Broadband Services Router 64000
BSR 64000

Cable Modem Termination System and Router

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Motorola's Broadband Services Router 64000 (BSR 64000) is a high-density, fully redundant Cable Modem Termination System (CMTS)/intelligent edge router that allows broadband operators to rapidly introduce differentiated data, voice, and multimedia services for both corporate and residential subscribers. It also offers the robust routing, flexibility, and scalability required to support the emerging generation of revenue-generating services, such as Voice over IP (VoIP) and Virtual Private Networks (VPNs).

The BSR 64000 is based on a distributed architecture and offers hardware-based filtering and forwarding to ensure high-performance throughput. It allows operators to deliver measurable Quality of Service (QoS) levels end-to-end across broadband access, metropolitan, and core networks. Broadband providers can deliver per-flow QoS to offer guaranteed Service Level Agreements (SLAs).

The SmartFlow™ features of the BSR 64000 perform content-aware packet classification through Layer 4 to provide unprecedented QoS flexibility. Since all the processing-intense filtering, forwarding, accounting, and QoS/SLA functions are performed in hardware at wire-speed, the BSR 64000 reduces latency to a fraction of that commonly found in legacy software-based routers.

The BSR 64000 is deployed in the distribution hub and brings advanced intelligence and sophisticated routing to the edge of the broadband network. It supports Multiprotocol Label Switching (MPLS), and enables cable operators to support open access and multiple service provider applications. With the MPLS features of the BSR 64000, operators can also offer VPN services to commercial customers. The BSR 64000 also offers Advanced Spectrum Management features that allow cable operators to increase throughput, reclaim bandwidth, deliver additional services, and generate new revenues from the existing cable plant.

> *The Broadband Services Router 64000 (BSR 64000) provides broadband carriers with a competitive edge in defining, deploying, and managing broadband services.*

FEATURES INCLUDE:

- Fully redundant, carrier-class system architected for "five-nines" (99.999 percent) availability

- Based on open systems standards, the BSR 64000 is Data Over Cable Service Interface Specification (DOCSIS) and EuroDOCSIS 1.1-qualified, PacketCable 1.0-qualified, and compatible with DOCSIS 2.0 and Euro-DOCSIS 2.0

- Advanced Spectrum Management featuring an integrated, intelligent spectrum analyzer ensures reliable and high-quality service delivery, and enables efficient migration to DOCSIS 2.0

- Wire-speed forwarding

- Carrier-class intradomain, interdomain, and multicast routing with OSPF v2, RIP v1 and v2, BGP4, IS-IS, VRRP, IGMP, IP Tunneling, DVMRP, and PIM-SM

- SmartFlow QoS classification for thousands of flows at wire-speed with guaranteed SLAs

- Virtual Private Networking and open access support with policy-based routing and full-featured MPLS

- Carrier-class reliability and robust QoS control enables support for real-time VoIP services

A Next-Generation Multi-Service Platform

The BSR 64000 is DOCSIS and EuroDOCSIS 1.1-qualified, PacketCable 1.0-qualified, and compatible with DOCSIS 2.0 and Euro-DOCSIS 2.0.

It is a fully redundant, carrier-class, intelligent edge router with an integrated, high-density CMTS for Hybrid Fiber Coax (HFC) connectivity. The BSR 64000 includes an internal RF matrix switch to provide the CMTS redundancy and resilience necessary for demanding, mission-critical applications delivered over cable infrastructure.

The BSR 64000 delivers the per-flow packet treatment needed to enable end-to-end SLAs across broadband access networks—including handoffs to metropolitan or core networks using DiffServ and/or MPLS. It is PacketCable 1.0-qualified and supports important standards for packetized voice services, including Dynamic QoS (DQoS), Common Open Policy Service (COPS), IPsec, and the Communications Law Enforcement Act (CALEA) for legal intercept.

The BSR 64000 allows operators to efficiently manage impairments on the HFC network so they can continuously optimize performance, create bandwidth, and efficiently migrate to DOCSIS 2.0 while leveraging investments in deployed DOCSIS 1.0 and 1.1 cable modems.

Advanced Spectrum Management features allow operators to optimize throughput and cancel out or avoid impairments. This includes innovative features such as ingress noise cancellation, post-equalization, sophisticated noise measurement, and noise avoidance capabilities.

The BSR 64000 is a high-performance, intelligent edge router that performs sophisticated traffic grooming and forwarding in a distributed fashion at the periphery of the broadband access network to enable end-to-end service delivery across access, metropolitan, and core networks.
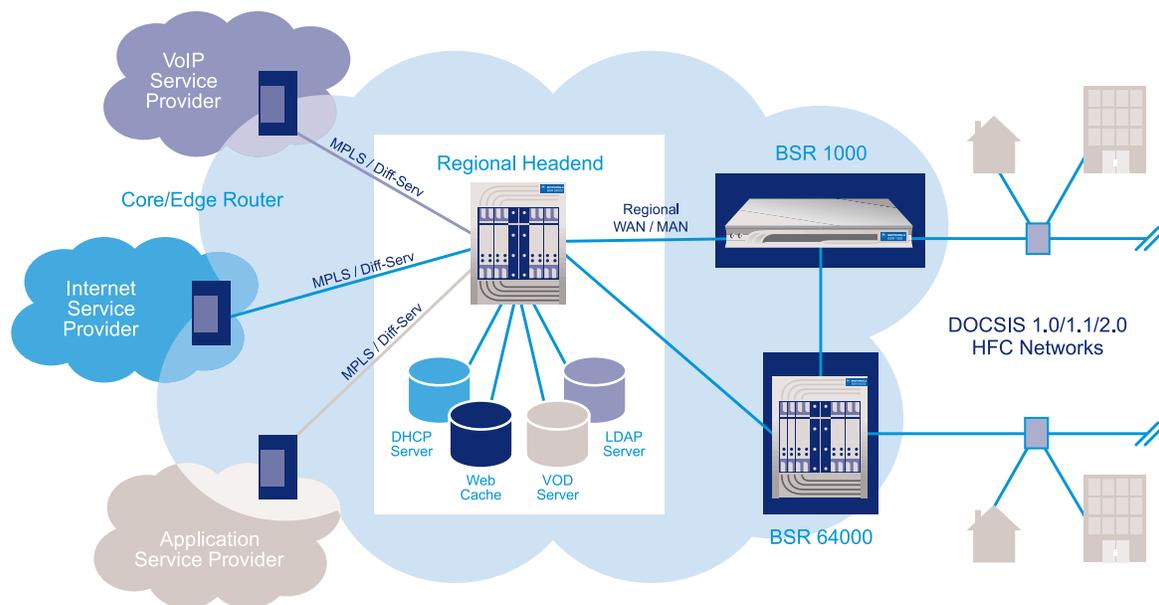
High-Performance, Redundant, and Cost-Effective Routing

This high-density platform streamlines operations and management. The BSR 64000 can support up to 24 downstream transmitters and up to 96 upstream receivers in a single, space-saving chassis.

The system includes flexible interfaces for Gigabit Ethernet, 10/100 Ethernet, and SONET/SDH connectivity and it eliminates the need for discrete CMTS equipment, up converters, aggregation switches, and routers. The BSR 64000 offers unified management of routing, QoS and CMTS functions and it scales economically to meet ever-increasing subscriber demands and the introduction of new services.

The BSR 64000 design is based on centralized routing table calculations and distributed forwarding, and it provides the benefits of simple configuration (single router appearance), scalable performance (each additional line card brings an associated forwarding engine), and low cost-of-entry (operators only purchase the forwarding power required). It can be deployed to consolidate traffic flows on the broadband access network and provide access to metropolitan networks and the core networks of one or more providers. High-speed interfaces allow connectivity to local servers so operators can efficiently distribute content, services, and applications over the access network.
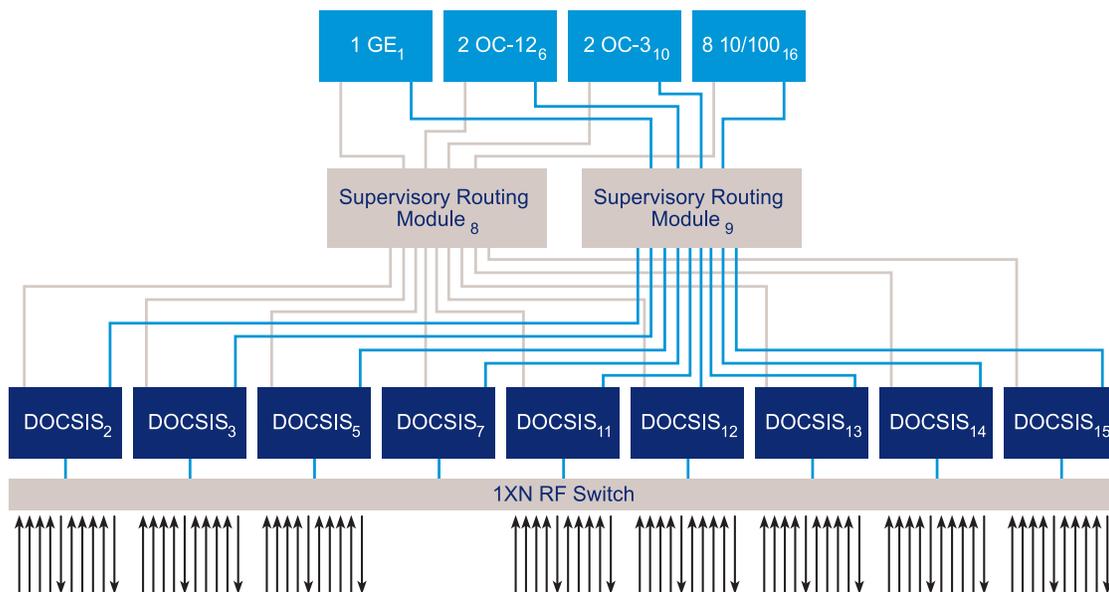
Unprecedented SmartFlow QoS and Multi-Service Support

Broadband access networks are the foundation for new classes of entertainment and business services, including: IP telephony; interactive, multiplayer gaming; on-demand music, audio and video; tiered-data services; VPNs; and application hosting. Provisioning these services over a shared media requires robust QoS control to deliver the fine levels of service granularity required for real-time applications.

Traditional solutions lack the wire-speed QoS capabilities, density, ingress noise cancellation, spectrum analysis, and scalability required for large-scale deployment. The BSR 64000 with SmartFlow allows per-flow policing and traffic shaping at wire-speed to provide unmatched abilities to offer customized QoS levels and guaranteed SLAs. Among the QoS parameters that can be included are:
· Maximum Available Bandwidth (MAB) per application
· Configured Active Percent (CAP)
· Constant Bit Rate (CBR)
· Maximum bandwidth allocation for sustained traffic flows or bursts
· Minimum bandwidth guarantees with measurable Committed Information Rates (CIRs)
· Bounded delays
· Minimal packet loss guarantees

Operators can deliver measurable and guaranteed QoS from the subscriber to the core backbone networks of multiple providers of services, applications, and content. SmartFlow allows operators to classify packets into flows based on packet content and provide the appropriate QoS treatment for each flow using DOCSIS for the upstream HFC network, hierarchical per-flow queuing for the downstream HFC network, and DiffServ or MPLS for the metropolitan and core networks.

Innovative and Redundant System Architecture

The BSR 64000 architecture optimizes performance and reliability by centralizing routing table calculations while distributing packet-forwarding functions. The system offers high levels of redundancy, including a redundant CMTS capability and redundant Network Interface Cards, controllers, power, and fans.

The next-generation, 16-slot, NEBS-compliant chassis has been designed to deliver advanced services while ensuring investment protection by enabling support for potentially higher densities in the future. The BSR 64000 has a midplane architecture that enhances serviceability by decoupling functional hardware modules from the physical I/O and connectivity. The midplane provides the physical paths used for interslot communications and includes the switch fabric cross-connect paths used by the data plane and a management bus used by the control plane.

The midplane design simplifies support and reduces Mean-Time-To-Repair (MTTR) by separating the front logic cards from the passive rear I/O cards, thus eliminating the need to change cable connections. The chassis provides dual redundant power connections for -48V DC power, and the BSR 64000 supports hot-insertion and removal capabilities. The slots can be populated with three types of hardware modules: the Supervisory Routing Modules (SRMs), the Network Interface Modules, and the DOCSIS or EuroDOCSIS modules.

Supervisory Routing Modules (SRMs)

The SRMs run all the routing protocols and control applications. Routing table calculations are centralized in these modules to optimize system performance and simplify configuration and management. The SRMs calculate the forwarding tables and distribute forwarding information to the Network Interface Modules and the DOCSIS or EuroDOCSIS modules, and they act as a centralized control system to manage other modules in the chassis.

They contain the redundant switch fabric that provides the connectivity between modules, and they include an I/O interface to the midplane for dedicated Ethernet and RS-232 management ports. Redundant control buses connect all modules to the primary and secondary SRMs and enable the flow of control and management information.

The SRMs support leading routing protocols, including Open Shortest Path First (OSPF) v2, Border Gateway Protocol (BGP) 4, Intermediate System-Intermediate System (IS-IS), Routing Information Protocol (RIP) v1, RIP v2, Internet Group Management Protocol (IGMP), Distance Vector Multicast Routing Protocol (DVMRP), Virtual Router Redundancy Protocol (VRRP), and Protocol-Independent Multicast/Sparse Mode (PIM-SM).

1:4 and 1:8 DOCSIS and EuroDOCSIS CMTS Modules

The 1:4 and 1:8 DOCSIS and EuroDOCSIS CMTS modules provide advanced intelligence for the access network so that cable operators can support a larger population of cable modems per module while maintaining wire-speed performance. These modules support DOCSIS 1.1 and contain broadband HFC network interfaces for the system. The 1:4 module includes one downstream transmitter and four upstream receivers, and the 1:8 module includes one downstream transmitter and eight upstream receivers.

Each module supports Advanced Spectrum Management functionality with integrated upstream spectrum analysis and management and configurable intelligent frequency, modulation, and bandwidth agility. The BSR 64000 offers an integrated, managed, tunable Radio Frequency (RF) up converter that simplifies operation, reduces rack space, and eliminates the costs and management overhead of external up converters. These modules support QPSK and 16 QAM upstream, and 64 and 256 QAM downstream. They implement per-flow packet classification, apply QoS policies, and perform distributed forwarding.

Network Interface Modules

The Network Interface Modules classify packets, apply QoS policies, and forward traffic flows. They provide the high-speed local, wide-area, and metropolitan-area interfaces for the BSR 64000. They enable wire-speed flow classification and forwarding in hardware to optimize throughput. Network Interface Module configurations include:
- 2-port OC-3/STM-1 or 2-port OC-12/STM-3 Packet over SONET/SDH (POS)
- 1-port Gigabit Ethernet
- 8-port 10/100BaseT Ethernet

All Network Interface Modules support full 1:1 redundancy to ensure uninterrupted service for revenue-generating applications such as voice, data, and video.

2:8 DOCSIS and EuroDOCSIS 2.0 CMTS Modules

The 2:8 DOCSIS and EuroDOCSIS 2.0 CMTS modules deliver higher density and support for DOCSIS 2.0. Based on industry-leading DOCSIS 2.0 silicon from Broadcom Corp, these modules enable Advanced Spectrum Management, which includes ingress noise cancellation, post-equalization, sophisticated noise measurement, and noise avoidance capabilities.

Each module occupies a single slot in the BSR 64000 and has two downstream and eight upstream ports. While eight receivers per module are available for servicing subscriber traffic, Motorola has architected a ninth receiver onto each module to enable Advanced Spectrum Management.

The DOCSIS 2.0 CMTS module's ninth receiver can monitor performance on any one of the upstream ports without impacting throughput. It can non-obtrusively gain access to all of the return nodes connected to one of the receiver ports and perform tests on any available modem on any one of the receiver port's supported nodes.

The BSR 64000 supports both ATDMA and SCDMA and allows DOCSIS 2.0 cable modems to coexist with DOCSIS 1.X modems. Motorola has leveraged the DOCSIS ATDMA specification and adds value by including advanced noise cancellation techniques that work with all DOCSIS 1.X and 2.0 cable modems to help operators increase throughput. Cable operators can double the performance of legacy modems while concurrently deploying DOCSIS 2.0 modems that enable new services and increased performance levels. The BSR 64000 noise cancellation capabilities allow operators to optimize performance while operating in DOCSIS 1.X/2.0 mixed mode.

Motorola's post-equalization capabilities offer the operator the ability to increase the throughput of DOCSIS 1.0 cable modems by allowing them to operate in 16-QAM mode virtually anywhere that it is possible to operate in QPSK. The BSR 64000 2x8 DOCSIS 2.0 CMTS module performs per-burst equalization that enables the receiver to equalize—and thus correct for—the effects of micro-reflections, amplitude distortion, and group delay distortion.

These impairments have historically been the limiting factors in achieving QAM modulation higher than 4 QAM (QPSK). The combination of post equalization and superior ingress noise cancellation capabilities results in a DOCSIS 1.X system today where 16-QAM, error-free operation is achievable virtually anywhere in the return path. Therefore, operators can effectively double the throughput of their installed base of modems.
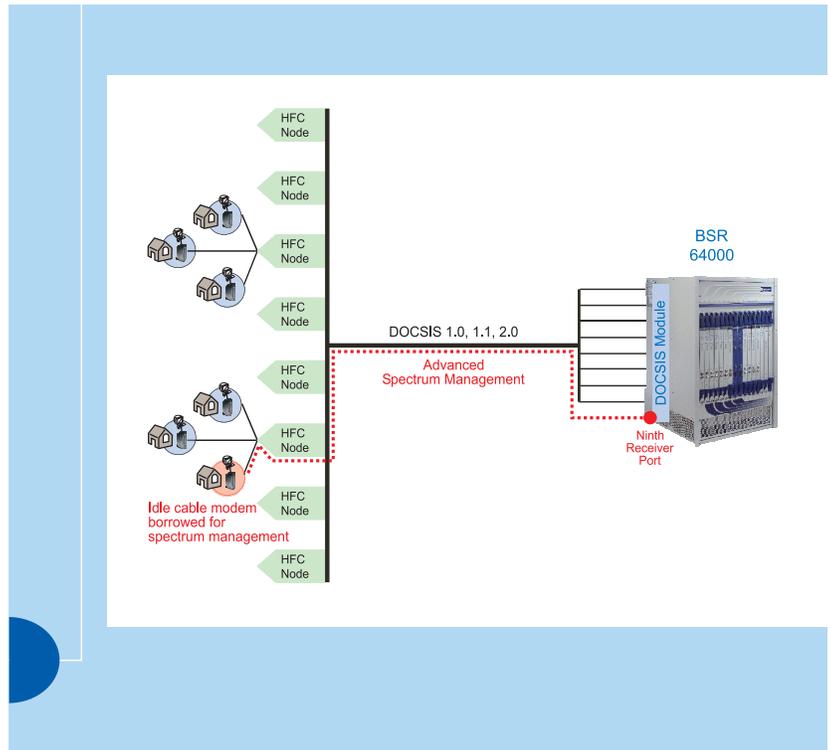
Integrated RF Switch

The Integrated RF Switch connects the input and output of each DOCSIS or EuroDOCSIS CMTS module to the RF plant to allow 1:N redundancy.

These modules support automatic CMTS module switchover with a single standby CMTS module serving as a backup to all other DOCSIS or EuroDOCSIS modules in the chassis, containing configuration information for all of the active modules.

This allows broadband operators to support hitless failover and offer carrier-grade availability for services such as IP telephony, which are intolerant of the extended cable modem re-registration times that typically occur following CMTS card failures.

Flexible Configuration

The two central slots in the chassis are reserved for the primary and secondary SRMs to enable 1:1 redundancy. Typical configurations will also include redundant Network Interface Modules for upstream metropolitan or wide-area connectivity, another Network Interface Module for high-speed LAN connectivity to server applications and caches, and up to 11 active DOCSIS or EuroDOCSIS CMTS modules and a spare.

Bi-directional, non-blocking 2.1 Gbps data packet transport is provided between modules in a cross-connect manner via a redundant, 64 Gbps fabric. This distributed architecture provides the density and performance required to accelerate the mass deployment of new revenue-generating services over HFC infrastructure. This architecture provides the capability to support even higher density interfaces and new features. In the future, operators can deploy the BSR 64000 safe in the knowledge they can evolve the platform to capitalize on new technologies and business opportunities.

MPLS and Policy-Based Routing

You can deploy the BSR 64000 as an MPLS Label Edge Router (LER) at the edge of the network or as an MPLS Label Switch Router (LSR) to provide high-speed Layer 2 transport across the network. You can then support multiple service provider access as well as commercial VPN services.

Because of the BSR 64000's hardware-based distributed forwarding architecture, MPLS traffic flows can be routed at wire-speed so broadband network operators can deploy additional revenue-generating services.

Treatments for QoS are based on the policies defined for each MPLS Label Switched Path (LSP) to enable end-to-end traffic treatment across access, metropolitan, and core, networks. The BSR 64000 offers a carrier-class implementation of policy-based routing with MPLS. Motorola's MPLS implementation supports IETF standards and is fully interoperable with MPLS-enabled routers and switches.

Packet routing is partially determined by looking at the source IP address, understanding which service provider partner the IP address belongs to, applying the appropriate MPLS label, and then routing the traffic on the appropriate LSP to that partner for handling. This packet inspection allows the BSR 64000 to implement more sophisticated QoS policies than possible by simply looking at the data's destination address. The BSR 64000 can assign QoS and routing policies based on parameters such as service provider, subscriber, and application.

Support for BGP/MPLS VPN (RFC 2547) allows cable operators to provide compelling VPN services for enterprise customers that encourage them to migrate from their incumbent carriers. Broadband operators can offer services with the same parameters for QoS, security, and performance at a fraction of the cost of traditional leased line or Frame Relay/ATM services offered by incumbent providers—and operators can provide enhanced value by allowing commercial customers to quickly and easily provision additional bandwidth.

Broadband System Flow
Service Provider Flow
Subscriber Flow
Application Flow
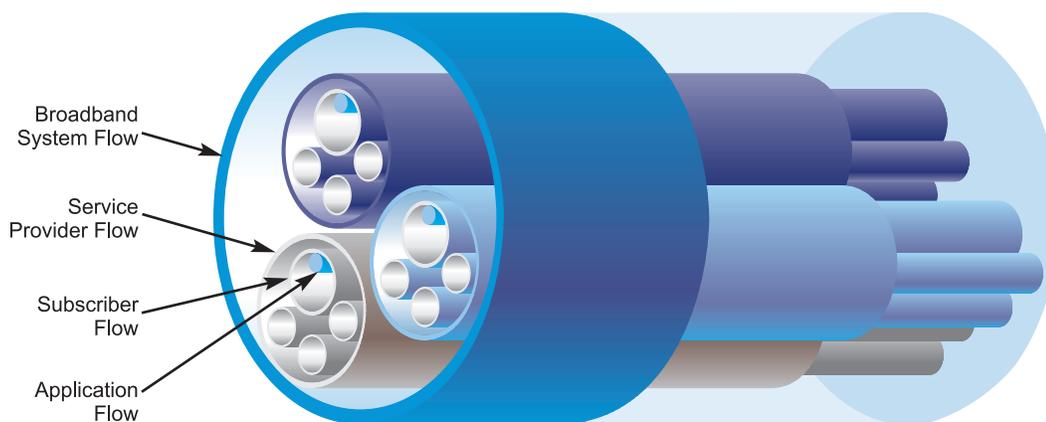
SmartFlow Granular QoS
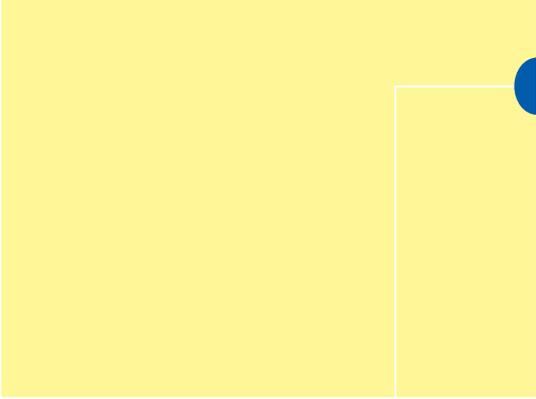
Redundancy and Availability

The BSR 64000 is architected for 99.999 percent availability and provides the fault detection and switchover required for high-availability services. The system is designed for cost-effective reliability and offers 1:1 redundancy for the switch fabric, SRM, and Network Interface Modules. The DOCSIS and EuroDOCSIS CMTS modules can be configured for 1:N redundancy so that a single spare can efficiently provide backup for up to 12 live modules.

The carrier-class BSR 64000 supports all of the traditional Central Office (CO) operational requirements—such as minimal disruptive software upgrades in redundant pairs, live insertion, version roll-back, integration into the alarming scheme, and full NEBS compliance. Extensive fault detection and reporting features let operators optimize system performance and deliver primary-line IP telephony reliability.

Carrier-Class VoIP

The BSR 64000 is a carrier-class platform architected for the 99.999 percent availability and wire-rate performance required for real-time voice services. It supports continuous operation in a mission-critical, service-oriented environment. The BSR 64000's architecture integrates Central Office features that lower operational and maintenance cost.

These features include: a Stratum 3 clock; a mid-plane chassis design with field replaceable modules; "cable once" rear cabling; simple front access; fully redundant control; sophisticated route calculations; and an internal 64 Gbps switching fabric. The BSR 64000 supports continuous operation regardless of internal and external failures. SmartFlow provides the QoS control necessary for prioritizing voice calls to ensure real-time service delivery. With the BSR 64000, operators can deliver converged voice and data services over the HFC network using a scalable, cost-effective system that provides carrier-class availability.

Network Management and Control

The BSR 64000 offers several options for efficient administration, management, and control to streamline deployment and operation costs. In headend locations with limited availability of trained staff, troubleshooting on the BSR 64000 is simple, with easy-to-read diagnostic LEDs as well as remote management capability to support provisioning, configuration, monitoring, and problem identification.

The BSR 64000 supports Simple Network Management Protocol (SNMP) v1 and v3. Motorola supports all appropriate standard MIBs and offers custom MIBs to monitor and control the BSR 64000's value-added features. Partitioned management allows users with different administrative access needs customized views according to their access privileges.

Because of the importance of network security, the BSR 64000 supports RADIUS, TACACS+, Secure Shell (SSH) login, Syslog authentication, and other security measures. The system supports the File Transfer Protocol (FTP) for bulk data transfer, and management of the BSR 64000 can be seamlessly integrated into the existing network management infrastructure.

The BSR 64000 also offers extensive diagnostic capabilities and includes a Cisco-compatible Command Line Interface (CLI) for ease-of-use and interoperability with legacy infrastructure. The CLI supports full scripting capability and ASCII-formatted command files can be uploaded, downloaded, and executed.

Enabling Next-Generation, Multi-Service Broadband Networks

The BSR 64000 allows operators to swiftly deploy enhanced IP services to generate new revenue streams, capture market share, and accelerate return-on-investment for network infrastructure. This carrier-class switching and service-provisioning solution provides broadband carriers with a competitive edge in defining, deploying, and managing broadband services.

This fully redundant, high-density solution is architected for 99.999 percent availability so broadband providers can offer enhanced IP services as well as IP telephony.

SmartFlow sophisticated flow classification and QoS treatment delivers the intelligence needed to offer guaranteed SLAs, and the tight integration of intelligent edge routing and CMTS features allows broadband providers to maximize the use of headend space and simplify management and operations while delivering robust new services.
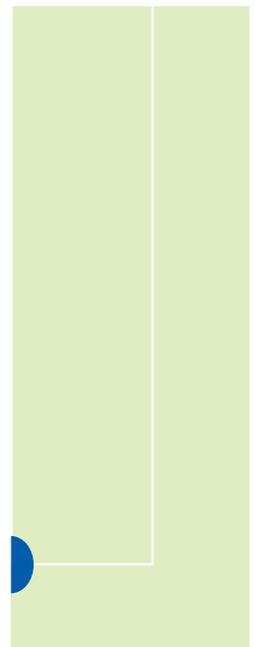
Scalable Platform for Growth

Hot-swappable Modules

Redundant Power and Fan Units

1:1 SRM Redundancy

1:N DOCSIS and EuroDOCSIS Module Redundancy

Redundant 64 Gbps Switch Fabric

VxWorks Real-time Operating System

Form	16-slot, NEBS-compliant chassis
Height	29.75" (75.56 cm)
Width	19" (48.26 cm)
Depth	19.75" (50.17 cm)
Fully-configured Weight	140 lbs (63.5 kgs)
Power	-48V DC (Optional AC Power)
Operating Temperature	0° C to 40° C
Non-operating Temperature	-20° C to 60° C
Operating Humidity	10 - 90% (Non-condensing)
Non-operating Humidity	5 - 95% (Non-condensing)

Standards-Based Interoperability

- DOCSIS 1.0 and EuroDOCSIS 1.0 qualified
- DOCSIS 1.1 and EuroDOCSIS 1.1 qualified
- DOCSIS 2.0 and EuroDOCSIS 2.0 compatible
- PacketCable 1.0 qualified
  DQoS

  IPsec

  COPS

  CALEA

Flexible Configurations

- 2-port OC-3/STM-1 or 2-port OC-12/STM-3 POS
- 1-port Gigabit Ethernet (Single Mode and Multimode)
- 8-port 10/100Base-T Ethernet

Intradomain/Interdomain Routing

RIP v1	RIP v2	IS-IS
OSPF v2	BGP4	VRRP

Multicast Routing Support

DVMRP	PIM-SM	IGMP v2

Advanced QoS

IP DiffServ	Standards-based MPLS	BGP/MPLS VPNs (RFC 2547)

Per-SID Queing on the DOCSIS Module and EuroDOCSIS Module

Network Management and Provisioning

- Cisco-compatible CLI
- Standard DOCSIS and IETF MIBs
- LDAP v3
- COPS Client
- TACACS+
- SYSLOG
- SNMP v1 and v3
- Motorola MIBs
- DHCP Relay
- Radius Interoperability
- SSH Login
- Multiple Community Strings
- Telnet with Security Extensions
- Multiple Levels of Account/Password Authentication
- Open Interfaces to Provisioning, Accounting, and Billing Applications

Full RF Spectrum Support

DOCSIS and EuroDOCSIS

Up to 24 Downstream Transmitters

Up to 96 Upstream Receivers

Advanced Spectrum Management Functionality

Downstream DOCSIS Transmitter

Integrated, Managed Tunable Up Converter for RF Output

Upstream Modulation	QPSK and 16, 32, 64, 128, 256 QAM
Upstream Per-channel Bit Rate	0.320 - 40.96 Mbps
Upstream Input Frequency Range	5 - 42 MHz DOCSIS
	5 - 65 MHz EuroDOCSIS
Downstream Modulation	64, 256, 512, and 1024 QAM
Downstream Output Frequency Range	88 - 857 MHz (Channel Center)
Output Frequency Step Size	32.0 kHz
Downstream Per-channel Bit Rate	27.00 Mbps (64 QAM DOCSIS)
	36.00 Mbps (64 QAM EuroDOCSIS)
	38.00 Mbps (256 QAM DOCSIS)
	56.00 Mbps (256 QAM EuroDOCSIS)
	48.28 Mbps (512 QAM DOCSIS)
	59.20 Mbps (512 QAM EuroDOCSIS)
	53.60 Mbps (1024 QAM DOCSIS)
	65.80 Mbps (1024 QAM EuroDOCSIS)

High-Performance IP Routing

Wire-speed Forwarding and Flow Classification

More than 3 Million Packets-per-Second for Each Network Interface Module

More than 42 Million Packets-per-Second for Each Chassis

Wire-speed QoS

Routing Policy Support

50 Route Updates/Second

Specifications are subject to change without notice.

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