CTAO
Cherenkov Telescope Array Observatory

Array Control

CTAO summer school 2024 – La Palma

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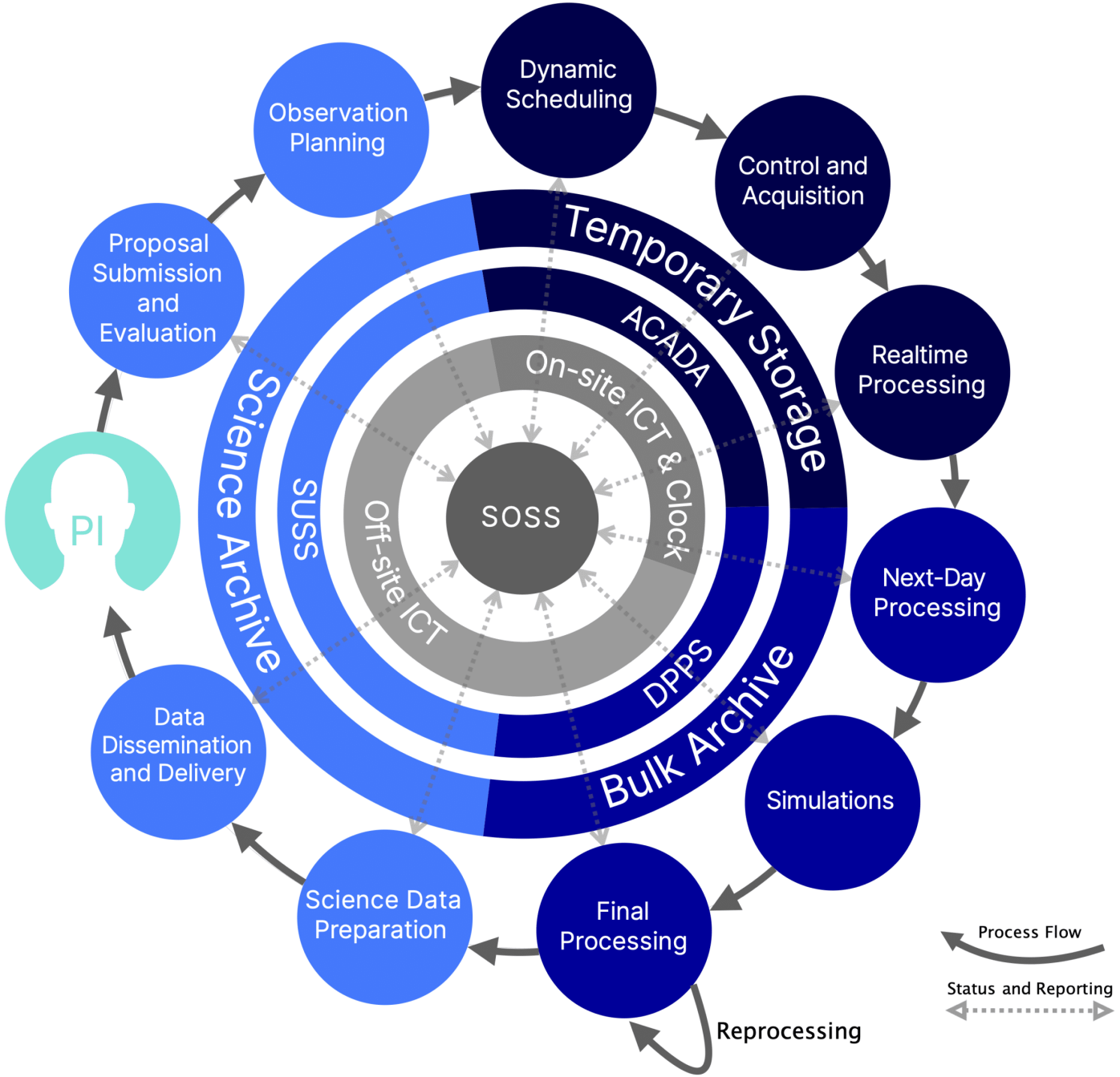
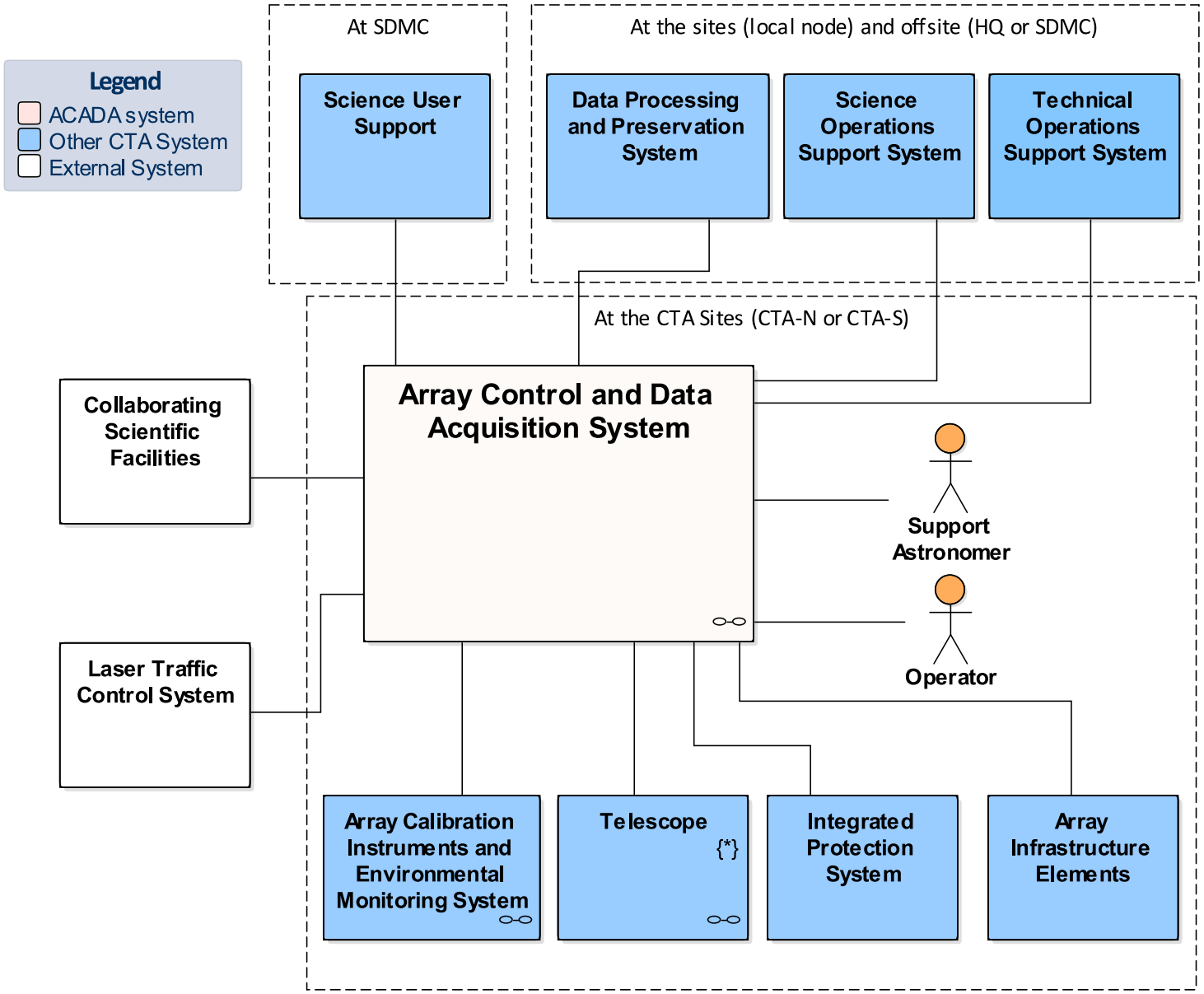
1 ACADA in CTAO

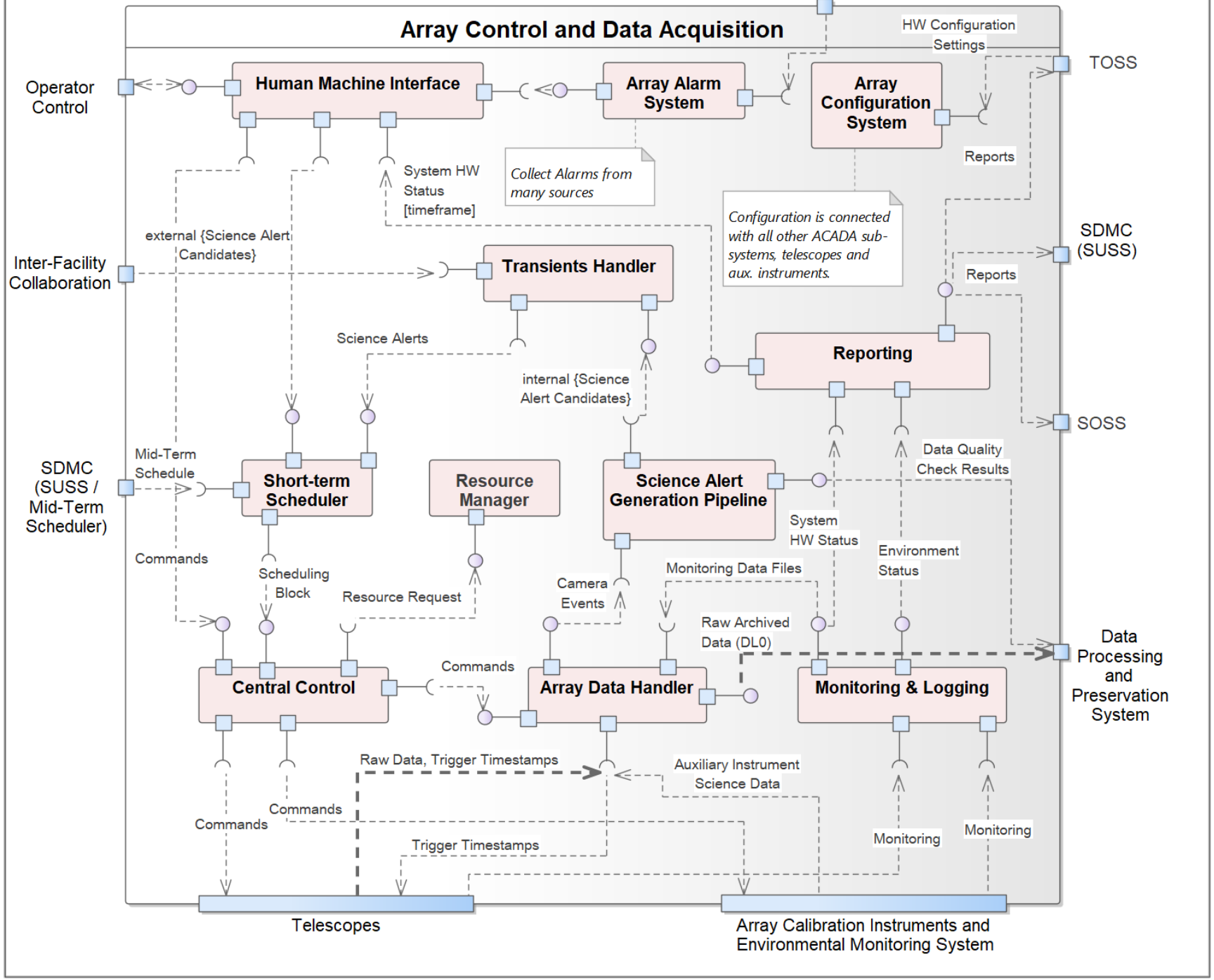

Observation Planning
Dynamic Scheduling
Control and Acquisition
Realtime Processing
Next-Day Processing
Simulations
Final Processing
Science Data Preparation
Data Dissemination and Delivery
Proposal Submission and Evaluation
PI
Temporary Storage
ACADA
On-site ICT & Clock
SOSS
Off-site ICT
SUSS
Science Archive
DPPS
Bulk Archive
Reprocessing
Process Flow
Status and Reporting



ACADA is the Supervisory Control and Data Acquisition (SCADA) system of the scientific instrumentation at each CTAO array site, including Telescopes, Array Calibration, and Environmental Monitoring devices.

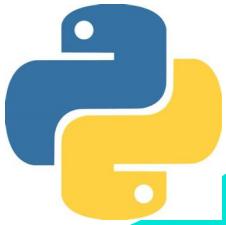
- Highly reliable & Fault tolerant
-

2 Parts of ACADA


Array Control and Data Acquisition
HW Configuration Settings
TOSS
Operator Control
Human Machine Interface
Array Alarm System
Array Configuration System
Reports
System HW Status [timeframe]
Collect Alarms from many sources
Configuration is connected with all other ACADA sub-systems, telescopes and aux. instruments.
external {Science Alert Candidates}
Inter-Facility Collaboration
Transients Handler
SDMC (SUSS)
Reports
Science Alerts
Reporting
internal {Science Alert Candidates}
SOSS
Mid-Term Schedule
SDMC (SUSS / Mid-Term Scheduler)
Short-term Scheduler
Resource Manager
Science Alert Generation Pipeline
Data Quality Check Results
System HW Status
Environment Status
Commands
Scheduling Block
Resource Request
Camera Events
Monitoring Data Files
Raw Archived Data (DL0)
Data Processing and Preservation System
Central Control
Commands
Array Data Handler
Monitoring & Logging
Raw Data, Trigger Timestamps
Auxiliary Instrument Science Data
Commands
Commands
Trigger Timestamps
Monitoring
Monitoring
Telescopes
Array Calibration Instruments and Environmental Monitoring System

Array Configuration (CDB)

- stores and distributes the configurations of
  - ACADA system
  - Telescopes
  - Calibration Systems
  - including the software deployment configuration



Resource Manager

responsible for supervision of all other systems of ACADA, and any external system under its supervision such as the Telescope Control Systems, as well as for coordinating the allocation of telescopes to sub-arrays.

- Incl. Supervision Tree Support Libraries

Central Control

- responsible for the execution of the scheduling blocks (SB) provided by the short-term scheduler (STS) by sending corresponding commands to the telescopes and other controllable array elements, while supervising the ongoing operations, and overseeing the Array Data Handler.
- Incl. Obs. Script Sequencer

Short Term Scheduler

- decides, in real-time, how to group and use the Telescopes of CTAO to perform nightly operations
- based on a Mid-Term Schedule
- reacts in real time to changing environmental conditions
- Reacts to and to science alert observation requests by the Transients Handler.
- Includes functionalities for short-term planning, lidar coordination with other scientific installations near the CTA array sites, and the coordination of observations between both CTA array sites and with other scientific installations.

Transients Handler

- Manages internal and external transient science alert candidates by filtering, processing, and ranking them, submitting Scheduling Blocks to the Short-Term Scheduler, and requesting immediate reaction if needed.

Science Alert Generation

The analysis pipeline running online that performs a quick look analysis of the acquired data and produces data quality indicators, which are exposed to the support astronomer at the control room and transferred to the DPPS.

- generates internal candidate scientific alerts → TH.
- science monitoring (sky maps & light curves) for the Support Astronomer.

Array Data Handler

- Provides Software Array Trigger (SWAT)
- Handles raw data from the array instrumentation
- Includes components to handle the Cherenkov cameras data and to reduce the received volume of data
- Handles acquired data by Auxiliary Instrumentation onboard telescopes, as well as for the Array Calibration and Environmental Monitoring System devices
- Provides local temporary storage of data until the on-site DPPS system receives that data

Monitoring & Logging

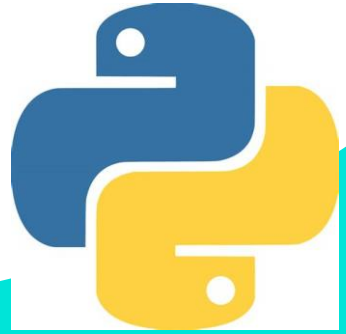
- Components providing services for monitoring data items from the Telescopes and other devices deployed at the CTA array sites and making those data immediately available for the operator interface and for quick-look quality checks, as well as to store them for later detailed inspection.
- Includes the production of the software for the Monitoring System (incl. Repository) Logging System (incl. Repository) and Logs Analyzer

Array Alarm System

- gathers, filters, exposes, and persists all the relevant alarms raised
  - ACADA processes,
  - Telescopes,
  - and auxiliary instrumentation under the supervision of the ACADA system.
- creates new alarms based on the analysis and correlation of the system software logs and the status of the hardware systems and provides mechanisms for alarm filtering.
- → Operator via HMI

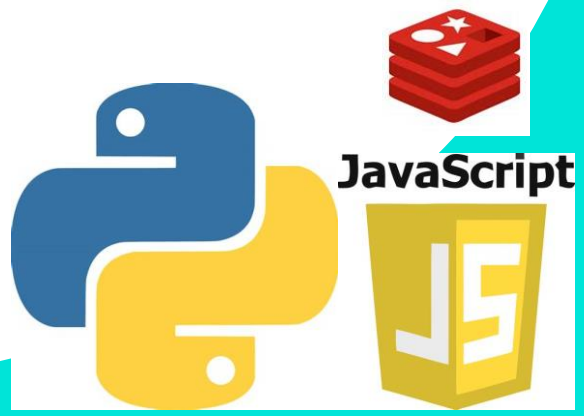
Reporting

- Responsible for gathering the relevant data from the other ACADA sub-systems in order to produce status and quality reports of the ACADA operations for the HMI and for other systems outside the ACADA.
- Includes the software for the reporting of the HW status, environment status, and the status of the observed data.
- Operator logbook.

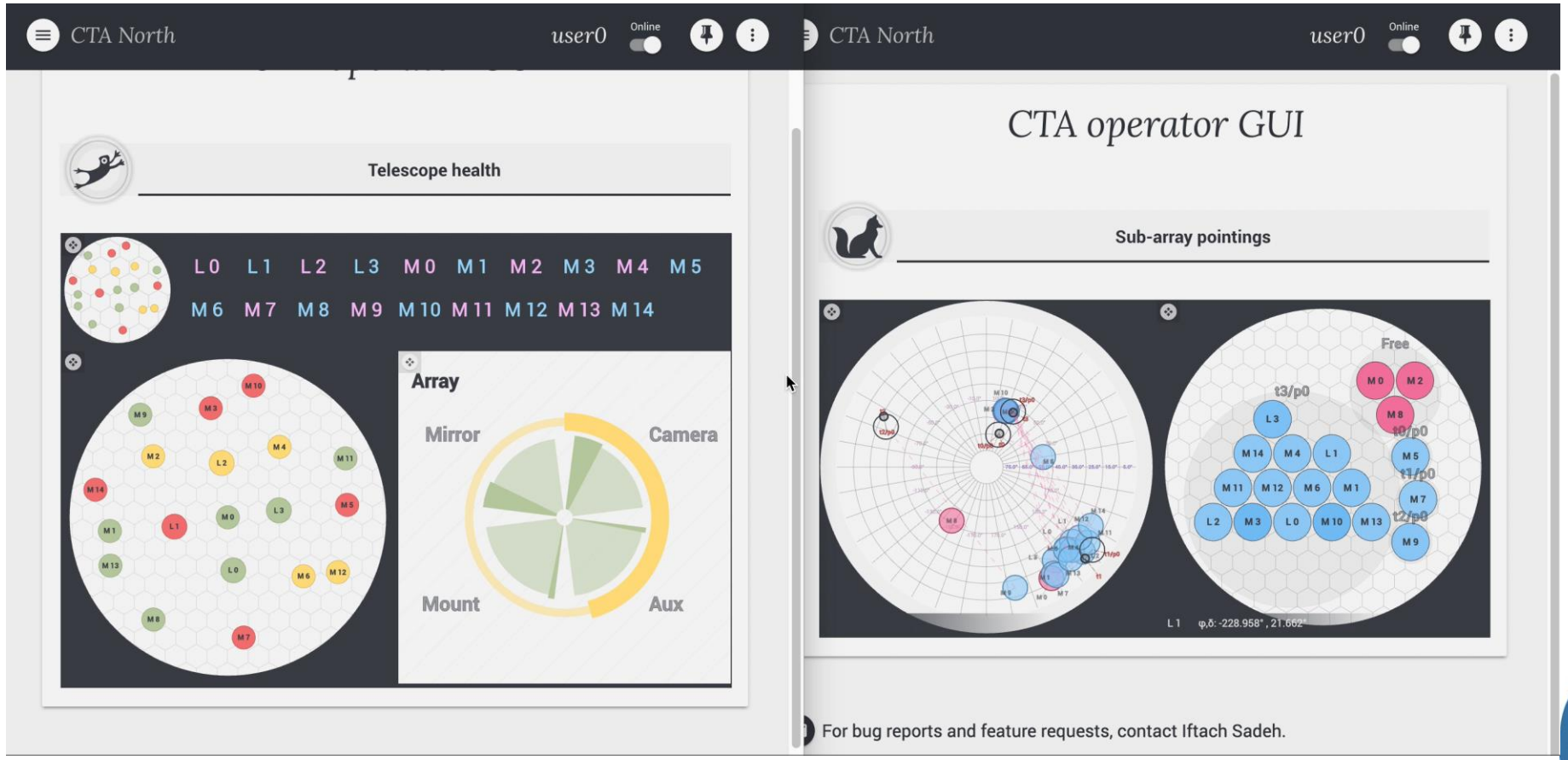


Human Machine Interface

- Comprehensive view of the status of the observations to the Operators and Support Astronomer located in the control room of the CTA installation, providing means to interact with the array elements.
- Creation of Scheduling Blocks
- Overview of ongoing & planned Observations

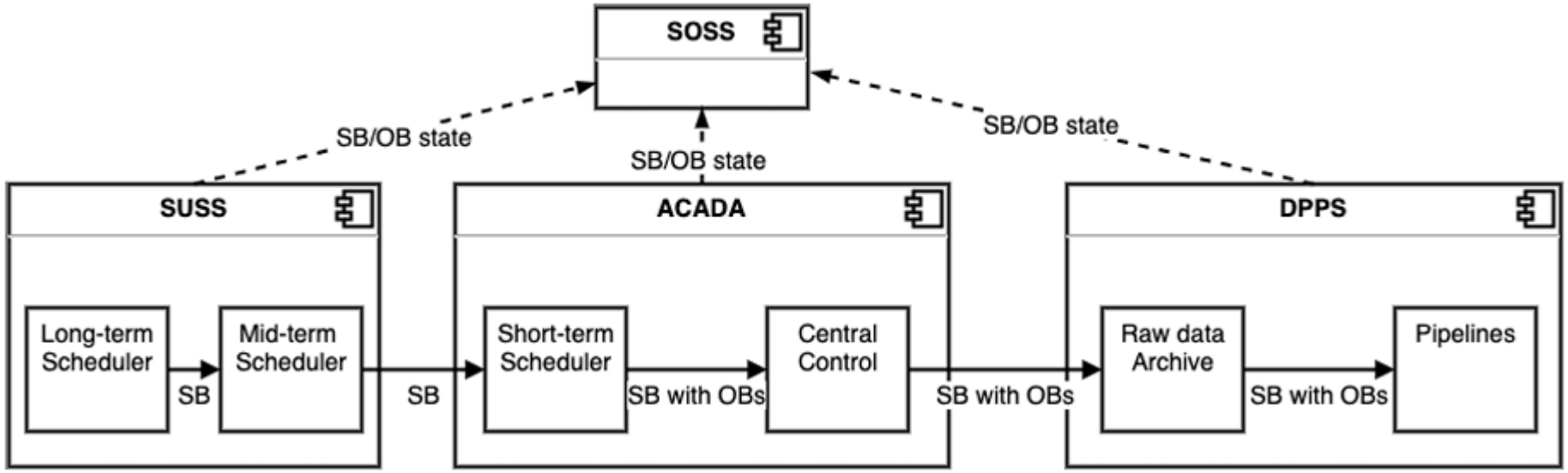


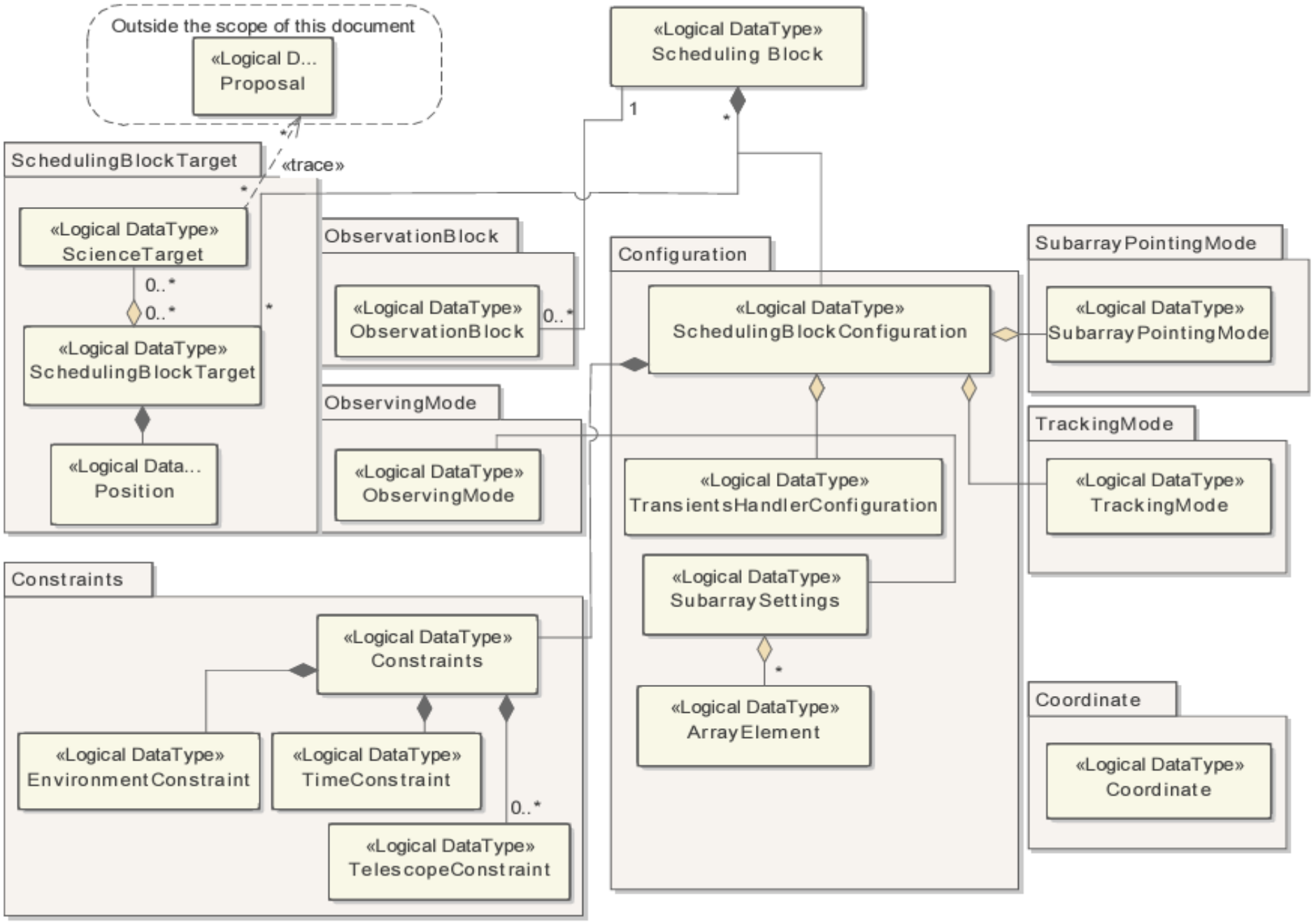
Human Machine Interface



3 Concepts

Scheduling Blocks




Outside the scope of this document
«Logical D...
Proposal
«Logical DataType»
Scheduling Block
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*
«trace»
SchedulingBlockTarget
*
«Logical DataType»
ScienceTarget
0..*
0..*
«Logical DataType»
SchedulingBlockTarget
«Logical Data...
Position
*
ObservationBlock
«Logical DataType»
ObservationBlock
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ObservingMode
«Logical DataType»
ObservingMode
Configuration
«Logical DataType»
SchedulingBlockConfiguration
«Logical DataType»
TransientsHandlerConfiguration
«Logical DataType»
SubarraySettings
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«Logical DataType»
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SubarrayPointingMode
«Logical DataType»
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TrackingMode
«Logical DataType»
TrackingMode
Coordinate
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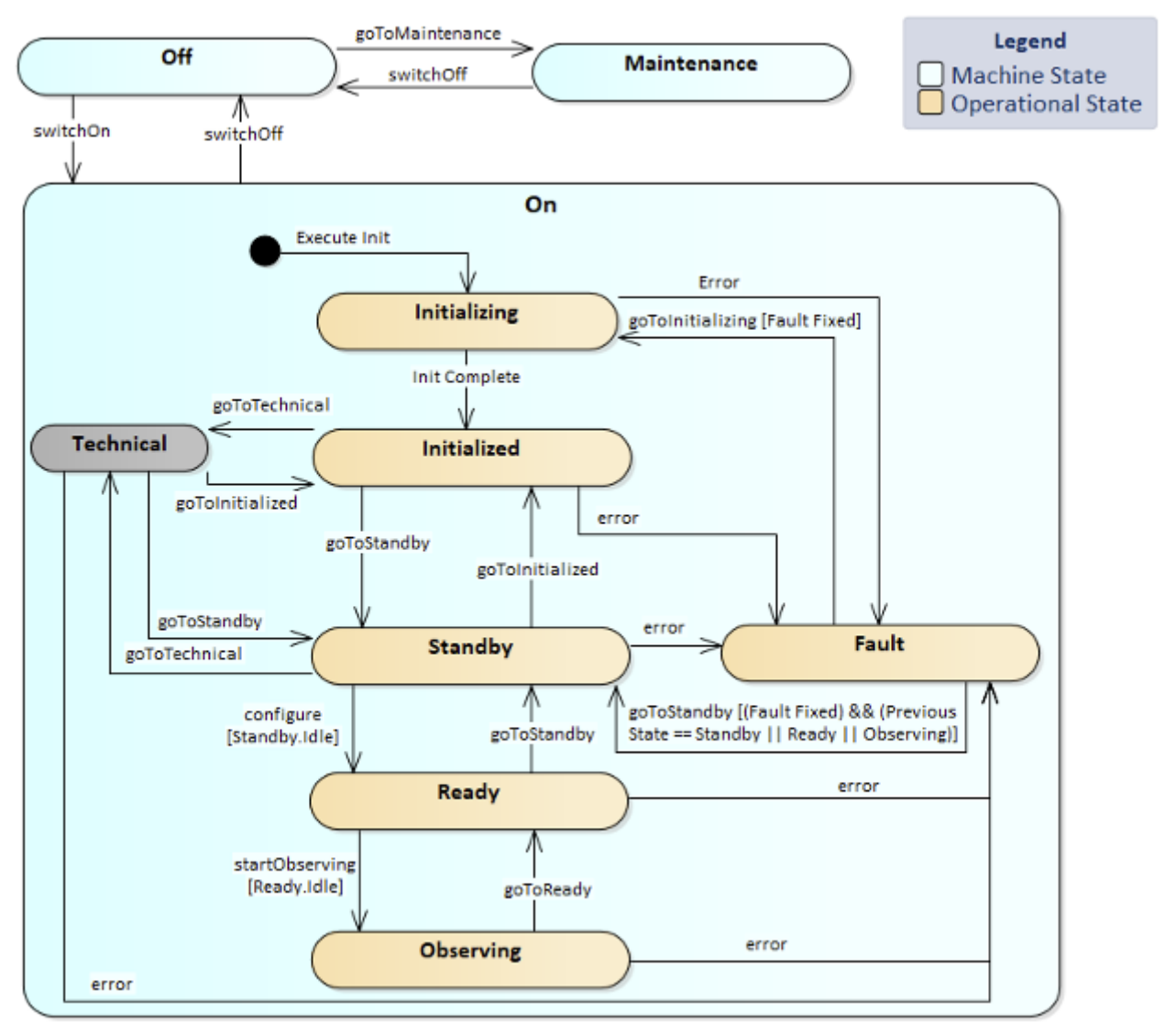
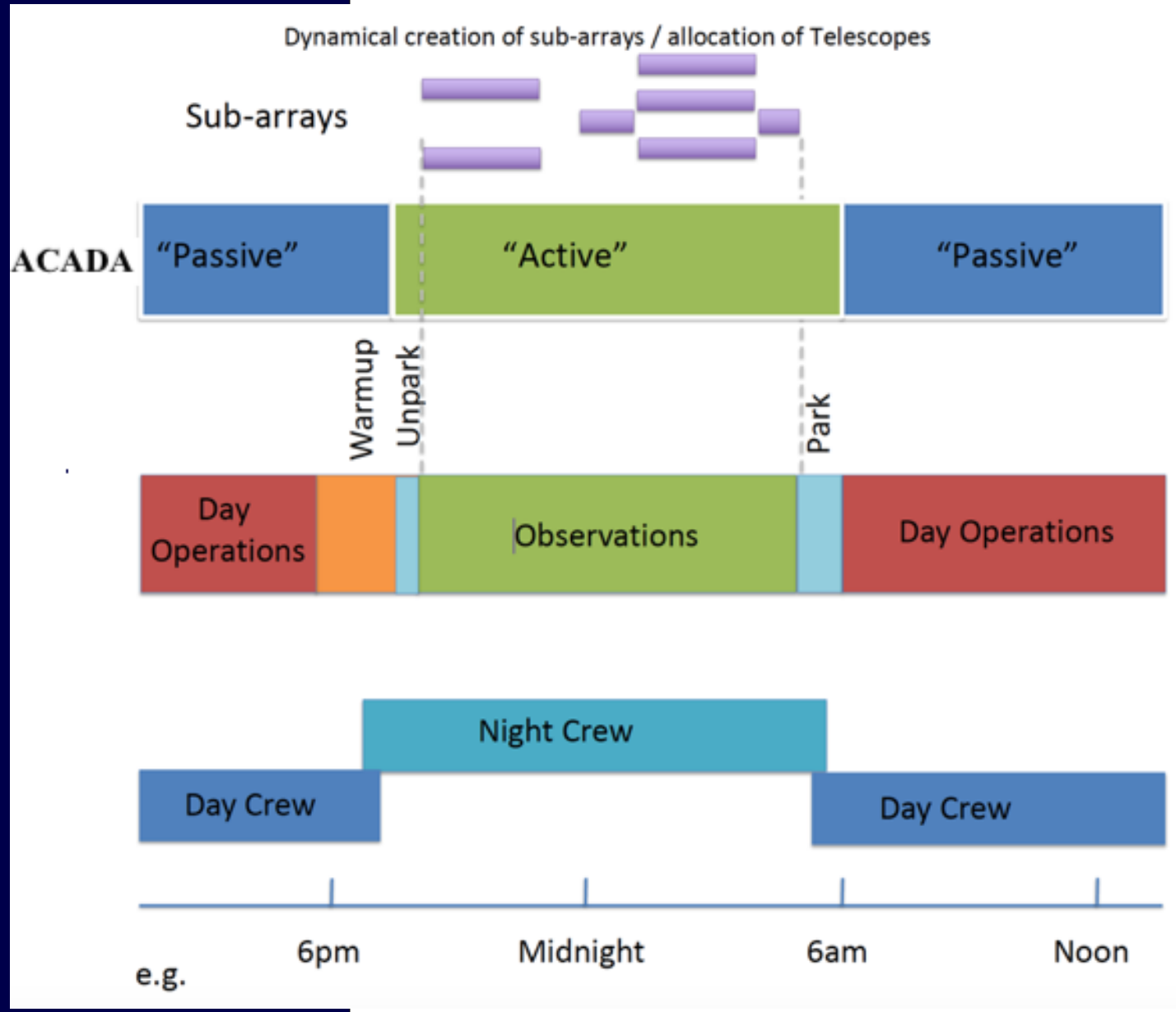
Coordinate
Constraints
«Logical DataType»
Constraints
«Logical DataType»
EnvironmentConstraint
«Logical DataType»
TimeConstraint
0..*
«Logical DataType»
TelescopeConstraint

Array Element FSM



- Initialized: Safe & Monitored
- Standby: still safe, all components activated. Structure: all internal systems on & unparked.
- Ready: prepared for a rapid transition to the Observing State. Internal calibration activities may take place.

Operation Modes



4 Middleware - ACS

ALMA Common Software

- documented collection of common patterns in and of components, which implement those patterns.
- based on a distributed component model
- ACS components implemented as CORBA objects in any of the supported programming languages.
- provides common CORBA-based services such as logging, error and alarm management, configuration database and lifecycle management.

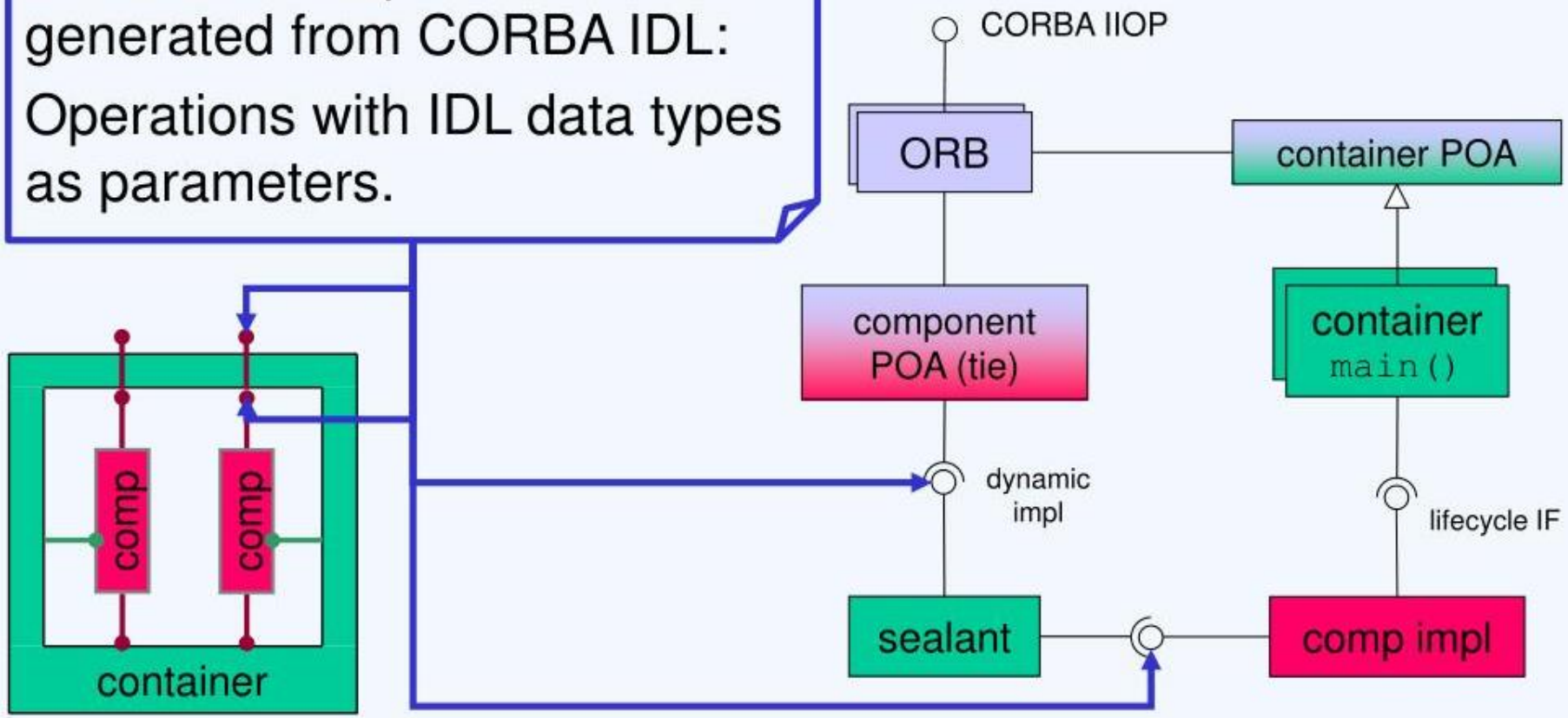
ALMA ACS Documentation Confluence

ACS git repo

Container / CORBA

functional component interface generated from CORBA IDL:

Operations with IDL data types as parameters.

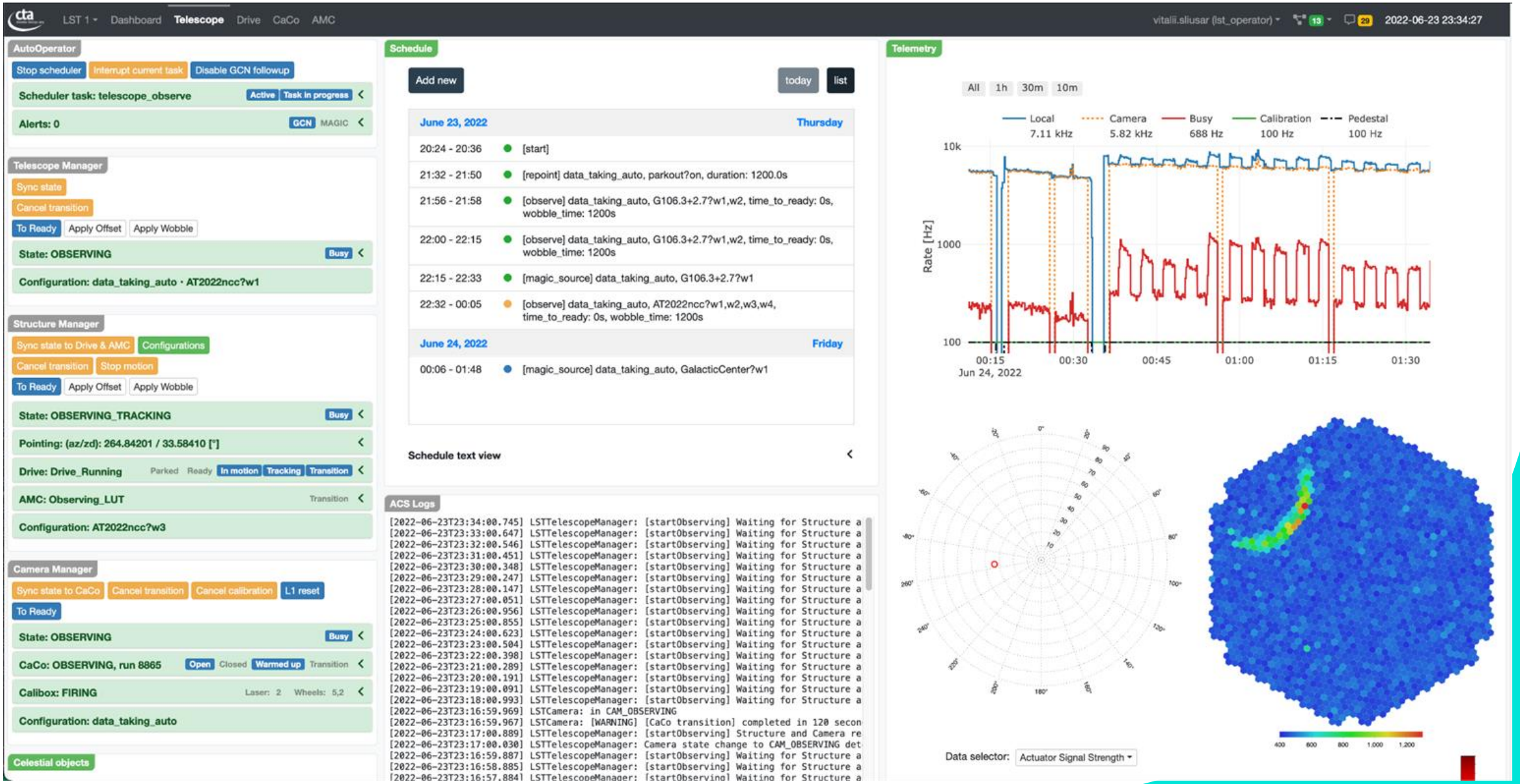


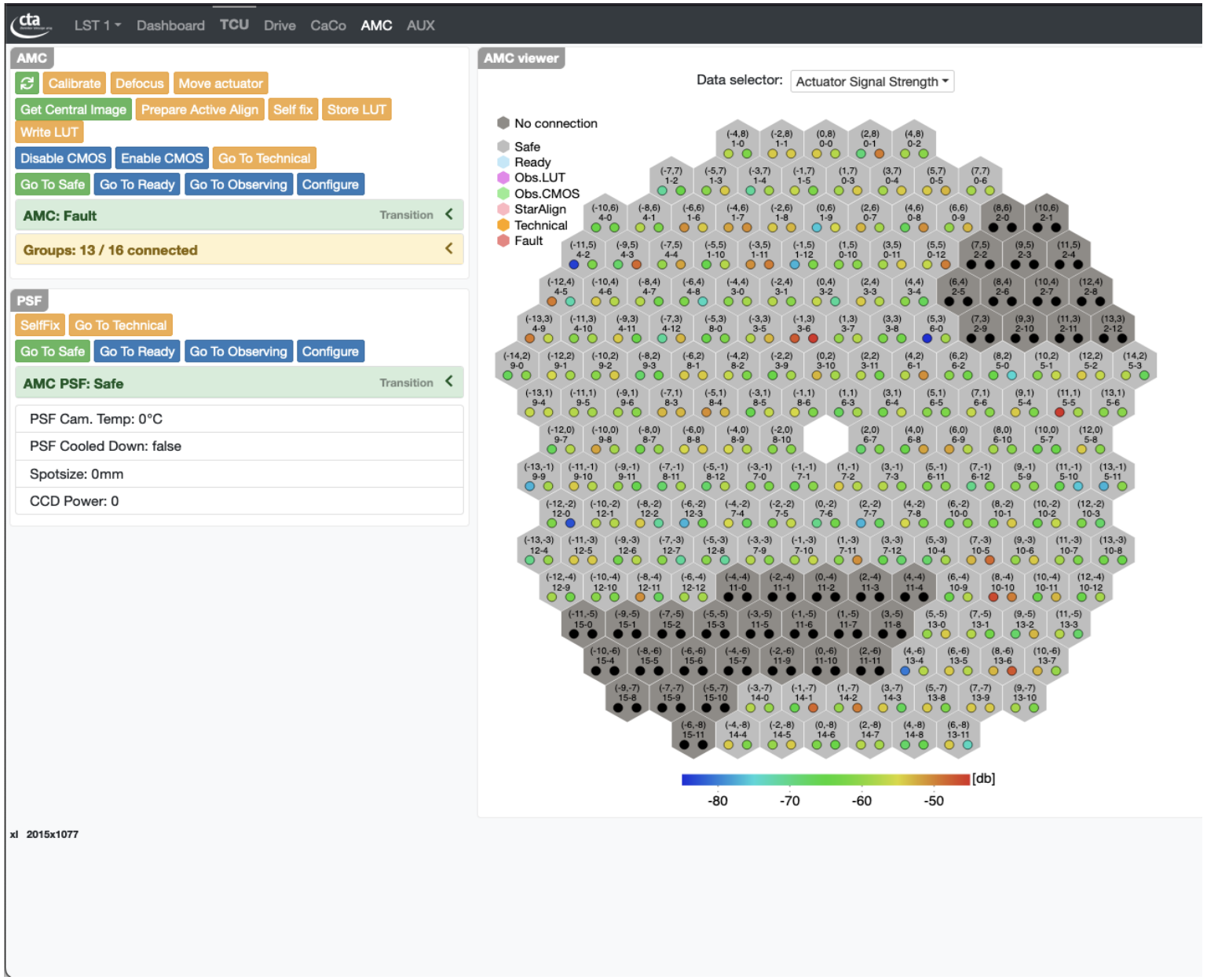
OMG IDL

- IDL is a declarative language for defining the interaces of CORBA objects
- IDL is language independent
- ILD is used by ORB-specific IDL compilers to generate stubs, seltons and interface code in a given programming language in compliance with the IDL mapping specification for that programming language.

5 LST1 Control

Example for tonight




cta
LST 1
Dashboard
TCU
Drive
CaCo
AMC
AUX
AMC
Calibrate
Defocus
Move actuator
Get Central Image
Prepare Active Align
Self fix
Store LUT
Write LUT
Disable CMOS
Enable CMOS
Go To Technical
Go To Safe
Go To Ready
Go To Observing
Configure
AMC: Fault
Transition
Groups: 13 / 16 connected
PSF
SelfFix
Go To Technical
Go To Safe
Go To Ready
Go To Observing
Configure
AMC PSF: Safe
Transition
PSF Cam. Temp: 0°C
PSF Cooled Down: false
Spotsize: 0mm
CCD Power: 0
AMC viewer
Data selector:
Actuator Signal Strength
No connection
Safe
Ready
Obs.LUT
Obs.CMOS
StarAlign
Technical
Fault
[db]
-80
-70
-60
-50
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6
Quo Vadis ACADA?

ACADA Release Schedule

REL0: 16.06.21
- **Mini-ACADA**
  - Put existing disperse ACADA prototypes into a SW structure and official code repository.
  - Start to use the ACADA workflows and the environment for continuous integration and QA.

✓

REL1: 28.7.23
- **LST1-ACADA**
  - Operate the LSTN-01 in a semi-autonomous way.

✓

REL1.5: Q1 24
- Operate one FRAM
- Incorporate ACADA Configuration System

← We are here

REL2: Q1 25
- **4xLST-ACADA**
  - Operate four LSTs.
  - Operate one ~~LIDAR~~ → Iluminator
  - Operate in more autonomous way. / Deployment of ACADA Alarm System.

REL3: Q2 25
- **4xLST+1xMST–ACADA**
  - Operate four LSTs and one MSTs, 2 sub-arrays.
  - Operate in more autonomous way.
  - On-line scheduling.

LIDAR

REL4: Q4 25
- **Full CTA-N Phase-1 ACADA**
  - Support fully deployed Phase 1 CTAO-N.
  - Operate in more autonomous way.

REL5: Q2 26
- **Early CTA-S ACADA**
  - Support earlier stages of CTAO-S operations incl. the operation of up to 10 SSTs and 4 MSTs, 4 sub-arrays.
  - Automatic mitigation of big problems.

REL6: Q4 26
- **Phase-1 CTA-S ACADA**
  - Operate up to 37 SSTs and 14 MSTs.
  - Operate in a very autonomous way.

REL7: Q2 27
- **Fully-Capable ACADA**
  - Support of full array element for CTAO phase 1, 8 sub-arrays.
  - Full support of all science cases.
  - Inter-site communications.

Doc: CTA-PLA-ACA-303000-0005 2b ACADA Release Schedule

Thank you & Stay Tuned!