

## Redback Networks

# SmartEdge 800 Service Gateway

### KEY BENEFITS

- ▶ **Session level reliability:** The only router that supports Non-Stop Forwarding and keeps Subscriber Sessions running uninterrupted during a Route Processor fail-over
- ▶ **Advanced software architecture:** Modular design provides stability and protects against crashes and protocol errors
- ▶ **Highly redundant hardware:** Engineered to carrier standards and deployed in carrier networks worldwide
- ▶ The only product in the industry that supports 64,000 active subscribers and more than 3,000 VPN contexts simultaneously
- ▶ **Unmatched subscriber scalability:** Supports 16,000 L2TP tunnels and 64,000 PPP or IP-DHCP subscriber sessions
- ▶ **Highly scalable routing platform:** Supports over 3000 contexts, over 1,000 BGP peers, and more than 2.5 million BGP routes
- ▶ **High performance programmable packet forwarding:** Based on a Packet Processing ASIC (PPA) developed by Redback
- ▶ **Familiar command line interface:** Simplifies provisioning and improves time to-market for new service delivery

**An integrated Service Gateway system for delivering third-generation broadband subscriber management functionality to deliver personalized triple play services to consumers and carrier-class IP services to businesses - all on a single platform.**

### Next Generation Platform for Delivering Triple Play Services - Video, Voice and High Speed Data to consumers

Days of simple data connectivity are over. Now, consumers are signing up for broadband communication services that offer a complete bundle of services from broadcast TV to Video on demand and from voice to online gaming to wireless. Moreover, consumers are willing to pay a price premium to providers that offer differentiated services based on each users unique needs. Clearly, offering the entire range of communication services tailored for every user is now a key element of broadband services.

Service providers too want to grow their revenue by fulfilling customers' new expectations by rolling out new services that the users are willing to pay for. However, these new services demand unprecedented levels of reliability, scalability, and security from the network elements, along with a mechanism to identify every user and deliver specific services that the user has signed up for.

### Access Divergence and Service Convergence

The Internet and intra-nets, running mission critical applications, have become essential business tools, creating a surge of demand for business-oriented services. Cost conscious businesses have also started migrating to lower priced DSL / metro Ethernet services in addition to the existing ATM / frame relay networks. Moreover, businesses want the new network interfaces to be backward compatible with their existing legacy interfaces. Thus, interface requirements on an edge router are increasing quickly.

Additionally, both consumers and businesses have started running similar applications such as VoIP that do not tolerate outages. They both demand more than 99.999% reliability and QoS guarantees. This service convergence means that an edge router has to provide very similar set of services to very dissimilar set of users.

### A True Converged Edge Router

While carriers want to cater to both these market segments to increase their revenues, limited available capital does not permit building two separate networks. Collapsing these two hitherto different networks into one single network that can offer a variety of services - saves both capital outlays as well as operational expenditures. As a result, providers are looking for next generation router that seamlessly combines Broadband Remote Access Server (BRAS) platform with an edge router. The days of building separate devices to deliver different services are clearly over.

Redback Networks, building upon its vast experience in building broadband aggregation systems, has delivered industry's first routing platform that offers unprecedented IP routing and VPN scaling and performance along with an impressive suite of third generation BRAS features, designed specifically for broadband based communication service delivery.

The SmartEdge® 800 Service Gateway is a true converged edge router targeted at Broadband Aggregation, video content delivery, Virtual Private Networks, IP Dedicated Access Services, as well as traditional edge routing functionality such as Lease Line Aggregation. The SmartEdge 800 can run all of these applications simultaneously, with unprecedented reliability, and has total flexibility to support new IP services in the future.



### System Architecture

Designed from the ground-up, the SmartEdge 800 platform is engineered for deployment in the most demanding network environments. Redback has invested heavily in building highly resilient hardware and software for the SmartEdge 800 products. The product was designed with availability, scalability, programmability, and high performance in mind. It supports 99.999% reliability, scales both physically and logically to thousands of sessions, is flexible enough to be upgraded to support new services, and can forward packets at line rate even with features enabled.

*“The SmartEdge 800 platform packs considerable performance into an extremely compact form factor.”*

All common equipment and line cards are hot swappable and critical components such as

the Route Processor can be put in service in redundant configuration. Innovative software enables fast failover to a hot standby Route Processor with no interruption to forwarding and near hitless software upgrades. The packet switching-mesh employs high-performance ASICs developed by Redback and is distributed to every line card, thus having no single point of failure. There is a dedicated processor for time critical I/O functions such as fault and performance monitoring and alarms. Power and return lines are diversely routed across the backplane to every slot in the chassis. The SmartEdge 800 platform packs considerable performance into an extremely compact form factor. The 15.75" chassis (9 Rack Units, 4 chassis per rack) has a packet mesh that delivers 240 Gbps (120 Gbps full duplex) of sustained packet forwarding. There are 14 slots in the chassis, two for route processors and 12 for line cards. High port densities allow providers to maximize the use of rack space and conserve power, both of which are significant contributors to operational expense.

Interface Type	Ports per Slot	Ports per Chassis
Ch OC-12 to DS3	1	12
Ch OC-12 to DS1/DS3	1	12
Ch DS3	12	120
Clear Channel DS3	12	120
Ch STM-1	3	36
Ch E1	24	288
Clear Channel E3	6	60
OC-12c/STM-4 (POS)	4	48
OC-3c/STM-1 (POS)	8	96
OC-48c/STM-16c (POS)	1	12
OC-12c/STM-4 (ATM)	1	12
OC-3c/STM-1 (ATM)	4	48
DS3 (ATM)	12	120
10/100TX Ethernet	12	144
Gigabit Ethernet	4	48
Gigabit Ethernet	10	120
Gigabit Ethernet (double wide)	20	120
10 Gigabit Ethernet	1	12

### System Feature Highlights

**Software modularity and process restartability.** The SmartEdge OS is highly modular to improve system reliability. Every protocol such as PPP, SNMP, BGP, OSPF, IS-IS, and RIP is implemented as a separate process. The Routing Information Base (RIB) and configuration UI are also separate processes. Failure of one process has no impact on any other process. For example, if a network event crashes BGP process it does not affect any other protocols and does not cause a system crash. If any process fails, it can simply be restarted without affecting any other process.

#### High-performance switching and programmable forwarding.

The SmartEdge 800 platform employs a very high-performance packet mesh, whereby every card is interconnected to every other card. The packet mesh has 240 Gbps of switching capacity and is built with ASICs developed by Redback. All of the packet forwarding functions in the SmartEdge 800 are implemented with Redback's specialized network processors, called Packet Processing ASICs (PPA).

The SmartEdge 800 platform uses a dedicated PPA on every line card for input packet processing and another dedicated PPA on every line card for outgoing packet processing. With dedicated packet processors for incoming and outgoing traffic, the SmartEdge 800 platform can support high-performance forwarding, with a rich set of packet processing features (ACLs, rate limiting, etc.) turned on, both on the access side (toward the customer) and the backbone side. Since PPA is fully programmable, new services can be introduced simply by reprogramming them with right software code. Thus, PPAs offer investments protection along with ability to add new functionality with virtually no hardware swap.

**Distributed forwarding.** Forwarding functions on the SmartEdge 800 platform are distributed on every line card and handled by the PPA. A failure of one line card has no impact whatsoever on packet forwarding for any other line card. Thus, there is no central point of failure for packet forwarding, even for specialized packet types.

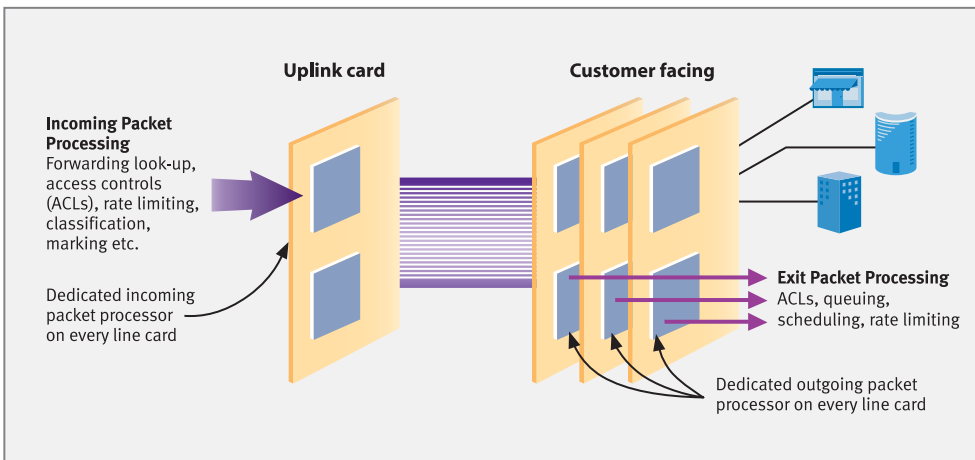
### Subscriber Management Feature Highlights

**Broadband aggregation.** Leveraging the vast experience and proven technology of Redback's SMS platform, the SmartEdge 800 platform supports the provisioning, aggregating, and servicing today's demanding broadband subscribers. Moreover, this third generation BRAS supports other applications such as VPNs and multicast content delivery. Thus service providers can offer next-generation services such as VPNs and streaming video to their DSL subscribers. SmartEdge 800 support all methods of subscriber encapsulation are supported, such as RFC 1483, RFC 1490, PPP over ATM and PPP over Ethernet. Wholesaling via L2TP or MPLS VPN is also available.

Moreover, going beyond DSL aggregation, SmartEdge products also support subscriber termination over cable and Wi-Fi networks, owing to its support for Client-Less IP Services (CLIPS).

**Quality of Service features.** The SmartEdge 800 platform has a full complement of packet processing features that can be used to enable IP services. These include extensive packet classification or filtering capabilities based on ingress port/circuit, source/destination IP address and/or TCP port or protocol. Packets can be marked per the Diffserv specification or the Type of Service bits can be set. Access Control Lists are supported to permit or deny packets based on the same filter criteria.

Quality of Service functions include ingress policing and egress shaping, whereby incoming and outgoing traffic are conditioned to



meet a mutually agreed upon traffic profile, typically a sustained bandwidth value plus a burst tolerance. The SmartEdge 800 platform also supports sophisticated queuing and scheduling. Each line card has extensive queuing capability and the number and use of the queues is configurable. Priority queuing (PQ) or Enhanced Deficit Round Robin (EDRR) is used in conjunction with policing and shaping to manage bandwidth. For congestion control, the SmartEdge 800 platform uses Random Early Detect (RED) and Weighted Random Early Detect (WRED), the two most commonly employed techniques available today.

**DSL Forum BRAS requirements.** SmartEdge 800 platform incorporates TR-59, TR-92 and WT-101 philosophy in the product design. Both ATM and Ethernet card capabilities are specifically designed to deliver advanced traffic management with hierarchical QoS and high queue count. Moreover, Redback's expertise in ASIC technology expedites delivery of these evolving service-oriented requirements on both ATM and Ethernet transport.

**Broadcast video delivery using leading multicast implementation.** The SmartEdge 800 platform also supports a complete suite of multicast routing protocols: IGMP, MSDP, PIM-SM, SSM. These protocols together with the hardware assisted multicast forwarding make for a superior multicast implementation, supporting very high fanouts. To protect link bandwidth and preserve the quality of multicast streams, network providers can also limit the number of members in a multicast group on a per-port basis.

**Virtual private network support.** Virtual private networks (VPNs) allow carriers to offer new services which leverage existing infrastructure investments. The SmartEdge 800 platform supports both Layer 2 and Layer 3 VPNs in conjunction with multiple contexts to create a flexible and powerful service offering. Each VPN gets its own IP address space, routing table, protected network traffic, user authentication, and other attributes. VPNs can be built across a carrier network with a variety of different technologies, including BGP/MPLS (RFC 2547bis), Layer 2 MPLS (draft-martini), and GRE tunneling. The customer can be terminated into the VPN with a variety of different methods, including

ATM, frame relay, Ethernet, and leased line. Because of the SmartEdge 800's support of virtual interfaces, customers can be easily switched between different types of VPNs with only one configuration line change.

### **Advanced Subscriber Management Feature Highlights**

**Session level reliability.** The SmartEdge 800 hardware and software support a hot standby Route Processor with fast fail-over and minimal to none interruption to forwarding. SmartEdge 800 products deliver industry's only router that can retain subscriber sessions and forward traffic,

often without dropping a single packet, even through the XCRP switchover. In this feature, SmartEdge platform is significantly ahead of competition.

Additionally, the Active Component Upgrade feature allows service providers to upgrade any individual module in critical situations without any impact on forwarding.

### **Management and Control Feature Highlights**

**Industry Standard CLI.** Redback has implemented an industry standard CLI, which makes it easier for the service provider to use existing pool of Network Engineers with minimal additional training for configuration of the SmartEdge platform. The CLI that provides an extensive command set to aid in provisioning and troubleshooting and allows operators to rapidly become familiar with the commands and configurations of the SmartEdge platform. A CLI session via a Secure Shell (or telnet) is the primary mechanism to configure a SmartEdge.

**SNMP.** The SmartEdge platform has an embedded SNMP agent, with support for SNMP v1, v2c and v3. The embedded SNMP agent can be used to collect statistics for both Enterprise and IETF standards based MIBs, and it can also be configured to generate SNMP traps.

**Bulkstats.** SmartEdge 800 platform implements bulkstats to provide a more efficient alternative to SNMP as a means of gathering network accounting statistics. The router samples and stores system, network, and traffic statistics at specified sampling intervals. The data are then sent at specified intervals as a text file via FTP to a network management station, allowing for easier network management.

**Traffic mirroring.** Traffic mirroring is a powerful tool for troubleshooting, lawful interception, and traffic analysis. Packets can be mirrored or sampled from any circuit in the system, at ingress or egress, and then sent to any other circuit on the system. Up to eight classes of packets can be specified, with each class being mirrored to a different output circuit.

### **Routing Feature Highlights**

#### **Routing protocols designed for availability, scalability, and flexibility.**

Recognizing that all of the routing protocol suites available in the open market lack high availability and high scalability characteristics, the SmartEdge OS was built from the ground up. The code is optimized for high availability and engineered for scalability to support next-generation requirements for peering and edge aggregation. It is also designed to accommodate new protocols such as MPLS and IPv6 with new encapsulations and Address Families.

**Support for multiple contexts.** A unique service enabling capability of the SmartEdge 800 platform is support for multiple routing contexts, which allow a provider to partition a chassis with software to create "contexts" or virtual routers. Each context appears to the service provider (and end customer) as a full-featured router with a console along with all of the monitoring and configuration features they would expect to see in a dedicated router. The use of contexts in combination with MPLS or GRE VPNs provides a powerful VPN model that allows for increased customer visibility into VPNs.

**Routing protocol interoperability and scaling.** Delivering IP services requires a complete set of scalable interior and exterior gateway routing protocols equipped with the latest feature extensions. The SmartEdge 800 platform supports BGP, IS-IS, OSPF, RIP and Static Routes as well as a Redback proprietary Dynamic Verified Static Routes DVSR. BGP features include Route Aggregation, MD5 Authentication, Route Reflection, Route Flap Dampening, Confederations, Communities, Peer Groups and new extensions such as BGP Refresh, Outbound Route Filtering, and BGP Graceful Restart. IS-IS features include: multiple levels, multiple instances (with redistribution between instances), load balancing and authentication. For any combination of route table size and peers, the routing protocols will offer unmatched convergence times.

### **Advanced Routing Feature Highlights**

#### **Non-stop forwarding by separation of control and forwarding plane.**

The SmartEdge 800 platform can support non-stop forwarding by continuing to forward packets even when the control plane is adversely affected by network instability or a protocol crash or restart. This is because routing and forwarding functions are strictly separated. The Route Processor is dedicated exclusively to processing route updates and calculating routes. Business customer traffic and SLAs are not affected by control plane transitions; instead, the network remains available.

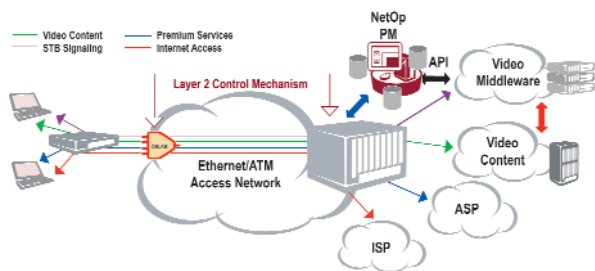
**Graceful restart.** The SmartEdge 800 platform supports graceful restart for BGP, OSPF, LDP, RSVP and IS-IS. Graceful restart is a mechanism which promotes high availability in the network and minimizes the impact of restarting routing protocols. Normally, when a protocol is restarted, a router's peers detect that a session went down and cause reconvergence throughout the network. The resulting route recomputation and network wide routing updates consume processing resources and potentially cause packet loss in transient forwarding loops. When graceful restart is supported, a router's peers do not immediately cause network wide reconvergence. The restarting router is given the opportunity to re-establish routing sessions and download fresh routes. Graceful restart works in tandem with the forwarding plane stability introduced by non-stop forwarding to support a new measure of control plane stability.

**Cross-connect support.** The cross connect features on the SmartEdge 800 platform allow network providers to offer premium services such as service insertion to end customers while minimizing both equipment expenditures and customer downtime. The SmartEdge 800 platform can locate specific packets within an end customer traffic flow and direct them toward separate networks.

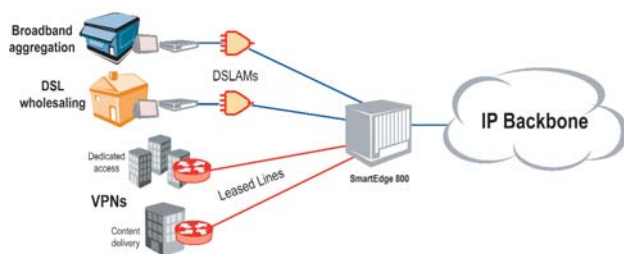
For example, all PPP over Ethernet packets can be sent to one network for standard Internet service, and all IPv4 and IPv6 packets can be directed toward a premium services network. Additionally, disparate media such as ATM and Ethernet can be cross-connected together so ATM PVCs could be aggregated into Gigabit Ethernet trunks. Layer 2 switching with virtual circuit pass through is also supported.

*"The SmartEdge 800 platform has a full complement of packet processing features that can be used to enable IP services."*

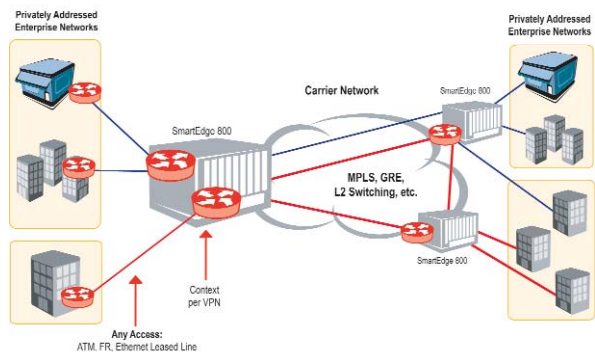
### DELIVERY OF BROADCAST VIDEO, A PREMIUM APPLICATION



### 3RD GENERATION BRAS



### VIRTUAL PRIVATE NETWORKS



### Delivery of Broadcast Video, a premium application

Premium Service Delivery such as delivering broadcast TV over broadband networks provides a means of adding higher revenue premium services to a standard Internet offering. All connections are terminated on the SmartEdge 800 platform. The SmartEdge platform can differentiate between different packet types within each physical connection, and route these different packets to separate destinations. Service providers do not need to terminate a separate physical connection to a premium services network. At any time, they can augment their standard Internet service with premium service. Both additional capital expenditures and customer downtime are therefore minimized.

### 3rd Generation Broadband Subscriber Management

SmartEdge 800 platform delivers the next-generation of broadband networks, with session level reliability, a new technology designed to provide uninterrupted broadband Internet services for voice, video, online multi-player games and other applications. SmartEdge platform advances the company's five-nines-reliability platform, giving carriers and service providers the ability to offer stronger service-level guarantees to customers with important mission-critical applications running over broadband.

### Virtual Private Networks (VPNs)

VPNs allow carriers to offer new services, which leverage existing infrastructure investments. The SmartEdge 800 platform supports VPNs, which can be provisioned across a network in multiple ways, including BGP/MPLS (RFC 2547), Layer 2 (draft-martini), and GRE tunneling. The SmartEdge 800's support of virtual interfaces allows customers to be easily switched between different types of VPNs. VPNs work in conjunction with multiple contexts to support separate IP address space, routing table, protected network traffic, and user authentication for each VPN. The customer can be terminated into the VPN with a variety of different methods, including ATM, frame relay, Ethernet, and leased line.

As can be clearly seen from the above examples, the SmartEdge 800 platform can simultaneously support services such as broadband aggregation, leased line termination, VPNs, content delivery, virtual routers (contexts), and differentiated traffic. All customers have access to all applications on the SmartEdge 800 platform. As a result, broadband subscribers can be members of enterprise VPNs or receive multicast content. Providers can therefore earn greater revenue by enabling advanced services for broadband subscribers as well as reduce equipment and management costs by offering services on a single platform.

## PRODUCT SPECIFICATIONS

### Hardware

#### Chassis

- 15.75" (H) x 17.5" (W) x 16" (D), four chassis per 7' rack.
- 19" and 23" rack mountable (front)
- 14 slots, 2 for Route Processors; 12 universal slots for line cards, Weight: 50 lbs unloaded; fully loaded chassis approx. 90 lbs.
- Connectors on chassis: Power A, B; dual BITS synchronization inputs and outputs; alarm output, status input.
- Backplane forwarding capacity of 240 Gbps (120 Gbps full duplex)

#### Cross Connect Route Processor (XCRP) Module

- 2 per chassis (1 working + 1 hot standby)  
Power PC 750
- 1.25 GB memory for XCRP-Advanced
- 768 MB memory for XCRP-Base
- PC card slot for Microdrive for secondary storage
- BITS clock sources (2) for external stratum clock inputs
- Stratum 3 Oscillator
- Management ports: 2 craft ports: DB-9 RS-232, Rear async modem port, Ethernet 10/100TX
- 1:1 redundancy for all common CPUs

#### Line Cards

- Dual Packet Processing ASICs (PPA); 1 for ingress processing, 1 for egress processing
- Fully meshed backplane using Redback developed packet meshed ASICs (PMA)
- Per card forwarding performance of 5 Gbps (2.5 Gbps full duplex) at a sustained forwarding rate of 5.5 Mpps

#### Card Types

- 1 port Channelized OC-12 to DS3
- 1 port Channelized OC-12 to DS1/DS3 (336 channels)
- 12 port Channelized DS3 (336 channels)
- 12 port Clear Channel DS3
- 3 port Channelized STM-1 (336 channels)
- 24 port Channelized E1 (336 channels)
- 6 port Clear Channel E3
- 4 port OC-12c/STM-4 (POS)
- 8 port OC-3c/STM-1 (POS)
- 1 port OC-48c/STM-16 (POS)
- 1 port OC-12c/STM-4 (ATM)
- 4 port OC-3c/STM-1 (ATM)
- 12 port DS3 (ATM)
- 12 port 10/100TX Ethernet
- 4 port Gigabit Ethernet
- 10 port Gigabit Ethernet
- 20 port Gigabit Ethernet (double wide)
- 1 port 10 Gigabit Ethernet card

#### Redundancy

- 1+1 for all common CPUs, clock and independent power to each line card
- Hot standby route processors
- Restartable routing processes (for example PPP, BGP, SNMP, etc.)

#### Operating Environment

- Temperature: 5 to 50 C degrees
- Humidity: 5-90% RH
- Power: -48 V DC

#### Compliance

- NEBS Level III in process, CE Mark, UL 1950, GR-63 Core, GR-1089 Core, ETS 300 386-2 FCC Part 15, EN5022 class A, ETS 300 386-2

### Software

#### Architectural Features

- Restartable processes, Non-stop forwarding, Hot standby Route Processors, Active Component Upgrade

#### Virtual Private Networks

- MPLS VPNs (RFC 2547bis), Carrier of carriers and Inter-AS VPN, Layer 2 VPNs (draft-martin), Transport Independent VPN (MPLS VPN over soft GRE), Multicast over MPLS VPN, GRE, Hard GRE

#### Broadband Subscriber Management

- RADIUS Authentication, Authorization, and Accounting (AAA), dynamic circuit binding
  - Supports up to 48,000
  - Subscriber level bridging
  - Dynamic / Static CLIPS

#### Encapsulations

- PPP/HDLC, cHDLC, Ethernet, IEEE 802.1q, RFC 1490 routed IP over Frame Relay, MPLS, MLPPP, 802.3ad, MFLR
- PPP over Ethernet (RFC 2516), PPP over ATM, RFC 1483 bridged and routed IP over ATM

#### Layer 2 Tunnel Protocol

- LNS
- LTS
- LAC
- 16,000 tunnels

#### Routing Protocols

- BGP-4 (RFC 1771), IS-IS (RFC 1195 & ISO/IEC10589), OSPF v2 (RFC 2328), RIP v2 (RFC 2453), VRRP (RFC 2338)

#### Multicast Protocols

- PIM-SM (RFC 2362 + IETF Draft), PIM-DM (IETF Draft), IGMP v1, v2, v3 (RFC 3376), SSM (RFC 3569), MBGP (RFC 2858), MSDP (RFC 3618)

#### MPLS Features

- Traffic Engineering, RSVP (RFC 3209), LDP (RFC 3036, 3478), Layer 3 VPN (RFC 2547bis), Layer 2 VPN (draft-martin), Transport Independent, multicast, carrier of carriers.

#### Quality of Service

- Packet classification (RFC 2474, 2475, 2597, 2598); DiffServ packet marking by ACL, ingress policing, or BGP attribute-based QoS; class-based ingress policing and egress shaping; priority queuing and EDRR; RED and WRED; MPLS E-LSPs (RFC 3270), per-subscriber ATM queueing.

#### Hierarchical Scheduling and Traffic Management

- Aligned with DSL forum's WT-92 and TR-59 specifications

#### Security

- Reverse Path Forwarding (RPF) check, SSH, MD5 support for routing protocols, key rollover, RADIUS, TACACS+, Administrative ACLs, packet mirroring and sampling.

#### Subscriber Awareness

- Subscriber Name, Session, IP Address

#### Address Management

- DHCP Relay, DHCP Proxy, IPCP parameter negotiation, IP pools, RADIUS assigned addressing

#### Advanced features

- Multiple contexts with intercontext routing
- Premium Service Insertion
- Cross connect support (for L2 traffic)
- Bulkstats
- Network Address Translation (NAT)
- Dynamically Verified Static Routing (DVSR)
- Policy routing
- Traffic mirroring
- Access Control Lists

#### Configuration and Network Management

- Industry familiar Command Line Interface (CLI) support via telnet or Secure Shell (SSH)
- Multiple user groups or access levels with definable access privileges
- User authentication via RADIUS, TACACS+, local file
- Transaction based configuration against a configuration database including commits, aborts and ability to roll back unintended changes
- NetOp EMS support for event logs, SNMP traps, interface statistics for troubleshooting and performance monitoring, port views and chassis views.

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