



IPv6 network management

**6DEPLOY. IPv6 Deployment and Support**



# Contributions

**Simon Moyal, RENATER**

**Bernard Tuy, RENATER**

**Jérôme Durand, RENATER**

**Ralf Wolter, Cisco**

**Patrick Grossetête, Cisco**



# 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, IJJ, NTT/Verio, Abilene, ...)
  - IXs

## 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 forever
- 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**





# deploy

**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 is also supported on all equipment**

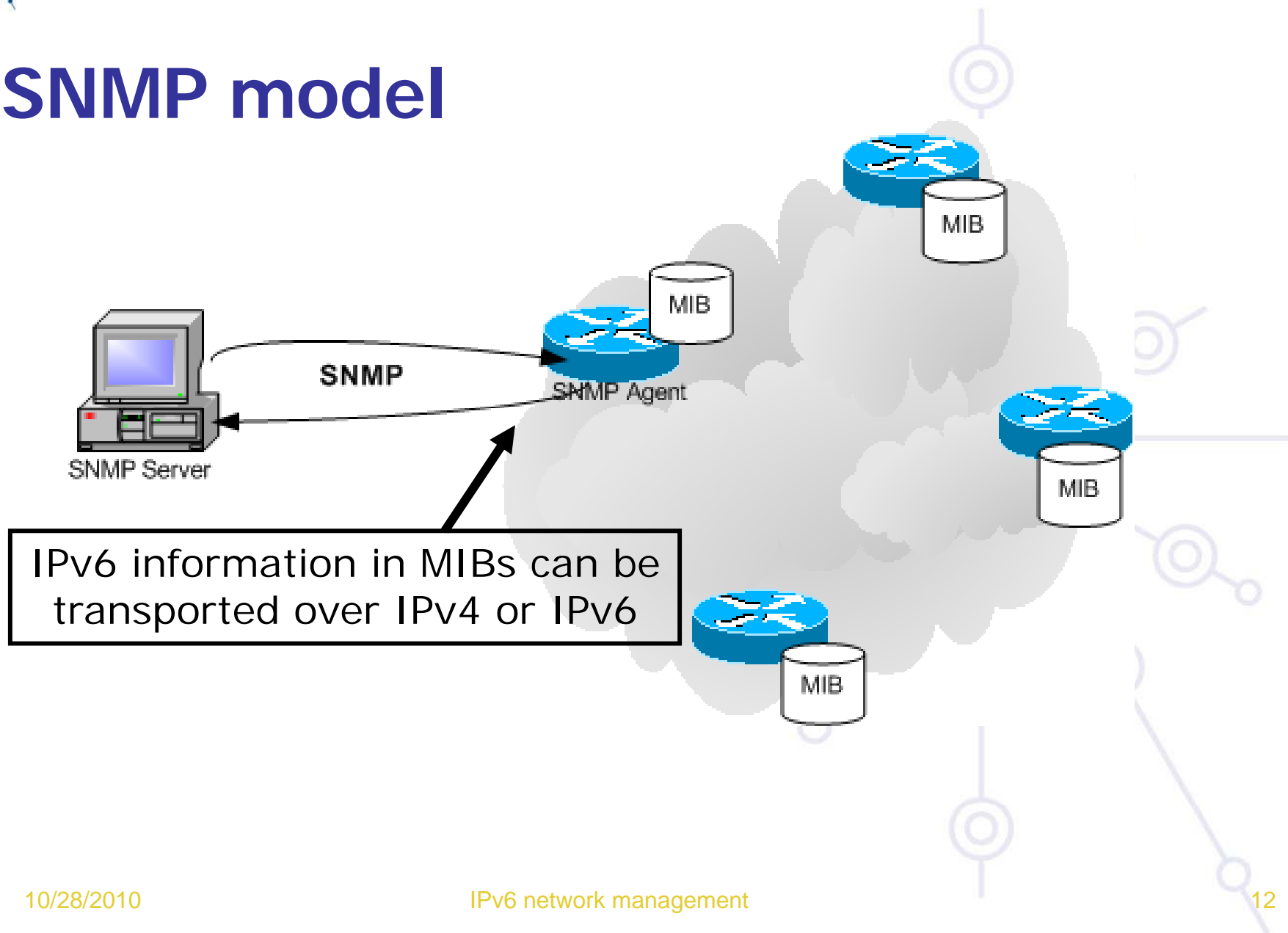
- Images can be downloaded over IPv6

## **FTP/IPv6 is not supported on CISCO routers**



**SNMP/MIBs and IPv6**  
**SNMP and IPv6**  
**IPv6 MIBs status**  
**Manufacturer's implementations**

# SNMP model



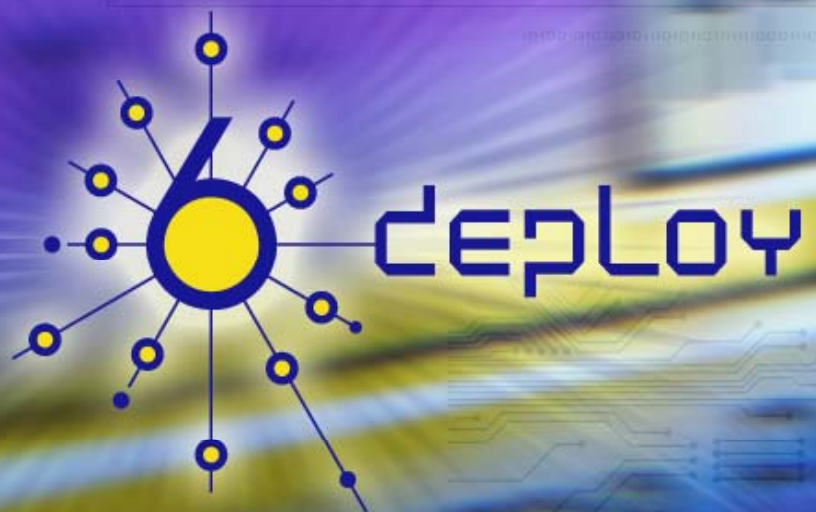
# SNMP over IPv6

## 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 status /1

**MIBs are essential for the network management**

**SNMP-based applications are widely used but others exist too (NetFlow, XML, ...)**

**SNMP rely upon MIBs**

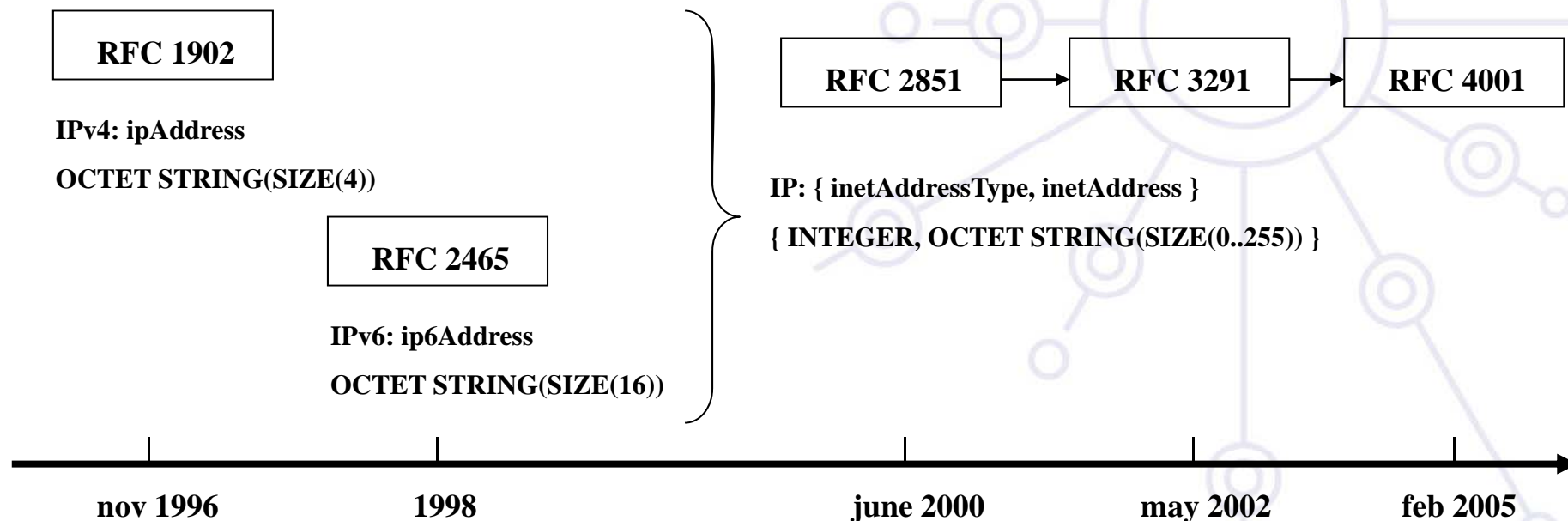
=> Need to have MIBs to collect IPv6 information as well as get MIBs reachable from an IPv6 address family



# IPv6 MIBs /2

## Standardization status at IETF:

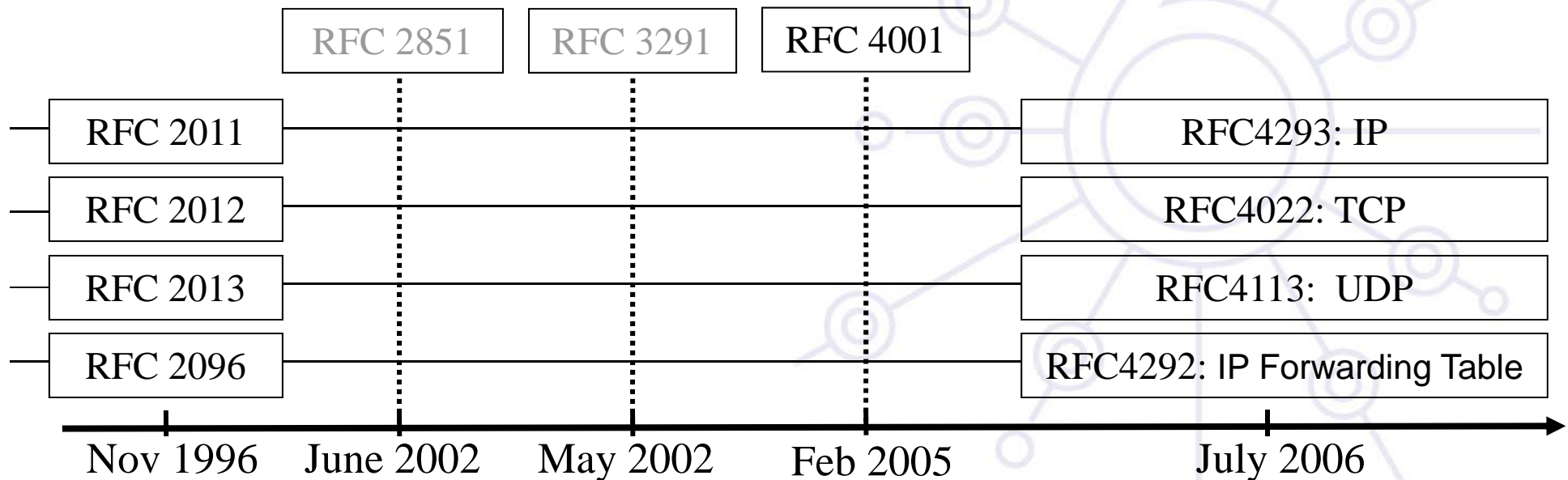
- At the beginning:
  - IPv4 and IPv6 MIBs were **disassociated**
- Currently, IPv4 and IPv6 use unified MIBs



# IPv6 MIBs /3

## Standardization status at IETF

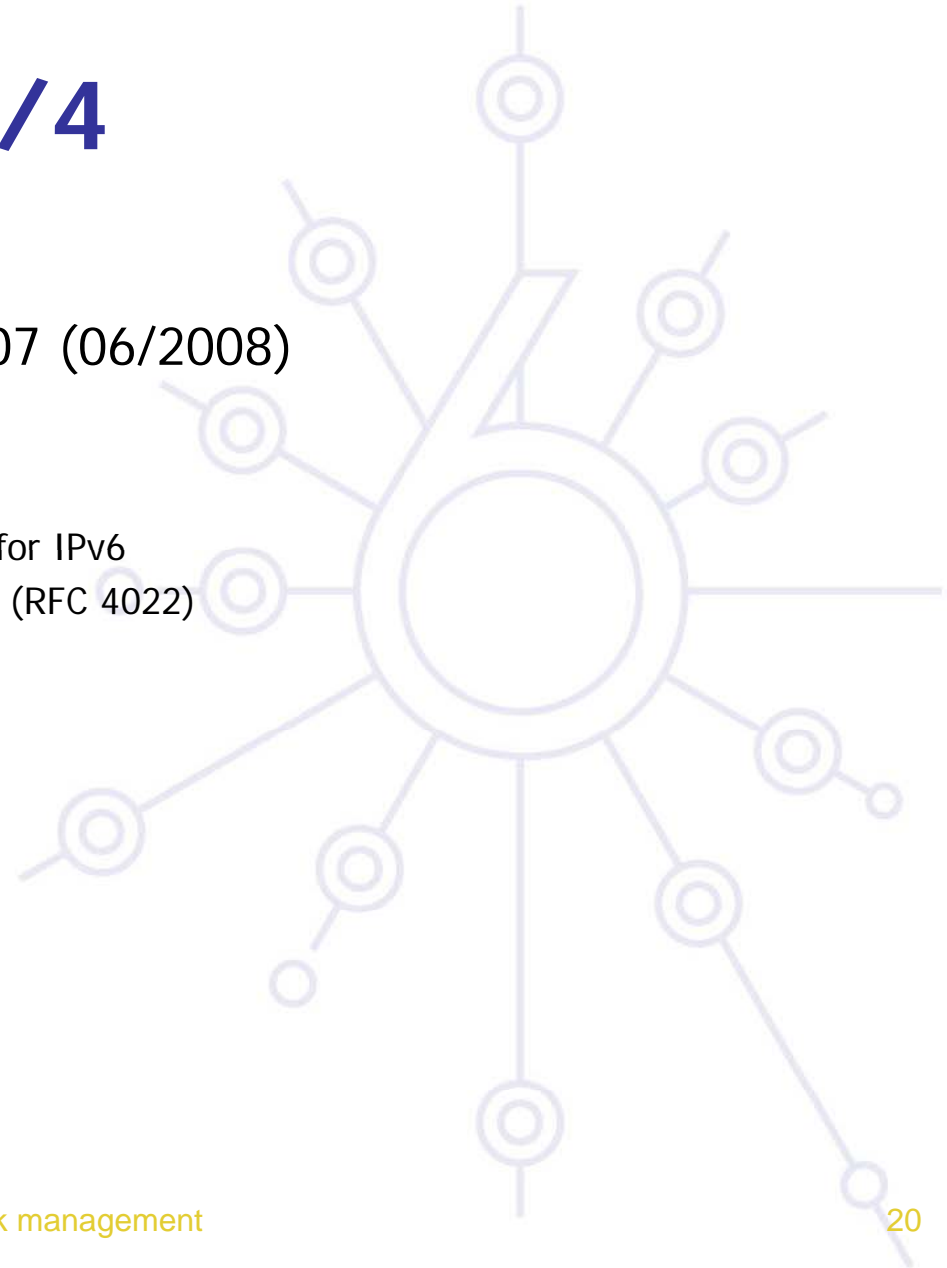
Today : **unified MIBs** are on standard track.



# IETF MIB Status /4

## BGP MIB v6:

- draft-ietf-idr-bgp4-mibv2-07 (06/2008)
  - Expires in Dec 2008
  - Includes IPv6
    - reference to RFC2545: BGP4 for IPv6
    - Reference to unified TCP MIB (RFC 4022)





deploy

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: **Private MIBs based on standards: traffic counters available (packets and bits) on 12.0(33)S. Available also on C7600:**
  - CISCO-IETF-IP-MIB
  - CISCO-IETF-IP-FORWARD-MIB
- Also, information available from CLI (if private MIBs not available)
  - 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:
  - Eg: 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/4

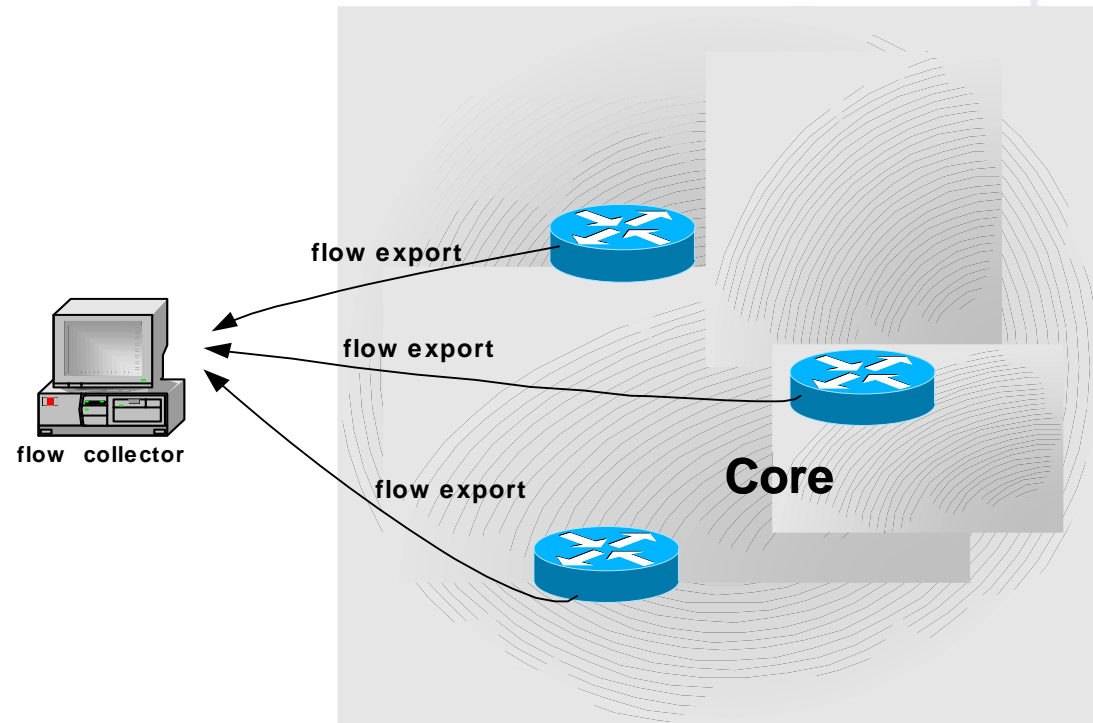
## Net-SNMP (Carnegie Mellon Univ)

- <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



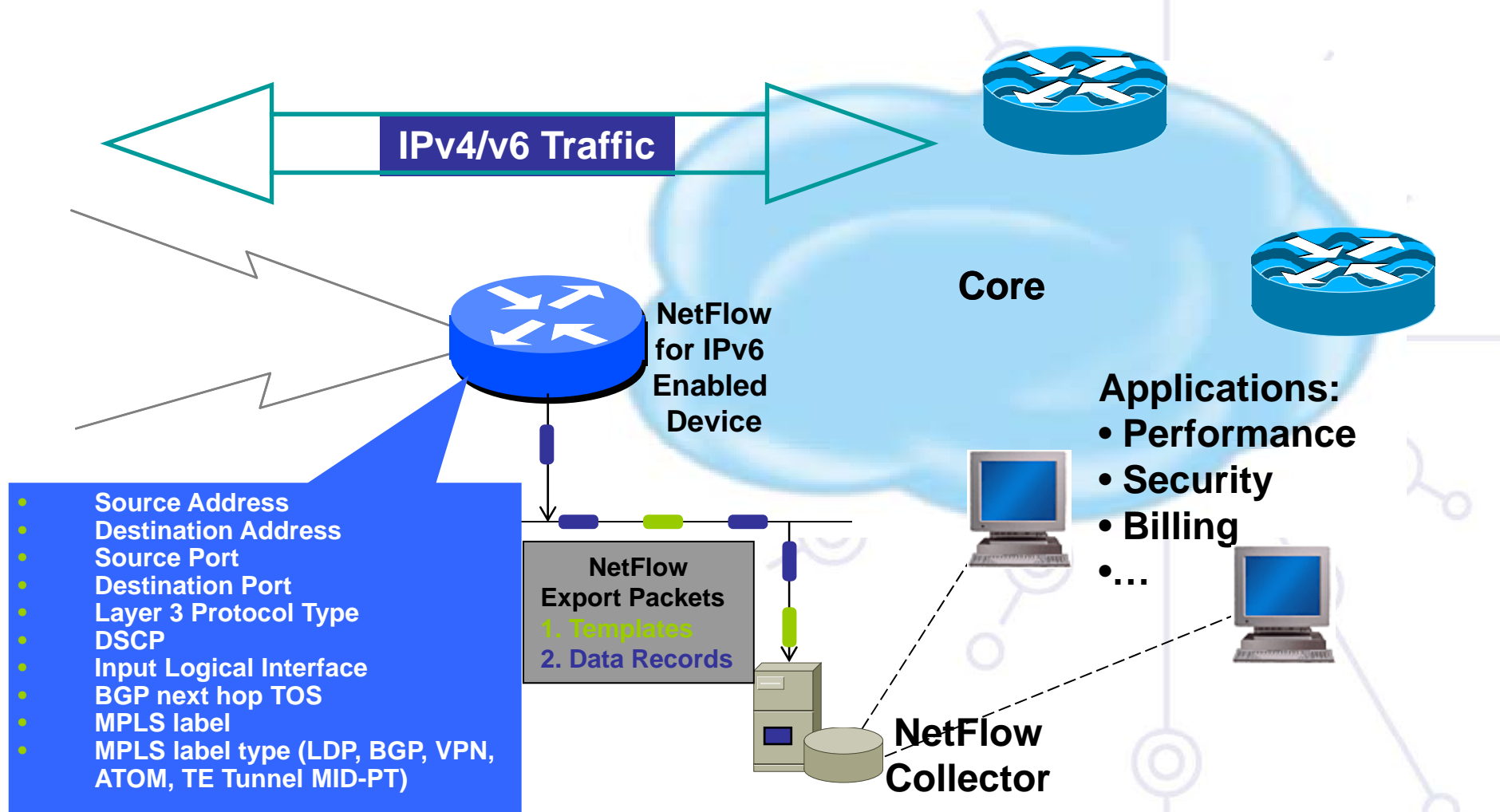
IPv6 flow monitoring

# Netflow & IPFIX model



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

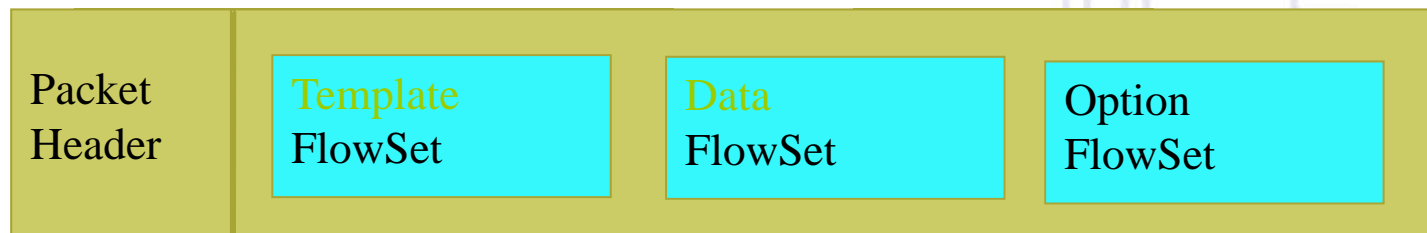
# NetFlow for IPv6



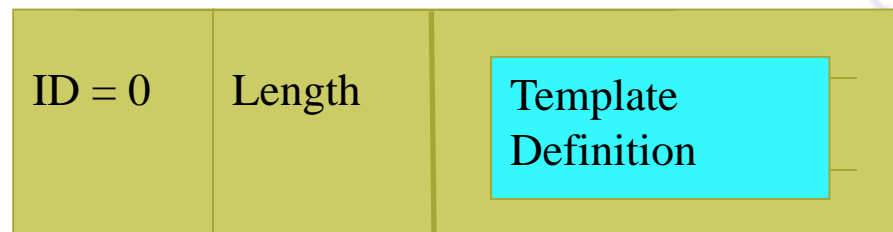


# NetFlow for IPv6

## Packet



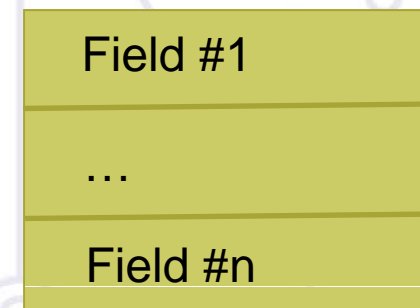
## Template Definition (Template FlowSet)



## Flow Records (Data FlowSet)



## Record

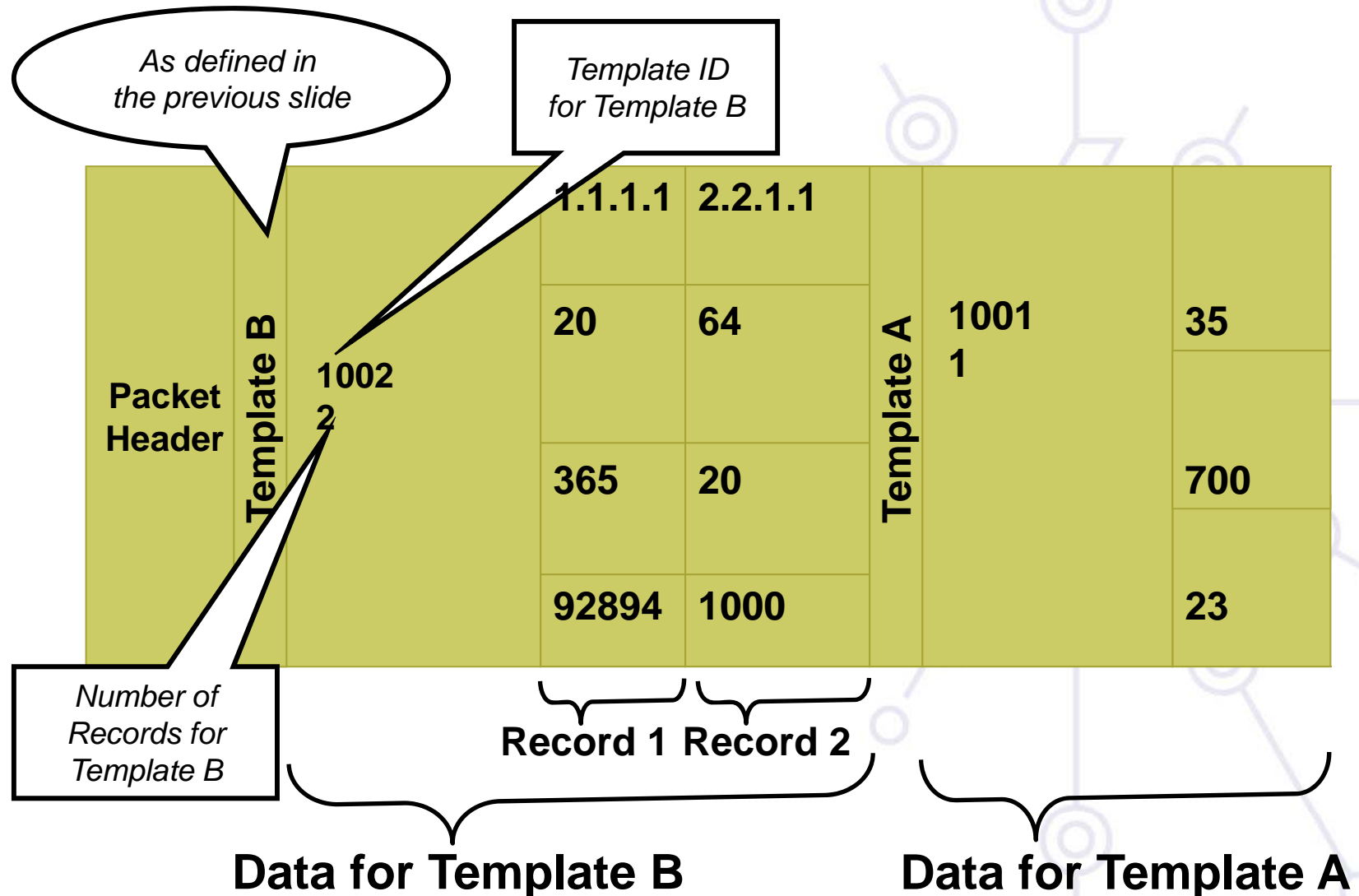


## NetFlow Version 9 Example for Template Definition

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, **12.2(33)SXH** and **12.0(33)S** and later version. Available on C7600.
  - 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)





deploy

**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 4.0.3
- Resource Manager Essential
- CiscoView version 6.1
- Cisco Network Registrar (CNR 6.2)
- Device Fault Manager
- Internet Performance Monitor
- Common services

## « Top ten » ...

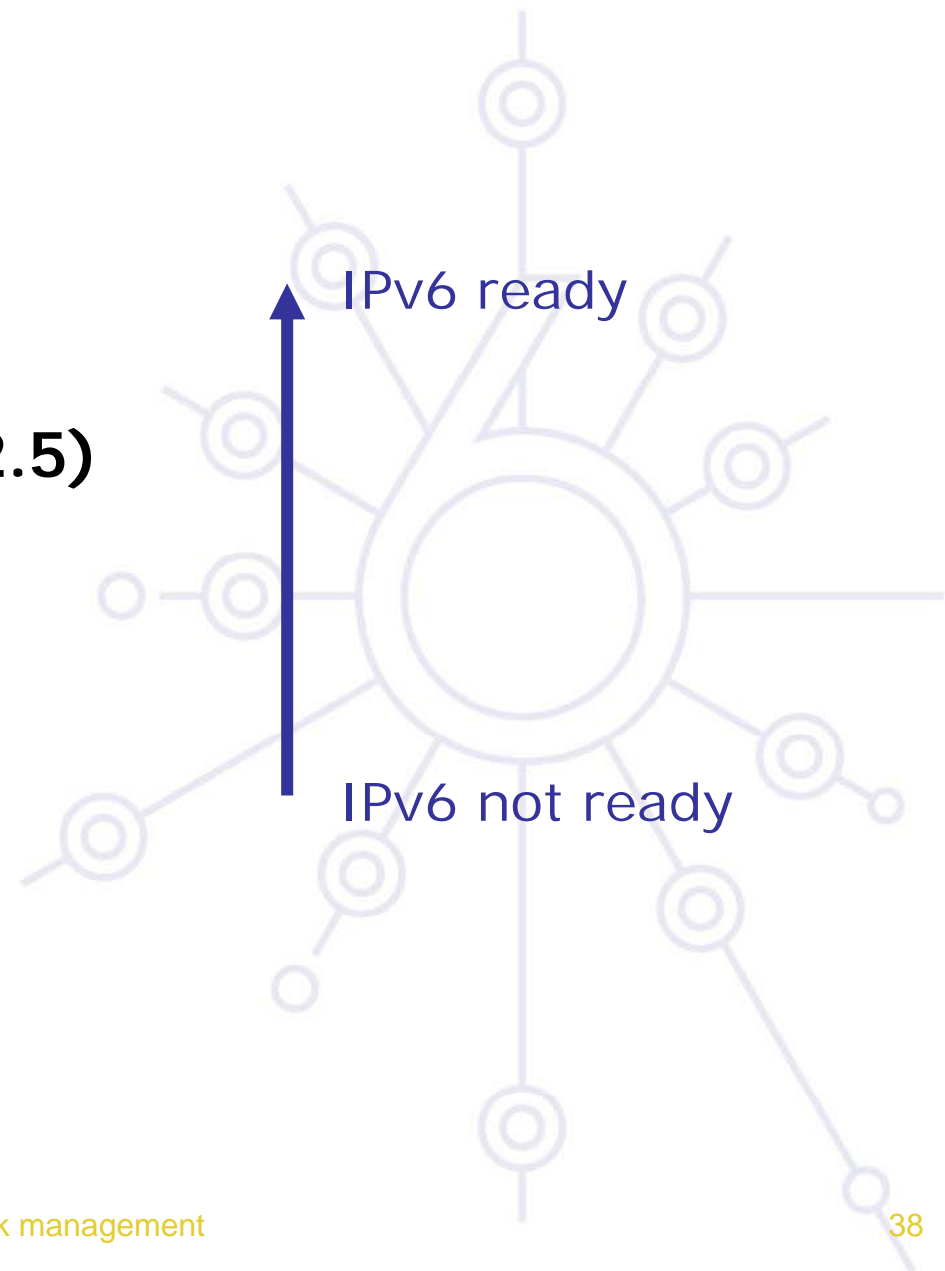
**HP Openview**

**Ciscoverks 2000 (LMS 2.5)**

**IBM Netview**

**Infovista, Tivoli**

...





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/>





deploy

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

name Serveurs-SIPA

status up

Name	Status
<a href="#">data-ipv6 IPv4</a>	<span style="background-color: green; color: black;">Ping FTP</span>
<a href="#">data-ipv6 IPv6</a>	<span style="background-color: green; color: black;">Ping FTP</span>
<a href="#">sem2 IPv4</a>	<span style="background-color: green; color: black;">Ping HTTP renater.fr</span>
<a href="#">sem2 IPv6</a>	<span style="background-color: green; color: black;">Ping HTTP renater.fr</span>

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

User: jdurand

[Override](#)

[Annotate](#)

[Flush Cache](#)

[Display Config](#)

[Debugging](#)

[Un-Acked](#)

[Notifies](#)

[Notifies](#)

[Error Log](#)

[Top](#)

[Logout](#)

Argus: 3.3


10:48  
lundi  
22/11/2004

Internet

# 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



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](http://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
<a href="#">data-ipv6</a>	DOWN	08-12-2003 15:26:43	148d 21h 58m 44s	/bin/ping -n -U -c 1 193.49.159.67
<a href="#">sem2</a>	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...)

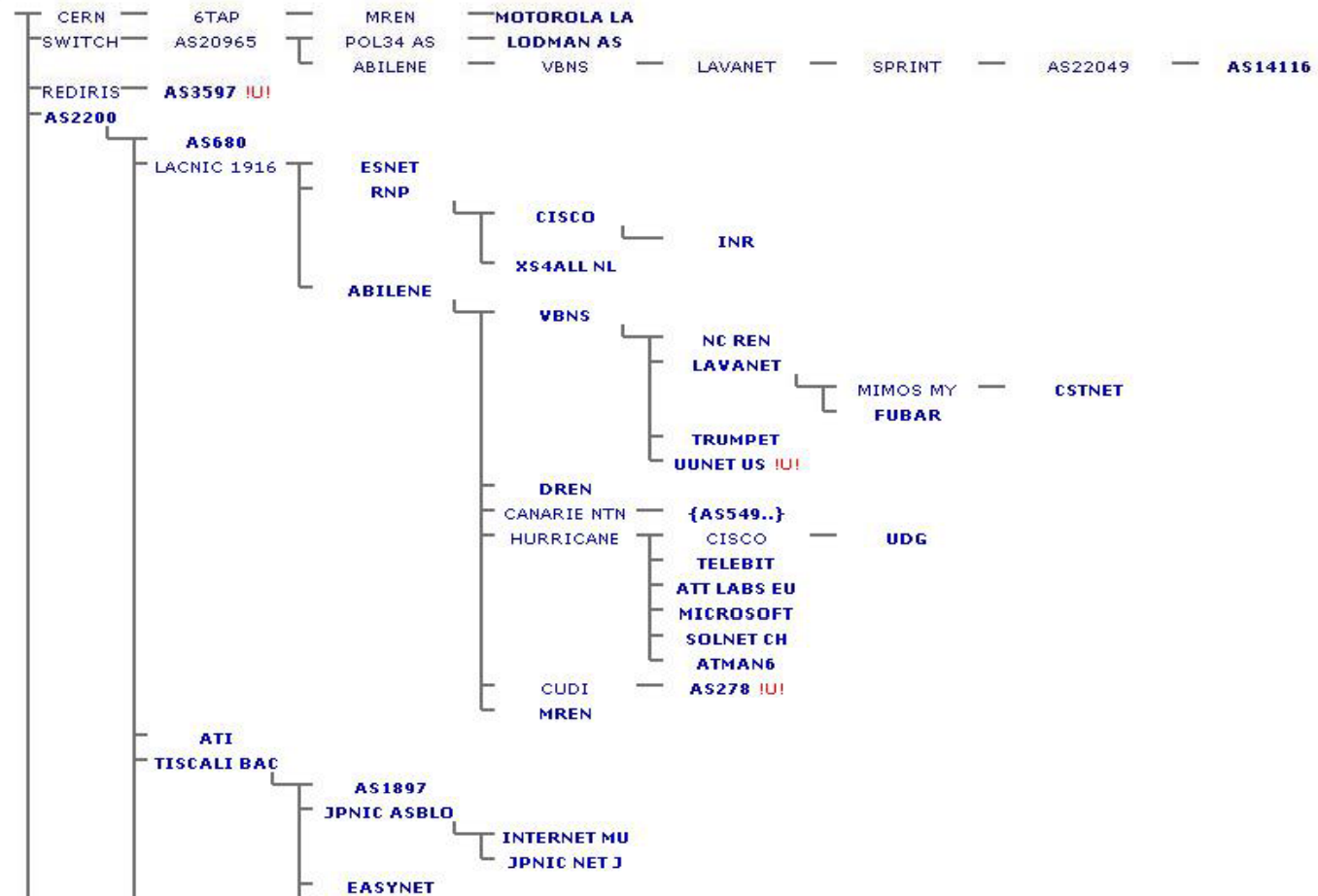
**Generate HTML pages**



# ASpath-Tree

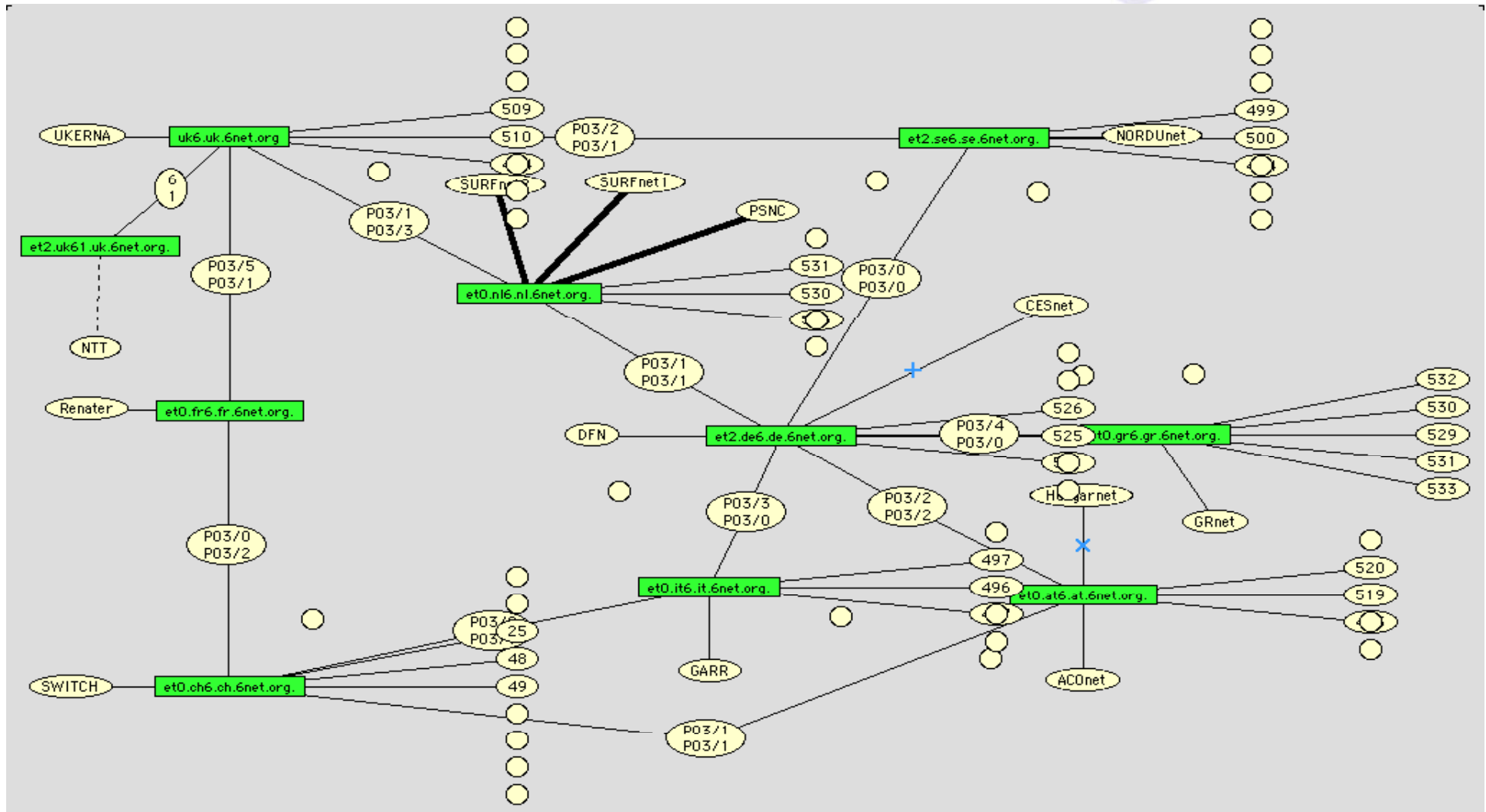
*Renater* The whole IPv6 BGP table

RENATER Project  
Network





# Intermapper



# Looking Glass

- **Get information on a router w/o direct connection**
- **Web Interface**
- **Final user doesn'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  
routing\_table  
summary  
neighbors

☐ IPv6 traffic  
☐ IPv6 interface  
☐ IPv6 tunnels  
☐ IPv6 neighbors  
☐ IPv6 route

**BGP with regular expression**

☐ show bgp IPv6 

regex

regular expression :

Don't use the character '\$'

☐ Ping XXXX  
☐ Traceroute XXXX  
☐ show ip bgp XXXX  
☐ 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 XXXX

☐ IPv4 address  .  .  .   
☐ IPv6 address   
☐ name address IPv4   
☐ name address IPv6

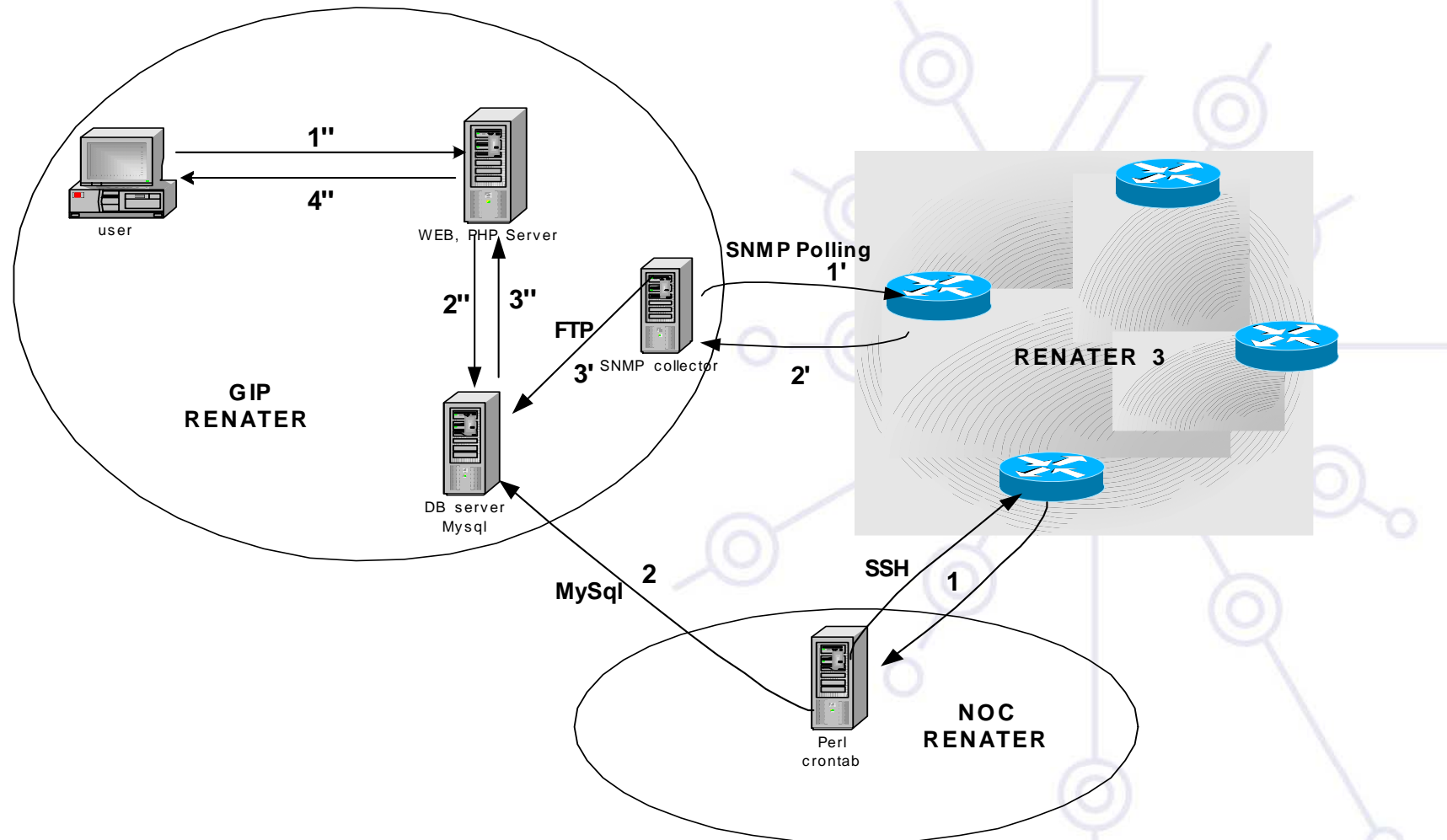
Router: 

Toulouse

submit





Reset

# Inventory: interfaces & peerings




# Inventory: BGP Peerings

## NR de PROJETS

PROJETS_GSR-NIO	PROJETS_GSR-6NET	PROJETS_7200-MCAST	PROJETS_M5
			

[interfaces](#)

Routeur PROJETS_GSR-NIO	Peering BGP												
	<b>peering iBGP</b> <table border="1" style="width: 100%;"> <tr> <td style="color: green;">Established</td> <td>*** Peer-group de tous les routeurs IBGP ***</td> <td>AS 1717 - FR-RENATER-PROJETS</td> </tr> <tr> <td style="color: green;">Established</td> <td>*** Peer-group de tous les routeurs IBGP ***</td> <td>AS 1717 - FR-RENATER-PROJETS</td> </tr> <tr> <td style="color: green;">Established</td> <td>*** Peer-group de tous les routeurs IBGP ***</td> <td>AS 1717 - FR-RENATER-PROJETS</td> </tr> </table>	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			
	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										
	<b>peering eBGP</b> <table border="1" style="width: 100%;"> <tr> <td style="color: green;">Established</td> <td>*** eBGP NRI-A RENATER3 ***</td> <td>AS 2200 - FR-RENATER</td> </tr> <tr> <td style="color: green;">Established</td> <td>*** eBGP RENATER3 IPv4 ***</td> <td>AS 2200 - FR-RENATER</td> </tr> <tr> <td style="color: red;">Active</td> <td>*** eBGP @IRS++ KWAK   durand@renater.fr ***</td> <td>AS 65004 -</td> </tr> <tr> <td style="color: red;">Active</td> <td>*** eBGP @IRS++ PIETRA   durand@renater.fr ***</td> <td>AS 65004 -</td> </tr> </table>	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 -
	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

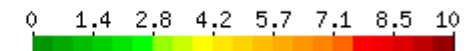
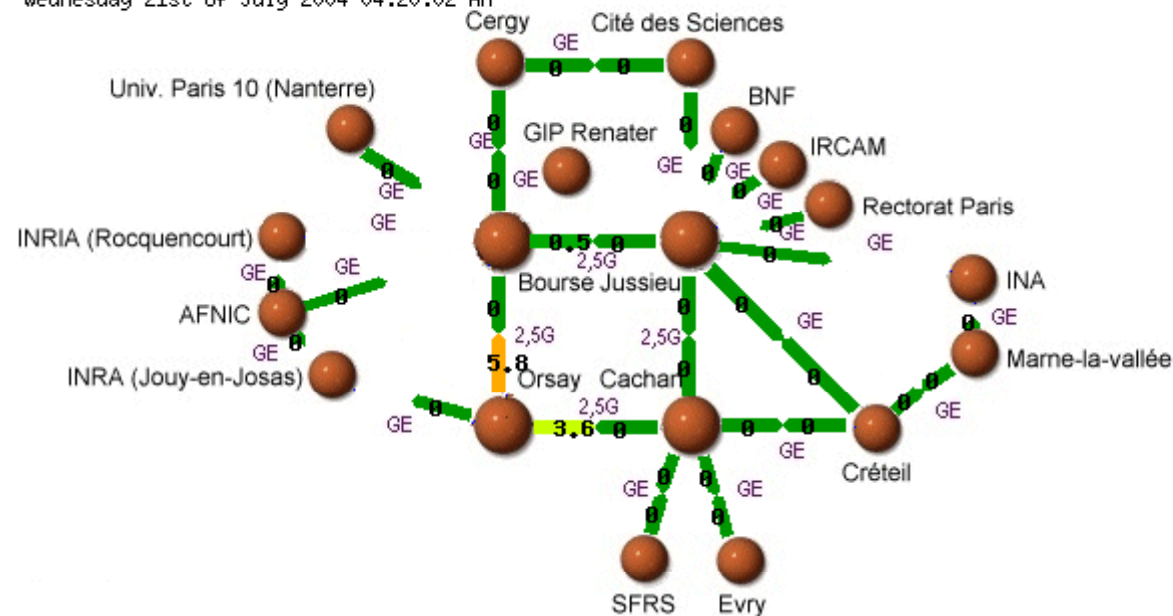
→ IPv6 Weather Map of RENATER



# 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:

12,5 0 NRI-A - NRI-B 1  
9,8 0 NRI-A - NRI-B 2  
6,3 0 NRI-A - NRI-B 3

0 NRI-B - AKAMAI  
0 NRI-B - GEANT  
0 NRI-B - SFINX 1  
0 NRI-B - SFINX 2

# Conclusion

**ISPs –and many 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, ...

