UniBoard and UniBoard^2

RadioNet FP7 / RadioNet3 Joint Research Activities

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Concept

- Generic, scalable high-performance computing platform for radio astronomy
- State-of-the-art FPGAs, as much IO as will fit
- Standard interfaces: 1GE, 10GE, DDR3, LVDS
- Force design to be generic by simultaneous development of 4 applications: correlator, digital receiver, pulsar binning machine, RFI mitigation
- Make firmware available through common repository, all open source

- All done on shoe-string budget…
Project setup

- Project lead, VLBI correlator, control code, hardware tests: JIVE
- Hardware development, tests: ASTRON
- Digital Backend: INAF, BORD
- Pulsar Binning: UMAN
- RFI mitigation: UORL, UMAN

- ShAO and Oxford joined project early 2010
- Additional developments:
  - APERTIF beamformer/correlator: ASTRON
  - all-dipole LOFAR correlator: ASTRON, UvA, UOXF
  - digital receiver for new 65 meter telescope: SHAO
  - RFI mitigation for digital receiver: UORL, BORD
  - Channeliser for pulsar binning system (in combination with commercial ADC and GPU cluster): MPG
  - SFP+ mini backplane (UORL)
From cartoon to reality
Results: hardware
And more hardware

- Has moved from ‘research’ to ‘real world’
- Several production runs
- Involving real instruments (Apertif, EVN correlator, Shanghai 65m telescope digital backend)
UniBoard correlator: cross correlations

UniBoard

SFXC
The future of radio astronomy: SKA

- Orders of magnitude increase of sensitivity, survey speed
- Instrument for transformational science
- ~1.500 M$, enormous technological challenge
- Costed design phase has ended, site selection done (Australia and South Africa)
- Construction phase 1 will start 2015
  - 250 single-pixel feed dishes, 60 AA stations
- Full SKA will generate more internet traffic than currently available globally
Relevance for SKA: dish array

• SKA Phase 1 correlator for dish array
  • Could be accommodated by current UniBoard
• Make use of excellent switching capabilities of UniBoard
Aperture Arrays in SKA

AAVS1:

- 256 antenna elements distributed over
  - 4 stations
  - 64 elements each
- APERTIF-like architecture
- Will make use of UniBoard (one)
Joint Research Activity in RadioNet3, follow-up of current project, start date July 2012

Partners: JIVE (project lead), ASTRON, UBORD, UORL, INAF, UMAN, MPG

Same basic idea, development of generic hardware complemented by a number of applications

Complete re-design, not a simple re-spin

Consolidate and build on expertise obtained through UniBoard project

Strong emphasis on power efficiency (green computing)

Production-ready in 2015/2016, a timescale that coincides with SKA phase 1
Main focus UniBoard²

- Complete re-design, using the next generation FPGAs
  - 28nm? 20nm?
- Non-leaded components
- Possible use of 40GE, 100GE
- Investigation into effects of hard-copy and partial hard-copy
  - Although actual hard-copy beyond (financial) scope
- Minimize power consumption:
  - Tuning of algorithms and firmware design
  - Balancing of system parameters and performance
  - Components switched off when not used
- Standardized interfaces and coding conventions to facilitate sharing and re-use of firmware blocks among developers of different applications
UniBoard\(^2\) considerations, wish list

- SKA construction starts ~2015, UniBoard\(^2\) ends July 2015
- Need to use latest technology: 20nm (?)
- Strong orientation on Xilinx in relevant institutes in SA, Australia
- Willingness to hold off hardware decision, squeeze time line
- But will need active support from Altera

- Interfaces: 2x4x25G per FPGA (QSFP+)
  - \(\geq\) 8 FPGAs
- Backplane oriented (to build larger, dense systems)
  - \(\geq\) 4 times more processing
  - \(\geq\) 4 more receiver input bandwidth
- Prototype available end 2014
- SKA could and should drive the design decisions …