IPv6 Hardware Router Design

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Introduction of Hitachi

HITACHI
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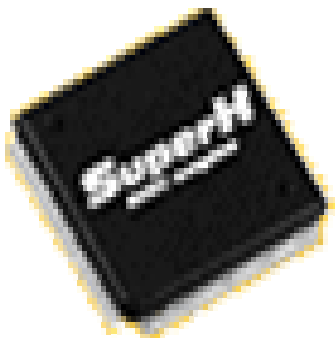
- Headquarters in Tokyo, Japan
- More than 1000 Subsidiary Companies
  - More than 350 outside Japan
- Hitachi made many kind of products.
  - LSI, Generator, Computer, etc.

Enterprise Server
Super Computer



Micro processor

IC card

Flat panel display

PC

Hitachi's IPv6 Deployment (1)

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- A Founding Member of IPv6 forum
- 7 Years Development of IPv6 routers.
  - With WIDE project IPv6 wg since 1995.
- World's First IPv6 Protocol Translation Router "NR60" in 1997.
- IETF contributions.
  - Especially RFC2767 (BIS).

Hitachi's IPv6 Deployment (2)

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- Early stage (1996-97) Interoperability Testing in UNH IOL. University of New Hampshire, Interoperability Laboratory
- A Member of KAME Project and USAGI project.
  - Hitachi's kame core member M. Sumikawa → S. Suzuki
  - http://www.kame.net
  - http://www.linux-ipv6.org/
- Some WIDE project members joined Hitachi's network product division.
- Interoperability Testing in TAHI Project.
  - http://www.tahi.org
- "**Toolnet6**" - Free Hitachi Software.
  - Driver Software For IPv6 Support - Windows 95/98/NT.

Hitachi's IPv6 Deployment(3)
IPv6 Software for Windows "Toolnet6"

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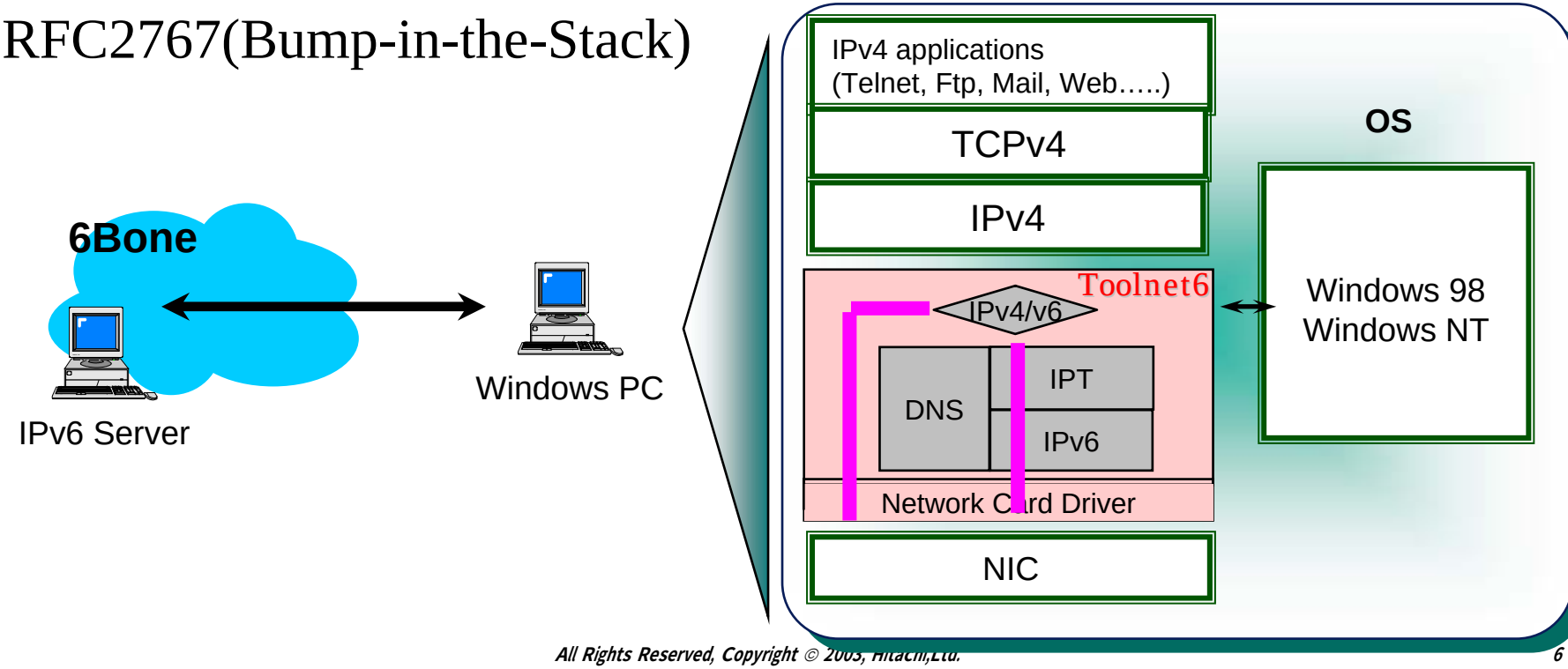
- Software Tool For Existing Windows(R) Applications Over IPv6.
- Enhancement For Network Interface Card Driver Software
- Free distribution from Hitachi home page
  - http://www.hitachi.co.jp/Prod/comp/network/pexv6-e.htm
- RFC2767(Bump-in-the-Stack)



Hitachi's IPv6 Deployment (4)

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- Many Japanese and worldwide Service Providers, Enterprises are already using GR2000 IPv6.
  - IPv6 iDC service with GR2000.
  - ISID(Information Services International Dentsu, Ltd.) is running to deploy their IPv6 network with GR2000.
  - CRL(Communications Research Laboratory) has already used wide area and high speed IPv6 network with GR2000.
  - JGN is using GR2000 for IPv6 network.

Hitachi's IPv6 Router

Background of Router Development

We need hardware based high speed routers!!

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Network Environment		Needs
Increase Internet Traffic	⇒	**Gigabit Speed**
・Promotion of ADSL, FTTH ・Large size contents		・Network construction by GbE
Increase Internet Routing Table	⇒	**Routing Processing Ability**
・More than 100,000 routing table		・We need from 500,000 to 2000,000 for future.
Wide Band Width Grantee Services	⇒	**QoS**
・ Enterprises use broadband services. →cannot guarantee traditional best effort service ・ IP telephony and Video services for home		・Important of Distinction Service Level by QoS (Diffserv and guarantee of minimum band widt
VPN Services	⇒	**IP-VPN**
・ Enterprises use broadband services. →Unrest security of traditional network ・Career/ISP services by VPN services		・Important of IP-VPN by MPLS and multiple L2
Expectation of Ubiquitous enviroment	⇒	**IPv6**
・mobile computing, home appliances, network games		・Construction of infrastructure for PtoP servic

Hitachi's IPv6 Router
Gigabit Router GR2000 Lineup

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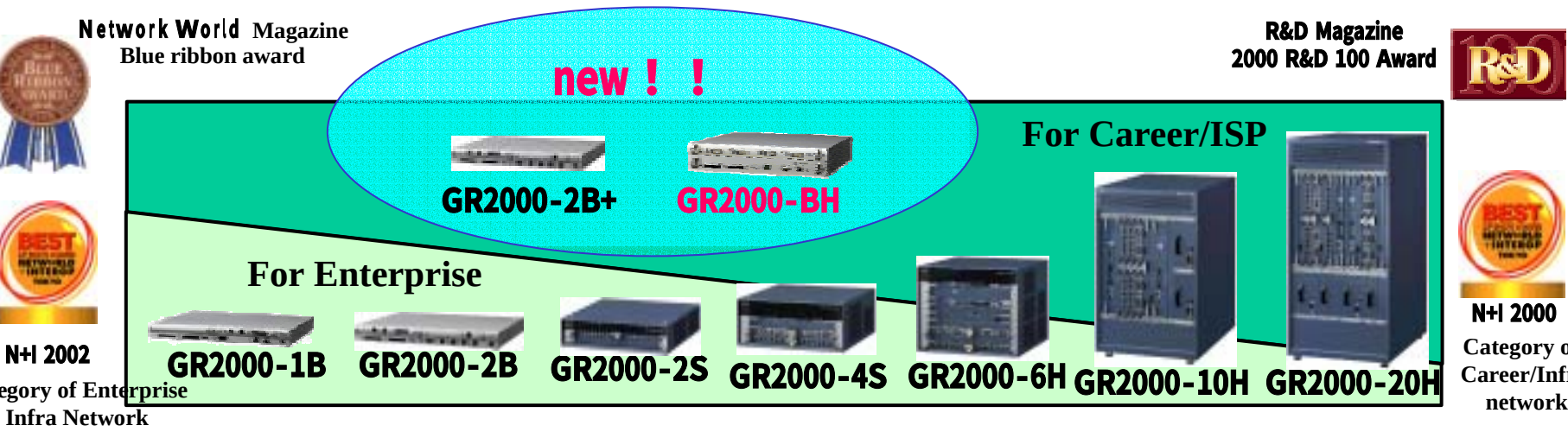
Same Architecture 7 models → 9 models lineup



- **High Speed Routing by Hardware (ASIC) Processing**
- **QoS Control (Diffserv), Filtering by Hardware**
  - Minimum band width guarantee width by each user and weighted band width guarantee, etc.
  - Priority/Bandwidth guarantee for Enterprise important data
- **IPv6 full support by Hardware**
  High speed IPv6 routing by Hardware (ASIC) processing*

(*) Only model 2S software processing

- **Design of High Reliability**
  - Use high reliability parts, same high quality assurance and production of main frame/super computer
  - High Reliability by hot standby and redundancy

Hitachi's IPv6 Router GR2000 Key Features

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- IPv4 and IPv6 symmetry design
  - Other routers are IPv4 only design plus IPv6 function.
- Layer-3 non-blocking switching performance
    - Up to 40Mpps Forwarding Rates
    - Up to OC48c (2.4Gbps)
- Distributed processing architecture
- Scalable WAN/LAN services
- Carrier class hardware and software assure system reliability (Designed to meet NEBS Level 3)
- Full suite of routing protocols ensures interoperability
    - OSPF, RIP, BGP4, IS-IS, IP, IPX, DVMRP, PIM(DM/SM/SSM), MPLS
- Hardware based QoS (priority & bandwidth control)
- Hardware based filtering
- IPv6 transition mechanism
  - tunnel
  - 6to4
  - NAT-PT (B model only)

IPv6 Gigabit Router Implementation

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- GR2000 IPv6 implementation
- GR2000 Architecture
- IPv6 Hardware for High Performance
- GR2000 approach for High Reliability
- GR2000 Hardware Based Filtering
- GR2000 Hardware Based QoS control
- GR2000 IPv6 Multicast
- GR2000 Multiple Network Interface

GR2000 IPv6 implementation(1)

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- Completely hardware based design
- IPv4 and IPv6 symmetry design
- GR2000 IPv6 software is based on KAME stack.
- GR2000 is a reference implementation of IPv6 routers.
- Standards Driven
  - RFC2460:Internet Protocol, Version 6(IPv6)
  - RFC2473:Packet Tunneling
  - RFC2080:RIPng
  - RFC2858,2545: Extensions for BGP-4
  - RFC2462:Address autoconfiguration
  - RFC1972, 2472 2492 :IPv6 packets over Ethernet,PPP,ATM
  - RFC2465,2466,2452,2454:MIB
  - etc.

GR2000 IPv6 implementation(2)

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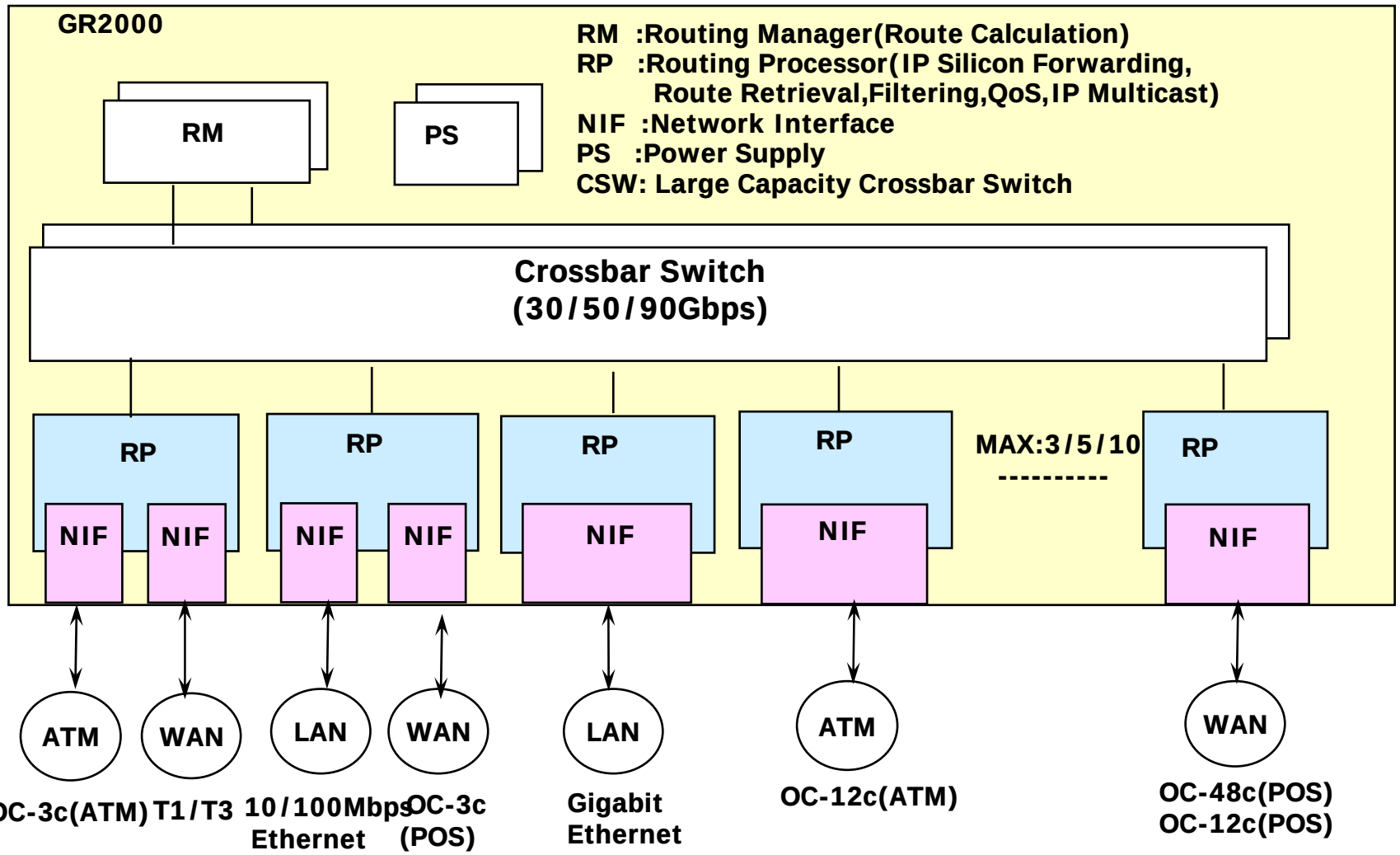
Major IPv6 Features

- QoS/Diff-Serv in hardware
- IPv6 MIB (RFC2465, 2466, 2452, 2454)
- Functions to support the shift from IPv4 to IPv6
  - IPv4/IPv6 dual-stack
  - IP tunneling in hardware: For IPv4 in IPv6, IPv6 in IPv4 and 6to4
- Routing protocol
  - RIPng , OSPFv3, BGP4+, IS-ISv6
- Filtering in hardware
- Auto-configuration (automatic configuration setting)
- Prefix Delegation

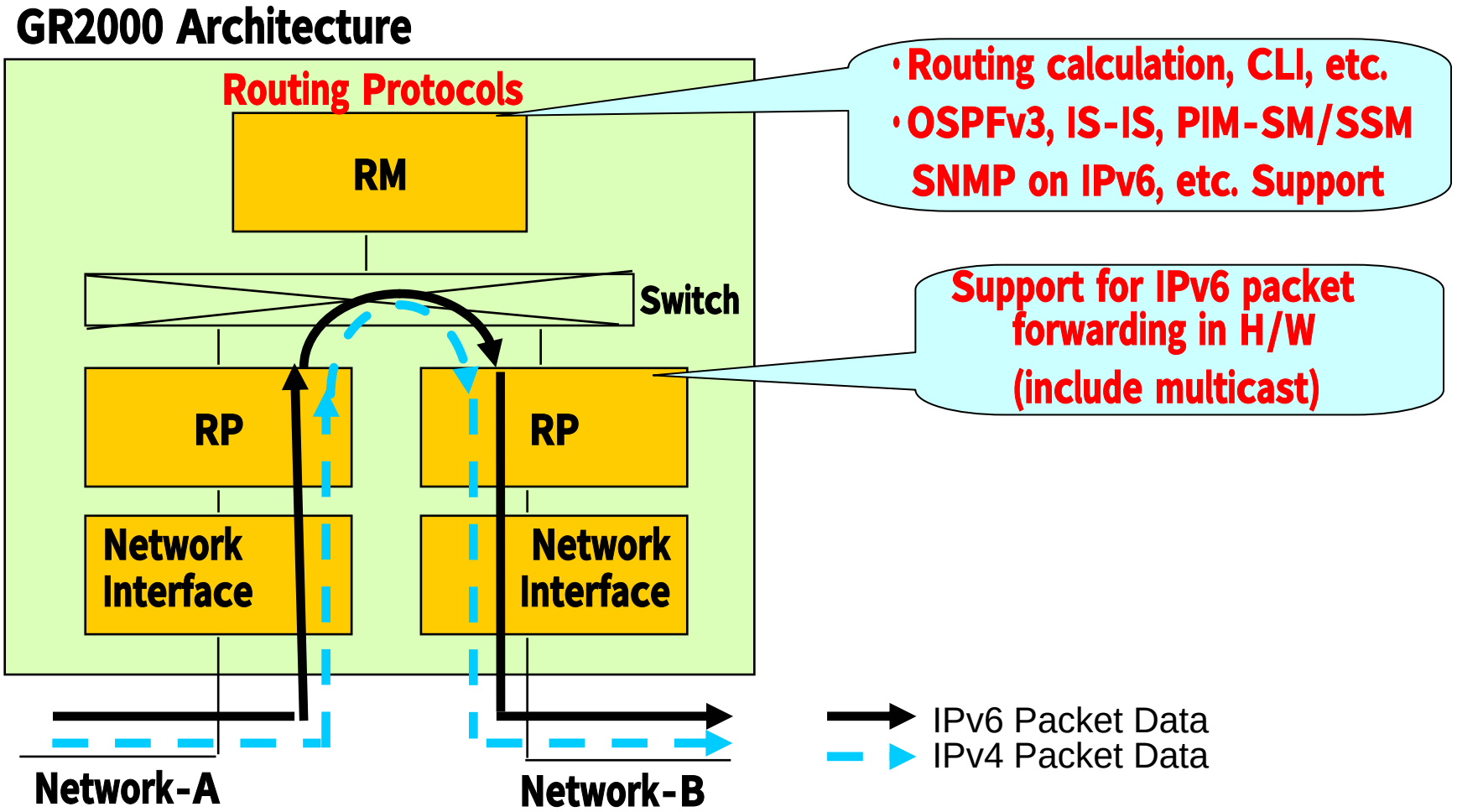
Operation management

- Management by SNMP (IPv4 and IPv6)
  - IPv6 MIB (RFC2465, 2466, 2452, 2454), link layer, etc.
- IPv6-supported applications: telnet , SSH, FTP, ping6 , traceroute6, etc

Distributed Architecture



GR2000 Architecture



RM: Routing Manager, RP: Routing Processor, NIF: Network Interface

GR2000 Architecture

Applied of High-end Server Hardware Technology

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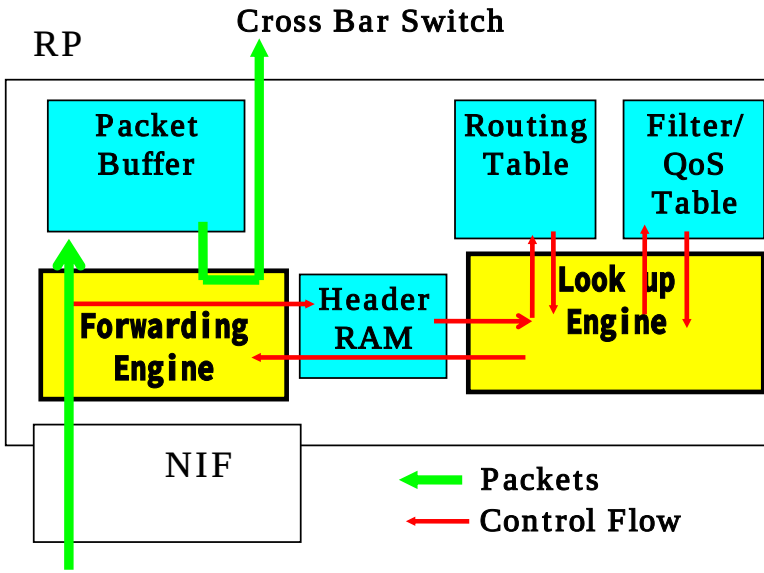
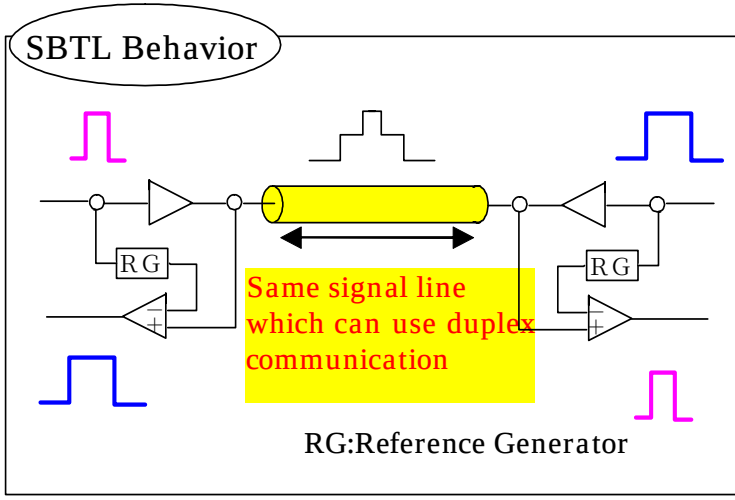
- Hardware routing
  - Newest custom LSI
    - We can use 0.13μm rule process and 6Mgate LSI.
    - Routing lookup engine does lookup and filter/QoS table lookup.
    - 1Mpps forwarding ability per LSI
- Cross bar switch use SBTL technology.
  - We use SBTL (Simultaneous Bi-directional Transceiver Logic).
  - Least of number pin, LSI, PK's layer.
  - Compact implementation.
    - We can make small size high performance models (B/BH).
    - Low cost design

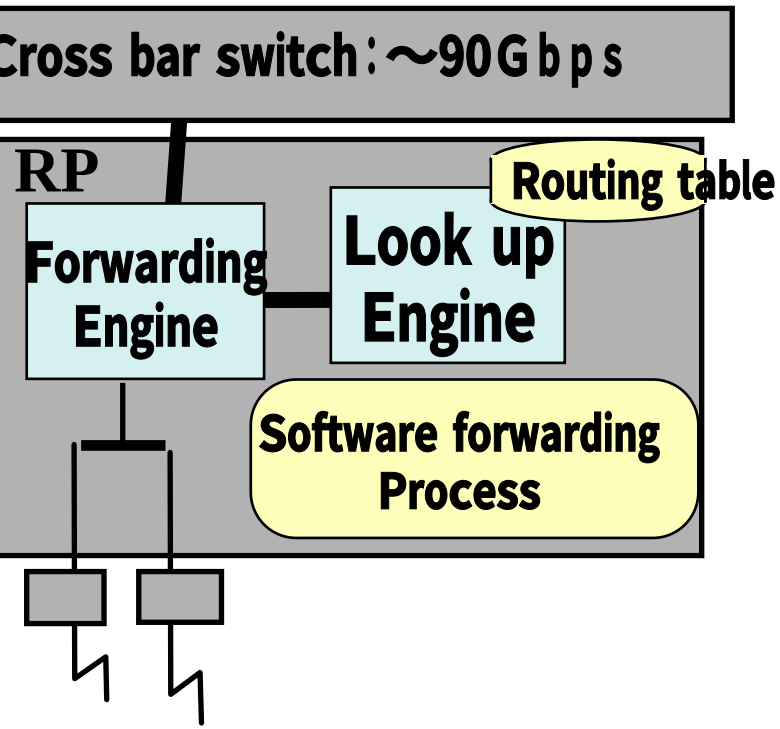




Packet relay for Giga bit class interfaces

Other Router : Software ⇨ **GR2000:Hardware**

about100μsec/packet **less than 1μsec/packet**



Relay Processes (e.g.)

- Receive buffer
- Input filter
- Routing table look up
- Output filter
- Search Output interface

Routing engine

- Pipeline processing
- Parallel processing

GR2000 Architecture

Hi Speed Forwarding Engine

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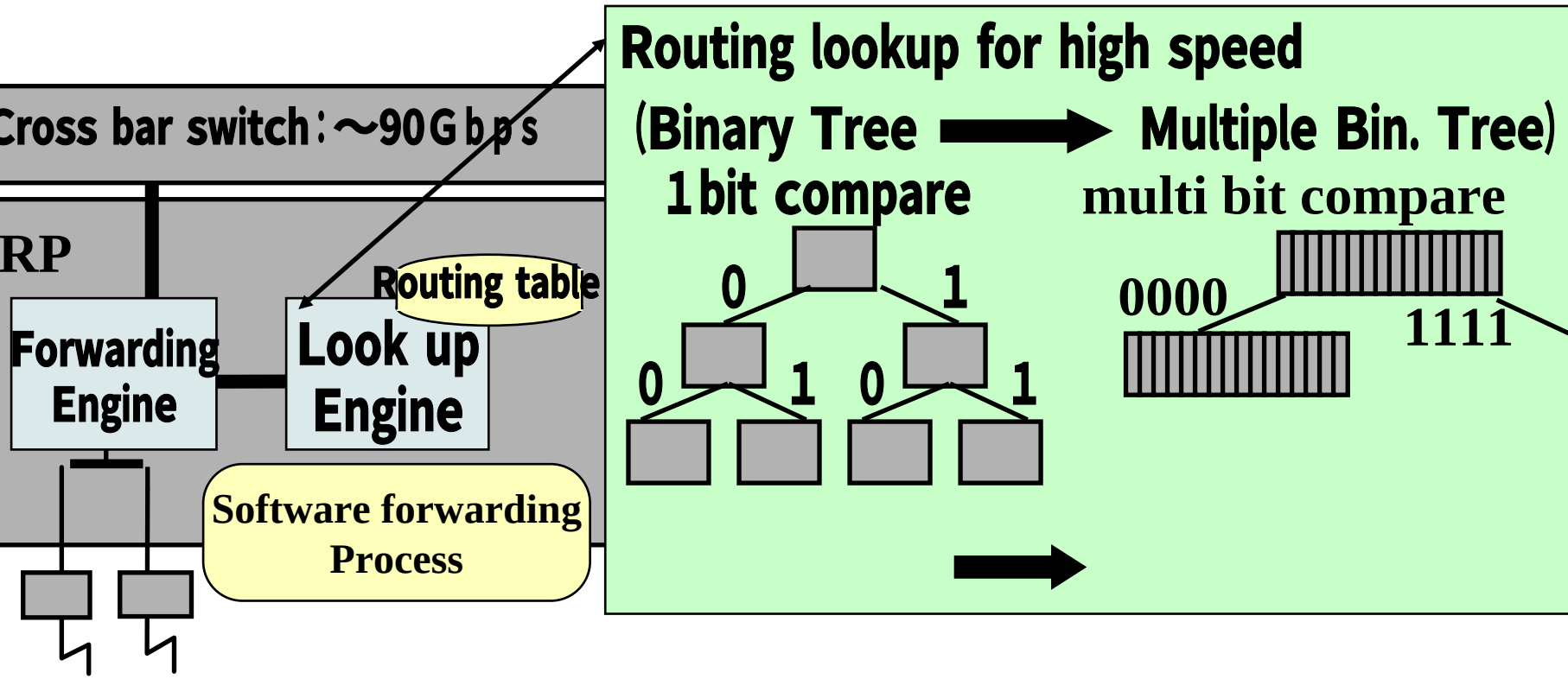

GR2000 Routing Table Lookup

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- Routing table lookup is “Radish” based algorithm.
- Suggestion of Radish is by Akira Kato and Kazu Yamamoto.
- Hitachi added many ideas for hardware implementation.

GR2000 Architecture

QoS Control by Hardware

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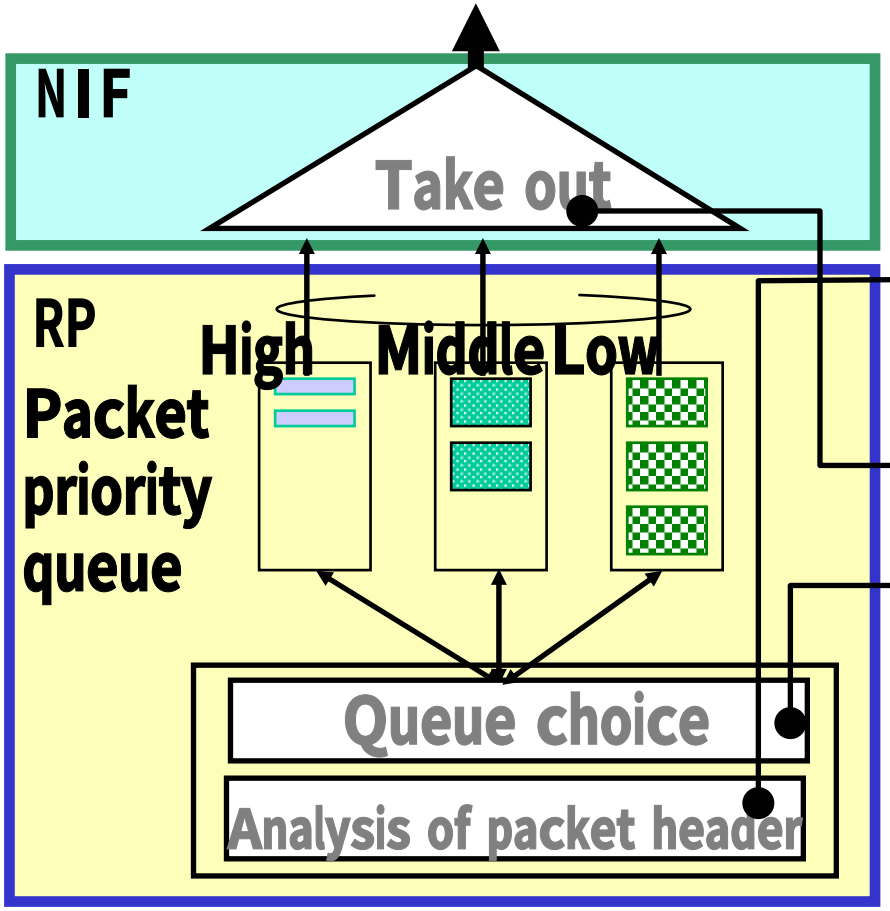

QoS control engine function

①Packet/flow detect
(choose application, host, etc.)

②Choose packet priority queue

③Take out from packet priority queue (weighted round robin)

④Assignment packet priority queue, queue length

⑤Packet reject priority control

IPv6 Hardware for High Performance

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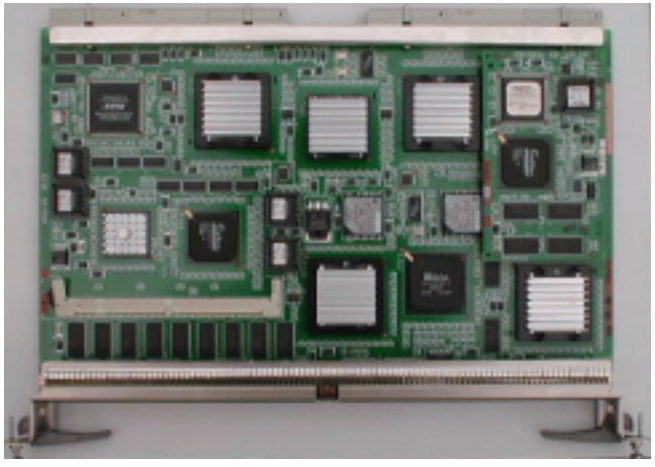
- **IPv6 routing in hardware*1**
  - Relay processing (wire-speed with OC-48c [2.4 Gbps])
  - QoS control (supports IPv6 Diff-Serv)
  - Policy routing (in development)
  - Filtering
  - IP tunneling
- **Increased speed of routing protocol process**
  - Faster engine for path accounting
  - Expanded capacity for routes
    (1 million route entries)



Routing Processor

*1 The GR2000-2S is dedicated to software routing only.

GR2000 approach for High Reliability

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Carrier/ISP Class

- Hardware
  - Redundancy (power and other shared components) is available.
- Software
  - Highly-stable BSD-based operating software.
  - Enables high mutual connectivity by adopting KAME, de-facto standard recognized in the network industry.

High quality of the products themselves

- Same manufacturing QA standards as for mainframes and backbone servers.
- Installation of more than 300 IPv6-supported routers in use worldwide, all of which are providing stable and reliable operation.

GR2000 - Hardware-Based Filtering -

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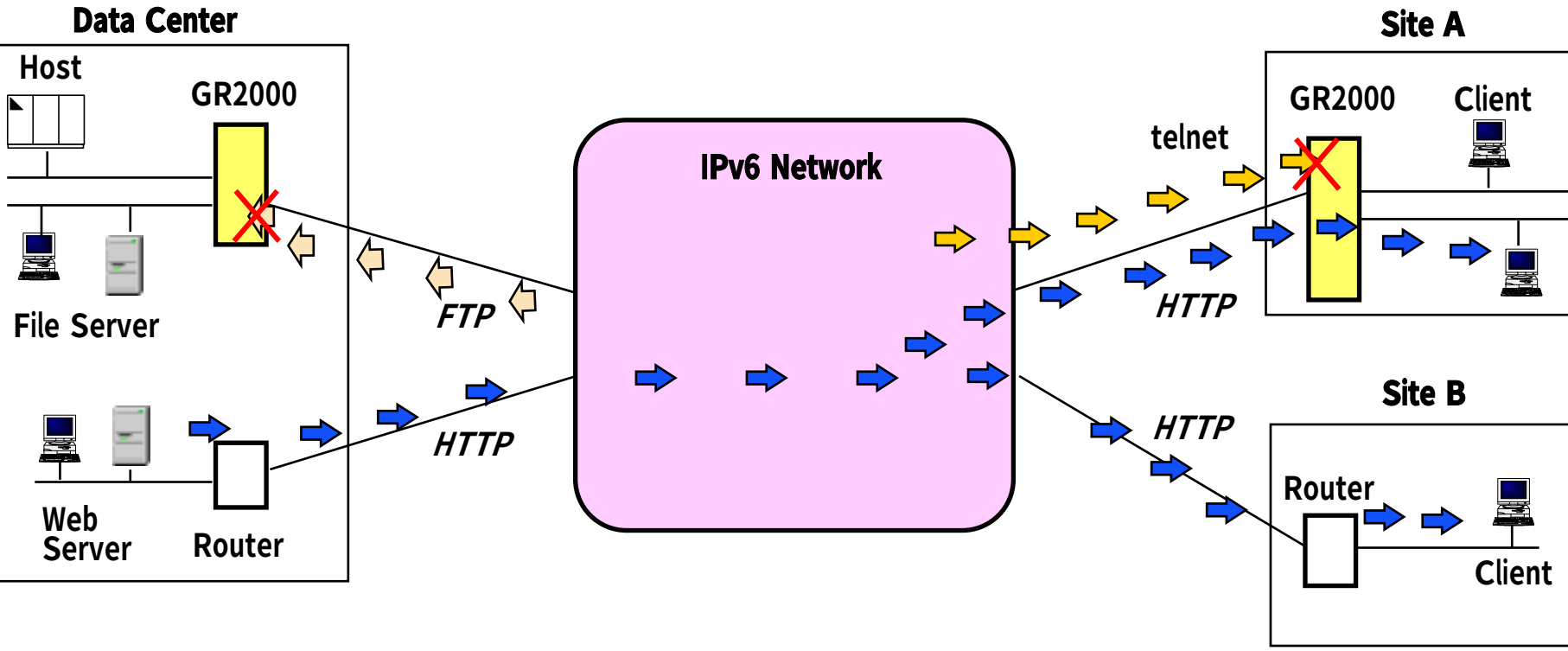
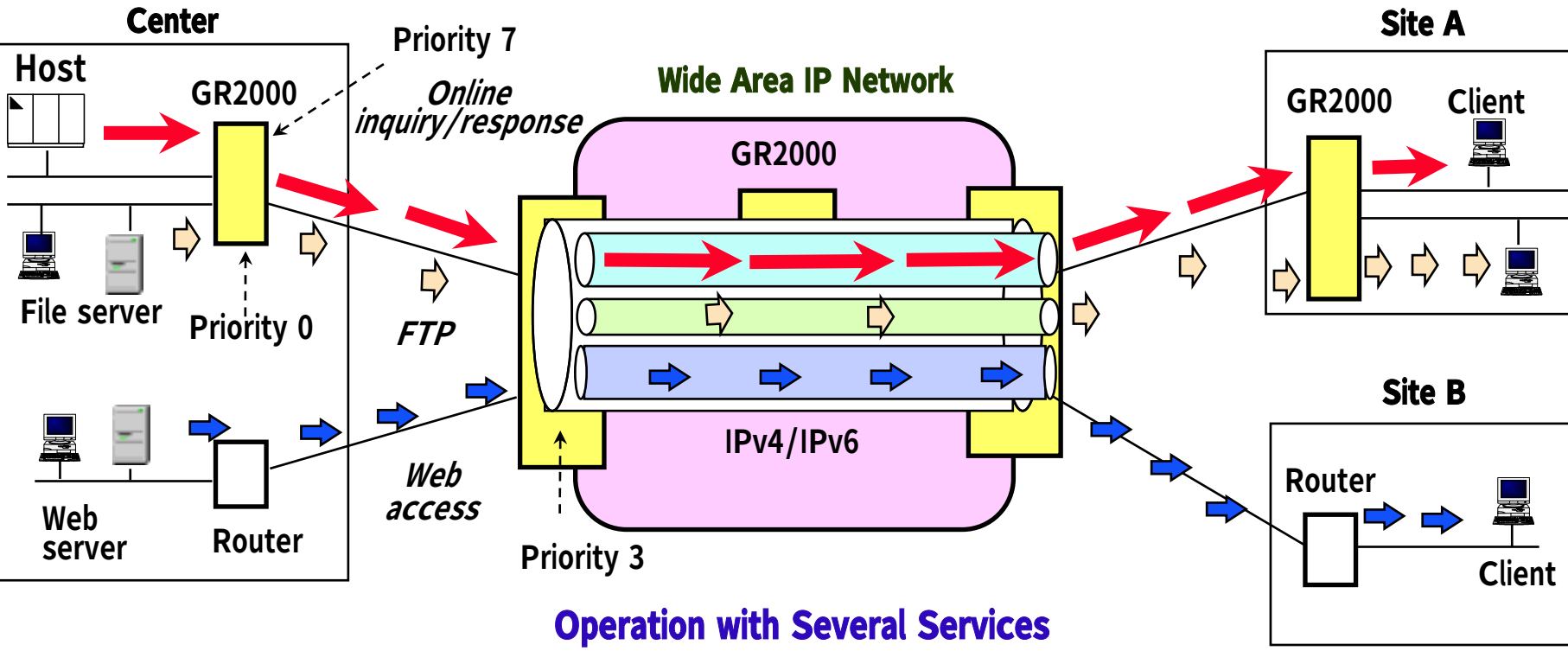
Detects various IPv4/IPv6 flows in hardware, and retains security at various levels by relaying or discarding specific IP packets. Examples:
- WWW packets should be relayed.
- Packets other than WWW, such as those of telnet or FTP, should be discarded.



Several communication services can be offered by the Diff-serv feature in hardware even when IPv4 and IPv6 coexist (dual-stack). Examples:
- Keeping the traffic of backbone tasks highly prioritized and preventing it from being discarded.
- Effective use of the bandwidth of access/backbone lines.



Operation with Several Services

GR2000 IPv6 Multi-cast

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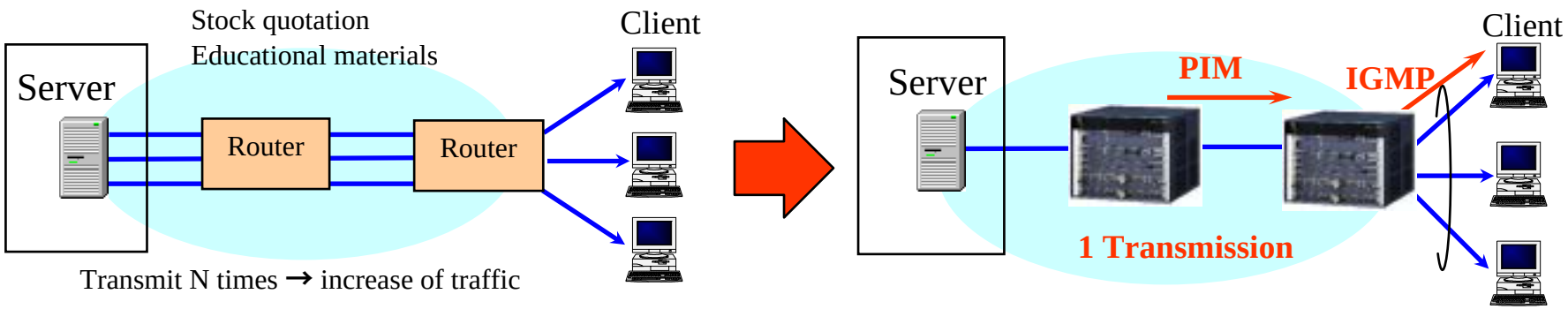
In communicating with multiple clients at same time,
we used to communicate N times (unicast) = increase traffic load
→decreasing traffic load of Network/Server by using multicast protocol

GR2000 Advantages

- Data flow is handled by Hardware and it's bandwidth is guaranteed.



Router-Router Protocol: PIM-SM/SSM

Router-Host Protocol: IGMPv2/MLDv1

Relayed PIM-SSM (GR2000 original feature)

PIM ：Protocol Independent Multicast
IGMP：Internet Group Management Protocol

Multiple Network Interface

High Speed WAN interfaces

- T3/E3, OC-3(ATM), OC-12(ATM), OC-3(POS), OC-12(POS), OC-48(POS)

Low Speed WAN interfaces

- Synchronous Serial (V.24/V.35/X.21) (max. 6 Mbps)
- T1/E1

High Speed LAN interfaces

- Gigabit Ethernet (1000Base-LX/1000Base-SX)
- Fast Ethernet (10Base-T/100Base-TX)

Conclusion

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- IPv6 - Already Started at Commercial Stages.
- As a Vendor, Hitachi Has Released IPv6 Products.
- GR2000 Hardware Based IPv4/IPv6 Dual Stack Gigabit Router
  - T1/E1 to OC48c I/F
  - OSPFv3, IS-ISv6, BGP4+
  - Manageable by IPv4/IPv6 NMS
  - Transition mechanism (Tunnel, 6to4, NAT-PT) by hardware accelerated
- GR2000 architecture is original distributed architecture.
  - Based Ideas & LSI technology
  - New function support (QoS, etc.)
- Next Step: Terabit Class IPv4/IPv6 Dual Stack Router
- **HITACHI continues to be the world leader in offering IPv6-supported network products and solutions.**

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