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# **SKA Tango Base Documentation**

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**NCRA India**

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This package provides shared functionality and patterns for SKA TANGO devices.



## DEVELOPER GUIDE

### 1.1 Getting started

This page will guide you through the steps to writing a SKA Tango device based on the `ska-tango-base` package.

#### 1.1.1 Prerequisites

It is assumed here that you have a subproject repository, and have [set up your development environment](#). The `ska-tango-base` package can be installed from the SKAO repository:

```
me@local:~$ python3 -m pip install --extra-index-url https://artefact.skao.int/  
↪ repository/pypi/simple ska-tango-base
```

#### 1.1.2 Basic steps

The recommended basic steps to writing a SKA Tango device based on the `ska-tango-base` package are:

1. Write a component manager.
2. Implement command class objects.
3. Write your Tango device.

#### 1.1.3 Detailed steps

##### Write a component manager

A fundamental assumption of this package is that each Tango device exists to provide monitoring and control of some *component* of a SKA telescope. That *component* could be some hardware, a software service or process, or even a group of subservient Tango devices.

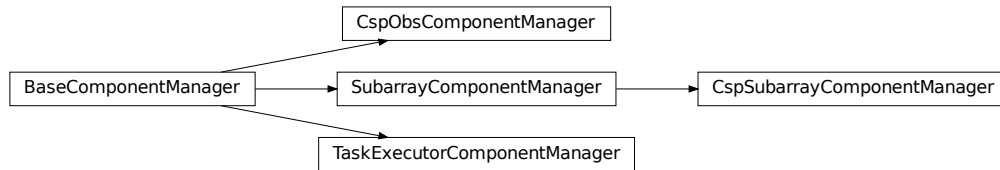
A *component manager* provides for monitoring and control of a component. It is *highly recommended* to implement and thoroughly test your component manager *before* embedding it in a Tango device.

For more information on components and component managers, see [Components and component managers](#).

Writing a component manager involves the following steps.

1. **Choose a subclass for your component manager.** There are several component manager base classes, each associated with a device class. For example,

- If your Tango device will inherit from `SKABaseDevice`, then you will probably want to base your component manager on the `BaseComponentManager` class.
- If your Tango device is a subarray, then you will want to base your component manager on `SubarrayComponentManager`.



These component managers are abstract. They specify an interface, but leave it up to you to implement the functionality. For example, `BaseComponentManager`'s `on()` command looks like this:

```
def on(self):
    raise NotImplementedError("BaseComponentManager is abstract.")
```

Your component manager will inherit these methods, and override them with actual implementations.

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**Note:** In addition to these abstract classes, there are also reference implementations of concrete subclasses. For example, in addition to an abstract `BaseComponentManager`, there is also a concrete `ReferenceBaseComponentManager`. These reference implementations are provided for explanatory purposes: they illustrate how a concrete component manager might be implemented. You are encouraged to review the reference implementations, and adapt them to your own needs; but it is not recommended to subclass from them.

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2. **Establish communication with your component.** How you do this will depend on the capabilities and interface of your component. for example:

- If the component interface is via a connection-oriented protocol (such as TCP/IP), then the component manager must establish and maintain a *connection* to the component;
- If the component is able to publish updates, then the component manager would need to subscribe to those updates;
- If the component cannot publish updates, but can only respond to requests, then the component manager would need to initiate polling of the component.

4. **Implement component monitoring.** Whenever your component changes its state, your component manager needs to become reliably aware of that change within a reasonable timeframe, so that it can pass this on to the Tango device.

The abstract component managers provided already contain some helper methods to trigger device callbacks. For example, `BaseComponentManager` provides a `component_fault` method that lets the device know that the component has experienced a fault. You need to implement component monitoring so that, if the component experiences a fault, this is detected, and results in the `component_fault` helper method being called.

For component-specific functionality, you will need to implement the corresponding helper methods. For example, if your component reports its temperature, then your component manager will need to

1. Implement a mechanism by which it can let its Tango device know that the component temperature has changed, such as a callback;



2. Implement monitoring so that this mechanism is triggered whenever a change in component temperature is detected.
5. **Implement component control.** Methods to control the component must be implemented; for example the component manager's `on()` method must be implemented to actually tell the component to turn on.

Note that component *control* and component *monitoring* are decoupled from each other. So, for example, a component manager's `on()` method should not directly call the callback that tells the device that the component is now on. Rather, the command should return without calling the callback, and leave it to the *monitoring* to detect when the component has changed states.

Consider, for example, a component that takes ten seconds to power up:

1. The `on()` command should be implemented to tell the component to power up. If the component accepts this command without complaint, then the `on()` command should return success. The component manager should not, however, assume that the component is now on.
2. After ten seconds, the component has powered up, and the component manager's monitoring detects that the component is on. Only then should the callback be called to let the device know that the component has changed state, resulting in a change of device state to ON.

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**Note:** A component manager may maintain additional state, and support additional commands, that do not map to its component. That is, a call to a component manager needs not always result in a call to the underlying component. For example, a subarray's component manager may implement its `assign_resources` method simply to maintain a record (within the component manager itself) of what resources it has, so that it can validate arguments to other methods (for example, check that arguments to its `configure` method do not require access to resources that have not been assigned to it). In this case, the call to the component manager's `assign_resources` method would not result in interaction with the component; indeed, the component may not even possess the concepts of *resources* and *resource assignment*.

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## Implement command class objects

Tango device command functionality is implemented in command *classes* rather than methods. This allows for:

- functionality common to many classes to be abstracted out and implemented once for all. For example, there are many commands associated with transitional states (*e.g.* `Configure()` command and CONFIGURING state, `Scan()` command and SCANNING state, *etc.*). Command classes allow us to implement this association once for all, and to protect that implementation from accidental overriding by command subclasses.
- testing of commands independently of Tango. For example, a Tango device's `On()` command might only need to interact with the device's component manager and its operational state model. As such, in order to test the correct implementation of that command, we only need a component manager and an operational state model. Thus, we can test the command without actually instantiating the Tango device.

Writing a command class involves the following steps.

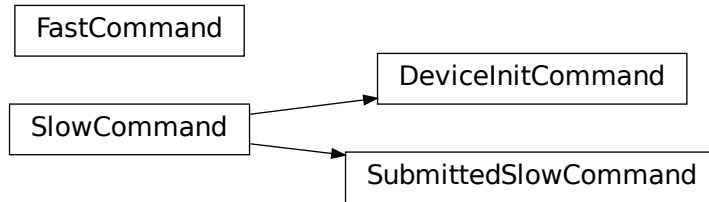
1. **Do you really need to implement the command?** If the command to be implemented is part of the Tango device you will inherit from, perhaps the current implementation is exactly what you need.

For example, the `SKABaseDevice` class's implementation of the `On()` command simply calls its component manager's `on()` method. Maybe you don't need to change that; you've implemented your component manager's `on()` method, and that's all there is to do.

2. **Choose a command class to subclass.**

- If the command to be implemented is part of the device you will inherit from (but you still need to override it), then you would generally subclass the base device's command class. For example, if you need to override `SKABaseDevice`'s `Standby` command, then you would subclass `SKABaseDevice.StandbyCommand`.

- If the command is a new command, not present in the base device class, then you will want to inherit from one or more command classes in the `ska_tango_base.commands` module.



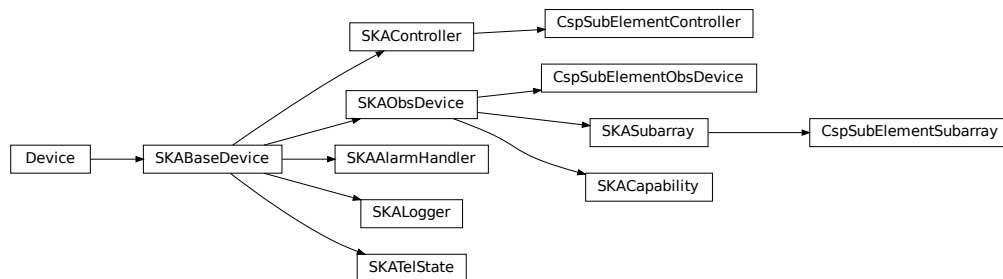
### 3. Implement class methods.

- In many cases, you only need to implement the `do()` method.
- To constrain when the command is allowed to be invoked, override the `is_allowed()` method.

## Write your Tango device

Writing the Tango device involves the following steps:

### 1. Select a device class to subclass.



- ### 2. Register your component manager.
- This is done by overriding the `create_component_manager` class to return your component manager object:

```
def create_component_manager(self):  
    return AntennaComponentManager(  
        self.op_state_model, logger=self.logger  
    )
```

- ### 3. Implement commands.
- You've already written the command classes. There is some boilerplate to ensure that the Tango command methods invoke the command classes:

1. Registration occurs in the `init_command_objects` method, using calls to the `register_command_object` helper method. Implement the `init_command_objects` method:

```
def init_command_objects(self):
    super().init_command_objects()

    self.register_command_object(
        "DoStuff", self.DoStuffCommand(self.component_manager, self.logger)
    )
    self.register_command_object(
        "DoOtherStuff", self.DoOtherStuffCommand(
            self.component_manager, self.logger
        )
    )
)
```

2. Any new commands need to be implemented as:

```
@command(dtype_in=..., dtype_out=...)
def DoStuff(self, argin):
    command = self.get_command_object("DoStuff")
    return command(argin)
```

or, if the command does not take an argument:

```
@command(dtype_out=...)
def DoStuff(self):
    command = self.get_command_object("DoStuff")
    return command()
```

Note that these two examples deliberately push all SKA business logic down to the command class (at least) or even the component manager. It is highly recommended not to include SKA business logic in Tango devices. However, Tango-specific functionality can and should be implemented directly into the command method. For example, many SKA commands accept a JSON string as argument, as a workaround for the fact that Tango commands cannot accept more than one argument. Since this use of JSON is closely associated with Tango, we might choose to unpack our JSON strings in the command method itself, thus leaving our command objects free of JSON:

```
@command(dtype_in=..., dtype_out=...)
def DoStuff(self, argin):
    args = json.loads(argin)
    command = self.get_command_object("DoStuff")
    return command(args)
```

## 1.2 Components and component managers

A fundamental assumption of this package is that each Tango device exists to provide monitoring and control of some *component* of a SKA telescope.

A *component* could be (for example):

- Hardware such as an antenna, dish, atomic clock, TPM, switch, etc
- An external service such as a database or cluster workload manager
- A software process or thread launched by the Tango device.
- In a hierarchical system, a group of subservient Tango devices.

By analogy, if the *component* is a television, the Tango device would be the remote control for that television.

## 1.2.1 Tango devices and their components

Note the distinction between a component and the Tango device that is responsible for monitoring and controlling that component.

A component might be hardware equipment installed on site, such as a dish or an antenna. The Tango device that monitors that component is a software object, in a process running on a server, probably located in a server room some distance away. Thus the Tango device and its component are largely independent of each other:

- A Tango device may be running normally when its component is in a fault state, or turned off, or even not fitted. Device states like OFF and FAULT represent the state of the monitored component. A Tango device that reports OFF state is running normally, and reporting that its component is turned off. A Tango device that reports FAULT state is running normally, and reporting that its component is in a fault state.
- When a Tango device itself experiences a fault (for example, its server crashes), this is not expected to affect the component. The component continues to run; the only impact is it can no longer be monitored or controlled.

By analogy: when the batteries in your TV remote control go flat, the TV continues to run.

- We should not assume that a component's state is governed solely by its Tango device. On the contrary, components are influenced by a wide range of factors. For example, the following are ways in which a component might be switched off:
  - Its Tango device switches it off via its software interface;
  - Some other software entity switches it off via its software interface;
  - The hardware switches itself off, or its firmware switches it off, because it detected a critical fault.
  - The equipment's power button is pressed;
  - An upstream power supply device denies it power.

A Tango device therefore must not treat its component as under its sole control. For example, having turned its component on, it must not assume that the component will remain on. Rather, it must continually *monitor* its component, and update its state to reflect changes in component state.

## 1.2.2 Component monitoring

Component *monitoring* is the main mechanism by which a Tango device maintains and updates its state:

- A Tango device should not make assumptions about component state after issuing a command. For example, after successfully telling its component to turn on, a Tango device should not assume that the component is on, and transition immediately to ON state. Rather, it should wait for its monitoring of the component to provide confirmation that the component is on; only then should it transition to ON state. It follows that a Tango device's On() command might complete successfully, yet the device's state() might not report ON state immediately, or for some seconds, or indeed at all.
- A Tango device also should not make assumptions about component state when the Tango device is *initialising*. For example, in a normal controlled startup of a telescope, an initialising Tango device might expect to find its component switched off, and to be itself responsible for switching the component on at the proper time. However, this is not the only circumstance in which a Tango device might initialise; the Tango device would also have to initialise following a reboot of the server on which it runs. In such a case, the component might already be switched on. Thus, at initialisation, a Tango device should merely launch the component monitoring that will allow the device to detect the state of the component.

### 1.2.3 Component managers

A Tango device's responsibility to monitor and control its component is largely separate from its interface to the Tango subsystem. Therefore, devices in this package implement component monitoring and control in a separate *component manager*.

A component manager is responsible for:

- establishing and maintaining communication with the component. For example:
  - If the component interface is via a connection-oriented protocol (such as TCP/IP), then the component manager must establish and maintain a *connection* to the component;
  - If the component is able to publish updates, then the component manager would need to subscribe to those updates;
  - If the component cannot publish updates, but can only respond to requests, then the component manager would need to initiate polling of the component.
- implementing monitoring of the component so that changes in component state trigger callbacks that report those changes up to the Tango device;
- implementing commands such as `off()`, `on()`, etc., so that they actually tell the component to turn off, turn on, etc.

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**Note:** It is highly recommended to implement your component manager, and thoroughly test it, *before* embedding it in a Tango device.

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## 1.3 Long Running Commands

Many SKA device commands involve actions whose duration is inherently slow or unpredictable. For example, a command might need to interact with hardware, other devices, or other external systems over a network; read to or write from a file system; or perform intensive computation. If a TANGO device blocks while such a command runs, then there is a period of time in which it cannot respond to other requests. Its overall performance declines, and timeouts may even occur.

To address this, the base device provides long running commands (LRC) support, in the form of an interface and mechanism for running such commands asynchronously.

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**Note:** Long Running Command: A TANGO command for which the execution time is in the order of seconds (CS Guidelines recommends less than 10 ms). In this context it also means a command which is implemented to execute asynchronously. Long running, slow command and asynchronous command are used interchangeably in this text and the code base. In the event where the meaning differ it will be explained but all refer to non-blocking calls.

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This means that devices return immediately with a response while busy with the actual task in the background or parked on a queue pending the next available worker.

New attributes and commands have been added to the base device to support the mechanism to execute long running TANGO commands asynchronously.

### 1.3.1 Monitoring Progress of Long Running Commands

In addition to the listed requirements above, the device should provide monitoring points to allow clients determine when a LRC is received, executing or completed (success or fail). LRCs can assume any of the following defined task states: STAGING, QUEUED, IN\_PROGRESS, ABORTED, NOT\_FOUND, COMPLETED, REJECTED, FAILED.

A new set of attributes and commands have been added to the base device to enable monitoring and reporting of result, status and progress of LRCs.

#### LRC Attributes

Attribute	Example Value	Description
longRunning-CommandsIn-Queue	('StandbyCommand', 'OnCommand', 'OffCommand')	Keeps track of which commands are on the queue
longRunning-Command-IDsInQueue	('1636437568.0723004_235210334802782_OnCommand', '1636437789.493874_116219429722764_OffCommand')	Keeps track of IDs in the queue
longRunning-CommandStatus	('1636437568.0723004_235210334802782_OnCommand', 'IN_PROGRESS', '1636437789.493874_116219429722764_OffCommand', 'IN_PROGRESS')	ID, status pair of the currently executing commands
longRunning-Command-Progress	('1636437568.0723004_235210334802782_OnCommand', '12', '1636437789.493874_116219429722764_OffCommand', '1')	ID, progress pair of the currently executing commands
longRunning-CommandResult	('1636438076.6105473_101143779281769_OnCommand', '0', 'OK')	ID, ResultCode, result of the completed command

#### LRC Commands

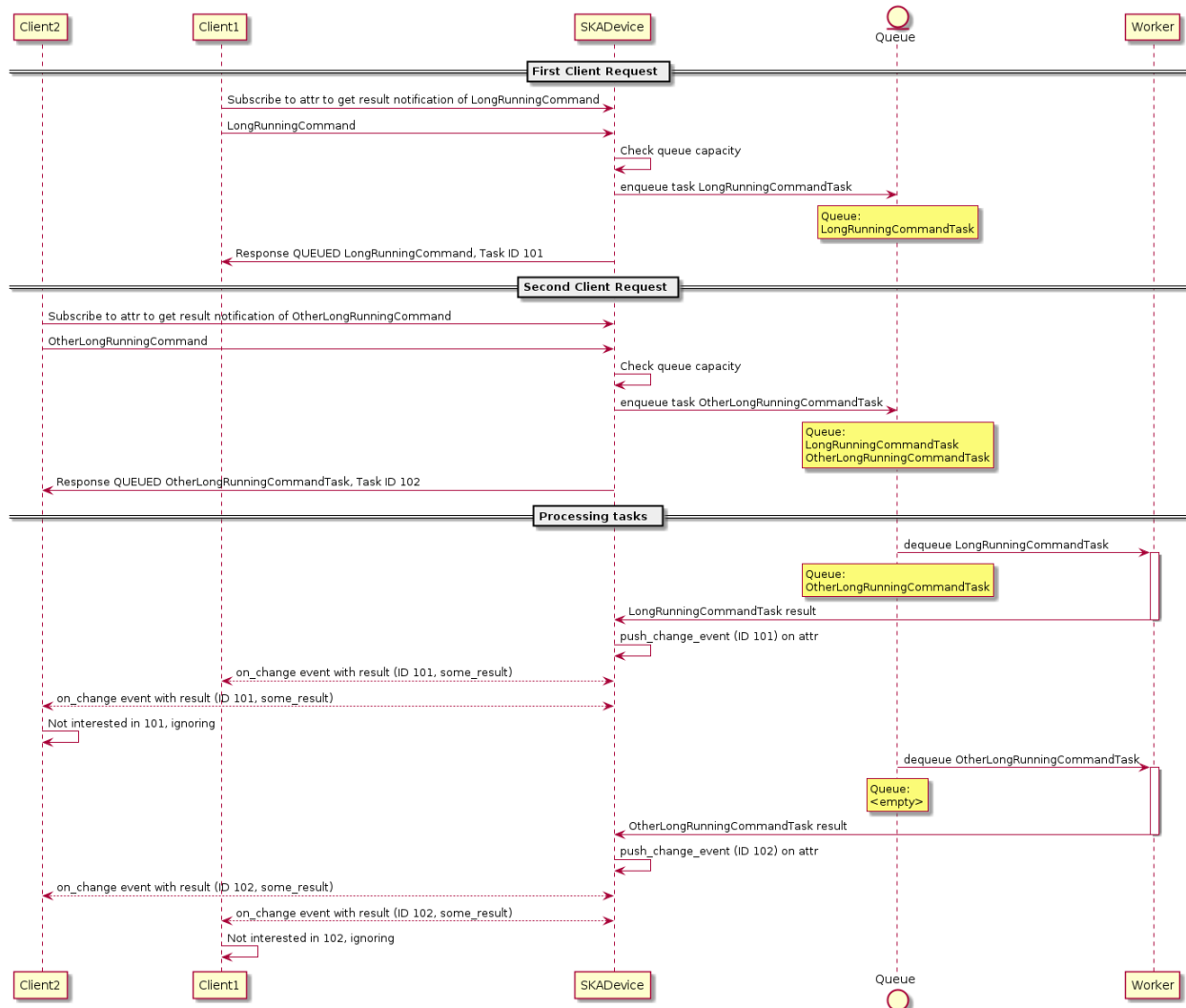
Command	Description
CheckLongRunningCommandStatus	Check the status of a long running command by ID
AbortCommands	Abort the currently executing LRCs and remove all enqueued LRCs

In addition to the set of commands in the table above, a number of candidate SKA commands in the base device previously implemented as blocking commands have been converted to execute as long running commands (asynchronously), viz: Standby, On, Off, Reset and GetVersionInfo.

The device has change events configured for all the LRC attributes which clients can use to track their requests. **The client has the responsibility of subscribing to events to receive changes on command status and results.**

### 1.3.2 UML Illustration

## Multiple Clients Invoke Multiple Long Running Commands



### 1.3.3 How to implement a long running command using the provided executor

A task executor has been provisioned to handle the asynchronous execution of tasks put on the queue. Your sample component manager will be asynchronous if it inherits from the provisioned executor. You can also swap out the default executor with any asynchronous mechanism for your component manager.

## Create a component manager

```
class SampleComponentManager(TaskExecutorComponentManager):
    """A sample component manager"""

    def __init__(
        self,
        *args,
        max_workers: Optional[int] = None,
        logger: logging.Logger = None,
        **kwargs,
    ):
        """Init SampleComponentManager."""

        # Set up your class

        super().__init__(*args, max_workers=max_workers, logger=logger, **kwargs)
```

## Add a method that should be executed in a background thread

```
# class SampleComponentManager

def _a_very_slow_method(
    logger: logging.Logger,
    task_callback: Callable = None,
    task_abort_event: Event = None,
):
    """This is a long running method

    :param logger: logger
    :type logger: logging.Logger
    :param task_callback: Update task state, defaults to None
    :type task_callback: Callable, optional
    :param task_abort_event: Check for abort, defaults to None
    :type task_abort_event: Event, optional
    """

    # Indicate that the task has started
    task_callback(status=TaskStatus.IN_PROGRESS)
    for current_iteration in range(100):
        # Update the task progress
        task_callback(progress=current_iteration)

        # Do something
        time.sleep(10)

    # Periodically check that tasks have not been ABORTED
    if task_abort_event.is_set():
        # Indicate that the task has been aborted
        task_callback(status=TaskStatus.ABORTED, result="This task aborted")
    return
```

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```
# Indicate that the task has completed
task_callback(status=TaskStatus.COMPLETED, result="This slow task has completed")
```

### Add a method to submit the slow method

```
# class SampleComponentManager

def submit_slow_method(self, task_callback: Callable = None):
    """Submit the slow task.

    This method returns immediately after it submitted
    `self._a_very_slow_method` for execution.

    :param task_callback: Update task state, defaults to None
    :type task_callback: Callable, optional
    """
    task_status, response = self.submit_task(
        self._a_very_slow_method, args=[], task_callback=task_callback
    )
    return task_status, response
```

### Create the component manager in your Tango device

```
class SampleDevice(SKABaseDevice):
    """A sample Tango device"""

    def create_component_manager(self):
        """Create a component manager."""
        return SampleComponentManager(
            max_workers=2,
            logger=self.logger,
            communication_state_callback=self._communication_state_changed,
            component_state_callback=self._component_state_changed,
        )
```

### Init the command object

```
# class SampleDevice(SKABaseDevice):

def init_command_objects(self):
    """Initialise the command handlers."""
    super().init_command_objects()

    ...

    self.register_command_object(
        "VerySlow",
```

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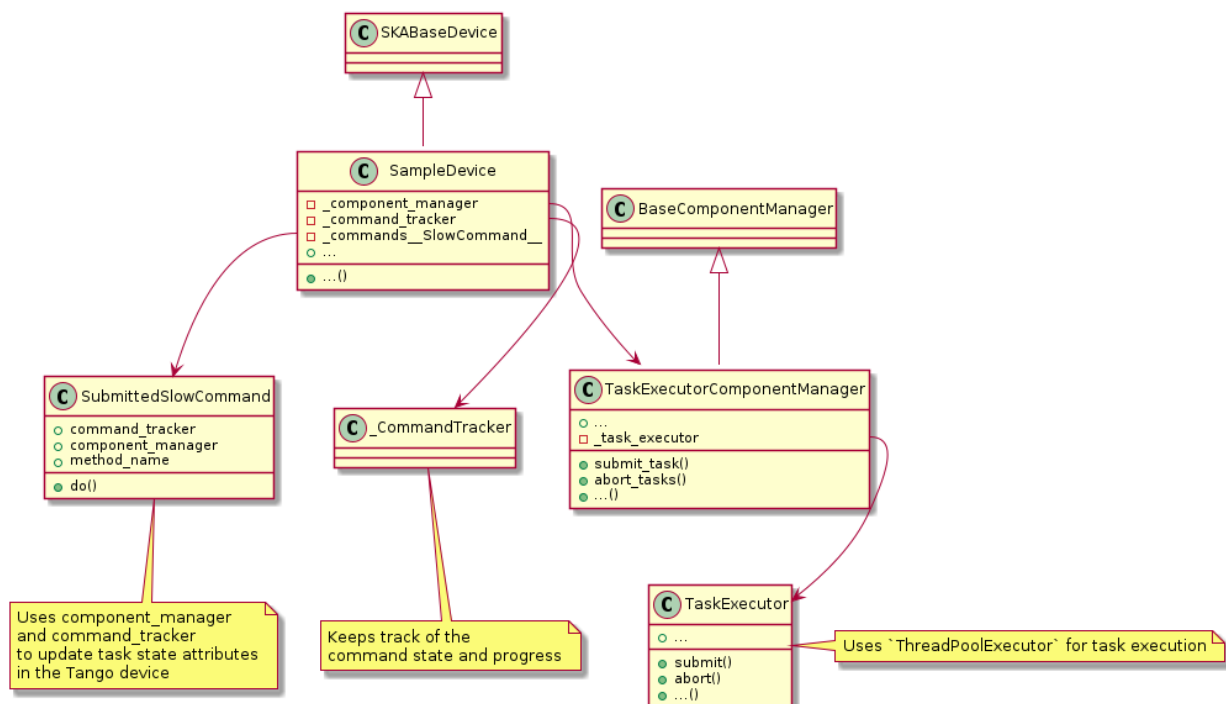
```
SubmittedSlowCommand(  
    "VerySlow",  
    self._command_tracker,  
    self.component_manager,  
    "submit_slow_method",  
    callback=None,  
    logger=self.logger,  
),  
)
```

## Create the Tango Command

```
# class SampleDevice(SKABaseDevice):

    @command(
        dtype_in=None,
        dtype_out="DevVarStringArray",
    )
    @DebugIt()
    def VerySlow(self):
        """A very slow command."""
        handler = self.get_command_object("VerySlow")
        (return_code, message) = handler()
        return f"{return_code}", message
```

### 1.3.4 Class diagram



## 2.1 Base subpackage

This subpackage implements functionality common to all SKA Tango devices.

### 2.1.1 Admin Mode Model

This module provides the admin mode model for SKA LMC Tango devices.

The model is now defined in the `ska_control_model` package, but is imported here for backwards compatibility.

### 2.1.2 Op State Model

This module provides the op state model for SKA LMC Tango devices.

The model is now defined in the `ska_control_model` package, but is imported here for backwards compatibility.

### 2.1.3 Base Component Manager

This module provides an abstract component manager for SKA Tango base devices.

The basic model is:

- Every Tango device has a *component* that it monitors and/or controls. That component could be, for example:
  - Hardware such as an antenna, APIU, TPM, switch, subrack, etc.
  - An external software system such as a cluster manager
  - A software routine, possibly implemented within the Tango device itself
  - In a hierarchical system, a pool of lower-level Tango devices.
- A Tango device will usually need to establish and maintain *communication* with its component. This connection may be deliberately broken by the device, or it may fail.
- A Tango device *controls* its component by issuing commands that cause the component to change behaviour and/or state; and it *monitors* its component by keeping track of its state.

**check\_communicating**(*func*: *Wrapped*) → *Wrapped*

Return a function that checks component communication before calling a function.

The component manager needs to have established communications with the component, in order for the function to be called.

This function is intended to be used as a decorator:

```
@check_communicating
def scan(self):
    ...
```

**Parameters**

**func** – the wrapped function

**Returns**

the wrapped function

**check\_on**(*func: Wrapped*) → *Wrapped*

Return a function that checks the component state then calls another function.

The component needs to be turned on, and not faulty, in order for the function to be called.

This function is intended to be used as a decorator:

```
@check_on
def scan(self):
    ...
```

**Parameters**

**func** – the wrapped function

**Returns**

the wrapped function

**class BaseComponentManager**(*logger: Logger, communication\_state\_callback: Optional[Callable[[CommunicationStatus], None]] = None, component\_state\_callback: Optional[Callable[[...], None]] = None, \*\*state: Any*)

An abstract base class for a component manager for SKA Tango devices.

It supports:

- Maintaining a connection to its component
- Controlling its component via commands like Off(), Standby(), On(), etc.
- Monitoring its component, e.g. detect that it has been turned off or on

**start\_communicating**() → *None*

Establish communication with the component, then start monitoring.

This is the place to do things like:

- Initiate a connection to the component (if your communication is connection-oriented)
- Subscribe to component events (if using “pull” model)
- Start a polling loop to monitor the component (if using a “push” model)

**Raises**

**NotImplementedError** – Not implemented it's an abstract class

**stop\_communicating()** → `None`

Cease monitoring the component, and break off all communication with it.

For example,

- If you are communicating over a connection, disconnect.
- If you have subscribed to events, unsubscribe.
- If you are running a polling loop, stop it.

**Raises**

`NotImplementedError` – Not implemented it's an abstract class

**property communication\_state:** `CommunicationStatus`

Return the communication status of this component manager.

**Returns**

status of the communication channel with the component.

**property component\_state:** `dict[str, Any]`

Return the state of this component manager's component.

**Returns**

state of the component.

**off**(*task\_callback: Optional[Callable] = None*) → `tuple[TaskStatus, str]`

Turn the component off.

**Parameters**

**task\_callback** – callback to be called when the status of the command changes

**Raises**

`NotImplementedError` – Not implemented it's an abstract class

**standby**(*task\_callback: Optional[Callable] = None*) → `tuple[TaskStatus, str]`

Put the component into low-power standby mode.

**Parameters**

**task\_callback** – callback to be called when the status of the command changes

**Raises**

`NotImplementedError` – Not implemented it's an abstract class

**on**(*task\_callback: Optional[Callable] = None*) → `tuple[TaskStatus, str]`

Turn the component on.

**Parameters**

**task\_callback** – callback to be called when the status of the command changes

**Raises**

`NotImplementedError` – Not implemented it's an abstract class

**reset**(*task\_callback: Optional[Callable] = None*) → `tuple[TaskStatus, str]`

Reset the component (from fault state).

**Parameters**

**task\_callback** – callback to be called when the status of the command changes

**Raises**

`NotImplementedError` – Not implemented it's an abstract class

**abort\_tasks**(*task\_callback: Optional[Callable] = None*) → *tuple[TaskStatus, str]*

Abort all tasks queued & running.

**Parameters**

**task\_callback** – callback to be called whenever the status of the task changes.

**Raises**

**NotImplementedError** – Not implemented it's an abstract class

**class TaskExecutorComponentManager**(\*args: *Any*, max\_workers: *Optional[int] = None*, \*\*kwargs: *Any*)

A component manager with support for asynchronous tasking.

**submit\_task**(*func: Callable*, args: *Optional[Any] = None*, kwargs: *Optional[Any] = None*, task\_callback: *Optional[Callable] = None*) → *tuple[TaskStatus, str]*

Submit a task to the task executor.

**Parameters**

- **func** – function/bound method to be run
- **args** – positional arguments to the function
- **kwargs** – keyword arguments to the function
- **task\_callback** – callback to be called whenever the status of the task changes.

**Returns**

tuple of taskstatus & message

**abort\_tasks**(*task\_callback: Optional[Callable] = None*) → *tuple[TaskStatus, str]*

Tell the task executor to abort all tasks.

**Parameters**

**task\_callback** – callback to be called whenever the status of this abort task changes.

**Returns**

tuple of taskstatus & message

## 2.1.4 Base Device

This module implements a generic base model and device for SKA.

It exposes the generic attributes, properties and commands of an SKA device.

**class SKABaseDevice**(\*args: *Any*, \*\*kwargs: *Any*)

A generic base device for SKA.

**class InitCommand**(*device: tango.server.Device*, *logger: Optional[Logger] = None*)

A class for the SKABaseDevice's init\_device() "command".

**do()** → *tuple[ResultCode, str]*

Stateless hook for device initialisation.

**Returns**

A tuple containing a return code and a string message indicating status. The message is for information purpose only.

**Return type**

(*ResultCode*, *str*)

**SkaLevel**

Device property.

Indication of importance of the device in the SKA hierarchy to support drill-down navigation: 1..6, with 1 highest.

**GroupDefinitions**

Device property.

Each string in the list is a JSON serialised dict defining the `group_name`, `devices` and `subgroups` in the group. A Tango Group object is created for each item in the list, according to the hierarchy defined. This provides easy access to the managed devices in bulk, or individually.

The general format of the list is as follows, with optional `devices` and `subgroups` keys:

```
[ {"group_name": "<name>",
  "devices": ["<dev name>", ...]},
  {"group_name": "<name>",
   "devices": ["<dev name>", "<dev name>", ...],
   "subgroups": [{<nested group>},
                  {<nested group>}, ...]},
  ...
]
```

For example, a hierarchy of racks, servers and switches:

```
[ {"group_name": "servers",
  "devices": ["elt/server/1", "elt/server/2",
              "elt/server/3", "elt/server/4"]},
  {"group_name": "switches",
   "devices": ["elt/switch/A", "elt/switch/B"]},
  {"group_name": "pdus",
   "devices": ["elt/pdu/rackA", "elt/pdu/rackB"]},
  {"group_name": "racks",
   "subgroups": [
     {"group_name": "rackA",
      "devices": ["elt/server/1", "elt/server/2",
                  "elt/switch/A", "elt/pdu/rackA"]},
     {"group_name": "rackB",
      "devices": ["elt/server/3", "elt/server/4",
                  "elt/switch/B", "elt/pdu/rackB"]},
     "subgroups": []}
  ] }
```

**LoggingLevelDefault**

Device property.

Default logging level at device startup. See [LoggingLevel](#)

**LoggingTargetsDefault**

Device property.

Default logging targets at device startup. See the project readme for details.

**init\_device()** → `None`

Initialise the tango device after startup.

Subclasses that have no need to override the default implementation of state management may leave `init_device()` alone. Override the `do()` method on the nested class `InitCommand` instead.

**set\_logging\_level**(*value*: *LoggingLevel*) → *None*

Set the logging level for the device.

Both the Python logger and the Tango logger are updated.

**Parameters**

**value** – Logging level for logger

**Raises**

*LoggingLevelError* – for invalid value

**set\_logging\_targets**(*targets*: *list[str]*) → *None*

Set the additional logging targets for the device.

Note that this excludes the handlers provided by the `ska_ser_logging` library defaults.

**Parameters**

**targets** – Logging targets for logger

**create\_component\_manager**() → *BaseComponentManager*

Create and return a component manager for this device.

**Raises**

*NotImplementedError* – for no implementation

**register\_command\_object**(*command\_name*: *str*, *command\_object*: *FastCommand* | *SlowCommand*) → *None*

Register an object as a handler for a command.

**Parameters**

- **command\_name** – name of the command for which the object is being registered
- **command\_object** – the object that will handle invocations of the given command

**get\_command\_object**(*command\_name*: *str*) → *FastCommand* | *SlowCommand*

Return the command object (handler) for a given command.

**Parameters**

**command\_name** – name of the command for which a command object (handler) is sought

**Returns**

the registered command object (handler) for the command

**init\_command\_objects**() → *None*

Register command objects (handlers) for this device's commands.

**always\_executed\_hook**() → *None*

Perform actions that are executed before every device command.

This is a Tango hook.

**delete\_device**() → *None*

Clean up any resources prior to device deletion.

This method is a Tango hook that is called by the device destructor and by the device Init command. It allows for any memory or other resources allocated in the `init_device` method to be released prior to device deletion.



**buildState()** → *str*

Read the Build State of the device.

**Returns**

the build state of the device

**versionId()** → *str*

Read the Version Id of the device.

**Returns**

the version id of the device

**loggingLevel(value: *LoggingLevel*)** → *None*

Set the logging level for the device.

Both the Python logger and the Tango logger are updated.

**Parameters**

**value** – Logging level for logger

**loggingTargets(value: *list[str]*)** → *None*

Set the additional logging targets for the device.

Note that this excludes the handlers provided by the `ska_ser_logging` library defaults.

**Parameters**

**value** – Logging targets for logger

**healthState()** → *HealthState*

Read the Health State of the device.

It interprets the current device condition and condition of all managed devices to set this. Most possibly an aggregate attribute.

**Returns**

Health State of the device

**adminMode(value: *AdminMode*)** → *None*

Set the Admin Mode of the device.

**Parameters**

**value** – Admin Mode of the device.

**Raises**

**ValueError** – for unknown adminMode

**controlMode(value: *ControlMode*)** → *None*

Set the Control Mode of the device.

**Parameters**

**value** – Control mode value

**simulationMode(value: *SimulationMode*)** → *None*

Set the Simulation Mode of the device.

**Parameters**

**value** – SimulationMode

**testMode(value: *TestMode*)** → *None*

Set the Test Mode of the device.

**Parameters**

**value** – Test Mode

**longRunningCommandsInQueue()** → list[str]

Read the long running commands in the queue.

Keep track of which commands are in the queue. Pop off from front as they complete.

**Returns**

tasks in the queue

**longRunningCommandIDsInQueue()** → list[str]

Read the IDs of the long running commands in the queue.

Every client that executes a command will receive a command ID as response. Keep track of IDs in the queue. Pop off from front as they complete.

**Returns**

unique ids for the enqueued commands

**longRunningCommandStatus()** → list[str]

Read the status of the currently executing long running commands.

ID, status pair of the currently executing command. Clients can subscribe to on\_change event and wait for the ID they are interested in.

**Returns**

ID, status pairs of the currently executing commands

**longRunningCommandProgress()** → list[str]

Read the progress of the currently executing long running command.

ID, progress of the currently executing command. Clients can subscribe to on\_change event and wait for the ID they are interested in.

**Returns**

ID, progress of the currently executing command.

**longRunningCommandResult()** → tuple[str, str]

Read the result of the completed long running command.

Reports unique\_id, json-encoded result. Clients can subscribe to on\_change event and wait for the ID they are interested in.

**Returns**

ID, result.

**is\_Reset\_allowed()** → bool

Return whether the *Reset* command may be called in the current device state.

**Returns**

whether the command may be called in the current device state

**is\_Standby\_allowed()** → bool

Return whether the *Standby* command may be called in the current device state.

**Returns**

whether the command may be called in the current device state

**is\_Off\_allowed()** → bool

Return whether the *Off* command may be called in the current device state.

**Returns**

whether the command may be called in the current device state

**is\_On\_allowed()** → bool

Return whether the *On* command may be called in the current device state.

**Returns**

whether the command may be called in the current device state

**class AbortCommandsCommand**(*component\_manager*: BaseComponentManager, *logger*: Optional[Logger] = None)

The command class for the AbortCommand command.

**do()** → tuple[ResultCode, str]

Abort long running commands.

Abort the currently executing LRC and remove all enqueued LRCs.

**Returns**

A tuple containing a return code and a string message indicating status. The message is for information purpose only.

**class CheckLongRunningCommandStatusCommand**(*command\_tracker*: CommandTracker, *logger*: Optional[Logger] = None)

The command class for the CheckLongRunningCommandStatus command.

**do**(*argin*: str) → str

Determine the status of the command ID passed in, if any.

- Check *command\_result* to see if it's finished.
- Check *command\_status* to see if it's in progress
- Check *command\_ids\_in\_queue* to see if it's queued

**Parameters**

**argin** – The command ID

**Returns**

The string of the TaskStatus

**class DebugDeviceCommand**(*device*: tango.server.Device, *logger*: Optional[Logger] = None)

A class for the SKABaseDevice's DebugDevice() command.

**do()** → int

Stateless hook for device DebugDevice() command.

Starts the debugpy debugger listening for remote connections (via Debugger Adaptor Protocol), and patches all methods so that they can be debugged.

If the debugger is already listening, additional execution of this command will trigger a breakpoint.

**Returns**

The TCP port the debugger is listening on.

**start\_debugger\_and\_get\_port**(*port*: int) → int

Start the debugger and return the allocated port.

**Parameters**

**port** – port to listen on

**Returns**

allocated port

**monkey\_patch\_all\_methods\_for\_debugger()** → None

Monkeypatch methods that need to be patched for the debugger.

**get\_all\_methods()** → list[tuple[object, str, Any]]

Return a list of the device's methods.

**Returns**

list of device methods

**static method\_must\_be\_patched\_for\_debugger**(owner: *object*, method: *method*) → *bool*

Determine if methods are worth debugging.

The goal is to find all the user's Python methods, but not the lower level PyTango device and Boost extension methods. The *types.FunctionType* check excludes the Boost methods.

**Parameters**

- **owner** – owner
- **method** – the name

**Returns**

True if the method contains more than the skipped modules.

**patch\_method\_for\_debugger**(owner: *object*, name: *str*, method: *object*) → *None*

Ensure method calls trigger the debugger.

Most methods in a device are executed by calls from threads spawned by the cppTango layer. These threads are not known to Python, so we have to explicitly inform the debugger about them.

**Parameters**

- **owner** – owner
- **name** – the name
- **method** – method

**set\_state**(state: *tango.DevState*) → *None*

Set the device server state.

This is dependent on whether the set state call has been actioned from a native python thread or a tango omni thread

**Parameters**

**state** – the new device state

**set\_status**(status: *str*) → *None*

Set the device server status string.

This is dependent on whether the set status call has been actioned from a native python thread or a tango omni thread

**Parameters**

**status** – the new device status

**push\_change\_event**(name: *str*, value: *Optional[Any]* = *None*) → *None*

Push a device server change event.

This is dependent on whether the push\_change\_event call has been actioned from a native python thread or a tango omni thread

**Parameters**

- **name** – the event name
- **value** – the event value

**push\_archive\_event**(name: *str*, value: *Optional[Any]* = *None*) → *None*

Push a device server archive event.

This is dependent on whether the push\_archive\_event call has been actioned from a native python thread or a tango omni thread

**Parameters**

- **name** – the event name
- **value** – the event value

**PushChanges()** → *None*

Push changes from state change & events that have been pushed on the queue.

The poll time is initially 5ms, to circumvent the problem of device initialisation, but is reset to 100ms after the first pass.

**main(\*args: *str*, \*\*kwargs: *str*)** → *int*

Entry point for module.

#### Parameters

- **args** – positional arguments
- **kwargs** – named arguments

#### Returns

exit code

```
class CommandTracker(queue_changed_callback: Callable[[list[tuple[str, str]]], None],
                      status_changed_callback: Callable[[list[tuple[str, TaskStatus]]], None],
                      progress_changed_callback: Callable[[list[tuple[str, int]]], None], result_callback:
                      Callable[[str, tuple[ResultCode, str]], None], exception_callback:
                      Optional[Callable[[str, Exception], None]] = None, removal_time: float = 10.0)
```

A class for keeping track of the state and progress of commands.

**new\_command**(command\_name: *str*, completed\_callback: *Optional*[Callable[[], None]] = None) → *str*

Create a new command.

#### Parameters

- **command\_name** – the command name
- **completed\_callback** – an optional callback for command completion

#### Returns

a unique command id

```
update_command_info(command_id: str, status: Optional[TaskStatus] = None, progress: Optional[int] =
                    None, result: Optional[tuple[ResultCode, str]] = None, exception:
                    Optional[Exception] = None) → None
```

Update status information on the command.

#### Parameters

- **command\_id** – the unique command id
- **status** – the status of the asynchronous task
- **progress** – the progress of the asynchronous task
- **result** – the result of the completed asynchronous task
- **exception** – any exception caught in the running task

**property commands\_in\_queue:** *list*[tuple[*str*, *str*]]

Return a list of commands in the queue.

#### Returns

a list of (command\_id, command\_name) tuples, ordered by when invoked.

**property** `command_statuses`: `list[tuple[str, TaskStatus]]`

Return a list of command statuses for commands in the queue.

**Returns**

a list of (command\_id, status) tuples, ordered by when invoked.

**property** `command_progresses`: `list[tuple[str, int]]`

Return a list of command progresses for commands in the queue.

**Returns**

a list of (command\_id, progress) tuples, ordered by when invoked.

**property** `command_result`: `Optional[tuple[str, Optional[tuple[ResultCode, str]]]]`

Return the result of the most recently completed command.

**Returns**

a (command\_id, result) tuple. If no command has completed yet, then None.

**property** `command_exception`: `Optional[tuple[str, Exception]]`

Return the most recent exception, if any.

**Returns**

a (command\_id, exception) tuple. If no command has raised an uncaught exception, then None.

**get\_command\_status**(*command\_id*: *str*) → *TaskStatus*

Return the current status of a running command.

**Parameters**

`command_id` – the unique command id

**Returns**

a status of the asynchronous task.

## 2.2 Obs subpackage

This subpackage models a SKA Tango observing device.

### 2.2.1 Obs State Model

This module provides the state model for observation state.

The model is now defined in the `ska_control_model` package, but is imported here for backwards compatibility.

### 2.2.2 Obs Device

SKAObsDevice.

A generic base device for Observations for SKA. It inherits SKABaseDevice class. Any device implementing an `obsMode` will inherit from SKAObsDevice instead of just SKABaseDevice.

**class** `SKAObsDevice`(\*args: *Any*, \*\*kwargs: *Any*)

A generic base device for Observations for SKA.

**class InitCommand**(*device: tango.server.Device, logger: Optional[Logger] = None*)

A class for the SKAObsDevice's `init_device()` "command".

**do()** → `tuple[ResultCode, str]`

Stateless hook for device initialisation.

**Returns**

A tuple containing a return code and a string message indicating status. The message is for information purpose only.

**always\_executed\_hook()** → `None`

Perform actions that are executed before every device command.

This is a Tango hook.

**delete\_device()** → `None`

Clean up any resources prior to device deletion.

This method is a Tango hook that is called by the device destructor and by the device Init command. It allows for any memory or other resources allocated in the `init_device` method to be released prior to device deletion.

**obsState()** → `ObsState`

Read the Observation State of the device.

**Returns**

the current `obs_state` value

**obsMode()** → `ObsMode`

Read the Observation Mode of the device.

**Returns**

the current `obs_mode` value

**configurationProgress()** → `int`

Read the percentage configuration progress of the device.

**Returns**

the percentage configuration progress

**configurationDelayExpected()** → `int`

Read the expected Configuration Delay in seconds.

**Returns**

the expected configuration delay

**main**(\*args: `str`, \*\*kwargs: `str`) → `int`

Entry point for module.

**Parameters**

- **args** – positional arguments
- **kwargs** – named arguments

**Returns**

exit code

## 2.3 CSP subpackage

### 2.3.1 CSP obs subpackage

This subpackage contains obs device functionality specific to CSP.

#### CSP Subelement Obs State Model

This module specifies CSP SubElement Observing state machine.

It comprises:

- an underlying state machine: `CspSubElementObsStateMachine`
- a `CspSubElementObsStateModel` that maps the underlying state machine state to a value of the `ska_control_model.obs_state.ObsState` enum.

**class** `CspSubElementObsStateMachine(*args: Any, **kwargs: Any)`

The observation state machine used by a generic CSP sub-element ObsDevice.

Compared to the SKA Observation State Machine, it implements a smaller number of states, number that can be further decreased depending on the necessities of the different sub-elements.

The implemented states are:

- **IDLE**: the device is unconfigured.
- **CONFIGURING\_IDLE**: the device in unconfigured, but configuration is in progress.
- **CONFIGURING\_READY**: the device in configured, and configuration is in progress.
- **READY**: the device is configured and is ready to perform observations
- **SCANNING**: the device is performing the observation.
- **ABORTING**: the device is processing an abort.

TODO: Need to understand if this state is really required by the observing devices of any CSP sub-element.

- **ABORTED**: the device has completed the abort request.
- **FAULT**: the device component has experienced an error from which it can be recovered only via manual intervention invoking a reset command that force the device to the base state (IDLE).

The actions supported divide into command-oriented actions and component monitoring actions.

The command-oriented actions are:

- **configure\_invoked** and **configure\_completed**: bookending the `Configure()` command, and hence the **CONFIGURING** state
- **abort\_invoked** and **abort\_completed**: bookending the `Abort()` command, and hence the **ABORTING** state
- **obsreset\_invoked** and **obsreset\_completed**: bookending the `ObsReset()` command, and hence the **OB-SRESETTING** state
- **end\_invoked**, **scan\_invoked**, **end\_scan\_invoked**: these result in reflexive transitions, and are purely there to indicate states in which the `End()`, `Scan()` and `EndScan()` commands are permitted to be run

The component-oriented actions are:

- **component\_obsfault**: the monitored component has experienced an observation fault
- **component\_unconfigured**: the monitored component has become unconfigured



- **component\_configured**: the monitored component has become configured
- **component\_scanning**: the monitored component has started scanning
- **component\_not\_scanning**: the monitored component has stopped scanning

A diagram of the state machine is shown below. Reflexive transitions and transitions to FAULT obs state are omitted to simplify the diagram.

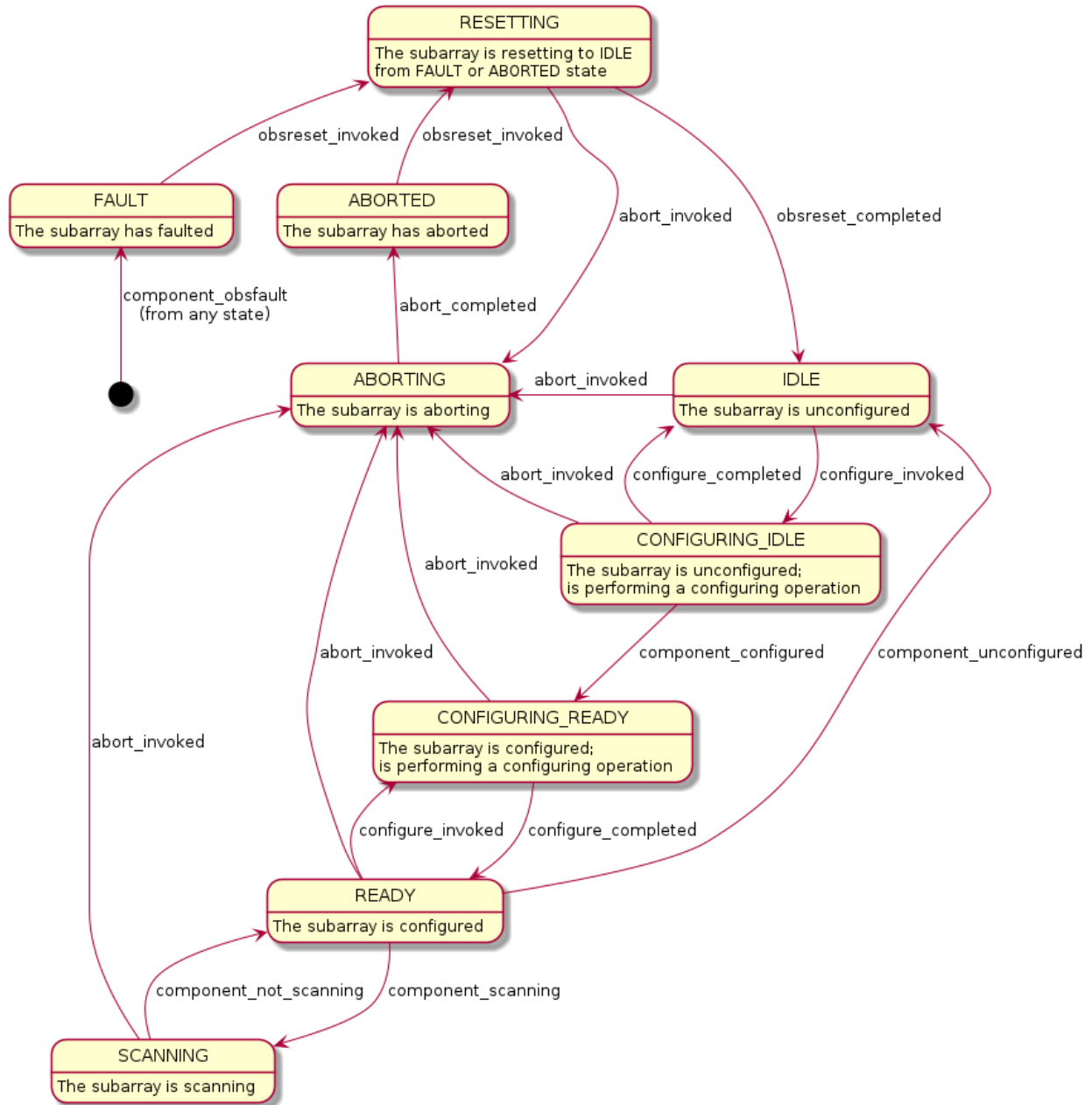


Fig. 1: Diagram of the CSP subelement obs state machine

```
class CspSubElementObsStateModel(logger, callback=None)
```

Implements the observation state model for a generic CSP sub-element ObsDevice.

Compared to the SKA observation state model, it implements a smaller number of states, number that can be

further decreased depending on the necessities of the different sub-elements.

The implemented states are:

- **IDLE**: the device is unconfigured.
- **CONFIGURING**: transitional state to report device configuration is in progress.  
TODO: Need to understand if this state is really required by the observing devices of any CSP sub-element.
- **READY**: the device is configured and is ready to perform observations
- **SCANNING**: the device is performing the observation.
- **ABORTING**: the device is processing an abort.  
TODO: Need to understand if this state is really required by the observing devices of any CSP sub-element.
- **ABORTED**: the device has completed the abort request.
- **RESETTING**: the device is resetting from an ABORTED or FAULT state back to IDLE
- **FAULT**: the device component has experienced an error from which it can be recovered only via manual intervention invoking a reset command that force the device to the base state (IDLE).

## CSP obs component manager

This module models component management for CSP subelement observation devices.

```
class CspObsComponentManager(logger: Logger, communication_state_callback:
    Optional[Callable[[CommunicationStatus], None]] = None,
    component_state_callback: Optional[Callable[[...], None]] = None, **state:
    Any)
```

A component manager for SKA CSP subelement observation Tango devices.

The current implementation is intended to \* illustrate the model \* enable testing of the base classes

It should not generally be used in concrete devices; instead, write a subclass specific to the component managed by the device.

**configure\_scan**(*configuration*, *task\_callback*)

Configure the component.

**Parameters**

**configuration** (*dict*) – the configuration to be configured

**deconfigure**(*task\_callback*)

Deconfigure this component.

**scan**(*args*, *task\_callback*)

Start scanning.

**end\_scan**(*task\_callback*)

End scanning.

**abort**(*task\_callback*)

Tell the component to abort whatever it was doing.

**obsreset**(*task\_callback*)

Reset the configuration but do not release resources.

**property scan\_id**

Return the scan id.

**property config\_id**

Return the configuration id.

**CSP Subelement Obs device**

CspSubElementObsDevice.

General observing device for SKA CSP Subelement.

**class CspSubElementObsDevice**(\*args: *Any*, \*\*kwargs: *Any*)

General observing device for SKA CSP Subelement.

**Properties:**

- **Device Property**

**DeviceID**

- Identification number of the observing device.
- Type: 'DevUShort'

**scanID**

Device attribute.

**configurationID**

Device attribute.

**deviceID**

Device attribute.

**lastScanConfiguration**

Device attribute.

**sdpDestinationAddresses**

Device attribute.

**sdpLinkCapacity**

Device attribute.

**sdpLinkActive**

Device attribute.

**healthFailureMessage**

Device attribute.

**init\_command\_objects()**

Set up the command objects.

**class InitCommand**(device: *tango.server.Device*, logger: *Optional[Logger]* = None)

A class for the CspSubElementObsDevice's init\_device() "command".

**do()**

Stateless hook for device initialisation.

**Returns**

A tuple containing a return code and a string message indicating status. The message is for information purpose only.

**Return type***(ResultCode, str)***always\_executed\_hook()**

Perform actions before any Tango command is executed.

This is a Tango hook.

**delete\_device()**

Clean up any resources prior to device deletion.

This method is a Tango hook that is called by the device destructor and by the device Init command. It allows for any memory or other resources allocated in the init\_device method to be released prior to device deletion.

**read\_scanID()**

Return the scanID attribute.

**read\_configurationID()**

Return the configurationID attribute.

**read\_deviceID()**

Return the deviceID attribute.

**read\_lastScanConfiguration()**

Return the lastScanConfiguration attribute.

**read\_sdpDestinationAddresses()**

Return the sdpDestinationAddresses attribute.

**read\_sdpLinkCapacity()**

Return the sdpLinkCapacity attribute.

**read\_sdpLinkActive()**

Return the sdpLinkActive attribute.

**read\_healthFailureMessage()**

Return the healthFailureMessage attribute.

**class ConfigureScanCommand**(*command\_tracker, component\_manager, callback, logger=None*)

A class for the CspSubElementObsDevices's ConfigureScan command.

**validate\_input**(*argin*)

Validate the configuration parameters against allowed values, as needed.

**Parameters**

**argin** (*str*) – The JSON formatted string with configuration for the device.

**Returns**

A tuple containing a return code and a string message.

**Return type***(ResultCode, str)***class ScanCommand**(*command\_tracker, component\_manager, logger=None*)

A class for the CspSubElementObsDevices's Scan command.

**validate\_input**(*argin*)

Validate the command input argument.

**Parameters**

**argin** (*str*) – the scan id

**Returns**

A tuple containing a return code and a string message indicating status. The message is for information purpose only.

**Return type**

(*ResultCode*, str)

**class AbortCommand**(*command\_tracker*, *component\_manager*, *callback*, *logger=None*)

A class for the CspSubElementObsDevices's Abort command.

**do()**

Stateless hook for Abort() command functionality.

**Returns**

A tuple containing a return code and a string message indicating status. The message is for information purpose only.

**Return type**

(*ResultCode*, str)

**is\_ConfigureScan\_allowed()**

Return whether the *ConfigureScan* command may be called in the current state.

**Returns**

whether the command may be called in the current device state

**Return type**

bool

**is\_Scan\_allowed()**

Return whether the *Scan* command may be called in the current device state.

**Returns**

whether the command may be called in the current device state

**Return type**

bool

**is\_EndScan\_allowed()**

Return whether the *EndScan* command may be called in the current device state.

**Returns**

whether the command may be called in the current device state

**Return type**

bool

**is\_GoToIdle\_allowed()**

Return whether the *GoToIdle* command may be called in the current device state.

**Returns**

whether the command may be called in the current device state

**Return type**

bool

**is\_ObsReset\_allowed()**

Return whether the *ObsReset* command may be called in the current device state.

**Returns**

whether the command may be called in the current device state

**Return type**

bool

**is\_Abort\_allowed()**

Return whether the *Abort* command may be called in the current device state.

**Returns**

whether the command may be called in the current device state

**Return type**

`bool`

**main**(args=None, \*\*kwargs)

Run the CspSubElementObsDevice module.

## 2.3.2 CSP subarray subpackage

This subpackage contains subarray device functionality specific to CSP.

### CSP Subarray Component Manager

This module models component management for CSP subarrays.

```
class CspSubarrayComponentManager(logger: Logger, communication_state_callback:
    Optional[Callable[[CommunicationStatus], None]] = None,
    component_state_callback: Optional[Callable[[...], None]] = None,
    **state: Any)
```

A component manager for SKA CSP subarray Tango devices.

The current implementation is intended to \* illustrate the model \* enable testing of the base classes

It should not generally be used in concrete devices; instead, write a subclass specific to the component managed by the device.

**property config\_id**

Return the configuration id.

**property scan\_id**

Return the scan id.

### CSP Subarray device

CspSubElementSubarray.

Subarray device for SKA CSP SubElement

```
class CspSubElementSubarray(*args: Any, **kwargs: Any)
```

Subarray device for SKA CSP SubElement.

**scanID**

Device attribute.

**configurationID**

Device attribute.

**sdpDestinationAddresses**

Device attribute.

**outputDataRateToSdp**

Device attribute.

**lastScanConfiguration**

Device attribute.

**sdpLinkActive**

Device attribute.

**listOfDevicesCompletedTasks**

Device attribute.

**configureScanMeasuredDuration**

Device attribute.

**configureScanTimeoutExpiredFlag**

Device attribute.

**assignResourcesMaximumDuration**

Device attribute.

**assignResourcesMeasuredDuration**

Device attribute.

**assignResourcesProgress**

Device attribute.

**assignResourcesTimeoutExpiredFlag**

Device attribute.

**releaseResourcesMaximumDuration**

Device attribute.

**releaseResourcesMeasuredDuration**

Device attribute.

**releaseResourcesProgress**

Device attribute.

**releaseResourcesTimeoutExpiredFlag**

Device attribute.

**init\_command\_objects()**

Set up the command objects.

**class** **InitCommand**(*device: tango.server.Device, logger: Optional[Logger] = None*)

A class for the CspSubElementObsDevice's `init_device()` "command".

**do()**

Stateless hook for device initialisation.

**Returns**

A tuple containing a return code and a string message indicating status. The message is for information purpose only.

**Return type**

(*ResultCode*, str)

**always\_executed\_hook()**

Perform actions that are executed before every device command.

This is a Tango hook.

**delete\_device()**

Clean up any resources prior to device deletion.

This method is a Tango hook that is called by the device destructor and by the device Init command. It allows for any memory or other resources allocated in the init\_device method to be released prior to device deletion.

**read\_scanID()**

Return the scanID attribute.

**read\_configurationID()**

Return the configurationID attribute.

**read\_sdpDestinationAddresses()**

Return the sdpDestinationAddresses attribute.

**write\_sdpDestinationAddresses(*value*)**

Set the sdpDestinationAddresses attribute.

**read\_outputDataRateToSdp()**

Return the outputDataRateToSdp attribute.

**read\_lastScanConfiguration()**

Return the lastScanConfiguration attribute.

**read\_configureScanMeasuredDuration()**

Return the configureScanMeasuredDuration attribute.

**read\_configureScanTimeoutExpiredFlag()**

Return the configureScanTimeoutExpiredFlag attribute.

**read\_listOfDevicesCompletedTasks()**

Return the listOfDevicesCompletedTasks attribute.

**read\_assignResourcesMaximumDuration()**

Return the assignResourcesMaximumDuration attribute.

**write\_assignResourcesMaximumDuration(*value*)**

Set the assignResourcesMaximumDuration attribute.

**read\_assignResourcesMeasuredDuration()**

Return the assignResourcesMeasuredDuration attribute.

**read\_assignResourcesProgress()**

Return the assignResourcesProgress attribute.

**read\_assignResourcesTimeoutExpiredFlag()**

Return the assignResourcesTimeoutExpiredFlag attribute.

**read\_releaseResourcesMaximumDuration()**

Return the releaseResourcesMaximumDuration attribute.

**write\_releaseResourcesMaximumDuration(*value*)**

Set the releaseResourcesMaximumDuration attribute.



**read\_releaseResourcesMeasuredDuration()**

Return the releaseResourcesMeasuredDuration attribute.

**read\_releaseResourcesProgress()**

Return the releaseResourcesProgress attribute.

**read\_releaseResourcesTimeoutExpiredFlag()**

Return the releaseResourcesTimeoutExpiredFlag attribute.

**read\_sdpLinkActive()**

Return the sdpLinkActive attribute.

**class ConfigureScanCommand**(*command\_tracker, component\_manager, callback, logger=None*)

A class for the CspSubElementObsDevices's ConfigureScan command.

**validate\_input**(*argin*)

Validate the configuration parameters against allowed values, as needed.

**Parameters**

**argin** (*str*) – The JSON formatted string with configuration for the device.

**Returns**

A tuple containing a return code and a string message.

**Return type**

(*ResultCode*, *str*)

**is\_ConfigureScan\_allowed()**

Return whether the *Configure* command may be called in the current state.

**Returns**

whether the command may be called in the current device state

**Return type**

*bool*

**is\_Configure\_allowed()**

Return whether the *Configure* command may be called in the current state.

**Returns**

whether the command may be called in the current device state

**Return type**

*bool*

**is\_GoToIdle\_allowed()**

Return whether the *GoToIdle* command may be called in the current device state.

**Returns**

whether the command may be called in the current device state

**Return type**

*bool*

**main**(*args=None, \*\*kwargs*)

Run the CspSubElementSubarray module.

### 2.3.3 CSP Subelement Controller device

CspSubElementController.

Controller device for SKA CSP Subelement.

**class CspSubElementController**(\*args: *Any*, \*\*kwargs: *Any*)

Controller device for SKA CSP Subelement.

**Properties:**

- **Device Property**

- PowerDelayStandbyOn**

- Delay in sec between power-up stages in Standby<-> On transitions.
    - Type: 'DevFloat'

- PowerDelayStandByOff**

- Delay in sec between power-up stages in Standby-> Off transition.
    - Type: 'DevFloat'

**powerDelayStandbyOn**

Device attribute.

**powerDelayStandbyOff**

Device attribute.

**onProgress**

Device attribute.

**onMaximumDuration**

Device attribute.

**onMeasuredDuration**

Device attribute.

**standbyProgress**

Device attribute.

**standbyMaximumDuration**

Device attribute.

**standbyMeasuredDuration**

Device attribute.

**offProgress**

Device attribute.

**offMaximumDuration**

Device attribute.

**offMeasuredDuration**

Device attribute.

**totalOutputDataRateToSdp**

Device attribute.

**loadFirmwareProgress**

Device attribute.

**loadFirmwareMaximumDuration**

Device attribute.

**loadFirmwareMeasuredDuration**

Device attribute.

**init\_command\_objects()**

Set up the command objects.

**class InitCommand(device: *tango.server.Device*, logger: *Optional[Logger]* = None)**

A class for the CspSubElementController's init\_device() "command".

**do()**

Stateless hook for device initialisation.

**Returns**

A tuple containing a return code and a string message indicating status. The message is for information purpose only.

**Return type**

(*ResultCode*, str)

**always\_executed\_hook()**

Perform actions always executed before any Tango command is executed.

This is a Tango hook.

**delete\_device()**

Clean up any resources prior to device deletion.

This method is a Tango hook that is called by the device destructor and by the device Init command. It allows for any memory or other resources allocated in the init\_device method to be released prior to device deletion.

**read\_powerDelayStandbyOn()**

Return the powerDelayStandbyOn attribute.

**write\_powerDelayStandbyOn(value)**

Set the powerDelayStandbyOn attribute.

**read\_onProgress()**

Return the onProgress attribute.

**read\_onMaximumDuration()**

Return the onMaximumDuration attribute.

**write\_onMaximumDuration(value)**

Set the onMaximumDuration attribute.

**read\_onMeasuredDuration()**

Return the onMeasuredDuration attribute.

**read\_standbyProgress()**

Return the standbyProgress attribute.

**read\_standbyMaximumDuration()**

Return the standbyMaximumDuration attribute.

**write\_standbyMaximumDuration(value)**

Set the standbyMaximumDuration attribute.

**read\_standbyMeasuredDuration()**

Return the standbyMeasuredDuration attribute.

**read\_offProgress()**

Return the offProgress attribute.

**read\_offMaximumDuration()**

Return the offMaximumDuration attribute.

**write\_offMaximumDuration(value)**

Set the offMaximumDuration attribute.

**read\_offMeasuredDuration()**

Return the offMeasuredDuration attribute.

**read\_totalOutputDataRateToSdp()**

Return the totalOutputDataRateToSdp attribute.

**read\_powerDelayStandbyOff()**

Return the powerDelayStandbyOff attribute.

**write\_powerDelayStandbyOff(value)**

Set the powerDelayStandbyOff attribute.

**read\_loadFirmwareProgress()**

Return the loadFirmwareProgress attribute.

**read\_loadFirmwareMaximumDuration()**

Return the loadFirmwareMaximumDuration attribute.

**write\_loadFirmwareMaximumDuration(value)**

Set the loadFirmwareMaximumDuration attribute.

**read\_loadFirmwareMeasuredDuration()**

Return the loadFirmwareMeasuredDuration attribute.

**class LoadFirmwareCommand(logger=None)**

A class for the LoadFirmware command.

**do(argin)**

Stateless hook for device LoadFirmware() command.

**Parameters**

**argin** – argument to command, currently unused

**Returns**

A tuple containing a return code and a string message indicating status. The message is for information purpose only.

**Return type**

(*ResultCode*, str)

**class PowerOnDevicesCommand(logger=None)**

A class for the CspSubElementController's PowerOnDevices command.

**do**(*argin*)

Stateless hook for device PowerOnDevices() command.

**Parameters**

**argin** – argument to command, currently unused

**Returns**

A tuple containing a return code and a string message indicating status. The message is for information purpose only.

**Return type**

(*ResultCode*, *str*)

**class PowerOffDevicesCommand**(*logger=None*)

A class for the CspSubElementController's PowerOffDevices command.

**do**(*argin*)

Stateless hook for device PowerOffDevices() command.

**Parameters**

**argin** – argument to command, currently unused

**Returns**

A tuple containing a return code and a string message indicating status. The message is for information purpose only.

**Return type**

(*ResultCode*, *str*)

**class ReInitDevicesCommand**(*logger=None*)

A class for the CspSubElementController's ReInitDevices command.

**do**(*argin*)

Stateless hook for device ReInitDevices() command.

**Parameters**

**argin** – argument to command, currently unused

**Returns**

A tuple containing a return code and a string message indicating status. The message is for information purpose only.

**Return type**

(*ResultCode*, *str*)

**is\_LoadFirmware\_allowed**()

Check if the LoadFirmware command is allowed in the current state.

**Returns**

True if command is allowed

**Return type**

*bool*

**is\_PowerOnDevices\_allowed**()

Check if the PowerOnDevice command is allowed in the current state.

**Returns**

True if command is allowed

**Return type**

*bool*

**is\_PowerOffDevices\_allowed**()

Check if the PowerOffDevices command is allowed in the current state.

**Returns**

True if command is allowed

**Return type**

`bool`

**is\_ReInitDevices\_allowed()**

Check if the ReInitDevices command is allowed in the current state.

**Returns**

True if command is allowed

**Return type**

`bool`

**main(args=None, \*\*kwargs)**

Entry point for the CspSubElementController module.

**Parameters**

- **args** – str
- **kwargs** – str

**Returns**

exit code

## 2.4 Subarray

This subpackage models a SKA subarray Tango device.

### 2.4.1 Subarray Component Manager

This module provides an abstract component manager for SKA Tango subarray devices.

```
class SubarrayComponentManager(logger: Logger, communication_state_callback:
    Optional[Callable[[CommunicationStatus], None]] = None,
    component_state_callback: Optional[Callable[[...], None]] = None,
    **state: Any)
```

An abstract base class for a component manager for an SKA subarray Tango devices.

It supports:

- Maintaining a connection to its component
- Controlling its component via commands like AssignResources(), Configure(), Scan(), etc.
- Monitoring its component, e.g. detect that a scan has completed

```
assign(resources: set[str], task_callback: Optional[Callable[[...], None]] = None) → tuple[TaskStatus, str]
```

Assign resources to the component.

**Parameters**

- **resources** – resources to be assigned
- **task\_callback** – callback to be called when the status of the command changes

**Raises**

**NotImplementedError** – This is an abstract class

**release**(resources: *set[str]*, task\_callback: *Optional[Callable[[], None]] = None*) → *tuple[TaskStatus, str]*

Release resources from the component.

**Parameters**

- **resources** – resources to be released
- **task\_callback** – callback to be called when the status of the command changes

**Raises**

**NotImplementedError** – This is an abstract class

**release\_all**(task\_callback: *Optional[Callable] = None*) → *tuple[TaskStatus, str]*

Release all resources.

**Parameters**

**task\_callback** – callback to be called when the status of the command changes

**Raises**

**NotImplementedError** – This is an abstract class

**configure**(configuration: *dict[str, Any]*, task\_callback: *Optional[Callable[[], None]] = None*) → *tuple[TaskStatus, str]*

Configure the component.

**Parameters**

- **configuration** – the configuration to be configured
- **task\_callback** – callback to be called when the status of the command changes

**Raises**

**NotImplementedError** – This is an abstract class

**deconfigure**(task\_callback: *Optional[Callable] = None*) → *tuple[TaskStatus, str]*

Deconfigure this component.

**Parameters**

**task\_callback** – callback to be called when the status of the command changes

**Raises**

**NotImplementedError** – This is an abstract class

**scan**(args: *str*, task\_callback: *Optional[Callable] = None*) → *tuple[TaskStatus, str]*

Start scanning.

**Parameters**

- **args** – scan parameters encoded in a json string
- **task\_callback** – callback to be called when the status of the command changes

**Raises**

**NotImplementedError** – This is an abstract class

**end\_scan**(task\_callback: *Optional[Callable] = None*) → *tuple[TaskStatus, str]*

End scanning.

**Parameters**

**task\_callback** – callback to be called when the status of the command changes

**Raises**

**NotImplementedError** – This is an abstract class

**abort**(*task\_callback: Optional[Callable] = None*) → *tuple[TaskStatus, str]*

Tell the component to abort whatever it was doing.

**Parameters**

**task\_callback** – callback to be called when the status of the command changes

**Raises**

**NotImplementedError** – This is an abstract class

**obsreset**(*task\_callback: Optional[Callable] = None*) → *tuple[TaskStatus, str]*

Reset the component to unconfigured but do not release resources.

**Parameters**

**task\_callback** – callback to be called when the status of the command changes

**Raises**

**NotImplementedError** – This is an abstract class

**restart**(*task\_callback: Optional[Callable] = None*) → *tuple[TaskStatus, str]*

Deconfigure and release all resources.

**Parameters**

**task\_callback** – callback to be called when the status of the command changes

**Raises**

**NotImplementedError** – This is an abstract class

**property assigned\_resources:** *list[str]*

Return the resources assigned to the component.

**Raises**

**NotImplementedError** – the resources assigned to the component

**property configured\_capabilities:** *list[str]*

Return the configured capabilities of the component.

**Raises**

**NotImplementedError** – list of strings indicating number of configured instances of each capability type

## 2.4.2 Subarray Device

SKASubarray.

A SubArray handling device. It allows the assigning/releasing of resources into/from Subarray, configuring capabilities, and exposes the related information like assigned resources, configured capabilities, etc.

**class SKASubarray**(\*args: *Any*, \*\*kwargs: *Any*)

Implements the SKA SubArray device.

**class InitCommand**(*device: tango.server.Device*, *logger: Optional[Logger] = None*)

A class for the SKASubarray's init\_device() "command".

**do()** → *tuple[ResultCode, str]*

Stateless hook for device initialisation.

**Returns**

A tuple containing a return code and a string message indicating status. The message is for information purpose only.



```
class AbortCommand(command_tracker: CommandTracker, component_manager:
    SubarrayComponentManager, callback: Callable[[], None], logger:
    Optional[Logger] = None)
```

A class for SKASubarray's Abort() command.

**do()** → tuple[ResultCode, str]

Stateless hook for Abort() command functionality.

**Returns**

A tuple containing a return code and a string message indicating status. The message is for information purpose only.

**init\_command\_objects()** → None

Set up the command objects.

**always\_executed\_hook()** → None

Perform actions that are executed before every device command.

This is a Tango hook.

**delete\_device()** → None

Clean up any resources prior to device deletion.

This method is a Tango hook that is called by the device destructor and by the device Init command. It allows for any memory or other resources allocated in the init\_device method to be released prior to device deletion.

**activationTime()** → float

Read the time of activation in seconds since Unix epoch.

**Returns**

Time of activation in seconds since Unix epoch.

**assignedResources()** → list[str]

Read the resources assigned to the device.

The list of resources assigned to the subarray.

**Returns**

Resources assigned to the device.

**configuredCapabilities()** → list[str]

Read capabilities configured in the Subarray.

A list of capability types with no. of instances in use on this subarray; e.g. Correlators:512, PssBeams:4 PstBeams:4, VlbiBeams:0.

**Returns**

A list of capability types with no. of instances used in the Subarray

**is\_AssignResources\_allowed()** → bool

Return whether the AssignResource command may be called in the current state.

**Raises**

*StateModelError* – command not permitted in observation state

**Returns**

whether the command may be called in the current device state

**is\_ReleaseResources\_allowed()** → bool

Return whether the *ReleaseResources* command may be called in current state.

**Raises**

*StateModelError* – command not permitted in observation state

**Returns**

whether the command may be called in the current device state

**is\_ReleaseAllResources\_allowed()** → bool

Return whether *ReleaseAllResources* may be called in the current device state.

**Raises**

*StateModelError* – command not permitted in observation state

**Returns**

whether the command may be called in the current device state

**is\_Configure\_allowed()** → bool

Return whether *Configure* may be called in the current device state.

**Raises**

*StateModelError* – command not permitted in observation state

**Returns**

whether the command may be called in the current device state

**is\_Scan\_allowed()** → bool

Return whether the *Scan* command may be called in the current device state.

**Raises**

*StateModelError* – command not permitted in observation state

**Returns**

whether the command may be called in the current device state

**is\_EndScan\_allowed()** → bool

Return whether the *EndScan* command may be called in the current device state.

**Raises**

*StateModelError* – command not permitted in observation state

**Returns**

whether the command may be called in the current device state

**is\_End\_allowed()** → bool

Return whether the *End* command may be called in the current device state.

**Raises**

*StateModelError* – command not permitted in observation state

**Returns**

whether the command may be called in the current device state

**is\_Abort\_allowed()** → bool

Return whether the *Abort* command may be called in the current device state.

**Raises**

*StateModelError* – command not permitted in observation state

**Returns**

whether the command may be called in the current device state

**is\_ObsReset\_allowed()** → bool

Return whether the *ObsReset* command may be called in the current device state.

**Raises**

*StateModelError* – command not permitted in observation state

**Returns**

whether the command may be called in the current device state

**is\_Restart\_allowed()** → bool

Return whether the *Restart* command may be called in the current device state.

**Raises**

*StateModelError* – command not permitted in observation state

**Returns**

whether the command may be called in the current device state

**main(\*args: str, \*\*kwargs: str)** → int

Entry point for module.

**Parameters**

- **args** – positional arguments
- **kwargs** – named arguments

**Returns**

exit code

## 2.5 Testing subpackage

This subpackage implements code for testing ska-tango-base devices.

### 2.5.1 Reference Testing Devices

This subpackage implements reference component managers.

These are example component managers for use in testing, and as explanatory material.

#### Reference Base Component Manager

This module provided reference implementations of a BaseComponentManager.

It is provided for explanatory purposes, and to support testing of this package.

```
class FakeBaseComponent(time_to_return: float = 0.05, time_to_complete: float = 0.4, power: PowerState =
    PowerState.OFF, fault: Optional[bool] = None, **state_kwargs: Any)
```

A fake component for the component manager to work with.

NOTE: There is usually no need to implement a component object. The “component” is an element of the external system under control, such as a piece of hardware or an external service. The component manager object communicates with the component in order to monitor and control it.

This is a very simple fake component with a power state and a fault state. When either of these aspects of state changes, it lets the component manager know by calling its *state\_change\_callback*.

It can be directly controlled via *off()*, *standby()*, *on()* and *reset()* methods. For testing purposes, it can also be told to simulate a spontaneous state change via *simulate\_power\_state`* and *simulate\_fault* methods.

When one of these command method is invoked, the component simulates communications latency by sleeping for a short time. It then returns, but simulates any asynchronous work it needs to do by delaying updating task and component state for a short time.

**set\_state\_change\_callback**(*state\_change\_callback*: *Optional[Callable[[...], None]]*) → *None*

Set a callback to be called when the state of this component changes.

**Parameters**

**state\_change\_callback** – a callback to be call when the state of the component changes

**off**(*task\_callback*: *Callable*, *task\_abort\_event*: *Event*) → *None*

Turn the component off.

**Parameters**

- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a *threading.Event* that can be checked for whether this task has been aborted.

**standby**(*task\_callback*: *Callable*, *task\_abort\_event*: *Event*) → *None*

Put the component into low-power standby mode.

**Parameters**

- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a *threading.Event* that can be checked for whether this task has been aborted.

**on**(*task\_callback*: *Callable*, *task\_abort\_event*: *Event*) → *None*

Turn the component on.

**Parameters**

- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a *threading.Event* that can be checked for whether this task has been aborted.

**simulate\_power\_state**(*power\_state*: *PowerState*) → *None*

Simulate a change in component power state.

This could occur as a result of the Off command, or because of some external event/action.

**Parameters**

**power\_state** – the power state

**reset**(*task\_callback*: *Callable*, *task\_abort\_event*: *Event*) → *None*

Reset the component (from fault state).

**Parameters**

- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a *threading.Event* that can be checked for whether this task has been aborted.

**simulate\_fault**(*fault\_state: bool*) → *None*

Tell the component to simulate (or stop simulating) a fault.

**Parameters**

**fault\_state** – whether faulty or not.

**property faulty:** *bool*

Return whether this component is faulty.

**Returns**

whether this component is faulty.

**property power\_state:** *PowerState*

Return the power state of this component.

**Returns**

the power state of this component.

```
class ReferenceBaseComponentManager(logger: Logger, communication_state_callback:
                                   Callable[[CommunicationStatus], None], component_state_callback:
                                   Callable[[], None], *args: Any, _component:
                                   Optional[FakeBaseComponent] = None, **kwargs: Any)
```

A component manager for Tango devices.

It supports:

- Maintaining a connection to its component
- Controlling its component via commands like Off(), Standby(), On(), etc.
- Monitoring its component, e.g. detect that it has been turned off or on

The current implementation is intended to

- illustrate the model
- enable testing of these base classes

It should not generally be used in concrete devices; instead, write a component manager specific to the component managed by the device.

**start\_communicating**() → *None*

Establish communication with the component, then start monitoring.

**stop\_communicating**() → *None*

Break off communication with the component.

**simulate\_communication\_failure**(*fail\_communicate: bool*) → *None*

Simulate (or stop simulating) a failure to communicate with the component.

**Parameters**

**fail\_communicate** – whether the connection to the component is failing

**property power\_state:** *PowerState*

Power mode of the component.

This is just a bit of syntactic sugar for *self.component\_state["power"]*.

**Returns**

the power mode of the component

**property** `fault_state: bool`

Whether the component is currently faulting.

**Returns**

whether the component is faulting

**off**(*task\_callback: Optional[Callable[[], None]] = None*) → `Tuple[TaskStatus, str]`

Turn the component off.

**Parameters**

**task\_callback** – a callback to be called whenever the status of this task changes.

**Returns**

TaskStatus and message

**standby**(*task\_callback: Optional[Callable[[], None]] = None*) → `Tuple[TaskStatus, str]`

Put the component into low-power standby mode.

**Parameters**

**task\_callback** – a callback to be called whenever the status of this task changes.

**Returns**

TaskStatus and message

**on**(*task\_callback: Optional[Callable[[], None]] = None*) → `Tuple[TaskStatus, str]`

Turn the component on.

**Parameters**

**task\_callback** – a callback to be called whenever the status of this task changes.

**Returns**

TaskStatus and message

**reset**(*task\_callback: Optional[Callable[[], None]] = None*) → `Tuple[TaskStatus, str]`

Reset the component (from fault state).

**Parameters**

**task\_callback** – a callback to be called whenever the status of this task changes.

**Returns**

TaskStatus and message

## Reference CSP OBS Manager

This module models component management for CSP subelement observation devices.

**class FakeCspObsComponent**(*time\_to\_return=0.05, time\_to\_complete=0.4, power=PowerState.OFF, fault=None, configured=False, scanning=False, obsfault=False, \*\*kwargs*)

An example CSP subelement obs component for the component manager to work with.

NOTE: There is usually no need to implement a component object. The “component” is an element of the external system under control, such as a piece of hardware or an external service. In the case of a subarray device, the “component” is likely a collection of Tango devices responsible for monitoring and controlling the various resources assigned to the subarray. The component manager should be written so that it interacts with those Tango devices. But here, we fake up a “component” object to interact with instead.

It can be directly controlled via `configure()`, `scan()`, `end_scan()`, `go_to_idle()`, `abort()` and `reset()` command methods.

For testing purposes, it can also be told to simulate an observation fault via `simulate_obsfault()` methods.

When a component changes state, it lets the component manager know by calling its `component_unconfigured`, `component_configured`, `component_scanning`, `component_not_scanning` and `component_obsfault` methods.

**property config\_id**

Return the configuration id.

**property scan\_id**

Return the scan id.

**configure\_scan**(*configuration*, *task\_callback*, *task\_abort\_event*)

Configure the component.

**Parameters**

- **configuration** (*dict*) – the configuration to be configured
- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**deconfigure**(*task\_callback*, *task\_abort\_event*)

Deconfigure this component.

**Parameters**

- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**scan**(*scan\_id*, *task\_callback*, *task\_abort\_event*)

Start scanning.

**Parameters**

- **scan\_id** – the unique id of the scan.
- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**end\_scan**(*task\_callback*, *task\_abort\_event*)

End scanning.

**Parameters**

- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**simulate\_scan\_stopped**()

Tell the component to simulate spontaneous stopping its scan.

**simulate\_obsfault**(*obsfault*)

Tell the component to simulate an obsfault.

**obsreset**(*task\_callback*, *task\_abort\_event*)

Reset the observation after it has faulted or been aborted.

**Parameters**

- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**class ReferenceCspObsComponentManager**(*logger, communication\_state\_callback, component\_state\_callback, \_component=None*)

A component manager for SKA CSP subelement observation Tango devices.

The current implementation is intended to \* illustrate the model \* enable testing of the base classes

It should not generally be used in concrete devices; instead, write a subclass specific to the component managed by the device.

**configure\_scan**(*configuration, task\_callback=None*)

Configure the component.

**deconfigure**(*task\_callback=None*)

Tell the component to deconfigure.

**scan**(*args, task\_callback=None*)

Tell the component to start scanning.

**end\_scan**(*task\_callback=None*)

Tell the component to stop scanning.

**abort**(*task\_callback=None*)

Tell the component to stop scanning.

**obsreset**(*task\_callback=None*)

Perform an obsreset on the component.

**property config\_id**

Return the configuration id.

**property scan\_id**

Return the scan id.

## Reference CSP Subarray Component Manager

This module models component management for CSP subelement observation devices.

**class FakeCspSubarrayComponent**(*time\_to\_return=0.05, time\_to\_complete=0.4, power=PowerState.OFF, fault=None, resourced=False, configured=False, scanning=False, obsfault=False, \*\*kwargs*)

A fake component for the component manager to work with.

NOTE: There is usually no need to implement a component object. The “component” is an element of the external system under control, such as a piece of hardware or an external service. In the case of a subarray device, the “component” is likely a collection of Tango devices responsible for monitoring and controlling the various resources assigned to the subarray. The component manager should be written so that it interacts with those Tango devices. But here, we fake up a “component” object to interact with instead.

It supports the `configure`, `scan`, `end_scan`, `end`, `abort`, `obsreset` and `restart` methods. For testing purposes, it can also be told to simulate a spontaneous state change via `simulate_power_state` and `simulate_fault` methods.

When one of these command methods is invoked, the component simulates communications latency by sleeping for a short time. It then returns, but simulates any asynchronous work it needs to do by delaying updating task and component state for a short time.



**property config\_id**

Return the unique id of this configuration.

**Returns**

a unique id

**property scan\_id**

Return the unique id of this scan.

**Returns**

a unique id

**assign**(resources, task\_callback, task\_abort\_event)

Assign resources.

**Parameters**

- **resources** – the resources to be assigned.
- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a threading.Event that can be checked for whether this task has been aborted.

**release**(resources, task\_callback, task\_abort\_event)

Release resources.

**Parameters**

- **resources** – resources to be released
- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a threading.Event that can be checked for whether this task has been aborted.

**release\_all**(task\_callback, task\_abort\_event)

Release all resources.

**Parameters**

- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a threading.Event that can be checked for whether this task has been aborted.

**configure**(configuration, task\_callback, task\_abort\_event)

Configure the component.

**Parameters**

- **configuration** (*dict*) – the configuration to be configured
- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a threading.Event that can be checked for whether this task has been aborted.

**deconfigure**(task\_callback, task\_abort\_event)

Deconfigure this component.

**Parameters**

- **task\_callback** – a callback to be called whenever the status of this task changes.

- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**scan**(*scan\_id*, *task\_callback*, *task\_abort\_event*)

Start scanning.

**Parameters**

- **scan\_id** – unique ID of this scan
- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**end\_scan**(*task\_callback*, *task\_abort\_event*)

End scanning.

**Parameters**

- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**simulate\_scan\_stopped**()

Tell the component to simulate spontaneous stopping its scan.

**simulate\_obsfault**(*obsfault*)

Tell the component to simulate (or stop simulating) an obsfault.

**Parameters**

**obsfault** – whether an obsfault has occurred

**obsreset**(*task\_callback*, *task\_abort\_event*)

Reset an observation that has faulted or been aborted.

**Parameters**

- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**restart**(*task\_callback*, *task\_abort\_event*)

Restart the component after it has faulted or been aborted.

**Parameters**

- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**class ReferenceCspSubarrayComponentManager**(*logger*, *communication\_state\_callback*,  
*component\_state\_callback*, *\_component=None*)

A component manager for SKA CSP subelement observation Tango devices.

The current implementation is intended to \* illustrate the model \* enable testing of the base classes

It should not generally be used in concrete devices; instead, write a subclass specific to the component managed by the device.

**start\_communicating()**

Establish communication with the component, then start monitoring.

**stop\_communicating()**

Break off communication with the component.

**simulate\_communication\_failure**(*fail\_communicate*)

Simulate (or stop simulating) a failure to communicate with the component.

**Parameters**

**fail\_communicate** – whether the connection to the component is failing

**property power\_state**

Power mode of the component.

This is just a bit of syntactic sugar for *self.component\_state["power"]*.

**Returns**

the power mode of the component

**property fault\_state**

Whether the component is currently faulting.

**Returns**

whether the component is faulting

**off**(*task\_callback=None*)

Turn the component off.

**standby**(*task\_callback=None*)

Put the component into low-power standby mode.

**on**(*task\_callback=None*)

Turn the component on.

**reset**(*task\_callback=None*)

Reset the component (from fault state).

**assign**(*resources, task\_callback=None*)

Assign resources to the component.

**Parameters**

**resources** (*list*(*str*)) – resources to be assigned

**release**(*resources, task\_callback=None*)

Release resources from the component.

**Parameters**

**resources** (*list*(*str*)) – resources to be released

**release\_all**(*task\_callback=None*)

Release all resources.

**configure**(*configuration, task\_callback=None*)

Configure the component.

**Parameters**

**configuration** (*dict*) – the configuration to be configured

**deconfigure**(*task\_callback=None*)

Deconfigure this component.

**scan**(*args, task\_callback=None*)

Start scanning.

**end\_scan**(*task\_callback=None*)

End scanning.

**obsreset**(*task\_callback=None*)

Deconfigure the component but do not release resources.

**restart**(*task\_callback=None*)

Tell the component to restart.

It will return to a state in which it is unconfigured and empty of assigned resources.

**property config\_id**

Return the configuration id.

**property scan\_id**

Return the scan id.

## Reference Subarray Component Manager

This module models component management for SKA subarray devices.

**class FakeSubarrayComponent**(*capability\_types: list[str], time\_to\_return: float = 0.05, time\_to\_complete: float = 0.4, power: PowerState = PowerState.OFF, fault: Optional[bool] = None, resourced: bool = False, configured: bool = False, scanning: bool = False, obsfault: bool = False, \*\*kwargs: Any*)

A fake component for the component manager to work with.

NOTE: There is usually no need to implement a component object. The “component” is an element of the external system under control, such as a piece of hardware or an external service. In the case of a subarray device, the “component” is likely a collection of Tango devices responsible for monitoring and controlling the various resources assigned to the subarray. The component manager should be written so that it interacts with those Tango devices. But here, we fake up a “component” object to interact with instead.

It supports the *assign*, *release*, *release\_all*, *configure*, *scan*, *end\_scan*, *end*, *abort*, *obsreset* and *restart* methods. For testing purposes, it can also be told to simulate a spontaneous *obs\_state* change via *simulate\_power\_state* and *simulate\_fault* methods.

When one of these command method is invoked, the component simulates communications latency by sleeping for a short time. It then returns, but simulates any asynchronous work it needs to do by delaying updating task and component state for a short time.

**property configured\_capabilities: list[str]**

Return the configured capabilities of this component.

### Returns

list of strings indicating number of configured instances of each capability type

**assign**(*resources: set[str], task\_callback: Callable, task\_abort\_event: threading.Event*) → *None*

Assign resources.

### Parameters

- **resources** – the resources to be assigned.

- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**release**(resources: *set[str]*, task\_callback: *Callable*, task\_abort\_event: *threading.Event*) → *None*

Release resources.

#### Parameters

- **resources** – resources to be released
- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**release\_all**(task\_callback: *Callable*, task\_abort\_event: *Event*) → *None*

Release all resources.

#### Parameters

- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**configure**(configuration: *dict*, task\_callback: *Callable*, task\_abort\_event: *Event*) → *None*

Configure the component.

#### Parameters

- **configuration** – the configuration to be configured
- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**deconfigure**(task\_callback: *Callable*, task\_abort\_event: *Event*) → *None*

Deconfigure this component.

#### Parameters

- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**scan**(args: *Any*, task\_callback: *Callable*, task\_abort\_event: *Event*) → *None*

Start scanning.

#### Parameters

- **args** – additional arguments
- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**end\_scan**(task\_callback: *Callable*, task\_abort\_event: *Event*) → *None*

End scanning.

#### Parameters

- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**simulate\_scan\_stopped()** → `None`

Tell the component to simulate spontaneous stopping its scan.

**simulate\_obsfault**(*obsfault: bool*) → `None`

Tell the component to simulate an obsfault.

**Parameters**

**obsfault** – fault indicator

**obsreset**(*task\_callback: Callable, task\_abort\_event: Event*) → `None`

Reset an observation that has faulted or been aborted.

**Parameters**

- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**restart**(*task\_callback: Callable, task\_abort\_event: Event*) → `None`

Restart the component after it has faulted or been aborted.

**Parameters**

- **task\_callback** – a callback to be called whenever the status of this task changes.
- **task\_abort\_event** – a `threading.Event` that can be checked for whether this task has been aborted.

**class ReferenceSubarrayComponentManager**(*capability\_types: list[str], logger: logging.Logger, communication\_state\_callback: Callable[[CommunicationStatus], None], component\_state\_callback: Callable[[None], None], \_component: Optional[FakeBaseComponent] = None*)

A component manager for SKA subarray Tango devices.

The current implementation is intended to \* illustrate the model \* enable testing of the base classes

It should not generally be used in concrete devices; instead, write a subclass specific to the component managed by the device.

**assign**(*resources: set[str], task\_callback: Optional[Callable[[None], None]] = None*) → `tuple[TaskStatus, str]`

Assign resources to the component.

**Parameters**

- **resources** – resources to be assigned
- **task\_callback** – a callback to be called whenever the status of this task changes.

**Returns**

task status and message

**release**(*resources: set[str], task\_callback: Optional[Callable[[None], None]] = None*) → `tuple[TaskStatus, str]`

Release resources from the component.

**Parameters**

- **resources** – resources to be released

- **task\_callback** – a callback to be called whenever the status of this task changes.

**Returns**

task status and message

**release\_all**(*task\_callback: Optional[Callable[[], None]] = None*) → *tuple[TaskStatus, str]*

Release all resources.

**Parameters**

- **task\_callback** – a callback to be called whenever the status of this task changes.

**Returns**

task status and message

**configure**(*configuration: dict[str, Any], task\_callback: Optional[Callable[[], None]] = None*) → *tuple[TaskStatus, str]*

Configure the component.

**Parameters**

- **configuration** – the configuration to be configured
- **task\_callback** – a callback to be called whenever the status of this task changes.

**Returns**

task status and message

**deconfigure**(*task\_callback: Optional[Callable[[], None]] = None*) → *tuple[TaskStatus, str]*

Deconfigure this component.

**Parameters**

- **task\_callback** – a callback to be called whenever the status of this task changes.

**Returns**

task status and message

**scan**(*args: Any, task\_callback: Optional[Callable[[], None]] = None*) → *tuple[TaskStatus, str]*

Start scanning.

**Parameters**

- **args** – additional arguments
- **task\_callback** – a callback to be called whenever the status of this task changes.

**Returns**

task status and message

**end\_scan**(*task\_callback: Optional[Callable[[], None]] = None*) → *tuple[TaskStatus, str]*

End scanning.

**Parameters**

- **task\_callback** – a callback to be called whenever the status of this task changes.

**Returns**

task status and message

**abort**(*task\_callback: Optional[Callable[[], None]] = None*) → *tuple[TaskStatus, str]*

Tell the component to abort the observation.

**Parameters**

- **task\_callback** – a callback to be called whenever the status of this task changes.

**Returns**

task status and message

**obsreset**(*task\_callback*: *Optional*[*Callable*[[], *None*]] = *None*) → *tuple*[*TaskStatus*, *str*]

Deconfigure the component but do not release resources.

**Parameters**

**task\_callback** – a callback to be called whenever the status of this task changes.

**Returns**

task status and message

**restart**(*task\_callback*: *Optional*[*Callable*[[], *None*]] = *None*) → *tuple*[*TaskStatus*, *str*]

Tell the component to restart.

It will return to a state in which it is unconfigured and empty of assigned resources.

**Parameters**

**task\_callback** – a callback to be called whenever the status of this task changes.

**Returns**

task status and message

**property assigned\_resources:** *list*[*str*]

Return the resources assigned to the component.

**Returns**

the resources assigned to the component

**property configured\_capabilities:** *list*[*str*]

Return the configured capabilities of the component.

**Returns**

list of strings indicating number of configured instances of each capability type

## 2.6 Alarm Handler Device

This module implements SKAAlarmHandler, a generic base device for Alarms for SKA.

It exposes SKA alarms and SKA alerts as Tango attributes. SKA Alarms and SKA/Element Alerts are rules-based configurable conditions that can be defined over multiple attribute values and quality factors, and are separate from the “built-in” Tango attribute alarms.

**class SKAAlarmHandler**(*\*args*: *Any*, *\*\*kwargs*: *Any*)

A generic base device for Alarms for SKA.

**init\_command\_objects**() → *None*

Set up the command objects.

**always\_executed\_hook**() → *None*

Perform actions that are executed before every device command.

This is a Tango hook.

**delete\_device**() → *None*

Clean up any resources prior to device deletion.

This method is a Tango hook that is called by the device destructor and by the device Init command. It allows for any memory or other resources allocated in the init\_device method to be released prior to device deletion.



**statsNrAlerts()** → *int*

Read number of active alerts.

**Returns**

Number of active alerts

**statsNrAlarms()** → *int*

Read number of active alarms.

**Returns**

Number of active alarms

**statsNrNewAlarms()** → *int*

Read number of new active alarms.

**Returns**

Number of new active alarms

**statsNrUnackAlarms()** → *float*

Read number of unacknowledged alarms.

**Returns**

Number of unacknowledged alarms.

**statsNrRtnAlarms()** → *float*

Read number of returned alarms.

**Returns**

Number of returned alarms

**activeAlerts()** → *list[str]*

Read list of active alerts.

**Returns**

List of active alerts

**activeAlarms()** → *list[str]*

Read list of active alarms.

**Returns**

List of active alarms

**class GetAlarmRuleCommand**(*logger: Optional[Logger] = None*)

A class for the SKAAlarmHandler's GetAlarmRule() command.

**do**(*argin: str*) → *str*

Stateless hook for SKAAlarmHandler GetAlarmRule() command.

**Parameters**

**argin** – Name of the alarm

**Returns**

JSON string containing alarm configuration info: rule, actions, etc.

**class GetAlarmDataCommand**(*logger: Optional[Logger] = None*)

A class for the SKAAlarmHandler's GetAlarmData() command.

**do**(*argin: str*) → *str*

Stateless hook for SKAAlarmHandler GetAlarmData() command.

**Parameters**

**argin** – Name of the alarm

**Returns**

JSON string specifying alarm data

**class** `GetAlarmAdditionalInfoCommand`(*logger*: *Optional*[*Logger*] = *None*)

A class for the SKAAlarmHandler's GetAlarmAdditionalInfo() command.

**do**(*argin*: *str*) → *str*

Stateless hook for SKAAlarmHandler GetAlarmAdditionalInfo() command.

**Parameters**

**argin** – Name of the alarm

**Returns**

JSON string specifying alarm additional info

**class** `GetAlarmStatsCommand`(*logger*: *Optional*[*Logger*] = *None*)

A class for the SKAAlarmHandler's GetAlarmStats() command.

**do**() → *str*

Stateless hook for SKAAlarmHandler GetAlarmStats() command.

**Returns**

JSON string specifying alarm stats

**class** `GetAlertStatsCommand`(*logger*: *Optional*[*Logger*] = *None*)

A class for the SKAAlarmHandler's GetAlertStats() command.

**do**() → *str*

Stateless hook for SKAAlarmHandler GetAlertStats() command.

**Returns**

JSON string specifying alert stats

**main**(\**args*: *str*, \*\**kwargs*: *str*) → *int*

Entry point for module.

**Parameters**

- **args** – positional arguments
- **kwargs** – named arguments

**Returns**

exit code

## 2.7 Capability Device

SKACapability.

Capability handling device

**class** `SKACapability`(\**args*: *Any*, \*\**kwargs*: *Any*)

A Subarray handling device.

It exposes the instances of configured capabilities.

**init\_command\_objects**() → *None*

Set up the command objects.

**class** `InitCommand`(*device*: *tango.server.Device*, *logger*: *Optional*[*Logger*] = *None*)

A class for the CapabilityDevice's init\_device() “command”.

**do()** → tuple[*ResultCode*, str]

Stateless hook for device initialisation.

**Returns**

A tuple containing a return code and a string message indicating status. The message is for information purpose only.

**Return type**

(*ResultCode*, str)

**always\_executed\_hook()** → None

Perform actions that are executed before every device command.

This is a Tango hook.

**delete\_device()** → None

Clean up any resources prior to device deletion.

This method is a Tango hook that is called by the device destructor and by the device Init command. It allows for any memory or other resources allocated in the init\_device method to be released prior to device deletion.

**activationTime()** → float

Read time of activation since Unix epoch.

**Returns**

Activation time in seconds

**configuredInstances()** → int

Read the number of instances of a capability in the subarray.

**Returns**

The number of configured instances of a capability in a subarray

**usedComponents()** → list[str]

Read the list of components with no.

of instances in use on this Capability

**Returns**

The number of components currently in use.

**class ConfigureInstancesCommand**(device: SKACapability, logger: Optional[Logger] = None)

A class for the SKALoggerDevice's SetLoggingLevel() command.

**do**(*argin*: int) → tuple[*ResultCode*, str]

Stateless hook for ConfigureInstances() command functionality.

**Parameters**

**argin** – nos. of instances

**Returns**

A tuple containing a return code and a string message indicating status. The message is for information purpose only.

**main**(\*args: str, \*\*kwargs: str) → int

Entry point for module.

**Parameters**

- **args** – positional arguments
- **kwargs** – named arguments

**Returns**

exit code

## 2.8 Logger Device

This module implements SKALogger device, a generic base device for logging for SKA.

It enables to view on-line logs through the Tango Logging Services and to store logs using Python logging. It configures the log levels of remote logging for selected devices.

**class SKALogger**(\*args: *Any*, \*\*kwargs: *Any*)

A generic base device for Logging for SKA.

**init\_command\_objects**() → *None*

Set up the command objects.

**create\_component\_manager**() → *None*

Create and return the component manager for this device.

**Returns**

*None*, this device doesn't have a component manager

**always\_executed\_hook**() → *None*

Perform actions that are executed before every device command.

This is a Tango hook.

**delete\_device**() → *None*

Clean up any resources prior to device deletion.

This method is a Tango hook that is called by the device destructor and by the device Init command. It allows for any memory or other resources allocated in the init\_device method to be released prior to device deletion.

**class SetLoggingLevelCommand**(logger: *Optional[Logger]* = *None*)

A class for the SKALoggerDevice's SetLoggingLevel() command.

**do**(argin: *Tuple[List[str], List[Any]]*) → *tuple[ResultCode, str]*

Stateless hook for SetLoggingLevel() command functionality.

**Parameters**

**argin** – tuple consisting of list of logging levels and list of tango devices

**Returns**

A tuple containing a return code and a string message indicating status. The message is for information purpose only.

**main**(\*args: *str*, \*\*kwargs: *str*) → *int*

Entry point for module.

**Parameters**

- **args** – positional arguments
- **kwargs** – named arguments

**Returns**

exit code

## 2.9 Controller Device

SKAController.

Controller device

**class SKAController**(\*args: Any, \*\*kwargs: Any)

Controller device.

**init\_command\_objects()** → None

Set up the command objects.

**class InitCommand**(device: *tango.server.Device*, logger: *Optional[Logger]* = None)

A class for the SKAController's init\_device() "command".

**do()** → tuple[*ResultCode*, str]

Stateless hook for device initialisation.

**Returns**

A tuple containing a return code and a string message indicating status. The message is for information purpose only.

**Return type**

(*ResultCode*, str)

**always\_executed\_hook()** → None

Perform actions that are executed before every device command.

This is a Tango hook.

**delete\_device()** → None

Clean up any resources prior to device deletion.

This method is a Tango hook that is called by the device destructor and by the device Init command. It allows for any memory or other resources allocated in the init\_device method to be released prior to device deletion.

**elementLoggerAddress()** → str

Read FQDN of Element Logger device.

**Returns**

FQDN of Element Logger device

**elementAlarmAddress()** → str

Read FQDN of Element Alarm device.

**Returns**

FQDN of Element Alarm device

**elementTelStateAddress()** → str

Read FQDN of Element TelState device.

**Returns**

FQDN of Element TelState device

**elementDatabaseAddress()** → str

Read FQDN of Element Database device.

**Returns**

FQDN of Element Database device

**maxCapabilities()** → list[str]

Read maximum number of instances of each capability type.

**Returns**

list of maximum number of instances of each capability type

**availableCapabilities()** → list[str]

Read list of available number of instances of each capability type.

**Returns**

list of available number of instances of each capability type

**class IsCapabilityAchievableCommand**(device: SKAController, logger: Optional[Logger] = None)

A class for the SKAController's IsCapabilityAchievable() command.

**do**(argin: tuple[list[int], list[str]]) → bool

Stateless hook for device IsCapabilityAchievable() command.

**Parameters**

**argin** – An array consisting pair of \* [nrInstances]: DevLong. Number of instances of the capability. \* [Capability types]: DevString. Type of capability.

**Returns**

Whether the capability is achievable

**main**(\*args: str, \*\*kwargs: str) → int

Entry point for module.

**Parameters**

- **args** – positional arguments
- **kwargs** – named arguments

**Returns**

exit code

## 2.10 Tel State Device

SKATelState.

A generic base device for Telescope State for SKA.

**class SKATelState**(\*args: Any, \*\*kwargs: Any)

A generic base device for Telescope State for SKA.

**always\_executed\_hook()** → None

Perform actions that are executed before every device command.

This is a Tango hook.

**delete\_device()** → None

Clean up any resources prior to device deletion.

This method is a Tango hook that is called by the device destructor and by the device Init command. It allows for any memory or other resources allocated in the init\_device method to be released prior to device deletion.

**main**(\*args: str, \*\*kwargs: str) → int

Entry point for module.

#### Parameters

- **args** – positional arguments
- **kwargs** – named arguments

#### Returns

exit code

## 2.11 Commands

This module provides abstract base classes for device commands, and a `ResultCode` enum.

The following command classes are provided:

- **FastCommand**: implements the common pattern for fast commands; that is, commands that do not perform any blocking action. These commands call their callback to indicate that they have started, then execute their do hook, and then immediately call their callback to indicate that they have completed.
- **DeviceInitCommand: Implements the common pattern for device Init**  
commands. This is just a `FastCommand`, with a fixed signature for the `__init__` method.
- **SlowCommand**: implements the common pattern for slow commands; that is, commands that need to perform a blocking action, such as file I/O, network I/O, waiting for a shared resource, etc. These commands call their callback to indicate that they have started, then execute their do hook. However they do not immediately call their callback to indicate completion. They assume that the do hook will launch work in an asynchronous context (such as a thread), and make it the responsibility of that asynchronous context to call the command's `completed` method when it finishes.
- **SubmittedSlowCommand: whereas SlowCommand makes no assumptions**  
about how the command will be implemented, `SubmittedSlowCommand` assumes the current device structure: i.e. a command tracker, and a component manager with support for submitting tasks.

**class ResultCode**(value)

Python enumerated type for command result codes.

**OK = 0**

The command was executed successfully.

**STARTED = 1**

The command has been accepted and will start immediately.

**QUEUED = 2**

The command has been accepted and will be executed at a future time.

**FAILED = 3**

The command could not be executed.

**UNKNOWN = 4**

The status of the command is not known.

**REJECTED = 5**

The command execution has been rejected.

**NOT\_ALLOWED = 6**

The command is not allowed to be executed.

**ABORTED = 7**

The command in progress has been aborted.

**class FastCommand**(logger: *Optional[Logger]* = None)

An abstract class for Tango device server commands that execute quickly.

That is, they do not perform any blocking operation, so can be safely run synchronously.

**class SlowCommand**(callback: *Optional[Callable]*, logger: *Optional[Logger]* = None)

An abstract class for Tango device server commands that execute slowly.

That is, they perform at least one blocking operation, such as file I/O, network I/O, waiting for a shared resources, etc. They therefore need to be run asynchronously in order to preserve throughput.

**class DeviceInitCommand**(device: *tango.server.Device*, logger: *Optional[Logger]* = None)

A SlowCommand with a fixed initialisation interface.

Although most commands have lots of flexibility in how they are initialised, device `InitCommand` instances are always called in the same way. This class fixes that interface. `InitCommand` instances should inherit from this command, rather than directly from `SlowCommand`, to ensure that their initialisation signature is correct.

**class SubmittedSlowCommand**(command\_name: *str*, command\_tracker: *CommandTrackerProtocol*, component\_manager: *BaseComponentManager*, method\_name: *str*, callback: *Optional[Callable]* = None, logger: *Optional[Logger]* = None)

A SlowCommand with lots of implementation-dependent boilerplate in it.

Whereas the `SlowCommand` is generic, and makes no assumptions about how the slow command will be executed, this `SubmittedSlowCommand` contains implementation-dependent information about the `SKABaseDevice` model, such as knowledge of the command tracker and component manager. It thus implements a lot of boilerplate code, and allows us to avoid implementing many identical commands.

#### Parameters

- **command\_name** – name of the command e.g. “Scan”. This is only used to ensure that the generated command id contains it.
- **command\_tracker** – the device’s command tracker
- **component\_manager** – the device’s component manager
- **method\_name** – name of the component manager method to be invoked by the do hook
- **callback** – an optional callback to be called when this command starts and finishes.
- **logger** – a logger for this command to log with.

**do**(\*args: *Any*, \*\*kwargs: *Any*) → *tuple[ResultCode, str]*

Stateless hook for command functionality.

#### Parameters

- **args** – positional args to the component manager method
- **kwargs** – keyword args to the component manager method

#### Returns

A tuple containing the task status (e.g. `QUEUED` or `REJECTED`), and a string message containing a `command_id` (if the command has been accepted) or an informational message (if the command was rejected)



```
class CommandTrackerProtocol(*args, **kwargs)
```

All things to do with commands.

```
new_command(command_name: str, completed_callback: Optional[Callable[[], None]] = None) → str
```

Create a new command.

#### Parameters

- **command\_name** – the command name
- **completed\_callback** – an optional callback for command completion

```
update_command_info(command_id: str, status: Optional[TaskStatus] = None, progress: Optional[int] = None, result: Optional[tuple[ResultCode, str]] = None, exception: Optional[Exception] = None) → None
```

Update status information on the command.

#### Parameters

- **command\_id** – the unique command id
- **status** – the status of the asynchronous task
- **progress** – the progress of the asynchronous task
- **result** – the result of the completed asynchronous task
- **exception** – any exception caught in the running task

## 2.12 Control Model

Module for SKA Control Model (SCM) related code.

For further details see the SKA1 CONTROL SYSTEM GUIDELINES (CS\_GUIDELINES MAIN VOLUME) Document number: 000-000000-010 GDL And architectural updates: <https://jira.skatelescope.org/browse/ADR-8> <https://confluence.skatelescope.org/pages/viewpage.action?pageId=105416556>

The enumerated types mapping to the states and modes are included here, as well as other useful enumerations.

## 2.13 Faults

General SKA Tango Device Exceptions.

```
exception SKABaseError
```

Base class for all SKA Tango Device exceptions.

```
exception GroupDefinitionsError
```

Error parsing or creating groups from GroupDefinitions.

```
exception LoggingLevelError
```

Error evaluating logging level.

```
exception LoggingTargetError
```

Error parsing logging target string.

```
exception ResultCodeError
```

A method has returned an invalid return code.

**exception StateModelError**

Error in state machine model related to transitions or state.

**exception CommandError**

Error executing a BaseCommand or similar.

**exception CapabilityValidationError**

Error in validating capability input against capability types.

**exception ComponentError**

Component cannot perform as requested.

**exception ComponentFault**

Component is in FAULT state and cannot perform as requested.

## 2.14 Release

Release information for ska\_tango\_base Python Package.

## 2.15 Utils

General utilities that may be useful to SKA devices and clients.

**exception\_manager**(cls: *type[Exception]*, callback: *Optional[Callable] = None*) → Generator

Return a context manager that manages exceptions.

**Parameters**

- **cls** – class type
- **callback** – a callback

**Yields**

return a context manager

**get\_dev\_info**(domain\_name: *str*, device\_server\_name: *str*, device\_ref: *str*) → *tango.DbDevInfo*

Get device info.

**Parameters**

- **domain\_name** – tango domain name
- **device\_server\_name** – tango device server name
- **device\_ref** – tango device reference

**Returns**

database device info instance

**dp\_set\_property**(device\_name: *str*, property\_name: *str*, property\_value: *Any*) → *None*

Use a DeviceProxy to set a device property.

**Parameters**

- **device\_name** – tango device name
- **property\_name** – tango property name
- **property\_value** – tango property value

**get\_device\_group\_and\_id**(*device\_name: str*) → list[str]

Return the group and id part of a device name.

**Parameters**

**device\_name** – tango device name

**Returns**

group & id part of tango device name

**convert\_api\_value**(*param\_dict: dict[str, str]*) → tuple[str, Any]

Validate tango command parameters which are passed via json.

**Parameters**

**param\_dict** – parameters

**Raises**

**Exception** – invalid type

**Returns**

tuple(name, value)

**coerce\_value**(*value: tango.DevState*) → str

Coerce tango.DevState values to string, leaving other values alone.

**Parameters**

**value** – a tango DevState

**Returns**

DevState as a string

**get\_dp\_attribute**(*device\_proxy: tango.DeviceProxy, attribute: tango.server.attribute, with\_value: bool = False, with\_context: bool = False*) → dict

Get an attribute from a DeviceProxy.

:param device\_proxy: a tango device proxy :param attribute: Attribute :param with\_value: default False :param with\_context: default False

**Returns**

dictionary of attribute info

**get\_dp\_command**(*device\_name: str, command: tango.server.command, with\_context: bool = False*) → dict

Get a command from a DeviceProxy.

**Parameters**

- **device\_name** – tango device name
- **command** – tango command
- **with\_context** – default False

**Returns**

dictionary of command info

**get\_tango\_device\_type\_id**(*tango\_address: str*) → list[str]

Return the type id of a TANGO device.

**Parameters**

**tango\_address** – tango device address

**Returns**

the type id of the device

**get\_groups\_from\_json**(*json\_definitions: List[str]*) → dict

Return a dict of tango.Group objects matching the JSON definitions.

Extracts the definitions of groups of devices and builds up matching tango.Group objects. Some minimal validation is done - if the definition contains nothing then None is returned, otherwise an exception will be raised on error.

This function will *NOT* attempt to verify that the devices exist in the Tango database, nor that they are running.

The definitions would typically be provided by the Tango device property “GroupDefinitions”, available in the SKABaseDevice. The property is an array of strings. Thus a sequence is expected for this function.

Each string in the list is a JSON serialised dict defining the “group\_name”, “devices” and “subgroups” in the group. The tango.Group() created enables easy access to the managed devices in bulk, or individually. Empty and whitespace-only strings will be ignored.

The general format of the list is as follows, with optional “devices” and “subgroups” keys:

```
[
  {
    "group_name": "<name>", "devices": [<dev name>, ...]},
    {
      "group_name": "<name>",
      "devices": [<dev name>, <dev name>, ...],
      "subgroups": [{<nested group>}, {<nested group>}, ...]
    },
    ...
]
```

For example, a hierarchy of racks, servers and switches:

```
[
  {
    "group_name": "servers",
    "devices": [
      "elt/server/1", "elt/server/2", "elt/server/3", "elt/server/4"
    ]
  },
  {
    "group_name": "switches",
    "devices": ["elt/switch/A", "elt/switch/B"]
  },
  {
    "group_name": "pdus",
    "devices": ["elt/pdu/rackA", "elt/pdu/rackB"]
  },
  {
    "group_name": "racks",
    "subgroups": [
      {
        "group_name": "rackA",
        "devices": [
          "elt/server/1", "elt/server/2", "elt/switch/A", "elt/pdu/rackA"
        ]
      },
      {
        "group_name": "rackB",
```

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```

        "devices": [
            "elt/server/3",
            "elt/server/4",
            "elt/switch/B",
            "elt/pdu/rackB"
        ],
        "subgroups": []
    }
]

```

**Parameters**

**json\_definitions** – Sequence of strings, each one a JSON dict with keys “group\_name”, and one or both of: “devices” and “subgroups”, recursively defining the hierarchy.

**Returns**

A dictionary, the keys of which are the names of the groups, in the following form: {“<group name 1>”: <tango.Group>, “<group name 2>”: <tango.Group>, ... }. Will be an empty dict if no groups were specified.

**Raises**

**GroupDefinitionsError** – # noqa DAR401,DAR402 arising from GroupDefinitionsError - If error parsing JSON string. - If missing keys in the JSON definition. - If invalid device name. - If invalid groups included. - If a group has multiple parent groups. - If a device is included multiple time in a hierarchy. E.g. g1:[a,b] g2:[a,c] g3:[g1,g2]

**validate\_capability\_types**(*command\_name*: *str*, *requested\_capabilities*: *list[str]*, *valid\_capabilities*: *list[str]*) → *None*

Check the validity of the capability types passed to the specified command.

**Parameters**

- **command\_name** – The name of the command to be executed.
- **requested\_capabilities** – A list of strings representing capability types.
- **valid\_capabilities** – A list of strings representing capability types.

**validate\_input\_sizes**(*command\_name*: *str*, *argin*: *Tuple[List[int], List[str]]*) → *None*

Check the validity of the input parameters passed to the specified command.

**Parameters**

- **command\_name** – The name of the command which is to be executed.
- **argin** – A tuple of two lists

**convert\_dict\_to\_list**(*dictionary*: *dict[Any, Any]*) → *list[str]*

Convert a dictionary to a list of “key:value” strings.

**Parameters**

**dictionary** – a dictionary to be converted

**Returns**

a list of key/value strings

**for\_testing\_only**(*func*: ~typing.Callable, *\_testing\_check*: ~typing.Callable[[], bool] = <function <lambda>>) → Callable

Return a function that warns if called outside of testing, then calls a function.

This is intended to be used as a decorator that marks a function as available for testing purposes only. If the decorated function is called outside of testing, a warning is raised.

```
@for_testing_only
def _straight_to_state(self, state):
    ...
```

#### Parameters

- **func** – function to be wrapped
- **\_testing\_check** – True if testing

#### Returns

the wrapper function

**generate\_command\_id**(*command\_name*: str) → str

Generate a unique command ID for a given command name.

#### Parameters

**command\_name** – name of the command for which an ID is to be generated.

#### Returns

a unique command ID string

## 2.16 Executor

This module provides for asynchronous execution of tasks.

**class TaskExecutor**(*max\_workers*: Optional[int])

An asynchronous executor of tasks.

**submit**(*func*: Callable, *args*: Optional[Any] = None, *kwargs*: Optional[Any] = None, *task\_callback*: Optional[Callable] = None) → tuple[TaskStatus, str]

Submit a new task.

#### Parameters

- **func** – the function to be executed.
- **args** – positional arguments to the function
- **kwargs** – keyword arguments to the function
- **task\_callback** – the callback to be called when the status or progress of the task execution changes

#### Returns

(TaskStatus, message)

**abort**(*task\_callback*: Optional[Callable] = None) → tuple[TaskStatus, str]

Tell this executor to abort execution.

New submissions will be rejected until the queue is empty and no tasks are still running. Tasks on the queue will be marked as aborted and not run. Tasks already running will be allowed to continue running

**Parameters**

**task\_callback** – callback for abort complete

**Returns**

tuple of task status & message

**class TaskStatus**(*value*)

The status of a task.

A task is any operation that is being performed asynchronously.

**STAGING = 0**

The request to execute the task has not yet been acted upon.

**QUEUED = 1**

The task has been accepted and will be executed at a future time.

**IN\_PROGRESS = 2**

The task is being executed.

**ABORTED = 3**

The task has been aborted.

**NOT\_FOUND = 4**

The task is not found.

**COMPLETED = 5**

The task was completed.

Note that this does not necessarily imply that the task was executed successfully. Whether the task succeeded or failed is a matter for the *ResultCode*. The COMPLETED value indicates only that execution of the task ran to completion.

**REJECTED = 6**

The task was rejected.

**FAILED = 7**

The task failed to complete.

Note that this should not be used for a task that executes to completion, but does not achieve its goal. This kind of domain-specific notion of “succeeded” versus “failed” should be passed in a *ResultCode*. Here, FAILED means that the task executor has detected a failure of the task to run to completion. For example, execution of the task might have resulted in the raising of an uncaught exception.





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