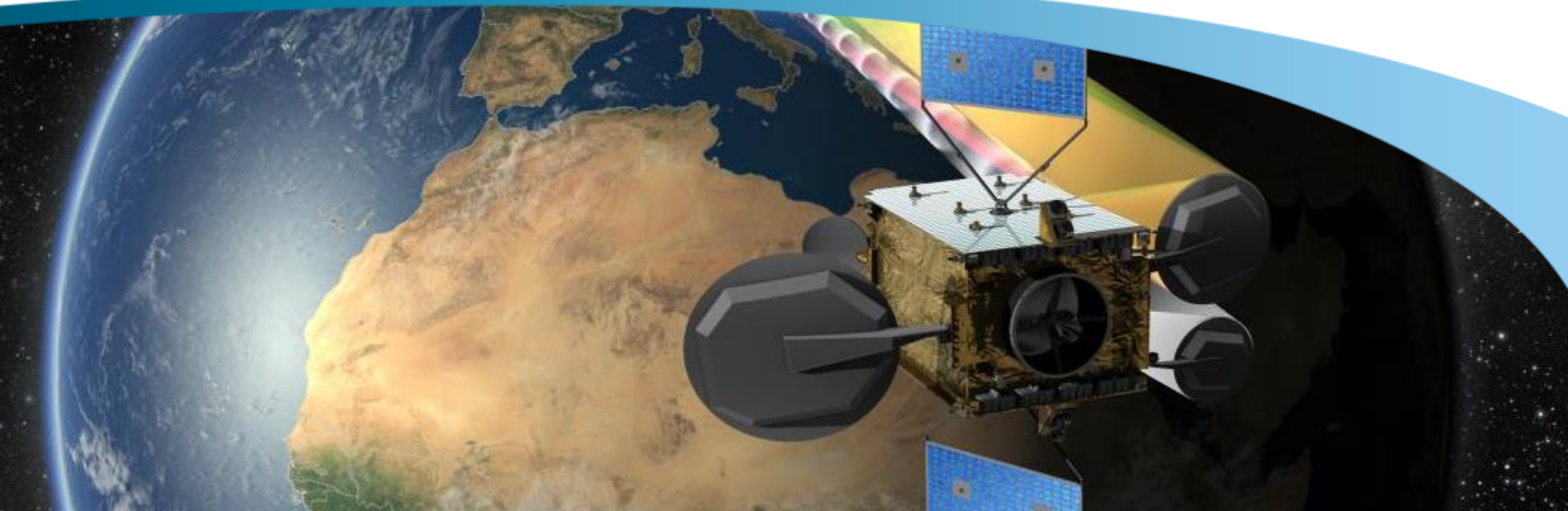


International Conference and Exhibition on Satellites
August 19, 2015 - Houston, TX, USA



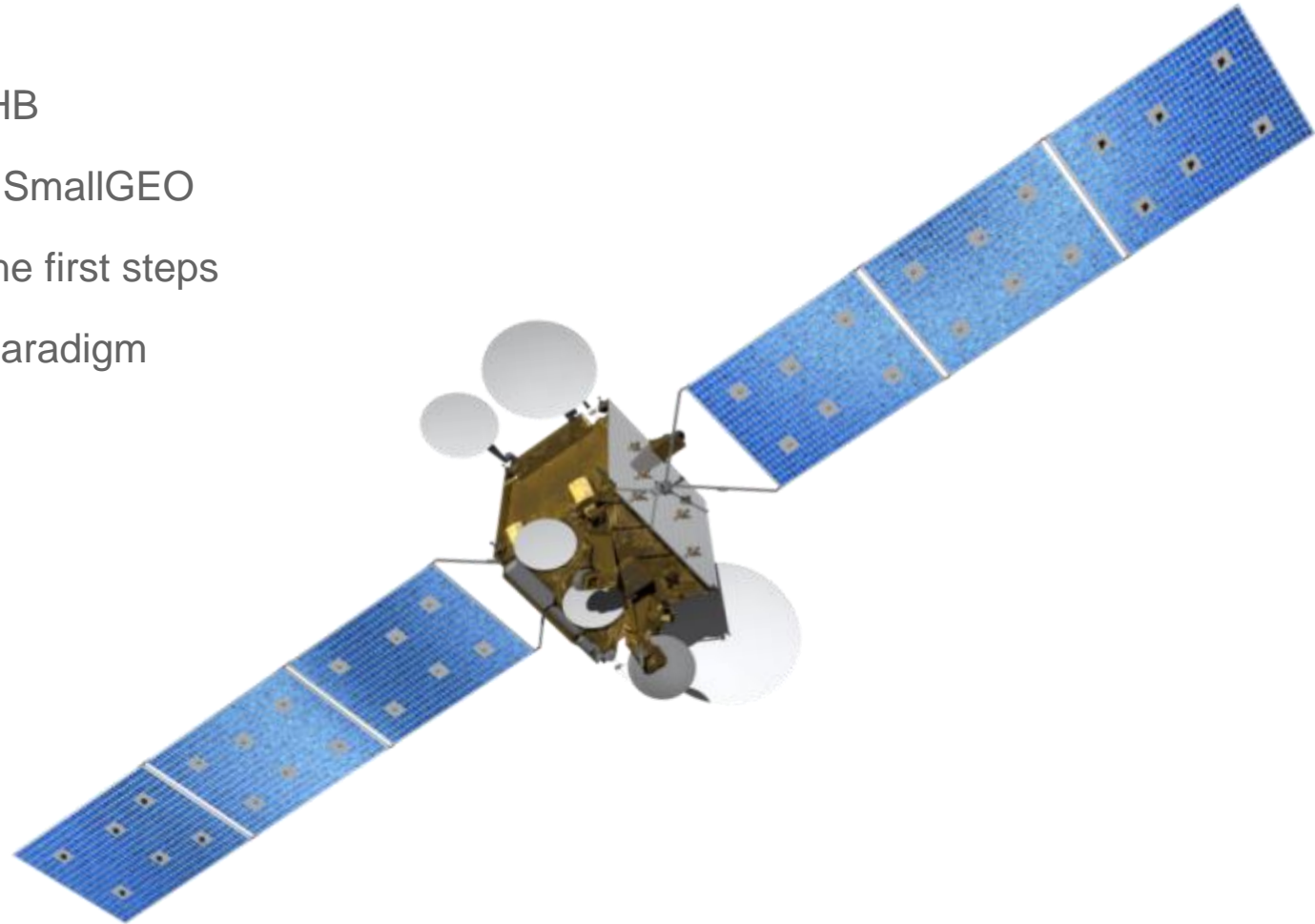
SPACE SYSTEMS

Future telecomsats as a new paradigm for satellite industries and operators

Antonio G. Accettura, Ph.D.
OHB System, Germany

Content

- An overview of OHB
- The vision behind SmallGEO
- A brief history of the first steps
- The Electra new paradigm
- Current Missions
- Roadmap
- Conclusions



Visionary. European.

- OHB SE is Germany's first listed technology and aerospace group
- Approx 2,000 employees stationed around Europe
- Two specified system branches deliver sophisticated, custom-made technology and systems to international customers
 - **Space Systems**
Design and development as well as implementation of space projects
 - **Aerospace + Industrial Products**
Product manufacturing for aerospace and telematics.



United under one roof

The value chain of the two specified system branches **Space Systems** and **Aerospace + Industrial Products** of OHB AG includes:

- Satellite design, construction and operation
- Data transmission and processing
- Design, development and construction of scientific payloads
- Structures for aerospace applications.

In Sept. 2014 we merged with Kayser-Threde GmbH



OHB is one of the most interesting space industries operating in Europe, with many projects ongoing. Why this model could be considered successful?

Several factors contributed:

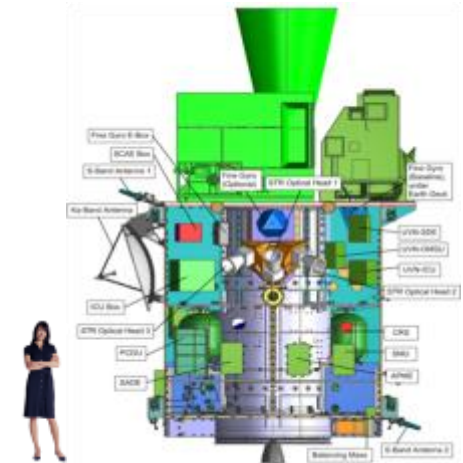
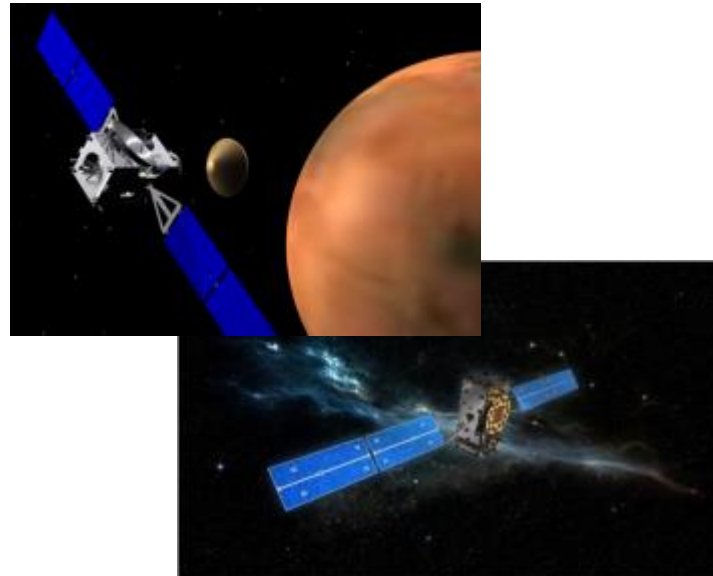
- 1. Full capabilities to master all system activities associated to a satellite life: from development to design, from manufacturing to integration, from launch to operations.**
- 2. Lean organization to achieve agility and react quickly.**
- 3. System-oriented teams, because each satellite is a core business and the system mindset is a driver.**
- 4. Strong Procurement Management organization: 75% activity subcontracted. Procurement is a strategic distinctive factor.**
- 5. The most important asset are people: more than 25 Countries worldwide are represented supporting the international mindset we developed along the years.**

OHBS-System design, manufacture, integrate, test and operate satellites (platform and payload).

Current Projects Overview

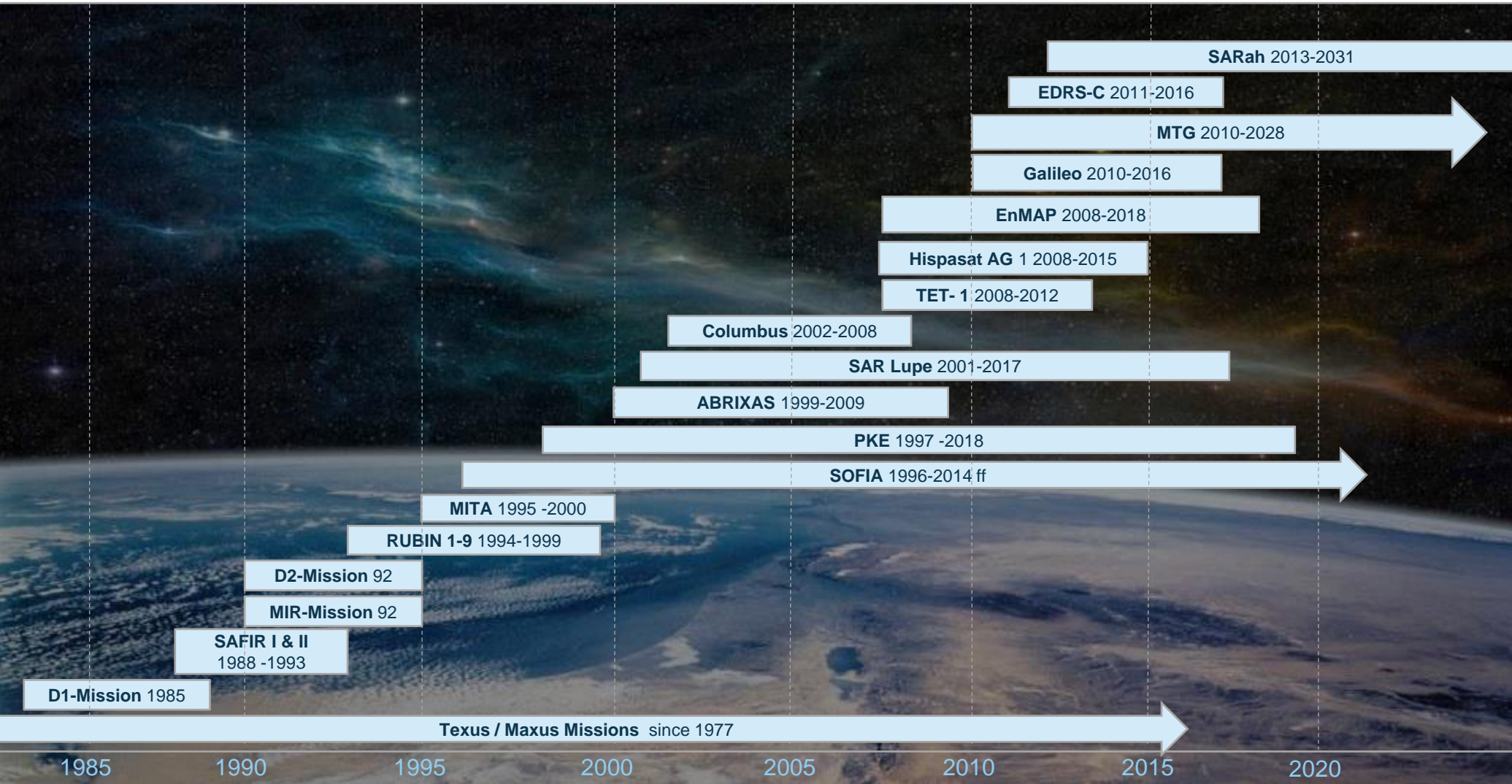
Since the SarLupe small constellation (6 sats), many objectives have been achieved and several projects are ongoing. Just if we consider OHBS-System the following satellites are under development or under a manufacturing phase, as platform or satellite prime contractor:

- ExoMars 2016
- Hispasat AG1
- Galileo FOC (22 sats)
- EDRS-C
- MTG (6 sates)
- ExoMars 2018
- EnMap
- Heinrich Hertz
- SARah (3 sats)
- Electra

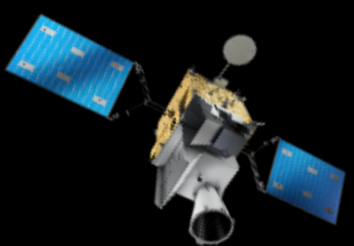


To the above list it should be added the huge amount of pre-development studies and ongoing bids.

Progression of project portfolio (selection)



Scope of activities



Earth Observation

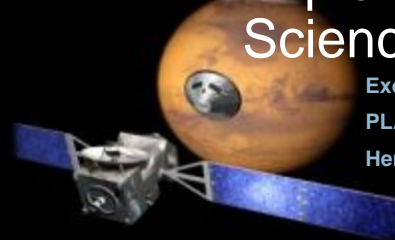
CarbonSat / EnMAP / MTG

Navigation



Galileo

Exploration / Science



ExoMars / Euclid / JUICE /
PLATO / XMM-Newton /
Herschel-PACS / ROSETTA



Tele-communications

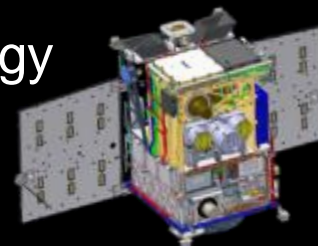
HISPASAT / Heinrich Herz / Electra

Security

SAR Lupe / SARah / Athene

Technology

Robotics / TET /
Precision clocks /
Fibre optics



Manned Spaceflight

International Space Station /
DC4EU



The European solution for small geostationary telecommunication satellites: SmallGEO

OHB System AG as European leader in small electric propulsion satellites

History of the first steps

The aims of the owner

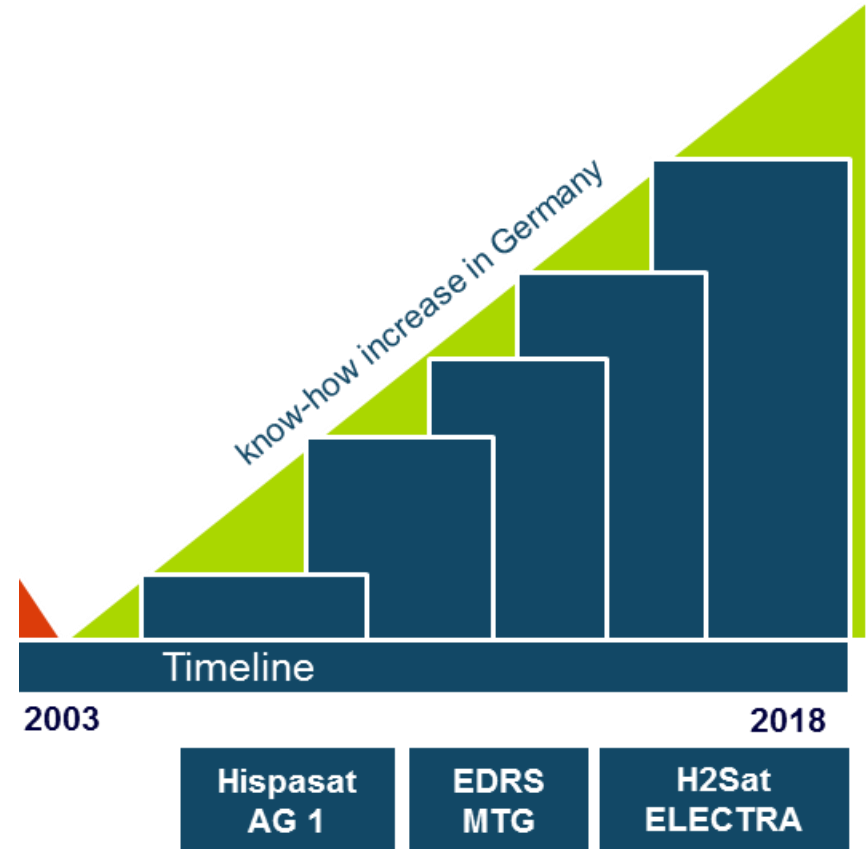
- Revitalize the capability to build geostationary satellites in Germany
- Place OHB System AG in the market segment for small geostationary satellites

The initial steps

- Until 2006: Pre-development with company funding and support of DLR (German Space Agency)
- Since 2006: Start of the development of SmallGEO platform in ESA Artes 11 program

Use of SmallGEO for major European missions

- Telecommunication
- Earth observation



SmallGEO product line

OHB System AG geostationary satellite solution

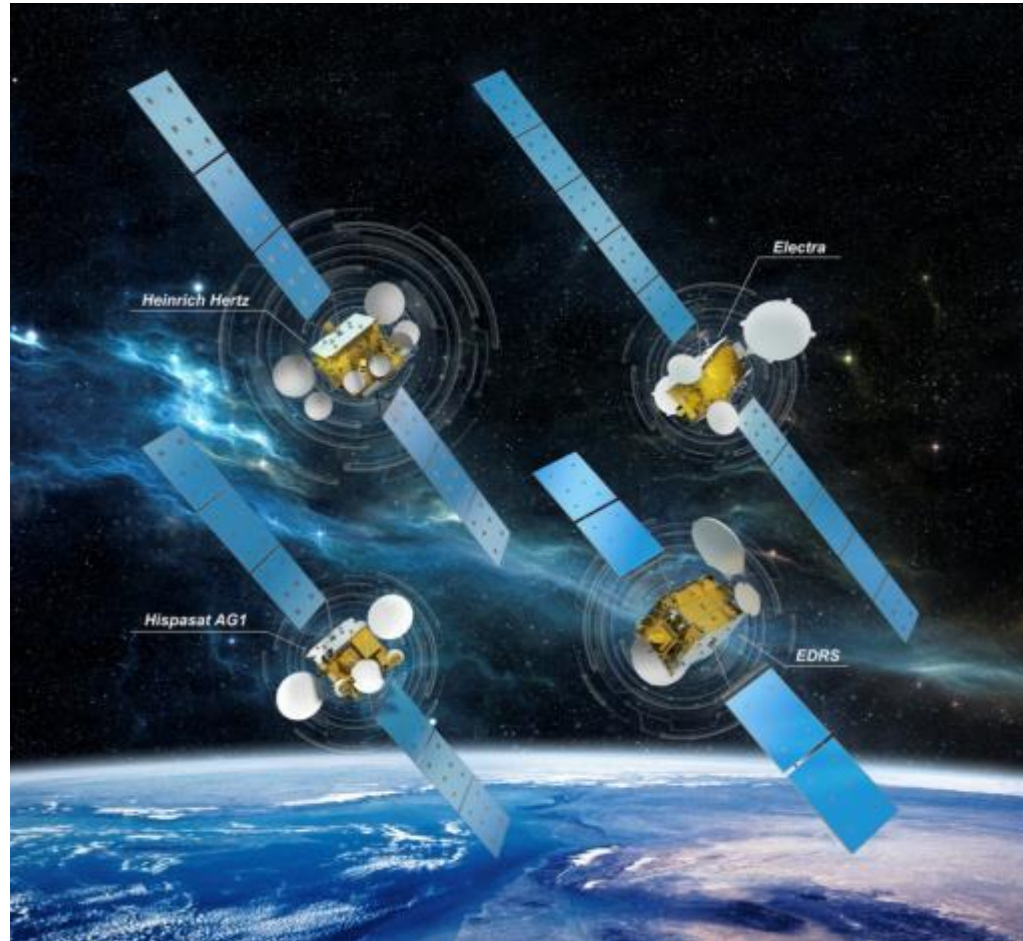
- Designed for geostationary satellites with a launching mass of 2 to 4 tons
- Capability to provide end-to-end solutions for satellite telecommunications

Flexibility

- Different configurations to serve individual customer/mission demands
- SmallGEO platform adaptable for other applications (Earth observation, optical communications)

Status

- **Ten satellites in preparation at OHB**



SmallGEO configurations

Classical solution (SmallGEO Fast Classical)

- All maneuvers with chemical propulsion
 - proven and simple system with long heritage

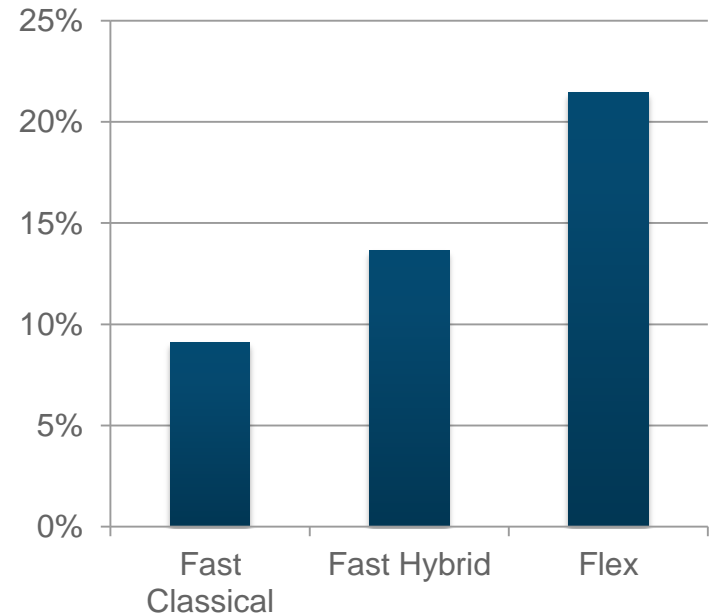
Hybrid solution (SmallGEO Fast Hybrid)

- Station keeping with electric propulsion
 - Increase payload performance by adding additional propulsion system

Full EP solution (SmallGEO Flex)

- All maneuvers (including transfer) with electric propulsion
 - High propellant saving with transfer time of up to 200 days

Payload / Launch mass



Time is Money

– Fast transfer

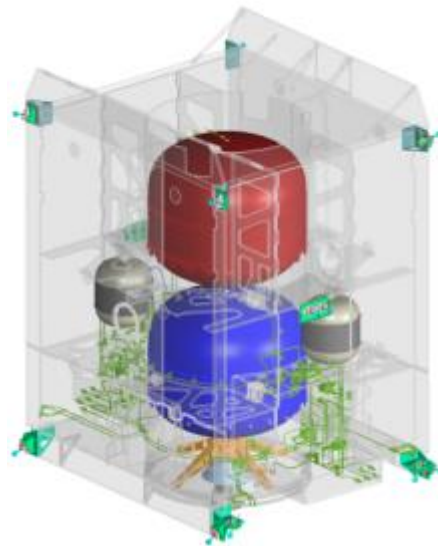
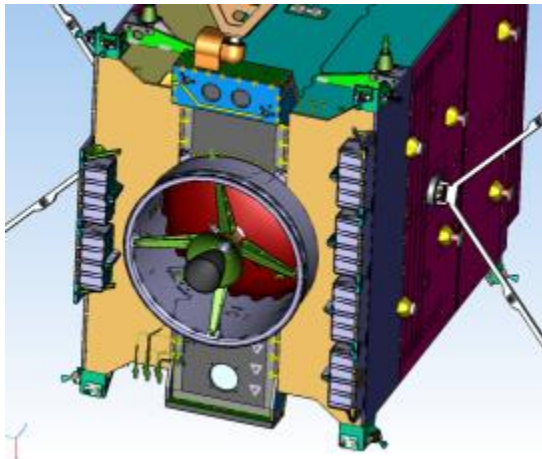
Performance is Money

– Flexible transfer
Min: Direct Injection
Max: LEO

SmallGEO Fast - Classical -

Based on chemical propulsion
(“small” size payload configuration)

- Classical approach: Launcher delivers satellite in Geostationary Transfer Orbit (GTO)
- Satellite with apogee engine (chemical propulsion) to perform the transfer to GEO
- Station keeping based on chemical propulsion



Mission	
Launchers	Ariane 5, Soyuz/Fregat (GSC), Falcon 9, Proton, Atlas V, Zenith (SL/SLB)
Dual launch	Upper position
Transfer	10 d

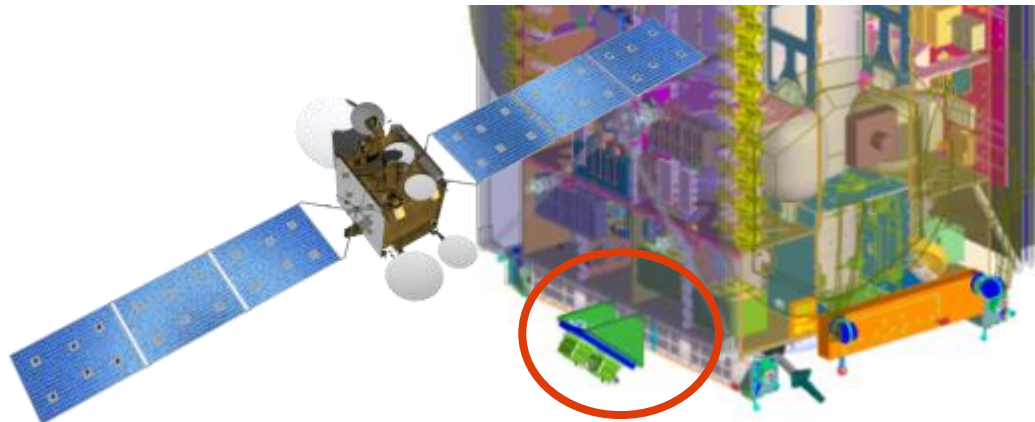
Payload	
TPE's	Up to 32
Mass	Up to 300 kg
Power EOL	Up to 4 kW (5,4 kW)

Satellite	
Launch Mass	Up to 3400 kg
Propulsion System	Station keeping: chemical Transfer: chemical

SmallGEO Fast - Hybrid -

Based on hybrid propulsion system (“large” size payload configuration)

- Launcher delivers satellite in GTO
- Satellite with apogee engine (chemical propulsion) to perform the transfer to GEO
- E/W station keeping based on chemical propulsion
- Contingency & Desaturation based on chemical propulsion
- **N/S Station-keeping based on electric propulsion**

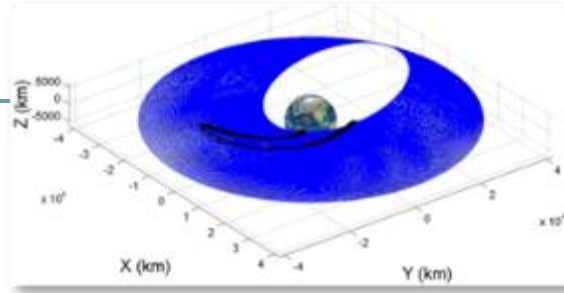


Mission	
Launchers	Ariane 5, Soyuz/Fregat (GSC), Falcon 9, Proton, Atlas V, Zenith (SL/SLB)
Dual launch	Upper position
Transfer	10 d

Payload	
TPE's	Up to 40
Mass	Up to 400 kg
Power EOL	Up to 3,6 kW (5 kW)

Satellite	
Launch Mass	Up to 3400 kg
Propulsion System	Station keeping: electric Transfer: chemical

SmallGEO Flex



Performance

- Payload capacity of medium size classical satellite (would need 5 to 6 t launch mass) with 2 to 3 t launch mass

Flexibility for customer

- Trade of mass vs. transfer time and propellant lifetime

Higher mission margins

- Deal: higher launch mass vs. longer transfer time
 - more robust to late changes, mass increase might be covered via transfer time
- E.g. launcher injection fault -> Artemis scenario

Launcher compatibility

- Compatible with wide range of today's GTO launchers
- Potential for future low cost launchers (e.g. GSLV or Cyclone)

Propellant lifetime opportunity

- Propellant lifetime of 20 years and beyond

Mission	
Launchers	Ariane 5, Soyuz/Fregat (GSC), Falcon 9, Proton, Atlas V, Zenith (SL/SLB)
Design Goal	Cyclone 4, GSLV – MKII, Soyuz Baikonur
Dual launch	Lower and upper position
Transfer	10 d to 200 d

Payload	
TPE's	Up to 64 (72)
Mass	Up to 700 kg
Power EOL	Up to 7 kW

Satellite	
Launch Mass	Up to 3200 kg
Propulsion System	Full electric

Hispasat AG 1 Mission

Customer

- Hispasat via ESA (Artes 11)

SmallGEO for TV broadcast and technology validation

- Platform qualification
- Coverage of Europe and South America
- Ku+Ka-band transparent repeater
- Advanced payload with phased array and on-board processor

Program Status

- OHB System AG is satellite prime
- Launch end 2015



EDRS-C Mission

Customer

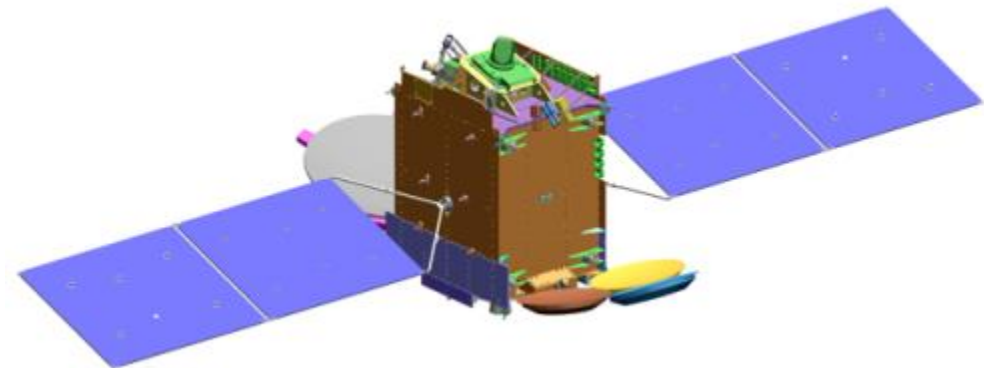
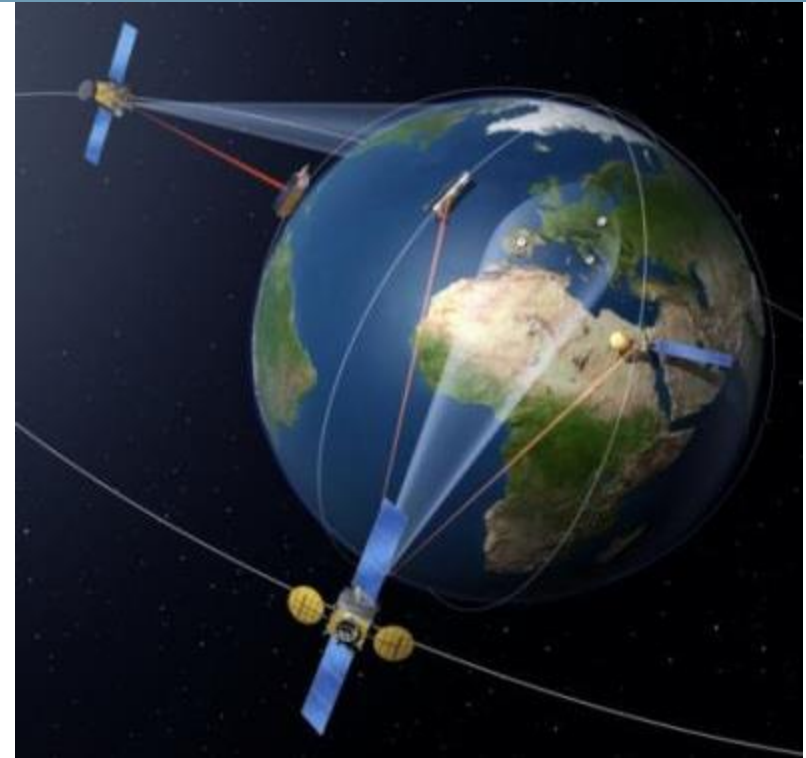
- European Union via ESA / Astrium Services

SmallGEO for Data Relay Applications

- ESA ARTES-7 program to serve the Copernicus Sentinel satellites
- Geostationary data-relay for earth observation satellites data downlink
 - optical and microwave Inter-Satellite-Links up to 1,8 Gbps
 - Ka-Band Downlink to ground segments
- SmallGeo satellite optimized for Data Relay Functions

Program Status

- OHB System AG is satellite prime
- Phase C/D ongoing
- Launch in 2017



Heinrich Hertz Mission

Customer

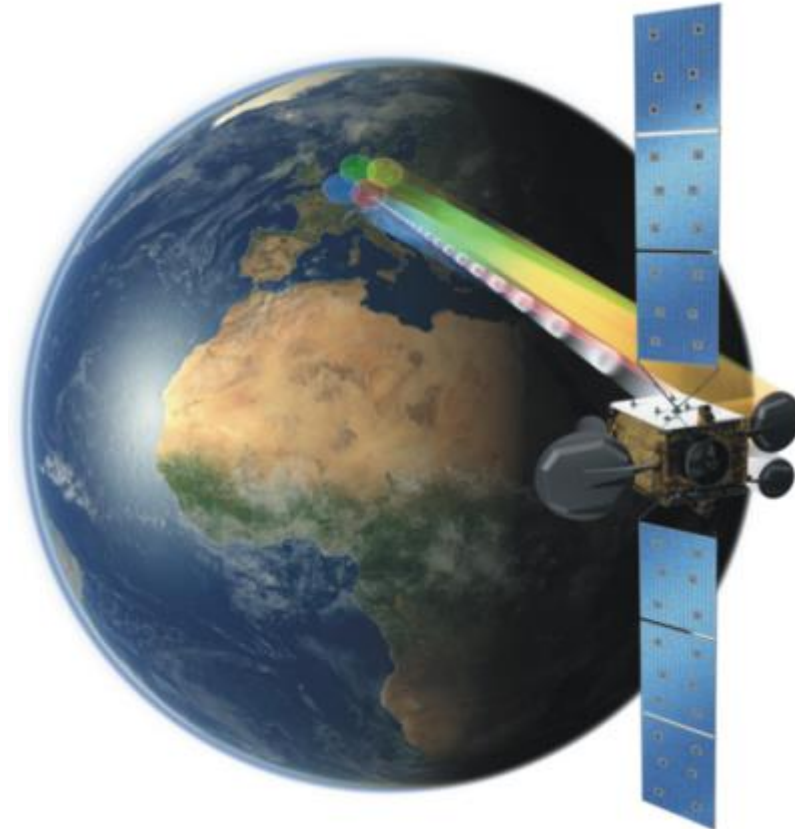
- German Centre for Aerospace - DLR
- Use of excess capacity for hosted BMVg (German DOD) payload

SmallGEO for Technology Validation

- Multi-spotbeam coverage, 4(+1) spots over Germany
- Inter-satellite links LEOs: e.g. DEOS
- Experiments as single-hop communications, new waveforms, regenerative communications
- Mobile services, test bed for ground technologies (e.g. Santana, MoSaKa)

Program status

- OHB System AG is mission prime
- Phase B completed with PDR in Q1/2014
- Start C/D in 2015
- Launch in 2019



Electra Mission

Customer

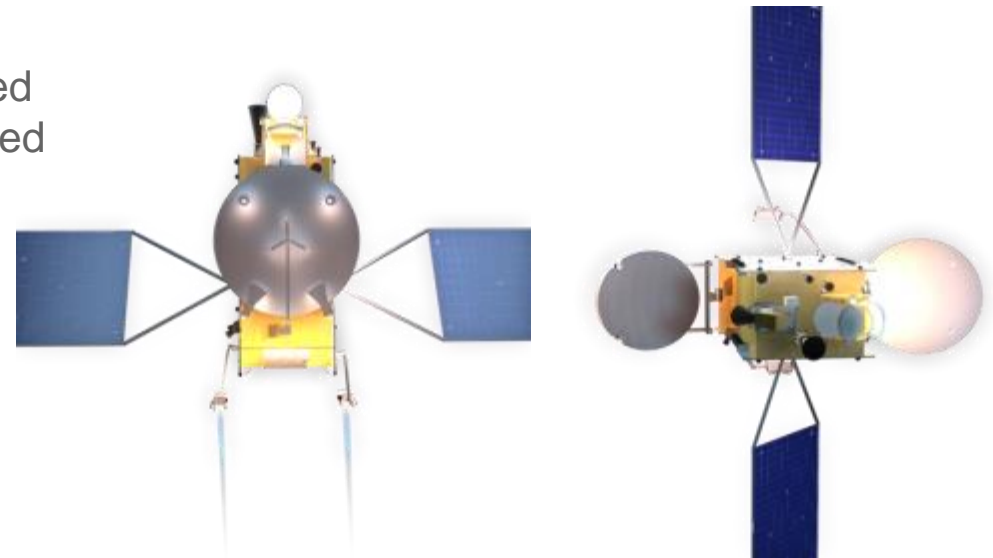
- SES S.A. (ESA)
- Public Private Partnership between ESA, SES S.A. and OHB System AG

Development and qualification of SmallGEO Flex

- Part of ESA ARTES 33 programme
- SmallGEO satellite with electric propulsion for transfer and station keeping
- Satellite offers a payload capacity of medium-sized satellites and reduced launching cost of small-sized satellites

Program Status

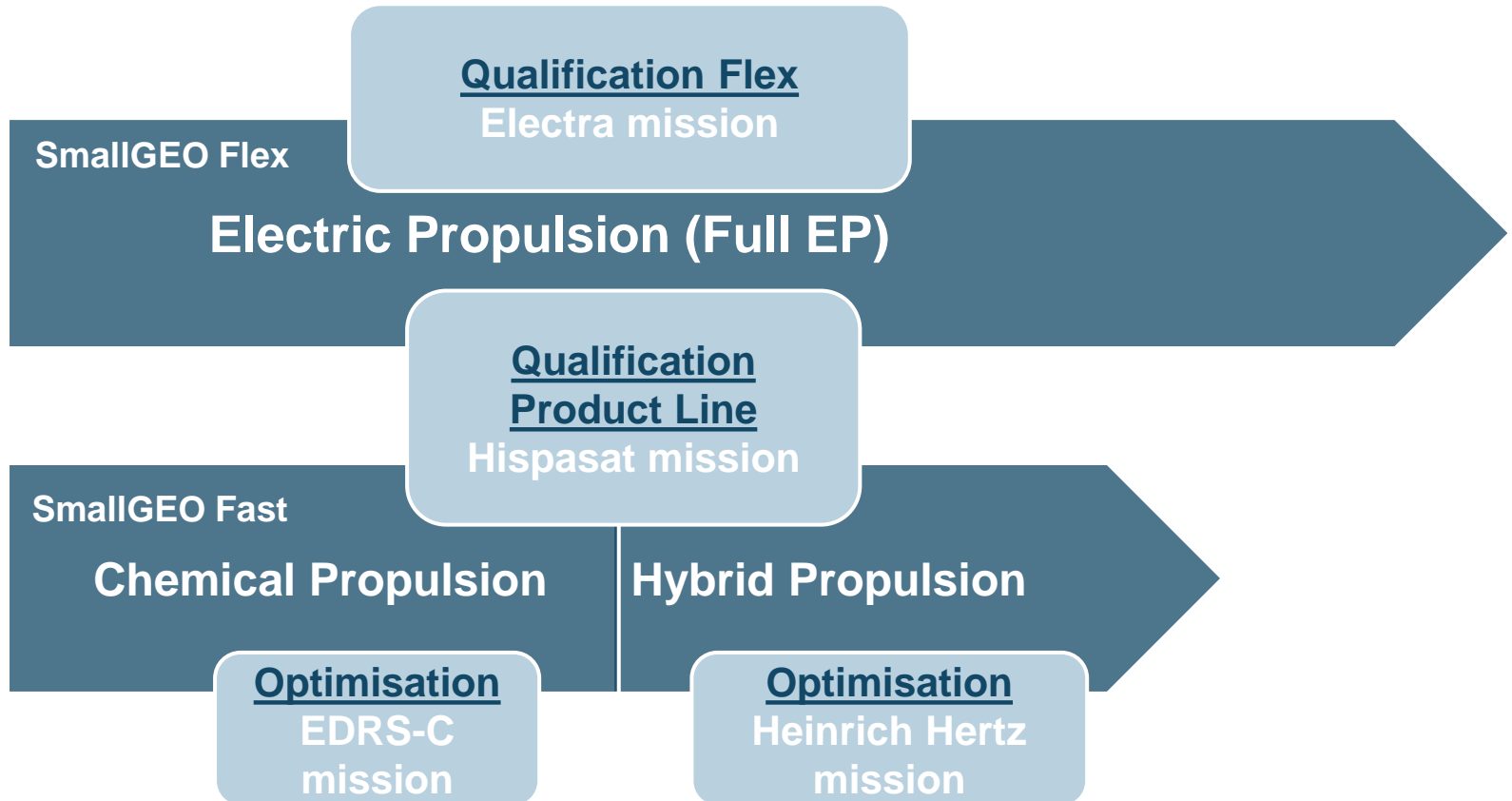
- OHB System AG is satellite prime
- Phase B kick-off in October 2013
- Platform PDR performed on 2014





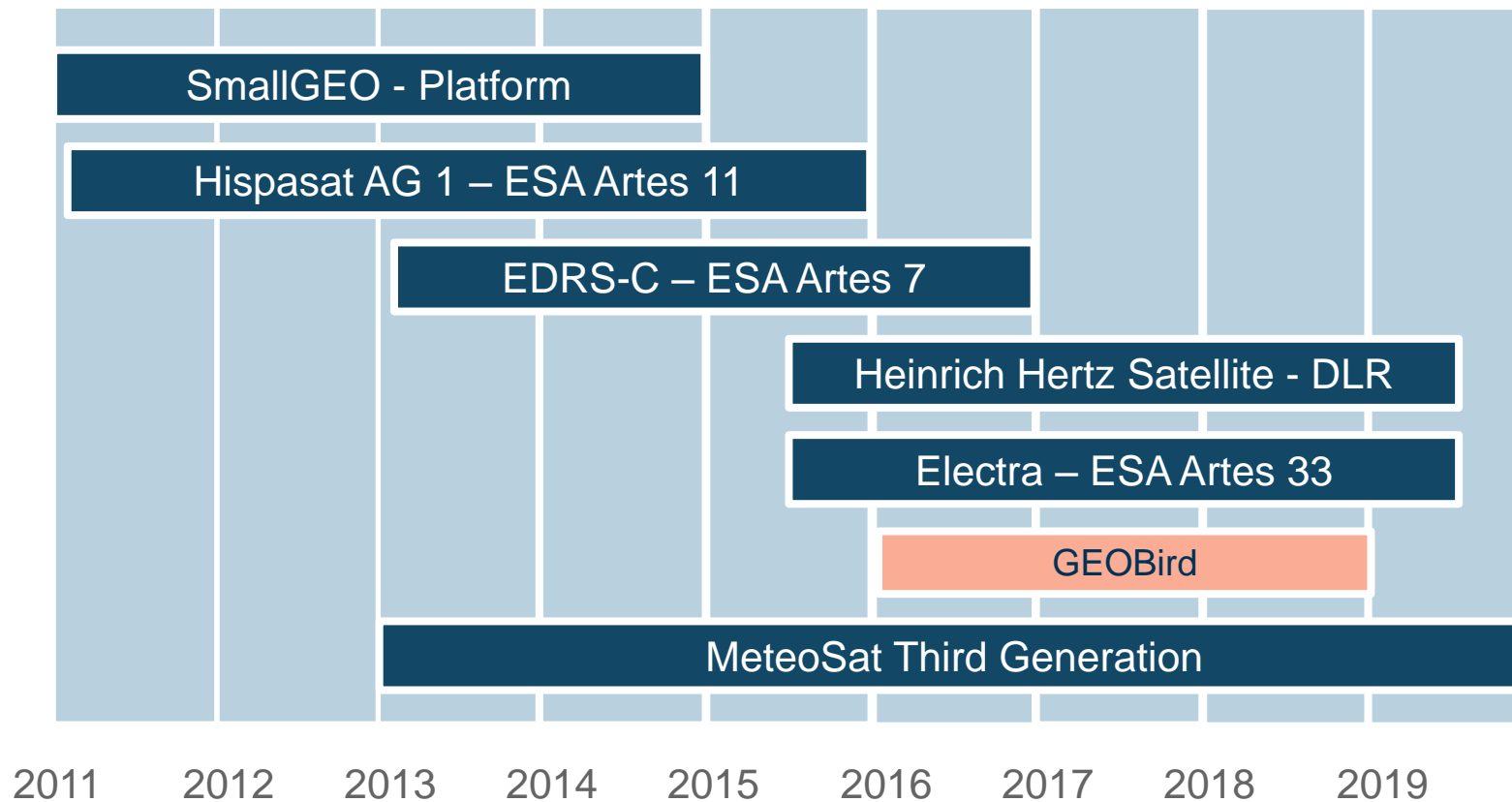
Hispasat HAG 1	EDRS-C	Heinrich Hertz	Electra program
Customer: Hispasat S.A./ ESA	Customer: Airbus Defence & Space Services	Customer: German Aerospace Center (DLR)	PPP between ESA, SES S.A. and OHB System AG
Realisation under the ARTES 11 programme	ESAARTES 7 programme: European data relay satellite system for complementing the Sentinel earth observation satellites under the EU Copernicus programme (formerly GMES)	Economical/technical part of the payload for testing innovative communications and platform technologies in the Ku and Ka band in space and on the ground	Part of the ESA's ARTES 33 programme
Ku and KA band TV transmission applications	Optical satellite links with data rates of up to 1.8 Gbps, downlink in Ka band		SmallGEO satellite with fully electrical propulsion system for transfer manoeuvres and attitude control
	Additionally: hosted payload for Avanti Communications Group plc	Military payload part for the German federal armed forces	Increased payload capacity compared to the chemical propulsion version, resulting in optimized launch costs
Launch scheduled for 2015	Launch scheduled for 2017	Launch scheduled for 2019	Launch scheduled for 2019

Roadmap



Payload-Mass	200 kg	300 kg	400 kg	600 kg
Payload-Power	3 kW	4 kW	5 kW	7 kW

Schedule



SmallGEO is a direct hit

- Four SmallGEO telecommunications missions
- Six SmallGEO platforms for Meteosat Third Generation

SmallGEO is well prepared for the commercial future

- Providing payload technology state-of-the-art and beyond
- Most advanced electric propulsion platform
- Sustainable European supplier network established

Electra new paradigm

- What is currently under development with Electra is a brand new concept, not paper based but exactly substantiated with a strong technical background.
- The telecomsats fleet currently under development and here presented, as well as the roadmap for a unified satellite platform, could perfectly match satellite capabilities and operator needs.
- This mutual growth will provide an exceptional added value to the market, including disclosing new opportunities for both governmental and commercial customers.

Objectives, vision and other targets

OHB is focusing on the achievement of selected goals:

- System and platform integrator for national, European and international satellite programs
- Full gamut of satellite missions and applications: earth observation, exploration, telecommunications, science and navigation
- Commercial, civil and security-relevant services
- European systems specialist:
 - Flat hierarchies and optimized cost structures
 - Proactive and agile management for customers' benefit
 - Commitment to customer-centric activity and lessons-learnt processes
 - Professional, project-oriented procurement management system
- Leadership in small Telecomsat through the development of Electra

OHB is the third European industrial pole capable to build turn-key satellites and we are working to improve this rank...

Thank you!

Contact

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