Lufthansa Systems
IT that makes your life easier

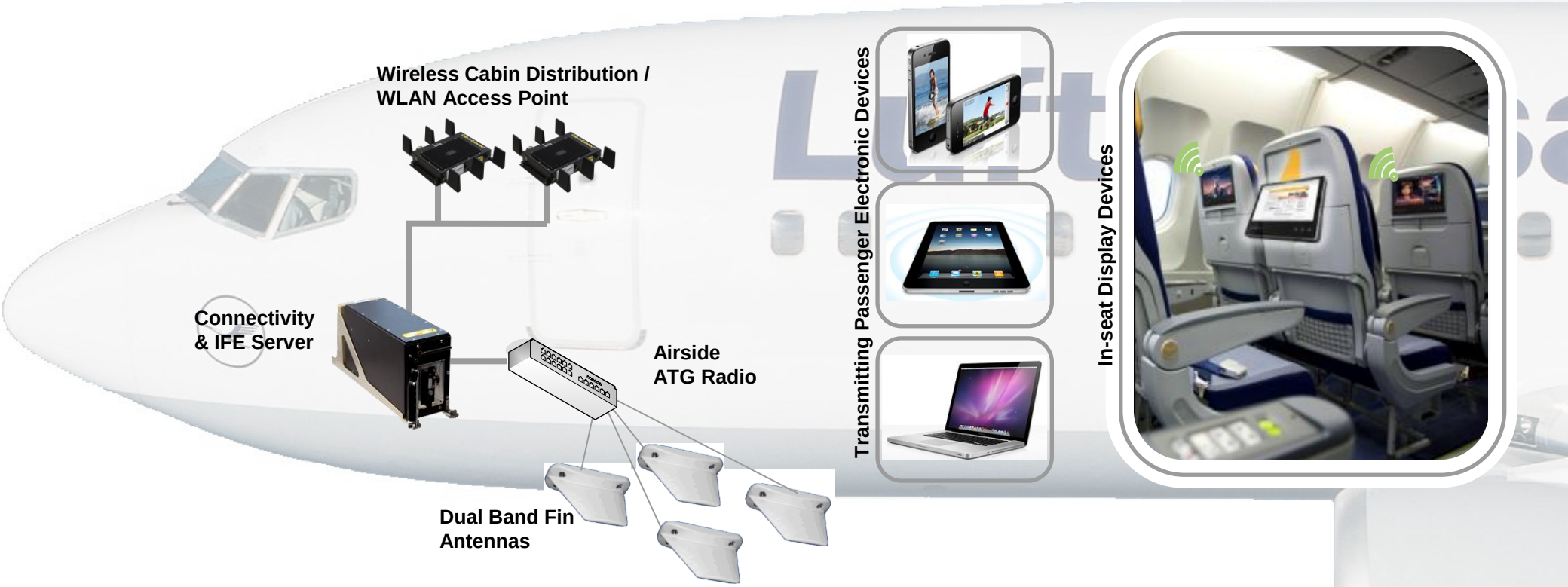
Direct Air to Ground Data Connectivity for A/C Use of License Exempt Spectrum

Broadband Connectivity Services Today

Technical Solutions for Broadband Connectivity

- **Satellite Ku-Band**
  Satellite based
  Provider: Panasonic, ROW 44, ViaSat
- **Satellite Ka-Band**
  Satellite based, Solution in Development;
  Provider: ViaSat, ROW44, Inmarsat (Today L-Band)
- **Terrestrial**
  North America: AirCell
  Terrestrial based solution in Europe not existing today
  Europe Future: Consortium Telekom, Lucent Alcatel, Airbus (licensed spectrum)
  Lufthansa Systems (license exempt spectrum);

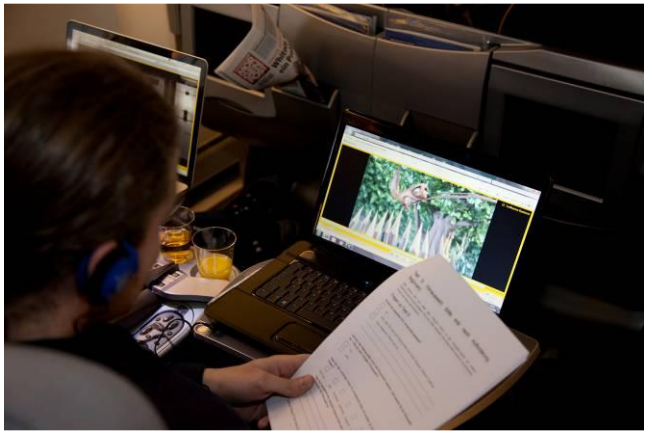
Wireless In-flight Infotainment enabling Passenger Devices as well as In-seat displays with Audio- and Video on demand, Broadband Internet Access …



In-flight Infotainment with enhanced functionality and drastically reduced cost

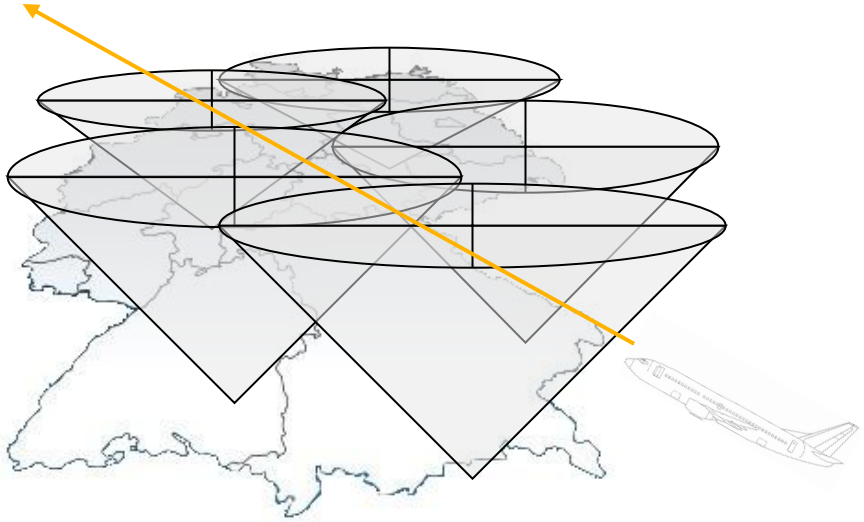
- **Low system installation cost,** no extensive cabin data wiring required, drastic reduced system components
- Reduced TCO for internet connectivity in comparison to current satellite based technologies
- **50-70% reduction in maintenance costs; 30-50% expected savings in operation cost** due streamlined content load

Wireless In-flight Infotainment:
Successful In-aircraft tests (Boeing 747/400, Airbus A300/400)



Tests inside A/C proved usability of wireless in-flight entertainment solution under full load conditions and with other communication channels in use.

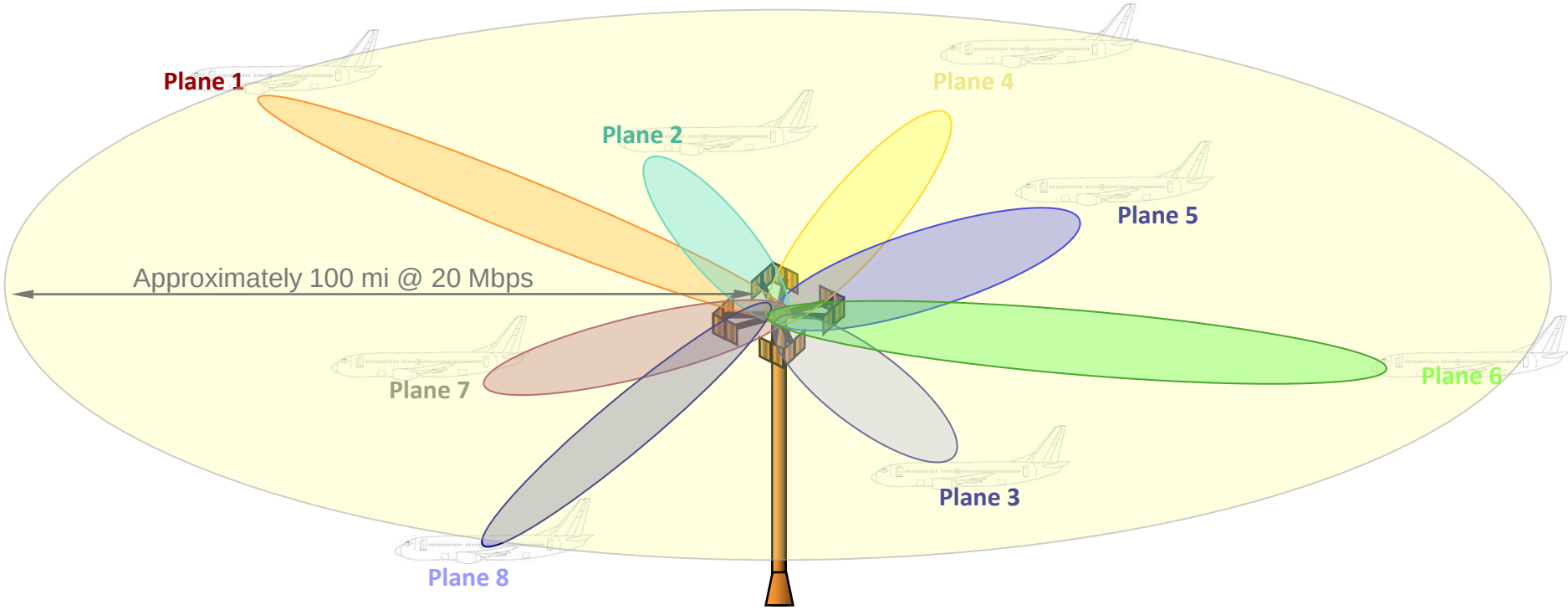
Air to Ground terrestrial Internet Connectivity



Terrestrial based Direct Air to Ground Internet Connectivity:

- Use of two license exempt frequencies (ISM Band):
  - 2,4 GHz – European legislation mandates maximum output power <= 100mW EIRP. Can be used without limitation in Europe.
  - 5,8 GHz – European legislation permits a maximum output power of up to 4W EIRP. However this requires specific approval of regulators as it's Broadband Fixed Wireless Access

Phased array antenna technology



Pencil beam

- Achieves great coverage and high data rates (radius approx. 100 mi)

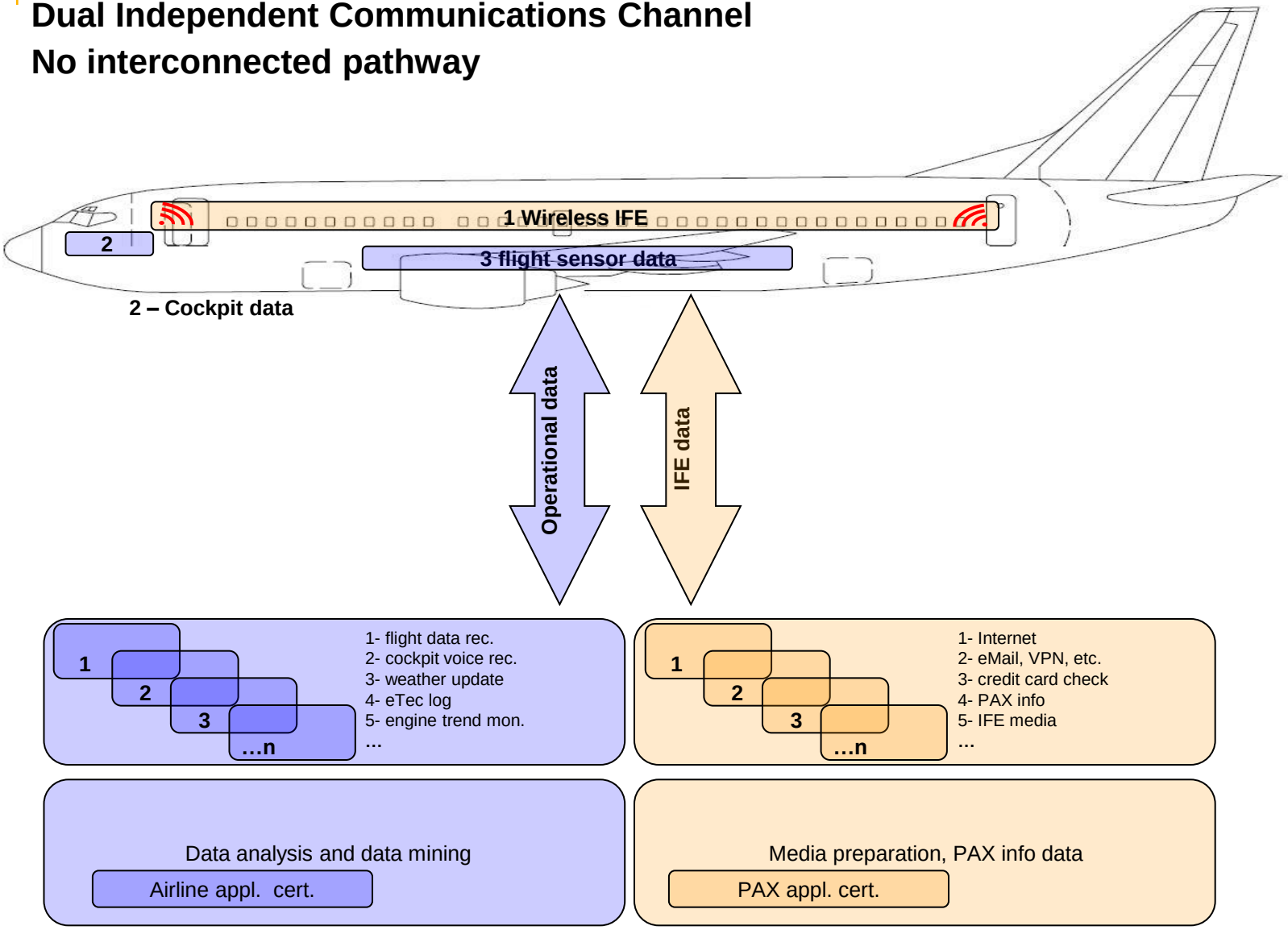
Frequency Reuse, Spatial Division Multiple Access (SDMA)

- Yields multiple broadband data rates per A/C

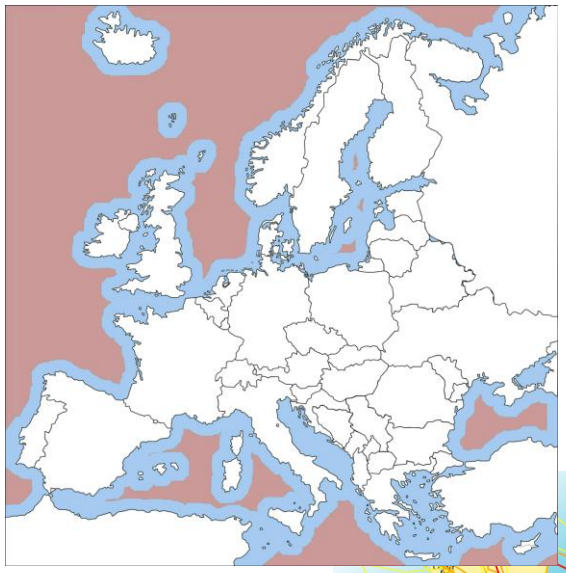
Interference-free

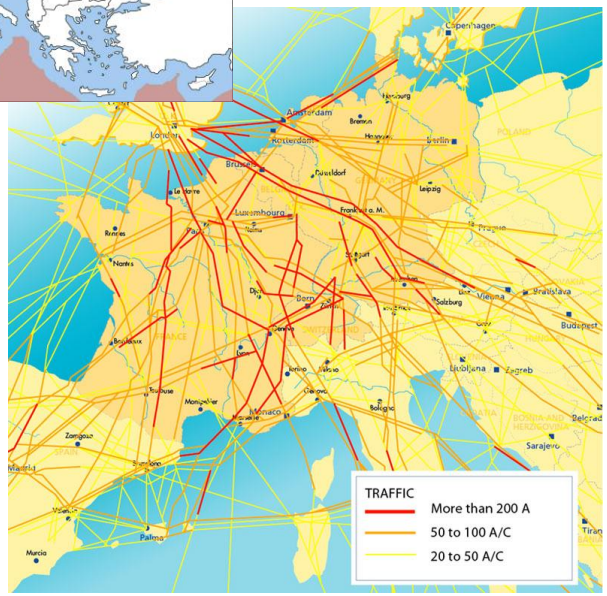
- Operation in license exempt spectrum (2,4 GHz & 5,8 GHz) No interference with WLANs in vicinity

Dual Independent Communications Channel
No interconnected pathway



Coverage of Base Station Network

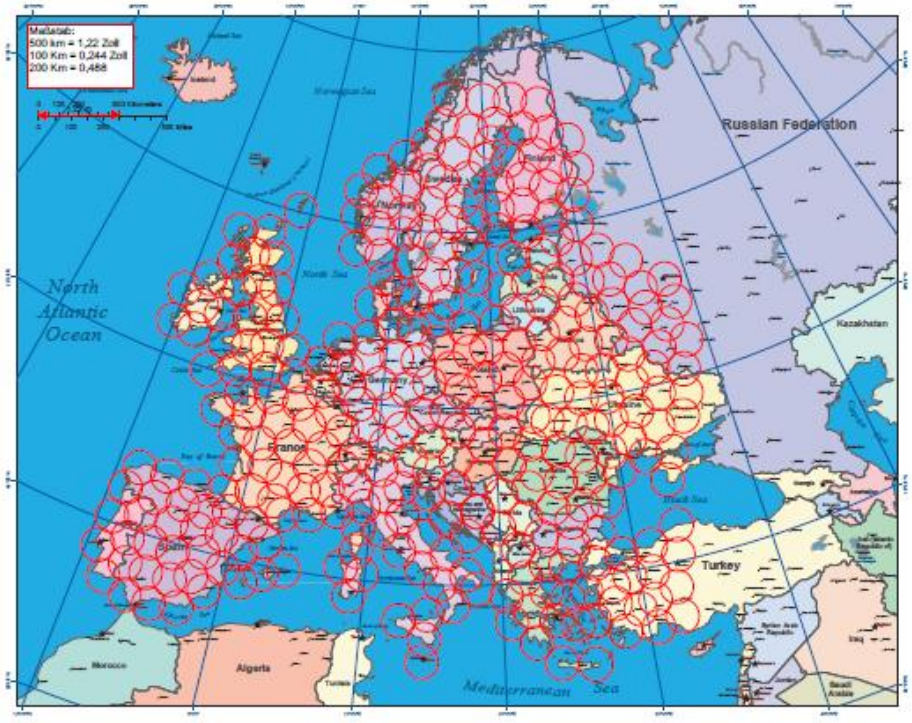




Continuous Coverage throughout Europe:

- Continuous coverage can be achieved over landmass of Europe
- However, in certain areas (over the sea) a continuous coverage is not achievable (see upper left graphic)
- Density of flight movements (Eurocontrol) suggests that certain flights are going to experience interrupted, not continuous coverage while over the sea

Test results (Tests with 2,4 GHZ and 100 mW)



Based on current test results:

- Deployment of base stations in order to get continuous coverage throughout Europe
  - coverage distance 100 km – 500 Basestation,
  - coverage distance 150 km – 245 Basestation

Key Features Summary

- Dual Band – License exempt
  - 2,4 Ghz
  - 5,8 GHz (5,8 GHz on Base Station – 2,4 GHz on Plane)
- Interference-free
  - Phased Array antenna
  - Tracking Pencil beams
  - Frequency reuse
  - No Interference with WLANs
- Dual Channel – Independent, no interconnected pathway)
  - First Channel - Internet for Cabin
  - Second Channel – Connectivity for Operational Data

Questions ?

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