SKA DISH Consortium

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SKA Engineering Meeting
October 2013
Outline

• DISH Consortium Partners
• WBS and Organization
• General Scope of Work
• Element Work Plans
  • Activities and Approaches
  • Prototypes
  • Challenges and Risks
• Schedule
DISH Consortium Partners

- CSIRO – Australia (Full)
- RPC Technologies – Australia (Industry)
- SKA – South Africa (F)
- EMSS – South Africa (I)
- JLRAT – China (F)
- NRC – Canada (F)
- INAF – Italy (F)
- EIE/SAM – Italy (I)
- Chalmers – Sweden (F)
- MPIfR – Germany (F)
- IAF Fraunhofer – Germany (F)
- Vertex Antennentechnik – Germany (I)
- Spain University Group (Associate)
SKADC Work Package Management Team

Dish Management
Mark McKinnon

Systems Engineering
Thomas Kusel

Phased Array Feeds
Mark Bowen

Single Pixel Feeds
Isak Theron

Receivers
Kris Caputa

Monitor and Control
Zhang Yifan

Structure
Dean Chalmers

DISH Prototype

Infrastructure
Henk Niehaus

SKA-P
Du Biao

DVA-C
Zheng Yuanpeng

DVA-1
Gary Hovey

MKT-1
Willem Esterhuysen
SKADC Systems Engineering Expertise Group

DISH Systems Engineering
  Thomas Kusel

Structure
  Dean Chalmers

Monitor & Control
  Corrado Trigilio

Infrastructure
  Henk Niehaus

DISH Prototype

Phased Array Feeds
  Russell Gough

Single Pixel Feeds
  Isak Theron

Receivers
  Kris Caputa

SKA-P
  Du Biao

DVA-C
  Zheng Yuanpeng

DVA-1
  Gary Hovey

MKT-1
  Willem Esterhuyse
SKADC General Scope of Work

• SKADC is responsible for the design and verification of the dish structure, optics, feed suites, receivers, and all supporting systems and infrastructure for SKA1-mid and SKA1-survey
SKADC Element Work Plans
Dish Structure

• Objective: Deliver the construction-ready design for the structure element of the SKA1-mid and SKA1-survey dishes

• Activities and Approaches
  • Analyse options of dish structure alternatives from prototypes
  • Estimate construction costs of alternatives for cost/performance comparison
  • Preliminary and detailed design of the chosen Dish Structure design
  • Preparation of detailed drawings and manufacturing and verification test plans for the design of the pre-production SKA Dish Structure prototype
  • Conduct reviews: concept, systems requirements, preliminary design, pre-production readiness, and critical design

• Challenges and Risks
  • Results from DVA verification tests not timely for design down-select
  • Design requirements drive cost to unacceptable levels
Dish Prototypes

• Activities and Approaches
  • Evaluate designs and perform verification tests of three prototype dishes to inform the design of a pre-production unit (SKA-P)
    – DVA-1 (NRC Canada)
    – DVA-C (JLRAT China)
    – MKT-1 (South Africa)
  • Detailed design, manufacture, verification, and costing of SKA-P by JLRAT to inform production cost

• Challenges and Risks
  • Short timescale to build and test DVA-C and SKA-P
  • Uniformity in evaluating and costing prototype units
Dish Prototypes: MKT-1
Dish Prototypes: MKT-1
Dish Prototypes: DVA-1

Oct 1, 2013
Single Pixel Feeds (SPFs) - I

• Activities and Approaches
  • Design and prototype feed elements (e.g. horns) for all 5 bands
  • Optimize feed types with optical configurations; down-select to final design
  • Design and prototype low noise amplifiers (LNAs). One LNA may cover all of Bands 3-5 in a single WBSPF
  • Design and prototype three cryostats: one each for Bands 1 and 2, and one for all of Bands 3-5
  • Design and prototype of high pressure helium and vacuum services
  • Integration of SPF packages; develop test and calibration equipment

• Challenges and Risks
  • Feed optimization may draw out design effort
  • Multiple, large feeds may not fit in a single cryostat
  • Effort required to coordinate work among large number of partners
Single Pixel Feeds (SPFs) - II

Block Diagram of SKA-mid receiver package
Receivers

• Activities and Approaches
  • Develop preliminary receiver design for SKA1 Bands 1-5
  • Conduct COTS studies and make major component selection
  • Detailed receiver design for the high-priority Bands 1 and 2, to include designs for system enclosure, cooling, RFI, and EMI
  • Develop and deliver prototypes of Band 1 and 2 receivers and common receiver sub-systems (e.g. enclosure, calibration test, local monitor & control)
  • Verification of the Band 1 and 2 receiver systems, and integrate them with the feed package and Dish

• Challenges and Risks
  • Receiver not complaint with EMI and RFI requirements, or with site operational requirements (e.g. thermal, gain, and phase stability)
  • Interface control with other consortia (e.g. SaDT)
Phased Array Feeds (PAFs) - 1

• Activities and Approaches
  • Design and prototype PAF Band 2 (includes sufficient electronics to form at least one beam, full chassis, cabling, cooling, and support infrastructure)
  • Develop preliminary designs of PAF Bands 1 and 3
  • Select optimum feed from tests of NRC Vivaldi & CSIRO chequerboard arrays
  • Design and prototype a PAF polyphase filter bank (PPFB) and beamformer for PAF Band 2, but also to accommodate PAF Bands 1 and 3
  • Develop integrated LNA, CMOS ADC, and high-speed link for on-antenna digitization (reduces cost, weight, and power consumption) as possible alternative to RF-over-fibre

• Challenges and Risks
  • Cost/performance depends upon RF-over-fibre receiver; could limit the number of channels per ADC
  • Full band sampling could lead to excessive costs
Phased Array Feeds (PAFs) - II

Block diagram of SKA-survey receiver package
Local Monitor and Control (LMC)

• Activities and Approaches
  • Define the architecture of the LMC system, to include interfaces with other DISH elements and Telescope Manager (TM), with emphasis on long term maintainability (e.g. use open source software)
  • Develop the detailed design of the LMC software, to include the TM interface, operational databases, scheduler, pointing program, operator displays, and alarm, logging, and monitoring services
  • Develop prototype software and hardware (e.g. computers, boards, interfaces, racks, and weather/environmental sensors) for the LMC system
  • Conduct interface and verification testing of the prototype

• Challenges and Risks
  • LMC architecture highly dependent on designs in other consortia, particularly TM and SaDT.
Systems Engineering

• Activities
  • Derive requirements for the DISH work element and its sub-elements
  • Manage interfaces between DISH and other work elements
  • Define alternative implementation concepts for the dish optics and structural configurations. Evaluate trade-offs to converge on a single concept.
  • Define the architectural design of the chosen concept and manage interfaces between sub-elements.
  • Manage the assembly, integration, and qualification of the work element
  • Work element logistics engineering

• Challenges and Risks
  • Difficult to converge on definition of dish optics concept and antenna preliminary design, and thus completion of pre-production prototype, due to distributed organizations and aggressive schedule
  • Maintaining a consistent level of product quality over different, internationally-distributed organizations
Management

• Activities
  • Overall consortium administration (e.g. SKAO interface, maintenance of and adherence to Consortium Agreement)
  • Schedule planning and tracking
  • Organization and coordination of reviews
  • Operation of the SKADC Board
  • Change control, risk management, and review of element costing
  • Support industrial partners and subcontractors

• Challenges and Risks
  • Potential delays due to negotiation of SKAO Memorandum of Understanding, Consortium Agreement, and IP policy
  • Significant effort required to communicate processes and requirements across a large and geographically diverse consortium
SKADC High-Level Schedule

- May 15, 2014: DISH optics review and selection (CoDR)
- Aug 15, 2014: DVA-C prototype testing complete
- Aug 15, 2014: MKT-1 prototype testing complete
- Nov 7, 2014: DISH PDR
- May 27, 2015: DISH Detail Design Review (DDR)
- Jul 23, 2015: Receiver prototype subassemblies complete
- Sep 18, 2015: PAF DDR complete
- Apr 27, 2016: SKA1 pre-production dish build complete
- Oct 12, 2016: SKA1 pre-production dish verification testing complete
- Nov 16, 2016: DISH CDR