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ELT HLCC User Manual

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Contents

1. Introduction

The ELT HLCC (High Level Coordination and Control) is the component of the control software responsible for coordination of all telescope subsystems to properly perform the activities required by scientific and technical operations.

The HLCC offers a single interface of the whole telescope toward operators and the instrument control software, except for deterministic interfaces that are provided by TREx. Its main task is for supervisory applications to coordinate the various telescope subsystems.

1.1 Scope

This document is the user manual for the ELT HLCC .

The intended audience are ELT users, consortia developers or software quality assurance engineers.

At the moment the document covers primarily the Telescope Simulator Software to be used by consortia and in the ECM as well as for development of HLCC itself.

In future issues of this document, alongside with the development of HLCC, it is foreseen to split this document putting the user manual for the actual system separated from the telescope simulator.

Some hyperlinks require access to ESO pages that require authentication (Jira, PDM, Gitlab, OneNotes). If you do not have acces to a page you would like to read, ask the HLCC team or you ESO contact person.

1.2 Related documents

1.2.1 Applicable Documents

The following documents, of the exact issue shown, form part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the content of this document specification, the content of this document specification shall be considered as a superseding requirement.

AD1 Not for the time being

1.2.2 Reference documents

The following documents, of the exact version shown herein, are listed as background references only. They are not to be construed as a binding complement to the present document.

RD1 ICD between the Instruments and the Central Control System
ESO-311982 version 3.8

RD2 ELT stellar positions calculations and structure
ESO-394280

RD3 Telescope Wavefront Perturbations Data Package for the E-ELT Instrument Consortia
ESO-271292 Version 2 - https://pdm.eso.org/kronodoc/HQ/ESO-271292/1

1.3 Acronyms

OLDB	CII Online Database
CCS	Central Control System
ECM	ELT Control Model
ELT	Extremely Large Telescope
HLCC	High Level Coordination and control
PFS	Pre-Focal Station
TREx	Telescope Real-Time Executor

1.4 Overview

1.4.1 HLCC Deployment

The HLCC is C++, Python, and Qt software for Linux which are executed on a mix of physical and virtual machines in the Armazones Computer Room. The software has only low requirements on determinism and synchronization, allowing hosting virtual machine instances on ESX servers with NTP time synchronization. Where greater determinism is required (for example for pointing kernels transmitting UDP data at 20Hz), physical machines with network connections to the Deterministic Network, and Time Reference Network (PTP) will be used. UIs will be displayed on terminals in the Armazones Local Control Room, remotely in Paranal Control Room, or on other terminals in the telescope area if required.

Most of the HLCC interfaces to Subsystem Control Systems are present in the Computer Room over 10GbE. Where data is exchanged with subsystems in the telescope area (e.g. PLCs of an LCS), an infrastructure of single and multimode fibers is available.

1.4.2 HLCC Architecture

The HLCC is architecturally composed of several functional building blocks, as can be seen in the Figure 1 below.

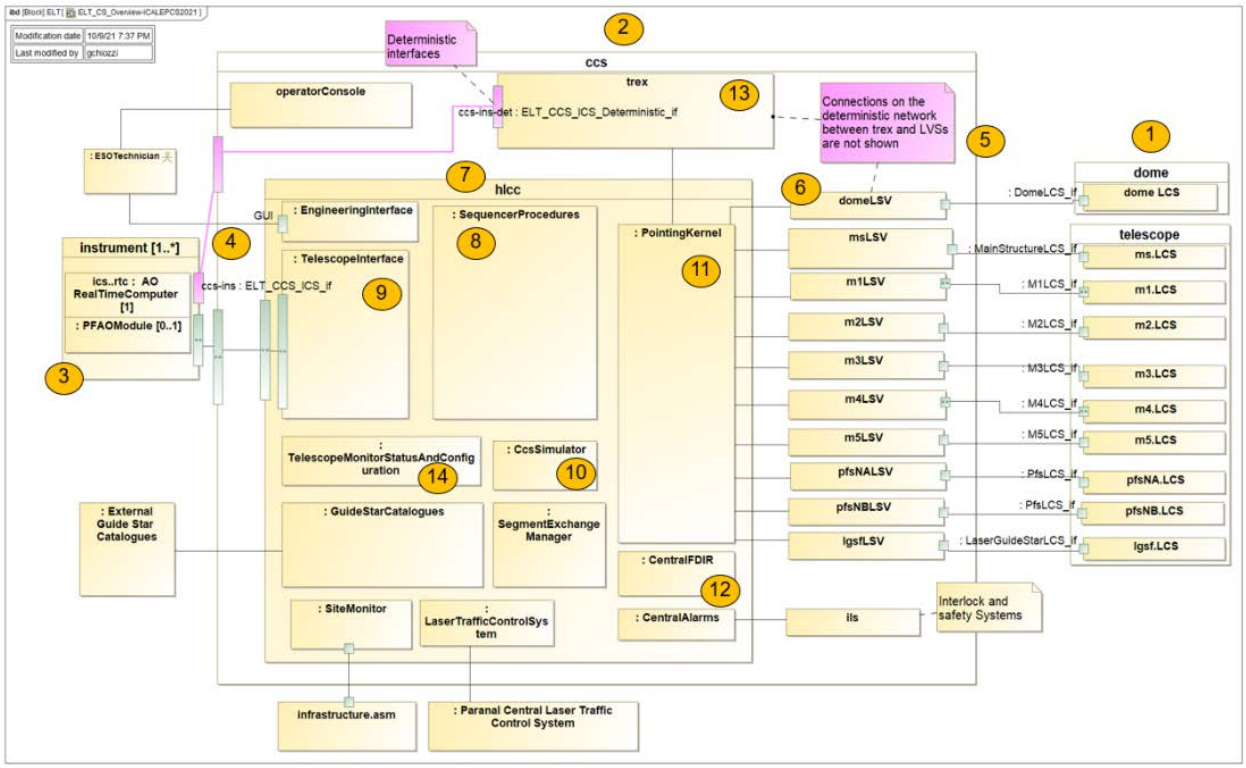


Figure 1

Among these:

- The interface toward the instruments, defined in the CCS-INS ICD [RD1], is allocated to the single component in Figure 1-(9), whose responsibility is to filter, validate and re-dispatch all commands received. This gives the flexibility to modify the internal structure without impacting the clients.
- In order to provide maximum flexibility during AIV and Commissioning, *features* of the system are implemented by independent supervisory applications designed to perform a complete operational function/use case of value to the users of the system. These procedures are managed by the SequencerProcedures module (Figure 1-(8)) and are written and executed using the Sequencer tool and are decoupled from the rest of the system. In this way also members of the AIV and commissioning teams can directly modify them and add new ones.

- The Telescope Monitor Status and Configuration component (Figure 1-(14)) is responsible for monitoring all components of CCS and consolidating this information to build global status indicators. It manages requests for high level changes in the configuration, propagating information to individual subsystems. It makes high level status information available to human users as well to other systems, instruments in particular.
- The PointingKernel (Figure 1-(11)) component coordinates and interacts with the pointing kernel components in dome, main structure, PFS and laser systems. It interacts with TREx for most of the pointing logic, but also commands the LSVs directly.
- The CentralFDIR (Figure 1-(12)) application monitors those aspects of quality and failures that involve more than a single subsystem.
- Other dedicated applications exist for star catalogues, monitoring and configuration, alarms, or specific tasks such as segment exchanges.

As a general architecture concept at ELT CCS level,

- Instructions are given to components using a command/reply pattern, but the reply is only used to acknowledge proper reception of a command.
- A client shall infer the proper execution and completion of a request from status information available through a publish/subscribe pattern.

For example, an instrument will send a Preset command to the HLCC Telescope Interface to request pointing and tracking to a new target in the sky and receive an OK if the target is valid. It will know that the telescope is on target and ready for the instrument to start exposures when the "*ready for handover*" status information is published.

2. Pointing Kernel functional design

This section is about design aspects related to domain concepts such as astrometric calculations and data products . Software design is described on the separate document Pointing Kernel software design.

Pointing kernel astrometric calculations are implemented in C++ in the ecos/ptk module.

The code includes plenty of comments, but a description of the algorithms is added here.

The astrometric calculations are based on the ERFA library (https://github.com/liberfa/erfa), a variant of the Sofa reference implementation, (https://www.iausofa.org/).

ERFA supports only transformations from star catalog data given in ICRS coordinates, where also the other intermediate coordinate systems that are part of the IAU 2000 definitions (e.g, CIRS), are different from the transformation chain previously used with Slalib (http://star-

www.rl.ac.uk/docs/sun67.htx/sun67.html) on the VLT and most other older telescopes. The pointing kernel uses the modern concepts, with two legacy exceptions:

- Intermediate results are still published in the old way: Local Apparent Sidereal Time instead of Earth Rotation Angle, and Apparent Position instead of CIP-based intermediate position. Changing this will require CCS-INS ICD changes. Likewise, the API still uses terms such as "mean position" that are associated with the old equinox-based coordinate systems.
- As currently also required by the ICD [RD1], the ptk supports not only ICRS/J2000.0 catalog positions, but also equinox-based coordinate systems with a Julian epoch other than J2000.0. For those we use code copied from PAL (http://www.starlink.ac.uk/star/docs/sun267.htx/sun267.html) as a temporary adaptation layer, to make the underlying ERFA look like the old Slalib API.

The calculations largely follow [RD2]. The main transformation chain is:

- From ICRS catalog position to apparent position.
  - Both are given in RA/DEC (or [*α, δ*]] coordinates, referring to the ICRS/J2000 frame, and the frame of date respectively.
  - Impl in ptk class HorizonEquatorialConverter, method MeanToApparent.
- From apparent position to observed position (HA/DEC).
  - The HA/DEC (or [*h, δ*]) is given in a frame that is aligned with Earth's axis of date, co-rotates with Earth, and counts HA westward from the site's meridian.
  - Impl in ptk class HorizonEquatorialConverter, method ApparentToObserved.
- From observed position (HA/DEC, local equatorial) to observed position (ALT/AZ, horizon).
  - This is merely a mathematical coordinate transformation, without considering physical effects.
  - Impl in ptk class HorizonEquatorialConverter, method LocalEquatorialToHorizontal.

Below we describe the steps in more detail. Features not yet implemented are mentioned *in italics*.

2.1 Preset/track with target given in catalog (mean) coordinates

- Read the RA/DEC target (incl. cumulative sky offset).
  - *We do not yet use "Xins" / "Yins" PFS straight through focal plane pointing origin coordinates.*
- Get applicable current time: We wait for the next global time event (every 50 ms tick in TAI/UTC) and calculate the time 100 ms in the future, see Jira tickets ETCS-904, ETCS-1105.
- An optional velocity offset (typically used for non-sidereal tracking on mean coordinates) is applied, using the given velocities in RA and DEC, and the time between the given epoch and the applicable current time.

  - *Note that to be actually useful, the epoch will need to be defined more precisely (ongoing ICD discussion).*
  - *We do not publish the resulting corrected mean position, but this requirement could be added.*
  - *We do not protect against unphysical velocities, since the velocity vector does not necessarily describe a physical motion.*
- Radial velocity: If zero (there is no "undefined" option in the interface) then derive it from a given redshift:
  - Uses the formula for Doppler redshift taken from https://en.wikipedia.org/wiki/Redshift#Doppler_effect, solved for v:

```
Int    c =  299792458; // in m/s
double v = c * (2*z + z*z) / (2 + 2*z + z*z);
```

  - *The feature of deriving radial velocity from redshift is ill-defined and will probably be removed, see ongoing ICD discussion*.
- Proper motion correction from target position epoch to coordinate system epoch:
  - This is necessary because the subsequent eraAtci13 (or palMap) call accepts the star position and magnitude of proper motion only for the epoch of the coordinate system (ICRS or equinox).
  - Uses ERFA function eraPmsafe (rather than eraStarpm) to
    - Correct the RA/DEC catalog position.
    - 3D-scale the PM vector (mainly perspective change due to radial velocity).
    - Correct a possible unphysical mismatch between PM velocity and parallax value.
    - (We do not precess the PM vector.)
- Transformation to a geocentric equatorial coordinate system of current epoch:
  - This corrects space motion, annual parallax, light deflection, annual aberration, precession-nutation.
  - We convert applicable current time from TAI to TT (Terrestrial Time).
  - In case of ICRS/J2000.0 target: Call eraAtci13, which includes the transformation from barycentric to geocentric. Then use the returned "equation of the origins" value to convert the returned CIO-based intermediate place to a legacy apparent position.
  - In case of a target given in legacy equinox-based mean coordinates other than J2000.0 (deprecated): Call palMap (drop-in replacement for slaMap) to get the apparent position.
  - We publish the apparent position (for HLCC-internal use only), along with other derived data.
- Transformation from apparent position to observed ALT/AZ coordinates:
  - This handles earth rotation, polar motion, transformation to local horizontal coordinates, diurnal aberration and parallax, atmospheric aberration/refraction.

  - We call eraApio13 and eraAtioq.
  - *We currently use some hardcoded values that should later be provided by the site monitor ubsystem:*
    - temperature = 273.15 K, pressure = 70108 Pa, humidity = 0.1 (should come from ASM).
    - Zero values for DUT1 correction and polar motion (should come from ELT TRS HKS).
    - Observing wavelength = 0.65*1e-6 m (should come from INS).
- Enforce telescope operational limits:
  - If tracking has taken the telescope outside the configured operational range (usually ALT from 20 to 88.5 deg, AZ from -180 to 360 deg), then we mark the preset target as invalid and set the current telescope position as the target position. This stops any presetting/tracking and leaves the telescope ready to receive a new preset command.
  - It is the user's responsibility to detect this condition from the published state and other measurement data.
  - For telescope testing, a "functional range" with wider limits can be enabled, but this is not possible for the instruments.
- Resolve ambiguous AZ target:
  - Note that the ELT AZ range is larger than a full circle: From -180 deg to +360 deg. Many sky AZ coordinates can be realized with 2 telescope AZ coordinates.
  - Normally we choose the telescope AZ target that is closest to the current telescope position, to make presets faster.
  - Circumpolar stars, when the telescope AZ is close to 360 deg, have the risk that later we track into the 360 deg limit. This applies to targets inside the small circle around the south pole, which always stays above the minimum ALT of 20 deg. (Normally "circumpolar" refers to the larger circle of targets that always stay above the horizon.) We play it safe in such cases and always preset the telescope by a full turn to the AZ = 0 deg range, where it can then track continuously for as long as it needs. *We do not optimize this yet by considering the length of the observation or the time until end of night.*
  - This strategy guarantees that the telescope never hits an AZ limit during tracking. This avoids the problems of either making the telescope "jump" during an observation, or ending the observation prematurely.
- In the telescope simulator, move the simulated telescope
  - This gets done using the RA/DEC target position that applies to current time, not the one computed 100 ms into the future.
  - The telescope's current position gets moved toward the target position. We use the constant configured speeds in ALT and AZ, ignoring acceleration or noise issues.

2.2 Published data

	Det. netw. (MUDPI)	Nondet. netw. (DDS)	OLDB public	OLDB HLCC-private	Det.netw. Llnetio – rtms Pointing kernel positions data
Target RA/DEC	x	x	x		x
Target ALT/AZ	x	x	x		x
Current ALT/AZ	x	x	x		x
RA/DEC apparent back-calculated from current ALT/AZ				x	
Hour angle back-calculated from current ALT/AZ				x	
Local sidereal time	x	x	x		x
Time TAI, UTC	x				x
Parallactic angle, north angle etc.	x	x	x		x
Control state		x	x		
Remaining tracking time					
Platescale					

All of the above steps together typically take less than 1 ms to execute, so that new data could then be published quickly for every iteration. However, in the simulation we introduce an artificial 10 ms delay in the independent software process that receives and publishes current and target positions,

to be closer to the future situation with a real telescope, where measurements have to travel from the local control system in various steps through the network.

The above table shows the data that gets published in every 20 Hz loop iteration. Not shown is other data that we publish at lower frequencies. Data in green rows applies to current time, while orange means 100 ms in the future.

The full set of data published by CCS for instrumentation is defined in [RD1].

The data published by the current implementation of the telescope simulator are listed in section 6.4.3.

2.3 Preset/track with target given in ephemeris

TODO: We do not yet support ephemerides.

2.4 Handling of time

The pointing kernel interface receives time values as TAI timepoints. For some parameters, it also accepts time as Julian epoch strings. The DUT1 offset gets passed separately. We never pass UT1 time through the interface.

Internally we convert as needed for the ERFA interface, e.g. to time in UTC in Julian Date representation.

The ptk is designed to work smoothly across leap seconds (positive or negative ones). This is achieved by using the C++ utc_clock::time_point and safe conversion routines. We only use system_clock when needed for calendar conversions, but then handling a possible current leap second as a special case.

With ERFA we consistently use their convention of "quasi-JD" leap second smearing and do not compute time durations as differences of such quasi-(M)JD values.

Another feature related to leap seconds is the adjustment of DUT1 values provided by ptk class Dut1. A DUT1 value that was retrieved before a leap second gets adjusted by Dut1, eventually shifted by 1 s, so that UTC+DUT1 stays continuous and correct. At some convenient time later, a new DUT1 value can be retrieved, which already contains the shift that was introduced by the leap second.

2.5 Backward calculation of mean (ra,dec)

The pointing kernel supports back calculations, using eraAtoi13 (to apparent) and eraAtic13 (to astrometric position in ICRS).

The result will in general be different from the original catalog position, because in the back-calculation we don't consider star-specific data such as proper motion or parallax.

HLCC only publishes back-calculated position in its private OLDB branch. There is no such data in the public interface. The back-calculation only considers the nominal mount position, without the effect of the various mirrors.

In the telescope simulation, when tracking, the published value "radec_at_xy_from_guide_stars" is equal to the commanded RA/DEC target position. In the actual system the value will be actually calculated based on the position of the guide stars in the PFS, when available.

3. Install and Build HLCC

Last Updated: 20240719 – Git tag: **v2.0.0-beta1**

3.1 Prerequisite

These instructions are targeted at building and installing HLCC on a development Virtual Machine

These instructions are tested with:

DevEnv : 5.1.0 (Latest 5.1.0-4)

Kernel : 6.8.9-100.fc38.x86_64

CII MAL : 4.2.0

CII SRV : 4.3.0

RAD : 5.5.0

Instructions for special cases, like manual installation of packages for debugging purposes are in light grey, so you know that you can normally skip them.

- This document describes how to install hlcc and the hlcc telescope simulator
  - From RPM (3.2)
  - From sources extracted from the git repository (3.3)

  on a machine already prepared with an ELT Development Environment.

  Execute first the common steps here below.

- See the DevEnv release notes here:
  Releases · Wiki · ecos / ELT SW Docs · GitLab (eso.org)

- The standard ELT virtual machines are updated periodically by eltmgr. In case manual updates are necessary, instructions are in this document:

E-ELT Linux Installation Guide

In order to install the latest official DevEnv release, the short story is:

As root:

```
$ dnf -y update puppet-elt
$ /root/elt/puppet-force-align
$ reboot      # to make sure all services are properly restarted, if needed
```

To update instead to the latest **ELT DevEnv Beta** package issue as root the following command:

```
$ /root/bin/update-puppet-beta
```

Notice that RPM packages you might have installed by hand, like rad or seq should be updated as well automatically because of their dependencies. After the update, check the installed versions of these packages (see below)

- In case of changes in the RPM repositories, it might be necessary and is anyway advisable to clean the cache:

  ```
  $ dnf clean all
  $ dnf repolist
  ```

- 16 GB of RAM are required for compilation.

- After a clean installation of DevEnv on a new machine (and in some cases after a DevEnv upgrade):

  It is necessary to perform some additional configuration as described here:
  https://gitlab.eso.org/ecs/eltsw-docs/-/wikis/KnowledgeBase/CII#how-to-post-install-cii-services

  Typically you need the following commands on a developer VM, **as root**:

  ```
  cii-services stop all
  # Run the postinstall scripts
  /elt/ciisrv/postinstall/cii-postinstall role_ownserver
  cii-services start all
  cii-services info
  ```

….logout and login again

- The accounts used are:
  - eltdev - Development account, where the software runs
  - eltmgr - ELT development environment configuration account
- If you are working on a completely clean machine, you need to configure the eltdev account.

  For a typical/basic development VM with DevEnv 5, the **.bash_profile** shoul look at configuration files in `.bashrc.d`.
  Verify you have this code in your `.bashrc`:

```
# User specific aliases and functions is loaded from ~/.bashrc.d
if [ -d ~/.bashrc.d ]; then
      for rc in ~/.bashrc.d/*; do
            if [ -f "$rc" ]; then
                  . "$rc"
            fi
      done
fi

unset rc
```

  and set only there your environment.

  A typical `~/.bashrc.d/env` file contains:

```
#######################################################
# GCH: IMPORTANT:
# It looks like I HAVE to explicitly set $HOME
# here, since it is otherwise not available when
# processes are started by nomad!!!!!!
# To be investigated
#######################################################
if [ -z ${HOME} ];
then
    WHOAMI=`whoami`
    export HOME=`getent passwd | grep $WHOAMI: | cut  -d ":" -f6`
fi
```

```
# User specific environment
if ! [[ "$PATH" =~ "$HOME/.local/bin:$HOME/bin:" ]]
then
    PATH="$HOME/.local/bin:$HOME/bin:$PATH"
fi
export PATH=$PATH:$HOME/.local/bin:$HOME/bin

### Setting the environment variables used to find Nomad and Consul
### This is a generic way that would work on a
### local development machine
### (as long as hostname is properly defined in /etc/hosts)
export NOMAD_ADDR="http://"`hostname --fqdn`":4646"
export CONSUL_HTTP_ADDR="http://"`hostname --fqdn`":8500"

export INTROOT=$HOME/INTROOT
module load introot

export PREFIX=$INTROOT

# On a development machine, in order to run integration tests
# without having to stop and cleanup CII services, add also
# See: https://jira.eso.org/browse/ETCS-630
export ELT_DEV_HOST=1

# Defines the statistics to provided by fastdds and
# visible in the fastdds_monitor
export
FASTDDS_STATISTICS="HISTORY_LATENCY_TOPIC;NETWORK_LATENCY_TOPIC;PUBLIC
ATION_THROUGHPUT_TOPIC;RTPS_SENT_TOPIC;RTPS_LOST_TOPIC;HEARTBEAT_COUNT
_TOPIC;ACKNACK_COUNT_TOPIC;NACKFRAG_COUNT_TOPIC;GAP_COUNT_TOPIC;DATA_C
OUNT_TOPIC;RESENT_DATAS_TOPIC;SAMPLE_DATAS_TOPIC;PDP_PACKETS_TOPIC;EDP
_PACKETS_TOPIC;DISCOVERY_TOPIC;PHYSICAL_DATA_TOPIC"

#
```

```
# User specific aliases and functions
#
alias lr="ls -altr"

#
# msgsend
# Source global definitions
#
if [ -f $INTROOT/resource/config/msgsend-completion.sh ]; then
   source $INTROOT/resource/config/msgsend-completion.sh
fi

#
# Add git branch name to prompt
#
parse_git_branch() {
  git branch 2> /dev/null | sed -e '/^[^*]/d' -e 's/* \(.*\)/(\1)/'
}
export -f parse_git_branch

export PS1="\u@\h \[\e[32m\]\w
\[\e[91m\]\$(parse_git_branch)\[\e[00m\]$ "

#
# Prevent bash to expand escaping environment variables when using tab
# i.e.
#   ls $INTROOT   <... TAB>
# would become otherwise
#   ls \$INTROOT/resource/
# instead of
#   ls /home_local/eltdev/INTROOT/resource/
#
shopt -s direxpand
```

```
#
# Reduces output from TestNG.
# See [ELTDEV-568]
export ETNGNOOUTREDIR=true
### end ~/.bashrc.d/env  ####
```

Attention: With DevEnv 5 and the new way to use Nomad, we have seen that there are problems (being investigated) setting these environment variables in `modulefiles/private.lua`
Please use `.bashrc` or `~/.bashrc.d/env` instead

- For more information on GIT/gitlab and our repository, see here:
  - GIT (internal OneNote link)
  - Remember to set your `user.name` and `user.email` configuration
  - **Note:**
    There are two options for cloning a repository:
    - `git clone git@gitlab.eso.org …`

    or
    - *`git clone https://gitlab.eso.org/ ….`*

    The first format is convenient on your own development machine, while the second format, asking for uid and password every time you access the remote repository, is better and safer on shared machines.

- Editorconfig - making editing rules consistent
  - EditorConfig helps maintain consistent coding styles for multiple developers working on the same project across various editors and IDEs.
  - The project's home page is: https://editorconfig.org/
  - Here you find configuration instructions and plugins for many editors/IDEs
  - Eclipse configuration was already described above
  - For Emacs, install the editorconfig plugin following instructions here: https://github.com/editorconfig/editorconfig-emacs

- After having configured the machine, logout from all shells and login again

3.1.1 Special dependencies

At the moment of releasing this document all dependencies are based on RPMs and it is not necessary to install packages from source in INTROOT.

Before doing it, check if RPMs have become in the meantime available

3.2 Installation from RPM

- The following steps describe how to install/upgrade an hlcc installation starting from rpm packages.
- Using RPM, all dependencies are installed automatically, but since packages are evolving it might be necessary to execute additional steps. In particular, specific dependencies to be installed in INTROOT cannot be handled by the RPM packaging.
- First of all it is necessary to update all currently installed packages to align the installation with the curring rolling release repository.
  As root:

  ```
  > dnf update
  ```

  If `elt-hlcc` is already installed on the machine, it will be updated together and consistently with all other packages.
- If elt-hlcc was not already installed, **as root** issue the command:

  ```
  > dnf install elt-hlcc-sw*
  ```

3.3 Installation from sources

- The following steps describe how to install/upgrade an hlcc installation starting from sources extracted from the git repository, from the latest tag or the master head.
- If you are upgrading a machine to a new DevEnv release, do not forget to:
  - Remove the INTROOT
  - cleanup hlcc and all dependencies running in each waf project with the commands

    ```
    > cd hlcc/interface
    > waf distclean
    > cd ../software
    > waf distclean
    ```
- Get from GIT the HLCC software, in the most convenient place.

- A typical place used by several developers is ~/MODULES:

```
git clone git@gitlab.eso.org:ccs/hlcc.git
Or
Git clone https://gitlab.eso.org/ccs/hlcc.git
```

- Checkout the branch/tag/commit you want to work with, for examcple the hlcc release tag mentioned on top of this chapter.
- **As root and from the parent folder where you have extracted the source code from git**,verify if all required develop RPM packages needed to build from sources are installed, in the proper versions, using the commands:

```
> dnf update
> dnf builddep --spec hlcc/elt-hlcc-sw.spec
```

If packages are missing or in the wrong version, the commands will interactively ask to install the required ones.

If the packages are in a specific repository, not configured by default, like the Beta repository, this can be specified on the command line. For example:

```
> dnf builddep --enablerepo=eso-elt-beta --spec hlcc/elt-hlcc-sw.spec
```

- After having installed all dependencies, logout from all shells and login again, to refresh the environment variable and run the new/changed lua files.

- Build the HLCC code:

```
> cd hlcc/interface
> waf configure build install
> cd ../software
> waf configure build install
```

- *it is also very often necessary to cleanup and reload the OLDB as described in section 4.4 (after having installed the latest HLCC)*.

3.4 Dependencies

- During development it might be necessary to install manually different versions of an RPM package or to install dependency packages from sources.

- In order to update to the latest packages in the repository to follow the rolling deployment of packages:

```
> dnf --repo eso-project-stable list 'elt-*'
> dnf install elt-*
```

- Here some tips/ common procedures taking the rad project as an example:
  - Check first if the correct version and all packages are already installed with the command:

```
eltdev@elthlccd60 ~ $ rpm -qa | grep elt-rad
elt-rad-doc-5.2.0-5.fc34.noarch
elt-rad-5.2.0-5.fc34.x86_64
elt-rad-devel-5.2.0-5.fc34.x86_64
```

  - To install the latest version for all packages:

```
> dnf install elt-rad*
```

  - To upgrade to the current version:

```
> dnf update elt-rad
```

  - You can check out from Git, build and install it into your INTROOT, if you need a version different from the one distributed with the DevEnv.
    For example if you need version 5.2.0:

```
cd somewhere  # e.g. MODULES/
git clone git@gitlab.eso.org:ifw/rad
cd rad
git checkout v5.2.0
waf configure
waf build install
```

4. Configure the system to run the HLCC code standalone

4.1 Initial system configuration

This section describes how to run HLCC as a standalone application, typically on a development machine.

- Initial configuration

  On a newly installed DevEnv machine, it is necessary to run the CII Post Install procedure that configures the plain CII services coming from the DevEnv RPMs. Details are described here: https://gitlab.eso.org/ecs/eltsw-docs/-/wikis/KnowledgeBase/CII#how-to-post-install-cii-services

  We configure the HLCC hosts as "own servers" (= single-developer set-up):

  Note you will need the root password.

```
$ su -c "/elt/ciisrv/postinstall/cii-postinstall role_ownserver"
Password:  <enter root password>
CII PostInstall
```

  - Manually update the astropy cache (only needed if running outside the ESO network):
    - HLCC Python scripts use astropy with a configuration that tries to avoid direct downloads from public internet servers for IERS data and leap second data. Instead, we download these cache updates from an ESO-internal server.
    - If you run HLCC outside the ESO network, then this download of astropy data updates will fail.
    - It is in that case recommended to update your local astropy cache.
      - This can be done by running (outside of HLCC scripts):
        ```
        from astropy.time import Time
        Time.now().ut1
        ```
      - Or alternatively follow https://docs.astropy.org/en/stable/utils/data.html to more explicitly manipulate the astropy cache, leading to up-to-date tables
        https://datacenter.iers.org/data/9/finals2000A.all
        https://hpiers.obspm.fr/iers/bul/bulc/Leap_Second.dat

- Note that even having older IERS_A data in the local cache is much better than not having this data cached at all. It avoids that astropy falls back to using the less accurate IERS_B table that was installed with astropy.

4.2 CII services

In order to run the telescope simulator or an application prototype, the CII services for Configuration and OLDB have to be running.

Details are described here:

https://gitlab.eso.org/ecs/eltsw-docs/-/wikis/KnowledgeBase/CII#how-to-startstop-cii-services

This excerpt assumes you have already done initial configuration (see 3.1 above).

```
$ sudo cii-services start all
```

This is the status I have now and that seems to work fine:

```
$ cii-services info
CII Services Tool (20240220)


# install .................. ..................
[oldb]    config-client-ini                              |install:
[oldb]             cii-oldb-default-redis          |active:yes       |boot:n
|install:/usr/bin/redis-server
[oldb]           cii-oldb-calc-daemon              |active:no        |boot:n
|install:/elt/ciisrv/bin/srv-oldb-calculation
[oldb]             cii-oldb-calc-scheduler       |active:no          |boot:n
|install:/elt/ciisrv/bin/srv-oldb-scheduler
[log]         rsyslog                                   |active:yes    |boot:y
|install:/usr/sbin/rsyslogd
[log]           systemd-journald                       |active:yes     |boot:y
|install:/usr/lib/systemd/systemd-journald
[log]          logrotate                                 |active:yes    |boot:y
|install:/usr/sbin/logrotate
[trace]      jaeger-all                                 |active:no      |boot:n
|install:/usr/local/bin/jaeger-all-in-one
[telem]   srv-telemetry            |active:no   |boot:n  |install:
```

```
[alarm]   cii_ias                  |active:no   |boot:n  |install:
[alarm]   kafka                    |active:no   |boot:n  |install:
[alarm]   kafka-zookeeper          |active:no   |boot:n  |install:
[alarm]   cii_alarm_mon            |active:no   |boot:n  |install:
[deprec]  filebeat                 |active:no   |boot:n  |install:
[deprec]  logstash                 |active:no   |boot:n  |install:
[deprec]  kibana                   |active:no   |boot:n  |install:
[deprec]  elasticsearch            |active:no   |boot:n  |install:
[deprec]  minio                    |active:no   |boot:n  |install:


# discovering ..........
# access .......
[oldb]    config-redis                        |access:yes   |host:127.0.0.1
|IP:127.0.0.1  |Port:6379
[oldb]    redis-server                        |access:yes   |host:localhost
|IP:127.0.0.1  |Port:6379
[oldb]    pubsub-server                       |access:yes   |host:localhost
|IP:127.0.0.1  |Port:6379
[oldb]    calc-node                          |access:no    |host:localhost
|IP:127.0.0.1  |Port:9117
[oldb]      redis-ext  testExtRedisServer    |access:yes    |host:localhost
|IP:127.0.0.1  |Port:6379
[trace]   jaeger                              |access:no    |host:localhost
|IP:127.0.0.1  |Port:14269
[telem]   telem                                           |host:localhost
|IP:127.0.0.1  |Port:9115
[alarm]   alarm-ias                                       |host:localhost
|IP:127.0.0.1
[alarm]   alarm-mon                           |access:n/a   |host:localhost
|IP:127.0.0.1  |Port:5602


# stats ....
config-redis   |total_connections_received:912579 |rejected_connections:0
redis-server   |total_connections_received:912580 |rejected_connections:0
jaeger
telem


# function ..........
```

```
Log      |functional:yes
OLDB DP  |functional:yes
OLDB CE  |functional:no
IntCfg   |functional:yes
```

- Run the OLDB Service GUI to monitor and inspect the OLDB:

```
$ oldbGui
```

- To start specific applications and the telescope simulator, see the individual pages in this section.
- The first thing to do is in any case to load the OLDB; see: Loading the OLDB (section (4.4))
- HLCC is available in different deployment configurations.
  See the specific pages below in this document for details on how to configure and start/stop each configuration.

4.3 Configuring Nomad and Consul

Deployment using Nomad and Consul is the standard way to run the system with respect to manual startup of processes.

Manual startup of one or more processes might still be necessary/useful during development or debugging.

This page contains instructions for the configuration of Nomad and Consul on a development machine, with Nomad and Consul running on the machine itself.

Other deployments (like instrumentation or ECM) have a specific setup, not explicitly considered here.

More general instructions for using HLCC with Nomad and Consul are in this page:

- software/nomad/examples/README · master · ccs / hlcc · GitLab (eso.org)

On the short (using as example the elthlccd64 host, used for RPM and Nomad testing):

4.3.1 Environment setup

The environment variables NOMAD_ADDR and CONSUL_HTTP_ADDR must be set in you .bashrc (and not any more in your ~/modulefiles/private.lua file (see elthlccd63 for an example):

```
export NOMAD_ADDR="http://elthlccd63.hq.eso.org:4646"
export CONSUL_HTTP_ADDR="http://elthlccd63.hq.eso.org:8500"
```

a generic way to set them for a local development machine can be (as long as hostname is correctly configured in /etc/hosts):

```
export NOMAD_ADDR="http://"`hostname --fqdn`":4646"
export CONSUL_HTTP_ADDR="http://"`hostname --fqdn`":8500"
```

4.3.2 Nomad and Consul configuration

Nomad and Consul configuration files should be prepared automatically by the installation procedures / puppet scripts.

If there are problems with Nomad/Consul configuration, a basic knowledge on the configuration of the tools is necessary. The baic steps to follow should be very simple:

1. Edit the `/etc/nomad.d/nomad.hcl` file (that shall be owned by eltdev)
2. Compare the current file with the example/template and check in particular that the IP addresses of your host and the host_network sections for deterministic and not deterministic networks are correct.
   Use the template files in software/nomad/examples · master · ccs / hlcc · GitLab (eso.org) as a starting point.

   Beware: do not forget to check the subnet for the host_network "control_non_deterministic", because experience shows it is easy to forget to adapt that.

   Starting from HLCC v2.0.0-alpha3 HLCC relies on Nomad meta-variables to configure if trs is active on the specific machine and if DDS traffic shall be limited to the single host.

   The following code (with the propervalues for your configuration) shall be in the /etc/nomad.d/nomad.hcl file:

```
meta {
    role = "hlcc,ms,trex"


    # Set to true on machines with PTP configured and therefore
    # trs health shall be checked
    trs_health_enabled = "0"


    # set to
    # Localhost_Only  on isolated machine, so that not DDS traffic comes in/out
    # Default         on machines that should exchange DDS data with other machines
    dds_profile = "Localhost_Only"


}
```

3. If the 'nomad.hcl' was modified in the previous step we need to restart the Nomad service (still as root) so Nomad can pick up the new file.

```
root$ systemctl restart nomad
```

4. Follow exactly the same procedure for the /etc/consul.d/consul.hcl file

4.3.3 Nomad and Consul startup

To have the Nomad and Consul services starting automatically at boot time, as root:

```
$ systemctl enable consul
$ systemctl enable nomad
```

Nomad and Consul services shall be otherwise started manually as root:

```
$ systemctl start consul
$ systemctl start nomad
```

If consul won't start check /usr/lib/systemd/system/consul.service and delete User and Group lines from this file.

4.4 Loading the OLDB

The OLDB of the HLCC is loaded using the oldbloader tool.

The HLCC startup sequences automatically check the status of the OLDB and eventually load the OLDB corresponding to the selected deployment, but it might be useful to load/check the OLDB manually.

You can skip this section is you are running HLCC only through the standard startup sequences and if your machine does not show problems with the OLDB.

Notes:

If upgrading from a previous DevEnv, it is most probably necessary and in any case advisable to clean-up the old oldb content and reload it, following Note2 here below.

The command

```
hlccOldbloader
```

iterates through all the Oldb description files and check/load them into the Oldb. This is also used in the startup sequence scripts to check the Oldb before start the applications.

The command line options are similar to `oldbloader` with a few additions; check below the most important:

- --check/--cleanup/none

  - --check - will check the *Oldb* for errors or inconsistencies using the *Oldb* description files defined by the --deployment option.
  - --cleanup - will clear all the datapoints described in the *Oldb* description files defined by the --deployment option.
  - If none of the above it will load all the datapoints described in the *Oldb* description files defined by the --deployment option.
- --override(-o) - when this command line option is used in conjunction with --check means that all the datapoints identified with errors/inconsistencies will be reloaded (cleared from the *Oldb* and loaded again) using the specification in the *Oldb* description files.
- --deployment(-d) - defines which deployment will be executed in the current operation. In this case deployment means a different set of *Oldb* description files that will be used to load/check/clear the *Oldb*.

  There are currently three deployments available:
    - dev - development
    - ecm - ELT control model
    - ins - instruments
- --abort - Aborts on error (by default would continue with the next item instead)

Therefore…..

To load the Oldb the best is to issue:

```
hlccOldbloader -d dev -o
```

To check the Oldb:

```
hlccOldbloader --check -d dev
```

Look inside the code of the command for more details on the individual steps executed.

Note 1:

If you are updating the HLCC application, you might get an updated OLDB that is not compatible with the one from the previous version that you have already installed and therefore you might get errors when loading the new database.

In this case, delete the current oldb using the oldb-gui application:

- start oldbGui
- enable write mode: Check options -> write enabled
- select the `elt` node
- press the delete button (or delete just the nodes that give problems) and confirm.

Note 2:

If you are updating the DevEnv or in any case if you find errors, you might need to clean-up the oldb content.

It should be sufficient to call the command:

```
> oldbReset
```

The option `–nuke` would execute, if necessary a harder reset

Note 3:

If you want to load/check individual configuration files, for example for debugging purposes, use the oldbloader command:

- Change the current directory to the place where the oldb files are located.

  source tree: cd <hlcc_root>/<module path>/resource

  INTROOT: cd $INTROOT/resource

  RPM: cd /elt/hlcc/resource

- Run the oldbloader command:

  oldbloader -p <prefix> oldb/<file to load>.yaml

The <prefix> parameter has the following format:

"elt/telif"

where the are no leading or training "/" characters.

The list of files handled by the hlccOldbloader is in

- folder: hlcc/software/common/hlccOldbloader/resource/config/hlccOldbloader
- files: config_xxx.yaml
  one file per each deployment containing names of files and prefix for the OLDB nodes in yaml format

4.5 Startup/shutdown of HLCC services using Nomad jobs

Once Nomad/Consul and the OLDB are ready, it is possible to start HLCC services using Nomad jobs.

This is actually done only for development and debugging, since normally HLCC services are started up and shutdown using sequences/OBs, as described below in section (5) for the telescope simulator.

Therefore this section can be normally safely skipped.

For example, in order to start the main HLCC services on the command line:

```
$ nomad job run /elt/hlcc/share/nomad/hlcc.nomad.hcl
```

or

```
$ nomad job run -var=prefix=$INTROOT
```

```
$INTROOT/resource/nomad/hlcc.nomad.hcl
```

depending on the installation for hlcc (RPM or from sources in $INTROOT).
There are specific startup jobs per each deployment.

Stopping HLCC services on the command line:

```
$ nomad job stop hlcc
```

Commands to start/stop nomad jobs can be issued with the nomad command line tool from any ma chine on any cluster, assuming NOMAD_ADDR is properly set.

Both Nomad and Consul have a web ui:

Nomad web UI: http://elthlccd63.hq.eso.org:4646/ui/clients

Consul web UI: http://elthlccd63.hq.eso.org:8500/ui/dc1/services

Nomad log files are easily accessible from the UI, but they are also available through journalclt and the filesystem:

Logs by nomad: journalctl -u nomad | less # explicit piping to less prevents truncation

Logs by the jobs: under /opt/nomad/data/alloc

5. Telescope System Deployment

The HLCC can be deployed in different ways, depending on the usage foreseen.

The components of the system are as much as possible the same, to allow maximizing reusage and testing, and the deployment is whenever possible managed through configuration options.

5.1.1 Available deployments

Currently 3 different deployments are available:

- INS: Integration with instrumentation software for HLCC simulation

  This deployment is meant to be used by instrumentation consortia to test their instrumentation software against a simulation of the telescope. The deployment is on a single VM and consists only of what is necessary to implement the INS/CCS interfaces.

- DEV: Development environment on one single virtual machine

  This is the normal deployment used by the members of the HLCC development team.

  It consists of all components of HLCC, used in standalone mode, without the need of other subsystems. Interfaces to other subsystems (in particular LSVs) are implemented with simulation processes.

  It is normally run on a single development Virtual Machine but it is also possible to run this configuration on the ELT Control Model for testing.

- ECM: ELT Control Model

  This is the configuration deployed on the ELT Control Model and it assumes that all LSVs/subsystems are installed and available there.

  It is also possible to run this deployment on a development VM for testing.

In the future more deployments will be added, with different configuration options.

5.1.2 Deployment files and structure

If you are going to use the HLCC software integrated with the INS software or in the ECM, check the specific procedures for integrated deployment in the instrumentation documentat6ion.

What is provided here are for the time being essentially examples that will be used to create the fully integrated deployment procedures.

For a better understanding, check the software deployment strategy document OneNote, that explains how deployment was planned and implemented.

Deployments are started and shutdown using sequences (actually sequencer Observation Blocks – Obs – that invoke sequences with proper parameters). Every deployment has a startup OB and a shutdown OB.

All OBs are located in the hlcc repository path: `"hlcc/software/seq/resource/config/seq"`

The Obs also can be configured using OB parameters to handle specific situations (the default values for the parameters are for the most common situation).

The Obs call/use sequences that are stored in “hlcc/software/seq/src/hlccseq”

Also in the same path we find other helper files like:

- `common/hlccdeployments.py` - This file contains the specification of all deployments. The startup / shutdown sequences will rely on the information in this file to properly execute.
- `common/hlccseq_lib.py` - Contains methods that are common to all deployments and which will be used by sequences.

Deployments sequences also start / stop nomad jobs, whose files are located in hlcc path: `"hlcc/software/nomad/src/"`

We assume here that Nomad and Consul have been properly configured as described in section 4.3.

Obs and sequences can be launched from the `seqtool gui` or from the `hlcctelsimui` or from the command line `seqtool run`.

In the two sections below we show how to run startup/shutdown Obs from the command line.

5.1.3 Deployment startup

Deployment startup OBs/sequences are responsible for:

- Load/check the Oldb according to the deployment needs

- Start all applications by running the jobs associated with the deployment.
- Init and Enable all applications and leave them in the ready state.

Select the proper OB and launch it manually (with the proper path). For example:

```
$ seqtool run hlccStartupIns.json
```

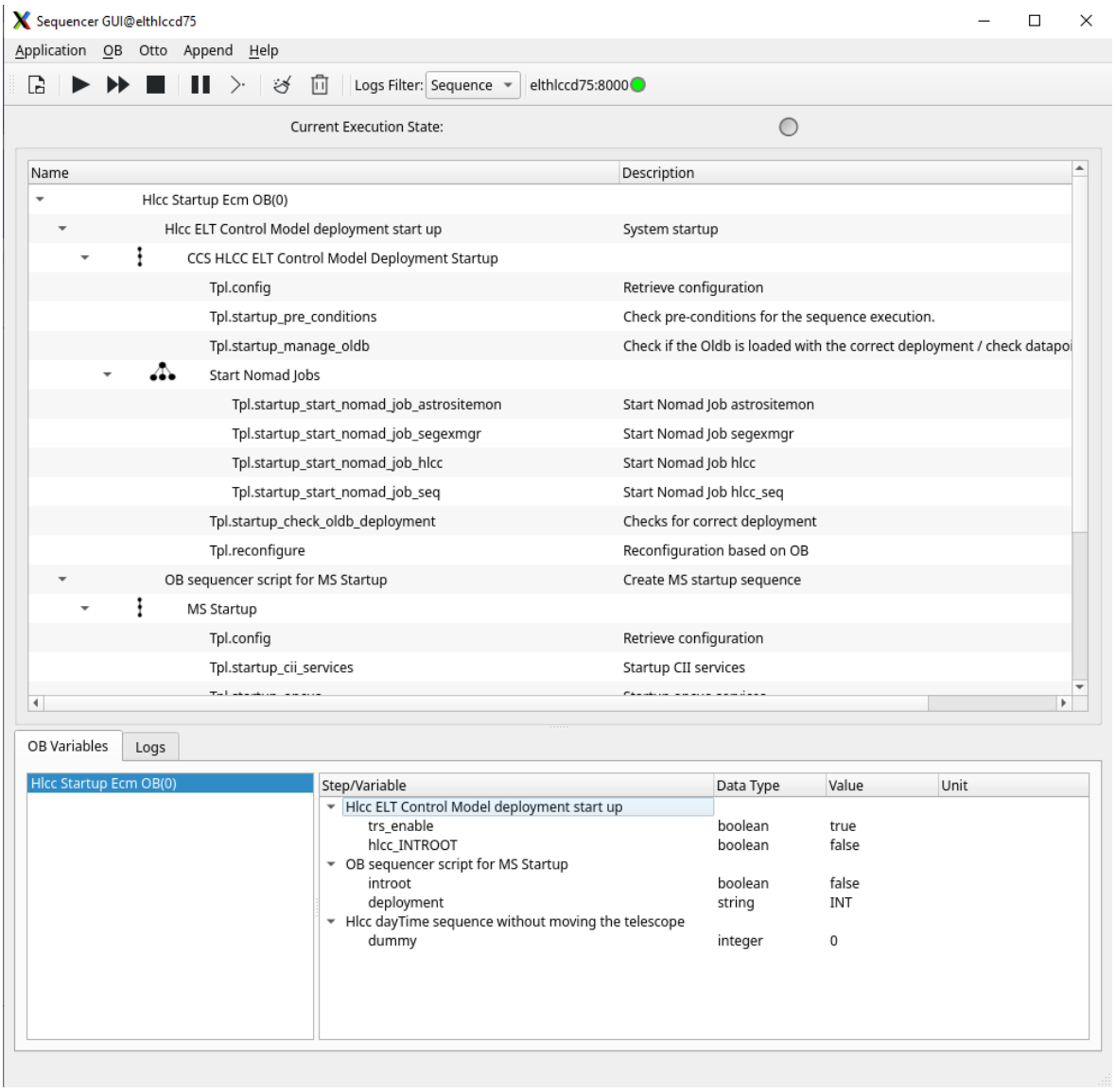
The name of the startup OB depends on the deployment, for example:

- `hlccStartupDev.`json - Development VM deployment
  Startup of the standalone HLCC configuration (no LSVs), assuming installation in INTROOT.
- `hlccStartupDevOnEcm.`json - Development configuration on ECM system
  Startup of the standalone HLCC configuration (no LSVs), assuming installation in INTROOT and assuming it is running on the ECM HW and SW configuration.
- `hlccStartupEcm.`json - ECM deployment
  Assume a deployment on the ECM HW and SW configuration, with the actual LSVs. Assuming installation as RPM for both HLCC and MS.
- `hlccStartupEcmOnDev.`json - ECM configuration on development VM
  Startup of the complete HLCC including LSVs, but assuming a single VM development HW configuration. Assuming installation in INTROOT of HLCC and as RPM for MS.
- `hlccStartupIns.`json - Instruments deployment

Alternatively, the OB can be launched from the `seqtool gui` or from the `hlcctelsimui`.

The Startup OBs are actually calling the same startup sequences setting different values for the parameters passed to them.

The Obs listed above are setting the parameters for the most common and convenient cases, but it is possible to manage more alternatives (for example ECM on DEV machine with MS installed in INTROOT) by changing the parameters on the seqtool gui:



trs is normally enabled on ECM, but not on development VMs

5.1.4 Deployment shutdown

Deployment Shutdown OBs are responsible for:

- Safely shutdown all deployment applications.
- Stop all the deployment *Nomad* jobs .

Select the proper sequence and launch it manually:

```
$ seqtool run hlccseq.hlccEcmShutdown
```

The name of the Shutdown sequence depends on the deployment:

- `hlccShutdownDev.` json - Development VM deployment
- `hlccShutdownEcm.` json - ECM deployment
- `hlccShutdownIns.` json – Instruments deployment

Alternatively the OS can be launched from the `seqtool gui` or from the `hlcctelsimui`.

6. Telescope Simulator

6.1 Overview

The Telescope System is the software

The Telescope Simulator consists in a subset of the HLCC tailored at providing a simulation of the telescope behavior, focusing in particular in providing an implementation of the CCS-INS telescope interface.

The first few sections in this chapter describe the basic functionality, useful when running in simulation mode from the INS perspective.

The following sections go into deeper details and are mostly useful for the users of the DEV and ECM deployments, to test functionality or to configure the system.

6.2 Telescope Simulator deliverables

The ELT Telescope Simulator includes:

- HLCC code (as RPM or source code from Git)
- Documentation

This allows to install it on the corresponding DevEnv release.

The delivered software components are:

- Run-time processes:
  - telifsim
  - telmon
  - eltpk

- trksim (Ms tracking simulator)
- lsvsim (lsv simulator configurable/generic process)

- User interfaces
  - hlcctelsimui
  - hlcctelsimui_mon
- Utilities
  - See: (7.11)

6.3 Telescope Simulator startup

The most natural way to startup the telescope simulator (i.e. the INS deployment on a Virtual Machine), once the system is fully configured, is the following:

- Load the OLDB:

  ```
  > hlccOldbloader -d ins -o
  ```

- Start the HLCC UI:

  ```
  > hlcctelsimui
  ```

- The Sequences tab will present a list of the OB/Sequences available for the INS deployment:

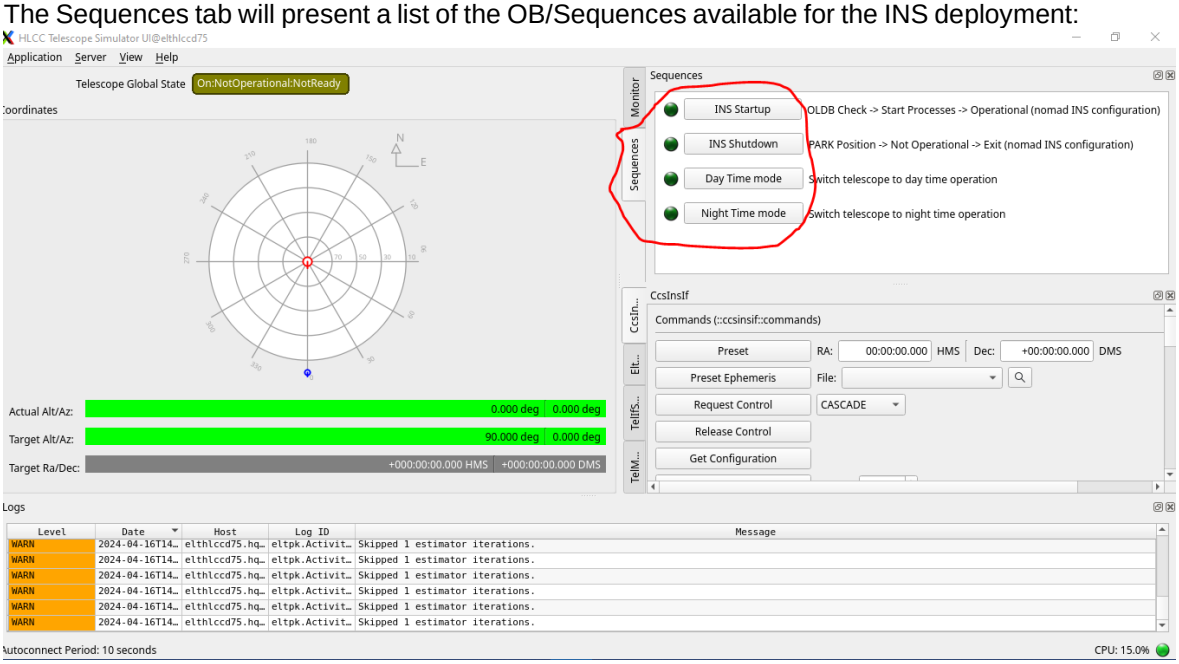


Figure 2

- Select the INS Statup button
- A sequenced GUI will open and the OB will be loaded
- Run the OB and the teelescope will be started in simulation
- At the end of the startup, the Telescope will be in Day Time mode, On:NotOperational:NotReady
- To bring it in Night Time mode, ready to preset, run in the same way the Night Time mode sequence/ob
- In a similar way you can shutdown the telescope.

More information on the hlcctelsimui is available in section 7.

6.4 Implemented features

The Telescope Simulator provides a (partial) implementation of the following features.

6.4.1 Standard Commands

The standard commands supported are described in this ICD:

- std/if/src/stdif.xml · master · ecs / ecs-interfaces · GitLab (eso.org)

The server URI is:

- `zpb.rr://[ip]:[port]/telifsim/StdCmds`

Example:

```
$> msgsend --uri `consulGetUri -r ifuri -s telifsim -i StdCmds`
::stdif::StdCmds::GetState
```

Note: The standard commands have only a partial implementation. In particular State and Status are reporting currently only the State and Status of the server process and not of the whole simulator.

Note: The `consulGetUri` *utility is used to query Consul for the uri dynamically assigned to any of the HLCC processes when they are started up by Nomad.*

6.4.2 CCS-INS ICS Commands on control network

The specific ccs-ins interface commands supported are described in this ICD:

- ccsinsif/icd/src/ccsinsif.xml · master · ccs / hlcc · GitLab (eso.org)

The following commands are currently (partially) implemented:

- Preset

- RequestControl
- ReleaseControl
- OffsetSetSky
- SetObservingWavelength
- SetVelocityOffset
- GetConfig
- RousConfig, RousExecute and corresponding monitor points

The server URI is:

- `zpb.rr://[ip]:[port]/telifsim/Commands`

Example:

```
$> msgsend --uri `consulGetUri -r ifuri -s telifsim -i Commands`
::ccsinsif::Commands::RequestControl '"CASCADE"'
```

(Notice the single quotes ' and double quotes " usage to delimit the parameter value according to the syntax accepted by msgsend)

6.4.3 Monitor data

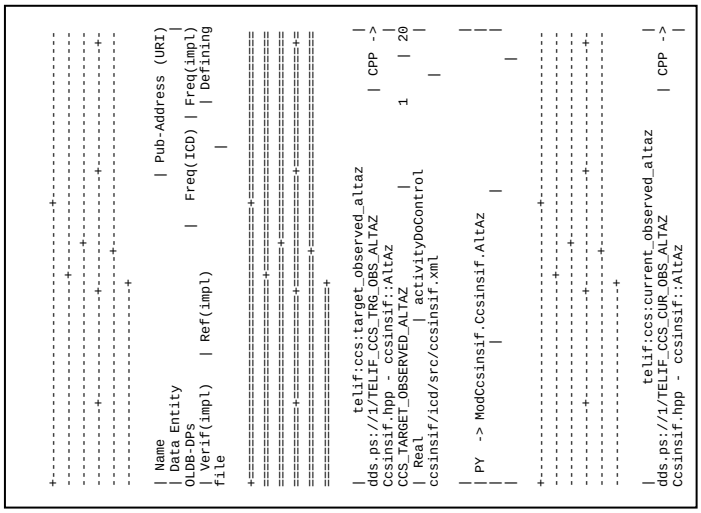
The table below lists the data points defined in the CCS-INS ICD that are currently published in the oldb, in the non-deterministic pub/sub (DDS) and in the deterministic pub/sub (MUDPI), with characteristics and limitations.

HLCC publishes data on different DDS Domain IDs.

According to the OneNote page ECM DDS domain IDs hlcc shall publish:

- **Domain 1:** for general info over several subsystems. In particular subsystems shall publish on domain 1 status information for supervisory applications, or data published by HLCC to be used by other subsystems.
- **Domain 2:** CCS/INS interface
- **Domain 3:** HLCC internal/private supervisory communication

The table itself is difficult to read on a printed version of this document, but is in the online documentation **[ToDo: Link to be added]** and can be generated dynamically from the source three.



The command to extract the information in the table above (plus more) from the code is:

```
software/tools/icd-info.py  interface/ccsinsif/topics/src/CcsInsTopics.xml
interface/ccsinsif/icd/src/ccsinsif.xml  interface/ccsinsif/icd-
determ/src/ccsinsdetif.xml     interface/ccsinsif/icd-33-
extref/src/ccsinsifextref.xml  interface/ccsinsif/icd-34-
stroke/src/ccsinsifstroke.xml  interface/ccsinsif/icd-35-ao/src/ccsinsifao.xml
software/telif/eltpk/eltpkif/icd/src/eltpkif.xml  interface/ccsinsif/icd-info-
topic-impl.yaml /elt/stdif/interface/icd/stdif.xml
```

To subscribe to monitor data, see for example, the utility (7.11.4):

```
$ telif_subscriber –help
```

and the example Jupyter notebooks

6.4.4 METADAQ Data Acquisition commands on control network

The application supports the metadaq commands described in this ICD:

- metadaq/if/src/metadaqif.xml · master · ecs / ecs-interfaces · GitLab (eso.org)

The following commands are currently (partially) implemented:

- StartDaq
- StopDaq
- AbortDaq
- GetDaqStatus

The server URI is:

zpb.rr://[ip]:[port]/telifsim/MetaDaq

Example:

```
$> msgsend --uri $(consulGetUri -r ifuri -s telifsim -i MetaDaq)
::metadaqif::MetaDaq::GetDaqStatus "'1'"
```

6.4.5 RAD Application commands

The application supports the standard RAD Application commands described in this ICD:

rad/cpp/appif/src/appif.xml · master · ifw / rad · GitLab (eso.org)

The server URI is:

zpb.rr://[ip]:[port]/telifsim/AppCmds

Example:

```
$> msgsend --uri $(consulGetUri -r ifuri -s telifsim -i AppCmds)
::appif::AppCmds::GetConfig """
```

6.4.6 Simulation specific commands

Additional commands to provide control of the simulation are described in this ICD:

- telif/telifsimif/icd/src/telifsimif.xml · master · ccs / hlcc · GitLab (eso.org)

The following commands are currently (partially) implemented:

- MoveToNamedPos
- MoveToAltAzPos
- UpdateRousTimer
- SetPresetSequenceMode
  Set the mode to be used when handling a preset command:
  - NO_SEQUENCE – executes an hard-coded preset algorithm
  - HEDLESS – executes the preset sequence without user interaction, started using the `seqtool run` command
  - GUI – executes the preset sequence expecting a sequencer GUI for the interaction with the operator.
    The sequence runs in a sequencer server instantiated at startup with Nomad.
    As such, the sequencer GUI can be therefore started with the following command:

    ```
    seqtool gui --address `consulGetUri -s seqserver -r
    ipport`
    ```

- SetPresetSequence
  Allows to define the specific preset sequence to be used when a preset command is received and mode is GUI or HEADLESS.

The server URI is:

- `zpb.rr://[ip]:[port]/telifsim/SimCmds`

Example:

```
$> msgsend --uri `consulGetUri -r ifuri -s telifsim -i SimCmds`
::telifsimif::SimCmds::MoveToNamedPos '"PARK"'
```

6.4.7 Supported commands and replies/error replies

Command		Condition	Message
TelifCommands	Preset	Command accepted	"OK"
		Failed to convert RA/DEC coordinates from mean to apparent position. hlcc::ptk::MeanApparentConverter throws exception during conversion.	"PRESET DATA ERROR!" (ccsinsif::GeneralException)
		Failed to get site position from Oldb due to error reading Longitude	"FAILED TO GET SITE POSITION: Error reading Longitude from Oldb" (ccsinsif::GeneralException)
		Failed to get site position from Oldb due to error reading Elevation	"FAILED TO GET SITE POSITION: Error reading Elevation from Oldb" (ccsinsif::GeneralException)
		Failed to get site position from Oldb due to error reading Latitude	"FAILED TO GET SITE POSITION: Error reading Latitude from Oldb" (ccsinsif::GeneralException)
		Failed due to position out of operational range	"POSITION OUT OF TELESCOPE OPERATIONAL RANGE!" (ccsinsif::GeneralException)
		Failed to publish preset args to Oldb	"ERROR PUBLISHING PRESET ARGUMENTS IN OLDB: " + reason (ccsinsif::GeneralException)
		Failed to connect to eltpk	"CONNECTION TO ELTPK NOT STABLISHED!" (ccsinsif::GeneralException)
		Command rejected.	"COMMAND REJECTED FROM ELTPK: " + reason (ccsinsif::GeneralException)
	SetObservingWavelength	Command accepted	"OK"
		Command failed	"FAILED TO SET OBSERVING WAVELENGTH: " + reason (ccsinsif::GeneralException)

	SetVelocityOffset	Command accepted	"OK"
		Ready for handover = false	"FAILED TO SET VELOCITY OFFSET: NOT READY!" (ccsinsif::GeneralException)
		Command failed	"FAILED TO SET VELOCITY OFFSET: " reason (ccsinsif::GeneralException)
	OffsetSetSky	Command accepted	"OK"
		Ready for handover = false or not successfully accepted be eltpk	"FAILED TO SET OFFSET SKY: NOT READY" (ccsinsif::GeneralException)
		Command failed	"FAILED TO SET OFFSET SKY: " + reason (ccsinsif::GeneralException)
		Command accepted	"OK"
	SetReferenceFocus		
		Command accepted	"OK"
	SetReferenceAberration		
		Command accepted	"OK"
	RequestControl	Command accepted but the requested control mode is already applied	"OK, NO CHANGE"
		If parameter not CASCADE nor SEQUENTIAL.	"FAILED TO REQUEST CONTROL: PARAMETER NOT VALID!" (ccsinsif::GeneralException)
		Ready for handover = false	"FAILED TO REQUEST CONTROL: NOT READY!" (ccsinsif::GeneralException)
		Failed to publish in oldb	"FAILED TO REQUEST CONTROL: " + reason (ccsinsif::GeneralException)
	ReleaseControl	Command accepted	"OK"
		Ready for handover = false	"FAILED TO RELEASE CONTROL: NOT READY!" (ccsinsif::GeneralException)
		Command source not CASCADE nor SEQUENTIAL	"FAILED TO RELEASE CONTROL: NOT IN

			CONTROL!" (ccsinsif::GeneralException)
		Failed to publish in oldb	"FAILED TO RELEASE CONTROL: " + reason (ccsinsif::GeneralException)
	GetConfig	Command accepted	String containing configuration as a json map. Any datapoint not successfully retrieved from Oldb will not be included in the map.
	RousConfig	Command accepted	"OK"
	RousExecute	Command accepted	"OK"
MetadaqCommands	StartDaq	Command accepted	The ID of created DAQ
		Ready for handover = false	"FAILED TO START DAQ: NOT READY" (ccsinsif::GeneralException)
		Daq id just created state is different from 'NotStarted'	"NOT POSSIBLE TO START DAQ ID" (ccsinsif::GeneralException)
		In the case the command was issued with empty ID and some exception happened when trying to determine the ID of next DAQ.	"FAILED TO DETERMINE ID FOR NEW ACQUISITION" (ccsinsif::GeneralException)
		If the provided DAQ ID already exists.	"DAQ ID ALREADY EXISTS" (ccsinsif::GeneralException)
		If for some unknow reason the DAQ just created return nullptr.	"FAILED TO CREATE NEW DAQ: UKNOWN REASON" (ccsinsif::GeneralException)
	StopDaq	Command accepted	The 'metadaqif::DaqStopReply' data
		Daq Id provided does not exist	"FAILED TO STOP DAQ: ID DOESN'T EXIST" (ccsinsif::GeneralException)
		Daq state is different from 'Acquiring'	"FAILED TO STOP DAQ ID. CURRENT DAQ STATE: " + daq current_state (ccsinsif::GeneralException)
	AbortDaq	Command accepted	The ID of aborted DAQ

		Daq Id provided does not exist	"FAILED To ABORT DAQ: ID DOES'T EXIST" (ccsinsif::GeneralException)
		Daq state is different from 'Acquiring' and 'NotStarted'	"FAILED To ABORT DAQ ID. CURRENT DAQ STATE: " + daq current_state (ccsinsif::GeneralException)
	GetDaqStatus	Command accepted	The 'metadaqif::DaqStatus' data
		Daq Id provided does not exist	"FAILED TO GET DAQ STATUS: ID DOES'T EXIST" (ccsinsif::GeneralException)
SimCommands	MoveToNamedPos	Command accepted	"OK"
		If given position is not in configuration	"POSITION NOT FOUND!" (stdif::ExceptionErr)
		If given position is out of telescope functional range	"POSITION COORDINATES OUT OF TELESCOPE FUNCTIONAL RANGE!" (stdif::ExceptionErr)
		Failed to connect to eltpk	"FAILED SET NEW COORDINATES:" + reason (stdif::ExceptionErr)
	MoveToAltAzPos	Command accepted	"OK"
		If given position is out of telescope functional range	"POSITION COORDINATES OUT OF TELESCOPE FUNCTIONAL RANGE!" (stdif::ExceptionErr)
		Failed to connect to eltpk	"FAILED SET NEW COORDINATES:" + reason (stdif::ExceptionErr)
	UpdateRousTimer	Command accepted	"OK"
		Rous state is different from ROUS_WAITING	"ROUS NOT IN CORRECT STATE!" (stdif::ExceptionErr)
AppCmds			
	GetConfig	Command accepted	String containing the configuration contents requested

	LoadConfig	Command accepted	"OK"
	SaveConfig	Command accepted	"OK"
	GetTrsHealth	Command accepted	“OK”, “BAD”
	… some more commands…		

7. HLCC Applications

HLCC consists of several interconnected applications.

Depending on the deployment, these applications are started with different configurations and talk with simulations of subsystems or with the real counterpart.

This is done with the purpose of minimizing the differences between the telescope simulation and the real telescope coordination software in the different deployments.

From the perspective of the users of the Telescope Simulation, the most relevant sections in this chapter are hlcctelsimui and hlcctelsimui_mon, describing the user interface, and telifsim, describing the front-ent process for the instruments.

All sections describe how the applications can be tuned/configure/extended and provide some insight on the architecture and on the design of the system.

7.1 hlcctelsimui documentation

This is the HLCC Simulator operator UI.

For the time being it provides only limited functionality:

- Connect/disconnect telifsim, telmon and eltpk processes
- Monitor logs in the system
- Send standard commands to telifsim, telmon and eltpk as well as some of the specific commands implemented.
- Monitor a few telemetry values
- Display the position of the telescope in the "dartboard”
- Execute sequences/OBs

To start the application:

```
$ hlcctelsimui
```

Note:

When the application is started up, it reads the current deployment configuration from the OLDB data point:

```
cii.oldb:///elt/telif/ccs/info/deployment
```

and it adapts some menus and features based on this information (see the OneNote page: Implemented strategy for multiple deployment configurations).

When the system is started for the first time after a cleanup of the OLDB, there is no current deployment.

The startup sequences set the current deployment by writing the proper value in the OLDB point mentioned above.

Since the deployment is not supposed to change frequently, we have not considered necessary to implement dynamic reconfiguration and in case of change of deployment it is necessary to restart the UI.

Note:

Some of the commands presented in the UI are not yet implemented in the underlying server applications. In this case an error is returned. See the list of implemented features in section 6.3.

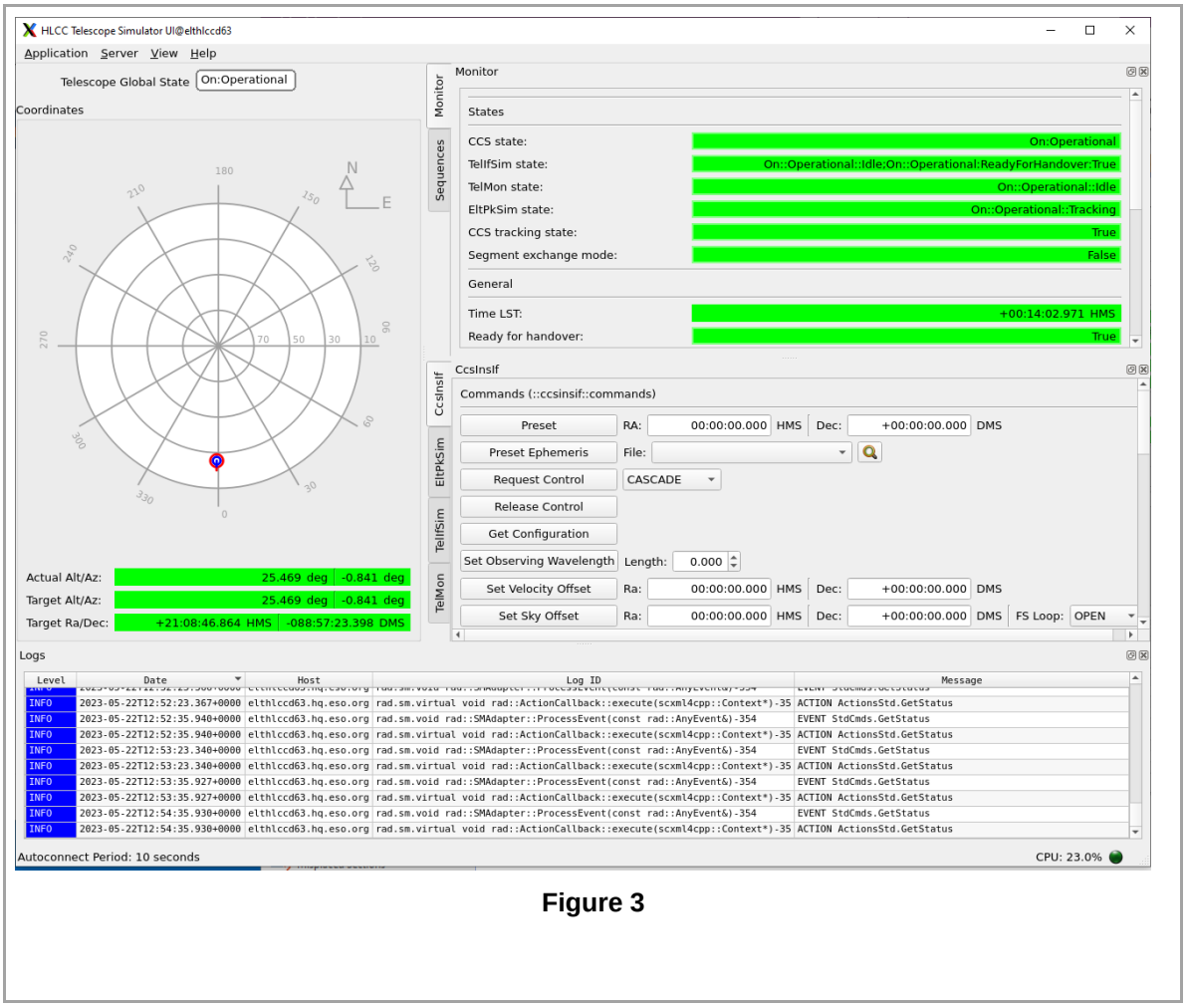


Figure 3

Here below the available command line options as from the output of the command:

`$ hlcctelsimui –help Usage: hlcctelsimui [options]`

HLCC Telescope Simulator UI is an application used to control the ELT Telescope Simulator.

Options:

-h, --help show this help message and exit

-s, --subscription Uses subscription instead of polling for OLDB datapoints updates

--polling-period=POLLINGPERIOD Polling period in ms. Default: 100[ms]

-v, --verbose Sets LogLevel to Debug. Output more information on application procedures.

-V, --extra-verbose Changes the LogLevel of the application to Trace. Outputs everything.

Taurus Options:

Basic options present in any taurus application

--taurus-log-level=LEVEL
taurus log level. Allowed values (case insensitive): critical, error, warning, info, debug, trace

--taurus-polling-period=MILLISEC
taurus global polling period in milliseconds

--taurus-serialization-mode=SERIAL
taurus serialization mode. Allowed values (case insensitive): serial, concurrent (default)

--tango-host=TANGO_HOST
Tango host name (either HOST:PORT or a Taurus URI, e.g. tango://foo:1234)

--remote-console-port=PORT
enables remote debugging using the given port

--default-formatter=FORMATTER
Override the default formatter

7.1.1 Connection

From the Server menu (Figure 1) it is possible to connect/disconnect from the Server, if for example they are executed from another application or the command line.

If the Server Autoconnect checkbox is selected (default) the ui will periodically try to automatically connect.

If HLCC is not running for a longer time, the time between two autoconnect attempts increases, to be reset as soon as a new autoconnect attempt succeed or a manual connection is requested.

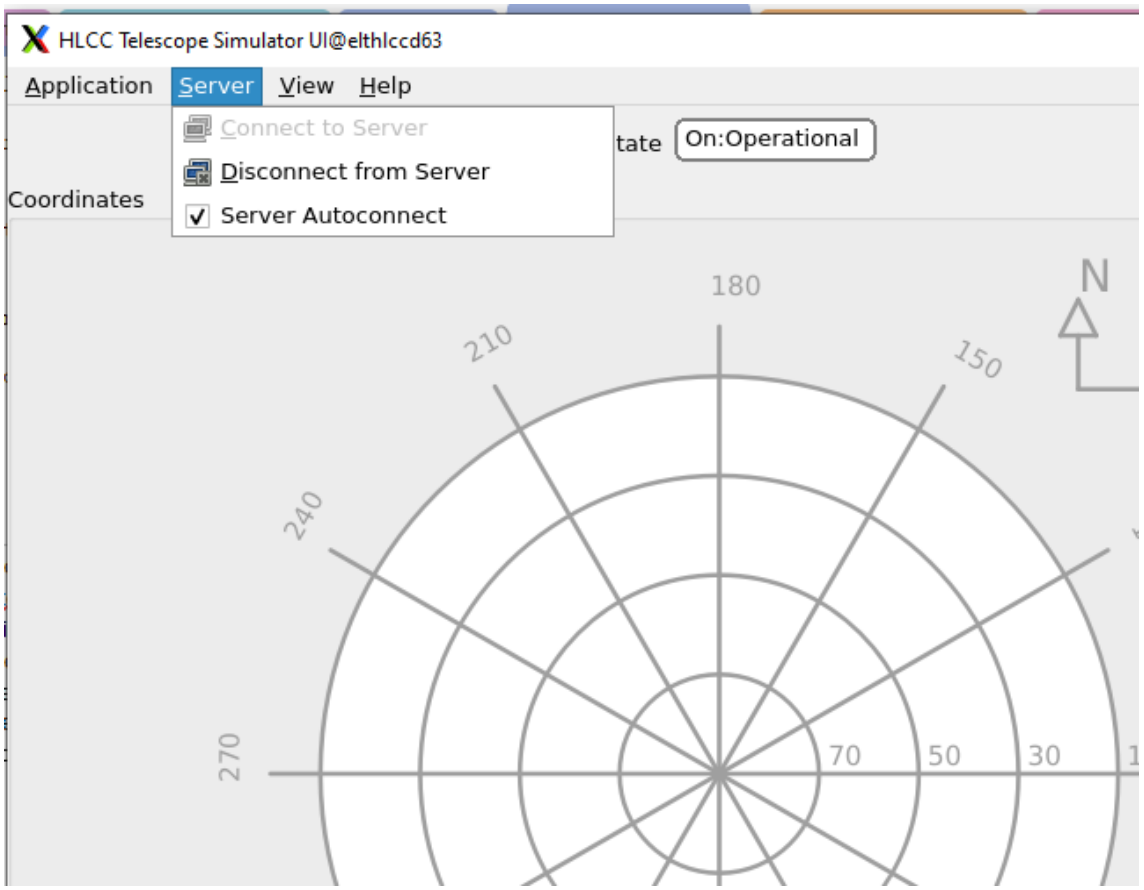


Figure 4

7.1.2 Command tabs

Clicking on a process tab on the left side of the "Commands" Panel, presents the commands for that particular application.

The CssInsIf tab provides all commands defined in the CCS-INS ICD (these commands are sent to the telifsim application, that is the frontend for the CCS-INS interface of the telescope).

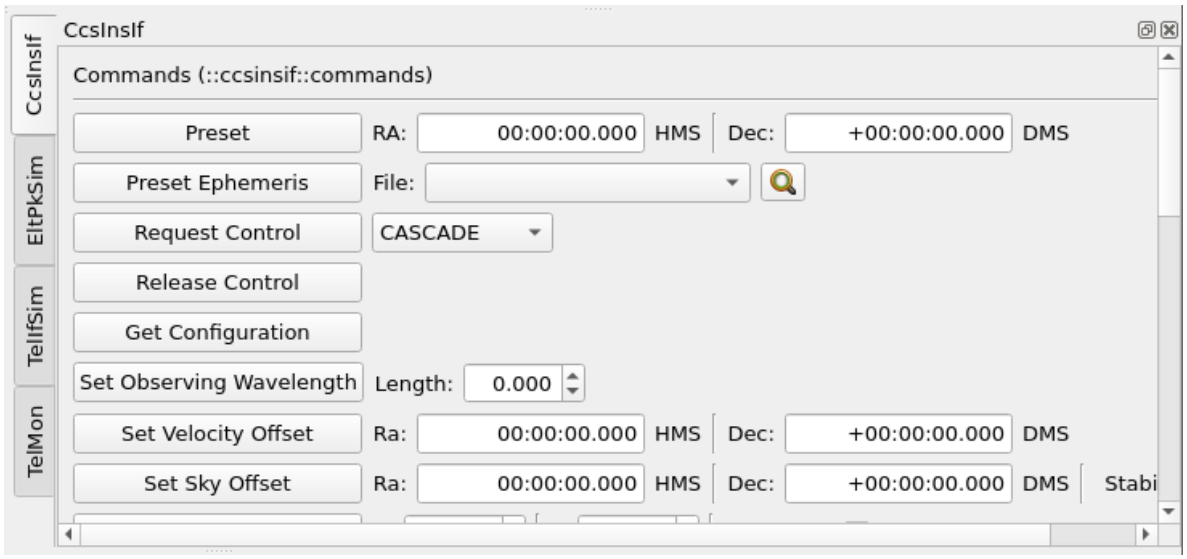


Figure 5

7.1.3 Monitor panel configuration

The content of the monitor panel can be tuned by changing the configuration file:

`hlcc/software/telsimui/resource/config/hlcctelsimui/monitors.json`

or its copy installed in INTROOT or in the RPM location.

For more details see section 7.1.9.

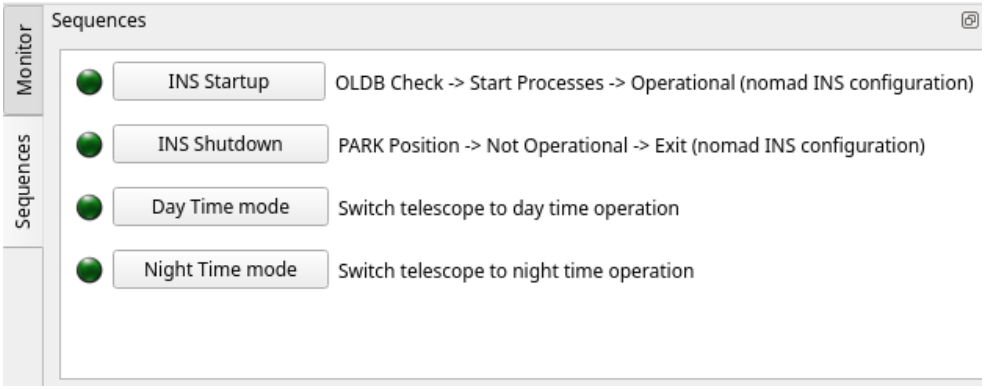
7.1.4 Sequences panel

The Sequences panel from the UI dock widget helps interact with pre-implemented scripts (Sequencer scripts or OBs in particular) and to execute them **detached** from the main process.

The contents of this panel depends on the deployment.

As can be seen in Figure 6, a Led indicates the running state of the process running the script and a simple description is also attached to the row entry configured for documentation. If anything fails, it is possible to see the failure return code in the logging widget. The success log entry is also added to the widget.

When a Sequence/OB is selected, a Sequencer GUI is started with an own Sequencer server and the Sequence/OB is loaded in the server. The user/operator can then start the sequence and interact with it using the Sequencer GUI.



loo

Figure 6

It's important to notice that only one script sequence of the same type can be executed at a given time, therefore if one is already running an information log will notify the user. There are instead no limitations in running multiple different sequences at the same time. It is responsibility of the user to avoid running in parallel conflicting sequences.

For details on the configuration of this panel see section 7.1.9.3.

7.1.5 Telescope State panel

The Telescope State panel is accessible form the `Application -> Telescope State menu`:

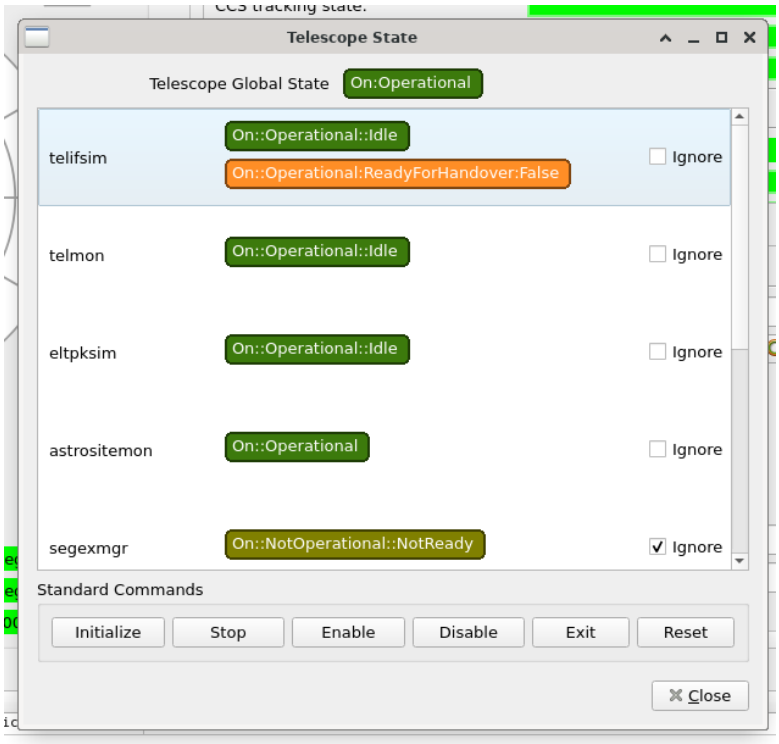


Figure 7

This panel allows to monitor the state of the processes that are part of the current deployment of HLCC (for example the INS telescope simulator deployment).

- It is possible to select each entry and send the standard lifecycle commands using the buttons in the bottom bar.
- The ignore toggle allow to ignore an individual process in the estimation of the global telescope state, that is shown on top of the panel.

Note: The "Exit" command will request the process to exit, but if the process is managed by Nomad, the process will be typically restarted automatically

7.1.6 List of HLCC Servers configuration

The list of HLCC servers, as they can be controlled with the application Server menu, can be tuned by changing the configuration file:

`hlcc/software/telsimui/resource/config/hlcctelsimui/processes.json`

or its copy installed in INTROOT or in the RPM location

For more details see section 7.1.9

7.1.7 Known Issues

This section list some issues you might encounter and we know of.

- None now

7.1.8 ToDo

Missing/incomplete important functionality:

- None now

7.1.9 UI Configuration (Telescope Monitor, Status, Scripts….)

In this section you can find a summarized explanation of how to configure some parameters of hlcctelsimui such as Logging, Monitor panel entries, Sequencer Script UI list, Global Telescope State window, etc...

At the moment it is possible to configure the application using the .json files:

- logging.json
- monitors.json
- sequences.json
- processes.json
- tools.json

These files are located under "`telsimui/resource/config/hlcctelsimui`" and are installed following the standard CCS conventions.

It is possible to use your own files, for example for a usage specific configuration, by:

- using your own resources folder <*`resource_folder`*> (for example `/home_local/eltdev/resource`)
- add it on top of *`$CFGPATH`*:

  export CFGPATH=<resource_folder>:$CFGPATH
- copying the resource file(s) you need to modify in
  - `<resource_folder>/config/hlcctelsimui/`
    for example:

    `/home_local/eltdev/resource/config/hlcctelsimui/monitors.json`
- edit the files there according to your needs

At this point when you restart `hlcctelsimui`, the application will find first your modified files and use them..

7.1.9.1 Monitor panel configuration:

The image below shows the monitor dock widget that displays a set of configured entries to be viewed by the user.

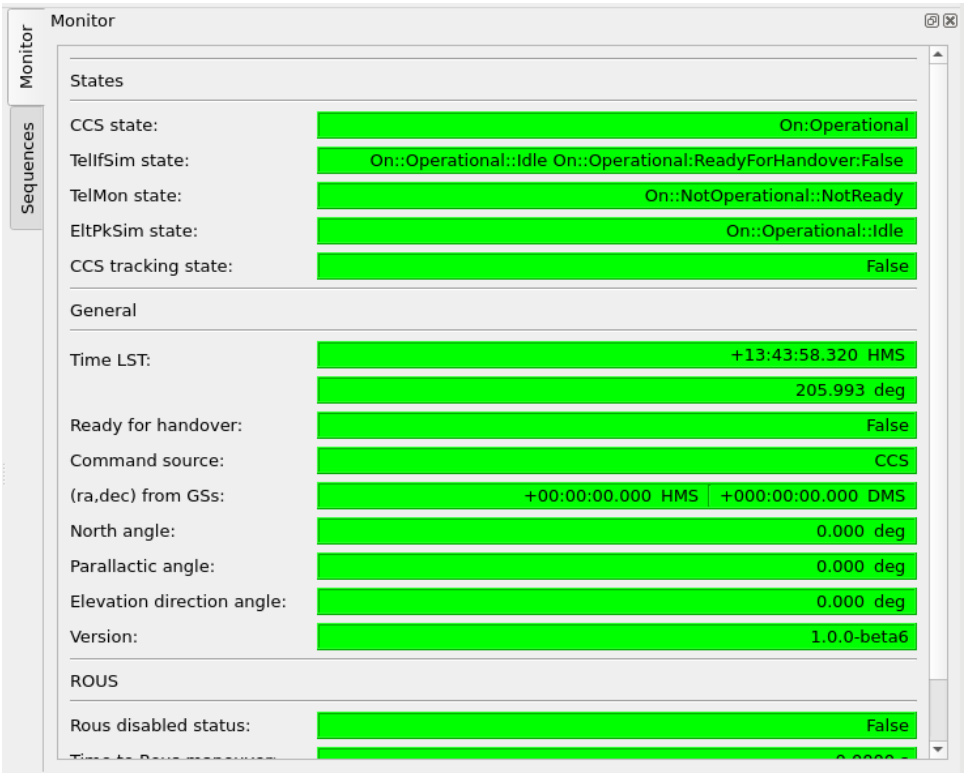


Figure 8

The "`monitor.json`" file responsible for this configuration will dynamically affect the panel view when instantiated.

The configuration can be divided into different '**groups'** and that will be reflected in the application window. For each group, it is possible to specify the label text to be displayed.

Inside the groups, monitor entries can now be added with the following data:

- **'label'**: Name of the entry to be displayed
- **'uri'**: OLDB datapoint identifier from where the value to be monitored shall be retrieved
- **'indexes'**: In case the datapoint value is a container it is possible to select one or more elements from it. Just add a list of indexes (ex. [0, 2, 4]).
- **'widgets'**: List of Widgets responsible to represent the value itself.

This **'widgets'** parameter can have different types depending on the python implementation.

For example if you have `["TaurusRadiansLabel", "TaurusHmsLabel", "TaurusSexagecimalLabel"]`, the 3 labels will be instantiated but only one will be showed at a

time. This logic is handled by the Qt Dynamic Property regarding the **Unit Type** choosen to be displayed.

The set of displayed units can be selected for the whole application using the Numerical Units menu:

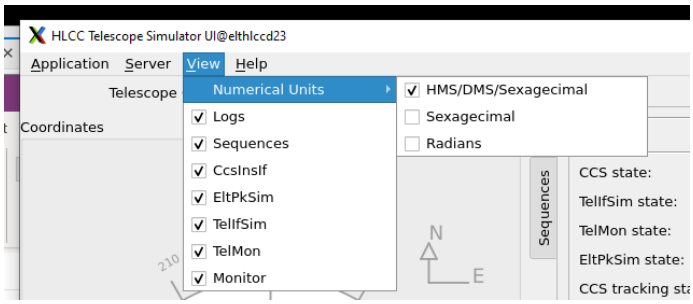


Figure 9

Since the types of widgets supported can change in the future it is advised to check **`'monitorpanel_item.py'`** for valid types.

Figure 10

7.1.9.2 Processes configuration:

The processes required for the application to work on (TelIfSim, Eltpk, etc, …) are dynamically retrieved from the telmon OLDB datapoint:

cii.oldb:///elt/hlcc/telmon/cfg/monitored_apps

The `telmon` process is responsible for populating this OLDB datapoint based on the current deployment, using Consul to retrieve the corresponding URIs.

7.1.9.3 Sequences Script UI List configuration:

In "`sequences.json`" you can configure the sequences/OBs or other executables that can be launched from the Sequences panel.

The list of sequences from the UI dock widget helps interact with the **scripts** pre-implemented and to execute them **detached** from the main process.

From the image below, a Led indicates the running state of the process running the script and a simple step description is also attached to the row entry configured for documentation. If anything fails, it is possible to see the failure return code in the logging widget. The success log entry is also added to the widget.

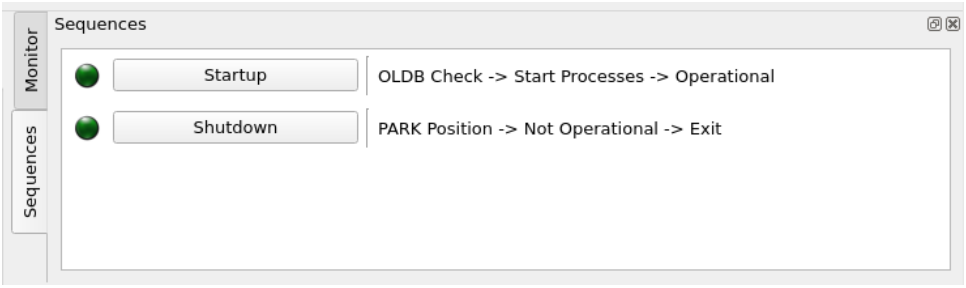


Figure 11

It's important to notice that only one script sequence of the same type can be executed at each time, therefore if one is already running an information log will notify the user. There are instead no limitations in running multiple different sequences at the same time. It is responsibility of the user to avoid running in parallel conflicting sequences.

Beyond the name and step description configuration, the way to indicate which sequence to associate to the Qt button is via a **command** call (normally is the **"seqtool gui",** that will start a sequencer GUI and server, or **"seqtool run"**, that will run the sequence unattended)

```
"sequences": [
  {
    "name": "DEV Manual Startup",
    "command": "seqtool gui",
    "sequence_file": "hlccseq/simStartup.py",
    "description": "OLDB Check -> Start Processes -> Operational (fixed ports)"
  },
  {
    "name": "DEV Manual Shutdown",
    "command": "seqtool gui",
    "sequence_file": "hlccseq/simShutdown.py",
    "description": "PARK Position -> Not Operational -> Exit (fixed ports)"
  },
  {
```

Figure 12

7.1.9.4 Telescope Global State configuration:

Figure 13

This panel is automatically instantiated based on the information retrieved from the telmon OLDB data point

`cii.oldb:///elt/hlcc/telmon/cfg/monitored_apps`

Each deployment provides a specific configuration for this data point.

When the Ignore flag is modified in the UI panel, the information is stored in the OLDB point.

7.1.9.5 External tools configuration:

"`tools.json`" contains configuraton of external applications which can be launched from Main Window tool menu under "**Launch**" option.

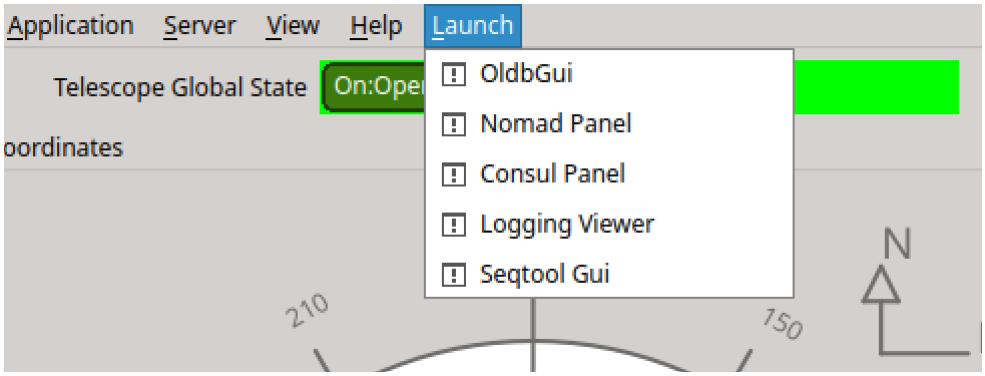


Figure 14

Each launcher entry is represented by an object in in "`tools.json`". During the application startup, these objects are used to create Launch menu entries.

```
{
    "tools": [
        {
            "name": "OldbGui",
            "command": "oldbGui",
            "param_type": "",
            "parameters": "",
            "description": "Starts Oldb Gui application"
        },
        {
            "name": "Nomad Panel",
            "command": "xdg-open",
            "param_type": "Environmental",
            "parameters": "$NOMAD_ADDR",
            "description": "Starts browser with Nomad panel"
        },
        {
            "name": "Seqtool Gui",
            "command": "seqtool gui",
            "param_type": "consulGetUri",
            "parameters": {
                "prefix": "--address",
                "service": "seqserver",
                "request": "ipport"
            },
            "description": "Starts browser with Consul panel"
        },
```

Figure 15

Following fields need to be defined for each launcher entry:

- **name** – tool name that is displayed in GUI
- **command** – command that is executed to launch a tool
- **param_type** – type of parameter that is passed with the command

- **parameters** – parameters of the command – depending on **param_type** this field is string or JSON object (explanation below)
- **description** – short description of the tool that shown in tooltip

It is necessary to define "**param_type**", because based on it parameters are interpreted. There are 3 possible values for "**param_type**" field:

- "consulGetUri" – set when parameter is actually an URI retrieved from Consul via command **consulGetUri** (example shown in Figure 15 for "Seqtool Gui"). Then "**parameters**" field is declared as JSON object with the following structure :

```
"parameters": {
      "prefix": string,
      "service": string,
      "request": string
}
```

- "Environmental" – set when parameter(s) is passed as plain string, e.g. in CLI. Individual parameters should be separated with space, whereas environmental variables which value has to retrieved first, should be typed with "$" sign (example shown in Figure 15 for "**Nomad Panel**")
- " " (empty) – set if command is invoked without parameters. In that case "**parameters**" filed should remain empty as well (example shown in Figure 15 for "**OldbGui**")

7.2 hlcctelsimui_mon documentation

This is an HLCC Simulator small monitoring UI, to be used as long as the main hlcctrelsim_ui panel is not implemented up to level of allow monitoring all simulator processes and OLDB attributes.

For the time being it provides only very limited functionality:

- Monitoring state of telifsim, telmon and eltpk rad applications
- Monitoring target and current positions as in the OLDB
- Monitoring a few flags

To start the application:

```
$ hlcctelsimui_mon
```

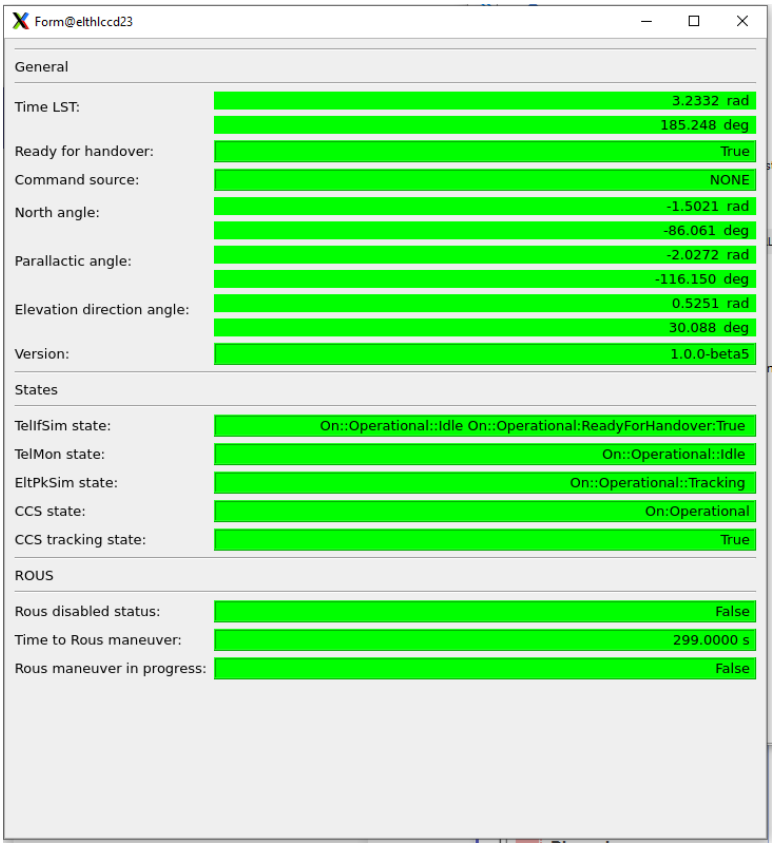


Figure 16

The content of the monitor panel can be tuned by changing the configuration file:
`hlcc/software/telsimui_mon/resource/config/telsimui_mon/monitors.json`
or its copy installed in INTROOT or in the RPM location.

7.3 telifsim documentation

This is the main entry point application to interact with the simulator.
All commands defined in the CCS-INS ICD are sent here.

7.3.1 Sending commands

To send a standard command using the `msgsend` utility:

```
$> msgsend --uri `consulGetUri -r ifuri -s telifsim -i StdCmds`
::stdif::StdCmds::GetState
```

To send a specific command defined in the `::ccsinsif::Commands:` interface:

```
$> msgsend --uri `consulGetUri -r ifuri -s telifsim -i Commands`
::ccsinsif::Commands::RequestControl '"CASCADE"'
```

To send a specific command defined in the `::telifsimif::SimCmds:` interface:

```
$> msgsend --uri `consulGetUri -r ifuri -s telifsim -i SimCmds`
::telifsimif::SimCmds::MoveToNamedPos '"PARK"'

$> msgsend --uri `consulGetUri -r ifuri -s telifsim -i SimCmds`
::telifsimif::SimCmds::MoveToAltAzPos '{"alt": 0.5, "az": 0.2}'

$> msgsend --uri `consulGetUri -r ifuri -s telifsim -i AppCmds`
::appif::AppCmds::GetConfig                    '"cfg/pub/dds/profile
cfg/rous/timer_period_s"'

$> msgsend --uri `consulGetUri -r ifuri -s telifsim -i AppCmds`
::appif::AppCmds::SetConfig '"cfg/rous/timer_period_s: 123"'
```

Because we are using Nomad/Consul to manage the deployment the uri to be used is retrieved with a query to consul using the consulGetUri command line utility, as seen in the examples above.

For example:

$> consulGetUri -r ifuri -s telifsim -i StdCmds

The standard commands supported are described in this ICD:

- std/if/src/stdif.xml · master · ecs / ecs-interfaces · GitLab (eso.org)ul

The standard commands supported by all RAD Applications are described in this icd:

- rad/cpp/appif/src/appif.xml · master · ifw / rad · GitLab (eso.org)

The specific ccs-ins interface commands supported are described in this ICD:

- ccsinsif/icd/src/ccsinsif.xml · master · ccs / hlcc · GitLab (eso.org)

Additional commands to provide control of the simulation are described in this ICD:

- telif/telifsim/telifsimif/icd/src/telifsimif.xml · master · ccs / hlcc · GitLab (eso.org)

The application also support the metadaq commands described in this ICD:

- metadaq/if/src/metadaqif.xml · master · ecs / ecs-interfaces · GitLab (eso.org)

The `preset` command has a parameter's structure that is currently not supported by the msgsend tool.

The python utility **telifsim_preset** allows to send the command in an easy way and can be used as an example to write more complex code. See HLCC utilities.

You can find a set of additional python examples in the jupyter notebooks.

7.3.2 telifsim State Machine

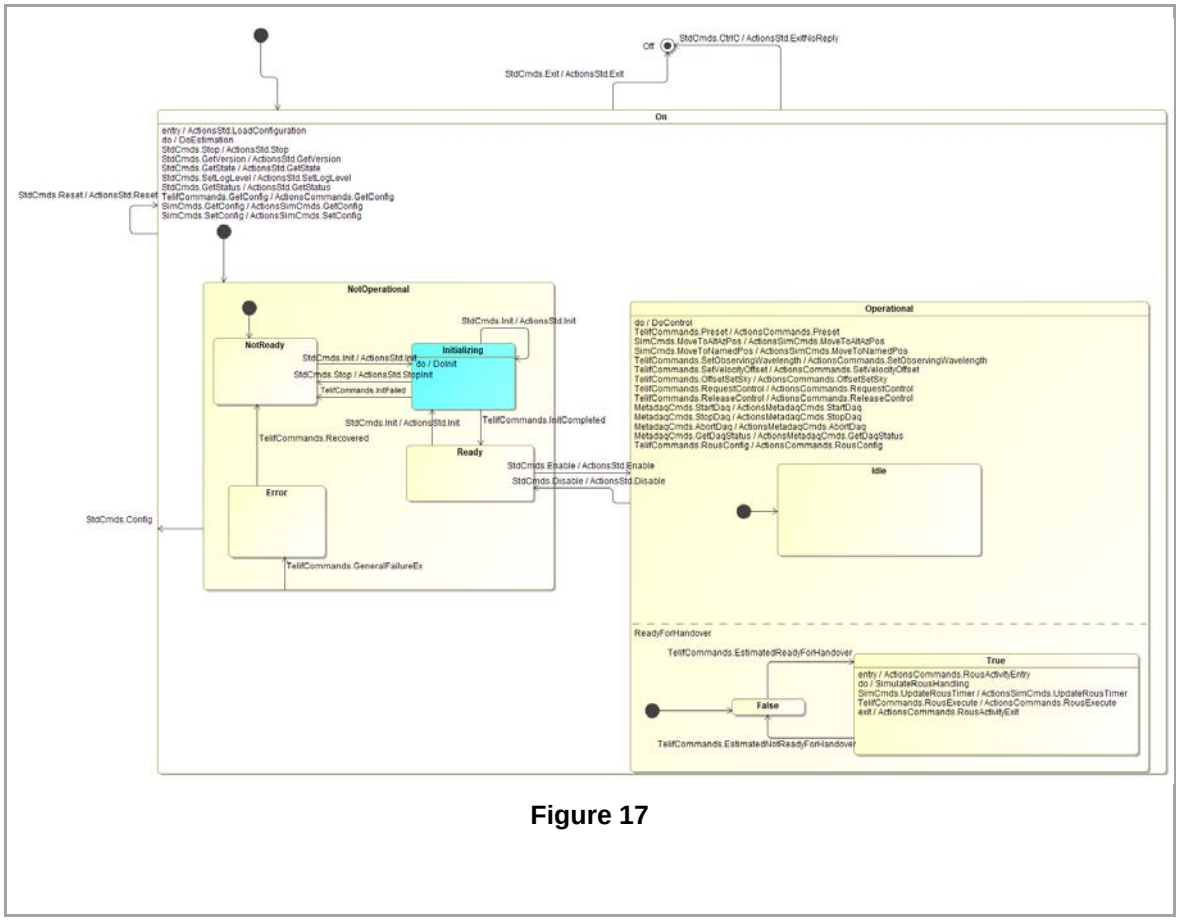


Figure 17

7.3.3 Rous Documentation

7.3.3.1 Rous Description

Rous takes place when the telescope is tracking and providing good image quality.

Recurrent Optimization of Unit's Stroke (ROUS) events can be disabled or executed immediately to align with observation needs. ROUS corrects the quasistatic aberrations and manages the distribution of strokes between the internal degrees of freedom. The dynamics of the positioning units are specified such that the transient perturbations remain within the limits described in [RD3], and it is expected that the instrument side control loops are robust against those disturbances

- The simulator executes a Rous maneuver at a given interval of time (specified in the configuration database).
- Commands:

- `RousConfig ENABLE/DISABLE`
  command that disables/avoids the automatic execution of ROUS maneuvers by CCS. Exact implementation to be agreed during design. It must be understood that delaying a ROUS cycle comes with the risk of degraded image quality.
  ENABLE = ROUS maneuvers are executed as scheduled by CCS
  DISABLE = Automatic execution of ROUS maneuvers is disabled
  Note that the telescope may force a ROUS maneuver if deemed necessary for system safety.
  For example:
  ```
  $ msgsend --uri $(consulGetUri -r ifuri -s telifsim -i Commands)
  ::ccsinsif::Commands::RousConfig '"ENABLE"'
  ```
- `RousExecute`
  command that executes a ROUS maneuver immediately.
  ===> This resets the counter
  For example:
  ```
  $ msgsend --uri $(consulGetUri -r ifuri -s telifsim -i Commands)
  ::ccsinsif::Commands::RousExecute
  ```

- Monitor signals on Control Network:
  - `rous:counter_act`
    Time to next ROUS maneuver. The algorithm and the amount of pre-warning time before the next ROUS are TBD.
    ===> The Rous control loop manages the counter
  - `rous:status`
    Boolean
    Status flag indicating whether ROUS is enabled or disabled:
    0 = enabled (i.e. not disabled)
    1 = disabled
    1 Hz
  - `rous:maneuver_in_progress`
    Boolean
    Duplicate of the ROUS maneuver status flag in ao:m4_setpoint_applied indicating whether a ROUS maneuver is currently being executed by CCS:
    0 = no maneuver
    1 = ROUS maneuver in progress

7.3.3.2 Rous Operation

By default Rous is enabled and as soon the telescope starts tracking, Rous starts its operation:

1. Loads Rous timer period from configuration
2. Waits until timer expires
3. Executes Rous Maneuver (currently Rous maneuver is not defined so Rous stays in this state for 1 second, so its possible to observe the state change)
4. Starts from step 1 again.

When Rous is disabled it resets the Rous timer and idles until it is enabled again.

To change the Rous disabled state, use the hlcctelsimui 'Ccsinsif' tab. See Figure 18 below:

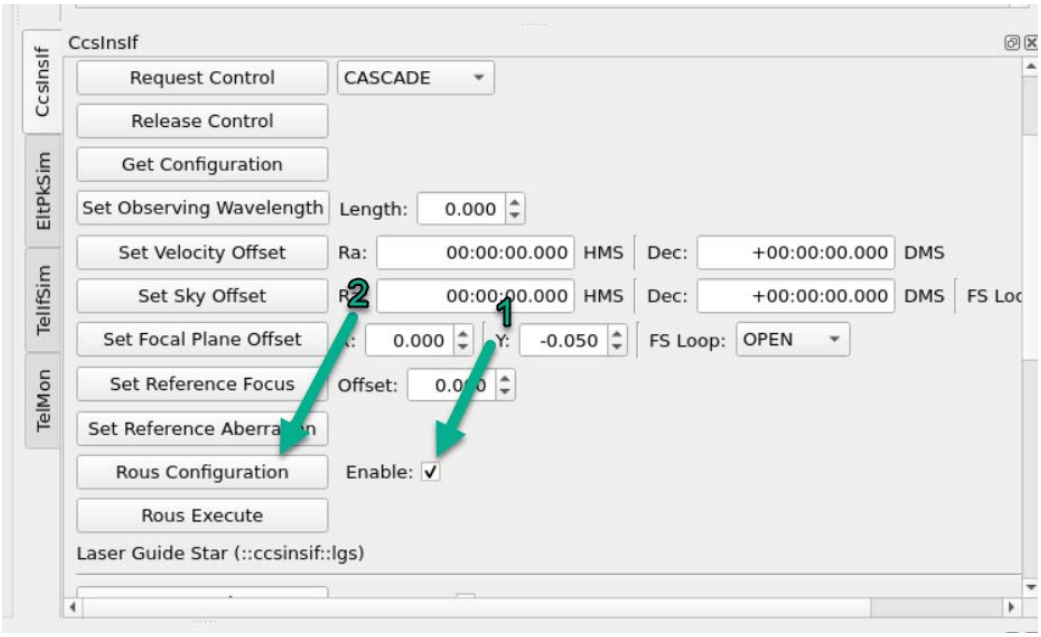


Figure 18

Set first the Rous status in the '***Enable***' box and then press '***Rous Configuration***': only when the button is pressed the command is sent to telifsim to change state.

Regardless of the Rous Enabled state or operation phase when Enabled, a Rous maneuver can be started manually by the operator by pressing in the '***Rous Execute***' Button. See picture above.

If Rous is enabled it will reset the Rous timer and start a new cycle.

If Rous is disabled it will return to the disabled state after the rous maneuver.

Its possible to check the current Rous status by observing the Rous information in the Oldb. That information is updated every second. See Figure 19 below.

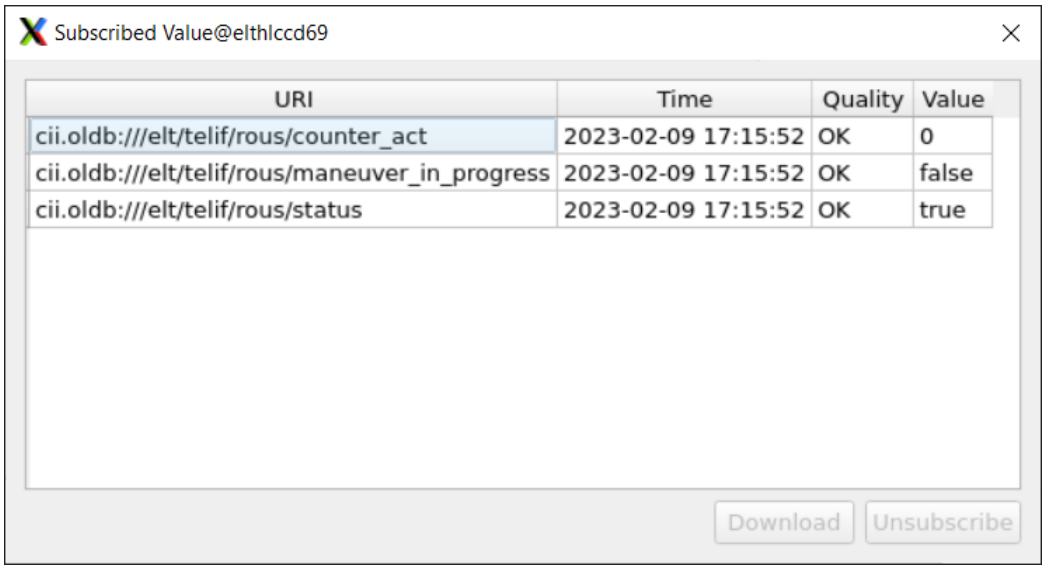


Figure 19

The ***status*** datapoint in the oldb is in fact the disabled status, meaning disabled when true.

7.3.4 Preset Documentation

From the telifsim perspective, the Preset operation can now be configured to run in one of multiple possible modes.

For usage by instrumentation, the default mode is sufficient.

The selection of modes is to explore the various possibilities and foster discussion with the users to converge toward an agreed strategy and will be used mainly with the dev and ecm deployments. Check below the available preset modes.

7.3.4.1 NO_SEQUENCE mode

The Preset sequence is hardcoded in a CPP preset function, very basic and not interactive. This will be phased out once agreed on all details and the procedures will be fully defined.

7.3.4.2 HEADLESS mode

The system will preset without involving the operator, with a fully automatic sequence. Essentially it will run a pre-defined sequence that is supposed to take care of the complete preset procedure.

The sequence is started using the `seqtool run` command, i.e. with a standalone instance of the sequencer.

For this mode the pre-defined sequence should not require any user interaction, otherwise the sequence will block indefinitely. Check further below how to change/define the sequence to be executed.

7.3.4.3 GUI mode

Will load the sequence in the common instance of the Sequencer server (*seqserver*) that is started by the Nomad job that starts all basic HLCC processes.

To do this telifsim:

- Queries Consul for the IP and "telnet" port of the *seqserver* service/process
- The *seqserver* provides a private "telnet" interface to be used by the GUI that allows to interact with it. Using this interface....
    - load the sequence.
    - run the sequence.

      Since the sequence will request operator interaction, it is necessary to have running a sequencer GUI.

      The sequencer GUI can now be started with the command:

      ```
      seqtool gui --address `consulGetUri -s seqserver -r ipport`
      ```

      that will ask Consul for the seqserver IP and port. If the sequencer GUI is running and connected.
    - The loaded sequence will appear in the Gui.
    - You will see it started.
    - It is advisable to have a dialog requesting the user input to continue with the sequence execution.

7.3.4.4 Preset Sequences/OBs

Currently we have two engineering OBs available as initial templates for discussion:

- hlccPreset.json – This OB is built to run automatically without any user intervention. It can be used in ‘HEADLESS’ or ‘GUI’ modes. This OB is basically the same implementation of the ‘NO_SEQUENCE’ mode, but done in an OB instead of hardcoded in c++.
- hlccPresetInteractive.json – This OB should only be configured to run in ‘GUI’ mode because it will request user interaction and a Sequencer Gui shall be available otherwise the OB will hang indefinitely. It implements the same behavior of hlccPreset but pops up a dialog at the beginning asking for user input.

7.3.4.5 Sequence and mode configuration

To define how the Preset sequence/OB will be executed we must configure correctly the preset which now is done in two Oldb datapoints. To change them we can edit directly the Oldb or use the correspondent telifsim commands.

- Sequence mode
    - Oldb address

        - `cii.oldb:///elt/hlcc/telifsim/preset/mode`
    - Available Modes:
        - HEADLESS
        - GUI
        - NO_SEQUENCE
    - Telifsim command:
        - `msgsend --uri `consulGetUri -r ifuri -s telifsim -i SimCmds` ::telifsimif::SimCmds::SetPresetSequenceMode '"GUI"'`
- Sequence/OB script
    - Oldb Address:
        - `cii.oldb:///elt/hlcc/telifsim/preset/sequence`
    - Default sequence
        - `hlccseq.hlccPreset`
    - Telifsim Command
        - `msgsend --uri `consulGetUri -r ifuri -s telifsim -i SimCmds` ::telifsimif::SimCmds::SetPresetSequence '" config/seq/hlccsePreset.json"'`

7.4 telmon documentation

This is the telescope monitoring applications.

Once started, the estimators (implemented as python scripts) periodically estimate the status of CCS and publish all status information available.

7.4.1 Sending commands

To send a standard command using the `msgsend` utility:

```
$> msgsend --uri `consulGetUri -r ifuri -s telmon -i StdCmds` ::stdif::StdCmds::GetStatus
```

To send a comand defined in the RAD Application standard interface:

```
$> msgsend --uri `consulGetUri -r ifuri -s telmon -i AppCmds` ::appif::AppCmds::GetConfig '"cfg/estimation_period_ms"'
```

To send a specific command defined in the `::telmon::MonCmds:` interface:

```
$> msgsend --uri `consulGetUri -r ifuri -s telmon -i MonCmds` ::telmonif::MonCmds::Reload
```

In a deployment managed by nomad/consul the uri to be used is retrieved with a query to consul using the consulGetUri command line utility instead of being hardcoded.

For example:

```
$> msgsend --uri `consulGetUri -r ifuri -s telmon -i StdCmds`
::stdif::StdCmds::GetState
```

The standard commands supported are described in this ICD:

- std/if/src/stdif.xml · master · ecs / ecs-interfaces · GitLab (eso.org)

The specific interface commands supported are described in this ICD:

- telif/telmon/telmonif/icd/src/telmonif.xml · master · ccs / hlcc · GitLab (eso.org)

For example,

to **change the ignore flag** of a monitored application:

```
$> msgsend --uri `consulGetUri -r ifuri -s telmon -i MonCmds`
::telmonif::MonCmds::SetAppIgnore '{"app_name": "telifsim", "ignore":
false}'
```

to retrieve a configuration parameter:

```
$> msgsend --uri `consulGetUri -r ifuri -s telmon -i AppCmds`
::appif::AppCmds::GetConfig '"cfg/estimation_period_ms"'
   REPLY: "cfg: \n  estimation_period_ms: 1000\n"
```

to set a configuration parameter:

```
   $> msgsend --uri `consulGetUri -r ifuri -s telmon -i AppCmds`
::appif::AppCmds::SetConfig '"cfg/estimation_period_ms: 1500"'
REPLY: "OK, Updated Parameters: cfg/estimation_period_ms"
```

to load confiuration from file:

```
   $> msgsend --uri `consulGetUri -r ifuri -s telmon -i AppCmds`
::appif::AppCmds::LoadConfig '"config/telmon/config.yaml"'
```

7.4.2 telmon State Machine

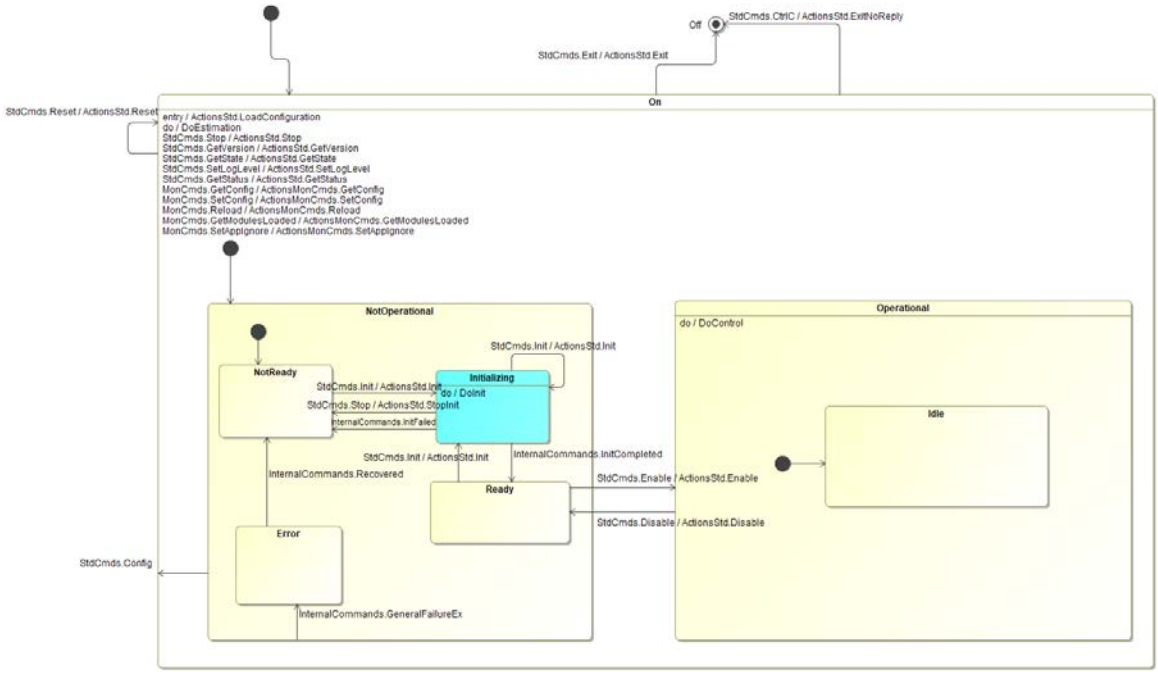


Figure 20

7.4.3 Adding new estimation scripts to Telmon

Estimation scripts will be loaded and executed by telmon, which is using the pybind11 dynamic python interpreter.

7.4.3.1 Telmon directory structure

The scripts directly distributed with the HLCC package are stored together with the telmon code:

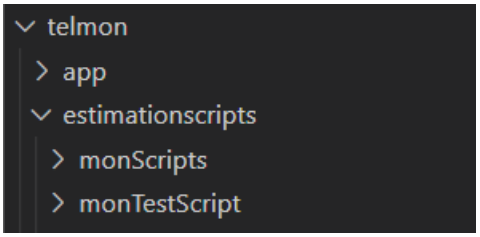


Figure 21

- The app directory contains the 'telmon' c++ source files.

- The `estimationscripts/monTestScripts` contains scripts only used in testing.
- The `estimationscripts/monScripts` contains all the estimation scripts executed by telmon.
  These can be used as good examples when creating new scripts.

7.4.3.2 Adding a new python script file

To add a new estimation script, create a python file (in the estimationscripts/monScripts/src/MonScripts directory if it has to be part of the telmon distribution) with a descriptive name.

The file should contain a class with the name matching the name of the file, the class should contain at least two methods which will be called by the telmon application:

- `def Execute(self, arg):` This method will be executed at every estimation cycle, it takes one argument which is a dictionary shared between all scripts and the cpp application as a `pybind::dict` object. It can be used by each estimation script to store data which will persist while the telmon estimation activity is running, even if the python script restarts.
- `def Terminate(self, arg):` This method will be executed when the telmon estimation activity is terminating (for example when the application is exiting). The purpose is to allow the estimation script to clean up in the end. It also takes one argument which is the same object argument in the Execute method.

7.4.4 Listing the scripts to be run by telmon

Configuration for the script is in:

`resource/config/telmon/config.yaml'`

Add the new estimation script to the list in `cfg: estim_scripts:`

The name of the script should be preceeded by the name of main module ('MonScripts' for the scripts distributed with telmon); check the example below:

```
cfg:
  estim_scripts                :
                                 - MonScripts.ReadyForHandoverEstimation
                                 - MonScripts.CcsStateEstimation
                                 - MonScripts.TrackingEstimation
                                 - MonScripts.SegmentExchangeModeEstimation
```

Figure 22

After restarting the application (reset command for example) the new script will be picked up and executed by telmon.

7.4.5 Reloading Scripts

For the time being, there is a command (see the telmonIf interface) for reloading the scripts that are already running, *it will not integrate new commands*. This command will not restart the telmon application or reload the configuration, it just reloads all the scripts that were in the configuration file when the application started. By "reloading" it means that it will pick any code changes that were applied to the script.

It is a fast way to develop and test scripts:

```
msgsend --uri zpb.rr://localhost:12084/telmon/MonCmds ::telmonif::MonCmds::Reload
```

7.4.6 Error handling

If python scripts have any problem or the class / method names are not correct, the telmon application will not load the script and will log an Error message for each script not successfully loaded.

After being loaded, if scripts throw any exception it will be logged by telmon but will not impact the execution of other scripts.

7.4.7 Telmon Estimation Scripts

The telmon application supports installing python scripts to be used for the estimation of state variables for the telescope. It is in this way possible to easily and dynamically define status information of interest for users of the system, without having to modify the code of the applications.

7.4.7.1 Ccs state estimation

This estimation script estimates the global ccs state by combing the state of all applications listed in the Oldb uri '*cii.oldb:///elt/hlcc/telmon/cfg/monitored_apps*'.

The applications with the ignore flag = true will be left out of the ccs state estimation.

The ccs state estimation is then published in the Oldb uri '*cii.oldb:///elt/telif/ccs/state*'. It is also being published in dds '*dds.ps://1://TELIF_STATUS'*.

It can be found in the telescope simulator monitor panel:

7.4.7.2 Ready for handover estimation

It estimates if the telescope is ready to handover the control to instruments.

The ready for handover estimation is then published in the Old uri '*cii.oldb:///elt/telif/ccs/ready_for_handover'*. It is also being published in dds '*dds.ps://1/TELIF_RDY_FOR_HANDOVER'*.

It can be found in the telescope simulator monitor panel:

7.4.7.3 Segment exchange mode estimation

Estimates if the telescope is in Segment exchange mode and publishes the estimation in '*cii.oldb:///elt/hlcc/telmon/mon/segment_exchange_mode*'

It can be found in the telescope simulator monitor panel:

7.4.7.4 Tracking estimation

Estimate the tracking state of the telescope and publishes the result in '*cii.oldb:///elt/hlcc/telmon/mon/tracking'*.

It can be found in the telescope simulator monitor panel:

7.4.7.5 Night time estimation

Estimates if the telescope is in night time mode and publishes the estimation result in 'cii.oldb:///elt/telif/ccs/night_time'.

It can be found in the telescope simulator monitor panel:

7.5 eltpk documentation

This is the pointing and tracking high level coordination process.

When running in simulation mode, it will communicate with the **`trksim`** process, that is implementing a tracking control loop (this is currently done in the INS and DEV deployments).

When running in "real telescope mode", it will instead communicate with the Main Structure LSV (and later on with other subsystem involved in pointing and tracking.)

7.5.1 Sending commands

To send a standard command using the msgsend utility:

```
$> msgsend --uri `consulGetUri -r ifuri -s eltpk -i StdCmds`
::stdif::StdCmds::GetState

$> msgsend –uri `consulGetUri -r ifuri -s eltpk -i StdCmds`
::stdif::StdCmds::Exit
```

To send a specific command defined in the `::eltpkif::PointingKernelCommands` interface:

```
$> msgsend --uri `consulGetUri -r ifuri -s eltpk -i Commands`
::eltpkif::PointingKernelCommands::SetTargetAltAzPos '{"alt": 0.2,
"az": 0.1}'
```

To send a comand defined in the RAD Application standard interface:

```
$> msgsend --uri `consulGetUri -r ifuri -s eltpk -i AppCmds`
::appif::AppCmds::GetConfig '"cfg/procname"'

REPLY: "cfg: \n  procname: \"eltpk\"\n"

$> msgsend --uri `consulGetUri -r ifuri -s eltpk -i AppCmds`
::appif::AppCmds::SetConfig '"cfg/params/alt_speed_deg_per_s: 7.5"'

REPLY: "OK, Updated Parameters: cfg/params/alt_speed_deg_per_s"
```

Because we are using Nomad/Consul to manage the deployment, the uri to be used is retrieved with a query to consul using the consulGetUri command line utility, as seen in the examples above.

For example:

$> consulGetUri -r ifuri -s eltpk -i StdCmds

The standard commands supported are described in this ICD:

- std/if/src/stdif.xml · master · ecs / ecs-interfaces · GitLab (eso.org)

The standard commands supported by all RAD Applications are described in this icd:

- rad/cpp/appif/src/appif.xml · master · ifw / rad · GitLab (eso.org)

The specific commands supported are described in this ICD:

- https://gitlab.eso.org/ccs/hlcc/-/blob/master/software/telif/eltpk/eltpkif/icd/src/eltpkif.xml

The preset command has a complex parameter structure that makes it look awkward when sending it to the eltpk application (::eltpkif::PointingKernelCommands::SetTargetRaDec) using the msgsend tool, for example:

```
{\"command\": \"FULL_PRESET\", \"preset_data\": {\"ra\":5.5003, \"dec\":-
1.5192, \"system\":\"J2000.0\", \"proper_motion_ra\":0.0,
\"proper_motion_dec\":0.0, \"epoch\":\"J2000.0\", \"parallax\":0.0,
\"radvel\":0.0, \"rshift\":0.0, \"velocity_offset_ra\":0.0,
\"velocity_offset_dec\":0.0, \"object_name\":\"Polaris Australis\",
\"guide_stars\":[] }}
```

Instead, for most uses we recommend to use the python utility `eltpk_preset` (see section 7.11.2), which allows to send the command in an easy way and can be used as an example to write more complex code.

You can find a set of additional python examples in the jupyter notebooks

7.5.2 eltpk State Machine

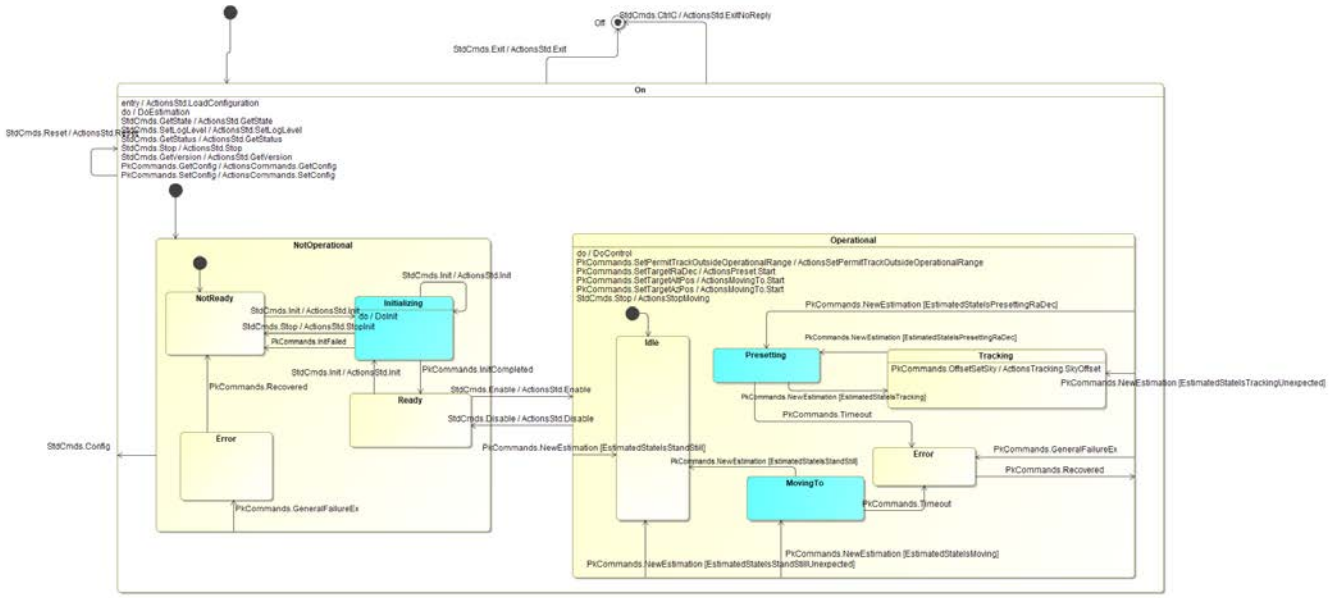


Figure 23

7.5.3 Configuration options

Application configuration is in:

```
<INTROOT>/resource/config/eltpk/config.yaml
```

- Networking
  - The eltpk publishes positions to a multicast address on the deterministic network. Per the factory settings, this publishing does not leave the localhost. To enable traffic to other hosts, set a real multicast-enabled network interface.
    For example: `cfg.pub.determ.nic = 192.168.100.161`
  - The eltpk publishes measurements to the non-deterministic network. Per the factory settings, this publishing does not leave the localhost. To enable traffic to other hosts, unset the DDS profile that is responsible for this.
    For example: `cfg.pub.dds.profile = ""`
- Support for PTP synchronization
  - If health checks by the ELT Time Reference System (TRS) are enabled in the configuration (`cfg.trs_health_enabled = 1`), then eltpk will receive notifications about the PTP health status.
  - Presetting and Tracking will then only be possible when PTP health is good:

- The preset (SetTargetRaDec) command gets rejected otherwise;
- An ongoing preset or tracking will be stopped when PTP health goes bad, and the state machine will consequently go to state Operational/Idle.

o The OLDB shows

- Configuration: cii.oldb:///elt/hlcc/eltpk/cfg/trs_health_enabled
- Actual health: cii.oldb:///elt/hlcc/eltpk/mon/trs/health
- Reason for health state: cii.oldb:///elt/hlcc/eltpk/mon/trs/reason

- Tracking simulation mode
  - o If simulation of MS LSv is enabled (`cfg.simulate_lsv_ms = 1`), then eltpk will communicate with the trksim process and not with the MS Mount controller.
  - o The OLDB shows:
    - Configuration: `cii.oldb:///elt/hlcc/eltpk/cfg/simulate_lsv_ms`

7.6 trksim documentation

This is the pointing kernel simulation process, implementing the tracking and pointing control loops.

It is used in tracking simulation mode and at the moment it implements the subset MS LSV interfaces used by the eltpk to talk to the MS LSV. It will be extended to cover simulation of the PFS and other subsystems.

7.6.1 Sending commands

To send a standard command using the msgsend utility:

```
$> msgsend --uri `consulGetUri -r ifuri -s trksim -i StdCmds`
::stdif::StdCmds::GetState

$> msgsend –uri `consulGetUri -r ifuri -s trksim -i StdCmds`
::stdif::StdCmds::Exit
```

To send a comand defined in the RAD Application standard interface:

```
$> msgsend --uri `consulGetUri -r ifuri -s trksim -i AppCmds`
::appif::AppCmds::GetConfig '"cfg/procname"'

REPLY: "cfg: \n  procname: \"eltpk\"\n"
```

Because we are using Nomad/Consul to manage the deployment, the uri to be used is retrieved with a query to consul using the consulGetUri command line utility, as seen in the examples above.

For example:

$> consulGetUri -r ifuri -s trksim -i StdCmds

The standard commands supported are described in this ICD:

- std/if/src/stdif.xml · master · ecs / ecs-interfaces · GitLab (eso.org)

The standard commands supported by all RAD Applications are described in this icd:

- rad/cpp/appif/src/appif.xml · master · ifw / rad · GitLab (eso.org)

The MS lsv commands that are (partially) supported are described in this ICD:

- https://gitlab.eso.org/lsv/ms/-/blob/main/interface/msif/src/msif.xml

The specific simulation commands supported are described in this ICD:

- software/trksim/interface/trksimif/icd/src/trksimif.xml · master · ccs / hlcc · GitLab (eso.org)

7.6.2 eltpk State Machine

Diagram to be updated

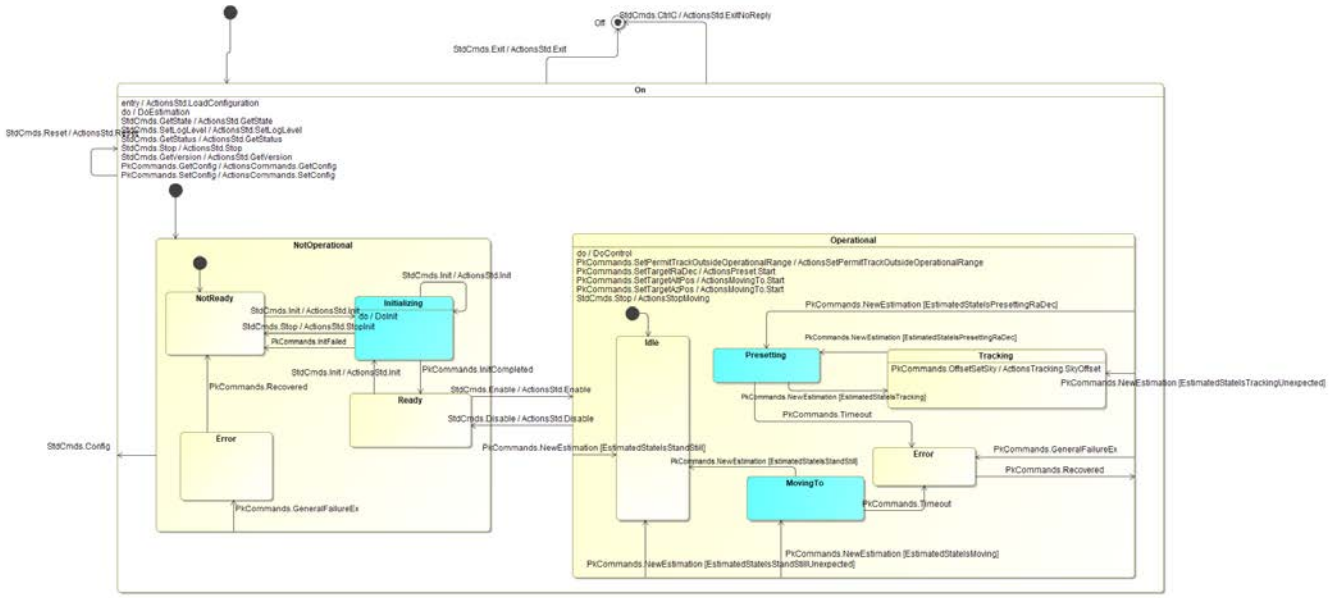


Figure 24

7.7 pfssimhlcc documentation

This is the pre-focal station simulation process, implementing receiving guide probes commands.

It is used to receive GpCmds from eltpk during presets.

7.7.1 Sending commands

To send a standard command using the msgsend utility:

```
$> msgsend --uri `consulGetUri -r ifuri -s pfssimhlcc -i StdCmds`
::stdif::StdCmds::GetState

$> msgsend –uri `consulGetUri -r ifuri -s pfssimhlcc -i StdCmds`
::stdif::StdCmds::Exit
```

To send a comand defined in the RAD Application standard interface:

```
$> msgsend --uri `consulGetUri -r ifuri -s pfssimhlcc -i AppCmds`
::appif::AppCmds::GetConfig '"cfg/procname"'

REPLY: "cfg: \n  procname: \"pfssimhlcc\"\n"
```

Because we are using Nomad/Consul to manage the deployment, the uri to be used is retrieved with a query to consul using the consulGetUri command line utility, as seen in the examples above.

For example:

```
$> consulGetUri -r ifuri -s pfssimhlcc-i StdCmds
```

The standard commands supported are described in this ICD:

- std/if/src/stdif.xml · master · ecs / ecs-interfaces · GitLab (eso.org)

The standard commands supported by all RAD Applications are described in this icd:

- rad/cpp/appif/src/appif.xml · master · ifw / rad · GitLab (eso.org)

The lsv pfs Guide Probes commands that are (partially) supported are described in this ICD:

- interface/pfsif/src/pfsif.xml · main · lsv / pfs · GitLab (eso.org)

The specific simulation commands supported are described in this ICD:

- https://gitlab.eso.org/ccs/hlcc/-/blob/master/software/pfssimhlcc/interface/pfssimhlccif/icd/src/pfssimhlccif.xml

7.8 lsvsim documentation

lsvsim is a generic process that can be used to simulate the behavior of an LSV or of other processes that HLCC might need to interface to.

The present implementation provides minimal features and can be extended in the future, if needed, to provide more features.

Currently, the DEV and the ECM deployments include some lsvsim processes, for the example a process instantiated as **`astrositemon`** to provide a basic emulation of an ELT Armazones Site Monitor. The following examples will be based on this lsvsim instance.

7.8.1 Sending Commands

ATTENTION: At the moment the endpoint registration for lsvsim applications is not consistent with the other HLCC applications, i.e. the endpoint does not contain the process name but only the interface. Therefore the msgsend command lines using consulGetUri are constructed in a different way.

The standard commands supported are described in this ICD:

- std/if/src/stdif.xml · master · ecs / ecs-interfaces · GitLab (eso.org)

To send a command:

```
$> msgsend --uri `consulGetUri -r uri -s astrositemon`/StdCmds
::stdif::StdCmds::GetState
```

Lsvsim app implements the comands defined in the RAD Application standard interface:

- rad/cpp/appif/src/appif.xml · master · ifw / rad · GitLab (eso.org)

To send a command:

```
$> msgsend --uri `consulGetUri -r uri -s astrositemon`/AppCmds
::appif::AppCmds::GetConfig '"cfg/sim_activity_period_ms"'
```

Check the list below and also examples on how to send them using the msgsend:

7.8.1.1.1 SetConfig

Writes, in process configuration, the value(s) for the given configuration parameter(s).

```
$> msgsend --uri `consulGetUri -r uri -s astrositemon`/AppCmds
::appif::AppCmds::SetConfig '"cfg/sim_activity_period_ms : 120"'
```

7.8.1.1.2 GetConfig

Retrieves the value(s) of the given configuration parameter(s) identified via the key(s). If multiple keys are given they must be "space" separated, if no keys are given (empty string) the whole configuration will be returned.

```
$> msgsend --uri `consulGetUri -r uri -s astrositemon`/AppCmds
::appif::AppCmds::GetConfig '"cfg/sim_activity_period_ms"'
```

7.8.1.1.3 LoadConfig

Writes, in process configuration, the value(s) for the given configuration file.

```
$> msgsend --uri `consulGetUri -r uri -s astrositemon`/AppCmds
::appif::AppCmds::LoadConfig '"config/lsvsim/config_m1.yam"'
```

7.8.1.1.4 LoadStateMachine

It loads a new State Machine model from file. If the loading fails, the old one is restored.

```
$> msgsend --uri `consulGetUri -r uri -s astrositemon`/AppCmds
::appif::AppCmds::LoadStateMachine '"lsvsim/sm.xml"'
```

7.8.1.2 Lsvsim interface

Lsvsim app implement the lsvsim interface commands that are described in this interface:

- lsvsim/interface/lsvsimif/icd/src/lsvsimif.xml · master · ccs / hlcc · GitLab (eso.org)

Check the list below and also examples on how to send them using the msgsend:

7.8.1.2.1 SetSim

Writes, in configuration parameter"cfg.sv_specific_confi", the value given, it is possible to change only one value per command and only scalar nodes are allowed to change. This command is similar to the SetConfig command from the lsv interface but in this case it will change the second layer Yaml configuration contained in the config parameter cfg.sv_specific_config, this configuration will be used by the SVs simulation scripts.

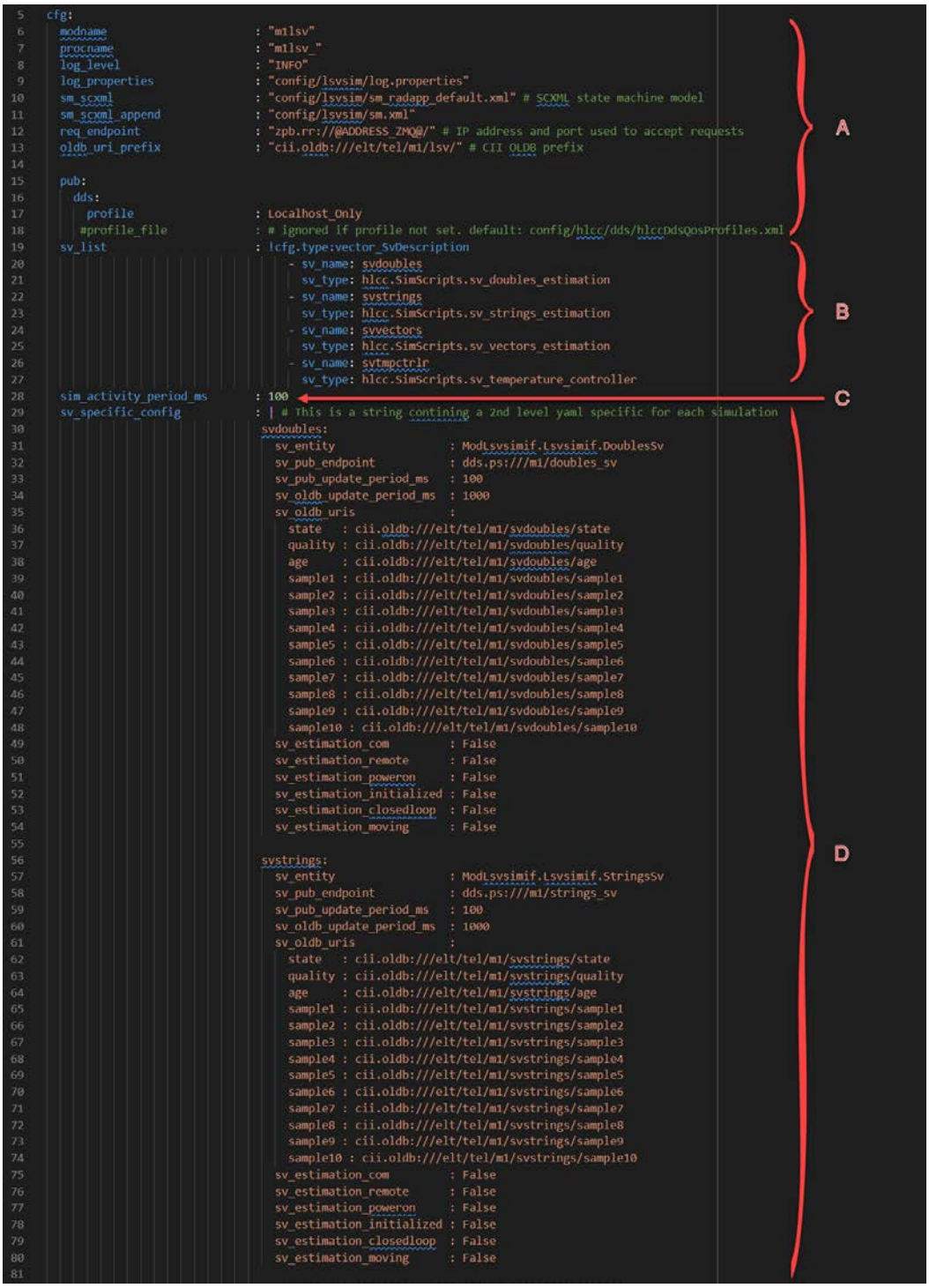
```
$> msgsend --uri `consulGetUri -r uri -s astrositemon`/SimCmds
::lsvsimif::SimCmds::SetSim
'"astrositemon.site_dps.air_temperature.value: 200.0"'
```

7.8.2 Configuration

Check below how the configuration of the lsvsim application looks like.

The file attached below is actually the configuration file

software/lsvsim/app-config/src/config_m1.yaml.in · master · ccs / hlcc · GitLab (eso.org)




```
cfg:
  modname                 : "m1lsv"
  procname                : "m1lsv_"
  log_level               : "INFO"
  log_properties          : "config/lsvsim/log.properties"
  sm_scxml                : "config/lsvsim/sm_radapp_default.xml" # SCXML state machine model
  sm_scxml_append         : "config/lsvsim/sm.xml"
  req_endpoint            : "zpb.rr://@ADDRESS_ZMQ@/" # IP address and port used to accept requests
  oldb_uri_prefix         : "cii.oldb:///elt/tel/m1/lsv/" # CII OLDB prefix

  pub:
    dds:
      profile             : Localhost_Only
     #profile_file         : # ignored if profile not set. default: config/hlcc/dds/hlccDdsQosProfiles.xml
  sv_list                 : !cfg.type:vector_SvDescription
                              - sv_name: svdoubles
                                sv_type: hlcc.SimScripts.sv_doubles_estimation
                              - sv_name: svstrings
                                sv_type: hlcc.SimScripts.sv_strings_estimation
                              - sv_name: svvectors
                                sv_type: hlcc.SimScripts.sv_vectors_estimation
                              - sv_name: svtmpctrlr
                                sv_type: hlcc.SimScripts.sv_temperature_controller
  sim_activity_period_ms  : 100
  sv_specific_config      : | # This is a string contining a 2nd level yaml specific for each simulation
                            svdoubles:
                              sv_entity               : ModLsvsimif.LsvsimifDoublesSv
                              sv_pub_endpoint         : dds.ps:///m1/doubles_sv
                              sv_pub_update_period_ms : 100
                              sv_oldb_update_period_ms: 1000
                              sv_oldb_uris            :
                                state   : cii.oldb:///elt/tel/m1/svdoubles/state
                                quality : cii.oldb:///elt/tel/m1/svdoubles/quality
                                age     : cii.oldb:///elt/tel/m1/svdoubles/age
                                sample1 : cii.oldb:///elt/tel/m1/svdoubles/sample1
                                sample2 : cii.oldb:///elt/tel/m1/svdoubles/sample2
                                sample3 : cii.oldb:///elt/tel/m1/svdoubles/sample3
                                sample4 : cii.oldb:///elt/tel/m1/svdoubles/sample4
                                sample5 : cii.oldb:///elt/tel/m1/svdoubles/sample5
                                sample6 : cii.oldb:///elt/tel/m1/svdoubles/sample6
                                sample7 : cii.oldb:///elt/tel/m1/svdoubles/sample7
                                sample8 : cii.oldb:///elt/tel/m1/svdoubles/sample8
                                sample9 : cii.oldb:///elt/tel/m1/svdoubles/sample9
                                sample10 : cii.oldb:///elt/tel/m1/svdoubles/sample10
                              sv_estimation_com       : False
                              sv_estimation_remote    : False
                              sv_estimation_poweron   : False
                              sv_estimation_initialized : False
                              sv_estimation_closedloop  : False
                              sv_estimation_moving    : False

                            svstrings:
                              sv_entity               : ModLsvsimif.LsvsimifStringsSv
                              sv_pub_endpoint         : dds.ps:///m1/strings_sv
                              sv_pub_update_period_ms : 100
                              sv_oldb_update_period_ms: 1000
                              sv_oldb_uris            :
                                state   : cii.oldb:///elt/tel/m1/svstrings/state
                                quality : cii.oldb:///elt/tel/m1/svstrings/quality
                                age     : cii.oldb:///elt/tel/m1/svstrings/age
                                sample1 : cii.oldb:///elt/tel/m1/svstrings/sample1
                                sample2 : cii.oldb:///elt/tel/m1/svstrings/sample2
                                sample3 : cii.oldb:///elt/tel/m1/svstrings/sample3
                                sample4 : cii.oldb:///elt/tel/m1/svstrings/sample4
                                sample5 : cii.oldb:///elt/tel/m1/svstrings/sample5
                                sample6 : cii.oldb:///elt/tel/m1/svstrings/sample6
                                sample7 : cii.oldb:///elt/tel/m1/svstrings/sample7
                                sample8 : cii.oldb:///elt/tel/m1/svstrings/sample8
                                sample9 : cii.oldb:///elt/tel/m1/svstrings/sample9
                                sample10 : cii.oldb:///elt/tel/m1/svstrings/sample10
                              sv_estimation_com       : False
                              sv_estimation_remote    : False
                              sv_estimation_poweron   : False
                              sv_estimation_initialized : False
                              sv_estimation_closedloop  : False
                              sv_estimation_moving    : False
```

Figure 25

A - These configuration parameters are the base configuration for the lsvsim RAD based app.

B - This parameter lists all the State Variables (SVs) to be simulated. For every SV we must specify a unique name (sv_name) and a script (sv_script) that defines the type of variable to be simulated.

- sv_name: is a string and must be a unique name to identify that SV.
- sv_type: is a string and is the path to the python SV script as python will need to import it.

C - This defines in milliseconds the period in which all the state variable scripts will run.

D - This is a string containing a Yaml configuration (2nd layer yaml config). This configuration will only be used by the SV simulation scripts and we must have a section (map) for each SV listed in the `cfg.sv_list`. Each section name must match the sv_name of each SV.

The configuration of each SV is flexible and depends on the sv_type.

The content of this configuration can be changed at runtime using the `'SetSim'` command like described above.

7.8.3 Other documentation

There is also a design documentation in OneNote for the lsvsim app and coding procedures on how to add state variables to lsvsim processes.

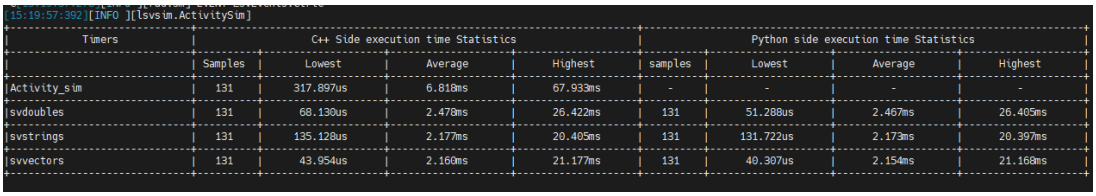
7.8.4 Code Execution Statistics

Code execution statistics are collected in the lsvsim application and also in the python scripts running on top of lsvsim by means of a class `'ExecTimeStats'` (We will refer to this as *Timer*) that will gather information about the execution times. Below the way it works:

- Each *Timer* will collect information about the execution time between 2 points in code. To collect that information we need to use the start and stop methods and place them in the beginning and at the end of the code chunk we need to measure.
    - Timer_start();
    - Timer_stop();

Measured times will be stored in a circular buffer from all the iterations of that code.

- Each *Timer* has a circular buffer that will store the last iterations, when the buffer is full the older data will be overridden. The size is configurable in the instantiation.
- We can have multiple *Timers*, also in python. When the lsvsim process is terminating a table is created with some statistics about all the *Timers* and printed in the console, check below an example:



[15:19:57:392][INFO][lsvsim.ActivitySim]

Timers	C++ Side execution time Statistics				Python side execution time Statistics			
	Samples	Lowest	Average	Highest	samples	Lowest	Average	Highest
Activity_sim	131	317.897us	6.818ms	67.933ms	-	-	-	-
svdoubles	131	68.130us	2.478ms	26.422ms	131	51.288us	2.467ms	26.405ms
svstrings	131	135.128us	2.177ms	20.405ms	131	131.722us	2.173ms	20.397ms
svvectors	131	43.954us	2.160ms	21.177ms	131	40.307us	2.154ms	21.168ms

Figure 26

In this example we have the following Timers:

- Activity_sim - This measures the time that the 'ActivitySim' iteration takes to complete. It is implemented on the C++ side.
- svdoubles, svstrings and svvectors - Timers implemented on the C++ and python sides. These are independent timers but have the same name, so in the table they will be aggregated in the same line.

  We measure the time the 'Execute' function takes to run, seen from the c++ side when invoking the python method, and also seen from the python method. This way we can measure the overhead from the c++ side when running python.

- The table includes the following fields:
  - Samples–- Is the number of samples in the buffer used to build the statistics data.
  - Lowest–- The lowest measured time.
  - Average–- Simple arithmetic average from all measured time values in the buffer.
  - Highest–- The highest measured time .

For each new SV simulation script added to the lsvsim process:

- Newly added SV simulation scripts will be added to the table automatically on the C++ side;
- If we also want the python side to measure the iteration time the following code needs to be added to the SV Python scripts:
  - __init__ method:
    - Create an instance on the ExecTimeStats class

```
# Instantiate Execution statistics object
# that will measure the time 'Execute' method takes to complete
self.exec_stats = ExecTimeStats(p_sv_name, 1000)
```

  - Execute method:
    - Call the 'timer_start()' before executing the method code and then call 'timer_stop()' just before exiting the method.

```python
def Execute(self, arg, iteration_start_timestamp_ms):

    # Start measuring the execution time
    self.exec_stats.timer_start()

    # Method code goes here
    ...

    # Stop measuring execution time
    self.exec_stats.timer_stop()

    return {}
```

- Terminate method:
  - We need to add the execution statistics data to the shared dictionary with c++ before the current object is destroyed, so add the following code to the end of the 'Terminate' method:

```python
def Terminate(self, arg):

    # Terminate code here
    ...

    # Write execution statistics in the shared object
    if 'exec_stats' not in arg:
        arg['exec_stats'] = {}
    arg['exec_stats'][self.exec_stats.stats_name] = self.exec_stats.get_stats_data()
```

7.8.5 PID Temperature Controller example

This page documents the State Variable example based on an emulation of a temperature controller based on the PID algorithm.

The idea is to have the PID algoritm to reach the predefined temperature on the (emulated) system under control.

Implemented as a consequence of this ticket: [ETCS-1146] lsvsim–- implement PID based state variable example–- ESO JIRA Projects

This SV simulation example is implemented in the HLCC git repository:

lsvsim/simulationscripts/simScripts/src/hlcc/SimScripts/sv_temperature_controller.py · master · ccs / hlcc · GitLab (eso.org)

Figure 27 below shows a simplified diagram of the main blocks for the process:

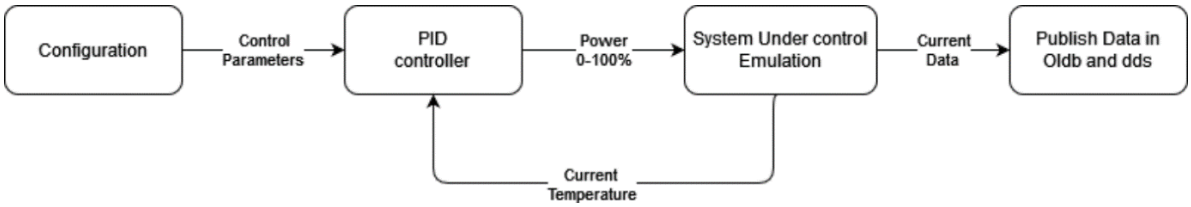


Figure 27

- The PID control parameters are stored in the configuration, and can be changed at runtime, if needed, using the command 'SetSim'.
- PID control algorithm to control a temperature of a system. It is implemented in a separate file | https://gitlab.eso.org/ccs/hlcc/-/blob/master/software/lsvsim/simulationscripts/simScripts/src/hlcc/SimScripts/PID.py and is basically a module that can be installed with pip, but in this case, for simplicity, we have added it directly to the repo because it is just 1 file (GitHub–- ivmech/ivPID: Python PID Controller).
- The System under control is a simple emulation of a heating element which is in an environment with a certain temperature and the element itself also has an initial temperature that can be different from the environment. The heating element will receive the power level (0-100%) and will compute the current temperature based on the energy received (power x duration). This emulation will consider things like:
    - power received from the controller
    - inertia, because in a real system the power is not instantly absorbed by the load
    - system losses, due to energy transfer to the environment.
- Publish at every iteration the system data in Oldb and dds.

7.8.5.1 To start the application

To start the simulation run the following command (in this case we run the simulator directly on the command line, without asking Nomad to deploy it, and therefore the simulator will use a predefined port for communication):

```
$ lsvsim -c config/lsvsim/config_m1.yaml
```

7.8.5.2 Sending commands

The SV starts with the PID switched Off and the system under control @25º.

We need to switch On the PID process using the msgsend command:

```
$ msgsend --uri zpb.rr://localhost:12090/SimCmds
::lsvsimif::SimCmds::SetSim '"svtmpctrlr.controller_poweron: True"'
```

To tune the PID parameters use the following commands:

```
$ msgsend --uri zpb.rr://localhost:12090/SimCmds
::lsvsimif::SimCmds::SetSim '"svtmpctrlr.target_temperature_c: 50"'
$ msgsend --uri zpb.rr://localhost:12090/SimCmds
::lsvsimif::SimCmds::SetSim '"svtmpctrlr.pid_kp: 10"'
$ msgsend --uri zpb.rr://localhost:12090/SimCmds
::lsvsimif::SimCmds::SetSim '"svtmpctrlr.pid_ki: 3.5"'
$ msgsend --uri zpb.rr://localhost:12090/SimCmds
::lsvsimif::SimCmds::SetSim '"svtmpctrlr.pid_kd: 0.4"'
```

To subscribe to dds use `telifsim_subscriber`:

```
$ telif_subscriber --uri dds.ps://1/m1/tmp_ctrlr_sv --entity
ModLsvsimif.Lsvsimif.TmpCtrlSv –-verbose --endafter 600
```

The data is also available in the OLDB in this node:

```
$ cii.oldb:///elt/tel/m1/svtempctrlr/
```

The PID controller can be used as a base to implement other examples or real applications.

Notice that when the application `lsvsim` terminates it writes execution time statistics that can be used to evaluate the performance of the application.

7.9 Segexmgr documentation

Segment Exchange Manager process (segexmgr) is based in the lsvsim application and will manage the M1 segment exchange procedure.

Currently this process is still dummy and not performing any useful tasks.

7.9.1 Sending commands

This process supports all the commands implemented in lsvsim application.

7.10 Astronomical site monitor simulator documentation

The astronomical site monitor application (astrositemon) is meant to provide a simulation of site monitor data and will in the future evolve into the application that interfaces with the ASM hardware to bring data to the telescope and make it available to instruments through the interfaces defined in the standard CCS-INS ICD.

It is based on the lsvsim application and is currentlty providing the following features:

- Publish in Oldb a set of values defined in configuration:
  - uri: cii.oldb:///elt/telif/site/air_temperature
  - uri: cii.oldb:///elt/telif/site/air_temperature_lapse_rate
  - uri: cii.oldb:///elt/telif/site/ambient_pressure
  - uri: cii.oldb:///elt/telif/site/relative_humidity
  - uri: cii.oldb:///elt/telif/site/seeing
  - uri: cii.oldb:///elt/telif/site/wind_direction
  - uri: cii.oldb:///elt/telif/site/wind_speed
- Compute the current moon data using the astropy lib and publish in Oldb:
  - uri: cii.oldb:///elt/telif/site/moon/altaz
  - uri: cii.oldb:///elt/telif/site/moon/phase
  - uri: cii.oldb:///elt/telif/site/moon/radec
  - uri: cii.oldb:///elt/telif/site/moon/target_distance

7.10.1 Sending commands

This process supports all the commands implemented in lsvsim application.

7.10.2 Changing parameters

It is possible to change at runtime parameters that are defined in the configuration to create simulations with changing values.

Check below the example command used to change the air temperature to 120.

The following example applies if we are running the application manually:

```
$> msgsend --uri zpb.rr://localhost:12091/SimCmds ::lsvsimif::SimCmds::SetSim
'"astrositemon.site_dps.air_temperature.value: 120"'
```

On a system running with Consul, we shall ask Consul for the service uri:

```
$> msgsend --uri `consulGetUri -r uri -s astrositemon`/SimCmds
::lsvsimif::SimCmds::SetSim '"astrositemon.site_dps.air_temperature.value: 120"'
```

Below the list of all parameters that can be updated:

- astrositemon.site_dps.air_temperature.value
- astrositemon.site_dps.air_temperature_lapse_rate.value
- astrositemon.site_dps.ambient_pressure.value
- astrositemon.site_dps.relative_humidity.value
- astrositemon.site_dps.seeing.value

- astrositemon.site_dps.wind_direction.value
- astrositemon.site_dps.wind_speed.value

7.11 HLCC utilities

This section documents a set of utilities/clients used for testing and as examples:

7.11.1 $ consulGetUri --help

usage: consulGetUri [-h] [--version] [-v VERBOSE] [-c CONSUL_HOST] [-p CONSUL_PORT] [-s SERVICE] [-i IFACE] -r {server,ipport,uri,ifuri}

Queries consul for information on a requested service. The command line arguments allow to select the information to be returned and the output format.

optional arguments:

-h, --help show this help message and exit

--version show program's version number and exit

-v VERBOSE, --verbose VERBOSE
Verbose mode: 0=WARNING, 1=INFO, >1=DEBUG

-c CONSUL_HOST, --chost CONSUL_HOST
Host where consul is running. Default: None (will parse $CONSUL_ADDR env var or localhost if undefined)

-p CONSUL_PORT, --cport CONSUL_PORT
Port used by consul. Default: None (will parse $CONSUL_ADD env var or use 8500 if undefined)

-s SERVICE, --service SERVICE
Service for which we are querying consul (requires -r port/uri/ifuri)

-i IFACE, --interface IFACE
Inteface for which we are querying consul (requires -r ifuri)

-r {server,ipport,uri,ifuri}, --request {server,ipport,uri,ifuri}
The requested uri information: server={server ip}, ipport={server ip}:{port}, uri=zpb.rr://{serverIp}:{port}, ifuri=full uri for the requested interface.
Default = ifuri

7.11.2 $ eltpk_preset --help

usage: eltpk_preset [-h] [-r RA] [-d DEC] [--init] [--test]

Sends a Preset command to eltpk process (passing no arguments == --test)

optional arguments:

-h, --help show this help message and exit

-r RA, --ra RA RA of target (rad)

-d DEC, --dec DEC DEC of target (rad)

--init Initializes and Enable before sending the Preset command

--test Initialize, Enable and Preset to a predefined test set of coordinates

--dipport Instead of querying nomad it uses the default IP:PORT of applications

Example:

eltpk_preset -r 5.54 -d -1.55

7.11.3 $ telifsim_preset –help

Sends a Preset command to telifsim process (passing no arguments == use defaults). Default values means that the telescope will always preset to a Ra/Dec that corresponds to an Alt/Az of 89.5deg/10deg at time of command execution.

usage: telifsim_preset [-h] [--ra RA] [--dec DEC] [--gs1] [--gs1-ra GS1_RA]
[--gs1-dec GS1_DEC] [--gs2] [--gs2-ra GS2_RA]
[--gs2-dec GS2_DEC]

Sends a Preset command to the telifsim process

optional arguments:

-h, --help show this help message and exit

-r RA, --ra RA RA of target (rad)

-d DEC, --dec DEC DEC of target (rad)

--gs1 Use guidestar 1

--gs1-ra GS1_RA RA of guidestar 1 (rad)

```
  --gs1-dec GS1_DEC  DEC of guidestar 1 (rad)
  --gs2              Use guidestar 2
  --gs2-ra GS2_RA    RA of guidestar 2 (rad)
  --gs2-dec GS2_DEC  DEC of guidestar 2 (rad)
  --version          show program's version number and exit
  --init             Initializes and Enable before sending the Preset command
  --test             Initialize, Enable and Preset to a predefined test set of coordinates
   --dipport         Instead of querying nomad it uses the default IP:PORT of applications
```

Example:
telifsim_preset -r 0.9 -d 0.7

7.11.4 $ telif_subscriber --help

```
usage: telif_subscriber [-h] [--uri URI] [--entity ENTITY]
                        [--endafter ENDAFTER] [--endifset ENDIFSET]
                        [--verbose] [--version]

Subscribes to PubSub

optional arguments:
  -h, --help          show this help message and exit
  --uri URI           publisher address (as URI), e.g.
                      "zpb.ps://localhost:12781/TELIF_CCS_TRG_OBS_ALTAZ"
  --entity ENTITY     entity classname (as FQN), e.g.
                      "ModCcsinsif.Ccsinsif.AltAz"
  --endafter ENDAFTER  max wait time (in seconds)
  --endifset ENDIFSET  wait for content (as dict), e.g. "{'alt':1.0,'az':2.0}"
  --verbose           print all received data (withuot that, received data would not be printed)
  --version           show program's version number and exit
```

Example 1: subscribing to the publisher example below (with dds and zpb)

```
$ telif_subscriber \
      --uri dds.ps://2/TELIF_CCS_TRG_OBS_ALTAZ \
      --entity ModCcsinsif.CcsinsifAltAz \
      --endifset '{"alt":3.0, "az":9.0}' \
      --endafter 10 \
      --verbose
recd {"alt": 1.0, "az": 9.0}
recd {"alt": 2.0, "az": 9.0}
recd {"alt": 3.0, "az": 9.0}

$ telif_subscriber \
      --uri dds.ps://2/TELIF_CCS_CUR_OBS_ALTAZ \
      --entity ModCcsinsif.CcsinsifAltAz \
      --endifset '{"alt":3.0, "az":9.0}' \
      --endafter 10 \
      --verbose
recd {"alt": 0.43097476541553403, "az": -0.022040684745402217}
recd {"alt": 0.430974692425593, "az": -0.022040689891149157}

$ telif_subscriber \
--uri zpb.ps://localhost:12781/TELIF_CCS_TRG_OBS_ALTAZ \
--entity ModCcsinsif.CcsinsifAltAz \
--endifset '{"alt":3.0, "az":9.0}' \
--endafter 10 \
--verbose
recd {"alt": 1.0, "az": 9.0}
recd {"alt": 2.0, "az": 9.0}
recd {"alt": 3.0, "az": 9.0}
```

Notice that with zpb the first sample is actually lost (this is a known zpb effect related with late joiner implementation)

$ echo $?

0

Example 2: subscribing to the PK-simulator's position stream

$ telif_subscriber \

--uri **mudpi.ps://224.0.0.1:12783/**TELIF_CCS_PK_POS \

--entity ModCcsinsdetif.Ccsinsif.PointingKernelPositions \

--verbose

Note: The entity data is too complex to be processed as JSON

Note: To boost the JSON processing, do: pip install jsons

Note: Falling back to plain attribute format

recd current_observed_altaz:SharedVectorConstDouble[0, 0] | elevation_direction_angle:0.0 | north_angle:0.0 | observed_altaz_at_requested_xy:SharedVectorConstDouble[0, 0] | parallactic_angle:0.0 | pupil_angle:0.0 | radec_at_xy_from_guide_stars:SharedVectorConstDouble[0, 0] | target_observed_altaz:SharedVectorConstDouble[0, 0] | time_lst:1.598577744817963 | time_tai:1659448989.1 | time_utc:1659448952.1

Example 3: subscribing to the PK-simulator's status message

$ telif_subscriber \

--uri **dds.ps://1/**TELIF_STATUS \

--entity ModStdif.Stdif.Status \

--endafter 120 \

--verbose

recd {"status": "On::NotOperational::NotReady "}

For a table describing the data published by HLCC, see section 6.4.3

7.11.5 $ telif_publisher --help

usage: telif_publisher [-h] [--uri URI] [--entity ENTITY] [--set SET]

[--interval INTERVAL] [--iterations ITERATIONS]

[--verbose] [--version]

Publishes to PubSub

optional arguments:

```
  -h, --help            show this help message and exit
  --uri URI             publisher address, e.g.
                        "zpb.ps://localhost:12781/TELIF_CCS_TRG_OBS_ALTAZ".
                        The host name will be ignored.
  --entity ENTITY       entity classname, e.g. "ModCcsinsif.Ccsinsif.AltAz"
  --set SET             data content (as dict), e.g. '{"alt":1, "az":1}'. If
                        specified multiple times, contents get accumulated.
  --interval INTERVAL   wait time between publications (in seconds)
  --iterations ITERATIONS
                        number of iterations
  --verbose             print all published data
  --version             show program's version number and exit
```

Example (dds and zpb):

```
$ telif_publisher \
    --uri dds.ps://1/TELIF_CCS_TRG_OBS_ALTAZ \
    --entity ModCcsinsif.Ccsinsif.AltAz \
    --set '{"alt":1.0, "az":9.0}' \
    --set '{"alt":2.0}' \
    --set '{"alt":3.0}' \
    --verbose
sent {"alt": 1.0, "az": 9.0}
sent {"alt": 2.0, "az": 9.0}
sent {"alt": 3.0, "az": 9.0}

$ telif_publisher \
--uri zpb.ps://localhost:12781/TELIF_CCS_TRG_OBS_ALTAZ \
--entity ModCcsinsif.Ccsinsif.AltAz \
```

```
--set '{"alt":1.0, "az":9.0}' \
--set '{"alt":2.0}' \
--set '{"alt":3.0}' \
--verbose
sent {"alt": 1.0, "az": 9.0}
sent {"alt": 2.0, "az": 9.0}
sent {"alt": 3.0, "az": 9.0}
```

7.11.6 $ telifsim_get_config --help

```
usage: telifsim_get_config [-h] [--notest] [--version]

Sends an GetConfig command to telifsim

optional arguments:
  -h, --help  show this help message and exit
  --notest    Sends a Getconfig command and print response on console without
              testing
  --version   show program's version number and exit
```

7.11.7 $ telifsim_metadaqcmds --help

```
usage: telifsim_metadaqcmds [-h] [-o {start,stop,abort,get_status}] [-i ID]
                            [--version] [--test]

Sends a Preset Daq commands to telifsim (passing no arguments == --test)

optional arguments:
  -h, --help            show this help message and exit
  -o {start,stop,abort,get_status}, --option {start,stop,abort,get_status}
```

Action to perform in the command
-i ID, --id ID Daq Id
--version show program's version number and exit
--test Runs the automated test routine
--dipport Instead of querying nomad it uses the default IP:PORT of applications

Meta data acquisition must happen while the telescope is tracking.

Example - Starting/stopping the meta data acquisition with ID = 1 :

telifsim_metadaqcmds -o start -i 1
Reply (DaqReply): Id '1'

telifsim_metadaqcmds -o stop -i 1
Reply (DaqStopReply): Id '1'
: Files []
: Keywords [{ "type":"esoKeyword", "name":"ESO TEL ALT", "value": 0.961 }, { "type":"esoKeyword", "name":"ESO TEL AZ", "value": 0.348 }, { "type":"esoKeyword", "name":"ESO TEL GEOELEV", "value": 3046.0 }, { "type":"esoKeyword", "name":"ESO TEL GEOLAT", "value": -0.4292 }, { "type":"esoKeyword", "name":"ESO TEL GEOLON", "value": 1.2251 }, { "type":"esoKeyword", "name":"ESO TEL TARG EPOCH", "value": 2000.000 }, { "type":"esoKeyword", "name":"ESO TARG EPOCHSYSTEM", "value": "J" }, { "type":"esoKeyword", "name":"ESO TEL TARG RADVEL", "value": 0.600 }, { "type":"esoKeyword", "name":"ESO TEL TARG PARALLAX", "value": 0.500 }, { "type":"esoKeyword", "name":"ESO TEL TARG ALPHA", "value": 205930.590 }, { "type":"esoKeyword", "name":"ESO TEL TARG DELTA", "value": -561702.970 }]

7.11.8 $ telifsim_sky_offset --help

usage: telifsim_sky_offset [-h] [-r RA] [-d DEC] [-f {closed,open}]
[-g GUIDESTAR] [--version] [--test]

Sends an OffsetSetSky command to telifsim (passing no arguments == --test)

optional arguments:
-h, --help show this help message and exit
-r RA, --ra RA RA offset (rad)
-d DEC, --dec DEC DEC offset (rad)

-f {closed,open}, --field {closed,open}
Field stabilization loop
-g GUIDESTAR, --guidestar GUIDESTAR
guide star parameter
--version show program's version number and exit
--test Sends a pre-defined offset to telifsim.
--dipport Instead of querying nomad it uses the default IP:PORT of applications

7.11.9 $ telifsim_request_release_control --help

usage: telifsim_request_release_control [-h] [-o {request,release}]
[-m {cascade,sequential}] [--version]
[--test]

Sends Request/Release command to telifsim (passing no arguments == --test)

optional arguments:
-h, --help show this help message and exit
-o {request,release}, --option {request,release}
Action to perform in the command
-m {cascade,sequential}, --mode {cascade,sequential}
Control Mode
--version show program's version number and exit
--test Sends a request / release control command
--dipport Instead of querying nomad it uses the default IP:PORT of applications

7.11.10 $ telifsim_rous --help

usage: telifsim_rous [-h] [-o {config,execute,update_timer}]
[-m {enable,disable}] [-t TIME] [--version] [--test]

Sends Request/Release command to telifsim (passing no arguments == --test)

optional arguments:
-h, --help show this help message and exit

-o {config,execute,update_timer}, --option {config,execute,update_timer}
Rous command to be executed
-m {enable,disable}, --mode {enable,disable}
Rous config Mode
-t TIME, --time TIME Time in seconds to update rous timer
--version show program's version number and exit
--test Executes the default Rous testroutine
--dipport Instead of querying nomad it uses the default IP:PORT of applications

7.11.11 pkp_llnetio_subscriber --help

Subscribe to llnetio – rtms to receive pointing kernel positions data.

Allowed options:

-h [--help] Show help message

-p [--port] arg (=5213) Listen UDP Port

-c [--count] arg (=1) Data to read count

-t [--test] Test execution

7.12 Jupyter notebooks

The code repository includes a set of jupyter notebooks with examples written in python.

There are two frontends to execute jupyter notebooks (see Project Jupyter | Home):

- Jupyter Notebook
- JupyterLab (not available in Fedora 38, See: [ELTDEV-1090] Package jupyterlab - ESO JIRA Projects)

The notebooks are in this folder in the GitLab repository:

- software/jupyter_notebooks · master · ccs / hlcc · GitLab (eso.org)

If you select any of the notebooks in GitLab, the viewer will properly format the contents, providing you with well readable examples.

The notebooks are installed by waf in:

```
$PREFIX/jupyter_notebooks
```

and in the RPM distribution are in:

```
/elt/hlcc/jupyter_notebooks
```

7.12.1 Start jupyter server and browser client on the same machine with one command

In order to actually execute the code in the notebooks on a machine with the system installed:

```
cd <hlcc repository folder/software>   # go where your git repository for
                                       # hlcc has been extracted
                                       # or where it has been installed
jupyter-notebook
        or:
jupyter-lab
```

A jupyter server will be started and the Firefox browser will open on the folder containing the code:

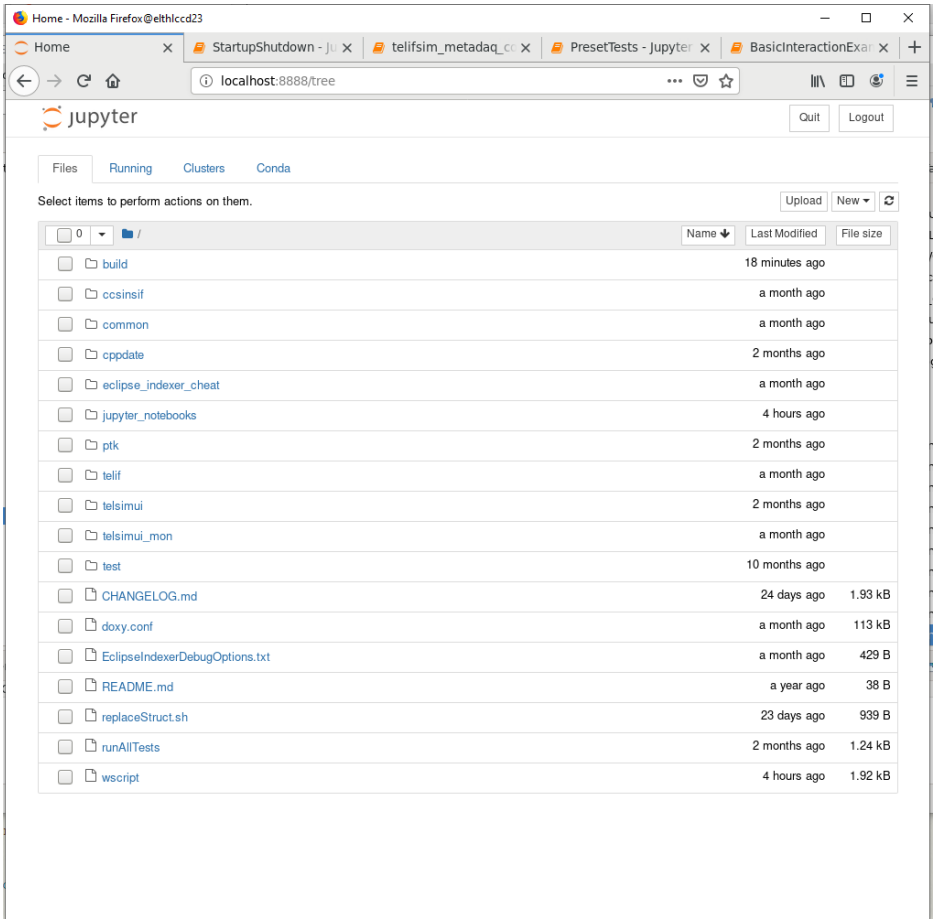


Figure 28

7.12.2 Start jupyter server and browser client on the different machines

It is also possible to run server and browser client in different machines.

On the machine where you want to run the server, cd to the root folder for your notebooks and issue the command

```
cd <hlcc repository folder/software>   # go where your git repository for hlcc
                                       # has been extracted
                                       # or where it has been installed


jupyter-notebook --no-browser --ip=0.0.0.0
```

or:

```
jupyter-lab --no-browser --ip=0.0.0.0
```

This start just the jupyter-server. The console where the server runs will tell how to attach the client:

```
[I 11:55:48.397 LabApp] The Jupyter Notebook is running at:
[I 11:55:48.397 LabApp]
http://elthlccd23:8888/?token=019b2a3cc9f8610b88d7d6b40976844fea310cbc4469ae34
[I 11:55:48.397 LabApp]  or
http://127.0.0.1:8888/?token=019b2a3cc9f8610b88d7d6b40976844fea310cbc4469ae34
[I 11:55:48.397 LabApp] Use Control-C to stop this server and shut down all kernels (twice
to skip confirmation).
[C 11:55:48.401 LabApp]

To access the notebook, open this file in a browser:
        file:///home/eltdev/.local/share/jupyter/runtime/nbserver-394842-open.html
    Or copy and paste one of these URLs:
        http://elthlccd23:8888/?token=019b2a3cc9f8610b88d7d6b40976844fea310cbc4469ae34
     or http://127.0.0.1:8888/?token=019b2a3cc9f8610b88d7d6b40976844fea310cbc4469ae34

To connect from any browser, just open the browser and and go to the URL with the given
token. In this case:

http://elthlccd23:8888/?token=019b2a3cc9f8610b88d7d6b40976844fea310cbc4469ae34
```

You can for example run the server on the machine where the hlcc is running and the client on a Microsoft Windows desktop with Microsoft Edge browser instead of Firefox.

In some cases this would be much more responsive.

7.12.3 Executing Jupyter Notebooks

You can select the `jupyter_notebooks` folder and open in the browser any of the noteboooks stored there.

For example:

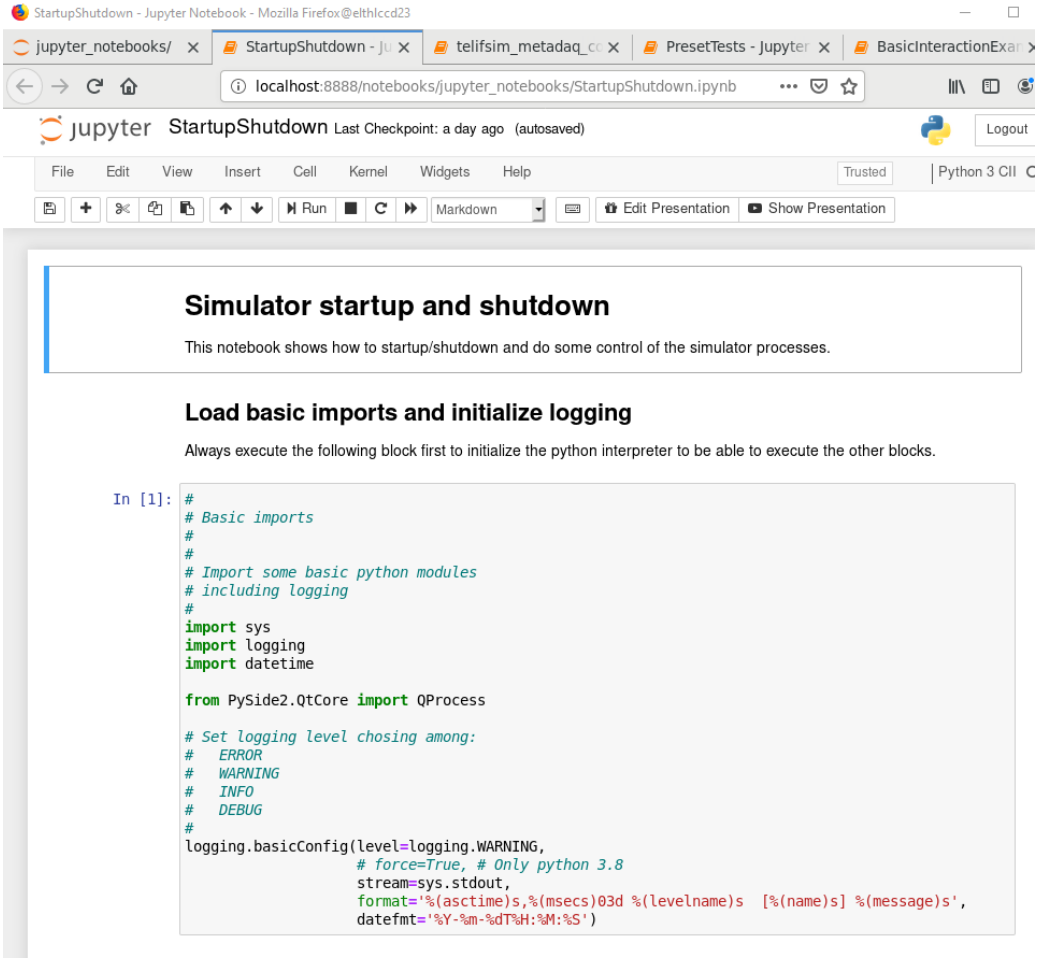


Figure 29

You can then run any single cell by:

- Selecting the cell you want to run
- Clicking the **Run** button

Read carefully the documentation of the notebooks.

Some cells are meant to setup the python kernel environment and shall be executed in any case before the other cells with specific actions can be executed.

A major advantage of using these notebooks is that you can (almost always) select any cell and execute them in any order or changing just some values. This makes running interactive tests and learning how the system behaves very easy.

The code can then be copied in your own scripts.

7.13 Sequencer scripts and Obs

The code repository includes a set of ELT Sequencer scripts and OBs:

The Sequencer scriptsare in this folder:

https://gitlab.eso.org/ccs/hlcc/-/tree/master/software/seq/src/hlccseq

and are installed as the `hlccseq` python module.

The OBs are in the folder:

https://gitlab.eso.org/ccs/hlcc/-/tree/master/software/seq/resource/config/seq

The scripts are python programs written using the sequencer libraries and can be executed in the seq server using the seg gui or manually from the command line.

It is possible to execute an individual sequence or an OB on the command line or using the sequencer server and the sequencer user interface.

7.13.1 Run an individual sequence on the command line

In order to run an individual sequence on the command line use the **`seqtool run`** command like:

```
> seqtool run hlccseq.simStartup
```

7.13.2 Run through sequencer server and GUI

In order to use the scripts you can start an independent the sequencer server, if not already running:

```
> seqtool server
```

In order to use the scripts, you can then start the sequencer graphical user interface

```
> seqtool gui
```

If no default sequencer server is running, the GUI will automatically start one.

You can start an independent the sequencer server, if not already running:

```
> seqtool server
```

A sequencer gui would then directly connect to this server.

HLCC deployment includes a sequencer server that is used for handling typically preset commands. You can open a sequencer GUI connected to this server by asking Consul for its uir, using the following command:

```
> seqtool gui --address `consulGetUri -s seqserver -r ipport`
```

Once the gui is started, there are two ways to load and run sequences from the sequencer gui:

1. Use the Application -> Load Script menu with the file chooser.
   In this way you have to locate the sequencer script source

2. Load them in the sequencer server from a python sequences library available in the PYTHON_PATH:
   - activate the debug mode from the Application->Debug mode menu
   - issue in the Console tab the commands to load specific sequences, like

     load hlccseq.simStartup

     load hlccseq.simShutdown

The sequencer will look for the sequencer scripts in the INTROOT or in the system folders and load them from there.

See the following screenshot:

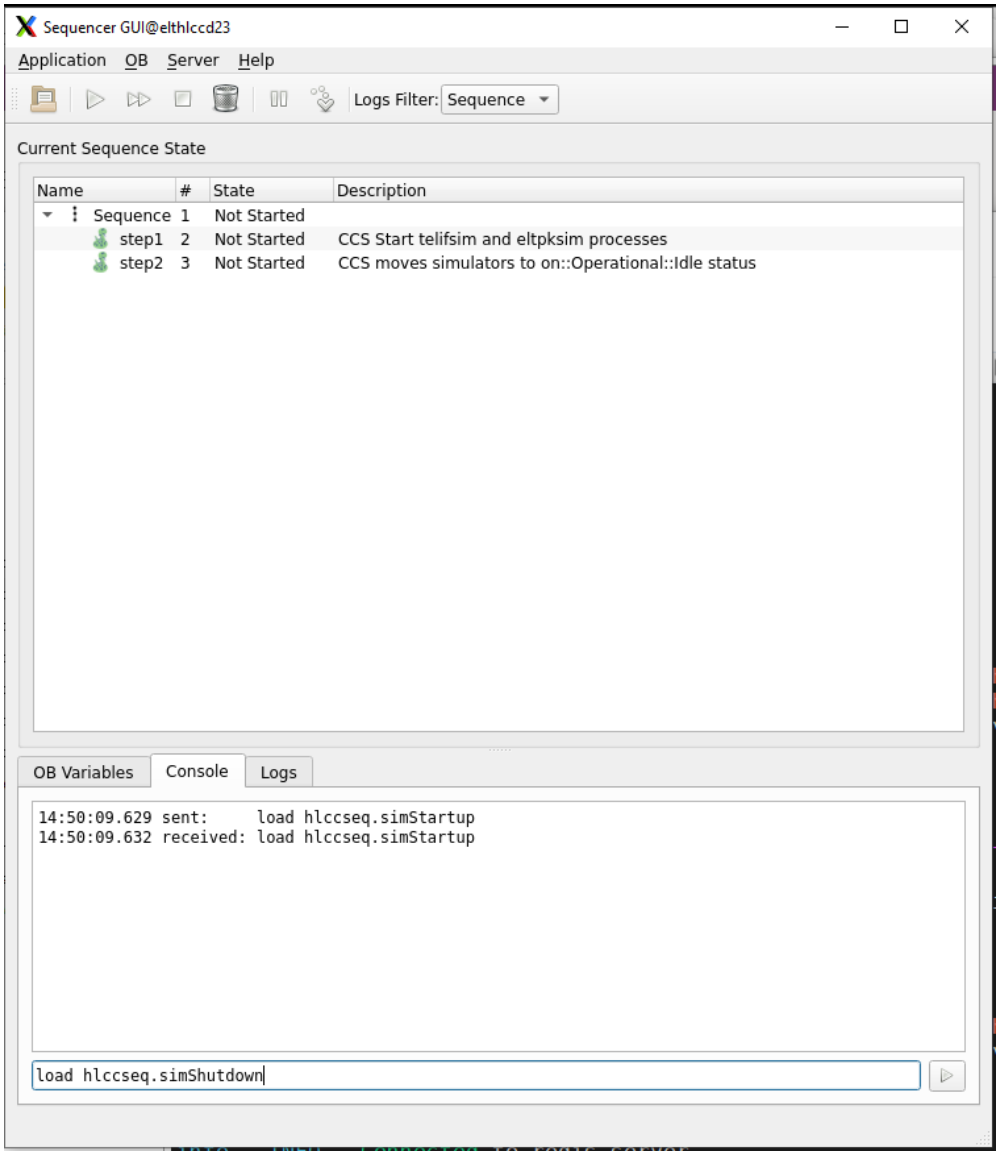


Figure 30

For more details on sequences and Obs, look at the Sequencer documentation in ELT Sequencer scripts

7.13.3 Known Issues

- The seqtool gui sometimes does not show a loaded sequence/OB.

In this case, restart the tool or reload the sequence.

See: [EICSSW-1879] seqtool gui sometimes does not show a loaded sequence - ESO JIRA Projects

7.13.4 ToDo

None listed here at the moment

7.14 Change Telescope site coordinates

By default the telescope is configured to be located in Armazones, at the actual ELT coordinates.

For testing purposes, it might be useful to "move the telescope" in a different location, for example the locations of UT1 in Paranal.

The change can be done

1. in the configuration deployment files or
2. dynamically sending a configure command

The configuration for the site location is under responsibility of the eltpk process, that is also responsible to make it available in the CCS-INS interface in the OLDB.

While the system is running, you can find the parameters for the site location in these OLDB branches:

cii.oldb:///elt/telif/site/info (public CCS-INS interface)

cii.oldb:///elt/hlcc/eltpk/cfg/site/info/elevation (eltpk private OLDB)

7.14.1 Change telescope location in configuration files

- The configuration is stored in the file https://gitlab.eso.org/ccs/hlcc/-/blob/master/software/telif/eltpk/app-config/src/config.yaml.in or in any of the corresponding deployment configuration files
- Edit the keys:

  cfg.site.info.elevation : 3046.0 # meters

  cfg.site.info.latitude : -0.429164 # Radians

  cfg.site.info.longitude : 1.225075 # Radians

  cfg.site.info.id : "ELT"

o Start the system with the new configuration

7.14.2 Change telescope location with configuration commands

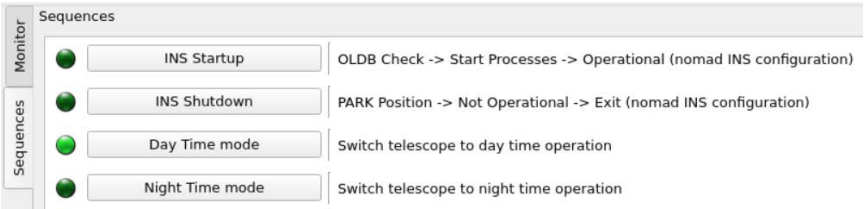
- The procedure is documented in details in the Jupyter notebook https://gitlab.eso.org/ccs/hlcc/-/blob/master/software/jupyter_notebooks/ChangeTelescopeSite.ipynb
- In summary:
  - The site location configuration keywords can be changed only when the `eltpk` process is in `On::NotOperational` state, therefore send a Disable command if it is `On::Operational`.
  - Prepare a file with the new site location keywords and send the LoadConfig command

    Or
  - Prepare a string with the same keywords and send the SetConfig command

7.15 Change Telescope operation mode

The normal daily cycle of the telescope is composed for 2 different operation modes: the daytime mode and the nighttime mode. The first will be active during the day for maintenance operations the second will be active during the night for astronomical observations.

To switch from one to the other we have implemented the skeleton for two sequences that will help in those procedures.



7.15.1 DayTime sequence

This sequence must be executed by the sequencer Gui because it will make use of dialogs.

To start the sequencer, with the preloaded sequence, press the “Day Time mode” button on the sequences panel of the telescope simulator UI (check picture above).

Note: Due to a potential problem in the sequencer sometimes the sequencer Gui does not come pre-loaded with the sequence, in that case close the sequencer Gui and try again.

The main purpose of this sequence is to:

- Move the telescope into segment exchange position.

- Disable the telescope axes and enable the processes used in the daytime mode.

7.15.2 NightTime sequence

To start the sequencer, with the preloaded sequence, press the “Night Time mode” button on the sequences panel of the telescope simulator UI (check picture above).

Note: Due to a potential problem in the sequencer sometimes the sequencer Gui do not come pre-loaded with the sequence, in that case close the sequencer Gui and try again.

The main purpose of this sequence is to:

- Disable all the processes used only in day time mode and set them to be ignored in the ccs state estimation.
- Enable all processes needed in Night mode to make observations.

7.15.3 Extending Daytime and NightTime sequences

If we need to add other processes to be managed by the daytime and nighttime sequences check below what needs to be done:

In the sequence file ‘hlccDayTime.py’:

- add the new process details to the list ‘self.hlcc_proc_list’;
- list that process in the lists: ‘self.daytime_not_operational’ or ‘daytime_operational’ according to what is the function of that process.

In the sequence file ‘hlccNightTime.py’:

- add the new process details to the list ‘self.hlcc_proc_list’;
- list that process in the lists: ‘self.nighttime_not_operational’ or ‘self.nighttime_operational’ according to what is the function of that process.

8. Known issues

Look in each section for specific issues and important ToDos.

This page list some general issues you might encounter and we know of.

9. Other HLCC applications

This section contains information on other HLCC applications not directly involved in the Telescope Simulator.

The section will be refactored and extended as the real system applications will be developed, to cover the functionality provided by the real system and specific needs of other deployments.

9.1 telif documentation

9.1.1 Start the application:

```
$> telif -c config/telif/config.yaml -lTRACE
```

where:

```
-c argument is the path to the configuration file, as a relative
path that will be searched using the $CFGPATH environment variable

-l [ --log-level ] arg Log level: ERROR, WARNING, STATE, EVENT,
ACTION, INFO, DEBUG, TRACE
```

9.1.2 Sending commands

To send a standard command using the `msgsend` utility:

```
$> msgsend --icd ../ecs-interfaces/std/if/src/stdif.xml --uri
zpb.rr://localhost:12081/telif/StdCmds ::stdif::StdCmds::Exit
```

To send a specific command defined in the `::ccsinsif::Commands:` interface:

```
$> msgsend --icd ./ccsinsif/icd/src/ccsinsif.xml --uri
zpb.rr://localhost:12081/telif/Commands
::ccsinsif::Commands::GetConfig
```

The standard commands supported are described in this ICD:

- std/if/src/stdif.xml · master · ecs / ecs-interfaces · GitLab (eso.org)

The specific commands supported are described in this ICD:

- ccsinsif/icd/src/ccsinsif.xml · master · ccs / hlcc · GitLab (eso.org)

The `preset` command has a parameter's structure that is currently not supported by the msgsend tool.

The python utility telifsim_preset allows to send the command in an easy way and can be used as an example to write more complex code. See HLCC utilities.

10. Stellarium: Installation and configuration

Stellarium is a free GPL software (Source code is available in GitHub: Stellarium GitHub) which renders realistic skies in real time with OpenGL. It is available for Linux/Unix, Windows and macOS. With Stellarium, you really see what you can see with your eyes, binoculars or a small telescope.

It is possible to integrate Stellarium with the HLCC Telescope Simulator, so that Stellarium view is centered at the place where the telescope is pointing and also to select objects in Stellarium and send the telescope pointing and tracking to that objects.

At the moment HLCC provides two Jupyter Notebooks that demonstrate such integration and in the future it is foreseen to implement a UI, some scripts or even an application implementing a telescope mount LSV interface simulator integrated with Stellarium

10.1 Installation

Stellarium can be installed on any machine accessible on the network from the HLCC machines.

For better performance it is advisable to install stellarium on the machine where the main operator display is running, for example on the MS Windows machine that is used as the main console.

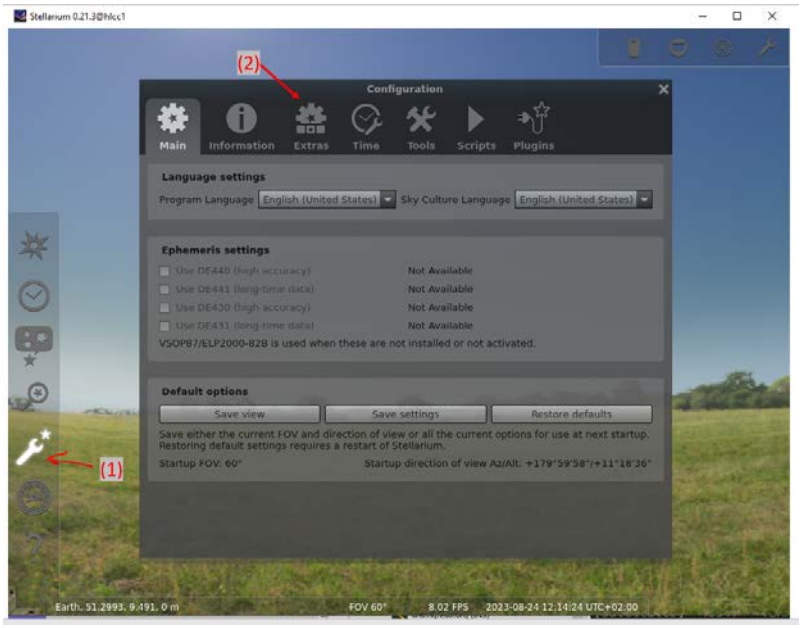
- Links to the packages for Linux, MS Windows and macOS are here: https://stellarium.org/
- Installation on ELT Fedora linux machines can be done directly as root with the dnf command
  - `dnf install stellarium`

10.2 Configuration

In order to optimally use Stellarium with HLCC it is necessary to configure it.

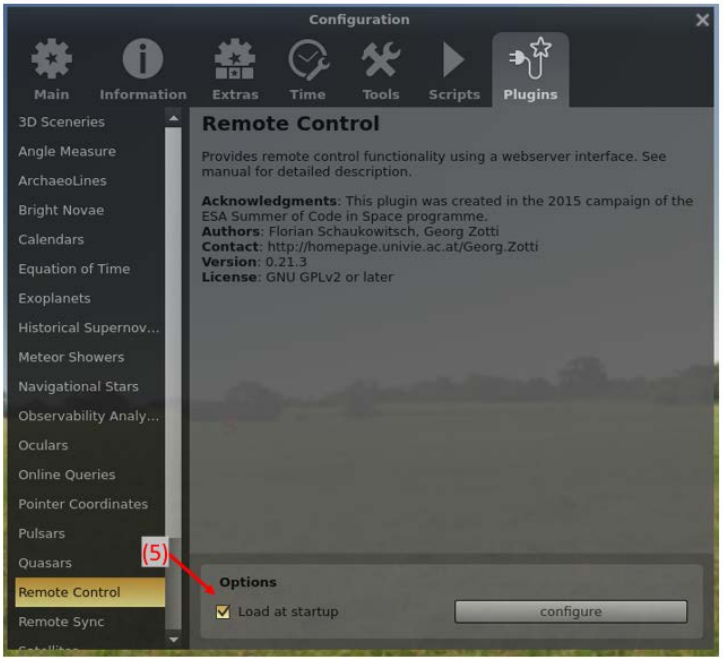
Most configurations can be also done programmatically and it is foreseen to implement applications to take care of the configuration, but for the time being what follow are the most important configuration steps (The numbers in parenthesis correspond to numbers in the screenshots).

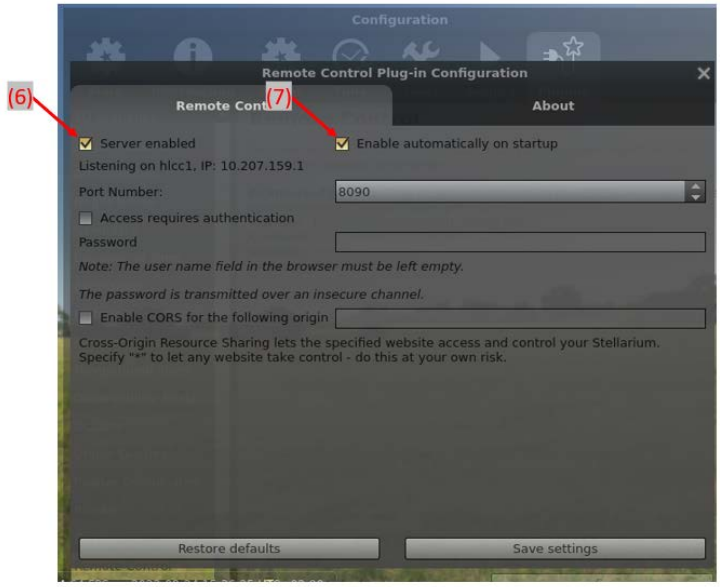
- Start Stellarium
- To exit from the default full-screen view press F11
- Open the cascade command bar on the left, by getting near to the left frame border
- Selet Configuration (1) to open the configuration panel
- Select Extras (2)



- Load all star catalogues (3)
  to get a more realistic view of what would be visible from the ELT.
  With all catalogues it is possible to see stars up to magnitude 17.

- Select Plugins (4)
  - Remote control plugin (plugin managing the web server with rest API)



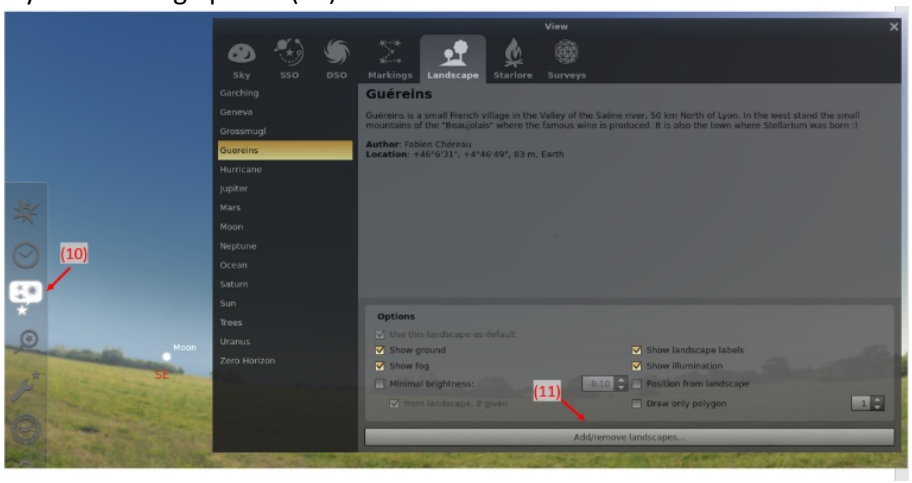


- Load at startup (5)
- restart Stellarium if not already selected
- Configure -> Server enabled (6), enable automatically at startup (7)

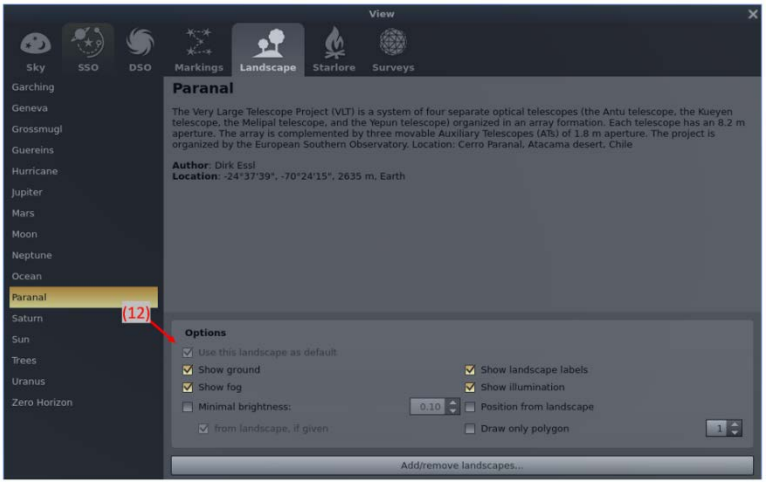
- Oculars

- Load at startup (8)
- restart Stellarium if not already selected

- Sky and viewing options (10)



  - Landscape
    - Download the Paranal landscape (we do not have a landscape for Armazones yet) from this SharePoint link: Paranal landscape
    - Add/remove landscapes -> add the downloaded landscape (11)
    - Select Paranal and use as default (12)



10.3 Running the Jupyter notebooks

At this point it is possible to run the Jupyter Notebooks.

All Notebooks provided by HLCC for usage with Stellarium are named

```
Stellarium*.ipynb
```

Read carefully the documentation inside the notebooks and first of all set the URI with the proper hostname or IP to access the Stellarium server.

The initialization cells will take care of setting some additional configuration parameters, like the telescope location coordinates.

To complete the configuration of stellarium, run first of all the notebook

`StellariumConfig.ipynb`

Two other very useful notebooks for usage with stellarium are:

`StellariumFollowsTelescope.ipynb`

Keeps the view of stellarium aligned with the line of sight of the hlcc telescope by reading in a loop the current (alt,az) and moving the display of the sky to that position

`StellariumPointTelescopeToSelected.ipynb`

Running the notebook once an object is selected in the ui of stellarium points the telescope to that object.

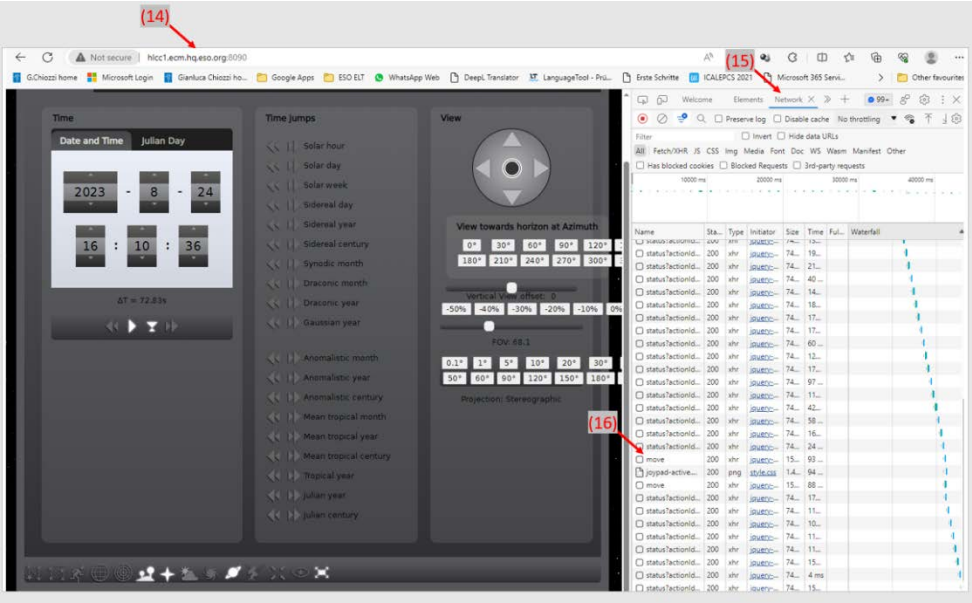
ToDo: *notice that for the time being location coordinates need to be set every time the application is started, since stellarium cannot set a default position to locations not contained in the database of named locations.*

10.4 Learning and debugging

A very good way to learn the Stellarium Remote Control API and to debug it, is

- open the Remote Cntrol Web API, accessible on port 8090 on the host where Stellarium is running with the web browser (here below the commands with Edge, other browsers have similar options)(14)
- right click and select "inspect" to open the debugger
- select network (15)

- watch header and payload: (16)



10.5 To know more

Here some llinks to know more about Stellarium,application, scripting and rest API:

- Stellarium Astronomy Software home page
- Stellarium/stellarium: Stellarium sources (github.com)
- Scripting Stellarium – planetmaker.de
- How to use Stellarium's Oculars plugin to match your optics (howtoforge.com)
- AstroQuest1: How I Set Up a Custom Landscape in Stellarium & Why!
- Stellarium: RemoteControl plugin HTTP API description
- Stellarium: StelMainScriptAPI Class Reference