Best Current Operational Practice for operators:

IPv6 Prefix Assignment for end-customers – persistent vs non-persistent and what size to choose

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Draft v2 meeting:

IPv6 Prefix Assignment for end-customers — persistent vs non-persistent and what size to choose
RIPE BCOP TF

https://www.ripe.net/participate/ripe/tf/bcop

https://www.ripe.net/publications/docs/ripe-690
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Executive Summary

• Making wrong choices when designing your IPv6 network will sooner or later have negative implications …
  – **IPv6 is not the same as IPv4.** In IPv6 you assign a short prefix to each end-customer site, so they are able to have as many subnets (/64s) as they need.
  – It is **strongly discouraged** to assign prefixes longer than /56. If you want a simple addressing plan, /48 for each end-customer.
  – In order to facilitate troubleshooting and have a future proof network, you should consider **numbering the WAN links using GUAs**.
  – Non-persistent prefixes are considered harmful in IPv6 as you can’t avoid issues that may be caused by simple end-customer power outages, so assigning **persistent prefixes is a safer and simpler approach**.
BCOP and Why?

• Describe best **actual** practices
• Target: ISPs deploying IPv6
• Lack of experience or following IPv4 practices bring unexpected or unwanted results
  – IPv6 “brokenness” = Content providers rejection of your AS
  – Lack of compliance with new standards such as Homenet
    • Complete **production** network renumbering, etc.
Size of end-customer prefix

• /48, /56 or something else?
• Change your mind, this is not IPv4!
• IPv6 has been designed to assign prefixes not addresses
• Tony Hain “maths”:
  – IPv6 lifetime over 480 years, and keep doing that several times
  – Scarcity of addresses is not going to be our next problem
/64 ?

• DO NOT DO THAT!
/64 ?

• DO NOT DO THAT!
  – NEVER!
/64 ?

• DO NOT DO THAT!
  – NEVER!
• NO WAY!
/64?

• DO NOT DO THAT!
  – NEVER!
• NO WAY!
  – BROKEN!
/64?

• DO NOT DO THAT!
  – NEVER!

• NO WAY!
  – BROKEN!

» VERY BAD FOR YOU
/64?

• DO NOT DO THAT!
  – NEVER!
• NO WAY!
  – BROKEN!

» VERY BAD FOR YOU
» BAD FOR YOUR CUSTOMER
Numbering the WAN link

1. /64 out of the end-customer prefix
2. /64 out of a dedicated pool
3. Unnumbered
4. ULA
/64 from customer prefix

• Use the 1\textsuperscript{st} /64 from the customer prefix
  – draft-palet-v6ops-p2p-from-customer-prefix-01
  – Simplifies routing and provisioning

• Some CPEs may not support RFC6603
  – Prefix exclude option for DHCPv6-PD

• Even being required by RFC7084
  – Basic Requirements for IPv6 CPEs
/64 from dedicated pool

• Most common scenario
  – Dedicated pool for WAN links

• CPE performs router discovery
  – If it is a host (PPPoE), setup is completed
  – If it is a router, will request a prefix (DHCPv6-PD)

• /126, /127, /112 or /64?
  – RFC6164 suggest /127
    • Not all hardware supports it
    • /64 is future proof
    • Hardware limitations for longer than /64 prefixes
    • Allocate /64, use /127 to prevent ND attacks

• If there is *always* a CPE, you can apply security policies w/o harming customers
Unnumbered

• Don’t use GUAs
  – Instead use Link-Local
• Doesn’t work for all the devices, which can’t request DHCPv6-PD
  – No GUAs means no traffic …
• Complicate troubleshooting
  – Not able to traceroute the point of failure
• Not suitable for unknown CPEs or non-CPEs attached to the WAN link
• End-host will stay unnumbered
• Some hardware may consume additional resources for numbered links
ULA

• Strongly discouraged
• ICMPv6 from the CPE to outside ISP
  – ULA source address will not traverse filters
  – PMTUD will break
  – IPv6 connection will break if Path MTU is not the same
WAN link summary

• /64 GUA is the recommended choice
  – From the customer prefix if RFC6603 is supported

• It may be even required when more that 2 endpoints
  – Managed bridges
  – Repeaters
  – Redundancy (VRRP, multiple routers)
  – Monitoring/troubleshooting devices
Prefix assignment options

- Align the size of the delegated prefix with a nibble boundary (multiples of 4 bits), so it match DNS reverse zone delegations
- A single customer network is /64
  - A single /64 is plain wrong
  - IETF work allows a single /64 for an interface
- Multiple /64 must be the rule
  - RIR policies allow /48
/48 for business, /56 residential

- Some operators do this
  - Rationale -> Marketing/Sales differentiation
- Advanced home users may have problems with this
  - You’re not able to use all the 4 digits (/48-/56)
- Some may have already an addressing plan with /48 (ULA, TB, transition, etc.)
  - /56 forces to redo it + renumbering
  - /48 just means changing the prefix
- Alternatively, reserve /48, assign /56
- Are you considering SMEs?
/48 for everybody

- Most practical and pragmatic
- Less call-centre time to sort out problems
- Single “flat” provisioning system
- Same prefix size as ULAs, transition, etc.
  - Direct mapping of existing addressing plans

BCOP IPv6 Prefix Assignment for end-customers – persistent vs non-persistent and what size to choose
Less than /56

• Not recommended
  – Technically no reason for that, enough addresses, this is not IPv4!
    • Over 134 million /56 in a /29
    • Over 16 million /56 in a /32
• Ask for more space to your RIR if required
• Never assign a single /64
  – Except for cellular phones (1 /64 for each PDP)
• LTE modems still require /56 or /48
Persistent or non-persistent

- Persistent typically by means of AAA or custom provisioning system
  - At customer connection they always get the same prefix
- Non-persistent by means of a big pool in each termination point
  - At customer connection they get a random prefix
  - If persistent, the lease time may provide days, weeks or even months
Non-persistent is easier?

• Less effort to deploy
  – Issues come later
  – It comes from IPv4 practices, DHCP
    • But we have NAT!
  – Looks easier for aggregation
  – Not looking for “customer” portability
    • May be an extra service

• Commonly using DHCPv6-PD
  – Each end-customer device has a GUA
However … non-persistent is harmful

• In case of power failure, CPE hang-up, …
  – Common even in highly-developed countries
• CPE doesn’t send prefix valid lifetime = 0
  – End-customer devices keep the old prefix
  – Will try to use it, will fail
    • Customers claims to the call-centre
• Content providers measure IPv6 brokenness
  – Will ignore your IPv6 traffic
• Power outage often happen several consecutive times …
• Non-persistent prefixes force a logging system
Best choice: Persistent or non-persistent

- Allow broadband services provided by the customer and the ISP
  - Allow stable DNS names
    - camera1.username.ispname.com
  - New business/apps/services, new incomes
- Key for non-residential customers
- Avoid having a logging system
- The WAN link still can be non-persistent
Questions?

Thanks!
IPv6 Deployment Survey (Residential/Household Services)

How IPv6 is being deployed? (January 2018)

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Consulintel, CEO/CTO
Survey Contents

- Basic ISP data (name, country, RIR)
- Technology of the customer link
- Is it a commercial service or a “pilot”
- IPv6 WAN link
- IPv6 customer addressing
- IPv4 service
- Transitioning and provisioning
- IPv6 DNS services
- Other data (optional contact details)

Note: Survey not intended for service to mobile phones, however, 2G/3G/4G response can be provided for service via a “CPE/modem”
Who is responding?

- Looking at whois …
- ISP employees
  - From their own network most of the time
- Customers
  - Most of the time from their own residential networks
- Most of the responder “networks” have both IPv4 and IPv6 allocations
  - Responding with IPv4 from ISP network probably means, even if they have deployed IPv6 to residential customers, may be not in (all) the corporate LANs.
- Other observations, looking at bind and apache logs:
  - Happy-eye-balls timeout …
  - Is that anymore needed? Time to retire it?
  - Hiding IPv6 network problems?
• Responses from 105 countries
Regional/Country analysis

• Is this meaning there are some regions/countries with a higher degree of residential deployment?
  – APNIC (Australia, China, Japan, Malaysia, New Zealand). Missing responses from South Korea, India.
  – ARIN (US, Canada)
  – LACNIC (Argentina, Brazil, Colombia, Guatemala, Paraguay, Peru, Venezuela). Missing responses from Mexico.
  – RIPE NCC (Belgium, Denmark, Finland, France, Germany, Greece, Luxembourg, Netherlands, Norway, Portugal, Romania, Russia, Slovenia, Spain, Sweden, Switzerland, UK)

• Or instead regions/countries not doing it?
  – AfriNIC
  – LACNIC
Deployment differences by technology

- More deployment by “newer” technologies:
  - FTTH
  - xDSL
  - Cable/DOCSIS
  - Wireless (WiFi, LMDS, WiMax, …)

- Avoids investing in replacing CPEs

- Are there problems/difficulties with some specific access technologies?
  - According to the responses, I don’t think so …

- Vendor or transition technologies issues with some access technologies?
  - Nothing reported
Is IPv6 already a commercial service?

No
243
35%

Yes
447
65%
Why still not commercial?

- 65% Yes, already commercial

- 35% No commercial
  - checked with some of the responders, they will go to commercial, typically it is a trial, but they plan to deploy (few months from now)
WAN prefix issues

- Remarkable -> /64 62%
- What means other?
  - /128, /62, /60, /56, /48, /32 ... No comments

- Why not stable (37%)?
  - Provisioning systems?

- 60% using GUA

- Interesting figures about using the /64 from the customer allocated prefix (69%)

- Distribution of those technical aspects not related to any specific country/region
LAN prefix issues

• What are the “other” sizes?
  – A few /60 and /62 (others … /29, /44, /57, /127, /128)
  – Surprising (1) response -> shared /64

• Are we doing right/wrong? It is related to specific regions or countries?
  – 33% /64 mainly in LACNIC, some countries in APNIC
  – 35% /56 ARIN/RIPE NCC
  – 23% /48 mainly “more advanced” countries (Australia, New Zealand, Germany, Finland, Denmark, France, UK, China, Japan)

• Are we realizing that services work better with “stable” addressing?
  – AfriNIC, RIPE NCC and APNIC mainly stable
  – ARIN, mainly not-stable
  – LACNIC, half and half

• Why not allowing stable even as an “extra”? 
  – Training issues? IPv4 mind-set?
  – Extra cost, very few
IPv4 service provided?
- Yes: 455 (96%)
- No: 19 (4%)

Public IPv4 address at CPE WAN?
- Yes: 375 (88%)
- No: 50 (12%)

IPv4 address is "stable"?
- Yes: 225 (54%)
- No: 188 (46%)

Can the customer opt to have IPv4 "stable"?
- Yes: 134 (65%)
- No: 62 (35%)

Extra cost for stable IPv4?
- Yes: 47 (85%)
- No: 14 (15%)
What transition mechanism?

- 464XLAT
- 6RD
- 6to4
- CGN (dual-stack with private IPv4 + GUA)
- DS-LITE
- Dual-stack (public IPv4 + GUA)
- lw4o6
- MAP-T
- NAT64
- Other
- Tunnel Broker
- Softwires (L2TP)
- MAP-E

- Dual-stack (public IPv4 + GUA)
  - 291
  - 71%

- Softwires (L2TP)
  - 2
  - 1%

- Tunnel Broker
  - 11
  - 3%

- NAT64
  - 7
  - 2%

- MAP-T
  - 1
  - 0%

- lw4o6
  - 1
  - 0%

- Other
  - 18
  - 4%

- MAP-E
  - 5
  - 1%

- 6RD
  - 11
  - 3%

- 6to4
  - 13
  - 3%

- CGN (dual-stack with private IPv4 + GUA)
  - 33
  - 8%
Transition and IPv4 issues

• It is a trend not providing IPv4 in the access?
  – It means some transition technologies being used which don’t require IPv4 in the access.

• Not related to specific regions/countries

• What other “transition” technologies?
  – Actually none, just “bad answers”

• CGN deployment increasing clearly increasing ...
DNS

• Seems to follow “LAN IPv6 stable prefix”

• Reverse DNS as an extra service?
Conclusions

- In general “correct” deployment
  - Some exceptions
  - IPv4 “mind-set” – lack of coherent expert training

- Misunderstandings on IPv6 technology/marketing/other reason:
  - IPv6 prefix size
  - Stability of prefix

- More “advanced” countries seem to do it smartly, less "misunderstandings"
Thanks !!

Survey link:
http://survey.consulintel.es/index.php/175122

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