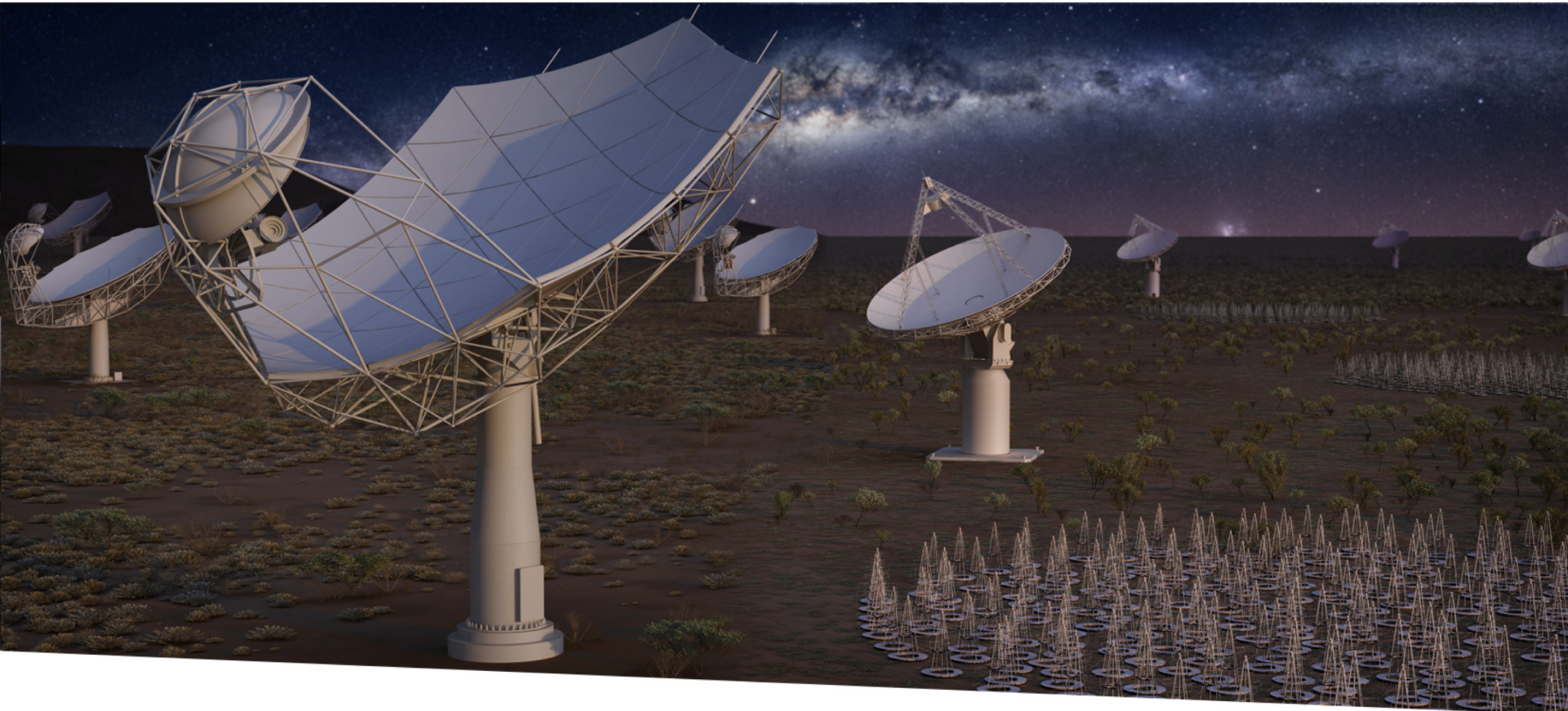# The SKA Control System

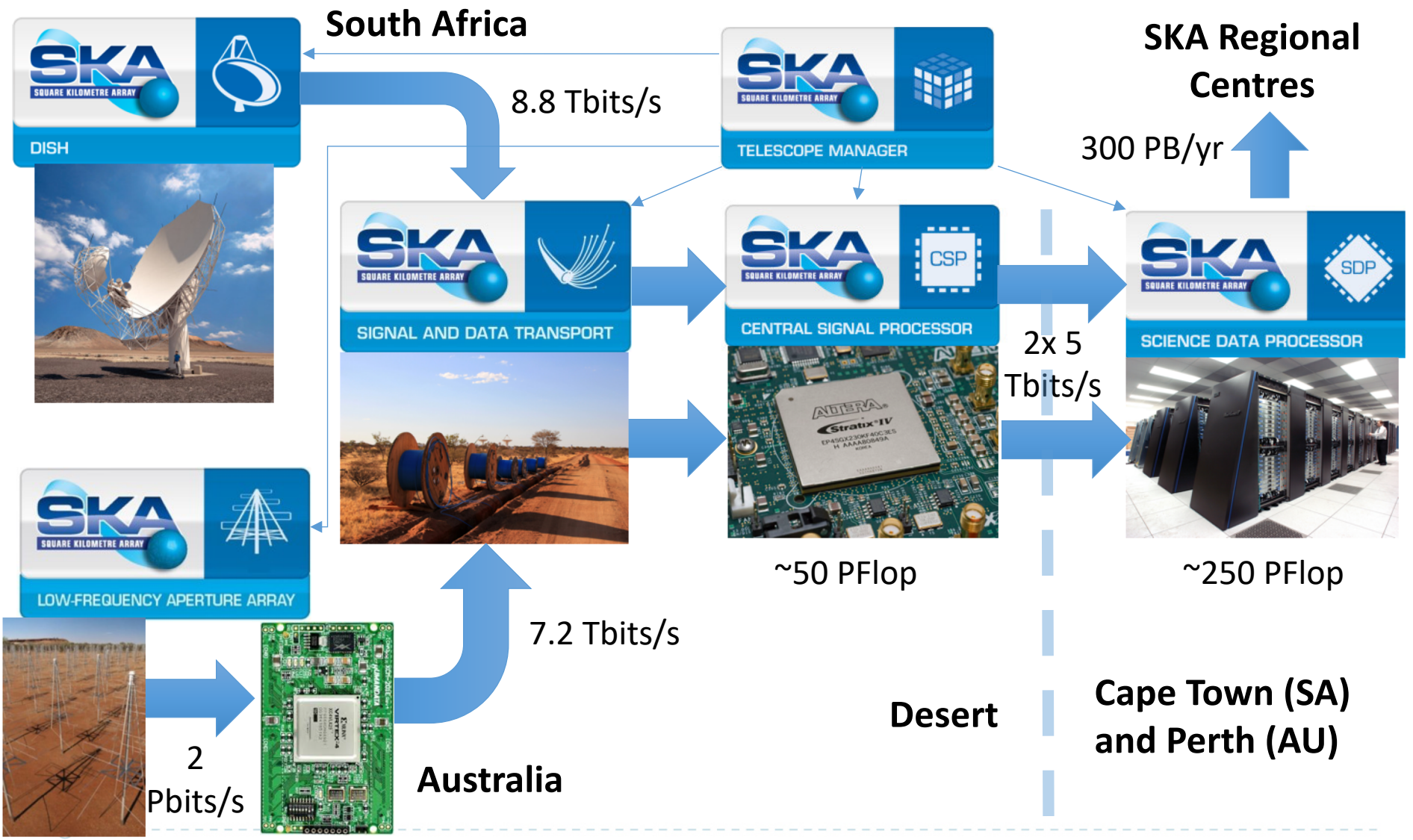**SQUARE KILOMETRE ARRAY**

Exploring the Universe with the world's largest radio telescope

Lorenzo Pivetta

5 April 2018

The System

South Africa

SKA Regional Centres

DISH

TELESCOPE MANAGER

8.8 Tbits/s

300 PB/yr

SIGNAL AND DATA TRANSPORT

CENTRAL SIGNAL PROCESSOR

SCIENCE DATA PROCESSOR

2x 5 Tbits/s

~50 PFlop

~250 PFlop

LOW-FREQUENCY APERTURE ARRAY

7.2 Tbits/s

Desert

Cape Town (SA) and Perth (AU)

2 Pbits/s

Australia

Computing

- ~25 PetaFLOPS/sec total sustained

- ~200 PetaByte/s aggregate bandwidth to fast working memory

- ~50 PetaByte fast working storage

- ~1 TeraByte/s sustained write to storage

- ~10 TeraByte/s sustained read from storage
    - ~ 10000 FLOPS/byte read from storage

- Current power cap proposed is ~5MW per site

Science data – Not related to control system

Telescope Manager
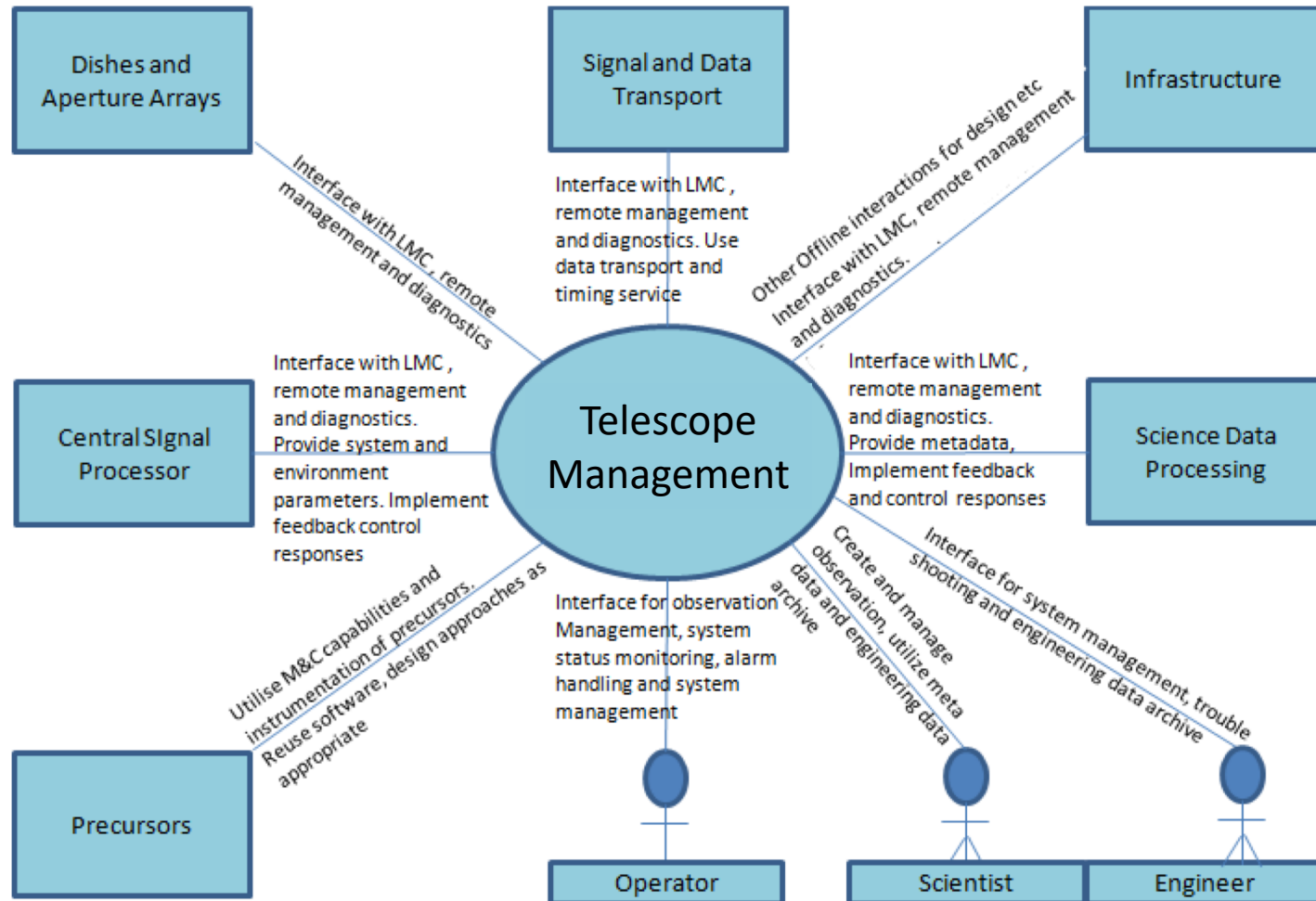
How TANGO

- LMC standardization workshop – 25-27 Mar 2015 - INAF-OATS – Trieste
  - *"The goal of the meeting is to define the criteria and process for selection of the common LMC platform (technology, framework, approach, method) to be used by all SKA Elements..."* **-> TANGO**

- TANGO LMC harmonisation through telescopes – 16-18 Feb 2016 – INAF-OATS+SKAO – Trieste
  - *"Building on the outcome of the LMC Standardization… aims to provide a path to LMC harmonization, beyond the selection of TANGO as a control system framework..."*

- LMC Harmonisation through telescopes: LMC peer review meeting 1 – 11-13 Apr 2016 – SKAO – Madrid
  - *"..the SKA community involved in Monitoring and Control supported and ratified the proposed path to have an harmonised MC system across all the SKA, through the evaluation of the Local Monitoring & Control implementations of the different SKA elements designs."*

- LMC Harmonisation through telescopes: LMC peer review meeting 2 - 4-6 Jul 2016 – SKAO-Edinburgh
  - *"...reports on the LMC architecture for LFAA and TM, together with an update from CSP, and the different task-groups from the ANT team."* -> **SKA Control System Guidelines**

CS Guidelines

A set of three main documents:

- SKA1 Control System Guidelines – Main volume

- SKA1 TANGO Developers Guidelines

- SKA1 TANGO Naming Convention

plus six additional technical notes, at various levels of completion:

- SKA Control Model

- SKA Logging

- SKA Configuration and Control

- Integrating Distributed TANGO Facilities

- Element Archiving and Central Archiving

- Element and Central Alarms Handling

making a total of some 330 pages (well... that's not so bad... and you can start with just 120)

SKA Control System Guidelines made possible by the contribution of a group of people.

Intended to be working documents -> evolve with the project.

Purpose

Control System harmonization across SKA

- Identify common approaches for Monitoring and Control

- Identify and summarize generic design patterns

- Identify proper TANGO design patterns

- Avoid TANGO anti-patterns

- Maximize the benefits of the TANGO framework

- Identify and draft preferred SKA Control System general architecture (with TANGO)

- Setup templates for Interface Control Documents

- Define guidelines for SKA TANGO developers

SKA TANGO facilities

- SKA telescope in fact made by two telescopes: MID and LOW

- Each telescope made by a number of different "Elements": DISH, CSP, SDP, INFRA, LFAA, SAT, TM... some belong to MID, some to LOW

- Each Element will be responsible of one or more TANGO facilities

Facility	Description	Facility	Description
SKA-MID	Central Telescope Manager for MID	SKA-LOW	Central Telescope Manager for LOW
MID-CSP	Central Signal Processing for MID	LOW-CSP	Central Signal Processing for LOW
MID-SDP	Science Data Processor for MID	LOW-SDP	Science Data Processor for LOW
MID-Dnnnn	One for each dish, 170 SKA1, ~2500 SKA2	LOW-LFAA	Low Frequency Aperture array
MID-SAT	Synchronization And Timing for MID	LOW-SAT	Synchronization And Timing for LOW
MID-SADT	Signal and Data Transport for MID	LOW-SADT	Signal and Data Transport for LOW
MID-INFRA-SA	Infrastructure SA	LOW-INFRA-AU	Infrastructure AU
MID-Mnn	MeerKAT precursor receptors (64)	LOW-ASKAP-WSS	ASKAP precursor ancillary
MID-MKAT-ANC	MeerKAT ancillary		

Element M&C

Element Monitoring and Control scope and responsibilities have been defined with respect to Central Telescope Manager:

- Standalone Element TANGO facility **top level hierarchy** for TANGO devices

- Control System pattern for operational control in normal use

- Control System pattern for rolled-up monitoring and reporting

- Archiving patterns

- Logging patterns

- Rolled-up SKA alarms reporting

- Drill-down diagnostics and monitoring

- Template for TANGO based TM-<Element> Interface Control Document (ICD)
  Capture logical Element to TM interface for operational control and rolled-up monitoring

SCM state(s) and mode(s)

SKA Control Model (SCM) state/mode Attributes and TANGO State

- Design pattern to define a set of "standard" common states and modes: **SCM Attributes**

- Mandatory SCM interactions specified as well

Name	R/W	Mem	Opt	Values
TANGO State	n	n	n	UNKNOWN, OFF, INIT, DISABLE, STANDBY, ON, ALARM, FAULT
obsState	n	n	y	IDLE, CONFIGURING, READY, SCANNING, PAUSED, ABORTED, FAULT
adminMode	y	y	n	ONLINE, OFFLINE, MAINTENANCE, NOT_FITTED, RESERVED
healthState	n	n	y	OK, DEGRADED, FAILED, UNKNOWN (mandatory for some devices)
obsMode	n	n	n	IDLE, IMG_CONTINUUM, IMG_SPECTRAL_LINE,...
controlMode	y	y	n	REMOTE, LOCAL
simulationMode	y	y	n	TRUE, FALSE
testMode	y	y	n	NONE, custom values
configProgress/ delayExpected	n	n	y	Percentage progress/ Time for CONFIGURING → READY transition

SCM interactions

- **healthState**
  - Interpreted based on children and own device State, adminMode, healthState
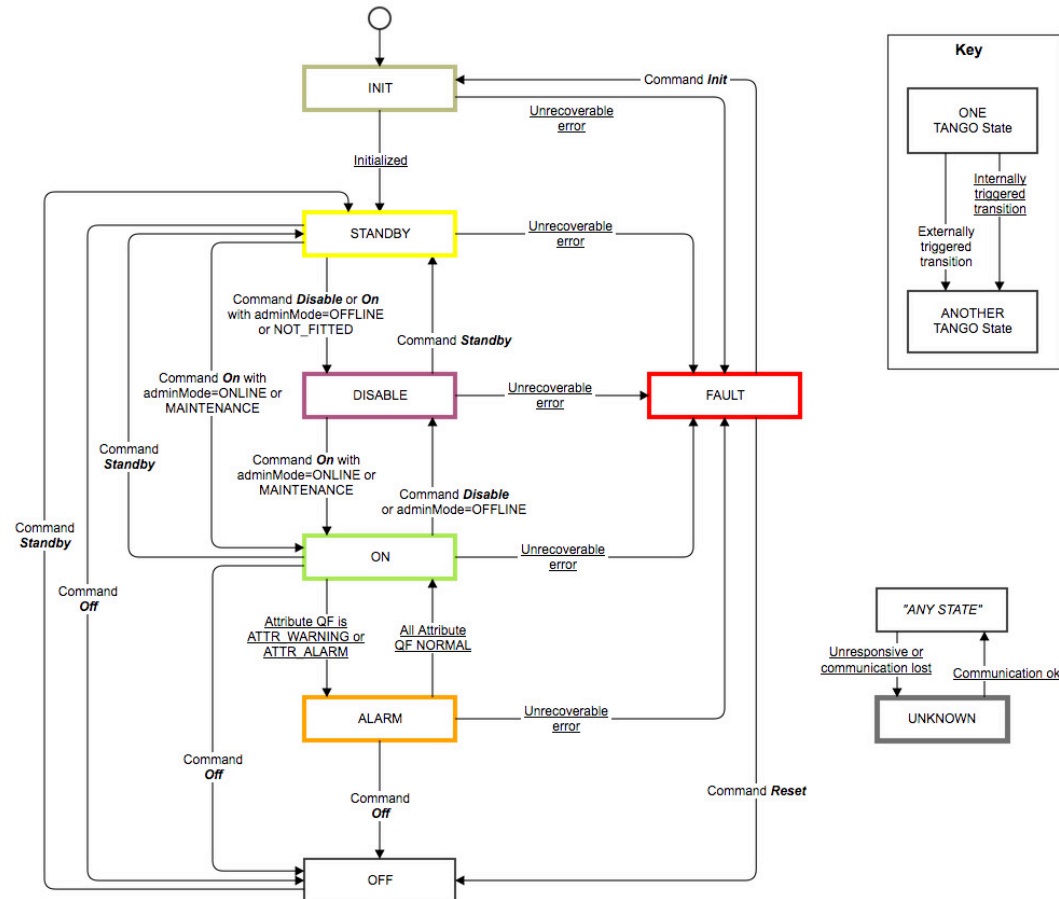 - ...

- **adminMode**
  - When adminMode is NOT_FITTED, TANGO State shall be DISABLE
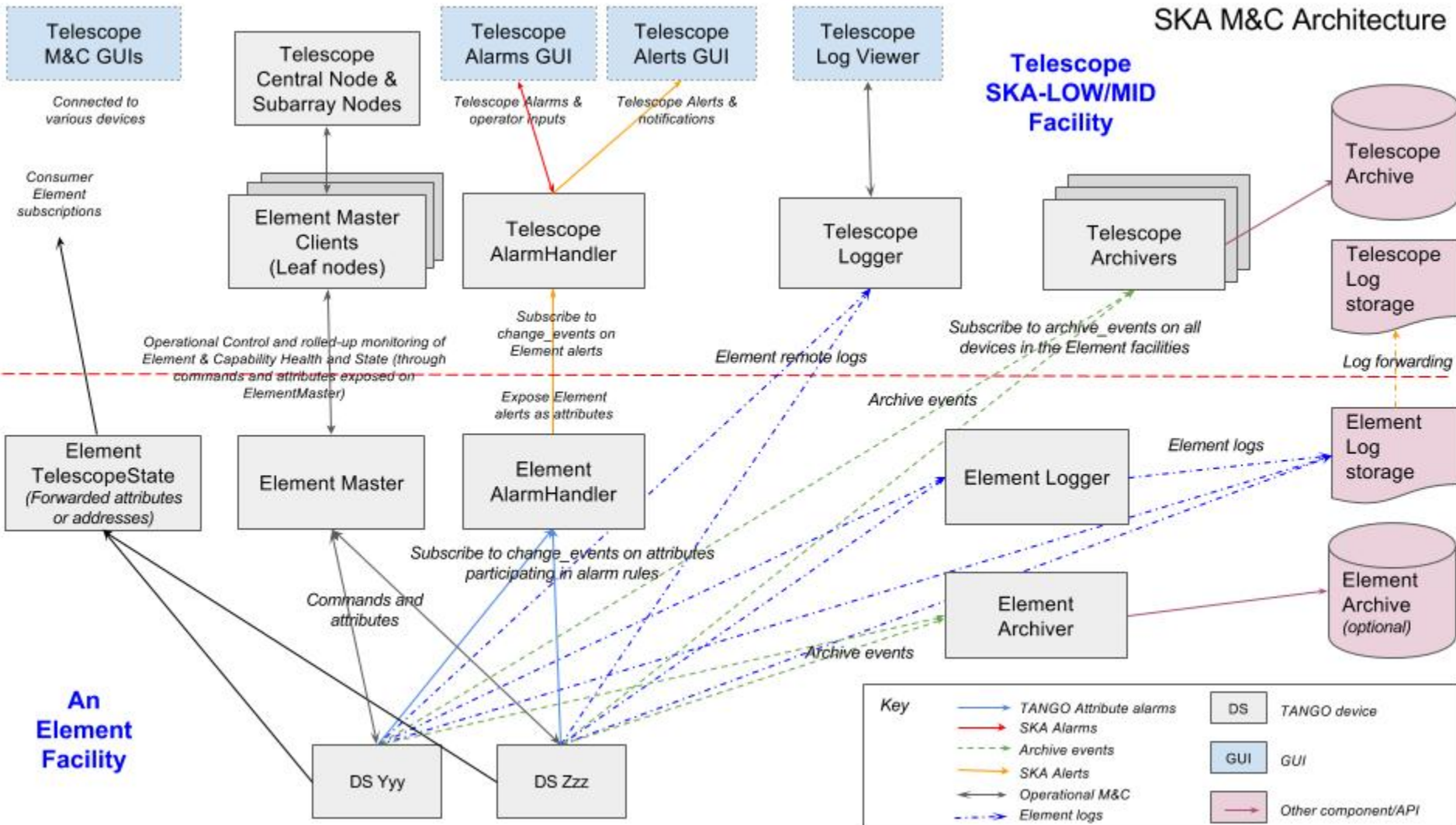 - When adminMode is RESERVE, TANGO State shall be DISABLE

  Rationale: prevent TANGO devices from raising Attribute alarms when devices off-duty

- **State** (TANGO State)
  - Equipment, i.e. devices shall power-up in STANBY State
  - TANGO State may be DISABLE for other reasons than those related to adminMode

Integrating TANGO facilities

Integrating TANGO facilities

Patterns and policies defined for:

- ElementMaster TANGO device
    - Element entry point for operational monitoring and control
    - Provide "Element level" FQDNs

- Logging services
    - TANGO Logging Service: in-time monitoring of log messages
        - ElementLogger/TelescopeLogger TANGO devices
            - ElementLogger: LogConsumer interface for Element-wide logs
            - TelescopeLogger: LogConsumer interface for Telescope-wide logs
    - Rsyslog + Elastic Search stack: log storage for fault finding and forensics
        - TANGO rsyslog device (Log4Cxx, Boost.log)

- Element AlarmHandler/Telescope AlarmHandler TANGO devices
    - Element level aggregation via formulas → provide just relevant alarms

- Element Archiver/Telescope Archiver TANGO devices
    - Element archiving → HDB++ featuring MariaDB backend (optional)
    - Telescope archiving → HDB++ featuring Cassandra backend

SKA TANGO developers guideline

Design Guidelines for the TANGO developers cover various aspects, including:

- Element and Device modeling
- Device Class documentation
- TANGO configuration database
- Device implementation aspects, including:
    - Device states and modes Polling and events Attributes
    - Attribute alarms
    - Quality factor
    - Attribute archiving
    - Unsolicited information / command progress
    - Configuration
    - Device locking
    - Commands provided by TANGO
- Naming conventions for commands, attributes, properties
- Standard commands foreseen for "Element Level" devices

SKA device naming convention

- Device names globally unique within the observatory

- Centralized management of SKA device names

- Naming for SKA TANGO facilities defined

- Naming for SKA TANGO devices defined
  - Avoid "." (dot) and "-" (dash) in device name

- Controlled number of SKA TANGO device domains (as in <domain>/<family>/<member>)

SKA TANGO base classes

- Under development (prototyping)

- SKA Base Device Class
- SKA Capability Device Class
- SKA Logger Device Class
- SKA Master Device Class
- SKA Subarray Device Class
- SKA TelescopeState Device Class

Thanks

Questions?