2011 Signal Processing CoDR: Element Level Risks

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Development of Risk Register

- System Risk Register
  - SP Element Risks Owned by SP Domain Specialist (W.Turner)
  - Some risks may flow upwards to System Level (T.Stevenson)
- Organisation SP Element Level Risk Register:
  - Signal Processing
    - Requirements
    - Technology
    - Staff Skills
    - Sub-System Design
    - Programmatic
    - Algorithm
  - Correlation
  - Non-Imaging Computing
  - Central Beamforming
- Includes estimate of Risk Exposure at SKA1 and SKA2
- 25 out of 40 Risks are currently identified as high exposure
- Mitigation of 16 of these risks are already underway

Risk Exposure

- Based on guidelines in the Risk Management Plan but simplified to 3x3 matrix
  - Likelihood:
    - Not likely : Low
    - Likely : Medium
    - Very likely : High
  - – Impact:

Impact	Cost	Schedule	Performance
Low	Around 2% impact	Very minor or no slip in milestone (several week s)	Very minor or no impact
Medium	Around 5% to 10% impact	Moderate slip in milestone (several weeks to few months)	Moderate functional impact or reduction in performance, performance almost acceptable but require minor redesign
High	Larger than 20% impact	Critical slip in milestone (more than 6 months)	Critical functional impact or reduction in performance, performance not acceptable and require new design

Risk Exposure

- Exposure:

		Impact		
		Low	Medium	High
Likelihood	High	Medium	High	High
	Medium	Low	Medium	High
	Low	Low	Low	Medium

The estimated exposure Phase 2 (SKA2) as shown in the table is subjective and has been estimated by the SPDO domain specialist based on their view and knowledge of the domain.

High Risks SP SKA1

- 1.1 Scope Creep: Failure to baseline and traceably manage requirements held in a central repository
- 1.2Errors introduced by the interpretation and analysis of requirements: The flow down of requirements is can be open to misinterpretation particularly when this is via document hand-over.
  - The acquisition of Requirement , Documentation Management and System Modelling Tools is under way
- 1.10 Corporate memory embodied as tacit knowledge: expertise is often acquired by individuals over the development of a project. This can be lost if they leave or retire.
  - Generate detailed and comprehensive documentation
- 1.11Limited number of experts: The combination of state of the art Signal Processing and Radio Astronomy skills is a rare combination.
  - Staffing for SPO at the PEP phase now defined

High risks SP SKA1

- 1.13 Operations: There is a potential for equipment to be designed to provide all the functionality for the science without consideration of how the potentially large amounts of data will be used or extracted from the system.
  - Starting to generate Use Cases
- 1.16 Cash Flow: Splitting the project into different non overlapping phases with separate funding may result in a cash flow problem as extensibility to the latter phases will inevitably require supporting activity in the earlier phases
- 1.17 Schedule and overruns: The schedule for the SKA is ambitious
- 1.19 Communication: The scale of the SKA requires the involvement of multi-national and multi-discipline teams each with their own terminology and working practices
  - The acquisition of Requirement , Documentation Management and System Modelling Tools is under way

High Risks SP SKA1

- 1.20 Bureaucracy: Perceived bureaucracy or misunderstood procedures
- 1.22Over-reliance on processes appropriate only small scale projects: Lifecycle development models that are appropriate for small scale exploration and preliminary implementations are very unlikely to work for development of large scale robust systems.
- 1.23 Moore's Law assumed to apply to development of software and firmware: Assuming that Moore's Law cures Brooks' "essential difficulties" in creating software and firmware; i.e. assuming "software is free"
  - Work with and monitor Software & Computing domain's mitigation strategy
- 1.24 Optimisation of software for maximum utilisation of high performance computer capabilities: Migration of High Performance Computing processor technology to multi- and many-core architectures
  - Benchmarking Activities in the Development Phase

High Risks Correlator

- 2.4 Correlator Output Rate: The theoretical output data rate from the correlator is high and potentially larger than the input data rate when baselines of over 200km are considered: The theoretical output data rate from the correlator is high and potentially larger than the input data rate when baselines of over 200km are considered
  - Develop ICD to the Science Computing in conjunction with Operations plan first drafts as input to the SRR
- 2.6 Insufficient attention to metadata definition and implementation issues: All kinds of observation will require generation, capture, storage and management of metadata associated with raw and reduced observational data – so metadata must be managed as carefully as the observational data
  - Define in the ICDs including Data exchange specifications first drafts as input to the SRR

High Risks Non Imaging Computing

- 3.1 Non visibility computing : Pulsar processing of the very large input data rates anticipated for the SKA is much less developed area. For non-visibility processing, the functional boundaries between hardware and software approaches (on general purpose computers) still need to be explored to ensure that unforeseen bottlenecks in data flow do not develop. The traditional boundaries may not be the best choices for the scale of the SKA, and hardware approaches may be needed where traditional practice has been software.
  - Benchmarking and development of Non-Imaging concepts
- 3.2 Parameter Space The parameter space required for engineering activities associated with Non Imaging processing is currently not completely defined within the System requirements or the DRM. For example, the characteristics the binary systems are currently not present. These parameters have a direct impact on the amount of processing required
  - First iteration with the science and systems teams in progress -> Document 1c

High Risks Non Imaging Computing

- 3.3 High Level of Candidate Pulsar Detections The combination of the SKA's sensitivity and an all sky survey will produce an extremely high number of candidate detections. Traditionally sifting through these candidates is done manually and can take up to 300 s per candidate.
  - Post CoDR Activities instigated to develop automated classification
- 3.4 Failure to detect exotic pulsars through the use of Automatic Detection The detection of pulsars through automatic techniques such as neural networks usually requires training using signatures of existing pulsars. This provides reasonable percentage detection rate for similar signatures but may not perform well for signatures that haven't been used in the training
- 3.5 Auto detection training At present there are no training time figures available within the SKA to indicate the amount of time and cost to configure an auto detector

High Risks Non Imaging Computing

- 3.6 Insufficient attention to metadata definition and implementation issues All kinds of observation will require generation, capture, storage and management of metadata associated with raw and reduced observational data – so metadata must be managed as carefully as the observational data
  - Develop first pass ICDs including Data Exchange specifications as input to the SRR

High Risks Central Beamforming

- 4.1 Compromise on the packing density of the telescope core The requirements for the receptor/ station positioning for imaging opposes that required for non-imaging processing. This means that the close packing requirement specified in the DRM is a compromise with a comparatively large core diameter of 5km. Beamforming across this diameter results in very small diameter pencil beams with implications on the processing power and data rates on downstream processing for a given survey speed
  - Scenario put forward in document 1c suggests 1km core may be sufficient and results in lower number of beams for same FoV
- 4.2 Sparse Array Configuration The Sparse Array configuration specification is not sufficiently mature to guarantee that the number of stations, their diameter and the number of beams may change
- 4.3 Beamformer Calibration The scale of the number of dishes and Sparse AA stations coupled with the performance requirements of the SKA present a major challenge to beamformer calibration.
  - Modelling and Benchmarking in the development phase

High Risk Central Beamforming

- 4.4 Insufficient attention to metadata definition and implementation issues All kinds of observation will require generation, capture, storage and management of metadata associated with raw and reduced observational data – so metadata must be managed as carefully as the observational data
  - Develop first pass ICDs including Data Exchange specifications as input to the SRR

Way Forward

- Ensure that the risks currently listed are owned management and mitigated (owner SP domain specialist: W.Turner)
- Ensure that new risks are identified and captured
- Continually track and monitor progress on risks.
- Review risks at the sub-system level (at the SRR review though initial identification of risks are contained within individual concept descriptions)
- Roll up risks and inform the system risk register
- Hand over to SPO for further management