For Service Providers, the network is responsible for driving revenue streams. For Enterprises, the network is critical to all business operations. Both organizations must implement network automation to simplify the process of provisioning and controlling network applications and services.

ND SatCom’s Network Management System (SKYWAN 5G NMS) enables enterprise customers and service providers to manage SKYWAN 5G networks with its DVB-S2X gateways. Network operators get an easy to use toolset to plan, roll-out and maintain the satellite communication network. Common tasks are automated and the user is guided step by step, e.g. when planning the network or provision and deploy new services. The NMS checks the entered data instantly to ensure consistent network-wide configuration at any time.

SKYWAN 5G NMS implements management functions at the Service Management Level (SML) of the OSS architecture enabling operators to focus on creating new revenue streams without having to deal with issues around integration, deployment and infrastructure management.

**KEY FEATURES**
- Client / Server System
- WebUI, Command Line Interface
- Multi-Language Support / Translation Editor
- LDAP user management
- Virtual Appliance
- Fail-safe Transaction based changes
- Device Inventory
- Service Level
- Software Manager

**PLUG AND PLAY**
- Network changes without service outage
- Real-time dynamic service orchestration
- Offline planning & export of validated device configuration
- Browser interface – ease of use without the need to install specialist software and extensive training
- Full featured free of charge NMS virtual appliance deployed rapidly within a few clicks.
**SKYWAN 5G NMS**

Network availability and reliability is most important to run a successful business. Automated, easy to access and to follow procedures save time and costs in managing the communication links and enables to instantly adapt to changing requirements. SKYWAN 5G NMS delivers measures for every aspect to maximize network uptime and provide an encouraging user experience.

**Client-Server Architecture – easy, secure access**

The SKYWAN 5G NMS is based on the Client-Server architecture. The physical server can be located anywhere in the network, just requiring IP connection to a SKYWAN 5G network entry point. The Clients access the NMS functions using a web browser with the benefit, that no special vendor software is required. All access is secure (WebUI uses HTTPS, CLI uses SSH) and the built-in user management supports the user authentication via LDAP (optionally).

**Centralized Management - With Transactions**

The transaction engine is the heart of the server-focused centralized network management. It handles transactions from the operations at the service layer to the actual deployment of configuration changes in the network. Using centralized management reduces operational complexity, improves security, and lowers risk through consistent policy application. The NMS applies all service changes towards the network as an atomic change-set, using distributed transactions. This ensures that the network is always in a consistent state and can automatically recover from failed configuration changes.

**Service Provisioning in real-time – Fail-safe with transactions**

The NMS and the SKYWAN 5G satellite router is designed to handle configuration changes online. In addition several measures for fail-safe operations are applied to achieve carrier grade link availability:

- Policy, relation-checks avoiding configuration conflicts on both node and network level
- Rollback to previous good known state
- Dry-run, List of changes ready to commit supports the operator to validate changes

**Network Availability – autonomously operating network**

The NMS is designed to deliver carrier-grade availability based on best-of-breed technology:

- Physical server built for 24/7 operation
- Hypervisor Type-1 for production systems. Less stringent Type-2 Hypervisor can be used for demonstration or training purposes on any PC/Laptop.
- Linux Server system with long term support.
- Backup and restore functionality.

Best of all, a provisioned SKYWAN 5G network in operation does not require an online NMS. As such, NMS maintenance tasks can be executed anytime without affecting communication services.

**Intuitive User Interface – Increases Productivity**

SKYWAN 5G NMS consists of two components:

- TDMA Calculator – a stand-alone tool to dimension the MF-TDMA channels and optimize the TDMA air interface for throughput and efficiency.
- NMS appliance – main application for centralized multi-client network management.

The NMS WebUI offers extensive support through:

- Effective Layout: Status Area, Devices, Services, Alarms, Dashboards
- Online validation of input parameters, comprehensive help text to every parameter, display of ranges
- Plausibility, range checks
- Automated tasks, e.g. planning and provisioning of Services, Dashboards providing real-time statistics and status.
SKYWAN 5G NMS Logical Structure and Interfaces

The NMS application provides northbound user interfaces (WebUI, CLI) and interfaces for other Management Applications. Network changes requested by a network engineer through the NMS WebUI or CLI are translated into the device configuration and sent over the southbound interfaces to the network elements. The southbound interfaces can be locked or unlocked for individual or all devices, specifying if the network element is managed or not. Offline stations are thus not polled, do not count for the status reports and management traffic overhead can be saved. All interfaces are secure requiring authentication and NETCONF (SSH), CLI (SSH) and the WebUI (HTTPS) are additionally encrypted. The NMS knows the capabilities of the managed network elements from its YANG device models containing all features, ranges and so on. Based on the device and service models the Service Manager, Software Manager and Device Manager can provision and maintain the services in the network.

NMS and SKYWAN 5G Data Exchange

The NETCONF protocol is used to configure the SKYWAN 5G satellite routers. One particular strength of NETCONF is its support for robust configuration change using transactions involving a number of devices. The XML based data encoding for the configuration is displayed in the NMS and can be read by the operator.

NMS Monitoring – Network Status in real-time and easy to realize

Device reachability is monitored periodically using ping. Other monitored data is collected using SNMP. This light-weight approach requires only 0.5 kbps management traffic per station and is providing fast status updates at the same time. An area displaying the overall network status indicated by a traffic light, a sidebar with the most important charts on the home screen and the individual device status displayed in the device area enables the operator to realize the network status immediately.

NMS Software Manager

The Software Manager distributes new software packages to all network elements in the background automatically. This function also migrates the parameter database and updates all nodes accordingly. The activation time can be set when all nodes restart with the new software simultaneously. Any major failure will trigger a network wide rollback to restore services and to analyze the root cause based on logfiles and statistics.
SKYWAN 5G NMS WebUI

The NMS WebUI follows a service oriented architecture to achieve faster deployment of new network applications and services. The Service level provides a global network view and parameters just need to be configured at one place and are applied to the device level accordingly. This way changes affecting multiple or all nodes are performed with a few clicks, e.g. moving the network to a new space segment when troubleshooting transponder issues. The user can customize the Home screen individually by closing or adding Services and Dashboard Charts and filtering the device view.

The NMS greatly facilitates effective network management by the following functions:

- **Multi-user capable:** Conflicts caused by concurrent operator configurations are detected by the NMS Server before uploading and activating configuration changes at individual nodes.
- **Devices:** All managed devices are shown as icons with status coloring and drill-down menus to modify specific parameters.
- **Services:** Services allow to visualize the status and modify devices on a network wide level. A single parameter change may affect either one node only or fire a network transaction to hundreds of remote SKYWAN 5G nodes- with no difference to the operator. Top-level services supported by SKYWAN 5G NMS are for TDMA, VRF, IP QoS, DVB-S2, Multicast, Encryption and Routing. Each top-level service is further sub-divided in more granular services.
- **Dashboards:** Carousel of monitoring charts showing connectivity quality, satellite traffic, SNR, or reachability either per network or per specific node. From the connectivity quality chart further TDMA statistics like TDMA connection quality, errors and BER statistics are accessible; the SNR chart is the entry point to node-specific TDMA signal quality charts.
- **Automated Processes:** Join / Leave for spare part management, software uploads, etc.
- **CLI:** scripting to automate repetitive tasks, network wide changes with a single command
- **Alarm Center / Logs:** All incidents are logged with severity and the operator can respond to it.
- **Device Inventory:** SKYWAN 5G, DVB Gateway, Transmitter and Receiver settings
- **IP standard tools:** ping, tracert
- **Commit:** Full transparency and traceability for changes. Transactions can be tested in advance (dry-run), cancelled, committed and the network can be set to earlier configurations (rollback points selected from a list of configurations).

KEY BENEFITS

- Network status at a glance
- Ease of use
- Service-oriented network wide configuration screens
- Device configuration screens
- Network wide software upgrades
- CLI scripting
Local and Network Management — Same Look & Feel

Operating communication networks typically involves different roles focusing on specific tasks:

- **Network Engineer**: concentrates on network planning, centralized management, preparation of site configuration, new services, monitoring and optimization of network performance
- **Commissioning Engineer**: concentrates on initial startup of a station, test procedures to ensure that equipment works to its specification, troubleshooting and repairing faults

Network and Commissioning Engineer work closely together and benefit from the same look & feel of the SKYWAN 5G NMS and the SKYWAN 5G user interfaces (WebUI, CLI). As such both can perfectly interact as all know the structure and meaning of the parameters. There is no difference in the complexity: a hub is as simple to operate as a remote station.

Once a remote station is hooked up to the network, all further monitoring, changes and optimization is done centralized through the NMS.

Although the Commissioning Engineer has a local focus, once the remote station joined the network other sites can be reached and accessed as well, for example when the connectivity and performance is verified and compared to other sites.

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**Glossary**

**OSS** Operations Support Systems - dealing with the telecom network itself, supporting processes such as maintaining network inventory, provisioning services, configuring network components and managing faults

**BSS** Business Support Systems - dealing with customers, supporting processes such as taking orders, processing bills and collecting payments

<table>
<thead>
<tr>
<th>CLI</th>
<th>Command Line Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>WebUI</td>
<td>Web User Interface</td>
</tr>
<tr>
<td>AAA</td>
<td>Authentication, Authorization, Accounting</td>
</tr>
<tr>
<td>NMS</td>
<td>Network Management System</td>
</tr>
</tbody>
</table>

| LDAP | Lightweight Directory Access Protocol |
| REST | Representational state transfer |
| XML | Extensible Markup Language |
| YANG | Data modeling language |

| NETCONF | Network Configuration Protocol |
Use Cases – Automated Processes

Central Management: NMS
- Wizard based Network Planning.
- Network Maintenance Wizards for stations joining and leaving the network.
- Spare part handling for replacing network nodes.
- Export of a configuration and software data package for each device for easy station line-up.
- Preconfigured BUCs and LNBs.
- QoS Templates for DNS, FTP, SSH, Telnet, VoIP, and NMS traffic templates for QoS.
- Troubleshooting with local and remote Ping and Trace-route within any VRF.
- TDMA service for configuring the satellite link layer for multiple spots, frequency ranges and different network topologies.
- VRF service for configuring the VRF network wide IP layer including VLANs.
- IP address scheme proposing auto generated IP addresses for all subnets.
- Routing service for OSPF with auto generated OSPF interfaces based on your IP interface configuration.
- Routing service for VRF network wide route redistribution in one single view.
- Routing service for VRF network wide BGP filter configuration in one single view.
- Routing service for VRF network wide static route configuration in one single view.
- Option for auto generating routes based on your network topology.
- Multicast service for the VRF network wide configuration of multicast groups needed for multicast traffic forwarding.
- Encryption service for centralized configuration your encryption engines.
- Fully integrated user administration with predefined user groups and rules.
- LDAP support for central user authentication within your domain.
- Software Manager for scheduling of network wide software upgrades with automatic fallback handling.
- Web based Server Administration.
- Backup and Restore functionality.
- Commit Transactions: View changes, Validate changes, dry-run, Commit, Cancel Changes, Rollback.
- Device Inventory with CSV import.
- Easy monitoring of your network status by charts showing the network wide satellite service health status, satellite traffic, SNR and reachability.
- Preconfigured and auto maintained thresholds raising alarms for the key performance indicators of your network when your attention is needed.
- Centralized DHCP Server configuration for SKYWAN 5G network devices.
- Centralized Beam Switching configuration for SKYWAN 5G network devices.
- Multi-Language WebUI, Translation Editor to support customized translations in any language
- Generation of network status reports.
- Visualization of the TDMA link layer topology.

Local Management: SKYWAN 5G
- Wizard Station Commissioning
- Monitoring of RF signals, satellite traffic and LAN traffic incl. preconfigured thresholds making you aware of the current system state.
- Pointing & peaking on MF-TDMA or DVB-S2 signal
- Lineup Report
- Multi-Language WebUI, Translation Editor to support customized translations in any language

Security Features
- CLI over SSH
- WebUI over HTTPS
- User Management based on NETCONF Access Control model (NACM)
- VRF specific user groups for virtual network operators (VNO).
- Domain based user authentication.

Carrier Dimensioning: TDMA Calculator
- Link Layer Planning Tool
- Optimization either starting with user datarate (kbps) or space segment (ksps).

NMS Redundancy
- The Network Management System can be operated with an active NMS and many slave NMS appliances.
- Configuration changes are synchronized automatically keeping the slave NMS up to date and ready to take over the active role.
- The operator is in control of which NMS appliance operates in active or standby mode.
SKYWAN 5G NMS provides server-based centralized network management of SKYWAN 5G satellite networks and its DVB Gateways. It supports the full network life-cycle from planning and roll-out up to optimization and maintenance. The NMS virtual appliance is operated on a Dell PowerEdge Server with Type-1 Hypervisor to maximize performance and uptime. The virtualization-ready server is supporting Microsoft® Windows Server® with Hyper-V®, VMWare® vSphere® ESXi® and Citrix® XenServer®. The Dell PowerEdge R430 server is shipped with the SKYWAN 5G NMS appliance pre-installed on vSphere. With its two hot-plug hard drives operated in RAID-1 configuration data protection is ensured. The physical server can be located anywhere in the network, just requiring an IP connection to the managed network. Users access the NMS server and its services using a web browser. Multiple users can access the NMS in parallel. The NMS performs service provisioning in real-time and fail-safe with transactions. User inputs are validated instantly and plausibility checks ensure a consistent network configuration at any time. The comprehensive service view supports changes to individual or multiple network nodes with a few clicks. Templates, automated tasks, default IP address schemes, setup wizards, services for VRF/VLAN/OSPF/BGP/Static Routing/ TDMA/DVB etc. further increases productivity in setting up new applications and services on the network.

KEY FEATURES

- 1RU rack server designed for 24/7 operation
- 2 Gb ethernet ports
- 64 GB RAM
- Powerful Intel Xeon processors
- 2 hot-plug hard drives with RAID-1

PLUG AND PLAY

- PowerEdge R430 rack server with pre-installed SKYWAN 5G NMS
- Licence free NMS appliance allowing multiple installations serving several networks
- Easy web browser access with intuitive graphical user interface
- Just requiring an IP connection to the SKYWAN 5G network, the server can be placed anywhere.
## Technical Specification SKYWAN 5G NMS

### VSAT Network

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network</td>
<td>All MF-TDMA topologies including DVB-S2X outbounds</td>
</tr>
<tr>
<td>No. of TDMA nodes</td>
<td>250 nodes per appliance</td>
</tr>
<tr>
<td>No. of DVB-S2X Gateways</td>
<td>unlimited</td>
</tr>
<tr>
<td>No. of configurations</td>
<td>Single network</td>
</tr>
</tbody>
</table>

### Software

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bundle</td>
<td>Appliance download, no license required (free of charge).</td>
</tr>
</tbody>
</table>

### NMS System Requirements

#### Production Systems

Server grade hardware with Type-1 Hypervisor resources assigned to the SKYWAN 5G NMS virtual appliance:
- 32 GB memory
- 4 CPU cores (2.6 GHz each or higher)
- 100 GB hard disk
- Two physical GB ethernet interfaces

In general it is recommended that all production systems reside on server grade hardware with redundant storage and proper backup procedures in place. It is recommended to use 19" form factor.

#### Demonstration / Test systems

Type-2 Hypervisor (e.g. VirtualBox) can be used for demonstration or training purposes.

### Physical / Environmental

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions (H x W x D)</td>
<td>1RU, width 19&quot;, rack-mountable</td>
</tr>
<tr>
<td>Rack Support</td>
<td>ReadyRails™ II sliding rails for tool-less mounting in 4-post racks with square or unthreaded round holes or tooled mounting in 4-post threaded hole racks, with support for optional tool-less cable management arm.</td>
</tr>
<tr>
<td>Weight</td>
<td>4.6 kg</td>
</tr>
<tr>
<td>Temperature Ranges</td>
<td>Operational: 0 °C to 40 °C</td>
</tr>
<tr>
<td>Input Power / Power Consumption</td>
<td>100 to 240 V AC with 50 to 60 Hz, &lt; 50 Watt</td>
</tr>
<tr>
<td>Compliance</td>
<td>Fully CE compliant with RoHS and REACH, Fully EMC compliant</td>
</tr>
</tbody>
</table>

### Ordering Options

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dell PowerEdge R430 Server</td>
<td>Dell PowerEdge Server series; 19&quot;-rack version with 1 HU; 2 HDDs with RAID-1;64 GB RAM ; without monitor/ keyboard/mouse; NMS software pre-installed; for medium networks</td>
</tr>
</tbody>
</table>

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