The High Resolution Wide Swath Mission and WorldSAR
The Next Generation of X-Band SAR Services

ISRSE-37, Tshwane

Jürgen Janoth, Markus Jochum, Alexander Kaptein
11th May 2017
Outline

1. HRWS Mission Overview
2. HRWS for Environmental Monitoring
3. WorldSAR Concept
German SAR Roadmap

2007
Formation Flight (TanDEM)

TerraSAR-X (2020+)

2010
TerraSAR/PAZ Constellation Partnership

2017
TanDEM-X (2020+)

2020+
TerraSAR-NG Export Systems

WorldSAR Constellation Partnerships

2022
Tandem-L (DLR Science Mission, BMBF)

~ 2022+
X-Band

HRWS "High Resolution Wide Swath"

2020+
L-Band

HRWS & WorldSAR – The Next Generation of X-Band SAR Services
HRWS Mission Background

Mission Context and Status

• Next National Civilian X-Band SAR Mission to continue successful TerraSAR-X Mission
• Partnership approach between DLR Space Administration and Industry
• Phase 0/A Study contracted by DLR to Airbus
• Mission Definition Review May, 16th
• Launch envisaged for 2022

Main User Groups

• National institutional users
• Science users
• Commercial users
• German Defence users (tbc)
HRWS Mission Objectives

Programmatic and Strategic Objectives:

• Fostering leading German capabilities in X-Band SAR technology
• Support to the overall goals of the German Space Programme
• Ensuring high resolution X-Band data continuity from 2022 onwards
• Continuation of successful EO-commercialisation

Main Scientific and Technical Objectives:

• In-Orbit demonstration of innovative Digital Beam-Forming technologies
• Utilisation of the newly available chirp bandwidth of 1200 MHz
• Formation flight capability to allow for an update/improvement of existing DEM
• Implementation of new modes with improved coverage and high resolution
HRWS – Technical Objectives

In-Orbit demonstration of innovative Digital Beam-Forming Technologies

**TerraSAR Generation**

- StripMap
  - Medium resolution and image size

**ScanSAR**

- Low resolution & large image size
- Very High resolution & very small images

**High Resolution or**

- Large Area Coverage

**HRWS - High Resolution Wide Swath**

- Large Area Coverage
- Excellent Resolution

**Very High Resolution and**

- Large Area Coverage

*ISRSE-37, Tshwane, May 11th, 2014*
HRWS – Technical Objectives

Very high resolution imagery

1 m | TerraSAR-X

25 cm | HRWS

Polarimetrie | HRWS
HRWS – Preliminary Mission Overview

HRWS Baseline

**Mission**
- Orbit: 514 km SSO (=TSX)
- Mission Configuration: 1 or 2 Satellites (tbc)
- Station Network: 2 near polar stations + DRS
- Launch: planned for 2022
- Operational Lifetime: 10 years

**Instrument**
- SAR Instrument: Active Phased Array with DBF
- Beam steering: Electronical + mechanical
- Polarisations: Quad, Dual & Single
- Bandwidth: 1200MHz

**Platform**
- AOCS Actuator
- D/L System: Ka- & X-Band
- CMG
**HRWS – Orbit Characteristics (preliminary)**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orbit Type</td>
<td>Sun-synchronous Dusk Dawn orbit</td>
</tr>
<tr>
<td>Orbit repeat cycle</td>
<td>11 days</td>
</tr>
<tr>
<td>Orbits per day</td>
<td>15 2/11</td>
</tr>
<tr>
<td>Orbits per repeat cycle</td>
<td>167</td>
</tr>
<tr>
<td>Mean Revisit</td>
<td>SpotLigth Mode @ 0.25 m resolution: 19.9 h</td>
</tr>
<tr>
<td>Equatorial crossing time</td>
<td>18:00 h +/- 0.25 h (ascending) 06:00 h ± 0.25h (descending)</td>
</tr>
<tr>
<td>Inclination</td>
<td>97,44°</td>
</tr>
<tr>
<td>Altitude at equator</td>
<td>514,8</td>
</tr>
<tr>
<td>Altitude variation</td>
<td>505 - 527 km</td>
</tr>
<tr>
<td>Attitude steering</td>
<td>Total Zero Doppler Steering</td>
</tr>
<tr>
<td>Orbit Tube</td>
<td>500 m diameter (Design goal 200 m)</td>
</tr>
</tbody>
</table>
HRWS – Imaging Modes

... mono-static

... or bi-static with two sensors
**HRWS – Selected Modes (preliminary)**

<table>
<thead>
<tr>
<th>Mode</th>
<th>Resolution</th>
<th>Polarisation</th>
<th>Scene Size / Swath Width</th>
<th>Performance Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHS 0.25</td>
<td>0.25 m</td>
<td>Single</td>
<td>15 x 15 km²</td>
<td>20° - 55°</td>
</tr>
<tr>
<td>VHS 0.5</td>
<td>0.5 m</td>
<td>Dual, Quad</td>
<td>25 x 25 km²</td>
<td>20° - 45°</td>
</tr>
<tr>
<td>SM 1</td>
<td>1.0 m</td>
<td>Single</td>
<td>45 km</td>
<td>20° - 45°</td>
</tr>
<tr>
<td>SM 2</td>
<td>2.0 m</td>
<td>Dual, Quad</td>
<td>20 km</td>
<td>20° - 45°</td>
</tr>
<tr>
<td>SM 3</td>
<td>3.0 m</td>
<td>Single</td>
<td>60 km</td>
<td>20° - 45°</td>
</tr>
<tr>
<td>SM 3</td>
<td>3.0 m</td>
<td>Dual, Quad</td>
<td>30 km</td>
<td>20° - 45°</td>
</tr>
<tr>
<td>SM 5</td>
<td>5.0 m</td>
<td>Single</td>
<td>80 km</td>
<td>20° - 45°</td>
</tr>
<tr>
<td>SC / TOPS 8</td>
<td>8.0 m</td>
<td>Single</td>
<td>250 km</td>
<td>20° - 45°</td>
</tr>
<tr>
<td>SC / TOPS 30</td>
<td>30.0 m</td>
<td>Single</td>
<td>500 km</td>
<td>20° - 50°</td>
</tr>
</tbody>
</table>
HRWS – Products and Data Access

HRWS Image Products and Services

- Basic Image Products (L1B)
- Multi-Look Ground range Detected (MGD, GEC, EEC)
- Single look Slant range Complex (SSC)
- New application specific processing variants

Geo-Information Products and Services

- Maritime Surveillance, GCP, Surface Motion Monitoring, DEMs, Change Detection

Data access and dissemination

- Data access subject to German Satellite Security Act
- Web based acquisition and catalogue browsing
- On-line product delivery via Delivery Server
- Off-line product delivery via Media Production System
- On-Line Streaming Services envisaged
Outline

1. HRWS Mission Overview
2. HRWS for Environmental Monitoring
3. WorldSAR Concept
HRWS for Environmental Monitoring

HRWS Mission Drivers

- Multi-user Mission with following key applications:
  - Surface Motion Monitoring
  - Environmental Monitoring / Thematic Mapping
  - Maritime Surveillance
  - Image Intelligence

Observation Planning

- On-request plus back ground mission (single Satellite)
- Systematic global acquisition plus on-request (Formation)

Specific HRWS Contribution Potential

- Contribution particular to UNFCCC and REDD+, Ramsar Wetlands due to
  - Large area coverage at high resolution (e.g. improved detection rate for logged trees)
  - Quad Polarisation
  - Bi-static acquisitions (in case of a formation)
HRWS & WorldSAR – The Next Generation of X-Band SAR Services

HRWS for Environmental Monitoring

Global Product Overview

- A Forest/Non-Forest dataset with Global Coverage
- A resolution of 50x50 meters
- Binary Forest/Non-Forest data
- Will be available for free (foreseen: 2017)

German Aerospace Center
Microwaves and Radar Institute

AIRBUS
Outline

1. HRWS Mission Overview
2. HRWS for Environmental Monitoring
3. WorldSAR Concept
WorldSAR Concept

WorldSAR Alliance

- Co-operation of independent spacecraft owners/operators
- Subscribers own observation capacity and gain constellation benefits through WorldSAR partners

Objectives

- Shorting the revisit time and the interferometric repeat cycle
- Enlarging coverage capacity

Secondary Benefits

- Reliability of delivery by mutual back-stopping in case of mission maintenance of failure
- Monitoring continuity (including the use of heritage modes) across missions and technology generations
WorldSAR Concept – Current and Future Missions

- TerraSAR-X (2007)
- TanDEM-X (2010)
- PAZ (2017)
- HRWS (2022)
- Export Type A
- Export Type B

WorldSAR Next Generation
- PAZ
- HRWS
- Export Mission(s)

WorldSAR Constellation cooperation with Hisdesat (ES)
Thank You for your Attention!

Jürgen Janoth

Head of R&D SAR Intelligence, Airbus Defence and Space

Mailing: 88039 Friedrichshafen | Germany
Courier: Claude-Dornier-Str. | 88090 Immenstaad | Germany
Tel +49 7545 8 4291 | Fax +49 7545 8 1337 |
Juergen.Janoth@airbus.com