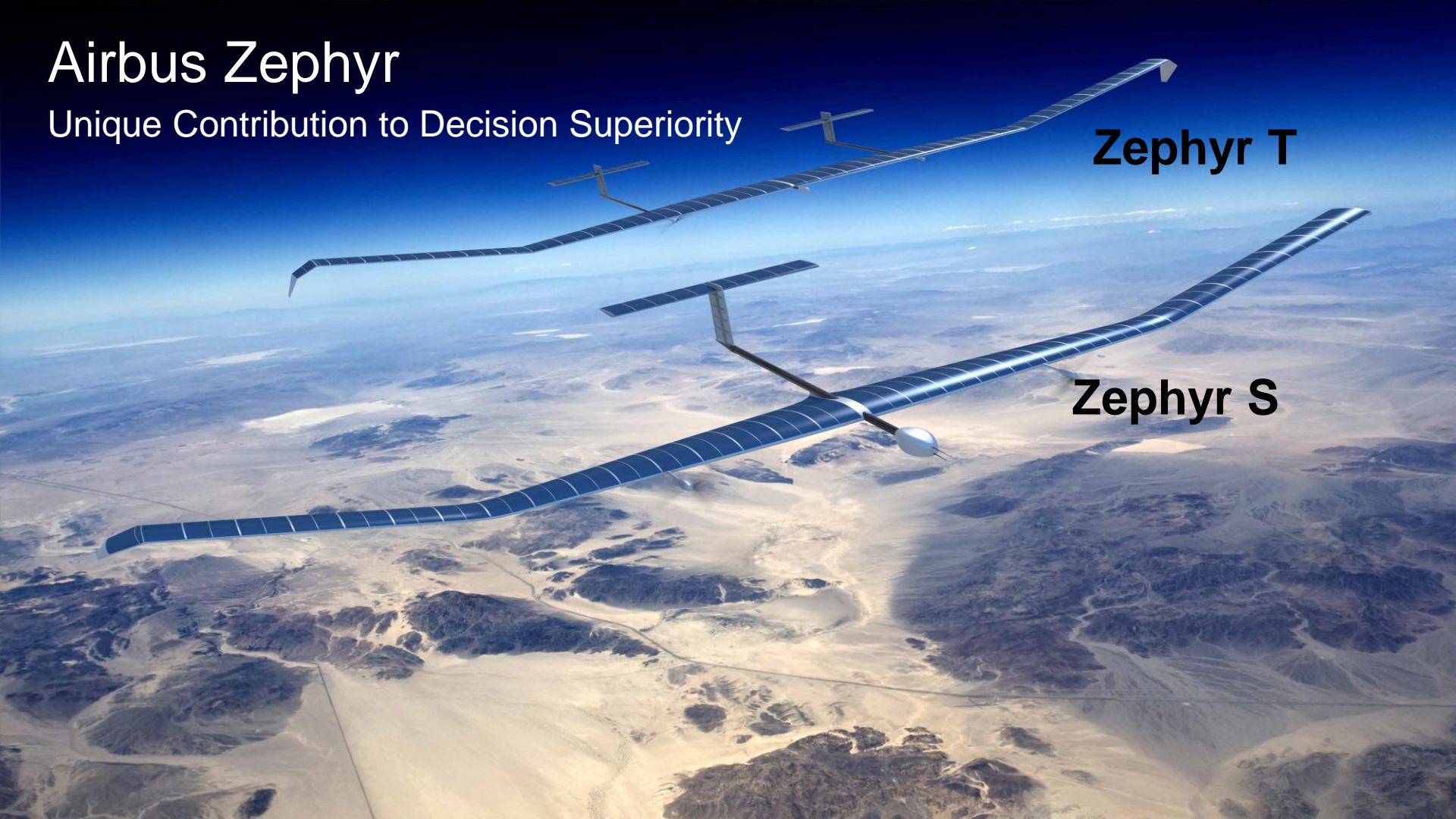


# Airbus Zephyr

Unique Contribution to Decision Superiority

**Zephyr T**

**Zephyr S**



# Why is Zephyr unique: persistent, local, low-cost pseudo-satellite services



## Satellites

*Long endurance*  
*Global coverage*  
**High capital cost**

HAPS are complimentary to both satellites and fuel-powered aircraft providing **affordable, persistent, local satellite-like services**

### HAPS are:

- enduring like a satellite
- focused like an aircraft
- cost effective

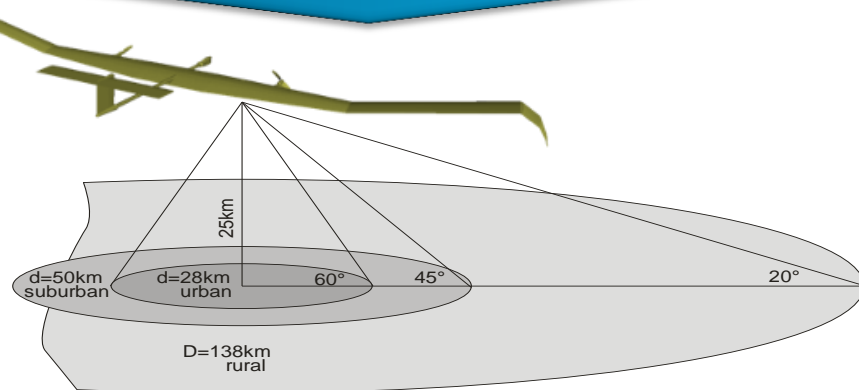


## "Classic" UAV

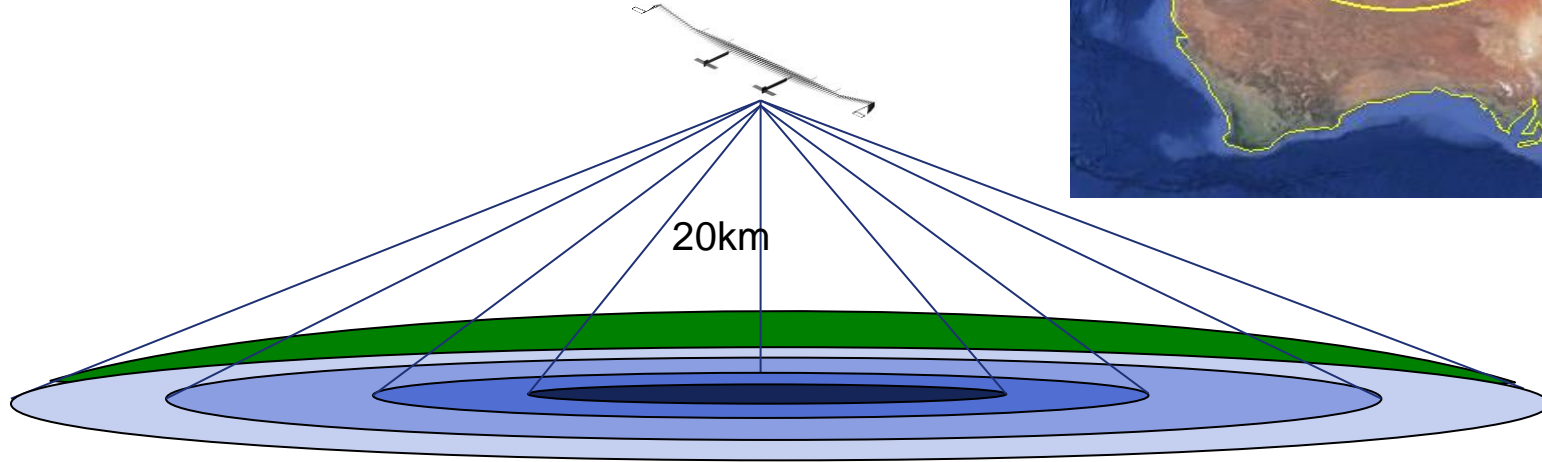
**Short endurance**  
*Local footprint*  
**High operational cost**

## Main technical characteristics of HAPS:

- Unmanned flying platform
- Running exclusively on solar power
  - batteries charged during daytime for operation at night
  - airborne for weeks → months
- Operating in the stratosphere (altitude >20 km) to be
  - above weather
  - above regular air traffic
- Mission types similar to satellites



# Zephyr Coverage



Optical utility @ 30° incidence = 35km = 3800km<sup>2</sup>

Radar utility @ 15° incidence = 70 km = 15,000 km<sup>2</sup>

Comms horizon @ 5° incidence = 200km = 125,000 km<sup>2</sup>

Horizon scan = 400km range

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# HAPS Markets

## Market: Security/Search & Rescue

### Application:

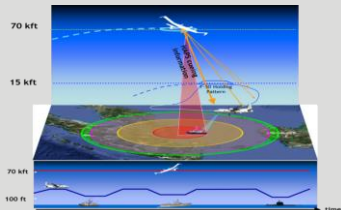
- Electronic Intelligence
- Maritime Surveillance/AIS
- Electronic Optical/IR



## Market: Civil remote sensing

### Application:

- GEO Intelligence
- Agriculture
- Site Planning
- Construction
- Mining
- Fire Detection and Monitoring



## Market: Emergency communications/ PPDR

### Application:

- Re-bro (VHF, UHF, S Band, LTE)
- In-theatre Internet coverage
- Theatre Backhaul



## Market: Internet connectivity

### Application:

- Backhauling





# ZEPHYR

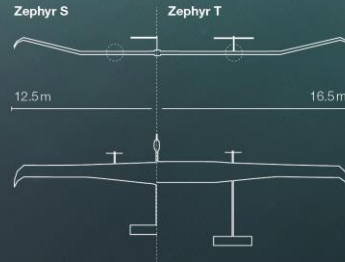
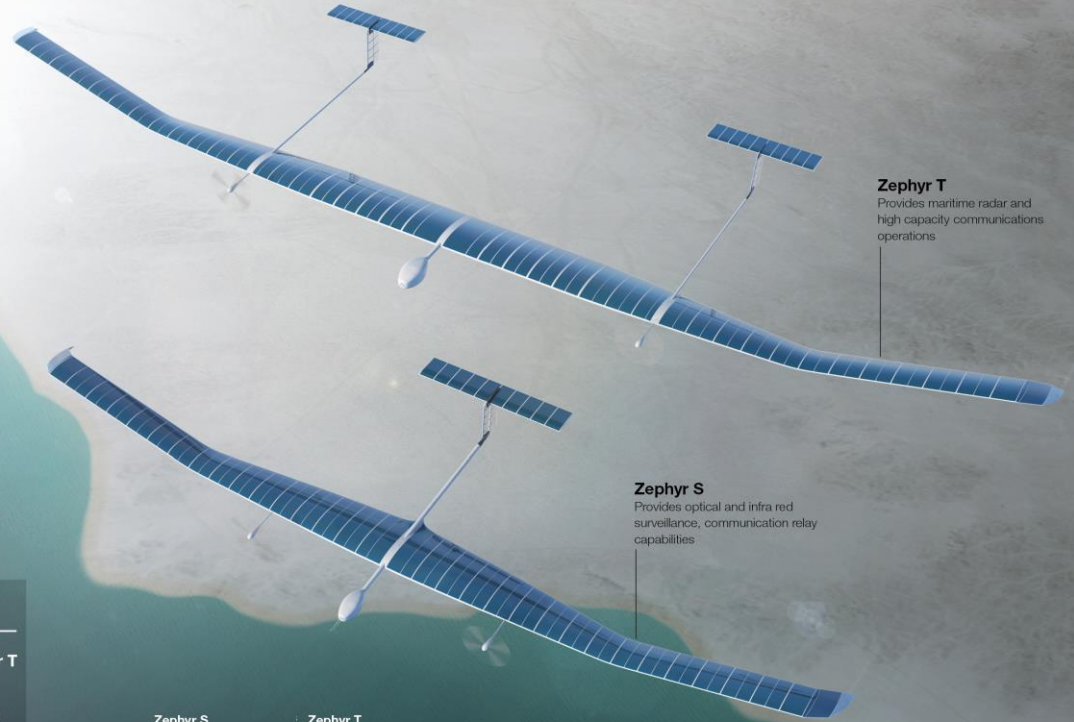
## Comparison

# ZEPHYR

## Comparison

### Facts & Figures

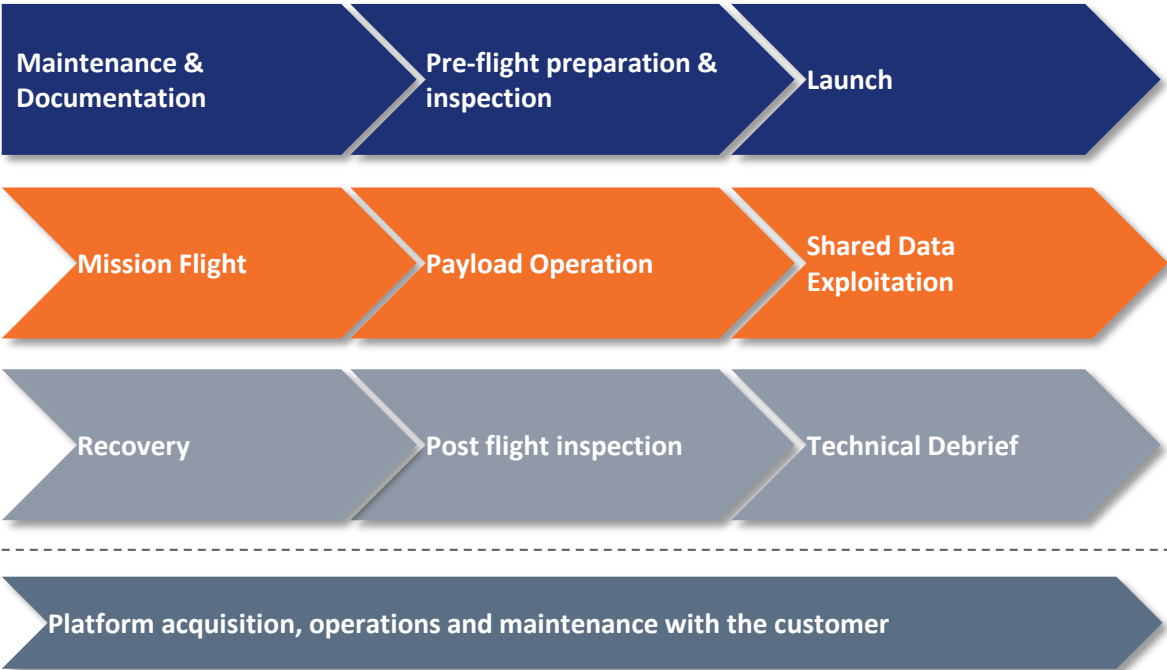
	Zephyr S	Zephyr T
 Weight:	62 kg	<140 kg
 Wing span:	25 m	33 m
 Current endurance:	at least 30 days	
 Operating altitude:	above 65,000 ft	



# General Zephyr Info

- 10 Flight campaigns completed with 1000 hours total programme flight time
- Current holder of 3 world records including an the endurance record for 14 days of constant flight – this will increase to 30 days this year.
- The aircraft relies entirely on solar power which drives the electric motors and charges the batteries for overnight power
- Zephyr does not need a dedicated runway to launch or land
- Zephyr operates in the tropopause, above the weather and air traffic
- Zephyr is a pseudo satellite, meaning it can access a variety of latitudes at a low life cost
- One Pilot can fly up to 4 Zephyrs simultaneously
- Low, simple maintenance costs and turnaround times

# Modus Operandi focus Lease / Maintain / Operate



**Zephyr Launch by AIRBUS**

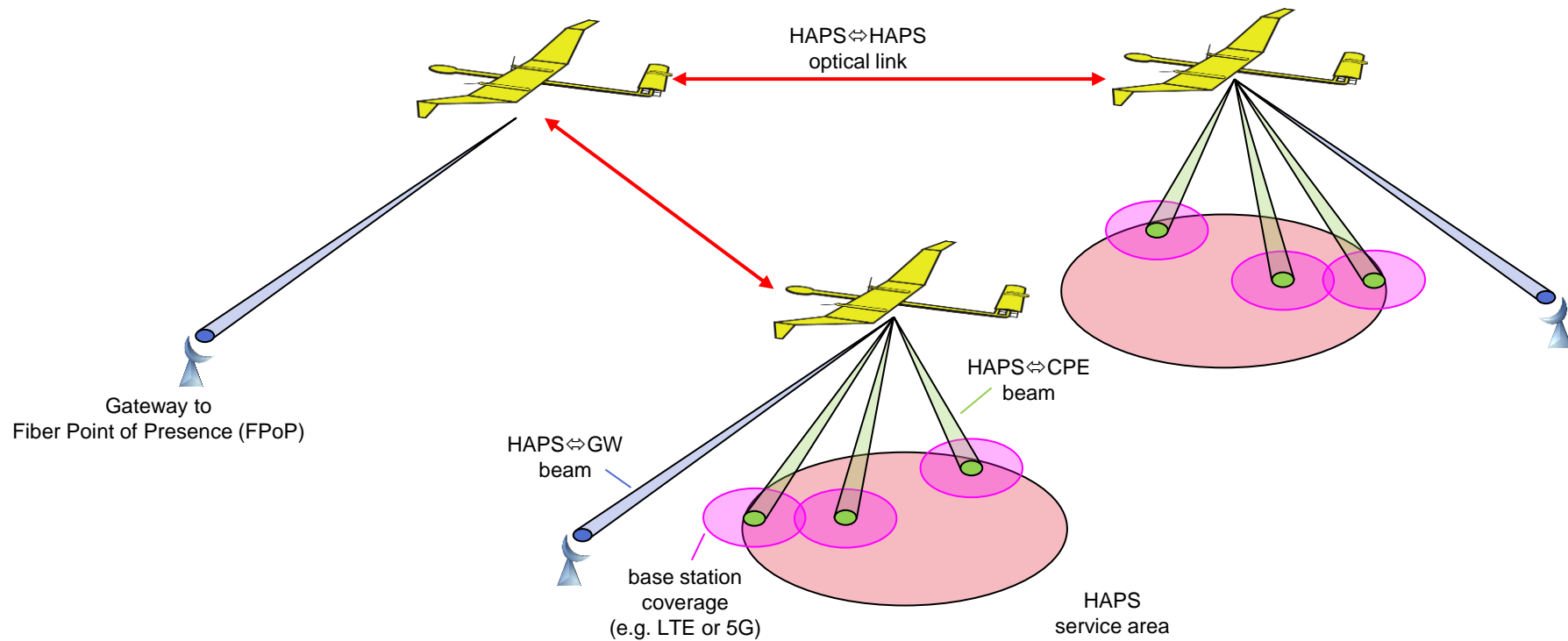
----- Handover -----

**AIRBUS / Customer**

----- Handover -----

**Zephyr Recovery by AIRBUS**

# Proposed System Architecture for A.I. 1.14 (Backhauling)





# Comparison of throughput requirements (lower/upper boundary)

Parameter	Min Throughput Need (40 km diameter)	Max Throughput Need (100 km diameter)
Average datarate per user	30Gbyte / month = 100kbps	30Gbyte / month = 100kbps
Average datarate for all users in footprint of HAPS	100kbps * 25 600 users = 2.56Gbps	100kbps*160 000 users = 16 Gbps
Capacity to simultanously stream videos	1000 users	6 400 users
Peak hour streaming capacity (factor 2)	2 000 users simultanously	12 800 users simultanously
Total sizing datarate requirement per HAPS	5.12Gbps	32 Gbps

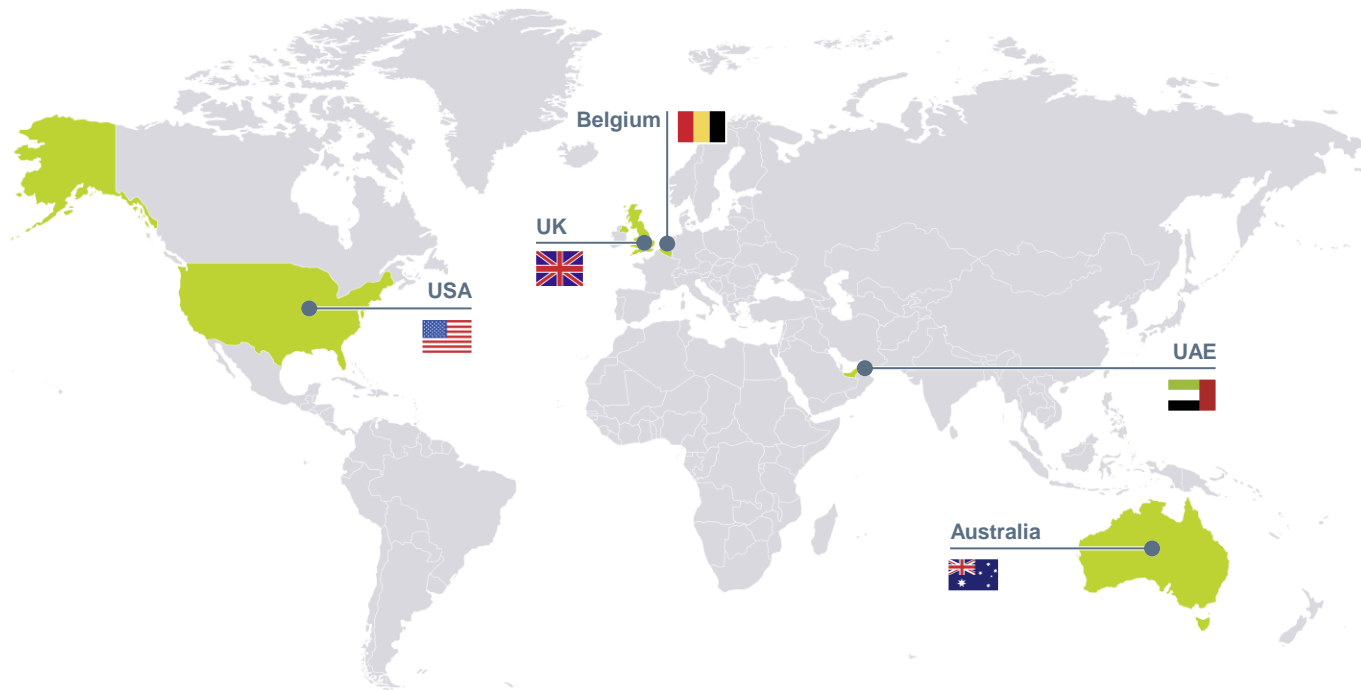
# Minimum Spectrum Requirement for broadband HAPS connectivity application

	Forward		Return		
	GW => HAPS	HAPS => CPE	CPE => HAPS	HAPS => GW	
<b>Number of beams</b>	2	16	16	2	a
<b>LHCP and RHCP polarisation factor</b>	2	2	2	2	b
<b>Reuse factor</b>	1	4	4	1	d
<b>Total required bandwidth</b>	7200 MHz	7200 MHz	1930 MHz	1930 MHz	e
<b>Total minimum required bandwidth taking into account the polarisation and reuse factors</b>	<b>1 800 MHz</b>	<b>900 MHz</b>	<b>240 MHz</b>	<b>480 MHz</b>	$f = \frac{e \times d}{a \times b}$

# Certification & Standards

## FLIGHT APPROVALS

- Approved for flight in 5 countries:
  - United Kingdom
  - USA
  - Belgium
  - Australia
  - United Arab Emirates



## Modern Datalink Technology (current generation) for High Frequency Bands (>20GHz)



- 4 tilted antennas each of 200 elements
- antennas are being used both for FPoP (GW) link and CPE links.
- Antenna are FDD based (simultaneously transmitting or receiving- interlaced Tx & Rx patches)
- 4 baseband chips (one at each panel)
- The payload operates with OnBoard Processing and Beam Hopping i.e. each transmit and receive will point to different location.
- 1 beam for FPoP link, 4 beam for CSL FWL link (one per antenna), 15 CSL RTL (4 return links per antenna)
- data is processed and routed in the payload with modems.

# Future

- Battery technology
- Payload development
- Legislation

- Increased performance
- Lower operational cost
- Enhanced operational flexibility (e.g. more platforms per pilot)
- Further capabilities



# WRC 19 A.I. 1.14 (HAPS)



WRC-19

**AI 1.14:** to consider, on the basis of ITU-R studies in accordance with Resolution 160 (WRC-15), appropriate regulatory actions for high-altitude platform stations (HAPS), within existing fixed-service allocations;

## Current HAPS Identifications

6 440-6 520 MHz ↓  
6 560-6 640 MHz ↑  
27.9-28.2 GHz ↓  
31.0-31.3 GHz ↑

**Strong Regional  
Limitations**

47.2-47.5 GHz ↓  
47.9-48.2 GHz ↑  
**Attenuation  
Constraints**

## New HAPS Candidate Bands

38-39.5 MHz  
on a global  
level

21.4-22.0 GHz  
24.25-27.5 GHz  
on a regional  
level in  
Region 2

## **RESOLUTION 160 (WRC-15):**

**„Facilitating access to broadband applications  
delivered by high-altitude platform stations“**

## **ITU HAPS Definition:**

HAPS is defined in No. 1.66A of the Radio Regulations as a station located on an object at an altitude of 20-50 km and at a specified, nominal, fixed point relative to the Earth, and is subject to No. 4.23;

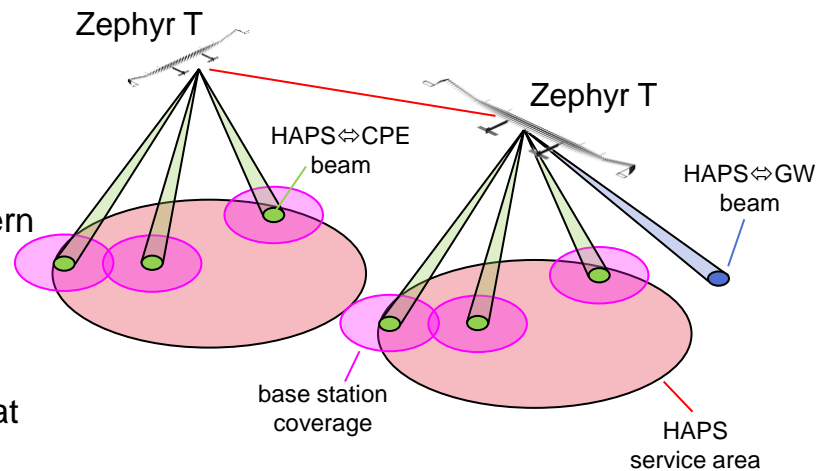
## **Article 4.23 of the Radio Regulations states**

“Transmissions to or from high altitude platform stations shall be limited to bands specifically identified in Article 5. (WRC-12)”.

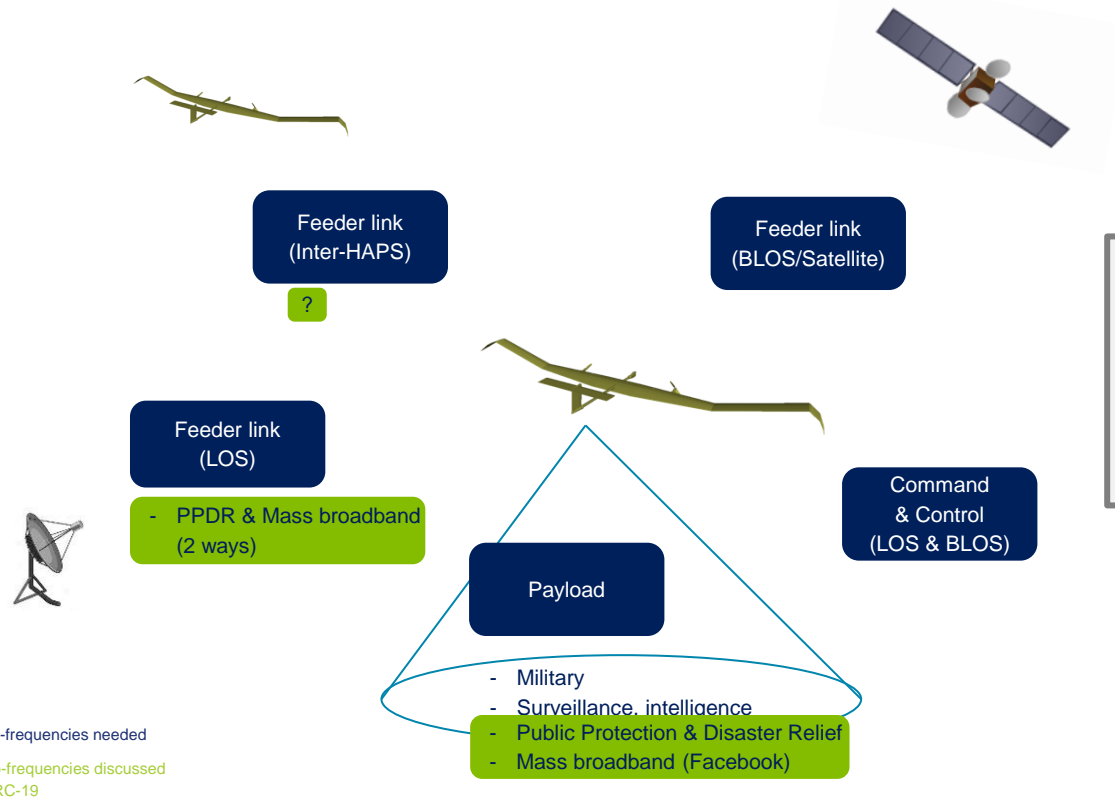
**AIRBUS**

# On-going regulatory work

- Definition of deployment scenarios and requirements for HAPS broadband systems
  - Airbus is supporting two main deployment scenarios:
    - Broadband connectivity HAPS applications
      - Backhauling scenario
    - Specific broadband HAPS applications
      - Disaster relief, fire detection, law enforcement
- Definition of technical and operational characteristics of modern HAPS systems (*finalised at WP5C Mai 2017*)
- Assessment of spectrum needs for the different deployment scenarios (*finalised at WP5C Mai 2017*)
  - Studies submitted and discussed within ITU WP5c show that current identification do not fulfil spectrum needs
  - Final definition of spectrum needs depends on final results of sharing studies and bands considered
- Sharing Studies in all current and new bands by WP5C Nov 2017 (*methodologies finalized at WP5C Mai 2017*)



# HAPS frequencies (reminder)



- ☐ WRC-19 will address frequencies for Broadband Connectivity and “Public Protection & Disaster Relief” (PPDR)
- ☐ All next slides focus on these two



- Radio-frequencies needed
- Radio-frequencies discussed at WRC-19

# Existing and possible future HAPS\* identifications in ITU

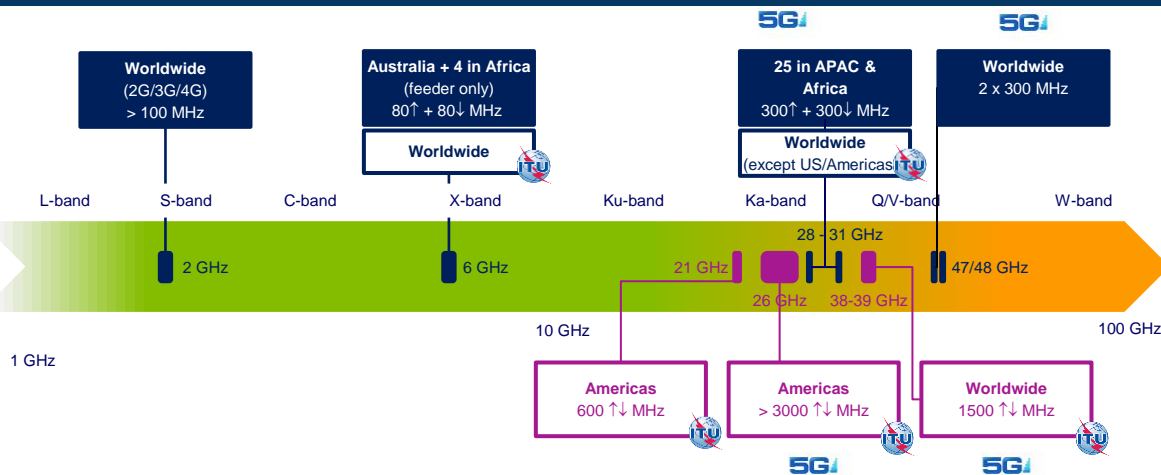
## Existing HAPS identifications (i)

- Limited bandwidth
- Insufficient coverage

## Possible add'l HAPS identifications (ii)

- Far wider bandwidth
- Mostly over America
- More than half is at study under ai 1.13 for IMT 2020

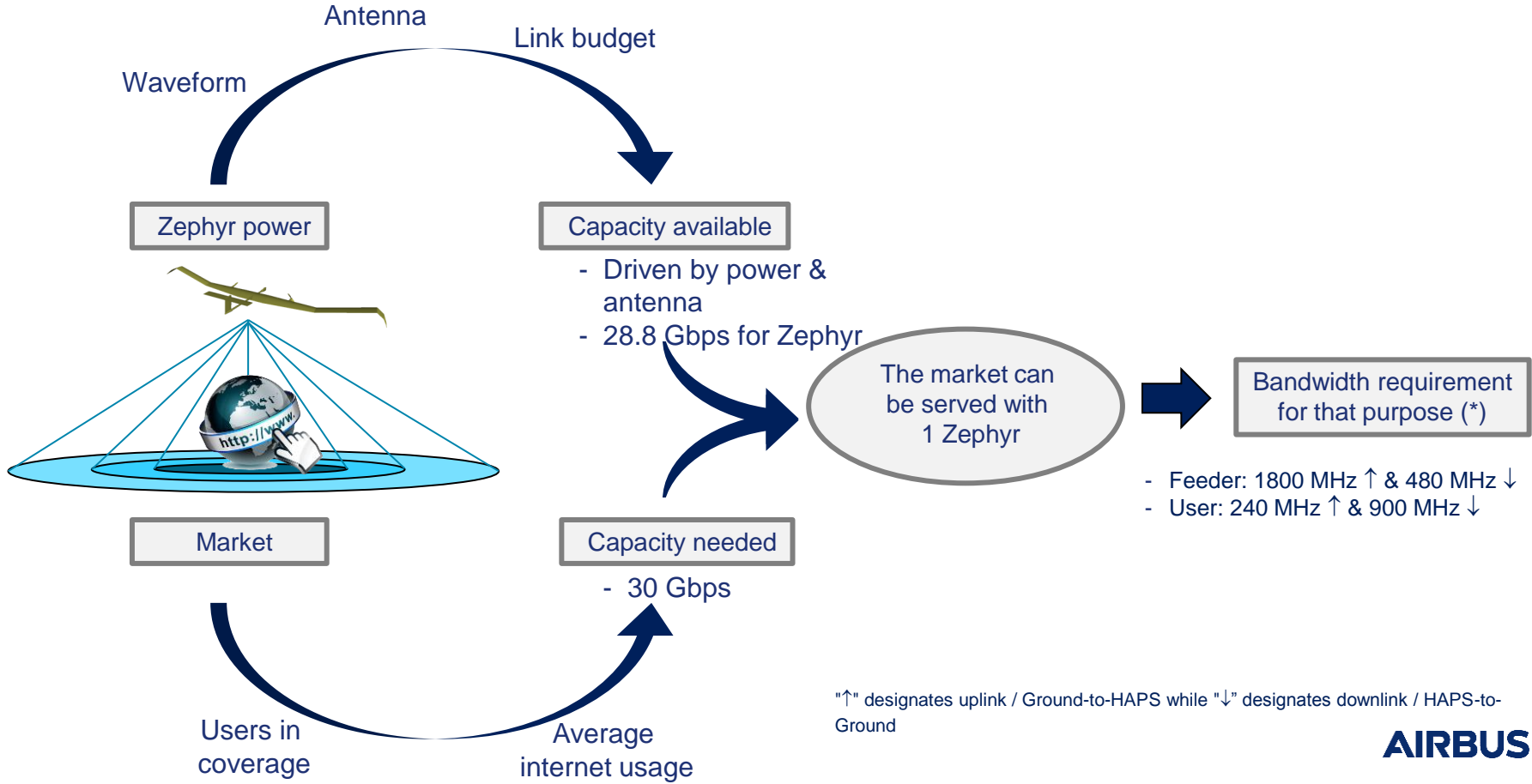
## Both are in WRC-19 mandate



\* In the ITU, HAPS are “High Altitude Platform Station” defined as “a station located on an object at an altitude of 20 to 50 km and at a specified, nominal, fixed point relative to the Earth”

\*\* Transmissions to or from HAPS are limited to bands specifically identified

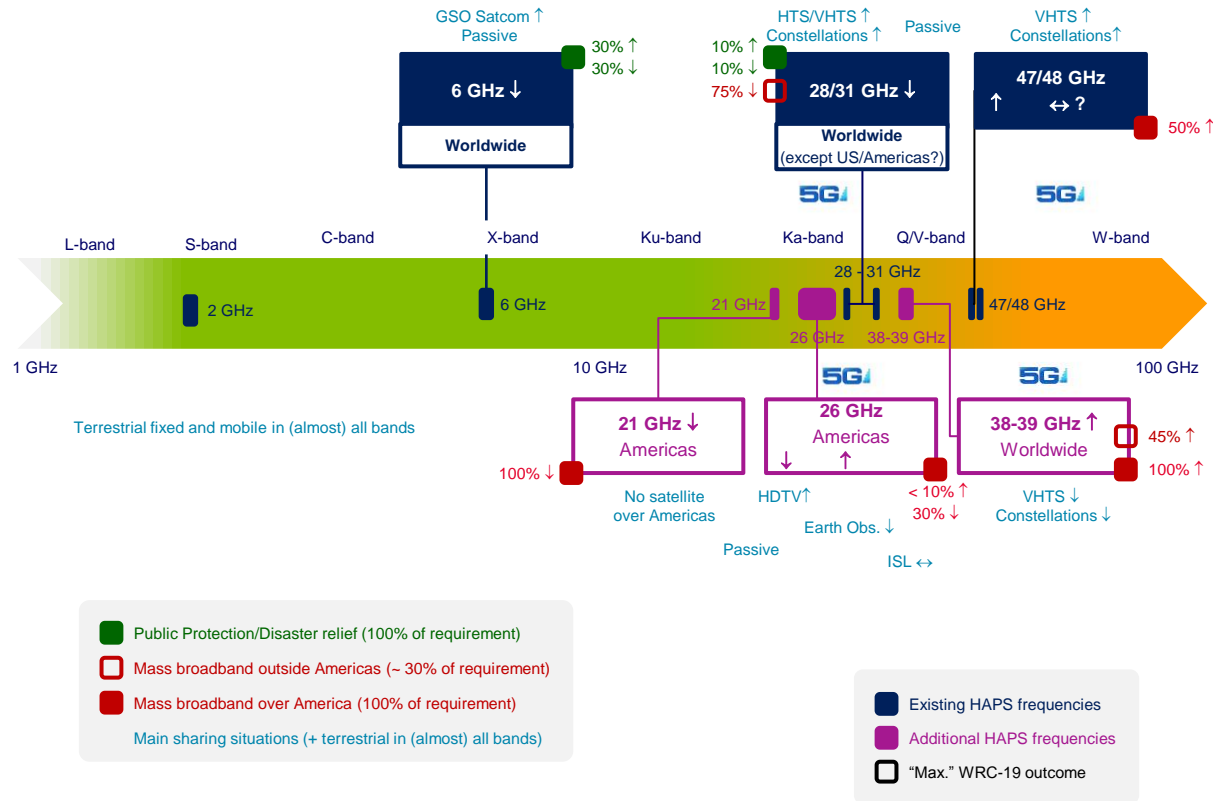
# Our case for broadband connectivity





# Initial Airbus DS frequency plan for HAPS/WRC-19

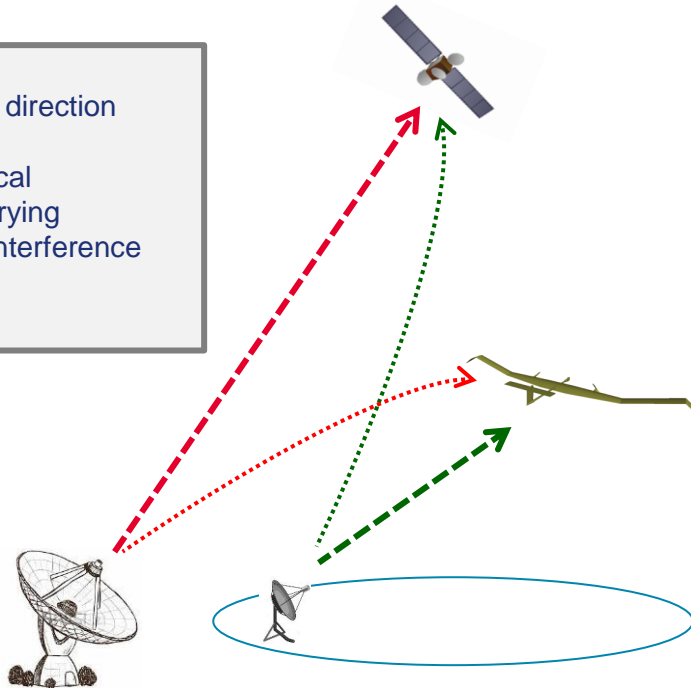
- ❑ Zephyr bandwidth requirement
  - Feeder: 1800 MHz ↑ & 480 MHz ↓
  - User: 240 MHz ↑ & 900 MHz ↓
  - ➔ Additional frequencies are needed
- ❑ Frequency plan based on
  - lower frequencies for HAPS emissions (to optimize power available)
  - reverse direction of transmissions with satellite applications (to make interferences reduced and local)
- ❑ Satisfying requirement depending on region for the 2 cases
  - Public Protection/Disaster relief
  - Mass broadband
- ❑ Inter HAPS links are under study



## Operations in the same or reverse direction of transmission

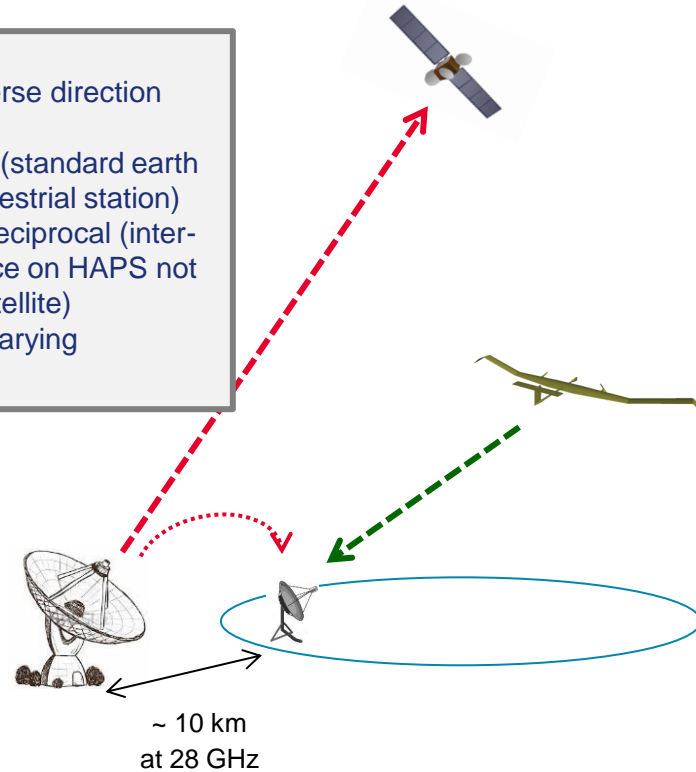
### Same direction

- ☐ Reciprocal
- ☐ Time varying
- ☐ Bigger interference footprint



### Reverse direction

- ☐ Local (standard earth to terrestrial station)
- ☐ Non reciprocal (interference on HAPS not on satellite)
- ☐ Non varying



## Sharing studies to WP5C / November 2017

### ❑ Two cases

(with their directions of transmission and priorities at this stage)

- Broadband connectivity at 21 ↓, 28/31 ↓ & 38-39 ↑ GHz then 47/48 ↑ & 26 ↑↓ GHz
- PPDR at 6 GHz & 28/31 ↑↓ GHz
- See slide 4 for details

### ❑ Sharing studies foreseen with all incumbent services

(for these frequency bands and directions of transmission)

- Terrestrial fixed (FS) and mobile (MS, AMS, 5G)
- Satellite communications (FSS) and science (EESS/SRS), including constellations
- Inter-satellite
- Passive, including out-of-band (RAS, EESS/SRS)
- Others (RLSS, RNS)

A solar plane is silhouetted against a bright, low sun that creates a large lens flare across the sky. The plane is positioned in the upper left quadrant of the frame. The overall color palette is dominated by warm oranges, yellows, and dark blues.

**Thank you  
for your attention!**

**AIRBUS**