The TerraSAR-X Mission
2nd STG/IPY SAR Coordination meeting
Oberpfaffenhofen, Sept 30, 2008

Stefan Buckreuss
Mission Manager
Microwaves and Radar Institute

Achim Roth
Science Coordinator
German Remote Sensing Data Center
TerraSAR-X Satellite

- Wet mass: 1209 kg
- Orbit average power: 800 W
- Size: 5 m height × 2.4 m diameter

- Thrusters
- Solar Generator
- X-Band Radar Antenna
  - 384 Transmit/Receive Modules
- S-Band TM/TC Antenna
- X-Band Downlink Antenna
  - Data Rate: 300 MBit/sec
  - 256 Gbit Solid State Mass Memory
- 256 Gbit Solid State Mass Memory
### “TerraSAR-X, a National Science Mission with Commercial Potential”

#### Public Private Partnership

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- Satellite tasking will be shared equally 50/50 (scientific/commercial)
- DLR is the owner of the TerraSAR-X satellite and all data
- Nominal mission duration is 5 years
- If commercially successful → TerraSAR-X2 (to be financed by industry)
Data Availability

Scientific Data:

- DLR is in charge of coordinating the scientific use of the TerraSAR-X data
- Data will be generally provided via an evaluation process
  - Announcement of Opportunity
  - Permanent submission interface (COFUR: cost of fulfilling the user request)
- License agreement is required

Commercial Data:

- Commercial Customers will receive data via Infoterra GmbH
- Market price will be determined by Infoterra GmbH
- http://www.terrasar.de
TerraSAR-X Locations in Germany

- Neustrelitz: Spacecraft Development
- Berlin: Research Center & Mission Control
- Munich: Commercial Exploitation
- Oberpfaffenhofen: Telecommand & Telemetry
- Friedrichshafen: Payload Data Reception
- Weilheim: Payload Data Reception

Information provided by DLR (Deutsches Zentrum für Luft- und Raumfahrt e.V.) and EADS (European Aeronautics Defence and Space Company).
TerraSAR-X Mission Profile

Downlink of stored radar data @ 300 Mbit/sec

S-Band Telemetry & Telecommand

Radar Data Take

Ground Segment

DLR Ground Station Weilheim


DLR-Oberpfaffenhofen:

DLR-Neustrelitz: Data Reception, SAR-Processing, Archiving, Data Distribution

DLR-Neustrelitz

Science Coordination

Commercial Exploitation

infoterra
TerraSAR-X Satellite Key Features

- High resolution in SpotLight mode
- Possibility of large area coverage by utilizing ScanSAR mode
- Multi-polarization capability
- Left Looking Mode (roll maneuver of S/C)
- Dual Receive Antenna (DRA) Mode (ATI, MTI, Quad. Pol.)
- 300 MHz transmit bandwidth (1 m range resolution)
- Reference orbit with ±250 m orbit tube (repeated acquisitions, interferometry, etc.)
- Total Zero Doppler Steering
- Secure operation by encryption of commands and data downlink
- Prepared for TanDEM-X operation (synchronization)
TerraSAR-X Nominal Imaging Modes

**StripMap Mode**
- Resolution: $3 \text{ m} \times 3 \text{ m}$
- Scene Size: $30 \text{ km} \times 50 \text{ km}$
  [Range × Azimuth]

**SpotLight Mode**
- Resolution: $1 \text{ m} \times 1.5...3.5 \text{ m}$
- Scene Size: $10 \text{ km} \times 5...10 \text{ km}$
  [Range × Azimuth]

**ScanSAR Mode**
- Resolution: $16 \text{ m} \times 16 \text{ m}$
- Scene Size: $100 \text{ km} \times 150 \text{ km}$
  [Range × Azimuth]
Secondary Payloads

- **LCT: Laser Communication Terminal**
  - DLR / TESAT
  - Technology-Demonstrator for Intersatellite Communication
  - Tests with NFIRE Satellite:
    - 5,5 Gbit/s transfer rate achieved!

- **TOR: Tracking, Occultation and Ranging Instrument Package**
  - Contribution of University of Texas and German Research Centre for Geosciences (GFZ)
  - Two-frequency GPS Receiver and Laser Reflector
  - High-precise Orbit determination for TerraSAR-X
Commissioning Phase (1)

- **Orbit and attitude verification via laser ranging**
- **Radar instrument characterization/verification**
  - instrument temperature characterization
  - check of instrument configurations
  - antenna pointing calibration, etc.
- **Overall SAR system performance characterization**
  - analysis of raw data and point targets
- **Calibration of the radar data**
  - geometric calibration
  - antenna pointing calibration
  - antenna model verification
  - relative radiometric calibration
  - absolute radiometric calibration
  - internal instrument calibration
Commissioning Phase (2)

- Check-out of DLR receiving station and processing system
- SAR product verification and release of the basic products
  - Verification of format, annotation and content
  - Updated basic product specification
    Improvements w.r.t. initial version as for example
    - absolute radiometric accuracy: 1.1 dB \(\rightarrow\) 0.6 dB
    - relative radiometric accuracy: 0.68 dB \(\rightarrow\) 0.31 dB
    - spotlight mode (azimuth) resolution: 2.2 m \(\rightarrow\) 1.7 m
    - pixel localization accuracy: 2.0 m \(\rightarrow\) 0.3 m in range
      2.0 m \(\rightarrow\) 0.53 m in azimuth
    - side lobe ratio improved by ca. 4 dB*
      *(at the cost of a reduction of the slant range resolution of 9 % from 1.1 m to 1.2 m)*
Commissioning Phase (3)

- Check out of Direct Access Stations operated by Infoterra GmbH
- Load tests including the Commercial Service Segment (Infoterra GmbH)
  - Simulation of a realistic load for ordering, processing and delivery work flow
- Interferometric processing
  - Verification of complex data product format
  - Consistency checks for Doppler, timing, velocity “B” parameter, etc.
  - Assessment of relative geolocation accuracy
  - Assessment of relative orbit accuracy
  - Verification of phase preserving processing
StripMap:
Bergen, Norway
March 13, 2008
Status Scientific Use

- 234 proposals accepted

- One user account is opened for each proposal
  - Prerequisite for connection: User license, list of users and confirmation of funding
  - 159 active accounts released for ordering
  - ca. 107 PIs have been ordering products and data takes

- AO for experimental products will be released in October 2008

- 3rd TerraSAR-X Science Team Meeting
  November 25-26, 2008 at DLR Oberpfaffenhofen, Germany
Status Summary

- Spacecraft and ground segment are fully operational
- Image products (Spotlight, Stripmap, ScanSAR) are calibrated and released
- Product quality within initial specification or better!
- SAR instrument proved to be very stable
- Demonstration of Repeat Pass Interferometry, Along Track Interferometry, persistent scatterer evaluation, TOPSAR, total zero Doppler steering
- Demonstration of quadpol mode
- The use of TerraSAR-X data was demonstrated for geo-scientific applications, oceanography and disaster monitoring during commissioning phase
Way Forward

⇒ Dual Receive Antenna (DRA) mode:
  ⇒ Calibration, Checkout and tests for GMTI and Quadpol-mode
  ⇒ Product release probably end of 2008

⇒ Operational implementation of TOPSAR mode (2009 tbc)

⇒ Preparation of TanDEM-X mission

⇒ 3rd TerraSAR-X Science Team Meeting,
   November 25-26, 2008 at DLR Oberpfaffenhofen, Germany