5G

Over Satellite

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Satellite's 5G Migration: Why a Phased Approach is Best

Satellite networks have always operated under their own bespoke standards, separate and independent from terrestrial networks. With the advent of large and growing aero, maritime, land, and remote IoT markets, the need to integrate satellite with terrestrial has become critical.

Ships need to connect to terrestrial networks as they approach land, aircraft require access to wireless networks on the ground, and vehicles of all types need to roam to satellite coverage as they move beyond terrestrial networks, all while doing so seamlessly. That's just one reason the satellite industry needs 5G. Not only does it solve the operators' roaming problem, but it also provides a whole new world of features and commercial opportunities for them to grow their businesses.

5G standardization allows satellite operators to address a much larger market by offering seamless services with terrestrial networks, moving from niche solutions to mass-market adoption. Integration with 5G expands business models, including direct-to-device connectivity, support for IoT/M2M services, and delivery of multiservice broadband, backhaul, and resilience for enterprise and government customers.

With 5G, operators leverage developed telecom supply chains for chipsets, modems, and network software, reducing costs and accelerating the time-to-market for new products and services.

5G also enables network slicing, which lets operators offer customized, differentiated services for various vertical markets (enterprise, mobility, maritime, remote mining, etc.), unlocking new revenue streams.

That's why operators and integrators are issuing RFPs and clamoring for a technical solution to bridge the gap from satellite networks to the 5G ecosystem,

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and why ST Engineering iDirect has developed an easy-to-implement, evolutionary path to 5G. To learn more about the company's innovative 5G migration strategy, we met with iDirect's Sr. Director of Corporate Development, Terry Neumann.

SMW: As the final 5G standards have yet to be defined, could you tell us about your 5G migration strategy?

Terry Neumann: Our first consideration in developing our 5G migration strategy was to enable our customers to leverage their existing Intuition-based satellite infrastructure, thereby minimizing additional capital investment.

Most satellite networks to date have been built using waveforms and technologies that were not defined by standards; we refer to these traditional proprietary networks as Non-3GPP networks.

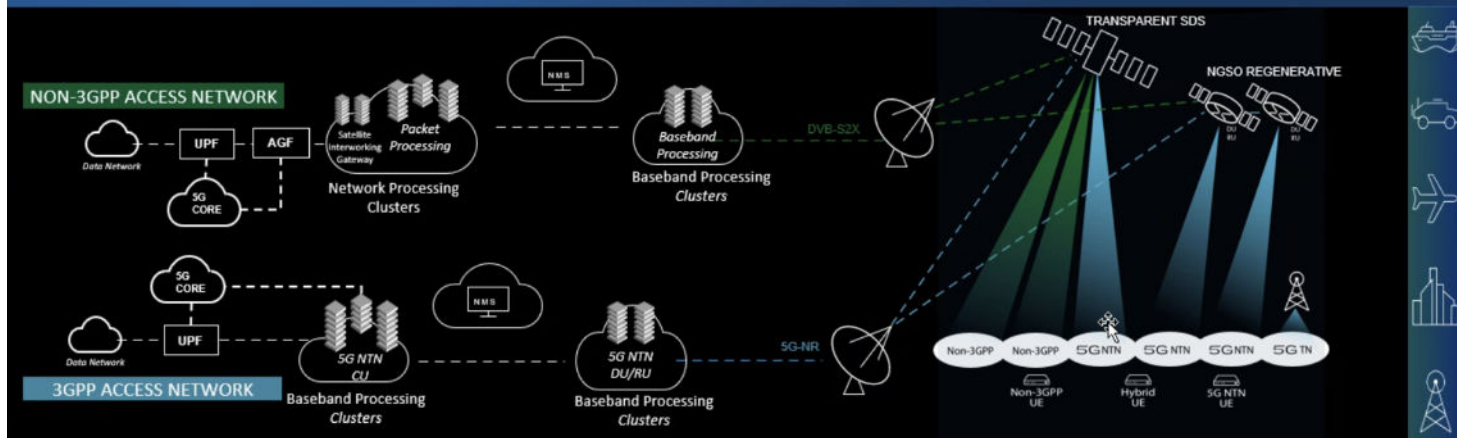As we examine the introduction of satellite technologies into the 3GPP standards, we recognize that this is an evolutionary journey. Some of the standards are clearly defined, while others are yet to be defined or finalized in the standardization process, and the hardware and software to support these implementations are still under development. Based on this reality, we have developed a multi-track approach for enabling our customers to take advantage of 5G technologies.

Track I: Non-3GPP Access to the 5G Core:

We've started by enabling non-3GPP satellite networks to connect to the 5G Core through a Satellite Interworking Gateway Function (SIG).

The 5G core is really the brain of a 5G network and is responsible for many of the different functions that make communications happen within a mobile network. The gateway acts as a bridge, translating satellite-specific network functions into 5G compatible formats. This enables communication between a 5G core

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Hybrid Roaming — ST Engineering

NON-3GPP ACCESS NETWORK

Data Network — UPF — AGF — Satellite Interworking Gateway / Packet Processing — 5G CORE — Network Processing Clusters

NMS — Baseband Processing / Baseband Processing Clusters — DVB-S2X

3GPP ACCESS NETWORK

5G CORE — UPF — Data Network — 5G NTN CU — Baseband Processing Clusters — NMS — 5G NTN DU/RU — Baseband Processing Clusters — 5G-NR

TRANSPARENT SDS — NGSO REGENERATIVE — DU/RU

Non-3GPP | Non-3GPP | 5G NTN | 5G NTN | 5G NTN | 5G TN

Non-3GPP UE | Hybrid UE | 5G NTN UE

Roaming between non-3GPP and 5G NTN
- Enables global connectivity, network resilience
- Opens new revenue streams, lowers infrastructure costs, and ensures scalable solutions for operators
- Users benefit from secure, reliable connectivity across diverse environments
- With Intuition Satellite Interworking Gateway, interoperable with AGF, Hybrid UE

Roaming between 5G NTN and 5G TN
- Seamlessly extends connectivity, converging into a unified network of networks
- Maximizes flexibility and interoperability for satellite operators and telcos

Roaming between non-3GPP (S2X/MRC) networks
- Unlocking new revenue opportunities with faster time-to-coverage with seamless roaming into visiting networks
- Home networks benefit from higher fill rates, ROI, and differentiated services
- End users enjoy seamless connectivity with consistent applications, security, and billing based on 5G framework

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and a traditional satellite network that may use different radio waveform protocols like DVB-S2X and Mx-DMA.

By doing so, existing satellite ground systems can appear fully 5G-compliant, even though they use different waveforms from terrestrial 5G NR.

This approach enables satellite operators to leverage the 5G Core's capabilities, including authentication, signaling, and policy enforcement, without necessitating immediate infrastructure upgrades.

For operators using Intuition, integrating the interworking gateway functions is straightforward and cost-efficient. The approach is intended to facilitate incremental adoption of 5G NTN by leveraging already deployed satcom architecture and enabling seamless 5G Core interoperability until the satellite-specific 5G NR waveform matures. Importantly, this integration will deliver immediate operational efficiency stemming from

unifying 5G core access.

Track II: Introduction of Advanced Radio Access Technology (RAT):

This approach introduces advanced wireless technologies that allow satellite networks to work seamlessly with 5G mobile networks. iDirect is modifying traditional cellular base station technology to better work in a satellite environment. A 5G base station, known as a gNodeB, handles all the radio frequency signals to and from communications devices. The 3GPP standards define how Non-Terrestrial Networks (which include Satellite networks) can integrate into traditional mobile networks and utilize a standardized waveform known as 5G New Radio or (5G NR).

iDirect is developing 5G gNodeB capabilities in our Intuition platform that will support the 5G NR waveform, enabling native 5G capabilities over both transparent and regenerative satellites. In this track, we are

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optimizing the 5G base station to support some of the more complex requirements needed when utilizing satellite. The result will be a totally standards-compliant solution from endpoints to the waveform, to the gNodeB connecting to the 5G core. Once this integration is complete, a satellite terminal will be able to roam between other 5G or terrestrial networks using the 5G NR wave form connecting back to the 5G core.

Track III: Hybrid Roaming:

Here, we introduce Hybrid 5G modems, new devices that can connect to both satellite and traditional cellular networks. These modems enable seamless switching between satellite and cellular networks worldwide, ensuring continuous service and allowing a single SIM to work on any network. As these modems evolve alongside improved virtualization, support for multiple satellite orbits, and new applications of AI, operators will be able to manage complex networks more easily. These features will become available as new standards are released, starting with 3GPP Release 19 and later updates.

SMW: What are the major advantages of iDirect's evolutionary approach to 5G integration?

iDirect's integration strategy is a structured way to gradually achieve full and seamless interoperability between satellite and 5G networks. This approach follows multiple tracks, helping satellite operators and service providers adapt as the telecom industry evolves. By taking this path, they can stay competitive with 5G Non-Terrestrial Networks (NTN) and work towards integrating with the 5G Core, while launching 5G NTN networks at a manageable pace.

It's a strategy that reduces the risks that come with adopting new ideas too early. Instead of a single, large, and costly upgrade, improvements can be made in phases. This enables operators

> *"iDirect's integration strategy is a structured way to gradually achieve full and seamless interoperability between satellite and 5G networks. This approach follows multiple tracks, helping satellite operators and service providers adapt as the telecom industry evolves. "*

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to utilize their existing assets and gradually introduce new features, keeping capital expenditures lower and budgets more predictable. Each track in the approach brings practical benefits.

Operators can begin implementing operational improvements immediately. New service capabilities and revenue opportunities are introduced gradually, rather than waiting for all upgrades to be finished. Overall, iDirect's strategy leads to scalable growth, cost-effective updates, and strong readiness for operating fully connected 5G and 5G-enabled networks.

What is the end-user impact of the transition to 5G? How does the end user benefit?

For end-users, journeys between ports, cities, remote environments, or across entire oceans will no longer be hindered by invisible coverage boundaries.

While some transitions may initially require specific modems, as 5G NR satellite technology becomes mainstream and hybrid modems are introduced, switching between land and satellite networks will feel as seamless as moving between mobile phone providers when crossing a national border.

Although the analogy to mobile phone roaming is relevant, the integration enables the delivery of continuous, high-performance data, voice, and connected application access for industries such as shipping, oil and gas, aviation, and remote enterprises - sectors that have traditionally faced challenges in achieving ubiquitous coverage.

Terry Neumann is the Senior Director of Corporate Development at ST Engineering iDirect, where he plays a pivotal role in shaping corporate strategy, driving initiatives that align with the company's vision, and fostering strategic partnerships. With a career spanning multiple senior leadership roles at iDirect, Neumann has been instrumental in market strategy and corporate marketing efforts.

Prior to joining ST Engineering iDirect,