M&C architecture and TM-LMC interfaces

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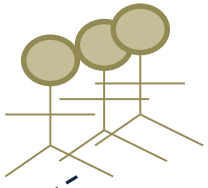
Agenda

- TM - Functional overview
- Discuss the M&C connection
- Highlight requirement and emergent architecture
- Discuss resultant M&C criteria
- Influence on the TM-LMC interaction
  - A glance of the guideline

TM – High-level functions



SKA stakeholders

Element integration for operations

Observation preparation, scheduling and execution

Overall control, coordination, Fault management and resource management

Archival of states, monitoring data and logs

User interfaces for SKA stakeholders (scientist/operators)

Facilitate external input – Telescope Model/external systems

Telescope Manager

DISH

SIGNAL AND DATA TRANSPORT

CENTRAL SIGNAL PROCESSOR

SCIENCE DATA PROCESSOR

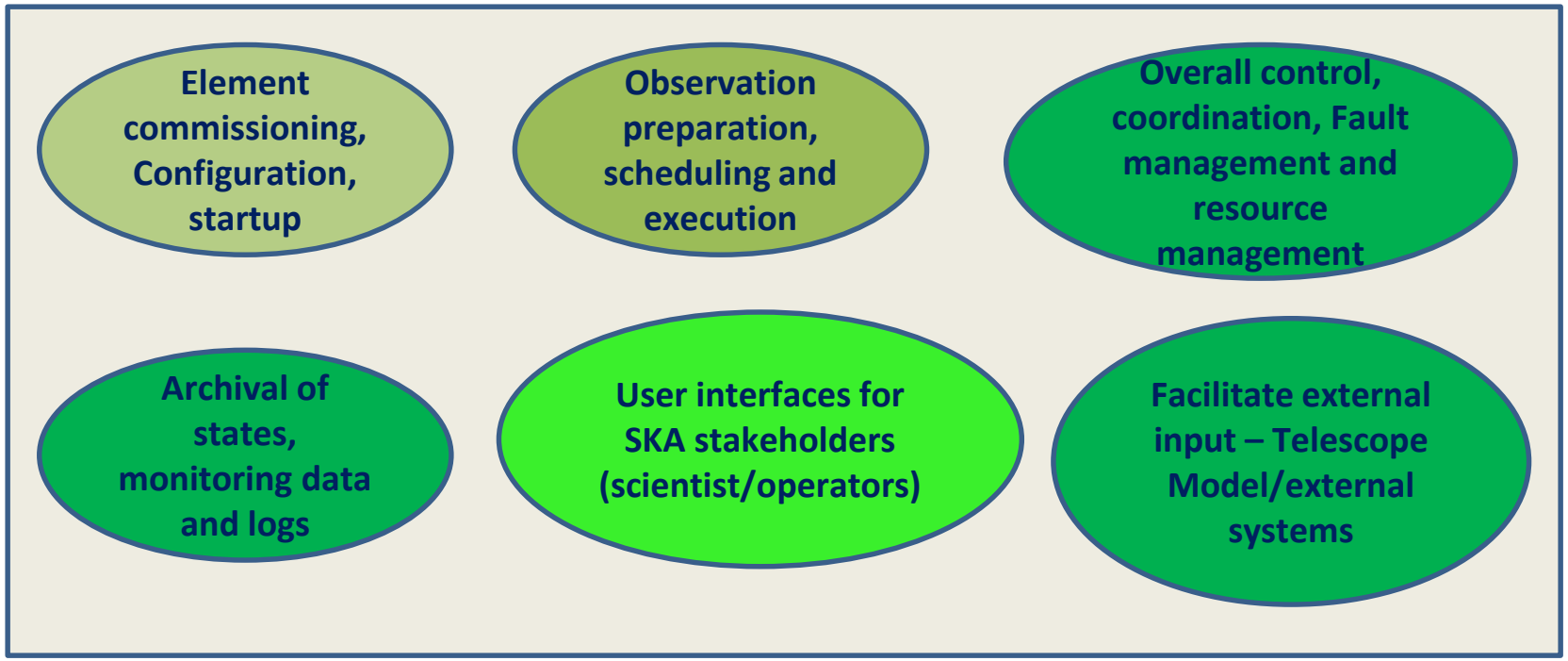
INFRA

ASSEMBLY, INTEGRATION & VERIFICATION

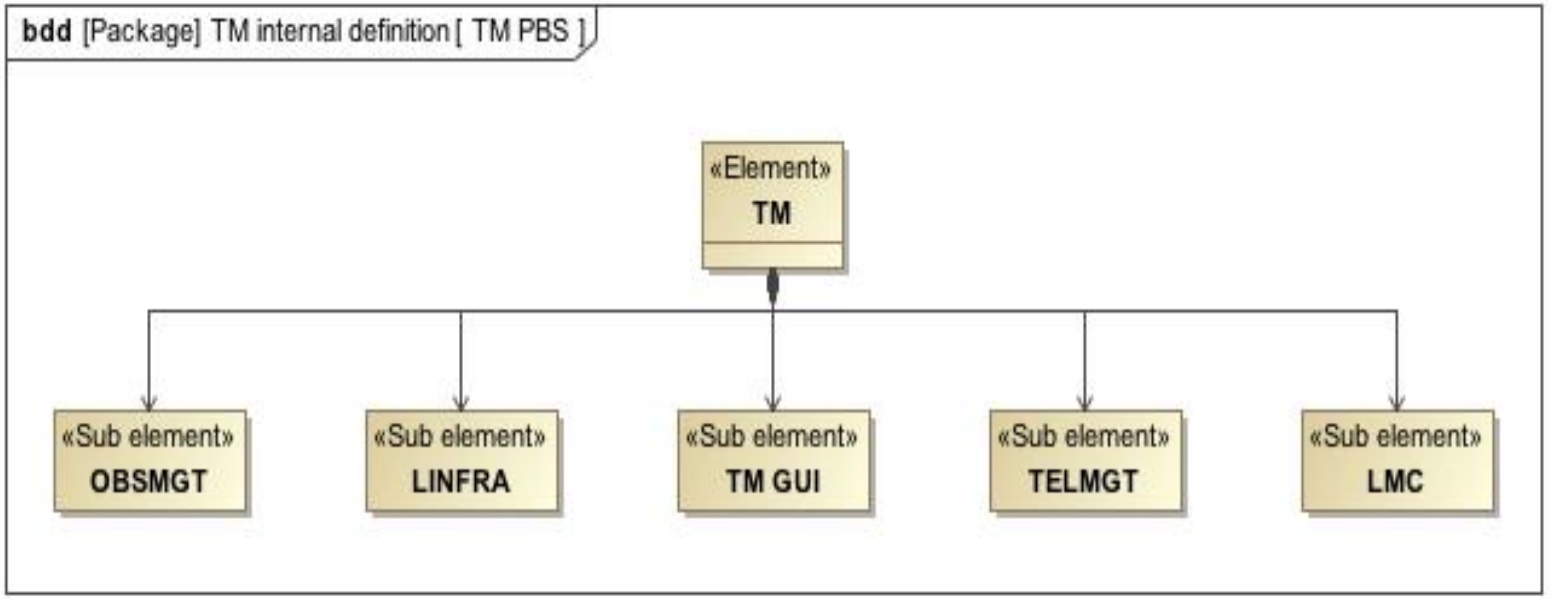
LOW-FREQUENCY APERTURE ARRAY

MID-FREQUENCY APERTURE ARRAY

Intensity of Influence on M&C related requirements



TM – Work-packages



Overall control, coordination, Fault management and resource management:

Requirements:

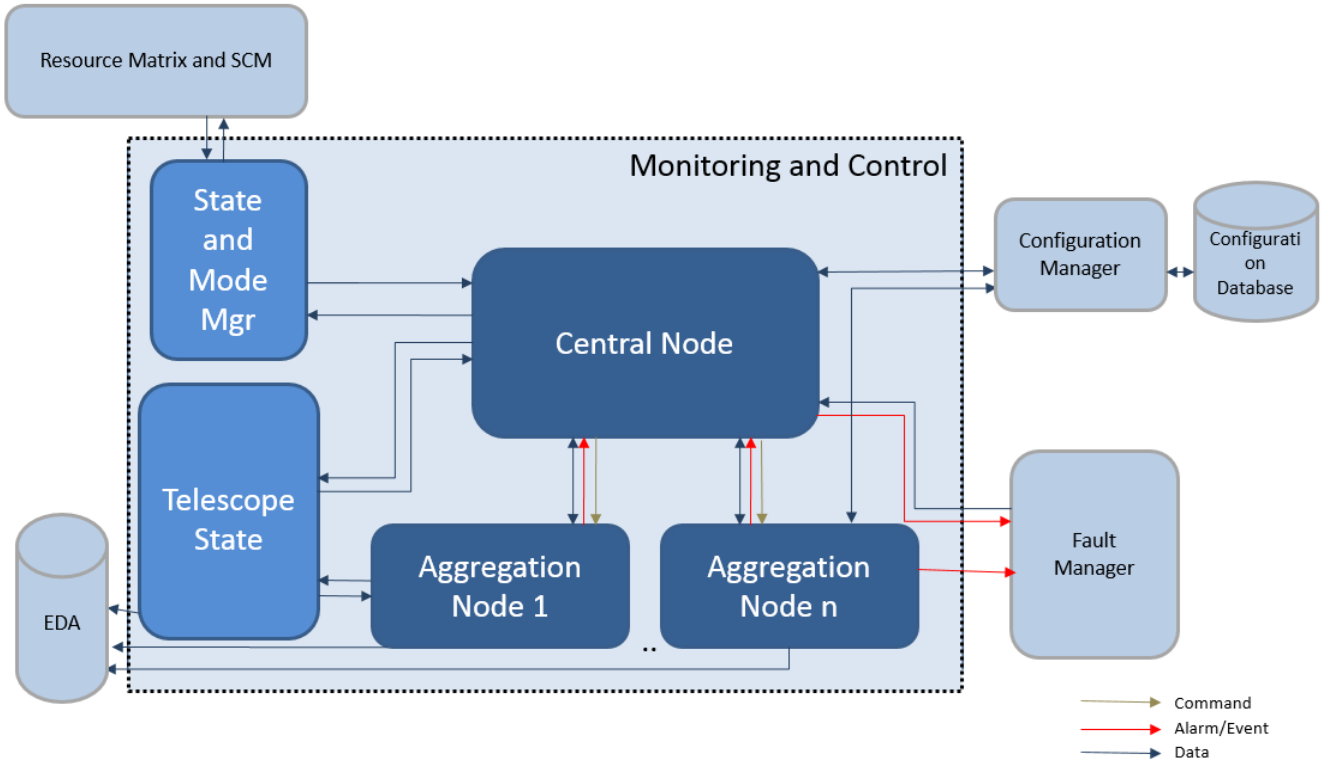
- Monitor and control telescope
  - Configure Telescope, Sub-array, set modes,
  - Facilitate calibration
  - Collect Element data, drilled down data for diagnostics , status/state, monitoring data, events
  - Process received data to detect undesirable condition (e.g. cross correlation across LMC's)
  - Trigger corrective actions through commands
  - Derive telescope status
  - Provide support to update operational knowledge and execute Telescope Model through scripting support
  - Provide Element LMC's with subscription data, events

Requirements (contd)

- Fault management
  - Collection of Alarms through subscriptions
  - Implementation to calculate derived alarms based on conditions
  - Mechanism to perform Alarm handling. E.g. suppress/acknowledge alarms
  - Filter Alarms to handle Alarm floods
  - Storage and display of Fault data, Alarms
  - Display of Alarms list (e.g. active) across locations (e.g. site, engg facility etc)
- Resource management
  - Maintain Capability information
  - Update Capability allocation matrix based on allocation/de-allocation

TELMGT_REQ_80-89, TELMGT_REQ_97, TELMGT_REQ_302, TELMGT_REQ_294 etc

Architecture impact : Generic configurable M&C nodes



- Central and Aggregation Nodes (+Element nodes): A configurable 'generic node' performing all roles with:
  - Functions, i.e. M&C, fault management and resource management.
  - Non functional e.g. ensure, derive and report telescope availability, reliability
- State and mode manager - perform derivation of the Telescope State based on Element State – needs state machine type execution engine
- Telescope state - is the interface with persistence to store telescope state

M&C Framework needs

Support for specific M&C features

- Multi level Control hierarchies (CN,AGN, Element node)
- Control loops with time constraints (e.g. 500 milliseconds timer).
- Multicast of alarms, events and monitoring data with required performance
- Execution of State machines or interface with State machine engines
- Handling of ~1000 process variables/monitoring points. (E.g. An AGN for a dish).
- Redundancy - saving and restoring the execution state of system components.
- Caching of online data reducing disk IO.

Unique

- Data driven generic node

M&C Framework needs (Contd.)

Fault management

- Specification of Alarms detection condition.
- Subscription and notification of Alarms.
- Development of Alarm handling strategies/mechanisms (grouping, actions and so on)
- Alarms visualization, annunciation
- Log Alarms
- Authorization to handle Alarms
- Out-of-box support to handle Alarm floods, Alarm filtration and summarization.

TM-LMC interaction: Some of the common control items identified in new LIG (section 5)

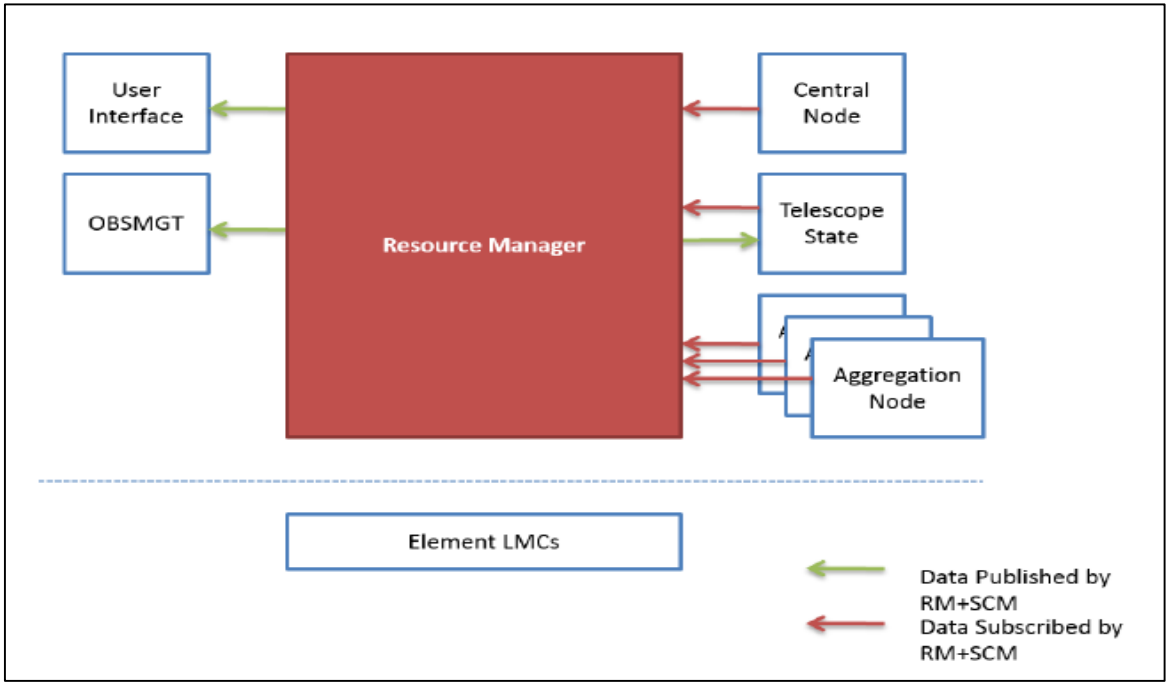
- Commands – Start, Stop, Restart
- Logging:
  - Target – E.g. Console, File, System, Database
  - Levels – E.g. OFF, FATAL, ERROR, WARNING etc.
- Alarms and Events
  - Types – Transient/Persistent
  - E.g. bandwidth reduced, communications protocol error
- Mode, State, Status – SKA Control Model. Each SKA Element must be able to maintain and report the mode, state, status information using the below indicators:
  - Element Type – E.g. REAL, SIMULATED, STANDBY, NOT-FITTED
  - Control Mode – E.g. CENTRAL, LOCAL
  - Operating Mode – E.g. ENABLED, DISABLED, MAINTENANCE
  - Operating State
  - Health Status
  - Usage Status
  - Capability Health Status
  - Sub-array State (Applicable for sub-arrays only)

Observation preparation, scheduling and execution

Requirements: TELMGT_REQ_22, TELMGT_REQ_26, TELMGT_REQ_294, TELMGT_REQ_39 and so on

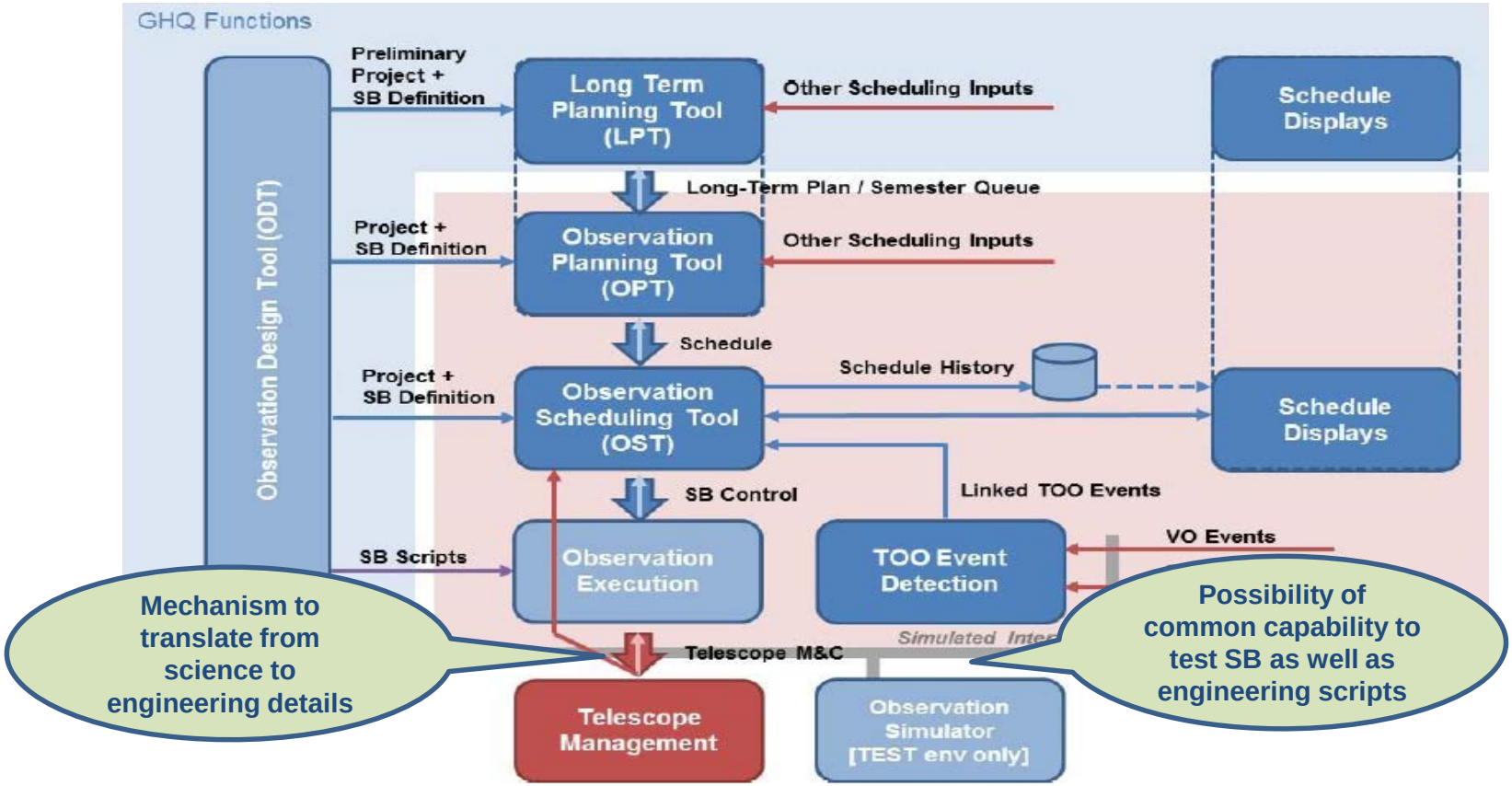
- Observation planning and scheduling
  - Based on availability of Element Capabilities
- Specification of
  - Scheduling Block (SB)
  - Scripts encoding engineering logic
- Testing and execution of experiments
  - Perform simulation to ensure experiment correctness
  - Generate execution status and derive decisions

Architecture : Resource Manager to manage Capability availability matrix



- Provide Capability availability information for planning
- Monitor Capability health
  - Update Capability availability based on SB execution context (Experiment abort leads to de-allocation of Capability)
  - Influence of Telescope status on Capability status (e.g. Impact of Maintenance on Capability availability)

Architecture perspective – Specification and execution



2 layer of programming interfaces

- Ability to specify from the 'Science' perspective (Used in Scheduling Block)
- Procedures coded with Element specific 'engineering' commands

Common capability for simulation based testing

M&C Framework needs

- Ability to interface with an independent Resource manager
  - Great if has an out-of-the-box Resource Matrix
  - Ability to interface with an off-the-shelf in-memory database
  - Ability to manage the SCM of the Capabilities
- Ability to support a 2 layered API architecture
  - Translation/invocation of one from another
- Ability to perform or integrate with simulation engines

TM-LMC interaction: Footprint of Capability on LIG?

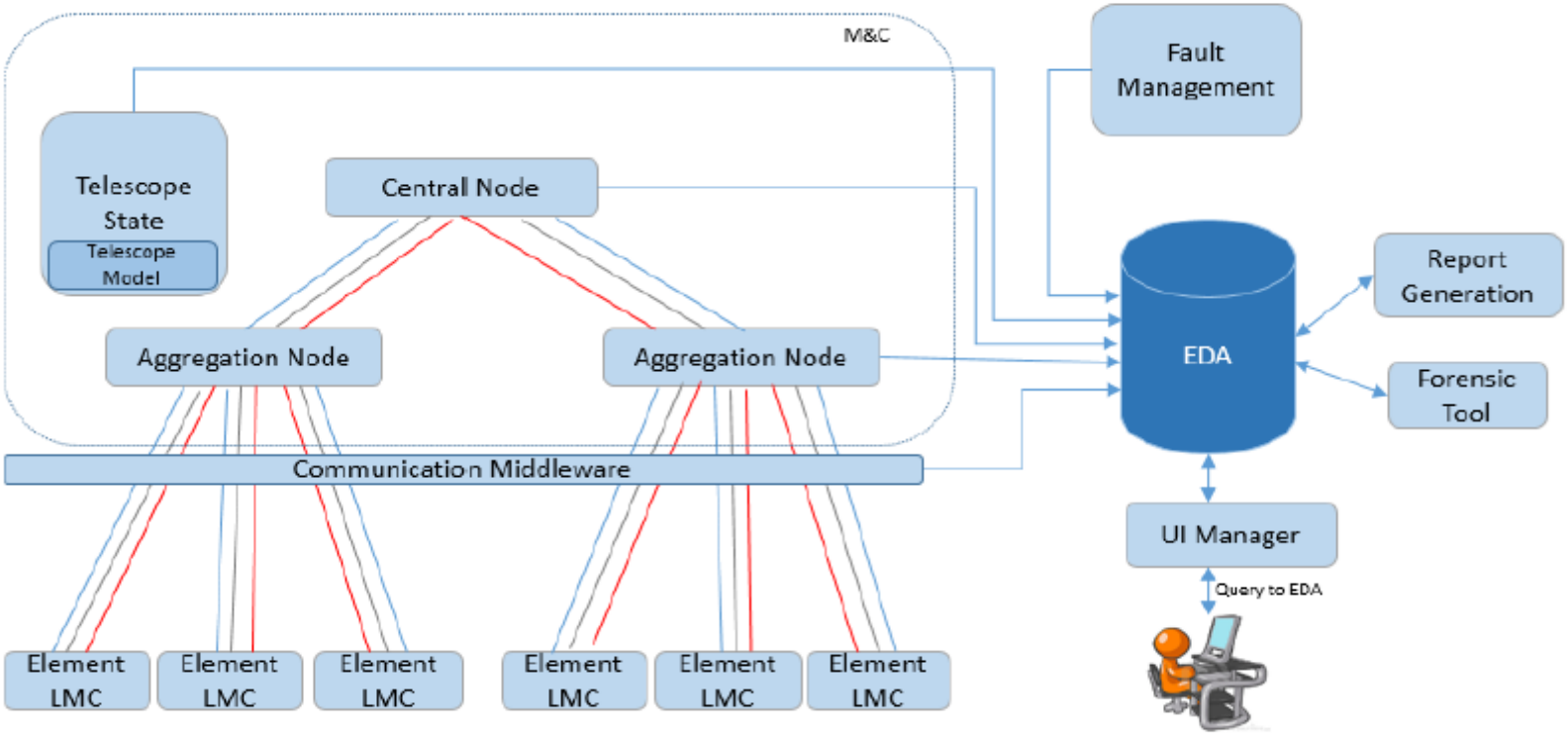
- “Capability Health Monitoring Data: Element LMC will intimate TM on health of capability based on the current conditions of that Capability, and indicates whether that Capability is operating normally, degraded or has failed. For example, health report for a Sub-array shall show status of the dishes or stations that belong to the subarray, or frequency band Capability of a DSH element.” [4.1.1]
- The Capability Health Status from the Element will conform to the SKA Control Model. [5.1.5]

Archival of states, monitoring data and logs

Requirements: TELMGT_REQ_111, TELMGT_REQ_213,TELMGT_REQ_214,TELMGT_REQ_221,TELMGT_REQ_223

- Collect and persist data
  - from distributed sources
  - monitoring data (e.g. sensor output), logs, System configuration data and so on.
  - external information (RFI, Satellite and so on)
- Make the data available to other components
  - Forensic tool for performing diagnostics and troubleshooting various problems.
  - Report Generation
- Enable
  - Data redundancy, backup and so on.

Architecture impact : Data collection and storage



- Archival of monitoring data, System Configuration data and all System logs.
- Providing data for Maintenance , failure diagnostic purpose
- Provide query capabilities to the archive
- Provide data to other components like Forensic tool, Report Generation system

M&C Framework needs

- Support publish-subscribe model
- Data collector that scales to the SKA needs
  - Support for communication protocol enabling distributed data capture
  - Support for more modern solutions to the persistence problem
  - Integration with Off-the-shelf Apache-Cassandra/Hadoop or other storage than the traditional relational databases
- Cache data
  - Might need temporary storage of Alarms and so on.
- Built in support for querying logs

TM-LMC interaction: LIG perspective

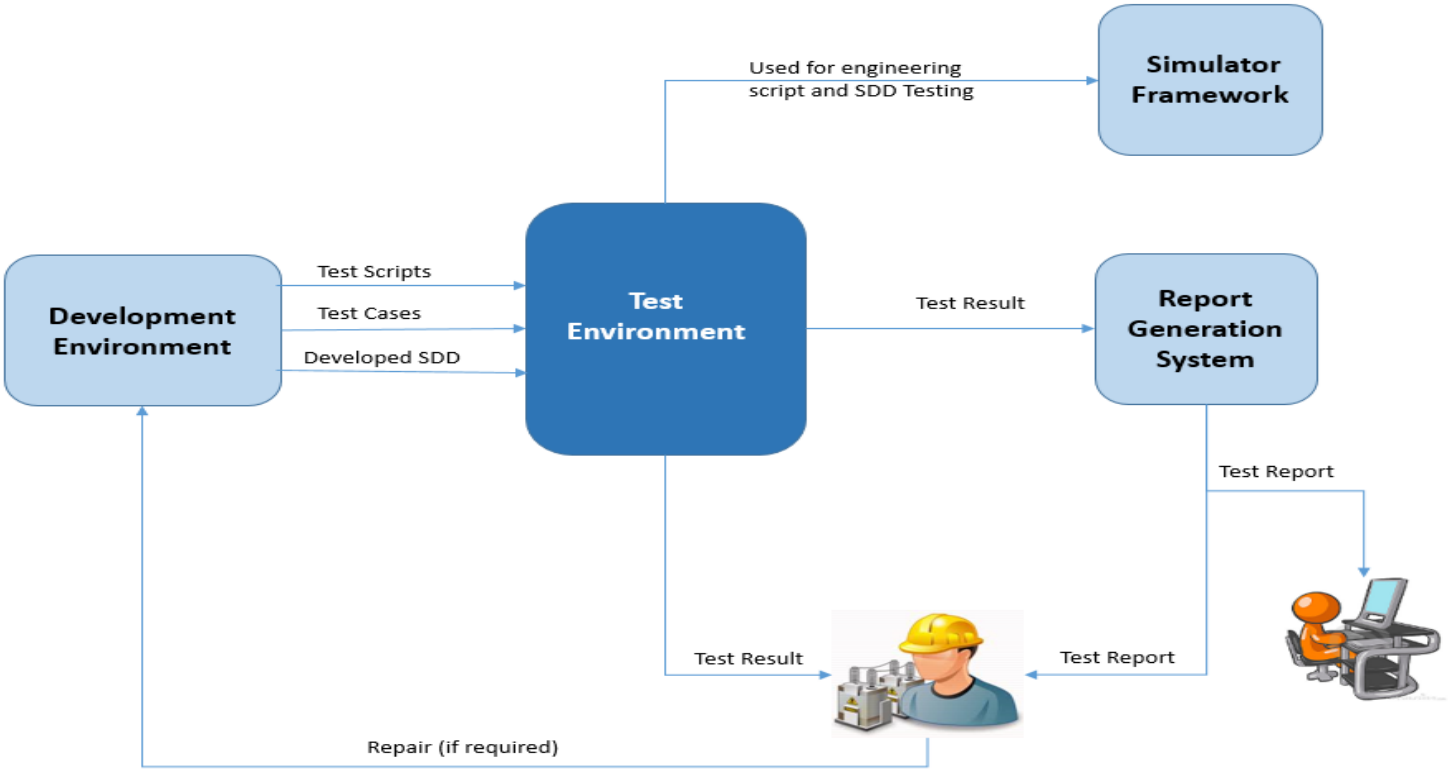
- Elements should leverage the TM data storage service even if they implement their own database
  - Will be very useful for diagnostic purposes which require cross correlation.
  - Enable common standard for logging.
    - Provision for TM to change the logging levels, upload and search the log files.
  - Can be used for other purposes such as overal Performance monitoring

Commissioning, configuration, Element initialization:

Requirements: TELMGT_REQ_2, TELMGT_REQ_8, TELMGT_REQ_289, TELMGT_REQ_290 and so on

- Adaptation of Element LMC's through Self Description Data (SDD) based integration
- Initialization of 'service catalogue' based on Capability definition from Elements
- Need for manual control for including network isolation, diagnostics, testing
- Subscription to Alarms, Events, Data of Element LMC's
- Facilitation for Elements to subscribe to parameters, SKA events, alarms and so on.
- Basic framework to facilitate "auto-discovery" while in operation

Architecture impact : Build Support for SDD Development and Element Verification features



- Editor to develop SDD with user assistance
- Validation, syntactic and domain specific
- Deployment of the SDD data (e.g. interpretation/code generation)
- Provide test harness to store test cases to test SDD
- Execution of the test cases and generation of reports/results
- Storage of test runs
- Validation of Scheduling blocks/engineering tasks based on simulated resources

M&C Framework needs

- Direct support for SDD based on integration (ideal)
  - Config file or Data driven software makes it possible!
- Else comply with third party SDD platform
  - Integration based on SDD through code generation/interpretation
  - Testing of the integration through simulation

TM-LMC interaction: New LIG section 5.1.9, 7.1

Below is the list of some of items which will be included as part of SDD:

- Equipment serial numbers
- Parameters for commands and their constraints/rules to validate them.
- Minimum and maximum for performance parameters
- Events/Alarms which needs to be handled by TM
- Monitoring data (For example: voltage, power, health status, temperature)
- Behaviour logic (state-machines)
  - Monitoring and coordinating logic
  - Alarm handling logic
- Software, hardware and firmware versions
- Subscription parameters

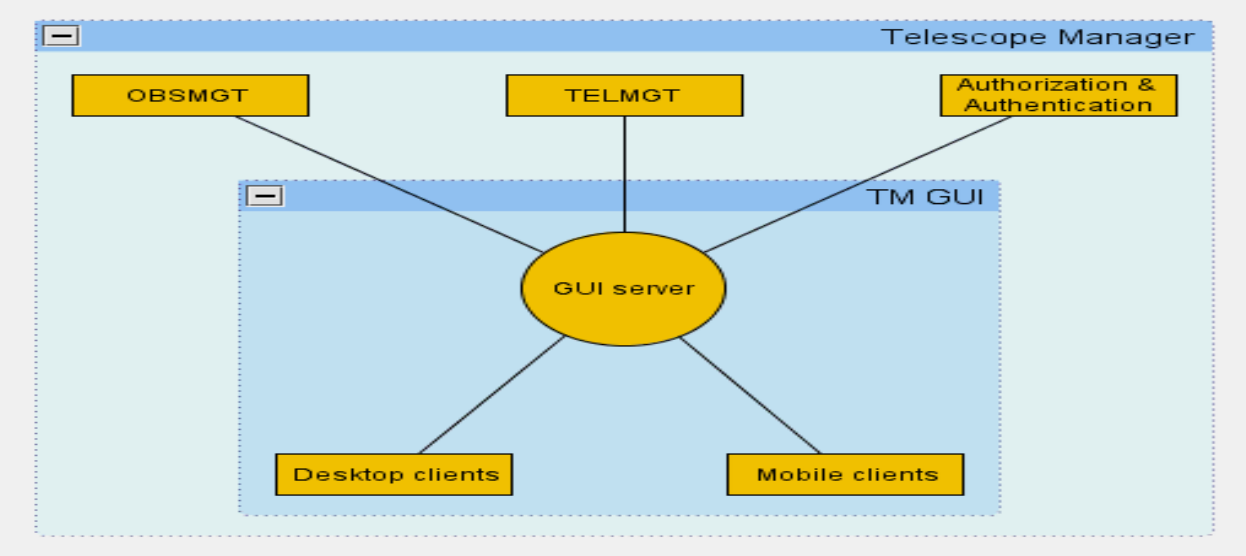
SDD_XML_Structure .xml

User interfaces for SKA stakeholders (scientist/operators)

Requirements: [TELMGT_REQ_87, TELMGT_REQ_97, TELMGT_REQ_128]

- UI for Scientists
  - Proposal submission, Observation Planning, SB preparation and so on
- Operator UIs
  - Command and control
  - Telescope and subarray status
  - Alarms notification and handling
  - Diagnostics and maintenance
- Need for interoperability
  - Invocation of operator UI's from the science context and so on

Architecture perspective : Notion of a UI platform



- A development platform used to build domain specific UIs
  - Can be used to build OBSMGT/TELMGT/LMC UIs (e.g. operator interfaces)
  - Not hard and fast, allows existence of UI's built using other platforms
- Execution based on Model-View-Controller paradigm
  - GUI Server: A generic, domain independent, configurable controller coordinating OBSMGT/TELMGT/LMC UI's
  - Allow bypass and usage of remote console

M&C Framework needs – from the User Interface perspective

- Great if it can provide the platform!
  - Support for domain specific UI's
- If not, at least should support the platform idea.
- Ability to integrate with third party UI's
  - Support for web based interface and so on

TM-LMC interaction: LIG from the UI standpoint

- “Operating mode of an Element can be set by TM (when Element is under Central control) or by operator/Engineer remotely using console tools (when Element is under Local control)”[5.1.5].

- “Element LMC Interface shall provide a standard console to TM for remote maintenance.”[6.1.2].

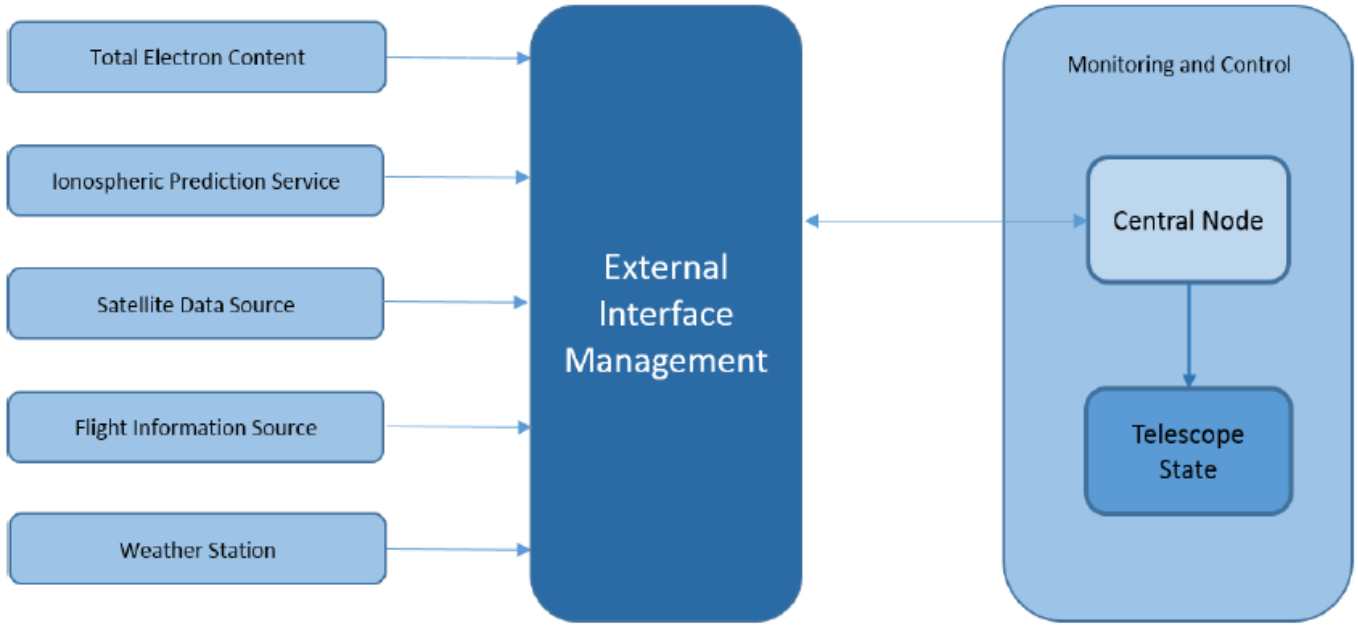
- LMC’s are also expected to provide debug interfaces and custom visualizations.[9 – Appendix section]

Facilitate external input – Telescope Model/external systems

Requirements: [TELMGT_REQ_111, TELMGT_REQ_126]

- Capture and store external information
  - Total Electron content, Satellite data and so on
- Provide data to other Elements based on publish-Subscribe model

Architecture : Integration to an ‘External Interface management system’



- Provide interface to external systems like TEC, IPS etc.
- Perform some amount of data formatting
- Provide data to other Elements based on subscription request
- Store the data

M&C Framework needs

- Gets covered with its ability to interface with third party systems
- The rest is same as points discussed above!

Thanks!