Why

• International project, 10 member countries (Australia, Canada, China, India, Italy, New Zealand, South Africa, Sweden, the Netherlands, United Kingdom)

• In fact, around 100 organizations across about 20 countries participating in the preliminary design and development of the SKA and now engaged in the critical design of the telescope

• Large worldwide community with different backgrounds

• Local Monitoring and Control (LMC) standardization + harmonization effort in place since 2015
What

A set of three main documents:

• SKA1 Control System Guidelines – Main volume
• SKA1 TANGO Developers Guidelines
• SKA1 TANGO Naming Convention

plus six additional technical notes, at various levels of completion:

• SKA Control Model
• SKA Logging
• SKA Configuration and Control
• Integrating Distributed TANGO Facilities
• Element Archiving and Central Archiving
• Element and Central Alarms Handling

making a total of some 330 pages (well... that’s not so bad... and you can start with just 120)

SKA Control System Guidelines made possible by the contribution of a group of people.
Intended to be working documents -> evolve with the project.
Purpose

Control System harmonization across SKA

• Identify common approaches for Monitoring and Control
• Identify and summarize generic design patterns
• Identify proper TANGO design patterns
• Avoid TANGO anti-patterns
• Maximize the benefits of the TANGO framework
• Identify and draft preferred SKA Control System general architecture (with TANGO)
• Setup templates for Interface Control Documents
• Define guidelines for SKA TANGO developers
SKA TANGO facilities

- SKA telescope in fact made by two telescopes: MID and LOW
- Each telescope made by a number of different “Elements”: DISH, CSP, SDP, INFRA, LFAA, SAT, TM... some belong to MID, some to LOW
- Each Element will be responsible of one or more TANGO facilities

<table>
<thead>
<tr>
<th>Facility</th>
<th>Description</th>
<th>Facility</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SKA-MID</td>
<td>Central Telescope Manager for MID</td>
<td>SKA-LOW</td>
<td>Central Telescope Manager for LOW</td>
</tr>
<tr>
<td>MID-CSP</td>
<td>Central Signal Processing for MID</td>
<td>LOW-CSP</td>
<td>Central Signal Processing for LOW</td>
</tr>
<tr>
<td>MID-SDP</td>
<td>Science Data Processor for MID</td>
<td>LOW-SDP</td>
<td>Science Data Processor for LOW</td>
</tr>
<tr>
<td>MID-Dnnnn</td>
<td>One for each dish, 170 SKA1, ~2500 SKA2</td>
<td>LOW-LFAA</td>
<td>Low Frequency Aperture array</td>
</tr>
<tr>
<td>MID-SAT</td>
<td>Synchronization And Timing for MID</td>
<td>LOW-SAT</td>
<td>Synchronization And Timing for LOW</td>
</tr>
<tr>
<td>MID-SADT</td>
<td>Signal and Data Transport for MID</td>
<td>LOW-SADT</td>
<td>Signal and Data Transport for LOW</td>
</tr>
<tr>
<td>MID-INFRA-SA</td>
<td>Infrastructure SA</td>
<td>LOW-INFRA-AU</td>
<td>Infrastructure AU</td>
</tr>
<tr>
<td>MID-Mnn</td>
<td>MeerKAT precursor receptors (64)</td>
<td>LOW-ASKAP-WSS</td>
<td>ASKAP precursor ancillary</td>
</tr>
<tr>
<td>MID-MKAT-ANC</td>
<td>MeerKAT ancillary</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Element M&C

Element Monitoring and Control scope and responsibilities have been defined with respect to Central Telescope Manager:

- Standalone Element TANGO facility **top level hierarchy** for TANGO devices
- Control System pattern for operational control in normal use
- Control System pattern for rolled-up monitoring and reporting
- Archiving patterns
- Logging patterns
- Rolled-up SKA alarms reporting
- Drill-down diagnostics and monitoring

- Template for TANGO based TM-<Element> Interface Control Document (ICD)
  Capture logical Element to TM interface for operational control and rolled-up monitoring
Terminology

- **Monitoring** – subscribing to attribute events to evaluate its value/quality factor
- **Archiving** – gathering attribute values from a device to save it to an engineering archive
- **Logging** – additional information emitted by components for fault finding or forensics. Can be stored as well (log storage)
- **Failure** – inability to perform the required function to the specification
- **Fault** – the condition which causes software to fail to perform its required function
- **Error** – difference between actual output and expected output
- **Alarms** – SKA adopts the IEC 62682 standard → **Clarifications**
  - TANGO Attribute alarms: TANGO core well known mechanism, not IEC 62682 compliant
  - Element/Telescope Alerts: any complex, rule-based, aggregated asynchronous notification
  - SKA/Telescope Alarms: IEC 62682 compliant alarms (i.e. requiring a timely response by the operator)
SCM state(s) and mode(s)

SKA Control Model (SCM) state/mode Attributes and TANGO State

- Design pattern to define a set of “standard” common states and modes: **SCM Attributes**
- Mandatory SCM interactions specified as well

<table>
<thead>
<tr>
<th>Name</th>
<th>R/W</th>
<th>Mem</th>
<th>Opt</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>TANGO State</td>
<td>n</td>
<td>n</td>
<td>n</td>
<td>UNKNOWN, OFF, INIT, DISABLE, STANDBY, ON, ALARM, FAULT</td>
</tr>
<tr>
<td>obsState</td>
<td>n</td>
<td>n</td>
<td>y</td>
<td>IDLE, CONFIGURING, READY, SCANNING, PAUSED, ABORTED, FAULT</td>
</tr>
<tr>
<td>adminMode</td>
<td>y</td>
<td>y</td>
<td>n</td>
<td>ONLINE, OFFLINE, MAINTENANCE, NOT_FITTED, RESERVED</td>
</tr>
<tr>
<td>healthState</td>
<td>n</td>
<td>n</td>
<td>y</td>
<td>OK, DEGRADED, FAILED, UNKNOWN (mandatory for some devices)</td>
</tr>
<tr>
<td>obsMode</td>
<td>n</td>
<td>n</td>
<td>n</td>
<td>IDLE, IMG_CONTINUUM, IMG_SPECTRAL_LINE,...</td>
</tr>
<tr>
<td>controlMode</td>
<td>y</td>
<td>y</td>
<td>n</td>
<td>REMOTE, LOCAL</td>
</tr>
<tr>
<td>simulationMode</td>
<td>y</td>
<td>y</td>
<td>n</td>
<td>TRUE, FALSE</td>
</tr>
<tr>
<td>testMode</td>
<td>y</td>
<td>y</td>
<td>n</td>
<td>NONE, custom values</td>
</tr>
<tr>
<td>configProgress/delayExpected</td>
<td>n</td>
<td>n</td>
<td>y</td>
<td>Percentage progress/Time for CONFIGURING → READY transition</td>
</tr>
</tbody>
</table>
**SCM interactions**

- **healthState**
  - Interpreted based on children and own device
    State, adminMode, healthState
  - ...

- **adminMode**
  - When adminMode is NOT_FITTED, TANGO State shall be DISABLE
  - When adminMode is RESERVE, TANGO State shall be DISABLE

  *Rationale: prevent TANGO devices from raising Attribute alarms when devices off-duty*

- **State (TANGO State)**
  - Equipment, i.e. devices shall power-up in STANBY State
  - TANGO State may be DISABLE for other reasons than those related to adminMode
Integrating TANGO facilities

SKA M&C Architecture

Telescope Archive
Telescope Log storage
Telescope Archivers
Log forwarding
Element Log storage
Element Archive (optional)

Key
- TANGO Attribute alarms
- SKA Alarms
- Archive events
- SKA Alerts
- Operational M&C
- Element logs
- Other component/API

Telescope M&C GUIs
Connected to various devices
Consumer Element subscriptions

Operational Control and rolled-up monitoring of Element & Capability Health and State (through commands and attributes exposed on ElementMaster)

Element TelescopeState (Forwarded attributes or addresses)

Element Master

Commands and attributes

Subscribe to change_events on attributes participating in alarm rules

An Element Facility

DS Yyy
DS Zzz

Telescope Central Node & Subarray Nodes

Element Master Clients (Leaf nodes)

Telescope Alarms Handler

Telescope Alarms & operator inputs

Telescope Alerts & notifications

Telescope Log Viewer

Subscribe to archive_events on all devices in the Element facilities

Telescope Logger

Element remote logs

Element Logger

Archive events

Element logs

Element Archiver

Archive events
Integrating TANGO facilities

Patterns and policies defined for:

- **ElementMaster TANGO device**
  - Element entry point for operational monitoring and control
  - Provide “Element level” FQDNs

- **Logging services**
  - TANGO Logging Service: in-time monitoring of log messages
    - ElementLogger/TelescopeLogger TANGO devices
      - ElementLogger: LogConsumer interface for Element-wide logs
      - TelescopeLogger: LogConsumer interface for Telescope-wide logs
  - Rsyslog + Elastic Search stack: log storage for fault finding and forensics
    - TANGO rsyslog device (Log4Cxx, Boost.log)

- **Element AlarmHandler/Telescope AlarmHandler TANGO devices**
  - Element level aggregation via formulas → provide just relevant alarms

- **Element Archiver/Telescope Archiver TANGO devices**
  - Element archiving → HDB++ featuring MariaDB backend (optional)
  - Telescope archiving → HDB++ featuring Cassandra backend
SKA TANGO developers guideline

Design Guidelines for the TANGO developers cover various aspects, including:

- Element and Device modeling
- Device Class documentation
- TANGO configuration database
- Device implementation aspects, including:
  - Device states and modes
  - Polling and events Attributes
  - Attribute alarms
  - Quality factor
  - Attribute archiving
  - Unsolicited information / command progress
  - Configuration
  - Device locking
  - Commands provided by TANGO
- Naming conventions for commands, attributes, properties
- Standard commands foreseen for “Element Level” devices
SKA device naming convention

- Device names globally unique within the observatory
- Centralized management of SKA device names
- Naming for SKA TANGO facilities defined
- Naming for SKA TANGO devices defined
  - Avoid “.” (dot) and “-” (dash) in device name
- Controlled number of SKA TANGO device domains (as in <domain>/<family>/<member>)
Where to?

...get the SKA Control System Guidelines?

• Documents unrestricted

• Main document revision 2 to be released

• The additional technical notes are at various levels of completion, require revision
Thanks

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