The SKA Pre-Construction Phase

P. Dewdney

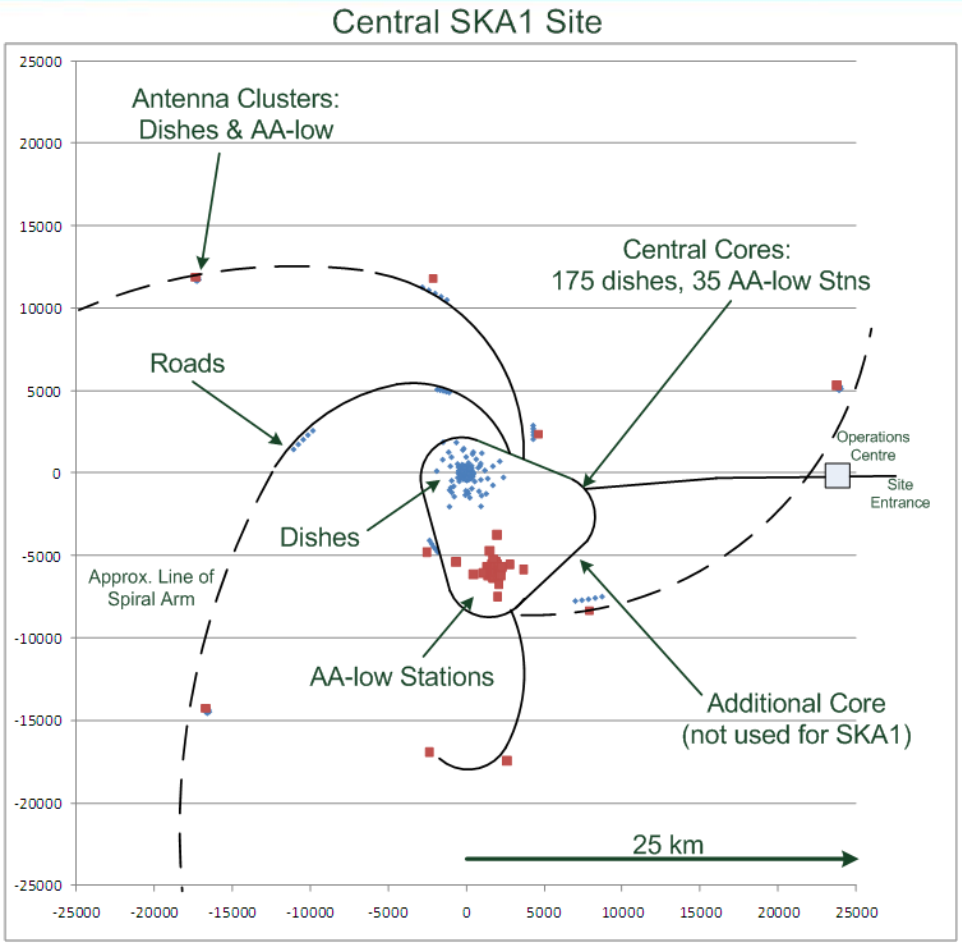
AAVP Workshop
Dwingeloo
Dec 12-15, 2011

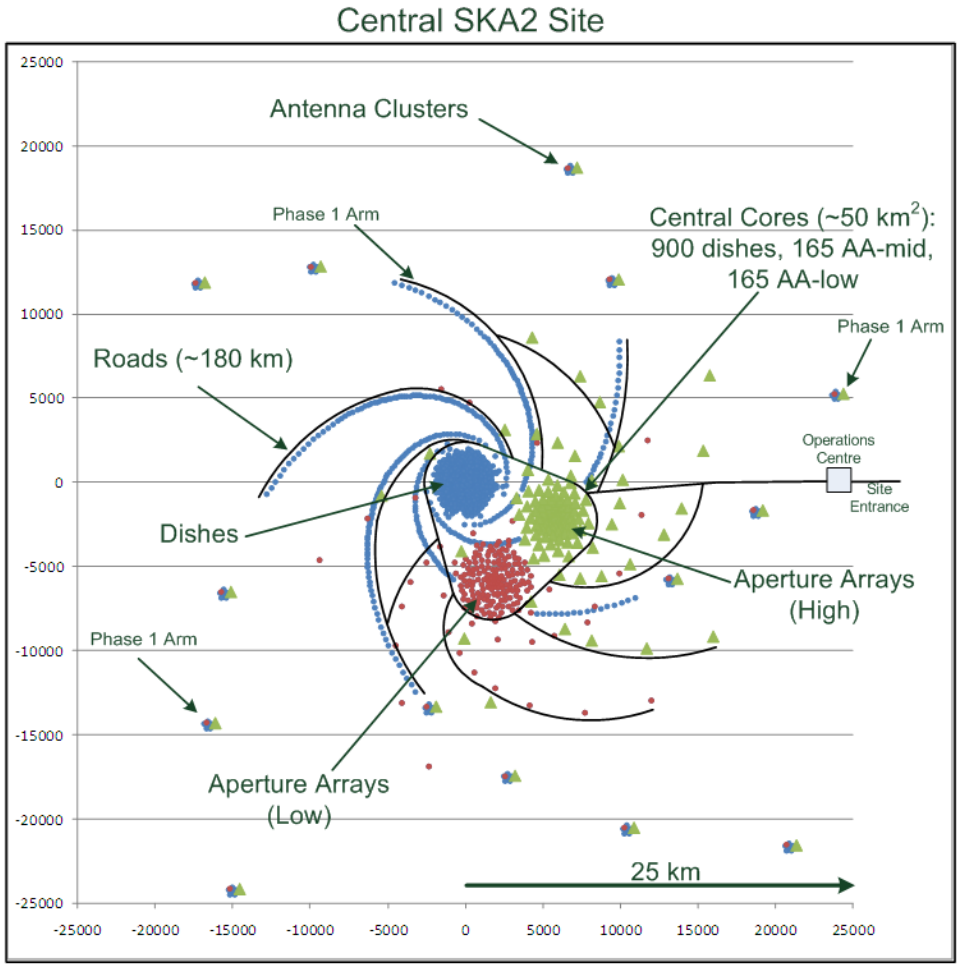
Why System Engineering for the SKA?

- System Complexity
  - Several technologies
  - Large physical scale
  - Remote operations in harsh environment
- Long build time
  - Two phases.
  - Probably a ~decade.
- International participation
  - Many contributing parties with their own agendas.
  - Technology choices
    - Fairness of treatment.
- For the sponsors
  - Minimizing cost
  - Recognition of the importance of a total life cycle approach to the execution of the project
  - Assurance of getting what is intended.

SEMP

Central SKA Site – massive physical system

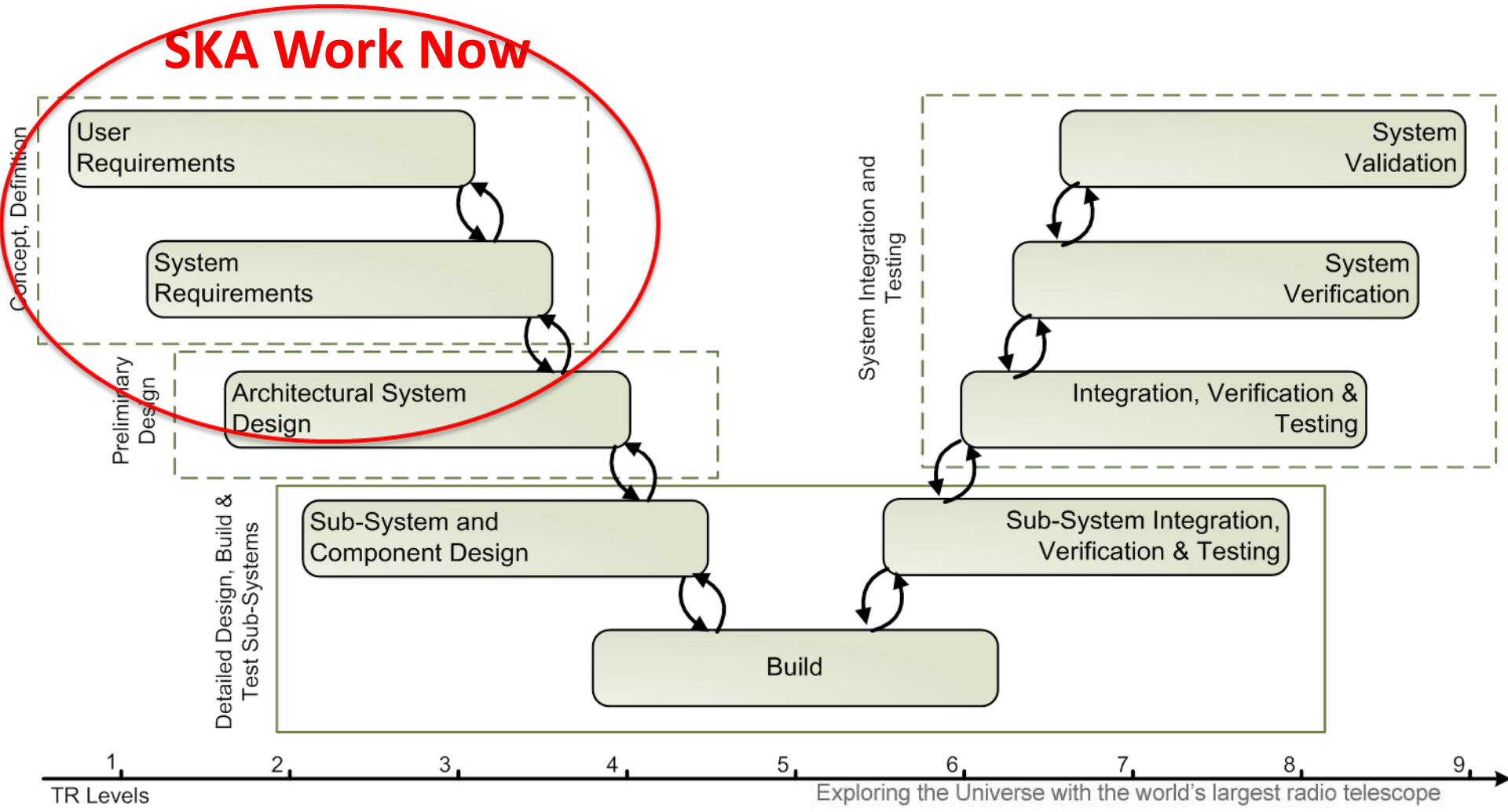




- SKA2 is ~10 x the collecting area of SKA1.
- Density increase of antennas is even larger in the central site.

Large Project ‘V’ Diagram showing SKA Phases

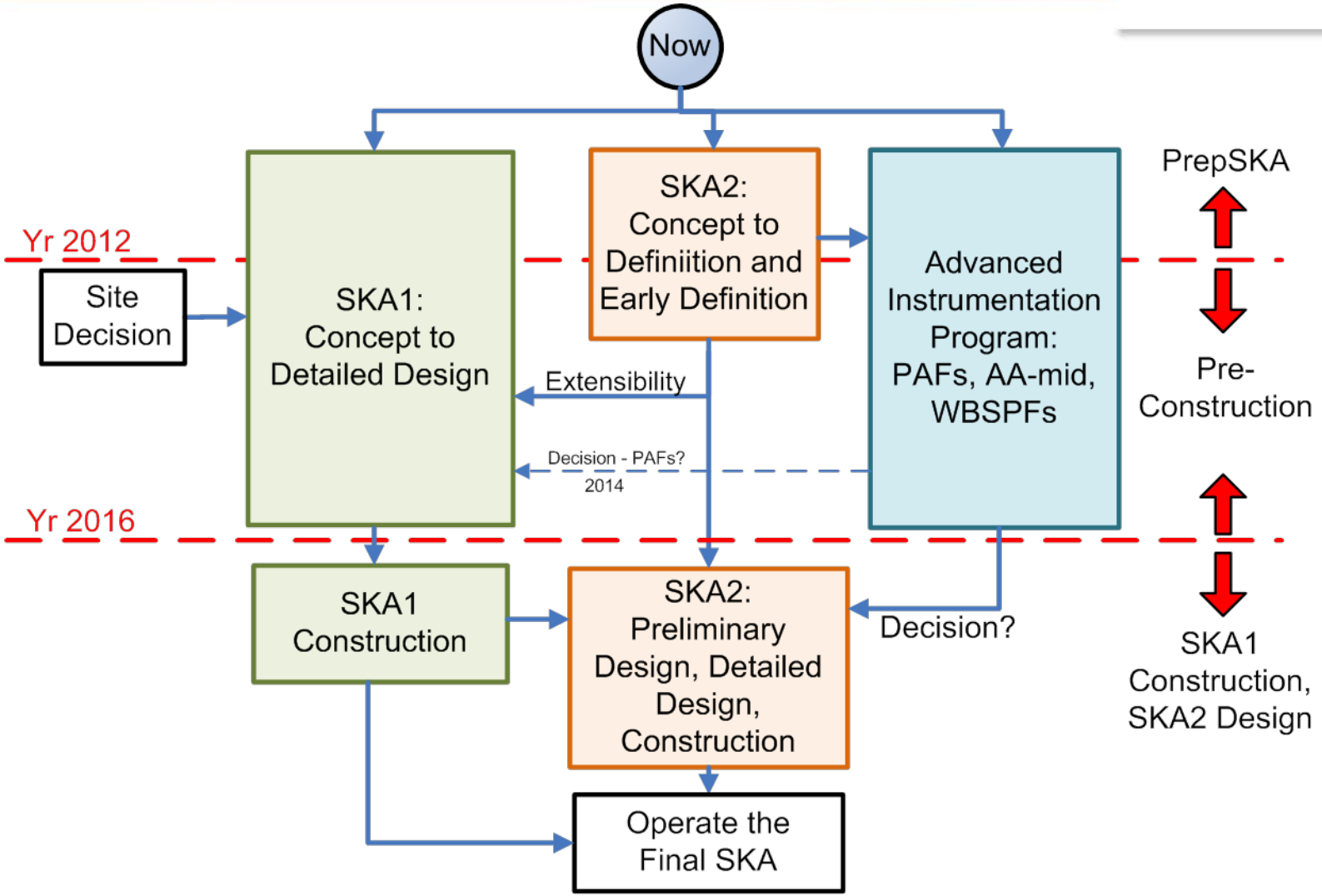
Large Project ‘V’ Diagram showing SKA Phases



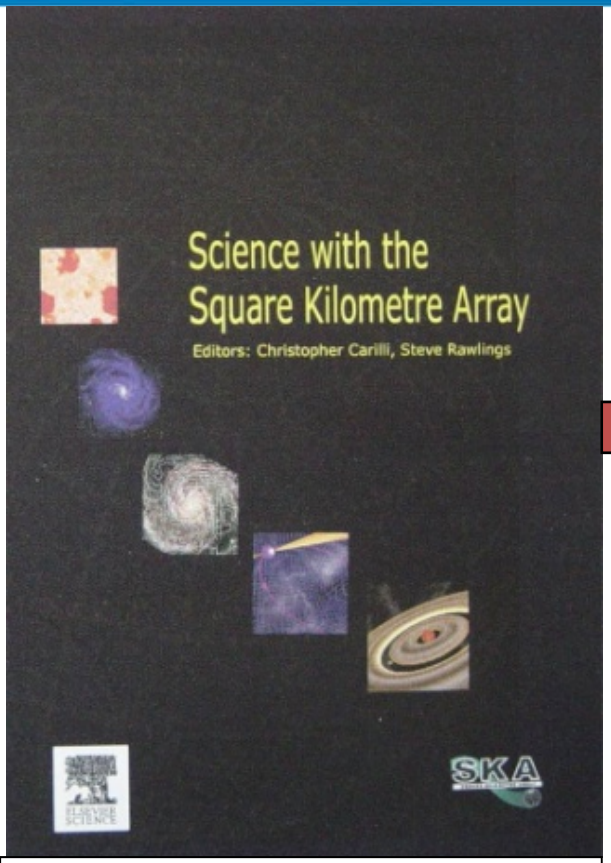
SKA1 => SKA2

- SKA1 has been broadly defined (science & technology).
  - "Step" along the way to constructing SKA2.
- However, the full technology complement for SKA2 is not yet well defined
  - a flexible plan for SKA1 => SKA2 is needed
  - introduce a program to mature the technologies that will enhance the science output of SKA2.
  - Advanced Instrumentation Program (AIP)
- The AIP will continue to develop innovative technology for:
  - phased array feeds on the dishes (PAFs),
  - Mid-frequency Aperture Arrays (AA-mid),
  - Ultra-wideband single pixel feeds on the dishes (WBSPFs).
- Development of AIP technologies
  - parallel with design and roll-out of SKA1 until early 2016
  - decision made on usage in SKA2.
- Extensibility document

Phased Approach to Technical Development



Science Case => Design Reference Mission => Science Requirements



Science Case
Lays out overarching goals, full suite of science

The Square Kilometre Array Design Reference Mission:
SKA Phase 1

SKA Science Working Group
v. 1.3

DRAFT

i

SKA1
Design Reference Mission.

```
Requirement #1
Requirement #2
Requirement #3
Requirement #4
Requirement #5
Requirement #6
Requirement #7
Requirement #8
Requirement #9
Requirement #10
Requirement #11
Requirement #12
Requirement #13
Requirement #14
Requirement #15
…
Requirement #N
```

Requirements Document
Incorporates input from science, but other inputs as well

Back-project result to original science case

Major Instrumental Requirements that Determine Science Performance

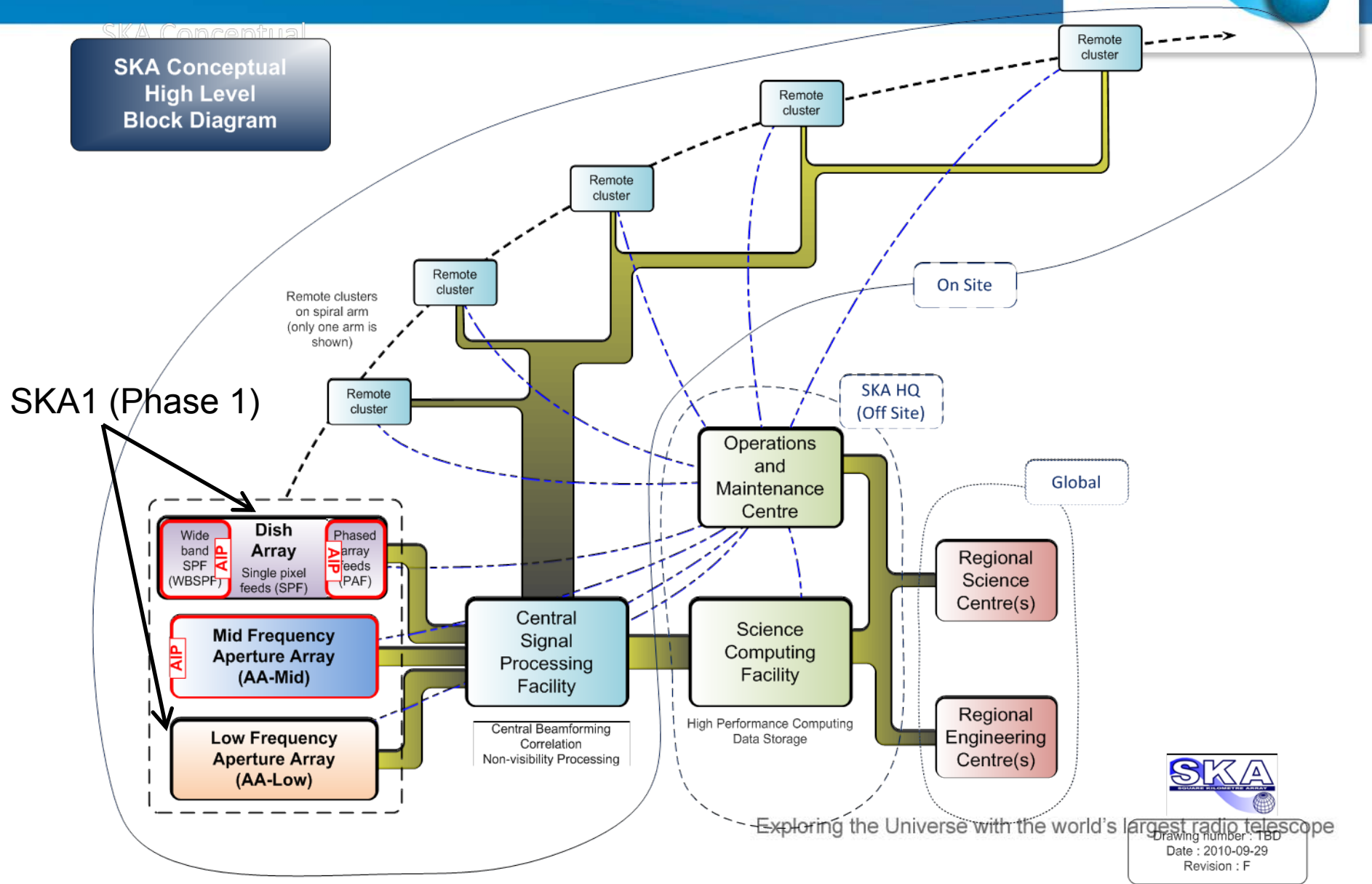
Science Requirements → Instrumental Requirements

- Frequency range
- Maximum baseline
  - (determines resolution)
- Sensitivity
  - A_e / T_{sys}
  - Survey Speed $[(A_e / T_{sys})^2 \ \Omega]$

Other Important Parameters

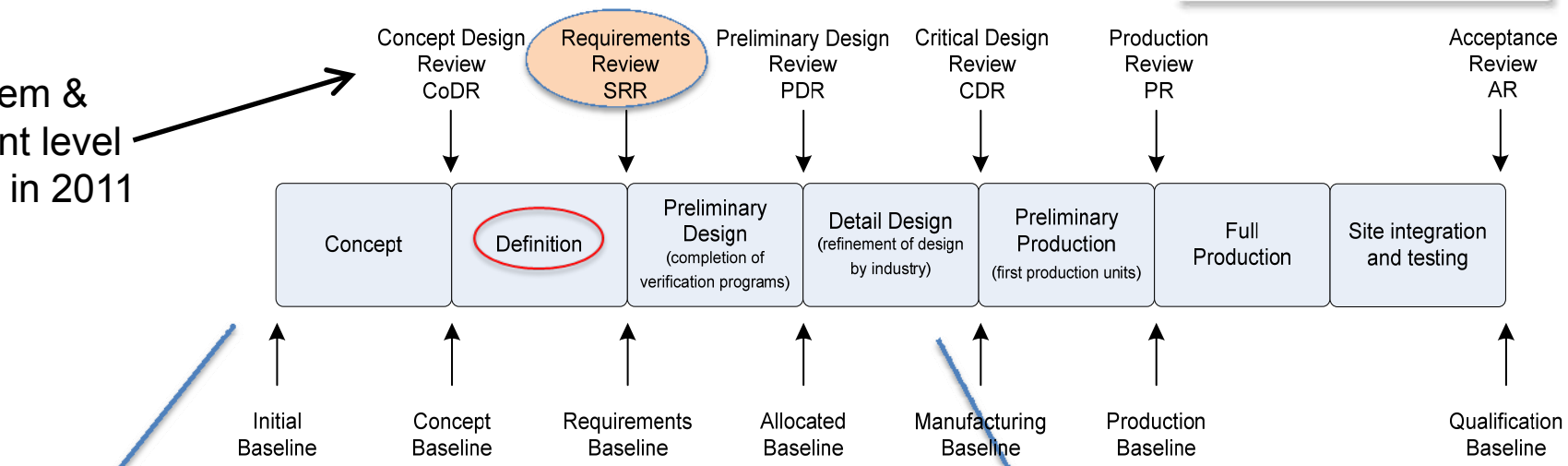
- Bandwidth
- Processing capability

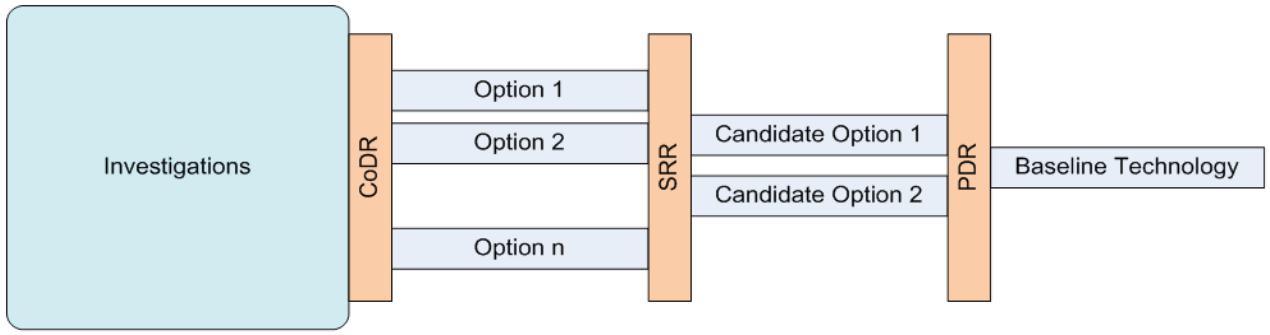
SKA System Diagram



Design Review Series

System & Element level CoDRs in 2011

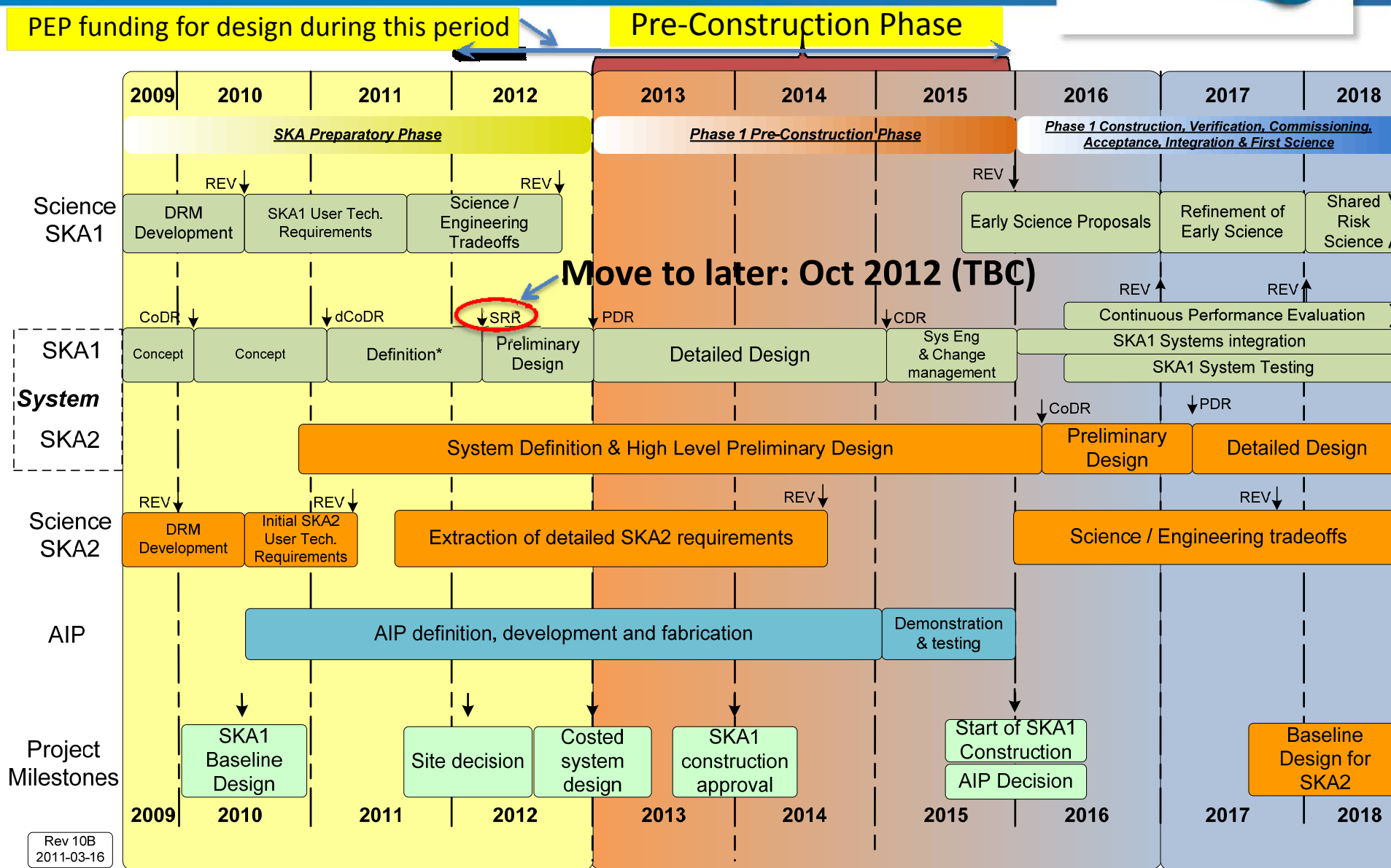




Conceptual Design Reviews in 2011

- 23-25 Feb System delta-CoDR on SKA_1 ✓
- 14-15 Apr Signal Processing ✓
- 19-20 Apr Aperture Arrays ✓
- 28-30 Jun Signal Transport & Networks ✓
- 13-15 July Dish and Dish Arrays ✓
  - 2-3 Feb CoDR Dish Verification Antenna #1
  - 5-7 Oct PDR Dish Verification Antenna #1
- 9-11 Nov Monitor & Control ✓
- 27-28 Nov AA-mid (delta) ✓
- 6-8 Feb Software & Computing

Context for Pre-Construction Phase



Goals of Pre-Construction Phase

1. Progress the SKA design to Production Readiness Review stage and let “contracts” for construction of major sub-systems, through Consortia Agreements.

2. Progress infrastructure roll-out on selected site to allow sub-systems to be deployed.

3. Mature the SKA legal entity into an organisation capable of carrying out the construction, verification, and operation of the telescope.

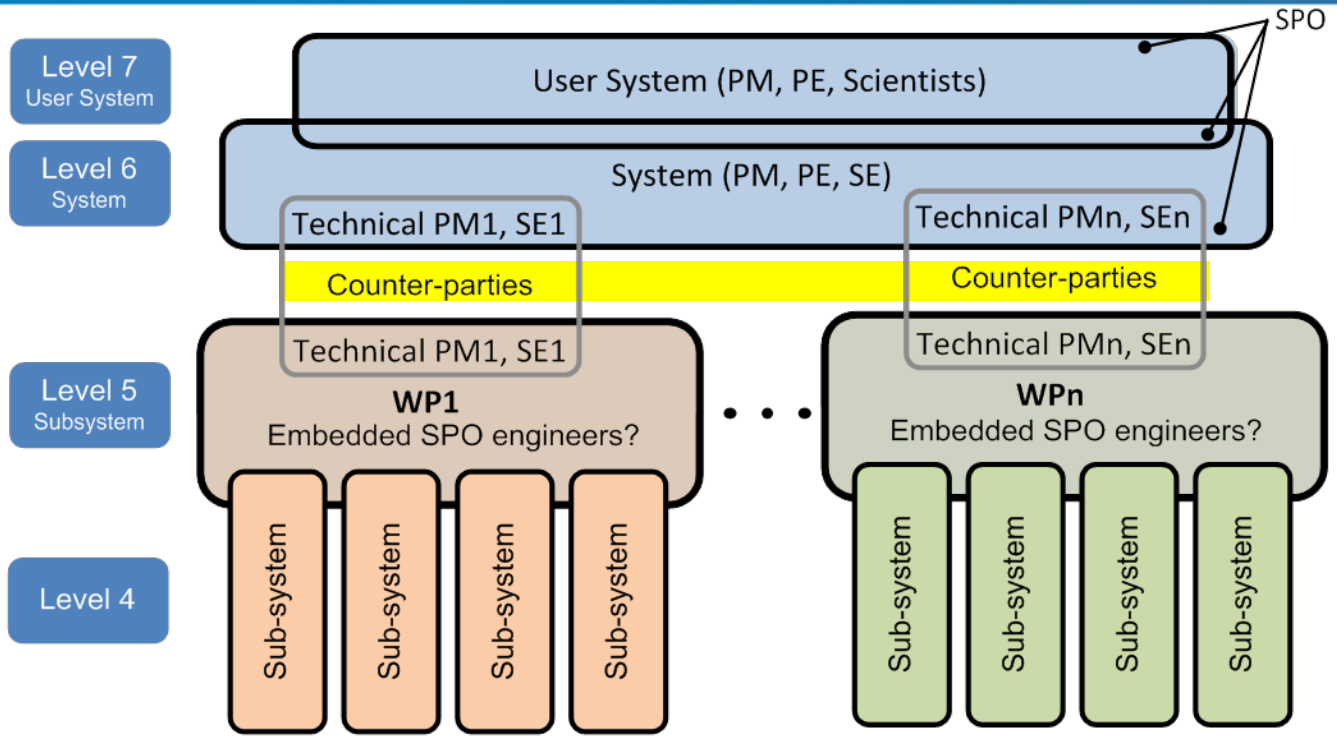
Roles of the SPO

- Responsible for and have authority over:
  - Overall management and engineering of the project
  - Steering the pre-construction phase
  - Addressing science and engineering challenges
- Develops and holds the system design
  - System Engineering

- The SKA Project Director will have the authority:
  - to hire people.
  - take financial decisions.
  - to sign agreements to carry out work packages and contracts with industry.
  - terminate agreements or contracts.
  - accept deliverables.
- SPO - Integrating body for both the managerial and engineering aspects.

- To achieve this, the SPO to be resourced with managers, engineers and support personnel at both system and subsystem level.

SPO-WPC Relationship



- SPO (as per PEP) contains a Technical Project Mgr and a System Engineer, devoted to each of five WPCs.
- Each WPC has a direct responsible counterparty (top WPC management and principal point of contact).

WPC Element Work in 2012-3

Pre-Stage 1

Planning

CoDR => SRR Work

(See next slide)

Stage 1

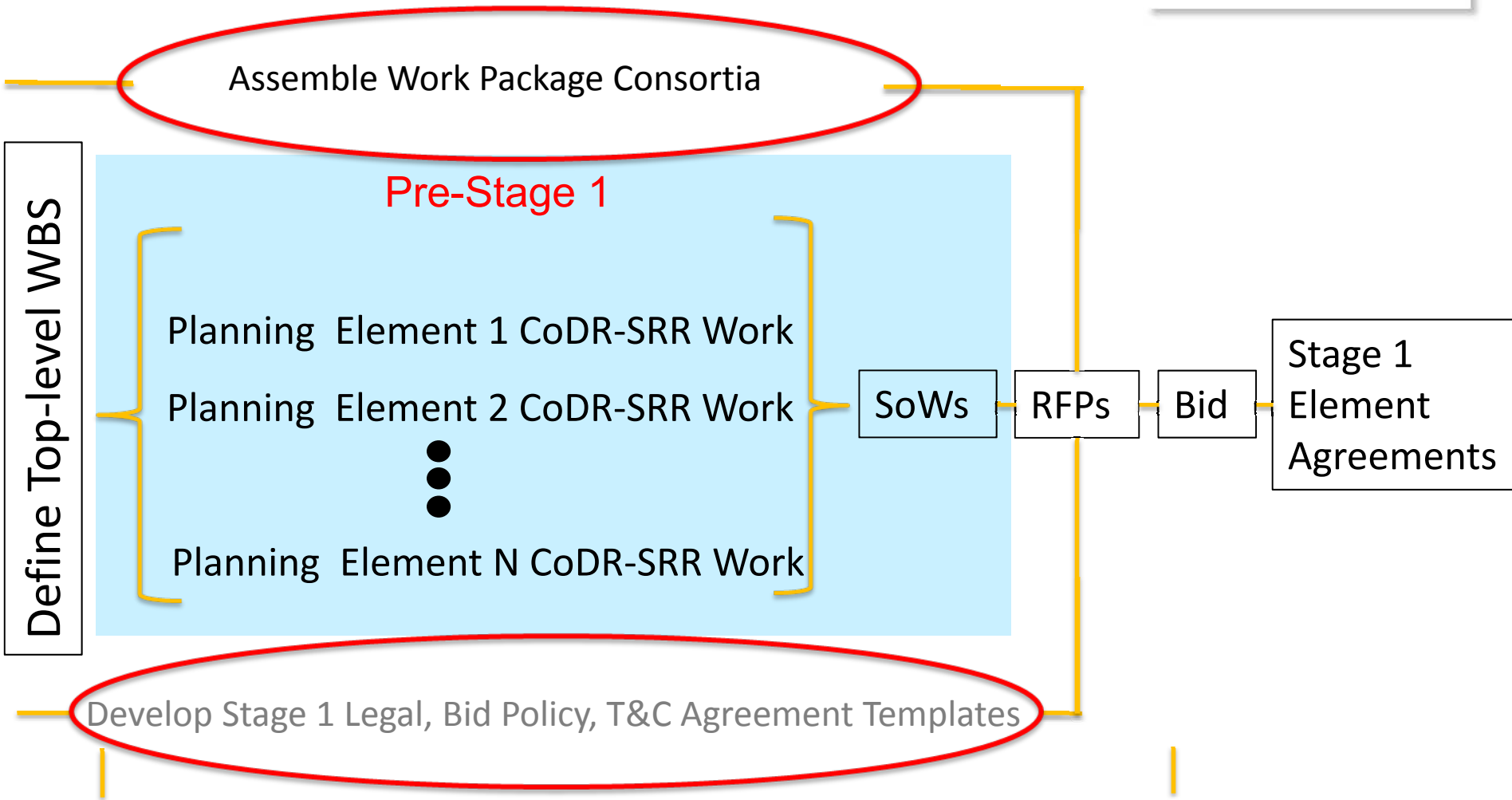
Allocated Requirements → Element Requirements, WBS Development and Design studies

Analysis of CoDRs →

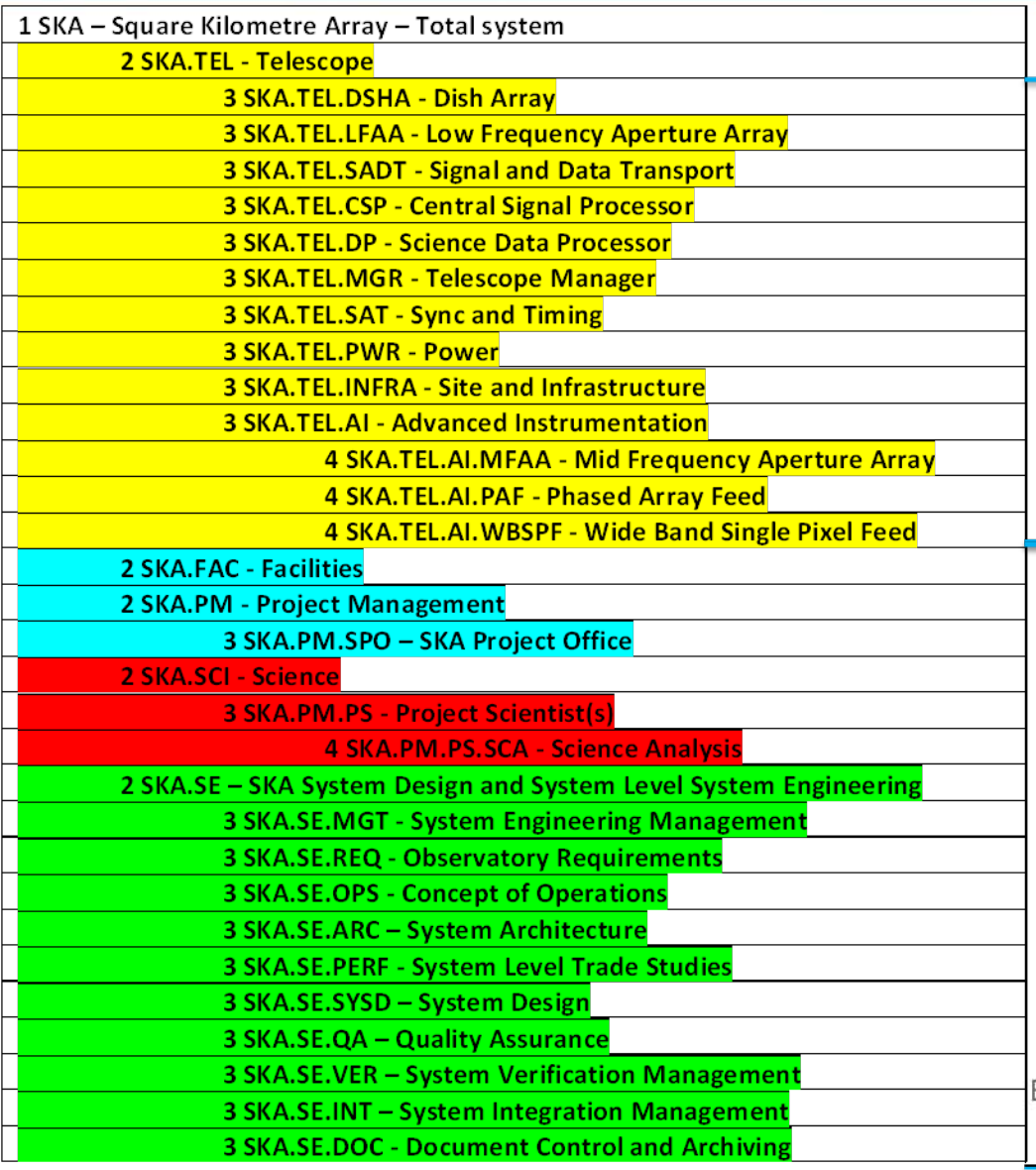
Verification Work →

→ Element SRR

Assembling Element Level RFPs for Stage 1 Work



Overall Work Breakdown Structure (WBS)



WPCs

SPO

WBS: Telescope

1 SKA – Square Kilometre Array – Total system
2 SKA.TEL - Telescope
3 SKA.TEL.DSHA - Dish Array
3 SKA.TEL.LFAA - Low Frequency Aperture Array
3 SKA.TEL.SADT - Signal and Data Transport
3 SKA.TEL.CSP - Central Signal Processor
3 SKA.TEL.DP - Science Data Processor
3 SKA.TEL.MGR - Telescope Manager
3 SKA.TEL.SAT - Sync and Timing
3 SKA.TEL.PWR - Power
3 SKA.TEL.INFRA - Site and Infrastructure
3 SKA.TEL.AI - Advanced Instrumentation
4 SKA.TEL.AI.MFAA - Mid Frequency Aperture Array
4 SKA.TEL.AI.PAF - Phased Array Feed
4 SKA.TEL.AI.WBSPF - Wide Band Single Pixel Feed

WBS: AA-low

AA-low WBS					
	Consortium Members				
3 SKA.TEL.LFAA - Low Frequency Aperture Array	1	2	3	...	Notes
4 SKA.TEL.LFAA.MGT - Management					
4 SKA.TEL.LFAA.SE - System Engineering					
4 SKA.TEL.LFAA.ELM - Elements	d	f			
4 SKA.TEL.LFAA.LNA - LNA's					
4 SKA.TEL.LFAA.SIGT - Signal Transport					
4 SKA.TEL.LFAA.BF - Beam Former	p		d	f	
4 SKA.TEL.LFAA.PWR - Power		p			
4 SKA.TEL.LFAA.INFRA - Infrastructure					
4 SKA.TEL.LFAA.LMC - Local Monitoring and Control					
4 SKA.TEL.LFAA.VS - Verification System					

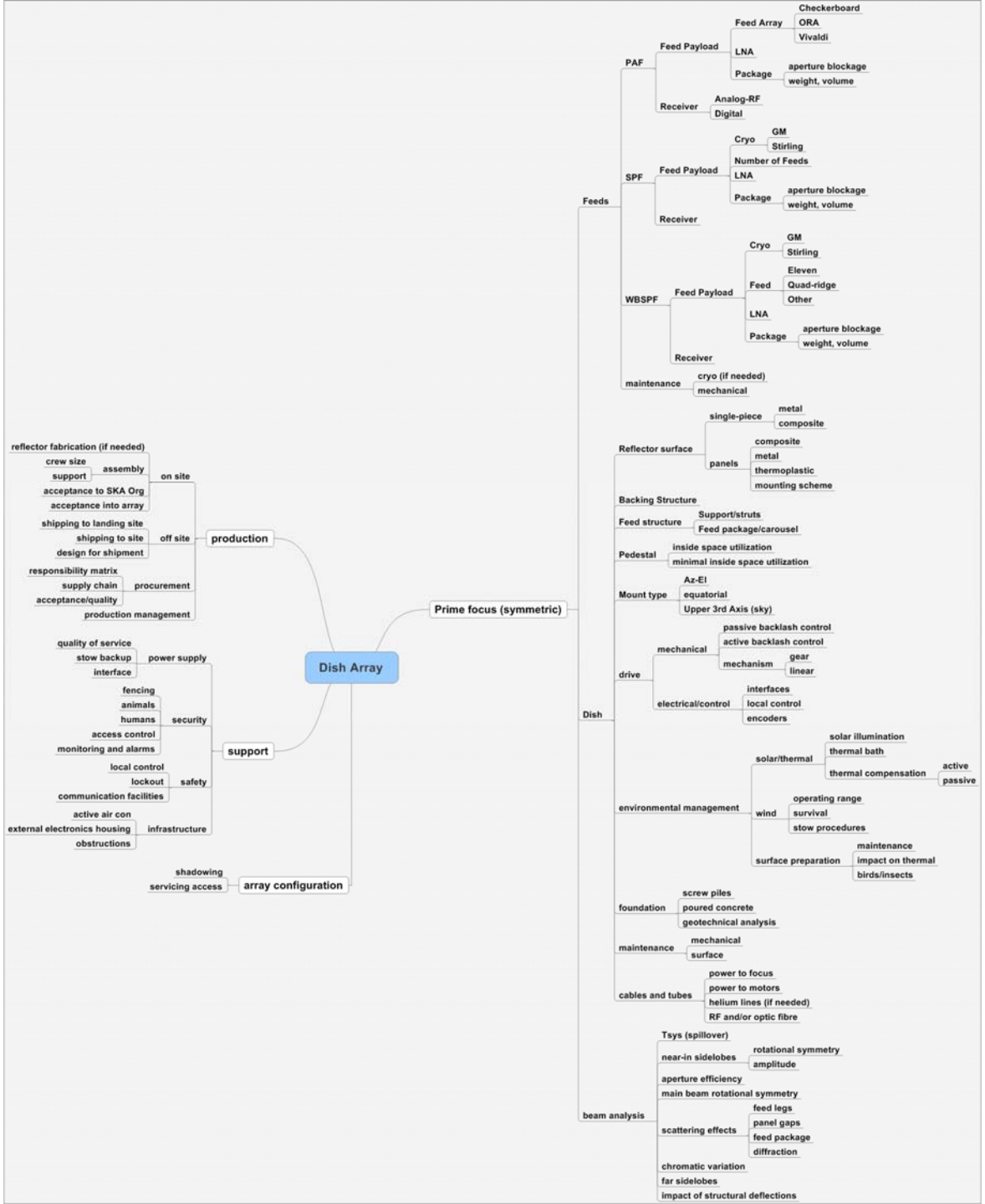
d=design; f=fabricate; p=participate

WBS: AA-mid

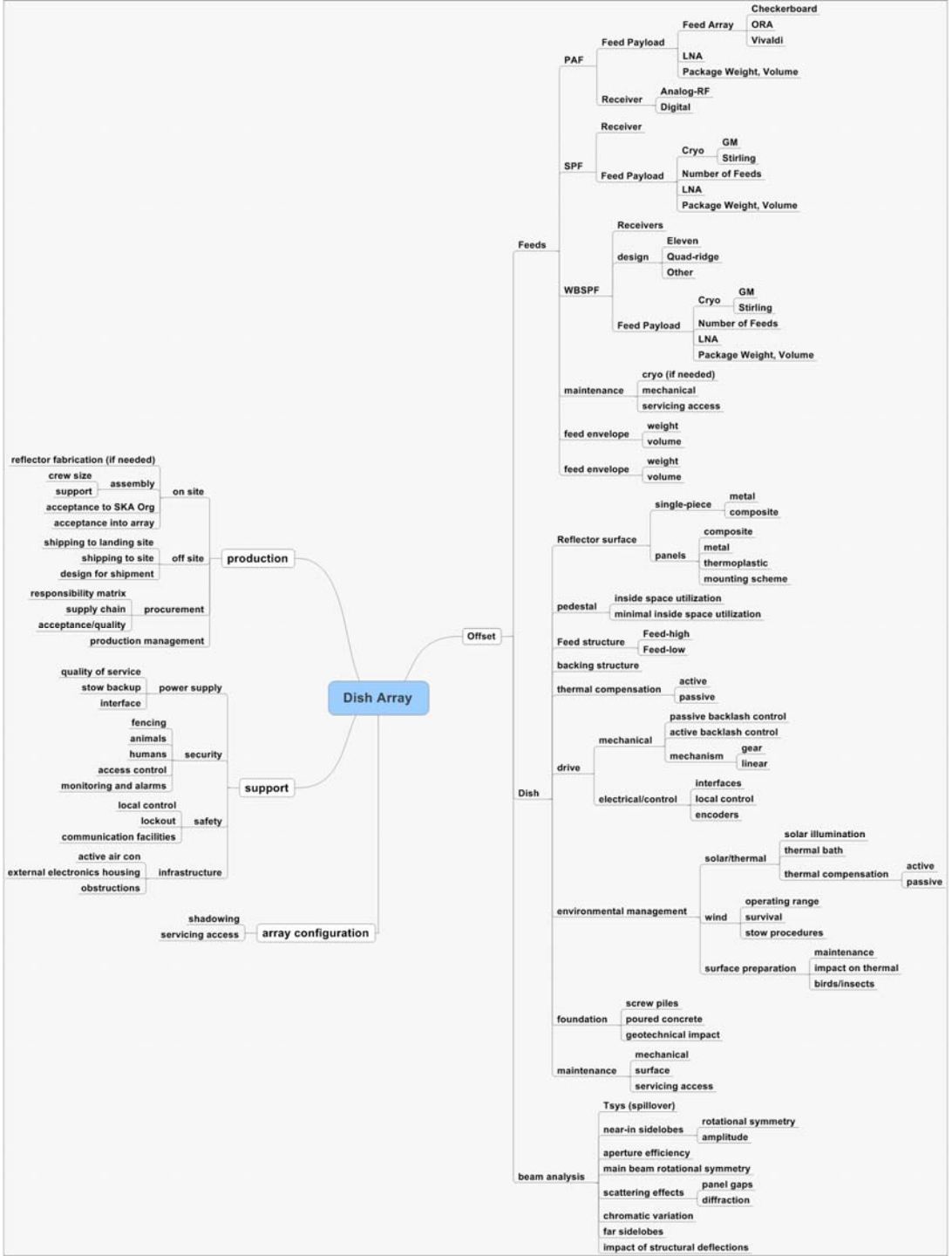
AA-mid WBS					
	Consortium Members				
	1	2	3	...	Notes
3 SKA.TEL.AI - Advanced Instrumentation					
4 SKA.TEL.AI.MFAA - Mid Frequency Aperture Array					
5 SKA.TEL.AI.MFAA.MGT - Management					
5 SKA.TEL.AI.MFAA.SE - System Engineering					
5 SKA.TEL.AI.MFAA.ARR - Array	d,f				
6 SKA.TEL.AI.MFAA.ARR.ELE - Elements			f		
6 SKA.TEL.AI.MFAA.ARR.RX - Receivers					
6 SKA.TEL.AI.MFAA.ARR.SIGT - Signal transport		f			
6 SKA.TEL.AI.MFAA.ARR.SP - Signal processor	d	f			
5 SKA.TEL.AI.MFAA.PWR - Power					
5 SKA.TEL.AI.MFAA.LMC - Local Monitoring and Control					

d=design; f=fabricate; p=participate

Symmetric Dish Decision/Option Tree



Offset Dish Decision/Option Tree



WPC attributes

- Each WPC will be a consortium of astronomical institutions and industry.
  - Probably a single lead institution.
- Very significant organisational structure on their own.
  - WPs are likely to be large.
- WPCs will need:
  - Clear, stable governance structure
    - can enter into legal agreements with the SPO, and probably with national funding agencies.
    - WPCs composed of consortia will need agreements.
  - Financially capable of taking on:
    - the work
    - the appropriate amount of risk
  - Intellectual Property (IP)
    - Managing, owning and protecting IP
    - Obtaining rights to required IP when necessary

WPC attributes (2)

- Demonstrated project management background
  - Project manager and chief system engineer will be the principal points of contact with the SPO
  - Rapid, meaningful (collaborative) lines of communication with SPO

- Sufficient **capacity** and **depth** to carry out the design work and any required verification programmes

- Engineering skill-set (talent pool) with the appropriate specialties and experience:
  - **Demonstrated technical expertise and experience**
  - Appropriate staff to develop **production data-packs** for the construction phase

Assembling Work Package Consortia

- The mechanisms by which Work Package Consortia will be assembled is still under discussion.
  - "Self assembly" will certainly happen.
  - Qualification process to be put together.
- Selection process for individual WPs is TBD.
- Industrial participation in Work Package Consortia is crucial to rounding out capabilities.
  - Very unlikely that any of the (sponsoring) research organisations have the engineering depth to carry out more than a small fraction of the work.
- There are many models for industry involvement:
  - A constant factor: Industry is needed to contribute at many levels to the SKA PEP phase.

End