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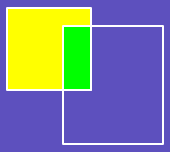
Building The Optimal Edge Network

Colorado Office
1317 Cherry Street
Denver, CO 80220
303.355.1982

Oklahoma Office
1307 South Boulder Avenue
Suite 120
Tulsa, OK 74119
918.382.0007

Texas Office
2208 Columbia Drive
Flower Mound, TX 75028
972.874.7791



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Service providers have seen tremendous changes in their networks due to rapid traffic growth and advances in technology the past few years. Significant capital investments have been made to modify and update networks to accommodate these changes. Unfortunately, the changes occur at such a rapid pace that it forces service providers to implement quick fixes that become obsolete in a short period of time. These quick fixes have placed a large amount of strain on their networks, particularly in the edge.

Putting Pressure on the Edge

Enterprises demand more from their service providers today than ever before. Demands range from simply connectivity and bandwidth to enhanced services and/or displacement services. Displacement services might include services that replace or interoperate with legacy services and/or with services that enterprises have traditionally employed as DIY (Do-It-Yourself) solutions.

These growing requirements typically add complexity to the service provider network, particularly the edge where much of the aggregation functions and intelligence reside. The list below identifies some of the most critical end-user requirements that have a significant impact on today's edge networks.

- **Higher Availability.** Corporate networks have become the lifeline of many enterprises, supporting mission-critical applications. Enterprises depend on their internal networks to communicate and conduct business with their suppliers, partners, customers, and internally between branch offices. Any network downtime can result in lost productivity and/or revenue. Therefore, service providers cannot risk having single points of failure or maintenance/upgrade processes that result in network degradation or outages.

- **Greater Flexibility.** The demand for different types of VPNs continues to grow. Enterprises may subscribe to a Layer 2 VPN service, a Layer 3 VPN service, or a combination of both where the end user chooses on a location-by-location basis the technology that best meets the needs of each location. In a hybrid solution, the network provides the interworking between Layer 2 and Layer 3 locations. Enterprise users need the flexibility to make these choices.

  As enterprises look for ways to increase their bandwidth, they are faced with limited bandwidth increment options. Many enterprises have outgrown their T1/E1 connections and need additional bandwidth. The next option from many service providers is a T3/E3 connection. T3/E3 connections are expensive, have limited availability, and oftentimes provide more bandwidth than what many businesses need. Therefore, the end users end up paying for much more than they use. Furthermore, provisioning a T3/E3 connection typically takes weeks, sometimes even months. As a result, many enterprises want the service providers to close the gap between T1/E1s and T3/E3s by offering multiple T1/E1 increments.

- **Better Security.** Enterprises express a high degree of concern about security, particularly with public IP-based services. Attacks on enterprise networks and websites have made security a top concern for IT managers. End users want assurance from the service providers that the networks have built-in enhanced security functions to protect enterprise data/content and control access security.

- **Rapid Service Delivery.** Enterprise networks are constantly undergoing change to keep pace with evolving business requirements, as well as application and technology advances. Enterprises are not willing to wait weeks for their service providers to provision new services/features or introduce new services. Thus, enterprises are demanding shorter service development and provisioning intervals from their service providers. The complex state of the edge network prohibits service providers from meeting this enterprise demand.

- **Lower Prices.** Along with more bandwidth options, enterprises want higher bandwidth speeds at lower prices. As bandwidth becomes more of a commodity, service providers feel the pressure to lower prices and/or offer value-added services for little-to-no additional charges to remain competitive. Pressure to lower prices requires the service provider to find ways to squeeze the cost out of network bandwidth, particularly in areas where there are opportunities for optimization. Optimization of the network edge allows service providers to achieve capital and operational cost savings, which they can in turn pass on to their customers.

The Service Provider's Painful Edge

Along with the enterprise demands discussed previously, other technology advances in both the access and core sections of the network have created challenges for service providers. A quick glance back in time helps explain how the edge network evolved into its current state. The edge layer is like a middleman in the network—it sits between the access layer and the core. It is responsible for exchanging traffic between these two layers. Technology advances in both the access and core has put much stress on the edge network.

Speeding up the Access Network

The access network has undergone significant changes in the last few years. The emergence of newly deployed broadband technologies such as DSL and cable has increased the overall speed of the access network. The access market went from having relatively low-speed dedicated access circuits to having new forms of broadband access. Consumers and enterprises alike welcome the emergence of new broadband technologies; however, this wide variety of access options adds layers of complexity to the service provider network. These new broadband options also require additional network components such as DSLAMs, subscriber management systems, and service management systems that service providers need to integrate and learn. In addition to these newer access technologies, the service providers continue to support traditional access methods such as dialup, ISDN, frame relay, and others.

The Core Network Busting Out at the Seams

The biggest change in the core network has come in the form of increased bandwidth. The growth of the Internet; convergence of voice, video, and data traffic in the core; increased reliance of enterprises on networks; and increased access speeds have all contributed to the resultant big, fat core network. Service providers build optical core networks with huge amounts of bandwidth using SONET and DWDM technologies. On top of these optical networks, service providers provision high-speed trunking facilities between their Layer 2 and Layer 3 switches/routers.

Impact on the Edge Network

The changes in the access and core have placed a whole new list of responsibilities on the edge network. Since it serves as the middleman between the two, it must quickly adapt and keep pace with the core and access. Without careful pre-planning and design, the edge can become a bottleneck between the access and core networks, as it has become in many networks today. Service providers have tried to minimize this bottleneck by patching their edge network together the best they could, with the devices available at that time.

The feature limitations and constraints imposed by purpose-built edge platforms have also played a role in today's highly complex network edge. More often than not, service providers compound their pain as they try to build edge networks with more intelligence using a mix of purpose-built solutions.

Specific types of equipment have been implemented to support the different protocols, traffic types, and services. This includes edge devices to support ATM, frame relay, IP, Ethernet, Layer 2 VPNs, and Layer 3 VPNs. These devices were deployed in the network to serve a specific purpose but add additional layers and complexity to the network. These devices have limited or no routing functions, which compounds the problem. Therefore, routers must also be installed to handle the necessary routing for the devices.

In addition, the many currently deployed edge platforms have difficulty scaling to meet the needs of the access and core networks. Some edge platforms are purpose-built to aggregate low-speed connections or high-speed connections, but not both. This then requires service providers to deploy multiple boxes to support a range of bandwidth options. Also, backplane and processing power limitations have an impact on the service provider's ability to scale its edge network.

Figure 1 shows a complex edge network composed of purpose-built platforms for different functions. This network has been a thorn in the side of many service providers, causing pain in different organizations at all levels.

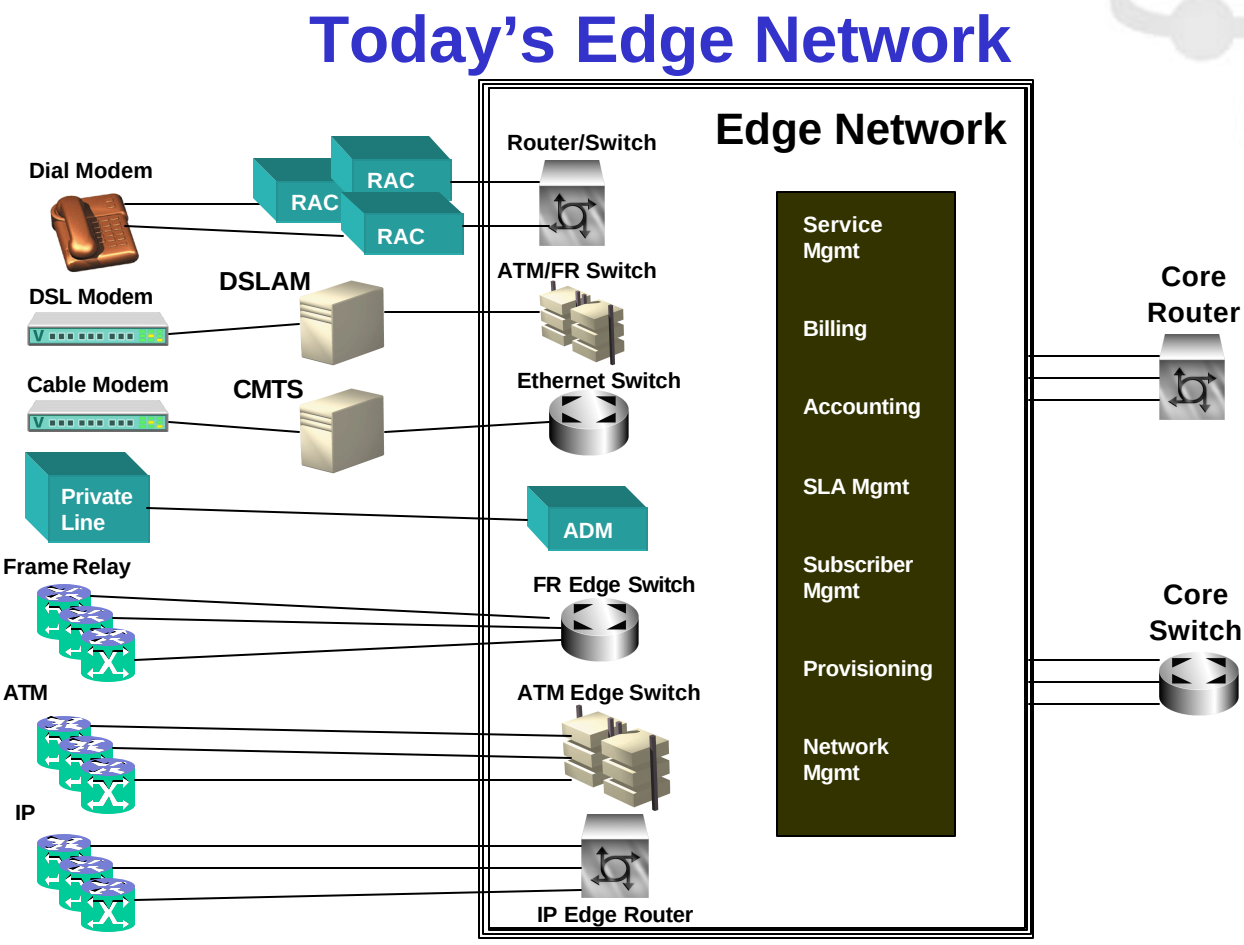

Figure 1. Today's complex network edge consists of many purpose-built devices to support different protocols, services, features, and bandwidth options.

Optimal Edge Platform's Foundation Elements

There is good news and hope for service providers. These service provider pains have led to new advancements in edge platform features and capabilities. As with any new technology, equipment vendors have their own unique solution and opinions on how to address the most important edge networking challenges. Service providers must carefully consider the features and capabilities of different devices and pick the best solution for their own unique needs.

This section concentrates on the deployment of routers at the edge of the network. Below are some guidelines for foundational elements for which service providers need to evaluate different edge router platforms. The following table also identifies how these foundational elements minimize or alleviate the pain mentioned in the previous section.

FOUNDATION ELEMENTS	DESCRIPTION	HOW IT ALLEVIATES PAIN
Scalable, Service-Rich Platform	The platform is built to support multiple services such as Layer 2 VPNs, Layer 3 VPNs, Ethernet services, Internet access, ATM, frame relay, and other IP services simultaneously and at scale. The platform offers a wide range of interface speeds from DS-0 up to SONET rates, including bandwidth increments between T1/E1 and T3/E3 using multilink. Multilink bonds individual T1/E1 connections to create a higher-speed link without the use of external inverse multiplexers. Services and features are supported consistently across interfaces and platforms.	**Simplifies the Network.** Scalable, service-rich platforms reduce the number of purpose-built devices in the network since they can support many services, protocols, and bandwidth options. It minimizes concerns about interoperability and interworking between different vendor products. **Eases Management and Maintenance.** A simple network edge makes maintenance and management easier as well. Troubleshooting capabilities improve, resulting in less frequent network problems, shorter problem resolution timeframes, and overall higher network availability. **Allows Rapid Service Introductions.** These platforms allow service providers to develop and launch services such as Layer 2 VPNs, Layer 3 VPNs, Internet access, Ethernet services, and others more quickly. It also enables service providers to offer migration or interworking features between the different services.
Built-in Enhanced Security Features	The edge platform inherently supports security features to prevent and suppress denial of service attacks. The platform should also support encryption to add another level of security, particularly for VPN services. It can support these features on a wide scale without any impact on performance or service quality.	**Simpler Security Design.** Built-in enhanced security features eliminate the need for purpose-built or adjunct security devices. **Prevent and Track Security Problems Quickly.** Inherent security features proactively protect the network from attacks. It also provides the service provider with tools to trace the attack to its source and stops it. **Improve Customer Comfort Level.** Enhanced security features improve the customers' comfort level with the service, makes the service more attractive, and provides a differentiator for the service provider.

NMS with OSS Integration	A single network management system that manages the edge network must easily integrate with the service provider's operational support systems using open APIs or XML.	**More Effective Service Delivery.** One network management system will simplify the entire process of managing the edge devices. Operations personnel will need to learn only one management system vs. multiple systems as in today's environment. It also improves overall service delivery and customer service as consistent information flows through the different back-office systems. This significantly improves provisioning time, trouble resolution, SLA reporting, and billing accuracy and timeliness.
High-Performance Processing Engines	The high-performance processing engines support comprehensive routing functions, multiple protocols, multiple services, and multiple security function ubiquitously across different interfaces. The end users do not experience any performance degradation as new services, features, and functions are enabled simultaneously.	**Less Trouble Tickets.** Operations spends less time troubleshooting performance degradation issues **Better Meet SLAs.** This feature allows service providers to meet SLAs regardless of the number of features enabled, number of customers, network size, or traffic volumes.
Provider-class, Redundancy Features	The edge platform should have redundancy built-in for both hardware and software. Hardware redundancy should include hot swappable cards for quick, non-interrupted replacement, redundant power supplies, redundant switching fabrics, and routing engines. Software redundancy should include back-up copies of software and extensions that allow communication even under severe duress.	**Improves Service Availability.** Redundancy in hardware and reliable software results in less network failures. This will reduce the number of customer problems and improves customer satisfaction. **Higher Availability SLAs.** Highly available edge networks allow service providers to offer higher availability SLAs. Service providers must have confidence in their network to offer SLAs, and enterprises gain confidence in service providers that offer them.

In addition to the many benefits mentioned, the optimal edge solution with its simplified network architecture composed of fewer devices to install and manage ultimately saves on both capital and operations costs. It also improves the overall return on investment as service providers can achieve greater revenue opportunities through the many new and incremental services the optimal edge platform can support. These financial benefits allow service providers to offer more cost-effective solutions and compete at more reasonable price points.

Figure 2 shows an implementation of an optimal edge router-based network. The foundation elements mentioned previously should help service providers evaluate different vendor platforms. Note that the combination of benefits of these foundational elements squarely addresses the enterprise requirements for higher availability, greater flexibility, better security, rapid service delivery, and lower prices.

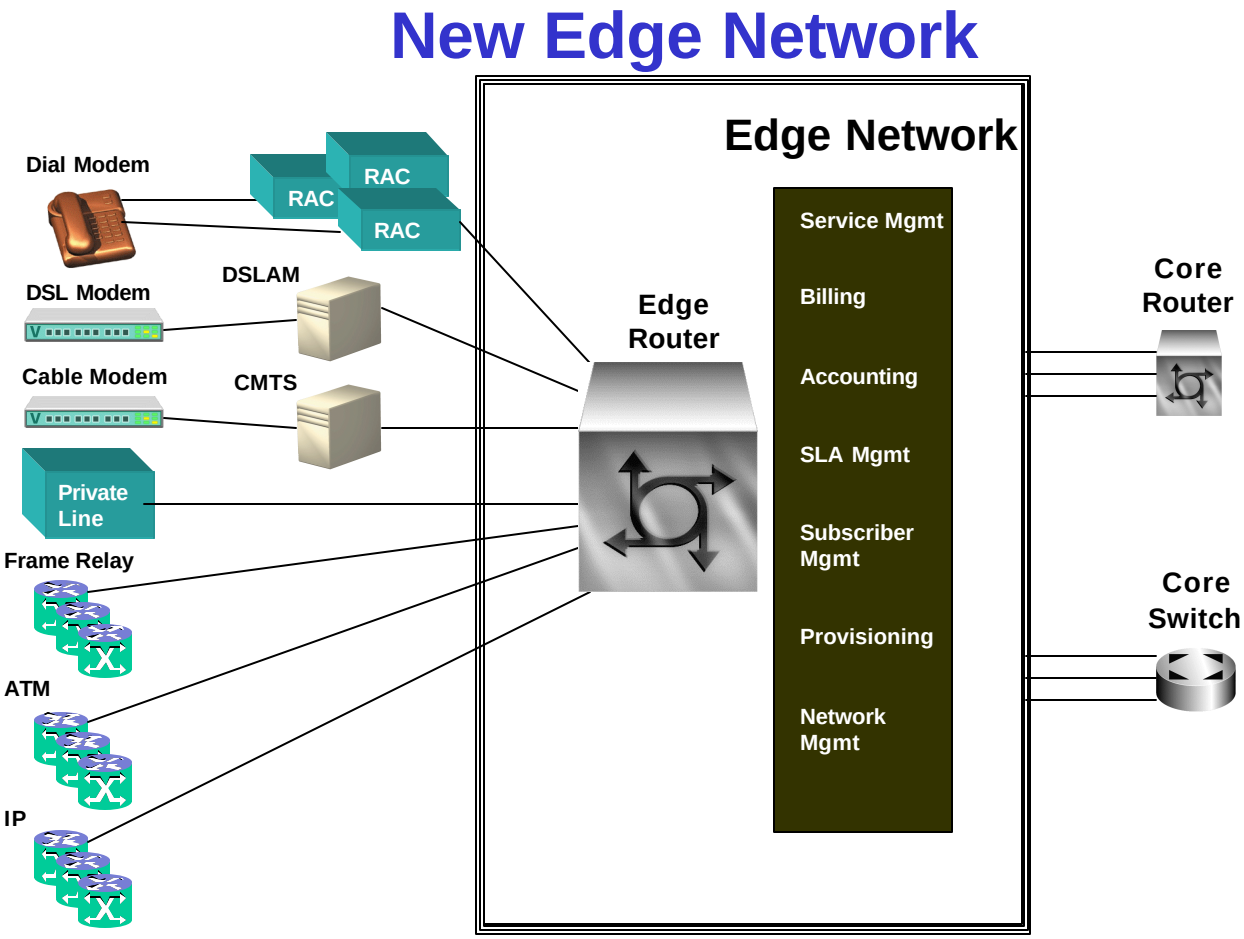

Figure 2. The optimal edge network has a much simpler design with an edge platform that embodies availability, flexibility, security, rapid service delivery, and lower prices.

The Juniper Networks Edge Solution

A number of technology vendors currently strive to satisfy all components of the optimal solution. The new Juniper Networks edge router, M40e Internet Router, seems to be the closest edge router-based solution at this point. The M40e is commercially available and ready for deployment.

The M40e provides a dense, highly redundant platform optimized for edge dedicated-access aggregation or mid-size core deployments. It allows service providers to target customers requiring higher-density access aggregation coupled with greater redundancy needed at the edge of the network.

The list below shows how the M40e allows service providers to meet the most critical enterprise requirements and alleviates many of the service provider's pains by providing the optimal edge solution's foundation elements.

Higher Availability

The Juniper M40e solution incorporates built-in redundancy in all critical areas of the router. Redundancy is included in the following areas:

- Switch Fabric
- Routing Engine
- Power
- Cooling

The M40e also has hot swappable physical interface cards that allow rapid replacement and minimal interruption of service when new cards are installed in the router. The M40e router is based on the proven M-series architecture. The Internet Processor II and operationally proven JUNOS Internet software position the M40e for quick deployments and stability.

Enhancements to JUNOS Internet software also improve availability by allowing communication with neighbor devices to continue even upon a routing protocol failure. This feature, called routing protocol Graceful Restart is based on available IETF drafts and allows the router to communicate to its neighbor that a process has failed, it is being restarted, and to continue sending data. The router can maintain forwarding during this period of duress. This provides a unique solution to routing software failures—a common cause of routing issues.

Greater Flexibility

The M40e has been designed to provide service providers with the flexibility needed to satisfy enterprise demands for different services and bandwidth options. The M40e can support a wide range of services including Layer 2 VPNs, Layer 3 VPNs, Ethernet services, and other IP-based services.

Physical Interface Cards (PICs) capable of supporting various speeds including DS0, T1/E1, NxT1/E1, DS3/E3, Fast and Gigabit Ethernet, all the way up to OC-48/STM-16 are available in the M40e. The M40e supports multilink capabilities, which enable service providers to provide bandwidth speeds between T1/E1 speeds and T3/E3 speeds. The 32 PIC slots can be mixed and matched, even within a single line card, based on service providers' needs. The M40e has greater than 40Gbps throughput capacity and uncompromising performance at OC-48 rates.

Better Security

Hardware-based filtering on all interfaces provides a fundamental key for building security policy, ensuring that packet filtering does not adversely affect other services on those interfaces. Source address verification, based on packet filtering, is supported to improve overall network security, particularly with regard to Denial of Service and anti-spoofing.

Service providers can also offer secure network-based VPN services. The M40e allows both Layer 2 and Layer 3 VPN services at high densities without any impact on routing performance or other service features.

A Physical Interface Card is also available for hardware-based IPSEC encryption. Capable of 1,000 tunnels per PIC, the card can be added to the chassis in multiples to increase tunnel support into the 1,000s. With 800Mbps of throughput per PIC, an M40e using the ES PIC terminates even the highest-speed dedicated access circuits up to OC-12.

Rapid Service Delivery

The M40e, using JUNOS software and the Internet Processor II, is designed to help service providers launch new services quickly and provision services rapidly. JUNOS software and the Internet Processor II are used on all Juniper M-series routers. This allows feature consistency across all M-series routers and all its interfaces and, as a result, reduces operational complexity. The deployment of Juniper routers in the edge as well as in the core of the network further improves the launch and provisioning time of services, as JUNOS works ubiquitously in both layers of the network.

JUNOS also works in conjunction with operating support systems through open APIs and XML, allowing service providers to utilize one network management system for all Juniper routers. Service providers can easily perform management tasks including fault, configuration, accounting, security, and performance. JUNOS can also be accessed for monitoring and configuring routers using an interactive command line interface.

Capital Cost Savings

An optimal edge platform that supports the foundation elements can help service providers save money, both capital and operations expenses, as previously discussed. A simple cost-saving analysis comparing two configurations using Juniper Network's M40e vs. a number of traditional platforms is shown in Figure 3.

This cost comparison provides an analysis for only a small subset of many parameters that make an overall impact on the total cost savings. It primarily takes into consideration box characteristics such as architecture, port density, redundancy, and types of interfaces. Therefore, depending on the configuration, mix of services/features, mix of bandwidth options, and number of customers, service providers can achieve greater cost savings than outlined below. These additional cost savings can come from more capital savings, lower operations expenses, reduction of space and power requirements, and capacity consumption efficiencies.

The two box configurations highlighted below for both the M40e and the traditional solutions are as follows:

1. Two OC-12 trunks supporting 12 DS3s' worth of end-user traffic, which equates to 50% trunk utilization.

2. Two OC-12 trunks supporting 24 DS3s' worth of end-user traffic, which equates to 100% trunk utilization.

These two configurations show how a service provider's network requirements might grow over time as the number of customers and traffic volumes increase.

PLATFORM CAPITAL COST COMPARISON

50% TRUNK UTILIZATION

	M40e		Traditional Solutions	
	Quantity	Total Cost	Quantity	Average Cost
Equipment Configuration				
Channelized DS3 ports (or 50% of uplink bandwidth)	12		12	
OC12 trunks	2		2	
# of Chassis	1		1	
Total Capital Costs		**$ 418,000**		**$ 549,500**

100% TRUNK UTILIZATION

	M40e		Traditional Solutions	
	Quantity	Total Cost	Quantity	Average Cost
Equipment Configuration				
Channelized DS3 ports (or 100% of uplink bandwidth)	24		24	
OC12 trunks	2		2	
# of Chassis	1		1	
Total Capital Costs		**$ 658,000**		**$ 895,050**

Assumptions:
List price for all platforms
Cost for traditional solution based on the average of two of Juniper's main competitors

Figure 3. Platform capital cost comparison between Juniper Network's M40e and traditional solutions.

Some key results of this analysis are as follows:

- The traditional solutions have less flexibility in scaling from the low- to the high-volume configuration. One of the traditional platforms required a larger chassis to support the configuration with higher traffic volumes.
- With the higher traffic configuration, the M40e has more available slots than the traditional solutions, even compared with the larger chassis of one of the traditional platforms. The M40e has the same or more available slots in the configuration supporting only 12 DS-3s.
- Service providers can achieve up to approximately 25% savings on platform capital cost.

Overall, the M40e's level of flexibility and scalability allows service providers to grow their networks easily and cost effectively, without having to worry about forklift upgrades of equipment.

Summary and Conclusions

Service providers face the challenge of minimizing capital and operations expenses while growing revenues. The edge network is one area that can help service providers meet this goal, as the edge of the network has become extremely complex and has room for further optimization.

Today's edge networks consist of a myriad of purpose-built devices to support various end-user service requirements. Optimization of the edge layer through the deployment of an optimal edge solution can minimize the number of devices deployed and simplify the network edge architecture, hence improving network and operational efficiencies.

The optimal edge solution has foundation elements that address the end users' requirements of higher availability, greater flexibility, better security, rapid service delivery, and lower prices. These foundation elements include: scalable service-rich platform, built-in enhanced security features, NMS with OSS integration, high-performance processing engines, and carrier-grade redundancy features.

In addition to simplifying the edge network and improving operational efficiencies, the optimized edge allows service providers to launch and provision services quickly, manage the network more effectively, offer more cost-effective solutions, improve and meet SLAs, and improve overall customer satisfaction. Furthermore, it saves on capital and operations expenses.

Juniper's M40e platform was designed with these foundation elements, the service provider's challenges, and the enterprise demands of the service providers in mind. With the commercial availability of this platform, service providers can finally begin optimizing their edge networks with a platform that is real and ready for deployment.

About TeleChoice

TeleChoice assists companies in creating new markets around innovative business models, technologies, products, services, and applications. As the strategic catalyst™ for the telecom industry, TeleChoice helps start or greatly accelerate the process of crystallizing a business or market strategy, value proposition, or differentiated position. Playing a strategic role, TeleChoice enables clients to launch new businesses, new markets, and new products and services rapidly and successfully.

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