Mission Planning at the German Space Operations Center

IMPRS-EPP YSW Ringberg 2012

DLR

Overview

- Part One: The interesting part

- Part Two: The *very* interesting part

The DLR

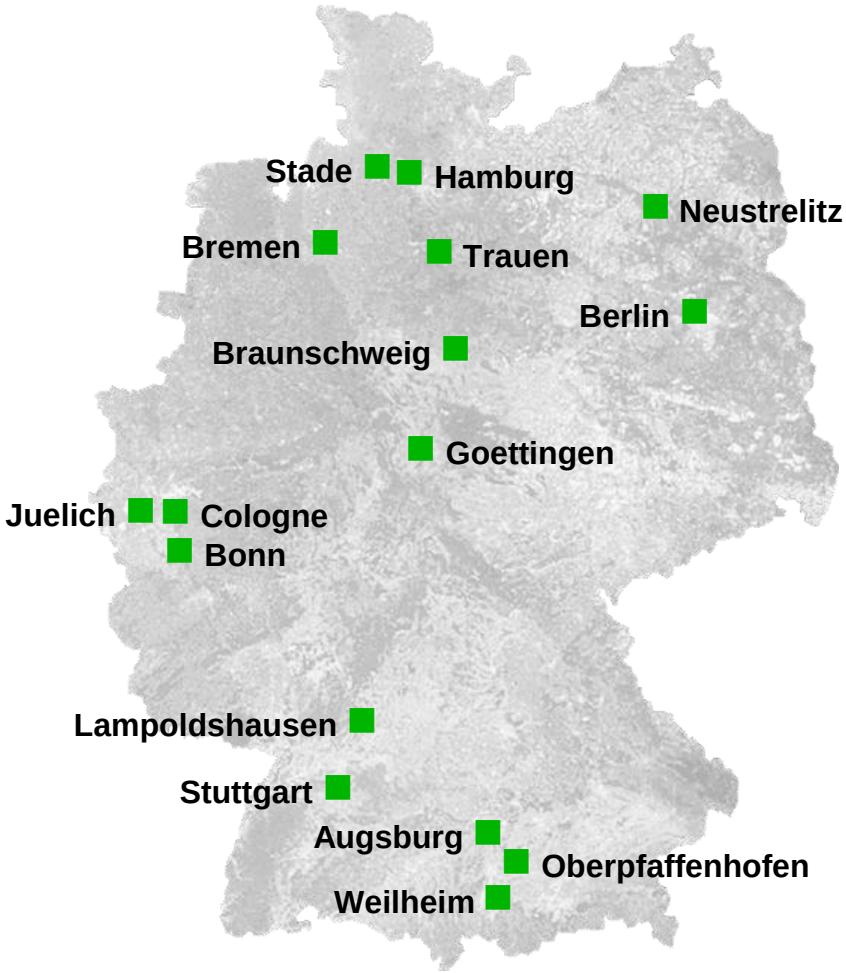
- German Aerospace Center (**D**eutsches Zentrum für **L**uft- und **R**aumfahrt)
- Research Institution
- Space Agency
- Project Management Agency

- Research Areas:
  - Aeronautics
  - Space Research and Technology
  - Transport
  - Energy
  - Space Administration

Locations and Employees

7000 employees across
32 institutes and facilities at
16 sites.

Offices in Brussels,
Paris, Washington and Singapore.



DLR Institutes

- German Remote Sensing Data Center (DFD)
- DLR Earth Observation Center
- DLR Institute of Aerodynamics and Flow Technology
- DLR Institute for Aeroelasticity
- DLR Institute of Propulsion Technology
- DLR Institute of Structures and Design
- DLR Institute of Vehicle Concepts
- DLR Institute of Composite Structures and Adaptive Systems
- DLR Institute of Flight Guidance
- DLR Institute of Air Transport and Airport Research
- DLR Institute of Flight Systems
- DLR Microwaves and Radar Institute
- DLR Institute of Communications and Navigation
- DLR Institute of Aerospace Medicine
- DLR Institute of Material Physics in Space
- DLR Remote Sensing Technology Institute
- DLR Institute of Atmospheric Physics
- DLR Institute of Planetary Research
- DLR Institute of Space Propulsion
- DLR Institute of Space Systems
- DLR Institute of Robotics and Mechatronics
- DLR Institute of Solar Research
- DLR Institute of Technical Physics
- DLR Institute of Technical Thermodynamics
- DLR Institute of Combustion Technology
- DLR Institute of Transport Research
- DLR Institute of Transportation Systems
- DLR Institute of Materials Research
- DLR Design Organisation
- DLR Flight Experiments
- DLR Institute of Air Transportation Systems
- Space Operations and Astronaut Training
- DLR Simulations and Software Technology

* blue = space operations institutes

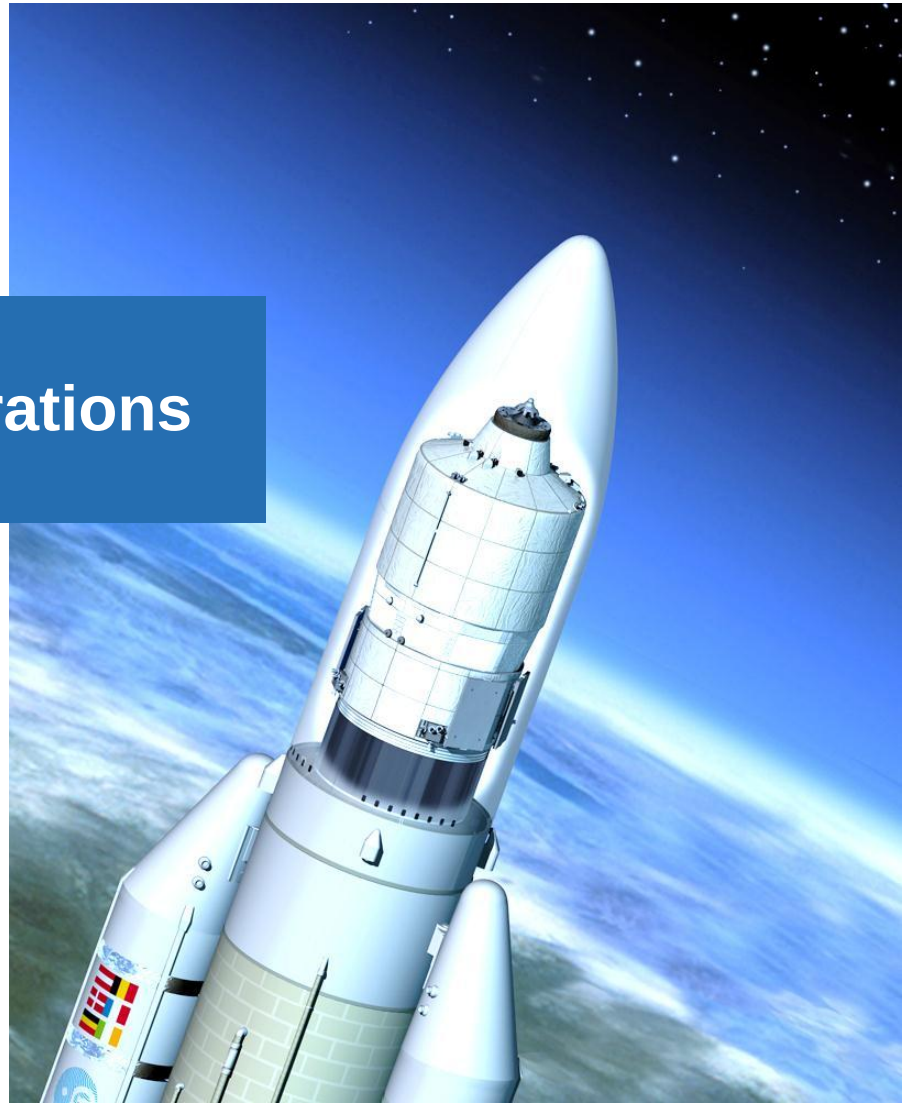
DLR

DLR Site Oberpfaffenhofen

Employees: Approx. 1600
Size of site: 245 000 m²
Research institutes and facilities:

- Microwaves and Radar Institute
- Institute of Communications and Navigation
- Institute of Atmospheric Physics
- Remote Sensing Technology Institute
- Institute of Robotics and Mechatronics
- German Remote Sensing Data Center
- Space Operations and Astronaut Training (incl. German Space Operations Center)
- Galileo Control Center
- Flight Experiments

Starting in Space Operations



TAFF
AOS
ASM-MTQ
ARI
ECSS
LCT
PTS
TMTC
SGS
TMSP
DIMS
NOM-AH
PDR
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FDS
SAR
NSG
OHG
IOCS
MET
WHM
PGS
TLE
IOV
IOCS
MOS
AOCS
KMF
MPS
DFD
EOC
TET
MRD
MET
TOR
USO
KIR
TDX
ROI
R2CC
ORI
MOS
CHM
OBC
MIB
TLA

DLR

Can you guess the Abbreviation?

	HEP/ATLAS	Space operations
LL	Leading Log	Left-Looking
IOV	Interval of Validity	In-Orbit Verification
CAL	Calorimeter	Calibration
MCS	Monte Carlo Simulation	Monitoring & Control System
MT	Transverse Mass	Magnetic Torquer
MET	Missing Transverse Energy	Mission Elapsed Time
Satellite control room	**Secondary** control room	**Main** control room

LIFT OFF: - 00 : 57 : 41
On Orbit Verification
TET-1
GROUND STATIONS
Weilheim .....
Svalbard .....
CSA .....
DATA / VOICE LINES
Weilheim .....
Svalbard .....
CSA .....
GSOC
Systems ..
MCS.....
FD.....
LAUNCH SITE
LAUNCH SITE:
Launcher..
Weather...
SPACECRAFT:
TET.....
UTC 204/05:43:57
MET-000/01:49:22
0002 E CAM 2
0002 22-ИЮЛ-12 11:43:18
Raumfahrt Kontrollzentrum
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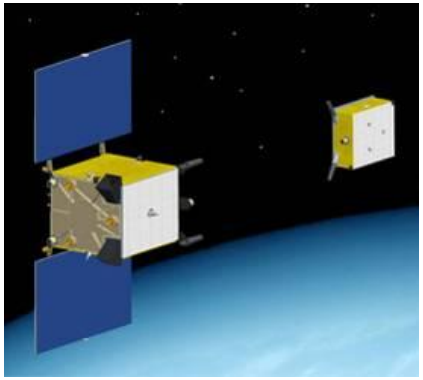
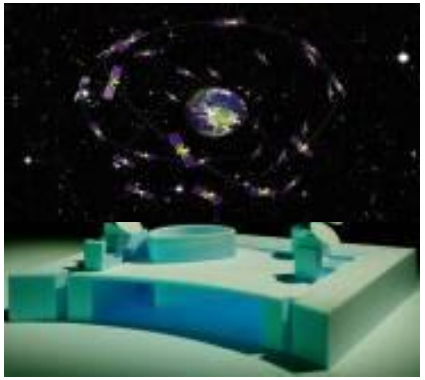
GSOC

German Space Operations Center (GSOC) Overview

Mission Operations	Ground Stations & Communications	Space Flight Technology	Galileo Operations (GfR)
			
Mission operations Project coordination Training	Data transfer Communication Ground stations	Flight dynamics Navigation Simulation	Operations Hosting Logistics

Competence and Innovation for the Way to Space

Types of Missions at GSOC

Scientific missions

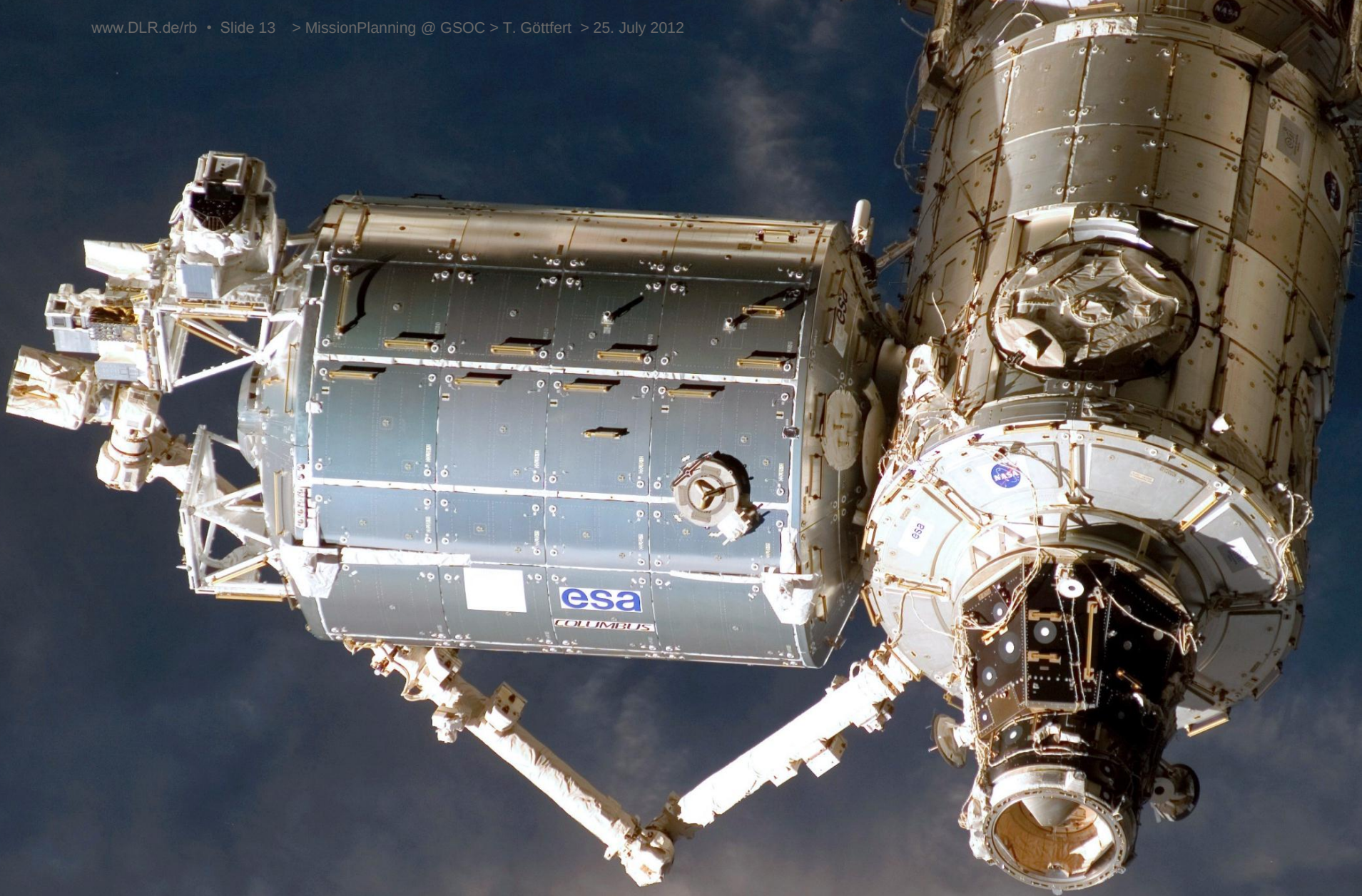
Commercial missions

Security relevant missions

Earth observation missions

Technology demonstration missions

Communication and navigation missions



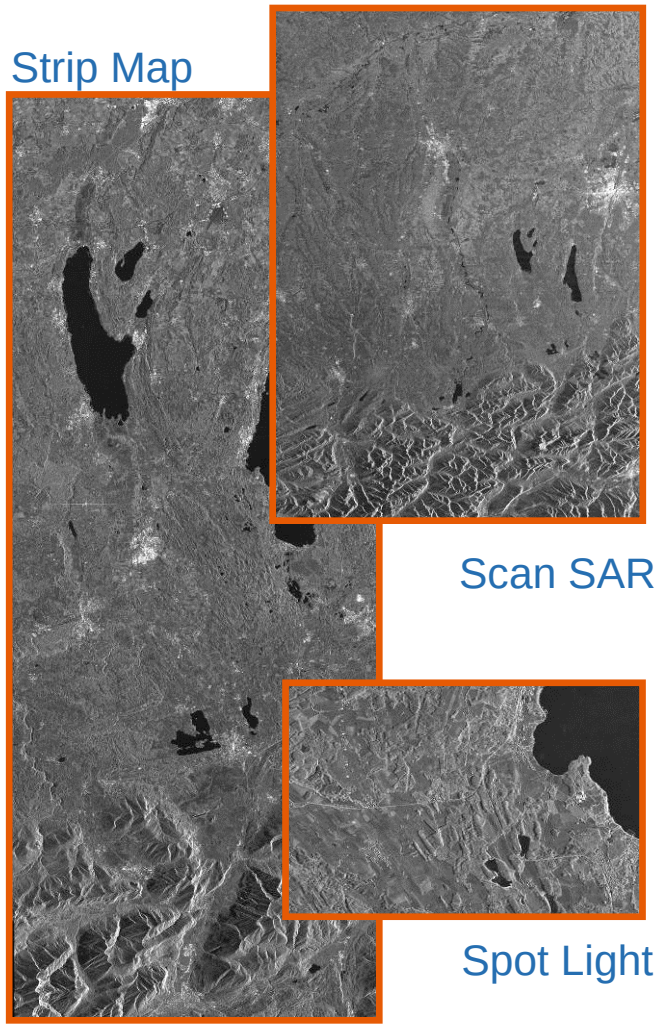
Columbus Module on the ISS

Mission Planning

First: The Mission
TerraSAR-X and TanDEM-X

TerraSAR-X Technical Data

Launch:	15 June 2007 Baikonour
Weight, dimensions:	1023 kg, 5 x 2,4 m
Orbit altitude:	514 km
Orbit inclination:	97,44°
Reference orbit:	11 day cycle
X-Band frequency:	9.65 GHz
bandwidth:	max. 300 MHz
Length of antenna:	4.8 m
Incidence angle:	20° -55° (rightlooking)
Best resolution	High Resolution Spotlight 1m
Largest coverage	Scan SAR 120 km swath width
Polarisation:	HH,VH,HV,VV
Mission duration:	> 5 Jahre

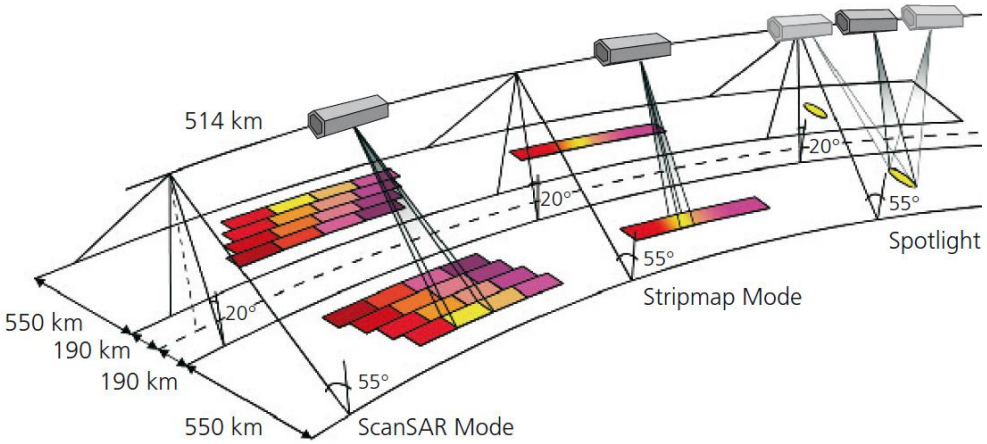


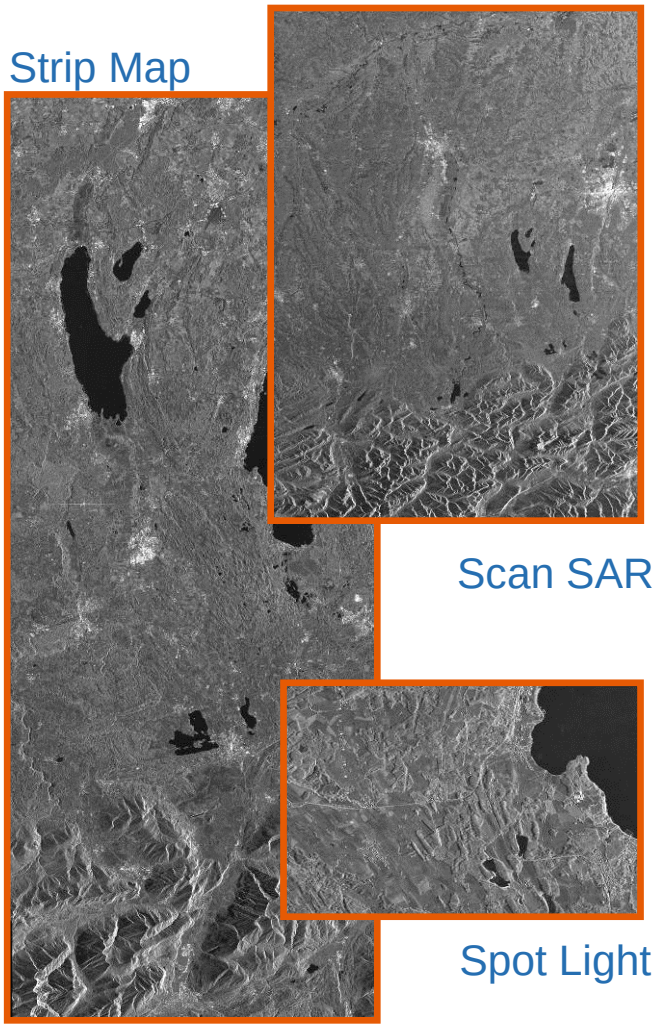
SAR Payload

Active Radar: Satellite transmits radar pulses, echo of earth surface is received & stored.

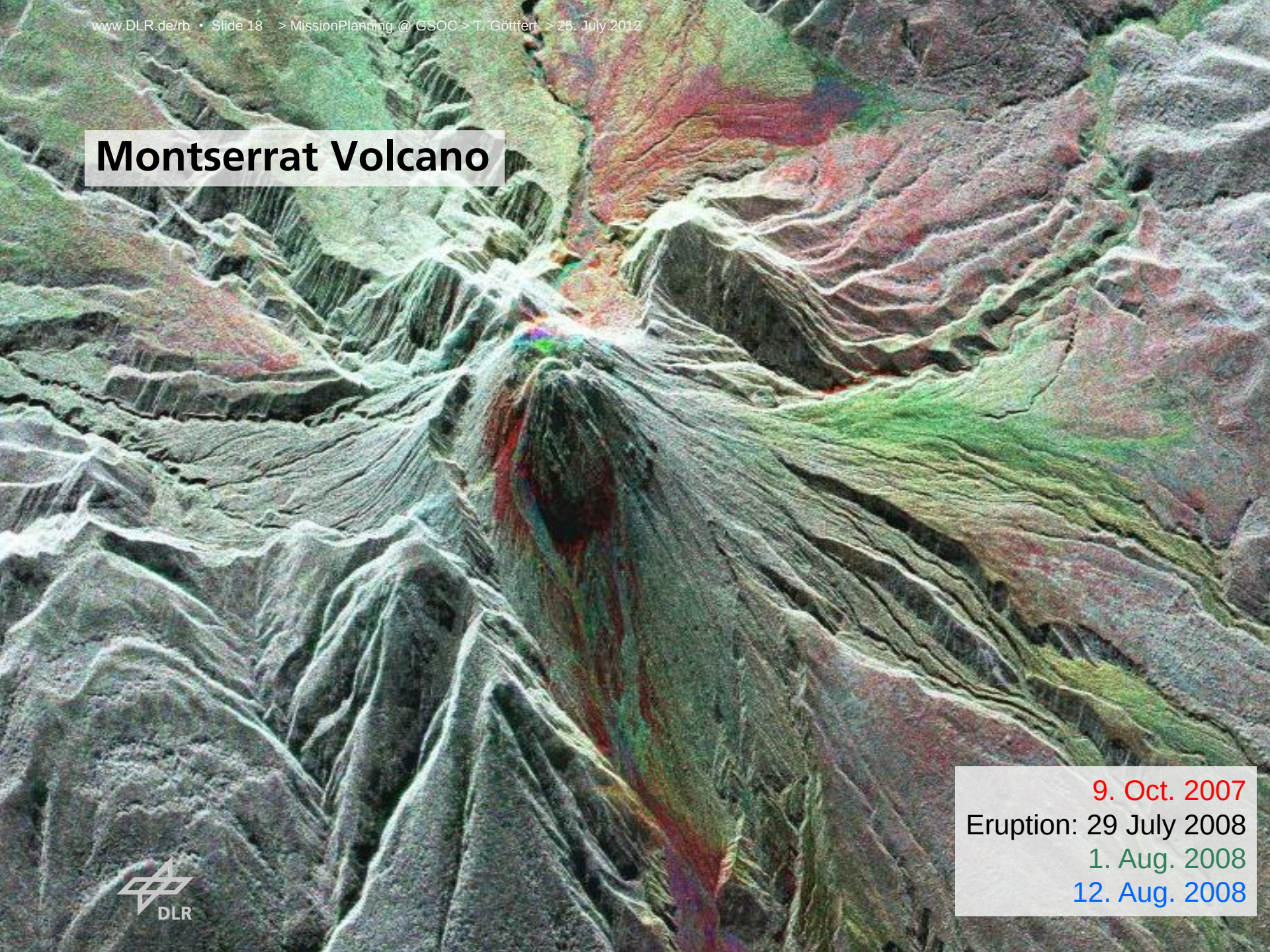
Synthetic Aperture: Improves resolution by continuously sampling the target during motion of the physical antenna.

TerraSAR-X resolution (down to 1m) comparable to physical antenna of 15 km length.





Montserrat Volcano



9. Oct. 2007
Eruption: 29 July 2008
1. Aug. 2008
12. Aug. 2008

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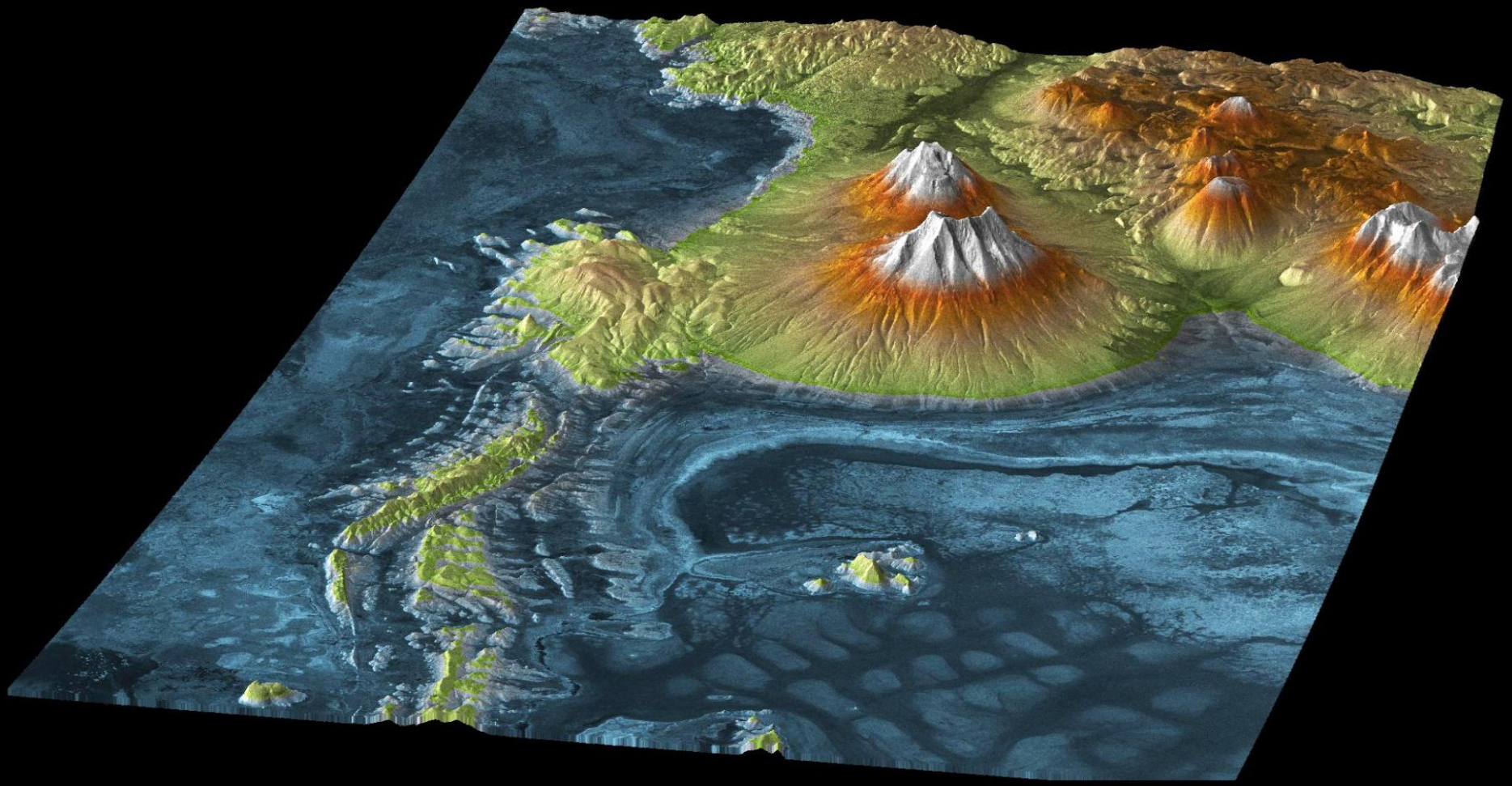
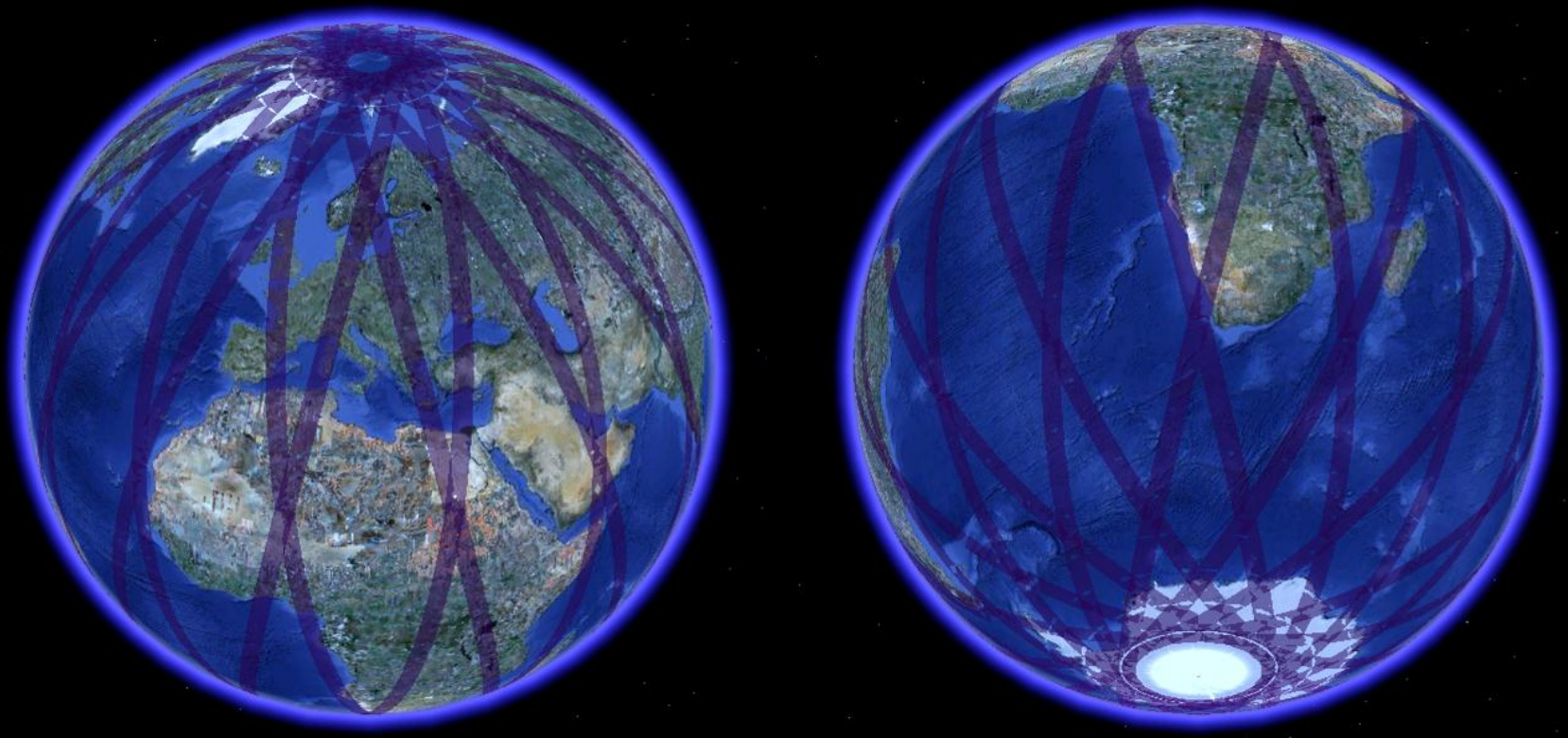
Salar de Uyuni, the largest salt flats in the world next to the Atacama Desert (December 2010)



Second: The Planning



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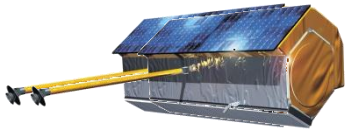
Payload Mission Planning means to …

… organize usage of space craft resources to achieve mission goals

… ensure that technical boundary conditions of space craft and ground facilities are respected

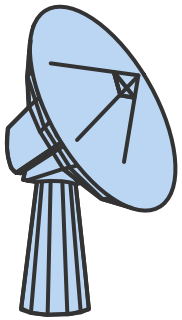
… resolve conflicts in between different user groups

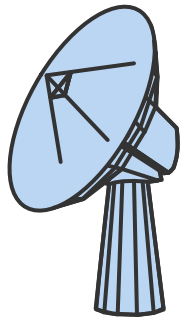
The principal output of Mission Planning is a timeline.



payload data

commands





downlink of payload data

on-ground schedule **timeline**

uplink of telecommands

users

orders

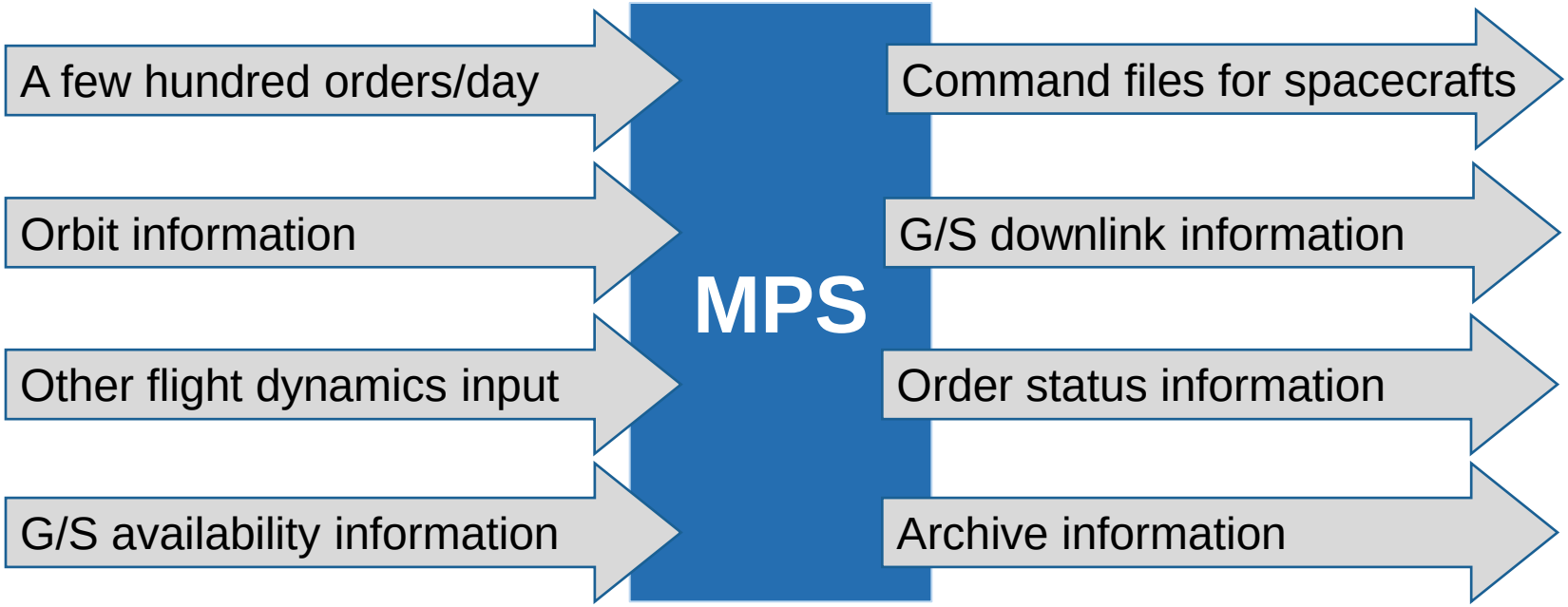
preview

status

Mission Planning

DLR

Mission Planning System (MPS)



MPS …

… distributes 2 missions to 2 spacecrafts and 2 groundstation networks

… is fully automated

… contains safety additions for close formation flight

MPS Responsibilities

Timeline must…

- be conflict free

- respect all constraints and limitations, e.g.
  - memory size
  - battery power
  - heat load, …

- contain all auxiliary activities that are payload-related, e.g.
  - instrument activation level
  - data downlink
  - file/memory management tasks, …

A few Numbers …

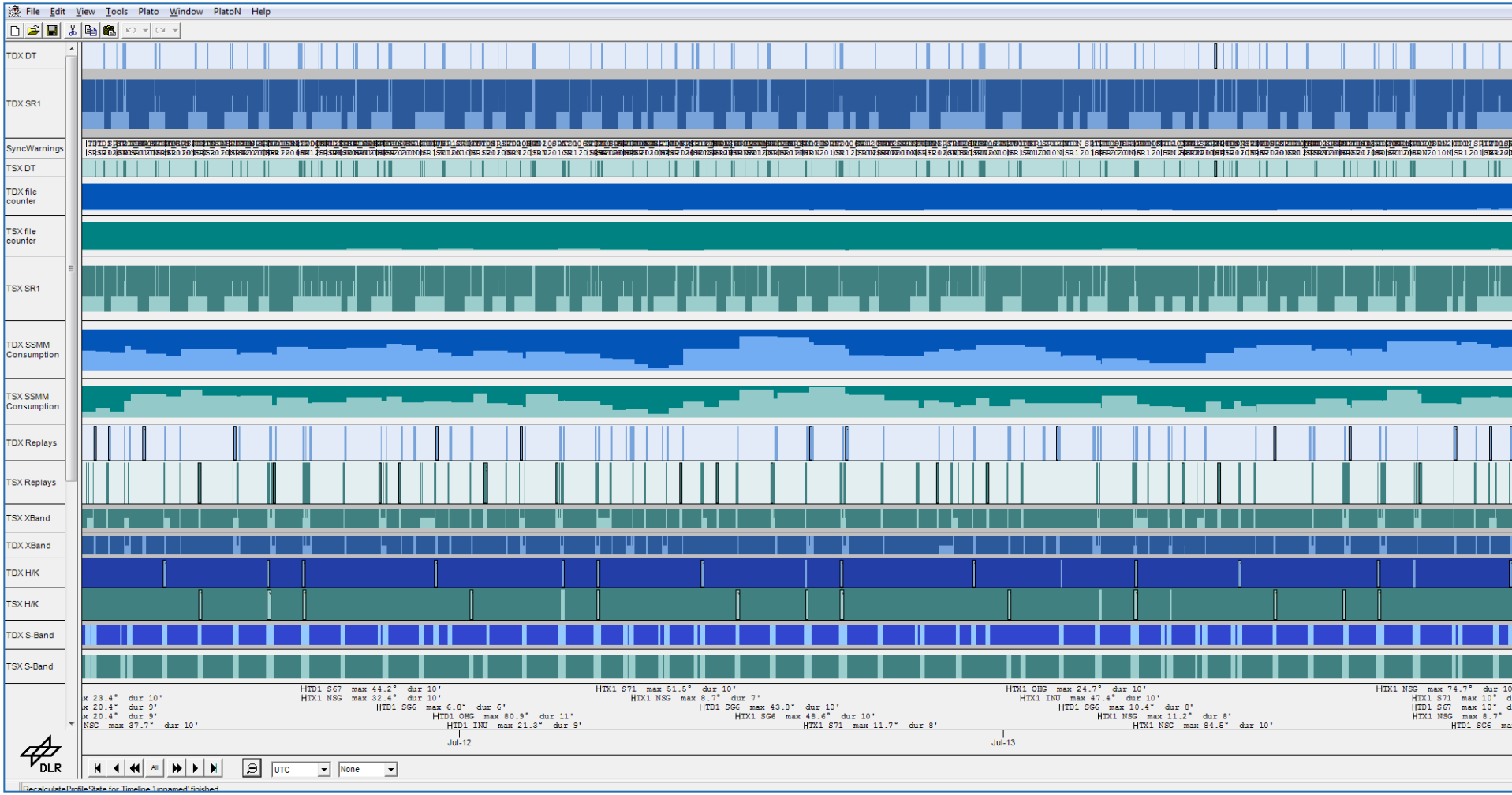
- MPS is designed for a few hundred orders per day
- 180 different telecommands available

- Since the start of the TanDEM-X mission (August 2010)
  - 110k datatakes executed (~150 per day)
  - >1500 MPS uplink contacts
  - 30k data downlink contacts
  - 1.1M commands uplinked (~1500 per day)
  - >750k files delivered by MPS

- Current orbit number:
  - TerraSAR-X satellite: 29260
  - TanDEM-X satellite: 11530

- 4/3 of land surface covered by 3D datatakes for the global elevation model

Example TerraSAR-X/TanDEM-X Timeline (1 week)



My Tasks @ GSOC

- Software Engineering and Development:
  - Design,
  - Write,
  - Maintain mission planning software

- For the TanDEM-X/TerraSAR-X MPS:
  - Configuration management
  - Maintain documents
  - Coordinate our external interfaces across institutes and groundsegment-wide

- Participate in the Mission Operations Software Group
  - Data Analysis support for Offline Telemetry Data

Team, Career, Starting @ GSOC …

Prerequisite: degree in physics, aerospace engineering, maths, informatics, chemistry, electrical engineering …

- ✓ Variable and interesting work
- ✓ Possibility of taking over responsibility quite fast
- ✓ Young team
- ✓ Size of DLR allows for development, flexibility and change of job orientation

Further Information

Links:

- Site of Space Operations and Astronaut Training: www.DLR.de/rb

- DLR job portal: www.DLR.de/jobs

Open day at Oberpfaffenhofen: 21 October 2012

Thanks for listening!