



IPv6 network management



DITCHE, Port Elizabeth, Sep. 2005

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



DITCHE, Port Elizabeth, Sep. 2005

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



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSEmination and Exploitation

Introduction

- Network Management : What is it?
 1. Configurations
 2. Inventory
 3. Topology
 4. Fault
 5. Security
 6. Accounting
- ...



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSEmination and Exploitation

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, ...)



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

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



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

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)



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

IPv6 only networks

- Topology discovery (LAN, WAN ?)
 - IPv6 SNMP agent
 - SNMP over IPv6 transport
- => Need to identify the missing parts



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

SSH/TELNET/TFTP...

Basic requirements to manage a network



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

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



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

SNMP/MIBs and IPv6

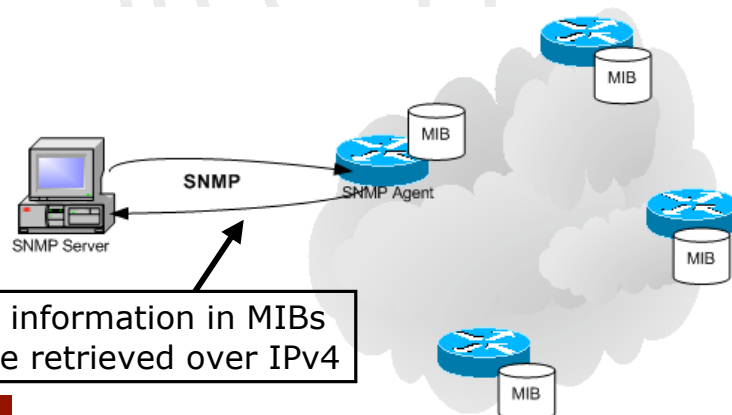
- SNMP and IPv6
- IPv6 MIBs status
- Manufacturers implementations



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

SNMP model



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

SNMP over IPv6

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



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

IPv6 MIBs Status



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

IPv6 MIBs status

- 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.



DITCHE, Port Elizabeth, Sep. 2005

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		RFC2466
ICMP MIB			
TCP MIB	RFC2012	RFC2452	
UDP MIB	RFC2013	RFC2454	



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

IPv6 MIBs / 3 (Hidden)

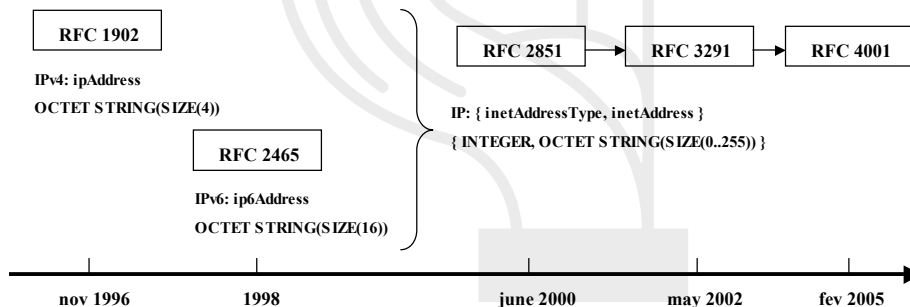
- Standardization status at IETF: Unified MIBs
 - Definition of new Textual Conventions (TC) taking into account both versions of IP:
 - **RFC2851**:
 - IP: {InetAddressType, InetAddress}
 - **RFC3291** (Obsoletes RFC2851):
 - New TCs: InetAddressPrefixLength, InetPortNumber, InetAutonomousSystemNumber
 - **RFC4001** (Obsoletes RFC3291):
 - New TCs: InetZoneIndex, InetScopeType, InetVersion



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

IPv6 MIBs / 3



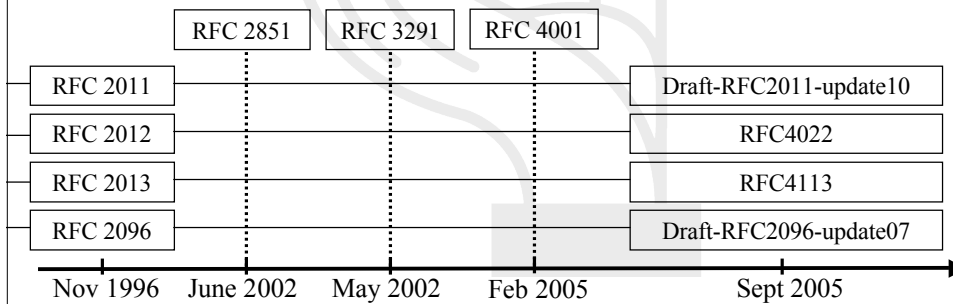
DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

IPv6 MIBs / 4

■ Standardization status at IETF

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



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

IETF MIB Status / 5

- draft-ietf-ipv6-rfc2011-update-10.txt
 - **IP MIB** (05/2004)
 - In the RFC Editor's queue (06/2004)
- RFC4022
 - **TCP MIB** (03/2005)
- RFC4113
 - **UDP MIB** (06/2005)
- draft-ietf-ipv6-rfc2096-update-07.txt
 - **IP Forwarding Table MIB** (02/2004)
 - proposed standard RFC
(in the RFC Editor's queue...)



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

IETF MIB Status / 6

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

Note that the same people are working on

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



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

IPv6 MIBs implementations



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

IPv6 MIBs implementation/ 1

- Cisco
 - Private Cisco MIBs implement ID-00 of RFC 2011 & 2096 updated drafts
 - Working 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*
 - ...



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

Cisco: IPv6 CLI

"show interface accounting"

- Differentiate IPv4/IPv6 counters at the interface level for all Cisco routers, except:
 - 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)



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

IPv6 MIBs implementation/2

- Juniper
 - MIB based on RFC 2465
 - with different counters for IPv4 and IPv6 traffic
 - Or based on filters to collect IPv6 traffic:
 - Ex: Geant monitoring



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

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.



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

IPv6 MIBs implementation/4

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



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

IPv6 MIBs implementation/5

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



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

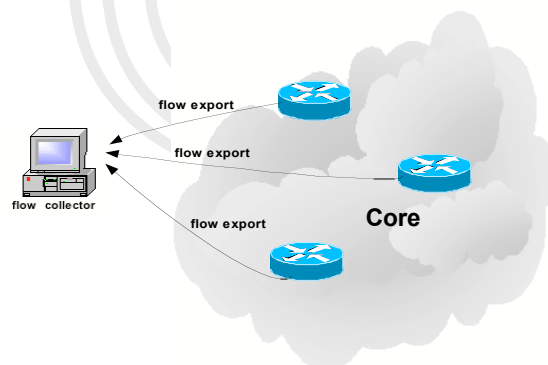
IPv6 flow monitoring



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

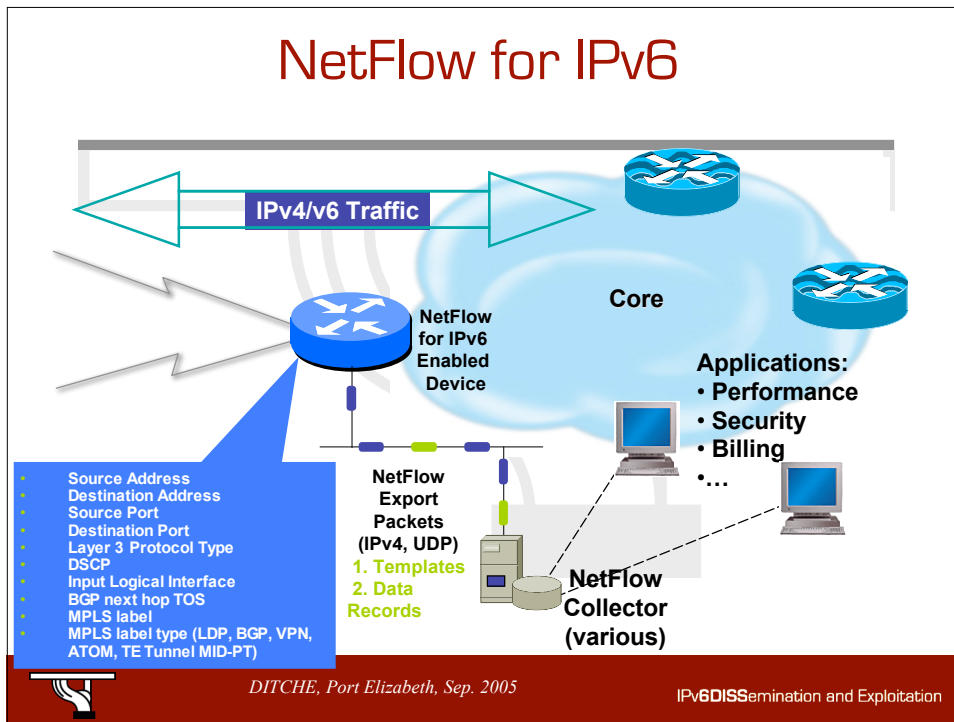
Netflow & IPFIX model



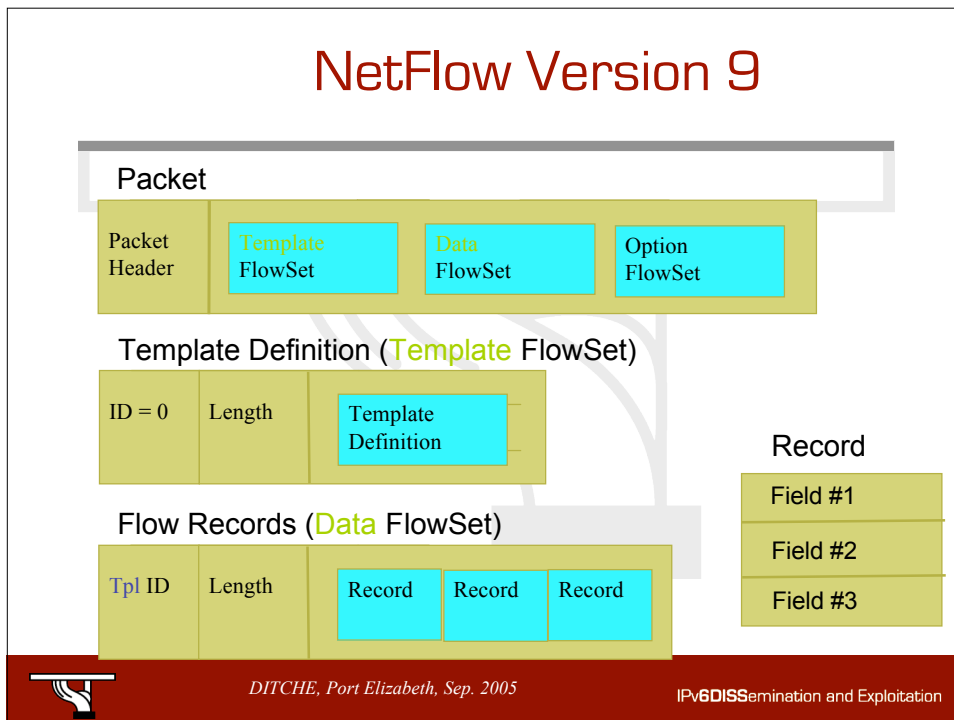
DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

NetFlow for IPv6



NetFlow Version 9



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	1002
(Template ID)	(Template ID)
3	4
(# of Fields)	(# 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



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

Example for Export Packet

		Same as Template ID for Template B; Refer to Previous Slide			
Packet Header	Template B	1.1.1.1	2.2.1.1	Template A	1001
	1002 2(# of Records)	20	64	1	35
		365	20		700
		92894	1000		23
		Record 1 Record 2			



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

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 ...



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

IPv6 flow monitoring / 2

- Hitachi
 - Support sflow (<http://www.sflow.org/>) and Netflow is on the roadmap.
- 6WIND:
 - Not available
- Juniper:
 - Not available



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation



Commercial Management platforms



DITCHE, Port Elizabeth, Sep. 2005

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
 - Campus Manager under testsApplication note on IPv6 management
- **Tivoli Netview** doesn't propose any IPv6 features
- **Infovista** : « no IPv6 plan at the moment »



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

Cisco: NMS Application Support for IPv6

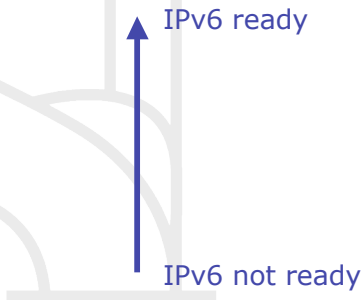
- Cisco NetFlow Collector (NFC) 5.0
 - Full support for IPv6 records
 - Note: device export still IPv4 only
- CiscoWorks
 - Campus - Functional test has started
 - RME - Functional test starts soon
 - CiscoView - under development
- Cisco Network Registrar (CNR):
 - Phase 1 (1H2005): Manage IOS DHCPv6 servers
 - Phase 2: Add DHCPv6 and DNS-over-IPv6



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

« Top ten » ...

- HP Openview
 - Ciscoworks 2000 (Campus Manager)
 - IBM Netview
 - Infovista, Tivoli
 - ...
- 



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation



Monitoring tools



DITCHE, Port Elizabeth, Sep. 2005

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/>



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

LAN - recommendations

- Traffic & service management (web, DNS, SMTP, IMAP...)
 - A single tool: *Argus*, *Nagios* or *Ntop*
- End-to-end performance of the IPv6 network
 - *Iperf* or *Pchar*
- Configuration management
 - *Rancid*
- Analysis of packets on shared links for occasional troubleshooting
 - *Ethereal*, *tcpdump* or *Ntop*
- IPv6 multicast management
 - *Multicast (D)beacon*



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

WAN - recommendations

- Traffic management
 - *MRTG*, *Cricket* or *Nagios*
- Equipment and link status:
 - *Intermapper* or *Nagios*
- Routing management:
 - *ASpath-tree* (routing policy study)
 - *Home-made scripts* (routing fault management)
- For accounting management:
 - *Ipflow*, *CISCO NFC v5.0* or *Home-made collectors*
- Configuration management:
 - *Rancid*, *Home-made inventory tool*
- *Looking-glass* for customers



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation



Examples



DITCHE, Port Elizabeth, Sep. 2005

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



DITCHE, Port Elizabeth, Sep. 2005

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>

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	14 0:00:00	100.0	0.00	0
2 Days Ago	Sat 20 Nov 00:00:00 2004	14 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 104 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

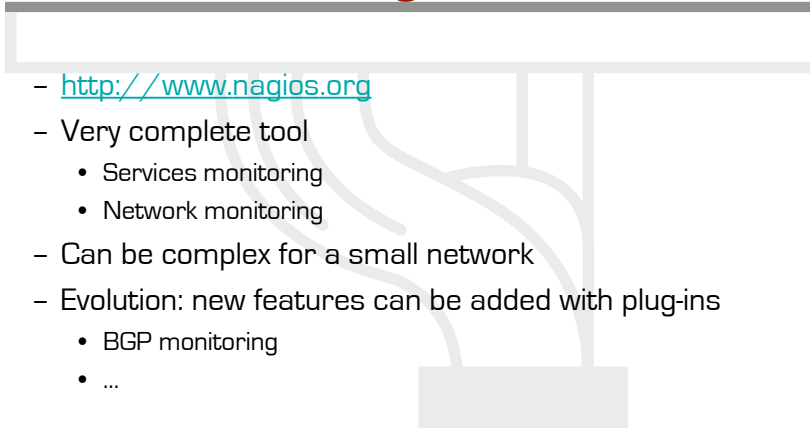
Argus: 33

10:48
lundi
22/11/2004

DITCHE, Port Elizabeth, Sep. 2005 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
 - ...



DITCHE, Port Elizabeth, Sep. 2005 IPv6DISSemination and Exploitation

Nagios

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

Host Status Totals

Up	Down	Unreachable	Pending
11	1	0	0

Service Status Totals

Ok	Warning	Unknown	Critical
11	0	1	3


Host Status Details For All Host Groups

Host	Status	Last Check	Duration	Status Information
gate-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


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

 DITCHE, Port Elizabeth, Sep. 2005 IPv6DISSemination and Exploitation

ASpath-Tree

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

 DITCHE, Port Elizabeth, Sep. 2005 IPv6DISSemination and Exploitation

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



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

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 regexp

regular expression :

Don't use the character "\$"

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

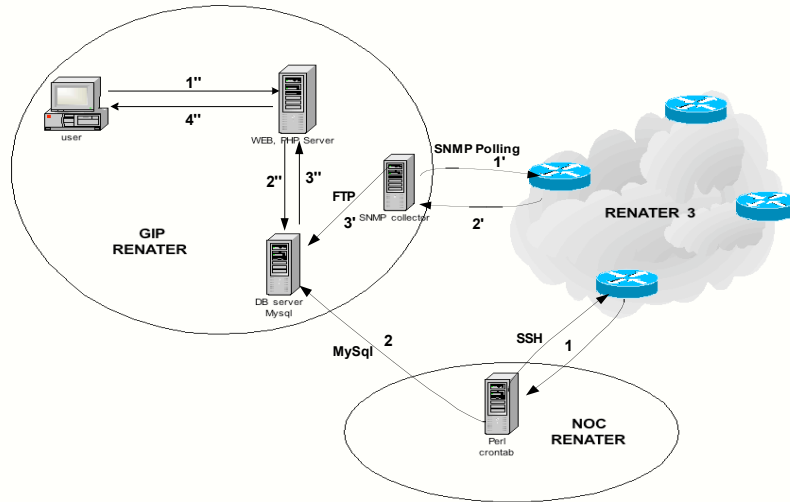
Router: Toulouse



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

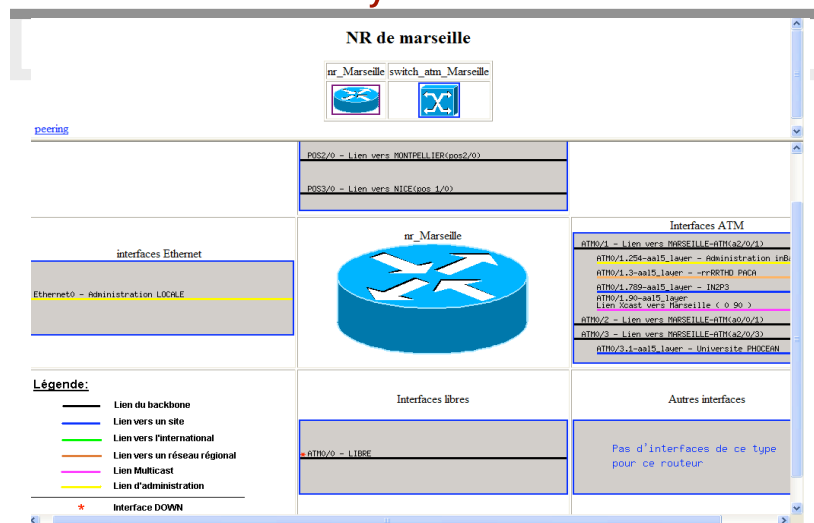
Inventory : interfaces & peerings



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

Inventory: Interfaces



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

Inventory: BGP Peerings

The screenshot displays a network management interface for a Cisco router named 'Routeur PROJETS_GSR-NIO'. At the top, there are four tabs: 'PROJETS_GSR-NIO', 'PROJETS_GSR-6NET', 'PROJETS_7200-MCAST', and 'PROJETS_M5'. Below the tabs, there are four icons representing different network components. The main content area is divided into two sections: 'Peering BGP' and 'Peering eBGP'. The 'Peering BGP' section shows three established peerings with the status 'Established' and the peer group '*** Peer-group de tous les routeurs IBGP ***'. The 'Peering eBGP' section shows three peerings: two established and one active. The active peerings are for '@IRS++ KWAK' and '@IRS++ PIETRA'.

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



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

IPv6 traffic on Cisco routers

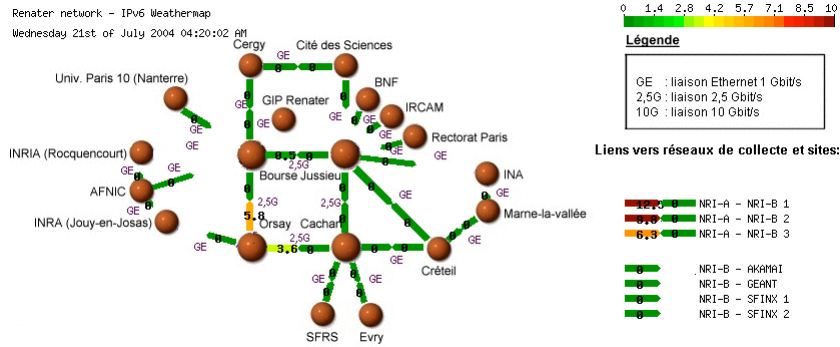
- Based on CLI program
 - "show interface accounting"
 - Differentiate IPv4/IPv6 counters at the physical interface level
- One query per hour
 - IPv6 Weather Map of RENATER



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

IPv6 traffic on Cisco routers



DITCHE, Port Elizabeth, Sep. 2005

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 ?



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSemination and Exploitation

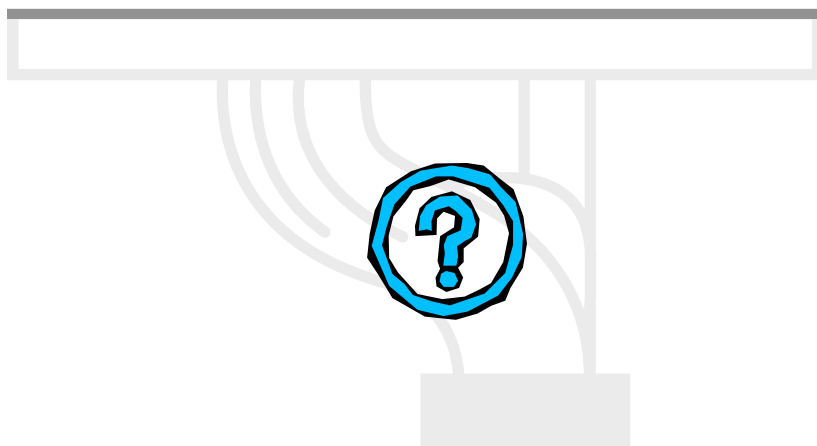
Retrieve this information ...

- <http://sem2.renater.fr/ipv6/biblio/presentation.html>
 - > Presentations
 - > Bibliography, RFCs, ...



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSEmination and Exploitation



DITCHE, Port Elizabeth, Sep. 2005

IPv6DISSEmination and Exploitation