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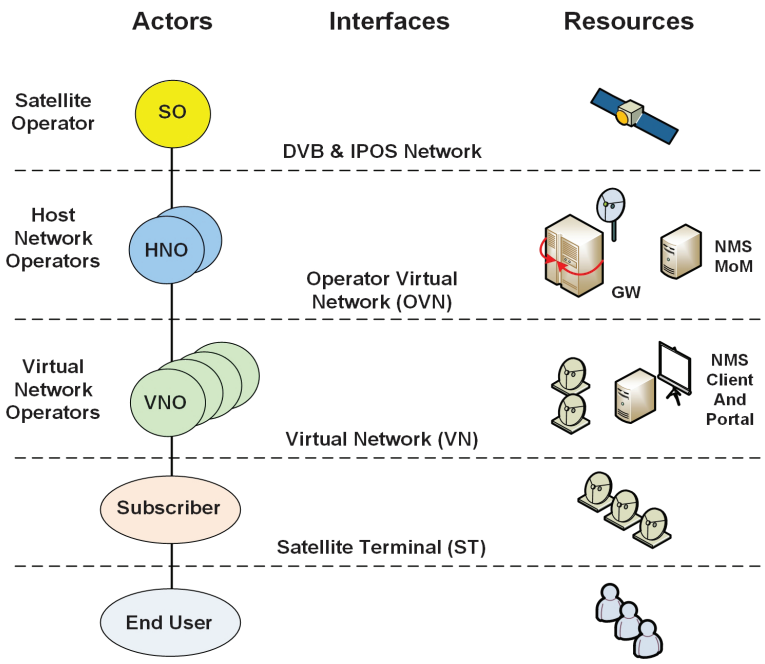
JUPITER™ System Virtual Network Operator (VNO) Capabilities

Integral to the Hughes JUPITER System is the concept of enabling multiple Virtual Network Operators (VNO) each which has the capability to manage their own partition of network capacity and an independent set of remote terminals. The VNO construct enables the JUPITER System operator or Host Network Operator (HNO) to set up the infrastructure to configure multiple VNOs, each with its own unique allocation of resources and different user classification types for VNO operators. Each of these operator classifications will contain a configurable set of access rights (both functional and modular capabilities).

The JUPITER System is designed in such a way that the HNO allocates and manages the satellite bandwidth (space segment) to the VNOs, in addition to making physical resources such as gateway and teleport infrastructure available for VNOs. The VNOs are provided with the tool set to create and manage their service offerings without investing in physical infrastructure, but instead, relies on the HNO to make these investments. The HNO, in turn, is able to resell network services to multiple VNOs; thereby, achieving economies of scale.

- The Satellite Operator (SO) owns the satellite and is responsible for maintaining, managing, deploying, and operating the satellite. The SO sells satellite capacity to one or more HNOs. For any given network, the SO and the HNO can be the same entity.
- The HNO controls its own capacity, owns at least one gateway and NMS/NOC, configures time/frequency plan, divides the DVB-S2X/IPoS network into one or more virtual networks and distributes its own resources among them.
- The VNO is assigned to a virtual network with either Mbps or MHz bandwidth subscription, and it owns and manages its terminals that form the virtual network. The VNO gets restricted client mode access to the NMS



A hierarchical view of a virtual network

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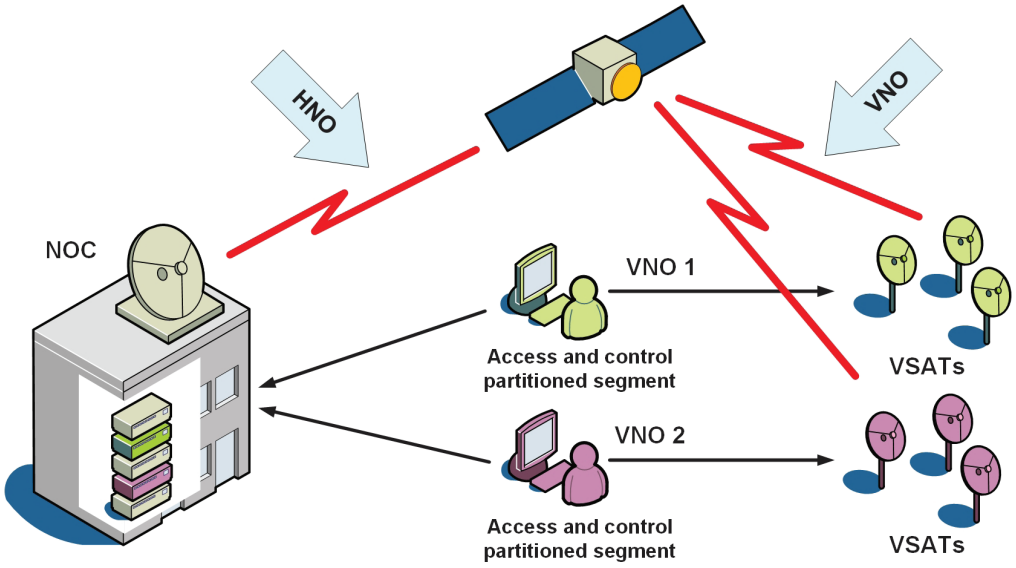
HNO and VNO Roles

The HNO generally has the following roles and responsibilities:

- Maintain RF and satellite connectivity
- Configuration and management of all physical NOC/Gateway components
- Monitor all VNOs and aggregate bandwidth
- Establish access control/configuration separation between VNOs

Each VNO generally has the following roles and responsibilities:

- Define its own service plans for allocated bandwidth
- Configure terminal devices
- Monitor allocated bandwidth within its scope
- Manage/troubleshoot terminals and service without involvement from the HNO



HNO-VNO Relationship

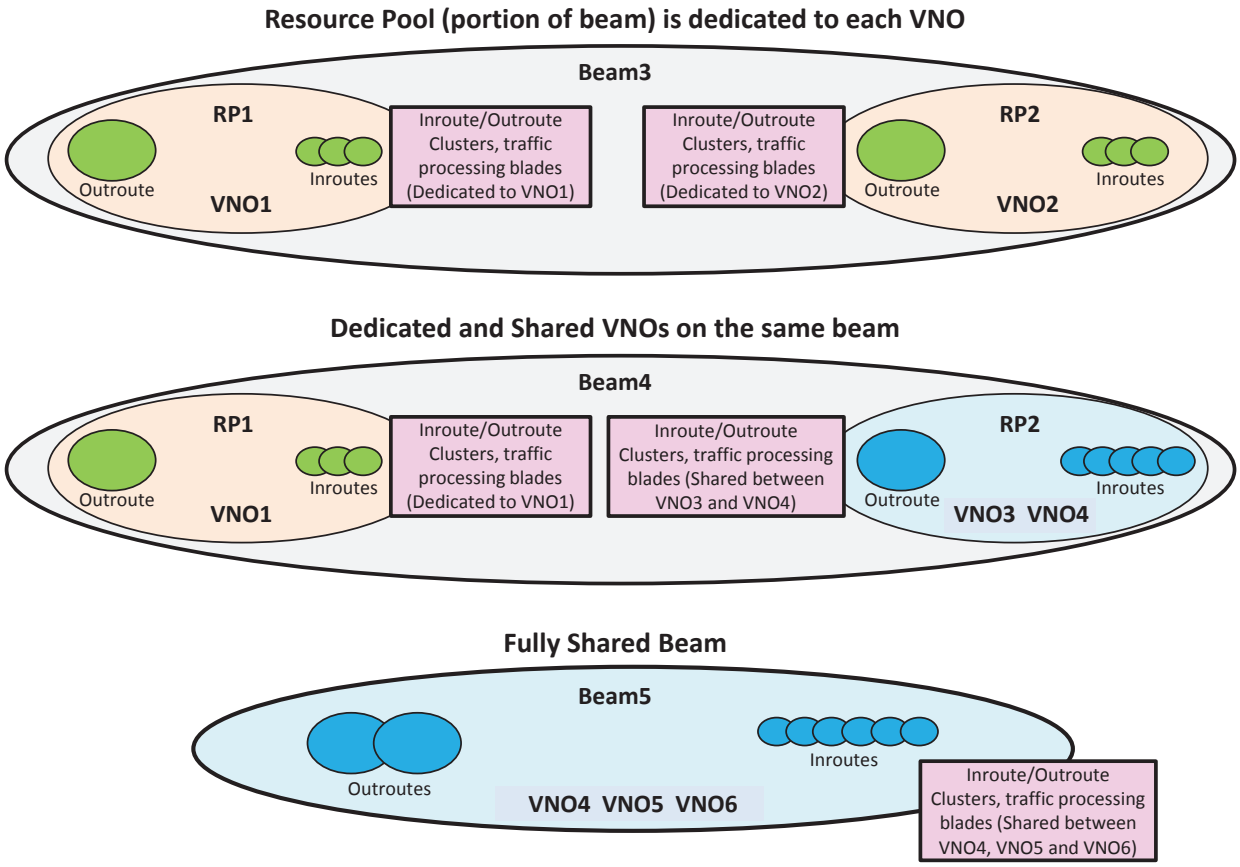
The key features of the JUPITER System VNO functionality include:

- Logical partition into bandwidth pools
- Bandwidth management within a single beam or across multiple beams
- Shared (Mbps)and dedicated (MHz) types
- Offered load and satellite usage policing
- Bandwidth managers to enforce VNO bandwidth
- Integrated management portal for VNO operators

VNO Models

The JUPITER system supports two VNO models:

- **Shared VNO:** This is the 'Mbps model,' with shared bandwidth and physical resources. It enables the HNO to efficiently manage capacity and take advantage of internal compression when allocating bandwidth to VNOs. The HNO has the responsibility to efficiently guarantee Mbps and policing bandwidth across VNOs. The HNO can adjust the VNO priority weights to ensure high value VNOs have bandwidth allocation preference over others during periods of congestion.
- **Dedicated VNO:** This is the 'MHz (spectrum-based) model,' with dedicated bandwidth and physical equipment. A dedicated VNO is allocated dedicated spectrum and has full control of it. However, the physical equipment is still within the HNO domain and hence the configuration of the gateway, frequency plan, and other transport parameters are not provided to the VNO.



Sample Shared and Dedicated VNO Configurations

VNO Bandwidth Over-Subscription Support

Bandwidth is allocated by the HNO to VNOs as "bandwidth pools," both on the inroute and outroute. The HNO can oversubscribe the physical capacity via the number of VNOs and bandwidth amount allocated to each VNO. Also, the VNO can oversubscribe its dedicated capacity by committing more bandwidth to the set of configured terminals than it has subscribed for.

The VNO bandwidth subscription is configured to define the amount of outroute and inroute bandwidth per VNO. Each gateway hosts a Bandwidth Manager Subsystem that performs VNO bandwidth policing and congestion management functions. The Bandwidth Manager also provides the ability to extract statistics related to terminal Service Level Agreement (SLA) and VNO bandwidth usage for both HNO and VNO monitoring.

The Bandwidth Manager enforces the VNO subscription limit and also ensures fairness of bandwidth allocation across VNOs in case of oversubscription and congestion (e.g., due to weather degradation). The Bandwidth Manager facilitates implementation of differentiated VNO subscription plans by prioritizing certain VNOs over others through the use of a weighting factor. During congestion a higher value the VNO will maintain more capacity relative to a lower value VNO.

VNO Capabilities and Portal

The JUPITER System has a rich set of NMS features including full management, control, and monitoring of Gateway components and terminals via an easy-to-use graphical user interface. The HNO has the ability to selectively assign a set of management capabilities to the VNO during virtual network setup. The system allows a VNO to log into its partition and configure the full set of terminal resources (service plans and terminal profiles) to be assigned when provisioning terminals. The service plan configuration contains the complete set of terminal configuration parameters, including (but not limited to) downlink/uplink speeds, traffic classification rules, IP addressing, and terminal identification parameters. The VNO can actively monitor real-time throughput (Mbps) against the configured limits.

The following is a list of VNO capabilities supported by the JUPITER System:

- Full configuration/management of terminals
  - Assign service plans
  - Define QoS and traffic classification rules
  - Configure remote terminals
  - Manage terminal activation/deactivation (commissioning)
- Rich set of monitoring capabilities
  - Monitor total bandwidth usage against bandwidth subscription
  - Monitor terminal usage (throughput) in real time
  - Long-term bandwidth trending on a per-terminal basis
- Troubleshooting and diagnostics
  - Control terminals (reset, change configuration, etc.)
  - Terminal diagnostics and pertinent real-time statistics

A key feature is that the VNO has full control of its own network elements but is prevented from accessing or viewing other VNO components.

The VNOs are provided an access into the NMS using a Web portal. The VNO Portal is the primary web-based interface that the VNO accesses in order to perform any network operation functions within the system. This portal is designed for ease-of-use and streamlined functionality for a VNO operator. Once the Virtual Network for a VNO is created along with a VNO operator, the VNO can then log in to the VNO Portal.

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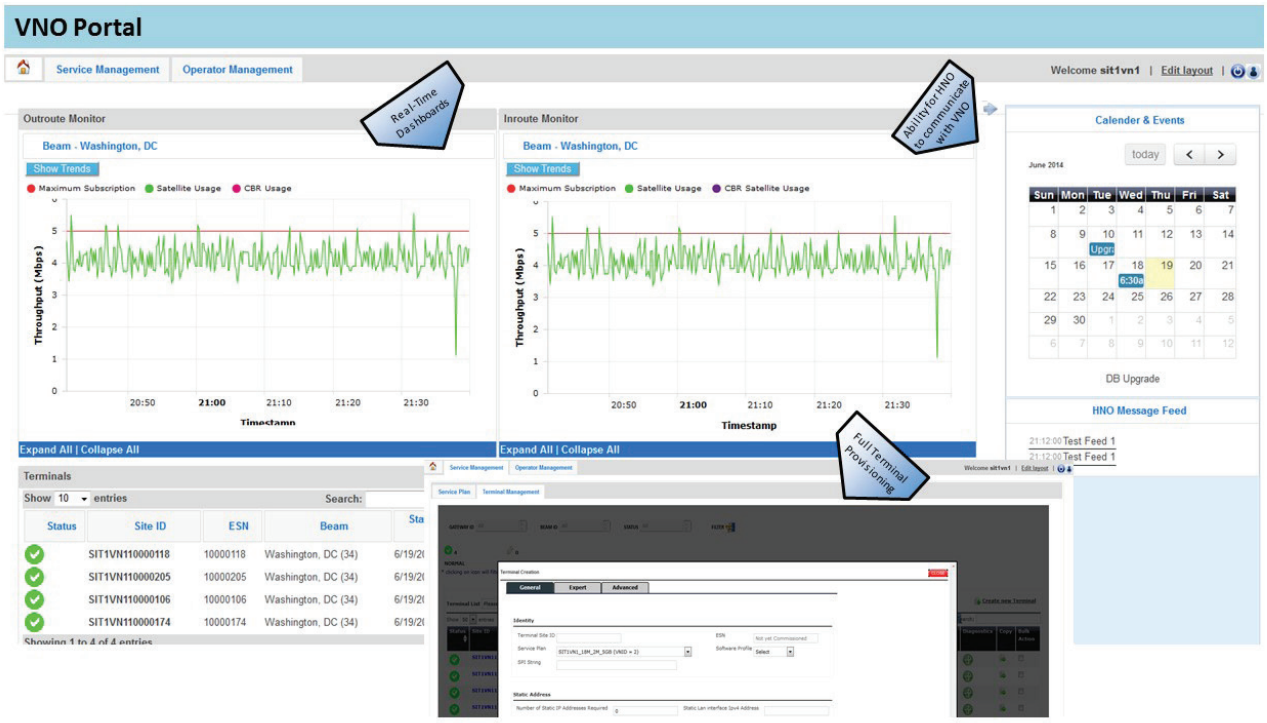
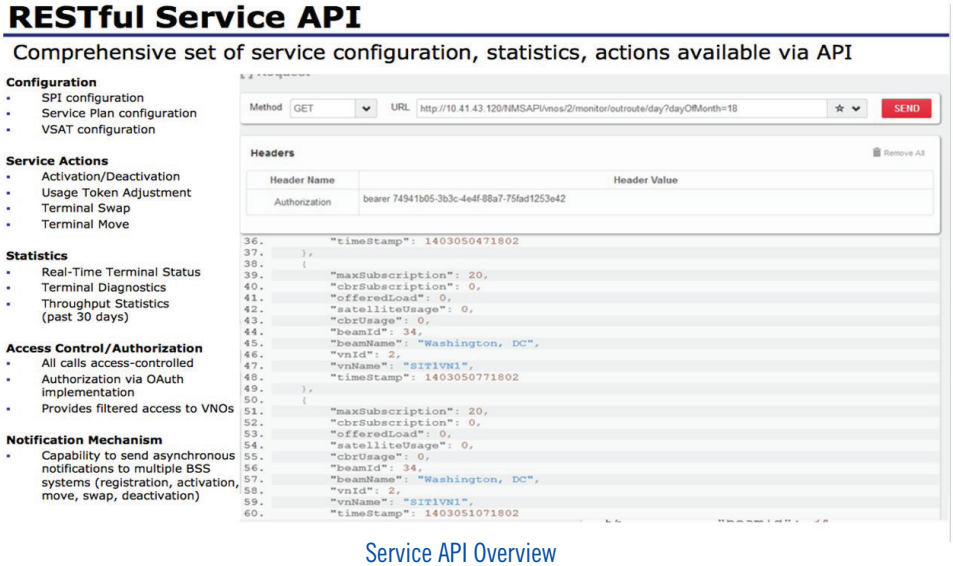


VNO Portal Overview

Rich and Flexible API

An integral component of the JUPITER System NMS (Network Management System) is a rich Application Programing Interface (API) based on the "RESTful" architectural approach. It enables a VNO to electronically interface with the NMS and perform such functions as terminal management, subscriber management, and network management.



Service API Overview

Proprietary Statement