"Exploring the Universe with the world's largest radio telescope"

2010
Annual WP2 Meeting

WP2.1 Tools and strategies

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Overview of talk

- SE Tools
- Strategies on aspects important to the SKA

SE Tools

- As indicated in SEMP (Rev E): Tools for the implementation and control of the systems engineering process are still under investigation.
- Initiated this investigation
- Tools under consideration for:
  - System modelling (SysML)
  - Requirements management
  - Documentation Management
- Should establish a base now to build upon in the next phases.
- Watch (participate in?) this space

CoDR Document

STRATEGIES AND PHILOSOPHIES

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Purpose

- The purpose of this document is to address and set out high level strategies for various important aspects within the Square Kilometre Array project.
- For each of the aspects a way forward is being proposed. Although they are primarily aimed at the Preparatory Phase of the SKA (PrepSKA) of the project some of them do attempt to look beyond the PrepSKA phase.
- Each strategy also sets out guidelines of the work and aspects to take into consideration within the various domains and lower levels of the project.

Chapters (1)

Some 15 Chapters in the document addressing:

- Cost
- Power
- EMC
- Software Engineering
- Cooling and Temperature Stabilisation
- Reliability, Availability, Maintainability (RAM)
- Standards and Standardisation
- Units of Measure

Chapters (2)

- Quality
- Health and Safety
- Obsolescence
- Human Factors Engineering
- Testability and Fault Diagnosis Requirements
- Configuration and Change Management
- Data Packs
- Interface Management

Other strategies

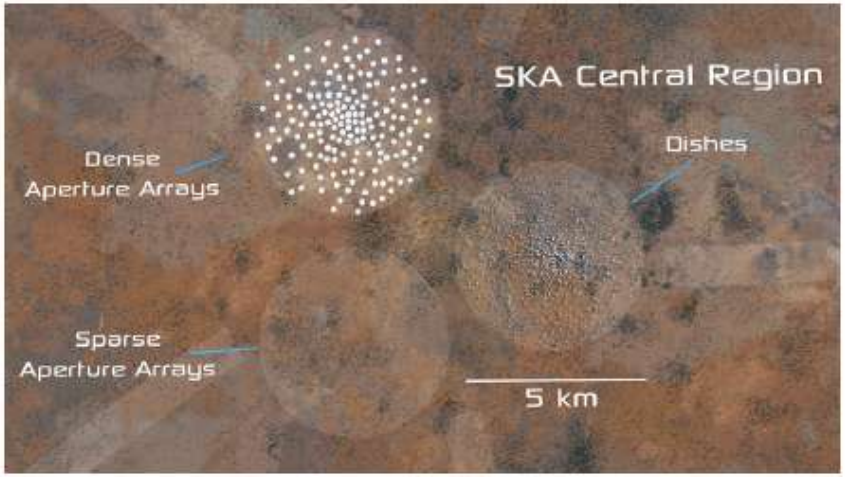
Two additional strategies that were developed:

- SITE CLIMATE AND GEOTECHNICAL INFORMATION
- SKA MONITORING AND CONTROL STRATEGY

- Append the system CoDR presentation at the back of this presentation.
- Documents available on the system CoDR sites mentioned earlier (see PE Dewdney talk)

Thank you

SPDO



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SKA System CoDR

Strategies

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- ALMA documents

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Strategies : Cooling and Temperature Stabilisation

Why is it important?

- Karoo and Western Australia are hot and hostile environments in which to operate facilities that require controlled temperature environments.
- Likely that the capital and operational expenditure on cooling and other temperature stabilisation technologies will be a major cost.
- The largest part of the operational costs will be for the power that is consumed.
- It is therefore important to investigate and consider as wide as possible range of cooling/heating/ temperature stabilisation technologies during design.

Way forward

- It is a multi layered challenge and technologies are wide ranging
- Cooling needs must be amalgamated to avoid the proliferation of a large number of small systems, to benefit from the economy of scale, and to simplify operations and maintenance.
- RFI challenge to be handled in accordance with EMC philosophy
- Information on technologies, old and new, should shared
- Lessons learnt and technologies used in sectors outside radio astronomy will be investigated.

Way forward

- Potential concepts and solutions will be reviewed during each of the design reviews.
- SPDO will attempt to consolidate work done (in and outside the project).
- SPDO system engineer will also ensure that a full life cycle system view maintained.
- SPDO system engineer will ensure that the multilayered aspects of cooling are addressed from a system perspective.

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Strategies : Reliability, Availability, Maintainability (RAM)

Introduction

- To identify and develop the optimum range and quantity of logistic support resources, and to have the logistic support considerations influence the design, a measure of the operational performance for the system is required.
- This is documented in Reliability, Availability & Maintainability (RAM) expectations which originates from the top hierarchical levels of the project (typically the level 7 User System) and is fed down to lower levels.

Definitions

- **Reliability** is a measure of a system's ability to avoid failure.
  - Low reliability imply lost performance, compromised safety and the need for maintenance.
  - The most convenient measure is the Mean Time between Failures (MTBF).
- **Maintainability** is the probability that a system, as a result of failure, will be restored within a given period of time, exclusive of logistic or administrative delays.
  - The most convenient measure of maintainability is the Mean Time to Repair (MTTR) and as an average it is easier to derive than a probability and is useful for calculations.
- **Availability** is the probability that a system is operating satisfactorily at any point in time under stated conditions.
  - It is a measure of how often an item fails (Reliability) and how quickly it can be restored to operation (Maintainability).

Way forward

- A two pass approach to the RAM and the failure modes, effects and critically analysis (FMECA) processes is proposed.
  - Use first high level estimates from the top and from the bottom to do a first pass of the process.
  - The bottom numbers will be obtained during, for example, the various CoDRs.
  - These high level numbers and resultant design will be reviewed at the system PDR at the end of PrepSKA.
  - Repeat the process post PrepSKA as information and data from the top and the bottom are refined

Way forward – steps during PrepSKA

- Confirm the operational cycles of the system
- Confirm the failure contributions of the system, derive system RAM figures.
- Use derived figures in top level specifications, allocate to the lower levels (top down allocation).
- From the lower levels, utilise RAM estimates to derive higher level RAM estimates (bottoms up estimation)
- Identify the RAM drivers and identify action plans to mitigate non compliances where required.
- Use high level RAM figures as an input to the FMECA and task analysis efforts to determine first order of magnitude logistic support resources.
- Use the high level FMECA to determine the requirements (such as redundancy) on the system.

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Strategies : Standards and Standardisation

Standards

- Standardisation is the process of developing and agreeing upon technical standards.
- A standard is a document that establishes uniform engineering or technical specifications, criteria, methods, processes, or practices.
- Some standards are mandatory while others are voluntary.
- It entails the development and implementation of concepts, doctrines, procedures and designs to achieve and maintain the required levels of compatibility, interchangeability or commonality in the operational, procedural, material, technical and administrative fields to attain interoperability.

Importance

- Examples of the benefits of using standards and standardisation are:
  - The quality of the deliverables across the board is of a high standard,
  - Parts used in different places and different equipment are the same,
  - Tests are performed against internationally recognised standards and are repeatable,
  - Best practices based on years of experience are being followed in a coherent manner and across borders and different organisations.

Way forward

- Proposed that the PrepSKA phase be utilised to investigate the utilisation of international standards and their applicability to the SKA. Examples are:
  - ISO software development standards (ISO/IEC 15288), Risk management (IEEE 1540), Quality management (ISO 9001), Logistics and support (DEF_STD_060, MIL-STD-1388-2B, MIL-STD-1629A), Health and Safety (MIL-STD-882D, IEC 62061, IEC 61511), Electronic publications (AECMA 1000D), Obsolescence (BS EN 62402:2007), Electromagnetic Compatibility (MIL-STD-461-E, ITU-R RA769-2, NRS 083-2, SANS 61000-5-2), Configuration Management (ISO 10007:2003), Environmental testing (IEC 60529, MIL-STD-810
- If found to be applicable, standards will be introduced and made applicable.
- Work to be undertaken by the SPDO system engineer and first guidance on this matter shall be presented by no later than the system requirements review.

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Strategies : Units of Measure

Units of measure

- To ensure compatibility of work it is important to standardise on the units of measure. It is proposed that the SKA adopt the same standards as adopted within the ALMA project.
- The SKA shall adopt and use the International System of Units (also known as the ‘metric’ or Système International d'unités, SI).

Applicability

- Applicable to all aspects including:
  - Drawings
  - CAD files
  - Customs designed components
  - COTS (with minor exceptions)
  - Raw material (with minor exceptions)
  - Software code
  - Indicators
  - Labels
- Non compliant equipment to be clearly identified (and approved)

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Strategies : Quality

Quality

- Quality touches each and every aspect of the project ranging from the selection of components, writing of documents, reviews, acceptance events, audits, inspections, recording and traceability of supporting information and data, etc...
- TQM definition: ‘process *that seeks to integrate all organizational functions (marketing, finance, design, engineering, and production, customer service, etc.) to focus on meeting customer needs and organizational objectives’*.

WP2 Quality objectives

- The quality objectives for WP2 are to:
  - Produce the deliverables that meet the Framework 7 revised Description Of Work objectives,
  - Produce deliverables that are compliant with applicable contract and project requirements,
  - Empower personnel to take responsibility for the quality of their products and services,
  - Prevent and resolve problems by implementing effective work processes,
  - Promote continuous improvement in work processes to improve quality, timeliness, and cost-effectiveness, and to
  - Improve the effectiveness of the processes and their supporting tools, techniques, standards, and procedures.

Processes

- Several processes have already been developed and publicised. Examples:
  - The system engineering process as described in the System Engineering Management Plan (SEMP),
  - The risk management process as described in the Risk Management Plan (RMP),
  - The documentation handling and control procedure,
  - The document review process (to be developed),
  - The configuration and change management process as described in Section 16 of this document.
- Are by no means a complete set and have not been fully rolled out and/or adopted within WP2 yet.

Way forward

- Fully fledged ISO 9001 quality system approach not proposed during the PrepSKA
- As the project moves forward the focus on quality assurance will have to be increased
  - Fully staffed and independent quality assurance division/group.
  - Accreditation against ISO 9001 to be considered.

Way forward

- Quality Assurance Plan be developed
- Gaps be identified between objectives and current processes
- Gaps be addressed
- Current processes be reviewed, be agreed to and rolled out.
- The primary responsibility for quality will reside in the WP2 Domain Specialists, the Liaison Engineers of the lead institutions and the project managers and system/project engineers of the verification programs.

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Strategies : Health and Safety

Health and safety

- Wide ranging discipline and cuts across many aspects.
- It is enforced by legislation and many standards and guidelines have been developed to aid in the guidance, establishment of requirements and testing of these requirements.
- Important to address the health and safety requirements from early on.
- To initiate this process a Health and Safety Plan must be developed. Set out the path for the development and introduction of health and safety aspects.
- Plans and guidelines already existing should be studied and utilised (ALMA for example) .
- The impact on safety aspects due to the location of the site will also have to be investigated. ects into the SKA.
- SPDO project manager to lead effort to have high levelby end of 2010.

SKA System CoDR

Strategies : Obsolescence

Obsolescence

- Defined as:
  - The impending loss of production of an item, or support services being no longer available from the OEM or supplier
  - The loss, or impending loss, of the manufacturers or suppliers of items, or shortages of raw materials.
- For systems designed and developed over years and then be deployed and operated for many more years, product obsolescence and software deprecation must be addressed.
- Components and items can become obsolete even before production stages are reached.
  - severely impact the supportability and life cycle costs of systems.
- Also applicable during operation and support phase

Way forward

- The objective is to ensure that obsolescence is managed as an integral part of design, development, production and in-service support in order to minimise the financial and availability impact throughout the product lifecycle.
- During PrepSKA obsolescence will be tracked and managed by the various organisations developing and testing prototypes.
- Possible obsolescence risks be made visible as and when they occur.
- Obsolescence risks be highlighted during each of the design reviews.
- Post PrepSKA phases the identification and management of obsolescence will become more important and will have to be managed more formally.
  - Plan to be developed within SKA organisation.

SKA System CoDR

Strategies : Human Factors Engineering

Human factors engineering

- The discipline of applying what is known about human capabilities and limitations to the design of products, processes, systems, and work environments.
- Human factors engineering focuses on how people interact with tasks, machines (or computers), and the environment with the consideration that humans have limitations and capabilities
- Being such a large and distributed instrument, the SKA will undoubtedly place high demands on, for example, its operators and maintainers in terms of information loads.
- HFE can also be applied in a wider context such as the design and layout of operator centres, human accessible and work spaces, visitor centres etc.

Way forward

- It is not foreseen that HFE will play a significant role in early stages of PrepSKA.
- Use this period to understand the role of HFE better and to plan the extent and depth that HFE will be utilised.
- Will most definitely play a role during the subsequent phases of the project when, for example, operator interfaces, maintainer interfaces and operator centres are being designed and developed.
- The following should be investigated and considered for application within the design processes for PrepSKA WP2:
  - Purchase of consulting services from a company that has experience in usability engineering,
  - Reference to, adoption of, and testing against generic guidelines,
  - Reference to, adoption of, and testing against guidelines focused on HMI for safety aspects.

SKA System CoDR

Strategies : Testability and Fault Diagnosis Requirements

Testing

- Testing will play a key role in ensuring the SKA operates as effectively as possible.
- Testability is a measure of how well a test exposes a fault (fault detection), and how well it can be isolated (or diagnosed).
- To be effective both detection and diagnosis have to be addressed early in the design.

Testability principles and requirements

- To be effective, tests needs to be both controllable and observable.
  - A test needs to be able to affect a specific part, or node, in a module and the result should be directly observable so either correct operation of the node under test can be readily established, or a fault can be readily isolated and diagnosed.
- Where feasible, test infrastructure should be built into modules.
- Test sets should be thorough and exercise all aspects of the module.

Testability requirements

- Strategy address issues such as:
  - Controllability
  - Observability
  - Granularity
  - Fault Model
  - Fault Coverage
  - Hierarchical and Modular Testing
  - Functional Testing
  - Interconnect and Interface Testability Requirements

Testability requirements

- Testability Design Requirements
  - Design Test and Verification Plans
  - Manufacturing Test Plan
  - Factory Acceptance Test (FAT) Plan
  - Site Acceptance Test (SAT) Plan
  - In-Service Test Plan
  - Service and Repair Test Plan

SKA System CoDR

Strategies : Configuration and Change Management

Configuration management

- It is the process of creating and maintaining an up-to-date record of all the components of the system, including related documentation and has four elements:
  - Configuration Identification
  - Configuration Change Control (or Change Management)
  - Configuration Status Accounting
  - Configuration Verification and Auditing

Importance

- During the life cycle of a project many artefacts are created and will eventually have to be operated and supported.
- Configuration management forms the backbone of the process to establish and maintain this control.
- Its purpose is to show what makes up the system and illustrate the physical locations and links between each item.

Way forward

- Don’t have a configuration management system yet.
- Plan at what level of the organisation Configuration Management System (CMS) is to be applied.
  - Specific project,
  - All projects, or
  - Whole organisation.
- Inclusion of all the work packages in the CMS to be investigated.
- As part of configuration management the following will be addressed:
  - Item Numbering Philosophy
  - Document Type Philosophy
  - Change Procedure
  - Tools
  - Roll out and utilisation

SKA System CoDR

Strategies : Data Packs

Data packs

- Data Packs can be defined as the set of data (drawings, procedures, structures) of a System/Element/Subsystem/Assembly/Sub-assembly/Component/Part that describes how the item was designed, manufactured, qualified, tested and allows for ease of maintenance by personnel not involved in the development of the subject.
- To ensure integrity and real time up to date information of the data pack for use by all, configuration management principles must be applied constantly and consistently.

Data packs

- Data packs typically consist of the following data;
  - **Design Data**; Specifications, Architecture Description Documents, Interface definitions, Qualification Procedures and Results, Acceptance Test Procedures and Results.
  - **Manufacturing Data**; Identification of items grouped to provide Physical Breakdown Structures, Assembly Drawings, Manufacturing Drawings, Parts Lists, Data Sheets for procured items, Supplier Data, Responsibilities etc.
  - **Support Data**; Technical Manuals, Training Courses, Support Management Procedures/Plans, etc.

Way forward

- To the end of PrepSKA, the following should be applicable
  - Establish the Interim CMS
  - Develop System Structures
    - Develop SKA structures top down in accordance with the system hierarchy from level 7 to level 4.
    - Develop the level 3 structures where available for review at the PDR.
  - Link developed data to system structures
    - Link design data to applicable structures/items
    - Where available, link manufacturing data to items.

Thank you