ARTN Modular View

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**ARTN Modular Topography Evaluation Format:**

* Module purpose, what it does
* Event sequence - steps taken to implement process
* Current ARTN status and evaluation
* What is still needed to make this happen?
  + computer/hardware/software/engineering/designing/wish list
* Categorize action items
* Prioritize action items

**ARTN System Operating Modes**

* System can be run in two modes
  + Computer controlled, fully automated
    - The ultimate goal (assumption)
    - Taking steps to achieve this goal
  + Human controlled, partially automated
    - Current state
    - Human doing some of the processes at the telescope
    - Ongoing implementation towards full automation

**ARTN Modular Topography:**

*Safety Module Start Up*

* First module to start
* Event Sequence
  + Safety computer started remotely

*Safety Module*

* If safety does not get good feedback from any module then entire system is not allowed to continue remote operation
* Constantly monitoring all variables needed for safe operation
* Safety parameters monitored
  + Weather limits
  + Safety interlocks
  + Instrument warnings
    - Temperature monitoring
* Interacts with all other modules
* Interrupts other modules when limits exceeded
* Smart design implements corrective action linked to the limit exceeded
  + Examples
    - Dome door opened
      * Telescope tracking and auto dome stopped
    - Lightning is within XXX distance
      * Normal shutdown sequence followed by lightning shutdown sequence
* Ability to override all other modules
* Action Items
  + Need official weather station
    - Monitoring scripts linked to automated hardware
      * Wind speed
      * Humidity
      * Lightning
      * Precipitation
      * Particulates in air
        + Dust
        + Smoke
  + Elevator down interlock
  + Door to dome interlock
  + Door to catwalk interlock
  + Overhead crane in dome interlock
  + Dome shutter interlock
  + Dome rotation interlock

*Lightning Start Up Module*

* All safety parameters met, monitoring in progress - see safety module
* Brings site out of LS
* Sequence started once safety module deems all clear to start
* No electrical activity within XXX miles
* Action Items
  + Need professional assessment of vulnerabilities to lightning
  + Need Observatory agreement on what we can and cannot spare to loose
  + Need electrical engineering plan to implement first two points above
  + Installation of remotely activated disconnects
    - Breakers
    - Knife switches
    - Other

*Power Up Module*

* Safety monitoring in progress – see safety module
* Brings up all power needed for remotely operating telescope and instrumentation
* Brings up all computers needed for telescope and instrument operations
* Event sequence
  + All safety parameters met, monitoring in process - see safety module
  + Remote power on UPS
  + Remote power on main power upstairs
  + Remote power on telescope power upstairs
  + Remote power up NG box
  + Remote power up instrumentation??!!
  + Reed remotely activated computers
  + Computers started up via sequencing script
  + Computers
    - Gerard
    - AzCam
    - Guider
    - Telcom
    - BigAux
    - GPS
    - TCS
    - BigPOP
  + Script to execute programs on computers
    - Indi Server
    - TCS-NG
    - "galilserver"
    - "dataserver"
    - "fw-gui"
    - RTS2
    - DRAP (Data Reduction and Analysis Program)
    - Big Brother (scheduler)
    - AzCam M4K
    - AzCam Guiding
  + Status report once complete
    - Telescope at zenith?
    - Dome stowed?
    - Mirror covers closed?
    - Windscreens stowed?
    - Dome closed?
    - Lights on in dome?
    - Interlocks in safe state (elevator down, door closed etc.)

*System Standby Module*

* Safety monitoring in progress – see safety module
* RTS2, DRAP, Big Brother waiting for start command
* Entire system powered up and running
* Waiting in halted state for signal to implement next module
  + At the start of the next night
    - System Initiation Module
  + If lightning is XXX distance away
    - Power Down Module
* Telescope stowed
* Mirror covers closed
* Dome stowed
* Dome shutter closed
* Event Sequence
  + All safety parameters met, monitoring - see safety module
  + Telescope disabled in Xephem software

*System Initiation Module*

* Safety monitoring in progress – see safety module
* Signal sent to start nightly observations
* Over view of nightly target selection process
  + Information gleaned from transient brokers
    - Example - LSST data
    - GRB example very interesting
  + Science proposals submitted
    - Example – science requirements require time on 61" to image variable star every 3 hours for 5 nights, 10 minutes each time – great new and exciting science!
    - Dark time or gray time needed?
  + Science proposals selected and given rating, A+, B-, etc.
  + Weighted targets fed into database
  + High level program considers what to observe from database
  + Smart software (Big Brother?) decides what gets observed
  + Software interfaces with 90", VATT and 61"
  + Feeds information into RTS2

*Calibration Module*

* Safety monitoring in progress – see safety module
* RTS2 started, calibrations initiated
* DRAP (Data Reduction and Analysis Program) reviews incoming data
  + DRAP runs throughout night and constantly monitors quality of data!
  + Have separate from RTS2.
  + Data reduction script
  + Enough counts?
  + Uniformity of flat fields. Compares current flat fields with old flat fields.
  + Checks noise in bias frames for consistency.
  + Pointing accurate from target to target?
  + Checks focus
* Automated sequence to take calibration images
* Bias frames, darks, flat field images
* Note – if switched to Sky Flats system would be much less complicated
* Event Sequence
  + All safety parameters met, monitoring in progress - see safety module
  + Dome stowed? Stow
  + Dome initialized? Initialize
  + Dome closed? Windscreens Stowed?
  + Dome lights off?
  + AzCam flush CCD three times as "test" frames
  + Start sequence of bias frames and continue to completion
  + Start sequence of dark frames if needed and continue to completion
  + Rotate dome to flat field screen
  + Open mirror covers
  + Scope sent to FF position
  + Flat field lamps on set to intensity needed in XXX filter
  + AzCam starts FF sequence in X filter
  + Next lamp intensity set for new filter
  + AzCam starts FF sequence in X filter
  + repeat as needed until finished
  + FF lamps off
  + Scope to stow
  + Mirror covers closed
  + dome sent to stow

*Opening Module*

* Safety monitoring in progress – see safety module
* May be repeated multiple times per night due to clouds, wind etc.
* Prepares telescope and instrument for night of observing
* Event sequence
  + All safety parameters met, monitoring - see safety module
    - weather checks
    - interlock system checks
    - instrument temp OK?
    - mirror covers closed etc.
  + Turn lights in dome off
  + Telescope stow
  + Dome stow
  + Dome initialize if needed
  + Dome open
  + Windscreens fully retracted
  + Mirror covers open

*Focus Module*

* Safety monitoring in progress – see safety module
* Focus lookup table based on temperature
  + Reviews what focus is supposed to be for night based on temperature
  + Once focus is derived the lookup table is updated
* Uses star field currently pointing at (zenith)
* Finds correct focus for M4K
* Automated scripting
  + RTS2 calls focus script
  + Lesser writes AzCAm script to use
* Event Sequence
  + All safety parameters met, monitoring - see safety module
  + AzCam focus sequence started
    - Example similar to what has been developed for 90Prime
      * Identify number of focus exposures
      * Identify number of rows to shift detector
      * Identify units to shift focus
      * Start sequence
      * Note - double row shift on last image
  + DRAP analyzes focus image and selects best one
  + RTS2 sets focus

*Initialization Module*

* Safety monitoring in progress – see safety module
* RTS2 running telescope and instrument
* DRAP evaluates images and sets pointing for the night
* Critical as a wrong initialization = wrong pointing = wrong software limits = telescope thinks it is in safe position when may not be!
* Automated scripting
* Event sequence
  + All safety parameters met, monitoring - see safety module
  + Take bias images X3 to flush CCD
  + Take Object image with appropriate exposure time to sky brightness
  + Submit image to astrometry.net for coordinate determination
  + Initialize telescope to coordinates
  + Send telescope to first target
  + Start autodome
  + Once on target take exposure
  + DRAP verifies object in center of M4K FOV
  + Adjust pointing as needed to center target in FOV
  + Initialize again if needed
  + Telescope continues to track object

*Observing Module*

* Safety monitoring in progress – see safety module
* RTS2 runs night
* Que observing
* Interrupts for high priority transient events
* Big Brother coordinates between 90", 61", VATT
* DRAP
  + Constantly checking focus
  + Constantly checking pointing
  + Sky transparency and exposure time
    - How deep (magnitude) are you going with current exposure time?
    - Feeds back into scheduler
  + Every image checks pointing
    - Compares requested to what is observed
  + Feeds back into Big Brother
    - How close to being finished, project successful or not?
    - How much more data required to finish project?
* Event Sequence
  + all safety parameters met, monitoring - see safety module

*Closing Module*

* Safety monitoring in progress – see safety module
* Sends telescope and dome back into standby state
* May be repeated multiple times per night due to clouds, wind etc.
* Event Sequence
  + All safety parameters met, monitoring - see safety module
  + Telescope sent to stow
  + Mirror covers closed
  + Dome sent to stow
  + Dome shutters closed
  + Windscreens stowed

*System Standby Module*

* Safety monitoring in progress – see safety module
* Entire system powered up and running
* Add electrical disconnects for drives so telescope cannot run away during day
* Waiting in halted state for signal to implement next module
  + At the start of the next night
    - System Initiation Module
  + If lightning is XXX distance away
    - Power Down Module
* Telescope stowed
* Mirror covers closed
* Dome stowed
* Dome shutter closed
* Windscreens stowed
* Event Sequence
  + All safety parameters met, monitoring - see safety module
  + Telescope disabled in Xephem software

*Power Down Module*

* Safety monitoring in progress – see safety module
* Shuts down all computers needed for telescope and instrument operations
* Shuts down all power need for telescope and instrumentation operations
* Event sequence
  + All safety parameters met, monitor - see safety module
  + Status report
    - Telescope at zenith?
    - Dome stowed?
    - Mirror covers closed?
    - Windscreens stowed?
    - Dome closed?
    - Lights on in dome?
  + Script to kill programs on computers
    - Indi Server
    - TCS-NG
    - "galilserver"
    - "dataserver"
    - "fw-gui"
    - RTS2
    - DRAP
    - Big Brother
    - AzCam M4K
    - AzCam Guiding
  + Computers shut down via sequencing script
    - Gerard
    - AzCam
    - Guider
    - Telcom
    - BigAux
    - GPS
    - TCS
    - BigPOP
  + Remote power down NG box
  + Remote power down instrumentation??!!
  + Remote power down telescope power upstairs
  + Remote power down main power upstairs
  + Remote power down UPS

*Lightning Shut Down Module*

* Safety monitoring in progress – see safety module
* Verifies power down module completed
* Puts telescope into LS
* Occurs when electrical activity within XXX miles
* Action Items
  + Need professional assessment of vulnerabilities to lightning
  + Need Observatory agreement on what we can and cannot spare to loose
  + Need electrical engineering plan to implement first two points above
  + Installation of remotely activated disconnects
    - Breakers
    - Knife switches
    - Other

*Safety Module*

* May be left on to continue monitoring conditions and when appropriate brings system back up

*Safety Module Shutdown*

* Remotely login and shutdown safety computer

**Short Term List of Automation Points:**

1. Dome shutter
2. Mirror covers
3. Windscreens
4. Dome counter - mechanism to get accuracy and repeatability of dome location, i.e. when sent to stow needs to be there precisely
5. Accurate and repeatable dome flat field positioning (could be eliminated with twilight flats)
6. Flat field lamp automation - on/off/intensity (could be eliminated with twilight flats)
7. Pointing routine, initialization
8. DRAP – develop Data Reduction and Analysis Program
9. Automated focus routine
10. Weather monitoring
11. Lightning shutdown
12. Dome lights
13. Video monitoring camera