Interface Management for SKA Telescope Manager

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TM Context

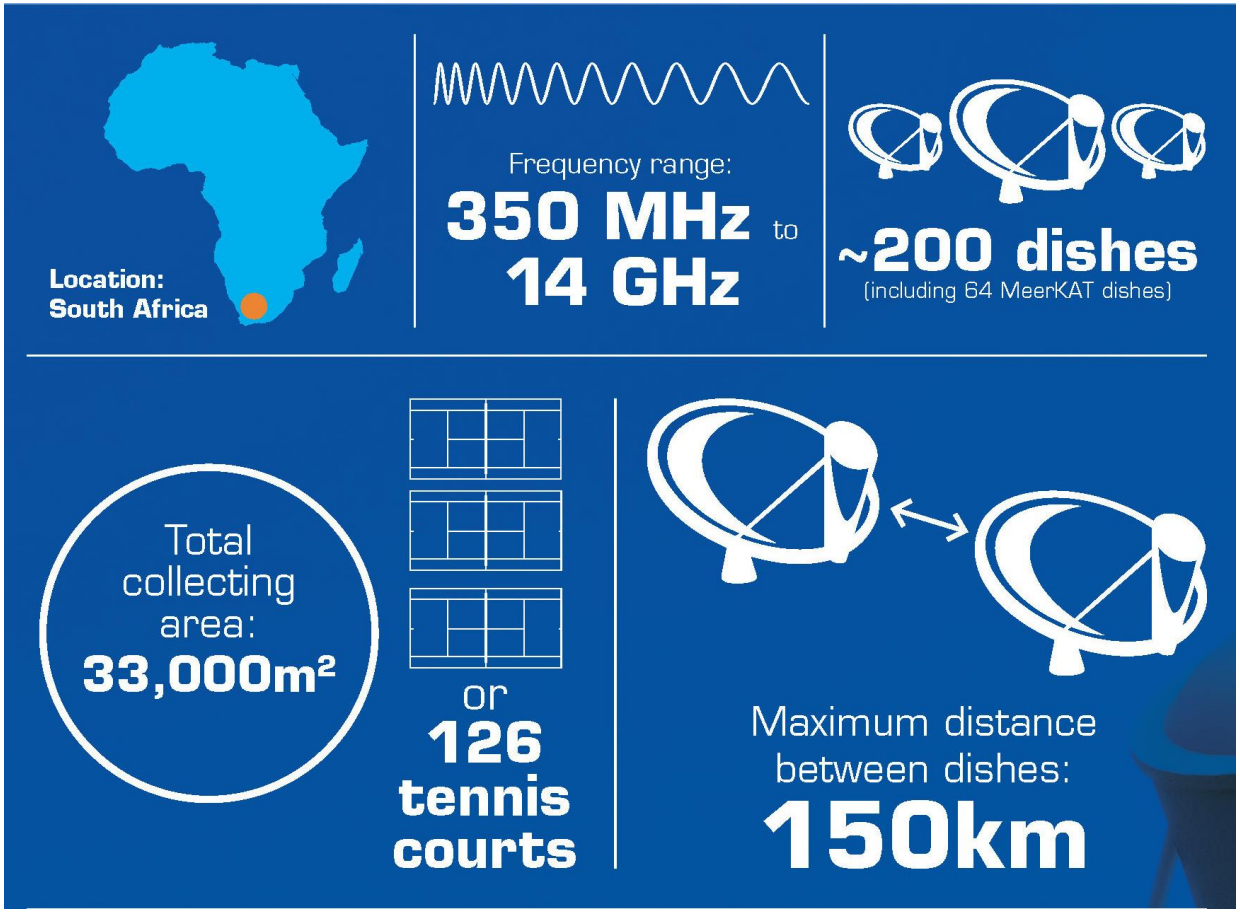
- SKA
  - Will revolutionise understanding of the universe
  - Currently in Phase 1 (fraction of Phase 2)
  - 2 telescopes in SKA1 Observatory

SKA1-Low (Australia)

SKA1-Mid (South Africa)

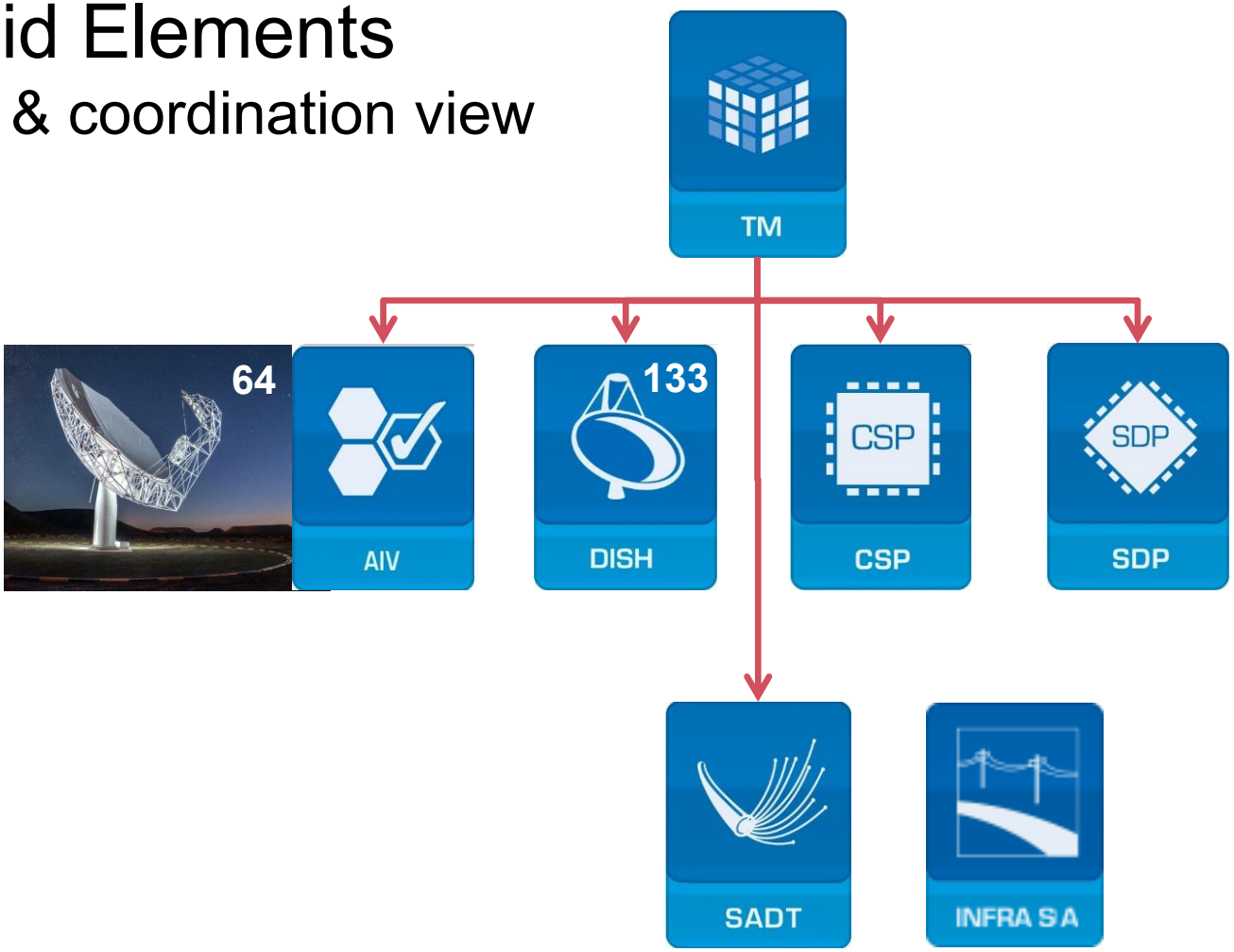
TM Context

- SKA1-Mid Telescope



TM Context

- SKA1-Mid Elements
  - Control & coordination view



TM Functionality

- Managing:
  - astronomical observations,

TM Functionality

- Managing:
  - astronomical observations,
  - telescope sub-systems

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TM Functionality

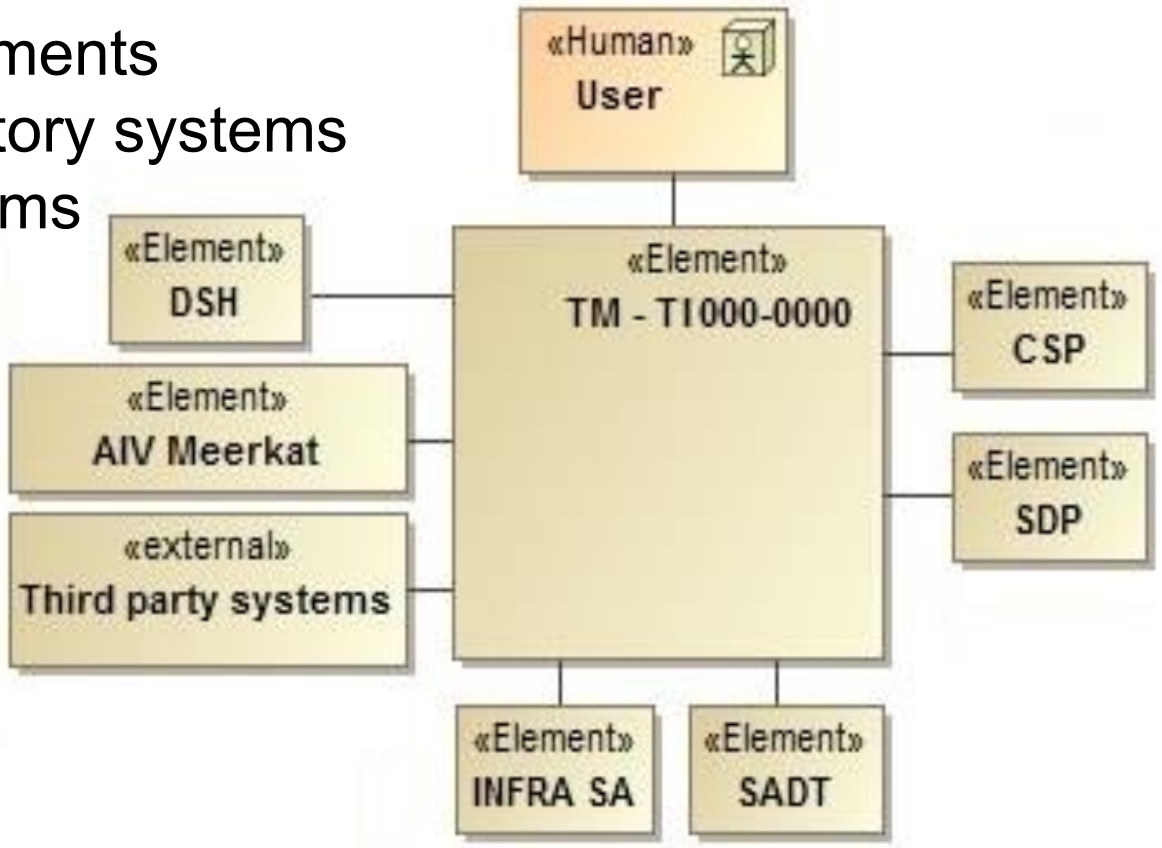
- Managing:
  - astronomical observations,
  - telescope sub-systems to perform observations,
  - data

TM Functionality

- Managing:
  - astronomical observations,
  - telescope sub-systems to perform observations,
  - data to support users in achieving operational, maintenance & engineering goals.

SKA1-Mid TM Ext. Interfaces

- Interfaces with:
  - telescope Elements
  - SKA Observatory systems
  - external systems



SKA1-Mid TM Ext. Interfaces

- Interfaces with Elements:
  - Data exchange (estimated 2GBps throughput [1]):
    - Monitoring and Control
      - (CSP, SDP, Dish, MeerKAT Dish, SADT)
    - General
      - (CSP, SDP)
    - Network connectivity
      - (SADT)
    - Synchronisation and timing
      - (SADT)

[1] P.S. Swart et al, “SKA TM Design Report”, T0000-0000-DR-001, Rev D, June 2015.

SKA1-Mid TM Ext. Interfaces

- Interfaces with SKA Observatory systems:
  - Physical (INFRA-SA)
    - Mechanical, Electrical, Cooling
  - Data exchange (INFRA-SA)
    - INFRA SA provides key status indicators that affects telescope operations (cooling & power)
  - Data exchange (ILS System)
    - TM sends failure related sensor data
  - User interface (scientists, observation planners, engineers, commissioners, maintainers, operators)
  - APIs: scheduling block construction, obs. scripts

SKA1-Mid TM Ext. Interfaces

- Interfaces with external systems:
  - Services:
    - Virtual Observatory Events
    - Astronomical catalogues
    - Satellite information
    - Flight information service
    - Earth orientation parameters
    - Ionospheric prediction
  - Custom experiment hardware

TM interface challenges

- TM interfaces with diverse & many systems.
  - Major source of requirements for TM,
  - Interface diversity causes complexity,
  - Risk: inconsistency TM requirements & interfaces.
- SKA project a collaboration of Element Consortia (geo. distributed institutions).
  - Challenge of communication & coordination.
- Initial absence of central, comprehensive architectural representation for telescope.
  - Uncertainty of TM scope and boundaries.
- Various Human interfaces

Mitigations

- Telescope architecture impacts TM external Interfaces.
- SKA1-Mid functional architecture with allocations to Elements.
- TM external interface standardisation.
- Consistency between TM requirements and external interface definition.
- User interface development focus.

Observatory architecture impact on TM interfaces

- Local M&C functions allocated to Elements.
- Control hierarchy
  - Levels:
    - Human (infrequent, judgement based intervention),
    - TM (telescope, sub-array coordination),
    - Element LMC (frequent real-time autonomous).
- Conversely, upwards abstraction.
- Cause separation of concerns and reduce complexity. [1]
- Enabled M&C interface standardisation.

[1] E. Fosse, C.L. Delp, "Systems Engineering Interfaces: A Model Based Approach", in Proceedings of 2013 IEEE Aerospace Conference, IPAC'14, Big Sky, MT, USA (2013); http://dx.doi.org/10.1109/AERO.2013.6497322

M&C Interface Standardisation

- Standardisation reduces M&C interaction diversity and produce guidelines for technical communication with Element Consortia.
- Standardisation helped set some TM M&C scope & boundaries.
- We produced a set of interface requirements for TM & Elements (to be refined).
- Aspects: general principles, required functionality, format and content of messages & communication infrastructure.
- LMC Guidelines document was distributed.

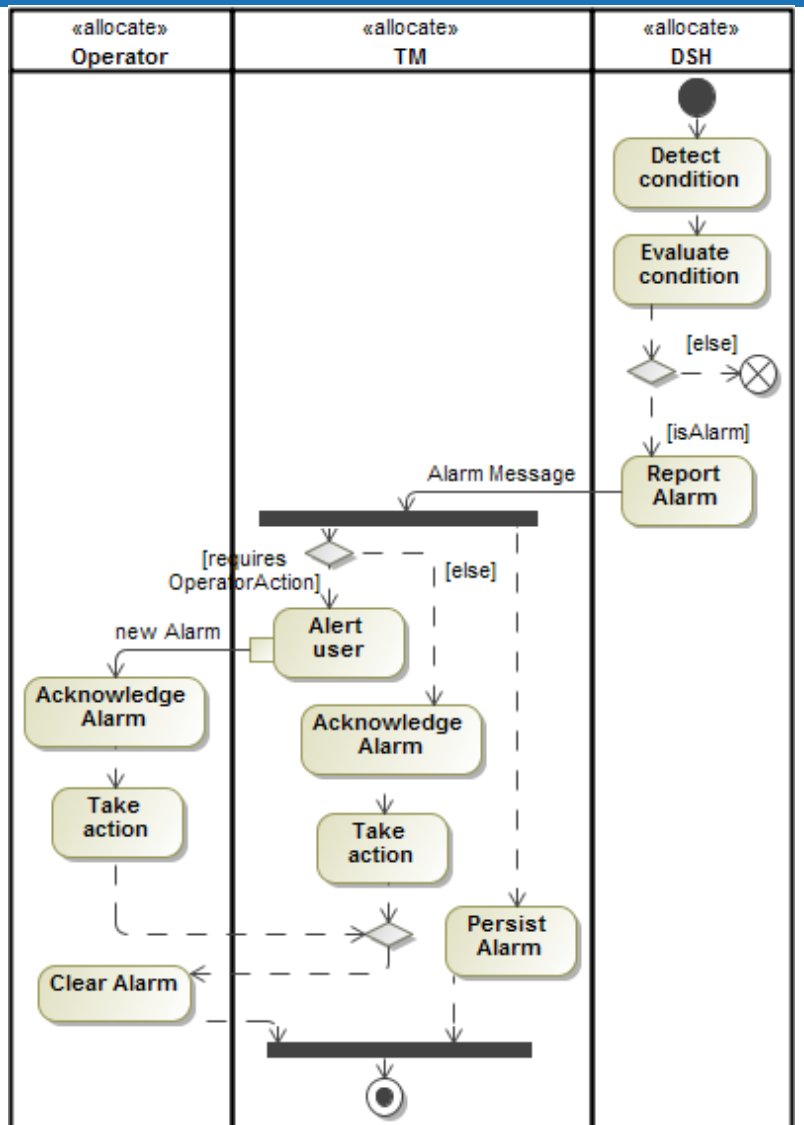
M&C Interface Standardisation: Framework

- Frameworks & communication protocols based on general interface requirements.
- TMC listed requirements for framework, led effort to identify, investigate & nominate candidate technologies (ACS, EPICS, TANGO).
- SKA Consortia representatives discussed candidates & criteria (Trieste March 2015).
- TANGO Control Systems selected as technology of choice for implementation of M&C interfaces between TM & Elements, recommended internal to Element (optional).

Consistency: TM interfaces & requirements analysis

- Up to now:
  - Telescope requirements allocated to TM.
  - Derived TM functional structure.
  - TM functions specified by TM requirements.
  - TM requirements refer to ext. Interfaces for interactions with Elements (some verifiable consistency).
  - External ICDs focussed on information flow.
  - SysML use case diagrams and swimlane activity diagrams describe TM behaviour in interactions via external interfaces.

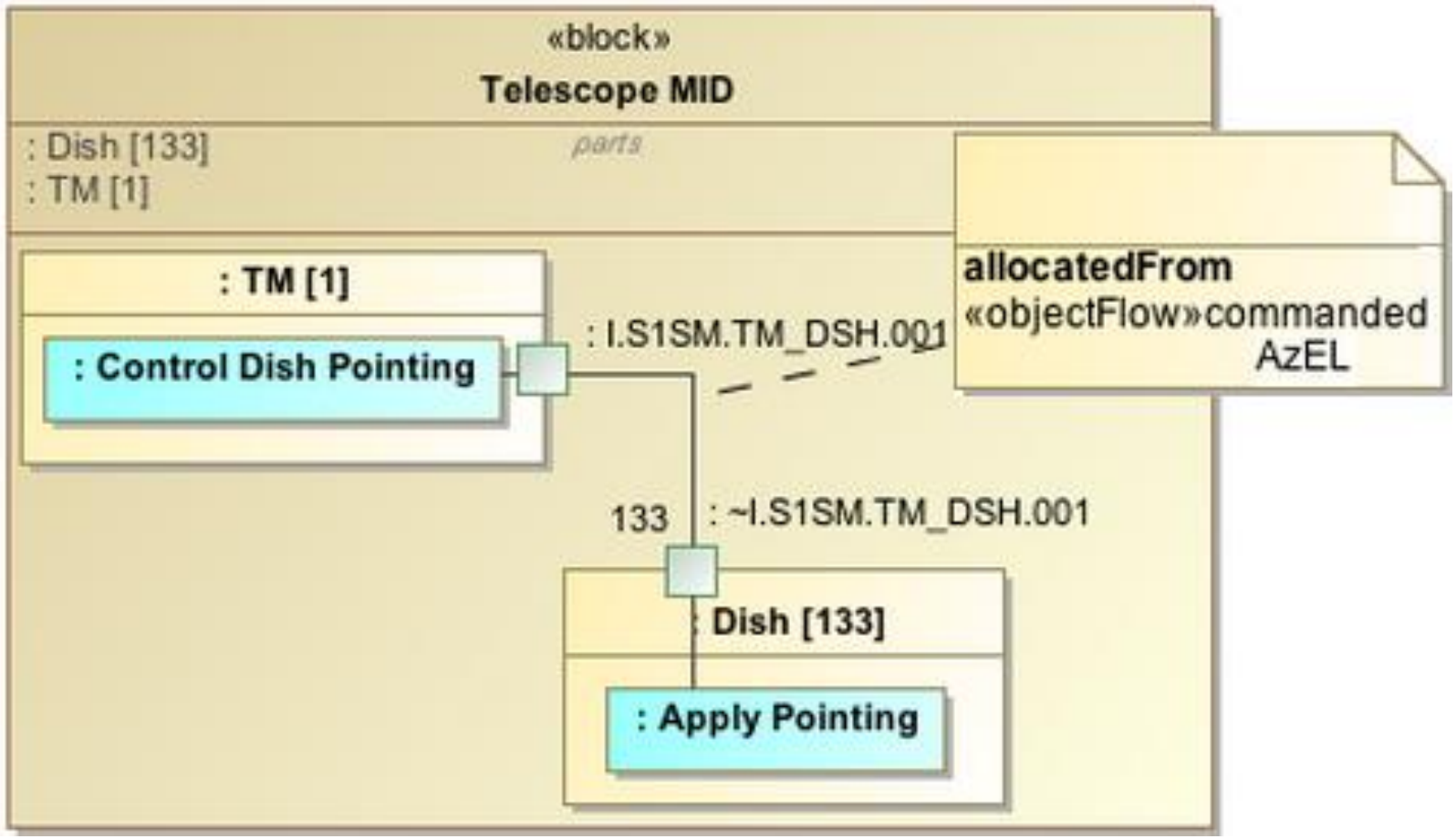
Consistency: TM interfaces & requirements analysis



Consistency: TM interfaces & requirements analysis

- Going forward:
  - Modelling information exchange between TM & Elements as SysML object flows.
  - Allocate functions to TM and Elements,
  - Model functions as SysML activities,
  - Now object flow between TM & Elements can be shown.
  - By tracing each object flow to an allocated interface port and connector, behaviour (function) (specified by TM requirements) and structure (interfaces) are linked together, ensuring verifiable consistency.

Consistency: TM interfaces & requirements analysis



TM User Interface Development Focus

- User interaction with TM is via user interface.
- Users & task analysis from TM requirements, SKA Concept of Operations & SKA Use cases.
- Project glossary is single definition of actors, roles, tasks.
- Represent scenario's and interaction workflows with SysML use case diagrams.
- Detail it out with textual descriptions & swimlane diagrams to describe dynamic behaviour.

Summary

- TM external interfaces: diverse & many.
- Handling resulting complexity by M&C separation of concerns and interface standardisation.
- SysML models integrate interface definition and requirements analysis, supports UI analysis & design.
- M&C standardisation and UI development are two focus areas of TM Consortium interface work.

Thank you

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For more information, see: P.S. Swart, , S. Chauduri, G.M. le Roux, A. Marassi, R. Smareglia, S. Vircic, "Interface Management for the SKA Telescope Manager", MOD3O06, ICALEPCS 2015.