Yangmingshan Communication Center of Chunghwa, Taipei City, Taiwan. Photo courtesy of Chunghwa Telecom

Adapting to enable ground station evolution

In the era of digital DTH, mobility, HTS and constellations, major equipment manufacturers have been tasked with re-inventing innovation time and time again to realise satellite's greatest advances. To stay ahead of the pack, the leaders will need to continue adapting to support future networks.

Eric Schmidt, Vice President, Sales, Comtech Xicom Technology

Communications satellites have been serving customers since 1964, and to date, great advances have been made in their capabilities to offer the fundamental advantages afforded today. Service providers have taken advantage of the technological and regulatory evolution that has lowered the cost per bit and increased reliability, enabling them to offer fresh products, wholly new applications, and revolutionary communications services. From enabling the remote worker and global broadcast, to scalable broadband networks, path diversity and more, the advantages of satellite have become evident.

As satellite communications (satcom) continue to enter the mainstream market, it will continue to prove its value, and its need to be readily available everywhere will become universally well known. While all players across the satellite value chain need to innovate to reduce the cost per bit and improve end-user experience, the pressure on the ground segment's equipment manufacturers is sky high and still rising. It is only with innovative new products that satellite's advances come to fruition. It is essential that equipment makers innovate to uncharted ends, and then push themselves even further to prepare for future requirements.

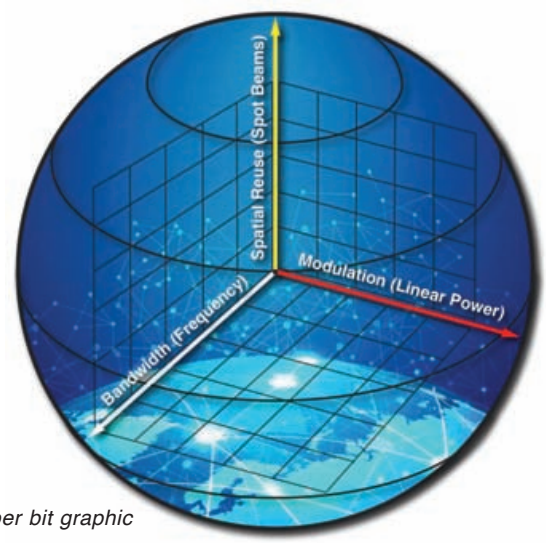
Looking back at some of satellite's advances offers a glimpse into the equipment makers' technological feats. Here we see how revolutionary ingenuity got us to where we are today, offering encouragement that an even brighter future awaits.

Sophisticated links: Reducing the cost per bit

In the early days, service was primarily voice traffic and satellite beams covered whole hemispheres using 500MHz of C-band spectrum. By using two polarisations, one GHz of capacity was available from each orbital slot.

In the 1970s, Ku-band satellites introduced tighter national beam patterns, increasing the effective capacity of an orbital slot, and lowering the cost per bit. This paved the way for distributed networks and cable TV distribution by satellite. The ground segment innovated to make advances in digital compression and additional frequency allocation, giving rise to the digital Direct-to-Home (DTH) business, which quickly captured subscribers around the globe.

In the early 1990s, Ka-band spectrum became available and satellite spot beam technology matured to offer a further dramatic reduction in the cost per bit, enabling regional video coverage. Ka band's impact was made again in 2007 with the advent of the High Throughout Satellite (HTS) market. Today, supported by hardware on the ground boasting



Cost per bit graphic

unprecedented capabilities, HTS spacecraft are heading to capacities of 500Gbps. These technologies have reduced the cost per bit and continue to evolve to drive new services.

Other downward drivers of cost are prevalent in both the space and ground segments. The costs associated with successfully launching satellites into their orbital locations are significant. Many companies are addressing reductions in launch costs via re-usable rockets, airborne launch platforms and shared payloads. There is also the cost of user terminals. DTH and HTS systems showcase technological sophistication but must offer low-cost and easy-to-install user equipment. Finally, there is the cost to operate, service and maintain the Earth station or gateway terminal. Today, employees need to be multi-skilled, and equipment must be reliable, easy to service and controlled automatically.

Teleports: The rise of data over video

Private teleports have been evolving since the 1970s. Initially, most traffic was video, which is constant and predictable. The business model was to lease capacity that could be optimized for the needs of long-term users. This model is changing,

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and teleports are re-inventing themselves to transport data via managed services. Now, ground station infrastructure needs to be robust enough for high Quality of Service (QoS), yet flexible enough to meet the needs of many customers. This ever-changing traffic requires 24/7/365 management as well as broadly skilled personnel and high-reliability, redundant equipment, all controlled by intelligent network management systems.

These changes, and the trend towards data and away from video, are more of an evolution than revolution. One of

Comsat Teleport Southbury, CT

Embratel Claro Teleport in Guaratiba – Rio, Brasil

750W Ku-band TWTAs. Photo courtesy of Comtech Xicom Technology

the biggest changes, arguably, is that teleport silos are going away. Successful teleports need to aware of, and plugged into, the larger telecom fabric with integrated operational and business systems.

To survive any evolution, adaptation is imperative. Adapting well and in time not only potentiates survival but the realization of opportunities. There are new market segments emerging, including linking cloud-based data centers via satellite. We are seeing major cloud companies making investments in satellite technology. Successful integration of teleport operators into cloud services, including data storage, data processing and data analysis, is a future growth area. Another area of interest is the market for government customers who need resilient and survivable networks. Military systems will need to be smaller and nimble. Supported by fresh innovation, teleport operators can adapt and tap into this segment of the market.

Adapt, support, prosper

In 2018, AWS announced ground station as a service. Other companies like Leaf Space and incumbents such as KSAT and SCC were already exploring this business model. In this scenario, teleport operators sell their facility and operational management as a subscription service. It can be dedicated, shared or occasional service, saving the satellite user the capital investment and sharing existing skilled personnel and infrastructure.

Cost constraints put more pressure on maintenance which must be performed quickly. Staff need to have broad skills to perform numerous tasks and service an array of equipment, from an antenna bearing and air conditioner to HPA and software upgrades. At the same time, the systems need to be reliable enough to continue functioning in between maintenance windows.

Network management must work across a suite of products and vendors. On any given antenna, products can be changed, and the system needs to continue working. Products must be easy to install and turn on. Set-up should be intuitive and fast with good documentation and 24/7 customer service should issues arise.

These evolutionary changes in teleports and the opportunities they present have all been on the back of the equipment manufacturers who adapted, rose to the challenge, and succeeded in producing the enabling technologies. The manufacturers leading innovation understand that teleports and service providers have extremely high Service Level Agreements (SLA) that require highly robust, rugged equipment. As one of many examples, this appreciation led to the Line Replacement Unit (LRU) concept for ease of set-up, speed of maintenance and ability to stock common spare parts and modules. The LRU works very well with on-site staff who need to be able to quickly install, configure and turn up new equipment.

DTH's cool technology

There is no doubt that non-linear and Over-The-Top (OTT) streaming services are increasingly on the rise. While they have significantly impacted the market in areas where high-speed data connections are available, global DTH is still achieving six percent growth annually.

In the early 1990s, DTH pioneers were focused on highly robust systems, so much so that, looking back, they may have overbuilt them. Systems were 100 percent redundant with diversity sites. The stations were automatic, and the sites could run very lean with diversity sites completely unattended. This is a testament to the quality of the hardware and management system, which could essentially run itself. The

750W DBS TWTA with liquid cooling

facilities could be lean in their staffing, comprising of cross-trained technicians. Sporting full redundancy, maintenance could be easily scheduled while transmission was continuous via the diversity site.

Fast forward to today, DTH operators have more control and predictability of their networks, including control of both the space and ground segments. They're able to establish common architecture and have economies of scale and scope in their operations.

The DTH market has been successful in ushering in technological changes required to keep its competitive edge. A prime example is its transition to liquid cooling. With necessity the mother of invention, the liquid-cooled Traveling Wave Tube Amplifier (TWTA) was developed, enabling teleports offering DTH services a noise-friendly outdoor upgrade from indoor klystron power amplifiers.

Indoor klystron power amplifiers lose most of their power in switching systems and reaching the outdoor antenna hub. The inefficiency is even worse at higher frequencies. Being able to have high-power amplifiers at the antenna hub or platform saves energy and reduces OpEx for the life of the system. It also opens up more real estate in the equipment room for baseband or storage systems.

Efficiency gains and OpEx reductions aside, outdoor amplifiers increase acoustic noise to the ambient environment. It is here that liquid cooling plays an important and quiet role, as the amplifiers do not require noisy cooling fans. But the ground segment's innovative equipment manufacturers didn't stop at just this benefit, they ensured that more gains were to be had.

These amplifiers can be tightly packed into antenna hubs, allowing for Radio Frequency (RF) power to get even closer to the antenna feed, eliminating the need to clean fins and replace fans. This elimination of the need for service is especially important to help reduce maintenance at unattended diversity stations.

HTS and the ground segment's supreme capabilities

Like teleports currently, HTS business is data driven, yet it shares similarities with DTH in its overall control of the entire network architecture. HTS operators are essentially data warehouses linked by fibre and connected to the customer by satellite.

They can offer cost-per-bit pricing that is competitive with terrestrial fibre and serve both untethered users in rural locations and mobility markets. Having a common architecture allows HTS operators to easily add new customers to the systems with quick installation and pre-planned service offerings.

To achieve the hundreds of Gbps throughput, HTS networks require advanced modulation formats to maximise the bits per hertz. They also operate in Ka band (5+GHz of bandwidth) and are migrating to V band (10GHz of bandwidth) – both of which can be heavily impacted by rain-fade. To maximise link throughput while maintaining fade margins, HTS operators employ large antennae and extremely high-power amplifiers.

Succeeding here requires supreme capabilities. It is critical that these billion-dollar systems be supported by equipment manufacturers with an unimpeachable reputation. Not only must the hardware be fully developed and ready for on-time delivery, but it must be reliable to meet the performance specs of today as well as in future. The RF chain must integrate into the antenna hub with easy-to-connect interfaces that work every time.

All products must be easy to align and service by a skilled but generalist workforce.

Manufacturers must support programme objectives, meet their commitments, and improve the probability of success. It's a big ask, but getting it right means that vendors stand behind their products year after year. It is an innate drive to innovate that motivates the leading equipment manufacturers to continue developing the enabling technologies that allow for the significant advances gained in satellite communications.

But to stay at the forefront requires even the most seasoned manufacturer to adapt today for future developments. ■