Broadcast Video & Data Over MPLS

The UK core network platform – a world first from BT
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INTRODUCTION

BT is in the final stages of deploying a large scale MPLS network to form the basis of a multi-service platform. One of the initial requirements of this network is to carry real-time broadcast television traffic for a large independent broadcaster in the UK as well as non-real-time data traffic. This platform forms the first phase of a new generation strategic IP based national infrastructure. In the evolution of this platform capability, several key broadcast requirements have been addressed to achieve a platform capable of supporting the critical real time video as well as other data flows. The combination of the MPLS-TE and the point-to-multipoint capabilities of this network, realised working with router manufacturer Juniper Networks, make it a world-first for real broadcast customer traffic.

Why IP?

IP networks have become increasingly dominant for data applications, the public internet being just one example of a large scale network. This means that money has already been invested in developing the network equipment to the stage where it can carry huge amounts of data, and the quantity of such equipment that has been deployed means that it is now relatively cost effective. Currently carriers tend to have to build special networks on top of SDH or PDH systems to allow real-time broadcast video to be transported. Either these will use proprietary methods, or be small ATM networks. There is the potential for cost savings to be made by using a common infrastructure as the technology now provides the required capabilities. In addition, the level of ongoing investment in ATM technology by manufacturers is diminishing.

The trend towards non-real time

There is now an undeniable trend in the broadcast production industry to move away from traditional tape based production methods towards file based solutions – the great interest in the MXF and AAF file formats is just one example of this. This is gradually spreading out from the studio environment into the wide area, and the need for video material to be sent between locations using real time transmission is diminishing, though it will never disappear. Using a common network infrastructure for both real-time video and file transfers means it is then a simple matter to ‘repartition’ the balance between these over time.

MPLS

The emergence of MPLS, and its evolution over the last few years has taken it to the stage where it is now possible, and common, to carry Frame Relay and ATM data over MPLS networks, using a direct MPLS mapping without an IP layer.

For the traditional data case these Frame Relay and ATM connections have often been carrying IP data, so in this case it is desirable to remove the original IP data from its Frame Relay or ATM wrapper, and map the IP data onto the MPLS network.

The use of Voice over IP systems has become more commonplace, and some carriers are now using Voice over IP systems to replace traditional switched voice networks, particularly where a new network build is being installed in a location where there is not already a voice network owned by that carrier.
Early MPLS network deployments solved the issue of performance under load by avoiding it! Most current MPLS deployments are run lightly loaded – links are allowed to become a maximum of 50% full, in some cases networks are designed to run with a 33% loading.

For broadcast use this is not cost effective, and, as critical services are diversely routed anyway (see later), there is not a need to reserve capacity to allow all traffic to be re-routed in the event of a link failure.

Modern MPLS routers have improved queuing mechanisms which can guarantee the quality of service performance even when links are overloaded. As a result, if a network is built from such routers it is possible to run the network at a much higher load level – typically 75%-80% loaded, and still guarantee that high priority traffic will be treated preferentially to low priority traffic, even in the event of link or node failures.

**Enablers to allow modern MPLS networks to be used for broadcast**

The major advances which have allowed modern MPLS networks to be used for broadcast are improved router design:

- The routing look-up speed has improved - much more of the forwarding process happens in hardware in modern routers.
- Separation of the forwarding and control systems – older router designs would start to lose packets when updates were happening in the control plane, because the same processor was used for managing control plane updates and forwarding decisions.
- Separation of the different control plane processes. Though this does not directly improve the router’s ability to forward packets, it does give improved management access to the router. If one process has a fault and crashes the rest of the control plane software should remain running, and it should still be possible to gain management access to the router to restart the failed process, and investigate the reasons for its failure.
- Modern router implementations have much better queuing designs than older systems. They will usually have several hardware queues that packets can be placed in, which allows for a guaranteed quality of service differentiation. As designs evolve the number of hardware queues increases, which allows still better separation of different types of traffic.
MAJOR TECHNICAL ACHIEVEMENTS

There have been some major areas where technical investigation has been required to close the gap between traditional IP/MPLS data networking and what is required for the transport of broadcast video. Some of these are:

Point-to-Multipoint capabilities

Traditional video services often use a one to many distribution model – the simplest example being the terrestrial or satellite distribution to the end user. IP networks have traditionally been good at point to point data flows, but support for clearly defined point to multipoint abilities was limited.

IP multicast was designed to address some of these issues, but has three major disadvantages:

- **Lack of security:** If raw IP multicast were used on a carrier’s backbone there would be no means of segregating the multicast traffic from different customers
- **Lack of control:** With IP multicast any receiver can send a request to join any multicast session, and there is not usually any means of rejecting the request. With traditional IP multicast routing protocols it can be very difficult to determine which route through a network IP multicast traffic will take, and more difficult still to determine what will happen in the event of node or link failures.
- **Lack of QoS:** Native IP multicast cannot be traffic engineered to explicit routes or enjoy bandwidth reservation, both of which are key to achieving a deterministic quality of service for real time video delivery.

In other packet switched network technologies such as ATM, there is native support for Point-to-Multipoint Virtual Connections, which match well to the requirements of real-time broadcast services – they are unidirectional, have a tightly controlled route, and the bandwidth they will use is tightly controlled.

Point-to-Multipoint LSPs

For point-to-point applications MPLS networks have an equivalent capability to the Virtual Connection, known as a Label Switched Path (LSP). This has the bandwidth reservation requirements (using RSVP), which together with policing techniques ensures that the connection will not traverse a link which does not have enough capacity available for it. In addition it is possible to explicitly determine the route the connection will take, for the default case, and when the default route is not available. Even if the network is allowed to automatically determine the path it is still possible to interrogate the routers to discover the path that is being used.

What is required for broadcast multipoint applications is a point-to-multipoint version of the LSP. Following from these identified requirements for BT’s converged network, a solution has been evolved resulting in this capability being included in the latest software releases of the Juniper routers. The initial release provides a static mapping of IP or ATM traffic to a pre-configured point-to-multipoint LSP. This principle is flexible enough to allow it to be further extended to support intelligent behaviour in the future. A possible final goal is that receivers that require a particular multipoint stream can signal to their host router using the latest version of the Internet Group Messaging Protocol (IGMP), which allows a particular source to be specified. The routers will then automatically build the appropriate point-to-multipoint tree. There is still a control challenge here which
may prevent this from being desirable in all cases, and there is currently no
standard to allow a sender to indicate to its host router what bandwidth is required
for the stream it is sending.

Guaranteeing diversity

In broadcast applications any service outages are unacceptable. As all packet
based network technologies take at least several milliseconds to re-route
connections in the event of a failure, it is necessary to continue the approach that
was common when dedicated circuits were used for video connections – namely
1+1 protection - route two diverse connections to the receiver, and perform
intelligent switching at the receiver to ensure that any service interruption on a
network link is hidden from the video receiving equipment. When dedicated
circuits were used it was a relatively straightforward, and completely static
process to ensure that the two links were never travelling along the same physical
route – and thus vulnerable to both being interrupted at the same time. In a
packet network it is much more challenging to ensure that the two connections
stay separate, even in the event of node or link failures.

MPLS solutions have a means of ‘colouring’ links and nodes, and specifying
colours that a LSP connection should follow or avoid so that connections that are
part of a 1+1 protected circuit never travel through a common point.
High availability

One area where the data network community has traditionally had a very different attitude to the broadcast community is in the area of high availability. It is common for data networks to have outages of many seconds, if not minutes, and that is considered acceptable.

For broadcast applications any outage which causes more than a handful of packets to be lost is unacceptable, and traditionally dual diverse connections are used to resolve this difference.

A major disadvantage of using dual diverse connections is that the amount of equipment required is doubled – at every point where a router is required two have to be installed to protect against failures. Ideally it would be possible to use one device, but have enough diversity within the device to ensure that no single component failing can interrupt all traffic flows through the device.

Modern MPLS routers have high availability features to allow this to happen, but there is still often a disparity between what a broadcast network designer means by high availability and what the network equipment provider means. Generally the broadcast network designer will mean no outage at all, while often the network equipment provider considers moving from several seconds of outage to a few milliseconds outage to be acceptable.

BT has worked with Juniper Networks to pick a hardware platform from the Juniper Networks portfolio that is technically capable of satisfying the zero outage requirement in the event of switching from primary to secondary components, or removing and replacing failed components, and also to ensure that the latest software releases will match the hardware’s ability.

The video interface

Having achieved a deterministic data flow through the network, the encapsulation of the real time video data into IP/MPLS and back again is a critical operation. Many solutions for this use a processor-based architecture. One of the key elements of the new network being deployed in the UK is the new generation network adaption units, the IVNP, which provide the whole data path flow deterministically in hardware. This guarantees the throughput of the video stream in and out of the network. In addition these units provide comprehensive service management and control.

Standardisation

Standardisation work is taking place to ensure that the point-to-multipoint LSP extensions are adopted by the IETF. Internet Drafts on the subject are already under scrutiny by the IETF MPLS working group.

Another area for standardisation is the video interface equipment. BT has chaired the ProMPEG forum WAN group, which has developed ‘Codes of Practice’ on the mapping of video data onto IP networks. These codes of practice have the support of several video equipment vendors, which encourages interoperability between the solutions from these vendors. Where possible these Codes of Practice have been based upon standards already produced by the IETF, though some customisation has been required to increase the suitability for true broadcast use.
THE CORE NETWORK PLATFORM

The core network platform has now been rolled out across the UK and is already running a variety of real time video and data services. Extensive testing prior to deployment ensured that all the required capabilities are in place to guarantee the required quality of service is delivered.
CONTACTS

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