

# Dish LMC Software Development:

The role of simulators in software implementation and delivery



Samuel Twum, Controls Software Engineer @ SKAO

A. Lethole, M. Nzama, B. Ojur, N. Padavattan, D. Petrie, Y. Reddi, U. C. Silere, A. Venter

**SKAO**

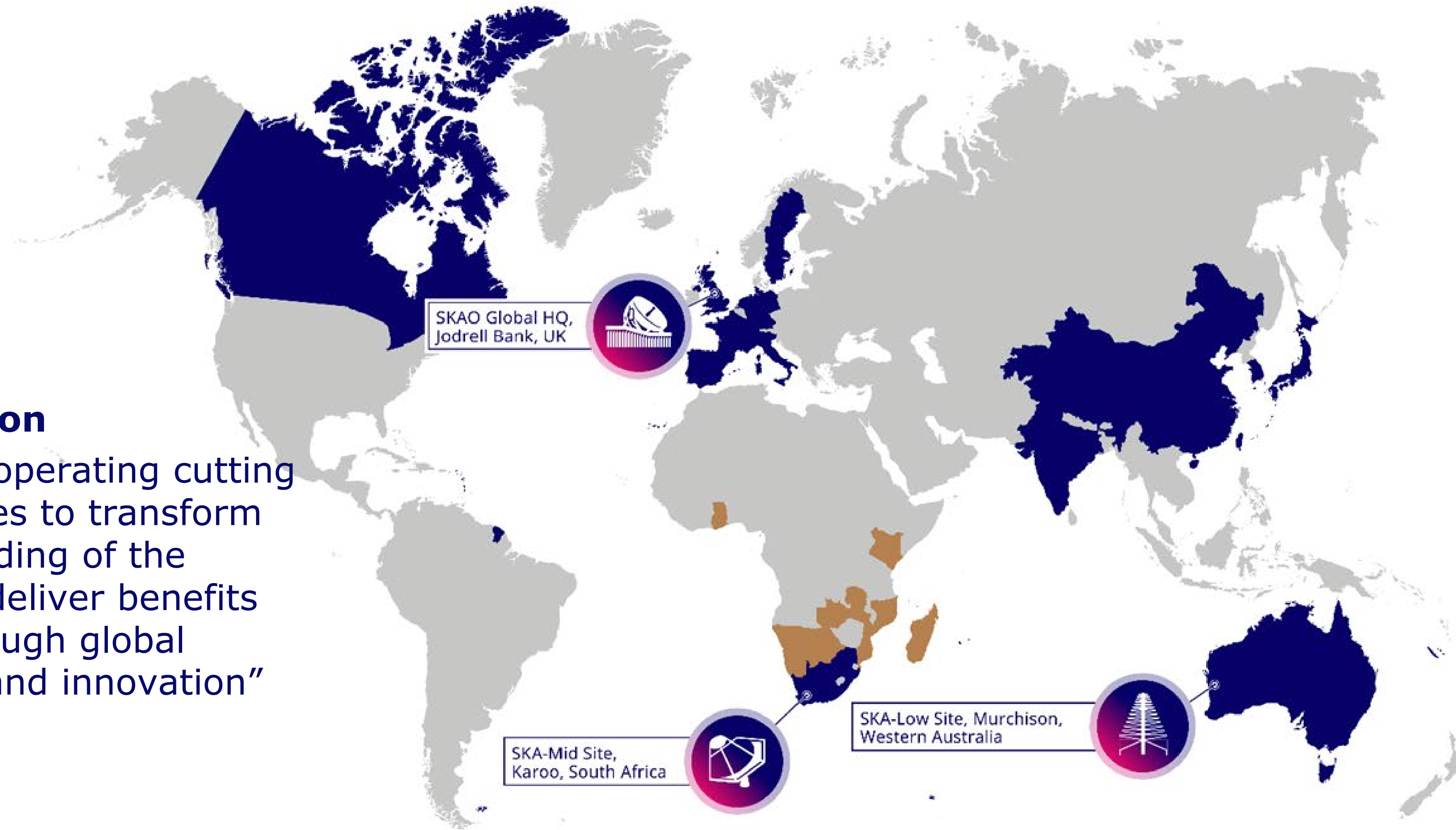
22nd September, 2025 @ ICALEPCS 2025, Digital Twins & Simulation (MOBR004)



# One Observatory Two Telescopes Three Continents

## SKAO's Mission

"To build and operating cutting edge telescopes to transform our understanding of the universe and deliver benefits to society through global collaboration and innovation"



*Australia  
Canada  
China  
Germany  
India  
Italy  
The Netherlands  
Portugal  
South Africa  
Spain  
Switzerland  
United Kingdom*

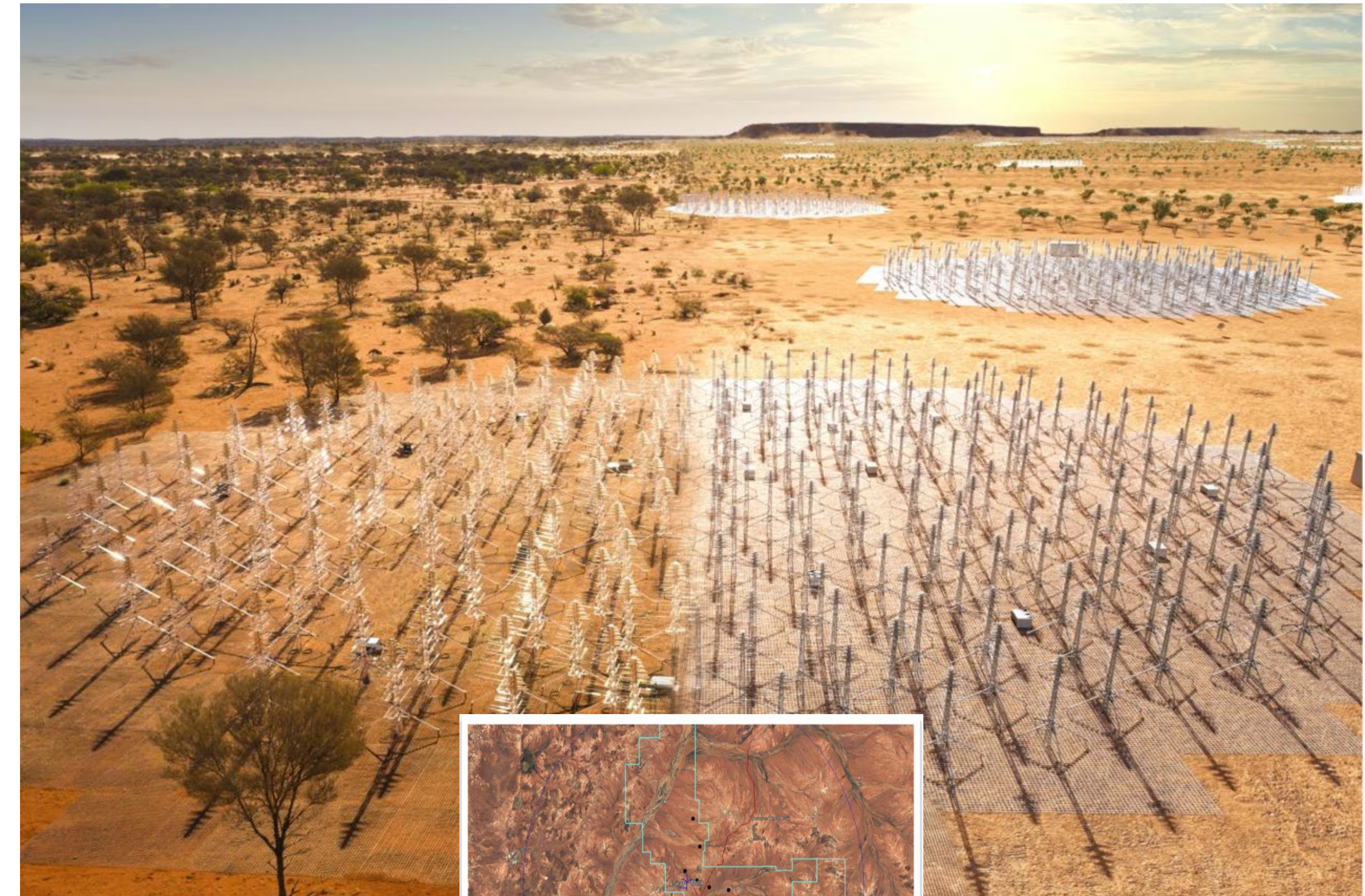
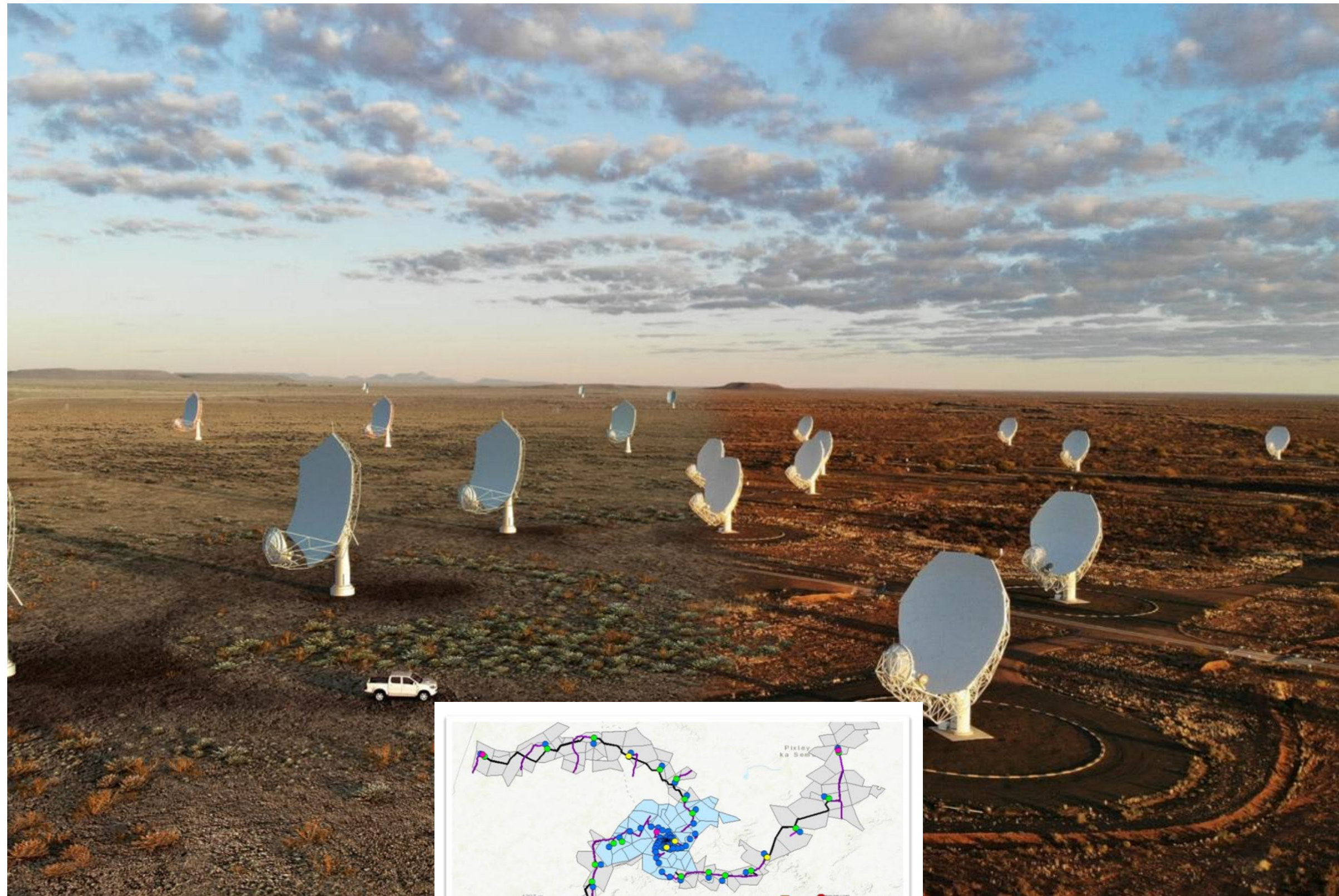
SKAO Partnership - includes SKAO Member States\* and SKAO Observers (as of August 2025)



African Partner Countries



# SKA Telescope - Overview



**197** fully steerable dishes  
Maximum baseline **150 km**  
Frequency range **350 MHz - 15.4 GHz**

**512** stations  
Maximum baseline **70 km**  
Frequency range **50 MHz - 350 MHz**



# SKA-Mid Dish

The Mid Dish system consists of the following sub-systems:

- Dish Structure
- Single Pixel Feed (SPF)
- Single Pixel Feed Receiver (SPFRx)
- Local Monitoring & Control (LMC)

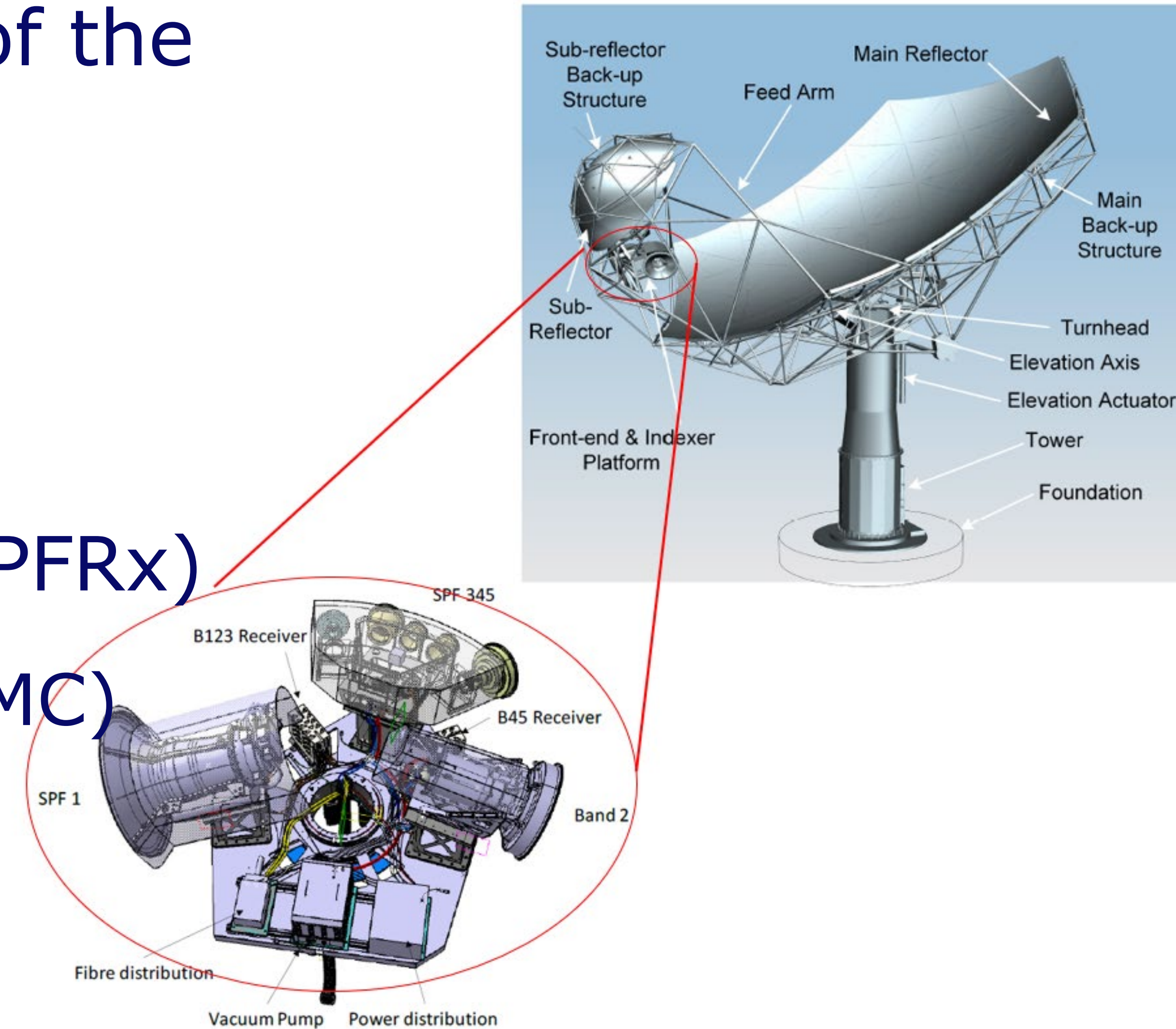


Image credit: Alice Pellegrini, SKAO



# SKA-Mid Dish

## DS

- Controller
- Mechanical and electrical system: Amplifiers, drives, encoders & limit switches for azimuth, elevation and feed indexer
- Safety and support: Stow pin installation ...

## SPF

- Band 1 Single Pixel Feed
- Band 2 Single Pixel Feed
- Band 345 Single Pixel Feed
- Helium & Vacuum Services
- ...

## SPFRx

- Controller & Electronics
- Cooling Systems (cryogenics / helium circulation)
- Signal Chain: Low Noise Amplifiers (LNAs), Down-conversion modules, Digitisers ...

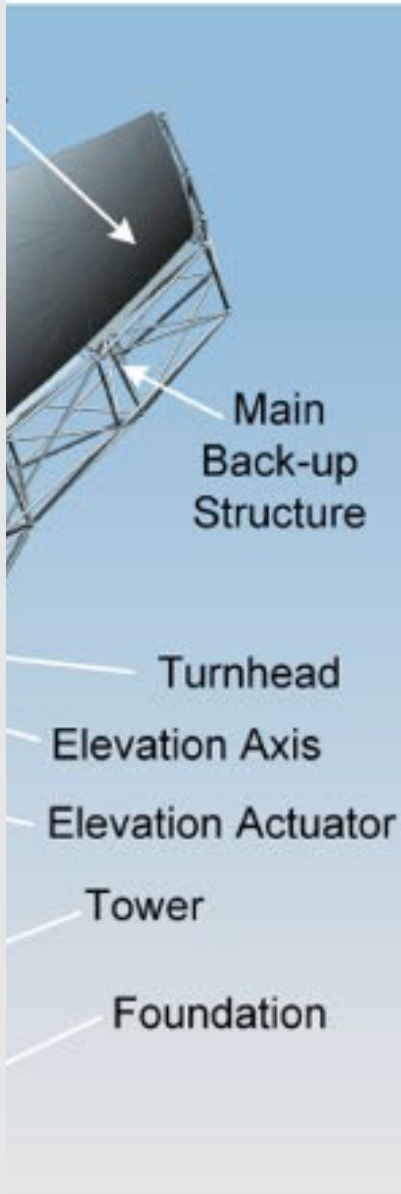


Image credit: Alice ...



# SKA-Mid Dish

The Mid Dish system consists of the following sub-systems:

- Dish Structure
- Single Pixel Feed (SPF)
- Single Pixel Feed Receiver (SPFRx)
- **Local Monitoring & Control (LMC)**

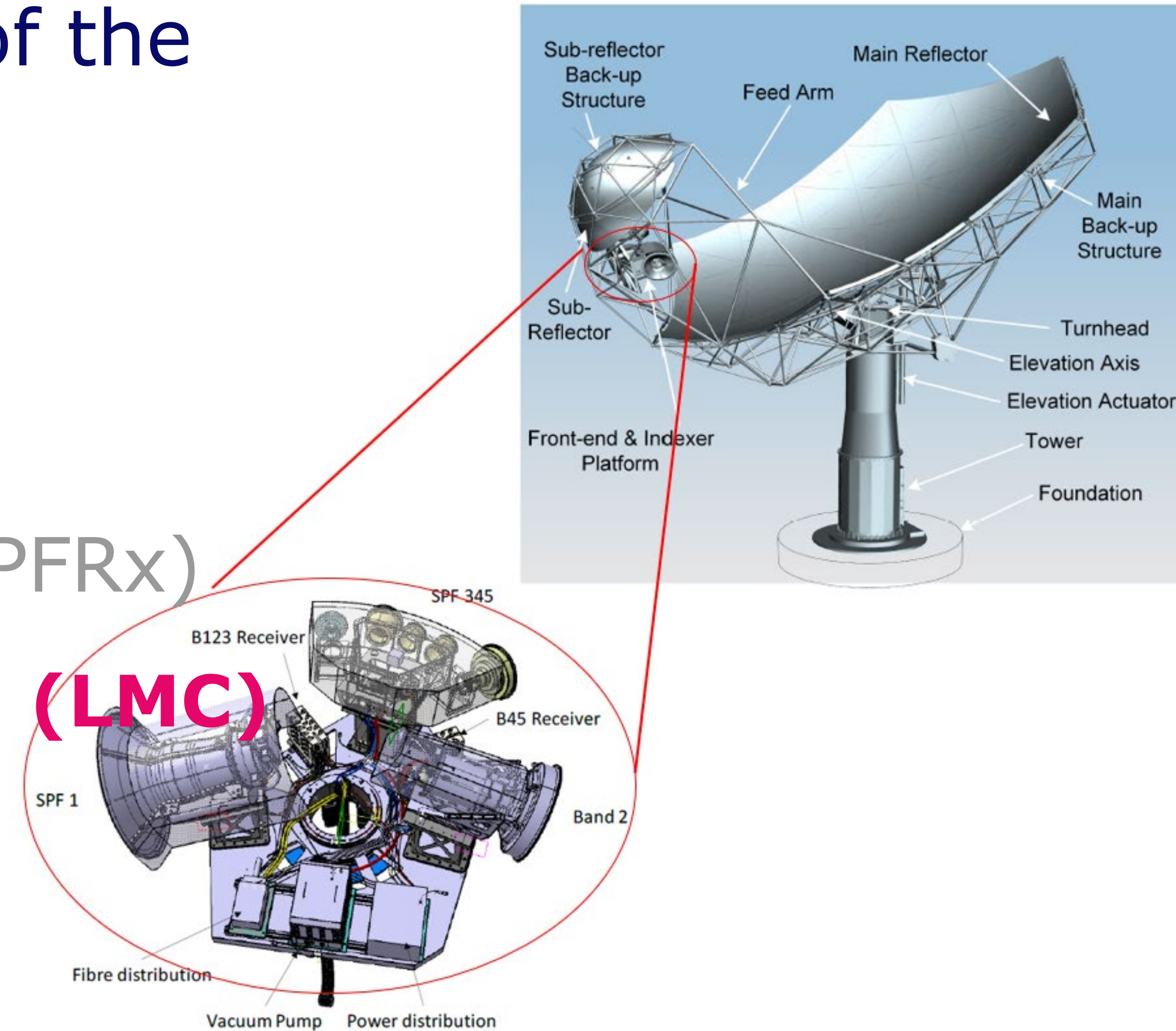
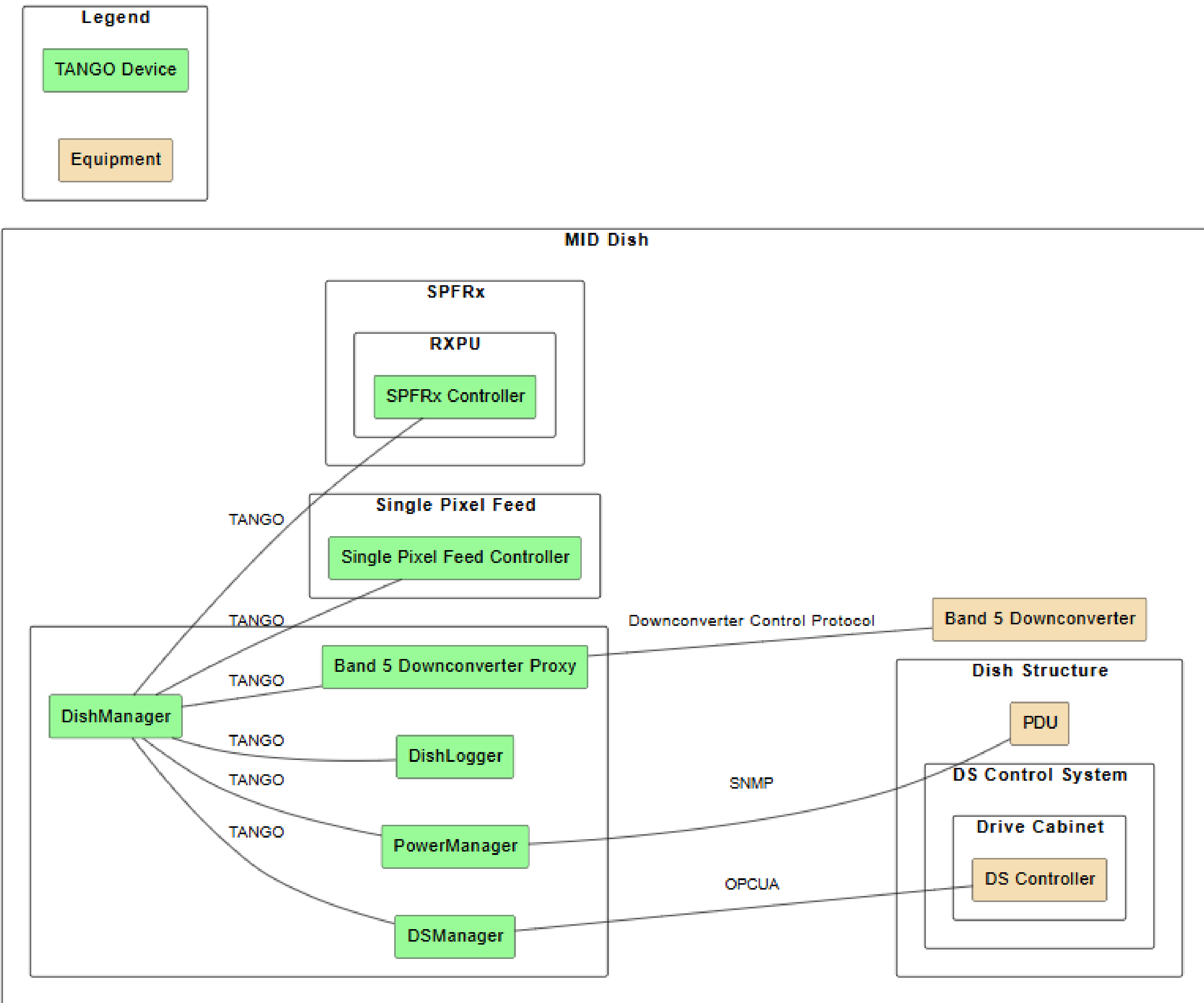


Image credit: Alice Pellegrini, SKAO



# Dish LMC Software Architecture - Overview



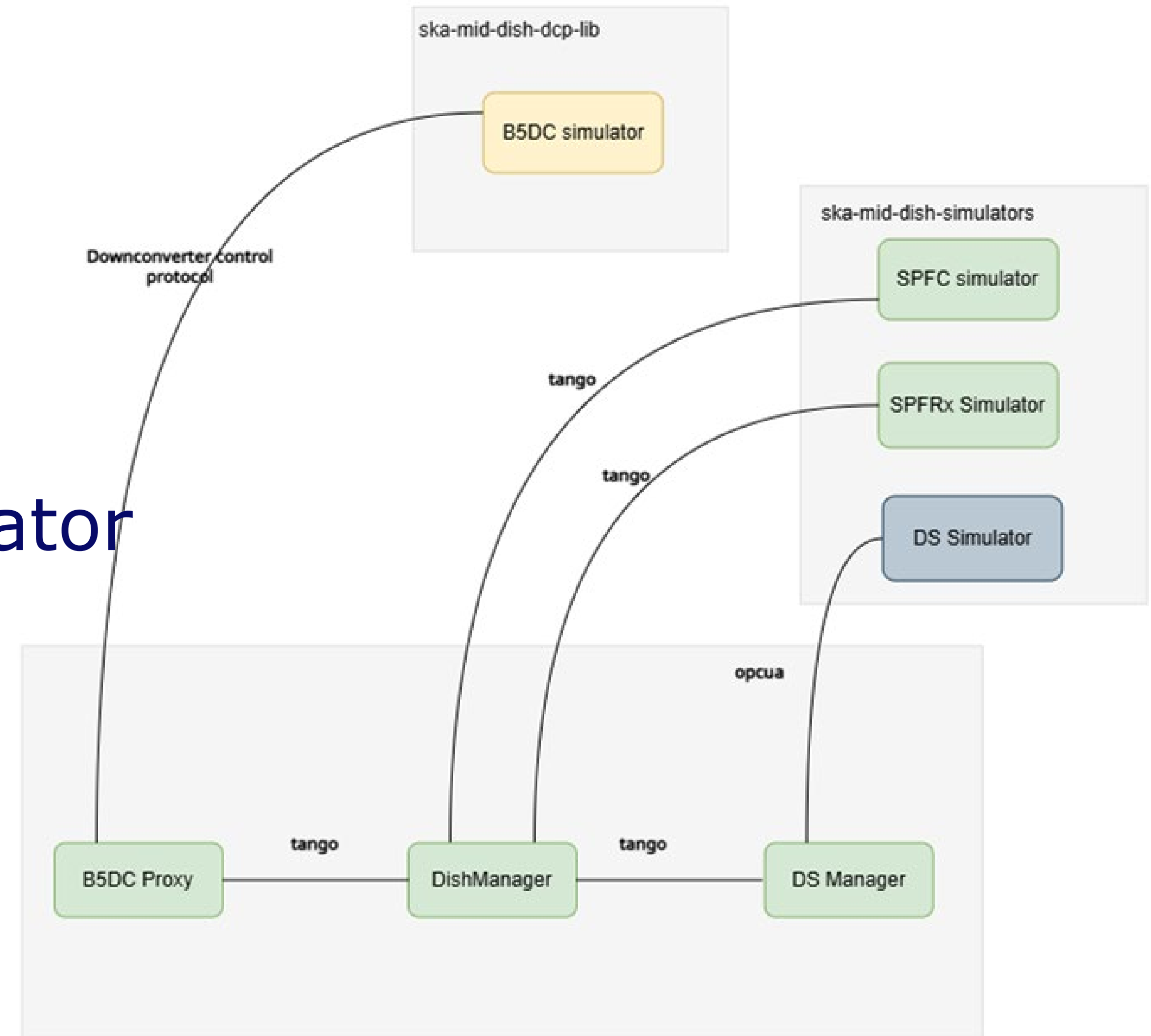
# Dish LMC Simulators

## ska-mid-dish-simulators

- SPF simulator
- SPFRx simulator
- Dish Structure Controller simulator

## ska-mid-dish-dcp-lib

- B5DC simulator



Dish LMC Software and Simulators: Current Status



# Dish LMC Simulators

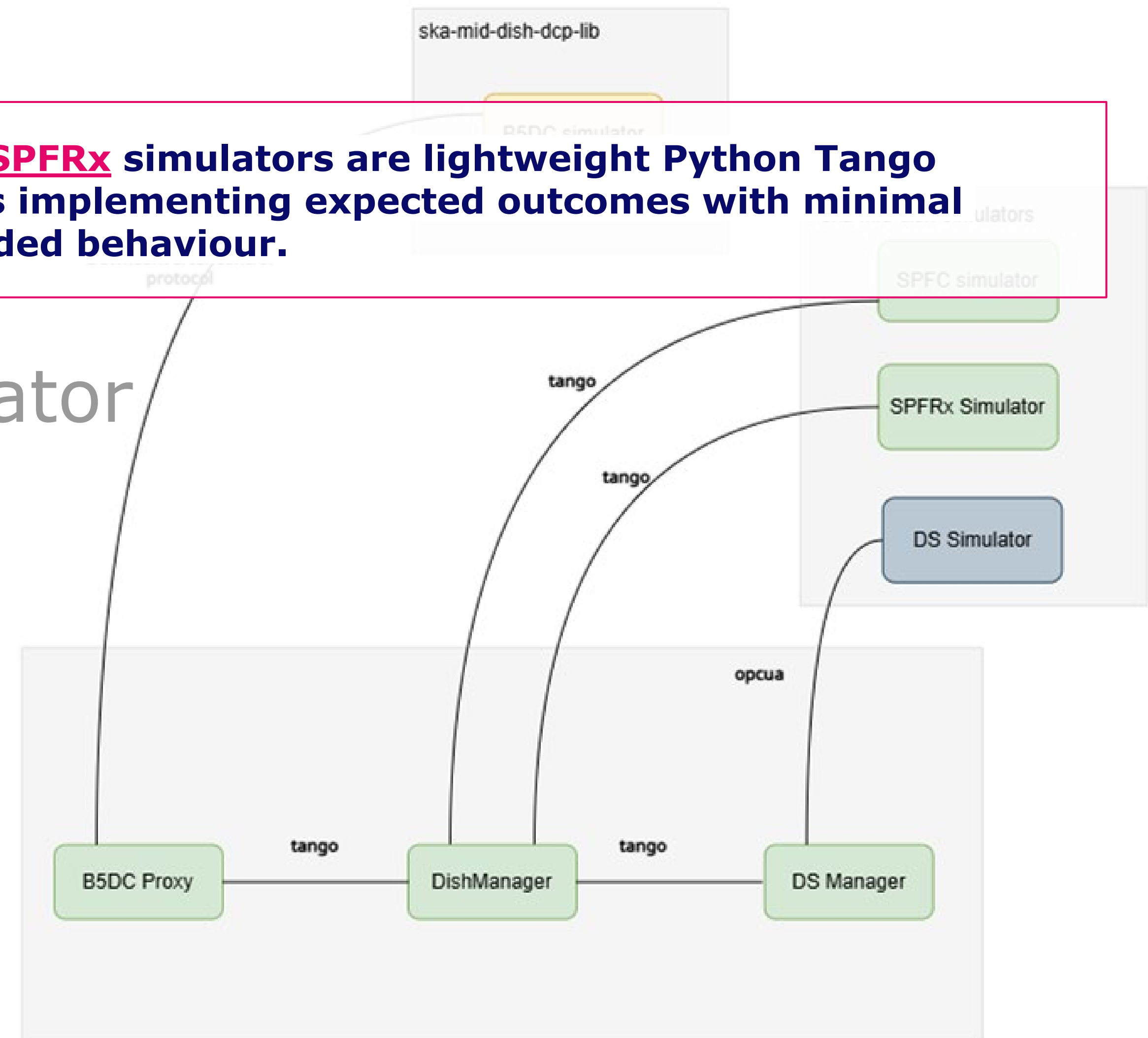
## ska-mid-dish-simulators

- SPF & SPFRx simulators
- Dish Structure Controller simulator

## ska-mid-dish-dcp-lib

- B5DC simulator

**SPF & SPFRx** simulators are lightweight Python Tango devices implementing expected outcomes with minimal embedded behaviour.



Dish LMC Software and Simulators: Current Status



# Dish LMC Simulators

## ska-mid-dish-simulators

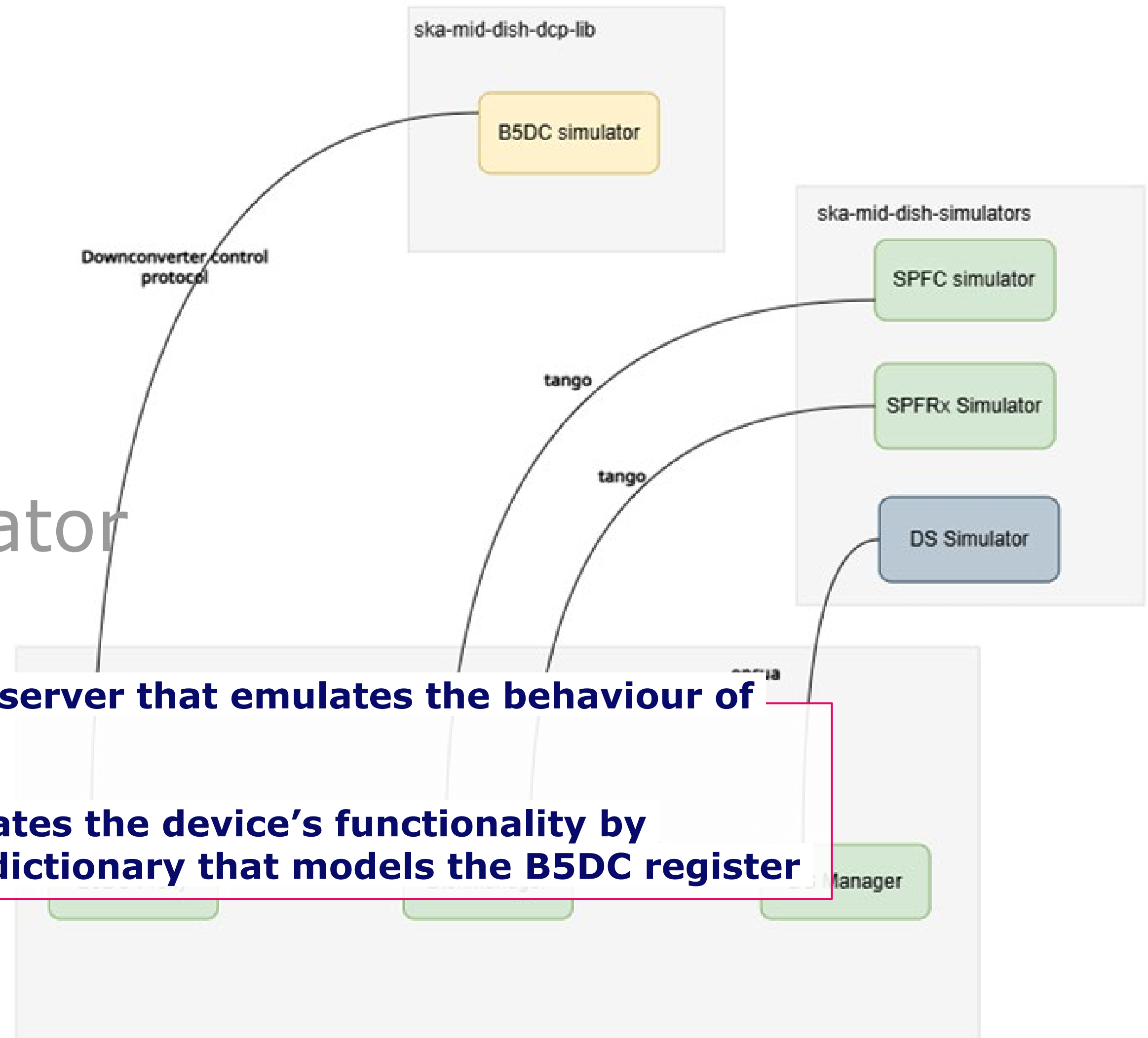
- SPF simulator
- SPFRx simulator
- Dish Structure Controller simulator

## ska-mid-dish-dcp-lib

- B5DC simulator

**B5DC** simulator UDP server that emulates the behaviour of the B5DC device.

This simulator replicates the device's functionality by creating an internal dictionary that models the B5DC register bank



Dish LMC Software and Simulators: Current Status



# Dish LMC Simulators

## ska-mid-dish-simulators

- SPF simulator

- SPFRx simulator

**DSC** simulator implements an **OPC-UA** device closely approximating states and modes, and motion of the dish

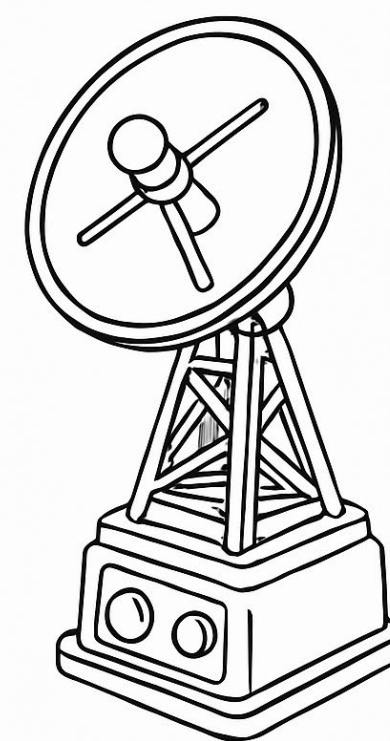
- Dish Structure Controller simulator

**Incorrect simulator implementations, particularly in the DSC, have led to improper use of the Dish LMC.**

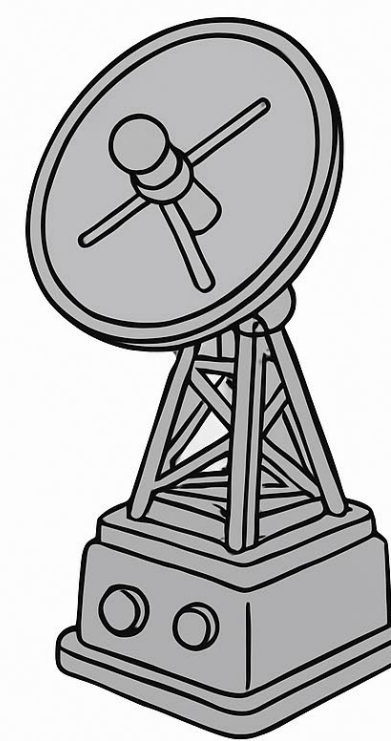
## ska-mid-dish-dcp-lib

- B5DC simulator

**Simulators ≠ real system — need to balance accuracy vs. complexity**



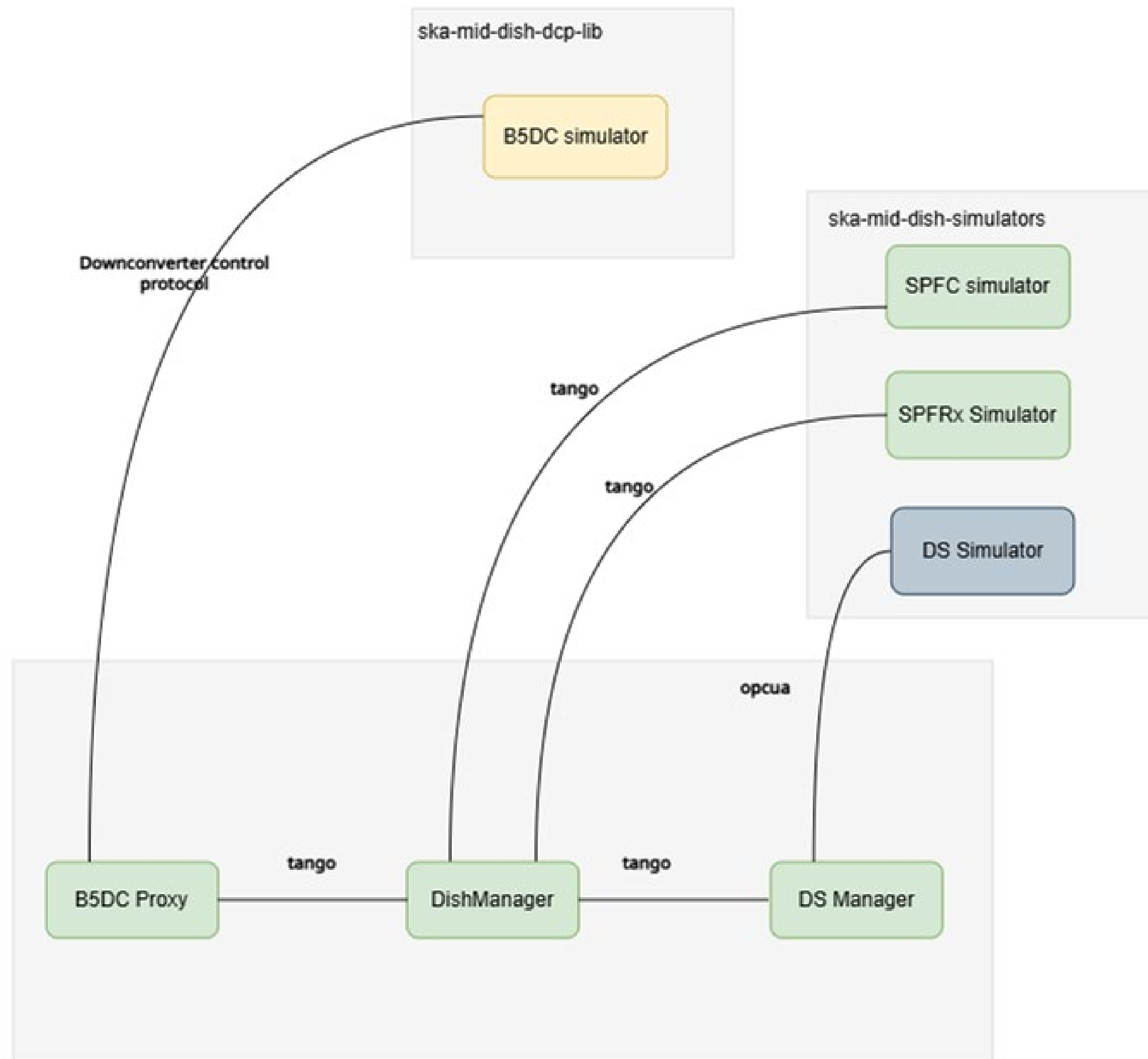
Simulator



Real



# Testing and Integration: Simulators



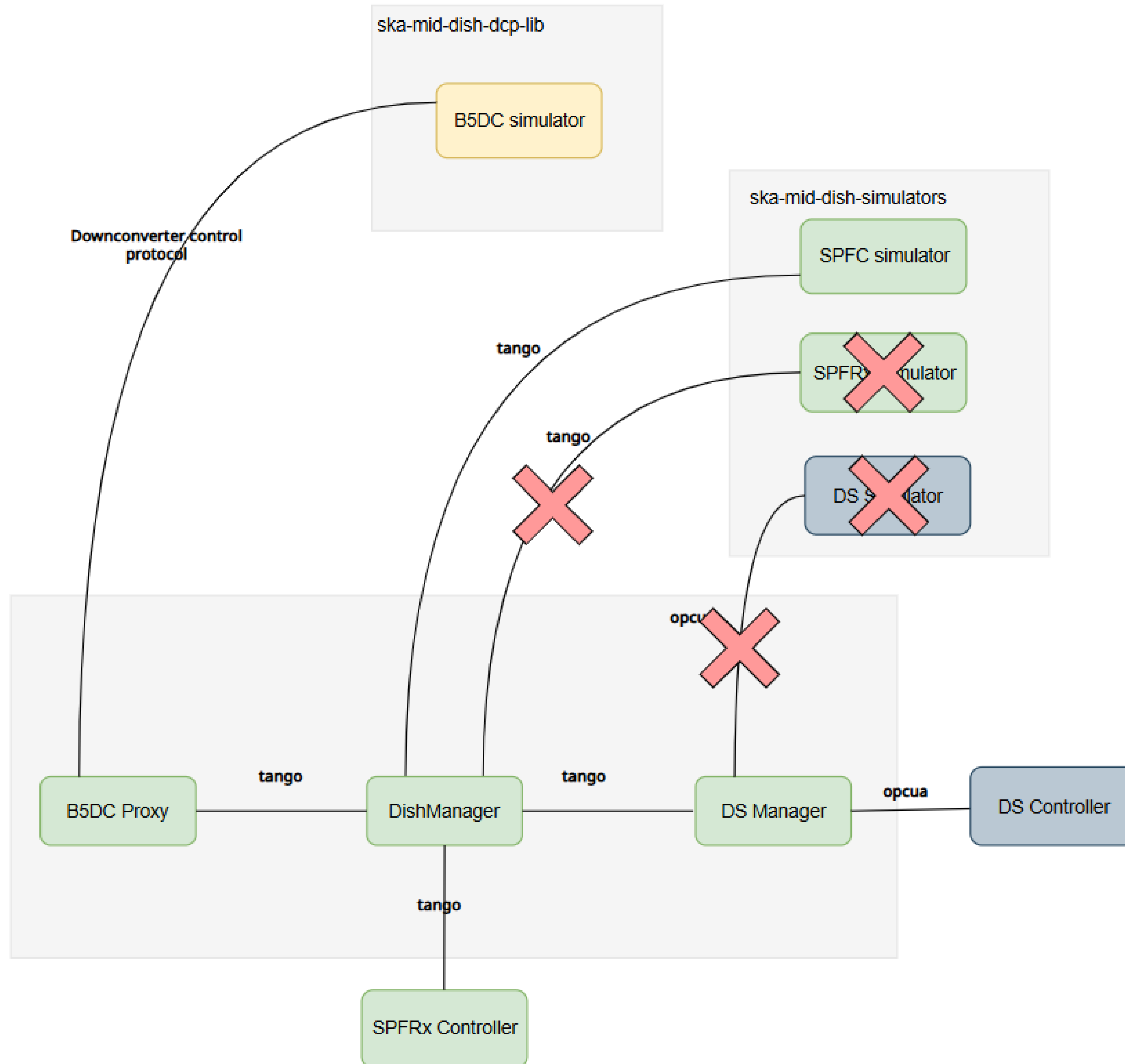
```
ska-mid-dish-simulators:  
enabled: true  
deviceServers:  
  # spfrx simulator ENABLED  
  spfrxdevice: ←  
  enabled: true  
  # opcua simulator ENABLED  
  dsOpcuaSimulator: ←  
  enabled: true  
  # spf simulator ENABLED  
  spfdevice: ←  
  enabled: true
```

```
ska-mid-dish-dcp-lib:  
enabled: true  
# b5dc simulator ENABLED  
b5dcSimulator: ←  
enabled: true
```



# Testing and Integration: Hardware

See example [deployment pipeline](#) showing stages for hardware integration



```

ska-mid-dish-manager:
dishmanager:
  # spfrx hardware tango address
  spfrx: ←
  fqdn: "SKA005/spfrxpu/controller"

ska-mid-dish-ds-manager:
dishstructuremanager:
  # DSC opcua device address
  dsc: ←
  fqdns: ["opc.tcp://127.0.0.1:8080/"]
  ds_opcua_namespace: "http://somenamespace"

ska-mid-dish-simulators:
enabled: true
deviceServers:
  # spfrx simulator DISABLED
  spfrxdevice:
    enabled: false ←
  # opcua simulator DISABLED
  dsOpcuaSimulator:
    enabled: false ←
  ...
  # spf simulator ENABLED ←
  # b5dc simulator ENABLED
  
```



# Conclusion and Thanks

Simulators have been crucial in accelerating Dish LMC development.

While they cannot fully replace real hardware validation, their continued evolution will ensure they remain a valuable tool for testing, regression, and future upgrades.

Thanks to the Dish LMC development team, AIV team and dish engineers for making dish control possible!



# SKA contributions

- **TUBG004**: Software Release and Integration Verification for the SKA Observatory **23 Sept 2025, 11:00**
- **TUBG006**: Hunting for hidden bugs: dealing with test flakiness in SKA control software **23 Sept 2025, 11:30**
- **WEPD008**: SKA Telescope Control System in 2025 **24 Sept 2025, 16:30**
- **WEPD057**: Overview and Current Status of the SKA-Low Monitoring, Control and Calibration Software **24 Sept 2025, 16:30**
- **WEPD062**: Field Deployment and Iterative Enhancement of the Dish Structure Qualification (DiSQ) Software for SKA-Mid **24 Sept 2025, 16:30**
- **THCR003**: A long term storage solution for Tango attribute data at SKAO **25 Sept 2025, 14:15**
- **THPD071**: A multi-level monitoring interface for the SKA Central Signal Processor using the Taranta synoptic view **25 Sept 2025, 16:15**



# Questions?

*We recognise and acknowledge the  
Indigenous peoples and cultures that have  
traditionally lived on the lands on which  
our facilities are located.*

**SKAO**

[www.skao.int](http://www.skao.int)