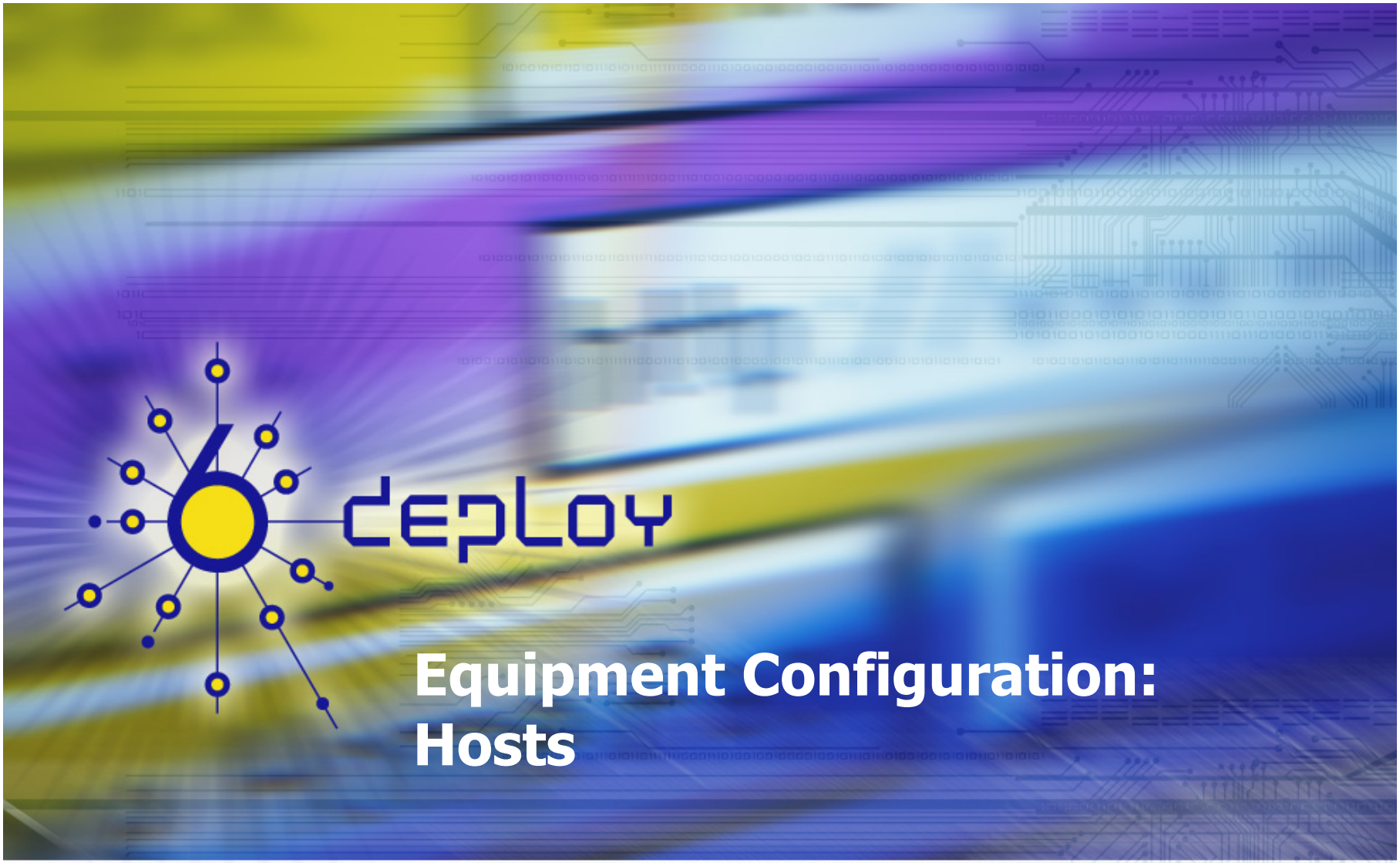

Equipment Configuration: Hosts

6DEPLOY. IPv6 Deployment and Support

IPv6 Workshop, Almaty, July 2011

IPv6 Support – Hosts Operating Systems

Vendor	First versions supporting IPv6	More Information
Apple	MAC OS X 10.2	http://developer.apple.com/macosx/
BSD	FreeBSD 4.0 OpenBSD 2.7, NetBSD 1.5 BSD/OS 4.2	http://www.kame.net/
HP / Compaq	HP-UX 11i, Tru64 UNIX V5.1, OpenVMS V5.1	http://docs.hp.com/en/5990-7247/index.html
IBM	z/OS Rel. 1.4, AIX 4.3, OS/390 V2R6 eNCS	http://www-01.ibm.com/software/info/ipv6/compliance.jsp
Linux	Red Hat 6.2, Mandrake 8.0, SuSE 7.1, Debian 2.2	http://www.bieringer.de/linux/IPv6/status/IPv6+Linux-status-distributions.html
Microsoft	Windows 7, Vista, XP, Server 2003, Server 2008, CE .NET, Mobile	http://www.microsoft.com/ipv6/
Novell	Netware 6.1	http://www.novell.com/documentation/oes2/ntwk_ipv6_nw/index.html?page=/documentation/oes2/ntwk_ipv6_nw/data/ai4x21f.html
Sun	Solaris 8, 9 and 10	http://docs.sun.com/app/docs/doc/817-0573?l=en

General purpose and embedded OSs supporting IPv6 http://www.ipv6tf.org/index.php?page=guide/organizations/vendors/oss

Host Equipment

Windows

BSD

Linux

Solaris

Mac OS X

WINDOWS

IPv6 on Windows

Full support

- Windows 7, Vista and XP SP1 and later
- Windows Server 2003 and 2008

Technology preview

- Windows XP without SP
- Windows 2000 (not compatible with SP2 or later)

Developer Edition

- Windows NT 4.0 (source was available)

No official support but third party products available

- Windows 95/98/ME

Supported features:

- autoconfiguration, 6in4 tunnel, 6to4 tunnel, 6to4 relay, TEREDO tunnel, ISATAP tunnel, IPSec (manual keying)

IPv6 in Windows 7

IPv6 is installed by default

Configuration is based on GUI and netsh (see Vista)

IPv6 Support similar to Vista, differences are:

- Change: Random Interface ID is on by default (RFC 3041)
  - Doesn't use EUI-64 by default to get the interface ID in autoconfigured addresses: netsh interface ipv6 set global [[randomizeidentifiers=]enabled|disabled]
- New Feature: IP-HTTPS (IP over Secure HTTP)
- New Feature: DirectAccess
  - Transparent VPN allowing communication in both directions
  - Needs Windows Server 2008

IPv6 in Windows Vista

IPv6 is installed by default

It not only supports the basic functionalities as in previous versions (i.e. Windows XP and 2003) but also new advanced features such as

- Dual IP layer architecture Installed and enabled by default
- Graphical user interface (GUI)-based configuration
- Full Support for IPsec
- MLDv2
- DNS messages over IPv6
- LLMNR (Link Local Multicast Name Resolution)
- Literal IPv6 addresses in URLs
- Support for ipv6-literal.net names
- IPv6 over PPP
- DHCPv6

Windows Vista configuration (1)

- **Automatic address configuration**
  1. Stateless address autoconfiguration with IPv6 RA
  2. Stateful address autoconfiguration with DHCPv6
- **Manual address configuration**
  1. The GUI of the properties of TCP/IPv6 component
  2. Commands in the netsh interface ipv6 context

```
netsh interface ipv6 add address interface_name
ipv6_address
```

- **Address selection configuration**
  - RFC3484 provides a standardized method to choose source and destination IPv6 addresses with which to attempt connections
  1. A destination address selection algorithm to sort the list of possible destination addresses in order of preference
  2. A source address selection algorithm to choose the best source address to use with a destination address

Windows Vista configuration (2)

Unlike XP, IPv6 in Vista cannot be uninstalled

To disable IPv6 on a specific connection

- Network Connections folder > properties of the connection > clear the check box next to the TCP/IPv6 component
- This method disables IPv6 on your LAN interfaces and connections
- But does not disable IPv6 on tunnel interfaces or the IPv6 loopback interface

To selectively disable IPv6 components and configure behaviors

- Create and configure the following registry value (DWORD type)

  `HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\tcpip6\Parameters\DisabledComponents`

  `DisabledComponents` is set to 0 by default

IPv6 in Windows XP

Not installed by default, and installation varies on service packs

SP1 additions:

- vendor support
- GUI installation
- configuration via netsh command

SP2 additions

- Teredo client
- host-specific relay support
- IPv6 firewall

IPv6 installation in Windows XP

No service packs

- type ipv6 install from the command prompt

SP1

- install protocol "Microsoft IPv6 Developer Edition" from Connection Properties window

SP2

- install protocol "Microsoft TCP/IP version 6" from Connection Properties window

Windows XP configuration (1)

Command for IPv6 configuration

- ipv6 (will be discontinued, not present since Windows Server 2003)
- netsh interface ipv6

Autoconfiguration is working

- netsh interface ipv6
- interface 1 - loopback
- interface 2 - ISATAP
- interface 3 - 6to4 interface
- interface 4... – real network interfaces
- interface 5 – Teredo interface

Windows XP configuration (2)

Set manual address

- `netsh ipv6 interface {add|set} address [interface=] <interface> [address=] <address>`
- `<interface>` - interface name or index
- `<address>` - address in IPv6 format

Deleting manual address

- `netsh ipv6 interface delete address [interface=] <interface> [address=] <address>`

Windows XP configuration (3)

Set/remove static IPv6 route

- `netsh ipv6 interface {add|set|delete} route [prefix=]<prefix>/<length> [interface=]<interface> [[nexthop=] <address>]`

Applications

- ipconfig, netstat, ping6, tracert6, pathping
- All Wininet.dll based applications
  - ftp, telnet, IExplorer,

Windows 2003 server

- `netsh interface ipv6 (only!)`
- file/print sharing-et (site-local) supported over IPv6
- IIS and media server

Windows XP configuration (4)

Neighbor cache

- `netsh interface ipv6 show neighbors (ipv6 nc)`

IPv6 routing table

- `netsh interface ipv6 show routes (ipv6 rt)`

Reconfiguration

- `netsh interface ipv6 renew (ipv6 renew)`

Address selection policy

- `netsh interface ipv6 show prefixpolicy`
- `netsh interface ipv6 set prefixpolicy [prefix=]<prefix>/<length> [precedence=]precedence [label=]label`

What Windows cannot do with IPv6

DNS messages over IPv6

- not for Windows XP, but Windows Vista, Win7 and Server 2003 can, there is a builtin proxy for it

IPv6 support for file and print sharing

- Windows 2003 can

IPv6 support for the WinInet, IPHelper, and DCOM APIs

Windows XP configuration (4)

IPSec

- `ipsec6 sp/sa/s/l`
- No ESP support by default

.NET

- IPv6 support, but IPv6 literal address does not work

IPv6 firewall support after SP2 or Advanced networking pack

IPv6 teredo support after SP2 or Advanced networking pack

Further information: http://www.microsoft.com/ipv6/

Important! You should switch on IPv6 support if you have IPv6 connectivity or you have to tweak RFC3484 knobs

Windows XP configuration (5)

Windows XP ICF – same rules for IPv4 and IPv6

- Show configuration:
  - `netsh firewall show globalport`
  - `netsh firewall show adapter`
- Set configuration
  - `set globalport [port#=enable|disable] [name=name] [protocol=tcp|udp]`
  - `set adapter [name] [icmp type#=enable|disable] [port port#=enable|disable [name=name] [protocol=tcp|udp]] [ignoreglobalport port#=enable|disable] [name=name] [protocol=tcp|udp]] [filtering=enable|disable]`
  - `set logging [filelocation=<location>] [filesize=integer] [droppedpackets=enable|disable] [successfulconnections=enable|disable]`

After SP2

- in the firewall you can configure Path MTU discovery support
- per process configuration possible

Further information:

http://www.microsoft.com/technet/community/columns/cableguy/cg0104.mspx

Reminder about RFC3484

(Default Address Selection for IPv6)

Multiple source addresses: - linklocal, global, tunneling, mobile, choosing IPv6 or IPv4 for communication – which one to select?

- implement sorting in getaddrinfo()- via policy table:

prefer native IPv6

Prefix	Precendence	Label
::1/128	50	0
::/0	40	1
2002::/16	30	2
::/96	20	3
::ffff:0:0:/96	10	4

prefer IPv4

Prefix	Precendence	Label
::1/128	50	0
::/0	40	1
2002::/16	30	2
::/96	20	3
::ffff:0:0:/96	100	4

BSD

IPv6 on *BSD

Supported

- autoconfiguration, IPv4 tunnel, 6to4, MLDv1, IPSec, Jumbogram, ICMP mode information query, TRT, privacy extension

Available since FreeBSD 4.0, OpenBSD 2.7, NetBSD 1.5

KAME extension

- NAT-PT, DHCPv6, PIM-(S)SM, multicast DNS, EDNS resolver, ISATAP (not any more), anycast (integrated)

FreeBSD configuration (1)

Installation: not necessary, the default kernel has it

The installer asking for IPv6 support

- `ipv6_enable="yes" in /etc/rc.conf`
- Autoconfiguration is working
- `ifconfig -a`

FreeBSD configuration (2)

Manual address configuration

- `ipv6_prefix_fxp0="2001:DB8:1:2"`
- `ipv6_ifconfig_fxp0="2001:DB8:1:2::1 prefixlen 64"`
- then `/etc/netstart`
- or `ifconfig`

Neighbor cache

- `ndp -a`

Routing table

- `route/netstat`

FreeBSD configuration (3)

Configuration of further addresses

- `ipv6_ifconfig_if0_alias0="fec0:0:0:5::2/64"`

What about if you don't have IPv6 connectivity

- ip6addrctl(8) program – according RFC3484 you can adjust default address selection

```
#preferip4connection_policy
#Prefix        Precedence Label
::1/128               50     0
::/0                  40     1
2002::/16             30     2
::/96                 20     3
::ffff:0:0/96        100     4
```

FreeBSD configuration (4)

Reconfiguration

- `rtsol fxp0`

Applications

- ping6, traceroute6, ftp, telnet, r* commands, sendmail, apache, Mozilla, proftpd, OpenSSH, LPD, NFS/YP (Since FreeBSD 5.0), courier-imap ,irc, openldap, tftp, tcpdump, inn, tin

Further information

- http://www.freebsd.org
- http://www.kame.net
- http://ipv6.niif.hu/m/FAQ

FreeBSD configuration (5)

Configure an IPv6 in IPv4 tunnel

- ifconfig gif1 create
- ifconfig gif1 tunnel @IPv4_source @IPv4_dest
- ifconfig gif1 inet6 @IPv6_address up

Configure an IPv6 in IPv6 tunnel

- ifconfig gif1 create
- ifconfig gif1 tunnel @IPv6_source @IPv6_dest
- ifconfig gif1 inet6 @IPv6_address up

FreeBSD configuration (6)

Configure a static route

- Default route

```
route add -inet6 default fe80::X:X:X:X%interface
route add -inet6 default X:X:X:X::X (if global address)
```

- Others

```
route add -inet6 X:X:X:X:: -prefixlen YY X:X:X:X::X
route add -inet6 X:X:X:X:: -prefixlen YY fe80::X:X:X:X%interface
```

%*interface* notation

If link-local address, need to specify on which interface the address is available

FreeBSD configuration (7)

Router advertisement: /etc/rtadvdv.conf

```
default:\
        :chlim#64:raflags#0:rltime#1800:rtime#0:retrans#0:\
        :pinfoflags="la":vltime#2592000:pltime#604800:mtu#auto:
```

- ```
  ef0:\              :addr="2001:DB8:ffff:
  1000::":prefixlen#64:tc=default:
  ```
  ```

FreeBSD configuration (8)

RIPng: route6d daemon

`route6d`

`-L` *`IPv6_prefix,interface`* (receives only prefixes derived from *`IPv6_prefix`* on interface *`interface`*)

`-N` *`interface`* (do not receive and advertise routes on interface)

`-O` *`IPv6_prefix, interface`* (advertise only on interface the IPv6 prefix)

BGP: bgpd daemon

Better to use Zebra/Quaggua BGP daemon

LINUX

IPv6 on Linux

Supported

- autoconfiguration, IPv4 tunnel, 6to4
- since Kernel 2.2.x recommended at least 2.4.8, or 2.6.18

USAGI patch (mostly included in 2.6.x series)

- Node information query, anycast, ISATAP, privacy extension, IPSec, applications, bug-fix, mobile IP

General Linux configuration (1)

Kernel compile options

- CONFIG_IPv6=m/y
- If the IPv6 module is loaded, file `/proc/net/if_inet6` should be present
- IPv6 module can be loaded by `modprobe ipv6`

Autoconfiguration supported

- `ifconfig`

General Linux configuration (2)

Address configuration

- `ifconfig <interface> inet6 add <ipv6address>/<prefixlength>`

Neighbor cache

- `ip -6 neigh show`

IPv6 routing table

- `route -A inet6/netstat`

Red Hat configuration (1)

Enabling Global IPv6 support

/etc/sysconfig/network file:

```
NETWORKING_IPV6="yes"
```

Enabling IPv6 support on a particular interface

/etc/sysconfig/network-scripts/ifcfg-eth0 file:

```
IPV6INIT="yes"
```

Configuring IPv6 interface address

/etc/sysconfig/network-scripts/ifcfg-eth0 file:

```
IPV6ADDR="2001:DB8:20::291D:6A83/48"
```

Default route configuration

/etc/sysconfig/static-routes-ipv6 file:

```
eth0 ::/0 2001:DB8:20::922:A678
```

Red Hat configuration (2)

Applications

- ping6, traceroute6, tcpdump, tracepath6, apache, bind, imap (xinetd), sendmail, openssh, telnet, ftp, mozilla, lynx, wget, kde, xchat, etc.

Further information

- http://www.bieringer.de/linux/IPv6
- http://www.linux-ipv6.org/

Fedora configuration (1)

- **(Fedora Core 2 only) append to `/etc/sysconfig/network`:**
  - `NETWORKING_IPV6=yes`
  - `IPV6_DEFAULTDEV="your exit device e.g. tun6to4"`
- **(Fedora Core 1 only) append to /etc/sysconfig/network**
  - `NETWORKING_IPV6=yes`
  - `IPV6_GATEWAYDEV="your exit device e.g. tun6to4"`
- **6to4 gateway- append to /etc/sysconfig/network-scripts/ifcfg-eth0**
  - `IPV6INIT=yes`
  - `IPV6TO4INIT=yes`

Debian configuration (1)

Enabling IPv6

You should put "`ipv6`" in "`/etc/modules`"

Address configuration

"/etc/network/interfaces":

```
iface eth0 inet6 static
address 2001:XXXX:YYYY:ZZZZ::1
netmask 64
```

Further information

http://wiki.debian.org/DebianIPv6

Debian configuration (2)

Tunnel configuration

"/etc/network/interfaces":

```
iface tun0 inet6 v4tunnel
    endpoint A.B.C.D
    address 2001:XXXX:1:YYYY::2
    gateway 2001:XXXX:1:YYYY::1
    netmask 64
```

Debian configuration (3)

RA configuration on Debian router

"/etc/radvd.conf" :

```
interface eth0
{
    AdvSendAdvert on;
    AdvLinkMTU 1500;
    prefix 2001:XXXX:YYYY:ZZZZ:/64 {
        AdvOnLink on;
        AdvPreferredLifetime 3600;
        AdvValidLifetime 7200;
    };
};
```

Debian configuration (4)

Configuration on router

```
net.ipv6.conf.all.autoconf = 0
net.ipv6.conf.all.accept_ra = 0
net.ipv6.conf.all.accept_redirects = 0
net.ipv6.conf.all.forwarding = 1
net.ipv6.conf.all.router_solicitations = 0
```

Firewalls

```
iptables -I INPUT -j ACCEPT --proto 41
```

SOLARIS

Solaris configuration (1)

Supported since Solaris 8

- autoconfiguration, IPv4 tunnel, 6to4, IPSec, applications

Solaris configuration (2)

Autoconfiguration

existing "`/etc/hostname6.<intf>`"

Static address configuration "`/etc/hostname6.<intf>`" :

```
addif 2001:DB8:1:2::100 up
```

Static name ↔IPv6 address resolution:

```
in /etc/inet/ipnodes
```

DNS resolution should be enabled

/etc/nsswitch.conf

ipnodes: files dns

MAC OS X

Mac OS X configuration (1)

Supported since Mac OS X 10.2 (since Darwin kernel version 6)

- autoconfiguration, IPv4 tunnel, 6to4, IPSec, applications, Apple Filing Protocol (since AFP version 3.1)
- Rendez-vous point supports IPv6
- Basically – what you can expect from *BSD
- No DHCPv6 support (until Lion 10.7)

Mac OS X configuration (2)

Enabled by ip6config command

`ip6config command interface`

- commands:
  - start-v6 –enable IPv6 on given (all) interface
  - stop-v6 –disable IPv6 on given (all) interface
  - start-stf – enable IPv6 as defined in /etc/6to4.conf
  - start-rtadvd – start router advertisement daemon and enable IPv6 packet forwarding between interfaces
- ip6 – enable disable per interface

Autoconfiguration

enabled by default

Questions?

6DEPLOY Project Web Site:

http://www.6deploy.eu