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# INTRODUCTION

- Qatar has made significant advancements in modern aviation infrastructure through the continuous enhancement of Communication, Navigation, Surveillance, and Air Traffic Management (CNS/ATM) systems.
- With the rapid growth of air traffic operations, increasing cybersecurity and airspace security challenges, and the emergence of advanced aviation technologies, the modernization of CNS/ATM infrastructure has become a strategic national priority.
- These initiatives collectively support Qatar's vision for a future-ready, resilient, and highly secure aviation environment aligned with ICAO global modernization objectives and the evolving demands of international air traffic operations.

This presentation highlights the few of the key technological advancements implemented across Qatar's aviation ecosystem to enhance aviation safety, surveillance performance, operational efficiency, resilience, and airspace security.

1. GNSS Interference Resilience: Mitigation of Jamming and Spoofing Threats in Aviation

2. Counter-Unmanned Aircraft Systems (C-UAS) : Operational Framework for Detection, Tracking, Identification & neutralization of micro to small Unmanned Aerial threats

3. Enhanced Flight Planning: Implementation of eFPL within the FF-ICE Framework for Collaborative ATM Operations

4. Advanced ATC Communications: Next-Generation Voice Communication System (VCS X10) - Architecture and Operational Capabilities

5. Surveillance Infrastructure Performance: Spotlight on Integrated MLAT/ADS-B Surveillance full Coverage at HIA and DIA Airports

# GNSS Interference Resilience:

## Mitigation of Jamming and Spoofing Threats in Aviation


**DETECT**
Identify Threats

**MITIGATE**
Reduce Impact

**ASSURE**
Ensure Integrity

Strengthening GNSS Reliability.
Securing Aviation Operations.

**MONITOR**
Continuous Surveillance

**ANALYZE**
Advanced Analytics

**RESPOND**
Timely Alerts & Countermeasures

**PROTECT**
Reliable Navigation. Safe Operations.

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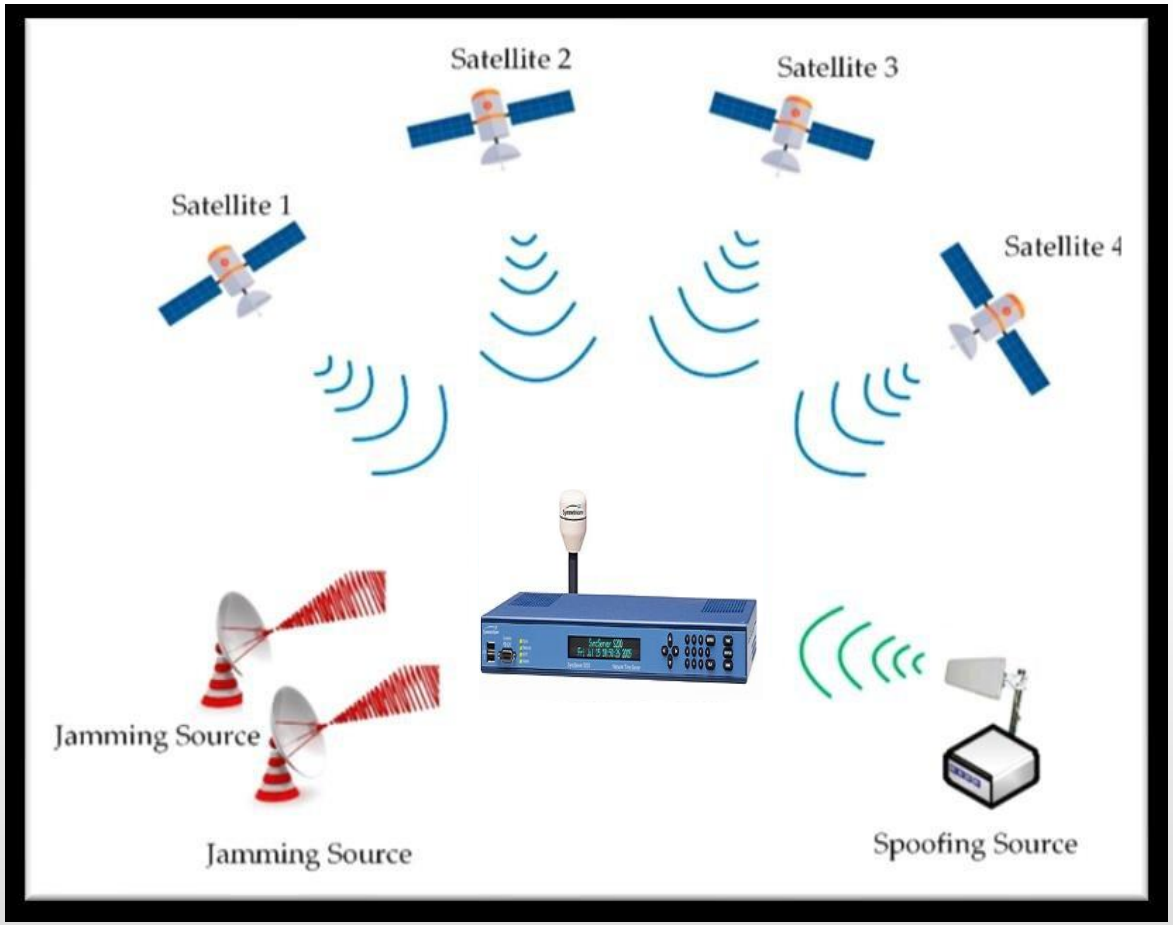
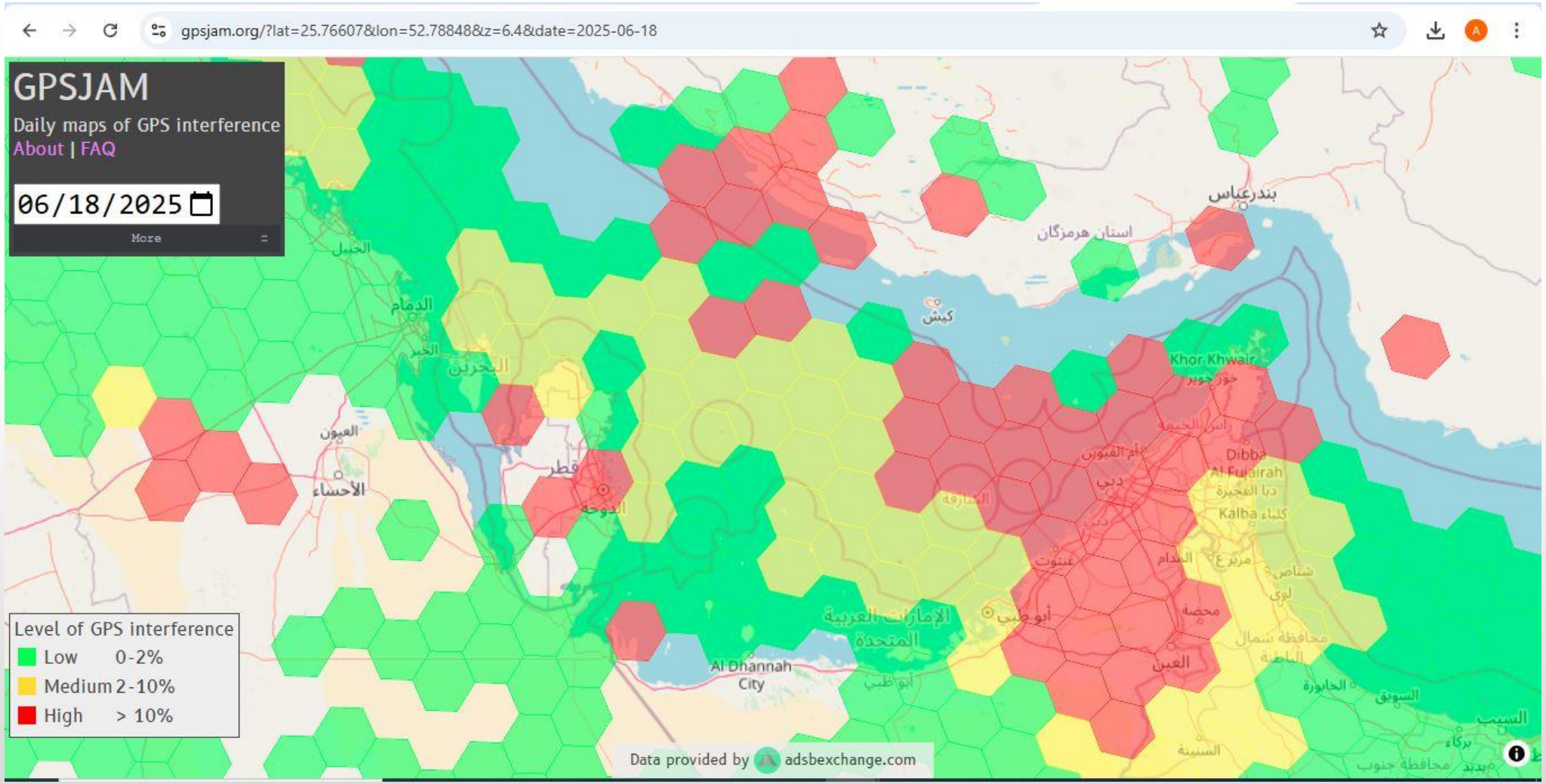
# Summary Comparison

| Aspect | GPS Jamming | GPS Spoofing |
|---|---|---|
| **Definition** | Blocking or overwhelming GPS signals | Sending fake GPS signals to mislead receivers |
| **Objective** | Deny GPS functionality (no signal, no data) | Deceive receiver with false position/time data |
| **How it works** | Emits noise/interference on GPS frequencies | Broadcasts counterfeit GPS signals mimicking satellites |
| **Effect on GNSS** | No GNSS fix or position | Wrong position, speed, or time shown |
| **Detectability** | Easily detectable (loss of signal) | Harder to detect (appears as a valid signal) |

# Overview of GNSS Jamming and Spoofing



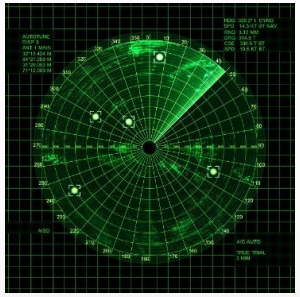
# RECENT GPS JAMMING MAP



# Global GNSS Constellations & Frequency

| GNSS SATELITE | Country / Region | Constellation Name | Frequency Bands | Services |
|---|---|---|---|---|
| **GPS** | USA | NAVSTAR GPS | - **L1**: 1575.42 MHz (C/A code, civilian) - **L2**: 1227.60 MHz (military, L2C) - **L5**: 1176.45 MHz (safety of life) | Civil, Military, Safety of Life |
| **GLONASS** | Russia | GLONASS | - **L1**: 1602 MHz ± FDMA offset (civilian) - **L2**: 1246 MHz ± offset - **L3**: 1202.025 MHz (future) | Civil, Military |
| **Galileo** | European Union | Galileo | - **E1**: 1575.42 MHz (civilian) - **E5a**: 1176.45 MHz (aviation) - **E5b**: 1207.14 MHz (open service) - **E6**: 1278.75 MHz (commercial) | Open, Commercial, Encrypted |
| **BeiDou** | China | BeiDou Navigation System | - **B1I**: 1561.098 MHz - **B1C**: 1575.42 MHz - **B2a**: 1176.45 MHz - **B2b**: 1207.14 MHz - **B3I**: 1268.52 MHz | Civil, Military, Encrypted |
| **NavIC** | India | IRNSS / NavIC | - **L5**: 1176.45 MHz - **S-band**: 2492.028 MHz (regional use) | Regional, Civil & Military |
| **QZSS** | Japan | QZSS | - **L1**: 1575.42 MHz - **L2C**: 1227.60 MHz - **L5**: 1176.45 MHz - **L6**: 1278.75 MHz | Regional, augmentation of GPS |

# AVIATION'S GROWING DEPENDENCE ON GNSS



- Precise time sync: radar stations, ATC, airports.


- GNSS used in ADS-B, MLAT and navigation.

- UTM Server

- Even short outages can impact aviation safety.

# CURRENT THREAT LANDSCAPE

- Increase in GPS jamming and spoofing incidents.
- Low-cost devices can disrupt civil aviation GNSS.
- Documented disruptions in Europe, Middle East, maritime zones.

# RISKS IN QATAR'S AVIATION ECOSYSTEM

- Strategic location near conflict zones
- Exposure to maritime jamming threats.
- GNSS Dependency for ATC and future UTM systems.

Ground based Monitoring & detection of GPS/GNSS jamming/spoofing events

&

Protection of Critical CNS infrastructure from any GNSS Jamming/interference threats.

(Protect GNSS signals With Multi layer measures)

# Protect GNSS signals With Multi layer measures

# GNSS Resilience– Hardware Layer

**Mitigation at the GNSS antenna side**

- **Antenna Level (CRPA)**: Controlled Reception Pattern Antenna (CRPA) units are the primary hardware defense. They use multiple antenna elements to create "nulls" in the direction of a jammer, effectively "turning off" reception from the interference source.

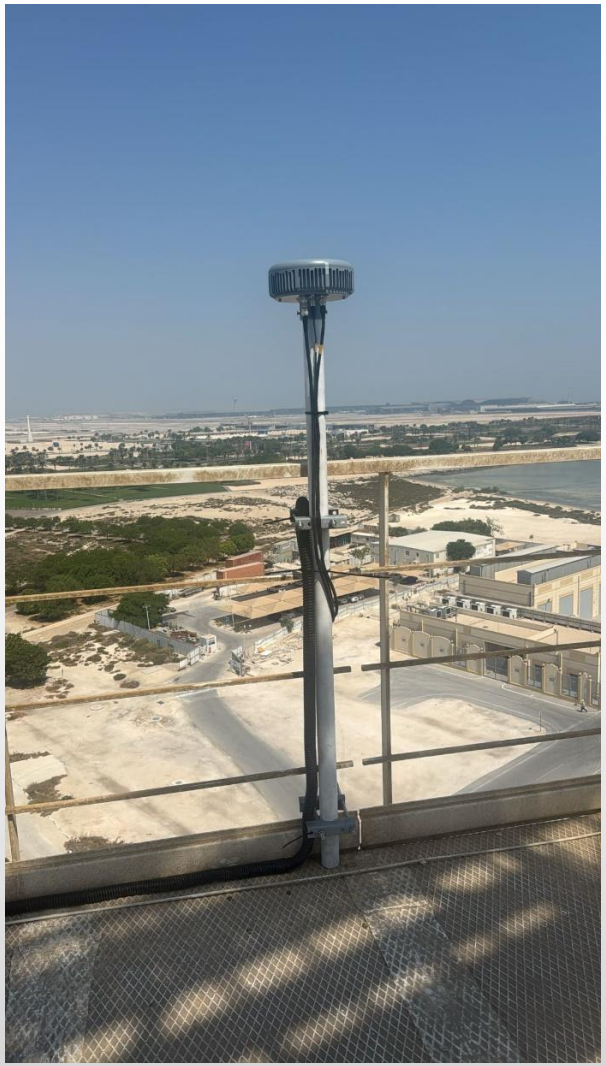
**Mitigation at GNSS receiver side**

- **Multi-Constellation/Multiband GNNS receivers**: Modern GNSS receivers have the physical RF front-end capacity to track multiple satellite systems (GPS, Galileo, BeiDou, GLONASS) across several frequencies (L1, L2, L5).

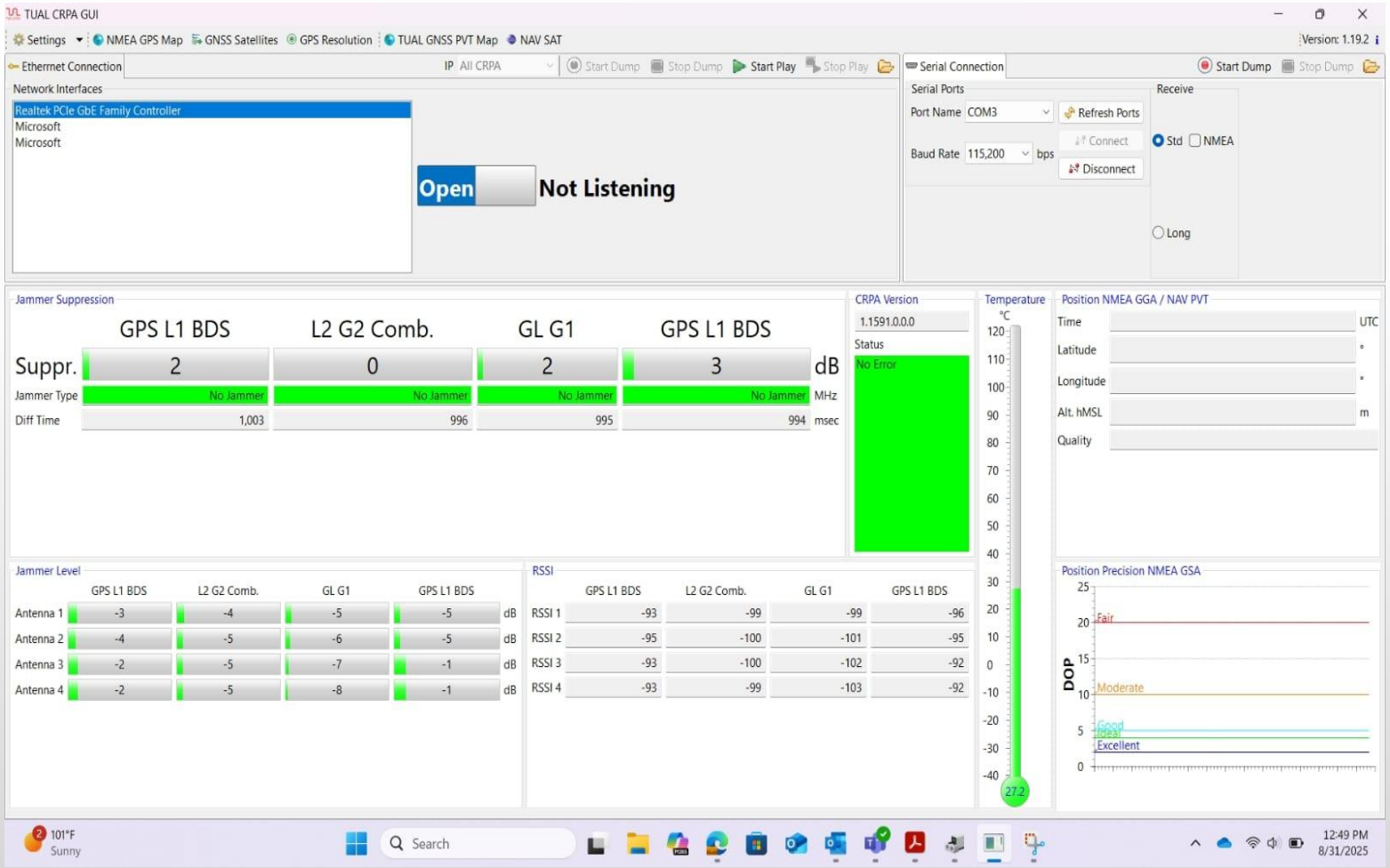
## GNSS Resilience – Software Layer

**Signal Processing and Anti-Jamming & Anti-Spoofing Algorithms** : Software filters, such as adaptive notch filters ,pulse blanking etc. to identify and excise specific types of jamming signals within the digital stream.

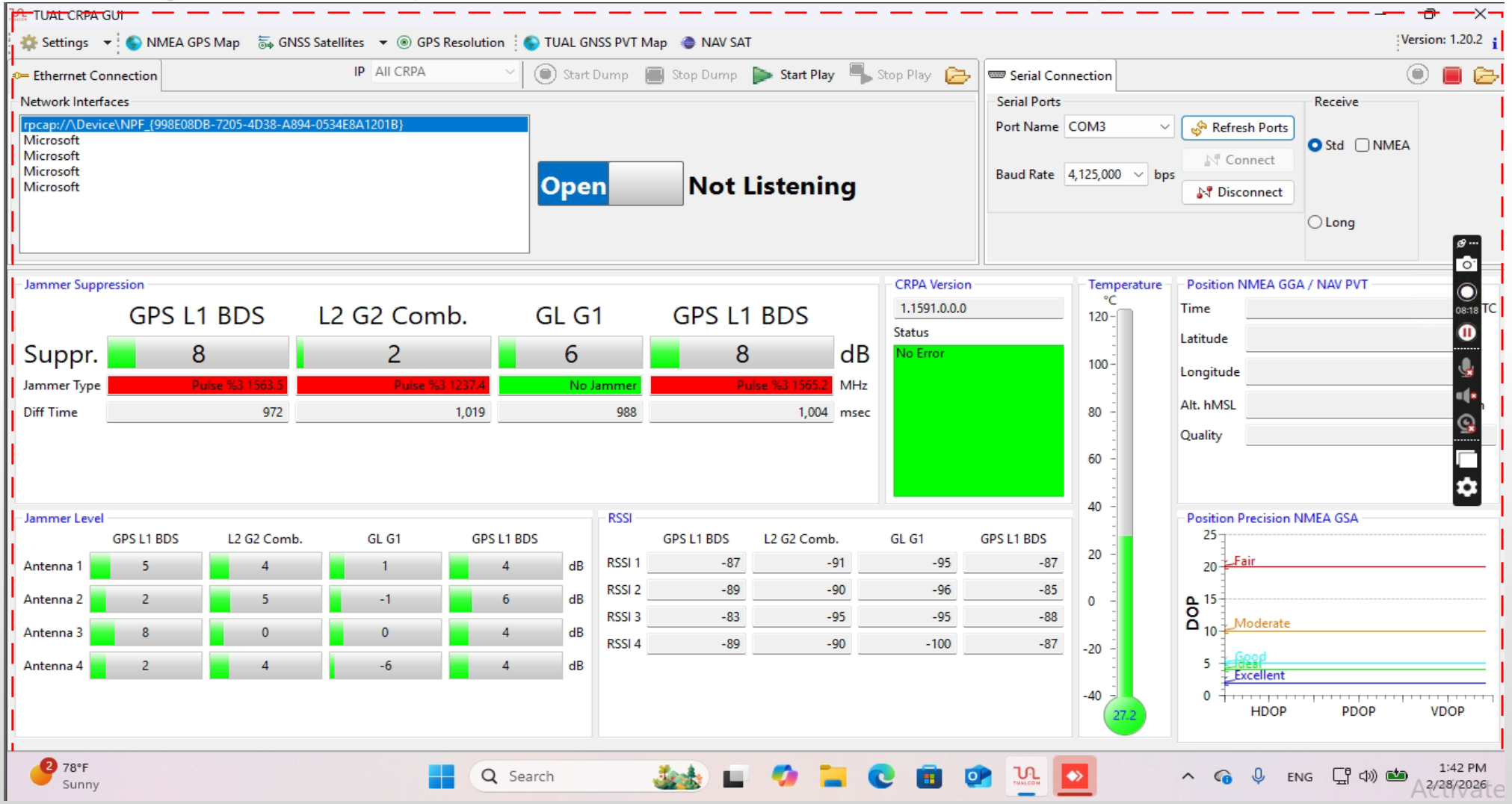
# SITE PICTURES OF DEPLOYMENT IN QCAA CNS INFRASTRUCTURE



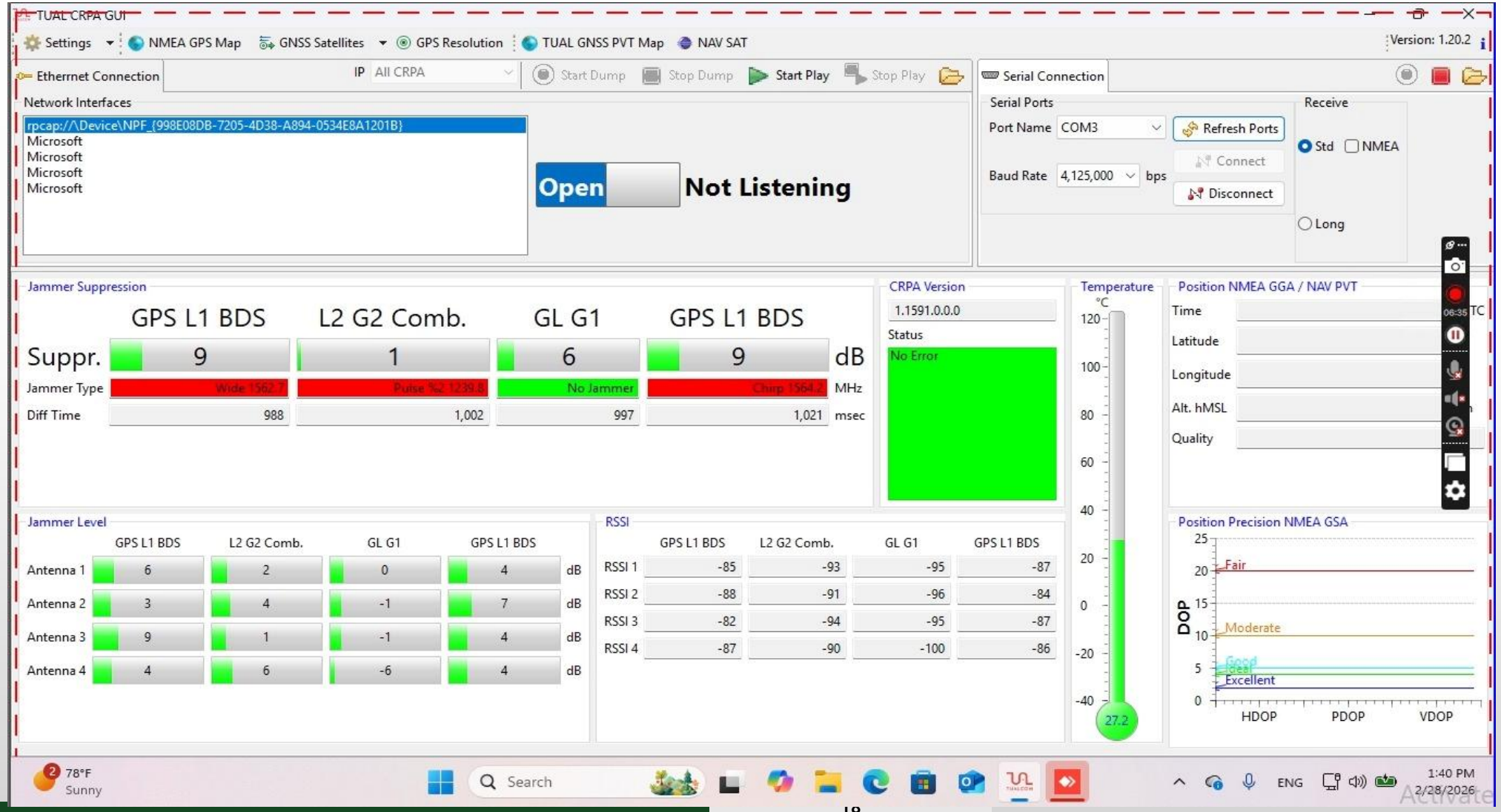
## HMI pictures (no Jamming)



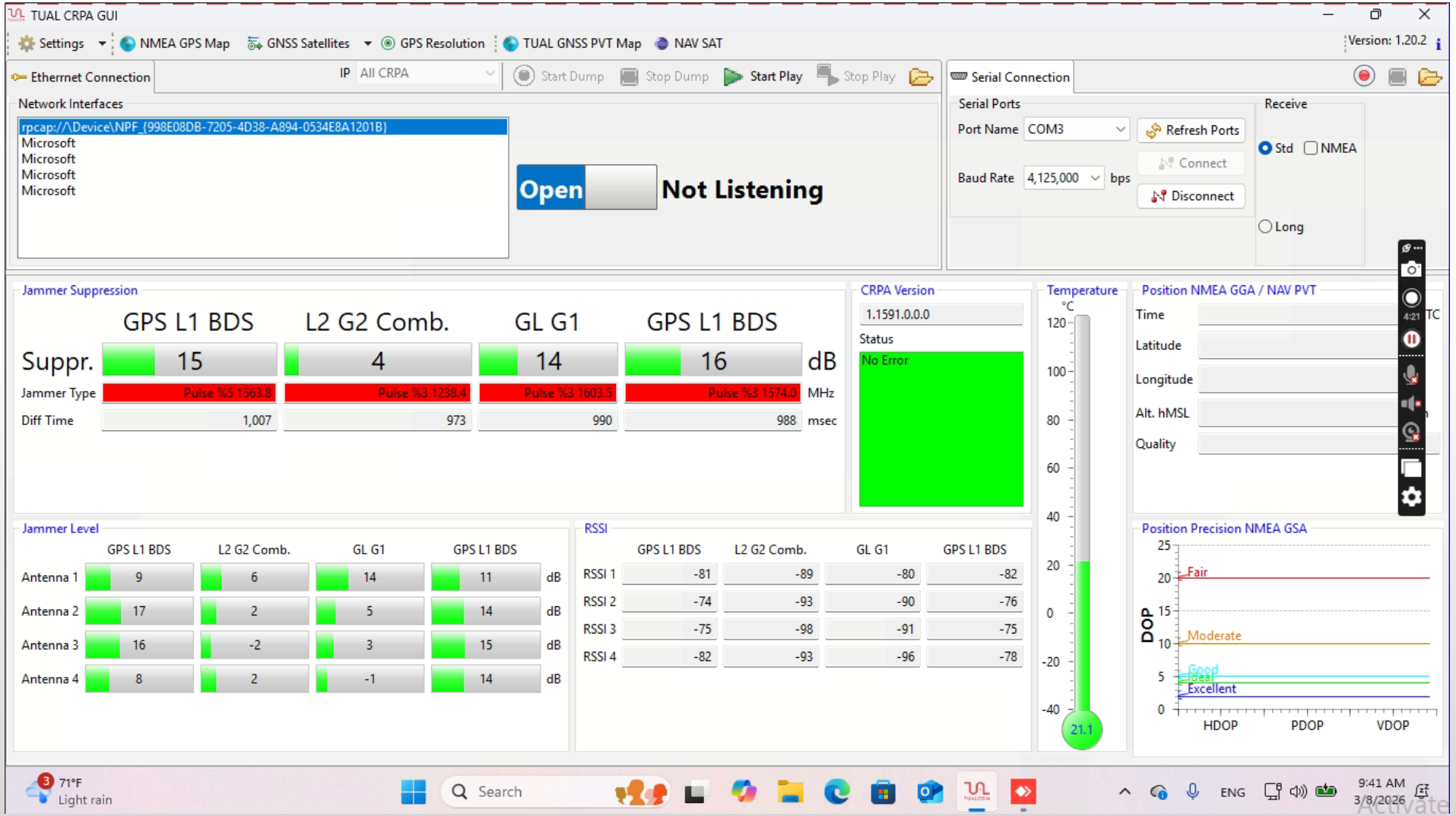
# HMI pictures (taken from 28th Feb 2026)



# HMI pictures (taken from 28th Feb 2026)



# HMI pictures (taken from 8th Mar 2026)



# Protection against GNSS Resilience using CRPA

**Controlled Reception Pattern Antenna (CRPA)** technology is the "gold standard" for protecting GNSS signals by using spatial diversity to differentiate between real satellites and interference.

Unlike standard GNSS antennas which has a single antenna that receive signals from all directions, a CRPA works by using multiple small antenna elements together with a digital signal processor to electronically shape the antenna reception pattern and suppress interference/jammers while still receiving genuine GNSS satellite signals.

**Main Purpose**

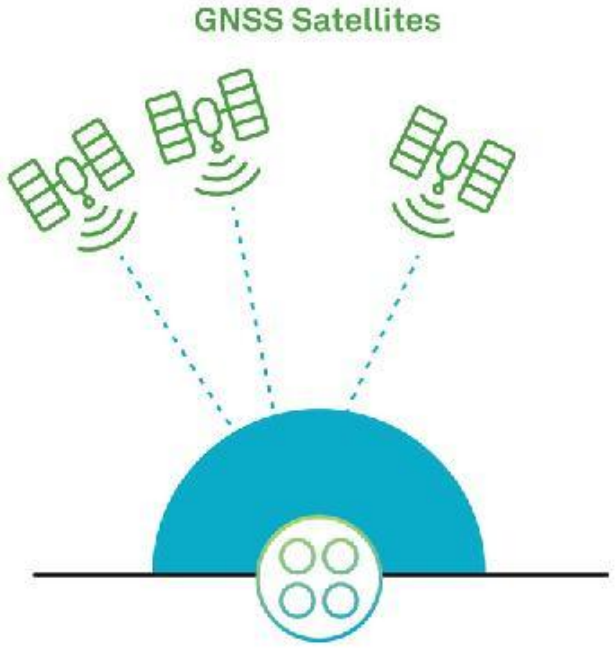
The unit protects critical GNSS-based systems by:

- Detecting interference sources
- Suppressing reception of interference signals
- Preserving authentic satellite signals
- Maintaining reliable Positioning, Navigation & Timing (PNT)

## How CRPA Works

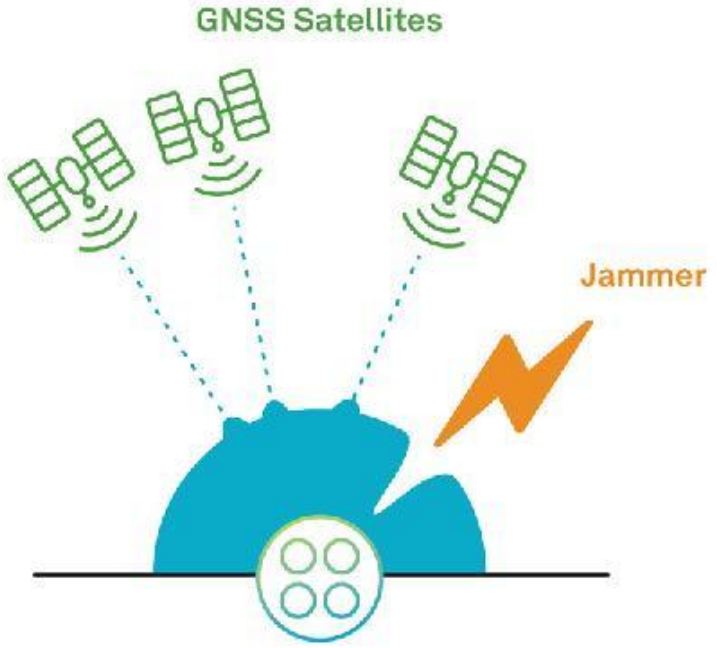
A CRPA system consists of a multi-element antenna array (typically 4 to 16 elements) and an antenna electronics (AE) unit. It uses two primary signal processing techniques

- **Null-Steering:** The system detects the direction of an interference source and electronically creates a "null" (a blind spot) in its reception pattern toward that specific direction. This can suppress jammers by **30–65 dB**.
- **Beamforming (Beam-Steering):** The system simultaneously amplifies the gain in the direction of legitimate satellites, increasing the signal-to-noise ratio to maintain a position lock even in high-interference environments




**No Jammer**

Near-hemispherical gain pattern of a CRPA antenna.




**Jammer Attack**

CRPA antenna forms a null in the direction of jammer and beams of gain are steered at satellites.

GNSS Satellites
↓
CRPA Antenna Array
↓
Anti-Jam Processing Unit
↓
Protected GNSS Output
↓
MLAT / ADS-B / ATM / NTP / Radar Systems

| CRPA Elements | Approx Jammer Nulls |
|---|---|
| 4-element | 3 jammers |
| 7-element | 6 jammers |
| 16-element | 15 jammers |

## Key Benefits vs. Standard Antennas

- **Resilience:** It is significantly more effective than software-only filters because it blocks the interference physically before it enters the receiver.
- **Anti-Spoofing:** Because spoofers usually transmit multiple fake satellite signals from a single ground source, CRPA systems can detect this single-point origin and block the entire spoofing source.
- **Dynamic Adaptation:** The system constantly re-evaluates the signal environment, adjusting its nulls and beams in real-time as the aircraft or the jammer moves.

# Main Components

1. **CRPA Antenna**
   - Multi-element antenna array
   - Receives GNSS signals from multiple directions
   - Detects direction of interference

2. **Anti-Jam Processor**
   - Core electronic unit performing:
   - Adaptive beamforming
   - Null steering
   - Interference suppression
   - Signal filtering algorithms

3. **GNSS Receiver Interface**

Provides protected GNSS signals to:

- MLAT sensors synchronization
- ADS-B systems
- Timing servers
- ATM systems
- NAVIGATION equipment
- Defence equipment

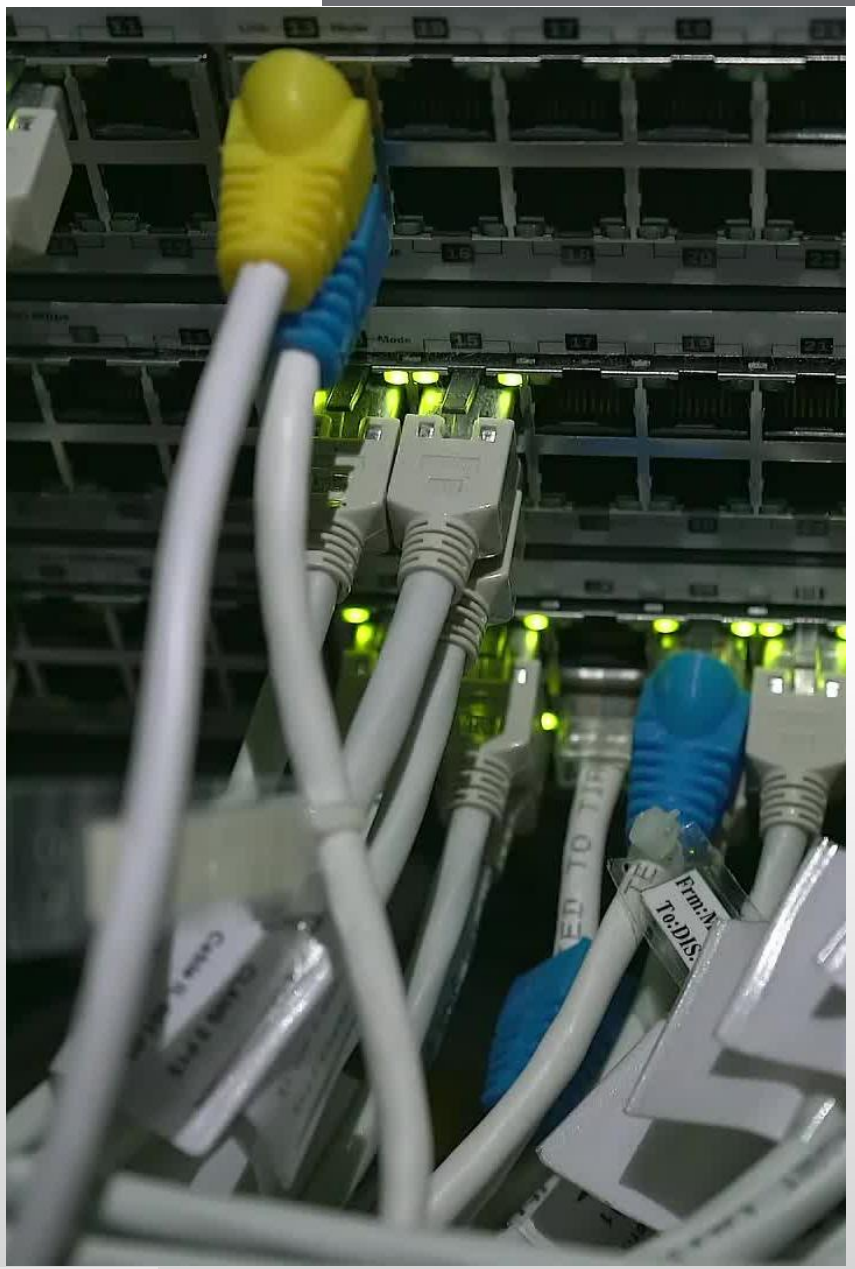
4. **Monitoring & Control Interface**
   - Jam levels & alarms in multi bands & constellation
   - RF monitoring
   - System status
   - Event logging
   - Performance visualization

# Key Functionalities

1. Anti-Jamming & spoofing (Adaptive Nulling & Beamforming)
2. Multi-Constellation Support & Multi-Frequency Support. It covers all constellations and its bands
3. Real-Time detailed Monitoring of RF interference in each bands/constellations and providing alarms

# INTEGRATION WITH CNS SYSTEMS

- Compatible with ATC time servers, MLAT & ADS-B ground stations.
- Works with standard PTP/NTP infrastructure.
- Scalable for protection of other GNSS dependent navigation & surveillance equipment.



# COUNTER-UNMANNED AIRCRAFT SYSTEMS (C-UAS)

**Operational Framework for Detection, Tracking, Identification & neutralization of micro to small Unmanned Aerial Threats/Drones in Airport environment**


- DETECTION
- TRACKING
- IDENTIFICATION
- NEUTRALIZATION

- ENHANCE AIRPORT SAFETY & SECURITY
- REAL-TIME SITUATIONAL AWARENESS
- RAPID RESPONSE & MITIGATION
- PROTECT PASSENGERS, ASSETS & OPERATIONS

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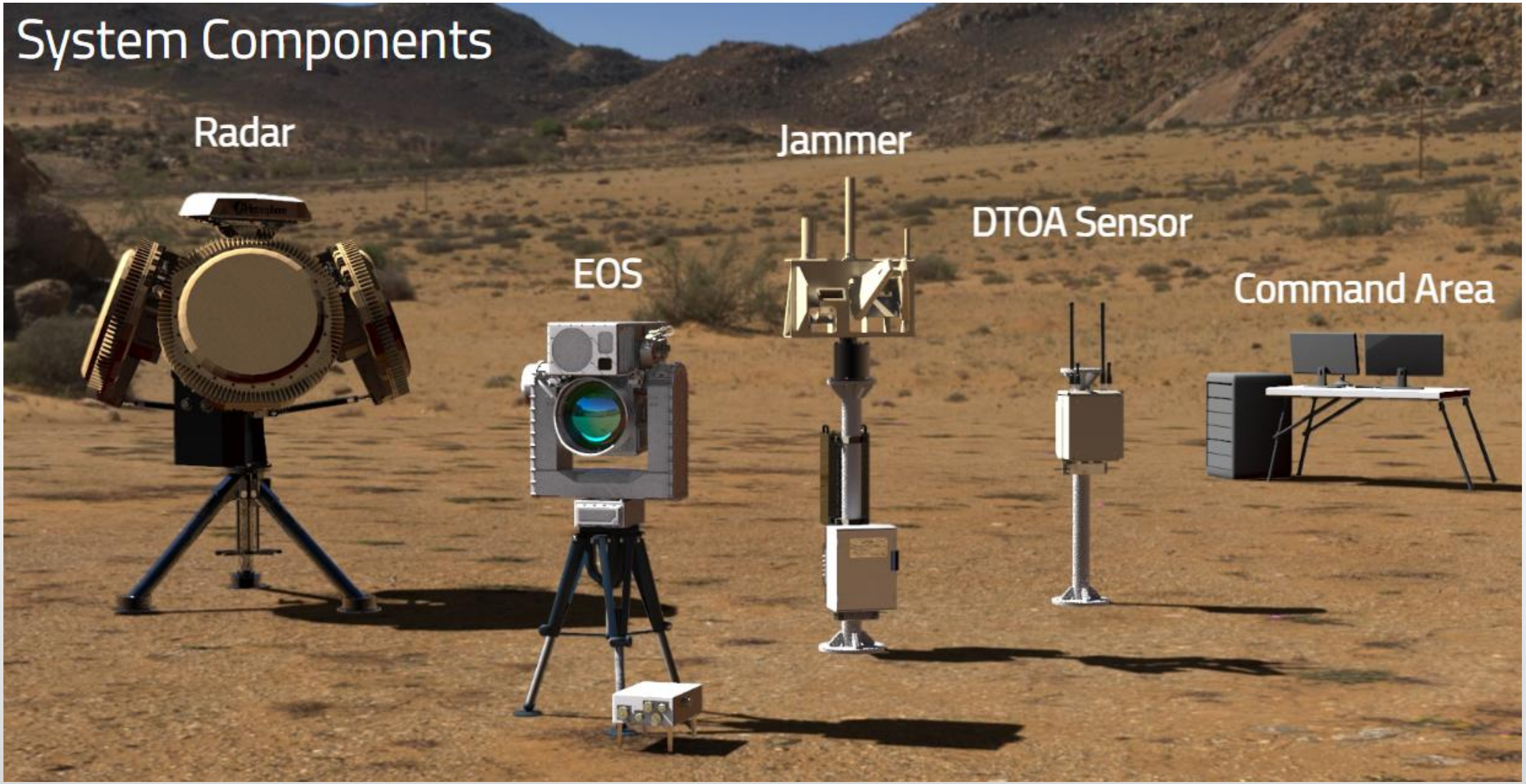
## C-UAS

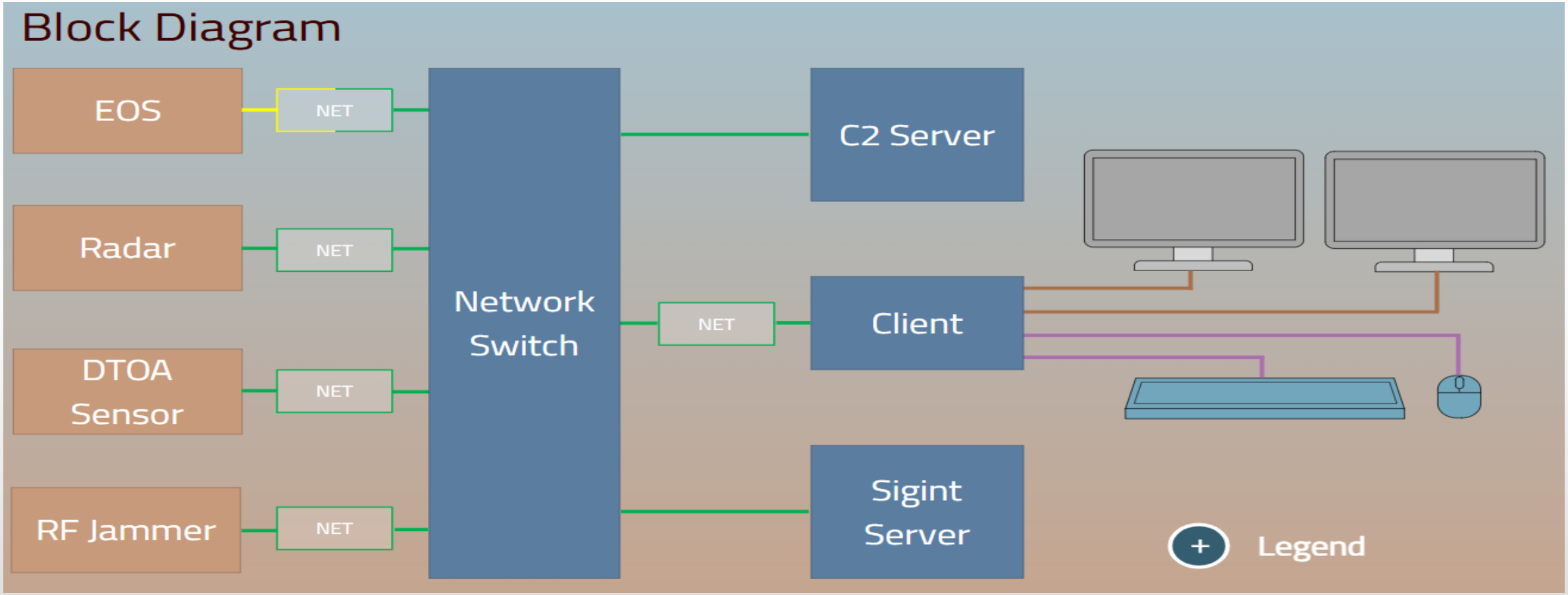
An adaptable system of integrated units for detection, tracking, identification and defeat of micro to small UAS's, that is controlled by a unified C2 System and operates in complicated environments, in all weather conditions, at all times of day.


## End-to-End Solution

- Detection – The DTOA Sensors and Radar detect targets in bound
- Tracking– Once a target has been detected, the optical system can track the target
- Identification – After the target has been locked and tracked, the operator can change the identification of it in the C2
- Defeat– By decision of the operator, the RF Jammer disrupts the target and the threat is eliminated


System Components
Radar
Jammer
DTOA Sensor
EOS
Command Area

## OPERATION PROCESS - EXPLAINED



# OPERATION PROCESS - EXPLAINED

## OPERATION PROCESS - EXPLAINED

Detection | Tracking | Identification | Defeat | Summary

### Detection & Scanning

- The DTOA Sensor scans, detects and analyzes use of wireless communications in the Defended Asset's vicinity and alerts the operator
- The Radar, at the same time, scans the area and detects all targets in its coverage range

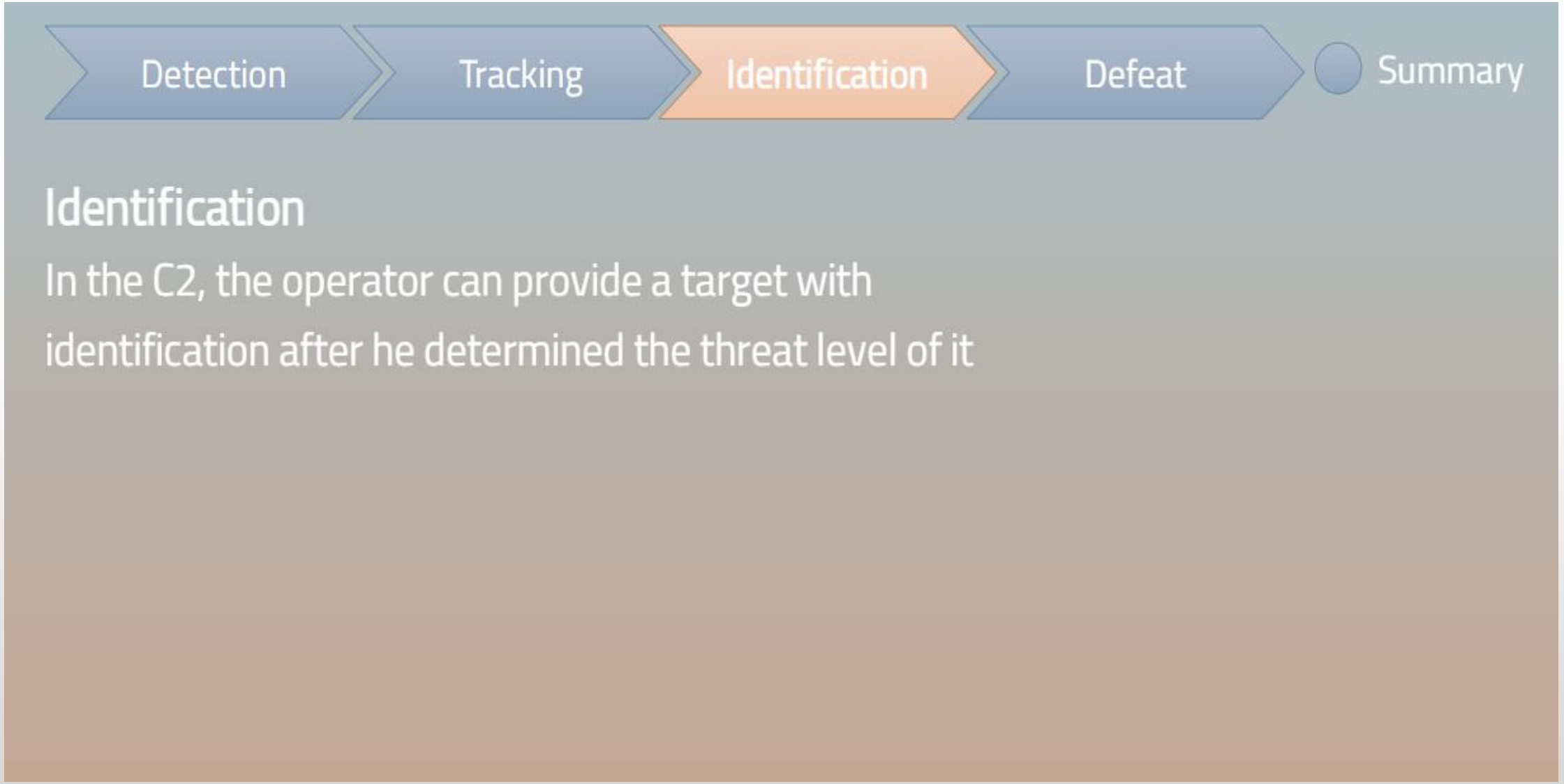
## OPERATION PROCESS - EXPLAINED

Detection | Tracking | Identification | Defeat | Summary

### Tracking

- The C2 displays the targets on a tactical map
- By an operator choice, the is EOS enslaved to a target
- The C2 transfers target data to the EOS and redirects it to the target location
- Optical tracking is done manually once the operator locks the EOS on the target

## OPERATION PROCESS - EXPLAINED



## OPERATION PROCESS - EXPLAINED

Detection | Tracking | Identification | Defeat | Summary

### Defeat

- Jamming activation command is manually sent by the operator through the C2
- Disables the drone's communication with its controller and/or its GPS capabilities, essentially neutralizing the threat

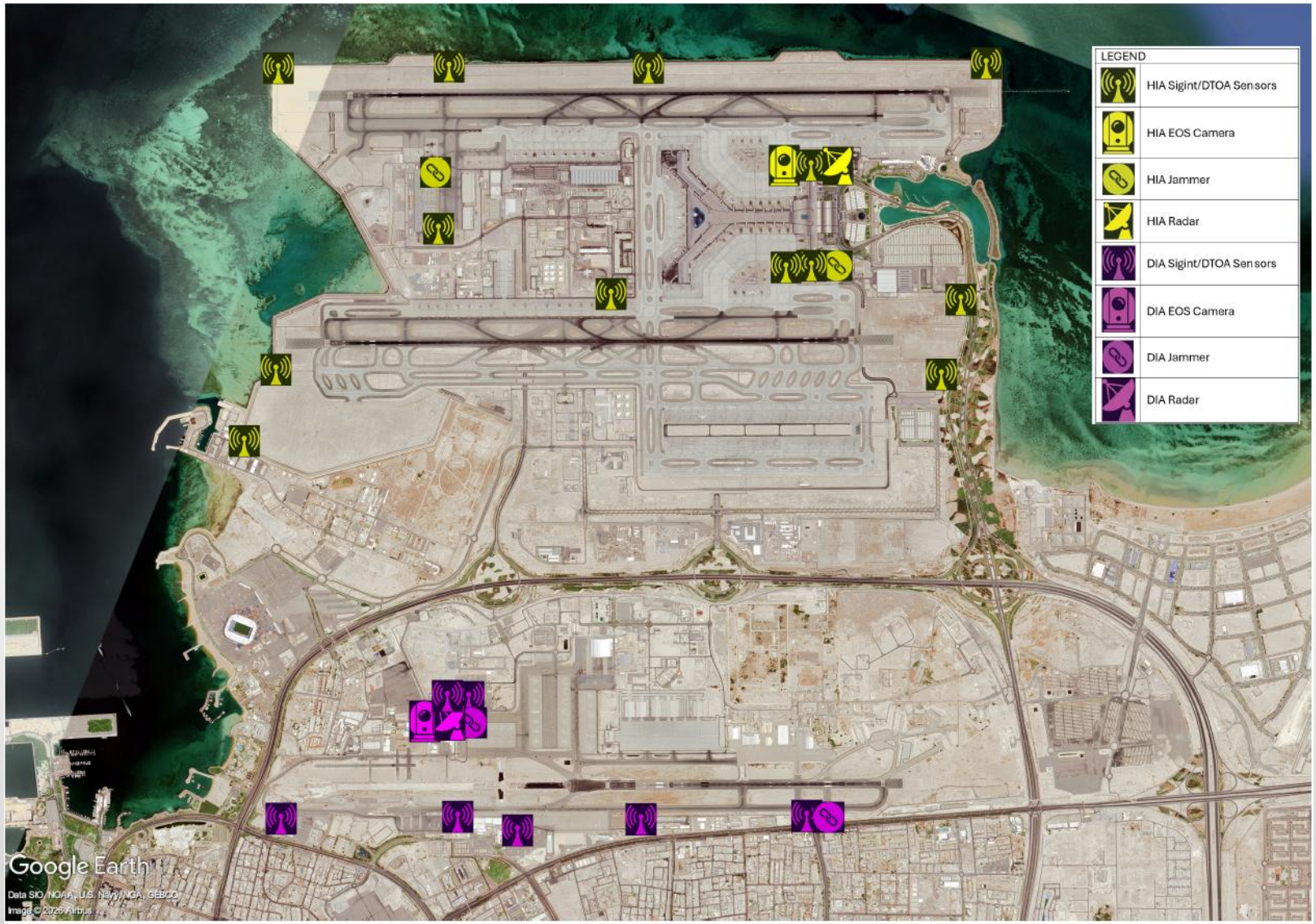
Detection | Tracking | Identification | Defeat | Summary

## Summary

- The C2 interfaces the sub-systems, assists in calibration and displays a deployment map
- The DTOA Sensors provide early alerts and, alongside the Radar, detects potential threats
- The EOS visually tracks the target
- The RF Jammer neutralizes the target

| TOPIC | COVERAGE |
| --- | --- |
| **Detection 1** | Based on DToA (military combat proven) high end Rf Protocol type analyzer<br>Cover more protocols than DJI and updated to new protocols frequently – cannot be bypassed range 3d location |
| **Detection 2** | High end RPS 82 Radar up to 7km detection for micro UAV |
| **Detection 3** | Combat proven High end optical large lens sensor (day and night) |
| **Defeat neutralization** | Combat proven Omni/directional Jammers , operator can choose if to block specific frequency, GNSS or communication only – or all together |
| **C2** | Web based, can be shared with cell phones or any other platform. Can accommodate Multiple sensors effectors and users! |

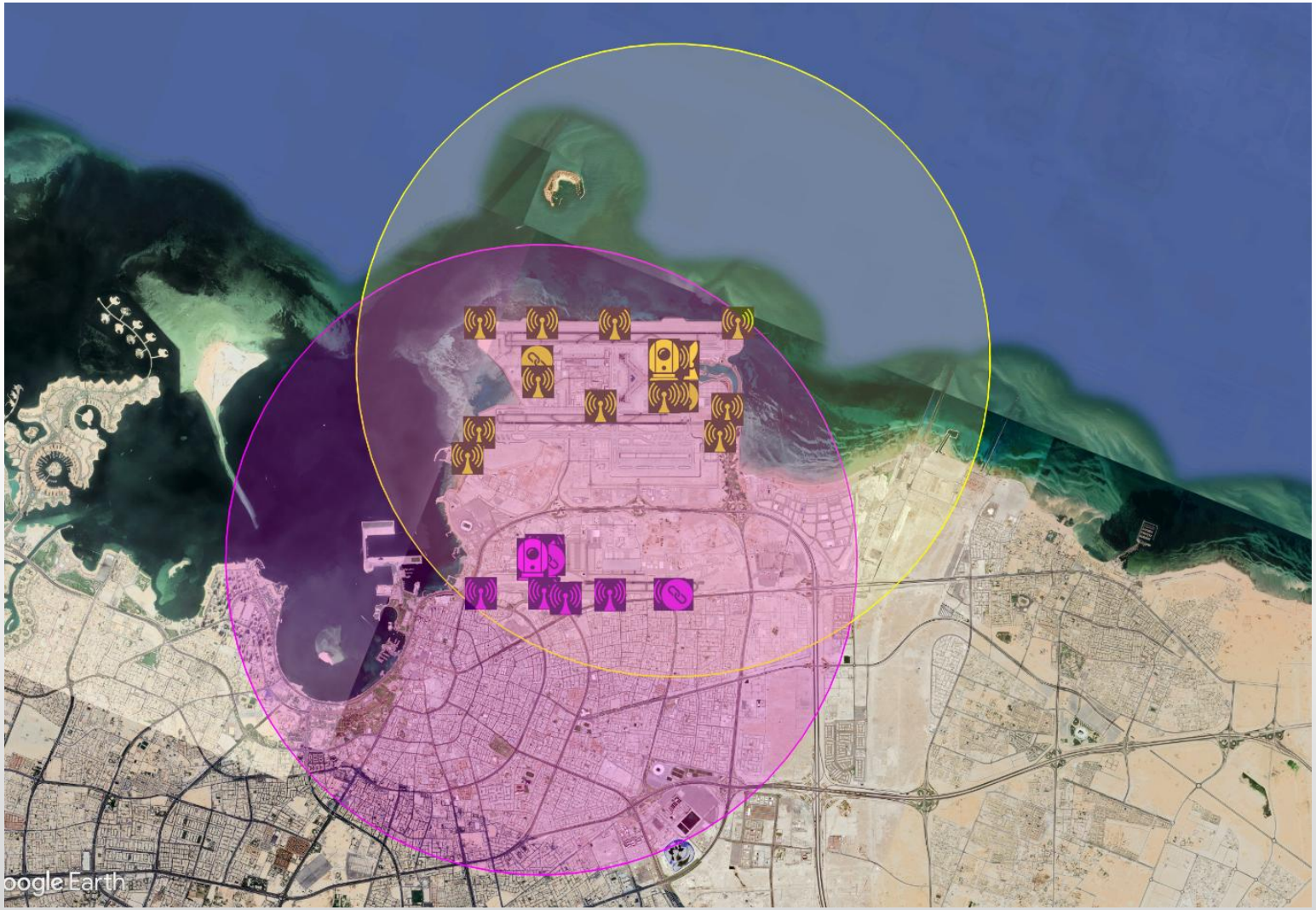
# LOCATION OF SENSORS AT HIA + DIA (GOOGLE EARTH IMAGE)



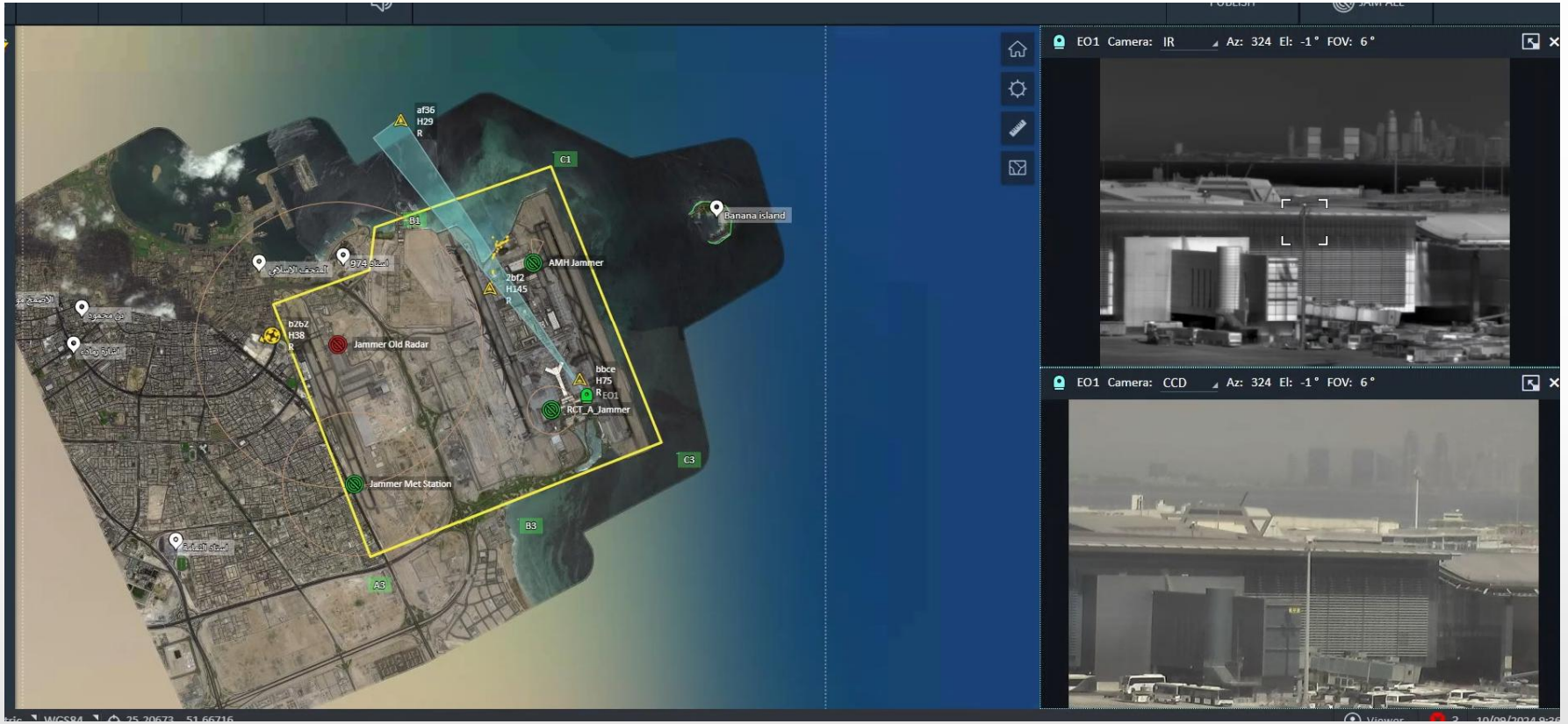
# SUMMARY TABLE OF SENSORS AT HIA & DIA

| ANTI DRONE SYSTEM - HIA/DIA | | | | | |
|---|---|---|---|---|---|
| SL. NO | NAME OF THE EQUIPMENT | TOTAL QUANTITY | INSTALLED LOCATION | | FUNCTION |
| | | | HIA | DIA | |
| 1 | RF/SIGINT SENSOR | 20 | 13 | 7 | A DTOA SENSOR IS USED TO IDENTIFY UNAUTHORIZED FREQUENCIES AND TYPE OF OPERATION IN ITS VICINITY. DTOA SENSOR DETERMINES THE LOCATION OF A SIGNAL SOURCE (SUCH AS A DRONE OR ITS REMOTE CONTROLLER) BY MEASURING THE DIFFERENCE IN THE TIME IT TAKES FOR THE SAME RF SIGNAL TO REACH MULTIPLE SENSORS. |
| 2 | RADAR | 2 | 1 | 1 | RADAR, WHICH STANDS FOR RADIO DETECTION AND RANGING, IS AN OBJECT-DETECTION SYSTEM THAT USES RADIO WAVES TO DETERMINE THE RANGE, ANGLE, AND VELOCITY OF TARGETS. AT BOTH HIA AND DIA, ONE RADAR UNIT HAS BEEN INSTALLED AT EACH AIRPORT TO PROVIDE COMPREHENSIVE AIRSPACE COVERAGE AND CONTINUOUS MONITORING. |
| 3 | ELECTRO OPTICAL SENSOR | 2 | 1 | 1 | THE SYSTEM IS A MULTI-SENSOR SOLUTION ENABLING REAL-TIME, LONG-RANGE TARGET DETECTION AND IDENTIFICATION UNDER BOTH DAY AND NIGHT CONDITIONS. AT HIA AND DIA, ONE UNIT HAS BEEN INSTALLED AT EACH LOCATION TO PROVIDE CONTINUOUS AIRSPACE MONITORING AND SITUATIONAL AWARENESS. |
| 4 | JAMMER | 4 | 2 | 2 | THE JAMMING SYSTEM DISRUPTS SPECIFIC FREQUENCIES UNDER OPERATOR CONTROL VIA THE COMMAND AND CONTROL (C2) PLATFORM AND CAN SIMULTANEOUSLY BLOCK ALL PRE-DEFINED FREQUENCY BANDS. IT EMPLOYS TWO JAMMING TECHNIQUES—OMNIDIRECTIONAL AND DIRECTIONAL—TO EFFECTIVELY NEUTRALIZE THREATS. AT BOTH HIA AND DIA, TWO UNITS OF EACH TYPE HAVE BEEN DEPLOYED TO ENSURE COMPREHENSIVE COVERAGE. |

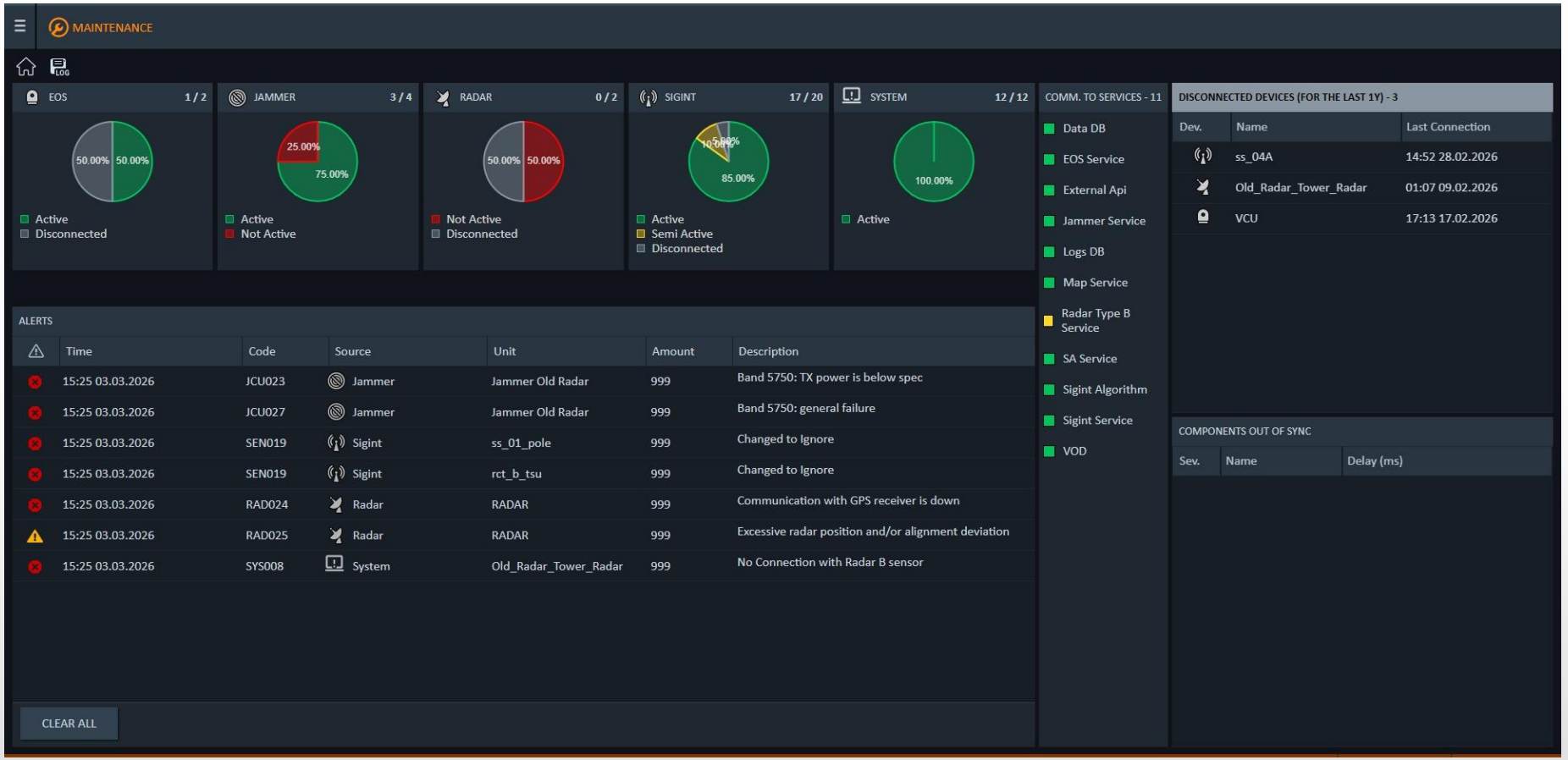
# COVERAGE DIAGRAM FOR HIA & DIA



# HMI PICTURES OF HIA & DIA



# HMI PICTURES OF HIA & DIA



# Radar – Target Detection

- Detects, classifies and tracks aerial objects
- Features MHR technology using Track-While-Scan (TWS)
- Provides velocity, direction and altitude of detected tracks
- Performs target initial classification supporting micro-doppler

| 7 KM | 3.3-3.4 GHz | 4000 W |
|---|---|---|
| UAS DETECTION RANGE | FREQUENCY RANGE | MAX POWER CONSUMPTION |

# DTOA Sensor

- A radio frequency receiver that monitors and analyzes frequencies within a sector of 360°
- Based on differential time of arrival technology that enables pinpointing targets location according to time calculations

**70Mhz-6Ghz**
FREQUENCIES RANGE

**360°**
AZIMUTH RANGE

# EOS – Tracking and Classification

- Electro Optic-Sensor – enables real-time long range, day/night target identification
- Enables target investigation, optical tracking
- Power and video conversions are performed using a Front Converter Box (FCB)
- Consists of two sensors: CCD & FLIR

| 360° | 1 rad/sec | -10°-(+70°) |
|---|---|---|
| AZIMUTH RANGE | TURNING SPEED | ELEVATION RANGE |

# RF Jammer

- Enables soft neutralization of the threat
- Transmits a blocking signal at the relevant frequencies
- Selection between directional or omni jamming
- 5 Jamming frequencies:
  - 433 Mhz
  - 900 Mhz
  - 1.6 Ghz – GPS
  - 2.4 Ghz
  - 5.8 Ghz

# ENHANCED FLIGHT PLANNING:

## Implementation of eFPL within the FF-ICE Framework for Collaborative ATM Operations


IMPROVED COLLABORATION | GREATER EFFICIENCY | ENHANCED SAFETY | FUTURE-READY ATM

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# QCAA AIM AND FLIGHT DATA MANAGEMENT

## Capabilities


## Highlights

### SWIM connectivity

- Data set distribution
- EAD interface

### Digital NOTAM

- Data originator portal
- Compliant with digital NOTAM event specification
- Distribution via SWIM

### AIM data management

- AIXM 5 based
- Data set production

### Initial flight processing

- 4D trajectory modelling using BADA 3 data
- AIXM 5 data driven validation
- FPL2012 baseline, eFPL upgrade planned

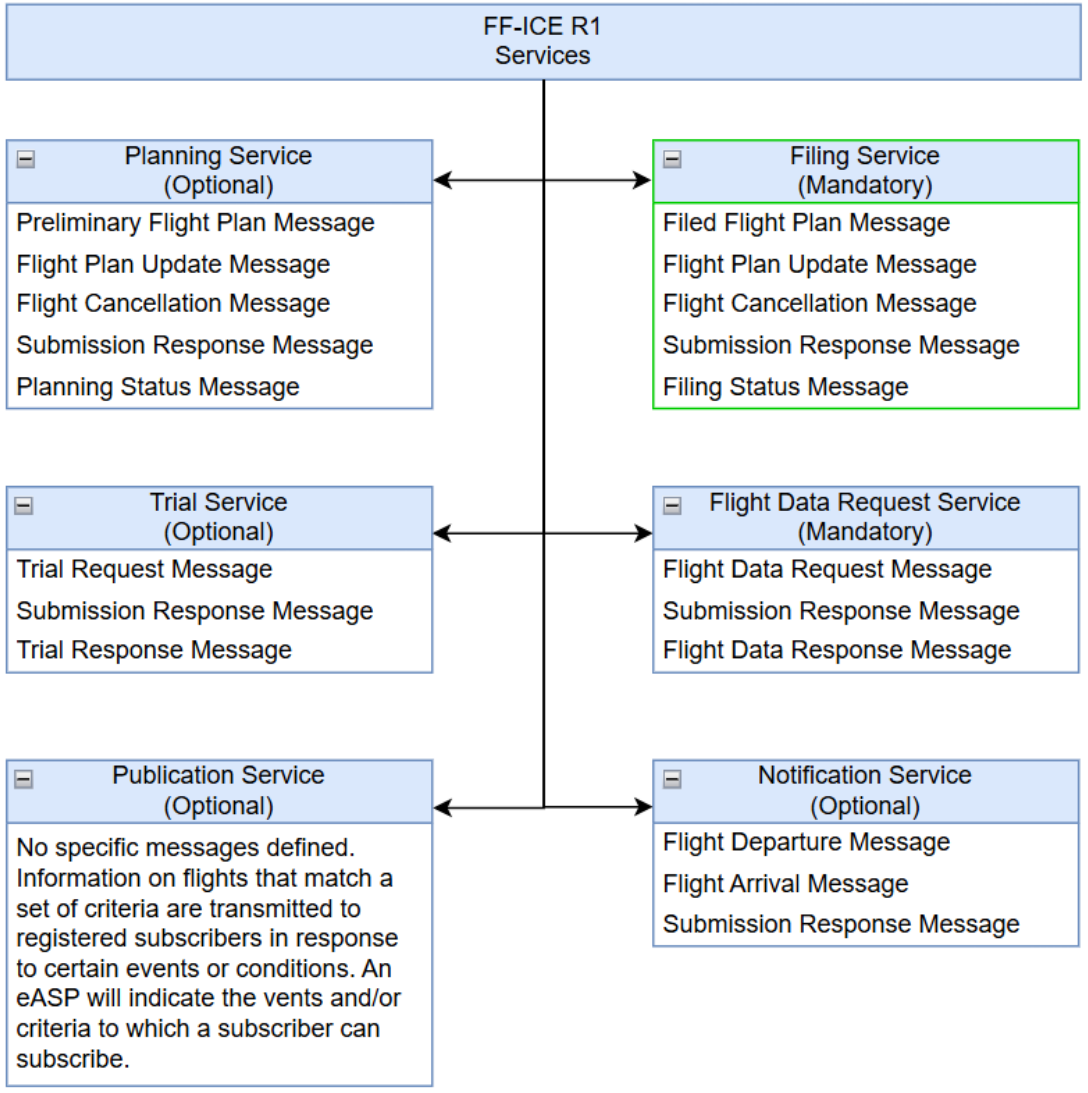
# eFPL IMPLENTATION IN QCAA AIM INFRASTRUCTURE

- We are currently working on the extension of the existing AIM system of QCAA to support Enhanced Flight Plan (eFPL) operations based on the Flight and Flow Information for a Collaborative Environment (ICAO FF-ICE/R1) concept, through a phased implementation approach.
- eFPL transforms the traditional static flight plan messaging model into a rich, collaborative, and service-oriented digital information exchange framework, enabling more efficient, flexible, and future-ready ATM operations.

**FPL2012** = Traditional ATM flight plan messaging

**eFPL** = Next-generation digital collaborative flight planning within SWIM/FF-ICE architecture

# eFPL IMPLEMENTATION IN QCAA AIM INFRASTRUCTURE



# What is eFPL?

eFPL is part of the:

- FF-ICE framework
- SWIM-based digital ATM ecosystem

It uses:

- FIXM data model
- Web services/API architecture
- Rich structured data exchange

- Instead of simple text messages as in FPL2012, eFPL contains:
  - Detailed trajectory information
  - Operational intent
  - Collaborative flow information
  - Extended metadata

| Aspect | eFPL (Enhanced Flight Plan) | FPL2012 |
|---|---|---|
| Full Form | Enhanced Flight Plan | ICAO Flight Plan 2012 |
| Framework | FF-ICE (Flight & Flow Information for a Collaborative Environment) | Traditional ICAO flight plan format |
| Communication Method | SWIM/API-based digital services | AFTN/AMHS message-based |
| Data Format | Structured digital data (FIXM/XML/JSON) | Fixed text message format |
| Information Richness | Rich and extensible data model | Limited predefined fields |
| Trajectory Information | Supports 4D trajectory information | Limited trajectory representation |
| Collaboration | Enables collaborative ATM operations | Mainly point-to-point filing |
| Flexibility | Highly extensible and scalable | Rigid message structure |
| Real-Time Updates | Dynamic service-based updates | Static message exchange |
| Validation | Advanced digital validation | Traditional syntax validation |
| Interoperability | SWIM-compliant interoperability | Legacy ATS interoperability |
| Future Readiness | Designed for future ATM modernization | Legacy operational standard |
| Data Exchange | Service-oriented architecture (SOA) | Message routing architecture |
| Integration Capability | Easy integration with ATFM/DCB/UTM/SWIM | Limited integration capability |
| Human Readability | Primarily machine-readable | Human-readable ATS message |
| Underlying Standard | FIXM + FF-ICE | ICAO Doc 4444 FPL2012 |

# MAIN OPERATIONAL ADVANTAGES OF eFPL

## 1. RICHER FLIGHT INFORMATION

eFPL can include:

- 4D trajectories
- Dynamic operational constraints
- Flow management information
- Collaborative decision-making data
- FPL2012 is limited to fixed ATS fields.

## 2. BETTER ATM COLLABORATION

eFPL supports:

- Airlines
- ANSPs
- Eurocontrol
- ATFM systems
- SWIM services

All exchanging synchronized digital information.

## 3. DYNAMIC UPDATES

eFPL supports:

- Filing updates
- Status tracking
- Interactive acknowledgements
- Real-time responses
- instead of simple static message transmission.

## 4. FUTURE ATM READINESS

eFPL is designed for:

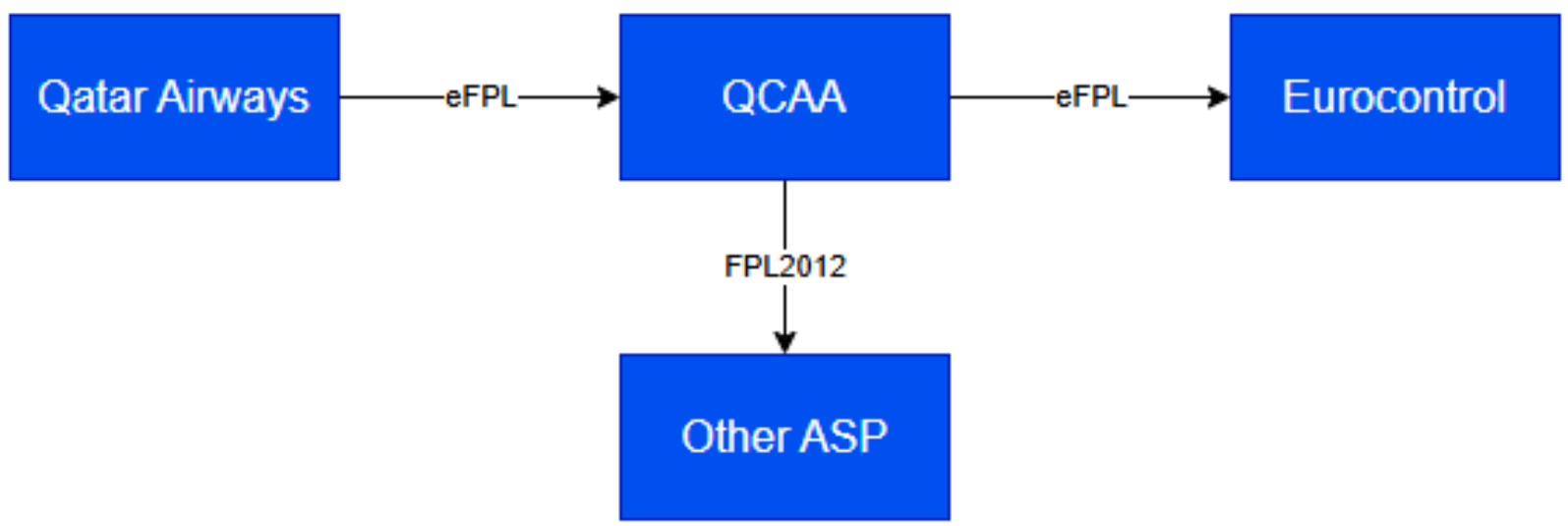
- Trajectory-Based Operations (TBO)
- SWIM
- Digital ATM
- Collaborative ATM
- AI/automation-enabled ATM

## OBJECTIVES PLANNED IN PHASE 1 APPROACH;

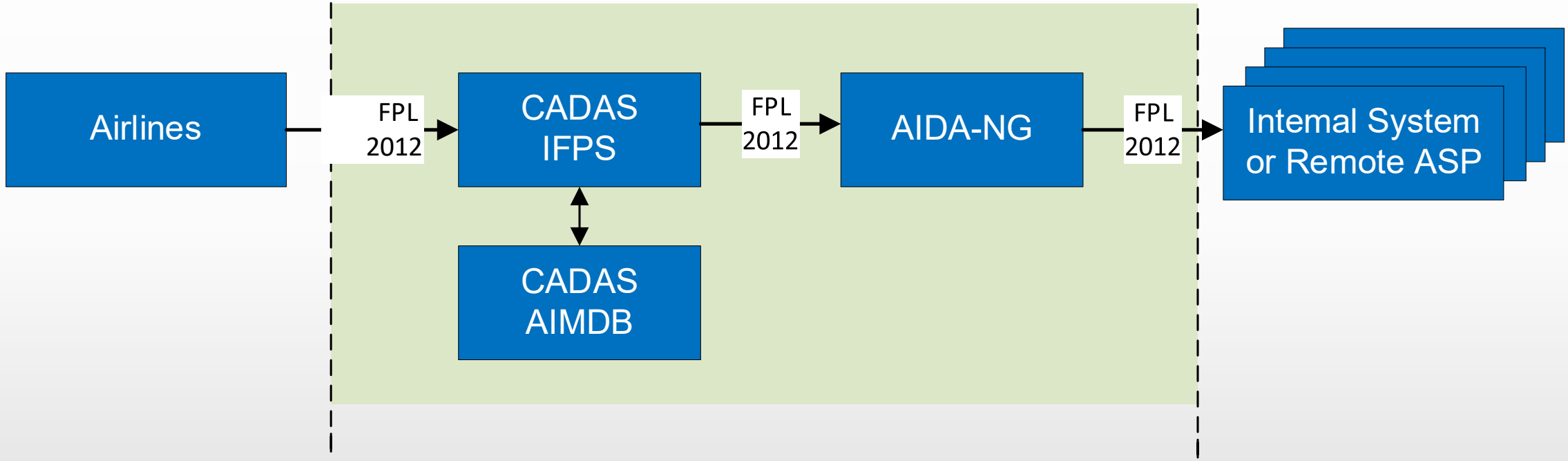
- Enable QCAA to receive flight plans as FF-ICE/R1 compliant eFPL messages from Qatar Airways for Europe destination

  Note: all other AUs shall continue to send the flight plans as FPL2012

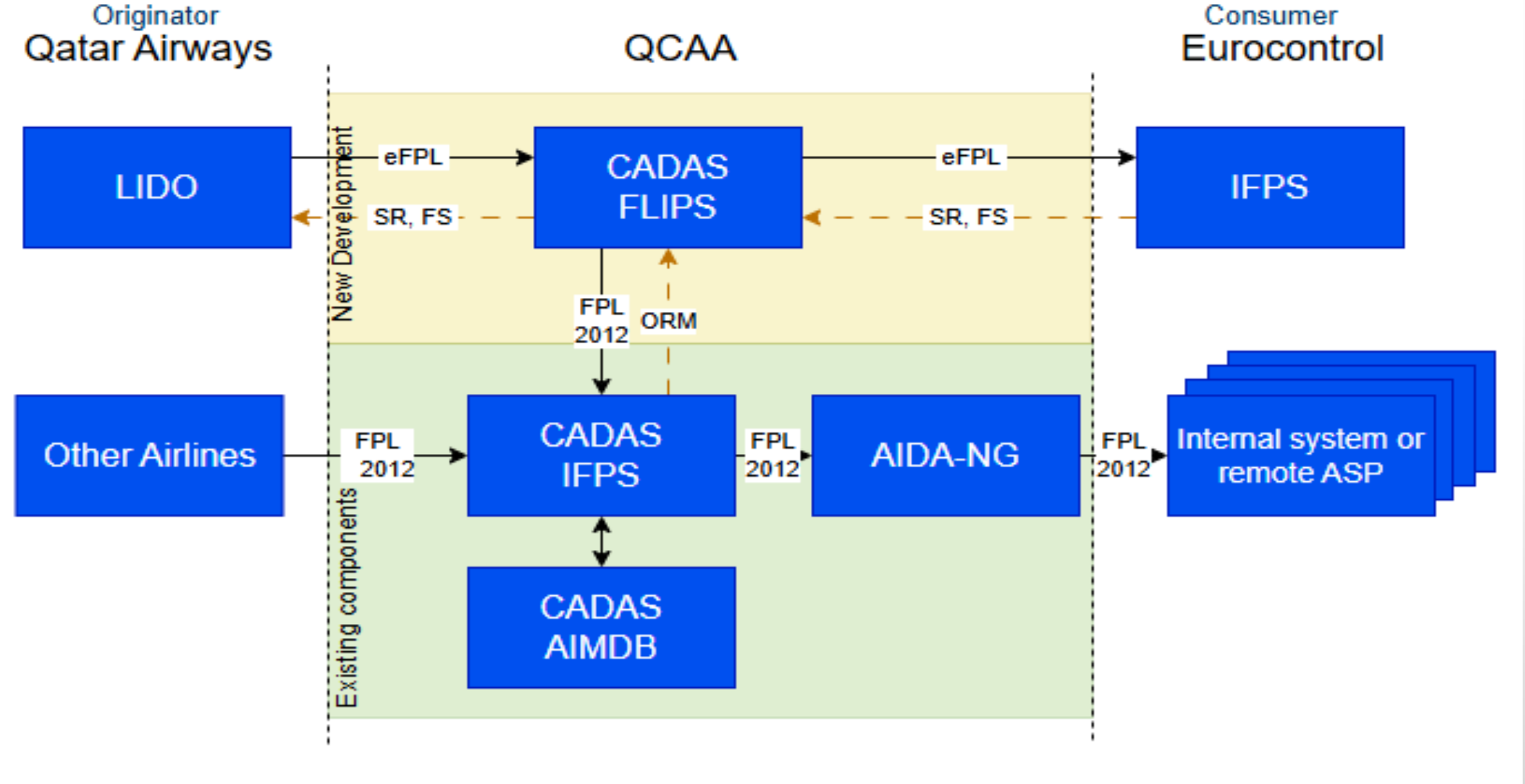
- After validations of received eFPLs from Qatar airways , eFPL for flights to Europe shall be distributed to Eurocontrol's IFPS
- The distribution to all other ASPs (not supported with FF-ICE/SWIM services) shall be as conventional AFTN formatted FPL2012 via AMHS/AFTN network . CADAS converts the eFPL to FPL2012 for distribution to other ASPs
- The FPL originator, Qatar Airways, will receive the appropriate FF-ICE response messages to their filing request sent to CADAS-FLIPS.



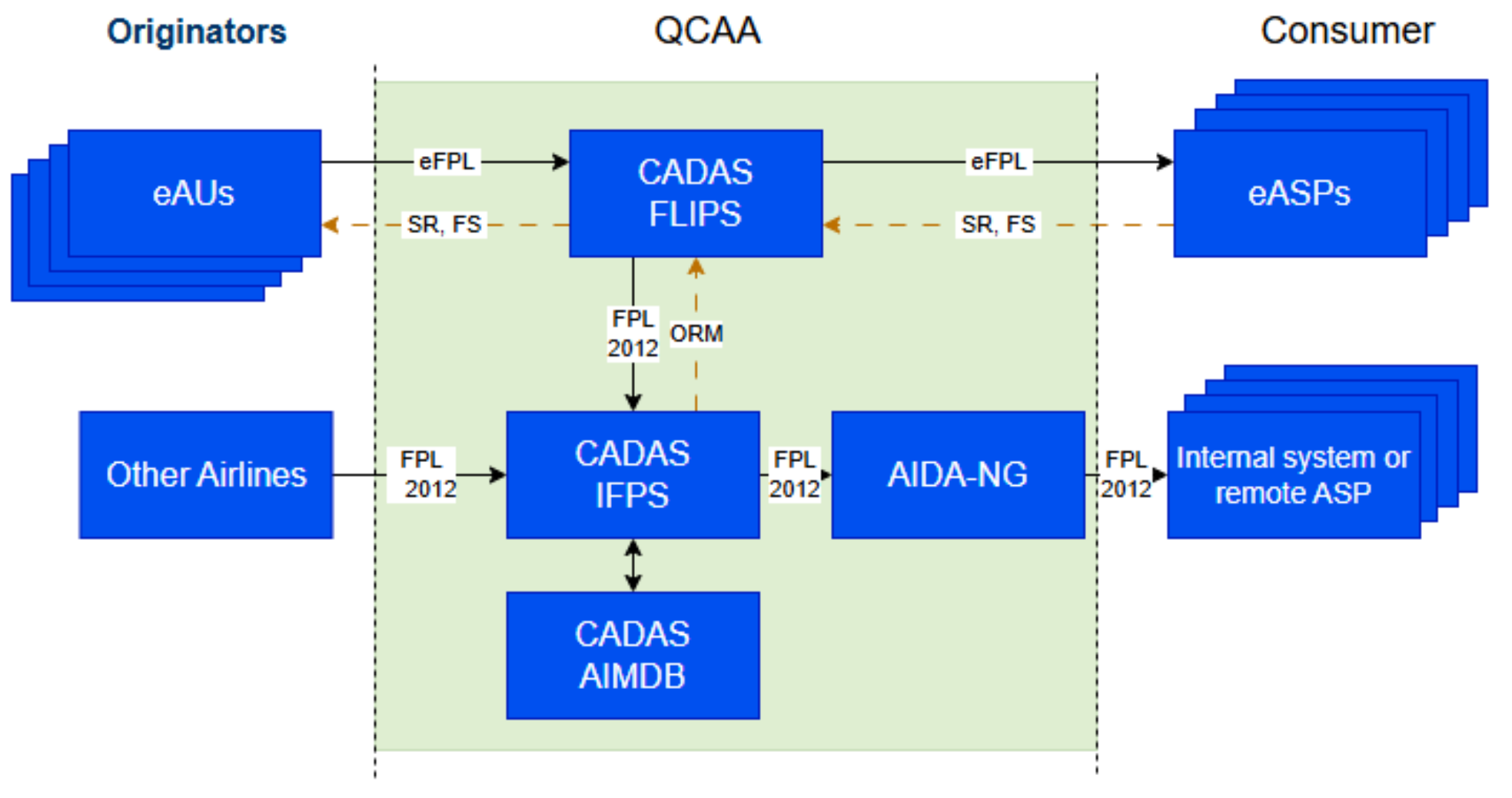
# CURRENT SETUP WITHOUT FF/ICE eFPL IMPLEMENTATION



# NEW SETUP AFTER FF/ICE eFPL IMPLEMENTATION

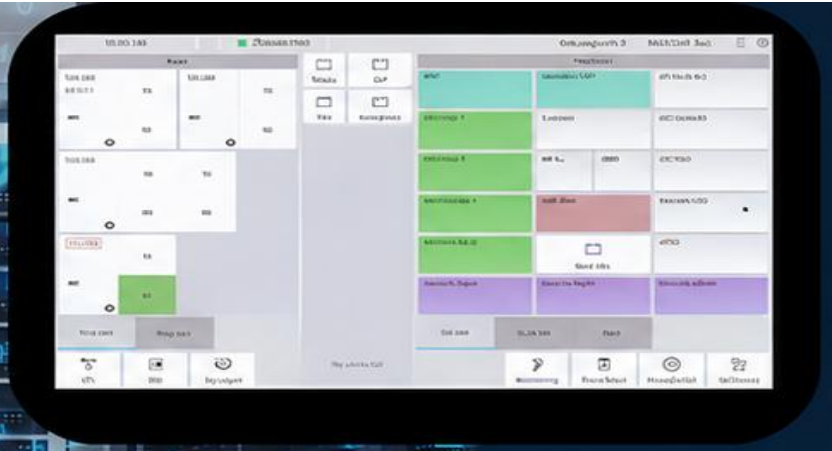


# FUTURE EXTENSIBILITY / SCALABILITY



# FUTURE EXTENSIBILITY / SCALABILITY

- This phased implementation is focused on enabling FF-ICE/R1 compliant eFPL information exchange between Qatar Airways, Qatar Civil Aviation Authority, and EUROCONTROL.
- As the regional SWIM network has not yet been established, data exchange with remote Air Navigation Service Providers (ANSPs) who are not SWIM enabled to be conducted through conventional AFTN/AMHS messaging mechanisms.
- However, the proposed eFPL solution is designed with scalability and future interoperability in mind, making it well suited to support additional eFPL connections in the future. Once the regional SWIM network becomes available, remote connections can be progressively migrated from AFTN/AMHS to fully SWIM-based eFPL information exchange.



# ADVANCED ATC COMMUNICATIONS

## Next-Generation Voice Communication System (VCS X10) - Architecture and Operational Capabilities

bayanat ENGINEERING

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Civil Aviation Authority
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# INTRODUCTION

- QCAA is in the process of implementing the innovative, service-oriented Frequentis X10 Voice Communication System (VCS) at Qatar Air traffic control center (QATCC) for the ACC & Approach ATC control positions setting a benchmark for modernisation and efficiency in communication infrastructure and ensuring robust & reliable communication for air traffic controllers.
- The X10 system also supports future scalability, aligning with QCAA long-term goals for digital transformation in air traffic management.

  - **MAIN VCS** WITH HMIS FOR ATCOS IN THE QATCC CONTROL ROOM.
  - **BACKUP VCCS** WITH CONNECTIVITY TO THE ATCO HMIS IN THE QATCC

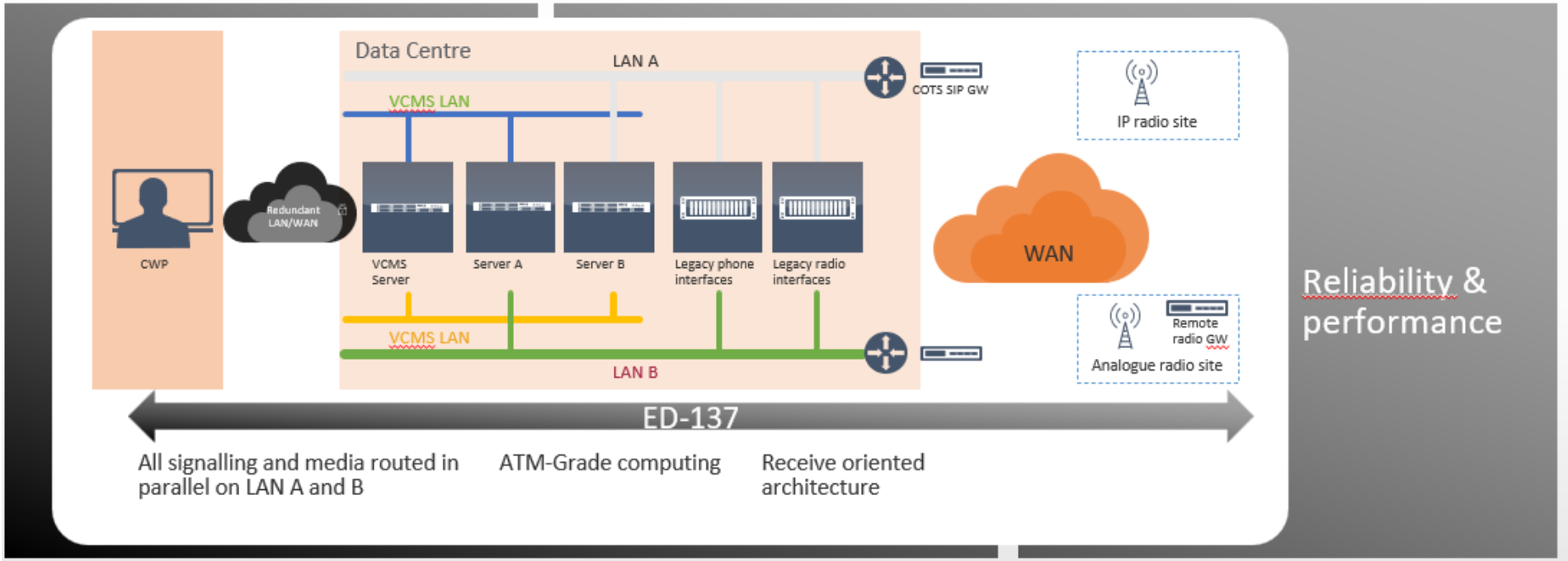
# KEY FEATURES/BENEFITS OF X10 VCS

- **Completely software Service-oriented solution deployed on IT COTS hardware :** Designed for maximum interoperability, X10 supports deployment on customer-supplied COTS hardware or
- **Seamless switchover between Main & Backup X10 VCS system from the CWP :** With integrated support for dual operations, ATC communication can be mirrored in real time between main and backup systems, ensuring continuous availability.
- **Controller-centric HMI :** It offers flexible layout configurations, dark/light modes, and gesture-based controls while retaining familiar workflows, making the transition from older systems seamless and training-light.
- **Simplified system maintenance & updates :** Through X10 microservices architecture, Operators can deploy new features or security patches at container level via a secure browser interface, reducing system downtime and IT overhead.

- **Evergreen lifecycle :** Since the X10 VCS is deployed on IT COTS hardware and avoiding any proprietary hardware's, system has got evergreen life cycle support
- **Easy Integration with external systems :** Building on the power of the Frequentis MosaiX platform, the X10 streamlines integration with existing ATM systems and ensures readiness for future concepts like sector less flight, UTM integration, and dynamic airspace management.
- **Multi-Level redundancy :** It supports geographically redundant data centres, dual-path audio, and role-based resource sharing, giving air traffic controllers instant access to backup systems, even on the same screen.
- **ATM grade cyber security :** The platform supports encrypted IP communication, hardened software containers, and strict access control, all tailored to air traffic management environments. When combined with the Frequentis SBC, its unique security capabilities deliver an unparalleled level of protection.

# SYSTEM OVERVIEW

## DISTRIBUTED INTELLIGENCE AND PARALLEL OPERATING FOR UNRIVALLED RESILIENCE, RELIABILITY and safety

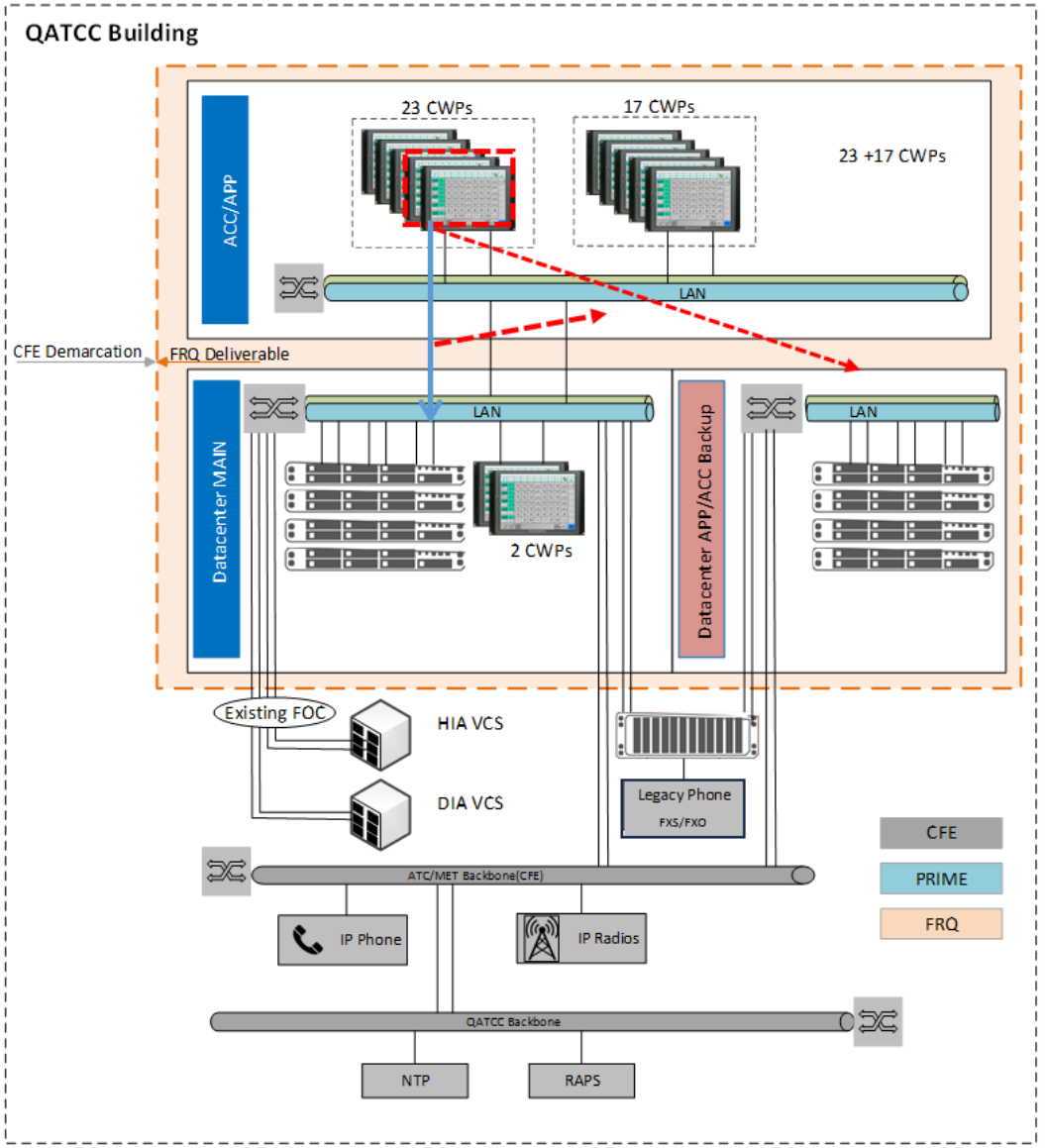



Both systems run continuously with equal priority

Faults in peripherals not affecting other system parts

Simple Network separation by duplication of audio

# REDUNDANT SYSTEM ARCHITECTURE

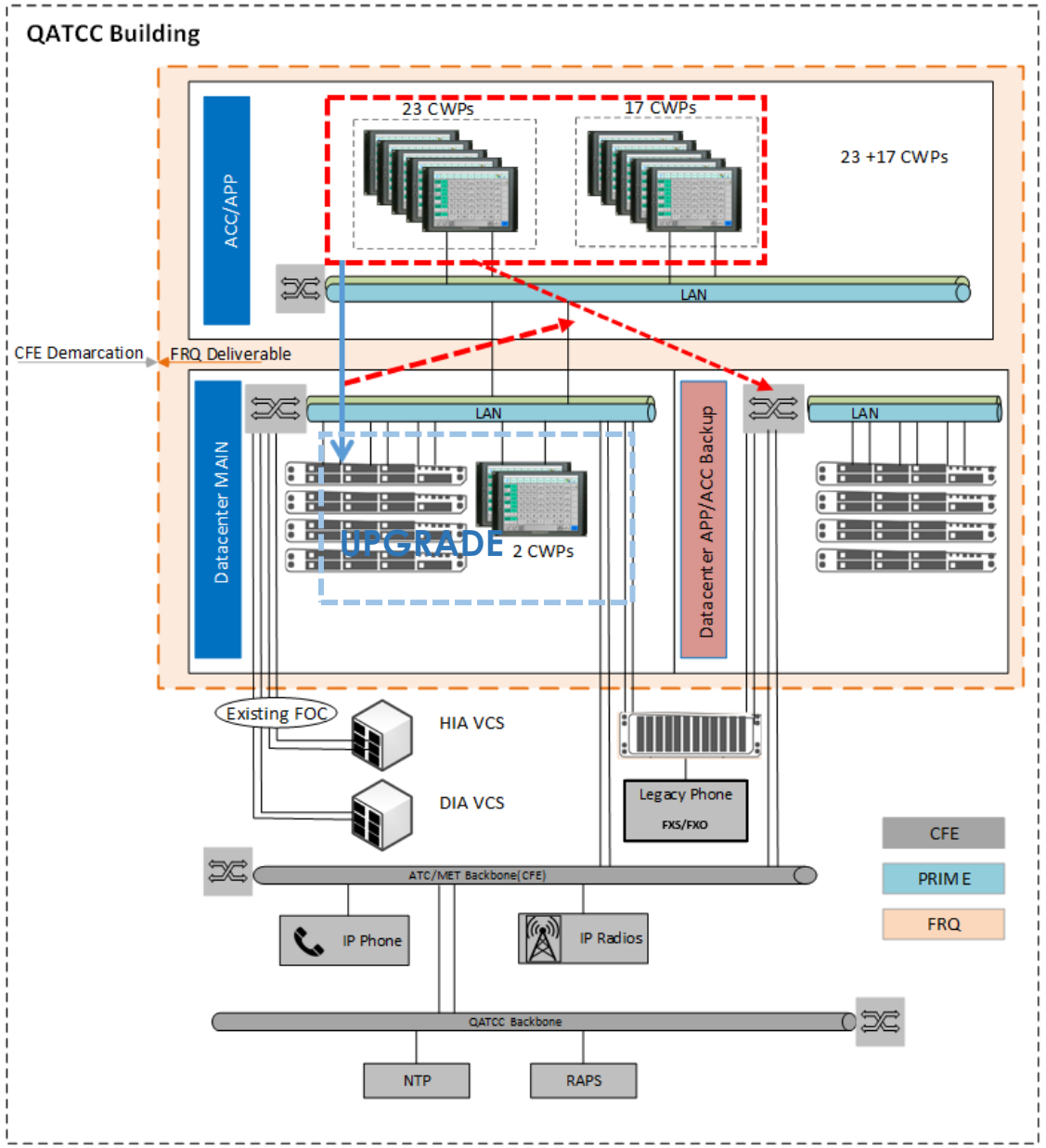


*[preliminary information]*

# REDUNDANT SYSTEM ARCHITECTURE

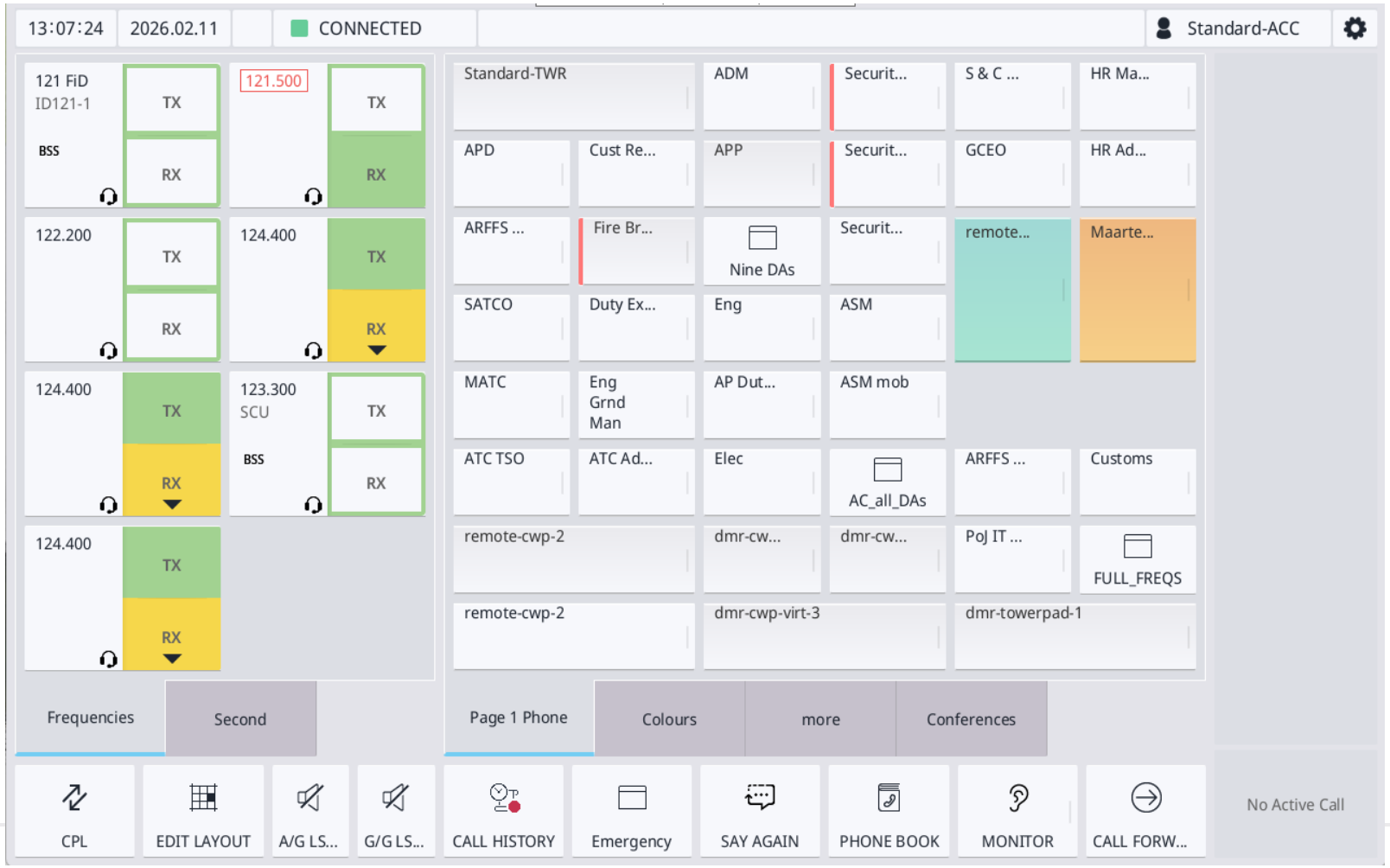
## Use Case : System Upgrade (No outage)

- Complete Operational Switchover from **Main** to **Ultimate** Contingency Datacentre
- **Upgrade of Main** Datacentre
- Switchback to **Main** Datacentre
- **Upgrade Ultimate** Datacentre
- **No Operational Outage during Upgrades**



# NEW CONTROLLER USER EXPERIENCE

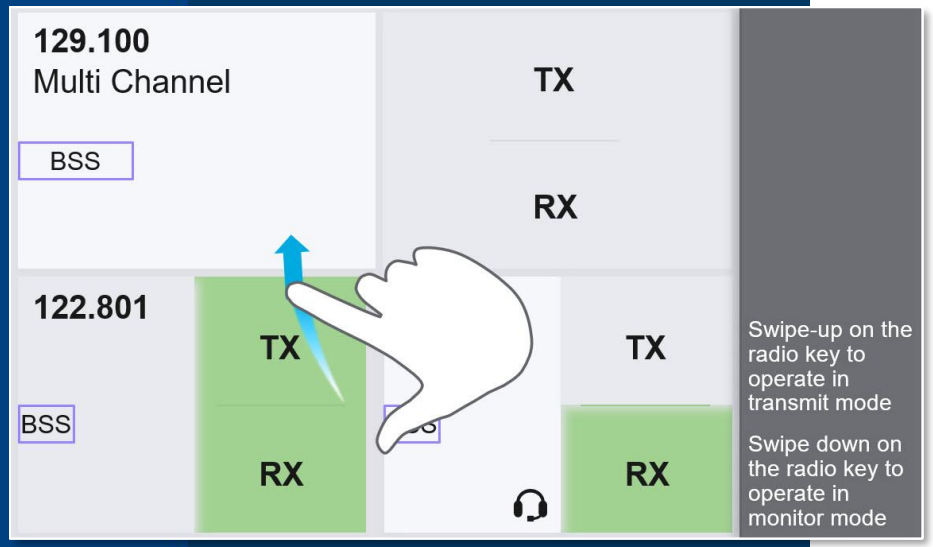
- Designed with controllers to use gestures and context sensitivity



*[preliminary information]*

# FOLLOW YOUR DEMAND - GESTURE CONTR

## CONTROLLER HMI
WITH INTUITIVE GESTURE CONTROLS

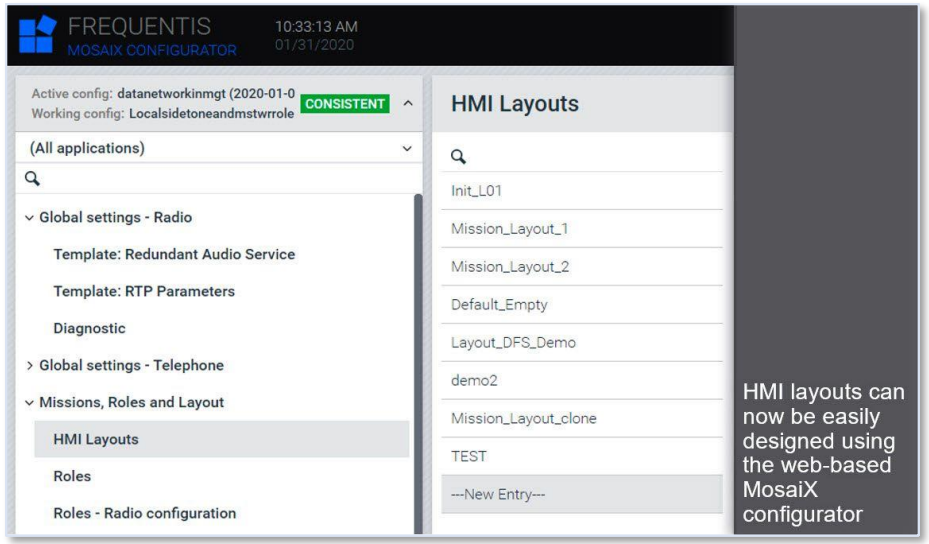



Transmit & monitor mode | Context sensitive menu normal call | Context sensitive menu on-going call | Customisable pop-up windows | Checklists / emergency procedures

## WEB-BASED GUI TOOL

### DESIGN YOUR OWN HMI USING A WEB-BASED GUI

THE WORLDS MOST FLEXIBLE VCS-HMI CONFIGURATION




MosaiX configurator | Widget & grid design | Drag & drop | Drag & drop – functions menu | Sub-grids & clones | Result

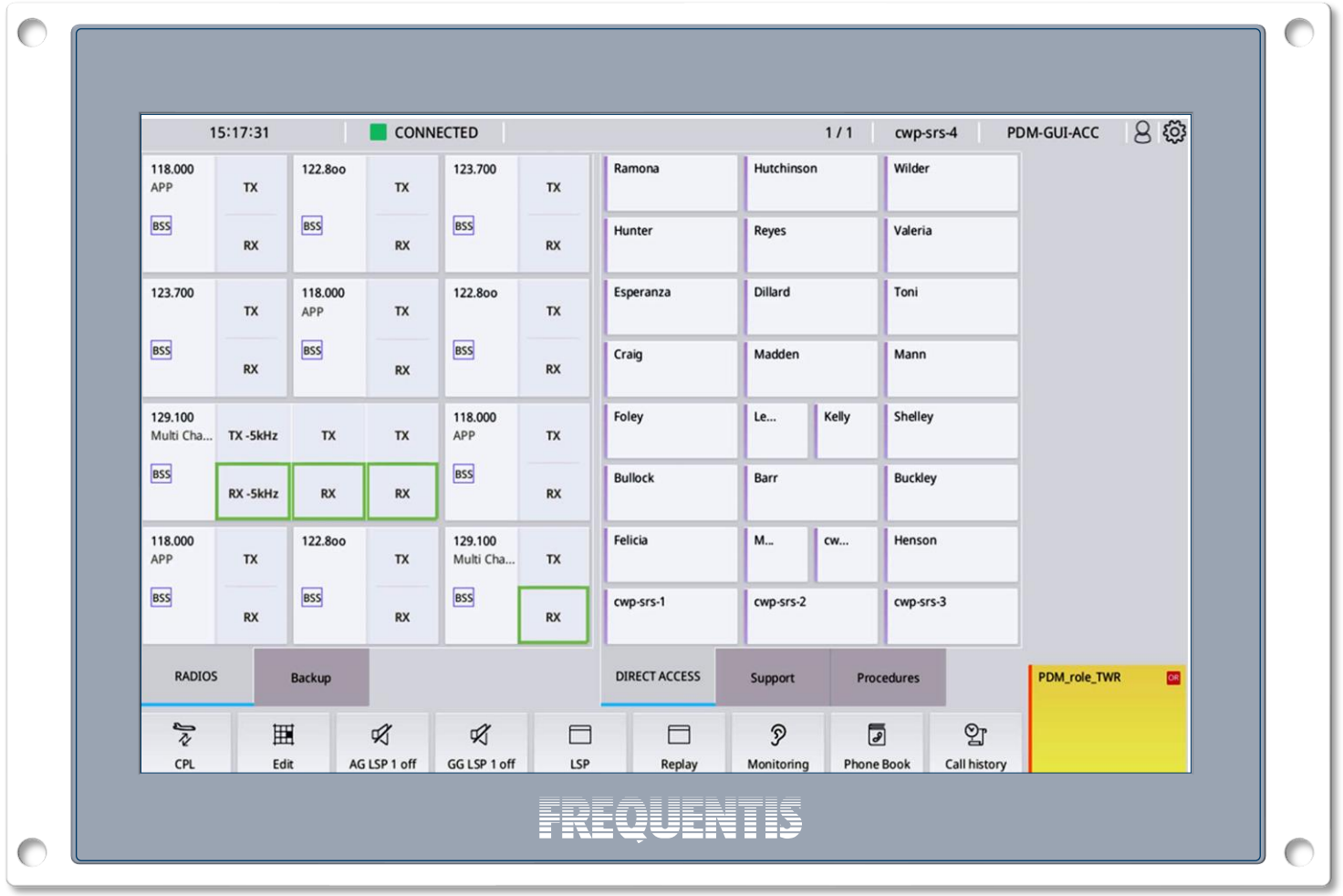
# NEW CONTROLLER USER EXPERIENCE

- Free Button Placement and Different Colour Schemes

*[preliminary information]*


# For exceptional user experience

- ACC
- COLOR
- TOWER
- LSP SELECTION
- EMERGENCY
- SPLIT



# Surveillance Infrastructure Performance:

## Spotlight on Integrated MLAT/ADS-B Surveillance full Coverage at HIA and DIA Airports


FULL COVERAGE | SAFETY ENHANCEMENT | PERFORMANCE OPTIMIZATION | INTEGRATION READY | COLLABORATION DRIVEN | FUTURE READY

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ICAO

# INTRODUCTION

- Multilateration system plays a vital part in HIA's Air traffic and Surface movement operations with most expanded coverage throughout HIA and DIA Airports.
- A total of 56 MLAT Sensors at HIA which make it as the single airport having largest number of eMLAT Sensors in the Middle East region and also 19 MLAT sensors in DIA contribute a major role in safe movements and setting a new standard to enhance aircraft and passenger safety.
- Saab Sensis MLAT System is an airport surface cooperative surveillance system consist of a central processing system and distributed set of ground sensors which provides accurate and reliable detection and tracking of Aircrafts and ground vehicles.
- The system is designed to provide surveillance of Mode S, Mode A, mode C and ADSB aircraft on the airport surface or on the final approach complying with the operational requirement of Qatar Civil Aviation authority to have 7.5m plot accuracy everywhere inside the runways and taxiways and 12meter plot accuracy at apron and stand area.

# LOCATION OF MLAT SENSORS AT HIA (GOOGLE EARTH IMAGE)

# LOCATION OF MLAT SENSORS AT DIA (GOOGLE EARTH IMAGE)

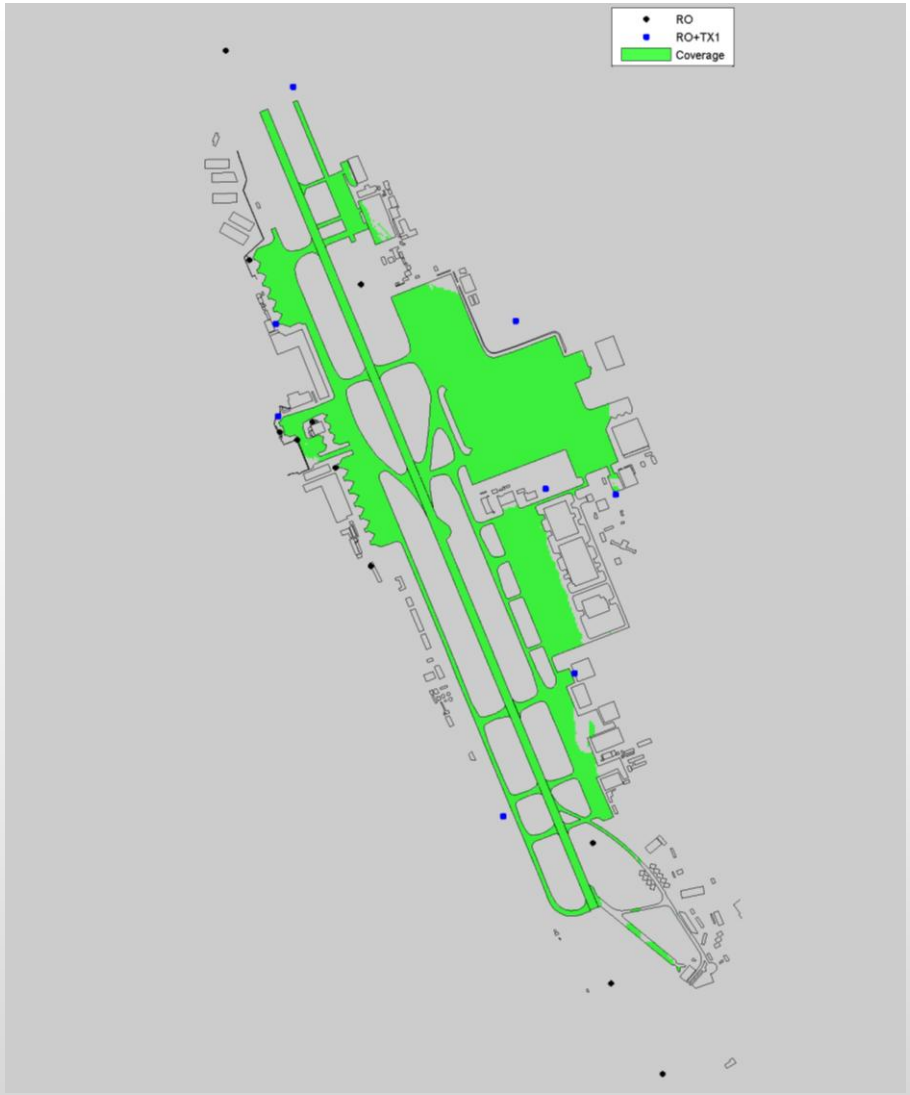
# LOCATION OF MLAT SENSORS AT HIA + DIA (VIDEO)

# 7.5 M MLAT COVERAGE DIAGRAM AT HIA AIRPORT

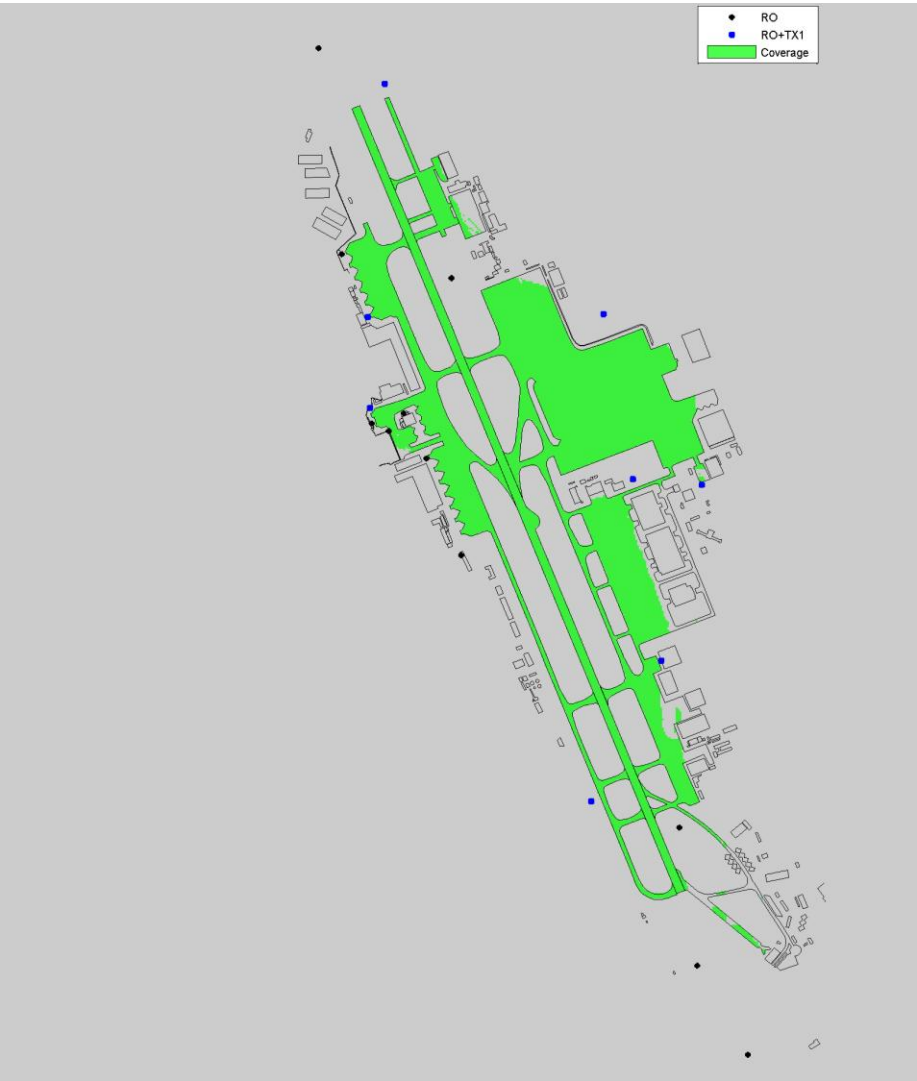
# 12 M MLAT COVERAGE DIAGRAM AT HIA AIRPORT

# 20 M MLAT COVERAGE DIAGRAM AT HIA AIRPORT

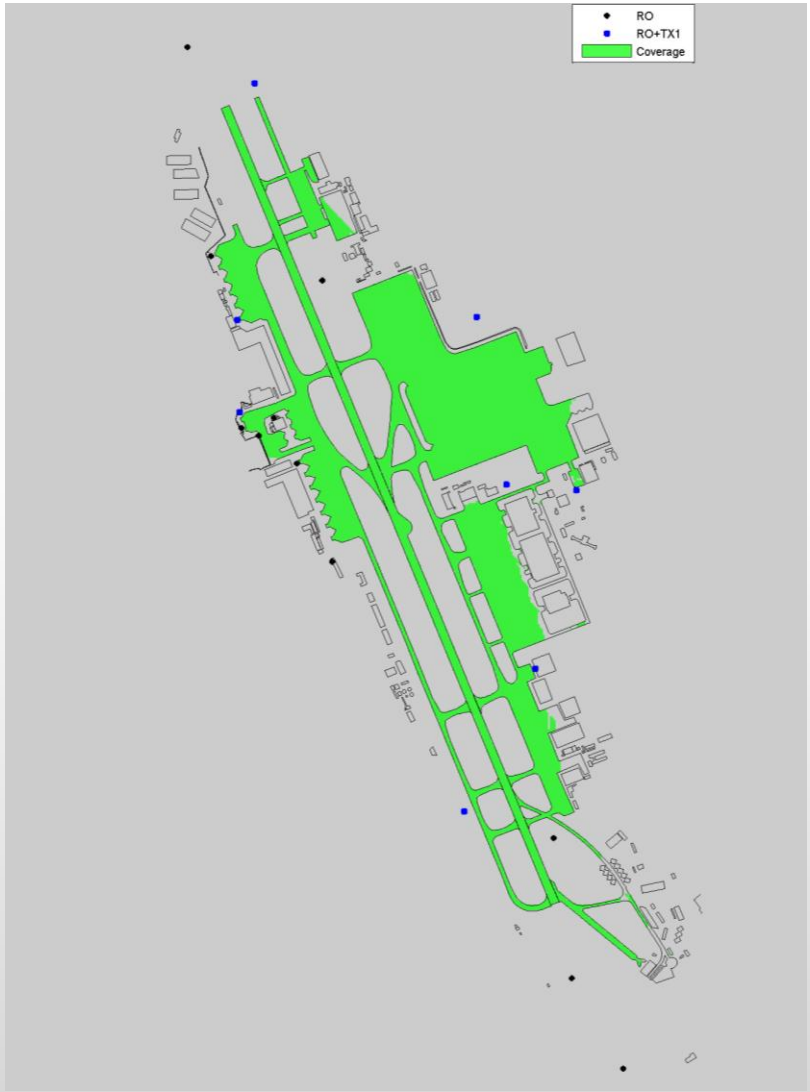
# 7.5 M MLAT COVERAGE DIAGRAM AT DIA AIRPORT



# 12 M MLAT COVERAGE DIAGRAM AT DIA AIRPORT



# 20 M MLAT COVERAGE DIAGRAM AT DIA AIRPORT



# TABLE FOR QTY OF SENSORS

| LOCATION | RO ONLY | RO + TX1 |
|---|---|---|
| HIA | 39 | 17 |
| DIA | 12 | 7 |

| HIA MLAT | | | | | |
|---|---|---|---|---|---|
| RU NUMBER | RU LOCATION | RU TYPE | RU NUMBER | RU LOCATION | RU TYPE |
| RU01 | LLZ 34 R | RO | RU29 | N8 - QJET AREA C5310 | RO |
| RU02 | GP16 L | RO+TX1 | RU30 | N9 - VEHICLE WASHING AREA | RO+TX1 |
| RU03 | MLAT RU3 | RO+TX1 | RU31 | N10 - MOTOR TRANSPORT WORKSHOP BUILDING- C4320 | RO |
| RU04 | SMR3 | RO | RU32 | N11 - FIRE STATION BUILDING-C3210 | RO+TX1 |
| RU05 | GP34R | RO | RU33 | N12 - PTC GATE A8 | RO+TX1 |
| RU06 | LLZ16L | RO+TX1 | RU34 | N13 - ISOLATION AREA | RO |
| RU07 | DVOR-DME | RO | RU35 | N14 - ISOLATION AREA | RO+TX1 |
| RU08 | LLZ16R | RO | RU36 | N15 - PTC GATE C12 | RO |
| RU09 | GP34L | RO+TX1 | RU37 | N16 - PTC GATE C13 | RO |
| RU10 | MLATRU10 | RO | RU38 | N17 - PTC GATE A4 | RO |
| RU11 | GP16R | RO | RU39 | N18 - PTC GATE B2 | RO+TX1 |
| RU12 | LLZ34L | RO | RU40 | N19 - PTC GATE C2 | RO |
| RU13 | MET BLDG | RO | RU41 | N20 - PTC GATE C3 | RO |
| RU14 | RX STATION | RO | RU42 | N21 - PTC GATE A3 | RO |
| RU15 | ATCT | RO+TX1 | RU43 | N22 - PTC GATE B1 | RO |
| RU16 | ATCT-EAST | RO+TX1 | RU44 | N23 - NORTH DET.POND SUBSTATION | RO |
| RU17 | EAST APRON CAB SOUTH | RO | RU45 | N24 - HANGER A&B | RO |
| RU18 | EAST APRON CAB NORTH | RO | RU46 | N25 - GA HANGER | RO |
| RU19 | WEST APRON CAB | RO | RU47 | N26 - AIRFIELD JULIET APRON ELE. BUILDING | RO |
| RU20 | ADS-B1 ASR SOUTH | RO | RU48 | NEAR TIB NORTH BUILDING (W1) | RO |
| RU21 | ADS-B2 ASR SOUTH | RO+TX1 | RU49 | HML 621 (W2) | RO |
| RU22 | N1 - VDGS Q21 | RO+TX1 | RU50 | HML 637B (W3) | RO+TX1 |
| RU23 | N2 - HANGER A | RO+TX1 | RU51 | NEAR PERIMETER FENCE (AREA 1) (W5) | RO+TX1 |
| RU24 | N3 - HANGER D | RO | RU52 | NEAR ESSENTIAL SUB-STATION (AREA 4) (W8) | RO+TX1 |
| RU25 | N4 - HANGER C | RO | RU53 | NEAR BY RUNWAY 16L HOLDING BAY (W9) | RO |
| RU26 | N5 - HANGER B | RO | RU54 | HML 628 (W10) | RO |
| RU27 | N6 - QJET AREA C5160 | RO | RU55 | NEAR TAXIWAY R2 (AREA 1) (W11) | RO |
| RU28 | N7 - GENERAL AVIATION TERMINAL | RO | RU56 | NEAR PERIMETER FENCE (AREA 1) (W12) | RO |

| DIA MLAT | | |
|---|---|---|
| RU NUMBER | RU LOCATION | RU Type |
| RU01 | MET Watch Tower | RO+TX1 |
| RU02 | QAS Tower | RO |
| RU03 | LLZ 33 Shelter | RO |
| RU04 | LLZ 15 Shelter | RO |
| RU05 | Qatar Airways Hangar | RO+TX1 |
| RU06 | ASR/SIRS Radar | RO+TX1 |
| RU07 | Tx Mast | RO+TX1 |
| RU08 | Rx5 MLAT shelter | RO+TX1 |
| RU09 | GP15 Shelter | RO |
| RU10 | VDGS Pole, A12 | RO |
| RU11 | VDGS Pole, A1 | RO |
| RU12 | VDGS Pole, A6 | RO+TX1 |
| RU13 | ATC Tower | RO |
| RU14 | GP33 Shelter | RO |
| RU15 | DVOR Shelter | RO |
| RU16 | Rx Mast | RO |
| RU17 | Next to Stand G3 | RO+TX1 |
| RU18 | Police Gate 2 | RO |
| RU19 | CCTV Pole next to Police Gate 2 | RO |

# Q&A

OPEN FOR DISCUSSION AND TECHNICAL CLARIFICATION.

DEMO AND WORKSHOP AVAILABLE ON REQUEST.