Telescope Manager (TM) Consortium : from Fremantle to Penticton (and beyond…)

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SKA Engineering Meeting, Penticton, 11th Nov 2015

Outline

- Overview : TM roles & responsibilities
- TM Organization : Sub-elements, who's doing what
- Progress since Fremantle meeting
- Future plans : quick look
- Major risks and issues

TM Roles & Responsibilities

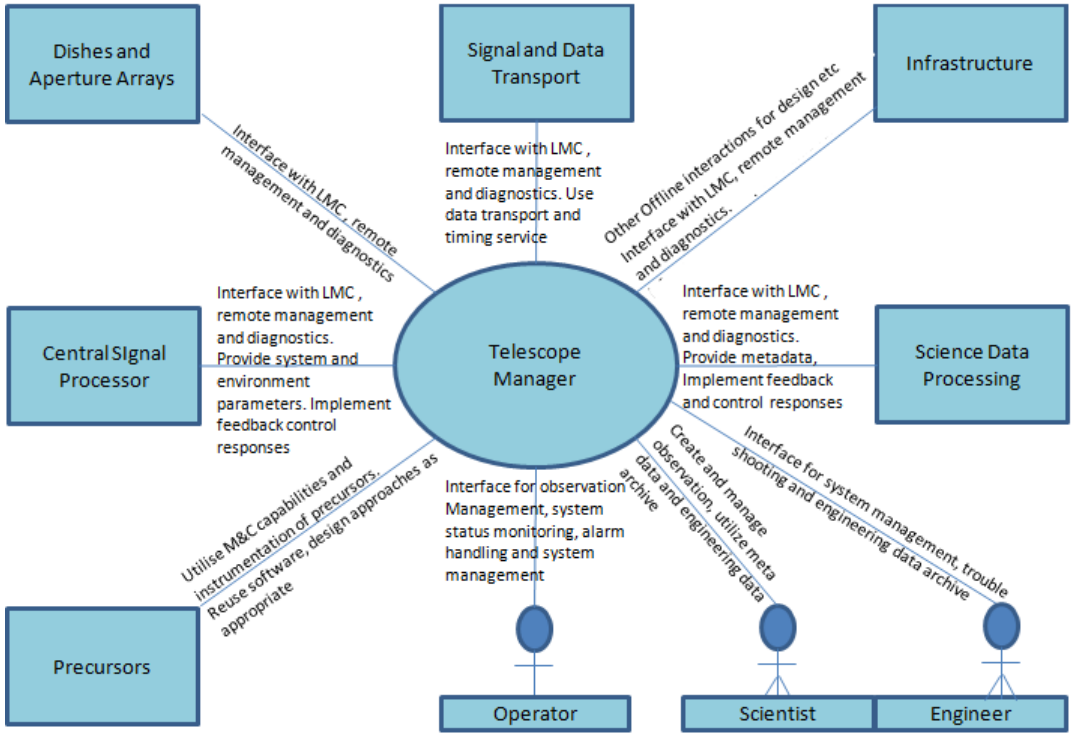
TM has 3 core roles & responsibilities :

- **Management of astronomical observations:** proposal submission, scheduling, observation preparation and execution management.
- **Management of the telescope hardware & software subsystems:** for astronomical observations and entire instrument life-cycle, including all Element LMC interactions.
- **Management of the data to support system operations and all stakeholders:** System state parameters and metadata, telescope behavioural model, archival of M&C data, forensic tool for diagnostics, operator & engineer UIs.

TM as the nerve centre of the SKA telescope(s)

TM talks to every Element

- TM is the central brain + nervous system of the SKA telescope
- Interacts with and controls every element of the observatory
- Plays the central role in carrying out the observations and managing the observatory resources.
- All inter-element “conversation” is to be routed via TM



TM structure : sub-elements and their roles

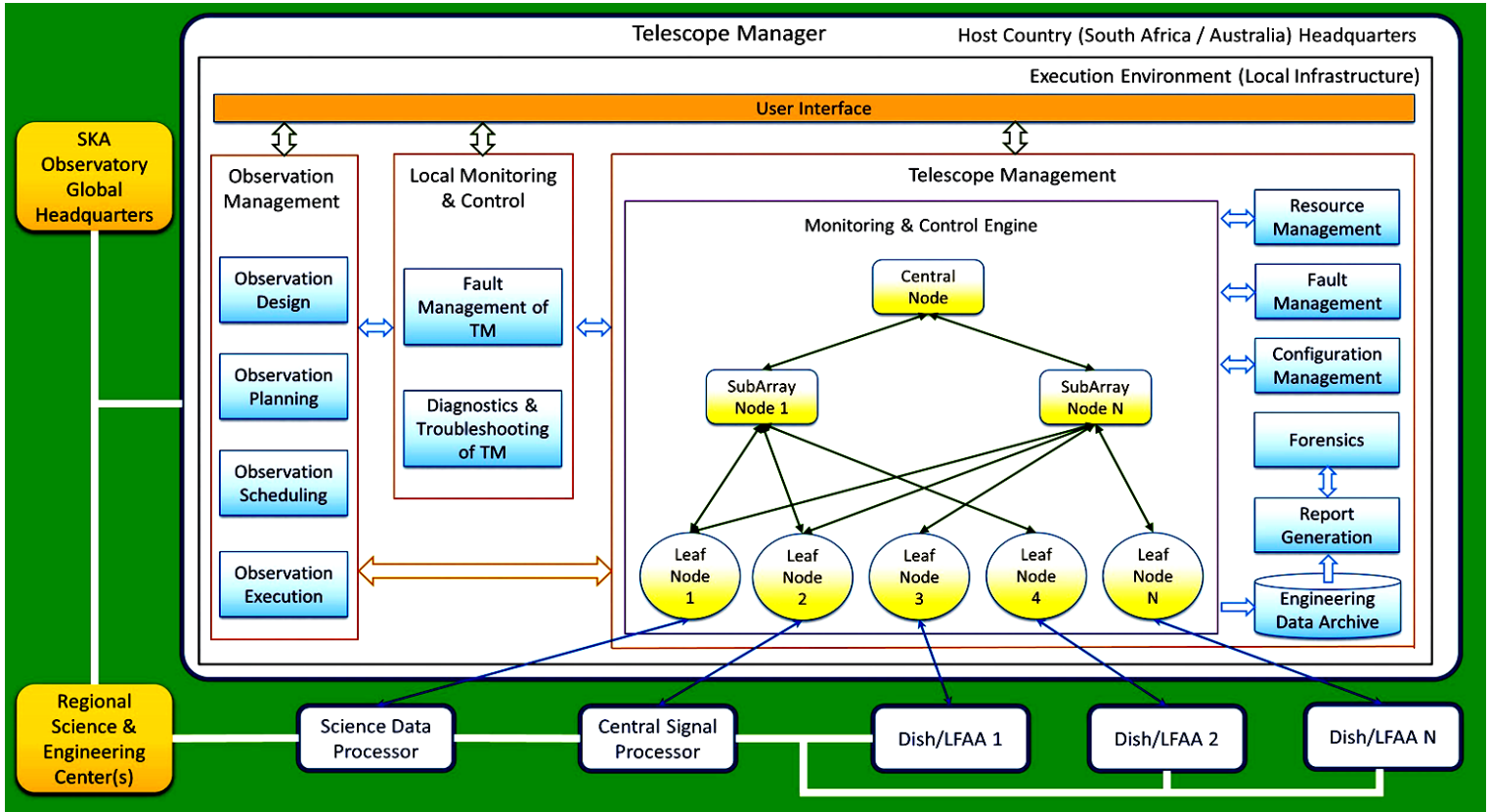
To meet the roles and responsibilities, TM is organised into the following sub-elements:

- Telescope Management (TelMgt) : Engineering management of the instrument
- Observation Management (ObsMgt) : Usage of the instrument for astronomical observations
- Local Monitor and Control (LMC) : Monitoring & Control of Telescope Manager itself
- Local Infrastructure (LINFRA) : Computational, communications, power and facilities infrastructure for Telescope Manager
- Prototyping (Proto) : Development of the required prototypes needed for the design process

+ Supporting work packages:

- System Engineering : Engineering artifacts related to requirements, architecture & interfaces
- Project Management : Consortium coordination

TM : high level organisation



TM Consortium : partners and roles

LMC (INAF, Italy)	Observation Management (UKATC , UK)	Project Management (NCRA, India)
	Telescope Management (NCRA , India)	System Engineering (SKA SA, South Africa)
	Infrastructure (Engage SKA Consortium , Portugal)	Prototyping (All; coordinated by NCRA, India)
		Review, support (CSIRO , Australia ; NRC, Canada)

Progress since Fremantle meeting

Significant work and achievements since last SKA Engineering meeting :

- PDR cleared (barring some formalities)
- LMC Interface Guidelines developed -- towards standardisation
- Technology downselect from main TM : the move to TANGO
- F2F all hands meeting in June 2015 to kick-of detailed design activities
- Progress in design activities : improved understanding and details
- Prototyping activity, including TANGO exploration
- Development of the Capability concept
- Bridging the gap in Operations Concept
- Contributing to SKA Functional Analysis

Clearing PDR

- TM PDR in Jan 2015 : fairly successful

- Review Panel recommended some further work to address the following issues :
  - Completion of technology choices (specifically for the software framework)
  - Further definition of the Operations Concept, in areas impacting TM
  - Factor in effects of project-wide re-baselining exercise
  - Closing out specific actions identified in PDR report

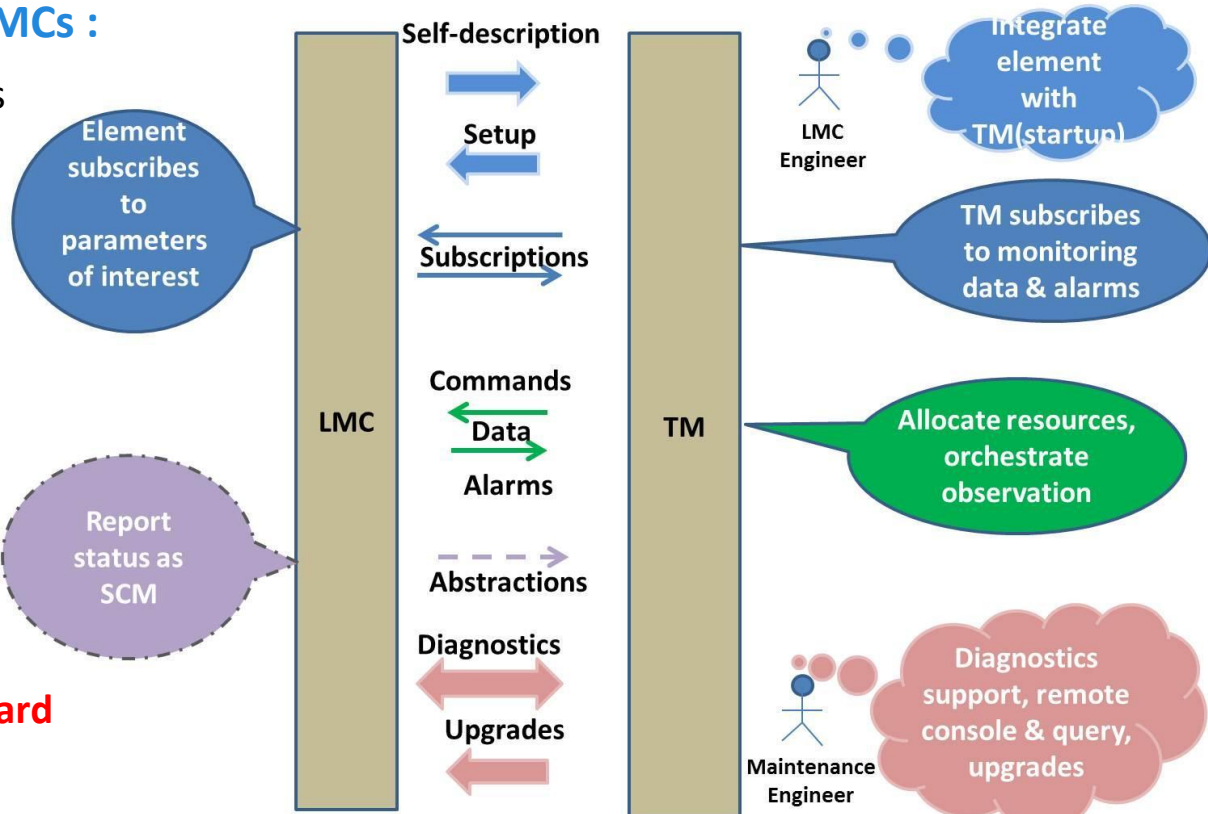
- Delta-PDR in Oct 2015 : cleared (barring some formalities of baselining updated docs)

TM – Element LMC Interaction Guidelines : Background

Interaction needs between TM & LMCs :

- Ability for TM to command elements via LMCs
- Communication of monitoring data, alarms from LMCs to TM
- Enabling LMCs to participate in the derivation and observation of the telescope state
- Facilitation of cross element communication via TM
- Integration of elements into the TM purview using self-description

- **Felt useful to work towards a standard format for interactions**



LMC Standardization Work

- **Developed the LMC Roles & Responsibilities (LSR) and LMC Interface Guidelines (LIG) Documents**
  - LSR : relative roles of TM and LMC's w.r.t overall SKA Monitoring and Control
  - LIG : guidelines for all TM-LMC interactions (primarily includes design time and operational interactions)
- **Build up a community of practice with LMC teams from each Element, starting 2014 (coordinated by Riccardo Smareglia)**
- **Held a joint workshop in March 2015 on LMC Standardisation and Frameworks Technology – the Trieste workshop**
- **LIG ver 'E' submitted to SKAO in Mar 2015**
  - Major items included : SCM, alarms/events, command/response format
  - Alignment to standards : X.731 and X.733
  - Received comments from SKAO (in Sep 2015)

LMC Standardization Work

- **Major Version (01) of LIG & LSR now ready for release with following improvements / additions :**
  - Closure of comments on LIG version ‘E’ (87 items)
  - Updates to SKA Control Model (SCM)
  - Design Considerations for TM-LMC Interface
  - Format for Element Self Description Data (SDD)
  - **Suitable for adoption as a SKA standard**

- **Future Plans**
  - Plans for a separate set of Tango specific guidelines
  - Separate design threads e.g. SCM alignment with RAM (Corrie’s model)
  - Effect of ‘Product’ orientation
  - **Plans for adoption as a “standards” document by SKAO to be finalised**

TM Technology Choice/Downselect

- From PDR review : Need to explore and enforce commonality of technologies throughout the Telescope Manager and Element LMCs, with specific attention to an adopted M&C framework platform.

- LMC Standardization Workshop involving TM & SKA Element LMCs, held in Trieste during Mar 25-27, 2015

- **Meeting was attended by TM, DSH, LFAA, CSP, SDP, SAT, AIV, INFRA, SKAO, and external experts representing the main M&C frameworks** [EPICS v3 and v4, TANGO Control System , KATCP + Meerkat CAM, Alma Common Software (ACS)]

- Elements separately presented their requirements and architecture

- Experts from three candidate frameworks (EPICS, TANGO, and ACS) presented each framework and discussed details

TM Technology Choice/Downselect

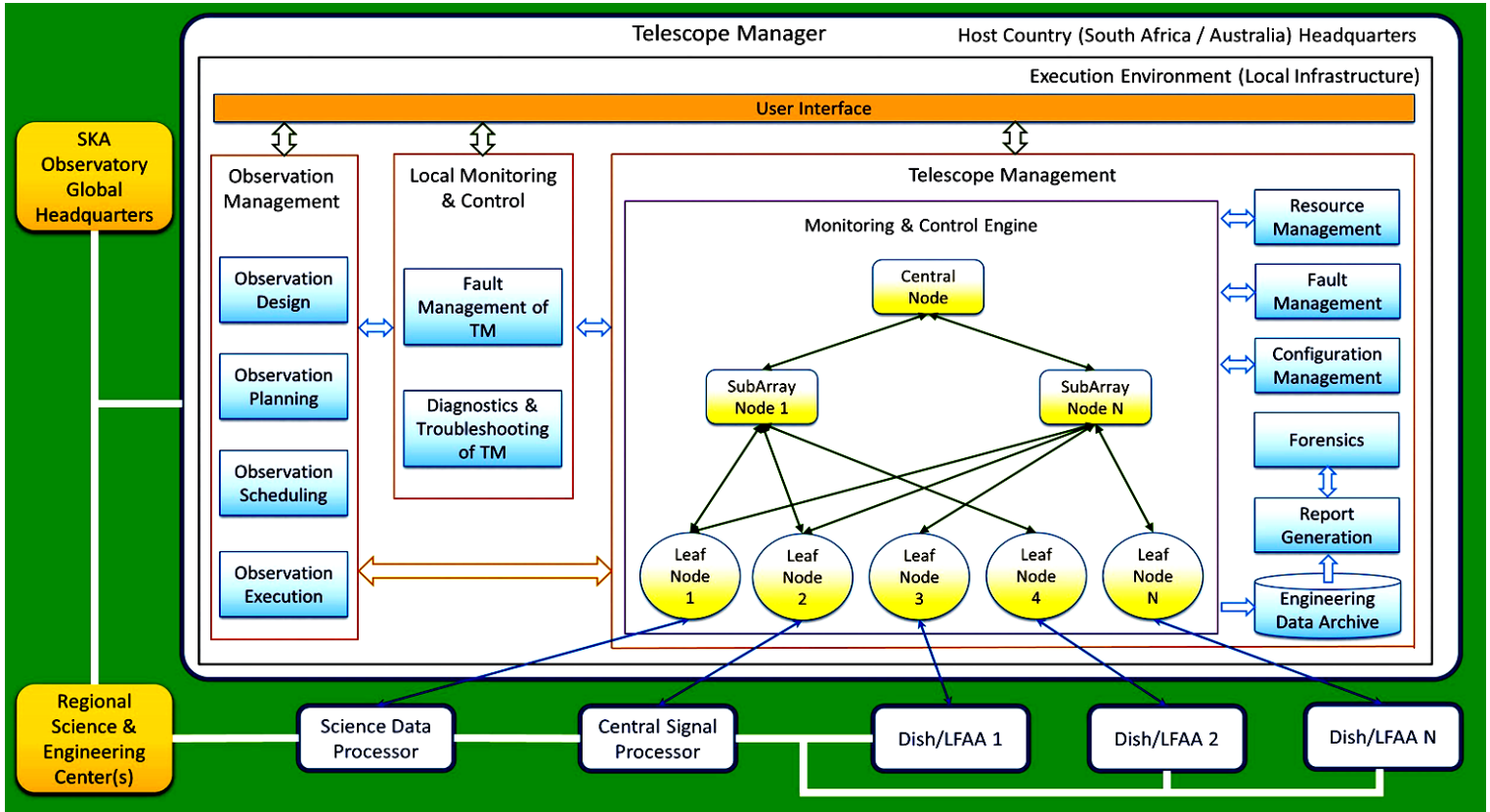
- **This process led to down selection of TANGO as the suitable framework of choice,** based on the following (extensive) set of criteria :
  - M&C Design Concepts & scalability
  - Modernity and future direction
  - Integration and reuse of precursors
  - Feedback from initial study done by members of TM.LMC team
  - Feedback from other consortia + opinion of experts
  - Technical Applicability
  - Industrial Standards and Fresh Module Development
  - User support, documentation
  - Risk reduction

TM Technology Choice/Downselect

- **Action taken, current status and further plans :**
  - Report submitted to the SKAO about the outcome of the workshop, with clear selection of TANGO.
  - TM and many of the other elements (but NOT all) have already reoriented design and prototyping activities to incorporate TANGO explicitly.
  - **Need to formalise a way for adopting TANGO as an observatory wide standard.**

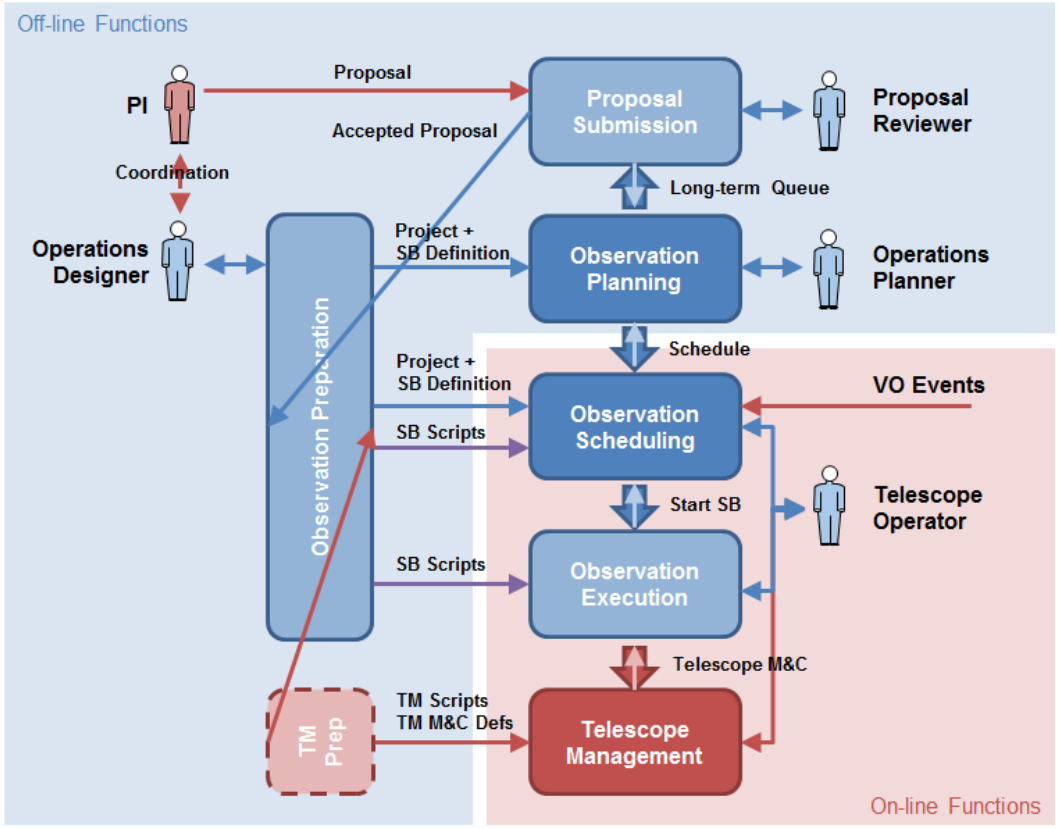
Progress in design activities

TM : high level organisation



Observation Management Process

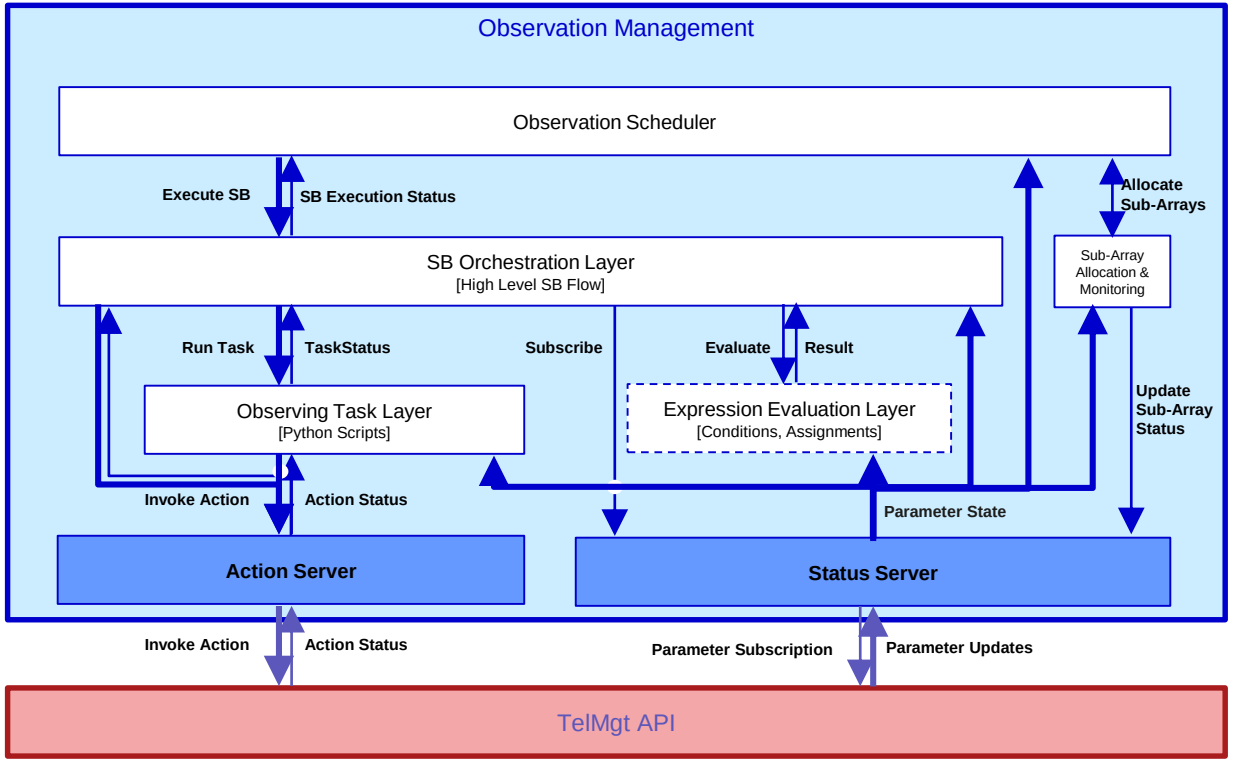
- From proposal submission to observation planning, scheduling and execution.
- Has real-time and off-line parts
- Location of the off-line part : TBD
- Flow of (meta)data from ObsMgt to CSP/SDP to be finalised (is being discussed…)
- Knowledge of Element capabilities and functionalities is important



ObsMgt <-> TelMgt Integration

Fitting the pieces together :

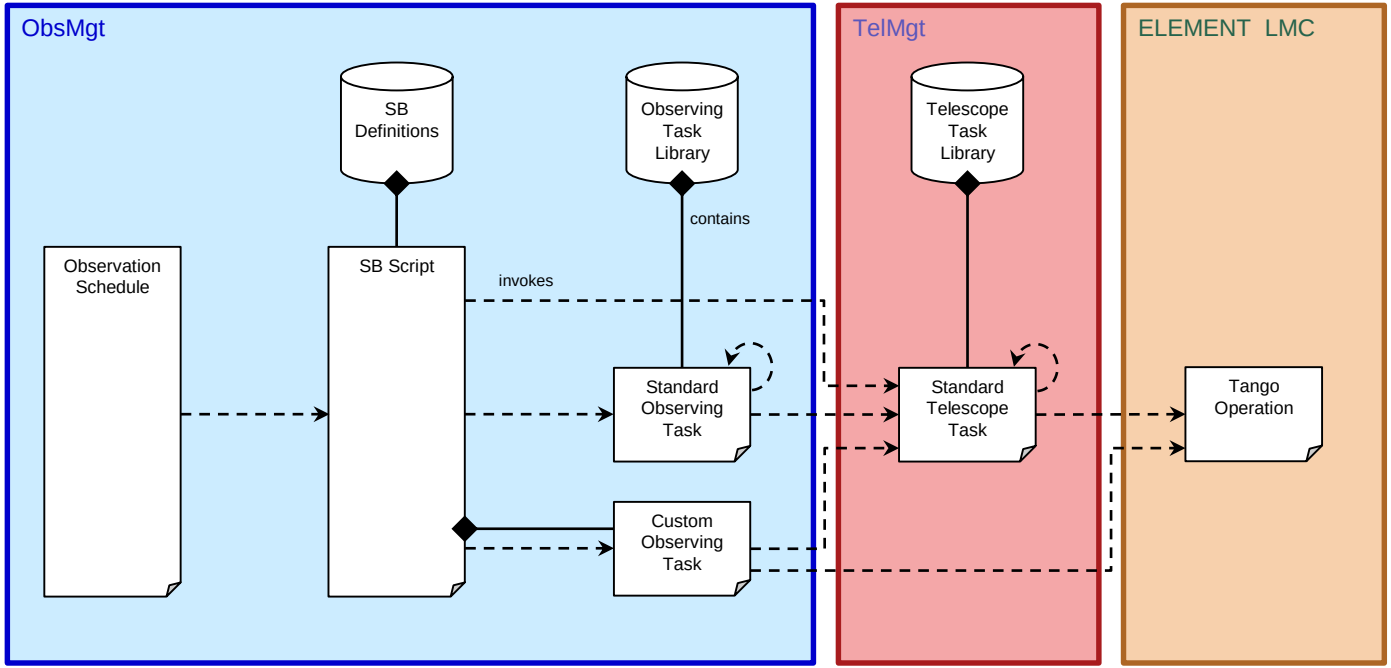
Interaction layers between
Observaion Management
&
Telescope Management



Observation Scripting and TelMgt

Fitting the pieces together :

Realisation via different layers of procedures (scripting)



The concept of Capabilities

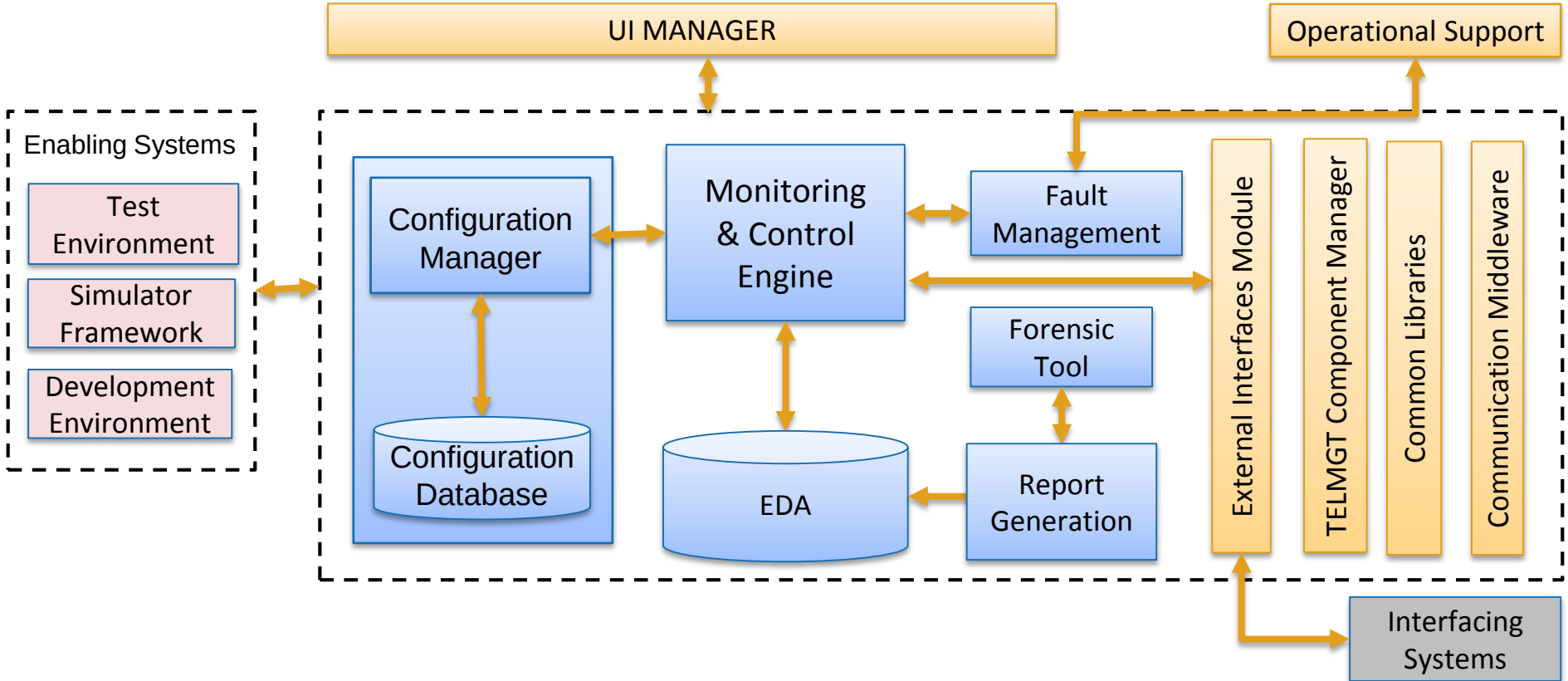
- **Element LMCs present their functionality to TM in terms of** capabilities e.g. frequency bands, subarray support, CSP modes, SDP capabilities etc.

- **Scheduling identifies the set of capabilities required to perform each observation**
  - Receptor capabilities, correlator capabilities, data processing capabilities, ...

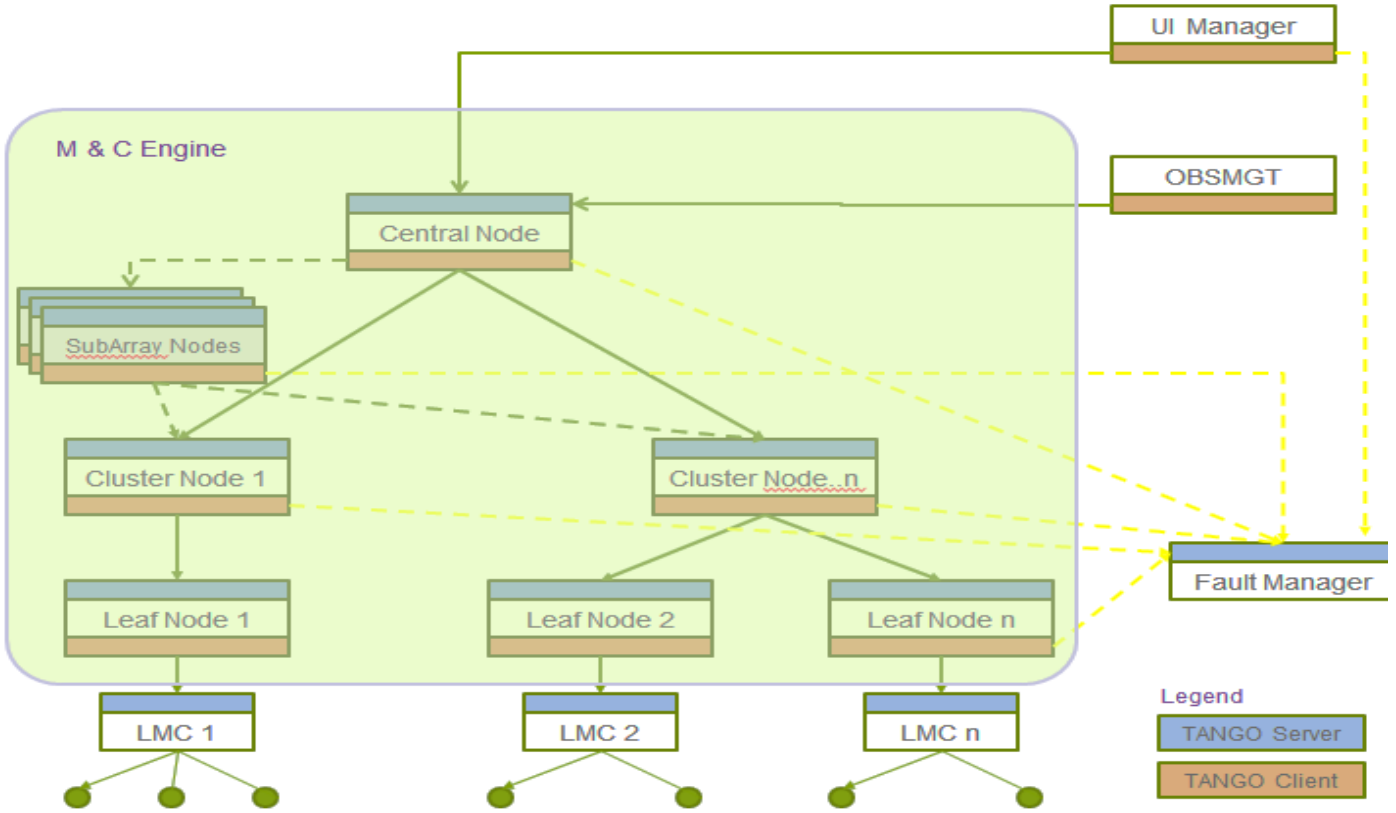
- **Using this information, scheduling creates long-term, medium-term and short-term plans, taking into account available resources and their capabilities, and can react dynamically to changing situations**

- **Resource allocation is based on identifying Elements that provide the needed capabilities and obtaining commitments**
  - Faults may affect the availability of capabilities

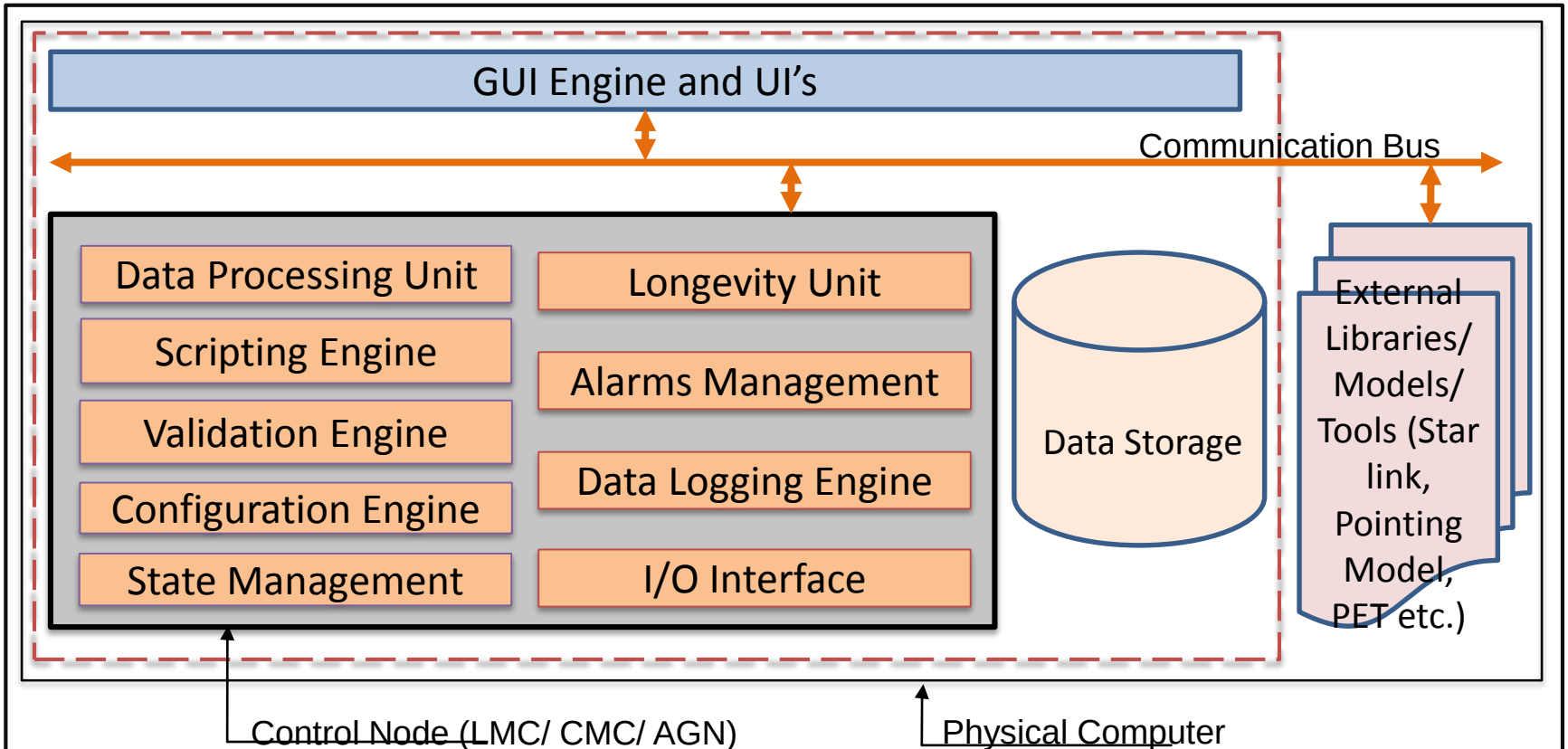
Telescope Management : Components Overview

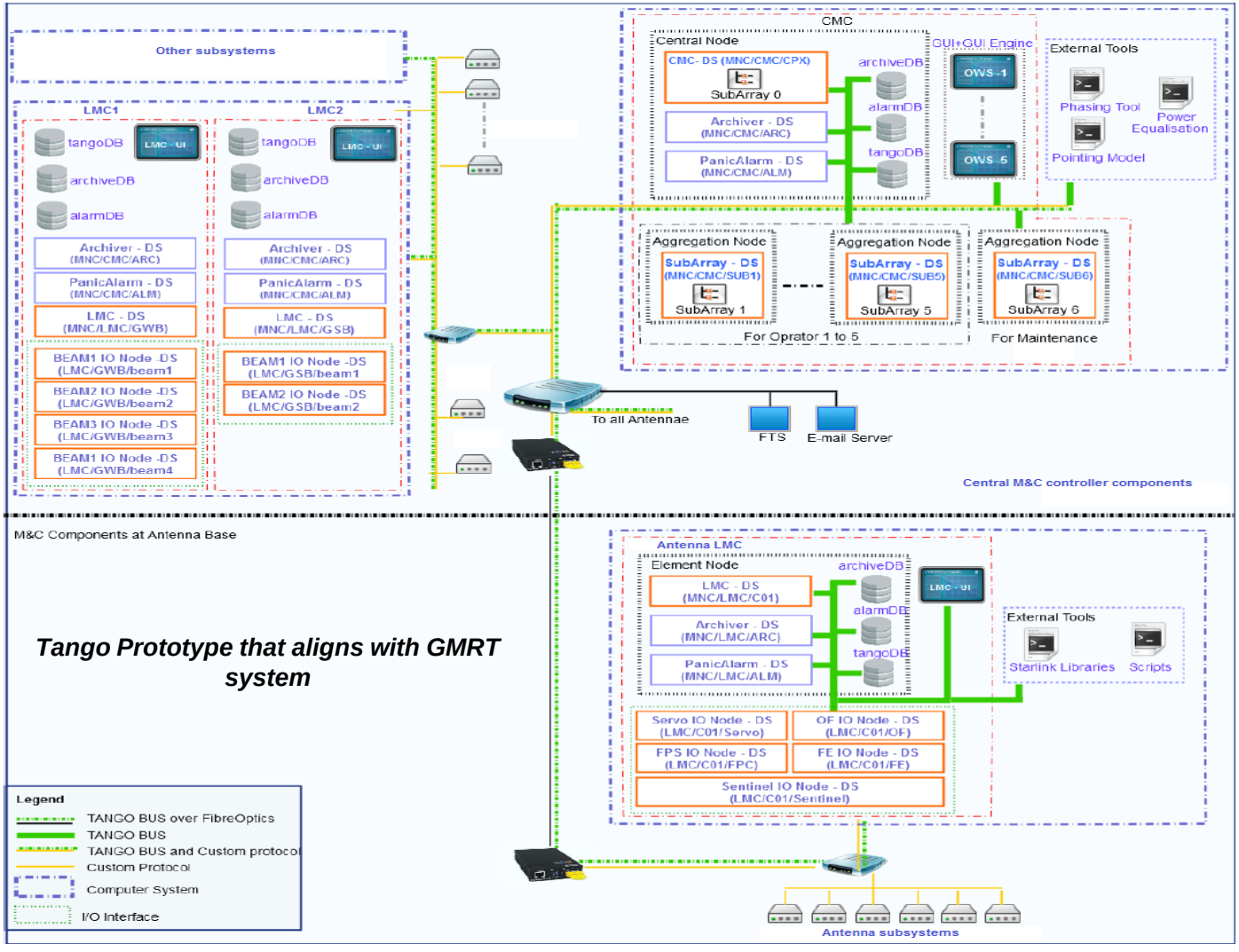


Telescope Management : Control Architecture Overview

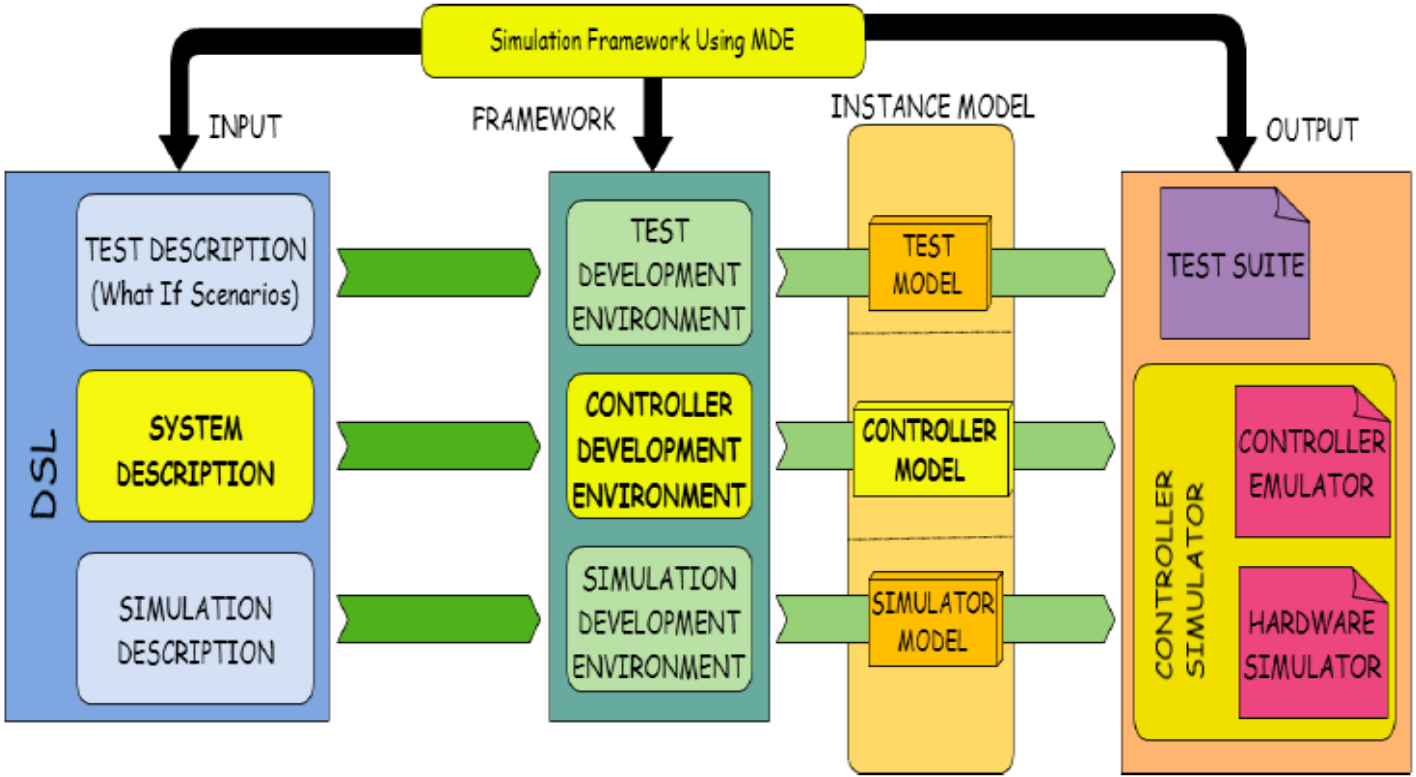


Telescope Management : Control Node zoom-in view

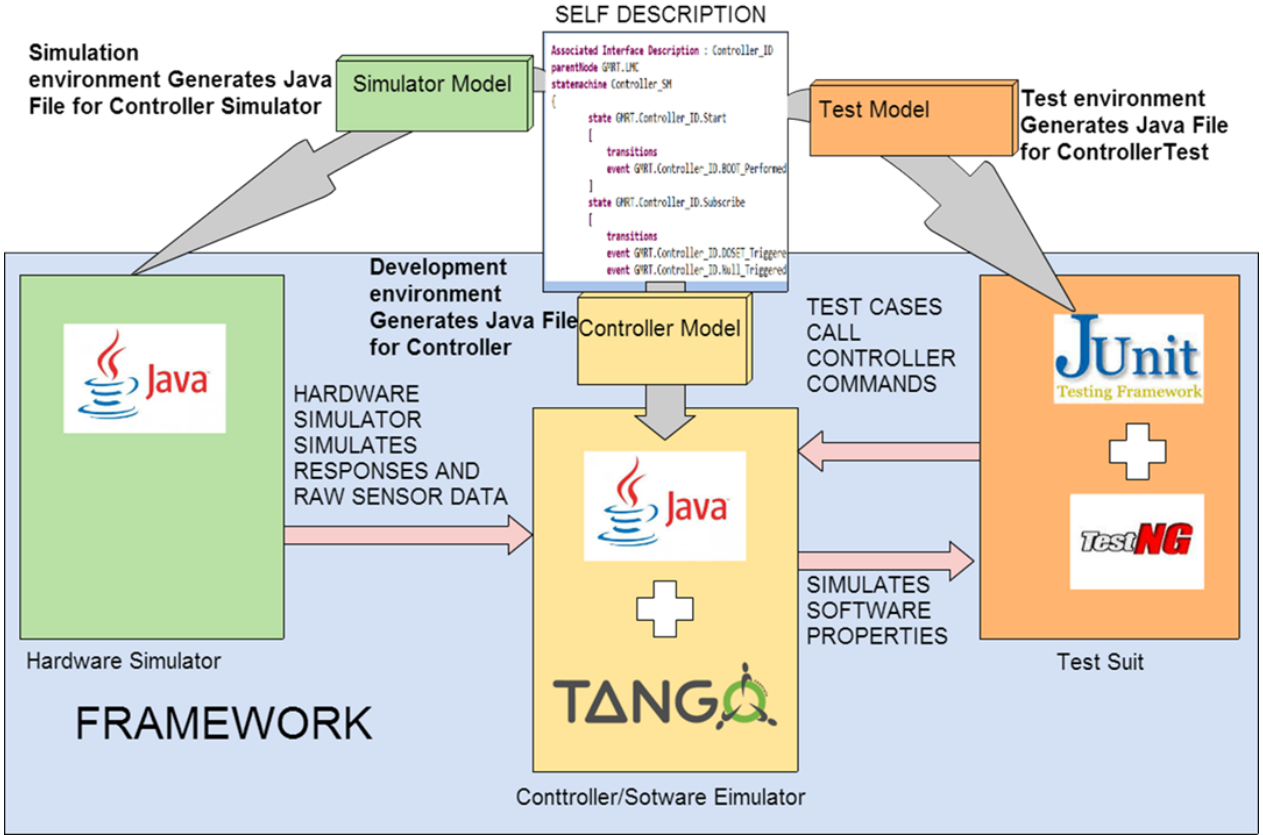



Other subsystems
LMC1
LMC2
tangoDB
archiveDB
alarmDB
LMC - UI
Archiver - DS (MNC/CMC/ARC)
PanicAlarm - DS (MNC/CMC/ALM)
LMC - DS (MNC/LMC/GWB)
LMC - DS (MNC/LMC/GSB)
BEAM1 IO Node -DS (LMC/GWB/beam1)
BEAM2 IO Node -DS (LMC/GWB/beam2)
BEAM3 IO Node -DS (LMC/GWB/beam3)
BEAM1 IO Node -DS (LMC/GWB/beam4)
BEAM1 IO Node -DS (LMC/GSB/beam1)
BEAM2 IO Node -DS (LMC/GSB/beam2)
CMC
Central Node
CMC- DS (MNC/CMC/CPX)
SubArray 0
Archiver - DS (MNC/CMC/ARC)
PanicAlarm - DS (MNC/CMC/ALM)
archiveDB
alarmDB
tangoDB
GUI+GUI Engine
OWS -1
OWS -5
External Tools
Phasing Tool
Power Equalisation
Pointing Model
Aggregation Node
SubArray - DS (MNC/CMC/SUB1)
SubArray 1
SubArray - DS (MNC/CMC/SUB5)
SubArray 5
SubArray - DS (MNC/CMC/SUB6)
SubArray 6
For Oprator 1 to 5
For Maintenance
To all Antennae
FTS
E-mail Server
Central M&C controller components
M&C Components at Antenna Base
Tango Prototype that aligns with GMRT system
Antenna LMC
Element Node
LMC - DS (MNC/LMC/C01)
Archiver - DS (MNC/LMC/ARC)
PanicAlarm - DS (MNC/LMC/ALM)
Servo IO Node - DS (LMC/C01/Servo)
OF IO Node - DS (LMC/C01/OF)
FPS IO Node - DS (LMC/C01/FPC)
FE IO Node - DS (LMC/C01/FE)
Sentinel IO Node - DS (LMC/C01/Sentinel)
Starlink Libraries
Scripts
Antenna subsystems
Legend
TANGO BUS over FibreOptics
TANGO BUS
TANGO BUS and Custom protocol
Custom Protocol
Computer System
I/O Interface

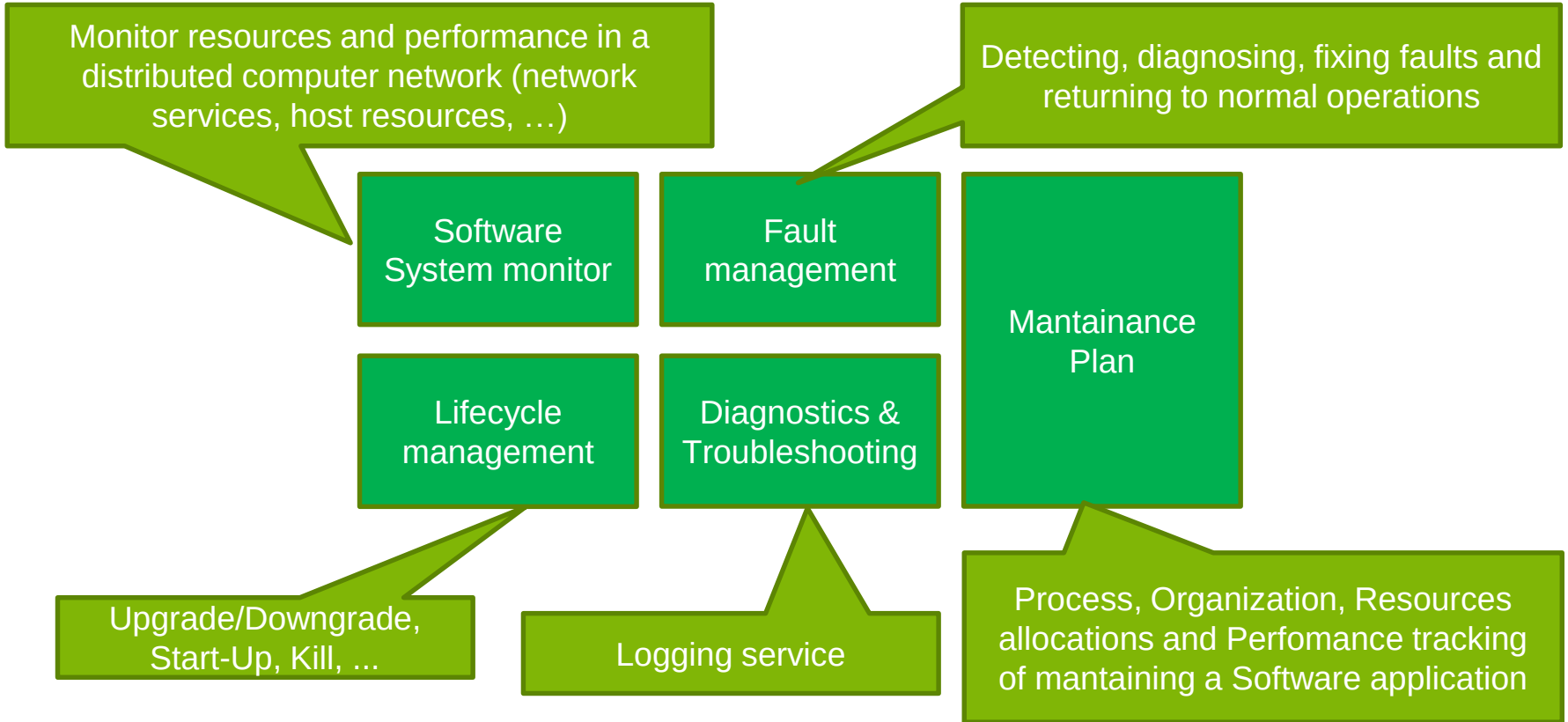
Telescope Management : Enabling Environment (dvl & test prototype)



Telescope Management : Enabling Environment - implementation view

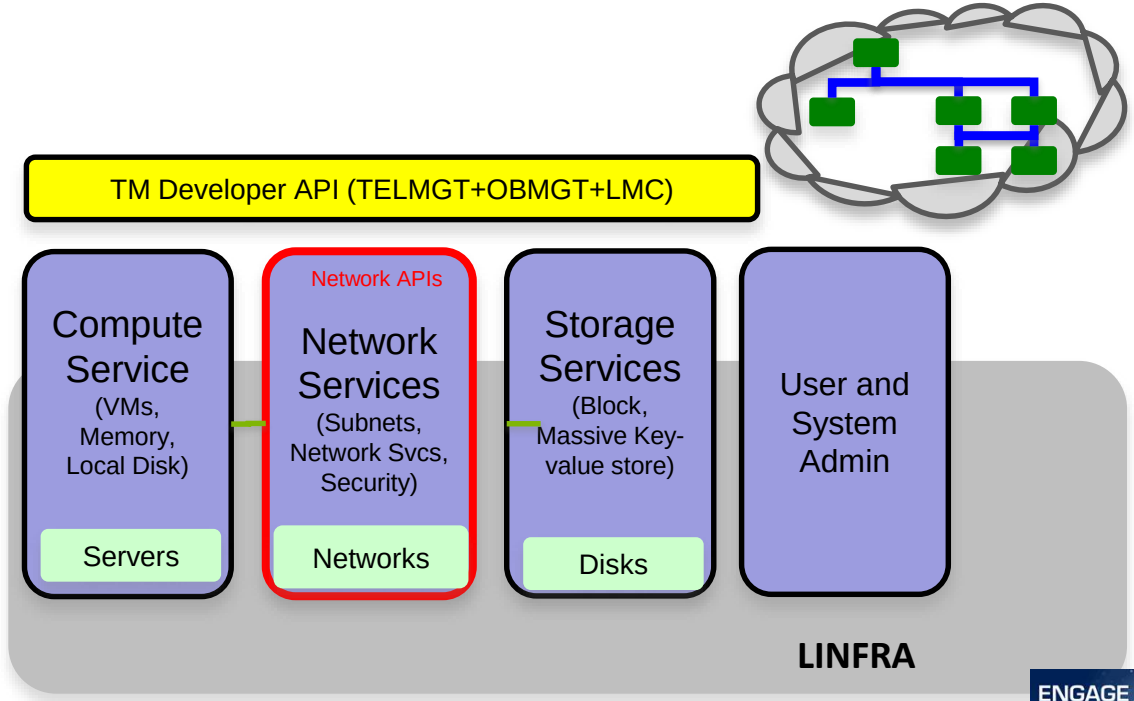


TM : Local Monitoring & Control Self Management



TM : Local Infra Support

- Infrastructure design and deployment planning & sizing : compute, storage & network
- Engineering anlysis (for TM as a whole) : performance, reliability, availability, failure modes, security, power and rfi analysis..
- Exploration of OpenStack technologies for automated deployment, fail-over, patch management
- Integration of technology stacks – possibility of middleware layer



Prototyping Activity : Overview

- NEED for Prototyping :
  - Evaluation of technology
    - especially where novel or being used in new territory
  - Clarifying architectural concepts or design evaluation
    - Prototype iterations in parallel with design effort help inform and refine design concepts
  - Improving Requirements Capture
    - Interface identification and characterization
    - ‘Natural workflows’ and Usability in case of UIs
  - Qualification or assessment of metrics: Especially indicators of non functional parameters such as performance and scalability
- **Risk reduction was insisted on as a key criterion for approval**

Prototyping : Current status and representative outcomes

- 15 prototypes approved under various sub-elements (+ 1 LINFRA prototype in approval process)
- Iteration based planning and execution process.
  - 11 of the approved prototypes have been initiated, 9 have completed the first iteration
  - 3 prototypes will complete as per the plans by end November
- A few representative learnings from the protos so far
  - 'TANGO' based instantiation of proposed TM architecture validated
  - Development Environment (for auto generation of Self Description Data) being used and validated by developers
  - Observation Planning Tool (being adapted from a different domain) team was able to better define the Observability Window - Scheduling Block relationship
  - Early results from Proposal Handling Tool performance projections are encouraging

Detailed list of prototypes

- TelMgt Prototypes
  - M&C Engine Prototype
  - Test Environment
  - LMC Interface Simulator Framework
  - Engineering Data Archive (Database) Prototype
  - Development Environment Prototype
- ObsMgt Prototypes
  - Scripting Layer & ObsMgt-TelMgt Interface
  - Observation Planning Tool
  - Proposal Handling Tool
  - Observation Management Data Archive
  - Observation Scheduling Tool
- LMC Prototypes
  - Software system monitor prototype
  - Lifecycle control prototype
  - LIG LMC prototype
- LINFRA Prototypes
  - OS+service INFRA layer
- GUI Prototypes
  - Graphical User Interface Prototype
  - Authentication and Authorization (A&A)

Future Plans & Milestones : till CDR

- M14 : Nov-15 — Development Baseline Formed
- M15 : Jan-16 — RBS ECP-15001
- M16 : Apr-16 — Element RBL
- M17 : Jul-16 — Element DBL
- M18 : Jun-16 — ObsMgt, TelMgt, LMC RBL
- M19 : Sep-16 — ObsMgt, TelMgt, LMC DBL
- M20 : Jul-16 — LINFRA RBL
- M21 : Oct-16 — LINFRA DBL
- M22 : Jun-16 — Prototyping Report
- M23 : Oct-16 — Supplementary Pack #2
- M24 : Dec-16 — Supplementary Pack #3
- M25 : Mar-17 — CDR Submission
- M26 : Aug-17 — CDR Closure

Major Risks and Issues

- **Dependence on OCD**
  - Observatories operational processes (“business rules”) are embedded in the software architecture of the TM element sub-systems. The exposure for TM is significant.
- **Lack of Telescope Model definition**
  - Telescope Manager is not able to proceed with the design of the Telescope Model until appropriate clarity is received in terms of its definition and use.
- **Gaps in Arch Pack v3 and BDv2**
  - The quality of the BDv2 is insufficient for TM to be able to create its requirements and design baseline.
- **Inconsistency in the Telescope Architecture**
  - Telescope architecture as reflected in TM external ICDs, TM RS & TM DR does not match BDv2 model and SKA Telescope Calibration Framework.

Major Risks and Issues

- **Lack of information about management and support roles of TM**
  - The management and support processes of the SKA observatory are not clearly defined, however, TM is expected to support these processes.
- **Non availability of stable and complete L1 Requirements**
  - Areas that affect TM including operations, boundary with Enterprise functionality, quality requirements (performance, availability, security, safety, etc.), rebaselining changes, updated baseline design (BDv2) have still not been addressed by end of Jun as communicated.
- **Authentication and Authorization (A&A)**
  - Lack of scope description for A & A tasks in the SKA Observatory
- **TM has many dependencies : if these are not resolved adequately or in a timely manner, schedule delays can occur**

Thank You