

BUILDING A BETTER BROADBAND NETWORK

Understanding the Alternatives

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Executive Summary

This white paper compares the strengths and weaknesses of three common alternatives for building broadband networks. Upon completion, the reader should be able to use the information presented as a starting point to make an informed decision about which to implement. Juniper Networks® supports all of the described alternatives.

Introduction

Whether searching for information, sending emails, buying goods, or downloading videos, broadband has become part of our everyday lives. New applications, however, promise to even further revolutionize how we use the network. Specific revenue-generating opportunities include:

HD support: Being able to use nearly all bandwidth for IPTV would allow the subscriber to watch HD channels as well as support more TV sets watching standard definition (SD) programming. Many IPTV providers do not have sufficient bandwidth to support even one HD channel, while there is a need to support at least two HD streams (view one channel and record a different channel concurrently).

Premium Internet services: New applications—including gaming services and real-time Internet-based video viewed on your PC—require committed bandwidth to always function properly. The network must ensure that bandwidth is dedicated to this session to ensure a satisfactory experience.

Multi-purpose devices: From PCs with IPTV software to the Xbox, clients now need to support voice, video and data concurrently.

Just as what we do with the Internet has evolved, so too has the way that broadband operators can build their networks. The first and most fundamental decision requires selecting the appropriate broadband edge architecture: Triple play, enhanced triple play or multiplay. This white paper describes and compares these alternatives.

Good: Triple Play Network

In the standard triple play solution, most network capabilities required to support broadband communications¹ are implemented in a Multi-Service Access Node (MSAN), such as a DSLAM. This scenario is popular among broadband operators seeking to offer basic triple play service. Often there is a sense of urgency to offer IPTV service with minimal up-front investment, to compete against cable companies in their territory that are bundling their traditional television service with voice and data services.

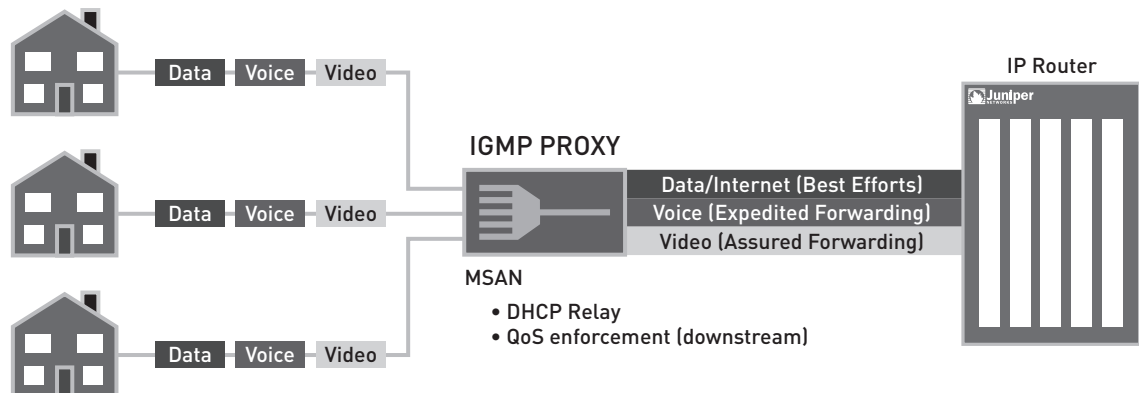


Figure 1: Triple play solution

The MSAN communicates upstream to a standard IP network, as shown in Figure 1, optionally through an intermediate aggregation switch (not shown). The first router may be Broadband Remote Access Server device which terminates PPPoX (family of point-to-point communication protocols) encapsulation, if that is used on the access network.

¹For information on network capabilities, see Do You Need a Broadband Remote Access Server, www.juniper.net/us/en/local/pdf/whitepapers/2000259-en.pdf

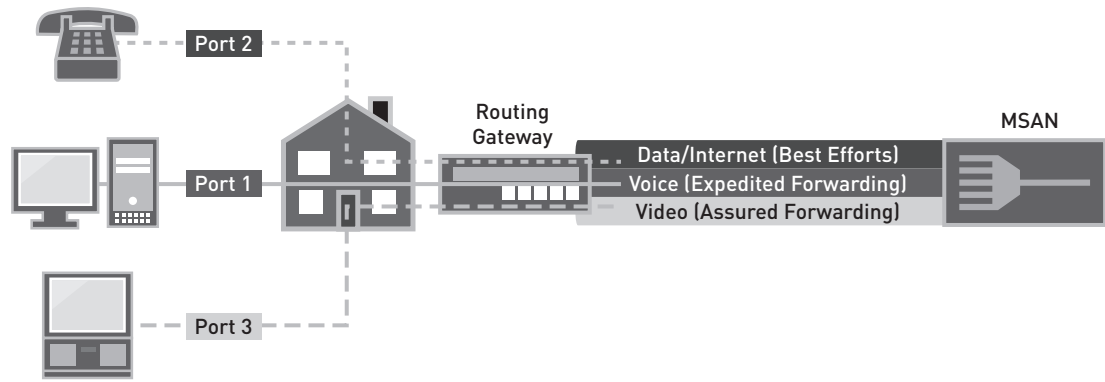


Figure 2: Device mapping

The key strengths of this solution include:

- Simple to understand. Each service has its own logical (VLAN) connection to the MSAN. This structure is the same regardless of whether there is an intermediate aggregation switch between the MSAN and the router.
- Low entry cost. The initial capital expense is relatively low since there is no need for a broadband services router (BSR). The trade-off is that the operator is often locked into a proprietary system and will pay more over the long haul for the MSANs, since they are doing more.

However, there are several challenges to this solution:

- Bandwidth carve-out. As depicted in Figure 2, bandwidth is “carved out” and dedicated to specific services, with each type of traffic assigned a specific priority level². For example, a 10 Mbps connection may have 8 Mbps allocated to IPTV. The remaining traffic is shared by voice and Internet traffic, with voice traffic marked as having priority over Internet traffic³.

There is no mechanism to protect against attempts to over-subscribe the network or local loop. Instead, the broadband operator restricts IPTV traffic by limiting the number and type of STBs which can be deployed within the home. The key design assumption is that the bandwidth required to support IPTV and voice will never exceed the total available bandwidth at any point in the network.

- Dedicated clients. Each port on the residential gateway (RG) in the home supports a specific service, e.g., port 1 is used for data and port 2 is used for TV service.
- One size fits all. Bandwidth is assigned based on application, with no regard for what each subscriber actually wants to do. The same bandwidth carve-out applies to all subscribers. There is no easy way to add additional applications as all bandwidth is typically assigned to existing applications.
- Difficult to add new services such as gaming. At the very least, every DSLAM must be programmed to support an additional VLAN and priority level. In many cases, there simply is no spare bandwidth to carve-out for an additional service.

The triple play model is widely deployed since it nicely supports simple best efforts Internet. It also supports high priority voice traffic, which will always get delivered since this is a small percentage of the overall traffic volume. This model has been extended to support IPTV by pushing MSANs and fiber closer to the subscriber, shortening the local loop to increase bandwidth. However, the growth of video on demand (VOD) and other unicast video and the need for multi-service clients are straining this architecture as the number and cost of MSANs increases at a faster pace than the revenue.

²IPTV is typically marked as “Assured Forwarding”, VoIP is designated as “Expedited Forwarding” and Internet traffic uses the default of “Best Efforts”.

³VoIP and Internet traffic may be carried on the same or separate VLANs.

Better: Enhanced Triple Play Network

In the enhanced triple play solution, most network capabilities required to support broadband communications are implemented in a centralized node in the data center, such as a Juniper Networks E Series Broadband Services Routers. This reduces operational cost over the traditional triple play model since there are fewer devices to update, configure and manage. It also yields a single operational model which supports any MSAN, regardless of the last mile technology or selected MSAN vendor. In addition, the MSAN adds a DHCP option 82 field to identify which subscriber (xDSL port or PON GEM ID) requested the IP address and forwards this information to the E Series. This allows the E Series to logically associate multiple IP addresses with a single subscriber, and centrally control traffic to each subscriber. Finally, adding a policy engine allows the operator to easily offer a different mix of services to different subscribers.

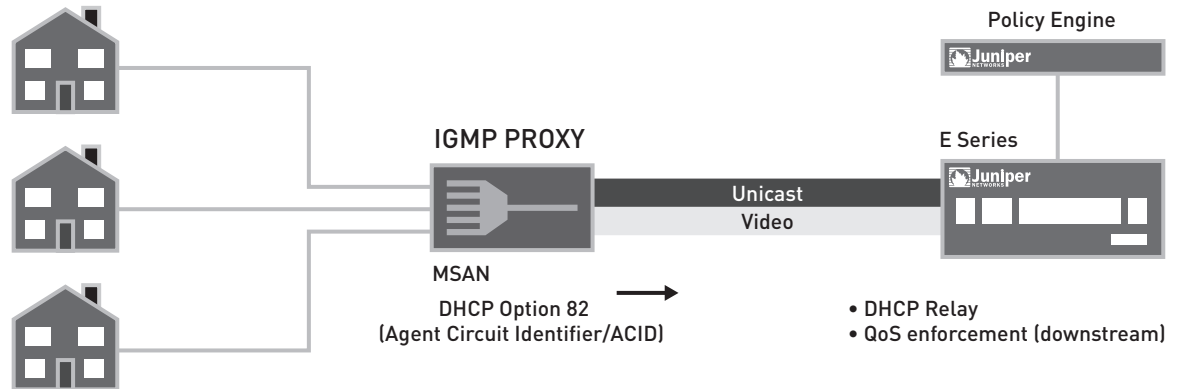


Figure 3: Enhanced triple play

The key strengths of enhanced triple play over the simple triple play model include:

- Lower operating expense via centralized operations. Centralizing the network intelligence—such as the ability to set/enforce QoS settings or comply with lawful intercept warrants—in an E Series Broadband Services Router reduces the overall operational cost. This becomes more critical as the number of MSANs and subscribers grows. For most operators, the operational benefits of deploying an E Series outweigh the incremental up-front costs.
- RADIUS integration. The E Series works with RADIUS servers to control access to services. For example, the E Series can prioritize voice over IP (VoIP) traffic if the subscriber pays for this service while transparently passing (or dropping) VoIP traffic from other subscribers. DHCP connections (instead of Point-to-Point Protocol over Ethernet) without an E Series typically do not support the advanced subscriber management functions available using RADIUS servers, and DHCP has not yet matured to support the same level of control.
- Enhanced subscriber management. Using a policy manager allows you to easily provide flexible service offerings and control network traffic. For example, subscribers can easily select from various bandwidth access speeds, or you can restrict bandwidth for certain types of traffic such as peer-to-peer. It also talks to other servers, such as a VoIP session border controller, to determine whether to allow the connections. This solution eliminates the “one size fits all” requirement of the original triple play solution.
- Better support for “over-the-top” applications such as Internet-based TV and gaming. DHCP option 82 identifies the physical MSAN port which originates each DHCP request, allowing the E Series to dynamically manage bandwidth to each subscriber. Since channel change requests are not forwarded by the MSAN, some bandwidth must still be carved-out for STB-destined traffic. However, all other traffic can share the remaining available bandwidth. This mitigates, but does not eliminate, the bandwidth carve-out issue with the previous solution.
- Improved security. Upstream untrusted traffic can be redirected to a security server as depicted in Figure 4. If the traffic is not a network attack, it is passed onward to the local or centralized video server, which responds by sending the requested content. If a threat is detected, the security device can notify the policy engine, which then shuts down the subscriber’s port.

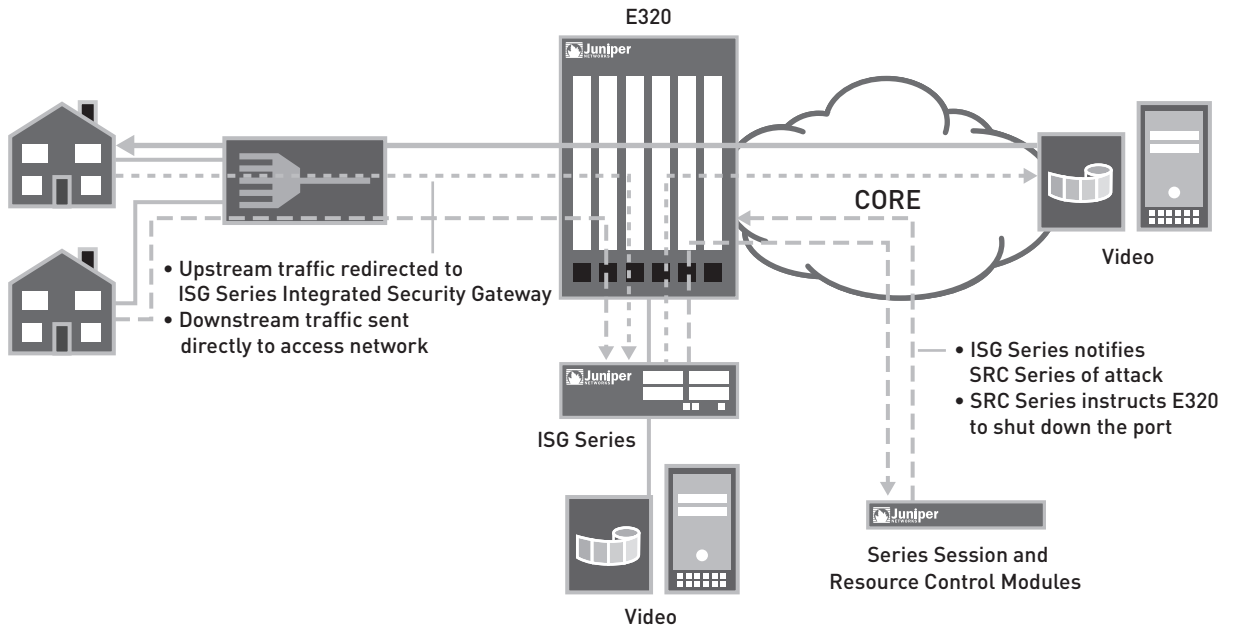


Figure 4: Broadband threat mitigation

Best: Multiplay Network

Building an enhanced triple play network is a step in the right direction, but does not provide the flexibility to support all services. Configuring the same hardware in a different way allows the network to dynamically adapt to support multiple services. This multiplay solution network treats all bandwidth to each subscriber as a pool which can be drawn from as additional services are accessed. This in turn ultimately leading to higher revenues, because the network can now support delivering more services to more devices. Equally important, since services are not dedicated to specific RG ports, any device can support any and all services.

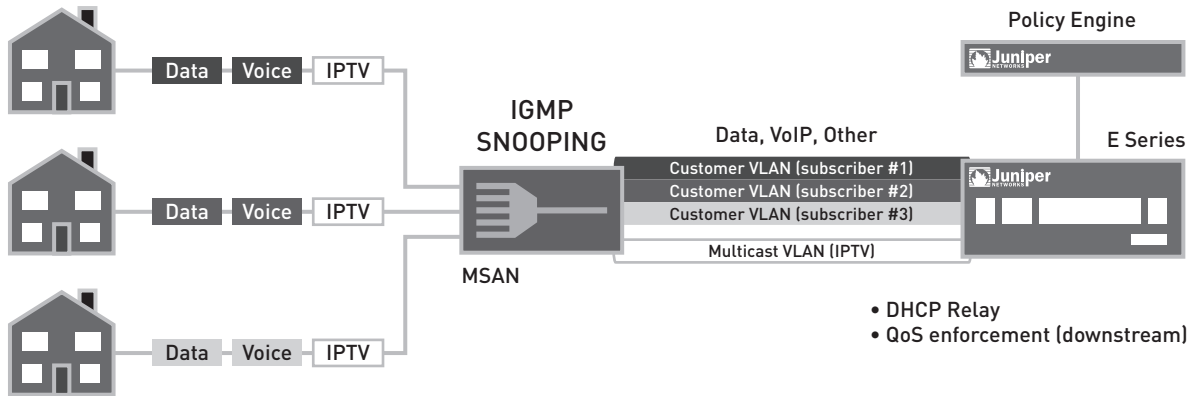


Figure 5: Multiplay access network

The key differences between multiplay and triple play are:

- A single VLAN carries all unicast traffic to a given subscriber. If most video traffic is unicast—including VOD, network PVR, Internet-based video streaming and Replay/Start-Over TV service—then this is all that is required. In this case, all video—even multicast IPTV—is carried to each subscriber in the same VLAN as all other traffic. If there is a significant amount of multicast IPTV, bandwidth efficiency is improved by adding a shared multicast VLAN that can carry multicast IPTV traffic to all subscribers. This is depicted in Figure 5.
- The E Series tracks which channels are being watched by each subscriber, allowing it to calculate the remaining bandwidth available to each subscriber for unicast traffic. To do this, the MSAN must transparently forward IGMP channel change requests upstream to the E Series. However, the MSAN can still respond to channel change requests to provide the best possible response time.

The multiplay architecture provides several benefits over the enhanced triple play solution:

- Any service to any client. A single client can support any service, since it is no longer tied to a specific RG port or VLAN. A subscriber can watch live TV, view video email from their college son asking for money, access the bank account to transfer funds, and bring up a phone directory to call and let him know that they money has been transferred—all from the same device.
- Support for more applications. Rather than pre-assigning bandwidth to each service, application servers can request bandwidth across the network as the subscriber accesses the application. For example, a subscriber with an 8 Mbps link may be able to watch four SD channels concurrently (at 2 Mbps each), or can view one high definition (6 Mbps) and still use one other STB to view SD content. In the enhanced triple play model, the subscriber was limited to just two STBs.

To support this, the policy manager communicates with application servers such as gaming systems, VOD systems, IPTV middleware and VoIP session border controllers to determine whether the network can support the request. It dynamically determines whether the application can be supported, and if necessary instructs the network to set aside bandwidth for this application to ensure that the subscriber is satisfied with the experience. Figure 6 illustrates this support with a VOD system.

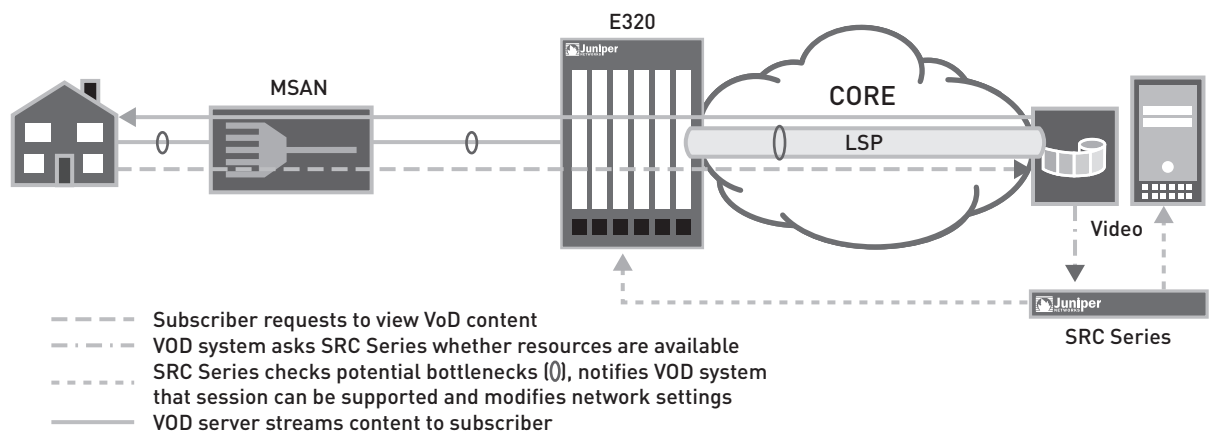


Figure 6: Video on demand call admission control

Solution Components

As broadband networks evolve to support multiple services, including more and more unicast IP video such as VOD, network reliability and scalability move to the forefront. As a result, Juniper Networks switches and routers are deployed in the world's largest broadband and IPTV networks. Key elements of Juniper's routing portfolio include:

- Juniper Networks JUNOS® Software is the world's first carrier class router operating system, offering the quality, features, reliability, security, and ubiquity required by the most demanding networks. The modular architecture of JUNOS provides full control over the router with protected processing resources for each function. With only one code train, JUNOS ensures continuity of features that work as expected, without problem, from the first customer shipment. The performance and integrity of JUNOS have been proven in the largest IP networks in the world.
- Juniper Networks MX Series Ethernet Services Routers enable telcos to profit from the tremendous growth of Ethernet transport with the confidence that the platforms they install now will have the performance and service flexibility to meet evolving customer requirements. The MX Series provides Ethernet switching without sacrificing the carrier-class routing features that our customers have come to expect from Juniper Networks. By extending the carrier-class routing functionality of JUNOS to include LAN switching functionality for migration and growth, Juniper brings its traditional advantages to Ethernet aggregation. Powered by JUNOS Software, the MX Series separates control and forwarding functions, surpassing the requirements of carrier-grade Ethernet switches as defined by the Metro Ethernet Forum.

⁴For additional information, see Juniper Networks MX Series Ethernet Services Routers, www.juniper.net/us/en/local/pdf/datasheets/1000208-en.pdf

- For those networks which must continue to support ATM and Frame Relay, Juniper offers the Juniper Networks M Series⁵ Multiservice Edge Routers. Like the MX Series, it is constructed with clean separation between the control plane, forwarding plane, and services plane, to support multiple services without compromise on a single platform—maximizing revenue and minimizing operational and capital costs. Services supported include a broad array of VPNs, network-based security, real-time voice and video, bandwidth-on-demand, rich multicast of premium content, IPv6 services, granular accounting, and much more. It supports current and emerging Layer 2 and Layer 3 services including the industry's most scalable and comprehensive Layer 3 VPN portfolio, featuring granular per logical interface quality of service (QoS), hardware-based IPv6, multicast, Network Address Translation (NAT), stateful firewall, and IPsec encryption. With models supporting from 8.4 to 320 Gbps, the M Series fits into any telco network.
- Designed to support the broadband edge, Juniper Networks E Series Broadband Services Routers are modular, carrier-class networking devices that deliver performance, reliability, and service differentiation to both business and consumer Internet users. The E Series models offer high port density, low power consumption, and fully redundant Internet access routing and edge aggregation. With 10 years of deployment in the world's largest broadband and IPTV networks, the software has been operationalized to minimize deployment time and operational complexity. For example, VLANs for each subscriber are created dynamically as each broadband subscriber begins to use the network.⁶
- Juniper Networks SRC Series Session and Resource Control Modules are a robust, customizable application that enables the rapid creation and deployment of new IP services to millions of subscribers. Available capabilities include a subscriber self-service web portal, which allows subscribers to dynamically make service changes; bandwidth-on-demand, which allows services such as video, gaming, or television programming to be given traffic delivery characteristics (QoS treatment) according to their needs; application admission control, in which the SRC Series determines whether sufficient resources are available to support a requested service flow; usage control, which tracks traffic to each subscriber and directs the subscriber to a portal to activate additional services or take other actions such as imposing rate limits on the traffic; and threat mitigation, which works with the Juniper Networks IDP Series Intrusion Detection and Prevention Appliances to detect threats, and which redirects traffic, filters the offending traffic, and/or notifies the Security Response team. The SRC Series supports standards-based interfaces such as SOAP/XML, RADIUS, Web services, CORBA, and LDAP to facilitate integration with diverse OSS applications.⁷

Juniper Networks ISG Series Integrated Security Gateways provide comprehensive and easy-to-use protection against current and emerging threats at both the application and network layers. Using industry recognized stateful detection and prevention techniques, they can be quickly and confidently deployed inline to effectively identify and stop network and application-level attacks before they inflict any damage—minimizing the time and costs associated with intrusions.⁸

Deploying Juniper Networks routers adds new levels of security, uptime, performance and operations flexibility to the network, with many systems and tools to assist platform introduction. With Juniper Networks routers, organizations can keep pace with their changing needs, satisfying the full set of requirements for secure and assured next-generation IP networks.

⁵For additional information, see Juniper Networks M Series Routing Platforms, www.juniper.net/us/en/local/pdf/datasheets/1000042-en.pdf

⁶For additional information, see Juniper Networks E Series Portfolio of IP Edge and Broadband Service Routing Platforms, www.juniper.net/us/en/local/pdf/datasheets/1000074-en.pdf

⁷For additional information, see C Series Controllers and SRC Software Modules, www.juniper.net/us/en/local/pdf/datasheets/1000195-en.pdf

⁸For additional information, see Juniper Networks Intrusion Detection and Prevention Solutions, www.juniper.net/us/en/local/pdf/brochures/1500025-en.pdf

Conclusion

There are numerous ways to build a broadband network which provide differing capabilities. These are summarized in Table 1.

Table 1: Summary of Broadband Models

	TRIPLE PLAY	ENHANCED TRIPLE PLAY	MULTIPLAY
Edge router	IP router(MX Series or M Series)	E Series	E Series
Optional elements	--	SRC-PE, ISG Series	SRC-PE, ISG Series
VLAN model	Service VLAN (N:1)	Service VLAN (N:1)	Customer VLAN (1:1)
Subscriber management	Static	Dynamic	Dynamic
Bandwidth management	No	No	Yes

As operators look to get the most revenue from every bit, the trend is towards implementing a multiplay network. This is true even for fiber to the home (FTTH) networks, since broadband operators typically limit the bandwidth to each subscriber to prevent it from becoming a commodity. Although these scenarios are presented as distinct solutions, there are multiple shades of gray. For example, only some MSANs support DHCP option 82 or can scale to support a unique VLAN per subscriber. Additional variations such as the need to support pre-existing PPPoX connections or installing a separate edge router for IPTV further complicate the decision process.

About Juniper Networks

Juniper Networks, Inc. is the leader in high-performance networking. Juniper offers a high-performance network infrastructure that creates a responsive and trusted environment for accelerating the deployment of services and applications over a single network. This fuels high-performance businesses. Additional information can be found at www.juniper.net.

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