

SKA Low Frequency Aperture Array LMC

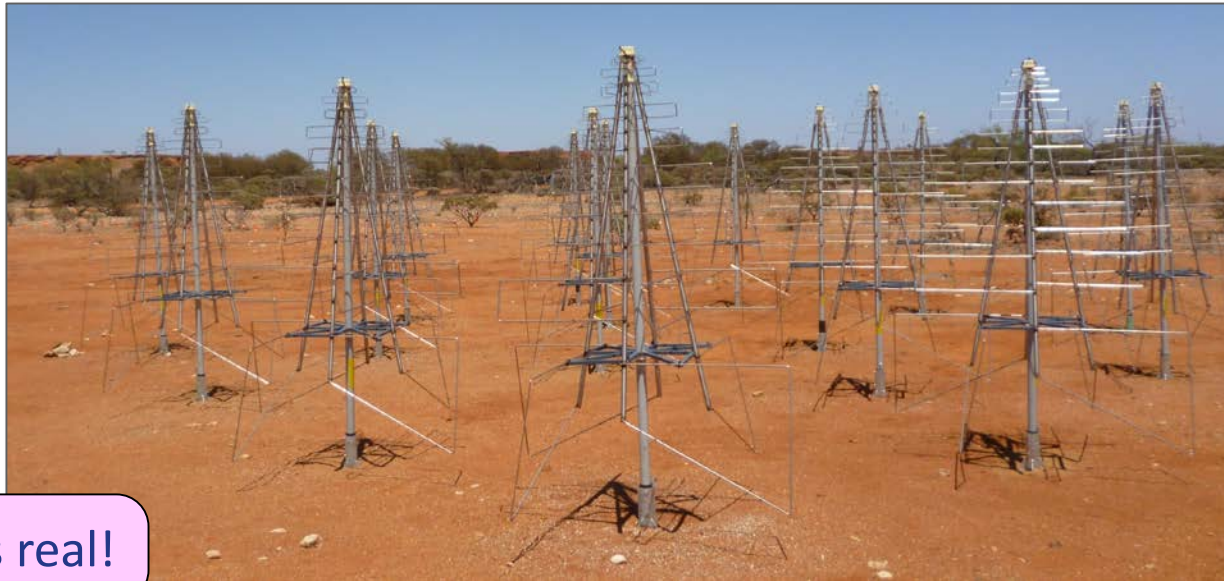
A.J. Faulkner
K. Zarb-Adami



SKA1-low requirements (after RBS)

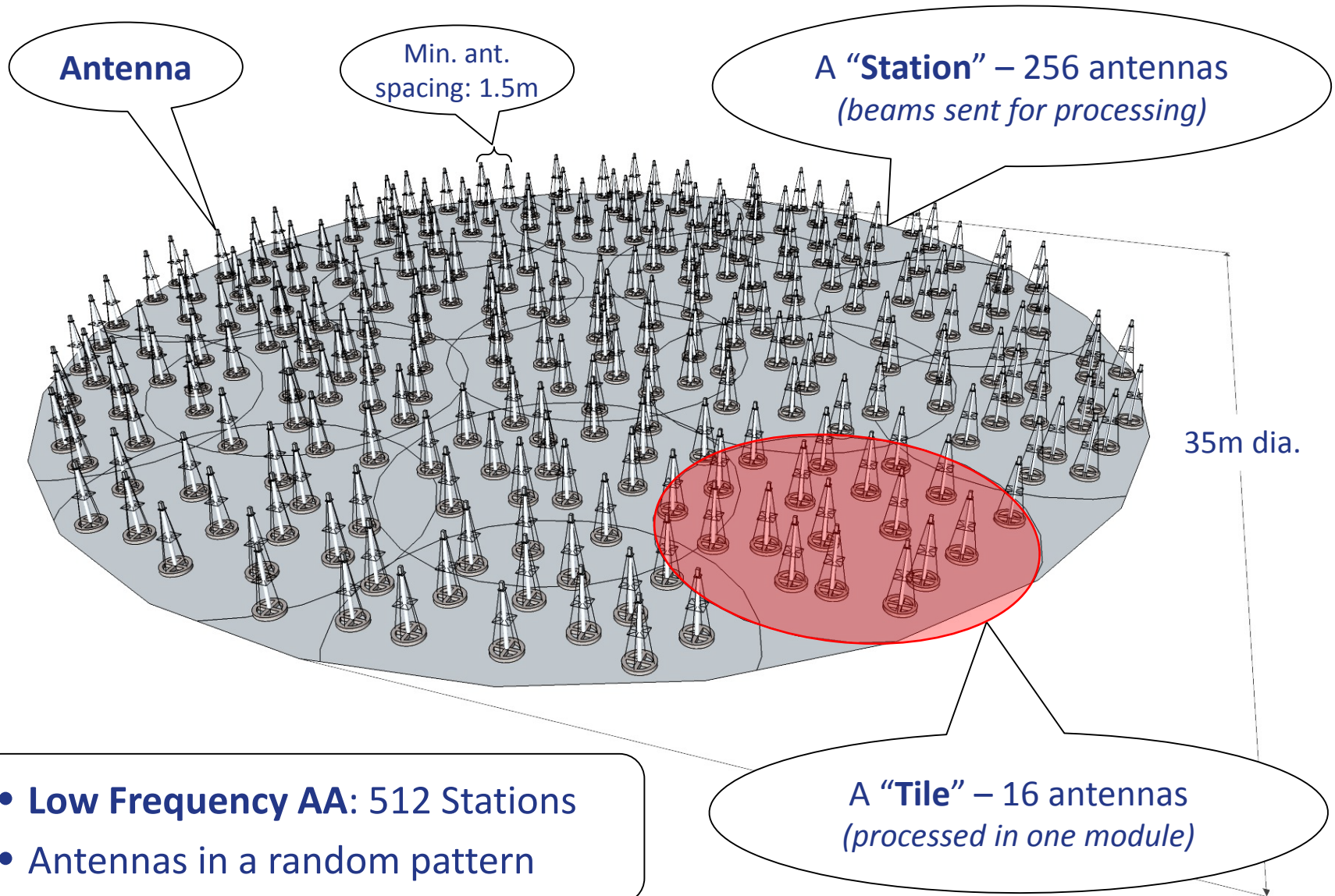
Frequency: 50MHz – 350MHz
Bandwidth: 300MHz
Sensitivity : 500m²/K (110–350MHz)
Polarisation: Dual (of good quality)
Beam size: >5° (no beam stitching)
Stations: 512

Scan angle: >45°
of beams: >5
Configuration: 50% <600m radius
(TBC) 75% <1km radius
95% <3km radius
3 spiral arms of 40km
Data rate: ~7.5Tb/s (total)



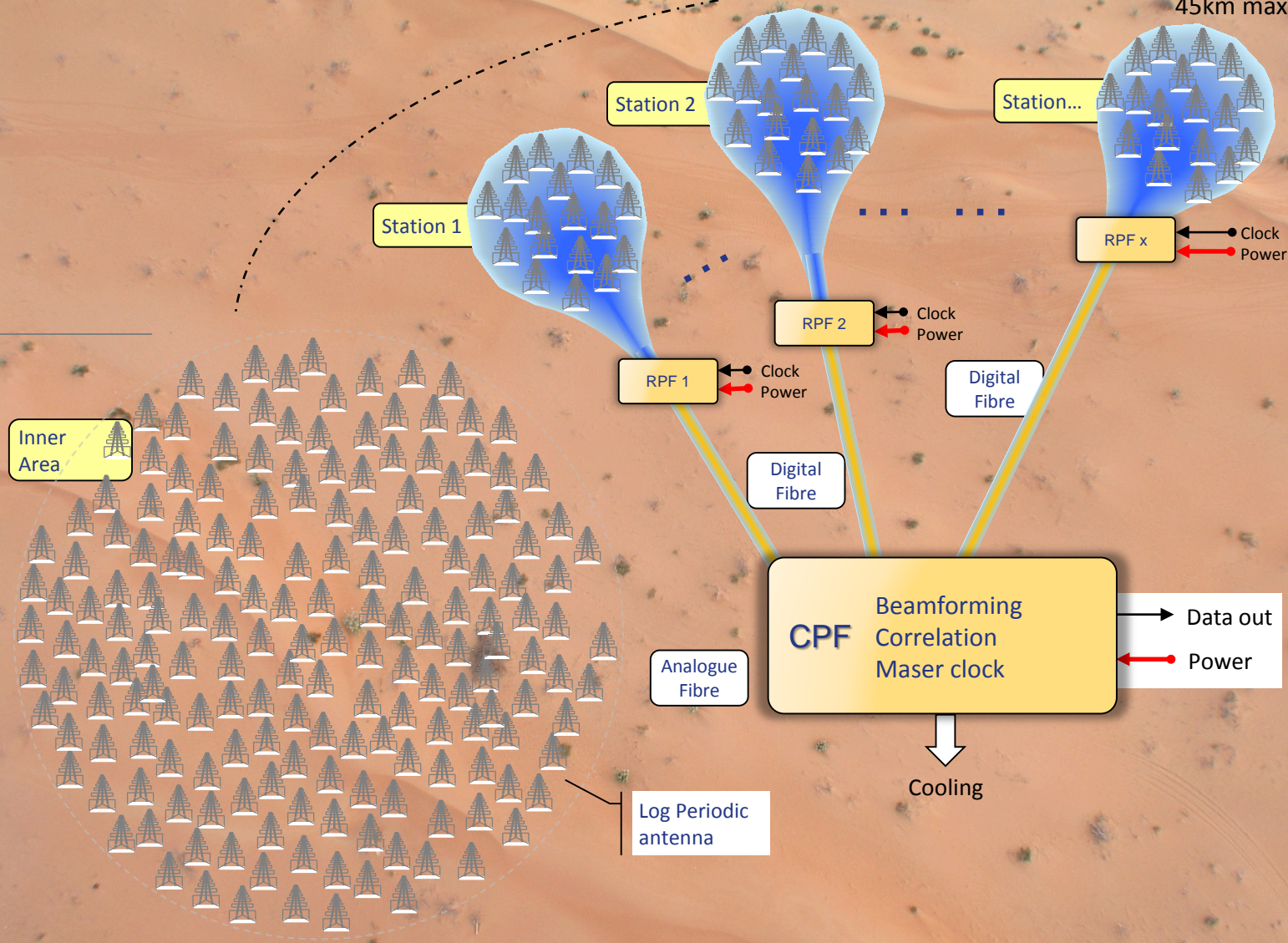
This is real!

Some definitions...

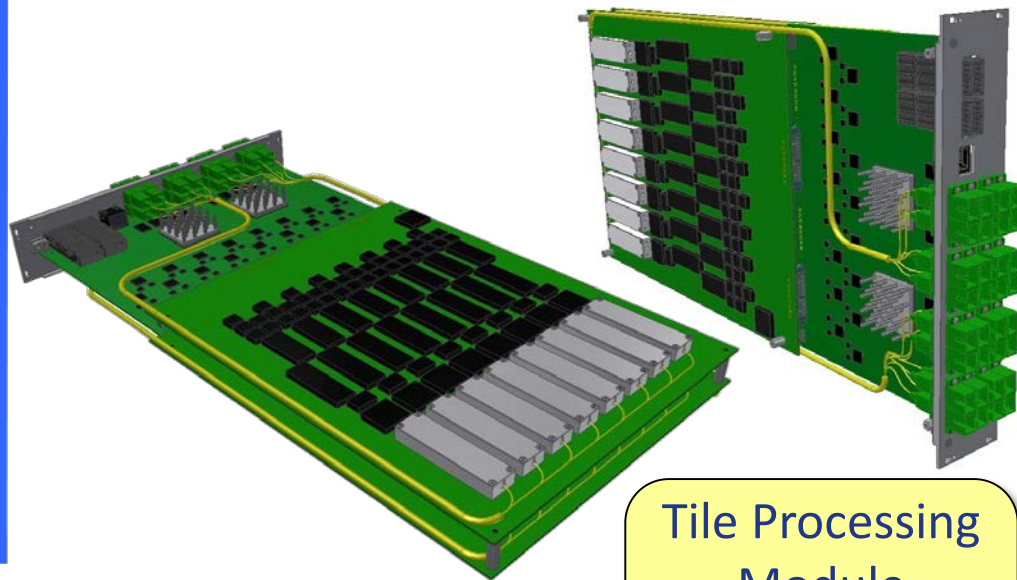
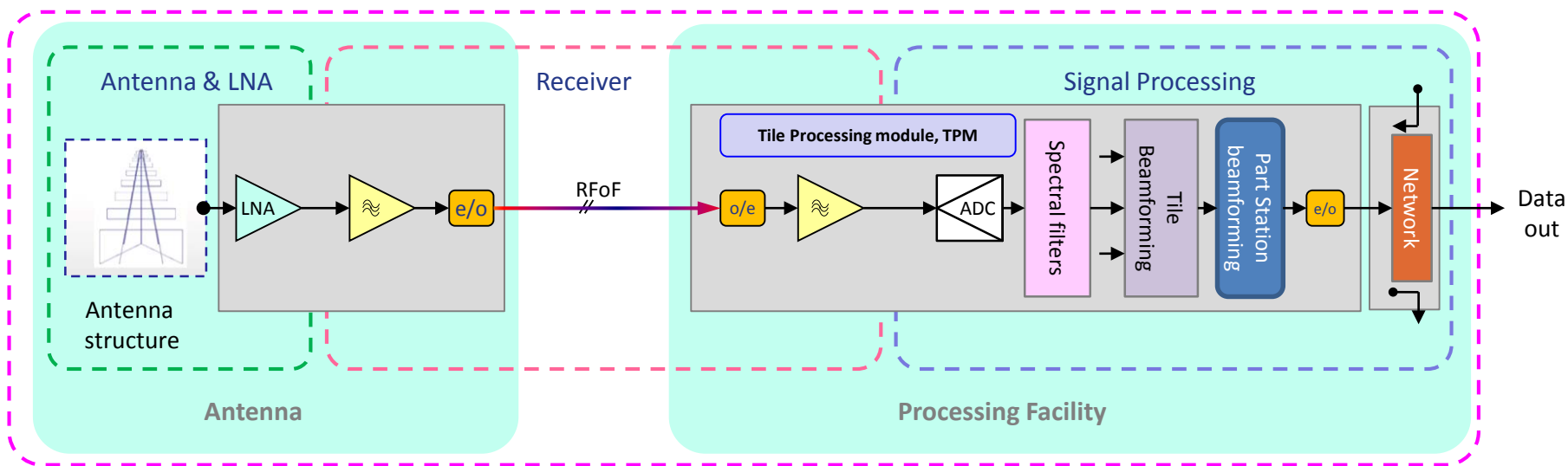


6km

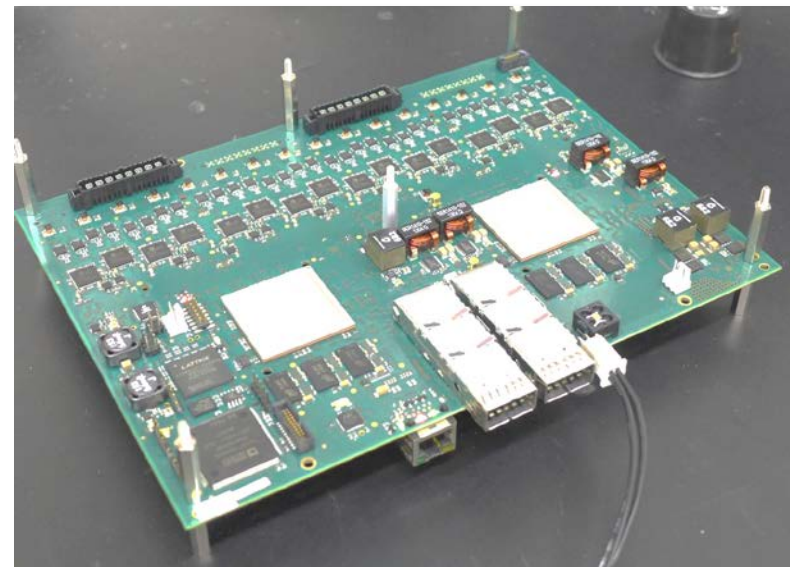
Distance
45km max.



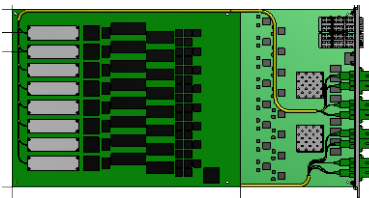
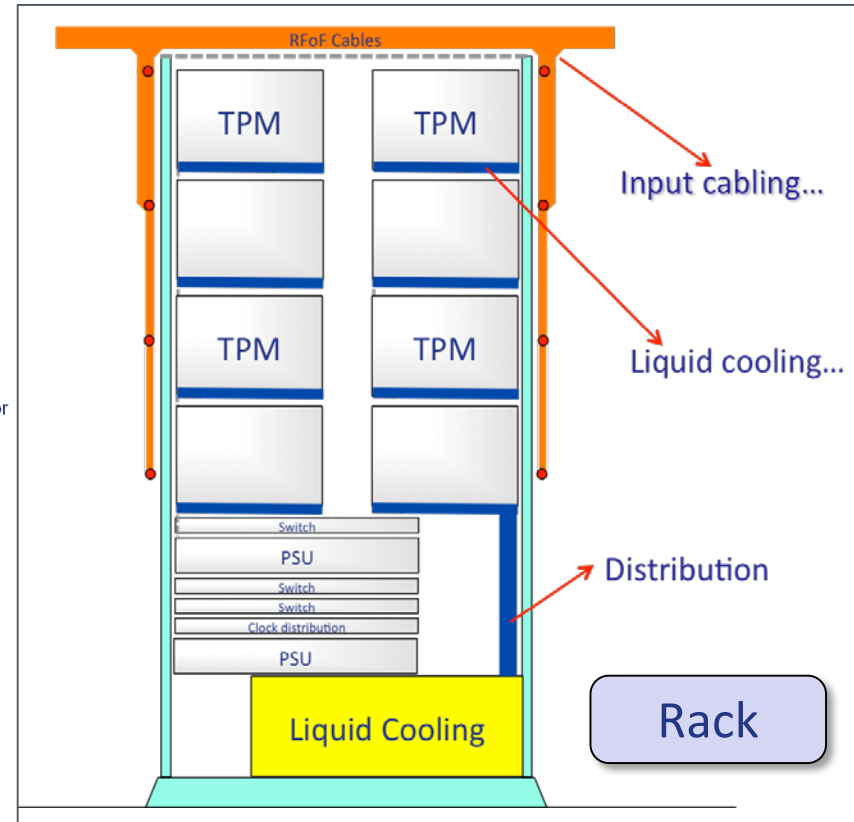
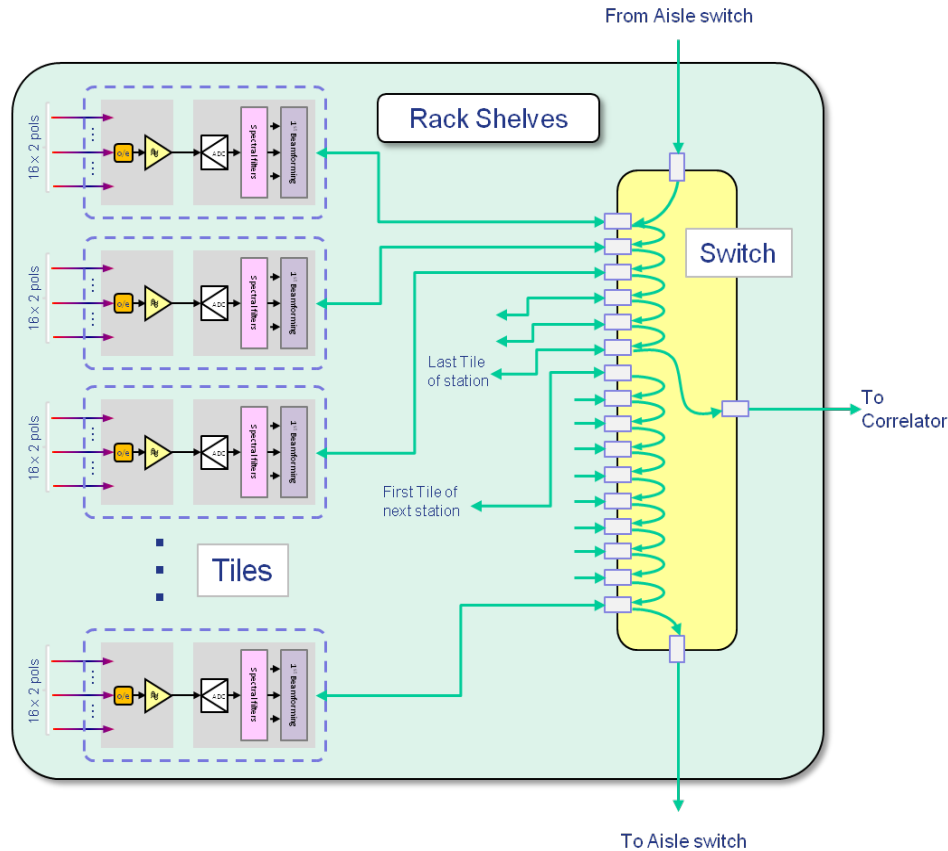
LFAA signal path:



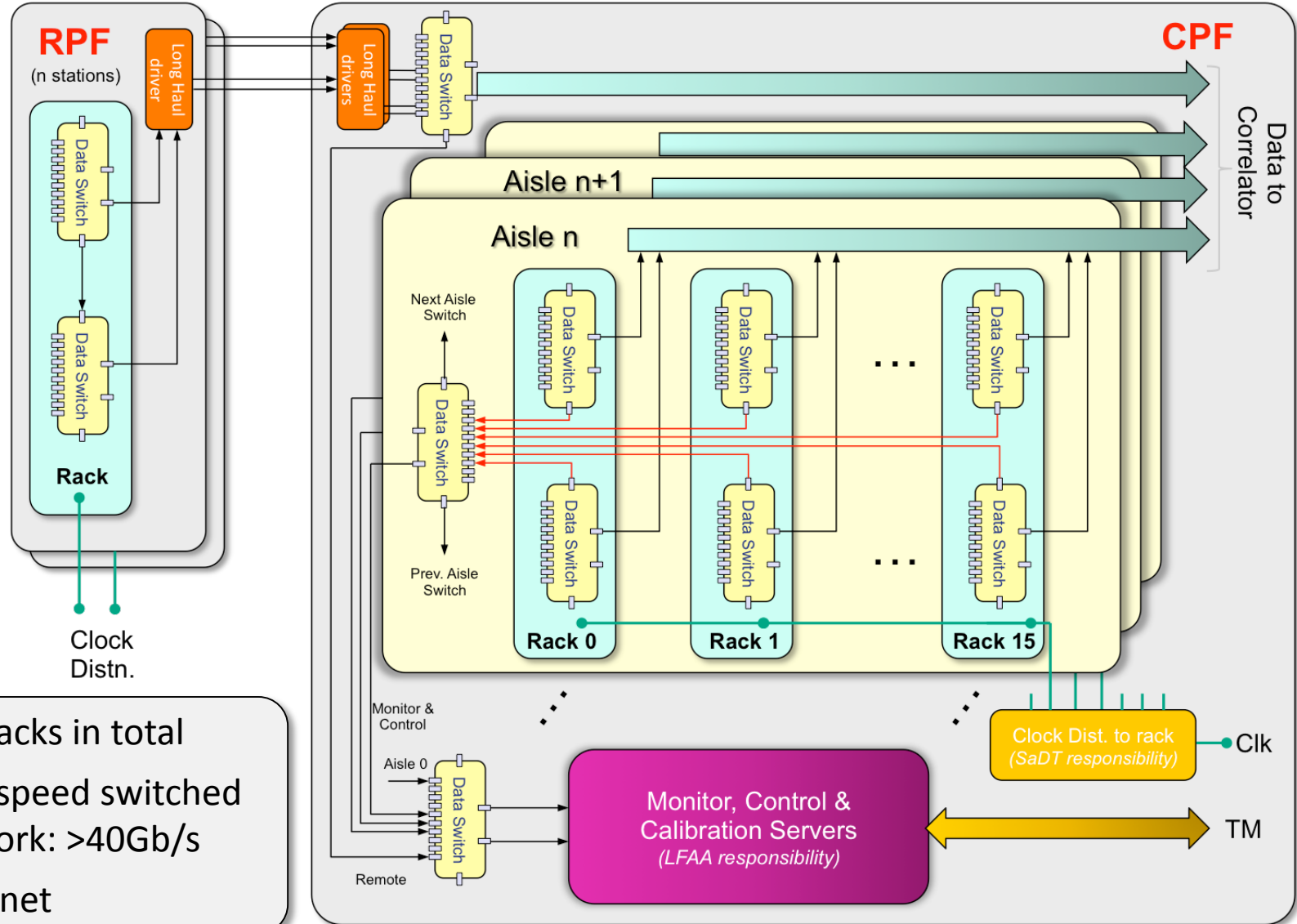
Tile Processing Module



Linking to switched network



LFAA Data Network

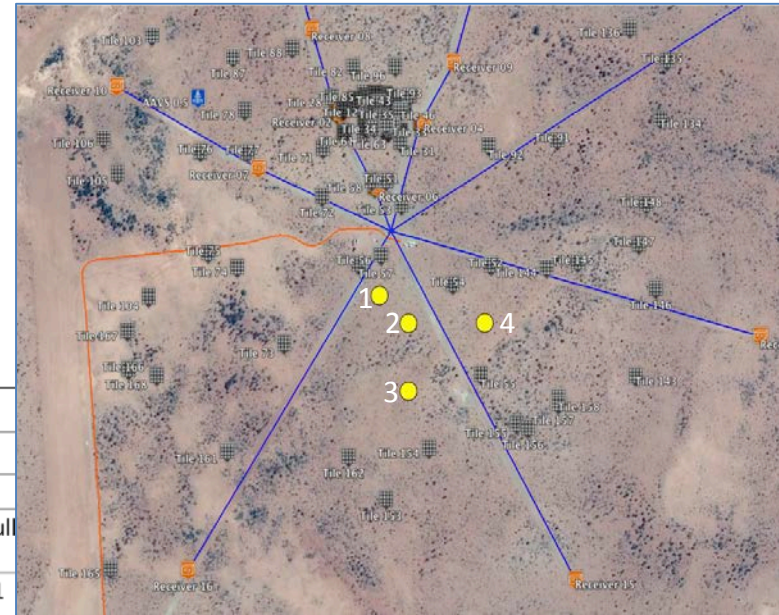


AAVS1 – Verification System (2015-16)

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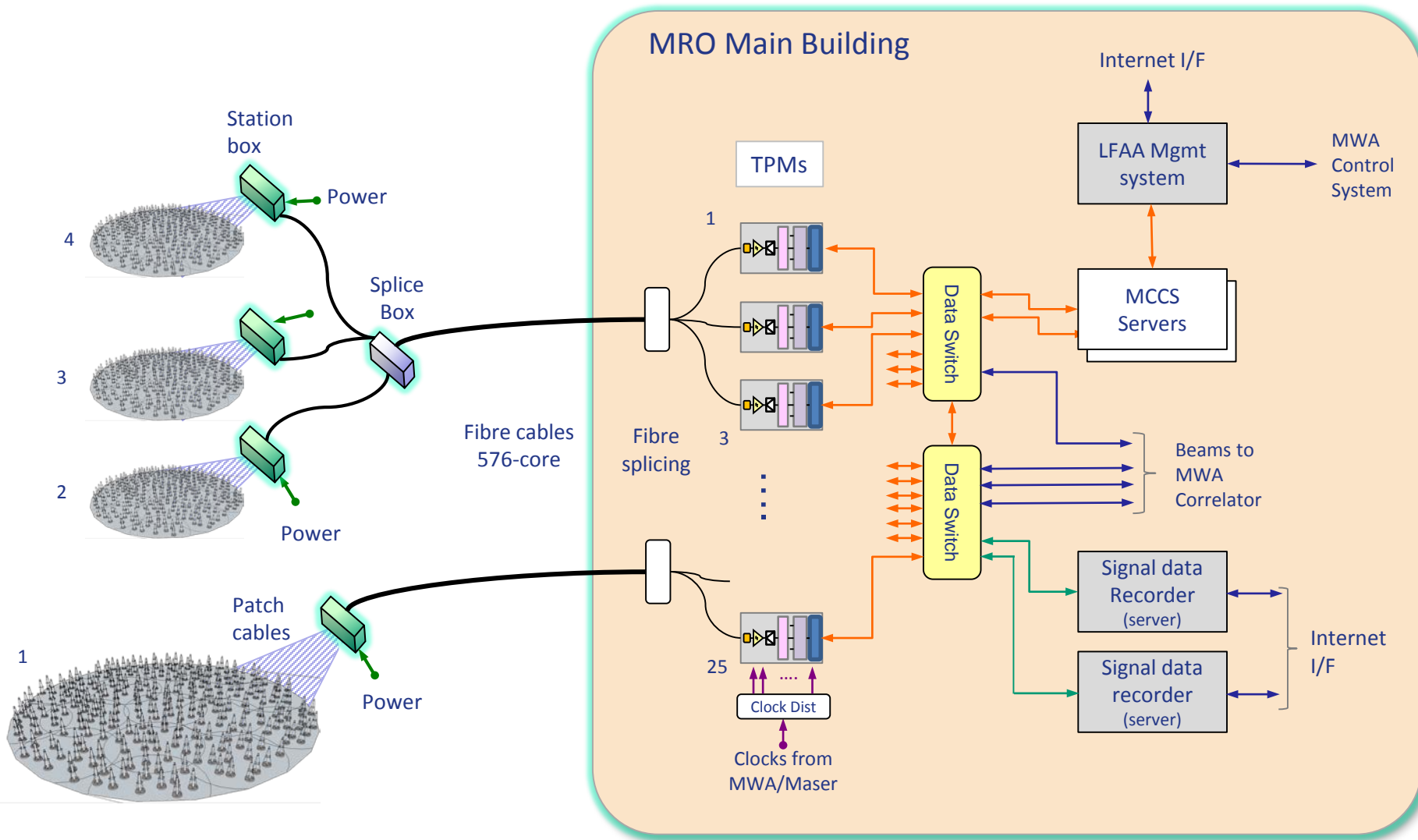
- Test overall System
- On MWA site – MRO
- 400 antennas
- 4 Stations
- Correlate with MWA

Design Parameter	Description/Value	Comments
Antenna type	Log periodic dipole array	SKALA-2 antenna
Number of stations	4	
Antennas per station	1 x 256 antenna station; 3 x 48 antenna stations	256 antenna station mimics a full station
Antenna placement in stations	Quasi-random: with average spacing at 1.9m and a 1.5 m minimum separation	Derived from SKA1-LOW/AAVS1 configuration studies
Station diameter	35 m	SKA1-LOW Baseline Design specification
Groundplane	Surface-laid mesh	Coarse mesh (~ 0.3m opening), light-gauge wire
Maximum station	240 m E-W; 200 m N-S (approx..)	
Total electrical load in the field	5 kW	RF-on-fibre signal transport solution
Electrical distribution	230V AC above ground to stations; low-voltage above- ground distribution within stations	Extensions from MWA trenching, installed in accordance with relevant national standards
Power source	MRO power station	
Antenna mounting	90 kg concrete base	No ground drilling required
Communications	Surface-laid optical fibre to MRO Control Routing?	All the processing needs to be in MRO main building



- Processing in ASKAP building
- Build in 2015
- Test in 2016

AAVS1 system layout



LFAA LMC Management Software

With Ascent Software

Functions of the LMC - MCCS

- Interface with TM – defined by ICD
- Interface and control TPMs
- Calculate and distribute beamforming coefficients
- Calibrate the antennas for phase and amplitude
- Distribute calibration coefficients
- Set up routing between TPMs
- Monitor hardware status
- Report hardware and system status

Control System Frameworks: ACS, EPICS & TANGO

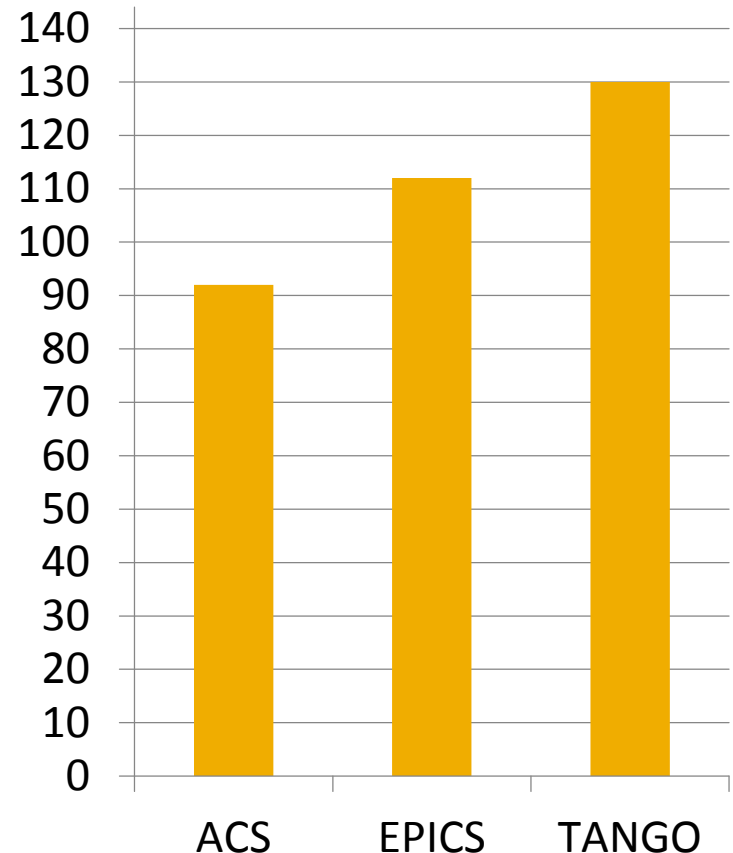
Component	ACS Common Software	EPICS v3	TANGO
Device Architecture	Object Oriented (CORBA)	Flat record database	Object Oriented (CORBA)
Communication Protocol	CORBA message middleware	Channel Access protocol	ZeroMQ
Scalability	Limited by CORBA	Proven scalability with flat architecture	ZeroMQ limited only by network bandwidth
User Interfaces	No GUI toolkit	X11/Motif + Control System Studio	Qt/Java/Web toolkits, Sardana+Control System Studio
Community	LGPL, not fully open source	Fully open source	Fully open source
Usage	Limited (~10 institutions)	Widespread, choice for ASKAP	Linux, Windows, OS X
Platform Support	Linux	VxWorks, Linux, Solaris, Windows, OS X	Growing steadily (~25 international partners)
Drivers	ALMA, Custom	Custom, Cosylab COTS support	Custom, Cosylab COTS support
Training	Extensive documentation, limited training	Extensive documentation, external on-site training available	Extensive documentation, training options available, active forums
Configuration Database	XML files	EPICS database	TANGO device server database
Archiving Database	None, data layer access API	ChannelArchiver	Historical, temporal and snapshot archives
Logging	API-based logging of data/actions/events	IOC level functions to send logs to text file (e.g. system log file)	Tango Logging Service (TLS), console, file, Tango log consumer/viewer, different log levels per device
Debugging	No dedicated debugger	No dedicated debugger	No dedicated debugger
Error Handling	Backtrace to handling device	Alarm states forwarded across links, client checks if alarm condition is present	CORBA exception handling, Alarms on attributes
Security	Container-level protection	User-level protection	User-level protection

Control System Assessment (II)

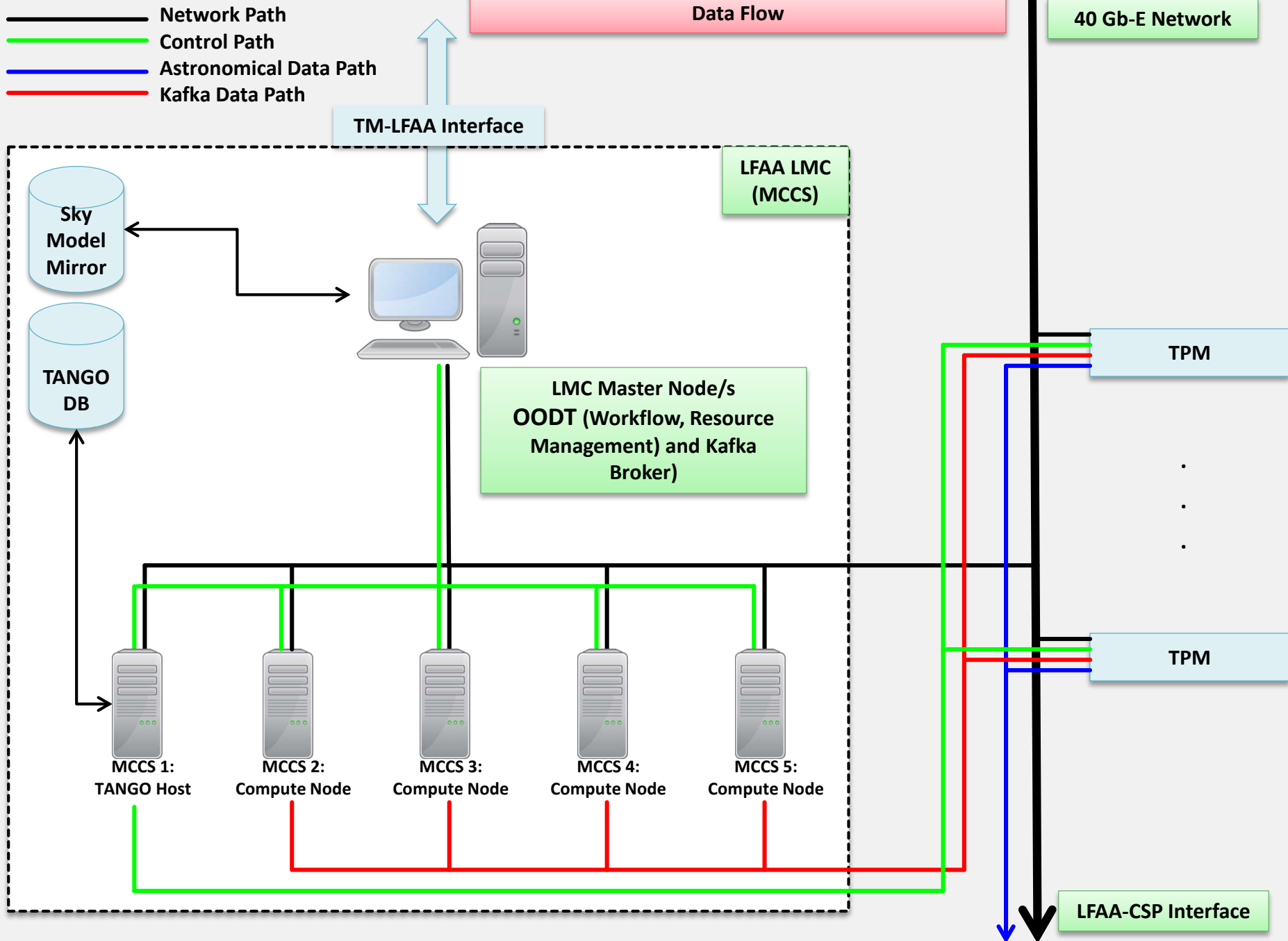
- General and Non-Functional
 - support and maintainability
- Communication Infrastructure
 - communication middleware design
- Monitoring and Control Functionality
 - core operation features and tools
- Total of 144 points

- *Scores*
 - *0: absent features*
 - *1: partially available/present features*
 - *2: fully available features*
- *A score of 1 also reflects minor shortcomings of an otherwise present feature.*

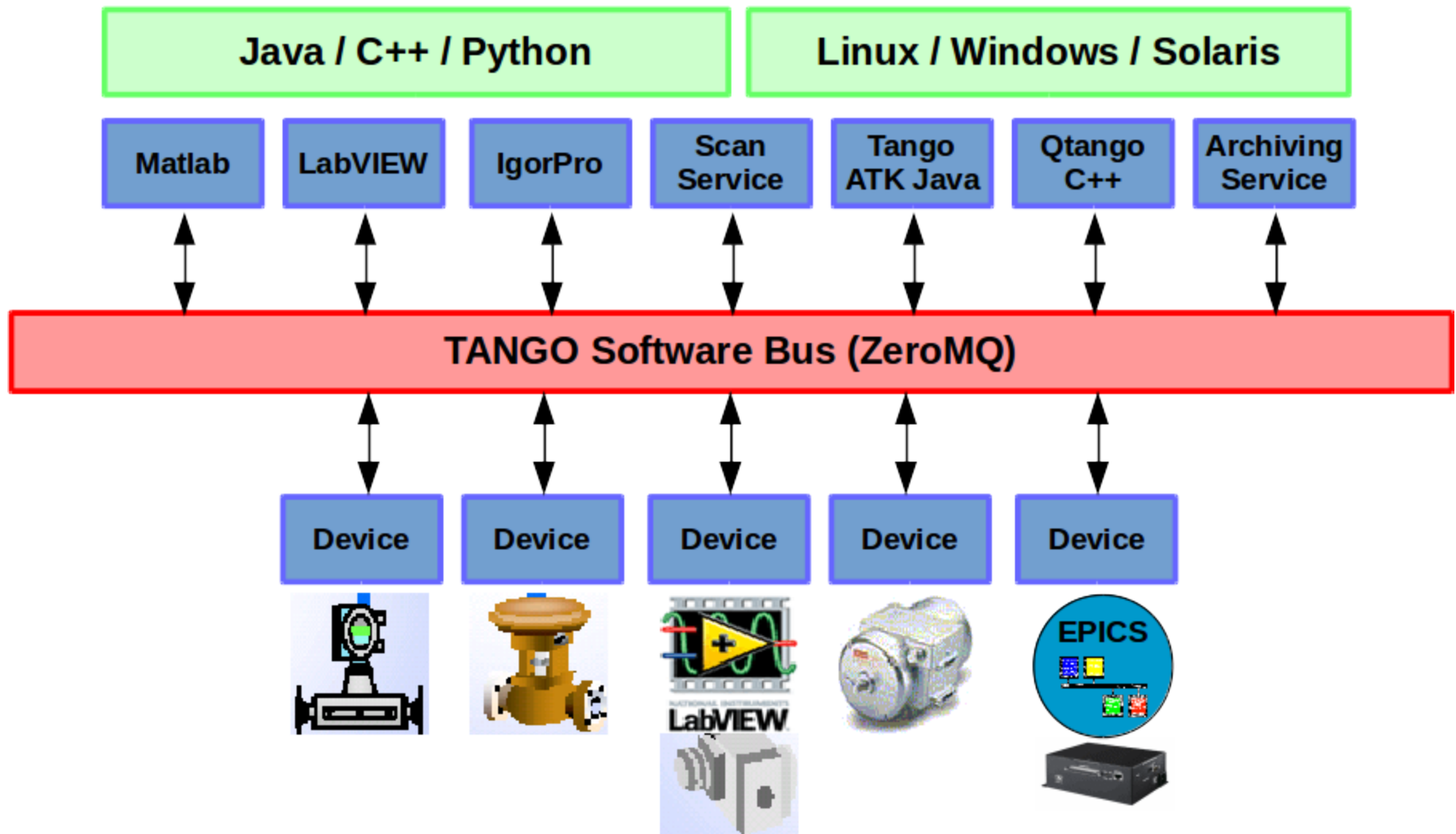
Assessment Score



LMC Structure



TANGO (I)



LFAA LMC Requirements (I)

- TANGO Devices
 - Wrapper around BSP
 - Commands and attributes
- Device States
 - 14 states
 - New states defined as Enums in TANGO device
- Data Taps
 - Upload of data into Kafka broker

LFAA LMC Requirements (II)

- Sensor Information
 - Alarms, events, polling through TANGO
- Array pointing/calibration
 - Set up as sequences of jobs with OODT Workflow Manager
 - Each job executed and monitored by OODT Resource Manager

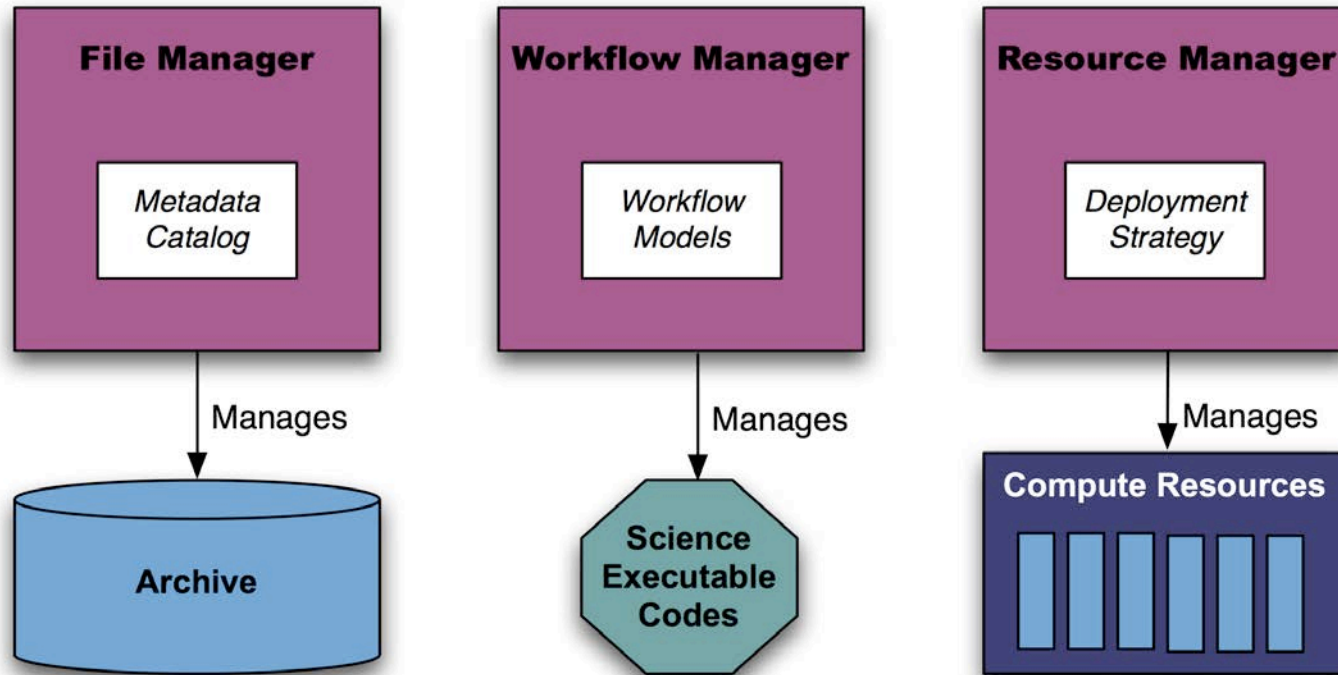
LFAA LMC Requirements (III)

- Logging:
 - Console, file, custom TANGO device
 - Levels: Debug < Info < Warn < Error < Fatal < Off
- Controlled Access
 - User-based, read, write, read/write rules
- Error Handling
 - Thrown exceptions

Apache OODT + Kafka

- Workflow Manager
 - Modeling, executing and monitoring groups of one or more Workflow Tasks
- Resource Manager
 - Sends jobs to resource nodes to be executed.
Monitors resource nodes.
- Kafka Cluster
 - Publish-subscribe distributed commit log.

OODT Core Components



- **All Core components implemented as web services**
 - XML-RPC used to communicate between components
 - Servers implemented in Java
 - Clients implemented in Java, scripts, Python, PHP and web-apps
 - Service configuration implemented in ASCII and XML files

Core Capabilities

- **File Manager does Data Management**

- Tracks all of the stored data, files & metadata
- Moves data to appropriate locations before and after initiating PGE runs and from staging area to controlled access storage

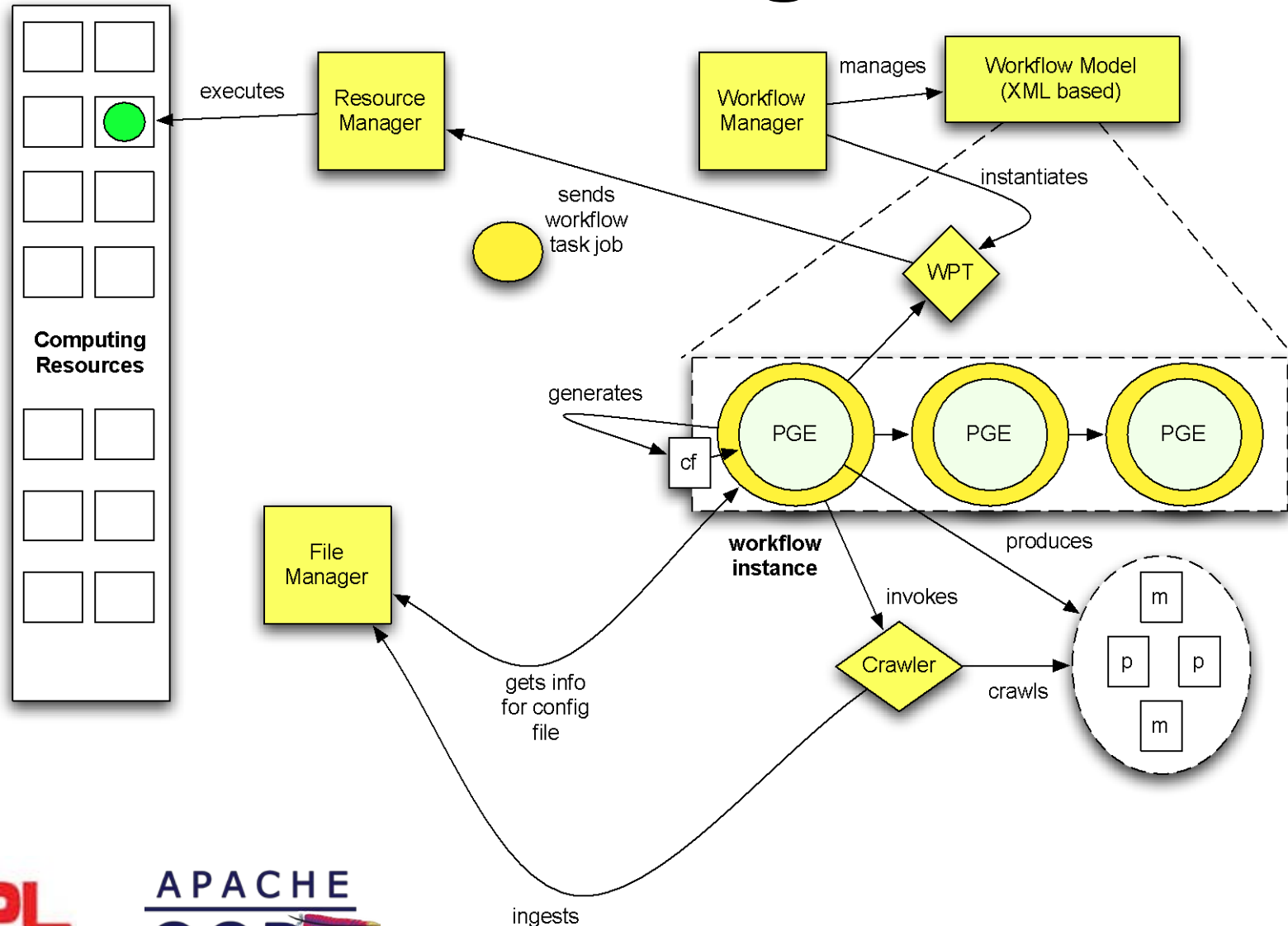
- **Workflow Manager does Pipeline Processing**

- Automates processing when all run conditions are ready
- Monitors and logs processing status

- **Resource Manager does Resource Management**

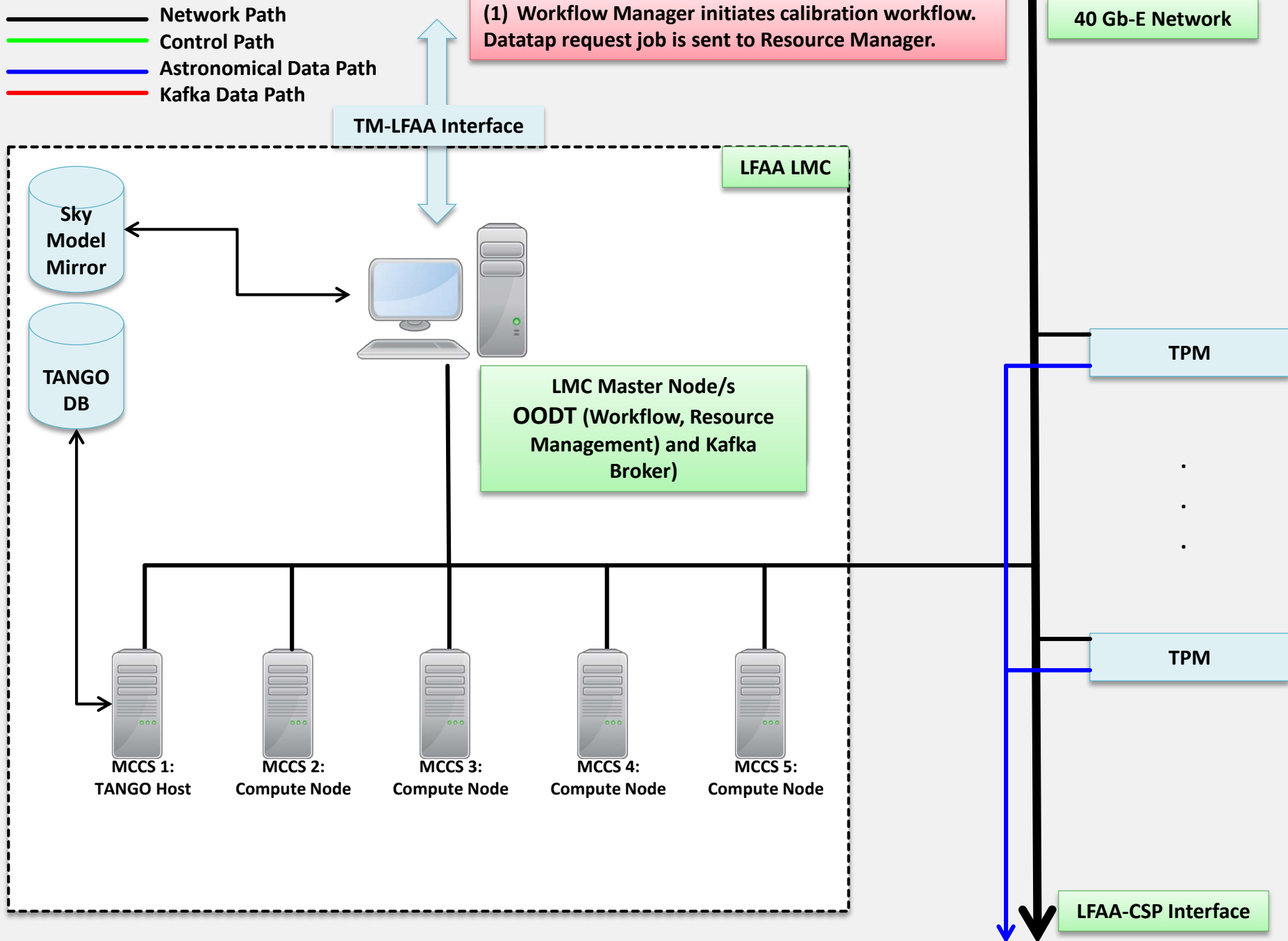
- Allocates processing jobs to computing resources
- Monitors and logs job & resource status
- Copies output data to storage locations where space is available
- Provides the means to monitor resource usage

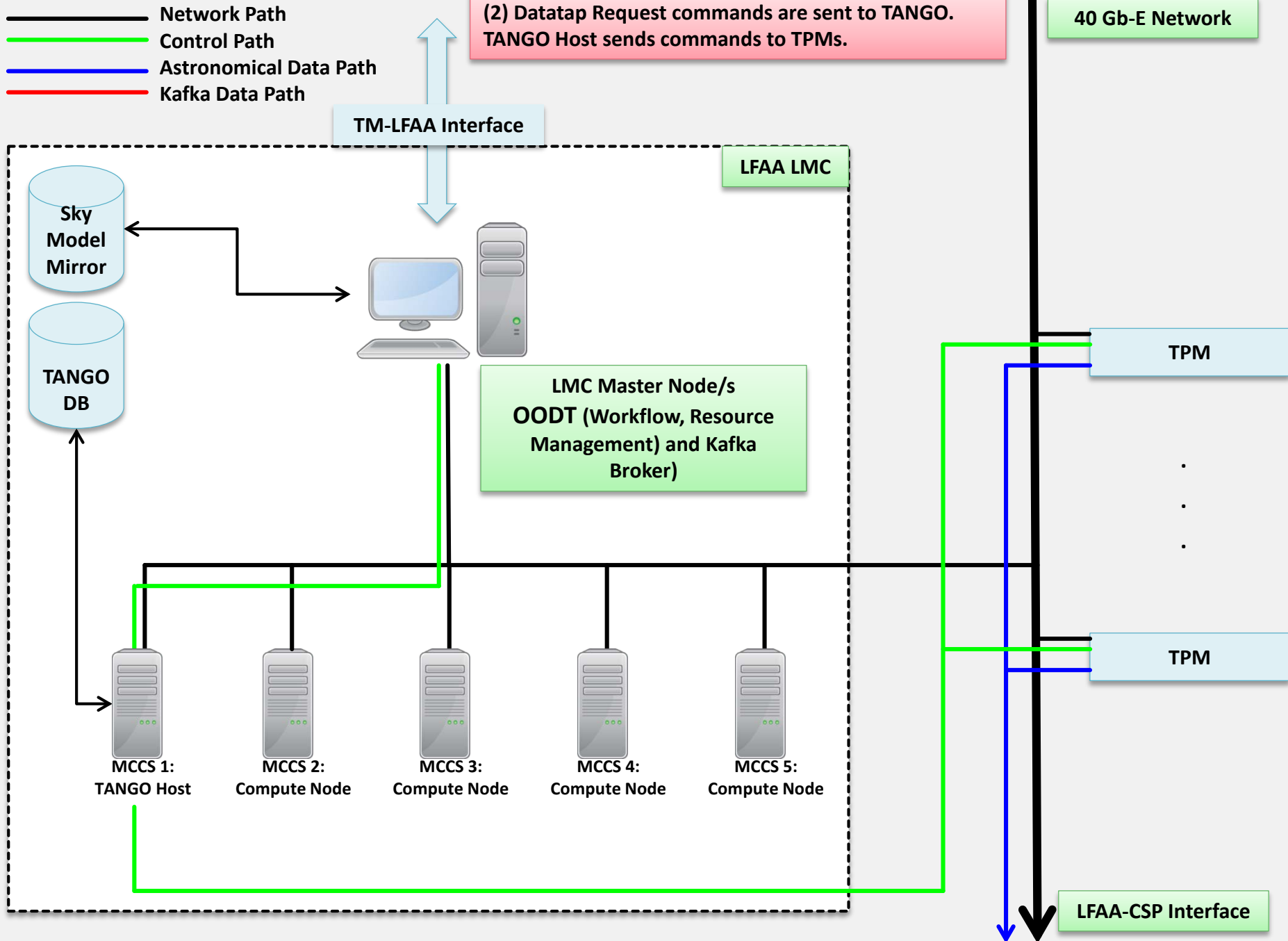
OODT Processing Use Case

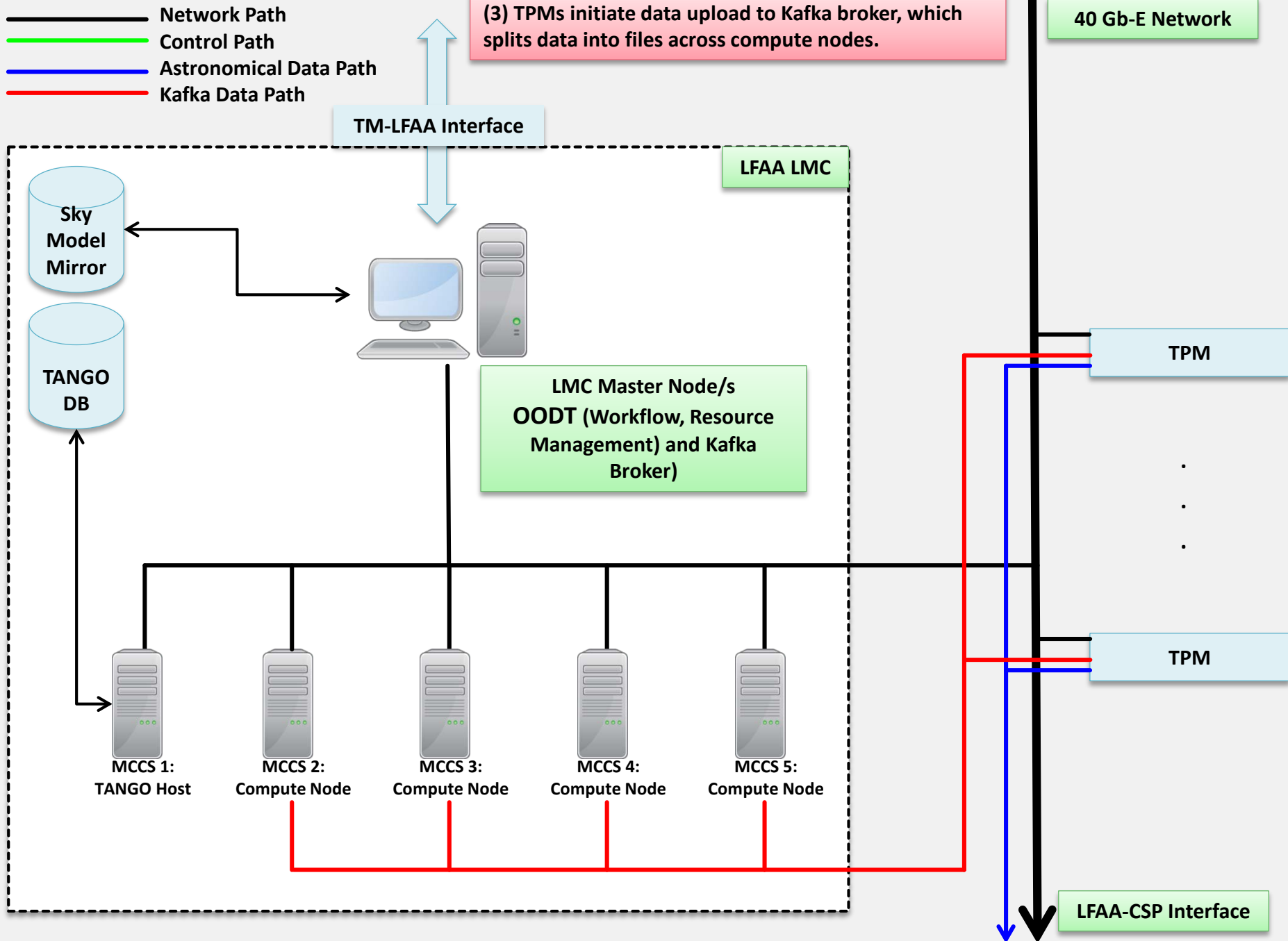


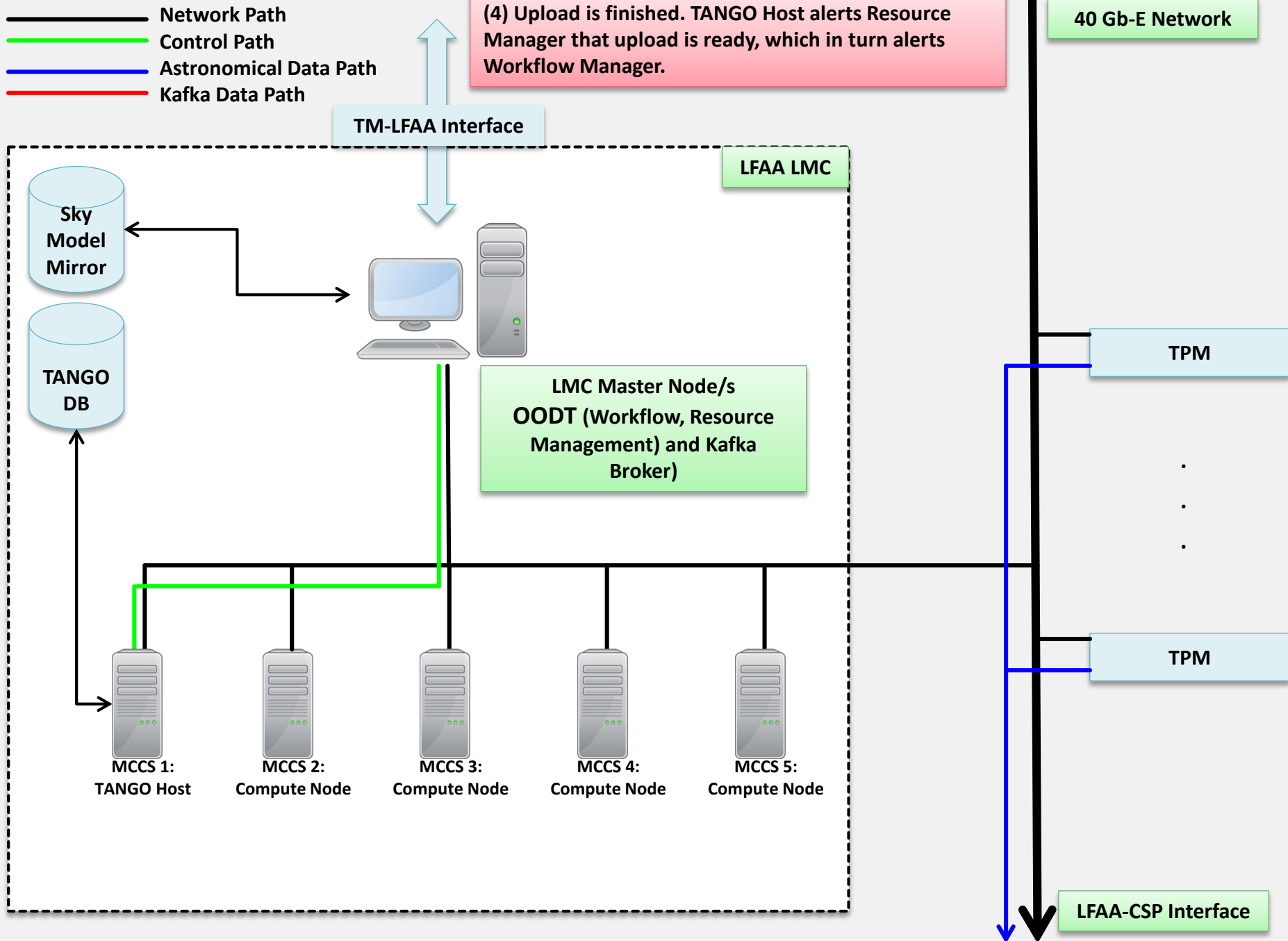
Example Workflow

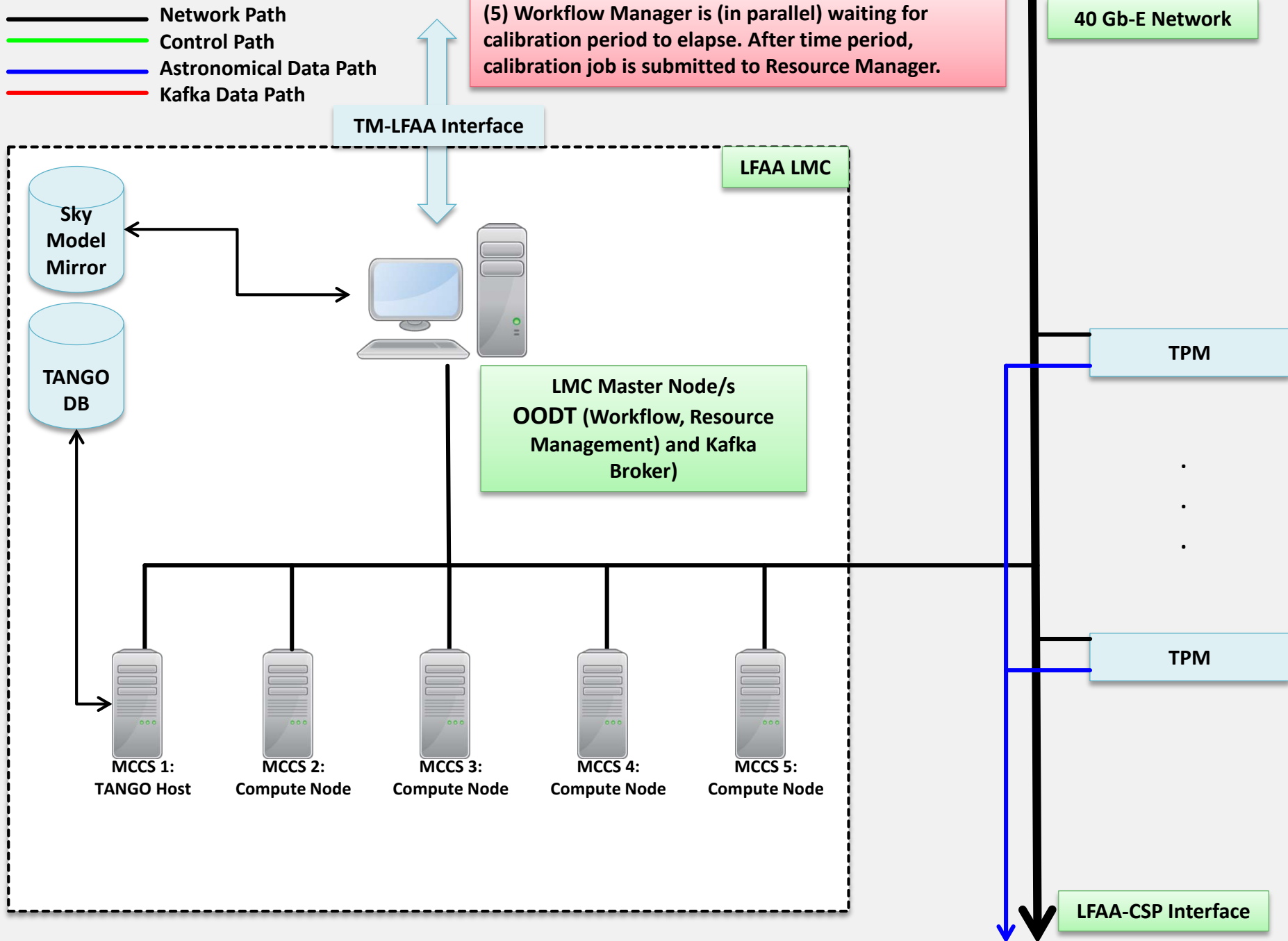
– Antenna Calibration

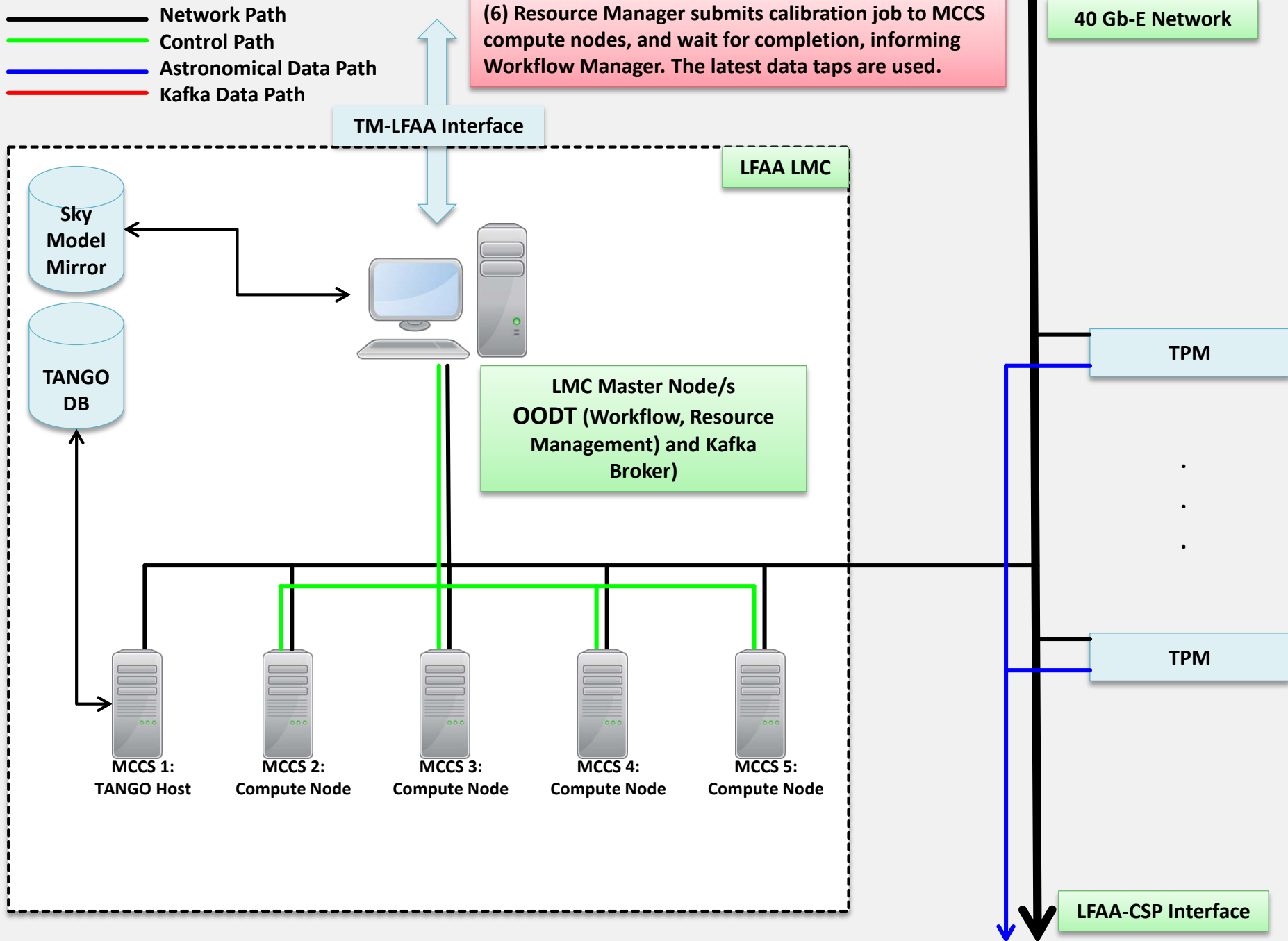


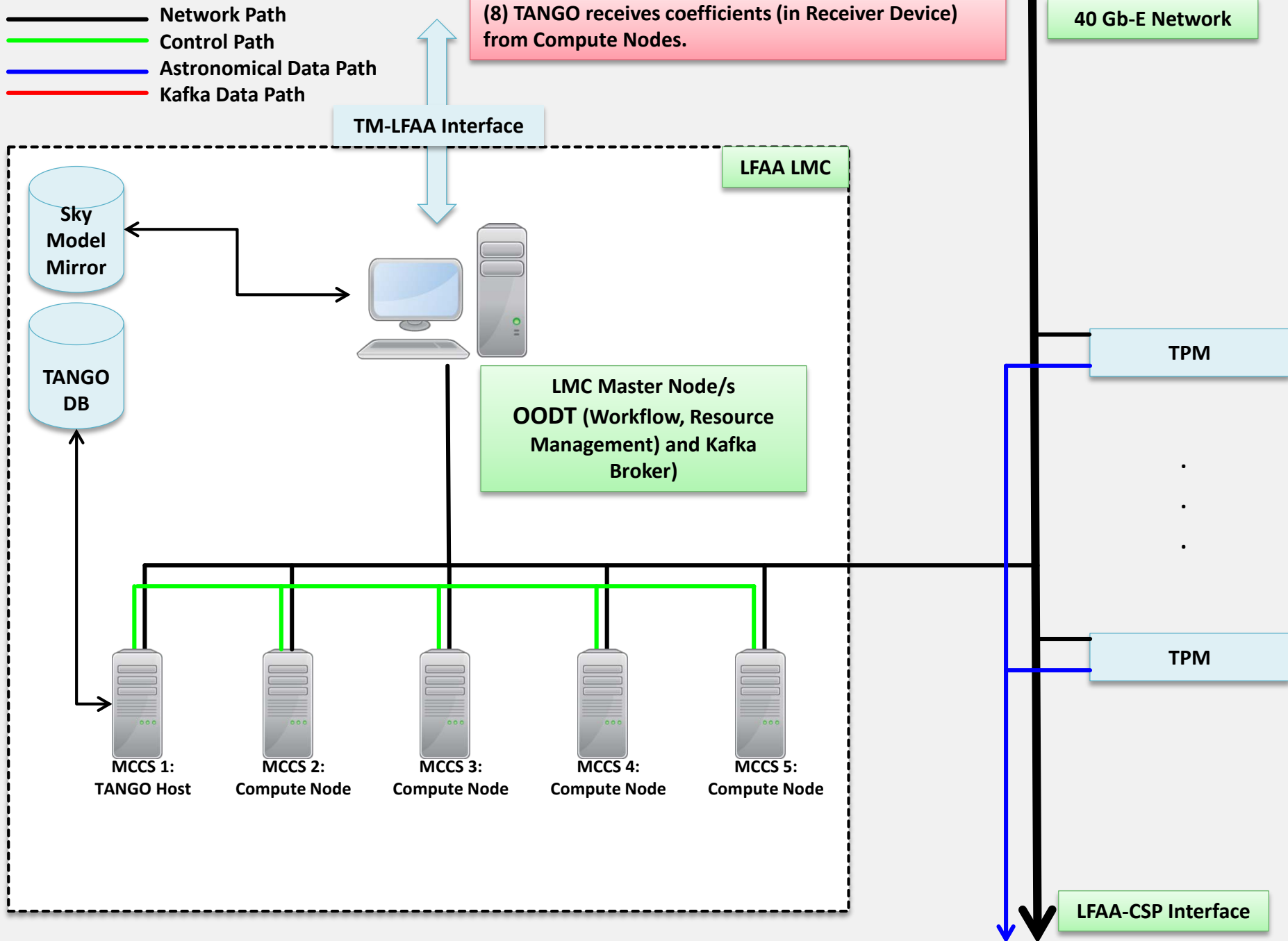


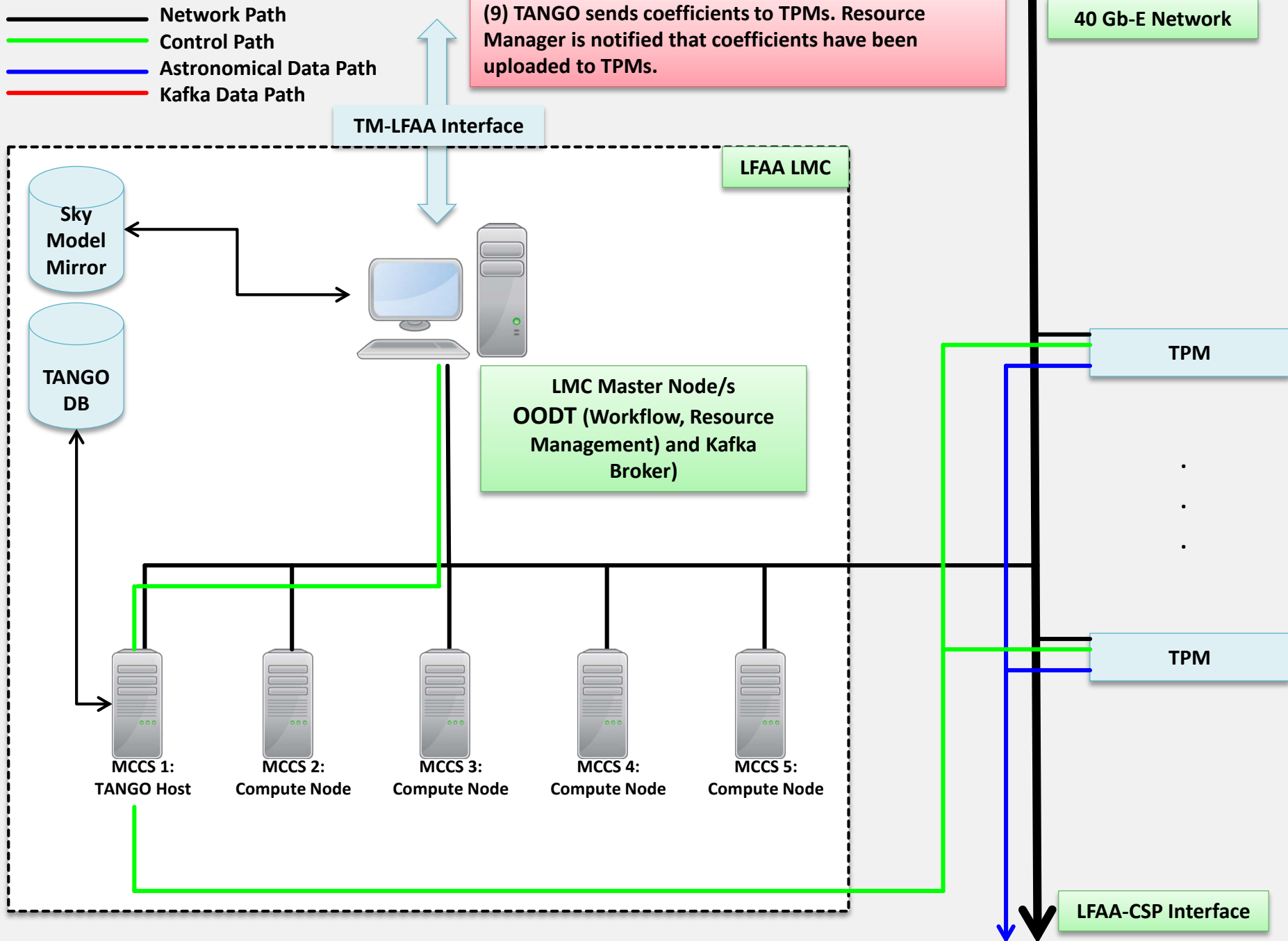


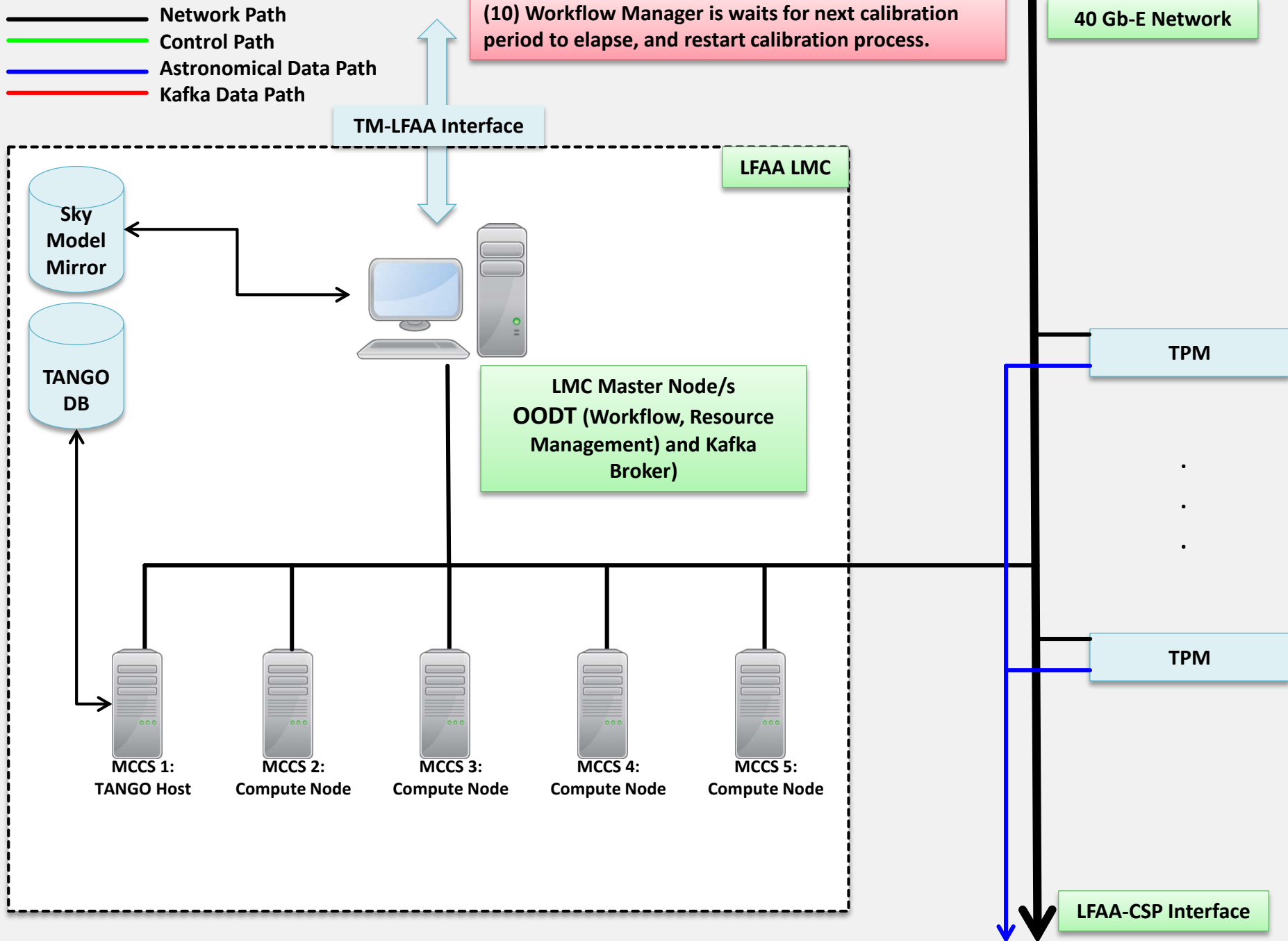












LFAA - TM

- TM <---> LFAA protocol
- Finalise ICD that is started
 - Define responsibilities of TM and LFAA
 - Define command structure

We look forward to the
meeting outcomes!