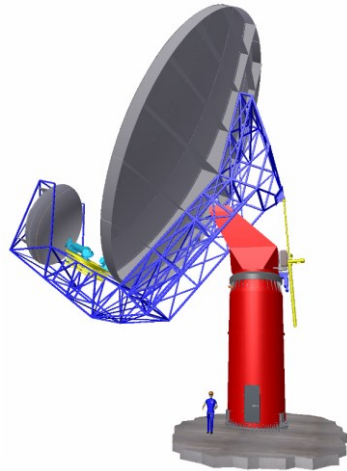# Capability reporting

Francesco Schillirò
INAF- OACT
LMC Harmonisation Workshop
Madrid 11-13 April 2016

MY EXPERIENCE

- Control Software for Noto Radiotelescope Facilities
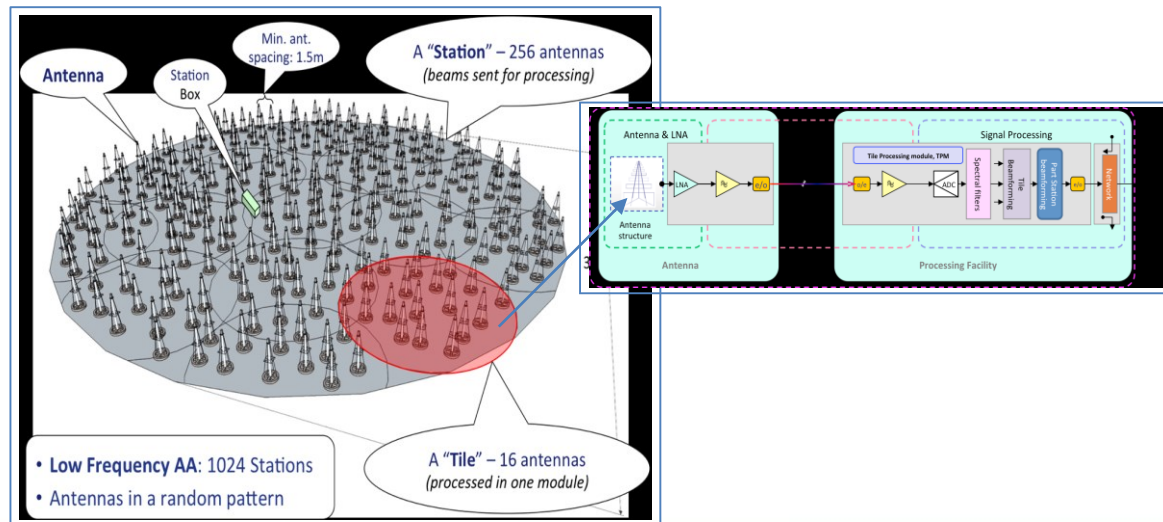
DISH-LMC

LMD DISH DESIGN
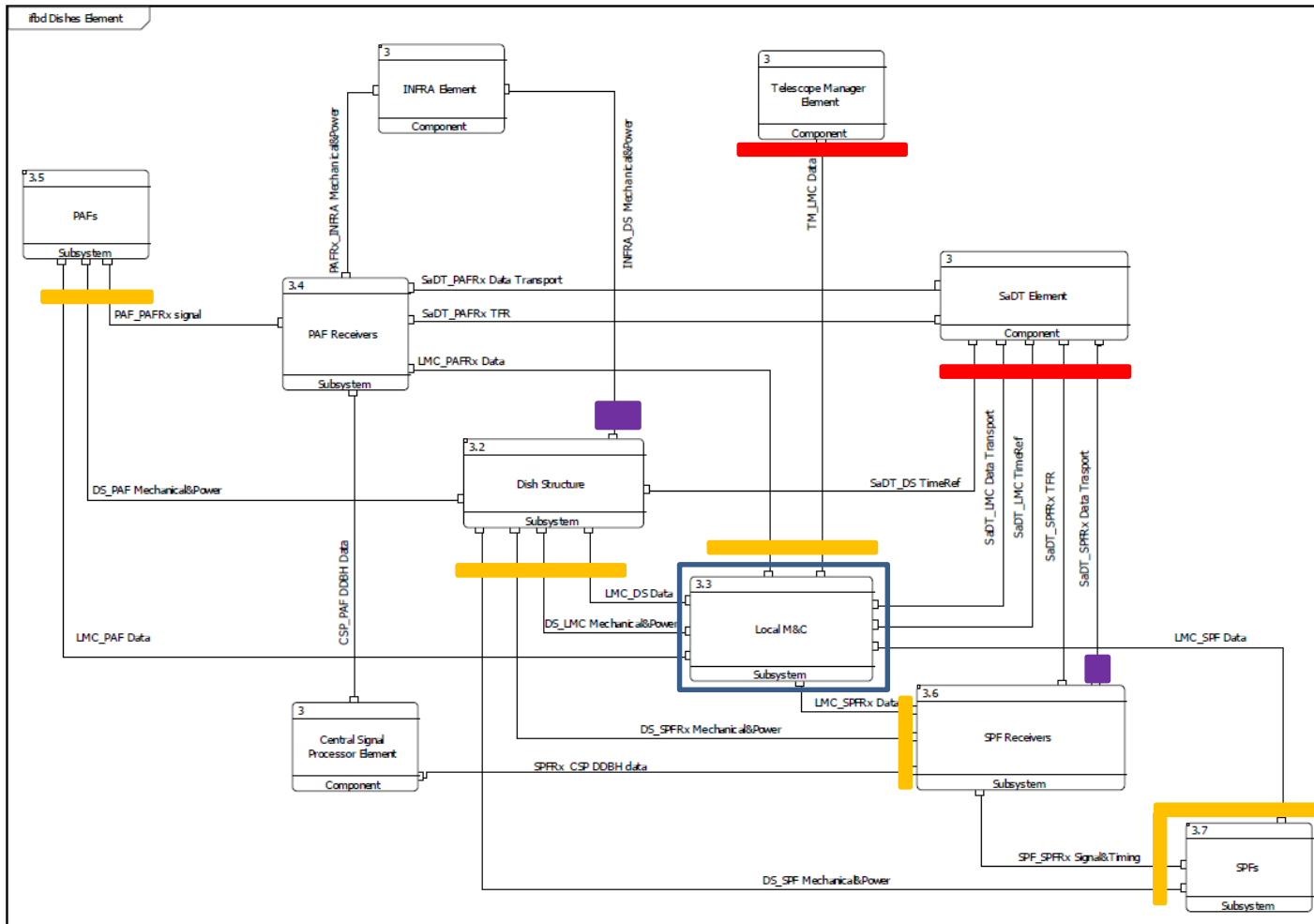
- Digital equipment design
- Signal Processing Development
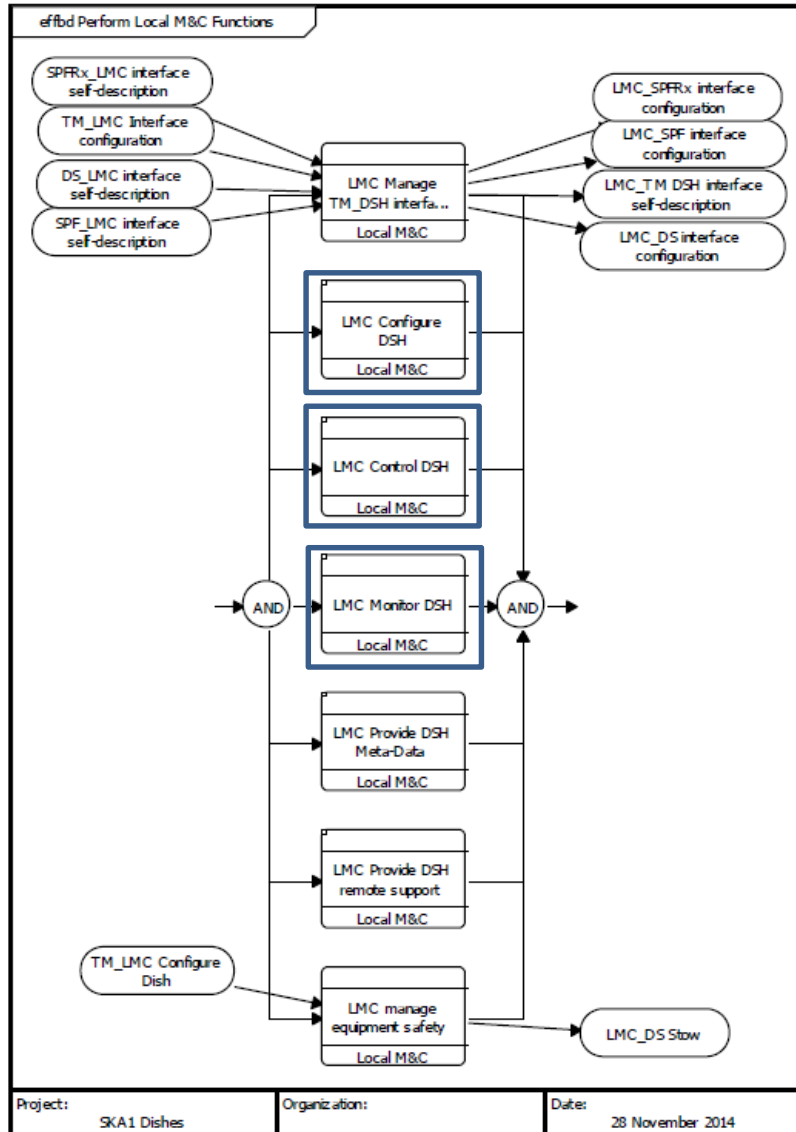
SKA-LOW
DIGITAL PROCESSOR BOARD

MID and Survey

Functional Breakdown

Functional breakdown

The following basic functions shall be implemented by the LMC:

- Managing the TM_LMC interface;

- Configuring all the components of the Dish in preparation for an observation;

- Real-time control of the Dish pointing and Beam forming during an observation;

- Monitoring of all Dish components and reporting of this monitoring information to the Telescope Manager;

- Sending meta-data to the TM that is required for the processing of signals;

- Providing functionality for the remote support of the Dish and all its sub-elements;

- Managing equipment safety;

OPERATING STATES

……from LMC interface guidelines document

4.1.4.4 Operating State

…..the actual internal Operating State is detected/derived/assigned by the Element LMC (or entity controller, for entities within the Element).

- This actual operating state must be mapped to an abstract operating state as defined by the SCM. Each Element will provide its current operating state to TM.
- This will enable TM to generate an aggregated state for the entire SKA telescope.
- Each state corresponds to a set of valid commands.
- Operating States are used by TM (and users) to determine what commands may be sent to the Element, and to monitor and manage their behaviour.
- The Operating State of the Element changes in response to internal events or Commands issued by TM,

it cannot be assigned directly by TM.

OPERATING STATES

INITIALIZING: This is a transient state in which the Element exists when it is starting up its processes, initializing the components, or configuring the sub-elements in order to get ready for use. Element is not ready to perform its function. Initialization may take different time for each Element. During the Element startup, Element may report this state.

SHUTTING-DOWN: This is a transient state in which Element is shutting down its processes, unloading its components, or performing a power off in order to attain a non-operational state. The Element is not available for use in this state.

UNKNOWN: TM is not aware of actual state of Element. This is never reported by the Element, but TM may assign this state when there is no response from the Element. When Element is reporting some state and it stops reporting its state then TM assigns UNKNOWN state to the Element. For example when connectivity is lost.

READY: Implies that the Element is available for use or being used in an observation.

ERROR: An Element reports an 'Error' state when it detects a problem that affects its ability to accept certain commands or execute certain processes/operations.
This could be a transient internal problem, which the Element is not able to recover immediately, or it can be a persistent problem

OFF-DUTY: Special non-operational state in which Entity has been placed to reduce power consumption or improve its resistance to threats and avoid equipment damage. For example, a Dish LMC may report this state when the dish is stowed in the event of high wind/storm.

OFF: This is a Powered off state. This will never be reported by the Element, but TM may assign this state when Element has not reported its state. The Element is not available for use in this state.

OPERATING STATE MACHINE
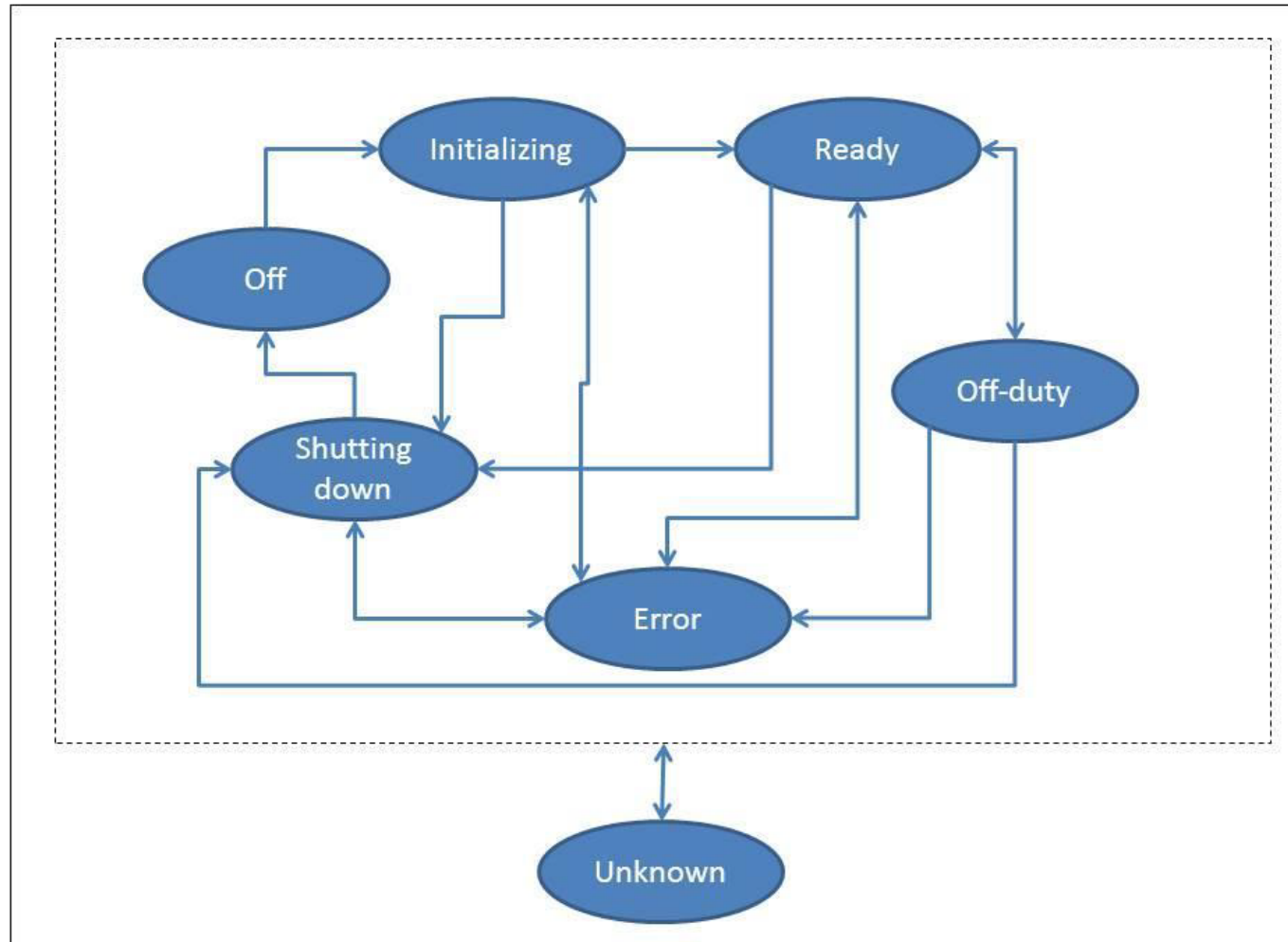
4.1.4.3 Operating Mode

Operating Mode is an engineering concept handled by TELMGT.

- **Operating mode of Element can be set by TM** (when the Element is under Central control)

  or by operator/Engineer remotely using console tools (when the Element is under Local control). This is used to determine what operations may be performed on the Element…….
- Operating Modes facilitate resource allocation, maintaining integrity of control and system status assessment.
- Operating mode is changed usually on user/operator request. User may request mode change on change of state/status or as per observation need.
- Operating Mode is indicative of the operator/engineer intention; it does not reflect the actual status of the equipment.

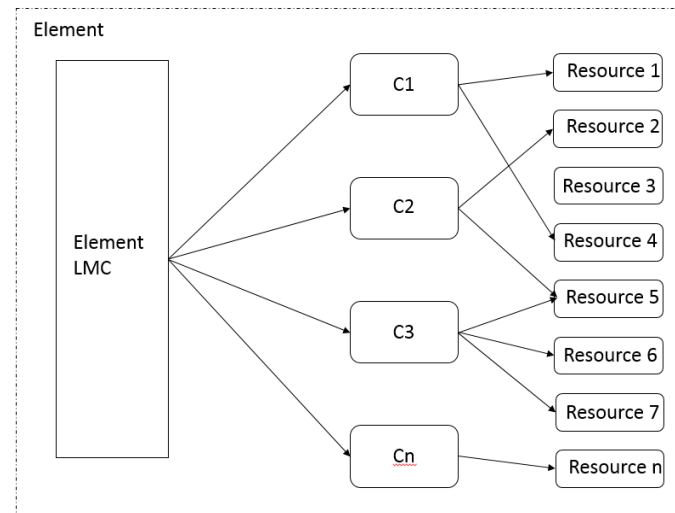For example, Equipment may be Normal and still be taken in Maintenance mode.

Not all modes might be applicable to an Element. Hence, it is not mandatory for Elements to implement all modes.

SKA-MID DISH CAPABILITY

A Capability is a functional grouping that is implemented by an Element.

For example, receive signal at particular frequency band, beam-forming for sub array, continuum imaging for sub array etc.

- Multiple physical and logical internal resources (components e.g. feeds, compute nodes, data buffers, network ports) may be required to deliver a Capability, and the same internal resources may contribute to multiple Capabilities.

- An Element may provide one or more capabilities.

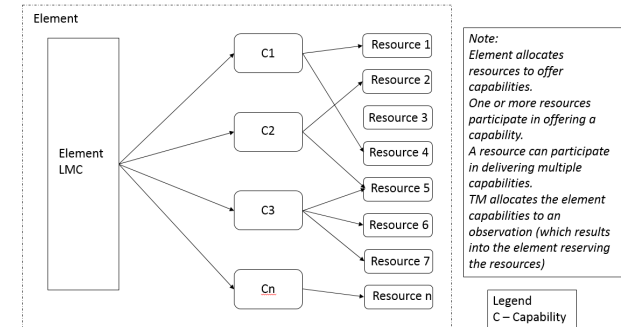- An Element may need certain dependencies to be satisfied in order to deliver certain capabilities.

Element

Element LMC

C1 → Resource 1
→ Resource 2
C2 → Resource 3
→ Resource 4
→ Resource 5
C3 → Resource 6
→ Resource 7
Cn → Resource n

Note:
Element allocates resources to offer capabilities.
One or more resources participate in offering a capability.
A resource can participate in delivering multiple capabilities.
TM allocates the element capabilities to an observation (which results into the element reserving the resources)
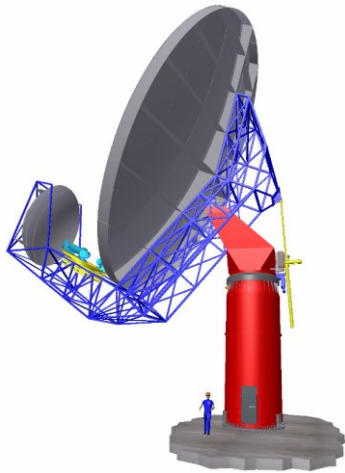
Legend
C – Capability

SKA-MID DISH CAPABILITY

SKA MID DISH CAPABILITY:

	Frequency range (GHz)	Instantaneous bandwidth (GHz)	Sampling rate (GSps)	Total digitized bandwidth (GHz)	Sampling bit depth	Transmit bit depth	Raw data transmit rate (Gbps)
Band 1	0.35 – 1.05	0.700	4	2	8	8	64
Band 2	0.95 – 1.76	0.808	4	2	8	8	64
Band 3	1.65 – 3.05	1.403	3.17	1.585	8[1]	8	50.72
Band 4	2.80 – 5.18	2.38	12	6	4	4	96
Band 5	4.60 – 13.8	2 x 2.5[2]	32	5	3	4[3]	80

Element

Element LMC → C1 → Resource 1, Resource 2, Resource 3, Resource 4

C2 → Resource 4, Resource 5

C3 → Resource 5, Resource 6, Resource 7

Cn → Resource n

Note:
Element allocates resources to offer capabilities.
One or more resources participate in offering a capability.
A resource can participate in delivering multiple capabilities.
TM allocates the element capabilities to an observation (which results into the element reserving the resources)

Legend
C – Capability

SKA MID DISH CAPABILITY EXAMPLE:

BAND5 4.6-13.8 GHz

- **Res1 : DS**
- **Res 1.1 : Indexer**
- **Res 1.2 : Sensors**
- **Res 1.3 : Antenna**
- **Res2 : LMC**
- **Res3 : BAND 5 SPF**
- **Res 3.1: Feed**
- **Res 3.2 :Vacuum Equipment**
- **Res 3.3 :Crio-Cooling Equipment**
- **Res4 : BAND 5 Rx (digitizers, processing)**
- **Res5 : Noise Diode**
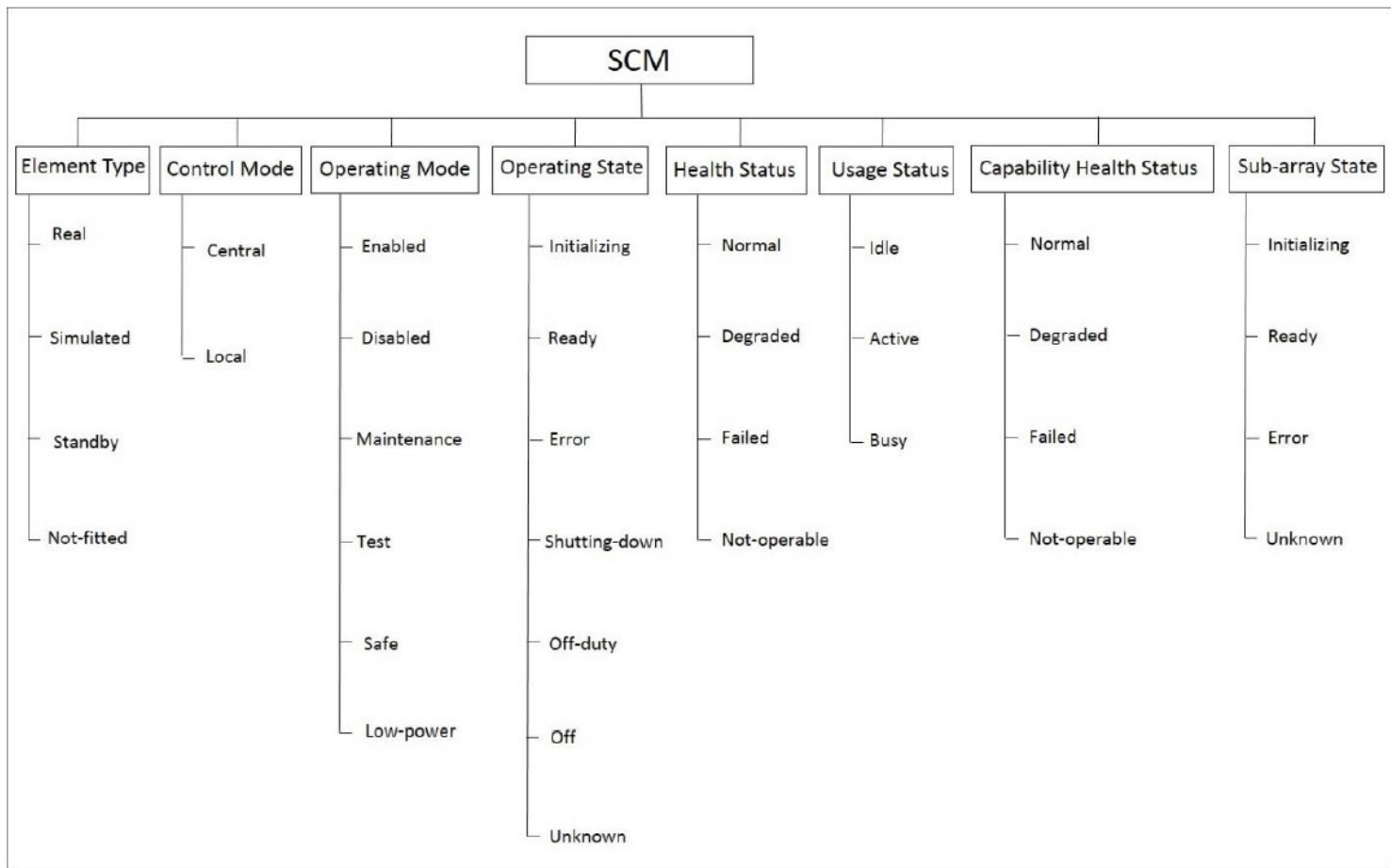
CAPABILITY HEALTH : SCM

Figure 2: SCM Indicators

R.LMC.FMON.10 LMC Report External State	LMC shall report the DSH element external state to TM as per the SKA Control Model, based on the mapping of sub-element states & modes, according to the LMC interface guideline [SKA-TEL-TM-0000031].	R.LMC.FMON.SFW.10 LMC Report External State D.I.M.LMC_SRx.D006 D.I.M.LMC_ SPF.D006

DISH CAPABILITY: MAPPING

Each Dish sub-elements produces a SCM according the SCMs of its controlled resources

DS SCM
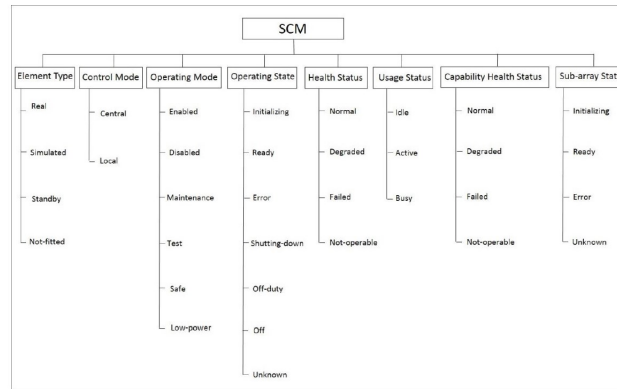
Figure 2: SCM Indicators

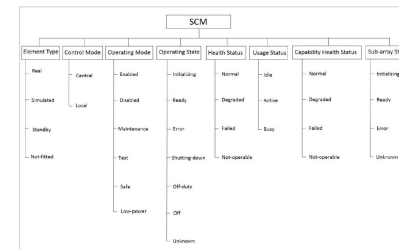## INDEXER SCM

Figure 2: SCM Indicators
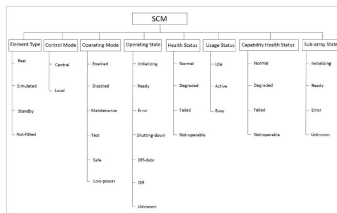
ANTENNA SCM

Figure 2: SCM Indicators

SENSORS SCM

Figure 2: SCM Indicators
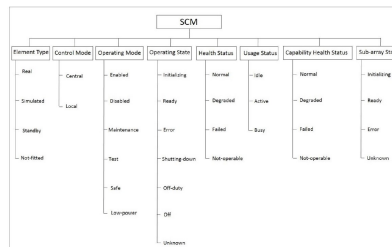
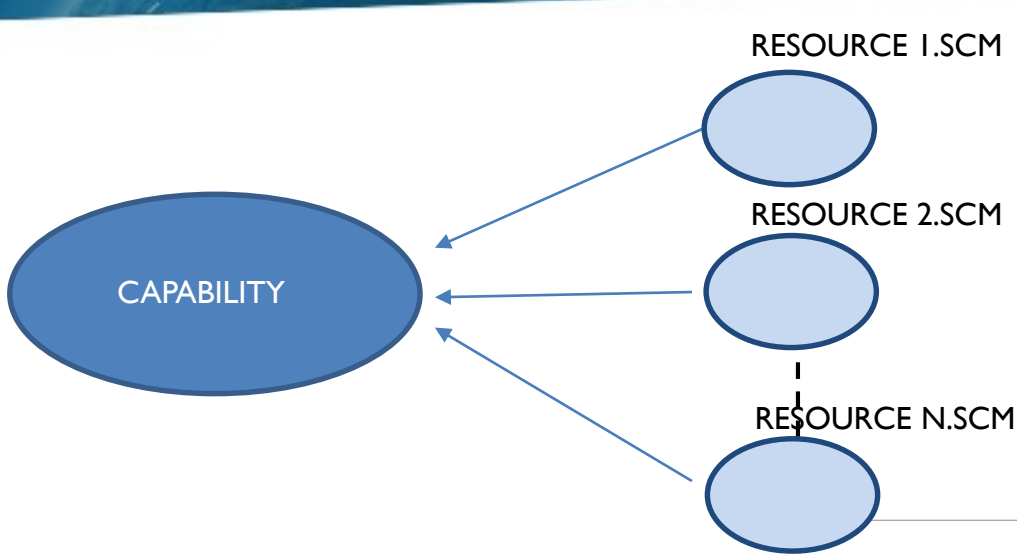# DISH CAPABILITY: MAPPING

RESOURCE 1.SCM

RESOURCE 2.SCM

RESOURCE N.SCM

CAPABILITY

Resource Health Status
- Normal
- Degraded
- Failed
- Not-Operable

Capability Health Status
- Normal
- Degraded
- Failed
- Not-Operable

SCM							
Element Type	Control Mode	Operating Mode	Operating State	Health Status	Usage Status	Capability Health Status	Sub-array State
Real	Central	Enabled	Initializing	Normal	Idle	Normal	Initializing
Simulated	Local	Disabled	Ready	Degraded	Active	Degraded	Ready
Standby		Maintenance	Error	Failed	Busy	Failed	Error
Not-fitted		Test	Shutting-down	Not-operable		Not-operable	Unknown
		Safe	Off-duty				
		Low-power	Off				
			Unknown				

DISH CAPABILITY: MAPPING
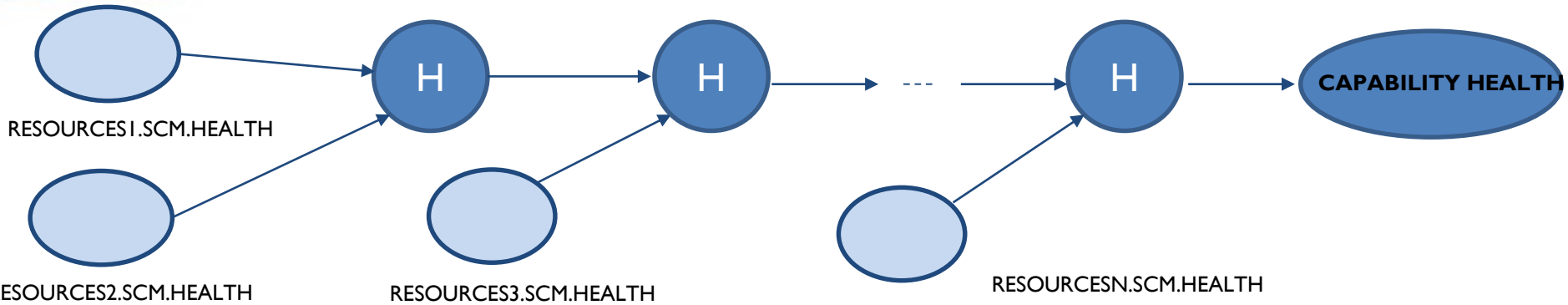
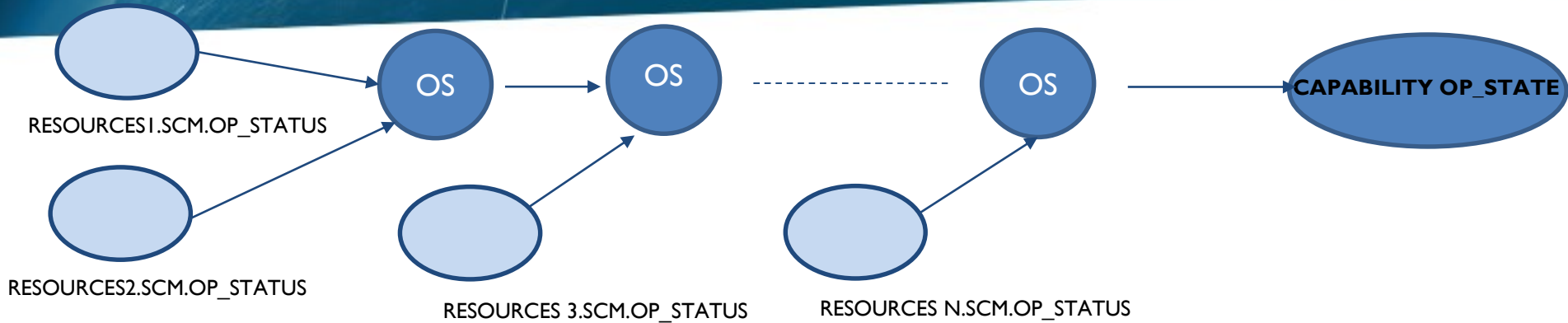| H function	NORMAL	DEGRADED	FAILED	NOT-OPERABLE
NORMAL	NORMAL	DEGRADED	FAILED	NOT-OPERABLE
DEGRADED	DEGRADED	DEGRADED	FAILED	DEGRADED
FAILED	FAILED	FAILED	FAILED	FAILED
NOT-OPERABLE	NOT-OPERABLE	DEGRADED	FAILED	NOT-OPERABLE

LEVEL of HEALTH=h(n)
for nth component

FAILED	4
DEGRADED	3
NOT-OPERABLE	2
NORMAL	1

Capability.Health =max (h(i))
For i=1 to n resources

DISH CAPABILITY : STATES

RESOURCES1.SCM.OP_STATUS

RESOURCES2.SCM.OP_STATUS

OS → OS ----------------- OS → **CAPABILITY OP_STATE**

RESOURCES 3.SCM.OP_STATUS

RESOURCES N.SCM.OP_STATUS

OS function	Init	Ready	Error	ShutD	Off-Duty	Off	Unknown
Init	Init	Init	Error	ShutD	Off-Duty	Off	Unknown
Ready	Init	Ready	Error	ShutD	Off-Duty	Off	Unknown
Error	Error	Error	Error	Error	Error	Error	Error
ShutD	ShutD	ShutD	Error	ShutD	ShutD	Off	Unknown
Off-Duty	Off-Duty	Off-Duty	Error	Off-Duty	Off-Duty	Off	Unknown
Off	Off	Off	Error	Off	Off	Off	Unknown
Unknown	Unknown	Unknown	Error	Unknown	Unknown	Off	Unknown

LEVEL of STATE= **s**

Error	7
Unknown	6
Off	5
Off Duty	4
ShutD	3
Init	2
Ready	1

ORDERE BY DESCENDING SEVERITY LEVEL

Capability.OpState=max(s(i))

STATES MAPPING

DSH SCM

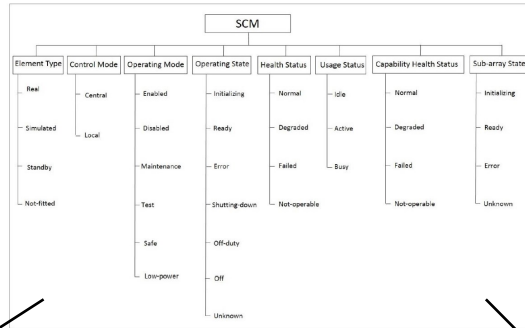DS SCM

SPF SCM   RX SCM   LMC SCM

Figure 2: SCM Indicators

INDEXER SCM

ANTENNA SCM

SENSORS SCM

Each Dish sub-elements produces a SCM according the SCMs of its controlled sub-systems, and transmit to upper level.

Overall STATE is calculated by the formula OpState=max(s(i))

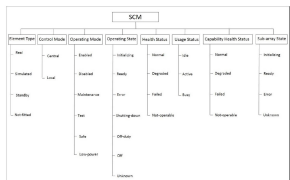Mode is set by TM, and shall be verified only if it is compliant with STATE and equipment operativity.
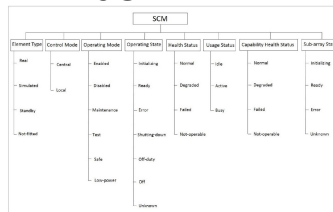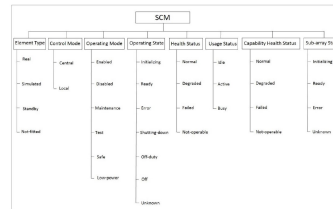
Figure 2: SCM Indicators

Figure 6 DSH States and Modes

SKA-MID DISH CAPABILITY

SCM functionalities

Capability Status

«block»
CAP
(320-020600)

«block»
SCM
320-020601

«block»
CAP MANAGER
320-020602

«block»
SCM MAPPER
320-020601.01

«block»
DSH SM MAPPER
320-020601.02

«block»
SCM SUBEL MANAGER
320-020601.03

«block»
CONFIG
320-020602.01

«block»
HEALTH
320-020602.01

Functionalities responsible for map the SCM of Sub-el into a SCM for Sub-element and Capability

Functionalities responsible for map the SCM of Sub-el into a DISH State and Mode map

Functionalities responsible for manager the SCM of Sub-elements

Functionalities responsible for Capability Configuration

Functionalities responsible for Capability and Element's health

THANKS!