Home Networking & IPv6

Trends, Challenges, Operational Practices & Solutions

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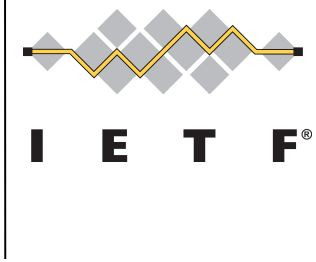
Outline

- Motivation & measurements
- Home networking trends
- Architecture
- Experiences
- Solutions

Motivation 1/4

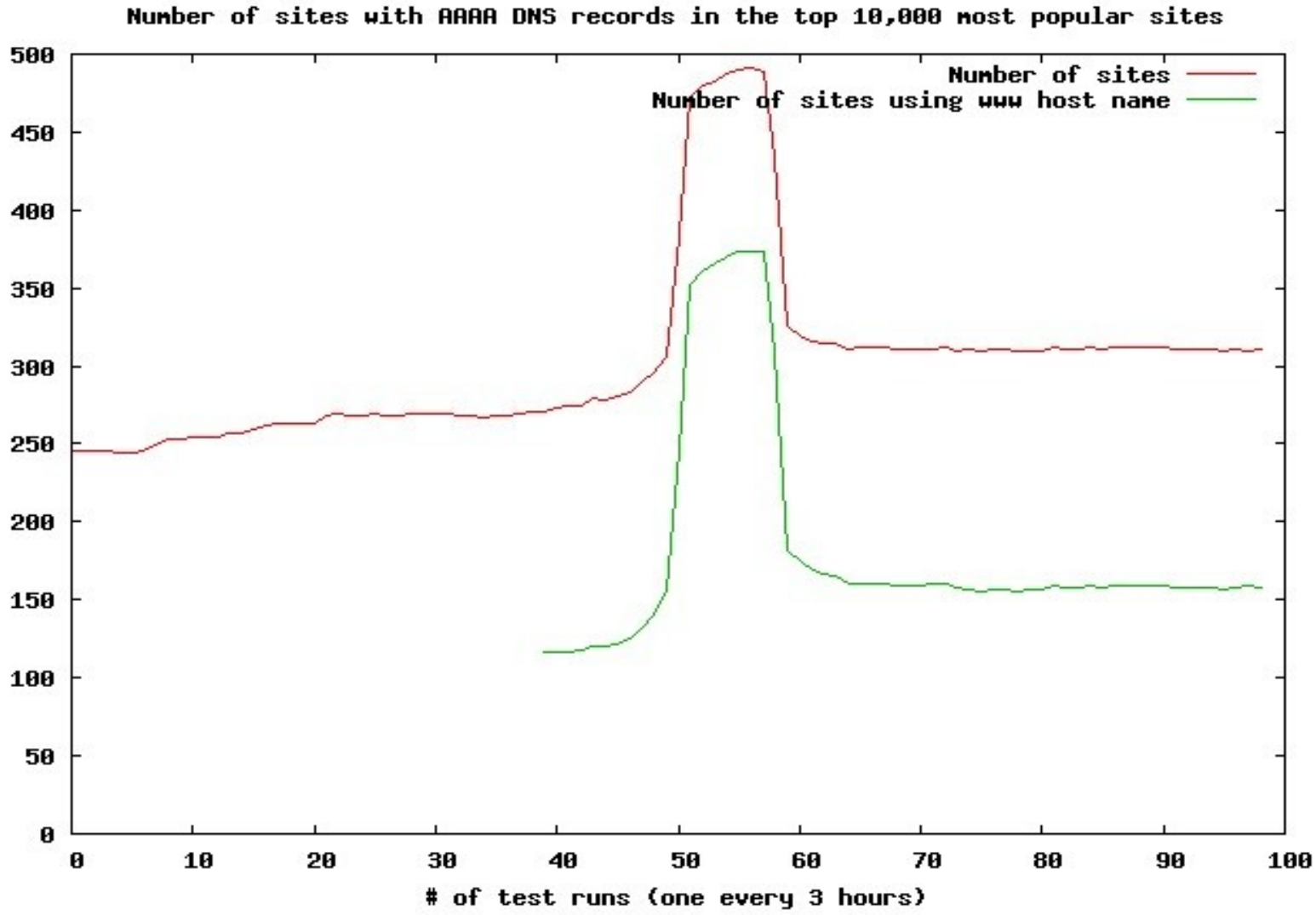
- There's only so many ways to deliver IPv4 & IPv6 to end users – wanting to move on
- Trying to focus more on what we can do with IPv6, not inventing new tunneling schemes
- IPv6 at home – is it ready to be turned on?
- We've been doing it for a long time, time to share our experiences?

Motivation 2/4: Where's the Problem?



- The world IPv6 Day was held on June 8th, 2011
- Over 400 participants, including the biggest content players such as Akamai, Microsoft, Facebook; Ericsson was there, too
- 35% of the top 100 content providers had enabled IPv6 (still there, if you are whitelisted)
- Perhaps the biggest one-day change in the history of the Internet

World IPv6 Day Results



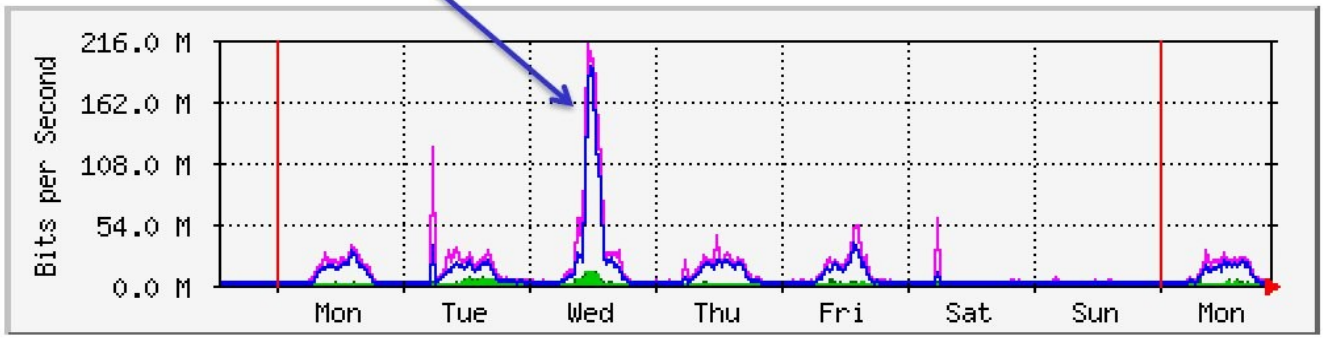
Motivation 3/4: The Problem is Lack of Users

- The day showed that content is there
- Global IPv6 routing is there, too
- We know operating systems are there, too
- What about end users and access networks?
- **Not doing too well there – only 0.2-0.3%**
- **This means also a relatively small amount of Internet traffic is on IPv6**

But the Traffic Can Grow Rapidly!

Percentage of Internet traffic over IPv6

- 1% (2009, before Google whitelisting)
- 2.5% (Google whitelisted)
- 10% (late Jan 2010, Youtube added)
- World IPv6 day… (peak at 68%)



Motivation 4/4: Action, Please!

- If we are serious about IPv6, we need to make it available to end users
- This involves much practical work:
  - (1) Turning it on in mobile networks
  - (2) Using native or tunnels in fixed networks
  - (3) Adding the support in home gateways
  - (4) Be able to use it in our home networks
- Lot of ongoing activity for (1) through (3)
- Are we ready for (4)?

Home Networking Trends
Can We Use IPv6 Just Like IPv4?

Home Networking Trends

- IPv6
- Explosion in the number of devices
- Separate networks (guest vs. private vs. utility)
- Differing network technology (ether vs. sensor)
- Borders and NATs
- Naming
- Self-configuration

The IPv4 model is clear – even if sometimes a bit ugly – but what about IPv6?

Home Network Architectures

Basic Network Architectures

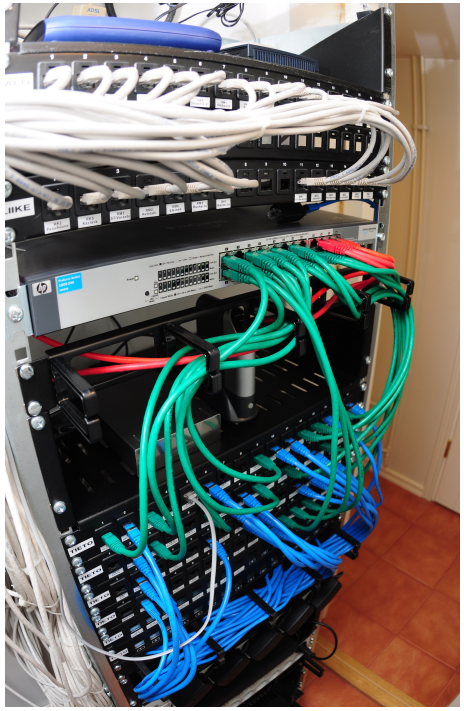
- One router, one subnet on the home side

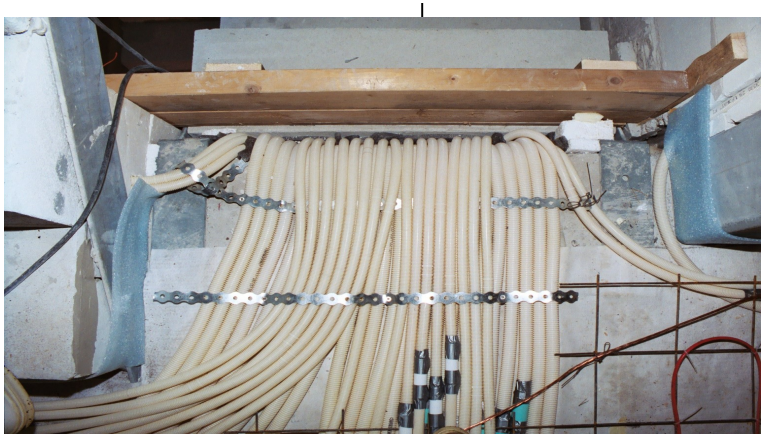
This is largely clear even on IPv6 (RFC 6204)

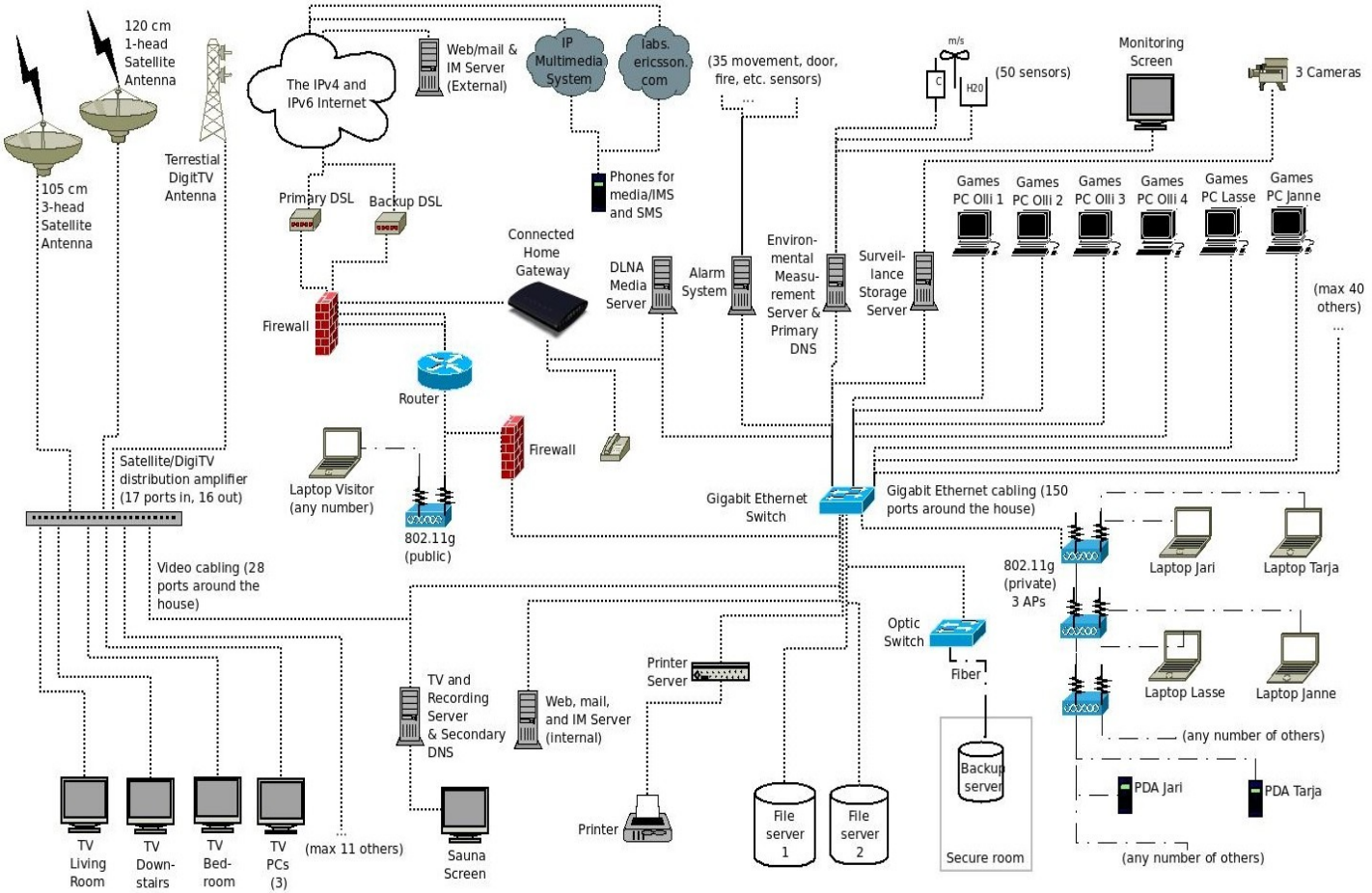
But it can also be more complicated:

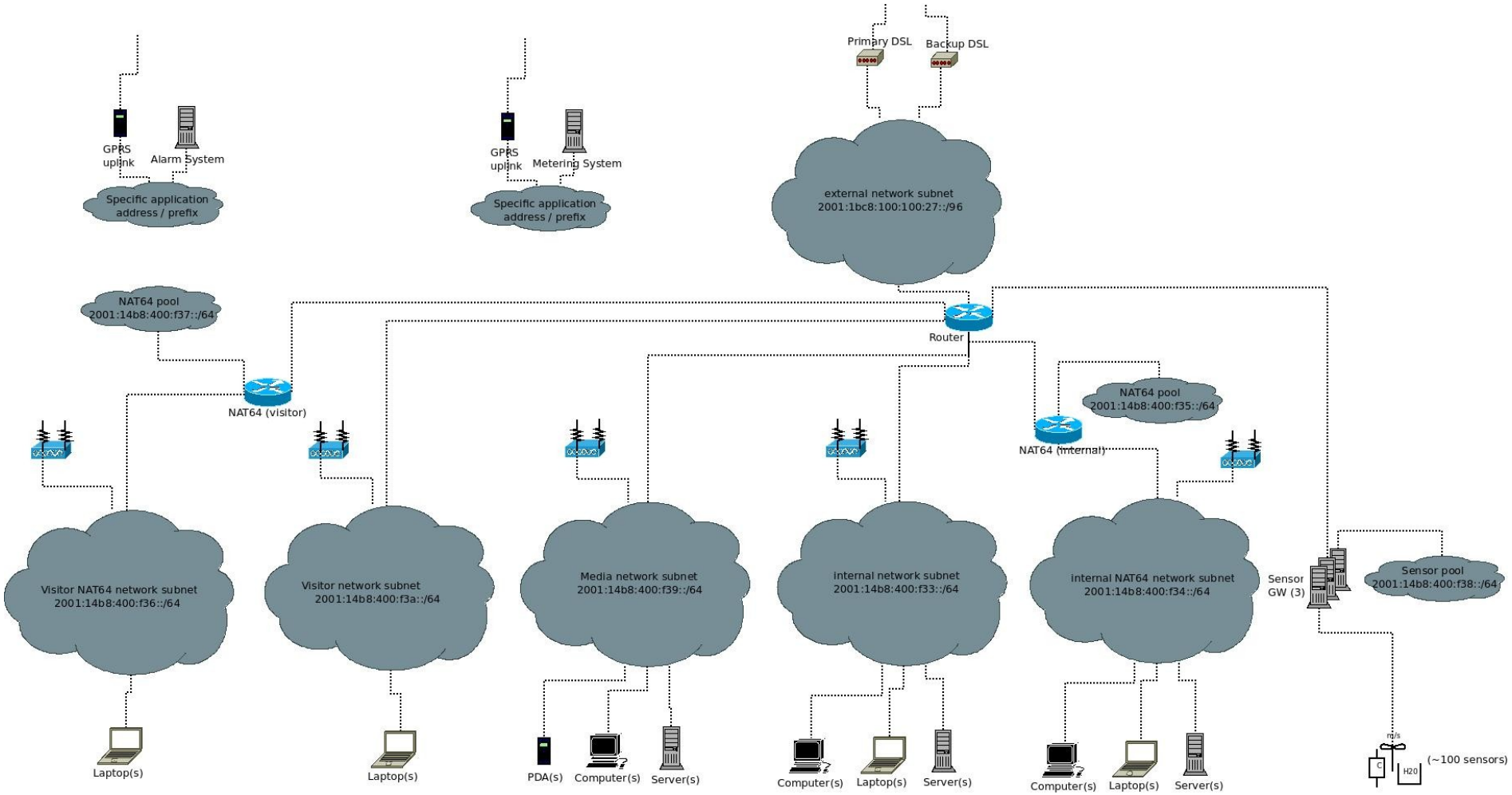
- Multiple subnets
- Or even multiple routers
- Heterogeneous link technology, mixture of old and new devices, routers and servers and hosts

A Real-World Example and Some Operational Experience






120 cm
1-head
Satellite
Antenna
105 cm
3-head
Satellite
Antenna
Terrestial
DigitTV
Antenna
The IPv4 and
IPv6 Internet
Web/mail &
IM Server
(External)
IP
Multimedia
System
labs.
ericsson.
com
(35 movement, door,
fire, etc. sensors)
...
m/s
C
H20
(50 sensors)
Monitoring
Screen
3 Cameras
Phones for
media/IMS
and SMS
Primary DSL
Backup DSL
Connected
Home
Gateway
DLNA
Media
Server
Alarm
System
Environ-
mental
Measu-
rement
Server &
Primary
DNS
Surveil-
lance
Storage
Server
Games
PC Olli 1
Games
PC Olli 2
Games
PC Olli 3
Games
PC Olli 4
Games
PC Lasse
Games
PC Janne
(max 40
others)
...
Firewall
Router
Firewall
Laptop Visitor
(any number)
802.11g
(public)
Satellite/DigiTV
distribution amplifier
(17 ports in, 16 out)
Video cabling (28
ports around the
house)
Gigabit Ethernet
Switch
Gigabit Ethernet cabling (150
ports around the house)
802.11g
(private)
3 APs
Laptop Jari
Laptop Tarja
Optic
Switch
Fiber
Laptop Lasse
Laptop Janne
(any number of others)
PDA Jari
PDA Tarja
(any number of others)
Backup
server
Secure room
Printer
Server
TV and
Recording
Server
& Secondary
DNS
Web, mail,
and IM Server
(internal)
Printer
File
server
1
File
server
2
TV
Living
Room
TV
Down-
stairs
TV
Bed-
room
TV
PCs
(3)
(max 11 others)
Sauna
Screen


GPRS uplink
Alarm System
Specific application address / prefix
GPRS uplink
Metering System
Specific application address / prefix
Primary DSL
Backup DSL
external network subnet 2001:1bc8:100:100:27::/96
NAT64 pool 2001:14b8:400:f37::/64
Router
NAT64 (visitor)
NAT64 pool 2001:14b8:400:f35::/64
NAT64 (internal)
Visitor NAT64 network subnet 2001:14b8:400:f36::/64
Visitor network subnet 2001:14b8:400:f3a::/64
Media network subnet 2001:14b8:400:f39::/64
internal network subnet 2001:14b8:400:f33::/64
internal NAT64 network subnet 2001:14b8:400:f34::/64
Sensor GW (3)
Sensor pool 2001:14b8:400:f38::/64
Laptop(s)
Laptop(s)
PDA(s)
Computer(s)
Server(s)
Computer(s)
Laptop(s)
Server(s)
Computer(s)
Laptop(s)
Server(s)
m/s
C
H20
(~100 sensors)

Some Experiences

Automation is needed (even for us geeks):

- It all started out manually... then I realized that I had to run a routing protocol
- … and a tool that discovers what devices I have
- … and now I've lost track of what prefixes I have where

And then I realized I really need automation

- One morning I found that my ISP had renumbered me

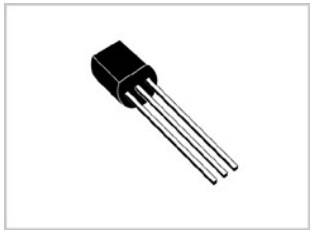
Some Experiences

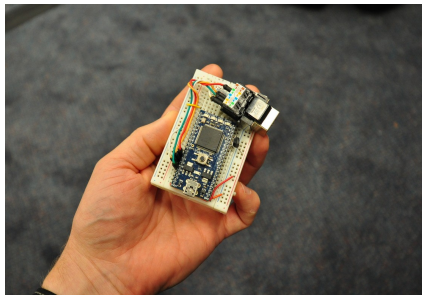
IPv6 service from the ISPs? You are on the bleeding edge:

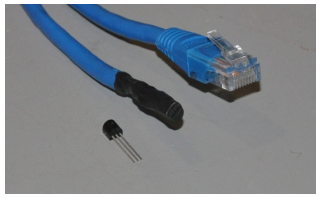
- They just don't have it
- ”IPv6 security is not defined yet”
- ”We'll give you 5 IPv6 addresses”
- “You get a /64”
- “You can get a /56 but only if you have an IPv4 subnet”
- They misconfigure filters for your prefix
- Overall, many people who do this end up exercising the code and practices for the first time

Experiences on M2M (1/2)

- Much legacy technology & gateways to IP
- You want all of it on same network
  - I'm moving from legacy-on-cat6 to IPv6-on-the-same-Ethernet-network model
- There are significant differences between LAN-based sensor networks and routed, multihop designs (I'm deploying the former)
- Multihop networks may need special, low-power routing protocol designs, LAN networks usually fit the rest of the architecture as-is
- Ownership, legal, safety may dictate different networks

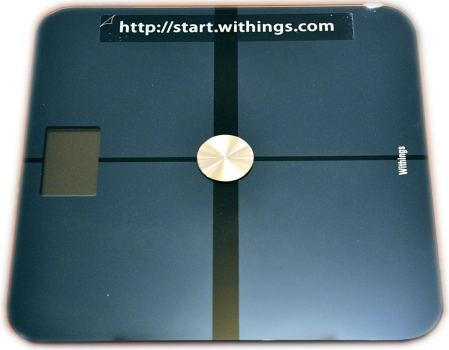






Experiences on M2M (2/2)

- The key is general-purpose technology
- We need more WLAN/GSM/Ethernet, more HTTP/COAP, more standard switches, routers, servers
- That's why we are migrating legacy solutions to IP
- My cat6 network has been tremendously flexible resource
- Now we will see the same with my Ethernet & IPv6 networks



More Experiences

Naming and service discovery

- Mandatory beyond running just a router
- File servers, printers, any home automation involving multiple devices, etc.

Necessary Functionality

- Prefix configuration (= address assignment is automatic)
- Managing routing (= automatically on)
- Naming (across the home)
- Service discovery (across the home)
- Security (beyond ”simple security” – RFC 6092)

Developments at the Homenet WG at the IETF

Approaches to Standardizing Home Networks

- Operational – this worked well for me
- Implementation commonality – this is available in most devices
- Functionality – we need this feature

I am mostly in the first two camps... need to be careful to not develop lots of extra complexity that may not be needed

Making a Useful Homenet Recommendation

- Make recommendations to turn on the things that already exist: DHCP PD, RIP/OSPF, …
- Add small enhancements where needed to ensure automatic self-configuration

How Homenet Can Improve Jari's Network

- I already do routing, multiple prefixes, run local DNS servers, etc
- But the routing was not automatically turned on, I had to manually assign all prefixes, and my naming services are not zero-config

Current Directions in the Homenet WG (1/2)

- Active group, interim in Philadelphia
- Focus on running code + some improvements
- ”Route where you had NAT44” architecture
- Link-state routing protocols such as OSPF seem like an acceptable compromise between code availability and functionality
  - Can also be used to assign /64 prefixes

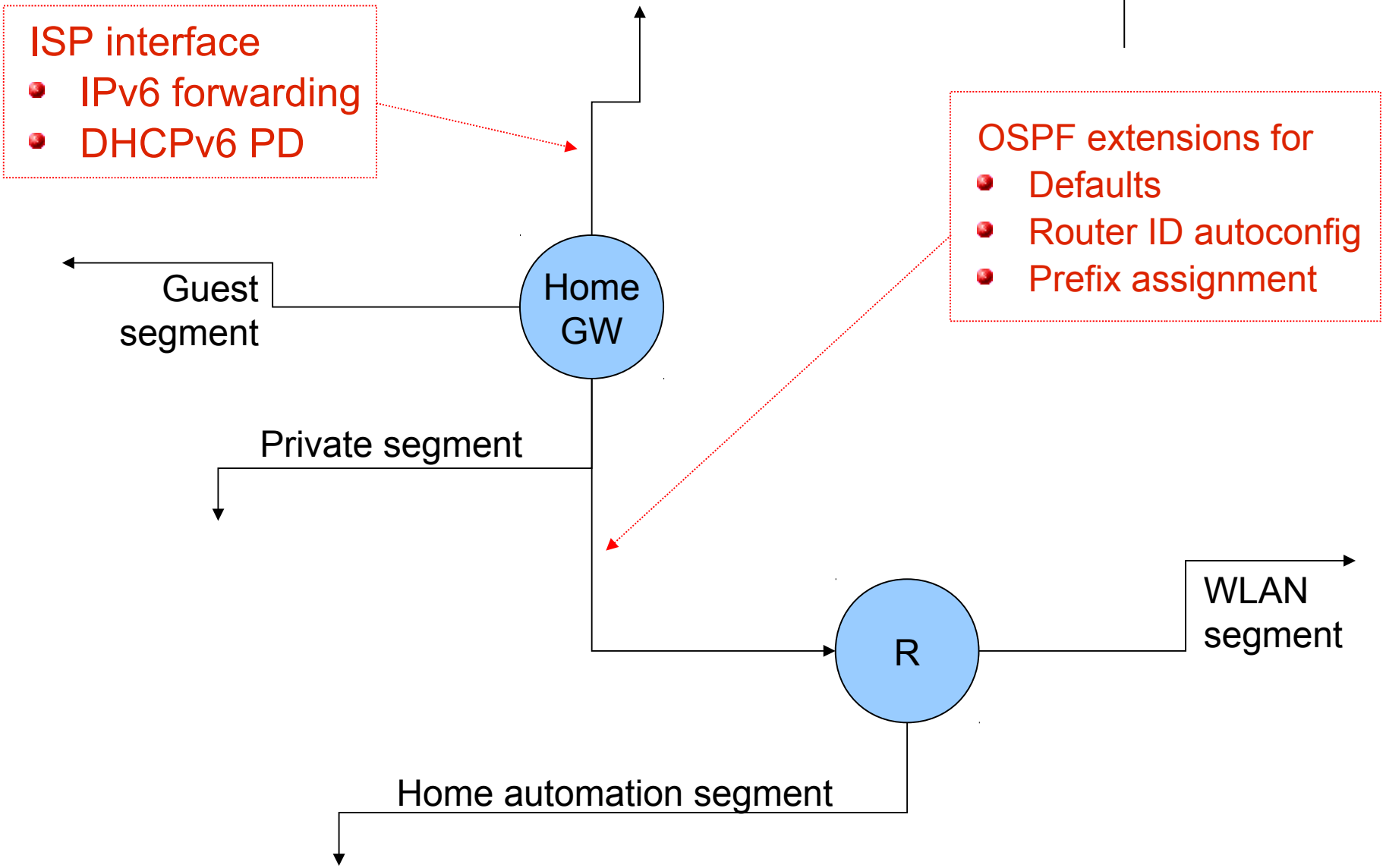
Current Directions in the Homenet WG (2/2)

- Sensor networks routing protocols are outside the scope; the router on the border to such a network can map to these mechanisms
- Most multihoming functionality is outside the scope, but it would be good to be able to use the right source address with multiple GWs
- The need for address assignment before home is connected to the Internet is TBD

Possible Homenet Recommendations

- Use an IPv6 router in place of an IPv4 NAT
- Use multiple subnets if cannot bridge
- External prefix delegation from the ISP
- Internal stable & efficient prefix assignment
- Use OSPF with prefix assignment extensions
- Local DNS servers & cross-subnet mcast DNS
- Implement Simple Security + PCP + extensions

OSPF-Based Home Networking



Summary & Next Steps

- IPv6 is an excellent fit for home networking
- The industry is updating home gateways and ISP practices to support this (products, BBF recommendations, etc)
- But need IPv6 counterparts for the IPv4 tricks
  - Use routing instead of NATs, PD
- The Homenet working group at the IETF is addressing this space – get involved!
- Ericsson is working on software to enable some of the necessary extensions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THANK YOU