SKA Monitor and Control - Harmonization Workshop

TANGO Use Case: SKA Central Signal Processor

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Use Case Description

Each of the two SKA Phase 1 telescopes (LOW and MID) consists of several elements, as follows:

1) LOW Telescope only: Low Frequency Aperture Array (consists of a large number of dipole antennae organized in tiles and stations. This includes all equipment required for data acquisition and transmission to Central Signal Processor.
2) MID Telescope only: 133 SKA1 Dishes (in this context term Dish identifies the dish itself, pedestal, receivers, digitizers and all other equipment required for operating the dish, data acquisition and transmission of data to Central Signal Processor).
3) MID Telescope only: 64 MeetKAT Dishes, including equipment required for conversion of collected data to SKA1 bands, and SKA1 monitor and control.
4) Central Signal Processor (CSP)
5) Science Data Processor
6) Signal and Data Transfer
7) Telescope Manager (overall monitor and control)

Each of the Elements listed above is a complex, functionality rich sub-system, and each has been sub-divided in sub-elements which themselves are complex systems and consist of many components. Each Element is responsible for monitoring and control of its components. This use case uses CSP as an example of a hierarchical architecture.

SKA Central Signal Processor (CSP)

Figure 1 below applies for both SKA1 telescopes (MID and LOW). The only exception is that in the LOW Telescope input comes from LFAA and in the MID from SKA1 Dishes and MeetKAT antennas. The CSP consists of four sub-elements:

- Correlator and Beamformer (CBF),
- Pulsar Search Engine (PSS),
- Pulsar Timing Engine (PST) and

- Local Monitor and Control (LMC).

CBF, PSS and PST perform signal processing while LMC is support sub-element which reports on behalf of CSP and provides a single point of access for TM. All monitor and control messages flow via LMC. The blue lines in the diagram represent flow of the observed astronomical data, while green lines represent flow of monitor and control data.

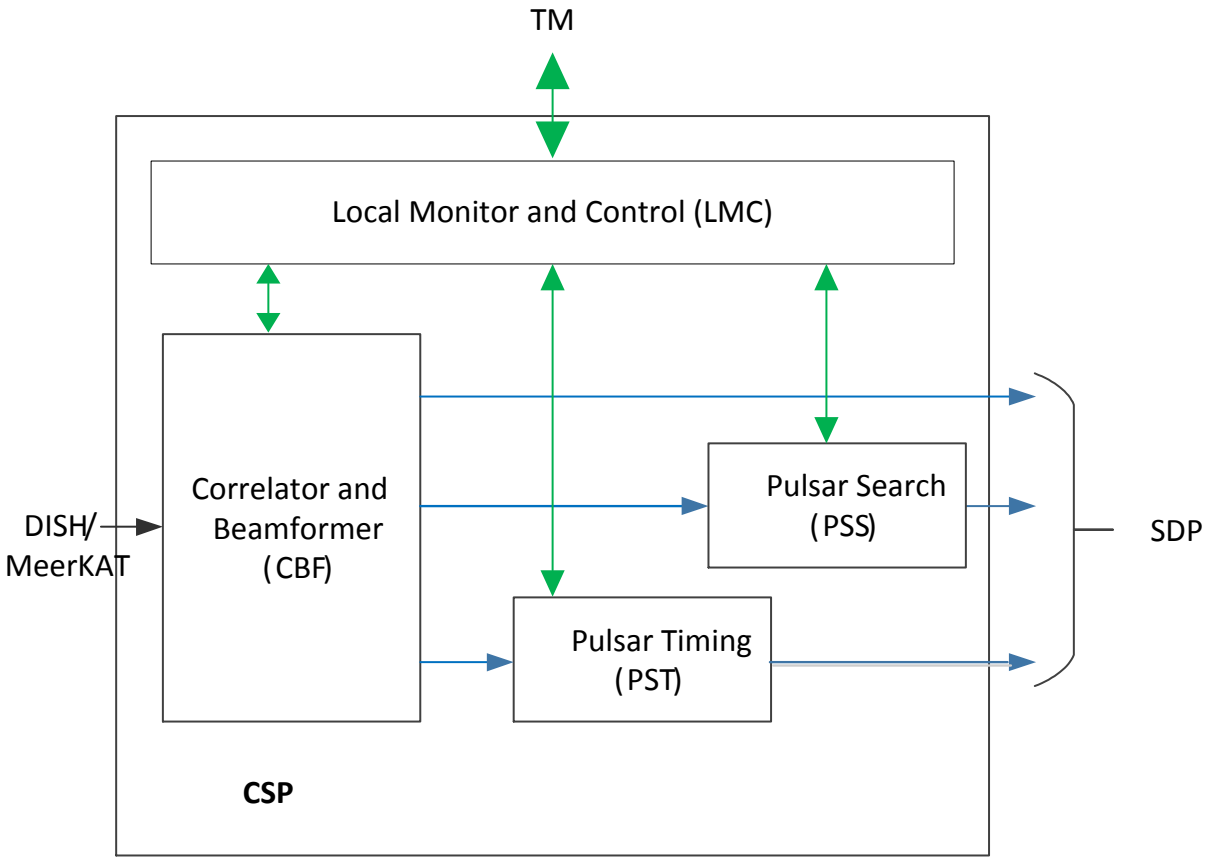


Figure 1 CSP sub-elements and data flow

All signal processing sub-elements (CBF, PSS and PST) receive configuration and commands from LMC (in most cases originator of configuration and commands is TM, but data is received via LMC). CBF, PSS and PST each have a single point of communication with LMC.

From the point of view of monitor and control, CSP sub-elements Correlator and Beamformer (CBF), Pulsar Search Engine (PSS) and Pulsar Timing Engine (PST) are 'loosely coupled'; they exchange very little information.

Each sub-element, except for the LMC itself, consists of many components (the number of LRUs is provided in Table 1, there may be several hardware and/or software components per LRU). In each sub-element, a single point of communication with TM is implemented by the so called 'sub-element master' which reports on behalf of the sub-element, in the same manner as CSP.LMC reports on behalf of the CSP Element. Depending on the sub-element functionality, architecture and design there can be more than two layers of the monitor and control hierarchy within a sub-element.

	LOW	MID
CBF	-85	~300
PSS	~250	~750
PST	~20	~20
LMC	1	1

Table 1 Number of LRUs per CSP sub-element

The CSP architecture has been defined with the following goals in mind:

- There is a single point of communication with TM, so that TM can monitor and control CSP as a single entity, in particular for monitor and control of observations.
- CSP makes provision for TM to create a sub-array, assign resources (capabilities), set observing mode and start signal processing without being aware which CSP sub-element(s) is/are used for a particular observation.
- For the purpose of monitoring performance and status, and for diagnostics and troubleshooting, TM has access to status and parameters of CSP 'devices' at all levels of hierarchy.

TANGO Devices

It seems intuitive to implement all CSP sub-elements, including CSP.LMC, as TANGO devices.

Sub-element CSP.LMC reports on behalf of:

- CSP
- CSP.LMC (i.e. itself)

Each Sub-element Master (CBF, PSS and PST) reports on behalf of:

- Sub-element (CBF, PSS or PST)

- Sub-element master (i.e. itself).

Both CSP.LMC and Sub-element Master implement two TANGO Devices. The same applies for all components that report on behalf of other component(s).

CSP_Mid.CBF will define at least one more level of hierarchy: CSP_Mid.CBF consists of three major groups of LRUs (components). LRUs are grouped according to functionality: F-part, X-part, BF-part.

F-Server is a software component which implements monitor and control functionality for X-part LRUs and reports on behalf of those LRUs. F-Server software may or may not be running on a dedicated COTS Server (LRU).

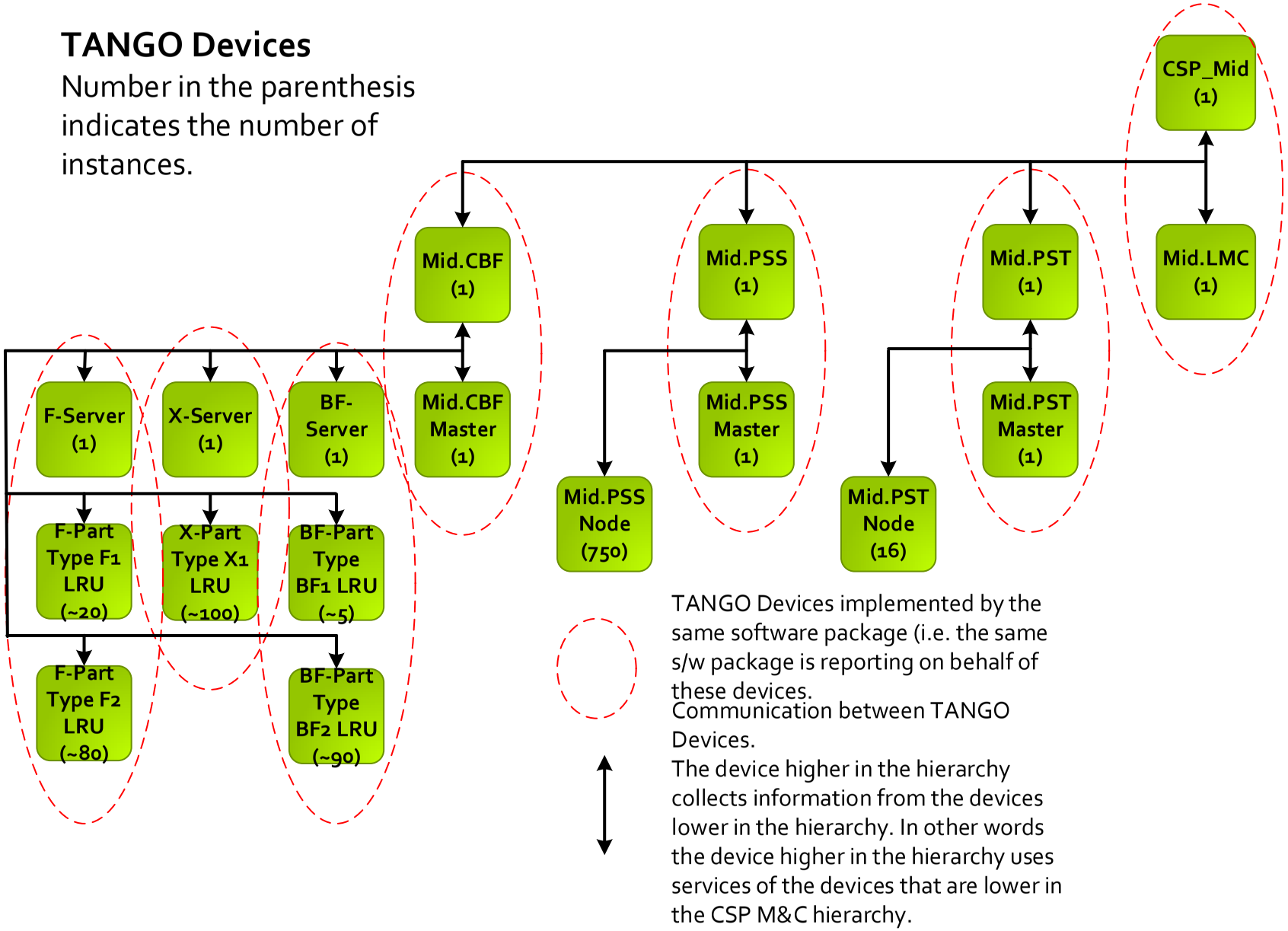
F-Server reports on behalf of:

- A number of (potentially different) F-part LRUs and software components, including the LRU the software is running on, and
- F-Server (itself).

In the same manner X-Server and BF-Server report on behalf of X-part LRUs and BF-part LRUs.

TANGO Devices

Number in the parenthesis indicates the number of instances.



TANGO Devices implemented by the same software package (i.e. the same s/w package is reporting on behalf of these devices.

Communication between TANGO Devices.

The device higher in the hierarchy collects information from the devices lower in the hierarchy. In other words the device higher in the hierarchy uses services of the devices that are lower in the CSP M&C hierarchy.

TANGO Facility

- Should CSP be implemented as a single Tango Facility?
- Or is it more appropriate and practical to implement each CSP sub-element (including LMC) as a distinct Tango facility?

What should we take in consideration when making this decision?

1. Complexity of the individual devices.
2. Number of devices (types, instances).
3. Hierarchy. I.e. how deep is the hierarchy (number of levels).
4. Encapsulation.
5. Organizational considerations:
    - Each CSP sub-element will be developed independently by a different group, using different technology and code base. Each sub-element will be integrated and tested independently, before integration at the CSP integration and test facility.
    - For each release, the sub-element acceptance test and sell-off will be performed for each sub-element independently, using test tools (input vector generators, emulators, simulators). CSP AIV group will be responsible for integration of the sub-elements and CSP acceptance test and sell-off to the SKA AIV Group.

Other …