The path to an upgraded ASKAP

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Key priorities and goals

- Complete the existing Survey Science Projects
  - Continuous improvement is needed to meet science requirements
- Clearly identify ASKAP's role in SKA-era radio astronomy
  - What is ATUC's vision for ASKAP?
- Identify and investigate possible upgrade strategies
  - Which upgrades would have the most impact?
- Determine how to deliver a large-scale upgrade plan
  - Prototype testing to stabilise designs before mass production
  - Deployment strategy that minimises downtime

What makes ASKAP unique in the SKA era?

- Large instantaneous field of view
- Low RFI site at radio wavelengths around 700-1100 MHz
- Integrated supercomputing and science-ready data products
- Efficient autonomous scheduling and pipeline processing

- Key science cases for ongoing/upgraded ASKAP operations
  - Transients – wide field of view and rapid release of data products
  - Spectral line survey capability – dealing with high data rates

The issue of collecting area: $\mathrm{SS} = \left(\frac{A_\mathrm{e}}{T_\mathrm{sys}}\right)^2 \Omega_\mathrm{FoV}$

- SKA-mid will have 33,000 square metres vs ASKAP's 4000 $(8x)^2$
- ASKAP has 30x SKA-mid's field of view
  - The above factors cancel within a factor of two
- ASKAP currently falls short on system temperature: 75K vs 18K

- Improving system temperature is the logical first step on an upgrade path
  - Technologically feasible with modern low-noise amplifiers (3x)
  - No effect on ASKAP's output data rate, compatible with digital systems

On-site digital systems

- Bandwidth has limited impact on survey speed
  - Observing more spectral lines simultaneously (flexible channel selection)
  - Improves continuum sensitivity but can make imaging more challenging
- More beams would only help at the highest ASKAP frequencies
  - We already use the entire PAF surface with 36 beams in the low band
- Reduced integration time may have some minor benefits
- Await transformational technology before upgrading?
  - PAF upgrade could support future bandwidth increase with new filters

High-performance computing

- ASKAP's integrated data pipeline is a key advantage, *however:*
- Processing the current data rate is already a challenge

- Focus effort on software development
  - Improve pipeline workflows to maximise throughput and efficiency
  - Improve compatibility with high-performance platforms

- Secure access to improved hardware when opportunities arise
  - Ingest cluster needs to be replaced in 2025

Survey Science Project progress

(The importance of data processing)

	Observed	Released	Rejected	Completion	Projection
EMU	209	164	39	19%	5.3 years
WALLABY	53	24	28	2%	50 years
POSSUM	261	155	62	8%	12.5 years
VAST	2956	2611	38	24%	4.2 years
FLASH	109	49	45	8%	12.5 years

- Assuming 1 year of observations to date (accounting for Setonix downtime)
  - GASKAP-HI, GASKAP-OH and DINGO have yet to begin
- Not all fields can be processed with sufficient quality using existing methods
- Some constraints will be hard to avoid (e.g. WALLABY night-only)

Imaging software and techniques

- Data quality impacted by artefacts that could be removed with improved processing algorithms
  - e.g. peeling bright sources in and near each field
- ASKAP's astrometry precision is limited to a few arcseconds
  - Most likely due to the calibration method we use
- ASKAPsoft's focus on HPC is an asset and a challenge
  - Need to overcome heavy reliance on disk I/O to achieve best performance
  - Need refactoring effort to integrate solutions developed during commissioning

Additional upgrade possibilities

- Replace bash processing pipeline with a new software framework
  - Improve ease of development and maintenance
  - Provide an additional layer of job management
- Build a dedicated supercomputer designed for ASKAP's workflow
  - Fast, dedicated storage, more memory per core, etc.
- Build more dishes to increase collecting area and resolution

- Ideas from ATUC welcome!

Conclusions

- Low-risk and well-bounded PAF upgrade on all antennas would increase survey speed by up to an order of magnitude
- ASKAP can retain its unique capabilities into the SKA era and has a huge head start on delivering all-sky data products