





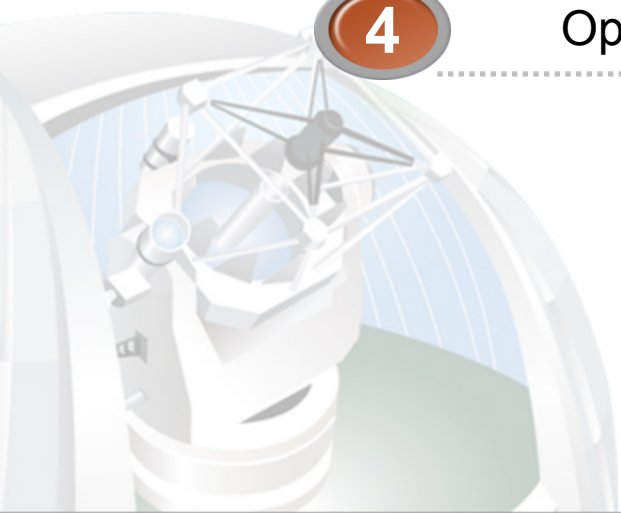
The New Korean SLR System and its Automatic Operation

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-  1 Current Status of Korean SLR Station
-  2 Introduction to New SLR System
-  3 Sensors for Automated Operation
-  4 Operation Software for Automated Operation



Two Korean SLR Stations



Sejong SLR Station (Aug 2015)



Geochang SLR Station (Nov 2017)

Sejong Core Station



- Composition
 - VLBI + GNSS + SLR
- VLBI and GNSS : NGII
 - Operated since March 2012
 - National Geographic Information Institute
- SLR : KASI
 - Operated since August 2015
- Radio Interference(VLBI, Radar)
 - Physical block by the building

- SLR
 - 40cm Rx and 10cm Tx telescope
 - 5kHz repetition rate
 - 2.5mJ/pulse and 50ps pulse width
 - Aircraft detection using a radar

- VLBI
 - 22m Cassegrain antenna
 - Rx frequency : 2, 8, 22 and 43GHz
 - Pointing accuracy : 47.2 arcsec
 - Hydrogen maser atomic clock

Characteristics of Geochang SLR System



■ Status and Plan

- Started from Jan. 2014 and now under the SAT(Site Acceptance Test)
- Test operation for 3 months (Nov. 2017 ~ Jan. 2018)

■ Tracking Capability

- Capable of tracking satellites between 300km and 36,000km altitude
 - LEO, MEO and GEO satellites
- Daytime and nighttime tracking
- 60Hz laser ranging for satellites and 10Hz laser ranging for space debris
- Satellite imaging using adaptive optics
 - Correction rate : > 30Hz
 - Deformable mirror : 97 channel

■ Ranging Accuracy Requirements

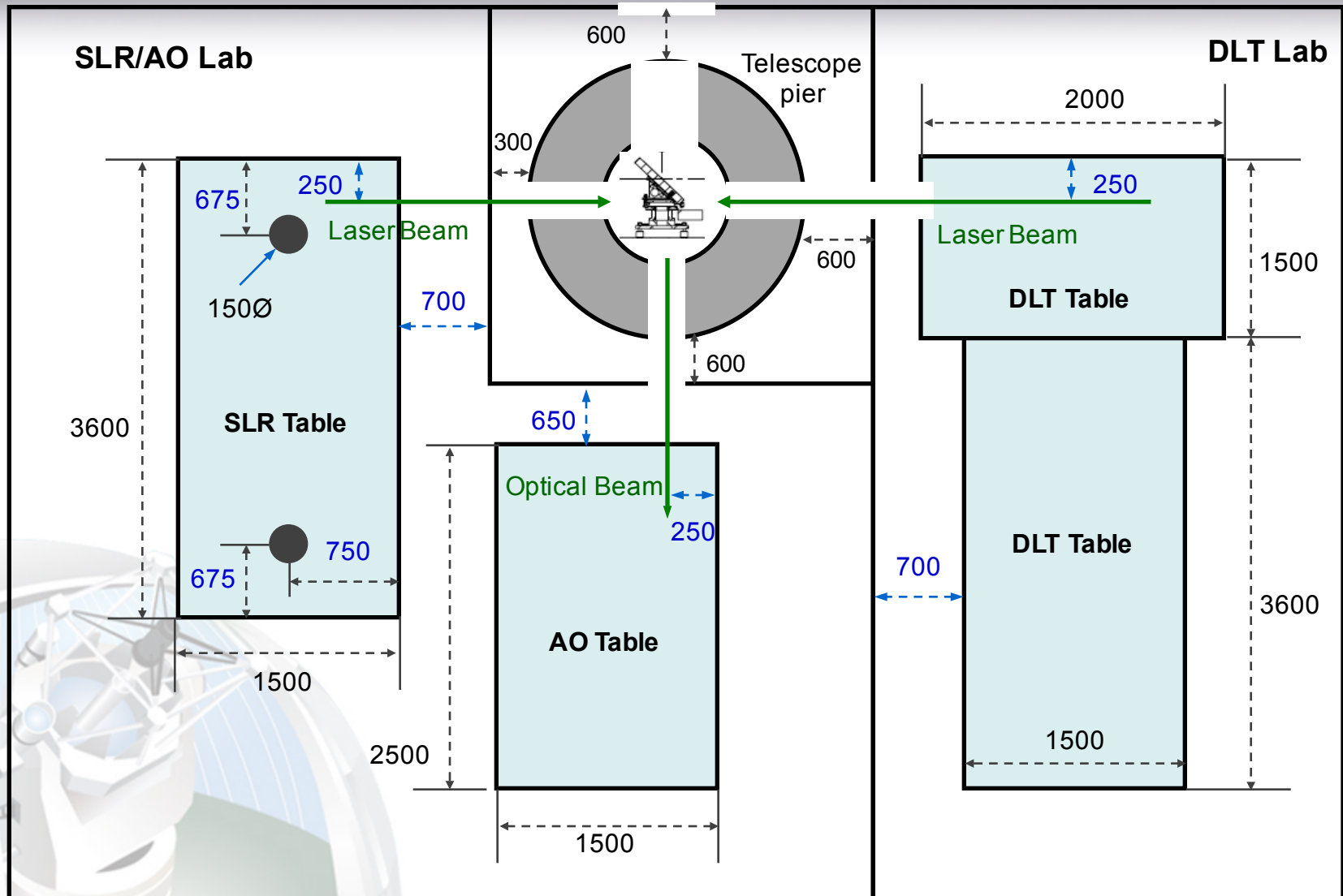
- Lageos : <10mm(SS), <3mm(NP)
- Ground Calibration : <5mm(SS)

■ Operational Functions

- Fully automatic remote operation
- Automatic ranging based on schedule and aircraft detection(radar and IR camera)



Layout of Optical Tables



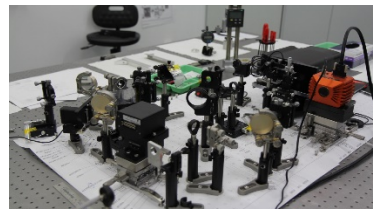
※ DLT : Debris Laser Tracking

System Configuration for SLR, AO and DLT



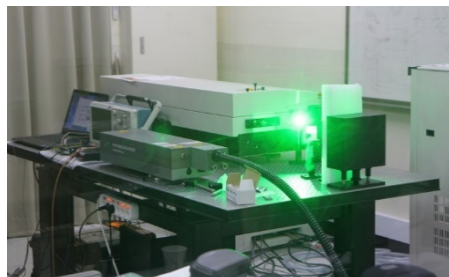
Using one OTA, tracking mount and operation system

SLR/AO/DLT Lab



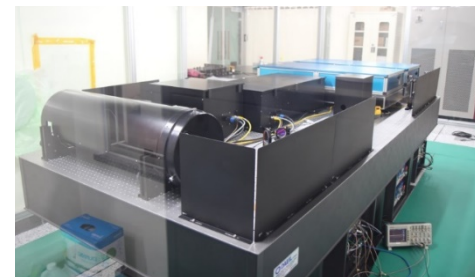
AO Lab

DLT Lab

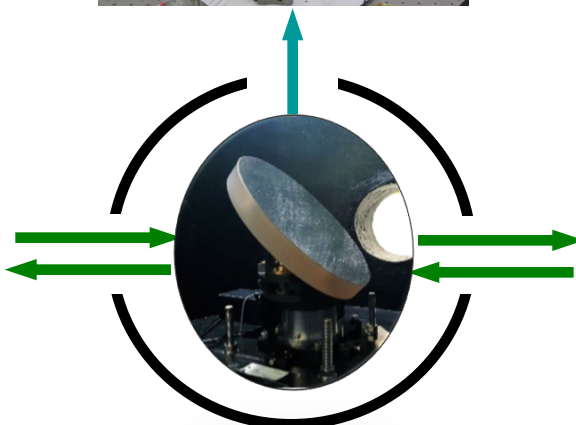


Laser, Tx/Rx Optics,
Timing system

SLR Lab



Laser, Tx/Rx Optics,
Timing system



C7 Rotation Mirror in Pier



Operation & Electric Room

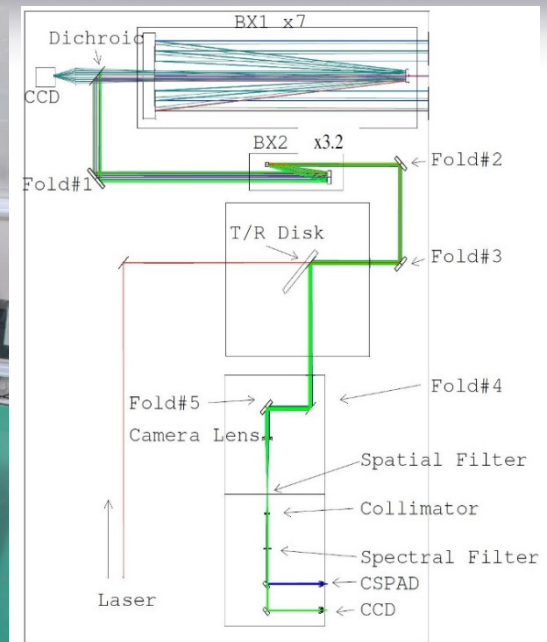
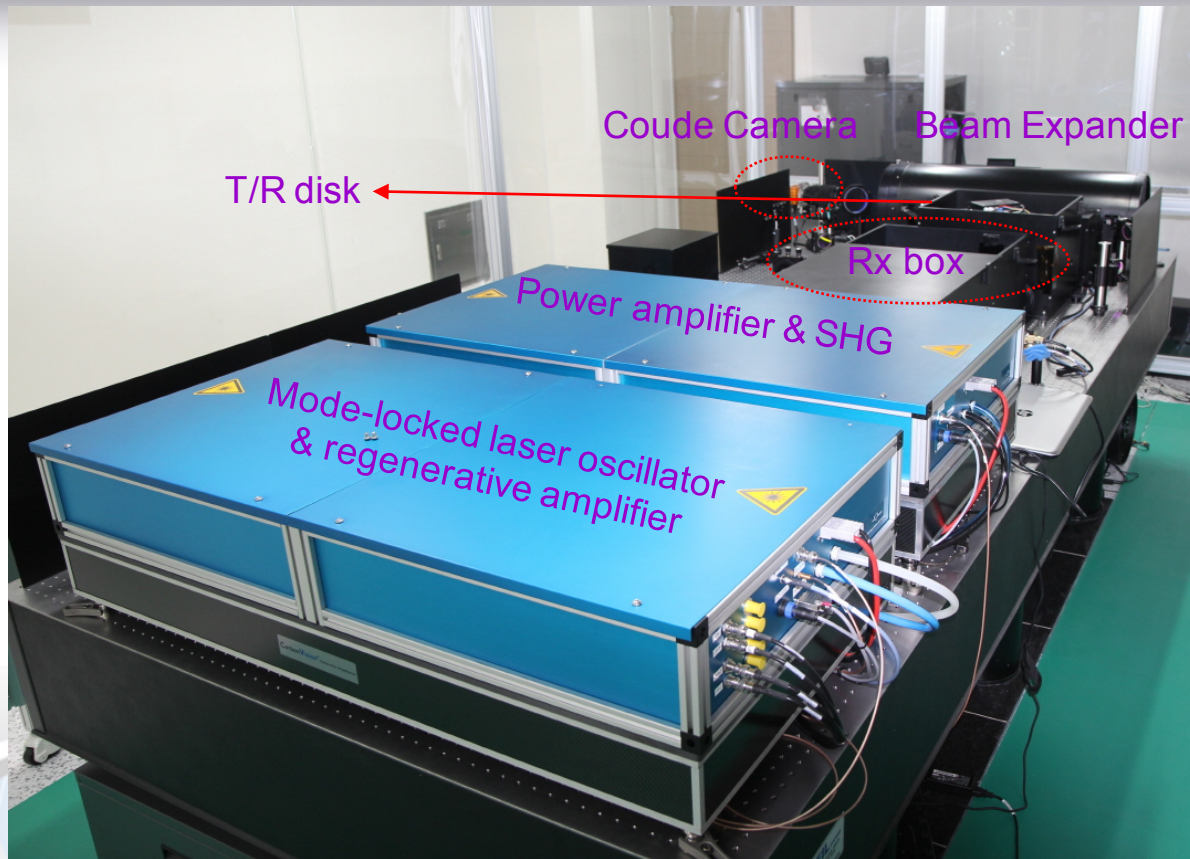


Weather Station



Aircraft Detection Radar

SLR Laser & Tx/Rx System



• T/R disk

- T/R disk provides optical switch (transmit/receive)
- Disk has mirror coating for receive with two coating holes for transmit
- Coating holes are synchronized to laser fire so that pulses are transmitted

• Laser

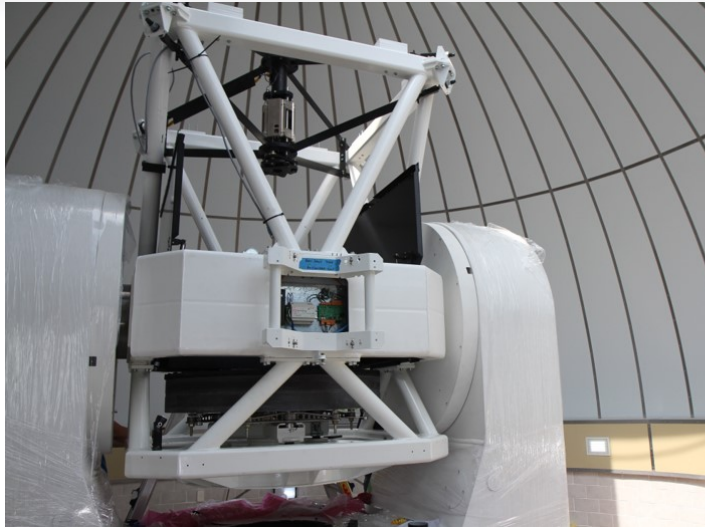
- Pulse energy : 15 mJ
- Pulse width : 10ps
- Beam diameter : 10 mm

• Receiving box

- Spatial & spectral filter
- C-SPAD, CCD camera

• Beam Expander

- Two beam expanders : x3.2, x7



- **Optical telescope**

- Clear aperture : 1000 mm(M1), 250 mm(M2)
- Material : Clearceram Z-HS(M1), Zerodur(M2)
- M1 reflectivity : 96%

- **Focus mechanism**

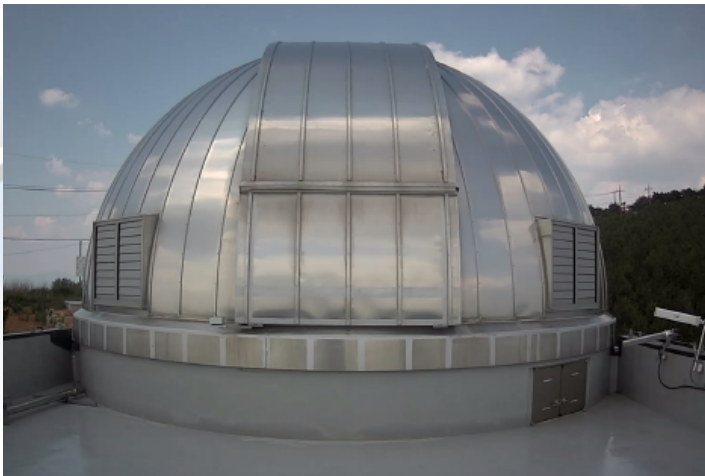
- Automated focus mechanism with 10um accuracy
- Two temp. sensors on truss maintain focus depending on temp.

- **Tracking mount**

- Slew rate : 30 deg/s(Az), 20 deg/s(EI)
- Acceleration : 10 deg/s²(Az), 5 deg/s²(EI)
- Slew range : ± 335 deg(Az), -5~185 deg(EI)
- Pointing and tracking accuracy : < 1 arcsec
- Arc motor torque(continuous/peak) : 976/3900 Nm

- **Dome**

- Type : ash dome
- Diameter : 8 meter
- Slew rate & acceleration : 15 deg/s & 8 deg/s²
- 4 windows to decrease the air turbulence for adaptive optics



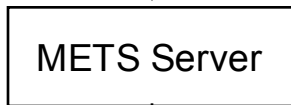
Sensors for Weather Monitoring



METS Sensor

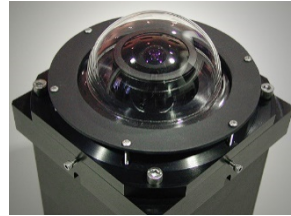


Ethernet

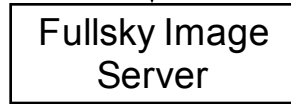
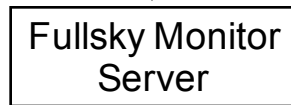


- Temperature
- Humidity
- Pressure
- Raining
- Visibility
- Dew point
- Wind direction
- Wind speed

Fullsky Camera

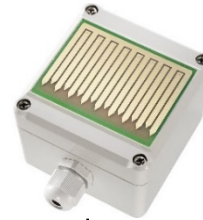


Ethernet



Sky image

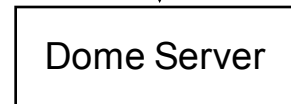
Rain Sensor (for dome close)



Serial



Ethernet



Emergency signal
(dome closed)

Cloud Sensor



Ethernet



- Ambient temp.
- Sky temp.
- Dew point
- Wind speed
- Humidity
- Moisture
- Brightness

Observatory
Server

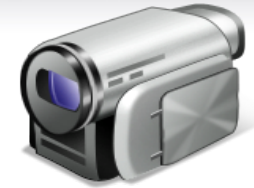
Sensors for Aircraft Detection



Aircraft Detection Radar



Aircraft Detection IR Camera



Serial Comm

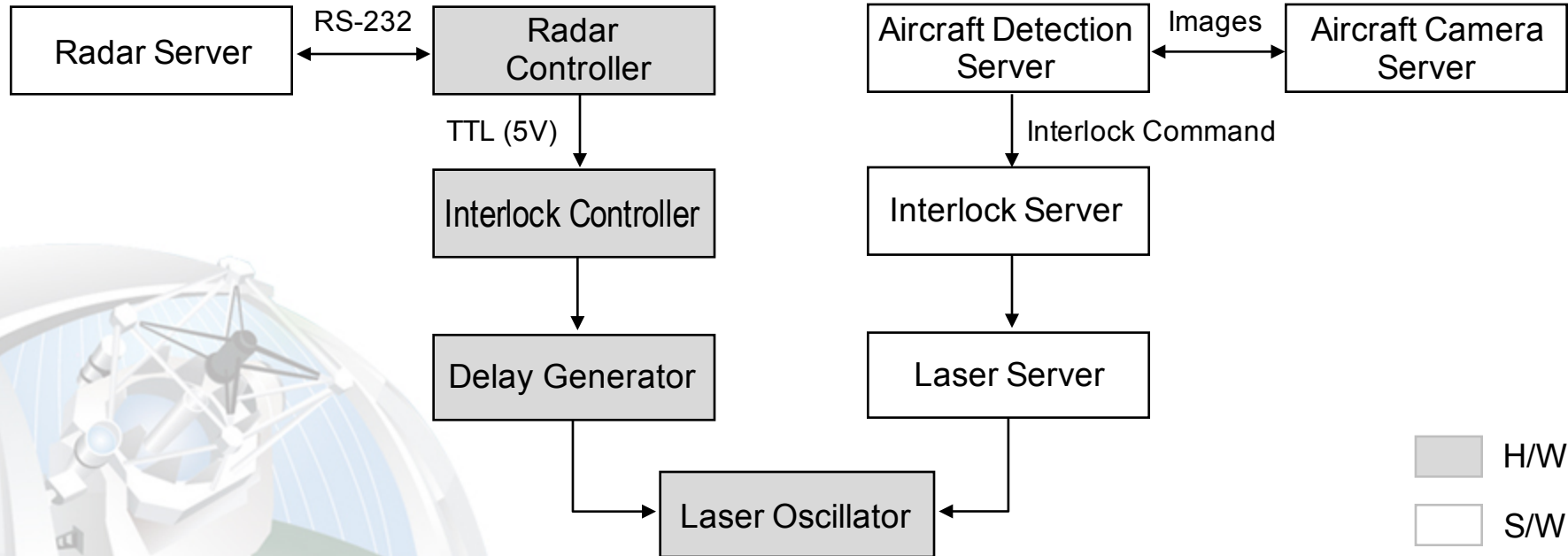
Ethernet

RS-232

Images

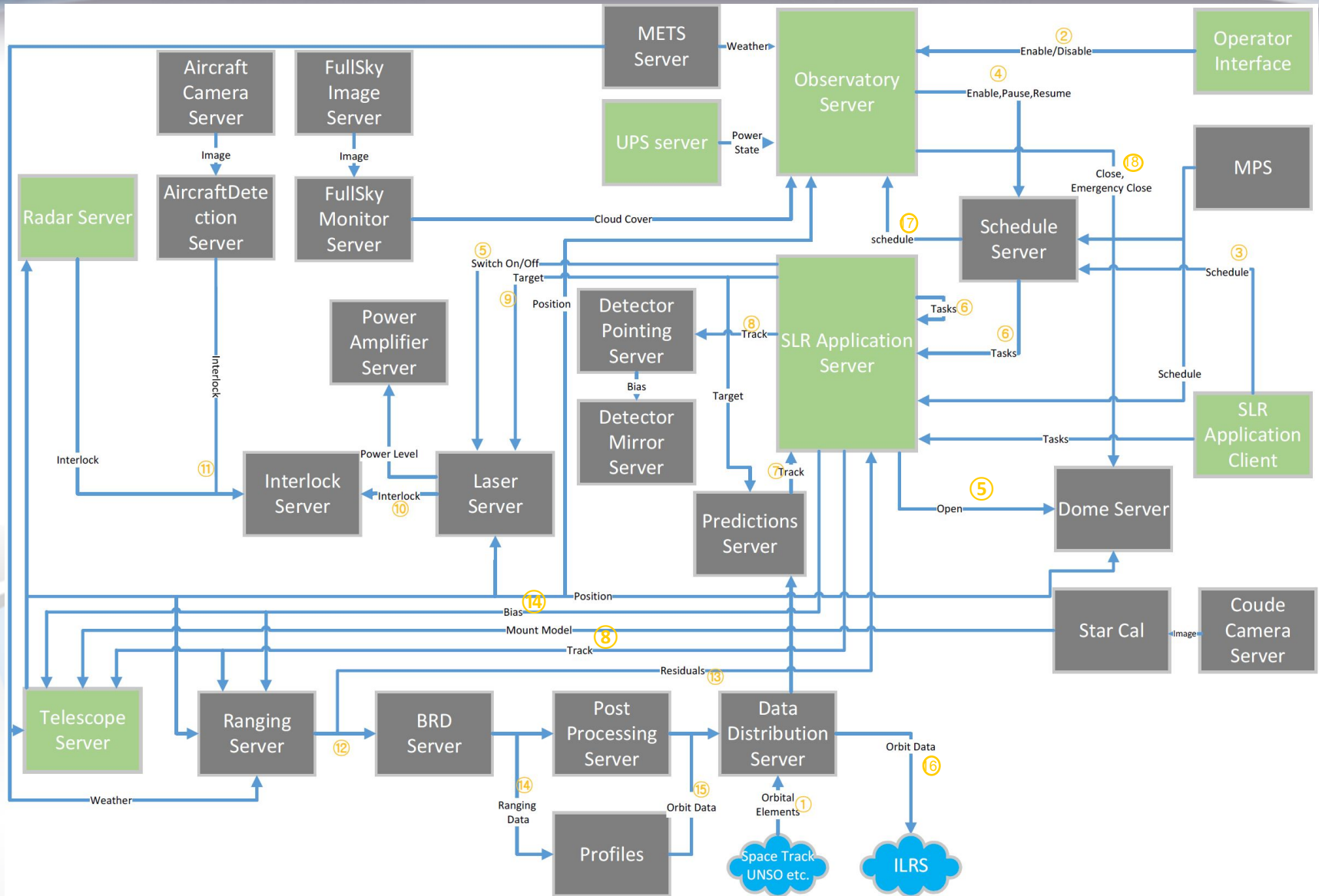
TTL (5V)

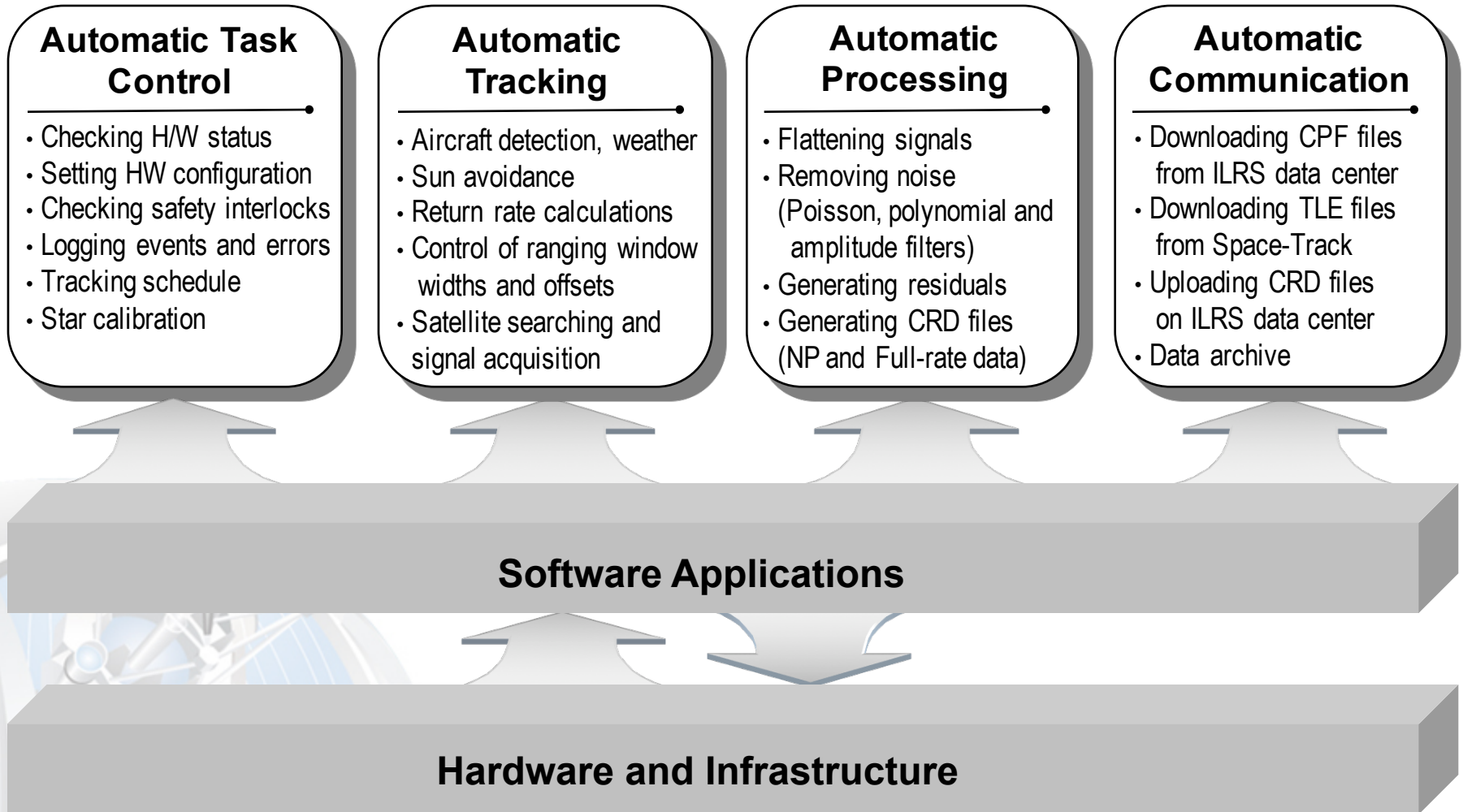
Interlock Command



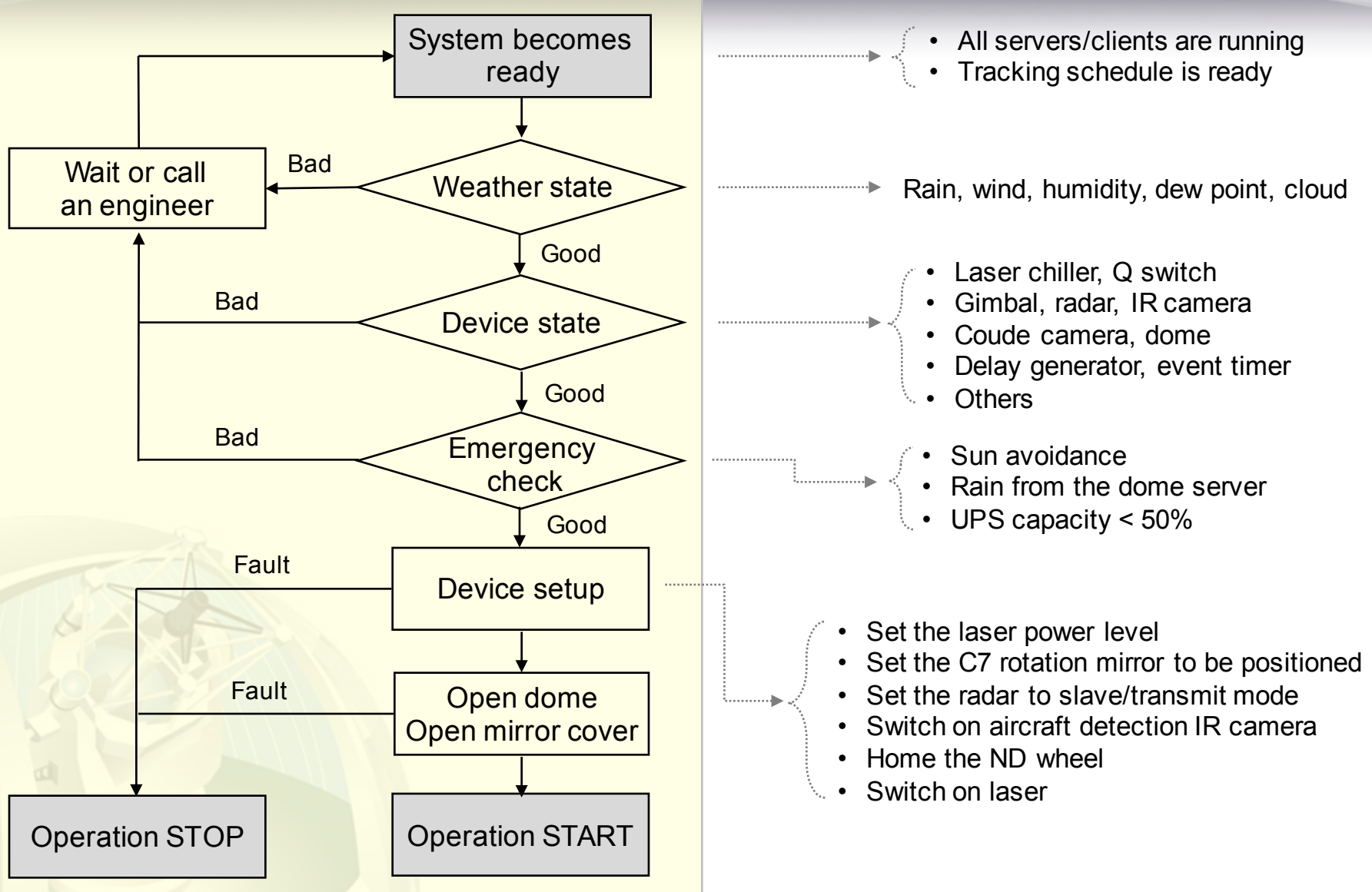
※ The laser fire is prohibited by the dual system, aircraft detection radar and IR camera in order to increase system reliability. The laser fire is paused when one of them detects an airplane.

Architecture of Operation Software

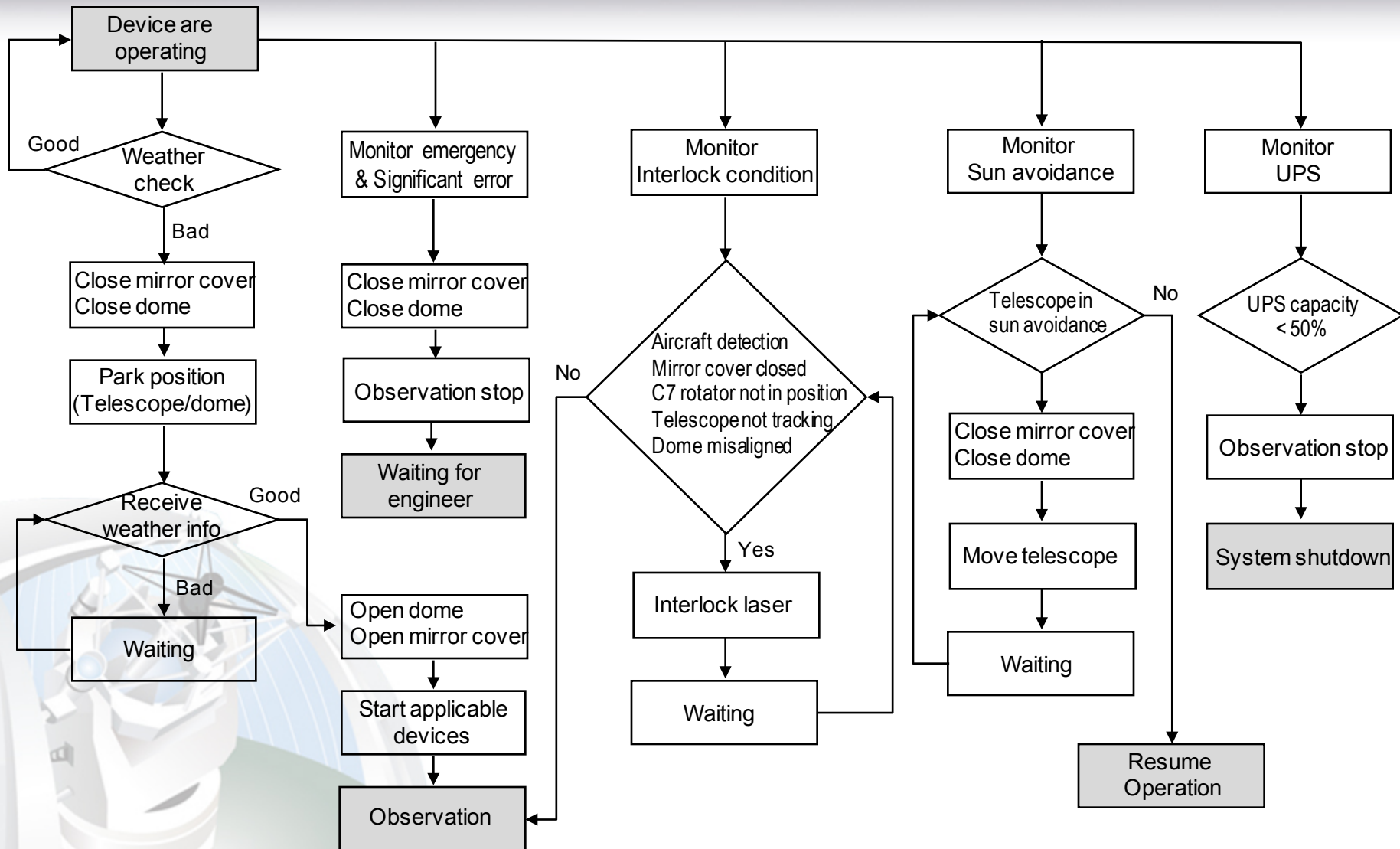




General Observation for Automated Operation



Exception Situation for Automated Operation



감사합니다
Thank you~!

Gam-sa-ham-ni-da !

