STRETCHING BOUNDARIES TO DELIVER NEXT GENERATION SATELLITE COMMUNICATIONS

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WHITE PAPER

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THE ELASTIC ERA

The satellite communication industry is going through an enormous transformation. Next generation satellite technology is evolving to multi-orbit constellations that include Non-Geostationary Orbit (NGSO) constellations, Very High Throughput Satellites (VHTS), as well as the traditional Geosynchronous Earth Orbit (GEO) satellites. This next phase will enable ubiquitous connectivity for fixed and mobility sites, 5G and IoT, and will require innovation to provide the needed higher throughput, higher flexibility and network orchestration between ground and space. At Gilat we refer to this next generation as the **Elastic Era** of satellite communication, based on the demand for agile, flexible and scalable solutions.

The Elastic Era, the next generation of satellite communication, will more accurately and efficiently focus resources on actual demand with minimal costs. This transformation will address the major satellite industry challenges of needing higher network capacity, at a lower cost, with ensured availability, lower latency, and higher throughput per user. The network elasticity will address both day-one operation as well as on-going changes in network requirements.

In this new era, fully elastic networks will be configured and maintained on-the-fly to best match customer bandwidth demand, maximize space segment efficiency and rapidly adapt the network to support changes in service requirements through the whole lifecycle of the network. The Elastic Era challenge must be met by both the satellite operators, as well as the ground segment providers.

The challenge requires the flexibility and adaptability of software-defined satellites. The new dimension in satellite connectivity supports hundreds to thousands of beams that can be created on-demand, with dynamic beam shapes enabling a flexible ground footprint. Using dynamic inter-beam connectivity, satellite beams no longer need to connect a service from only a preassigned gateway.

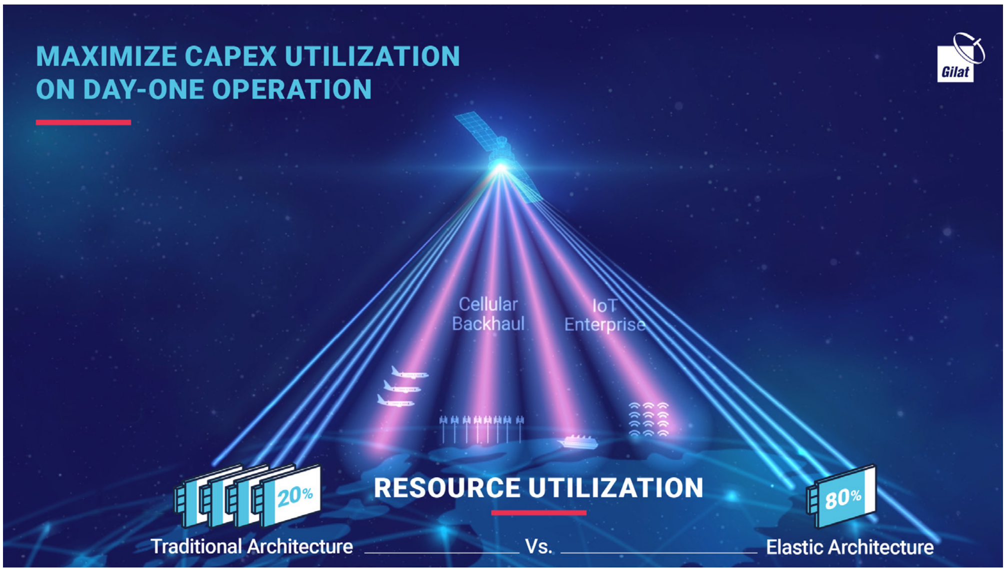
Furthermore, the throughput of software defined satellites can be modified per demand and maintained under fade conditions due to dynamic power and frequency allocation. The elastic satellites provide a better answer for changes in user demand and network conditions, as well as better meeting the challenges of mobile applications.

For the next generation network to operate most efficiently, harmonious integration between the elastic software-defined satellites and the elastic ground segment must take place. In addition, central orchestration of the ground and space segment with smart resource management is key to meeting the demands of the Elastic Era.

The Elastic Era will increase reach to better enable bridging the digital divide, will support bandwidth intensive applications such as used on cruise ships, wide-body passenger airplanes, 5G cellular backhaul, and IoT aggregation, as well as enable low latency real-time applications that will unleash new market opportunities, where satellite communication was previously unfeasible or commercially challenging. On top of this, new standards integrating the satellite domain with terrestrial communication will deliver added flexibility and improve utilization of all network assets to boost the connected world.

IMPLICATIONS OF THE ELASTIC ERA ON THE GROUND-SEGMENT

The implications of the next phase of satellite communication requires a ground-segment that is scalable and agile, providing an order of magnitude increase in performance, density and flexibility as well as providing support for multiple orbit solutions.

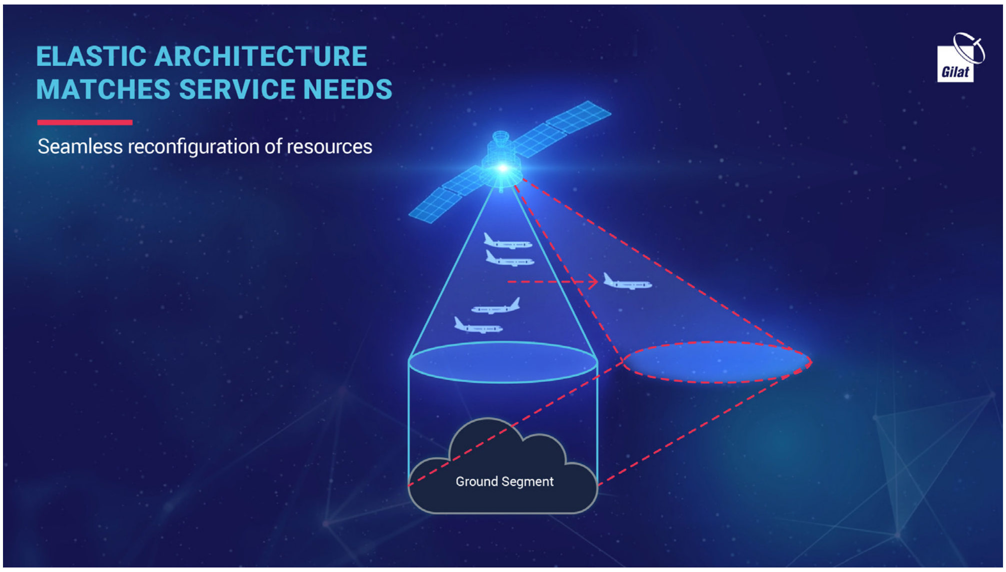


Gilat's elastic architecture supports the dynamic needs of the network throughout its ongoing operation. This includes accommodation of day-one operation over a large geographic coverage area, as well as scaling up with increased bandwidth, an increase in users and expanded geographic coverage as well as support during the network maturity phase and accommodating ongoing changing demands.

In the elastic architecture, ground-segment scalability is no longer tied to the beam structure and peak usage. This gives a great advantage for network scaling independent of the beam peak throughput, beam footprint and beam coverage. As a result, ground infrastructure is better optimized, reducing costs and footprint while hardware is added only as network utilization increases, enabling maximum CAPEX utilization on day-one operation.

The virtualized architecture supports a cloud infrastructure and thereby significantly improves software agility and compute density.

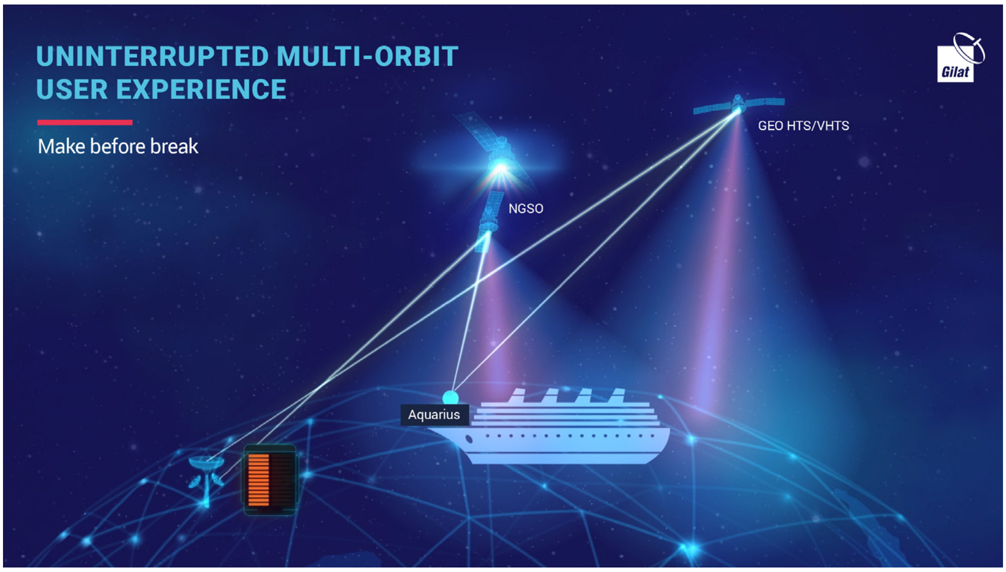
The programmable Software-Defined Network (SDN) also allows for on-the-fly changes to beam carrier configuration to address dynamic network optimization. Carriers can be modified to increase or reduce capacity to better accommodate service needs, or to mitigate signal fade conditions. For example, as a larger passenger airplane goes through a beam, capacity can be temporarily increased to accommodate the need of intensified usage. Or, when fade mitigation is required the SDN provides capacity steering to ensure uninterrupted service. The elastic architecture enables seamless reconfiguration of resources.



Gilat's elastic architecture also allows dynamic capacity steering of resources between beams to answer real-time changes in terminals throughput demand over specific geographic locations. No longer will it be required to allocate the maximum needed carrier size and compute power ahead of time. The inefficient "design to peak usage" is no longer essential, due to the architecture's elastic nature.

CHALLENGE OF TRANSITION TO NGSO

The Elastic Era has massive implications on the ground-segment in order to support NGSO constellations. Unlike GEO networks, the ground-segment now needs to communicate with "moving" satellites.



Gilat's elastic architecture is designed to address the multi-orbit operation of any satellite constellation, LEO or MEO, including seamless handovers between GEO and NGSO, implementing "make before break" for an uninterrupted user experience. This ensures that service is continuous and that the change of coverage between satellites in different orbits is totally transparent to the end-user.

On the physical layer, the Doppler effect and the dynamic fade of the physical link are significant in NGSO, as the satellites are constantly moving relative to each other. This effect can be mitigated with Gilat's Air-Interface modifications that include timing synchronization, frequency corrections and power management.

INTEGRATING SATELLITE AND GROUND-SEGMENT RESOURCES

The Elastic Era of satellite connectivity requires a much tighter integration between the satellite and ground-segment than was previously needed. In traditional networks the satellite and the ground system were managed separately and relatively decoupled. However, the next generation network requires a new entity, a Resource Manager (RM), to orchestrate between the space and the ground- segment. The elastic network is constantly changing to dynamically meet both user demand and network conditions.

This requires the RM to carefully analyze the real-time situation as well as to anticipate upcoming trends that must result in smart decisions on resource allocations in space and on the ground. The RM then must orchestrate the execution of the required changes simultaneously to both segments, in a coordinated streamlined fashion. As an example, creating a new beam in space and generating a new carrier on the ground must be coordinated from one central place, to ensure reliable and fast network operation.

For the Resource Manager to make the best ongoing decisions on current needs, it requires from the ground-segment real-time input on the network's status such as: per beam user demand, links' utilization, fade conditions and user locations. Furthermore, the RM receives detailed information on the status of the resources from both the ground and space segment.

Gilat's SDN platform is designed to provide the required high agility by enabling fast steering of platform resources in addition to providing high quality big-data collection that is used as input to the RM's smart decision making. This is done with a robust open interface that supports streaming of large volumes of information to the RM.

Gilat's next generation ground-system is designed to be able to monitor and collect detailed accurate information in real-time and at a high resolution, on all elements of the network. The ground-system must also have the intelligence to receive input from the RM in order to smoothly and seamlessly execute configuration changes without service interruption. It is the agility of the elastic architecture that steers network resources from place to place.

FOCUS ON FUTURE REQUIREMENTS: BETTER, FASTER, MORE DYNAMIC

In order to meet the future requirements of the Elastic Era, there are two additional elements that have to be addressed, namely network performance and multiple solution scenarios.

NETWORK PERFORMANCE

The Elastic Era of connectivity requires a tremendous increase in speed. The industry conversation has changed from requiring megabits per second to gigabits per second. The internet is no longer mainly the provider of content, but the platform for considerable data sharing requiring high bandwidth. The need for uploading data to the cloud, such as social media videos, is setting the requirements for faster VSATs in both directions.

Next generation VSATs must be designed to serve, with maximum efficiency, data intensive applications. The VSATs must exhibit ultra-high processing capacity achieving unprecedented high throughputs for both downloads and uploads including high packets per second processing to meet the high-performance demands. The combination of high throughput and the low latency from NGSO constellations creates an opportunity for delay-sensitive applications.

As an answer to this need, Gilat has already launched the Aquarius family of next generation VSATs to address the elastic nature of tomorrow's data and media intensive applications. The Aquarius family of VSATs builds-on Gilat's long-time expertise and patented technologies and enables over 2 Gigabits of concurrent speeds and higher packets per second to serve bandwidth hungry applications such as required for 5G connectivity.

The Aquarius VSAT family also answers the need for multi-access edge computing infrastructure, enabling deployment and orchestration of 3rd party virtualized network functions on the VSAT modem itself, simplifying remote site management and operations for next generation edge services, such as video caching and IoT gateways.

Another performance concern of a next generation satellite network is the return access scheme, that must rapidly adjust to the changes in the network. The VSATs must have the flexibility to best address the "moving" satellites as well as high throughput backhauling and mobility applications. It is essential for the elastic network to have the flexibility such as incorporating different VSAT types on the same beam and various applications on the same network. To meet this challenge, a wide range of return carrier symbol rates are needed to address the variety of applications and their dynamic needs. At Gilat we refer to the next generation access scheme as having elastic dimensions for dynamic channels.

MULTIPLE SOLUTION SCENARIOS

The next generation ground-segment must be built to support multiple solution scenarios. The platform must provide service to multiple vertical markets that can operate in multiple frequency bands, across multiple beams and satellites, as well as across multiple orbit constellations.

Gilat's elastic architecture serves multiple applications with varying needs and is equipped with a set of VSATs that are fine-tuned to best address the diverse dynamic needs.

We expect that GEO, MEO and LEO constellations will continue to live in harmony as complementary technologies, each with its own advantages. As such, Gilat's elastic architecture is designed to provide seamless handover between orbits. This is important to enable multi-orbit, per application and per geographic area with varied service options, and to deliver orbit redundancy. A seamless multi-orbit operation ensures that users can continue to enjoy uninterrupted service being completely oblivious to the orbit switch.

CONCLUSION: EXPANDING OUR HORIZONS

To conclude, the Elastic Era of satellite communication is introducing the opportunity for creating a gradual but profound change in our digital lives, which will influence all aspects of our existence, from health to education to banking and to social connectivity.

The significantly larger amounts of bandwidth, reduced service price, and promise of improved latency enable new markets including 5G, video conferencing, tele-medicine, compute intensive IoT, banking/trading and other cloud-based applications. This is in addition to new dimensions of more traditional markets such as maritime, commercial/business aviation, education, government and rich media services.

In order to harness the power of next generation satellite communications, elasticity is the name of the game.

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