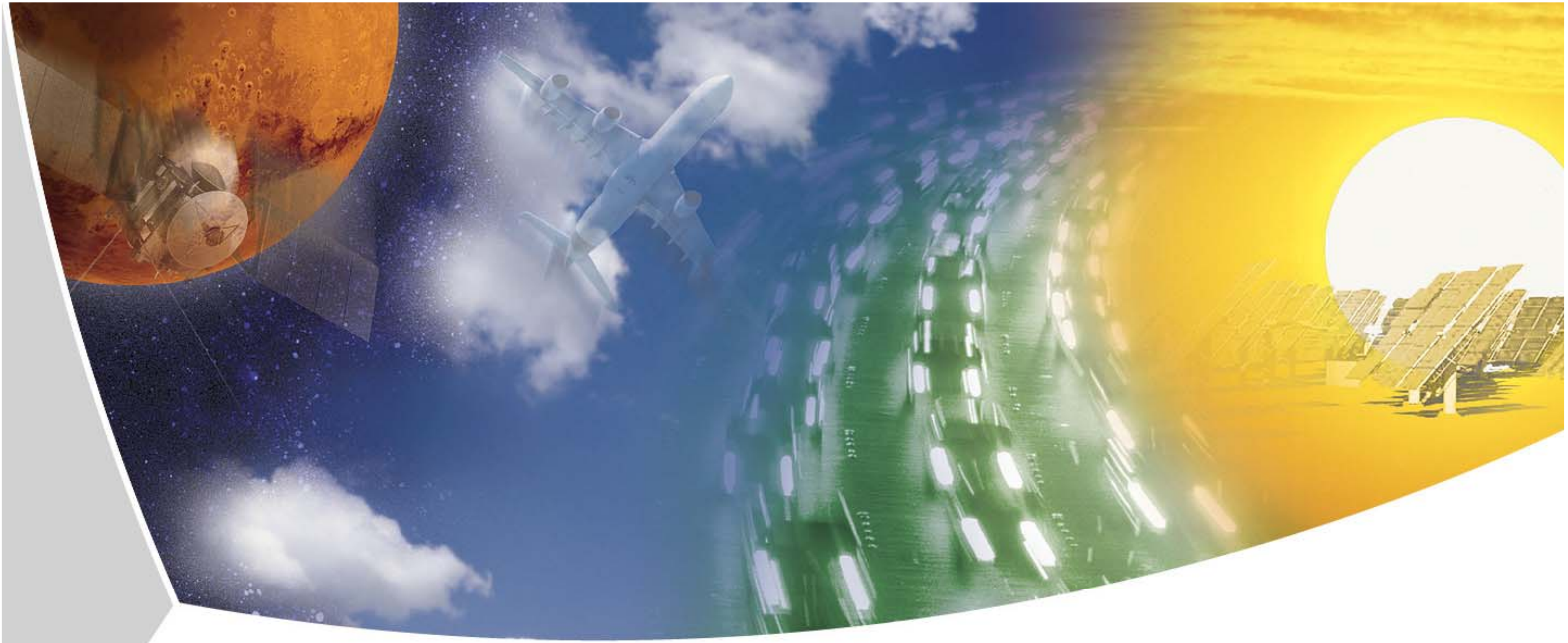


COL- CC and ESA Ground Segment

Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft

M&C Antenna Ground Station SpACE

- DLR has implemented a new antenna ground station M&C Framework for the Weilheim antennas. It will be the M&C software for the existing 3 S-Band antennas, the Ku-Band antenna and the 30 meter dish. Further it will be used for the upcoming Ka- Band antenna and the EDRS project.
- The software is based on open and standard technologies like C++, the ACE communications framework, Graphical User Interface Qt.
- The platforms supported are SuSE Enterprise Linux, Sun Solaris and Windows.
- The M&C Framework was built by DLR staff and now after successful testing, being implemented at the Weilheim Ground Station. It is planned that the new M&C system will be operational by mid of 2011.

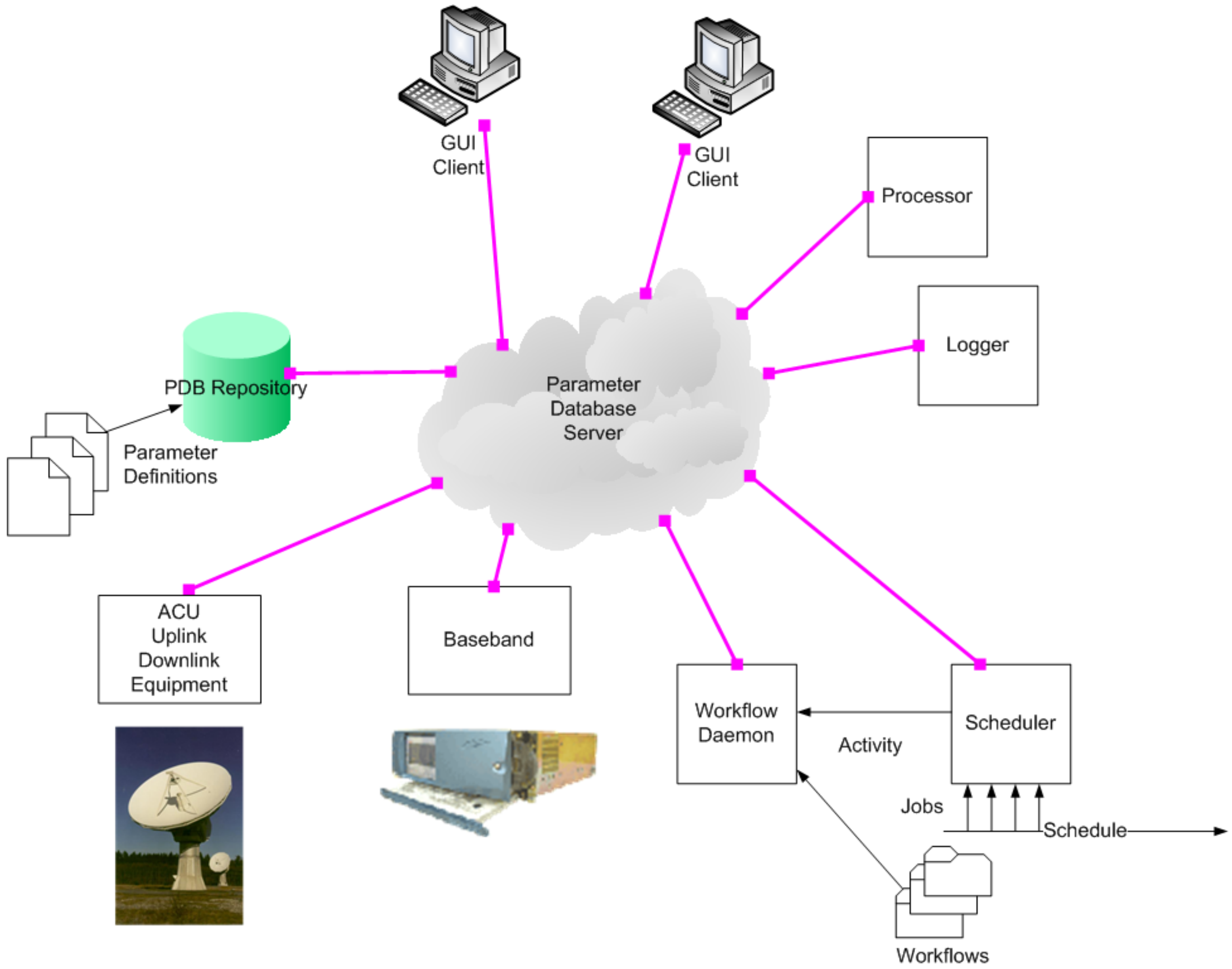
Monitor and Control System - What we had in mind ...

- generic distributed Parameter Database (PDB) with data generators and data consumers via parameter event channel
- everything that may be mapped on parameters may get monitored <u>and</u> controlled
- a real construction kit
- specialization leads to projects by exchanging only
  - generators (as they're talking to the 'real world')
  - GUIs (users want to see different things)
  - processors (internal logic)

Monitor and Control System - What we did ...

- multi-platform (Linux, Solaris, Windows) both GUI and non-GUI applications
- uses only OpenSource tools and frameworks
- fast (tested up to 12.000 updates/sec basic load and bursts even more)
- classic 3-tier architecture
- distributed, therefore scales pretty good
- fully scriptable
- decoupling of basic network communication and internal logic
- workflow usage
- reporting (template based, LaTex ;-)))
- logging of each and every parameter change
- tools for full automation are being developed right now

Monitor and Control System - Design Principle (1)

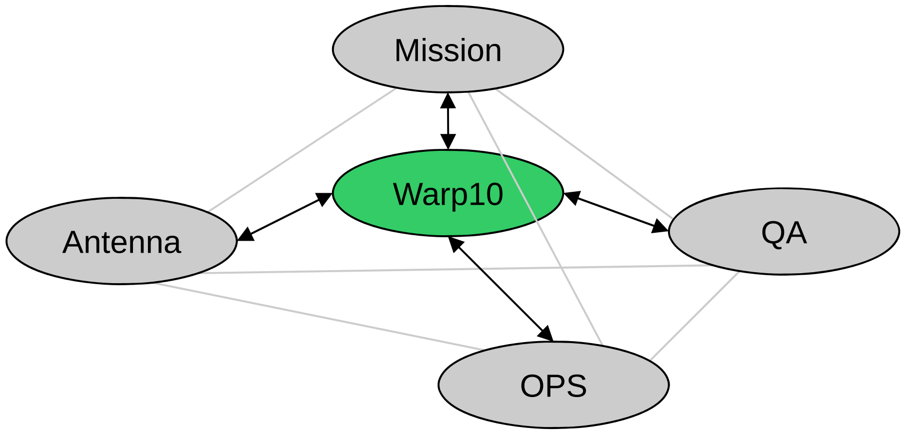


WHM MCS (Warp10)

Challenge:

Fulfill at a time the needs of

- different missions
- several antennas
- QA
- and operational issues



PDB construction kit and mission parameter abstraction layer does the job

WHM MCS (Warp10)

Some extra features:

- distributed and centralized operations is possible
- version controlled:
  allows for automated rollouts:
  CVS tree -> compile -> configure -> install -> running operational
  is one single button
- backup and archiving of sources, configuration and products
- fully redundant for highest availability
- state machine 'knows' the state of an antenna at any time and permits or forbids further configuration steps or actions
- resource management (devices)
- proxies:
  - interconnecting antennas and whole station
  - crossing network areas
- hierarchical MON display

Monitor and Control System - Available Parts

Online Applications

- Server (provides Channels) and Repository (Backend, incl small GUI)
- Generators
- GUIs (specialized and generic ones)
- Processor (scriptable or plugin)
- Proxy
- Logger
- Workflow GUI
- Workflow Daemon
- (Scheduler)

Offline Applications

- Admin GUI
- Logger GUI
- Report Generator
- Starter

Columbus Ground Segment and Operations

- The European decentralized operations concept enables all participating countries to establish a transnational centre of competence that actively cooperates in European participation to the International Space Station (ISS).
- Operating this Ground Segment is a significant challenge for the Ground Operations Team at Col-CC, not only due to the vast number of facilities and the related world-wide distribution, but also because of the number of different users (Columbus and ATV flight control, payload facilities, engineering support, PR) with their specific operational needs and constraints.
- The approach of the Columbus Ground Segment can be considered as precursor for future project with similar requirements regarding
  - Duration of Program
  - Availability of Core Services
  - Worldwide Distribution of Program Partners

The ESA Ground Segment – a unique network

This ESA Ground Segment with its distribution capability and usage requirements is unique in the space exploitation activities but can indeed applied as a precursor for future manned space missions, which require multi-national collaboration.

Large Distribution

- Connecting 21 Centers in Europe
- Interfacing with International Parnter Sites/networks
(NASA, RSA, *JAXA*)

Multiple Usage/User profiles

- Control Centers, Engineering Centers, Experiment Facility Centers, Experimenters, Training Center, Management Entities
- Multiple Missions: Columbus, ESA Payloads, ATV
- High flexibility in configuration

Parallelism of Activities

- Execution of current missions
- Preparation and Training for next increments
- Testing and Validation of enhancements
- Post evaluation

Nearly permanent coverage

- Few and short LOS
- High availability for core segment required

Parallelism requires multiple instances of (sub-)systems

- For the Main Systems 3 discrete instances are available:
  - **Real-Time** for Operations
  - **Simulation** for Preparation and Training
  - **Test** for Sustaining Engineering

- Nominal support of two activities in parallel (ops and sim/test) reality: two 'big' activities and some small ones
- Instances required to be totally decoupled to support
  - Different configurations for operations and preparation
  - Testing & Validation of new configurations, software/hardware releases and ops products
  - Different data basis (rt data vs. sim data)
  - Training with Simulator(s) and failure injections
- Different instances feasible for Data, TM/TC services and Ops Support Tools
- Not feasible or some draw backs for Voice, video, network, and management services

Long Lifetime requires sustaining engineering

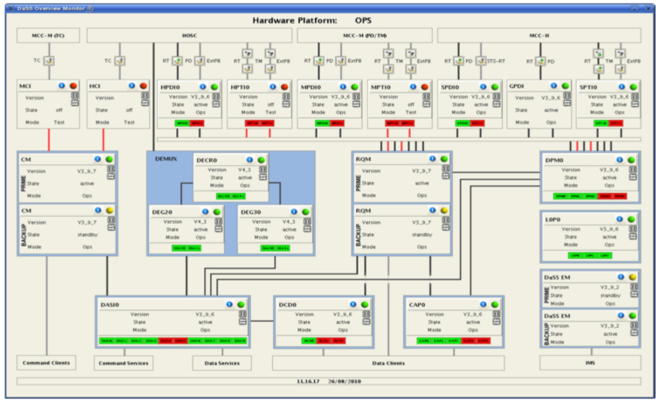
- New experiments/missions require
  - new configurations
  - adapted or even new services
  - Eventually new facilities to be added
- Maintenance/Obsolesence
  - of single equipment (hardware, software)
  - of entire services or subsystems

    E.g. we migrated already Wan technologie, Voice System, Data Storage, Network hardware, Server, Computer hardware
- Maintenance, and migration(!) activities with minimal interruption of service at least for operations
  - Importance of test instances
  - Complex planning required
  - Strict process: test -> validation -> migration in operational system

High availability - few downtimes

- Usage of a relay satellite system
  - Small percentage of LOS events
  - Short LOS periods a few minutes to max 30 min.
  - -> nearly permanent data flow
- Few downtimes of ground segment systems
  - Every downtime means impact on operations
  - Corrective maintenance to be coordinated with all(!) users
  - Downtimes for single services rather than for the entire ground segment
    - Careful impact analysis for this highly integrated system
- High availability for manned mission required
  - Redundant systems, but
    - Automatic failovers sometimes sources for single failures
    - Redundancy of end-to-end service is not that easy
    - Decupling of redundancy is sometimes required for troubleshooting
  - Troubleshooting vs. restoration of service
    - Main aim is to continue service rather than to investigate failure

Ground Segment Operations



- Ground Control separated from Flight Control
  - In order to support multiple missions in parallel
  - Separate Control room/area with dedicated layout
  - Dedicated team organization
  - Ground Control Team and GS Engineering Team in one organization
- Ground Segment Planning
  - Dedicated operations planning (Tool & Position)
  - Long-Term overall Planning
- Maintenance Structure
  - Level 1: helpdesk and service restoration by GCT
  - Level 2: maintenance by local system specialists
  - Level 3: vendor support
  - Overall coordination by GCT
- Hierarchical System Monitoring
  - Integrated Management System for Service Monitoring & Control
  - Element Management Systems for each System
  - Remote Control for all equipment outside the Control Center
- Configuration Management
- Hierarchical Anomaly Reporting

Operator Profile

- Many interactions with different users
  - Overall knowledge of all different mission
    - For user support even a basic knowledge of the different experiments and on-board facilities is required
  - Situation awareness also of on-board events
- Level 1 Maintenance requires a deep knowledge of GS Systems
  - 2 Positions required with Subsystem Matter Expertise
  - Close coordination with Subsystem Engineering Team
  - Information flow about system changes (problematic especially due to shift work)
- Most operators have an engineering degree
  - Shift work must be made attractive
    - Console/shift work combined with office tasks
  - Rotation of personal – high attrition rate
    - Knowledge must be kept
    - Rotation internal project to be offered
- Team Spirit Activities - Motivation

GSOC Security

Towards an Information Security Management System for GSOC

Driven by the so called Satellitendatensicherheitsgesetzes (SatDSiG) (law on satellite data security, mainly established for TSX/TDX), German Space Operation Center decided End 2008 to design, implement and maintain a coherent set of policies, processes and systems to manage risks to its information assets, thus ensuring acceptable levels of information security risk.

First Steps:

- develop a set of policies
- select a project for implementation
- identify the gaps and risks for the selected project
- develop an implementation plan to overcome the identified gaps
- audit the initiated process

Goal: Certification of the ISMS (ISO 27001)

GSOC ISMS

Status:

- a set of policies was created (high level)
- TSX/TDX was selected as a prototype candidate
- the risks within the ground segment were defined
- gaps to the policies were listed and an implementation plan is developed
- a first audit should be finished mid June 2011 with a certification of the TSX/TDX system.

Next steps:

- Close the defined gaps, be ready for recertification
- Define other projects in GSOC to follow the forerunner

GSOC ISMS

Policies are developed for

- information security - risk management
- information classification
- personal
- physical security
- secure operations
- user management
- subcontractor handling
- secure networking
- secure development
- logging and monitoring
- cryptography
- accident management

GSOC Information classification

GSOC Information classification is based on rules given in DLR and ESA:

1	**Offen**
2	**Intern / Internal-Use-Only**
3	**Vertraulich / Confidential**
4	**Verschlusssache (VS)**

	1	2	3		4	
ESA	ESA Unclassified	ESA Unclassified	ESA Unclassified	ESA Restricted	ESA Confidential	**ESA Secret**
Deutschland				VS-NfD	VS-Vertraulich	**Geheim**
DLR		normal	Vertraulich/ hoch	VS-NfD/ sehr hoch	VS-Vertraulich/ sehr hoch	**Geheim/ sehr hoch**
GSOC	**Offen**	**Intern**	**Vertraulich**	**VS-NfD**	**VS-Vertraulich**	**Geheim**

Source:

- ESA Security Directives, ESA/ADMIN/IPOL(2008)6, p.75f
- DLR-policy for handling of confidential information, November 2009
- IT-Security Concept of DLR, Februar 2009

Security Summary

If you want to establish an ISMS to get certified according ISO 27001

- start with a small project
- take, what is already in place
- be aware of the work to be done – not only in defining the policy but in implementing the policy in daily work.

good luck