

7 years IPv6 at the workplace ... and at home

or

IPv6 with a small budget
experience report, with some history

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...

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ECAI6 2007

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What is IPv6?

- ▶ level-3-protocol
- ▶ details in the lecture this morning
- ▶ usable parallel to or in place of IPv4 for some years
 - ▶ ... with modern hard- and software
 - ▶ ... ~~only with expensive hard- and software?~~
I don't think so.

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dedicated tunnel, 1999/2000

- ▶ needed to test ARCnet driver's interaction with routing and PMTUD
- ▶ got 6BONE connection to M.I.T.
- ▶ worked, but only really useful for testing
- ▶ high latency, high packet loss

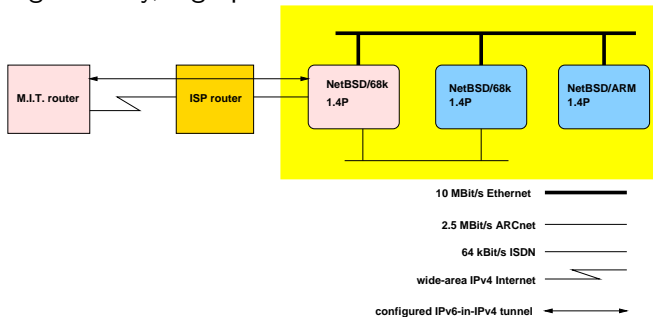


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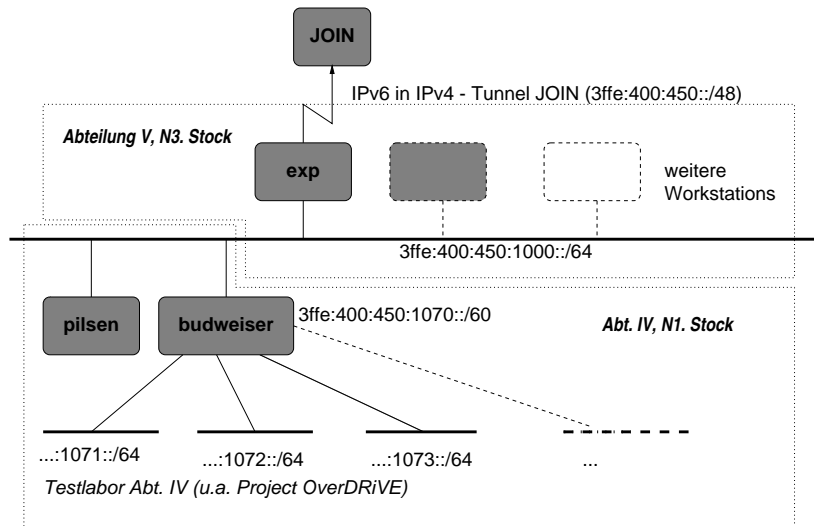
University of Bonn

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Questions?

- ▶ Tunnel router: i486/66 MHz, Fast Ethernet, NetBSD-1.4P
- ▶ IPv6 in IPv4 to Münster (JOIN)
- ▶ native IPv6 on the LAN
- ▶ first production use: Chair IV's networking lab, which needed multiple routed wired and wireless networks for hand-over algorithm testing



IPv6 in DFN until June 2005

- ▶ overlay network, topologie independent
- ▶ central IPv6-in-IPv4-router at the University of Münster (DFN-Project JOIN)
- ▶ experimental service
- ▶ connected to world-wide 6BONE
- ▶ switched off 20050607

<http://www.join.uni-muenster.de>

Bonn - Norway 2000

```
cosinus# traceroute6 www2.no.netbsd.org
traceroute to server.pasta.cs.uit.no (3ffe:2a00:100:3001::2), 30
hops max, 12 byte packets
 1 6bone.ipv6.uni-muenster.de 28.443 ms * 22.275 ms
 2 3ffe:600:8000::d 55.623 ms * 59.225 ms
 3 6bone-gw.sics.se 274.208 ms * 220.015 ms
 4 3ffe:200:1:b::2 218.731 ms * *
 5 3ffe:2a00:100:7003::2 249.568 ms * 280.394 ms
 6 tromso-ipv6.uninett.no 285.326 ms * 246.398 ms
 7 3ffe:2a00:100:7011:280:1cff:fe5d:3038 238.394 ms * 156.65 ms
 8 server.pasta.cs.uit.no 186.663 ms 282.858 ms 287.064 ms
```

- ▶ only a few apparent hops
... but each one hides a few or a lot of IPv4 hops!
- ▶ ... resulting in high latency, high packet loss

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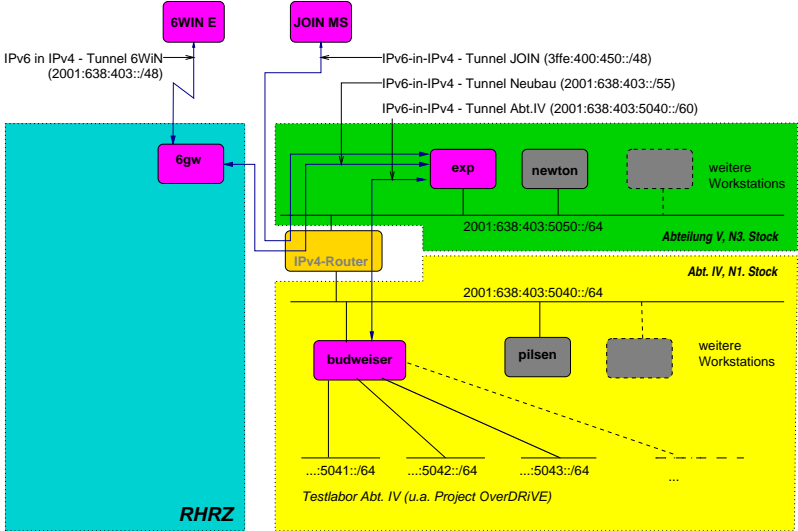
Questions?

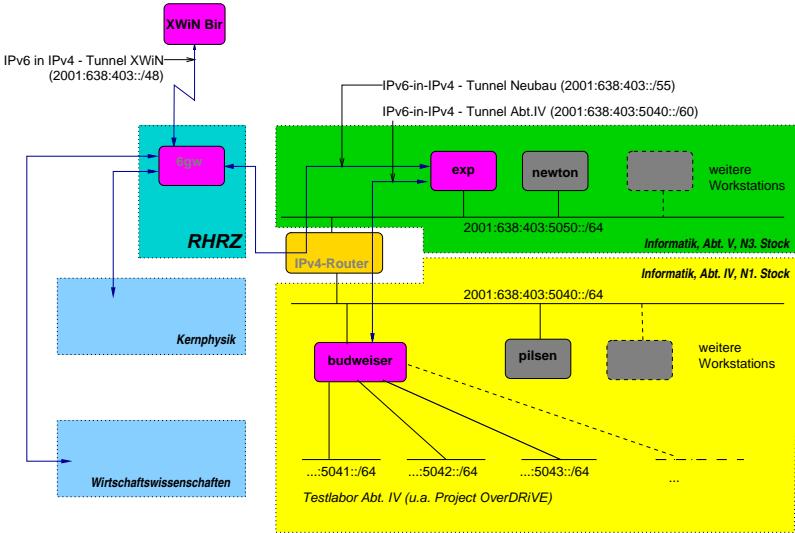
- ▶ CS Chair V:
 - ▶ tunnel router:
 - i586 MHz, fast ethernet, NetBSD-1.6
 - ▶ IPv6 in IPv4 to Münster (JOIN), switched off
 - ▶ IPv6 in IPv4 to the computing center's router
 - ▶ IPv6 in IPv4 to chair IV's laboratory
 - ▶ native IPv6 in our LAN
- ▶ CS Chair IV:
 - ▶ tunnel router: some Linux workstation
 - ▶ several Ethernet and 802.11 interfaces for the laboratory

computing center:

- ▶ dedicated hardware router
- ▶ tunnel to CS Chair V
- ▶ exp. tunnels to Economics and Nuclear Physics (2006-...)

- ▶ tunnel to Essen (until mid-2007)
- ▶ tunnel to Birlinghoven (now)





IPv6-Netz Uni Bonn/Informatik

2005-Mar-11 I. Souvatzis

IPv6-in-IPv4-Tunnel (WAN)
 IPv6-in-IPv4-Tunnel (LAN/MAN)
 Echtes IPv6 (LAN/MAN)

DFN 2002-2006-...

- ▶ beginning in about 2002 JOIN started to build a pre-production net for DFN
<http://www.6win.de>
- ▶ backbone: 5-node ring structure with one additional connection
 - ▶ separate from the IPv4 routers
- ▶ institutions were connected natively (at the backbone nodes) or over short tunnels
- ▶ In 2005, the JOIN project ended, and DFN-NOC took over operation of 6WiN
- ▶ ... moving to an integrated IPv6 network, as far as I noticed (but we'll hear about that tomorrow)

European education & research network

<http://www.geant2.net/>

- ▶ Backbone connections 2.5 to $N \cdot 10$ GB/s
- ▶ internal routing protocol switched from OSPF to IS-IS in 2005
- ▶ routing of IPv4 and IPv6 in parallel — no differences

Bonn - Norway 2006

1 exp.cs.uni-bonn.de 0.489 ms 0.355 ms 0.347 ms
2 2001:638:403:f01::1 2.074 ms 1.932 ms 2.023 ms
3 2001:638:f:500::403:1 8.709 ms 8.644 ms 8.659 ms
4 2001:638:0:9::2 32.253 ms 32.108 ms 32.007 ms
5 dfn.rt1.fra.de.geant2.net 32.524 ms 32.533 ms 32.531 ms
6 so-1-3-0.rt1.lux.lu.geant2.net 46.637 ms 46.667 ms 46.547 ms
7 nordunet-gw.rt1.cop.dk.geant2.net 46.462 ms 46.504 ms 46.593 ms
8 dk-gw.nordu.net 47.242 ms 46.97 ms dk-gw.nordu.net 47.075 ms
9 no-gw2.nordu.net 54.922 ms 55.019 ms 54.859 ms
10 no-gw.nordu.net 55.022 ms 54.84 ms 54.952 ms
11 oslo-gw1.uninett.no 55.316 ms 55.093 ms 55.212 ms
12 trd-gw.uninett.no 63.106 ms 62.954 ms 62.934 ms
13 tromso-gw.uninett.no 76.801 ms 76.422 ms 76.849 ms
14 tromso-ipv6-gw.uninett.no 77.269 ms 77.124 ms 77.319 ms
15 cisco.pasta.cs.uit.no 77.93 ms 77.526 ms 78.088 ms
16 server.pasta.cs.uit.no 77.94 ms 77.937 ms 77.836 ms

► more apparent hops — less latency, no packet loss

real-world applications

- ▶ network install of NetBSD from ftp.fr.netbsd.org: 1 MB/s, finished in a few minutes.
- ▶ ... too fast to think about local mirroring
- ▶ used to be faster than IPv4 (because of dedicated circuits), but, alas, the good times (6WiN (.de) + 6NET (.eu)) are gone
- ▶ but the new one is faster, so who cares...

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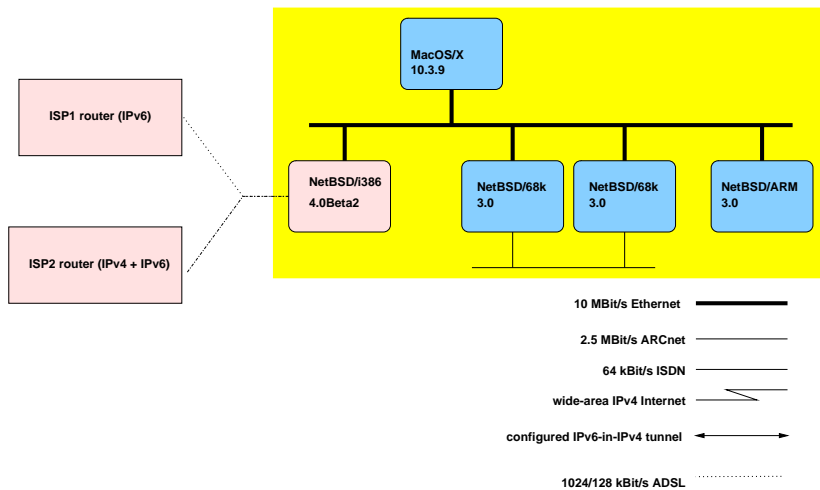
SOHO: tunnelled connections

- ▶ dedicated tunnels offered by: Freenet6 (or however they're called this year), XS26, SixXS, ...
 - ▶ often high packet loss or latency
- ▶ 6to4: /48 per IPv4 address
 - ▶ where to get a default route? (anycast, manually configured)
 - ▶ asymmetrical path
 - ▶ no control
 - ▶ often high packet loss or latency (but better in post-6bone 6to4)

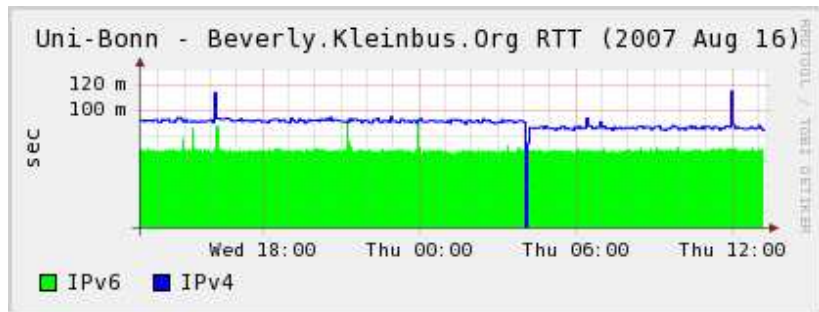
IPv6 (at home) on the wire, 2007

- ▶ ADSL network by Deutsche Telekom:
 - ▶ one provider with IPv6 for a couple of years
 - ▶ at least five providers now
 - ▶ usable, if you run some BSD / MacOS-X / or Linux or Solaris ... behind a dumb “ADSL-modem”
 - ▶ not usable, if you run some el cheapo integrated ADSL-modem & router

IPv6 (at home) on the wire: 2005-2007



IPv6 (at home) on the wire: 2005-2007



6to4 Home–Norway, 2007

traceroute6 to 2001:700:400:600::3 from 2002:d5f0:b48b::1

```
1 2001:a60::89:1:1:3 90.999 ms
2 2001:a60:9002:1::1 90.025 ms
3 2001:a60:0:1ff::1 90.856 ms
4 2001:a60:0:1ff::2 104.457 ms
5 2001:440:eeee:ffc8::2 258.152 ms
6 2001:440:eeee:ffc8::2 258.672 ms
7 2001:440:eeee:ffc8::1 250.807 ms
8 2001:440:1239:1001::2 257.039 ms
9 2001:440:1239:100d::2 286.282 ms
10 2001:7f8:d:fb::24 290.306 ms
11 2001:948:0:f049::2 288.639 ms
12 2001:948:0:f041::2 293.004 ms
13 2001:700:0:123::2 293.732 ms
14 2001:700:0:10::2 301.856 ms
15 2001:700:0:6::2 315.531 ms
16 2001:700:0:702::3 316.225 ms
17 2001:700:0:fff7::2 317.303 ms
18 2001:700:400:600::3 318.217 ms
```

Native Home–Norway, 2007

traceroute6 to 2001:700:400:600::3 from 2001:1a50:5031:77::1

1 2001:1a50:ffff:ffff::7 71.301 ms
2 2001:1a50:ffff:fffe::b1 64.428 ms
3 2001:7f8::4f9:0:1 67.268 ms
4 2001:5000:0:24::2 67.414 ms
5 2001:5000:0:13::3 64.97 ms
6 2001:5001:200:6::2 99.748 ms
7 2001:2000:3010::2 102.023 ms
8 2001:798:28:10dd::5 101.617 ms
9 2001:798:cc:2201:2801::1 123.657 ms
10 2001:798:cc:1501:2201::1 123.879 ms
11 2001:798:15:10aa::2 127.434 ms
12 2001:948:0:f055::2 123.79 ms
13 2001:948:0:f049::2 135.449 ms
14 2001:948:0:f041::2 145.738 ms
15 2001:700:0:123::2 145.42 ms
16 2001:700:0:10::2 153.449 ms
17 2001:700:0:6::2 171.44 ms
18 2001:700:0:702::3 167.228 ms
19 2001:700:0:fff7::2 167.179 ms
20 2001:700:400:600::3 168.591 ms

Some advice

When you setup your external connection

- ▶ blackhole or reject route all the (e.g.) /48 on your router
- ▶ more specific routes for active networks will override

(else you'll see 256-hop-pingpongs for every misaddressed packet!)

Some more advice

Before you announce a machine's AAAA record:

- ▶ make sure ICMP6 error messages can get out, or
- ▶ make sure IPv6 routing works, and the externally accessible services work with IPv6
- ▶ preferably both!

(else your clients will see a half- or one-minute timeout before their application move to the next, e.g. IPv4, address)

Questions?

backtostart