

# Airbus-Hisdesat Radar Constellation

## VH-RODA & CEOS SAR Calibration & Validation Workshop

November 18<sup>th</sup> - 22<sup>nd</sup>, 2019

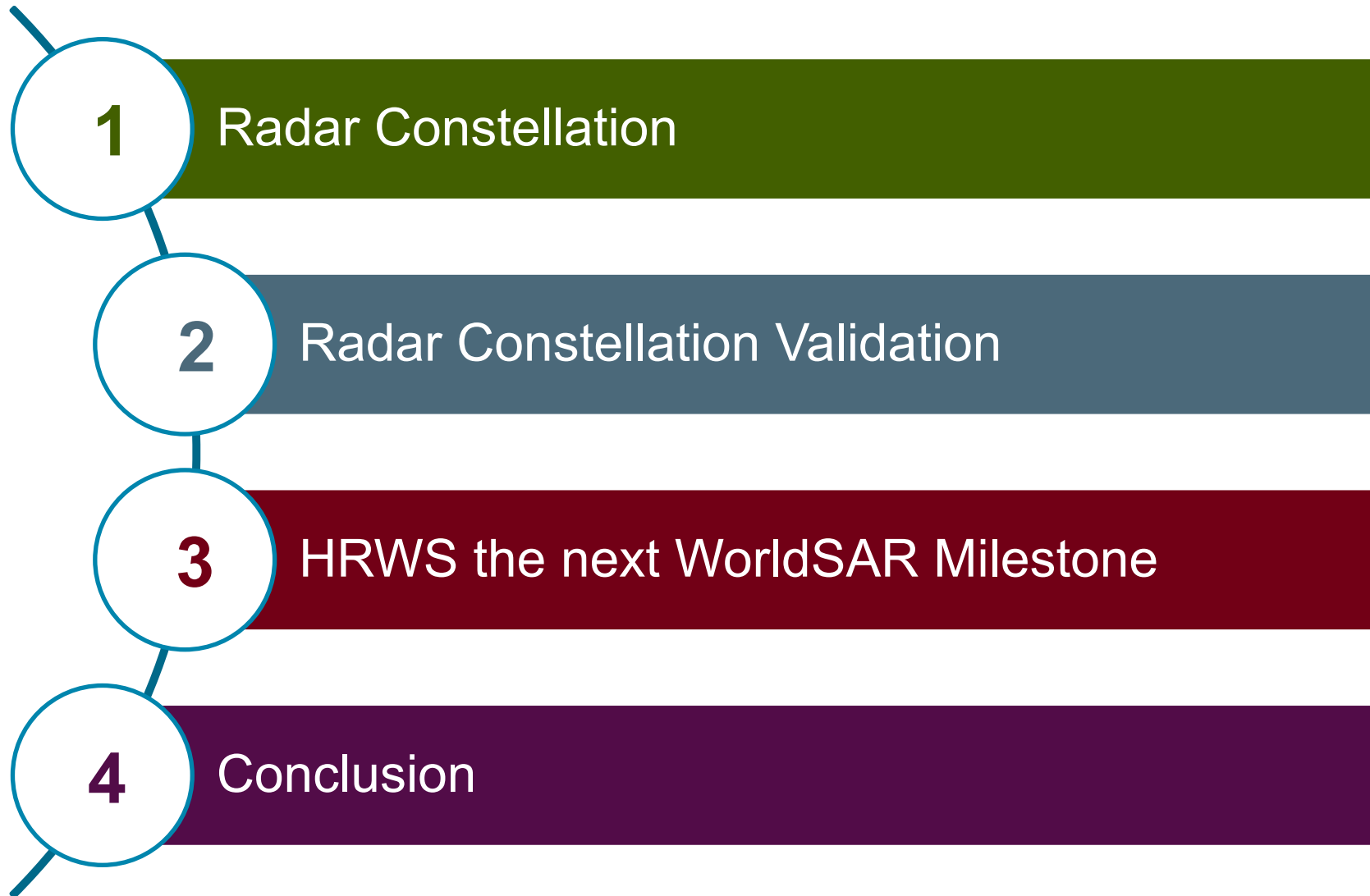
ESA ESRIN, Frascati

J. Janoth<sup>1</sup>, W. Koppe<sup>1</sup>, H. Kahabka<sup>1</sup>, V. d. E. Fernandez<sup>2</sup>, J. I. C. Pérez<sup>2</sup>

<sup>1</sup> Airbus Defence and Space GmbH, Intelligence; Hisdesat Servicios Estratégicos S.A.

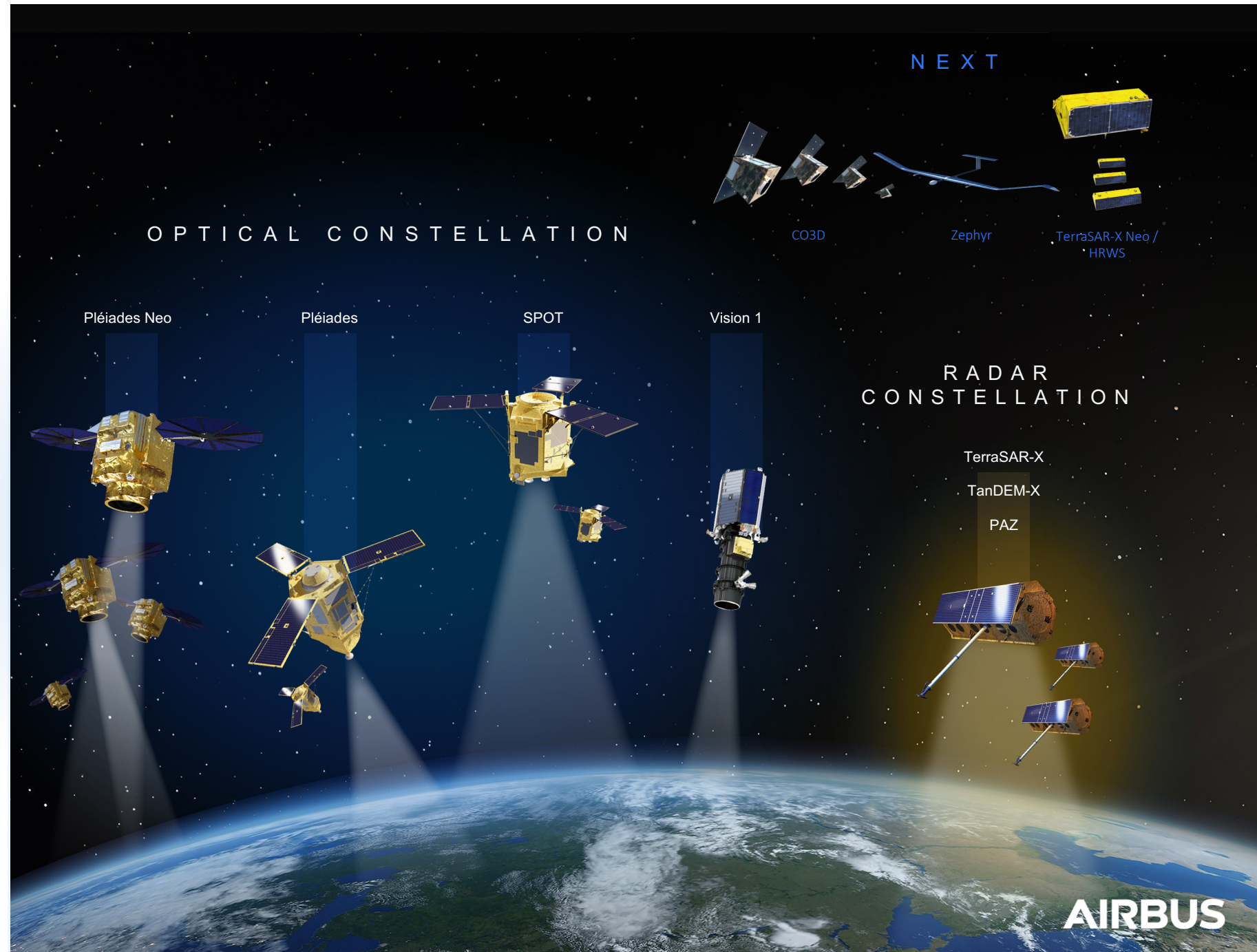


# Outline



# 30 years of development

and experience alongside our customers and partners



# Our Data Makes the Difference

## TerraSAR-X / TanDEM-X Formation

(Est. 2007/2010)

Reliability

Precision

Flexibility



# Our Data Makes the Difference

## PAZ Satellite

(Est. 2018)

Build by Airbus

Owned & managed by  
Hisdesat

AIS Receiver



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# Our Data Makes the Difference

## Radar Constellation

Improvements:

Acquisition Capacity

Overall Revisit Rate

InSAR Repeat Cycle



# Radar Constellation

## Orbit Position

- Same Orbit Plane
- ~98° anticlockwise phasing





# Radar Constellation

# Experience ...

... Coordinated Tasking



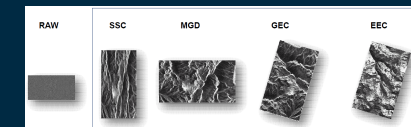
... Joint Pricelist



... same Acquisition Modes



... same Processing Levels





# Radar Constellation

# Experience ...



... same **Product Specification**



... same **Product Structure**



... same **Data Quality**



... same **Way of Delivery**



... same **Delivery Formats**

TSX1\_SAR\_\_AAA\_BBBB\_CC\_D\_EEE\_XXXXXXXXTXXXXX\_yyyyyyyTyyyyyy

# Radar Constellation

## Improvements

→ Acquisition Capacity  
**doubled**



→ **Benefitting Monitoring and Mapping applications**





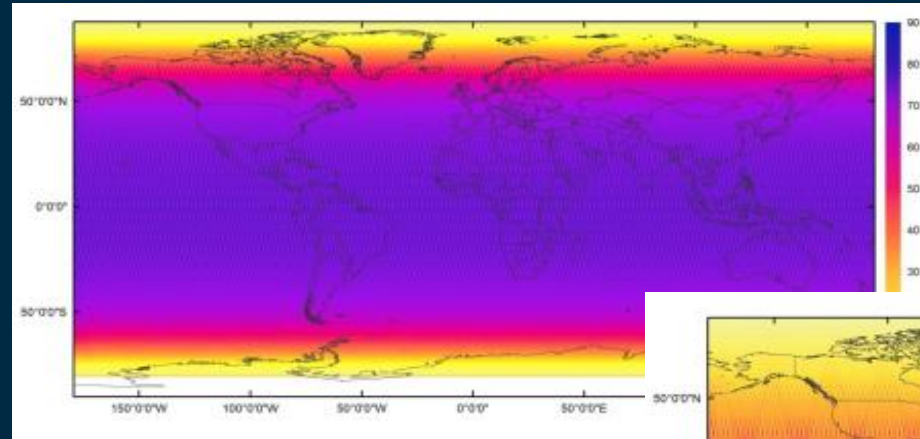
# Radar Constellation

## Improvements

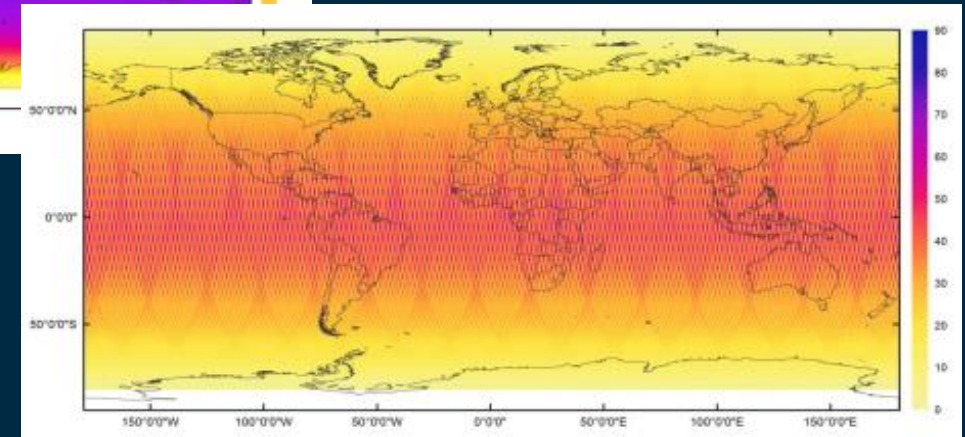
→ Revisit Capacity **strongly increased**

(daily mean revisit < 24 hours)

TSX/TDX only



Radar Constellation



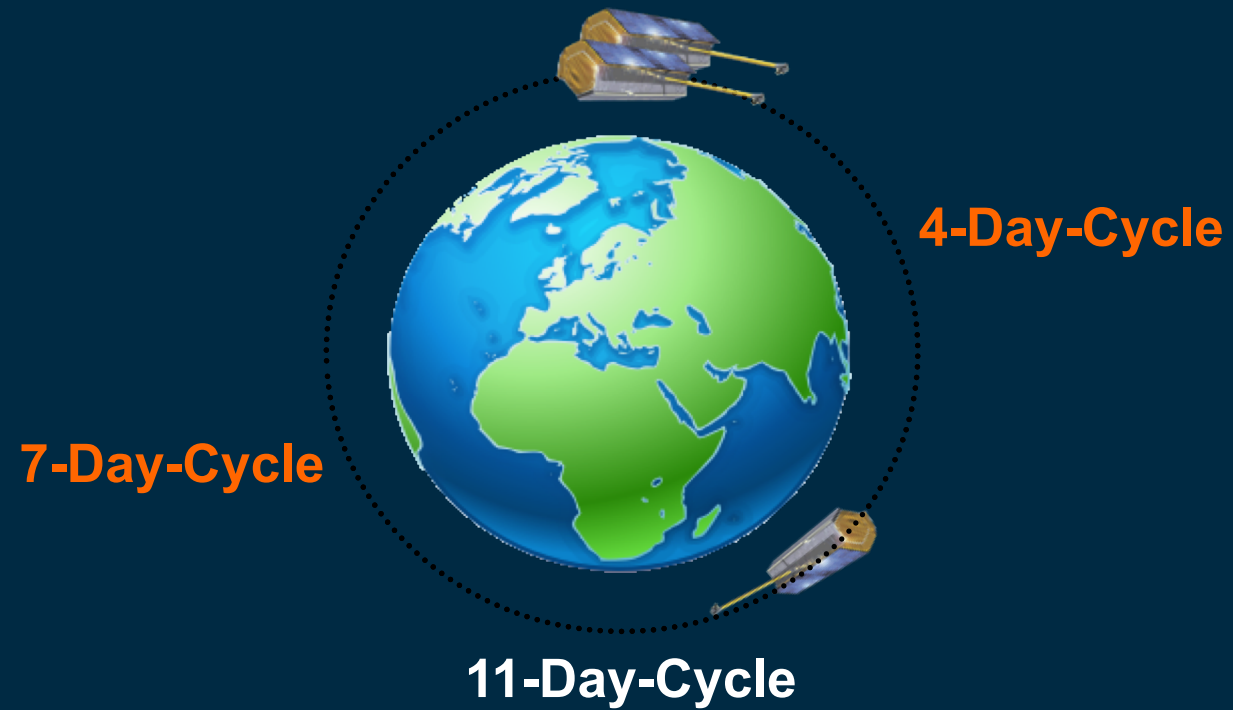
Mean Revisit Example: StripMap, left + right looking, Sat Phasing optimized for max. revisit time

→ **Benefitting Monitoring and Mapping applications**

# Radar Constellation

## Improvements

→ **Enhanced** InSAR-Repeat-Cycle



→ **Benefitting Monitoring applications**

- Interferometric Data Stacks
- Coherent Change Detection

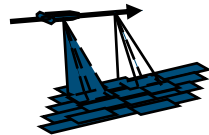


# Imagery – Acquisition Modes

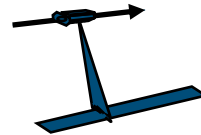
## Wide ScanSAR



## ScanSAR



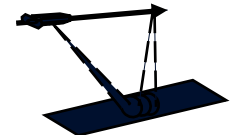
## StripMap



## High Res. SpotLight & SpotLight



## Staring SpotLight



**Multi-resolution – Multi-scale – Multi-polarized:  
Acquisition Modes for various Applications**

### 40m Resolution

200 - 270 x 200km

Large area maritime monitoring of traffic, oil, ice

### 18m Resolution

100 x 150km

Detailed maritime monitoring & detection

### 3m Resolution

30 x 50km

Detection & classification of vessels, infrastructure, etc.

### 1m/2m Resolution

10 x 5 km / 10 x 10 km

Recognition of objects (aircrafts, hangars, vessels,..)

### 0.25m Resolution

4 x 3.7km or 2.5 x 7.5km

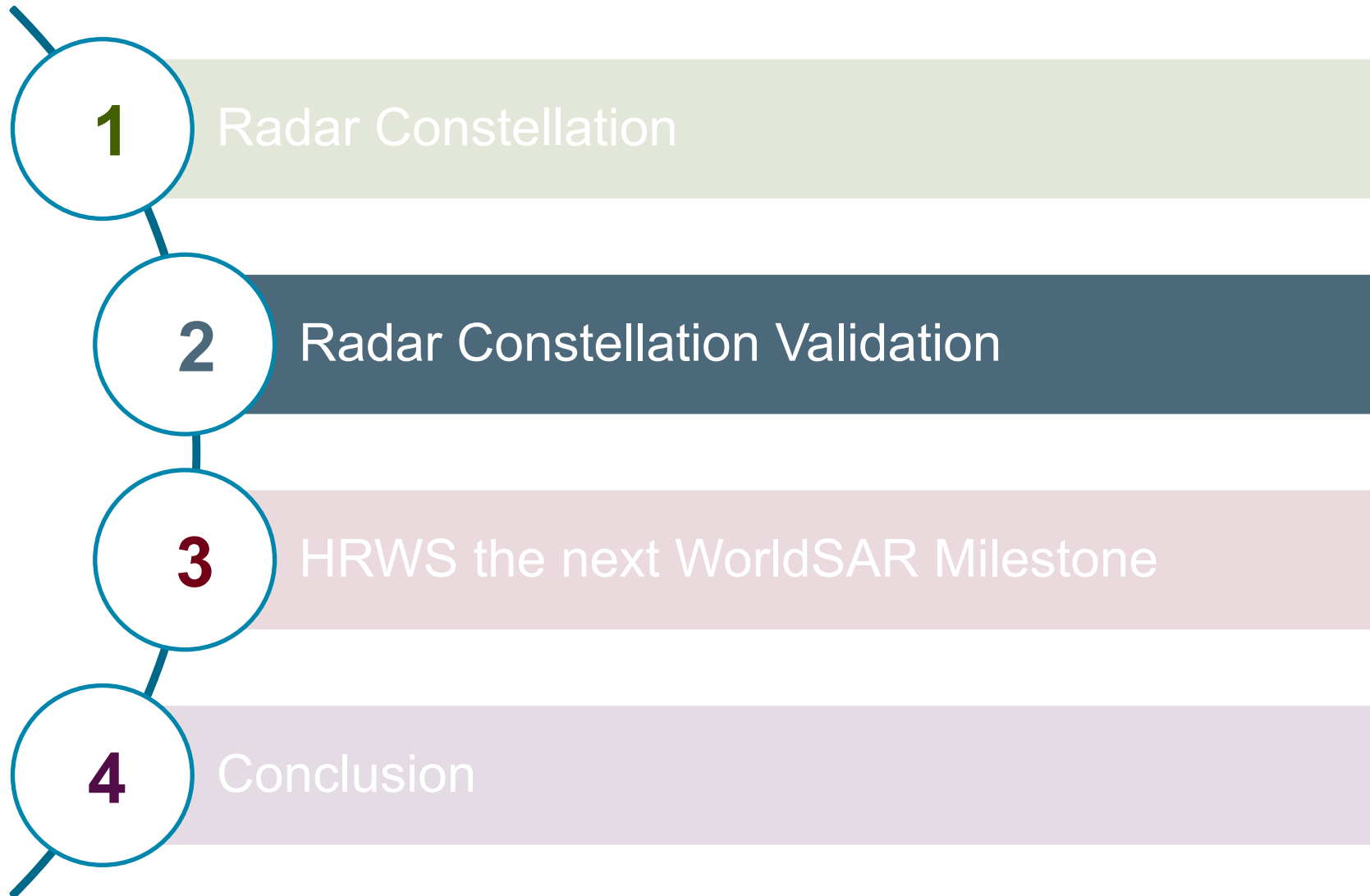
Identification of objects

Monitoring & Detection

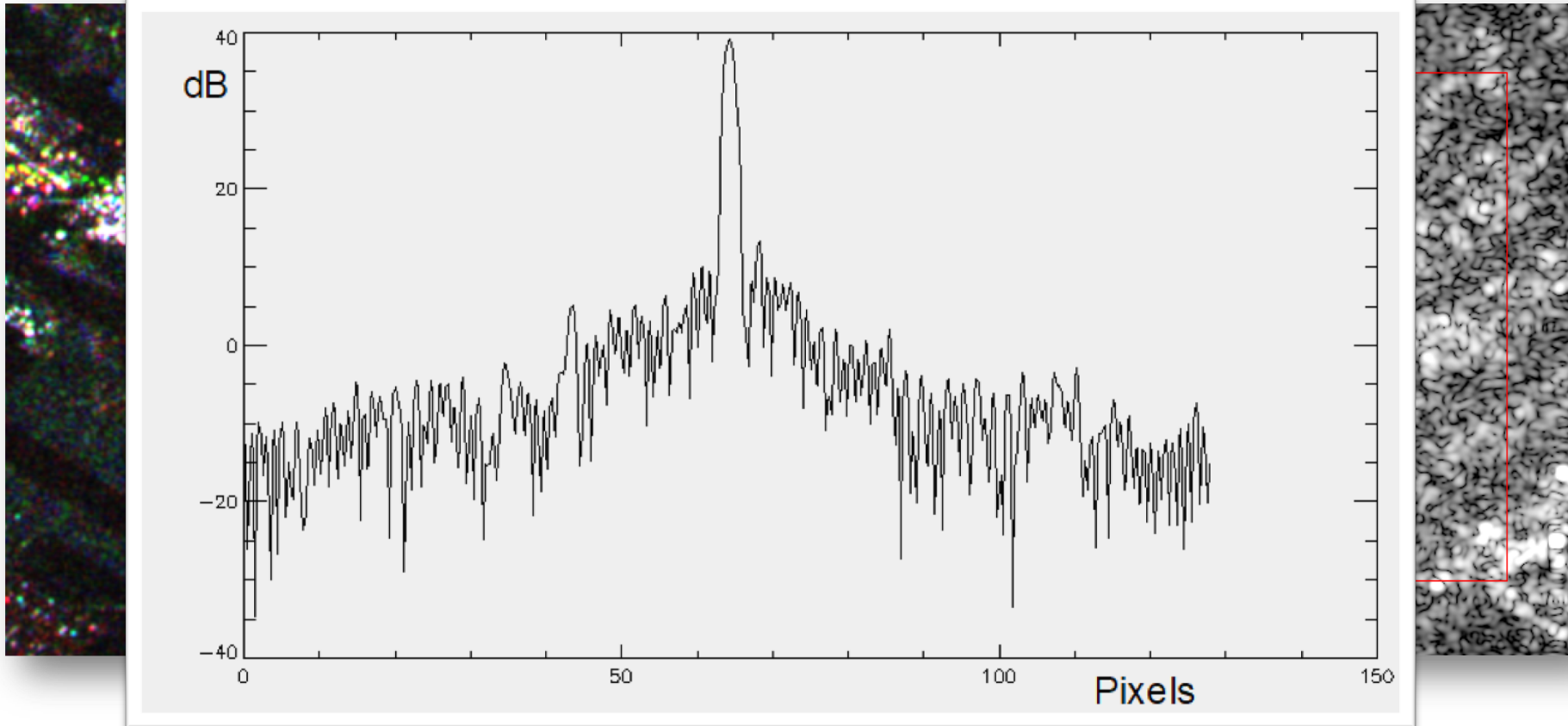
Recognition & Classification

Identification

# Agenda



# Radar Constellation Validation



## Radiometric Analysis

**Objective:**  
Comparative radiometric analysis

**Approach:**  
Analysis of responses of Point & Distributed Targets

**Results:**  
Values well within the specifications

# Radar Constellation Validation



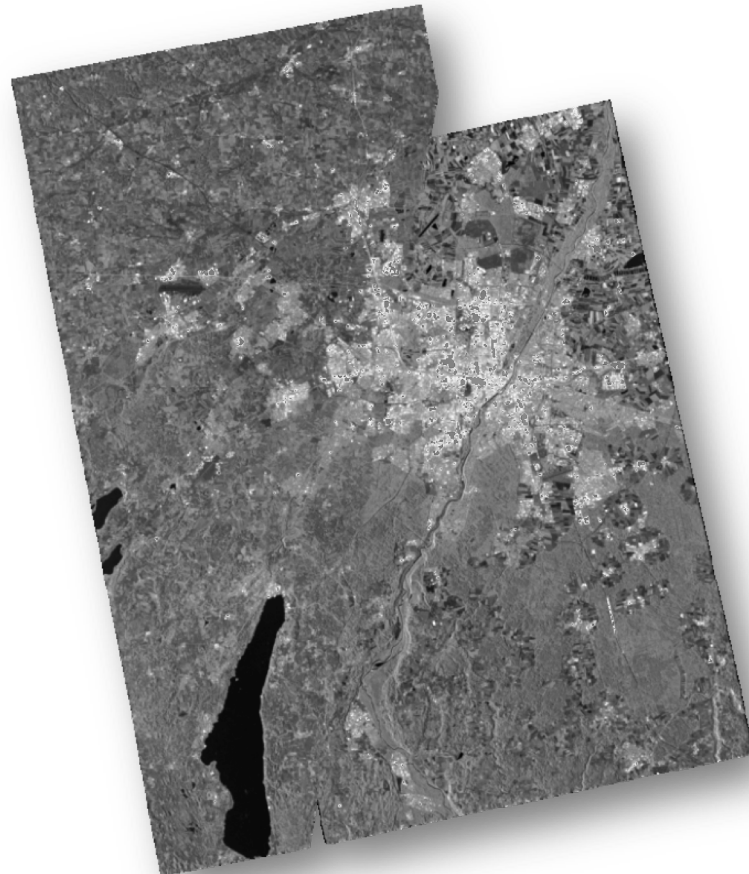
## Radiometric Analysis

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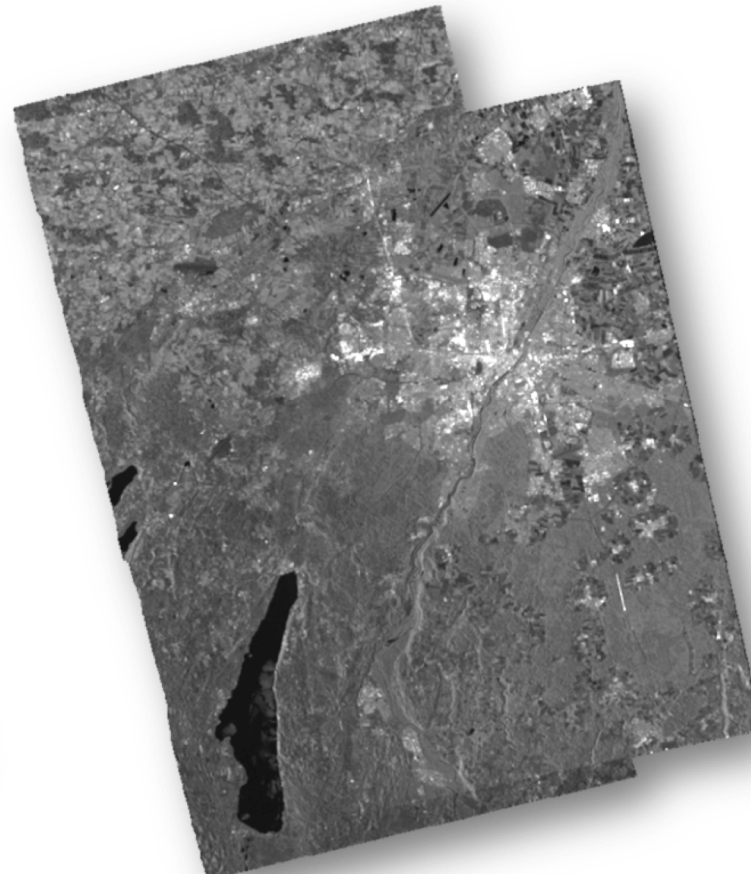
**Objective:**  
Comparative radiometric analysis

**Approach:**  
Analysis of responses of Point & Distributed Targets

**Results:**  
Values well within the specifications



Mosaic of PAZ at 37° dated 31.05.2019, and TerraSAR-X image at 47° of 20.01.2019



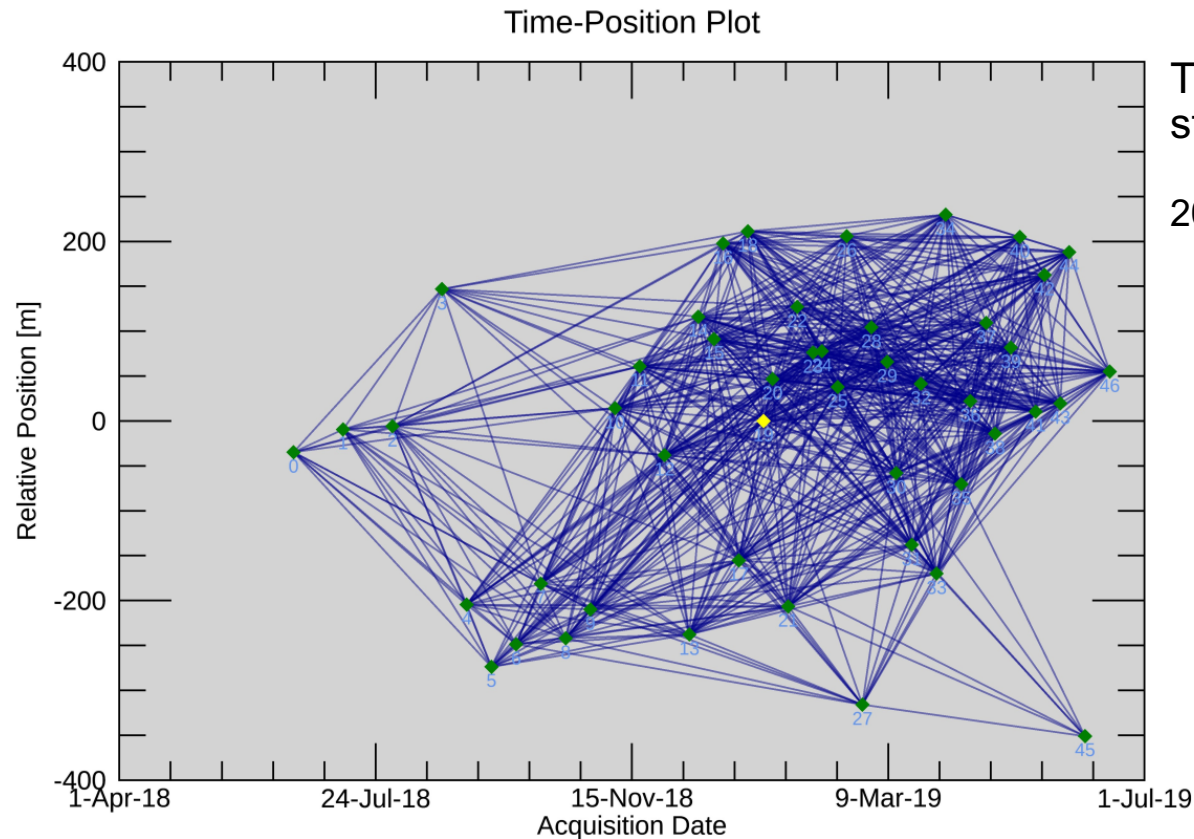
Mosaic of PAZ at 37° dated 31.05.2019, and TerraSAR-X image at 21° of 01.12.2018



# Radar Constellation Validation



## TerraSAR / PAZ Time Position Plot



TSX/PAZ mixed data stack

2018/06/17 – 2019/06/15

## Interferometric Validation

**Objective:** Combined use of TSX and PAZ for Interferometry

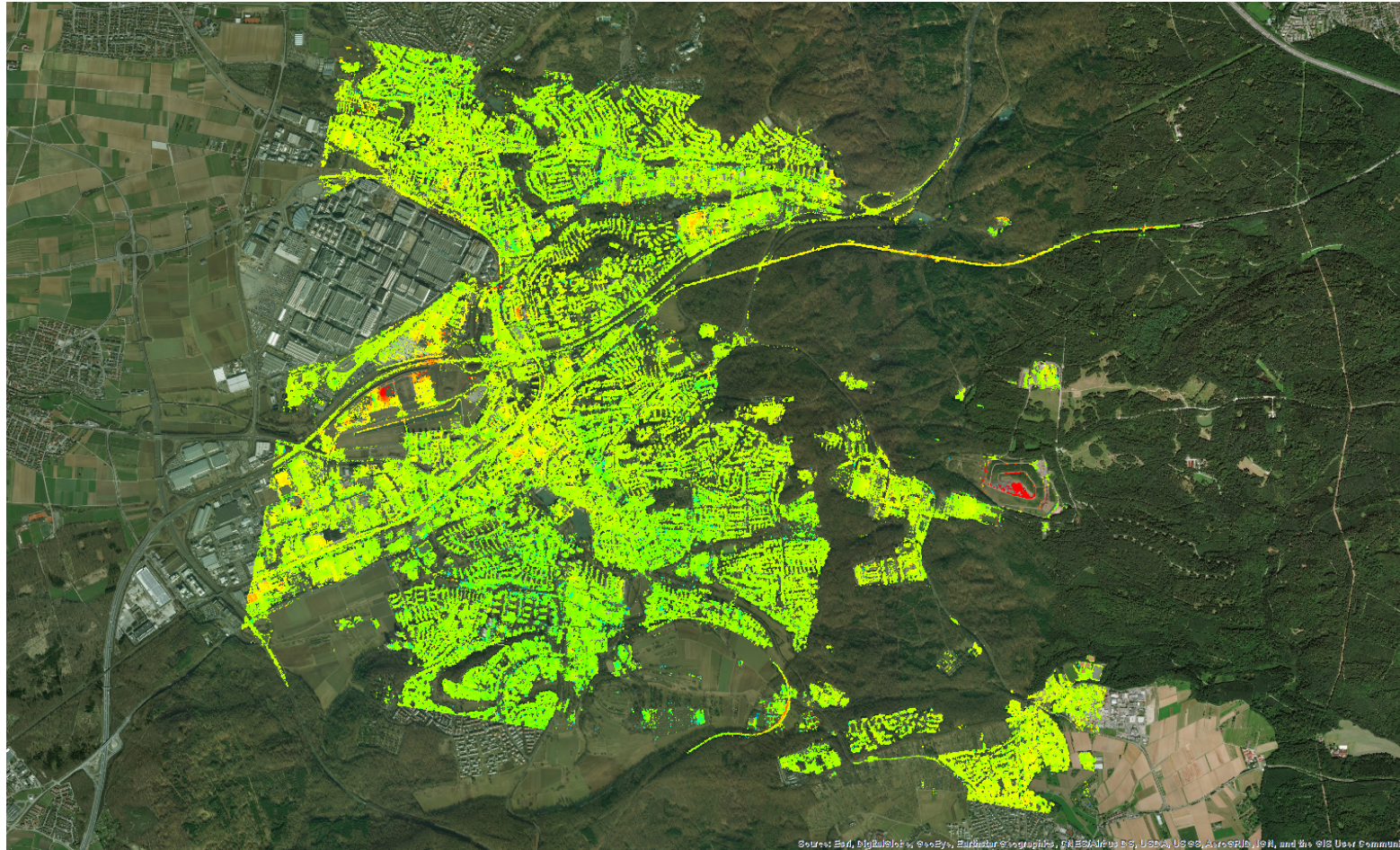
**Approach:** Analysis of a mixed TSX/PAZ data stack

Analysis of TSX/PAZ baselines

**Results:** Baselines well within nominal tube

# Radar Constellation Validation

## TerraSAR / PAZ SBAS Result Böblingen



TSX/PAZ mixed data stack: 2018/06/17 – 2019/06/15



## Interferometric Validation

**Objective:** Combined use of TSX and PAZ for Interferometry

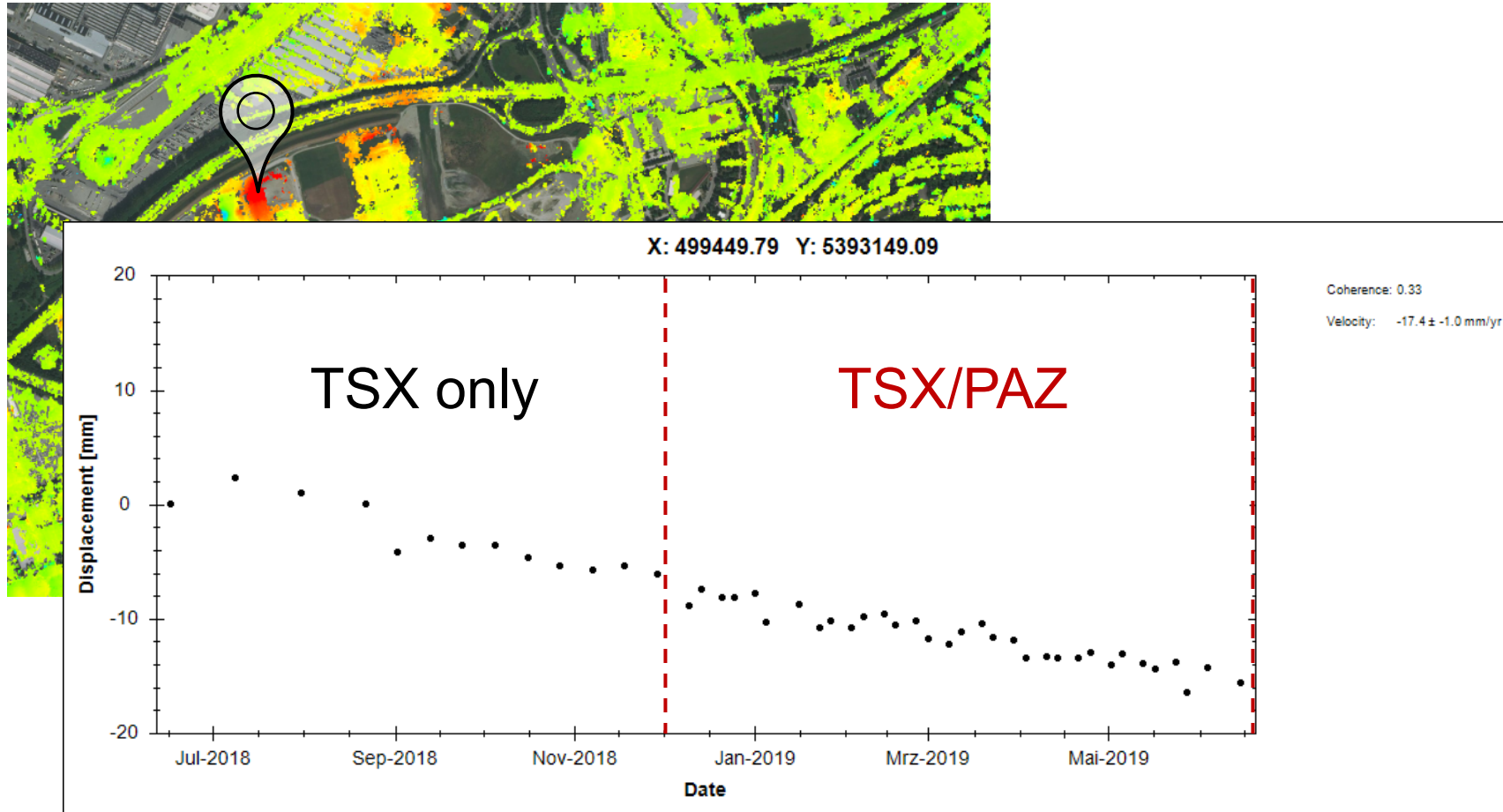
**Approach:** Analysis of a mixed TSX/PAZ data stack

SBAS Analysis

**Results:** No abnormalities while interferometric processing

# Radar Constellation Validation

## TerraSAR / PAZ SBAS Result Böblingen



TSX/PAZ mixed data stack: 2018/06/17 – 2019/06/15



## Interferometric Validation

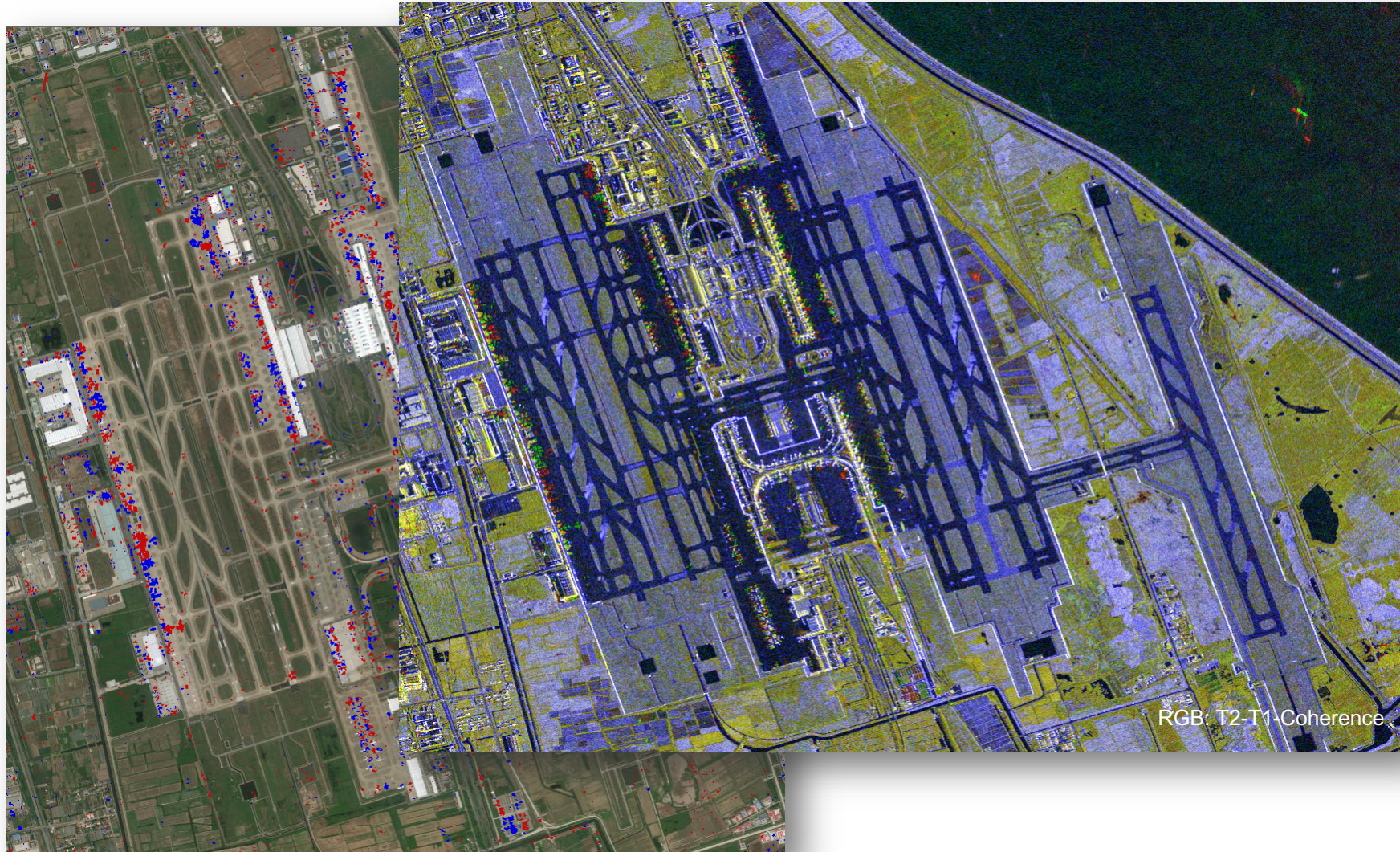
**Objective:** Combined use of TSX and PAZ for Interferometry

**Results:** TSX/PAZ baseline within nominal tube

No abnormalities while interferometric processing

SMM procedures with TSX/PAZ well done

# Radar Constellation Validation



## Change Detection Validation

**Objective:** Exploit increased revisit rate for Change Detection

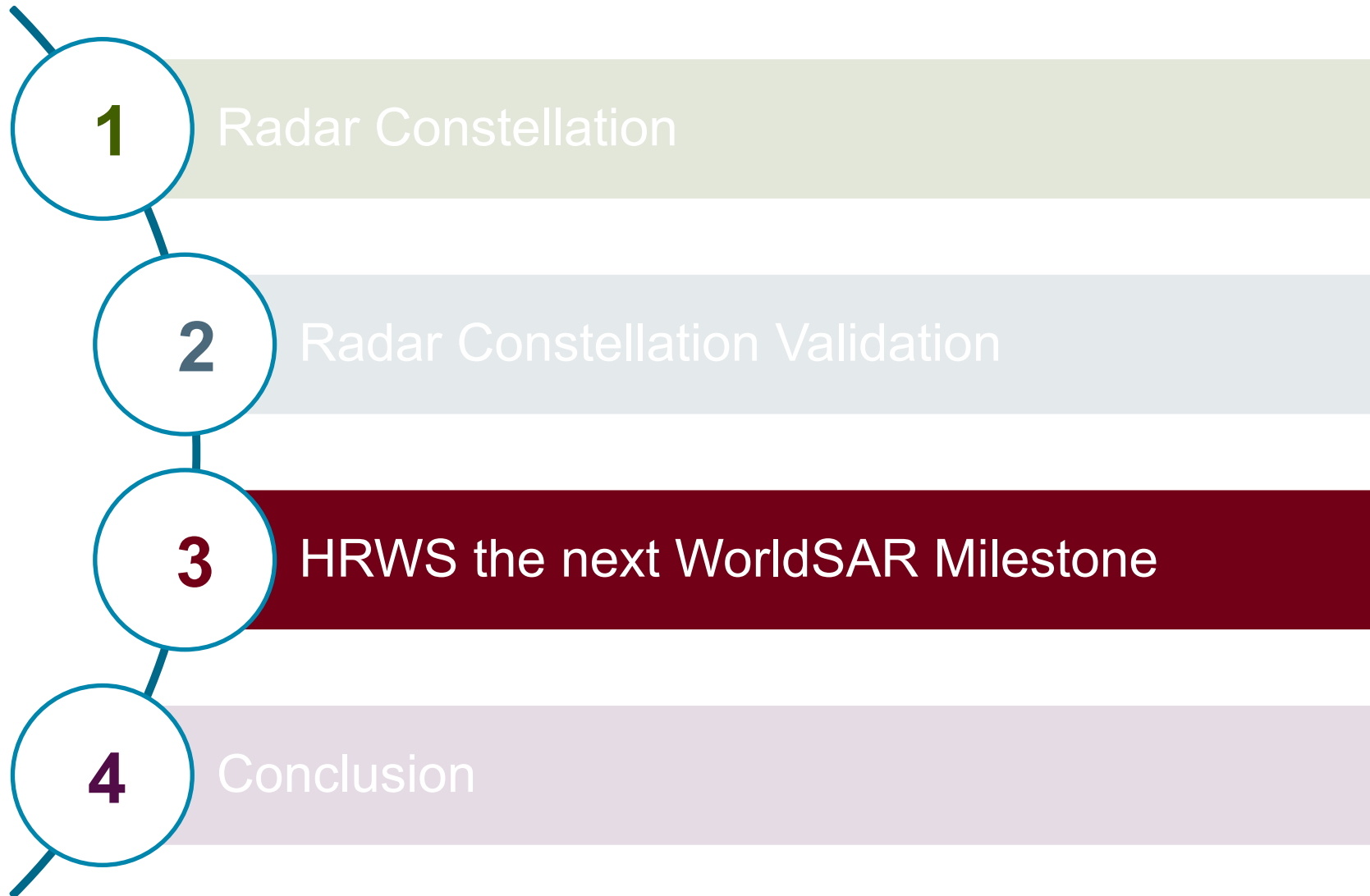
**Approach:** Combined Amplitude & Coherence Change Detection

**Results:** Image co-registration is precise

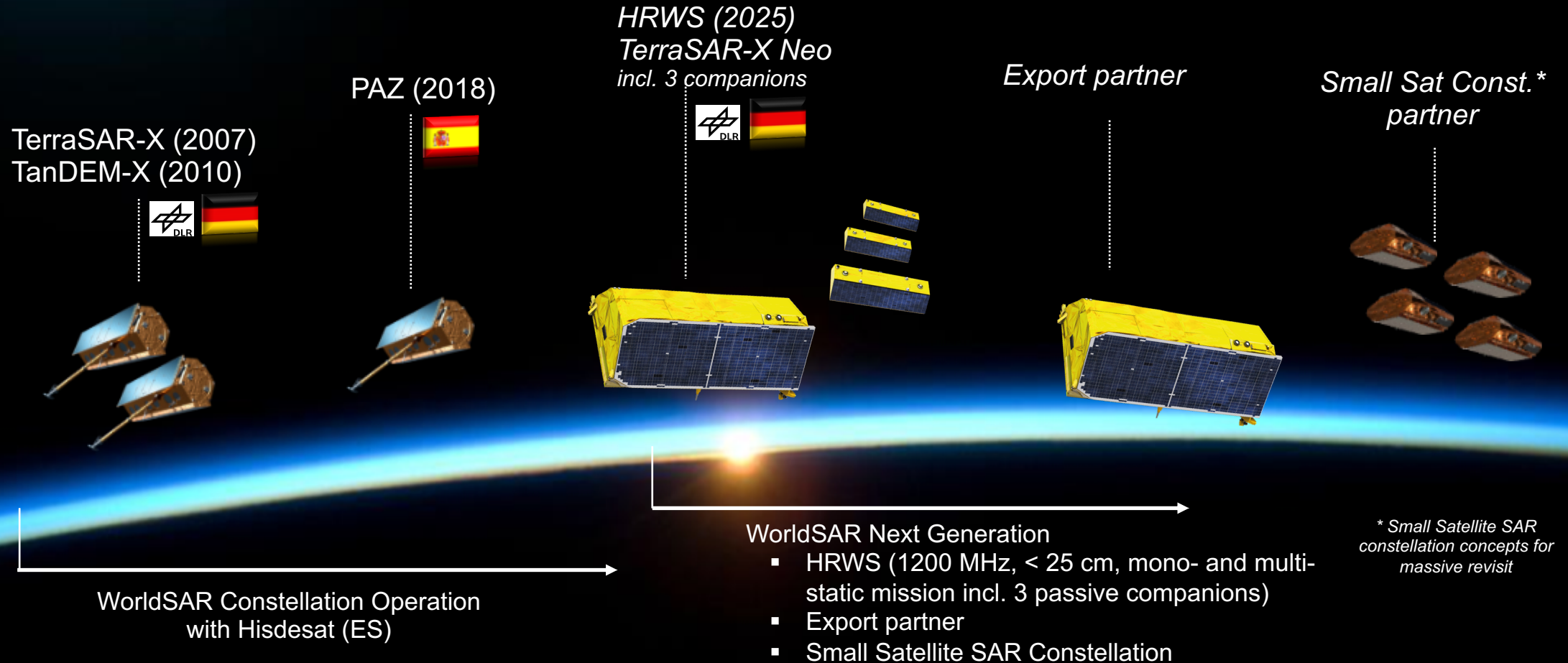
Amplitude & phase coherence exploitable for CD

**AIRBUS**

# Agenda



# WorldSAR – Current and Future Missions



# HRWS Mission Background

## Mission Context and Status

- Next National Civilian X-Band SAR Mission to continue the successful TerraSAR-X and TanDEM-X Missions
- Partnership approach between DLR Space Administration, Industry and international Partners
- Opportunity for joint mission development, manufacturing and utilization
- Phase 0/A Study contracted by DLR to Airbus
- Preliminary Requirements Review successfully passed
- Launch envisaged for 2025



## Main User Groups



Institutional Users  
including MOD



Science Users



Commercial Users

# HRWS Capability Overview

Best in class X-Band data and innovative multi-static 3D measurements

- ☑ Better resolutions and wider swaths at excellent image quality
- ☑ Best commercially available resolution (25 cm)
- ☑ High agility and flexibility
- ☑ On-demand high resolution digital elevation models
- ☑ Largely improved access revisit
- ☑ Low global latency through Space Data Highway (Option)
- ☑ Multi-polarisation (Quad Pol) for improved feature discrimination
- ☑ Ground Moving Target Identification (GMTI) / ATI capability

## 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



### 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

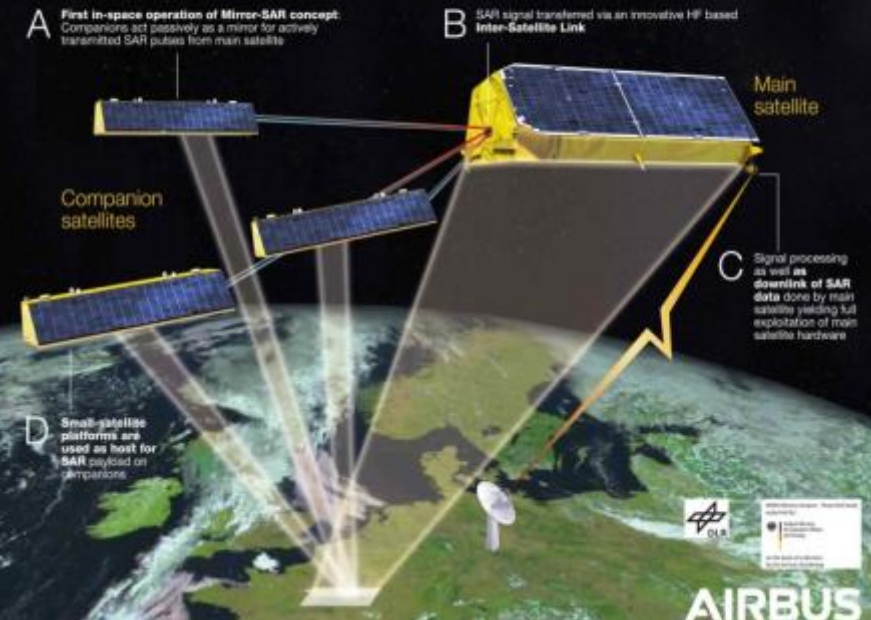
for on demand digital elevation models and height change maps...

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



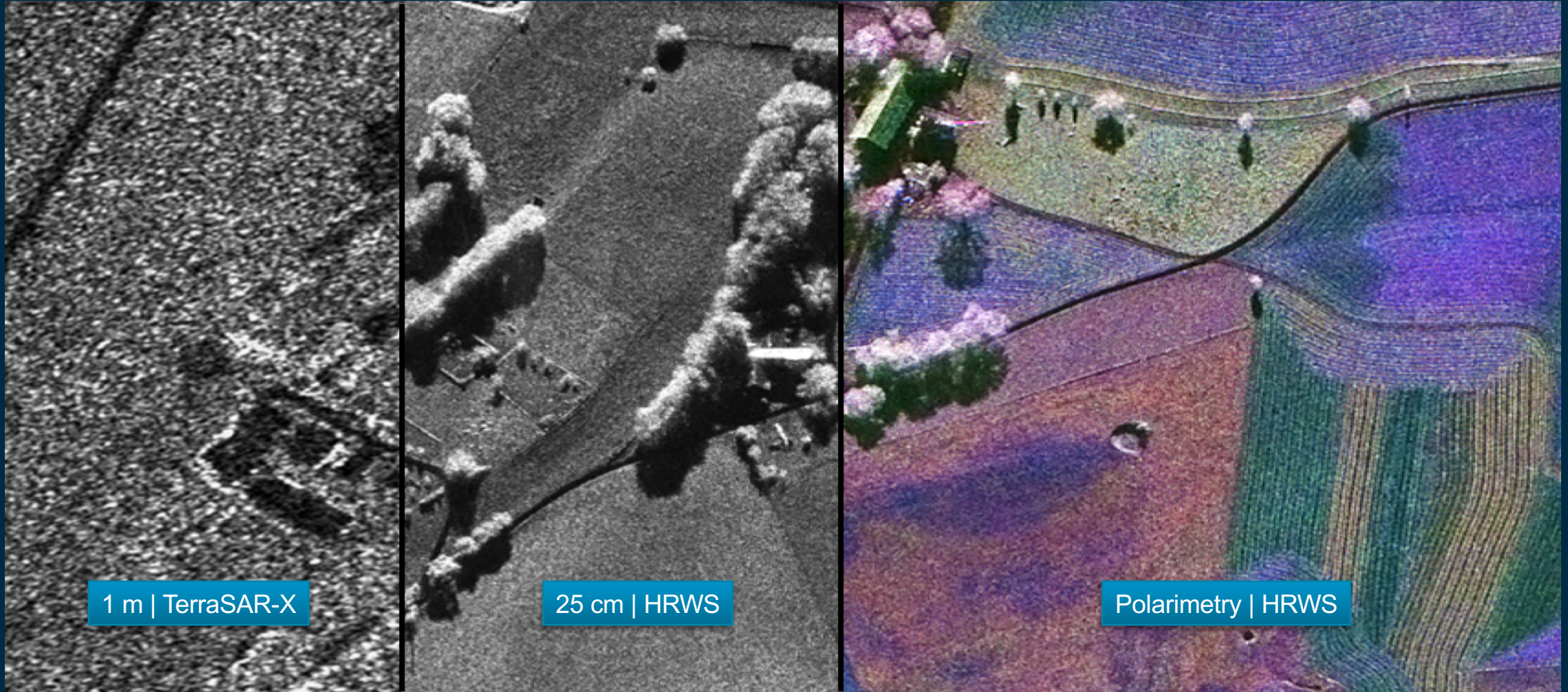
- Quick and on-demand availability, collected from just one pass
- Suitable for height change monitoring e.g. of stock piles

### Highly Innovative



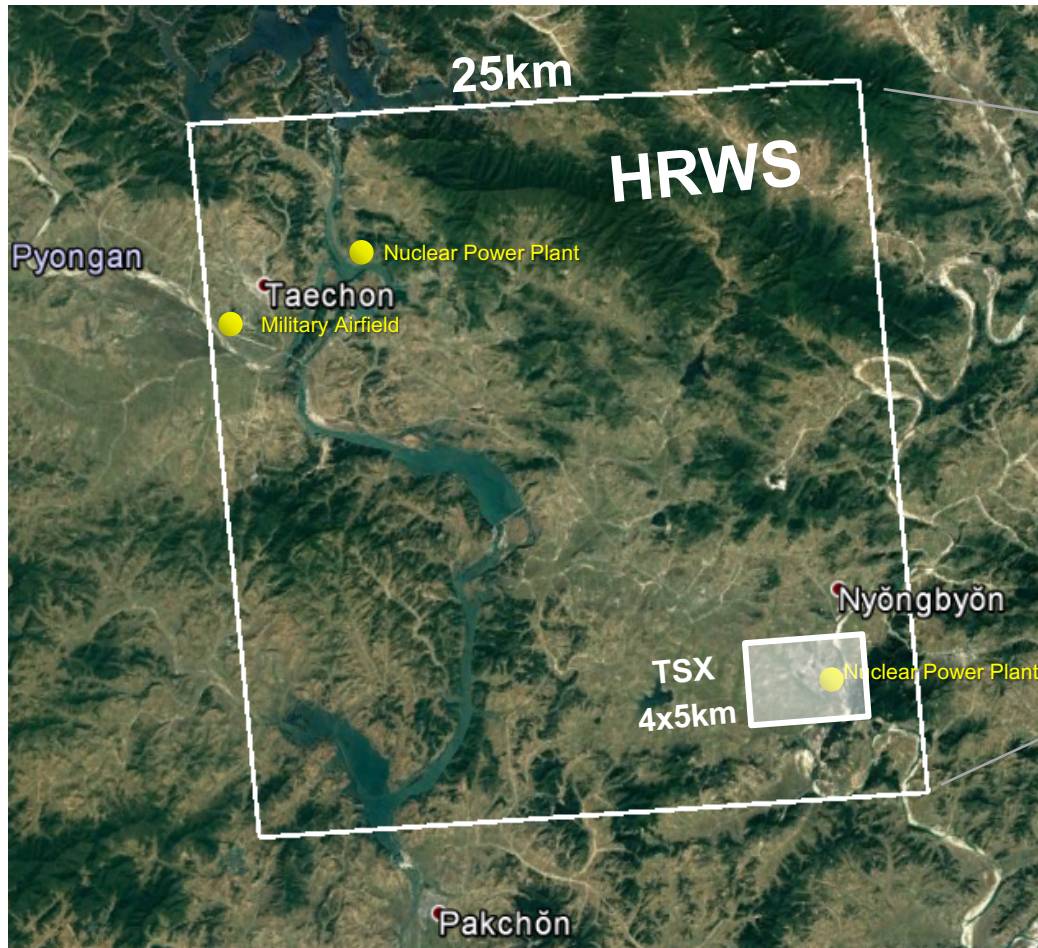


# HRWS SAR Performance Examples – VHR SpotLight



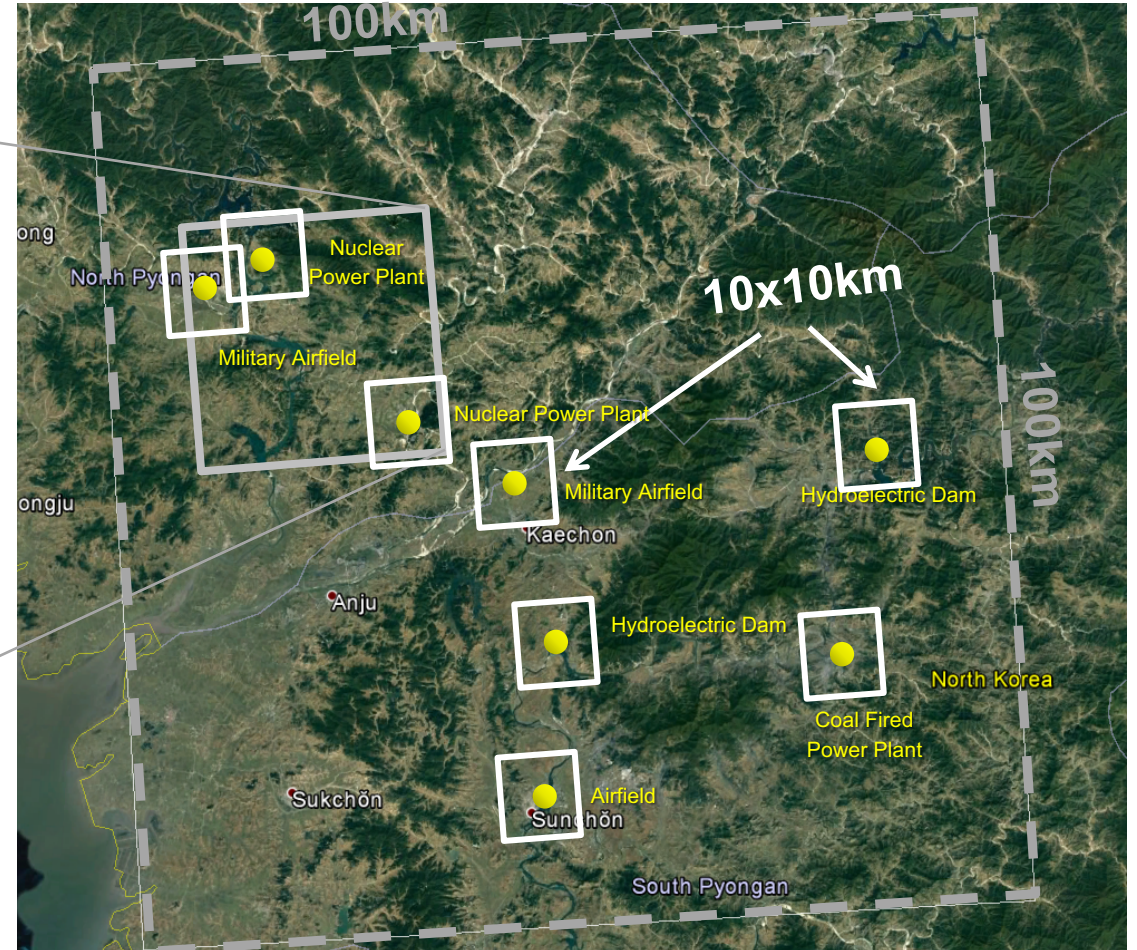
# VHR Imaging Modes for Site Monitoring

25 cm VHR Spot Light Mode



Revisit: 15 h

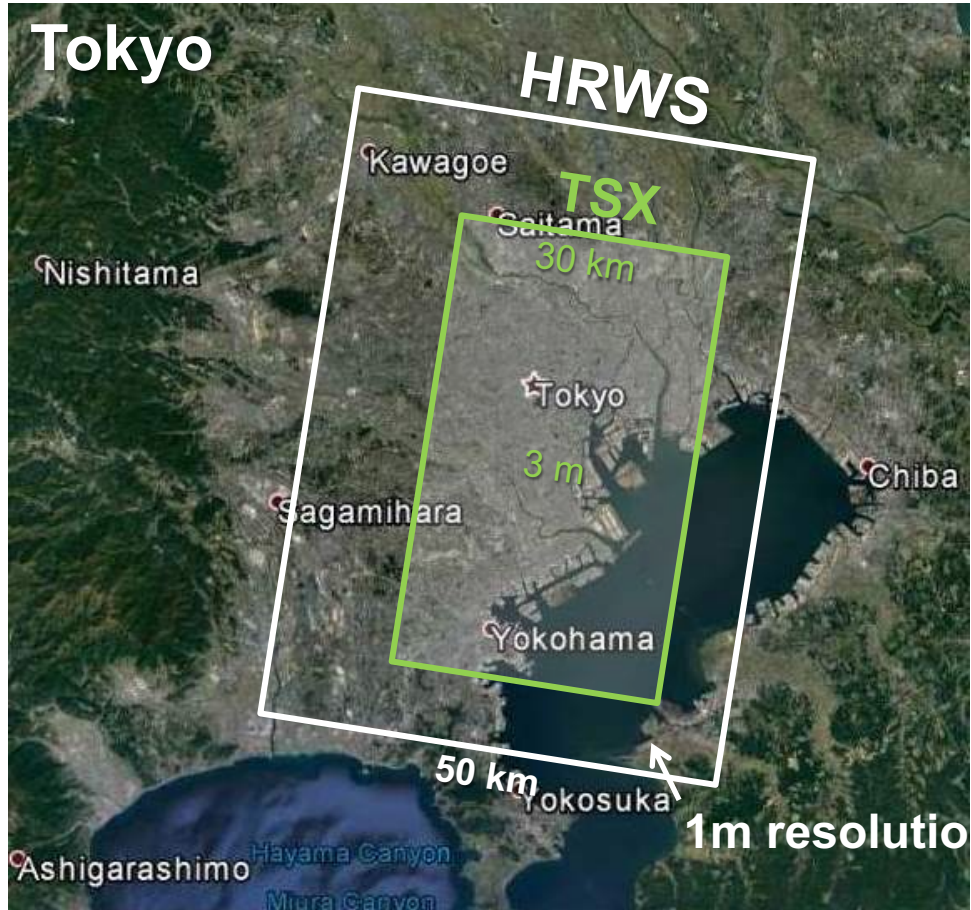
Theatre Mode in 25 cm VHR resolution



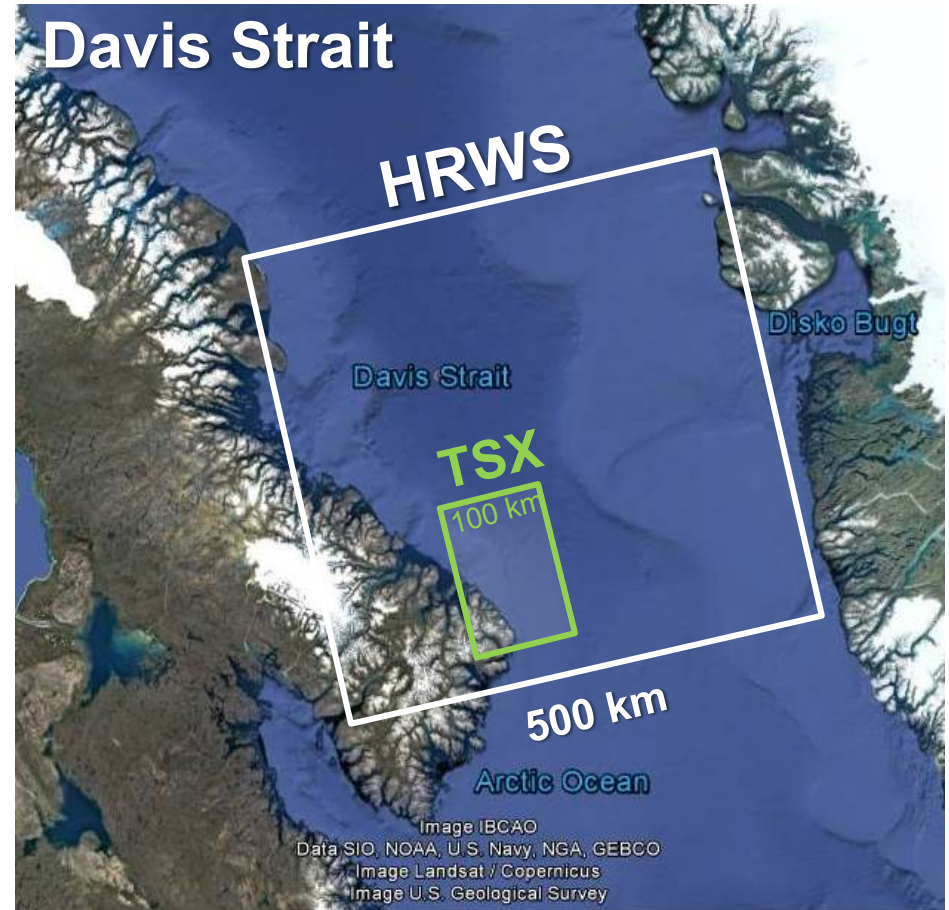
Revisit: 17 h

# Improved Stripmap and ScanSAR Modes for Monitoring & Surveillance

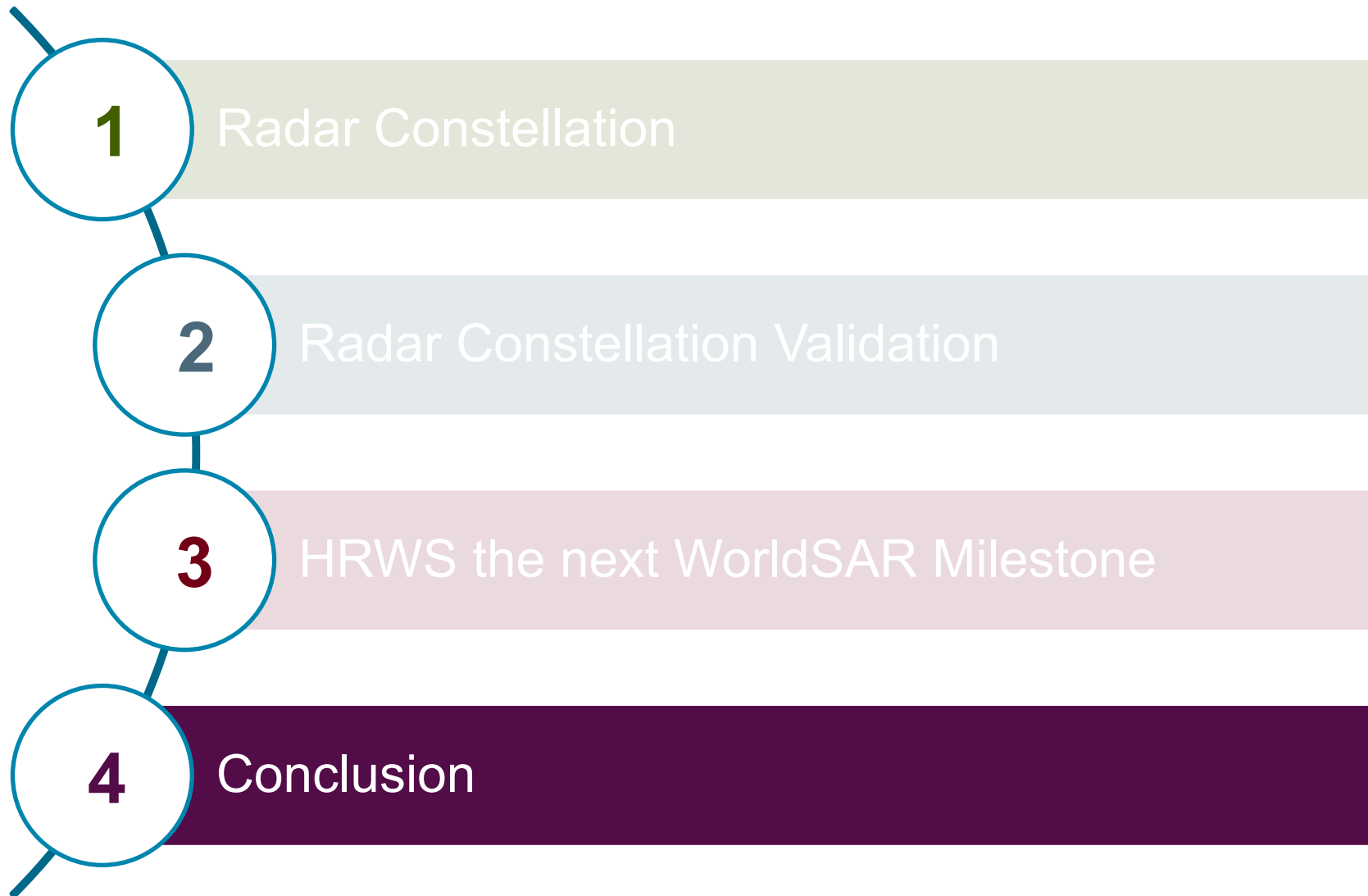
Larger Coverage and better resolution in Stripmap



Large area maritime surveillance in ScanSAR



# Agenda



## Conclusion

- The Radar Constellation is a unique programme in EO industry
- First SAR Constellation of independent Missions and first major milestone in the WorldSAR Programme
- The Radar Constellation will provide homogeneous Constellation Products and Services
- TerraSAR and PAZ Data can perfectly be used for combined applications
- HRWS / TerraSAR-X Neo is the next major breakthrough in commercial SAR Services



**Thank you very much!**

**Jürgen Janoth**

Head of Innovation & Product Management |  
SAR Applications

Intelligence

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