Broadcast Based Broadband

A Paradigm Shift in the Delivery of Broadband

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Abstract:

The provision of broadband services via satellite has attracted a great deal of interest recently, both commercially and academically. User expectations of data rates, volumes and quality will grow over time and this will put increasing demands on access and core networks that terrestrial technology may struggle to meet. A novel satellite system architecture called Broadcast-Based Broadband (B3) could overcome this problem by extending the principle of edge caching to the point where the network edge is the customer's receiver. B3 would also reduce the 'last mile' to the 'last metre' and de-couple broadband service performance from access network, with content access speeds only limited by local connectivity. This paper reviews the proposed platform architecture and identifies a number of technical challenges that are presently being addressed.

1 Introduction

Several terrestrial access technologies are being used to deliver broadband services to business and residential users worldwide. So far, satellite access delivery has been confined to areas where terrestrial infrastructure is less developed. In addition, increasingly bandwidth-hungry applications are being produced, featuring a combination of media-rich content and streaming and these applications are already stretching the capacity of the existing terrestrial core networks.

Satellite has an inherent broadcast capability that terrestrial broadband technologies lack. This capability can be exploited in order to deliver next generation broadband services, by broadcasting vast amounts of content directly to end user equipment for storing until required by the user – the B3 concept. This means that popular content would only be transported once (within the constraints of its refresh rate), rather than each time it is requested by a user, thus greatly reducing the satellite capacity required.

2. Platform Architecture

The B3 platform architecture uses broadcast satellite systems to extend the edge-caching concept direct to the customer premise equipment. This principle is illustrated in Figure 1. The proposed platform operates on the basis of the continual broadcast of a number of content carousels. A large range of offline services can be populated into the carousels, for example email delivery, web sites (to a specified page depth and including embedded content), video library files, catalogues, databases and their updates, newspaper and magazine content and advertising material. The content of the carousels can be updated as required, e.g. when a web page is updated or when a video library is updated or replaced.

Reliable delivery of off-line content transmission is achieved through a combination of multiple content transmissions (for statistically high probability of delivery) and acknowledgements (for guaranteed delivery), depending on service type and the required quality of service (QoS). The carousels are encrypted and delivered in satellite broadcast streams to all users. The encrypted content is stored within the Customer Premises Equipment (CPE) until required by the user. The CPE supports a local conditional access application to give the user access to the requested content on an on-demand or subscription basis. The CPE keeps a record of the on-demand content that is accessed, for charging purposes. The CPE may be made up of a single box supporting all the necessary facilities, or the

functionality could be distributed across more than one device, e.g. satellite receiver, PC and set-top box (STB). The B3 architecture effectively turns the user CPE (or part of it) into part of the network infrastructure.
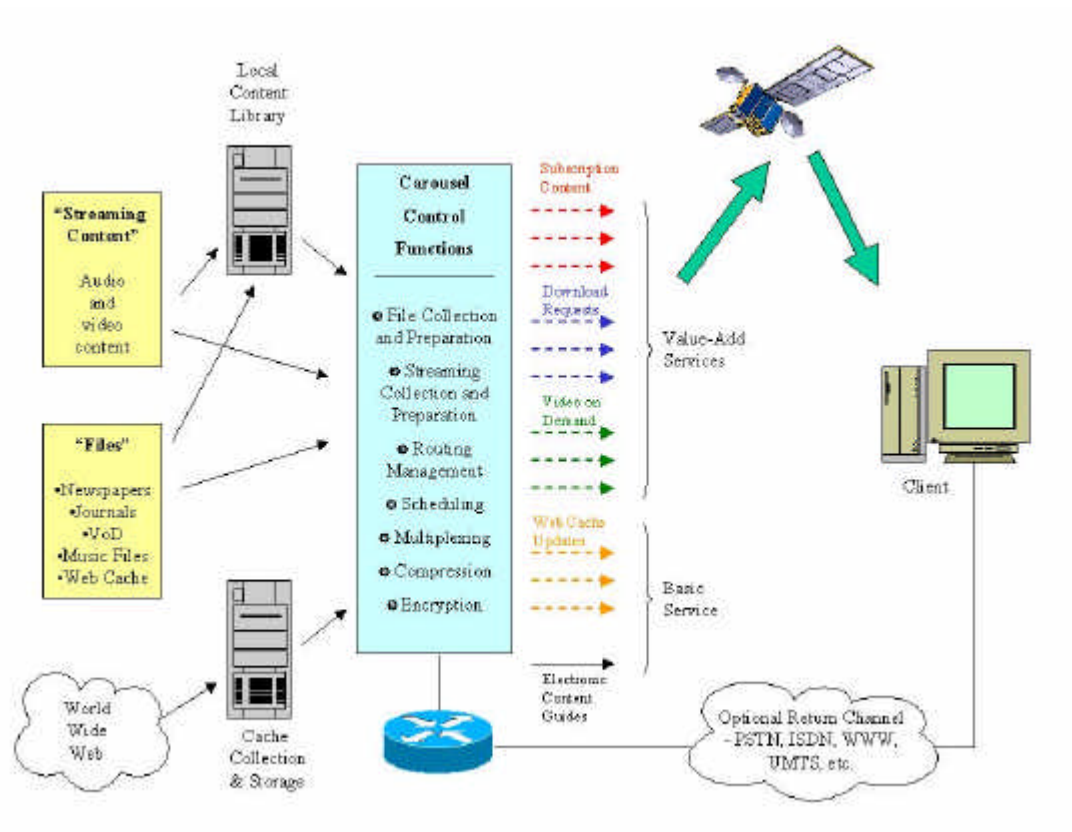

Figure 1. B3 Platform Architecture

The B3 network architecture has some special characteristics and implications that need to be considered and exploited:

Downstream data rate and contention issues are simplified. If the majority of the user's required content is delivered straight to the CPE for access on-demand, there is no contention for bandwidth and if this delivered content is chosen well, there will be a large reduction in the amount of point-to-point, unicast traffic that needs to be supported over the satellite. The delivery speed is then dictated by the technology deployed between the local content storage and the end user application, which could be via a PC bus, Ethernet, Wireless LAN, etc.

Carousels provide differentiated service delivery. Different types of content are updated at different rates. Some websites, such as news sites, have an update period of minutes while others, say company information sites, may only be updated once a month or maybe a longer period. Therefore, not all content occupies the same carousel capacity or time distribution

Revised definition of service availability. Where the required content is stored on the CPE, the user accesses that content, rather than pulling content over the satellite link on-demand, as with conventional SFI solutions. This has the benefit of allowing the delivery of content despite any intermittent system outages, such as those attributable to rain-fade. The freshness of the content is still linked to the availability of the satellite link but rain fades tend to be of short duration, and any lost data can usually await the next scheduled refresh, otherwise a real-time update can be requested. The ability to work through periods of system outage makes the B3 platform suitable for deployment over future Ka and V-band satellites, and to certain mobile applications.

Agnostic to return channel technology. The choice of return channel is dependent on user requirements and service availability. There is no pre-determined return channel specified for B3 and options include ISDN, GPRS, UMTS, DVB-RCS and xDSL.

3. Initial Service Offering

An initial set of services is proposed below:

Pushed Web Site Updates. The core service of the platform will be the delivery of popular web content, in an aim to serve the majority of browsing requests from user caches. Determination of the most popular sites and the quantities of data involved are an important topic that is presently being studied. Additional sites can be chosen that the user may be prepared to pay a premium to ensure these sites are maintained up-to-date.

Streaming Services. Many of the present audio and video feeds from websites are streamed using point to point connections. With a lack of global support for multicast channels over the Internet, this could result in a large number of identical individual streams being created from a website to a large number of users, who may all access the Internet through the same service provider. These streamed services could be provided to the B3 platform and offered as a multicast streaming service via satellite.

File Delivery Request. The central carousel can be augmented by pay services such as requested file delivery. End users could request files that do not form part of the basic carousel for scheduled delivery, e.g. overnight. This could include video and audio files, software updates or large documents from central servers.

Video-on-Demand (VoD). A carousel can be populated with video library files, such as the current top-ten movies or niche subjects, e.g. complete series' of popular TV shows. These can be offered as subscription services to generic packages (e.g. "SciFi"), or as time-limited package offers.

4. Present Research Work

There are a number of technical issues that need to be fully addressed for the B3 platform to be successfully deployed. Amongst others, these include the population and updating of the carousels and developing an electronic content guide (ECG) to advertise the location and scheduled broadcast times for particular content.

With the potentially massive amount of content that the platform can deliver, Content Management needs careful consideration to determine the appropriate strategy for managing content collection, carousel population, carousel content notification, user access to selected content, security management and monitoring of content usage. The hub station will need to be able to manage numerous carousels containing different content types. Carousel management covers several aspects such as:

- Updating web content to ensure the content available on the carousel remains fresh. This will vary, for example, from monthly for some government and industry websites, to every few minutes for popular news websites.
- Producing and managing the electronic content guide.
- Monitoring the residual point-to-point requests with a view to identifying any additional content that it would be beneficial to add to the carousels.

There will also need to be a logical connection between the hub station and the end user terminals for management of access to pre-paid services and monitoring of popular content usage to ensure that the content carousel is delivering the most widely required material. This logical connection is also essential for the management of the Digital Rights associated with a large proportion of the content broadcast over the platform.

The Electronic Content Guide (ECG) is of particular interest, as with each satellite transponder able to deliver around 350Gbytes of content per day, and the proposed system ultimately operating over

several transponders, this means a tremendous amount of data will be broadcast per day. It is essential that the ECG enables users to search for, select, locate and acquire content, wherever or whenever it is made available. Electronic Program Guides are well developed and deployed for TV systems, but IP data services have a different set of requirements. Although there are a limited number of proprietary solutions, nothing exists that is truly suited to IP and multi-transponder operation in particular. This is an area of current research and potential solutions involving metadata and/or DVB SI tables are presently being evaluated.

There has been a lot of academic work on datacasting over wireless links [1,2], content delivery networks [3,4] and the caching of web content [5,6]. This research is novel in that the edge caching is actually within the client's network equipment. Also, the pre-delivery of content and the operation of a local content caching system is novel and decouples user content selections from actual capacity requirements over the satellite links. In terms of novel work in the area of content identification, searching, selection and delivery, there is presently substantial work ongoing within the TV-Anytime Forum [7]. This research builds on the TV-oriented TV-Anytime system and discusses the similarities, parallel approaches and those areas where the required solutions are completely different.

5. Conclusions

This paper has proposed new satellite system architecture for the delivery of broadband services that exploits the inherent broadcast capability of existing satellites. This new architecture would reduce the broadband bottleneck experienced in core terrestrial networks and would also provide a platform to deliver exciting new services such as video on demand. The reduced space segment requirements will also enable significant cost reduction for broadband delivery independent of increasing user expectations of system performance.

A range of issues connected with the creation and management of content carousels, and the associated content guides, have been identified and introduced briefly in this paper. It is important that the quantity of data to be transmitted in the provision of content guides remains manageable. Throughout the update of content, it is vital that the CPE is able to differentiate between new, refreshed content and retransmissions of previous content, partly to minimise disk drive accesses and to speed read-access times.

There are still great many problems to overcome and a proof of concept demonstration is being proposed. This demonstration will address the key technical and commercial challenges involved in bringing the platform to commercial launch.

6. References

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