RIPE

IPv6 Deployment Status

Status of IPv6 and Thoughts on the Way Forward

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Agenda

- A brief introduction to draft-ietf-v6ops-ipv6-deployment
- Early findings
  - Some numbers on IPv6 deployment
  - IPv6 in the service layer (overlay) seems the real enabler for the transition rather than IPv6 in the network (underlay)
- Call for action
  - Some areas still need improvement
  - Solve the perceived open issues
- Q&A and thoughts sharing.

Draft-ietf-v6ops-ipv6-deployment - A brief history

- The initial proponents contributed to an ETSI effort
  - ETSI ISG IP6, IPv6 Best Practices, Benefits, Transition Challenges and the Way Forward, ETSI White Paper 35, August 2020
- Eventually, brought the topic to IETF
  - The aim was to focus on the current status and the technical challenges of the transition to IPv6 and provide an update to RFC 6036 (dated 2010)
  - Discussed at IETF 109 for the first time
- After IETF 110, adopted as a v6ops WG draft
  - Decision based on the mailing list activity
  - More people joined as co-authors(1)
  - Several threads opened up, triggering new ideas for the draft and, more in general, on how to bring the IPv6 adoption further.

(1) G. Fioccola, P. Volpato [Huawei], N. Eskins [INTC], J. Palet Martinez [The IPv6 Company], G. Mishra [Verizon], C. Xie [CMCC]

Early indications

- The IPv6 numbers seem relatively good
  - The connection end-points (terminals and contents) widely support IPv6
  - We can talk of native, end-to-end IPv6 connectivity
- The focus on IPv6 service layer (overlay) is growing
  - Several transition mechanisms available (e.g. 464XLAT, DS-Lite)
  - Ready to support the introduction of IPv6-based services
- Identify the actions that still need to be done to complete the transition
  - Feedback welcome.

Service Layer: Users (1/2)

Users[1] (000)	Jan-16	Jan-17	Jan-18	Jan-19	Jan-20	Jan-21	CAGR[*]
IPv6-capable	179,212	290,272	513,078	574,021	989,251	1,136,282	44.7%
Total	3,246,147	3,339,368	3,410,276	3,470,367	4,065,000	4,091,620	4.7%
Ratio	5.5%	8.7%	15.0%	16.5%	24.3%	27.8%	38.1%

(*) Compound Annual Growth Rate 2016-2021

- IPv6-capable users are growing very fast, CAGR is ten times higher than total
- The IPv6 over total ratio is also growing significantly.

(1) Data have been processed using, as a source, the IPv6 Resource Distribution Reports from https://resources.potaroo.net/iso3166/archive/

Service Layer: Content (2/2)

Websites (%)	Jan-16	Jan-17	Jan-18	Jan-19	Jan-20	Jan-21	CAGR(*)
IPv6-enabled(1)	6.1%	9.60%	11.40%	13.30%	15.00%	17.50%	23%

(*) Compound Annual Growth Rate 2016-2021

- 40% of World Top websites are IPv6-enabled(2) (e.g. hyperscalers)
- Facebook and Google alone generated 58% of mobile traffic(3)

⇨ The greatest part of content should be available on IPv6.

(1) W3Techs (Web Technologies Surveys), https://w3techs.com/technologies/details/ce-ipv6, looking at ~10M sites ranked by Alexa
(2) Cisco 6Labs, https://6lab.cisco.com/stats/cible.php?country=world&option=content, looking at the top world 500 sites by Alexa
(3) Sandvine 2020 Mobile Internet Phenomena Report

IPv6 Ratio in the RIPE Region

Registry	Jan-16	Jan-17	Jan-18	Jan-19	Jan-20	Jan-21	CAGR
RIPE NCC	6.3%	10.5%	11.2%	11.4%	14.4%	16.7%	21.7%
EU-27	10.9%	16.3%	18.0%	18.2%	24.3%	26.8%	19.7%
World	5.5%	8.7%	15.0%	16.5%	24.3%	27.8%	38.1%

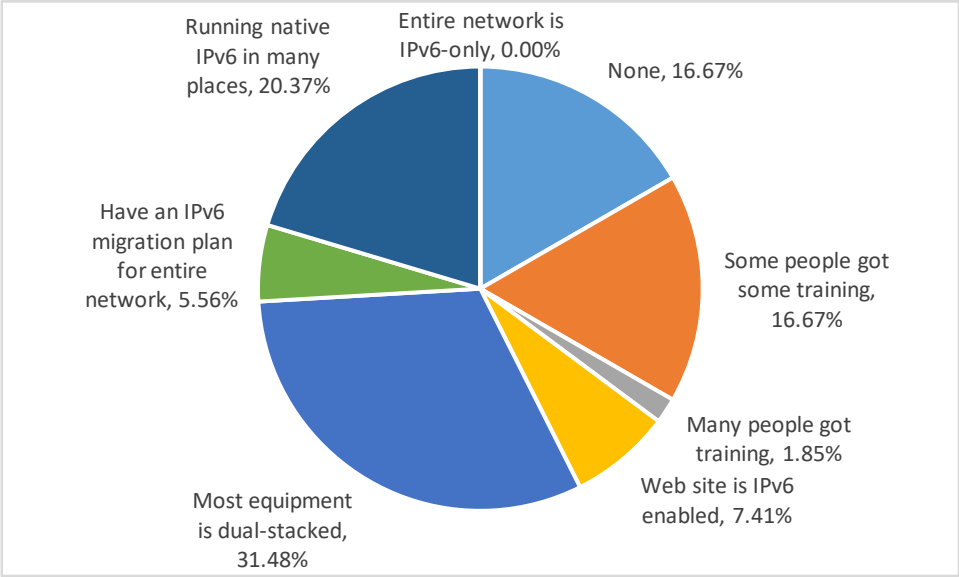
Source: https://resources.potaroo.net/iso3166/archive/
Aggregation is then obtained associating a country code to its registry as per https://www.ripe.net/participate/member-support/list-of-members/list-of-country-codes-and-rirs

The Survey on IPv6

- Several sources to track the use of IPv6 (Akamai, Google, Facebook, The Internet Society…)
- In addition, two independent polls submitted to operators and enterprises in Q3/Q4 2020:
  - The operators' poll: target to ask for the plans of EU-based carriers on IPv6
  - The enterprises' poll: delivered by the Industry Network Technology Council (INTC)(1) to check the needs of large enterprises in NAR
- Some findings in the next slide.

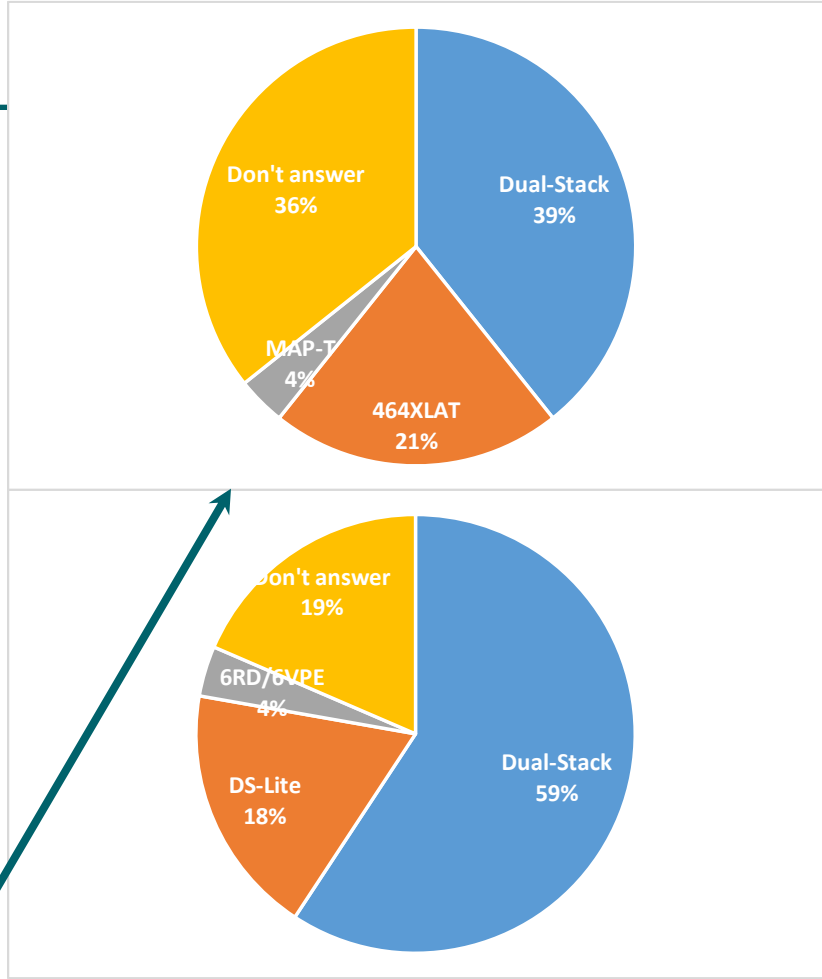
(1) https://industrynetcouncil.org/

The Survey on IPv6



How much IPv6 implementation have you done at your organization?

Which transition solution will you use? [Cellular above, wireline bottom]



Findings of the Survey

- Global IPv4 address depletion is reported as the key driver for IPv6 deployment
  - Run out of private address space as recommended in RFC1918
  - 5G, IoT service deployment is another incentive not only for business reasons but also for the need of more addresses
- Save the NAT costs
  - Dependent on the amount of investments already done in CGN
- Regulation
  - USA, China, France ARCEP as a requirement for the 5G licenses.

Practical Suggestions to do Transition to IPv6-only

- Most operators transition in 2 phases:
  1. IPv6 Introduction, and
  2. IPv6-only (IPv4 is supported as a service over IPv6 in this phase)
- IPv6 introduction is relatively easy, and produces results immediately (relieve address shortage, save NAT cost, etc.)
- Once “IPv6 introduction” is started, an operator will learn many IPv6 lessons, and decide when to start “IPv6-only” phase.

IPv6 introduction

- The scope is to enable IPv6 service in an originally-IPv4 network
- Dual-stack is the preferred solution, accounting for about 50% of all IPv6 deployments
- Network management can remain IPv4, relatively easy to start

IPv6-only (a.k.a. IPv4aaS)

- When IPv6 traffic grows to a certain extent, it’s advisable to move to IPv6-only
- It minimizes network & operations complexity by having just one protocol stack
- The infrastructure is IPv6. IPv4 services are still supported over the IPv6 infrastructure
- Users that can only use IPv4 (e.g. on legacy devices) can still use any IPv6/IPv4 services

Results from a Field Analysis (v6ops)[(1)]

Mobile carriers

IN	Dual Stack
US	?
BT	Dual Stack
FR	464XLAT
GB	464XLAT
TT	Dual Stack
DE	464XLAT, NAT64
DE	Dual Stack
EE	dual stack
TW	Dual Stack
VN	dual stack
NO	Dual stack
FR	Dual-stack
PL	464XLAT
IN	464XLAT
CA	NAT64/464XLAT
KR	464XLAT
US	464XLAT
US	464XLAT, NAT64
SE	Dual stack
AU	464XLAT
CA	464XLAT?
DK	Dual stack
US	Dual-stack

Fixed carriers

NO	6RD
US	6rd
US	Native IPv6 (Dual Stack)
CH	DS-Lite
US	Dual Stack
UK	Dual Stack, NAT64
US	dual stack
CR	Dual-stack
DE	Dual Stack
DE	lw4o6
IE	dual stack
GR	Dual-Stack, DS-Lite
NO	Dual stack
TW	Dual stack
DE	DS-Lite
DE	Dual Stack and NAT64
DE	DS-Lite
MA	Dual-Stack
UA	dual stack
DE	Dual Stack
CZ	DS-Lite
ES	dual stack, DS-Lite
FR	Dual-stack
PL	DS-Lite
SK	DS-Lite
GR	Dual-stack / MAP-E
BE	dual stack
DE	DS-Lite
AR	Dual stack
RO	Dual Stack
IN	MAP-T, Dual-stack
CA	Dual Stack
UK	Dual Stack
US	6rd
CH	6rd
AT	DS-Lite
CZ	Dual-stack
SI	Dual Stack
BE	dual stack
NO	Dual stack
EE	dual stack
DE	Dual Stack
DE	DS-Lite
CZ	DS-Lite
RO	DS-Lite
HU	DS-Lite
PL	DS-Lite
SK	DS-Lite
US	IPv4 only
IE	DS-Lite
NL	DS-Lite

- Most carriers are in "IPv6 introduction" phase
- When moving to IPv6-only, XLAT and DS-Lite are preferred

(1) https://mailarchive.ietf.org/arch/msg/v6ops/_8SKyRon_tbZb4l1F9Ysly5ZGSM/

A Call for Action - Areas for Improvement

Stakeholder	Factors that may have impact over the transition
Operators	Fixed operators: economic/technical limiting factors to move forward. e.g. networks with both DS and CGNAT will not do transition because of 1) ROI 2) wait for the update of CPEs
	Mobile operators: slow transition to IPv6-only. In some cases Regulation has positive effect, in others looking for a trigger to move from DS to IPv6-only
Enterprises	Quite late in IPv6 adoption. Many don't find any business reason to adopt IPv6. Engineering dept. with scarce knowledge of IPv6
Cloud and Data Centers	Adopted IPv6 in their internal infrastructure. Gathering IPv4 addresses on the transfer market to serve the current business needs of IPv4 connectivity
CPEs and user devices	Most are IPv6-enabled. There are exceptions e.g. smartTVs, STBs, game consoles
Industrial Internet	IPv6 promising but not yet widespread. Engineers not familiar with IPv6 in App development life cycle
Governments and Regulators	Examples of regulators that stimulated the adoption of IPv6. In some other cases, not perceived as a priority.

A Call for Action – Perceived Open Issues

Area	Reasons
Network Operations	• Need to remove misconceptions • To configure both the network and the upper systems to introduce IPv6 is not difficult
Performance	• Despite their differences, people tend to compare IPv6 vs IPv4 • In some cases, IPv6 behaving "worse" than IPv4 tends to re-enforce the justification of not moving on with IPv6
Security	• General feeling that IPv6 security is not at the same level of IPv4 • Probably related to the level of expertise of network and security engineers (more experience and confidence in deploying and operating IPv4) • Availability of features in security devices and tools

References to BCPs, research analyses, tools to create a "library" welcome

Conclusions

- IPv6 is growing faster than most people think
- IPv6 can provide value to all industry players
- IPv6 deployment can be done in two phases
- There is a role for Regulators
- General challenges
  - Training, Security, Performance, Operations
- What are the thresholds of IPv4/IPv6 traffic for the transition to IPv6-only?

Questions?