Space Japan Opinion

On the Evolution of the Commercial Communications Satellite Industry

Thomas C. Butash, Ph.D.
BAE Systems Engineering Fellow
and
Immediate Past Chair of the American Institute of Aeronautics and Astronautics (AIAA)
Technical Committee on Communications Systems

The commercial communications satellite industry, despite increasing, relentless competition from terrestrial fiber-optic and wireless network systems, has recently emerged from a four year recession. The industry is in the process of reinventing itself – a process which will determine whether commercial communications satellites continue as a principal medium for ubiquitous communications services or are ultimately relegated to niche applications such as transoceanic mobile and remote communications. A brief review of the industry's short but nonetheless illustrious history of innovation and growth is presented to provide a framework within which current industry challenges and future potential directions are examined.

A Remarkable History of Innovation and Growth

The commercial communications satellite industry's history [1] of innovation and growth was born, quite humbly, in 1945 with Arthur C. Clarke's landmark paper, "Extra Terrestrial Relays," [2] in which he presciently proposed a system of worldwide wireless communications effected with only three satellites in Geosynchronous Earth Orbit (GEO). In 1955, John R. Pierce [3] refined the concept of a communications "repeater" in earth orbit, estimating the capacity of such a transponded communications satellite at 1000 simultaneous telephone calls. In comparing this capacity to the 36 simultaneous call capacity of the first trans-Atlantic telephone cable (TAT-1) that was to be put in service the following year at a cost of 30-50 million dollars, Pierce suggested the transponded communications satellite might be worth a billion dollars. And the inevitable competition between terrestrial and satellite based communications was thus first recognized. The Communications Satellite Corporation (COMSAT) was chartered in US Congress by the Communications Act of 1962, and COMSAT's Early Bird became the first commercial communications satellite in 1965, only two decades after Clarke's visionary work.

Over the following three decades, the commercial communications satellite industry enjoyed rapid innovation and growth, culminating in the zenith of its prosperity, in the late 1990s, as a multi-billion dollar global enterprise. However, the first trans-Atlantic fiber-optic cable (TAT-8) was laid in 1988, and the ensuing years saw rapid growth in the capacity and geographic extent of terrestrial wireless and fiber-optic networks. Indeed, by the late 1990s, fiber-optic transmission technological advances, including Dense Wave-Division Multiplexing (DWDM), ultra-long haul optical transmission without the need for signal amplification or regeneration and optical switching without conversion to the electrical domain, had dramatically increased optical network capacity and lowered broadband bandwidth provisioning costs. These advances, when coupled with the phenomenal worldwide investment in optical network construction in the late 1990s, led to substantial excess communications capacity between and within most major metropolitan areas. Similar advances and investment in 2nd and 3rd generation cellular and other digital wireless technologies (e.g., 802.11 – 802.16) led to the exponential proliferation of terrestrial wireless networks. The resulting explosion of communications capacity and commensurate drop in service prices in virtually all broadband and wireless markets shortly after the turn of the 21st century led to the financial demise several commercial communications satellite ventures that had sought to serve these markets. Every commercial broadband satellite system development, including Astrolink, Cyberstar, Skybridge, Spaceway and Teledesic, was either terminated or repurposed. Indeed, even traditional Fixed Satellite Service (FSS) communications came under pressure as the ubiquitous spread of terrestrial communications networks brought unprecedented pricing pressure.

Suffering from over-investment and excess capacity in many sectors, the global telecommunications market entered a sharp recession. The commercial communications satellite industry arguably suffered the greatest downturn. Commercial communications satellite service providers and systems developers alike saw bankruptcies, Private Equity firm buyouts and unprecedented industry consolidation. And the venerable COMSAT, considered by many to have been instrumental in establishing ubiquitous international communications via satellite during its forty year life, was broken-up and ceased operation in 2002. The recession's nadir appears to have occurred between the final quarter of 2003 and first quarter of 2004.

During the last two years, the commercial communications satellite industry has experienced a welcomed recovery [4], due in large part to the industry's refusal to cease innovating. With its FSS segment under siege during the recession, the industry increased its focus on the two markets in which communications satellites enjoy an inherent advantage over terrestrial systems: broadcast and mobile services. As a consequence, Broadcast Satellite Services (BSS), including Direct to Home (DTH) Digital Video Broadcast (DVB) (e.g., DirecTV, EchoStar and SES Global), Digital Audio Radio Services (DARS) (e.g., XM, Sirius and WorldSpace) and the initiation of Digital Multimedia Broadcast (DMB) service, via MBSat, in Japan and Korea, provided notable impetus to the industry's recovery. Indeed, even a Ka-band broadband access satellite system, that couldn't compete with the relentless growth and falling price-points of terrestrial broadband access networks, was repurposed to provide DTH HDTV transmission.

Mobile Satellite Services (MSS) systems also contributed to the industry's rejuvenation. Boeing and others developed innovative phased array antennas to provide broadband Internet access and DVB reception aboard aircraft and other mobile platforms. GEO mobile cellular service with an Auxiliary Terrestrial Component (ATC), made possible by favorable regulatory rulings, the innovative development of unfurlable antennas with unprecedented apertures and ground-based interference canceling beamforming, will soon become a reality in the US. The FSS sector, however, remains stagnant, due primarily to the increasingly competitive terrestrial network access service environment.

Current Challenges

Although the commercial communications satellite industry has returned to path of healthy growth, the unrelenting spread of intense competition from fiber-optic and terrestrial wireless networks will continue to erode traditional communications satellite markets. Therefore, to ensure continued growth and a return to the prosperity it enjoyed in the 1990s, the industry must invest and innovate to offer new, unique services and to dramatically reduce the cost of providing communications satellite service capacity. In markets with any appreciable population, terrestrial communications system service providers continue to lower the cost of broadband, narrowband and telephony service faster than have communications satellite service providers. This is in part attributable to the economics of proximity and the physics of propagation. However, it is also due to the formidable investment being made in terrestrial communications technology, systems and infrastructure. Indeed, billions of dollars are being spent worldwide on 3rd generation cellular, WiFi and WiMax wireless and fiber-optic network technologies, system development and service deployment. In the US alone, Verizon Communications is spending billions on the deployment of a nationwide fiber-optic network providing Fiber to the Home (FTTH) connectivity at greater than 10 Mbps - to offer ubiquitous VOIP, broadband and video on demand access. The trend is undeniably clear. Commercial communications satellite system developers and service providers must find a way to offer comparable services at competitive prices. Failing to do so will, in the long run, relegate the industry to serving only remote pockets of demand.

Future Directions

Facing these formidable challenges, the commercial communications satellite industry's only hope for long term prosperity lies in new, competitive product development and deployment. To this end, the industry should perhaps initially focus its investment and innovation toward those applications where it has an inherent advantage – broadcast, wide-area mobile and disaster/emergency communications. Clearly, further reductions in the unit cost of service capacity are paramount.

Significant, judicious investment in developing more efficient:

- Solar arrays
- Batteries
- Power amplifiers
- Antenna apertures (of unprecedented effective dimensions)
- Adaptive Coding and Modulation (ACM), including more Bandwidth Efficient Modulation (BEM) designs, and
- On-board digital signal processing

might provide the necessary enabling technologies. This list is by no means exhaustive. But significant progress in a combination of these key technologies, including improvements in spacecraft reliability [5], should allow communications satellite service providers to compete "on a more level playing field" with their competitors who enjoy the benefit of providing service from terra firma.

It is doubtful whether industry alone has the resources to undertake this grand challenge. Indeed, any realistic hope of achieving substantive progress in these areas must be based on the assumption that a consortium of government, industry, academia and professional organizations will cooperatively accept the challenge. Events, such as the annual AIAA International Communications Satellite Systems Conference (ICSSC) (http://www.aiaa-icssc.org/pages/344640/index.htm), provide a venue for stimulating interest and exchange. And professional groups such as the AIAA Communications Systems Technical Committee (http://www.aiaa.org/tc/cms/) and Japan Forum on Satellite Communications provide exceptionally talented and experienced forums of industry professionals focused on advancing the state-of-the-art and fortunes of the industry.
With such venues and talent, it will surely be "…the set of the sails, and not the gales, which tells us the way to go" [6].

Dr. Butash and Mr. Suzuki of JFSC are talking on the future perspective of Satellite Communications (AIAA ICSSC 2005 at Rome)

References

1. D.J. Whalen, “Communications Satellites: Making the Global Village Possible,” *NASA website*: http://www.hq.nasa.gov/office/pao/History/satcomhistory.html
2. A.C. Clarke, “Extra Terrestrial Relays,” *Wireless World*, pp. 305-308, October 1945.
3. J.R. Pierce, “Orbital Radio Relays,” *Bell Systems Technical Journal*, 1955.
4. C.F. Hoeber, “Communications,” *Aerospace America*, pp. 44-45, December 2005.
5. E.L. Elizondo, *private correspondence*, February 2005.
6. E.W. Wilcox, “The Winds of Fate.”