Some figures...

Air traffic doubles every 15 years

3.6 billion Passengers

62.7 million Jobs supported

51.2 million Tonnes of freight

$2.7 trillion Global GDB annually

Source ATAG 2016
A commercial aircraft manufacturer with the two Divisions Defence and Space and Helicopters.

We make it fly.

129,000
Total workforce

997 billion
Order book

€59 billion
Annual revenue, restated
IFRS 15

June 2018
Commercial Aircraft’s global workforce is united by a passion for aviation and restless desire to create better ways to fly.

7,179 Backlog
400+ Operators
56,000 Employees
€43.5 billion Annual revenue, restated IFRS 15

Data dated May 2018
Our aircraft are a familiar sight around the world.

An Airbus takes off or lands every 1.4 seconds.

18,277 Aircraft sold
60 Produced monthly
25,000+ Daily flights
11,098 Delivered

Data to end April 2018
We are in a growth industry.

Strong and resilient passenger traffic growth with associated “Connectivity needs”

Over **34,900** new aircraft required by 2036.

A market value of **$5.2 trillion** by 2036.

MRO business by 2035: **$1.8 trillion** in total.
Among Airbus Commercial Aircraft’s
Fly, Communicate, Navigate with a commercial A/C
Aviation Challenges

Maintain level of Safety, Enable Traffic growth, Ensure Regularity of Flight, Reduce cost, Operate at optimum paths, Open new routes, Reduce Fuel Consumption, Reduce Carbon Emissions,

Commercial aircraft are equipped with **Communications, Navigation and Surveillance** systems (CNS) which provide essential and critical safety functions related to airworthiness and flight regularity.

CNS systems are standardized by ICAO (International Civil Aviation Organization) thus, beyond the harmonized regulatory framework, it ensures the worldwide interoperability
Aviation Challenges

- **Safety objectives**
  - Loss of C, N or S = MAJ to CAT
  - Combined loss of CNS systems = HAZ to CAT

- **Operational objectives**
  - Availability, continuity of service => Dispatch, Operational Interruption

- **Data Security Requirements**

Aviation has longer life cycle than other spectrum users, average aircraft duration life is 35 years, so key to maintain interoperability with ground and space networks.

Safety first : Need to ensure the availability of a protected aeronautical safety spectrum for aviation use on long term
Cockpit

Weather Radar

Transponder/ADS-B & Traffic Collision Avoidance

COM
- High Frequency Data Radio (HF DRA) - Long range (independent) voice & data communications
- Very High Frequency Data Radio (VHFDRA) - Short range (line of sight) voice & data communications

NAV
- Radio Nav aids
- Landing aids
- Radio Altimeter

TELEMETRY
Used for development A/C

Ground stations

Aircraft/Flightlink (VHF-FM/GSM/LTE)
Surface-airport communications

Satellite Communication (SATCOM)
Digital and voice transmissions re ensuring networks or LED systems

Global Navigation Satellites Systems (GNSSs)

Flight Management

ATC Controller

Airports

MMR
Recent evolutions within Aeronautical sector:

- WAIC - Wireless Avionics Intra Communications
- Space based ADS-B
- GADSS - Global Aeronautical Distress Safety System

>>>>> Efficient use of current aeronautical spectrum
Operations and Maintenance
Operations

Among Cockpit CNS,

Airlines Operations and Maintenance needs
A new dimension in data and connectivity access
An integrated & secured data pathway from the aircraft to skywise.
**Operations**

- **Avionics computers**
- **FOMAX**
- **Airline IT**
- **Airline users (OCC, MCC, engineering...)**

- **Capacity to connect any computers, any data**
- **Double 4G ground connection, including a dedicated channel for Skywise offer**
- **4G extended data**
- **4G QAR/DAR/SAR reports/EFB/FLS**

**ITU/SPbPU seminar - Aviation Communication**

**June 2018**

**FOMAX: Flight Operations Message eXchanger**
- QAR: Quick Access Recorder
- DAR: Direct Access Recorder
- SAR: Smart ACMS Report
- EFB: Electronic Flight Bag
- FLS: Field Loadable Software
Passengers
New needs: Social medias, Sport, News, Streaming, Video on Demand, Bring Your Own Device >>>> Bandwidth needs
A fast growing market using Satcoms in L, S, Ku, Ka bands, and Air to Ground systems …

* Source Euroconsult

x 3 connected A/C in 3 years (mostly retrofit)
From 5700 A/C connected to 23,000 in 2025

* Source Euroconsult
The frequency spectrum is increasingly requested for new applications, particularly from the mobile and internet industry (4G / LTE, 5G, Wi-Fi, WLAN, RLAN, M2M, IoT, New Satellite constellations, High Throughput Sat, Q & V bands...)

- Connected Aircraft Trends supporting Internet of Things
- Average mobile cost per megabyte is continuously decreased
- Mobile network connection speeds still increasing (threefold by 2021)

For Airline Operations and Passengers, take benefits of any type of spectrum properly allocated
Installation and Rationalization
Recent technical evolutions like Software Defined Radios will allow to optimize and rationalize A/C installation, so good timing to lower SWaP (Size Weight and Power) and Costs of CNS radio systems.

Avionic volume, Weight and Power **reduction**

Recurring Cost **reduction**

Increased **flexibility**, Evolutions, Options, New means, Decommissioning (software update)

Installation **friendly** (Smaller/combined antennas, less coaxial...)

**Installation and Rationalization**
Aircraft carry many radio equipment and antennas

COM: VHFx3, HFx2, Satcom, ELT
NAV: ILS(LOC & Glide)x2, VOR/Marker, DMEx2, GNSSx2, ADFx2
SURV: TCASx2, XPDR/MODE S/ADS-Bx2, WXR
Ka/Ku/DA2G/Wifi/4G/LTE
Aeromacs, IRIS, LDACS
5G, IoT, new Wifi…

Installation and Rationalization

Costs $$
Size > 40 MCU
Weight > 130 Kg (40% for wiring)
Power consumed

And more radio equipment might be needed in the future
Vision of a future globally distributed radio architecture for CNS

Possible Evolution of Communications and Surveillance Systems

- 2x HF
- 1x AeroMACS
- 1-2x SATCOM
- 1 TCAS
- 2 XPDR
- 3x VHF
- 1-2x LDACS

A Vision of Architecture for Future Radios and Smart antennas

- Remote RF Units
- Integrated Multi-Band Antenna
- TCAS / XPDR SMART Antennas
- Digital Interconnection (weight reduction)
- Universal Main Radio Unit (Hosting multiple radio software)
Distributed architectures concepts for radio systems were emerging and show promising benefits, as Airbus we proposed an Arinc Project Initiation/Modification.

APIM 18-003 calling for an assessment of future Communication, Navigation and Surveillance (CNS) radio system architectures was formally launched during the last AEEC General Session with the objective to define future ARINC Standards.

Airframers, main Radio suppliers, Airlines and Aeronautical sector ready to contribute, first report expected end 2020.
Cockpit evolutions and new functions leading to new spectrum needs
Cockpit evolutions

Flight Crew Optimization
Single Pilot Operations

Human as the Strategic Decision Maker
Focus on Crew Workload and Awareness

Tomorrow?
For these new Concepts which consist in optimizing flight crew operational’s, a Beyond Line Of Sight communication link with Ground Assistants/Opeators may be needed.
To be able to cover all situations cases according to strategic choices, like Autonomy, the Satcom Com means shall provide appropriate end to end performances to support Flight crew optimization:

- Availability, latency, coverages, bandwidth, cybersecurity …
- Secured ground Infrastructure
- Cost of use
- Safety of Life Spectrum
- Constellations life time
- Terrestrial complement
- ….
Formation Flight

Cockpit evolutions

Need very short range communications between Leader and Follower Aircraft (Voice & Data)

Fuel savings & CO2 emission reduction

Cruise phase

Break-away area

Rendez-vous area

June 2018

ITU/SPbPU seminar - Aviation Communication
Evolving environment
Prepare the future in new environment
How “Aviation Communications” will evolve

• **Aviation demands**
  – Traffic growth
  – New functions for Cockpit, Operations and Passengers
  – Additional airspace users (Drones, HAPS, Space planes, Orbital planes ...)

• **New technologies on the horizon**
  – Next Generation Radio Architecture (SDR, Antenna Beam forming..)
  – 5G with dual, satellite and terrestrial components
  – Internet of Things
  – Massive LEO satellite constellations
  – Q/V Bands for Satellite use
Key messages regarding spectrum aspects for Aviation

- Protected Spectrum for CNS to achieve Safety and Security objectives is key

- Take benefits from public market/operators to deploy new proposed services on commercial aircraft for non safety applications

- Monitor environment to anticipate congestion/saturation aspects
Any questions?
Thank you
# Glossary

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>A/C</td>
<td>Aircraft</td>
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<tr>
<td>ADF</td>
<td>Automatic Direction Finder</td>
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<tr>
<td>ADS-B</td>
<td>Automatic Dependent Surveillance-Broadcast</td>
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<tr>
<td>A/L</td>
<td>Airlines</td>
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<tr>
<td>AAC</td>
<td>Airlines Administrative Communication</td>
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<tr>
<td>AOC</td>
<td>Airlines Operational Control</td>
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<tr>
<td>APC</td>
<td>Airlines Passenger Communications</td>
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<tr>
<td>ATC</td>
<td>Air Traffic Control</td>
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<tr>
<td>A/G</td>
<td>Air to Ground</td>
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<tr>
<td>ATM</td>
<td>Air Traffic Management</td>
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<tr>
<td>ATS</td>
<td>Air Traffic Services</td>
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<tr>
<td>CNS</td>
<td>Communication, Navigation, Surveillance</td>
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<tr>
<td>CO2</td>
<td>Carbon</td>
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<tr>
<td>DAR</td>
<td>Digital Access Recorder</td>
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<tr>
<td>DFDR</td>
<td>Digital Flight Data Recorder</td>
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<tr>
<td>DLK</td>
<td>Data Link</td>
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<tr>
<td>DME</td>
<td>Distance Measuring Equipment</td>
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<td>EFB</td>
<td>Electronic Flight Bag</td>
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<tr>
<td>ELT</td>
<td>Emergency Locator Transmitter</td>
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<tr>
<td>FDS</td>
<td>Flight Data Streaming</td>
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<tr>
<td>FLS</td>
<td>Field Loadable Software</td>
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<tr>
<td>FOMAX</td>
<td>Flight Operations Message eXchanger</td>
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<tr>
<td>GADSS</td>
<td>Global Aeronautical Distress and Safety System</td>
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<tr>
<td>GEO</td>
<td>Geostationary Earth Orbit</td>
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<tr>
<td>GNSS</td>
<td>Global Navigation Satellite System</td>
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<tr>
<td>GPS</td>
<td>Global Positioning System</td>
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<tr>
<td>GSO</td>
<td>Geo Stationary Orbit</td>
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<tr>
<td>HAPS</td>
<td>High Altitude Platform System</td>
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<tr>
<td>HF</td>
<td>High Frequency</td>
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<tr>
<td>ICAO</td>
<td>International Civil Aviation Organisation</td>
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<td>IFRS</td>
<td>International Financial Reporting Standard</td>
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<tr>
<td>IoT</td>
<td>Internet of Things</td>
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<tr>
<td>ILS</td>
<td>Instrument Landing System</td>
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<tr>
<td>IP</td>
<td>Internet Protocol</td>
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<tr>
<td>LDACS</td>
<td>L-Band Digital Aeronautical Communication System</td>
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<td>LEO</td>
<td>Low Earth Orbit</td>
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<td>LOC</td>
<td>LOCalizer</td>
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<td>LTE</td>
<td>Long Term Evolution</td>
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<td>MCC</td>
<td>Mission Control Center</td>
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<td>MCU</td>
<td>Mission Control Center</td>
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<td>OEM</td>
<td>Original Equipment Manufacturer</td>
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<td>OCC</td>
<td>Operational Control Center</td>
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<td>OPX</td>
<td>Operations</td>
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<td>PAX</td>
<td>Passenger</td>
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<tr>
<td>QAR</td>
<td>Quick Access Recorder</td>
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<tr>
<td>RCC</td>
<td>Rescue Coordination Center</td>
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<tr>
<td>RF</td>
<td>Radio Frequency</td>
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<tr>
<td>RLAN</td>
<td>Radio Local Area Network</td>
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<tr>
<td>SAR</td>
<td>Smart ACMS Report</td>
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<tr>
<td>SWaP</td>
<td>Size, Weight and Power</td>
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<tr>
<td>TCAS</td>
<td>Traffic Computer Alerting System</td>
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<td>VDR</td>
<td>VHF Data Radio</td>
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<tr>
<td>VDB</td>
<td>VHF Data Broadcast</td>
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<tr>
<td>VHF</td>
<td>Very High Frequency</td>
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<tr>
<td>VOR</td>
<td>VHF Omni Range</td>
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<tr>
<td>XPDR</td>
<td>Transponder</td>
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<tr>
<td>WAIC</td>
<td>Wireless Avionics Intra-Communications</td>
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<tr>
<td>WLAN</td>
<td>Wireless Local Area Network</td>
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<tr>
<td>WXR</td>
<td>Weather Radar</td>
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<tr>
<td>5G</td>
<td>Fifth Generation</td>
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