



PLANNING COLLECTION PROCESSING ANALYSIS DISSEMINATION

DEFENCE AND SPACE

Big Birds and Small Satellites How To Make Them Work Together

ESA Phi Week, Frascati, 14.11.2018

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Airbus Defence and Space - Intelligence

AIRBUS



The existing heritage missions will be surrounded by an ever increasing amount of massive small satellite constellations.

Will one technology replace the other or will both, traditional and new space co-exist?

Are there opportunities for collaboration?

Airbus Constellation of Optical and Radar Satellites

Large Coverages at
high level of detail

>100 Bil km² Archive
data since 1986

DMC Constellation

22m Resolution



SPOT 6/7

1,5m Resolution



TerraSAR-X
TanDEM-X
PAZ

0,25-40m Resolution



Pléiades

0,5m Resolution



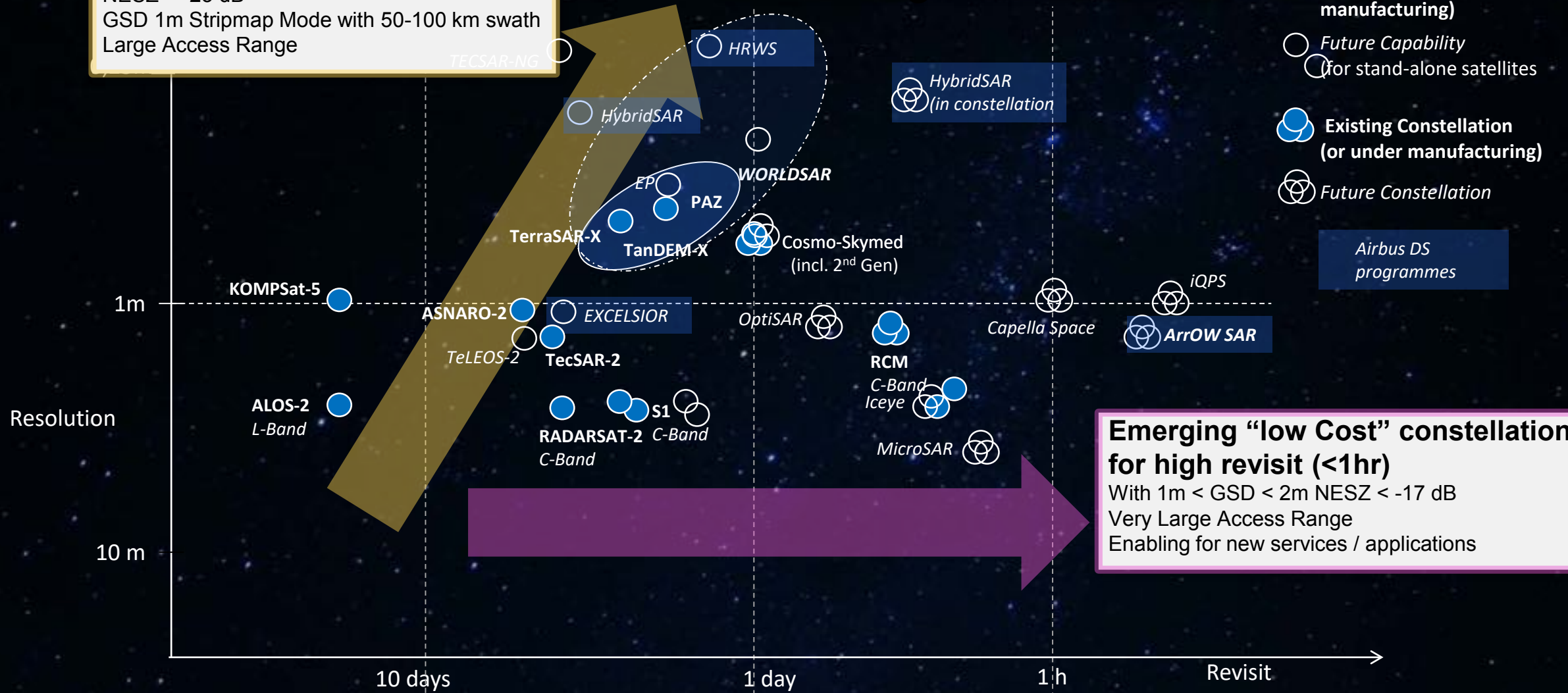
Radar Satellite Trends

Traditional "high end" market

Focus on high Performances
 GSD < 0.5 m for Spotlight
 NESZ < -23 dB
 GSD 1m Stripmap Mode with 50-100 km swath
 Large Access Range

Trend in "high-end" segment

Intra-day revisit of targets, at high to very high resolution (<0.5m)



Earth Observation Markets

01

Defence



02

Maritime
Surveillance



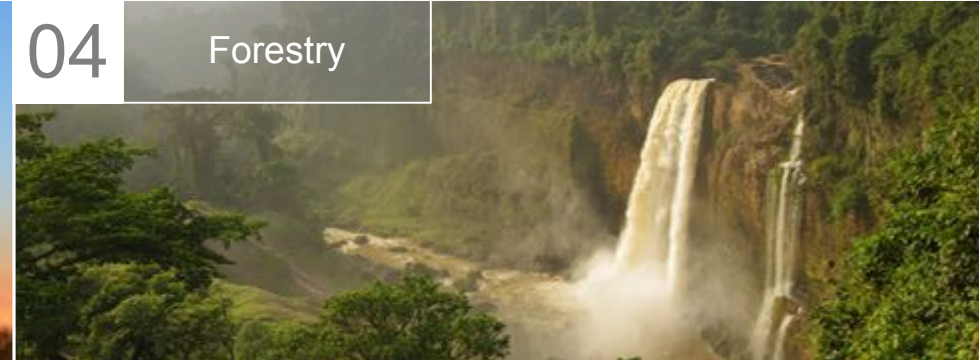
03

Agriculture



04

Forestry



05

Civil Institutions
Security



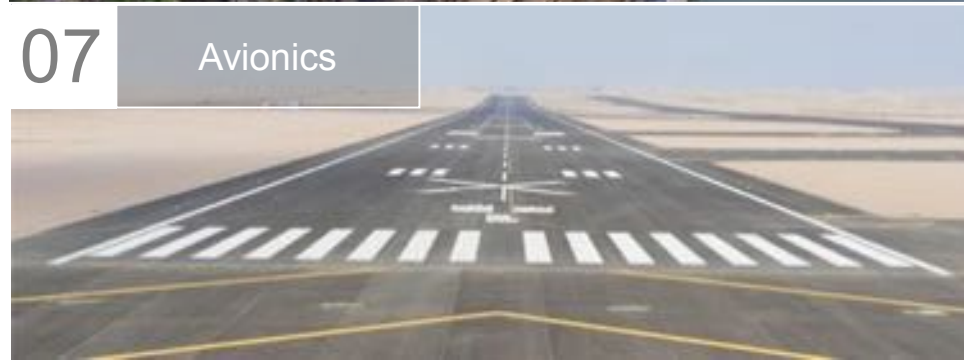
06

Oil, Gas,
Mining



07

Avionics



08

Location-based
Services

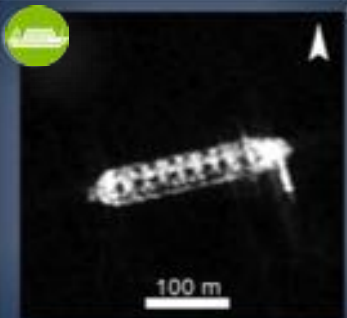


Future Trend: Using Radar as a measurement / detection tool

Some examples

AIRBUS DETECTED OBJECT
D1


LAT 36.129832°
LON -4.589716°
DATE 2015-10-26
TIME 06:23:21



SPEED 17 kts 75%
ORIENTATION 260° 95%
LENGTH 270 m 95%
WIDTH 45 m 95%
CLASS Cargo Vessel 80%
STATUS Moving 90%
CONFIDENCE 95%
PRODUCT Classify

MORE INFORMATION
AIS PANEL

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Displacement Time Series

Lat/Long: 41.70176, 8.15016
Average Velocity: 33.2m/year
Number of Pixels: 1
Confidence: 75
Percentage of Pixel Change: 26%
Standard Deviation of Pixels: 1.94

Average Velocity [m/y] Standard Deviation [m/y] Confidence DM



Summary of SAR related User Requirements

Result of Stakeholder Survey in 2017

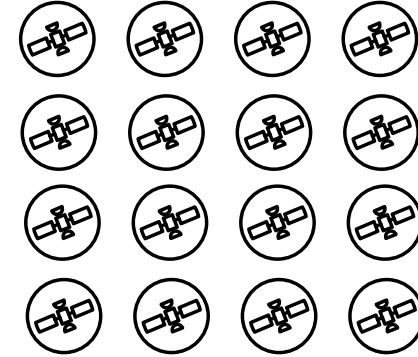
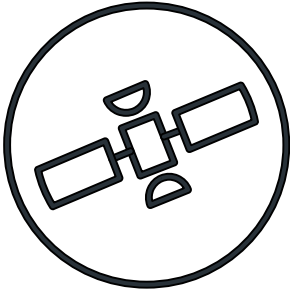
Trend for commercial SAR
Higher Resolution + higher revisit + more coverage and faster Delivery

Applications	Revisit	Delivery	Resolution	Swath
Surface Movement / Infrastructure	1-3 days	Standard	0,25-3 m	50-80 km
Maritime / Ocean Ship detection Oil, Ice, Monitoring, Wind speed, Ocean currents	4 hours	NRT	3-40 m	100-600 km
Change Detection	3 days	Standard	0,25-3 m	25-80 km
IMINT / GEOINT Image Intelligence (incl. Ground Control Points)	Daily	NRT	0,25-0,5 m	15-25 km
Thematic Mapping Agriculture, Forestry, Environment, Urban, Land Use, Flood, Permafrost, Glacier Monitoring	Weeks to months	Standard	1- 3 - 5 m	45-100 km
DEM Generation Improved global DEM Regional updates	Weeks	On-demand	1 m 4 m	45-60 km
Multi-static Application Volumetric- and Height measurement	Days	On-demand	1 m 4 m	45-60 km

HRWS Stakeholder Survey, funded by DLR Space Administration

Comparing Big and Small Satellites

Example: SAR



>200 Mio

Manufacturing Price

<4 Mio

1-4

Constellation Sats

18 - 30

>1,500kg

Platform weight

<100kg

Excellent SNR

Image Quality

Average SNR

25cm

Best Resolution

1-3 m

1-2 / day

Revisit

Every 3 hours

mm range

Accuracy

m range

Many Modes, InSAR & Accuracy support wide range of applications

Application Range

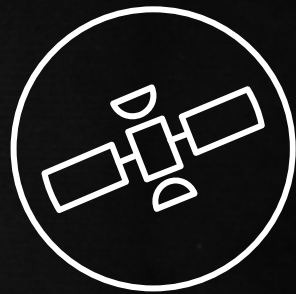
1 mode limits application range, open new applications, InSAR not for constellation

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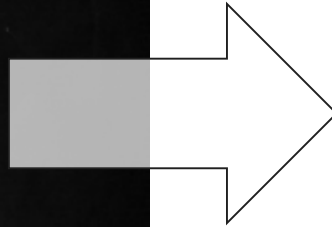
Tip-and-cue between missions

Wide area Monitoring

Wide Swath <550 x 1500km
With big satellite



t0



Ship Tracking

High Frequency monitoring
with small satellites

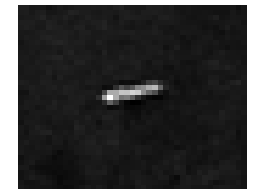
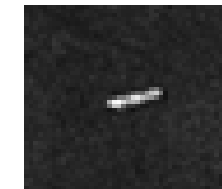
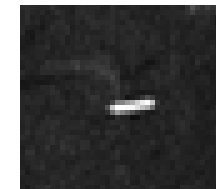
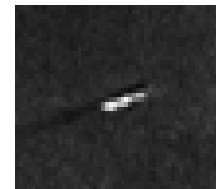


t1

t2

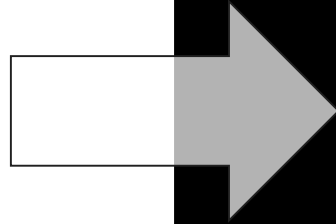
t3

t4



Ship Tracking

High Frequency Monitoring
with small satellites



Ship Classification

High Resolution Imaging
with big satellites

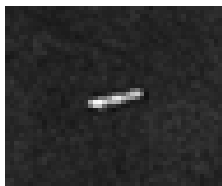
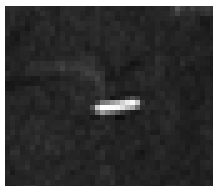
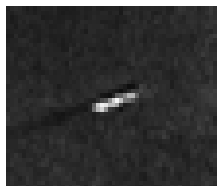


t1

t2

t3

t4



t5

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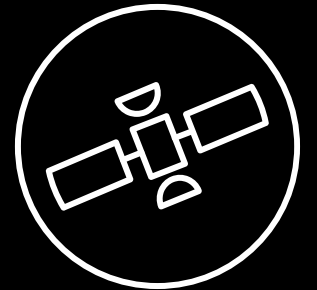
100 m

SPEED	17 kts	75%
ORIENTATION	260°	95%
LENGTH	270 m	95%
WIDTH	45 m	95%
CLASS	Cargo Vessel	80%
STATUS	Moving	90%
CONFIDENCE		95%
PRODUCT		Classify

MORE INFORMATION

AIS PANEL

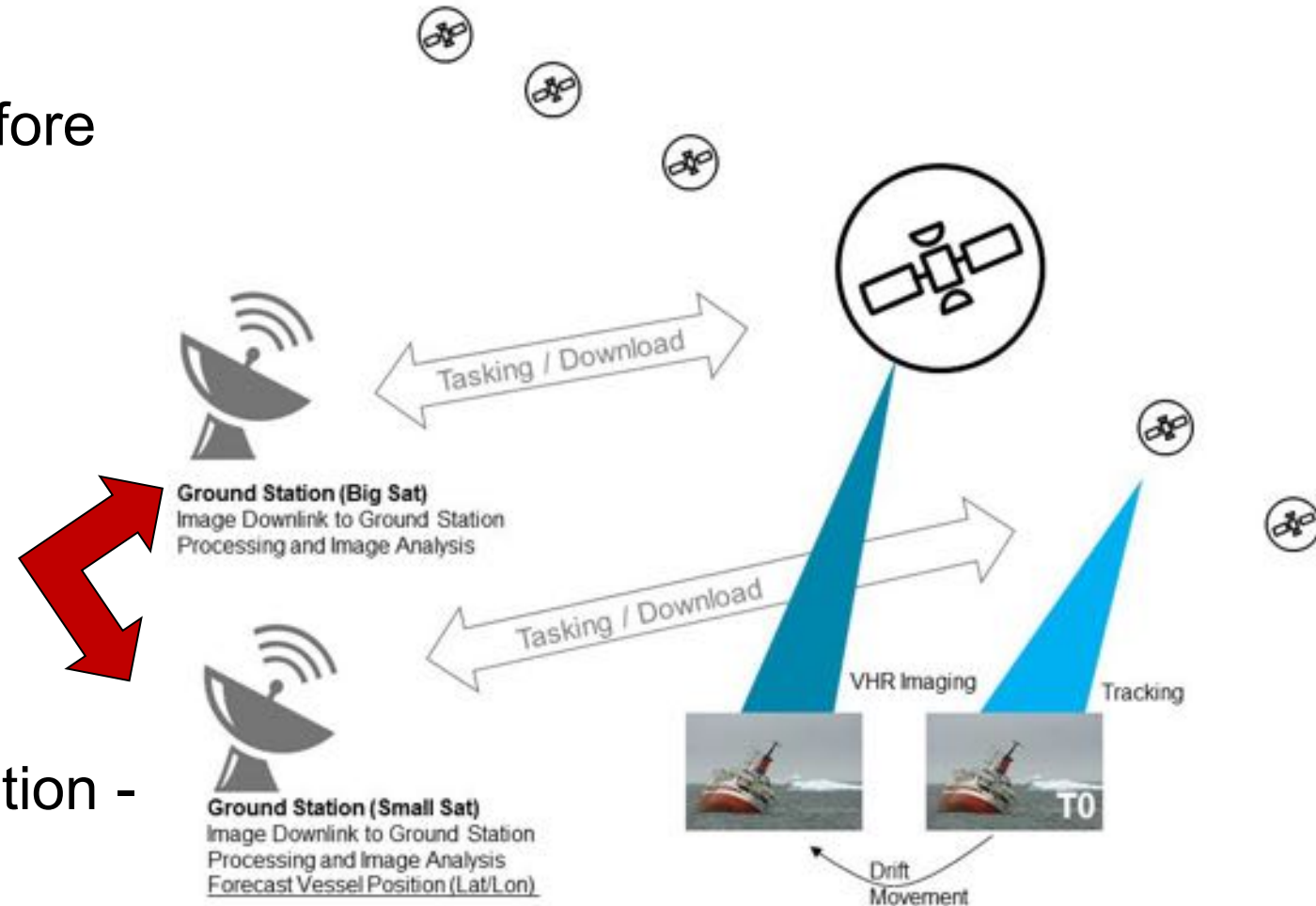
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The complementary opens new applications

Some challenges need to be solved first

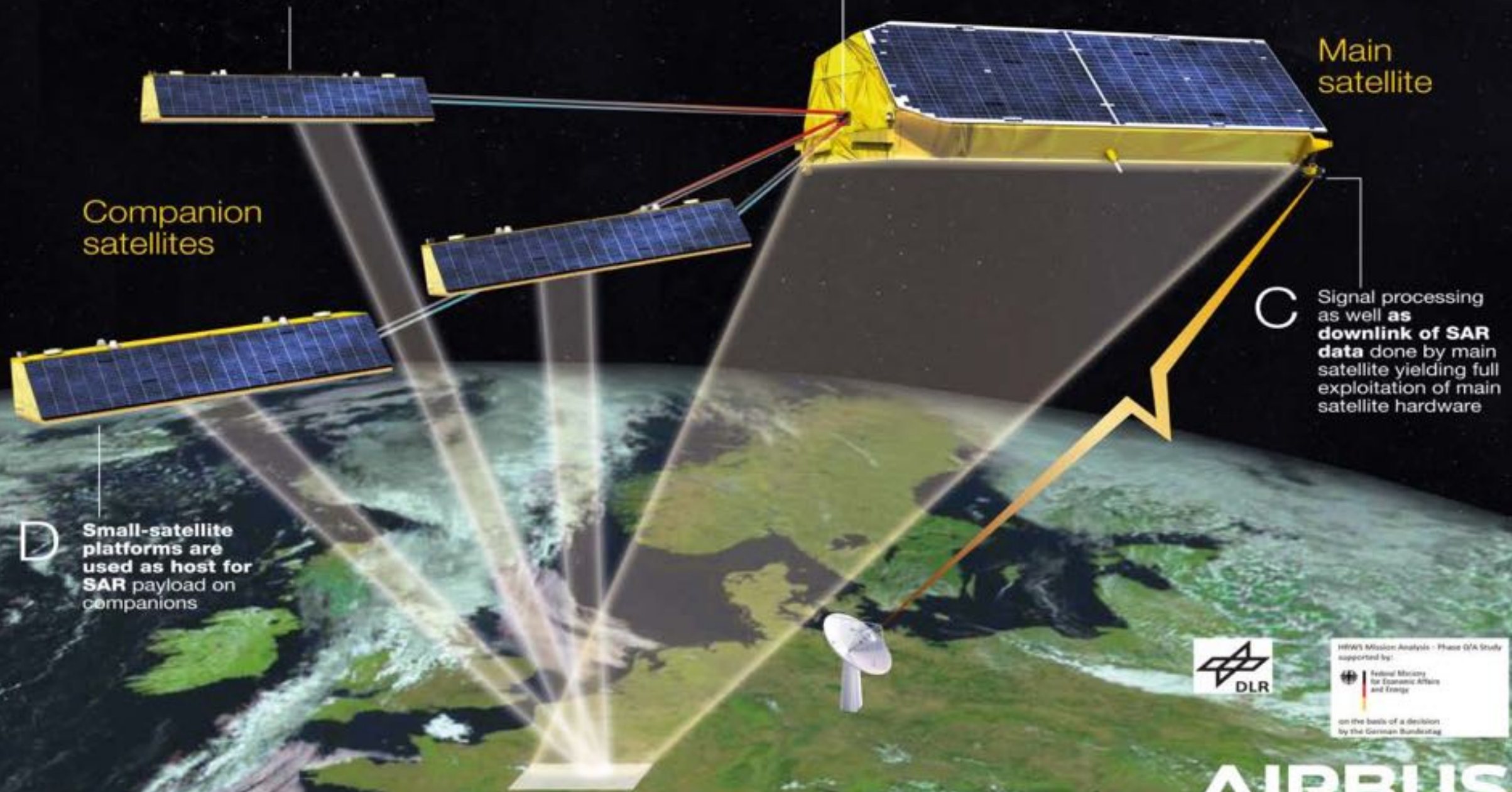
- Near Real time tasking 30 min before acquisition
- Near Real Time Delivery and processing
- Coordinated mission planning
- In case of moving objects, calculation - prediction of the future position



Adding new space elements to mission concepts

A First in-space operation of Mirror-SAR concept: Companions act passively as a mirror for actively transmitted SAR pulses from main satellite

B SAR signal transferred via an innovative HF based Inter-Satellite Link



Main satellite

Companion satellites

C Signal processing as well as **downlink of SAR data** done by main satellite yielding full exploitation of main satellite hardware

D Small-satellite platforms are used as host for SAR payload on companions



HEWS Mission Analysis - Phase 0/A Study supported by:
Federal Ministry for Economic Affairs and Energy
on the basis of a decision by the German Bundestag

AIRBUS

Multi-Static High Resolution Wide Swath (HRWS) Mission

Multi-Static HRWS is the evolution of successful TerraSAR-X Mission: **Broadest Synthetic Aperture Radar (SAR) product portfolio and highest performance achieved by formation of one active satellite and three small satellite companions.**

Multi-Talent



Resolutions
up to 25 cm



Scene sizes up to
500 km x 500 km



Full polarimetry

For serving a broad range of user needs and applications:



Infrastructure Monitoring



Surface Movement Monitoring



Maritime Monitoring



Image Intelligence



Ecosystem Monitoring

Very Agile

for strong hot spot performance

• Theatre mode capability for **quick and reliable acquisition of nearby images**

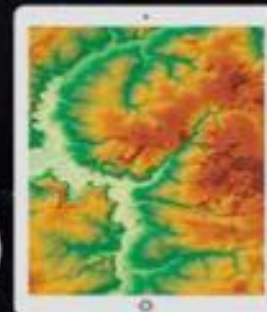


• **Data needs of different customers** in the same regions fulfilled in just one pass

Multi-Static

for on demand digital elevation models and height change maps...

• Unique quality of **4 m pixel spacing and 2 m relative height accuracy**

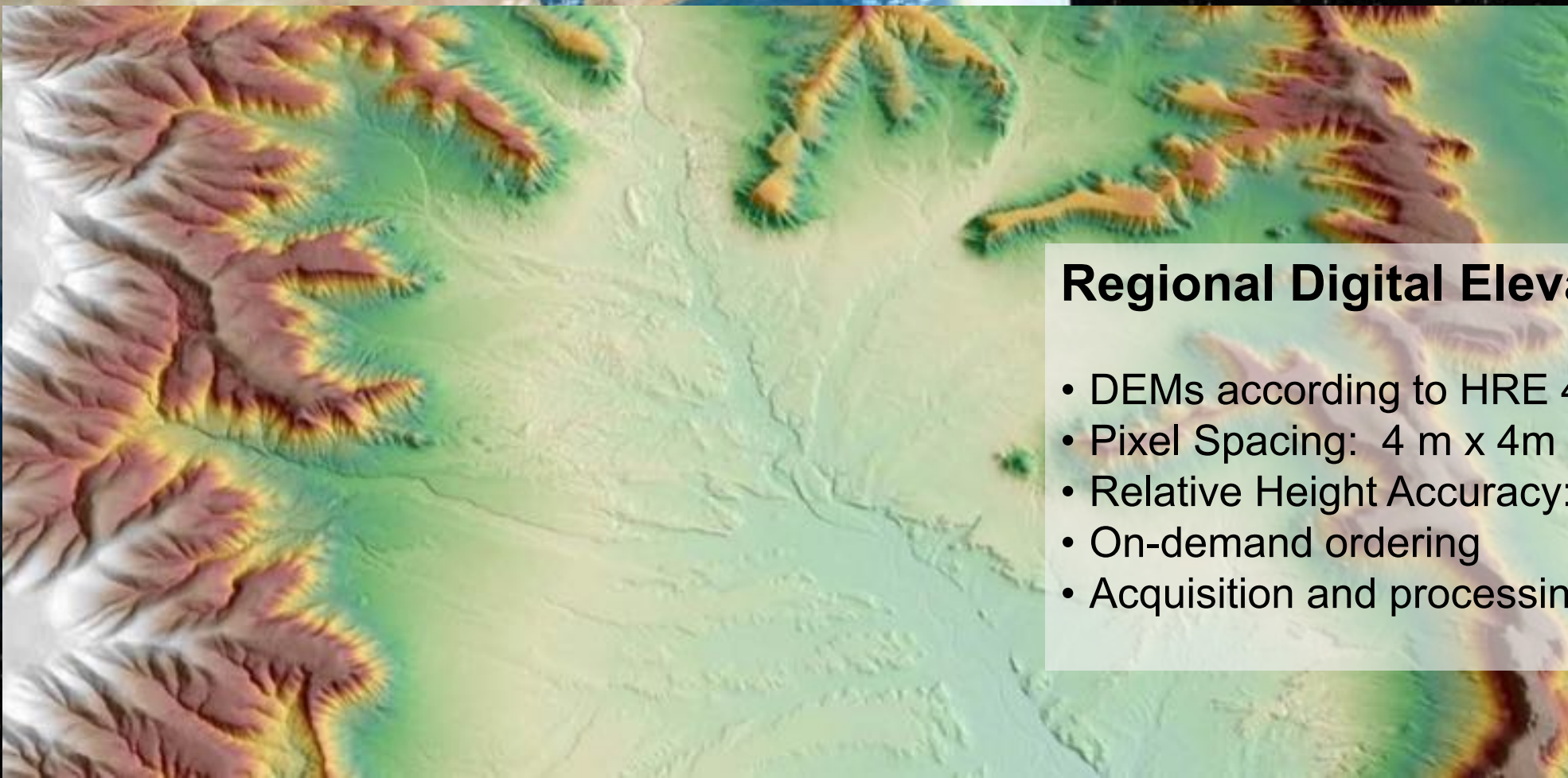


• **Quick and on-demand availability**, collected from just one pass

• **Suitable for height change monitoring** e.g. of stock piles

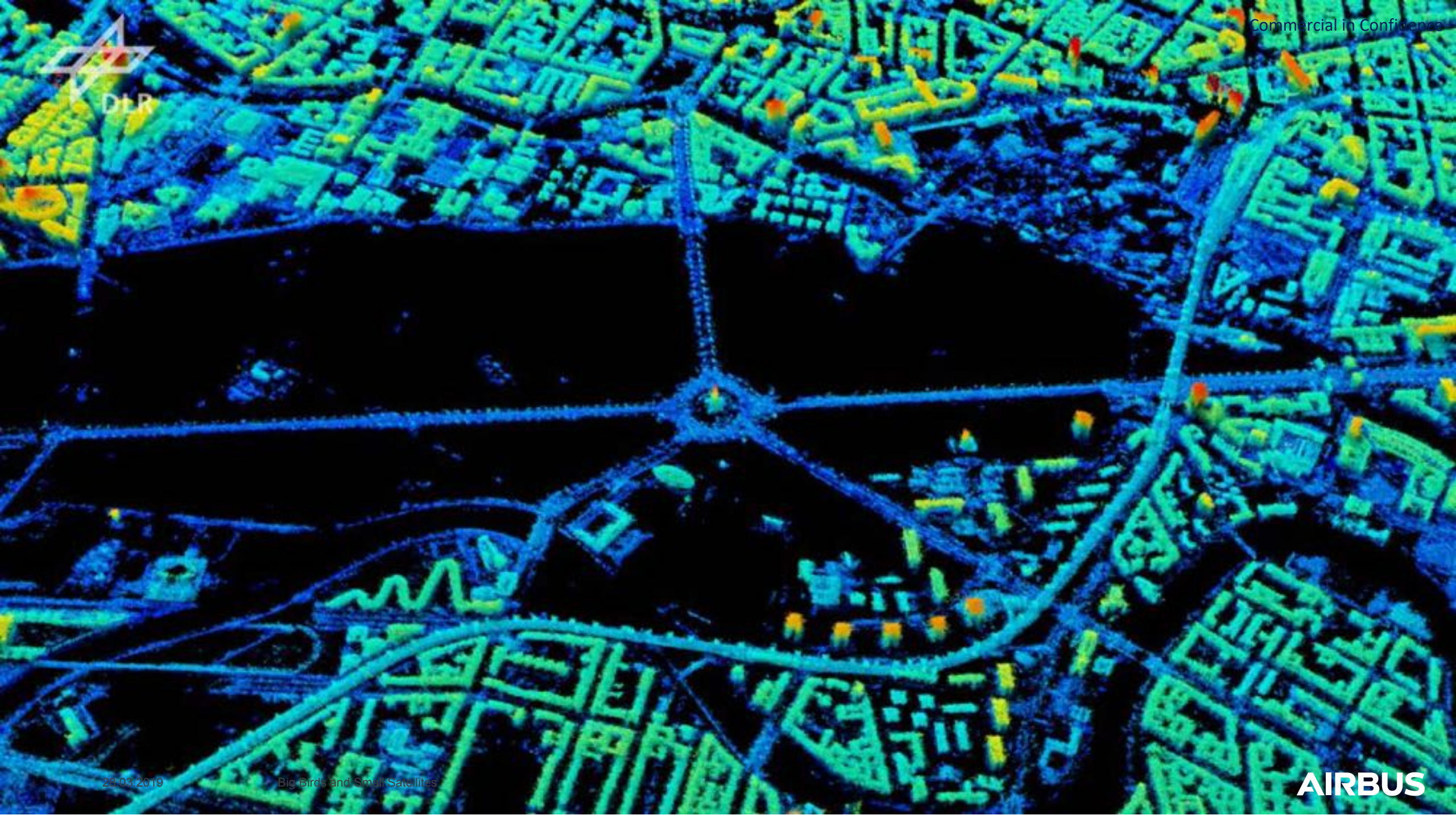
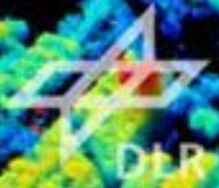
HRWS SAR Performance – VHR SpotLight



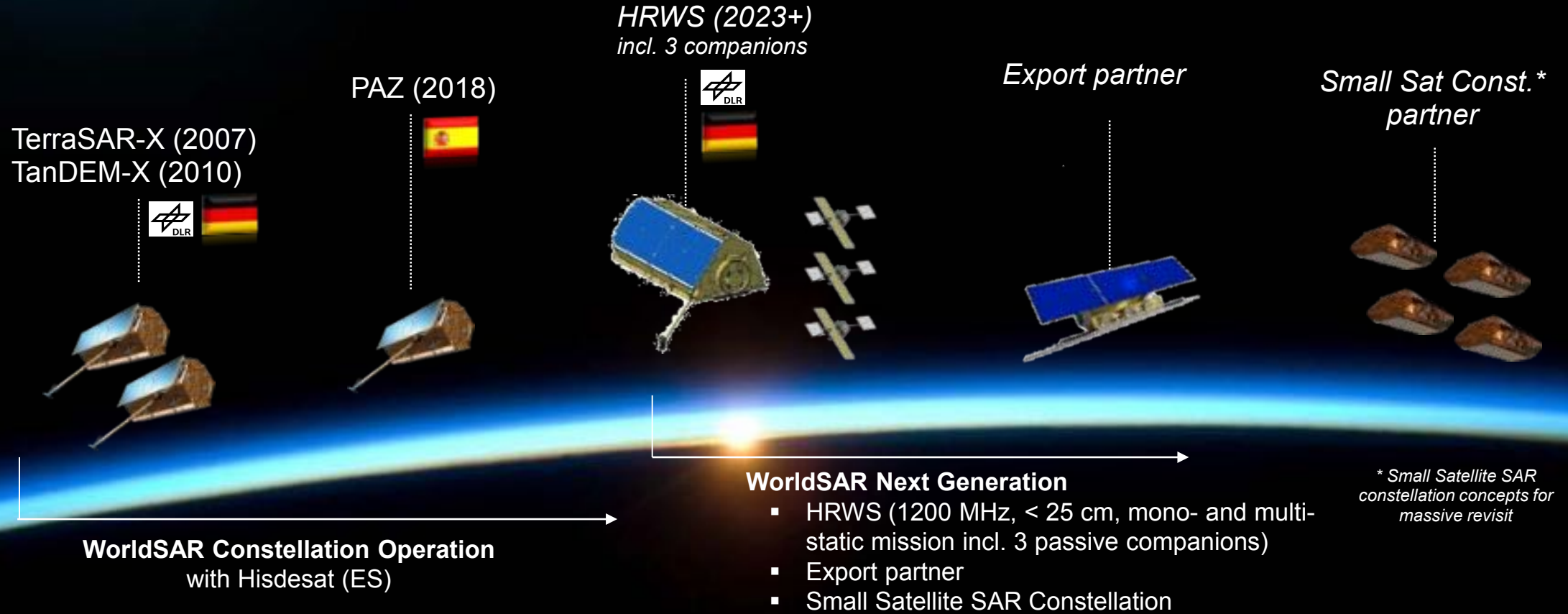


Regional Digital Elevation Models

- DEMs according to HRE 40 Standard
- Pixel Spacing: 4 m x 4m
- Relative Height Accuracy: < 2m
- On-demand ordering
- Acquisition and processing in short time



WorldSAR Partnerships





DEFENCE AND SPACE

Markus Jochum

Future SAR Programs

Airbus Defence and Space / Intelligence

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