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The Digital Edge and Why Hardware is More Crucial than Ever

By: [Craig Bowley](#)

The satellite industry is in the middle of a familiar kind of hype cycle: software will eat everything. Virtualized ground systems, cloud-native workflows, software-defined payloads, automated orchestration – all real, all transformative. But there’s a harder truth that operators, integrators, and enterprise buyers are rediscovering the moment they try to scale: the digital future of satcom only performs as well as the hardware foundation beneath it.



Cost effective high performance is a must have. We’re moving into an era defined by ubiquitous, high-speed connectivity – not just for consumers, but for industries building automation, autonomy, and resilience into everyday operations. In the last five years alone, the number of active satellites in orbit has grown from roughly 3,300 to 13,100. [Novaspace](#) predicts that a further 43,000 satellites are expected to launch by 2035, averaging 12 satellites and 8 tons of payload being launched every day. That scale changes everything. It doesn’t just increase capacity; it increases complexity. The satellite ground segment – often treated as the supporting cast – is becoming the stage itself.

The New Reality: Complexity Has Moved to the Ground

Demand is expanding because connectivity is no longer a “nice to have.” It’s becoming the backbone for applications that depend on reliability and responsiveness: the Internet of Things (IoT), autonomous systems, intelligent energy grids, smart buildings, and industrial automation. These use cases don’t merely require bandwidth; they require assured performance, the ability to adapt as requirements evolve, and resilience when conditions degrade. That is pushing networks toward flexibility: more dynamic allocation of resources, faster deployment models, and services that can scale up and down with demand. But the biggest change is architectural: satcom is shifting toward digital infrastructure and software-defined technologies to keep pace.

As this transformation accelerates, the ground segment is becoming more complex – not less. Equipment is expected to handle high-bandwidth, low-latency applications that drive Low Earth Orbit (LEO) adoption, while also supporting users who increasingly want multi-orbit and multi-band flexibility.

In practical terms, that means ground infrastructure must cope with:

- LEO dynamics: tracking and handover at scale.
- Multi-orbit operations: seamless switching between orbits based on service need or availability.
- Multi-band requirements: the ability to operate across bands as interference, regulation, or performance demands change.
- Simple auto acquire connectivity, smart switching, least cost routing all things taken for granted in the handset world are now a must in satellite ground systems.

This is the environment where “software-first” meets the edge of physics.

Digital Transformation Is Real — But It’s Not the Whole Story

The push toward digital infrastructure is not a trend; it’s a response to operational realities. Edge computing on the ground is helping to move workloads closer to users, reducing latency and improving security while enabling networks to adapt faster. Software-defined equipment is also expanding what ground systems can do, adding much-needed flexibility and operational efficiency. In some areas, software can replace traditional hardware – modems are a good example – enabling operators to scale and reconfigure capabilities on the fly.

But here’s the critical point: not all satcom components can be virtualized. The fundamental elements that make satellite communications possible – satellites, antennas, amplifiers – remain physical systems, governed by RF performance, thermals, materials, precision engineering, and environmental constraints. Which leads to a mistake the industry sometimes makes: assuming hardware is “static” while software is “agile.” In reality, the most important shift is not hardware being replaced – it’s hardware evolving from fixed-function to configurable, modular platforms that can keep up with software-driven networks.

Modern Hardware Is Becoming Configurable - Because It Has To

Look at what has happened in space. Satellites were once launched with preconfigured payloads designed for a specific mission. Increasingly, today’s satellites use software-defined payloads that can be reconfigured after launch – frequency, power distribution, beam steering – to respond to changing demand. The ground segment is following the same logic.

Modern antennas, for example, are moving beyond rigid, fixed parameters. They are becoming adaptable systems – often with software-defined capabilities – where performance can be controlled and optimised for different operational needs. Users can adjust operating frequencies, polarization, and radiation patterns to respond to changing conditions or interference. That adaptability is what makes multi-orbit and multi-band operation feasible – for example, supporting operation across Geostationary Earth Orbit (GEO), LEO, Medium Earth Orbit (MEO), and Highly Elliptical Orbit (HEO) while switching between Ka and Ku bands as requirements change.

Transceivers show the same pattern of convergence and integration. Rather than managing multiple discrete RF components, modern transceivers can consolidate the transmit and receive functions typically distributed across a Block Upconverter (BUC), Low Noise Block downconverter (LNB), Orthomode Transducer (OMT), and feed into a single component. Beyond improving RF performance, this drives tangible operational benefits in size, weight, power, and cost (SWaP-C) all of which matter when networks are deployed at scale. And crucially, modern architectures don’t stop at integration. With interoperability frameworks (such as OpenBMIP)

and smart modem pairing, transceivers can be configured for optimal transmit power and receive band selection, dynamically adjusting to network requirements to prevent overload.

This is what “hardware agility” looks like: not marketing language, but real operational adaptability at the physical layer.

The Defining Challenge: Interoperability at the RF–Digital Boundary

As both hardware and software evolve, the industry faces a new central constraint: interoperability between them.

At the heart of modern satcom operations is a simple requirement: RF signals generated and handled in hardware must be converted to digital formats that can move cleanly through virtualized and cloud-based workflows. If that conversion is inconsistent, proprietary, or poorly standardised, the benefits of digital infrastructure are throttled before they begin. That’s why standards matter. If RF signals are to be digitised and exchanged reliably across platforms and operators, the conversion process must be standardised – and the technology implementing it must be interoperable. Standardization lowers cost, increases agility, and supports flexible delivery over IP connectivity.

This is precisely the focus of the Digital Intermediate Frequency Interoperability (DIFI) Consortium, which is developing an open, interoperable digital IF/RF standard intended to replace the natural interoperability that analogue IF once provided. Widespread adoption is a key enabler for the industry’s digital transformation and for more flexible, scalable networks.

Interoperability is not a technical footnote. It is the lever that determines whether multi-orbit, multi-band, software-defined ground systems become a practical reality – or remain stuck as bespoke integrations.

Automation Is Inevitable — But It Depends on Getting the Foundations Right

Consider networks made up of thousands – potentially tens of thousands – of satellites and user terminals, where every element must perform optimally to deliver seamless data flow. At that scale, orchestration cannot be manual. Intelligent automation becomes essential – coordinating beam steering, adapting downlinks to shifts in demand, and optimising network behaviour in real time.

But automation doesn’t remove the need for hardware. It raises the standard hardware must meet – because automation can only orchestrate what the system can reliably sense, control, and interconnect. If the hardware layer lacks consistency, configurability, or interoperability, orchestration becomes fragile.

This is why the industry’s most important progress is happening in the spaces *between* disciplines: RF engineering that understands digital workflows; digital systems designed with the realities of RF performance; and physical products built to integrate into open, interoperable ecosystems.

At leading organizations, this hybrid mindset is where they see the market heading – not as a “hardware versus software” debate, but as a requirement to master both domains and make them work together at industrial scale.