SKA Correlator Working Group Report
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1. What technologies are understood well enough to require little further work before 2005?

   The underlying electronic technology to support correlator development is being developed by industry, but current cost projects are dependent on industry projections that Moore's Law will continue to function (as is fully expected through at least 2010). Electronic interconnect technology may be a concern for reliability and should be examined carefully.

   Optical communications technology is adequate for signal transport purposes from stations to correlator.

2. What technical areas need further development and what resources are required?

   Design for reliability, testability and maintainability of such a large system is judged to need serious investigation. Suggest consultation with industry/institutions that have built such large projects (telecom, Cern, Fermilab, others?).

   Affordable, reliable optical switching technology could be key to correlator flexibility and adaptability. This technology needs to be watched closely.

3. Who is working or is prepared to work on these development areas?

   For most part, no specific work on above areas by SKA; rely on industry to develop necessary underlying technologies.

   Correlator work on various sorts is currently being carried out by DRAO, ATNF, ASTRON, UCB, MIT (and possibly others), but no funded work on SKA correlator; some informal studies, such as Brent Carlson's poster paper.

4. What technical areas are currently not being addressed by anyone?

   Although not directly a correlator concern, an area that needs to be seriously addressed by SKA:
   - what to do with large volume of data flowing from correlator (may be > 1000 Tb/sec in some modes!!)
   - define exactly what is correlator output

5. What software issues need to be addressed specifically?

   The correlator software is conceptually straightforward, but will necessarily be very complex. Software must carefully address issues of diagnostics/maintenance, and may well benefit from use of automated tracking and maintenance systems.

6. What cooperative development efforts are currently under way, and what new ones need to be started? Which institutions and industry groups are or need to be involved. Who are the key individuals?

   Only informal studies so far; need funding support for serious work. Institutions are same as mentioned above, though others are welcome.

   Industry/institutional groups need to be consulted for expertise in building and managing large systems (can address such issues as packaging, heat control, testability, maintainability, operations management, etc).

7. Can a development leader or leaders be identified?

   Premature. At this point, interested people <u>are invited to submit ideas</u> for review and comment.

8. What trade-offs between scientific specifications and technical solutions are anticipated?

   It is clear from the outset that the correlator will not be all things to all people; current rough projected costs range from $40M to $1300M US!

   The major parameters available for trade-off in correlator design are (at least)
   - Spectral resolution (affect #lags or FFT size)
   - # of baselines (i.e. #stations)
   - # independent simultaneous beams (affects efficiency)
   - Bandwidth
   - Dump rate (affects single beam FOV)

   Other tradeoffs that must be examined:
   - FX vs XF
   - Reconfigurability vs cost

9. What are the major milestones that must be met before an SKA design can be selected?

   It would be useful in the near term, as a reality anchor, to scope out a <u>minimal realistic design</u> and the associated capabilities and projected cost.

   A few <u>case studies</u> of the capabilities of a few competing correlator architectures at several different price points is judged to be useful for review by the scientific users.

Ideally, models should be developed which will accept a set of specifiable scientific parameters (e.g. frequency, bandwidth, spectral resolution, FOV, # of beams, etc) and will, in turn, project the cost of the capability. This is not necessarily east to do, but would be quite useful.

Process for final selection of design not yet determined.

10. How does the technical development time line fit with the requirement for design selection in 2005?

    Seems to fit OK, but care must be taken to design, as much as possible, to take advantage of Moore's Law during replication phase some years later.

11. What critical review mechanism should be used to track the progress of development until 2005 in the areas addressed by this working group?

    Yearly review; consultation with scientific committee; others?

Other recommendations:

1. The number of stations has a huge impact on the correlator and should be pinned down as soon as possible.

2. Due to necessary synergy between RFI mitigation and correlation processes (at least potentially), a single 'Backend Digital Signal Processing' group should be formed.

3. A joint working group on interfaces should be formed (perhaps not immediately, but fairly soon).

4. The number of worldwide correlator experts is judged to be both shrinking and graying! SKA must encourage and support (if possible) training of new experts in this field for continuity of effort and injection of new blood and ideas into the field.

Other comments:

1. History has shown, despite many intentions to the contrary, that ~7-10 years is necessary for the development and construction of a large correlator system. The SKA correlator is reaching into new territory.

2. Correlator architecture must by scalable so hardware may be easily expanded or upgraded with minimal software impact.