MWA 32-T Objectives and Quality Assurance Evaluation Criteria

(with owners of each task specified)

Wayne Arcus
MWA Project Manager
Curtin University of Technology

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(Reference #'s, minor edits, and task owners added by Alan Whitney, 31 Aug 2009 and 4 Sep 2009; all changes from 31 Aug 2009 document are highlighted)

Background

As part of a wider meeting held at the Harvard-Smithsonian Center for Astrophysics on 31 July 2009, representatives of the NSF and MWA Project team met to discuss 32-T Objectives and Quality Assurance Evaluation Criteria. The intent of which was to review, identify and propose a common approach acceptable to both the NSF and AAL in order to align the milestone requirements and acceptance criteria.

Those present during the meeting were:

NSF	Richard Barvainis Vernon Pankonin
MWA Project	Alan Whitney Bernie Burke Colin Lonsdale Jacqueline Hewitt James Moran Lincoln Greenhill Steven Tingay Wayne Arcus

Notes captured herein represent a review of the understood 32-T objectives and verification criteria. Once finalized and agreed between the respective parties, the material will be used to formulate the relevant Acceptance Test Plan and Procedure (ATP&P) and will be adopted by the project in order to attain approval for completion of the mandatory Project Milestone – 32-T Demonstration.

Documents considered during this alignment review comprised:

[1] - NSF MWA Panel Review Final Report, 17 July 2009
[2] - MWA Antenna Critical Design Review, 22 July 2009
[3] - AAL Report, Appendix A, Proposed capabilities of 32 antenna demonstrator, 20 November 2009.

Summary and Outcomes

During the meeting, it was noted that a number of the items addressed in the NSF Panel Review Report (ref. [1]) were covered or better addressed/associated with the Antenna CDR process and not specifically seen as related to the 32-T acceptance criteria. Accordingly, the recommended outcomes captured below reflect this. It should also be noted that the Project's response to the Antenna CDR will be addressed separately.

The Project team noted that the NSF report introduced the term "fielded" when referred to the receiver and clock (cf. [1], pp 5, Recommendation 5) which, depending on interpretation, implied subsystems of considerable more maturity than intended for the 32-T demonstration – owing to aspects such as environmental enclosures and methods of deployment and testing. NSF subsequently confirmed that this was not the intention and the wording should be altered or suitably clarified.

During the meeting a model consistent with the adoption of a Systems Engineering approach was described[1] whereby the Project would translate the underlying 32-T objectives into system requirements (via a System Specification) whereupon the ATP&P would be developed. It was envisaged that these documents would be provided to both NSF and AAL for review prior to the 32-T system verification being conducted. The verification test procedures would then be executed and a report submitted using the created template as part of the ATP&P development. So doing, this will allow for expeditious review and approval by the agencies.

Furthermore, a Verification Cross Reference Matrix (VCRM) would be developed and maintained throughout the project lifecycle to assure system requirements are verified holistically across the Project.

Table 1 summarizes the assignment of criteria listed as outcomes in table 3 to the relevant verification phase in the project – akin to a mini-VCRM.

Table 1 –Verification Criteria Mapping to Project Review Point

Ref #	32-T Evaluation Criteria	Verification Activity Assignment	Owner
1	Orbcomm beam maps for 3 pointings	32-T Demonstration	Mitchell
2	Autocorrelation measurements	-	-
2a	• Demonstrate freedom from self-RFI	System CDR (via RFI Trade-off study)	(Not relevant for this review)
2b	• Demonstrate efficacy of RFI excision algorithm	A system characterization activity only – not a verification activity	Briggs
2c	• Show diurnal variation in power consistent with sky	Antenna CDR	Bowman (assistance from Oberoi, C. Williams)
2d	• Show consistency over several days of observation	32-T Demonstration	Briggs (assistance from Bowman, Oberoi, C. Williams)
3	Show the antenna positions via interferometry consistent with GPS measurement	32-T Demonstration	Briggs
4	FFT imaging with 16MHz	-	
4a	• Demonstrate basic performance at 3 frequencies	32-T Demonstration	Ord
4b	• Show that 32T calibration is consistent with system modeling	Out of scope for 32-T Demonstration.	Ord

[1] - as will be described in the Systems Engineering Management Plan (SEMP)

5	All-sky Map	-	-
5a	• Produce all-sky map at 3 pointings and 3 frequencies. Show expected noise limits.	32-T Demonstration – one (1) pointing and one frequency acceptable.	Greenhill (leading the RTS group)
5b	• Repeat over several days and demonstrate expected performance	32-T Demonstration	Greenhill (leading the RTS group)
6	Track and image sky field over 6-8 hours	32-T Demonstration	Greenhill (leading the RTS group)
7	Measure polarization of a known source	32-T Demonstration	Oberoi
8	Report on reliability, weathering etc.	Antenna CDR	Emrich (assistance from Burns)
9	Collect engineering data (power, temperature, Tsys versus frequency)	32-T Demonstration	Morgan

Table 2 – AAL and NSF Scope Comparison

Ref #	32-T Scope – AAL	32-T Scope – NSF	Comments	Owner
10	32 tiles beamformers	32 tiles and preproduction beamformers	Consistent	Morgan
11	4 receivers with interim cabling	4 preproduction receivers with cabling	"Interim cabling" means current configuration, as described in AAL report document. NSF wording was open to interpretation. **Note:** During the meeting with NSF it was agreed that demonstration of the receiver/enclosure and clock distribution are beyond the scope of 32-T demonstration but must be carried out in parallel.	Emrich (pending availability of Waterson)
12	Interim clock distribution and cabling	Preproduction clock distribution system	"Interim" means existing system distributed by copper in hut, as described in AAL report document. NSF wording is ambiguous.	Cappallo
13	Correlator	FPGA-based hardware correlator for 32T	Consistent (hardware configuration spelled out in AAL report document)	Cappallo
14	Interim real-time computer with real-time imaging	Interim real-time computer with real-time imaging	Consistent	Greenhill
15	Monitor and control automation	Monitor and control automation, including start/stop of diesel generator, start/stop of air conditioning, command of beamformers, receivers, correlator, and RTC.	Consistent, given explanation in AAL report document	A. Williams (assistance from Morgan)

Table 3 – 32-T Evaluation Criteria

(Note: Column ordering differs from original document; AAL 1st, NSF 2nd)

Ref #	32-T evaluation AAL accepted requirements	32-T Evaluation NSF panel recommendation	Comments	Discussion Outcomes
1	No requirement	Orbcomm beam maps for 3 pointings	Currently in progress, accuracy may be limited. Requirement should reflect inherent uncertainty.	• Limitations due to satellite signal variability plus carrier causing digital artifacts. • **Outcome:** Response better addressed as part of Antenna CDR not 32-T.
2	**Autocorrelation measurements**			
2a	Measure self-generated RFI	• *Demonstrate freedom from self-RFI*	Best done independent of fielded 32T due to interim nature of current deployment. Relevant engineering data available	• Relevant to other front-end elements too. • Goes also to RFI planning and ties into trade-off study and report and CDR for the System • **Outcome:** Decouple from 32-T as it goes to field-testing of the receiver.
2b	No requirement	• *Demonstrate efficacy of RFI excision algorithm*	Better test is a long integration showing expected noise decrease with time	• Main issue is characterizing the environment. Propose using long integration characterization with sufficient spectral resolution. • Has EOR relevance but pointed out radio-quiet requirement. • **Outcome:** Should not be considered an acceptance test, rather a general system characterization activity only.
2c	No requirement	• *Show diurnal variation in power consistent with sky*	Data in hand (drift scans)	• Goes to Sky tiling and outstanding recommendations of antenna CDR. • **Outcome:** Should not be considered a requirement of 32-T, rather of the Antenna CDR.
2d	No requirement	• *Show consistency over several days of observation*	Nature and degree of consistency unspecified	• **Outcome:** Should be considered a 32-T requirement but should constrain project impact by adopting minimal number of days (e.g., 3)

Ref #	32-T evaluation AAL accepted requirements	32-T Evaluation NSF panel recommendation	Comments	Discussion Outcomes
3	No requirement	Show the antenna positions via interferometry consistent with GPS measurement	Available now, except for error analysis	• Data available but analysis not undertaken at this time. • Estimated to require an astrometry expertise and may be labor intensive thus needing further consideration. • Needs to be important for decent imagery therefore natural for 32-T. • **Outcome:** Should be considered a requirement of 32-T.
4	**FFT imaging with 16 MHz**			
4a	Only a single frequency implied	• *Demonstrate basic performance at 3 frequencies*	No significant additional difficulty anticipated	• NSF call for 16MHz, AAL for 16MHz or greater. • Need to think about the appropriate frequencies to be considered across the band. • Calibration will be crude given 32-T limited capabilities. • System Modeling: need to consider carefully what are the success criteria? e.g., simulation in MAPS. • **Outcome:** A requirement of 32-T.
4b	Limited real-time calibration "can be demonstrated"	• *Show that 32T calibration is consistent with system modeling*	Cannot expect very much with 32T sensitivity	• See last paragraph in pp 6 of Antenna CDR. Inappropriate to turn this into a calibration and foreground subtraction exercise. • Could use simulation but many issues and effort involved. • **Outcome:** Project scientist to formulate a response. Not a 32-T Demonstration requirement per se but potentially valuable.

Ref #	32-T evaluation AAL accepted requirements	32-T Evaluation NSF panel recommendation	Comments	Discussion Outcomes
5	**All-sky map**			
5a	Make all-sky map	• *Produce all-sky map at 3 pointings and 3 frequencies. Show expected noise limits.*	Need to properly define what is meant by "all sky map". NSF requirement requires significantly more observing/analysis effort	• Involves a very large data set, data management and handling and therefore work for analysis. • Reduce data likely required (appox 1000 snap-shots). • Project to re-design demonstration and propose alternative. E.g., single-day all sky map at a single frequency. Project Scientist/RTS lead to propose. • **Outcome:** Considered to be a 32-T requirement but needs to be suitably defined. One (1) pointing and one (1) frequency was deemed sufficient.
5b	No requirement	• *Repeat over several days and demonstrate expected performance*	NSF requirement requires significantly more observing/analysis effort	• Same discussion points as above. • **Outcome:** Considered to be a 32-T requirement but needs to be suitably defined.
6	Track and image sky field over 6-8 hours	Track and image sky field over 6-8 hours	Consistent	• Note: with 32-T system, calibration will be a function of pointing. Degree to which residuals of calibrations will be discontinuous between pointings. There need to clearly outline. • **<u>Outcome:</u>** A 32-T requirement.

Ref #	32-T evaluation AAL accepted requirements	32-T Evaluation NSF panel recommendation	Comments	Discussion Outcomes
7	Measure polarization of a known source	Measure polarization of a known source	Consistent. Is it appropriate to use a satellite source?	• Linearly polarized signals need to be used. • Significant issue with ionospheric Faraday Rotation and other uncertainties. • Can we use a test range instead or signal processing. • Two aspect: answer CDR questions of polarization in the context of calibration; measure and explain in terms of 32-T. • **Outcome:** A 32-T requirements.
8	Report on reliability, weathering etc.	No requirement	Straightforward to do.	• **Outcome:** Should be removed as a 32-T requirement. More appropriate to be an Antenna CDR item (ref. recommendation 3).
9	No requirement	Collect engineering data (power, temperature, etc)	Planned as part of AAL requirements	• **Outcome:** A 32-T requirement as a matter of course.