Free-space optical communication technologies will enable next generation of Ultra High Throughput Satellite

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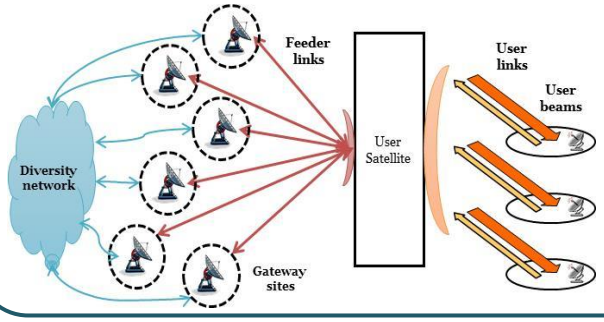
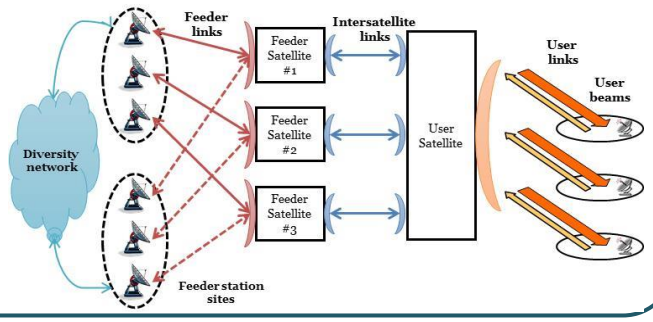
*The **FRACTIONATION** concept is replacing a single large spacecraft by a cluster of networked smaller spacecraft and to distribute the functions of a single GEO satellite among co-located satellites linked by Inter-Satellite Links.*

Single satellite configuration



Fractionated configuration

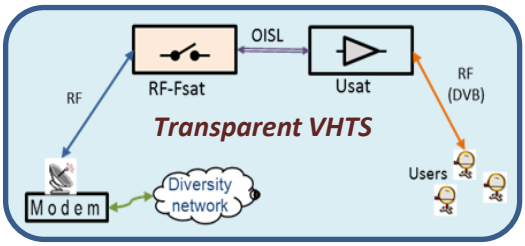


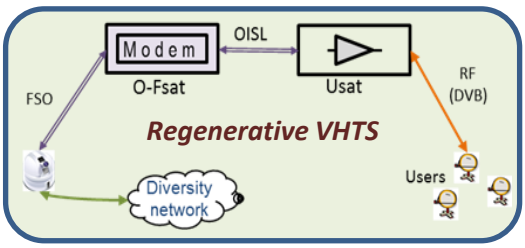
*The fractionation concept brings a new VHTS product **MATRIX** to life for the next decade. It reduces the cost and complexity of the feeder segment and offers the possibilities of progressive deployment and risk-free upgrade from a radio transparent VHTS to an optical regenerative VHTS.*

*The **MATRIX** product which was developed during an ESA founded study (AO9287-Multiple Access Telecom Reconfigurable Inter-satellites X) consists of a GEO cluster of three types of satellites:*

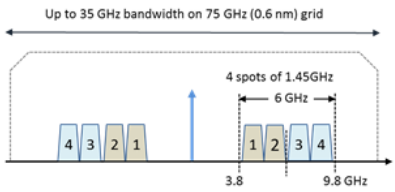
- *User satellite (**USat**) to provide High-Speed Internet access to end users,*
- *Radio Feeder satellites (**RF-FSat**) to connect to RF gateway stations,*
- *Optical Feeder satellites (**O-FSat**) to connect to optical ground stations.*

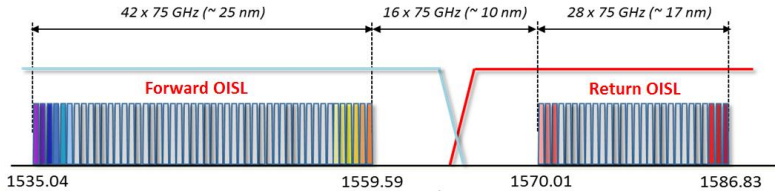
*To endow the **MATRIX** product with its extraordinary features, it will be essential to use the technology of **Free Space Optical** links on the **Inter-Satellite links** and on the **Feeder links** (ground ↔ space)*





The **Analogue Optical Inter-Satellite Links** are a key feature of **MATRIX**: they convey in a full transparent way the radio spectral contents of the user beams from USat to RF-FSat or to O-FSat and back. The radio signals of the user beams are transferred (intensity modulation) on to light carriers according to 4 spectra (beams) per wavelength (left figure). Then, the carriers are multiplexed in wavelength (WDM) on the OISL (right figure). So, the bandwidth of one OISL is up to 252GHz (168 beams of 1,5 GHz) on forward (Internet to users) and 84 GHz (168 beams of 0.5GHz) on return (users to Internet) .





Feeder and User satellites have the same OISL terminal whose optical head has a 15cm diameter. This unit could be derived from the OPTEL-C terminal developed by Thales Alenia Space–Switzerland for LEO constellations.

The **Optical Feeder Links** are also a key feature of **MATRIX**: they upload from the Optical Ground Station (OGS) to the O-Fsat Internet data intended for the users and download from the O-FSat to the OGS the data coming from users. The data are conveyed on 10 Gbps DPSK modulated optical carriers (λ). Then, the carriers are multiplexed in wavelength (WDM) on the FSO feeder link. So, each O-FSat has a throughput of 180 Gbps uplink (18λ @10Gbps) and 40 Gbps downlink (4λ @10 Gbps), corresponding in our example of the third of the total system capacity (540 Gbps forward and 120 Gbps return).

The **MATRIX** fractionating concept brings a new VHTS product to life for the next decade. It reduces the cost and complexity of the feeder segment and brings new possibilities such as progressive deployment of the feeder segment to follow the increase in traffic and such as seamless and risk-free upgrade from radio fed transparent VHTS to optically fed regenerative VHTS. The Free Space Optical communications are instrumental in the **MATRIX** product extraordinary features.