Juniper IPv6 Solution

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Track Record of Innovation

IPv6 Support Across All Platforms, Interfaces

- **Common ASIC technology**
- **Common JUNOS software**
- **Common architecture**

Packet Forwarding Performance per Rack Inch

M40

M20

M160

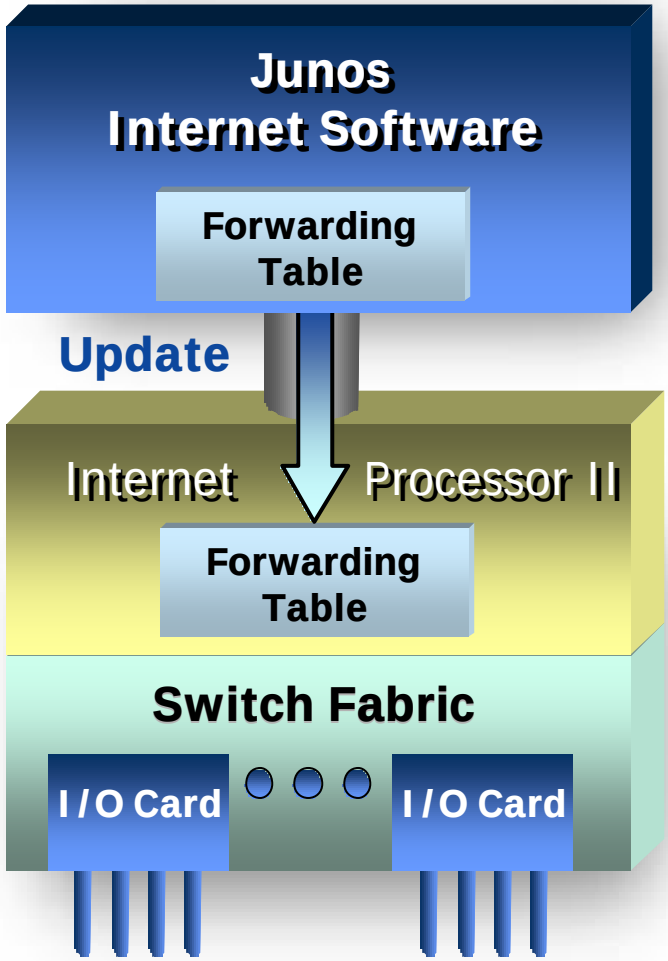
M5/M10

A Growing History of Rapid Innovation

September 1998 | December 1999 | March 2000 | September 2000

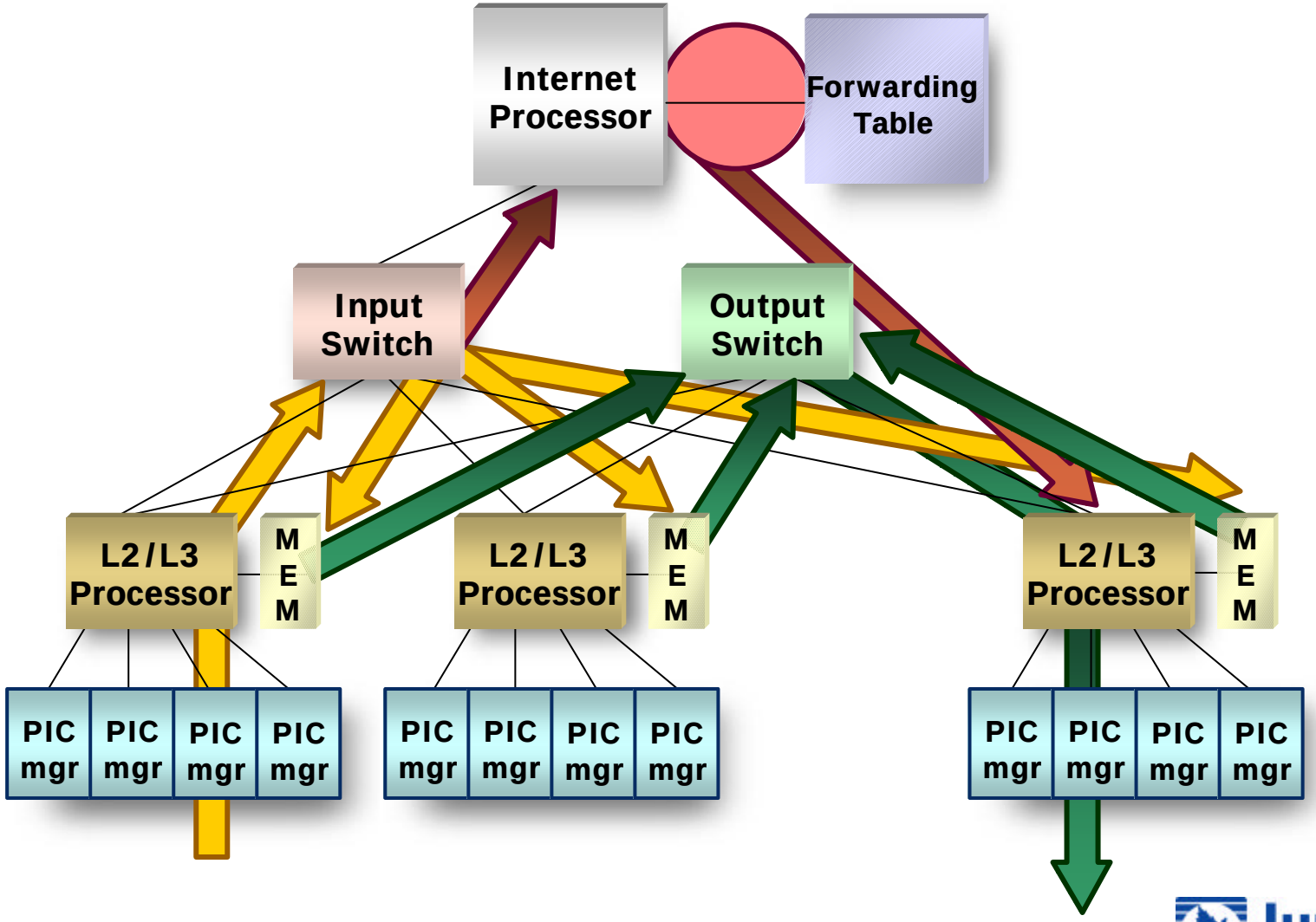
Juniper NETWORKS

System Architecture

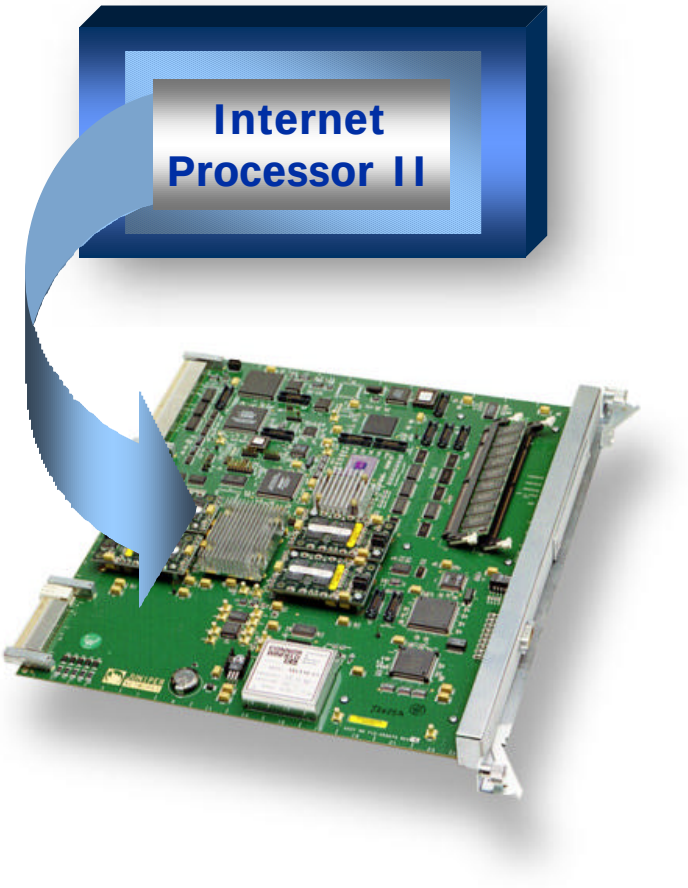


- **Routing Engine**
  - Maintains routing table and constructs forwarding table using knowledge of the network
- **Packet Forwarding Engine**
  - Receives packet forwarding table from Routing Engine
  - Copies packets from an input interface to an output interface
  - Conducts incremental table updates without forwarding interruption

Packet Flow Through Forwarding Engine



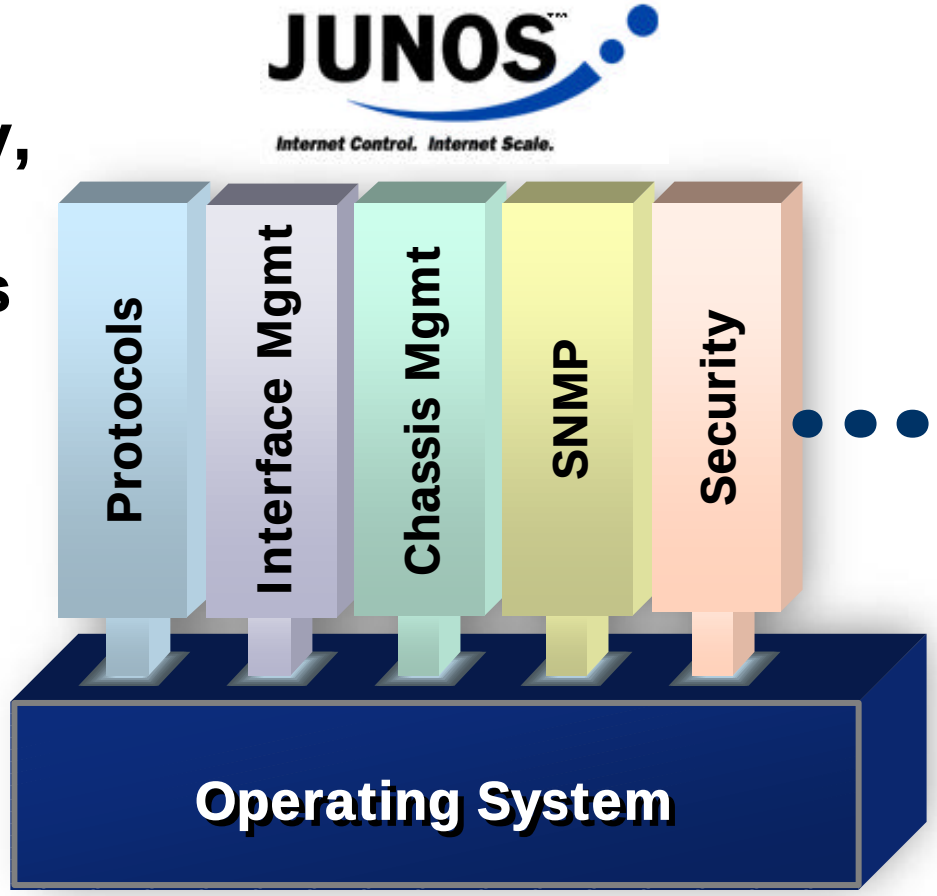
IP II ASIC Overview



- Leverages proven, predictable ASIC forwarding technology of Internet Processor
- Provides breakthrough technology to support performance-based, enhanced Services
  - Security and bandwidth control (I.e. filtering) at speed
  - Visibility into network operations at speed
- Delivers performance WITH services
  - Supported on all interfaces

JUNOS Internet Software

- Common software across entire product line leverages stability, interoperability, and a wide range of features
- Purpose built for Internet scale
- Modular design for high reliability
- Best-in-class routing protocol implementations



T640 Internet Routing Node
New Industry Benchmark

- **Front panel WAN connect**
  - 640 Gbps throughput
  - 770 Mpps forwarding
  - 32 x OC-192c/STM-64 ports
  - 128 x OC-48c/STM-16 ports
  - 40 Gig slots
- **Rear panel local connect**
  - Matrix Technology
    - Optical backplane extension
    - Any-to-any, non blocking
  - 1280 Gbps throughput
- **Seamless scale**
  - Single JUNOS image
  - T-series Internet Processor
  - PIC portability
  - IPv6

T640 INTERNET ROUTING NODE

True 'Two-Way' High Density Routing...
Front and Rear Connectivity

Juniper NETWORKS

JUNOS Feature Highlights

Category	Features
IP Scale	❖T-series & M-series: Single binary image ❖JUNOS seamless scale to multi-terabit
IP Dependability	❖Internet proven platforms ❖Internet proven JUNOS
IP Security	❖Any port, any speed, any scale ❖No compromise
IP Service Richness	❖Any port, any speed, any scale ❖No compromise

IPv6 Implementation

Platform, Interface Support

Category	Feature	JUNOS	Related RFC
Media Support	Ethernet	since 5.1	RFC 2464
	PPP	since 5.1	RFC 2472
	NBMA	since 5.1	RFC 2491
	ATM (all encapsulations)	since 5.1	RFC 2492
	Frame Relay	since 5.1	RFC 2590

IPv6 Support Across All Platforms, Interfaces

IPv6 Implementation

Fundamental Features

Category	Feature	JUNOS	Related RFC
Forwarding	IPv6 forwarding	since 5.1	--
Addressing	IPv6 Address types	since 5.1	RFC 2373
	Global unicast address aggregation	since 5.1	RFC 2373
	:hex format with zero suppression	since 5.1	RFC 2373
	DNS	since 5.1	RFC 2874
	Stateless autoconfiguration	since 5.1	RFC 2462
	Network prefix length notation	since 5.1	RFC 2373
Routing	Static routes	since 5.1	--
	RIPng	since 5.1	RFC 2080
	IS-IS	since 5.1	--
	BGP with v4 Peering	since 5.1	RFC 2283, 2245
	BGP with v6 Peering	since 5.1	RFC 2283, 2245

IPv6 Implementation

Neighbor Discovery

Category	Feature	JUNOS	Related RFC
Neighbor Discovery (Router portion)	Router discovery	since 5.1	RFC 2461
	Prefix discovery	since 5.1	RFC 2461
	Parameter discovery	since 5.1	RFC 2461
	Address autoconfiguration	since 5.1	RFC 2461
	Address resolution	since 5.1	RFC 2461
	Next-hop determination	since 5.1	RFC 2461
	Neighbor unreachability detection	since 5.1	RFC 2461
	Duplicate address detection	since 5.1	RFC 2461

Note: Host portion for router in Next Phase (see next slides)

IPv6 Implementation

Management

Category	Feature	JUNOS	Related RFC
ICMPv6	Destination unreachable	since 5.1	RFC 2436
	Packet too big	since 5.1	RFC 2436
	Time exceeded	since 5.1	RFC 2436
	Parameter Problem	since 5.1	RFC 2436
	Echo request/reply	since 5.1	RFC 2436
Management	IPv6 MIB	since 5.2	RFC 2465
	ICMPv6 MIB	since 5.2	
	SNMP over IPv6	since 5.2	
	Textual conventions for general/address	since 5.2	RFC 2465/2851
	JUNOScript	since 5.1	--
Transition	Dual stack	since 5.1	RFC 2767
	Configured tunnels	since 5.1	RFC 2898

IPv6 Implementation

Applications

Category	Feature	JUNOS	Related RFC
Applications	Ping	since 5.1	--
	Telnet	since 5.1	--
	Traceroute	since 5.1	--
	FTP	since 5.1	--
	Netstat	since 5.1	--
	TCPdump	since 5.1	--
	SSH	since 5.1	--
	ifinfo	since 5.1	--

IPv6 Implementation

MPLS

Category	Feature	JUNOS	Related RFC
MPLS	L2 MPLS VPN / CCC	5.1	--

IPv6 Implementation

Options and Miscellaneous

Category	Feature	JUNOS	Related RFC
Optional Headers	**Hop-by-hop**	**since 5.1**	**RFC 2460**
Path MTU Discovery	**Host portion**	**since 5.1**	**RFC 1981**
	Router portion	**since 5.1**	**RFC 1981**
	Multicast addresses (forwarding - NP)	**since 5.1/NP**	**RFC 2373**

IPv6 Available Features

Now

- **Available on all M-series platforms**

Addressing & Forwarding

- Forwarding in hardware
- Addressing
  - Link, site, global
  - Stateless autoconfiguration
- Neighbor discovery

Routing Protocols

- IS-IS
- BGPv6
- RIPng
- Static

Operations & Transition

- Common support
- ICMPv6
- IP applications
  - Ping, telnet, etc.
- Transition
  - Configured tunnels
  - Dual stack

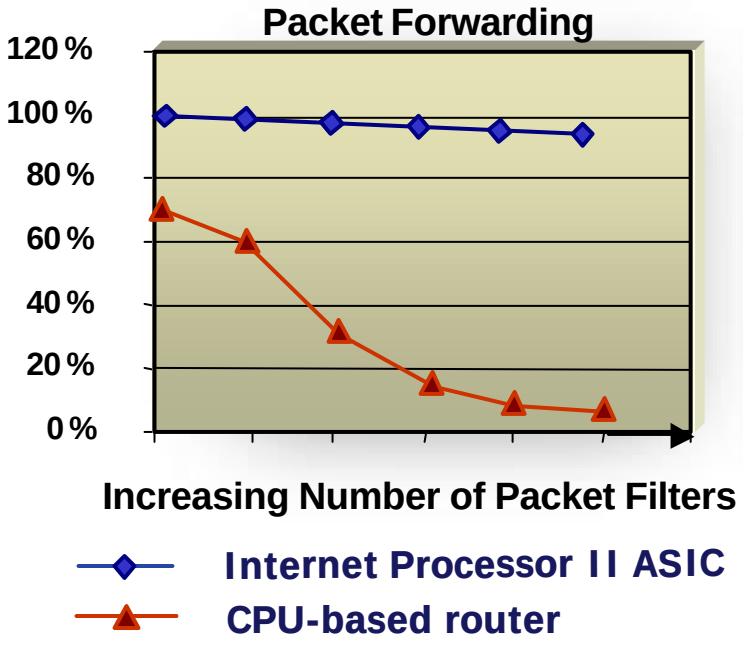
IPv6 FORUM

Juniper NETWORKS

IP2 Services
Filtering & Policing

5.3

- **Packet filtering**
  - DoS attack prevention
  - Comprehensive security
  - E.g. Source Address Filters
- **Policing**
  - Interface-level rate limiting
  - E.g. Bandwidth - limits bps
  - E.g. Maximum burst size
- **Predictable performance with rich IPv6 services**



IPv6 Filtering

- **IP-II enables significant functionality with applications to network management**
  - **Security**
  - **Monitoring**
  - **Accounting**

All IPv6 Packets Handled By Router

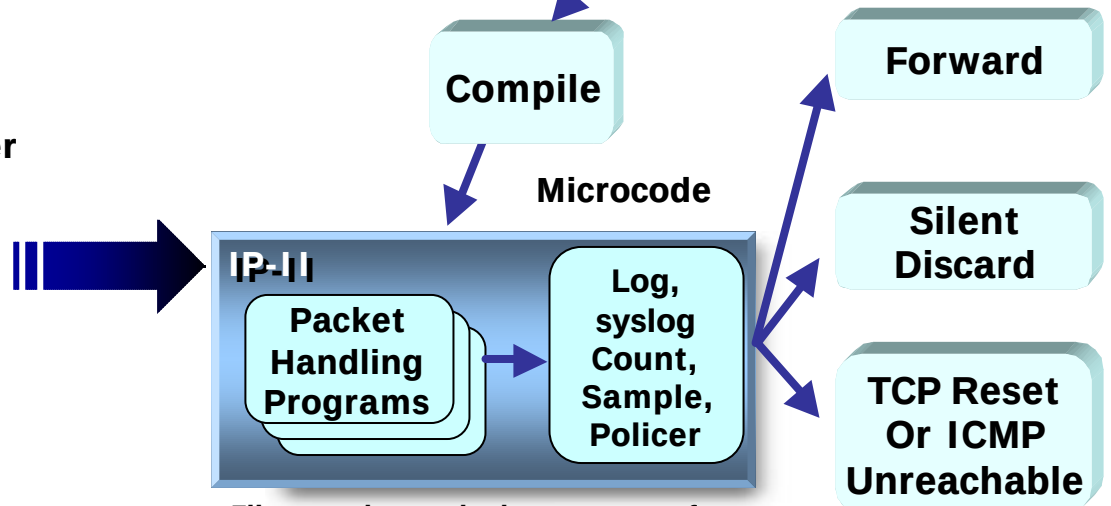
- IPv6 source address field
- IPv6 destination address field
- TCP or UDP source port field
- IP protocol field
- Next header field
- Traffic class field
- ICMP packet type

Filter Specification

5.3

```
filter Limit-Customer-A {
    policer Lim {
        if-exceeding {
            bandwidth-limit 1m;
            burst-size-limit 100k;
        }
        then discard;
    }
    term 1 {
        from {
            source-address {
                3ffe:1002:6411::/48;
            }
        }
        then {
            policer Lim;
            accept;
        }
    }
}
```

Multiple rules may be specified.

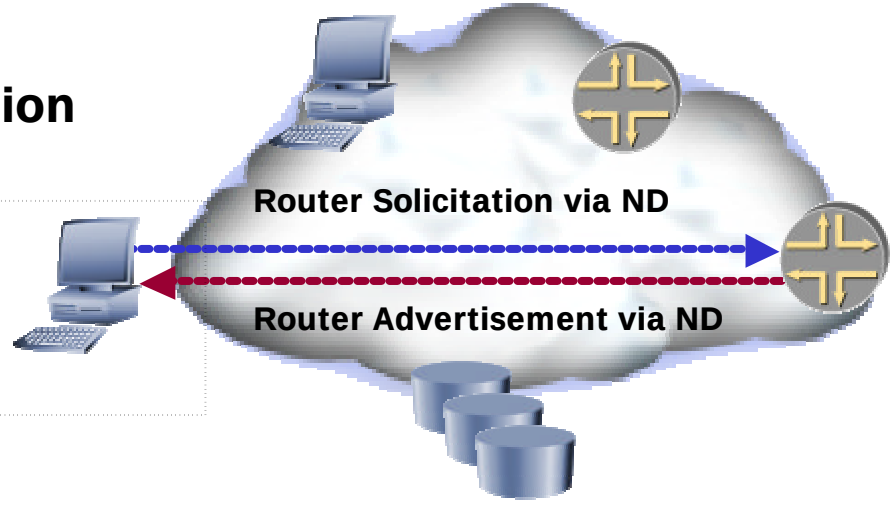


Filters and route lookup are part of same program

Autogeneration of EUI 64-bit Interface Addresses for IPv6

5.3

- **Stateless auto-configuration**
  - Node starts by appending its interface ID (EUI-64) to the link-local network prefix, fe80::/64
  - Sends router solicitation
  - Receives prefix from router advertisement
- **Benefits**
  - Simplifies host configuration
  - Broadens client coverage



IPv6 references (1)

- "As part of the GEANT IPv6 Test Program, GIP RENATER has been running a Juniper Networks M-series Internet router in its international POP to test IPv6 in a production network"

Bernard Tuy, manager of the IPv6 pilot service at GIP RENATER: "[…] Given the rapidly evolving plans regarding deployment of native IPv6 in research networks, we aim to run both IPv4 and IPv6 simultaneously over the same equipment while maintaining performance. We evaluated the Juniper Networks IPv6 implementation in a multi-domain environment. The first interoperability and stability tests carried out on equipment connecting to the 6bone (worldwide experimental network) and the 6TAP (US exchange point) proved Juniper Networks ability to play a major role in IPv6 integration in production networks".

PR 28/11/01

Source: http://www.juniper.net/news/pressreleases/2001/pr-011128.html

GÉANT IPv6 Test Programme: GTPv6

- The GÉANT project is the successor to QUANTUM, the project under which the European TEN-155 network was established. Where TEN-155 offered connectivity between National Research Networks of speeds up to 155Mbps, and in some instances 622Mbps, GÉANT will deliver multi-gigabit capacity. The network will also be extended into Eastern Europe.
- As part of the GÉANT project, a Test Programme has been established to evaluate and deploy new network technologies on the core network. This programme is being defined and operated by the TF-NGN (Task Force - Next Generation Networks), just as TF-TANT did for the test programme within QUANTUM. The TF-NGN activity is a joint venture of DANTE and TERENA.
- As part of the new GÉANT work programme, new work items have been agreed for study under GTPv6, and a new IPv6 pilot network deployment is being proposed. This new deployment will be much closer to a production-like network.

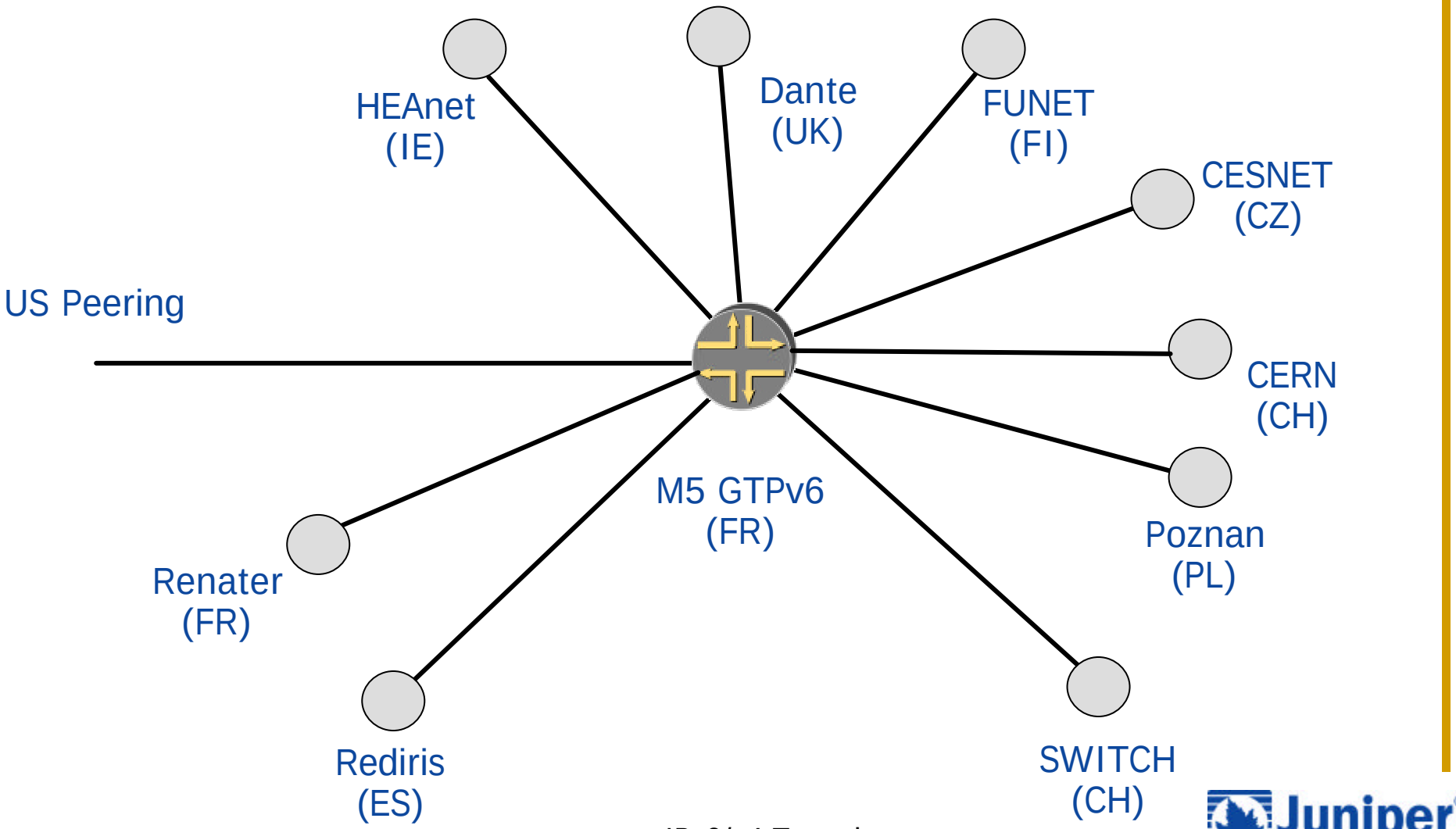
GTPv6 Objectives

- To gain and develop an understanding of the issues involved in deploying IPv6 networks, in terms of areas including physical infrastructure, address allocation, registries, routing and DNS operation.
- To gain experience in operational management of an IPv4/IPv6 backbone.
- To gain insight into the implications of the new IPv6 protocol, and how it will impact the backbone network, NRN backbones and University end sites.
- To deploy and operate a production(or as close as possible to) quality IPv6 backbone network that can interconnect to any GÉANT participant IPv6 network, and that can peer with/offer transit to other world-wide IPv6 networks.
- To encourage NRNs to participate in GTPv6 such that they in turn may offer IPv6 connectivity to their own Universities/sites.
- To collaborate with other European IPv6 projects to gain a better mutual understanding of IPv6 deployment issues.

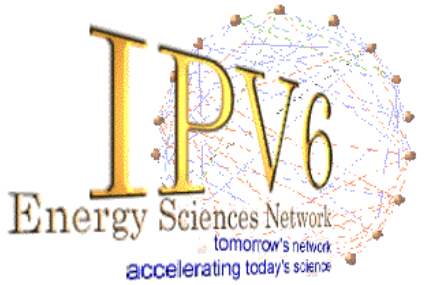
Juniper and GTPv6

- Renater (French REN) hosts and manages a Juniper M5 router to connect every participant of the TF-NGN ready to exchange IPv6 traffic through the MBS service provided by Dante
- The equipment is installed in Renater international connections premises in Paris (NIO) and connected to the Renater IPv6 pilot service. It is under Renater NOC responsibility where an engineer is dedicated to IPv6 connectivity matters
- Every partner is allowed to use the 6TAP connectivity

Juniper IPv6 router peerings



IPv6 references (2)



- ”The distributed 6TAP at PAIX in Palo Alto, Calif., an IPv6 exchange point where North American, European, and Asian IPv6 networks peer, also put Juniper Networks IPv6 in a tough live network environment. The distributed 6TAP is operated by the Energy Sciences Network (ESnet) in Palo Alto and New York, and jointly with CANARIE in Chicago at the STAR TAP.”

"As one of the distributed 6TAP peering points for many of the world's IPv6 networks, router interoperability, and performance are critical to our operations. The Juniper Networks IPv6 solution currently in use in the 6TAP production network has proven its ability to interoperate with the IPv6 routers used by our peers. We are looking forward to taking advantage of Juniper Networks high-performance IPv6 forwarding capabilities to support the expected worldwide growth in IPv6 traffic," commented Bob Fink, co-chair of the IETF's Next Generation Transition working group and a 6TAP co-founder.

PR 28/11/01

Source: http://www.juniper.net/news/pressreleases/2001/pr-011128.html

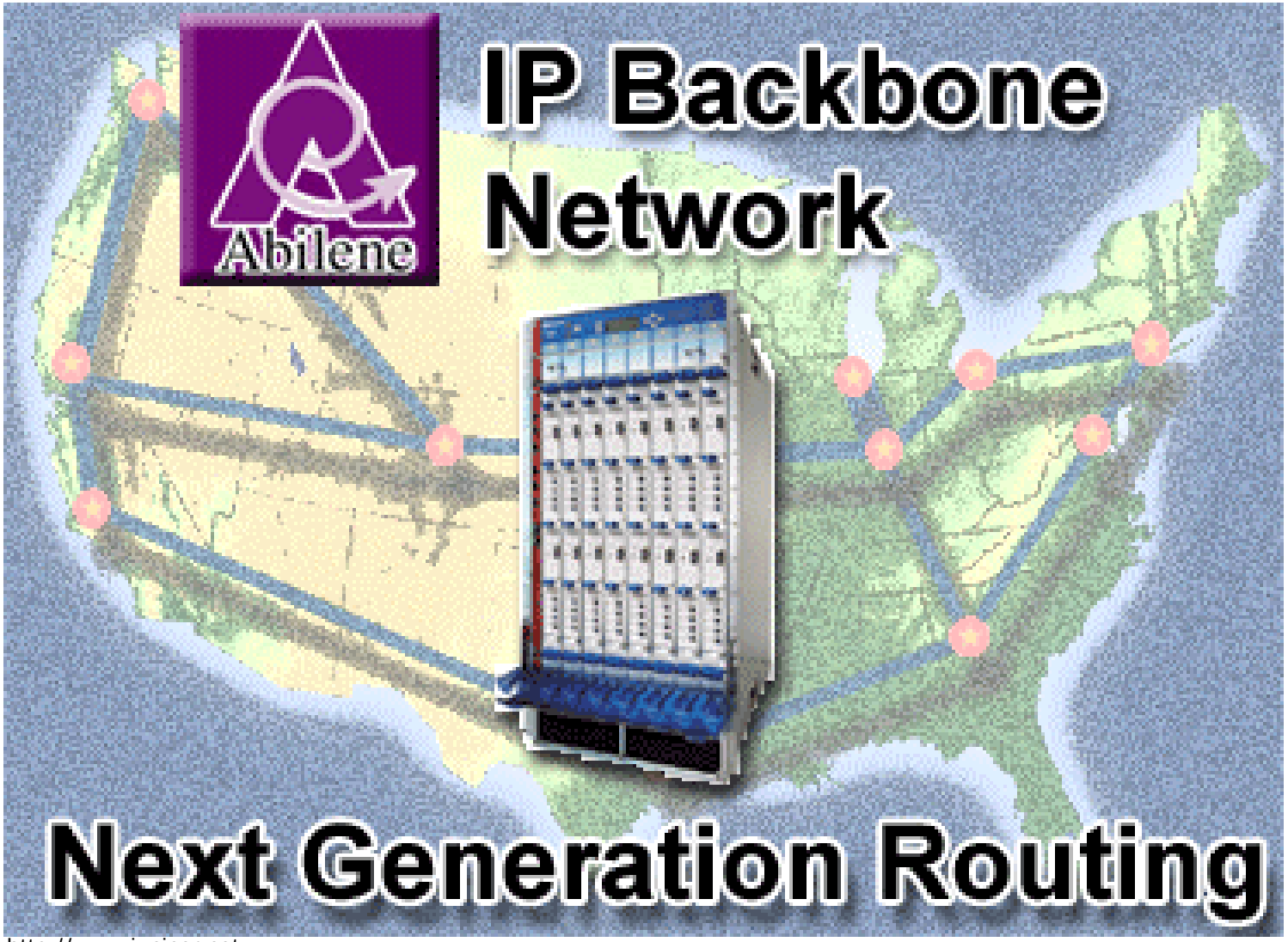
IPv6 references (3)

- "France Télécom Research and Development (France Télécom R&D) manages the very high bandwidth platform (VTHD) for a number of partners including research institutions, universities, and schools of engineering. […] IPv6 is now deployed in dual-stack mode with Juniper Networks. […] Amongst others results, these tests validated IPv6 packet throughput at OC-48c/STM-16 speeds, interoperability with other platforms and the ability of Juniper Networks routers to simultaneously run IPv4 and IPv6 without performance degradation.

PR 28/11/01

Source: http://www.juniper.net/news/pressreleases/2001/pr-011128.html

IPv6 references (4)



Source: http://www.internet2.edu

Abilene

- “Internet2 today announced that it will deploy Juniper Networks' most advanced core routing product for the next generation of the Abilene backbone network. The nationwide upgrade will quadruple Abilene's capacity to 10 gigabits per second and natively deploy the next generation Internet protocol, IPv6[…]. Abilene will deploy eleven T640 Internet Routing Nodes, the first product from Juniper Networks T-series Internet routing family. The T640 Internet Routing Node brings leading edge routing technology to Abilene, offering seamless multi-terabit scaling as well as IPv6 hardware forwarding. The routing platform upgrade to Abilene is scheduled to be complete by late fall 2002.”

PR 23/04/02

Source: http://archives.internet2.edu/guest/archives/I2-NEWS/log200204/msg00003.html

Thank You

http://www.juniper.net