Universal Extension

Universal Controller 7.6.x

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6.1 Summary

The Universal Extension developer will create a new *Universal Extension-based* Universal Template, declaring:

- Task fields required for defining and launching the process through the Universal Extension.
- Task Instance fields required for capturing data coming back throughout the life-cycle of the Universal Extension process.
- Task Instance commands, and their supported status(es), that can be executed through the Universal Extension.

The Universal Extension developer will then upload/attach an **Extension Archive** zip file to the Universal Template, recognized by the Universal Agent, which can either be deployed on-demand to registered agents, or automatically following a successful agent registration.

Once the Universal Template is created, and the **Extension Archive** zip file is attached, the Universal Extension developer can generate a zip package, recognized by the Universal Controller, containing both the Universal Template definition and the **Extension Archive** zip file recognized by the Universal Agent.

To create a Universal Extension, see Creating a Universal Template.

6.2 Agent Registration

All communication between the Universal Controller and the Universal Extension is managed through UAG; therefore, any registering agent that meets the release criteria can be a Universal Extension provider.

In order for the Universal Controller to know which Universal Extensions are supported by a registering agent, each Agent will report this information in the hello message handshake.

6.2.1 Universal Extension Deployment

Deployment of Universal Extensions is managed by the Universal Controller.

Any Universal Agent registering into the Universal Controller can automatically accept deployment of available Universal Extensions.

Note

It is important to review the Universal Agent configuration option, EXTENSION_ACCEPT_LIST, if you want to prohibit an agent from accepting deployment of any extension or if you want to limit deployment to specific extensions.

This allows full customization of the deployment approach, allowing agent extension configuration to be tailored based on corporate policy.

For automatic deployment of Universal Extensions to all registered agents, ensure that your agents are all installed with an **accept any extension** (default) configuration.

6.2.1.1 On-Registration Extension Deployment

On registration deployment of accepted Universal Extensions will commence immediately upon successful agent registration, depending on the configuration of the EXTENSION_DEPLOY_ON_REGISTRATION UAG configuration option.

6.2.1.2 On-Demand Extension Deployment

For Agents that are configured to accept extensions, but are not configured for on-registration deployment, their accepted extensions will be deployed only on-demand at task instance run time.

If on-demand deployment of an extension is required, the task instance will transition to the Queued **Status** with the *Deploy Extension* **Status Attribute**.

Upon successful deployment, the *Deploy Extension* **Status Attribute** will be cleared and the task instance will transition to the Running **Status**.

If the deployment is unsuccessful, the the *Deploy Extension* **Status Attribute** will be cleared and the task instance will transition to the Start Failure **Status**.

If an extension cannot be deployed to the destination agent due to the extension not being an accepted extension, the task instance will transition to Undeliverable **Status**.

Once the agent configuration has been updated, and the agent restarted, on-demand deployment can commence and the task instance will transition to Running **Status** upon successful deployment, as described above.

6.3 Universal Template/Extension Definition

The Universal Template definition will be enhanced to allow differentiating between a Universal Task that is executed by **UAG** in the form of a **Script**, and a Universal Task that is executed by a Universal **Extension**.

Under the **Universal Template Details** section, the user should still be able to refine the **Agent Type** (Any, Linux/Unix, or Windows), however, it can no longer be assumed that the **Script** related fields (**Use Common Script**, **Linux/Unix Script**, **Windows Script**, and **Windows Script File Type**) are applicable.

A new **Template Type** field, with options **Script** and **Extension**, will be introduced to distinguish between *Script-based* Universal Templates and *Universal Extension-based* Universal Templates, respectively.

The following fields, under their applicable sections, will be hidden when the **Template Type** is **Extension**.

- Universal Template Details
  - Use Common Script
  - Linux/Unix Script
  - Windows Script
  - Windows Script File Type

6.3.1 Output Only Field

A Universal Extension may need to send back runtime attributes associated with a task instance.

These fields are not applicable at definition time; therefore, when specifying a Universal Template Field of type **Text**, **Integer**, **Float**, or **Boolean**, a **Restriction** option was added where you can specify **No Restriction** or **Output Only**.

Output Only fields will be rendered as read-only on the Universal Task Instance form, and not shown on the Universal Task form.

6.3.1.1 Output Only Field Validation

Text	• The value cannot be more than 255 characters for text fields and 4000 characters for large text fields. • The following warning will be logged in the uc.log if the output field update is rejected by the controller. • Output Fields: Field value for field with template id *uuid* and field name "*field-name*" cannot be more than [255|4000] characters. {*field-value*}
Integer	• The value must be an integer between -2147483648 and 2147483647, inclusive. • The following warning will be logged in the uc.log if the output field update is rejected by the controller. • Output Fields: Field value "*field-value*" for field with template id *uuid* and field name "*field-name*" is not a valid integer.
Float	• The value must be a valid double-precision float. • The following warning will be logged in the uc.log if the output field update is rejected by the controller. • Output Fields: Field value "*field-value*" for field with template id *uuid* and field name "*field-name*" is not a valid float.
Boolean	• Any value other than **true** will be evaluated as **false**.

6.3.1.2 Preserve Output On Re-run

When **Restriction** is **Output Only**, an option to **Preserve Output On Re-run** can be specified.

On task instance **Re-run**, all **Output Only** field values are cleared, by default. To change this behavior, on a per field basis, enable the **Preserve Output On Re-run** option.

6.3.1.3 Extension Status

A field can be specified as **Extension Status** if **Restriction** is **Output Only**. Only one field can be specified as Extension Status per Universal Template.

The **Extension Status** for a task instance will be mapped to the Output Only field that specified as Extension Status = true.

> If the designated Extension Status Output Only field is changed in a universal template, the Extension Status of any pre-existing instances for that template will not be updated until the universal extension sends back an update for the new Extension Status Output Only field.

6.3.2 Text Field Text Type

For Extension-based Universal Templates only, a **Text Type** option will be introduced for Universal Template Fields of type **Text**.

This allows for the template administrator to designate a specific content type for a **Text** field, with the following content types currently supported.

- **Plain** (default)

- **JSON**
- **YAML**

When **JSON**, or **YAML** is selected as a **Text Type**, the following applies.

- The field value must be parsable at definition time, or at runtime, if the field contains an unresolved variable or function.
- The field value will passed to the Universal Extension as its designated type.

6.3.3 Dynamic Choice Field

Choice field types need to support dynamic, Universal Extension-derived options.

To accommodate this, *Universal Extension-based* Universal Templates will introduce a new **Dynamic Choice** boolean option on the **Universal Template Field** form, when the field type is **Choice**.

When the **Dynamic Choice** option is enabled, the template administrator will no longer be able to define static **Choices**.

It is feasible that the dynamic options depend on the value of one or more Universal Template Fields; therefore, a template administrator also is able to specify dependent fields through a new **Dependent Fields** option.

From the Universal Task form, dynamic choice field options will be populated through a request/response mechanism, initiated by Universal Controller to the Universal Extension.

6.3.4 Dynamic Commands

A Universal Extension may support additional operations against a task instance, therefore, we need to allow for defining such operations, which in the Universal Controller we refer to as commands.

A new **Commands** tab on the Universal Template will become available if and only if the **Template Type** is **Extension**.

To define a command extension, the command definition will require the following fields.

Name	Unique command name, adhering to the same naming convention as a Universal Template field name.
Label	User friendly display name for the command, to be displayed within the client.
Supported Status(es)	Specifies the task instance status (or statuses) that the dynamic command should be enabled for.
Dependent Fields	The administrator can select zero or more Universal Template fields that are required by the command. The values of those fields will be included in the command request.
Timeout	Specifies an optional command timeout, in seconds, if the command requires longer than the System-level default of 60 seconds. If the Controller (server) does not receive a command response from the **Extension** prior to the timeout being reached, a timeout message will be sent to the client (user interface), and displayed in the Console: Command "*command-name*" on task instance "*instance-name*" with id *instance-uuid* timed out.
Execution Option	Specification for whether the command runs out-of-process execution or in-process execution.
Asynchronous	If **Execution Option** is in-process; Specification for whether the command runs synchronously or asynchronously.

6.3.4.1 Command Permission

Users must have **Universal** (or **ALL**) command permission and **Read** permission for the Universal Task Instance, assigned by the **Task Instance** permission type, for authorization to execute a Universal dynamic command.

6.3.5 Universal Output

To allow for a *Universal Extension-based* Universal Task to contribute its own unique output upon job completion, the Controller added support for an EXTENSION output type that the Universal Extension can *optionally* return upon job completion.

6.3.6 Python Application Attachment

The Python Application implementing the Universal Extension must be packaged in a zip file, containing both an extension.py and an extension.yml.

The extension.yml is the YAML metadata configuration file, as shown below.

```
---
extension:
  name: extension1
  version: "0.1.0"
  api_level: "1.0.0"
  requires_python: ">=2.9"
  python_extra_paths: "${extension_zip}/lib:${extension_zip}/test/lib"
  zip_safe: true
owner:
  name: John Doe
  organization: Stonebranch, Inc.
comments: |
  These comments will appear in the Universal Template 'Extension Comments' field.
  The 'Extension Comments' field can be viewed from the Meta Data section, the List, or the Show
Details.
```

The extension `name` and `api_level` are required, while the extension `requires_python` (default ">=2.6") and `python_extra_paths` are optional.

Note

For `requires_python`, you can use wildcards to select certain Python versions.

For example, the following configurations are supported:

- `requires_python`: "==2.7*"
- `requires_python`: "!=3.9.1*"
- `requires_python`: "!=3*"

The `requires_python` field requires a comparison operator, and at least a major version field. See extension.yml for more details.

The owner `name` and `organization` are optional.

From the Universal Template form, the zip will be uploaded by clicking the add **[+]** icon (tooltip **Upload Extension Archive**) next to the **Extension** field, and persisted in the Universal Controller database as a byte[] (BLOB).

To download an already attached Extension Archive, click the link **[∞]** icon (tooltip **Download Extension Archive**).

To remove an already attached Extension Archive, click the remove **[-]** icon (tooltip **Delete Extension Archive**).

During the upload process, the extension.yml metadata will be parsed and made available from the Universal Template Metadata fields.

6.4 Import/Export Template

The Import/Export Template feature supports importing/exporting a Universal Template as a zip file.

The Universal Template zip file includes the following entries:

File Name	Description	Optional
template.json	The Universal Template definition in JSON format.	No
template_icon.png	The Universal Template **Icon** in PNG format. **Note** Icon metadata will be set as attributes in the Universal Template JSON.	Yes
extension_archive.zip	The Universal Template **Extension Archive** in ZIP format.	Yes

Export	To export an existing Universal Template as a zip file, click the **Export Template** button in the Universal Template Details. (You can also click **Export Template** in the Action menu that displays for that Universal Template record.) The exported Universal Template has the following filename format: {distribution}-{version}(-{build tag})?-{python tag}-{abi tag}-{platform tag}.whl
Import	To import a Universal Template zip file, click the **Import Template…** button on the Universal Templates list.

6.4.1 Release Levels

Export Template sets the following release level attributes in the Universal Template JSON:

Attribute	Description
minReleaseLevel	The minimum Universal Controller release level required to import the Universal Template. "minReleaseLevel" : "7.0.0.0"
exportReleaseLevel	The release level of the Universal Controller that the Universal Template was exported from. "exportReleaseLevel" : "7.0.0.0"

Import Template validation prevents importing a Universal Template if the Universal Controller does not meet the minimum release level requirement:

Cluster Node release level is 7.0.0.0, which does not meet the minimum release level of 7.0.0.1 for the Template.

6.5 List Import/Export

The List Import/Export feature continues to support exporting the Universal Task and Universal Template, as it has in previously releases.

Comparable to the Universal Template **Icon**, the **Extension Archive** will be encoded in the XML as base64.

List Import validation prevents an extension name from being associated with more than one Universal Template:

The template 'template-name1' specifies an extension name 'extension-name' that is already associated with template 'template-name2'.

6.6 Log Level

Each registered Agent within the Universal Controller displays its configured **Log Level**, with one of the following options.

- Trace
- Debug
- Info
- Warn
- Error
- Severe

For Extension-based Universal Tasks/Templates, a **Log Level** option will be introduced at both the **Universal Task**-level, the **Universal Task Instance**-level, and the **Universal Template**-level to specify the Log Level for Universal Extension logging.

The option will have a default value of **Inherited**, meaning the following.

Universal Task	• Specify Inherited to inherit the template Log Level setting.
Universal Task Instance	• Specify Inherited to inherit the template Log Level setting. • The initial Log Level is derived from the Universal Task definition at Universal Task Instance creation time.
Universal Template	• Specify Inherited to inherit the agent Log Level setting.

At Universal Task Instance runtime, if both the instance and the template are specified as Inherited, then the instance will inherit the agent Log Level.

6.7 Creating a Universal Extension

To create a Universal Extension:

- Define a new Template/Task in the user interface for a Universal Extension using the Universal Template/Task framework, including:
    - Task fields required for defining and launching the process through the Universal Extension.
    - Task Instance fields required for capturing data coming back throughout the life-cycle of the Universal Extension process.
    - Task Instance commands, and their supported status(es), that can be executed through the Universal Extension.

    - Universal Events, if any, that the Universal Extension may generate throughout the life-cycle of the Universal Extension process.
- Upload/attach an Extension Archive zip file to the Universal Template, recognized by the Universal Agent, which can either be deployed on-demand to registered agents, or automatically following a successful agent registration.
- Once the Universal Template is created, and the Extension Archive zip file is attached, generate a zip package recognized by Universal Controller that contains both the Universal Template definition and the Extension Archive zip file recognized by the Universal Agent.

For specific details on creating a Universal Extension, see Creating a Universal Template.

7 Universal Agent

7.1 Overview

A new dynamic "extension" subsystem in the Universal Automation Center (UAC) platform allows developers to implement custom solutions that can integrated into UAC. These “solutions” could be, for example, a task, trigger, or monitor.

The initial phase of this subsystem focuses on tasks.

This feature provides an easy way for Stonebranch, customers, and/or third party developers with special domain knowledge, to develop new solutions that can be seamlessly integrated into the UAC software stack. This is especially beneficial when the Domain knowledge required for a solution does not exist within the Stonebranch development teams and/or justification does not exist to devote the necessary resources.

While the Universal Task addresses this issue to some extent, it does not provide the level of integration and customer experience that can be achieved with the Universal Extension concept.

The main differentiators between Universal Extensions and Universal Tasks are:

- **Bidirectional communication** between the Extension instance and the Universal Controller. This allows an Extension instance running on an Agent system to dynamically update the associated instance running in the Controller as the state changes. For example, a “Task” type extension could update output fields on a task instance in the Controller (for example, Job ID, Run Status, Distribution Status, and Percentage Complete).
- **Dynamic command definitions** to support a complete solution (not just a single script execution). This allows an Extension solution to do things such as:
    - Provide commands that can help populate task definition form fields (such as is currently done with the PeopleSoft task type),
    - Provide a relative set of commands to be used on a task instance form that can be used to perform actions related to the unit of work that is specific to that task instance (such as is currently done with the SAP task type: Abort SAP job, Interrupt SAP Process Chain, etc.).
- **Dynamic event definition/generation** (Universal Events) allow Extension instances to trigger actions in the Controller. Universal Events defined and monitored in the Controller could be raised by an Extension instance on an Agent.

Note

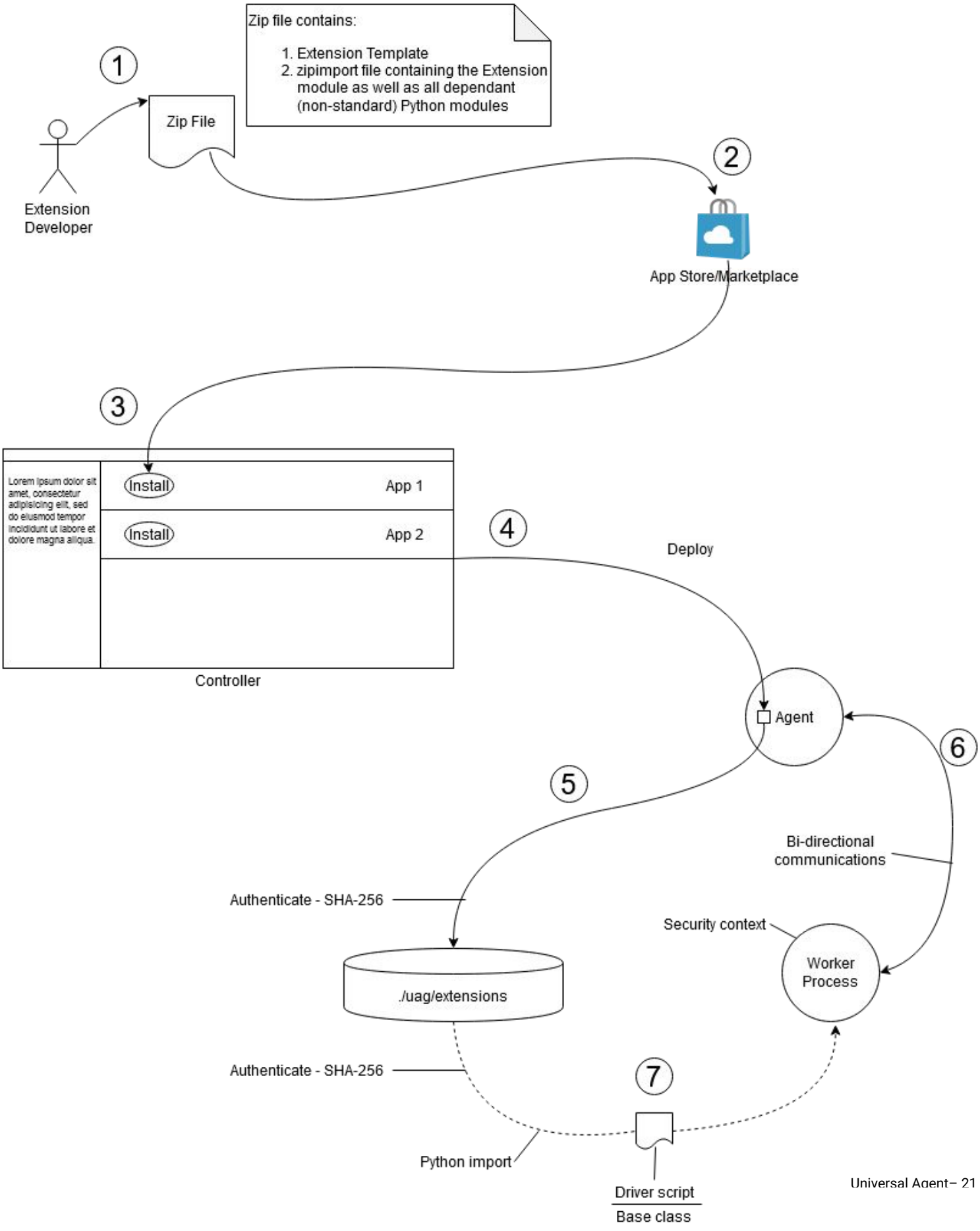
Universal Extension is not intended to replace Universal Task. Universal Task will remain a flexible, and perhaps more accessible, solution for many automation needs.

Universal Agent has been enhanced to support this new Universal Extension subsystem. The Extension subsystem allows various types of functionality to be developed and integrated into the UAC software stack (for example: tasks, triggers, and monitors).

The generic Extension concept supports the development of some primary operation (for example, task, along with an optional set of related secondary/supporting operations (Choice Commands, Dynamic Commands).

The initial phase (and this document) focuses on a “Task” type Extension. However, the architecture is designed with other extension types in mind.

Development to Execution



As illustrated in the diagram above:

1. Developer creates Extension implementation and zips up the Extension Template, the Python Extension module and any dependent non-standard Python import modules.
2. The zipped package is uploaded to the marketplace.
3. A user downloads the extension to the Universal Controller.
4. The Universal Controller deploys the Extension to an Agent.
5. The Agent persists the Extension to the file system in the Extension Repository. (after authenticating the deployment with the Controller supplied SHA-256 checksum.
6. The Agent starts a Worker process to execute an Extension instance (supporting bi-directional communication).
7. The Agent authenticates the Extension that is to be run (comparing its SHA-256 checksum with the Controllers reported checksum) and inserts a driver script into the Worker process starts the Extension instance.

7.2 Universal Extension Task Overview

A Universal Extension Task is comprised of the following:

- An Extension Task Template definition (defined in the Controller)
  - Input field definitions
  - Output-only field definitions
  - Custom command definitions
- An Extension module developed in Python (delivered/stored to the Agent system for execution)
  - Contains the code that provides the functionality for the Extension's primary operation (e.g. task)
  - Contains code that provides the functionality for the Extension's "Dynamic Commands"

Extension modules will be developed in an unspecified development environment.

Fully developed Universal Extensions are distributable (via the Stonebranch Marketplace, in-house Controller-to-Controller bundle promotion, etc.) to target Controller systems.

In a UAC deployment, the Controller serves as the primary repository and distributor of Universal Extensions. The Controller is responsible for pushing extension modules down to Agents as needed.

The deployment of Extension modules from Controller to Agent takes place via OMS messaging.

Note

For phase one of the Universal Extension platform, the deployment of Extension modules to Agent systems will be a manual process.

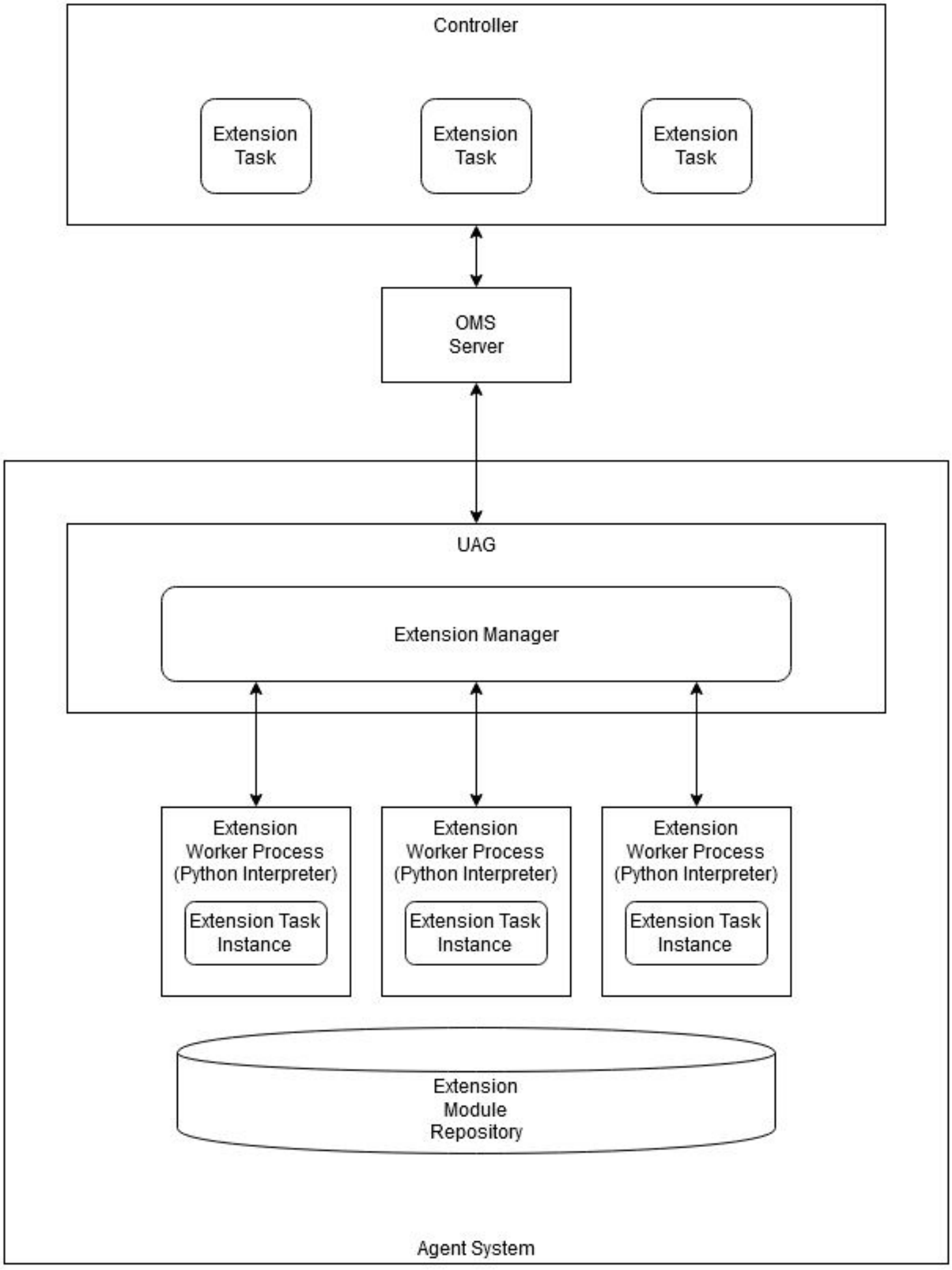
On the Agent side, Extension modules are stored in a cache repository (referred to as the **Extension Repository** throughout this document). This cache repository is simply be a directory on the Agent file system where Extensions modules passed from the Controller are stored. Extension modules are stored on the Agent file system as zipimport files (Python import modules stored as Zip archives).

- For Windows systems (System Mode install), the Extension Repository is under: **\Program Files\Universal\universal\UAGSrv\extensions**
- For *nix systems (System Mode install), the Extension Repository is under: **./var/opt/universal/uag/extensions**
- User mode installs use an equivalent path, for the “extension” directories above (for example, under uag in the “unvdata” install path).

The Universal Agent processes Extension tasks in much the same way as any other task type. A unit of work is executed on behalf of a Controller request. Artifacts of the unit of work are returned to the Controller (for example: standard output, standard error, return codes).

- Standard output generated from the Extension task instances is directed to *_stdout files in the UAG cache directory.
- Standard error generated from the Extension task instances is directed to *_stderr files in the UAG cache directory.

At a high level, the main difference between an Extension task and a Windows or Unix task is that the Agent is managing (or caching) a repository of modules that contain the functionality for the various “Extension” implementations.


Controller
Extension Task
Extension Task
Extension Task
OMS Server
UAG
Extension Manager
Extension Worker Process (Python Interpreter)
Extension Task Instance
Extension Worker Process (Python Interpreter)
Extension Task Instance
Extension Worker Process (Python Interpreter)
Extension Task Instance
Extension Module Repository
Agent System

7.3 Implementation

UAG has been enhanced in the following ways to support the new Extension subsystem:

- Agent start-up
- Agent registration
- Extension Task-related messages
- Extension Manager component
- UniversalExtension Python Base Class
- Extension Repository

This initial implementation of Universal Extensions uses Python for the language in which Extension modules are developed.

Extension modules were developed by extending a Stonebranch provided base class (**UniversalExtension**). This base class provides the functionality required to integrate, manage, and orchestrate custom functionality running on the Agent system with resources (for example, task instances) running in the Controller.

7.3.1 Agent Start-up

Upon start-up, UAG performs the following Extension specific operations:

- Python Discovery
- Extension Repository Initialization

7.3.1.1 Python Discovery

Python discovery is the process of locating available Python executables on the system and categorizing them by version. This discovery process is performed once at start-up to prepare for efficient Python Resolution later during the execution of Extension instances.

Universal Extensions may have specific Python version requirements that must be met in order for the Extension to run correctly. These requirements are specified in the "**requires_python**" metadata for the Extension (specified in **extension.yml** in the Extension zip module).

To satisfy the Python requirements of an Extension, UAG Extension Manager must know the available Python interpreters installed on the target system and choose one (if any) that meets all specified requirements.

Python discovery is performed by:

1. Checking for a Python distribution installed with the Universal Agent.
2. **[Windows specific]** Checking the "`HKEY_LOCAL_MACHINE\SOFTWARE\Python\PythonCore`" registry key for a Python installation.
3. Checking the value specified for the UAG Server EXTENSION_PYTHON_LIST configuration option, which can specify a comma-separated list of locations in which Python is installed.

1. This option has a default value of `/usr/bin/python3`, `/usr/bin/python`, and `/usr/libexec/platform-python` directories/symlinks for Unix agents.
2. For Windows, there is no default value. If this option is left empty, Python discovery stops at step 2.

For each Python executable found, UAG Extension Manager determines the version and record an entry (version and path) in an internal list for later lookup.

7.3.1.2 Extension Repository Initialization

Upon Agent start-up, UAG scans its Extension Repository for installed extension modules. Extension modules are stored in the repository as zipimport files (Python import modules stored as Zip archives).

For each extension module found in the Extension Repository, UAG collects the following information:

- **Extension Name**
  The Extension module file name (not including the file extension) is used as the Extension name. This should equate to the Universal Extension Template Name of the related Universal Extension defined in the Controller system to which the Agent connects.
- **Extension Checksum**
  A SHA-256 checksum of Extension file

The collected Extension information is stored in an internal table for later use with the JSS-HELLO message during Agent registration.

7.3.2 Agent Registration

7.3.2.1 Universal Extension Deployment

An Agent registering with the Universal Controller has the ability to automatically accept deployment of available Universal Extensions.

However, the owner of an Agent deployment may wish to control which (if any) Universal Extensions are allowed to be installed by the Controller. Therefore, the following configuration options have been added to UAG to control Extension deployment:

- EXTENSION_ACCEPT_LIST
- EXTENSION_DEPLOY_ON_REGISTRATION

An Agent must inform the Controller of which Extensions are currently installed on its system (collected at Agent start-up). Additionally, the Agent must supply the checksum associated with each installed Extension. This is required for the Controller to know which (if any) Extensions need to be installed or replaced on the Agent system. Any Extension on the Agent system with a checksum that does not match the checksum of the associated Extension in the Controller's repository must be replaced.

7.4 Extension Manager

UAG is enhanced with a new internal component (**Extension Manager**) that manages the execution of Extensions and facilitates the flow of messages between the Controller and the Extension instances. Extension instances run in a Python interpreter process (the **Extension Worker Process**) started in the security context of the user specified on the task definition (as do Windows and Unix/Linux tasks).

In general, the Extension Manager is responsible for handling work requests related to Extensions and managing the work resources and resulting message exchanges required to process the work.

Specifically, this involves:

- Starting and stopping Extension Worker processes.
- Authenticating Extension module with Controller provided checksum prior to import.
- Initiating Extension instances within a Worker process.
- Relaying information from Extension instances running in the Worker process to the Controller.
    - Status updates for associated output fields

    - Universal Events
- Executing Extension Commands (initiated from the Controller) to Worker Process.
- Canceling Extension instance (along with the Worker process) if/when requested by the Controller.

7.4.1 Extension Worker Process

Extension Worker processes are Python interpreter instances that are started by the Extension Manager. Worker processes exist to run Extension instances.

The Extension Manager controls the Worker process by formulating a small Python script designed to run a target Extension module and injecting that script into the Worker process over stdin.

The Extension instance running within the Worker process sends messages to the Extension Manager over a control channel (pipe).

Output generated by the Extension instance that is written to stdout and stderr are redirected to cache spool files that are created in the UAG cache directory.

7.4.1.1 Security Context

Each Worker process is created on demand to process a specific Extension operation. Each Universal Extension task definition specifies the user credentials that the task should run under. If no credentials are specified, the task should run under the security context of UAG. Therefore, when a worker process is created, it is created with the security context specified by the Extension task it is intended to process.

7.4.2 Starting an Extension instance

Extension instances are started when UAG receives a **JSS-LAUNCH, JSS-UNVCHOICEREQ,** or **JSS-UNVCMDREQ** message from the Controller.

Upon receiving the **JSS-LAUNCH, JSS-UNVCHOICEREQ,** or **JSS-UNVCMDREQ** message, the Extension Manager performs the following operations to start the new Extension instance:

- Authenticate the target Extension module currently residing in the Agents Extension Repository.
    - The checksum of the target extension module must match the checksum provided by the Controller in the initiating **JSS-LAUNCH, JSS-UNVCHOICEREQ,** or **JSS-UNVCMDREQ** message.
    - If the checksums do not match, the Extension is not started and a **JSS-STATUS(ERROR)** message will be returned to the Controller with an **ERRDESC** value of "**Extension checksum mismatch**".
    - This is considered a start failure and no further actions will be taken towards starting the extension.
- Open stdout/stderr spool files in the UAG cache directory - into which stdout and stderr of the Worker process will be redirected (<execid>_stdout and <execid>_stderr).
- Open a pipe to be used as a "message output channel" for the Worker process.
- Start a Worker process using CSK where:
    - The process runs under the security context of the runtime credentials specified in the **JSS** message.
        - If no credentials are specified in the JSS message, the process runs under the security context of the account the UAG runs under.
    - The stdout and stderr are redirected to the cache files mentioned above (<execid>_stdout and <execid>_stderr).
- Pass a handle to the write end of the "message output channel" into the Worker process.
- Generate a small Python script that will run the target Extension module with the parameters specified in the initiating **JSS** message

- Close stdin for the Worker process cause the Python interpreter to begin processing the script (and thus the Extension instance).

Generating a SHA-256 checksum for each attempted invocation of an extension instance is obviously ideal in terms of security. However, it could potentially add a significant performance hit to a system that makes heavy use of Extension tasks.

It may be sufficient to only generate a checksum (Agent side) if the cached checksum is older than some threshold. A threshold as small as 1 second could conceivably have significant impact on a burst of short lived Extension executions targeting the same Extension module.

Auto-deployment for "**Extension checksum mismatch"** start failures

The Controller could silently handle "**Extension checksum mismatch"** start failures and auto-deploy the target Extension module to the target Agent.

Following a successful deployment, the Controller could re-launch the Extension instance.

After starting the Worker process, the process resources (CSProcess structure, "message output channel" handle, etc.) are stored in an appropriate data structure to be used for monitoring the Worker process over the lifetime of the Extension instance.

7.4.3 Worker Process Management

Once the stdin of the Worker process is closed and the Extension Worker begins executing the Extension instance, no further input is required from the Extension Manager. At that point the management of the Worker process becomes a monitoring operation.

A dedicated monitoring thread will continuously monitor Running Worker processes for messages and completion. Potential messages sent from the Worker process are:

- ESS-STATUS-UPDATE
- ESS-UNVEVENT
- ESS-EXT-COMPLETE
- ESS-CMD-COMPLETE
- ESS-CHOICE-CMD-COMPLETE

7.4.4 Warm Start Processing

Warm Start Processing is a term used to refer to a process UAG goes through upon startup by which all task instances that were active at the time of the last shutdown (intentional or otherwise) are reviewed and proper action is taken based on state and platform.

Two general scenarios exist for tasks that were active at the time of the last UAG shutdown:

1. The process associated with the task instance has completed between the time of UAG shutdown and UAG restart.
2. The process associated with the task instance is still running at the time UAG restarts.

7.4.4.1 Scenario 1: Process has completed

For scenario 1, where the process has completed, UAG will send a **JSS-STATUS(JOB INDOUBT)** message back to the Controller to indicate that UAG is unable to determine how things turned out for the process in question. This behavior is consistent between Unix and Windows and no differences exist between Universal Extension tasks and other task types.

7.4.4.2 Scenario 2: Process is still active

For scenario 2, where the process is still active, there is a difference in behavior between platforms. On **Unix platforms**, UAG will send a **JSS-STATUS(JOB INDOUBT)** message back to the Controller just like with scenario 1. No attempt is made to resume monitoring the process. On **Windows platforms**, UAG will resume monitoring the process. Once monitoring has resumed, the task processing continues as though there was never a termination of UAG.

7.4.4.3 Warm Start Processing Enhancements for Universal Extension Tasks

Unlike other task types, Universal Extension Worker processes include a message channel (pipe) that allows the Extension instance to send messages back to UAG. If a UAG shutdown occurs while an Extension instance is still active, the message channel between the worker process and UAG is broken. However, all messages sent from Universal Extension instance must be processed in order to consider the execution a success.

Therefore, in order to "reconnect" to a Universal Extension instance during Warm Start Processing, UAG must regain access to the messages in addition to just monitoring the status of the process. To prevent message loss in such a case, Universal Extension instances are provided a **message cache** (in addition to the message pipe) during the initial instantiation.

The message cache is implemented as a dedicated flat file in the UAG cache directory. If the Extension Instance is unable to to send messages over the pipe (due to a UAG shutdown), the Extension will revert to the message cache. This allows UAG to "reconnect" to the message stream emitted by an Extension instance that is monitored after a Warm start. The process is transparent to the Controller. This brings the Warm Start Processing behavior of Extension tasks in line with other task types (from a user/Controller perspective).

7.5 UniversalExtension Base Class Package

The UniversalExtension base class package is a new Agent "component" that is part of the core Agent installation. It is a Python package that provides the functionality required to support the execution of custom Extensions within a Worker process.

Custom Extension implementations must provide a class that derives from the UniversalExtension base class. The UniversalExtension base class provides an interface that the Extension developer must implement. Additionally, it provides methods that allow the Extension instance to propagate state information back to the associated Extension instance running in the Controller.

The UniversalExtension base class package contains the following modules:

Module	Description
./extension_choice_result.py	Internal use
./extension_command_result.py	Internal use
./extension_result.py	Result handling class for use in Universal Extension implementation
./extension_start_result.py	Internal use
./universal_extension.py	Universal Extension base class
./deco/choice.py	Function decorator for Dynamic Choice Command in Universal Extension implementation
./deco/command.py	Function decorator for Dynamic Command in Universal Extension implementation

For detailed information on this package, see Universal Extension 1.0.0 API.

7.5.1 UniversalExtension Interface

7.5.1.1 def extension_start(self, state)

This method must be overridden by the custom Extension class that derives from the UniversalExtension class. It is called by UniversalExtension base class in response to a **JSS-LAUNCH** message sent from the Controller. This is essentially the main() function for an Extension implementation and is the starting point for work that will be performed. The **state** parameter passes in a dictionary of Extension instance fields that were defined in the Extension template.

7.5.2 Communication Methods

7.5.2.1 def update_extension_status(fields):

This method can be called at any time by the Extension instance. It is used to propagate state changes back to the associated extension instance in the Controller. Essentially, any/all output fields defined in the associated Extension Template can be updated using this method. This method results in an ESS-STATUS-UPDATE message being sent from the Worker process to the UAG Extension Manager, followed by a JSS-STATUS(JOB UPDATE) message being sent from UAG Extension Manager to the Controller (via OMS server).

The **fields** parameter expects a dictionary of output fields to be sent back to the controller for the associated Extension instance. Field names are implementation dependent and correlate with the Universal Template field names in the Controller's Template definition. For example:

```
{
  # Output fields to be updated
  "sysid": "BW7",
  "jobid": 81762549
}
```

7.5.2.2 def publish_extension_event(event_state):

This method can be called at any time by the Extension instance. It is used to publish a Universal Event to the associated Universal Controller.

Universal Events are optionally defined in the Universal Extension Template as part of the Universal Extension definition.

This method results in an ESS-UNVEVENT message being sent from the Worker process to the UAG Extension Manager, followed by a JSS-UNVEVENT message being sent from UAG Extension Manager to the Universal Controller (via OMS server).

The event_state parameter expects a dictionary of event related fields - including a list of implementation defined “event attributes”. For example:

```
{
  # The unique Universal Event name defined within the Universal Template.
  "event_name": "job_complete",
```

```
  # Time to live; how long, in minutes, the Universal Event data is kept (in the
Controller).
  "ttl": 30,

  # Dictionary of attributes associated with the Universal Event definition.
  # An attribute should be added for each attribute defined in Universal Event Template
  # definition associated with the specified "event_name".
  # Keys in the "event_attributes" dictionary correlate with an associated
  # Universal Event attribute defined in the associated template.
  "event_attributes":
  {
    "sysid": "BW7",
    "jobname": "JOB-1",
    "jobid": 81762549
  }
}
```

7.5.3 Universal Extension Definition (module)

Universal Extension modules allow for the development of simple or complex solutions that tightly integrate with the Universal Controller.

The UniversalExtension base class supports two types of custom functionality that can be invoked by the Controller:

- A mandatory singular primary operation (e.g. task implementation)
- An optional collection of Dynamic Commands

7.5.3.1 Primary Operation

The primary operation is the focus of the Extension and must be implemented. This is done by overriding the **extension_start** method of the UniversalExtension base class.

Of course, **extension_start** is just an entry point. A single primary operation could perform any number of variants or sub operations based on values passed in from the Controller.

7.5.3.2 Secondary Operation - Dynamic Commands

Dynamic commands are intended to support the functionality of the Primary Operation of the Universal Extension, They can be used to return additional information for a task instance or to carry out some related (or unrelated) action on behalf of the task instance. Dynamic commands can pass instance specific field data values from the task instance form to the extension process that executes the command on the Agent.

To implement a Dynamic Command in an Extension module, define a function or method with the following signature:

- def **my_command_function_name**(self, state):

Decorate the function with a **@dynamic_command** decorator:

- @dynamic_command(“dynamic_command_name”)

For example:

```
@dynamic_command(“my_dynamic_command”)
def my_command_function(self, state):
    # Do something
```

In the code snippet above, “**my_dynamic_command**” is the command name given to the Dynamic Command in the Controller’s Extension definition template and **my_command_function** is the actual python function name from the Extension module that processes the command.

The **@dynamic_command** decorator provides a means for custom Extension implementations to associate a function defined in the Extension module with a Dynamic Command in the Controller's related Extension template definition. The **@dynamic_command** decorator is defined in the ./deco/command.py module in the universal_extension.zip package.

When a dynamic command function is called, the **state** function variable will contain a dictionary populated with dependent fields (as defined in the Dynamic Command template definition) from the command invocation source. The keys of the dictionary will equate to the corresponding template field names and the values will be the values of the fields in the command invocation source (task instance form) at the time of invocation.

Dynamic command functions must return an object of type **ExtensionResult**. **ExtensionResult** is a class defined in module **./extension_result.py** in the **universal_extension.zip** base class module.

The **ExtensionResult** class is used to return the following attributes to the **UniversalExtension** base class:

Attribute	Description
rc	**Optional** This attribute represents the return code of the **extension_start** operation and determines whether the Extension task instance is perceived as completing with **Success** or **Failed** by the Controller. A value of 0 indicates **success**. All other values indicate an error condition and result in a status of **Failed** in the Controller. The non-zero value used to represent the error condition is implementation defined and therefore left up to the extension developer. The ExtensionResult class sets a **default value of 0** to the rc attribute.
message	**Optional** This attribute allows the extension to pass a completion message back to the Controller. If **rc** is set to 0, the message will be considered informational and will be logged by the Controller. If **rc** is non-zero, the message will be considered an error message and will be displayed to the user on the task instance form. **The default value is an empty string.**
output	**Optional** This attribute is a Boolean value that specifies if the command produced output that should be persisted and displayed under the task instance **Output** tab in the Controller task instance associated with the dynamic command invocation. **The default value is False.** **Note** This flag allows distinguishing between a command that does not produce output and a command that produces output but the output returned was empty.

Attribute	Description
output_data	**Optional** This attribute specifies the data that will be returned to the Controller for the command execution. It is interpreted as a UTF-8 encoded text object. If the **output** attribute is **True**, the **output_data** will be persisted in the Controller as a record under table ops_exec_output and appearing as **Universal Command** output type from the task instance **Output** tab. **The default value is None.**
output_name	This attribute is used to provided a custom name for the associated output data. The output_name (if provided) will be used in the presentation of the output_data by the Controller.

7.5.3.3 Sample Dynamic Command Return Value

Sample 1

```
  @dynamic_command("sample_1")
 def command_sample_1(self, state):
     """Dynamic command."""
     return ExtensionResult(
         message: 'sample_1 completed successfully',
         output = True,
         output_data = 'Hello from dynamic command sample_1!',
         output_name = 'DYNAMIC_OUTPUT')
```

Sample 2

```
    @dynamic_command("sample_2")
   def command_sample_2(self, state):
       """Dynamic command."""
       ...
       if (something_went_wrong):
           return ExtensionResult(rc = 1, message = "Something went wrong")
       return ExtensionResult(
           message: 'sample_2 completed successfully',
           output = True,
           output_data = str(state),
           output_name = 'DYNAMIC_OUTPUT')
```

7.5.3.4 Dynamic Command Use Cases

Extension developers can use dynamic commands for many different purposes.

Use Case	Description
Helper commands on task definition form	In this scenario, commands are used to retrieve data that will be used to populate form fields (like drop-downs). The commands may use input values from dependent fields on the form to pull data that is highly relevant to the task being defined. This scenario matches the behavior that is seen in the existing PeopleSoft task type. In this case, the command functionality is related to the Extension type but, is unrelated to any specific work that has been executed by a task instance.
Action commands on a task instance form	In this scenario, commands are used to perform some action related to the specific unit of work associated with the task instance. An example would be a task instance that is running an SAP process chain. For this task, an action command might be to “Interrupt Process Chain”. In order for the command to perform the action, it requires values from the task instance on which it is called. However, the required instance values are acquired from the task instance on the Controller side; no interaction with the associated running task instance on the Agent system is required. The command is run in an independent Worker process and, from there, reaches out to the SAP system to perform the requested action.
Action command on a task instance that interacts with the Worker process associated with the task instance	In this scenario, the command must run in the active Worker process that is processing the task instance. An example of this would be some type of “refresh” command that would instruct the running task instance (on the Agent side) to immediately send some state update back to the task instance in the Controller. The “refresh command” scenario would be more applicable to a “Monitor” type Extension but, could be envisioned for a “Task” type as well. This type of Dynamic Command that must be executed within the running Worker process that is executing the task instance adds many complications over the “out of process” scenarios described in Case 1 and Case 2. It involves synchronizing resources in a multi-threaded environment. If this “in process” command scenario is required, the UniversalExtension class would have to provide a framework that makes it easy for the Extension developer to implement. This use case is not supported in Phase 1.

7.5.3.5 Dynamic Choice Field Commands

Dynamic Choice commands are helper functions for dynamically populating choice fields on the Universal Extension task definition form in the Controller (like with the PeopleSoft task type).

To implement a Dynamic Choice Command in an Extension module, define a function or method with the following signature:

- def **my_choice_command_function_name**(self, state):

Decorate the function with a **@dynamic_choice_command** decorator:

- @dynamic_choice_command(“dynamic_choice_command_name”)

For example:

```
@dynamic_choice_command(“choice_field”)
def my_choice_command_function(self, state):
    # Do something
```

In the code snippet above, “**my_dynamic_choice_command**” is the command name given to the Dynamic Choice_Command in the Controller’s Extension definition template and **my_command_function** is the actual python function name from the Extension module that processes the command.

The **@dynamic_choice_command** decorator provide a means for custom Extension implementations to associate a function defined in the Extension module with a Dynamic Choice Field in the Controller's related Extension template definition. The **@dynamic_choice_command** decorator is defined in the universal_extension module.

When a dynamic choice command is called, the **state** function variable will contain a dictionary populated with dependent fields (as defined in the Dynamic Choice Field template definition) from the command invocation source (i.e. the task definition form in the Controller). The keys of the dictionary will equate to the corresponding template field names and the values will be the values of the fields in the command invocation source (task definition form, task instance form, etc.) at the time of invocation.

Dynamic Choice command functions must return an object of type **ExtensionResult**. **ExtensionResult** is a class defined in the **extension_result** module in the **universal_extension** package. The ExtensionResult class is used to return the following attributes to the UniversalExtension base class:

Attribute	Description
rc	**Optional** This attribute represents the return code of the **extension_start** operation and determines whether the Extension task instance is perceived as completing with **Success** or **Failed** by the Controller. A value of 0 indicates **success**. All other values indicate an error condition and result in a status of **Failed** in the Controller. The non-zero value used to represent the error condition is implementation defined and therefore left up to the extension developer. The ExtensionResult class sets a **default value of 0** to the rc attribute.
message	**Optional** This attribute allows the extension to pass a completion message back to the Controller. If **rc** is set to 0, the message will be considered informational and will be logged by the Controller. If **rc** is non-zero, the message will be considered an error message and will be displayed to the user on the task instance form. The default value is an empty string.
values	**Optional** This attribute provides a list which can be populated with a set of string values to be returned to the Controller and used to populate the associated dynamic choice field on the Extension task form. The default value is an empty list.

7.5.3.6 Sample Dynamic Choice Commands

Sample 1

```
    @dynamic_choice_command("choice_1")
    def choice_2(self, state):
        """Dynamic choice command."""
        self.log.info("Entering choice_2")
```

```
        message = 'Message: Hello from dynamic choice command choice_2!'
        values = ['value 1', 'value 2', 'value 3', 'value 4']
        self.log.info("Exiting choice_2")
        return ExtensionResult(message = message, values = values)
```

Sample 2

```
   @dynamic_command("sample_2")
    def command_sample_2(self, state):
        """Dynamic command."""
        ...
        if (something_went_wrong):
            return ExtensionResult(rc = 1, message = "Something went wrong.")
        return ExtensionResult(
                message = 'Message: Hello from dynamic command sample_2!',
                values = ['value 1', 'value 2', 'value 3', 'value 4'])
```

7.5.3.7 Dynamic Choice Field Use cases

Case 1: Helper commands on task definition form

In this scenario, commands are used to retrieve data that will be used to populate form fields (like drop-downs). The commands may use input values from dependent fields on the form to pull data that is highly relevant to the task being defined.

This scenario matches the behavior that is seen in the existing PeopleSoft task type. In this case, the command functionality is related to the Extension type but, is unrelated to any specific work that has been executed by a task instance.

7.6 Extension Repository

UAG will manage (in cooperation with the Controller) a repository of **Extension modules**. This management will include synchronization with the Controller in terms of which extension modules are available or allowed. The end goal is for the Controller to push Extension solutions down to the Agents as needed.

The extension repository is a path on the Agent file system where "Extension" modules are stored. The modules themselves are stored as zipimport files (Python import modules stored as Zip archives).

7.6.1 Windows

\Program Files\Universal\universal\UAGSrv\extensions

7.6.2 *nix

./var/opt/universal/uag/extensions

It may be desirable to have this be a configurable value. Therefore, the following configuration value is proposed for the UAG configuration file:

extension_repository

7.6.3 Extension Repository Security

Extension modules are written to the file system by UAG (after being pushed down from the Controller via OMS messages). Therefore, they will be owned by the account used to execute the Broker.

Extension modules must be world readable to allow Worker processes running under the security context of an unprivileged user to load the modules into the Python interpreter.

Write permission should be limited to the owner (Broker account) to prevent tampering. However, that is not enough. A malicious user with sufficient authority could potentially manipulate extension module code to perform undesirable actions. Therefore, another means is required to guaranty the integrity of the extension modules.

7.6.3.1 Checksums

The Controller is the central repository/authority with regards to Extension modules. Therefore, the Controller can pass down a known checksum for the Extension module associated with an Extension work request. The Extension manager can then use the provided checksum to verify the integrity of the Extension module residing on the Agent's file system. If the checksums do not match, the Extension Manager will consider it a pre-start failure and return a **JSS-STATUS(ERROR)** message to the Controller with an **ERRDESC** value of "**Extension checksum mismatch**". and a **EXT_CHECKSUM_MISMATCH** value of **true**.

8 Getting Started

Getting Started

Extension Development

VSCode Plugin

8.1 Extension Development

The following tutorials will cover how to develop and manage Universal Extensions from scratch:

Title	Description
The Basics	Covers the basics of creating a Universal Extension along with its functionalities.
Integrating Third Party Dependencies	Covers how to integrate third party Python modules in an Extension.
Customizing Starter Templates	Optional guide that covers how to create your custom, starter template for quick development.
Integrating OpenTelemetry	Covers how to integrate with OpenTelemetry, providing developers with metrics and tracing capabilities for improved Extension observability.

See How to Build a Universal Extension from Scratch for a video tutorial on how to build a Universal Extension.

8.1.1 The Basics

The following pages below will cover how to develop Universal Extensions from scratch:

Title	Description
Introduction	Introduction to Universal Extension and its capabilities.
Development Environment Set-Up	Requirements for setting up a Universal Extension development environment.
Universal Extension API	Detailed Information on the Universal Extension API.
Task Entry Point	Creating a Sample Universal Extension.
Dynamic Choice Field	Adding Dynamic Choice fields to the Sample Universal Extension.
Dynamic Update and Output Only Fields	Adding Output Only fields to the Sample Universal Extension.
Dynamic Command	Adding a Dynamic Command to the Sample Universal Extension.
In-Process Dynamic Commands	Adding two In-Process Dynamic Commands to the Sample Universal Extension.
Cancel Command	Adding Cancel Command to the Sample Universal Extension.

Title	Description
Publishing Events	Demonstration of the new event publishing API
Troubleshooting and Debugging	Checking log levels, retrieving output, and debugging commands.

8.1.1.1 Introduction

8.1.1.1.1 Universal Extension

A Universal Extension is a task type provided by Universal Controller. It allows third-party developers (or anyone with access) to implement custom solutions (Extensions) that can be tightly and seamlessly integrated into the Controller's native functionality.

Universal Extensions were designed to facilitate integrations between UAC and external sources of information or functionality. The extension implementation is stored and managed in the Controller and executed on agent systems.

Universal Extensions consist of two primary parts:

1. A Universal Template definition that is created and stored in the Controller.
2. A Python zip archive that is developed outside of the Controller and contains Python source code that implements the Extension functionality.

Although the Python zip archives are developed outside of the Controller, they are eventually uploaded to an associated Universal Template in the Controller. From there, the Controller will automatically manage the deployment of the Extension zip module down to agent systems as needed.

8.1.1.1.2 Unique Capabilities

The Universal Extensions provides unique capabilities that are not available with other general purpose task types.

Custom task form definition	As with Universal Tasks, Universal Extensions use the Controller's Universal Template form building system. This allows a new task type to be built up field by field using types and verbiage that is natural and specific to functionality requirements of the task type being created.
Dynamic Choice Fields	Dynamic Choice Fields are Universal Template Choice fields that can be added to a Universal Extension Task form. Dynamic Choice fields are backed by a custom command implementation (Dynamic Choice Command) that executes on a target agent system and send back data used to populate the drop-down. This can be used, for example, to pull data from third party system that may be needed to define a task (job names, process IDs, modes of operation, etc.).
Dynamic Commands	In addition to the standard instance commands (i.e. Cancel, Re-run, Retrieve Output, etc.), custom commands can be defined to extend the command capabilities of a Universal Extension Task instance.
Output Only fields	Fields can be defined with an Output Only restriction. These fields appear on the task instance as read-only and can be updated in real-time during task execution by the Extension instance running on the target agent system.
Job Completion Output	Universal Extensions support a new output type: EXTENSION. The EXTENSION output type is separated from STDOUT / STDERR and provides more advanced Success/Failure Output Contains processing.
Encapsulation of 3rd party dependencies	Universal Extensions support encapsulation of 3rd party modules/packages that are required for execution. This minimizes or eliminates manual deployment efforts.

Universal Event Support	Universal Extensions can be used to extend the Controller's monitoring capabilities through Universal Events and Universal Monitors/Universal Monitor Triggers.

8.1.1.1.3 UIP-CLI

With the 7.4.0.0 release, the `uip-cli (v2.0.0)` tool has been enhanced with the ability to purge build artifacts, making the process of creating, building, and uploading Extensions easier and convenient.

See the Development Environment Set-Up and Task Entry Point documents for information regarding installing and using the CLI.

8.1.1.1.4 UIP VS Code Extension

Alongside the `uip-cli` tool, the `UIP` Visual Studio Code Extension has also been enhanced with the ability to purge build artifacts.

Additionally, the `UIP` plugin now offers:

- Context aware code completion for field names in `dynamic_commands`, `dynamic_choice_commands`, and `extension_start`.
- Ability to debug Universal Extension tasks directly from VSCode without the need of Universal Agent and Universal Controller.

See the Development Environment Set-Up and Task Entry Point documents for information regarding installing and using the UIP VS Code Extension.

8.1.1.2 Development Environment Set-Up

8.1.1.2.1 Requirements

8.1.1.2.1.1 Python Distribution

Universal Extensions are implemented in Python. Therefore, an appropriate Python distribution must be available on the agent system where Universal Extensions run.

The portion of the Universal Extension implementation that is provided by Stonebranch (the **Universal Extension Base Package**) is compatible with Python versions 2.6 and higher. However, user developed Extensions are free to restrict Python version requirements to a smaller subset of Python versions in order to meet the needs of the extension.

8.1.1.2.1.2 Universal Agent

Universal Extensions require a compatible Universal Agent for execution. The Universal Extension functionality is available in agent distributions starting with Version 7.0.0.

8.1.1.2.1.3 Universal Controller

Universal Extensions require a compatible Controller. The Universal Extension functionality is available in Universal Controller distributions starting with Version 7.0.0.

8.1.1.2.1.4 Platform

The Universal Extension Base Package is platform-independent. It is supported by the Universal Agent on the following platforms:

- AIX
- Linux x64 Debian
- Linux x64 Redhat
- Linux PPC64LE
- Linux S390x
- Solaris SPARC
- Solaris x64
- Windows X64

Universal Extensions can be developed on and targeted for any/all of the supported platforms.

8.1.1.2.1.5 Code Editor

Any text editor can be used to develop Universal Extensions. However, an IDE with support for the Python language is recommended.

For the purposes of this document, the code editor of choice will be Visual Studio Code. From this point, documentation will be described in the context of a Visual Studio Code development environment however, the code and concepts will be applicable to any editor.

8.1.1.2.1.6 Environment

As mentioned, the code editor used for this documentation will be Visual Studio Code. Visual Studio Code runs on multiple platforms (macOS, Linux, and Windows).

For this documentation, Visual Studio will be running in Windows with the “Remote WSL extension”: (WSL is Windows Subsystem for Linux). This set-up is essentially a Linux development environment running in Windows.

8.1.1.2.1.7 UIP-CLI Tool and UIP VS Code Extension

As mentioned in the previous document, `uip-cli` can be used to make the process of creating, editing, and deploying Extensions convenient. The UIP VS Code Extension takes this a step further by integrating the functionality of uip-cli into the VS Code IDE. However, the UIP VS Code Extension is specific to the Visual Studio Code IDE, whereas uip-cli is development environment agnostic.

The tutorials in the rest of the documentation will presented in the context of a Visual Studio Code development environment. Therefore, the tutorial will demonstrate the functionality using the UIP VS Code Extension. For additional details on working with uip-cli directly, refer to the documentation here.

See the set-up instructions below for instructions regarding installing UIP VS Code Extension and `uip-cli`.

The latest 2.0.0 releases of uip-cli and UIP VS Code Extension have dropped support for Python 2.7. The minimum Python version required is 3.6.x.

8.1.1.2.1.8 Environment Set-up

1. Installing Universal Controller Universal Controller version 7.0.0 or greater. This does not have to be on the development host; however, you must be able to access the Controller from the development host.
2. Installing Universal Agent Universal Agent version 7.0.0 or greater on the target development host. Ensure that the agent is connecting to the same OMS server that is being used by the Controller.
3. Install Visual Studio Code (optional)
   a. Install the Python extension for Visual Studio Code (optional)
   b. Install the Remote Development extension pack (optional)
   c. For additional details on setting up and using Visual Studio Code with WSL, Microsoft provides the following page: "Get started using Visual Studio Code with Windows Subsystem for Linux".
   d. Install UIP VS Code Extension from the Visual Studio Code Marketplace. This can be performed from within the Visual Studio Code IDE by selecting the View→Extensions and typing "UIP" into the search field.
   e. **Note: uip-cli can be automatically installed as needed by the UIP VS Code Extension.**
4. Install `uip-cli` from the PyPi database (optional). The README on the project homepage contains instructions for downloading the CLI and verifying the install. **Note: If using the UIP VS Code Extension, the uip-cli install can be performed automatically as needed.**

8.1.1.3 Universal Extension API

8.1.1.3.1 Introduction

Universal Extensions are developed by adhering to a simple API. This API is provided by the Universal Extension base package. The concise API documentation can be found here: Universal Extension 1.3.0 API.

8.1.1.3.2 Universal Extension Base Package

The Universal Extension Base Package (**universal_extension**) is a Python package provided by Stonebranch that contains a collection of classes and functionality required to develop Universal Extensions. This package is distributed with the Universal Agent. It is automatically installed with all installation types for all platforms that support Universal Extensions. The package resides within a zip archive (**universal_extension.zip**) and is installed to the following locations:

Windows	`C:\Program Files\Universal\UAGSrv\uext\universal_extension.zip`
Unix	`/opt/universal/uagsrv/uext/universal_extension.zip`

8.1.1.3.3 Extension Class

An Extension implementation must provide a Python class named **Extension** that derives from the Universal Extension base class **UniversalExtension** and resides in a file named **extension.py**.

At a minimum, the **Extension** class must:

1. Reside in a file called **extension.py**.
2. Derive from base class **UniversalExtension**.
3. Provide a constructor method that, in turn, calls the initializer for the base class.
4. Implement method **extension_start** (which is an override of a method defined in the **UniversalExtension** base class).
5. Return an instance of class **ExtensionResult** from method **extension_start**.

The following code snippet contains the minimum requirements stated above. It has everything needed to execute as a Universal Extension. **It does not do anything, but it could execute without error**.

Minimum Extension implementation requirement (extension.py)

```
"""Minimum Universal Extension implementation."""
from universal_extension import UniversalExtension
from universal_extension import ExtensionResult

class Extension(UniversalExtension):
    """Universal Extension sample module."""

    def __init__(self):
        """Init class."""
        super(Extension, self).__init__()

    def extension_start(self, fields):
        """Universal Extension primary operation."""

        return ExtensionResult()
```

8.1.1.3.4 ExtensionResult Class

The **ExtensionResult** class is the required return type from all Universal Extension work requests. It can be seen in the code snippet above returning from **extension_start**. Each type of work request supports a different set of parameters that are used to return information from that request type back to the Controller. The parameters are all optional, and appropriate defaults are set. However, it would usually not make sense to return without setting some parameters (as in the code snippet above). The use of **ExtensionResult** will be discussed further in the context of the specific work request types documented below.

8.1.1.3.5 Work Requests

Universal Extensions support three types of work requests from associated Universal Extension tasks in the Controller: **Task Execution**, **Choice Commands**, and **Dynamic Commands**. These work requests are described below.

8.1.1.3.5.1 Task Execution (extension_start)

Task Execution is the primary operation of a Universal Extension task. This is the work request that results from launching a task. All Extensions must implement **extension_start**. This is accomplished by adding a method named **extension_start** with the following signature to the **Extension** class in file **extension.py**.

def extension_start(self, fields):

The **extension_start method** is the starting point for work that will be performed for a task instance. The **fields** parameter passes in a dictionary populated with field values from the associated task instance that was launched in the Controller. **The keys of the dictionary correlate with field names of the task instance** that is invoking the extension (defined in the associated Universal Template) and **the key values are the values from the associated form fields** when the task is launched. The Extension developer can perform any work that is required here: executing binaries on the system, connecting to other systems, etc.

Additional functionality required by the extension can be defined in other classes, files, and or packages. **extension_start** is just required as the entry point.

Once the work is done, the extension_start method **must** return an instance of **ExtensionResult**. **ExtensionResult** is a class provided in the universal_extension base package for the purpose of returning from work requests.

The following parameters can be passed to the constructor of ExtensionResult for extension_start:

Parameter	Type	Default	Description
rc	*int, optional*	0	This parameter represents the return code of the task instance that initiated the **extension_start** operation. The value returned is implementation-defined and therefore left up to the Extension developer. The value can be used by the "return code processing" of the task instance in the Controller to determine if the Extension task instance is perceived as completing with **Success** or **Failed**.
message	*str, optional*	None	This parameter specifies a short status string (error message or success message) to be sent to the "Status Description" field on the task instance form.
output_fields	*dict, optional*	None	Dictionary containing output fields. The parameter is a dictionary of output fields to be sent back to the controller for the associated Extension instance. Field names are implementation dependent and correlate with the Universal Template field names in the Controller's Template definition.
unv_output	*str, optional*	None	This parameter specifies the data that will be returned to the Controller for the command execution. It is interpreted as a UTF-8 encoded text object. If the output parameter is True, the output_data will be persisted in the Controller as a record under table ops_exec_output, and appearing as Universal Command output type from the task instance Output tab.

The following is an example of a simple extension_start implementation returning a payload of "Hello world!".

extension_start

```
1     def extension_start(self, fields):
2         """Universal Extension primary operation."""
```

```
3           return ExtensionResult(unv_output = "Hello World!")
```

Upon execution, the extension_start implemented above would result in the following output in the associated task instance in the Controller:

8.1.1.3.5.2 Choice Commands

Choice Commands support the task definition process in the Controller. They allow a drop-down "**Choice Field**" on a task definition form to call down to a Universal Extension on an agent system and retrieve data to populate the drop-down. This can be used to satisfy any number of scenarios but, typical use cases would be to pull values from a third-party system that may be needed to define the work the task is intended to perform (for example, job names, file names, modes of operation, etc.).

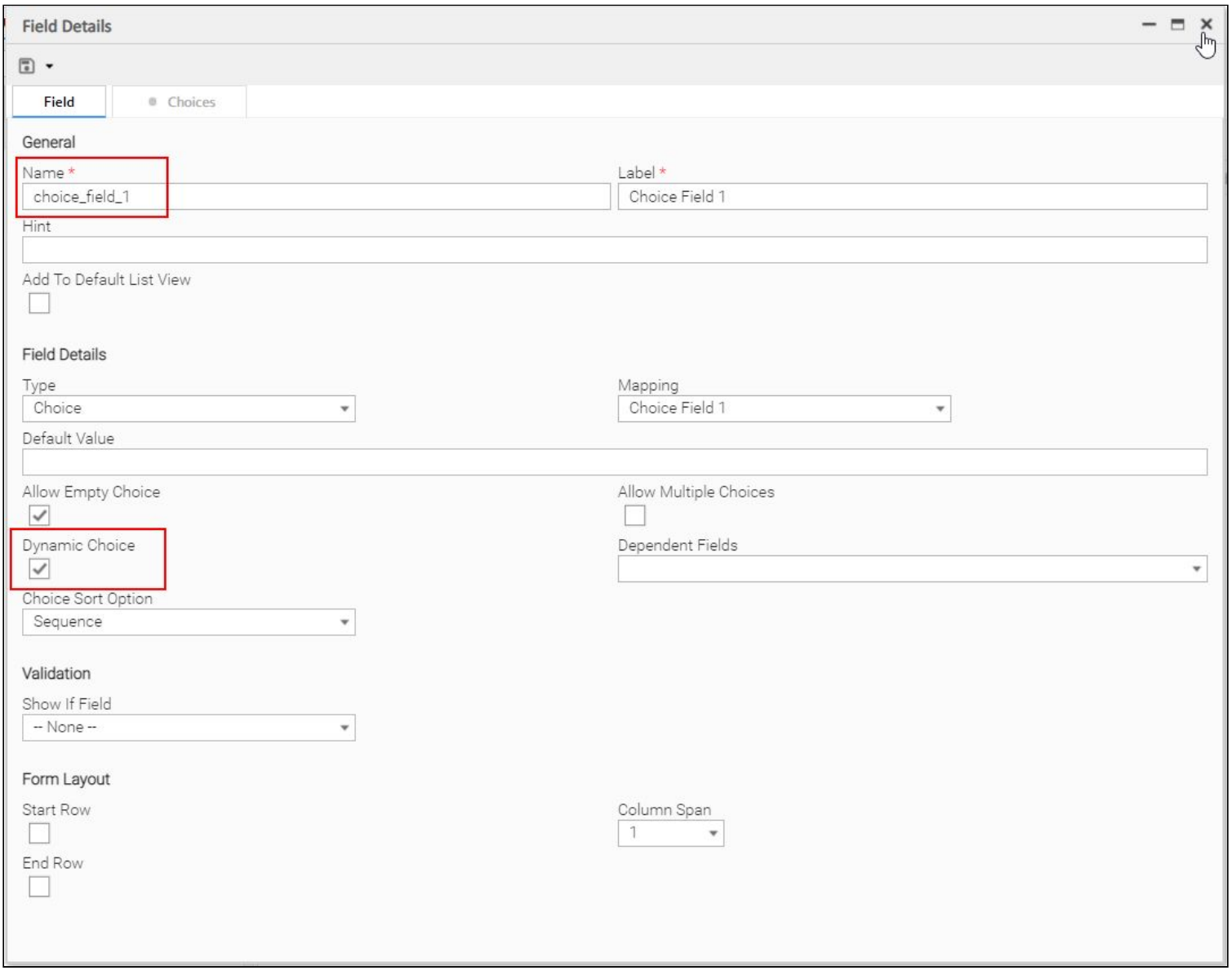
- **Choice Commands are optional and are not required in an Extension implementation.**
- An Extension may define any number of Choice commands.

Choice commands are defined by adding a method to the Extension class with an appropriate signature and decorating it with the **@dynamic_choice_command** decorator defined in the universal_extension base package. Below is an example of a decorated function with the required signature:

Choice Command in extension.py

```
1       @dynamic_choice_command("choice_field_1")
2       def choice_command_1(self, fields):
3           """Dynamic choice command."""
4           return ExtensionResult(
5               rc = 0,
6               message = "Values for choice field 'choice_field_1'",
7               values = ["Value 1", "Value 2", "Value 3"]
8               )
```

In the code snippet above, "**choice_field_1**" corresponds to the field **Name** of a field of type **choice** with "**Dynamic Choice**" checked in an associated Universal Template in the Controller. The function name **choice_command_1** is arbitrary and could just as well have been **my_choice_command_function**. The linkage between a Universal Template choice field and the backing Choice Command handler is made by matching the choice field's "Name" with the value in the @dynamic_command decorator. In this case "choice_field_1".



Once the work is done, the Choice Command method **must** return an instance of **ExtensionResult**. **ExtensionResult** is a class provided in the universal_extension base package for the purpose of returning from work requests.

The following parameters can be passed to the constructor of ExtensionResult for returning from a Choice Command:

Parameter	Type	Default	Description
rc	*int, optional*	0	This parameter represents the return code of the 'choice' operation and determines whether the command is perceived as completing with success or failure by the Controller. A value of 0 indicates success. All other values indicate an error condition and will be ignored by the Controller for form field population. However, the Controller will log the command response. The non-zero value used to represent the error condition is implementation defined and therefore left up to the extension developer.
message	*str, optional*	Empty string	This parameter specifies a short status string (error message or success message) that will be logged by the Controller.

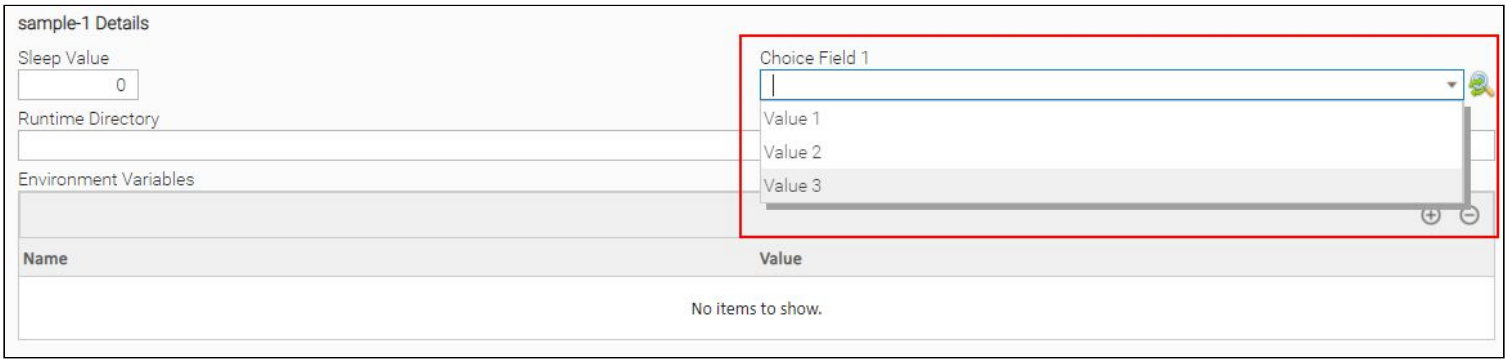
values	*list, optional*	Empty list	This parameter specifies a list which can be populated with a set of string values to be returned to the Controller and used to populate the associated dynamic choice field on an Extension task form. The default value is an empty list.

The following is an example of a simple Choice Command implementation returning a list of hard coded values that would be used by the Controller to populate an associated Choice field drop-down:

Dynamic Choice Command in extension.py

```
@dynamic_choice_command("choice_field_1")
def choice_command_1(self, fields):
    """Dynamic choice command."""
    return ExtensionResult(
        rc = 0,
        message = "Values for choice field 'choice_field_1'",
        values = ["Value 1", "Value 2", "Value 3"]
        )
```

Execution, the Choice Command implemented above would result an associated Choice field drop-down in the Controller being populated:



8.1.1.3.5.3 Dynamic Commands

Dynamic Commands are intended to support the functionality of the Primary Operation of the Universal Extension (task execution).

They can be made available to a task instance in any/all of the following task states:

- Defined
- Waiting
- Time Wait
- Held
- Exclusive Requested
- Exclusive Wait
- Resource Requested
- Resource Wait
- Execution Wait
- Undeliverable

- Queued
- Submitted
- Action Required
- Started
- Running
- Running/Problems
- Cancel Pending
- In Doubt
- Start Failure
- Confirmation Required
- Cancelled
- Failed
- Skipped
- Finished
- Success

Dynamic Commands can be used to return additional information for a task instance or to carry out some related (or unrelated) action on behalf of the task instance. The key to Dynamic commands is that they can pass instance specific field data values from the task instance form to the extension process that executes the command on the agent. This allows them to perform instance specific actions without the user needing to copy/paste values from the task instance into a new task to perform some action.

An example use case for this would be to implement a cancel command for work that was started in a third-party system. This would be independent of the task instance running (or completed) in the Controller. Instance specific values (job ID, process ID, etc. could automatically be pulled from the task instance and passed to the Command handler in the Universal Extension on the agent system).

Dynamic Commands are optional and are not required in an Extension implementation. An Extension may define any number of Dynamic Commands.

The following parameters can be passed to the constructor of ExtensionResult for returning from a Dynamic Command:

Parameter	Type	Default	Description
rc	*int, optional*	0	This parameter represents the return code of the Dynamic Command operation and determines whether the command is perceived as completing with success or failure by the Controller. A value of 0 indicates success. All other values indicate an error condition and the command result will not be added to the Controller's Output tab. However, the Controller will log the command response. The non-zero value used to represent the error condition is implementation defined and therefore left up to the extension developer.
message	*str, optnial*	Empty string	The **message** parameter specifies a short status string (error message or success message) that will be logged by the Controller.
output	*bool, optional*	False	This parameter is a Boolean value that specifies if the command produced output that should be persisted and displayed under the task instance Output tab in the Controller task instance associated with the dynamic command invocation. **The default value is False.** This flag allows distinguishing between a command that does not produce output and a command that produces output but the output returned was empty.

output_data	*str, optional*	None	This parameter specifies the data that will be returned to the Controller for the command execution. It is interpreted as a UTF-8 encoded text object. If the **output** attribute is **True**, the **output_data** will be persisted in the Controller as a record under table ops_exec_output, and appearing as **Universal Command** output type from the task instance **Output** tab. **The default value is None.**
output_name	*str, optional*	None	This parameter is used to provide a custom name for the associated output data. The **output_name** (if provided) will be used in the presentation of the **output_data** by the Controller.

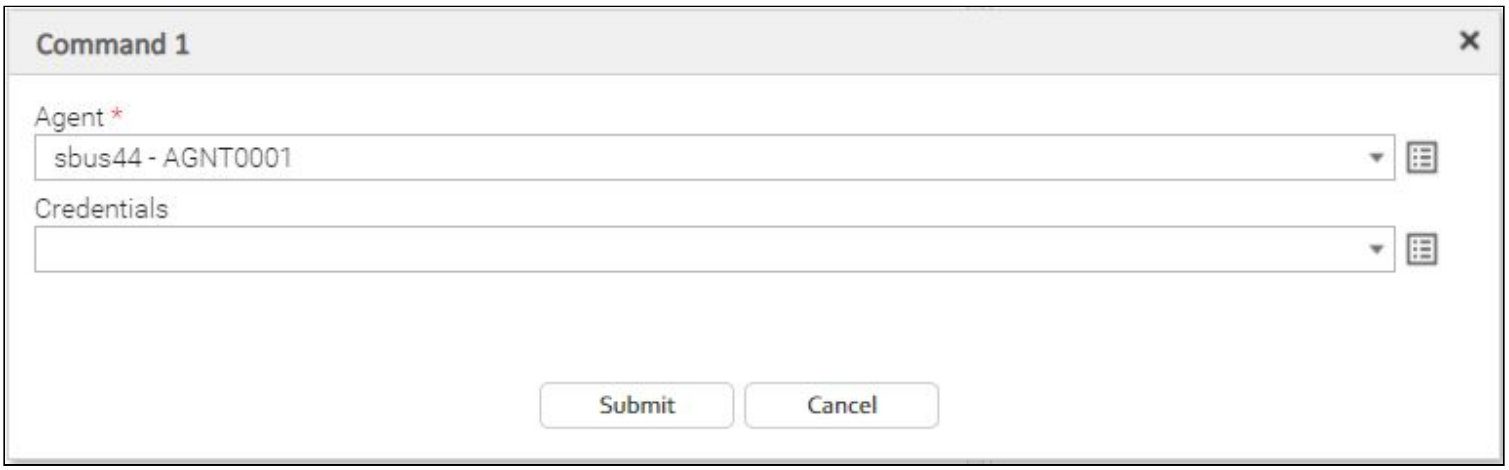
The following is an example of a simple Dynamic Command implementation returning a string "**Sample output**".

Dynamic Command in extension.py

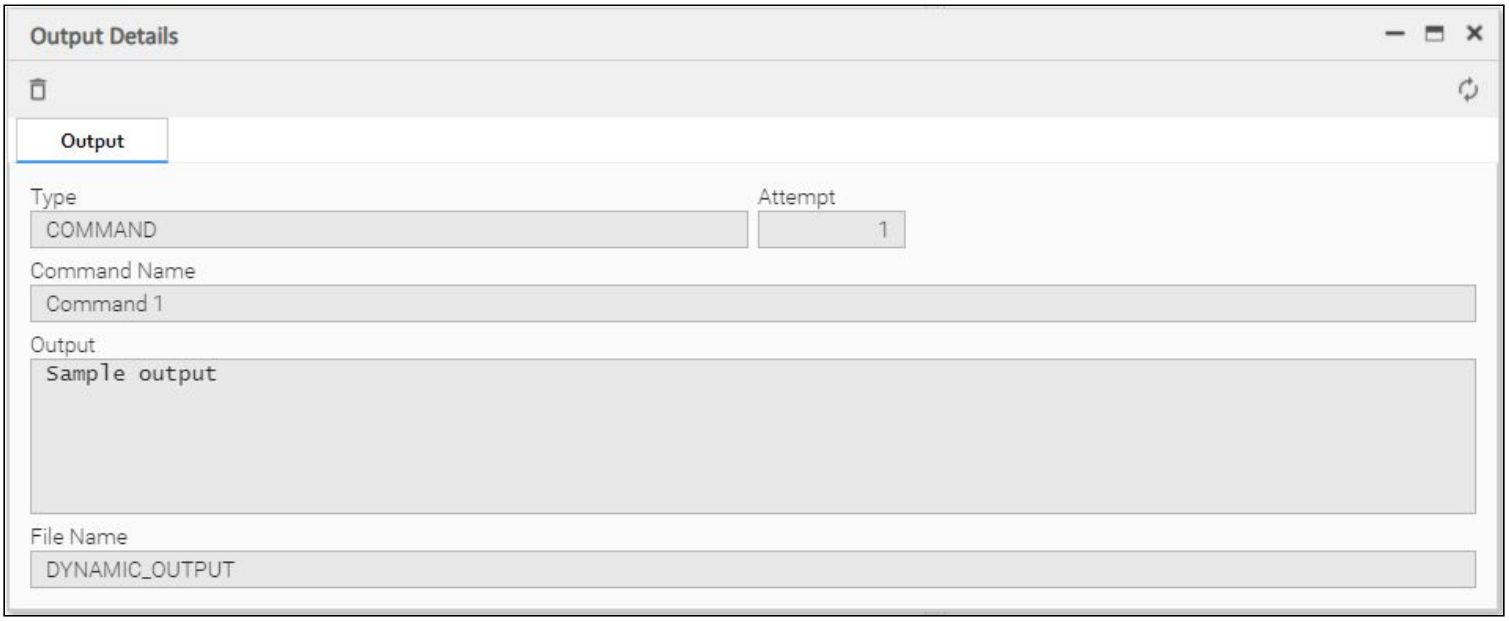
```
    @dynamic_command("command_1")
    def dynamic_command_1(self, fields):
        """Dynamic command."""
        return ExtensionResult(
            rc = 0,
            message = "command_1 output",
            output = True,
            output_data = 'Sample output',
            output_name = 'DYNAMIC_OUTPUT')
```

In the Controller, the Dynamic Command could be invoked from a task instance of the appropriate Universal Extension type.

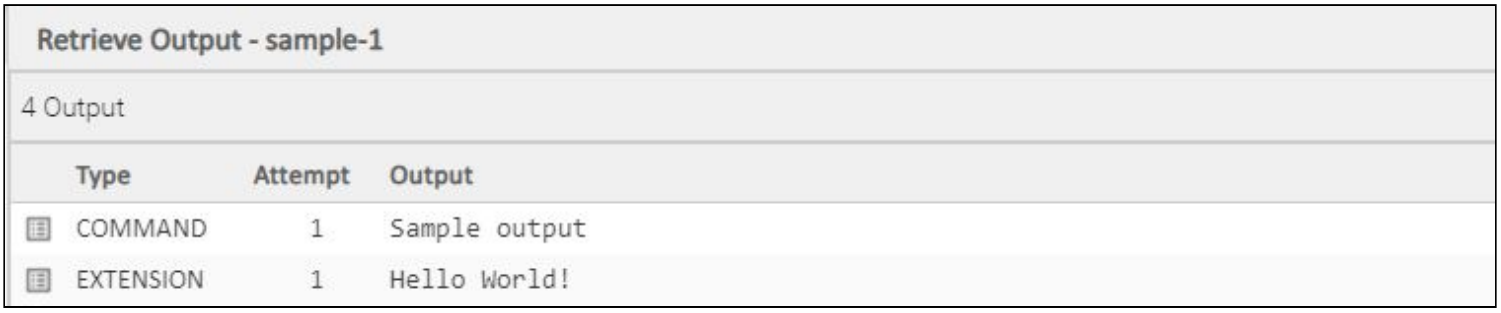
Selecting the Dynamic Command for the task instance allows the adjustment of any dependent fields.



If the Dynamic Command produces output, a popup window appears to show the result of the Command.



Additionally, the results of Dynamic Commands are persisted with the task instance and can be viewed on the Output tab of the task instance.

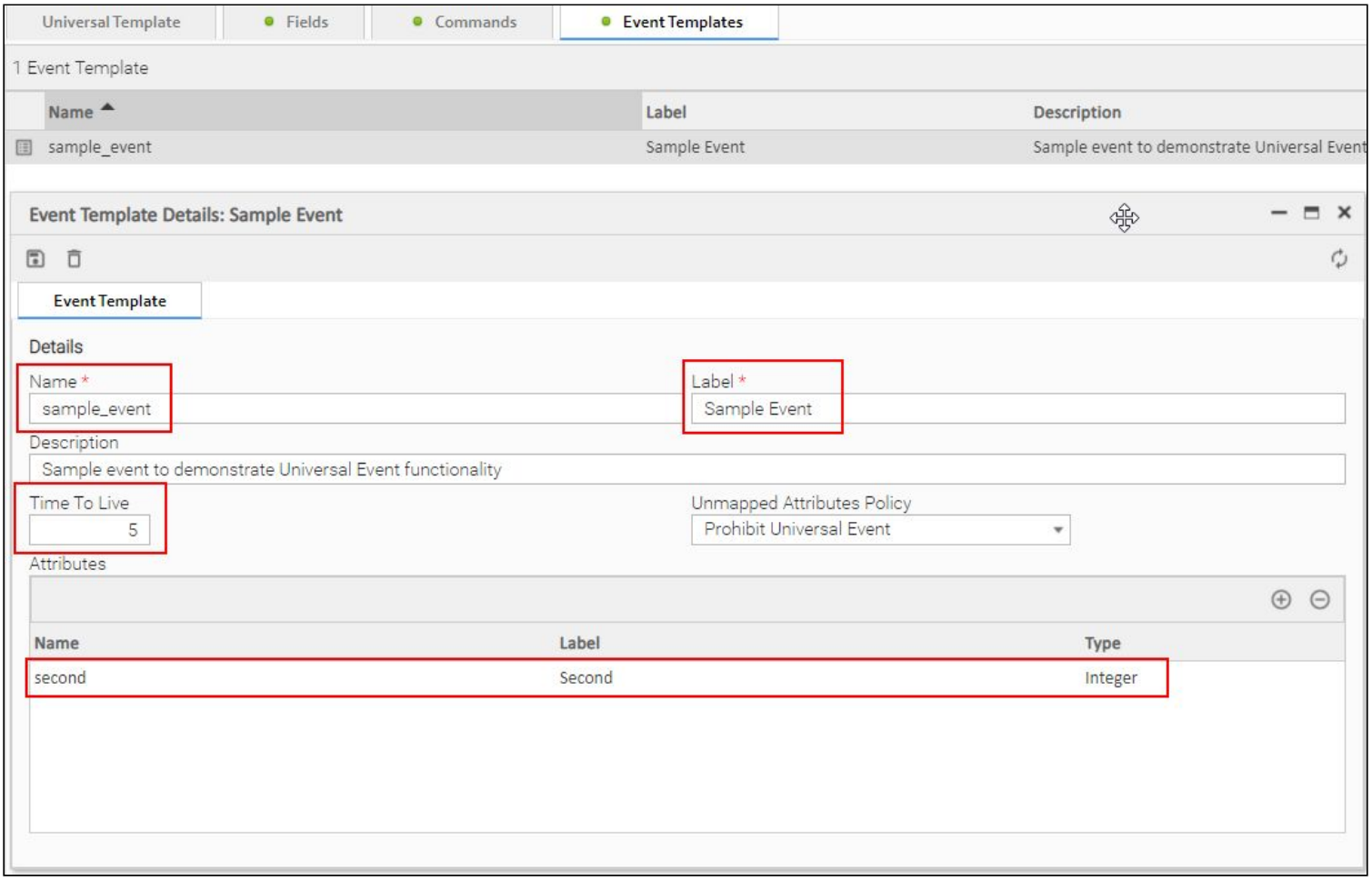


8.1.1.3.5.4 Publishing Events

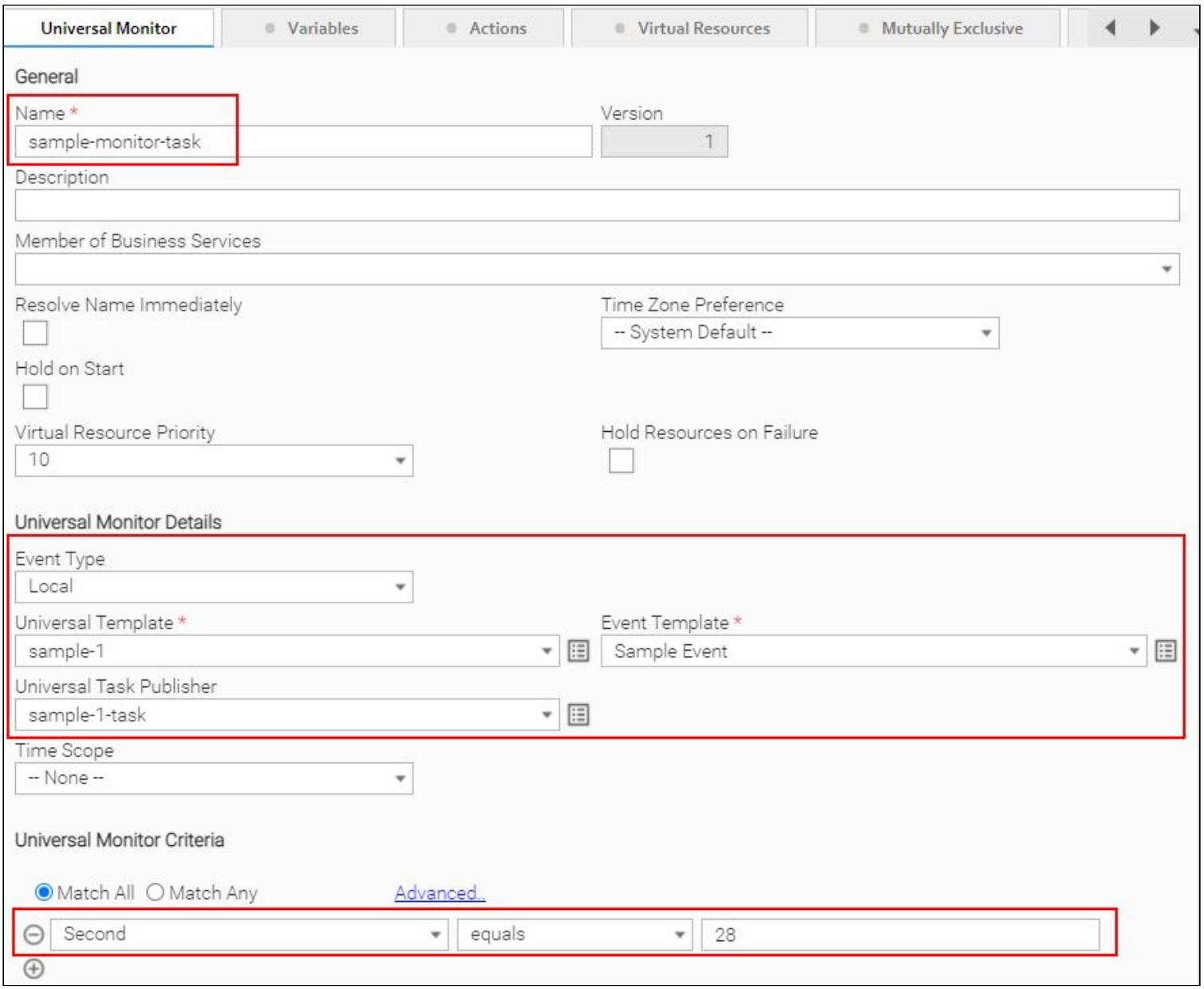
With the 7.2.0.0 release, the ability to publish events was added to the Universal Extension API to extend the Controller's monitoring capabilities. This new addition has a multitude of use cases. For instance, Extensions can now be used to

implement a custom Database Monitoring solution; Extensions publish events containing data from a database which Universal Monitors can use to detect a desired event.

To use this functionality, a Universal Event must be declared globally or locally. Shown below is the definition of a local Universal Event that is part of the `sample-1` Universal Template:



The Universal Event is then tied to a Universal Monitor task as shown below:



The `sample-monitor-task` above will end up in the "Success" status once it receives an event from the Extension attached to the sample-1 Universal template with the "second" attribute set to 28.

On the Extension side, events are published using the **publish** method implemented in the **event** module accessible through the universal_extension module. The method signature is as follows:

def publish(name, attributes, time_to_live=None):

The **name** parameter specifies the target Event name, **attributes** is a dictionary specifying the Event's attributes as key-value pairs, and **time_to_live** specifies the maximum time the published event lives before it expires.

The code snippet below continuously publishes an event with the attributes containing the current second extracted from the time:

Publishing an event

```
1  while self.run:
```

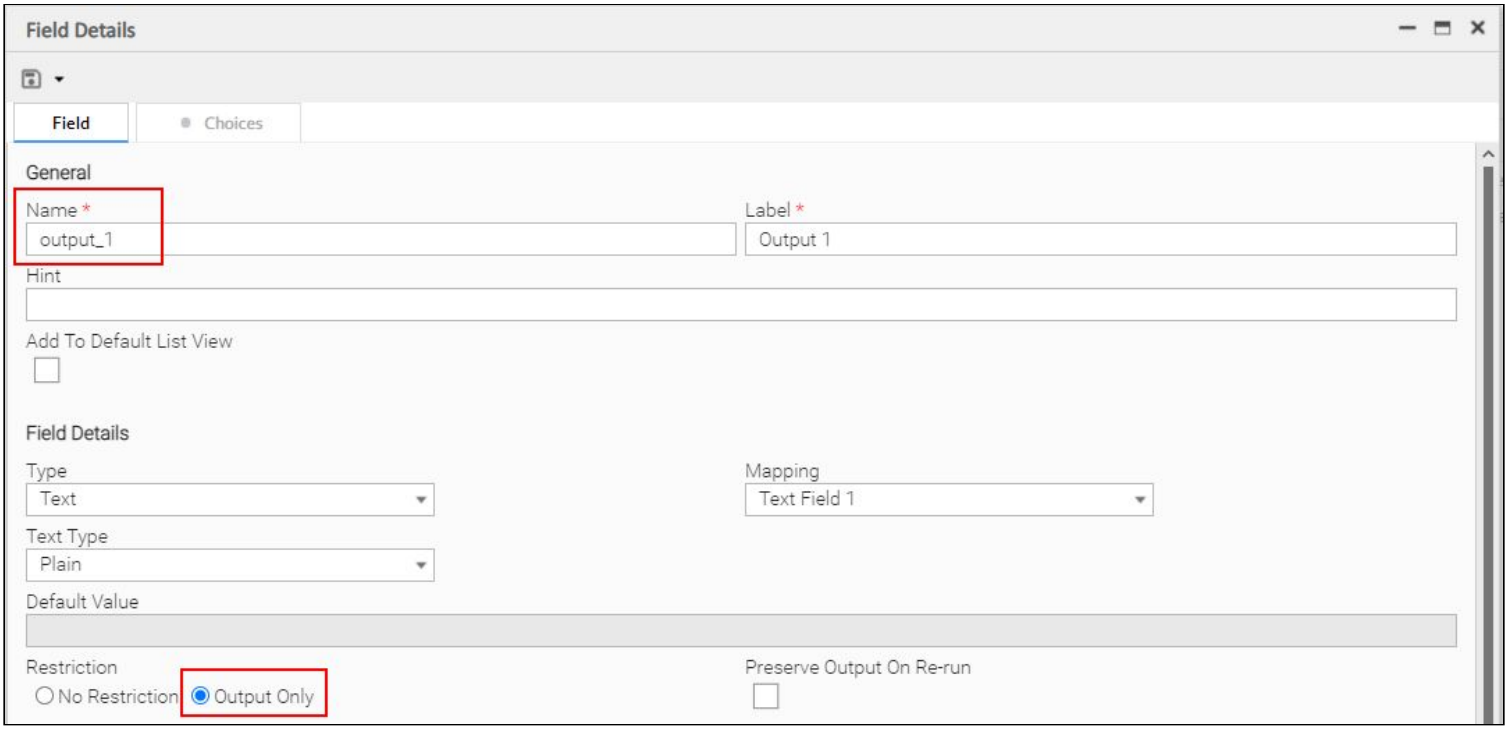
```
    # get current seconds from the time
    second = datetime.now().second

    # Publish the event
    event.publish(
        'sample_event',
        {'second': second}
    )

    # Wait a second before continuing
    time.sleep(1)
```

Once the `sample-monitor-task` is launched, the `sample-1-task` will automatically be launched as well.

The `sample-1-task` will publish an event every second. Once the condition specified in the `sample-monitor-task` is met, both tasks will end up in the "Success" state.

8.1.1.3.6 Output Only Fields (update_extension_status/update_output_fields)

Universal Extensions provide support for an "**Output Only**" type field. This is a field defined in a Universal Template of type Extension that is given a restriction of Output Only.



Output only fields can be updated at any time by a Universal Extension instance running a Task Execution request (extension_start) on an agent system. This provides a means for the task instance to send back relevant state information. The Output Only fields can be updated by the task instance as many times as needed.

The updating of Output Only fields is accomplished by calling the **update_extension_status** method implemented in the **UniversalExtension** base class or by calling **update_output_fields** from the **ui** module accessible through the universal_extension module. The **update_output_fields** method is more versatile as it can be called in another file/module that is part of the full Extension. Functionally, however, the methods are exactly the same.

Both methods have the following signature (only **update_output_fields** is shown from now on):

def update_output_fields(fields):

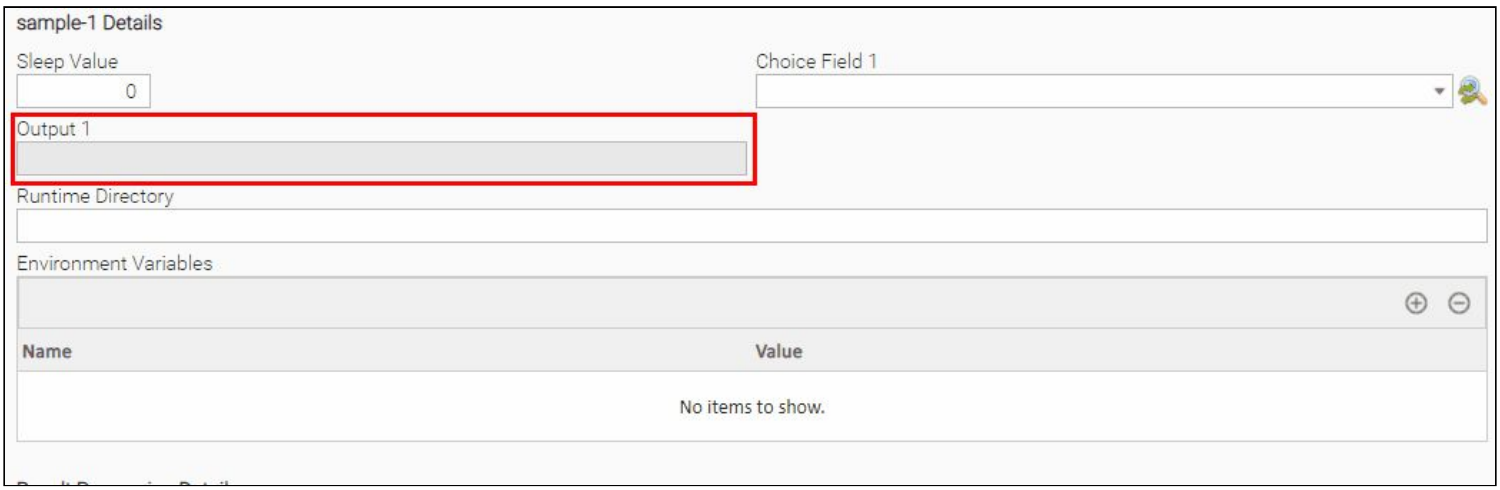
The **fields** parameter expects a dictionary populated with any/all Output Only fields that should be updated. The keys of the dictionary directly correlate with the Output Only field names specified in the associated Universal Template. The values of the dictionary are the values that will be used to update the corresponding Output Only field for the task instance in the Controller.

The following code snippet demonstrates two calls to update the same output only field ("output_1"). To simulate work being done in-between the updates, a delay is created using the sleep function from the time module.

Updating Output Only fields

```
sleep_value = fields.get('sleep_value', 5)

time.sleep(sleep_value)

# Update output fields.
out_fields = {}
out_fields["output_2"] = "Step One"
ui.update_output_fields(out_fields)

# Do some processing...
time.sleep(sleep_value)

# Update output fields.
out_fields = {}
out_fields["output_2"] = "Step Two"
ui.update_output_fields(out_fields)
```

The animation below shows the task instance form being updated (note the refresh icon at the top right of the task instance form was clicked continuously for the real-time updates):



8.1.1.4 Task Entry Point

8.1.1.4.1 Introduction

To demonstrate the process of Extension development, a sample Extension will be created and deployed using Visual Studio Code with the UIP Visual Studio Code Extension. The UIP Visual Studio Code Extension relies heavily on functionality provided by the `uip-cli` tool to enhance the UIP development experience. Therefore, a similar experience can be achieved with other code editors using uip-cli manually. This alternative use scenario will be documented as well.

The functionality of this sample Extension is contrived and serves no real purpose other than to illustrate the process of developing an extension that supports and utilizes all features available. The sample Extension, however, can be a good starting point for creating more complex Extensions.

On this page, we will cover the following:

1. Introduce the UIP Visual Studio Code Extension and `uip-cli` that will be used to create and configure the sample Extension.
2. Deploy the initial Extension without any changes and review the output.
3. Modify the sample Extension.
4. Deploy the modified Extension to the Controller and review the output.

Note that it is assumed the latest version 2.0.0 of UIP Visual Studio Code Extension and `uip-cli` are already installed. See the previous document for installation instructions.

8.1.1.4.2 Step 1 - Create a New Extension Project using the UIP VS Code Extension

As mentioned in Development Environment Set-Up, this tutorial will be using Visual Studio Code running in Windows and connected to a WSL (Windows Subsystem for Linux) project environment.

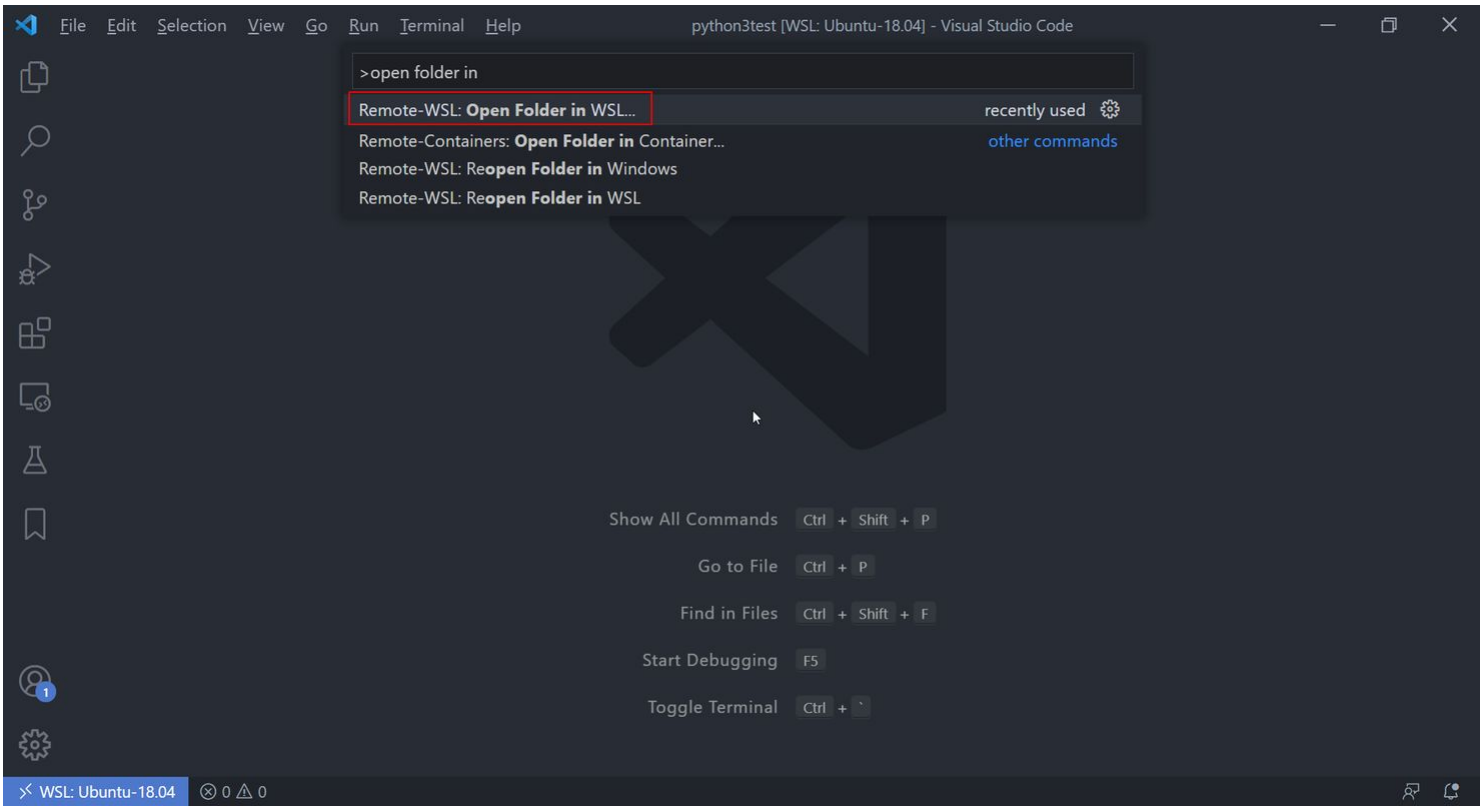
Initializing a new UIP project is a multi-step process.

1. Select a folder for VS Code to open for the new UIP project.
2. Select a starter template for the UIP project.
3. Iterate over the template parameters.

To begin, create a project directory (for example, **~/dev/extensions/sample-task**) in the WSL file system where the Universal Extension will be created.

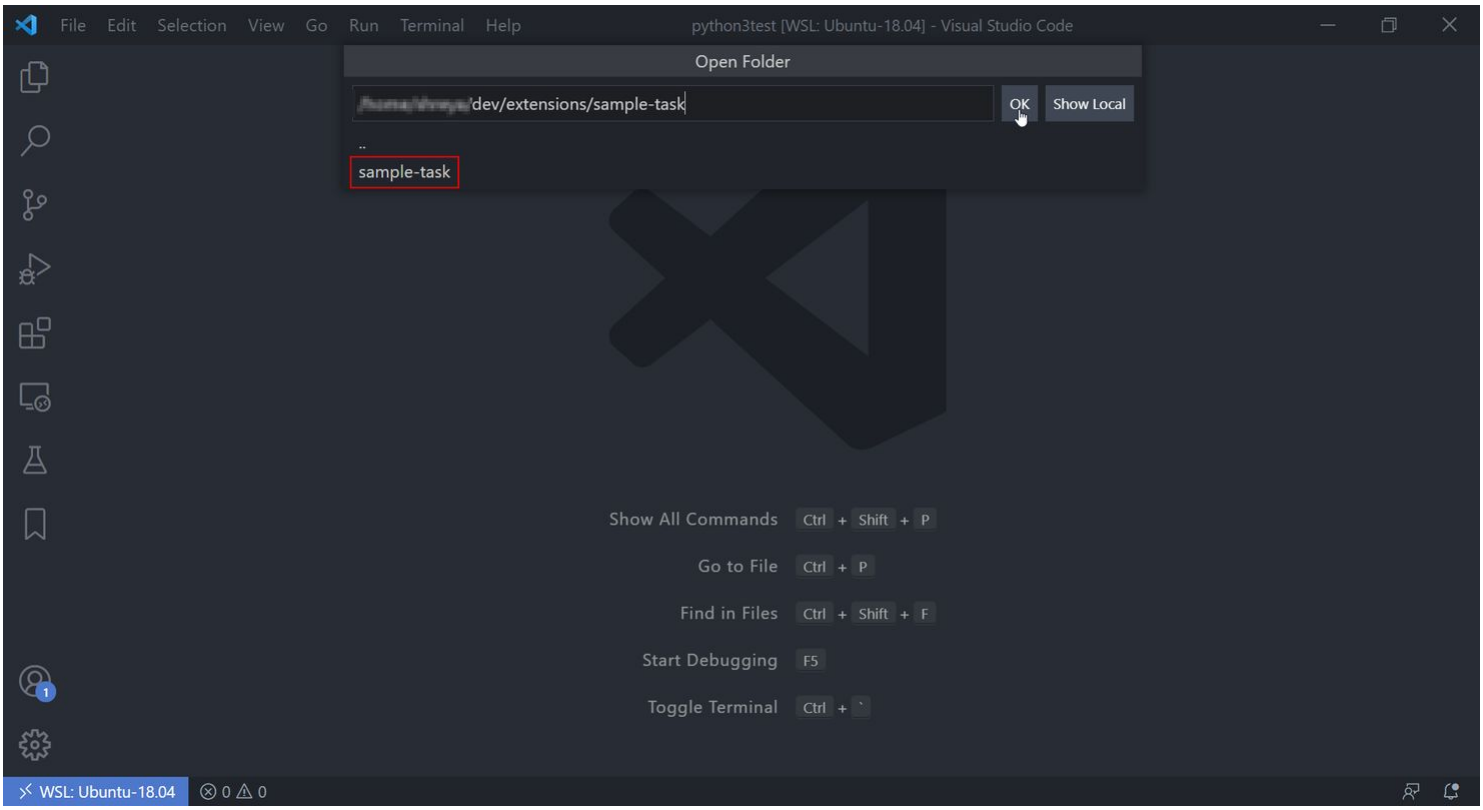
8.1.1.4.2.1 Select project folder

Next, Use Visual Studio Code to open the **sample-task** folder in WSL:



1. Open the Remote Window command pallet.
2. Select "Open Folder in WSL...".

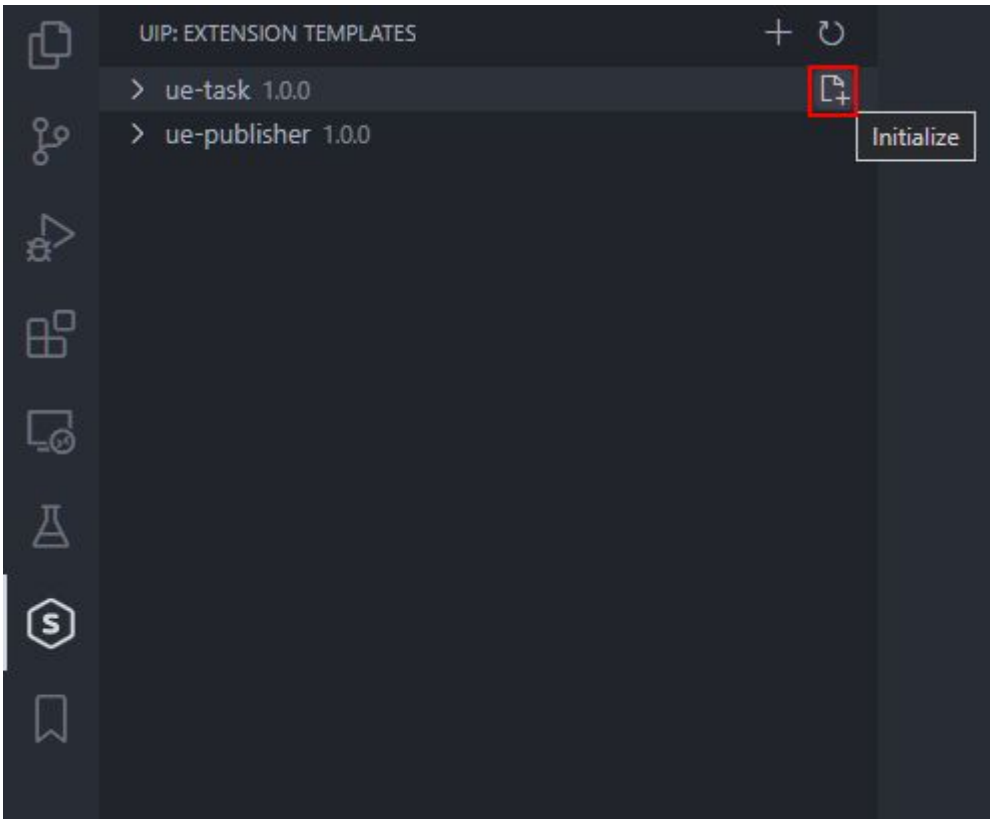
In the resulting dialog, navigate to the sample-task folder and click on Select Folder:



8.1.1.4.2.2 Selecting starter template

Now that VS Code is in the WSL environment, navigate to the activity bar on the left hand size and click the Stonebranch logo.

This will expand the menu and you should see a list of all the available extension templates. Go ahead and click the icon shown below to initialize the **ue-task** template:

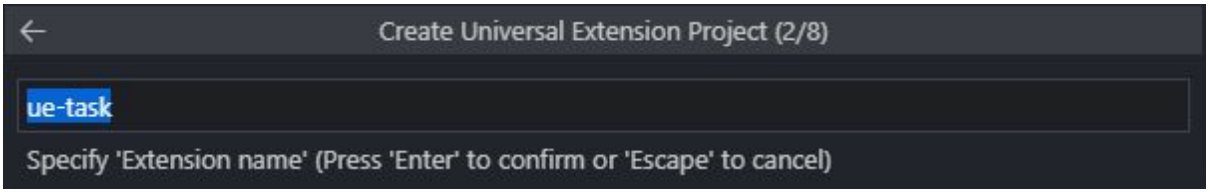


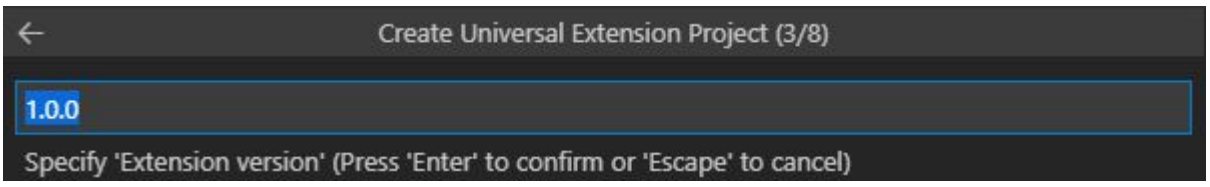
8.1.1.4.2.3 Setting template parameter values for selected starter template

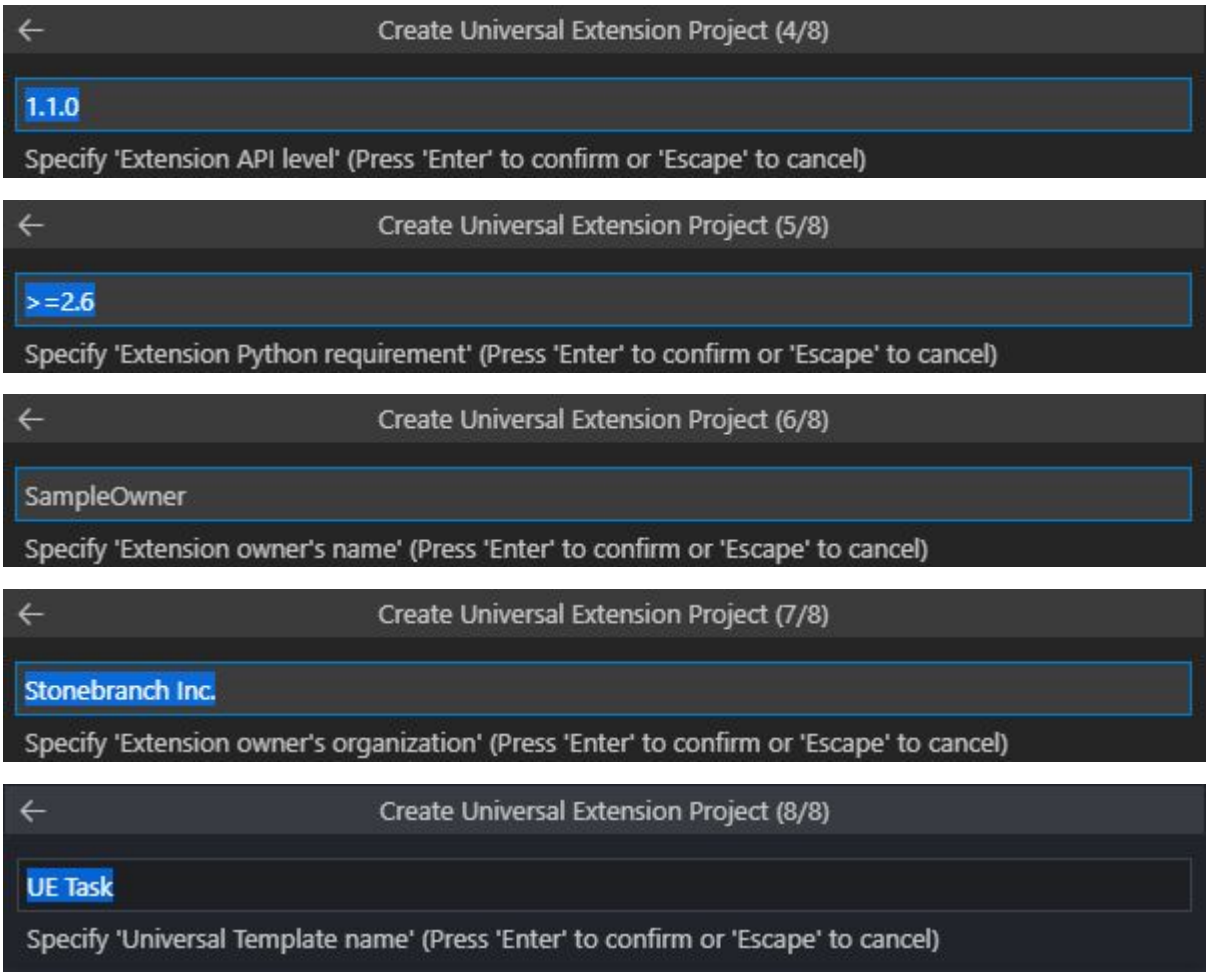
A few seconds after clicking the icon shown above, a sequence of input boxes will shown up containing the parameters for the ue-task starter template. The parameters allow you to supply project specific values into boilerplate template code at creation time.

For this tutorial, all parameters are suitable so, just pressing 'Enter' to select the default for each parameter would be sufficient. However, in the series of images below, the '**Extension Owner**' parameter was modified to use a value of "**SampleOwner**" (step 6/8). Notice that the dialog title will update to indicate which step you are on and how many steps are left to complete the dialog - (2/8), (3/8), (4/8), etc..

Note that pressing “Alt + left arrow” or clicking the ← icon in the top left of the image will return to the previous step (preserving the value of the current step).

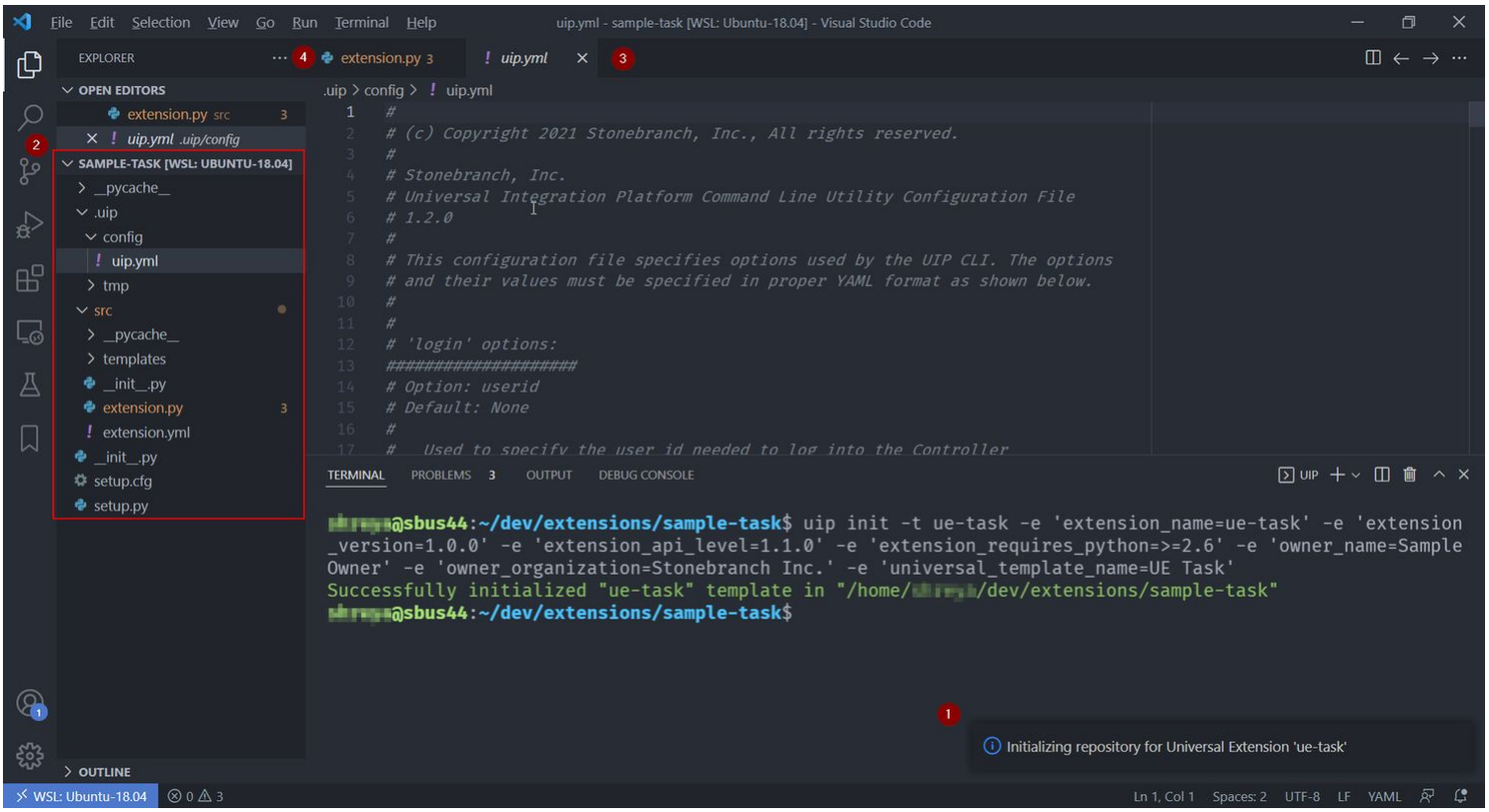






After hitting enter on the last parameter:

1. A notification pops up to indicate the new project has been created.
2. The new project is created
3. The uip.yml project configuration file is opened in an editor.
4. The generated extension.py source file is opened in an editor.



When the "**UIP: Initialize New Project**" command completes, a project will be initialized in the selected folder with the following structure:

```
|-- sample-task                 # Sample project directory
    |--setup.py                 # Setup file for packaging extension
    |--setup.cfg                # Configuration file for configuring setup
    |--__init__.py
    |
    |--.uip                     # Folder used by CLI to validate directory
    |   |--config               # Configuration File Folder
    |       |--uip.yml          # Local Configuration File
    |
    |--src                      # Source directory for Extension implementation
        |--extension.py         # Extension implementation
        |--extension.yml        # Extension metadata
        |--__init__.py
        |
        |--templates
            |--template.json    # Universal Template JSON Definition File
```

At this point, the project is fully initialized.

Click here to expand uip-cli details...

8.1.1.4.2.4 Step 1 supplemental - Create a New Extension Project using the CLI

Create a project directory (for example, **~/dev/extensions/sample-task**) where the sample-task Extension will be created, and cd into the directory.

As of now, the CLI offers two starter Extension templates called **ue-task** and **ue-publisher**. To see all the available starter Extension templates, type the template-list command:

```
[redacted]@sbus44:~/dev/extensions/sample-task$ uip template-list
+--------------------+-------------------------------------------------------------+
| Extension Template | Description                                                 |
+--------------------+-------------------------------------------------------------+
| ue-publisher       | starter Extension with a local Universal Event template     |
+--------------------+-------------------------------------------------------------+
| ue-task            | starter Extension with minimal code                         |
+--------------------+-------------------------------------------------------------+
```

Both the starter Extensions above can be configured before they are initialized.

To see the list of variables that can be used to configure one of the starter Extension templates, type the template name after the previous command.

Shown below are the list of variables for the **ue-task** starter template:

```
[redacted]@sbus44:~/dev/extensions/sample-task$ uip template-list ue-task
+--------------------------+------------------+--------------------------------+
| Variable Name            | Default          | Description                    |
+--------------------------+------------------+--------------------------------+
| extension_name           | ue-task          | Extension name                 |
| extension_version        | 1.0.0            | Extension version              |
| extension_api_level      | 1.1.0            | Extension API level            |
| extension_requires_python | >=2.6           | Extension Python requirement   |
| owner_name               | Stonebranch      | Extension owner's name         |
| owner_organization       | Stonebranch Inc. | Extension owner's organization |
| universal_template_name  | UE Task          | Universal Template name        |
+--------------------------+------------------+--------------------------------+
```

As shown in the image above, there are quite a few ways to configure the Extension. As for the sample Extension developed for this tutorial, we will work with **ue-task**, and only the *owner_name* option will be configured. Everything else will be set to the default value.

The Extension can be configured and initialized using the **init** command. There are three ways to configure the **ue-task** Extension template using the command line:

- Using the **-e** option multiple times:

```
[redacted]@sbus44:~/dev/extensions/sample-task$ uip init -t ue-task -e 'owner_name=SampleOwner'
Successfully initialized "ue-task" template in "/home/shreya/dev/extensions/sample-task"
```

- Using a JSON string

```
[redacted]@sbus44:~/dev/extensions/sample-task$ uip init -t ue-task -e '{"owner_name": "SampleOwner"}'
Successfully initialized "ue-task" template in "/home/shreya/dev/extensions/sample-task"
```

- Using a JSON/YAML file
  - Create a YAML file called *vars.yml* and define the variables as follows:

```
1 owner_name: "SampleOwner"
```

  - Use the YAML file to initialize the project:

```
[redacted]@sbus44:~/dev/extensions/sample-task$ uip init -t ue-task -e '@vars.yml'
Successfully initialized "ue-task" template in "/home/shreya/dev/extensions/sample-task"
```

Pick one of the three ways shown above; it does not matter which one. Note that an optional, positional argument can be provided at the end of each of the three commands that specifies the directory in which the Extension will be initialized to. If the directory does not exist, the CLI will create it.

To verify that the Extension was configured as intended, open the **extension.yml** file (see directory structure below), and ensure the *owner_name* is SampleOwner.

This is the directory structure of the *sample-1* Extension:

```
|-- sample-task                # Sample project directory
    |--setup.py                # Setup file for packaging extension
    |--setup.cfg               # Configuration file for configuring setup
    |--__init__.py
    |
    |--.uip                    # Folder used by CLI to validate directory
    |   |--config              # Configuration File Folder
    |       |--uip.yml         # Local Configuration File
    |
    |--src                     # Source directory for Extension implementation
        |--extension.py        # Extension implementation
        |--extension.yml       # Extension metadata
        |--__init__.py
        |
        |--templates
            |--template.json   # Universal Template JSON Definition File
```

8.1.1.4.3 Step 2 - Deploy the Initial Extension using the UIP VS Code Extension

Before deploying the Extension, let's take a look at the code to get a sense of the expected output. Open the **~/dev/extensions/sample-task/src/extension.py** in VS Code (It should already be open in the editor following the project initialization):

extension.py

```
1  from __future__ import (print_function)
2  from universal_extension import UniversalExtension
3  from universal_extension import ExtensionResult
4  from universal_extension import logger
5
6
7  class Extension(UniversalExtension):
8      """Required class that serves as the entry point for the extension
9      """
10
11     def __init__(self):
12         """Initializes an instance of the 'Extension' class
13         """
14         # Call the base class initializer
15         super(Extension, self).__init__()
16
17     def extension_start(self, fields):
18         """Required method that serves as the starting point for work performed
19         for a task instance.
```

```
20
21          Parameters
22          ----------
23          fields : dict
24              populated with field values from the associated task instance
25              launched in the Controller
26
27          Returns
28          -------
29          ExtensionResult
30              once the work is done, an instance of ExtensionResult must be
31              returned. See the documentation for a full list of parameters that
32              can be passed to the ExtensionResult class constructor
33          """
34
35          # Get the value of the 'action' field
36          action = fields.get('action', [""])[0]
37
38          if action.lower() == 'print':
39              # Print to standard output...
40              print("Hello STDOUT!")
41          else:
42              # Log to standard error...
43              logger.info('Hello STDERR!')
44
45          # Return the result with a payload containing a Hello message...
46          return ExtensionResult(
47              unv_output='Hello Extension!'
48          )
```

The code presented above is ready to run without any modifications.

Note the following points of interest from the code above:

Line 17	Starts the implementation of the extension_start override method. This is the entry point for normal task execution and must be implemented by all Universal tasks.
Line 36	Extracts the value of the 'action' field passed down from the Controller (See the Info box below).
Line 38-40	Uses the standard Python print function to print the 'Hello STDOUT!' message to standard output stream if the selected action is 'print'
Line 42-43	Uses the ExtensionLogger class (exposed as part of the universal_extension file) to log the 'Hello STDERR!' message to the standard error stream if action is anything other than 'print'
Line 46	Uses the unv_output parameter of the ExtensionResult class to send the 'Hello Extension!' string to the EXTENSION output payload associated with the task instance in the Controller.

What is the 'action' field?

You may have noticed the **template.json** file in the sample-task directory structure above. That is the Universal Template, in JSON format, that the Controller uses to render the template UI.

One of the things **template.json** defines is the 'action' field of type Choice with two possible values: 'print' and 'log'. Soon, the template will be pushed out to the Controller where we will be able to see it visually.

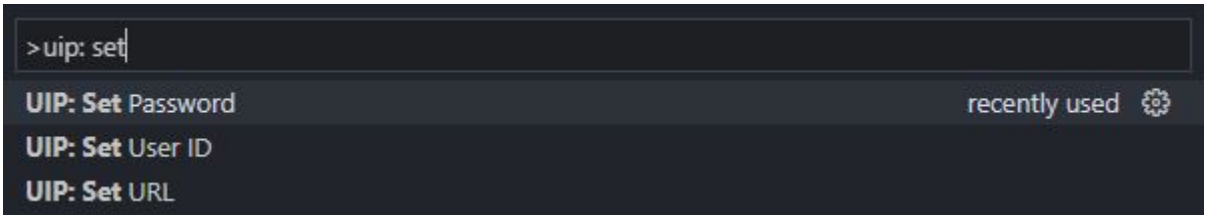
For now, keep in mind that the Extension can use fields defined in the Universal Template.

Now, let's deploy the Extension. Note that Extensions are stored in the Controller as Universal Templates of type Extension.

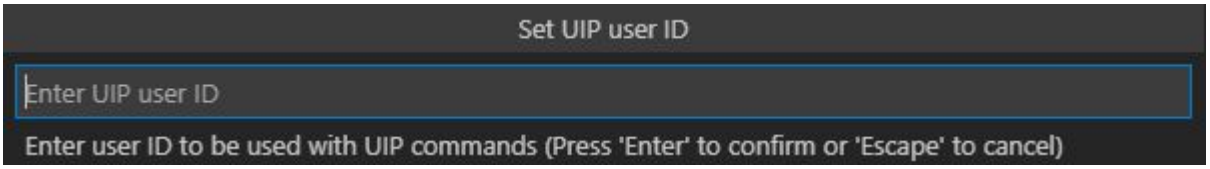
To connect to the Controller, the CLI needs the Controller's URL along with userid and password. To avoid typing the same information multiple times, the URL and userid can be stored in the local configuration file (~/dev/extensions/sample-task/.uip/config/**uip.yml**), and the password can be stored as an environment variable. Alternatively, all values can be set as environment variables and, using the UIP VS Code Extension, those values can be persisted with the project and reloaded as needed.

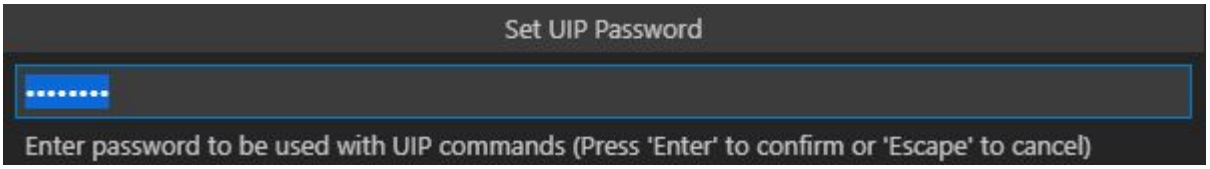
8.1.1.4.3.1 Set Project specific Environment Variables

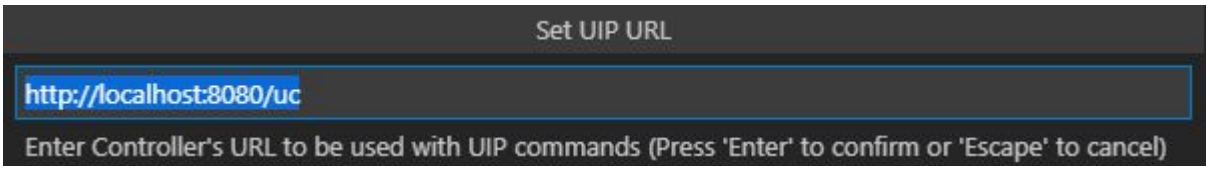
Open the VS Code command pallet (ctrl+shift+p) and type "**uip set**". This will show a list of UIP commands for setting environment variables:



Select each command (one at a time) and enter appropriate values to connect to your Controller:

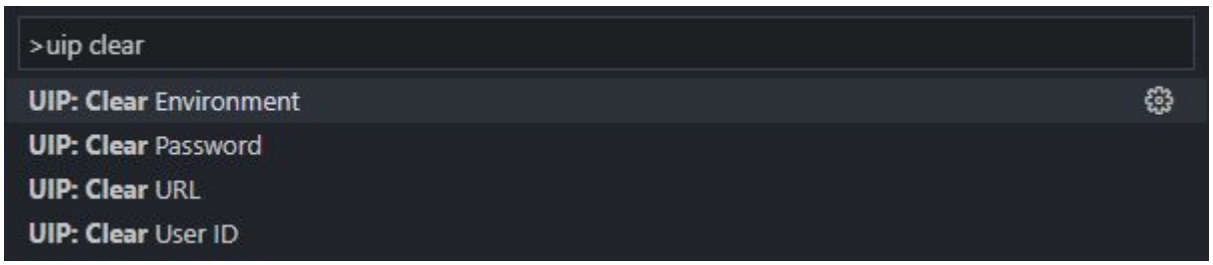






Once these values are set, they will be persisted to project specific storage and be reloaded each time the VS Code project is opened.

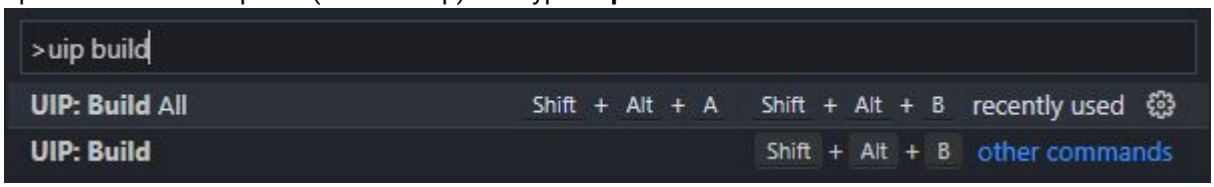
To clear the values from the project, open the VS Code command pallet (ctrl+shift+p) and type "**uip clear**" and select the appropriate command:



UIP: Clear Environment clears user ID, Password, and URL with a single command.

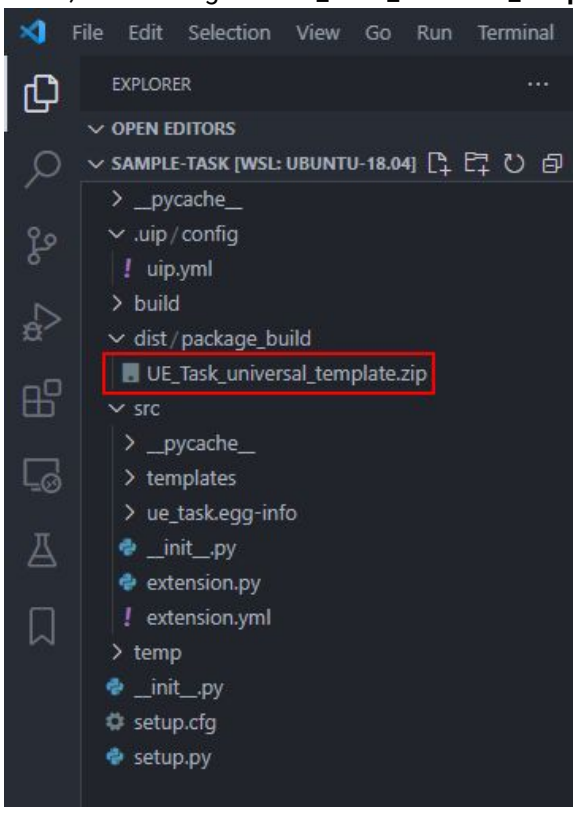
Using the UIP VS Code Extension, there are two primary ways to deploy the Extension: using the **UIP: Push** command, or the **UIP: Build All** command followed by the **UIP: Upload All** command. The latter method will be shown once below, but in subsequent deployments throughout the rest of the tutorial, the **UIP: Push** command will be used.

- Open the command pallet (ctrl+shift+p) and type "**uip build**" and select **UIP: Build All**:

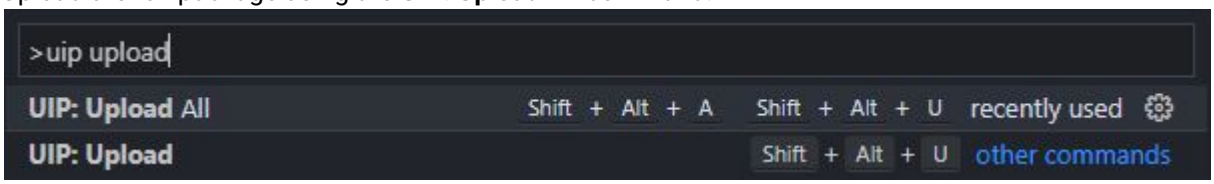


  The **UIP: Build All** command will build the full package (Extension + Universal Template). Recall that the Universal Template is called **UE Task**, and it does not exist in the Controller. Therefore, the entire package must be built and uploaded.
  Upon selecting the command, the status bar will show the build command running in the background:

- If the command succeeded, you should see the full package was built by going to the ./sample-task/dist/**package_build** folder, and making sure **UE_Task_universal_template.zip** file exists:



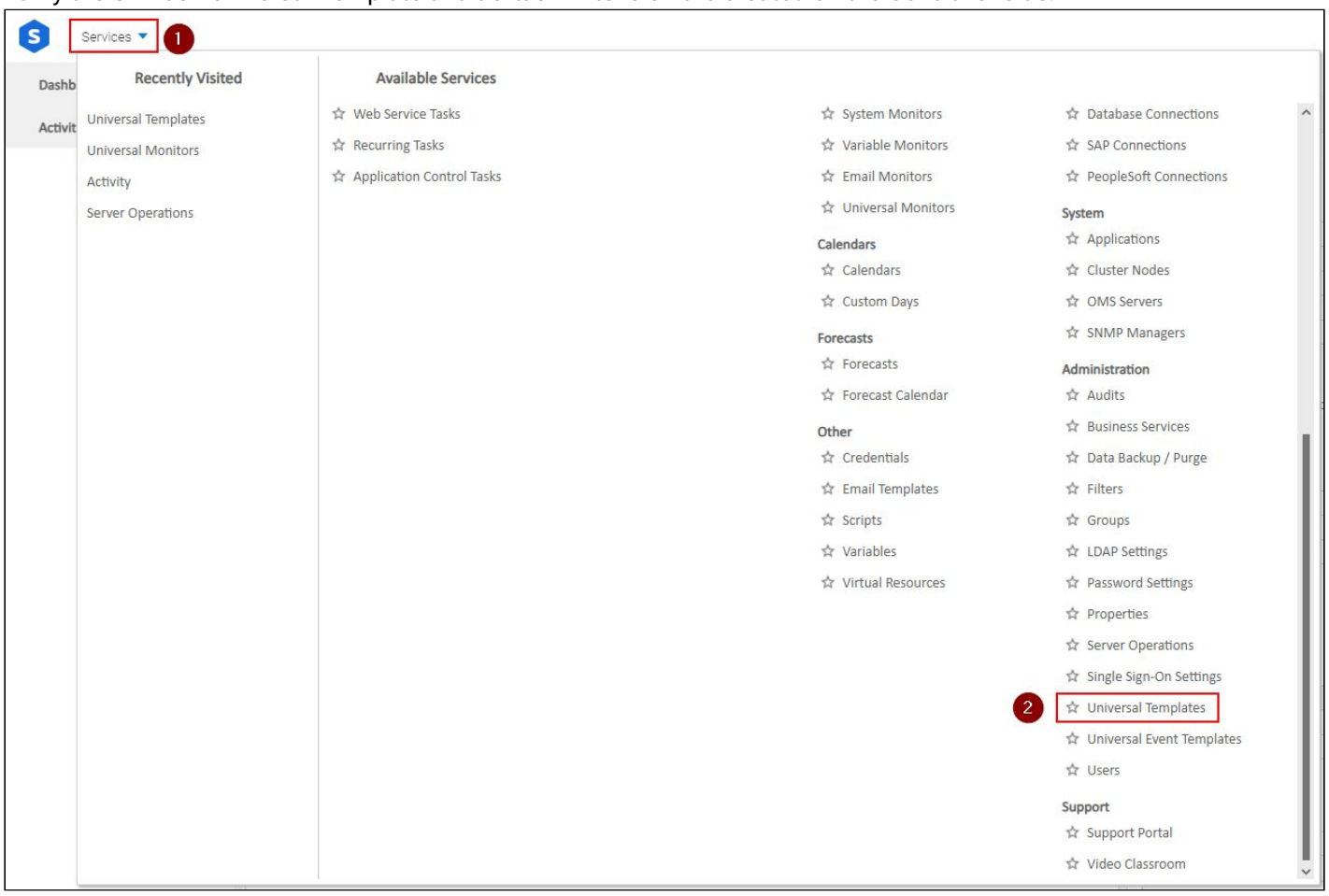
- Upload the full package using the **UIP: Upload All** command:

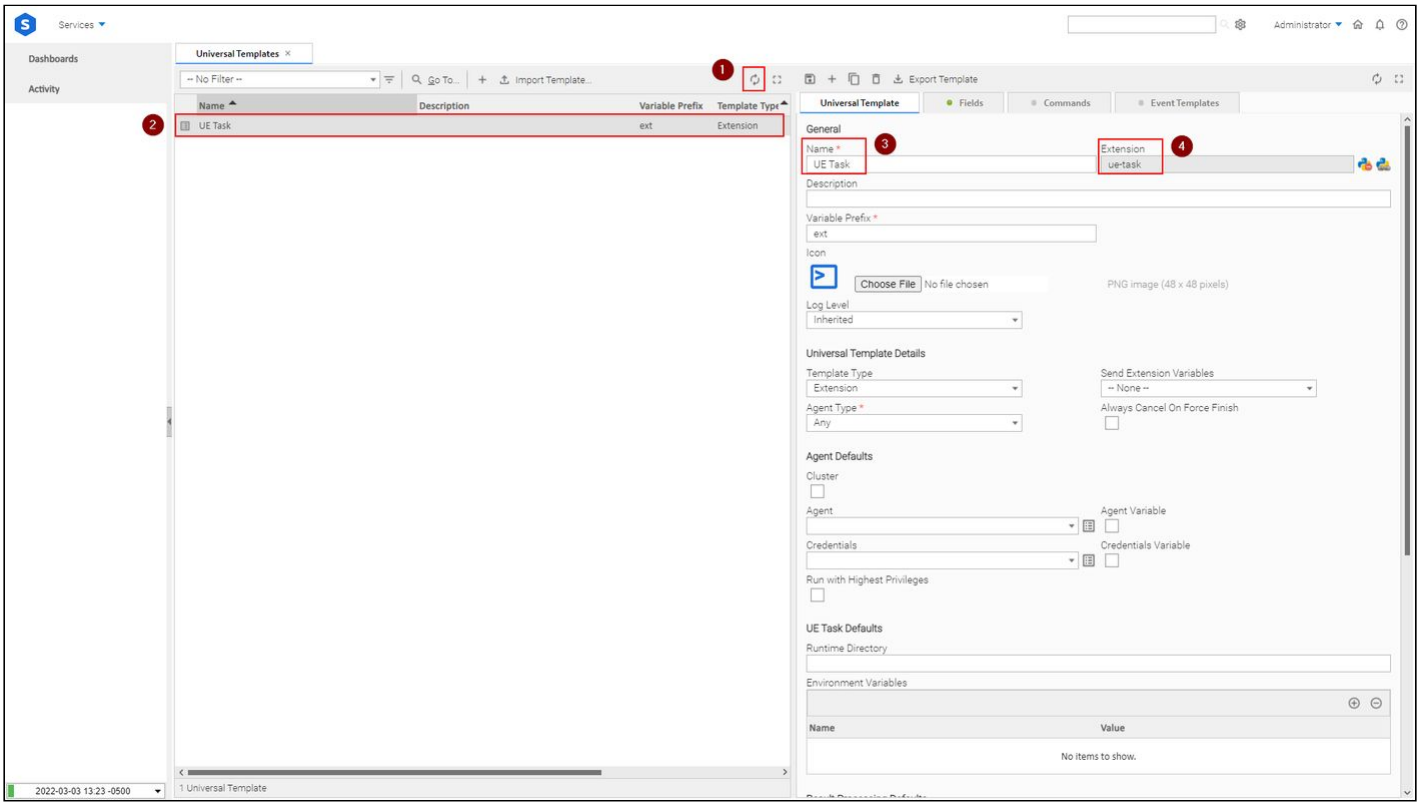


Once again, the **UIP: Upload All** option indicates the full package needs to be uploaded.

When the command is selected, the plugin will upload the full package, in the background. If an error occurs, you will get a notification.

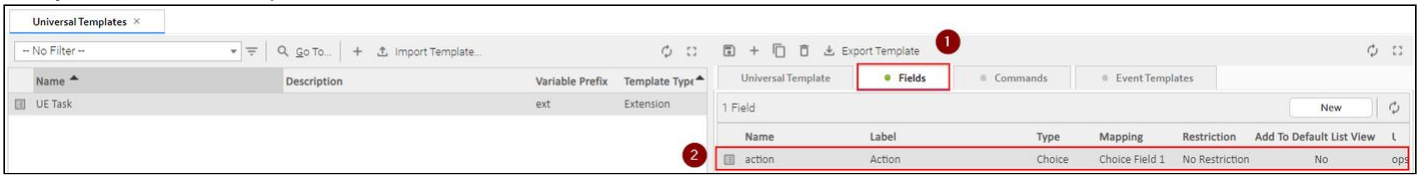
- Verify the **UE Task** Universal Template and **ue-task** Extension are created on the Controller side:





1) Click the "Refresh" icon, if necessary
2) Verify the **UE Task** template is listed
3) Verify the template name is **UE Task**
4) Verify the **ue-task** Extension is attached to the template

- Verify the **UE Task** template contains the "action" field:



  - If you are curious, double-click the "action" field and explore the field details. In the "Choices" tab, you will see the 'print' and 'log' choices

Click here to expand uip-cli specific instructions...

8.1.1.4.3.2 Step 2 Supplemental - Deploy the Initial Extension using the CLI

To connect to the Controller, the CLI needs the Controller's URL along with userid and password. To avoid typing the same information multiple times, the URL and userid will be stored in the local configuration file, and the password will be stored as an environment variable.

- Recall that the local configuration file is located in ~/dev/extensions/sample-task/.uip/config/**uip.yml**. Open the file, and enter the URL and userid information near the end of the file. Shown below is a sample snippet:

```
##############################################################################
#
# Configuration Options Section
#
##############################################################################
#
userid: admin
url: http://localhost:8080/uc
# variables: <JSON string | JSON/YAML file>
# build-all: <yes/no>
# upload-all: <yes/no>
# push-all: <yes/no>
# template-name: <name>
```

- Go back to the command line, and create an environment variable called UIP_PASSWORD with the password as the value.
    - If using Windows, then in CMD: `set UIP_PASSWORD=<your password>`
    - If using Unix/Linux, then in the terminal: `export UIP_PASSWORD=<your password>`

Using the CLI, there are two primary ways to deploy the Extension: using the **push** command, or the **build** command followed by the **upload** command. The latter method will be shown once below, but in subsequent deployments throughout the rest of the tutorial, the **push** command will be used.

- cd into the **sample-task** directory, if not already in there. The CLI can only execute the deployment commands if it is called from the directory containing the **.uip** folder. In this case, it is **sample-task**.
- Issue the build command as follows:

```
$ uip build -a
```

  The **-a** command will build the full package (Extension + Universal Template). Recall that the Universal Template is called **UE Task**, and it does not exist in the Controller. Therefore, the entire package must be built and uploaded.
- Verify the full package was built by going to the ~/dev/extensions/sample-task/dist/**package_build** folder, and making sure **UE_Task_universal_template.zip** file exists.
- Upload the full package as follows:

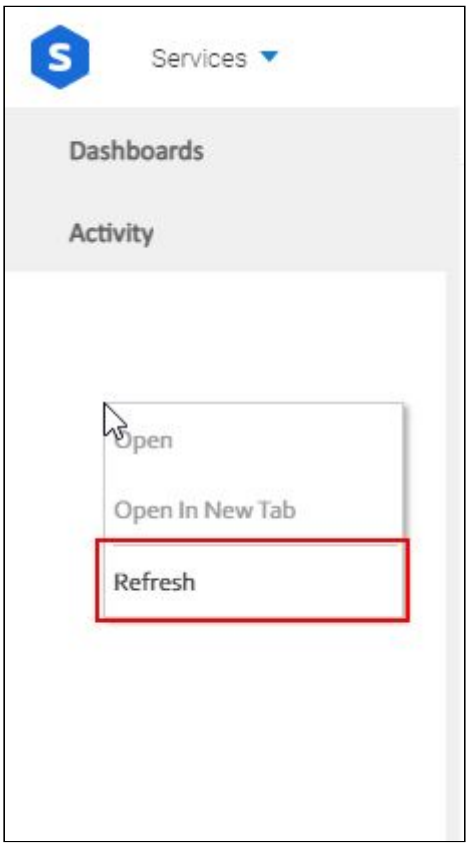
```
$ uip upload -a
```

  Once again, the **-a** option indicates the full package needs to be uploaded.
- Verify the **UE Task** Universal Template and Extension are created on the Controller side using the procedure shown above the supplemental

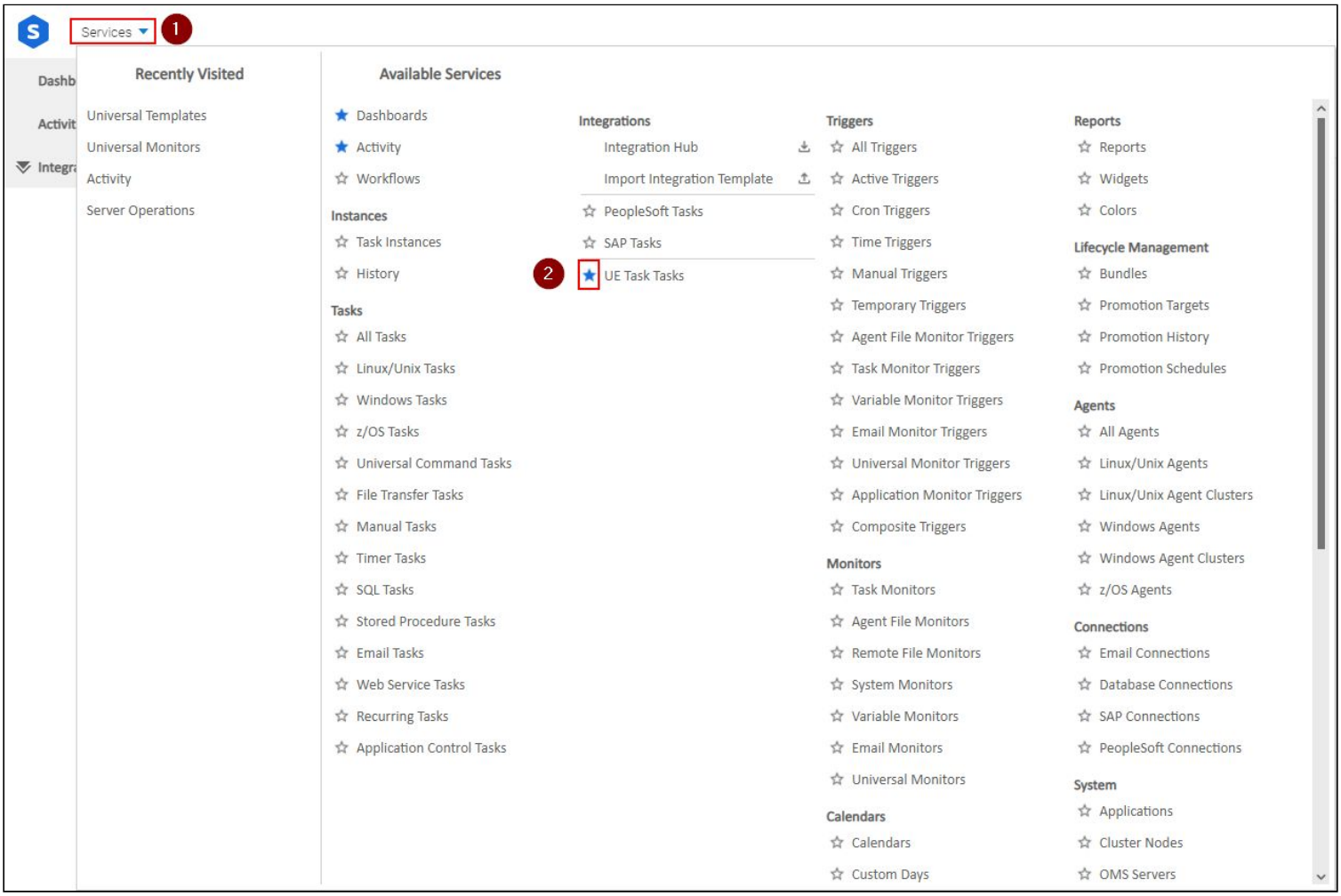
8.1.1.4.4 Step 3 - Create and launch a new 'ue-task-test' task

We are now ready to create a new task to test the initial **ue-task** Extension. In order to make the new **UE Task** task type available in the Integrations section of the Controller's Services menu, we must first refresh the Navigation Tree.

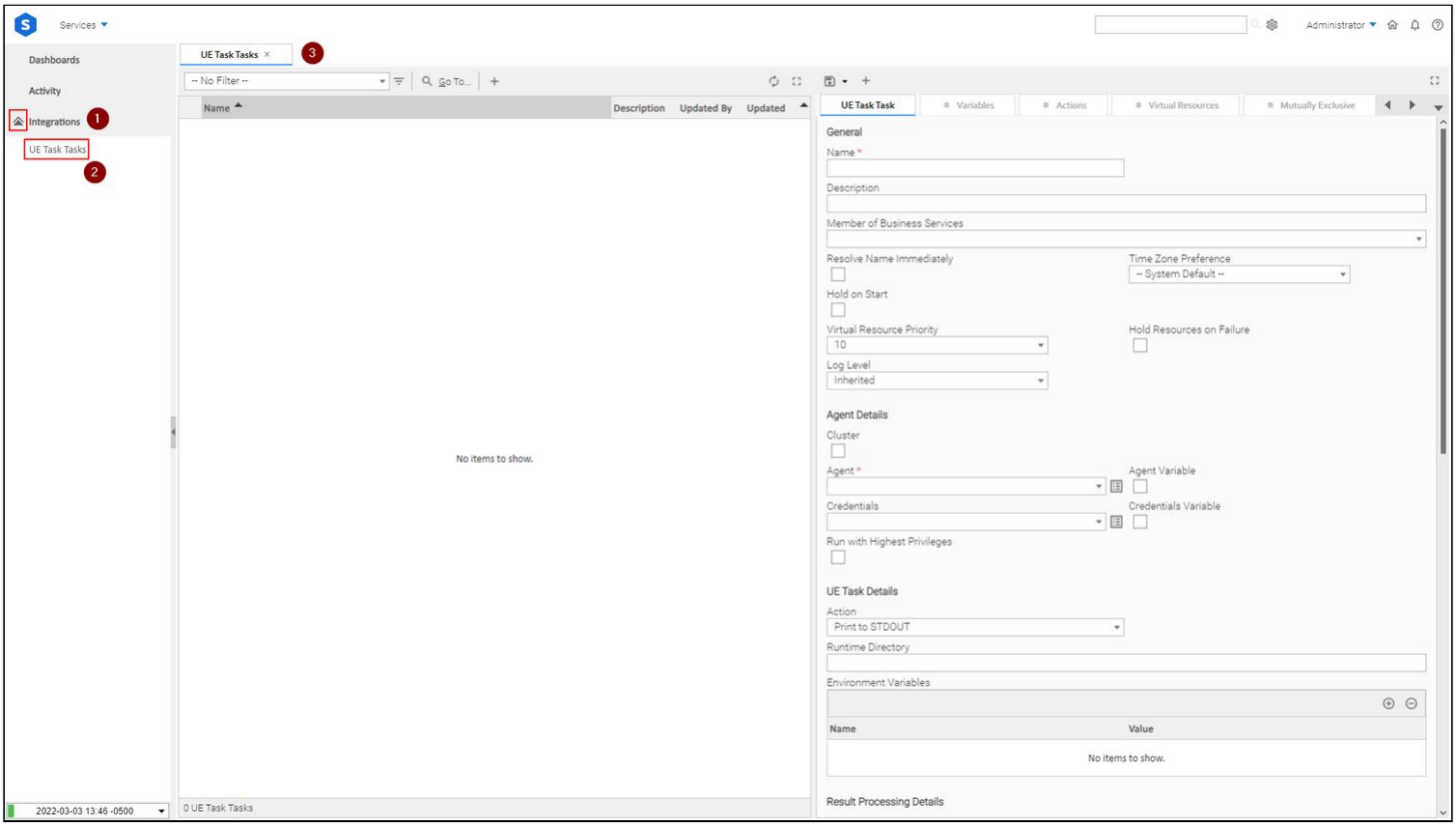
To do this, right click anywhere in the Navigation Tree and select **Refresh**



Click the "Services" menu and click the star/favorites icon next to "UE Task Tasks"

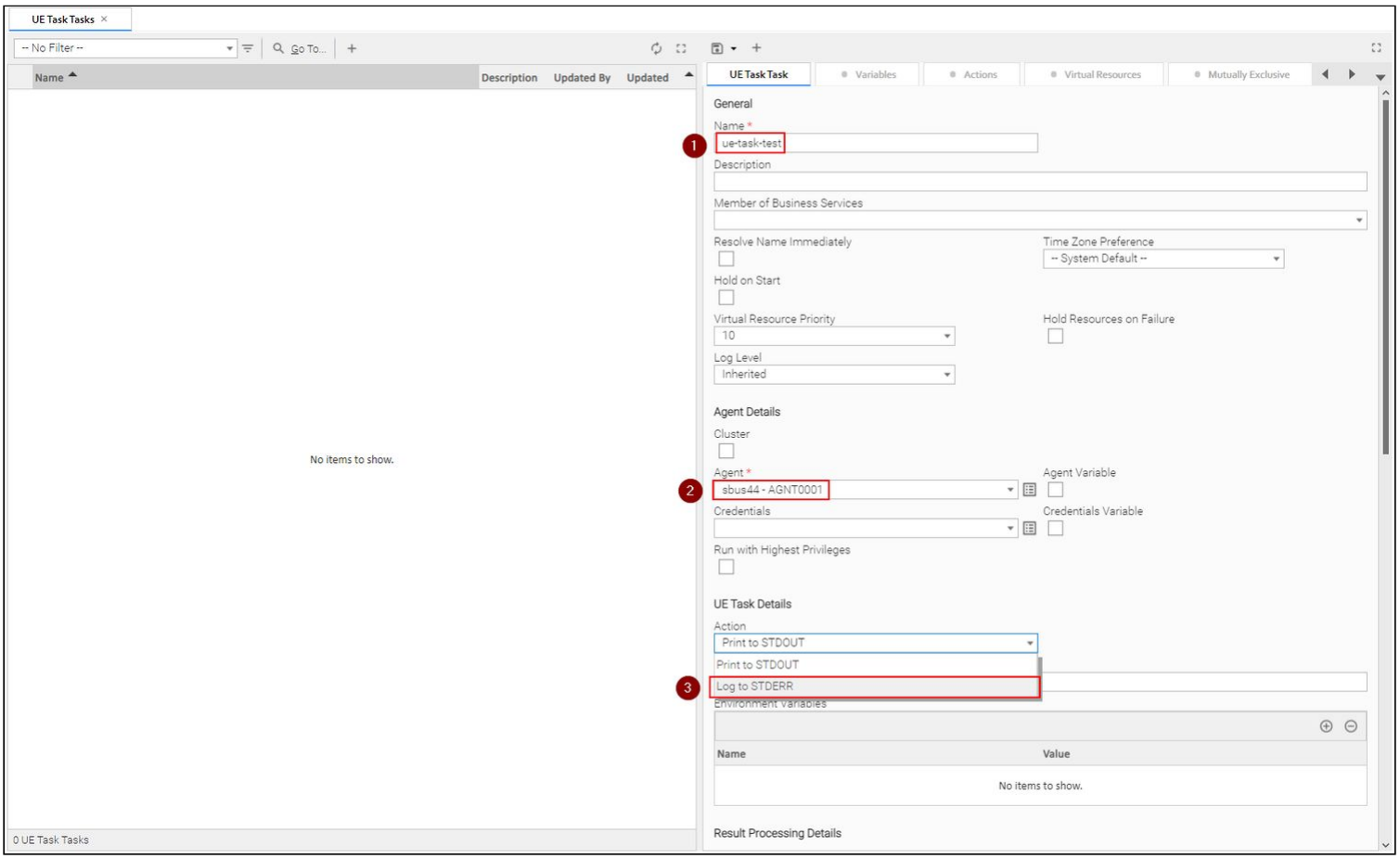


Clicking the star/favorite icon will make the "Integrations" dropdown visible in the Navigation tree. Click the "Integrations" dropdown and select "UE Test Tasks". This should open the "UE Test Tasks" tab

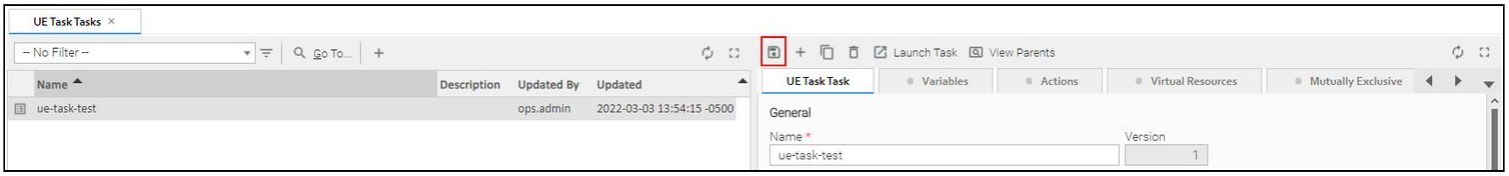


Create the task as show below

1. Give the task a name (for example, **ue-task-test** as shown)
2. Select an **active** agent of **version 7.0.0.0 or higher** for the task to run on.
3. Select the "Log to STDERR" action

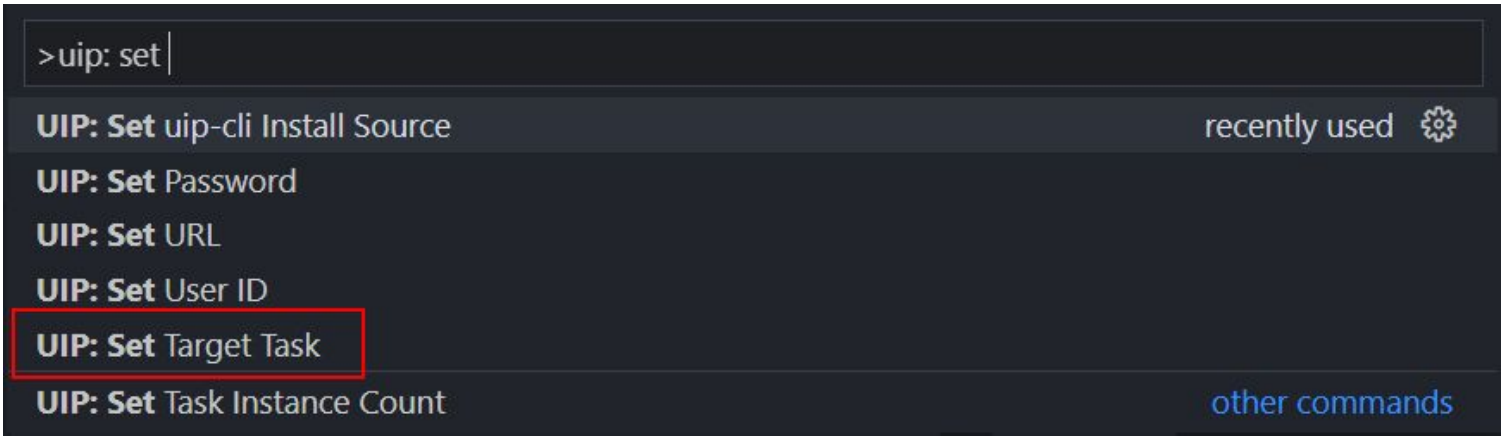


Save the task.

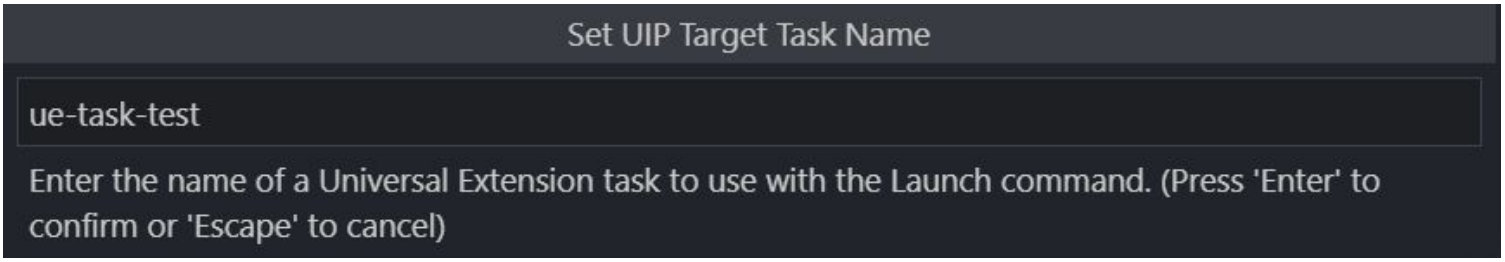


Now, we are ready to launch the task. This can either be done manually through the Controller or using the VS Code Extension as shown below.

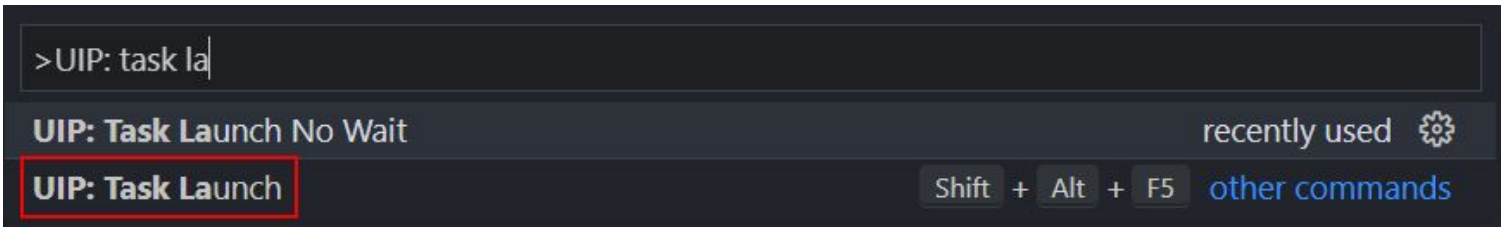
Open the command palette (ctrl + shift + p), search for "UIP: Set", and select "UIP: Set Target Task":



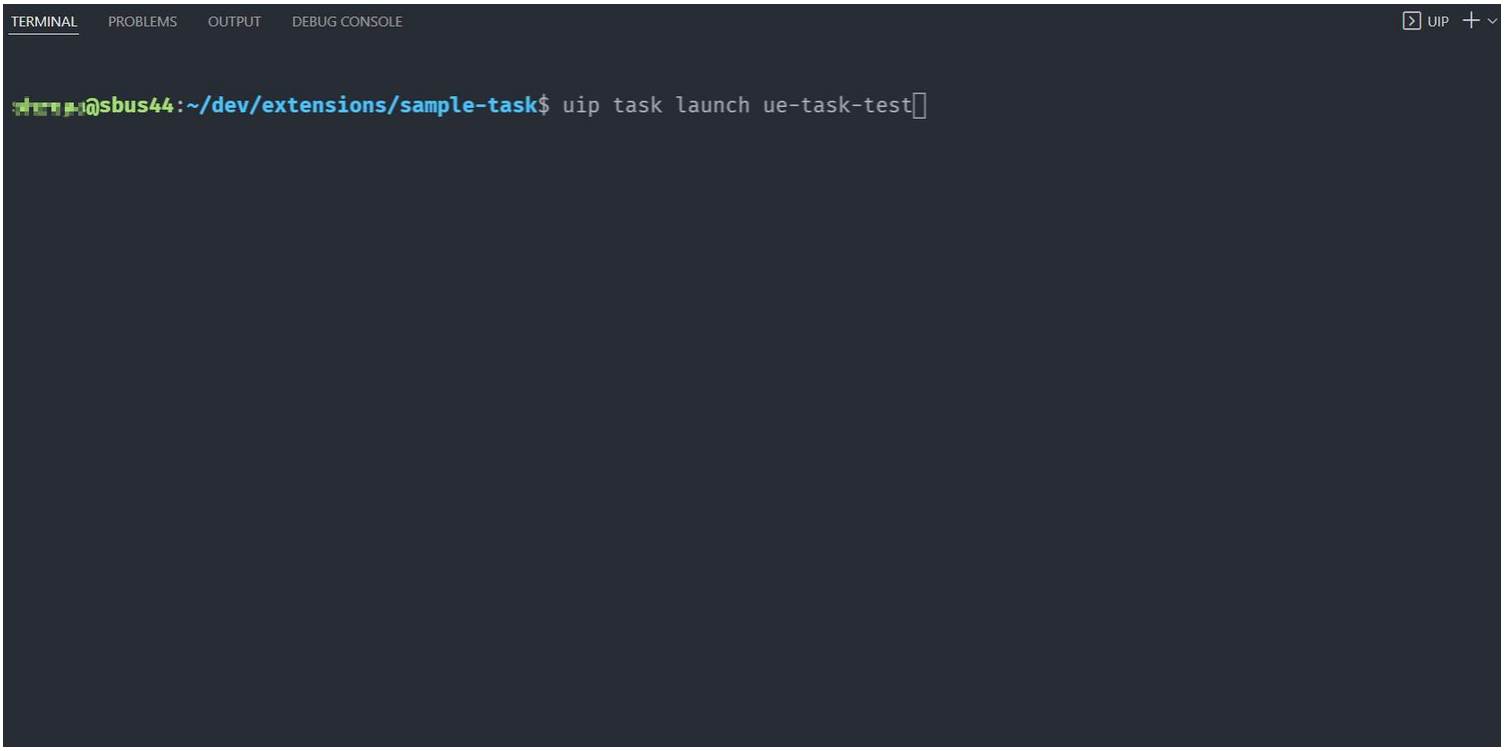
Type the task name and press enter:



Launch the task by opening the command palette and selecting "UIP: Task Launch"



The terminal should be opened, and the uip-cli will be invoked to launch the task. You should see the task status transition from Queue to Running to Success as shown below:



Upon task completion, the task output will be retrieved and printed to the screen.

Notice that the STDOUT output section is empty since we are not printing anything using the `print()` function.

The EXTENSION output section contains "Hello Extension!" which is exactly what we coded in line 46 of **extension.py**

The STDERR output contains "Hello STDERR!" because we selected the "Log to STDERR" action in the task form. In the next step, we will change the action to "print to STDOUT" instead and observe the behavior.

Click here to expand uip-cli specific instructions...

8.1.1.4.4.1 Step 3 Supplemental - Create and launch a new 'ue-task-test' task

The task creation process is exactly the same as above. As for launching the task, run the command shown in the GIF animation above.

8.1.1.4.5 Step 4 - Modify the Extension and Deploy using the UIP VS Code Extension

So far, we have pushed the initial Extension, created a task for it, and tested the Extension code. Now, the **extension.py** file will be slightly modified to demonstrate the process of deploying a modified Extension using the UIP VS Code Extension.

Edit the ~/dev/extensions/sample-task/src/**extension.py** file to contain the following code:

extension.py

```
from __future__ import (print_function)
from universal_extension import UniversalExtension
from universal_extension import ExtensionResult
from universal_extension import logger


class Extension(UniversalExtension):
    """Required class that serves as the entry point for the extension
    """

    def __init__(self):
        """Initializes an instance of the 'Extension' class
        """
        # Call the base class initializer
        super(Extension, self).__init__()

    def extension_start(self, fields):
        """Required method that serves as the starting point for work performed
        for a task instance.

        Parameters
        ----------
        fields : dict
            populated with field values from the associated task instance
            launched in the Controller

        Returns
        -------
        ExtensionResult
            once the work is done, an instance of ExtensionResult must be
            returned. See the documentation for a full list of parameters that
            can be passed to the ExtensionResult class constructor
        """

        # Get the value of the 'action' field
        action = fields.get('action', [""])[0]

        # Print/Log the message 3 times
        for _ in range(3):
```

```
40              if action.lower() == 'print':
41                  # Print to standard output...
42                  print("Hello STDOUT!")
43              else:
44                  # Log to standard error...
45                  logger.info('Hello STDERR!')
46
47          # Return the result with a payload containing a Hello message...
48          return ExtensionResult(
49              unv_output='Hello Extension!'
50          )
```

The changes made above are:

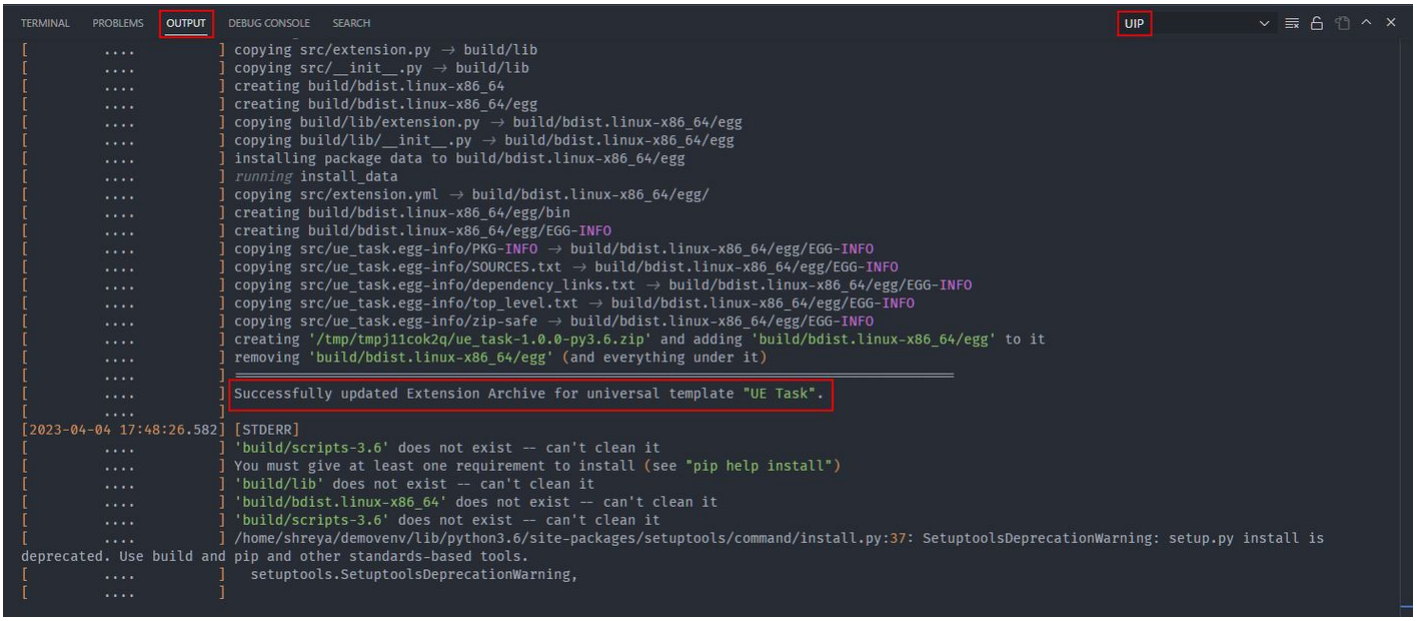
Line 38	For-loop that runs three times. In each iteration, either the STDOUT or STDERR message will be printed

Now, we need to deploy the modified Extension to the Controller. Unlike the first time where the entire package needed to be deployed, only the Extension needs to be deployed this time since that is all we changed.

- Open the command pallete and run the **UIP: Push** command:

The command will continue to run, in background. You should see the status bar updated as follows:

If the command failed, you should get an error notification. You can view the command output anytime in the UIP output channel



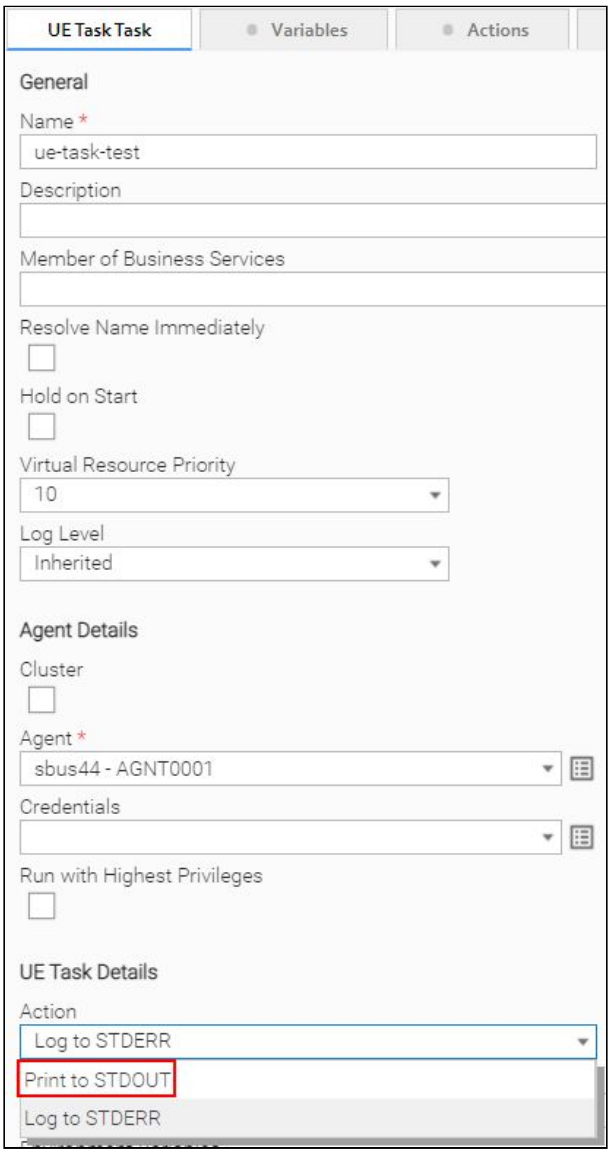
Instead of **UIP: Build All** followed by **UIP: Upload All**, this time **UIP: Push** was used as it is essentially just a

combination of **UIP: Build** and **UIP: Upload**. Notice that the **UIP: Push All** command was not used given that we are only pushing the Extension and not the entire package. If the **template.json** file was modified locally, then the **UIP: Push All** command should be used to update the entire package on the Controller side.
If you are wondering how the **UIP: Push** command knows what Universal Template to push the **ue-task** extension to, open the ~/dev/extensions/sample-task/src/templates/**template.json** file, and there will be a field called "name" with the value "UE Task". The "UE Task" is the name of the Universal Template. Internally, the CLI reads the **template.json** file and extracts the name from it.

To verify the **ue-task** Extension was updated successfully, run the **ue-task-test** task again as shown in the previous step. The output should look similar to the one shown below:

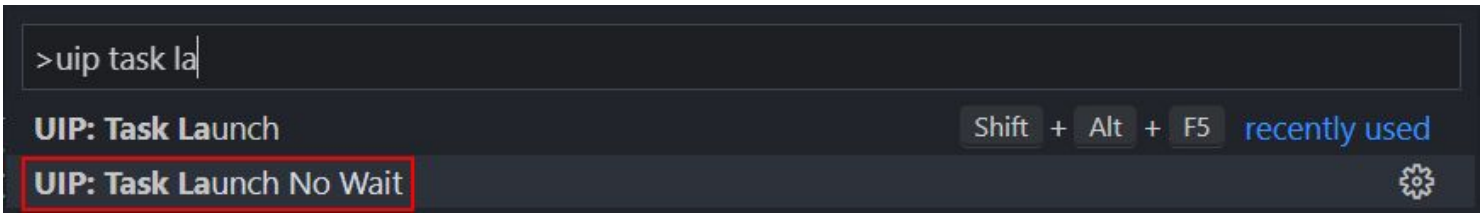
```
[redacted]@sbus44:~/dev/extensions/sample-task$ uip task launch ue-task-test
Successfully launched the Universal task "ue-task-test" with task instance id 164633139281755974O6S5X4SRHJYIEE.
================================================================================================================
Status: Success
================================================================================================================


STDERR Output:
==============
2022-03-03 15:38:07,782 - 14500 MainThread          - extension.py[44] INFO: Hello STDERR!
2022-03-03 15:38:07,782 - 14500 MainThread          - extension.py[44] INFO: Hello STDERR!
2022-03-03 15:38:07,782 - 14500 MainThread          - extension.py[44] INFO: Hello STDERR!


STDOUT Output:
==============
[empty]

EXTENSION Output:
=================
Hello Extension!
```

Notice that the STDOUT in the output above is still empty as expected. Now, we will change the value of the "Action" field in **ue-task-test**. Navigate to the task and change the "Action" to "Print to STDOUT":



Make sure to save the task as shown previously.

Now, we will run the task using the "UIP: Task Launch **No Wait**" option shown below:



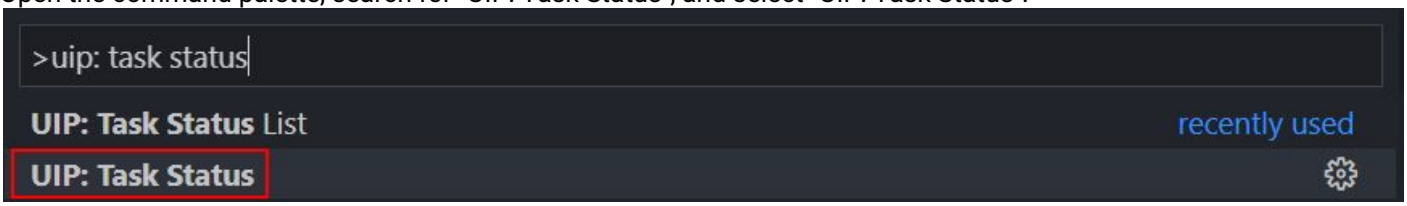
The "No Wait" signifies the task will be launched, but the CLI will not wait for the task to finish. Consequently, the final status and output of the task will NOT be retrieved.

Go ahead and launch the task using the "No Wait" option. You should see something similar as shown below:

```
[redacted]@sbus44:~/dev/extensions/sample-task$ uip task launch ue-task-test --no-wait
Successfully launched the Universal task "ue-task-test" with task instance id 1646331392817624740ANZG6STM0DTT0.
[redacted]@sbus44:~/dev/extensions/sample-task$
```

We can retrieve the task status and output manually from the Controller or use the VS Code Extension as shown below.

Open the command palette, search for "UIP: Task Status", and select "UIP: Task Status":

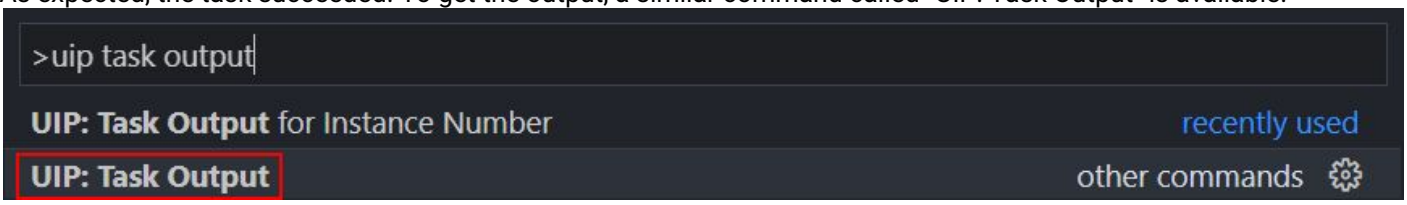


The "UIP: Task Status" command lists the status of the most recent task instance whereas the "UIP: Task Status List" gets the statuses of the 20 (this number can be configured using "UIP: Set Task Instance Count") most recent task instances.

Upon running the command, you should see something similar to the output shown below (the "Instance Number", "Instance Id", and "Launch Time" will most likely be different):

```
[redacted]@sbus44:~/dev/extensions/sample-task$ uip task status ue-task-test
+-----------------+----------------------------------+---------------------+--------------------+--------------------+
| Instance Number | Instance Id                      | Launch Time         | Status (Exit Code) | Status Description |
+-----------------+----------------------------------+---------------------+--------------------+--------------------+
| 19              | 1646331392817624740ANZG6STM0DTT0 | 2022-03-03 15:50:09 | Success (0)        | N/A                |
+-----------------+----------------------------------+---------------------+--------------------+--------------------+
```

As expected, the task succeeded. To get the output, a similar command called "UIP: Task Output" is available:



The "UIP: Task Output" command retrieves the output of the latest task instance whereas the "UIP: Task Output for Instance Number" gets the output of a task instance with a specific instance number.

Since we want to get the output of the recent task instance, "UIP: Task Output" is sufficient. Run the command, and the output should be similar to one shown below:

```
TERMINAL  PROBLEMS 3  OUTPUT  DEBUG CONSOLE                                UIP

shreya@sbus44:~/dev/extensions/sample-task$ uip task output ue-task-test
STDERR Output:
==============
[empty]

STDOUT Output:
==============
Hello STDOUT!
Hello STDOUT!
Hello STDOUT!


EXTENSION Output:
=================
Hello Extension!
```

Notice that this time, the STDERR output is empty and STDOUT output is not. This is expected since we changed the value of the "Action" field in the task form.

8.1.1.4.6 Step 5 - Reset the Extension Changes

The For-Loop changes that prints out the 'Hello' message multiple times were added to demonstrate the process of modifying and deploying the Extension. The next few tutorials assume that the For-Loop changes aren't in **extension.py**, so either undo the For-Loop changes or copy the code shown below to **extension.py** before moving on to the next guide:

extension.py

```
from __future__ import (print_function)
from universal_extension import UniversalExtension
from universal_extension import ExtensionResult
from universal_extension import logger


class Extension(UniversalExtension):
    """Required class that serves as the entry point for the extension
    """

    def __init__(self):
        """Initializes an instance of the 'Extension' class
        """
        # Call the base class initializer
        super(Extension, self).__init__()

    def extension_start(self, fields):
        """Required method that serves as the starting point for work performed
        for a task instance.

        Parameters
        ----------
        fields : dict
            populated with field values from the associated task instance
            launched in the Controller

        Returns
        -------
        ExtensionResult
            once the work is done, an instance of ExtensionResult must be
            returned. See the documentation for a full list of parameters that
            can be passed to the ExtensionResult class constructor
        """

        # Get the value of the 'action' field
        action = fields.get('action', [""])[0]

        if action.lower() == 'print':
            # Print to standard output...
            print("Hello STDOUT!")
        else:
            # Log to standard error...
            logger.info('Hello STDERR!')

        # Return the result with a payload containing a Hello message...
        return ExtensionResult(
```

```
            unv_output='Hello Extension!'
        )
```

8.1.1.5 Dynamic Choice Field

8.1.1.5.1 Introduction

On this page, we will enhance the ue-task Extension developed in the previous chapter by adding two Dynamic Choice Fields to the "UE Task" template. A corresponding change will be made in extension.py to implement the functionality that will populate the Dynamic Choice Fields.

These choice fields will be available to "UE Task" task types at definition time and allow the user to select values that are populated by the target agent system prior to task submission.

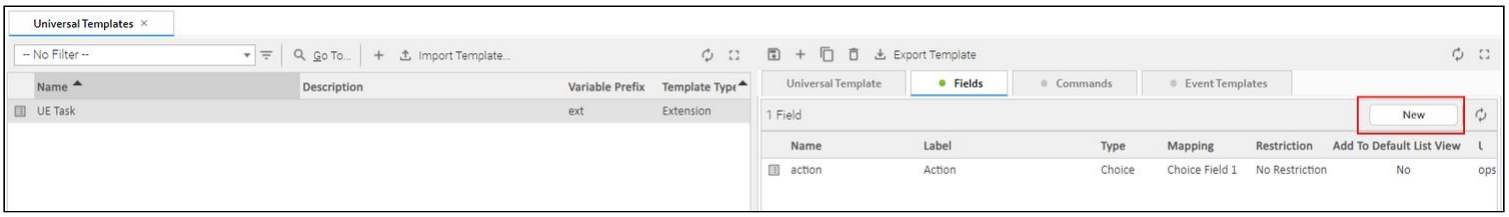
This page will cover the following:

1. Add Dynamic Choice fields to the "UE Task" Universal Template.
2. Add backing implementation for Dynamic Choice fields to the extension.py file in the sample-task Extension project.
3. Rebuild and upload the modified Extension.
4. Populate the Dynamic Choice fields on a task definition form.

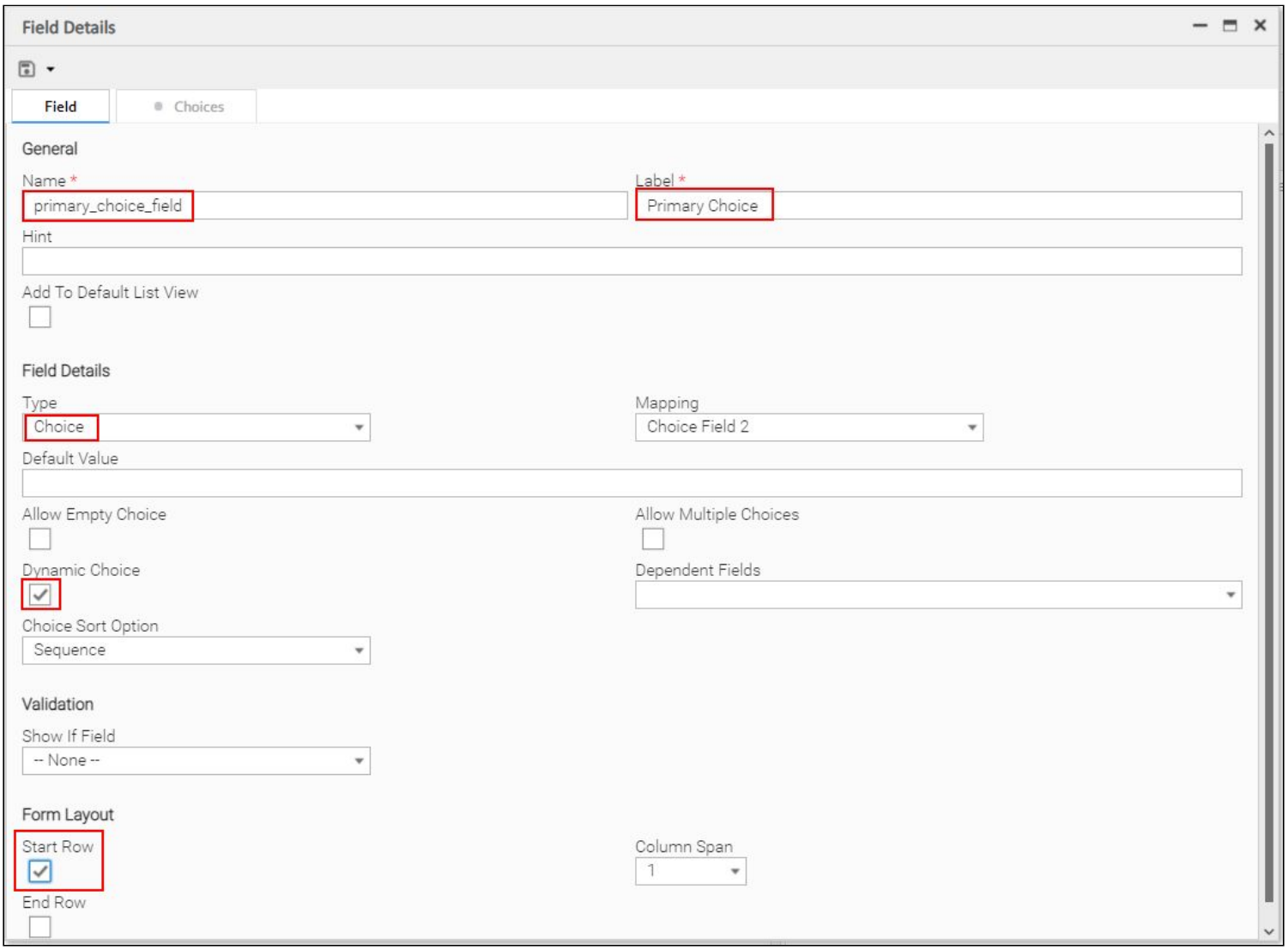
8.1.1.5.2 Step 1 - Add Dynamic Choice fields to the "UE Task" Universal Template

Go back to the "UE Task" Universal Template form.

Click on the "New" option in the "Fields" tab of the template

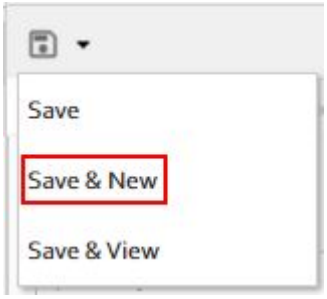


In the new field popup windows, create a new Dynamic Choice field with a name of “**primary_choice_field**”:

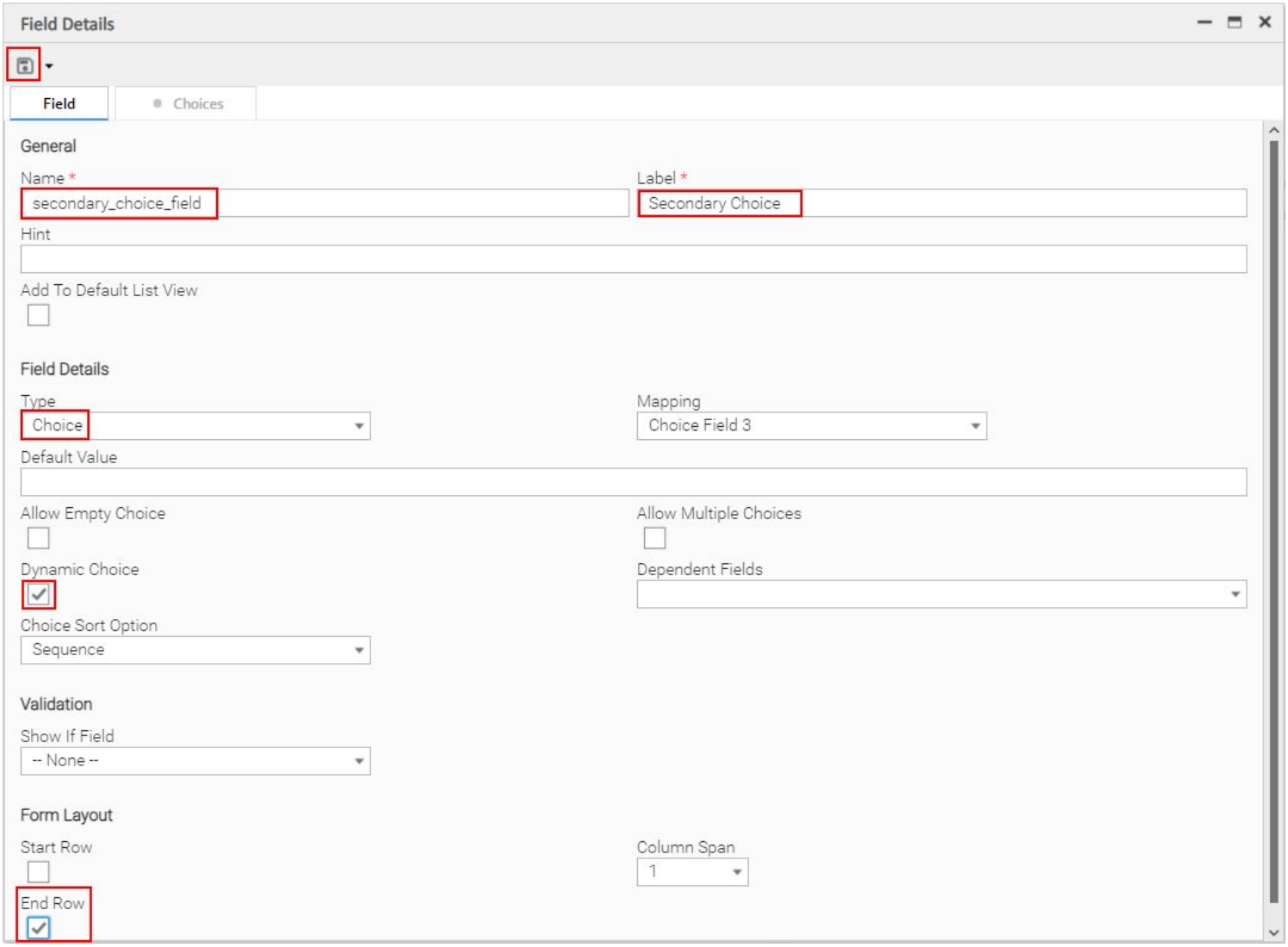


Note that "Start Row" is checked in the Form Layout section. This is not required. It is selected only to achieve a better layout of form fields.

Click the dropdown next to the "Save" icon and select "Save & New":



Next, create a second Dynamic Choice field with a name of "**secondary_choice_field**".



Note that "End Row" is checked in the Form Layout section. This is not required. It is selected only to achieve a better layout of form fields.

Click the "Save" icon to save the field.

8.1.1.5.3 Step 2 - Add backing implementation for Dynamic Choice fields to extension.py

Open file `~/dev/extensions/sample-task/src/extension.py` in your editor of choice.

Add the implementation of the **primary_choice_field** and **secondary_choice_field** Dynamic Choice Commands:

primary_choice_field Dynamic Choice Command

```
1  from __future__ import (print_function)
2  from universal_extension import UniversalExtension
3  from universal_extension import ExtensionResult
4  from universal_extension import logger
5  from universal_extension.deco import dynamic_choice_command
6
7
```

```
class Extension(UniversalExtension):
    """Required class that serves as the entry point for the extension
    """

    def __init__(self):
        """Initializes an instance of the 'Extension' class
        """
        # Call the base class initializer
        super(Extension, self).__init__()

    @dynamic_choice_command("primary_choice_field")
    def primary_choice_command(self, fields):
        """Dynamic choice command implementation for
        primary_choice_field.

        Parameters
        ----------
        fields : dict
            populated with the values of the dependent fields
        """
        return ExtensionResult(
            rc=0,
            message="Values for choice field: 'primary_choice_field'",
            values=["Start", "Pause", "Stop", "Build", "Destroy"]
        )

    @dynamic_choice_command("secondary_choice_field")
    def secondary_choice_command(self, fields):
        """Dynamic choice command implementation for
        secondary_choice_field.

        Parameters
        ----------
        fields : dict
            populated with the values of the dependent fields
        """
        return ExtensionResult(
            rc=0,
            message="Values for choice field: 'secondary_choice_field'",
            values=["System", "Command", "Application", "Transfer", "Evidence"]
        )

    def extension_start(self, fields):
        """Required method that serves as the starting point for work performed
        for a task instance.

        Parameters
        ----------
        fields : dict
            populated with field values from the associated task instance
            launched in the Controller

        Returns
        -------
        ExtensionResult
            once the work is done, an instance of ExtensionResult must be
            returned. See the documentation for a full list of parameters that
```

```
63              can be passed to the ExtensionResult class constructor
64          """
65
66          # Get the value of the 'action' field
67          action = fields.get('action', [""])[0]
68
69          if action.lower() == 'print':
70              # Print to standard output...
71              print("Hello STDOUT!")
72          else:
73              # Log to standard error...
74              logger.info('Hello STDERR!')
75
76          # Return the result with a payload containing a Hello message...
77          return ExtensionResult(
78              unv_output='Hello Extension!'
79          )
```

Line 5	We added an import for the dynamic_choice_command decorator which comes from the UniversalExtension base package.
Lines 18 to 32	The complete implementation of the Dynamic Choice command that supports the Dynamic Choice field **primary_choice_field** defined in the Universal Template.
Lines 34 to 48	The complete implementation of the Dynamic Choice command that supports the Dynamic Choice field **secondary_choice_field** defined in the Universal Template.

Note

The value supplied to the dynamic_choice_command decorator must match the field name of the associated Dynamic Choice field in the Controller's Universal Template (for example, @dynamic_choice_command("**primary_choice_field**")).

8.1.1.5.4 Step 3 - Build and Upload the Extension Zip Archive Using the UIP VS Code Extension

Save all changes to extension.py.

From the VS Code command pallet, execute the **UIP: Push** command as shown below:

Recall that the **UIP: Push** command builds and uploads the Extension zip archive

Click here to expand uip-cli details...

8.1.1.5.4.1 Step 3 Supplemental - Build and Upload the Extension Zip Archive Using the CLI

Save all changes to extension.py.

From the command line, cd to the sample-task directory and execute the **push** command as shown below:

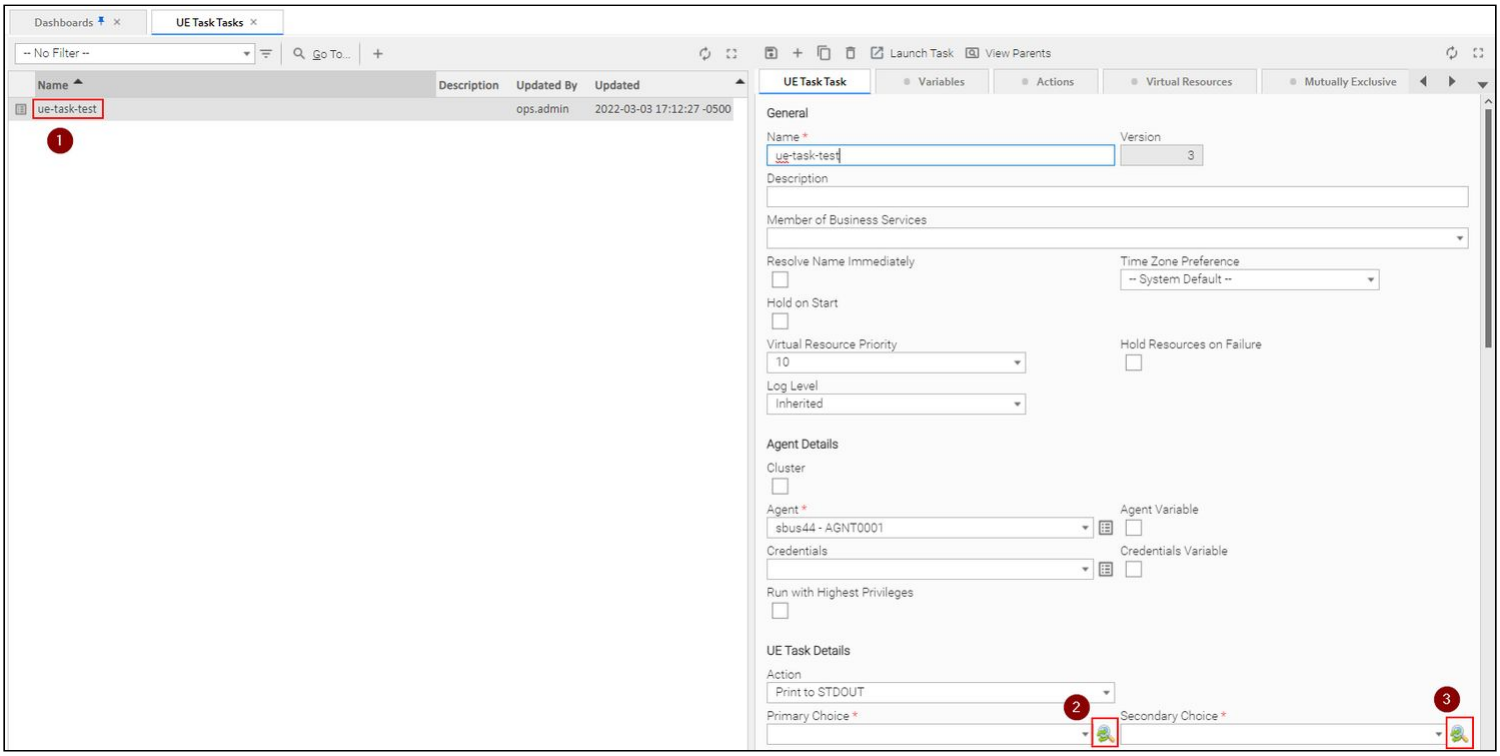
```
$ uip push
```

Recall that the **push** command builds and uploads the Extension zip archive

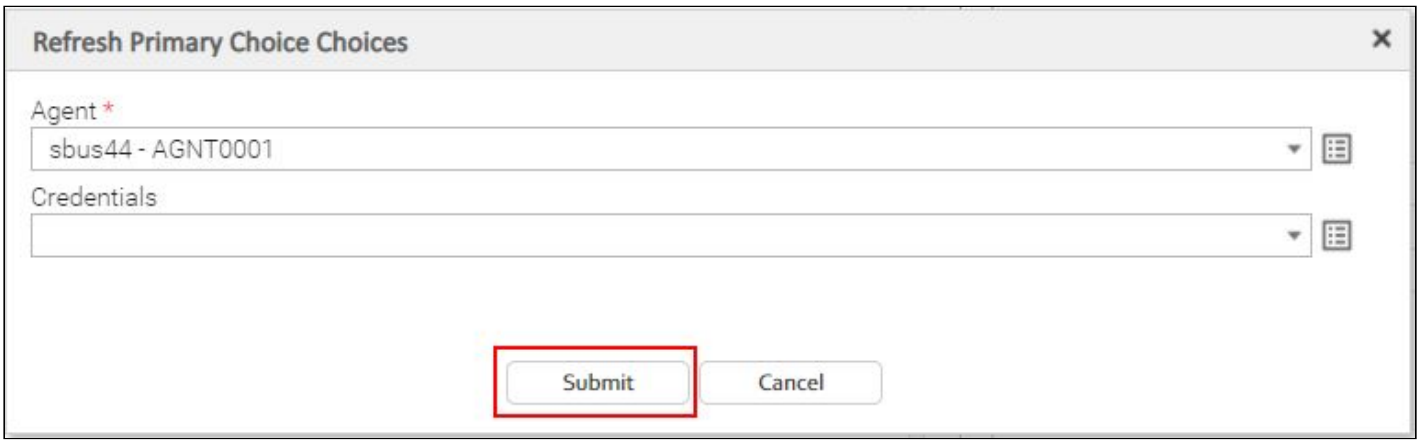
8.1.1.5.5 Step 4 - Experience the Dynamic Choice Fields in Action

In the Controller, if the **UE Task** Tasks tab is open, close it now (required to pick up the addition of the Dynamic Choice fields).

Open **UE Task** Tasks tab:



1. Select the **ue-task-test** (or whatever name you gave it) task
2. Select an **active** agent of **version 7.0.0.0 or higher** for the task to run on.
3. Click on the “Primary Choice Field” search icon to initiate a Dynamic Command call. Clicking on the “Primary Choice” search icon will open the following dialog. Click the “Submit” button.



Upon clicking the Submit button, the Primary Choice Field search icon will turn grey for a moment while the Dynamic Command request is sent down to the Agent and results are returned to populate the drop-down.

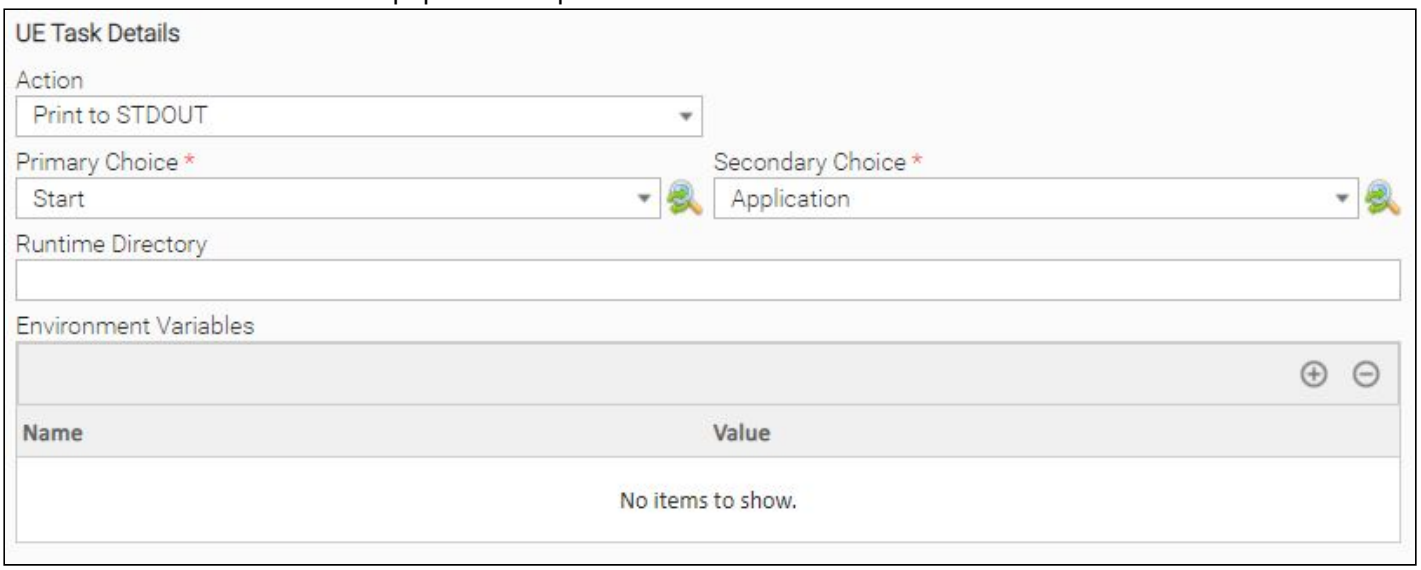
When the operation is complete, the icon will turn green again and the Primary Choice drop-down will be populated with the values supplied by `@dynamic_choice_command("primary_choice_field")` code in the extension on the Agent system.

You have just executed a Dynamic Choice Command from the "Primary Choice" Dynamic Choice field!

> **Note**
>
> By clicking the search icon for the first time, the Controller automatically re-deployed the modified Extension archive to the target agent.

Select a value from the “Primary Choice” drop-down.

4. Follow the previous procedure from “3” to execute the Dynamic Choice Command search for the “Secondary Choice field” and select a value from the populated dropdown.



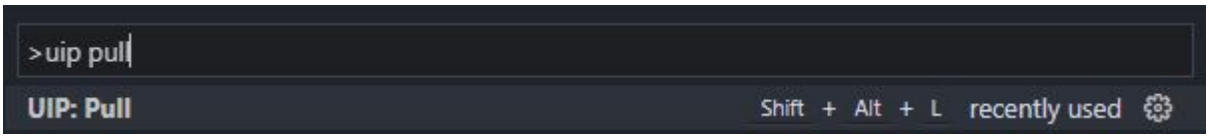
Save the task

8.1.1.5.6 Step 5 - Update the Local template.json

In step 1, we modified the Universal Template by adding new Dynamic Choice Fields. Recall that inside ~/dev/extensions/sample-task/src/templates, there is a **template.json** file. This file should correspond to the Universal Template in the Controller.

Right now, they are not both the same. The Controller's version of **template.json** has the Dynamic Choice Fields changes. To grab those changes, use the **pull** command as shown below:

8.1.1.5.6.1 UIP VS Code Extension



Click here to expand uip-cli details...

Step Supplemental - CLI

Now, both the local and Controller's version of the Universal Template are the same.

It is a good practice to keep both of them in-sync. Otherwise, one or the other could be overwritten. For example, if the local **template.json** does not contain any new changes that the Controller's version of Universal Template does, then issuing the **UIP: Push All** or **push -a** command will overwrite the Controller's version of the Universal Template.

8.1.1.6 Dynamic Update and Output Only Fields

8.1.1.6.1 Introduction

On this page, we will enhance the ue-task Extension to support Output Only fields. These are fields that are designed to be updated by an Extension instance running on an agent system. They can be used for any purpose but, a typical use case is to reflect state changes that occur in the Extension instance. That is what we will simulate here.

This page will cover the following:

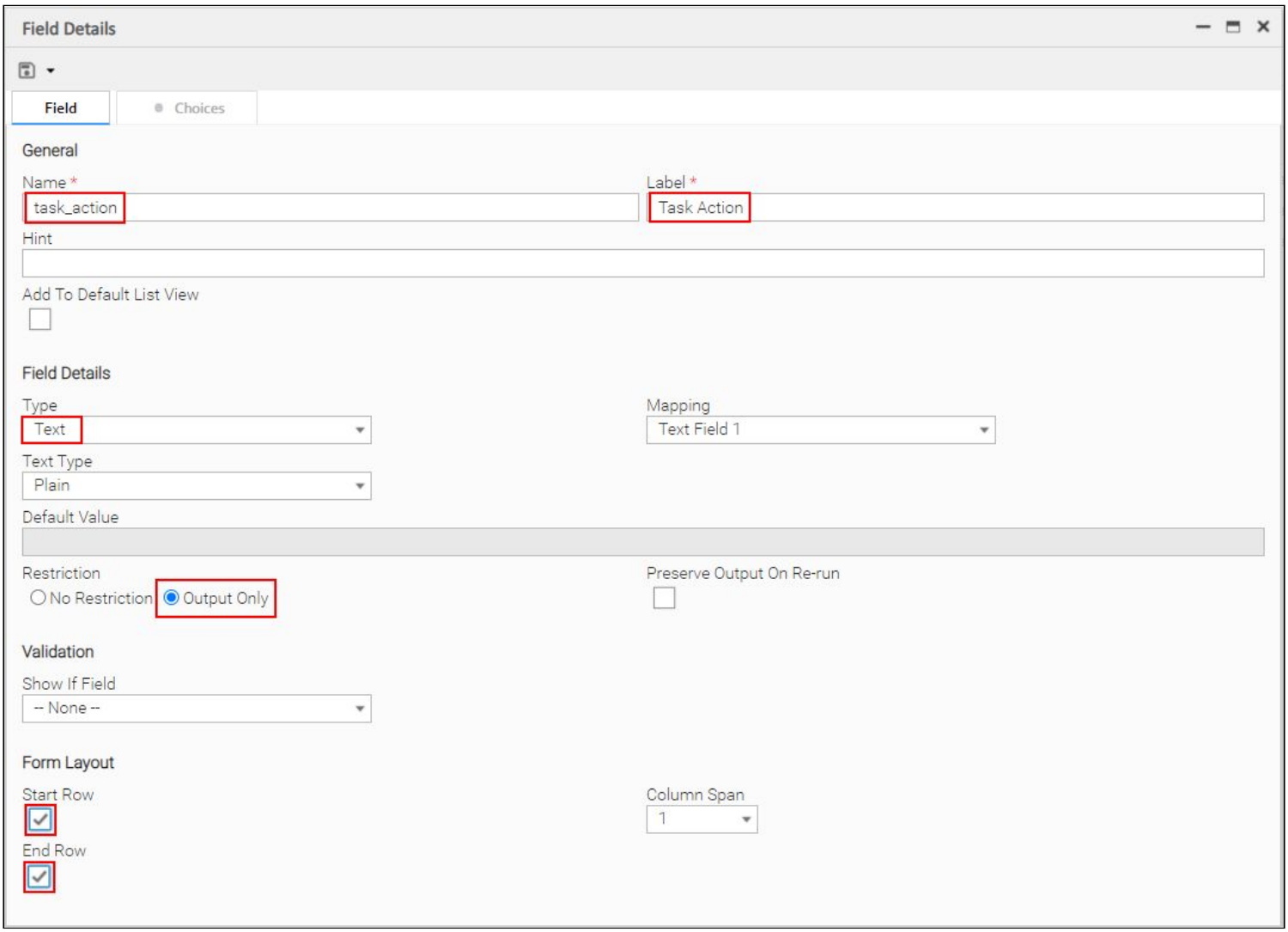
1. Add Output Only fields to the "UE Task" Universal Template.
2. Modify extension.py to populate Output Only fields.
3. Execute ue-task-test task and review the Output Only field updates

8.1.1.6.2 Step 1 - Output Only fields to the "UE Task" Universal Template

Go back to the "UE Task" Universal Template form.

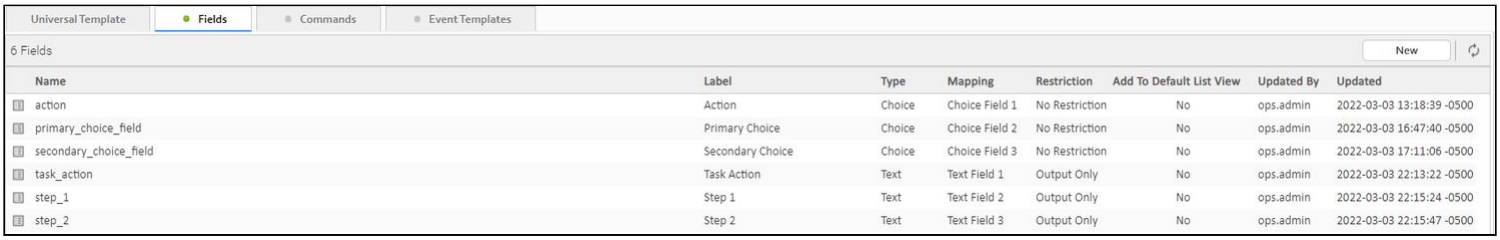
On the Fields tab of the Universal Template, create three Output Only fields of type Text:

1. task_action
2. step_1
3. step_2



Click the "Save & New" option in the dropdown next to the "Save" icon and create the step_1 and step_2 fields. (For a better layout, don't check the "Start Row" and "End Row" boxes for step_1 and step_2 fields).

At this point, the Template's Field tab should be populated as follows:



Name	Label	Type	Mapping	Restriction	Add To Default List View	Updated By	Updated
action	Action	Choice	Choice Field 1	No Restriction	No	ops.admin	2022-03-03 13:18:39 -0500
primary_choice_field	Primary Choice	Choice	Choice Field 2	No Restriction	No	ops.admin	2022-03-03 16:47:40 -0500
secondary_choice_field	Secondary Choice	Choice	Choice Field 3	No Restriction	No	ops.admin	2022-03-03 17:11:06 -0500
task_action	Task Action	Text	Text Field 1	Output Only	No	ops.admin	2022-03-03 22:13:22 -0500
step_1	Step 1	Text	Text Field 2	Output Only	No	ops.admin	2022-03-03 22:15:24 -0500
step_2	Step 2	Text	Text Field 3	Output Only	No	ops.admin	2022-03-03 22:15:47 -0500

The **task_action** field will be used to reflect the task action taken by the **ue-task-test** task.

Fields step_1 and step_2 will be used to reflect the progression of work in the task instance as it works its way through them.

8.1.1.6.3 Step 2 - Add support for updating Output Only fields in extension.py

Open file ~/dev/extensions/sample-task/src/**extension.py** in your editor of choice.

Enhance the extension_start method with the following code:

primary_choice_field Dynamic Choice Command

```
from __future__ import (print_function)
import time
from universal_extension import UniversalExtension
from universal_extension import ExtensionResult
from universal_extension import logger
from universal_extension.deco import dynamic_choice_command
from universal_extension import ui


class Extension(UniversalExtension):
    """Required class that serves as the entry point for the extension
    """

    def __init__(self):
        """Initializes an instance of the 'Extension' class
        """
        # Call the base class initializer
        super(Extension, self).__init__()

    @dynamic_choice_command("primary_choice_field")
    def primary_choice_command(self, fields):
        """Dynamic choice command implementation for
        primary_choice_field.

        Parameters
        ----------
        fields : dict
            populated with the values of the dependent fields
        """
        return ExtensionResult(
            rc=0,
            message="Values for choice field: 'primary_choice_field'",
            values=["Start", "Pause", "Stop", "Build", "Destroy"]
        )

    @dynamic_choice_command("secondary_choice_field")
    def secondary_choice_command(self, fields):
        """Dynamic choice command implementation for
        secondary_choice_field.

        Parameters
        ----------
        fields : dict
            populated with the values of the dependent fields
        """
        return ExtensionResult(
            rc=0,
            message="Values for choice field: 'secondary_choice_field'",
            values=["System", "Command", "Application", "Transfer", "Evidence"]
        )

    def extension_start(self, fields):
        """Required method that serves as the starting point for work performed
```

```
        for a task instance.

        Parameters
        ----------
        fields : dict
            populated with field values from the associated task instance
            launched in the Controller

        Returns
        -------
        ExtensionResult
            once the work is done, an instance of ExtensionResult must be
            returned. See the documentation for a full list of parameters that
            can be passed to the ExtensionResult class constructor
        """

        sleep_value = 5

        # Update the 'task_action' Output Only field on the task instance form
        out_fields = {}
        task_action = "{0} {1}".format(
            fields['primary_choice_field'][0],
            fields['secondary_choice_field'][0])
        out_fields["task_action"] = task_action
        ui.update_output_fields(out_fields)

        # Sleep
        time.sleep(sleep_value)

        # Update the 'step_1' Output Only field on the task instance form
        out_fields = {}
        out_fields["step_1"] = "Step 1 - Success"
        ui.update_output_fields(out_fields)

        # Sleep
        time.sleep(sleep_value)

        # Update the 'step_2' Output Only field on the task instance form
        out_fields = {}
        out_fields["step_2"] = "Step 2 - Success"
        ui.update_output_fields(out_fields)

        # Get the value of the 'action' field
        action = fields.get('action', [""])[0]

        if action.lower() == 'print':
            # Print to standard output...
            print("Hello STDOUT!")
        else:
            # Log to standard error...
            logger.info('Hello STDERR!')

        # Return the result with a payload containing a Hello message...
        return ExtensionResult(
            unv_output='Hello Extension!'
        )
```

Line 2	We added an import for the time module to gain access to the sleep function which we will use to force controlled delays between Output Only field updates.
Line 7	We added an import for the **ui** module to access the **update_output_fields()** method
Line 70	We initialize variable **sleep_value**. This variable will be used to control the sleep delays.
Line 73	We create a new dictionary to hold output fields to be sent back to the Controller.
Lines 74 to 76	We format a **task_action** string using the **primary_choice_field** and **secondary_choice_field** values passed down from the Controller.
Line 77	We assign the formatted **task_action string value** to the **out_fields dictionary** using key **"task_action"** to associate it with the "task_action" Output Only field in associated task instance in the Controller.
Line 78	This calls the **update_output_fields()** method from the **ui** module. This will send a message to the Controller and update the value of the specified fields in the associated task instance (in this case just "task_action").
Lines 80 to 94	This follows the same basic basic procedure to update Output Only fields **step_1** and **step_2**. A sleep delay is introduced between each output field update.

8.1.1.6.4 Step 3 - Build and Upload the Extension Zip Archive Using the UIP VS Code Extension

From the VS Code command palette, execute the **UIP: Push** command as shown below:

Recall that the **UIP: Push** command builds and uploads the Extension zip archive

Click here to expand uip-cli details...

8.1.1.6.4.1 Step 3 Supplemental - Build and Upload the Extension Zip Archive Using the CLI

Save all changes to extension.py.

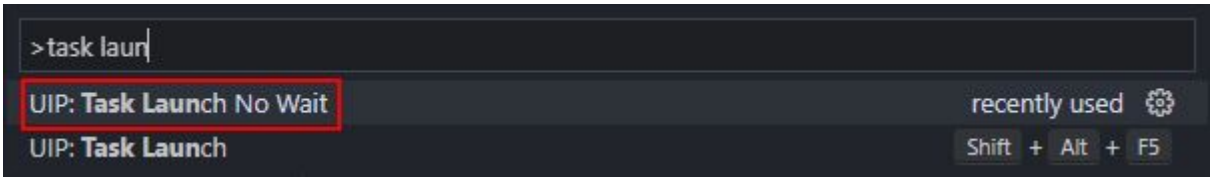
From the command line, cd to the ./sample-1 directory and execute the **push** command as shown below:

```
$ uip push
```

Recall that the **push** command builds and uploads the Extension zip archive

8.1.1.6.5 Step 4 - Launch task and observe the output only fields

From the VS Code command palette, execute the **UIP: Task Launch No Wait** command as shown below:

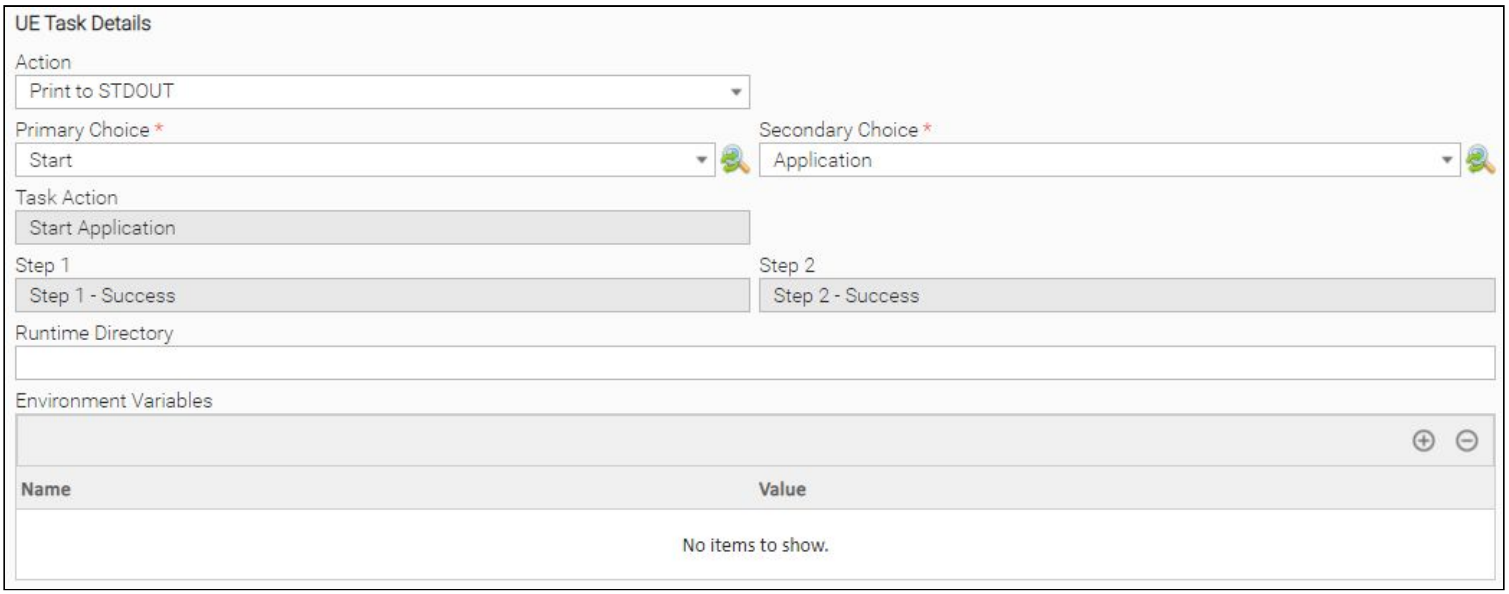


In the Controller, open the "UE Task Tasks" tab and select the **ue-task-test** task (or whatever name you gave it).

Switch to the Instances tab for the task and you should see the recently launched tasks with a status of Running or Success (depending on timing). If the task shows a status of Running, click refresh every few seconds until it goes to Success.

Once the task goes to Success, double click on it to open the task instance form.

Scroll down to the "sample-1 Details" section and review the Output Only fields:



The “Task Action” field along with the “Step 1” and “Step 2” fields have been updated by the Extension instance running on the agent.

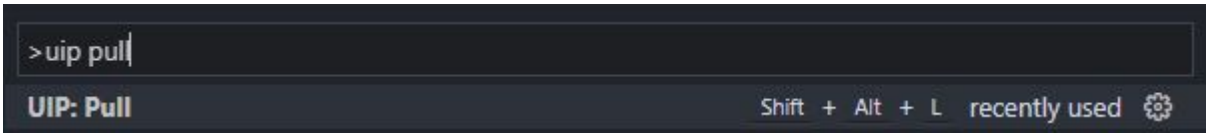
This was accomplished by the calls to `ui.update_output_fields (out_fields)` in the `extension_start` method in extension.py.

8.1.1.6.6 Step 5 - Update the Local template.json

In step 1, we modified the Universal Template by adding new Output Only Fields. Recall that inside ~/dev/extensions/sample-task/src/templates, there is a **template.json** file. This file should correspond to the Universal Template in the Controller.

Right now, they are not both the same. The Controller's version of **template.json** has the Dynamic Choice Fields changes. To grab those changes, use the **pull** command as shown below:

8.1.1.6.6.1 UIP VS Code Extension



```
[redacted]@sbus44:~/dev/extensions/sample-task$ uip pull
The following files were updated:
  - template.json
```

Click here to expand uip-cli details...

Step Supplemental - CLI

```
[redacted]@sbus44:~/dev/extensions/sample-task$ uip pull
The following files were updated:
  - template.json
```

Now, both the local and Controller's version of the Universal Template are the same.

8.1.1.7 Dynamic Command

8.1.1.7.1 Introduction

Dynamic Commands allow you to add supporting functionality to a task instance. In this chapter, we will enhance the ue-task Extension developed in the previous chapters by adding a Dynamic Command. The command we create will reset the task instance - to prepare it for a rerun scenario.

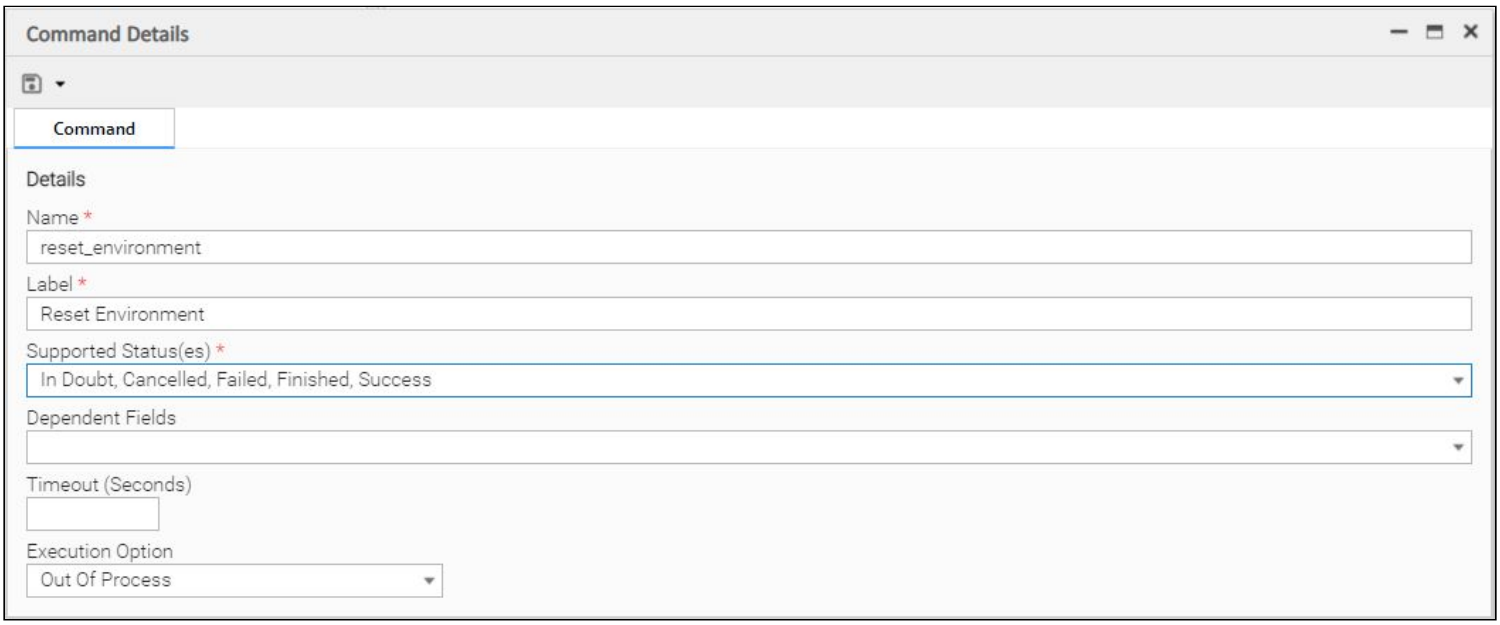
On this page, we will cover the following:

1. Add Dynamic Command to the "UE Task" Universal Template.
2. Add a backing implementation for Dynamic Command to the extension.py file in the ue-task Extension project.
3. Rebuild and upload the modified Extension.
4. Execute the Dynamic Command

8.1.1.7.2 Step 1 - Add a Dynamic Command to the "UE Task" Universal Template

Go back to the "UE Task" Universal Template form.

On the Commands tab, click the "New" button and create the following “Reset Environment” command.



Note that the "Supported Status(es)" is set to: In Doubt, Cancelled, Failed, Finished, and Success. These are the task instance statuses where the command will be available for execution. For all other statuses the command will be greyed out.

Save the command.

8.1.1.7.3 Step 2 - Add Backing Implementation for Dynamic Command to extension.py

Open file `~/dev/extensions/sample-task/src/extension.py` in your editor of choice.

Add the implementation of the **reset_environment** Dynamic Command:

reset_environment Dynamic Command

```
1  from __future__ import (print_function)
2  import time
3  from universal_extension import UniversalExtension
4  from universal_extension import ExtensionResult
5  from universal_extension import logger
6  from universal_extension import ui
7  from universal_extension.deco import dynamic_choice_command
8  from universal_extension.deco import dynamic_command
9
10
11 class Extension(UniversalExtension):
12     """Required class that serves as the entry point for the extension
13     """
14
15     def __init__(self):
16         """Initializes an instance of the 'Extension' class
17         """
18         # Call the base class initializer
19         super(Extension, self).__init__()
20
       @dynamic_choice_command("primary_choice_field")
21     def primary_choice_command(self, fields):
```

```
        """Dynamic choice command implementation for
        primary_choice_field.

        Parameters
        ----------
        fields : dict
            populated with the values of the dependent fields
        """
        return ExtensionResult(
            rc=0,
            message="Values for choice field: 'primary_choice_field'",
            values=["Start", "Pause", "Stop", "Build", "Destroy"]
        )

    @dynamic_choice_command("secondary_choice_field")
    def secondary_choice_command(self, fields):
        """Dynamic choice command implementation for
        secondary_choice_field.

        Parameters
        ----------
        fields : dict
            populated with the values of the dependent fields
        """
        return ExtensionResult(
            rc=0,
            message="Values for choice field: 'secondary_choice_field'",
            values=["System", "Command", "Application", "Transfer", "Evidence"]
        )

    @dynamic_command("reset_environment")
    def reset_environment(self, fields):
        """Dynamic command implementation for reset_environment command.

        Parameters
        ----------
        fields : dict
            populated with the values of the dependent fields
        """

        # Reset the state of the Output Only 'step' fields.
        out_fields = {}
        out_fields["step_1"] = "Initial"
        out_fields["step_2"] = "Initial"
        ui.update_output_fields(out_fields)

        return ExtensionResult(
            message="Message: Hello from dynamic command 'reset_environment'!",
            output=True,
            output_data='The environment has been reset.',
            output_name='DYNAMIC_OUTPUT')

    def extension_start(self, fields):
        """Required method that serves as the starting point for work performed
        for a task instance.

        Parameters
```

```
        ----------
        fields : dict
            populated with field values from the associated task instance
            launched in the Controller

        Returns
        -------
        ExtensionResult
            once the work is done, an instance of ExtensionResult must be
            returned. See the documentation for a full list of parameters that
            can be passed to the ExtensionResult class constructor
        """

        sleep_value = 5

        # Update the 'task_action' Output Only field on the task instance form
        out_fields = {}
        task_action = "{0} {1}".format(
            fields['primary_choice_field'][0],
            fields['secondary_choice_field'][0])
        out_fields["task_action"] = task_action
        ui.update_output_fields(out_fields)

        # Sleep
        time.sleep(sleep_value)

        # Update the 'step_1' Output Only field on the task instance form
        out_fields = {}
        out_fields["step_1"] = "Step 1 - Success"
        ui.update_output_fields(out_fields)

        # Sleep
        time.sleep(sleep_value)

        # Update the 'step_2' Output Only field on the task instance form
        out_fields = {}
        out_fields["step_2"] = "Step 2 - Success"
        ui.update_output_fields(out_fields)

        # Get the value of the 'action' field
        action = fields.get('action', [""])[0]

        if action.lower() == 'print':
            # Print to standard output...
            print("Hello STDOUT!")
        else:
            # Log to standard error...
            logger.info('Hello STDERR!')

        # Return the result with a payload containing a Hello message...
        return ExtensionResult(
            unv_output='Hello Extension!'
        )
```

Line 8	We added an import for the `dynamic_command` decorator which comes from the the `UniversalExtension` base package. (Also moved the `time` module import to line 2)
Lines 53 to 73	The complete implementation of the Dynamic Command that backs the **reset_environment** command defined in the Universal Template.

Note

The value supplied to the dynamic_command decorator must match the command Name of the associated Dynamic Command defined in the Controller's Universal Template (for example, @dynamic_command("**reset_environment**")).

8.1.1.7.4 Step 3 - Build and Upload the Extension Zip Archive Using the UIP VS Code Extension

Save all changes to extension.py.

From the VS Code command pallet, execute the **UIP: Push** command as shown below:

Recall that the **UIP: Push** command builds and uploads the Extension zip archive

Click here to expand uip-cli details...

8.1.1.7.4.1 Step 3 Supplemental - Build and Upload the Extension Zip Archive Using the CLI

Save all changes to extension.py.

From the command line, cd to the ~/dev/extensions/sample-task directory and execute the **push** command as shown below:

```
$ uip push
```

Recall that the **push** command builds and uploads the Extension zip archive

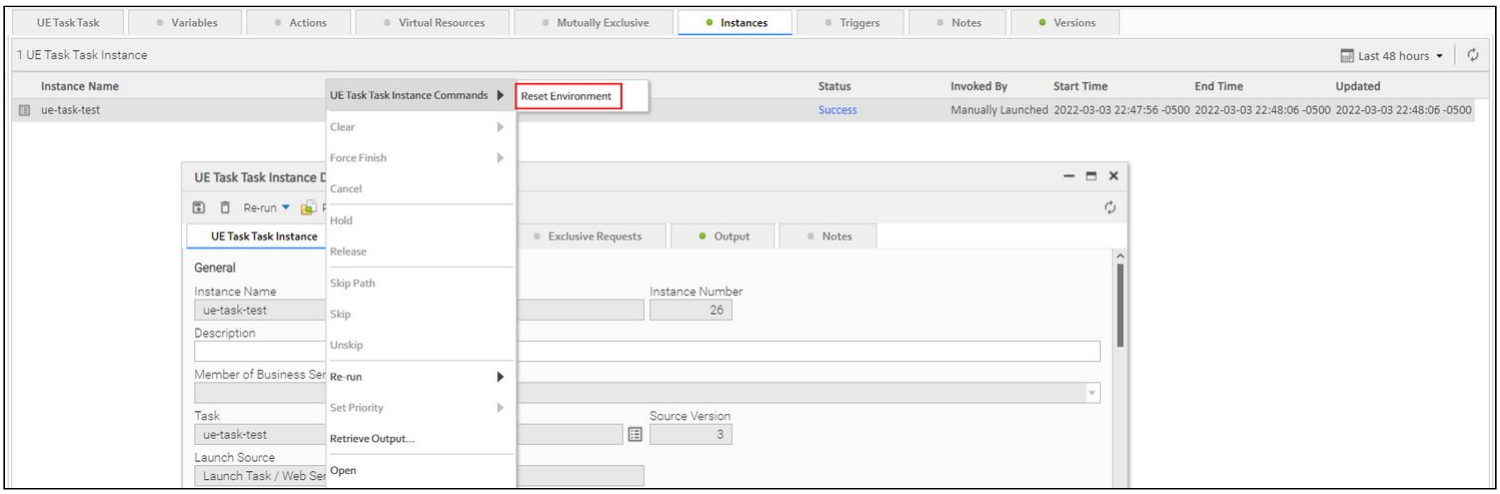
8.1.1.7.5 Step 4 - Execute Dynamic Command

In the Controller, open the "UE Task tasks" tab. **If the tab is already open, it must be closed and reopened before the the new Dynamic Command will be available on the task instances.**

Switch to the Instances tab. If there are no task instances in the list, launch a new one now using the VS Code Command (or manually from the Controller) and let it run to completion.

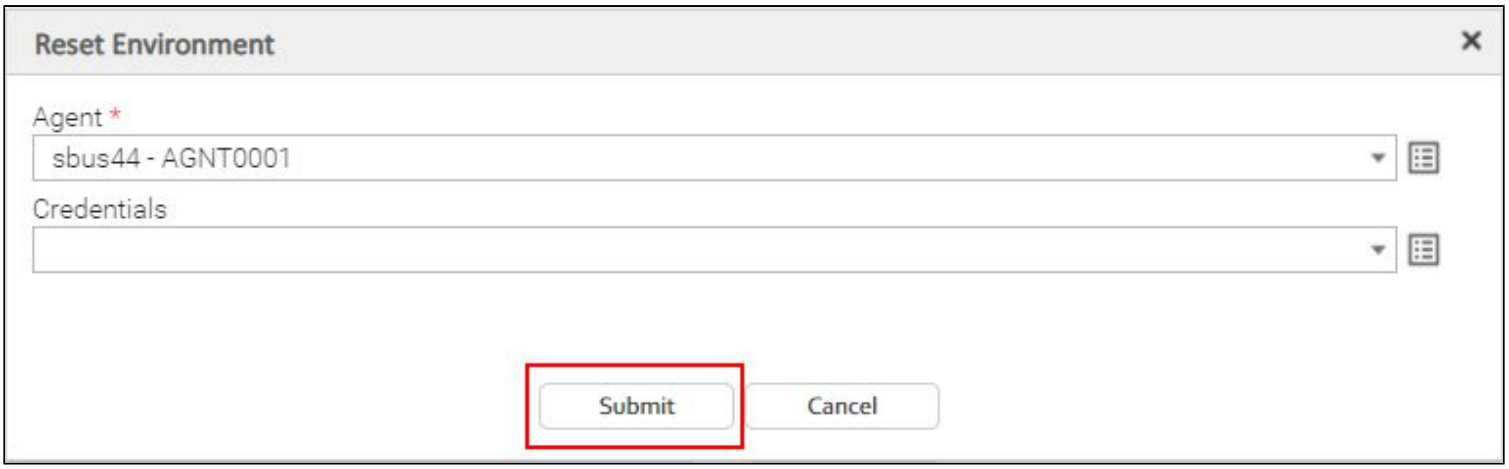
Dynamic Commands are available from the context menu generated by right-clicking on the task instance form and from the context menu generated by right-clicking on the task instance in a list of task instances (for example, in the Activity Monitor and/or the Instances tab of a task definition form).

For this example, double-click on a completed task to open the task instance form. next, right-click on the form to open a context menu. At the top of the context menu should be the "UE Task Task Instance Commands".



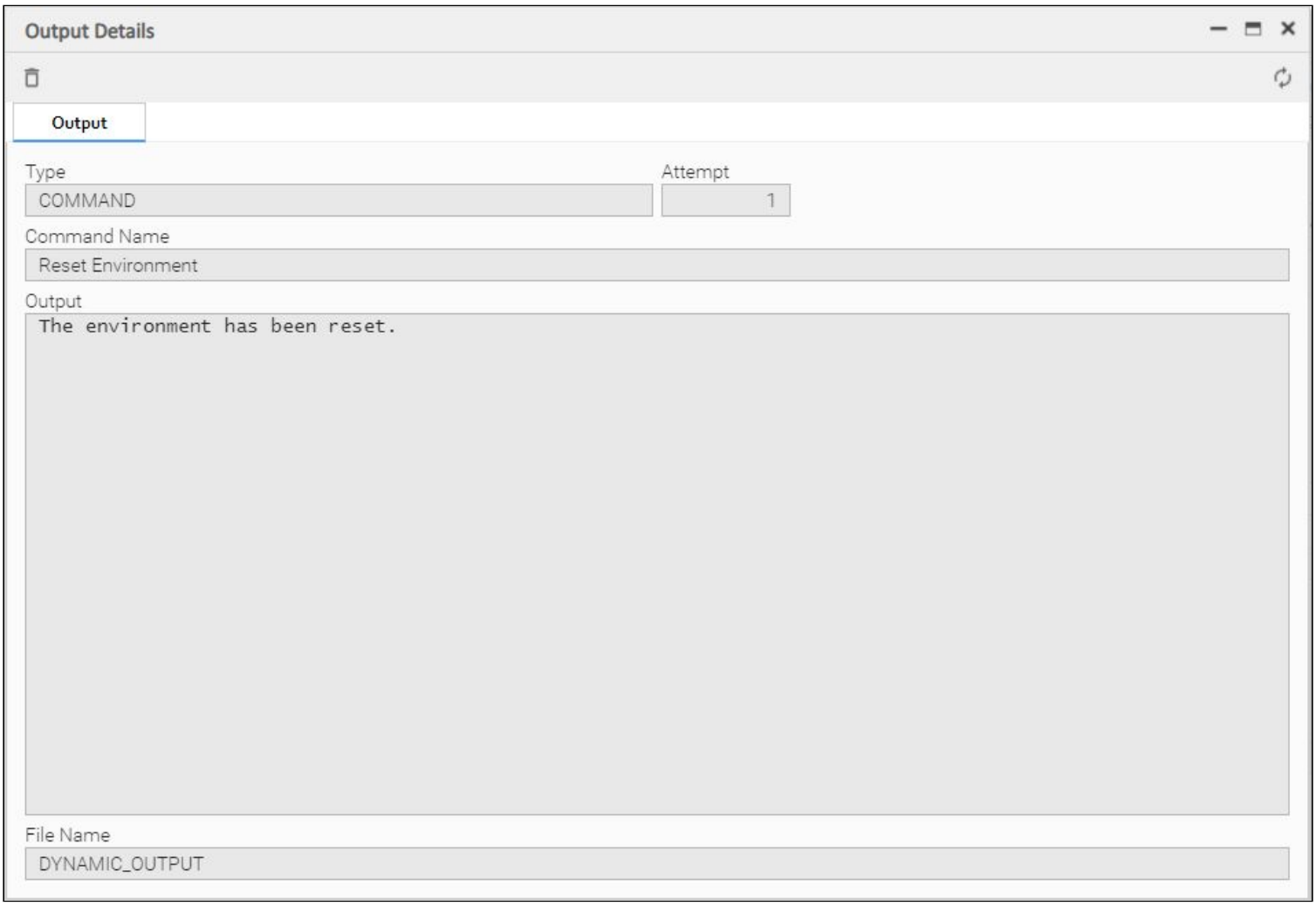
Select the **Reset Environment** command.

This displays an additional dialog, which can be used to pull in dependent fields from the task form if needed. This is optional functionality that is defined in the Universal template and made use of by the backing implementation in the extension archive.



Submit the Dynamic Command.

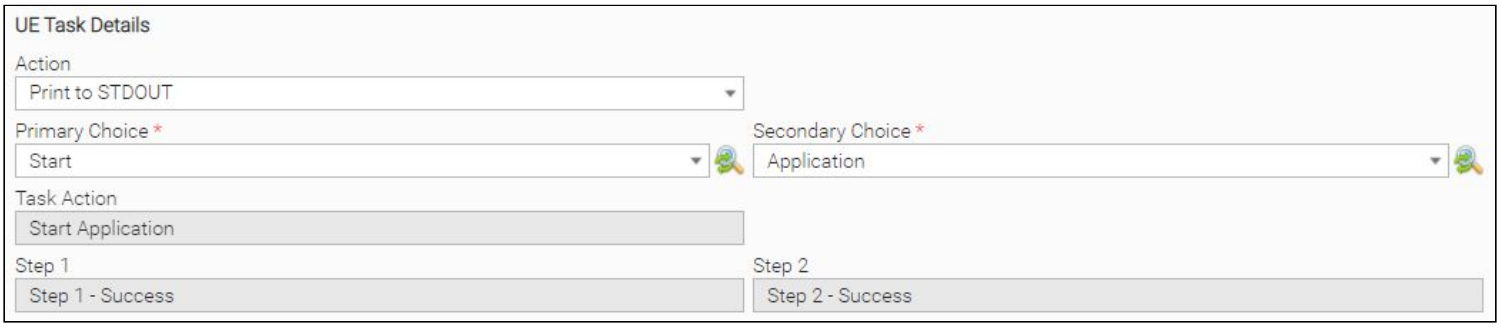
The immediate result of Dynamic Command is new window showing the output results of the command.



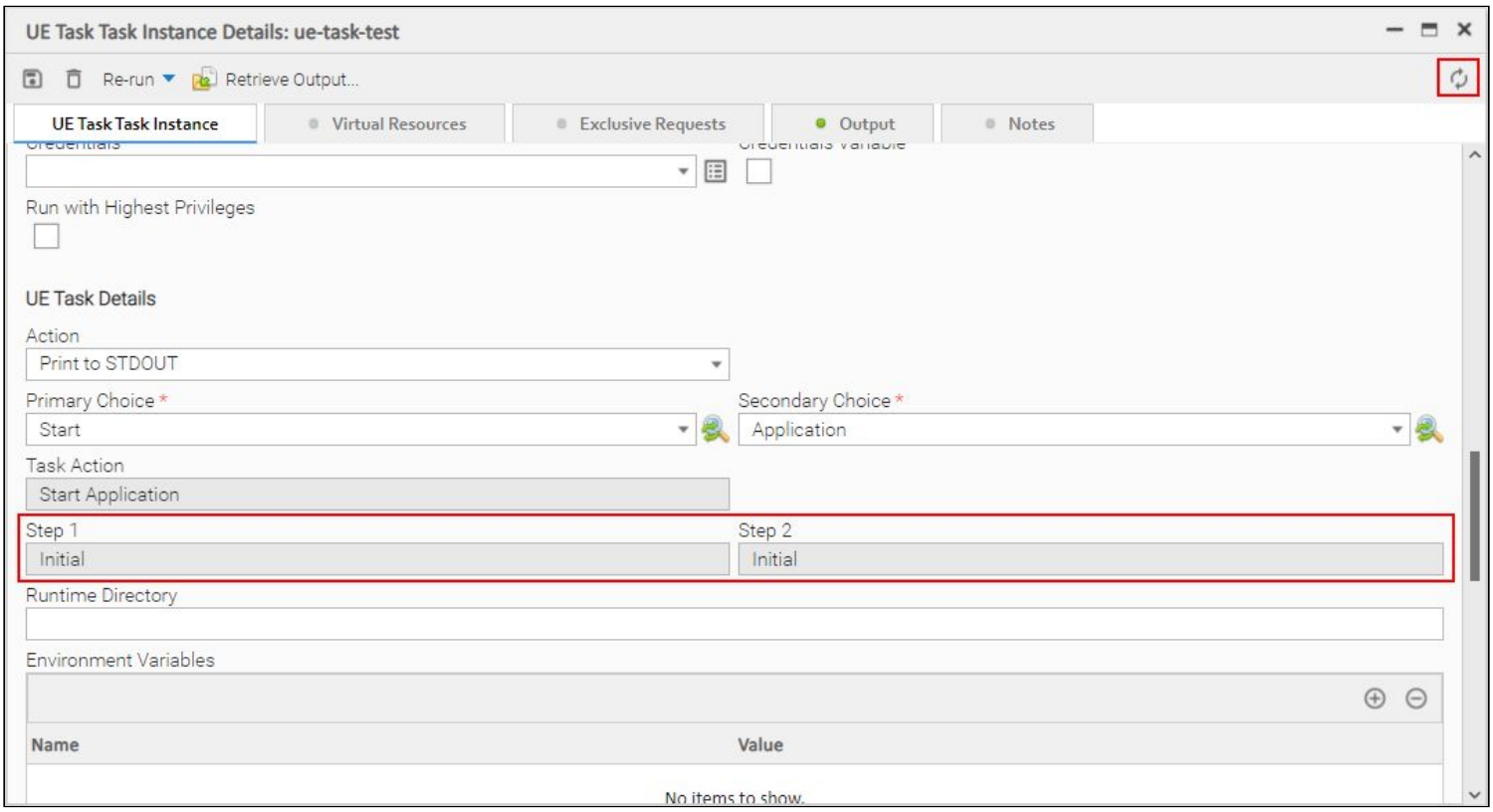
In this case, the resulting output is “The environment has been reset”.

Additionally, the **Reset Environment** command was designed to “reset” the “Step” Output Only fields on the task instance form.

To see this, close the “Output Details” window and scroll the open task instance form to view the “UE Task" Details section.



To reveal the change, refresh the task instance form.



The Step 1 and Step 2 Output Only fields have been set to **Initial**. This is a contrived example, but it demonstrates how a Dynamic Command could be used as a helper command for a task instance by performing some action on the target agent system (or beyond) and then updating the task instance in a meaningful way that may be required for a rerun scenario.

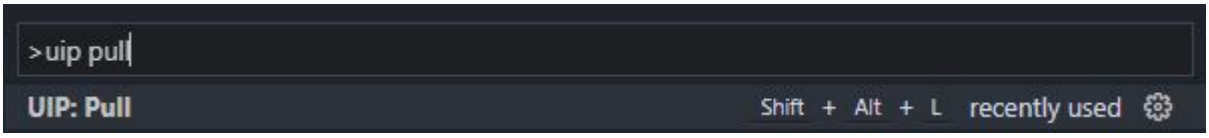
In this case, information flowed from the Dynamic Command execution back to the task instance fields. However, task specific information could also have been passed down to the Dynamic command.

8.1.1.7.6 Step 5 - Update the Local template.json

In step 1, we modified the Universal Template by adding a new Dynamic command. Recall that inside ~/dev/extensions/sample-task/src/templates, there is a **template.json** file. This file should correspond to the Universal Template in the Controller.

Right now, they are not both the same. The Controller's version of **template.json** has the Dynamic Choice Fields changes. To grab those changes, use the **pull** command as shown below:

8.1.1.7.6.1 UIP VS Code Extension



Click here to expand uip-cli details...

Step Supplemental - CLI

```
[redacted]@sbus44:~/dev/extensions/sample-task$ uip pull
The following files were updated:
  - template.json
```

Now, both the local and Controller's version of the Universal Template are the same.

8.1.1.8 In-Process Dynamic Commands

8.1.1.8.1 Introduction

The Dynamic Command created in the previous chapter always runs in a separate process from the Extension instance. In this chapter, In-process Dynamic Commands will be introduced, which run within the process of an associated Extension instance. As a result of running "in-process", the dynamic commands can impact the execution of the Extension instance.

On this page, we will cover the following:

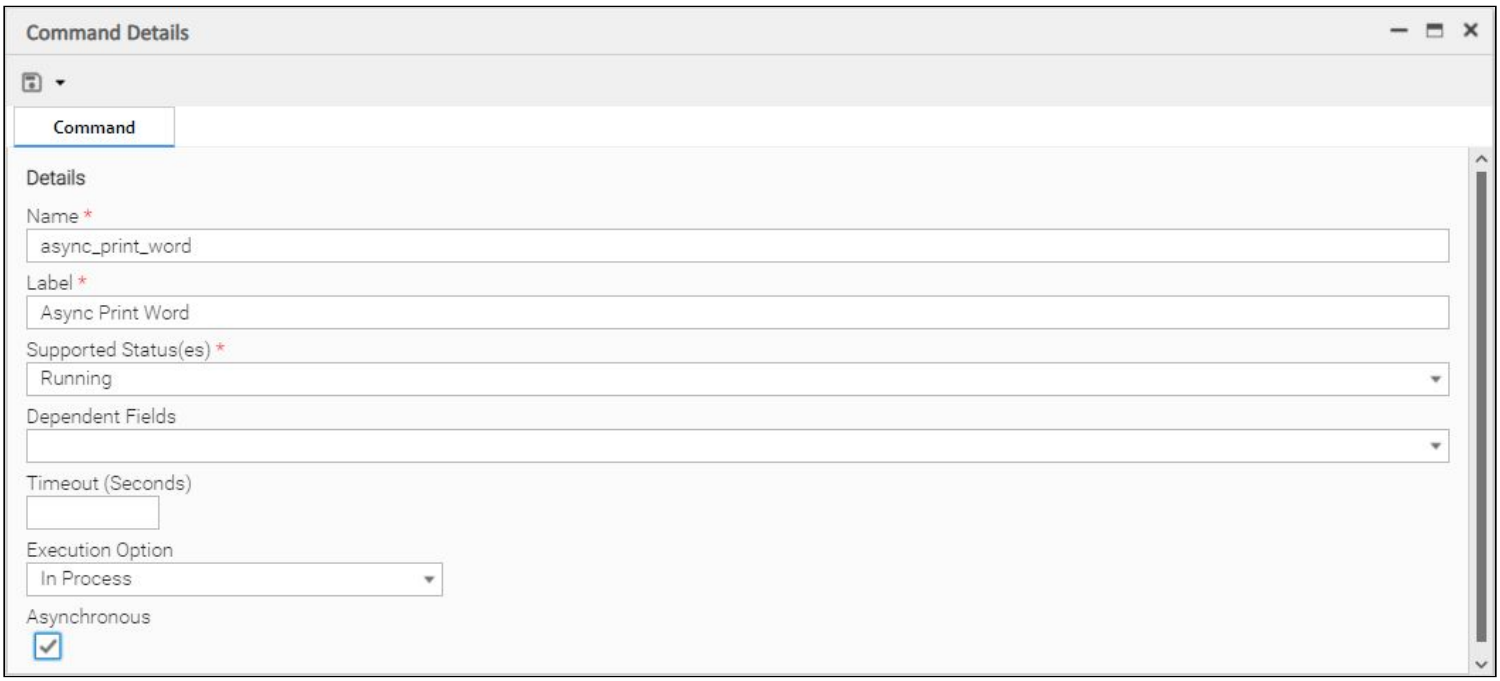
1. Add Asynchronous In-Process Dynamic Command to the "UE Task" Universal Template.
2. Add Synchronous In-Process Dynamic Command to the "UE Task" Universal Template.
3. Add a new text field to the "UE Task" Universal Template.
4. Add a backing implementation for both Asynchronous and Synchronous In-Process Dynamic Commands to the extension.py file in the ue-task Extension project.
5. Build and Upload the modified Extension.
6. Execute the Asynchronous Dynamic Command.
7. Execute the Synchronous Dynamic Command.

> The steps below assume Controller version is at least 7.1.0.0

8.1.1.8.2 Step 1 - Add Asynchronous In-Process Dynamic Command to the "UE Task" Universal Template

Go back to the "UE Task" Universal Template form.

On the Commands tab, click the "New" button and create the following “Async Print Word” command.



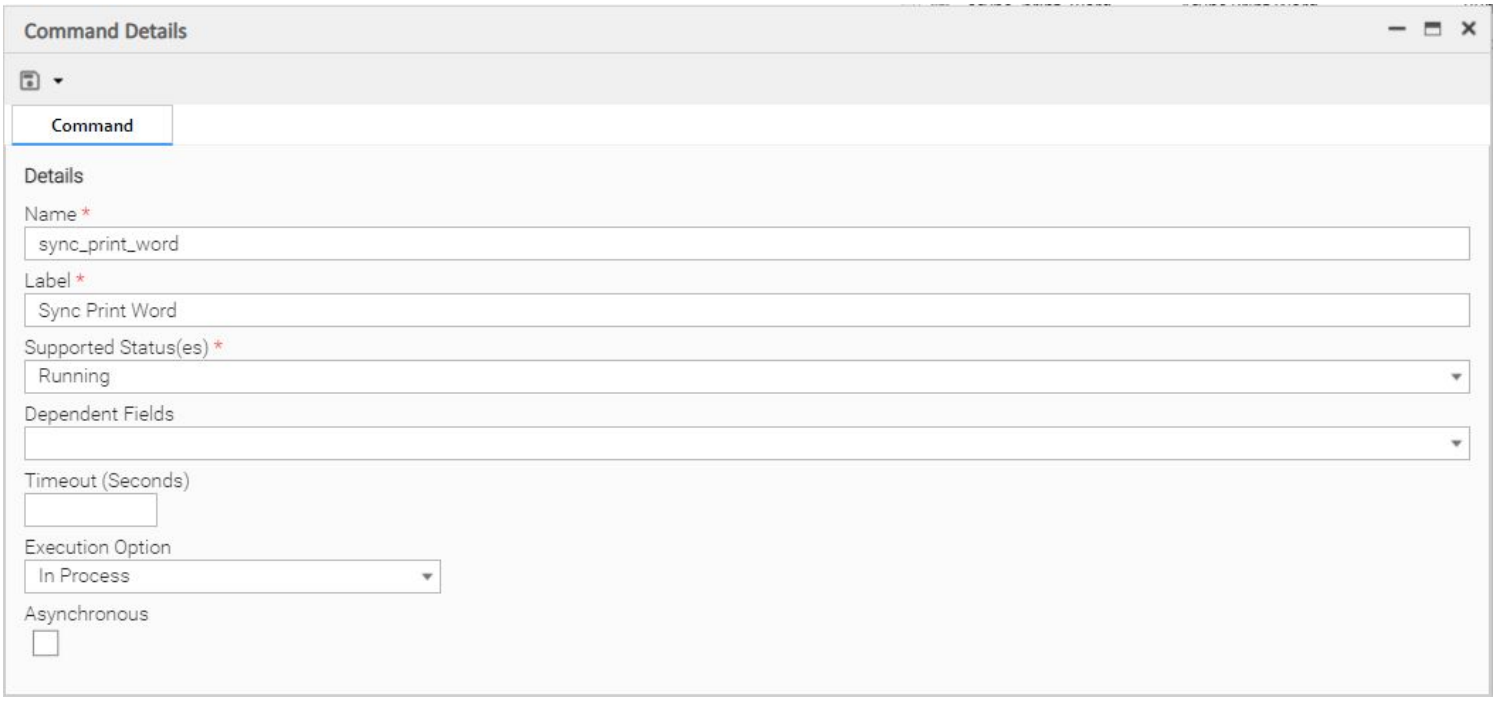
Note that the “Supported Status(es)” is set to **Running** only. This is because In-Process Dynamic commands can only run while the Extension instance is running. For all other task statuses, the command will be greyed out.

Also note that the "Execution Option" is explicitly set to **In Process**, and the **Asynchronous** option is checked.

8.1.1.8.3 Step 2 - Add Synchronous In-Process Dynamic Command to the "UE Task" Universal Template

Go back to the "UE Task" Universal Template form.

On the Commands tab, click the "New" button and create the following “Sync Print Word” command.



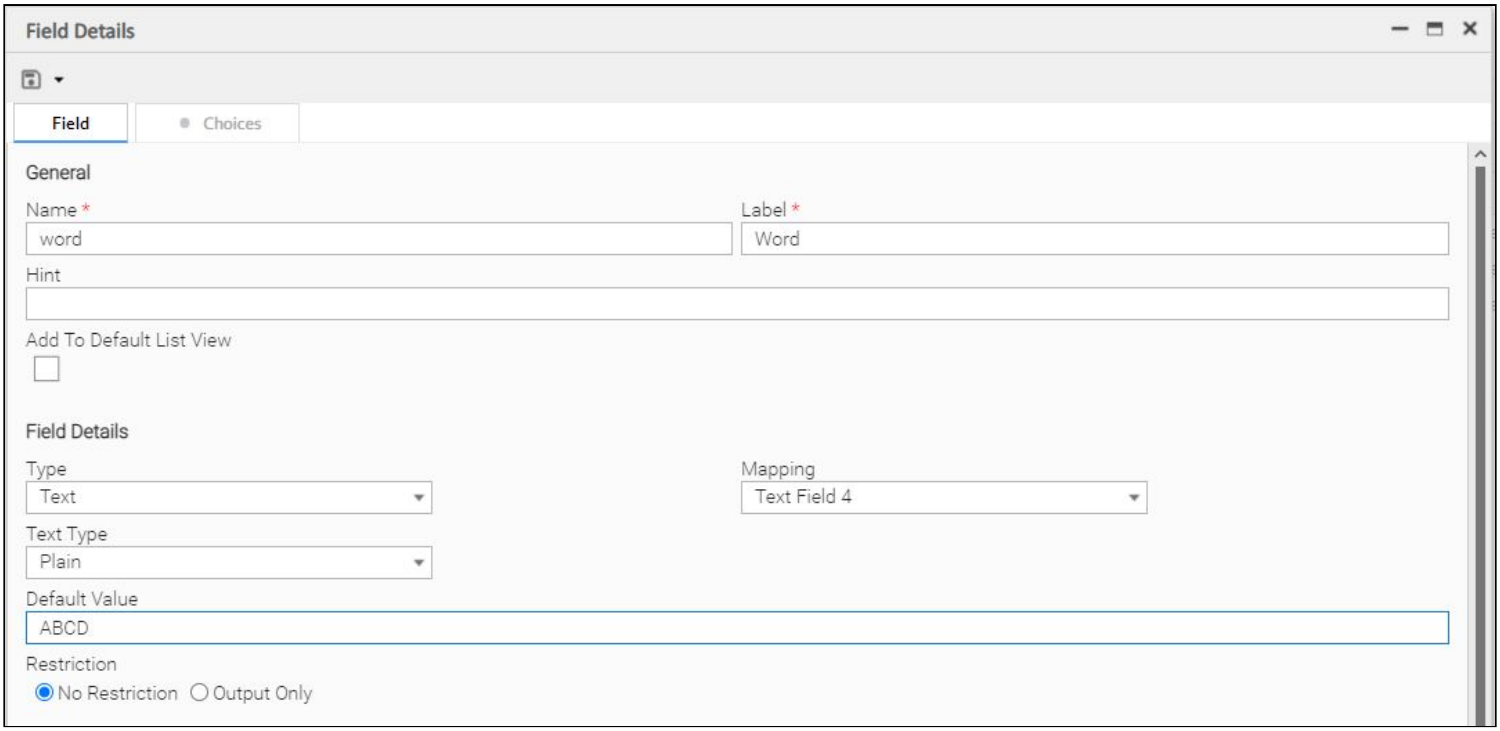
Note that the “Supported Status(es)” is set to **Running** only. This is because In-Process Dynamic commands can only run while the Extension instance is running. For all other task statuses, the command will be greyed out.

Also note that the "Execution Option" is explicitly set to **In Process**, and the **Asynchronous** option is **NOT** checked.

8.1.1.8.4 Step 3 - Add a new text field to the "UE Task" Universal Template

Go back to the "UE Task" Universal Template form.

On the Fields tab, click the "New" button and create the following “Word" field.



Ensure that the default value is set to **ABCD**

8.1.1.8.5 Step 4 - Add a backing implementation for both Asynchronous and Synchronous In-Process Dynamic Commands to the extension.py file

Open file `~/dev/extensions/sample-task/src/extension.py` in your editor of choice.

Add the implementation of the **async_print_word()** and **sync_print_word()** Dynamic Commands:

reset_environment Dynamic Command

```
1  from __future__ import (print_function)
2  import time
3  from universal_extension import UniversalExtension
4  from universal_extension import ExtensionResult
5  from universal_extension import logger
6  from universal_extension import ui
7  from universal_extension.deco import dynamic_choice_command
8  from universal_extension.deco import dynamic_command
9
10
11 class Extension(UniversalExtension):
12     """Required class that serves as the entry point for the extension
```

```
    """

    def __init__(self):
        """Initializes an instance of the 'Extension' class
        """
        # Call the base class initializer
        super(Extension, self).__init__()

    @dynamic_choice_command("primary_choice_field")
    def primary_choice_command(self, fields):
        """Dynamic choice command implementation for
        primary_choice_field.

        Parameters
        ----------
        fields : dict
            populated with the values of the dependent fields
        """
        return ExtensionResult(
            rc=0,
            message="Values for choice field: 'primary_choice_field'",
            values=["Start", "Pause", "Stop", "Build", "Destroy"]
        )

    @dynamic_choice_command("secondary_choice_field")
    def secondary_choice_command(self, fields):
        """Dynamic choice command implementation for
        secondary_choice_field.

        Parameters
        ----------
        fields : dict
            populated with the values of the dependent fields
        """
        return ExtensionResult(
            rc=0,
            message="Values for choice field: 'secondary_choice_field'",
            values=["System", "Command", "Application", "Transfer", "Evidence"]
        )

    @dynamic_command("reset_environment")
    def reset_environment(self, fields):
        """Dynamic command implementation for reset_environment command.

        Parameters
        ----------
        fields : dict
            populated with the values of the dependent fields
        """

        # Reset the state of the Output Only 'step' fields.
        out_fields = {}
        out_fields["step_1"] = "Initial"
        out_fields["step_2"] = "Initial"
        ui.update_output_fields(out_fields)

        return ExtensionResult(
```

```
            message="Message: Hello from dynamic command 'reset_environment'!",
            output=True,
            output_data='The environment has been reset.',
            output_name='DYNAMIC_OUTPUT')

    @dynamic_command("async_print_word")
    def async_print_word(self, fields):
        """
        Adds each letter of self.WORD to self.async_queue

        If curr_index is odd, then the function will sleep
        for 5 seconds before adding self.WORD to self.async_queue
        """

        curr_index = self.async_index

        if curr_index % 2 != 0:
            self.async_index += 1
            time.sleep(5)
        else:
            self.async_index += 1

        self.async_queue.append(self.WORD[curr_index])

        return ExtensionResult(
            message="",
            output=True,
            output_data="async_print_word()",
            output_name='DYNAMIC_ASYNC_OUTPUT')

    @dynamic_command("sync_print_word")
    def sync_print_word(self, fields):
        """
        Adds each letter of self.WORD to self.sync_queue

        If curr_index is odd, then the function will sleep
        for 5 seconds before adding self.WORD to self.sync_queue
        """

        curr_index = self.sync_index

        if curr_index % 2 != 0:
            self.sync_index += 1
            time.sleep(5)
        else:
            self.sync_index += 1

        self.sync_queue.append(self.WORD[curr_index])

        return ExtensionResult(
            message="",
            output=True,
            output_data="sync_print_word()",
            output_name='DYNAMIC_SYNC_OUTPUT')

    def extension_start(self, fields):
        """Required method that serves as the starting point for work performed
```

```
122         for a task instance.
123
124         Parameters
125         ----------
126         fields : dict
127             populated with field values from the associated task instance
128             launched in the Controller
129
130         Returns
131         -------
132         ExtensionResult
133             once the work is done, an instance of ExtensionResult must be
134             returned. See the documentation for a full list of parameters that
135             can be passed to the ExtensionResult class constructor
136         """
137
138         self.WORD = fields['word']
139         self.async_index = 0
140         self.sync_index = 0
141
142         self.async_queue = []
143         self.sync_queue = []
144
145         # Sleep for 40 seconds to keep the Extension instance running
146         # while the In-Process Dynamic Commands run
147         time.sleep(40)
148
149         # Log the Async and Sync Queues
150         logger.info('Async Queue: %s' % ' -> '.join(self.async_queue))
151         logger.info('Sync Queue: %s' % ' -> '.join(self.sync_queue))
152
153         # Get the value of the 'action' field
154         action = fields.get('action', [""])[0]
155
156         if action.lower() == 'print':
157             # Print to standard output...
158             print("Hello STDOUT!")
159         else:
160             # Log to standard error...
161             logger.info('Hello STDERR!')
162
163         # Return the result with a payload containing a Hello message...
164         return ExtensionResult(
165             unv_output='Hello Extension!'
166         )
```

Line 75-98	The complete implementation of **async_print_word()** is defined. In short, the method adds each letter of **self.WORD** to **self.async_queue**. If **self.async_index** is odd, the function sleeps for 5 seconds before adding it to **self.async_queue.**
Line 100-123	The complete implementation of **sync_print_word()** is defined. The method does the exact same thing as **async_print_word()** except it works with **self.sync_queue** and **self.sync_index**.
Lines 143-156	The **extension_start()** method grabs the value of the **word** field and initializes the queues and index variables. It sleeps for 40 seconds to keep the process running as required by the In-Process Dynamic commands. At the end, it prints out the queues.

8.1.1.8.6 Step 5 - Build and Upload the Extension Zip Archive Using the UIP VS Code Extension

Save all changes to extension.py.

From the VS Code command palette, execute the **UIP: Push** command as shown below:

Recall that the **UIP: Push** command builds and uploads the Extension zip archive

Click here to expand uip-cli details...

8.1.1.8.6.1 Step 5 Supplemental - Build and Upload the Extension Zip Archive Using the CLI

Save all changes to extension.py.

From the command line, cd to the ~/dev/extensions/sample-task directory and execute the **push** command as shown below:

```
$ uip push
```

Recall that the **push** command builds and uploads the Extension zip archive

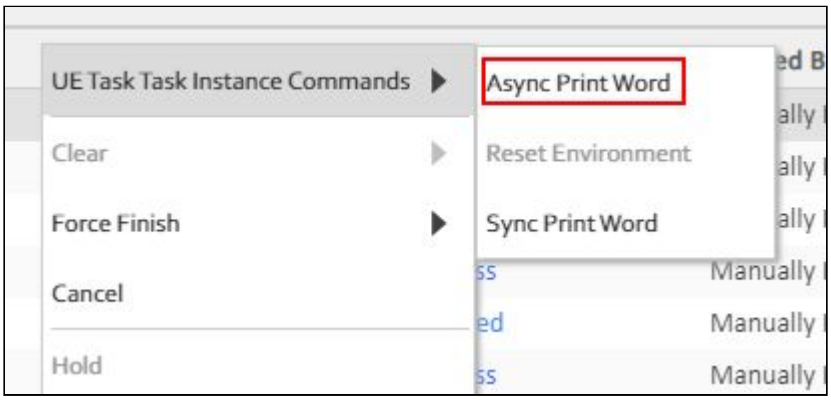
8.1.1.8.7 Step 6 - Execute the Asynchronous Dynamic Command

In the Controller, open a "UE Task Tasks" tab. **If the tab is already open, it must be closed and reopened before the new In-Process Dynamic Commands are available on the task instances.**

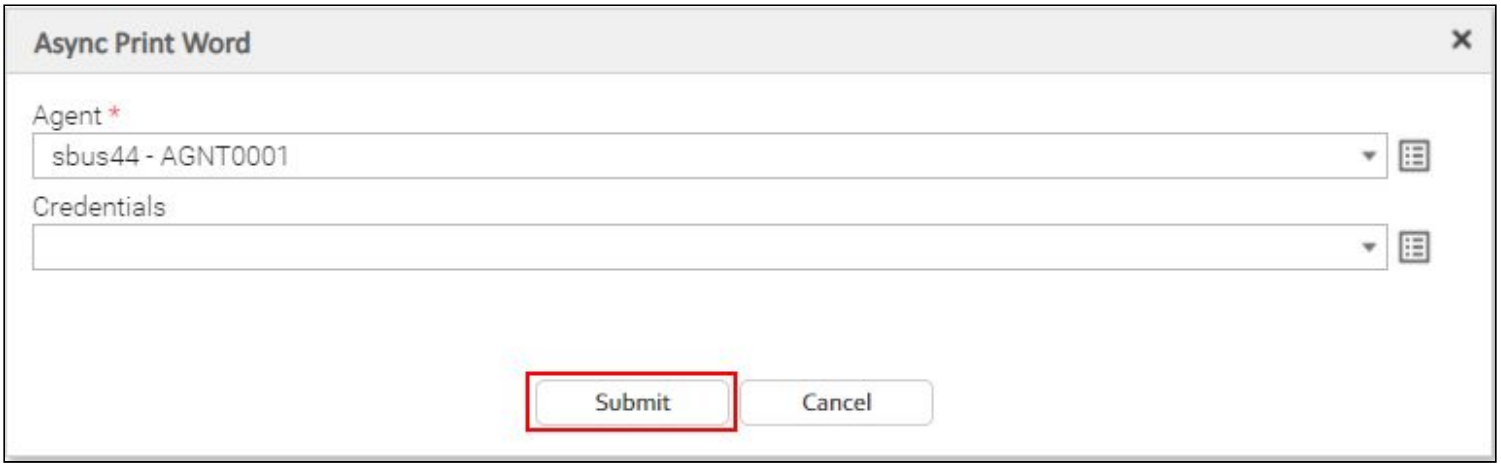
As mentioned in the previous chapter, Dynamic Commands are available from the context menu generated by right-clicking on the task instance form and from the context menu generated by right-clicking on the task instance in a list of task instances (for example, in the Activity Monitor and/or the Instances tab of a task definition form).

> It is recommended to read the entire step before executing the dynamic command as it needs to be done in a timely manner to get the proper results

Launch a new task, switch to the Instances tab, right-click on the task-instance (should be in "Running" status), and in the "**UE Task Task Instance Commands**" dropdown, click "**Async Print Word**".

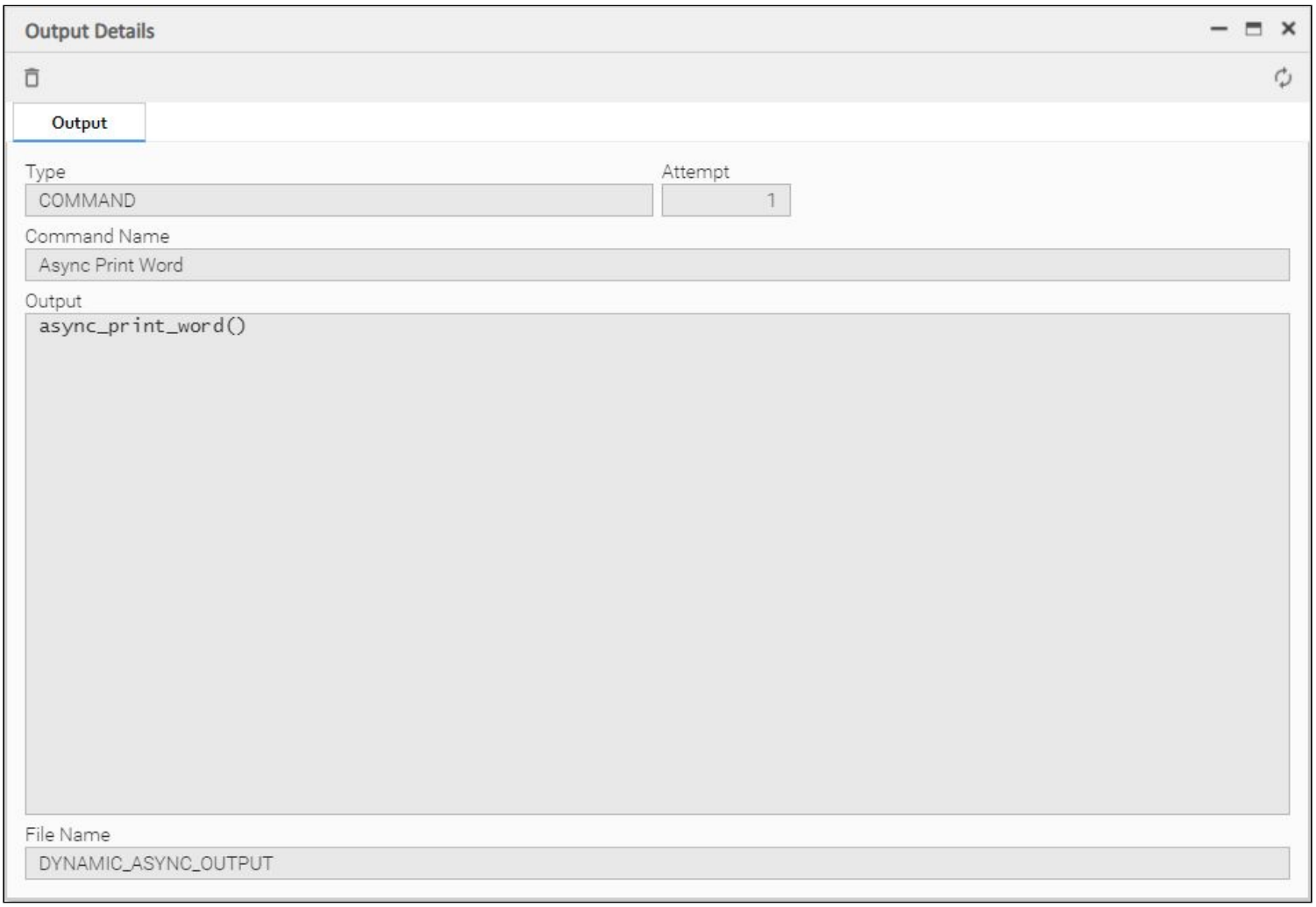


This displays an additional dialog, which can be used to pull in dependent fields from the task form if needed. This is optional functionality that is defined in the Universal template and made use of by the backing implementation in the extension archive.



Submit the Dynamic Command.

The immediate result of Dynamic Command is a new window showing the output results of the command.



Close the "Output" dialog, and execute "**Async Print Word"** 4 more times one after the other. Because of the 5 second sleep period when **self.async_qeueue** is an odd number, the "Output" dialog will not appear immediately for the 2nd (self.async_queue == 1) and 4th (self.async_queue == 3) execution. Don't wait for the dialog to appear. **Immediately** execute the next Dynamic command after the previous one. In total, the Asynchronous Dynamic Command should be executed 5 times.

After all commands are executed, wait until the task goes to completion. It should end up in "Success" state.

Once finished, right-click on the task instance and click "Retrieve Output" or use the VS Code Extension's "UIP: Task Output" command to retrieve the output as shown below:

```
[redacted]@sbus44:~/dev/extensions/sample-task$ uip task output ue-task-test
STDERR Output:
==============
2022-03-04 09:20:19,970 - 10612 AsyCommand          - universal_extension.py[572] ERROR: Unhandled exception in Dynamic Command 'async_print_word'.
Traceback (most recent call last):
  File "C:\Program Files\Universal\UAGSrv\uext\universal_extension.zip\universal_extension\universal_extension.py", line 553, in _execute_dynamic_command
    result = _dynamic_commands[command](self, state)
  File "C:\Program Files\Universal\UAGSrv\extensions\ue-task.zip\extension.py", line 91, in async_print_word
    self.async_queue.append(self.WORD[curr_index])
IndexError: string index out of range
2022-03-04 09:20:38,993 - 63188 MainThread          - extension.py[154] INFO: Async Queue: A -> C -> B -> D
2022-03-04 09:20:38,996 - 63188 MainThread          - extension.py[155] INFO: Sync Queue:


STDOUT Output:
==============
Hello STDOUT!


EXTENSION Output:
=================
Hello Extension!

COMMAND Output:
===============
async_print_word()

COMMAND Output:
===============
async_print_word()

COMMAND Output:
===============
async_print_word()

COMMAND Output:
===============
async_print_word()
```

Now, let's examine the output. It will show us what exactly "Asynchronous" means in the context of Dynamic commands.

Recall that the default value of the word field was **ABCD**, but the async queue that's logged in STDERR is: **A → C → B → D**. The **C** and **B** are flipped because of how the Asynchronous Dynamic Command executes:

- When "**Async Print Word**" is first clicked, **self.async_index** is 0 (even), so the method does not sleep for 5 seconds and immediately adds **A** to **self.async_queue**
- When "**Async Print Word"** is clicked for the second time, **self.async_index** is 1 (odd), so the method sleeps for 5 seconds before adding **B** to **self.async_queue**
- While the second "**Async Print Word**" is sleeping, "**Async Print Word**" is clicked for the third time where **self.async_index** is 2 (even), so the method does not sleep for 5 seconds and immediately adds **C** to **self.async_queue**
- After the third instance of "**Async Print Word**" is finished, the fourth instance of "**Async Print Word**" is launched where **self.async_index** is 3 (odd), so it will sleep for 5 seconds before adding **D** to **self.async_queue**
- While the fourth instance is sleeping, the second instance will have finished which will result in adding **B** to **self.async_index**. At the same time, the fifth and last instance of "**Async Print Word**" is launched where **self.async_index** is 4 (even).
- The fifth instance will end up with an internal failure since index 4 is out of bounds. However, this will **NOT** impact the main Extension instance or any of the other running Dynamic Command instances.
- After a couple seconds, the fourth instance will finish and add **D** to **self.async_queue**

As noted above, any exceptions in a Dynamic Command instance will not affect the Extension instance or any other Dynamic Command instances. We can see this clearly by examining the timestamps of the Exception **(09:20:19)** vs. the log statements **(09:20:38).**

The exception occurred first, but that did not prevent the log statements from being printed in **extension_start()**

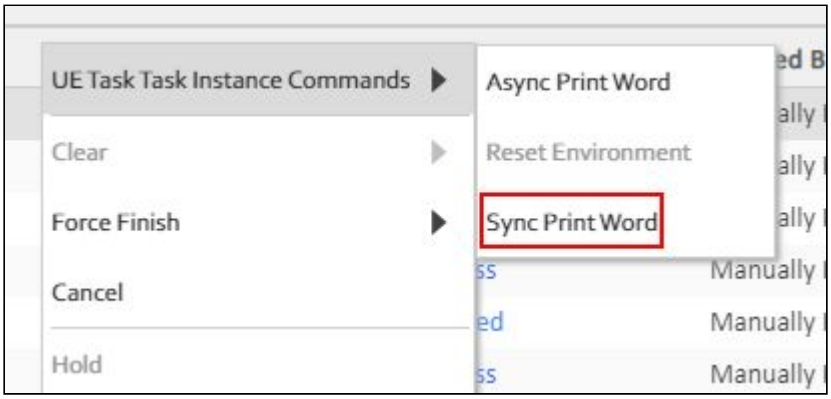
8.1.1.8.8 Step 7 - Execute the Synchronous Dynamic Command

In the Controller, open a "UE Task Tasks" tab. **If the tab is already open, it must be closed and reopened before the new In-Process Dynamic Commands are available on the task instances.**

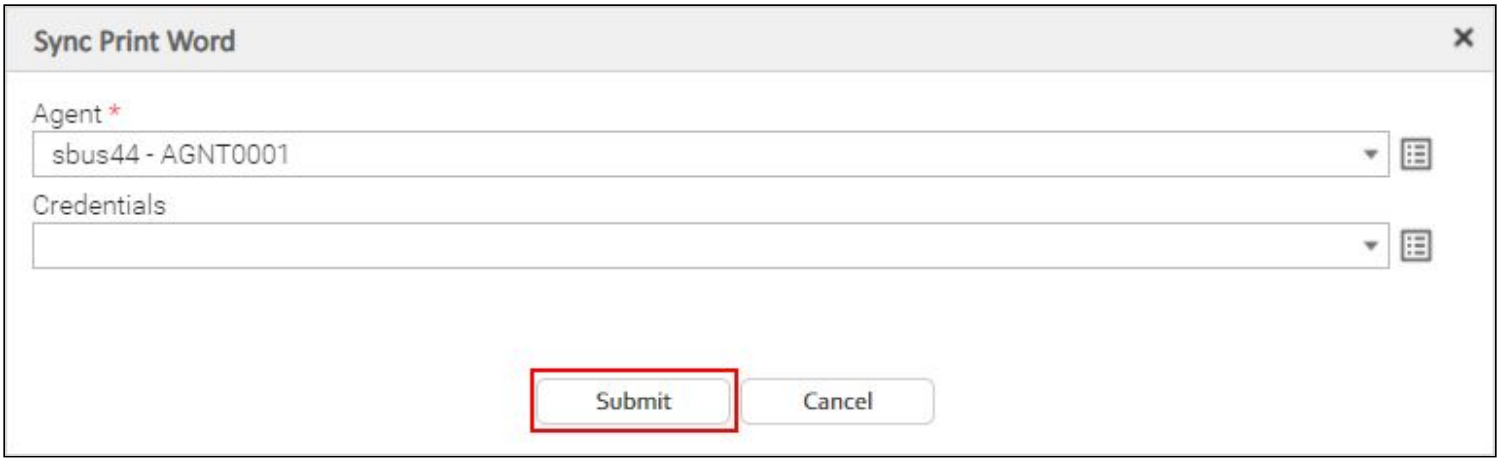
As mentioned in the previous chapter, Dynamic Commands are available from the context menu generated by right-clicking on the task instance form and from the context menu generated by right-clicking on the task instance in a list of task instances (for example, in the Activity Monitor and/or the Instances tab of a task definition form).

> It is recommended to read the entire step before executing the dynamic command as it needs to be done in a timely manner to get the proper results

Launch a new task, switch to the Instances tab, right-click on the task-instance (should be in "Running" status), and in the "**UE Task Task Instance Commands**" dropdown, click "**Sync Print Word**".

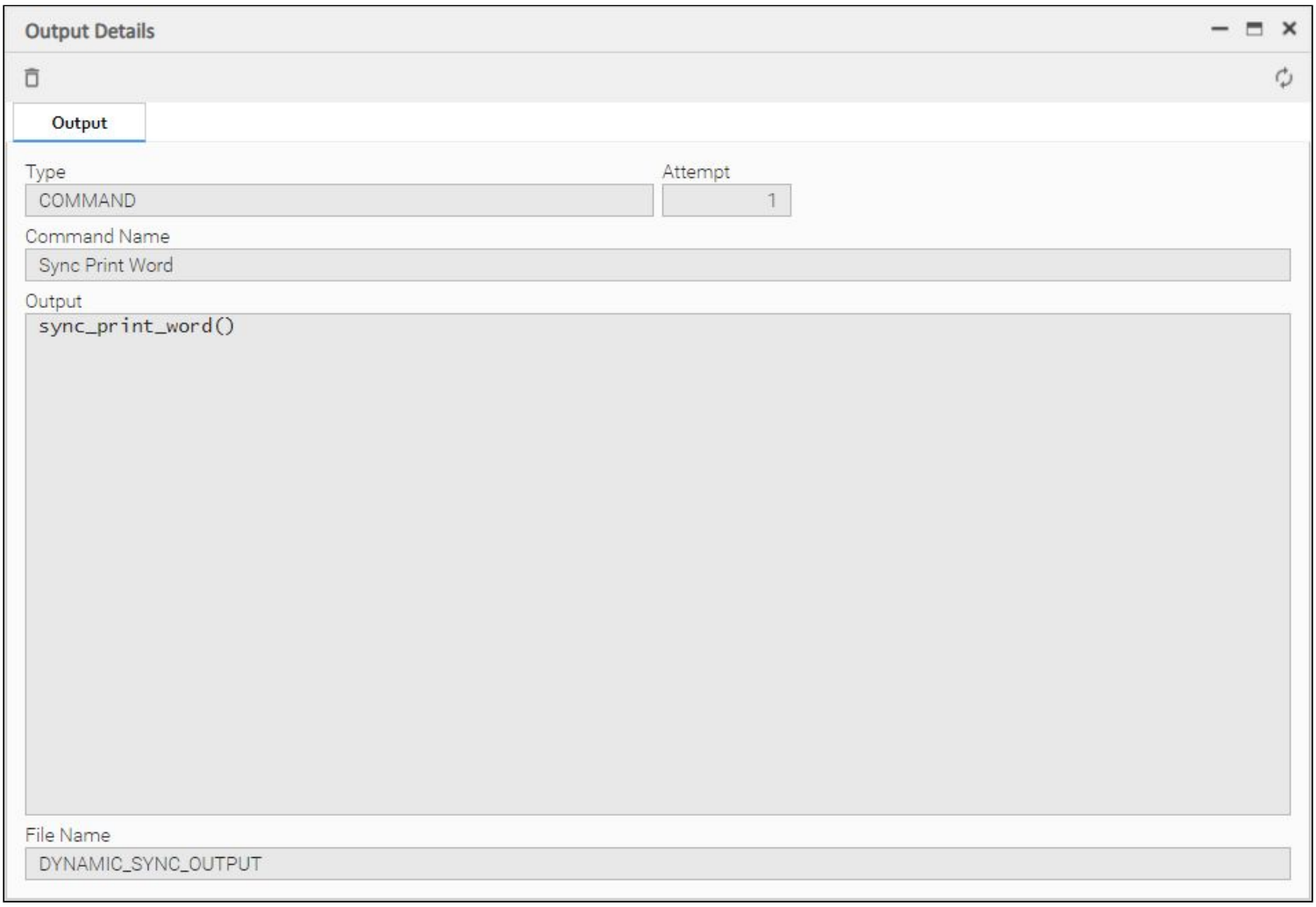


This displays an additional dialog, which can be used to pull in dependent fields from the task form if needed. This is optional functionality that is defined in the Universal template and made use of by the backing implementation in the extension archive.



Submit the Dynamic Command.

The immediate result of Dynamic Command is a new window showing the output results of the command.



Close the "Output" dialog, and execute "**Sync Print Word**" 4 more times one after the other. In total, the Synchronous Dynamic Command should be executed 5 times. Note that the commands must be executed immediately after the previous one.

After all commands are executed, wait until the task goes to completion. It should end up in "Success" state.

Once finished, right-click on the task instance and click "Retrieve Output" or use the VS Code Extension's "UIP: Task Output" command to retrieve the output as shown below:

```
[redacted]@sbus44:~/dev/extensions/sample-task$ uip task output ue-task-test
STDERR Output:
==============
2022-03-04 09:31:47,207 - 17580 SynCommandProcessor - universal_extension.py[572] ERROR: Unhandled exception in Dynamic Command 'sync_print_word'.
Traceback (most recent call last):
  File "C:\Program Files\Universal\UAGSrv\uext\universal_extension.zip\universal_extension\universal_extension.py", line 553, in _execute_dynamic_command
    result = _dynamic_commands[command](self, state)
  File "C:\Program Files\Universal\UAGSrv\extensions\ue-task.zip\extension.py", line 116, in sync_print_word
    self.sync_queue.append(self.WORD[curr_index])
IndexError: string index out of range
2022-03-04 09:32:04,282 - 72120 MainThread          - extension.py[154] INFO: Async Queue:
2022-03-04 09:32:04,285 - 72120 MainThread          - extension.py[155] INFO: Sync Queue: A -> B -> C -> D


STDOUT Output:
==============
Hello STDOUT!


EXTENSION Output:
=================
Hello Extension!

COMMAND Output:
===============
sync_print_word()

COMMAND Output:
===============
sync_print_word()

COMMAND Output:
===============
sync_print_word()

COMMAND Output:
===============
sync_print_word()
```

Notice that unlike the Asynchronous Dynamic Command, the Synchronous one logs the word in order: **A** → **B** → **C** → **D**. This is because a Synchronous Dynamic Command cannot start processing until all previously received Synchronous Dynamic Commands have completed.

Similar to the Asynchronous Dynamic Command, the Exception does not impact the Extension instance or any other Dynamic Command instances.

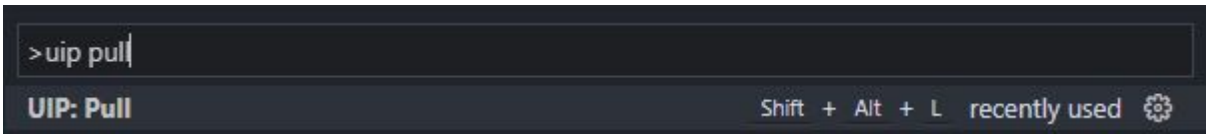
8.1.1.8.9 Step 8 - Update the Local template.json

In steps 1 to 3, we modified the Universal Template by adding new Dynamic Commands.

Recall that inside ~/dev/extensions/sample-task/src/templates, there is a **template.json** file. This file should correspond to the Universal Template in the Controller.

Right now, they are not both the same. The Controller's version of **template.json** has the In-Process Dynamic Command changes. To grab those changes, use the **pull** command as shown below:

8.1.1.8.9.1 UIP VS Code Extension




```
[redacted]@sbus44:~/dev/extensions/sample-task$ uip pull
The following files were updated:
  - template.json
```

Click here to expand uip-cli details...

Step Supplemental - CLI

Now, both the local and Controller's version of the Universal Template are the same.

8.1.1.9 Cancel Command

8.1.1.9.1 Introduction

In versions prior to 7.1.0.0, Universal Extension task instances could be cancelled via the Controller just like any other task type, but the instances do not participate in the Cancellation process. As a result, there is no chance to do any sort of cleanup before Cancellation. Starting with 7.1.0.0, the Universal Extension API was enhanced with a new method called **extension_cancel()** which allows for any cleanup work before the process is terminated.

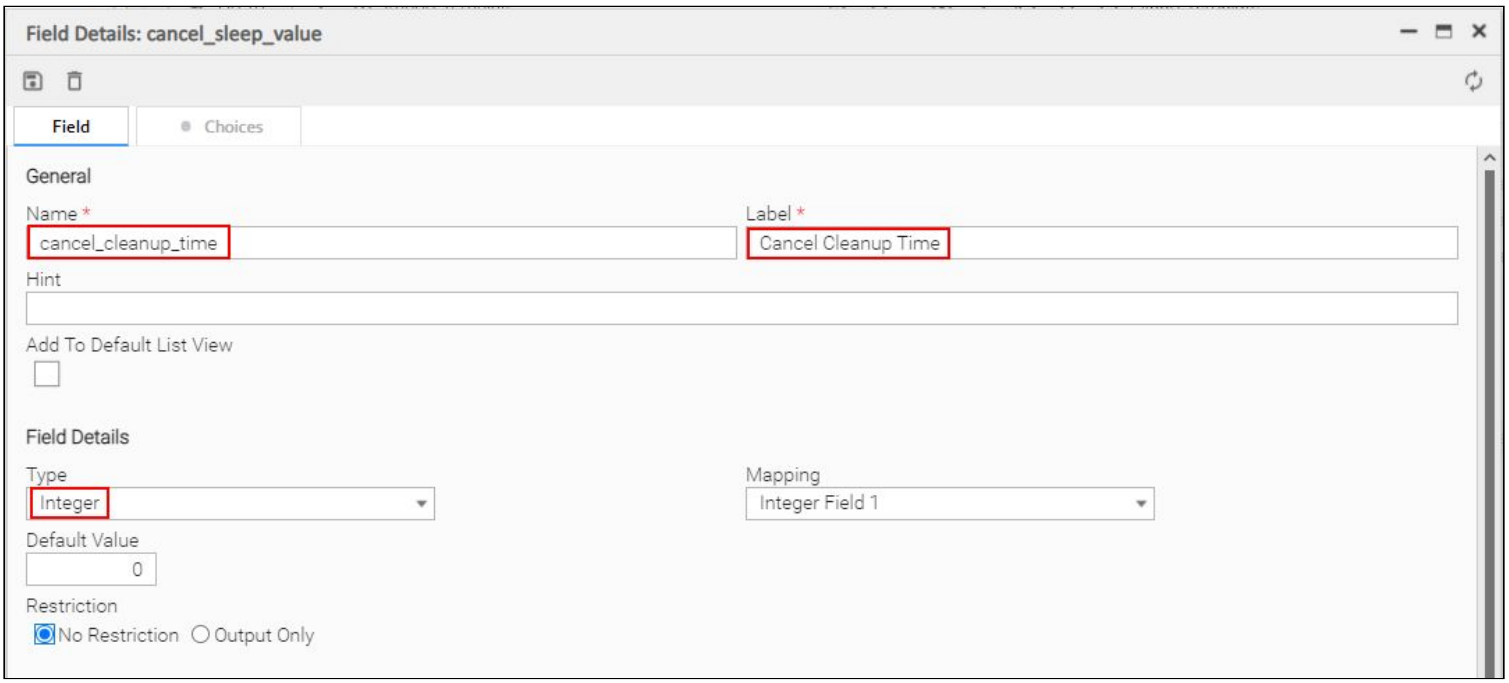
On this page, we will cover the following:

1. Add a new cancel_cleanup_time field to the "UE Task" Universal Template
2. Add a backing implementation for Cancel Command to the extension.py file.
3. Build the modified Extension.
4. Upload the modified Extension.
5. Demonstrate the Cancel command in three different scenarios
    a. Graceful Cancellation
    b. Timeout
    c. Double Cancel

8.1.1.9.2 Step 1 - Add a new "cancel_cleanup_time" field to the "UE Task" Universal Template

Navigate to the "UE Task" Universal Template.

In the "Fields" tab, add a new field called "cancel_cleanup_time" as shown below:



The value of this field will be used to simulate the time spent doing the cleanup work in `extension_cancel()`.

Save the field.

8.1.1.9.3 Step 2 - Add a backing implementation for Cancel Command to the extension.py file

Open file `~/dev/extensions/sample-task/src/extension.py` in your editor of choice.

Add the implementation of the **extension_cancel()** method:

reset_environment Dynamic Command

```
1  from __future__ import (print_function)
2  import time
3  from universal_extension import UniversalExtension
4  from universal_extension import ExtensionResult
5  from universal_extension import logger
6  from universal_extension import ui
7  from universal_extension.deco import dynamic_choice_command
8  from universal_extension.deco import dynamic_command
9
10
11 class Extension(UniversalExtension):
12     """Required class that serves as the entry point for the extension
13     """
14
15     def __init__(self):
16         """Initializes an instance of the 'Extension' class
17         """
18         # Call the base class initializer
19         super(Extension, self).__init__()
20
     @dynamic_choice_command("primary_choice_field")
```

```
    def primary_choice_command(self, fields):
        """Dynamic choice command implementation for
        primary_choice_field.

        Parameters
        ----------
        fields : dict
            populated with the values of the dependent fields
        """
        return ExtensionResult(
            rc=0,
            message="Values for choice field: 'primary_choice_field'",
            values=["Start", "Pause", "Stop", "Build", "Destroy"]
        )

    @dynamic_choice_command("secondary_choice_field")
    def secondary_choice_command(self, fields):
        """Dynamic choice command implementation for
        secondary_choice_field.

        Parameters
        ----------
        fields : dict
            populated with the values of the dependent fields
        """
        return ExtensionResult(
            rc=0,
            message="Values for choice field: 'secondary_choice_field'",
            values=["System", "Command", "Application", "Transfer", "Evidence"]
        )

    @dynamic_command("reset_environment")
    def reset_environment(self, fields):
        """Dynamic command implementation for reset_environment command.

        Parameters
        ----------
        fields : dict
            populated with the values of the dependent fields
        """

        # Reset the state of the Output Only 'step' fields.
        out_fields = {}
        out_fields["step_1"] = "Initial"
        out_fields["step_2"] = "Initial"
        ui.update_output_fields(out_fields)

        return ExtensionResult(
            message="Message: Hello from dynamic command 'reset_environment'!",
            output=True,
            output_data='The environment has been reset.',
            output_name='DYNAMIC_OUTPUT')

    @dynamic_command("async_print_word")
    def async_print_word(self, fields):
        """
        Adds each letter of self.WORD to self.async_queue
```

```
75
76          If curr_index is odd, then the function will sleep
77          for 5 seconds before adding self.WORD to self.async_queue
78          """
79
80          curr_index = self.async_index
81
82          if curr_index % 2 != 0:
83              self.async_index += 1
84              time.sleep(5)
85          else:
86              self.async_index += 1
87
88          self.async_queue.append(self.WORD[curr_index])
89
90          return ExtensionResult(
91              message="",
92              output=True,
93              output_data="async_print_word()",
94              output_name='DYNAMIC_ASYNC_OUTPUT')
95
    @dynamic_command("sync_print_word")
96      def sync_print_word(self, fields):
97          """
98          Adds each letter of self.WORD to self.sync_queue
99
100         If curr_index is odd, then the function will sleep
101         for 5 seconds before adding self.WORD to self.sync_queue
102         """
103
104         curr_index = self.sync_index
105
106         if curr_index % 2 != 0:
107             self.sync_index += 1
108             time.sleep(5)
109         else:
110             self.sync_index += 1
111
112         self.sync_queue.append(self.WORD[curr_index])
113
114         return ExtensionResult(
115             message="",
116             output=True,
117             output_data="sync_print_word()",
118             output_name='DYNAMIC_SYNC_OUTPUT')
119
120     def extension_start(self, fields):
121         """Required method that serves as the starting point for work performed
122         for a task instance.
123
124         Parameters
125         ----------
126         fields : dict
127             populated with field values from the associated task instance
128             launched in the Controller
129
130         Returns
```

```
131         -------
132         ExtensionResult
133             once the work is done, an instance of ExtensionResult must be
134             returned. See the documentation for a full list of parameters that
135             can be passed to the ExtensionResult class constructor
136         """
137
138         # Extract the cancel_cleanup_time
139         self.cancel_cleanup_time = fields.get('cancel_cleanup_time', 0)
140
141         # Sleep for 45 seconds
142         time.sleep(45)
143
144         # Get the value of the 'action' field
145         action = fields.get('action', [""])[0]
146
147         if action.lower() == 'print':
148             # Print to standard output...
149             print("Hello STDOUT!")
150         else:
151             # Log to standard error...
152             logger.info('Hello STDERR!')
153
154         # Return the result with a payload containing a Hello message...
155         return ExtensionResult(
156             unv_output='Hello Extension!'
157         )
158
159     def extension_cancel(self):
160         """Optional method that allows the Extension instance to perform
161         any cleanup work.
162         """
163         logger.info('About to sleep for %d seconds' % self.cancel_cleanup_time)
164         time.sleep(self.cancel_cleanup_time)
165         logger.info('Done with extension_cancel()')
```

Line 144	The **cancel_cleanup_time** field is extracted from **fields** and stored in **self.cancel_cleanup_time** so that it can be accessed in **extension_cancel()**
Lines 147	The **extension_start()** method is modified to sleep for 45 seconds.
Lines 164-170	The **extension_cancel()** method sleeps for **self.cancel_cleanup_time** number of seconds. It also logs two statements; one before and one after the sleep time period.

8.1.1.9.4 Step 2 - Build and Upload the Extension Zip Archive Using the UIP VS Code Extension

Save all changes to extension.py.

From the VS Code command pallet, execute the **UIP: Push** command as shown below:

Recall that the **UIP: Push** command builds and uploads the Extension zip archive

Click here to expand uip-cli details...

8.1.1.9.4.1 Step 2 Supplemental - Build and Upload the Extension Zip Archive Using the CLI

Save all changes to extension.py.

From the command line, cd to the ~/dev/extensions/sample-task directory and execute the **push** command as shown below:

```
$ uip push
```

Recall that the **push** command builds and uploads the Extension zip archive

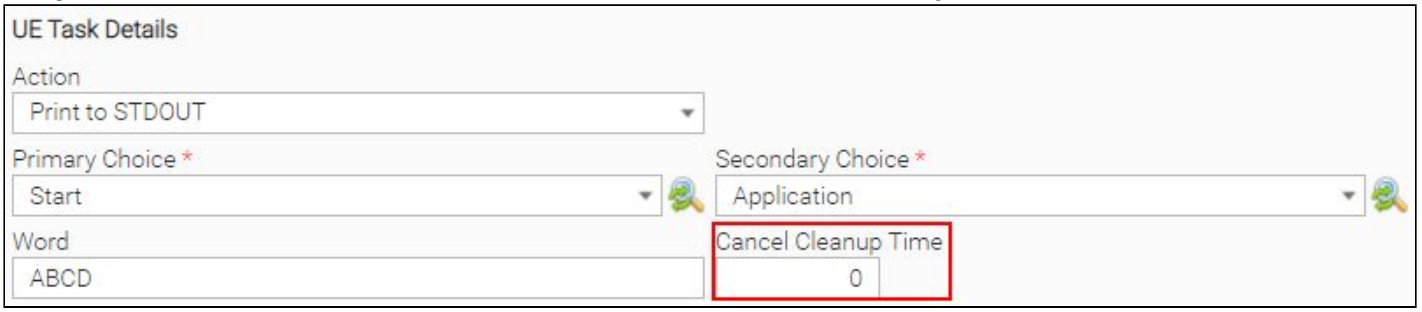
8.1.1.9.5 Step 3 - Demonstrate Cancel Command

Before working with the Cancel command, we will need to make sure the cancel timeout value (this is NOT the cancel_cleanup_time field above) is set to 10 seconds. Unless you have explicitly modified the value, it will be 10 seconds by default. Open **uags.conf,** and if there is an entry for **extension_cancel_timeout,** make sure it is 10 seconds.

8.1.1.9.5.1 a. Graceful Cancellation

Graceful Cancellation is when the **extension_cancel()** method finishes before the 10 second Cancel timeout period is up.

- Navigate to the "ue-task-test" task instance form, and ensure the **Cancel Cleanup Time** field is set to 0 as shown:



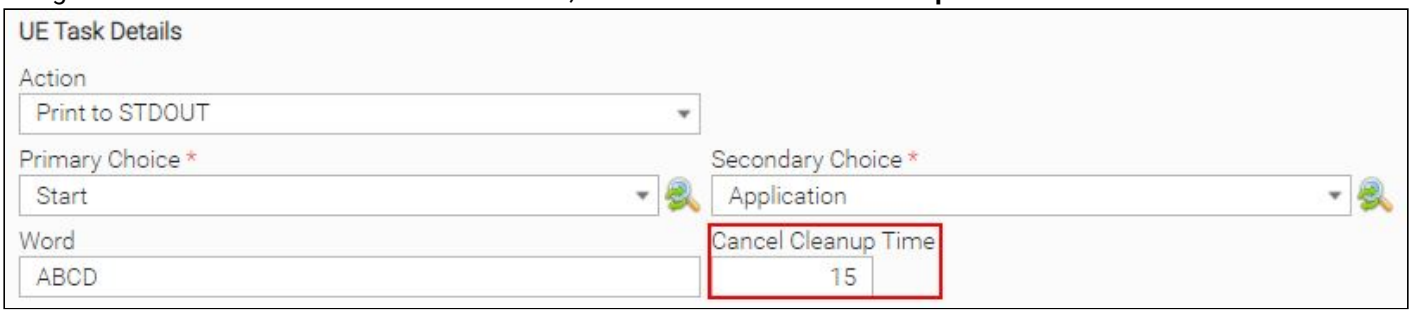
- Launch the task using the VS Code "UIP: Task Launch" command
- After about 2-3 seconds, right-click the task instance on the Controller and click "Cancel"
- Wait until the task status is "Cancelled"
- The entire process should look similar to:

Notice that both the log statements were printed since the timeout period of 10 seconds did not expire before the **extension_cancel()** cleanup finished.

8.1.1.9.5.2 b. Timeout

Timeout is when the **extension_cancel()** method has not finished before the 10 second Cancel timeout period is up.

- Navigate to the "ue-task-test" task instance form, and ensure the **Cancel Cleanup Time** field is set to 15 as shown:



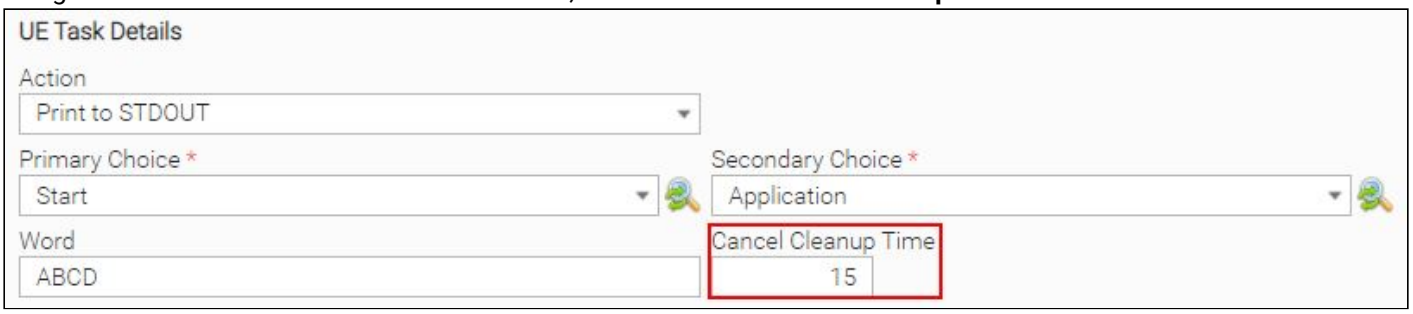
- Launch the task using the VS Code "UIP: Task Launch" command
- After about 2-3 seconds, right-click the task instance on the Controller and click "Cancel"
- Wait until the task status is "Cancelled"
- The entire process should look similar to:

Notice that only the first log statement was printed. Since the cancel cleanup time value was set to 15 seconds, the Cancel command timed out after 10 seconds, and the Extension process was forcefully terminated.

8.1.1.9.5.3 c. Double Cancel

Double Cancel is when the Extension instance is "Cancelled" twice from the Controller. When the agent receives the second Cancel, it immediately terminates the Extension process regardless of whether the timeout has occurred or not.

- Navigate to the "ue-task-test" task instance form, and ensure the **Cancel Cleanup Time** field is set to 15 as shown:



- Launch the task using the VS Code "UIP: Task Launch" command
- After about 2-3 seconds, right-click the task instance on the Controller and click "Cancel"
- Immediately after, right-click the task instance and click "Cancel" once again.
- The status should immediately transition to "Cancelled"

- The entire process should look similar to:

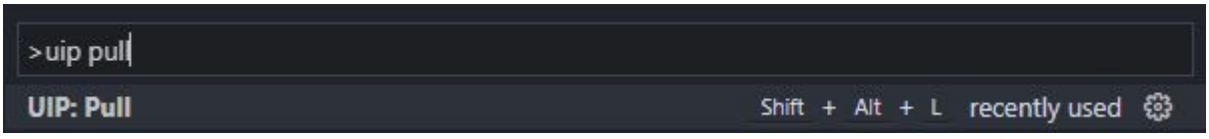
Notice that only the first log statement was printed. Since the Extension process was terminated by the Double Cancel before the 15 second sleep period was up, the second log statement did not get printed.

8.1.1.9.6 Step 4 - Update the Local template.json

In step 1, we modified the Universal Template by adding the new cancel_cleanup_time field. Recall that inside ~/dev/extensions/sample-task/src/templates, there is a **template.json** file. This file should correspond to the Universal Template in the Controller.

Right now, they are not both the same. The Controller's version of **template.json** has the new field. To grab those changes, use the **pull** command as shown below:

8.1.1.9.6.1 UIP VS Code Extension



Click here to expand uip-cli details...

Step Supplemental - CLI

```
[redacted]@sbus44:~/dev/extensions/sample-task$ uip pull
The following files were updated:
  - template.json
```

Now, both the local and Controller's version of the Universal Template are the same.

8.1.1.10 Publishing Events

8.1.1.10.1 Introduction

As part of 7.2.0.0, Universal Extensions can now be used to extend the Controller's monitoring capabilities through Universal Events and Universal Monitors/Universal Monitor Triggers.

Specifically, the Universal Extension API has been enhanced to supported publishing events using the **publish** method from the **event** module.

Throughout this document, the event publishing functionality will be demonstrated using a contrived file monitor example.

On this page, we will cover the following:

1. Set up the new **UE Publisher** template.
2. Add a **directory** field to the **UE Publisher** template.
3. Enhance the **UE Publisher's** local event template.
4. Modify the **ue-publisher** Extension.
5. Create a task for the **UE Publisher** template.
6. Create a Universal Monitor task and trigger.
7. Run the Universal Monitor Trigger.
8. Update the local template.json.

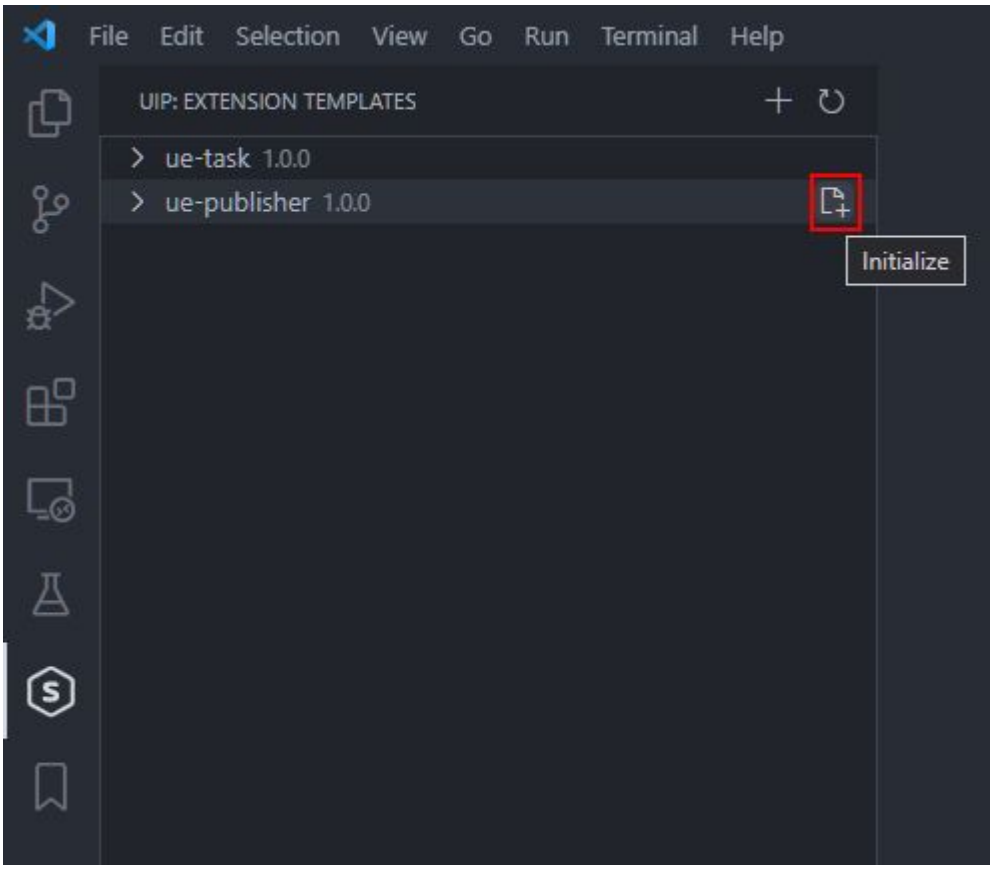
8.1.1.10.2 Step 1 - Set up the new "UE Publisher" template

Up until now, we have been working with the "UE Task" Universal Template. For this tutorial, we will need to use the "UE Publisher" template that was added to the VS Code Extension and UIP-CLI.

Create a new folder `~/dev/extensions/sample-publisher` where the new template will be stored.

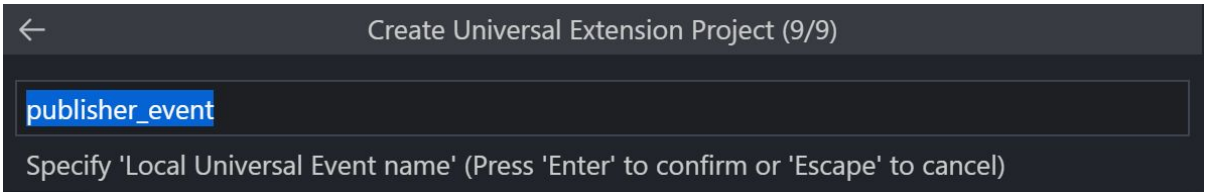
Navigate to the activity bar on the left hand size and click the Stonebranch logo.

Go ahead and click the icon shown below to initialize the **ue-publisher** template:



8.1.1.10.2.1 Setting template parameter values for selected starter template

In the following prompts that are used to configure the template, everything can be kept as is. Note the "UE Publisher" template has an additional option called "Local Universal Event name" shown below.



Open the `~/dev/extensions/sample-publisher/extension.py` if currently not open. Let's examine the file:

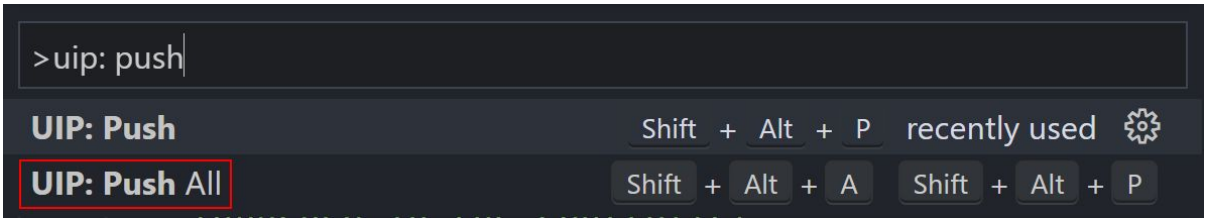
extension.py

```
from __future__ import (print_function)
from time import sleep
from universal_extension import UniversalExtension
from universal_extension import ExtensionResult
from universal_extension import event


class Extension(UniversalExtension):
    """Required class that serves as the entry point for the extension
    """

    def __init__(self):
        """Initializes an instance of the 'Extension' class
        """
        # Call the base class initializer
        super(Extension, self).__init__()

        # Flag to control the event loop below
        self.run = True

    def extension_start(self, fields):
        """Required method that serves as the starting point for work performed
        for a task instance.

        Parameters
        ----------
        fields : dict
            populated with field values from the associated task instance
            launched in the Controller

        Returns
        -------
        ExtensionResult
            once the work is done, an instance of ExtensionResult must be
            returned. See the documentation for a full list of parameters that
            can be passed to the ExtensionResult class constructor
        """
```

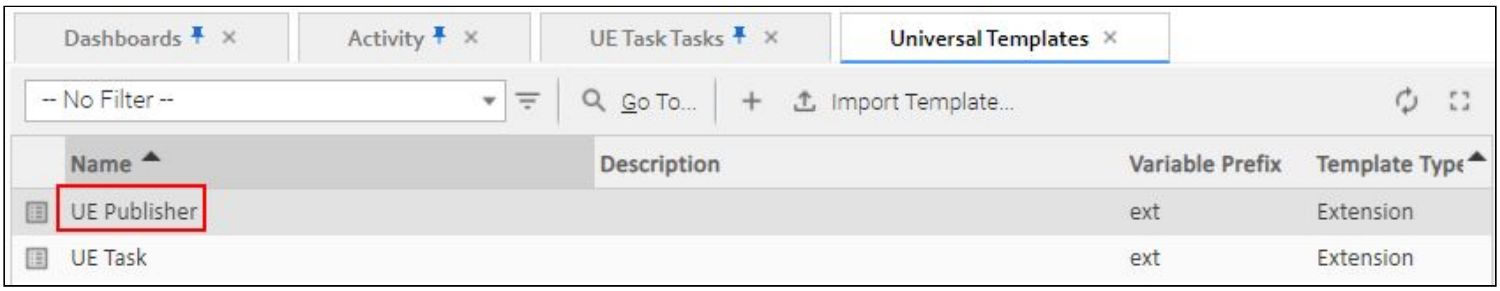
```
38
39          # Get the value of the 'sleep_value' field
40          sleep_value = fields.get('sleep_value', 3)
41
42          # loop that publishes events continuously as long as self.run is True
43          while self.run:
44              # Publish an event
45              event.publish(
46                  'publisher_event',
47                  {}
48              )
49
50              # sleep before publishing next event
51              sleep(sleep_value)
52
53          # Return the result with a payload marking the end of extension_start()
54          return ExtensionResult(
55              unv_output='extension_start() finished'
56          )
57
58      def extension_cancel(self):
59          """Optional method that allows the Extension to do any cleanup work
60          before finishing
61          """
62          # Set self.run to False which will end the event loop above
63          self.run = False
```

Line 2	Imports the sleep method from the time module which will be used to add a delay between successive events.
Line 5	Imports the event module which contains the **publish** method used later on.
Line 19	A flag called **self.run** with initial value of **True** is added to control the event loop.
Line 40	Extract the **sleep_value** field from the task instance passed down by the Controller.
Line 43	While loop that runs as long as the **self.run** field value is **True**
Line 45-48	Used to publish an empty event, as shown by the empty attributes dictionary.
Line 51	Used to add a tiny delay before the next event is published
Line 58-63	Upon receiving the Cancel command from the Controller, the **self.run** flag is set to **False**

Now, let's push the extension out to the Controller. Since this is the first time, use the **UIP: Push All** command:

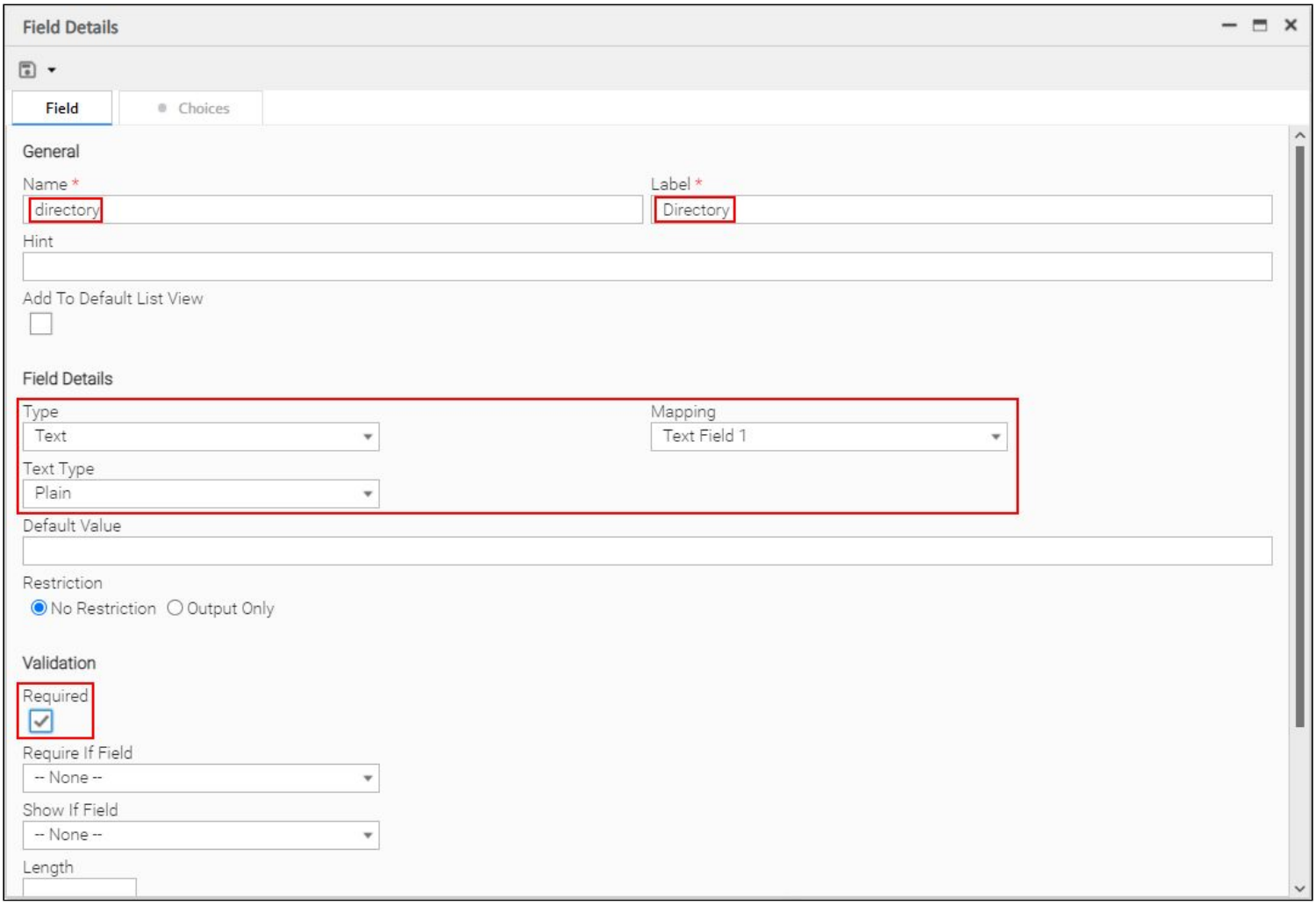


If successful, you should see the "UE Publisher" template in the "Universal Templates" list:



8.1.1.10.3 Step 2 - Add a directory field to the "UE Publisher" template

Navigate to the **Fields** tab of the **UE Publisher** template, and add a new field as shown below:

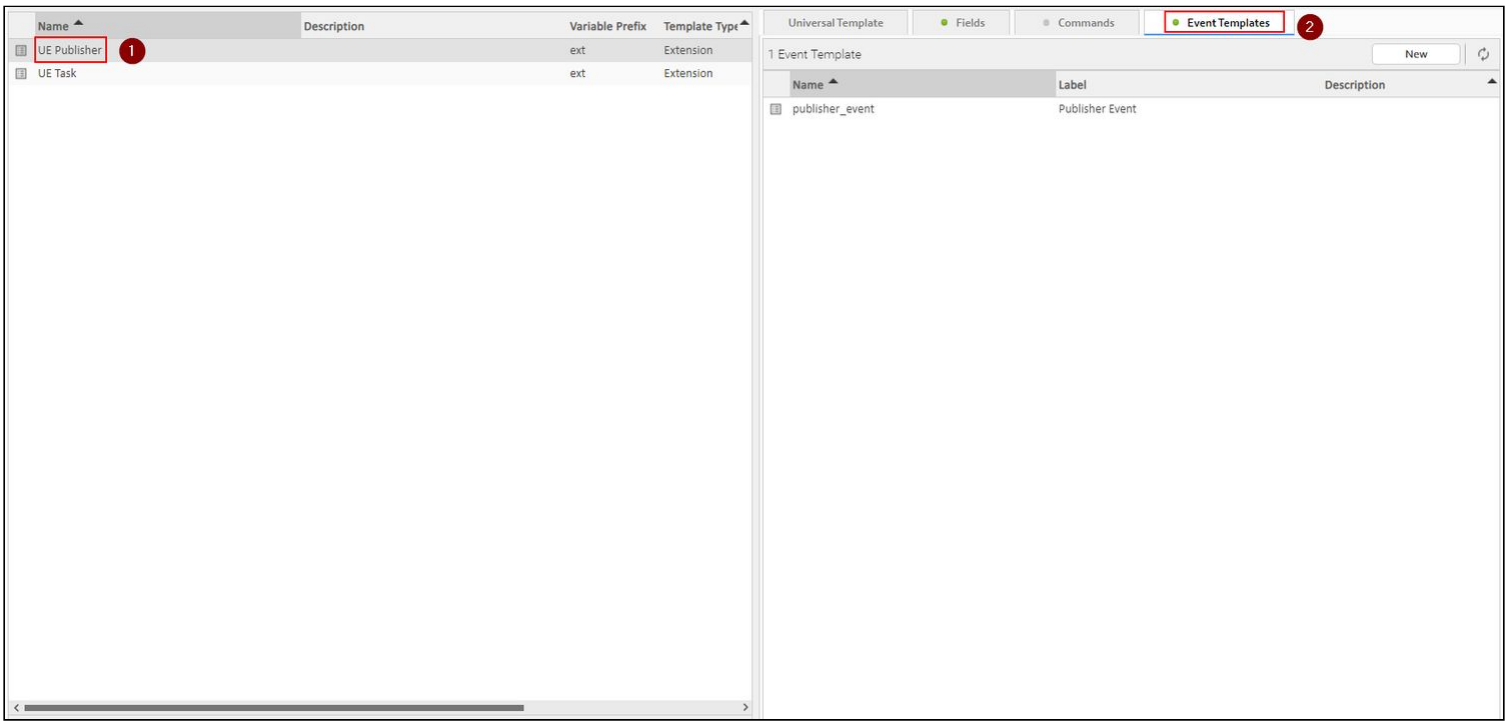


This required field will be used to specify the directory to get the file list of.

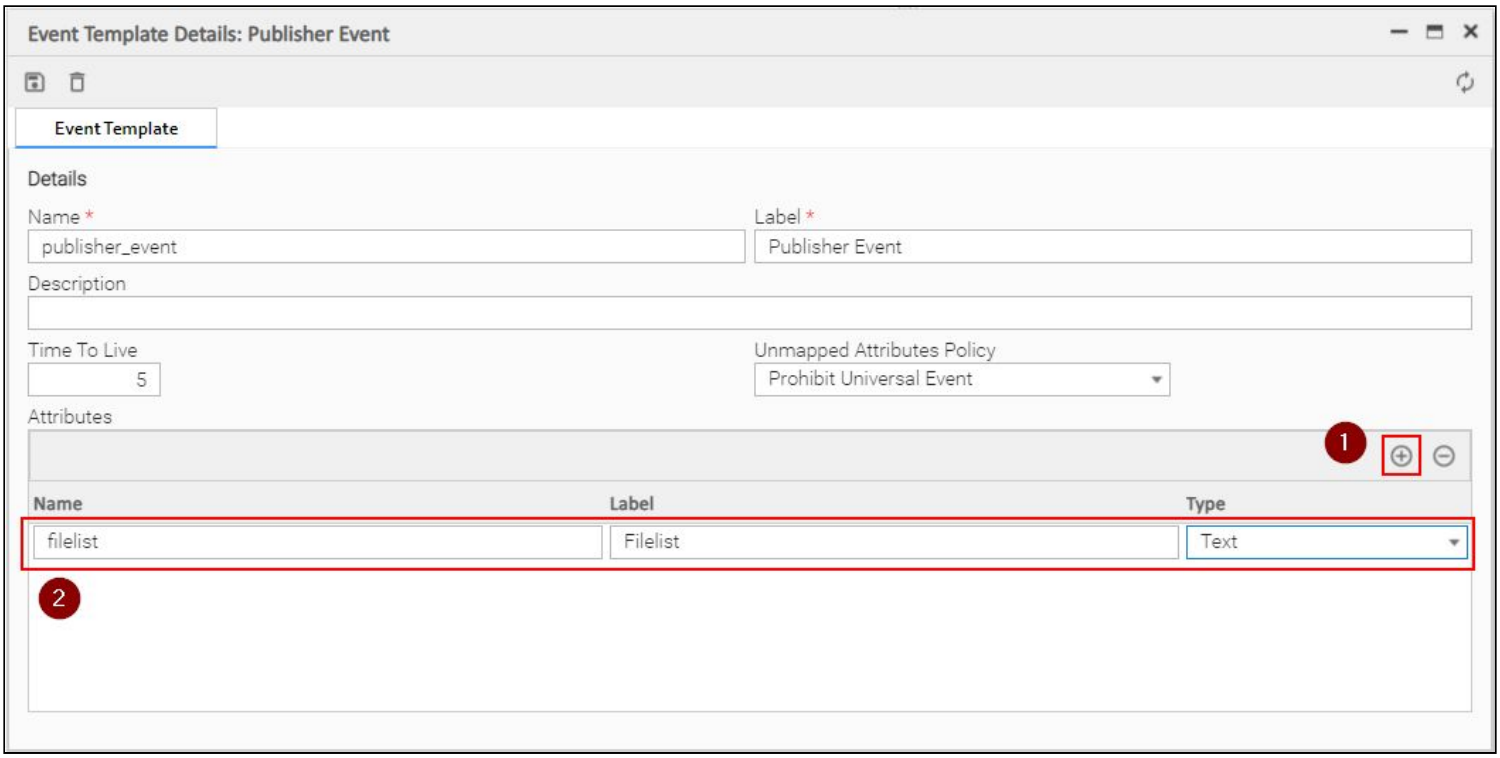
Save the template.

8.1.1.10.4 Step 3 - Enhance the "UE Publisher's" local event template

Navigate to the **Event Templates** tab of the **UE Publisher** template:



Double click the **publisher_event** entry, and modify it as shown below:



A new attribute of type **Text** called **filelist** is added which will contain the list of files (formatted as a string) in the directory specified by the **directory** field added in the last step.

Save the Event Template.

8.1.1.10.5 Step 4 - Modify the ue-publisher extension

Now, we need to enhance `~/dev/extensions/sample-publisher/extension.py` to publish the filelist event. Update the file as shown below:

extension.py

```
from __future__ import (print_function)
from time import sleep
import os
from universal_extension import UniversalExtension
from universal_extension import ExtensionResult
from universal_extension import event


class Extension(UniversalExtension):
    """Required class that serves as the entry point for the extension
    """

    def __init__(self):
        """Initializes an instance of the 'Extension' class
        """
        # Call the base class initializer
        super(Extension, self).__init__()

        # Flag to control the event loop below
        self.run = True

    def extension_start(self, fields):
        """Required method that serves as the starting point for work performed
        for a task instance.

        Parameters
        ----------
        fields : dict
            populated with field values from the associated task instance
            launched in the Controller

        Returns
        -------
        ExtensionResult
            once the work is done, an instance of ExtensionResult must be
            returned. See the documentation for a full list of parameters that
            can be passed to the ExtensionResult class constructor
        """

        # Get the value of the 'sleep_value' field
        sleep_value = fields.get('sleep_value', 3)

        # Get the value of the 'directory' field
        directory = fields.get('directory', '')

        # Verify the directory exists
```

```
47          if not directory:
48              return ExtensionResult(
49                  rc=-1,
50                  unv_output="specified directory is empty"
51              )
52          elif not os.path.exists(directory):
53              return ExtensionResult(
54                  rc=-1,
55                  unv_output="specified directory does not exist"
56              )
57
58          prev_filelist = set()
59          # loop that publishes events continuously as long as self.run is True
60          while self.run:
61              curr_filelist = set(os.listdir(directory))
62
63              # Subtracting 'prev_filelist' from 'curr_filelist' will ensure the
64              # 'filelist' only contains the newly detected files.
65              filelist = curr_filelist - prev_filelist
66              filelist = ','.join(filelist)
67
68              prev_filelist = curr_filelist.copy()
69
70              if filelist:
71                  print(filelist)
72
73              # Publish the event
74              event.publish(
75                  'publisher_event',
76                  {"filelist": filelist}
77              )
78
79              # sleep before publishing next event
80              sleep(sleep_value)
81
82          # Return the result with a payload marking the end of extension_start()
83          return ExtensionResult(
84              unv_output='extension_start() finished'
85          )
86
87      def extension_cancel(self):
88          """Optional method that allows the Extension to do any cleanup work
89          before finishing
90          """
91          # Set self.run to False which will end the event loop above
92          self.run = False
```

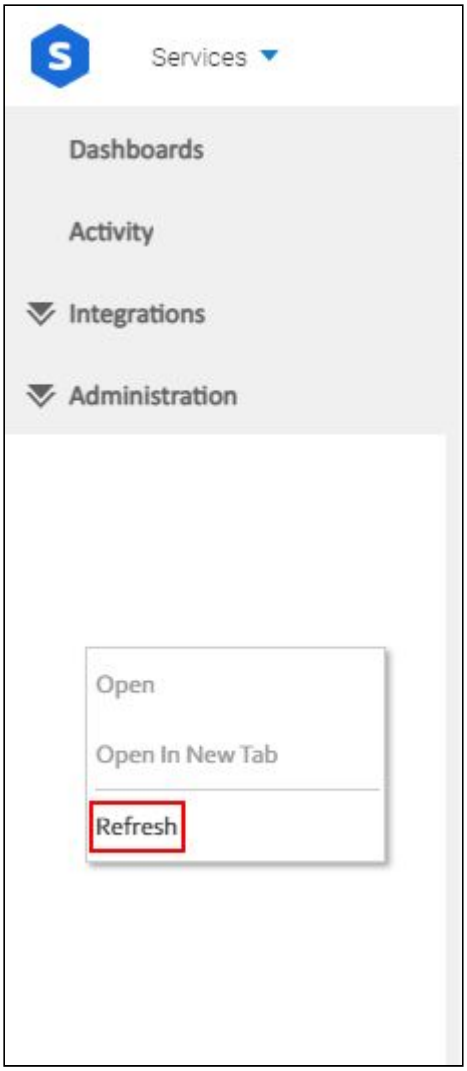
Line 3	Imports the os module used to list files in an directory.
Line 44	Extract the **directory** field from the task instance passed down by the Controller.
Line 47-56	Verify the **directory** exists
Line 58-80	Get the current directory listing and remove the files from the previous iteration, only leaving new files discovered in the current iteration. Then, publish the filtered file listing as a comma-separated string to the **publisher_event** event.

Save the changes to `extension.py` and execute the **UIP: Push** command as shown below:

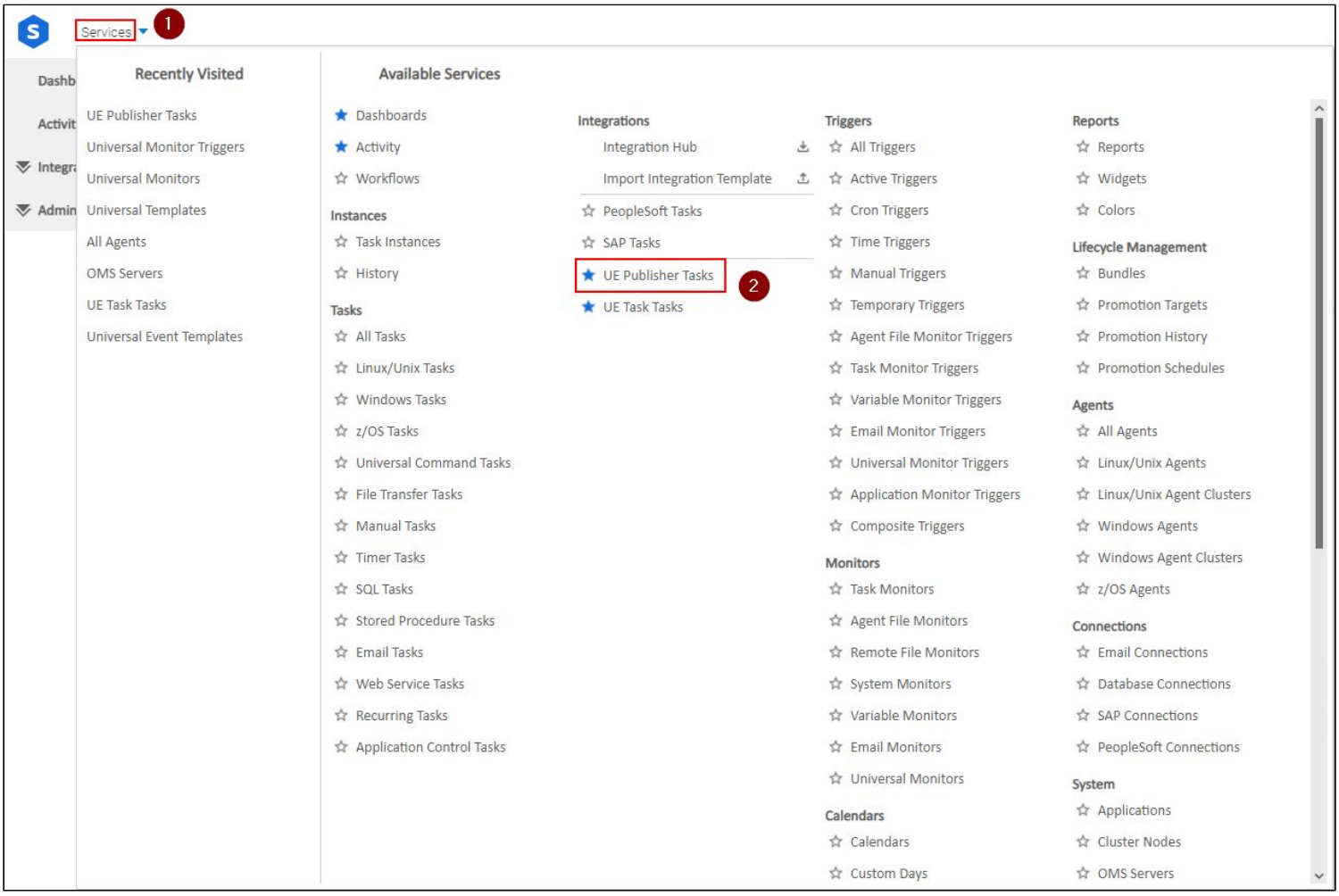
Recall that the **UIP: Push** command builds and uploads the Extension zip archive

8.1.1.10.6 Step 5 - Create a task for the "UE Publisher" template

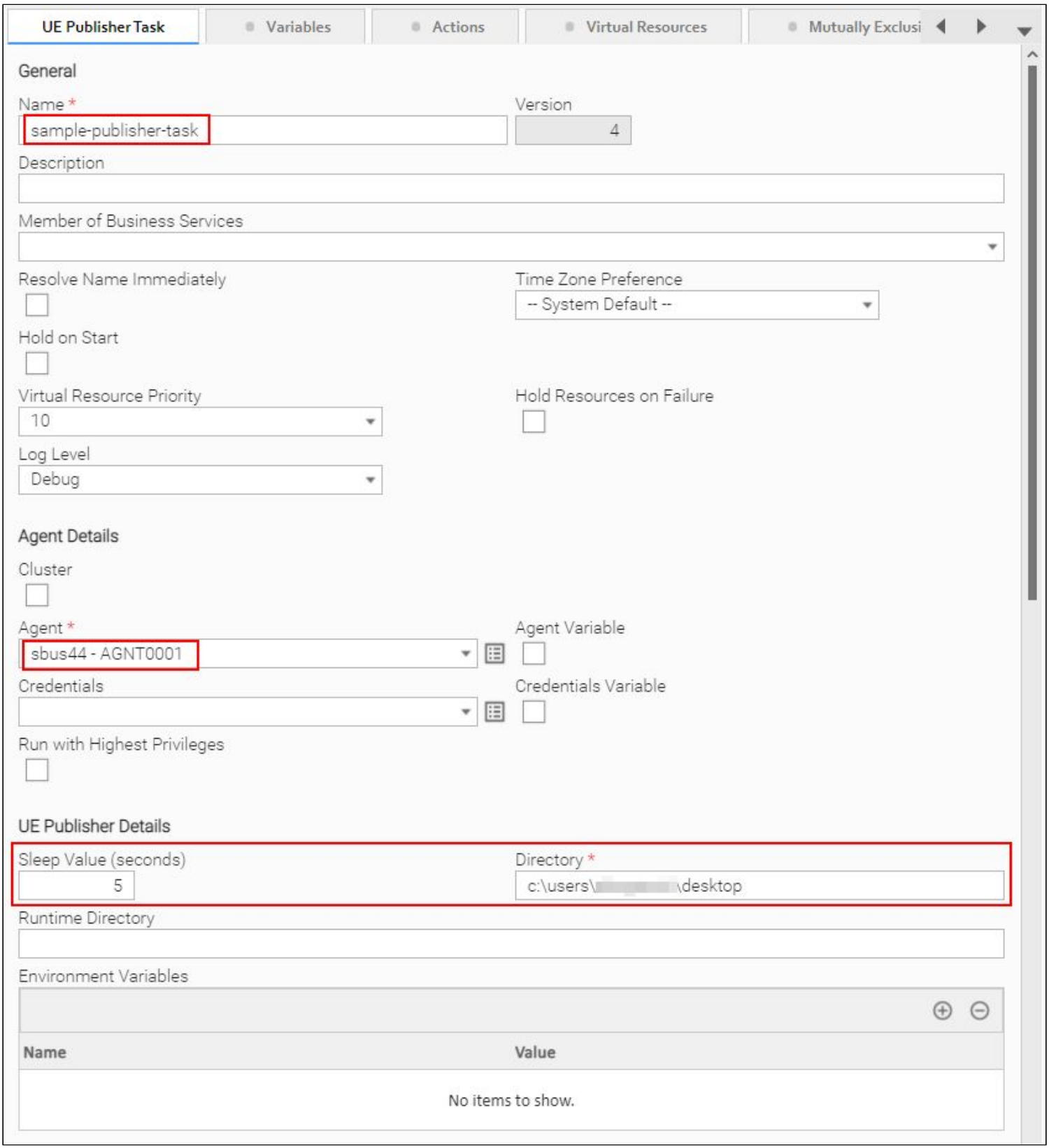
Right-click on the navigation tree pane, and click **Refresh** as shown below:



Then under the **Services** menu, click **UE Publisher Tasks** under the **Integrations** section:



Create a new task called **sample-publisher-task**:



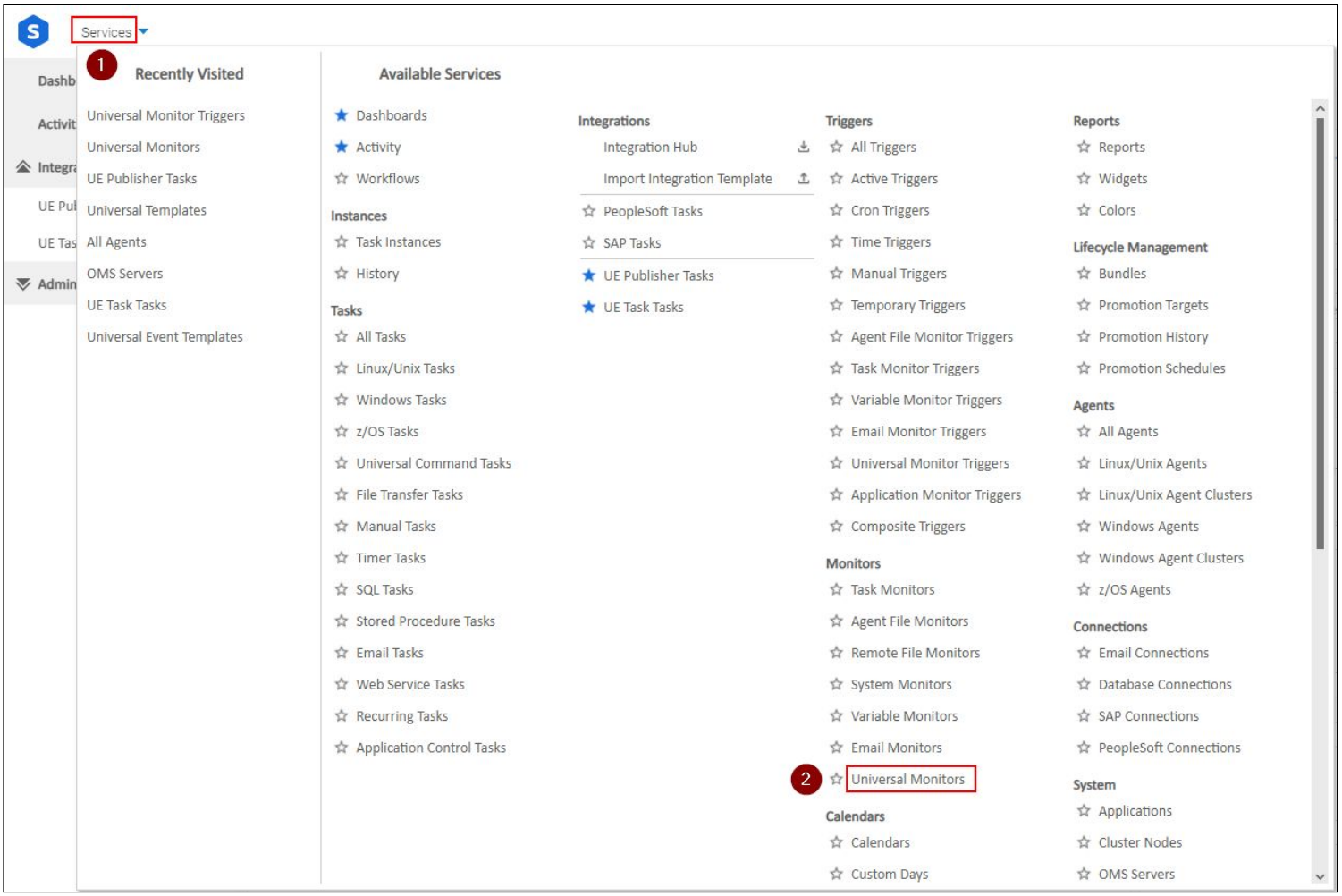
- For the directory field, type in a valid path on the system where the selected agent is running

Save the task.

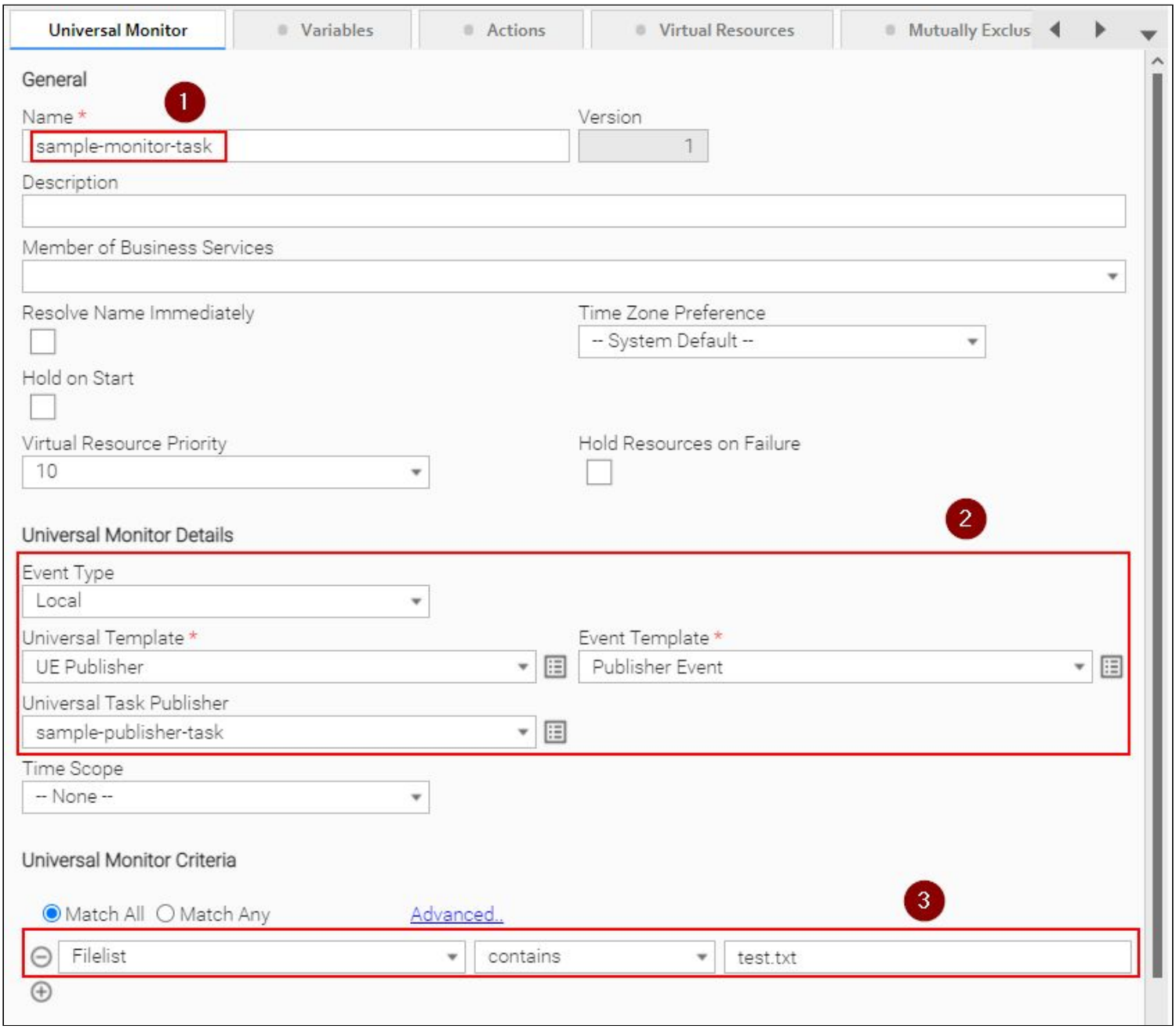
8.1.1.10.7 Step 6 - Create a Universal Monitor task and trigger

Now that we have the event publishing logic added, we need to attach the event itself to a Universal Monitor task.

Under the **Services** menu, click **Universal Monitors** under the **Monitors** section as shown below:



Create a new Universal Monitor task as shown below:

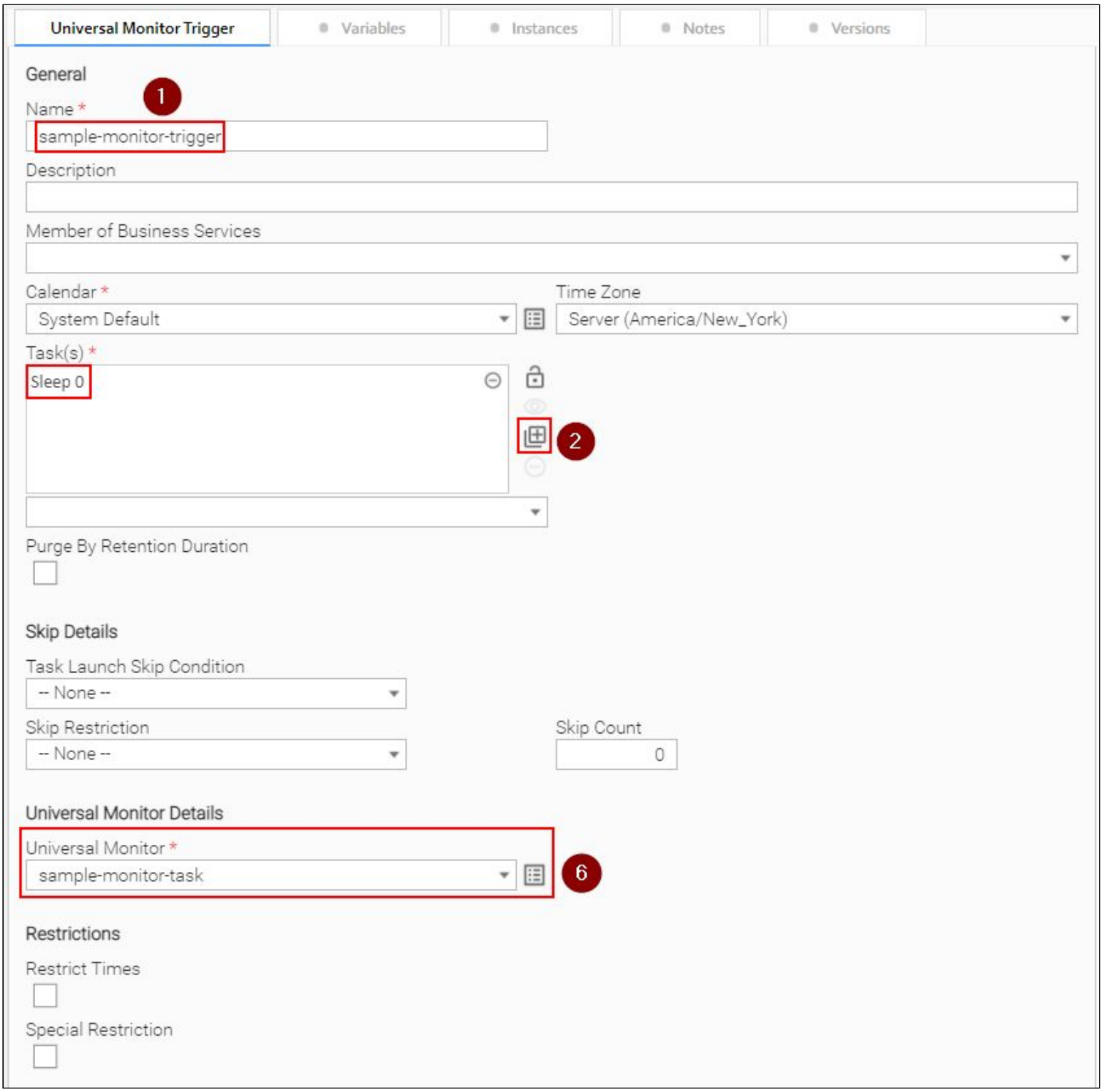


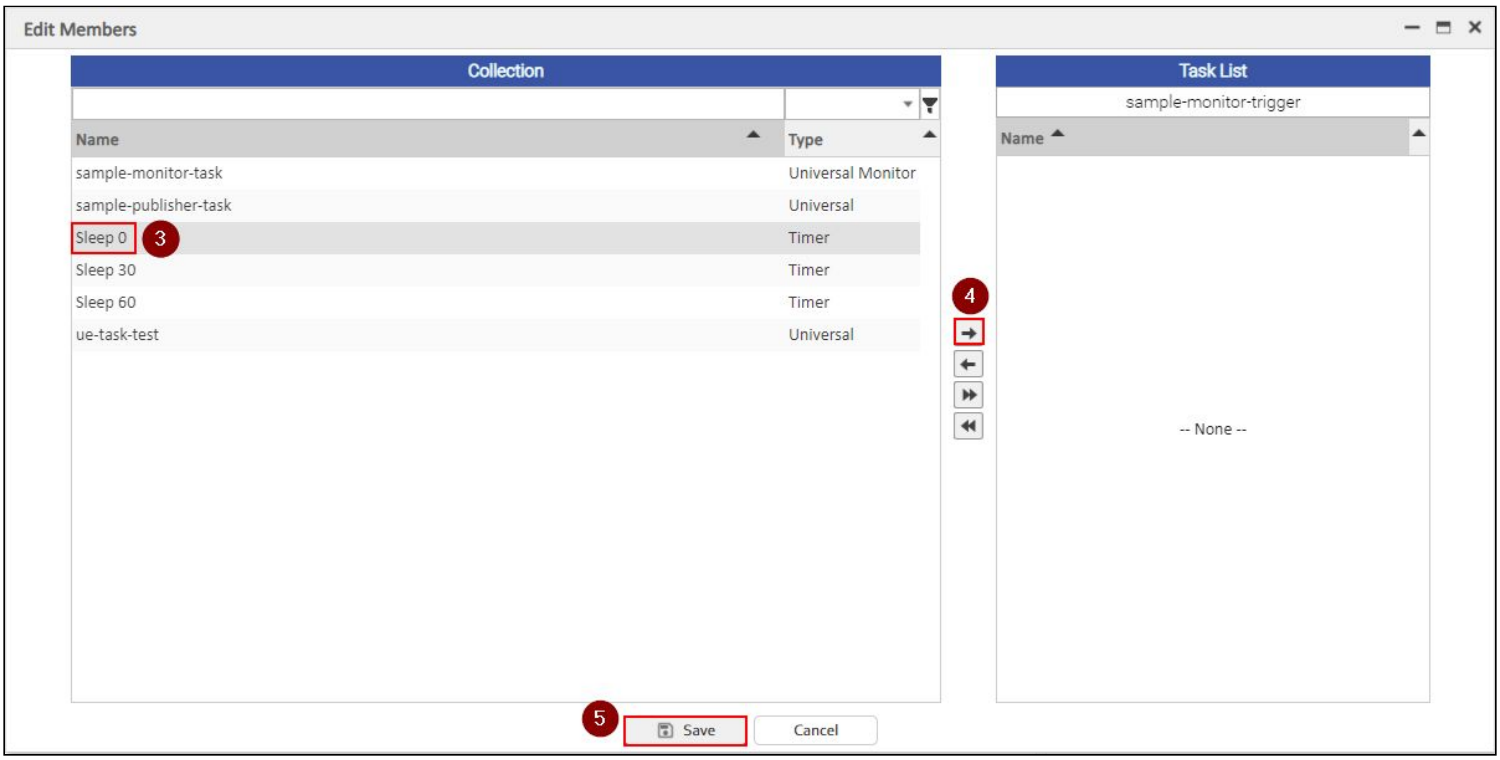
- Make sure the **Event Type** is set to **Local** since the **ue_publisher** Event Template is (locally) attached to the **UE Publisher** Universal Template
- Make sure the **Universal Template** is set to **UE Publisher**
- Make sure the **Event Template** is set to **Publisher Event** (this is the user-friendly name of **ue_publisher** Event Template)
- Make sure the **Universal Task Publisher** is set to **sample-publisher-task**
- Make sure there is an entry for **Filelist** as shown above. As you may have guessed, this Universal Monitor task will check if **Filelist** contains **test.txt**

Save the task.

We can either run the **sample-monitor-task** as a standalone task which finishes upon detecting the target file (**test.txt**), or we can attach the task to a Universal Monitor trigger. To cover the complete functionality, we will attach it to a Universal Monitor Trigger.

Under the **Services** menu, click **Universal Monitor Triggers** under the **Triggers** section. Create a new trigger as shown below:


Universal Monitor Trigger
Variables
Instances
Notes
Versions
General
1
Name *
sample-monitor-trigger
Description
Member of Business Services
Calendar *
System Default
Time Zone
Server (America/New_York)
Task(s) *
Sleep 0
2
Purge By Retention Duration
Skip Details
Task Launch Skip Condition
-- None --
Skip Restriction
-- None --
Skip Count
0
Universal Monitor Details
Universal Monitor *
sample-monitor-task
6
Restrictions
Restrict Times
Special Restriction

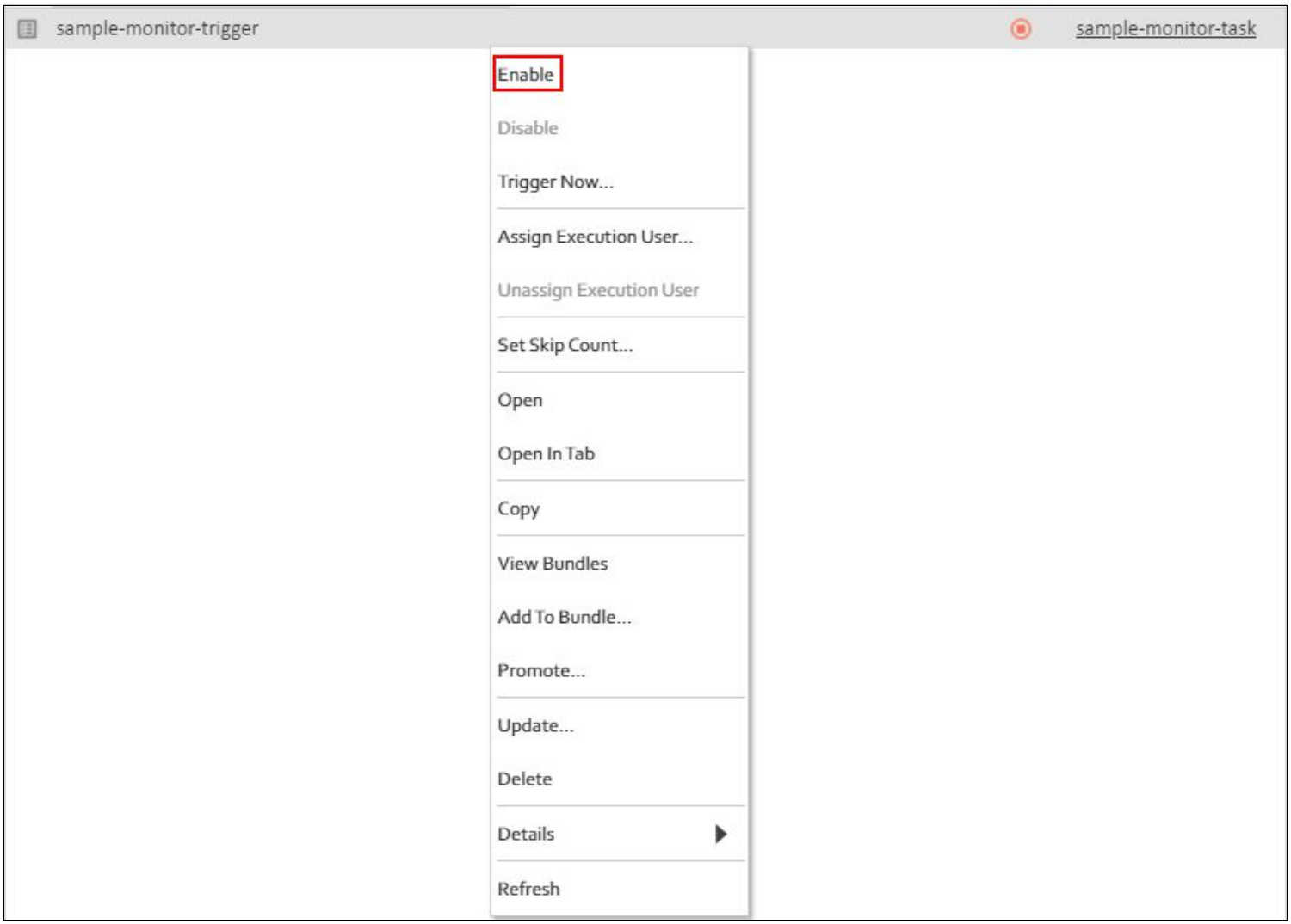


The trigger above will launch the **Sleep 0** task when the **sample-monitor-task's** specified criteria is matched.

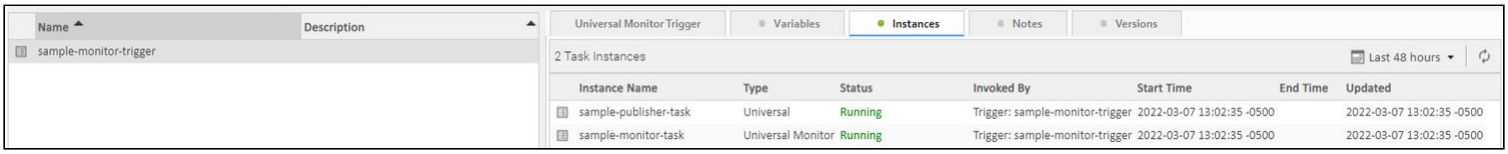
Save the trigger.

8.1.1.10.8 Step 7 - Run the Universal Monitor Trigger

We are finally ready to see the event functionality in action. Navigate to the **sample-monitor-trigger**, right-click on it, and select **Enable**:

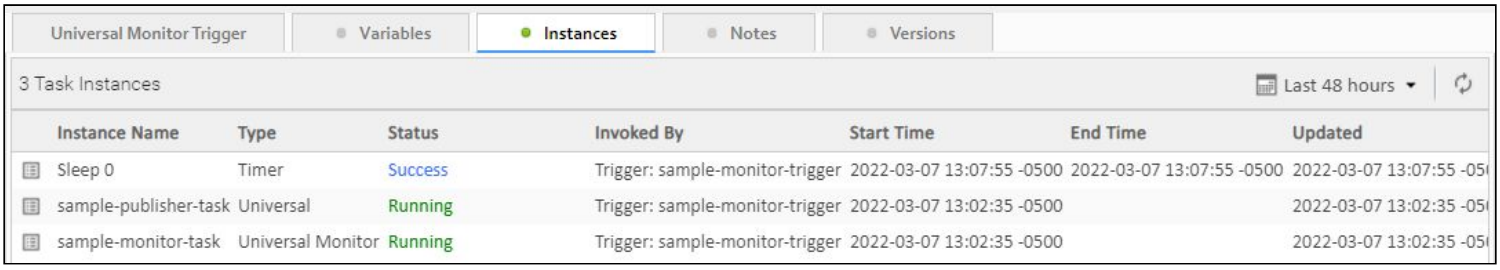


Clicking **Enable** will launch the **sample-monitor-task** and **sample-publisher-task**. To see this, go to the **Instances** tab of the **sample-monitor-trigger**. You should see the following:



The **sample-publisher-task** is sending an event every 5 seconds with the filelisting. Since we haven't created the **test.txt** file in the specified directory, the **Sleep 0** task isn't triggered yet.

In your specified directory, create the **test.txt** file. After about 5 seconds, click the **Refresh** icon in the **Instances** tab of the **sample-monitor-trigger**, and you should see the following:



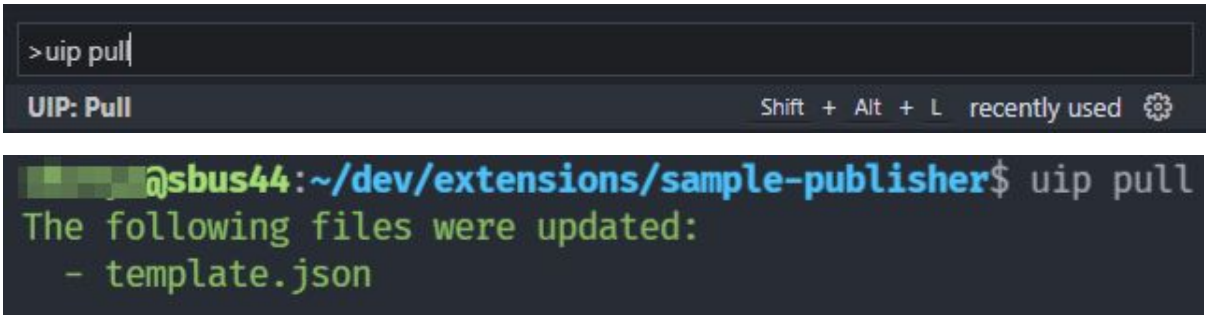
If you delete the **test.txt** file and create it again, the **Sleep 0** Timer task should be launched again by the trigger.

8.1.1.10.9 Step 8 - Update the local template.json

Throughout the tutorial, we modified the Universal Template several times. Recall that inside ~/dev/extensions/sample-publisher/src/templates, there is a **template.json** file. This file should correspond to the Universal Template in the Controller.

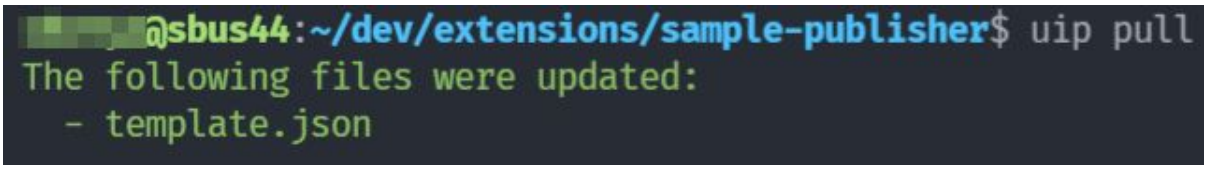
Right now, they are not both the same. To grab those changes, use the **pull** command as shown below:

8.1.1.10.9.1 UIP VS Code Extension



Click here to expand uip-cli details...

Step Supplemental - CLI

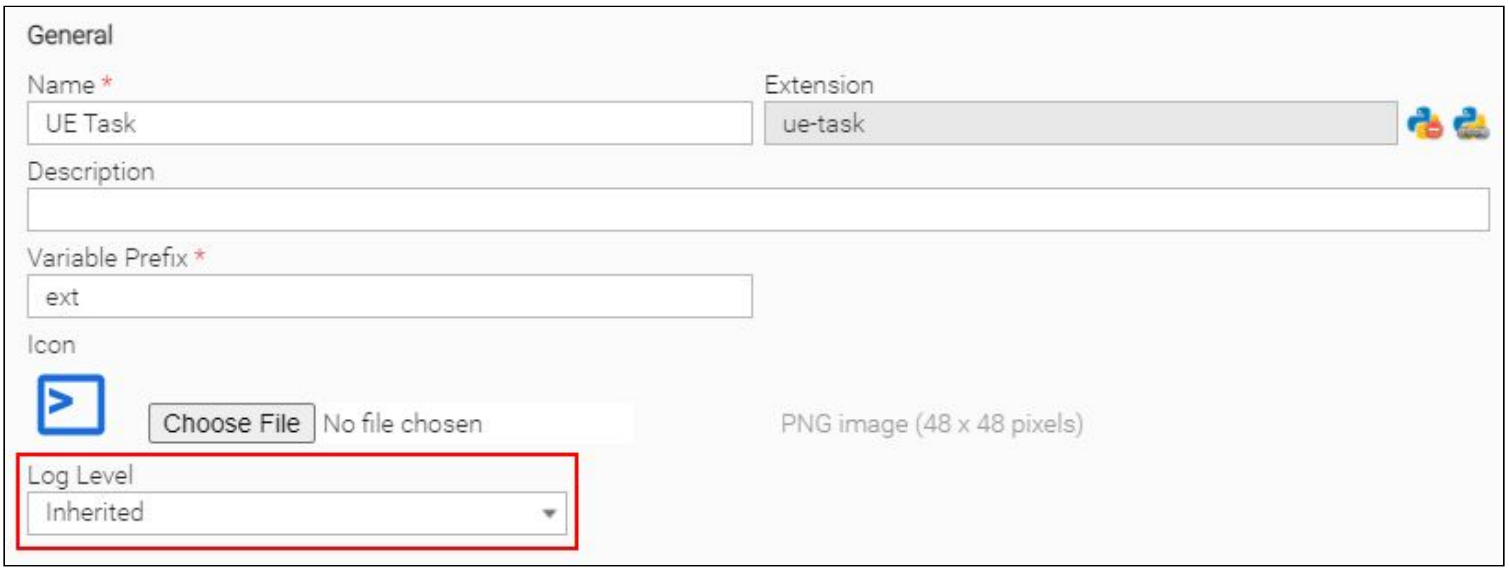


Now, both the local and Controller's version of the Universal Template are the same.

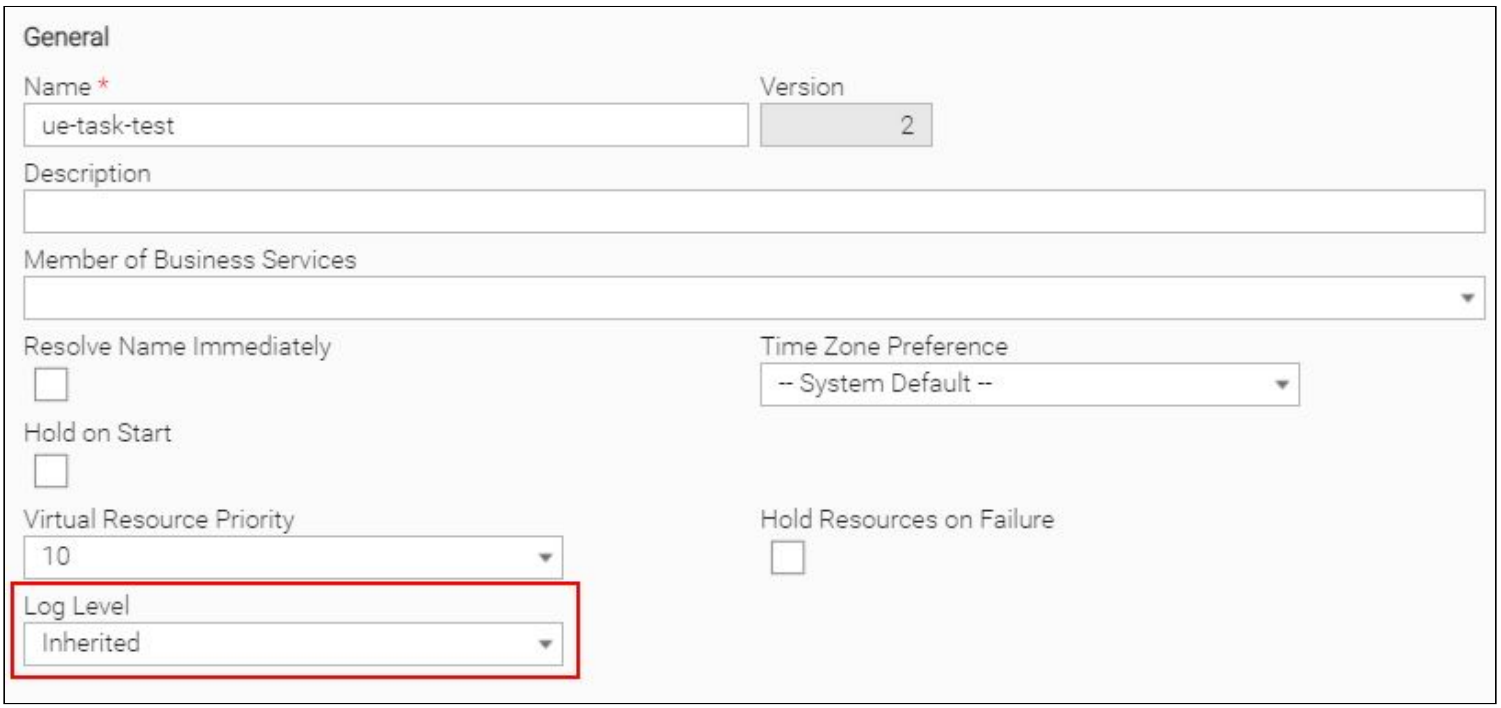
8.1.1.11 Troubleshooting and Debugging

8.1.1.11.1 Log level

Universal Extensions support a configurable log level. The log level can be specified at template level:



And overridden at task level:



This allows Extension code to be written with logging statements only print if the log level is set to an appropriate level (e.g. Debug).

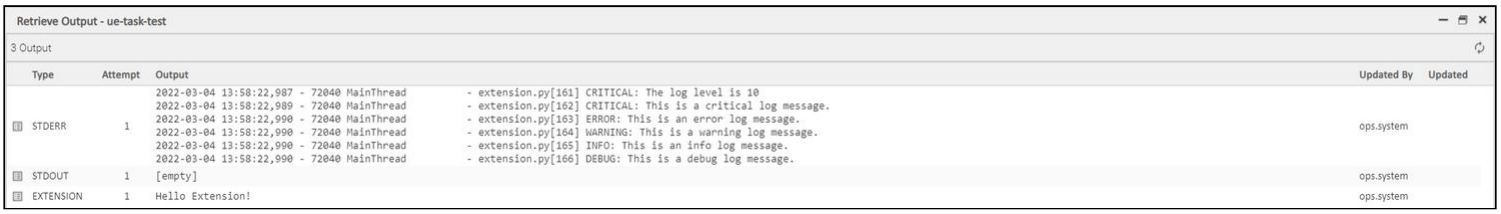
For example, adding the following code to an extension under **extension_start()**:

Logging messages

```
        # Display current log level.
        level = logger.level
        logger.critical("The log level is %s", level)
        logger.critical("This is a critical log message.")
        logger.error("This is an error log message.")
        logger.warn("This is a warning log message.")
```

```
7           logger.info("This is an info log message.")
8           logger.debug("This is a debug log message.")
9
10          logger.info("state: ")
11          logger.info(state)
```

and setting the Log Level to Debug would produce the following output:

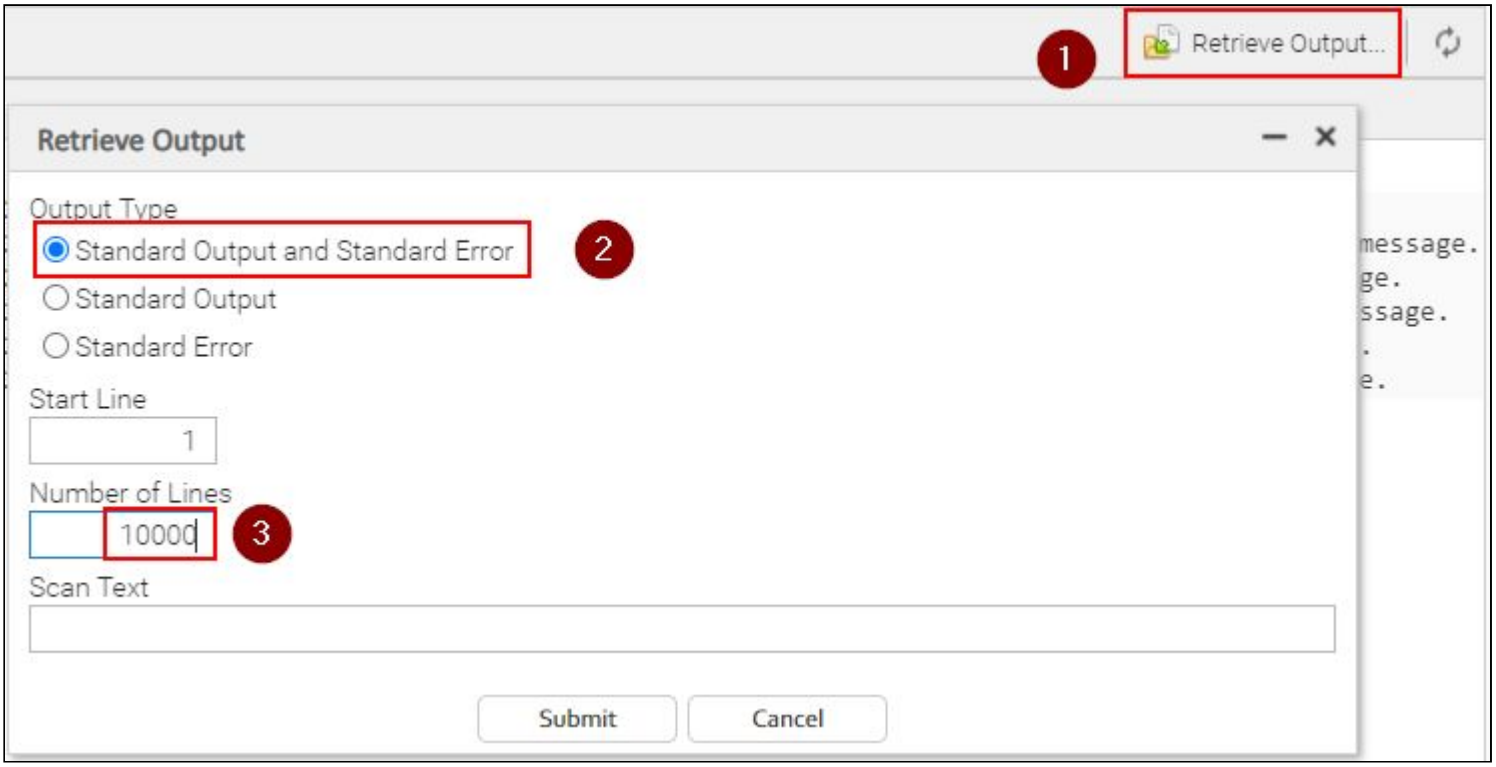


As you can see, in addition to printing the message passed to the logging function, valuable context information is added automatically like timestamp, file name, and line number.

Adding Debug level statements throughout your code that can be easily turned on and off as needed will go a long way towards finding problems.

8.1.1.11.2 Retrieve Output

If an Extension task completes with an unexpected result (and perhaps no output), perform a "Retrieve Output" and select "Standard Output and Standard Error". Be sure to set a sufficient line count to ensure you get back everything:



This will ensure you are seeing everything that was produced by the execution of the Extension task.

8.1.1.11.3 Agent Cache Directory

As an alternative to retrieving the output from the Controller, you can go right to the cache directory on the target agent system. The standard out and standard error for all tasks are written to these directories.

Windows	`C:\Program Files\Universal\UAGSrv\cache\`
Unix	`/opt/universal/uagsrv/cache/`

The files have the format:

<UUID>_stdout

<UUID>_stderr

Where <UUID> is the UUID of the task instance. For example:

161840901164633648 7EAG8TLHASQSQ7_stdout
161840901164633648 7EAG8TLHASQSQ7_stderr

8.1.1.11.4 Debugging Dynamic Choice Field

Dynamic Choice commands do not return stdout or stderr to the Controller. If the expected output does not show up in the Choice field drop-down, it may be difficult to understand what went wrong. The information provided here will help you understand how to find the cause of problems.

8.1.1.11.4.1 Console

If a Dynamic Choice Command returns an error, the Controller will log the error message in its Console. This will provide limited information but, in some cases, it will be all that is needed to determine the cause of the problem. In other cases, it may be necessary to troubleshoot by reviewing files in the cache directory.

8.1.1.11.4.2 Choice Commands under the hood

When Choice Commands execute on the target agent system, an Extension instance is started in it's own Worker process to execute the command (just like with task execution). A stdout and stderr file is created for the process under the agent's cache directory - again, just like with task execution.

If a Dynamic Command encounters an unexpected error, stack trace information will be written to stderr and, therefore, be available in a <UUID>_stderr file in the cache directory. In the case of Dynamic Choice Commands, the UUID is the request ID of the message sent by the Controller to the target agent - not the UUID of the task from which it is issued.

8.1.1.11.4.3 Logging

The same logging facility described above for task execution is available to Dynamic Choice Commands:

Logging

```
1        self.log.debug("This is a debug log message.")
```

While, the stderr file that contains the logged messages is not sent back to the Controller, it is available in the agent cache directory on the target agent system.

8.1.1.11.5 Debugging Dynamic Commands

Dynamic commands do not return stdout or stderr to the Controller so, if the expected output does not show up in the task instance, it may be difficult to understand what went wrong. The information provided here will help you understand how to find the cause of problems.

8.1.1.11.5.1 Console

If a Dynamic Command returns an error, the Controller will log the error message in its Console. This will provide limited information but, in some cases, it will be all that is needed to determine the cause of the problem. In other cases, it may be necessary to troubleshoot by reviewing files in the cache directory.

8.1.1.11.5.2 Dynamic Commands under the hood

When Dynamic Commands execute on the target agent system, an Extension instance is started in it's own Worker process to execute the command (just like with task execution). A stdout and stderr file is created for the process under the agent's cache directory - again, just like with task execution.

If a Dynamic Command encounters an unexpected error, stack trace information will be written to stderr and, therefore, be available in a <UUID>_stderr file in the cache directory. In the case of Dynamic Commands, the UUID is the request ID of the message sent by the Controller to the target agent - not the UUID of the task instance from which it is issued.

8.1.1.11.5.3 Logging

The same logging facility described above for task execution is available to Dynamic Commands:

Logging

```
1          logger.debug("This is a debug log message.")
```

While, the stderr file that contains the logged messages is not sent back to the Controller, it is available in the agent cache directory on the target agent system.

8.1.2 Integrating Third Party Dependencies

In The Basics, we developed a simple Extension and walked through most of the functionalities. One key benefit of Universal Extensions, however, was not covered, which is its ability to seamlessly integrate third party Python modules.

> It is highly recommended to go through The Basics, if this is your first time developing Extensions (especially with uip-cli and VSCode plugin).

The following pages below will show how to use the uip-cli and VSCode plugin v2.0.0 to develop Extensions that use third party dependencies.

Title
Setting up the Extension
Running the Extension
Adding and Using `psutil` Dependency
Building and Testing the Extension

8.1.2.1 Setting Up the Extension

8.1.2.1.1 Prerequisites

The following products should be installed:

- VSCode Plugin 2.0.0
- uip-cli 2.0.0
- Universal Controller 7.4.0.0
- Universal Agent 7.4.0.0

All work will be done in a Python 3.7.16 virtual environment. Make sure the uip-cli is installed in the virtual environment.

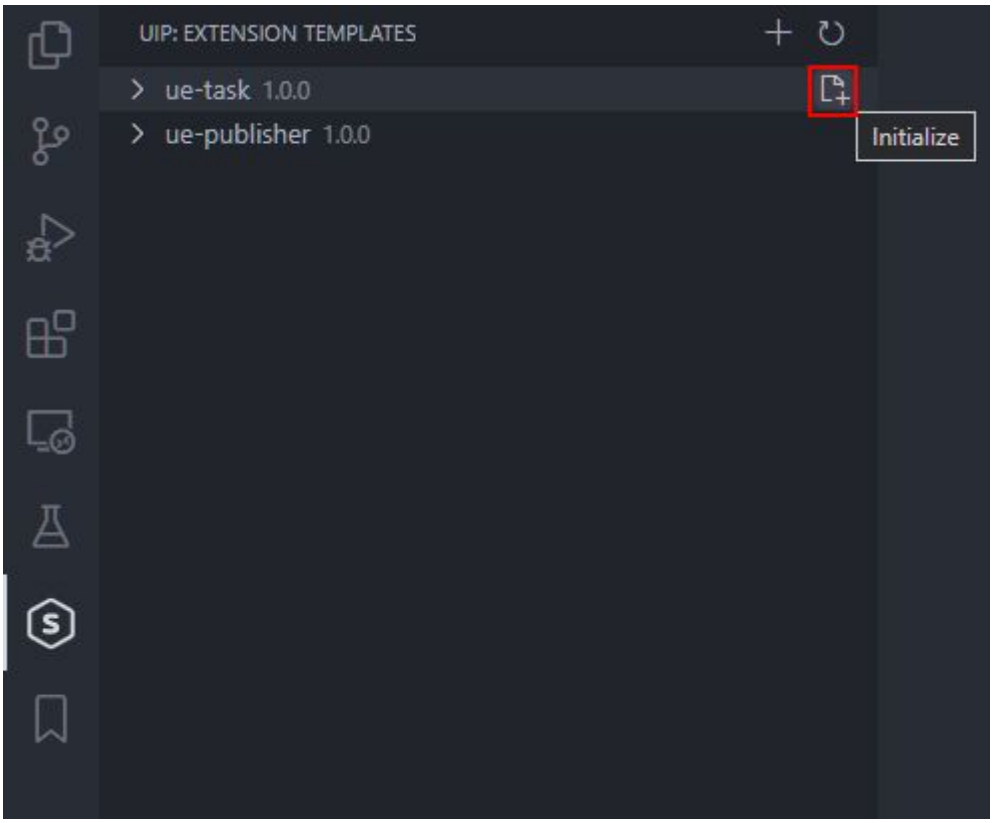
8.1.2.1.2 Introduction

We will create an Extension that uses the `requests` module (pure Python) and `psutil` module (not pure Python as it requires C runtime).

8.1.2.1.3 Step 1 - Initializing the Extension

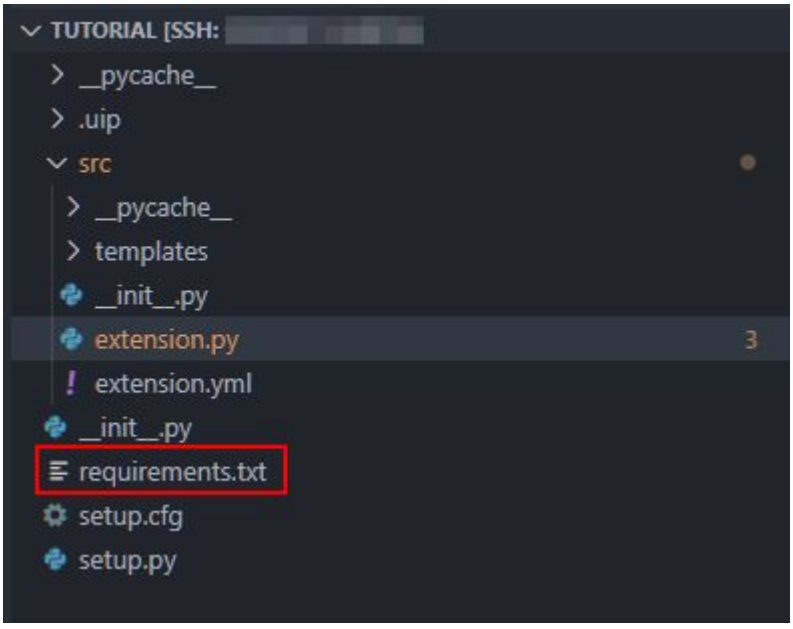
Open VSCode to an empty folder (e.g. `/tmp/tutorial`) and activate the virtual environment you wish to use.

Initialize the `ue-task` extension by clicking:



For this tutorial, all parameters are suitable so, just pressing 'Enter' to select the default for each parameter is sufficient.

Once initialized, you should now have a file called `requirements.txt` in your working folder:



Open the file and add `requests==2.28.2` (version is optional) as follows:

requirements.txt

```
1  #
```

```
# Specify any third-party Python modules that should be bundled with the
# extension. uip-cli will automatically download and bundle the modules
# upon running `uip build` or `uip push`.
#
# Refer to https://pip.pypa.io/en/stable/reference/requirements-file-format/
# for the expected format.
#

requests==2.28.2
```

8.1.2.1.4 Step 2 - Using `requests` module

Open `extension.py` and modify it as follows:

extension.py

```
from __future__ import (print_function)
from universal_extension import UniversalExtension
from universal_extension import ExtensionResult
from universal_extension import logger
import requests


class Extension(UniversalExtension):
    """Required class that serves as the entry point for the extension
    """

    def __init__(self):
        """Initializes an instance of the 'Extension' class
        """
        # Call the base class initializer
        super(Extension, self).__init__()

    def extension_start(self, fields):
        """Required method that serves as the starting point for work performed
        for a task instance.

        Parameters
        ----------
        fields : dict
            populated with field values from the associated task instance
            launched in the Controller

        Returns
        -------
        ExtensionResult
            once the work is done, an instance of ExtensionResult must be
            returned. See the documentation for a full list of parameters that
            can be passed to the ExtensionResult class constructor
        """

        resp = requests.get(
            'https://httpbin.org/basic-auth/user/pass',
```

```
38              auth=('user', 'pass')
39          )
40          print(resp.status_code)
41
42          # Return the result with a payload containing a Hello message...
43          return ExtensionResult(
44              unv_output='Hello Extension!'
45          )
```

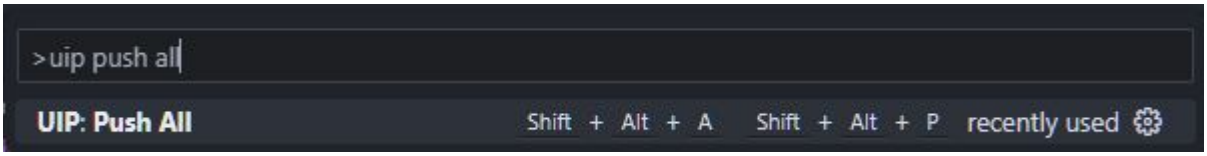
On line 5, we import the `requests` module

On lines 36-40, we call `requests.get` on a sample url and print the status code

8.1.2.1.5 Step 3 - Pushing out Extension

We are ready to test out our extension!

Assuming this Extension has not been pushed out to the Controller, go ahead and run



You may need to configure the username, password, and url first.

Running the Push All command internally runs the Build All command followed by the Upload All command. The Build All command will download all dependencies specified in `requirements.txt` to a folder called `3pp` and package the folder in the final package archive.

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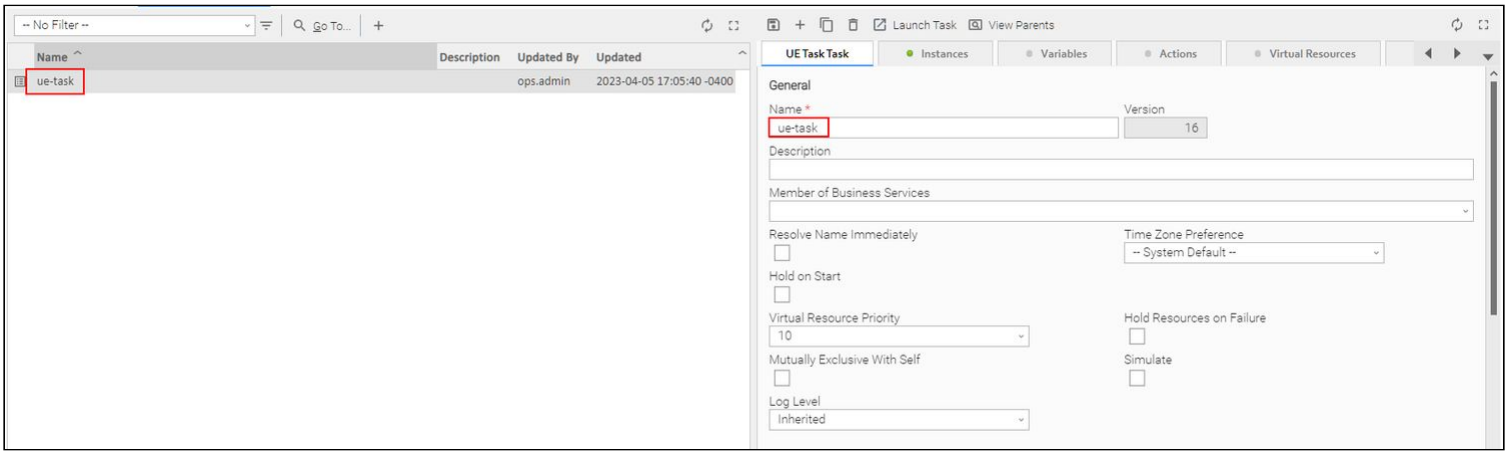
8.1.2.2 Running the Extension

8.1.2.2.1 Step 1 - Creating the task

Now that the Extension has been pushed out to the Controller, go ahead and create a task called `ue-task` (or whatever you want to name it) on the Controller side.



8.1.2.2.2 Step 2 - Running the task

Run the task, either from the Controller or using the VSCode plugin. Once run, in STDOUT, you should see status code 200 printed:

```
$ uip task launch ue-task
Successfully launched the Universal task "ue-task" with task instance id 168052810510208268 40AUODJQ23GCDC.
================================================================================================================
Status: Success
================================================================================================================


STDERR Output:
==============
[empty]

STDOUT Output:
==============
200


EXTENSION Output:
=================
Hello Extension!
```

We were able to successfully use the `requests` module!

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8.1.2.3 Adding and Using psutil Dependency

8.1.2.3.1 Step 1 - Adding `psutil` dependency

Open `requirements.txt` and add `psutil ==5.9.4` as follows:

requirements.txt

```
#
# Specify any third-party Python modules that should be bundled with the
# extension. uip-cli will automatically download and bundle the modules
# upon running `uip build` or `uip push`.
#
# Refer to https://pip.pypa.io/en/stable/reference/requirements-file-format/
# for the expected format.
#

requests==2.28.2
psutil==5.9.4
```

In addition to modifying `requirements.txt`, we will also need to modify `src/extension.yml` as follows:

extension.yml

```
extension:
  name: ue-task
  version: "1.0.0"
  api_level: "1.4.0"
  requires_python: ">=2.6"
  zip_safe: false
owner:
  name: Stonebranch
  organization: Stonebranch Inc.
comments: |
  Created using ue-task template
```

On line 6, the `zip_safe` property was set to `false`. This must be done, anytime an Extension uses a third party dependency requiring the C runtime (e.g. `psutil`).

8.1.2.3.2 Step 2 - Using the `psutil` dependency

Open `extension.py` and modify it as follows:

extension.py

```
from __future__ import (print_function)
from universal_extension import UniversalExtension
from universal_extension import ExtensionResult
from universal_extension import logger
import requests
import psutil


class Extension(UniversalExtension):
```

```
10      """Required class that serves as the entry point for the extension
11      """
12
13      def __init__(self):
14          """Initializes an instance of the 'Extension' class
15          """
16          # Call the base class initializer
17          super(Extension, self).__init__()
18
19      def extension_start(self, fields):
20          """Required method that serves as the starting point for work performed
21          for a task instance.
22
23          Parameters
24          ----------
25          fields : dict
26              populated with field values from the associated task instance
27              launched in the Controller
28
29          Returns
30          -------
31          ExtensionResult
32              once the work is done, an instance of ExtensionResult must be
33              returned. See the documentation for a full list of parameters that
34              can be passed to the ExtensionResult class constructor
35          """
36
37          resp = requests.get(
38              'https://httpbin.org/basic-auth/user/pass',
39              auth=('user', 'pass')
40          )
41          print(resp.status_code)
42
43          print(psutil.test())
44
45          # Return the result with a payload containing a Hello message...
46          return ExtensionResult(
47              unv_output='Hello Extension!'
48          )
```

On line 6, we import the `psutil` module

On lines 43, we print the result of `psutil.test()`

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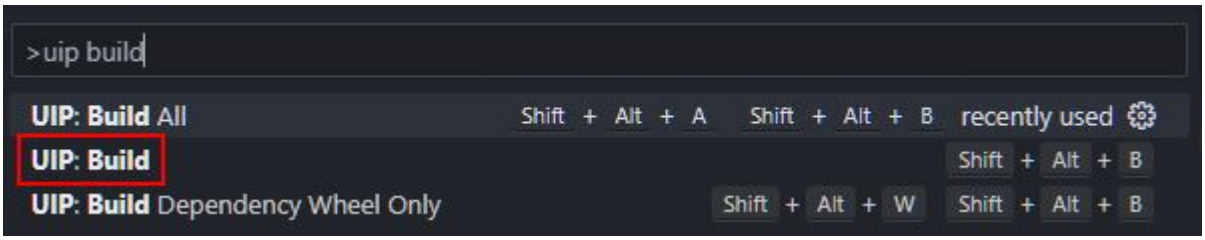
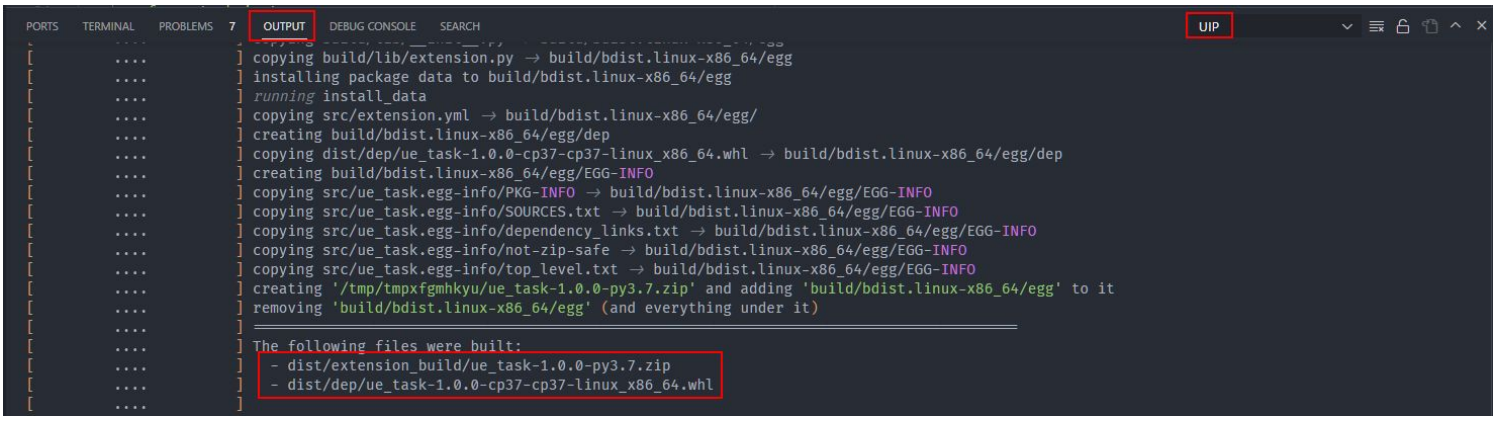
8.1.2.4 Building and Testing the Extension

8.1.2.4.1 Step 1 - Building and Uploading the Extension

Go ahead and run the `UIP: Build` command



If you inspect the output, you will see two build artifacts were generated:



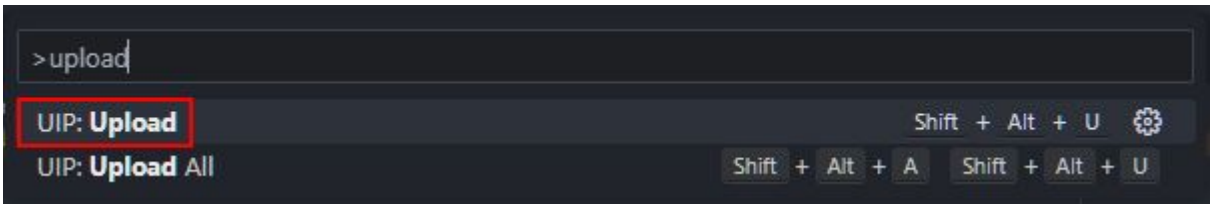
Anytime the `zip_safe` flag in `src/extension.yml` is set to `false`, both the final extension zip (`ue_task-1.0.0-py3.7.zip`) and the platform specific dependency wheel file (`ue_task-1.0.0-cp37-cp37-linux_x86_64.whl`) will be generated. The final extension zip actually embeds the wheel file inside it.

The wheel file contains all the dependencies; in this case, that would be the `requests` and `psutil` modules. Furthermore, the wheel file was generated using a Python 3.7.16 virtual environment on a Linux x86-64 machine. As a result, if the Extension is NOT run using a Python 3.7 virtual environment on a Linux x86-64 system, the wheel file will not be used, and the extension may end up failing.

If your Extension supports various Python environments and systems, you must activate the desired virtual environment on the target machine and run the `UIP: Build Dependency Wheel Only` (or if using only the CLI, run `uip build --dep-whl-only`) command. Once the dependency wheel file is built, copy it to the `dist/dep` folder on the Extension development environment. For instance, the Extension above targets Python 3.7.16 on Linux x86-64. If you wish to target Python 3.7.16 on Windows:

1. activate the Python 3.7.16 virtual environment on Windows
2. replicate the Extension development environment
3. Run `uip build --dep-whl-only` . This should create a wheel file in `dist/dep` folder
4. Copy the `dist/dep/<wheel file>` to the Linux x86-64 Extension development environment
5. On the Linux x86-64 system, run `uip build` again to embed the wheel file in the final extension zip

Now that we have built the Extension, use the `UIP: Upload` command to update the Extension on the Controller side:



If you run into issues uploading the Extension because of size limitations, make sure to adjust

- OMS Maximum Message Size using the `MAX_MSG_SIZE` configuration option
- Universal Template Extension Maximum Bytes Controller Property (See doc for more details)

Alternatively, the `UIP: Push` command could also have been used, but Build + Upload approach was used to highlight the new build artifact.

8.1.2.4.2 Step 2 - Running the Extension

Now that the Extension is updated on the Controller, go ahead and launch the task.

In STDOUT, you should see the output from `psutil.test()`

If the Extension fails with an import error, ensure

- the `zip_safe` flag was set to `false` in `src/extension.yml`
- the Python interpreter used to launch the Extension matches the wheel file. Inspect the Agent Log to ensure this.

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8.1.3 Customizing Starter Templates

In the previous set of pages (The Basics), Extensions were created based off the built-in starter templates, `ue-task` and `ue-publisher`. While the templates are generic and often a good start, they are not very customizable.

This tutorial is optional for Extension development

The following pages below will show the new functionality introduced in uip-cli and VSCode plugin v2.0.0 that allows Extension developers to create (and share) their own, customizable starter templates:

Title
Creating, Configuring, and Packaging the Initial Template

Title
Initializing the Template
Deleting, Adding, and Exporting the Template
Managing Template with Multiple Versions

8.1.3.1 Creating, Configuring, and Packaging the Initial Template

8.1.3.1.1 Prerequisites

It is assumed the VSCode Plugin and uip-cli version 2.0.0 are installed.

The development environment will be WSL (Windows Subsystem for Linux), however, it could be any of the supported platforms. The tutorial assumes a folder called `demo_template` has been opened in VSCode.

8.1.3.1.2 Introduction

The custom, starter template that we will create is a contrived example, but it sufficiently covers all the features and its usefulness.

8.1.3.1.3 Step 1 - Create the Initial Template

To create a custom starter template, we will first make use of the built-in `ue-task` template. Open up the terminal to the `demo_template` folder and run

```
 uip init -t ue-task -e "extension_name=my_custom_ext" -e
"universal_template_name=my_custom_template"
```

The directory structure should be as follows (not showing the Python `*.pyc/__pycache__` files):

```
demo_template/
├── .uip
│   └── config
│       └── uip.yml
├── __init__.py
├── requirements.txt
├── setup.cfg
├── setup.py
└── src
    ├── __init__.py
    ├── extension.py
    ├── extension.yml
    └── templates
        └── template.json
```

The basic structure of the custom template is almost finished! Go ahead and create a file called `template_config.yml` at the same level as the `src/` folder. The resulting directory tree is as follows:

```
demo_template/
├── .uip
│   └── config
│       └── uip.yml
├── __init__.py
├── requirements.txt
├── setup.cfg
├── setup.py
├── src
│   ├── __init__.py
│   ├── extension.py
│   ├── extension.yml
│   └── templates
│       └── template.json
└── template_config.yml
```

8.1.3.1.4 Step 2 - Configuring the Initial Template

To make the template configurable, add the following content below to `template_config.yml`:

template_config.yml

```yaml
name: example-template

version: 1.0.0

description: this is the description for example template

files_to_template:
  - src/extension.py
  - src/templates/template.json

variables:
  msg:
```

```
    default: test_message
    description: message to print to STDOUT and STDERR
  log_level:
    default: Info
    description: Universal Template Log Level
```

template_config.yml details

Each `template_config.yml` must contain:

- `name`
  - A string that identifies the name of the template (this is **NOT** referring to the Universal Template name). It can be anything other than the name of the built-in templates: `ue-task` and `ue-publisher`.
- `version`
  - A string that identifies the template version. Not restricted to `x.y.z` (SemVer); it could be anything (e.g. `v1`).
- `description`
  - A string describing the template.

Although not required, it can also contain:

- `files_to_template`
  - An array containing paths to files that will be "templated" using `Jinja2`. All files must be specified relative to `template_config.yml`.
- `variables`
  - A mapping/dictionary of variables that will be substituted in the relevant files specified by `files_to_template`. The value of each key/variable is another mapping/dictionary that must contain `default` and `description`.

Now, open `src/extension.py` and replace `extension_start()` with the code below:

src/extension.py::extension_start()

```
    def extension_start(self, fields):
        """Required method that serves as the starting point for work performed
        for a task instance.

        Parameters
        ----------
        fields : dict
            populated with field values from the associated task instance
            launched in the Controller

        Returns
        -------
        ExtensionResult
            once the work is done, an instance of ExtensionResult must be
            returned. See the documentation for a full list of parameters that
            can be passed to the ExtensionResult class constructor
```

```
17          """
18
19          my_msg = "{{ msg }}"
20
21          # Get the value of the 'action' field
22          action_field = fields.get('action', [])
23          if len(action_field) != 1:
24              # 'action' field was not specified or is invalid
25              action = ''
26          else:
27              action = action_field[0]
28
29          if action.lower() == 'print':
30              # Print to standard output...
31              print(my_msg)
32          else:
33              # Log to standard error...
34              logger.info(my_msg)
35
36          # Return the result with a payload containing a Hello message...
37          return ExtensionResult(
38              unv_output='Hello Extension!'
39          )
```

On line 19, a variable called `my_msg` is defined with the value of `"{{ msg }}"`. This is Jinja2 syntax that will eventually be replaced with the specified value for `msg` (or the default, if they don't specify anything) during initialization time.

On lines 31 and 34, the message was changed to print the value of `my_msg`.

Now, open `src/templates/template.json` and replace the value of `logLevel` key (should be around line 86) with the change shown below:

template.json

```
1       "sysId": "535c354ed083489cb10413019d71a57c",
2       "textType": "Plain"
3     }
4   ],
5   "logLevel": "{{ log_level | title }}",
6   "minReleaseLevel": "7.0.0.0",
7   "name": "my_custom_template",
```

On line 86 of the snippet above, the value of `logLevel` was changed from `Inherited` to `{{ log_level | title }}`. Once again, this is Jinja2 syntax that will eventually be replaced with the specified value of `log_level` (or the default, if nothing is specified). Additionally, the built-in `title` filter is applied to the value of `log_level`. This will ensure values like `trACe` end up as `Trace` (first letter capitalized and everything else lowercase) as required by `template.json`.

8.1.3.1.5 Step 3 - Packaging the Initial Template

Although the example is a bit contrived, we have managed to create a fully-functional customized template.

To package the template, simply zip up everything into a file called `example_template.zip` (or whatever you want to call it). Its structure should be as follows (if `*.pyc` and `__pycache__` files are there, it's fine):

```
Archive:  example_template.zip
```

```
  Length      Date    Time    Name
---------  ---------- -----   ----
        0  2023-04-04 15:37   __init__.py
      306  2023-04-04 15:37   requirements.txt
       43  2023-04-05 11:03   setup.cfg
    12088  2023-04-05 11:03   setup.py
        0  2023-04-05 11:03   src/
     1723  2023-04-05 11:03   src/extension.py
      221  2023-04-05 11:03   src/extension.yml
        0  2023-04-05 11:03   src/templates/
     3278  2023-04-05 11:09   src/templates/template.json
        0  2023-04-04 15:37   src/__init__.py
      349  2023-04-05 11:05   template_config.yml
---------                     -------
    18008                     11 files
```

Next >

8.1.3.2 Initializing the Template

8.1.3.2.1 Step 1 - Initializing the Custom Template

We will now initialize the custom template we created in the previous page.

Open the terminal to an empty folder and run:

```
uip init -t <path to example_template.zip> -e "log_level=WaRn"
```

The command should run successfully with the following output:

```
Successfully initialized "example-template (1.0.0)" template in "<path may vary>"
```

The directory structure (ignoring `*.pyc` and `__pycache__`) should be as follows:

```
<folder name>/
├── .uip
│   └── config
│       └── uip.yml
├── __init__.py
├── requirements.txt
├── setup.cfg
├── setup.py
└── src
    ├── __init__.py
    ├── extension.py
    ├── extension.yml
    └── templates
        └── template.json
```

At this point, we have successfully initialized the custom template with the custom parameters, `log_level` and `msg`.

Open `src/extension.py`, and you should see `my_msg` on line 19 set to `"test_message"`. Since a value for the `msg` variable wasn't specified during initialization time, the default value (defined in `template_config.yml)` of `test_message` was substituted.

Open `src/templates/template.json`, and you should see the `logLevel` property set to `Warn` as expected.

8.1.3.2.2 Step 2 - Saving the Template using `uip init`

In the previous step, we initialized an Extension using the `example_template.zip`. If we want to do that again, the zip file will need to be specified again as well.

There are two ways to save the `example_template` for future use, and the first one is shown below:

Go ahead and delete the Extension initialized in the folder, including the `.uip/` folder. Assuming it's an empty folder, run

```
uip init -t <path to example_template.zip> -e "log_level=WaRn" -e "msg=sample message!" --save
```

Specifying `--save` will save the template in a location known to the CLI. If you now run

```
uip template list
```

you should see the `example-template` listed as well for future use

```
+--------------------+---------+-------------------------------------------------------------+
| Extension Template | Version | Description                                                 |
+--------------------+---------+-------------------------------------------------------------+
| ue-task            | 1.0.0   | starter Extension with minimal code                         |
+--------------------+---------+-------------------------------------------------------------+
| ue-publisher       | 1.0.0   | starter Extension with a local Universal Event template     |
+--------------------+---------+-------------------------------------------------------------+
| example-template   | 1.0.0   | this is the description for example template                |
+--------------------+---------+-------------------------------------------------------------+
```

The value of `name`, `version`, and `description` from `template_config.yml` are used to populate the table entry for `example-template`

To see the variables we defined in `template_config.yml`, run

```
uip template list example-template
```

which will print

```
+---------------+--------------+-----------------------------------------+
| Variable Name | Default      | Description                             |
+---------------+--------------+-----------------------------------------+
```

```
| msg           | test_message | message to print to STDOUT and STDERR |
| log_level     | Info         | Universal Template Log Level          |
+---------------+--------------+---------------------------------------+
```

Go ahead and delete the previously initialized Extension once again, including the `.uip/` folder. Assuming it's an empty folder, run

```
uip init -t example-template -e "log_level=WaRn" -e "msg=sample message!"
```

Notice that the path to the zip file no longer needs to be specified, since the template has already been saved.

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8.1.3.3 Deleting, Adding, and Exporting the Template

```

```

8.1.3.3.1 Step 1 - Deleting the Saved Template

To save the `example-template` above, we had to initialize AND specify the `--save` flag. This can be inconvenient if one does not want to initialize the template now, but still wants to save it.

The alternate way of saving/adding the template is using the `uip template add` command. Before doing so, let's first delete the saved template by running

```
uip template delete example-template
```

which should print

```
Successfully deleted "example-template (1.0.0)"
```

Running

```
uip template list
```

should now only show the built-in templates (which cannot be deleted):

```
+--------------------+---------+-------------------------------------------------------------+
| Extension Template | Version | Description                                                 |
+--------------------+---------+-------------------------------------------------------------+
| ue-task            | 1.0.0   | starter Extension with minimal code                         |
+--------------------+---------+-------------------------------------------------------------+
| ue-publisher       | 1.0.0   | starter Extension with a local Universal Event template     |
+--------------------+---------+-------------------------------------------------------------+
```

8.1.3.3.2 Step 2 - Adding the Template using `uip template add`

To add/save the `example-template` without having to initialize first, run

```
uip template add <path to example-template.zip>
```

which should print

```
Successfully added "example-template (1.0.0)"
```

Running

```
uip template list
```

should now only show the built-in templates (which cannot be deleted):

```
+--------------------+---------+-------------------------------------------------------------+
| Extension Template | Version | Description                                                 |
+--------------------+---------+-------------------------------------------------------------+
| ue-task            | 1.0.0   | starter Extension with minimal code                         |
+--------------------+---------+-------------------------------------------------------------+
| ue-publisher       | 1.0.0   | starter Extension with a local Universal Event template     |
+--------------------+---------+-------------------------------------------------------------+
| example-template   | 1.0.0   | this is the description for example template                |
+--------------------+---------+-------------------------------------------------------------+
```

8.1.3.3.3 Step 2.1 - Updating the Template

In addition to adding the template, the CLI also supports updating the template.

!!!

Each template is uniquely identified by its name and version, defined in `template_config.yml`. As long as those two things don't change, the saved template can be updated.

Navigate to the folder where we **created** `example-template`. This folder should contain `template_config.yml.`

The updates to `example-template` will be pretty minor. Open up `template_config.yml` and

- Change the description to `this is the UPDATED description for example template`
- Add an entry for `src/test.txt` in the `files_to_template` array

The updated `template_config.yml` should be as follows:

template_config.yml

```
name: example-template

version: 1.0.0

description: this is the UPDATED description for example template

files_to_template:
  - src/extension.py
  - src/templates/template.json
  - src/test.txt

variables:
  msg:
    default: test_message
    description: message to print to STDOUT and STDERR
  log_level:
    default: Info
    description: Universal Template Log Level
```

Create a new file called `test.txt` under the `src` folder (file should be at the same level as `extension.py`) and populate it with:

src/test.txt

```
{{ msg }}
```

Now, zip up all the contents once again in a file called `updated_example_template.zip` (or whatever you want to call it).

To update the saved template, simply run

```
uip template add <path to updated_example_template.zip>
```

which should print

```
Successfully updated "example_template (1.0.0)"
```

If you now list the available templates, you will see the updated description

```
+--------------------+---------+-------------------------------------------------------+
| Extension Template | Version | Description                                           |
+--------------------+---------+-------------------------------------------------------+
| ue-task            | 1.0.0   | starter Extension with minimal code                   |
+--------------------+---------+-------------------------------------------------------+
| ue-publisher       | 1.0.0   | starter Extension with a local Universal Event template |
+--------------------+---------+-------------------------------------------------------+
| example-template   | 1.0.0   | this is the UPDATED description for example template  |
+--------------------+---------+-------------------------------------------------------+
```

If you initialize `example-template` now using

```
uip init -t example-template -e 'msg=this is a new message'
```

you will see the new file, `src/test.txt`, containing the specified message.

8.1.3.3.4 Step 3 - Exporting the Saved Template

The CLI also supports exporting a saved template. This may be helpful, if you no longer have access to the original template zip and want to share it.

To export `example-template`, run

```
uip template export example-template
```

This will export a file called `example_template-1.0.0.zip` in your current working directory. This zip can be shared and imported by others.

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8.1.3.4 Managing Template with Multiple Versions

8.1.3.4.1 Step 1 - Creating `example-template` version `1.1.0`

As mentioned in the previous step, an existing, saved template can be updated as long as the `name` and `version` in `template_config.yml` haven't changed.

If the `name` changes, then the new template will get it's own entry in the `template list` table. Since the names are different, initializing using just the name won't be a problem.

If the `version` changes but not the `name`, then the new template will get it's own entry in the `template list` table, however, since the names didn't change, the user will have to distinguish the template they want to initialize by providing the version as well

---

Navigate to the folder where the template was updated (Step 2.1 from the previous page). If the folder was deleted, you could always export the template and unzip it.

Open `template_config.yml` and change the value of the `version` field to `1.1.0`. Zip up the contents and save it in a file called `example-template-1.1.0.zip` (or whatever else you want to call it).

Running the add command below

```
uip template add <path to example-template-1.1.0.zip>
```

should now print

```
Successfully added "example-template (1.1.0)"
```

And running

```
uip template list
```

will now show both versions of `example-template`:

```
+--------------------+---------+-------------------------------------------------------------+
| Extension Template | Version | Description                                                 |
+--------------------+---------+-------------------------------------------------------------+
| ue-task            | 1.0.0   | starter Extension with minimal code                         |
+--------------------+---------+-------------------------------------------------------------+
| ue-publisher       | 1.0.0   | starter Extension with a local Universal Event template     |
+--------------------+---------+-------------------------------------------------------------+
| example-template   | 1.0.0   | this is the UPDATED description for example template        |
+--------------------+---------+-------------------------------------------------------------+
| example-template   | 1.1.0   | this is the UPDATED description for example template        |
+--------------------+---------+-------------------------------------------------------------+
```

8.1.3.4.2 Step 2 - Initializing/Listing/Deleting/Exporting Templates with Multiple Versions

In the previous step, we successfully added multiple versions of the `example- template` template.

To initialize, list, delete, or export `example-template`, the version must also be specified as follows:

- To initialize `example-template` version `1.0.0`

  ```
  uip init -t example-template@1.0.0
  ```

- To initialize `example-template` version `1.1.0`

  ```
  uip init -t example-template@1.1.0
  ```

- To list `example-template` version `1.0.0`

  ```
  uip template list example-template@1.0.0
  ```

- To list `example-template` version `1.1.0`

  ```
  uip template list example-template@1.1.0
  ```

- To delete `example-template` version `1.0.0`

```
uip template delete example-template@1.0.0
```

- To delete `example-template` version `1.1.0`

```
uip template delete example-template@1.1.0
```

- To export `example-template` version `1.0.0`

```
uip template export example-template@1.0.0
```

- To export `example-template` version `1.1.0`

```
uip template export example-template@1.1.0
```

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8.1.4 Integrating OpenTelemetry

Starting with 7.6.0.0, the Universal Extension framework (along with UA and UC) now offers seamless integration with OpenTelemetry, providing developers with metrics and tracing capabilities for improved Extension observability.

The following pages below will walk you through a complete example of integrating Opentelemetry within an Extension:

Title
Prerequisites
Setting up a Basic File Transfer Extension
Enabling and Using Tracing Functionality
Enabling and Using Metrics Functionality

8.1.4.1 Prerequisites

It is assumed the following are installed and configured properly:

- Opentelemetry Collector
- Jaeger
- Prometheus
- Grafana
- Universal Agent 7.6.0.0 or higher
- Universal Controller 7.6.0.0 or higher
- UIP-CLI 1.3.0 or higher
- UIP VSCode Plugin 2.1.0 or higher

It is highly recommended to first go through The Basics and VSCode Plugin, if this is the first time you are creating an Extension.

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8.1.4.2 Setting up a Basic File Transfer Extension

8.1.4.2.1 Introduction

To showcase the Opentelemetry functionality, we will be creating a basic, contrived Extension that transfer files locally from one folder to another.

8.1.4.2.2 Step 1 - Initializing the `OtelDemo` Extension

Go ahead and navigate to a directory where you would like to store the Extension. Download the attached Extension template below.

OtelDemoTemplate.zip

Now, we will create an Extension based off the `OtelDemo` Extension template. Open up the terminal to that folder and run

```
uip init -t <path to OtelDemoTemplate.zip> OtelDemoExt
```

This command should create a folder named `OtelDemoExt` with the Extension inside of it.

Now would be a good time to go through `src/ extension.py` and see how/what it's doing.

8.1.4.2.3 Step 3 - Testing the Extension

We will test the Extension using the UIP VSCode Plugin debugger.

Go ahead and open the folder containing the Extension in VSCode. It is assumed that the new Universal Extension Bundle 2.1.0, containing API Level 1.5.0, is installed, and the 1.5.0 API level is selected.

Once opened, press `F5` and add a debug configuration as follows:

configurations.yml

```
api:
  extension_start:
    - name: es1
      log_level: Inherited
      runtime_dir: /home/shrey/dev/extensions/test/OtelDemoTest
      fields:
        src_folder: /tmp/test_src
        dst_folder: /tmp/test_dst
        file_type:
          - txt
```

We will be transferring all `*.txt` files from `/tmp/test_src` to `/tmp/test_dst`. Ensure the source and destination directories exist, and the source folder contains `a.txt`, `b.txt`, `c.zip`, `d.json`, `e.yaml`.

Debug the `es1` target, and you should see `a.txt` and `b.txt` transferred to the `/tmp/test_dst`. Inspect the `UIP Debug` output channels to ensure everything worked as expected.

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8.1.4.3 Enabling and Using Tracing Functionality

8.1.4.3.1 Introduction

On this page, we will enable and use the Opentelemetry Tracing functionality to get a visual representation of our Extension. Once again, we will use the UIP VSCode Plugin to test our changes, for now.

8.1.4.3.2 Step 1 - Enabling Tracing

Go ahead and open `configurations.yml` and add in the `properties` block:

configurations.yml

```
properties:
  agent:
    log_level: Info
    netname: UIP-DBG-01
    otel:
      enable_tracing: true
      export_metrics: false
      trace_endpoint: http://192.168.56.11:4318
      metrics_endpoint: http://localhost:4318
      service_name: vscode-uip-debugger
      uip_service_name: uip/${extension_name}
```

```
api:
  extension_start:
    - name: es1
      log_level: Inherited
      runtime_dir: /home/shrey/dev/extensions/test/OtelDemoTest
      fields:
        src_folder: /tmp/test_src
        dst_folder: /tmp/test_dst
        file_type:
          - txt
```

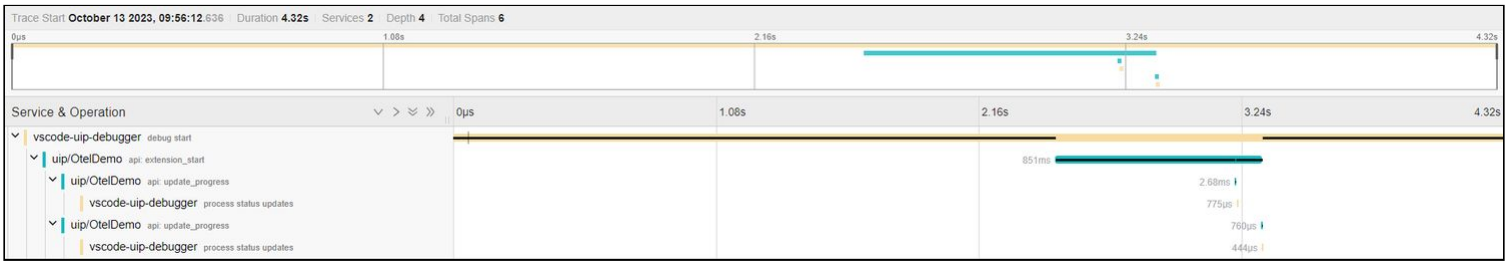
As part of UIP VSCode Plugin version 2.1.0, the `properties -> agent` object was enhanced with new `netname` and `otel` properties. To enable tracing, we have set `enable_tracing` to `true` and set `trace_endpoint` to the Opentelemetry Collector URL (this will need to be changed according to your setup).

Enabling in UA

Similar properties exist in `uags.conf` and `omss.conf` that can be used to enable tracing in the Agent.
See OTEL_ENABLE_TRACING - UAG configuration option and OTEL_ENABLE_TRACING - OMS configuration option.

8.1.4.3.3 Step 2 – Visualizing Default Spans

Now that we have enabled tracing, we actually don't have to do anything else to get a basic trace. Go ahead and delete all the files inside `/tmp/test_dst` and debug the Extension again using `F5`. Once finished, head on over to Jaeger (or whatever trace visualization tool you have set up) and you should see:



Without modifying the Extension code at all, we have a meaningful way of looking at the Extension instance. Go ahead and inspect the spans (`debug start` , `api: extension_start` , etc.) by clicking on them; you will find useful information such as the fields passed into `extension_start()` , `rc` , `unv_output` etc. all consolidated in one place.

8.1.4.3.4 Step 3 – Adding Additional Spans

Even though the default spans above offer insight into our Extension, we are not able to clearly see when a file gets transferred or even how long it takes. Let's add some custom spans to capture this information. Go ahead and update `extension.py` a s follows:

extension.py

```
from __future__ import print_function
from universal_extension import UniversalExtension
from universal_extension import ExtensionResult
from universal_extension import ui
from universal_extension import logger

from universal_extension import utility
from universal_extension import otel

import time
import shutil
import os
import random
import json

if otel.is_compatible:
    from opentelemetry import trace


class Extension(UniversalExtension):
    def __init__(self):
        """Initializes an instance of the 'Extension' class"""
        # Call the base class initializer
        super(Extension, self).__init__()
        self.stop = False

        self.setup_tracer()

    def setup_tracer(self):
        if otel.is_compatible:
            self.tracer = trace.get_tracer(__name__)
        else:
            self.tracer = utility.NoOp()

    def transfer_file(self, src_path, dst_path, span):
        span.set_attributes({"src_file": src_path, "dst_folder": dst_path})

        # Ensure destination directory exits
        if not os.path.exists(dst_path):
            raise FileNotFoundError(
                "Destination directory ({0}) does not exist".format(dst_path)
            )

        # Ensure the source file is not already present in the destination
        # directory (unless overwrite is selected)
        if os.path.exists(os.path.join(dst_path, os.path.basename(src_path))):
            logger.info(
                "'{0}' already exists in '{1}'".format(
                    os.path.basename(src_path), dst_path
                )
            )
            if otel.is_compatible:
                span.set_status(
```

```
                    trace.Status(
                        status_code=trace.StatusCode.ERROR,
                        description="'{0}' already exists in '{1}'".format(
                            os.path.basename(src_path), dst_path
                        ),
                    )
                )
            return False

        shutil.copy(src_path, dst_path)
        time.sleep(random.uniform(0, 2))

        return True

    def extension_start(self, fields):
        """Required method that serves as the starting point for work performed
        for a task instance.

        Parameters
        ----------
        fields : dict
            populated with field values from the associated task instance
            launched in the Controller

        Returns
        -------
        ExtensionResult
            once the work is done, an instance of ExtensionResult must be
            returned. See the documentation for a full list of parameters that
            can be passed to the ExtensionResult class constructor
        """

        files_transferred = []
        src = fields["src_folder"]
        dst = fields["dst_folder"]

        file_types = [
            ft.lower() if ft.startswith(".") else "." + ft.lower()
            for ft in fields["file_type"]
        ]

        if not os.path.exists(src):
            raise FileNotFoundError("'{0}' does not exist".format(src))

        all_file_list = os.listdir(src)

        # filter the files
        file_list = []
        for f in all_file_list:
            file_path = os.path.join(src, f)
            file_type = os.path.splitext(file_path)[1]
            if os.path.isfile(file_path) and file_type in file_types:
                file_list.append(file_path)

        logger.info(
            "Found {0} files that can be transferred".format(len(file_list))
        )
```

```
111
112         for f in file_list:
113             if self.stop:
114                 break
115
116             span_ctx = (
117                 utility.noop_context()
118                 if not otel.is_compatible
119                 else self.tracer.start_as_current_span("transferring file")
120             )
121
122             with span_ctx as span:
123                 if self.transfer_file(f, dst, span):
124                     files_transferred.append(f)
125                     ui.update_progress(
126                         int(len(files_transferred) / len(file_list) * 100)
127                     )
128                     logger.info("Transferred '{0}' to '{1}'".format(f, dst))
129
130         return ExtensionResult(
131             rc=0 if len(file_list) - len(files_transferred) == 0 else 1,
132             unv_output="The following files were transferred: \n {0}".format(
133                 json.dumps(files_transferred)
134             ),
135             message="{0} files found and {1} files transferred".format(
136                 len(file_list), len(files_transferred)
137             ),
138         )
139
140     def extension_cancel(self):
141         self.stop = True
```

- Lines 7-8 import the new `utility` and `otel` modules used to integrate Opentelemetry into the Extension.
- Lines 16-17 conditionally import the `trace` module from `opentelemetry`. We are doing it conditionally because Opentelemetry is only supported on Python 3.7 and higher. If your Extension is not supported on <3.7, then you do not need to guard the import with `otel.is_compatible`
- Lines 27-33:
  - Lines 29-33 define a separate method to set up the Opentelemetry tracer used to create custom spans. Once again, it is guarded with `otel.is_compatible`. If Opentelemetry is not compatible, then we assign `utility.NoOp()` to `self.tracer`, which will mimic the actual tracer object without affecting anything.
  - Line 27 calls the `self.setup_tracer()` method
- Lines 35-66:
  - Line 35 modifies the `transfer_file()` method to accept an additional parameter called `span`
  - Line 36 adds the source file and the destination folder as attributes on the `span` object
  - Lines 52-60 explicitly set the status of the `span` as error when the source file exists in the destination folder.
- Lines 116-129:
  - Lines 116-120 create a `span_ctx` variable that will store the Span Context. This is needed to ensure the Extension does not break, if Opentelemetry is not compatible.

- Lines 122-128 use `span_ctx` to create a Span object called `span` which is then passed into `self.transfer_file`.

Now, let's visualize our changes. From the last debugging session, the `/tmp/test_dst` folder should contain `a.txt` and `b.txt`. Keep these in there (if you have deleted them, just copy them manually). Go ahead and modify the `configurations.yml` to also transfer `zip` and `json` files:

configurations.yml

```
      fields:
        src_folder: /tmp/test_src
        dst_folder: /tmp/test_dst
        file_type:
          - txt
          - zip
          - json
```

Once modified, press `F5` and head on over to Jaeger. You should see:

We can now clearly see how long each file takes to transfer. We can see that `a.txt` and `b.txt` failed to transfer because they were already in the destination folder. `c.zip` and `d.json` succeeded, and we can see their transfer times. Inspect the spans, and you will be able to see the custom `src_file` and `dst_folder` attributes that we added.

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8.1.4.4 Enabling and Using Metrics Functionality

8.1.4.4.1 Introduction

On this page, we will enable and use the Opentelemetry Metrics functionality. Once again, we will use the UIP VSCode Plugin to test our changes, for now.

It is assumed that the Opentelemetry Collector is properly configured to accept metric data and expose as a Prometheus endpoint.

8.1.4.4.2 Step 1 - Enabling Metrics

Go ahead and open `configurations.yml` and edit the `properties` block as shown:

configurations.yml

```
properties:
  agent:
    log_level: Info
    netname: UIP-DBG-01
    otel:
      enable_tracing: true
      export_metrics: true
      trace_endpoint: http://192.168.56.11:4318
      metrics_endpoint: http://192.168.56.11:4318
      service_name: vscode-uip-debugger
      uip_service_name: uip/${extension_name}
api:
  extension_start:
    - name: es1
      log_level: Inherited
      runtime_dir: /home/shrey/dev/extensions/test/OtelDemoTest
      fields:
        src_folder: /tmp/test_src
        dst_folder: /tmp/test_dst
        file_type:
          - txt
```

The `export_metrics` property was set to `true` and the `metrics_endpoint` was changed to the Opentelemetry Collector URL (it will need to be changed according to your setup).

Enabling in UA

Similar properties exist in `uags.conf` and `omss.conf` that can be used to enable tracing in the Agent.
See OTEL_EXPORT_METRICS - UAG configuration option and OTEL_EXPORT_METRICS - OMS configuration option.

8.1.4.4.3 Step 2 – Adding Custom Metrics

Let's add some custom metrics. Go ahead and update `extension.py` as follows:

extension.py

```
from __future__ import print_function
from universal_extension import UniversalExtension
from universal_extension import ExtensionResult
```

```
from universal_extension import ui
from universal_extension import logger

from universal_extension import utility
from universal_extension import otel

import time
import shutil
import os
import random
import json

if otel.is_compatible:
    from opentelemetry import trace
    from opentelemetry import metrics
    from opentelemetry.sdk.metrics import MeterProvider
    from opentelemetry.sdk.metrics.view import (
        ExplicitBucketHistogramAggregation,
        View
    )
    from opentelemetry.sdk.metrics.export import PeriodicExportingMetricReader
    from opentelemetry.exporter.otlp.proto.http.metric_exporter import (
        OTLPMetricExporter,
    )


class Extension(UniversalExtension):
    def __init__(self):
        """Initializes an instance of the 'Extension' class"""
        # Call the base class initializer
        super(Extension, self).__init__()
        self.stop = False

        self.setup_tracer()
        self.setup_metrics()

    def setup_tracer(self):
        if otel.is_compatible:
            self.tracer = trace.get_tracer(__name__)
        else:
            self.tracer = utility.NoOp()

    def setup_metrics(self):
        if otel.is_compatible:
            self.meter = metrics.get_meter(__name__)
        else:
            self.meter = utility.NoOp()

        self.num_files_transferred_cntr = self.meter.create_counter(
            name="num.files.transferred",
            description="Number of files transferred",
        )
        self.file_transfer_duration = self.meter.create_histogram(
            name="file.transfer.duration",
            description="How long the file took to transfer",
            unit="s",
        )
```

```
    @classmethod
    def extension_new(cls, fields):
        if not otel.is_compatible:
            return cls.ExtensionConfig()

        return cls.ExtensionConfig(
            meter_provider=MeterProvider(
                views=[
                    View(
                        instrument_name="file.transfer.duration",
                        aggregation=ExplicitBucketHistogramAggregation(
                            (0, 0.5, 1, 1.5, 2, 10)
                        ),
                    )
                ],
                metric_readers=[
                    PeriodicExportingMetricReader(
                        OTLPMetricExporter(), export_interval_millis=1000
                    )
                ],
            )
        )

    def transfer_file(self, src_path, dst_path, span):
        start_time = time.time()

        span.set_attributes({"src_file": src_path, "dst_folder": dst_path})

        # Ensure destination directory exits
        if not os.path.exists(dst_path):
            raise FileNotFoundError(
                "Destination directory ({0}) does not exist".format(dst_path)
            )

        # Ensure the source file is not already present in the destination
        # directory (unless overwrite is selected)
        if os.path.exists(os.path.join(dst_path, os.path.basename(src_path))):
            logger.info(
                "'{0}' already exists in '{1}'".format(
                    os.path.basename(src_path), dst_path
                )
            )
            if otel.is_compatible:
                span.set_status(
                    trace.Status(
                        status_code=trace.StatusCode.ERROR,
                        description="'{0}' already exists in '{1}'".format(
                            os.path.basename(src_path), dst_path
                        ),
                    )
                )
            return False

        shutil.copy(src_path, dst_path)
        time.sleep(random.uniform(0, 2))
```

```
            self.num_files_transferred_cntr.add(
                1, {"file_type": os.path.splitext(src_path)[1]}
            )
            self.file_transfer_duration.record(time.time() - start_time)

            return True

        def extension_start(self, fields):
            """Required method that serves as the starting point for work performed
            for a task instance.

            Parameters
            ----------
            fields : dict
                populated with field values from the associated task instance
                launched in the Controller

            Returns
            -------
            ExtensionResult
                once the work is done, an instance of ExtensionResult must be
                returned. See the documentation for a full list of parameters that
                can be passed to the ExtensionResult class constructor
            """

            files_transferred = []
            src = fields["src_folder"]
            dst = fields["dst_folder"]

            file_types = [
                ft.lower() if ft.startswith(".") else "." + ft.lower()
                for ft in fields["file_type"]
            ]

            if not os.path.exists(src):
                raise FileNotFoundError("'{0}' does not exist".format(src))

            all_file_list = os.listdir(src)

            # filter the files
            file_list = []
            for f in all_file_list:
                file_path = os.path.join(src, f)
                file_type = os.path.splitext(file_path)[1]
                if os.path.isfile(file_path) and file_type in file_types:
                    file_list.append(file_path)

            logger.info(
                "Found {0} files that can be transferred".format(len(file_list))
            )

            for f in file_list:
                if self.stop:
                    break

                span_ctx = (
                    utility.noop_context()
```

```
174                 if not otel.is_compatible
175                 else self.tracer.start_as_current_span("transferring file")
176             )
177
178             with span_ctx as span:
179                 if self.transfer_file(f, dst, span):
180                     files_transferred.append(f)
181                     ui.update_progress(
182                         int(len(files_transferred) / len(file_list) * 100)
183                     )
184                     logger.info("Transferred '{0}' to '{1}'".format(f, dst))
185
186         return ExtensionResult(
187             rc=0 if len(file_list) - len(files_transferred) == 0 else 1,
188             unv_output="The following files were transferred: \n {0}".format(
189                 json.dumps(files_transferred)
190             ),
191             message="{0} files found and {1} files transferred".format(
192                 len(file_list), len(files_transferred)
193             ),
194         )
195
196     def extension_cancel(self):
197         self.stop = True
```

- Lines 18-27 import all the necessary metrics-related modules from the Opentelemetry library.
- Line 46-60 creates a method called `setup_metrics()` which set up the meter and uses it to create two metrics. The first metric will be used to count the number of files transferred, and the second to capture the transfer duration.
- Line 62-83 implements the new `extension_new()` method introduced in API Level 1.5.0. It allows developers to control the initialization of the `MeterProvider` and `TracerProvider` (see UniversalExtension Class (1.5.0) for details). Within `extension_new()`, we customize the `MeterProvider` to change the bucket boundaries to the transfer duration histogram; the default boundaries are not suitable for our data. Additionally, we modify the export interval from the default 60 seconds to 1 second.
- Lines 85-123 update the metrics:
  - Line 86 captures the start time at the beginning of the method
  - Lines 118-120 update the `num.files.transferred` counter.
  - Line 121 records how long it took to transfer the file.

8.1.4.4.4 Step 3 - Verifying Metrics

Now, let's verify our changes. Go ahead and delete all the files inside `/tmp/test_dst`. Once deleted, press `F5` to start the debugging session. Upon completion, navigate to the Prometheus endpoint (`http://192.168.56.11:8000/metrics` in my case – this will vary) and you should see:

Metrics

```
# HELP file_transfer_duration_seconds How long the file took to transfer
# TYPE file_transfer_duration_seconds histogram
```

```
file_transfer_duration_seconds_bucket{agent_id="UIP-DBG-01",instance="sa-u18:5678",job="Stonebranch
.UAC/uip/OtelDemo",security_business_services="",task_name="es1",le="0"} 0
file_transfer_duration_seconds_bucket{agent_id="UIP-DBG-01",instance="sa-u18:5678",job="Stonebranch
.UAC/uip/OtelDemo",security_business_services="",task_name="es1",le="0.5"} 1
file_transfer_duration_seconds_bucket{agent_id="UIP-DBG-01",instance="sa-u18:5678",job="Stonebranch
.UAC/uip/OtelDemo",security_business_services="",task_name="es1",le="1"} 3
file_transfer_duration_seconds_bucket{agent_id="UIP-DBG-01",instance="sa-u18:5678",job="Stonebranch
.UAC/uip/OtelDemo",security_business_services="",task_name="es1",le="1.5"} 3
file_transfer_duration_seconds_bucket{agent_id="UIP-DBG-01",instance="sa-u18:5678",job="Stonebranch
.UAC/uip/OtelDemo",security_business_services="",task_name="es1",le="2"} 4
file_transfer_duration_seconds_bucket{agent_id="UIP-DBG-01",instance="sa-u18:5678",job="Stonebranch
.UAC/uip/OtelDemo",security_business_services="",task_name="es1",le="10"} 4
file_transfer_duration_seconds_bucket{agent_id="UIP-DBG-01",instance="sa-u18:5678",job="Stonebranch
.UAC/uip/OtelDemo",security_business_services="",task_name="es1",le="+Inf"} 4
file_transfer_duration_seconds_sum{agent_id="UIP-DBG-01",instance="sa-u18:5678",job="Stonebranch.UA
C/uip/OtelDemo",security_business_services="",task_name="es1"} 3.421269655227661
file_transfer_duration_seconds_count{agent_id="UIP-DBG-01",instance="sa-u18:5678",job="Stonebranch.
UAC/uip/OtelDemo",security_business_services="",task_name="es1"} 4
# HELP num_files_transferred_total Number of files transferred
# TYPE num_files_transferred_total counter
num_files_transferred_total{agent_id="UIP-DBG-01",file_type=".json",instance="sa-u18:5678",job="Sto
nebranch.UAC/uip/OtelDemo",security_business_services="",task_name="es1"} 1
num_files_transferred_total{agent_id="UIP-DBG-01",file_type=".txt",instance="sa-u18:5678",job="Ston
ebranch.UAC/uip/OtelDemo",security_business_services="",task_name="es1"} 2
num_files_transferred_total{agent_id="UIP-DBG-01",file_type=".zip",instance="sa-u18:5678",job="Ston
ebranch.UAC/uip/OtelDemo",security_business_services="",task_name="es1"} 1
```

As you can see, a total of 4 files were transferred, 2 of them were `.txt`, 1 was `.json` and other was `.zip`. Additionally, we can see the transfer duration. Tools like Grafana can be used to visualize the metrics in a meaningful manner.

< Prev

8.2 VSCode Plugin

This document will demonstrate how the code completion and debugging functionalities of the `UIP` VSCode Plugin can be used to speed up the Extension development process.

It is highly recommended to first go through Extension Development before following the tutorials in this document.

The debugging functionality is shown in the following pages:

Title	Description
Debugging Capabilities	Introduction to the plugin's debugging capabilities.
Downloading/Installing Dependencies	Ensuring all the plugin's dependencies are downloaded and available for use.
Setting Up Initial Debugging Configuration	Creating the initial debugging configuration for a `dynamic_choice_command`.
Debugging a `dynamic_choice_command`	Testing out the initial debugging configuration.
Editing and Testing Debugging Configuration	Modifying the configuration and testing it.

Title	Description
Dynamically updating `configurations.yml`	Dynamically updating `configurations.yml` in response to a change in `template.json`
Debugging `extension_start`	Adding a configuration entry for `extension_start` and testing it.
Simulating Extension Cancel	Demonstrating the Cancel functionality during a debug session.
Changing Universal Extension API Level	Showing the ability to change API level for quick testing.
Full Reference	Contains detailed documentation of the debugging functionality for reference.

The context aware code completion functionality is shown in the following pages:

Title	Description
Code Completion Capabilities	Introduction to the plugin's code completion capabilities.
Demo Requirements	List of required items to follow along with the demo.
`extension_start` Fields Code Completion	Demonstrating code completion for `extension_start` fields.
`dynamic_choice_command` Fields Code Completion	Demonstrating code completion for `dynamic_choice_command` fields.
`dynamic_command` Fields Code Completion	Demonstrating code completion for `dynamic_command` fields.

8.2.1 Debugging Functionality Demonstration

The debugging functionality is shown in the following pages:

Title	Description
Debugging Capabilities	Introduction to the plugin's debugging capabilities.
Downloading/Installing Dependencies	Ensuring all the plugin's dependencies are downloaded and available for use.
Setting Up Initial Debugging Configuration	Creating the initial debugging configuration for a `dynamic_choice_command.`
Debugging a `dynamic_choice_command`	Testing out the initial debugging configuration.
Editing and Testing Debugging Configuration	Modifying the configuration and testing it.
Dynamically updating `configurations.yml`	Dynamically updating `configurations.yml` in response to a change in `template.json`
Debugging `extension_start`	Adding a configuration entry for `extension_start` and testing it.
Simulating Extension Cancel	Demonstrating the Cancel functionality during a debug session.

Title	Description
Changing Universal Extension API Level	Showing the ability to change API level for quick testing.
Full Reference	Contains detailed documentation of the debugging functionality for reference.

8.2.1.1 Debugging Capabilities

8.2.1.1.1 Limitations

In prior versions (<7.3.0.0), debugging Universal Extension tasks was not possible. The best option was to just use print/log statements. Furthermore, launching the task itself requires both the Agent and Controller to be installed. This can be cumbersome for those who want to quickly test some changes.

This tutorial will demonstrate the new functionality added to the VSCode UIP Plugin that allows Extension developers to launch and debug Universal Extension tasks without the need of an Agent or Controller. The section below lists all its capabilities.

8.2.1.1.2 Capabilities

The debugging functionality:

- Makes use of the same Universal Extension Base Class Components that are used by the Agent/Controller
- Supports the following Universal Extension API Levels:
  - 1.0.0 (released with UA 7.0.0.0)
  - 1.1.0 (released with UA 7.1.0.0)
  - 1.2.0 (released with UA 7.2.0.0)
  - 1.3.0 (released with UA 7.3.0.0)
  - 1.4.0 (released with UA 7.4.0.0)
- Can simulate the following actions:
  - Launching/Debugging an Extension
  - Launching/Debugging a Dynamic Choice Command
  - Issuing the Cancel command on a running Extension (API Level >1.0.0)
- Can retrieve and show the output of:
  - STDOUT
  - STDERR
  - Extension (Exit Code, Status Description etc. returned by `ExtensionResult()`)
  - Dynamic Choice Command
  - Output Only Fields
  - Published Events
- Allows the Extension developer to fully configure the fields received by `extension_start()` and any Dynamic Choice Command using a YAML file

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8.2.1.2 Downloading/Installing Dependencies

8.2.1.2.1 Requirements

8.2.1.2.1.1 `UIP` Plugin

You may already have the `UIP` plugin installed if you went through the Extension Development tutorial. If not, open Visual Studio Code's extension marketplace and download the `UIP` plugin.

8.2.1.2.1.2 Sample Extension

In subsequent documents, the debugging functionality will be demonstrated using a sample extension. The extension is contrived, but it is sufficient to demonstrate the major capabilities.

Go ahead and download `DebuggingDemo.zip` attached below. Make sure to save it in a known location.

DebuggingDemo.zip

8.2.1.2.1.3 Universal Extension Bundle (v2.0.0)

As mentioned in the previous page, the debugging functionality makes use of the same Universal Extension Base Class Components that are used by the Agent/Controller.

To achieve this, the plugin requires a proprietary zip file containing the Universal Extension Base Class code for all the supported API levels (1.0.0, 1.1.0, 1.2.0, 1.3.0, and 1.4.0) mentioned in the previous page. The zip file is available for download from the Stonebranch Customer Portal. A customer username and password – provided by Stonebranch, Inc. – are required to access the Customer Portal.

Go ahead and download the `universal_extension_bundle_2.0.0.zip` file from the customer portal and save it in a known location. It will be used in subsequent pages.

If you have set up the plugin to use `universal_extension_bundle_1.2.0.zip` from the previous release, it will continue to work as long as the API level selected is less than 1.4.0. If you wish to debug extensions with API level 1.4.0, `universal_extension_bundle_2.0.0.zip` will be needed.

8.2.1.2.1.4 `debugpy` PIP module

The `debugpy` module is required for VSCode's Python debugger (client) to connect to the Extension Python process (server).

The plugin has built-in prompts and logic to install this pip module automatically. Nothing needs to be done right now.

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8.2.1.3 Setting Up Initial Debugging Configuration

8.2.1.3.1 Introduction

On this page, we will cover the following:

1. Development environment recommendations
2. Extracting and opening the Extension contained in `DebuggingDemo.zip`
3. Setting up initial debugging configuration for a `dynamic_choice_command`

It is assumed the UIP Visual Studio Code Extension is already installed. See the previous document for installation instructions.

8.2.1.3.2 Step 1 - Development Environment Recommendations

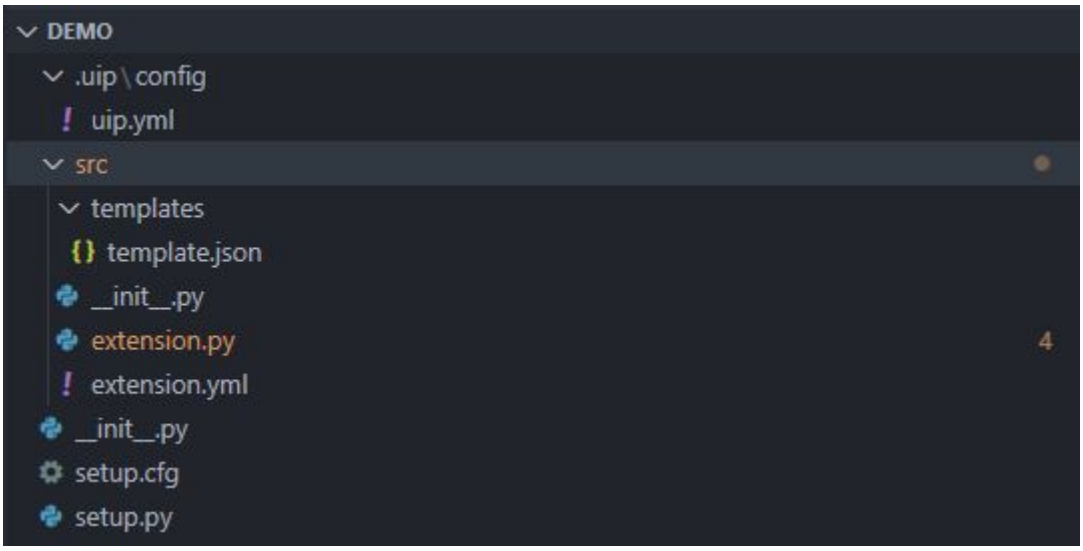
In this and subsequent pages, Visual Studio Code will be running on Windows with the "Remote WSL extension" (WSL is Windows Subsytem for Linux). This set-up is essentially a Linux development environment running on Windows. This is not strictly required, as any platform that supports Visual Studio Code will work.

As mentioned in the previous page, the debugging functionality depends on the `debugpy` PIP module. It is highly recommended to use a Python Virtual Environment to avoid dependency issues. See Using Python Environments in VS Code for using the Virtual Environment in Visual Studio Code.

8.2.1.3.3 Step 2 - Extract `DebuggingDemo.zip` and Open the Contained Extension

Assuming `DebuggingDemo.zip` has been downloaded from the previous page, go ahead and extract it to a known location (e.g. `~/dev`).

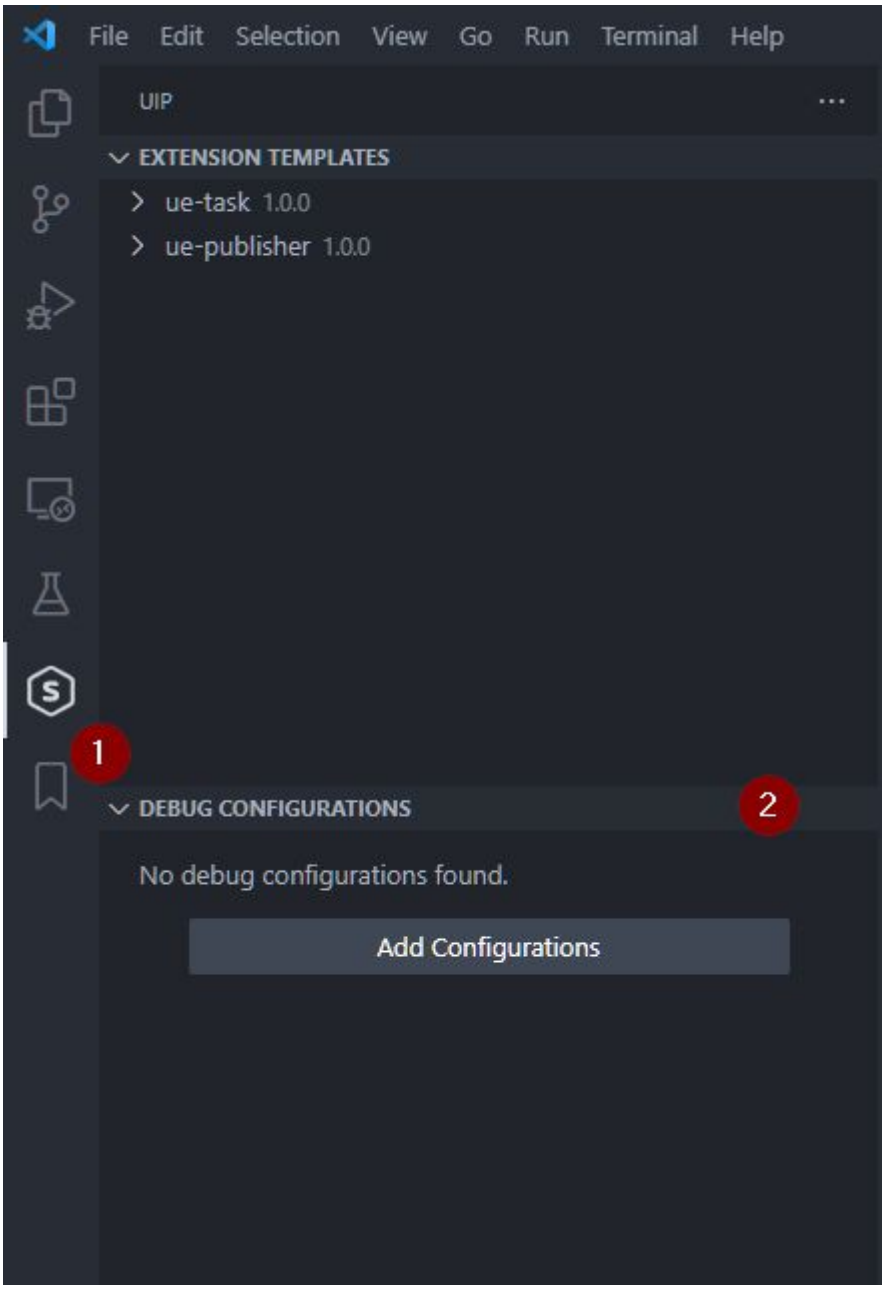
Open the extracted `DebuggingDemo` folder in VSCode. The directory structure must be as follows for the plugin to work:



Now would be a good time to set up the virtual environment in VSCode.

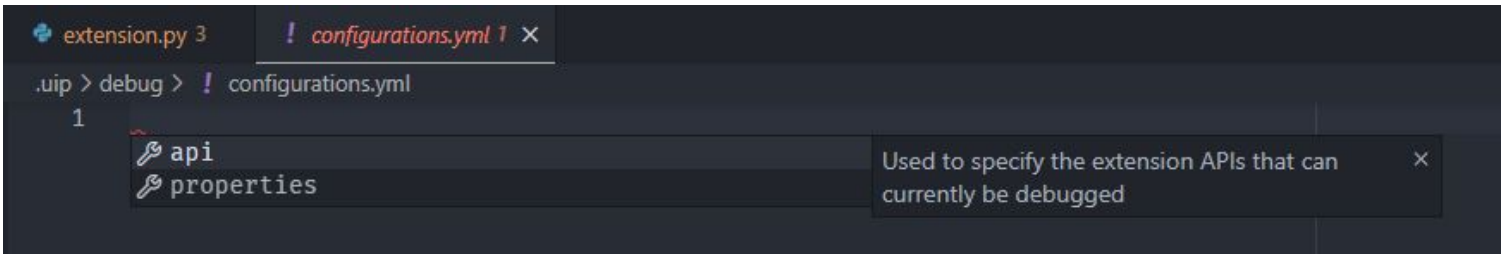
8.2.1.3.4 Step 3 - Setting Up Initial Debugging Configuration for a `dynamic_choice_command`

To get started, click the “Stonebranch” icon on the activity bar, followed by a click on “DEBUG CONFIGURATIONS”:



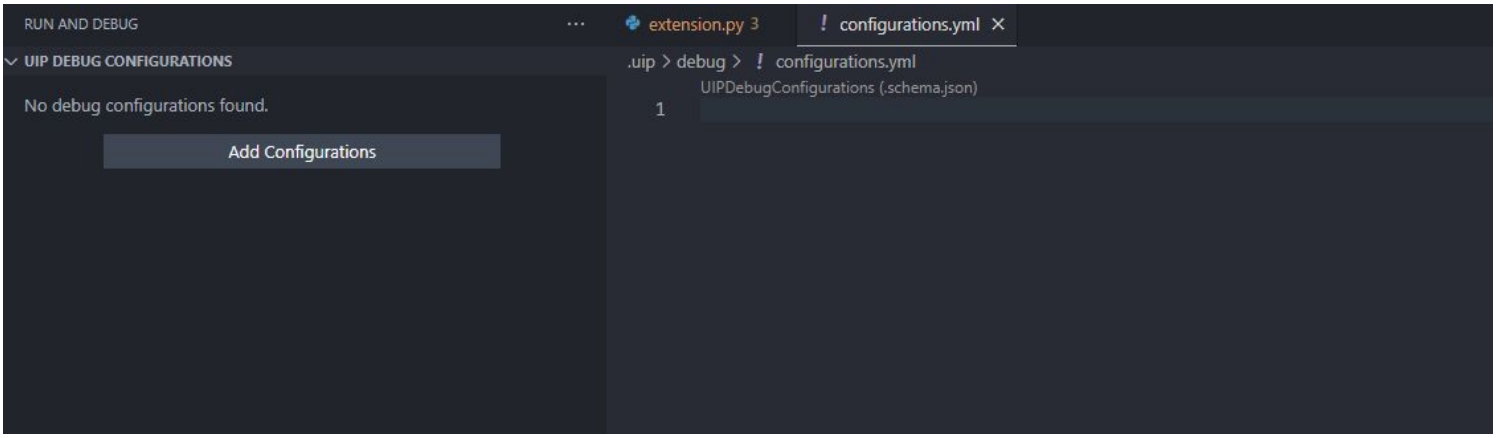
Alternatively, you can also press `F5` which will open the "UIP DEBUG CONFIGURATIONS" view

Now, click "Add Configurations" which should create and open a file called `configurations.yml` (located in `.uip/debug`) and suggest two items as shown below (if not suggested, press `Ctrl+Space`):



`configurations.yml` is used to configure to define debugging configurations. See Full Reference for details.

From the suggestion box, select `properties`, then press `Ctrl+Space` and select `agent`, followed by another `Ctrl+Space` and select `log_level`. If you press `Ctrl+Space` one more time, it will show all the log levels that can be possibly set. For now, select `Info`:

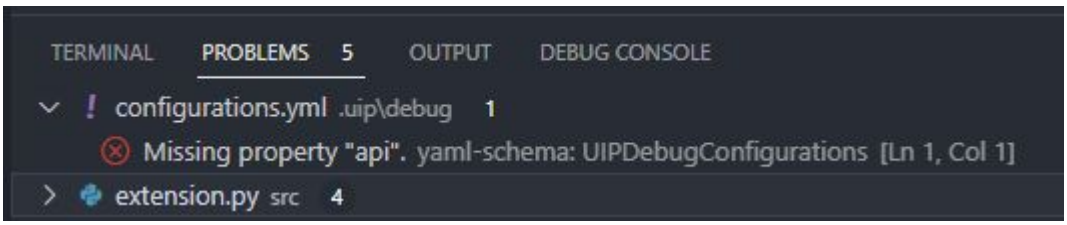


configurations.yml

```
properties:
  agent:
    log_level: Info
```

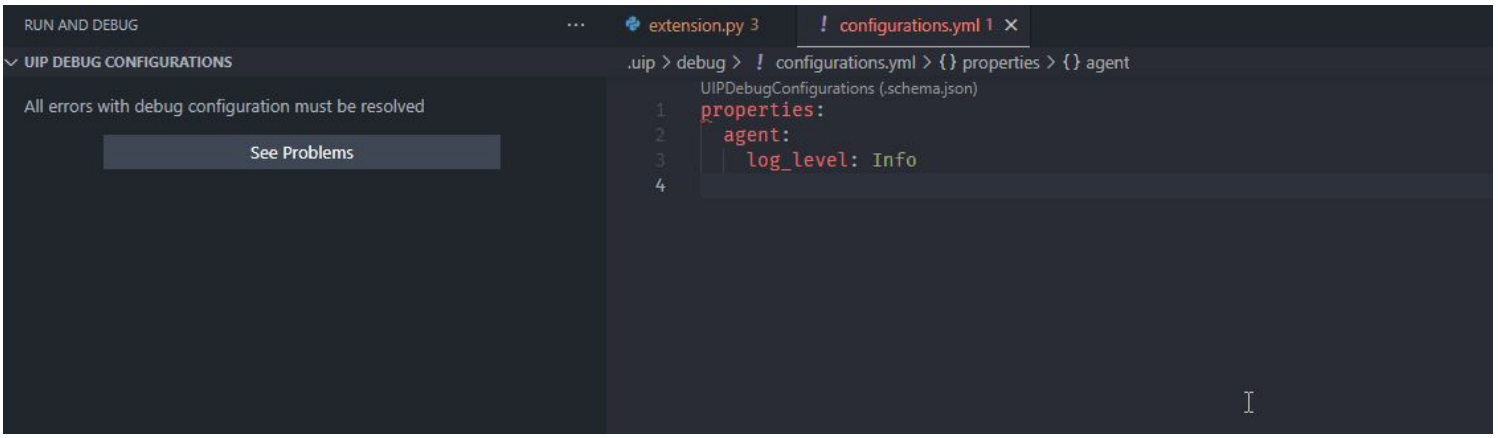
As the structure implies, the `log_level` object inside `properties -> agent` is used to configure the Agent log level.

You may have noticed that the “UIP DEBUG CONFIGURATIONS” view no longer has “Add Configurations”. Instead, it is complaining that the configurations.yml file has errors, and they must be resolved. Click "See Problems", and it should show the following error:



The `properties` object we added above is actually optional; the one that's required is `api`. The `api` object is where the developer can target a specific feature of Universal Extensions. As of now, the `api` object consists of `extension_start` and `dynamic_choice_commands`.

At the very beginning of the next line after `log_level`, do the following `Ctrl+Space -> api -> Ctrl+Space -> dynamic_choice_commands -> Ctrl+Space -> exclude_file_ext`:

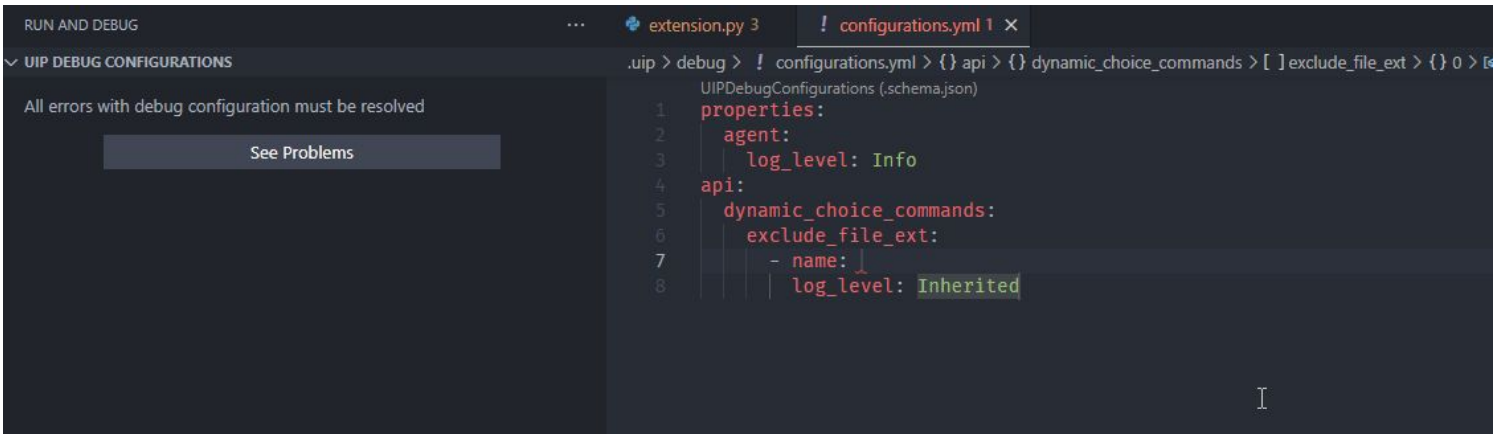


configurations.yml

```
properties:
  agent:
    log_level: Info
api:
  dynamic_choice_commands:
    exclude_file_ext:
      - name:
        log_level: Inherited
```

You may have noticed that `exclude_file_ext` object is an array of objects as denoted by the indented `-`. This means that the Extension developer can write multiple "cases"/configurations for a given dynamic choice command.

For now, in the `name` field, type in something unique to identify this (only) configuration. Upon save, the "UIP DEBUG CONFIGURATIONS" view should refresh automatically and show:

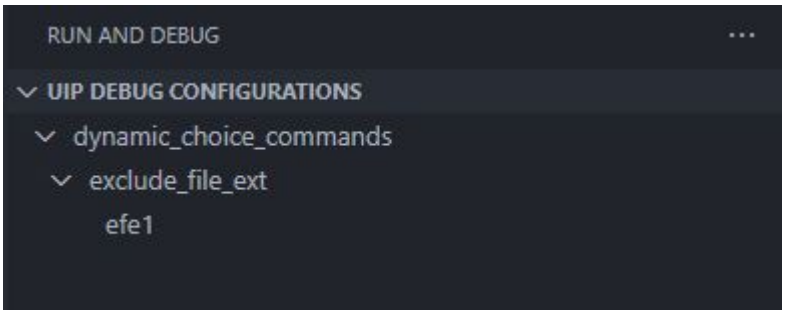


configurations.yml

```
properties:
  agent:
    log_level: Info
api:
  dynamic_choice_commands:
    exclude_file_ext:
      - name: efe1
        log_level: Inherited
```

Press `F5`, and you should get the following error notification:

In the "UIP DEBUG CONFIGURATIONS" view, hover over the `efe1` entry and click the "star" icon as shown below:



Clicking the "star" icon sets `efe1` as the default launch target. Once we add more configurations, setting a default will come in handy.

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8.2.1.4 Debugging a dynamic_choice_command

8.2.1.4.1 Introduction

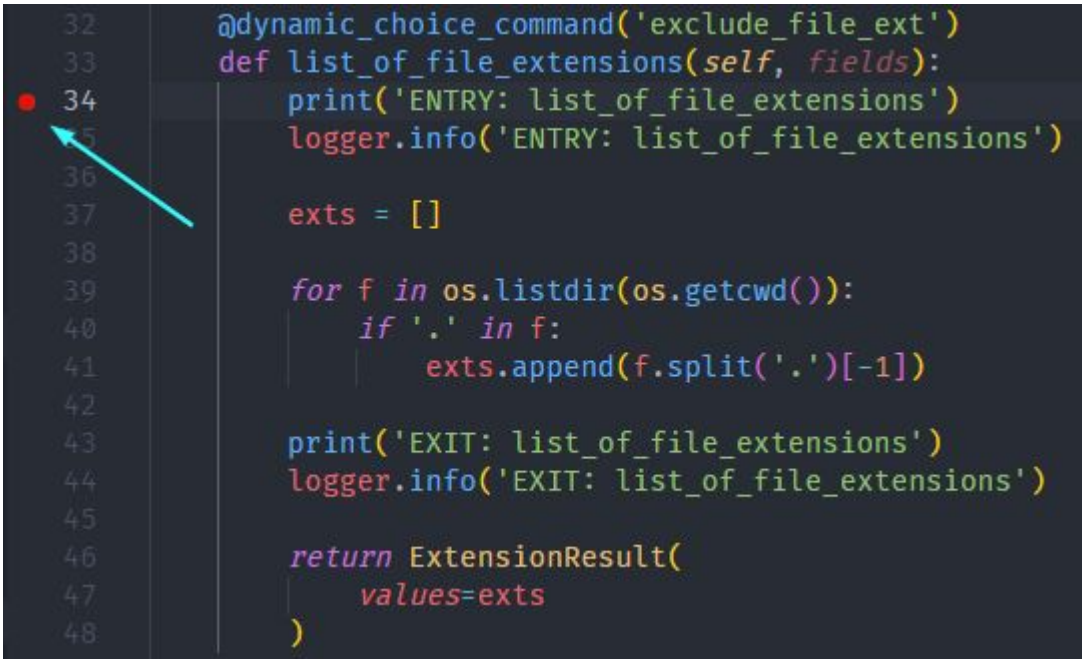
On this page, we will cover the following:

1. Preparing the debug session

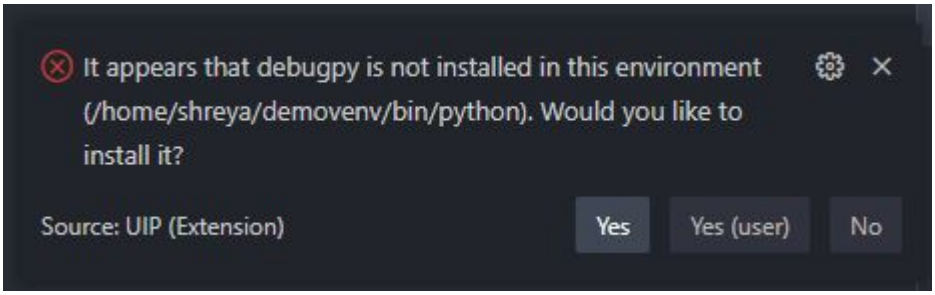
2. Starting the debug session

8.2.1.4.2 Step 1 - Preparing the Debug Session

Open the `extension.py` file and set a breakpoint on the first line in the `list_of_file_extensions` method as shown below:

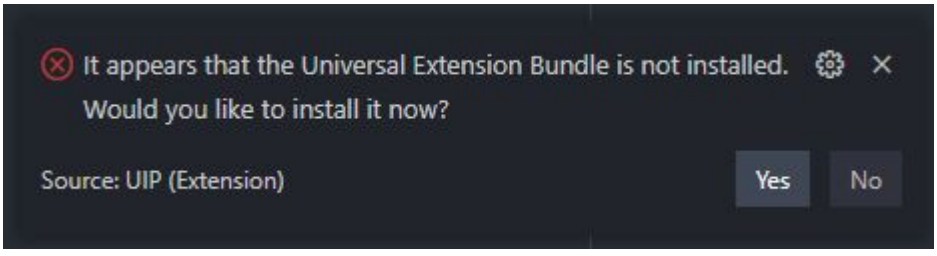


Now, press `F5` and you should get the following error:

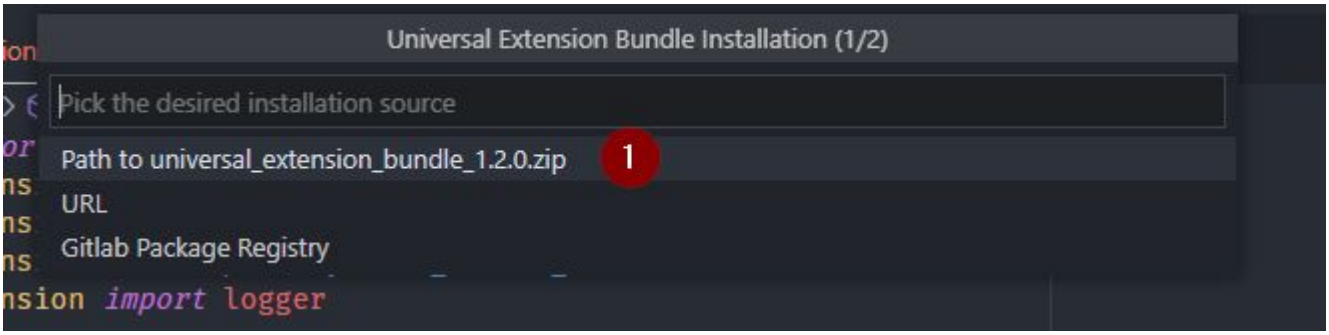


Click `Yes` and wait for VSCode to install `debugpy`

Immediately following `debugpy` installation, you should get another error notification:

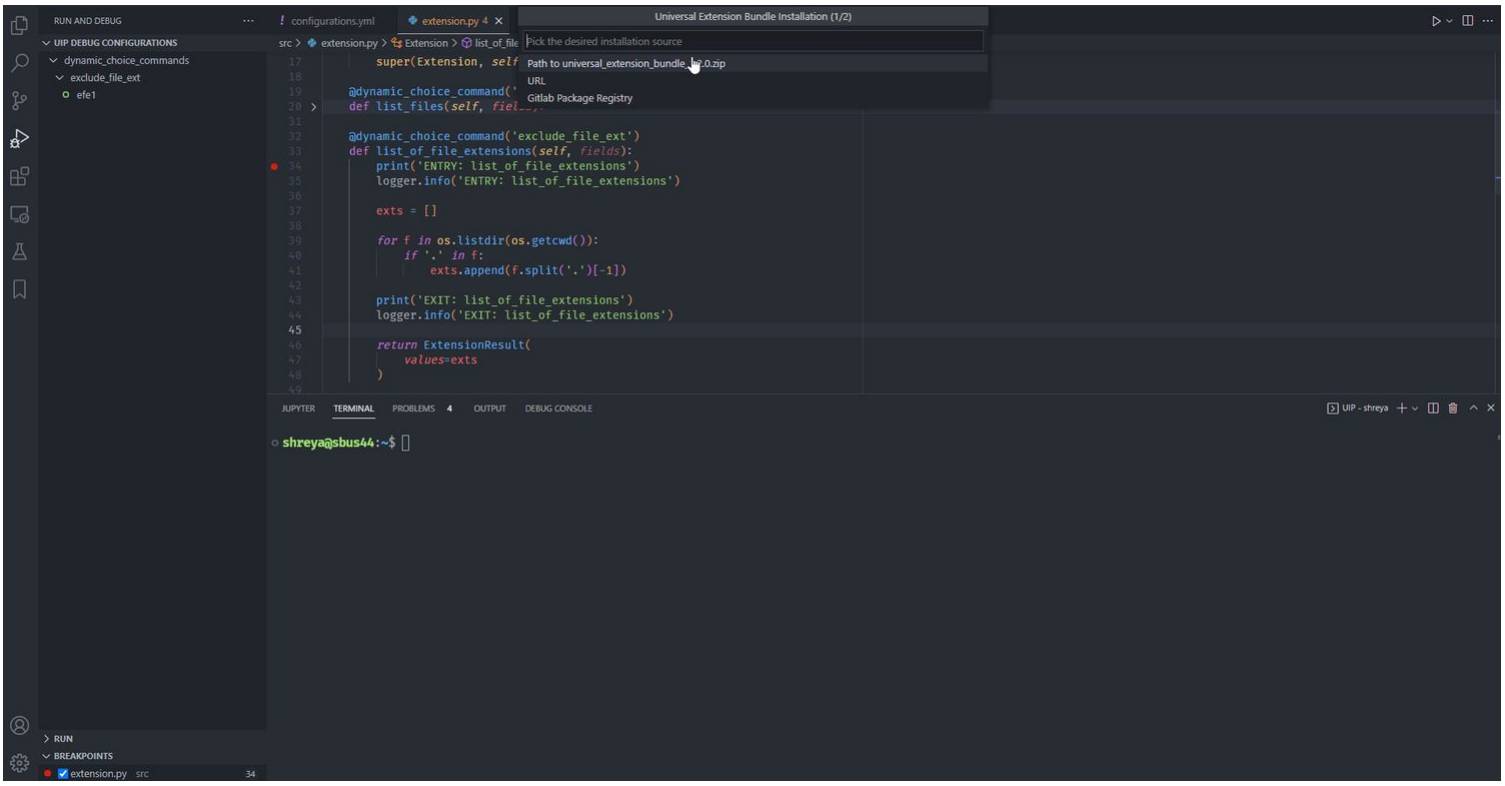


Click `Yes` and select `Path to the universal_extension_bundle_1.2.0.zip` option in the dropdown:

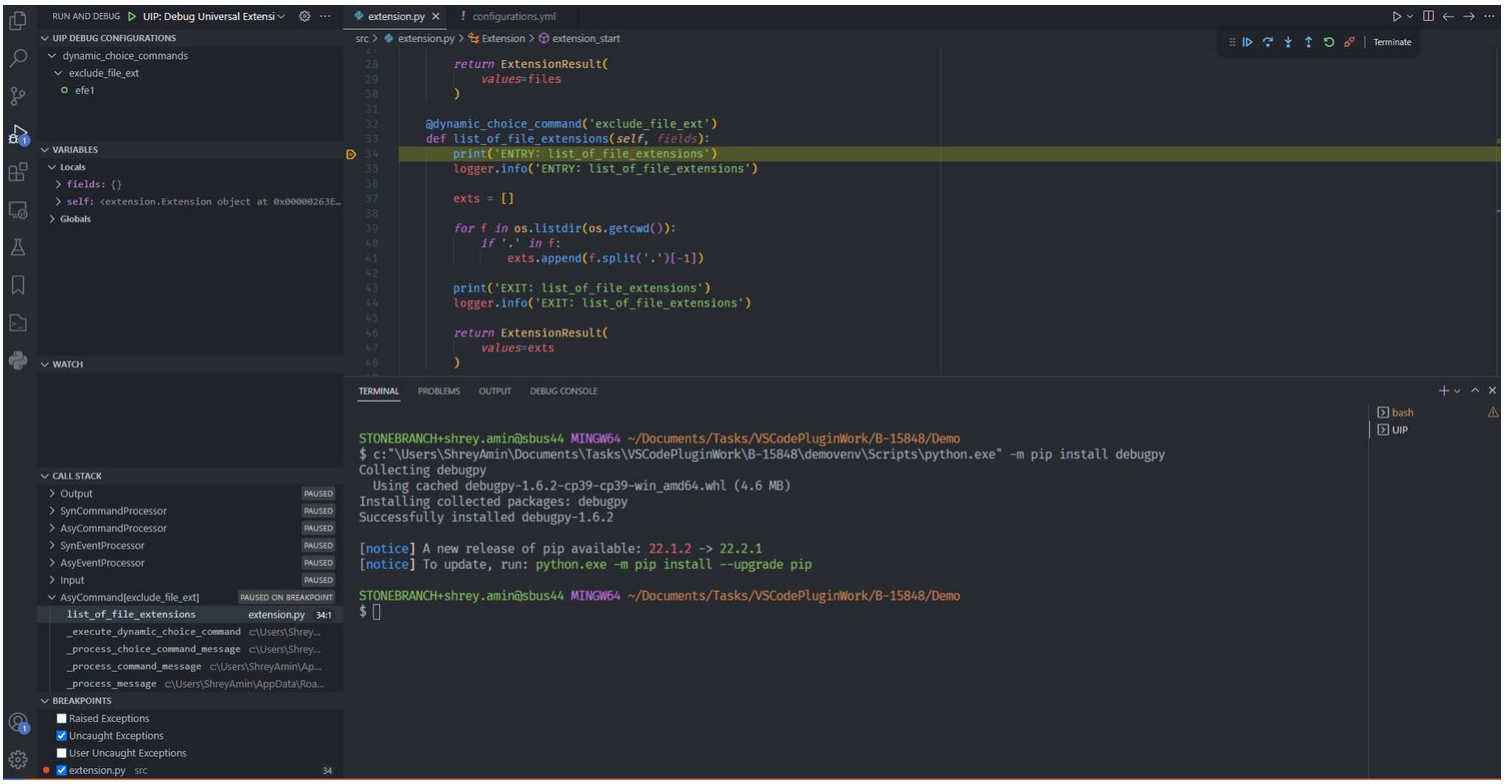


8.2.1.4.3 Step 2 - Starting the debug session

In the subsequent file picker dialog, locate the downloaded bundle zip (See Downloading/Installing Dependencies) and the following set of events should take place:



After installing the bundle, the plugin started the debugging session and hit the breakpoint. The following sequence of steps shows how to view the output (in real time) of the `exclude_file_ext` dynamic choice command:



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8.2.1.5 Editing and Testing Debugging Configuration

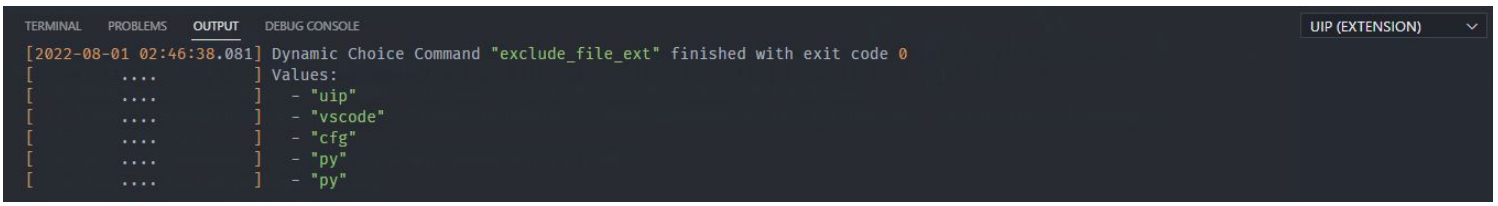
8.2.1.5.1 Introduction

On this page, we will cover the following:

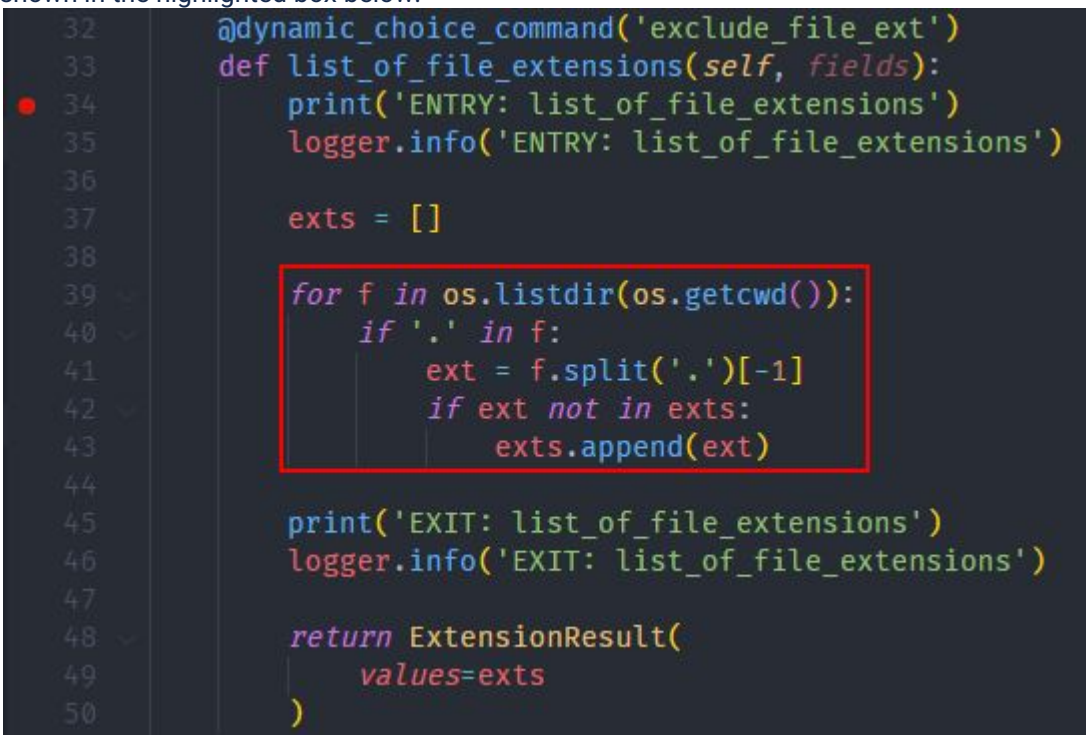
1. Editing and testing `exclude_file_ext` dynamic choice command
2. Editing and testing changes to `configurations.yml`

8.2.1.5.2 Step 1 - Editing and testing `exclude_file_ext` dynamic choice command

In the previous page, we debugged the `exclude_file_ext` dynamic choice command. You may have noticed the output in the `UIP (EXTENSION)` (can be opened with `Shift+Alt+3`) output channel contains `py` twice:



This is because the code does not take into account duplicate entries. Make the following set of changes to `extension.py` shown in the highlighted box below:



extension.py::list_of_file_extensions

```
@dynamic_choice_command('exclude_file_ext')
def list_of_file_extensions(self, fields):
    print('ENTRY: list_of_file_extensions')
    logger.info('ENTRY: list_of_file_extensions')

    exts = []

    for f in os.listdir(os.getcwd()):
        if '.' in f:
            ext = f.split('.')[-1]
            if ext not in exts:
                exts.append(ext)

    print('EXIT: list_of_file_extensions')
    logger.info('EXIT: list_of_file_extensions')

    return ExtensionResult(
        values=exts
    )
```

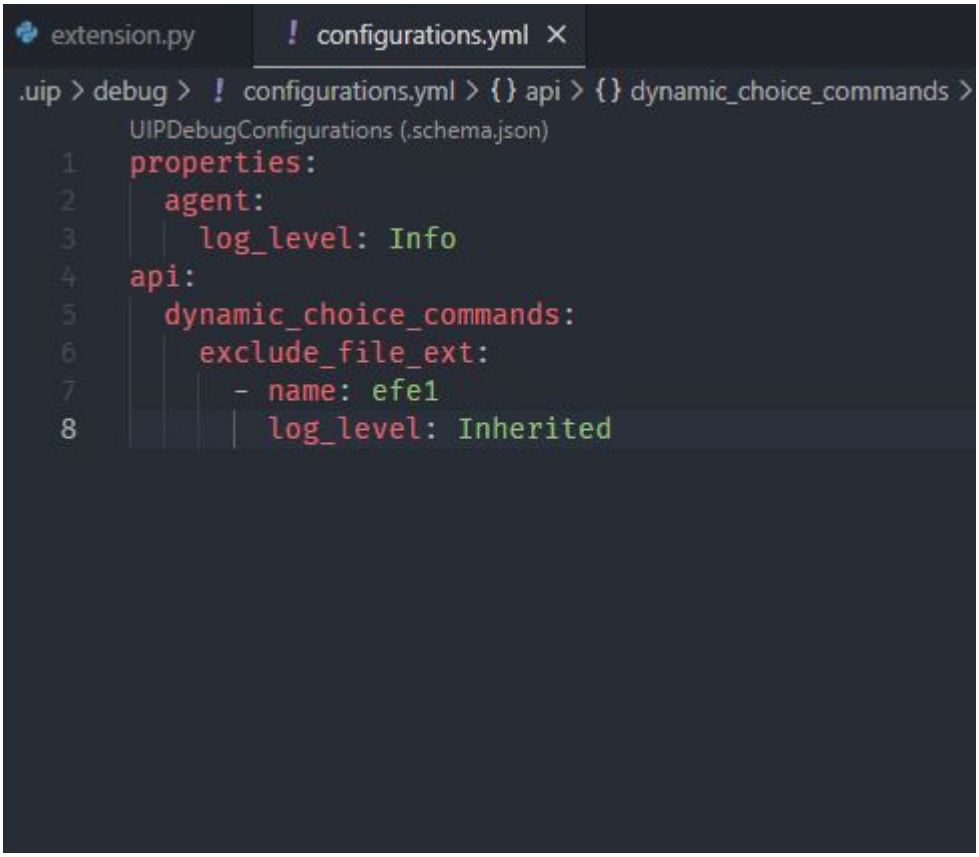
To test this change, simply press `F5` and the debugger should stop at the breakpoint once again. No need to build anything! Let the execution finish by pressing the “Continue” button, and the output should now look as follows:

```
[2022-08-01 13:32:55.900] Dynamic Choice Command "exclude_file_ext" finished with exit code 0
[          ....          ] Values:
[          ....          ]   - "uip"
[          ....          ]   - "vscode"
[          ....          ]   - "cfg"
[          ....          ]   - "py"
```

Notice the second `py` is no longer printed

8.2.1.5.3 Step 2 - Editing and testing changes to `configurations.yml`

As mentioned in the previous page, we can have multiple cases/configurations for each target. Add another entry to the `exclude_file_ext` array with the `log_level` set to `Trace`:

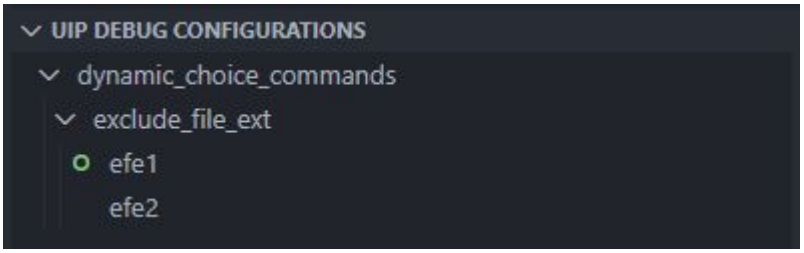


configurations.yml

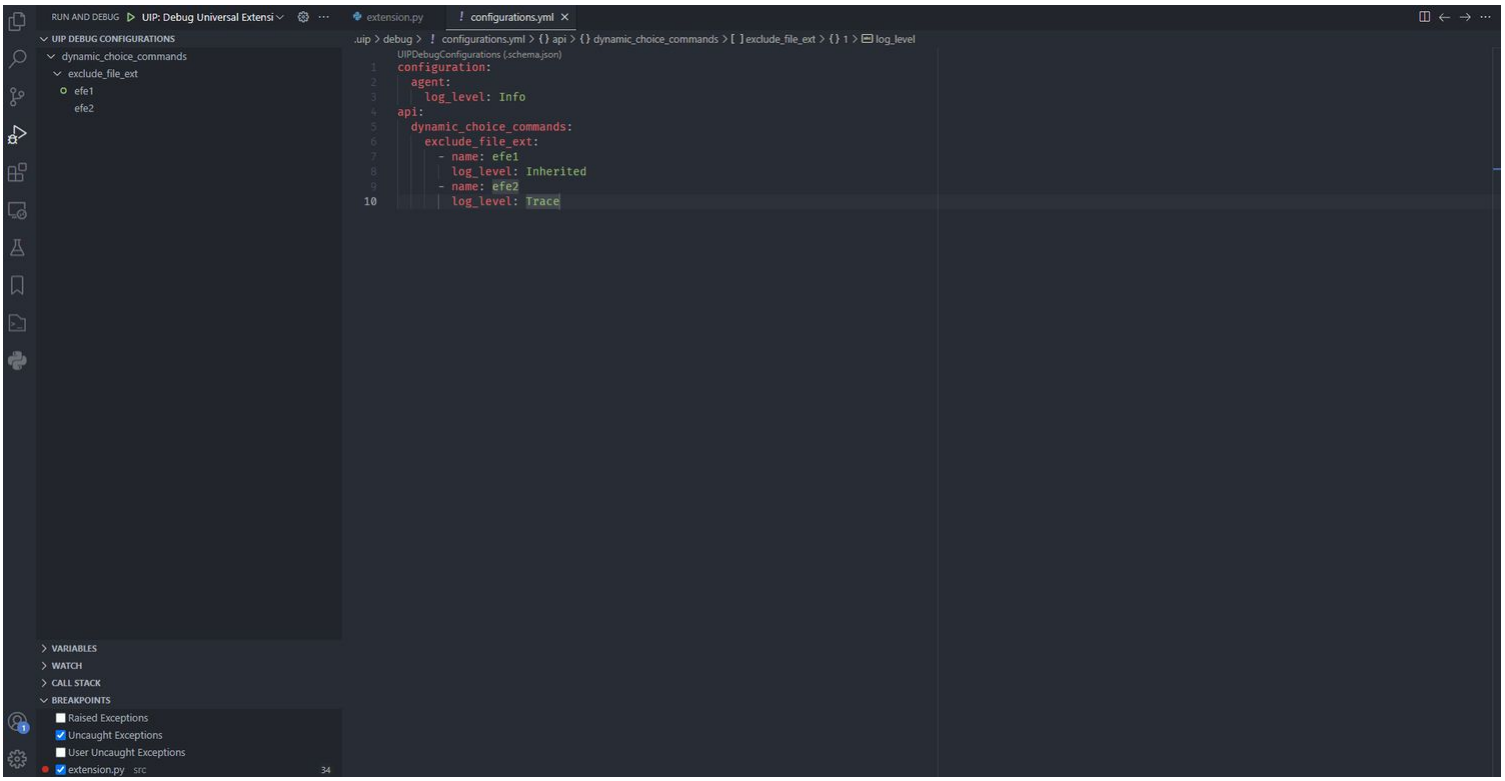
```
properties:
  agent:
    log_level: Info
api:
  dynamic_choice_commands:
    exclude_file_ext:
      - name: efe1
        log_level: Inherited
      - name: efe2
```

```
10          log_level: Trace
```

Both `efe1` and `efe2` are identical in functionality except `efe1` inherits its log level from the agent's log level whereas `efe2` 's log level is explicitly set to `Trace`. In the "UIP DEBUG CONFIGURATIONS" view, you should now see:



Notice that `efe1` is still selected as the default, and we will keep it that way. To launch/debug `efe2` without setting it as default, hover over it and press the "Debug" icon:



This demonstrates alternate means of launching/debugging a configuration besides setting as default. It also shows the effect of changing the log level.

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8.2.1.6 Dynamically updating configurations.yml

8.2.1.6.1 Introduction

On this page, we will cover the following:

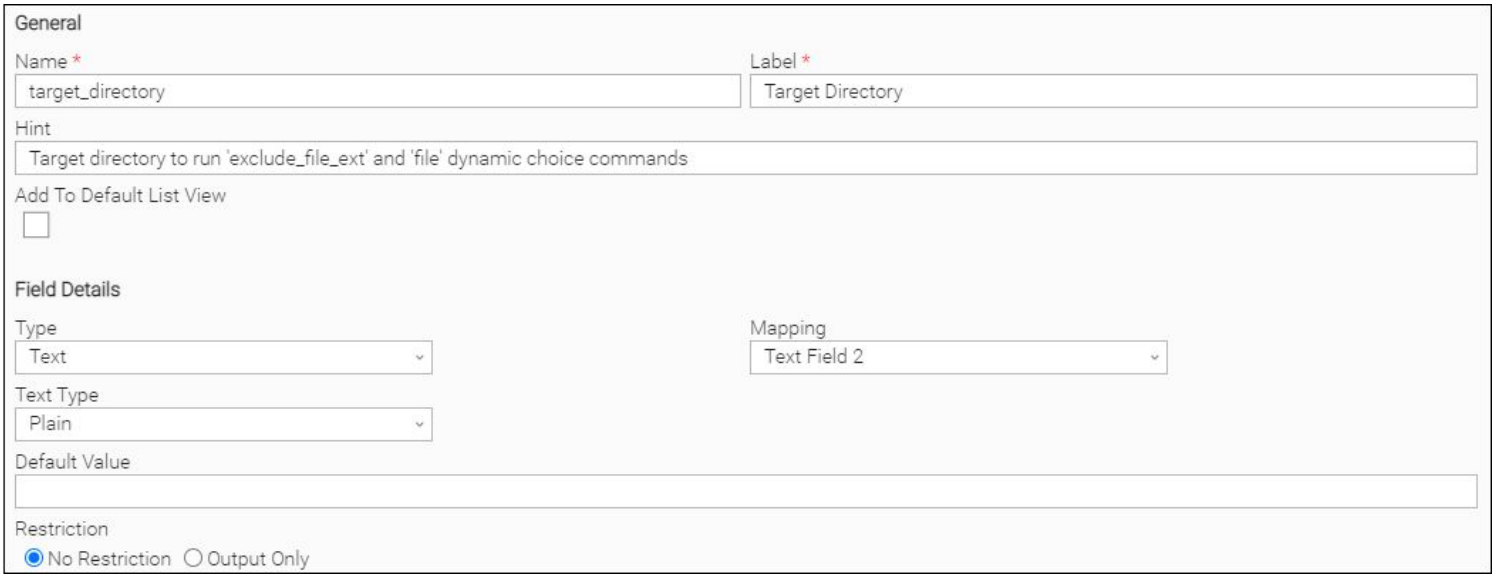
1. Adding a new dependent field to `exclude_file_ext` and `file` dynamic choice fields
2. Updating the local `template.json` to grab the new field
3. Using the newly added field

8.2.1.6.2 Step 1 - Adding a new dependent field to `exclude_file_ext` and `file` dynamic choice fields

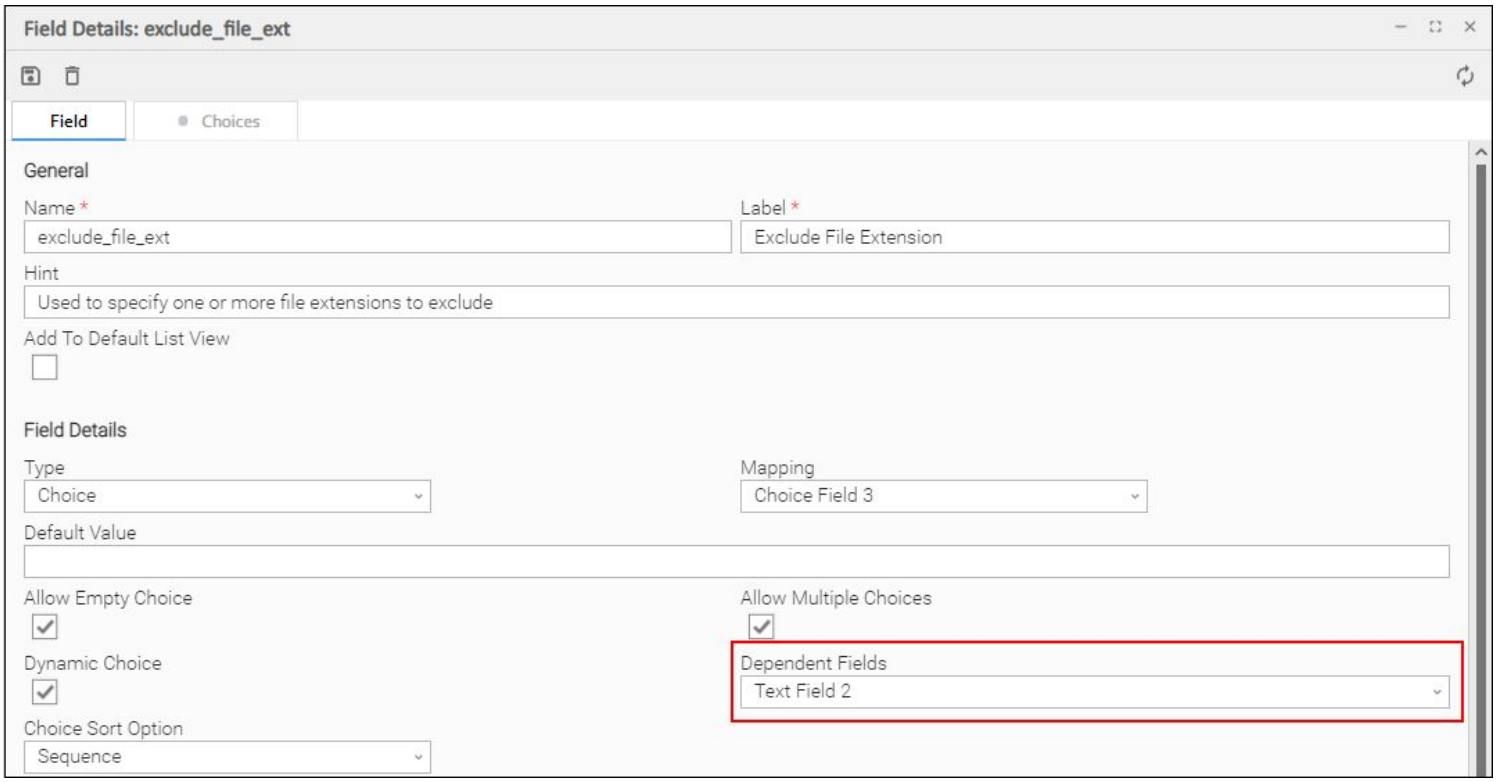
The `exclude_file_ext` dynamic choice command runs in the same directory as the workspace, which is why the output shows `uip, vscode, cfg, and py`. To grab the file extensions in some other directory, we need a new field.

At the time of writing this document, the Controller does NOT allow setting the runtime directory when executing a dynamic choice command. To keep it consistent, the VSCode Plugin also doesn't allow this. Thus, the best way to set a target directory is to add a new field and have `exclude_file_ext` depend on it.

Using the `UIP: Push All` command (See Extension Development), push the extension and template to the Controller. Once uploaded, add a new text field called `target_directory` as shown below:



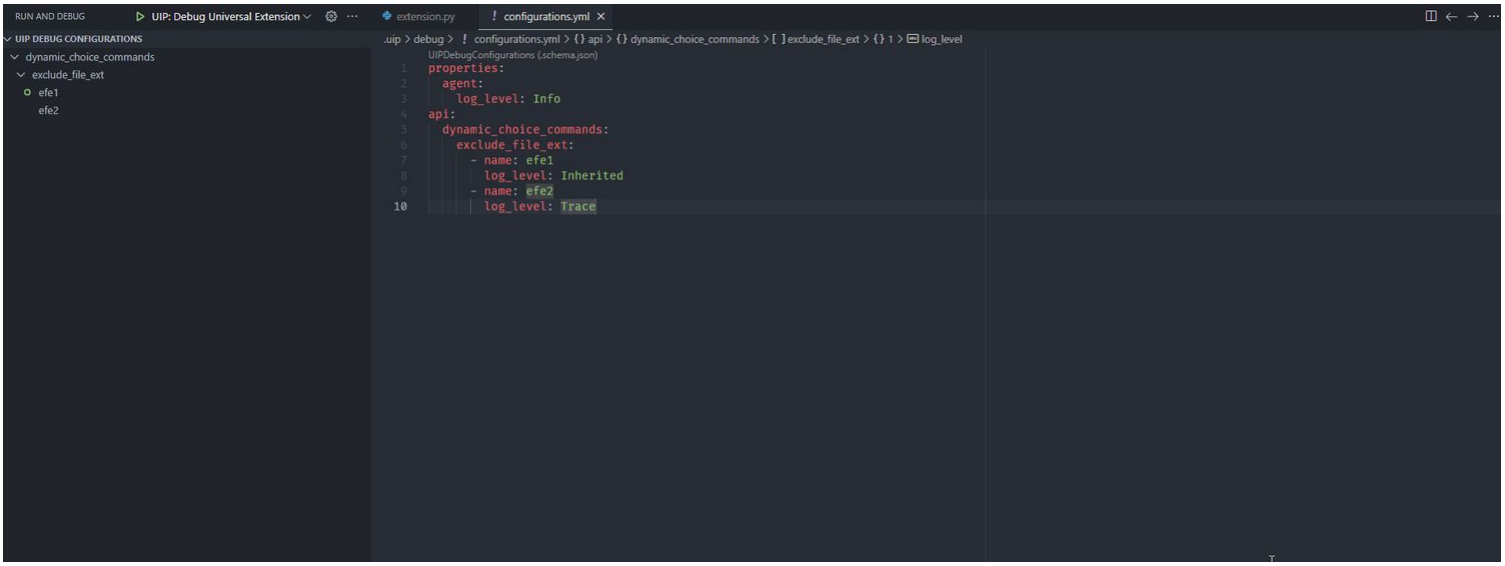
Then, double-click on the `exclude_file_ext` field and set `Text Field 2` as a dependent field:



Repeat the same for the `file` field.

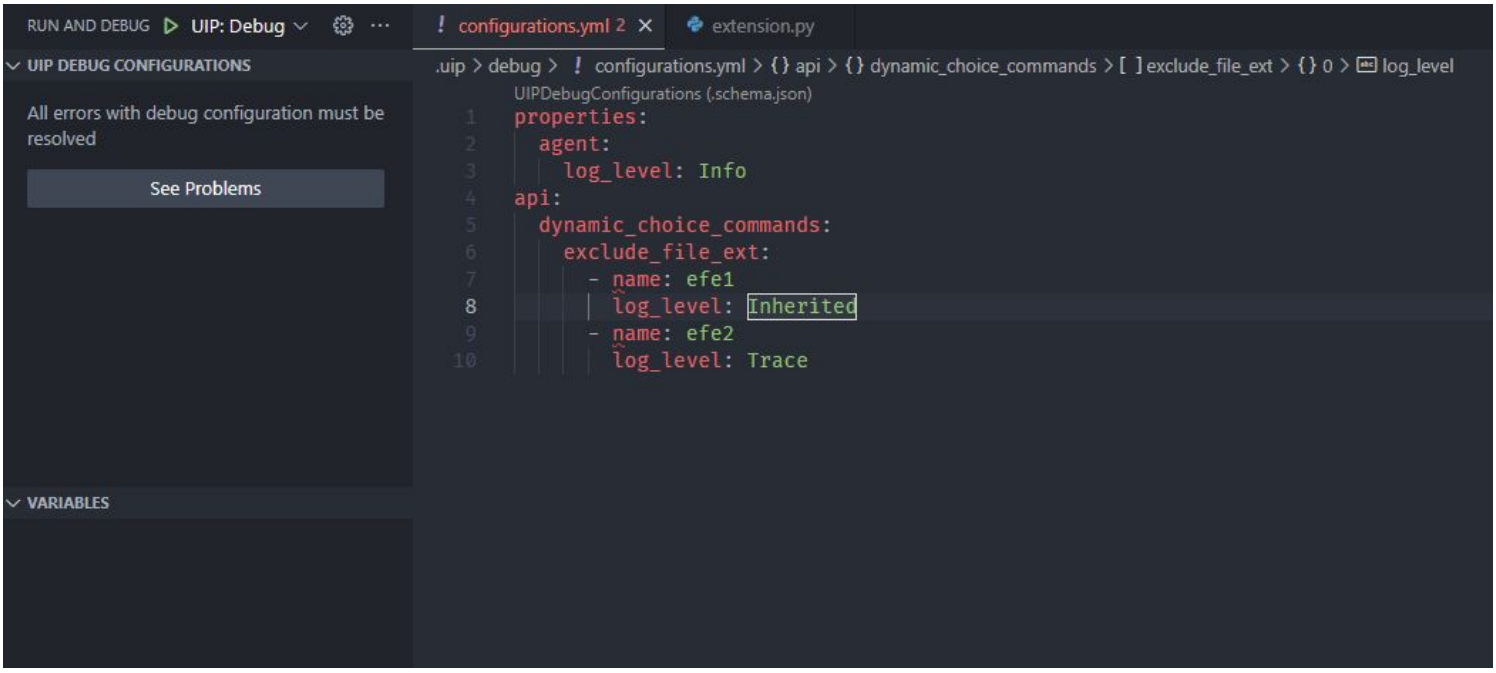
8.2.1.6.3 Step 2 - Updating the local `template.json` to grab the new field

Now, go back to VSCode and run `UIP: Pull`. You should see the following changes:



Whenever `template.json` changes, the `.schema` file under `.uip/debug` also changes. `.schema` is used by

`configurations.yml` to validate the field types, offer code-completion etc. In this case, updating `template.json` results in some problems because `exclude_file_ext` was changed to depend on `target_directory`, but in `configurations.yml`, we haven't specified a value for it yet. Go ahead and add the `target_directory` field (the value can be any directory, as long as it has some files in it) as shown below:



configurations.yml

```
properties:
  agent:
    log_level: Info
api:
  dynamic_choice_commands:
    exclude_file_ext:
      - name: efe1
        log_level: Inherited
        fields:
            target_directory:
      - name: efe2
        log_level: Trace
        fields:
            target_directory:
```

8.2.1.6.4 Step 3 - Using the newly added field

Make the following changes to `list_of_file_extensions` method in `extension.py` to use the new `target_directory` field:

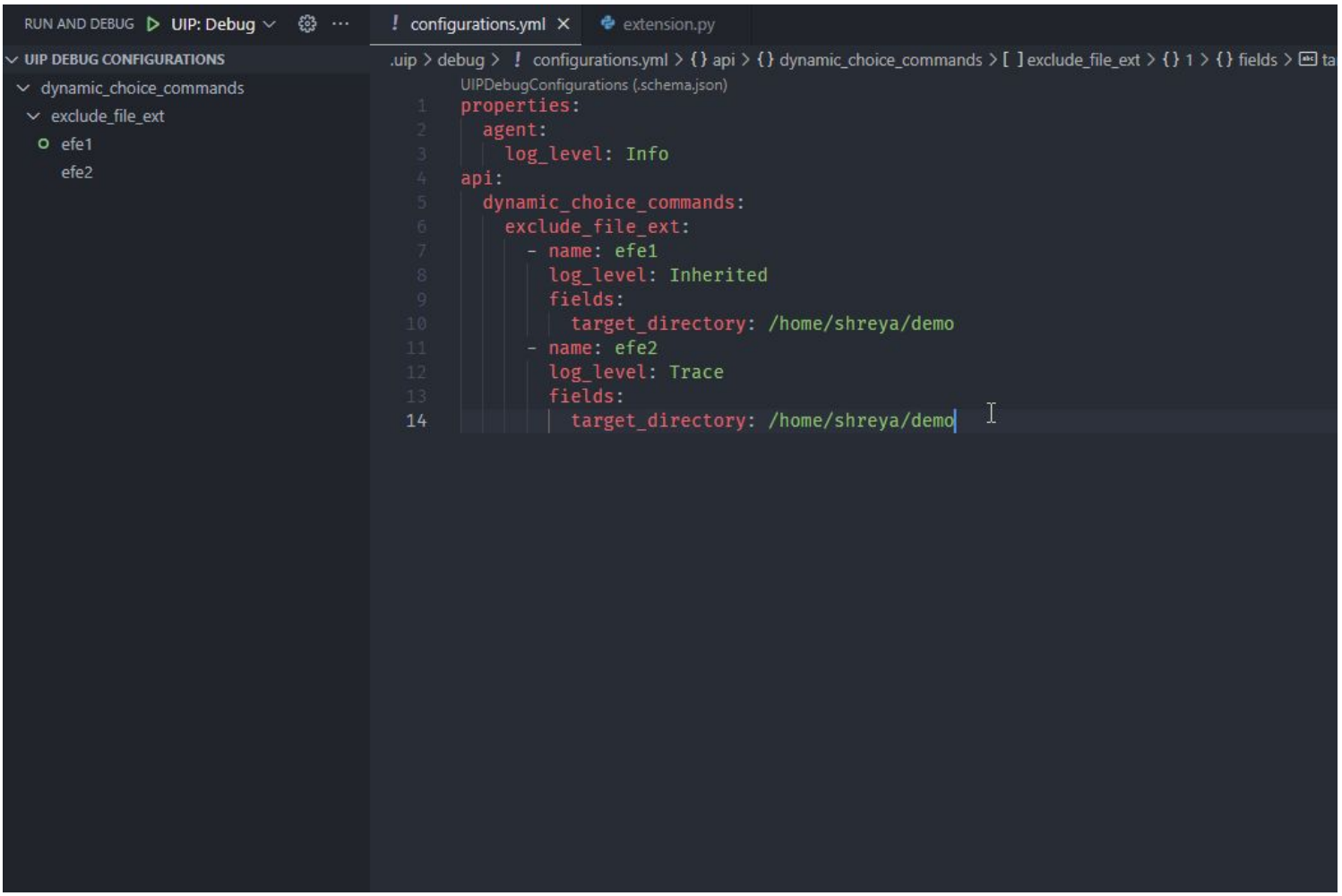
extension.py::list_of_file_extensions

```
@dynamic_choice_command('exclude_file_ext')
def list_of_file_extensions(self, fields):
    print('ENTRY: list_of_file_extensions')
    logger.info('ENTRY: list_of_file_extensions')

    exts = []

    target_dir = fields.get('target_directory', os.getcwd())

    for f in os.listdir(target_dir):
        if '.' in f:
            ext = f.split('.')[-1]
            if ext not in exts:
                exts.append(ext)

    print('EXIT: list_of_file_extensions')
    logger.info('EXIT: list_of_file_extensions')

    return ExtensionResult(
        values=exts
    )
```

Now, press `F5` (`efe1` should still be the default) and it should hit the breakpoint. Let the dynamic choice command run to completion, and the output should show all the file extensions in `target_directory`. In my case, the output is:

```
[2022-08-01 15:03:14.706] Dynamic Choice Command "exclude_file_ext" finished with exit code 0
[          ....          ] Values:
[          ....          ]   - "exe"
[          ....          ]   - "json"
[          ....          ]   - "msi"
[          ....          ]   - "rar"
[          ....          ]   - "sh"
[          ....          ]   - "txt"
[          ....          ]   - "yml"
[          ....          ]   - "zip"
```

Now, let's add a couple of configurations for the `file` dynamic choice command, which will retrieve the list of files in `target_directory`:



configurations.yml

```
properties:
  agent:
    log_level: Info
api:
```

```
dynamic_choice_commands:
  exclude_file_ext:
    - name: efe1
      log_level: Inherited
      fields:
        target_directory:
    - name: efe2
      log_level: Trace
      fields:
        target_directory:
  file:
    - name: list_all_files
      log_level: Inherited
      fields:
        exclude_file_ext:
          - ""
        target_directory:
    - name: exclude_json_files
      log_level: Inherited
      fields:
        exclude_file_ext:
          - json
        target_directory:
```

The `list_all_files` configuration should list all the files in `target_directory` whereas `exclude_json_files` will list all files except the ones that end in `.json`. You may have to change `exclude_json_files` depending on the types of file that your `target_directory` contains.

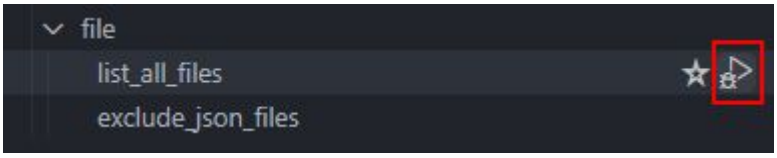
Modify the `list_files` method in `extension.py` to use the `target_directory` as well:

```
@dynamic_choice_command('file')
def list_files(self, fields):
    to_exclude = fields.get('exclude_file_ext', [])
    files = []

    target_dir = fields.get('target_directory', os.getcwd())

    for f in os.listdir(target_dir):
        if f.split('.')[-1] not in to_exclude:
            files.append(f)

    return ExtensionResult(
        values=files
    )
```

extension.py::list_files

```
@dynamic_choice_command('file')
def list_files(self, fields):
    to_exclude = fields.get('exclude_file_ext', [])
    files = []

    target_dir = fields.get('target_directory', os.getcwd())

    for f in os.listdir(target_dir):
        if f.split('.')[-1] not in to_exclude:
            files.append(f)

    return ExtensionResult(
        values=files
    )
```

Now, go ahead and launch `list_all_files`:



Since a breakpoint wasn't set in `list_files`, the debugger will attach and finish almost immediately. Upon completion, press `Shift+Alt+3`, and you should see a listing of all the files in your `target_directory.`
Do the same with `exclude_json_files` (or whatever you named it), and it should show all the files except the ones that end in `.json`.

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8.2.1.7 Debugging extension_start

8.2.1.7.1 Introduction

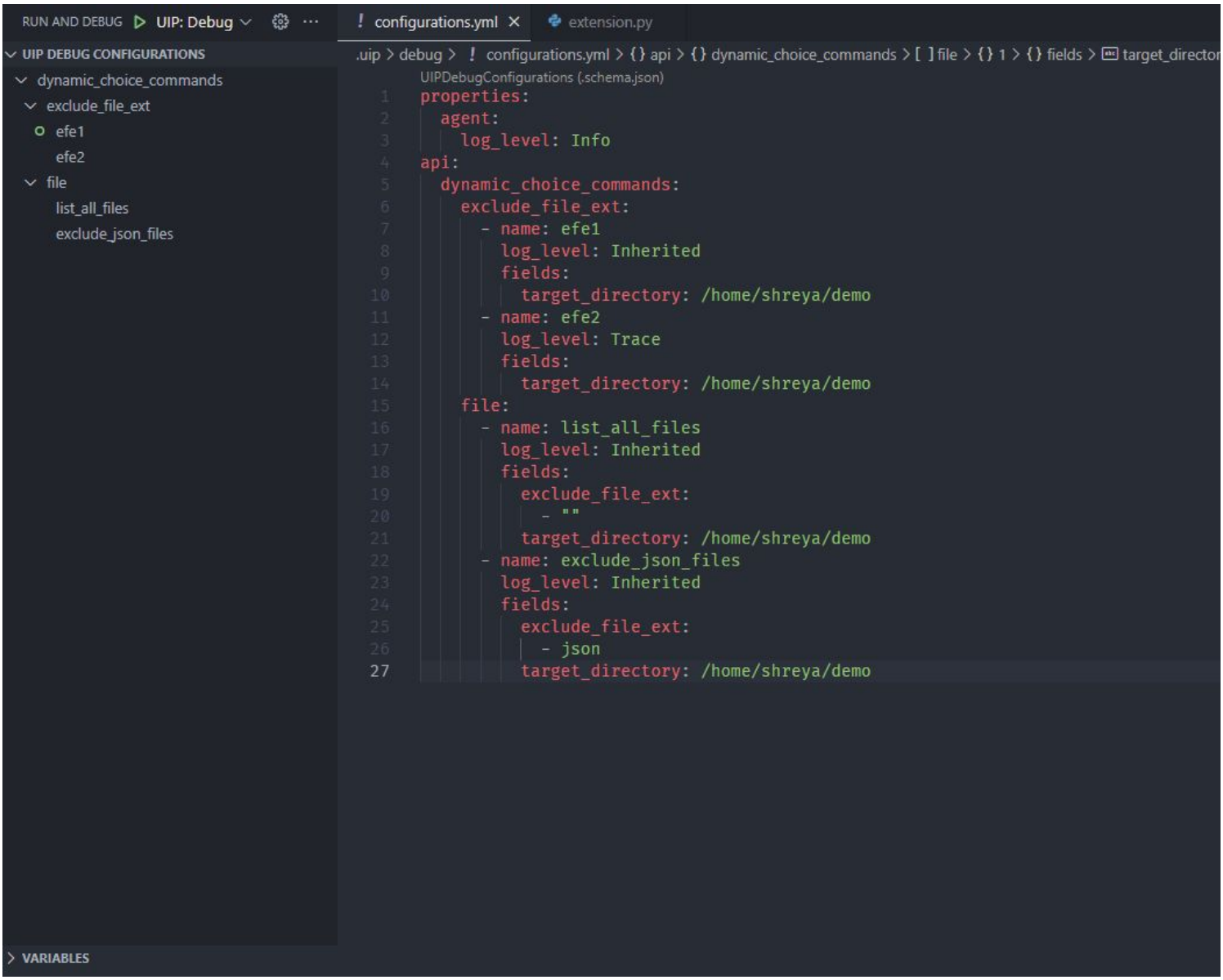
On this page, we will cover the following:

1. Debugging `extension_start`

8.2.1.7.2 Step 1 - Debugging `extension_start`

So far, we have launched/debugged two different dynamic choice commands. Now, to put it all together, we will add two configurations for `extension_start`: one that will delete a file and another for appending contents to a file.

Add an entry to delete a file. You may need to change which file and what directory to delete in:



configurations.yml

```
properties:
  agent:
    log_level: Info
api:
  dynamic_choice_commands:
    exclude_file_ext:
      - name: efe1
        log_level: Inherited
        fields:
          target_directory:
      - name: efe2
        log_level: Trace
        fields:
          target_directory:
    file:
```

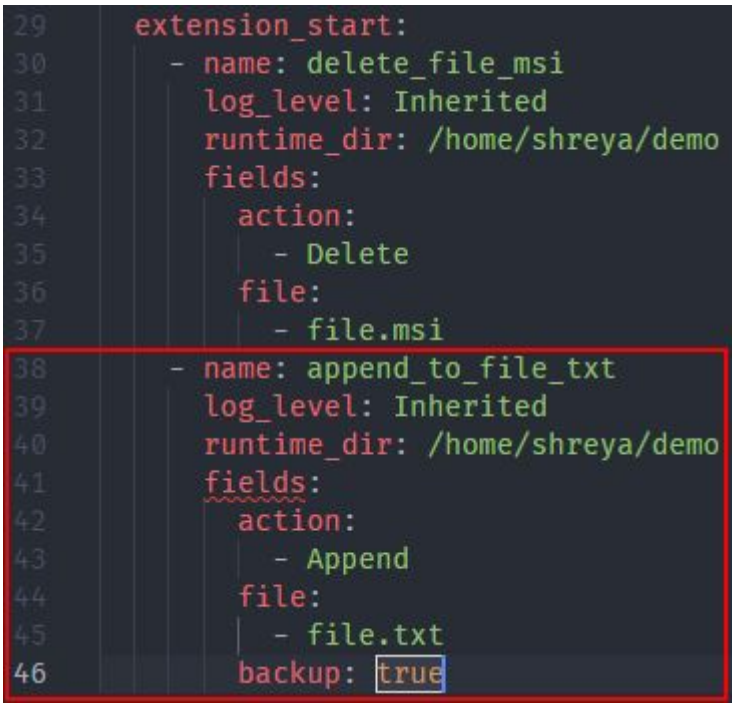
```
      - name: list_all_files
        log_level: Inherited
        fields:
          exclude_file_ext:
            - ""
          target_directory:
      - name: exclude_json_files
        log_level: Inherited
        fields:
          exclude_file_ext:
            - json
          target_directory:

  extension_start:
    - name: delete_file_msi
      log_level: Inherited
      runtime_dir:
      fields:
        action:
          - Delete
        file:
          - file.msi
```

Notice that `extension_start` accepts an array of configurations similar to how dynamic choice commands were configured above. `extension_start` has some additional unique properties, one of them being `runtime_directory`. From the Controller, it is possible to set the runtime directory before launching the Extension (once again, not possible for dynamic choice commands). So, the `runtime_directory` property is added to mimic that behavior. For `extension_start`, we don't need to use the `target_directory` field, though we could if we wanted to (with some extra steps of changing to that directory manually).

Launch `delete_file_msi` (or whatever you named it). Inspect the directory specified in `runtime_directory` and the specified `file` should have been removed.

Now, we will add another configuration entry to `extension_start` to show how `configurations.yml` detects dependent fields and issues errors. Go ahead and add an entry similar to the one shown below:



```
extension_start:
  - name: delete_file_msi
    log_level: Inherited
    runtime_dir: /home/shreya/demo
    fields:
      action:
        - Delete
      file:
        - file.msi
  - name: append_to_file_txt
    log_level: Inherited
    runtime_dir: /home/shreya/demo
    fields:
      action:
        - Append
      file:
        - file.txt
      backup: true
```

configurations.yml

```
properties:
  agent:
    log_level: Info
api:
  dynamic_choice_commands:
    exclude_file_ext:
      - name: efe1
        log_level: Inherited
        fields:
          target_directory:
      - name: efe2
        log_level: Trace
        fields:
          target_directory:
    file:
      - name: list_all_files
        log_level: Inherited
        fields:
          exclude_file_ext:
            - ""
          target_directory:
      - name: exclude_json_files
        log_level: Inherited
        fields:
          exclude_file_ext:
            - json
          target_directory:

  extension_start:
    - name: delete_file_msi
```

```
      log_level: Inherited
      runtime_dir:
      fields:
        action:
          - Delete
        file:
          - file.msi
    - name: append_to_file_txt
      log_level: Inherited
      runtime_dir:
      fields:
        action:
          - Append
        file:
          - file.txt
        backup: true
```

`configurations.yml` should be reporting an error now. If you hover over the `fields` property under `append_to_file_txt`, it should say `Missing property "contents"`. The `contents` field was set to be required if the value of `action` is `Append` (you can verify this by opening the template in the Controller and checking the `contents` field). The `.schema` file has logic to enforce this behavior as well, which is why `configurations.yml` is complaining. Go ahead and add the `contents` field along with some sample contents:

configurations.yml

```
    - name: append_to_file_txt
      log_level: Inherited
      runtime_dir:
      fields:
        action:
          - Append
        contents: |
          this is line 1
          this is line 2
          this is line 3
        file:
          - file.txt
        backup: true
```

Now, launch `append_to_file_txt` (or whatever you named it). Inspect the directory specified in `runtime_directory` and the specified `file` should have been appended with `contents` and a backup should have been made with `.bkp` extension.

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8.2.1.8 Simulating Extension Cancel

8.2.1.8.1 Introduction

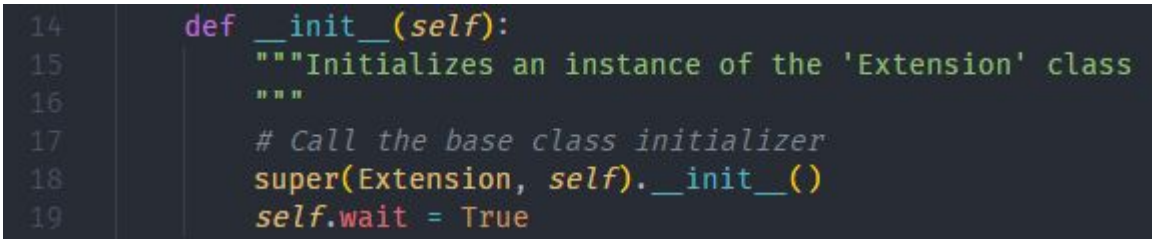
On this page, we will cover the following:

1. Setting up extension.py to handle Cancellation
2. Issuing the Cancel command

8.2.1.8.2 Step 1 - Setting Up `extension.py` to Handle Cancellation

With this extension, it is a little hard to demonstrate cancel functionality in a meaningful manner. So, the feature will be demonstrated using a contrived example.

In the `__init__` method in `extension.py`, add a property called `self.wait = True`:



extension.py::__init__

```
1  def __init__(self):
2      """Initializes an instance of the 'Extension' class
3      """
4      # Call the base class initializer
5      super(Extension, self).__init__()
6      self.wait = True
```

In the `extension_start` method in `extension.py`, add the following lines of code at the beginning:

```
58      def extension_start(self, fields):
59          """Required method that serves as the starting point for work performed
60          for a task instance.
61
62          Parameters
63          ----------
64          fields : dict
65              populated with field values from the associated task instance
66              launched in the Controller
67
68          Returns
69          -------
70          ExtensionResult
71              once the work is done, an instance of ExtensionResult must be
72              returned. See the documentation for a full list of parameters that
73              can be passed to the ExtensionResult class constructor
74          """
75
76          if self.wait:
77              while self.wait:
78                  continue
79              return ExtensionResult(
80                  rc=0,
81                  message='done waiting...'
82              )
83
84          # Get the value of the 'action' field
85          action = fields['action'][0]
86          file = fields['file'][0]
87
```

extension.py::extension_start

```
1  if self.wait:
2      while self.wait:
3          continue
4      return ExtensionResult(
5          rc=0,
6          message='done waiting...'
7      )
```

Add the `extension_cancel` method to the `Extension` class in `extension.py` as follows:

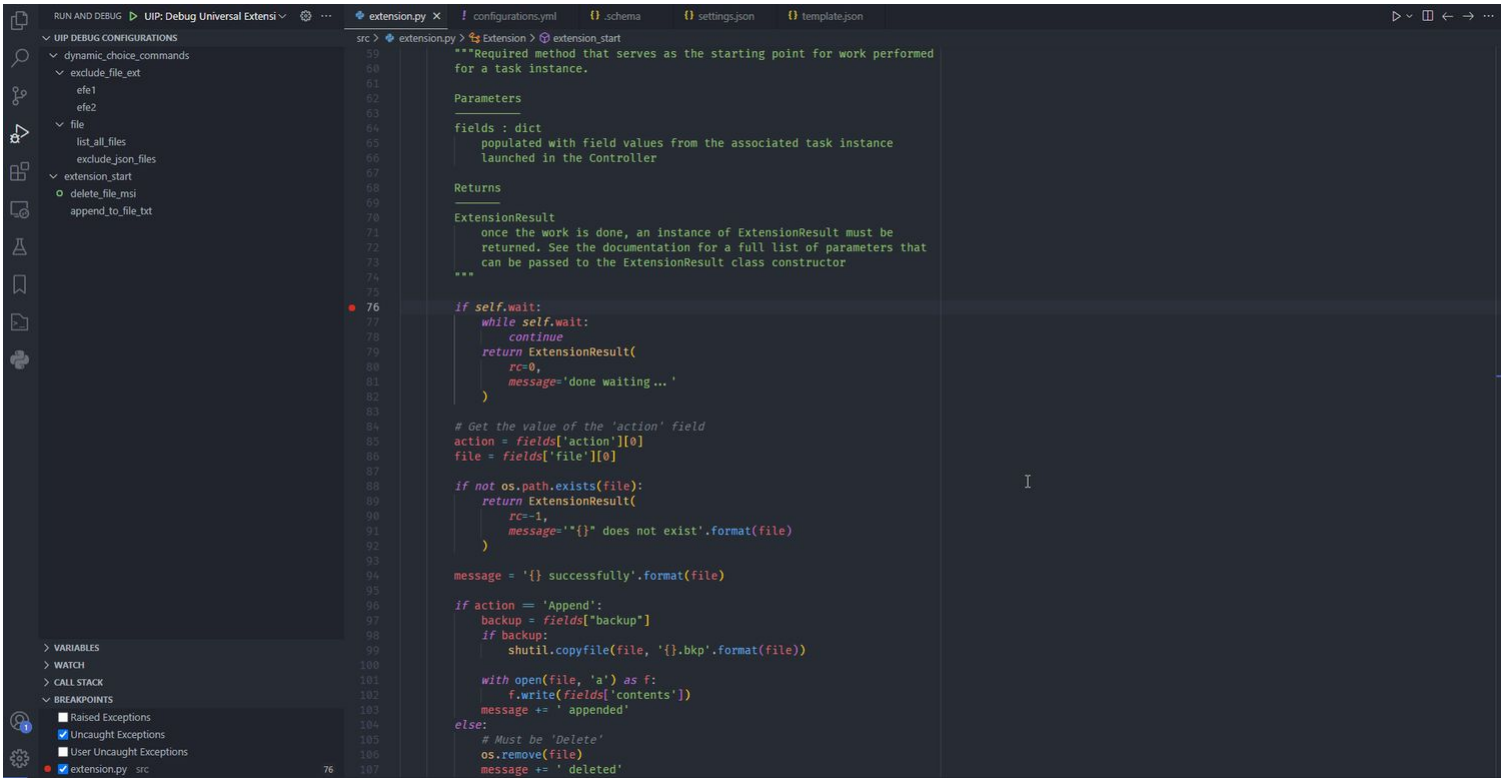
```
116     def extension_cancel(self):
117         print('setting self.wait to False')
118         self.wait = False
```

extension.py::extension_cancel

```
def extension_cancel(self):
    print('setting self.wait to False')
    self.wait = False
```

8.2.1.8.3 Step 2 - Issuing the Cancel Command

The idea is that `extension_start` will be stuck in the infinite while-loop, and the only way to exit is if `extension_cancel` is called. Go ahead and launch any of the `extension_start` configurations, and perform the actions shown below:



As you can see in the execution above, the while-loop exited once `Cancel` was pressed, which results in `extension_cancel` being called.

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8.2.1.9 Changing Universal Extension API Level

8.2.1.9.1 Introduction

On this page, we will cover the following:

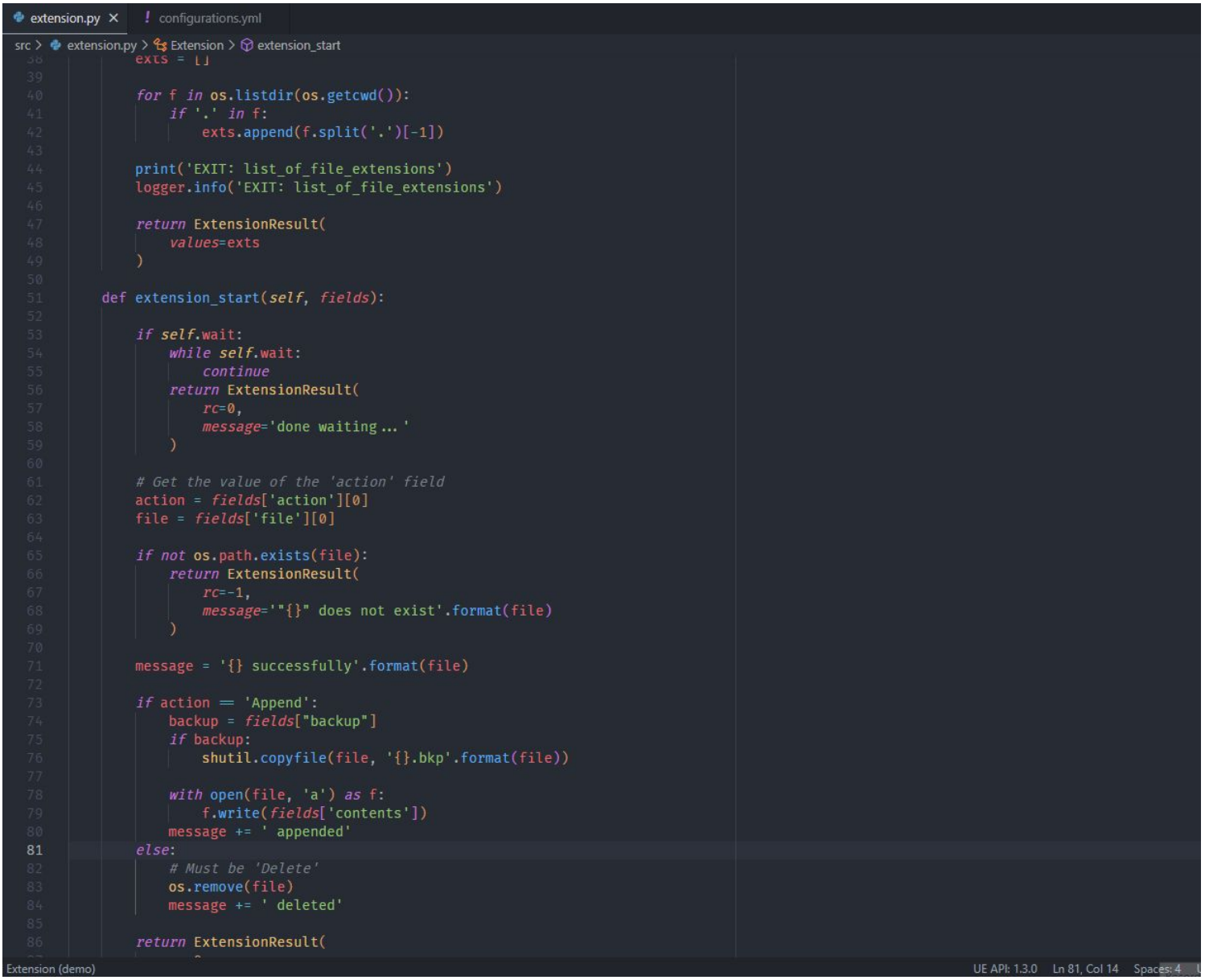
1. Changing Universal Extension API Level

8.2.1.9.2 Step 1 - Changing Universal Extension API Level

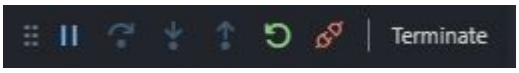
As mentioned in the requirements, this backlog should allow the developer to easily test their Extension against the officially supported Universal Extension API Levels.

You may have noticed a new addition to the VSCode Status Bar that shows the currently select Universal Extension API Level:

Go ahead and click `UE API: 1.3.0` and select `1.0.0.`



Now, launch one of the `extension_start()` configurations; it doesn't matter which one. In my case, I'm launching `delete_file_msi`. Upon launch, you will see the debugger is running, but there is no cancel button:



In API Level 1.0.0, the cancel functionality was not available, which is why the debug toolbar doesn't show it. Go ahead and press the "Terminate" button to force kill the extension.

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8.2.1.10 Full Reference

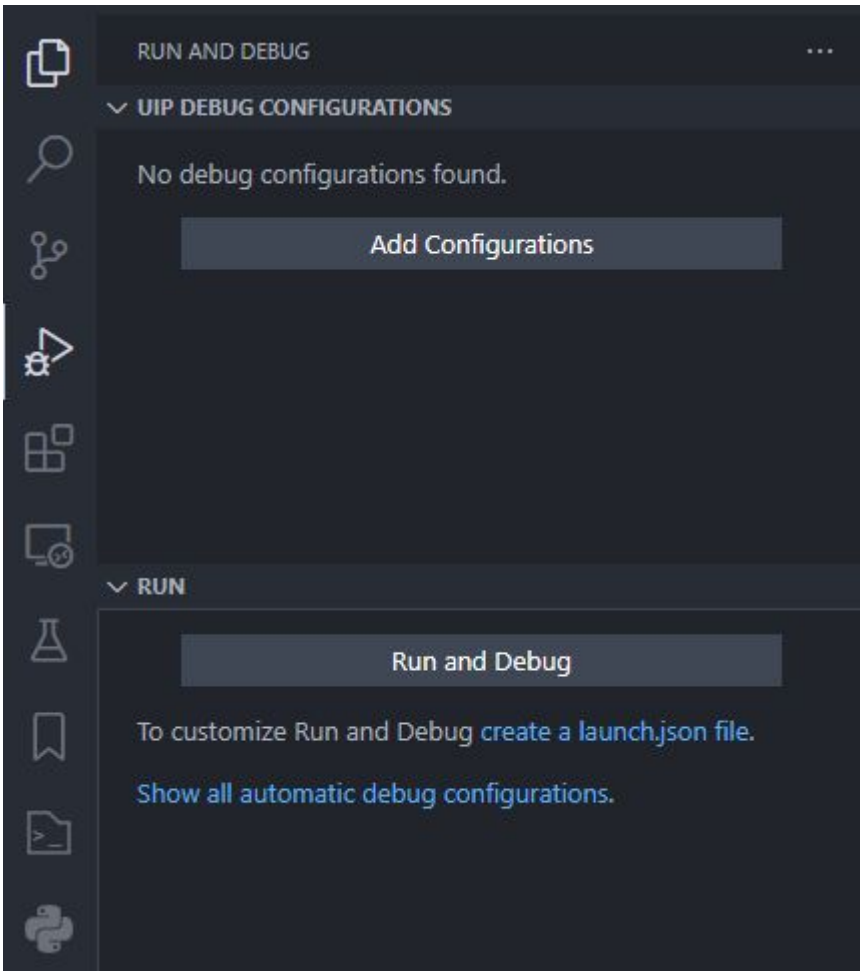
8.2.1.10.1 Introduction

On this page, the debugging functionality will be documented in its entirely:

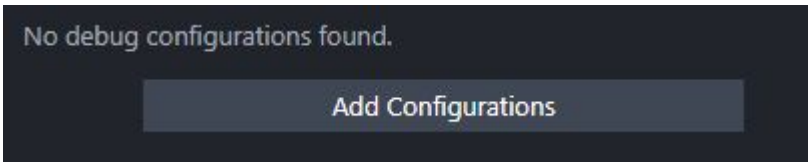
1. "UIP DEBUG CONFIGURATIONS" View
2. Plugin Dependencies
3. configurations.yml
4. Universal Extension API Levels
5. Launching/Debugging
6. Output Only Fields and Publishing Events
7. Output Channels
8. Known Limitations

8.2.1.10.2 1 - "UIP DEBUG CONFIGURATIONS" View

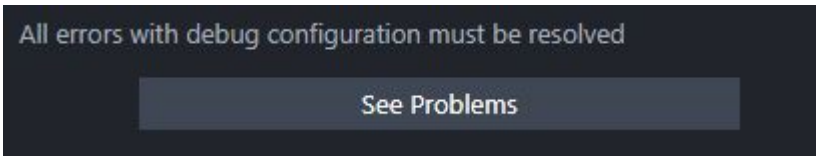
The "UIP DEBUG CONFIGURATIONS" view located in the "Run and Debug" section is responsible for showing all the launchable configurations defined in configurations.yml:



Initially, `configurations.yml` will not be present, so the view will report that and show a button to “Add Configurations”:

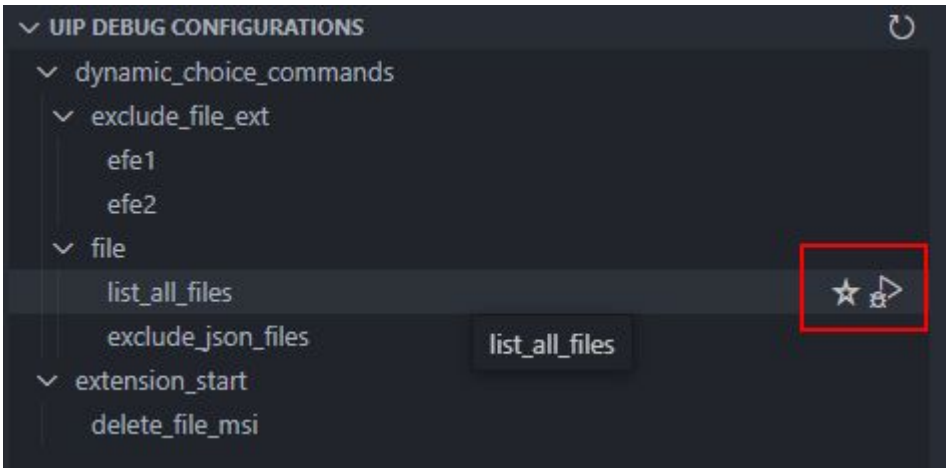


If there are any issues with `configurations.yml`, the view will report that and show a button to “See Problems”:

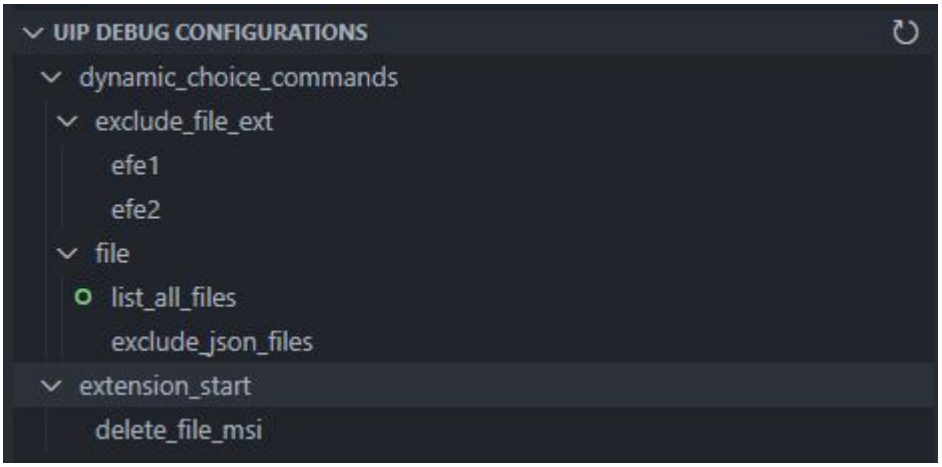


If there are no problems and there is at least 1 valid configuration, the view will render the contents of `configurations.yml` (layout will differ depending on the structure of your `configurations.yml`):

Hovering on each configuration entry should expose the following two icons:



Clicking on the “star” icon will mark the selected configuration entry as the default one (Clicking again will deselect it). This will be indicated with a green circle to the left of the configuration entry name:



The default configuration entry will persist even if after VSCode has been closed. Clicking on the “debug” icon (next to the “star” icon) will launch that specific entry.

To update the list of entries in the "UIP DEBUG CONFIGURATIONS” view, click the “refresh” icon:

Clicking the “refresh” icon, however, should not be necessary. The view will automatically be updated when

- `configurations.yml` changes
- `template.json` changes (during `UIP: Pull`)

8.2.1.10.3 2 - Plugin Dependencies

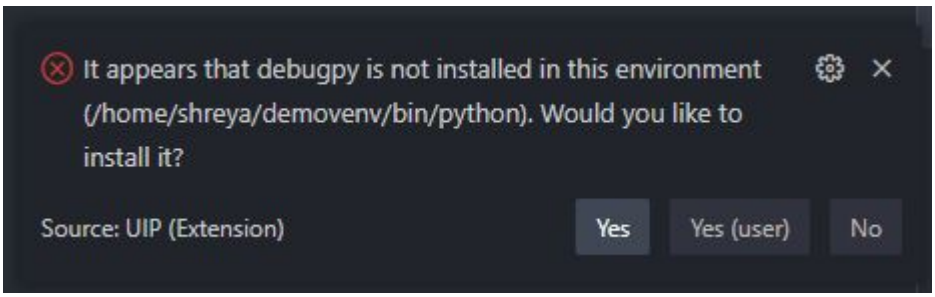
The debugging functionality has two dependencies: `debugpy` PIP module, and Universal Extension Bundle (`universal_extension_bundle_1.2.0.zip`).

- `debugpy` module is required for the Python debugger on VSCode’s end (client) to connect to the debugging server on the Extension side.
- Universal Extension Bundle is a proprietary zip file which contains the Universal Extension Base Class code for all the supported API levels mentioned in the requirements section. Specifically, the bundle zip consists of a folder called `bundle` which has:
  - `universal_extension_1.0.0.zip`
  - `universal_extension_1.1.0.zip`
  - `universal_extension_1.2.0.zip`
  - `universal_extension_1.3.0.zip`

The plugin has logic to install and setup both of the dependencies. For the bundle, however, additional steps are required on the user’s end.

8.2.1.10.3.1 2.1- Installing `debugpy`

If the plugin detects `debugpy` is not installed in the active Python interpreter, it will go ahead and prompt the user to install it:



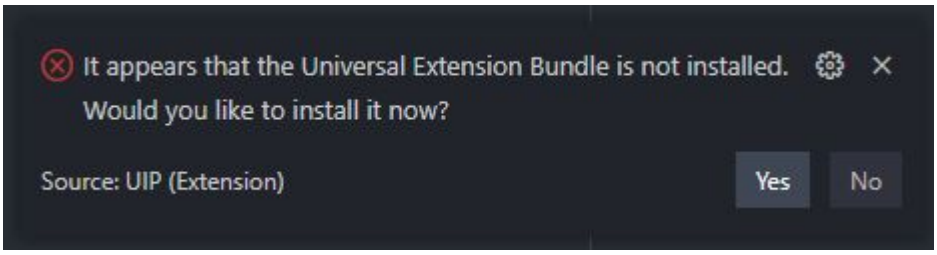
8.2.1.10.3.2 2.2 - Installing `universal_extension_bundle_1.2.0.zip`

The bundle zip is extracted and stored in:

- `C:\Users\<USER>\AppData\Roaming\Code\User\globalStorage\stonebranch.uip` (Windows)
- `/home/<USER>/.vscode-server/data/User/globalStorage/stonebranch.uip` (WSL using remote access)
- `/home/<USER>/.config/Code/User/globalStorage/stonebranch.uip` (Linux/Unix)

Once extracted, there should be a folder called `bundle` in `stonebranch.uip` folder with all the zip files for each of the API versions. Note, the bundle only needs to be installed once.

If the plugin detects the bundle is not present in `stonebranch.uip`, the plugin will show the following prompt:

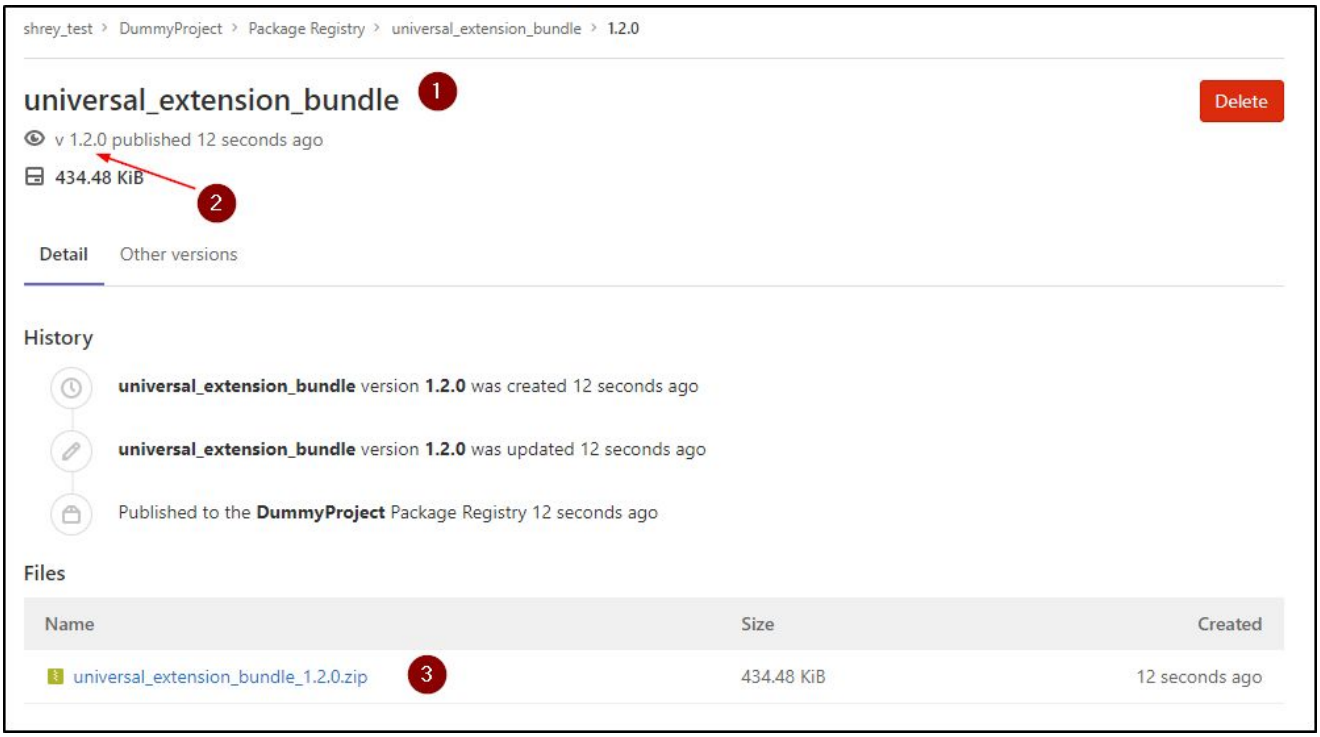


If the user selects `Yes`, then a dropdown will be shown to select the installation source.

- If the user selects `Path to universal_extension_bundle_1.2.0.zip`, a file picker dialog will show up and let the user select **only** a zip file.
- If the user selects `URL`, they can specify a download link to the bundle zip. Upon selecting `URL`, 3 additional inputs will be shown:
  - One for the URL that must start with either `http` or `https`.
  - One for the username, if applicable. **Can be empty.**
  - One for the password/token, if applicable. **Can be empty. User input will be masked out.**

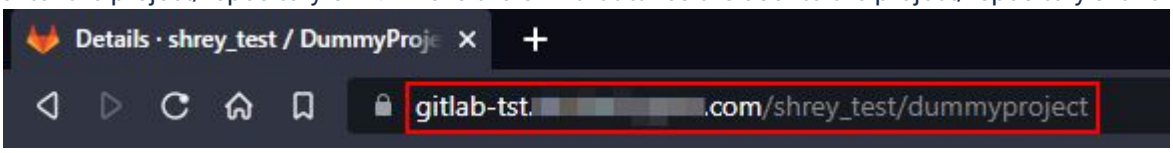
The plugin will attempt to download the file from the URL. If the URL does not point to a zip file, it will issue an error.

- If the user selects `Gitlab Package Registry`, they will need to specify a full URL to the project/repository whose Package Registry contains the bundle zip. For instance, assuming that the user has a project/repository called `DummyProject`,
  a. Upload the `universal_extension_bundle_1.2.0.zip` as a generic package to `DummyProject`'s package registry using the steps outline in GitLab Generic Packages Repository | GitLab. If successful, you should see something like this:



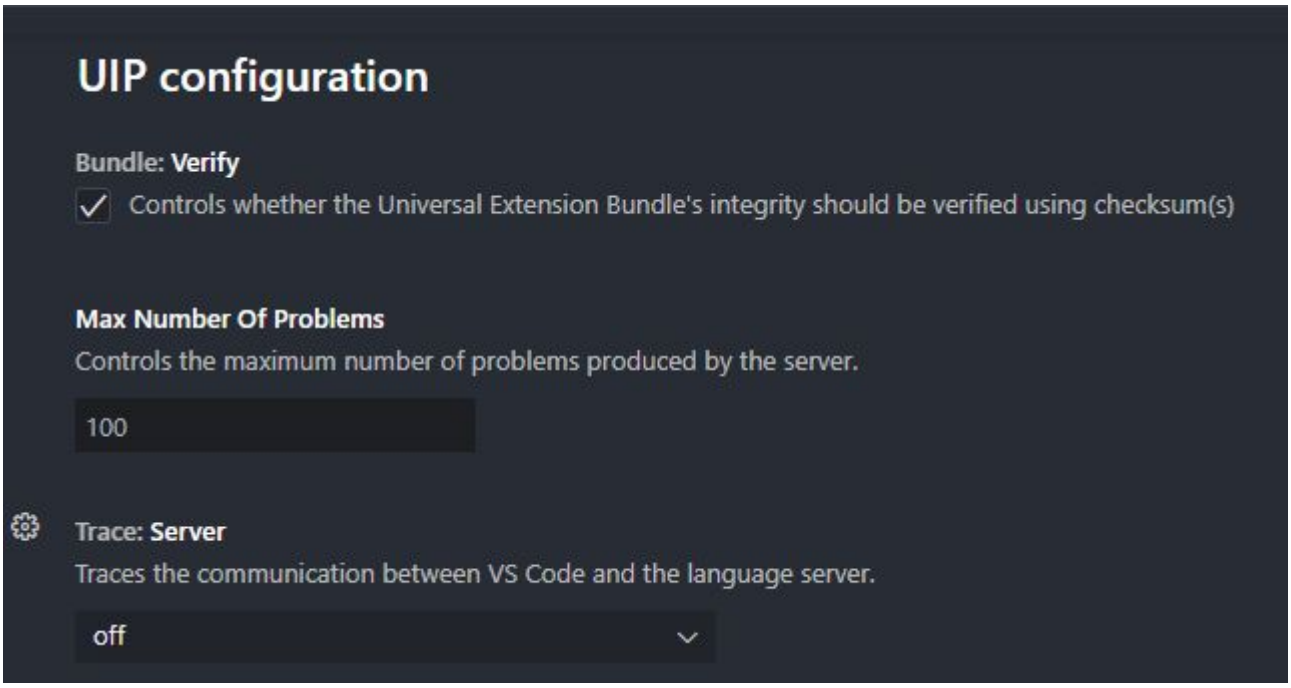
Note that `shrey_test` is a group, `DummyProject` is a project/repository. In the image above,
- #1 shows the package name. This does not have to be `universal_extension_bundle`, but it makes sense to name it that, and it makes the job of finding the actual zip easier for the plugin.
- #2 shows the package version. Once again, it doesn't have to be `1.2.0`, but it makes sense to keep it that.
- #3 shows the actual, uploaded bundle zip. This must be named `universal_extension_bundle_1.2.0.zip`

b. Assuming `Gitlab Package Registry` was clicked from the dropdown menu, the next prompt should be to enter the project/repository URL. This is the URL that takes the user to the project/repository's landing page:



c. Then the next prompt should ask for the Personal Access Token.
d. Depending on how the package was uploaded in *step 1*, two things can happen:
   i. The plugin can find the `universal_extension_bundle_1.2.0.zip` given that the package name is `universal_extension_bundle` (#1 in Figure 49) and package version is `1.2.0` (#2 in Figure 49)
   ii. The plugin cannot find the bundle zip because the package name and version are something other than `universal_extension_bundle` and `1.2.0.` If so, the plugin will show another dropdown with all the packages, and the user must select the one that contains `universal_extension_bundle_1.2.0.zip`

Assuming the zip file is available, the plugin will verify it using checksums before proceeding further. This is the default, but the user can turn off checksum verification in the settings:



Even if the verification is turned off, the plugin will still ensure the zip file consists of the `bundle` folder, which itself should contain the files mentioned previously.

8.2.1.10.3.3 2.3 - Uses of `universal_extension_bundle_1.2.0.zip`

Aside from allowing the debugger to accurately launch/debug Universal Extension tasks, the bundle zip also adds autocompletion/suggestion functionality to `extension.py`. For example, without the bundle installed, VSCode will complain that it cannot find the `universal_extension` module:

```
from universal_extension import UniversalExtension
from universal_extension import ExtensionResult
from universal_extension.deco import dynamic_choice_command
from universal_extension import logger
import os
import shutil
```

With the bundle installed,

```
from __future__ import (print_function)
from universal_extension import UniversalExtension
from universal_extension import ExtensionResult
from universal_extension.deco import dynamic_choice_command
from universal_extension import logger
import os
import shutil
```

8.2.1.10.4 3 - `configurations.yml`

`configurations.yml` (located in `.uip/debug/configurations.yml`) is what the developer uses to define their debug configurations. At the top level, it consists of two objects:

- `properties` (optional)
- `api` (required)

The `properties` object is used to define "global" options that apply to all debug configurations. As of now, it only consists of the `agent` object which only has the `log_level` property.

The `api` object is where the developer actually defines the debug configurations. Specifically, they can add configurations for:

- Dynamic choice commands using `dynamic_choice_commands` object
- Extension Start using `extension_start` object

`dynamic_choice_commands` is an object where the key is the name of a dynamic choice field and the value is an array of configuration entries.

For instance, in the figure below, `dynamic_choice_commands` consists of the `exclude_file_ext` and `file` dynamic choice fields. `exclude_file_ext` is a dynamic choice field with two debug entries (can have any number of entries >=1) uniquely identified by the `name` property.

```yaml
properties:
  agent:
    log_level: Info
api:
  dynamic_choice_commands:
    exclude_file_ext:
      - name: efe1
        log_level: Inherited
        fields:
          target_directory: /home/shreya/demo
      - name: efe2
        log_level: Trace
        fields:
          target_directory: /home/shreya/demo
    file:
      - name: list_all_files
        log_level: Inherited
        fields:
          exclude_file_ext:
            - ""
          target_directory: /home/shreya/demo
      - name: exclude_json_files
        log_level: Inherited
        fields:
          exclude_file_ext:
            - json
          target_directory: /home/shreya/demo
```

`extension_start` is simply an array of configuration entries:

```yaml
extension_start:
  - name: delete_file_msi
    log_level: Inherited
    runtime_dir: /home/shreya/demo
    fields:
      action:
        - Delete
      file:
        - file.msi
  - name: append_to_file_txt
    log_level: Inherited
    runtime_dir: /home/shreya/demo
    fields:
      action:
        - Append
      contents: |
        this is line 1
        this is line 2
        this is line 3
      file:
        - file.txt
      backup: true
```

Each debug configuration entry must have the `name` property, and it must be unique.

The `log_level` property is optional, and by default, it will have a value of `Inherited` which means it will inherit the value from the `agent`'s `log_level` defined in the `properties` object.

For `extension_start`, the `fields` object is required if there is at least 1 field defined. For a dynamic choice field under `dynamic_choice_commands`, the `fields` object is required if it has at least 1 dependent field.

`extension_start` has some additional properties besides `name, log_level, and fields` that are useful. It has:

- `runtime_dir` which can be used to set the runtime directory for the Extension instance. By default, the runtime directory is the currently opened VSCode workspace.
- `env_vars` which can be used to define environment variables that are available in `extension_start()` method (can be accessed using os.environ).
    - example:

```yaml
env_vars:
  test_var1: val1
  test_var2: val2
```

- `uip` object which maps to the `self.uip` object introduced in 7.2.0.0. The `uip` object consists of:

- `is_triggered` boolean property with an initial value of false. The developer can access this using `self.uip.is_triggered`. If it is set to true, then in `extension_start()`, the following additional values will be available for access:
  - `self.uip.trigger_id` which is a randomly generated uuid
  - `self.uip.monitor_id` which is a randomly generated uuid
- The `self.uip` object also has an `instance_id` property (accessed using `self.uip.instance_id`) which is always available. Once again, it is a randomly generated uuid.

> The `self.uip` object is only available for Universal Extension API levels `1.2.0` and greater. For levels `<= 1.1.0`, the `self.uip` object will not be available.

- `variables` object can be used to define task variables. The variables can be accessed using `self.uip.task_variables` dictionary.
  - example:

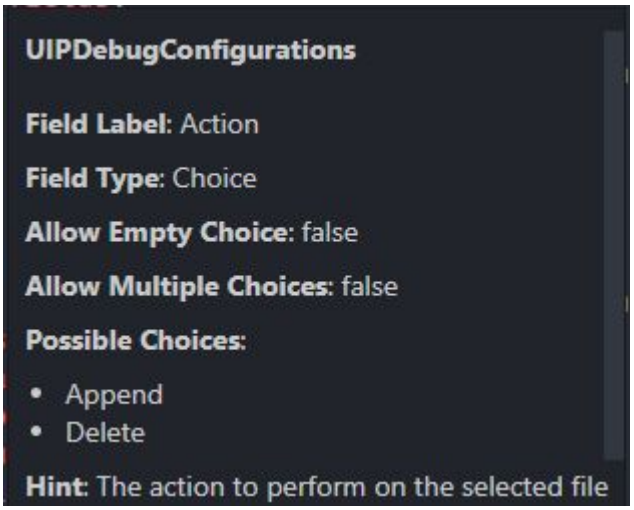
```
uip:
  is_triggered: false
  variables:
    var1: value1
    var2: 123
    var3: [4,5,6]
```

Note that:

- the type of the value of each variable is string. In other words, `self.uip.task_variables['var3']` will return `'[4,5,6]'` which is a `string` and **NOT** a list. This is enforced to keep the behavior consistent with how the controller passes in task variables.
- if `variables` object is not defined, the `task_variables` dictionary will not be made available UNLESS `template.json` has the `sendVariables` property set to `Local` in which case an empty dictionary will be passed in for `task_variables`.

In addition to supporting autocompletion as shown in the demo, `configurations.yml` also supports type checking (e.g. an integer value specified for a Text field will be flagged as an error).

Hovering over a field will reveal some information about it. See the example below:



`configurations.yml` supports all field types that the Controller supports. This includes:

- Plain text field
- Yaml text field
- Json text field
- Large text field
- Credential field
- Script field
    - Essentially a text field that accepts the full path to a file. The developer is responsible for creating the script file.
- Boolean field
- Integer field
- Float field
- Choice fields (dynamic and non-dynamic)
- Array fields

Here is an example below showing how to use the fields:

```yaml
fields:
  text_field_yaml: |
    obj1:
      prop1: val1
      prop2: val2
      prop3:
        - prop4: val4
        - prop5: false
        - prop6: 123
  text_field_plain: PLAINTEXTFIELD
  text_field_json: {
    "JSON": "TEXT",
    "a": [1,2,3],
    "b": false,
    "c": null
  }
  credential_field_complex:
    user: shreya
    password: test_pwd
    keyLocation: /usr/test/key
    passphrase: test_passphrase
    token: test_token
  script_field_complex: /usr/test
  array_field_complex:
    - a: 1
    - b: c
    - d: 123
  integer_field_simple: 55
  boolean_field_true_false: false
  dynamic_choice_field_complex:
    - sdf
  float_field_complex: 3.44
  choice_field_complex:
    - ANOTHER_CHOICE_VALUE
```

8.2.1.10.5 4 - Universal Extension API Levels

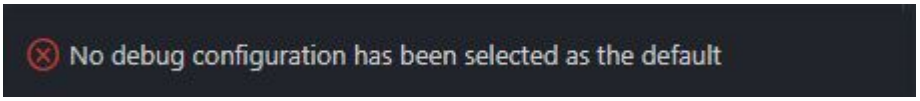
As shown in the demo, the developer can change the API Level they want to target using:

Clicking on `UE API: 1.3.0` in the screenshot above will allow the developer to easily change the API Level. No additional change is required.

8.2.1.10.6 5 - Launching/Debugging

Assuming `configurations.yml` is correctly configured, and the plugin dependencies are installed, the developer can start debugging by simply pressing `F5`.

If a configuration entry has not been select as a default in the “UIP DEBUG CONFIGURATIONS” view, the following error will be issued:



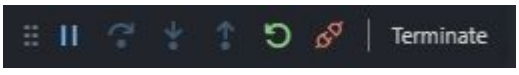
and the view will be opened automatically.

Assuming an entry has been selected as the default, pressing `F5` will start the debugging session as shown in the previous pages.

> The VSCode Python Debug Client attempts to connect to the `debugpy` server injected in the Extension instance. The `debugpy` server listens on `127.0.0.1` port `5678`. In most cases, this should be fine. If the developer is already using port `5678` for something else (or it’s being used by the OS/other program), the developer can change the port by modifying `launch.json` in the `.vscode` folder.

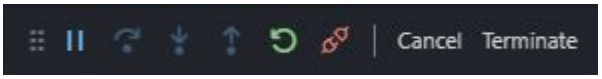
If a breakpoint has not been set, the debugger will start and finish without stopping. This is essentially the same as just simulating a launch.

The VSCode debug toolbar has also been enhanced to include a “Terminate” button:



This is used to force kill the Extension instance. This is useful if the Extension is stuck in an infinite loop (or in other blocking calls).

A “Cancel” button has also been added to simulate the Cancel command:



Clicking the “Cancel” button will call the `extension_cancel` method. Since the Cancel functionality does not apply to dynamic choice commands, it will not be shown when a dynamic choice command is being debugged. Furthermore, the Cancel functionality was not available in API Level `1.0.0`, and thus, it will not be shown if the Universal Extension API Level in the Status Bar shows `1.0.0`.

8.2.1.10.7 6 - Output Only Fields and Publishing Events

Output only fields can be updated as usual using the `update_output_fields` method from the `ui` module (or using `self.update_extension_status` method). For example,

```
def extension_start(self, fields):

    update_output_fields({
        'field1': time.time(),
        'field2': 'sample field value'
    })

    return ExtensionResult(
        rc=0,
        message='finished extension_start()',
        output_fields={
            'field2': 'new value'
        }
    )
```

Running `extension_start()` shown above will result in:

```
TERMINAL  PROBLEMS  OUTPUT  DEBUG CONSOLE                                UIP (CONSOLE)
[2022-08-08 14:48:13.291] Output field "field1" updated to 1659970093.287999
[2022-08-08 14:48:13.291] Output field "field2" updated to "sample field value"
[2022-08-08 14:48:13.299] Output field "field2" updated to "new value"
```

As you can see in the figure above, the status of all output only fields (when they are updated) is printed in the `UIP (CONSOLE)` output channel. `UIP (CONSOLE)` will update in real-time as the fields are updated.

Publishing events is a similar process. Running the following:

```
def extension_start(self, fields):

    publish(
        name='event_1',
        attributes={
            'attr1': 'val1',
            'attr2': 2
        },
        time_to_live=5
    )

    time.sleep(3)

    publish(
        name='event_2',
        attributes={
            'attr3': 'val2'
        },
        time_to_live=6
    )

    return ExtensionResult(
        rc=0,
        message='finished extension_start()'
    )
```

will result in

(Note that both the events were received about 3 seconds apart just as expected)

Even though publishing events is supported, it isn't all that useful since the concept of triggers and monitor does not apply to the plugin. They can be useful to verify the event is successfully configured/setup.

8.2.1.10.8 7 - Output Channels

There are four output channels that the Extension sends output to:

- UIP (STDOUT)
    - `Shift+Alt+1` for quick access
- UIP (STDERR)
    - `Shift+Alt+2` for quick access
- UIP (EXTENSION)
    - `Shift+Alt+3` for quick access

- UIP (CONSOLE)
    - `Shift+Alt+4` for quick access

All four channels will be updated in real-time for all Universal Extension API Levels except `1.0.0` (Output will still be available for `1.0.0`, but after the Extension finishes).

> In API Level `1.0.0`, the STDOUT and STDERR channels were not modified to flush output as soon as it was received. As a result, the output wasn't available until the buffer was full or until the Extension process had finished.

As the name implies, `UIP (STDOUT)` will contain all output the Extension sends to STDOUT. This includes the output of all `print` statements.

As the name implies, `UIP (STDERR)` will contain all output the Extension sends to STDERR. This includes the output of the logger (e.g. `logger.info/self.log.info` etc.)

`UIP (EXTENSION)` will show the output of `ExtensionResult` returned by `extension_start()` or a dynamic choice command. All possible parameters of `ExtensionResult` will be rendered. For instance, the following

```
def extension_start(self, fields):

    return ExtensionResult(
        rc=0,
        message='finished extension_start()',
        unv_output='Sample unv output'
    )
```

will result in

`UIP (CONSOLE)` will contain miscellaneous output that is still useful, but doesn't fit in STDOUT/STDERR/EXTENSION. As shown in the previous section, it contains the output of Output Only Fields and Events.

8.2.1.10.9 8 - Known Limitations

8.2.1.10.9.1 8.1 - Uncaught Exceptions

While debugging, if an uncaught exception occurs (e.g. `a = 1/0`), VSCode sometimes opens the `universal_extension.py` base class file with some additional pop-ups. This can be prevented by unchecking the `Uncaught Exceptions` option in the Breakpoints section:

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8.2.2 Code Completion Functionality Demonstration

The context aware code completion functionality is shown in the following pages:

Title	Description
Code Completion Capabilities	Introduction to the plugin's code completion capabilities.
Demo Requirements	List of required items to follow along with the demo.
`extension_start` Fields Code Completion	Demonstrating code completion for `extension_start` fields.
`dynamic_choice_command` Fields Code Completion	Demonstrating code completion for `dynamic_choice_command` fields.
`dynamic_command` Fields Code Completion	Demonstrating code completion for `dynamic_command` fields.

8.2.2.1 Code Completion Capabilities

8.2.2.1.1 Capabilities

The VSCode API provides support for integrating custom context-aware code completion logic. The UIP VSCode Plugin could take advantage of this to greatly enhance the Universal Extension development experience. The benefits would include:

- Increased efficiency in initial coding effort
- Reduce bugs caused by misspelled items in extension code that do not match the associated items in the Extension template.
- Improved user experience

Specifically, the new functionality provides:

- Code completion for field names when referenced in a `dynamic_choice_command`, `dynamic_command`, and `extension_start`.
- Code completion for Dynamic Choice Command declarations.
- Code completion for Dynamic Command declarations.

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8.2.2.2 Demo Requirements

8.2.2.2.1 Requirements

To follow along with the demo, download the `CodeCompletionDemo.zip` Extension and extract it to a known location.

CodeCompletionDemo.zip

The demo assumes the Extension has been pushed out to the Controller. This can be done using the `UIP: Push All` command.

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8.2.2.3 extension_start Fields Code Completion

8.2.2.3.1 Introduction

On this page, we will cover the following:

1. Showing the code completion for the `fields` parameter in `extension_start.`
2. Adding a new credential field and showing the update code completion menu.

It is assumed the `CodeCompletionDemo` Extension has already been pushed to the Controller.

8.2.2.3.2 1 - Showing the code completion for the `fields` parameter in `extension_start`

The `CodeCompletionDemo` Extension already has a few fields which are ready to be used:

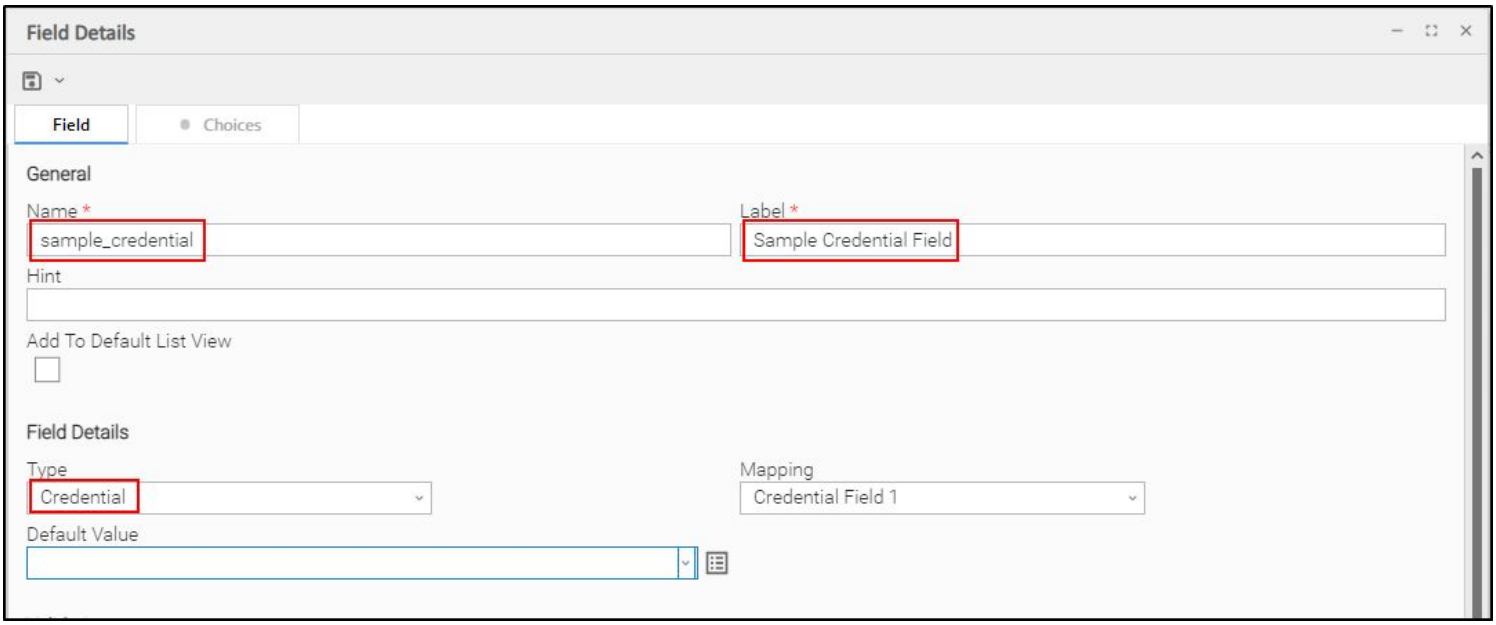
```
def extension_start(self, fields):
    """Required method that serves as the starting point for work performed
    for a task instance.

    Parameters
    ----------
    fields : dict
        populated with field values from the associated task instance
        launched in the Controller

    Returns
    -------
    ExtensionResult
        once the work is done, an instance of ExtensionResult must be
        returned. See the documentation for a full list of parameters that
        can be passed to the ExtensionResult class constructor
    """


    # Get the value of the 'action' field
    action = fields.get('action', [""])[0]

    if action.lower() == 'print':
        # Print to standard output ...
        print("Hello STDOUT!")
    else:
        # Log to standard error ...
        logger.info('Hello STDERR!')
```

As can be seen in the figure above, typing `fields[` presents a list of available field names that is filtered down further as additional characters are typed.

Cycling through the fields reveals additional information such as `Field Label, Field Type, Hint, Dependent Fields` etc.

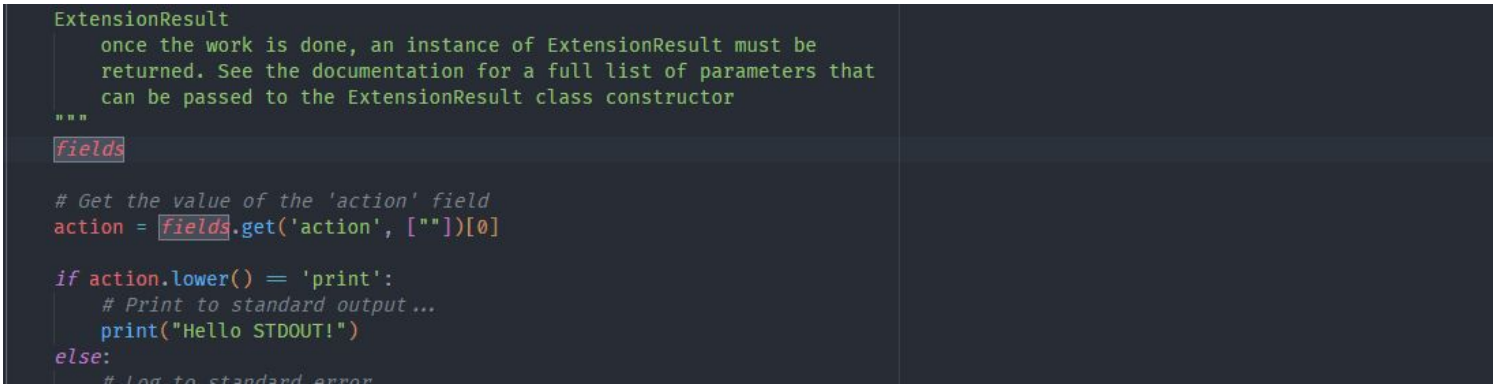
8.2.2.3.3 2 - Adding a new credential field and showing the updated code completion menu

The code completion logic is responsive to changes in `template.json.` To show this, first add a new credential field on the Controller side as shown below:



Using `UIP: Pull`, update the local `template.json`.

Assuming `template.json` is up-to-date, typing `fields[` will now show the new `sample_credential` field:



Additionally, as shown above, the specific component parts (e.g. `keyLocation, passphrase, password, user`) of a credential field can be accessed by typing a second `[` following `fields["sample_credential"]`

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8.2.2.4 dynamic_choice_command Fields Code Completion

8.2.2.4.1 Introduction

On this page, we will cover the following:

1. Showing the code completion for dynamic choice command declarations.

2. Showing the dynamic choice command specific fields.

8.2.2.4.2 1 - Showing the code completion for dynamic choice command declarations

Shown below is the code completion menu when using the `dynamic_choice_command` decorator:

```
def __init__(self):
    """Initializes an instance of the 'Extension' class
    """
    # Call the base class initializer
    super(Extension, self).__init__()

def test(self, fields):
    pass

def extension_start(self, fields):
    """Required method that serves as the starting point for work performed
    for a task instance.

    Parameters
```

As expected, only the dynamic choice fields are shown.

8.2.2.4.3 2 - Showing the dynamic choice command specific fields

In the previous page, the code completion menu when accessing the `fields` within `extension_start` showed all the fields as expected.

With `dynamic_choice_command` 's however, only its dependent fields should be shown. The code completion logic takes this into account as shown below:

```
    super(Extension, self).__init__()

@dynamic_choice_command("sample_dynamic_choice_2")
def test(self, fields):

    pass

def extension_start(self, fields):
    """Required method that serves as the starting point for work performed
    for a task instance.

    Parameters
```

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8.2.2.5 dynamic_command Fields Code Completion

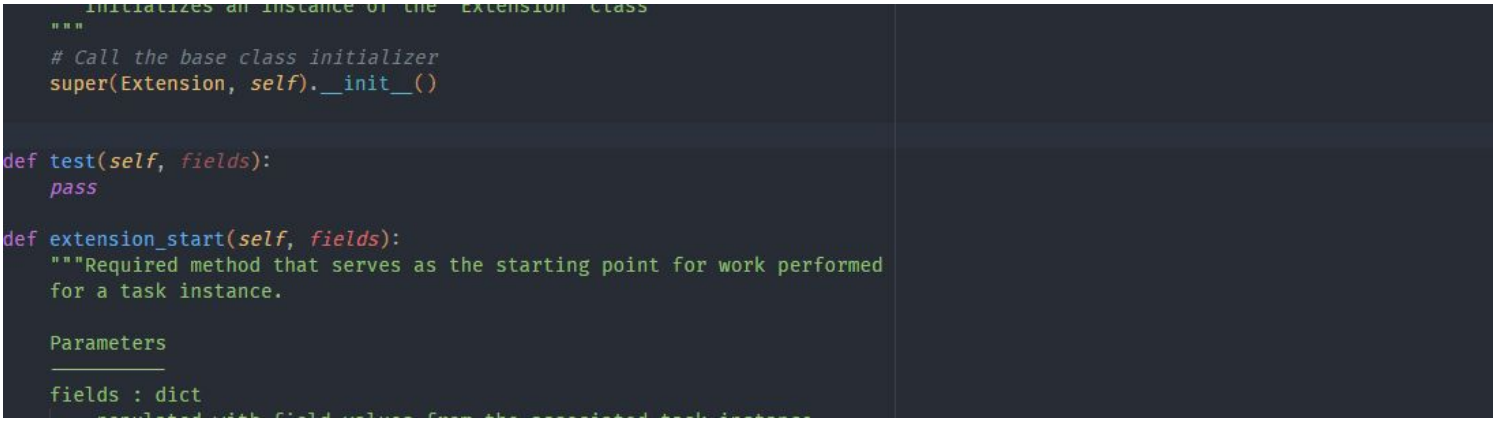
8.2.2.5.1 Introduction

On this page, we will cover the following:

1. Showing the dynamic command specific fields.

2. Adding a new SAP Connection field and showing the update code completion menu.

8.2.2.5.2 1 - Showing the dynamic command specific fields



The GIF above shows the code completion menu when using the `dynamic_command` decorator. Notice that relevant information such as `Supported Statuses, Timeout, Execution Option, and Asynchronous` is also shown.

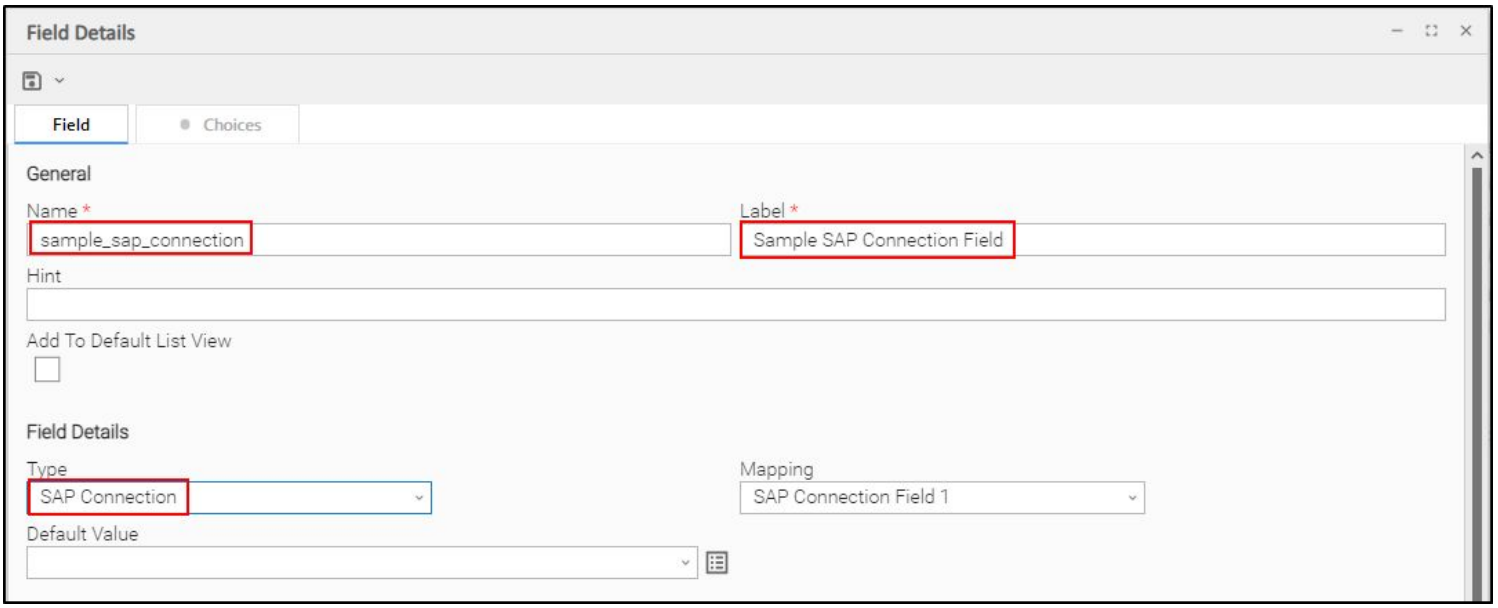
The `sample_outprc_dynamic_cmd` does not depend on any fields, which is why typing `fields[` results in zero suggestions.

8.2.2.5.3 2 - Adding a new SAP Connection field and showing the update code completion menu.

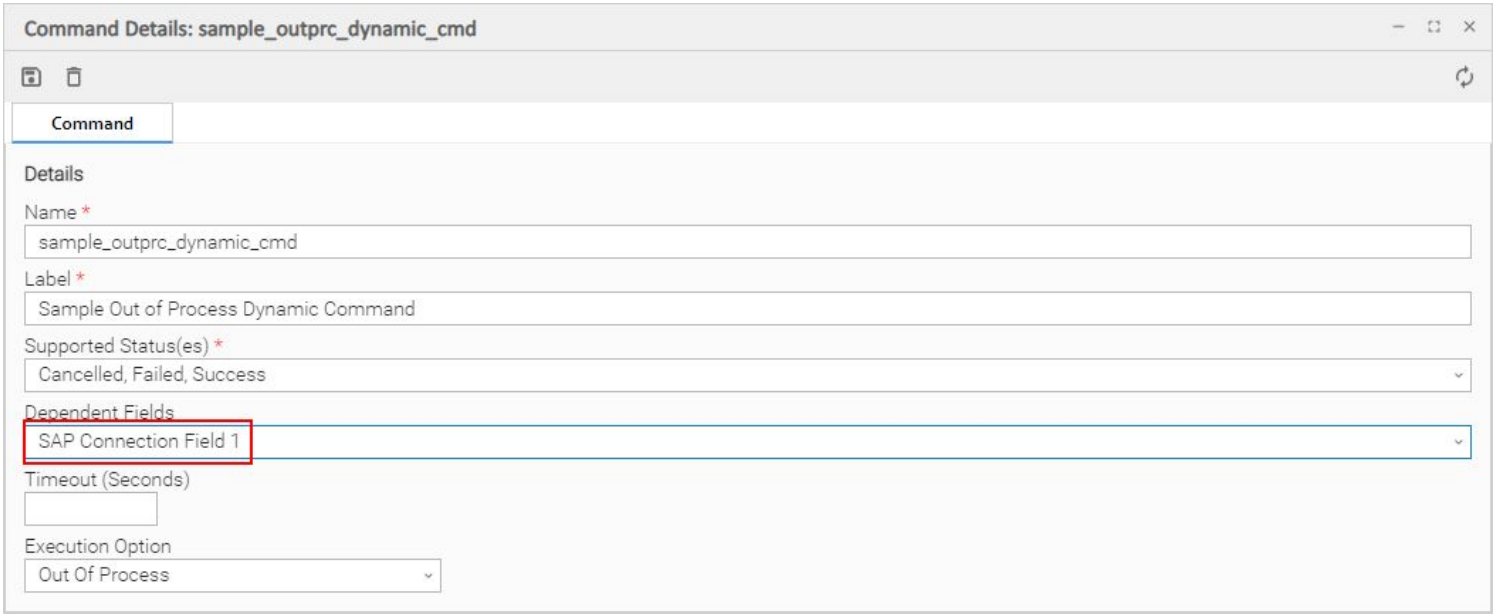
Let's add a new SAP Connection field and add it as a dependent field of `sample_outprc_dynamic_cmd` to demonstrate:

- The code completion is responsive to changes in `template.json.`
- The code completion menu specific to a SAP Connection type field.

Go ahead and add a new SAP connection field as shown below:



Add the new field as a dependency of `sample_outprc_dynamic_cmd:`



Execute `UIP: Pull` to update the local `template.json`.

Assuming the local template has been updated, typing `fields[` will now show the new `sample_sap_connection` field:

```
@dynamic_command("sample_outprc_dynamic_cmd")
def test(self, fields):

    pass

def extension_start(self, fields):
    """Required method that serves as the starting point for work performed
    for a task instance.

    Parameters
    ----------
    fields : dict
        populated with field values from the associated task instance
        launched in the Controller

    Returns
    -------
    ExtensionResult
        once the work is done, an instance of ExtensionResult must be
```

Additionally, as shown above, the specific component parts (e.g. `sap_ashost, sap_client, sap_connection_type etc.`) of a SAP Connection field can be accessed by typing a second `[` following `fields["sample_sap_connection"]`

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9 API Reference

Universal Extension APIs

9.1 Universal Extension 1.0.0 API

9.1.1 Universal Extension Package

9.1.1.1 UniversalExtension class

Base class for Stonebranch Universal Extension module implementations

9.1.1.1.1 Methods

`extension_start` (*fields*)

This method must be overridden by the custom Extension class that derives from the UniversalExtension class. It is called by UniversalExtension base class in response to a `JSS-LAUNCH` message sent from the Controller.

This is essentially the `main()` function for an Extension implementation and is the starting point for work that will be performed. The *fields* parameter passes in a dictionary of Extension instance fields that were defined in the Extension template.

Input	Parameters: • *fields*: dict The *fields* parameter passes in a dictionary of implementation-dependent fields, which correspond to the Universal Template field names in the Controller's Template definition for the associated task.
Output	ExtensionResult

`update_extension_status` (*fields*)

This method can be called at any time by the Extension instance. It is used to propagate state changes back to the associated extension instance in the Controller. Essentially, any/all output fields defined in the associated Extension Template can be updated using this method.

This method results in an `ESS-STATUS-UPDATE` message being sent from the Worker process to the UAG Extension Manager, followed by a `JSS-STATUS(JOB UPDATE)` message being sent from UAG Extension Manager to the Controller (via OMS server).

Input	Parameters: • *fields*: dict The *fields* parameter expects a dictionary of output fields to be sent back to the controller for the associated Extension instance. Field names are implementation dependent and correlate with the Universal Template field names in the Controller's Template definition for the associated task.
Output	None

9.1.1.2 ExtensionResult class

class `ExtensionResult` (***kwargs*)

The constructor for the ExtensionResult class takes different forms depending on the context. See the notes below.

Extension Start

The form of the ExtensionResult constructor when instantiated in the context of *Extension Start*, is as follows:

`ExtensionResult(rc=0, message='', output_fields=None, unv_output=None, **kwargs)`

Parameter	Type	Default	Description
rc	*int, optional*	0	This parameter represents the return code of the task instance that initiated the **extension_start** operation. The value returned is implementation-defined and therefore left up to the Extension developer. The value can be used by the "return code processing" of the task instance in the Controller to determine if the Extension task instance is perceived as completing with **Success** or **Failed**.
message	*str, optional*	Empty string	This parameter specifies a short status string (error message or success message) to be sent to the "Status Description" field on the task instance form.
output_fields	*dict, optional*	None	Dictionary containing output fields. The parameter is a dictionary of output fields to be sent back to the controller for the associated Extension instance. Field names are implementation dependent and correlate with the Universal Template field names in the Controller's Template definition.
unv_output	*str, optional*	None	This parameter specifies the data that will be returned to the Controller for the command execution. It is interpreted as a UTF-8 encoded text object. If the output parameter is True, the output_data will be persisted in the Controller as a record under table ops_exec_output, and appearing as Universal Command output type from the task instance Output tab.

Choice Command

The form of the ExtensionResult constructor when instantiated in the context of *Choice Command*, is as follows:

```
ExtensionResult(rc=0, message='', values=None, **kwargs)
```

Parameter	Type	Default	Description
rc	*int, optional*	0	This parameter represents the return code of the 'choice' operation and determines whether the command is perceived as completing with success or failure by the Controller. A value of 0 indicates success. All other values indicate an error condition and will be ignored by the Controller for form field population. However, the Controller will log the command response. The non-zero value used to represent the error condition is implementation defined and therefore left up to the extension developer.
message	*str, optional*	Empty string	This parameter allows the extension to pass a completion message back to the Controller. The message will be logged by the Controller.
values	*list, optional*	Empty List	This parameter specifies a list of string values to be returned to the Controller and used to populate the associated dynamic choice field on the Extension task form.

Dynamic Command

The form of the ExtensionResult constructor when instantiated in the context of *Dynamic Command*, is as follows:

```
ExtensionResult(rc=0, message='', output=False, output_data=None, output_name=None, **kwargs)
```

Parameter	Type	Default	Description
rc	*int, optional*	0	This parameter represents the return code of the Dynamic Command operation and determines whether the command is perceived as completing with success or failure by the Controller. A value of 0 indicates success. All other values indicate an error condition and the command result will not be added to the Controller's Output tab. However, the Controller will log the command response. The non-zero value used to represent the error condition is implementation defined and therefore left up to the extension developer.
message	*str, optional*	Empty string	The **message** parameter specifies a short status string (error message or success message) that will be logged by the Controller.
output	*bool, optional*	False	This parameter is a Boolean value that specifies if the command produced output that should be persisted and displayed under the task instance Output tab in the Controller task instance associated with the dynamic command invocation. **The default value is False.** This flag allows distinguishing between a command that does not produce output and a command that produces output but the output returned was empty.
output_data	*str, optional*	None	This parameter specifies the data that will be returned to the Controller for the command execution. It is interpreted as a UTF-8 encoded text object. If the **output** attribute is **True**, the **output_data** will be persisted in the Controller as a record under table ops_exec_output, and appearing as **Universal Command** output type from the task instance **Output** tab. **The default value is None.**

output_name	*str, optional*	None	This parameter is used to provide a custom name for the associated output data. The **output_name** (if provided) will be used in the presentation of the **output_data** by the Controller.

9.1.1.3 ExtensionLogger class

class `ExtensionLogger` (*name*)

Class for providing logging functionality for Universal Extensions. Do not instantiate this class directly. UniversalExtension instantiates this class via a call to the logging.getLogger API call.

9.1.1.4 Universal Extension Decorator

9.1.1.4.1 Methods

`dynamic_choice_comman d` (*field_name*)

Register a dynamic choice command.

Input	Parameters: • *field_name:* str The field name.
Output	ExtensionResult

`dynamic_command` (*command_name*)

Register a dynamic command.

Input	Parameters: • *command_name:* str The name of the dynamic command.
Output	ExtensionResult

9.2 Universal Extension 1.1.0 API

The Universal Extension 1.1.0 API was delivered with Universal Agent 7.1.0.0.

See the pages below for a description of the classes and methods available in the API.

Pages
UniversalExtension Class (1.1.0)
ExtensionResult Class (1.1.0)
ExtensionLogger Class

Pages
Universal Extension Decorators (1.1.0)

9.2.1 UniversalExtension Class (1.1.0)

universal_extension.universal_extension API documentation

9.2.1.1 Classes

`class UniversalExtension`
Base clase for Stonebranch Universal Extension module implementations

9.2.1.1.1 Methods

`extension_cancel(self)`
Implement in derived class.

`extension_start(self, fields)`
Implement in derived class.

`update_extension_status(self, fields)`
Propagate state changes back to the associated extension instance in the Controller.

- Can be called at any time by an Extension instance.
- Any/all output fields defined in the associated Extension Template can be updated using this method.

9.2.1.1.2 Parameters

`fields` : `dict`
The fields parameter expects a dictionary of output fields to be sent back to the controller for the associated Extension instance. Field names are implementation dependent and correlate with the Universal Template field names in the Controller's Template definition for the associated task.

9.2.1.1.3 Returns

`None`

9.2.1.1.4 Examples

```
>>> my_ext = MyExt() # my_ext is an instance of a (derived) extension class called MyExt
>>> fields = {"foo": "bar"}
>>> my_ext.update_extension_status(fields)
```

9.2.2 ExtensionResult Class (1.1.0)

universal_extension.extension_result API documentation

9.2.2.1 Classes

```
class ExtensionResult
(**kwargs)
```

Depending on the context of the initialization, different parameters need to be passed to the constructor. See the notes below.

Note

The form of the ExtensionResult constructor when instantiated in the context of **Dynamic Command**, is as follows:

Constructor Signature

*(rc = 0, message = '', output = False, output_data = None, output_name = None, call_frame = None, **kwargs)*

9.2.2.1.1 Parameters

`rc` : `int`, optional

This parameter represents the return code of the Dynamic Command operation and determines whether the Extension task instance is perceived as completing as Success or Failed by the Controller.
A value of 0 indicates success. All other values indicate an error condition and result in a status of Failed in the Controller. The non-zero value used to represent the error condition is implementation defined and therefore left up to the extension developer.

The ExtensionResult class sets a default value of 0.

`message` : `str`, optional

This parameter allows the extension to pass a completion message back to the Controller. If rc is set to 0, the message will be considered informational and will be logged by the Controller.
If rc is non-zero, the message will be considered an error message and will be displayed to the user on the task instance form.

The default value is an empty string.

`output` : `bool`, optional

This parameter specifies if the command produced output that should be persisted and displayed under the task instance Output tab in the Controller task instance associated with the dynamic command invocation.

The default value is False.

`output_data` : `str`, optional
This parameter specifies the data that will be returned to the Controller for the command execution. It is interpreted as a UTF-8 encoded text object.

If the output attribute is True, the output_data will be persisted in the Controller as a record under table ops_exec_output, and appearing as Universal Command output type from the task instance Output tab.

The default value is None.

`output_name` : `str`, optional
This attribute is used to provided a custom name for the associated output data. The output_name (if provided) will be used in the presentation of the output_data by the Controller.

The default value is None.

`call_frame` : `frame`, optional
Frame of a function call where previous activity of interest occured.

The default value is None.

Note

The form of the ExtensionResult constructor when instantiated in the context of **Choice Command**, is as follows:

Constructor Signature

*(rc = 0, message = '', values = None, call_frame = None, **kwargs)*

9.2.2.1.2 Parameters

`rc` : `int`, optional
This parameter represents the return code of the 'choice' operation and determines whether the command is perceived as completing with success or failure by the Controller. A value of 0 indicates success. All other values indicate an error condition and will be ignored by the Controller for form field population. However, the Controller will log the commnd response. The non-zero value used to represent the error condition is implementation defined and therefore left up to the extension developer.

The ExtensionResult class sets a default value of 0 to the rc attribute.

`message` : `str`, optional
This parameter allows the extension to pass a completion message back to the Controller. The message will be logged by the Controller.

The default value is an empty string.

`values` : `list`, optional
This parameter specifies a list of string values to be returned to the Controller and used to populate the associated dynamic choice field on the Extension task form.

The default value is an empty list.

`call_frame` : `frame`, optional
frame of the function call where previous activity of interest occured, by default None

Note

The form of the ExtensionResult constructor when instantiated in the context of **Extension Start**, is as follows:

Constructor Signature

*(rc = 0, message = '', output_fields = None, unv_output = None, call_frame = None, **kwargs)*

9.2.2.1.3 Parameters

`rc` : `int`, optional
This parameter represents the return code of the extension_start operation. The associated Universal Task instance in the Controler can use this value to determine the completion status of the Extension instance. The value is implementation defined and therefore left up to the extension developer.

The ExtensionResult class sets a default value of 0.

`message` : `str`, optional
This parameter allows the extension to pass a completion message back to the Controller. If rc is set to 0, the message will be considered informational and will be logged by the Controller.
If rc is non-zero, the message will be considered an error message and will be displayed to the user on the task instance form.

The default value is an empty string.

`output_fields` : `dict`, optional
Dictionary containing output fields.

The default None.

`unv_output` : `str`, optional
The value for this parameter is considered the payload of the task execution. It appears on the task instance Output tab as Universal output type.

The default value is None.

`call_frame` : `frame`, optional
Frame of a function call where previous activity of interest occured.

The default value is None.

9.2.3 ExtensionLogger Class

universal_extension.logger API documentation

9.2.3.1 Global variables

`logger`
global `logger` instance that can be imported in other modules.

9.2.3.1.1 Examples

```
>>> # This example demonstrates how to import the global logger in other Python modules.

>>> # Assume that logger is imported below in test.py that resides in the same folder as
```

```
extension.py
>>> from universal_extension import logger
>>> logger.info('sample info message from test.py')
>>> logger.warning('sample warning message from test.py')
>>> logger.critical('sample critical message from test.py')
```

9.2.3.2 Classes

```
class ExtensionLogger
(name)
```

Class for providing logging functionality for Universal Extensions. Do not instantiate this class directly. UniversalExtension instantiates this class via a call to the `logging.getLogger` API call. See the example above for instructions on obtaining the `logger` instance.

The following log levels are officially supported:

- CRITICAL
- ERROR
- WARNING
- INFO
- DEBUG

Note

In addition to the levels listed above, there is another level, **TRACE**, which is used by the Universal Extension internal API. It is **NOT** available for use in developing Extensions.

9.2.4 Universal Extension Decorators (1.1.0)

universal_extension.deco.command API documentation

9.2.4.1 `Command`

```
dynamic_command(command_name)
```

Register a dynamic command.

9.2.4.1.1 Parameters

`command_name` : `str`
the command name

9.2.4.1.2 Returns

`None`

universal_extension.deco.choice API documentation

9.2.4.2 `Choice`

`dynamic_choice_command(field_name)`
Register a dynamic choice command.

9.2.4.2.1 Parameters

`field_name` : `str`
the field name

9.2.4.2.2 Returns

`None`

9.3 Universal Extension 1.2.0 API

The Universal Extension 1.2.0 API was delivered with Universal Agent 7.2.0.0.

See the pages below for a description of the classes and modules available in the API.

Pages
UniversalExtension Class
ExtensionResult Class
Universal Extension Decorators
Logging Module
Event Module
UI Module

9.3.1 UniversalExtension Class

universal_extension.universal_extension API documentation

9.3.1.1 Classes

`class UniversalExtension`
Base class for Stonebranch Universal Extension module implementations

9.3.1.1.1 Instance variables

`uip`
can be used to access the following properties of an Extension task instance:

- `task_variables` : `dict`
- `is_triggered` : `bool`
- `trigger_id` : `str`
- `instance_id` : `str`
- `monitor_id` : `str`

9.3.1.1.2 Examples

```
>>> ops_task_id = self.uip.task_variables['ops_task_id']
>>> is_triggered = self.uip.is_triggered
>>> trigger_id = self.uip.trigger_id
>>> instance_id = self.uip.instance_id
>>> monitor_id = self.uip.monitor_id
```

9.3.1.1.2.1 Methods

`extension_start(self, fields)`
Serves as the starting point for work that will be performed for a task instance. It must be implemented in the derived class.

9.3.1.1.3 Parameters

`fields` : `dict`
populated with field values from the associated task instance launched in the Controller

9.3.1.1.4 Returns

`ExtensionResult`
once the work is done, an instance of ExtensionResult must be returned. See the ExtensionResult documentation for a full list of parameters that can be passed to the class constructor

`extension_cancel(self)`

Optional method that allows the Extension to do any cleanup work before terminating. To use it, implement in the derived class.

9.3.1.1.5 Parameters

None

9.3.1.1.6 Returns

`None`

`update_extension_status(self, fields)`

Propagate state changes back to the associated extension instance in the Controller.

- Can be called at any time by an Extension instance.
- Any/all output fields defined in the associated Extension Template can be updated using this method.

9.3.1.1.7 Parameters

`fields` : `dict`

The fields parameter expects a dictionary of output fields to be sent back to the controller for the associated Extension instance. Field names are implementation dependent and correlate with the Universal Template field names in the Controller's Template definition for the associated task.

9.3.1.1.8 Returns

`None`

9.3.1.1.9 Examples

```
>>> fields = {"foo": "bar"}
>>> self.update_extension_status(fields)
```

9.3.2 ExtensionResult Class

universal_extension.extension_result API documentation

9.3.2.1 Classes

```
class ExtensionResult
(**kwargs)
```

Depending on the context of the initialization, different parameters need to be passed to the constructor. See the notes below.

Note

The form of the ExtensionResult constructor when instantiated in the context of **Dynamic Command**, is as follows:

Constructor Signature

*(rc = 0, message = '', output = False, output_data = None, output_name = None, call_frame = None, **kwargs)*

9.3.2.1.1 Parameters

`rc` : `int`, optional

This parameter represents the return code of the Dynamic Command operation and determines whether the Extension task instance is perceived as completing as Success or Failed by the Controller.
A value of 0 indicates success. All other values indicate an error condition and result in a status of Failed in the Controller. The non-zero value used to represent the error condition is implementation defined and therefore left up to the extension developer.

The ExtensionResult class sets a default value of 0.

`message` : `str`, optional

This parameter allows the extension to pass a completion message back to the Controller. If rc is set to 0, the message will be considered informational and will be logged by the Controller.
If rc is non-zero, the message will be considered an error message and will be displayed to the user on the task instance form.

The default value is an empty string.

`output` : `bool`, optional

This parameter specifies if the command produced output that should be persisted and displayed under the task instance Output tab in the Controller task instance associated with the dynamic command invocation.

The default value is False.

`output_data` : `str`, optional

This parameter specifies the data that will be returned to the Controller for the command execution. It is interpreted as a UTF-8 encoded text object.

If the output attribute is True, the output_data will be persisted in the Controller as a record under table ops_exec_output, and appearing as Universal Command output type from the task instance Output tab.

The default value is None.

`output_name` : `str`, optional

This attribute is used to provide a custom name for the associated output data. The output_name (if provided) will be used in the presentation of the output_data by the Controller.

The default value is None.

9.3.2.1.2 Example

```
>>> @dynamic_command('reset_environment')
>>> def reset_environment(self, fields):
>>>     # Implementation omitted
>>>     return ExtensionResult(
...         message = "Message: Hello from dynamic command 'reset_environment'!",
...         output = True,
...         output_data = 'The environment has been reset.',
...         output_name = 'DYNAMIC_OUTPUT'
...     )
```

Note

The form of the ExtensionResult constructor when instantiated in the context of **Choice Command**, is as follows:

Constructor Signature

*(rc = 0, message = '', values = None, call_frame = None, **kwargs)*

9.3.2.1.3 Parameters

`rc` : `int`, optional

This parameter represents the return code of the 'choice' operation and determines whether the command is perceived as completing with success or failure by the Controller. A value of 0 indicates success. All other values indicate an error condition and will be ignored by the Controller for form field population. However, the Controller will log the command response. The non-zero value used to represent the error condition is implementation defined and therefore left up to the extension developer.

The ExtensionResult class sets a default value of 0 to the rc attribute.

`message` : `str`, optional

This parameter allows the extension to pass a completion message back to the Controller. The message will be logged by the Controller.

The default value is an empty string.

`values` : `list`, optional

This parameter specifies a list of string values to be returned to the Controller and used to populate the associated dynamic choice field on the Extension task form.

The default value is an empty list.

9.3.2.1.4 Example

```
>>> @dynamic_choice_command("primary_choice_field")
>>> def primary_choice_command(self, fields):
>>>     # Implementation omitted
>>>     return ExtensionResult(
...         rc = 0,
```

```
...         message = "Values for choice field: 'primary_choice_field'",
...         values = ["Start", "Pause", "Stop", "Build", "Destroy"]
...         )
```

Note

The form of the ExtensionResult constructor when instantiated in the context of **Extension Start**, is as follows:

Constructor Signature

*(rc = 0, message = '', output_fields = None, unv_output = None, call_frame = None, **kwargs)*

9.3.2.1.5 Parameters

`rc` : `int`, optional
: This parameter represents the return code of the extension_start operation. The associated Universal Task instance in the Controler can use this value to determine the completion status of the Extension instance. The value is implementation defined and therefore left up to the extension developer.

  The ExtensionResult class sets a default value of 0.

`message` : `str`, optional
: This parameter allows the extension to pass a completion message back to the Controller. If rc is set to 0, the message will be considered informational and will be logged by the Controller.
  If rc is non-zero, the message will be considered an error message and will be displayed to the user on the task instance form.

  The default value is an empty string.

`output_fields` : `dict`, optional
: Dictionary containing output fields.

  The default None.

`unv_output` : `str`, optional
: The value for this parameter is considered the payload of the task execution. It appears on the task instance Output tab as Universal output type.

  The default value is None.

9.3.2.1.6 Example

```
>>> def extension_start(self, fields):
>>>     # Implementation omitted
>>>     return ExtensionResult(
...         unv_output = "extension_start() finished successfully",
...         rc = 0
...         )
```

9.3.3 Universal Extension Decorators

universal_extension.deco.choice API documentation

9.3.3.1 `Choice`

`dynamic_choice_command(field_name)`
Decorator that can be used to register a dynamic choice command.

9.3.3.1.1 Parameters

`field_name` : `str`
the value specified must match the field name of the associated Dynamic Choice field in the Controller's Universal Template

9.3.3.1.2 Returns

`None`

9.3.3.1.3 Examples

```
>>> @dynamic_choice_command("primary_choice_field")
>>> def primary_choice_command(self, fields):
>>>     # Implementation omitted
```

universal_extension.deco.command API documentation

9.3.3.2 `Command`

`dynamic_command(command_name)`
Decorator that can be used to register a dynamic command.

9.3.3.2.1 Parameters

`command_name` : `str`
the value specified must match the command name of the associated Dynamic Command defined in the Controller's Universal Template

9.3.3.2.2 Returns

`None`

9.3.3.2.3 Examples

```
>>> @dynamic_command("reset_environment")
>>> def reset_environment(self, fields):
>>>     # Implementation omitted
```

9.3.4 Logging Module

universal_extension.logger API documentation

9.3.4.1 Global variables

`logger`

global `logger` instance that can be imported in other modules.

The following log levels are officially supported:

- `CRITICAL`
- `ERROR`
- `WARNING`
- `INFO`
- `DEBUG`

Note

In addition to the levels listed above, there is another level, `TRACE`, which is used by the internal UniversalExtension API. It is **NOT** available for use in developing Extensions.

9.3.4.2 Examples

```
>>> # This example demonstrates how to import the global logger in other Python modules.
>>> # Assume that logger is imported below in test.py that resides in the same folder as extension.py
>>> from universal_extension import logger
>>> logger.info('sample info message from test.py')
```

9.3.5 Event Module

universal_extension.event API documentation

9.3.5.1 Functions

`publish(name, attributes, time_to_live=None)`
Publish a Universal Event to the associated Universal Controller.

- Can be called at any time by an Extension instance.
- Universal Events are optionally defined in the Universal Extension Template as part of the Universal Extension definition.

9.3.5.2 Parameters

`name` : `str`
The name of a target event defined in the Controller.
`attributes` : `dict`
the attributes of the event
`time_to_live` : `int`, optional
maximum time (in minutes) the event can live. If no value is specified, the default value from the Universal Event Template will be used.

9.3.5.3 Returns

`None`

9.3.5.4 Examples

```
>>> from universal_extension import event
>>> event_attributes = {}
>>> event_attributes["attribute_1"] = "value_1"
>>> event_attributes["attribute_2"] = "value_2"
>>> event_attributes["attribute_3"] = "value_3"
>>> event.publish("my_event", event_attributes, 20)
```

9.3.6 UI Module

universal_extension.ui API documentation

9.3.6.1 Functions

`update_output_fields(fields)`
Propagate state changes back to the associated extension instance in the Controller.

- Can be called at any time by an Extension instance.

- Any/all output fields defined in the associated Extension Template can be updated using this method.

9.3.6.2 Parameters

`fields` : `dict`
The fields parameter expects a dictionary of output fields to be sent back to the controller for the associated Extension instance. Field names are implementation dependent and correlate with the Universal Template field names in the Controller's Template definition for the associated task.

9.3.6.3 Returns

`None`

Note

This method is equivalent to the `update_extension_status` method from the UniversalExtension Class with the added functionality that it can be used from external modules.

9.3.6.4 Examples

```
>>> from universal_extension import ui
>>> fields = {"foo": "bar"}
>>> ui.update_output_fields(fields)
```

9.4 Universal Extension 1.3.0 API

The Universal Extension 1.3.0 API was delivered with Universal Agent 7.3.0.0.

See the pages below for a description of the classes and modules available in the API.

Pages
UniversalExtension Class (1.3.0)
ExtensionResult Class (1.3.0)
Universal Extension Decorators (1.3.0)
Logging Module (1.3.0)
Event Module (1.3.0)
UI Module (1.3.0)

9.4.1 UniversalExtension Class (1.3.0)

universal_extension.universal_extension API documentation

9.4.1.1 Classes

`class UniversalExtension`
Base class for Stonebranch Universal Extension module implementations

9.4.1.1.1 Instance variables

`uip`
can be used to access the following properties of an Extension task instance:

- `task_variables` : `dict`
- `is_triggered` : `bool`
- `trigger_id` : `str`
- `instance_id` : `str`
- `monitor_id` : `str`

9.4.1.1.2 Examples

```
>>> ops_task_id = self.uip.task_variables['ops_task_id']
>>> is_triggered = self.uip.is_triggered
>>> trigger_id = self.uip.trigger_id
>>> instance_id = self.uip.instance_id
>>> monitor_id = self.uip.monitor_id
```

9.4.1.1.2.1 Methods

`extension_start(self, fields)`
Serves as the starting point for work that will be performed for a task instance. It must be implemented in the derived class.

9.4.1.1.3 Parameters

`fields` : `dict`
populated with field values from the associated task instance launched in the Controller

9.4.1.1.4 Returns

`ExtensionResult`
once the work is done, an instance of ExtensionResult must be returned. See the ExtensionResult documentation for a full list of parameters that can be passed to the class constructor

`extension_cancel(self)`

Optional method that allows the Extension to do any cleanup work before terminating. To use it, implement in the derived class.

9.4.1.1.5 Parameters

None

9.4.1.1.6 Returns

`None`

`update_extension_status(self, fields)`

Propagate state changes back to the associated extension instance in the Controller.

- Can be called at any time by an Extension instance.
- Any/all output fields defined in the associated Extension Template can be updated using this method.

9.4.1.1.7 Parameters

`fields` : `dict`

The fields parameter expects a dictionary of output fields to be sent back to the controller for the associated Extension instance. Field names are implementation dependent and correlate with the Universal Template field names in the Controller's Template definition for the associated task.

9.4.1.1.8 Returns

`None`

9.4.1.1.9 Examples

```
>>> fields = {"foo": "bar"}
>>> self.update_extension_status(fields)
```

9.4.2 ExtensionResult Class (1.3.0)

universal_extension.extension_result API documentation

9.4.2.1 Classes

```
class ExtensionResult
(**kwargs)
```

Depending on the context of the initialization, different parameters need to be passed to the constructor. See the notes below.

Note

The form of the ExtensionResult constructor when instantiated in the context of **Dynamic Command**, is as follows:

Constructor Signature

*(rc = 0, message = '', output = False, output_data = None, output_name = None, call_frame = None, **kwargs)*

9.4.2.1.1 Parameters

`rc` : `int`, optional

This parameter represents the return code of the Dynamic Command operation and determines whether the Extension task instance is perceived as completing as Success or Failed by the Controller.
A value of 0 indicates success. All other values indicate an error condition and result in a status of Failed in the Controller. The non-zero value used to represent the error condition is implementation defined and therefore left up to the extension developer.

The ExtensionResult class sets a default value of 0.

`message` : `str`, optional

This parameter allows the extension to pass a completion message back to the Controller. If rc is set to 0, the message will be considered informational and will be logged by the Controller.
If rc is non-zero, the message will be considered an error message and will be displayed to the user on the task instance form.

The default value is an empty string.

`output` : `bool`, optional

This parameter specifies if the command produced output that should be persisted and displayed under the task instance Output tab in the Controller task instance associated with the dynamic command invocation.

The default value is False.

`output_data` : `str`, optional

This parameter specifies the data that will be returned to the Controller for the command execution. It is interpreted as a UTF-8 encoded text object.

If the output attribute is True, the output_data will be persisted in the Controller as a record under table ops_exec_output, and appearing as Universal Command output type from the task instance Output tab.

The default value is None.

`output_name` : `str`, optional

This attribute is used to provide a custom name for the associated output data. The output_name (if provided) will be used in the presentation of the output_data by the Controller.

The default value is None.

9.4.2.1.2 Example

```
>>> @dynamic_command('reset_environment')
>>> def reset_environment(self, fields):
>>>     # Implementation omitted
>>>     return ExtensionResult(
...         message = "Message: Hello from dynamic command 'reset_environment'!",
...         output = True,
...         output_data = 'The environment has been reset.',
...         output_name = 'DYNAMIC_OUTPUT'
...     )
```

Note

The form of the ExtensionResult constructor when instantiated in the context of **Choice Command**, is as follows:

Constructor Signature

*(rc = 0, message = '', values = None, call_frame = None, **kwargs)*

9.4.2.1.3 Parameters

`rc` : `int`, optional

This parameter represents the return code of the 'choice' operation and determines whether the command is perceived as completing with success or failure by the Controller. A value of 0 indicates success. All other values indicate an error condition and will be ignored by the Controller for form field population. However, the Controller will log the command response. The non-zero value used to represent the error condition is implementation defined and therefore left up to the extension developer.

The ExtensionResult class sets a default value of 0 to the rc attribute.

`message` : `str`, optional

This parameter allows the extension to pass a completion message back to the Controller. The message will be logged by the Controller.

The default value is an empty string.

`values` : `list`, optional

This parameter specifies a list of string values to be returned to the Controller and used to populate the associated dynamic choice field on the Extension task form.

The default value is an empty list.

9.4.2.1.4 Example

```
>>> @dynamic_choice_command("primary_choice_field")
>>> def primary_choice_command(self, fields):
>>>     # Implementation omitted
>>>     return ExtensionResult(
...         rc = 0,
```

```
...         message = "Values for choice field: 'primary_choice_field'",
...         values = ["Start", "Pause", "Stop", "Build", "Destroy"]
...         )
```

Note

The form of the ExtensionResult constructor when instantiated in the context of **Extension Start**, is as follows:

Constructor Signature

*(rc = 0, message = '', output_fields = None, unv_output = None, call_frame = None, **kwargs)*

9.4.2.1.5 Parameters

`rc` : `int`, optional
: This parameter represents the return code of the extension_start operation. The associated Universal Task instance in the Controler can use this value to determine the completion status of the Extension instance. The value is implementation defined and therefore left up to the extension developer.

  The ExtensionResult class sets a default value of 0.

`message` : `str`, optional
: This parameter allows the extension to pass a completion message back to the Controller. If rc is set to 0, the message will be considered informational and will be logged by the Controller.
  If rc is non-zero, the message will be considered an error message and will be displayed to the user on the task instance form.

  The default value is an empty string.

`output_fields` : `dict`, optional
: Dictionary containing output fields.

  The default None.

`unv_output` : `str`, optional
: The value for this parameter is considered the payload of the task execution. It appears on the task instance Output tab as Universal output type.

  The default value is None.

9.4.2.1.6 Example

```
>>> def extension_start(self, fields):
>>>     # Implementation omitted
>>>     return ExtensionResult(
...         unv_output = "extension_start() finished successfully",
...         rc = 0
...         )
```

9.4.3 Universal Extension Decorators (1.3.0)

universal_extension.deco.choice API documentation

9.4.3.1 `Choice`

`dynamic_choice_command(field_name)`
Decorator that can be used to register a dynamic choice command.

9.4.3.1.1 Parameters

`field_name` : `str`
the value specified must match the field name of the associated Dynamic Choice field in the Controller's Universal Template

9.4.3.1.2 Returns

`None`

9.4.3.1.3 Examples

```
>>> @dynamic_choice_command("primary_choice_field")
>>> def primary_choice_command(self, fields):
>>>     # Implementation omitted
```

universal_extension.deco.command API documentation

9.4.3.2 `Command`

`dynamic_command(command_name)`
Decorator that can be used to register a dynamic command.

9.4.3.2.1 Parameters

`command_name` : `str`
the value specified must match the command name of the associated Dynamic Command defined in the Controller's Universal Template

9.4.3.2.2 Returns

`None`

9.4.3.2.3 Examples

```
>>> @dynamic_command("reset_environment")
>>> def reset_environment(self, fields):
>>>     # Implementation omitted
```

9.4.4 Logging Module (1.3.0)

universal_extension.logger API documentation

9.4.4.1 Global variables

`logger`

global `logger` instance that can be imported in other modules.

The following log levels are officially supported:

- `CRITICAL`
- `ERROR`
- `WARNING`
- `INFO`
- `DEBUG`

Note

In addition to the levels listed above, there is another level, `TRACE`, which is used by the internal UniversalExtension API. It is **NOT** available for use in developing Extensions.

9.4.4.2 Examples

```
>>> # This example demonstrates how to import the global logger in other Python modules.

>>> # Assume that logger is imported below in test.py that resides in the same folder as extension.py
>>> from universal_extension import logger
>>> logger.info('sample info message from test.py')
```

9.4.5 Event Module (1.3.0)

universal_extension.event API documentation

9.4.5.1 Functions

`publish(name, attributes, time_to_live=None)`
Publish a Universal Event to the associated Universal Controller.

- Can be called at any time by an Extension instance.
- Universal Events are optionally defined in the Universal Extension Template as part of the Universal Extension definition.

9.4.5.2 Parameters

`name` : `str`
The name of a target event defined in the Controller.
`attributes` : `dict`
the attributes of the event
`time_to_live` : `int`, optional
maximum time (in minutes) the event can live. If no value is specified, the default value from the Universal Event Template will be used.

9.4.5.3 Returns

`None`

9.4.5.4 Examples

```
>>> from universal_extension import event
>>> event_attributes = {}
>>> event_attributes["attribute_1"] = "value_1"
>>> event_attributes["attribute_2"] = "value_2"
>>> event_attributes["attribute_3"] = "value_3"
>>> event.publish("my_event", event_attributes, 20)
```

9.4.6 UI Module (1.3.0)

universal_extension.ui API documentation

9.4.6.1 Functions

`update_output_fields(fields)`
Propagate state changes back to the associated extension instance in the Controller.

- Can be called at any time by an Extension instance.

- Any/all output fields defined in the associated Extension Template can be updated using this method.

9.4.6.2 Parameters

`fields` : `dict`
: The fields parameter expects a dictionary of output fields to be sent back to the controller for the associated Extension instance. Field names are implementation dependent and correlate with the Universal Template field names in the Controller's Template definition for the associated task.

9.4.6.3 Returns

`None`

Note

This method is equivalent to the `update_extension_status` method from the UniversalExtension Class with the added functionality that it can be used from external modules.

9.4.6.4 Examples

```
>>> from universal_extension import ui
>>> fields = {"foo": "bar"}
>>> ui.update_output_fields(fields)
```

9.5 Universal Extension 1.4.0 API

The Universal Extension 1.4.0 API was delivered with Universal Agent 7.4.0.0.

See the pages below for a description of the classes and modules available in the API.

Pages
UniversalExtension Class (1.4.0)
ExtensionResult Class (1.4.0)
Universal Extension Decorators (1.4.0)
Logging Module (1.4.0)
Event Module (1.4.0)
UI Module (1.4.0)

9.5.1 UniversalExtension Class (1.4.0)

universal_extension.universal_extension API documentation

9.5.1.1 Classes

`class UniversalExtension`
Base class for Stonebranch Universal Extension module implementations

9.5.1.1.1 Instance variables

`uip`
can be used to access the following properties of an Extension task instance:

- `task_variables` : `dict`
- `is_triggered` : `bool`
- `trigger_id` : `str`
- `instance_id` : `str`
- `monitor_id` : `str`

9.5.1.1.2 Examples

```
>>> ops_task_id = self.uip.task_variables['ops_task_id']
>>> is_triggered = self.uip.is_triggered
>>> trigger_id = self.uip.trigger_id
>>> instance_id = self.uip.instance_id
>>> monitor_id = self.uip.monitor_id
```

9.5.1.1.2.1 Methods

`extension_start(self, fields)`
Serves as the starting point for work that will be performed for a task instance. It must be implemented in the derived class.

9.5.1.1.3 Parameters

`fields` : `dict`
populated with field values from the associated task instance launched in the Controller

9.5.1.1.4 Returns

`ExtensionResult`
once the work is done, an instance of ExtensionResult must be returned. See the ExtensionResult documentation for a full list of parameters that can be passed to the class constructor

---

`extension_cancel(self)`

Optional method that allows the Extension to do any cleanup work before terminating. To use it, implement in the derived class.

9.5.1.1.5 Parameters

None

9.5.1.1.6 Returns

`None`

`update_extension_status(self, fields)`

Propagate state changes back to the associated extension instance in the Controller.

- Can be called at any time by an Extension instance.
- Any/all output fields defined in the associated Extension Template can be updated using this method.

9.5.1.1.7 Parameters

`fields` : `dict`

The fields parameter expects a dictionary of output fields to be sent back to the controller for the associated Extension instance. Field names are implementation dependent and correlate with the Universal Template field names in the Controller's Template definition for the associated task.

9.5.1.1.8 Returns

`None`

9.5.1.1.9 Examples

```
>>> fields = {"foo": "bar"}
>>> self.update_extension_status(fields)
```

9.5.2 ExtensionResult Class (1.4.0)

universal_extension.extension_result API documentation

9.5.2.1 Classes

```
class ExtensionResult
(**kwargs)
```

Depending on the context of the initialization, different parameters need to be passed to the constructor. See the notes below.

Note

The form of the ExtensionResult constructor when instantiated in the context of **Dynamic Command**, is as follows:

Constructor Signature

*(rc = 0, message = '', output = False, output_data = None, output_name = None, call_frame = None, **kwargs)*

9.5.2.1.1 Parameters

`rc` : `int`, optional

This parameter represents the return code of the Dynamic Command operation and determines whether the Extension task instance is perceived as completing as Success or Failed by the Controller.
A value of 0 indicates success. All other values indicate an error condition and result in a status of Failed in the Controller. The non-zero value used to represent the error condition is implementation defined and therefore left up to the extension developer.

The ExtensionResult class sets a default value of 0.

`message` : `str`, optional

This parameter allows the extension to pass a completion message back to the Controller. If rc is set to 0, the message will be considered informational and will be logged by the Controller.
If rc is non-zero, the message will be considered an error message and will be displayed to the user on the task instance form.

The default value is an empty string.

`output` : `bool`, optional

This parameter specifies if the command produced output that should be persisted and displayed under the task instance Output tab in the Controller task instance associated with the dynamic command invocation.

The default value is False.

`output_data` : `str`, optional

This parameter specifies the data that will be returned to the Controller for the command execution. It is interpreted as a UTF-8 encoded text object.

If the output attribute is True, the output_data will be persisted in the Controller as a record under table ops_exec_output, and appearing as Universal Command output type from the task instance Output tab.

The default value is None.

`output_name` : `str`, optional

This attribute is used to provide a custom name for the associated output data. The output_name (if provided) will be used in the presentation of the output_data by the Controller.

The default value is None.

9.5.2.1.2 Example

```
>>> @dynamic_command('reset_environment')
>>> def reset_environment(self, fields):
>>>     # Implementation omitted
>>>     return ExtensionResult(
...         message = "Message: Hello from dynamic command 'reset_environment'!",
...         output = True,
...         output_data = 'The environment has been reset.',
...         output_name = 'DYNAMIC_OUTPUT'
...     )
```

Note

The form of the ExtensionResult constructor when instantiated in the context of **Choice Command**, is as follows:

Constructor Signature

*(rc = 0, message = '', values = None, call_frame = None, **kwargs)*

9.5.2.1.3 Parameters

`rc` : `int`, optional

This parameter represents the return code of the 'choice' operation and determines whether the command is perceived as completing with success or failure by the Controller. A value of 0 indicates success. All other values indicate an error condition and will be ignored by the Controller for form field population. However, the Controller will log the command response. The non-zero value used to represent the error condition is implementation defined and therefore left up to the extension developer.

The ExtensionResult class sets a default value of 0 to the rc attribute.

`message` : `str`, optional

This parameter allows the extension to pass a completion message back to the Controller. The message will be logged by the Controller.

The default value is an empty string.

`values` : `list`, optional

This parameter specifies a list of string values to be returned to the Controller and used to populate the associated dynamic choice field on the Extension task form.

The default value is an empty list.

9.5.2.1.4 Example

```
>>> @dynamic_choice_command("primary_choice_field")
>>> def primary_choice_command(self, fields):
>>>     # Implementation omitted
>>>     return ExtensionResult(
...         rc = 0,
```

```
...         message = "Values for choice field: 'primary_choice_field'",
...         values = ["Start", "Pause", "Stop", "Build", "Destroy"]
...         )
```

Note

The form of the ExtensionResult constructor when instantiated in the context of **Extension Start**, is as follows:

Constructor Signature

*(rc = 0, message = '', output_fields = None, unv_output = None, call_frame = None, **kwargs)*

9.5.2.1.5 Parameters

`rc` : `int`, optional
This parameter represents the return code of the extension_start operation. The associated Universal Task instance in the Controler can use this value to determine the completion status of the Extension instance. The value is implementation defined and therefore left up to the extension developer.

The ExtensionResult class sets a default value of 0.

`message` : `str`, optional
This parameter allows the extension to pass a completion message back to the Controller. If rc is set to 0, the message will be considered informational and will be logged by the Controller.
If rc is non-zero, the message will be considered an error message and will be displayed to the user on the task instance form.

The default value is an empty string.

`output_fields` : `dict`, optional
Dictionary containing output fields.

The default None.

`unv_output` : `str`, optional
The value for this parameter is considered the payload of the task execution. It appears on the task instance Output tab as Universal output type.

The default value is None.

9.5.2.1.6 Example

```
>>> def extension_start(self, fields):
>>>     # Implementation omitted
>>>     return ExtensionResult(
...         unv_output = "extension_start() finished successfully",
...         rc = 0
...         )
```

9.5.3 Universal Extension Decorators (1.4.0)

universal_extension.deco.choice API documentation

9.5.3.1 `Choice`

`dynamic_choice_command(field_name)`
Decorator that can be used to register a dynamic choice command.

9.5.3.1.1 Parameters

`field_name` : `str`
the value specified must match the field name of the associated Dynamic Choice field in the Controller's Universal Template

9.5.3.1.2 Returns

`None`

9.5.3.1.3 Examples

```
>>> @dynamic_choice_command("primary_choice_field")
>>> def primary_choice_command(self, fields):
>>>     # Implementation omitted
```

universal_extension.deco.command API documentation

9.5.3.2 `Command`

`dynamic_command(command_name)`
Decorator that can be used to register a dynamic command.

9.5.3.2.1 Parameters

`command_name` : `str`
the value specified must match the command name of the associated Dynamic Command defined in the Controller's Universal Template

9.5.3.2.2 Returns

`None`

9.5.3.2.3 Examples

```
>>> @dynamic_command("reset_environment")
>>> def reset_environment(self, fields):
>>>     # Implementation omitted
```

9.5.4 Logging Module (1.4.0)

universal_extension.logger API documentation

9.5.4.1 Global variables

`logger`

global `logger` instance that can be imported in other modules.

The following log levels are officially supported:

- `CRITICAL`
- `ERROR`
- `WARNING`
- `INFO`
- `DEBUG`

Note

In addition to the levels listed above, there is another level, `TRACE`, which is used by the internal UniversalExtension API. It is **NOT** available for use in developing Extensions.

9.5.4.2 Examples

```
>>> # This example demonstrates how to import the global logger in other Python modules.

>>> # Assume that logger is imported below in test.py that resides in the same folder as extension.py
>>> from universal_extension import logger
>>> logger.info('sample info message from test.py')
```

9.5.5 Event Module (1.4.0)

universal_extension.event API documentation

9.5.5.1 Functions

`publish(name, attributes, time_to_live=None)`

Publish a Universal Event to the associated Universal Controller.

- Can be called at any time by an Extension instance.
- Universal Events are optionally defined in the Universal Extension Template as part of the Universal Extension definition.

9.5.5.2 Parameters

`name` : `str`

The name of a target event defined in the Controller.

`attributes` : `dict`

the attributes of the event

`time_to_live` : `int`, optional

maximum time (in minutes) the event can live. If no value is specified, the default value from the Universal Event Template will be used.

9.5.5.3 Returns

`None`

9.5.5.4 Examples

```
>>> from universal_extension import event
>>> event_attributes = {}
>>> event_attributes["attribute_1"] = "value_1"
>>> event_attributes["attribute_2"] = "value_2"
>>> event_attributes["attribute_3"] = "value_3"
>>> event.publish("my_event", event_attributes, 20)
```

9.5.6 UI Module (1.4.0)

universal_extension.ui API documentation

9.5.6.1 Functions

`update_output_fields(fields)`

Propagate state changes back to the associated extension instance in the Controller.

- Can be called at any time by an Extension instance.

- Any/all output fields defined in the associated Extension Template can be updated using this method.

9.5.6.2 Parameters

`fields` : `dict`
The fields parameter expects a dictionary of output fields to be sent back to the controller for the associated Extension instance. Field names are implementation dependent and correlate with the Universal Template field names in the Controller's Template definition for the associated task.

9.5.6.3 Returns

`None`

Note

This method is equivalent to the `update_extension_status` method from the UniversalExtension Class with the added functionality that it can be used from external modules.

9.5.6.4 Examples

```
>>> from universal_extension import ui
>>> fields = {"foo": "bar"}
>>> ui.update_output_fields(fields)
```

`update_progress(percent_done)`
New in API Level 1.4.0
Propagate execution progress back to the associated extension instance in the Controller.

- Can be called at any time by an Extension instance.

9.5.6.5 Parameters

`percent_done` : `int`
an integer value specifying the execution progress (in percent). The value must be in range [0..100].

9.5.6.6 Returns

`None`

9.5.6.7 Examples

```
>>> from universal_extension import ui
>>> ui.update_progress(75) # Extension is 75% complete
```

9.6 Universal Extension 1.5.0 API

The Universal Extension 1.5.0 API was delivered with Universal Agent 7.6.0.0.

See the pages below for a description of the classes and modules available in the API.

Pages
UniversalExtension Class (1.5.0)
ExtensionResult Class (1.5.0)
Universal Extension Decorators (1.5.0)
Logging Module (1.5.0)
Event Module (1.5.0)
UI Module (1.5.0)
Utility Module (1.5.0)
Otel Module (1.5.0)

9.6.1 UniversalExtension Class (1.5.0)

universal_extension.universal_extension API documentation

9.6.1.1 Classes

`class RequestType`

Enum representing the type of work the Extension worker process will be performing.

The value will be one of:

- `EXTENSION_START`
- `DYNAMIC_CHOICE`
- `DYNAMIC_COMMAND`

`class UniversalExtension`

Base class for Stonebranch Universal Extension module implementations

9.6.1.1.1 Class variables

`ExtensionConfig`

A namedtuple that, as of API version 1.5.0, accepts an optional `meter_provider` and `tracer_provider` which will be used to initialize the Opentelemetry framework.

The value of `meter_provider` can either be `None` or an instance of `MeterProvider` provided by the Opentelemetry library. Similarly, for the `tracer_provider`, the value must either be `None` or an instance of `TracerProvider`. The default arguments for both `meter_provider` and `tracer_provider` is `None`.

9.6.1.1.2 Examples

```
>>> ec1 = ExtensionConfig()
>>> ec2 = ExtensionConfig(
...         meter_provider=MeterProvider(
...             resource=Resource.create({"attr1": "value1"})
...         )
...       )
```

9.6.1.1.2.1 Instance variables

`uip`

can be used to access the following properties of an Extension task instance:

- `task_variables` : `dict`
- `is_triggered` : `bool`
- `trigger_id` : `str`
- `instance_id` : `str`
- `monitor_id` : `str`

Starting with API version 1.5.0, `uip` will also contain a property called `request_type` that will be one of:

- `RequestType.EXTENSION_START`
- `RequestType.DYNAMIC_CHOICE`
- `RequestType.DYNAMIC_COMMAND`

If the request type is a dynamic choice, there will be an additional property called `choice_field_name` in `uip`. Similarly, for dynamic command, the `dynamic_command_name` property will be defined.

9.6.1.1.3 Examples

```
>>> ops_task_id = self.uip.task_variables['ops_task_id']
>>> is_triggered = self.uip.is_triggered
>>> trigger_id = self.uip.trigger_id
>>> instance_id = self.uip.instance_id
```

```
>>> monitor_id = self.uip.monitor_id
```

9.6.1.1.3.1 Class methods

`extension_new(fields)`
Optional class method which, if implemented, will be run before the Extension() class is initialized.

Note

The `cls` class instance will have the `uip` context when this method is called.

9.6.1.1.4 Parameters

`fields` : `dict`
Depending on the type of work (i.e. extension_start, dynamic_choice_command, or dynamic_command) that will be executed, the dictionary will be populated with the appropriate field values from the selected in the Controller.

9.6.1.1.5 Returns

`ExtensionConfig`
An instance of ExtensionConfig

9.6.1.1.5.1 Instance Methods

`extension_start(self, fields)`
Serves as the starting point for work that will be performed for a task instance. It must be implemented in the derived class.

9.6.1.1.6 Parameters

`fields` : `dict`
populated with field values from the associated task instance launched in the Controller

9.6.1.1.7 Returns

`ExtensionResult`
once the work is done, an instance of ExtensionResult must be returned. See the ExtensionResult documentation for a full list of parameters that can be passed to the class constructor

---

`extension_cancel(self)`

Optional method that allows the Extension to do any cleanup work before terminating. To use it, implement in the derived class.

9.6.1.1.8 Parameters

None

9.6.1.1.9 Returns

`None`

`update_extension_status(self, fields)`

Propagate state changes back to the associated extension instance in the Controller.

- Can be called at any time by an Extension instance.
- Any/all output fields defined in the associated Extension Template can be updated using this method.

9.6.1.1.10 Parameters

`fields` : `dict`

The fields parameter expects a dictionary of output fields to be sent back to the controller for the associated Extension instance. Field names are implementation dependent and correlate with the Universal Template field names in the Controller's Template definition for the associated task.

9.6.1.1.11 Returns

`None`

9.6.1.1.12 Examples

```
>>> fields = {"foo": "bar"}
>>> self.update_extension_status(fields)
```

9.6.2 ExtensionResult Class (1.5.0)

universal_extension.extension_result API documentation

9.6.2.1 Classes

```
class ExtensionResult
(**kwargs)
```

Depending on the context of the initialization, different parameters need to be passed to the constructor. See the notes below.

Note

The form of the ExtensionResult constructor when instantiated in the context of **Dynamic Command**, is as follows:

Constructor Signature

*(rc = 0, message = '', output = False, output_data = None, output_name = None, call_frame = None, **kwargs)*

9.6.2.1.1 Parameters

`rc` : `int`, optional

This parameter represents the return code of the Dynamic Command operation and determines whether the Extension task instance is perceived as completing as Success or Failed by the Controller.
A value of 0 indicates success. All other values indicate an error condition and result in a status of Failed in the Controller. The non-zero value used to represent the error condition is implementation defined and therefore left up to the extension developer.

The ExtensionResult class sets a default value of 0.

`message` : `str`, optional

This parameter allows the extension to pass a completion message back to the Controller. If rc is set to 0, the message will be considered informational and will be logged by the Controller.
If rc is non-zero, the message will be considered an error message and will be displayed to the user on the task instance form.

The default value is an empty string.

`output` : `bool`, optional

This parameter specifies if the command produced output that should be persisted and displayed under the task instance Output tab in the Controller task instance associated with the dynamic command invocation.

The default value is False.

`output_data` : `str`, optional

This parameter specifies the data that will be returned to the Controller for the command execution. It is interpreted as a UTF-8 encoded text object.

If the output attribute is True, the output_data will be persisted in the Controller as a record under table ops_exec_output, and appearing as Universal Command output type from the task instance Output tab.

The default value is None.

`output_name` : `str`, optional

This attribute is used to provide a custom name for the associated output data. The output_name (if provided) will be used in the presentation of the output_data by the Controller.

The default value is None.

9.6.2.1.2 Example

```
>>> @dynamic_command('reset_environment')
>>> def reset_environment(self, fields):
>>>     # Implementation omitted
>>>     return ExtensionResult(
...         message = "Message: Hello from dynamic command 'reset_environment'!",
...         output = True,
...         output_data = 'The environment has been reset.',
...         output_name = 'DYNAMIC_OUTPUT'
...     )
```

Note

The form of the ExtensionResult constructor when instantiated in the context of **Choice Command**, is as follows:

Constructor Signature

*(rc = 0, message = '', values = None, call_frame = None, **kwargs)*

9.6.2.1.3 Parameters

`rc` : `int`, optional

This parameter represents the return code of the 'choice' operation and determines whether the command is perceived as completing with success or failure by the Controller. A value of 0 indicates success. All other values indicate an error condition and will be ignored by the Controller for form field population. However, the Controller will log the command response. The non-zero value used to represent the error condition is implementation defined and therefore left up to the extension developer.

The ExtensionResult class sets a default value of 0 to the rc attribute.

`message` : `str`, optional

This parameter allows the extension to pass a completion message back to the Controller. The message will be logged by the Controller.

The default value is an empty string.

`values` : `list`, optional

This parameter specifies a list of string values to be returned to the Controller and used to populate the associated dynamic choice field on the Extension task form.

The default value is an empty list.

9.6.2.1.4 Example

```
>>> @dynamic_choice_command("primary_choice_field")
>>> def primary_choice_command(self, fields):
>>>     # Implementation omitted
>>>     return ExtensionResult(
...         rc = 0,
```

```
...         message = "Values for choice field: 'primary_choice_field'",
...         values = ["Start", "Pause", "Stop", "Build", "Destroy"]
...         )
```

Note

The form of the ExtensionResult constructor when instantiated in the context of **Extension Start**, is as follows:

Constructor Signature

*(rc = 0, message = '', output_fields = None, unv_output = None, call_frame = None, **kwargs)*

9.6.2.1.5 Parameters

`rc` : `int`, optional
: This parameter represents the return code of the extension_start operation. The associated Universal Task instance in the Controler can use this value to determine the completion status of the Extension instance. The value is implementation defined and therefore left up to the extension developer.

  The ExtensionResult class sets a default value of 0.

`message` : `str`, optional
: This parameter allows the extension to pass a completion message back to the Controller. If rc is set to 0, the message will be considered informational and will be logged by the Controller.
  If rc is non-zero, the message will be considered an error message and will be displayed to the user on the task instance form.

  The default value is an empty string.

`output_fields` : `dict`, optional
: Dictionary containing output fields.

  The default None.

`unv_output` : `str`, optional
: The value for this parameter is considered the payload of the task execution. It appears on the task instance Output tab as Universal output type.

  The default value is None.

9.6.2.1.6 Example

```
>>> def extension_start(self, fields):
>>>     # Implementation omitted
>>>     return ExtensionResult(
...         unv_output = "extension_start() finished successfully",
...         rc = 0
...         )
```

9.6.3 Universal Extension Decorators (1.5.0)

universal_extension.deco.choice API documentation

9.6.3.1 `Choice`

`dynamic_choice_command(field_name)`
Decorator that can be used to register a dynamic choice command.

9.6.3.1.1 Parameters

`field_name` : `str`
the value specified must match the field name of the associated Dynamic Choice field in the Controller's Universal Template

9.6.3.1.2 Returns

`None`

9.6.3.1.3 Examples

```
>>> @dynamic_choice_command("primary_choice_field")
>>> def primary_choice_command(self, fields):
>>>     # Implementation omitted
```

universal_extension.deco.command API documentation

9.6.3.2 `Command`

`dynamic_command(command_name)`
Decorator that can be used to register a dynamic command.

9.6.3.2.1 Parameters

`command_name` : `str`
the value specified must match the command name of the associated Dynamic Command defined in the Controller's Universal Template

9.6.3.2.2 Returns

`None`

9.6.3.2.3 Examples

```
>>> @dynamic_command("reset_environment")
>>> def reset_environment(self, fields):
>>>     # Implementation omitted
```

9.6.4 Logging Module (1.5.0)

universal_extension.logger API documentation

9.6.4.1 Global variables

`logger`

global `logger` instance that can be imported in other modules.

The following log levels are officially supported:

- `CRITICAL`
- `ERROR`
- `WARNING`
- `INFO`
- `DEBUG`

Note

In addition to the levels listed above, there is another level, `TRACE`, which is used by the internal UniversalExtension API. It is **NOT** available for use in developing Extensions.

9.6.4.2 Examples

```
>>> # This example demonstrates how to import the global logger in other Python modules.

>>> # Assume that logger is imported below in test.py that resides in the same folder as extension.py
>>> from universal_extension import logger
>>> logger.info('sample info message from test.py')
```

9.6.5 Event Module (1.5.0)

universal_extension.event API documentation

9.6.5.1 Functions

`publish(name, attributes, time_to_live=None)`
Publish a Universal Event to the associated Universal Controller.

- Can be called at any time by an Extension instance.
- Universal Events are optionally defined in the Universal Extension Template as part of the Universal Extension definition.

9.6.5.2 Parameters

`name` : `str`
The name of a target event defined in the Controller.
`attributes` : `dict`
the attributes of the event
`time_to_live` : `int`, optional
maximum time (in minutes) the event can live. If no value is specified, the default value from the Universal Event Template will be used.

9.6.5.3 Returns

`None`

9.6.5.4 Examples

```
>>> from universal_extension import event
>>> event_attributes = {}
>>> event_attributes["attribute_1"] = "value_1"
>>> event_attributes["attribute_2"] = "value_2"
>>> event_attributes["attribute_3"] = "value_3"
>>> event.publish("my_event", event_attributes, 20)
```

9.6.6 UI Module (1.5.0)

universal_extension.ui API documentation

9.6.6.1 Functions

`update_output_fields(fields)`
Propagate state changes back to the associated extension instance in the Controller.

- Can be called at any time by an Extension instance.

- Any/all output fields defined in the associated Extension Template can be updated using this method.

9.6.6.2 Parameters

`fields` : `dict`
The fields parameter expects a dictionary of output fields to be sent back to the controller for the associated Extension instance. Field names are implementation dependent and correlate with the Universal Template field names in the Controller's Template definition for the associated task.

9.6.6.3 Returns

`None`

Note

This method is equivalent to the `update_extension_status` method from the UniversalExtension Class with the added functionality that it can be used from external modules.

9.6.6.4 Examples

```
>>> from universal_extension import ui
>>> fields = {"foo": "bar"}
>>> ui.update_output_fields(fields)
```

`update_progress(percent_done)`
New in API Level 1.4.0
Propagate execution progress back to the associated extension instance in the Controller.

- Can be called at any time by an Extension instance.

9.6.6.5 Parameters

`percent_done` : `int`
an integer value specifying the execution progress (in percent). The value must be in range [0..100].

9.6.6.6 Returns

`None`

9.6.6.7 Examples

```
>>> from universal_extension import ui
>>> ui.update_progress(75) # Extension is 75% complete
```

9.6.7 Utility Module (1.5.0)

universal_extension.logger API documentation

9.6.7.1 Functions

`noop_context(noop=NoOp)`
A NoOp/Dummy context manager that does basically nothing. It can be used as a stand-in for a more useful, but optional, context manager.

9.6.7.2 Parameters

`noop` : `object`, optional
The object to yield, by default NoOp()

9.6.7.3 Yields

`noop`
An instance of the NoOp class.

9.6.7.4 Examples

```
>>> from universal_extension import utility as util
>>> with noop_context() as test:
>>>     test.run(5).stop()
>>> valid = True
>>> with noop_context() if not valid else real_context() as test:
>>>     test.run()
```

9.6.7.5 Classes

`class NoOp`
`(**kwargs)`
A NoOp/Dummy class that can be used for stubbing out other classes.

9.6.7.5.1 Raises

`None`

9.6.7.5.2 Examples

```
>>> from universal_extension import utility as util
>>> t = util.NoOp(1, 2, "testing")
>>> t.num = 5
>>> t.update("a", "b")
```

9.6.8 Otel Module (1.5.0)

universal_extension.logger API documentation

9.6.8.1 Global variables

`is_compatible`
: Global boolean variable that can be used to check if Opentelemetry is compatible with the active Python version. As of 1.5.0, Opentelemetry is supported on Python versions `3.7` and higher on Windows and Linux/Unix (except Solaris).

9.6.8.2 Examples

```
>>> from universal_extension import otel
>>> if otel.is_compatible:
>>>     from opentelemetry import trace
```

9.7 Universal Extension 1.6.0 API

The Universal Extension 1.5.0 API was delivered with Universal Agent 7.6.0.0.

See the pages below for a description of the classes and modules available in the API.

Pages
UniversalExtension Class (1.6.0)
ExtensionResult Class (1.6.0)
Universal Extension Decorators (1.6.0)
Logging Module (1.6.0)
Event Module (1.6.0)
UI Module (1.6.0)
Utility Module (1.6.0)

Pages
Otel Module (1.6.0)

9.7.1 UniversalExtension Class (1.6.0)

universal_extension.universal_extension API documentation

9.7.1.1 Classes

`class RequestType`

Enum representing the type of work the Extension worker process will be performing.

The value will be one of:

- `EXTENSION_START`
- `DYNAMIC_CHOICE`
- `DYNAMIC_COMMAND`

`class UniversalExtension`

Base class for Stonebranch Universal Extension module implementations

9.7.1.1.1 Class variables

`ExtensionConfig`

A namedtuple that, as of API version 1.5.0, accepts an optional `meter_provider` and `tracer_provider` which will be used to initialize the Opentelemetry framework.

The value of `meter_provider` can either be `None` or an instance of `MeterProvider` provided by the Opentelemetry library. Similarly, for the `tracer_provider`, the value must either be `None` or an instance of `TracerProvider`. The default arguments for both `meter_provider` and `tracer_provider` is `None`.

9.7.1.1.2 Examples

```
>>> ec1 = ExtensionConfig()
>>> ec2 = ExtensionConfig(
...         meter_provider=MeterProvider(
...             resource=Resource.create({"attr1": "value1"})
...         )
...       )
```

9.7.1.1.2.1 Instance variables

`uip`
can be used to access the following properties of an Extension task instance:

- `task_variables` : `dict`
- `is_triggered` : `bool`
- `trigger_id` : `str`
- `instance_id` : `str`
- `monitor_id` : `str`

Starting with API version 1.5.0, `uip` will also contain a property called `request_type` that will be one of:

- `RequestType.EXTENSION_START`
- `RestRequestType.DYNAMIC_CHOICE`
- `RestRequestType.DYNAMIC_COMMAND`

If the request type is a dynamic choice, there will be an additional property called `choice_field_name` in `uip`. Similarly, for dynamic command, the `dynamic_command_name` property will be defined.

9.7.1.1.3 Examples

```
>>> ops_task_id = self.uip.task_variables['ops_task_id']
>>> is_triggered = self.uip.is_triggered
>>> trigger_id = self.uip.trigger_id
>>> instance_id = self.uip.instance_id
>>> monitor_id = self.uip.monitor_id
```

9.7.1.1.3.1 Class methods

`extension_new(fields)`
Optional class method which, if implemented, will be run before the Extension() class is initialized.

Note

The `cls` class instance will have the `uip` context when this method is called.

9.7.1.1.4 Parameters

`fields` : `dict`
Depending on the type of work (i.e. extension_start, dynamic_choice_command, or dynamic_command) that will be executed, the dictionary will be populated with the appropriate field values from the selected in the Controller.

9.7.1.1.5 Returns

`ExtensionConfig`
: An instance of ExtensionConfig

9.7.1.1.5.1 Instance Methods

`extension_start(self, fields)`
: Serves as the starting point for work that will be performed for a task instance. It must be implemented in the derived class.

9.7.1.1.6 Parameters

`fields` : `dict`
: populated with field values from the associated task instance launched in the Controller

9.7.1.1.7 Returns

`ExtensionResult`
: once the work is done, an instance of ExtensionResult must be returned. See the ExtensionResult documentation for a full list of parameters that can be passed to the class constructor

---

`extension_cancel(self)`
: Optional method that allows the Extension to do any cleanup work before terminating. To use it, implement in the derived class.

9.7.1.1.8 Parameters

None

9.7.1.1.9 Returns

`None`

`update_extension_status(self, fields)`
: Propagate state changes back to the associated extension instance in the Controller.

- Can be called at any time by an Extension instance.

- Any/all output fields defined in the associated Extension Template can be updated using this method.

9.7.1.1.10 Parameters

`fields` : `dict`
The fields parameter expects a dictionary of output fields to be sent back to the controller for the associated Extension instance. Field names are implementation dependent and correlate with the Universal Template field names in the Controller's Template definition for the associated task.

9.7.1.1.11 Returns

`None`

9.7.1.1.12 Examples

```
>>> fields = {"foo": "bar"}
>>> self.update_extension_status(fields)
```

9.7.2 ExtensionResult Class (1.6.0)

universal_extension.extension_result API documentation

9.7.2.1 Classes

```
class ExtensionResult
(**kwargs)
```

Depending on the context of the initialization, different parameters need to be passed to the constructor. See the notes below.

Note

The form of the ExtensionResult constructor when instantiated in the context of **Dynamic Command**, is as follows:

Constructor Signature

*(rc = 0, message = '', output = False, output_data = None, output_name = None, call_frame = None, **kwargs)*

9.7.2.1.1 Parameters

`rc` : `int`, optional
This parameter represents the return code of the Dynamic Command operation and determines whether the Extension task instance is perceived as completing as Success or Failed by the Controller.
A value of 0 indicates success. All other values indicate an error condition and result in a status of Failed in the Controller. The non-zero value used to represent the error condition is implementation defined and therefore left up to the extension developer.

The ExtensionResult class sets a default value of 0.

`message` : `str`, optional

This parameter allows the extension to pass a completion message back to the Controller. If rc is set to 0, the message will be considered informational and will be logged by the Controller.
If rc is non-zero, the message will be considered an error message and will be displayed to the user on the task instance form.

The default value is an empty string.

`output` : `bool`, optional

This parameter specifies if the command produced output that should be persisted and displayed under the task instance Output tab in the Controller task instance associated with the dynamic command invocation.

The default value is False.

`output_data` : `str`, optional

This parameter specifies the data that will be returned to the Controller for the command execution. It is interpreted as a UTF-8 encoded text object.

If the output attribute is True, the output_data will be persisted in the Controller as a record under table ops_exec_output, and appearing as Universal Command output type from the task instance Output tab.

The default value is None.

`output_name` : `str`, optional

This attribute is used to provide a custom name for the associated output data. The output_name (if provided) will be used in the presentation of the output_data by the Controller.

The default value is None.

9.7.2.1.2 Example

```
>>> @dynamic_command('reset_environment')
>>> def reset_environment(self, fields):
>>>     # Implementation omitted
>>>     return ExtensionResult(
...         message = "Message: Hello from dynamic command 'reset_environment'!",
...         output = True,
...         output_data = 'The environment has been reset.',
...         output_name = 'DYNAMIC_OUTPUT'
...     )
```

Note

The form of the ExtensionResult constructor when instantiated in the context of **Choice Command**, is as follows:

Constructor Signature

*(rc = 0, message = '', values = None, call_frame = None, **kwargs)*

9.7.2.1.3 Parameters

`rc` : `int`, optional

This parameter represents the return code of the 'choice' operation and determines whether the command is perceived as completing with success or failure by the Controller. A value of 0 indicates success. All other values indicate an error condition and will be ignored by the Controller for form field population. However, the Controller will log the command response. The non-zero value used to represent the error condition is implementation defined and therefore left up to the extension developer.

The ExtensionResult class sets a default value of 0 to the rc attribute.

`message` : `str`, optional

This parameter allows the extension to pass a completion message back to the Controller. The message will be logged by the Controller.

The default value is an empty string.

`values` : `list`, optional

This parameter specifies a list of string values to be returned to the Controller and used to populate the associated dynamic choice field on the Extension task form.

The default value is an empty list.

9.7.2.1.4 Example

```
>>> @dynamic_choice_command("primary_choice_field")
>>> def primary_choice_command(self, fields):
>>>     # Implementation omitted
>>>     return ExtensionResult(
...         rc = 0,
...         message = "Values for choice field: 'primary_choice_field'",
...         values = ["Start", "Pause", "Stop", "Build", "Destroy"]
...         )
```

Note

The form of the ExtensionResult constructor when instantiated in the context of **Extension Start**, is as follows:

Constructor Signature

*(rc = 0, message = '', output_fields = None, unv_output = None, call_frame = None, **kwargs)*

9.7.2.1.5 Parameters

`rc` : `int`, optional

This parameter represents the return code of the extension_start operation. The associated Universal Task instance in the Controler can use this value to determine the completion status of the Extension instance. The value is implementation defined and therefore left up to the extension developer.

The ExtensionResult class sets a default value of 0.

`message` : `str`, optional

This parameter allows the extension to pass a completion message back to the Controller. If rc is set to 0, the message will be considered informational and will be logged by the Controller.
If rc is non-zero, the message will be considered an error message and will be displayed to the user on the task instance form.

The default value is an empty string.

`output_fields` : `dict`, optional
Dictionary containing output fields.

The default None.

`unv_output` : `str`, optional
The value for this parameter is considered the payload of the task execution. It appears on the task instance Output tab as Universal output type.

The default value is None.

9.7.2.1.6 Example

```
>>> def extension_start(self, fields):
>>>     # Implementation omitted
>>>     return ExtensionResult(
...         unv_output = "extension_start() finished successfully",
...         rc = 0
...         )
```

9.7.3 Universal Extension Decorators (1.6.0)

universal_extension.deco.choice API documentation

9.7.3.1 `Choice`

`dynamic_choice_command(field_name)`
Decorator that can be used to register a dynamic choice command.

9.7.3.1.1 Parameters

`field_name` : `str`
the value specified must match the field name of the associated Dynamic Choice field in the Controller's Universal Template

9.7.3.1.2 Returns

`None`

9.7.3.1.3 Examples

```
>>> @dynamic_choice_command("primary_choice_field")
>>> def primary_choice_command(self, fields):
>>>     # Implementation omitted
```

universal_extension.deco.command API documentation

9.7.3.2 `Command`

`dynamic_command(command_name)`

Decorator that can be used to register a dynamic command.

9.7.3.2.1 Parameters

`command_name` : `str`

the value specified must match the command name of the associated Dynamic Command defined in the Controller's Universal Template

9.7.3.2.2 Returns

`None`

9.7.3.2.3 Examples

```
>>> @dynamic_command("reset_environment")
>>> def reset_environment(self, fields):
>>>     # Implementation omitted
```

9.7.4 Logging Module (1.6.0)

universal_extension.logger API documentation

9.7.4.1 Global variables

`logger`

global `logger` instance that can be imported in other modules.

The following log levels are officially supported:

- `CRITICAL`
- `ERROR`

- `WARNING`
- `INFO`
- `DEBUG`

Note

In addition to the levels listed above, there is another level, `TRACE`, which is used by the internal UniversalExtension API. It is **NOT** available for use in developing Extensions.

9.7.4.2 Examples

```
>>> # This example demonstrates how to import the global logger in other Python modules.

>>> # Assume that logger is imported below in test.py that resides in the same folder as extension.py
>>> from universal_extension import logger
>>> logger.info('sample info message from test.py')
```

9.7.5 Event Module (1.6.0)

universal_extension.event API documentation

9.7.5.1 Functions

`publish(name, attributes, time_to_live=None)`

Publish a Universal Event to the associated Universal Controller.

- Can be called at any time by an Extension instance.
- Universal Events are optionally defined in the Universal Extension Template as part of the Universal Extension definition.

9.7.5.2 Parameters

`name` : `str`
: The name of a target event defined in the Controller.

`attributes` : `dict`
: the attributes of the event

`time_to_live` : `int`, optional
: maximum time (in minutes) the event can live. If no value is specified, the default value from the Universal Event Template will be used.

9.7.5.3 Returns

`None`

9.7.5.4 Raises

`ValueError`

- If `name` is not of type `str`
- If `time_to_live` is not of type `int` or less than 0
- If the attribute values are not of type `str`, `float`, `int`, `bool`, or a list of `str` / `float` / `int` / `bool` (mixed-types NOT allowed)

9.7.5.5 Examples

```
>>> from universal_extension import event
>>> event_attributes = {}
>>> event_attributes["attribute_1"] = "value_1"
>>> event_attributes["attribute_2"] = 123
>>> event_attributes["attribute_3"] = False
>>> event_attributes["attribute_4"] = [1.23, 4.56, 7.89]
>>> event.publish("my_event", event_attributes, 20)
```

9.7.6 UI Module (1.6.0)

universal_extension.ui API documentation

9.7.6.1 Functions

`update_output_fields(fields)`

Propagate state changes back to the associated extension instance in the Controller.

- Can be called at any time by an Extension instance.
- Any/all output fields defined in the associated Extension Template can be updated using this method.

9.7.6.2 Parameters

`fields` : `dict`

The fields parameter expects a dictionary of output fields to be sent back to the controller for the associated Extension instance. Field names are implementation dependent and correlate with the Universal Template field names in the Controller's Template definition for the associated task.

9.7.6.3 Returns

`None`

Note

This method is equivalent to the `update_extension_status` method from the UniversalExtension Class with the added functionality that it can be used from external modules.

9.7.6.4 Examples

```
>>> from universal_extension import ui
>>> fields = {"foo": "bar"}
>>> ui.update_output_fields(fields)
```

`update_progress(percent_done)`

New in API Level 1.4.0

Propagate execution progress back to the associated extension instance in the Controller.

- Can be called at any time by an Extension instance.

9.7.6.5 Parameters

`percent_done` : `int`

an integer value specifying the execution progress (in percent). The value must be in range [0..100].

9.7.6.6 Returns

`None`

9.7.6.7 Examples

```
>>> from universal_extension import ui
>>> ui.update_progress(75) # Extension is 75% complete
```

9.7.7 Utility Module (1.6.0)

universal_extension.logger API documentation

9.7.7.1 Functions

`noop_context(noop=NoOp)`

A NoOp/Dummy context manager that does basically nothing. It can be used as a stand-in for a more useful, but optional, context manager.

9.7.7.2 Parameters

`noop` : `object`, optional

The object to yield, by default NoOp()

9.7.7.3 Yields

`noop`
: An instance of the NoOp class.

9.7.7.4 Examples

```
>>> from universal_extension import utility as util
>>> with noop_context() as test:
>>>     test.run(5).stop()
>>> valid = True
>>> with noop_context() if not valid else real_context() as test:
>>>     test.run()
```

9.7.7.5 Classes

`class NoOp`
`(**kwargs)`
: A NoOp/Dummy class that can be used for stubbing out other classes.

9.7.7.5.1 Raises

`None`

9.7.7.5.2 Examples

```
>>> from universal_extension import utility as util
>>> t = util.NoOp(1, 2, "testing")
>>> t.num = 5
>>> t.update("a", "b")
```

9.7.8 Otel Module (1.6.0)

universal_extension.logger API documentation

9.7.8.1 Global variables

`is_compatible`

Global boolean variable that can be used to check if Opentelemetry is compatible with the active Python version. As of 1.5.0, Opentelemetry is supported on Python versions `3.7` and higher on Windows and Linux/Unix (except Solaris).

9.7.8.2 Examples

```
>>> from universal_extension import otel
>>> if otel.is_compatible:
>>>     from opentelemetry import trace
```

10 Concepts

Concepts

10.1 Special Field Types

10.1.1 Introduction

Universal Extensions consist of two primary parts:

1. A Universal Template definition that is created and stored in the Controller.
2. A Python zip archive that is developed outside the Controller and contains Python source code that implements the Extension functionality.

The Universal Template essentially defines the User interface for a Universal Task. That includes the fields that supply data for a task

The Universal Template supports the following field types:

- Text
- Integer
- Float
- Boolean
- Array
- Choice
- Script
- Credential
- SAP Connection
- Database (DB) Connection

During task execution, fields are passed to the `extension_start` method of the Python script that implements the logic of the Extension via the `fields` parameter. The `fields` parameter is a dictionary populated with field values from the associated task instance that was launched in the Controller. **The keys of the dictionary correlate with field names of the task instance** that is invoking the extension (defined in the associated Universal Template) and **the key values are the values from the associated form fields** when the task is launched.

The following sections describe how field values of each field type represented in Python when passed to the Extension instance in the `fields` dict.

10.1.2 Text Type Field

Fields defined in a Universal Template as type **Text** will have a value of type `str` in the fields dict. The value will be the contents of the form field from the Controller.

10.1.3 Integer Type Field

Fields defined in a Universal Template as type **Integer** will have a value of type `int` in the fields dict. The value will be the integer representation of the form field from the Controller.

10.1.4 Float Type Field

Fields defined in a Universal Template as type **Float** will have a value of type `float` in the fields dict. The value will be the floating-point representation of the form field from the Controller.

10.1.5 Boolean Type Field

Fields defined in a Universal Template as type **Boolean** will have a value of type `bool` in the fields dict. The value will be the boolean representation of the form field from the Controller (i.e., `True` or `False`).

10.1.6 Array Type Field

Fields defined in a Universal Template as type **Array** will have a value of type `list` in the fields dict. Each element of the list will be populated with a `dict` that represents the array element from the Controller. The `dict` representing the array element will contain a key value pair where the key corresponds to the element Name in the Controller and value corresponds to the element Value in the Controller. The "value" portion of the element will be of type `str`. For example:

```
{
  "array_1": [
    { "My_element_1": "Value 1" },
    { "My_element_2": "Value 2" }
  ]
}
```

10.1.6.1 Code Example

```
# Get and print array_1
print('Array 1:')
array_1 = fields.get("array_1", [])
# The array is stored as a list of dicts - each containing a
```

```
# single key/value pair indicating the 'name' and 'value' for
# the given array element.
for row_dict in array_1:
    for k,v in row_dict.items():
        # Print the array element 'name' and 'value'.
        print('{0}\t{1}'.format(k,v))
```

10.1.7 Choice Type Field

Fields defined in a Universal Template as type **Choice** will have a value of type `list` in the fields dict. The elements of the list will be the values associated with the selected "choices" in the associated task instance. The values will be of type `str`. For example:

```
{
  "choice_1": [ "choice value" ]
}
```

10.1.7.1 Code Example

```
# Get the value of the 'choice_1' field
choice_value = fields.get('choice_1', [""])[0]
```

10.1.8 Script Type Field

Fields defined in a Universal Template as type **Script** will have a value of type `str` in the fields dict. At execution time, UAG will write the Data Script associated with the Script type field to the file system. The path to that Data Script file on the local file system is what is passed in the field value. For example:

```
'C:\\Program Files\Universal\tmp\97eb9821-d3fc-43b8-b355-abf6979d7286.'
```

10.1.9 Credential Type Field

Fields defined in a Universal Template as type Credential will have a value of type `dict`. The `dict` representing the credential will contain key value pairs for the following keys:

- user
- password
- keyLocation
- passphrase
- token

For example:

```
{
  "credential_1": {
    "user": "value",
    "password": "value",
```

```
    "keyLocation": "value"
    "passphrase": "value",
    "token": "value",
  }
}
```

10.1.9.1 Code Example

The Credential values in the `fields dict` can be referenced as follows:

```
user = fields[“credential_1"]["user"]
password = fields["credential_1"]["password"]
```

10.1.9.2 Key to Field Mapping

The key value pairs in the Credential `dict` represent the similarly named fields that make up a Credential definition in the Controller. Below is a mapping of `dict` key name to Credential field name in the Controller.

dict Key	Field Name
`user`	Runtime User
`password`	Runtime Password
`keyLocation`	Key Location
`passphrase`	Passphrase
`token`	Token

The value portion of the key value pair will be of type `str` and contain the corresponding value from the resolvable credential selected for the field in the Controller.

10.1.10 SAP Connection Type Field

Fields defined in a Universal Template as type SAP Connection will be passed to the extension instance as a value of type `dict`. The `dict` representing the SAP Connection will contain a collection of key value pairs that represent a set of fields from an SAP Connection defined in the Controller. The specific collection of fields represented in the `dict` will be dependent upon the "Connection Type" of the SAP Connection being referenced by the field (i.e., "Specific Application Server" or "Load Balancing").

10.1.10.1 Specific Application Server

A “Specific Application Server” connection type will have the following collection of keys:

```
{
  "sap_connection": {
    "name": "ABC - XBP 3.0 with Business Warehouse",
    "description": "ABC Test System",
    "sap_connection_type": "Specific Application Server",
    "sap_client": "800",
    "sap_ashost": "my-sapsys",
    "sap_sysnr": "45",
    "sap_gwhost": "",
    "sap_gwserv": "",
    "sap_mysapsso2": "",
    "sap_x509cert": "",
    "sap_saprouter": "",
    "sap_snc_mode": ""
    "sap_snc_lib": "",
    "sap_snc_myname": "",
    "sap_snc_partnername": "",
    "sap_snc_qop": "",
    "sap_snc_sso": ""
  }
}
```

10.1.10.2 Load Balancing

A “Load Balancing” connection type will have the following collection of keys:

```
{
  "sap_connection": {
    "name": "ABC - XBP 3.0 with Business Warehouse",
    "description": "ABC Test System",
    "sap_connection_type": "Specific Application Server",
    "sap_client": "800",
    "sap_mshost": "abcmain",
    "sap_r3name": "ABC",
    "sap_group": "PUBLIC",
    "sap_use_symbolic_names": "",
    "sap_mysapsso2": "",
    "sap_x509cert": "",
```

```
    "sap_saprouter": "",
    "sap_snc_mode": ""
    "sap_snc_lib": "",
    "sap_snc_myname": "",
    "sap_snc_partnername": "",
    "sap_snc_qop": "",
    "sap_snc_sso": ""
  }
}
```

10.1.10.3 Code Example

The SAP Connection values in the `fields dict` can be referenced as follows:

```
ashost = fields[“sap_connection"]["sap_ashost"]
sysnr = fields["sap_connection"]["sap_sysnr"]
client = fields[“sap_connection"]["sap_client"]
```

10.1.10.4 Key to Field Mapping

The key value pairs in the SAP Connection `dict` represent the similarly named fields that make up an SAP Connection definition in the Controller. Below is a mapping of `dict` key name to SAP Connection field name in the Controller.

dict Key	Field Name	Connection Type
`name`	Name	All
`description`	Description	All
`sap_connection_type`	Connection Type	All
`sap_client`	Client	All
`sap_ashost`	Application Server	Specific Application Server
`sap_sysnr`	System Number	Specific Application Server
`sap_gwhost`	Gateway	Specific Application Server
`sap_gwserv`	Gateway Service	Specific Application Server
`sap_mshost`	Message Server	Load Balancing

dict Key	Field Name	Connection Type
`sap_r3name`	System ID	Load Balancing
`sap_group`	Group	Load Balancing
`sap_use_symbolic_names`	Use Symbolic Names	Load Balancing
`sap_mysapsso2`	Single Sign-On Ticket	All
`sap_x509cert`	X.509 Certificate	All
`sap_saprouter`	SAProuter	All
`sap_snc_mode`	SNC Mode	All
`sap_snc_lib`	SNC Library	All
`sap_snc_myname`	SNC My Name	All
`sap_snc_partnername`	SNC Partner Name	All
`sap_snc_qop`	SNC Quality Of Protection	All
`sap_snc_sso`	SNC Single Sign-On	All

10.1.11 Database (DB) Connection Type Field

Fields defined in a Universal Template as type DB Connection will be passed to the extension instance as a value of type `dict`. The `dict` representing the DB Connection will contain a collection of key value pairs that represent a set of fields from a DB Connection defined in the Controller. The `dict` will contain the following keys:

- name
- description
- type
- url
- driver
- max_rows
- credentials
    - user
    - password
    - keyLocation
    - passphrase
    - token

For example:

```
{
  "db_connection": {
    "name": "DB name",
    "description": "",
    "type": "",
    "url": "",
    "driver": "",
    "max_rows": 5,
    "credentials": {
        "user": "value",
        "password": "value"
        "keyLocation": "value"
        "passphrase": "value",
        "token": "value",
    }
  }
}
```

10.1.11.1 Code Example

The DB Connection values in the `fields dict` can be referenced as follows:

```
name = fields["db_connection"]["name"]
password = fields["db_connection"]["credentials"]["password"]
max_rows = fields["db_connection"]["max_rows"]
```

10.1.11.2 Key to Field Mapping

The key value pairs in the DB Connection `dict` represent the similarly named fields that make up a DB Connection definition in the Controller. Below is a mapping of `dict` key name to DB Connection field name in the Controller.

dict Key	Field Name
name	Name
description	Description
type	Database Type
url	Connection URL
driver	Driver
max_rows	Maximum Rows

dict Key	Field Name
credentials	Credentials

Note, the value of `credentials` is a `dict` that contains

dict Key	Field Name
`user`	Runtime User
`password`	Runtime Password
`keyLocation`	Key Location
`passphrase`	Passphrase
`token`	Token

10.2 extension.yml

The `extension.yml` document contains metadata pertaining to a Universal Extension. This document must be included in the Universal Extension zip archive at the root level (along with `extension.py`).

extension.yml

```
extension:
  name: extension1
  version: "0.1.0"
  api_level: "1.4.0"
  requires_python: ">=3.6"
  python_extra_paths: "${extension_zip}/lib:${extension_zip}/test/lib"
  zip_safe: true
owner:
  name: John Doe
  organization: Stonebranch, Inc.
comments: |
  These comments will appear in the Controller in the Universal Template 'Extension Comments' field
.
  The 'Extension Comments' field can be viewed from the Meta Data section, the List, or the Show
Details.
```

The file contains three sections: extension, owner, and comments.

10.2.1 extension

The extension section contains attributes that pertain to extension management and operation. Some fields are optional.

10.2.1.1 name

The `name` attribute is **required**. It is used to identify the extension within the UAC system and therefore, must be unique within that system.

10.2.1.2 version

The `version` attribute is **required**. This attribute is used in the generation of dependency package file names for a given extension.

10.2.1.3 api_level

The `api_level` attribute is **required**. This attribute is used to specify the Universal Extension API level required by the extension.

> The Universal Controller will only run a Universal Extension task on an agent that supports the specified `api_level`.
>
> The extension developer should choose the target API level carefully in order to prevent unnecessarily restricting the compatibility of the extension. For example, specifying the latest API level available at the time of extension development would restrict the extension to only running on the latest agents that support that API level. Unless the extension was explicitly using functionality introduced with that API level, it would be unnecessarily restricting the compatibility.
>
> In general, an extension should not specify an API level higher than what is required by the extension. Doing so only serves to restrict the range of agent versions it can run on.

10.2.1.4 requires_python

The `requires_python` attribute is **optional**. This attribute allows the extension to specify the versions of Python it can work with. The syntax and semantics are a subset of PEP 440 version specifiers. Its value consists of one or more version specifier clauses delimited by commas. A specifier clause consists of a comparison operator and a version number. if not specified, a default value of `>=2.7` will be used. Valid comparison operators are as follows:

Operator	Meaning
==	Equal to
!=	Not equal to
<	Less than to

Operator	Meaning
<=	Less than or equal to
>	Greater than
>=	Greater than or equal to

A single version specifier consists of one of the above operators, followed by a version which must use one of these formats.

Major		Minor		Patch	Note
Number					Equivalent to Number `.` 0 `.` 0
Number	`.`	Number			Equivalent to Number `.` Number `.` 0
Number	`.`	Number	`.`	Number	
Number	`.`	`*`			
Number	`*`				Equivalent to Number `.*`
Number	`.`	Number	`.`	`*`	
Number	`.`	Number	`*`		Equivalent to Number `.` Number `.*`

The wildcard `*` is used in place of the minor number to mean that any version with a matching major number matches the specifier; or in place of the patch number to mean that any version with a matching major and minor number matches the specifier.

For example:

!=2*,!=3.9.*	No 2 version, and no 3.9 version	<2,>=3,<3.9,>=4	Less than 2.0.0, and greater or equal to 3.0.0, and less than 3.9.0 and greater or equal to 4.0.0	!=2*,!=3.*	No 2 version, and no 3 version
==2.7.*,>=3.5	Any 2.7 version, and greater than or equal to 3.5.0	>=2.7.0,<=2.8	Greater than or equal to 2.7.0, and less than or equal to 2.8.0	==3.11.2	Equal to 3.11.2
>=3.6	Greater than or equal to 3.6.0	==2.8.*	Any 2.8 version	>3.6.*	Greater than any 3.6 version

The comparison algorithm is as follows: given Python versions A and B,

1. If A.major > B.major, A > B
2. If A.major < B.major, A < B
3. If either A.minor or B.minor is a wildcard, A == B
4. If A.minor > B.minor, A > B
5. If A.minor < B.minor, A < B
6. If either A.patch or B.patch is a wildcard, A == B

7. If A.patch > B.patch, A > B
8. If A.patch < B.patch, A < B
9. A == B

10.2.1.5 python_extra_paths

The `python_extra_paths` attribute is **optional**. This attribute provides a means for the extension developer to specify additional paths that will be included in the Python runtime environment in which the extension runs. Since it is impossible for the extension developer to know the path to the deployed extension at runtime, a special token is provided that will resolve to the deployed extension path at runtime: `${extension_zip}`.

At runtime, `${extension_zip}` will be replaced with the file system path to the deployed extension. For example, if an extension archive included a directory for test modules:

```
├── extension.py
├── extension.yml
└── test
    └── test1.py
    └── test2.py
    └── test3.py
```

The following `python_extra_paths` value would setup pathing in the runtime environment allowing the extension code to access the `test` package:

`python_extra_paths: ${extension_zip}/test`

10.2.1.6 zip_safe

The `zip_safe` attribute is **optional**. It specifies whether the extension should be run directly from the zip archive or extracted to the file system in a private cache and run from there. **The default value is true**.

This attribute was introduced in Universal Extension API level 1.4.0. In order for `zip_safe: false` to have any impact, the extension must specify a Universal Extension API level >= 1.4.0 via the `api_level` attribute in `extension.yml`.

If an extension requires "dependency packages" (introduced in Universal Extension API 1.4.0), the extension must specify `zip_safe: false`.

10.2.2 owner

This section pertains to the owner of the extension (the extension developer or developer's organization).

10.2.2.1 name

The `name` attribute is **optional**. Specifies the Universal Extension owner's name. This field is displayed in the Metadata section of an extensions Universal Template in the Universal Controller. It is for informational purposes only.

10.2.2.2 organization

The `organization` attribute is **optional**. Specifies the Universal Extension developer's organization. This field is displayed in the Metadata section of an extensions Universal Template in the Universal Controller. It is for informational purposes only.

10.2.3 comments

The `comments` section is **optional**. This attribute allows the extension developer to provide information about the extension. This field is displayed in the Metadata section of an extensions Universal Template in the Universal Controller. It is for informational purposes only.

10.3 Universal Extension Dependency Packages

10.3.1 Introduction

From the onset, Universal Extensions have supported the encapsulation of 3rd party modules/packages that are required by the extension for execution. However, prior to UAC 7.4.0, this support was limited to "pure Python" modules that are platform agnostic. Modules containing C libraries and other binary code were not supported. This was due, in part, to the fact that extensions were always executed directly from the zip archive that contained them - and binary content is not supported in this context. Furthermore, there was no means to "choose" extension content based on platform or Python runtime environment.

Starting with UAC 7.4.0.0, Universal Extensions support the ability to embed "Dependency Packages" within the extension archive. Dependency Packages remove the "pure python" restriction from what can be delivered with a Universal Extension. This makes it possible to build a wider range of extensions while reducing (or eliminating) any dependencies on the target system where extensions will run - beyond a Universal agent and Python.

10.3.2 What is a Dependency Package

A dependency package is an archive that contains an extension's dependencies. More specifically, a dependency package contains the dependencies required for a specific Python runtime environment (or range of runtime environments). Dependency package archive files use Python's "weel built package" naming convention:

```
{extension name}-{extension version}(-{build tag})?-{python tag}-{abitag}-{platform tag}.whl
```

This allows the Universal agent to select the appropriate dependency package for the Python environment an extension runs in.

10.3.3 How is a Dependency Package Created

Extension developers use the UIP-CLI utility to generate dependency packages for their extensions. The process is simple and automated. Just include the extension's dependencies in the project's requirements.txt file and UIP-CLI will perform the necessary steps with simple build commands. Additional information on using UIP-CLI to generate dependency packages can be found here,

> In the UAC 7.4.0 release, the dependency packages must be built on the target platforms. This can be done easily using UIP-CLI. However, at this time, the developer must collect the dependency packages generated on each system and place them in appropriate folder in the primary Universal Extension project that is used to generate the extension.

10.3.4 How is a Dependency Package Deployed

Dependency packages are built into an associated Universal extension archive. They are delivered to the target agent along with the extension archive during extension deployment. When the agent deploys an extension that contains dependency packages, it first selects an appropriate Python interpreter from the list of interpreters defined to that agent. It then chooses the best (most compatible) dependency package available in the extension archive. The chosen dependency package is then extracted to the system and setup for extension execution.

When instances of the extension are started by the agent, they will run under the same Python interpreter selected during deployment and the runtime environment will be setup with pathing that includes the dependencies from the deployed dependency package.

10.3.5 Developer Considerations

10.3.5.1 zip_safe

The `zip_safe` option in the `extension.yml` file of an extension must be set to `false` in order for a Universal agent to extract the extension and deploy a dependency package.

```
zip_safe: false
```

By specifying `zip_safe: false`, the extension is declaring that it is not safe to run the extension in the zipped form (<extension_archive>.zip).

10.3.5.2 requires_python

For extensions that use dependency packages, the developer should carefully consider the `requires_python` option specified in the extension's `extension.yml` file. The extension developer must deliver dependency packages that are compatible with any Python interpreter that could match the specified `requires_python` statement.

In many cases, a single dependency package may be compatible with many Python versions - possibly all targeted versions. In such a case, the extension developer would only need to provide one dependency package for each of the target platforms (Windows, linux, etc.). However, in some cases, the dependencies required by an extension are tightly coupled to a Python version. The `numpy` package is a good example of a tightly coupled dependency. Extensions including `numpy` in the dependency packages would have to deliver a separate dependency package for each version and for each python version - for each platform. In such a case, the extension developer may choose to be more restrictive in the `requires_python` statement to limit the number of dependency packages that need to be delivered. If not, the developer would have to at least understand what the chosen `requires_python` statement means in terms dependency requirements.

10.3.5.3 Testing

In order to provide a good experience for the end user of a Universal extension, the developer must ensure that the extensions contain the dependency resources that match the supported Python environments specified in the `requires_python` state ment of the `extension.yml` file. As stated in the previous section, the number of dependency packages required for a given extension is entirely dependent on the extension's particular dependencies. The extension developer must determine the compatibility breaking points between the minimum Python version specified in the `requires_python` clause and the maximum. At each breaking point, the developer would need to include a dependency package that satisfies the needs of that version.

10.4 Multithreading

10.4.1 Introduction

Universal Extensions run in a "worker process" that manages execution and facilitates integration services between the extension and the Universal Controller. The worker process utilizes Python threading capabilities to perform its required actions in a cooperative manner alongside the extension specific actions. In general, this is transparent to the extension developer and requires no special action on the developer's part. However, there are some concepts that would be helpful for the extension developer to keep in mind.

10.4.2 User Code Entry Points

The Universal Extension API provides four entry points where user code is executed:

- Dynamic Choice Command: `@dynamic_choice_command`
- Dynamic Command: `@dynamic_command`
- Extension Start: `extension_start()`
- Extension Cancel: `extension_cancel()`

Each of the entry points listed above run in their own thread. In most cases, there is only one user entry point that is executed during the lifespan of a worker process instance. For example, when an end user executes a Dynamic Choice command, a new worker process is started to process that command. It is impossible for two Dynamic Choice commands to run in the same process. It is also impossible for a Dynamic Choice command to run in the same process as any other user entry point.

The only scenario where multiple user entry points will be active in the same process is when in-process Dynamic Commands are run against an active extension instance. In this case, `extension_start()` and the executed in-process Dynamic Command(s) are both running in the same process. Additionally, asynchronous in-process Dynamic Commands may be run in parallel. It is therefore possible to have multiple Dynamic Commands executing simultaneously along with `extension_start()`. This scenario alone does not require any special action by the extension developer. However,

the point of in-process Dynamic Commands is their ability to interact with a running extension. It is these interactions that will potentially cross thread boundaries may require access to shared resources in a thread safe way.

10.4.3 Python Multithreading

Multithreading in Python can be useful for concurrent execution of tasks, but it also introduces some potential code problems. Below are some of the most common issues that may arise in a multithreaded environment along with techniques to prevent them.

10.4.3.1 Race Conditions

One of the most common problems is race condition, which occurs when two or more threads access and modify a shared resource without proper synchronization. For example, consider the following code that increments a global variable by one in two threads:

```
import threading

counter = 0

def increment():
    global counter
    counter += 1

t1 = threading.Thread(target=increment)
t2 = threading.Thread(target=increment)

t1.start()
t2.start()

t1.join()
t2.join()

print(counter)
```

The expected output of this code is 2, but it may sometimes print 1. This is because the counter += 1 operation is not atomic, and it involves three steps: reading the current value of counter, adding one to it, and writing the new value back to counter. If two threads perform this operation at the same time, they may read the same value of counter, increment it by one, and overwrite each other's result.

One way to solve this problem is to use a lock object, which prevents multiple threads from accessing a resource at the same time. A lock can be acquired and released by a thread using the acquire() and release() methods. Only one thread can hold a lock at a time, and other threads have to wait until the lock is released. For example, the following code uses a lock to protect the counter variable:

```
import threading

counter = 0
lock = threading.Lock()

def increment():
    global counter
    lock.acquire()
    counter += 1
```

```
    lock.release()

t1 = threading.Thread(target=increment)
t2 = threading.Thread(target=increment)

t1.start()
t2.start()

t1.join()
t2.join()

print(counter)
```

This code will always print 2, as each thread will increment the counter atomically.

10.4.3.2 Deadlocks

Using locks is a best practice for accessing shared resources in a multithreaded environment. However, using locks also introduces some overhead and complexity, and it may cause deadlock if not used carefully. Deadlock occurs when two or more threads are waiting for each other to release a lock that they hold. For example, consider the following code that tries to swap the values of two global variables using two locks:

```
import threading

a = 1
b = 2
lock_a = threading.Lock()
lock_b = threading.Lock()

def swap():
    global a, b
    lock_a.acquire()
    lock_b.acquire()
    a, b = b, a
    lock_b.release()
    lock_a.release()

t1 = threading.Thread(target=swap)
t2 = threading.Thread(target=swap)

t1.start()
t2.start()

t1.join()
t2.join()

print(a, b)
```

This code may never terminate, as each thread may acquire one lock and wait for the other lock to be released by the other thread. To avoid deadlock, one possible solution is to use a single lock for both variables, or to acquire the locks in the same order in both threads.

10.4.4 Conclusion

In conclusion, Universal Extensions run in a multithreaded environment. In most cases, the complexity of multithreading is transparent to the extension developer and no special action is required to deal with it. However, under certain scenarios, like when using in-process Dynamic Commands, the extension developer may have to take special precautions to ensure their code will perform in a thread safe manner. The sections above discuss the most common issues that may be encountered in such a scenario and ways to deal them. This is by no means a complete reference on the topic and the developer is encouraged to seek additional sources for a more complete understanding of multithreading programming in Python.