



IPv6 network management



Contributions

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Agenda

- Introduction
- Retrieving information from routers
 - TELNET/SSH/TFTP/FTP...
 - SNMP/MIBs and IPv6
 - Netflow
- Management platforms
- Management tools
 - 6NET work
 - Recommendations (LAN, WAN...)
 - Examples
- Conclusion & Demo



Introduction

- IPv6 networks deployed:
 - Most are dual stack
 - LANs (campuses, companies, ...)
 - MANs
 - WANs - ISPs (Géant, NRENs, IJ, NTT/Verio, Abilene, ...)
 - IX's
- Testbed, pilot networks, production networks
 - Management tools/procedures are needed
- What applications are available for managing these networks ?
 - Equipment, configurations, ...
 - **IP services** (servers : DNS, FTP, HTTP, ...)



Introduction

- Different types of networks
 - Dual stack IPv6 & IPv4 networks
 - IPv6 only networks (few of them)
- Important to keep in mind
 - Dual stack is not for ever
 - One IP stack should be removed... one day
 - No reasons for network admins to face twice the amount of work



Dual Stack IP networks

- Part of the monitoring via IPv4
 - Connectivity to the equipment
 - Tools to manage it (inventory, configurations, «counters», routing info, ...)
- Remaining Part needs IPv6
 - MIBs IPv6 support
 - NetFlow (v9)



IPv6 only networks

- Topology discovery (LAN, WAN ?)
- IPv6 SNMP agent
- SNMP over IPv6 transport

=> Need to identify the missing parts





SSH/TELNET/TFTP...

Basic requirements to manage a
network



SSH/TELNET/TFTP...

- All routers support IPv6 connections (SSH, TELNET)
 - Periodic scripts can retrieve information from the routers over IPv6
- TFTP/IPv6 as well supported on every equipment
 - Images can be downloaded over IPv6
- FTP/IPv6 not supported on CISCO routers



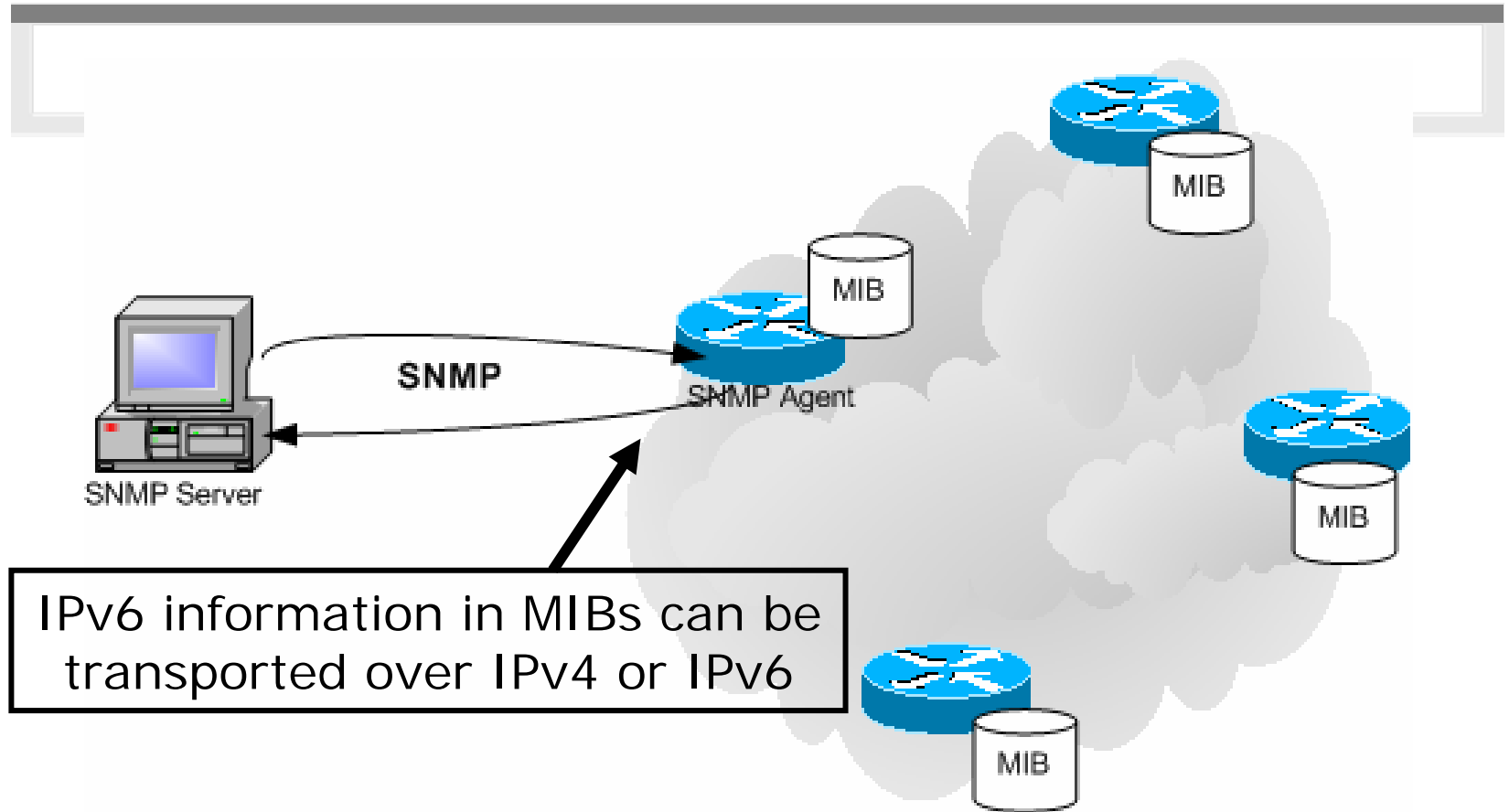


SNMP/MIBs and IPv6

- SNMP and IPv6
- IPv6 MIBs status
- Manufacturers implementations



SNMP model



SNMP over IPv6

- Cisco:
 - SNMP over IPv6 is available in 12.0(27)S and 12.3(14)T
 - IOS 12.4 & 12.4T too
 - More features available from 12.0(30)S
- Juniper, Hitachi, 6wind:
 - SNMP over IPv6 is available





IPv6 MIBs Status



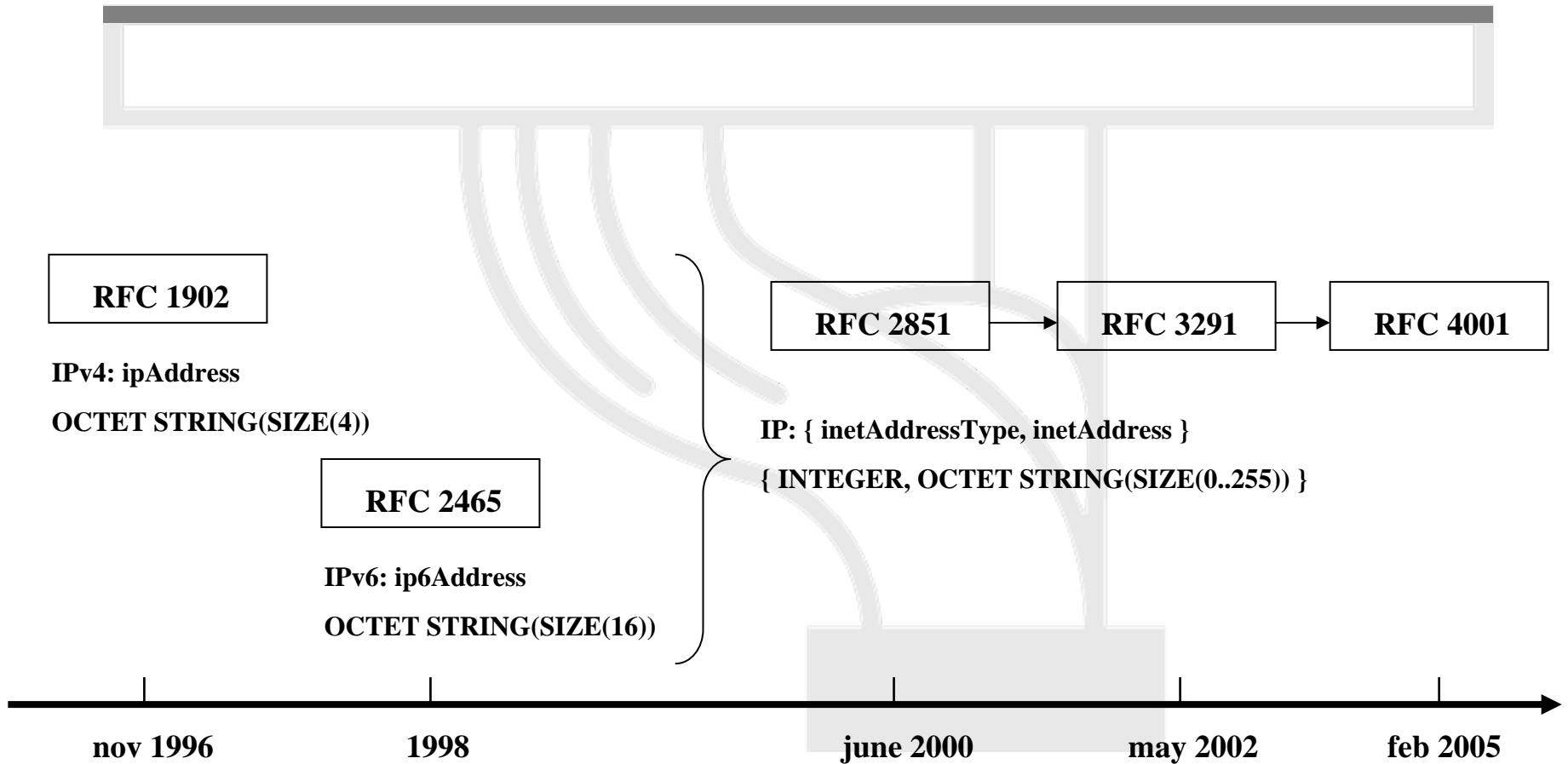
IPv6 MIBs /2

- Standardization status at IETF:
 - At the beginning:
 - IPv4 and IPv6 MIBs **dissociated**

	IPv4	IPv6	Remarks
Textual Conventions	RFC1902	RFC2465	Definition of IP address format
IP MIB	RFC2011		
ICMP MIB		RFC2466	
TCP MIB	RFC2012	RFC2452	
UDP MIB	RFC2013	RFC2454	

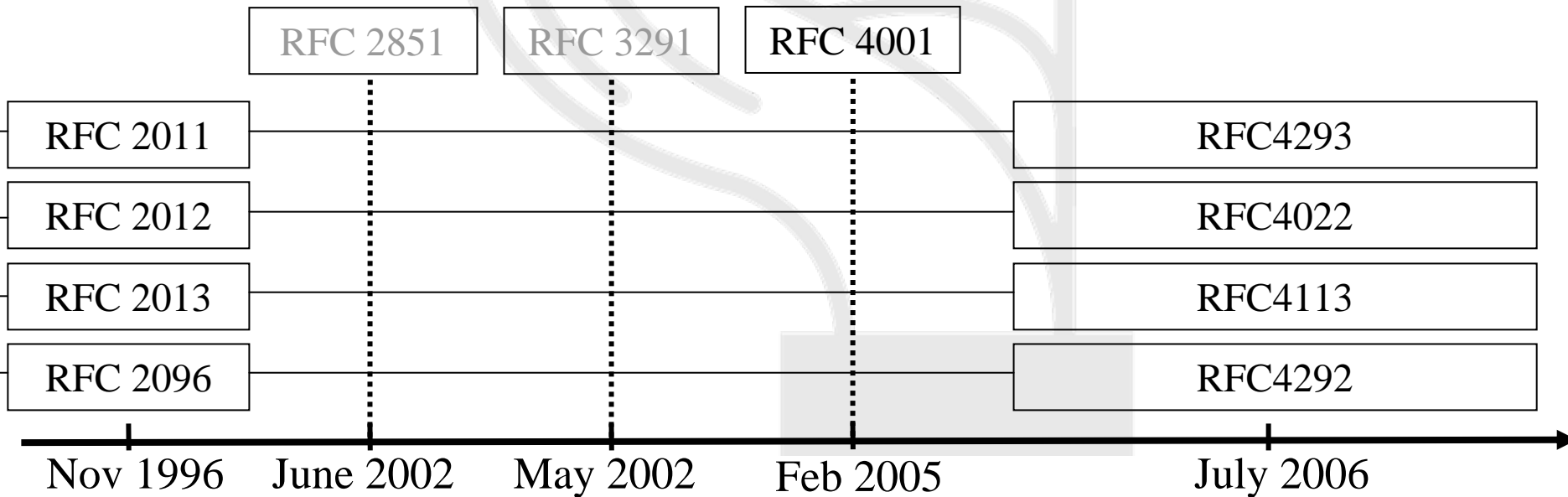


IPv6 MIBs /3



IPv6 MIBs /4

- Standardization status at IETF
 - Today : **unified MIBs** are on standard track.



IETF MIB Status /6

- BGP MIB v6:
 - draft-ietf-idr-bgp4-mibv2-05.txt (07/2005)
 - Expired

Note that the same people are working on

- draft-ietf-idr-bgp4-mib-15.txt (08/2004)
 - → RFC 4273
 - *This draft consider only IPv4 addresses:*
 - « **IMPORTS IpAddress** » → 32 bits





IPv6 MIBs implementations



IPv6 MIBs implementation/1

- Cisco
 - Private Cisco MIBs implement RFC 2011 (IP) & 2096 (Forwarding) updated drafts
 - Work on implementing the new standards
 - No distinction between IPv4 and IPv6 traffic at the interface level from the MIBs (available when new IETF MIB get implemented)
 - Information available from CLI
 - `show interface accounting`
 - ...



Cisco: IPv6 CLI

```
"show interface accounting"
```

- Differentiate IPv4/IPv6 counters at the interface level for all Cisco routers, except for:
 - Catalyst **6500** / Cisco **7600** supervisor engine 720:
Counts only for packets that are software switched, not the hardware switched packets.
 - GSR:**
 - 'show interface counters' correctly counts IPv6 traffic and separates ingress and egress traffic
 - **Engine 3:**
 - * OUTPUT IPv6 traffic is counted under IPv6 (correct)
 - * INPUT IPv6 traffic is counted under IP (will get corrected)



IPv6 MIBs implementation/2

- Juniper
 - MIB based on (old) RFC 2465
 - with different counters for IPv4 and IPv6 traffic
 - Or based on filters to collect IPv6 traffic:
 - Ex: Geant monitoring
- => Expected : unified MIBs implementation



IPv6 MIBs implementation/3

- Hitachi
 - Routers (GR2000/GR4000) and Switches (GS4000) support IPv6 standard MIBs:
 - RFC 2452: TCP/IPv6
 - RFC 2454: UDP/IPv6
 - RFC 2465: IPv6
 - RFC 2466: ICMPv6
 - The unified MIBs are not implemented yet.



IPv6 MIBs implementation/5

- Net-SNMP (Carnegie Mellon Univ)
 - <http://net-snmp.sourceforge.net/>
 - IPv6 support from version 5.0
 - RFC 2452: TCP/IPv6
 - RFC 2454: UDP/IPv6
 - RFC 2465: IPv6
 - RFC 2466: ICMPv6
 - RFC 3291: (new) textual convention for representing Internet Addresses

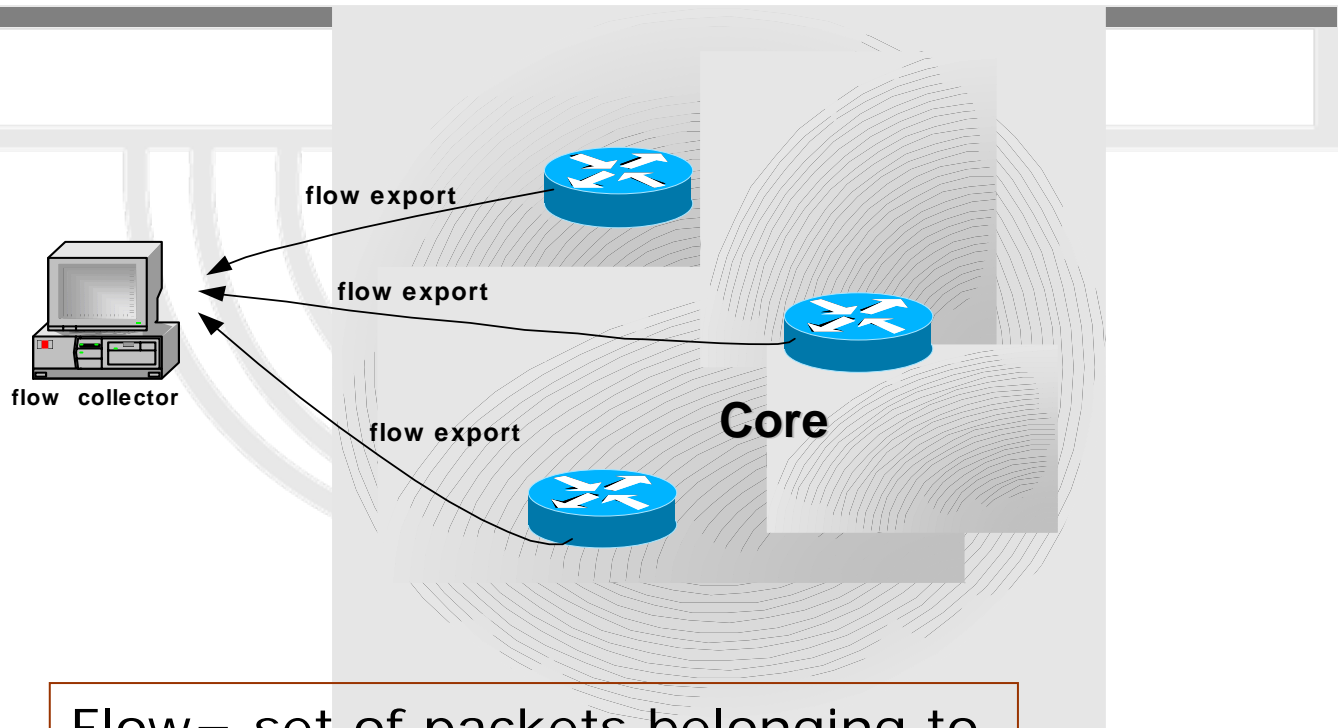




IPv6 flow monitoring



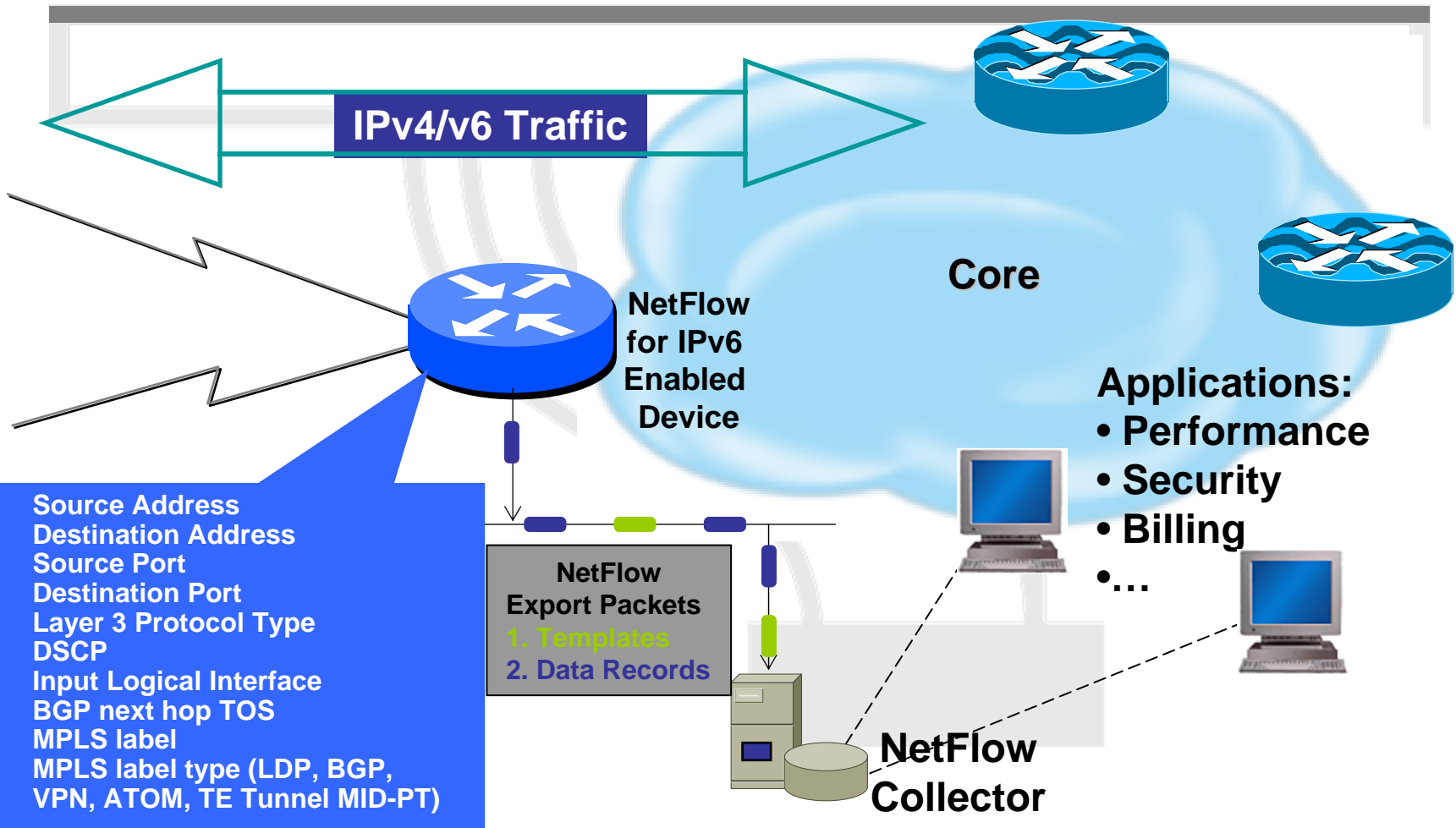
Netflow & IPFIX model



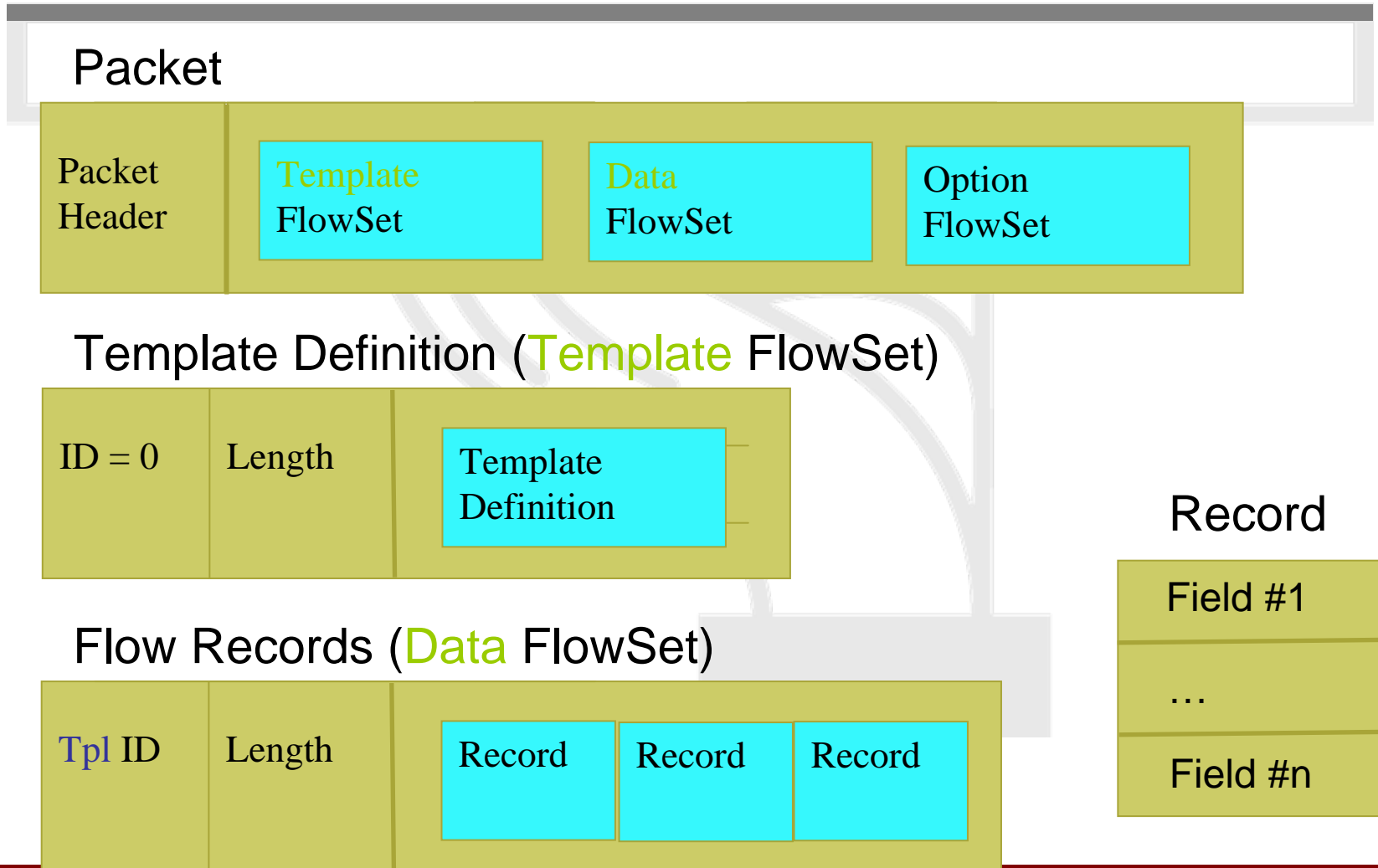
Flow= set of packets belonging to the same application between a Source/Destination couple



NetFlow for IPv6



NetFlow Version 9



NetFlow Version 9

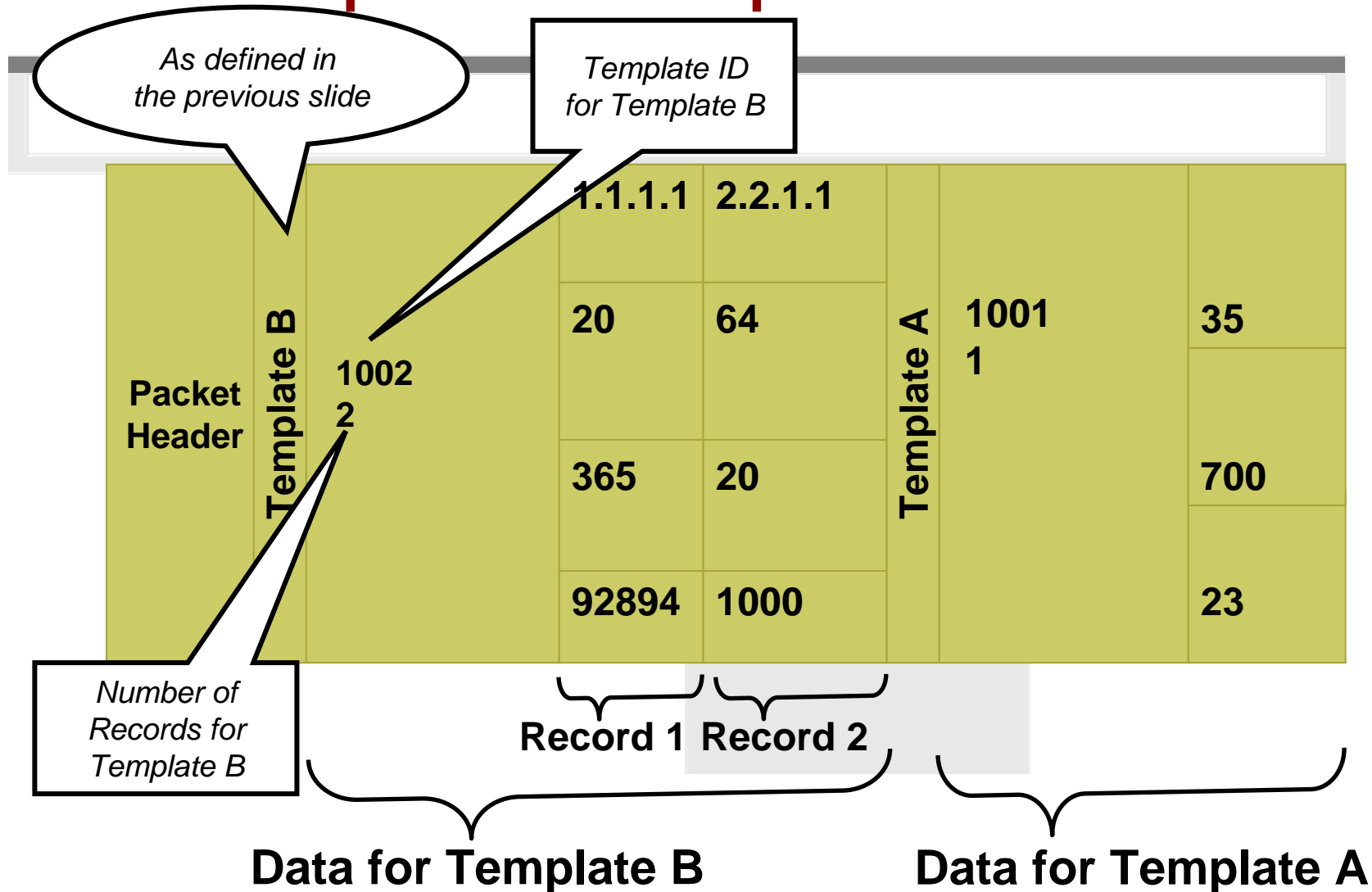
Example for Template Definition

Template A
Flow Set ID (0 for Template)
Length of Template Structure
1001 (Template ID)
3 (# of Fields)
SRC_AS_NUMBER
2
DST_AS_NUMBER
2
L4_PROTOCOL
2

Template B
Flow Set ID (0 for Template)
Length of Template Structure
1002 (Template ID)
4 (# of Fields)
SRC_IP_PREFIX
4
SRC_AS_NUMBER
2
PACKET_COUNT
2
BYTE_COUNT
2



Example for Export Packet



IPv6 flow monitoring /1

- Cisco
 - Available in IOS 12.3(7)T and later version
 - IPv6 packets captured (**needs IPv6 CEF**)
 - Export done with *Netflow v9*
 - Still uses *IPv4 transport*
 - Need to update your own Netflow Collector
 - Cisco NFC v5.0 available
 - Other collectors are available as well
 - » <http://supervision-ipv6.renater.fr/Portail/>
 - » Netflow v9 collector : Renater's collector (**Renetcol**)



IPv6 flow monitoring /2

- Hitachi
 - Support **Sflow** RFC 3176 (<http://www.sflow.org/>)
 - and Netflow is on the roadmap ?
- 6WIND:
 - Not available
- Juniper:
 - **Cflowd** (#Netflow)





Commercial Management platforms



Commercial platforms

- Commercial ISPs use to have integrated management platforms (NRENs mainly use GPL or home-made tools)
- **HP-OV** proposes a version with IPv6 features: NNM 7.0 (sept 2003). Need some hack for automatic IPv6 discovery of CISCO routers.
 - **Ciscoworks**: IPv6 version for
 - LMS 2.5 : LAN Management solution
 - Includes a set of functionalities (Campus Manager 4.0, Ciscoview 6.1, ...)
 - CNR 6.2 : Cisco Network Registrar (Naming & addressing services)
Application note on IPv6 management
 - **Tivoli Netview** doesn't propose any IPv6 features
 - **Infovista** : « no IPv6 plan at the moment »



Cisco: LMS Application supports IPv6

LMS: LAN Management Solution version 2.5

- Includes :
 - Campus Manager 4.0
 - Resource Manager Essential
 - CiscoView version 6.1
 - Cisco Network Registrar (CNR 6.2)
 - Device Fault Manager
 - Internet Performance Monitor
 - Common services



« Top ten » ...

- HP Openview
- Ciscoworks 2000 (LMS 2.5)
- IBM Netview
- Infovista, Tivoli
- ...

IPv6 ready

IPv6 not ready





Monitoring tools



6Net and IPv6 monitoring tools

- 6Net WP6 : managing large scale IPv6 networks
 - Tests lots of IPv6 ready tools
 - Many others ported to IPv6
- 30+ monitoring tools for IPv6
 - Tested
 - Implemented
 - Documented
- URL: <http://tools.6net.org/>





Examples



Argus

- Administration of network:
 - PCs, Switches, Routers
 - Availability
 - Traffic on the network
- Administration of services:
 - http, ftp, dns, imap, smtp...
- Evolution: new features can be easily added



Argus - Top:Serveurs-SIPA - Microsoft Internet Explorer

Fichier Edition Affichage Favoris Outils ?

Adresse <http://supervision-ipv6.renater.fr/private/argus/prog?object=Top:Serveurs-SIPA;func=page>

Top:Serveurs-SIPA User: jdurand

name Serveurs-SIPA
status up

Name	Status
data-ipv6 IPv4	Ping FTP
data-ipv6 IPv6	Ping FTP
sem2 IPv4	Ping HTTP renater fr
sem2 IPv6	Ping HTTP renater fr

Status: up since Thu 11 Nov 20:59:44 2004

	start	elapsed time	% up	% down	times down
Today	Mon 22 Nov 00:00:00 2004	10:00:00	100.0	0.00	0
Yesterday	Sun 21 Nov 00:00:00 2004	1d 0:00:00	100.0	0.00	0
2 Days Ago	Sat 20 Nov 00:00:00 2004	1d 0:00:00	100.0	0.00	0
This Month	Mon 1 Nov 00:00:00 2004	21d 9:48:49	98.28	1.72	1
Last Month	Fri 1 Oct 00:00:00 2004	1m 1:00:00	99.97	0.03	1
2 Months Ago	Mon 13 Sep 11:14:37 2004	17d 12:33:52	100.0	0.00	1
This Year	Mon 13 Sep 11:14:37 2004	2m 10d 23:22:41	99.46	0.54	3

Thu 11 Nov 20:59:44 2004 up TRANSITION - data-ipv6_IPv4
 Thu 11 Nov 12:08:57 2004 down TRANSITION - data-ipv6_IPv6
 Wed 13 Oct 17:13:44 2004 up TRANSITION - data-ipv6_IPv4
 Wed 13 Oct 17:02:33 2004 down TRANSITION - data-ipv6_IPv6
 Mon 13 Sep 11:28:39 2004 up TRANSITION - sem2_IPv4

[Override](#)

[Annotate](#)

[Flush Cache](#)

[Display Config](#)

[Debugging](#)

[Un-Acked Notices](#)

[Notifies](#)

[Error Log](#)

[Top](#)

[Logout](#)

Argus: 3.3

10:48
lundi
22/11/2004

Internet 40

Nagios

- <http://www.nagios.org>
- Very complete tool
 - Services monitoring
 - Network monitoring
- Can be complex for a small network
- Evolution: new features can be added with plug-ins
 - BGP monitoring
 - ...



Nagios

Nagios

General

- Home
- Documentation

Monitoring

- Tactical Overview
- Service Detail
- Host Detail
- Status Overview
- Status Summary
- Status Grid
- Status Map
- 3-D Status Map
- Service Problems
- Host Problems
- Network Outages
- Comments
- Downtime
- Process Info
- Performance Info
- Scheduling Queue

Current Network Status
 Last Updated: Thu Jan 8 09:33:05 CET 2004
 Updated every 90 seconds
 Nagios@ - www.nagios.org
 Logged in as ?

[View Service Status Detail For All Host Groups](#)
[View Status Overview For All Host Groups](#)
[View Status Summary For All Host Groups](#)
[View Status Grid For All Host Groups](#)

Host Status Totals

Up	Down	Unreachable	Pending
1	1	0	0
All Problems		All Types	
1		2	

Service Status Totals

Ok	Warning	Unknown	Critical
1	0	1	3
All Problems		All Types	
4		5	

Host Status Details For All Host Groups

Host ↑↓	Status ↑↓	Last Check ↑↓	Duration ↑↓	Status Information
data-ipv6	DOWN	08-12-2003 15:26:43	148d 21h 58m 44s	/bin/ping -n -U -c 1 193.49.159.67
sem2	UP	08-12-2003 15:27:43	148d 21h 55m 22s	(Host assumed to be up)

2 Matching Host Entries Displayed



ASpath-Tree

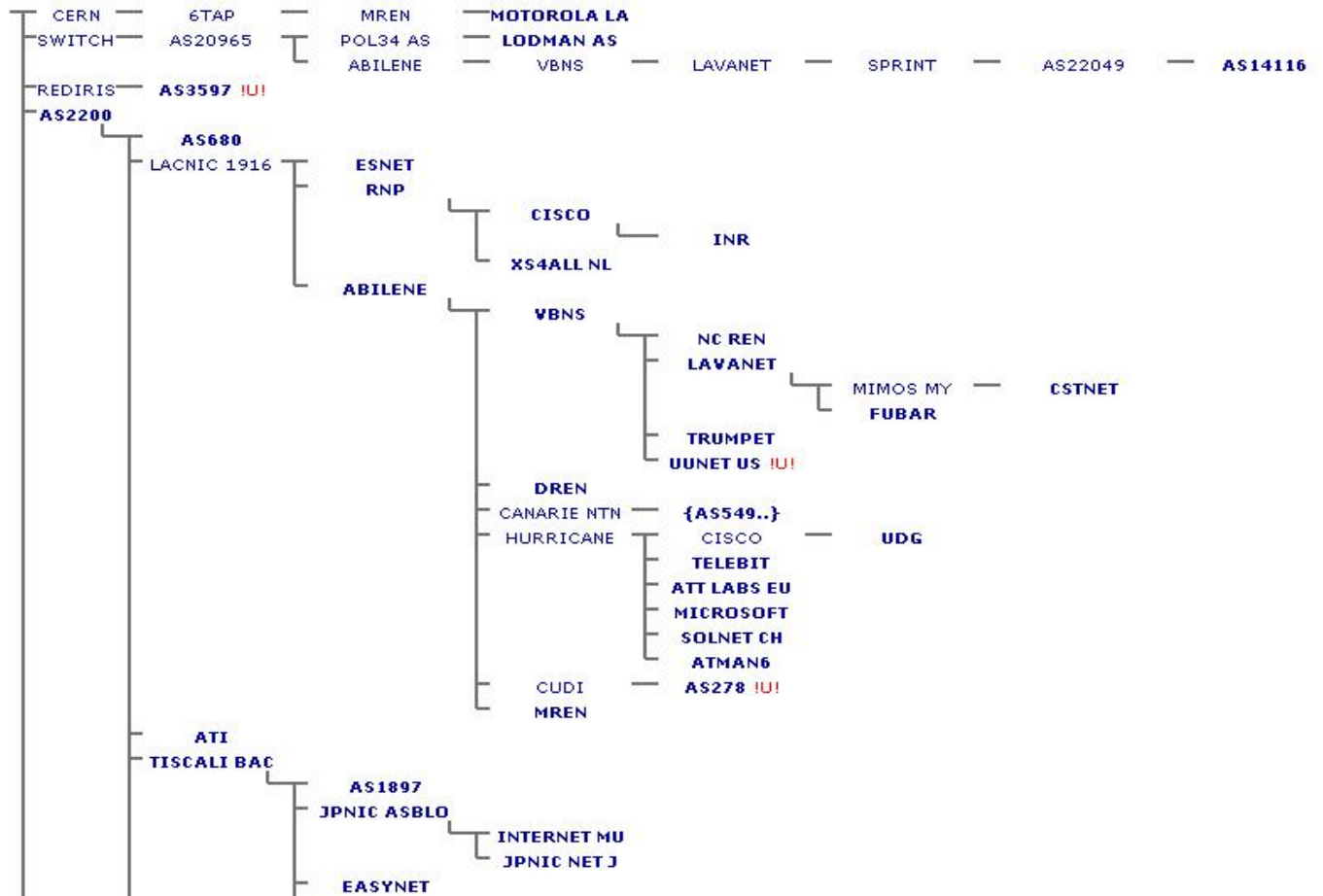
- Display BGP4+ « topology » from
 - BGP4+ routing table
 - Retrieved from connection to routers (RSH/SSH...)
- Generate HTML pages.



ASpath-Tree

Renater The whole IPv6 BGP table

RENATER Project Network



Looking Glass

- Get information on a router w/o direct connection
- Web Interface
- Final user don't need a login
- Allows the user to detect causes of failures w/o asking the NOC or netadmin



Looking Glass

RENATER Looking Glass

BGP tables

show bgp IPv6

- routing_table
- summary
- neighbors

BGP with regular expression

show bgp IPv6

regular expression :

Don't use the character "\$"

IPv6 traffic

IPv6 interface

IPv6 tunnels

IPv6 neighbors

IPv6 route

Ping XXXXX

Traceroute XXXXX

show ip bgp XXXXX

show ip bgp summary

show ip bgp dampening dampened-paths

show ip mroute summary

show ip mroute active

show ip mbgp summary

show ip mbgp XXXXX

IPv4 address . . .

IPv6 address

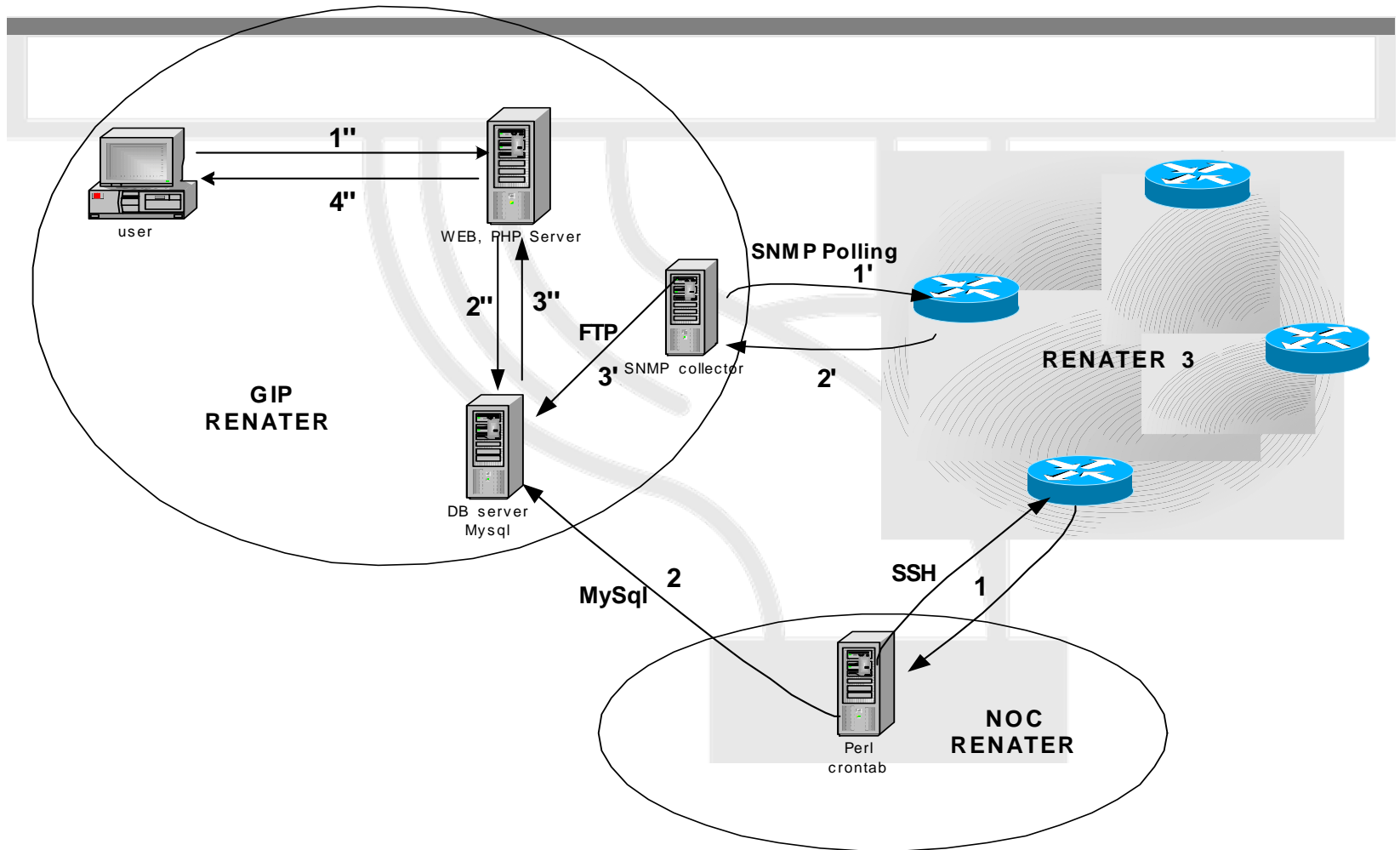
name address IPv4

name address IPv6

Router:





Inventory : interfaces & peerings




Inventory: Interfaces

NR de marseille

nr_Marseille	switch_atm_Marseille
	





[peering](#)

	POS2/0 - Lien vers MONTPELLIER(pos2/0) <hr/> POS3/0 - Lien vers NICE(pos 1/0)	
<p style="text-align: center;">interfaces Ethernet</p> <hr/> Ethernet0 - Administration LOCALE	 <p>nr_Marseille</p>	<p style="text-align: center;">Interfaces ATM</p> <hr/> ATM0/1 - Lien vers MARSEILLE-ATM(a2/0/1) ATM0/1.254-aa15_layer - Administration inB ATM0/1.3-aa15_layer - -rrRRTHD PACA ATM0/1.789-aa15_layer - IN2P3 ATM0/1.90-aa15_layer Lien Xcast vers Marseille (0 90) <hr/> ATM0/2 - Lien vers MARSEILLE-ATM(a0/0/1) ATM0/3 - Lien vers MARSEILLE-ATM(a2/0/3) <hr/> ATM0/3.1-aa15_layer - Universite PHOCEAN
<p>Légende:</p> <ul style="list-style-type: none"> Lien du backbone Lien vers un site Lien vers l'international Lien vers un réseau régional Lien Multicast Lien d'administration <p>* Interface DOWN</p>	<p style="text-align: center;">Interfaces libres</p> <hr/> *ATM0/0 - LIBRE	<p style="text-align: center;">Autres interfaces</p> <hr/> Pas d'interfaces de ce type pour ce routeur




Inventory: BGP Peering

NR de PROJETS

PROJETS_GSR-NIO	PROJETS_GSR-6NET	PROJETS_7200-MCAST	PROJETS_M5
			

[interfaces](#)

Routeur PROJETS_GSR-NIO	Peering BGP
	peering iBGP
	Established *** Peer-group de tous les routeurs IBGP *** AS 1717 - FR-RENATER-PROJETS
	Established *** Peer-group de tous les routeurs IBGP *** AS 1717 - FR-RENATER-PROJETS
	Established *** Peer-group de tous les routeurs IBGP *** AS 1717 - FR-RENATER-PROJETS
	peering eBGP
	Established *** eBGP NRI-A RENATER3 *** AS 2200 - FR-RENATER
	Established *** eBGP RENATER3 IPv4 *** AS 2200 - FR-RENATER
	Active *** eBGP @IRS++ KWAK durand@renater.fr *** AS 65004 -
	Active *** eBGP @IRS++ PIETRA durand@renater.fr *** AS 65004 -



IPv6 traffic on Cisco routers

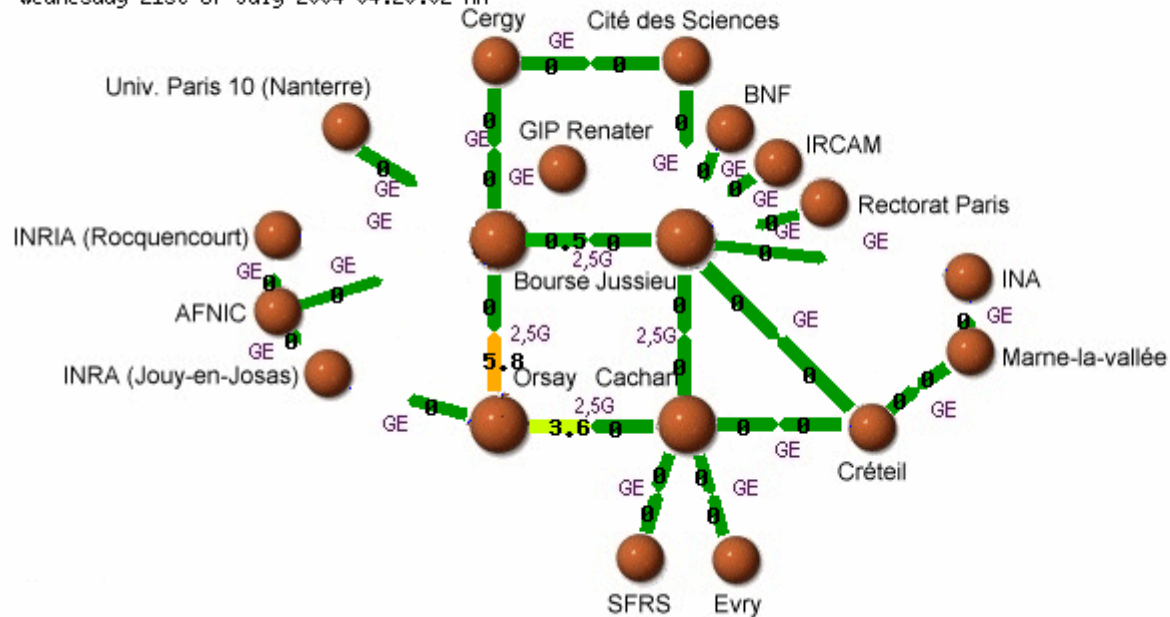
- Based on CLI program
 - "show interface accounting"
 - Differentiate IPv4/IPv6 counters at the physical interface level
- One query per hour
 - IPv6 Weather Map of RENATER



IPv6 traffic on Cisco routers

Renater network - IPv6 Weathermap

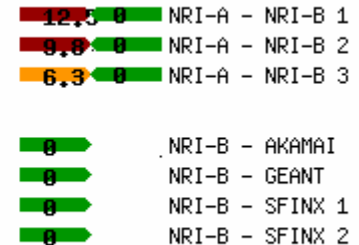
Wednesday 21st of July 2004 04:20:02 AM



Légende

GE : liaison Ethernet 1 Gbit/s
 2,5G : liaison 2,5 Gbit/s
 10G : liaison 10 Gbit/s

Liens vers réseaux de collecte et sites:



Conclusion

- ISPs –and any other organizations- need monitoring tools to launch a new service/protocol into production
- Most of management protocols are on standard track
- Lots of monitoring tools are now ready for IPv6 networks
- But :
 - Q1: are my usual tools (used for IPv4 monitoring) available for IPv6 too ?
 - Q2: what do I need to stress to my favourite vendor to be ready and manage my IPv6 network ?



Retrieve this information ...

- <http://www.renater.fr> > users > training courses
 - -> Presentations
- <http://www.renater.fr> > research & innovation > bibliographie
 - -> Bibliography, RFCs, ...



