Pushing Down the Cost:

Can content-push reduce the cost of space segment for Satellite Fast Internet Systems?

Adrian Tregunna[†]

†BT Broadcast and Satellite Communications and University College London,

Abstract: There has been academic and commercial interest recently in the use of geostationary satellites for the provision of "Fast Internet" services. To ensure financial viability, however, present service operators have tended to share satellite capacity between many thousands of users per transponder, where the resultant contention can threaten to reduce the average data rate to a level similar to narrowband. This work explores the deployment of multicast technologies to improve the financial model. This paper introduces some of the key issues and explores some of the areas currently being addressed.

1 Introduction.

There is presently a great deal of interest in the provision of Internet access to residential users, via satellite, using Digital Video Broadcast (DVB) [1]. These services typically operate over a geostationary satellite operating in the Ku-Band (12-14GHz) through a dish, normally no greater than 65cm in diameter. Terrestrial dial-up return paths allow for full interactivity but increasingly, the return channel could be provided via a 2-way satellite link. Figure 1 shows a typical system using a terrestrial return channel.

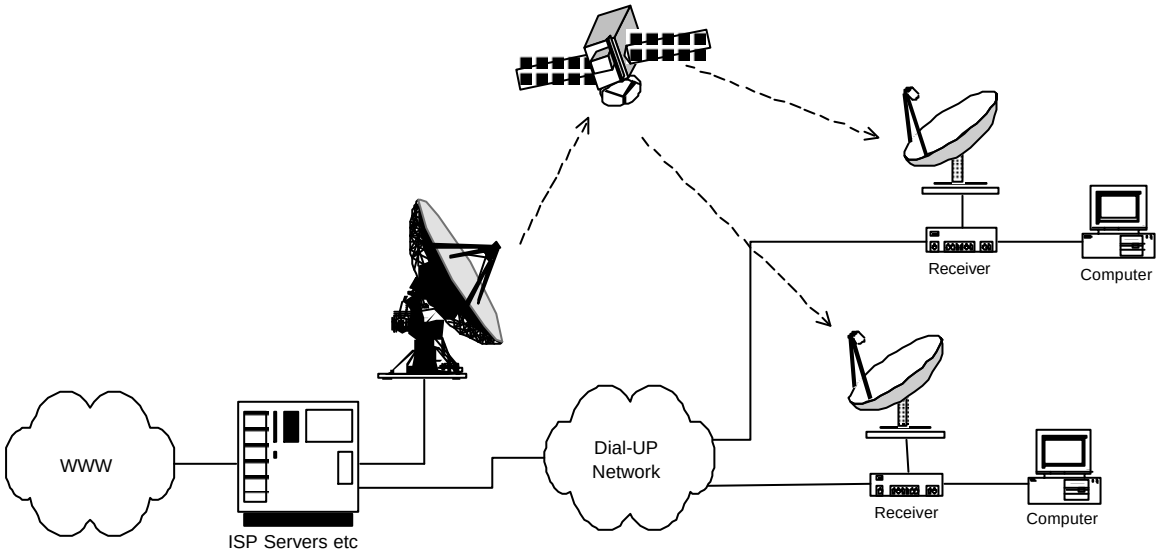

Figure 1: Typical Satellite Internet Access with Terrestrial Return.

2. The Capacity Problem

Satellite Fast Internet systems deliver Internet content purely on an on-demand basis and the dominant cost item is the space segment. The amount of capacity required on the satellite is a combination of the number of users; the peak data rate available to each user; the activation ratio (number of users online at any one time) and also the contention ratio. Also, as user activity and performance expectation increases over time, fewer customers will be supported in a given bandwidth, resulting in an

increasing bandwidth cost per customer. With 1MHz of capacity typically costing £5.5k per month, this increasing bandwidth requirement would eventually result in unrealistic space segment requirements. As an example, Figure 2 shows the number of transponders needed for various user activation and contention ratios when supporting a 500kbps service.

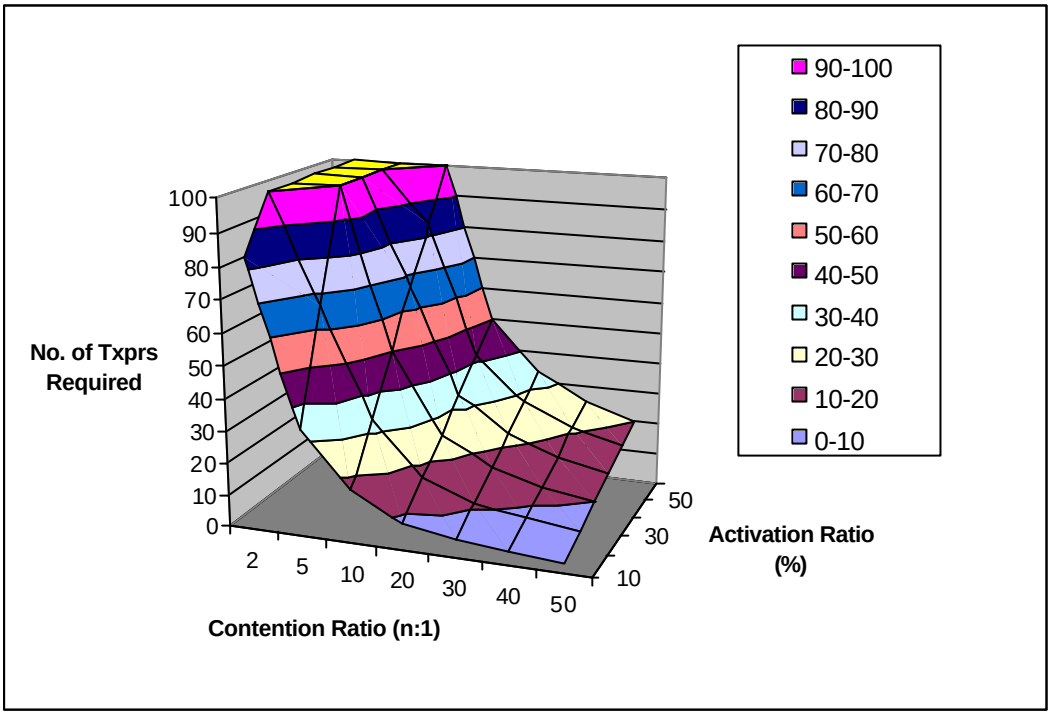

Figure 2. Number of transponders needed for various user activation and contention ratios when supporting a 500kbps standard satellite fast Internet service. [2]

This graph assumes a user-base of 100,000 customers and models the number of satellite transponders required to cater for a range of activation and contention ratios, for a typical peak data rate of 500kbit/s. It can be seen that for a relatively low activation ratio of just 10% of users online at any one time, with an ADSL-like contention ratio of 50:1, would require 3 transponders, at a typical cost of £6.75m per annum. Echostar in the US [3] has cited high costs such as these as the reason for their withdrawal from the Satellite Internet market.

3. Pushing Cache Content to Ease the Problem

The delivery of popular websites into end user caches can help to reduce the levels of unicast browsing traffic. The more content that can be cached locally to the end users, the lower the need for unicast browsing requests. Tests by Cacheflow suggest that "in general, web edge caching indicates that downstream traffic across the core network can be reduced by up to 50-60% by moving popular content to the network edge."[4]

The most popular websites can either be pushed to all users or, at present, a more likely scenario is for the service provider to offer a range of the most popular websites and for users to select those websites that are of interest. This second approach offers a potentially lower reduction in required bandwidth as the websites offered might not reflect those most visited by a particular group of users but this is a matter for service operators to best select the websites offered to maximise the effectiveness.

The required satellite capacity can become less dependent on the number of users, depending on how closely a new user's traffic requirement correlates with the content delivered to the STB. The resulting impact on cost per customer can be very significant compared with the conventional browsing architecture, because of the potential halving of spacecraft capacity costs. The key issue for the service providers is to determine the most appropriate sites to make available for caching, so as to maximise the number of browsing requests that can be served from the client cache, and hence, to maximise the potential bandwidth savings.

In addition, given the relatively long round-trip delay of a satellite based network, the user experience should be improved if the requested content can be simply returned from a cache held locally on the client's computer, or ultimately within the STB.

4. Multi-Transponder Operation

When a service provider has sufficient end users to support multiple transponder operation, there are additional problems to consider. The end user antenna and Low Noise Block (LNB) are wideband devices, the tuner stages of the set-top box (STB) are normally limited to a single transponder. If a user is tuned to a particular transponder, to allow efficient use of the pushed content the user's STB must be able to access the content delivery channels.

Potential solutions include:

1. The retransmission of cache content continuously on each transponder so that all the remote terminals can receive the content regardless of which transponder they are tuned to for unicast traffic. This is simple to implement but repeating content could be very costly in terms of satellite capacity, depending on the volume of content delivered.

2. It is possible to limit unicast traffic for a certain time period, say overnight, and use the bandwidth to deliver cache content during this time on all transponders. This offers little improvement on Option 1 and also relies on the Service Operator knowing when is the optimum time to reduce unicast bandwidth, so as to cause little or no disruption to customers who do wish to browse at that time.

3. To develop and deploy a STB with dual front-end stages and decoders in the STB. This option would allow the remote terminal to receive data from two transponders simultaneously – one for unicast and one for multicast. This requires enhanced STB functionality above that presently available commercially and this option is presently being discussed by the author with several leading manufacturers of STB technology. The validity of this solution requires a trade-off between reduced space segment costs and the increased costs of the CPE and associated client software.

4. Provide an IP Program Guide in the form of a DVB Transport Stream table in each transponder to allow the STB to intelligently receive the required multicast content from the required transponder. This approach has recently been presented for discussion within both ETSI and the IETF and although these discussions are in the very early stages, it is possible that some form of control channel could be adopted. The proposal suggests that "it shall be possible to signal the availability of IP services in IP cells other than the one the client is currently connected." [5] This would allow the STB to identify the location of the required content incoming from the satellite and tune the STB tuner stages as appropriate. Although this solution would appear to offer a long-term solution, the implementation of any new control channels will require adoption by both IP-DVB encapsulation gateway, and set-top box, manufacturers, which may prevent a possible launch in the short term.

5. A final option considered is to develop and provide a client-server application between the uplink equipment and the remote terminals to dynamically retune the STB to the required transponder for

the appropriate content delivery and retune afterwards. This maintains intelligence and control at the uplink site but does require a greater degree of system complexity, and as there are no standardised tuning API's for receivers, separate drivers will be required for all STB's to be supported. This option also requires the dial-up link to be connected and as the proposal is to be able to deliver the cache content offline, this is not a practical option for a platform with a terrestrial return due to the call charges incurred.

The two key solutions are the development of tuners with multiple front-end stages or the introduction of a control-channel system within the DVB transport stream. The control-channel approach may take some years to be standardised and implemented by manufacturers so a short-term approach is still required and this can be provided by the development of additional functionality in the STB. As the transmit site is unaffected by this solution, the development work lies within the client equipment end only, where large manufacturing volumes allows for the developments to be incorporated at minimal additional cost.

5. Conclusions.

Satellite Fast Internet services are particularly attractive to areas where terrestrial networks are less developed regarding broadband access. Paul Reynolds, CEO of BT Wholesale, recently suggested that BT "are absolutely committed to bringing the latest communication services to as many people as possible on the best terms possible. This satellite solution enables us to offer affordable high-speed connections where it is impossible with our other technologies. [6]

It has been found to be expensive to meet user expectations using just conventional content-pull through web browsing. A number of operators have withdrawn from the market as they have struggled to make their platforms financially sound, mainly, it seems due to the high price of satellite capacity. It is suggested that the pushing of cache content could help to improve this situation.

Problems regarding access to content when operating over multiple satellite transponders has been discussed and a number of potential solutions presented. A long-term solution is the modification of the DVB standard to support IP channel signalling and this is being pursued. Due to the need for extensive manufacturer involvement, a short-term solution to develop tuners with multiple front-end stages is suggested. This approach simplifies access to push-content channels while maintaining access to unicast web-browsing channels, and allows the service provider the opportunity to use the delivery of cache content to improve the financial model for the platform.

References.

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