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AUSTRALIAN SQUARE KILOMETRE PATHFINDER - COMMISSIONING TO OPERATIONS

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Abstract

The Australian Square Kilometre Array Pathfinder (ASKAP) [1] is CSIRO's newest radio frequency interferometer located in Western Australia. It is currently operating in a mixed early science and commissioning phase. This paper gives an overview of the current instrument, highlighting updates and changes to software since the last status update. As previous papers, this overview centers on the monitoring and control software of ASKAP known as the Telescope Operating System (TOS).

OVERVIEW

Since the last status update [2] a lot of work by the monitoring and control software team has gone into supporting debugging of hardware and firmware of ASKAP. As engineers and scientist are progressing their understanding of this new, never used technology, requirements are continuously added or refined. We have also focused on the high level user interfaces as more time is allocated to routine observations and users gain experience with the instrument. The overall monitoring and control software architecture has been solid and has not changed since its inception about 10 years ago. Some minor modifications to this architecture have been driven by technology limitations or new requirements. The logical view of is presented in Fig. 1.

One of the features of the TOS is its configuration management. New deployment sites can be added mainly through configuration only additions. This is used to differentiate between different target deployments or even instruments now:

- ASKAP - the configuration of the main telescope containing the commissioned antennas and correlator
- MATES - the hardware test laboratory system
- COMMISSIONING - a independent subset of telescopes and hardware still to be commissioned
- EFFELSBERG - a self-contained TOS deployment for a PAF operating on Max Planck Institute for Radioastronomy Effelsberg telescope
- FASTRX - an engineering set-up to test the FAST multibeam receiver constructed by CSIRO for the FAST 500 meter telescope

For the EPICS systems sites are simply distinguished through different process variable prefix. This even allows co-location of systems in the same network deployment. The list above also shows non-ASKAP telescope deployments demonstrating the solid architectural choice. We are currently working on a TOS deployment for the next generation receiver system on our Parkes 64m telescope.

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PROJECT STATUS

Infrastructure

30 antennas have been with phased-array feed (PAF) technology. 24 antennas have the full compliment of digital signal processing backends installed in the central building and five out of seven correlator backends are available for use. The new hybrid diesel/solar power station, including battery storage has been connected to the telescope. 16 telescopes and the correlator form the ASKAP array for early science programs, the remaining eight are part of the COMMISSIONING array. The final six PAFs, 12 backend system and two correlator blocks are being installed in the upcoming months.

Science Data Processing

The ingest of data on the science data processing side is currently setting the limiting of antennas used for early science programs to 12. Processing is not yet done automatically after data ingest, but early science programs are processing their data suing the Pawsey supercomputing platform.

MONITIORING AND CONTROL SOFTWARE

Software Infrastructure

Software technologies have progressed since the inception of the TOS. In the early stages of the project numerous third party software systems were not available as part of the host operating system or were rapidly changing. For this purpose a from source recursive build system was developed in house. All software is deployed as a single version e.g. TOS-2.13 including all dependencies. We are in the process of moving towards OS provided packages and are changing as part of the upgraded to the latest version of debian - stretch. After this upgrade, software release will be per logical set of software as part of a continuous deployment platform. To facilitate this automation we are in the process of moving from subversion to git which integrates better with automated process and our issue tracking system JIRA. During this upgrade process all TOS software will move from bare server hosting to high-availability servers for better operational integrity and uptime.

EPICS

The `asyn` abstraction and composite IOC structure has been proven to work extremely well in hiding the complexity of the system. We are still based on EPICS version 3.12.x, however `pvaSrv` has now been added to all IOCs, so we can leverage v4 features. As described in the previous paper,

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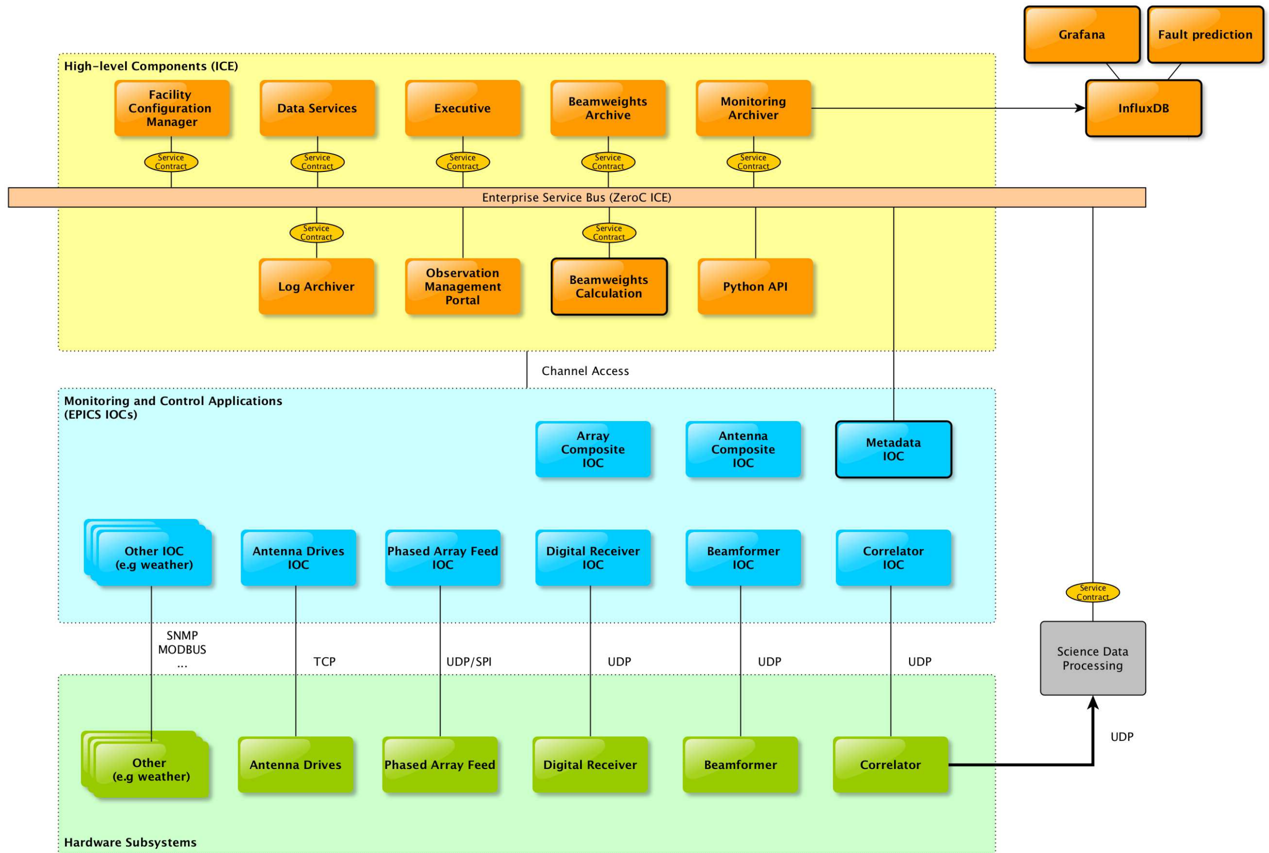

Figure 1: Logical view of the ASKAP software as implemented in latest version of TOS. Bold, black bordered components are recent additions.

most of out I/O records and archiving configuration is auto-generated for the header files associated with the hardware subsystems. This results in an EPICS deployment of:

- more than 300 soft IOCs
- more than 2.5 million I/O points
- more than 250,000 archived records
- six linux soft IOC host machines

Ice Services

Ice services are building the high-level software components to control observations. A number of these components remain unchanged. The LogArchiver implementation and the decision to log all observation relevant information through this interface is under review. The implementation of the LogArchiver is going to move to a dedicated logging stack in elasticseach/logstash/kibana. (ELK) This stack wasn't available during the initial implementation phase but provides much better scaling, feature set and support then our in-house solution. This choice is also integrating nicely with our log4cxx EPICS logging solution. The science data processing team has already demonstrated and deployed this as part of their c++ components.

To form beams on the sky from the phased-array feed detector, specialized observations are needed to generate so called beam weights. This creates a specific beam pattern. The per antenna raw data capture of these antenna covariance matrices are too large to move around the system for processing. To allow a data co-located computation to be done a distributed beamweights calculation component was added to the architecture. The design also takes into account a new hardware component, the on-dish calibration system to adjust beamweights on a per-antenna bases on the fly. These components had not been part of the ASKAP requirements.

Archiving

For archiving of monitoring and control points we use the in-house product open-monica. It provides per-point archive policies which are generated from the same header files as the EPICS records. The front-end to MoniCA, both for display and querying doesn't scale to ASKAP volumes, so an alternative was firstly prototyped and is now being rolled out to the observatory. This software stack comprised of InfluxDB, Telgegraf and Grafana build a package called DiaMonica (add ref). Access to this time series database platform is also given to users via data science analytics tools based on python, pandas as well as machine learning prototypes.

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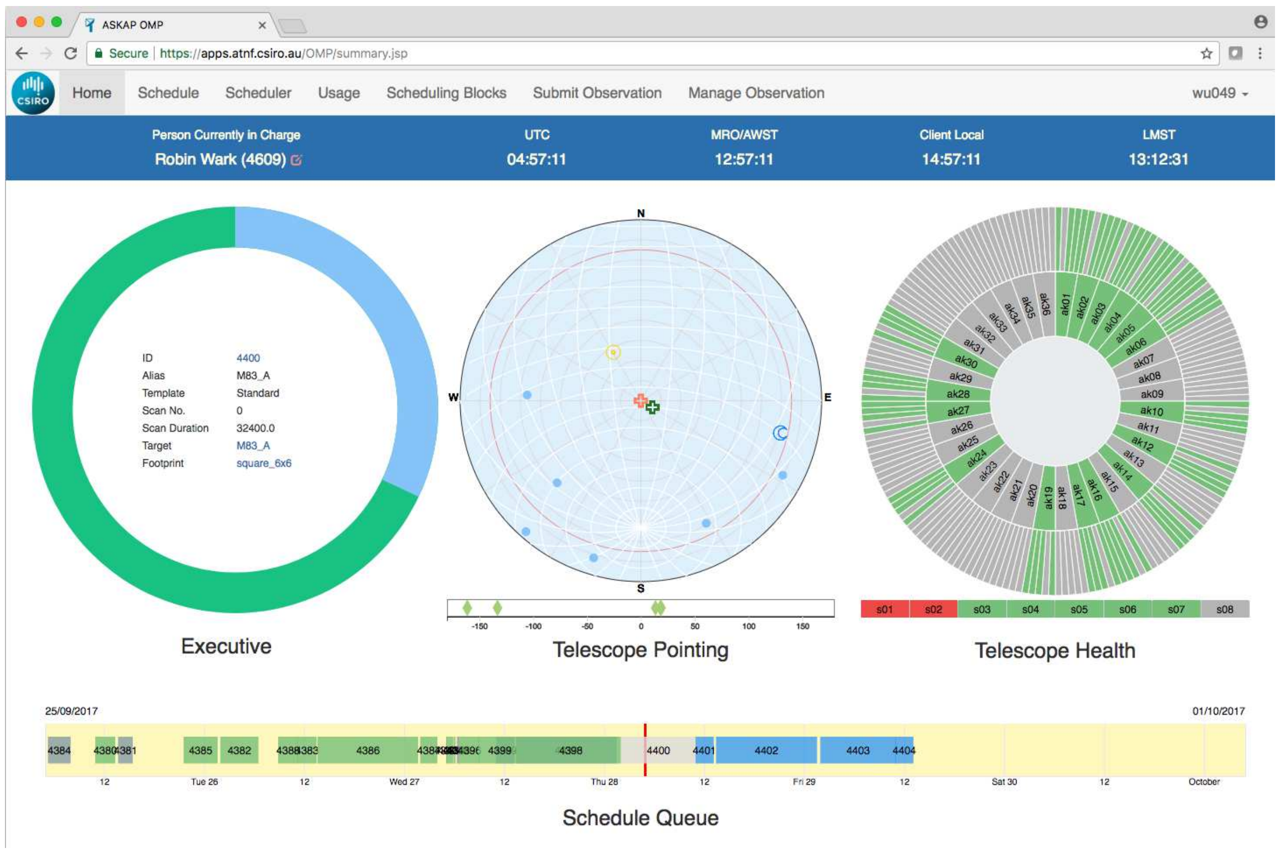

Figure 2: Logical view of the ASKAP software as implemented in latest version of TOS. Bold black bordered components are new additions.

User Interfaces

Observation Management Portal The Observation Management Portal (OMP) is the main high-level ASKAP user interface to interact with the telescope. It has gone through several iterations and re-designs as user became more aware of how to operate this instrument. It is a web-based portal, providing role-based authorization. Through tab-based views, the user can create new observation drafts and submit observations for scheduling (see Fig. 2). A scheduler can view and adjust the schedule. The OMP backend is implemented in jsp communicating with the various Ice services. The frontend is written in html5/javascript and is supported by bootstrap and D3.js for data visualization.

Engineering Display Currently, all of our engineering or close to the hardware graphical user interfaces are based on cs-studio v3.4. Due to the frequent use of OPI scripting an upgrade path to cs-studio v4 has been problematic. It would largely require to rebuild a significant amount of displays from scratch. cs-studio doesn't have a large developer base so there is concern about future support. As a result we are investigating open-source, widely-used web technologies and are prototyping a PVAcess to websocket interface, with a ReactJS based UI component frontend. This will also require a rebuild of all displays, but as it is common technology this could be contracted out. For archival data, we have moved to another open-source package with a large user-base.

REFERENCES

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