Status of IPv6

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IPv6

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- About me & my IPv6 related work
- Status of IPv6 address deployment and in DNS
- Status of IPv6 support in operating systems and routers
- Status of IPv6 support of firewalling
- Status of IPv6 support in applications
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About me (or who I am)

- Living in Munich (Germany)
- Employee of *AERAsec Network Services and Security GmbH* (since 2000)
  - focussing on IT security and network consulting
  - trainer for IPv6, TCP/IP and others
- Co-founder and core member of *Deep Space 6*
- Member of the German IPv6 Task Force

My IPv6-related time line

- 1993: First contact with the Internet
- 1996: Got a request designing a course on IPv6
- 1997: *IPv6 & Linux – HowTo*, *initscripts-ipv6*
- 1999: *IPv6 & Linux - Current Status*
- 2001: *Linux IPv6 HOWTO*, *ipv6calc*
- 2002: Co-founded *Deep Space 6*

History of my IPv6 related documents

- *IPv6 & Linux - HowTo*
  - 1997: first release
  - Format: HTML only
  - Focus: how to enable IPv6 in Linux and some daemons
  - 2001: migration of important content into *Linux IPv6 HOWTO*
  - **Status: going obsolete after end of migration**

  URL:
  http://www.bieringer.de/linux/IPv6/IPv6-HOWTO/IPv6-HOWTO.html

History of my IPv6 related documents

- *Linux IPv6 HOWTO*
  - 2001: first release
  - Format: HTML, PS, PDF generated from SGML source
  - Focus: extensive information about IPv6 on Linux
  - Currently available in the following languages:

 English (since beginning)

 German (since February 2003)

 French (since May 2003)

 Italian (since March 2004)

 Greek (work in progress)

  - **Status: maintained**

URLs:
http://www.tldp.org/HOWTO/Linux+IPv6-HOWTO/ (English only)
http://mirrors.bieringer.de/ (all available languages)

History of my IPv6 related documents

- *IPv6 & Linux - Current Status*
  - 1999: first release
  - Format: HTML only
  - Focus: status of IPv6 in kernel, applications and distributions
  - 2003: migration of application status to *Deep Space 6*
  - **Status: still partially maintained**
  - Planned for Q4/2004: migration of kernel status to *Deep Space 6*

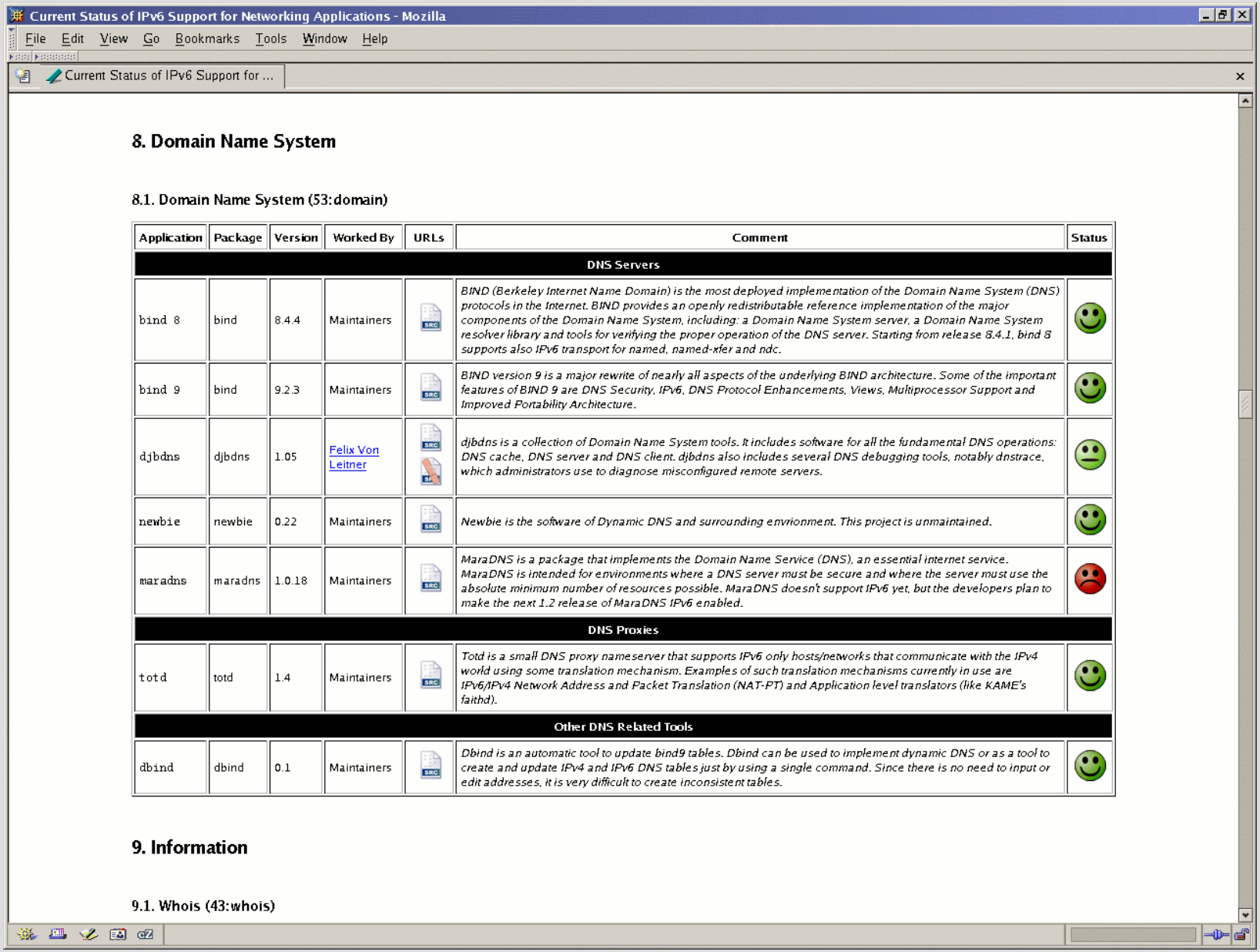
  URL:
  http://www.bieringer.de/linux/IPv6/status/IPv6+Linux-status.html

History of my IPv6 related documents

- *Current Status of IPv6 Support for Networking Applications*
  - 2003: first release
  - Format: HTML generated from XML
  - Migration of content from *IPv6 & Linux - Current Status*
  - Focus: status of IPv6 in networking applications
  - **Status: extended and maintained by *Deep Space 6* team**
  - Statistics (July 2, 2004):
    - Native support: 171
    - IPv6 patch available: 38

  URL:
  http://www.deepspace6.net/docs/ipv6_status_page_apps.html

Screenshot of Application Status



8. Domain Name System

8.1. Domain Name System (53:domain)

Application	Package	Version	Worked By	URLs	Comment	Status
DNS Servers						
bind 8	bind	8.4.4	Maintainers		*BIND (Berkeley Internet Name Domain) is the most deployed implementation of the Domain Name System (DNS) protocols in the Internet. BIND provides an openly redistributable reference implementation of the major components of the Domain Name System, including: a Domain Name System server, a Domain Name System resolver library and tools for verifying the proper operation of the DNS server. Starting from release 8.4.1, bind 8 supports also IPv6 transport for named, named-xfer and ndc.*	
bind 9	bind	9.2.3	Maintainers		*BIND version 9 is a major rewrite of nearly all aspects of the underlying BIND architecture. Some of the important features of BIND 9 are DNS Security, IPv6, DNS Protocol Enhancements, Views, Multiprocessor Support and Improved Portability Architecture.*	
djbdns	djbdns	1.05	Felix Von Leitner		*djbdns is a collection of Domain Name System tools. It includes software for all the fundamental DNS operations: DNS cache, DNS server and DNS client. djbdns also includes several DNS debugging tools, notably dnstrace, which administrators use to diagnose misconfigured remote servers.*	
newbie	newbie	0.22	Maintainers		*Newbie is the software of Dynamic DNS and surrounding envrionment. This project is unmaintained.*	
maradns	maradns	1.0.18	Maintainers		*MaraDNS is a package that implements the Domain Name Service (DNS), an essential internet service. MaraDNS is intended for environments where a DNS server must be secure and where the server must use the absolute minimum number of resources possible. MaraDNS doesn't support IPv6 yet, but the developers plan to make the next 1.2 release of MaraDNS IPv6 enabled.*	
DNS Proxies						
totd	totd	1.4	Maintainers		*Totd is a small DNS proxy nameserver that supports IPv6 only hosts/networks that communicate with the IPv4 world using some translation mechanism. Examples of such translation mechanisms currently in use are IPv6/IPv4 Network Address and Packet Translation (NAT-PT) and Application level translators (like KAME's faithd).*	
Other DNS Related Tools						
dbind	dbind	0.1	Maintainers		*Dbind is an automatic tool to update bind9 tables. Dbind can be used to implement dynamic DNS or as a tool to create and update IPv4 and IPv6 DNS tables just by using a single command. Since there is no need to input or edit addresses, it is very difficult to create inconsistent tables.*	

9. Information

9.1. Whois (43:whois)

History of my IPv6 related projects

- *initscripts-ipv6*
  - 1997: start of development
  - Focus: integration of handling of permanent IPv6 setup into IPv4 *initscripts* (Fedora/Red Hat Linux and clones)
  - Status:
    - Maintained
    - Sometimes development of new features (see CVS for more)
    - Migration into official *initscripts* (with help of Pekka Savola)

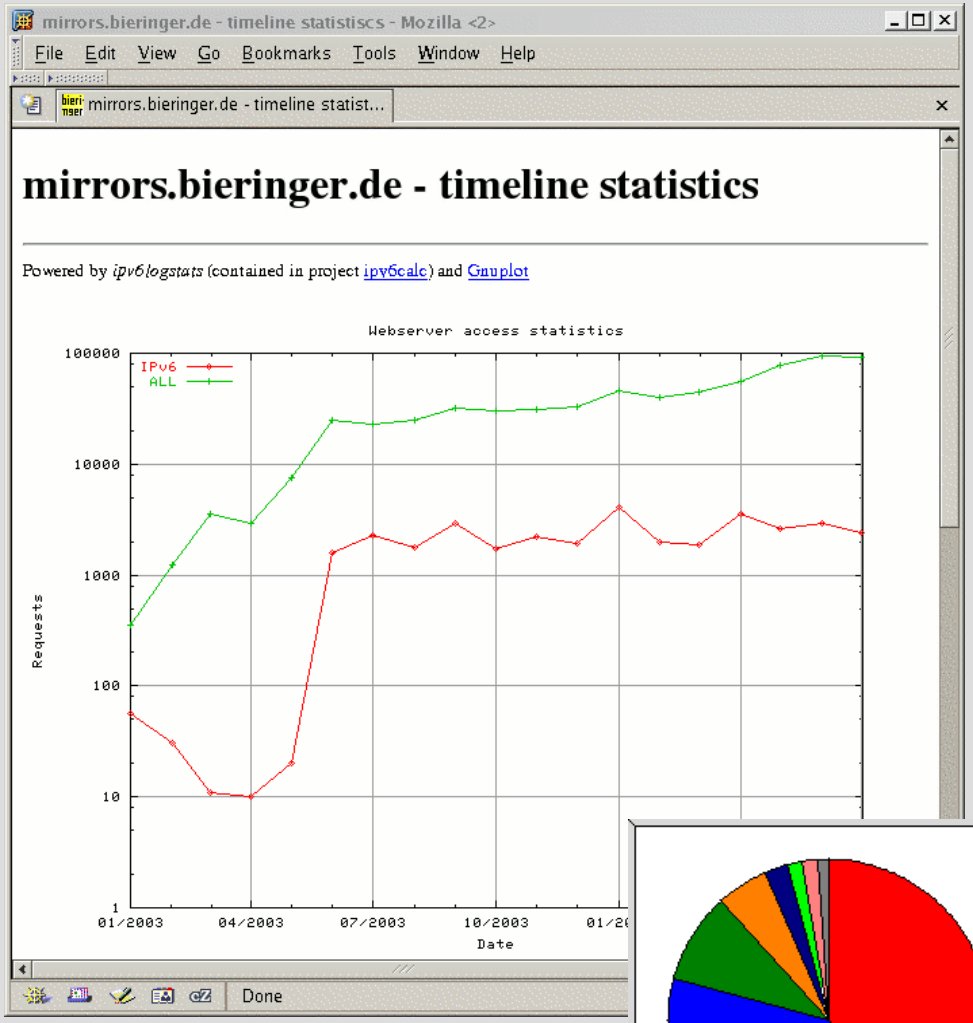
  URLs:
  http://www.deepspace6.net/projects/initscripts-ipv6.html
  http://cvs.deepspace6.net/view/initscripts-ipv6/
  http://fedora.redhat.com/projects/additional-projects/initscripts/

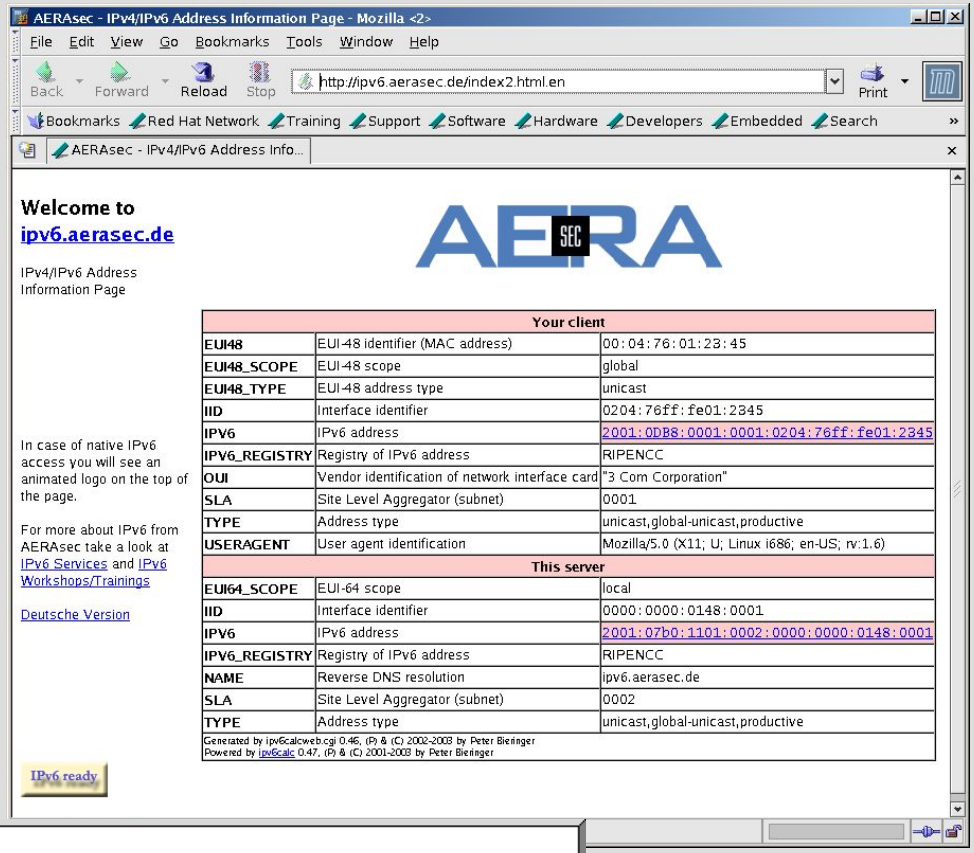
History of my IPv6 related projects

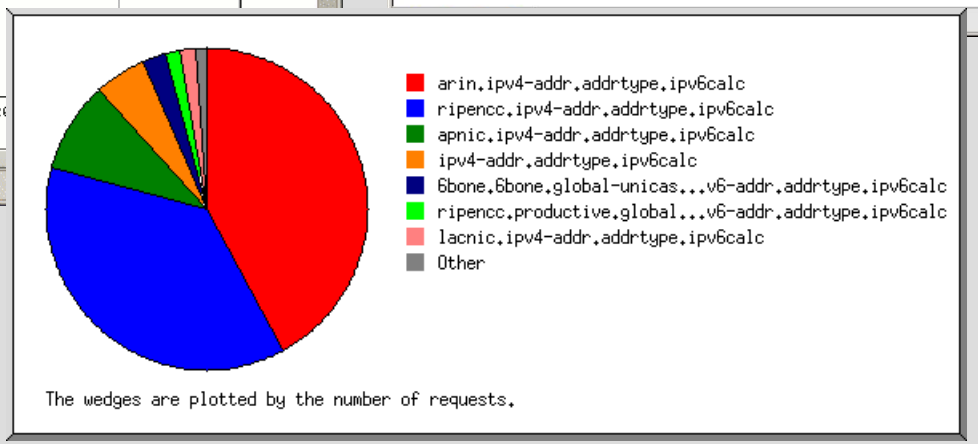
- *ipv6calc*
  - 2001: start development
  - Reason: no tools exist for manipulation of IPv6 addresses
  - Conversion tool for various IPv6 related address formats
    Powering also *ipv6calcweb.cgi* and *ipv6logconv*
  - Status:
    - Maintained
    - Sometimes development of new features

  URLs:
  http://www.deepspace6.net/projects/ipv6calc.html
  http://cvs.deepspace6.net/view/ipv6calc/

Examples powered by ipv6calc







Status of IPv6

address deployment
support of IXPs and ISPs
tunnel brokers
support in DNS

IPv6 address deployment

- `3ffe::/16` 6bone address space
  - Further assignement already stopped, slow migration to productive space recommended
  - RFC 3701 *6bone Phaseout* - June 6, 2006 (6.6.2006)

- `2001::/16` Productive address space
  - Available through IPv6-enabled ISPs

- `2002::/16` „6to4“ address space
  - Instant use of a /48 network, only one global IPv4 address is required
  - RFC 3056 *Connection of IPv6 Domains via IPv4 Clouds*
  - RFC 3068 *An Anycast Prefix for 6to4 Relay Routers*

IPv6 address deployment

- IPv6 address allocation in Europe by RIPE NCC
  - URL: http://www.ripe.net/ripe/docs/ipv6.html
  - RIPE members (ISPs) receive /32 or larger from RIPE
  - All ISP customers can receive a static /48 network from ISP

- `2001::` allocations per region (June 2004)
  - RIPE: 361
    - /23 received from IANA: 23
    - /48 IXP assignements made: 42
    - ip6.arpa delegations made: 215
  - APNIC: 156
  - ARIN: 92
  - LACNIC: 14

IXPs and IPv6 – Current Status

- Native IPv6 support in Europe
  - 2/1999: AMS-IX in Amsterdam
  - 9/2000: INXS in Munich
  - 9/2001: DE-CIX in Frankfurt
  - 2004: all major IXPs, e.g.
    - Netherlands: AMX-IX, NDIX, XchangePoint, NL-SIX
    - Germany: BCIX, DE-CIX, INXS, NDIX, XchangePoint
    - UK: LINX, LIPEX, LoNAP, MaNAP, XchangePoint
    - Italy: MIX, NaMeX, TOPIX
    - France: PARIX, FNIX6
    - Spain: ESPANIX, mad-iX, CATNIX
    - Switzerland: CIXP, TIX
    - Others: VIX (Austria) AIX (Greece), BNIX (Belgium), GIGAPIX (Portugal), INEX (Ireland), LIX (Luxembourg), MSK-IX (Russia), Netnod (Sweden), NIX (Norway), NIX.CZ (Czech Republic), ...

URL: http://www.euro-ix.net/isp/choosing/search/matrix.php

ISPs and IPv6 – Current Status

- Germany
  - June 2004: 25% of the ISPs connected to DECIX (Frankfurt) have native IPv6 connectivity, e.g.
    - Space.net
    - Versatel/Tesion
    - Deutsche Telekom (T-Com)
      - Realizing internal IPv6 pilot in late 2004
    - DFN-Backbone (6WiN)
      - 30 instituitions connected (07/2004), 7 native, other via tunneling
- Switzerland
    - Swisscom Mobile
      - Commercial expected in 2004 (WLAN) and 2005 (UMTS)
    - Swisscom Enterprise Solutions
      - Test environment with native IPv6 connectivity to Euro6IX since June 2003
    - Bluewin
      - Test environment since 2002, commercial expected 2004/2005

ISPs and IPv6 – Current Status

- Other countries, e.g.
  - Spain: Telefonica
  - Italy: Wind, Edisontel, Telecom Italia
  - Portugal: Telepac
  - UK: BritishTelecom
  - France: OpenTransit, FranceTelecom
  - Netherlands: XS4ALL
  - Sweden: Telia

  - Europe: Tiscali, Colt

-> Ask your local ISP for IPv6 support!

Tunnel Brokers

- Useful if your ISP doesn't support native IPv6 connectivity
- Requirements:
  - Global IPv4 address (static NAT scenario is possible)
  - Registration
- Advantages in difference to *6to4*
  - Static IPv6 prefix (mostly even if IPv4 address is dynamically assigned)
  - Reverse DNS delegation possible
  - More stable IPv6 connectivity
- Common used Tunnel Brokers:
  - http://www.sixxs.net/ (NL)
  - http://www.freenet6.net/ (CA)
  - http://tb.consulintel.euro6ix.org/
  - http://tunnelbroker.as8758.net/ (CH)

IPv6 in DNS

- Forward lookup (name to IPv6 address)
  - New record type is needed: „AAAA“

```
ipv6host IN AAAA 2001:0DB8::1
```

- Reverse lookup (IPv6 address to name)
  - nibblewise reverse, similar to IPv4
  - but using another top level domain: ip6.arpa

```
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
  0.8.b.d.0.1.0.0.2.ip6.arpa. IN PTR ipv6host
```

IPv6 in DNS

- Notes:
  - A6 is thrown back to very experimental (and now historic...)
  - [\x<bitstring>].ip6.arpa. was replaced by nibblewise
  - Delegation of 2.0.0.2.ip6.arpa and e.f.f.3.ip6.arpa should be now possible (June 2004, pushed by the IAB)
    - URL: http://www.iab.org/documents/correspondence/2004-07-16-iana-delegation.html
  - Already 5 DNS root servers are reachable via native IPv6
    - URL: http://www.root-servers.org/
    - But to avoid problems, root-zone currently does not contain AAAA records
  - Some TLD servers are already reachable by IPv6 (active AAAA entry!):
    - de: a.nic.de
    - ch: merapi.switch.ch, sec3.apnic.net
    - it: ns.ripe.net, dns.nic.it
    - fr: c.nic.fr, ns2.nic.fr, ns-ext.vix.com

Status of IPv6 support in

operating systems
routers

IPv6 support in Operating Systems

- Operating Systems, e.g.
  - Sun
    - Solaris 8, Solaris 9
  - Microsoft
    - Windows 2000: experimental patch
    - Windows XP, 2003: built-in
  - Linux
    - Since later 2.4.x kernel series usable
      - first occurance in 2.1.8
  - *BSD (powered by KAME project)
    - FreeBSD 4.0 and beyond
    - OpenBSD 2.7 and beyond
    - NetBSD 1.5 and beyond
    - BSD/OS 4.2 and beyond
    - Mac OS X 10.2 and beyond

IPv6 support in routers

- Commercial appliances, e.g.
  - Cisco
    - since May 2001 official release in IOS 12.2(2)T
    - since June 2003 in „ISP Backbone“ IOS 12.0S/12.2S
  - Juniper
    - since Nov. 2001 in JunOS 5.1/5.2
  - Hitachi
    - since 1997
- Routing protocols
  - RIP: adopted (RFC 2080)
  - BGP: adopted (RFC 2545)
  - OSPF: adopted (RFC 2740)

Status of IPv6 support of firewalling and security

Firewalling in IPv6 is very important...

...there is no implicit „protection“ anymore!

Reasons for IPv6 Firewalling

- Firewalling in IPv6 is very important, because
  - Client gets a global IPv6 address by design
    - in case if a global prefix is available
      - quickly happen by autoconfiguration after receiving a router advertisement
  - Unlike in IPv4, no hiding NAT on border routers possible
    - in IPv6, NAT was left out from design (see also RFC 2993)
    - but hiding NAT in IPv4 does not solve all security problems...think about tunneling via HTTPS (HTTP CONNECT), DNS or ICMP payload
  - Without protection, any listening service can be accessed from remote

Like in very modern IPv4 world

firewalling on

border AND **host**

is also required for IPv6

Reasons for IPv6 Firewalling

- Need careful design because
  - Tools are already available
    - Latest versions of *nmap* are already IPv6 capable
  - IPv6 networking is not as well reviewed and tested as IPv4 code
    - the developers hopefully learnt from the bugs found in IPv4 code
- One „advantage“...address range scanning isn't easy anymore
  - Per subnet 2^{64} addresses are possible
    - This can consume much time...
    - But reduction to 2^{24} per a chosen common used NIC vendor ID
  - But clients normally respond to IPv6 ping to all-node link-local multicast address
    - Example: `ping6 -I eth0 ff02::1`
    - Currently only a problem in link-local range

IPv6 support in firewalling

- Non-commercial
  - Linux: netfilter project supported by USAGI team
  - *BSD: ipf, ip6fw, pf
- Commercial, e.g.
  - Nokia IPSO (packet filter) since version 3.6
  - Check Point FW-1 since version R54 (NG AI)
    - running on Sun Solaris, Nokia IPSO
    - still no support for running on SecurePlatform or other supported Linux distributions :-(
  - Cisco IOS (packet filter) since version 12.2(2)T
  - Cisco PIX
    - available, but still not well enough
  - Fortinet since version 2.8

Security enhancement in IPv6

- IPsec is defined as mandatory feature for IPv6
  - IPv6-IPsec is not more secure than IPv4-IPsec!
    - Same protocol layer
    - Protocol specifications are the same
    - Same used algorithms
    - (Mostly) same used IKE daemon
  - Advantages
    - End-to-end transparency (no NAT involved)
    - Workarounds in IPv4-NAT scenarios like ESP-over-UDP are no longer required

Status of IPv6 support in applications

IPv6-ready DNS

- Server
  - Support of AAAA record
    - BIND since 4.9.5
  - Native IPv6 transport
    - BIND8 since 8.4.0, BIND9 all versions
    - djbdns with patch
- Resolver (Linux/Unix)
  - IPv6 address query support
    - GNU C-Library since version 2.1
    - dietlibc
  - Resolver able to use IPv6 transport for queries
    - GNU C-Library since version 2.2
    - dietlibc since version 0.10

Other IPv6-ready daemons/clients

List is not exhaustive, see for more:

http://www.deepspace6.net/docs/ipv6_status_page_apps.html

- SSH:
  - Server: OpenSSH
  - Client: OpenSSH
- HTTP:
  - Server: Apache2, thttpd
  - Client: Mozilla, konqueror, lynx, w3m
- FTP:
  - Server: proftpd, vsftpd, pure-ftpd
  - Client: lftp

Other IPv6-ready daemons/clients

List is not exhaustive, see for more:

http://www.deepspace6.net/docs/ipv6_status_page_apps.html

- SMTP
  - Server: postfix, sendmail, exim, courier
  - Client: mutt, ximian-evolution
- POP3/IMAP4:
  - Server: courier-imap, dovecot, solidpop3d
  - Client: see SMTP
- LDAP
  - Server: openldap
- Routing:
  - Server: quagga, zebra, MRTd

Future Outlook

Future Outlook

- Application support
  - Unix/Linux
    - Around 200 are ported or patch available
    - Major missing ones for IPv6-only networking:
      - common used syslog daemons
      - RPC for e.g. NFS (Linux specific issue, no forecast)
        - GNU C-Library: status unknown (currently none)
        - *dietlibc*: no IPv6 support planned
      - *squid* (no forecast, outdated patch, *privoxy* can used instead/as cache-peer)
      - *amanda* (no forecast)
      - *coda* (first occurance of IPv6 support in 6.0.4)
    - Conclusion
      - For Internet usage mostly all IPv6-enabled
      - For Intranet usage still some important missing
  - Windows
    - Still really behind Unix/Linux
    - Microsoft's plan for Longhorn is „full IPv6-enabled“

Future Outlook

- Solving the still missing business case problem by
  - Reducing IPv4-NAT complexity
    - Communication industries:
      - SIPv6
      - 3G / UMTS: IMS (IP Multimedia Subsystem) with VoIP, IM, MMS, PoC
    - Automobile industries
      - VAN (Vehicular Area Network), PAN (Personal Area Network)
      - Moving Networks based on Mobile IPv6
    - Everyone
      - Peer-to-peer networking
      - Ambient Intelligence
  - Seamless Internet connectivity all the time
    - by autoconfiguration
    - by Mobile IPv6
  - Very big address space, global address for everyone
    - Service can be established between as many users/components which are online

Further Information

- General IPv6 information, News and Links
  - http://www.ipv6.org/
  - http://www.join.uni-muenster.de/
  - http://www.ist-ipv6.org/
  - http://www.hs247.com/
- IPv6 Task Forces
  - http://www.ipv6tf.org/
  - http://www.eu.ipv6tf.org/
  - http://www.ch.ipv6tf.org/
  - http://www.ipv6tf.de/
- How *6to4* and other tunneling methods are working
  - http://staff.csc.fi/~psavola/residential.html

Contact Information

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http://www.aerasec.de/services/ipv6.html

Thank you for listening!

Q&A

Credits to
Thomas Graf (invitation, suggestions)
Gert Döring (informations)
Jordi Palet Martinez (informations)