CCG CONSULTING INC

IS SATELLITE BROADBAND READY FOR PRIME TIME?

There is a general opinion among wireline carriers that satellite broadband as an access technology is inferior to other sources of Ethernet. The perception is that satellite broadband has serious latency problems (time delays) and jitter issues that make it inadequate to support advanced applications, particularly VoIP. There is also a general perception that satellite Ethernet is costly to establish and that it is rarely price competitive with other sources of Ethernet, except in very remote locations.

To some degree these observations still apply to much of the satellite industry. This industry has been historically focused on serving only very large backbone transport for carriers in very remote locations or the video broadcast industry where in excess of 70% of their revenue is still derived and an annual basis. The major vendors of satellite data have been very slow to react to the general explosion of Ethernet in the world and they have not seized upon more mainstream opportunities in the landline world. To some degree we can compare the large satellite data providers to the RBOCs – they are large incumbents who are satisfied with their market niche and not particularly open to change. Their behavior is geared towards selling wholesale transponder space as opposed to delivering value-added network services.

However, there are now hardware solutions that have overcome much of the inherent problems with satellite Ethernet and we believe that there are many applications where satellite data should be considered. In this paper we will look at one particular technology that we think makes satellite Ethernet equal to other Ethernet, plus we will look at strategies for using satellite data in your networks.

The Satellite Industry

The satellite industry has historically been controlled by a handful of very large providers who both own and operate satellites or who have contracted for much of the usage on satellites. Companies like Hughes and Spacenet have created very stable businesses by selling large data pipes to remote locations. The customers for such data tend to be governments and large businesses that have large data needs in remote locations. These data connections have always been expensive compared to normal terrestrial data prices, but the remoteness of the sites have given the satellite providers a virtual monopoly of service. The hardware for satellite data delivery has historically been very expensive and most satellite data users typically purchased large amounts of bandwidth at a given site.

Historically, customers also had an opportunity to purchase a narrowband link used for point-of sale transactional type networks or were forced to procure a very expensive point-to-point SCPC (single customer per channel) connection. No shared and cost effective broadband service able to meet the application needs of the enterprise user was available.

The commercial satellite data business is in a no-growth mode for the traditional backbone services. The industry has seen very modest growth in the number of terminal locations, but the revenue per terminal has been dropping steadily. This is the result of competition from fiber networks and terrestrial microwave sites that are picking off the largest remote customers.

The satellite providers are also having trouble supplying the needs of data users. For example, one of the fastest growing segments in Ethernet delivery is the use of VPNs (Virtual Private networks). VPN connections allow for multiple users to share the same terminal site and still maintain data security. The standards employed in current satellite data transmission do not allow for the easy creation of VPNs. The historical solution used by the industry was to supply a separate terminal device for each user, thus

increasing equipment cost. The transmission techniques used by the satellite providers are usually proprietary, meaning that a user must rely on the provider as the sole source of equipment.

Residential and Small Business Data over Satellite

In recent years a number of companies have started selling satellite data to the residential market. These connections generally offer less speed at a greater price than cable modem and DSL connections. However, the fact that satellite data is available almost everywhere means that remote customers often find satellite as their only alternative.

The standard and technology used today for residential data delivery from satellites is DVB (Digital Video Broadcast). DVB was designed to deliver one-way downstream MPEG video signal and the application of this standard to data has been an afterthought. However, DVB is the standard of choice in the marketplace for data delivery since it is a simple standard that can be supported with low cost and easily available chip sets.

A new standard has also been developed for upstream satellite data – DVB-RCS (Return Channel via Satellite). This standard allows for two-way data services. Early satellite data products required a dial-up connection for outbound data, which basically defeated the whole purpose of having a high-speed connection.

The DVB standard has a number of characteristics that are important when looking at the ability to deliver data. The biggest problem with DVB is that is uses a standard MPEG frame around each data packet. MPEG headers and frames have two characteristics that decrease data efficiency. First, MPEG headers are relatively large and thus the headers use up a significant percentage of available transmission space. Worse, MPEG packets are fixed in size, meaning that large IP packets must be broken down into multiple MPEG packets. DVB has another disadvantage in that it uses the same forward error correction scheme, called RSV (Reed-Solomon Viterbi) that is used for video transmission. Video transmission is more forgiving than data transmission and it allows for a higher level of missing, incomplete or delayed bytes than is acceptable to data users.

However, there are still some advantages of DVB. On the download side the simple standard means that there is easy interoperability between vendors and thus different brands of terminal equipment can work well together. This results in low cost terminals, which is a major advantage in the residential market.

There is a very different story for residential data upload. The DVB-RCS standard also uses the same MPEG frames for packet headers and suffers from the same inefficiencies as downloads. However, the upstream delivery is further complicated by the use of TDMA (Time Division Multiplexing) in arranging the data bytes. The use of IP encapsulated within MPEG and using TDMA has created proprietary hardware and software as each manufacturer has developed their own solutions to satellite uplinks. This means that any efficiency gained by equipment compatibility is lost since each provider has a proprietary uplink.

There are also inefficiencies at the system level for data using the DVB standard. In the satellite industry each major supplier must create at least one hub location. The hub is a location where the provider maintains control over the system. While the DVB standard allows for inexpensive customer hardware, the cost of hub hardware is very high. This means that only very large companies are willing to invest in using satellite data and that it is not easy to build a scaled system to control only a handful of customer locations.

Further, the DVB standard does not use the satellite transponders very efficiently when transmitting data. Again, this standard was developed for the one-way delivery of video signal and it is very efficient for video delivery. Satellite usage is sold on a “per transponder” basis and an underlying provider will lease a number of transponders. The various data inefficiencies I have mentioned, such as the inefficient MPEG header size all result in data transmission being far less efficient than video transmission. This greatly increases the delivery cost per byte from the satellite providers. Inefficiency in satellites results in higher power usage in the satellite, and power is almost always the limiting factor with satellites. A transponder

delivering data will use more power than one delivering only video, and the underlying providers have priced data delivery accordingly.

VoIP and DVB

As I have shown, the DVB/RCS standard does not allow for the efficient delivery of Ethernet. These inefficiencies mean that more advanced Ethernet applications like VoIP are nearly impossible with a DVB system.

When engineering for VoIP a number of things must be considered:

- Propagation delay. Satellites have an inherent 280 msec propagation delay due to the location of geo stationary orbit of satellites.
- Jitter. Jitter quantifies the effect of network delay of packets arriving at the receiver in any Ethernet system. Jitter is calculated by measuring the inter-arrival time of successive packets. Since VoIP is a real-time product it needs low jitter.
- Packet loss. Packet loss causes degradation of any real time service. Packet loss is measured using BER (Bit Error Rate) – and VoIP needs a low BER.
- QOS and traffic prioritization. Packet switched networks are subject to congestion since data traffic is typically "bursty". Congested networks wreak havoc for real-time services like VoIP due to delayed, dropped or out-of-sequence packets. QOS is needed to give priority to VoIP packets over data packets.
- Compression techniques and standards. The most standard encoding scheme in the industry is G.729 codec. G.729 coding requires 8kbps of bandwidth, but because of the overhead associated with IP/UDP/RTP headers, the actual overhead associated with most satellite transmissions is as much as 16 to 18 Kbps in wasted bandwidth.

Above I mentioned the lack of interoperability due to the DVB-RCS upload standard, and this lack of interoperability has a major impact on the ability of a DVB system to handle VoIP. Since each DVB provider is creating a proprietary platform for the uplink, using IP within MPEG using TDMA, attaching a standard VoIP handset to these proprietary devices is nearly impossible. With the proprietary systems the differences in TDMA alone causes major problems – TDMA time slots differ in size, some systems allow hopping while others are static, frame sizes and code rates differ, and different providers allow for different quantities of simultaneous routes. There are no commercial production networks today that have a DVB solution using equipment from different manufacturers, meaning that the standard is not delivering all that was hoped for.

The iDirect Solution

One company has come up with a solution to all of the problems caused with data delivery using DVB. iDirect Technologies of Reston, Virginia has developed hardware and software that allows for the delivery of traditional Ethernet over satellite. This means that with iDirect equipment that in many cases the cost of satellite data can rival terrestrial Ethernet prices.

Here are some of the highlights of what iDirect has done:

- Gets rid of fixed size packet cells. Large packets have one header according to the inherent size of packets. This is how normal terrestrial Ethernet networks handle data. This creates tremendous throughput efficiency. For example, a typical satellite transmission path using 500KHz of transponder would be able to deliver 385 kbps of data. With iDirect this can be as much as 530 kbps. iDirect headers tend to be about one fourth the size of DVB headers plus far fewer packets are needed.
- iDirect uses Turbo Product Code (a new standard) for FEC. The efficiencies of this standard allow a satellite channel to use less energy for the same level of data transmitted (and allows for lower operator costs and thus cheaper prices for bandwidth). Power is a limiting factor in satellites. An RSV system requires about 1.5 dB more power than iDirect. This means iDirect uses 50% less satellite power.

- iDirect is much more efficient on the return channel. This eliminates collisions and lost packets and makes iDirect around 36% more cost effective than DVB/RCS.
- iDirect is very granular and can deliver bandwidth in increments of 1kbps starting at 64kbps. DVB systems can only deliver very large amounts of data. Granularity means you can deliver just the bandwidth needed at each site and cut costs tremendously.
- Has QOS standards triggered by applications. Thus QOS protocols only kick in when voice packets are present.
- Allows bandwidth on demand. iDirect looks at data utilization 8 times a second and can shift data among user sites as needed. A user (or pool of users) will be supplying bandwidth to many different sites, thus allowing for the equivalent of over-subscription. Normal DVB systems allocate only a fixed amount of bandwidth per location.
- iDirect allows VLANs. This allows a user to support multiple IP networks at one location with one piece of hardware. DVB systems would require a different receiver for each dedicated user.
- Small equipment size and lower power units (compared to competition).
- iDirect has a much more efficient and scalable hub. Large hub costs are a barrier to entry for a new provider using DVB. iDirect also has the ability to partition the hub allowing multiple network operators to render services from a single hub.
- Built in encryption for high-security needs. Saves on buying a second box as is required by most satellite hardware. Since the encryption is built in to the fabric of the device, it also permits for the acceleration of the encrypted data.
- Provides carrier class transmission path that will easily support VoIP and other enhanced IP real-time services.
- iDirect improves TCP utilization using various techniques that are common in terrestrial Ethernet systems. They allow local DNS caching. They use TCP acceleration and Web acceleration. The overall effect of these improvements is the elimination of latency issues.
- One box solution – modem, IP router, QOS, encryption and TCP optimization in one box.
- Allows multiple topologies and network designs – stars, point-to-point, and star-mesh.
- Carrier class equipment with redundant cards. Supports multiple uploads. Can support use from five satellites at the same time. Supports real VPN.
- Full OSS platform. Allows remote authentication. GUI based. Allows remote monitoring, configuration and maintenance.

When Does Satellite Data Make Sense?

With the iDirect solution satellite data can compete quite well in cost with other sources of Ethernet. As mentioned above, satellite can deliver in excess of a full T1 of bandwidth almost anywhere at significantly reduced prices. More importantly you can scale the size of the data pipe (and your cost) upward and downward as needed. With that said, following are some of the ways that you might be able to incorporate satellite data into your network:

- Redundancy. Consider using a satellite link as a backup to terrestrial data sources. Many rural providers find it nearly impossible to find a redundant Ethernet path to the outer world. Satellite can provide the redundant path at affordable prices. It is the ultimate back-up since it does not rely on terrestrial access loops.
- Scalable Data Pipes. Consider using satellite data whenever you want to provide high-speed data services to customers who are not on your network. With iDirect equipment you can provide data to any location in increments as small as 128k up to extremely large data pipes. It is often difficult in the terrestrial world to get a scalable Ethernet connection. Historical pricing has bunched products into multiples of T1s. If you have a remote location that only needs 512k then it is very inefficient to buy a T1. Satellite data allows you to supply just what you need at each location, while also allowing for easy (almost instant) growth.
- Consider as a wire replacement. Equipment prices for satellite delivery have fallen to the point where satellite can provide a clear alternative to building new drops to remote locations. Before building a fiber to a distant location you should consider satellite. The savings in hardware costs can allow you to make profits while avoiding the huge fixed costs of building expensive fiber

spurs. The iDirect hardware is so inexpensive that you should consider this as a possible alternative for remote customers even in your own territory. This can efficiently replace expensive loops and allow you to deliver high-speed data to every customer.

- Expand your footprint. Our clients often stumble across opportunities that are remote from your footprint. Satellite data will allow you to contemplate such opportunities while allowing you to monitor and control the customer from your own hub. You can deliver a full package of voice, video and data almost anywhere over a satellite link.
- Gap Service. Use satellite service to customers as an interim way to serve customers before constructing permanent landline facilities. The satellite equipment can then be re-used as needed for other customers. Protect your customer's interest and to immediately start generating revenue.

CCG Consulting has no financial link or other tie to iDirect. We present this article as a way to inform our clients that satellite data, using the iDirect solution can be a great and cost effective alternative in your network.

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