

Main Telescope Slew simulation: Setup notebook

....

This notebook does slew simulations, and check all aos components (M1M3, M2, hexapods) behavior during the slew-and-track process

This is expected to work both for SUMMIT and NCSA

```
In [1]: %load_ext autoreload
        %autoreload 2
```

```
In [2]: import rubin_jupyter_utils.lab.notebook as nb
        nb.utils.get_node()
```

```
/tmp/ipykernel_36495/1665379685.py:2: DeprecationWarning: Call to deprecated f
unction (or staticmethod) get_node. (Please use lsst.rsp.get_node())
    nb.utils.get_node()
```

```
Out[2]: 'yagan04'
```

```
In [3]: import os
        import sys
        import asyncio
        import logging

        import pandas as pd

        from matplotlib import pyplot as plt

        from lsst.ts import salobj
        from lsst.ts.observatory.control.maintel.mtcs import MTCS
```

```
|lsst.ts.utils.tai INFO: Update leap second table
```

```
|lsst.ts.utils.tai INFO: current_tai uses the system TAI clock
```

```
In [4]: summit = 1 #use this for summit testing
        # summit = 0 #use this for NCSA
```

Check environment setup

The following cell will print some of the basic DDS configurations.

```
In [5]: print(os.environ["OSPL_URI"])
        print(os.environ["LSST_DDS_PARTITION_PREFIX"])
        print(os.environ.get("LSST_DDS_DOMAIN_ID", "Expected, not set."))
```

```
file:///home/blquint/WORK/ts_ddsconfig/config/ospl-shmem.xml
summit
0
```

Setup logging

Setup logging in debug mode and create a logger to use on the notebook.

```
In [6]: logging.basicConfig(format="%(name)s:%(message)s", level=logging.DEBUG)
```

```
In [7]: log = logging.getLogger("setup")
log.level = logging.DEBUG
```

Starting communication resources

We start by creating a domain and later instantiate the MTCS class. We will use the class to startup the components.

```
In [8]: domain = salobj.Domain()
```

```
In [9]: mtcs = MTCS(domain=domain, log=log)
mtcs.set_rem_loglevel(40)
```

```
|setup.MTCS DEBUG: mtmount: Adding all resources.
|setup.MTCS DEBUG: mtptg: Adding all resources.
|setup.MTCS DEBUG: mtaos: Adding all resources.
|setup.MTCS DEBUG: mtm1m3: Adding all resources.
|setup.MTCS DEBUG: mtm2: Adding all resources.
|setup.MTCS DEBUG: mthexapod_1: Adding all resources.
|setup.MTCS DEBUG: mthexapod_2: Adding all resources.
|setup.MTCS DEBUG: mtrotator: Adding all resources.
|setup.MTCS DEBUG: mtdome: Adding all resources.
|setup.MTCS DEBUG: mtdometrajectory: Adding all resources.
```

```
In [10]: await mtcs.start_task
```

```
|MTHexapod INFO: Read historical data in 0.05 sec
```

```
|MTHexapod INFO: Read historical data in 0.06 sec
```

```
Out[10]: [None, None, None, None, None, None, None, None, None, None]
```

```
|MTM1M3.hardpointActuatorData ERROR: tel_hardpointActuatorData DDS read queue is full (100 elements); data may be lost
|MTM1M3.hardpointMonitorData ERROR: tel_hardpointMonitorData DDS read queue is full (100 elements); data may be lost
|MTM1M3.hardpointMonitorData ERROR: tel_hardpointMonitorData DDS read queue is full (100 elements); data may be lost
|MTM1M3.hardpointMonitorData ERROR: tel_hardpointMonitorData DDS read queue is full (100 elements); data may be lost
|MTM1M3.powerSupplyData ERROR: tel_powerSupplyData DDS read queue is full (100 elements); data may be lost
|MTM1M3.inclinometerData ERROR: tel_inclinometerData DDS read queue is full (100 elements); data may be lost
|MTM1M3.imsData ERROR: tel_imsData DDS read queue is full (100 elements); data may be lost
```

```
MTM1M3.accelerometerData ERROR: tel_accelerometerData DDS read queue is full (100 elements); data may be lost
MTM1M3.hardpointActuatorData ERROR: tel_hardpointActuatorData DDS read queue is full (100 elements); data may be lost
MTM1M3.imsData ERROR: tel_imsData DDS read queue is full (100 elements); data may be lost
MTM1M3.powerSupplyData ERROR: tel_powerSupplyData DDS read queue is full (100 elements); data may be lost
MTM1M3.accelerometerData ERROR: tel_accelerometerData DDS read queue is full (100 elements); data may be lost
```

Starting components

From now on we will start the various components of the MTAOS. You may wonder why are we not simply sending all CSCs to ENABLED state in one go, as we usually do on other systems.

The answer is that the MTCS components have some initialization dependencies that need to be observed for the components to be enabled properly. We will describe these as we work our way the initialization steps.

Starting MTPtg

We start by making sure the pointing component is alive, by waiting for a heartbeat. Next we enable the component using `mtcs.set_state` method.

We select to start with the `MTPtg` mainly because, of all components of the `MTCS` it is the only pure-software components. As such the `MTPtg` is pretty independent and can be brought to enabled in any condition.

It is also worth noticed that, as a pure-software component, the `MTPtg` does not have a simulation mode.

Furthermore, as you will notice below, we are not checking the software version of the `MTPtg`, mainly because the component is currently not sending this information.

```
In [11]: await mtcs.next_heartbeat("mtptg")
```

```
Out[11]: <ddsutil.MTPtg_logevent_heartbeat_b28358a6 at 0x7f2d134c9160>
```

```
In [12]: await mtcs.set_state(salobj.State.ENABLED, components=["mtptg"])
```

```
setup.MTCS DEBUG: [mtptg]::[<State.STANDBY: 5>, <State.DISABLED: 1>, <State.ENABLED: 2>]
setup.MTCS INFO: All components in <State.ENABLED: 2>.
```

Starting MTMount

This is one case where the initialization order is important.

The MTMount needs to be enabled before we enable the MTRotator. The reason is that the MTRotator needs to know the position of the Camera Cable Wrap (CCW), which is provided by the MTMount, before it can be enable. If the MTRotator does not receive the position of the CCW, it will immediately activate the breaks and transition to FAULT state.

We start by verifying that the CSC is sending heartbeats.

```
In [13]: await mtcs.next_heartbeat("mtmount")
```

```
Out[13]: <ddsutil.MTMount_logevent_heartbeat_d373cb25 at 0x7f2d133b4310>
```

Now we can enable the CSC.

```
In [14]: await mtcs.set_state(salobj.State.ENABLED, components=["mtmount"])
```

```
| setup.MTCS DEBUG: [mtmount]::[<State.STANDBY: 5>, <State.DISABLED: 1>, <State.ENABLED: 2>]
```

```
| setup.MTCS INFO: All components in <State.ENABLED: 2>.
```

Perform some basic checks

The following are a couple of sanity checks we routinely perform when starting the MTMount.

We check if the CSC is running in simulation mode and then the version of the CSC.

Finally, we verify that the camera cable wrap following is enabled.

```
In [15]: mtmount_simulation_mode = await mtcs.get_simulation_mode(["mtmount"])

mode = mtmount_simulation_mode["mtmount"].mode
timestamp = pd.to_datetime(mtmount_simulation_mode["mtmount"].private_sndStamp,

log.debug(
    f"MTMount simulation mode: {mode} @ {timestamp}"
)
```

```
| setup DEBUG: MTMount simulation mode: 1 @ 2022-04-29 18:19:15.920637184
```

```
In [16]: mtmount_software_versions = await mtcs.get_software_versions(["mtmount"])

csc_version = mtmount_software_versions["mtmount"].cscVersion
timestamp = pd.to_datetime(mtmount_software_versions["mtmount"].private_sndStamp,

log.debug(
    f"MTMount software version: {csc_version} @ {timestamp}",
)
```

```
| setup DEBUG: MTMount software version: 0.21.1 @ 2022-04-29 18:19:15.921166592
```

```
In [17]: mtmount_ccw_following = await mtcs.rem.mtmount.evt_cameraCableWrapFollowing.age
```

```

timestamp = pd.to_datetime(mtmount_ccw_following.private_sndStamp, unit='s')

if mtmount_ccw_following.enabled:
    log.debug(f"CCW following mode enabled: {mtmount_ccw_following.enabled} @ {timestamp}")
else:
    await mtcs.set_state(salobj.State.DISABLED, ["mtmount"])
    raise RuntimeError(
        "CCW following mode not enabled. Usually this means that the MTMount ccw was not
        not see telemetry from the rotator when it was enabled. To correct this, you should
        make sure the MTRotator telemetry is being published, then execute the
        MTMount CSC will be left in DISABLED state."
    )

```

| **setup DEBUG:** CCW following mode enabled: 1 @ 2022-05-10 15:32:10.345899264.

```

In [18]: # We want to turn off CCW following if MTMount is in Simulation Mode
if mtmount_simulation_mode["mtmount"].mode:
    await mtcs.disable_ccw_following()

```

| **setup.MTCS WARNING:** Disabling CCW following, slew activities will fail.

Starting Rotator

```

In [19]: await mtcs.next_heartbeat("mtrotator")

```

```

Out[19]: <ddsutil.MTRotator_logevent_heartbeat_6ca7fbf4 at 0x7f2d13522520>

```

```

In [20]: await mtcs.set_state(salobj.State.ENABLED, components=["mtrotator"])

```

```
setup.MTCS ERROR: Unable to transition mtrotator to <State.ENABLED: 2> None
Type: None
```

```
Traceback (most recent call last):
```

```
File "/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scip
ipe-3.0.0/lib/python3.8/site-packages/lsst/ts/salobj/csc_utils.py", line 15
7, in set_summary_state
```

```
    await cmd.start(timeout=timeout)
```

```
File "/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scip
ipe-3.0.0/lib/python3.8/site-packages/lsst/ts/salobj/topics/remote_command.
py", line 485, in start
```

```
    return await cmd_info.next_ackcmd(timeout=timeout)
```

```
File "/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scip
ipe-3.0.0/lib/python3.8/site-packages/lsst/ts/salobj/topics/remote_command.
py", line 195, in next_ackcmd
```

```
    raise base.AckError(msg="Command failed", ackcmd=ackcmd)
```

```
lsst.ts.salobj.base.AckError: msg='Command failed', ackcmd=(ackcmd private_
seqNum=472707173, ack=<SalRetCode.CMD_FAILED: -302>, error=1, result="Faile
d: SET_STATE command with param1=<SetStateParam.ENTER_CONTROL: 7> failed: E
xpectedError('Not expected state in timeout')")
```

The above exception was the direct cause of the following exception:

```
Traceback (most recent call last):
```

```
File "/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scip
ipe-3.0.0/lib/python3.8/site-packages/lsst/ts/salobj/csc_utils.py", line 15
9, in set_summary_state
```

```
    raise RuntimeError(
```

```
RuntimeError: Error on cmd=cmd_enable, initial_state=5: msg='Command faile
d', ackcmd=(ackcmd private_seqNum=472707173, ack=<SalRetCode.CMD_FAILED: -3
02>, error=1, result="Failed: SET_STATE command with param1=<SetStateParam.
ENTER_CONTROL: 7> failed: ExpectedError('Not expected state in timeout')")
```

```
-----
RuntimeError                                Traceback (most recent call last)
Input In [20], in <cell line: 1>()
----> 1 await mtcs.set_state(salobj.State.ENABLED, components=["mtrotator"])

File ~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/
control/remote_group.py:732, in RemoteGroup.set_state(self, state, overrides,
components)
    729         self.log.debug(f"[{comp}]:{ret_val[i]!r}")
    731 if error_flag:
--> 732     raise RuntimeError(
    733         f"Failed to transition {failed_components} to "
    734         f"{salobj.State(state)!r}."
    735     )
    736 else:
    737     self.log.info(f"All components in {salobj.State(state)!r}.")

RuntimeError: Failed to transition ['mtrotator'] to <State.ENABLED: 2>.
```

```
In [21]: await mtcs.set_state(salobj.State.ENABLED, components=["mtrotator"])
```

```
setup.MTCS DEBUG: [mtrotator]: [<State.DISABLED: 1>, <State.ENABLED: 2>]
```

```
setup.MTCS INFO: All components in <State.ENABLED: 2>.
```

Perform some basic checks

The following is a few sanity checks we routinely perform to verify the system integrity at this stage.

```
In [22]: mtrotator_simulation_mode = await mtcs.get_simulation_mode(["mtrotator"])

mode = mtrotator_simulation_mode["mtrotator"].mode
timestamp = pd.to_datetime(mtrotator_simulation_mode["mtrotator"].private_sndSt

log.debug(
    f"MTRotator simulation mode: {mode} @ {timestamp}"
)
```

```
| setup DEBUG: MTRotator simulation mode: 0 @ 2022-04-20 22:39:19.706884096
```

```
In [23]: mtrotator_software_versions = await mtcs.get_software_versions(["mtrotator"])

csc_version = mtrotator_software_versions["mtrotator"].cscVersion
timestamp = pd.to_datetime(mtrotator_software_versions["mtrotator"].private_snd

log.debug(
    f"MTRotator software version: {csc_version} @ {timestamp}",
)
```

```
| setup DEBUG: MTRotator software version: 0.23.0 @ 2022-04-20 22:39:19.707275008
```

```
In [31]: elevation = await mtcs.rem.mtmount.tel_elevation.next(flush=True, timeout=5)
azimuth = await mtcs.rem.mtmount.tel_azimuth.next(flush=True, timeout=5)
ccw = await mtcs.rem.mtmount.tel_cameraCableWrap.next(flush=True, timeout=5)
rotator = await mtcs.rem.mtrotator.tel_rotation.next(flush=True, timeout=5)

log.info(f"mount elevation Angle = {elevation.actualPosition}")
log.info(f"mount azimuth angle = {azimuth.actualPosition}")
log.info(f"CCW angle = {ccw.actualPosition}. Needs to be within 2.2 deg of rota
log.info(f"rot angle = {rotator.actualPosition} diff = {rotator.actualPosition
```

```
| setup INFO: mount elevation Angle = 80.0
```

```
| setup INFO: mount azimuth angle = 0.0
```

```
| setup INFO: CCW angle = 0.9229059020369732. Needs to be within 2.2 deg of r
rotator angle
```

```
| setup INFO: rot angle = 0.9228176250434217 diff = -8.827699355151708e-05
```

Debugging MTMount and MTRotator

`mtmount` was not publishing telemetry (el, az). The way to fix this is restarting the CSC. So this is what we are doing here.

```
In [26]: await mtcs.set_state(salobj.State.OFFLINE, components=["mtmount"])

| setup.MTCS DEBUG: [mtmount]::[<State.ENABLED: 2>, <State.DISABLED: 1>, <Sta
te.STANDBY: 5>, <State.OFFLINE: 4>]
| setup.MTCS INFO: All components in <State.OFFLINE: 4>.
```

```
In [27]: await mtcs.set_state(salobj.State.ENABLED, components=["mtmount"])
```

```
setup.MTCS DEBUG: [mtmount]::[<State.STANDBY: 5>, <State.DISABLED: 1>, <State.ENABLED: 2>]
```

```
setup.MTCS INFO: All components in <State.ENABLED: 2>.
```

```
In [29]: await mtcs.set_state(salobj.State.STANDBY, components=["mtrotator"])
```

```
setup.MTCS DEBUG: [mtrotator]::[<State.FAULT: 3>, <State.STANDBY: 5>]
```

```
setup.MTCS INFO: All components in <State.STANDBY: 5>.
```

```
In [30]: await mtcs.set_state(salobj.State.ENABLED, components=["mtrotator"])
```

```
setup.MTCS DEBUG: [mtrotator]::[<State.STANDBY: 5>, <State.DISABLED: 1>, <State.ENABLED: 2>]
```

```
setup.MTCS INFO: All components in <State.ENABLED: 2>.
```

CCW telemetry too old

This warning message may appear in the `MTRotator` in a couple different conditions.

The most common occurrence is when the `MTMount` component is not publishing the CCW telemetry. This should be rectified by enabling the CSC, as we've done on the section above, and is one of the reasons we enable `MTMount` before the `MTRotator`.

The less common but more critical condition is when the clock on the `MTMount` controller is out of sync with the observatory clock server. In this case, the `timestamp` attribute, used by the `MTRotator` to determine the relevant time for the published telemetry, will be out of sync and we won't be able to operate the system.

You can use the cell below to determine whether this is the case or not. If so, you need to contact IT or someone with knowledge about the `MTMount` low level controller to fix the time synchronization issue.

```
In [32]: ccw = await mtcs.rem.mtmount.tel_cameraCableWrap.next(flush=True, timeout=5)
rotator = await mtcs.rem.mtrotator.tel_rotation.next(flush=True, timeout=5)

ccw_snd_stamp = pd.to_datetime(ccw.private_sndStamp, unit='s')
ccw_timestamp = pd.to_datetime(ccw.timestamp, unit='s')
ccw_actual_position = ccw.actualPosition

rotator_snd_stamp = pd.to_datetime(rotator.private_sndStamp, unit='s')
rotator_timestamp = pd.to_datetime(rotator.timestamp, unit='s')
rotator_actual_position = rotator.actualPosition

log.info(
    f"CCW:: snd_stamp={ccw_snd_stamp} timestamp={ccw_timestamp} actual position={ccw_actual_position}"
)
log.info(
    f"Rotator:: snd_stamp={rotator_snd_stamp} timestamp={rotator_timestamp} actual position={rotator_actual_position}"
)

ccw_telemetry_maximum_age = pd.to_timedelta(1.0, unit='s')

if abs(ccw_snd_stamp - ccw_timestamp) > ccw_telemetry_maximum_age:
    log.warning(
```



```
f"CCW timestamp out of sync by {abs(ccw_snd_stamp - ccw_timestamp)}s. '
"System may not work. Check clock synchronization in MTMount low level
")
```

```
setup INFO: CCW:: snd_stamp=2022-05-10 15:53:05.574196992 timestamp=2022-05-10 15:53:05.573291776 actual position=0.9229059020369732
```

```
setup INFO: Rotator:: snd_stamp=2022-05-10 15:53:05.617431808 timestamp=2022-05-10 15:53:05.527177728 actual position=0.9231443809485427
```

Clearing error in MTRotator

If the MTRotator is in FAULT state, you need to send the `clearError` command before transitioning it back to `ENABLED`.

This is a particularity of the `MTRotator` (and `MTHexapod`) that violates our state machine.

```
In [ ]: if False:
        await mtcs.rem.mtrotator.cmd_clearError.set_start()
```

Checkpoint

At this point the system is ready for exercising slew activities, without involving the optical components.

Starting M1M3 (Mount telemetry mode)

If running the test on level 3 and if M1M3 is configured to listen for the mount telemetry, we first need to make sure the `MTMount` is pointing to zenith.

The reason is that `M1M3` is in a fixed position and, when we try to enable/raise it, it will check the inclinometer data against the elevation data. If they differ by more than a couple degrees the process will fail.

Once M1M3 is mounted on the telescope and we are operating the actual mount, instead of in simulation mode, this will not be necessary.

```
In [33]: await mtcs.rem.mtmount.cmd_moveToTarget.set_start(azimuth=0, elevation=90)
```

```
Out[33]: <ddsutil.MTMount_ackcmd_d68fb318 at 0x7f2d134a2790>
```

```
In [34]: await mtcs.next_heartbeat("mtm1m3")
```

```
Out[34]: <ddsutil.MTM1M3_logevent_heartbeat_d6c09f79 at 0x7f2d134a7e50>
```

```
In [35]: await mtcs.set_state(
        state=salobj.State.ENABLED,
        components=["mtm1m3"]
    )
```

```

|setup.MTCS DEBUG: [mtm1m3]:: [<State.DISABLED: 1>, <State.ENABLED: 2>]
|setup.MTCS INFO: All components in <State.ENABLED: 2>.

```

Raise m1m3

Now that m1m3 is enabled we can raise it.

The following has a trick to allow raising the m1m3 in the background and give control back to the notebook. If, in middle of the process, you need to abort the operation you can still do it from the notebooks.

Once you execute the cell bellow you will notice that the log messages will appear below the cell, but you can also see that the cell will be masked as "finished executing". That means, instead of seeing an `*` you will see the number of the cell. This is because the operation is running in the background and we have control over the notebook to execute additional cells.

```

In [36]: task_raise_m1m3 = asyncio.create_task(mtcs.raise_m1m3())

|setup.MTCS DEBUG: M1M3 current detailed state {<DetailedState.PARKEDENGINEE
|RING: 9>, <DetailedState.PARKED: 5>}, executing command...
|setup.MTCS DEBUG: process as completed...
|setup.MTCS DEBUG: M1M3 detailed state 6
|setup.MTCS DEBUG: mtm1m3: <State.ENABLED: 2>
|setup.MTCS DEBUG: mtm1m3: <State.ENABLED: 2>
|setup.MTCS DEBUG: M1M3 detailed state 7

```

The next cell contain a command to abort the raise operation initiated in the background on the cell above. Note that the command to execute the abort operation is encapsulated by an `if False`. This is to prevent the command from executing if the notebook is being executed by papermill or by accident.

If you need to abort the operation change the if statement to `if True`.

```

In [ ]: if False:
        await mtcs.abort_raise_m1m3()

```

The next cell will wait for the raise_m1m3 command to finish executing. This is to make sure a batch processing of the notebook won't proceed until the raise operation is completed.

```

In [37]: await task_raise_m1m3

```

```

In [38]: await mtcs.enable_m1m3_balance_system()

|setup.MTCS DEBUG: Enabling hardpoint corrections.

```

```

In [39]: await mtcs.reset_m1m3_forces()

```

Starting M2

```
In [44]: await mtcs.next_heartbeat("mtm2")
```

```
Out[44]: <ddsutil.MTM2_logevent_heartbeat_c8b944e6 at 0x7f2cb5edfa90>
```

```
In [45]: await mtcs.set_state(
          state=salobj.State.ENABLED,
          components=["mtm2"]
        )
```

```
setup.MTCS ERROR: Unable to transition mtm2 to <State.ENABLED: 2> NoneType:
None
```

```
Traceback (most recent call last):
  File "/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scip
  ipe-3.0.0/lib/python3.8/site-packages/lsst/ts/salobj/csc_utils.py", line 15
  7, in set_summary_state
    await cmd.start(timeout=timeout)
  File "/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scip
  ipe-3.0.0/lib/python3.8/site-packages/lsst/ts/salobj/topics/remote_command.
  py", line 485, in start
    return await cmd_info.next_ackcmd(timeout=timeout)
  File "/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scip
  ipe-3.0.0/lib/python3.8/site-packages/lsst/ts/salobj/topics/remote_command.
  py", line 195, in next_ackcmd
    raise base.AckError(msg="Command failed", ackcmd=ackcmd)
lsst.ts.salobj.base.AckError: msg='Command failed', ackcmd=(ackcmd private_
seqNum=531314071, ack=<SalRetCode.CMD_FAILED: -302>, error=1, result='Faile
d: enable not allowed in state <State.FAULT: 3>')
```

The above exception was the direct cause of the following exception:

```
Traceback (most recent call last):
  File "/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scip
  ipe-3.0.0/lib/python3.8/site-packages/lsst/ts/salobj/csc_utils.py", line 15
  9, in set_summary_state
    raise RuntimeError(
RuntimeError: Error on cmd=cmd_enable, initial_state=1: msg='Command faile
d', ackcmd=(ackcmd private_seqNum=531314071, ack=<SalRetCode.CMD_FAILED: -3
02>, error=1, result='Failed: enable not allowed in state <State.FAULT: 3
>')
```

```

-----
RuntimeError                                Traceback (most recent call last)
Input In [45], in <cell line: 1>()
----> 1 await mtcs.set_state(
      2     state=salobj.State.ENABLED,
      3     components=["mtm2"]
      4 )

File ~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/
control/remote_group.py:732, in RemoteGroup.set_state(self, state, overrides,
components)
    729         self.log.debug(f"[{comp}]:{ret_val[i]!r}")
    731 if error_flag:
--> 732     raise RuntimeError(
    733         f"Failed to transition {failed_components} to "
    734         f"{salobj.State(state)!r}."
    735     )
    736 else:
    737     self.log.info(f"All components in {salobj.State(state)!r}.")

RuntimeError: Failed to transition ['mtm2'] to <State.ENABLED: 2>.

```

```
In [46]: await mtcs.rem.mtm2.cmd_clearErrors.set_start()
```

```
Out[46]: <ddsutil.MTM2_ackcmd_b60441f4 at 0x7f2d1361d520>
```

```
In [47]: await mtcs.set_state(
      state=salobj.State.STANDBY,
      components=["mtm2"]
      )
```

```
| setup.MTCS DEBUG: [mtm2]: [<State.FAULT: 3>, <State.STANDBY: 5>]
| setup.MTCS INFO: All components in <State.STANDBY: 5>.
```

```
In [48]: await mtcs.set_state(
      state=salobj.State.ENABLED,
      components=["mtm2"]
      )
```

```
| setup.MTCS DEBUG: [mtm2]: [<State.STANDBY: 5>, <State.DISABLED: 1>, <State.
| ENABLED: 2>]
| setup.MTCS INFO: All components in <State.ENABLED: 2>.
```

Prepare M2 for operation

Switch on m2 force balance system and reset m2 forces.

```
In [49]: await mtcs.enable_m2_balance_system()
```

```
| setup.MTCS INFO: M2 force balance system already enabled. Nothing to do.
```

```
In [50]: await mtcs.reset_m2_forces()
```

Starting Camera Hexapod

```
In [51]: await mtcs.next_heartbeat("mthexapod_1")
```

```
Out[51]: <ddsutil.MTHexapod_logevent_heartbeat_ae564757 at 0x7f2cb5f78550>
```

The documentation below is now deprecated. We are leaving it just for the sake of keeping the information alive. You can simply run the commands that follow.

The command bellow to enable the Camera Hexapod should work, in general. Nevertheless, we found an issue with the interaction between the low level controller and the CSC that was causing it to fail from time to time. The error report can be found in [DM-31111](#). Until this ticket is worked on you may encounter failures when executing the cell below. You can continue by running the cell again.

In addition to the ticket above, the software of camera hexapod controller and EUI v1.2.0 on summit require the `mthexapod_1` to be in `DISABLED` state when setting the command source to DDS/CSC.

```
In [53]: await mtcs.set_state(
          state=salobj.State.ENABLED,
          components=["mthexapod_1"]
        )
```

```
| setup.MTCS DEBUG: [mthexapod_1]::[<State.DISABLED: 1>, <State.ENABLED: 2>]
| setup.MTCS INFO: All components in <State.ENABLED: 2>.
```

```
In [54]: mthexapod_1_simulation_mode = await mtcs.get_simulation_mode(["mthexapod_1"])

mode = mthexapod_1_simulation_mode["mthexapod_1"].mode
timestamp = pd.to_datetime(mthexapod_1_simulation_mode["mthexapod_1"].private_s

log.debug(
    f"Camera Hexapod simulation mode: {mode} @ {timestamp}"
)
```

```
| setup DEBUG: Camera Hexapod simulation mode: 0 @ 2022-04-26 16:00:42.878412
544
```

```
In [55]: mthexapod_1_software_versions = await mtcs.get_software_versions(["mthexapod_1"]

csc_version = mthexapod_1_software_versions["mthexapod_1"].cscVersion
timestamp = pd.to_datetime(mthexapod_1_software_versions["mthexapod_1"].private

log.debug(
    f"Camera Hexapod software version: {csc_version} @ {timestamp}",
)
```

```
| setup DEBUG: Camera Hexapod software version: 0.26.0 @ 2022-04-26 16:00:42.
878898944
```

```
In [56]: if False:
          await mtcs.rem.mthexapod_1.cmd_clearError.set_start()
```

```
In [57]: await mtcs.enable_compensation_mode(component="mthexapod_1")
```

```
| setup.MTCS DEBUG: Setting mthexapod_1 compensation mode from False to True.
```

```
In [58]: await mtcs.reset_camera_hexapod_position()
```

```
| setup.MTCS INFO: Camera Hexapod compensation mode enabled. Move will offset with respect to LUT.
```

```
| setup.MTCS DEBUG: Wait for Camera Hexapod in position event.
```

```
| setup.MTCS DEBUG: Camera Hexapod in position: True.
```

```
| setup.MTCS DEBUG: Camera Hexapod already in position. Handling potential race condition.
```

```
| setup.MTCS INFO: Camera Hexapod in position: False.
```

```
| setup.MTCS INFO: Camera Hexapod in position: True.
```

```
| setup.MTCS DEBUG: Camera Hexapod in position True. Waiting settle time 5.0s
```

Starting M2 Hexapod

```
In [60]: await mtcs.next_heartbeat("mthexapod_2")
```

```
Out[60]: <ddsutil.MTHexapod_logevent_heartbeat_ae564757 at 0x7f2d134d18b0>
```

We have been mostly running the M2 Hexapod in simulation mode, because the actual hardware is mounted on the telescope. This means the M2 Hexapod is not affected by the issue we reported above for the Camera Hexapod.

```
In [61]: await mtcs.set_state(
          state=salobj.State.ENABLED,
          components=["mthexapod_2"]
        )
```

```
| setup.MTCS DEBUG: [mthexapod_2]::[<State.STANDBY: 5>, <State.DISABLED: 1>, <State.ENABLED: 2>]
```

```
| setup.MTCS INFO: All components in <State.ENABLED: 2>.
```

```
In [62]: mthexapod_2_simulation_mode = await mtcs.get_simulation_mode(["mthexapod_2"])

mode = mthexapod_2_simulation_mode["mthexapod_2"].mode
timestamp = pd.to_datetime(mthexapod_2_simulation_mode["mthexapod_2"].private_s

log.debug(
    f"M2 Hexapod simulation mode: {mode} @ {timestamp}"
)
```

```
| setup DEBUG: M2 Hexapod simulation mode: 1 @ 2022-04-22 16:59:22.436866560
```

```
In [63]: mthexapod_2_software_versions = await mtcs.get_software_versions(["mthexapod_2"]

csc_version = mthexapod_2_software_versions["mthexapod_2"].cscVersion
timestamp = pd.to_datetime(mthexapod_2_software_versions["mthexapod_2"].private

log.debug(
    f"M2 Hexapod software version: {csc_version} @ {timestamp}",
)
```

```
| setup DEBUG: M2 Hexapod software version: 0.25.0 @ 2022-04-22 16:59:22.437270784
```

```
In [64]: await mtcs.enable_compensation_mode(component="mthexapod_2")

| setup.MTCS DEBUG: Setting mthexapod_2 compensation mode from False to True.

In [65]: await mtcs.reset_m2_hexapod_position()

| setup.MTCS INFO: M2 Hexapod compensation mode enabled. Move will offset with respect to LUT.
| setup.MTCS DEBUG: Wait for M2 Hexapod in position event.
| setup.MTCS DEBUG: M2 Hexapod in position: True.
| setup.MTCS DEBUG: M2 Hexapod already in position. Handling potential race condition.
| setup.MTCS INFO: M2 Hexapod in position: False.
| setup.MTCS INFO: M2 Hexapod in position: True.
| setup.MTCS DEBUG: M2 Hexapod in position True. Waiting settle time 5.0s
```

Starting all other components

```
In [66]: await mtcs.enable()

| setup.MTCS INFO: Enabling all components
| setup.MTCS DEBUG: Expand overrides None
| setup.MTCS DEBUG: Complete overrides: {'mtmount': '', 'mtptg': '', 'mtaos': '', 'mtm1m3': '', 'mtm2': '', 'mthexapod_1': '', 'mthexapod_2': '', 'mtrotator': '', 'mtdome': '', 'mtdometrajectory': ''}
| setup.MTCS DEBUG: [mtmount]::[<State.ENABLED: 2>]
| setup.MTCS DEBUG: [mtptg]::[<State.ENABLED: 2>]
| setup.MTCS DEBUG: [mtaos]::[<State.STANDBY: 5>, <State.DISABLED: 1>, <State.ENABLED: 2>]
| setup.MTCS DEBUG: [mtm1m3]::[<State.ENABLED: 2>]
| setup.MTCS DEBUG: [mtm2]::[<State.ENABLED: 2>]
| setup.MTCS DEBUG: [mthexapod_1]::[<State.ENABLED: 2>]
| setup.MTCS DEBUG: [mthexapod_2]::[<State.ENABLED: 2>]
| setup.MTCS DEBUG: [mtrotator]::[<State.ENABLED: 2>]
| setup.MTCS DEBUG: [mtdome]::[<State.STANDBY: 5>, <State.DISABLED: 1>, <State.ENABLED: 2>]
| setup.MTCS DEBUG: [mtdometrajectory]::[<State.STANDBY: 5>, <State.DISABLED: 1>, <State.ENABLED: 2>]
| setup.MTCS INFO: All components in <State.ENABLED: 2>.
```

Closing MTCS and Domain

You can use the commands below to easily shut-down (send to STANDBY) all the components.

```
In [ ]: await mtcs.set_state(salobj.State.STANDBY, components=["mtaos"])
```

```
In [ ]: # Move this to a shutdown notebook...
```

```
await mtcs.lower_m1m3()
```

```
In [ ]: await mtcs.set_state(salobj.State.STANDBY, components=["mtm1m3"])
```

```
In [ ]: await mtcs.set_state(salobj.State.STANDBY, components=["mtm2"])
```

```
In [ ]: await mtcs.set_state(salobj.State.STANDBY, components=["mthexapod_1"])
```

```
In [ ]: await mtcs.set_state(salobj.State.STANDBY, components=["mthexapod_2"])
```

```
In [ ]: await mtcs.standby()
```

```
In [ ]: await mtcs.close()
```

```
In [ ]: await domain.close()
```