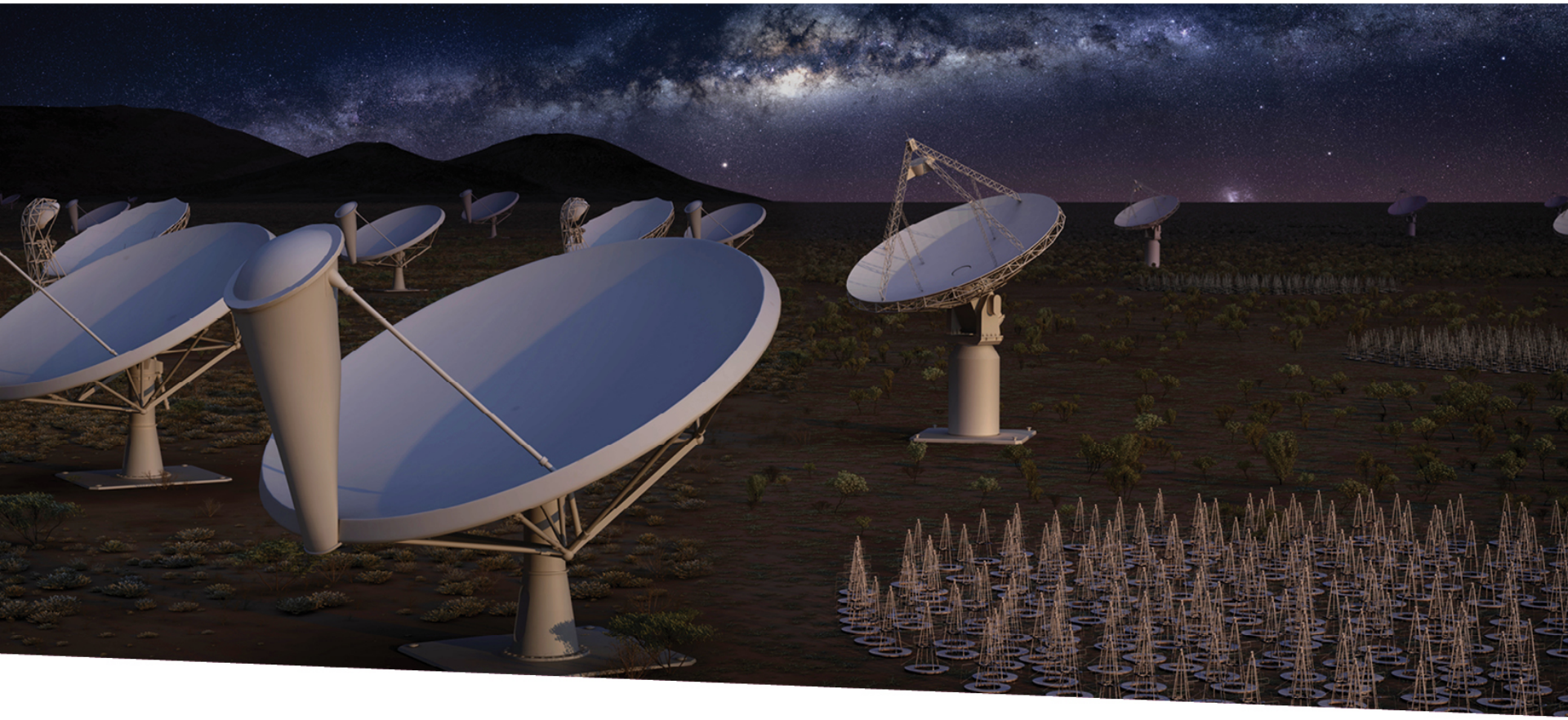
SKA1 Low Telescope Functional Analysis



SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

H.Schnetler & MG Labate

2015-11-12

What is functional analysis?

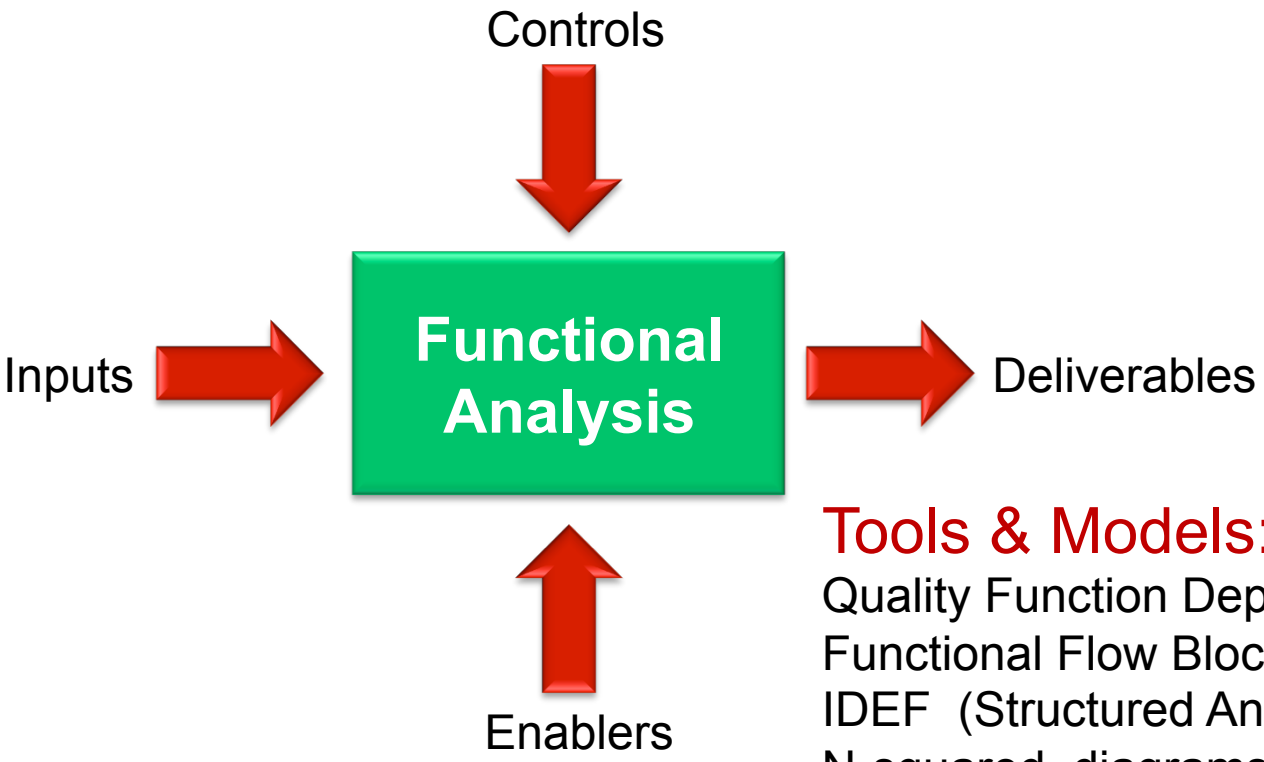
- It is the Systems Engineering (SE) process that
  - Translates stakeholder NEEDs into
    - A sequenced and
    - Traceable
    - FUNCTIONAL ARCHITECTURE
- The deliverable = Functional Description (which become the framework for developing the SYSTEM PHYSICAL ARCHITECTURE
- Functional performance is the association of the performance characteristics with each function

Why doing a Functional Analysis

- It improves:
  - Synthesis of design
  - Innovation
  - Requirements development and
  - Integration

- The benefits are twofold:
  - It discourages single-point solutions
  - It describes the needed behaviours that lead to
    - Requirements
    - Physical architectures (implementation solutions)

Functional Analysis Process



Tools & Models:

Quality Function Deployment (QFD),
Functional Flow Block Diagrams,
IDEF (Structured Analysis and Design Technique),
N-squared diagrams,
Requirement Allocation Sheet,
Timelines,
Data Flow Diagrams,
State/Mode Diagrams,
Behaviour Diagrams.

Functional Analysis Activities

- Define system states and modes
- Define system functions & external interfaces
- Define functional interfaces
- Allocate performance requirements to functions
- Analyse:
  - performance
  - timing and resources
  - failure mode effects and criticality
- Define fault detection and recovery behaviour
- Integrate functions

Functional Analysis and Deliverables

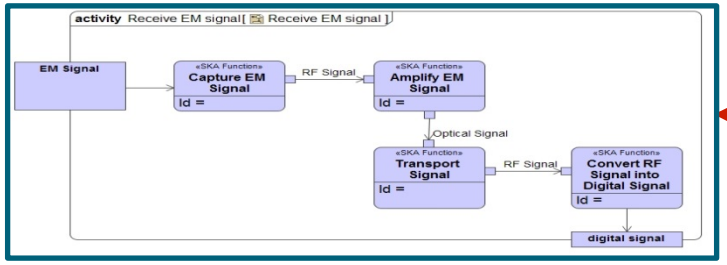
- Functional analysis defines the “what” a system has to do and contains “doing” words (action verbs)
- Functions are discrete actions – necessary to achieve the system’s OBJECTIVES

Deliverables:

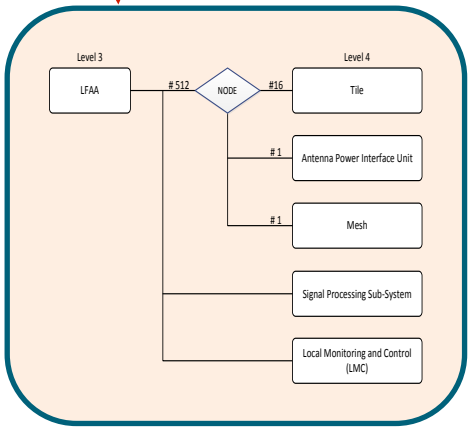
- Functional Flow Block Diagram (FFBD)
- N^2 Diagram

Model Centric

Functional Model



Architectural Model



Deriving Requirements

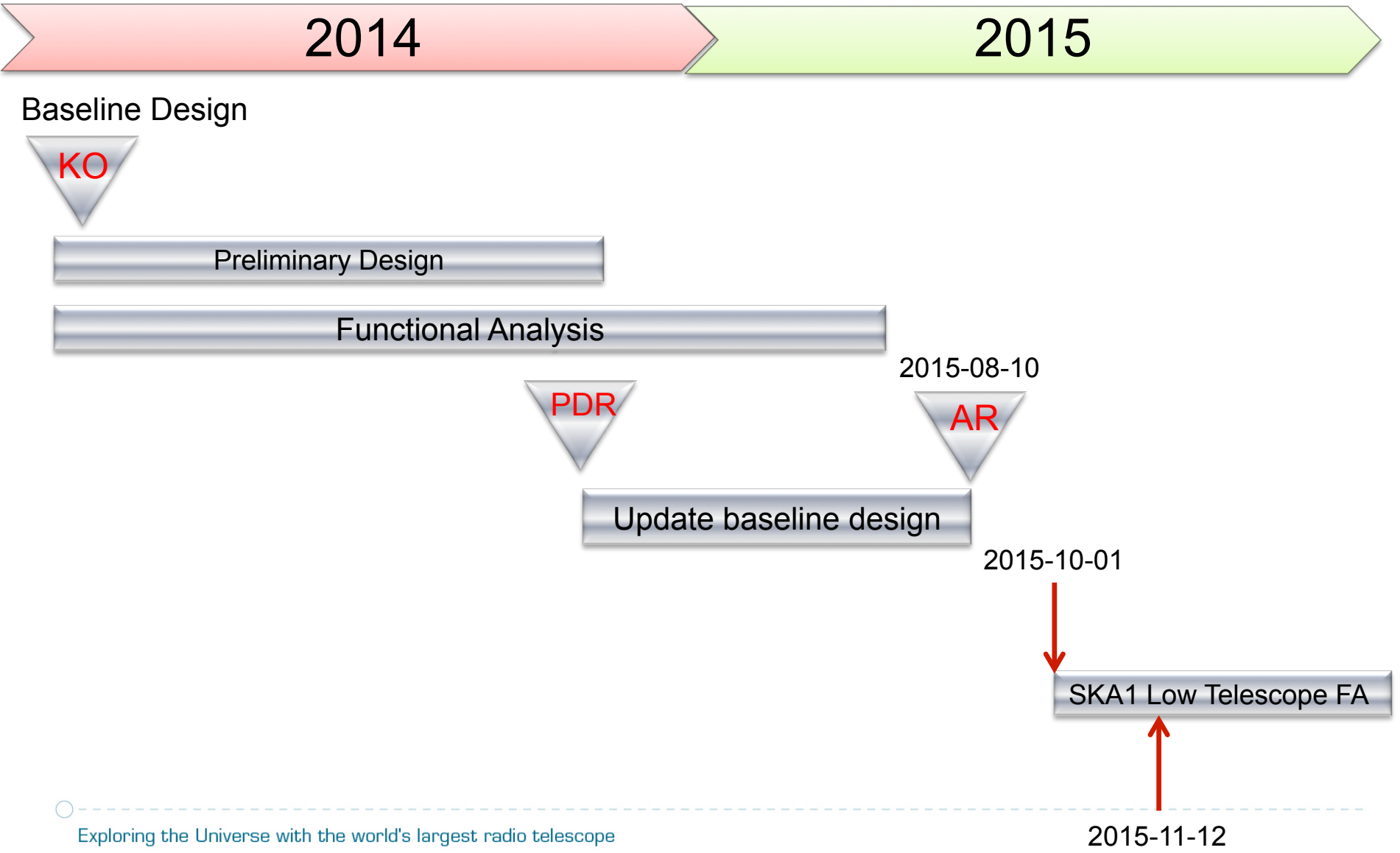
Specification is a by-product

Decision Database

LFAA

Test View

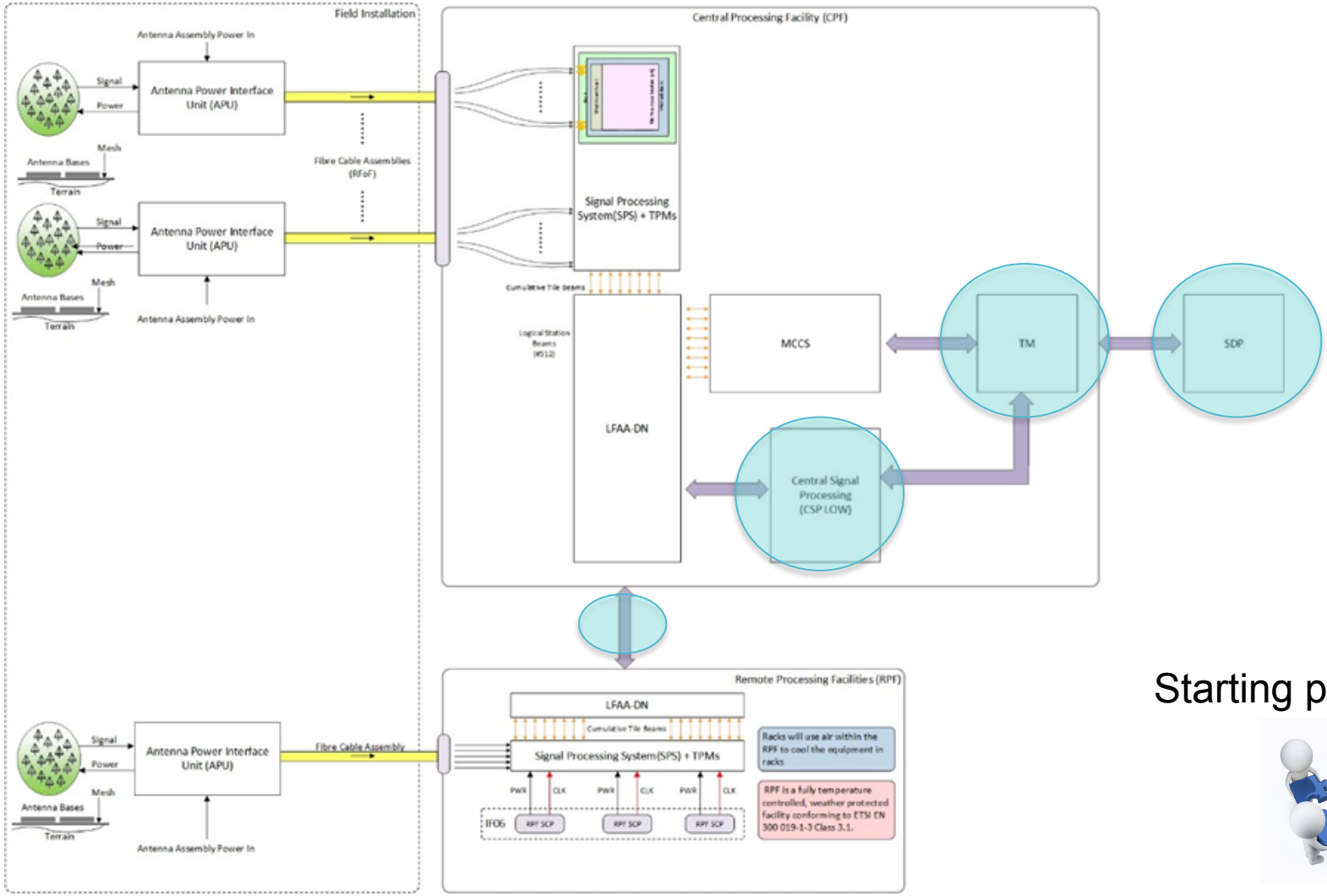
SKA1 Timeline – Functional Analysis



SKA1 Low Telescope Functional Analysis

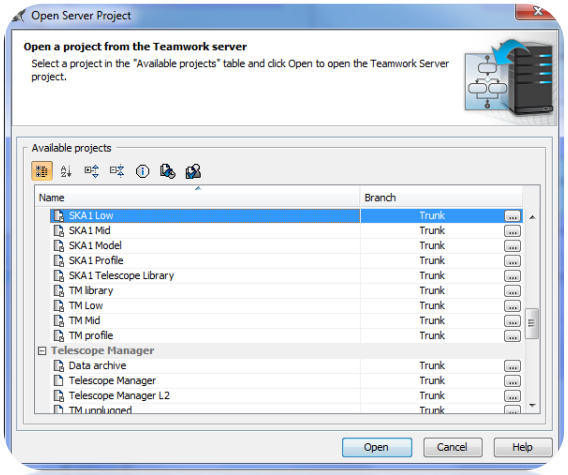
- GAP analysis
  - Identify all the mission critical functions
  - Implement all mission critical functions and
  - Update and optimise the Baseline Design
- Scope
  - Identification all primary mission critical system level functions.
  - Describe the data and control flow V
  - Verify functional coverage
  - Verify interfaces

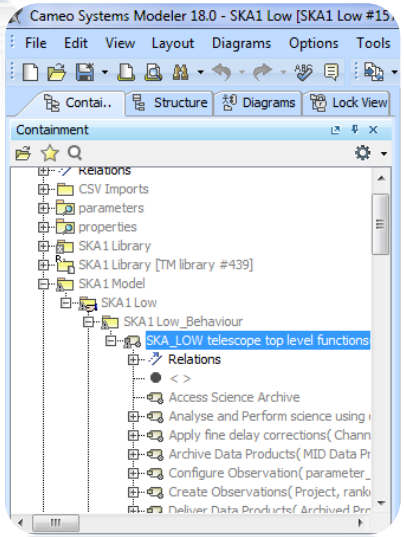
SKA1 Low Telescope

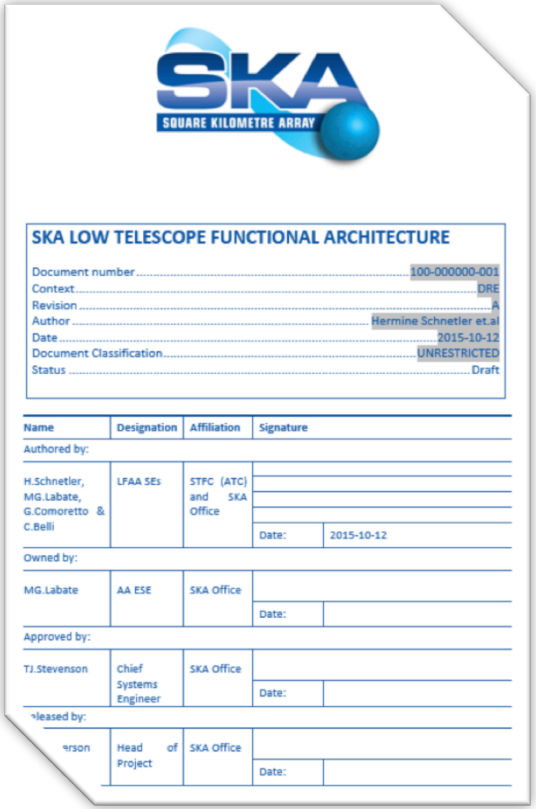


Starting point

A first draft







SKA LOW TELESCOPE FUNCTIONAL ARCHITECTURE

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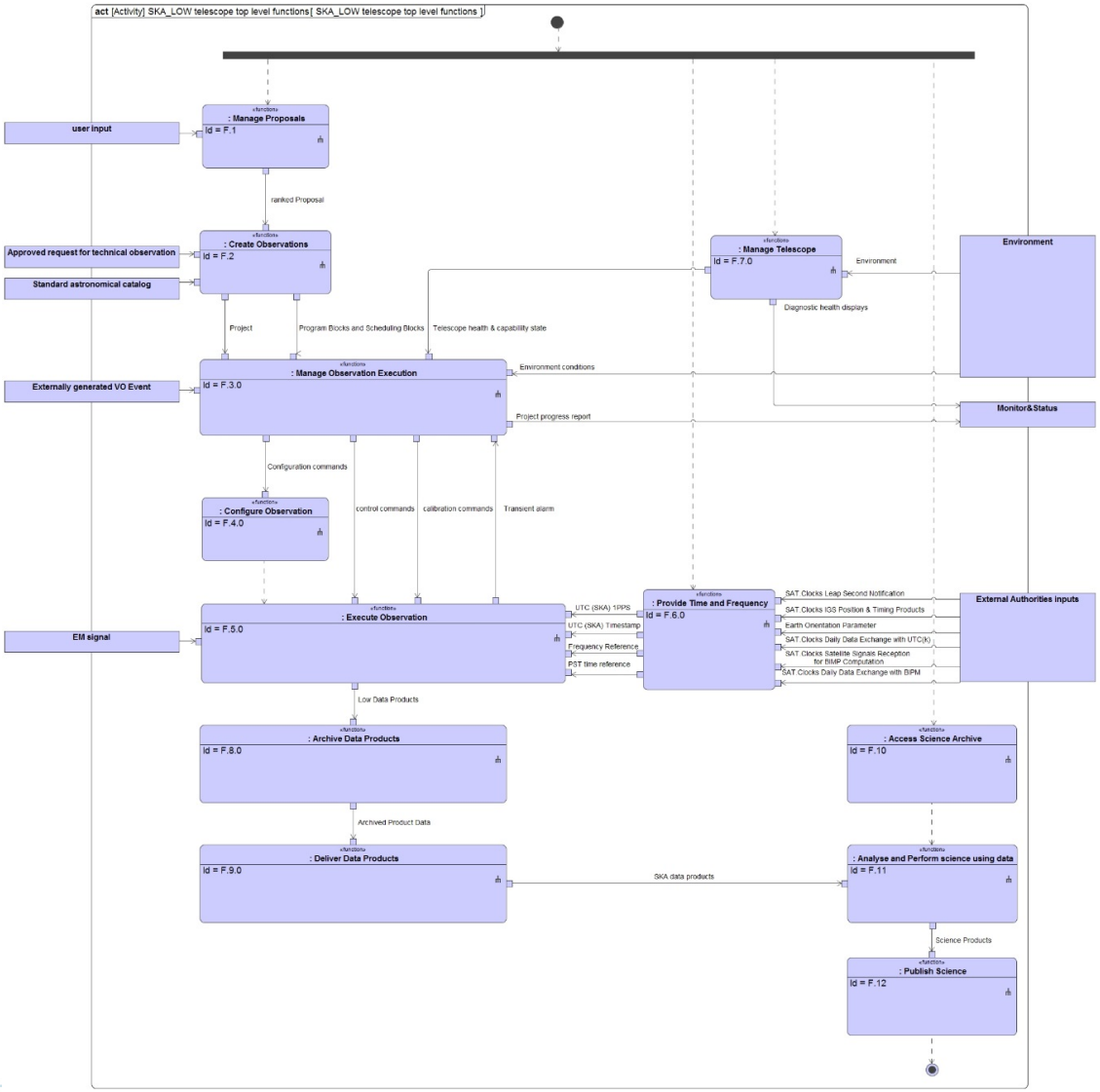
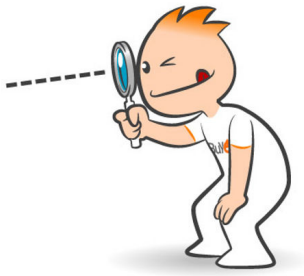
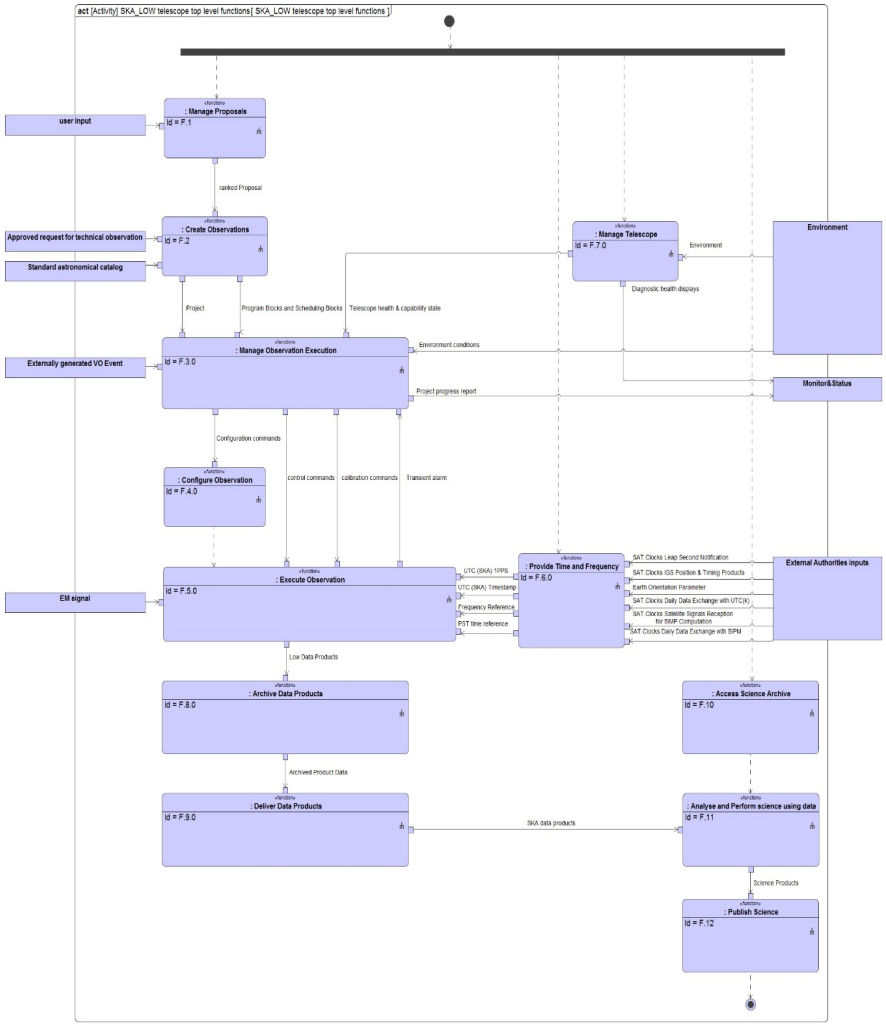
SKA1 Low Telescope Top Level FFBD



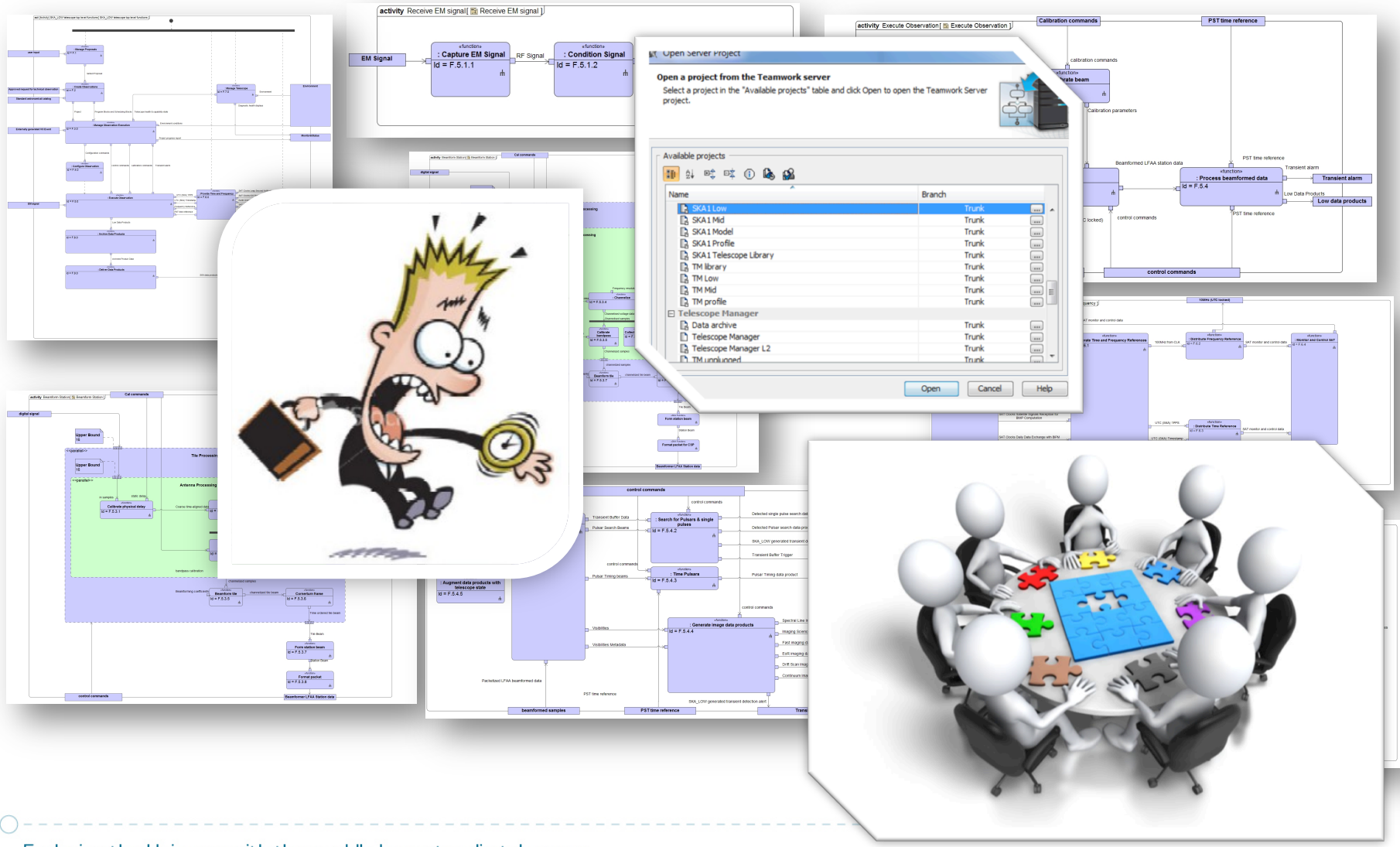


SKA1 Low Telescope Top Level FFBD

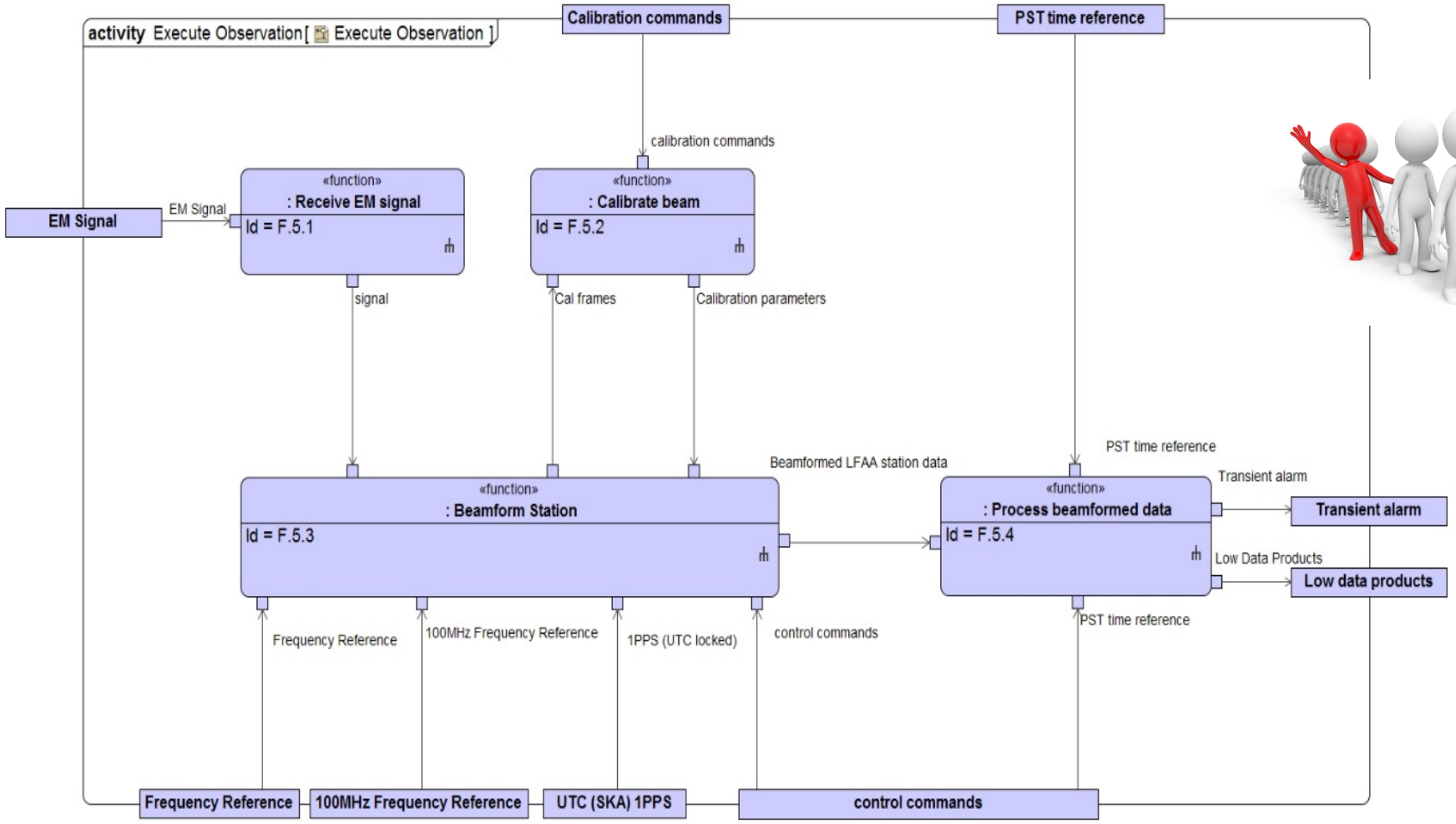


1	Manage Proposals
2	Create Observations
3	Manage Observation Execution
4	Configure Observation
5	Execute Observation
6	Provide time and frequency
7	Manage Telescope
8	Archive data products
9	Deliver data products
10	Access Science Archive
11	Analyse and perform science using data
12	Publish science

And further decomposition



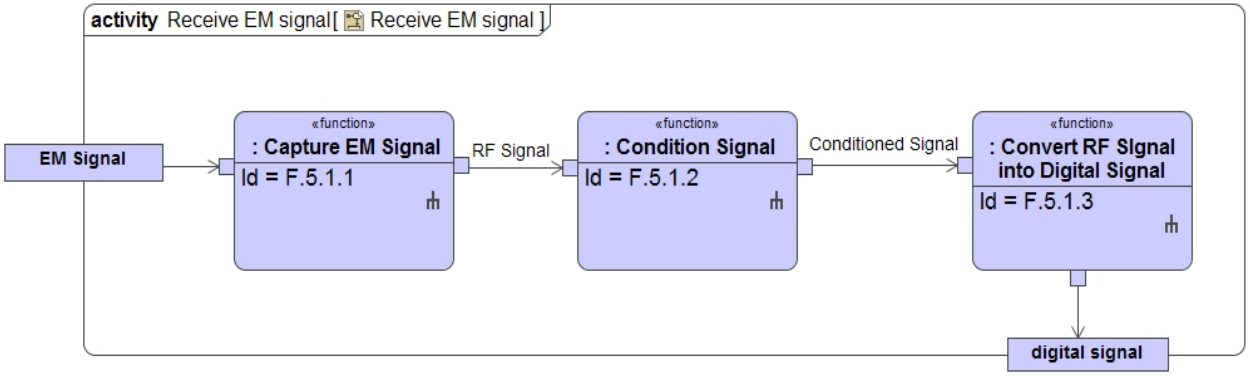
Execute Observation



Receive EM Signal

5	**Execute Observation**
5.1	Receive EM signal
5.2	Calibrate Beam
5.3	Beamform Station (Form logical station beam)
5.4	Process beam formed data

5.1.1	Calibrate Physical delay
5.1.2	Channelize
5.1.3	Calibrate bandpass

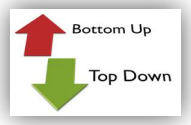


Beamform Station

5	**Execute Observation**
5.1	Receive EM signal
5.2	Calibrate Beam
5.3	Beamform Station (Form logical station beam)
5.4	Process beam formed data

5.3.1	Calibrate Physical delay
5.3.2	Channelize
5.3.3	Calibrate bandpass
5.3.4	Collect calibrate samples
5.3.5	Beamform tile
5.3.6	Corner turn frame
5.3.7	Form Station Beam
5.3.8	Form Packet

The way forward

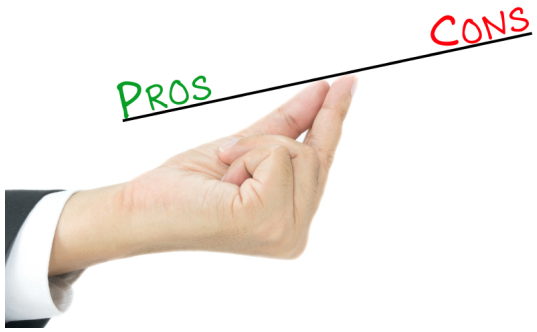


- Top down approach to be consolidated
- Requirement and actual PBS mapping to be included/updated in the model
- It is important that all the element consortia work on the functional analysis
  - A busy week workshop is essential
- Once the model is completed – it is important that it is reviewed
- Telescope operational concept should be defined in detail
- Low Telescope Functional Performance need to be evaluated in terms of the science

Pros and Cons

Cons
Collaboration not easy
Time consuming, especially if work in progress (i.e. changes needed)
Difficulty to make it readable for ***A4 format***
To ***map*** functions, requirements and products we need other parts of the model to be in place

Pros
Once the model is in place, and is the source of all system design information, **changes** will be easier
Easier to communicate a **common understanding**
Understanding the **behaviour of the system**, is easier within the model, rather than to have to trawl through many documents
Integrated model allow for "**what if**" analysis



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Thank you

…and for any question please use our spreadsheet