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ATM System Interoperability

A Thales Perspective

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Agenda

Traditional ATM Systems

Modern ATM Systems

New Developments

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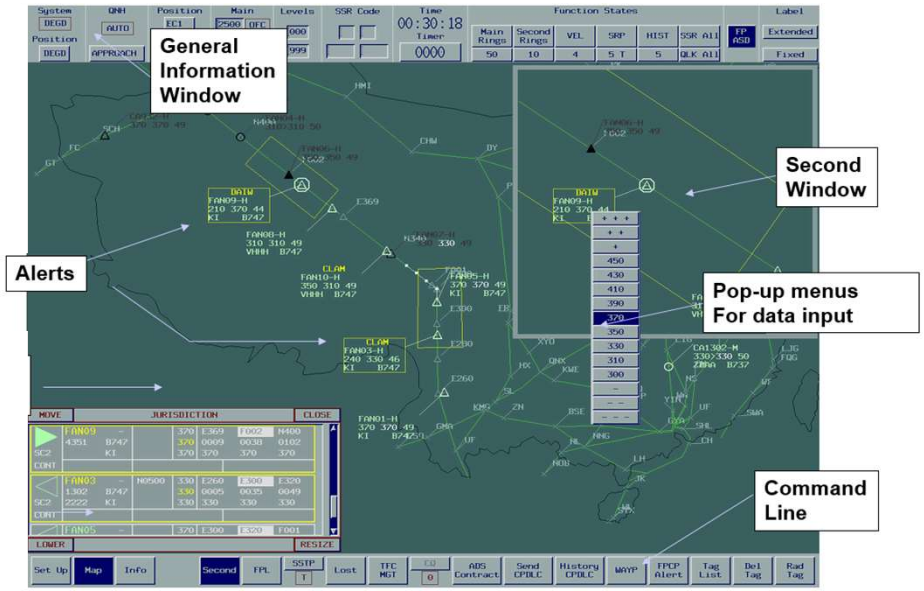
Traditional ATM Systems

Traditional ATM System

Flight Plan and Surveillance Focused

- **Multi-Radar** Processing
- Flight Plan Management
- Some Safety Nets
- ADS-C
- Integrated Display
  - Surveillance, Flight Plan, Alerts, Electronic Strips, Coordination Messages, ADS-C, CPDLC …



Point to point messaging for basic cross boundary coordination

Traditional ATM System – Interfaces & Interoperability

Ground/Ground Interfaces

- **Radar**: to provide aircraft positioning
- **AFTN**: to distribute aeronautical movement messages
- Automated coordination between ATC systems using **AIDC or OLDI**
- Flight plan and system track export service

Air/Ground/Air Communications

- ADS-C to provide aircraft positioning for non-radar surveillance
- Radio, CPDLC (Data link communications)

Serial Line based communication protocols

Interoperability focusing on flight plan awareness and boundary coordination

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Modern ATM Systems

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Modern ATM System

Improved Integration

- Synchronisation of **Main, Fall-back, Emergency** systems

Enhanced Surveillance Processing

- ModeS, ADS-B, WAM, ADS-C

Enhanced Safety Nets

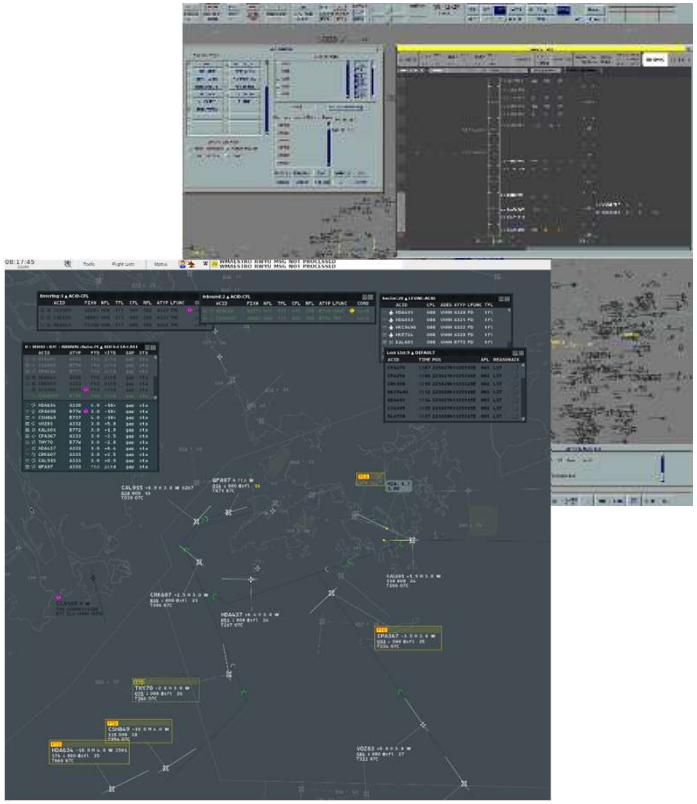
- Medium Term Conflict Detection (MTCD) and intent based alerts
- FMS data (DAPs) used for consistency check and emergency alerts

New Tools for efficiency improvements

- Flow management tools (AMAN, DMAN, ATFM integration)
- RECAT & Approach Separation Management tools

IP Based Interfaces

- AMHS, Radar, ADS-B, WAM, Weather, GRIB, TMA Wind, Integrated Control & Monitoring …
- Integration with other systems. E.g. EFS, ASMGCS, Integrated Tower, AMAN/DMAN



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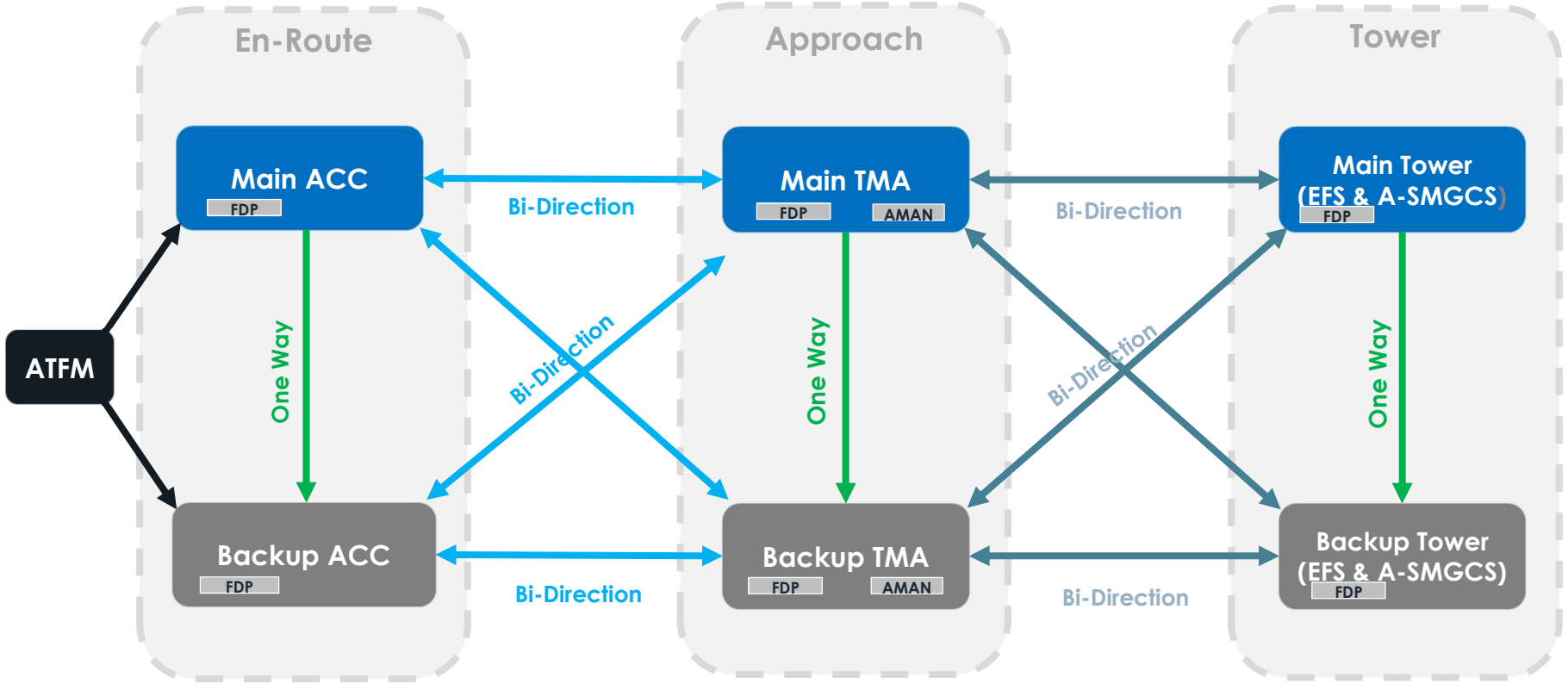
Modern ATM System Interoperability Example



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Data Sharing Example

In China, Flight plan and synchronisation messages use the MHT 4029.3 standard, message format similar to ADEXP

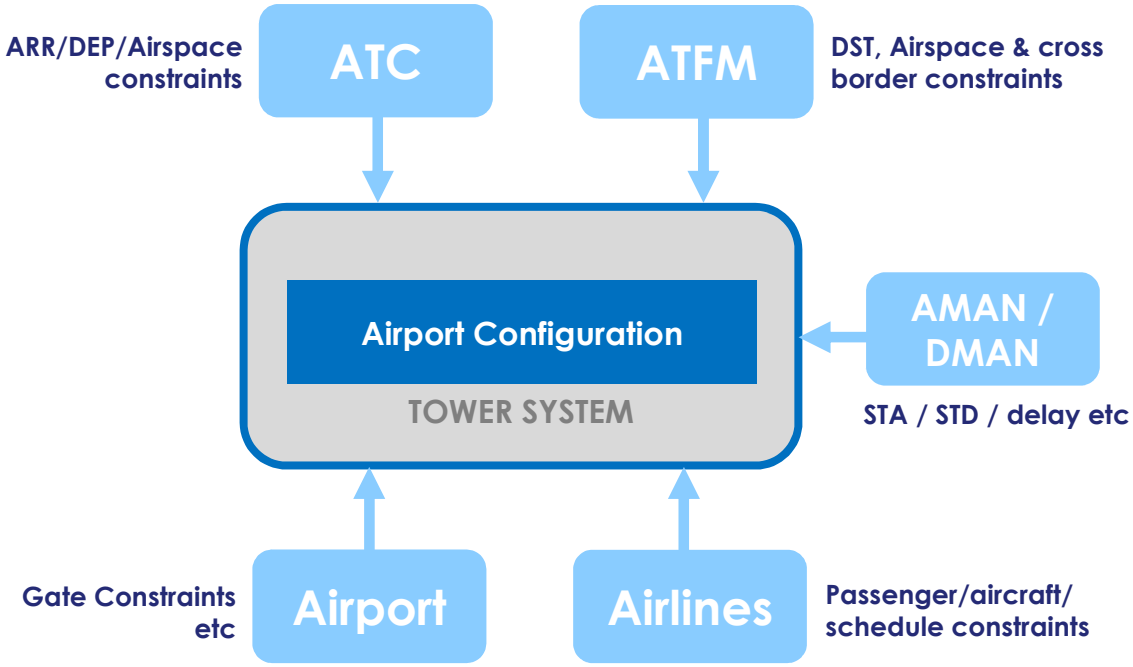
From	To	Direction	Example data shared between systems
Main ENR	Main ENR, APP & TWR	Bi-Direction	Flight information, coordination, transfer of control, AMAN data etc.
Main ENR & APP	Backup ENR & APP	One Direction	Flight information, HMI settings, sectorisation, runway configuration etc.
Main ENR & APP	Main Tower	Bi-Direction	Bi-directional flight information, coordination, transfer of control, AMAN data etc
Main Tower	Backup Tower	One Direction	Unidirectional update of flight information, HMI settings, sectorisation, runway configuration etc.

Modern ATM System Interoperability

Integrated Tower System

- Multiple stakeholders and complex interoperability requirements

Consider integrated tower / ATC automation systems



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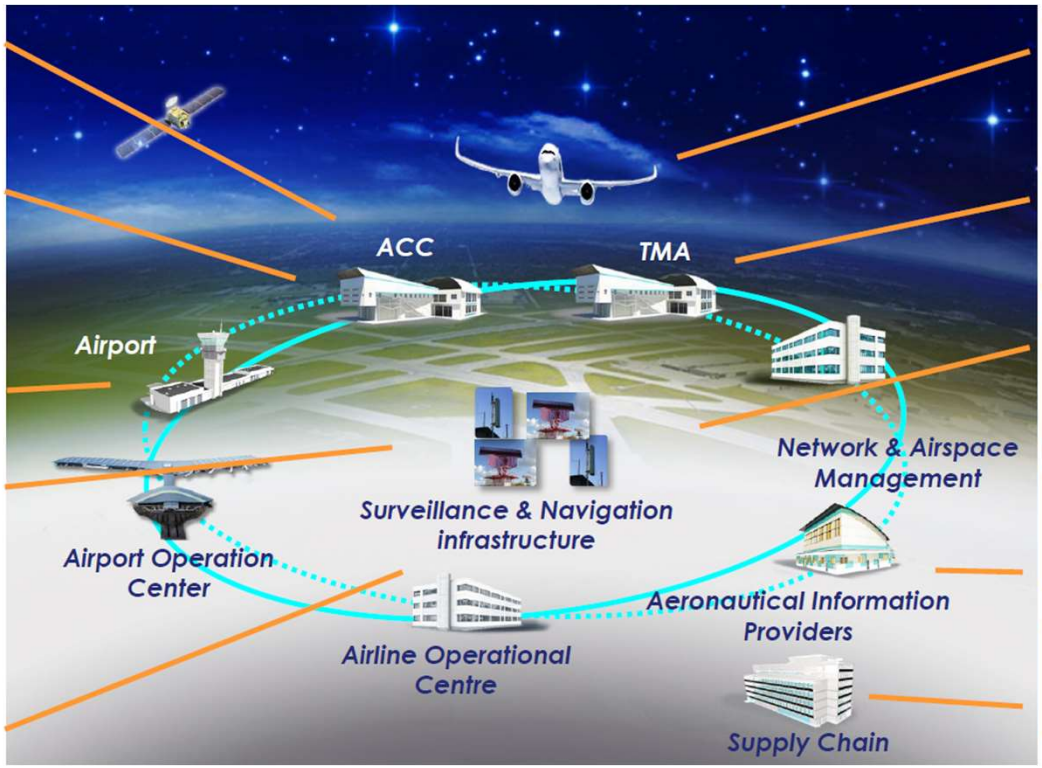
Cyber Security Threats

- Insertion of infected USB key on Online system
- Login usurpation on Online system
- Remote access to ATC LAN and gain admin on Online system
- Spoofing of ADS-B radio signal
- Spoofing over radar data network



- CPDLC Controller or Pilot usurpation
- Malware injection in maintenance
- GPS radio signal time spoofing
- Spoofing of Aeronautical Information
- Malware injection in software supply

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Modern ATM System – Cyber Security Practices

China ATM Systems

- Cyber enhancements in order to meet the MLPS (Multi-Level Protection Schema) requirements

Cyber security enhancements

- System zones
- Data flow segregation
- Boundary protection
- Authentication
- OS and network infrastructure hardening
- Audit logging
- SIEM integration …

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Fast developing requirements and solutions

Interfaces and Interoperability

- IP based interface replacing serial lines
- Fast increasing interoperability requirements between ATC systems, other stakeholders
- Flight information
  - Expectation of **high level of data consistency** and interoperability with **bi-directional updates**
- Some solutions have been developed
  - Often use **customized interfaces** and solutions
  - Complex connections as the number of systems increase
  - Some level of standardization (e.g. MHT 4029.3 in China)
  - Weak in rules for message sending and processing
- **Cyber Security is becoming critical**

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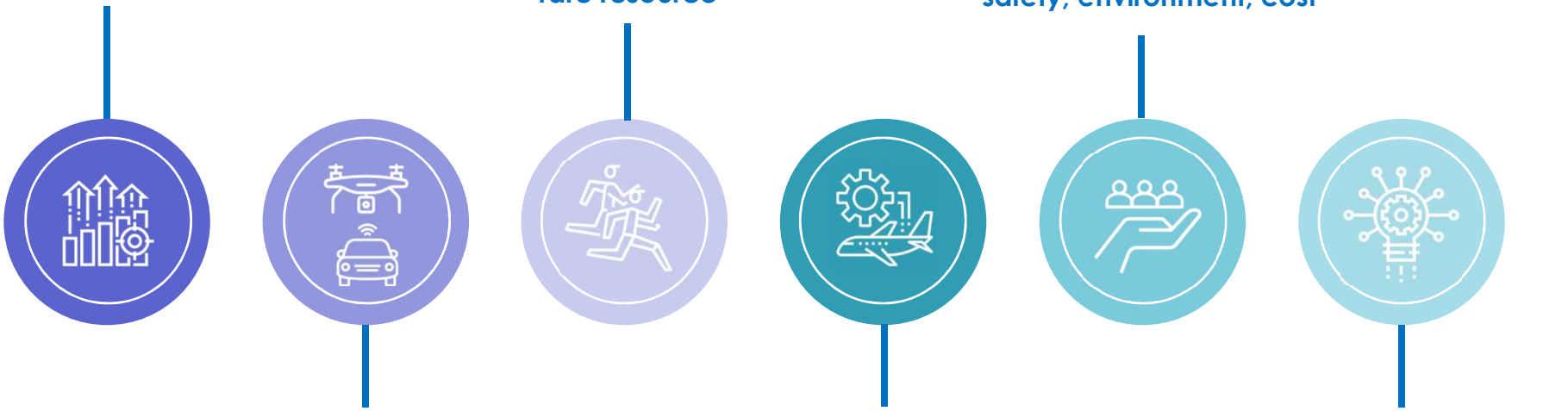
New Developments

The Future of Airspace Management



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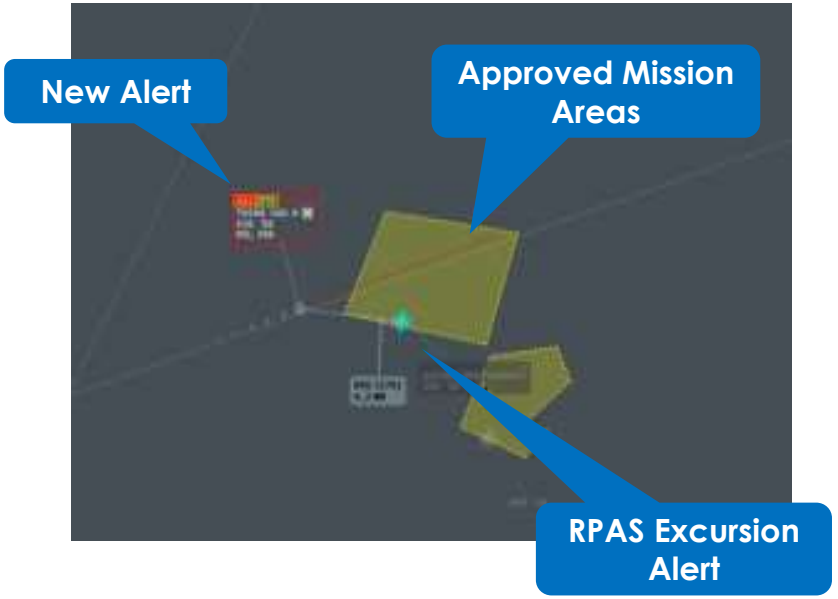
UAS pushing the need - From Accommodation to Integration

Accommodation

- Accommodation of IFR-capable UAS in controlled airspace
- Possible through FUA/AFUA techniques
- Caters for low number of UAS operations

Integration

- UAS integrate as any other airspace user
- Enable civil and military UAS to fly in non-segregated airspace
- Requires regulations, standards and relevant supporting technology, to meet the specific airspace requirements



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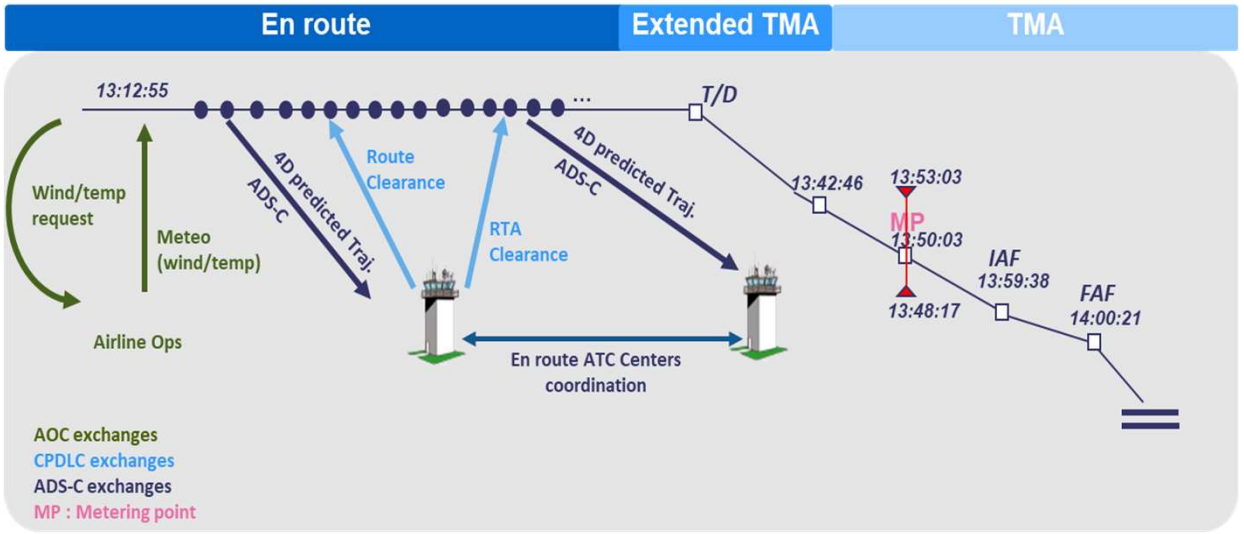
New concepts pushing the need - From Trials to Full TBO

Trajectory Based Operations (TBO)

- Close-loop: trajectory modelling, environmental data
- For example, wind / temperature, arrival and approach path definition
- Predictability = Efficiency
- Less tactical intervention: e.g. speed profile and full trajectory known to runway threshold

Increase in complex interactions

- Trajectory agreed in all the flight phases
- Between multiple stakeholders: Airspace management, ATFM, airlines and aircraft, ATC, airports



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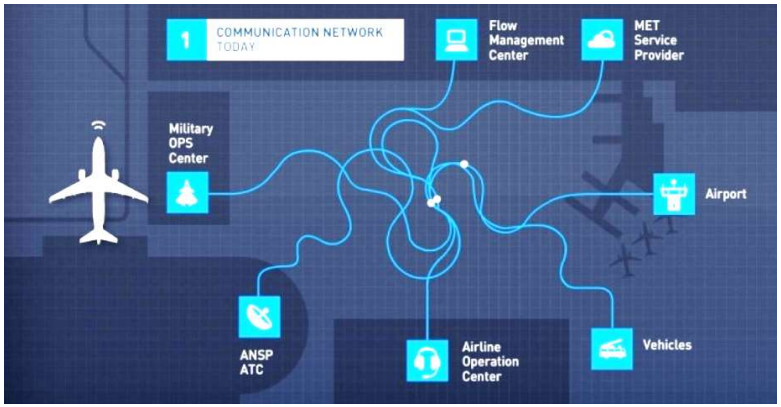
Possible Technical Enabler – SWIM

One-to-One

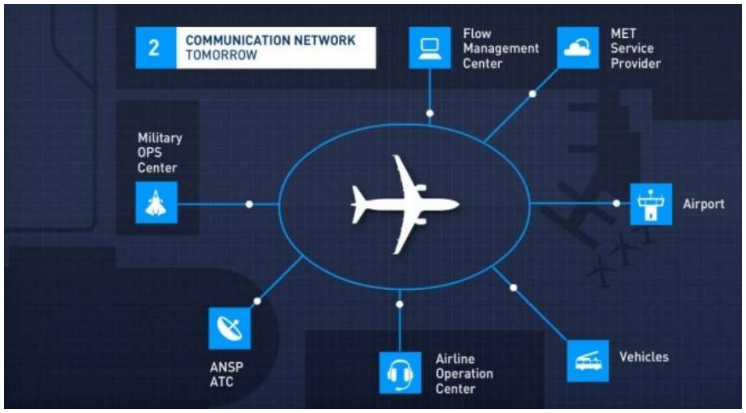
For n systems, up to n(n-1) interfaces



- Many custom communication protocols
- Each interface is custom designed, maintained individually and locally
- Inconsistently updated
- Low reuse, low duplication

Net Centric

For n systems, n interfaces



- Decouple information producers from consumers (Service Oriented Architecture)
- Use of open standards
- Functionality packaged as a suite of interoperable services

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SWIM - China Research & Development

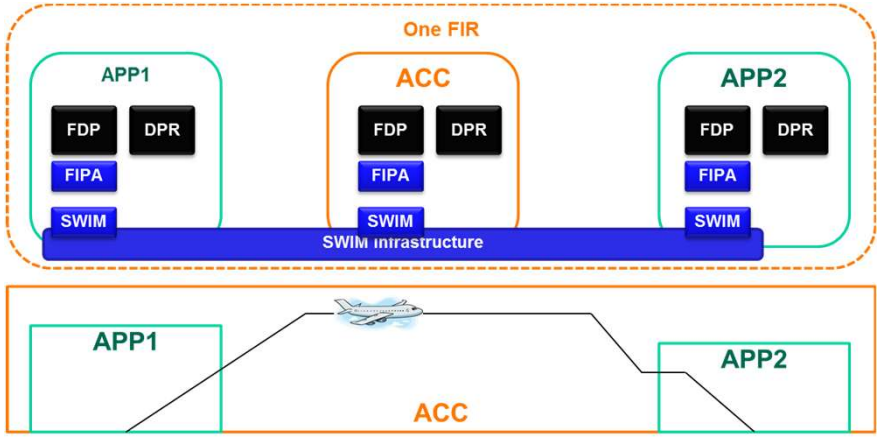
Use the ICAO SWIM concepts

- Adapt ICAO / European IOP concept
- Simplifications of ED133 IOP Flight Object

1 FIR, 1 ACC system & 2 APP systems

3 Steps

1) Demonstrate the FO sharing EUROCAT-X: One ACC and multiple APPs within one FIR **[2017-18]**
2) Maturity enhancement: disconnection, re-synchronisation, degraded modes **[2018-19]**
3) Interoperability with 3rd party systems using common data model (FIXM) **[2020-2021]**



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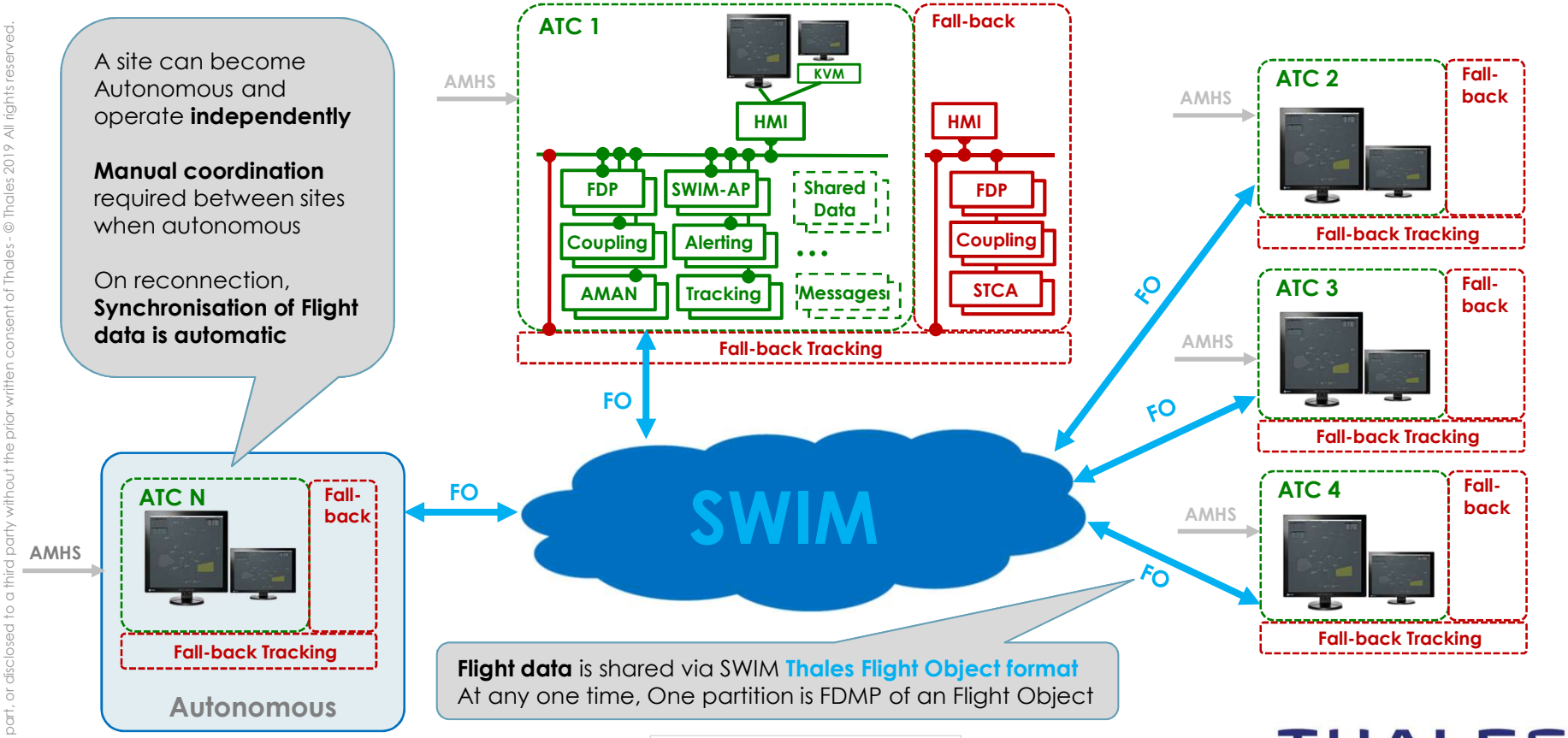
SWIM Industrialization - Nx ATC Systems



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SWIM Industrialization – SWIM component

FF-ICE

- Eurocontrol NM B2B Flight Services

IOP middleware

- *SWIM Blue Profile*
- Publish/Subscribe service
- Traffic synchronisation services
- Export Arrival, Flight Data, and Airport Configuration

Support for Standards

- EUROCONTROL: SWIM-TI Yellow Profile
- EUROCAE: ED-133, ED-254
- FIXM 4.1 / 4.2,
- Web Services, AMQP 1.0, OMG DDSI

Deployment #1 Flight plan service

- Connect TopSky ATC to NOP Flight services and retrieve flight plan data and their updates from NM B2B Web Services

Deployment #2 AMAN/DMAN Data Export

- "ArrivalSequence" MAESTRO data in FIXM 4.2.0 as per EUROCAE ED-254
- "AirportConfiguration" data in XML
- Export "FlightData" data in FIXM 4.2.0

New Developments – Summary

Airspace becomes a rare resource

New Operational Concepts call for a disruption in interoperability solution

- ATM & UTM Integration, Trajectory Based Operation, Extended AMAN, ATFM, CDM …
- Open, connectivity, high level of data consistency, interoperable
- But, with loose coupling at the same time
- Cybersecurity requirements grow with the increase of the connectivity

Standards & Industrial Implementation

- R&D and POC projects to validate the concepts.
- Standards & Technical specification are developing: open technologies, services replacing the message based exchange, protocols on top of data formats
- Some industrial deployment between homogeneous systems, or for more matured applications (e.g. Yellow profile)

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Thank you

Keep in touch

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