Ground Stations & Network Operations Center

DLR

Ground Stations & Network Operations Center

The Network Operations Center (NOC) is an organizational entity that provides various infrastructure, communications and ground station services for satellite missions. The basic idea of the NOC is to operate service-oriented, in order to provide users with defined, standardized services with customized service levels.

The Network Operations Center provides an international Ground Station Network cooperation, the communication tools and the corresponding software interfaces.

In addition, topics such as troubleshooting support, data and network security support, commissioning of third parties, frequency coordination and support of tests or validations are also within the competence of NOC.

The NOC leverages the benefits of existing infrastructure of the German Space Operations Center (GSOC) and enables optimization between multiple missions through smart resource utilization. Multiple tools and software are used to provide a defined level of service for each project. Among these tools, the standard Space Link Extension (SLE) communication subsystem between the control center and ground stations is essential. It uses the CCSDS standard SLE which is now a widely adopted protocol for terrestrial communication in space applications. The SLE gateways can support various additional protocols to provide an interface to other components in the chain. GSOC uses the SLE switchboard (SSB) or the Weilheim service provider for cortex (WSP-C) to connect to the mission monitoring and control system and the baseband device in the ground station.

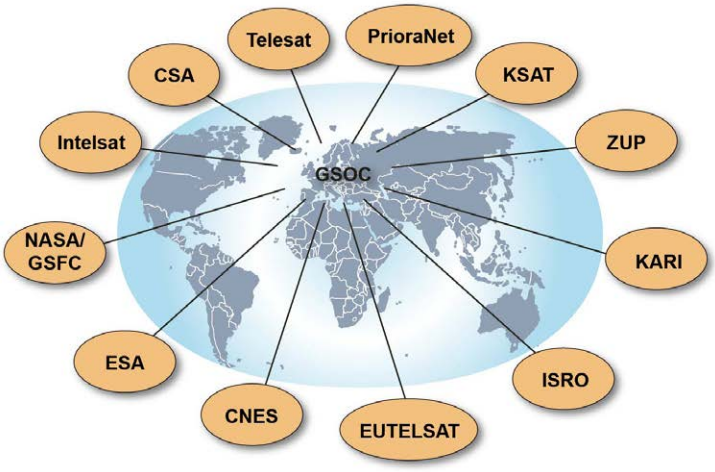


Fig. 1-1 International GSN cooperation from the perspective of an MCC-like GSOC

Point of Contact

German Aerospace Center (DLR)
Space Operations and Astronaut Training
Marcin Gnat
Münchener Str. 20, 82234 Weßling

Phone: +49 8153 28 3201
E-Mail: Marcin.Gnat@dlr.de

DLR.de/RB

Table of Contents

Publisher
German Aerospace Center (DLR)
Spacecraft Operations and Astronaut Training
Münchener Straße 20, 82234 Weßling

2. NOC Core Services

NOC Core Services are central services of the GSOC NOC. They are required as baseline for provision of other NOC services. NOC Core Services cover project initiation at NOC, inclusion of respective administrative mechanisms (like contracting, purchasing and accounting) as well as definition of internal personnel assignment. In a typical customer project situation, the first thing to do is the selection of the NOC Core Service(s). This selection sets the specific service level for complete mission support.
The Core Services also defines the respective contractual frame in terms of service provision time period.

Service ID	Type	Description
S-NOC-01 (P/L/R)	NOC Service - Basic	**This service includes:** • Preparation (S-NOC-1P) – Analysis of mission requirements – Preparation of detailed cost estimation – Preparation of NOC design for the mission and delivery as an input – Participation in 3 local project meetings or teleconferences (no travel) – Configuration of NOC systems (network, data storage) • LEOP support (S-NOC-1L) – Support of pre-LEOP tests (up to 20h of test time) – Support of LEOP operations by engineering during one day shift and rest by NC operator, for maximum of 2 days – On-call engineering support during LEOP days – Provision of post LEOP report • Mission support in routine phase (S-NOC-1R): – Normal priority – Support of the mission during routine passes by Network Controller of NOC (operator support) or automatically (no operator) – Participation in project meetings (4h a month) – Monthly inputs to project reports • Basic scheduling of ground station contacts – Simple requests, – Delivery of station provided available passes • Usage of station passes according to the station used – In case of DLR stations following station service can be used (as described in Module "Ground Station Support"): – Short Duration Pass – Long Duration Pass S-NOC-01P, L and R may be charged separately. The S-NOC-01R is a routine support charged with yearly fee.
S-NOC-02 (P/L/R)	NOC Service - Extended	**Includes S-NOC-01 NOC Service - Basic, additionally:** • Preparation (S-NOC-2P) – Preparation of separate NOC Design Document – One additional travel for meeting/kick-off – Consulting regarding ground station selection – Configuration of NOC systems (network, data storage) – Up to 50h of test for infrastructure and interface tests for customer support – Provision of Ground Operation Procedures as input – On-call engineering support during critical tests or simulations (up to 10 days) • LEOP support (S-NOC-2L) – Support of pre-LEOP tests (up to 50h of test time) – Support of LEOP operations by engineering during two shifts a day and rest by NC operator, for maximum of 7 days – Provision of post LEOP report • Mission support in routine phase (S-NOC-2R): – Normal priority – Support of on-call engineering – Total 50h of engineering troubleshooting in year included – Participation in project meetings (8h a month) – Monthly project reports • Extended scheduling service: – Conflict resolution – Rule based scheduling (shopping lists, standing orders) S-NOC-02P, L and R may be charged separately. The S-NOC-02R is a routine support charged with yearly fee.

Service ID	Type	Description
S-NOC-03 (P/L/R)	NOC Service - Premium	**Includes S-NOC-02 NOC Service - Extended, additionally:** • Preparation (S-NOC-3P) – Up to three additional travel for meetings/kick-off – Consulting regarding ground segment design (inkl. network, software, operational aspects) – Provision of Ground Operation Procedures Document – Up to 200h of test for infrastructure and interface tests for customer support – On-call engineering support during critical tests or simulations (up to 20 days) • LEOP support (S-NOC-3L) – Support of pre-LEOP tests (up to 100h of test time) – Support of LEOP operations by engineering during three shifts a day complimented by NC operator (for for example standby or drift phases), for maximum of 14 days – Provision of post LEOP report • Mission support in routine phase (S-NOC-2R): – High priority – Total 100h of engineering troubleshooting/support in year included S-NOC-03P, L and R may be charged separately. The S-NOC-03R is a routine support charged with yearly fee.
S-NOC-04 (P/L/R)	NOC Service - Custom	**Agreed upon contract.** S-NOC-04P, L and R may be charged separately. The S-NOC-04R is a routine support charged with yearly fee.

3. NOC Engineering Support

The engineering support is a widely understood support of qualified personnel to different tasks which may occur during preparation and execution of space missions. The selection of personnel is based on the type of task and can be understood as a long term engagement as well as ad hoc support in case of some critical situation.

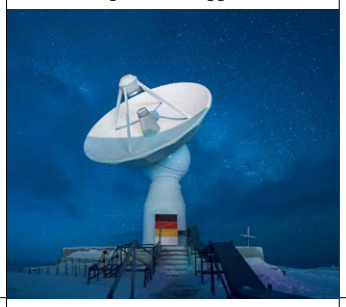
Service ID	Type	Description
SA-NOC-10	NOC Engineering On-Call	Engineering personnel is on-call and can be called in for support at any time (24/7). Can be ordered day-wise and is accounted per day per engineer.
SA-NOC-11	NOC Engineering Support	Engineering personnel is on site and supports the customer related tasks. This service is accounted hourly.

4. Ground Station Integration

Ground station integration services are subservices which are mainly executed under specific NOC Core Services, depending on the selected ground stations. They comprise technical tasks and documentation. The actual administrative tasks related to third party ground stations therefore belong to the NOC Core Services.

The below services are mainly performed by the Ground Data Systems team, with support of ground station personnel and additional experts, as required (i.e. voice, network, software).

The Ground Station Integration services are typically performed in phase D of space projects, which typically stretches from earliest 18 months before launch until the Technical Acceptance Review (TAR).

Service ID	Type	Description	Used Resources
S-GSN-01	Station Integration Weilheim (WHM) 	**Station integration as described in:** Service Portfolio Module Ground Station Support **Additionally:** • Configuration of offline file transfers • Configuration of SLE • Testing • Preparation of documentation: – DMR – ICD – Test Plan – Test Report	Weilheim Ground Station Network and Systems Control Room SLE Communication Subsystem GDS Engineering Team
S-GSN-02	Station Integration O'Higgins (OHG) 	**Integration of ground station in O'Higgins. Includes:** • Station configuration • Configuration of offline file transfers • Configuration of SLE • Testing • Preparation of documentation: – DMR – ICD – Test Plan – Test Report	O'Higgins Station Network and Systems Control Room SLE Communication Subsystem GDS Engineering Team
S-GSN-03	Station Integration Inuvik (INU) 	**Integration of ground station in Inuvik. Includes:** • Station configuration • Configuration of offline file transfers • Configuration of SLE • Testing • Preparation of documentation: – DMR – ICD – Test Plan – Test Report	Inuvik Station Network and Systems Control Room SLE Communication Subsystem GDS Engineering Team
S-GSN-04	Station Integration Neustrelitz (NSG) 	**Integration of ground station in Neustrelitz. Includes:** • Station configuration • Configuration of offline file transfers • Configuration of SLE • Testing • Preparation of documentation: – DMR – ICD – Test Plan – Test Report	Neustrelitz Station Network and Systems Control Room SLE Communication Subsystem GDS Engineering Team

Service ID	Type	Description	Used Resources
S-GSN-05	Generic Ground Station Integration - Service Level Basic	**Integration of generic ground station.** **Typically this would be integration of third party station for offline only / reception only support**. **Includes:** • Analysis of customer requirements • Analysis of Space 2 Ground ICD • Station configuration according to S2G ICD • Testing (up to 5h of test time) • Configuration of offline TM file recording and provision (RAW, Cortex or TMR formats*) • Preparation of documentation: – ICD (Interface Control Document) between station and customer *) Specific formats availability may vary on actual station capabilities	Ground Station GDS Engineering Team
S-GSN-06	Generic Ground Station Integration - Service Level Standard	**Integration of generic ground station. Includes Service Level Basic (S-GSN-05) and additionally:** • Configuration of tracking products production and provision (angle)* • Configuration of SLE* – SLE configuration defined by NOC – SLE Online (RAF, RCF, FCLTU) – Maximum 2 Service Instances • Testing (up to 20h of test time) • Preparation of documentation: – DMR (Detailed Mission Requirements) – Test Plan – Test Report *) Specific data, protocols and formats availability may vary on actual station capabilities	Ground Station Network and Systems Control Room SLE Communication Subsystem GDS Engineering Team
S-GSN-07	Generic Ground Station Integration - Service Level Extended	**Integration of generic ground station. Includes Service Level Standard (S-GSN-06) and additionally:** • Configuration of tracking products production and provision (angle, Doppler, ranging)*, – Tracking data provided in Cortex RAW or CCSDS TDM format* – Calibration data available • Configuration of SLE* – SLE configuration provided by Customer – Maximum 4 service instances • Testing (up to 50h of test time) *) Specific data, protocols and formats availability may vary on actual station capabilities	Ground Station Network and Systems Control Room SLE Communication Subsystem GDS Engineering Team
S-GSN-08	Generic Ground Station Integration - Service Level Premium	**Integration of generic ground station. Includes Service Level Extended (S-GSN-07) and additionally:** • Configuration of tracking products production and provision (angle, Doppler, ranging)* – Includes testing of tracking data quality (i.e. by tracking existing spacecraft) with up to 20h of tracking time. • Configuration of SLE* – Any number of service instances – SLE Online (ROCF) – SLE Offline • Possibility to use another online or offline protocol (i.e. Cortex) • One re-configuration of station or SLE (i.e. due to changes in Space 2 Ground ICD) included • Testing (up to 100h of test time) This service level enables also custom development (accounted according to NOC Engineering Support) for additional file formats or features. *) Specific data, protocols and formats availability may vary on actual station capabilities	Ground Station Network and Systems Control Room SLE Communication Subsystem GDS Engineering Team
S-GSN-09	RF Compatibility Test Support National	RF Compatibility Test (RFCT)	RF Compatibility test facilit
S-GSN-10	RF Compatibility Test Support International		Respective test facility as of station selected

5. Station Scheduling

The ground station scheduling is a task of planning, booking and coordination of station allocations for space missions. It includes in some cases special algorithms for conflict avoidance or rule based scheduling, whereas at the same time it must support multiple interfaces, protocols and data formats for exchange between all relevant parties. Station scheduling is mainly involved during LEOP and routine phases.

The GSOC Scheduling Office provides the following services:
- Importing of station visibilities from flight dynamics
- Reception of pass requests from internal and external projects
- Reception of maintenance requests and notifications from stations
- Coordination and conflict resolution between projects
- Generation of weekly published schedule (XML and Text formats)
- Automated e-mail notification on new schedule releases

The station scheduling is currently not provided as a standalone service, and therefore is to be considered as an integral part of NOC Core Services.

6. WAN Link Integration

The services in this section are generally focused on design, implementation and integration of Wide Area Network links for space missions. In most cases such links will be set up between GSOC and ground stations or ground station providers, or between GSOC and another control center. For some missions WAN Link Integration services may be optional (customers may choose to provide WAN links on their own), and for some may be implied by selection of other services or options.

WAN Link Integration services are solely preparatory services, and explicitly do not cover routine/operations phase. The maintenance and troubleshooting of WAN links is part of respective NOC Core Services.

Service ID	Type	Description
SA-NOC-03	WAN Link Integration - Service Level Basic	**This service includes:** • Analysis of requirements • Consolidation of design together with all involved parties • Ordering of required equipment* • Coordination and ordering with communications provider if needed* • Configuration of VPN over Internet • Documentation of final design *) Additional hardware or external provider cost, especially recurring costs, will be charged extra
SA-NOC-04	WAN Link Integration - Service Level Standard	**This service includes:** • Single MPLS based link of bandwidth selected by customer* • Analysis of requirements • Consolidation of design together with all involved parties • Ordering of required equipment* • Coordination and ordering with communications provider* • Configuration of link • Documentation of final design *) Additional hardware or external provider cost, especially recurring costs, will be charged extra
SA-NOC-05	WAN Link Integration - Service Level Extended	**This service includes:** • Single or redundant MPLS based link of bandwidth selected by customer* • Analysis of requirements • Consolidation of design together with all involved parties • Ordering of required equipment* • Coordination and ordering with communications provider* • Configuration of link • Documentation of final design • Preparation of monitoring configuration *) Additional hardware or external provider cost, especially recurring costs, will be charged extra
SA-NOC-06	WAN Link Integration - Service Level Premium	**This service includes:** • Redundant MPLS based link of bandwidth selected by customer* • Analysis of requirements • Consolidation of design together with all involved parties • Ordering of required equipment* • Coordination and ordering with communications provider* • Configuration of link • Documentation of final design • Preparation of monitoring configuration • Possibility to additionally set up VPN/Encryption over these links* *) Additional hardware or external provider cost, especially recurring costs, will be charged extra
SA-NOC-07	WAN Link Integration - Custom	Agreed upon contract.

7. Teams supporting NOC

7.1 GDS Project Management Team

The GDS Project Management Team manages NOC projects and takes care of tasks like contracts, orders, personnel and resource planning. Each NOC project gets its responsible GDS manager who takes care about organizational topics as well as coordination within NOC teams and with external partners.

7.2 GDS NOPE Engineering Team

The GDS Network Operations Engineering (NOPE) Team takes care of numerous technical and organizational tasks related to specific satellite missions. As a rule, each mission is assisted by a specific GDS engineer who accompanies the project from Phase C onward, attends project meetings and acts as contact person in the absence of the GDS manager. The main tasks of the GDS engineers are mission preparation (including LEOP) and support, performing connection tests, preparing communication device configurations, troubleshooting and analysis.

7.3 Network Control Team

The Network Control (NC) Team and the associated Network and Systems Control Room (alias "Systems" Room) are part of GSOC's operational chain. The team consists of 24/7 shift workers and support technicians who coordinate the shift team and control the work and operations in the "Systems" Room. This room is a central hub where all connections (operational and technical) from all GSOC control rooms or external partners are routed to worldwide ground stations. As a permanently staffed position, it also functions as a voice contact center (either via telephone or a dedicated voice conferencing system) with all projects and all stations, enabling for instance a rapid response in case of emergencies. In addition, this function is needed for example to coordinate extraordinary contact requests during holidays or at night when the GSOC scheduling office is unattended. The main tasks of the "Systems" include network control in routine operation, support of NOPE in LEOP, monitoring of connections and the network in GSOC.

7.4 Scheduling Office

The Scheduling Office is a service that becomes increasingly important with a growing number of missions and available antennas, as coordination between these elements becomes essential to avoid conflicts and to take advantage of synergies between missions. Currently, the Scheduling Office at GSOC is staffed by one person and operates during office hours. The Scheduling Office provides a weekly contact plan for all GSOC missions and supports the missions in conflict resolution. Scheduling Office uses the Station Scheduling Subsystem for its operations.

7.5 Network Infrastructure Team

The Network Infrastructure Team mainly takes care of the GSOC internal network, its maintenance, configuration and troubleshooting. Additional tasks related to general IT topics as well as ordering and technical integration of WAN lines are in the responsibility of this team.

7.6 Data Center Team

The Data Center Services Team maintains and improves the data center of GSOC, providing server and network application infrastructure for all of the NOC Services.

7.7 Infrastructure and Hardware Team

The infrastructure group is responsible for the provision, maintenance and repair of the control center infrastructure. The term "control center infrastructure" encompasses most of the hardware within GSOC´s buildings 133 and 140 and some others.

The responsibilities of the group concerning buildings, rooms and hardware are defined in a handbook, where also the interfaces to other DLR departments and the processes are clarified in full detail (e.g., how to request the services of the group, on-call services, etc.).

The group is also responsible for the roof antennas of building 140/03 and the hardware of the Voice and Video system whilst operational support of those systems is provided by the technical services groups.

7.8 Security Team

Security Management is a process where the department of Controlling and Acquisition (CTA) has the overall responsibility. The department for Communication and Ground Stations (KOB) supports this process in two areas:

- Assistance within single projects when questions concerning security appear (Project Security Manager)
- Technical aspects of the security domain

In addition, the technical supervision of the GSOC admission control system is performed by the security group.

7.9 Software Team

The Software Team is in charge of developing, updating and supporting internal operational software used in the context of the NOC. These are dedicated solutions for the control center but using classical space standards like defined by CCSDS:

- SLE communication software to transport Telemetry and Telecommand from/to the spacecrafts
- Antenna Monitoring & Control system to control the antennas in Weilheim Ground Station
- Automation System to operate spacecraft contacts automatically using the Scheduling information

7.10 Technical Services Team

Technical Services of KOB encompass groups which support the operations of the voice and video systems, the archive systems and the Wide Area Network. In addition, the overall system engineering and the organisation of maintenance and logistics are performed by these groups. One group is in charge of supporting projects (support of offer preparation, project planning, project controlling and preparation of proper project documentation according to ECSS standards).