Web-based alarm management: How hard can it be?

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SKA-LOW

THE SKAO'S LOW-FREQUENCY TELESCOPE

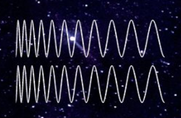
FREQUENCY RANGE:
50 MHz–
350 MHz

131,072
ANTENNAS
SPREAD ACROSS **512** STATIONS

MAXIMUM BASELINE:
~74km

SKA-MID

THE SKAO'S MID-FREQUENCY TELESCOPE



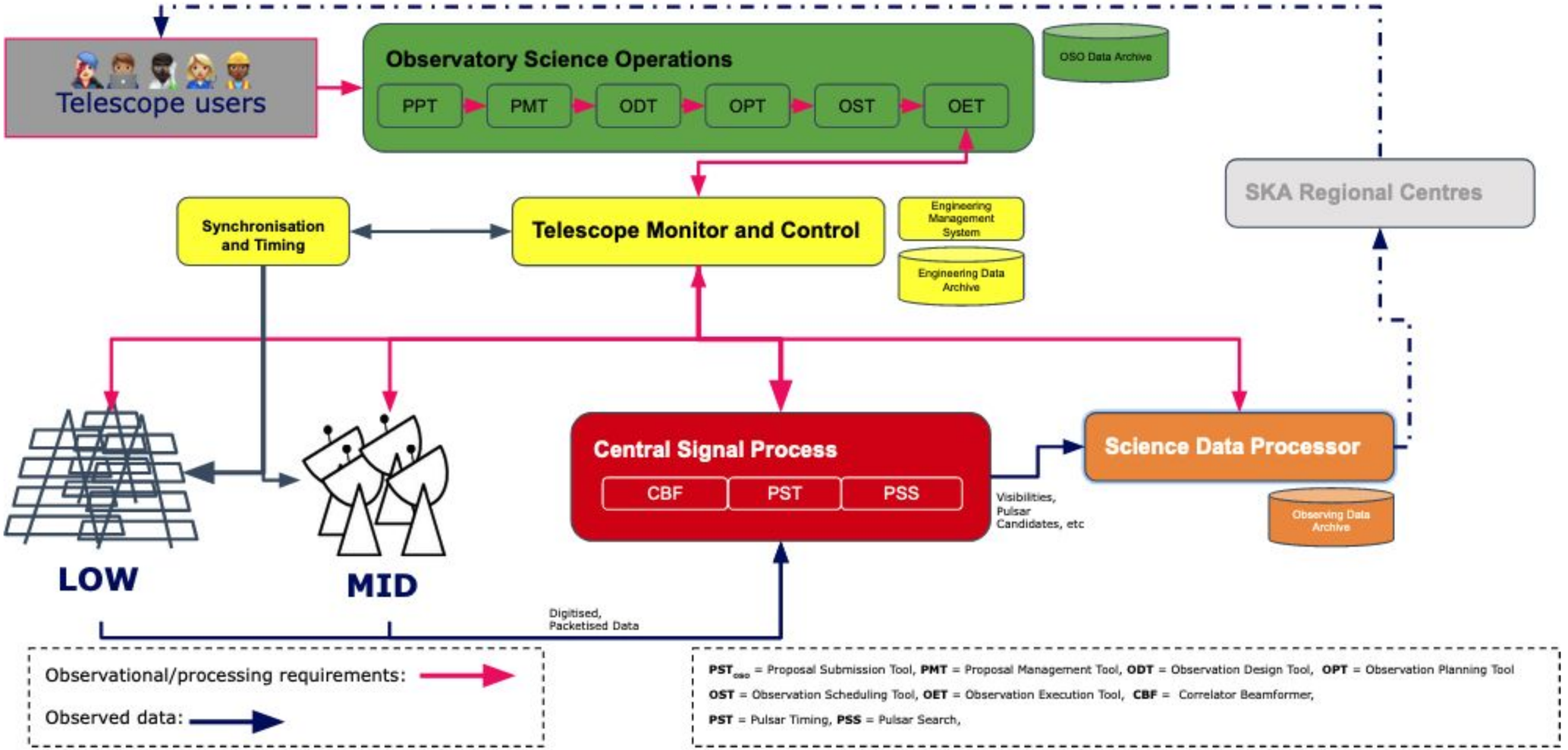
FREQUENCY RANGE:
350 MHz–
15.4 GHz
WITH A GOAL OF 24 GHz

197 DISHES
(INCLUDING 64 MEERKAT DISHES)

Distance: ~8800km

MAXIMUM BASELINE:
150km

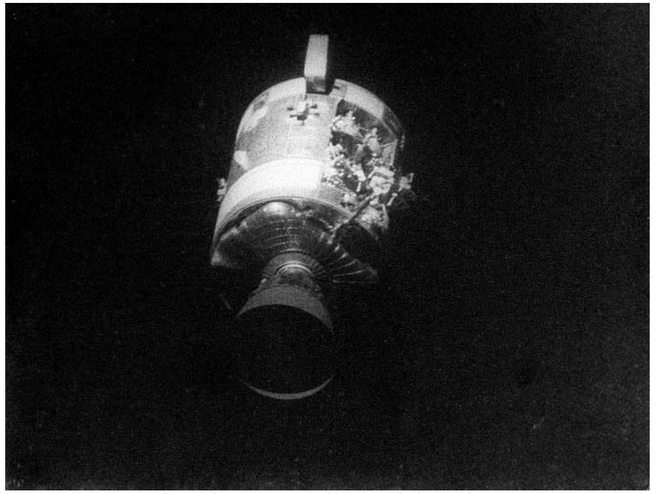
We have two BIG telescopes (well, kind of, still building)



When things are going well:
Everybody is happy.

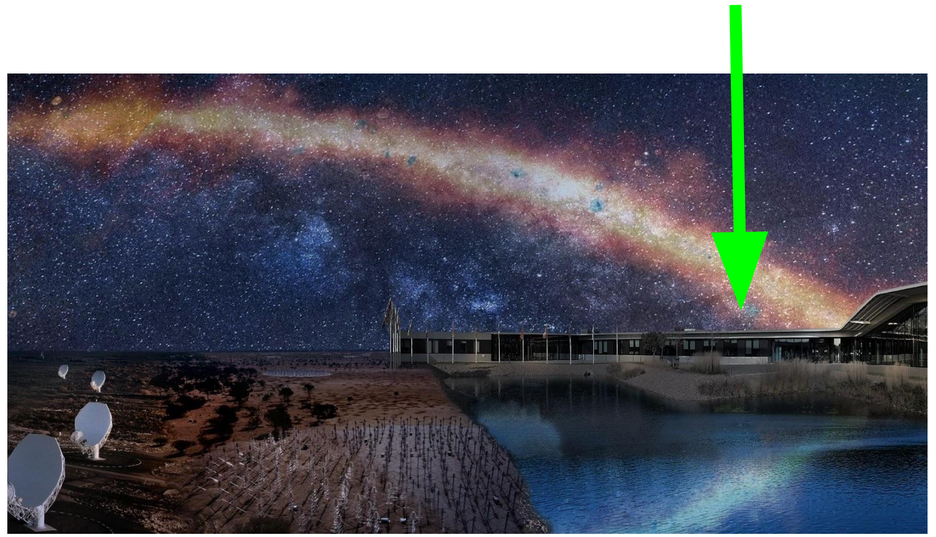
What if things are not going well?

(Imagine a slightly muted explosion sound)
"Houston, we've got a problem!"
(Crackling noise on the radio)
(A few seconds pass…)
(More noise on the radio)



Apollo 13 (with a small problem), © NASA

Not Houston
(But the SKAO HQ)



Q1: Who is Houston?
Q2: Is Houston listening?
(Q3: How could Houston help?)

Q: Who is Houston?

Houston = Human being
(Operator)

→ **First responder** ←

Houston, no doubt!
(And one can listen to her)
Unfortunately not that Houston from the radio call

Problems = <u>Abnormal condition</u>:

Reported to Operator by SKAO **Alarm Management System (AMS)**

We'll get back to this later

The Houston that we need right here!

Abnormal condition reporting: Operator

Provide enough information to assess the situation!

Example Qs that an Operator might ask:

- How is the problem affecting the observation?
- How is the problem affecting the telescope?
- Is the problem caused by an equipment malfunction?
- Can the operational state be recovered?
- Is human intervention required?
- Who needs to take action?

Many questions!

→Operator←

- Needs comprehensible information (**standardised**)
- Should not be flooded with (redundant) information
- Can drill down based on information provided

Tangent:
SKAO Alarm Management System Requirements

Requirements for the SKAO Alarm Management System

- Latency from the time a measurement crosses an alarm set-point until the time it is signalled to the operator shall be no more than 1 second. (Identified in SKAO-SYS REQ-2312)
- Alarm notification shall be active (via SMS, email, etc.) rather than passive (requiring an Operator query).(Identified in SKAO-SYS REQ-2309)
- It shall be possible to filter alarms individually or by group. (Identified in SKAO-SYS REQ- 2310)
- SKA1-Mid and SKA1-Low shall provide monitoring to log all alarms, alerts and warnings, with a human readable report presented to authorised personnel. (Source: SKA1 Operational Concept Document SKA-TEL-SKO-0000307) (Identified in SKAO-SYS REQ-2279)
- The TMC shall record the following data from failures: (Identified in SKAO-TM REQ-297) – Failure indication data received from Elements.
  - Physical location of the item from which the failure is reported.
  - Configuration Item Number (CIN) of the item from which the failure is reported. – If applicable, the serial number of the item from which the failure is reported.

Summary

- We have 1s to display alarms on the operator screen (from the time the measurement was taken)
- Alarm reporting must be active (push)
- Alarm must be presented
  - in human readable form, identify location
  - and source
    - as detailed as possible

Joint mission:
Tango Attribute Alarm + IEC 62682 = Alarm & Alert

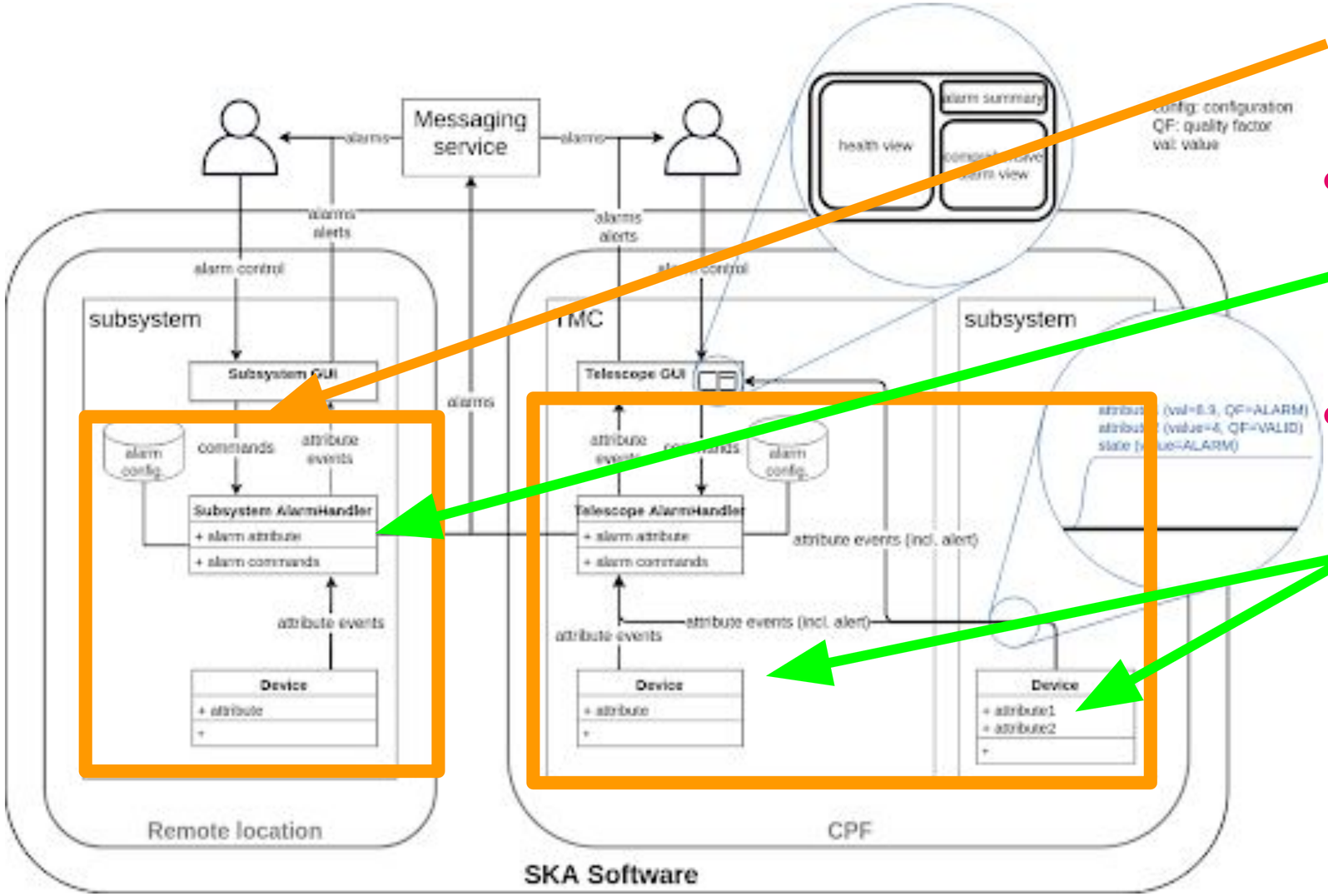
- **TANGO Attribute Alarm**
  - Generated when the attribute value crosses a threshold, resulting in quality factor change.
  - TANGO device attribute quality factor change triggers:
    - generation of an event (Alarm event, built in),
    - device state transition from ON to ALARM (built in).
  - Displayed on the user interface and/or monitored by another TANGO device.
  - Provides a mechanism to report any type of condition (urgent or not).

- **IEC 62682 Alarm**
  - "An audible and/or visible means of indicating to the operator an equipment malfunction, process deviation, or abnormal condition requiring a timely response."
- **IEC 62682 Alert**
  - "an audible and/or visible means of indicating to the operator an equipment or process condition that can require evaluation when time allows"

S2Innovation's IC@MS

SKAO Alarm Management System

Another Tangent:
SKAO Alarm Management Baseline Design



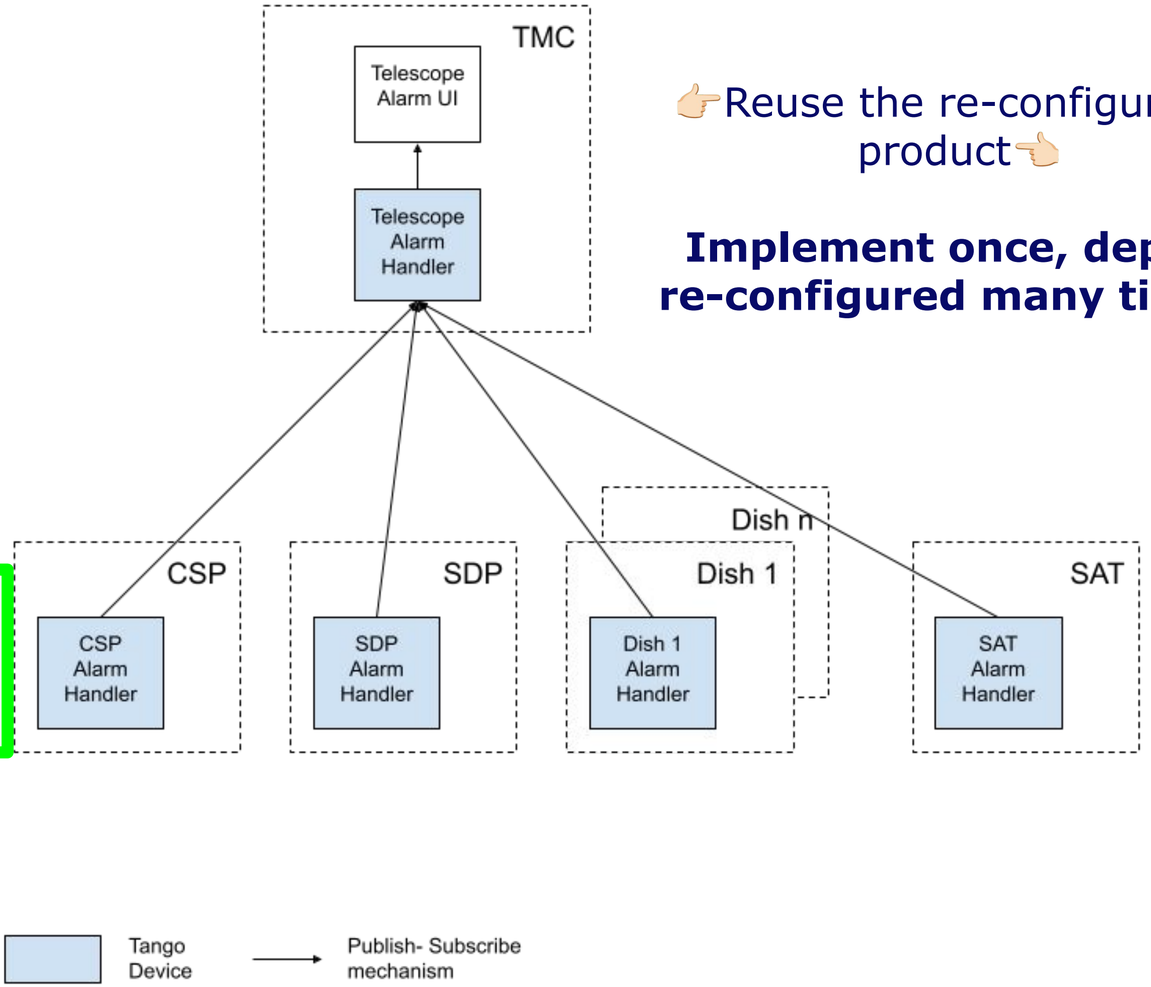
Key components

- TangoDB (Optional)
- **One or more AlarmHandler Tango Device(s) that monitor the values of the attributes in the Tango Devices**
- **One or more Tango Device(s) with one or more attributes that have well defined warning and alarm thresholds**
- Alarm Configurator to add, remove or modify alarm formulas (Optional)
- Alarm displaying front end (Optional)
- Alarm repository for historical records/data storage (Optional)

Use the force!
Hierarchies of AlarmHandlers Devices

- AlarmHandler Devices can be **chained**:
  - One subscribes to Change Events of another AlarmHandler's Attribute
- Alarm formulas can combine multiple Attributes:

```
test/power supply/1/current == 8.4 &&
test/alarmhanbdler/33/weirdalarm == NACK
```



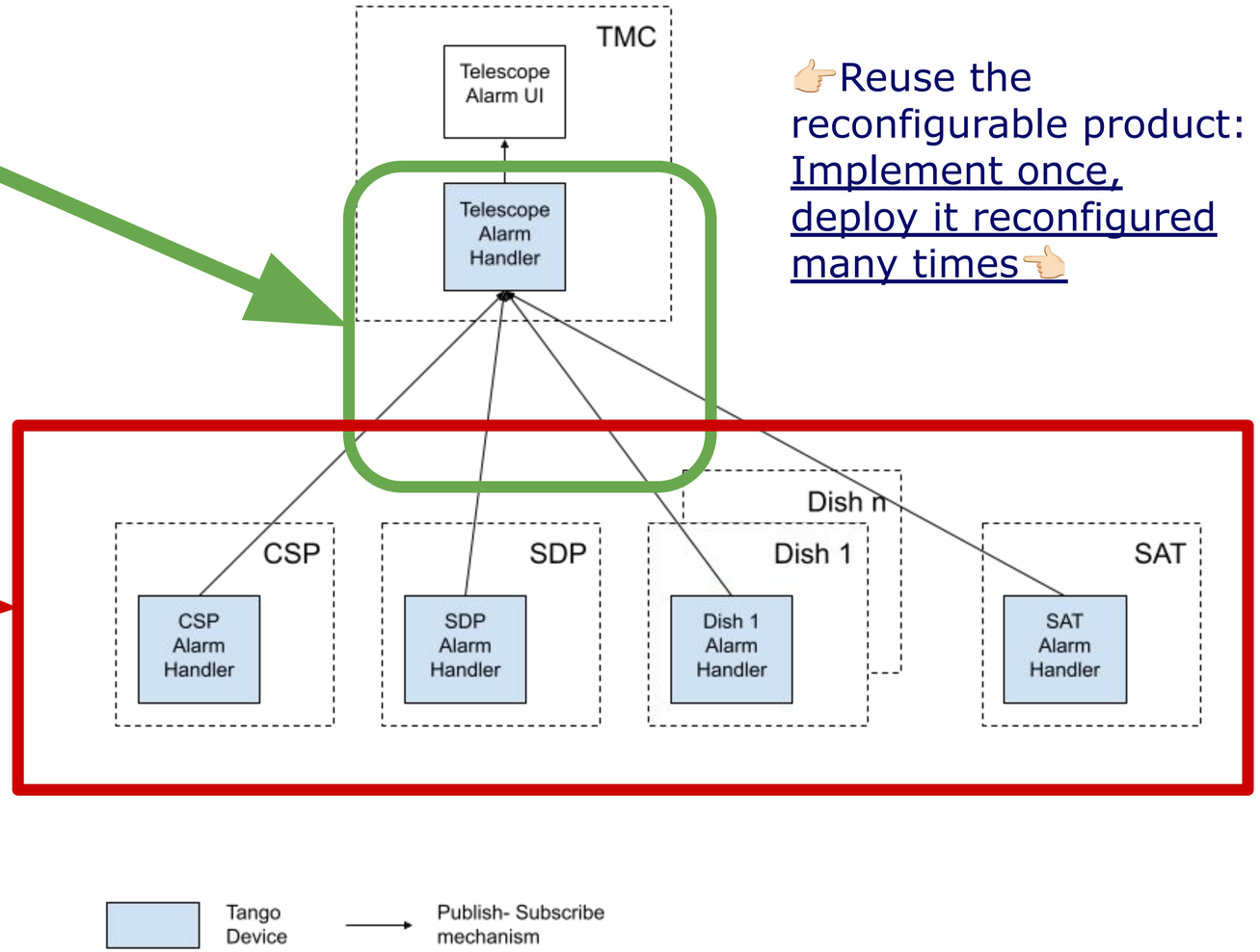
👉Reuse the re-configurable product👈

Implement once, deploy re-configured many times!

Aggregation of Tango alarms into IEC Alerts

Scalability

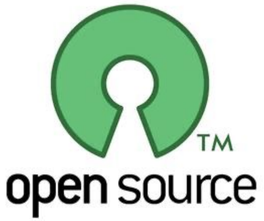
- Vertical: AlarmHandler subscribes to Attributes in other AlarmHandlers
- Horizontal: Add more AlarmHandlers to support more Tango Attributes (limited bandwidth of one AlarmHandler)



👉Reuse the reconfigurable product: Implement once, deploy it reconfigured many times👈

Implementation

- Core component: AlarmHandler Tango Devices (**Open Source**)
  - **Elettra AlarmHandler** (AA0.5)
- Implementation of **Alarm Handler Configurator** CLI/GUI (Minimum Viable Product)
- **Front & back end: IC@MS (licensed to SKAO under BSD 3-clause)**
- **Containerisation** of components: **OCI images**
- Pack components in **Helm charts**
  - Adds flexibility for configuration and resource availability
- Deploy in **Kubernetes** environment



Conclusion

- Software from the Tango Controls Community helped minimizing time spent on new development
- Very flexible deployment through re-configuration
- Solution can be scaled horizontally and vertically without need of a re-design
- Current design meets requirements (mostly 😅 plan vs reality)

Combination of above helped to accomplish our goal:

Operator is able to react based on sufficient information

Crew rescued thanks to operators
©NASA

Lots of text...

But is there something to see?

I had prepared a demo for you...

(Demo effect incoming 😬🤞)

Actually: No Demo possible

My AMS does not work

And now what?

- SKA AMS is already available in public repos under SKAO's project
- But we want to work on it at least until ~2026-09 before "releasing" it to the community:
  - Front end
    - Bug fixes
    - Usability improvements
    - Redraw improvements
    - More improvements to increase maintainability
  - Back end
    - Change to use TangoGQL-Ariadne ✅
    - Remove dependency on PyTango ✅
    - Bug fixes ✅
    - More improvements to increase maintainability
- Once done: Want to move entire project to gitlab.com/tango-controls
- **And that's the point in time** from when on you should contribute your improvements, bug fixes and more

Thank you very much for your attention.

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