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HEPiX IPv6 WG update

David Kelsey (UKRI/STFC-RAL)
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On behalf of all members of the HEPiX IPv6 working group - (many thanks all!)



M Babik (CERN), M Bly (RAL), N Buraglio (ESnet), T Chown (Jisc),
D Christidis (CERN/ATLAS), J Chudoba (FZU Prague), P Demar (FNAL), J Flix (PIC),
C Grigoras (CERN/ALICE), B Hoeft (KIT), H Ito (BNL), D P Kelsey (RAL),
E Martelli (CERN), S McKee (U Michigan), C Misa Moreira (CERN),
R Nandakumar (RAL/LHCb), K Ohrenberg (DESY), F Prelz (INFN), D Rand (Imperial),
A Sciabà (CERN/CMS), T Skirvin (FNAL)

(underlined names – here this week)

- Many more in the past, and members join/leave from time to time
- ***many thanks also to WLCG operations, WLCG sites, LHC experiments, networking teams, monitoring groups, storage developers...***

Overview

Outline of talk

- Meetings of the working group (since Oct 2023)
- Dual-stack IPv6/IPv4 storage deployment
- Dual-stack CPU
- WLCG DC24
- IPv6-only WLCG
- Summary
- Now for the “training” session



IIPv6 traffic maps

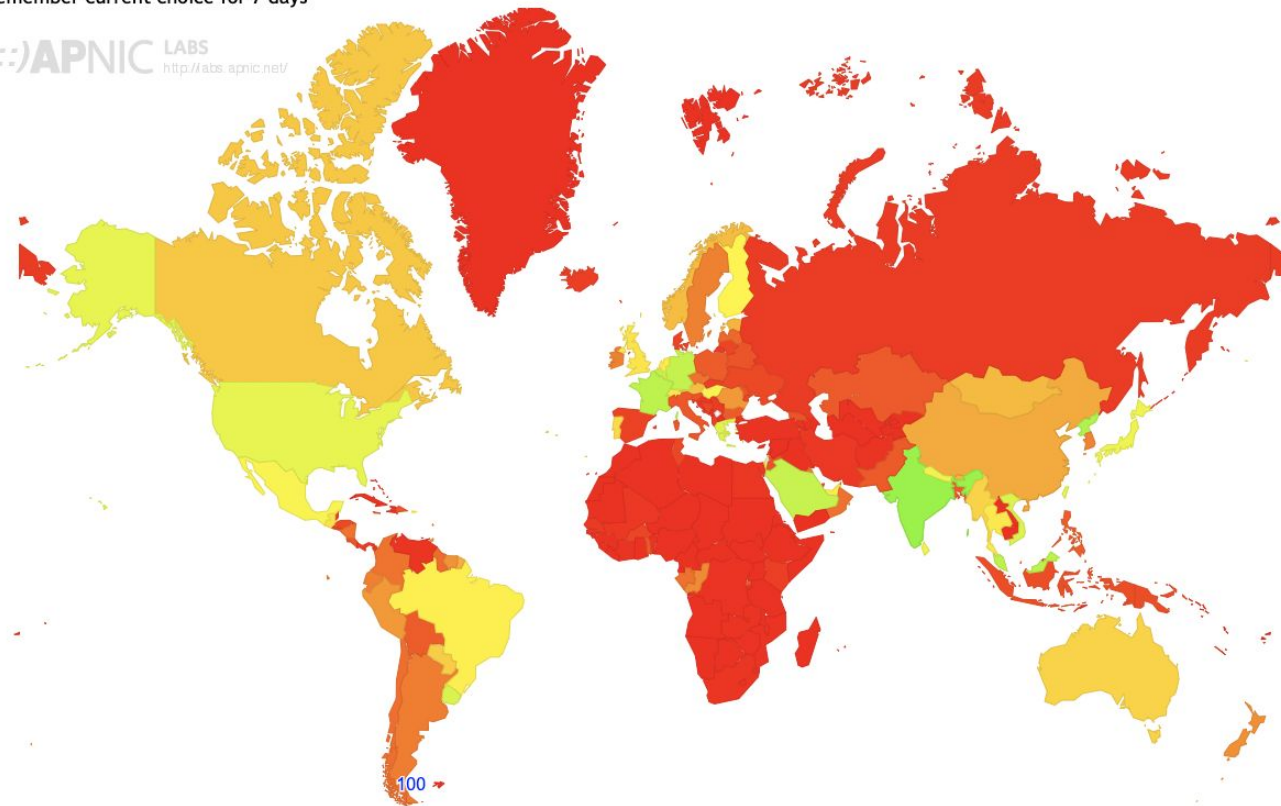
<https://stats.labs.apnic.net/ipv6>

IPv6 Capable Rate by country (%)

[Click here for a zoomable map](#)

Remember current choice for 7 days

(::)APNIC LABS
<http://labs.apnic.net/>



IPv6 traffic continues to grow

APNIC measurements

Use of IPv6 for France (FR)



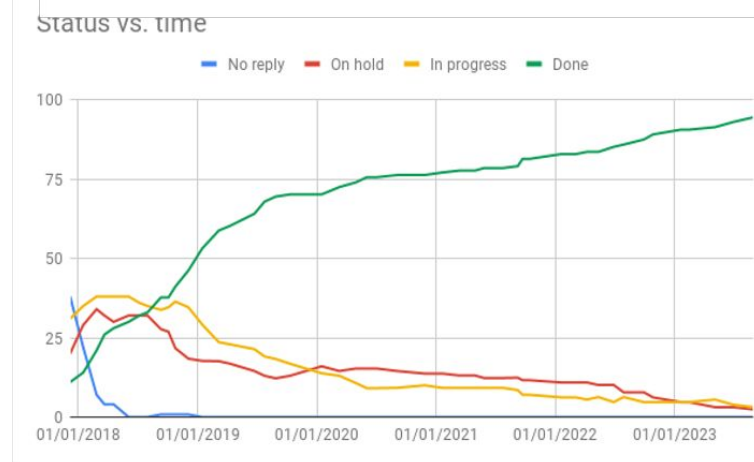
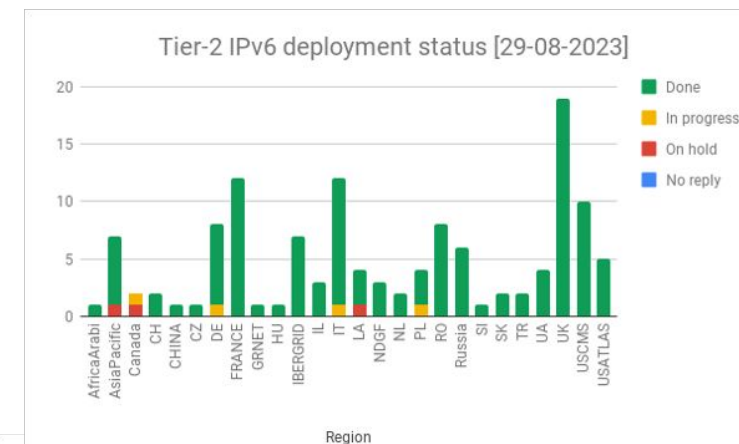
IPv6 working group - meetings

- See <https://indico.cern.ch/category/3538/>
- Since Oct 2023
 - In person - 22-23 November 2023 - Jisc offices, London
 - After UK IPv6 Council meeting (Bruno Hoelt gave a presentation)
 - <https://www.ipv6.org.uk/2023/09/19/ipv6-council-annual-meeting-2023/>
 - In person - 5-6 March 2024 - at CERN
 - One-hour Zoom meetings: 13 Dec, 18 Jan, 25 Jan, 1 Feb, 6 Feb, 15 Feb, 20 Feb (frequent meetings to plan for monitoring during WLCG DC24)

Dual-stack storage (Oct 2023) (No change since then)

- Tier-1 complete
- Tier-2 deployment from Nov17
- ([status](#)) shows >94% T2 sites
- **97%** of Tier-2 storage dual stack

Experiment	Fraction of T2 storage accessible via IPv6
ALICE	91%
ATLAS	95%
CMS	100%
LHCb	100%
Overall	97%



Dual-stack CPU and WNs

- Proposed to and approved by WLCG MB
- GGUS ticket campaign started end of 2023 - target date 30 June 24
- See next talk by Andrea Sciaba for all details.

Drivers for use of IPv6 (and IPv6-only)

- Sites running out of routable IPv4 addresses (avoid NAT)
 - Use IPv6 addresses for external public networking
- To be ready to support use of IPv6-only CPU clients
- There are **other drivers** for IPv6:
 - scitags.org – packet marking (in header of IPv6 packets)
 - Research Networking Technical Working Group ([RNTWG](#))
 - USA Federal Government – [directive](#) on “IPv6-only” (Nov 2020)

WLCG - from dual-stack to IPv6-only (CHEP2019) <https://doi.org/10.1051/epjconf/202024507045>

- Planning for an **IPv6-only** WLCG
- To **simplify** operations
 - Dual-stack infrastructure is the most complex
 - Dual-stack is less secure
- Large infrastructures (e.g. Facebook, Microsoft,...) use IPv6-only internally
- The goal we are working towards
 - IPv6-only for the majority of WLCG services and clients
 - Do we support IPv4-only clients? - still to be decided
 - Plan that this will not be needed
- Timetable still to be defined and agreed with Management Board
 - but before HL-LHC starts is a good target

WLCG DC24 - Feb 2024 - IPv6 R&D

Use of IPv6 during DC24

A network R&D project was proposed and approved

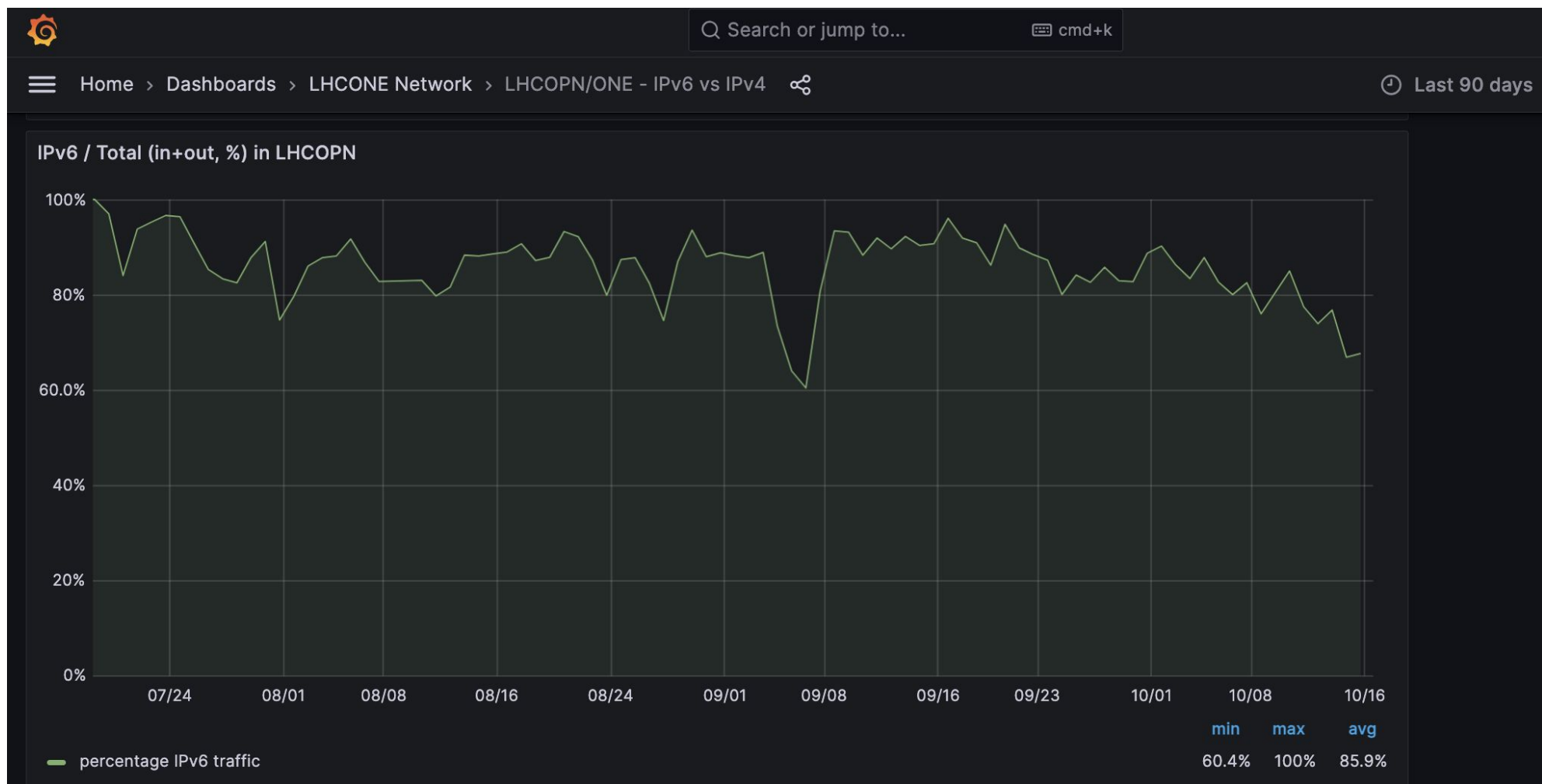
- Inspect traffic the CERN-KIT LHCOPN link to determine remaining use of IPv4
- Identify how remaining use of IPv4 can be removed, and all traffic be IPv6
- Establish a proposal for making specific links IPv6-only

So - we monitored use of IPv4 and of IPv6 during DC24

Good news - traffic was mostly IPv6 (but not all)

LHCOPN %IPv6 at CERN – Aug to Oct 2023

(IPv4 only CPU will be a reason – deploy dual-stack!)

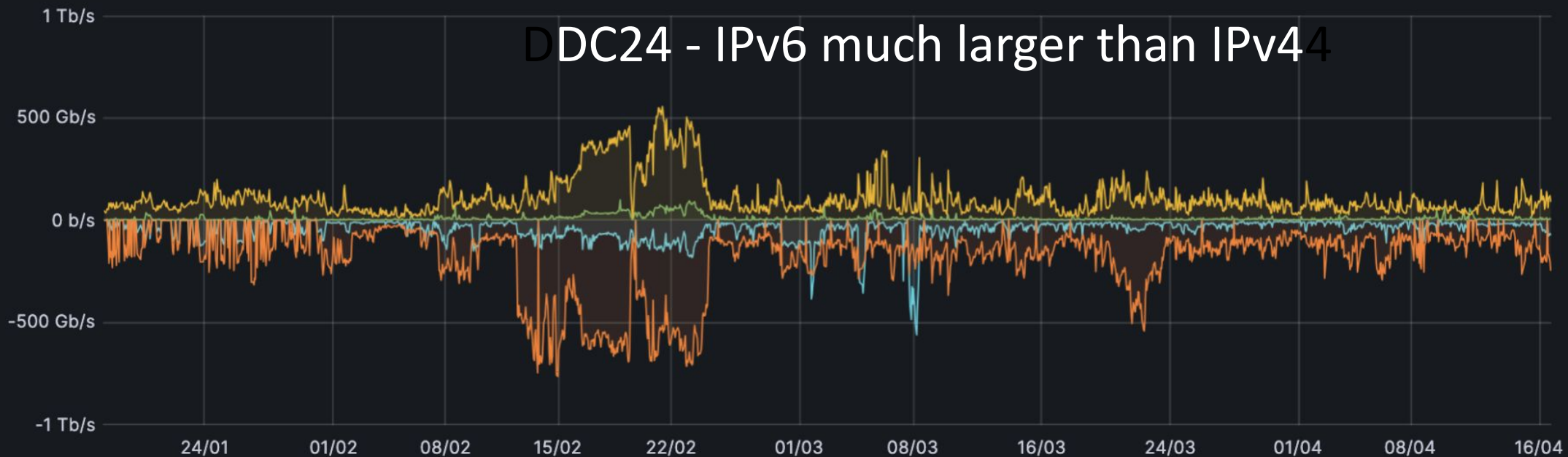




- CA-TRIUMF, DE-KIT, ES-PIC, FR-IN2P3, IT-INFN-CNAF, NDGF, NL-T1, PL-NCBJ, RU-JINR, RU-KI, UK-RAL, US-BNL, US-FNAL

IPv4 vs IPv6 in LHCOPN

DDC24 - IPv6 much larger than IPv4



	min	max	avg
In IPv4 to CERN	587 Mb/s	100 Gb/s	10.9 Gb/s
In IPv6 to CERN	11.7 Gb/s	556 Gb/s	112 Gb/s
Out IPv4 from CERN	0 b/s	560 Gb/s	44.2 Gb/s
Out IPv6 from CERN	0 b/s	763 Gb/s	189 Gb/s



At LHCOPN/ONE meeting last week

Analysis of LHCONE traffic during WLCG DC24 (by GEANT)



DC24 top-talkers

Source Route Prefix/LEN	Source AS Number	Site	Destination AS Number	Destination Route Prefix/LEN	Average Gbits/s
128.142.0.0/16 (1.net.cern.ch)	European Laboratory for Particle Physics (CERN)	AS513 GEN	Janet (JISC) AS786	130.246.0.0/16 (-)	127.48
2001:1458::/32 (-)	European Laboratory for Particle Physics (CERN)	AS513 GEN	Janet (JISC) AS786	2001:630::/32 (-)	77.39

Large IPv4 traffic - CERN to RAL.

Transfers to WNs (see talk by Martin Bly - IPv6 being deployed)

IPv6 traffic is CERN to UK (Imperial London or RAL)

Summary

- WLCG supports IPv6-only clients
- Tier-1s: complete; Tier-2s: 97% storage is IPv6 capable
- Most data transfers use IPv6
- We have concentrated on “ensuring” use of IPv6, e.g. during DC24
 - LHCOPN/LHCONE can be 95% IPv6 - **but not always!**
- Dual-stack CPU and WN campaign is underway and going well
 - see next talk by Andrea Sciaba
- End point is still IPv6-only services (IPv4 is “legacy” networking)
- **Deploy IPv6 wherever you can and ensure it is being used!**

More information

Some papers from the HEPiX IPv6 working group

a) *“IPv6 Security”*

- M Babik et al 2017 J. Phys.: Conf. Ser. 898 102008
- <http://dx.doi.org/10.1088/1742-6596/898/10/102008>

b) *“IPv6 in production: its deployment and usage in WLCG”*

- M Babik et al, EPJ Web of Conferences 214, 08010 (2019)
- <http://dx.doi.org/10.1051/epjconf/201921408010>

c) *“IPv6-only networking on WLCG”*

- M Babik et al EPJ Web of Conferences 245, 07045 (2020)
- <http://dx.doi.org/10.1051/epjconf/202024507045>

d) *“Overcoming Obstacles to IPv6 on WLCG”*

- M Babik et al, EPJ Web of Conferences (to be published CHEP2023)



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Questions?