Parkes Backend Status Update

Jimi Green (on behalf of Science Operations)
Oct 2016 (minor revision)

Summary

An ongoing process has been rationalizing the frontend and backend capability at Parkes, as described previously by E. Carretti. From the backend perspective, this has recently been impacted by the requirement to house the processing of the Breakthrough Listen programme. The currently available backends are:

- DFB4 – for time domain and spectrometry
- CASPSR – for single-beam time domain and new limited piggyback spectrometry
- HIPSR/BPSR – for multi-beam (13) time domain and spectrometry
- DAS – for VLBI
- Mk-V – for VLBI (mainly Geodesy)

MBCORR was removed from the racks late 2015 and as a consequence this has removed multibeam spectral line capability (at least at a spectral resolution beyond that of HIPSR). Additionally, DFB3 has become unreliable (to the point of unusable) and has been 'benched'. This has further reduced the spectrometer capability, with the reduction of available I.F.s (two inherently, three when used with DFB4 simultaneously). It has also removed a reserve option for pulsar timing and searching. Furthermore, the work on the VLBI replacement backend, XCube, has stalled.

There is currently a GPU cluster utilized for the backend processing of the Max Planck Institute Phased Array Feed (MPI PAF). This cluster will be remaining at Parkes, after the MPI PAF is delivered to Germany, as a national facility instrument, in the first instance as the correlator for the new Ultra Wideband (UWB) receiver coming in 2017.

The long range goal at Parkes is to move towards a single backend providing for all the current scientific needs, single-beam or multi-beam (including Phased Array Feeds), spectral and/or time-domain, narrow or wideband, the 'Meister'[1] of correlators, and it is the intention to utilize the PAF/UWB GPU cluster. This correlator would also serve VLBI observations, and development efforts will be made towards this, rather than the previous XCube development.

[1] Adopting an alternative German word to the now somewhat overused, and taxi centric, 'über'.

Current Developments

Breakthrough Listen

The Breakthrough Listen programme is estimated to require four racks of space. One rack will be freed through movement of existing equipment in time for the start of the programme in October 2016, with the full (multibeam) deployment due early 2017. In addition to the space requirement, this installation also has additional power requirements. The functionality of HIPSR and CASPSR will need to move to the new GPU cluster, and neither DFB3 nor MBCORR will return to the racks.

Functionality

Current

For full details of the current correlator modes, facilitated by the backends described in the introduction, see Appendix A. Without MBCORR functionality, and also without a reliable DFB3, the current backends do not adequately serve the astronomy community.

Required

Multibeam spectral line with a spectral resolution of 4kHz or better (to replace that lost with the MBCORR removal) is required. If additional rack space was available, MBCORR could in theory be reinstated, however this is constrained by the Breakthrough Listen deployment as stated above. Also this mode could be serviced with an additional mode to HIPSR and/or through a flexible spectrometer on the new GPU cluster (the preference from the perspective of a streamlined backend setup). A backup option for the continuing pulsar timing projects is also preferable.

Roles & Responsibilities

The intended GPU cluster correlator should be able to be maintained by CSIRO, and should overlap in functionality and programming with ASKAP where possible, ideally to the level at which it can provide experience/input into the ongoing ASKAP effort. There is internal interest to provide support for this, as well as external interest, although the latter does not provide stability in the long term. There would be options for postdoctoral involvement in the coming years as modes are implemented and tested (requiring a knowledge of GPU coding, web interfaces and data transfer for example).

Projected Timeline

In order to accommodate the full Breakthrough Listen backend and the UWB, the physical location of backends will change and the HIPSR functionality will need to be ported to the GPU cluster (in order to free the rack space currently occupied by HIPSR). This required downtime of the backends in question: DFB4 moved into the previous location of DFB3 (~ 1 day); and CASPSR moved into consolidated space (~3 days). The porting of the functionality of HIPSR is envisaged as a two stage process, first enabling the processing on the GPU cluster concurrent with the existing HIPSR processors (currently underway), and then switching across to allow removal of the original GPUs. The HIPSR digitization will also be assessed as to whether it should be updated (to ROACH2 rather than ROACH1, or an alternative such as SNAP).

The new GPU cluster based correlator is required in time for Ultra Wideband Receiver, due for commissioning mid to late 2017. Time domain modes will be developed by Swinburne (in conjunction with their efforts for the time domain modes for the MPI PAF). Spectrometry will be developed by CSIRO on the same timescale.

The higher spectral resolution mode previously provided by MBCORR will either be through the implementation of a new mode on the ported HIPSR or through the early development of a spectrometer on the GPU cluster.

Redundancy/Backup

HIPSR is required until the ported version is implemented and thoroughly tested. The pulsar community would prefer to have a backup system (having lost DFB3 in that role), particularly for ongoing timing programmes. In the near-term this could be provided again through implementing the search and timing modes on the new GPU cluster, and running this concurrently with the existing systems.

Appendix A: Current Correlator Modes

Mode	Dual Pol. Bands	Beams	Bandwidth (MHz)	Channels	Max. Pol. Products*	Time Bins	Name	Current Correlator	Data Format
Pulsar Search[1] (-)	1	1	12	513	3	1	srch_16_512	DFB4	PSRFITS
Pulsar Search[1] (-)	1	1	64	513	3	1	srch_64_512	DFB4	PSRFITS
Pulsar Search[1] (-)	1	1	64	257	3	1	srch_64_256	DFB4	PSRFITS
Pulsar Search[1] (64μs)	1	1	256	513	3	1	srch_256_512	DFB4	PSRFITS
Pulsar Search[1] (128μs)	1	1	256	1025	3	1	srch_256_1024	DFB4	PSRFITS
Pulsar Search[1] (-)	1	1	256	129	3	1	srch_256_128	DFB4	PSRFITS
Pulsar Search[1] (-)	1	1	512	513	3	1	srch_512_512	DFB4	PSRFITS
Pulsar Search[1] (-)	1	1	512	129	3	1	srch_512_128	DFB4	PSRFITS
Pulsar Search[1] (64μs)	1	1	1024	513	3	1	srch_1024_512	DFB4	PSRFITS
Pulsar Fold[2] (4.10ms)	1	1	64	1025	3	256	pdfb4_256_64_1024	DFB4	PSRFITS
Pulsar Fold[2] (8.20ms)	1	1	64	1025	3	512	pdfb4_512_64_1024	DFB4	PSRFITS
Pulsar Fold[2] (4.10ms)	1	1	64	513	3	128	pdfb4_128_64_512	DFB4	PSRFITS
Pulsar Fold[2] (4.10ms)	1	1	64	513	3	512	pdfb4_512_64_512	DFB4	PSRFITS
Pulsar Fold[2] (4.10ms)	1	1	64	129	3	1024	pdfb4_128_64_1024	DFB4	PSRFITS
Pulsar Fold[2] (4.10ms)	1	1	64	257	3	512	pdfb4_256_64_512	DFB4	PSRFITS
Pulsar Fold[2] (-)	1	1	128	513	3	1024	pdfb4_512_128_1024	DFB4	PSRFITS
Pulsar Fold[2] (-)	1	1	128	513	3	512	pdfb4_512_128_512	DFB4	PSRFITS
Pulsar Fold[2] (-)	1	1	128	513	3	2048	pdfb4_512_128_2048	DFB4	PSRFITS
Pulsar Fold[2] (2.05ms)	1	1	256	513	3	1024	pdfb4_512_256_1024	DFB4	PSRFITS
Pulsar Fold[2] (1.03ms)	1	1	256	257	3	1024	pdfb4_256_256_1024	DFB4	PSRFITS
Pulsar Fold[2] (1.03ms)	1	1	256	513	3	512	pdfb4_512_256_512	DFB4	PSRFITS
Pulsar Fold[2] (4.10ms)	1	1	256	513	3	2048	pdfb4_512_256_2048	DFB4	PSRFITS
Pulsar Fold[2] (0.52ms)	1	1	256	257	3	512	pdfb4_256_256_512	DFB4	PSRFITS
Pulsar Fold[2] (2.05ms)	1	1	256	257	3	2048	pdfb4_256_256_2048	DFB4	PSRFITS
Pulsar Fold[2] (0.52ms)	1	1	512	513	3	512	pdfb4_512_512_512	DFB4	PSRFITS
Pulsar Fold[2] (2.05ms)	1	1	512	513	3	2048	pdfb4_512_512_2048	DFB4	PSRFITS
Pulsar Fold[2] (1.03ms)	1	1	512	513	3	1024	pdfb4_512_512_1024	DFB4	PSRFITS
Pulsar Fold[2] (1.03ms)	1	1	1024	513	3	2048	pdfb4_512_1024_2048	DFB4	PSRFITS
Pulsar Fold[2] (0.26ms)	1	1	1024	513	3	512	pdfb4_512_1024_512	DFB4	PSRFITS
Pulsar Fold[2] (2.05ms)	1	1	1024	257	3	1024	pdfb4_256_1024_1024	DFB4	PSRFITS
Pulsar Fold[2] (0.52ms)	1	1	1024	513	3	1024	pdfb4_512_1024_1024	DFB4	PSRFITS
Pulsar Fold[2] (1.03ms)	1	1	1024	257	3	512	pdfb4_256_1024_512	DFB4	PSRFITS
Pulsar Fold[2] (0.52ms)	1	1	1024	257	3	2048	pdfb4_256_1024_2048	DFB4	PSRFITS
Spectrometer	1	1	8	8192	2	1	sdfb4_8_8192	DFB4	RPFITS
Spectrometer	1	1	8	8192	2	1	sdfb4_8_8192_fqsw	DFB4	RPFITS

Spectrometer	1	1	64	1024	2	1	sdfb4_64_1024	DFB4	RPFITS
Spectrometer	1	1	64	2048	2	1	sdfb4_64_2048	DFB4	RPFITS
Spectrometer	1	1	64	8192	2	1	sdfb4_64_8192	DFB4	RPFITS
Spectrometer	1	1	128	1024	2	1	sdfb4_128_1024	DFB4	RPFITS
Spectrometer	1	1	128	8192	2	1	sdfb4_128_8192	DFB4	RPFITS
Spectrometer	1	1	128	8192	2	1	sdfb4_128_8192_fqsw	DFB4	RPFITS
Spectrometer	1	1	256	128	2	16	sdfb4_tb16_256_128	DFB4	RPFITS
Spectrometer	1	1	256	512	2	16	sdfb4_tb16_256_512	DFB4	RPFITS
Spectrometer	1	1	256	1024	2	1	sdfb4_256_1024	DFB4	RPFITS
Spectrometer	1	1	256	8192	2	1	sdfb4_256_8192	DFB4	RPFITS
Spectrometer	1	1	1024	512	2	16	sdfb4_tb16_1024_512_ncal	DFB4	RPFITS
Spectrometer	1	1	1024	1024	2	16	sdfb4_tb16_1024_1024	DFB4	RPFITS
Spectrometer	1	1	1024	2048	2	16	sdfb4_tb16_1024_2048_ncal	DFB4	RPFITS
Spectrometer	1	1	1024	8192	2	1	sdfb4_1024_8192	DFB4	RPFITS
Spectrometer	1	13	400	8192	4	1		HIPSR[3]	HDF5
Spectrometer	1	13	200	16384	4	1		HIPSR[3]	HDF5
Pulsar Search	1	13	400	1024	2	1		BPSR[3]	SIGPROC
Pulsar Fold	2	1	400 /64	512/256	4	1024	Dspsr.nosk[4]	CASPSR[3]	PSRFITS
Pulsar Fold	2	1	400 /64	512/256	4	1024	Dspsr.sktoo[5]	CASPSR[3]	PSRFITS
Spectrometer[6]	1	1	5	2048?	2	1	Dspsr.hi	CASPSR[3]	RPFITS?
VLBI	2	1	4	∞[7]	2	n/a	See VLBI documents	DAS	LBADR
VLBI	2	1	8	∞[7]	2	n/a	See VLBI documents	DAS	LBADR
VLBI	2	1	16	∞[7]	2	n/a	See VLBI documents	DAS	LBADR
VLBI	2	1	64	∞[7]	2	n/a	See VLBI documents	DAS	LBADR
VLBI	2	1	2x16	∞[7]	2	n/a	See VLBI documents	DAS	LBADR
VLBI	1	1	8x16	∞[7]	2	n/a	See VLBI documents	Mk-V	Mark5b
VLBI	1	1	16x16	∞[7]	1	n/a	See VLBI documents	Mk-V	Mark5b

* where polarization products are AA, BB and/or AB

1 Number in brackets is fastest time sampling (the value is dependent on no. of bits and no. of pols, listed value is for 1 bit, 1 pol. with a cycle time of 10s)

2 Number in brackets is finest folding period

3 Responsibility/Maintenance external to CASS (Swinburne)

4 Not including Spectral Kurtosis

5 Including Spectral Kurtosis

6 Spectrometer mode reliant on pulsar target and simultaneous high time resolution data, specifications listed are arbitrary.

7 Software based correlation with user defined channelization, hence effectively infinite possibilities.