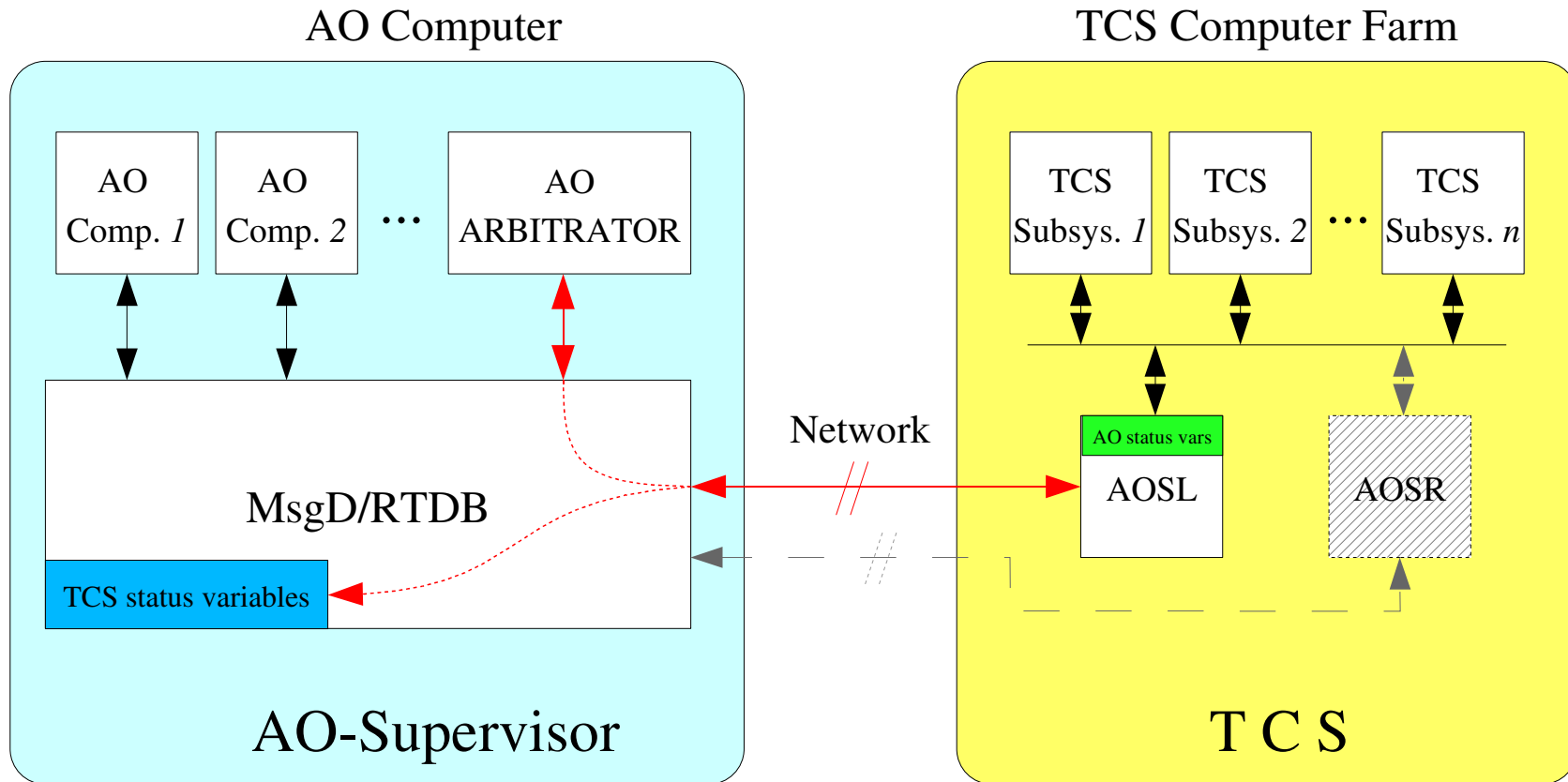

AOS Functions

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AOS Architecture



AOS main tasks

- Accept commands from TCS subsystems and convert them into commands for the AO supervisor
- Accept commands from the AO supervisor and convert into commands for other TCS subsystems
- Reflect a subset of AO supervisor status variables into TCS Data Dictionary
- Reflect a subset of TCS status into AO supervisor RTDB

AO Supervisor Service States

- **STANDALONE**
 - The AO is operational but doesn't allow interaction with the TCS.
- **ENGINEERING**
 - The AO is performing calibration or maintenance functions and requires service from the telescope.
 - The AO operates much like an instrument
- **READY**
 - The AO is waiting for, either:
 - The TCS sends a request to proceed to OBSERVATION status
 - The operator at the AO console sets status to ENGINEERING or STANDALONE
- **OBSERVATION**
 - The AO is supporting an observation

ENGINEERING vs. OBSERVATION

- ENGINEERING service status
 - The AO system is performing maintenance or calibration tasks
 - The AO supervisor is in *master mode*
 - ➔ Interaction is initiated by supervisor
 - ➔ TCS may asynchronously send a limited number of requests to Supervisor
 - The AO supervisor will register with the telescope much like an instrument

- OBSERVATION service status
 - The AO is supporting an observation
 - The AO supervisor is in *slave mode*
 - ➔ Interaction is initiated by TCS (i.e.: by the instrument SW through IIF call)
 - ➔ AO supervisor may asynchronously send a limited number of requests to TCS

OBSERVATION *Operating Modes*

- FIX-AO
 - Seeing limited mode: the Adaptive Secondary holds a “flat” shape.
 - Various different “flats” may be selected
- TTM-AO
 - Tip-Tilt Mode. When only first order corrections are provided
- ACE-AO.
 - Auto Configured Adaptive Optics Mode. The AO operates in full corrected mode with automatic optimal selection of loop parameters
- ICE-AO
 - Interactively Configured Adaptive Optics Mode. The AO operates in full corrected mode and the observer may adjust (a subset of) AO loop parameters

- Availability
 - **READY status**
- Description
 - **Requests the AO supervisor to step from READY to OBSERVATION status**
- Parameters
 - **None**
- Actions
 - **AOS sends the request to AO-Sup and waits for acknowledge.**
 - **AO-Sup performs the needed steps (e.g.: modifies the behaviour of engineering GUI at AO Console) and sends the acknowledge**

- Availability
 - OBSERVATION status
- Description
 - Request to prepare for the FIX-AO mode of observation
- Parameters
 - Name of the specific flat vector (from a list of predefined vectors)
- Actions
 - AOS sends the request to the AO supervisor and waits for acknowledge.
 - The supervisor applies the shape and returns an acknowledge

- Availability
 - OBSERVATION status
- Description
 - Request to prepare for one of the adaptive modes of observation (TTM-AO, ACE-AO, ICE-AO)
- Parameters
 - AO mode, WFS source, Sc.Obj. Coords, Ref.Obj. Coords,
- Actions
 - AOS sends the request to the AO supervisor and waits for acknowledge.
 - The supervisor performs all operations needed to be ready to acquire the reference source, then sends an acknowledge and waits for a subsequent AcquireRefAO command.

Note: presetting for reference acquisition can be done while the telescope is slewing to pointing position.

- Availability
 - **OBSERVATION** status
- Description
 - Request to point and acquire the reference source
- Actions
 - AOS sends the request to AO-Sup and waits for acknowledge.
 - AO-Sup points the reference source and computes data needed for loop optimization. Then adjusts optics accordingly.
 - AO-Sup sends back an acknowledge together with loop characterization data (e.g.: number of corrected modes, CCD parameters, R0, ...)
 - AO-Sup waits for a command (either: RefineAO or StartAO)

- Availability
 - OBSERVATION status
- Description
 - Request to perform loop optimization
- Parameters
 - AO loop parameters to be modified
- Actions
 - AOS sends the request to AO-Sup and waits for acknowledge.
 - AO-Sup sets the new values and adjusts optics accordingly.
 - AO-Sup sends back an acknowledge together with loop characterization data
 - AO-Sup waits for a command (either: RefineAO or StartAO)

- Availability
 - OBSERVATION status
- Description
 - Request to close the AO loop
- Actions
 - AOS sends the request to AO-Sup and waits for acknowledge.
 - AO-Sup closes the loop and sends back an acknowledge.

- Availability
 - OBSERVATION status
- Description
 - Request to offset the pointing of the reference source (e.g.: by moving the WFS stages)
 - This will result in an offset of the scientific camera field
- Parameters
 - Offset amount
 -
- Actions
 - AOS sends the request to AO-sup and waits for acknowledge.
 - AO-Sup adjusts pointing and sends back an acknowledge.

- Availability
 - **OBSERVATION** status
- Description
 - Request to apply a modal correction to the mirror shape (e.g.: to make active optics corrections in seeing limited mode, or to correct non-common path aberrations in AO mode)
- Parameters
 - A vector of Δ values
- Actions
 - AOS sends the request to the AO supervisor.
 - No reply is expected (errors are managed via the default error notification mechanism)

- Availability
 - OBSERVATION status
- Description
 - Request to stop the current operation
- Parameters
 - Reason for stop request
- Actions
 - AOS sends the request to AO-sup and waits for acknowledge.
 - AO-Sup performs the requested operations (e.g.: opens the AO loop) end sends an acknowledge.
 - In order to resume operations after stop a new PresetAO command must be used

- Availability
 - OBSERVATION status
- Description
 - Request to temporarily suspend current operation
- Actions
 - AOS sends the request to the AO supervisor and waits for acknowledge.
 - AO-Sup performs the requested operations (e.g.: opens the AO loop) end sends an acknowledge.
 - AO-Sup waits for a subsequent command (usually Resume)

- Availability
 - OBSERVATION status
- Description
 - Request to resume a suspended operation
- Actions
 - AOS sends the request to the AO supervisor and waits for acknowledge.
 - AO-Sup resumes the operations (e.g.: closes the AO loop) and sends an acknowledge.

- Availability
 - OBSERVATION status
- Description
 - Request to terminate observation
- Actions
 - AOS sends the request to the AO supervisor and waits for acknowledge.
 - AO-Sup will properly put all device into safe conditions and go back to READY service status.

Note: the final shutdown of AO hardware and software, and maybe of the AO Workstation, will then be performed by an operator at the AO console.

- Availability
 - OBSERVATION, ENGINEERING, READY
- Description
 - Emergency shutdown request
- Parameters
 - Reason for Panic
- Actions
 - AOS sends the request to the AO supervisor and closes the connection with AO-Sup
 - AO-Sup will do its best to shutdown as soon as possible.

Notes:

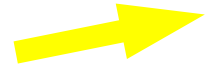
- After UserPanic the connection will be closed and no further interaction will be possible. As a consequence the command is not interruptible.
- Recovering from the shutdown will require an operator at the AO console to follow a proper procedure

- Availability
 - ENGINEERING
- Description
 - Notifies that the AO system wants to start engineering operations which need services from the telescope
 - Functionally equivalent to a call to an IIF Register call (but concurrent registration of an instrument should be possible)
- Actions
 - AO-Sup sends the request to AOS and waits for acknowledge
 - AOS will check telescope availability and allow (or reject) registration
 - AOS will reply with proper acknowledge

- Availability
 - ENGINEERING
- Description
 - Notifies that the AO system has finished with engineering operation and want to release telescope resources.
- Actions
 - AO-Sup sends the request to AOS and waits for acknowledge
 - AOS will unregister and acknowledge.

- Availability
 - ENGINEERING, OBSERVATION
- Description
 - Request to log some piece of information into the TCS Logging System.
 - AO-Sup is provided with own logging system for debugging and troubleshooting tasks. A selected subset of the AO telemetry data will be stored in the TCS telemetry subsystem in order to keep historical data
- Parameters
 - String to be logged
- Actions
 - AOS forwards the data to the log facility.

- Availability
 - ENGINEERING
- Description
 - Request to stop current operation.
- Actions
 - AO-Sup sends the request to AOS and wait for acknowledge
 - AOS will perform the required operations.



- Availability
 - ENGINEERING, OBSERVATION
- Description
 - Used to notify that AO-Sup has detected some condition which should be properly managed
- Parameters
 - Warning specification
- Actions
 - In ENGINEERING mode AOS will simply update the related DD variables
 - In OBSERVATION mode it will also fire an event so that proper management may be performed.

- Example

- A **Warning** message is used to manage offloading of accumulated modal errors:
 - AO-Sup keeps updated a vector of variables indicating current modal error
 - A warning command is a suggestion to TCS that accumulated error must be corrected (e.g.: by moving the hexapod)
 - The AOS, when receiving the `warning` message will simply fire a specific event.
 - It is responsibility of some TCS subsystem or, possibly, of the instrument software, to catch the event and take proper measures.
 - A properly behaved instrument may avoid to reach the `warning` condition by polling the related DD variables and correct accumulated errors in advance.

Note: upon receiving a warning message TCS has full responsibility on how to manage it. It may also ignore it, but this will soon cause an `Error` message from AO-Sup

- Availability
 - ENGINEERING, OBSERVATION
- Description
 - Notifies that AO-Sup has detected some error condition and has stopped the current operation.
 - This may happen when a previous warning has not been managed.
- Parameters
 - Error specification
- Actions
 - In ENGINEERING mode AOS will update the related DD variables
 - In OBSERVATION mode it will also notify the operator at the telescope console

- Availability
 - ENGINEERING, OBSERVATION
- Description
 - Used to notify that AO-Sup has detected some severe error condition and has initiated a complete shutdown
- Parameters
 - Specification
- Actions
 - AO-Sup sends the command to AOS, sets the service status to STANDALONE and sets the hardware in safe conditions.
 - AOS will stop any current operation and notify properly.

- Availability
 - ENGINEERING
- Description
 - Request to set telescope position
- Parameters
 - AltAz coordinates
- Actions
 - AO-Sup sends the command to AOS.
 - AOS issues proper commands to the MCS.

Note: the telescope position and status variables are continuously updated by AOS

- Availability
 - ENGINEERING
- Description
 - Request to set hexapod position
- Parameters
 - Hexapod coordinates (and reference system)
- Actions
 - AOS issues proper commands to the OSS

Note: the hexapode position and status variables are continuously updated by AOS

- Availability
 - ENGINEERING
- Description
 - Request to set rotator angle
- Parameters
 - Rotator angle
- Actions
 - AOS issues proper commands to the OSS.

Note: the rotator angle and status variables are continuously updated by AOS

- Availability
 - ENGINEERING
- Description
 - Request to set tertiary mirror position
- Parameters
 - Tertiary coordinates
- Actions
 - AOS issues proper commands to the OSS.

Note: the tertiary position and status variables are continuously updated by AOS

- Availability
 - ENGINEERING
- Description
 - Request to activate the telescope preset GUI
 - Used to select a reference star to perform calibration
- Parameters
 - Telescope preset information
- Actions
 - AOS activates the preset GUI and waits for acknowledge.
 - AOS returns `PresetAO` data to allow AO-Sup to acquire the reference star

- Availability
 - ENGINEERING
 -
- Description
 - Request to point the telescope to a given sky position and start tracking
- Parameters
 - Sky coordinates
- Actions
 - AO-Sup sends the command to AOS and waits for acknowledge.
 - AOS issues the request to point the telescope, waits for completion and sends the acknowledge.

- Availability
 - ENGINEERING
- Description
 - Request to offset telescope pointing position
- Parameters
 - Δ Sky coordinates
- Actions
 - AO-Sup sends the command to AOS and waits for acknowledge.
 - AOS perform the request to pointing system, waits for completion and sends the acknowledge.

- Availability
 - ENGINEERING
- Description
 - Request to offload modal errors
- Parameters
 - Modal error vector
- Actions
 - AO-Sup sends the command to AOS.

Variables: TCS status reflected in RTDB

- AOSVersion
 - String specifying version of AOS
- TelStatus
 - Block of data representing current telescope status
- TelPointingEqu
 - Current pointing equatorial coord. (both “target” and “achieved” values)
- TelPointingAlt
 - Current pointing alt-azimuth coordinates
- HexapodPos
 - Current hexapod position
- RotatorPos
 - Current rotator position
- TertiaryPos
 - Current tertiary position
- Environment
 - Environment and weather information (temperature, pressure, humidity, etc.)

Variables: AO-Sup status reflected in TCS-DD

- AOVersion
 - String specifying version of AO-Sup
- AOServStat
 - AO service status
- AOStatus
 - Current AO system operating status (FIX-AO, TTM-AO, ACE-AO, ICE-AO)
- ImageQuality
 - Current image quality parameters
- OffModes
 - Current modal error vector
- OffFlags
 - Current modal vector flags (indicate modal error components which are approaching limit conditions)