DEFENCE AND SPACE

Surface Movement Monitoring (SMM) based on High-Resolution TerraSAR-X Satellite Data

Operational Case Studies and Latest Developments

Dr. Jan Anderssohn

5th July 2018

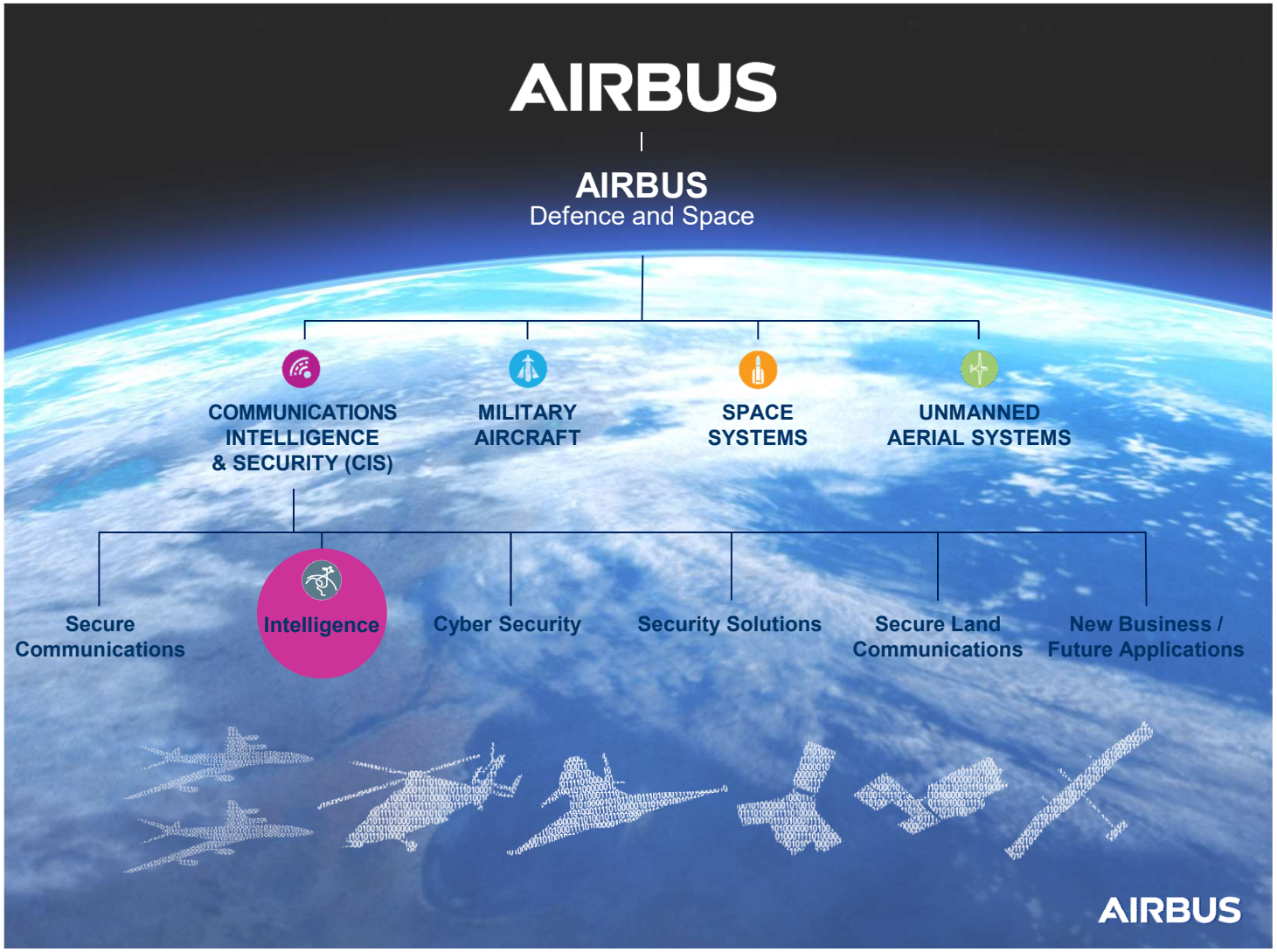
AIRBUS

The **Power** of **AIRBUS**

World-Class Capabilities

Earth Observation

Defence Solutions



DEFENCE AND SPACE

Delivering Value

FROM DATA

IN OUR Digitally

CONNECTED

World

VISIT US: www.intelligence-airbusds.com

FOLLOW US: #AirbusSpace

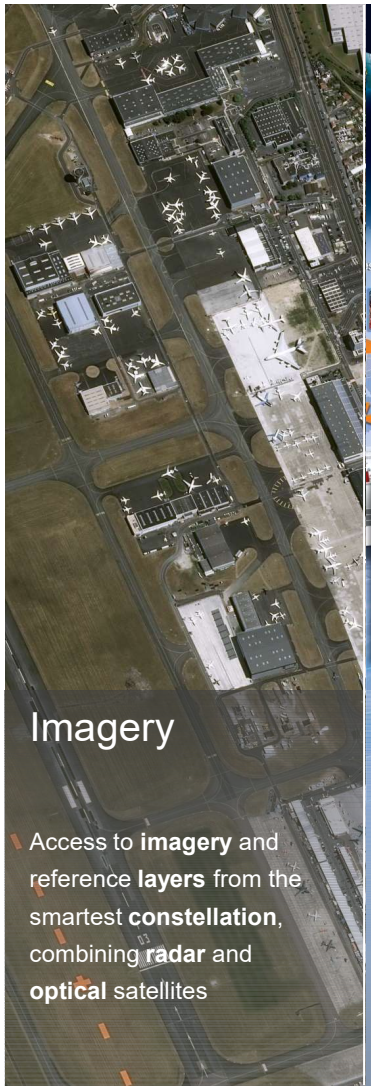
AIRBUS

Our Dedicated and Engaged Teams

Worldwide Presence

DEFENCE AND SPACE

Our **Portfolio**

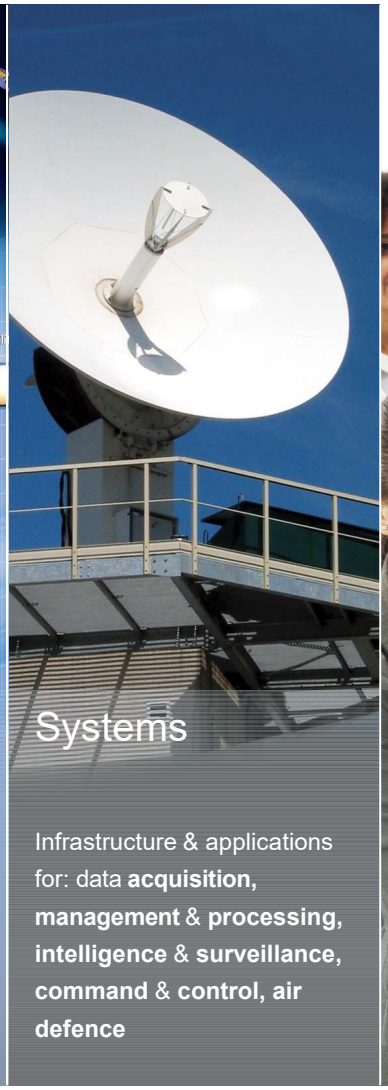


Imagery

Access to **imagery** and reference **layers** from the smartest **constellation**, combining **radar** and **optical** satellites

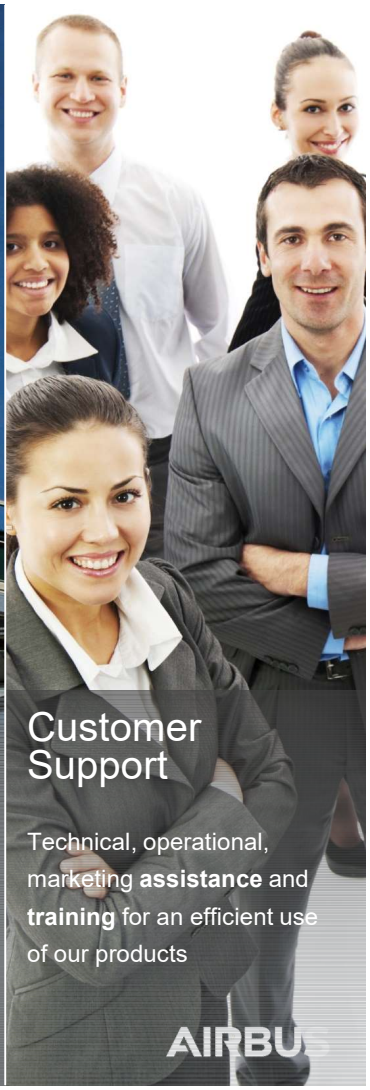
Services

Delivery of **application-specific** information resulting from the expert **analytical** processing of geospatial data



Systems

Infrastructure & applications for: data **acquisition, management** & **processing, intelligence** & **surveillance, command** & **control, air defence**



Customer Support

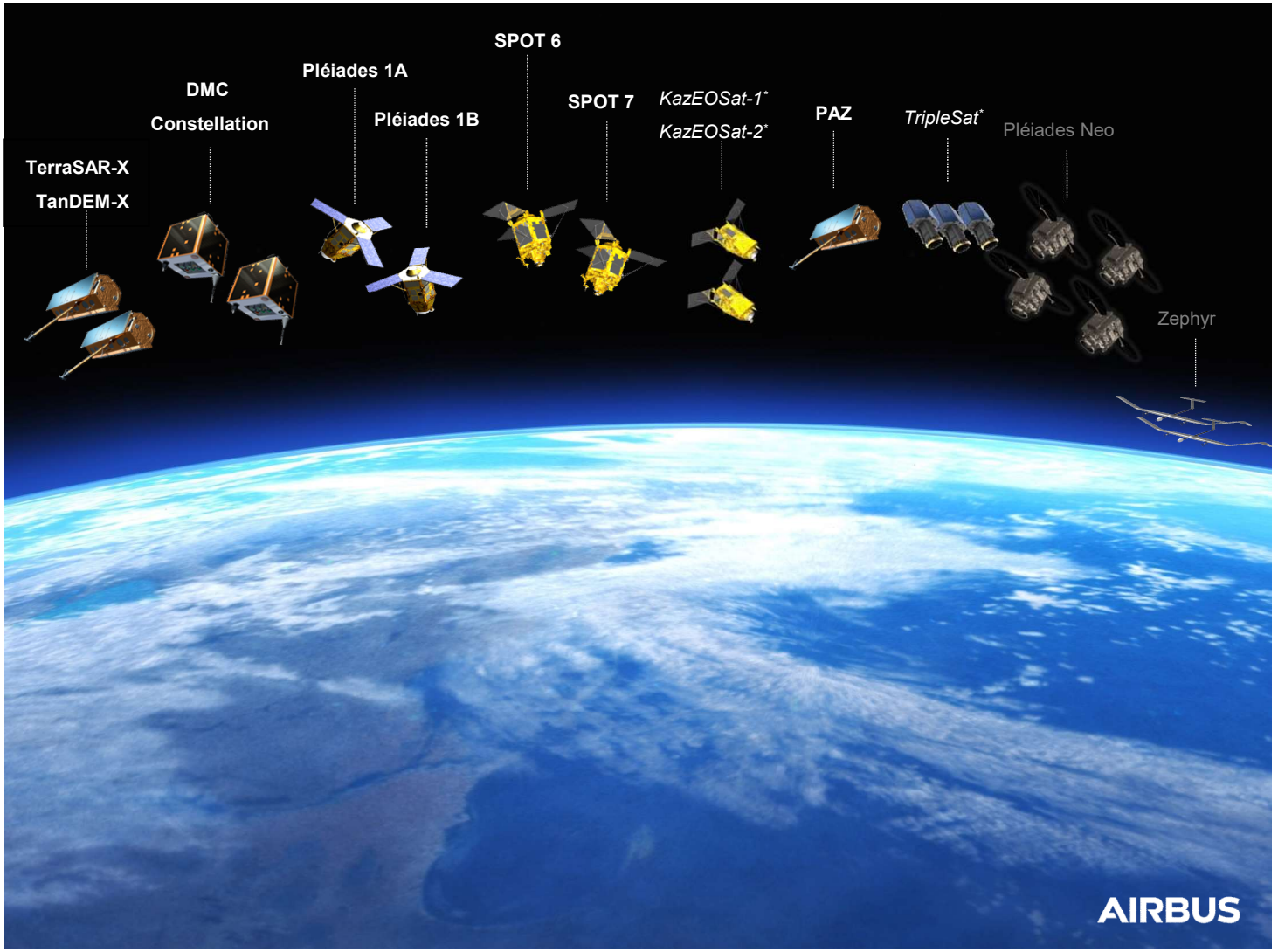
Technical, operational, marketing **assistance** and **training** for an efficient use of our products

DEFENCE AND SPACE

Our Data Makes the **Difference**

14 complementary **satellites**

*including 5 partner sensors



PAZ Satellit Launch

- 22.02.2018
- Built by Airbus
- TerraSAR-X / PAZ Constellation

TerraSAR-X / PAZ Constellation

- 30 minute orbit separation
- InSAR monitoring increased to weekly (4/7 day)
- True TerraSAR-X /PAZ constellation with identical orbit tube, imaging modes & interferometric capabilities

AIRBUS

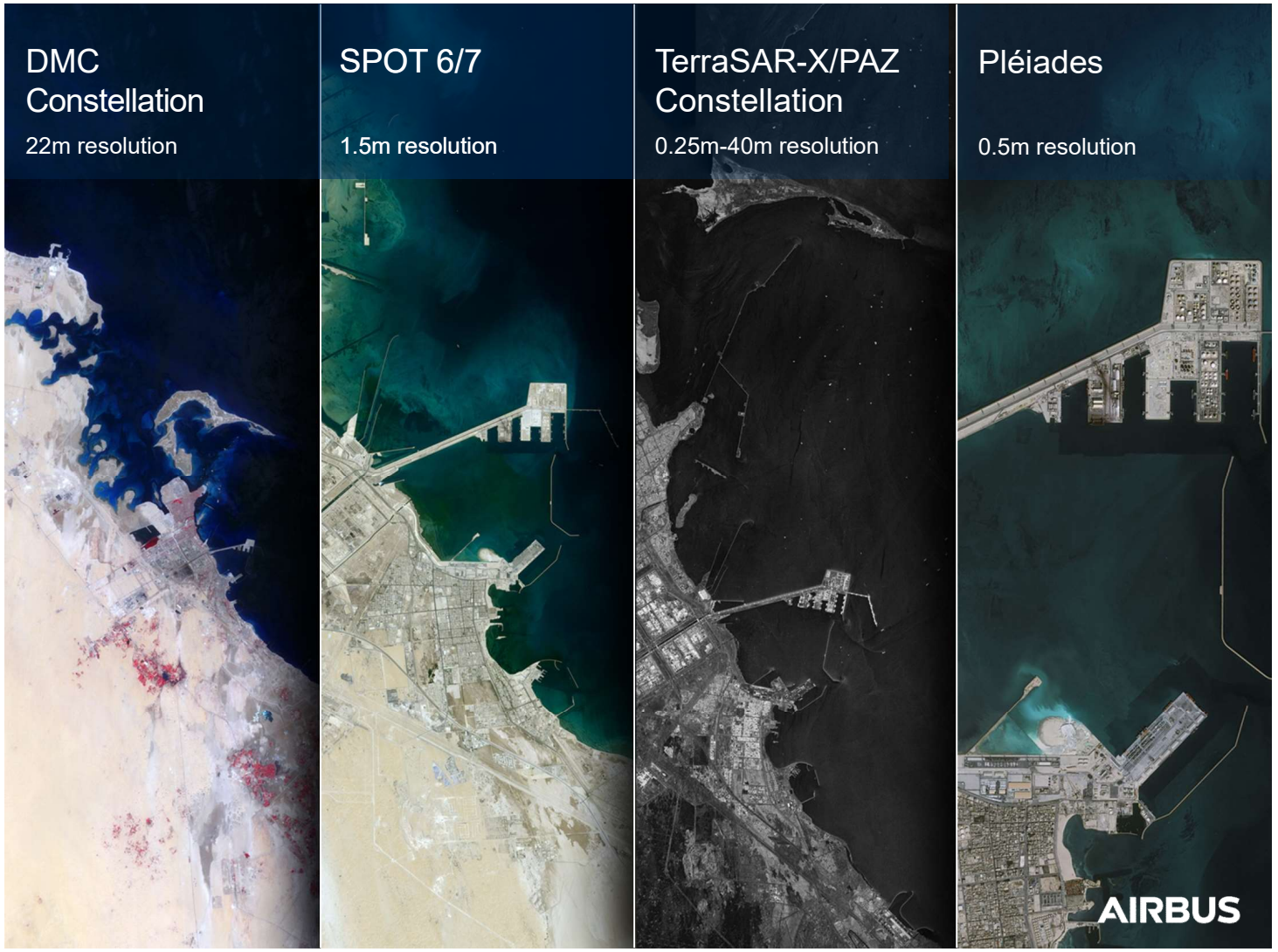
DEFENCE AND SPACE

Our Data Makes the **Difference**

Our Constellation

Diversity of Insights and Usage

Strong Positioning



DEFENCE AND SPACE

Delivering **Insight** for **Decision Making**

DEFENCE AND SPACE

Delivering **Insight** for **Decision Making**

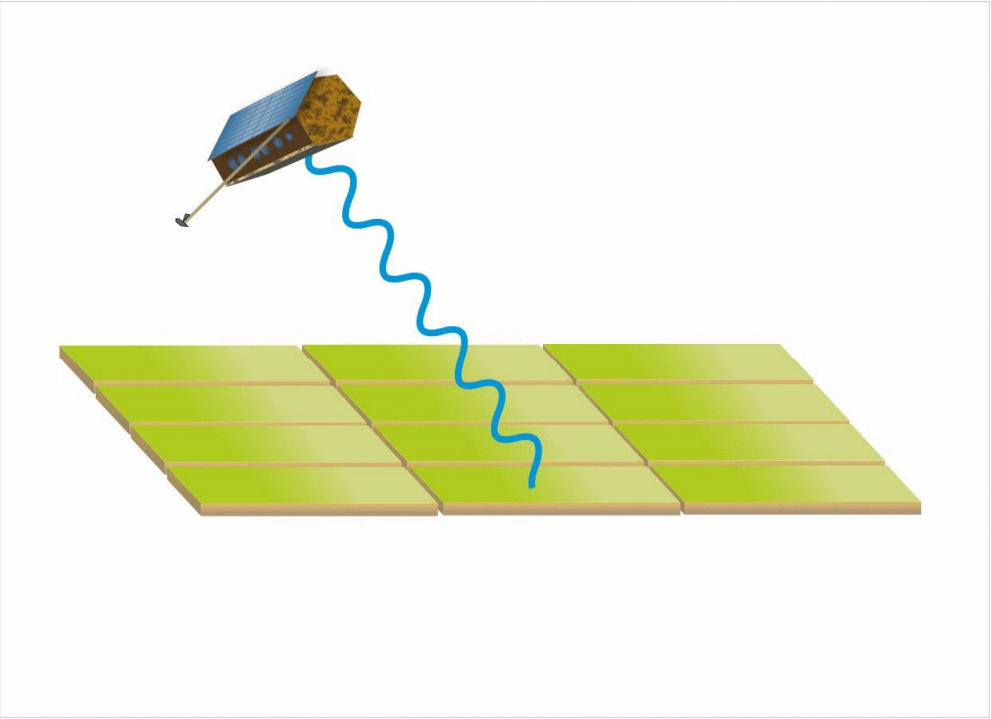
Multiple Markets

Surface Movement Monitoring (SMM)

Basics

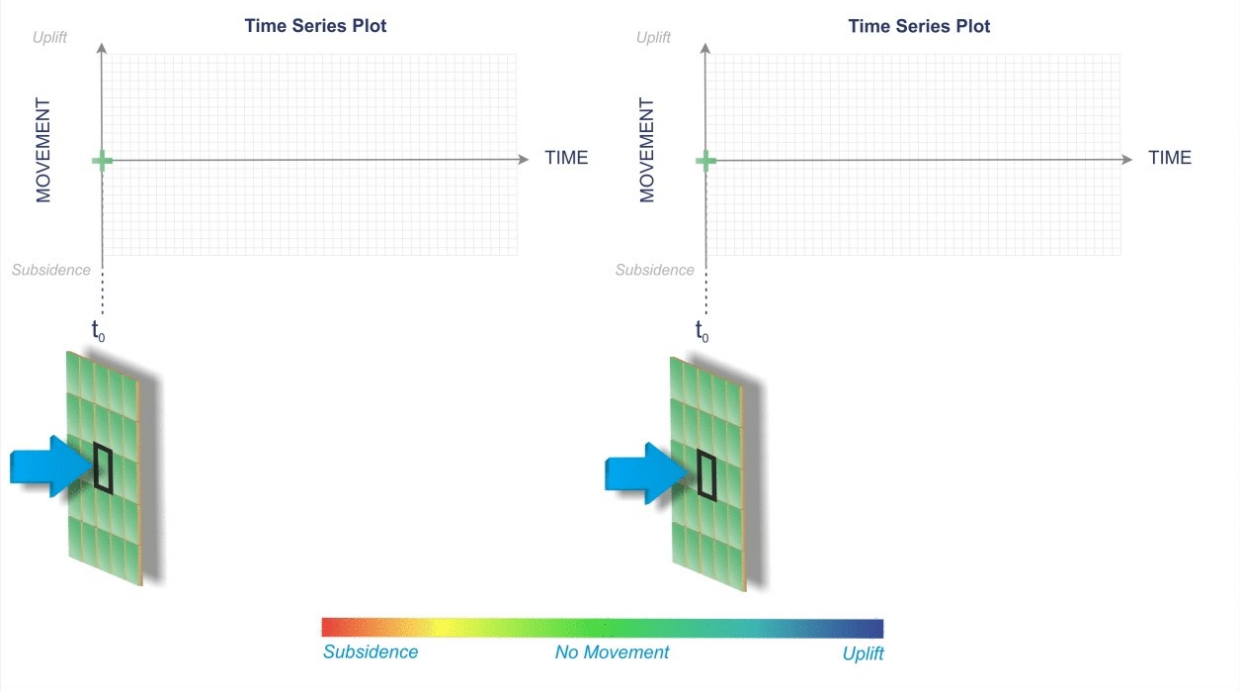
Surface Movement Monitoring (SMM) Principle

- Comparing a pixel in a set of acquisitions at different times, the movement of the pixel within this period can be measured.
- The measurement direction is along the line-of-sight of the satellite sensor.
- Movements are indicated by a path length difference.



Time Series of Surface Movement

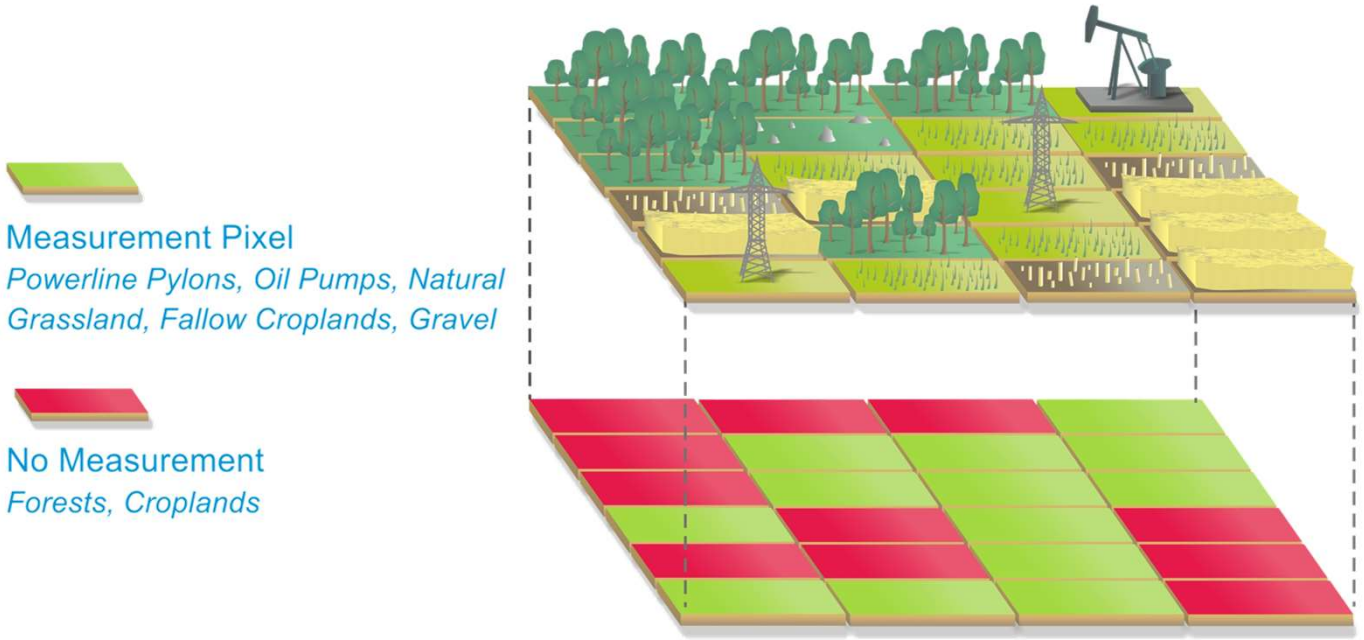
- If more than two acquisitions are made, time series of movement can be evaluated



AIRBUS

Time Series of Surface Movement

- Example of time series measurement pixels in a **rural** environment

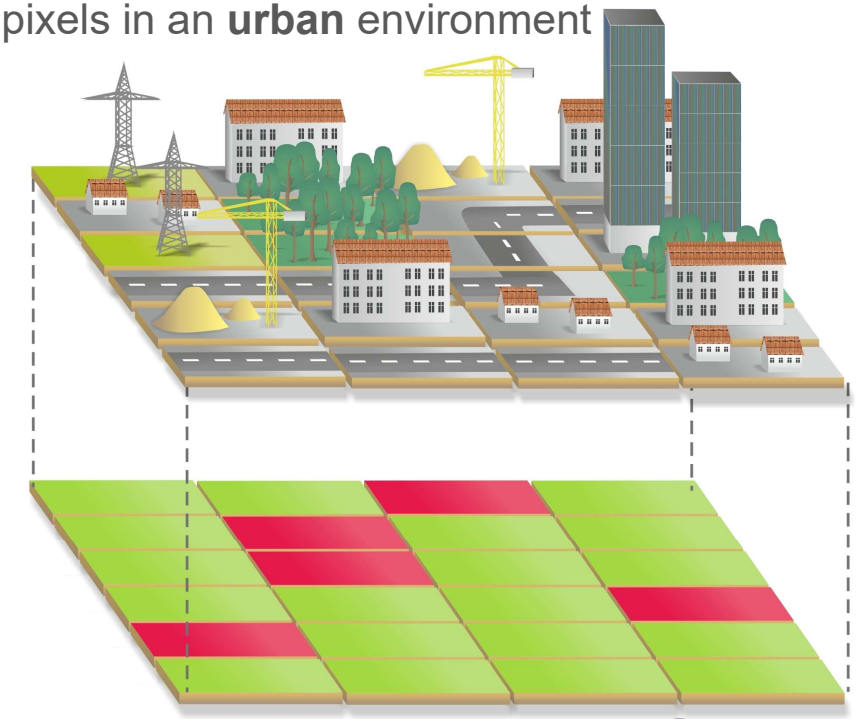


Time Series of Surface Movement

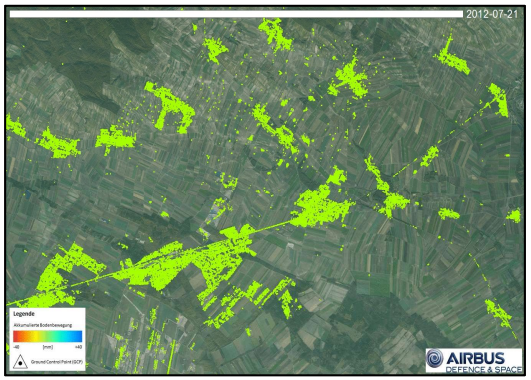
- Example of time series measurement pixels in an **urban** environment

Measurement Pixel
Buildings, Powerline Pylons

No Measurement
Parks, Construction Sites

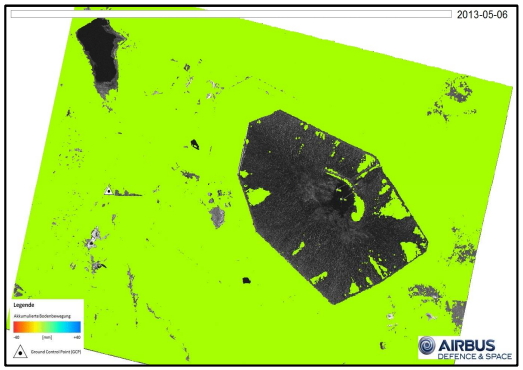


Oil & Gas: Austria



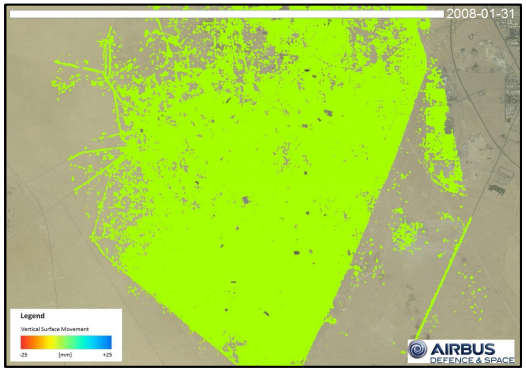
Landlside: United Kingdom

Mining: South Africa



Civil Engineering: Germany

Oil & Gas: Kuwait



Civil Engineering: Germany

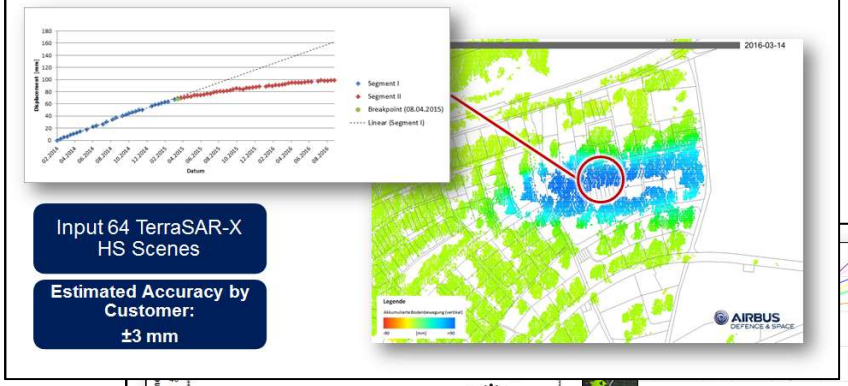
© DLR e.V. 2018 and © Airbus Defence and Space GmbH 2018

Processed with SARscape AIRBUS

SMM - Accuracy

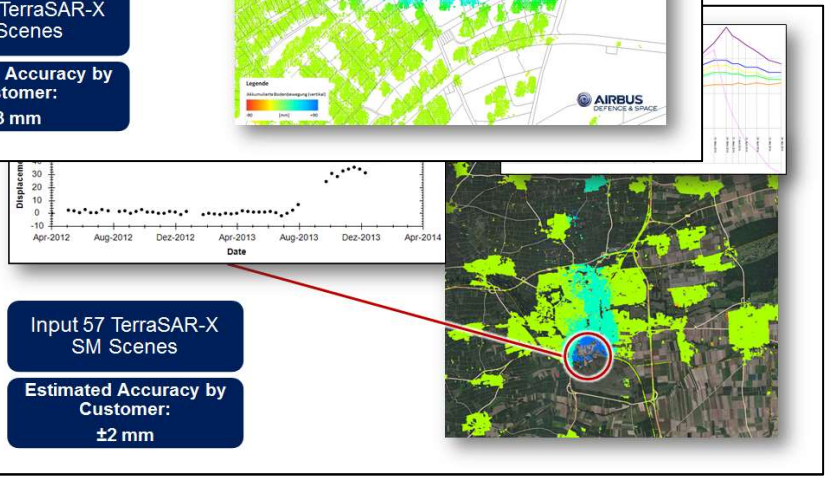
© DLR e.V. 2018 and © Airbus Defence and Space GmbH 2018

Accuracy - Reference Project 2015 (Germany)



Input 64 TerraSAR-X HS Scenes

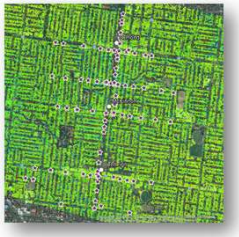
Estimated Accuracy by Customer: ±3 mm

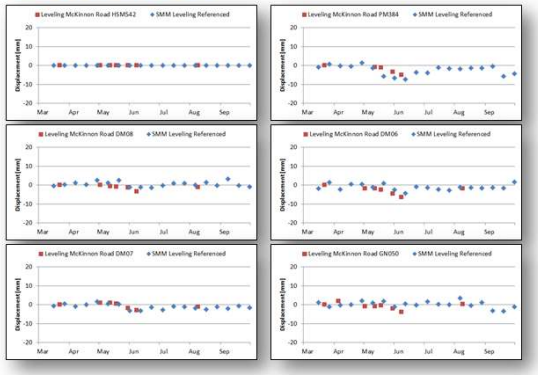


Input 57 TerraSAR-X SM Scenes

Estimated Accuracy by Customer: ±2 mm

Accuracy - Reference Project 2016 (Australia)

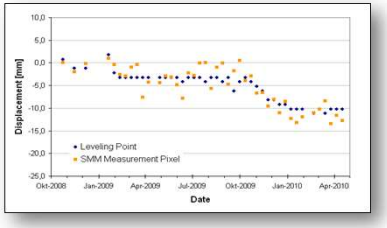


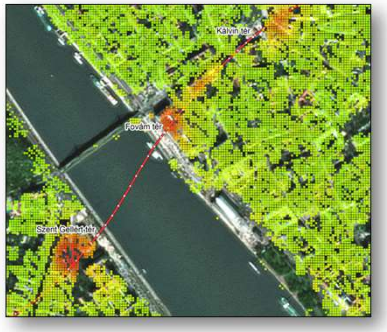


Input 19 TerraSAR-X ST Scenes

Estimated Accuracy: ±1.9 mm

Accuracy - Reference Project 2011 (Hungary)





Input 43 TerraSAR-X SM Scenes

Estimated Accuracy: ±2.4 mm

SMM – Accuracy (TerraSAR-X)

Common to GPS, SMM is a relative measurement with respect to a reference point

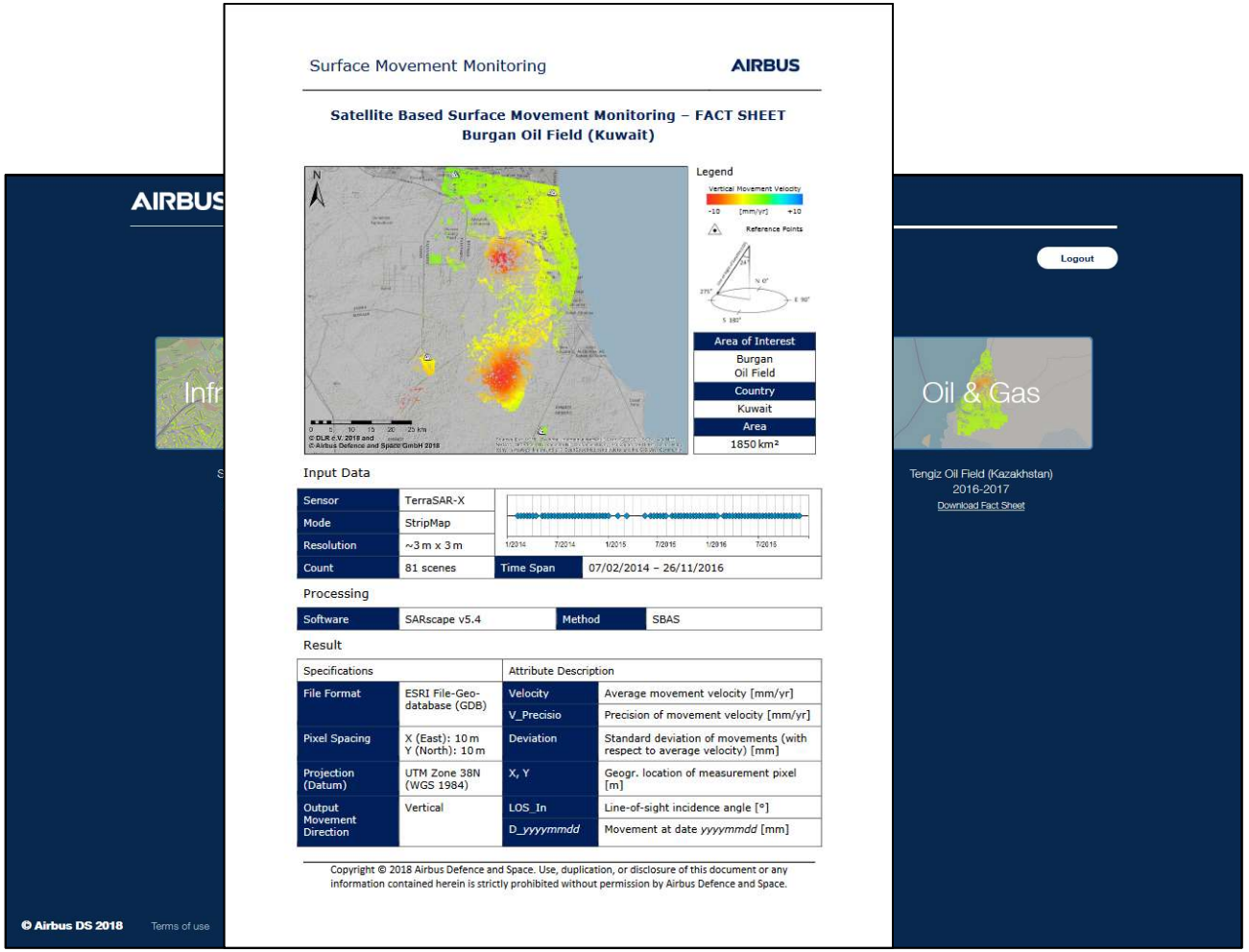
Precision depends on: number of images, pixel density, atmosphere, reference point, etc.

	Velocity	Displacement
Precision	~1 mm/yr	<3 mm

Surface Movement Monitoring – Web Platform: GeoView

SMM - GeoView

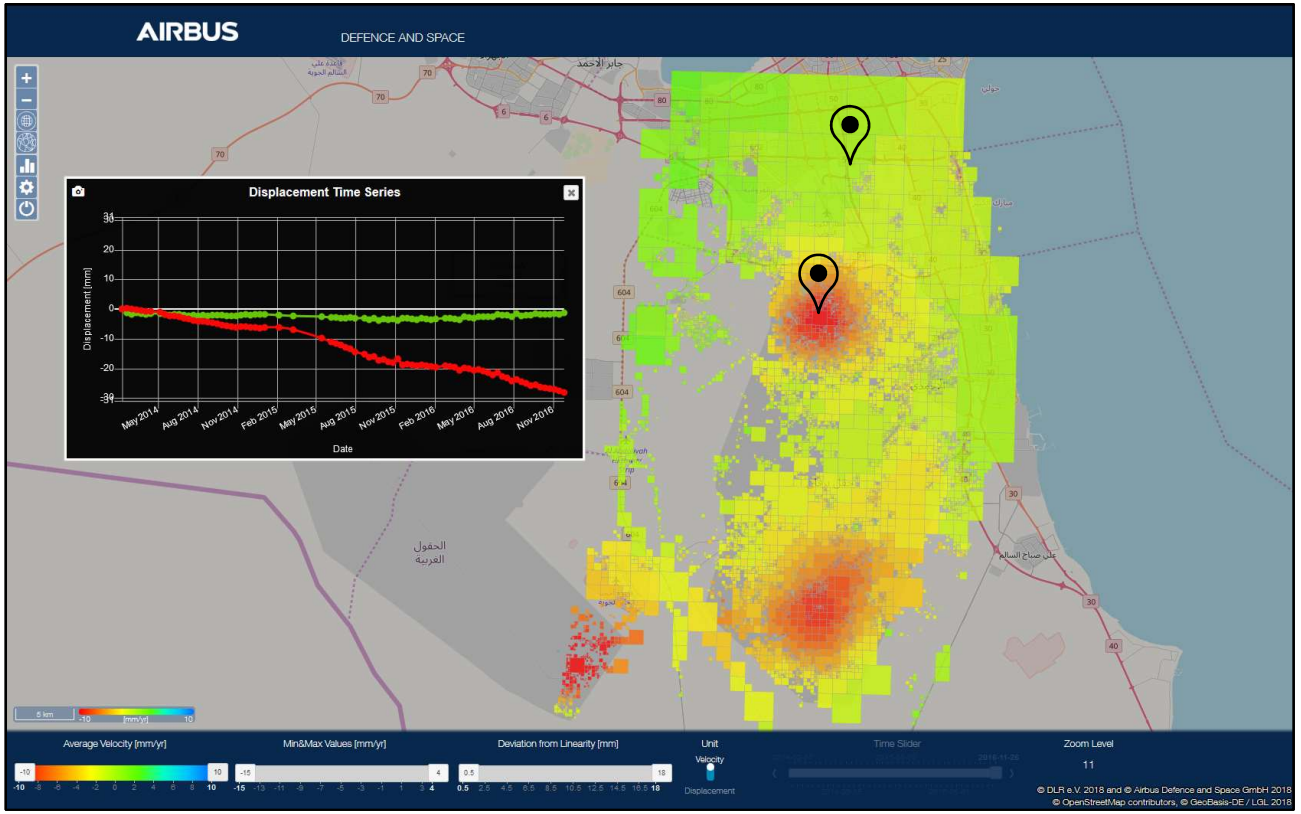
- SMM web platform (online APP)
- Visualization and analytic tools (time series)
- User dedicated access from anywhere in the world (browser based)
- Secure client portal



© DLR e.V. 2018 and © Airbus Defence and Space GmbH 2018

SMM - GeoView

- SMM web platform (online APP)
- Visualization and analytic tools (time series)
- User dedicated access from anywhere in the world (browser based)
- Secure client portal



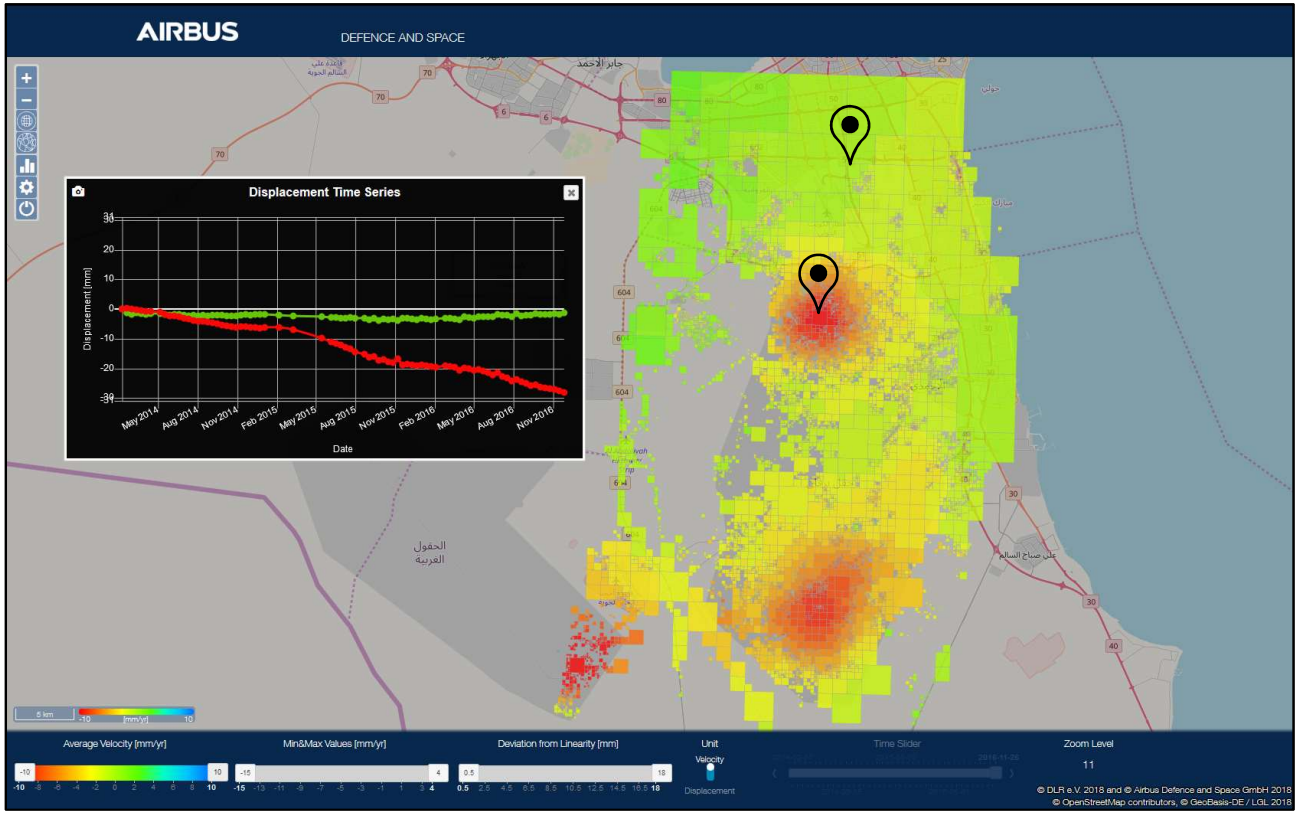
© DLR e.V. 2018 and © Airbus Defence and Space GmbH 2018

Surface Movement Monitoring – Burgan Oilfield, Kuwait

AIRBUS

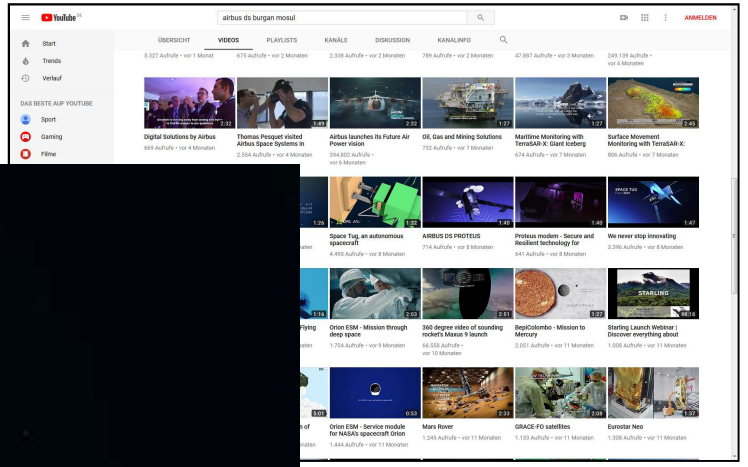
Burgan Oilfield, Kuwait

- Monitoring period **~2.5 year**
- **81** TerraSAR-X SM Scenes
- Resolution ca. **10 m x 10 m**



© DLR e.V. 2018 and © Airbus Defence and Space GmbH 2018

Burgan Oilfield, Kuwait



Airbus DS’
YouTube Channel

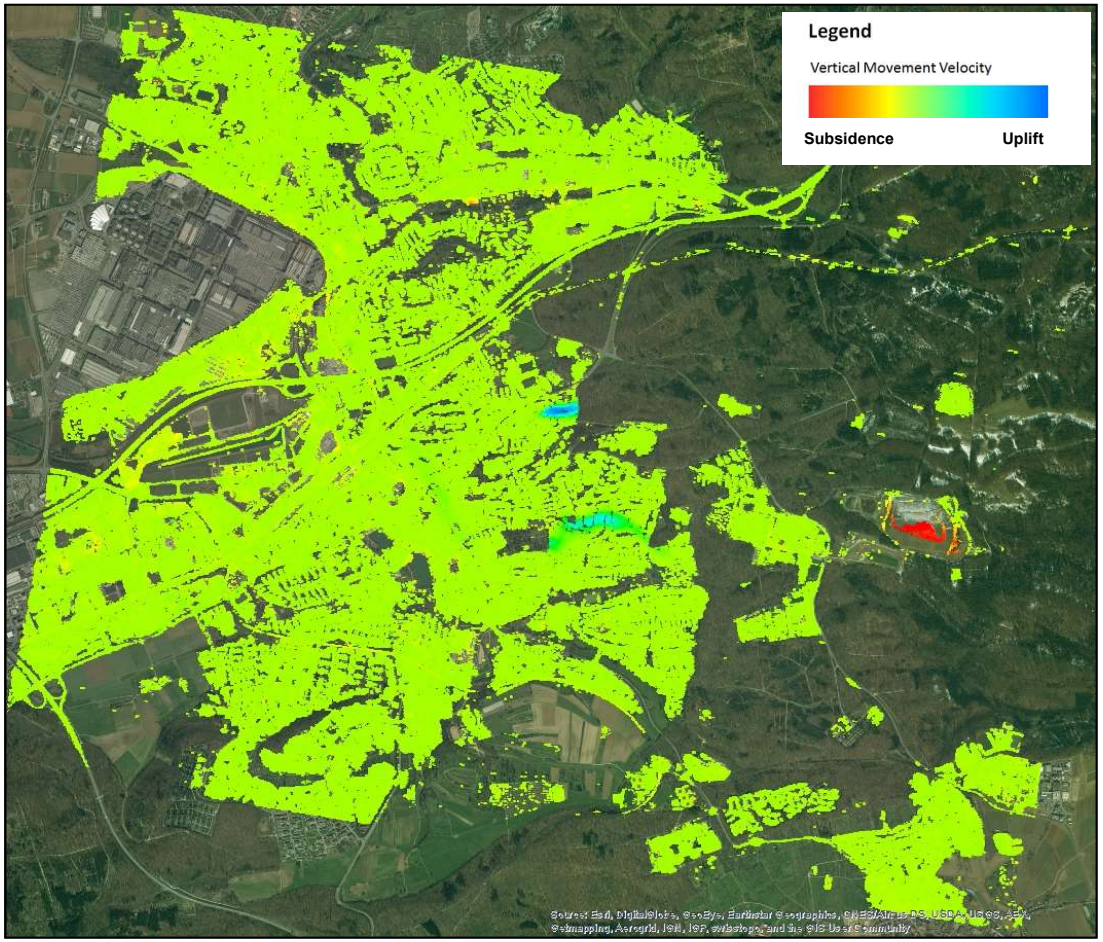
AIRBUS

From Millions of Pixels to Actionable Information (Value Adding)

AIRBUS

Satellite Measurement

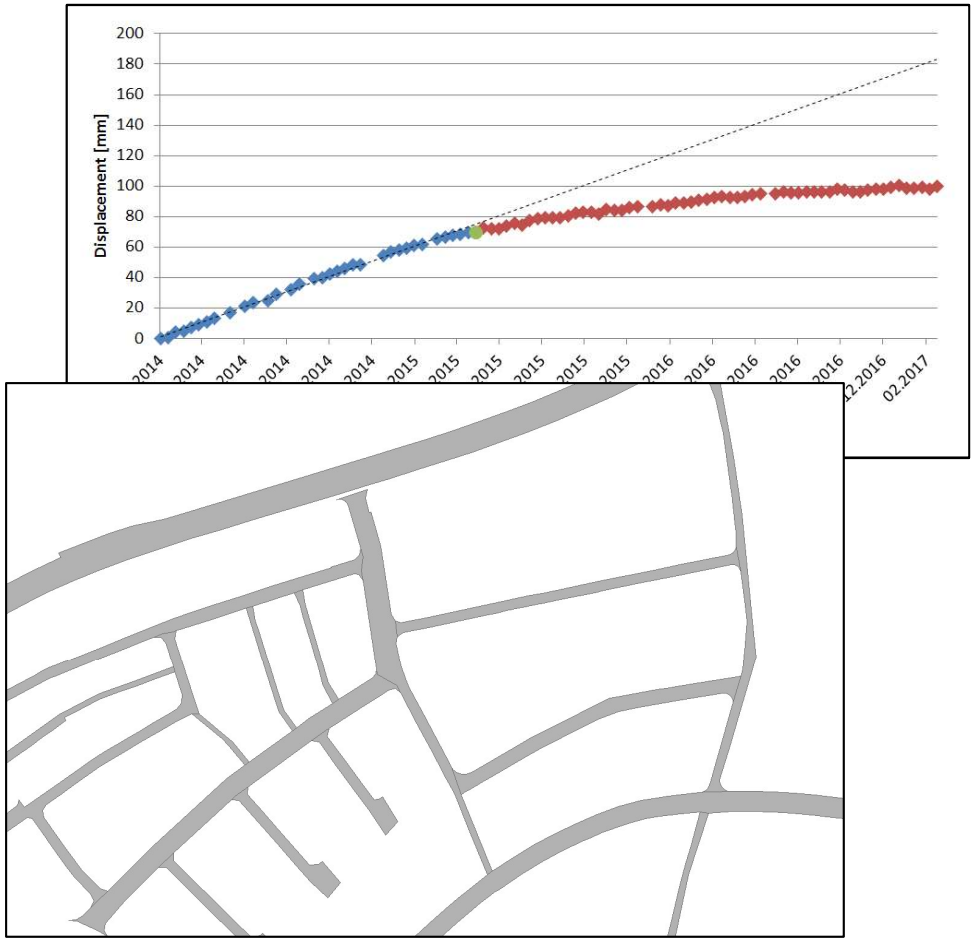
- **124** TerraSAR-X HS scenes
- Resolution **2 m x 2 m**
- Monitoring period **>4 years**
- **2,5 Million** measurement pixels
- Ongoing updates (quarter year)



© DLR e.V. 2018 and © Airbus Defence and Space GmbH 2018

Satellite Measurement

- Monitoring of uplift zones within the city
- Assessment of consequences in the course of geothermal well reconstruction
- Derivation of spatio-temporal causalities
- Regulation of damages and perception of citizens' interests

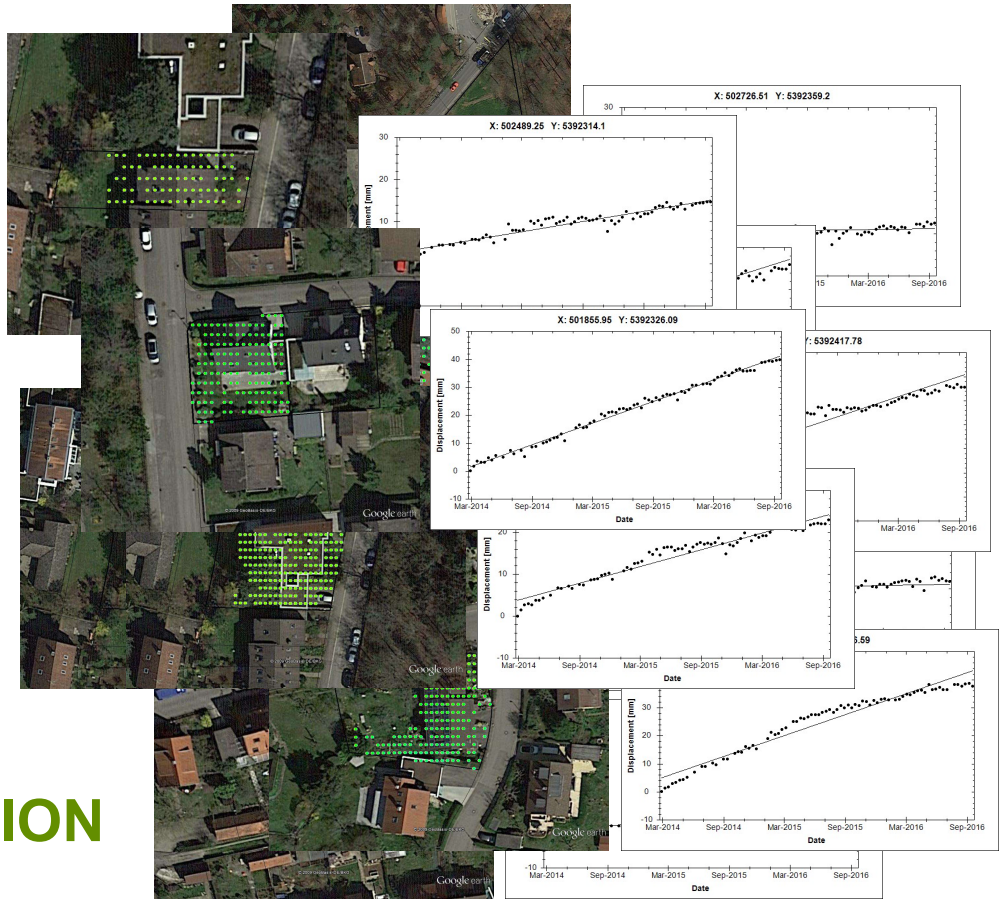


© DLR e.V. 2018 and © Airbus Defence and Space GmbH 2018

AIRBUS

Challenge (Big Data)

- Available:
  - Million of Measurement Pixels
  - Difficult to handle **DATA** mass
- Necessary Resources:
  - Terrabyte large storage volume
  - GIS Software (local)
- Required:
  - convenient, actionable **INFORMATION**



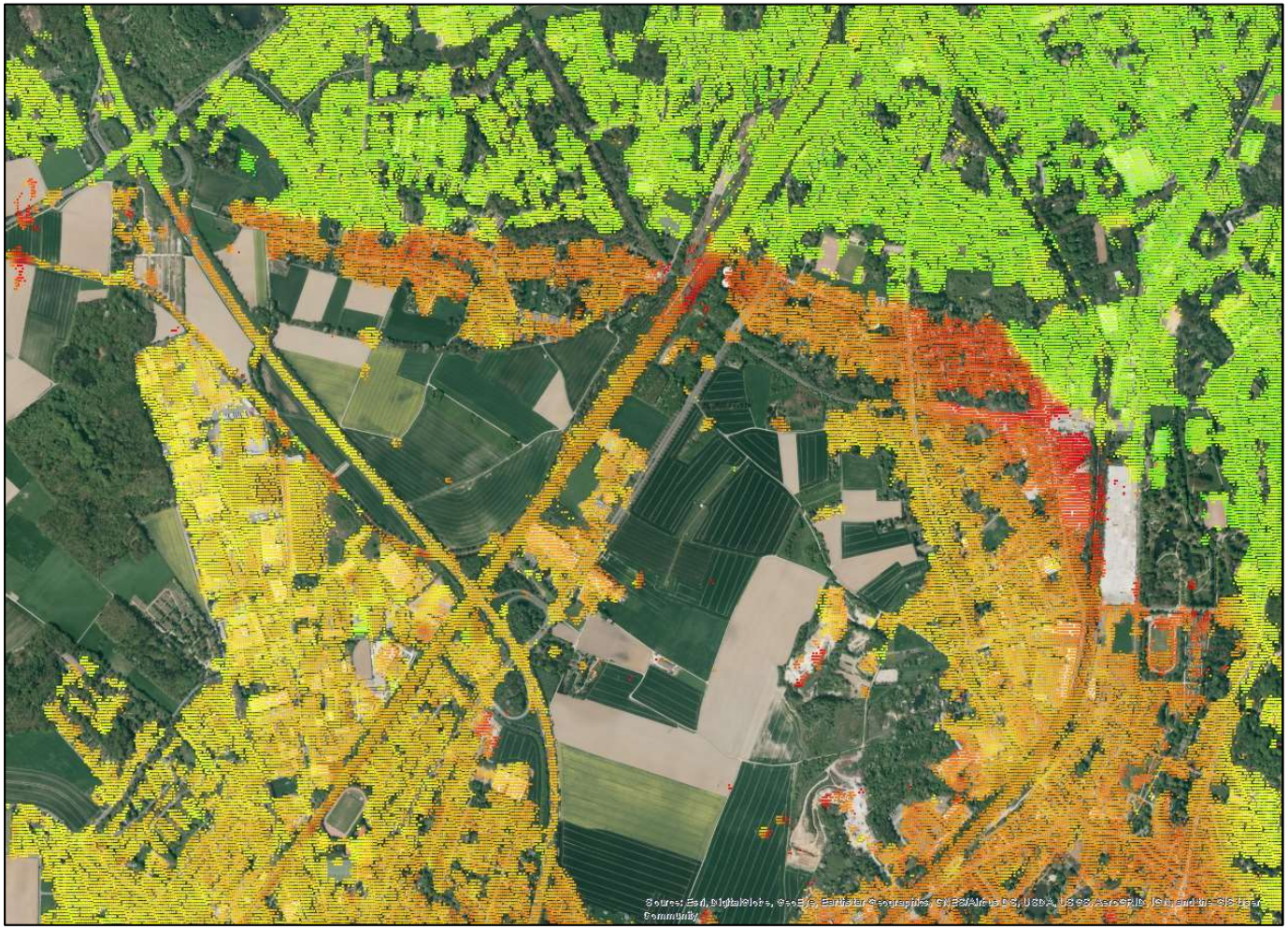
© DLR e.V. 2018 and © Airbus Defence and Space GmbH 2018

Solution (Data Mining)

- **Mass Reduction**
  - Clustering
  - Generalization
- **Linking** to other complementary geospatial information
  - Allocation to railways, houses, roads
- **Value Adding**
  - Convenient, actionable information for decision makers
- **Online Visualization**

SMM Result

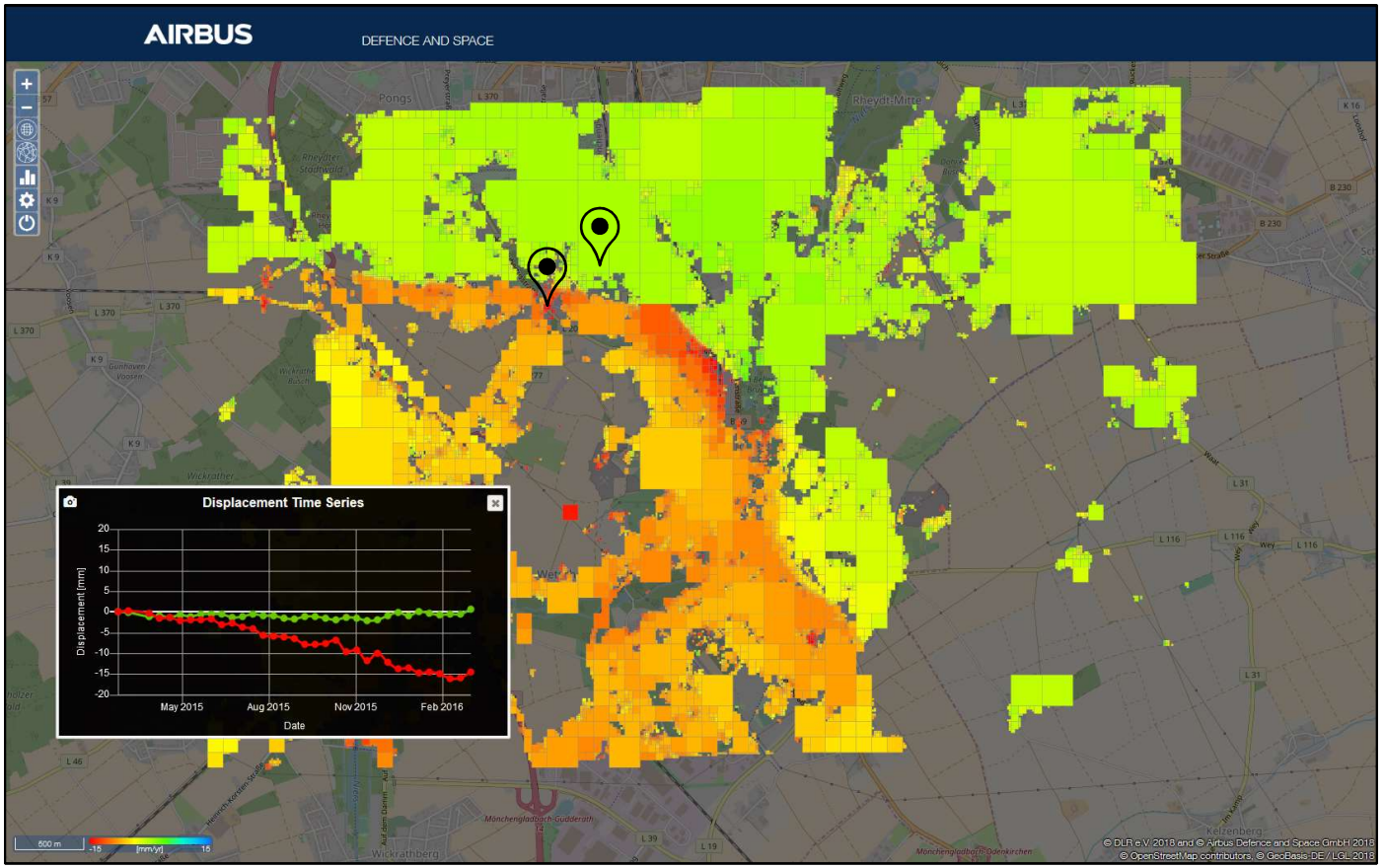
- Monitoring period **1 Year**
- **34** TerraSAR-X SM Scenes
- Resolution ca. **3 m x 3 m**
- Millions of Pixels



© DLR e.V. 2018 and © Airbus Defence and Space GmbH 2018

Clustering

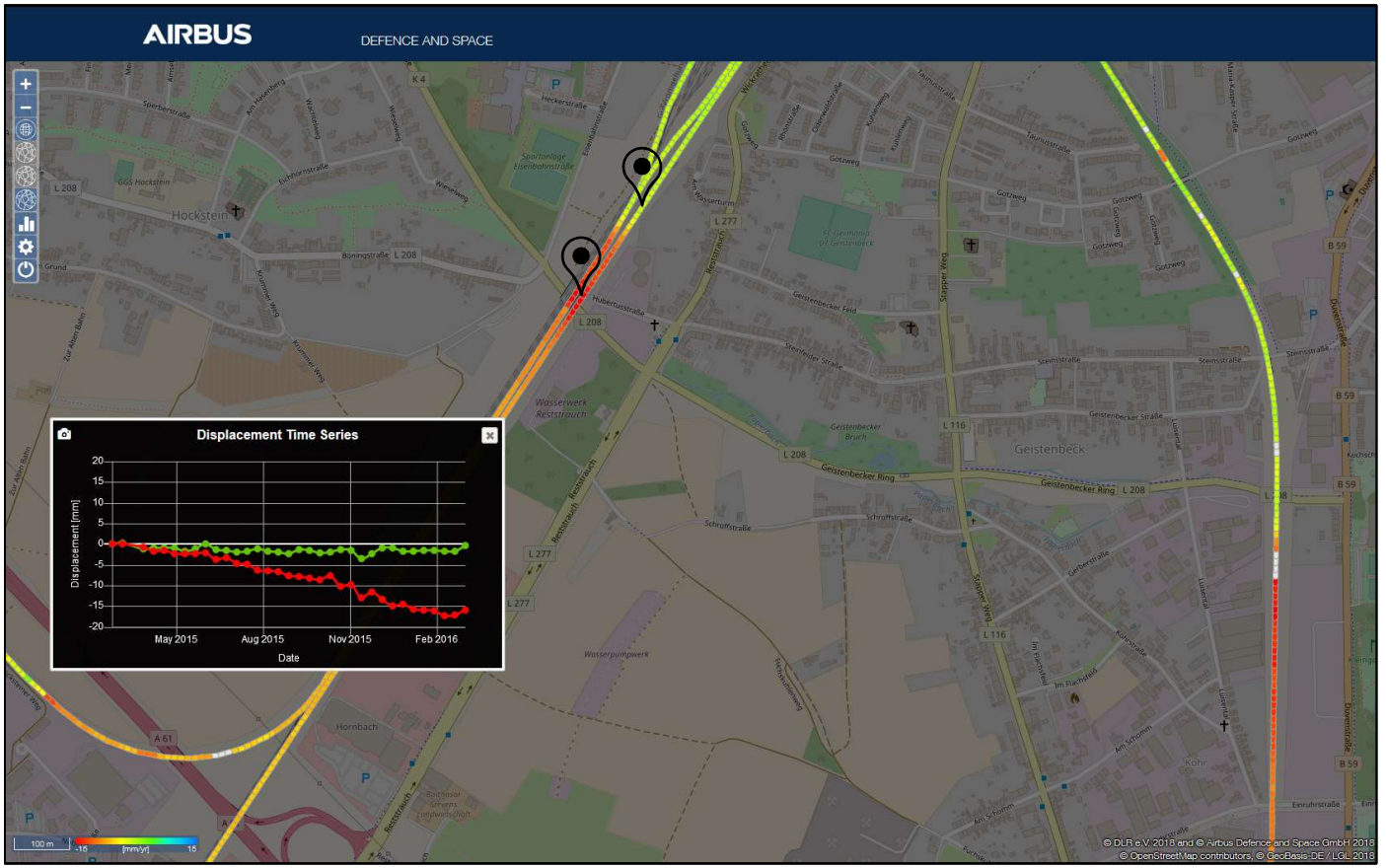
- Advanced Quadtree clustering
- Mass reduction for performant online vizualisation (GeoView)
- Time series analyzable



© DLR e.V. 2018 and © Airbus Defence and Space GmbH 2018

Allocation

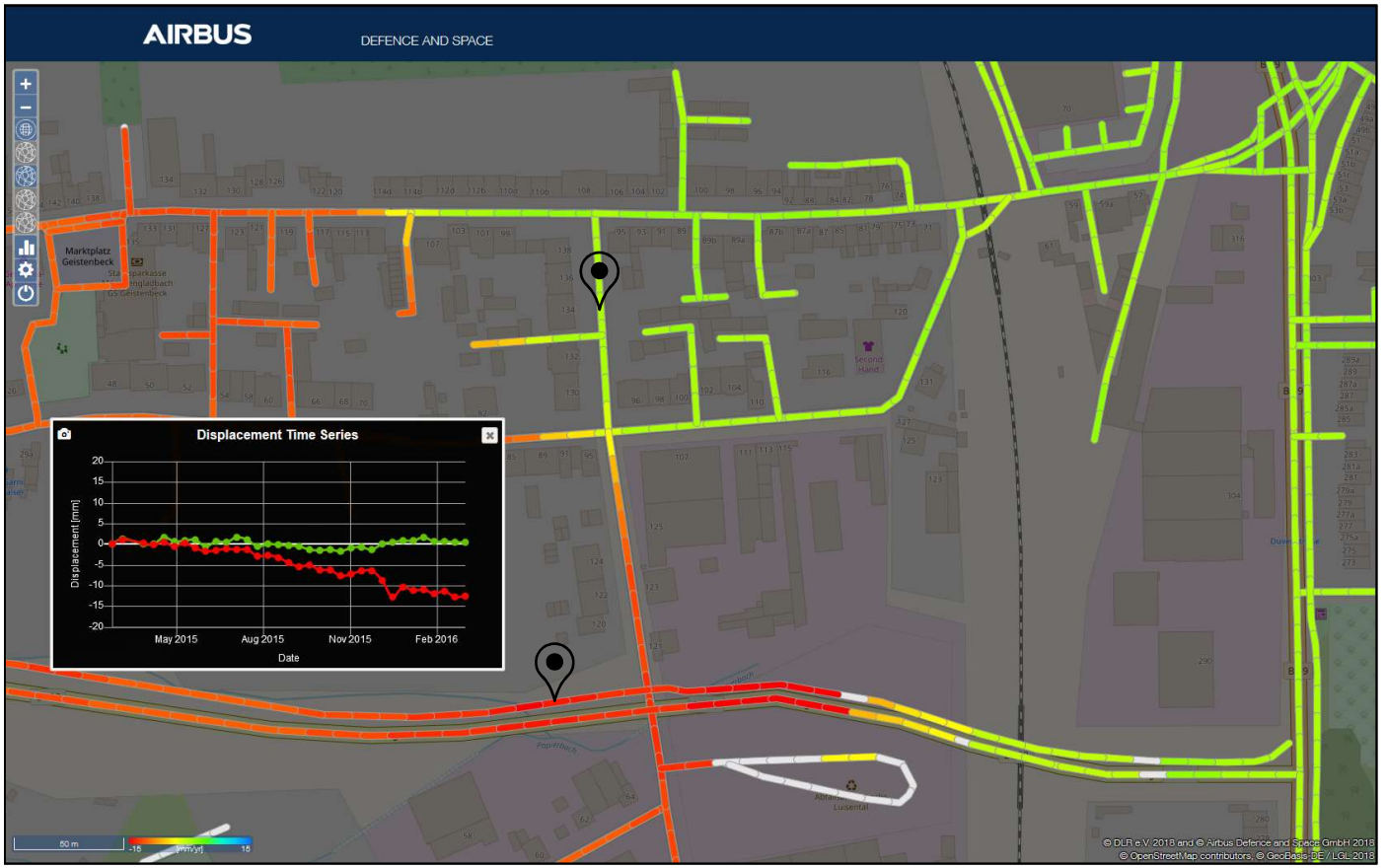
- Point allocation to **railways**
- Reduction and linkage
- Time series analyzable



© DLR e.V. 2018 and © Airbus Defence and Space GmbH 2018

Allocation

- Point allocation to **roads/streets**
- Reduction and linkage
- Time series analyzable



Legend

Vertical Movement Velocity

Subsidence **Uplift**

© DLR e.V. 2018 and © Airbus Defence and Space GmbH 2018

Allocation

- Point allocation to **houses**
- Reduction and linkage
- Time series analyzable

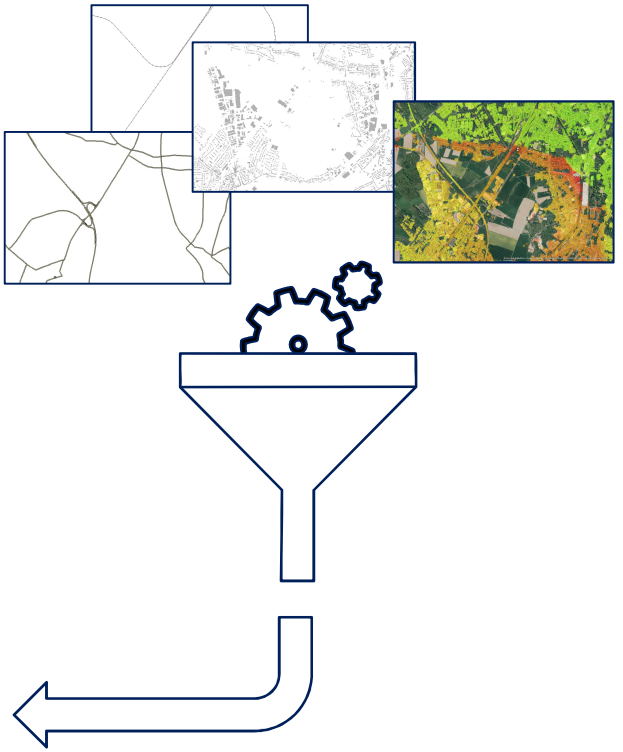
Legend

Vertical Movement Velocity

Subsidence **Uplift**

© DLR e.V. 2018 and © Airbus Defence and Space GmbH 2018

Value Adding

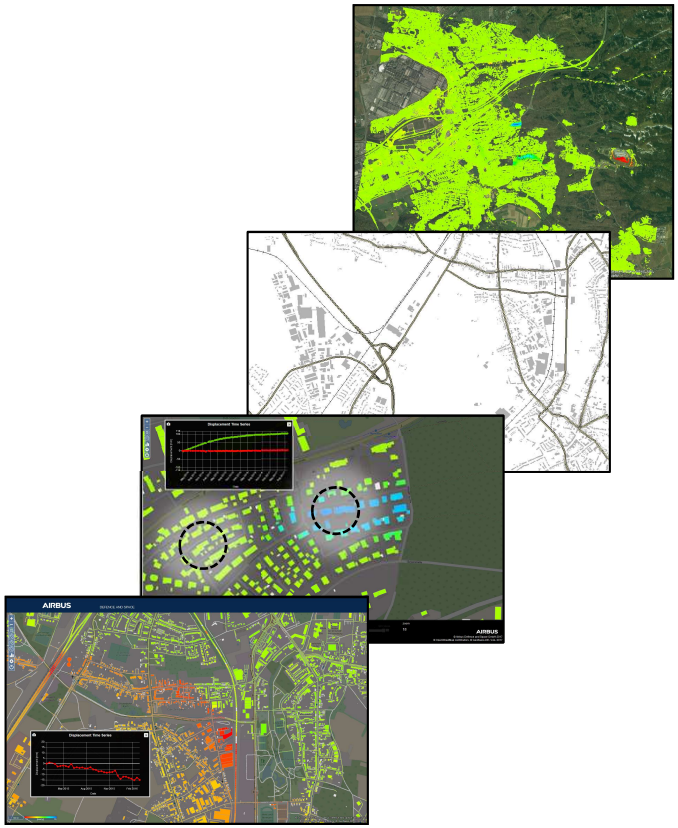


© DLR e.V. 2018 and © Airbus Defence and Space GmbH 2018

AIRBUS

Conclusion

- **Very high resolution** TerraSAR-X data allow reliable spatio-temporal **surface movements** estimation
- **Millimeter Accuracy** can be derived under optimal conditions
- Monitoring of **individual buildings** possible
- **Linking** to other geo-data yield convenient and **actionable information** (value adding)
- Easy to use **online visualization** (GeoView)



© DLR e.V. 2018 and © Airbus Defence and Space GmbH 2018

Dr. Jan Anderssohn

Airbus Defence and Space

Platz der Einheit 14, 14467 Potsdam, Germany
T +49 331 237 484 22
F +49 331 237 484 27
E jan.anderssohn@airbus.com

Copyright Airbus 2018

AIRBUS