**WBS structure (outline) - PAFSKA inputs**

*In this document we show the WBS we (CSIRO) has submitted as a ‘strawman’ to the SPO-led Dish Array WBS working group. The WBS and SOW are being drawn up through to March 2012 to provide the basis for the SKA PEP-phase ‘bid’ documentation packages. The WBS and SOW describe the work to be done in the Dish Array package during SKA PEP Stage 1 – this being about 12 months work from ~July 2012 up to the Dish Array SRR.*

*Please note that this is very much a working document; this is now under development by the entire SPO-led Dish Array WBS working group.*

*At this stage we warmly invite the PAFSKA participants to review and add comments - to the PAF part of the WBS structure in particular. Comments on other parts of the structure are welcome; these will be forwarded to Peter Dewdney and there remains the opportunity to participate in the ongoing development of this entire WBS.*

*We have adopted the terms ‘element’ (in this case the whole dish array), ‘sub system’ (e.g. PAF, dish, OBSPF, etc) and ‘assembly’ (e.g. OBSPF payload) as defined for the CoDR stage.*

*On pages 3 onwards we have started to work on the task descriptions. These are not finalised and should be read as indicative notes only.*

*Examples of the Levels 4 and 5 WBS Items* *4 SKA.TEL.AI.PAF (Phased Array Feeds subsystem) and 5 SKA.TEL.AI.PAF.FPL (Feed Payload assembly) are shown on pages 11 – 14. These, too, are “strawman” drafts – constructive comments would be welcome.*

*.........................*

**3 SKA.TEL.DSHA – Dish Array Element**

**4 SKA.TEL.DSHA.MGT - Management**

**4 SKA.TEL.DSHA.SE - System Engineering**

**5 SKA.TEL.DSHA.SE.MGT – Dish Array Requirements**

**5 SKA.TEL.DSHA.SE.DS - Design Studies**

**4 SKA.TEL.DSHA.GLOBAL\_CALIBRATION – Element calibration of the dish array system**

**4 SKA.TEL.DSHA.SIGT – element signal transport**

**4 SKA.TEL.DSHA.PWR – element power**

**4 SKA.TEL.DSHA.INFRA – element infrastructure**

**4 SKA.TEL.DSHA.LMC – element Local Monitoring and Control**

**4 SKA.TEL.DSHA.DVS – Element verification**

**4 SKA.TEL.DSHA.DSH – Dish sub-system**

**5 SKA.TEL.DSHA.DSH.OPTICS**

**5 SKA.TEL.DSHA.DSH.FEED\_ROTATOR**

**5 SKA.TEL.DSHA.DSH.CALIBRATION\_LOCAL**

**5 SKA.TEL.DSHA.DSH.FOUNDATIONS**

**5 SKA.TEL.DSHA.DSH.MECHANICAL\_DESIGN\_OFFSET**

**5 SKA.TEL.DSHA.DSH.MECHANICAL\_DESIGN\_AXISYM**

**5 SKA.TEL.DSHA.DSH.CONTROL\_SYSTEM**

**5 SKA.TEL.DSHA.DSH.POWER**

**5 SKA.TEL.DSHA.DSH.LOCAL\_M\_AND\_C**

**5 SKA.TEL.DSHA.DSH.VERIFICATION – Dish sub system verification**

**5 SKA.TEL.DSHA.DSH.ACCEPTANCE\_PLANNING**

**4 SKA.TEL.DSHA.OBSPF –** **Octave band Single Pixel Feed sub-system**

**5 SKA.TEL.DSHA.OBSPF.FPL - Feed payload assembly**

**6 SKA.TEL.DSHA.OBSPF.FPL.FEED - Feed**

**6 SKA.TEL.DSHA.OBSPF.FPL.CRYO - Cryo**

**6 SKA.TEL.DSHA.OBSPF.FPL.POL – Polarisation transducer**

**6 SKA.TEL.DSHA.OBSPF.FPL.LNA - Low Noise Amplifier**

**6 SKA.TEL.DSHA.OBSPF.FPL.PCKG - Package**

**6 SKA.TEL.DSHA.OBSPF.FPL.PCKG.PWR - Power**

**6 SKA.TEL.DSHA.OBSPF.FPL.PCKG.THERM - Thermal Management**

**6 SKA.TEL.DSHA.OBSPF.FPL.PCK LMC - Local Monitoring and Control**

**5 SKA.TEL.DSHA.OBSPF.RX - Receiver System assembly**

**6 SKA.TEL.DSHA.OBSPF.RX.PWR - Power**

**6 SKA.TEL.DSHA.OBSPF.RX THERM - Thermal Management**

**6 SKA.TEL.DSHA.OBSPF.RX.LMC - Local Monitoring and Control**

**5 SKA.TEL.DSHA.OBSPF.CALIBRATION\_LOCAL**

**5 SKA.TEL.DSHA.OBSPF.VS - OBSPF sub-system verification**

**5 SKA.TEL.DSHA.OBSPF.ACCEPTANCE\_PLANNING**

**3 SKA.TEL.AI - Advanced Instrumentation Element**

**4 SKA.TEL.AI.MFAA - Mid Frequency Aperture Array**

(being developed by the AA team )

**4 SKA.TEL.AI.PAF - Phased Array Feed sub-system**

**5 SKA.TEL.AI.PAF.MGT - Management**

*(a standard template for this task will exist from SPO)*

**5 SKA.TEL.AI.PAF.SE - System Engineering**

*(a standard template for this task will exist from SPO)*

**5 SKA.TEL.AI.PAF.FPL - Feed Payload assembly**

**5 SKA.TEL.AI.PAF.RX - Receiver System assembly**

**5 SKA.TEL.AI.PAF.PWR - Power**

**5 SKA.TEL.AI.PAF.INFRA - Infrastructure**

**5 SKA.TEL.AI.PAF.LMC - Local Monitoring and Control**

**5 SKA.TEL.AI.PAF.VS – PAF sub-system verification**

**4 SKA.TEL.AI.WBSPF - Wide Band Single Pixel Feed sub-system**

*(yet to be developed by the dish array working group)*

Note on how we understand the scope of this WBS; The WBS defines everything required for the Dish Array element development. The WBS needs to be well-developed for PEP Stage 1 now. During PEP Stage 1, the WBS tasks for PEP Stage 2 will be defined, ready for Stage 2 to start after the Dish Array (sub-)SRR.

The Dish Array WBS tasks all take as inputs the system requirements (locked down after the System SRR) and “respond” (i.e. have outputs) at the Dish Array (sub-)SRR on how these will be met (or otherwise).

Therefore the WBS as far as PEP Stage 1 must cover all work necessary to get to the Dish Array (sub) system requirements review; for this to take place, work on the costs, requirements (including performance metrics and test schemes) must be in place. Deeper analyses, e.g. full FEA will likely be left to the earlier parts of Stage 2 (must be fairly early to get through PDR etc and actually get to build DVA for dish, feeds etc).

**3 SKA.TEL.DSHA – Dish Array Element**

Top-level task for the integrated, optimised and SRR-compliant SKA Dish Array element. This element includes the dish, receivers (front-ends), back-ends, control systems, and associated analyses (e.g. optics/performance analyses, calibration scheme(s), etc) for the complete dish array. The level-4 tasks define the delivery of the constituent sub-systems of the dish array system; below these, at level 5 are the detailed tasks which include both the development of the assemblies and the verification programs for the sub-systems themselves.

There is one level-4 task to define the delivery of the integrated Dish array verification element; the verified sub-systems (e.g. dish, receivers etc) are delivered via the level-5 verification tasks defined under each of the sub-systems.

**4 SKA.TEL.DSHA.MGT - Management**

*Presume that this task will follow a ‘template’ for WBS management*

**4 SKA.TEL.DSHA.SE - System Engineering**

**5 SKA.TEL.DSHA.SE.MGT – Dish Array Requirements**

**5 SKA.TEL.DSHA.SE.DS - Design Studies**

*Again, we suggest there should be a ‘template’ set of tasks for the System Engineering tasks, describing the scope, deliverables etc of these tasks – to include*

* *a complete integration of the sub-tasks,*
* *ensuring SRR ‘s are allocated across the Dish Array sub-system appropriately (i.e. starting with a pointing spec budget, then refining this as the work progresses. Noting that this also includes all OHSE, conops etc requirements (and not necessarily all technical functions)*
* *Maintaining risk registers, working to retire risks*
* *Development of the LEMP etc plans for the dish array system (working from the elements upwards)*
* *Evaluating the SRR match of the options being developed; defining verification and or down-select options so that by the time of the Dish Array SRR the options to be carried beyond the SRR are clear and agreed.*

**4 SKA.TEL.DSHA.GLOBAL\_CALIBRATION –Element calibration of the dish array system**

Task to integrate the total dish array calibration systems (physical and logical).

**4 SKA.TEL.DSHA.SIGT – Element signal Transport**

Task to integrate the complete signal transport dish array systems (physical and logical), including cable path management, LO distribution etc; will define ICDs with other parts of the WBS structure.

**4 SKA.TEL.DSHA.PWR – Element power**

Task for the management of the total dish array power budget and distribution systems.

**4 SKA.TEL.DSHA.INFRA – Element infrastructure**

Task to define the total infrastructure requirements of the dish array system.

**4 SKA.TEL.DSHA.LMC – Element Local Monitoring and Control**

Task to integrate all M&C systems across the Dish Array and to define ICDs with other parts of the WBS structure as appropriate.

**4 SKA.TEL.DSHA.DVS**

This task will bring together the plan(s) and results from the sub-systems and apply a consistent and uniform verification program at the element level. Note that each of the Dish and receiver options will have been VERIFIED by the tasks defined within each of these sub-systems separately.

**4 SKA.TEL.DSHA.DSH Dish sub-system**

Top-level task for the integrated, optimised and SRR-compliant SKA Dish (by the end of PEP stage 2). A number of level-5 tasks provide the detailed SOWs to deliver (including verifying) the dish.

For PEP Stage 1 by the SRR this task will deliver a (set of) analysed dish designs, with analyses and justification for the options to proceed through to PEP Stage 2.

**5 SKA.TEL.DSHA.DSH.OPTICS**

Inputs – design outlines from CoDR of (5) dish options for SKA

* defined physical characteristics of feed suite (SKA1, SKA2)
* requirements specs for optical imaging (from sci, operations etc)
* SRR’s, including Extensibility

Review design options for the dish optics, define calibration and imaging procedures for each option including PAF, define the relevant performance metrics (1st sidelobe level, squint, imaging DR from the optical system, FoV including FoV vs PAF size, etc), procedures for estimating performance, possible upgrade paths and requirements for each option and (as output) provide quantified optics options for the SKA dish.

Outputs – optical performance of the dish options (however many there are..)

* Cost performance trade-off (viz optical system options only)

**5 SKA.TEL.DSHA.DSH.FEED\_ROTATOR**

Inputs – defined physical characteristics of feed suite (SKA1, SKA2)

* SRR’s, including Extensibility
* Performance requirements (speed of changing, simulataneous operation, stability etc)

Review and design the feed rotator system(s) to meet the optics and mechanical dish designs, including defining ICDs between the Feed systems and the Dish mechanical, electrical and M&C systems.

Outputs – design of feed rotator system for dish options (could be same for both offset and axi-symm – or may be different)

* Cost of feed rotator as specification
* Options to reduce cost (cost-performance trade-off)?

(*this task could be embedded in the dish design, but for now it is left separate).*

1. **SKA.TEL.DSHA.DSH.CALIBRATION\_LOCAL**

Inputs – defined physical characteristics of feed suite (SKA1, SKA2),

* optics designs from DSH.OPTICS
* Performance requirements (speed of changing, simulataneous operation, stability etc)

Develop dish calibration systems required to meet requirements of the feed systems.

Outputs - design of local calibration systems including PAF

**5 SKA.TEL.DSHA.DSH.FOUNDATIONS**

In PEP STAGE 1 we think that there would be little or no work on this task. However by Stage 2 this will be a task to interface to infrastructure/site development as follows;

Inputs – dish designs – pedestal/foundation interface definition, FEA outputs

* Site information
* Performance requirements – wind, environment, stability etc

Outputs – design of foundation interface (pedestal bolt cage, cabling, etc) for each dish design, done in conjunction with SKA.TEL.INFRA.GWK.DSF and other tasks across the WBS

* Options to reduce costs
1. **SKA.TEL.DSHA.DSH.MECHANICAL\_DESIGN\_OFFSET**

Inputs – dish design for SKA Offset fed option(s) from CoDR

* defined physical characteristics of feed suite (SKA1, SKA2) and their supporting components e.g. cryo, digital etc systems
* defined signal transport information e.g. from SKA.TEL.SADT.DSH
* requirements specs for optical imaging (from sci, operations etc).
* results from SKA.TEL.DSHA.DSH.OPTICS or prior studies (USA TDP?)
* results from SKA.TEL.DSHA.DSH.FEED.ROTATOR or prior studies (USA TDP?)
* environmental and operating specs (tolerance, maintenance, access, security etc)
* results from SKA.TEL.DSHA.DSH.CALIBRATION\_LOCAL or prior studies

Outputs – Analysis of proposed dish design’s options to meet requirements spec

* initial analysis of design options – performance for each feed type including sky coverage, expected DR, pointing spec, sidelobe characteristics, stability etc
* Analysis of design options – cost/performance - what are the key things driving the cost (or able to be improved?)
* Cost of this design – quantity 100, 200, 1000
* First analysis of manufacturability – from discussions with potential suppliers
* Early phase identification of potential suppliers
* First analyses of build options – ease of build? Number of personnel? Deployments to remote sites? Requirement of manufacturing support infrastructure close to site?
* Timeline, budget and plan to develop DVA-x system, for those design(s) suitable for further (post-Dish array SRR) development.

**5 SKA.TEL.DSHA.DSH.MECHANICAL\_DESIGN\_AXISYM**

Inputs – dish design for SKA axi-symmetric option(s) from CoDR

* defined physical characteristics of feed suite (SKA1, SKA2) and their supporting components e.g. cryo, digital etc systems
* defined signal transport information e.g. from SKA.TEL.SADT.DSH
* requirements specs for optical imaging (from sci, operations etc).
* results from SKA.TEL.DSHA.DSH.OPTICS or prior studies (USA TDP?)
* results from SKA.TEL.DSHA.DSH.FEED.ROTATOR or prior studies (USA TDP?)
* environmental and operating specs (tolerance, maintenance, access, security etc)
* results from SKA.TEL.DSHA.DSH.CALIBRATION\_LOCAL or prior studies

Outputs – Analysis of proposed dish designs’ options to meet requirements spec

* Initial analysis of design options – performance for each feed type
* Cost of this design – quantity 100, 200, 1000
* analysis of design options – cost/performance - what are the key things driving the cost (or able to be improved?)
* First analysis of manufacturability – from discussions with potential suppliers
* Early identification of potential suppliers
* First analysis of build options – ease of build? Number of personnel? Deployments to remote sites? Requirement of manufacturing support infrastr close to site?
* Timeline, budget and plan to develop DVA-x system, for those design(s) suitable for further (post-Dish array SRR) development.
1. **SKA.TEL.DSHA.DSH.CONTROL\_SYSTEM**

Inputs – dish design for SKA Offset fed option(s)

* defined physical characteristics of feed suite (SKA1, SKA2)
* Relevant requirements specs from sci, operations etc

Outputs – definition of scope of control system (i.e. defining interface to SKA Telescope Operating System)

* Definition of operations to be handled by the dish control system (servo and control)
* Define scope of control system – expected cost; required complexity and power (motor size, motor ratings etc)
* Design of control system to integrate with each dish design; include physical aspects (where to locate motors, encoders etc; anti-backlash etc) as well as RFI concerns – show how the system will adhere to SKA requirements (SKA.SE.SYSD.EMC etc)
* Initial investigation of whether dish manufacturers would be able to meet spec, or if it should be developed in-house (within SKA community) or out-sourced separately.
1. **SKA.TEL.DSHA.DSH.POWER**

Inputs – for each dish design – mechanical/control system power estimates

* Details (spec) on power inputs, PLC control requirements etc

Outputs – an analysis of total power requirements; assuming phased slewing of the dishes (within some sensible approach), it will calculate the total power for the dish array.

* Options for cost-performance trade-offs will be presented.
* A design for the antenna switchboard to accommodate all requirements as defined by SKA.TEL.MGR.PWR

**5 SKA.TEL.DSHA.DSH.LOCAL.M\_AND\_C**

Define how the SKA dish and control system will report local status, and how this will be managed across the array.

**5 SKA.TEL.DSHA.DSH.VERIFICATION\_SYSTEM dish sub-system verification**

Deliver verified DISH (only) sub-system to meet the SRRs. This task will need to include the delivery of test systems to be used (only) in testing the DISH element only (e.g. holography, an X-band receiver, if the SKA spec is 10 GHz, etc), plus back end systems suitable to process the verification data for the Dish itself.

**5 SKA.TEL.DSHA.DSH.ACCEPTANCE\_PLANNING**

Task to define the suite of standard acceptance tests for the dish verification program(mes) to be used at the sub-system and elementlevels.

**4 SKA.TEL.DSHA.OBSPF - Octave band Single Pixel Feed sub-system**

Top-level technical task to develop an integrated, optimised and SRR-compliant suite of Octave Band Single Pixel Feed sub-system(s). A number of level-5 tasks provide the detailed SOWs to deliver (including verifying) these feed systems.

**5 SKA.TEL.DSHA.OBSPF.FPL - Feed payload assembly**

Task develops Octave band Single Pixel Feed payload assembly/ies including suitable feed optics/performance analyses, etc. The details of these tasks are broken into a number of level- 6 tasks which we outline here (but perhaps don’t need to?)

**6 SKA.TEL.DSHA.OBSPF.FPL.FEED – Feed sub-assembly**

Review design options for the SKA Octave band Single Pixel Feeds define the relevant performance metrics. As output this task will provide Feed subsystem requirements (including performance metrics and test schemes) for the SKA Octave band Single Pixel Feeds and refined and finalised WBS tasks for PEP Stage 2.

Inputs: – feed package designs from CoDR or elsewhere

– defined physical characteristics of feed suite (SKA1, SKA2)

Outputs:– Feed subsystem requirements prepared for WP5 Dish Array Requirements Review

– Feed performance metrics

– Feed testing protocol

– Preliminary feed design

– Costing of preliminary feed design

– Finalised WBS tasks for PEP Stage 2

**6 SKA.TEL.DSHA.OBSPF.FPL.CRYO - Cryo sub-assembly**

Review cryogenic cooling system options for SKA Octave band Octave band Single Pixel Feeds, the cost/performance analyses, etc.

Inputs – dish design from CoDR

* defined physical characteristics of feed suite (SKA1, SKA2):
* requirements specs for sensitivity (from sci, operations etc).

This task will review design options for the cryogenic cooling system for SKA Octave band Single Pixel Feeds, define the relevant performance metrics and (as output) provide quantified options for the cryogenic cooling of SKA Octave band Single Pixel Feed packages.

Output – cost/performance analyses of the cryogenic cooling options

* Early phase identification of potential suppliers
* Initial, timeline, budget and plan to develop the cryogenic cooling system for SKA Octave band Single Pixel Feed packages

**6 SKA.TEL.DSHA.OBSPF.FPL.POL – Polarisation transducer sub-assembly**

Review design options for the polarisation transducers for SKA Octave band Single Pixel Feed receivers, the cost/performance analyses, etc.

Inputs –materials from CoDR and elsewhere

- defined physical characteristics of feed suite (SKA1, SKA2):

-requirements specs for sensitivity (from sci, operations etc).

Output – review and analyses of the polarisation transducers options

* + Early phase identification of potential suppliers
	+ Initial, timeline, budget and plan to develop polarisation transducers for SKA Octave band Single Pixel Feed packages

**6 SKA.TEL.DSHA.OBSPF.FPL.LNA - Low Noise Amplifier sub-assembly**

Review options for Low Noise Amplifiers for SKA Octave band Single Pixel Feed receivers.

Inputs –LNA designs from CoDR

* defined physical characteristics of feed suite (SKA1, SKA2):
* requirements specs for sensitivity (from sci, operations etc).

Output – review and analyses of the Low Noise Amplifier options

* Early phase identification of potential suppliers
* Initial, timeline, budget and plan to develop Low Noise Amplifiers for SKA Octave band Single Pixel Feed packages

**6 SKA.TEL.DSHA.OBSPF.FPL.PCKG - Package sub-assembly**

Review and design the receiver package

Inputs –feed package option from CoDR or elsewhere

* results from SKA.TEL.DSHA. OBSPF.FPL.CRYO or prior studies
* results from SKA.TEL.DSHA. OBSPF.FPL.POL or prior studies
* results from SKA.TEL.DSHA. OBSPF.FPL.Rx or prior studies
* defined physical characteristics of feed suite (SKA1, SKA2):
* requirements specs for sensitivity (from sci, operations etc).

Output – review and analyses of the receiver package options

* Early phase identification of potential suppliers
* Initial, timeline, budget and plan to develop receiver package for SKA Octave band Single Pixel Feed packages
1. **SKA.TEL.DSHA.OBSPF.FPL.PCKG.PWR – Power**

Power management of the OBSPF assembly

1. **SKA.TEL.DSHA.OBSPF.FPL.PCKG.THERM - Thermal Management**

Thermal management of the OBSPF assembly

**6 SKA.TEL.DSHA.OBSPF.FPL.PCK LMC - Local Monitoring and Control**

M&C management of the OBSPF assembly

**5 SKA.TEL.DSHA.OBSPF.RX - Receiver System assembly**

Task develops the Octave band Single Pixel Feed receiver assembly.

Inputs – dish design from CoDR

* results from SKA.TEL.DSHA. OBSPF.FPL.CRYO or prior studies
* results from SKA.TEL.DSHA. OBSPF.FPL.POL or prior studies
* results from SKA.TEL.DSHA. OBSPF.FPL.PCKG or prior studies
* defined physical characteristics of feed suite (SKA1, SKA2):
* requirements specs for sensitivity (from sci, operations etc).

 Output – review and analyses of the receiver system options

* Early phase identification of potential suppliers
* Initial, timeline, budget and plan to develop receiver system for SKA Octave band Single Pixel Feeds

**SKA.TEL.DSHA.OBSPF.RX.PWR – Power**

Power management of the OBSPF receiver assembly

**6 SKA.TEL.DSHA.OBSPF.RX THERM - Thermal Management**

Thermal management of the OBSPF receiver assembly

**6 SKA.TEL.DSHA.OBSPF.RX.LMC - Local Monitoring and Control**

Power management of the OBSPF receiver assembly

**5 SKA.TEL.DSHA.OBSPF.CALIBRATION\_LOCAL**

Develop receiver calibration systems required to meet requirements for the OBSPF sub-systems.

**5 SKA.TEL.DSHA.OBSPF.VS OBSPF - sub-system verification**

Task to deliver verified OBSPF sub-system(s) to meet the SRRs. This task will need to include the delivery of test systems to be used (only) in testing these feed elements only (e.g. back end systems) suitable to process the verification data for the feeds themselves, plus define suitable platforms (existing dishes?) to do these tests.

**5 SKA.TEL.DSHA.OBSPF.ACCEPTANCE\_PLANNING**

Define the suite of standard acceptance tests for the OBSPFs to be used at the sub-system and element levels. Define how and where these will take place.

**PAF-specific TASK outlines start here -🡪**

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| **Example of WBS Item: 4 SKA.TEL.AI.PAF -** |
| **WBS element identification** | 4 SKA.TEL.AI.PAF - Phased Array Feeds subsystem – Advanced Instrumentation Element |
| **WBS element description** | Design and develop the **SKA Phased Array Feeds** subsystem. This task includes the preliminary design and evaluation of **Feed Payload assembly and Receiver System assembly** alternatives**,** the detailed design of the preferred **Phased Array Feeds** subsystem design andthe evaluation of the **performance** of the **Phased Array Feeds** subsystem. This task will also include PAF sub-system verification. The outputs will be one or more **Phased Array Feeds** subsystem designs.The design and development of options for the complete **SKA Phased Array Feeds** subsystem will include those elements which are common to all options, and also consider the system optimisation (or alternatives).The evaluation of the **performance** of the **Phased Array Feeds** subsystem is to include the evaluation of the **Power,** **Infrastructure** and **Local Monitoring and Control requirements,** of the design options for the **Phased Array Feeds** subsystem, as well as assessing the overall merits and TRL of the design option. |
| **Inputs** |
| * SKA Management Plans, Policies and Philosophies including:
	+ PEP
	+ Risk Management Plan
* Dish Array Concept Design review documentation set
* Dish Array Concept Design review panel report
* results from SKA.TEL.AI (Advanced Instrumentation Element) or prior studies
* defined physical characteristics of feed suite (SKA1, SKA2):
* requirements specs for sensitivity (from sci, operations etc).
* DVA1 Design review documentation sets (PDR and CDR)
* SKA Management Plans, Policies and Philosophies
 |
| **Tasks** |
| * To carry out the design and development of the **SKA Phased Array Feeds** subsystem.
	+ Preliminary design and evaluation of **Feed Payload assembly and Receiver System assembly alternatives,**
	+ Investigate the feasibility of cryogenically cooling the low-noise amplifiers
	+ The detailed design of the preferred **Phased Array Feeds** subsystem design,
	+ The evaluation of the **performance** of the **Phased Array Feeds** subsystem.

The **SKA Phased Array Feeds** subsystem will include PAF sub-system verification.* To evaluate the **performance** of the **Phased Array Feeds** Feed Payload assembly that will include evaluation of :
	+ **Power,** **requirements,**
	+ **Infrastructure requirements,**
	+ **Local Monitoring and Control requirements**
	+ **Cost, reliability, technology readiness**
	+ **Overall system optimisation and the relative merits of the Phased Array Feed/Low-Noise amplifier design alternatives.**
 |
| **Outputs/deliverables** |
| * Detailed design and performance analyses of the **SKA Phased Array Feeds** subsystem.
* A recommendation of options to be progressed post-Stage 1.
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| --- |
| **Example of WBS Item: 5 SKA.TEL.AI.PAF.FPL -** |
| **WBS element identification** | 5 SKA.TEL.AI.PAF.FPL - Feed Payload assembly – Phased Array Feeds |
| **WBS element description** | Design and develop the **SKA Phased Array Feeds** Feed Payload assembly. This task includes the preliminary design and evaluation of **Phased Array Feed/Low-Noise amplifier design alternatives,** the detailed design of the preferredFeed Payload assembly design andthe evaluation of the **performance** of the **Phased Array Feeds** Feed Payload assembly. This task will also investigate the feasibility of cryogenically cooling the low-noise amplifiers. The outputs will be one or more **Feed Payload** designs which may include a **Chequerboard Array**, an **Octagonal Ring Array** or an array of **Vivaldi** **Antennas**.The design and development of options for the complete **SKA Phased Array Feeds** Feed Payload assembly will include those elements which are common to all options, and also consider the system optimisation (or alternatives) which require the following elements also: **PAF Feed Elements, the Low-Noise amplifier**, **the Cryogenic system subassembly** (if present) and **Feed Package**.The evaluation of the **performance** of the **Phased Array Feeds** Feed Payload assembly is to include the evaluation of the **LNA noise contribution, Phased Array Feed noise contribution and illumination efficiency, Package Weight, Package Volume** and **Package Power requirement** of the design options for the **Phased Array Feeds** Feed Payload assembly, as well as assessing the overall merits and TRL of the design option. |
| **Inputs** |
| * SKA Management Plans, Policies and Philosophies including:
	+ PEP
	+ Risk Management Plan
* Dish Array Concept Design review documentation set
* Dish Array Concept Design review panel report
* results from SKA.TEL.AI.PAF (Phased Array Feed sub-system) or prior studies
* defined physical characteristics of feed suite (SKA1, SKA2):
* requirements specs for sensitivity (from sci, operations etc).
* DVA1 Design review documentation sets (PDR and CDR)
* SKA Management Plans, Policies and Philosophies
 |
| **Tasks** |
| * To carry out the design and development of the **SKA Phased Array Feeds** Feed Payload assembly.
	+ Preliminary design and evaluation of **Phased Array Feed/Low-Noise amplifier design** alternatives**,**
	+ Investigate the feasibility of cryogenically cooling the low-noise amplifiers
	+ The detailed design of the preferredFeed Payload assembly design,
	+ The evaluation of the **performance** of the **Phased Array Feeds** Feed Payload assembly.

The **Phased Array Feed/Low-Noise amplifier design alternatives** mayinclude the design and development of: * + **Chequerboard Array**,
	+ **Octagonal Ring Array** and
	+ an array of **Vivaldi** **Antennas**
* To evaluate the **performance** of the **Phased Array Feeds** Feed Payload assembly that will include evaluation of :
	+ **LNA noise contribution,**
	+ **Phased Array Feed noise contribution and illumination efficiency,**
	+ **Package Weight**
	+ **Package Volume** and
	+ **Package Power requirement.**
	+ **Cost, reliability, technology readiness**
	+ **Overall system optimisation and the relative merits of the Phased Array Feed/Low-Noise amplifier design alternatives.**
 |
| **Outputs/deliverables** |
| * Detailed design and performance analyses of the **SKA Phased Array Feeds** Feed Payload assembly.
* A recommendation of options to be progressed post-Stage 1.
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