Airbus Approach to Constellations: The Arrow Product

DEFENCE AND SPACE

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HO Radar & Microwave Missions
Advanced Programmes

AIRBUS

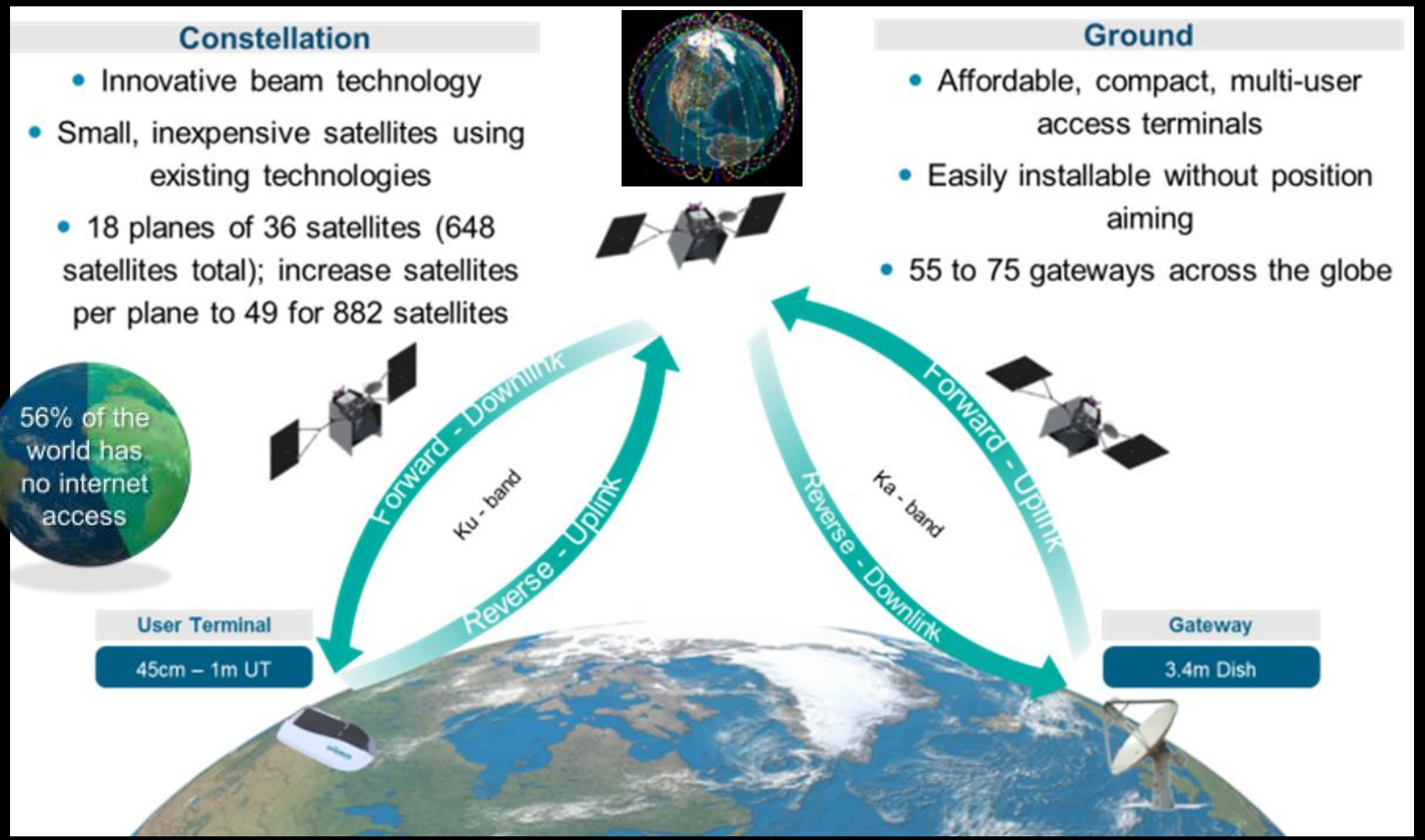
DEFENCE AND SPACE

Introduction

AIRBUS

ONEWEB MISSION AND AIRBUS ROLE

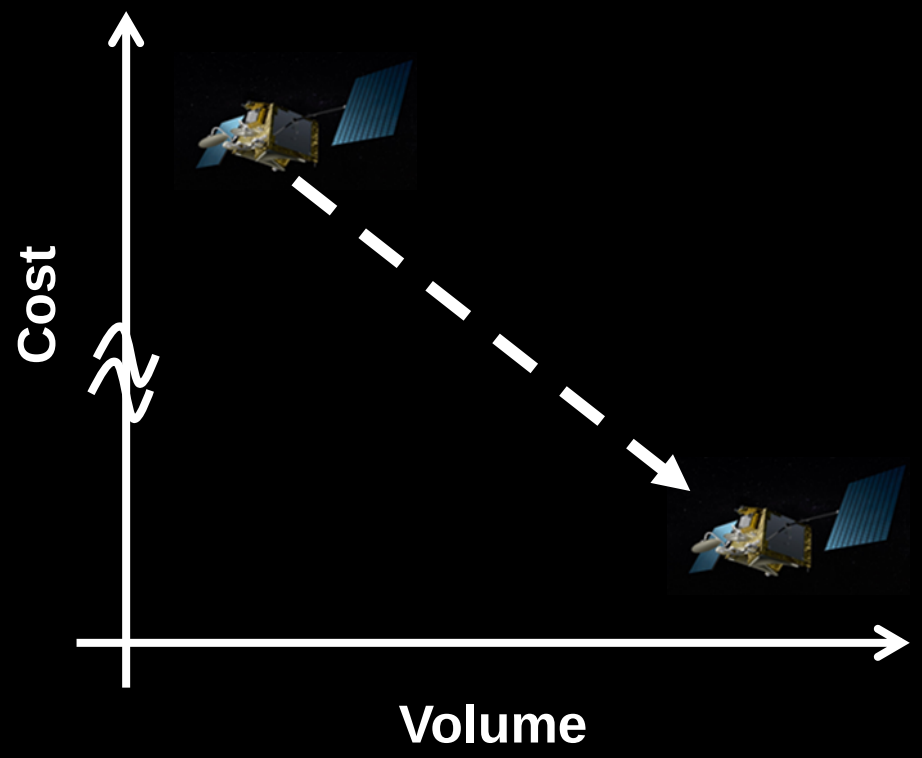
WORLD-WIDE INTERNET ACCESS



- AIRBUS was selected mid 2015 as industrial partner after a worldwide competition (US, Canada, Germany, France)
- An innovation project which placed Airbus at the forefront of the new space initiative fostering competitiveness and growth of the small satellites constellations in LEO.
- A level of innovation never achieved in the satellite industry
- The creation of a JV responsible for the space segment: Design and manufacturing of the satellites
- 2 contract phases: Industrial set up, Design and development and industrialization of the satellites with 10 pilot satellites in Toulouse, and thereafter the serial production with a dedicated factory in Florida

OneWeb Platform : A unique affordable & powerful solution for this class of platform

Redefining Satellite Manufacturing



OneWeb Satellite Key Characteristics

- 5 years minimum Lifetime in LEO orbit (@1200 km)
- Electric Propulsion (Significant orbit raising capability)
- High flexibility in orbit parameters
- Compliant with post-mission disposal regulation
- Payload capabilities Up to 100 kg
- Min 250 Watts EOL

Providing Key Advantages

- ✓ Disruptive pricing approach
- ✓ Modular design allowing for different instruments
- ✓ Access to the highest in class payload
- ✓ Full orbit flexibility thanks full electric propulsion
- ✓ Fitting with all launchers

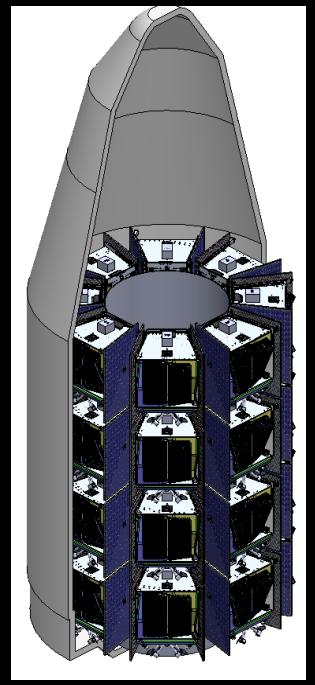
Launch Solutions

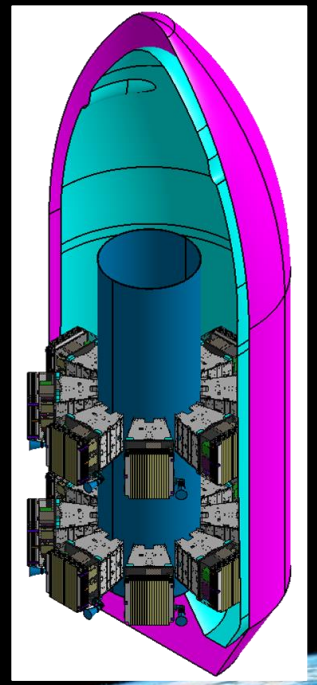
Launch Options

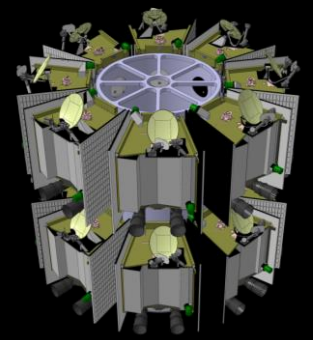
- Various capabilities on dedicated launchers or co-passengers (w.r.t. numbers of sats, orbits, schedule)
- Dispenser NREC to be funded in some cases

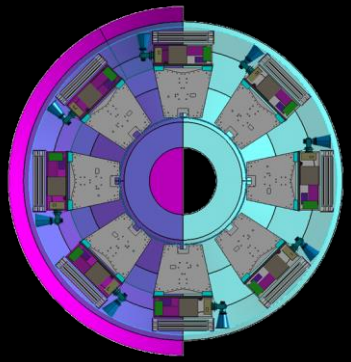
Launch Configurations (exemplary)

- Flexible launch configurations depending on mission (HR, MR, SAR, …)
- Full constellation typically deployable already with one launch

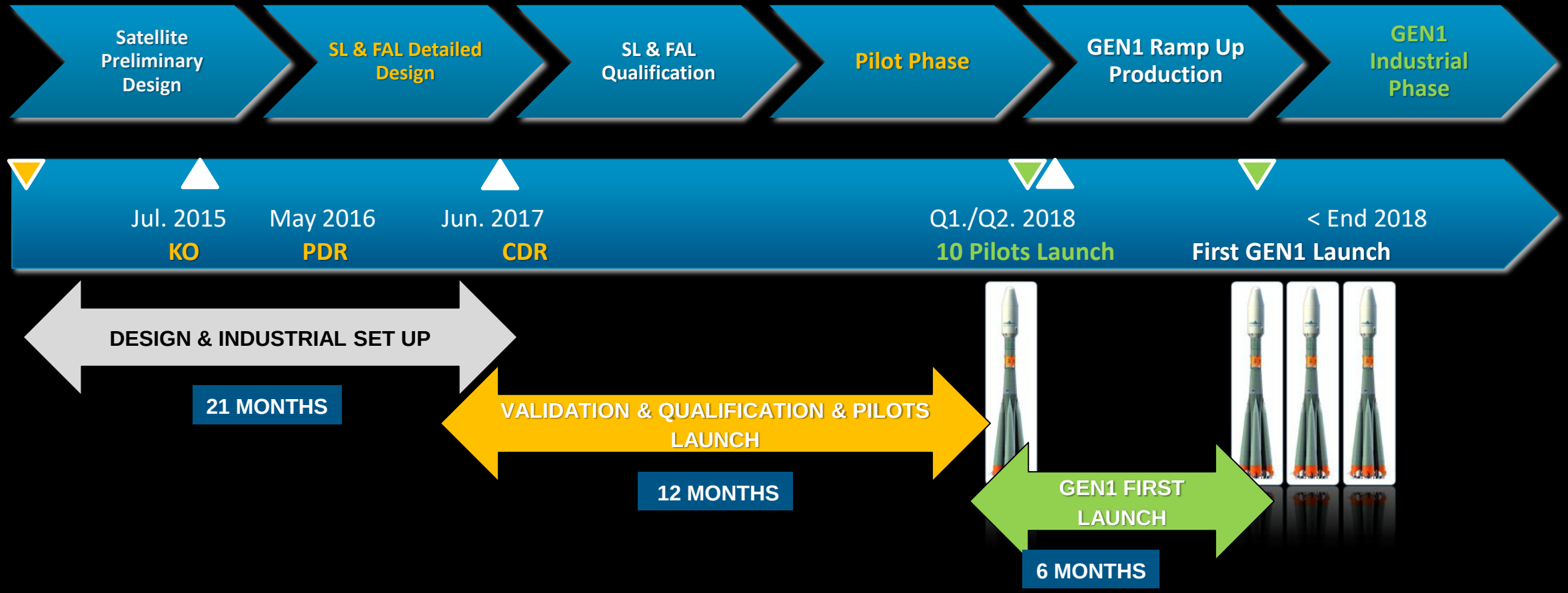








OneWeb Overall Schedule & Key Dates

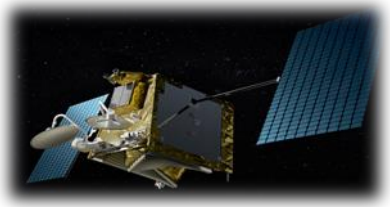


AIRBUS

What is Arrow?

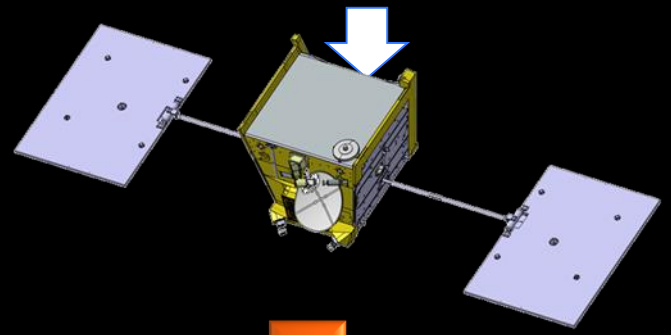
ARROW = LEO platform product derived from the OneWeb Satellite

OneWeb satellite



OneWeb 900 sats constellation

Standard PL deck



Satellite typical characteristics:

- Satellite 150-250 kg class
- Payload ~100 kg class
- Typically ~250 Watt Payload Orbital Average Power
- Orbit range LEO 500 km – 1500 km
- Electric Propulsion (DV 800 m/s)

Targeting new market opportunities

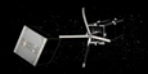
Mission as a Service

Global communications and Internet of Things

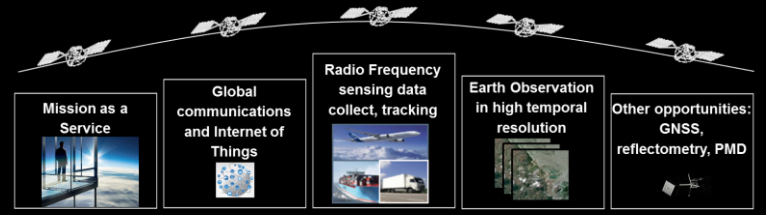
Radio Frequency sensing data collect, tracking

Earth Observation with high revisit

Other opportunities: GNSS, reflectometry, PMD



What are the main targeted markets



Mission as a Service

- IOD / IOV
- Science
- Space Weather

- Radio Occultation

Telecom

- Defense

- Voice / Data
- IoT / M2M (narrowband)

- Trunking / Backhauling

RF / collect / track

- ADSB

- AIS / VDES
- Surveillance S&R
- Spectrum Survey

- Argos

Earth Observation

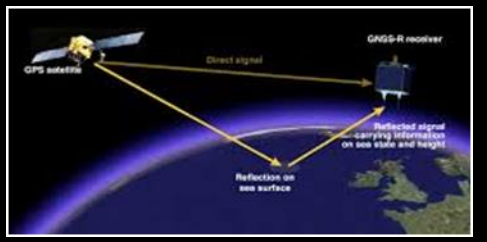
- Optical MR

- Optical HR (high revisit)

- SAR (high revisit)
- Multi-Spactral
- Meteorology

Other

- GNSS
- Reflectometry



- Debris Removal

- …
- …

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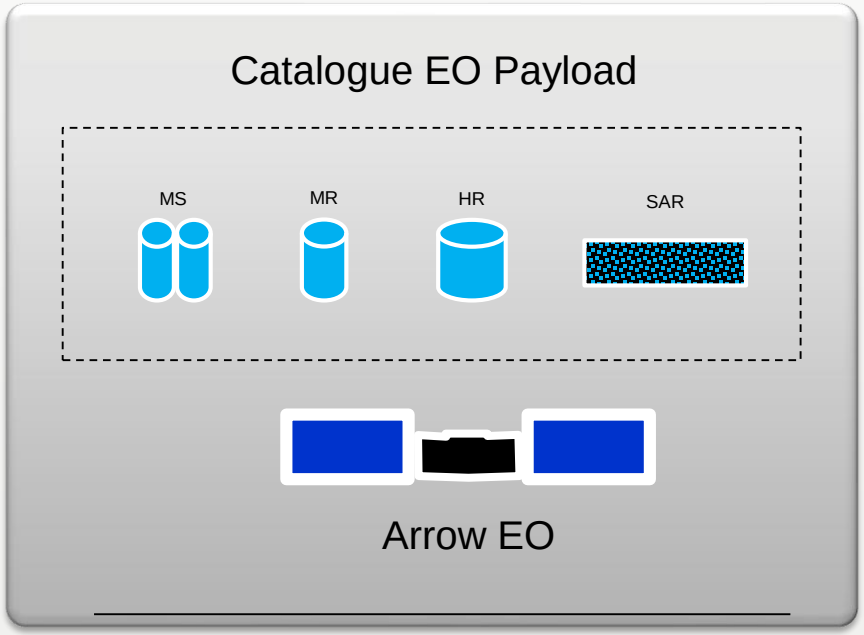
Arrow Products Overview

AIRBUS

Sales Models & Product Line

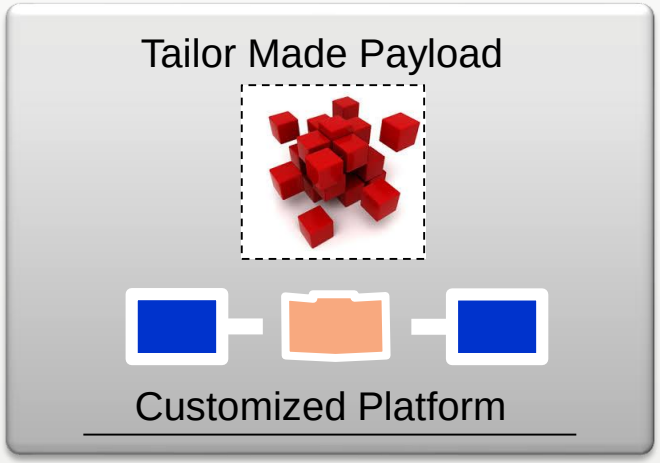
Solution based on a platform product catalog

End to end system solution with space segment, Ground Segment, Launch & Satellite Operations

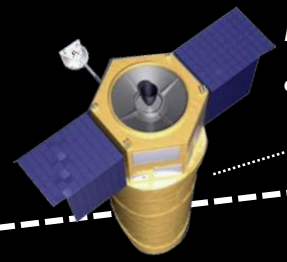


Tailor made space solution

Fully customized satellite system



Arrow within Airbus EO product range

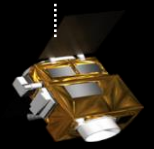


Persistant imaging and video

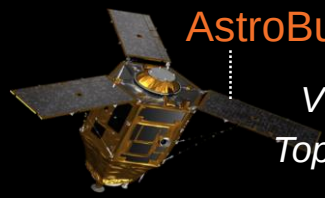
GO3S 15y

GEO Orbit (1/3 of the earth)

AstroBus-S 10y



VHResolution High Performance



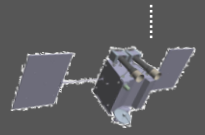
AstroBus-L 10y

VHResolution Top Performance

TerraSAR-X NG 10y

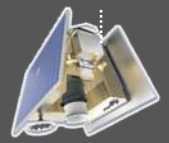
Constellations: high revisit rate

Arrow MR/MS 5y



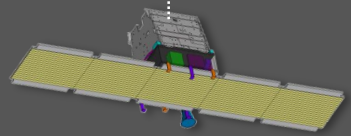
daily earth refresh Medium Resolution (3-6m)

Arrow HR 5y



intraday revisit High Resolution (<1m)

Arrow SAR 5y



Intraday revisit Medium Resolution (3m)

Low Earth Orbit (Global coverage)

30 days

Zephyr OPAZ

Persistent focused extremely high resolution

Stratosphere (Local coverage)

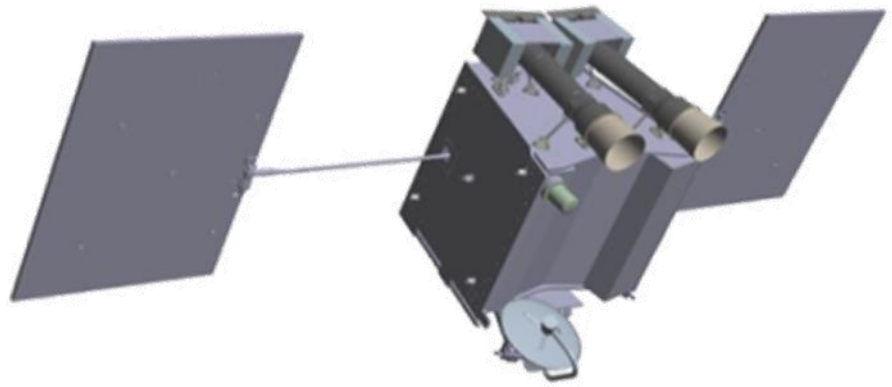
Cloud based data access

Ground

ARROW-MR

Turnkey system for a daily acquisition in Medium Resolution (3-6m) of the globe

Satellite View

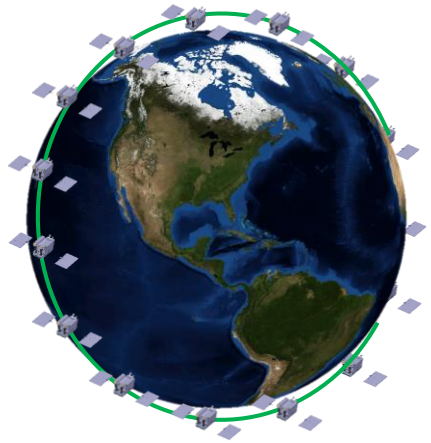


Value Proposition

- Cost efficient
  The best valuable Constellation for an optical application allowing high revisit rate capability with middle range Ground Sample Definition
- Reliable and long term
  A satellite design allowing missions over 5 years in orbit
- Clean & Sustainable
  Benefits from Airbus Defense & Space wide system expertise in orbits management, collision avoidance, frequency regulation and end of life disposal operation,

Concept Description

- Earth Observation medium resolution constellation (typically 8 to 16 satellites)
- Daily cover of all land surfaces at 6 meters resolution in 4 spectral bands achievable with 16 satellites
- Satellites always Nadir oriented allowing simple satellites operations
- Images available in 5-10 hours
- Addressing marketing needs notably for agriculture and maritime surveillance



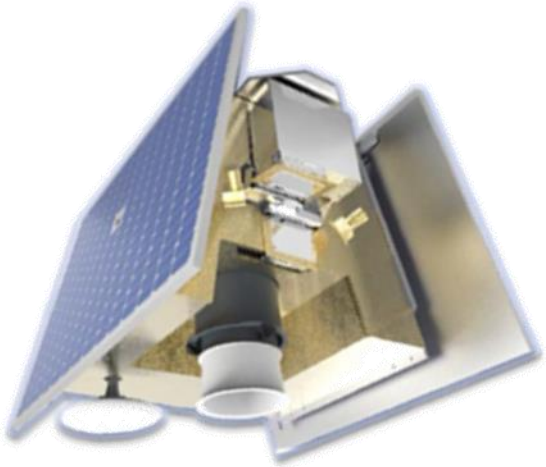
Performance Description

Instrument	Resolution / Swath	3-6 meters (4 spectral bands) / 180 km
	Quality	SNR > 150 G & NI, > 250 R, > 110 B MTF 9%
	Capacity	9 000 000 km^2 per day
Data link	1-1,2 Gbps dataline X-band 2 channels dual polarization	
Orbit Range	Typical: 600 km (SSO LTDN* of 10.30 AM)	

ARROW-HR

Turnkey system for high revisit imagery in high resolution (<1m)

Satellite View



Value Proposition

- Cost efficient
  The best valuable Constellation for an optical application allowing high revisit rate capability with high resolution,
  Higher performances (resolution, image quality) vs competitors
- Reliable and long term
  A satellite design allowing missions over 5 years in orbit
- Clean & Sustainable
  Benefits from Airbus Defense & Space wide system expertise in orbits management, collision avoidance, frequency regulation and end of life disposal operation

Concept Description

- Earth Observation constellation
  (e.g. 8 satellites in 8 planes)
- Intraday revisit, minimum 4 revisits per day
- Delivering ultra low latency worldwide on demand images, accessible through a digital platform
- Fostering novel image based added value services
- Design to industrialize approach allowing affordable and fully scalable market entry

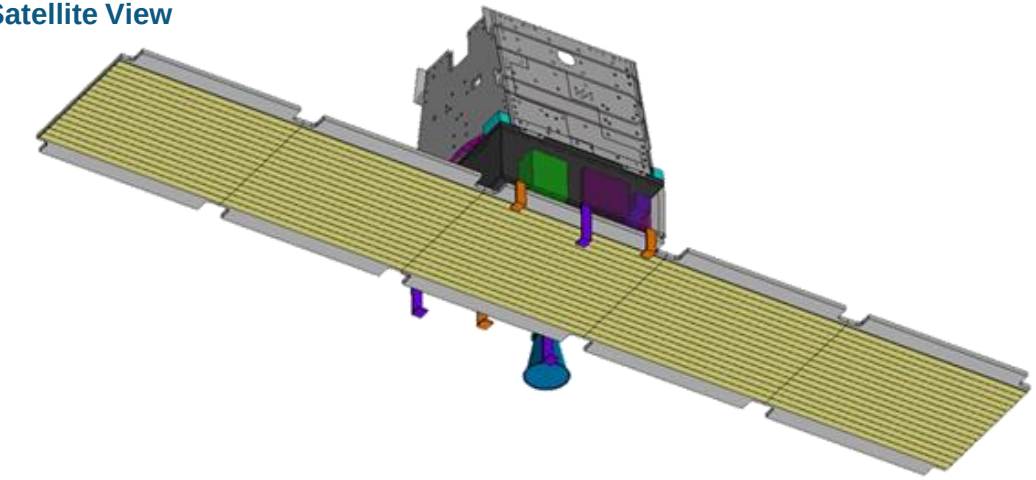
Performance Description

Instrument	Resolution / Swath	<1 meter / 4-12 km
	Capacity	1000 images / day per satellite
Imaging	Agility	Roll and Pitch angle max 40° Imaging modes: slalom, mosaic, stereo
Data link	600 Mbps dataline X-band	
Orbit Range	Typical: 450 – 600 km (SSO or inclined orbits)	

ARROW-SAR

Turnkey system for a high refresh Radar imaging (<3m)

Satellite View



Value Proposition

- Unique global day/night, all-weather access
- Unique persistency that allows customer to access the whole globe every 3 hours
- Rapid system response time using an innovative combination of on-board processing and EDRS communications
- Imaging modes that allow Detection, Recognition, Identification 24/7/365
- SAR envelope allows accommodation of secondary payloads for complementary detection / tracking capabilities (e.g. AIS)

Concept Description

- SAR constellation (typically 16 satellites in 16 planes at 85 degrees inclin.)
- Target detection of 3m in azimuth and range
- Constellation offers access over entire globe (± 75 deg) every 3h 11’
- Satellites always Nadir oriented allowing simple satellites operations
- Global access over entire area between (+-75 degrees), 3h11 minutes
- System response time 1 – 3 hours
- Addressing marketing needs notably for land and maritime surveillance

Performance Description

Instrument	Resolution / Swath	<3m / 25km in Stripmap mode, Maritime mode with 100km swath
	Capacity	360 Gbits per satellite per orbit
Imaging	Agility	Access range: 8-50 degrees in Stripmap (each side of ground track) 45 – 71 degrees in Maritime mode (each side of the ground track)
Data link	0.6 Gbps (X-band) or 1.8 Gbps (EDRS)	
Orbit Range	550-600 km (85 degrees inclination)	

Thank you

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