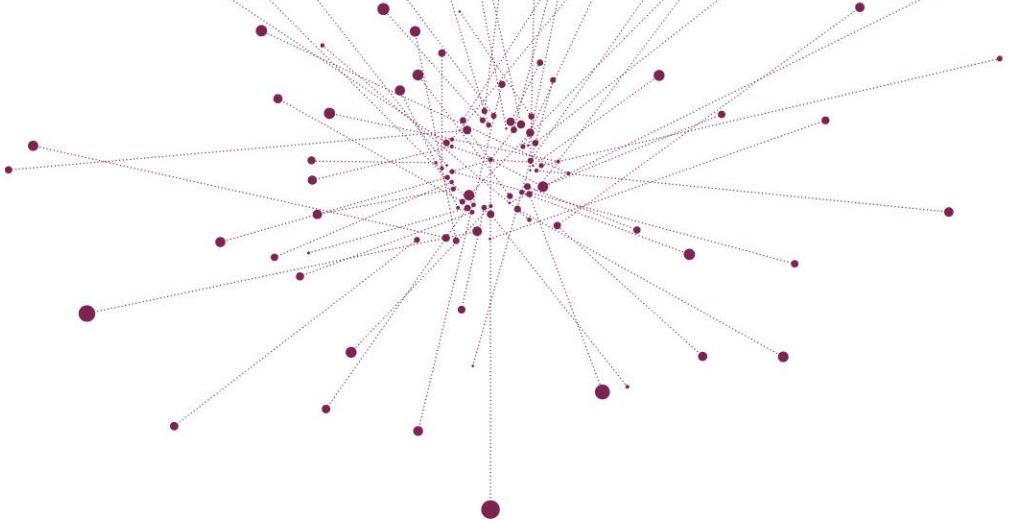

BEREC Workshop on IPv6 deployment across Europe

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BEREC introduction and opening of workshop

BEREC public technical workshop on IPv6 deployment across Europe
19.05.2021

Klaus Nieminen (Traficom, Finland)
Co-Chair of the BEREC Open Internet Working Group

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BEREC's mission

"BEREC aims at fostering the independent, consistent and high-quality regulation of digital markets for the benefit of Europe and its citizens."

(BEREC strategy 2021-2025)

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BEREC has NO FORMAL MANDATE in the domain of IPv6

BUT…

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BEREC's focus on IPv6

- BEREC's high-level strategic priorities:
  - promoting full connectivity
  - supporting sustainable and open digital markets
  - empowering end-users

- Public IP addresses are needed so that end-users can use and provide services of their choice and that the internet continues to function as an engine for innovation

- The RIPE NCC has run out of IPv4 addresses already in 2019 and transition to IPv6 is essential

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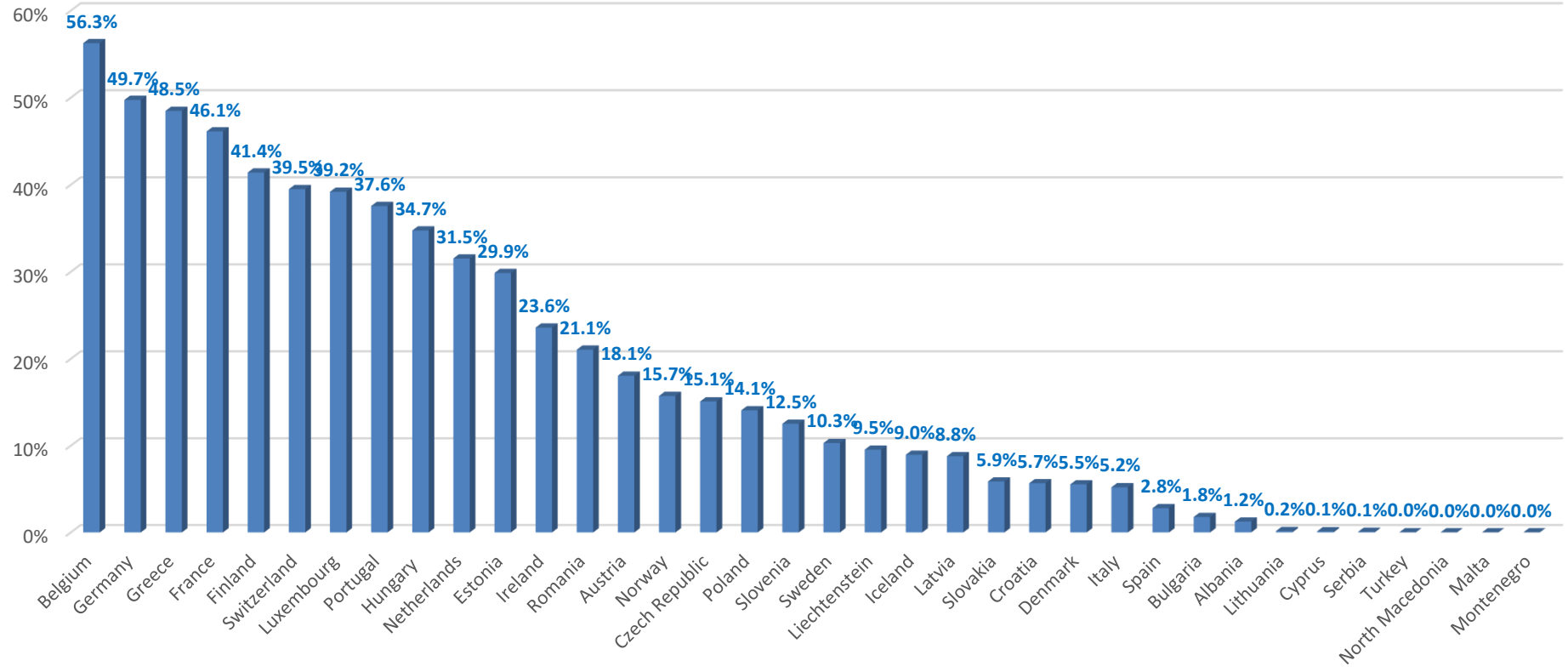
IPv6 deployment across BEREC+ (BEREC members and participants)



Source : "Google IPv6 adoption", "Facebook IPv6 adoption","Akamai IPv6 adoption" and " Apnic IPv6 preferred" median value as of mid-May 2021.

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Agenda

Wednesday, 19 May 2021

14.00	**Start of Meeting**
14.00-14.10	**BEREC introduction and opening of workshop** **Mr Klaus Nieminen (Traficom, Finland),** Co-Chair of BEREC Open Internet Working Group - current situation and BEREC's motivation vis-à-vis the importance of IPv6 roll-out **Mr Pierre Bonis,** CEO of Afnic, Brief introduction of speakers
14.10-14.20	**Presentation by Mr Marco Hogewoning, Manager of Public Policy and Internet Governance at RIPE NCC** Impacts of delayed transition to IPv6 – the cost of not doing IPv6
14.20-14.30	**Presentation by Ms Maarit Palovirta, Director of Regulatory Affairs at ETNO** State of play of IPv6 deployment in Europe – operators' perspective
14.30-14.40	**Presentation by Mr Paul Saab, Software Engineer at Facebook** Challenges and lessons learned by CAPs with respect to IPv6 transition
14.40-14.50	**Presentation by Ms Constanze Buerger, Information Technology Specialist at the German Federal Ministry of the Interior** IPv6 more than a technical issue in the public administration of Germany
14.50-15.00	**Presentation by Mr Matthew Ford, Technology Program Manager at Internet Society** National approaches to fostering IPv6 deployment
15.00-15.55	**Panel discussion led by Mr Bonis**
15.55-16.00	**Wrap up by Mr Bonis and closing remarks by Mr Nieminen**
16.00	**End of Webinar**

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RIPE NCC

RIPE NCC
RIPE NETWORK COORDINATION CENTRE

Impacts of Delayed Transition to IPv6

The cost of not doing IPv6

Marco Hogewoning | BEREC | 19 May 2021

What Was The Problem Again?

- An IPv4 address is 32 bits long
  - That gives you 2^32 = 4.2 billion unique addresses to choose from
- Within an IP network, each node needs its own unique address
  - The Internet is setup to behave as one global unfragmented network
  - Within the “network of networks” each participant needs its own unique addresses
- Ultimately the Internet only has 4.2 billion IPv4 addresses
  - And we have many many more nodes connected
  - At the registry level (IANA and RIR) there is no more unused space available
- Everybody knew this moment would come
  - It was first recognised in the early nineties, when Internet commercialised

The Solutions

- Initially some short term changes were introduced:
  - Leave the classful system for variable subnet lengths: reduce the “waste”
  - Introduce the needs-based allocation mechanism the RIRs applied
  - Repurpose network address translation techniques that existed already
    - Translating to/from non-unique or private address ranges to public space
    - “Oversubscribe” those translations, sharing one address between multiple nodes
- The longer term plan was a new protocol (IPng)
  - Develop and standardise a replacement for the IPv4 protocol
  - Ensure it scales up to beyond what is expected
  - Have the industry adapt and change to the new protocol, **in time for the run-out**

IPv6 in a Nutshell

- The next generation Internet Protocol was dubbed version 6
- Main feature is that it uses 128 bit addresses
  - 2^128 unique possibilities is a very very large number (3.4e38)
- It had other features, at the time considered optimisations
  - Extension headers allowed for new features to be introduced
  - More rigid structure designed to allow for faster switching
  - Some features got abandoned, in other areas technology caught up
- Designed to be a drop-in replacement for IPv4
  - **The transport layer and rest of the stack could remain in place unaltered**

The Real Challenge: Timing

- The design allowed and called for IPv4 and IPv6 to co-exist
  - It was deemed unfeasible to organise a “flag day” event and deploy all at once
  - The protocols are designed to be compatible, not interoperable
    - **They can exist at the same time in the same network**
    - They won’t get in each other’s way, they don’t notice each other
- The basic idea: if both nodes can use IPv6, use it!
  - As deployment progresses, the preference will be to use IPv6
  - IPv4 slowly disappears as every one prefers and is capable of using IPv6
- The question becomes: who goes first?
  - The benefit only becomes visible once the other party deploys

The Real Problem: Timing

- IPv6 was standardised right with the Internet boom (1995)
  - Everybody was in a rush to deploy, no time and money for “unproven” technology
  - The problem of running out of addresses was something of distant future
  - No immediate downsides on deploying IPv4
- The Internet changed towards a client-server model
  - The original idea of peer-to-peer is almost gone
  - This emphasised the “chicken and egg” problem of who goes first
- IPv6 got hit by a first mover disadvantage
  - You have to trust the others to also deploy IPv6 in your timeframe
  - If they don’t, your investment is worthless

The Situation Right Now

- The RIR system has run out of available IPv4 space
  - Waiting lists exist to distribute small portions (/24) of returned address space
- A secondary market has emerged, trading unused IPv4 space
  - Transfer the registration (uniqueness) of address blocks to another operator
  - Demand and supply determine the price of such transfers
  - RIRs register the transfer, but not involved in the market or valuations
- There is quite a lot of IPv6 “in use”
  - But is a very scattered landscape in markets and technologies
    - Rich countries mostly ahead of poorer ones, but not always(!)
    - Fixed lines ahead of mobile deployments, but in every market(!)

This Is No Longer a Technical Problem

- IPv6 has proven to work at scale on different technologies
  - Commercial deployments in DSL, DOCSIS, Fibre and 4G
  - All major software and hardware supports IPv6 out of the box
    - The huge exception is “smart” devices (embedded technology)
- Can argue it is not even an economical problem
  - It is true that IPv6 deployment will cost money
  - Planning ahead will greatly reduce those costs
  - Technology and speed upgrades provide a great opportunity to deploy
  - Lots of developing nations outperform developed ones (e.g. India)

Commercial Challenges

- There are no clear immediate benefits for the end user
  - We have gotten so used to NATs, we don’t notice what is missing
  - Performance and scalability of address sharing increased to not be a problem
- The expected return on investment is unclear and too far out
  - Especially when you are in a nearly saturated market
- The drawbacks that exist are external to the operator
  - Issues with attribution due to address sharing goes to LEAs
  - Barrier of entry exists mostly for newcomers, incumbents are fine
  - Whatever additional costs for IPv4 are carried by the user

IPv6 Becomes a Political Challenge

- The problem exists for future generations
  - Everybody who is “on the Internet” thinks they are fine
  - Not doing IPv6 hampers future growth and opportunities
    - This includes the technological space (e.g. IoT devices)
- The problem exists for the underserved
  - Connecting the unconnected becomes a real problem
  - Developing nations are at a massive disadvantage
    - Later to adopt the Internet, they have less IPv4 space available
    - The costs of obtaining IPv4 space or sharing makes it less affordable

The Cost of Not Doing IPv6

- We introduce or maintain barriers of entry
  - Software and protocols must assume addresses are shared
  - Any new network or service is forced to find some IPv4 addresses
- We greatly limit the market potential of the Internet
  - Especially towards unlocking new markets and emerging economies
- Access to IPv4 might become a privilege
  - Stakeholders feel they are “left out” because of scarcity and uneven cost distribution
  - You find new technologies proposed to challenge and replace IPv4
- You risk splitting the Internet over protocol boundaries

Questions

marcoh@ripe.net

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ETNO

IPv6 Deployment: ISP Perspective

ETNO-GSMA @BEREC workshop on 19 May 2021

@ETNOAssociation #ThinkDigital #ETNODigital

BEREC workshop

Content

1. Background
2. State of Play
3. Going forward?

Background to IPv6

- Not a new story: IPv4 addresses have been depleting for many years.
- Serious impacts, if IPv6 is not deployed in a timely manner.
- Impossibility to assign (IPv4) addresses to clients is a risk to business continuity.
- IPv6 is a catalyst of emerging services (IoT, intelligence transport services..), such a services can not be delivered without IPv6 resources.
- IPv6 adoption is a long-term project for a company and non-deployment can lead to critical issues when IPv6 will be massively adopted.

Deployment of IPv6 in Europe

- Since the early 2000s, most large operators have published their IPv6 deployment strategies.
- **Large majority of European ISPs has adopted IPv6 in dual stack IPv4/IPv6** e.g. Proximus, Telefonica, Deutsche Telekom, Orange… (https://www.akamai.com/uk/en/resources/our-thinking/state-of-the-internet-report/state-of-the-internet-ipv6-adoption-visualization.jsp)
- Hurdles remain: lack of convincing incentive to make the shift from IPv4 to IPv6.

The Need for IPv6 Going Forward

- The main message: ***IPv6 is not a constraint; it's a great business development opportunity.***
- Indeed, it will be a necessity for emerging services such as IoT and ITS, carried on next generation networks e.g. 5G.
- The huge expansion of these services means that connected devices requiring an IP address will need to have an IPv6 address.

How Can We Foster IPv6 Deployment?

- **Standards**: not all technologies are ready for IPv6.
- The standardisation effort is essential to ensure that all technologies, which will require IPv6, are ready.
- There is a role to play for network operators, service providers, and public decision-makers to drive this effort, with the **goal of ensuring interoperability**.

European Telecommunications
Network Operators' Association

GSMA

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FACEBOOK

IPv6@Facebook

A solution when the Internet is running out of room

Paul Saab
Engineering

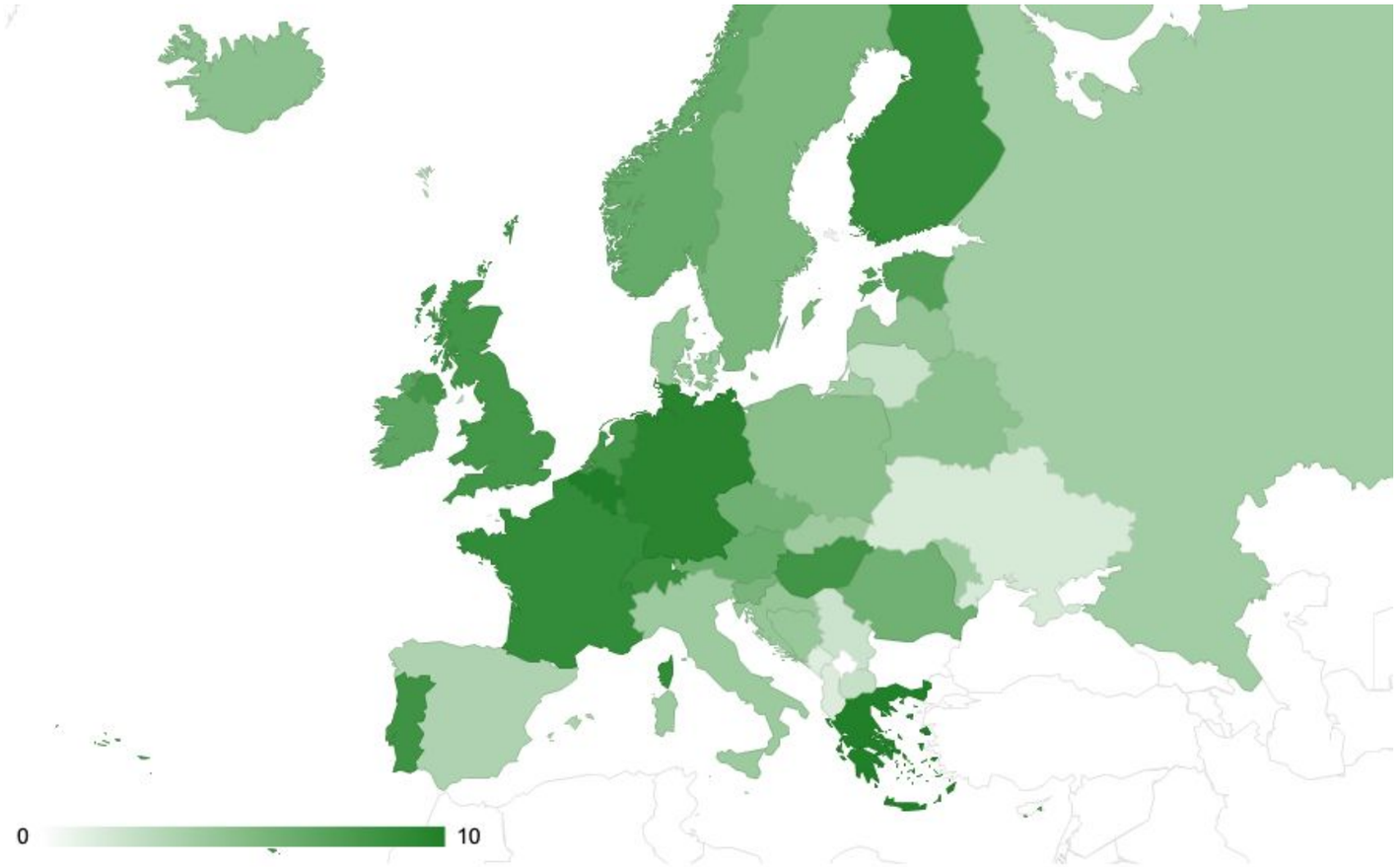
FACEBOOK Infrastructure


In 2015, IPv4 officially
ran out of new
addresses to allocate

Global IPv6 adoption is at 31.3% as of today (EU = 15%)

Source: https://www.facebook.com/ipv6/?tab=ipv6

European IPv6 Adoption (as of 1 May, 2021)



Source: https://www.google.com/intl/en/ipv6/statistics.html

Top IPv6 countries in EU
(5 out of global Top 10)

Germany	47.3% (top 10, #2)
Belgium	46.5 (top 10, #3)
Greece	43.9% (top 10, #5)
France	43.15 (top 10, #8)
Switzerland	41.7% (top 10, #10)
Hungary	33.1%
Luxembourg	32.6%

How Europe looks compared to other regions?

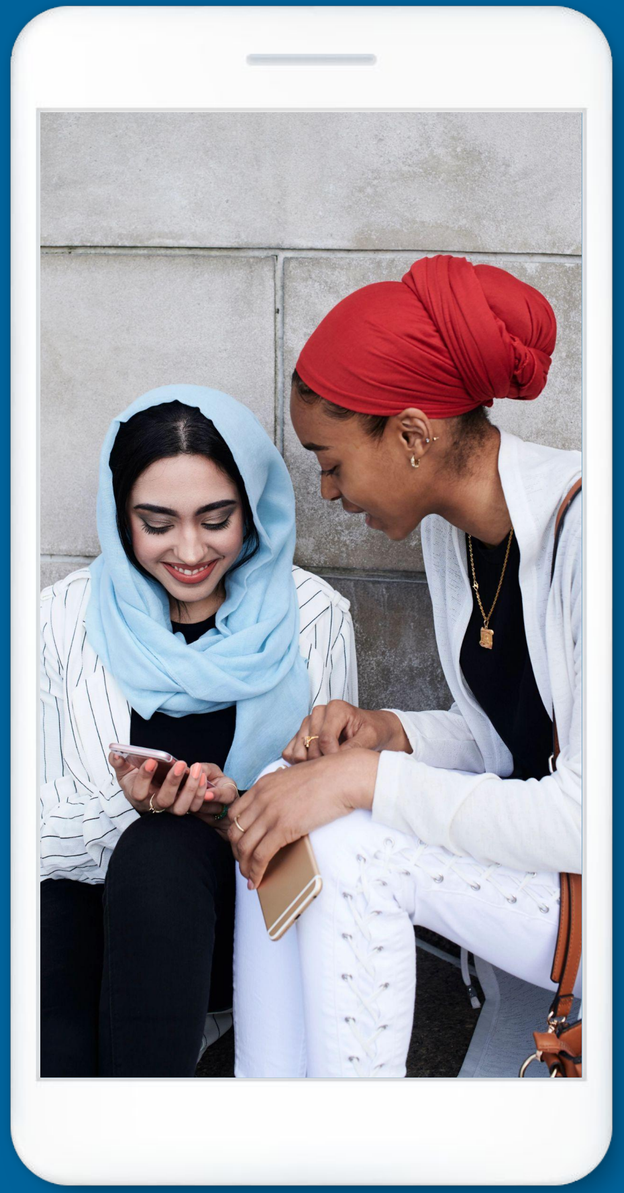
Africa	1.66%
Asia	13.65%
Oceania	3.91%
North America	32.97%
Central America	4.94%
Caribbean	2.76%
South America	13.34%

31%

Of the world reaches Facebook over IPv6 …
We would like this number to increase

~60%+

Of the United States reaches Facebook over IPv6 … India is #1 @ ~67% (*thanks to Reliance Jio*)



Source: https://www.facebook.com/ipv6/?tab=ipv6

Solving the Urban Bandwidth Challenge

Terragraph is a multi-node, wireless, mesh technology designed to meet the growing demand for reliable, high-speed internet access in urban and suburban environments. Using street-level mmWave radios, Terragraph leverages existing street furniture to create a wireless distribution network ideally suited for last-mile fixed access. Terragraph is able to deliver fiber-like connectivity to customers at a fraction of the cost of fiber.

terragraph helps Network Operators and Municipalities Solve the Urban Bandwidth Problem, Wirelessly

Delivers Wireless Gigabit Connectivity

Terragraph leverages millimeter wave frequency (60GHz) that delivers gigabit speeds to your customers when complimented with Fiber

Lowers Cost of Network Deployment

Terragraph nodes are designed to leverage street furniture, significantly reducing deployment costs compared to buried fiber.

Faster Time to Market

Deploy faster than any wireline service because it does not require costly right of way permissions

Scales up as Needed

Mesh technology and a purpose-built MAC layer enable Gbps connectivity over extensive geographic areas that easily scales as your demand grows

Mesh Network Design

Deploying a Terragraph mesh network allows for redundancy and automatic rerouting when disruptions are detected. Helping you provide consistent, reliable connectivity to your customers

terragraph: Industry's first IPv6-native Mesh Network

Facebook built end2end mmWave platform with Open/R, BGP peering and IPv6 data path

Barrier to Adoption

Legacy IPv4 switches

Unfamiliarity with IPv6

Lack of interest in existing deployments

Motivation for Adoption

IPv6 is inside the terragraph mesh network only

IPv6 datapath is Linux kernel and DPDK / VPP based and future-proof

terragraph helps with integration of legacy IPv4 networks

What can Operators do?

Leverage L2 / IPv4 tunneling, SRv6 / VxLAN and NAT64

Use terragraph tools for IPv6 deployments

Train from terragraph training and support programs

terragraph can accelerate IPv6 adoption in EU

While spectrum is the primary hurdle for Terragraph, IPv6 remains an another important one!

- **IPv6**
  - Realize that IPv4 exhaustion is real, cellular and mobile networks need widespread IPv6 adoption
  - Recognize that *patchworks* and *bandaids* do not work at scale, e.g., large-scale NAT
  - Most Silicon, HW and SW components in the network are already IPv6 enabled

- **Terragraph**
  - Multiple EU countries, e.g., Croatia, France, Greece and Netherlands are not yet open for unlicensed 60GHz and tracking Yellow from Terragraph perspective
  - Leverage success stories and reference deployments, e.g., Mikeduba in Hungary
  - Terragraph upper-stack / L3 code will be open sourced (following Open/R stack that is open-source already)
    - Enables open approach to accelerate IPv6 adoption in EU (as well as globally)

FACEBOOK Infrastructure

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GERMAN FEDERAL MINISTRY OF THE INTERIOR

Federal Ministry
of the Interior, Building
and Community

IPv6 more than a technical issue in the public administration of Germany

Berlin, 05/2021

Legal and political mandate

- Public administration has to provide IT-services
    - for everyone
    - everywhere
    - without discrimination

⇨ **to guarantee communication**

- Digitization needs more services and more devices
- The Internet (RFC 1918) „Address Allocation for Private Internets“ limits the limits the amount of internal IPv4 Addresses

⇨ **This makes IPv6 mandatory**

IPv6 strategy of the public administration of Germany

- Local Internet Registry (LIR) including organizational structure
- ::/23 IPv6 address space and corresponding address plan
- Public Administration Information Network
- 2020 -IPv6-Masterplan for the federal public administration itself
- Supporting documents

Federal Ministry
of the Interior, Building
and Community

LIR de.government

[de:government] addressing tomorrow

provision and management of *IPv6* & public *IPv4*-addresses & *ASNs*

BMI CI 5 - strategic LIR de.government

Bundesministerium des Innern, für Bau und Heimat

BDBOS - operative LIR de.government

Bundesanstalt für den Digitalfunk der Behörden und Organisationen mit Sicherheitsaufgaben

Sub Allocation n x ::/32

Sub LIR Bund (BDBOS)

NdB Netze des Bundes

Informations Technik Zentrum Bund

Auswärtiges Amt

Sub LIR BMVg

BMVg - strat. Sub-LIR

BWI op. Sub-LIR

ITSysBw op. Sub-LIR

Sub LIR PSN

BKA - strat. Sub-LIR

BKA op. Sub-LIR

BPol op. Sub-LIR

Sub LIR DRV Bund

Sub LIR BA

Sub LIR Konsens

KONSENS

17 Sub LIRs federal states

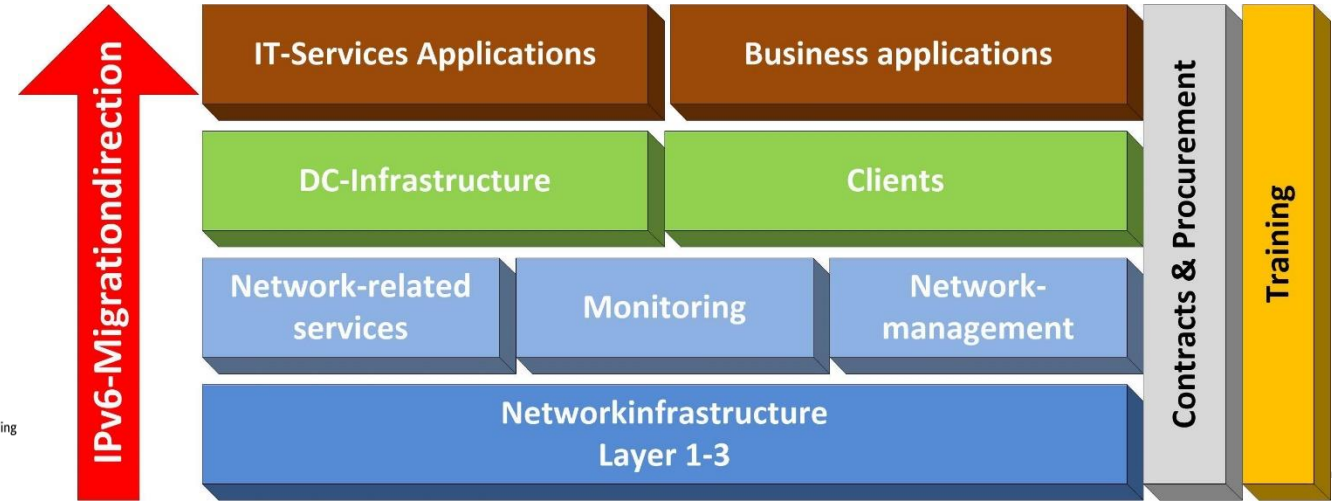
IPv6 AG

Expert working group of Sub-LIRs – coordinated by LIR de.government (BMI CI 5)

Federal Ministry of the Interior, Building and Community

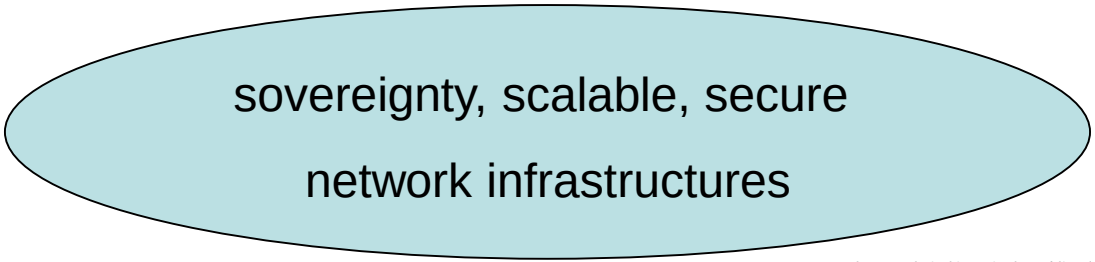
The need for IPv6 and its implications

- In contrast to IPv4, IPv6 forces to take a look at all OSI layers and overarching architectures
- This requires new forms of communication and collaboration
- Multi-stakeholder-based decision

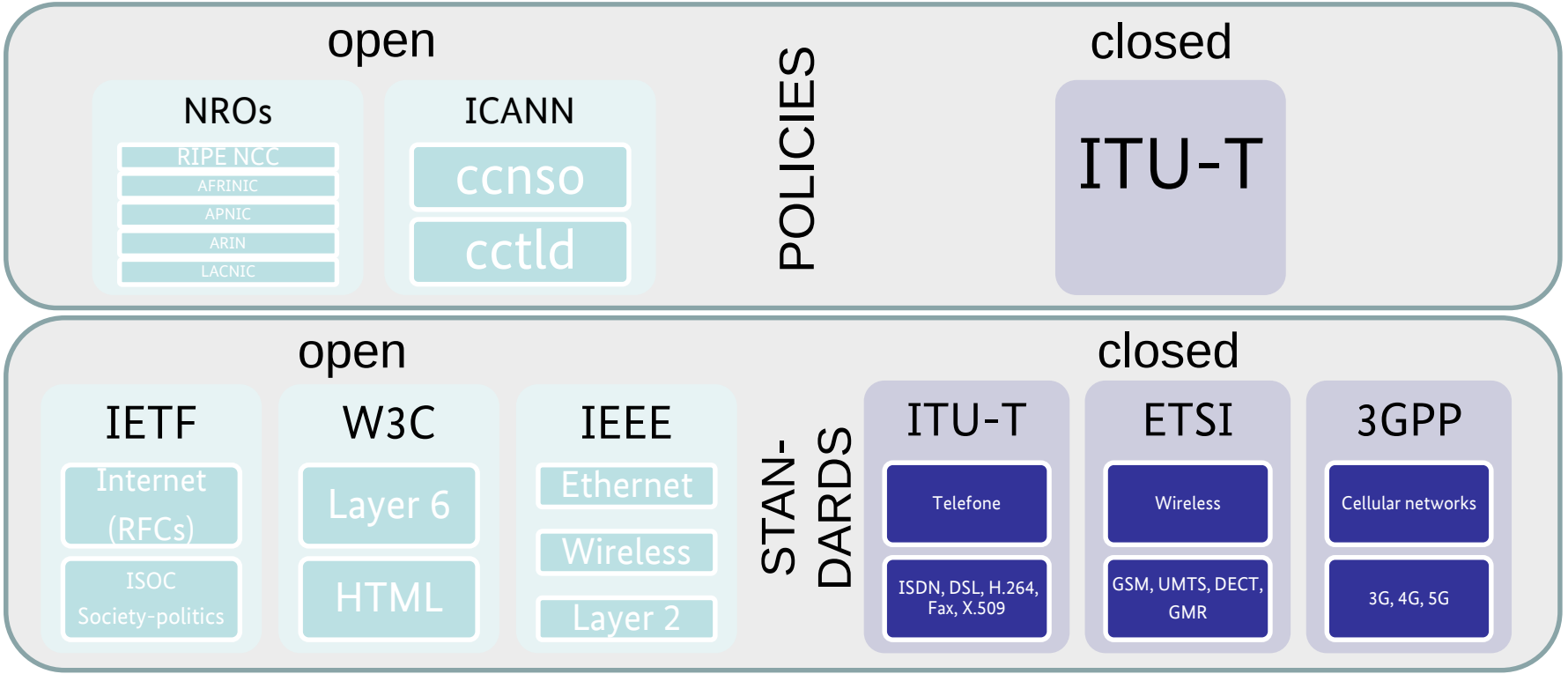


IPv6 is more than a technical issue

- IPv6 forces us to think beyond our organization / process
- We have to engage within the open multistakeholdergroups developing Internet standards and policies
- Today technical functions and code are implementing conventions and values of societies
- IPv6 leads to new fields of action in the standardization of IT networks for regulatory authorities as well as administration and politics



Policy and standards bodies



Thank you for your attention.

Contact

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Constanze.buerger@bmi.bund.de
CI5@bmi.bund.de

Federal Ministry
of the Interior, Building
and Community

[de:government]
addressing tomorrow

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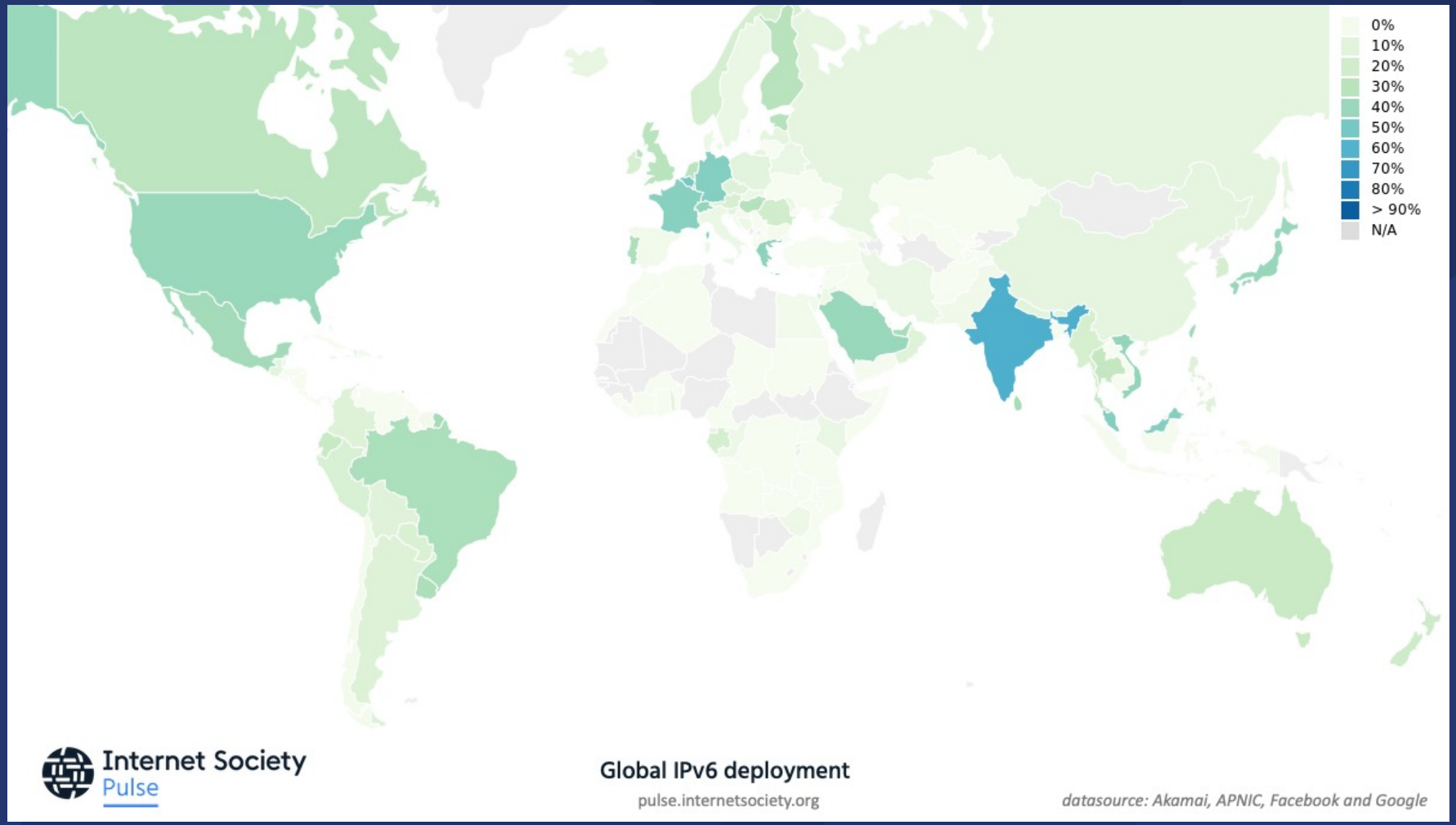
INTERNET SOCIETY

BEREC IPv6 Deployment Workshop
19 May 2021

National Approaches to Fostering IPv6 Deployment

Matthew Ford
Technology Program Manager
Internet Society
ford@isoc.org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Global IPv6 deployment
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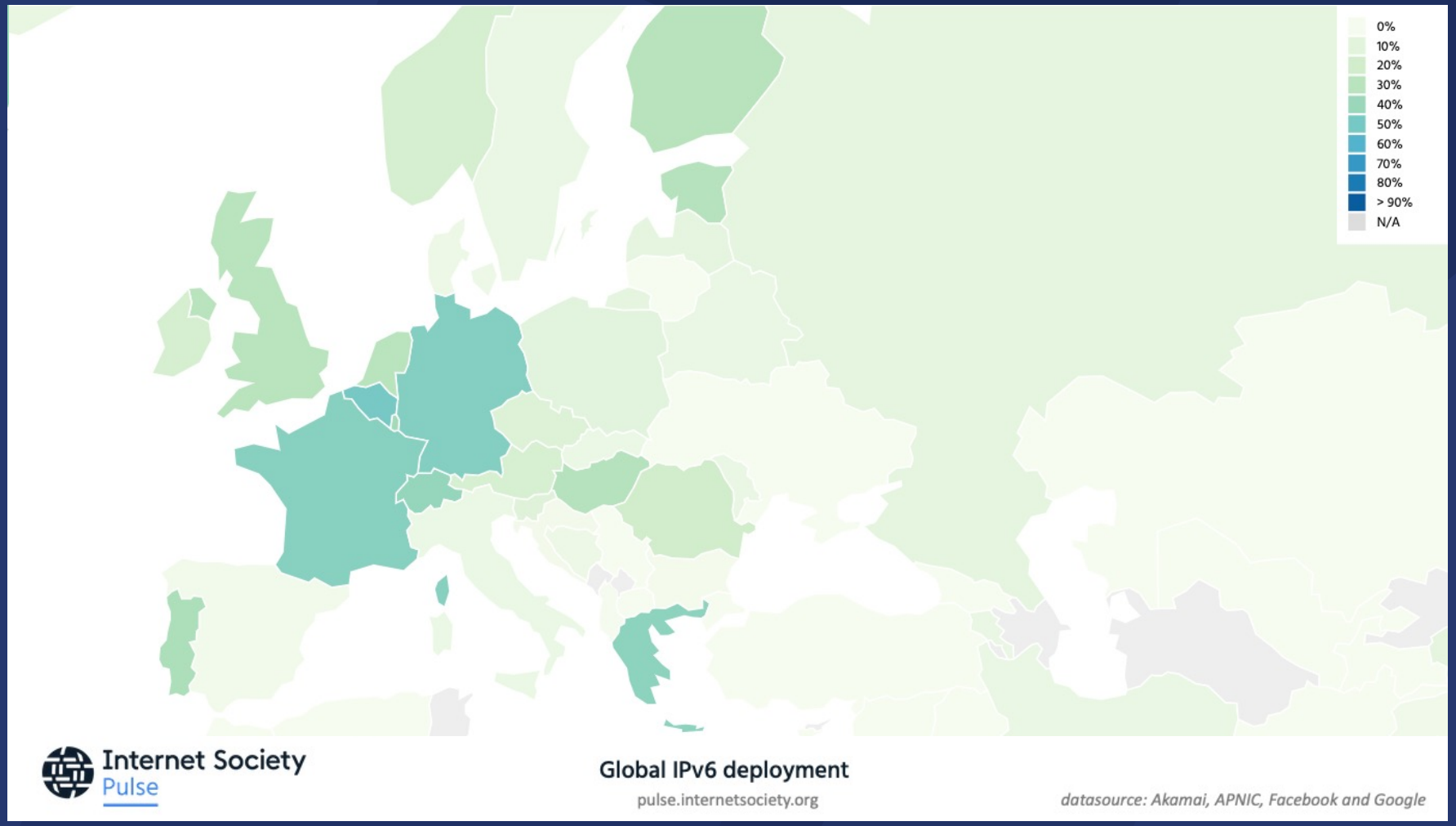
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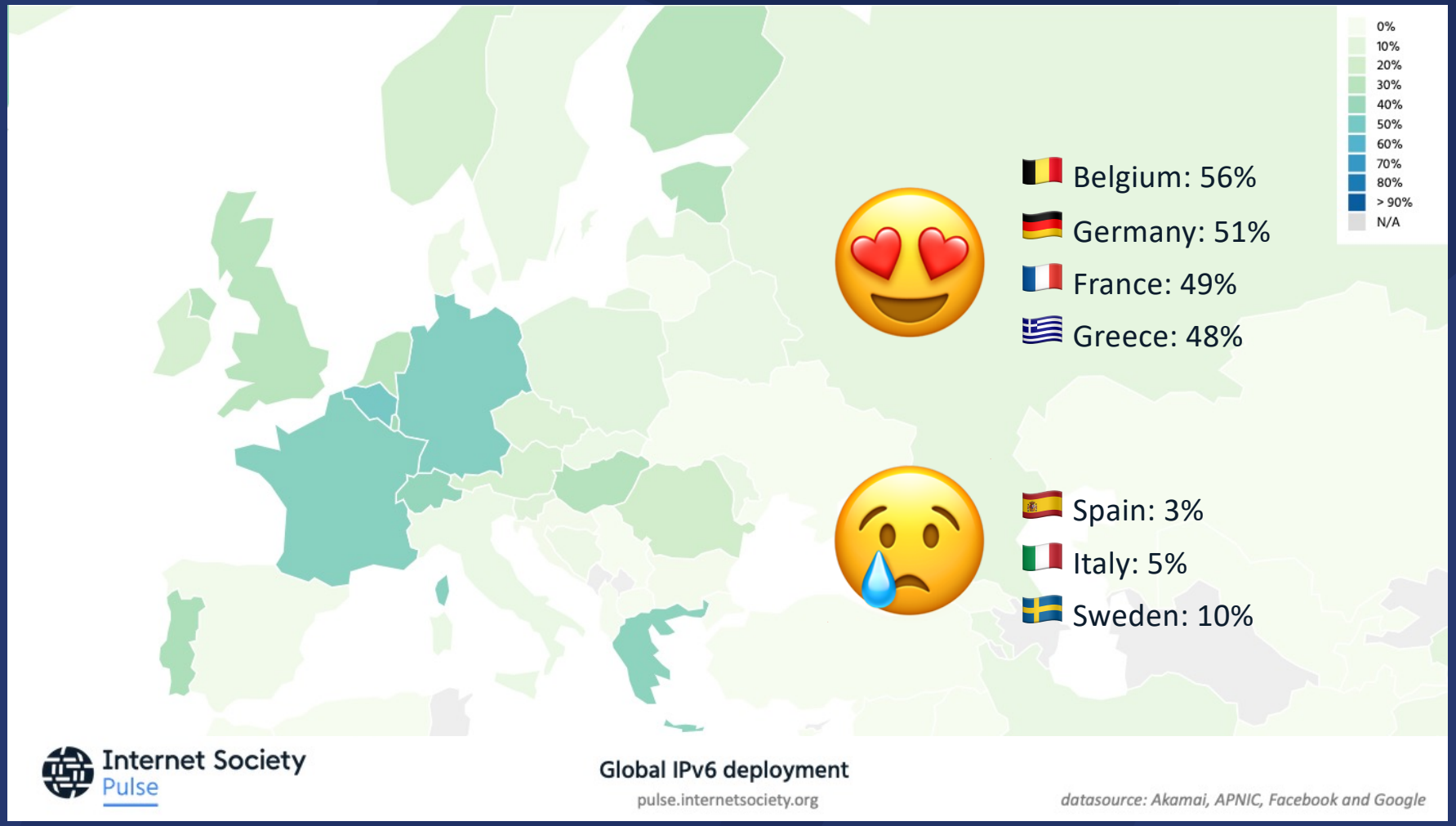
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Italy: 5%
Sweden: 10%
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datasource: Akamai, APNIC, Facebook and Google

Case Study: Belgium

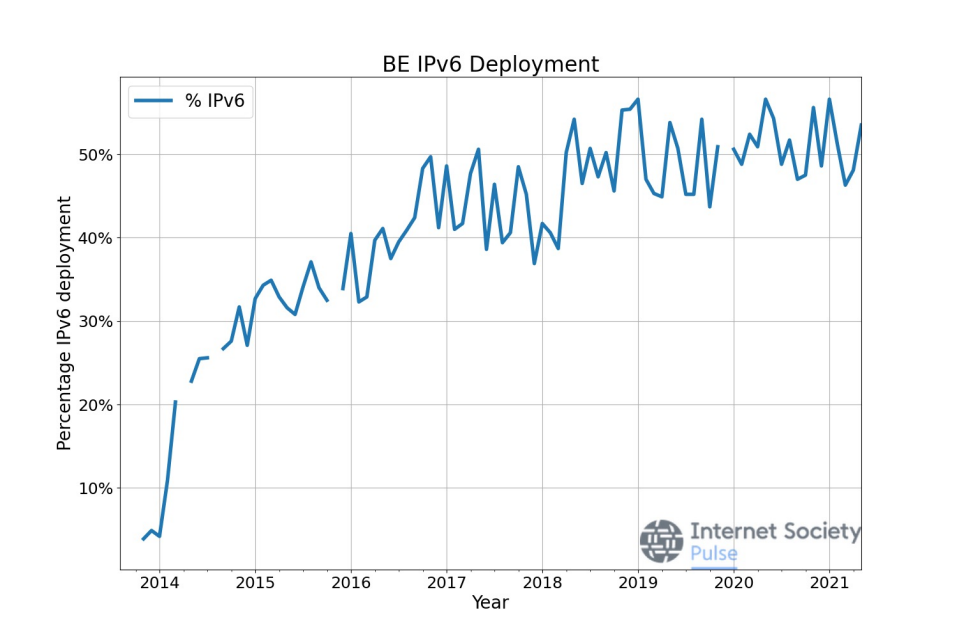
#1 for IPv6 deployment in Europe

Shortage of IPv4 addresses and regulatory limits on the use of CGN

Sharing of experiences and roadmaps at IPv6 Council meetings – strong spirit of collaboration

Mobile networks still lagging

Lesson: collaborative competition with regulatory impetus



Case Study: UK

UK IPv6 Council created in 2014 to promote IPv6 and share best practices

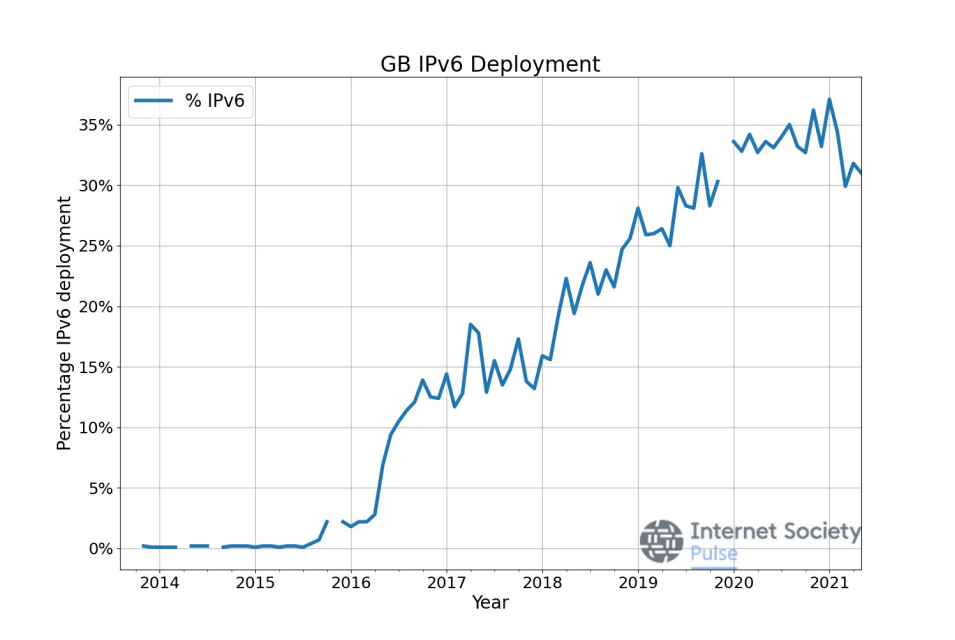
- Diverse core team membership: ISPs, content providers, enterprises, R&E
- Volunteers – no legal entity, relying on sponsorship and hosts to deliver free, public events

UK IPv6 growth started 2015

- Sky deployed dual-stack to 5M residential users
- BT deploying dual-stack
- EE has deployed to millions of mobile users IPv6-only using 464XLAT

IPv6 security topics draw the biggest audience

IPv6 cloud services growing in importance



Case Study: Saudi Arabia

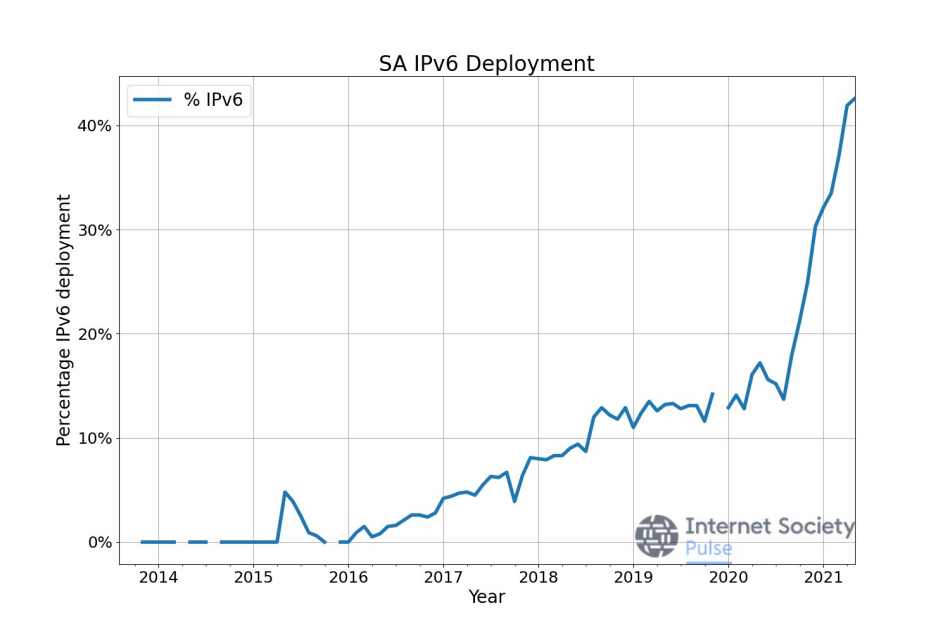
Regulator formed a taskforce including service providers and key institutions

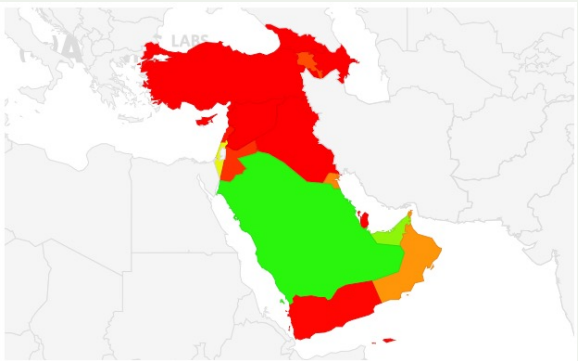
- Developed strategy focusing initially on core networks, ccTLD and training
- Published best practices and guidance for public and private orgs with deployment

From 2018, awareness that SA was falling behind in comparison to global adoption rates

- Redoubled efforts – more regular meetings, formalized regular KPI progress reporting
- RIPE NCC helped with case studies and workshops to discuss challenges openly and learn from others
- Solutions identified early in 2020, impact clear to see from adoption measurements

Saudi Arabia is now a leader in IPv6 adoption in the region





Data source: APNIC Labs

Conclusions

How to foster IPv6 deployment?

- Shortage of IPv4 addresses helps
- Regulation limiting the sharing of IPv4 addresses across subscribers helps

Key: formation of a collaborative/competitive environment with good information sharing

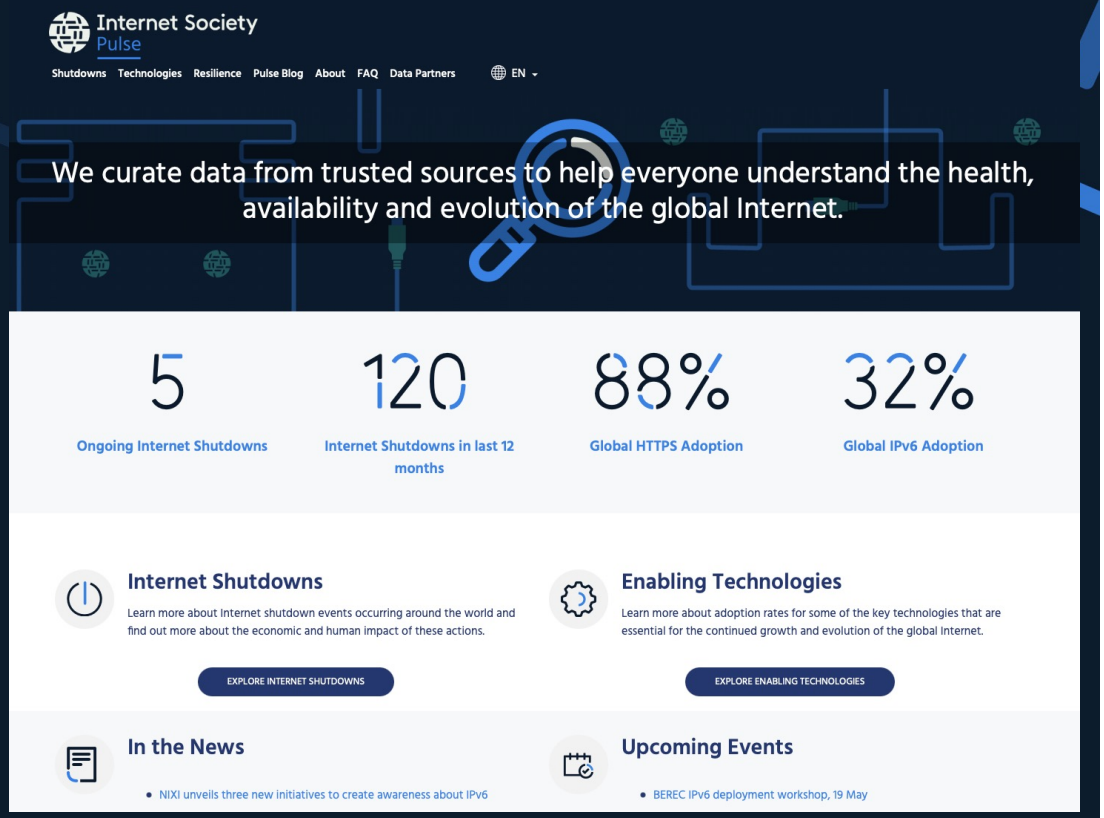
- Involve service providers, hosting providers, R&E networks, anyone with an interest
- Share information publicly wherever possible
- Vetted groups for information sharing among engineering teams using Chatham House rule
- Meet regularly and use the tools available to observe impact of actions and observe international shifts
- Document and share experiences and wins to encourage others

Thank you.

Web: pulse.internetsociety.org

Twitter: @isoc_pulse

Email: pulse@isoc.org



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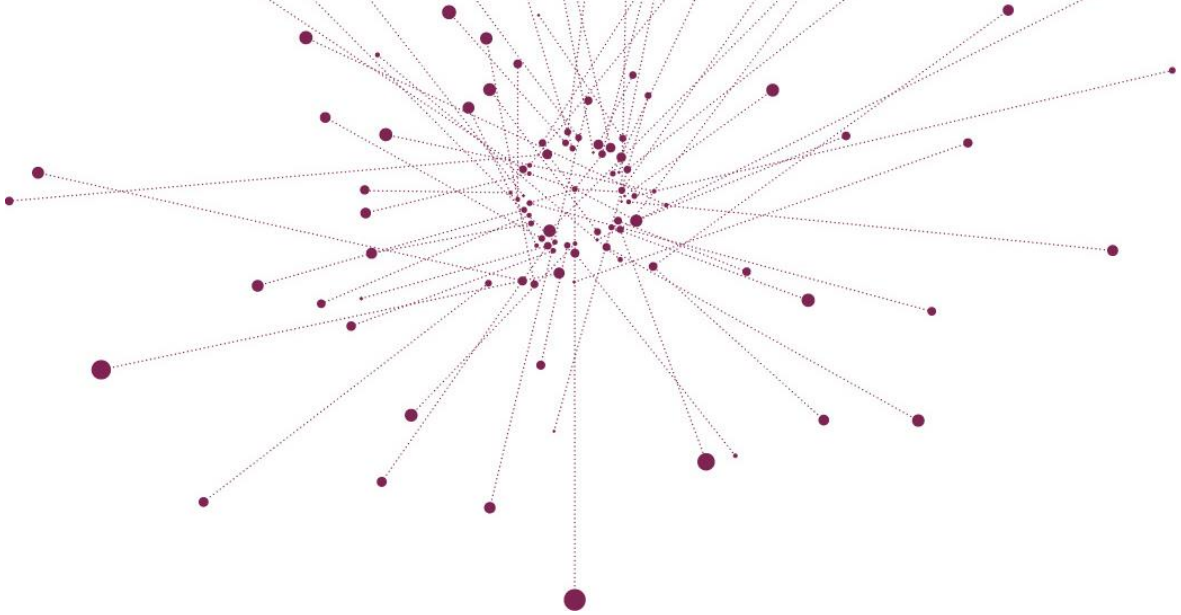
PANEL DISCUSSION



Thank you!

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