



IPv6 network management

**6DEPLOY. IPv6 Deployment and Support**

# Contributions

**Simon Muyal, RENATER**

**Bernard Tuy, RENATER**

**Jérôme Durand, RENATER**

**Ralf Wolter, Cisco**

**Patrick Grossetête, Cisco**



# Agenda

## Introduction

## Retrieving information from routers

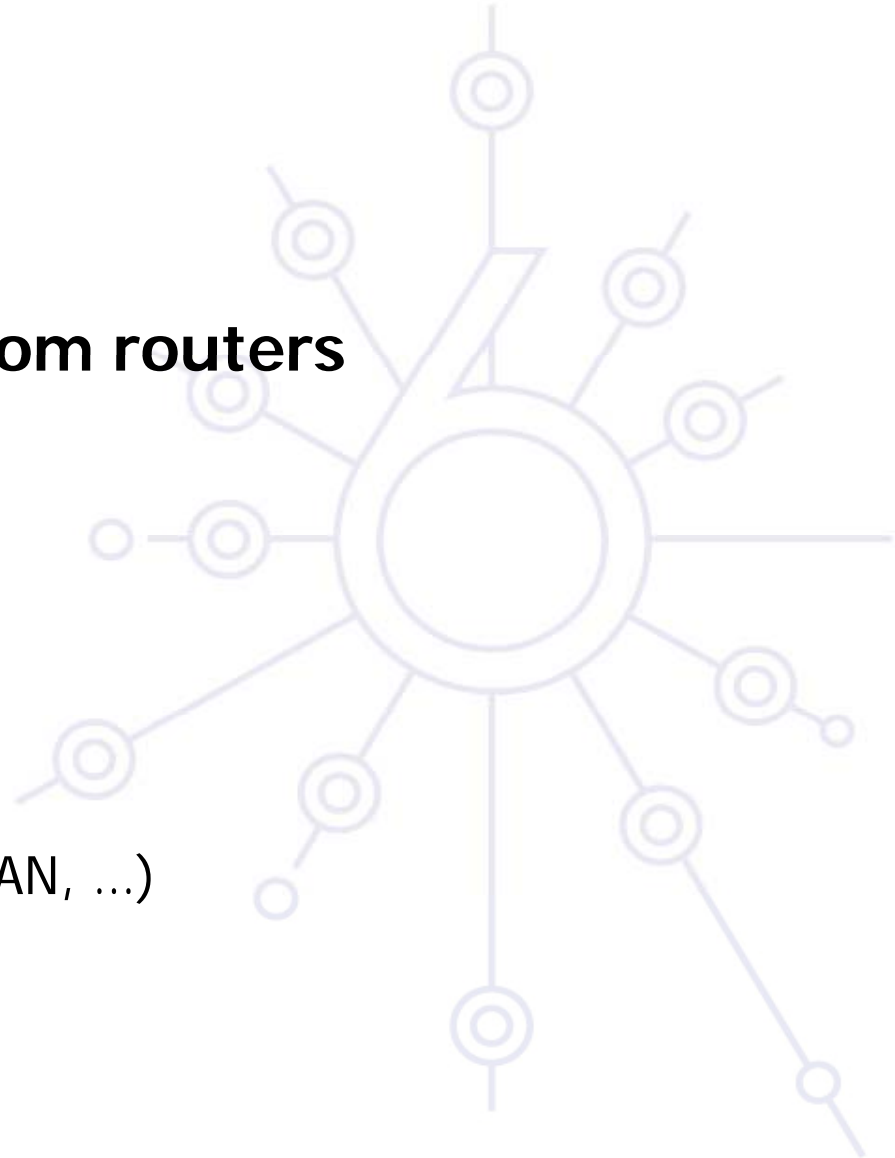
- TELNET/SSH/TFTP/FTP, ...
- SNMP/MIBs and IPv6
- Netflow

## Management platforms

## Management tools

- 6NET work
- Recommendations (LAN, WAN, ...)
- Examples

## Conclusion



# Introduction

## IPv6 networks deployed:

- Most are dual stack
  - LANs (campuses, companies, ...)
  - MANs
  - WANs - ISPs (Géant, NRENs, IJ, 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



deploy

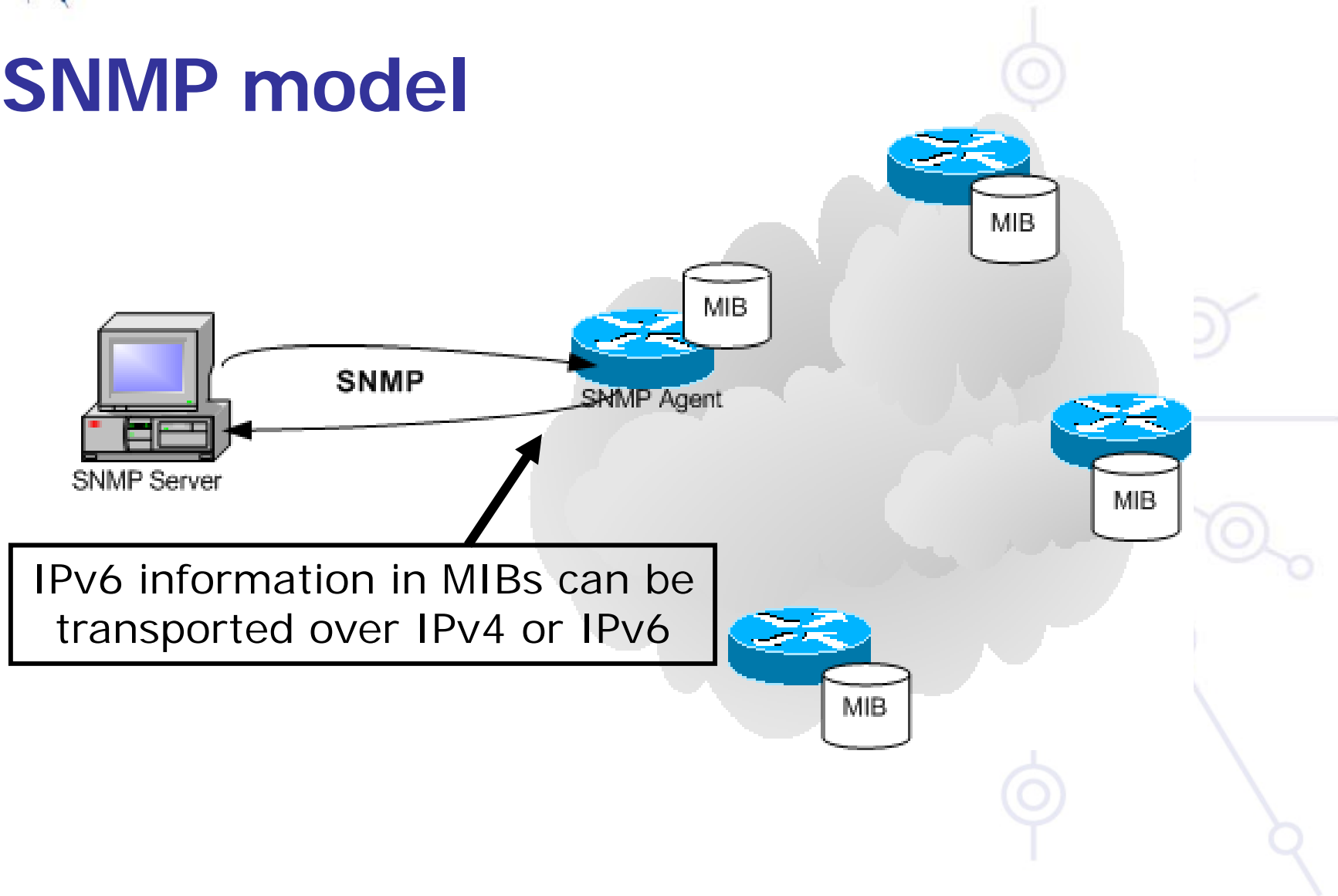
**SNMP/MIBs and IPv6**

**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



DEPLOY

## 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, ...)**

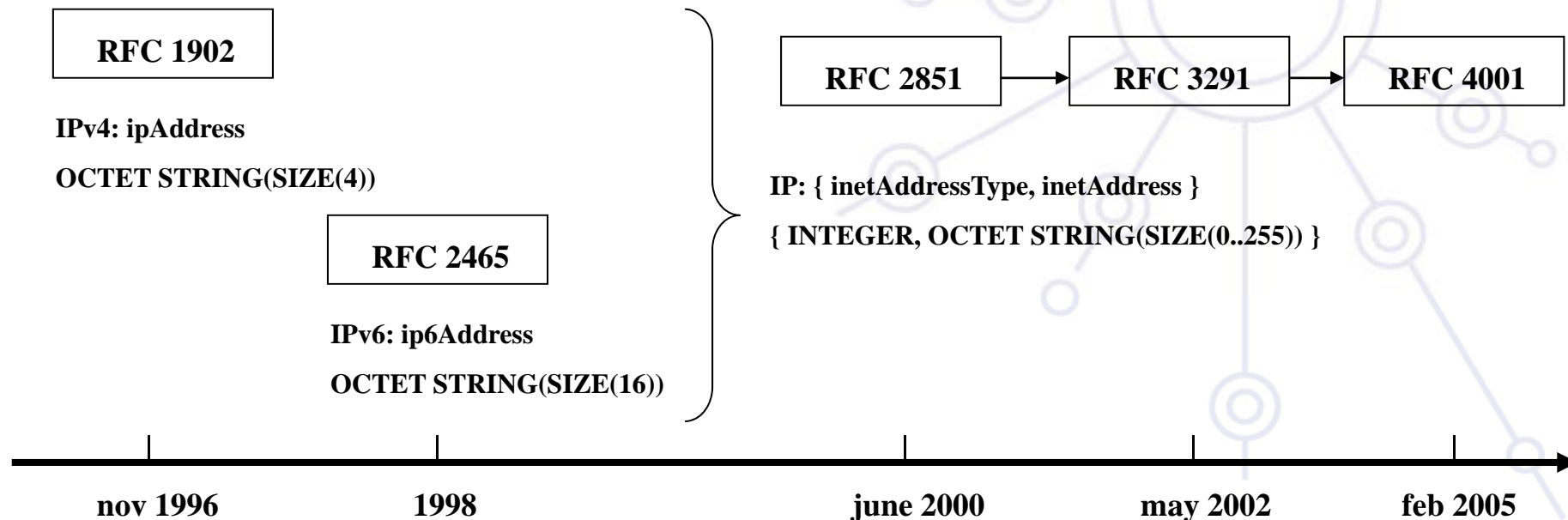
**SNMP rely upon MIBs**

=> 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:

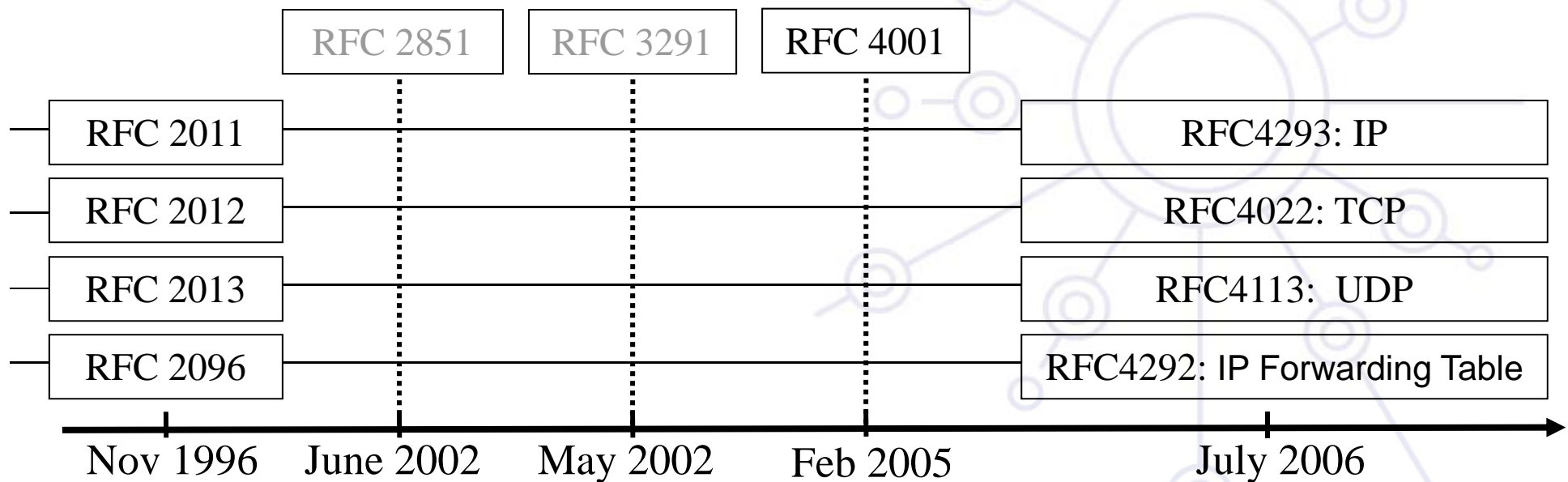
- At the beginning:
  - IPv4 and IPv6 MIBs were **disassociated**
- Currently, IPv4 and IPv6 use unified MIBs



# 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-mibv2-10
  - Expires in August 2010
  - Includes IPv6
    - Add the ability to monitor IPv6 BGP-4 peering sessions and carry IPv6 reachability
    - Reference to RFC2545: BGP4 for IPv6
    - Reference to unified TCP MIB (RFC 4022)



6  
DEPLOY

IPv6 MIBs implementations

# IPv6 MIBs implementation/1

## Cisco

- Cisco has long supported IP-MIB and IP-FORWARD-MIB in IPv4.
- CISCO-IETF-IP-MIB and CISCO-IETF-IP-FORWARDING-MIB are IPv6 MIBs that are defined as being protocol-independent, but are implemented only for IPv6 objects and tables.
- In Cisco IOS Release 12.2(33)SRC, IP-MIB and IP-FORWARD-MIB were updated to RFC 4293 and RFC 4292 standards
- 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

- The JUNOS IPv6 and ICMPv6 MIB provides support for the JUNOS implementation of IPv6 and ICMPv6
- 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)

- Net-SNMP is a suite of applications used to implement [SNMP v1](#), [SNMP v2c](#) and [SNMP v3](#) using both IPv4 and IPv6.
- <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

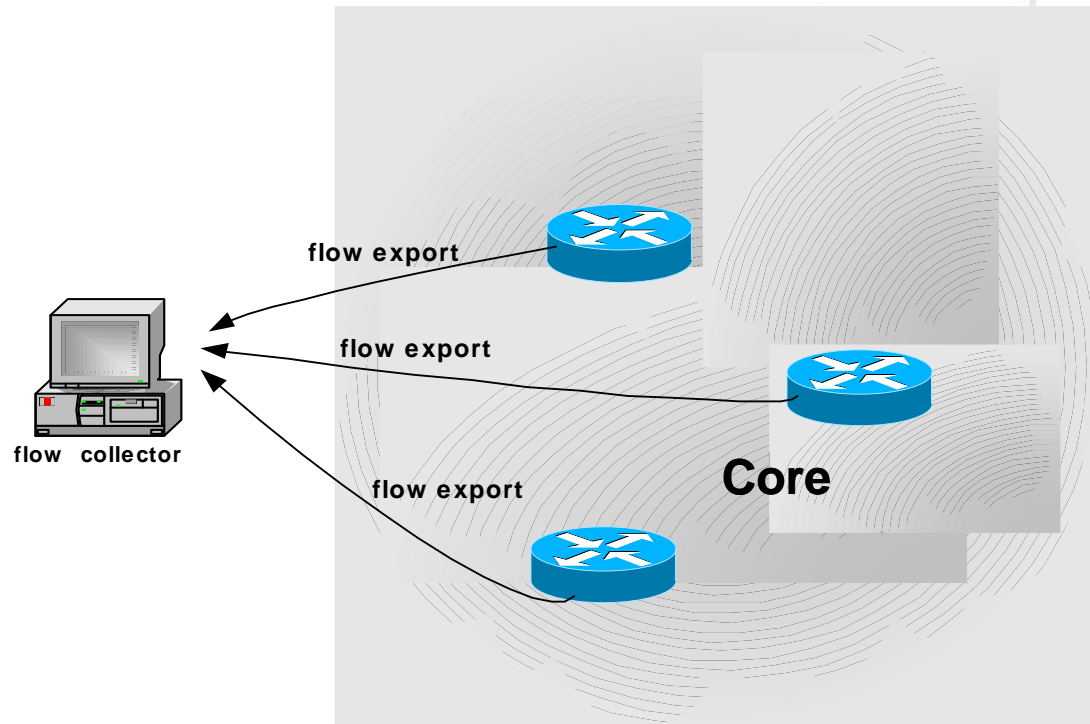


6 deploy

IPv6 flow monitoring

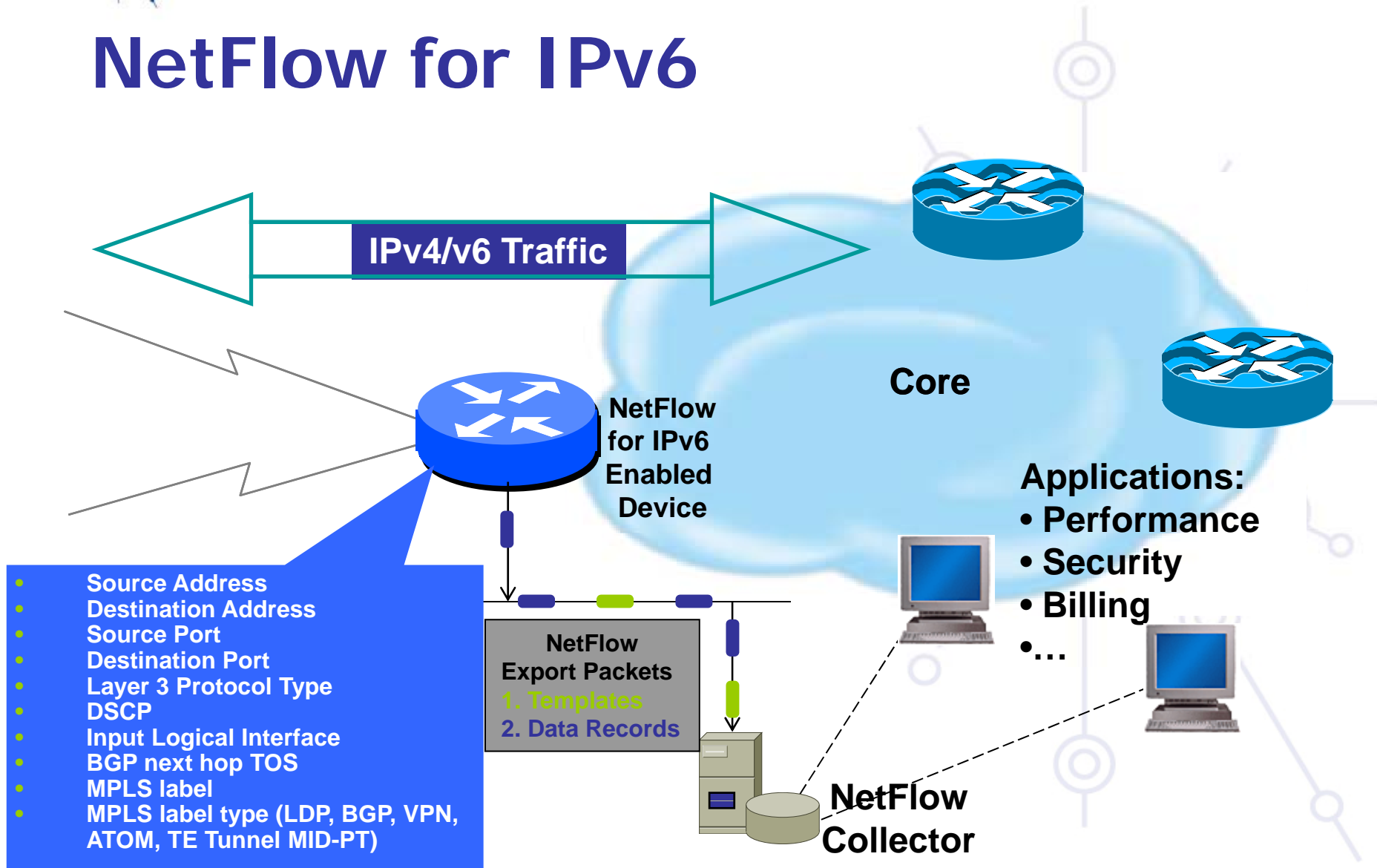


# Netflow & IPFIX model



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

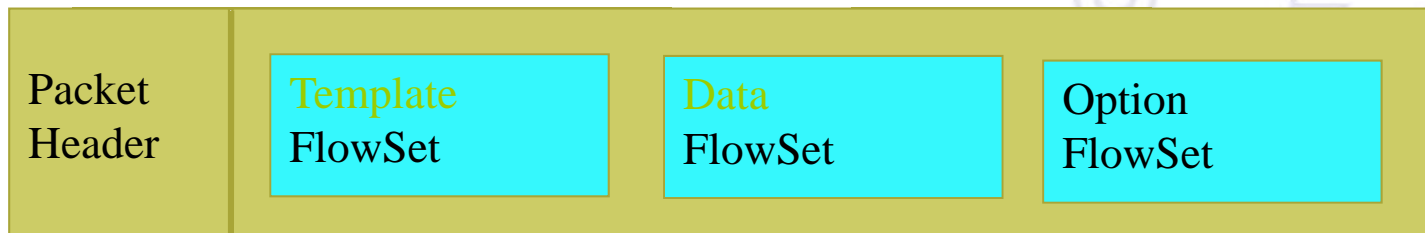
# NetFlow for IPv6



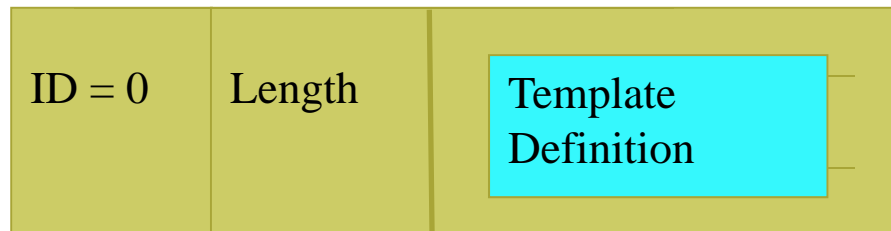
- Source Address
- Destination Address
- Source Port
- Destination Port
- Layer 3 Protocol Type
- DSCP
- Input Logical Interface
- BGP next hop TOS
- MPLS label
- MPLS label type (LDP, BGP, VPN, ATOM, TE Tunnel MID-PT)

# NetFlow for IPv6

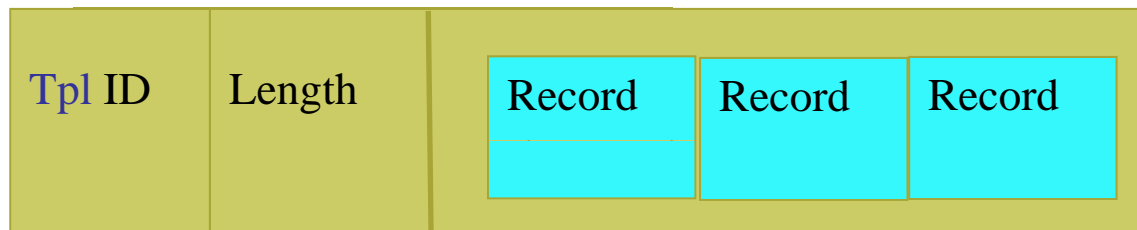
## Packet



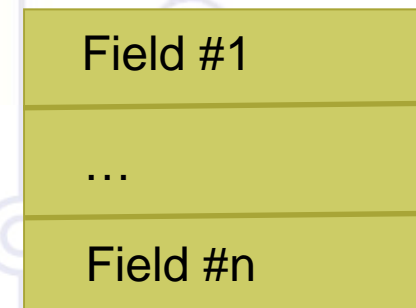
## Template Definition (Template FlowSet)



## Flow Records (Data FlowSet)



## Record



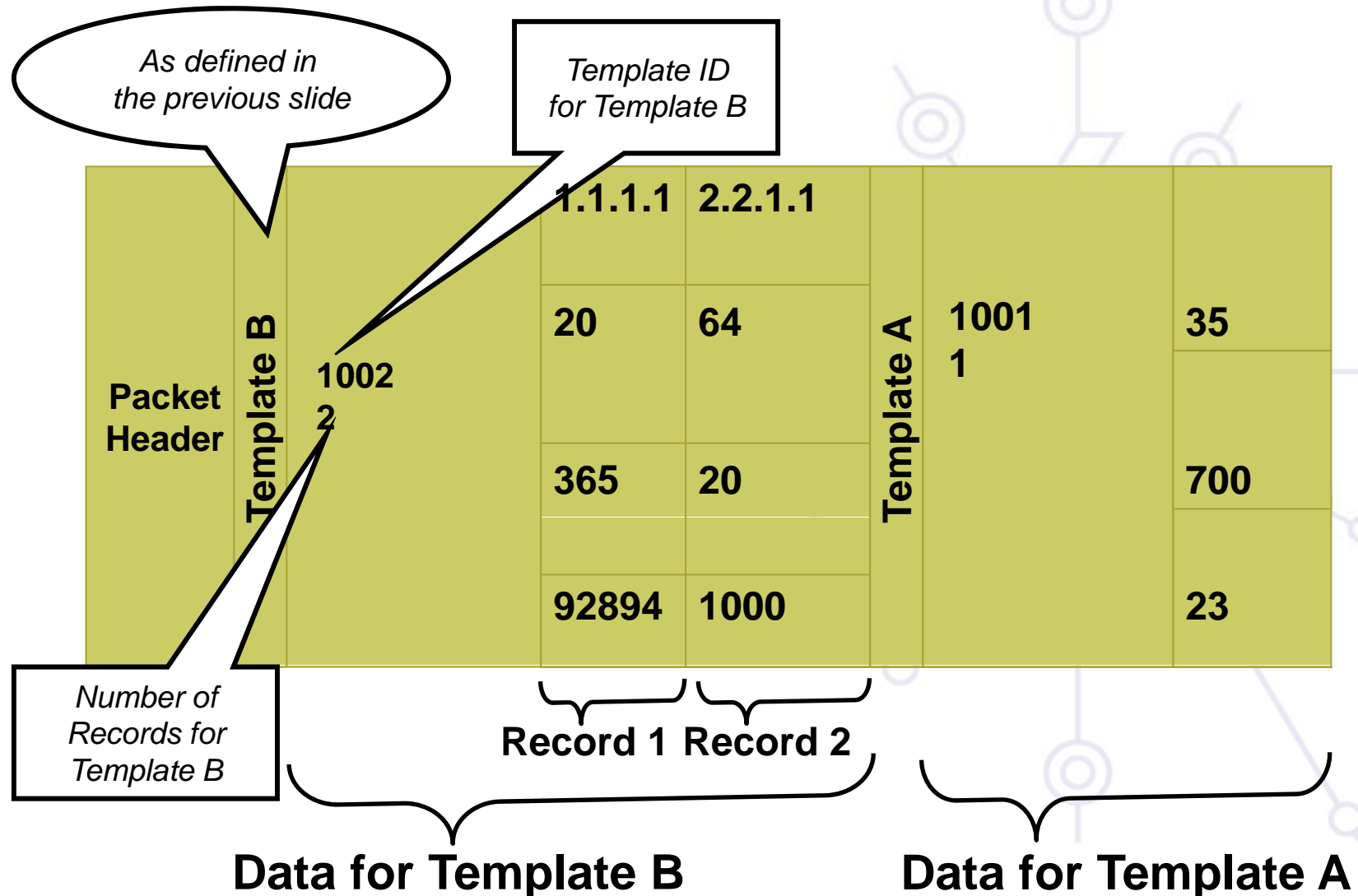
# NetFlow Version 9

## 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)
- Flow tools





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** : plan to support IPv6

# 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

Current Version: CiscoWorks LAN Management Solution 3.2

## « Top ten » ...

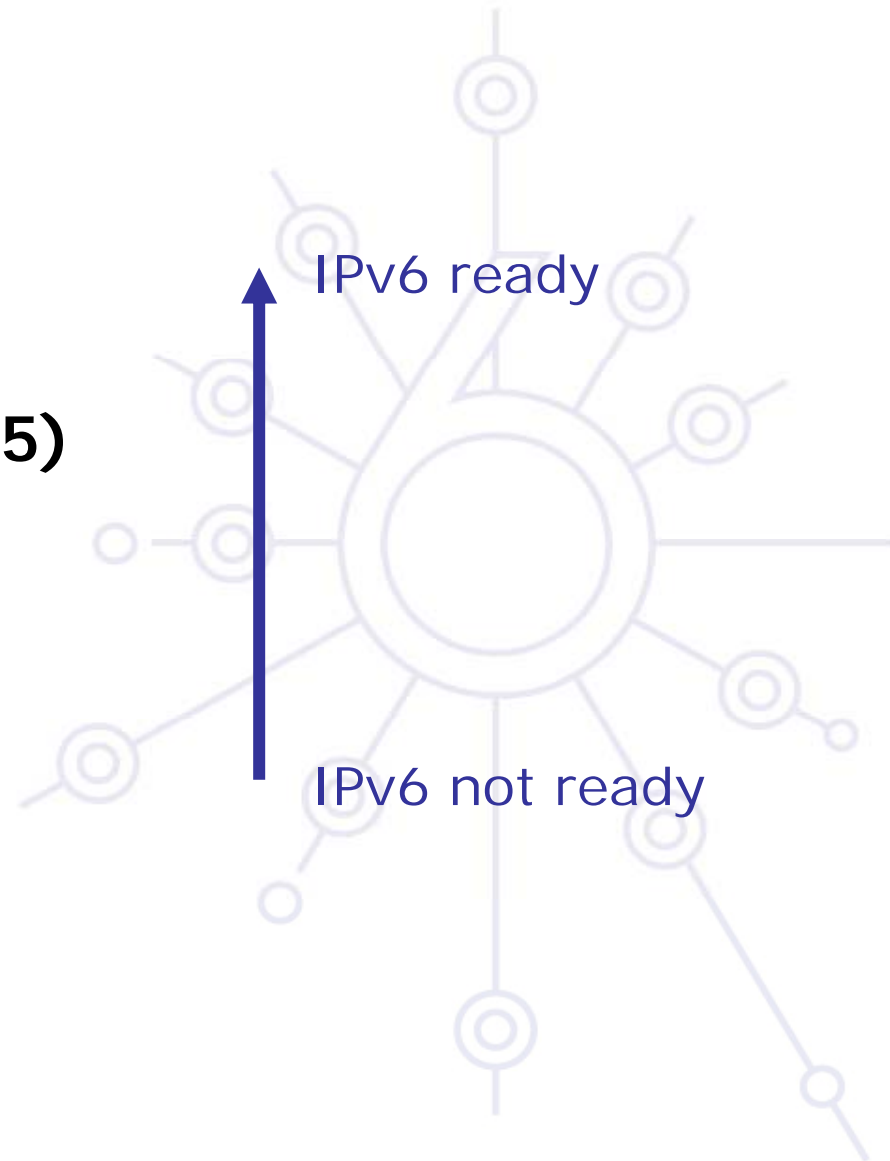
**HP Openview**

**Ciscoverks 2000 (LMS 2.5)**

**IBM Netview**

**Infovista, Tivoli**

...





DEPLOY

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/>

# IPv6 monitoring tools - WANs

- **AS-path-tree** (<http://carmen.ipv6.tilab.com/ipv6/tools/ASpath-tree/>)
- **6NET looking glass** (<http://tools.6net.org> , <http://w6.loria.fr>)
- **IPflow** (<http://www.rrt.cr-picardie.fr/~fillot/nf6/>)
- **IPv6 support for netflow v9 in IOS**  
(<http://www.cisco.com/go/netflow/>)
- **Mping** (<http://mping.uninett.no>)
- **RIPE TT server** (<http://www.ripe.net/ttm//ttm-ipv6.html>)
- **Cricket** (<http://cricket.sourceforge.net/>)
- **MRTG** (<http://people.ee.ethz.ch/~oetiker/webtools/mrtg/>)

# IPv6 monitoring tools - LANs

- **Argus** (<http://argus.tcp4me.com>)
- **Ethereal** (<http://www.ethereal.com>)
- **Multicast Beacon** (<http://dast.nlanr.net/Projects/Beacon/> and <http://noc.man.poznan.pl/noc/strony/aplikacje.html>)
- **Pchar** (<http://www.employees.org/~bmah/Software/pchar>)
- **Iperf** (<http://dast.nlanr.net>)
- **Ntop** (<http://www.ntop.org>)
  
- **IPv6 management gateway** (<http://www.ipv6.man.poznan.pl>)
- **Nagios** (<http://www.nagios.org>)
- **Rancid** (<http://www.shrubbery.net/rancid/>)



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 User: jdurand

name Serveurs-SIPA

status up

Name	Status
<a href="#">data-ipv6 IPv4</a>	<span style="background-color: green; color: white; padding: 2px;">Ping FTP</span>
<a href="#">data-ipv6 IPv6</a>	<span style="background-color: green; color: white; padding: 2px;">Ping FTP</span>
<a href="#">sem2 IPv4</a>	<span style="background-color: green; color: white; padding: 2px;">Ping HTTP renater.fr</span>
<a href="#">sem2 IPv6</a>	<span style="background-color: green; color: white; padding: 2px;">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

[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

# 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](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)

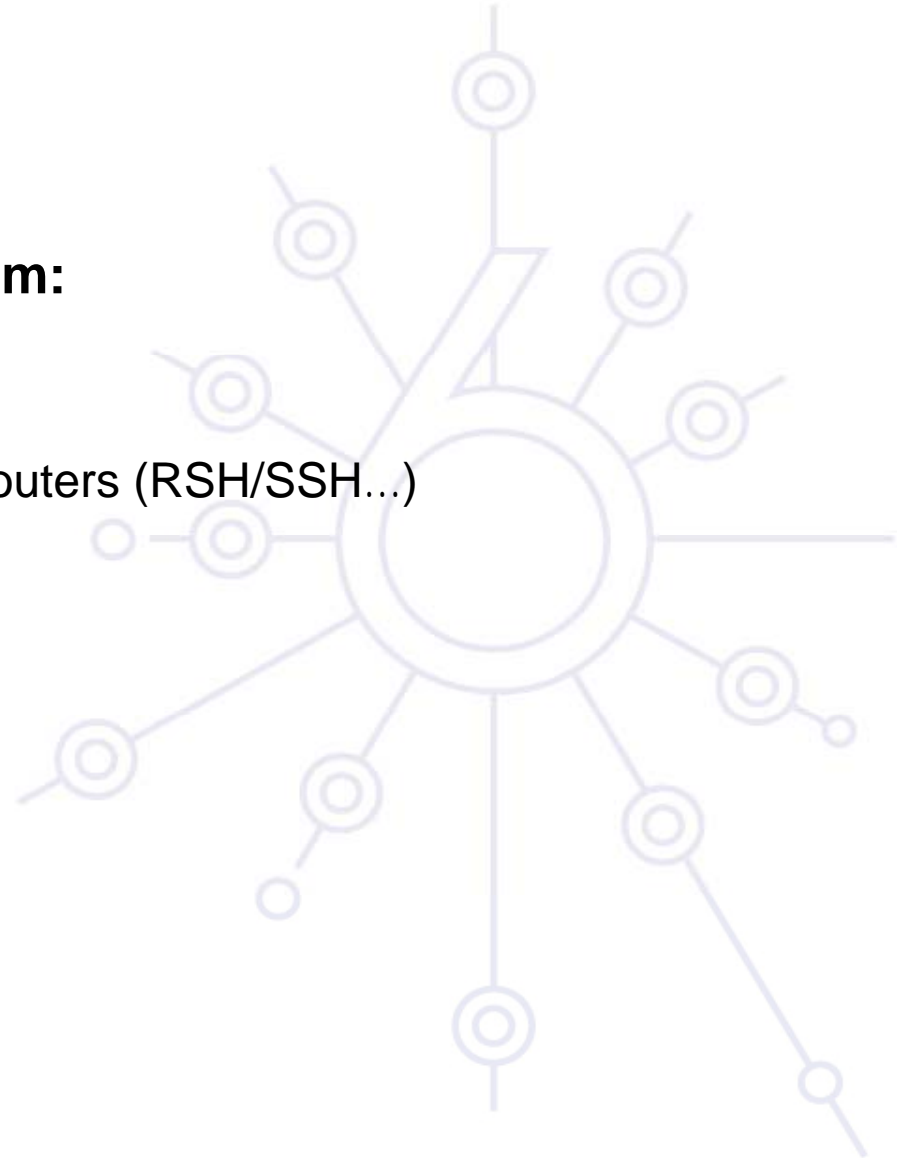
2 Matching Host Entries Displayed

# ASpath-Tree

**Display BGP4+ « topology » from:**

- BGP4+ routing table
- Retrieved from connection to routers (RSH/SSH...)

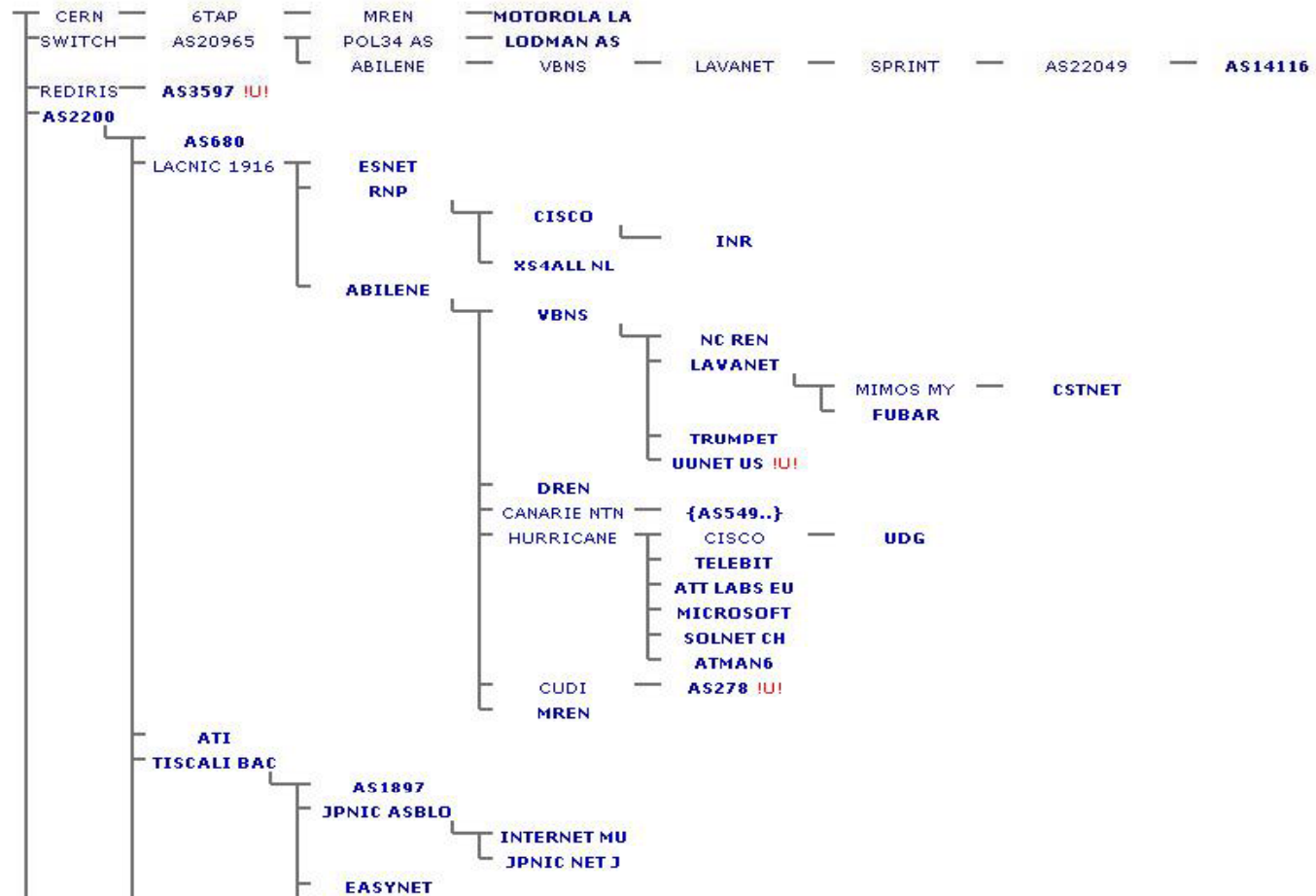
**Generate HTML pages**



# ASpath-Tree

*Renater* The whole IPv6 BGP table

RENATER Project Network



# 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

**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:



# 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



# 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, ...

