Space based aviation *applications*

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EUROPEAN PARTNERSHIP

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Potential drivers

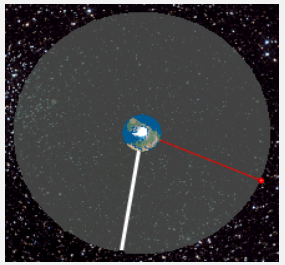
for moving from terrestrial to space-based

- No terrestrial option available
  Oceanic, remote areas
- Better performance than (some) terrestrial based options
  Reliable, scalable, capacity, resilience, latency, cybersecurity
- Higher cost efficiency
  Shared resources, shared usage, prioritisation
  Regional rather than national or local
- Higher spectrum efficiency
  Bigger surfaces, less impact from curvature earth

CNS satellite systems

Note that distance has impact on:

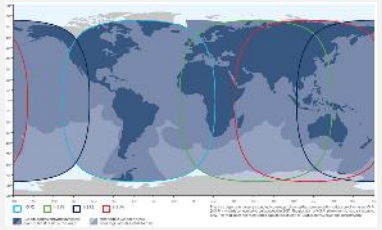
-Geostationary & Coverage
-Rotation time & Doppler effect
-Transmission time & Latency
-Potential disruptions

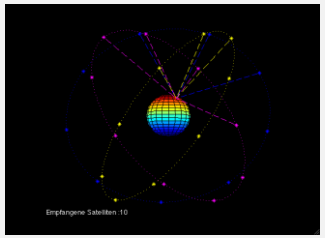


GEO – Geostationary Orbit

- **NAV:**
Satellite Based Augmentation System (SBAS) – EGNOS, WAAS, GAGAN

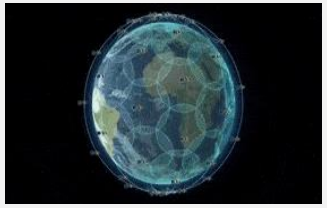
- **COM:**
Inmarsat





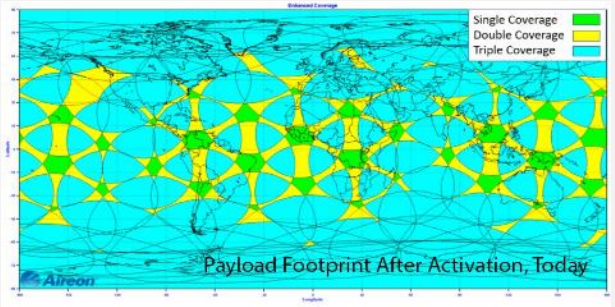
MEO – Medium Earth Orbit

- **NAV:** GNSS:
GALILEO, GPS, GLONASS, BEIDOU



LEO – Low Earth Orbit

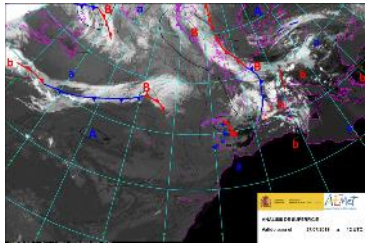
- **COM:** Iridium
- **SUR:** Aireon Payload in Iridium Satellites



Communication: Operational needs

i4D/EPP

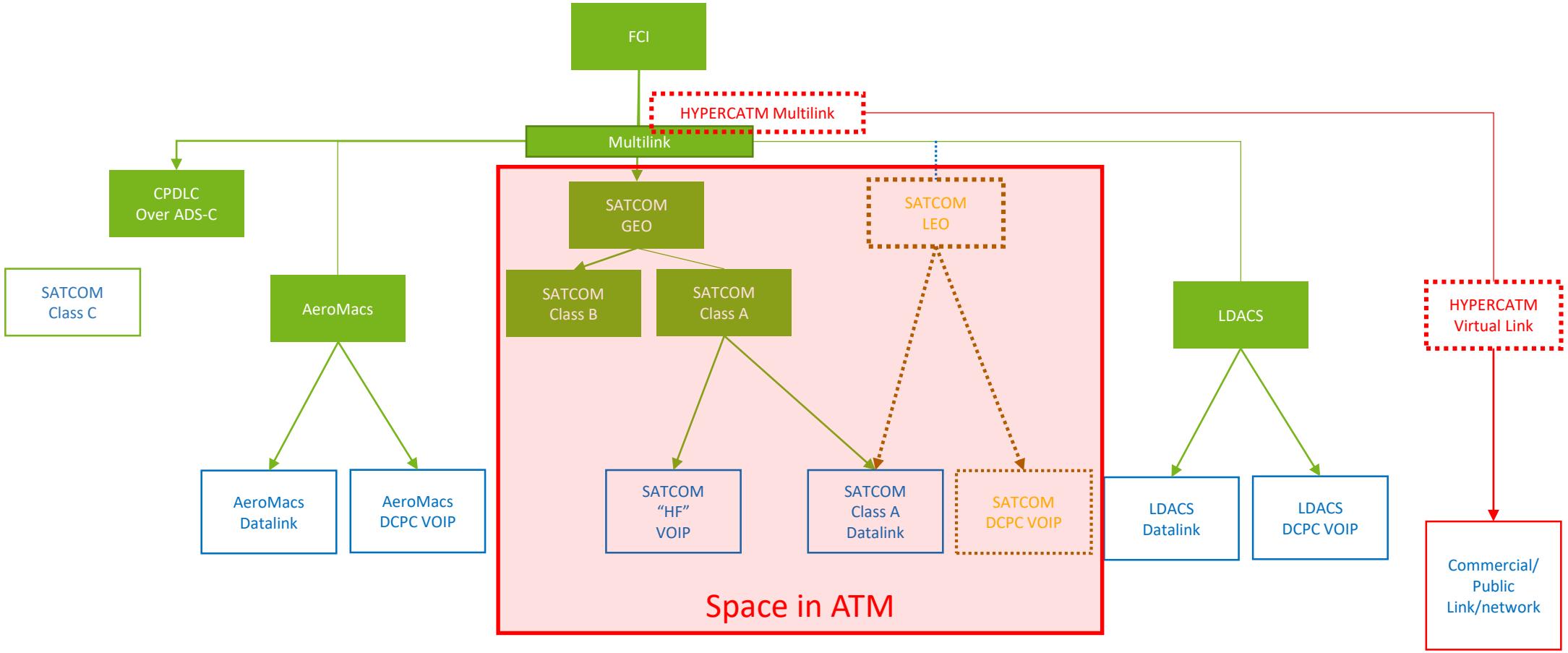
FULL 4D



- ATC
  - R/T (“VHF radio”) – Analogue or digital
  - CPDLC datalink \
  - ADS-C EPP / TBO
- AOC
  - AOC – pilot voice connection (“SATVOICE”)
  - Meteo, Aeronautical- and Network data for EFB
  - Passenger services
  - Non-critical cabin data
  - Flight Engineering data
- New entrants
  - U-space (drones)
  - High Altitude Operations

Different QoS needs
Message prioritisation \
Authentication & encryption / IPS

Communication: Research & Development



Different QoS needs

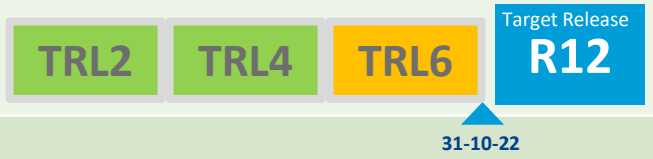
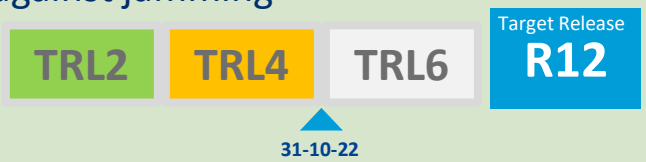
Message prioritisation \
Authentication & encryption / IPS

Navigation: Operational needs

Area navigation	VOR, DME	+ GNSS
Approach and landing navigation		
• CAT I landings	ILS cat I	+ SBAS + GBAS GAST-C
• CAT II	ILS cat II	+ SBAS + GBAS GAST D/F
• CAT III	ILS cat III	+ GBAS GAST-D/F
Accurate (airborne) time reference	Airborne clock	+ GNSS

Space in ATM

GNSS: SBAS and GBAS evolutions

Technology	Characteristics	Performance
SBAS (EGNOS/WAAS)	Single constellation (GPS), single frequency	CAT. I
SBAS MCMF	Multi constellation, multi frequency (GPS + GALILEO)	CAT. II under research
GBAS GAST-C	Single constellation (GPS), single frequency	CAT. I
GBAS GAST-D	Single constellation (GPS), single frequency	CAT. II/III 
GBAS GAST-F	Multi constellation, multi frequency Ground based error processing (GPS + GALILEO)	CAT. II/III GPS independent More resilient against ionosphere disruptions More resilient against jamming 

Future targeted research on navigation
- U-space (drones)
- High Altitude Operations
- From Barometric to Geometric altimetry

Surveillance

The ability to accurately and reliably determine the location of aircraft.

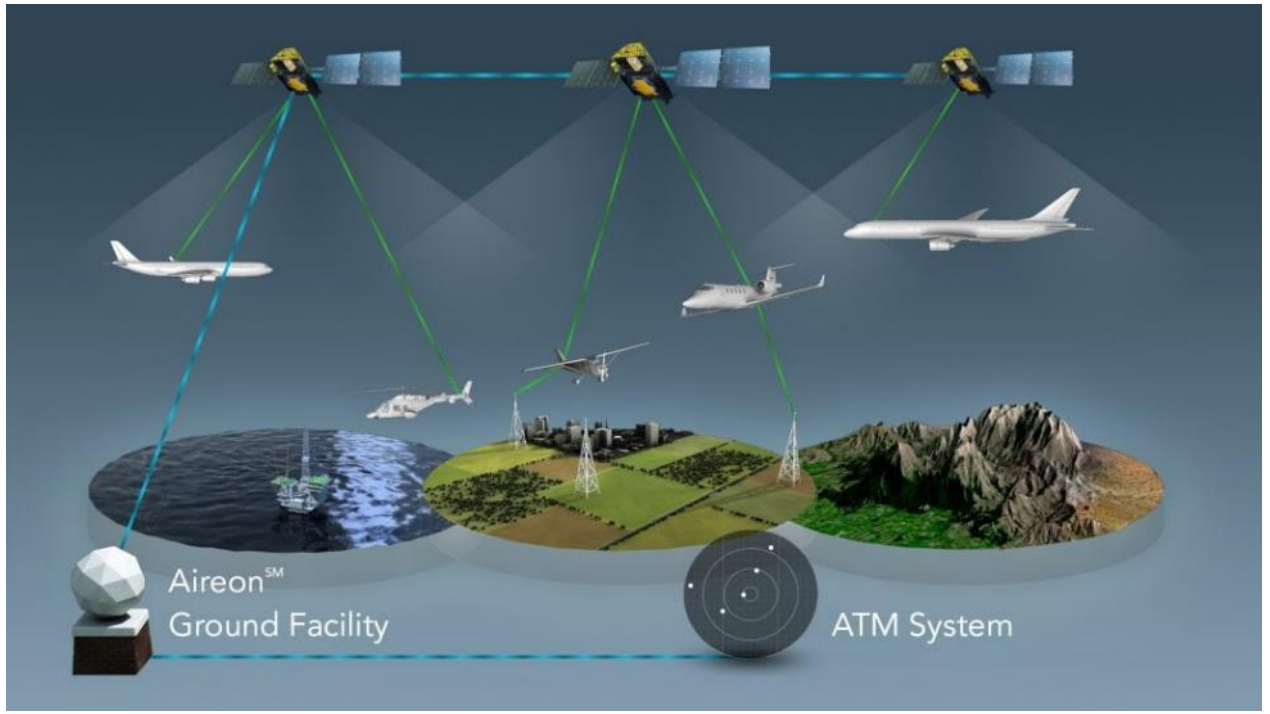
Has a direct influence on the separation distances required between aircraft (i.e. separation standards), and therefore on how efficiently a given airspace may be utilised.

- Primary radar
- Mode-S
- ADS-B (Automatic Dependent Surveillance – Broadcast)
- Wide Area Multilateration (WAM)

Industrial research:

- Improved monitoring by combining signals from space and ground
- End-to-end performance monitoring

Space in ATM



Since 2019 NAV CANADA and NATS began using space-based ADS-B data (Certified by EASA) to separate aircraft in the North Atlantic Ocean

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JOINT UNDERTAKING

THANK YOU FOR YOUR ATTENTION

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