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Parkes Instrumentation Options

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Framework

- Inputs from New Operation Model for Parkes:
  - To keep “The Dish” delivering cutting-edge science
  - Reduced staff support
  - Remote Operations
  - Limited suite of instrumentation
  - Focused on project requiring less support

  - Progressive reduction of support
    - Moderate reduction for the first 2-3 years of new operations model
    - Ultimate goal of 40% over the years (5 year time)

- Discussed here are only steps for the moderate reduction (2-3 yr)
- Options presented here satisfy the inputs and requirements above
- ATUC are consulted for answers, inputs, and feedback on these options.

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Parkes Receiver Fleet

Frequency	Receiver	Remotely Operable?	Perform. 1=poor, 5=good	Reliability 1=poor, 5=good	Usage (last 3yr)
1.2-1.6 GHz	MB-20	Y	5	5	54.4 %
700-764 MHz 2.6-3.6 GHz	10/50 cm	Y	5	5	16.4 %
1.2-1.8 GHz	H-OH	Almost	5	5	5.5 % (now ~1%)
2.2-2.5 GHz	GALILEO	Almost[2,3]	5	5	4.6 % (now ~1%)
6.0-6.7 GHz	Methanol 6	Almost[2,3]	3	3	2.4 %
8.1-8.5 GHz	MARS	Almost[3]	5	5	2.4 %
2.3+8.5GHz (S/X) 5 GHz (C)	Multi band (S/X , C)	Almost[2,3]	2	2	1.4 %
12-15 GHz	Ku	Almost[2,3]	2/3	3-	0.4 %
16-26 GHz	13 mm	Y	5	4	4.3 %

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BACKENDS

Backend	IF x channels	Maximum Bandwidth [MHz]	Polarisations (1,2= total intens. 4= full Stokes)	Freq res (spectrometers)	Observation modes
MBCORR (Multi-Beam Correlator)	14 x 2048	64	2	2 kHz (13 beams) 0.25 kHz (1 beam)	Spectral lines Continuum
BPSR	13 x 1024	400	2		Pulsar
AFB	14 x 96	288	1		Pulsar
HIPSR (to be commiss.)	13 x 8192	400	4	1.5 kHz (13 beams) (potentially arbitrary)	Pulsar Spectral lines Continuum Polarization
PDFB3	2 x 8192	1024	4	1 kHz	Pulsar Continuum Polarization Spectral lines (VLBI)
PDFB4[4]	1 x 8192	1024	4	1 kHz	Pulsar Continuum Polarization Spectral lines
APSR	1 x arbitrary	1024	4		Pulsar
DAS	2	64	4		VLBI
Mk-V	1	14x16	4		VLBI

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TELESCOPE USE

Observation Type	Fractional observing time
Pulsar	64.7 %
Polarization & continuum	12.9 %
VLBI	7.3 %
HI	2.9 %
Spectral lines (non HI)	4.6 %
Geodynamic	1.5 %
Others (non-standard, ASKAP tests, etc.)	6.0 %

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OPERATIONS SUPPORT REDUCTION

- Operations support reduction required (See Douglas talk)

- Science Operations (SO) support reduction more significant than Engineering Operations (EO) one
- EO will be moderately affected: reorganisation needed but moderate impact
- SO support: major impact
- **SO support reduction drives the Instrumentation restructure**

SCIENCE OPERATIONS (SO)

- SO is responsible for a number of tasks
  - Reconfiguring and calibrating after and in between receiver changes;
  - Training observers;
  - Design and setup of new config for non-standard projects;
  - Supporting system development;
  - Assisting observers (scheduling, start observing, checking data quality, begin data reduction, ….);
  - System tests for equipment characterisation;
  - Diagnosing faults (along signal path) and assist EO;
  - S/W support
  - Computing system support

REDUCING COMPLEXITY

- Remote operations and reducing complexity to cope with that

- **Reducing complexity:**
  - Smaller number of receiver changes
  - Reduced system complexity
  - Reduced project diversity

OVERALL STRATEGY

- The strategy to obtain the needed simplification is in three steps:

1. Long term strategy for receivers

- Replacing the entire fleet with a smaller number of Ultra Wide Receivers and a new array.
- To be reviewed and assessed with ATUC

2. Ad interim solution

- Based on current receiver fleet
- Reducing number of receiver changes (options to evaluate)
- Mothballing 2-3 receivers (options to assess and ATUC advice sought)

3. Backends

- Decommissioning a few backends,
- Mostly those redundant, with no or marginal loss of capability

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1) LONG TERM STRATEGY

- Ideal solution:
  - Replacing the entire fleet with a smaller number of receivers
  - Permanently installed in focus cabin (F/C)
  - Eliminating the need of receiver changes
  - Without limiting the telescope scientific capability
- Room available in Focus Cabin (F/C)
  - One large array
  - Two single pixel receivers.

- Proposed strawman:
  - An array with PAF technology replacing the MB-20 (20cm multibeam)
  - Two Ultra Wide Band (UWB) receivers – single pixels.
  - 3:1 ratio bandwidth state-of-the-art have been successfully developed (see 16cm ATCA system)
  - Next development step is toward higher ratios

1) LONG TERM STRATEGY: strawman

1. Phase Array Feed (PAF) array:
   - Covering 700-1800 MHz at least (ASKAP B/W)
   - Same number of beams as ASKAP (36).
   - Cryogenic
   - Possible extension to 2.5 – 3.0 GHz
2. Low frequency UWB (UWL)
   - 0.7-4.0 GHz (tentative, might be limited to 3.0 GHz)
   - Cryogenic
   - e.g. see Manchester at ATUC October 2011 (0.7-4.0 GHz)
   - e.g. Bonn receiver 0.7-3.0 GHz
3. High frequency UWB (UWH)
   - Approx. 5-24 GHz
   - Cryogenic
   - 6:1 ratios are more critical at high frequency
   - To assess whether one or two receivers in the same package

1) LONG TERM STRATEGY: benefits

- No receiver changes: increasing reliability, reducing support need
- Reduced complexity (smaller number of systems)
- Flexibility and agility (all frequencies always available)
- State-of-the-art broadband receivers opening new space of parameters (high potential for new discoveries)
- Keeping leading position in receiver development (both PAFs and UWB receivers are among SKA plans)
- Funds and resources to be pursued, informal discussions underway

1) LONG TERM STRATEGY: questions

1. Is this broad scenario right?
2. Is 5-24 GHz essential for UWH, or a narrower BW sufficient?
3. In case of splitting of UWH, which pair of ranges is optimal?
4. Is there strong scientific motivation to get down to 4.0 GHz
5. Is there strong motivation to further extend the UWH high frequency end (e.g. up to 26 GHz?)
6. If both #4 and #5 are positive, what priorities in case there are tech issues to cover the entire 4-26 GHz range?
7. High frequency PAF?

2) AD INTERIM SOLUTION

- The long term strategy is essential to the ultimate cost saving goal
- But it will take 3-5 years to complete
- An Ad Interim solution is needed to deal with the support cuts outlined
- Solution is based on:
  - Reducing number of **receiver changes**
  - Rationalising the **receiver** fleet
  - Rationalising the **backend** fleet

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2) AD INTERIM SOLUTION: receiver changes

- Reducing number of receiver changes is essential to cope with the 50% SO support cut

- receiver changes require significant SO support (see SO tasks)
  - Setup
  - Calibration
  - Resolving receiver related faults (mostly associated to receiver changes)
  - Keeping track of project related to the installed receivers

- Reduced receiver availability
  - less project diversity,
  - Required to cope with less SO support

2) AD INTERIM SOLUTION: receiver changes

- Current number of receiver changes a semester: 12
- **We now think it is possible to offer up to 6 receiver changes**
- **How to organise such receiver changes?**
- Currently the most used receivers are MB-20 and 10/50cm
  - changes involving MB-20 are not an option (too complex)
  - 10/50cm is required for observations with ~3 weeks gaps
- Other receivers are required for some 30% of the time
- **We have identified 4 options**

2) AD INTERIM SOLUTION: receiver change options

- Option #1:
  - 10/50 taken out 3x a semester for 2-4 weeks each time
  - Replaced by other 2 receivers
  - three rx changes to taken 10/50cm out and 3 to put it back
  - All receivers are potentially available all semesters
  - 10/50 can run as required by pulsar projects
  - 9-12 weeks of other receiver availability

- Option #2:
  - As for #1, but 10/50cm is taken out 2x a semester only
  - Replaced by 2 receivers
  - Then replaced by 2 more receivers before it is put back again
  - More flexibility in the number of times a receiver different from 10/50 can be used
  - at the expense of only 6-8 weeks of availability

2) AD INTERIM SOLUTION: receiver change options

- Option #3:
  - The constraint of having 10/50cm up every 3-4 weeks is relaxed
  - The 6 rx changes are used for a more flexible use of the telescope
  - Benefit: more flexible use of the telescope
  - At the expense of impacting on pulsar timing projects
- Option #4:
  - All of the three options above are considered
  - Which one to apply is decided at any one semester
  - depending on the scientific merit of the accepted projects
- We ask ATUC to advice on their preference

2) AD INTERIM SOLUTION: implications for receiver availability

- Potentially this still allows deploying all receivers in any one term
- Options #1 and #2 can accommodate al least the current allocation of receivers different form 10/50cm
- **However, we'd like to stress that this reduction of number of receiver changes will have impacts:**
  - It will limit the variety of projects that can be run in any one semester
  - e.g. if a highly ranked project will require many epochs with the same receivers, it will limit the offer of other receivers in that semester
  - Or, if not highly ranked, it could not be scheduled
  - So, there will be limitations for those projects requiring a flexible use of the receiver they need.

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2) AD INTERIM SOLUTION: receiver fleet

- Receiver fleet to be reviewed to reduce complexity
- To free time to keep high level support to equipment to keep
- At least two receivers to mothball
- The following scenario is based on:
  - Receiver indicators (performance, use, reliability)
  - Possible use of the telescope in the coming years
- We seek ATUC
  - Review this scenario
  - Modifications compatible with support constraints

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2) AD INTERIM SOLUTION: receiver fleet

- MB-20 and 10/50cm are the most demanded receivers
- Then MARS (8 GHz), Methanol-6 (6 GHz), and 13mm (22 GHz)
- H-OH (1.2-1.8 GHz) and Galileo (2.2-2.5 GHz)
  - less used but high performance and low maintenance
  - H-OH still has lot of potential use (OH line, single-dish for ASKAP, …)
  - GALILEO is less demanded even though still attracts projects
- Ku-band and S/X-C-band
  - oldest, lowest performance, and low-demanded receivers
  - Ku-band is the least demanded (0.4%)
  - S/X-C-band is oldest and has been the most troublesome of the fleet
  - Ku-band has still potential use for methanol and OH lines.

2) AD INTERIM SOLUTION: receiver fleet scenario

- The scenario we propose and we ask review for is as follows:

To offer	To mothball
MB-20 10/50cm H-OH Methanol 6 MARS 13mm Galileo or Ku-band	S/X-C-band (AT Multiband) Galileo or Ku-band

- A choice to mothball either GALILEO or KU-BAND to be taken

- **We stress we ask ATUC to review this scenario. The review should not exclude any receiver, including MB-20 and 10/50cm.**
- Constraint: 2 receivers to mothball (3 if S/X-C-band is to be kept)

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3) BACKENDS

- Eight backends currently offered
- Their support represents one of the major items of the budget
- Reducing complexity required by decommissiong those whose capability can be replaced by other equipment
- no loss of capability, although loss of some configuration is possible

3) BACKENDS

- The planned backend restructure is as follow

To retain	To decommission
DFB3 DFB4 BPSR (=> HIPSR) APSR (=> HIPSR) MK-V HIPSR (to be commissioned)	AFB MBCORR DAS

AFB

- for multibeam observations:
  - **Will be replaced by BPSR (1 October 2012)**

- for individual beam observations:
  - Mainly used for searching pulsars
  - **Will be replaced by DFB3-DFB4 in search mode (1 October 2012)**
  - October-November 2011 development and tests have shown the search mode works correctly now.
  - issues on file splitting and loss of time samples look fixed.
  - We acknowledge users offered themselves to help further testing with parallel observations also to facilitate migration.
  - There is still one semester to allow a smooth migration (APR12)

MBCORR

- for **multibeam** observations:
  - **replaced by HIPSR when commissioned (2013)**
  - 400 vs 64 MHz BW; 8192 vs 2048 frequency channels
  - Polarization, 1.5 vs 2.0 kHz resolution

- for **individual beam** observations:
  - It requires manual swapping of boards and rewiring of cables
  - **replaced by DFB3: 1 October 2012** (used already by most users)
  - Better performance (2 GHz vs 64 MHz BW; 8 vs 2 bits; dual vs one IF)
  - S/W development completed => ready for full migration

  - Some configurations lost (1.0 vs 0.25 kHz max freq resolution (but very little use, << 1%).

    Not completely true: might be recovered with HIPSR…

DAS (VLBI)

- DAS
  - 20cm observations require conversion linear-to-circular pols
  - By an Hybrid: can be setup manually only
  - Need for broader B/W (future developments)

To migrate to DFB3 (goal: 1 October 2012)

- Circularisation can be done via F/W by DFB3
- Broader BW: 1024 vs 64 MHz => room for future developments
- further reduction of equipment to support
- More linear polarization receivers can be used

- the VLBI team is working on this with the CASS Technology group since some time now
- The project requires to be given high priority and completed by 1 October 2012

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SUMMARY OF QUESTIONS FOR ATUC

1. Is the broad direction of the long-term strategy right?
2. On the high-frequency receiver (long-term strategy):
   a) is it essential to cover the range 5–24 GHz or is a narrower range sufficient?
   b) in case of splitting, what is the pair of frequency ranges with the highest scientific return?
   c) is there strong scientific motivation to extend the low end down to 4.0 GHz? (e.g., to match the 4–12 GHz system at Narrabri)
   d) what are the scientific motivations to extend the high end beyond 24 GHz (e.g., up to 26 GHz)?
   e) in case both are important, which one is most relevant in case technical issues do not allow the entire 4–26 GHz range to be covered?
3. Which interim receiver scheduling strategy is preferred?
4. Which receivers should be mothballed?