IPv6 network management
IPv6 workshop – WALC 2006

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Contributions

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• Munecika Sumikawa, Hitachi
• Patrick Paul, 6WIND
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

- 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
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
IPv6 information in MIBs can be transported over IPv4 or IPv6
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

<table>
<thead>
<tr>
<th></th>
<th>IPv4</th>
<th>IPv6</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textual Conventions</td>
<td>RFC1902</td>
<td>RFC2465</td>
<td>Definition of IP address format</td>
</tr>
<tr>
<td>IP MIB</td>
<td>RFC2011</td>
<td>RFC2466</td>
<td></td>
</tr>
<tr>
<td>ICMP MIB</td>
<td>RFC2012</td>
<td>RFC2452</td>
<td></td>
</tr>
<tr>
<td>TCP MIB</td>
<td>RFC2013</td>
<td>RFC2454</td>
<td></td>
</tr>
<tr>
<td>UDP MIB</td>
<td>RFC2013</td>
<td>RFC2454</td>
<td></td>
</tr>
</tbody>
</table>
IPv6 MIBs /3

- RFC 1902
  IPv4: ipAddress
  OCTET STRING(SIZE(4))

- RFC 2465
  IPv6: ip6Address
  OCTET STRING(SIZE(16))

- RFC 2851
  IP: { inetAddressType, inetAddress } { INTEGER, OCTET STRING(SIZE(0..255)) }

- RFC 3291

- RFC 4001
  feb 2005

Time:
- nov 1996
- 1998
- june 2000
- may 2002
- feb 2005

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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
  - \(\Rightarrow \) RFC 4273
  - *This draft consider only IPv4 addresses:*
    - « IMPORTS IpAddress » \(\Rightarrow\) 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
    - ...

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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

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

IPv4/v6 Traffic

NetFlow for IPv6 Enabled Device

Core

Applications:
• Performance
• Security
• Billing
• ...

NetFlow Collector

NetFlow Export Packets
1. Templates
2. Data Records

• 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)

IPv6 Distribution and Exploitation

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NetFlow Version 9

Packet

Template Definition (Template FlowSet)

ID = 0  Length  Template Definition

Flow Records (Data FlowSet)

Tpl ID  Length  Record  Record  Record

Record

Field #1

...
**NetFlow Version 9**

**Example for Template Definition**

<table>
<thead>
<tr>
<th>Template A</th>
<th>Template B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Set ID (0 for Template)</td>
<td>Flow Set ID (0 for Template)</td>
</tr>
<tr>
<td>Length of Template Structure</td>
<td>Length of Template Structure</td>
</tr>
<tr>
<td>1001 (Template ID)</td>
<td>1002 (Template ID)</td>
</tr>
<tr>
<td>3 (# of Fields)</td>
<td>4 (# of Fields)</td>
</tr>
<tr>
<td>SRC_AS_NUMBER</td>
<td>SRC_IP_PREFIX</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>DST_AS_NUMBER</td>
<td>SRC_AS_NUMBER</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>L4_PROTOCOL</td>
<td>PACKET_COUNT</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>BYTE_COUNT</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>
### Example for Export Packet

**Packet Header**

<table>
<thead>
<tr>
<th>Template B</th>
<th>Template ID for Template B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1002</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

**Number of Records for Template B**

- **Record 1**
  - 1.1.1.1
  - 20
  - 365
  - 92894

- **Record 2**
  - 2.2.1.1
  - 64
  - 20
  - 1000

**Data for Template B**

<table>
<thead>
<tr>
<th>1001</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>35</td>
</tr>
</tbody>
</table>

**Data for Template A**

<table>
<thead>
<tr>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>700</td>
</tr>
</tbody>
</table>

*As defined in the previous slide*

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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/](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
IPv6 ready

IPv6 not ready

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

« Top ten » …
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/
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
### WAN - recommendations

<table>
<thead>
<tr>
<th>Category</th>
<th>Tools/Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plotting monitoring data</td>
<td>MRTG, Cricket or Nagios</td>
</tr>
<tr>
<td>Equipment and link status:</td>
<td>Intermapper or Nagios</td>
</tr>
<tr>
<td>Routing management:</td>
<td>ASpath-tree (routing policy check)</td>
</tr>
<tr>
<td></td>
<td>Home-made scripts (routing fault management)</td>
</tr>
<tr>
<td>For accounting management:</td>
<td>Ipflow, CISCO NFC v5.0 or Home-made collectors</td>
</tr>
<tr>
<td>Configuration management:</td>
<td>Rancid, Home-made inventory tool</td>
</tr>
<tr>
<td>Looking-glass for customers</td>
<td></td>
</tr>
</tbody>
</table>
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
### Top:Serveurs SIPA

**name** Serveurs-SIPA  
**status** up

<table>
<thead>
<tr>
<th>Name</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>data-ipv6_IPV4</td>
<td>Ping</td>
</tr>
<tr>
<td>data-ipv6_IPV6</td>
<td>Ping</td>
</tr>
<tr>
<td>sem2_IPV4</td>
<td>Ping</td>
</tr>
<tr>
<td>sem2_IPV6</td>
<td>Ping</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Start</th>
<th>Elapsed Time</th>
<th>% Up</th>
<th>% Down Time</th>
<th>Downtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Today</td>
<td>00:00:00</td>
<td>100.0</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>Yesterday</td>
<td>00:00:00</td>
<td>100.0</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>2 Days Ago</td>
<td>00:00:00</td>
<td>100.0</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>This Month</td>
<td>21:42:49</td>
<td>98.28</td>
<td>1.72</td>
<td>1</td>
</tr>
<tr>
<td>Last Month</td>
<td>01:00:00</td>
<td>99.97</td>
<td>0.03</td>
<td>1</td>
</tr>
<tr>
<td>2 Months Ago</td>
<td>01:00:00</td>
<td>100.0</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>This Year</td>
<td>10:22:41</td>
<td>99.46</td>
<td>0.54</td>
<td>3</td>
</tr>
</tbody>
</table>

Thu 11 Nov 20:59:44 2004 up TRANSITION - data-ipv6_IPV4  
Thu 11 Nov 12:08:57 2004 down TRANSITION - data-ipv6_IPV4  
Wed 13 Oct 17:02:33 2004 down TRANSITION - data-ipv6_IPV4  
Mon 13 Sep 11:28:39 2004 up TRANSITION - sem2_IPV4
Nagios

- [http://www.nagios.org](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
  - ...

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Nagios

Current Network Status
Last Updated: Thu Jan 6 09:33:35 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: 1
Down: 0
Unreachable: 0
Pending: 0

Service Status Totals
Ok: 1
Warning: 1
Unknown: 3
Critical: 0

All Problems: 4
All Types: 5

Host Status Details For All Host Groups

<table>
<thead>
<tr>
<th>Host</th>
<th>Status</th>
<th>Last Check</th>
<th>Duration</th>
<th>Status Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>date-inv</td>
<td>DOWN</td>
<td>00-12-2003 12:28:43</td>
<td>148d 21h 56m 44s</td>
<td>/bin/ping -b -W 2 -c 1 192.168.156.67</td>
</tr>
<tr>
<td>somo2</td>
<td>UP</td>
<td>08-12-2003 15:27:43</td>
<td>148d 21h 55m 22s</td>
<td>(Host assumed to be up)</td>
</tr>
</tbody>
</table>

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
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 [regexp]
  - regular expression:
    - Don't use the character "$"

IPv6 traffic
- IPv6 interface
- IPv6 tunnels
- IPv6 neighbors
- IPv6 route

Router: Toulouse
- submit
- Reset

IPv6 address
IPv6 address
name address IPv4
name address IPv6

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Inventory: interfaces & peerings

GIP RENATER

WEB, PHP Server

DB server

MySQL

SNMP collector

FTP

SSH

MySql

SNMP Polling

RENATER 3

NOC RENATER

Perl cron job
Inventory: Interfaces
Inventory: BGP Peerings
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
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, …