



PAW

L-Band Digital Aeronautical Communications System (LDACS) Future Communications in Aviation

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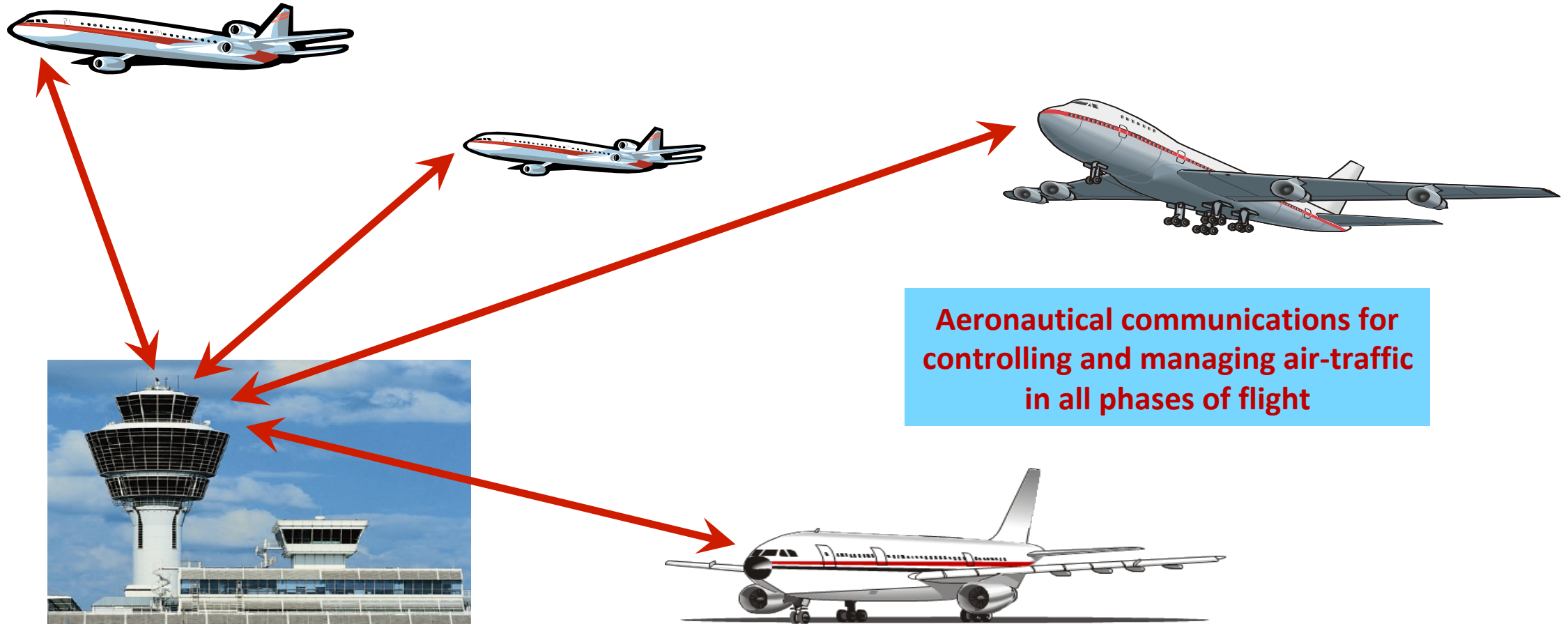
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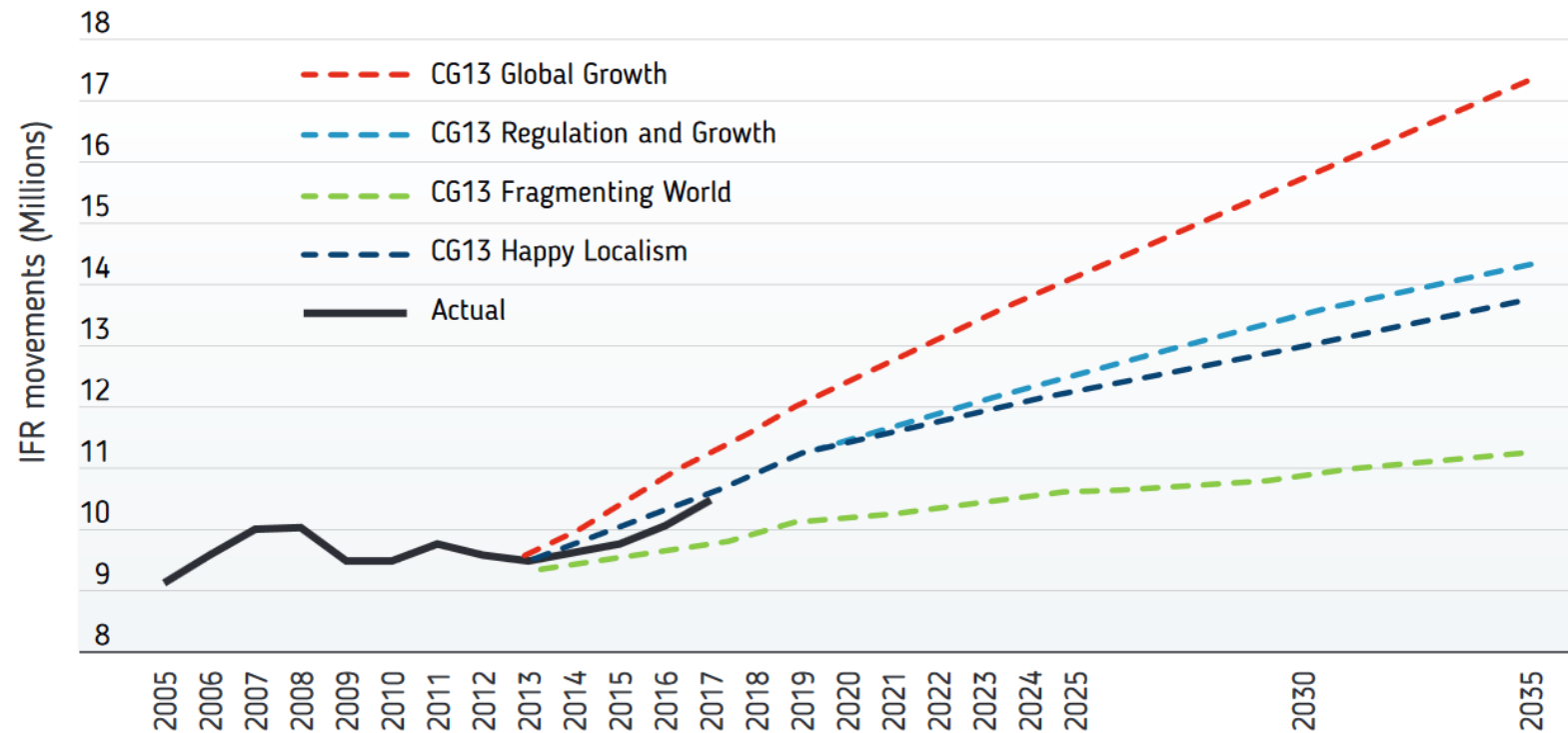
Motivation - Aeronautical Communications



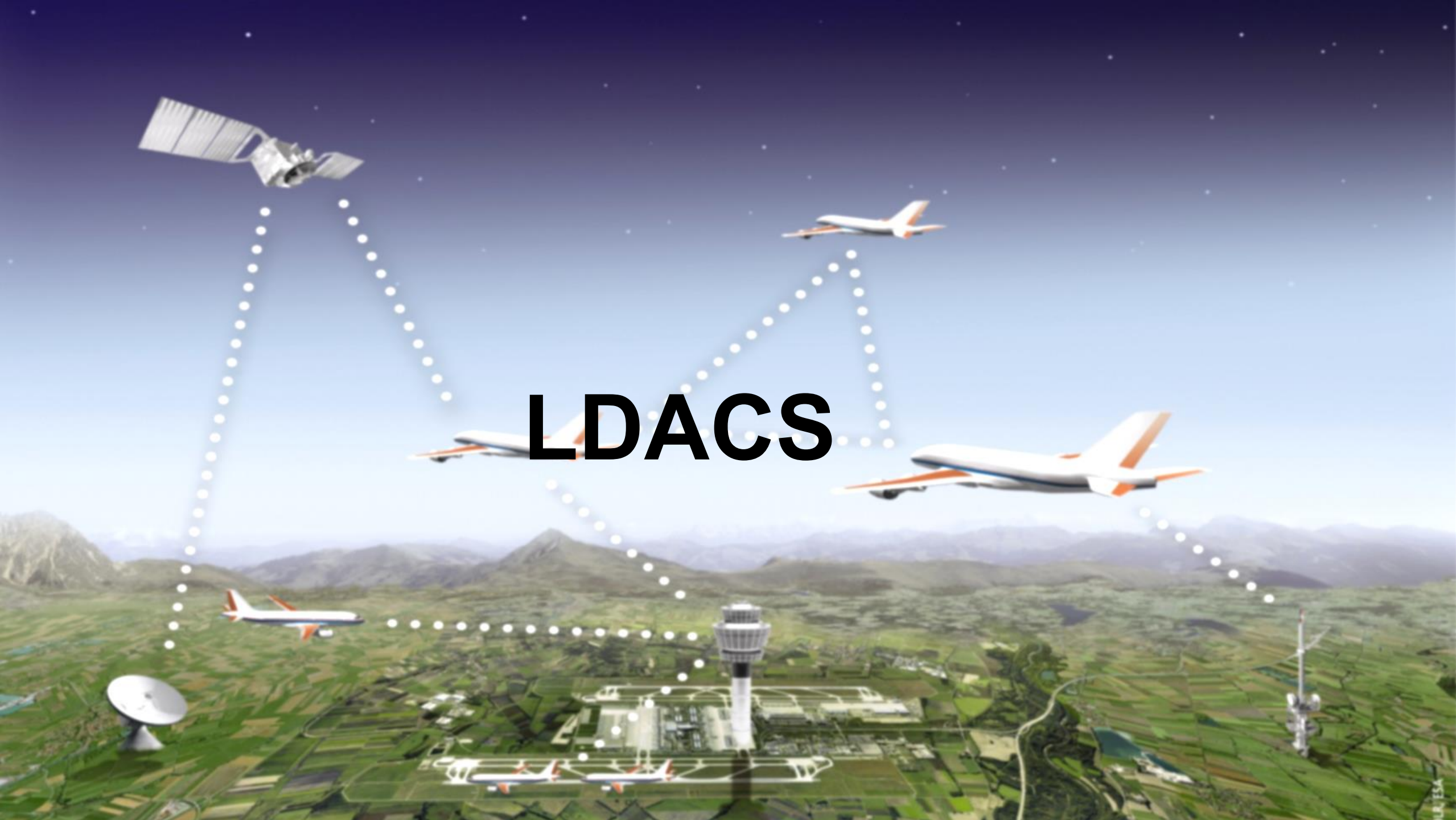
Digital Datalinks in Air Traffic Management (ATM)



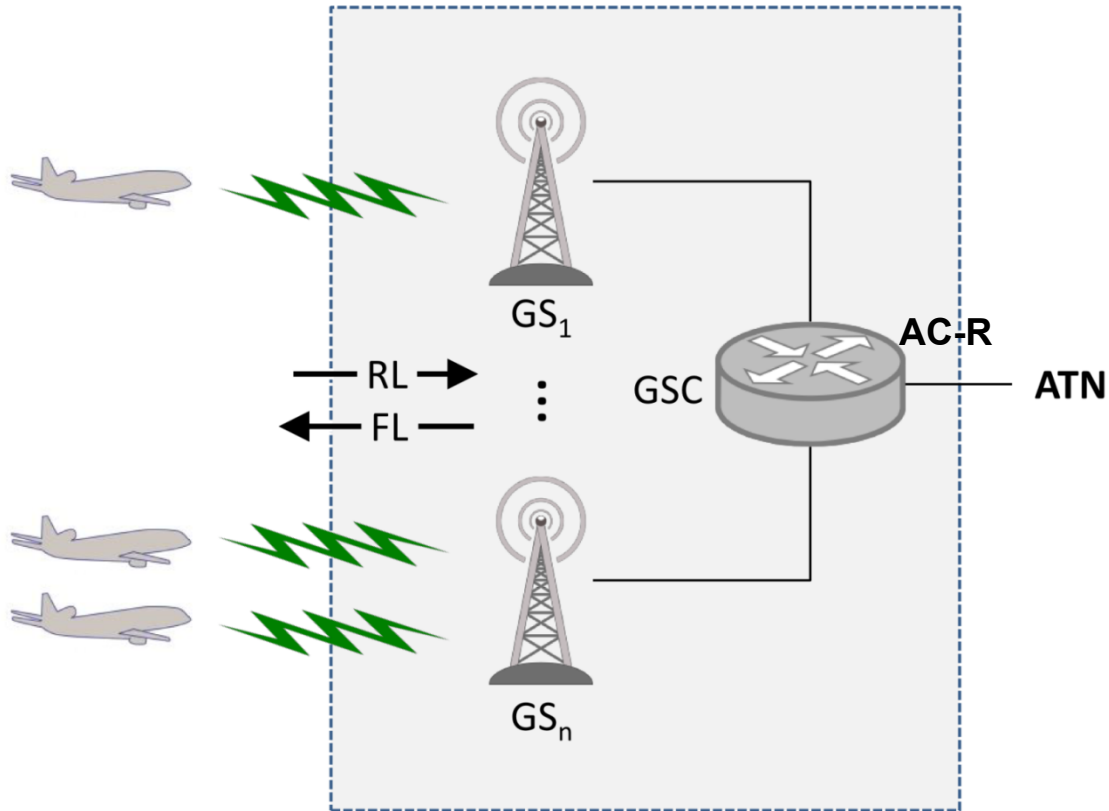
- Worldwide civil air traffic estimated to grow **by 84% until 2040 compared to 2017**
- **Legacy systems in ATM** will reach **capacity limit**
- **VHF band** is becoming **saturated** in **high density areas of Europe, US and Asia**



LDACS



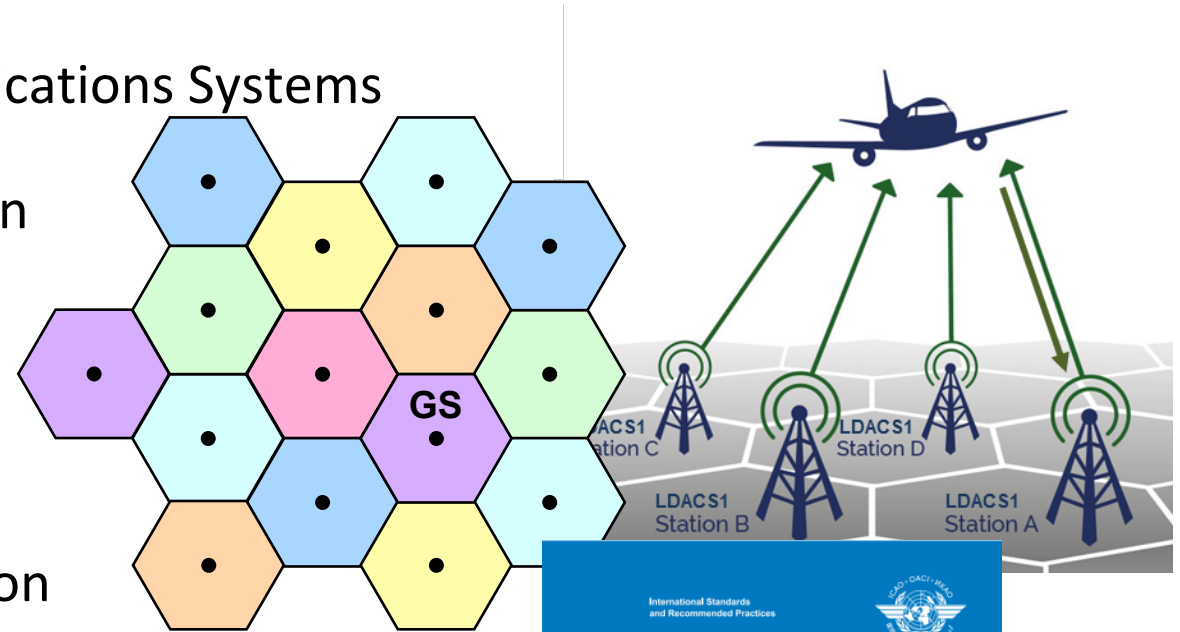
LDACS – Entities, Capabilities



- **LDACS**: L-band Digital Aeronautical Communications Systems
- **Terrestrial digital wireless communication system for civil operational aeronautical safety-of-life communication**
- Based on 3G and 4G technology
- **Enabler for digital data (ATN/IPS) and voice communication in civil aviation**
 - ATM communication (ATS, AOC, APC, AAC, ...)
 - Enables **broadband applications**:
4D Trajectories, Weather maps, SWIM integration, Digital Voice, Video capabilities
 - LDACS as broadband extension of VDL mode 2

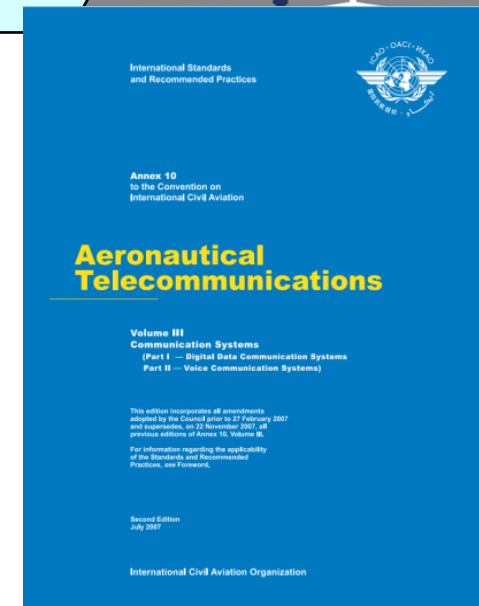
LDACS - Main Characteristics

- **LDACS**: L-band Digital Aeronautical Communications Systems
- Controller/Pilot communications
- Centralized communication via ground station
- Cellular deployment concept
- Duplex scheme is **FDD**
- Multiple-access schemes
 - Forward link (FL): **pure OFDM**
 - Reverse link (RL): **OFDMA/TDMA**
- **LDACS** supports **data and voice** communication



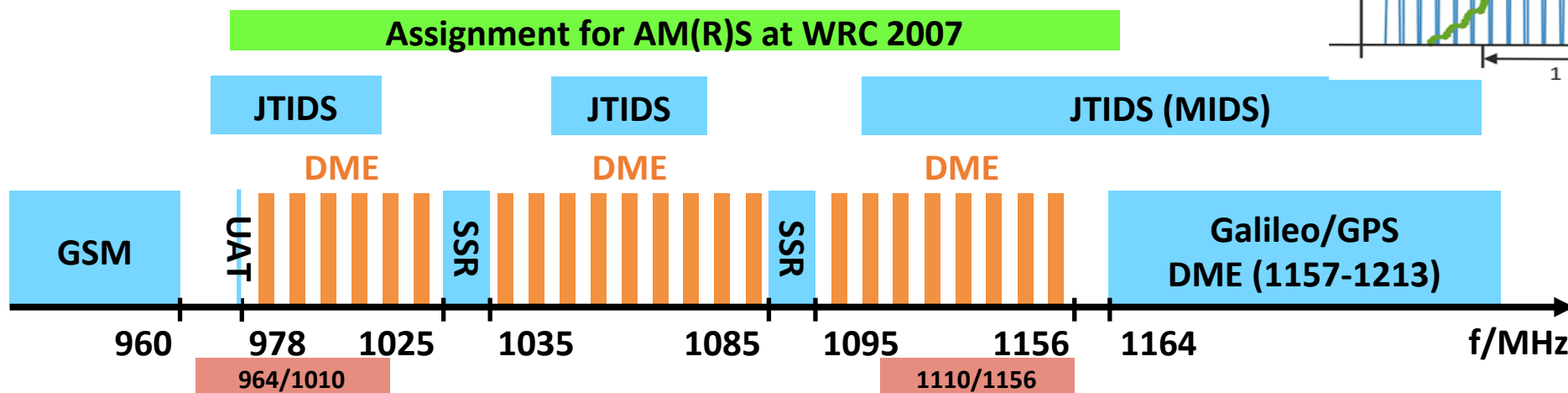
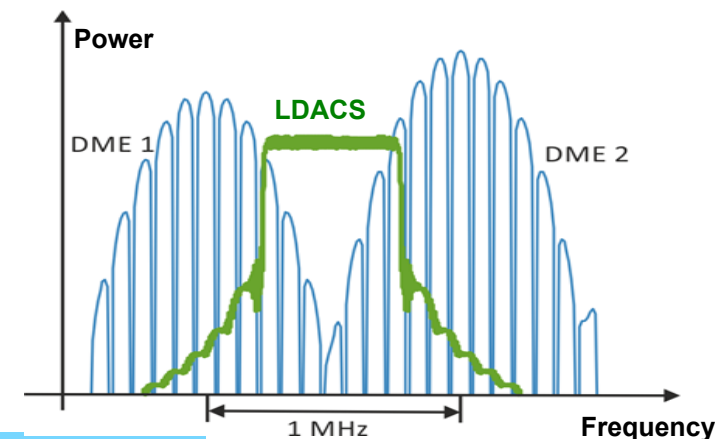
Standardization

- System design finalized
- Performance evaluations by theory and simulations finalized
- **ICAO Standardization** initiated and draft SARPs ready



LDACS - Key Characteristics

- **LDACS** data rates & adaptive coding and modulation (ACM)
 - Bandwidth (overall / occupied) **625 / 488,28 kHz**
 - Modulation rate (overall FL + RL) **833.33 ksymb/s**
 - Min. net data rate (overall) **291+270 kbit/s**
 - Max. net data rate (overall) **1318+1267 kbit/s**



Preferred Deployment: **Inlay Scenario**

Main Issue: **L-band Compatibility**

Approach for LDACS Inlay Scenario:
 → Out-of-band radiation reduction
 → Interference mitigation at receiver

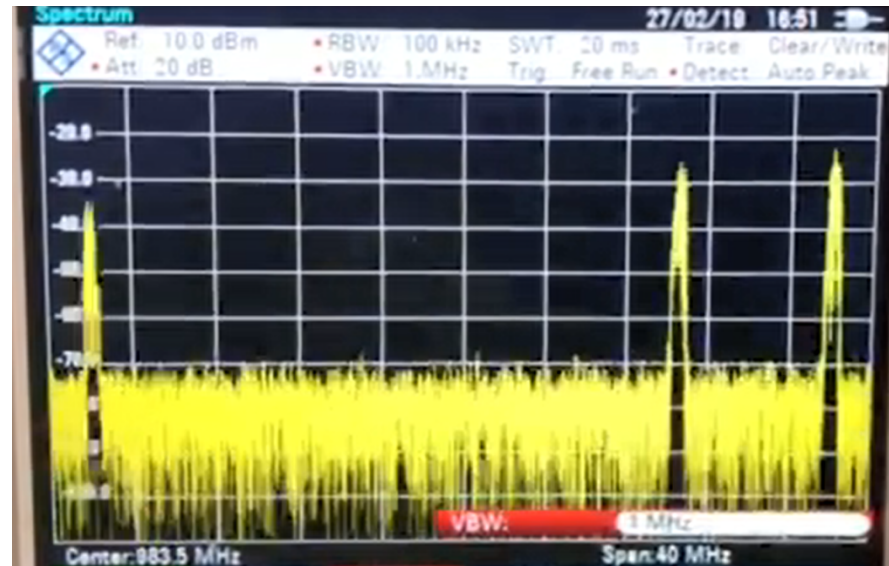
LDACS in Reality – Current Flight Trials

MICONAV Project

- Integration of LDACS hard- and software at DLR labs
- Preparation of flight trials including equipment certification
- Demonstration



AS



Spectrum AS, GS1, GS3



GS

LDACS Summary

- Intended for communication related to the “safety and regularity of flight”
 - Wireless data link between aircraft and ground network
 - Mostly infrequent and small messages (<200B) that must be delivered with very high reliability
- Must be deployed in aeronautical spectrum for regulatory reasons
 - Available spectrum restricts the data rate to several hundred kilobits/second
 - One-way latency is in the order of hundred milliseconds
 - High number of users (~250) per cell expected due to limited possibilities to deploy base-stations
 - For the same regulatory reasons standardization of LDACS layer 2 is performed under the umbrella of ICAO
- Shall be deployed in the aeronautical telecommunications network “ATN-B3”
 - Private IPv6 based global network for air traffic control and related services
 - Aircraft are multi-homed mobile IPv6 networks
 - LDACS is one of several down-links to the ground network
 - Network architecture is currently under development by industry (LISP-based multi-homing of provider independent mobile network prefixes)

LDACS Bibliography

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- [3] T. Gräupl, C. Rihacek and B. Haindl: LDACS A/G Specification. German Aerospace Center (DLR), Germany, SESAR2020 PJ14-02-01 D3.3.010, 2017.
- [4] A. Bilzhause, B. Belgacem, M. Mostafa and T. Gräupl: Datalink Security in the L-band Digital Aeronautical Communications System (LDACS) for Air Traffic Management. IEEE Aerospace and Electronic Systems Magazine, 32(11), 22-33, November 2017.
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- [7] Website on Future Aeronautical Communications - LDACS: <https://www.ldacs.com/> (last access March 20, 2019)