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SKA Monitor and Control: Harmonization Challenges

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Abstract. The Square Kilometre Array (SKA) project is an international effort to build the world's largest radio telescope, with eventually over a square kilometre of collecting area. The Project is one of the largest scientific endeavours in history and will bring together close to 100 organizations from 20 countries. This is why a recent decision has introduced (SKA-wide) a coherent approach to the monitoring and control task. A dedicated workshop, held in Trieste, has indicated Tango Control Framework as the tool of choice.

This project is too large to be managed in pseudo-real time, due to the ensemble of interacting hardware and software which makes it extremely complex. Once we have identified the right tools to solve it, the current challenge is to find the smartest strategies to implement the whole SKA project by using the Tango Control framework. In particular we are developing a uniform class schema proposal and some alternative approaches to program and control the complex subsystems which constitute a large part of SKA.

1. SKA Control Model

The Square Kilometer Array (SKA) is a giant radio telescope project and will be the largest Radio Telescope ever built.

It will have two phases: a smaller one, SKA1 and the final SKA. It will be placed in two locations, South Africa and Australia. SKA1 will consist of two networks of antennas: the Low array of 1024 groups of 256 small antennas and the Mid array of 194 large dish telescopes. SKA2 will be nearly 10 times larger.

From a functional point of view SKA is divided into a small numbers of Elements. The development of those Elements has been granted to a few international consortia. Also the functional and control models follow the same organization. From the controlling point of view, the main elements are:

- Telescope Manager (TM)
- Central Signal Processor (CSP)[1]
- Dish (DSH)
- Low-Frequency Aperture Array (LFAA)
- Science Data Processor (SDP)
- Signal and Data Transport (SaDT)

[1]Baffa et al. (2016)

- Infrastructure Australia and Africa (INFRA)

The control model assumed for the whole telescope is a top-down model: all the interactions with the observer and all the controls of the underlining structure are assigned to the Telescope Manager (TM). Moreover each element should have a single point of monitor and control (Element-LMC). In this way each node control point (or Element Master) should provide a wrap-up overview of the element and give the possibility of an engineering drill-down to sub-elements. Such control model is recommended to be applied, as far as possible, to lower level components.

2. Tango, The Software Infrastructure

SKA consortia chose Tango Control as the infrastructure of all Monitor and Control operations. TANGO Control is an open source object oriented software framework for building distributed control systems, developed collaboratively by an international community of research institutions.

In TANGO everything which needs to be controlled is modelled as a Device. The Device is the core concept of TANGO. A Device can represent: some equipment/hardware, a set of equipment, a set of software functions/components or a group of equipment/components constituting a subsystem. The modelling of the equipment, either hardware or software, is the first fundamental step when writing a TANGO device.

3. The LMC Devices Strategy

SKA project started a LMC Harmonization process to set a common controlling structure and the use of common strategies across the different components of this huge project. The developer community appointed a small committee (The Ant Team) to collect the different solutions proposed and to match those which comply with the Tango Best Practices to the different needs of the various sub-projects.

The Ant Team collected the vast bulk of SKA Control community preliminary work in a set of documents:

0. SKA Control System Guidelines (main)
1. Element & Central Alarms Handling
2. SKA Logging
3. SKA Device Naming Convention
4. SKA Control Model
5. SKA Configuration & Control
6. Integrating Distributed TANGO Facilities
7. Element Archiving & Central Archiving
8. SKA TANGO Developers Guideline

Following the Tango standard approach the hierarchy of the Tango Device driver structure follows the functional decomposition of the Telescope. In particular a parallel structure (MID and LOW) will be implemented following, as far as possible, common solutions. Also the logical structure of the topmost components (the Elements) can be replicated at lower levels when it offers advantages.

4. Main points in Monitor and Control structure

In the harmonization process some key points have been established:

Standalone Element TANGO facility Each Element will implement a single standalone TANGO facility in which the Element Master TANGO Device Server will be the entry point.

Single point of control/coordination for general operations The Element Master is the single point of control and coordination of an Element for general operations from TM. For normal operational control TM will communicate only with the Element Master device.

Rolled-up monitoring and reporting The ElementMaster will also be the entry point for Element Level monitoring by central tools during general operations. The ElementMaster shall intelligently interpret information from sub-elements and lower level devices for rolled-up reporting of status, health and configuration on the Element level and the Element Capabilities.

Rolled-up SKA alarms reporting All Elements will adhere to the common SKA design pattern for standardised alarms reporting. SKA alarms are rules-based configurable conditions that can be defined over multiple attribute values and quality factors, and are separate from the "built-in" TANGO attribute alarms. Hierarchies of alarm handlers may be implemented in the Element, but the top-level ElementAlarms shall interpret all internal alarms and expose SKA alarm attributes.

Centralised Telescope archiving The TM will maintain a central archive. In principle the Element does not have to implement any special archiving functionality in addition to the standard TANGO mechanisms and core device servers available.

Centralised Telescope logging and Element logging The TM will maintain a central log archive and in principle the Element does not have to implement any local logging. However the Element developers can choose to implement a local repository to support development and maintenance.

5. Future Developments

The SKA control system design is still an ongoing process. In particular the standardisation topics currently being addressed are:

Device Naming Convention for SKA A common device naming convention across all TANGO facilities for the full SKA project. It will include conventions to facilitate "static" TANGO groups, and potentially other mechanisms for identification of groups of homologous devices.

Integrating the Distributed TANGO facilities To coordinate the different independent Element TANGO facilities and the Central TANGO facility into a working unit as an integrated instrument.

Future topics may include:

Device/Element Simulators To explore design patterns to combine simulated and real Elements across and within facilities and identify utilities needed to support this.

SDD/DSL and TANGO database To explore the feasibility of DSL/SDD and how this relates to the TANGO configuration database, and to define SKA design and usage patterns.

SKA TANGO Facility standardisation To analyse further common design patterns to implement within each SKA TANGO facility.

Simulating TM with TANGO Tools To explore ways that Elements can operate in absence of TM and identify standard TANGO Tools that can be used.

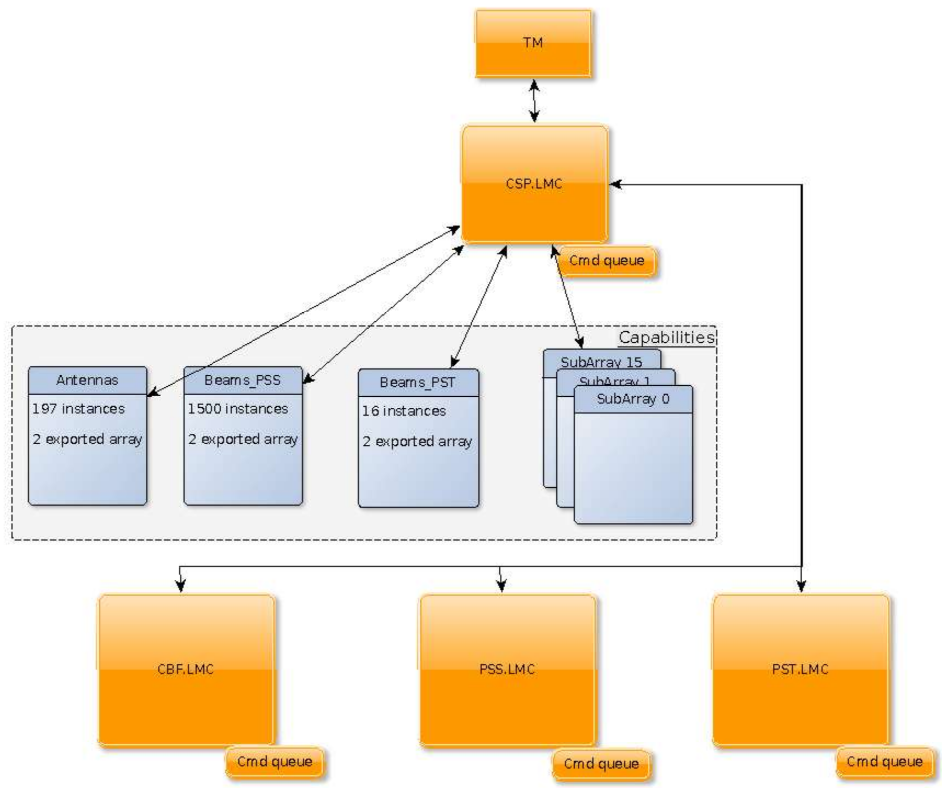

Figure 1. Basic Control Schema of a SKA element (CSP)

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References

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