PART 1

MPLS-VPN Assessment Part 1 – Design and Planning

Daniel Cortez

ID: 9849909

MPLS – VPN Assessment Part 1 - Design Proposal

About this assessment:

These assessment tasks provide an opportunity to demonstrate the competencies covered in the IT Networking and Telecommunications Network Engineering MPLS-VPN subject.

You are allowed to refer to your text books, notes and the Internet during the Assessment.

The documentation and research work must be entirely your own. The ACIT/IFTV academic honesty policy should be read and understood.

Successful completion of this assessment contributes towards attaining competency in the following:

ICTTEN610 Design and configure an IP-MPLS network with virtual private network tunnelling
ICTTEN612 Design and manage internet protocol TV in a service provider network
ICTPMG611 Prepare a detailed design brief
ICTTEN611 Produce an ICT network architecture design

ICTNWK529 Install and manage complex ICT networks

Scenario

Pacific Internet Solutions, a multinational Internet Service Provider (ISP) offers a range of internet services to customers. The company also offers Layer 3 VPN's and Virtual Private LAN Services (VPLS) to corporate customers. The company has recently secured a contract with a major provider of pay (cable) television to deliver IPTV to its customers. Pacific Internet Solutions needs to incorporate efficient delivery of IPTV services into its delivery capabilities. The company has not previously provided multicast services. The current network only supports unicast services. The company is in need of an efficient IPTV delivery method.

Pacific Internet Solutions expects that after IPTV is available to subscribers its number of subscribers will increase from the present number of 20,000 to 100,000 over the next 5 years.

Requirements

1. You are required to design and implement Virtual Private LAN Services (VPLS) to meet the requirements of corporate customers.
2. You are required to design an end-to-end IPTV functional architecture and implement the core network infrastructure using MPLS. The design should minimize Pacific Internet Solutions costs by reducing bandwidth requirements while maintaining a high level of customer experience by providing high quality video and fast channel changes.

Your task is to redesign the network infrastructure for Pacific Internet Solutions so that it meets the business requirements for the organization, and to write a detailed proposal which you will submit to Pacific Internet Solutions for consideration.

The questions below will guide you through some of the things you need to consider for your proposal. You need to answer the questions and then write your proposal.

Question 1.

Describe the function and operation of a Virtual Private LAN Service (VPLS). *References - Juniper Junos MPLS and VPN's student guide- Chapter 17*

The virtual private LAN service (VPLS) is an Ethernet-based point-to-multipoint Layer 2 virtual private network (VPN) that enables you to connect geographically dispersed Ethernet local area network (LAN) sites to each other across an MPLS backbone. For customers who implement VPLS, all sites appear to be in the same Ethernet LAN even though traffic travels across service provider networks.

VPLS, in its implementation and configuration, has much in common with a Layer 2 VPN. In VPLS, a packet originating within a service provider customer´s network is sent first to a customer edge (CE) device (for example, a router or Ethernet switch). It is then sent to a provider edge (PE) router within the service provider network. The packet traverses the service provider network over an MPLS label-switched path (LSP). It arrives at the egress PE router, which the forwards the traffic to the CE device at the destination customer site. The difference is that, for VPLS, packets can traverse the service provider networks in point-to-multipoint fashion, meaning that a packet originating from a CE device can be broadcast to all the PE routers participating in a VPLS routing instance. In contrast, a Layer 2 VPN forwards packets in point-to-point fashion. The paths carrying VPLS traffic between each PE router participating in a routing instance are called pseudowires.

The pseudowires are signaled using either BGP or LDP, based on the VPLS implementation. There are two standardized VPLS implementations supported by the IETF: RFC 4761, Virtual Private LAN Service (VPLS) Using BGP for Auto-Discovery and Signaling, and RFC 4762, Virtual Private LAN Service (VPLS) Using Label Distribution Protocol (LDP) Signaling.

VPLS multihoming enables you to connect a customer site to multiple PE routers to provide redundant connectivity while preventing the formation of a Layer 2 loops in the service provider network. A VPLS site that is multihomed to two or more PE routers provides redundant connectivity in the event of a PE router-to-CE device link failure or the failure of a PE router.

When multihoming a VPLS site (potentially in different autonomous systems [Ass]), the PE routers connected to the same site can either be configured with the same VPLS edge (VE) device identifier or with different VE device identifier. If you are using different VE device identifier, you must run the Spanning Tree Protocol (STP) on the CE device, and possibly on the PE routers, to construct a loop-free VPLS topology.

If the PE routers are connected to the same site and assigned the same VE device identifier, a loop-free topology is constructed using a routing mechanism such as BGP path selection. When a BGP speaker receives two equivalent network layer reachability information (NLRI) advertisements, it applies standard path selection criteria, such as local preference and AS path length, to determine which NLRI to choose, and selects only one.

Because a PE router picks one of the received NLRI advertisements with a particular VE device identifier, it establishes the pseudowire only to the PE router from which the winning advertisement originated. This prevents the creation of multiple paths between sites and formation of Layer 2 loops in the network. If the selected PE routers fails, all PE routers in the network automatically switch to the backup PE router and establish pseudowires through the backup PE router.

Two VPLS NLRIs are considered equivalent from a path selection perspective if the following are the same:

. Route distinguisher

.VE device identifier

. VE block offset

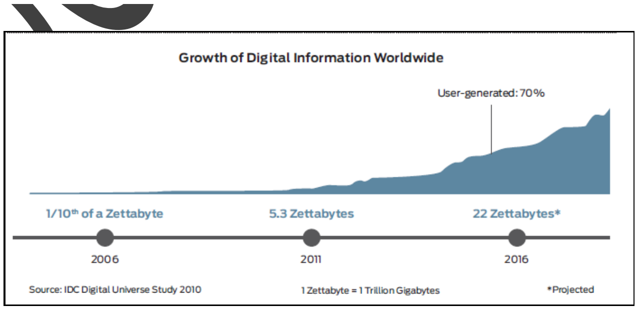
If two PE routers are assigned the same VE device identifier in a given VPLS, they must also advertise the same VE block size for a given VE offset. The PE routers can be configured with the same route distinguisher or with distinct route distinguishers.

Question 2

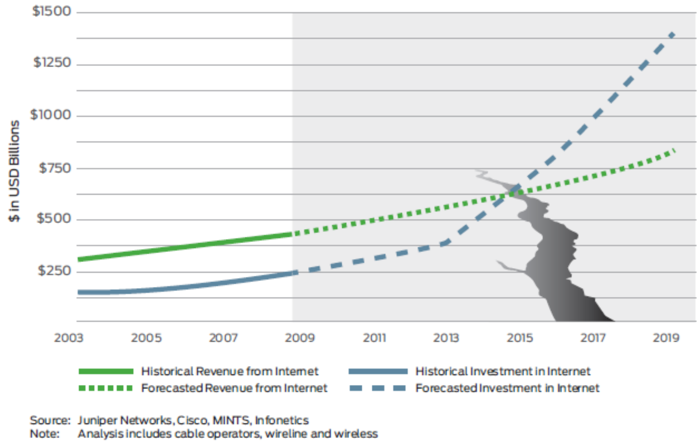
Describe the different sources of video content accessed by subscribers (end users) and the impact/challenges that each of these have on Network Service Providers. *References - Delivering Residential Services Using Juniper-Chapter 1*

Fueled by the significant growth in video, the amount of available content is increasing exponentially. In addition to traditional linear television service, VOD and network-based Personal Video Recorders (PVR) provide a seemingly never-ending source of entertainment. Furthermore, on-demand download services have expanded the choices of available content. Separately, the advent of user-generated content, such as Youtube, enables viewers to express their own creativity rather than be limited to only studio-produced content. Even traditional web pages often include video clips.

However, there is a price to pay for accessing virtually unlimited content. The dynamic growth of video consumes tremendous amounts of bandwith.



This video growth fundamentally changes the economics of broadband delivery, as Network Service Providers (NSPs) are forced to deploy ever-increasing bandwidth in all parts of the network. Concurrently, fierce competition makes it difficult to pass along these costs to cost-conscious customers. The net result is that network investment will outweigh the revenues. Following their existing path, NSPs will need to choose between absorbing the costs of network upgrades or of not providing the high-bandwidth access that customers continue to demand.



One key challenge is that, as services have evolved, the network has required changes to match these services. Of course, in some ways this is more of the same. Whether moving from crossbar switches to electronic switches, from large Central Offices (Cos) to class 5 switches, rotary to touch-tone, or landline to mobil, NSPs are continually finding ways to provide enhanced services at a price that their customers can afford.

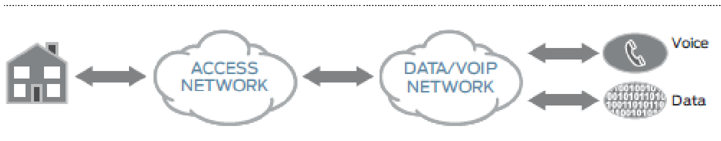
This discussion focuses on two areas. One, the access network has evolved to effectively deliver multiple services, including Internet-based video. Two, content caching reduces costs and improves performance.

Until recently, the focal point for providing a better subscriber experience has been on enhancing the broadband access network. Notably, the introduction of digital TV and Internet-based video has forced many service providers to rethink how the access network connects to the core. The three stages of this connection include:

_Single-edge: The original implementations were designed solely to provide Internet access to web-based information. Introducing Quality of Service (QOS) on the broadband nertwork also allowed this model to support VoIP because the voice traffic represented a small percentage of the overall traffic.

_Dual-edge (multi-edge): The introduction of digital broadband TV service strained the existing broadband networks, which were not designed to support high bandwidth, real-time traffic. As a result, an interim step was to create a second, parallel core network for delivering TV content. However, because the bulk of the subscriber´s bandwidth is dedicated to the television service, high quality Internet-based video cannot consistently be delivered smoothly to every subscriber.

_ Multiplay: A combination of the best of the above listed. Multiplay supports all services using converged access and core infrastructures. In addition to eliminating the costs associated with operating a second network, this scalable approach supports even High Definition (HD) quality Internet-based video.



Broadband network using data-centric single edge topology (double play)

Some operators deploy DSLAMs with some subscriber management functionality, rather than deploy a specialized BSR. Smaller operators generally use this approach.

Wired pay TV services

Just a few years ago, video delivery was seen as a panacea for network service providers looking to compete more effectively with the triple play packages offered by cable operators. TV service-including linear TV, plus a myriad of related services such as DVR-were heralded as the next generation of revenue for which consumers are willing to pay. Leveraging their key ability to reach almost everybody, incumbent NSPs appeared to be in an excellent position to take advantage of the growth of these video services.

To support this, traditional telcos began using their Xdsl infrastructure to deploy IPTV services in addition to traditional broadband access and broadband voice. This “tripleplay” set of services allowed telcos to compete more effectively with cable operators, which had leveraged their high-bandwidth video-enabled cable networks to deliver also broadband access and voice. NSPs managed and delivered this *walled garden* service.

Network issues were considered problematic but no overwhelming. The first and foremost problem was bandwidth. For early IPTV deployments, the biggest challenge was the last mile to the subscriber premises, which often supported less than 5 Mbps. Because TV was the only source of high-bandwidth. real-time (in other word, video) content, most of the access bandwidth could be reserved or “carved out” for TV service, with broadband and VoIP sharing whatever bandwidth remainded. For example, a tyipical service would reserve 8 Mbps for two standard-defintion digital television (SDTV) sets. Internet access and voice shared the remaining bandwidth, often well under 1 Mbps.

Because TV subscribers are the largest bandwidth consumers, upgrades to support this service would be included in the consumer´s bill. The decreasing cost of technology also allowed NSPs to limit price increases.

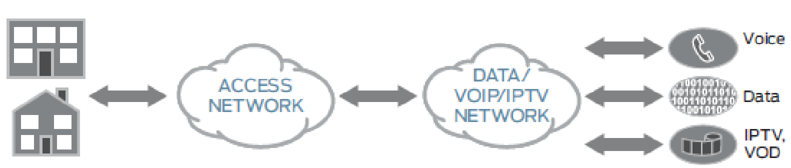
Another challenge was multicast delivery. Multicast is critical for broadcasting each channel to customers throughout the network. Early multicast suffered from scaling issues, was difficult to troubleshoot and required a different operational model than compared with unicast. The need for multicast also drove an evolution from the existing Point-to-Point (PPP) – based model to a PPP-free model.

Early implementations relied on a dual-edge strategy in which different services were forwarded to different edge routers.While internet and VoIP traffic continued to flow through the traditional data network, video traffic was forwarded using an additional, newly installed parallel network. While costlier than a single network, this lower-risk approach works fine as long as video and Internet services never converge.

Back to the future: Multiplay Access

A major challenge to the dual edge model is that access bandwidth must be allocated to each of the to edges. The majority of the access bandwidth is reserved for the "TV" content, with the remaining bandwidth is used for Internet access. This model does not support the emerging trend for delivering ever-increasing amounts of video content using the Internet.

The multiplay delivery model supports data, VoIP and video as well as emerging services. Unlike triple-play models that dedicate bandwidth to IPTV service, multiplay enables any application to use any bandwidth to the subscriber. Based on Juniper Networks MX Series 3D Universal Edge Router, the dramatic growth in Internet-based video makes this fundamental differentiator more important than ever. The key to a multiplay network is the BSR, which can support multiple services for thousands of subscribers, eliminating the need for separate service-specific networks. In addition, the multiplay model easily supports business and residential broadband service delivery using the same access and core infrastructure.



Broadband network using multiplay-capable single edge (including business services)

While the access network has converged on the multiplay approach, there are additional challenges to Internet-delivered video. The solution can be summarized as "store the content closer to the subscriber". Two different techniques have evolved to support this:

_ Reverse proxy: This approach supports managed content. This content is copyrighted and controlled by an organization such as a studio, which has the right to specify where their content can be stored. Reverse proxy provides this capability. Content Delivery Network (CDN) providers today use reserve proxy. In addition, many NSPs are looking to implement this capability within their own network to efficiently distribute their own content.

_Transparent proxy: This technique is deployed to supports unmanaged or over-the-top (OTT) content. This content is typically user-generated, which is not directly controlled by the NSP or another organization. Transparent proxy arbitrarily stores web content various points in the network. It essentially reduces network bandwidth by adding storage and servers across the network. Transparent proxy also can be used to cache managed content, notably localized premium content, provided certain legal restrictions are met.

Unmanaged OTT Content

While IPTV service enables NSPs to compete on an even footing with cable companies, the emergence of Internet-based video has challenged all broadband providers. Driven by lower production costs (the price of a home video camera) and low-cost distribution (such as YouTube), consumers started using their computers to watch User-Generated Content (UGC). Traditional web pages also began incorporating video make their message more appealing and digestible.

Internet-based video creates a tremendous burden for NSPs, who are suddenly obligated to deliver this Internet-based OTT traffic, resulting in higher network investments as well as higher peering charges. At the same time, competitive forces make it difficult to raise process, so there is no new subscriber revenue to pay for this. Furthermore, because the content is free to the subscriber and does not contain advertisements, there are no back-end revenue sources to leverage.

Figure 1.7. NSP conundrum

NSP Conundrum

Another complication is the lack of standards for web-based video. While both studio-produced content and user-generated content use MPEG encoding, the content is packaged differently for client delivery. For example, delivery to STBs uses Real Time Streaming Protocol (RTSP), while web-based delivery uses HTTP. In addition, websites publish their content using different formats.

Supporting OTT content is an exercise in minimizing costs.To this end, NSPs are deploying caches that support transparent proxy to store OTT content on their own networks. Essentially, NSPs are investing in caching hardware to reduce peering charges and minimize bandwidth consumption by popular content, such as viral videos. These caches store content throughout the network.

Managed OTT Content

Although unmanaged content captured the consumer´s imagination, it is the emergence of high bandwidth managed OTT content that potentially devastates NSPs. Content service providers control managed content, while the subscriber pays to access it. Gaming services, such as Xbox Live and OnLive are examples of these services. However, it is the explosion of high quality, online video from providers, such as sports programmers (FIFA.com, MLB.com), content aggregators (Hulu, Netflix) and content owners (hbo.com) that provide the greatest challenge because the subscriber does not pay any additional funds to the NSP, yet these services are driving the increased need for additional bandwidth. Netflix is now 29.7 percent of peak downstream traffic in North America and has become the largest source of Internet traffic overall. In addition, this model threatens the Pay TV revenue stream.

SNL Kagan forecasts that 10 percent of U.S homes (12.1 million) will cut the cord on their pay-TV subscriptions by the end of 2015, substituting OTT alternatives.

The traditional solution for viewing this larger and longer studio content- download the content until there is sufficient content to start streaming, and periodically halt playback while waiting for the next portion to download-is not acceptable for higher-quality studio content. Subscribers want instant access and undisrupted viewing, while content providers seek to avoid piracy to prevent content storage on user's hard drives. This demand has led to the emergence of caching and Content Delivery Network (CDN) services. Originally offered as a third-party worldwide service to minimize peering charges, CDNs store (cache) content closer to the subscriber, allowing the subscriber to begin viewing the content quickly, therefore minimizing the number of dropped packets that affect video quality. Moving video content closer to the subscriber creates lower latency and improved video, which are critical to the success of Internet-based video.

Figure1.8. High level view of CDN delivery model

CDNs are an essential element to delivering broadcast-quality Internet video as well as traditional Internet content. However, this growth in Internet-based video drives bandwidth without providing the NSP with any additional revenue because the subscriber pays the content provider directly. However, NSPs can also profit from this transition. CDNs get the content closer to the subscriber, but they cannot ensure that the subscriber will have unfettered access to the desired content. Start-up delays, pauses while content re-buffers and poor quality due to lost packets can all be symptoms of an overburdened or high latency network. The content provider cannot ensure a good subscriber experience without the help of the NSP guaranteeing that adequate bandwidth and appropriate QoS occur. As adoption grows, the content must be moved closer and closer to the subscriber- directly onto the NSP´s network.

Juniper´s Media Flow Controller software enables NSPs and other organizations to reduce costs and improve the profitability of delivering rich media content. Its groundbreaking software architecture enables Media Flow Controller to maximize system and disk performance to deliver unmatched throughput, session density and storage scaling. In addition, Media flow Controller optimizes the efficiency of cache storage with hierarchical caching, a unique innovation which intelligently aligns the requirements of content with the memory type in which it is stored.

Multi-Screen Services

The sense of satisfaction of managing bandwidth lasted about a dayand a half. No sooner was this challenge conquered than a new one erupted—multi-screen delivery of content to PCs, smartphones, tablets and even web-enabled televisions. The idea of delivering each service to a dedicated device is defunct. Linear TV is sent to PCs as well as STBs; TVs have broadband applets to watch Internet-based content; and gaming devices can view walled garden IPTV and Internet-based video, as well as serve their original purpose. Today´s subscribers watch content on wireless devices. At the same time, the consumer should see a common look and feel regardless of the device being used.

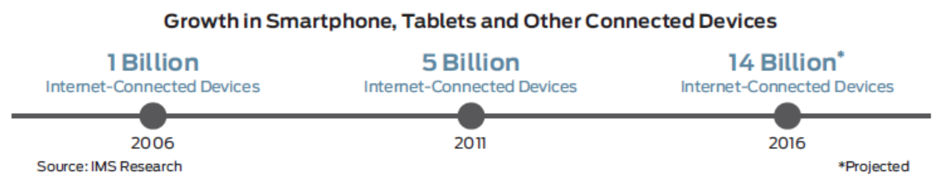


Figure 1.9. Multi-screen growth

Multi-Screen growth

Cell phones provide a unique challenge as the amount of bandwidth available across mobile networks changes based upon a variety of conditions, including distance from the cell tower and weather condition. Adaptive streaming mechanism address this by sending the video in small (often approximately two seconds) chunks and can vary the screen quality based upom how much bandwidth is available. While the industry is converging on HTTP progressive download, major vendors have their own implementation. In addition, not all devices support all video format. This means that content providers must publish their content in multiple formats.

To address this growing problem, Juniper Networks Media Flow Publisher simplifies the workflow by performing adaptive stream segmentation, stream packaging, metadata publishing and adaptive stream format translation. The Media Flow Publisher enables network operators and content providers to leverage their existing TV and video encoding infrastructure for adaptive stream production, eliminating the need for specialized encoders and servers.

In conclusion

NSP are again evolving their networks, this time to support the dramatic growth in video traffic, the shift to Internet-based video and the growth of CDN-based services. As the leaders in high performance networking, Juniper Networks provides a world-class infrastructure that delivers high bandwidth and real-time services, including IPTV, VoIP and videoconferencing.

Question 3

Estimate the IPTV bandwidth required to service an area with 2000 subscribers. How can bandwidth requirements be contained as subscribers in the area increase? *References - IPTV Bandwidth Management Juniper*

MCAC for IGMP Proxy or Snooping

When the AN (Access Node) is replicating multicast, the simplest method for traffic planning is to send a copy of all multicast groups from the BSR to the AN, ensuring there is no congestion at the network edge. For example, if there is 500 Mbps of offered multicast traffic, the entire 500 Mbps is sent to the AN. This works for small multicast group counts or if there is a surplus of bandwidth to the AN. As the network evolves, however, sending all groups to the AN becomes inefficient and can even result in the reduction of bandwidth for revenue-generating unicast applications.

This inefficiency is highlighted in the following graphs. The following figure shows the offered load of multicast received by the BSR from the core network. The average multicast load is 343 Mbps. This is a steady average across all days of the week and is based solely on the number of multicast groups (aka TV channels) and their corresponding bandwidths. This value only changes based on the number of groups offered, and the encoding rate changes either lower to optimized encoding schemes or higher based on industry adoption of HDTV. This value is independent if user viewing.

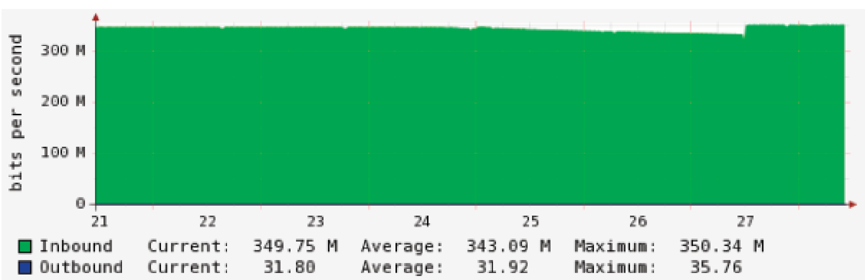


Figure 2: Offered Multicast Load for IPTV

Actual user multicast consumption was measured at the BSR MVLAN for a user base of 2000 households as shown in the following figure. The average bandwidth is only 141 Mbps, about 40 percent of the offered load. The peak is measured at 170 Mbps, still about 50 percent of the offered multicast load. This highlights the bandwidth savings that can be achieved by not planning for all multicast groups to be pushed to the AN at all times.

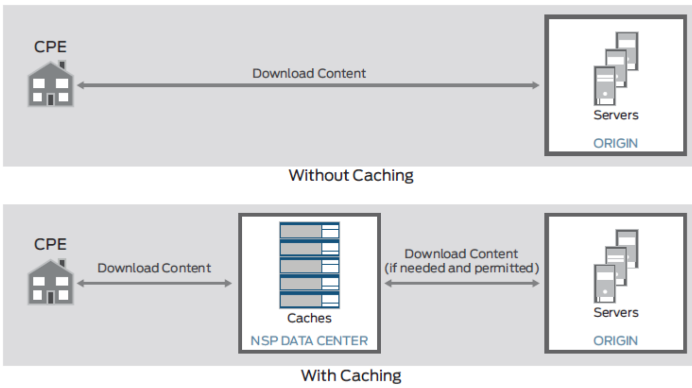
*Figure 3: Aggregate Multicast Bandwidth for 2000 Households**

Question 4

Describe how content caching can reduce bandwidth requirements and improve customer experience. Describe a typical caching infrastructure architecture - you may use a diagram if needed. *References - Delivering Residential Services Using Juniper- Part 4*

Caches store content closer to the subscriber. For the subscriber, this reduces the time required to download (or start viewing) the requested content. Caching can also improve audio/video quality by minimizing the chance that packets are dropped or delayed. For the NSP, deploying caches reduces network bandwidth usage by eliminating repetitive downloads for the same content from various clients. This reduces costs by mitigating the growing need for more bandwidth. Overall, caching improves user experience, while reducing costs for the service providers and the content provider.

The following figure illustrates the use of caches. Without caching (top of figure), internet based content is retrieved directly from the origin server, the server where the original content resides. Every time a given piece of content is requested, it is downloaded across the Internet. With caching (bottom of figure), the content is stored at an intermediate location. The request flows across the Internet only if it is not already stored in cache.



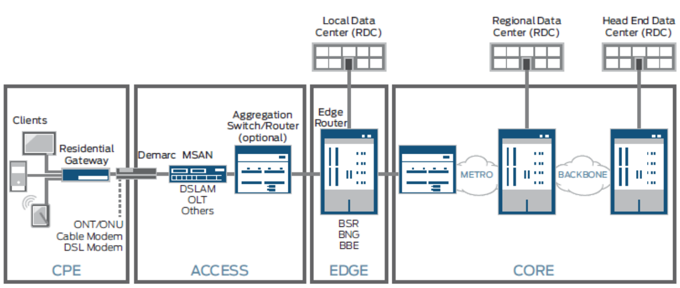
Caching Overview

HTTP/1.1 defines the rules governing whether and how content can be cached. Content can be flagged (marked) as non-cacheable. Each cache can be configured to honor or ignore this indicator, with legal ramifications varying widely by country and content source.

There are two caching techniques used in new deployments: *Transparent proxy caching* and reverse *proxy caching.* For transparent proxy, the DNS resolution process always returns the address of the origin server, and network elements redirect content requests to caches. For reverse proxy, the DNS system can return different IP addresses, typically based on the location of the requestor and the nearest content.

Server Load Balancers (SLBs) are an important component of most caching implementations. The SLB determines to which cache or server each request is forwarded. Successive requests, required to build a single page, may get forwarded to different caching devices. Server Load Balancing is one of the functions provided by a class of equipment called Application Delivery Controllers (ADCs), which also provides additional functions, such as NAT and firewalling.

The following figure shows us an overview of where the caching process occurs



Example Scenario Explaining Multicast Admission Control for IGMP Proxy

The second model detailed for MCAC is IGMP proxy or snooping. In this model, the AN will receive and process IGMP joins from each household. Now the BSR is only processing per-AN IGMP and can only make resource determinations regarding the amount of multicast sent over each M-VLAN interface to the AN.

The following figure highlights this model across two households. The BSR keeps a local mapping of multicast groups and their bandwidth. This table can be statically created or dynamically measured.

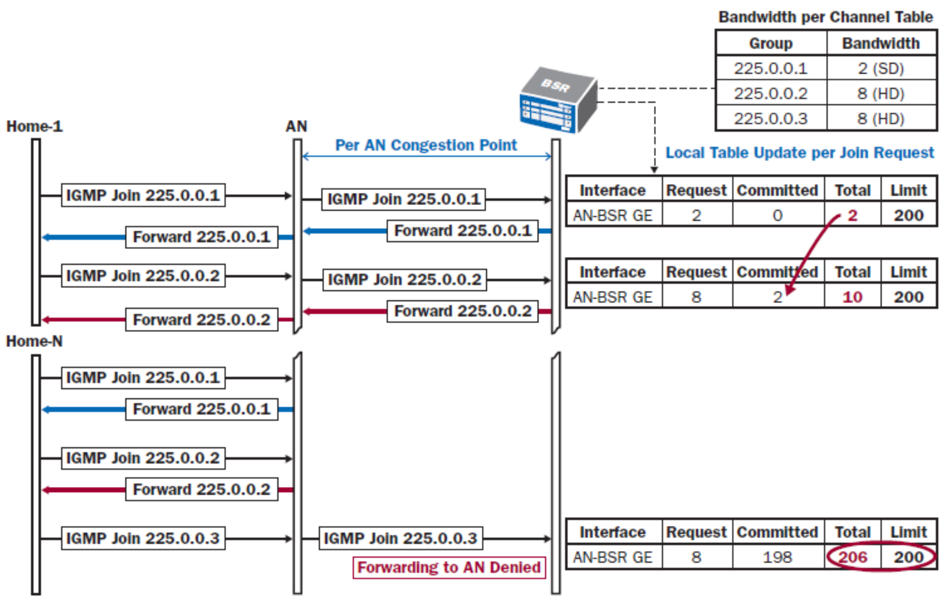


Figure 5: MCAC for Port or M-VLAN Across N Households

The BSR keeps an admission control resource table per M-VLAN mapping to an AN. In this example each M-VLAN is set with a limit of 200 Mbps of multicast. The M-VLAN limit can be set based on planned traffic engineering values.

As each IGMP joing request comes in, the BSR sums the amount of currently committed bandwidth and the request amount. As long as this amount is below the configured limit then the interface is sent a copy of the multicast group. The resource state table is then updated with a new commited rate that includes the new multicast group.

If the limit is exceeded, then the BSR will deny the join request and not send a copy of the multicast out that interface.

Since the BSR only sees unique join requests per group, the resource admission control only applies to unique groups per AN. If both homes 1 and 2 join the same group, then only a single resource check happens in the BSR.

If the bandwidth limit is exceeded, then the BSR will deny the join request and not send a copy of the multicast out of that interface. Note that this capability is at the network level. If a join request is denied, then the STB will not receive any type of feed back notification directly from the router. The router will generate a trap can be used for future capacity planning or integrated to the video application for direct STB feedback messages.

Lab Analysis for C-VLAN and Port Multicast Admission Control for IGMP Proxy/Snooping

For the IGMP proxy model, only M-VLAN multicast admission control is configured with a maximum amount of multicast bandwidth allowed to be replicated across that interface using the following JUNOSe software command under the M-VLAN subinterface:

```
ip multicast admission-bandwidth-limit 200000000
```

Hereafter it is assumed that the AN forwards proxied or snooped IGMP messages onto only the M-VLAN. However, there might be cases where IGMP joins can be received by the BNG on a different interface than that of the M-VLAN. In these cases a port-based command like the following one should be used in order to track all of the IGMP requests:

```
mroute port <# slot #>/<# bay #>/<# port #> admission-bandwidth-limit <#
bandwidth #>
```

In this test a maximum limit of 200 Mbps is used so that with the 3.5 to 4.0 Mbps SDTV video streams only three unique groups can be joined, although multiple subscribers can all watch the same three streams. The show ip route output shows that the first three groups (224.0.20.103, 224.0.20.106, 224.0.20.107) were joined successfully.

```
E320_MRA_ER_0#show ip mroute
…
(11.1.5.66, 224.0.20.103) uptime 0 00:00:38
  Admission bandwidth: 4005000 bps (adaptive)
  QoS bandwidth: 4005000 bps (adaptive)
  RPF route: 11.1.5.0/24, incoming interface GigabitEthernet3/1/2
      neighbor 11.1.6.2, owner IsIs (ECMP route)
  Incoming interface list:
      GigabitEthernet2/1/3 (11.1.6.1/30), Discard/Pim
      GigabitEthernet3/1/2 (11.1.6.5/30), Accept/Pim (RPF IIF)
  Outgoing interface list:
      GigabitEthernet15/0/0.222 (192.168.13.1/24), Forward/Pim, 0 00:00:38/
never
```

```
(11.1.5.66, 224.0.20.106) uptime 0 00:00:41
  Admission bandwidth: 3864000 bps (adaptive)
  QoS bandwidth: 3864000 bps (adaptive)
  RPF route: 11.1.5.0/24, incoming interface GigabitEthernet2/1/3
      neighbor 11.1.6.2, owner IsIs (ECMP route)
  Incoming interface list:
      GigabitEthernet2/1/3 (11.1.6.1/30), Accept/Pim (RPF IIF)
  Outgoing interface list:
      GigabitEthernet15/0/0.222 (192.168.13.1/24), Forward/Pim, 0 00:00:41/
never

(11.1.5.66, 224.0.20.107) uptime 0 00:00:21
  Admission bandwidth: 4252000 bps (adaptive)
  QoS bandwidth: 4252000 bps (adaptive)
  RPF route: 11.1.5.0/24, incoming interface GigabitEthernet3/1/2
      neighbor 11.1.6.2, owner IsIs (ECMP route)
  Incoming interface list:
      GigabitEthernet2/1/3 (11.1.6.1/30), Discard/Pim


      GigabitEthernet3/1/2 (11.1.6.5/30), Accept/Pim (RPF IIF)
  Outgoing interface list:
      GigabitEthernet15/0/0.222 (192.168.13.1/24), Forward/Pim, 0 00:00:21/
never
```

However, when the fourth group (224.0.20.108) join request is received by the BSR it will exceed the admission bandwidth limit, resulting in a non-replicated group:

```
(11.1.5.66, 224.0.20.108) uptime 0 00:00:04
  Admission bandwidth: 3752000 (adaptive)
  QoS bandwidth: 3752000 bps (adaptive)
  RPF route: 11.1.5.0/24, incoming interface GigabitEthernet2/1/3
      neighbor 11.1.6.2, owner IsIs (ECMP route)
  Incoming interface list:
      GigabitEthernet2/1/3 (11.1.6.1/30), Accept/Pim (RPF IIF)
  Outgoing interface list:
      GigabitEthernet15/0/0.222 (192.168.13.1/24), Blocked (intf-adm-limit)/
Pim, 0 00:00:05/never
```

This group is shown *as blocked*, denoting that group replication is not occurring due to an interface administrative limit *(intf-adm-limit).* This type of blocking impacts any subscriber issuing a join request for a new multicast group that must be delivered over the M-VLAN to the AN. If the AN proxy join request is beyond the 15 Mbps M-VLAN bandwidth limit, then AN replication cannot occur.

If per-subscriber admission control limits are required, this must be performed in the AN. The AN used in the test scenario does not support this feature and therefore was not tested. The BSR cannot provide per-subscriber multicast control since it is not responsible for per-subscriber replication.

Group Priorities for Multicast Admission Control

Instead of just using a simple group-bandwidth table for multicast admission control, JUNOSe software provides the extra capability of prioritizing groups that are part of the decision process.

By default, any entry in the route-map that is used to map a bandwidth to a multicast address or range of addresses also maps a priority of 0 to those addresses. If some of the groups cannot be blocked in any circumstance, then a priority higher than 0 should be associated with those groups.

```
 !
route-map "per-group-mcast-bandwidth" permit 10
 match ip address "PAY-TV-SDTV"
 set admission-bandwidth adaptive
 set priority 1
route-map "per-group-mcast-bandwidth" permit 20
 match ip address "SDTV"
 set admission-bandwidth adaptive
 !
Note when the port-level command is used:
mroute port <# slot #>/<# bay #>/<# port #> admission-bandwidth-limit
<# max-bandwidth #> priority-bandwidth-limit <# priority-bandwidth #>
hysteresis <# value #>
```

All groups are accepted until the *priority-bandwidth* level has been reached. Once that threshold has been hit, only those groups for which the *route-map per-group-mcast-bandwidth* associates a priority 1 are honored (unless already served below the priority-*bandwidth level*) until the second bandwidth threshold *max-bandwidth* is reached. After that all groups are blocked.

The hysteresis value is a percentage number and it relates to the priority-bandwidth. Once the priority-bandwidth-limit has been reached, in order to accept again non-prioritized channels multicast bandwidth has to go below that percentage.

There is an implicit, non-configurable hysteresis value also for the *admission-bandwidth-limit*, which is 85 percent.

Show commands are similar to those already seen in this document. The following is an example of an accepted prioritized group:

```
E320_MRA_ER_0#show ip mroute
…
(11.1.3.26, 224.0.17.104) uptime 0 00:14:56
  Admission bandwidth: 3907000 bps (adaptive)
  QoS bandwidth: 3907000 bps (adaptive)
  Priority: 1
  RPF route: 11.1.3.0/24, incoming interface GigabitEthernet2/1/3
      neighbor 11.1.6.6, owner IsIs (ECMP route)
  Incoming interface list:
      GigabitEthernet2/1/3 (11.1.6.1/30), Accept/Pim (RPF IIF)
  Outgoing interface list:
      GigabitEthernet15/0/0.600 (192.168.15.1/24), Forward/Pim, 0
00:15:00/never
```

In conclusion

There are a range of trade-offs involved in designing an IPTV network that delivers content using both unicast and multicast technologies. By choosing the right architecture at key points in the network, service providers can oversubscribe the edge network and still deliver the quality of experience (QoE) needed to satisfy customer demand and thus to compete effectively. The network designer must also be aware of the capabilities that are needed in key network components- in both the data and control planes-to support the desired architecture.

Juniper Networks has the expertise and product portfolio that service providers need to design the next-generation networks that can deliver a high QoE and maximize investment in infrastructure and administrative staff.

Question 5

You are required to write a design proposal to Pacific Internet Solutions. Your proposal must provide the following:

- an assessment of the client's business problems, opportunities and objectives
- an assessment of the client's current needs and possible future needs
- a detailed list of business requirements that must be met by the new network design including the need to contain bandwidth requirements while maintaining a high level of customer experience by providing high quality video and fast channel changes.
- an explanation of why the current network configuration does not meet the business requirements
- a prediction future network demands and the impact of this on the proposed network design. Determine estimated network traffic and planned growth
- a description of the network design that you propose presented in a clear and logical fashion. Provide advice to client on reasons for your design choice. Inform the client of design limitations, performance expectations and possible unanticipated outcomes

Document the network design and present documentation to appropriate person (your instructor) for approval. Present the design in a clear and logical fashion. The most important idea to keep in mind is that the goal of any proposal is to convince potential clients to award you their contracts.

Submission requirements

1. The written tasks must be completed on a word processor and submitted to the learning portal in word or pdf 0lformat.

PACIFIC INTERNET SOLUTIONS

Cyber Division

Daniel Cortez

ID:9849909

1. Assessment of the client´s business problems, opportunities and objectives.

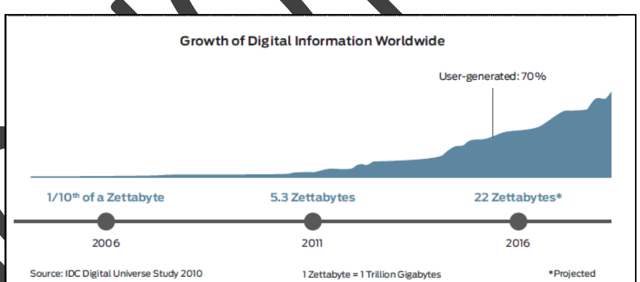
The implementation of the IPTV service for customer requirements can be very challenging, we need to update our bandwidth, we need to distribute the best possible video quality, at the same time that, of course, precisely what our end-users appears on the screen be looking and paying for watch. At the same time this inevitably leads us to consider the opportunities our clients have as television providers to develop a strong, efficient, safe and reliable project.

Comentado [dc1]:

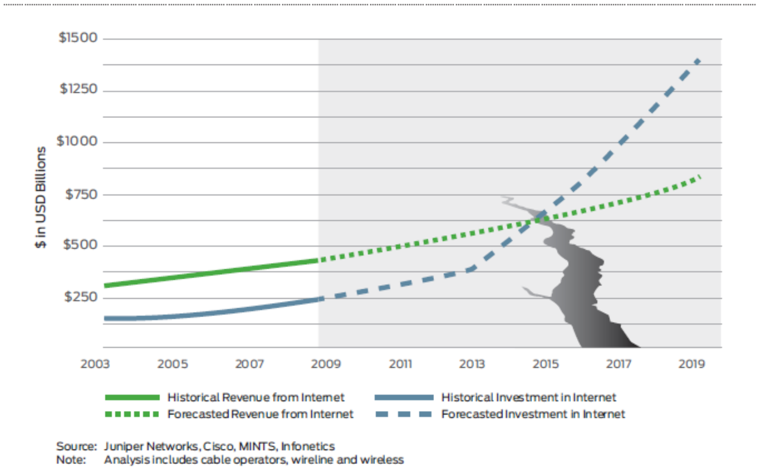
Comentado [dc2R1]:

We know that the main objective of our agreement is to satisfy the exponential growth of clients, in addition to the bandwidth requirement.

One of the biggest challenges is the growth of video traffic, VOD and network-based personal video recorders, which cause never ending video traffic. These in-house customer requirements consume a tremendous amount of bandwidth as shown below.



To this challenge we must add the fierce competition that exists in the market for different IPTV services, for which the challenge also consists of not passing on the costs of a robust bandwidth to the client itself. Therefore, the objective is to reinforce the bandwidth without the client taking charge, since otherwise a video service will not be able to be delivered according to the advantages of distributing high-quality video.



One key challenge is that, as services have evolved, the network has required changes to match these services. Of course, in some ways this is more of the same. Whether moving from crossbar switches to electronic switches, from large Central Offices (Cos) to class 5 switches, rotary to touch-tone, or landline to mobil, NSPs are continually finding ways to provide enhanced services at a price that their customers can afford.

This discussion focuses on two areas. One, the access network has evolved to effectively deliver multiple services, including Internet-based video. Two, content caching reduces costs and improves performance.

Until recently, the focal point for providing a better subscriber experience has been on enhancing the broadband access network. Notably, the introduction of digital TV and Internet-based video has forced many service providers to rethink how the access network connects to the core.

Another challenge is multicast delivery. Multicast is critical for broadcasting each channel to customers throughout the network.

So, if the objective is to distribute good quality video content with a low bandwidth requirement, the best solution and technology that we will use this time will be the multiplay delivery model.

2. Assessment of the client´s current needs and possible future needs.

Pacific Internet Solutions expects that after IPTV is available to subscribers its number of subscribers will increase from the present number of 20,000 to 100,000 over the next 5 years.

So, with this in mind, we will adopt the following measures:

Subscribers want instant access and undisrupted viewing, while content providers seek to avoid piracy to prevent content storage on user's hard drives. This demand has led to the emergence of caching and Content Delivery Network (CDN) services. CDNs store (cache) content closer to the subscriber, allowing the subscriber to begin viewing the content quickly, therefore minimizing the number of dropped packets that affect video quality. Moving video content closer to the subscriber creates lower latency and improved video, which are critical to the success of Internet-based video.

Juniper´s Media Flow Controller software enables NSPs and other organizations to reduce costs and improve the profitability of delivering rich media content. Its groundbreaking software architecture enables Media Flow Controller to maximize system and disk performance to deliver unmatched throughput, session density and storage scaling. In addition, Media flow Controller optimizes the efficiency of cache storage with hierarchical caching, a unique innovation which intelligently aligns the requirements of content with the memory type in which it is stored.

Another need is multi-screen delivery of content to PCs, smartphones, tablets and even web-enabled televisions. The idea of delivering each service to a dedicated device is defunct. Linear TV is sent to PCs as well as STBs; TVs have broadband applets to watch Internet-based content; and gaming devices can view walled garden IPTV and Internet-based video, as well as serve their original purpose. Today´s subscribers watch content on wireless devices. At the same time, the consumer should see a common look and feel regardless of the device being used.

To address this growing problem, Juniper Networks Media Flow Publisher simplifies the workflow by performing adaptive stream segmentation, stream packaging, metadata publishing and adaptive stream format translation. The Media Flow Publisher enables network operators and content providers to leverage their existing TV and video encoding infrastructure for adaptive stream production, eliminating the need for specialized encoders and servers.

3. Detailed list of business requirements

- The need to contain bandwidth requirements while maintaining a high level of costumer experience by providing high quality video and fast channel changes. The following is the solution:

Multicast Admission Control for IGMP Proxy

In this model, the AN will receive and process IGMP joins from each household. Now the BSR is only processing per-AN IGMP and can only make resource determinations regarding the amount of multicast sent over each M-VLAN interface to the AN.

The following figure highlights this model across two households. The BSR keeps a local mapping of multicast groups and their bandwidth. This table can be statically created or dynamically measured.

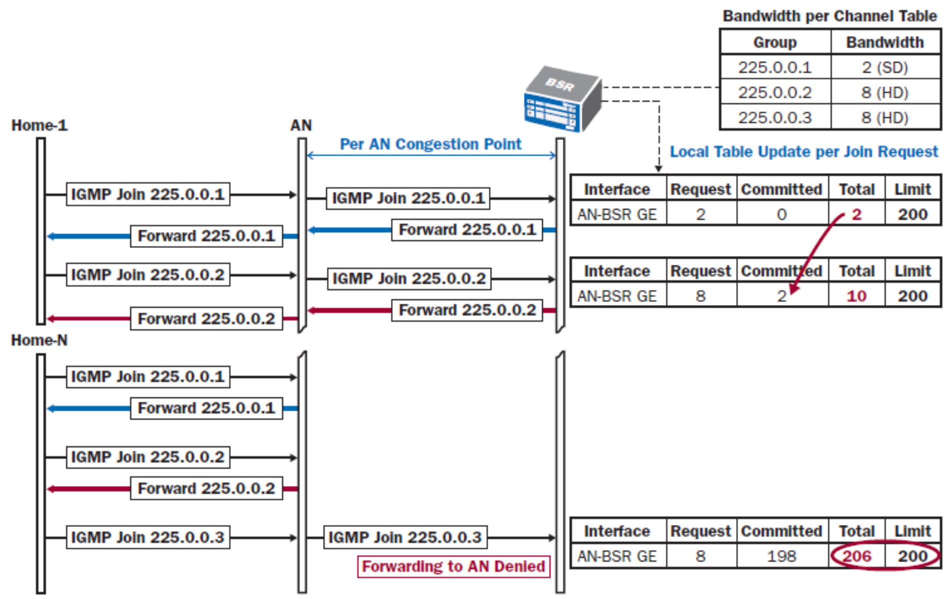


Figure 5: MCAC for Port or M-VLAN Across N Households

The BSR keeps an admission control resource table per M-VLAN mapping to an AN. In this example each M-VLAN is set with a limit of 200 Mbps of multicast. The M-VLAN limit can be set based on planned traffic engineering values.

As each IGMP join request comes in, the BSR sums the amount of currently committed bandwidth and the request amount. As long as this amount is below the configured limit then the interface is sent a copy of the multicast group. The resource state table is then updated with a new committed rate that includes the new multicast group.

If the limit is exceeded, then the BSR will deny the join request and not send a copy of the multicast out that interface.

Group Priorities for Multicast Admission Control

Instead of just using a simple group-bandwidth table for multicast admission control, JUNOSe software provides the extra capability of prioritizing groups that are part of the decision process.

By default, any entry in the route-map that is used to map a bandwidth to a multicast address or range of addresses also maps a priority of 0 to those addresses. If some of the groups cannot be blocked in any circumstance, then a priority higher than 0 should be associated with those groups.

All groups are accepted until the *priority-bandwidth* level has been reached. Once that threshold has been hit, only those groups for which the *route-map per-group-mcast-bandwidth* associates a priority 1 are honored (unless already served below the priority-*bandwidth level*) until the second bandwidth threshold *max-bandwidth* is reached. After that all groups are blocked.

- Caching:

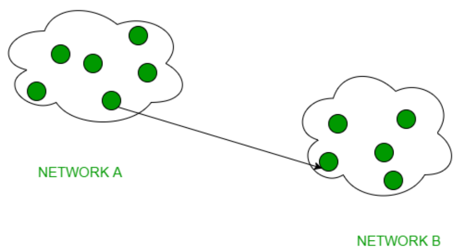
Caches store content closer to the subscriber. For the subscriber, this reduces the time required to download (or start viewing) the requested content. Caching can also improve audio/video quality by minimizing the chance that packets are dropped or delayed. For the NSP, deploying caches reduces network bandwidth usage by eliminating repetitive downloads for the same content from various clients. This reduces costs by mitigating the growing need for more bandwidth. Overall, caching improves user experience, while reducing costs for the service providers and the content provider.

Without caching (top of figure), internet-based content is retrieved directly from the origin server, the server where the original content resides. Every time a given piece of content is requested, it is downloaded across the Internet. With caching (bottom of figure), the content is stored at an intermediate location. The request flows across the Internet only if it is not already stored in cache.

4. An explanation of why the current network configuration does not meet the business requirements

The main reason why the current network configuration does not work is because it is unicast. Next we will explain what are the characteristics of each of the models (unicast and multicast) and the difference between them.

UNICAST: This type of information transfer is useful when there is a participation of single sender and single recipient. So, it can term it as a one-to-one transmission. For example, a device having IP address 10.1.2.0 in a network wants to send the traffic stream (data packets) to the device with IP address 20.12.4.2 in the other network, then unicast comes into the picture. This is the most common form of data transfer over the networks.



UNICAST EXAMPLE

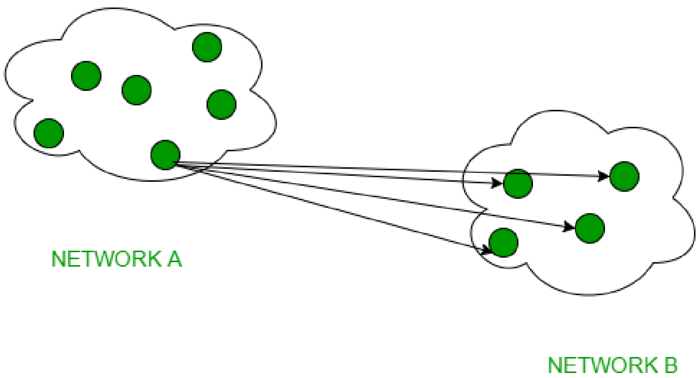
The implementation of unicast applications is a bit easy as they use well-established IP protocols; however, they are particularly incompetent when there is a need for many-to-many communications. In the meantime, all packets in the data stream must be sent to every host requesting access to the data stream. However, this type of transmission is ineffective in term of both network and server resources as it equally presents obvious scalability issues.

This is a one-to-one connection between the client and the server. Unicast uses IP provision techniques such as TCP (transmission control protocol) and UDP (user datagram protocol), which are session-based protocols. Once a Windows media player client connects via unicast to Windows media server that client gets a straight connection to the server. Every unicast client that connects to the server takes up extra bandwidth. For instance, if you have 10 clients all performing 100 Kbps streams, it means those clients taking up 1,000 Kbps. But you have a single client using the 100 Kbps stream, only 100 Kbps is being used.

MULTICAST: Multicast lets server´s direct single copies of data streams that are then simulated and routed to hosts that request it.

Hence, rather than sending thousands of copies of a streaming event, the server instead streams a single flow that is them directed by routers on the network to the hosts that have specified that they need to get the stream. This removes the requirement to send redundant traffic over the network and also be likely to reduce CPU load on systems, which are not using the multicast system, yielding important enhancement to efficiency for both server and network.

In multicasting, one/more senders and one/more recipients participate in data transfer traffic. In this method traffic recline between the boundaries of unicast (one-to-one) and broadcast (one-to-all). Multicast lets server´s direct single copies of data streams that are then simulated and routed to hosts that request it. IP multicast requires support of some other protocols like IGMP (Internet Group Management Protocol), Multicast routing for its working. Also in classful IP addressing Class D is reserved for multicast groups.



Differences between Unicast and Multicast:

S.No.	Unicast	Multicast
1.	It has one sender and one receiver.	It has one or more senders and multiple receivers.
2.	It sends data from one device to single device.	It sent data from one device to multiple devices.
3.	It works on Single Node Topology.	It works on star, mesh, tree and hybrid topology.
4.	It does not scale well for streaming media.	It does not scale well across large networks.
5.	Multiple unicasting utilizes more bandwidth as compared.	It utilizes bandwidth efficiently.
6.	Web surfing, file transfer is an example of a unicast.	Switch is an example of a multicast device.
7.	It has one-to-one mapping.	It has one-to-many mapping.

So, in conclusion there are two central methods that Windows Media servers use to send data to Windows Media Player clients: Unicast and Multicast.

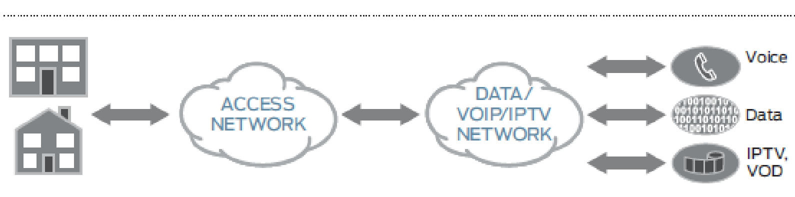
Multicast or Unicast can be used for broadcasting live video or audio. Your network setting by default determines who the clients are and what sort of broadcast it is needed to prefer.

5. A prediction future network demands and the impact of this on the proposed network design. Determine estimated network traffic and planned growth

As we already know, as a prediction in the future after the installation of the new design, the estimated number of subscribers will increase from 20,000 to 100,000 in 5 years, so the solution we propose for this growth will be explained below:

A major challenge to the dual edge model is that access bandwidth must be allocated to each of the to edges. The majority of the access bandwidth is reserved for the “TV” content, with the remaining bandwidth is used for Internet access. This model does not support the emerging trend for delivering ever-increasing amounts of video content using the Internet.

The multiplay delivery model supports data, VoIP and video as well as emerging services. Unlike triple-play models that dedicate bandwidth to IPTV service, multiplay enables any application to use any bandwidth to the subscriber. Based on Juniper Networks MX Series 3D Universal Edge Router, the dramatic growth in Internet-based video makes this fundamental differentiator more important than ever. The key to a multiplay network is the BSR, which can support multiple services for thousands of subscribers, eliminating the need for separate service-specific networks. In addition, the multiplay model easily supports business and residential broadband service delivery using the same access and core infrastructure.



Broadband network using multiplay-capable single edge (including business services)

While the access network has converged on the multiplay approach, there are additional challenges to Internet-delivered video. The solution can be summarized as “store the content closer to the subscriber”. We will do Transparent proxy:

_Transparent proxy: This technique is deployed to supports unmanaged or over-the-top (OTT) content. This content is typically user-generated, which is not directly controlled by the NSP or another organization. Transparent proxy arbitrarily stores web content various points in the network. It essentially reduces network bandwidth by adding storage and servers across the network. Transparent proxy also can be used to cache managed content, notably localized premium content, provided certain legal restrictions are met.

6. Description of the network design. Proposal

NETWORK DESIGN PROPOSAL

Cyber Division

Daniel Cortez
ID:9849909

The implementation of the IPTV service for customer requirements can be very challenging, we need to update our bandwidth, we need to distribute the best possible video quality, at the same time that, of course, precisely what our end-users appears on the screen be looking and paying for watch. At the same time this inevitably leads us to consider the opportunities our clients have as television providers to develop a strong, efficient, safe and reliable project.

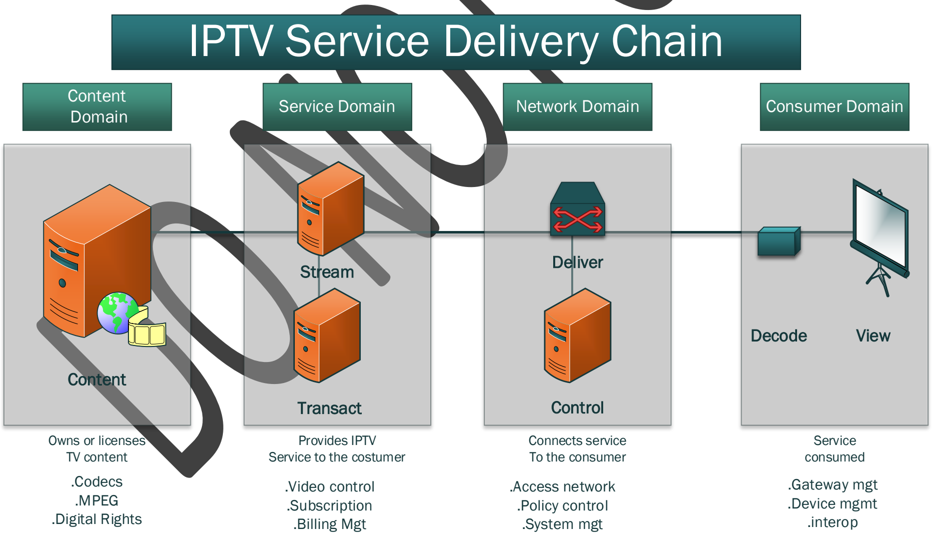
We know that the main objective of our agreement is to satisfy the exponential growth of clients, in addition to the bandwidth requirement.

Pacific Internet Solutions expects that after IPTV is available to subscribers its number of subscribers will increase from the present number of 20,000 to 100,000 over the next 5 years.

Our network architecture proposal is based on world installation standards that are based on the search for optimization and better distribution and user experience.

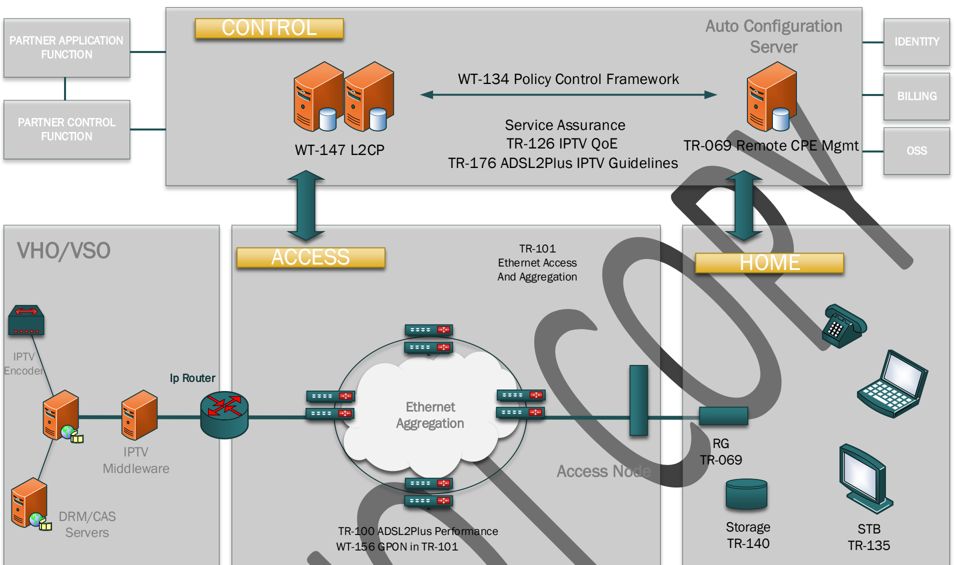
That is why we propose, going from the general to the particular, starting with a healthy IPTV service delivery chain based on its 4 domains: Content, service, network and consumer domains. This will give us the peace of mind and the certainty of a good distribution chain as the Broadband forum has discussed and has established it as a guide for a successful installation.

The IPTV Ecosystem



As we mentioned before, and of course still talking about our network architecture proposal, we will base ourselves on the ideas of the Broadband forum, why? Well, because through its Technical Reports (TRs) you have defined requirements for establishing an optimized network and management platform for IPTV.

The work of Broadband Forum addresses specific issues in three network realms: BroadbandAccess, BroadbandControl and BroadbandHome that are necessary if the IPTV user is to experience a superior quality experience beyond what is already provided by existing TV delivery methods.



This “Plan” is designed to minimize provisioning and maintenance issues for service and application providers who must support vast and growing requirements of new applications and hardware. With BroadbandSuite, components work together seamlessly, delivering a high-quality consumer experience vital for driving next-generation voice, video, data and mobile services.

These efforts address the following key areas:

_ **BroadbandAccess:** Defines specifications for broadband “agnostic” access network architectures that deliver inherent quality, scalability, resiliency, and inter-working capabilities that enable services to be delivered via multiple business models.

_BroadbandControl: Creates an intelligent, programmable control layer that unifies all next generation network assets and empowers service providers to deliver personalized services that enhance the subscriber experience.

_BroadbandHome: Unifies the home networking environment by establishing a common a set of CPE capabilities as well as automating device activation and configuration in order to simplify the service delivery process.

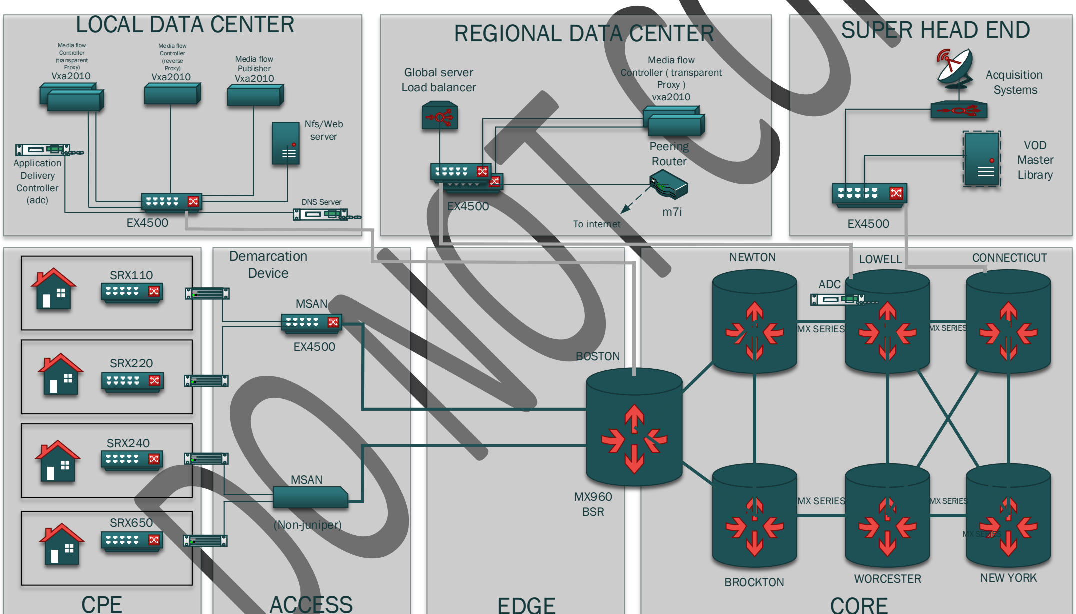
Collectively the BroadbandSuite domains provide an end-to-end transport architecture that gives service providers a solid foundation on wich to deliver next-generation services such as IPTV, while reducing operations costs through automated network operations.

IPTV network network architecture

Having already explained the above at the level of standards, ideas and model, I would now like to go on to detail at the level of devices and connection what is our proposal for the general architecture.

Well, we are thinking of a typical network architecture that is already validated. It should be mentioned previously that our distribution proposal is based on the VPLS model in an MPLS architecture distributed by LSPs signaled by the BGP protocol.

Here is an overview of what architecture with the explanation of the different areas:



The Wan consists of the following domains:

_Core network, which is a multicast-enabled MPLS backbone network.
_The BSRs are MX Series routers that support subscriber management services.
_Access equipment, which includes DSLAMs to support xDSL users, as well as an EX Series Ethernet Switches that support Ethernet-attached subscribers. This network does not include aggregation switches.

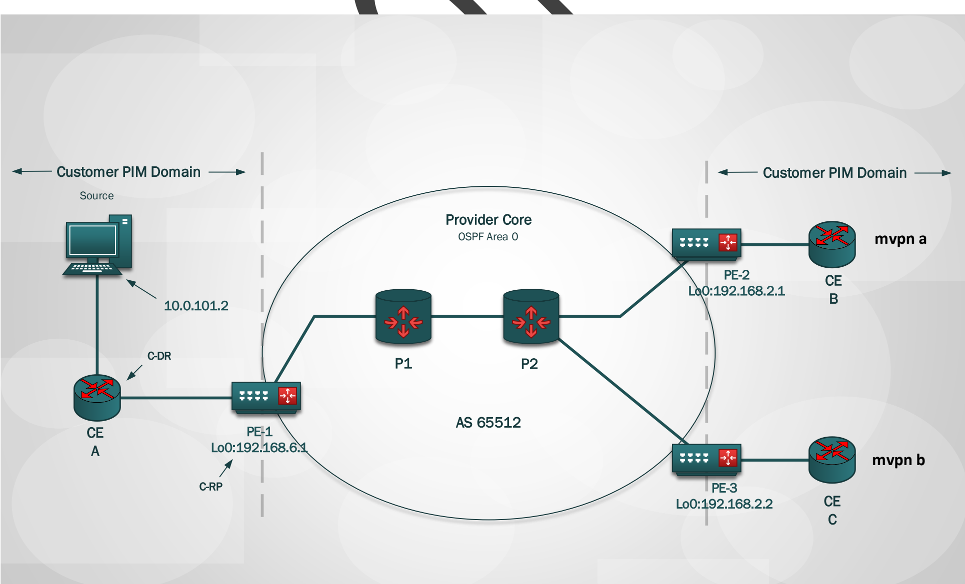
Tiered data centers also represent part of the entire network architecture:

Super Head End (SHE) data center, which is the centralized storage and download point for many types of content, including linear TV. This site is referred to by a variety of other names, including National Data Center.

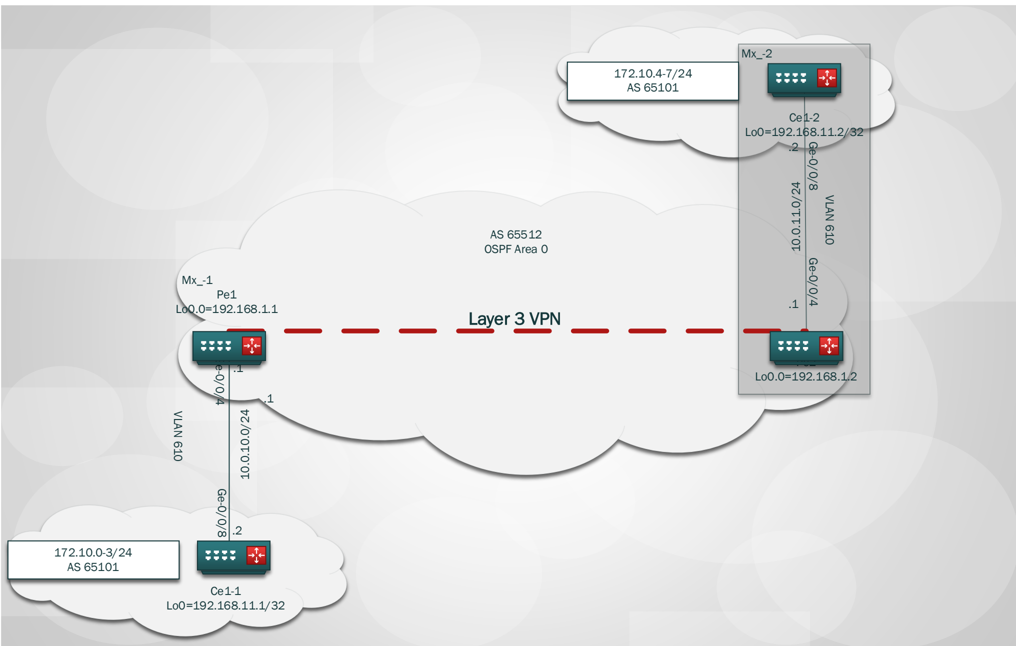
Regional Data Centers (RDCs), which are the primary data centers serving the subscribers. For example, advertisements are inserted into the linear TV stream, and it is this stream that is forwarded to the subscribers. VoIP switches and Internet peering points often reside at this location. This site is also called the Video Hub Office (VHO) or Local Head End (LHE) among other names.

Edge data centers, which primarily consist of aggregation equipment and content caches. These sites also are known as broadband edge (BBE) sites,
Video Service Office (VSO) or Central Office (CO).

In the next diagram, we propose the multicast MPLS network that we will use for IPTV distribution.

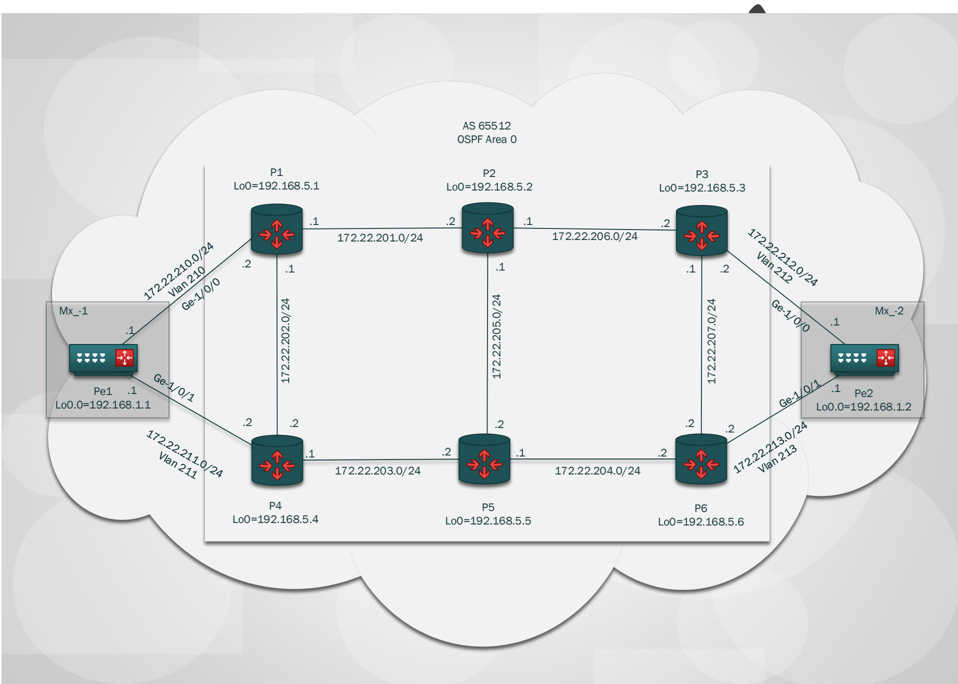


Since we have our network design in a general way, in the following diagram we will focus on the network design and connectivity between the customer edge and the provider edge and we will observe the connection between PE based on a layer 3 VPN.



As we mentioned before the layer 3 VPN, now we propose the following model itself.

This will be the baseline of our MPLS proposal where we will have the routers (P) that will connect the routers (PE) through BGP signaling, and where the LSPs will be configured for effective point-to-multipoint distribution.



Distribution model

To the costumer in the VPLS (virtual private LAN service) model, the provider's network appears to function as a single LAN segment and the administrator does not need to map local circuit IDs to remote sites. The PE device learns MAC address form received layer 2 frames and are dynamically mapped to outbound MPLS LSPs and / or interfaces. In other words it works like a big switch.

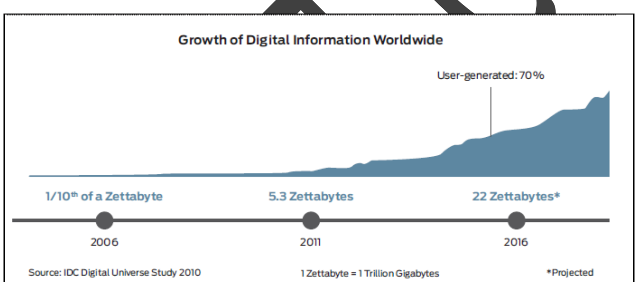
What we propose is to work with the VPLS RFC 4761 standard that uses M-BGP to signal. And is that the benefits are several, for example auto-discovery or that it is a scalable protocol which means to handle lots of routes in addition to being designed to work through autonomous systems.

In VPLS, a packet originating within a service provider customer's network is sent first to a customer edge (CE) device (for example, a router or Ethernet switch). It is then sent to a provider edge (PE) router within the service provider network. The packet traverses the service provider network over an MPLS label-switched path (LSP). It arrives at the egress PE router, which the forwards the traffic to the CE device at the destination customer site. The difference is that, for VPLS, packets can traverse the service provider networks in point-to-multipoint fashion, meaning that a packet originating from a CE device can be broadcast to all the PE routers participating in a VPLS routing instance.

VPLS multihoming enables you to connect a customer site to multiple PE routers to provide redundant connectivity while preventing the formation of a Layer 2 loops in the service provider network. A VPLS site that is multihomed to two or more PE routers provides redundant connectivity in the event of a PE router-to-CE device link failure or the failure of a PE router.

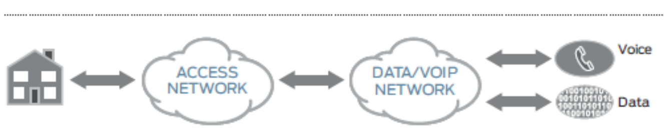
Source of video: Impact/challenges

Fueled by the significant growth in video, the amount of available content is increasing exponentially. In addition to traditional linear television service, VOD and network-based Personal Video Recorders (PVR) provide a seemingly never-ending source of entertainment.



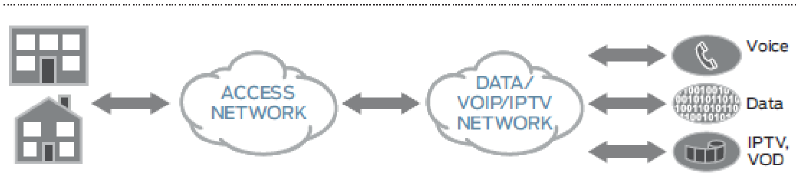
So, if the objective is to distribute good quality video content with a low bandwidth requirement, the best solution and technology that we will use this time will be the multiplay delivery model.

Multiplay supports all services using converged access and core infrastructures. In addition to eliminating the costs associated with operating a second network, this scalable approach supports even High Definition (HD) quality Internet-based video.



Broadband network using data-centric single edge topology (double play)

The multiplay delivery model supports data, VoIP and video as well as emerging services. Unlike triple-play models that dedicate bandwidth to IPTV service, multiplay enables any application to use any bandwidth to the subscriber. Based on Juniper Networks MX Series 3D Universal Edge Router, the dramatic growth in Internet-based video makes this fundamental differentiator more important than ever. The key to a multiplay network is the BSR, which can support multiple services for thousands of subscribers, eliminating the need for separate service-specific networks. In addition, the multiplay model easily supports business and residential broadband service delivery using the same access and core infrastructure.



Broadband network using multiplay-capable single edge (including business services)

NSP are again evolving their networks, this time to support the dramatic growth in video traffic, the shift to Internet-based video and the growth of CDN-based services. As the leaders in high performance networking, Juniper Networks provides a world-class infrastructure that delivers high bandwidth and real-time services, including IPTV, VoIP and videoconferencing.

Of course, we know the challenges and opportunities that our clients have ahead, the implementation of the IPTV service for customer requirements can be very challenging, we need to update our bandwidth, we need to distribute the best possible video quality, at the same time that, of course, precisely what our end-users appears on the screen be looking and paying for watch.
We know that the main objective of our agreement is to satisfy the exponential growth of clients, in addition to the bandwidth requirement.

One of the biggest challenges is the growth of video traffic, VOD and network-based personal video recorders, which cause never ending video traffic.

To this challenge we must add the fierce competition that exists in the market for different IPTV services, for which the challenge also consists of not passing on the costs of a robust bandwidth to the client itself. Therefore, the objective is to reinforce the bandwidth without the client taking charge, since otherwise a video service will not be able to be delivered according to the advantages of distributing high-quality video.

This discussion focuses on two areas. One, the access network has evolved to effectively deliver multiple services, including Internet-based video. Two, content caching reduces costs and improves performance. Another challenge is multicast delivery. Multicast is critical for broadcasting each channel to customers throughout the network.

So, if the objective is to distribute good quality video content with a low bandwidth requirement, the best solution and technology that we will use this time will be the multiplay delivery model.

Another need is multi-screen delivery of content to PCs, smartphones, tablets and even web-enabled televisions. The idea of delivering each service to a dedicated device is defunct. Linear TV is sent to PCs as well as STBs; TVs have broadband applets to watch Internet-based content; and gaming devices can view walled garden IPTV and Internet-based video, as well as serve their original purpose. Today´s subscribers watch content on wireless devices. At the same time, the consumer should see a common look and feel regardless of the device being used.

To address this growing problem, Juniper Networks Media Flow Publisher simplifies the workflow by performing adaptive stream segmentation, stream packaging, metadata publishing and adaptive stream format translation. The Media Flow Publisher enables network operators and content providers to leverage their existing TV and video encoding infrastructure for adaptive stream production, eliminating the need for specialized encoders and servers.

The need to contain bandwidth requirements while maintaining a high level of costumer experience by providing high quality video and fast channel changes. The following is the solution:

Multicast Admission Control for IGMP Proxy

In this model, the AN will receive and process IGMP joins from each household. Now the BSR is only processing per-AN IGMP and can only make resource determinations regarding the amount of multicast sent over each M-VLAN interface to the AN.

The following figure highlights this model across two households. The BSR keeps a local mapping of multicast groups and their bandwidth. This table can be statically created or dynamically measured.

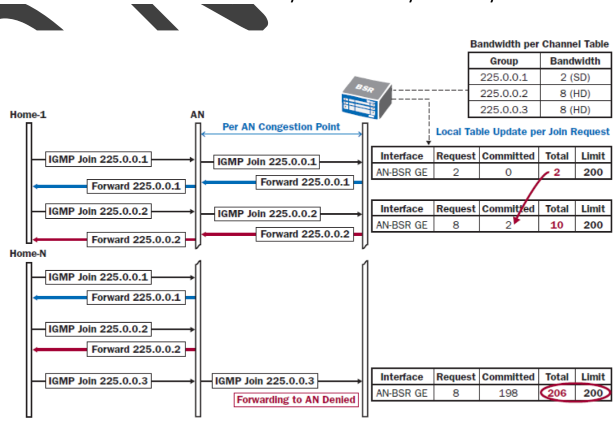


Figure 5: MCAC for Port or M-VLAN Across N Households

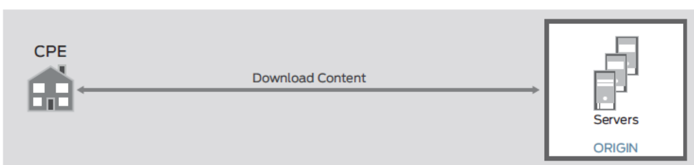
The BSR keeps an admission control resource table per M-VLAN mapping to an AN. In this example each M-VLAN is set with a limit of 200 Mbps of multicast. The M-VLAN limit can be set based on planned traffic engineering values.

As each IGMP join request comes in, the BSR sums the amount of currently committed bandwidth and the request amount. As long as this amount is below the configured limit then the interface is sent a copy of the multicast group. The resource state table is then updated with a new committed rate that includes the new multicast group.

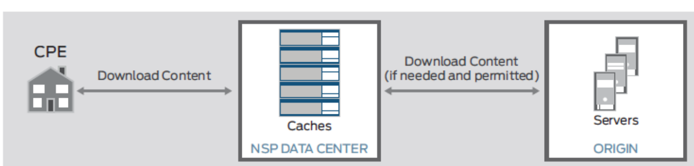
If the limit is exceeded, then the BSR will deny the join request and not send a copy of the multicast out that interface.

Reducing bandwidth requirements: Caching

Caches store content closer to the subscriber. For the subscriber, this reduces the time required to download (or start viewing) the requested content. Caching can also improve audio/video quality by minimizing the chance that packets are dropped or delayed. For the NSP, deploying caches reduces network bandwidth usage by eliminating repetitive downloads for the same content from various clients. This reduces costs by mitigating the growing need for more bandwidth. Overall, caching improves user experience, while reducing costs for the service providers and the content provider.

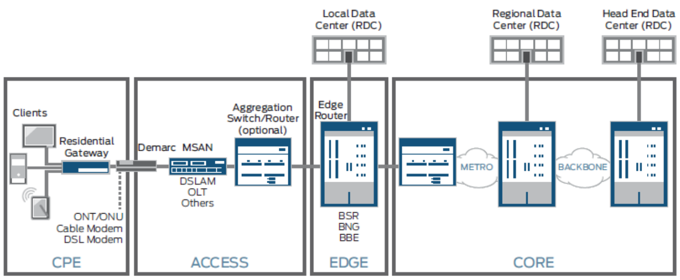


Without Caching



With Caching

The following figure shows us an overview of where the caching process occurs:



In conclusion

As Pacific Internet Solution, our greatest passion and motivation is to maintain a healthy network, with a vision of the future, to take into account every step in which technology at our disposal advances, we know that the challenges are great, we know that subscribers to digital content demand immediate, reliable, safe and easy content.

We firmly believe that this proposal meets all the requirements that the industry thinks of as standard and its implementation will be carried out according to the times and needs that are agreed between all parties.