Evolution of Broadband Satellite Architecture to Full On-Board Processing System

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ABSTRACT

With their tremendous success in broadcasting entertainment services, digital satellite systems are rapidly being viewed as viable service delivery vehicles. Since a broadband digital pipe already exists in millions of households under the footprint of the satellite, many network operators are exploiting these channels and are offering broadband access and multimedia services to supplement and enhance their existing service offerings and to extend their reach. Major traditional long distance operators are also acquiring cable operators to use their network infrastructure to provide broadband access to residential users. Due to high infrastructure cost for cable plants, other service providers (mainly ISPs) are looking at direct-to-home satellite service as a viable access vehicle to the residential consumers to remain competitive with traditional telcos.

The extensive geographic reach of Geosynchronous (GEO) satellites, the availability of spectrum in the Ka-band, and the ability for rapid deployment of user access units all combine to make satellite-based solutions very attractive. However, most proposed Ka-band satellite-based multimedia communications require advanced switching technology, optical inter-satellite links (ISLs), and signal processing on-board satellites that will directly impact their cost, performance, availability, and time-to-market.

Given the recent commercial failures and technical glitches in the launch of global mobile satellite services using on-board processing and low earth orbit (LEO) constellation, the industry is becoming more cautious in undertaking high risk and expensive satellite projects. Given the amount of commercial and technical risk involved in such complex systems, satellite operators have been looking for solutions that are simpler, yet flexible. Inherent issues with latency of GEO satellite, and propagation environments for Ka-band system at 20 to 30 GHz, by themselves pose challenges for delivery of quality of service

for multimedia applications. Coupled with the requirement for tracking a fast moving LEO satellite to maintain the communications link, the design of next generation broadband systems poses interesting challenges in network design and architecture, hence delivery of broadband services with stringent quality of service requirements.

Given the ambiguity of market demand and applications, it is important that an expensive network asset, such as a satellite, that is expected to have a long life (i.e., 10 to 12 years) be flexible and not become obsolete prematurely. As a result, bent-pipe satellite technology still remains very attractive as a space asset.

One elegant solution is to use Ka-band on the return path and digital video broadcast (DVB) on the Ku or Ka-band forward path on existing and proven bent-pipe satellite technology. The open and neutral nature of this architecture will provide bandwidth-on-demand broadband access that is both attractive and ubiquitous when compared with terrestrial solutions. Building on this foundation, with additional and incremental on-board processing, the satellite functionality can be enhanced with intermediate frequency switching followed by some simple demodulation and re-modulation of signals for providing meshed connectivity among satellite access units and least cost routing for optimum usage of satellite resources.

This paper explores the several options available in the development of broadband satellite networking systems and the corresponding ground system architecture. While some approaches are revolutionary, there are others that allow a graceful evolution of existing bent-pipe broadcast satellite systems into full fledged, “fiber-in-the-sky” broadband satellite systems to realize the vision of global, broadband, interactive communication systems. Pitfalls and potentials of these approaches will be identified. A roadmap will be presented that will provide a technically feasible approach to providing broadband multimedia service over satellite while reducing the skepticism surrounding advanced programs. The roadmap builds on proven and simple space technology with a path to full on-board processing system, including low earth orbit constellation for low latency for mission critical applications.