

# IPv6 network management

Gosier, La Guadeloupe  
March 5-9 2007

[Simon.Muyal@renater.fr](mailto:Simon.Muyal@renater.fr)  
[Stig.Venaas@uninett.no](mailto:Stig.Venaas@uninett.no)  
[Bernard.Tuy@renater.fr](mailto:Bernard.Tuy@renater.fr)



Gosier, la Guadeloupe -March 2007

1

IPv6DISSemination and Exploitation

## Contributions

- Simon Muyal, RENATER
- Bernard Tuy, RENATER
- Jérôme Durand, RENATER
- Ralf Wolter, Cisco
- Patrick Grossetête, Cisco
- Munechika Sumikawa, Hitachi
- Patrick Paul, 6WIND



Gosier, la Guadeloupe -March 2007

2

IPv6DISSemination and Exploitation

# 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, IIJ, NTT/Verio, Abilene, ...)
    - IX's
  - Management tools/procedures are needed
- Testbed, pilot networks, production networks
- 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



## 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

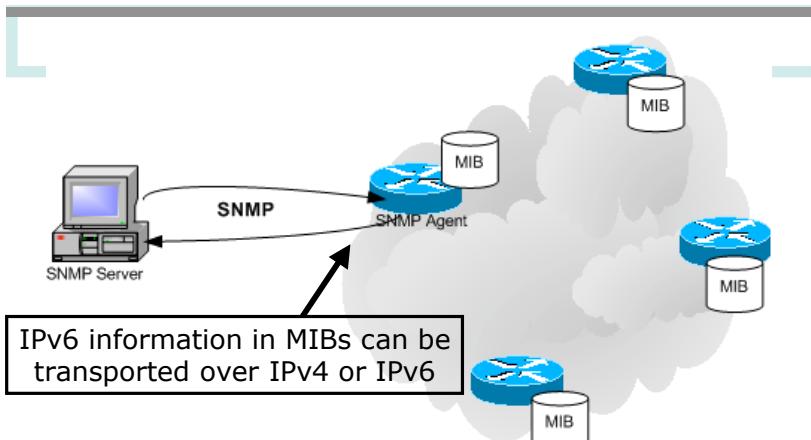


## SNMP/MIBs and IPv6

- SNMP and IPv6
- IPv6 MIBs status
- Manufacturers implementations



## SNMP model



Gosier, la Guadeloupe -March 2007

12

IPv6DISSemination and Exploitation

## 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

Gosier, la Guadeloupe -March 2007

13

IPv6DISSemination and Exploitation

## IPv6 MIBs Status



Gosier, la Guadeloupe -March 2007

14

IPv6DISSemination and Exploitation

## 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	

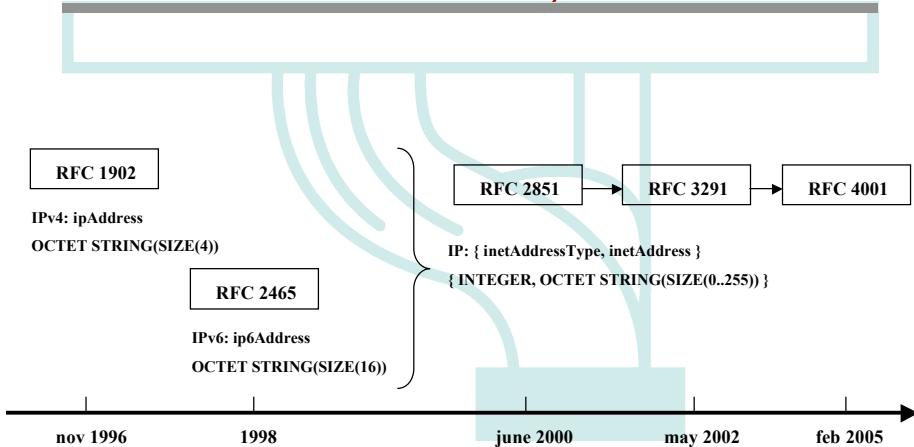


Gosier, la Guadeloupe -March 2007

16

IPv6DISSemination and Exploitation

## IPv6 MIBs /3



Gosier, la Guadeloupe -March 2007

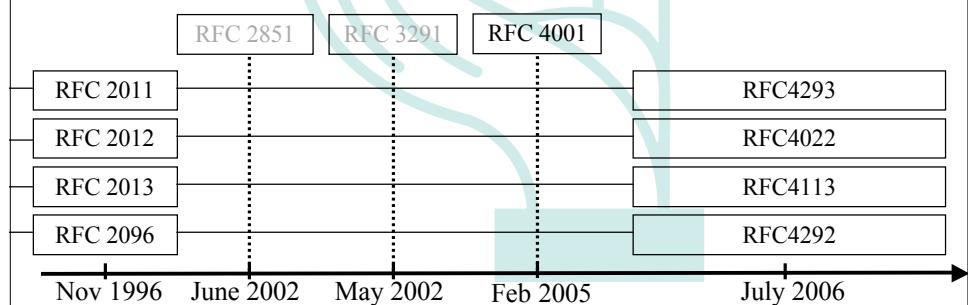
18

IPv6DISSemination and Exploitation

## IPv6 MIBs /4

### Standardization status at IETF

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



Gosier, la Guadeloupe -March 2007

19

IPv6DISSemination and Exploitation

## 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/4

- 6WIND
  - MIBs based on RFC 2465 and RFC 2466
  - Checked at our lab.
  - Unified MIBs ?

Gosier, la Guadeloupe -March 2007

27

IPv6DISSemination and Exploitation

## 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

Gosier, la Guadeloupe -March 2007

28

IPv6DISSemination and Exploitation

## IPv6 flow monitoring

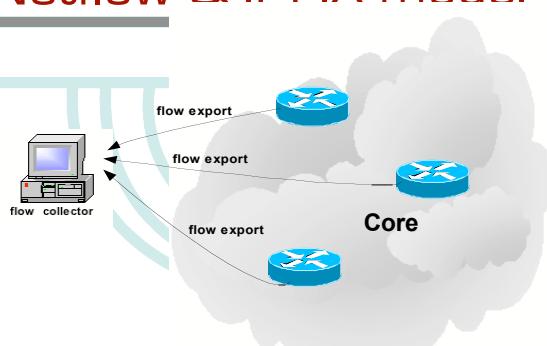


Gosier, la Guadeloupe -March 2007

29

IPv6DISSemination and Exploitation

## Netflow & IPFIX model



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

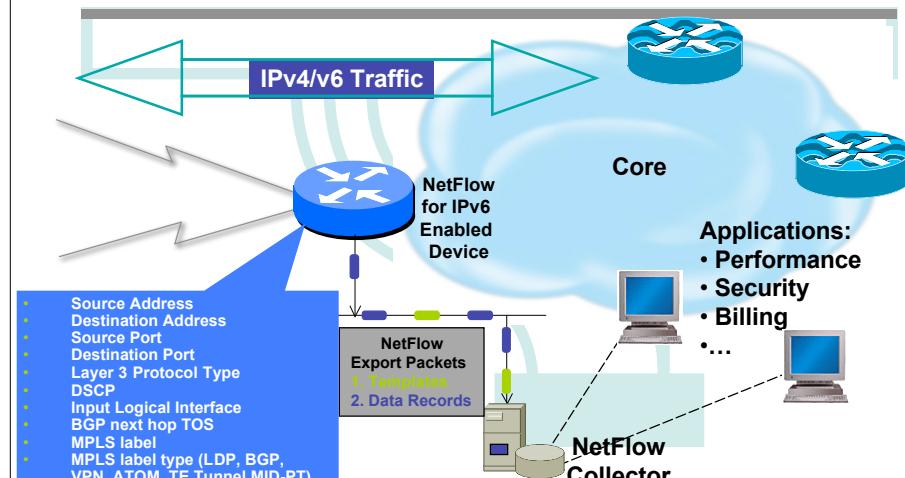


Gosier, la Guadeloupe -March 2007

30

IPv6DISSemination and Exploitation

## NetFlow for IPv6

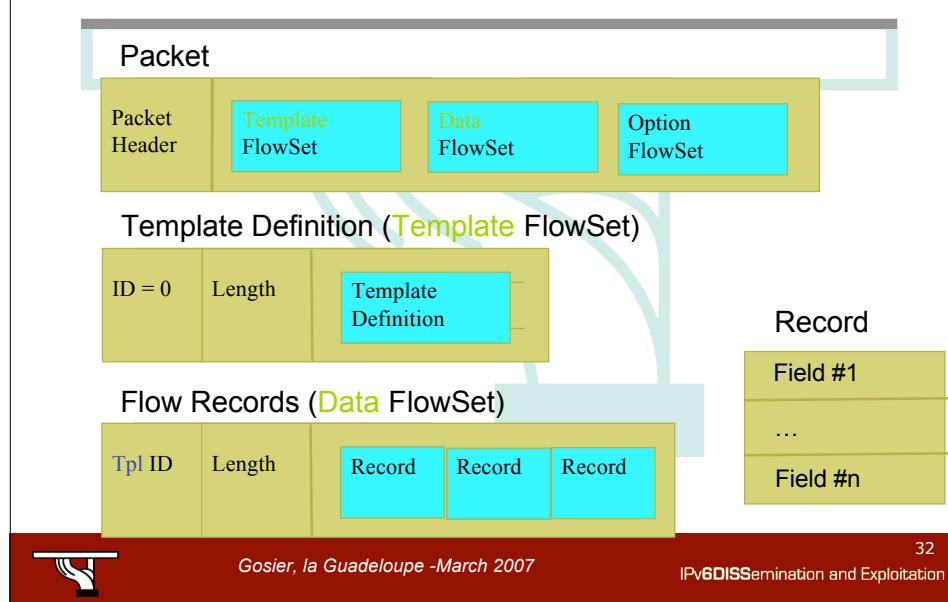


Gosier, la Guadeloupe -March 2007

31

IPv6DISSemination and Exploitation

## NetFlow Version 9



Gosier, la Guadeloupe -March 2007

32

IPv6DISSemination and Exploitation

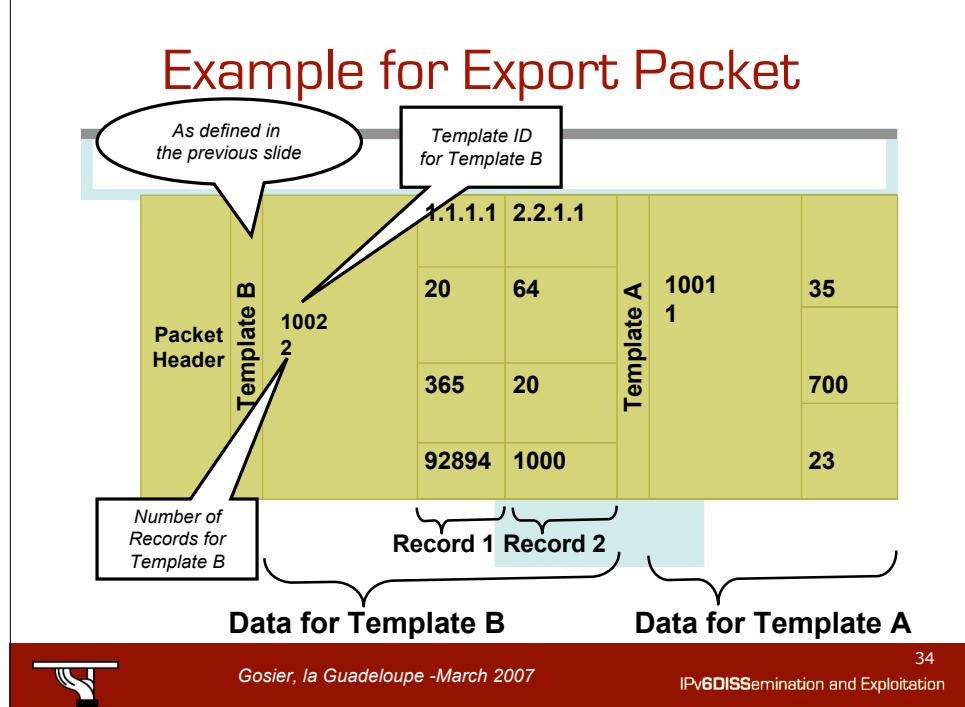
## NetFlow Version 9 Example for Template Definition

Template A		Template B	
Flow Set ID (0 for Template)		Flow Set ID (0 for Template)	
Length of Template Structure		Length of Template Structure	
1001 (Template ID)		1002 (Template ID)	
3 (# of Fields)		4 (# of Fields)	
SRC_AS_NUMBER		SRC_IP_PREFIX	
2		4	
DST_AS_NUMBER		SRC_AS_NUMBER	
2		2	
L4_PROTOCOL		PACKET_COUNT	
2		2	
		BYTE_COUNT	
		2	
			33

Gosier, la Guadeloupe -March 2007

IPv6DISSemination and Exploitation

## 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



Gosier, la Guadeloupe -March 2007

37

IPv6DISSemination and Exploitation

## 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 »



Gosier, la Guadeloupe -March 2007

38

IPv6DISSemination and Exploitation

## 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

41

IPv6DISSemination and Exploitation

## 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/>

42

IPv6DISSemination and Exploitation

## Examples



Gosier, la Guadeloupe -March 2007

43

IPv6DISSemination and Exploitation

## 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



Gosier, la Guadeloupe -March 2007

44

IPv6DISSemination and Exploitation

**Argus - Top Serveurs-SIPA - Microsoft Internet Explorer**

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

User: jdurand

Top Serveurs-SIPA

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

Argus: 33

Gosier, la Guadeloupe -March 2007

IPv6DISSemination and Exploitation

## 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
  - ...

Gosier, la Guadeloupe -March 2007

IPv6DISSemination and Exploitation

# Nagios

The screenshot shows the Nagios web interface. On the left, there's a navigation menu under 'Monitoring' with options like 'Tactical Overview', 'Service Detail', 'Host Detail', etc. The main area displays 'Current Network Status' with a timestamp of 'Thu Jan 8 09:33:05 CET 2004'. It includes 'Host Status Totals' and 'Service Status Totals' tables. Below these are 'Host Status Details For All Host Groups' and a table listing two hosts: 'data.ipv6' (DOWN) and 'sem2' (UP). A note at the bottom says '2 Matching Host Entries Displayed'. The footer contains the text 'Gosier, la Guadeloupe -March 2007' and 'IPv6DISSemination and Exploitation'.

47

IPv6DISSemination and Exploitation

# ASpath-Tree

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



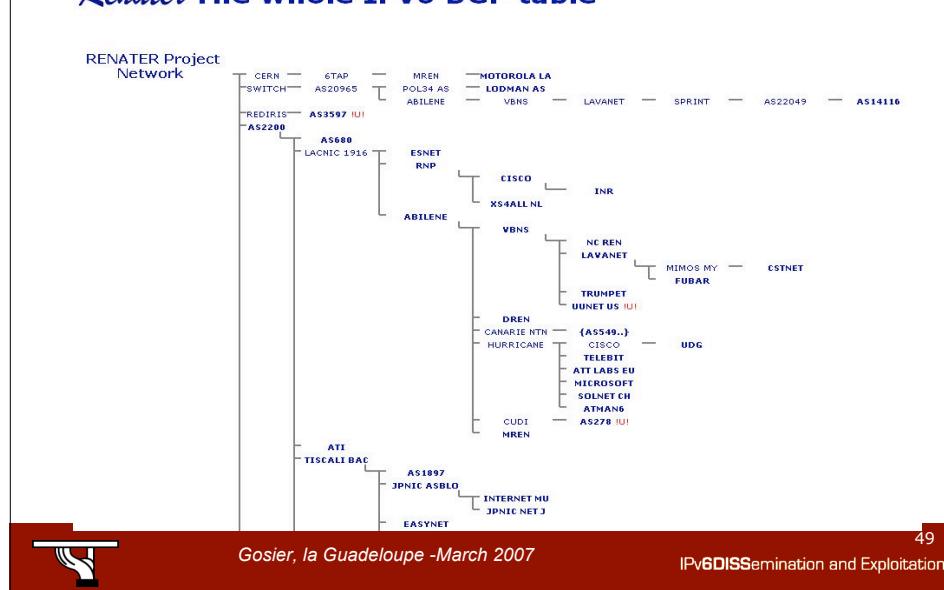
Gosier, la Guadeloupe -March 2007

48

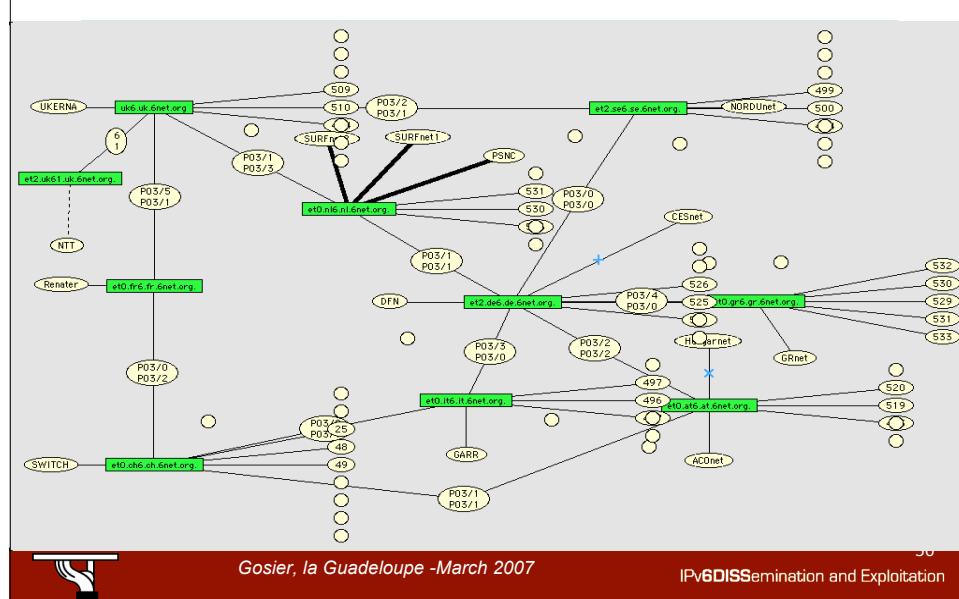
IPv6DISSemination and Exploitation

# ASpath-Tree

*Renater The whole IPv6 BGP table*



# Intermapper



## 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

Gosier, la Guadeloupe -March 2007

51

IPv6DISSemination and Exploitation

## Looking Glass

### RENATER Looking Glass

The screenshot shows a web-based management interface for a router. On the left, there's a sidebar with a red header containing the RENATER logo and the text "RENATER Looking Glass". Below the header, there are two main sections: "BGP tables" and "Network Monitoring".

**BGP tables:** A dropdown menu is open, showing options: "show bgp IPv6 routing\_table", "routing\_table", "summary", and "neighbors".

**Network Monitoring:** This section contains several groups of checkboxes and input fields:

- BGP with regular expression:** Includes a dropdown for "show bgp IPv6 regexp" and a text input field for "regular expression" with a note "Don't use the character '\$'".
- General Monitoring:** Options include "Ping XXXXX", "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", and "show ip mbgp XXXX".
- Address Resolution:** Options include "IPv4 address [ ] . [ ] . [ ] . [ ]", "IPv6 address [ ] . [ ] . [ ] . [ ]", "name address IPv4 [ ]", and "name address IPv6 [ ]".

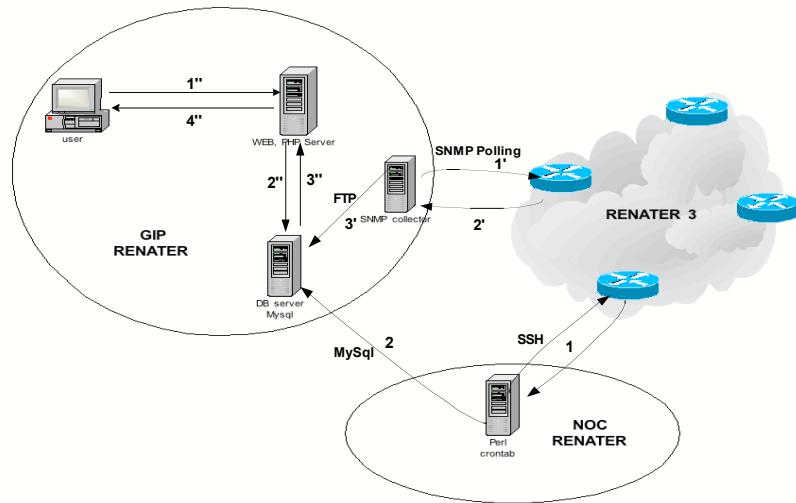
At the bottom of the interface, there is a "Router:" dropdown set to "Toulouse", and buttons for "submit" and "Reset".

Gosier, la Guadeloupe -March 2007

52

IPv6DISSemination and Exploitation

## Inventory : interfaces & peerings

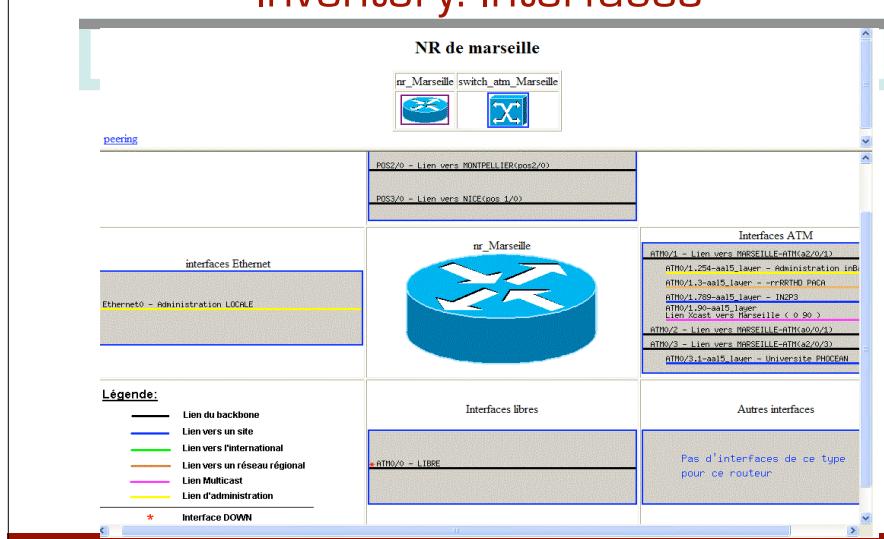


Gosier, la Guadeloupe -March 2007

53

IPv6DISSemination and Exploitation

## Inventory: Interfaces



Gosier, la Guadeloupe -March 2007

54

IPv6DISSemination and Exploitation

## Inventory: BGP Peerings

The screenshot shows a network management interface titled "NR de PROJETS". At the top, there are four icons representing different projects: PROJETS\_GSR-NIO, PROJETS\_GSR-6NET, PROJETS\_7200-MCAST, and PROJETS\_M5. Below this, a section titled "interfaces" displays a blue circular icon representing the router "Routeur PROJETS\_GSR-NIO". To the right of the router icon, a table titled "Peering BGP" lists the current BGP connections:

peering iBPG	
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 eBPG	
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 -

At the bottom of the interface, there is a footer bar with the text "Gosier, la Guadeloupe -March 2007" and "IPv6DISSemination and Exploitation". On the far left of the footer is a small logo of a hand holding a stylized letter.

55

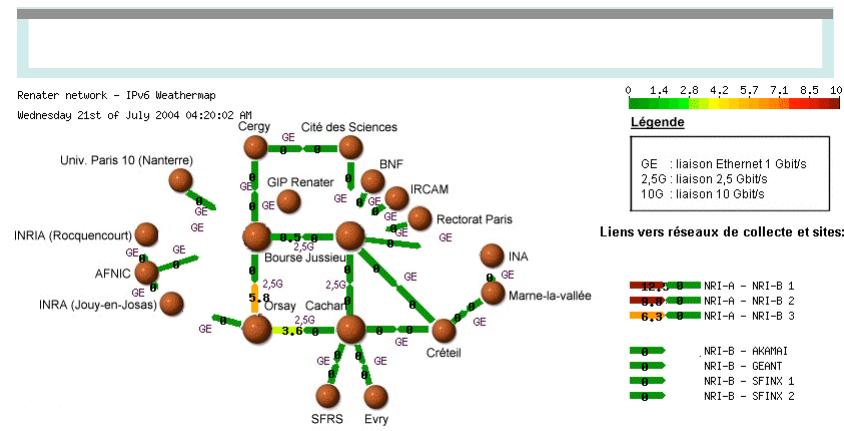
## IPv6 traffic on Cisco routers

- 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

The screenshot shows a network management interface with a red header bar containing the text "Gosier, la Guadeloupe -March 2007" and "IPv6DISSemination and Exploitation". On the far left of the header is a small logo of a hand holding a stylized letter. The main area of the interface displays various network interface statistics, including IPv6 traffic counts.

56

## IPv6 traffic on Cisco routers



Gosier, la Guadeloupe -March 2007

57

IPv6DISSemination and Exploitation

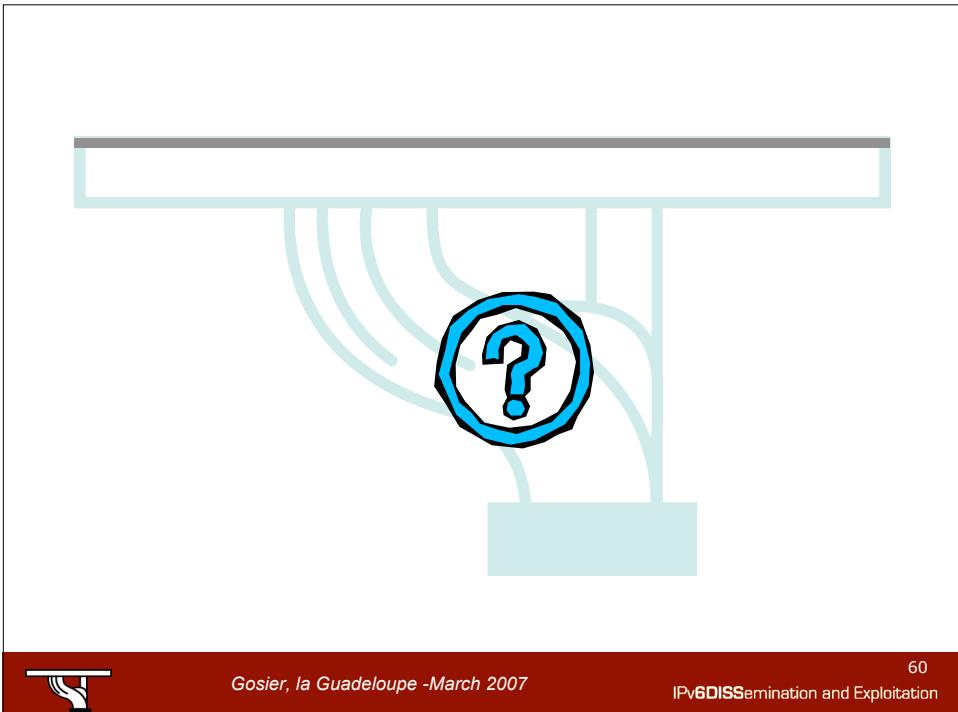
## Conclusion

- 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 ?

Gosier, la Guadeloupe -March 2007

58

IPv6DISSemination and Exploitation



Gosier, la Guadeloupe -March 2007

60  
IPv6DISSemination and Exploitation