ST Engineering

NEW GROUND FOR A CONVERGED EUROPEAN SECURE SPACE CONNECTIVITY SYSTEM

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ST Engineering iDirect (Europe) CY NV
EU Satcom Center of Excellence

With the satellite industry undergoing a major transformation including new elements, capabilities, and innovations in space, this paper explores the potential that opens for government and military satellite communications (GOVSATCOM/MILSATCOM) ground segment networks and specifically how EU Space programs such as the EU Union Secure Connectivity (USC) and the EU GovSatCom initiative should capitalize on the advancements to obtain the operational advantage, take decisive action and gain EU autonomy.

Introduction

In the advent of key technology innovation breakthroughs and their implementation in next generation satellite networks, it is a good time to take a step back and reflect how these technologies will enable new capabilities and improve civil, government and military missions and operations. Convergence is the central theme across these new generation of satellite networks that reunite the space segment, ground segment, user segment and service layer. With the adoption of 5G and cloud-based architectures convergence also applies to the increased demand for hybrid networks combining satellite and terrestrial technologies into a single network. The main purpose for the convergence is to remove the complexity of ground segment networks and cater for an orchestration of services across these networks, allowing for new operational scenarios and supporting increased scalability and flexibility for globally dispersed government and military operations connecting fixed, on-the-move and on-the pause platforms on the ground, in the air and at sea.

At the centre of these transformations and convergence is ST Engineering iDirect's 'New Ground' initiative that connects and manages the 'New Space' assets, the 5G architecture and the virtualization drive towards convergence, standardization and orchestration of satellite and hybrid networks. In this paper we will explore how the New Ground technology can benefit government and military networks and in particular, the upcoming EU Space Program with the EU Union Secure Connectivity (USC) and the EU GovSatCom initiative.

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From New Space to New Ground

The accelerated pace of innovation, the shift in the geo-political landscape, the growing amount of data shared over satellite and the complexity of government and military networks connecting dispersed operations over satellite have created the context and the demand for a new generation of satellite networks and ground segment technologies, called 'New Ground' an analogy to the 'New Space' initiative.

On the European side, in February 2022 EU Commissioner Breton presented a 6 billion Euro plan for secure satellite communications to provide key communications services and surveillance data. The aim is to develop a multi-orbital space-based connectivity system that will extend the availability of these services and to increase the European autonomy not to depend on non-EU based industry.

With new technology and constellations coming on line comes the transformation of satcom ground networks and the need for 'New Ground' capabilities.

The EU Union Secure Connectivity (USC) program is not the only initiative organized by a geo-political actor that will boost the request for next generation multi-orbit satellite networks. Likewise, the US DoD is launching the National Defence Space Architecture (NDSA) initiative, a satellite constellation with hundreds of satellites that can track targets, provide PNT services and communicate with the warfighter. A lot of the technology for that constellation has not been produced and the US DoD will rely on their homegrown industry to develop capabilities as of 2022.

In 2021 China announced the "Guowang" (GW) or SatNet mega-constellation of 13.000 LEO satellites across the globe to complement satellite-based internet services and provide communications services all over the world, not just in China, competing with Western companies. On the Russian side the 264-satellite Sfere multi-orbit constellation is allegedly close to implementation providing broadband and Earth observation capabilities.

The upcoming government funded multi-orbit satellite constellations are following the footsteps of the commercial multi-orbit satellite implementations that are already launching thousands of satellites today and activating a variety of services for both commercial and government applications. Five of these commercial multi-orbit constellations are notable due to their size and development maturity: SpaceX Starlink, Amazon Kuiper, Telesat, OneWeb and SES mPOWER.

The innovations in space and on the ground are not only linked to the NGSO (non-GEO Stationary orbit) constellations, but also on the more traditional military GEO-satellites to provide more flexibility and throughput to the dispersed military operations across the globe. For example, the UK government is spending £5 billion GBP on upgrading the country's Skynet satellite communications capability, which provides strategic communication services to the UK Armed Forces and allies. Other military space programs include the French Syracuse and the Spanish Spainsat NG programs.

New Ground Key Innovations

We are in the midst of possibly the largest transformation in our satellite industry. This encompasses a lot of new elements, new capabilities and new innovations in space. It's extremely important that governments start planning on how they take advantage of these disruptive innovations. With New Space, the satellite industry introduces a variety of multi-orbit (GEO/MEO/LEO/HEO), very high throughput (VHTS) and massive capacity from gigabyte to terabyte level constellations, as well as satellites featuring standardized, fully programmable and fully digitized payloads to support flexible and scalable services.

It's clear that a successful satcom strategy is not only dependent on technological capabilities in the sky, but also the innovation and integration on the ground. That's why New Ground, a movement spearheaded by ST Engineering iDirect, aims to highlight the critical and unifying role of ground segment in New Space and satellite's future in a much broader connectivity landscape.

When we are looking at the bigger picture, we clearly see that ecosystems in the space, telecom and IT industries are converging driven by the advent of 5G and its promise to connect everything, everywhere. 5G is reshaping and standardizing the way in which we will look at services, how we will deliver services, how we will build services for our customer base. In that sense, 5G is set to become the network of the networks. Satellite needs to feed into this network of networks, bringing its own unique attributes that will benefit users, especially those that are out of reach of terrestrial infrastructure.

The New Ground environment gets a central and unifying role connecting both the 5G and the New Space ecosystems.

NEW GROUND

Standardization, orchestration, virtualization and access to the cloud are the key defining elements to provide end-to-end services across a network that includes both multi-orbit satellite and terrestrial access points.
New Ground systems are now evolving rapidly from static to dynamic networks. As satellites are becoming software defined, New Ground systems adapt to do the same. This means that the ground segment will move away from the traditional dedicated equipment and appliances to a more virtualized infrastructure similar to the telecom world. By virtualizing the satellite communications ground segment infrastructure, network operators can easily, automatically and dynamically allocate and deliver resources to their end-users. Standardization and interoperability will be achieved by implementing 3GPP and MEF standards as used by the terrestrial counterparts across the entire network architecture. Once a unified architecture is defined services and resources can be streamlined through service orchestration across the entire government or military network.

The satellite industry is adopting the cloud-based infrastructure concurrent with the 5G, terrestrial networks and New Space innovations. Both commercial enterprises and government agencies are moving their vital operations and IT infrastructure to the cloud - a trend that has increased in recent years and that shows no signs of slowing down. Military and sensitive government applications will stay away from the public cloud. However, through their own private cloud infrastructure in their government or military enclave, they still want to leverage the multiple advantages that cloud, edge cloud and edge computing (see Stage 5 below for explanations) have to offer such as increased flexibility, scalability, efficiency of operations and resiliency. This development has major implications for the satellite industry: To keep pace and stay relevant and useful to government and military end-users both present and future networking infrastructure needs to migrate to the cloud.

New Ground for Gov/MilSatCom Networks

The adoption towards New Ground, New Space, 5G and cloud architectures for government networks can be achieved through a gradual approach building from existing capabilities towards a next generation (next-gen) network. We can identify six (6) different stages in the evolution from a traditional satellite network to a next-gen New Ground satellite network to support today's and future government and military use cases.

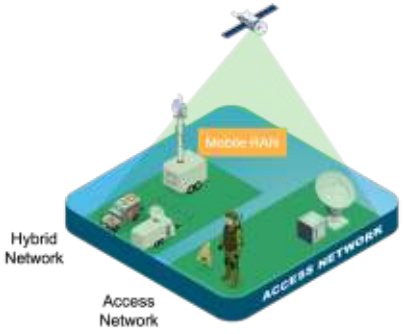
Stage 1: Traditional VSAT network

Exhibit 1: VSAT Network

Government and military organizations have always relied on VSAT technology in access networks over GEO widebeam satellite capacity to reach remote locations without terrestrial connectivity and/or for quick deployment. In a disaster management scenario, VSAT connects deployed first responders to a command centre for situational awareness, setting up logistics, quick medical response and coordination efforts. The complexity in these types of networks is introduced by the requirement to support the growing amount of data, video and voice communications over satellite as well as supporting on-the-move/on-the-pause (OTM/OTP) applications in a global network as operations become more dispersed. Through a multi-service VSAT platform different applications, services and platforms can already be addressed in an efficient and flexible manner with an extra layer of security and resiliency measures applied on both network and waveform level to counter the increasing amount of security threats (see ST Engineering iDirect's white paper, Gaining Operational Advantage).

Stage 2: Hybrid (Terrestrial/VSAT) Network

Exhibit 2: Hybrid Network



Hybrid networks are a mix of satellite and terrestrial connectivity and provide a converged solution for reliable and persistent communications towards different government end-users for their mission. Hybrid networks are advantageous in areas that have terrestrial connectivity where extra satellite bandwidth may be required for occasional usage (e.g. while a crisis is taking place and terrestrial comms are no longer available, secure or reliable). VSAT is complementary because it does not require infrastructure to be installed such as terrestrial networks and is relatively easy to deploy.

The combo VSAT and LTE/4G/5G/Wi-Fi connectivity provides the deployed end-users with a failover and failback scenario. When one network is down, the other can be used as a back-up. Part of the hybrid crisis management networks are Mobile RANs (Radio Access Network) to connect end user devices (e.g. radios, sensors, cameras, medical devices or to set up local networks) to a core network, COWs (cellular on wheels) that may set-up temporary connectivity access in a location that recently lost terrestrial connectivity and satellite connectivity to emergency or local command vehicles. Hybrid networks provide the government and military end users with the flexibility and redundancy needed in crisis situations to communicate in real-time and get the job done as efficiently as possible.

Stage 3: Multi-orbit Connectivity Combining GEO and NGSO Satellites

Exhibit 3: Multi-Orbit Network

Government and military agencies are closely monitoring the evolution in the New Space domain with the launch of satellite constellations in different orbits around the globe. The term 'multi-orbit' groups wideband and spotbeam GEO satellites as well as NGSO satellites in different orbits (MEO/LEO/HEO). A primary challenge for government operators would be to connect to a new constellation since some of these ecosystems are closed networks. A secondary challenge arises when the end-user wishes to build a portfolio of different capabilities in different orbits in order to build resilience, to optimise services, support new operational scenarios or provide connectivity across the globe.

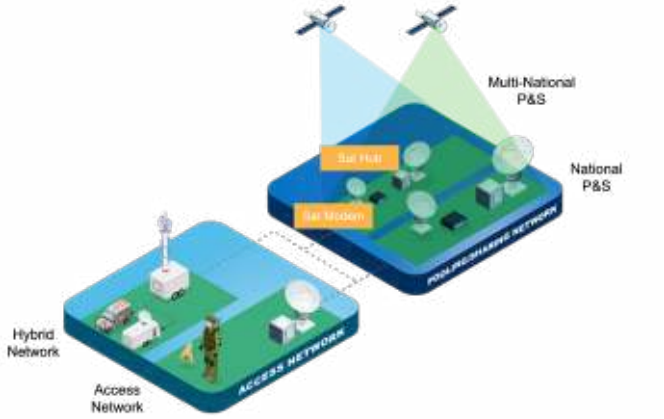
By connecting to different constellations and orbits in a multi-layered network the operator adds resiliency for government and military communications by mitigating intentional or non-intentional interferences, outages or unstable link quality. A government may primarily use its own sovereign satellite, leverage allied satellites via a government-to-government arrangement, or purchase bandwidth and managed services from a commercial satellite operator or service provider for additional capacity.

From a New Ground perspective a majority of the baseband technology is available or under development to manage satellite handovers, roaming and networking or orchestration demands. A key element to ensure connectivity to different satellites and networks is the introduction of the multi-personality modem. With a simple switch in the software the software defined multi-personality modem can adapt itself according to the network it interfaces with. As such the end-user only needs a single modem in operation which provides full resilience and network diversity capabilities.

The real gamechanger technology will come from the FPA (flat panel technology) technology providers to develop multi-frequency satellite terminals that can connect to different constellations in different orbits and different frequencies in a seamless manner. A wide offering of technological innovations are already being tested (Electronically and Mechanically Steered Antennas, Lens Technology etc.) but no clear winner has come out of the antenna or terminal race yet.

Stage 4: National and Multi-National Pooling and Sharing Networks

Exhibit 4: Pooling & Sharing Networks



A Pooling and Sharing (P&S) network refers to an initiative where a central hub aggregates satellite bandwidth or services from a group of satellite operators or service providers and distributes resources amongst different government end-users in times of crises or as part of the daily government operations (e.g. the EU GovSatCom hub). The government end-users have the choice to either select a managed service from the central P&S hub catalogue including services, bandwidth and remote hardware, or the government end-user can feed in his existing access network and interface with the P&S network.

These P&S networks are set up to increase collaboration and provide a more resilient, alternative and cost-efficient way for end-users to access secure communication services. Pooling and Sharing services are particularly beneficial as they are available at short notice and are highly responsive to quickly groom capacity and support changing needs, for example, first responders requiring immediate satcom access after a disaster. The P&S capability is not limited to first responder use cases but can be extended to communications between government agencies on a national or multi-national level as well as defence agencies, or providing secure connectivity to key infrastructure operators, maritime and border authorities.

To enable the aggregation and distribution of satellite bandwidth and services through a central P&S hub, some 'New Ground' innovations are needed to allow for an efficient management of the operations. Key enablers are the end-to-end orchestration of P&S services across multiple satellite constellations and end-user platforms, the usage of standards and open interfaces to embrace the need for interoperability and to connect the ground segment and end-user terminals to a single P&S hub. Finally, virtualized network and infrastructure technology support increased service agility and faster new service rollouts.

Exhibit 5: Cloud Networks

Stage 5: Leveraging the Cloud

An increasing number of applications is moving towards the cloud. How will government and defence agencies look at integrating both Central Cloud and Edge Cloud capabilities to their satellite networks? An initial reaction from government and defence agencies might be that moving capabilities to the cloud may also increase security issues for sensitive applications. These security issues can be mitigated by refraining from connectivity to the public cloud and operating on a private cloud within the government premises or on the secured infrastructure of an approved cloud provider.

Moving to a cloud-based infrastructure makes sense for network operators to unlock the full potential of new MEO/LEO/HEO/GEO constellations and highly flexible digitized high throughput satellites. This newer generation of satellites will require a more scalable, flexible and powerful infrastructure solution. Cloud provides a remedy for the mounting problem of adding new equipment and processing power to ground segment gateways to keep up with high throughput demands and the rapidly expanding beam numbers being deployed by each new generation of satellites. Cloud-based solutions can accommodate current and future innovation trends in the satellite space segment by providing easy scalability without the need for additional CAPEX investments. Cloud also helps in building redundancy schemes and back-up scenarios in case of disasters. (see ST Engineering iDirect's white paper, Embracing the Cloud in Hybrid Networks).

Next to centralized cloud capabilities, edge cloud and edge computing bring additional benefits to the government and defence end-user. The proliferation of sensors, unmanned vehicles, command posts, and mobile-enabled personnel has resulted in a field scenario that is increasingly complex and sophisticated. Bringing the cloud to the edge allows end-users to run applications remotely during operations without the need to exchange the data with a central hub over satellite reducing the risk of interference, interception or reduced throughputs. Edge cloud and edge computing are key to delivering real-time performance for situational awareness, ISR, emergency services and in-theatre communications.

Stage 6: New Ground for Government and Defense based on 5G

The edge cloud application builds the bridge between cloud capabilities and the evolution towards integrating 5G into next-gen government networks. This fifth-generation technology standard for communication networks encompasses more than just the backhaul of data from remote operations or edge computing/cloud applications. The emerging 5G technology offers government and defence agencies access to advanced communications and networking capabilities with improved data rates, lower latency, agility and interoperability. While 5G largely evolves from the 4G standard there are significant shifts in terms of network architecture, development of standards to allow for interoperability and increased capabilities. With 5G being adopted by both the terrestrial and satellite industry we can observe a major transformation and a convergence between both worlds into fully hybrid networks.

Exhibit 6: 5G Network

New Ground for a Converged European Secure Space Connectivity System

The key question is how to merge these disruptive technologies and innovations into the EU context. The EU is planning for more autonomy and wants to become a more capable security provider. In the EU Strategic Compass the EU member states agree on a common strategic vision for the EU's role in security and defence and commit to a set of concrete and wide-ranging objectives to achieve these goals in the coming 5 to 10 years. In the same document it is outlined that space has a key focus and an EU Space Strategy for security and defence needs to be developed. The EU Space Programme and other space infrastructure of the EU and its Member States will contribute to the resilience of the Union as they offer key services that substitute or complement ground infrastructures for earth observation, satellite navigation or telecommunication. The EU space systems will offer global connectivity to security and defence actors. To this end, the EU Commission is working on the proposal for an EU space-based global secure communication system also called the EU Union Secure Connectivity (USC) to be developed and deployed between 2023 and 2027.

On one hand, the USC program provides the opportunity to model a space and ground segment that embraces todays and future requirements blending in all advantages that new disruptive technologies have to offer, including the New Ground capabilities.

On the other hand, it gives the EU space program the prospect to converge different subsystems into one larger centrally managed space system for the EU:

Firstly, there is a convergence between the space segment, ground segment, user segment and service layer inside the USC itself for secure satellite communications. At the centre of these transformations and convergence is the 'New Ground' segment which the USC system and the EU GovSatCom hub could exploit to connect and manage the New Space assets, the 5G architecture and the virtualization drive towards convergence, standardization and orchestration of satellite networks. Software defined multi-personality modems and multi-frequency terminals at the remote side of the satellite network provide agility, resilience and network diversity through their seamless switching capabilities to overcome satellite link disruptions. These technologies can immediately be embedded in the USC and EU GovSatCom programs as well as in EDF initiatives such as the European Protected Waveform, the ISR Small Satellites call and the Responsive Space System capabilities.

Secondly, we see a convergence between satellite communication systems and terrestrial communication technology into hybrid networks. As described in Stage 2 in this paper the hybrid networks provide EU member states with the flexibility and redundancy needed in crisis situations to communicate in real-time and get the job done as efficiently as possible. The main drivers here are the use of standard interfaces, common 5G architectures and moving capabilities towards the cloud.

Thirdly, in a further future the EuroQCI solution should protect communications flowing over the USC and EU GovSatCom systems and interface directly with the 'New Ground' segment baseband equipment to set up the encryption. The EuroQCI initiative aims to build a secure quantum communication infrastructure to safeguard sensitive data and critical infrastructures. The hybrid nature of future communication networks is emphasized by the fact that EuroQCI includes a terrestrial segment relying on fibre communications networks linking strategic sites at national and cross-border level, and a space segment based on satellites which will link national quantum communication networks across the EU and provide global coverage.

Finally, other EU Space programs will have a direct or indirect connection to the 'New Ground' system for example for the relay, exchange and distribution of earth observation or ISR sensor data.

Exhibit 7: Sample EU Constellation

ST Engineering iDirect Europe Taking Center Stage for EU New Ground Technologies

ST Engineering iDirect Europe is located in Sint-Niklaas, Belgium and is the EU Satcom Center of Excellence specializing in the development of ground segment technology and equipment for the EU. We have over 35 years of experience and have built a strong base of expertise and a dedicated team of domain specialists, close to 400 people today. As such we have become the strategic ground technology partner to the world's top satellite operators, government and defence network operators and service providers. We deliver advanced satellite baseband technology, secure and efficient waveforms and ground segment capabilities that enable our customers to achieve their operational goals in the most efficient and agile manner.

Our portfolio of high-value product lines and services offers a comprehensive solution set for multiple markets. We have the largest installed base of satellite modems, VSAT systems and satellite platforms inside EU government, defence, intergovernmental, first responder and NGO users which makes us a true stakeholder and partner for EU initiatives linked to the Ground Segment technologies and services.

Our ST Engineering iDirect VSAT systems have traditionally been managed as standalone or multiservice systems in GEO-satellite based networks, but today this is changing because terrestrial standards are now becoming dominant. Standards will help our customers to integrate satellite communication systems into an existing terrestrial environment rather than having to manage the satellite communication system as something on the side with its own proprietary APIs and interfaces. Satellite systems can be plugged into the wider telecom ecosystem converging towards a single 5G standard.

For us, collaboration with technology partners is key to push forward these concepts. Over the years, we have been participating directly into the 3GPP standards initiatives around 5G, as well as other organizations such as 5GPPP and ETSI driving several frameworks supporting 5G deployments. As we adopt new 3GPP standards and releases defining 5G, we see a substantial rise of satellite network deployments. They will become both easier and more cost effective. (see ST Engineering iDirect's white paper, Breaking Ground in the 5G Era).

Today ST Engineering iDirect Europe is already involved in multiple EU programs. A prime example is the EDF2021 program on the European Protected Waveform (EPW). The EPW idea was initiated through a paper published in June 2018 by ST Engineering iDirect Europe. Our company is consortium leader for the EPW project including 19 companies from 11 EU member nations for the development of the EPW capability. The EPW is built around 4 corner stones: efficiency, secure and resilient communications, affordability and interoperability. The EPW is accessible to small, midsized and large EU nations seeking to embrace today's and future challenges related to increased throughput over satellite, dispersed operations, mobility and new security threats.

The EPW will be key for the communication across the USC and EU GovSatCom system for military and mission critical secure applications.

Conclusion

The satellite industry is going through an immense transformation. At the centre of this transformation and convergence is the 'New Ground' initiative that connects and manages the New Space assets in different orbits, the 5G architecture, the hybrid terrestrial-satellite networks and the virtualization drive towards convergence, standardization and orchestration of satellite networks. The increased number of threats and interferences, both intentional and unintentional, make implementing a multi-layered security approach as part of the New Ground initiative more important than ever. Through this innovative and secure New Ground approach government and defence end-users will gain operational advantage and information superiority. In the context of the EU the New Ground technologies fully serve the requirements of the EU GovSatcom, the EU Union Secure Connectivity (USC) and related EU space programs in the EU's ambition to gain more autonomy and to become a more capable security provider.

To learn more about ST Engineering solutions, visit: https://www.idirect.net/st-engineering-idirect-europe/

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