

## Memorandum

**To**                **Richard Schilizzi, Director of the SPDO**  
**From**            **Dorte Olesen, Chair of the SKA Data Transport Expert Panel**

**Subject**        **Observations and Recommendations to the SPDO from the Expert Panel**

4th November, 2011

### I. The Charge to the SKA Data Transport Expert Panel

The SKA Data Transport Expert Panel has been charged with providing a report assessing the strengths and weaknesses of the data transport design and rollout plan for both sites in relation to that required by the Request for Information. This report should highlight any shortfalls of the responses in presenting an infrastructure plan that will support the operation of the SKA:

*For each functional subsystem specified in the Request for Information (or a site's proposed alternative solution), the Expert Panel is required to give their informed opinion on the quality of the response in terms of:*

- *Feasibility of the solution within the context of the site – is the proposed solution a logically possible proposition?*
- *Credibility of the solution – has the information presented come from a reliable source with sufficient expertise?*
- *Costs – are they reasonable / comparable with the Expert Panel's experience of such implementations in similar environments (percentage over or under estimate,  $\pm$  %)*
- *Fit for Purpose – does the proposed implementation deliver the capability that is required*
- *Gaps in the sites response to the RfI (or deviation from specification)*
- *Sequencing of the implementation – does the plan facilitate a smooth rollout*

The functional subsystems to be evaluated are specified as follows:

1. *From receptors to the data processor near the physical centre of the array*
2. *From the data processor to the super-computer centre*
3. *From the super-computer centre to data centres in other parts of the world*

*Two further sub-systems utilize signal transport networks. These are:*

1. *Monitor and Control (M&C) services and*
2. *Timing/synchronization services*

The information requested in the RFI from the proposing sites, is summarized as follows:

- 1) *Describe the implementation plan for the cable network in the Central Area out to 180 km. In your response, please provide information on:*
  - a. *The capital cost to the project of implementing and commissioning the network described in the Model of the SKA*
  - b. *The operating costs to the project of maintaining the described network*
  - c. *The regulatory environment governing networks of this type and the impact of any regulations on the described model of operation*
  - d. *Any existing data connectivity infrastructure to be incorporated in the implementation*
  - e. *Examples of existing capability and capacity of local contractors, if these are available*
  
- 2) *Provide a connectivity plan describing how the SKA signal transport and network requirements described in the SKA Model will be accommodated, and on what timescales, for:*
  - a. *remote sites to data processor*
  - b. *data processor to supercomputer centre, and*
  - c. *super-computer centre to data centres in other parts of the world, and to the Main Office building if that is not co-located with the super-computer centre*
  
- 3) *For the data connectivity plans described in (2) in each case provide information on:*
  - a. *The capital cost to the project of implementing and commissioning these networks*
  - b. *The operational cost of running these networks*
  - c. *The regulatory environment governing networks and of this type and the impact of any regulations on the described model of operation*
  - d. *The management and operations plans for these networks, including details of suggested service level agreements and typical mean time to repair times for comparable locations*
  - e. *Examples of existing capability and capacity of local contractors if these are available*
  - f. *Existing infrastructure to be incorporated into the implementation*

## **II. The Assessment Process Followed by the Panel**

After the panel members had received copies of the relevant information from the bids on the 20<sup>th</sup> of September, 2011 they met in a two-day face-to-face meeting in Copenhagen on the 5<sup>th</sup> and 6<sup>th</sup> of October 2011.

Richard Schilizzi and Roshene McCool from the SPDO participated in the meeting and provided important additional background information as well as clarifications on the terms of reference. This included the instruction to the panel that the “alternative” Australian/New Zealand proposal is outside the

scope of the RFI and should not be assessed. It was also suggested that a total length of the two assessments together could appropriately be about 20 pages.

The individual panel members gave their initial reactions to the proposals and the panel had extensive discussions clarifying the issues raised.

The structure of the assessment report was then agreed as proposed by Dorte Olesen in the invitation to the meeting and the individual panel members took on the various tasks and agreed on a template for the assessments.

Finally, a number of clarifying questions were formulated for the two sites and a process for asking further clarifying questions to the proposers was defined with Richard Schilizzi. A number of questions were asked by panel members both at the meeting and over the following days and replies were rapidly made available from the proposers. These replies have all been taken into account in the final assessment reports.

### **III. General Reactions from the Panel on the Process and the Proposals**

#### **III.1 Time and Data Transport Technology**

The time horizon for the SKA project is not compatible with an in-depth evaluation of all the technical solutions and future risks in the Data Transport area. Technological evolution and the development of commercial offerings take place on a much, much shorter time scale.

The assessments have therefore generally been made for a time horizon of 10-20 years. This is already quite a challenge (as can be seen from some of the comments) in this rapidly evolving field. There is no doubt in the minds of the panel members that over the projected 50 year lifetime of the project there will, necessarily, be important changes to the technology and significant upgrades to the SKA1 installations.

#### **III.2 Proposals as a Contribution to the Design Process**

The fact that the proposals have been made at a time when the detailed design has not been fixed has had important consequences for the assessments. In particular the cost area has been difficult to assess realistically for some of the subsystems.

#### **III.3 Gaps and Risks**

Only major gaps in each of the two proposals have been identified in the two independent assessments. The panel has not reviewed all the gaps and risks identified in one of the proposals with respect their relevance for the other one but it has a general feeling that many of the risks are completely shared between the two even when not explicitly identified in the assessment, e.g. those related to complexity and scale, the harsh environment, the difficulties of extrapolating current experience and competence by orders of magnitude, etc.

The lack of a structured risk identification template with proposals for mitigations by the proposers is felt as an important gap in general. After all, this is a long term, large project and has plenty of risks in terms of time and budget both in the construction phase and in the operational and maintenance phase. See recommendations below.

#### **III.4 No Proposals on M&C and T&S**

Finally, two of the functional subsystems: Monitor and Control (M&C) Services and Timing/Synchronization (T&S) Services could not be evaluated properly due to the lack of information provided by the replies to the RFI. The RFI is, indeed, not totally consistent between the text in the main body of SSG-RFI (pp. 7-8/38) and its annex (p. 26/38). The annex is flagged with the following sentence, referring to the two sub-systems related to M&C and T&S: *“These sub-systems are not included in the model and need not be included in the response.”*

The M&C and T&S subsystems will play a key role for the SKA right from the beginning. In view of this fact the missing information in this area prevents assessing key criteria like sequencing, cost and the way these systems will interact with other parts of the overall design.

Please note that the Australian-New Zealand team did provide some information on these subsystems in reply to a question but the panel does not feel in a position to assess in detail the proposal for M&C and T&S for any of the two proposals.

#### **III.5. Costs Based on External Supplier Estimates**

Much of the cost estimation in the proposals is based on more or less formal consultations with suppliers. This is very reasonable at this early stage but the budgetary uncertainties over the time scale of the SKA project are very large due to the fact there are no formal commitments possible at this stage: Service Level Agreements (SLAs), Indefinite Rights of Use (IRUs), no charge for services from government entities and other contractual “details” will need to be worked out, some of them through competitive bidding and this is likely to change the estimates significantly – or at least limit them in time to 5-10 years!

### **IV. Observations on Individual Parts of the Assessments**

#### **IV.1. Location of the Super-computer Centre Relative to the Data Processor**

A difficulty in providing comparable assessments has arisen in connection with the functional subsystem connecting the Data Processor to the super-computer centre. The South African proposal is to co-locate the two at the astronomy site. This avoids a lot of complicated long distance connections and connected costs and operational risks and is in full compliance with the RFI. The Australian-New Zealand proposal locates the super-computer centre outside the astronomy site also in full compliance with the RFI.

The issues the panel is concerned with here are:

- 1) the connection cost difference when evaluated by the South African reply is VERY big, so big that it has a significant impact on the cost of the overall project
- 2) the electrical specifications in the RFI seem to imply that the super-computer centre must be at a distance from the astronomy site. Clarifications of the boundary conditions for the location of the super-computer centre (e.g. radio-wave emissions) will probably be needed going forward.

#### **IV.2. Sequencing**

Of the six assessment criteria used by the panel, sequencing has proven impossible to assess in detail since very little specific information has been included about this aspect in the two proposals. Further work remains to be done here once the detailed design has been made.

#### **IV.3. Costs**

The cost estimates in the two proposals have been assessed by the panel and, generally, found to be reasonable. Without a detailed design and much more information about the constructional and operational risks of long distance fibre communications in the harsh climatic conditions of the two sites the panel has had to refrain from any detailed assessment of the nature requested: “percentage over- or underestimate”.

Of course the cost estimate for the M&C subsystem have not been assessed in detail. In particular the panel considers that a major capital expense will be necessary for the development of the management and control software. This expense can be quite large and its maintenance and upgrade costs should be added to the operational expenses.

#### **IV.4. Active Components**

The RFI stipulates that “No active components are included” in the fibre networking system for the “Central Area to Data Processor” (§6.1.1 of the RFI).

The reasons for this exclusion are well understood by the panel. There will, however, undoubtedly be a requirement for **passive** WDM equipment to multiplex multiple data channels onto single fibers in order to keep the fiber count to a workable number within the 180 km diameter of the core area.

However, this number is not in the budget summary and there is apparently no estimate given for passive equipment. The passive equipment will be considerably less expensive than active equipment, but still involves high power line drivers (“long-reach optics”) for the interfaces between the telescope instrument modules and the passive WDM (optical multiplexers), the many WDM devices required to get the telescope signals onto the fiber, and some (probably substantial) number of optical amplifiers that will likely be needed to

reach the whole 180km area. So even using a passive system the cost will not be negligible, and should be included in the budget.

It was also unclear to the panel members whether the exclusion of the cost of the active components apply or not in the subsystem connecting the Data Processor to the Super-computer Centre. It even seems as if the Australian-New Zealand proposal does not include them explicitly (but maybe implicitly) whereas the South African proposal does in the not-proposed (but presented and assessed...) option of locating the Super-computer Centre remotely in Cape Town.

## **V. Recommendations for the Next Steps in the Site Selection Process as far as the Data Transport Aspects are Concerned.**

### **V.1. A More Comprehensive and Detailed M&C/T&S Design and Planning**

The other subsystems in the SKA project should be taken into account in the M&C design. The inter-operation of the M&C and T&S systems should also be described and the preferred topology made explicit (e.g. single or multiple point of contact). T&S requirements for the M&C system should be elaborated.

Besides the issues of real-time expectations and the handling of all related data, the overall logical architecture is also likely to be more sophisticated than mentioned in the RFI.

All this represents a lot of effort and the present situation seems inadequate compared to the challenges involved.

### **V.2. A More Structured Approach to Risk Analysis.**

There is little information in the proposals about the proposers' view of the risks involved. This aspect should be addressed going forwards. Examples of risks which should be identified and where detailed mitigation plans should be presented for the fibre network are:

- the time needed for the construction within the 180 km diameter core area. Digging, splicing, testing, access for testing, convergence, time to get goods, time to get subcontractors and overhead to coordinate them, etc.
- operational risks: Fibre aging, access for future fibre upgrades, weather incl. flash floods and lightning and mechanical or political incidents which could affect the operational stability of the system,
- contractual and economic uncertainties in the operation after 10-20 years: contracts with NRENS, contracts with commercial companies (IRUs), government guarantees for costs.

### **V.3. Design the Data Transport System to the Scientific Community in the Rest of the World together with the Users Now**

A detailed model should be worked out in order to evaluate costs and find the optimal technical solutions for the connection of the computer centre with the rest of the world. Discussions with the big user groups and with the NRENs should start as soon as possible. The Large Hadron Collider (LHC) data processing approach could be the inspiration: evaluate and simulate the data rates years in advance, define a tier structure for the processing centres if required, testing everything in advance, etc. The approach will be different by continent.

## **VI. Panel Membership**

Dorte Olesen, chair  
Thomas Brunner  
Mauro Campanella  
Shigeki Goto  
Christian Grimm  
Bill Johnston  
David Salmon (for Jeremy Sharp)  
Dany Vandromme  
Pedro Veiga  
Tor Bloch, rapporteur

Thomas Brunner was prevented from participating in the meeting and teleconference of the panel due to other commitments. The other members all took active part in both these events.