The SKA Dish Local Monitoring and Control System

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The Square Kilometer Array (SKA): the world's largest and most sensitive radio observatory

- **2 radio antenna arrays** (Fig. 1)
  - SKA1-Mid: South Africa
  - SKA1-Low: Western Australia
- **2 construction phases foreseen**
  - Phase 1 (2018-2024): SKA1-Mid + SKA1-Low arrays
  - Phase 2 (mid 2020s): expansions of both arrays in Southern Africa and Australia
- **SKA pre-construction phase 1 ongoing**
  - Lead by 8 major consortia coordinated by the SKA Organization
  - 10 member countries, >100 research institutions and companies across 20 countries
  - Consortia completing their critical design

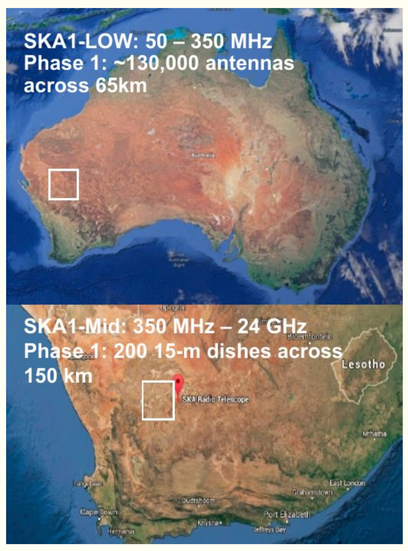

Fig. 1: SKA1-Low (top) and Mid (bottom) locations

SKA1-Mid array layout (Fig. 2)

- 130 15-m diameter dish antennas (+64 Meerkat dishes)
- Extension: 120 km
- Observing frequencies: 0.35-14 GHz
- Phase 1: band 1, 2 in each dish, band 5 in 67 dishes
- Extension to ~2500 antennas in SKA 2

Fig. 2: Pictorial view of SKA1-Mid array (left) and dish antenna (right). Image credits: SKAO

SKA DISH OVERVIEW

Dish instrumentation (Fig. 3) mounted at 3 major locations (indexer, pedestal, yoke) and designed by:

- **Dish Structure (DS)**: antenna structure and optics, feed indexer, servo systems, power distribution and safety systems.
- **Single-Pixel Feed (SPF):** feed packages (OMTs, LNAs), feed helium cooling and vacuum system and relative controllers.
- **Receiver (SPFRx)**: RF digitizer system and relative controllers.

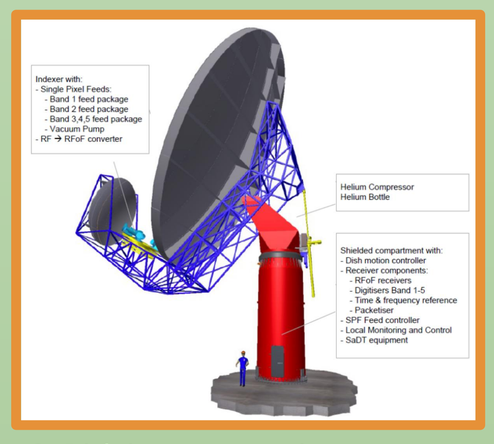

Fig. 3: Dish instrumentation

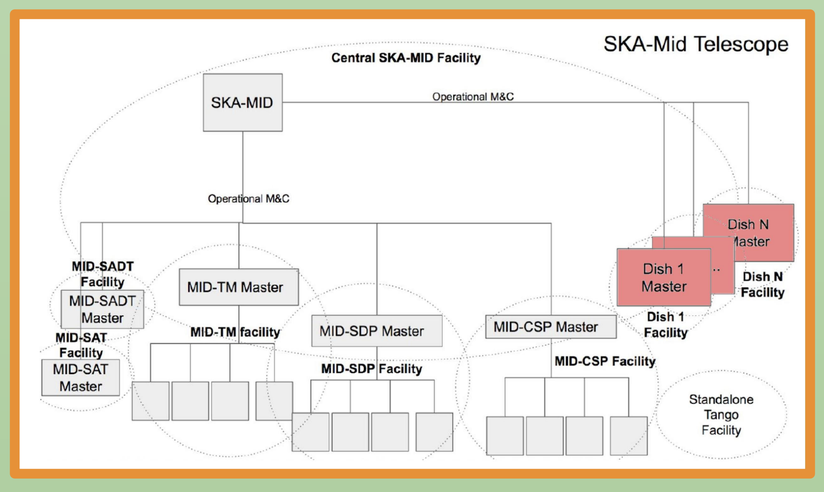

Fig. 4: High-level SKA1-Mid CS hierarchy

DISH LMC ROLE IN SKA CS

- **SKA Control System (CS) design** (Fig. 4)
  - based on Tango framework
  - organized in hierarchical Element facilities (=Tango domains)
  - Harmonized across Elements with common guidelines & patterns
- **Each Dish has a Local Monitoring and Control (LMC) system**
  - LMC provides dish master control and rolled-up monitoring to Telescope Manager (TM)
  - TM remotely coordinates the telescope scientific and M&C operations
- **Dish LMC "size" from a M&C view**
  - Monitoring points: <2000
  - M&C data flow to TM: ~200 kbps
  - Fastest M&C rate: 100 ms
  - Number of Tango Device Servers (TDS): <20

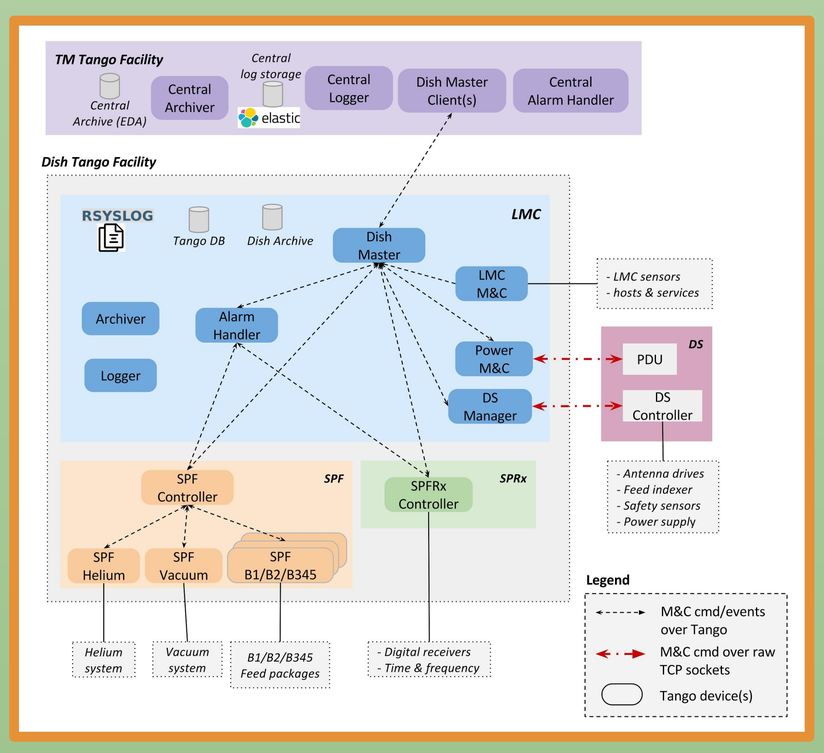

Fig. 5: Dish LMC high-level architecture

DISH LMC DESIGN AND PROTOTYPE

- **Dish LMC high-level architecture designed** (Fig. 5)
  - 1 master TDS for high-level Dish M&C
  - 1 TDS controller per Dish sub-element
  - 1 logger/archiver/alarm handler TDS per Dish instance
  - Additional TDS for LMC self M&C, power control
- **Prototype implementation started**
  - Aim: design validation + dish qualification
  - Technologies selected (Table 1)
  - Tango extensions implemented

LMC Tango extensions

- Logging to syslog targets
- Dynamic attributes from XML config files
- Tango attribute-based command state machines
- Formula attributes
- Tango device proxy utilities
- Task sequences
- Tango-Nagios interface

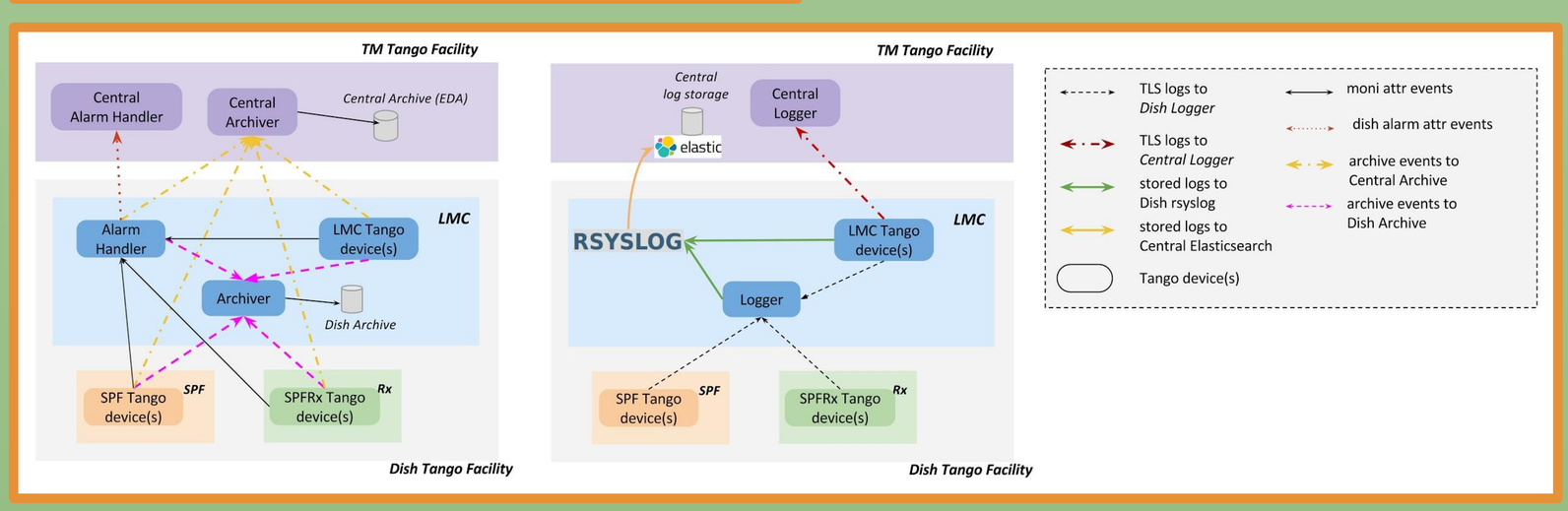

Table 1: List of Dish LMC prototype employed technologies

Type	Technology
Progr. language(s)	C++ (control system), python (configuration & testing)
M&C framework	Tango 9
Tango tools	PyTango, yat4tango, Elettra Alarm System, HDB++ Archiver, Taurus GUI
Libraries & tools	boost, jsoncpp, pugixml, Exprtk, Nagios 4
Build system	cmake
Version control	git (GitLab)
Testing	Google Test, python behave + nose
Configuration management	Ansible
Continuous integration	Jenkins
Documentation	Doxygen + Sphinx/breathe
Virtualization & OS	VirtualBox, Ubuntu 14/16

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