Memo 75

Signal Transport for the SKA

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Summary

This white paper looks at the data and signal transport issues for SKA. It is clear that optical fibre technology has a number of advantages including high data rates, low loss and low cost. There are design issues for fibre links which need to be considered, and the use of COTS equipment on cost grounds will mean that certain compromises will have to be made. SKA is big, not only in collecting area but also in terms of the interconnections required and hence transmitter/receiver pairs. Currently the highest data rate systems (40 Gbps and above) are expensive, however the expectation is that costs will decrease, driven by the needs of the telecommunications industry. A cost model is developed here based on current costs of 10-Gbps equipment, though the expectation is that SKA will have higher data rates particularly in the inner array. The costs on this basis are high, and form a substantial fraction of the proposed budget, and even vastly exceed it. However it is expected that the rapid developments in this technology will lead to a reduction in the cost per bit per second over the next few years. A number of issues raised are already being addressed by the SKA international community, however the signal transport task force also needs to keep a close eye on device and system developments with an eye to cost reduction.

1 Introduction

Interconnection of the various elements in a large radio telescope is fundamental, particularly when aperture synthesis techniques are used requiring signals from all pairs of elements to be brought together for correlation. The large bandwidths required particularly at high frequencies will require many Gbps for high fidelity data transport. Meeting the cost requirements will present a challenge. All the concepts being considered for SKA require high data rate connection from individual antenna or feed elements to processing devices. Accumulation of signals is likely to occur on several scales, for example in the sequence: feed elements → beam formers → stations → correlators, many aspects of which depend on details of the antenna concept. It is therefore difficult to come up with a general design and cost model which covers all possibilities, however the reference design provides a suitable basis on which to make initial calculations. This white paper will look at various aspects of data transport, concentrating on fibre optic aspects, with the aim of identifying the most critical areas. This work follows on from last year's discussions and papers presented at the Penticton SKA meeting [1,2].

The next section looks at the arguments for using optical fibre, followed in section 3 by discussion of the design issues involved for multi- mode and single- mode fibre links, for the use of analogue or digital links, and for LO signal transfer. Section 4 contains a cost model based on the reference design, but with an extension to other concepts in the form of a table. Finally conclusions and suggestions for further work are drawn.

2 Why Optical Fibres?

The techniques to be used for interconnection depend on distance and more particularly bandwidth. The bandwidth required for SKA depends on the application, for example we might envisage 1 Gbps data rates per domain for multiple narrow bands at L band (i.e. several bands placed in the 1-2 GHz band), or several 10's Gbps if wide bands (GHz) are used at cm wavelengths as for ALMA [3], E-VLA [4] and e-MERLIN [5]. Connection can be via coaxial cable, radio links, free space optical links, or by optical fibre.