# 1 ERX System Overview

This chapter provides a general overview of the ERX system.



## Product Description

The Juniper Networks ERX system is a new-generation edge router built to address service provider challenges at the edge of the Internet. The system is the ideal platform for service providers who need to meet large-scale demands for IP access.

The system offers:

- Unparalleled port density to conserve scarce point-of-presence (POP) space and power
- Sustained wire-speed routing under the most demanding traffic patterns
- Exceptional reliability and availability to meet the requirements for strict service level agreements (SLAs)
- Support for multiple IP service classes to provide the foundation for virtual private networks (VPNs) and premium services deployment

## ERX System Models

The ERX edge routers are modular, carrier-class networking devices that deliver performance, reliability, and service differentiation to both business and consumer Internet users. The systems offer high port density, low power consumption, and fully redundant Internet access routing and edge aggregation. The ERX edge routers offer the complete edge solution for IP-optimized carriers.

Four models of ERX edge router are available:

- ERX-1440 system
- ERX-1410 system
- ERX-710 system
- ERX-705 system

All models use the same software. However, the specific model determines:

- The combination of line modules supported
- The total capacity throughput of the system

### *ERX-1400 Series*

The ERX-1440 system is a 14-slot system that manages an extremely high volume of network traffic, and uses the 40-Gbps switch route processor (SRP) module (SRP-40G). In this model, all line modules operate at full wire speed simultaneously.

The ERX-1410 system is a 14-slot system that manages high levels of network traffic, and uses the 10-Gbps SRP module (SRP-10G). You can configure the ERX-1410 system to enable the line modules either to operate at full line rate performance or to allow line modules to operate at a rate dependent on the resources available. The former option restricts the allowed combinations of line modules. For information on configuring performance of line modules, see *ERX System Basics Configuration Guide, Chapter 3, Managing Line Modules and SRP Modules*.

Externally, the ERX-1440 chassis is the same as the ERX-1410 chassis (see Figure 1-1 and Figure 1-2). Both systems contain 14 vertical slots to accommodate modules. Installation procedures and operating procedures are identical for both systems. All ERX systems use the same SRP I/O modules.

***Note:*** *The system may look different from the systems shown in the figures in this chapter, depending on the line modules in the slots.*

Internally, the ERX-1440 chassis differs from the ERX-1410 chassis, and includes a special midplane for the 40-Gbps SRP module.

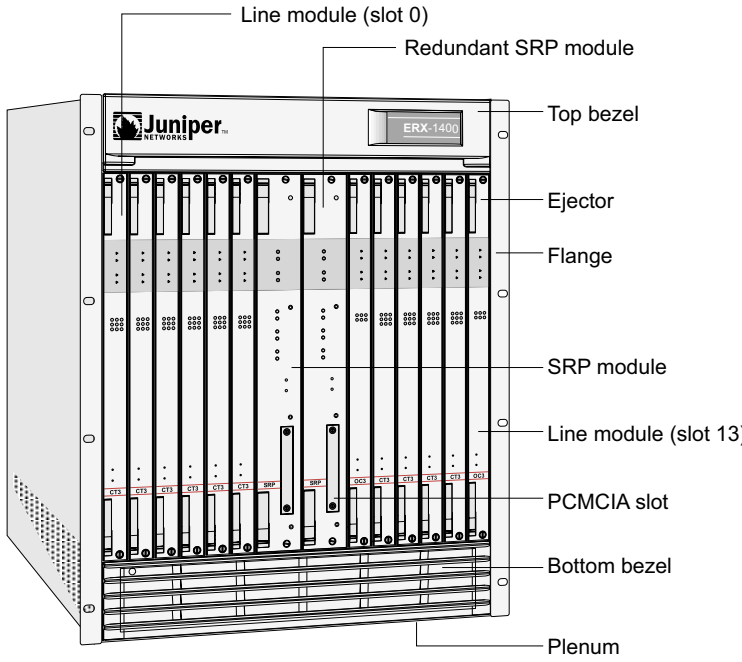


**Figure 1-1** ERX-1400 series front view

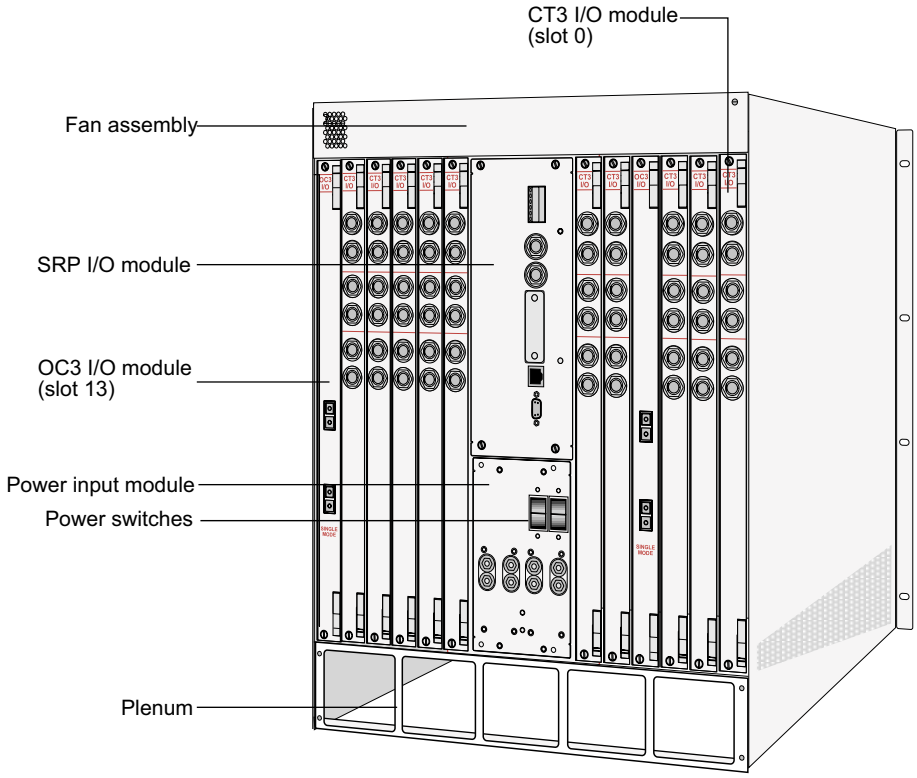


**Figure 1-2** ERX-1400 series rear view

*ERX-700 Series*

The ERX-705 system is a compact, high-performance 7-slot model that manages low-density traffic and uses a 5-Gbps SRP module (SRP-5G+). The ERX-710 system is a robust, high-density system that uses the 10-Gbps SRP module.

You can configure the ERX-700 series to enable the line modules either to operate at full line rate performance or to allow line modules to operate at a rate dependent on the resources available. For information about configuring performance of line modules, see *ERX System Basics Configuration Guide, Chapter 3, Managing Line Modules and SRP Modules.*

The ERX-705 chassis is the same as the ERX-700 chassis (see Figure 1-3 and Figure 1-4). The chassis contains seven slots to accommodate modules. Installation procedures and operating procedures are identical for both systems. All ERX systems use the same SRP I/O modules.

***Note:*** *The system may look different from the systems shown in the figures in this chapter, depending on the line modules in the slots.*

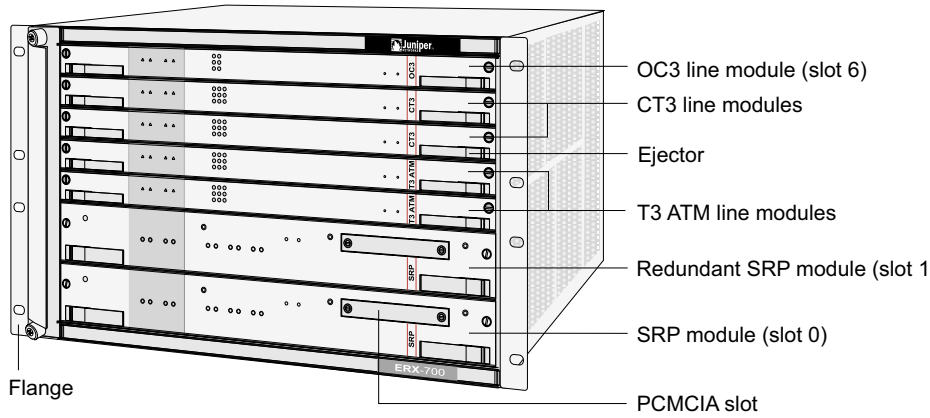


**Figure 1-3** ERX-700 series front view

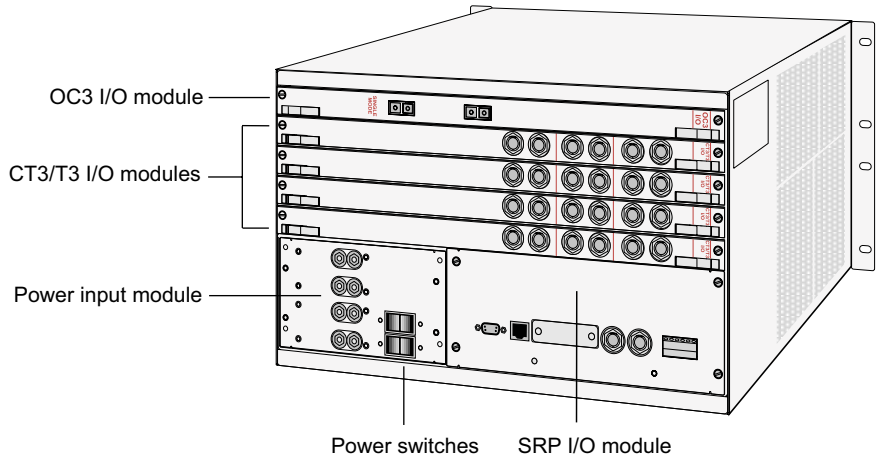


**Figure 1-4** ERX-700 series rear view

## ERX System Components

The ERX system consists of several components, including:

- A fan-cooled 7-slot or 14-slot chassis with a midplane architecture
- A distributed power system that adds power as modules are added to the chassis

- A high-performance SRP module with a 5-, 10,- or 40-Gbps switching fabric
- Line modules and input/output modules that support the system's distributed architecture
- System software that supports:
  - Full routing capabilities for BGP-4, IS-IS, OSPF, and RIP
  - Advanced routing support for MPLS
  - QoS policy control and enforcement for IP and ATM
  - IP traffic handling for multiple encapsulation types
  - IP session termination
  - Broadband Remote Access Server (B-RAS) features
  - IP VPN creation
  - IP wholesale support
- Network management systems' options for configuring, provisioning, managing, diagnosing, and accounting
- Complete documentation available in hard copy or CD-ROM and integrated online Help

The ERX-1400 series and ERX-700 series are edge routers optimized for the termination of high-speed physical and logical IP connections. The ERX platform enables service providers to deliver new higher-speed, service-differentiated IP connections to their subscribers with increased profitability.

Examples of the line modules that receive traffic into and forward traffic out of the system chassis are shown in Figure 1-5.

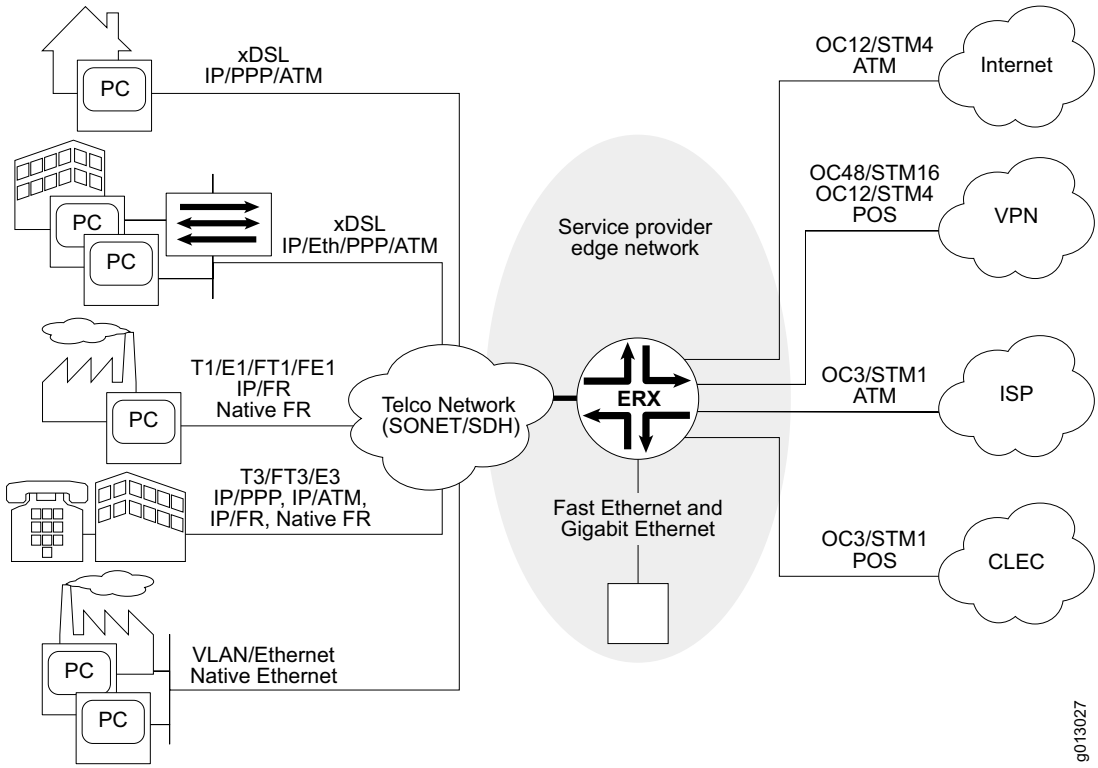


**Figure 1-5** The ERX system supports a variety of ingress and egress traffic types

The system is capable of handling all edge aggregation functions in its single high-performance platform. These functions include:

- Receiving ingress traffic and stripping the encapsulation method to retrieve native IP packets, or receiving native layer 2 packets (such as SNA/Frame Relay or Voice/Frame Relay) for encapsulation into IP for IP transport.
- Examining IP packets at wire speed in order to apply QoS, VPN, and routing policies.
- Gathering detailed statistics and accounting information on each packet.
- Routing IP packets into the network, through BGP-4, IS-IS OSPF, RIP, static routes, or MPLS or IP tunnels (L2TP, GRE).

A variety of ERX line modules and the protocols they support are identified in Table 1-1. Any line module can be used for ingress or egress without restrictions.

**Table 1-1** ERX interface types with transport protocol

| Physical Interface | Transport Protocol |
|---|---|
| Channelized T3 (T1, FT1, DS0)<br>Channelized T1 (T1, FT1)<br>Channelized E1 (E1, FE1) | IP/PPP, IP/Frame Relay, Cisco HDLC, native layer 2 |
| Channelized OC3/STM1<br>Channelized OC12/STM4 | IP/PPP, IP/FR, Cisco HDLC, native layer 2 |
| Fast Ethernet (10/100 Base-T)<br>Gigabit Ethernet (1000 Base-LX/SX) | IP/Ethernet, IP/PPPoE/Ethernet, IP/VLAN, PPPoE/VLAN, native layer 2 |
| HSSI | IP/PPP, IP/Frame Relay, IP/HDLC, native layer 2 |
| OC3c/STM1<br>OC12c/STM4 | IP/ATM, IP/POS, IP/PPP/Ethernet/ATM, IP/PPP/ATM |
| OC48 | IP/POS |
| Unchannelized T3/E3 | IP/PPP, IP/Frame Relay, IP/ATM, IP/PPP/ATM, IP/PPP/Ethernet/ATM, native layer 2 |

## ERX System Product Strengths

The most powerful product strengths of the ERX edge router include:

- Superior physical and logical density
- Wire-speed performance
- Scalability
- Carrier-class product design
- IP services, such as QoS, VPNs, security, flexible bandwidth, and routing
- Comprehensive network management

Each of these is briefly described in the following sections.

*Unparalleled Port Density*

The system offers a ten to one hundred times density improvement over current-generation solutions, with the industry's highest port density in an Internet edge device. A single ERX-1400 22.75-inch shelf supports more than 24,000 fractional T1 terminations and up to 100,000 IP interfaces, while drawing less than 25 Amps of power. Up to three shelves may be stacked in a standard 7-foot rack, ensuring optimal use of scarce POP space.

*Sustained Wire-Speed Routing*

Internet traffic studies have shown that nearly half the packets traversing the backbone are less than 44 bytes in length. These smaller packets, generated by Web-intensive applications, necessitate more packet per second (pps) performance to deliver wire-speed routing. Using an average packet size of 40 bytes, an OC3/STM1 (155 Mbps) line module running ATM must route more than 300,000 pps to keep the trunk full, while OC12 (622 Mbps) running ATM requires nearly 1.4 million pps of routing performance.

The ERX system implements a next-generation architecture relying on a combination of IP-optimized ASICs and standard RISC processors to deliver maximum wire-speed performance on all interfaces. This wire-speed performance is maintained even with all features in use, including statistics gathering, accounting, QoS policy enforcement, and routing.

*Scalability*

The system has a highly scalable design. As more line modules are added to a chassis, more packet-processing power is added on.

The ERX-1400 series and ERX-700 series support:

- Copper T1/E1 interfaces for T1/E1 and FT1/FE1 and support for up to 288 T1s and 6912 FT1s/FE1s per chassis
- Copper T3/E3 interfaces for unchannelized T3/E3 and support for up to 144 T3/E3s and CT3 support for up to 24,000 FT1s per chassis
- Channelized optical OC3/STM1 and OC12/STM4 interfaces for up to 12 OC12/STM4s, 48 OC3/STM1s, 144T3s/E3s, 4000T1s/E1s, 24,000 DS0s
- 48 OC3/STM1 ATM ports per chassis
- 48 OC3/STM1 POS ports per chassis
- 12 OC12/STM1 ATM ports per chassis

- 12 OC12/STM1 POS ports per chassis
- 12 Gigabit Ethernet ports per chassis
- 96 Fast Ethernet ports per chassis
- Up to 3 ERX-1400 chassis per 7-foot rack; 5 or 6 ERX-700 chassis per 7-foot rack (depends on hole-spacing in the rack)
- 100,000 independent IP interfaces, allowing service providers to deploy the system for IP session termination applications, such as aggregating the output from DSLAMs for broadband RAS (B-RAS) applications
- 100,000 PPP sessions per chassis
- 12,000 Frame Relay virtual circuits per chassis on the ERX-1400 series and 5,000 virtual circuits per chassis on the ERX-700 series
- 128,000 ATM virtual circuits per chassis
- Up to 1,500,000 route table entries
- Up to 1,000 virtual routers within a single ERX system to allow service providers to configure multiple separate, secure routers within a single chassis
- 400 BGP-4 peers and more than 1,500,000 routes for interaction with external networks, such as peer and wholesale networks
- 100 IS-IS adjacencies and 10,000 IS-IS routes for use by large service providers as the interior routing protocol to share route table information between routers in the same service provider network
- 100 OSPF adjacencies and 10,000 OSPF routes for use by large service providers as the interior routing protocol to share route table information between routers in the same service provider network
- Up to 64,000 individual queues to support six QoS service levels: Platinum, Gold, Silver, Bronze, Best Effort, and a Network Control level for management. Service providers can set the relative ERX buffer and bandwidth levels to define a series of service classes.
- 32 policy management rules per IP interface for traffic classification with support for up to 96,000 rules per system

*Exceptional Reliability and Availability*

The level of reliability required on IP networks is fast approaching the level that is currently available on the global voice network. In recognition of this trend, the ERX system is designed for continuous availability and consistent high performance to achieve the service levels required from carriers as more mission critical applications are added to IP networks.

Hardware Design

The ERX system supports full-logic and line module redundancy, hot-swap components, an innovative distributed DC power system, front-to-back airflow strategy, and is certified for Telcordia Technologies NEBS Level 3 standards. These features decrease the time and complexity of maintenance functions, while allowing service providers to confidently deliver network reliability guarantees as part of overall SLAs.

Software Design

Reliability is as much a function of software architecture as it is hardware. With this in mind, Juniper Networks engineers have implemented a high-performance modular, object-oriented software design. Each program module has access to dedicated system resources, including memory, packet buffers, and processor cycles. This approach improves stability and reliability by ensuring that the behavior of one module does not adversely affect others. When compared with the monolithic operating systems of first-generation routers, this approach provides more predictable behavior and reduces the possibility of overall system failure.

The combination of carrier-grade hardware and innovative software design helps decrease the time and complexity of maintenance functions, lowering overall operations costs and increasing subscriber satisfaction.

*Support for IP Services*

With the transformation of the Internet into a commercial infrastructure, the ability to provide differentiated services to users with widely varying requirements is becoming as important as meeting bandwidth demands. Service providers must be able to deliver a number of IP service profiles tailored to their subscribers, such as:

- VPNs
- Differentiated traffic handling

- Secure routing
- Varied bandwidth policies

To deliver these policy-based services, the system identifies critical data flows and defines profiles at wire speed for thousands of simultaneous subscriber flows.

The ERX system has inherent strength for IP QoS delivery that can prevent a low-priority application from monopolizing bandwidth, or prevent aggressive users from consuming network bandwidth and degrading the performance of other users. This capability differentiates premium and standard classes of Internet traffic, allowing service providers to work toward increasing reliability for their business subscribers, and away from the traditional "best effort" IP delivery system.

The ERX system's policy-based QoS allows service providers to increase revenues and strengthen brand recognition by offering tiered bandwidth, varied service levels, and pricing options. For example, one service offering may include a premium-priced *Gold* service, midpriced *Silver* service, and low-priced *Bronze* service. In addition, the system gives service providers the platform redundancy they need to offer SLAs with guaranteed performance.

The ERX system also gives service providers the capability to offer VPN services for wholesaling applications and corporate outsourcing. The system's VPN capabilities can also be layered with the system's QoS services to support specialized VPN services with delivery guarantees.

*Comprehensive Management Tools*

Some service providers estimate that they use more than 75 percent of their operating budget for ongoing network operations. We recognize three key facts:

1. Network management is often the most important long-term product consideration.
2. Service providers need to integrate new products into existing operational support systems (OSSs) and operational procedures that are already in place.
3. New customer-activated services drive down time to market for new services.

The ERX system offers a wide range of network management options, which include:

- Support for industry-standard command line interface
- An automated scripting language
- Full SNMP SET and GET support
- Leading-edge JAVA-based external management applications
- Integration into existing OSSs
- Leading-edge support for policy management, with a standard COPs-based management interface

The Juniper Networks management tools allow service providers to manage the network at the service and subscriber levels in addition to the element level, allowing for faster initial service creation and more proactive subscriber-based responsiveness.

## Applications Overview

The ERX system can be used for a number of edge aggregation applications: *Private line aggregation, VPN creation, xDSL aggregation application, cable subscriber management, VLAN implementation*, and *fixed and 802.11 wireless applications* are briefly described in this section. *Chapter 6, Applications Overview*, provides more detailed application examples.

A key benefit to the ERX system is that it offers service providers a single IP entry point into the network, allowing for multiple access lines and protocols, yet provides a common IP service offering.

### *Private Line Aggregation Application*

Service providers who want to offer high-speed Internet connections to their subscribers can achieve dramatic space, power, and management savings with the ERX system products. One system can support more than 24,000 FT1 terminations, with minimal power draw and maximum rack space to optimize scarce and expensive POP space.

The ERX system handles all edge aggregation functions, including:

- Stripping off the encapsulation method
- Examining the IP packet and applying routing, bandwidth, security, VPN, and QoS policies as defined by the service provider

- Routing the packet onto a POS or ATM link into the core of the service provider network with OC3/STM1 or OC12/STM4 or via a Gigabit or 100 Base-T Ethernet connection

*VPN Creation*

The ERX system can be used to offer either IP VPNs or layer 2 VPNs to existing T1, T3, VLAN, or xDSL customers. The ERX system supports a number of VPN technologies, including L2TP, GRE, IPSec, MPLS, RFC 2547, and MPLS Martini drafts, allowing service providers to offer outsourced VPN creation and management to a wide range of enterprise customers.

*xDSL Aggregation Application*

The next-generation architecture of the ERX system makes it the ideal solution for aggregating digital subscriber line access multiplexers (DSLAMs) onto the Internet backbone. Deployed by carriers in the central office or by service providers at the POP, the ERX system aggregates data traffic from multiple DSLAMs from any vendor-specific DSL implementation. The ERX system is ideal for service providers who are faced with the challenge of a mass-market xDSL deployment.

Carriers, such as incumbent local exchange carriers (ILECs) and competitive local exchange carriers (CLECs), can deploy the ERX system and offer wholesale DSL connection services to their service provider and corporate or consumer subscribers. Additionally, service providers can use the system to concentrate Internet subscribers from a set of carriers.

Although most vendors view DSL as a consumer service, we recognize that corporate DSL users have different needs. The system's unique IP QoS capabilities allow service providers to provide differentiated services to DSL subscribers. For telecommuters, a premium DSL service may be preferable to a one-size-fits-all consumer-oriented service. In addition, all service classes benefit from the wire-speed forwarding performance, especially under heavy traffic load.

Unlike most Broadband Remote Access Server products, the ERX system is a fully featured first-generation router, and does not require an additional routing device to connect subscribers to one network.

*Cable Subscriber Management Application*

Multiservice operators (MSOs) offering high-speed, broadband Internet access services as well as new, advanced IP services to their subscribers will benefit from the next-generation architecture of the ERX system.

MSOs in regional or “super” headend locations can deploy the ERX system to aggregate traffic from cable modem termination systems (CMTSs) for access to the Internet backbone. The system simultaneously aggregates data traffic from existing and future cable networks by supporting both data-over-cable service interface specifications (DOCSIS) and non-DOCSIS networks.

*VLAN Implementation*

The ERX system offers a significant advantage to service providers who use its powerful virtual LAN (VLAN, IEEE 802.1q) capabilities. VLANs let service providers logically segregate subscribers and their traffic on a shared interface, such as Gigabit Ethernet or Fast Ethernet.

The ERX system delivers the densest, most feature-rich implementation in the market, allowing service providers to create separate services and policies per VLAN customer.

*Fixed and 802.11 Wireless Applications*

Fixed wireless applications refer to the operation of wireless devices in homes and offices, and in particular to equipment connected to the Internet via specialized modems. Common examples of wireless equipment in use today include cordless phones (not to be confused with cell phones), satellite television, and wireless LANs.

The ERX product family is the first fixed-wireless local loop (WLL) subscriber access platform to deliver the performance, density, and scalability for comprehensive IP service delivery in large-scale fixed-wireless deployments. The ERX platform combines subscriber-access functions with Tier-1-class routing and innovative IP QoS to enable service providers to offer and deliver new, competitive IP services to their fixed-wireless subscribers.

Especially innovative is the client-based and clientless support that the ERX system offers.

## Standards Support

The ERX system software set supports a large number of IETF and IEEE standards, including the key directives for IP, BGP-4, IS-IS, OSPF, RIP, SNMP, PPP, ATM, Frame Relay, VLAN, multicasting (PIM, MBGP, DVMRP, IGMP) and SONET/SDH. In addition, the system supports emerging IP QoS standards for DiffServ and Multiprotocol Label Switching (MPLS).

***Note:*** *The individual RFCs are detailed in the specific software sections in Chapter 3.*

The ERX-1400 series and ERX-700 series are certified NEBS and ETSI Telecom switching gear. The systems are designed to comply with the international standards listed in Table 1-2.

**Table 1-2** International standards compliance list for ERX system

| Certification Type | Standard |
|---|---|
| Safety | IEC 950 (Asia), AS3260 (Australia and New Zealand), CE Mark (Europe), EN 60825-1 (Europe), EN 60950 (Europe), UL 1950 and CUL 950 (US and Canada) |
| EMC | EN 55024 (Europe), GR-63 and 1089 (US and Canada Telcordia) |
| EMI | AS3548 (Australia and New Zealand), EN 55022 (Europe), CISPR 22 (Europe), VCCI (Japan), FCC Part 15 A/B (US and Canada) |
| Telecom | Telecom Directive (Europe), JATE (Japan), NEBS GR-63 and 1089 Level 3 (US and Canada), FCC Part 68 (US and Canada), IC CS-03 (Canada), |