IPv6 in a scalable and easy way

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Me

- Co founder and 25% owner of Interlan
- Interlan celebrating 20 years in some weeks!
- Used IPv6 since 2000/2001
- Have much IPv6 and DNSSEC stuff at https://dnsecandipv6.se

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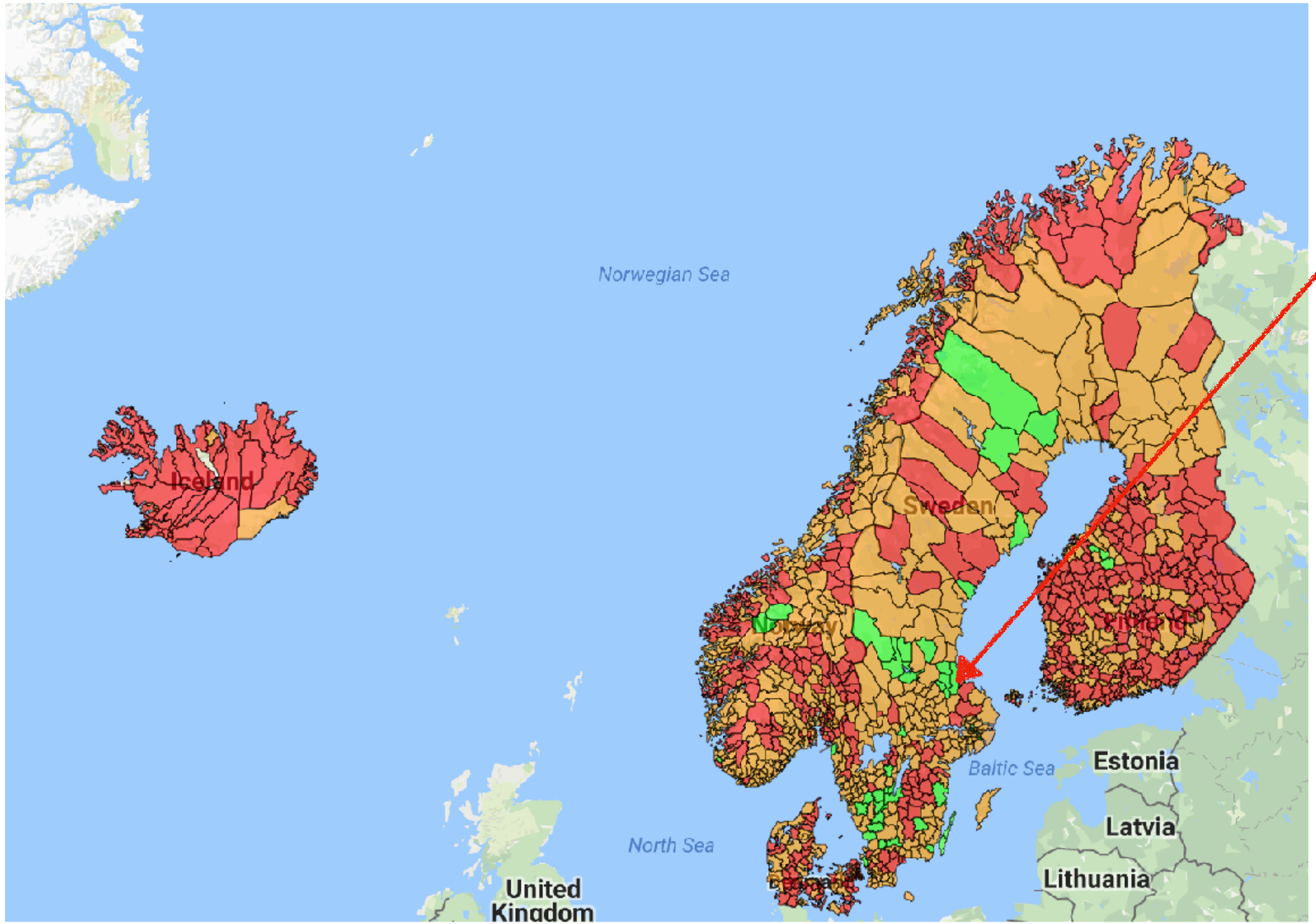
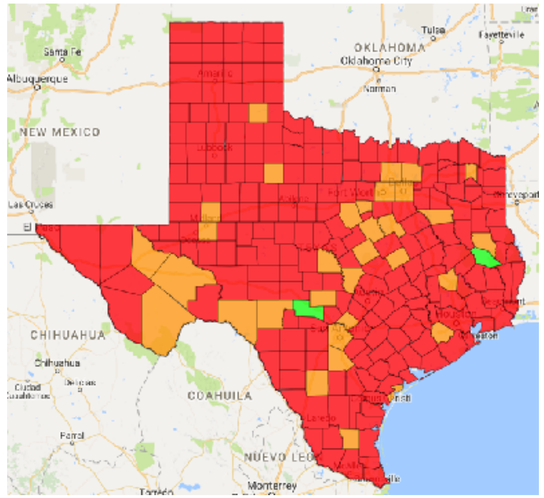
kommunermedipv6.se

~municipalitieswithipv6.se

Green if working -
www
DNS
smtp



Interlan HQ



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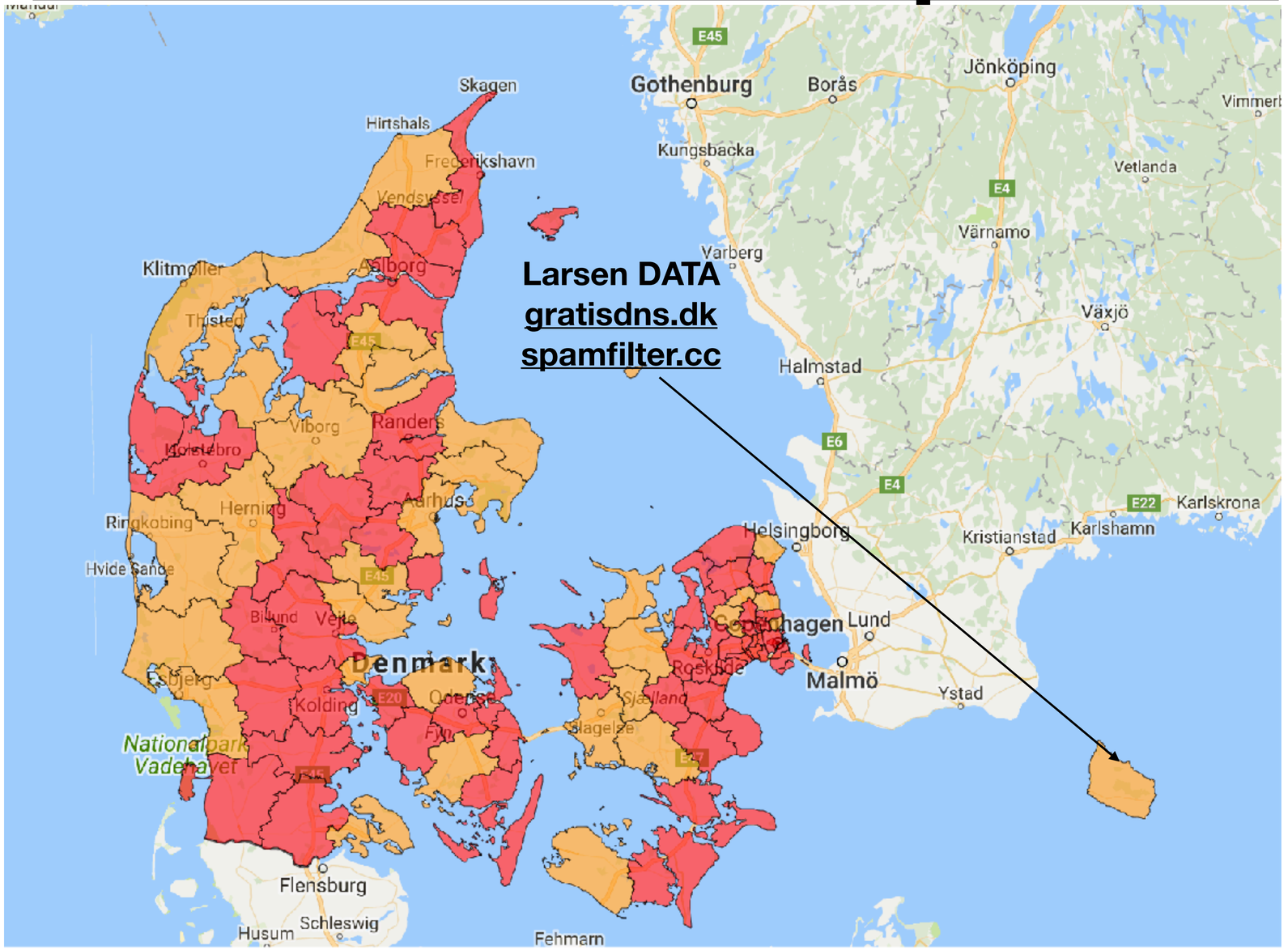

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Christmas goat and IPv6

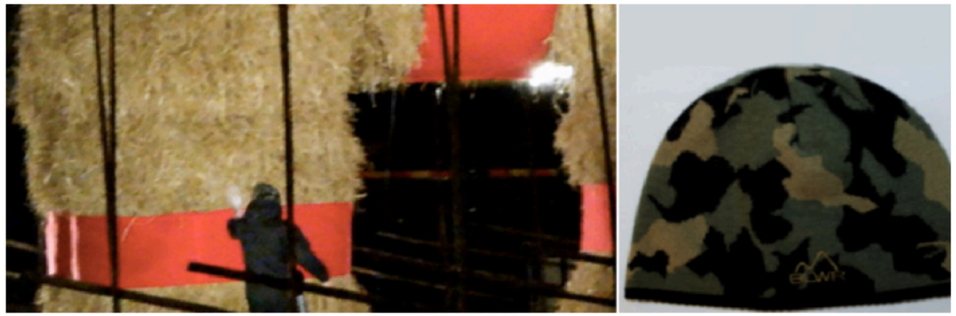
The Christmas Goat and IPv6 (Year 7)

Dec 14, 2016 10:12 AM PDT | Comments: 2 | Views: 6,710

By **Torbjörn Eklöv** Comment | Print

It was a great year for the goat! 2016 marked the 50th anniversary for the Christmas Goat and there was a grand opening ceremony along with music and fireworks. But only a few hours after the opening, a pyromaniac set the goat on fire.

The only track the police have is a cap below that they hope to find DNA in and a crappy picture of the pyromaniac's back.



Municipality of Gavle decided not to rebuild the Goat but there have been a little brother of it nearly in the same spot for many years. They moved that goat to the original place. But after a few days a car ran into the smaller Goat and overturned it. But shame on those who give up — so today the smaller goat is in place and upright!

This year it was 27% native IPv6 unique visitors! But as usual there are very little action from Sweden.

Values from previous measurements:

2010 – 0.1% Native IPv6
2011 – 1 %
2012 – 1.4 %
2013 – 3.4 %
2014 – 11.1 % (!!!)
2015 – 14 %
2016 – 27%

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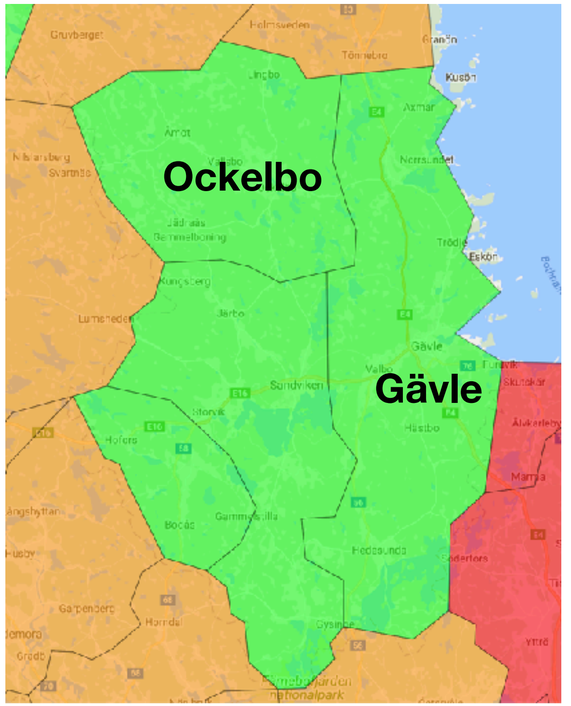
GavleNet - AS16117

- Gävle + Ockelbo municipality ~110’ inhabitants
- City network owned by the municipality's energy company
- They can’t be outside these two municipalities
- Many small villages and long distances
- ~20’ customers in a few years
- GavleNet also celebrates 20 years!



Gävle kommun

~100 km

Our POC
Harkskär - 200 customers

~80% lives here

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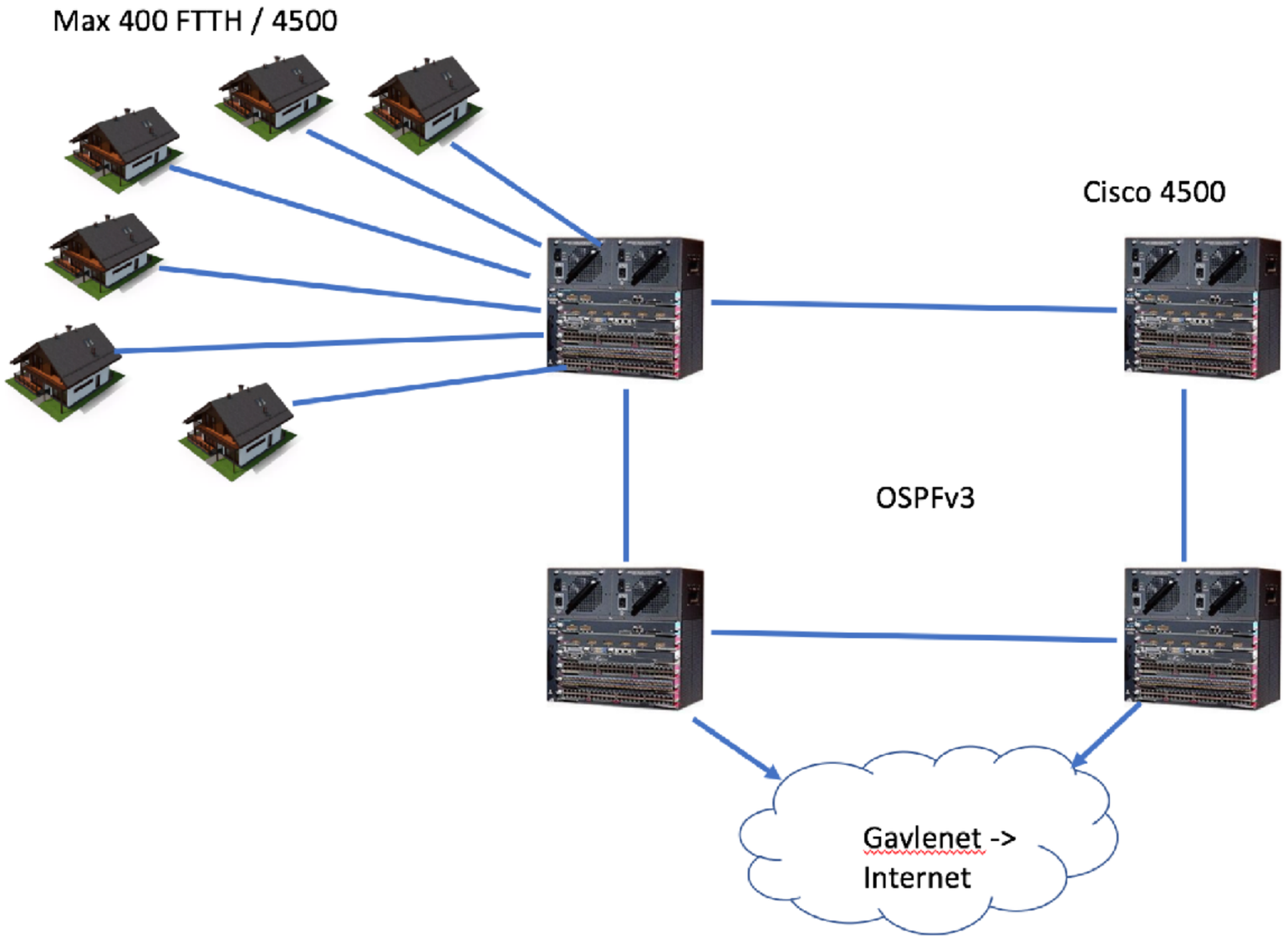
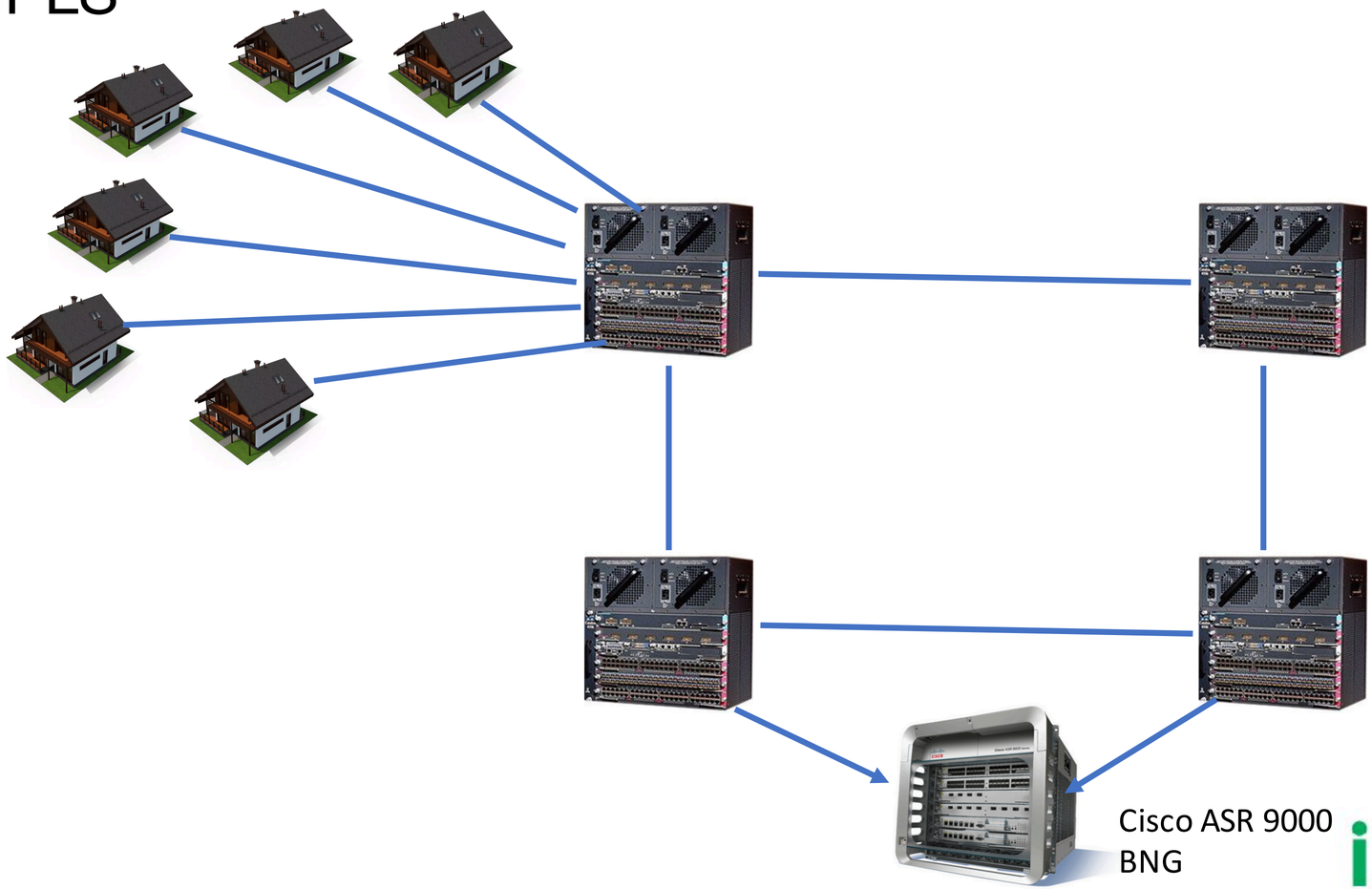
GavleNet FTTH



Cisco 4500

- 400 FTTH / switch - but we want to be able to easy scale up

- Maybe a BNG and MPLS in the future?



GavleNet

GavleNet was allocated 2001:b48::/29 by RIPE NCC way back in early 2003. This allocation gives them up to 2^{35} -- that's over 34 billion -- /64 networks to assign. They divide their space as described in this table:

2001:b48::/32	Enterprise with static addresses
2001:b49::/32	**DHCPv6 PD for FTTH**
2001:b4a::/32	Free
2001:b4b::/32	Free
2001:b4c::/32	Part of 2001:b4c::/30 for 6RD
2001:b4d::/32	Part of 2001:b4c::/30 for 6RD
2001:b4e::/32	Part of 2001:b4c::/30 for 6RD
2001:b4f::/32	Part of 2001:b4c::/30 for 6RD

Active since 2007/2008

~200 customers activated

6RD with option 212 since 2013

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/16 - /32 - /48

- 2001::/16
- 2001:0b49::/32
- 2001:0b49:0000::/48
- Remember that it’s often easier to skip :: and use :0000:0000: in documentation and like now.

Address plan - /32

- 2001:b49:0000::/32 = > 65536 /48’s
- /48 => 65536 /64 per subscriber
  2001:b49:0000:**0000**:
- 256 is enough so lets use /56 instead
  2001:b49:0000:00**00**:

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Adress plan - /44

- Always use prefix even divisible with 4
- /64, /56 , /44 etc
- You don’t want split a number
  2001:b49:4567:8000/50
- We chose to allocate a /44 per Cisco 4500 =>
- 56 - 44 = 12 bits => we can expand to 4096 /56 per switch
  2001:b49:000|0:00|00/56
- => 4096 Cisco 4500
  2001:b49:|000|0:0000
- 2001:b49:|000|0:00|00/56

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Adress plan - part 2 - /44

2001:b49::/32 provides 4,096 /44s in total. That's a lot. GavleNet's FTTH network is built almost exclusively with Cisco 4500 switches. We choose to assign a /44 to each Cisco 4500 as shown in this table:

The **1st** Cisco 4500	2001:b49:**0010**::/44
The **2nd** Cisco 4500	2001:b49:**0020**::/44
The **3rd** Cisco 4500	2001:b49:**0030**::/44
The **4th** Cisco 4500	2001:b49:**0040**::/44
etc.	

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Adress plan - part 3

- With /44 per FTTH POP we can chose other products who connects more FTTH / unit
- We can ”easy” move one /44 to a BNG.
- Or take a /4? from the /32 to the BNG for more then 4096
- Or 2001:b4a::/32?
- etc

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DHCPv6 PD

- ”static” /56 per customer port through option 37 - remote-id
- Tried ISC’s normal dhcpd.conf but we couldn’t get it work with option 37
- KEA 1.20 in april 2017 looks good with ”*using hardware address or DUID in DHCPv6.*”

- **apt-get install libtool autoconf g++ libssl-dev liblog4cplus-dev libboost-dev**
  git clone https://github.com/isc-projects/kea.git
  autoreconf --install
  ./configure --enable-logger-check --with-openssl --with-dhcp-mysql —enable-debug && make && make install
  Time for coffee! :)

- Cisco 4500 with dhcpv6 relay inserts remote-id default

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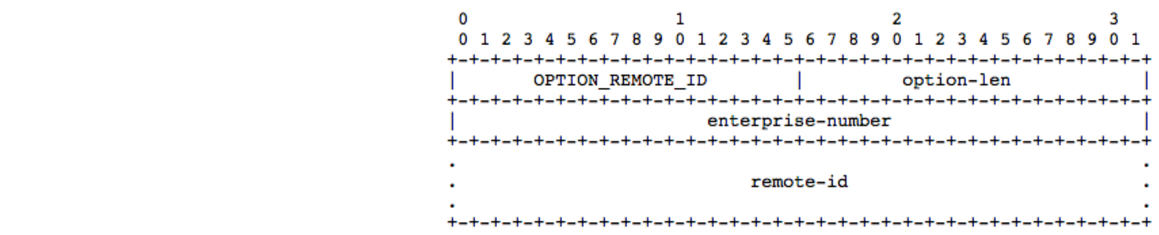
Remote ID

3. The Relay Agent Remote-ID Option

This option may be added by DHCPv6 relay agents that terminate switched or permanent circuits and have mechanisms to identify the remote host end of the circuit.

The format of the DHCPv6 Relay Agent Remote-ID option is shown below:



option-code: OPTION_REMOTE_ID (37)

option-len: 4 + the length, in octets, of the remote-id field. The minimum option-len is 5 octets.

enterprise-number: The vendor's registered Enterprise Number as registered with IANA [5].

remote-id: The opaque value for the remote-id.

The definition of the remote-id carried in this option is vendor specific. The vendor is indicated in the enterprise-number field. The remote-id field may be used to encode, for instance:

- a "caller ID" telephone number for dial-up connection
- a "user name" prompted for by a Remote Access Server
- a remote caller ATM address
- a "modem ID" of a cable data modem
- the remote IP address of a point-to-point link
- a remote X.25 address for X.25 connections
- an interface or port identifier

Each vendor must ensure that the remote-id is unique for its enterprise-number, as the octet sequence of enterprise-number followed by remote-id must be globally unique. One way to achieve uniqueness might be to include the relay agent's DHCP Unique Identifier (DUID) [1] in the remote-id.

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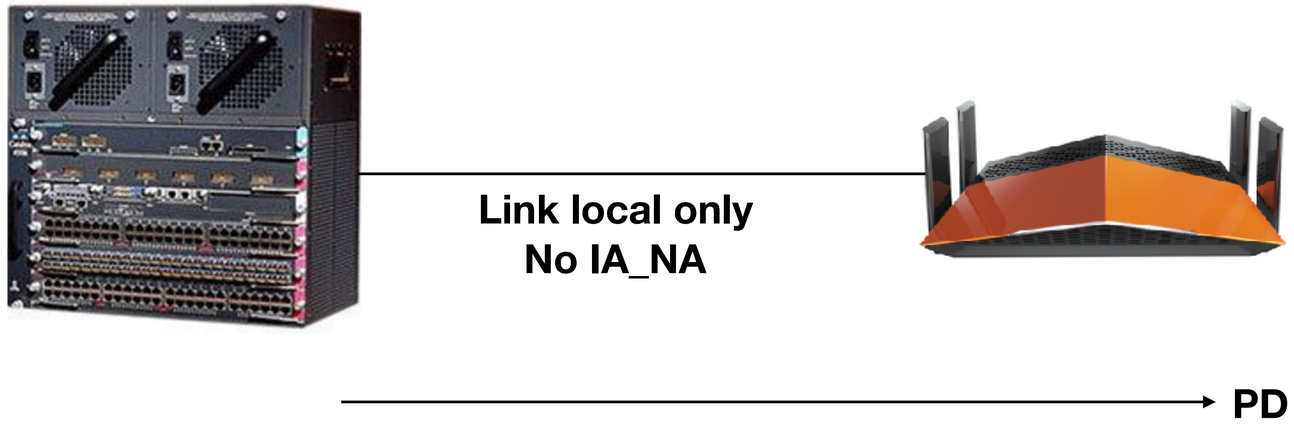
KEA testing!



- We only use PD, no IA_NA
- JSON format was something new! :)
- Logging isn't 100% yet - must debug dhcpv6 packets for proper logging

```
{
    "name": "kea-dhcp6.packets",
    "output_options": [ {
        "output": "syslog"
    } ],
    "debuglevel": 55, <- 55 is needed
    },
```

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KEA

```
"Dhcp6": {
    "mac-sources": [ "remote-id" ],
.
,
```

```
{
        "name": "kea-dhcp6.packets",
        "output_options": [ {
            "output": "syslog"
        } ],
        "debuglevel": 55,
        "severity": "DEBUG"
        },
```

Feb 14 08:51:08 nadhcp2VM LOCAL0: DEBUG [kea-dhcp6.packets] DHCP6_QUERY_DATA duid=[00:03:00:01:10:62:eb:36:9d:fc], tid=0x7b23c6, packet details: localAddr=[2001:b48:0:aaaa::bbbb]:0 remoteAddr=[2001:b48:0:aaaa::bbbb]:547#012msgtype=1(SOLICIT), transid=0x7b23c6#012type=00001, len=00010: 00:03:00:01:10:62:eb:36:9d:fc#012type=00003(IA_NA), len=00012: iaid=184770717, t1=0, t2=0#012type=00006, len=00010: 64(uint16) 31(uint16) 23(uint16) 24(uint16) 99(uint16)#012type=00008, len=00002: 0 (uint16)#012type=00020, len=00000: #012type=00025(IA_PD), len=00041: iaid=184770717, t1=0, t2=0,#012options:#012 type=00026(IAPREFIX), len=00025: **prefix=2001:b49:80:0010:/56**, preferred-lft=600, valid-lft=600#0121 relay(s):#012relay[0]: msg-type=12(RELAY_FORWARD), hop-count=0,#012**link-address=2001:b49:80::1**, peer-address=fe80::1262:ebff:fe36:9dfc, 2 option(s)#012type=00018, len=00006: 56:6c:33:35:30:33**#012type=00037, len=00022: 9 (uint32) 020021000DBC000A00030001001F6CD1DB80 (binary)**

Option 37 - remote ID

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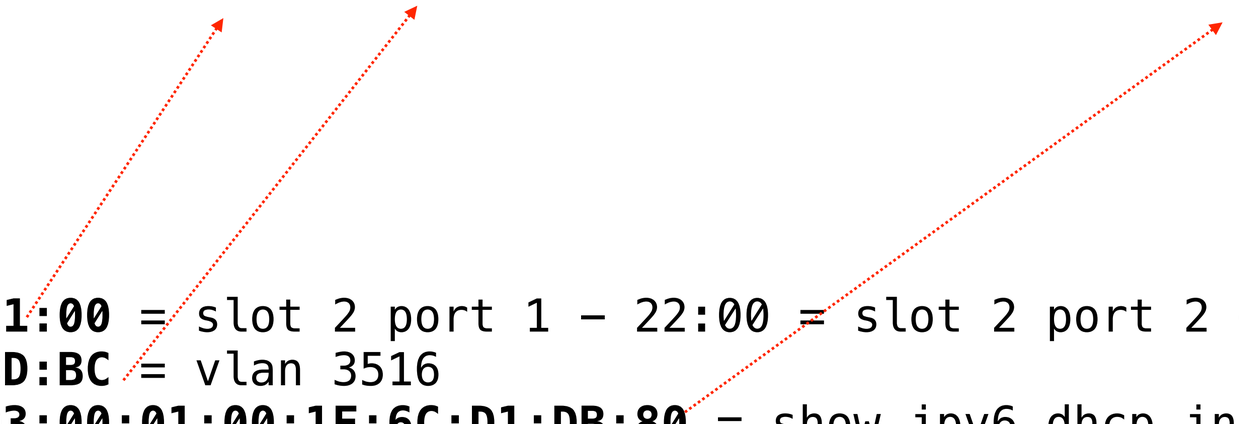
This is the magic option 37. Unique for every switch and port => we can identify and provide static and unique /56

020021000DBC000A00030001001F6CD1DB80 =>

01:00: **21:00** : **0D:BC** : 00:0A:00 : **03:00:01:00:1F:6C:D1:DB:80**



21:00 = slot 2 port 1 – 22:00 = slot 2 port 2 – 20:01 = slot 2 port 8. :)
0D:BC = vlan 3516
03:00:01:00:1F:6C:D1:DB:80 = show ipv6 dhcp in the switch

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```
"subnet6": [ {
                "subnet": "2001:b49:0080::/48",
                "pd-pools": [ { "prefix": "2001:b49:0080::", "prefix-len": 48,"delegated-len": 56 } ],
                "reservations":  [
                { "hw-address": ”02:00:21:00:0D:BC:00:0A:00:03:00:01:00:1F:6C:D1:DB:80", "prefixes":
[ "2001:b49:0080:0100::/56" ] },
.
.


             }

          ]
```

21:00 = slot 2 port 1 – 22:00 = slot 2 port 2 – 20:01 = slot 2 port 8. :)
0D:BC = vlan 3516
03:00:01:00:1F:6C:D1:DB:80 = show ipv6 dhcp in switch

In this way we can provide ”static” /56 per customer
OBS!! You must fill all /48 with dummy /56 if they not are in use!

Same provisioning system for IPv4 and IPv6 – Netadmin

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Interface config

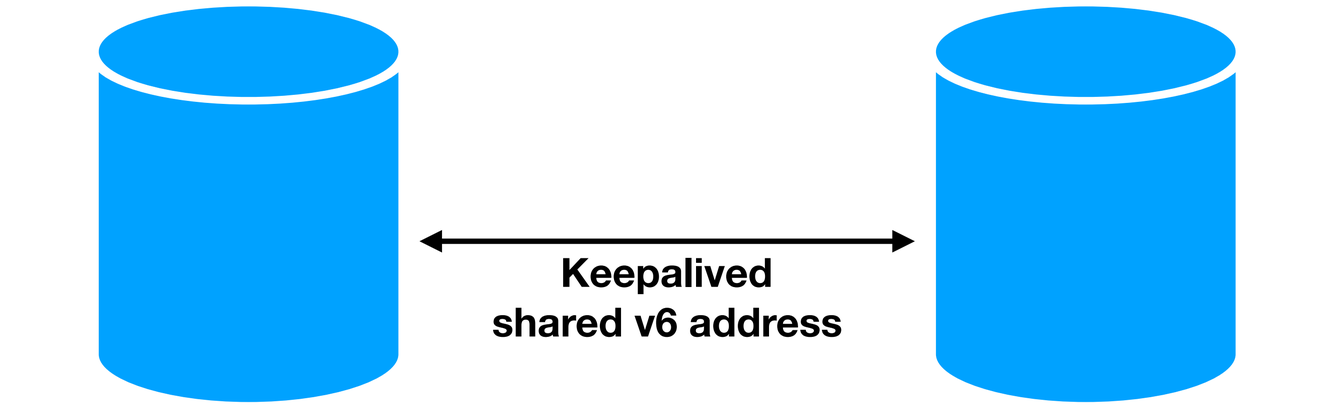
```
interface Vlan3516
      description FTTH_ro-harkskar01
      ipv6 address 2001:B49:80::1/64
      ipv6 enable
      ipv6 nd prefix default no-advertise
     ipv6 nd prefix 2001:B49:80::/64 no-advertise
     ipv6 nd managed-config-flag
     ipv6 nd other-config-flag
     ipv6 nd router-preference High
     ipv6 nd ra interval 10
     ipv6 verify unicast source reachable-via rx allow-default
     ipv6 dhcp relay destination 2001:B48:0:AAAA::BBBB
     ipv6 dhcp relay source-interface Vlan3516
     ipv6 dhcp relay trust
end
```

M and O flag for DHCPv6

BCP 38 - SAVI

Keepalived address

KEA



Virtual Ubuntu 16.04
active

Bare metal Ubuntu 16.04
Standby

Same DUID on both server
failover not tested - yet :)

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Result

show ipv6 route static

```
IPv6 Routing Table - default - 98 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       R - RIP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
       IS - ISIS summary, D - EIGRP, EX - EIGRP external, ND - ND Default
       NDp - ND Prefix, DCE - Destination, NDr - Redirect, O - OSPF Intra
       OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1
       ON2 - OSPF NSSA ext 2, la - LISP alt, lr - LISP site-registrations
       ld - LISP dyn-eid, lA - LISP away, a - Application
S   2001:B49:80::/44 [1/0]
     via Loopback10, directly connected
S   2001:B49:81:8C00::/56 [1/0]
     via FE80::3AD5:47FF:FEBB:78F0, Vlan3516
S   2001:B49:81:B600::/56 [1/0]
     via FE80::8226:89FF:FEEA:1FA8, Vlan3516
S   2001:B49:81:CC00::/56 [1/0]
      via FE80::1262:EBFF:FEF9:152D, Vlan3516
```

/44 routed to loopback
OSPFv3 only announces that prefix
A messy router can only disturb local vlan

show ipv6 dhcp relay binding

```
Relay Bindings associated with default vrf:
Prefix: 2001:B49:81:6000::/56 (Vlan3516)
  DUID: 000100012184B8A618D6C771E4FD
  IAID: 16345
  lifetime: 3600
  expiration: 17:15:52 SST Oct 26 2017
Prefix: 2001:B49:81:8C00::/56 (Vlan3516)
  DUID: 0003000138D547BB78F0
  IAID: 751856
  lifetime: 3600
  expiration: 17:07:51 SST Oct 26 2017
Prefix: 2001:B49:81:B600::/56 (Vlan3516)
  DUID: 00030001802689EA1FA8
  IAID: 151953439
  lifetime: 3600
  expiration: 17:14:25 SST Oct 26 2017
Prefix: 2001:B49:81:CC00::/56 (Vlan3516)
  DUID: 000300011062EBF9152D
  IAID: 185569301
  lifetime: 3600
  expiration: 17:14:01 SST Oct 26 2017
Summary:
  Total number of Relay bindings = 4
  Total number of IAPD bindings = 4
  Total number of IANA bindings = 0
  Total number of Relay bindings added by Bulk lease = 0
```

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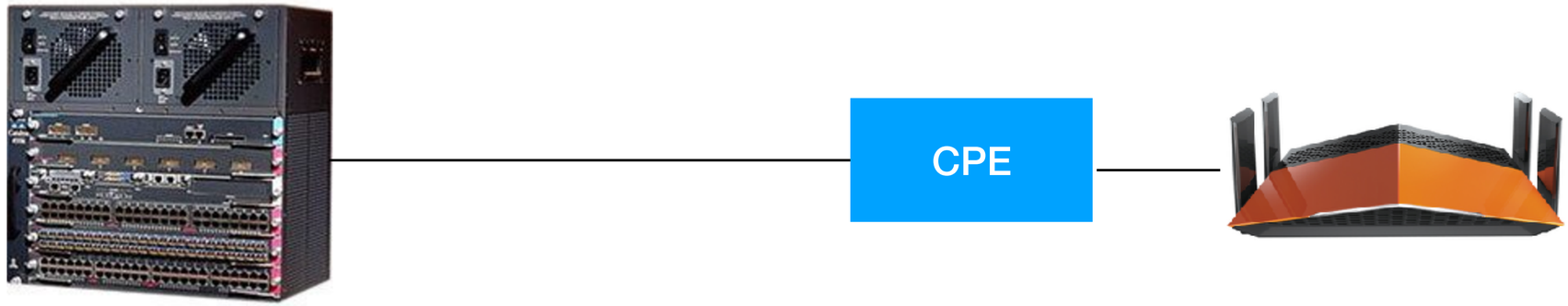
Lessons learned



- IGMP snooping in customer’s CPE block ICMPv6
- Disabled IGMP snooping on ”wan” port in CPE => ICMPv6 works ok

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Lessons learned

- Cisco 4500 reused port number from port 60 to 80 =>
- port 60 had same option 37 as port 1
  port 61 = port 2 etc.
- Solved by an upgrade but nothing about it in release notes

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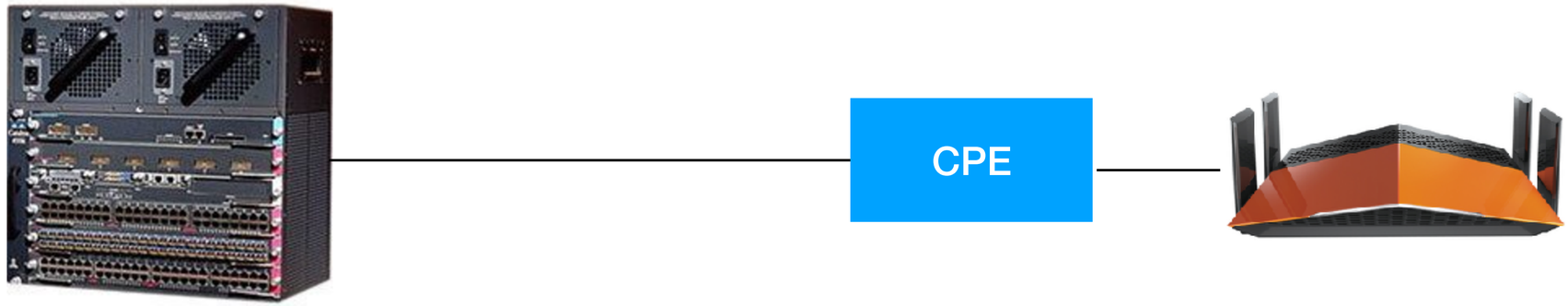
Problem!



- In Sweden we almost always buy our own homerouter
- IPv6 isn’t supported or don’t enabled default
- 200 customer => 6 active with IPv6

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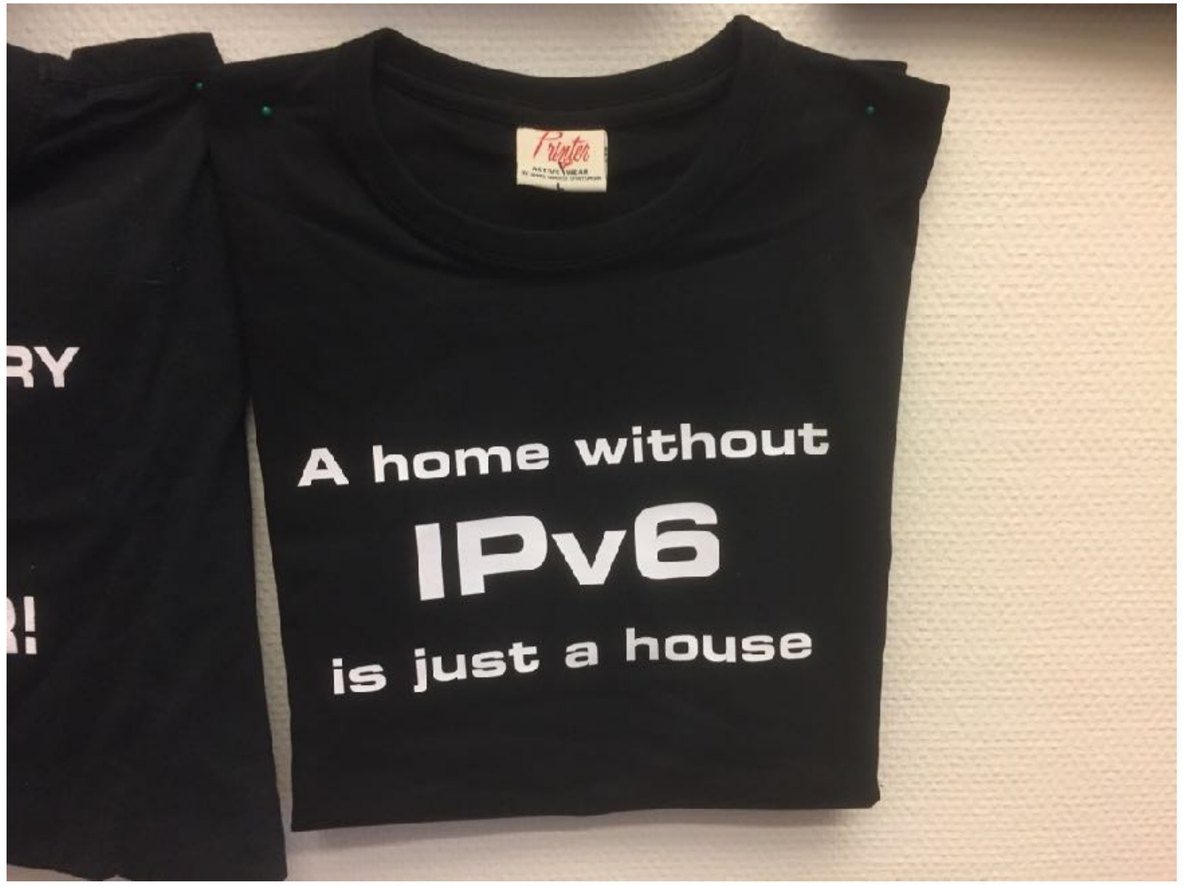
Thanks!



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