

Belnet IPv6 Deployment Lessons Learned

Belnet – Jeroen Valcke
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Belnet
dedicated connectivity

.be

Belnet Intro

- **Belgian NREN**
- **Established in September 1993**
- **Operate three networks**
- **Current Belnet backbone (2008)**
 - Nation-wide, 20 PoPs, >200 org, >650.000 end-users
 - 10GE (DWDM)
- **Not your typical ISP**
- **Native IPv6 since September 2003**

Why IPv6 @ Belnet?

- **Research & Education Network**
 - It's our mission
 - Forefront of innovation
 - Empower the power users
- **Break the chicken and egg dilemma**
- **Real customer demand (small)**
- **EC promoting IPv6**
 - 2010 / 2011 National political support

How

- **Education, education, education**

- Attend some conferences
- Training
- Study some more
- Experiment (tunnels)

- **The actual work**

- Inventorize
- Addressing Plan
- Routing Plan
- Implement, configuration

Inventorize

- **New network gear, IPv6 ready**
 - Built a new network in 2003, IPv6 was a requirement
 - Seperate commercial IPv6 license
- **Servers and software?**

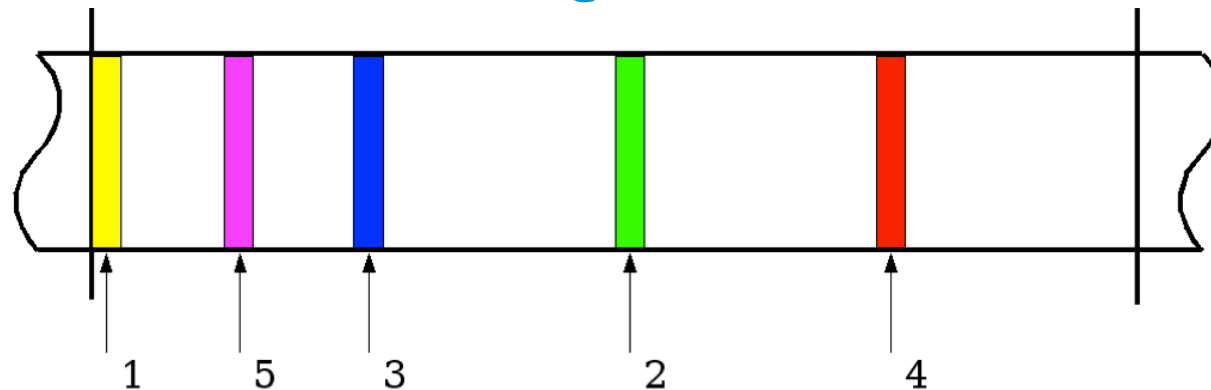
Addressing Plan

- **Principles**

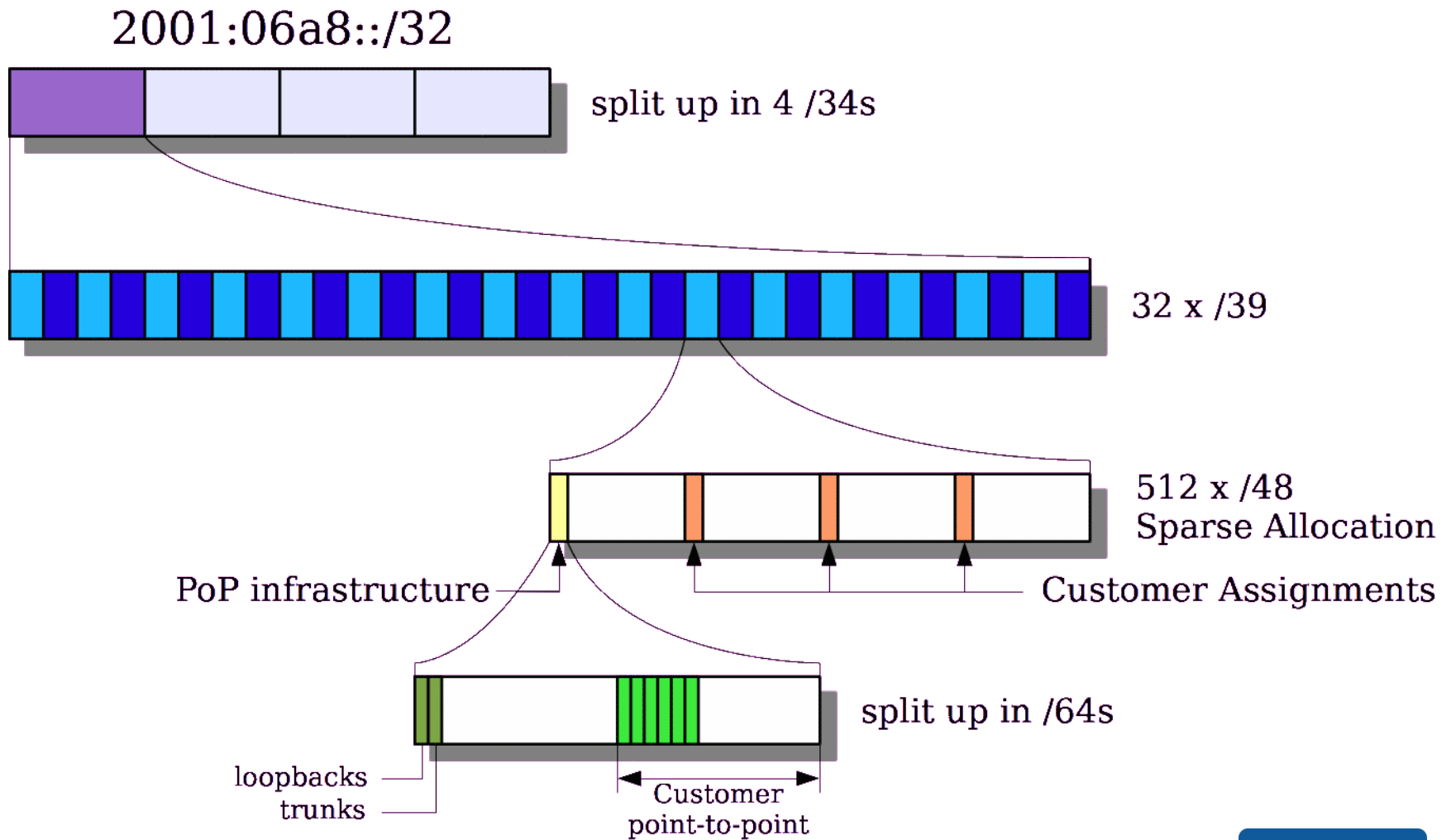
- Kiss, Keep it simple
- Aggregation
- Sparse Allocation

- **Geographical Aggregation?**

- **Sparse Allocation/Assignment**



Addressing Plan



Routing

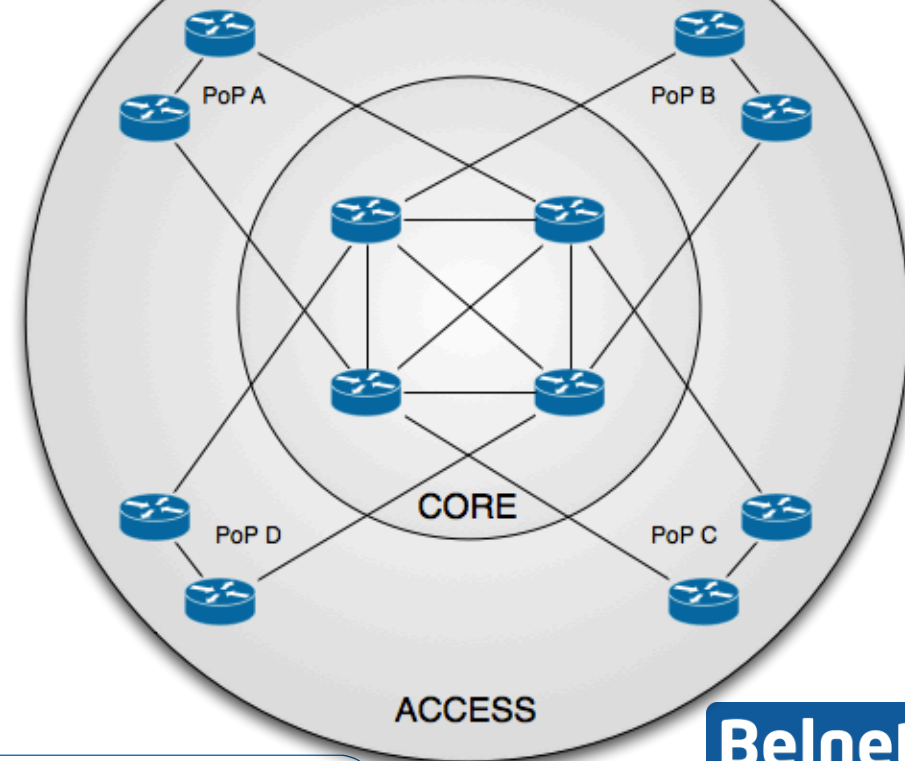
- **Choosing an IGP**
 - OSPFv3
 - IS-IS
- **BGP, redistribute full routing table (iBGP)**
- **IPv6 connectivity with other IPv6 networks (eBGP)**
- **Seperate BGP sessions for IPv4 and IPv6**
- **Completely parallel network**
 - IPv6 is independent of IPv4

Implement

- **Just a simple matter of configuring your routers**
- **Continue to run two IGPs?**
- **Hey wait a minute, what about MPLS?**
 - Latest generation of Belnet backbone is an MPLS backbone.
 - How does this impact IPv6?

The Invisible IPv4 Core

```
jeroen@jeroen:~$ traceroute www.kuleuven.ac.be
traceroute to www.kuleuven.ac.be (134.58.242.132), 30 hops max, 40 byte packets
 1  argos.fw.belnet.be (172.24.192.3)  0.248 ms  0.238 ms  0.231 ms
 2  ge.ar1.brusci.belnet.net (193.190.198.3)  0.423 ms  0.419 ms  0.481 ms
 3  10ge.ar1.leuhev.belnet.net (193.191.17.110)  4.877 ms  4.876 ms  4.868 ms
 4  kuleuven.ar1.leuhev.belnet.net (193.191.9.10)  5.585 ms  5.887 ms  6.101 ms
 5  mcco1.kulnet.kuleuven.be (134.58.253.50)  5.182 ms  5.174 ms  5.157 ms
```



Belnet

The Visible IPv6 Core

```
jeroen@jeroen:~$ traceroute6 -n 2001:06a8:2d80::1
traceroute to 2001:06a8:2d80::1 (2001:6a8:2d80::1) from
2001:6a8:3c80:8000:222:19ff:fe14:a617, 30 hops max, 16 byte packets
 1 2001:6a8:3c80:8000::1 0.202 ms 0.206 ms 0.103 ms
 2 2001:6a8:3c80::1 0.314 ms 0.271 ms 0.354 ms ← ar1.brusci
 3 2001:6a8:0:2006::1 0.934 ms 0.904 ms 0.828 ms ← cr1.bruvil
 4 2001:6a8:0:e002::1 1.384 ms 1.13 ms 1.221 ms ← cr2.brueve
 5 2001:6a8:0:e00a::2 3.114 ms 3.059 ms 2.998 ms ← ar1.lieseg
 6 2001:6a8:2c00:8000::2 3.215 ms 3.149 ms 3.211 ms ← ucl
 7 2001:6a8:2d80:bac0::8 3.321 ms 3.244 ms 3.222 ms
 8 2001:6a8:2d80:bac0::5 3.425 ms 3.165 ms 3.265 ms
 9 2001:6a8:2d80:bac0::5 3000.02 ms !H 3000.09 ms !H 2999.96 ms !H
```

How to Tackle this 'Problem'?

- **6PE**

- 'Tunnel' IPv6 over an IPv4 MPLS backbone
- Seems like a step back

- **IPv6 signaled RSVP LSPs**

- No vendor support
- IPv6-only core? With "4PE" for IPv4 connectivity?

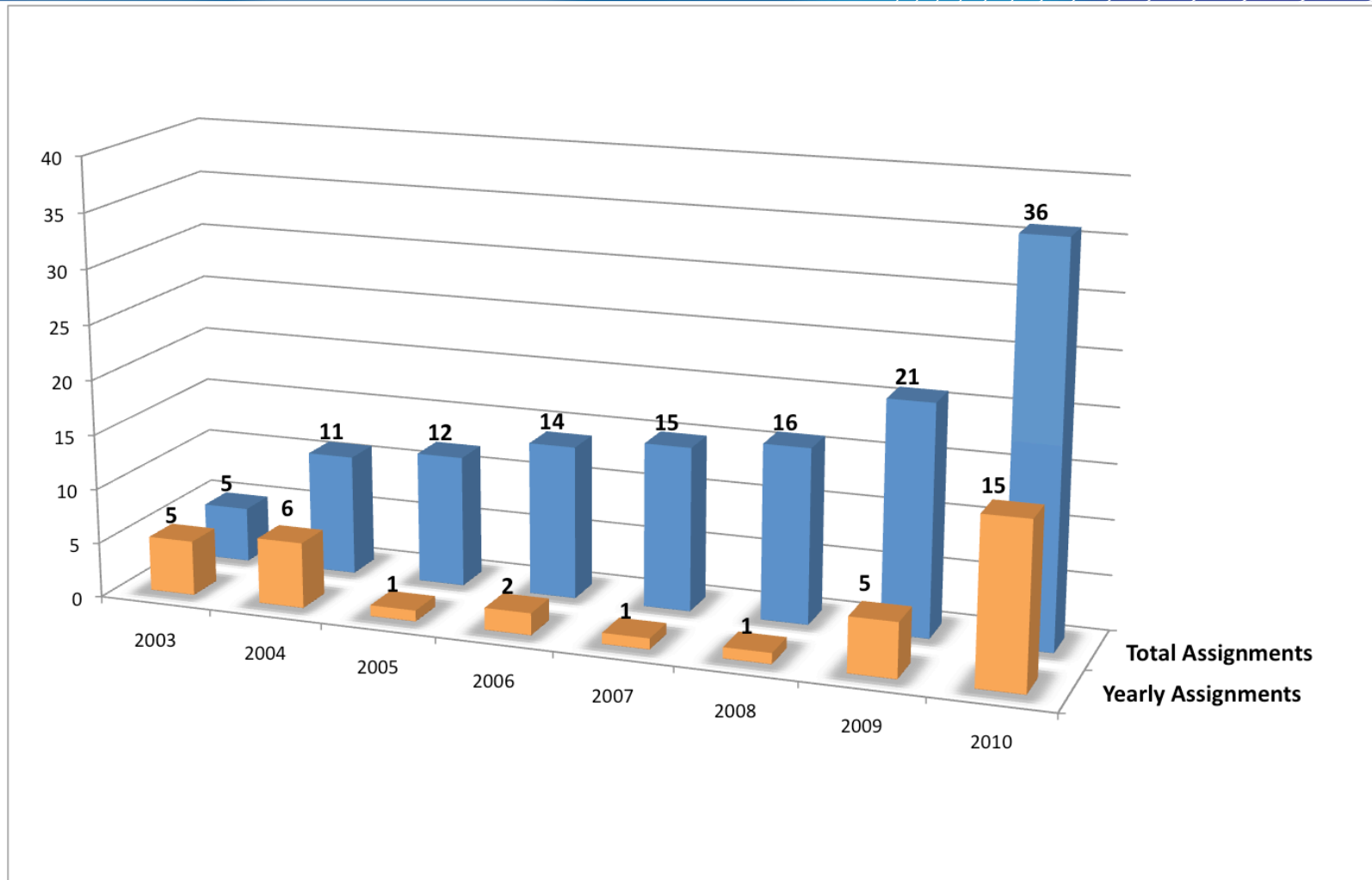
- **Keep IP routing for IPv6**

- We currently don't need Traffic Engineering for IPv6
- No Fast Reroute
- In the long run, we'll have to do something about this

Current State of Affairs

- **Backbone supports IPv6**
- **IPv6 peerings**
 - Geant, pan-european NREN
 - BNIX participants (?/44)
 - Other IXes, AMS-IX, LINX, SFINX
 - 2 out of 3 IP transit providers
- **Belnet services on IPv6**
 - http
 - ftp
 - dns
 - Jabber
 - mail

Customer Adoption



Some Issues, Caveats

- **Geographical Aggregation**
 - Not really usefull (for us)
- **MPLS and IPv6**
- **Reverse DNS**
 - Can be a real pain
- **Traffic Monitoring, Stats**
 - Hard to integrate, no MIBs
 - Currently (still) no IPv6 traffic stats – Shame on us!
- **Scepticism, Ignorance**
- **Other stuff**

Conclusion

- **Get educated!**
- **Introducing IPv6 is no rocket science**
- **Think about addressing before implementing**
 - Is geographical aggregation the right fit?
 - Use ‘sparse allocation’ technique wisely
- **YMMV, don’t just copy**
 - Specific industries
 - Specific equipment (cable modems, DSLAM, CPE, ...)
- **Get everybody, all departments involved!**



Thanks for your Attention
Questions?
jeroen.valcke@belnet.be