



# PrepSKA – A Regional Contributor's Perspective

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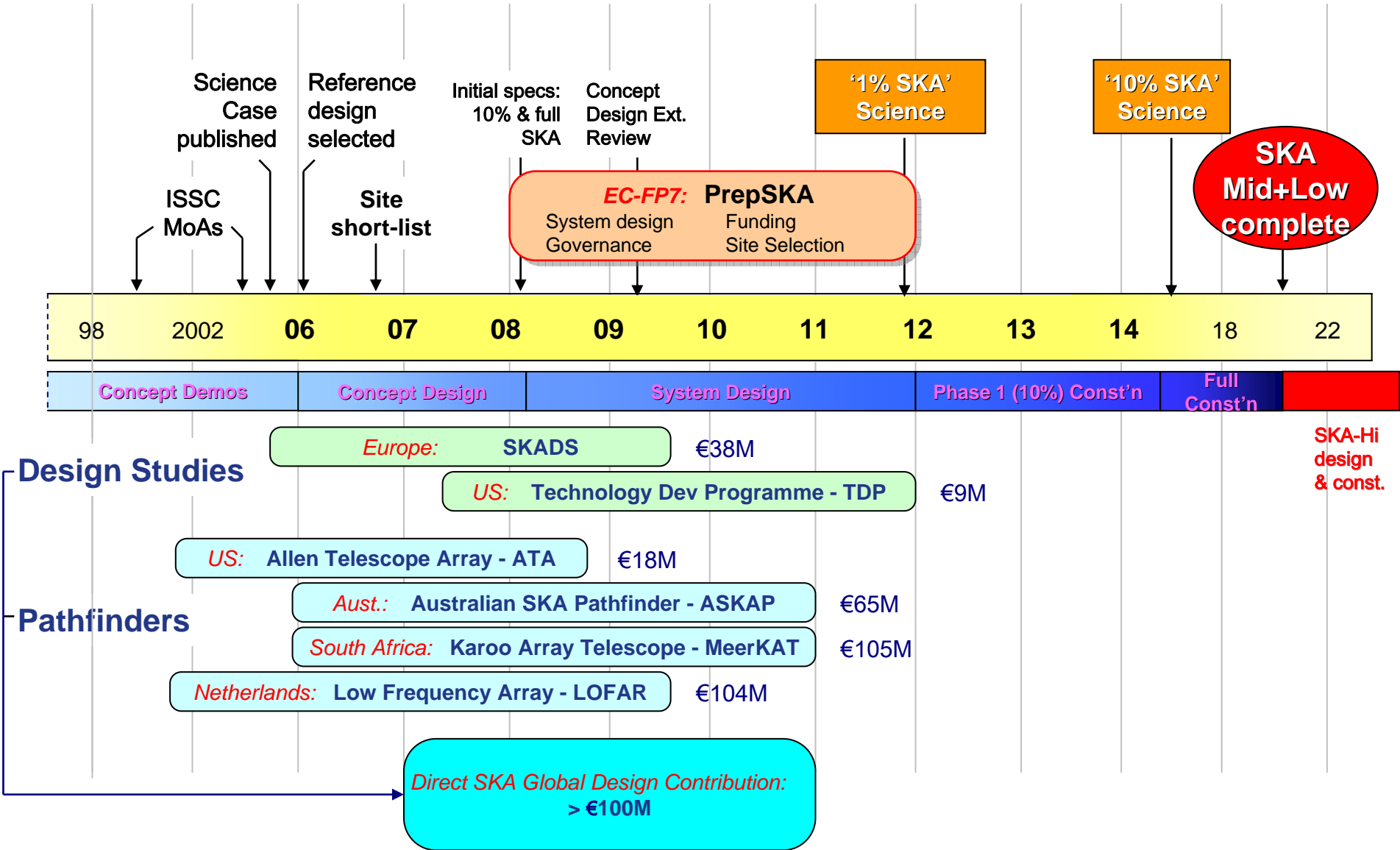
*Deep Surveys of the Radio Universe with SKA Pathfinders*

*Perth, April 4, 2008*

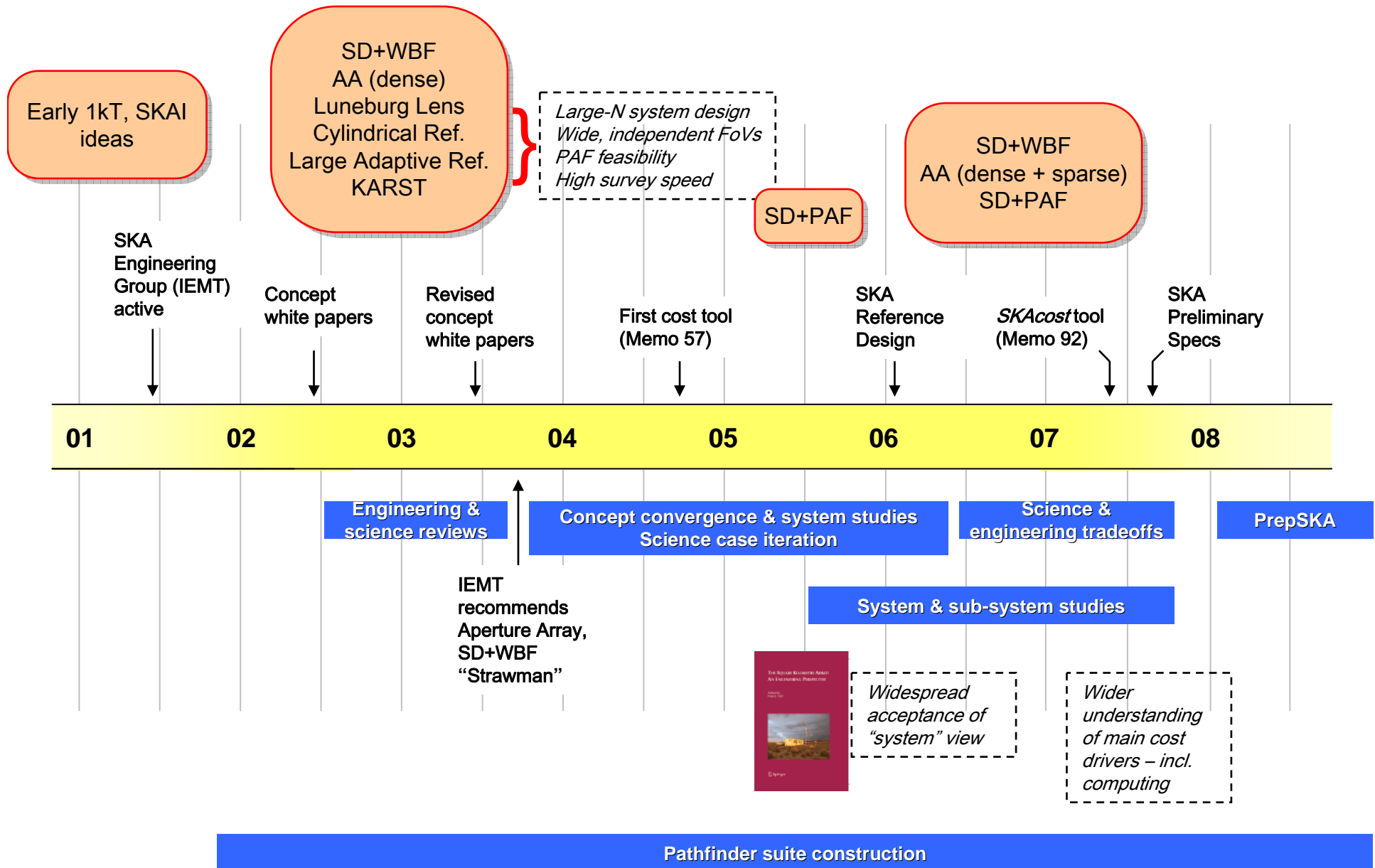
## Overview

- **SKA engineering context**
  - Where have we come from and where are we going?
- **SKA Preparatory Phase Study + Work Package 2 overview**
  - (WP2 = SKA system design task)
- **WP2 in practice**
  - Roles, responsibilities of CDIT and regional partners
- **WP2 augmentation**
  - Growth of 2007 design study proposal










# SKA timeline



# SKA concept evolution



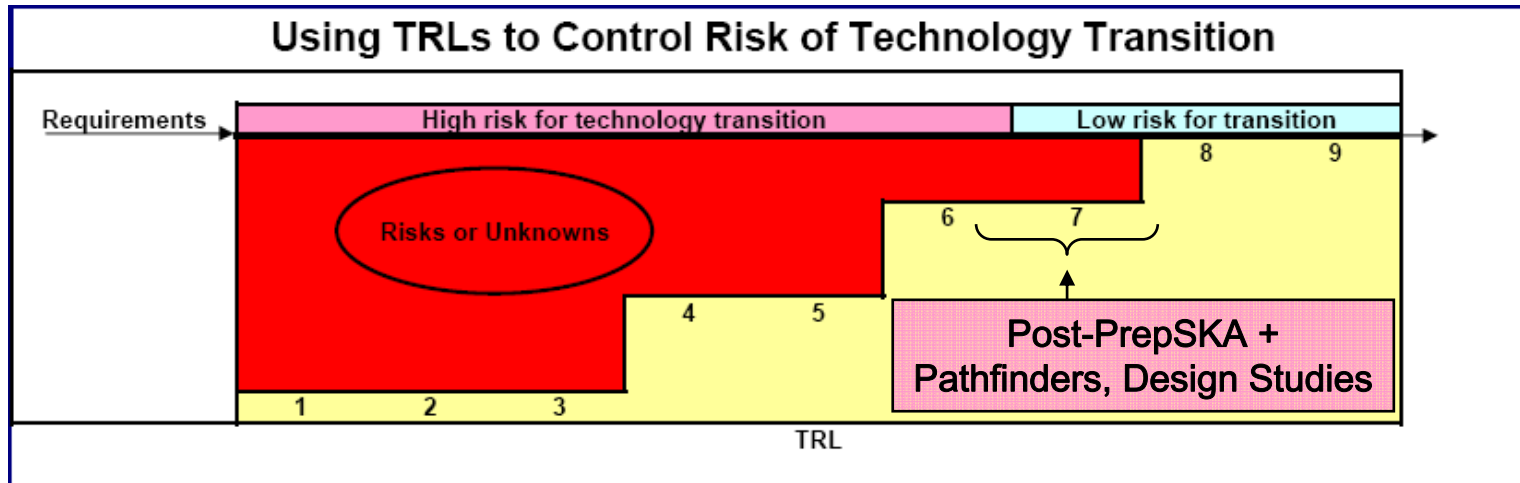
# SKA receptor technology - 2008

	Frequency range (GHz)	Sparse Aperture Array (AA)	Dense Aperture Array (AA)	Dish + Phased Array Feed (SD+PAF)	Dish + Single-Pixel Wideband Feed (SD+WBF)
Low-band "EoR" array	0.1 - 0.3				
All-sky monitor	0.3 - 1				
Imaging mid-band array	0.3 - 10	 (to ~0.5 GHz)	 (to ~1 GHz)	 (to ~1.5 GHz)	  (<1.5 GHz) (>1.5 GHz)
High-band array	10 - 25+				
Pathfinders or Design Studies		LOFAR, MWA, LWA	SKADS	ASKAP, APERTIF	ATA, TDP, meerKAT
Astronomical use?		Yes	Not yet	Not yet	Yes

# Technology Readiness Levels (TRLs)

Generate Knowledge (Research)			Generate Knowledge (Research)	
			Description: DoD 5000.2-R, Appendix 6, April 5, 2007	
Basic Technology Research	Level 1	Basic principles observed and reported	TRL 1	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties.
Research to Prove Feasibility	Level 2	Technology concept and/or application formulated	TRL 2	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
Technology Development	Level 3	Analytical and experimental critical functions and/or characteristic proof-of-concept	TRL 3	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
Technology Development	Level 4	Component and/or breadboard validation in laboratory environment	TRL 4	Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.
Technology Demonstration	Level 5	Component and/or breadboard validation in relevant environment	TRL 5	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include "high fidelity" laboratory integrations.
System/Subsystem Development	Level 6	System/subsystem model or prototype demonstration in a relevant environment	TRL 6	Representative model or prototype system, which is well beyond that of TRL5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high fidelity laboratory environment or in simulated operational environment.
System/Subsystem Development	Level 7	System prototype demonstration in an operational environment	TRL 7	Prototype near or at planned operational system. Represents a major step up from TRL6, requiring demonstration of an actual system prototype in an operational environment, such as in aircraft, vehicle, or space. Examples include testing the prototype in a test bed aircraft.
System Test and Operation	Level 8	Actual system completed and qualified through test and demonstration	TRL 8	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.
System Test and Operation	Level 9	Actual system proven through successful mission operations	TRL 9	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions.
Produce Products and Capabilities (Development)			Produce Products and Capabilities (Development)	

## Using TRLs to Control Risk of Technology Transition



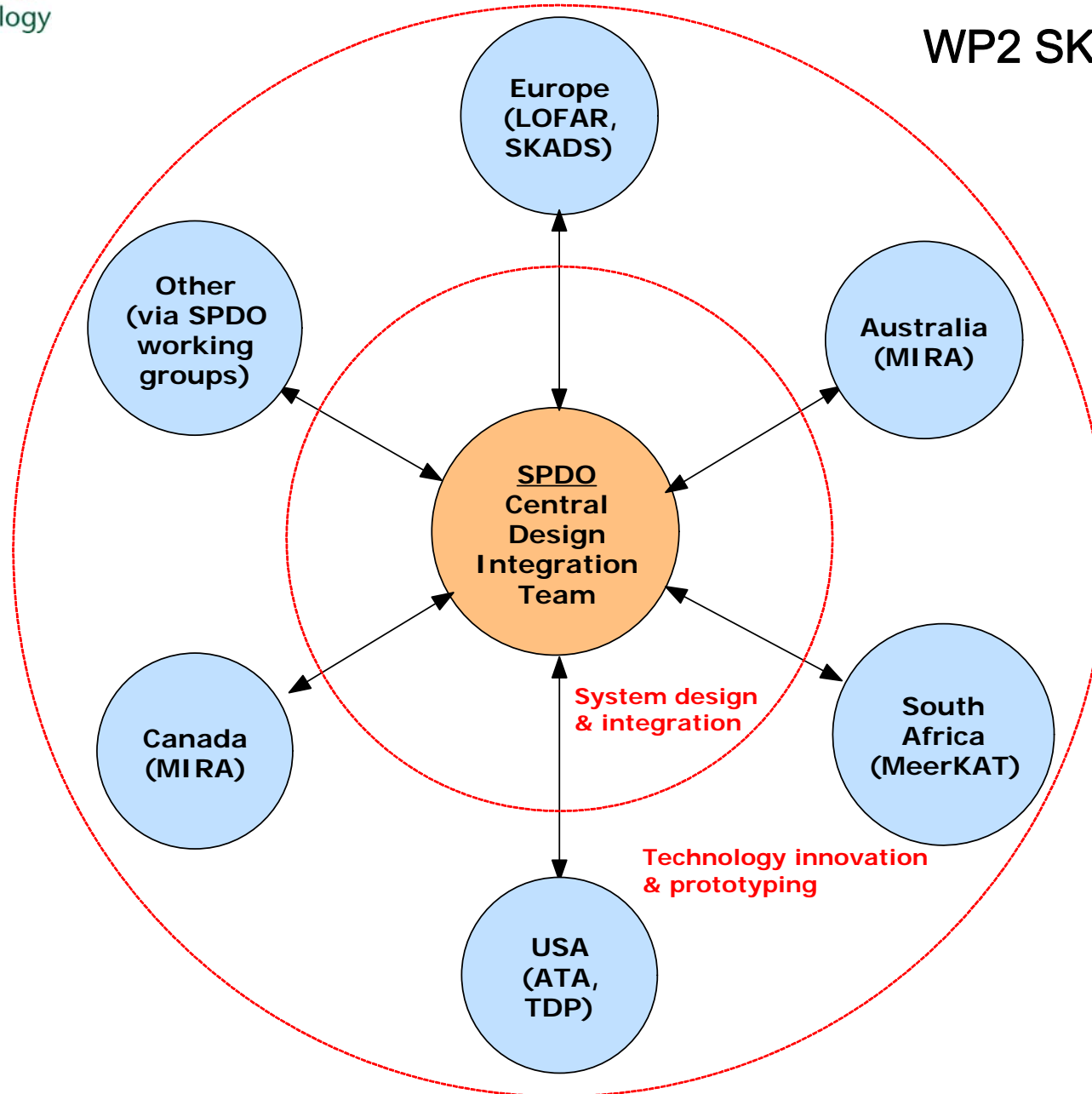
NASA/DoD

# SKA preparatory phase: PrepSKA (2008 – 2011)

- WP1: PrepSKA management
- WP2: SKA system design (4-YEAR PROGRAM) (SPDO)
  - Establishes SPDO Central Design Integration Team (CDIT)
    - » 15 engineers
    - » Located Manchester, UK
  - Includes Initial Verification System
- WP3: Continuing site selection process (SPDO)
  - Regional, international, joint projects
- WP4: Governance (NWO)
- WP5: Industry and procurement policy (INAF)
- WP6: Funding model (STFC)
- WP7: SKA implementation strategy – linking task

€ 20M European program with strong international collaboration  
(including US Technology Development Project)

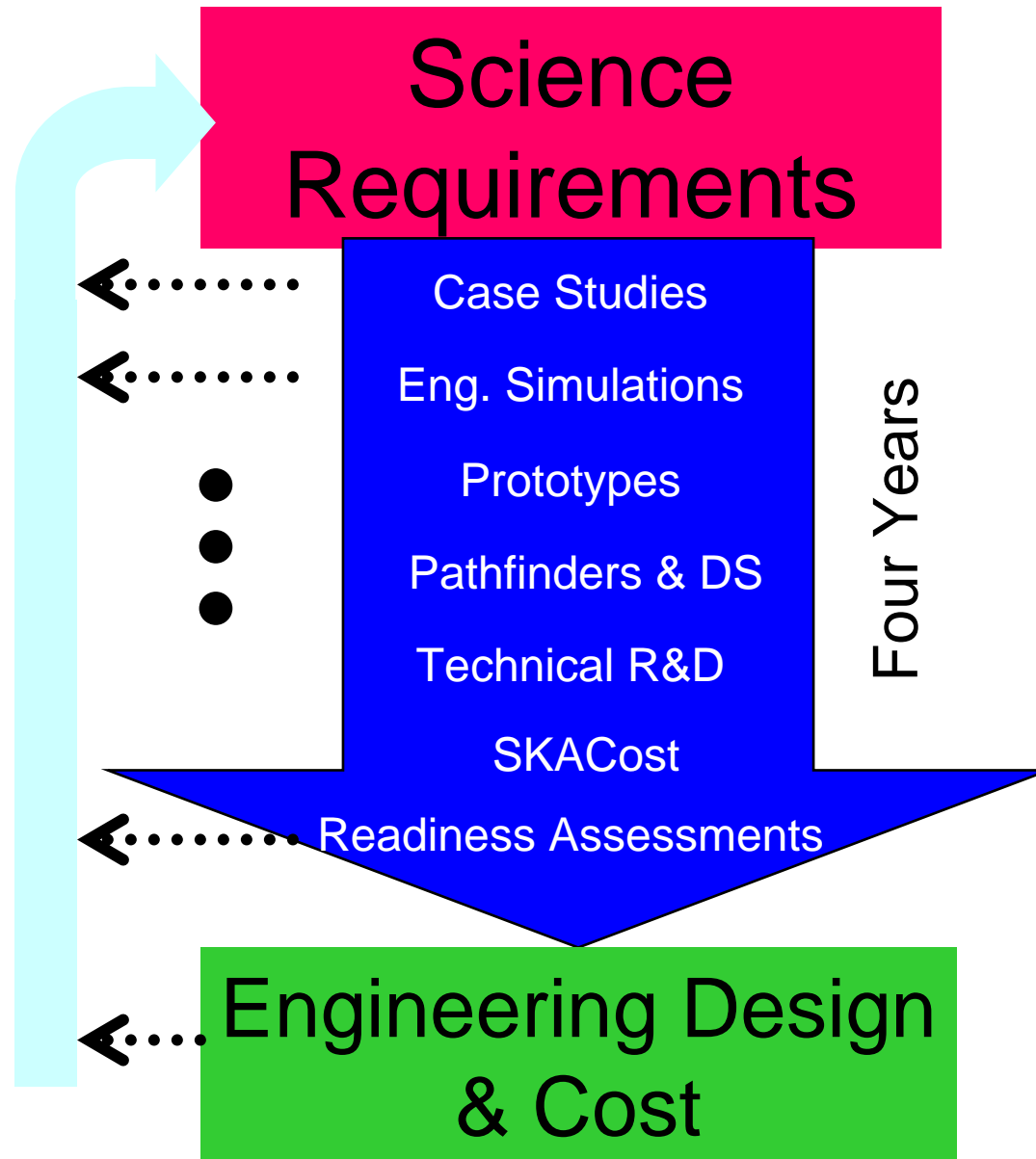
## WP2 SKA design



## PrepSKA WP2: SKA design

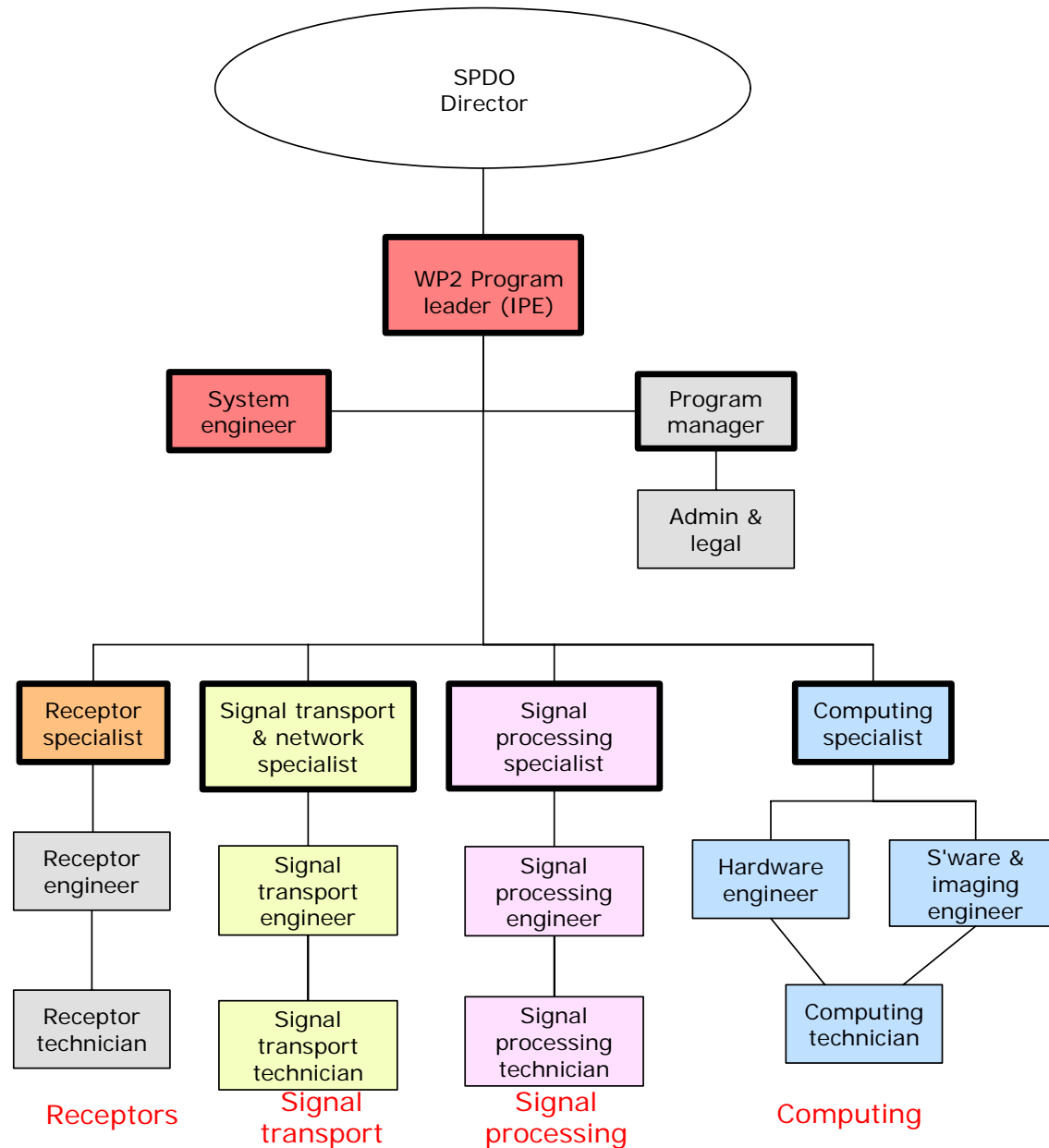
- **Integrates global SKA knowledge into coherent design**
  - Brings the best technologies together into complete program
  - Emphasizes “fit for manufacture” design
- **Delivers**
  - Overall SKA concept design, with costing
  - Detailed SKA Phase 1 design
  - Initial Verification System prototype for SKA Phase 1 design
- **Demonstrates functional central team, plus strong working links to regional engineering**
- **~180 p\*yr effort**
- **Many shared central and regional projects**
- **Adopts SD+WBF as “base” SKA design (partly risk mitigation)**
  - Add extensions to base design (WFOV) as proven feasible
- **Emphasizes “make or break” design aspects**
  - Dynamic range, polarization, ... performance
  - Data transport / processing developments and realities
  - Software requirements and implementation realities
  - Operational drivers to system design

# The Job of PrepSKA



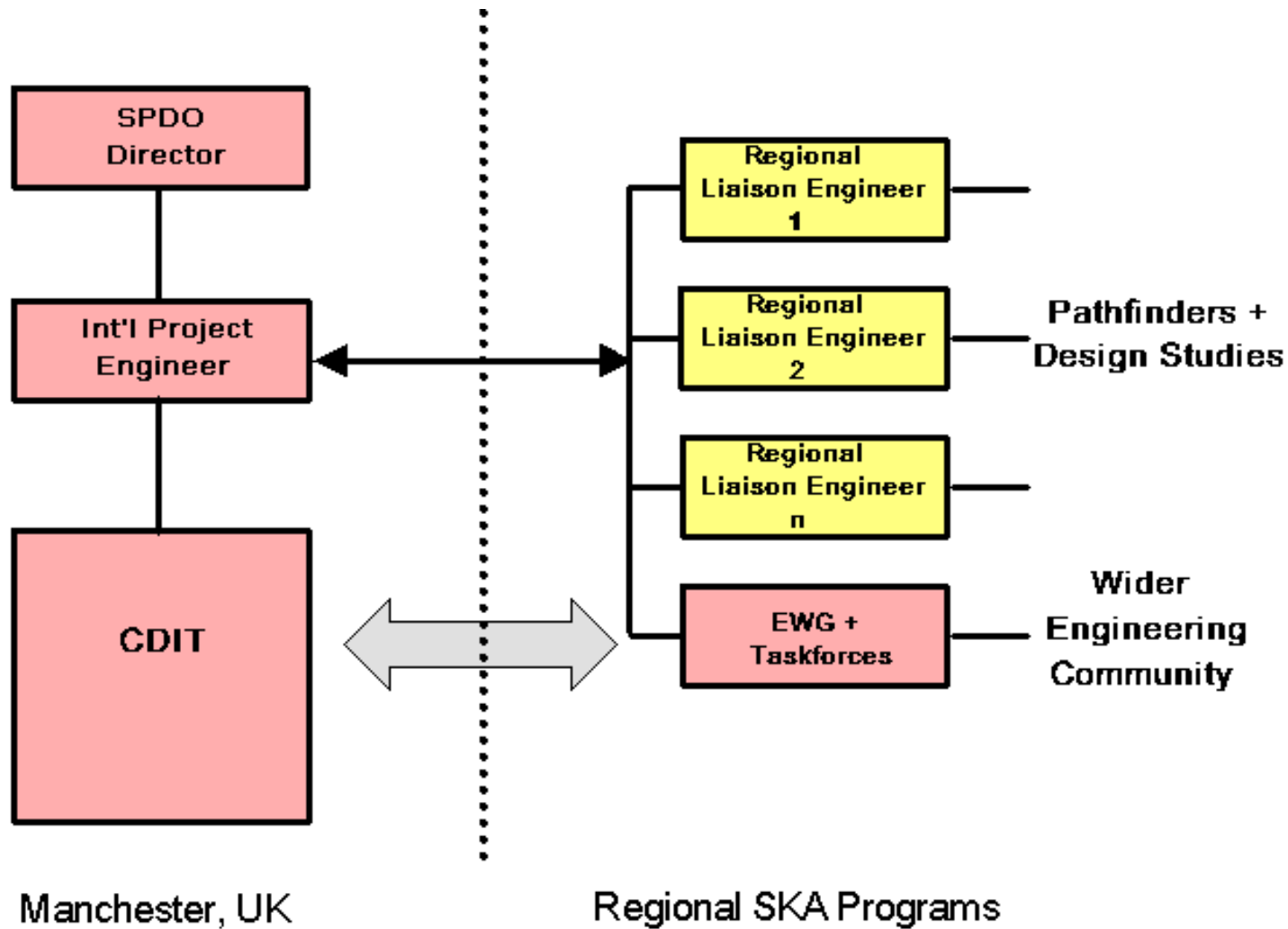
Courtesy  
Peter Dewdney

# CDIT structure

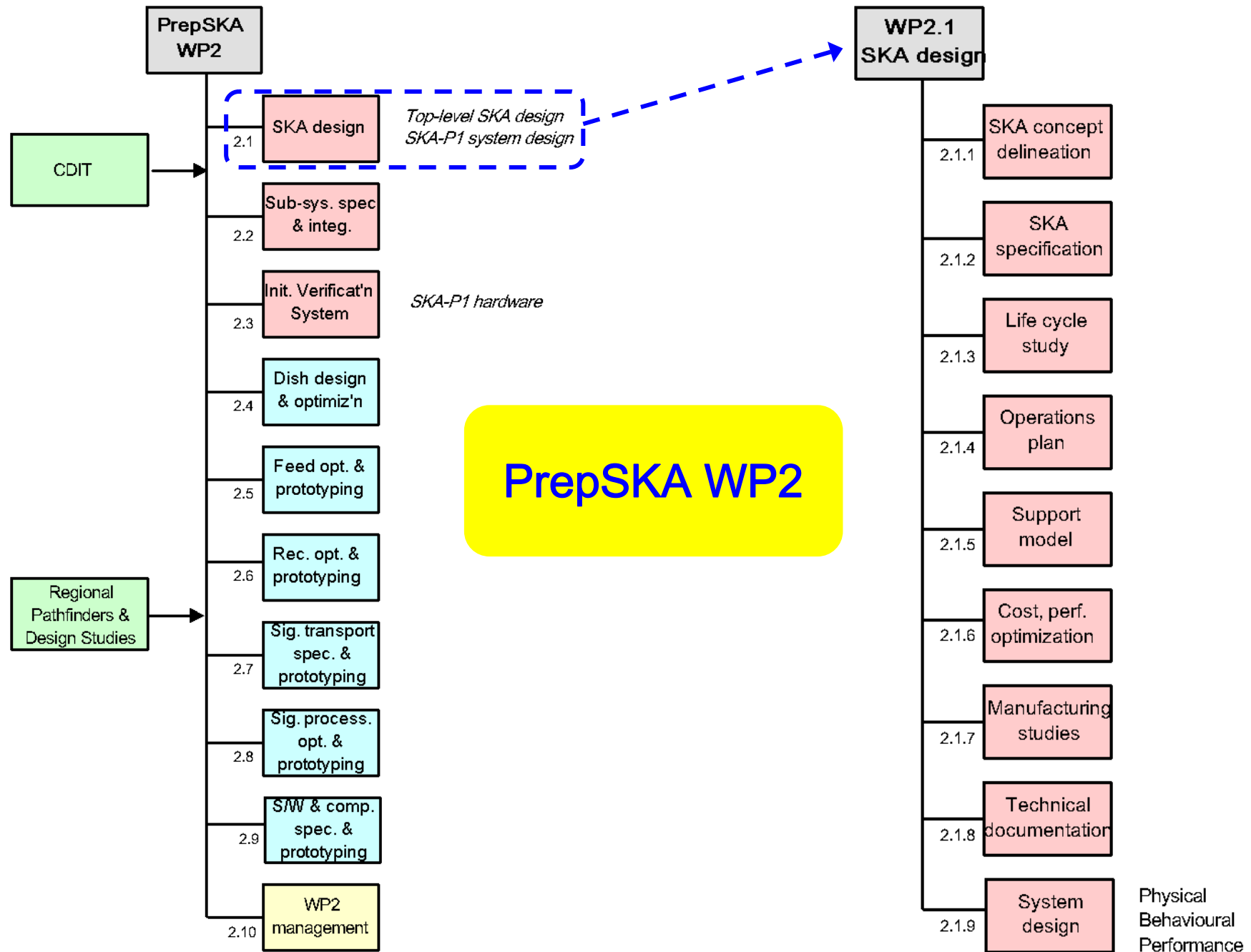


**APPLY NOW!**

# CDIT liaison – a model



PJHall, March 08





## WP2: First tasks (approximate dates)

- **SKA concept delineation**
  - Report Q4 2008
- **Draft SKA engineering specs**
  - SKA Phase 1 specs + SKA performance goals
  - Includes performance boundaries for system + sub-systems
  - Draft specs report Q1 2009
- **International Engineering Advisory Committee review**
  - Report Q2 2009
  - Working engineering specs set Q2 2009 (SSEC)
- **Other tasks begin mid to late 2008, e.g.**
  - Life cycle study
  - Operations plan
  - Support model
  - Performance – cost optimization
  - Manufacturing studies
  - Technical documentation



Need 2008 initial  
SKA specs

## CDIT obligations

- **Draft (soon) MoUs for WP2 deliverables**
- **Recognize primacy of regional projects as key technology developers**
- **Implement “high-performance” link between International Project Engineer and Regional Liaison Engineers**
- **Ensure 2-way information flow to/from regional domain specialists**
  - Includes links to groups tackling activities outside immediate scope of 2007 WP2 plan
- **Be pro-active in engaging engineering strategy and review bodies**
  - Engineering working group
  - International Engineering Advisory Committee

## WP2 regional obligations

- **Negotiate (soon) MoUs for deliverables**
- **Recognize CDIT as SKA system designer and integrator**
- **Encourage transfers and secondments to CDIT**
- **Appoint motivated senior engineer(s) as Regional Liaison Engineer(s)**
- **Ensure PrepSKA work has required priority**
  - Includes prototyping and Initial Verification System (IVS)
- **Be pro-active in disseminating Pathfinder key results to PrepSKA and beyond**
- **Contribute to SPDO strategic and review forums**
  - EWG and others
- **De-couple science and engineering from site politics**

# Emerging design study priorities - examples

## ■ Additional effort on existing tasks

- Performance-cost estimation
  - » e.g. 75 person-month effort at Curtin U.
- “Sensible” end-to-end system simulation (e.g. DR studies)
- Time domain processors
- SKA operations models, following SSRC review
  - » Incl. “use case” analyses

## ■ New technical activities

- Sparse aperture arrays >300 MHz
- Intra-chip, chip-to-chip optical communications
- Low-power design strategies
- Efficient environmental conditioning
- Renewable energy solutions
  - » At least for remote SKA stations

## Evolution of SKA design study

- **New regional programs must add coherently to 2007 PrepSKA work plan**
- **SPDO must be able to negotiate new programs and priorities as design progresses**
- **Practical mechanisms:**
  - Add resources to PrepSKA where feasible
  - Allow CDIT to “outsource” emergent R&D via tight collaborations with capable institutes or industry
- **Bottom line: need maximum flexibility to get the job done**
  - May involve “extra PrepSKA” links between SPDO and collaborators

## Conclusion

- **Pathfinders and Design Studies are delivering results**
  - Timely technology demonstration remains the criterion for inclusion in SKA
- **Substantial challenges remain in most areas of system design**
  - Present performance and cost goals are almost certainly too optimistic, despite usefulness in initial project scoping
- **PrepSKA is the vehicle for combining global engineering progress and making design trade-offs**
  - But PrepSKA needs to accommodate emerging technology imperatives
- **Productive CDIT – regional collaboration is the path to SKA**