cell & sat

Operating hybrid networks with terrestrial and space components

1. New paradigm

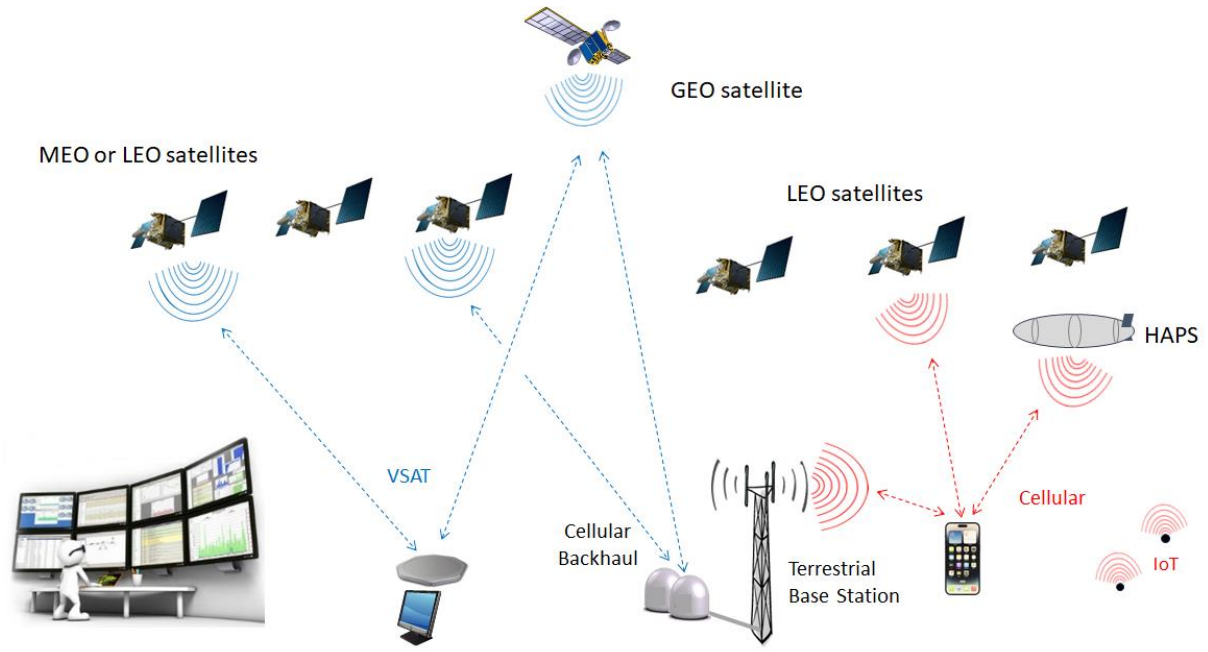
We are seeing important innovations in the satellite field, with in particular the launch of very high capacity GEO satellites and the parallel deployment of large MEO and LEO constellations. Concurrently, cellular networks are also undergoing rapid evolution. In particular the 3GPP standard now encompasses “Non-Terrestrial Network” (NTN) options, enabling 5G devices to connect not just to terrestrial base stations but also to satellites.

These developments prepare for the arrival of hybrid telecommunications networks, bringing together multiple radio technologies with a collaboration between satellite and terrestrial telecommunications operators. These networks will offer a wide variety of professional and residential services to users equipped with either fixed terminals (with parabolic or electronically scanned directional antennas), smartphones or low-speed IoT sensors.

2. Operational challenges

The potential benefits of these hybrid networks can only be fully harnessed with the establishment of appropriately adapted operational organizations and procedures, supported by the use of efficient management platforms. In this paper, we outline some operational requirements which we believe are critical for the technical and commercial success of upcoming networks that integrate terrestrial and Non-Terrestrial Network (NTN) components.

The accompanying figure illustrates a hybrid network offering fixed broadband access satellite services, cellular base station backhaul links, as well as cellular and IoT services utilizing terrestrial, satellite and stratospheric (High Altitude Platform Station) network components.



Hybrid network multi-services operation

3. Managing partnerships

Establishing an effective operational organization necessitates first clarifying the roles of the different operators involved and understanding the specifics of their contractual relationships.

Normally, each operator is expected to oversee its own equipment. This means satellite operators typically handle their space platforms, while cellular operators manage their base stations and core network. Yet, for some ground network components or possible base station units embedded in satellites, the optimal operating organization needs to be determined.

In terms of commercial management of end users, this responsibility usually falls to a single operator based on the type of service. For instance, a satellite operator might manage VSAT type services, while a cellular operator could handle services related to smartphones and IoT. However, it may be desirable to implement mechanisms for risk sharing among operators. Traffic measurements would then be necessary not just at the end-user interface but also between network components, e.g. to allow satellite operator charging on a "per-Gbyte" basis.

4. Facilitating growth

A key goal of technical operations is to simplify the network's complexity for the end user. This includes ensuring straightforward installation and maintaining high service quality, even during network reconfigurations and regular software updates.

Practically, activating new users can be a multi-step process that should be automated. For instance, in satellite communications, activating a single VSAT terminal might require coordination with both GEO satellites and LEO constellations. In upcoming hybrid networks, simultaneous authentication in the cellular core will also be necessary for new subscribers.

Additionally, the management system should facilitate network evolution, such as integrating a new GEO satellite or regularly launching new MEO/GEO satellites. It should also accommodate the deployment of new cellular base stations, which might necessitate changes to satellite network parameters (or, in case of stratospheric coverage, to HAPS fleet settings).

5. Controlling quality

State-of-the-art networks, either cellular (4G/5G) or satellite, come integrated with advanced Quality of Service (QoS) control features. In operating hybrid networks, it is crucial to ensure that the combined services from various sub-networks meet the QoS parameters defined in Service Level Agreements. This requires a central management system to process and analyze statistics from different subsystems. When a problem is detected, the operational tools and procedures should in particular enable the rapid identification of which subsystem, whether terrestrial or space-based, is the most likely to cause a degradation.

Telecommunication networks also involves specific constraints, such as legal interception. In terrestrial networks, these obligations are typically fulfilled within the operator's country. However, some satellite links may reroute traffic to anchor points outside the home country, necessitating specific configurations to comply with national legal interception requirements.

Last but not least, security considerations cannot be overlooked. The combination of diverse satellite and terrestrial segments may introduce vulnerabilities, necessitating dedicated and vigilant monitoring.