Data Handling and Preservation of the TanDEM-X Satellite Mission

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Outline

➤ An Overview of the TanDEM-X Satellite Mission
➤ A short Introduction into the Data and Information Management System (DIMS)
➤ DIMS for TanDEM-X
    ➤ The Acquisition Request Workflow
    ➤ The SAR Data Workflow
    ➤ The DEM Production Workflow
➤ Conclusion
An Overview of the TanDEM-X Satellite Mission

- **TanDEM = TerraSAR add-on for Digital Elevation Measurement**
- The primary purpose of the mission is the production of a global consistent and reliable Digital Elevation Model (DEM) with a minimum accuracy to HRTI-3 (spatial resolution: 12m x 12m, relative vertical accuracy < 2m)
  - In comparison:
    - SRTM from 2000:
      - Coverage: between 60°N and 58°S
      - Resolution for the USA: (30m x 30m, relative vertical accuracy < 6m)
  - Two SAR (Synthetic Aperture Radar) interferometric satellites will fly in close formation.
  - During the operational mode of at least two and a half year every point of the land surface should be acquired two times at minimum.
  - **Expected data volume:**
    - Raw data :~ 350 TB
    - Intermediate data :~ 1700 TB
    - End product :~ 15 TB
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TanDEM-X – an Extension of the TerraSAR-X Mission

- Adding a further satellite to the already flying TSX-satellite.

- Enhancing the receiving station network to be able to downlink the data.

- Updating the payload ground segment (including the Data and Information Management System DIMS) to handle the new workflows.
A short Introduction into the Data and Information Management System (DIMS)

- DIMS is the data handling infrastructure of the German Remote Sensing Center (DFD).
- The DIMS services are decoupled by functionalities:
  - User services
  - Order handling
  - Production control
  - Product inventory and archiving
  - Monitoring & control, operating
  - Processing management

- The services are scalable and can be plugged together within a distributed service network according to required request and data flows.
- DIMS is in operational use since the year 2000.
- DIMS components are deployed in more than 15 sites.
### DIMS at DLR, some numbers

<table>
<thead>
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<th></th>
<th>Oberpfaffenhofen</th>
<th>Neustrelitz</th>
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<tr>
<td>Processing Systems connected to DIMS</td>
<td>8</td>
<td>37</td>
<td>45</td>
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<tr>
<td>Product Transfers per Month</td>
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<td>Files</td>
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<td>1,700,000</td>
<td>6,611,000</td>
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<tr>
<td>Amount of Data</td>
<td>180 TByte</td>
<td>160 TByte</td>
<td>340 TByte</td>
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This and the next viewgraph were taken from W. Wildegger
DIMS and the joined Satellite Missions TerraSAR-X and TanDEM-X

The existing DIMS in the configuration for TerraSAR-X
- provides ordering, processing and delivering of future acquisitions from individual user request also as catalogue orders.
- is operational since July 2007
- has processed more 60,000, resulting in more than 76,500 products with a amount of more than 55 TB.

Necessary configuration extensions to support the joined missions

TerraSAR-X:
- Handle the second satellite

TanDEM-X:
- Acquisition Request-Workflow
- SAR Data Workflow
- DEM Procduction Workflow
- Catalogue Ordering
DIMS for TanDEM-X

Acquisition-Request Workflow

DEM Production Workflow

SAR data Workflow
The Acquisition Request Workflow

- Basis for the TanDEM-X mission is a pre-planed acquisition time line; it is optimized relating to
  - Satellite resources (only 50 % are available, the other part is necessary to fulfill the ongoing TerraSAR-X mission)
  - Downlink capacity
  - Earth surface
  - ...
- Every point of the surface should be acquired at least twice; the second acquisition should be one year after the first one.
- Because of the drift of the satellites there exists only one optimum constellation for the acquisition of the data of a special region in every acquisition phase, so that a fast reordering of acquisition of bad quality is necessary.

Challenge: (Partial) downlinks at various receiving stations; connected to the processing facility in Oberpfaffenhofen over a “small cable” (e.g. Antarctica)
Fast Quality Feedback – a Solution for the Challenge of the Acquisition Request Workflow

- The received data will be screened at the ground station.
- This quality annotations will be transferred online to the Processing Facility.
- An Ingestion System stores these information into the Product Library as a product component and calculates the completeness.
- If the quality information of the joined acquisition (both datatakes) are complete, a processor performs a interferometric quality pre-check.
- Depending on this result, a re-acquisition can be started.
- The mass data will be shipped on tape.
The SAR Data Workflow

- The recorded raw data must be archived and processed to intermediate products (CoSSC and rawDEM)
  - CoSSC product size : 2,3 GB
  - rawDEM product size : 0,9 GB
  - Joint datatakes will be divided into smaller scenes
  - Every scene and all existing CoSSCs with the same spatial coverage of earlier acquisitions are the basis for a new CoSSC
  - One CoSSC results into one rawDEM
  - Production rate (second acquisition phase) : 400 + 50 (Reproc.) / day

- This workflow is data driven.

Challenges:
1. Diversity in transportation time of the mass data.
2. High data transfer rates between the archive and the processing systems.
A Solution for the Challenge of the SAR-data Workflow

- The Ingestion System must calculate the completeness of both datatakes of the joined acquisition.
- If the acquisition is complete, the next processing system will be triggered.

But:

The shipping time of the tapes maybe take some weeks.

- The archive cache must be extended (from currently 3 TB up to 40 TB) to speed up the product retrieval.
The DEM Production Workflow

- In contrast to the SAR-data workflow this task is
  - operator-driven
  - region based
- The operator searches for regions (e.g. Iberian Peninsula) with sufficient rawDEMs of a good quality.
- Reports containing information about expected acquisitions and existing rawDEMs will be generated on a daily basis to support the operator.
- A reprocessing of some rawDEMs could be necessary.
- A final DEM tile with a size of 1° x 1° at the equator will be composed with the rawDEMs of various acquisitions.
Using a Second Network – A Solution for the Challenge of High Data Volumes

- Until now, the Product Library and the various processing systems were linked by 1GBit Ethernet. Using this network, the requests as well as the products are transferred.

- To meet the requirements of the TanDEM-X mission, a further network was installed (IP over Fiber Channel) between the TanDEM specific processing systems and the Product Library.

- In this extended configuration, the control flow remains in the GBit network; whereas the product transfer uses the collision-free network.
Conclusion

- The TanDEM-X mission faces various challenges:
  - High data volume
  - Distributed downlinks
  - Regional bulk processing
  - Integration with operational TerraSAR-X mission
  - Short time to extend the ground segment
- DIMS is able to give answer to system evolution for
  - Acquisition request workflow
  - SAR data workflow
  - Archiving and data transfer
Thank you for your attention!

Questions?

Comments and further questions are welcome:
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