Deliverable 2.17 – Periodic WP2 Progress Report 3

1.1 Objectives of WP2

WP2 is the main SKA design activity; it was aimed at producing a costed top-level design for the SKA and a detailed system design for Phase 1 of the SKA. This work was undertaken by the SKA Program Development Office based at the University of Manchester, together with the organisations and institutes participating in WP2. WP2 is divided in 7 subtasks and the progress within each of these subtasks during the period 1 April 2011 to 31 March 2012 (T+37 to T+48 months) is presented in this report.

1.2 Overview

During the second reporting period WP2 was restructured to reflect the system engineering approach adopted within the project. This restructuring resulted in a consolidation and reorganisation of the subtasks and the activities within each of them. Milestones and deliverables were also changed to reflect the focus on design reviews to be conducted within each of the subtasks.

The table below summarise the Concept Design Review (CoDR) and (Sub)System Requirements Review (SRR) dates that were planned at the start of the restructured WP2 as reported in the previous periodic report.

Milestone no.	Deliverable No.	Milestone name	Original Delivery date	Revised delivery date
WP2.1 SKA System				
MS7		System Concept Design review (CoDR)	T+22	T+22 (Feb 2010)
	D2.1	System CoDR Report	T+23	T+23 (Mar 2010)
MS7		System delta Concept Design review (CoDR)	None	T+34 (Feb 2011) (23 - 25 Feb 2011)
	D2.1	System delta CoDR Report	None	T+35 (Mar 2011)
MS8		System Requirements review (SRR)	T+36	T+43 (Feb 2012)
	D2.2	System SRR Report	T+37	T+46 (Mar 2012)
MS9		System Preliminary Design	T+45	T+57 (Jan 2013)
	D2.3	System Preliminary Design Report	T+45	T+58 (Feb 2013)
WP2.2 Dish Verification Programme				
MS35		Dish and Dish Array CoDR	T+26	T+39 (Jul 2011) **(13 - 15 July 2011)**
	D2.4	Dish and Dish Array CoDR Report	T+27	T+40 (Aug 2011)
MS36		Dish and Dish Array SRR	T+36	T+59 (Mar 2013)

	D2.5	Dish and Dish Array SRR Report	T+36	T+60 (Apr 2013)
		Final Dish Array PrepSKA Wrap up report	None	T+48 (Apr 2012)
WP2.3 Aperture Array Verification Program				
MS59		Aperture Arrays CoDR	T+30	T+36 (Apr 2011) **(19 - 20 April 2011)**
	D2.6	Aperture Array CoDR Report	T+31	T+37 (May 2011)
MS60		Aperture Array SRR	T+45	T+49 (May 2012)
	D2.7	Aperture Array SRR Report	T+46	T+50 (Jun 2012)
		Final Aperture Array PrepSKA Wrap up report	None	T+48 (Apr 2012)
WP2.4 Signal Transport and Networks				
MS73		Signal Transport & Networks CoDR	T+26	T+39 (Jul 2011) **(28 - 30 June 2011)**
	D2.8	Signal Transport & Networks CoDR Report	T+27	T+40 (Aug 2011)
MS74		Signal Transport & Networks SRR	T+42	T+55 (Nov 2012)
	D2.9	Signal Transport & Networks SRR Report	T+43	T+56 (Dec 2012)
MS75	D2.10	Final STaN PrepSKA wrap up Report	T+48	T+48 (Apr 2012)
WP2.5 Digital Signal Processing				
MS90		Digital Signal Processing CoDR	T+26	T+36 (Apr 2011) **(14 - 15 April 2011)**
	D2.11	Digital Signal Processing CoDR Report	T+27	T+37 (May 2011)
MS91	D2.12	Final Digital Signal Processing PrepSKA Wrap up report	T+48	T+48 (Apr 2012)
WP2.6 Software and Computing				
MS104		Software & Computing CoDR	T+33	T+42 (Nov 2011) **(12 - 14 October 2011)**
	D2.13	Software & Computing CoDR Report	T+34	T+43 (Des 2011)
MS105	D2.14	Final Software & Computing PrepSKA wrap up report	T+48	T+48 (Apr 2012)
WP2.7 WP2 Design Study Management				
MS128	D2.15	Periodic WP2 progress report 1	T+18	
MS129	D2.16	Periodic WP2 progress report 2	T+36	T+36 (Apr 2011)
MS130	D2.17	Periodic WP2 progress report 3	T+48	T+48 (Apr 2012)
		Annual Project Plans for WP2 tasks	T+21, T+33	T+33 (Jan 2011)

Key

	Milestones and deliverables which have slipped beyond the WP2 PrepSKA timeframe. Preliminary documentation has been submitted as evidence of the work in this area.
	Deliverables that have been added to wrap up the domain for WP2

During the execution of the WP2 programme, it became clear that some of the planned reviews would inevitably slip beyond the PrepSKA timeframe. The next table shows the actual reviews and deliverables that were achieved during the PrepSKA WP2 timeframe.

Milestone no.	Deliverable No.	Milestone name	Original Delivery date	Revised delivery date
WP2.1 SKA System				
MS7		System Concept Design review (CoDR)	T+22	T+22 (Feb 2010)

	D2.1	System CoDR Report	T+23	T+23 (Mar 2010)
MS7		System delta Concept Design review (CoDR)	None	T+34 (Feb 2011) **(23 -25 Feb 2011)**
	D2.1	System delta CoDR Report	None	T+35 (Mar 2011)
		Monitor and Control CoDR	None	T+43 (Nov 2011) **(8-9 Nov 2011)**
		Final System PrepSKA Wrap up report	None	T+48 (Apr 2012)
WP2.2 Dish Verification Programme				
MS35		Dish and Dish Array CoDR	T+26	T+39 (Jul 2011) **(13-15 July 2011)**
	D2.4	Dish and Dish Array CoDR Report	T+27	T+43 (Nov 2011)
		Final Dish Array PrepSKA Wrap up report	None	T+48 (Apr 2012)
WP2.3 Aperture Array Verification Program				
MS59		Aperture Arrays CoDR	T+30	T+36 (Apr 2011) **(19-20 Apr 2011)**
	D2.6	Aperture Array CoDR Report	T+31	T+37 (May 2011)
		Aperture Array Mid dCoDR	None	T+43 (Nov 2011) **(23 -25 Nov 2011)**
		Final Aperture Array PrepSKA Wrap up report	None	T+48 (Apr 2012)
WP2.4 Signal Transport and Networks				
MS73		Signal Transport & Networks CoDR	T+26	T+39 (Jul 2011) **(28-30 Jun 2011)**
	D2.8	Signal Transport & Networks CoDR Report	T+27	T+43 (Nov 2011)
MS75	D2.10	Final STaN PrepSKA wrap up Report	T+48	T+48 (Apr 2012)
WP2.5 Digital Signal Processing				
MS90		Digital Signal Processing CoDR	T+26	T+36 (Apr 2011) **(14-15 Apr 2011)**
	D2.11	Digital Signal Processing CoDR Report	T+27	T+37 (May 2011)
MS91	D2.12	Final Digital Signal Processing PrepSKA Wrap up report	T+48	T+48 (Apr 2012)
WP2.6 Software and Computing				
MS104		Software & Computing CoDR	T+33	T+46 (Feb 2012) **(15-16 Feb 2012)**
	D2.13	Software & Computing CoDR Report	T+34	T+47 (Mar 2012)
MS105	D2.14	Final Software & Computing PrepSKA wrap up report	T+48	T+48 (Apr 2012)
WP2.7 WP2 Design Study Management				
MS128	D2.15	Periodic WP2 progress report 1	T+18	
MS129	D2.16	Periodic WP2 progress report 2	T+36	T+36 (Apr 2011)
MS130	D2.17	Periodic WP2 progress report 3	T+48	T+48 (Apr 2012)
		Annual Project Plans for WP2 tasks	T+21, T+33	T+33 (Jan 2011)

Although none of the planned SRRs took place during the PrepSKA timeframe, preliminary Requirements documentation was produced, and has been submitted as the deliverables most appropriate to the eventual requirements review, and as evidence of the work carried out in this area. The project also managed to achieve some additional CoDRs that were not originally envisaged. These included the Monitor and Control CoDR and the Mid Frequency Aperture Array delta CoDR.

More detail on the progress within each of the subtasks of the restructured WP2 is covered in the paragraphs below.

1.3 WP2.1 System

1.3.1 Objectives

This subtask represents the engineering work to be done to define and design the SKA as a complete system. System engineering processes and procedures are also being developed as part of this subtask with the aim to roll out and adopt these processes across all level s of the project.

1.3.2 Participants

Work package number	WP2.1		**Start date or starting event**			T+0 months	
Work package title	SKA system						
Activity Type	SUPP						
Participant id	4	7	9	10	11	12	13
Person-months per beneficiary	6	(38)	(12)	8 (+24)	(6)	(26)	(12)
Person months delivered							
Participant id	14	15	17	ICRAR	SPDO	18	
Person-months per beneficiary	(12)	(24)	(16)	(24)	**102** (+66)	6	
Person months delivered							

1.3.3 WP2.1.1 SKA definition and design

As previously reported, the programme was re-scoped as a result of the SKA System CoDR concluded during February 2010. The Review Panel recommended a two phase approach, and work started immediately on defining the scope of the first Phase.

A revised strategy and guidelines were published in SKA Memo 125. As a result of these changes the system scope and definition had to be re-established. This culminated in the system delta CoDR (dCoDR) performed during February 2011. The same review panel members were invited back to participate in the dCoDR and they concluded that the re-scoping was satisfactory and this milestone had successfully been passed. This achievement set the scene for the performance of the series of CoDR's at the Domain level of the SKA and formed the focus of the activities during 2011 and the first quarter of 2012.

The dCoDR documentation set is available at:

http://www.skatelescope.org/public/2011-02_System_delta_CoDR_Documents/

Domain Concept Design Reviews were carried out during the latter three quarters of 2011 and the first quarter of 2012. In order, they were:

- Signal Processing. 14 - 15 April 2011, Univ. of Manchester, UK
- Aperture Arrays. 19 - 20 April 2011, Schiphol NL
- Signal Transport & Networks. 28 - 30 June 2011, Jodrell Bank, UK
- Dish Array. 13 - 15 July 2011, Penticton, CA
- Monitoring & Control. 8 - 9 November 2011, Pune, IN
- AA Mid deltaCoDR. 23 - 24 November 2011, Astron, NL

- Software & Computing. 15 - 16 February 2012, Univ. of Manchester UK

Panel reports for all Reviews have been received and responses have been made. In summary:

- Panels variously issued cautions regarding Requirements definition – the status of Requirements was, in general barely sufficient to allow the 'weeding out' of concepts at this stage. This is however not in scope of these Reviews.
- Comparability of concepts (scope, maturity) – the range of readiness levels and indeed of technical scope, was wide, making intercomparison difficult.
- System level responsibilities – Panels made recommendations of various kinds which were addressed to the System level engineering and management rather than the Domain level.
- More than 50 concepts covered -
  - Dish designs, Aperture Array Elements, Cryo-coolers, Feeds, Receivers, Digitisers, Beamformers, Signal & Data transport technologies , Synchronisation & Timing technologies, non-imaging computing, correlators, etc
- Cost information patchy – The cost data provided varied widely, insufficient for cost comparisons to be carried out comprehensively.

Notwithstanding these Panel inputs, the Project now has a pool of concepts for all high risk elements of the SKA as currently envisioned.

The topmost User Requirements document, the Design Reference Mission (DRM) continued development throughout the reporting period. As of March 2012, version 2 was being finalised for baselining following an extensive community wide review ending in December 2011. Baselining is expected in May 2012, whereupon requirements analysis, extraction and allocation work will commence in earnest.

The requirements capture and analysis framework is under development, with a detailed document tree and templates/contents for each item being produced. The elaboration of the System Engineering approach, including these items and more besides, will be incorporated in a series of updates to the System Engineering Management Plan.

Tools are expected to be vitally necessary, especially in the system engineering domain; therefore during the reporting period, a candidate requirements database tool (JAMA Contour) was identified, procured and evaluation was initiated. This work is ongoing.

1.3.4 WP2.1.2 SKA Life Cycles studies and analysis

Work within this activity has continued. An internal document, addressing the availability requirements for the SKA, has been developed. This document was an outflow of the work that has been done in support of the site selection process. The product of this work is a series of sections in the topmost Operations document, the Concept of Operations, in preparation.

1.3.5 WP2.1.3 SKA Science Operations

During the delta system review documents regarding science operations were presented. However, these documents are only first drafts of the concepts and will be developed further during the next phase of the project. The product of this work is a series of sections in the topmost Operations document, the Concept of Operations, in preparation.

1.3.6 WP2.1.4 SKA Support operations

Progress within this activity has been made and a concept for support operations has been developed and included in the site selection documentation. This work will be continued during the next phase of the project. The product of this work is a series of sections in the topmost Operations document, the Concept of Operations, in preparation.

1.3.7 WP2.1.5 SKA monitoring and control

During 2010 the lead for this activity was transferred to the Indian institute, NCRA-TIFR and their industrial partner TCS. NCRA-TIFR has committed considerable resources to this task and the emphasis for the remainder of the PrepSKA period was to engage with the wider community in the development of the requirements of the SKA monitoring and control system. This work culminated in a Monitoring and Control domain CoDR conducted in November 2011. The CoDR was successful, with a constructive Panel Report whose contents provide useful guidance for the next phase.

1.3.8 WP2.1.6 SKA electromagnetic compatibility

A strategy and philosophy with regards to the self-generated interference part of this activity has been developed and presented during the system CoDR's. In particular, it was found to be self-evident that a suite of measures and procedures will be required and be enforced to prevent the very sensitive receptors picking up interference emanating from installations and electronics at the sites. For that reason draft guidelines and specifications are being developed and published by the SPDO, which must be adhered to for equipment developed for the SKA, and for adapting commercial equipment that will be used at the site. The last category of interference hazards is particularly critical, as it requires close interaction with partners from industry. The prevention of excessive interference from power installations and reticulation has been recognized as a critical element in this respect. Equipment of any kind that has not undergone successful interference compatibility testing at a certified test facility will not be allowed at the sites. This work will be taken further during the next phase of the project. Good progress with regards to the RFI mitigation within the system has been made and is continuing. This work is being led by OBSPAR and UORL.

1.3.9 WP2.1.7 SKA cost analysis

A Costing strategy and a short 'How To' manual have been developed and published as part of the system dCoDR. These documents form the basis of the cost collection and development within the SKA. Costing information was collected during the Element CoDRs. The costing information was assessed to be at BECL 5. The cost coverage for the estimates presented at the CoDRs was also assessed for completeness. As the project moves forward the costing will be refined and the cost coverage increased. This information has been rolled up and consolidated at system level as part of an ongoing process. Apart from that information, cost data will also be obtained during the site selection process. The aim is to integrate all the costing, in accordance with the Costing Strategy, to provide a comprehensive view of the cost of the SKA.

1.3.10 WP2.1.8 SKA power consumption

During the reporting period there have been two major pieces of work carried out which make a significant contribution to the power consumption area of SKA development.

1. The first of these is the development of the Request for Information documentation and model for the purposes of site selection. In order to enable the two proponent countries to show the benefits of their own site, it was decided that a generic model of the SKA should be

used which would enable direct comparison between the two submissions. In the process of putting together this model, some preliminary power estimates have been made which were then responded to by the sites themselves. The site selection documentation is currently embargoed but it is expected that once the decision has been taken some of the information contained within these reports will be made available to the Office of the SKA Organization and the wider SKA community. These reports were supplemented by expert consultants' reports which reviewed the material from the two sites. This body of information will be extremely valuable to the project in the future.

2. The second area of work is the development of the Work Breakdown Structure (WBS) and associated Statements of Work (SoW) for the area of Power for the next year to eighteen months of work in the Preconstruction phase. This work was carried out in the absence of the information described above (given that the site decision was still pending) and hence had to remain site agnostic. The Power Specialist developed this Work Breakdown Structure in close collaboration with the SKA community (excluding representation from either of the site proponents) in order to outline the work that will be required in developing the power requirements for the SKA and hence the resultant requirements on the various subsystems of the SKA.

1.3.11 Deliverables and milestones

The tables below show all those originally within the reporting period. Shaded rows now fall outside the PrepSKA time frame. As noted above, the preliminary documentation leading to each SRR has been delivered to provide evidence of the work carried out in this respect.

DELIVERABLES									
Del. no.	**Deliverable name**	**WP no.**	**Nature**	**Lead beneficiary #**	**Estimated indicative person months**	**Diss. level**	**Delivery Date (orig.)**	**Delivery Date (updated)**	**Date Delivered**
D2.1	System Concept Design Review (CoDR)	2.1	Report	9	19.15	PU	T+23	T+34	T+35
	System delta CoDR	2.1	Report	9	Additional	PU	None	T+34	T+36
	Monitoring and Control CoDR report	2.1	Report	9	Additional	PU	None	T+44	T+44

MILESTONES					
Milestone number	**Milestone name**	**Lead beneficiary #**	**Due date**	**Slip since last report**	**Date Delivered**
MS7	System Concept Design Review (CoDR)	9	T+22	0	T+34
MS7a	System delta CoDR	9	None	0	T+36
MS7b	Monitoring and Control CoDR	9	None	0	T+44
MS8	System Requirements Review (SRR)	9	T+62	16	-