



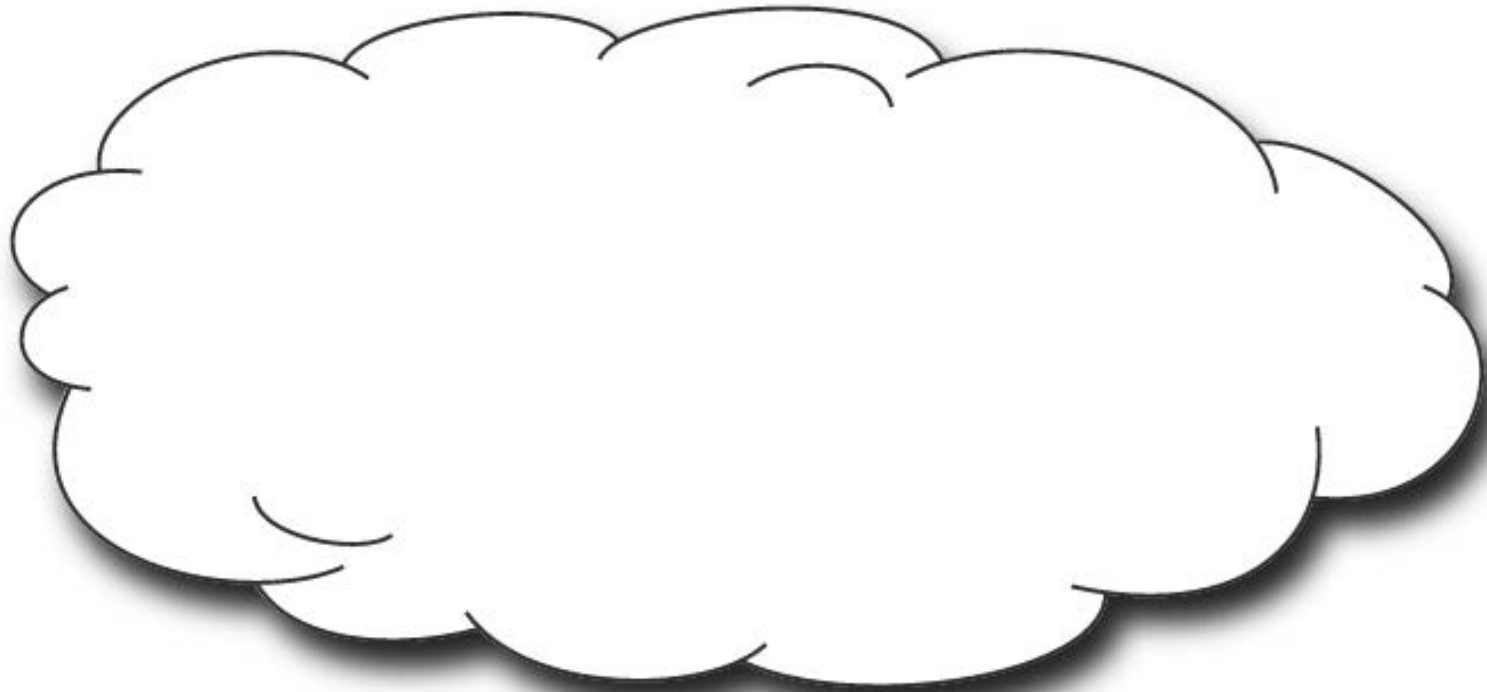
RIPE NCC

RIPE NETWORK COORDINATION CENTRE

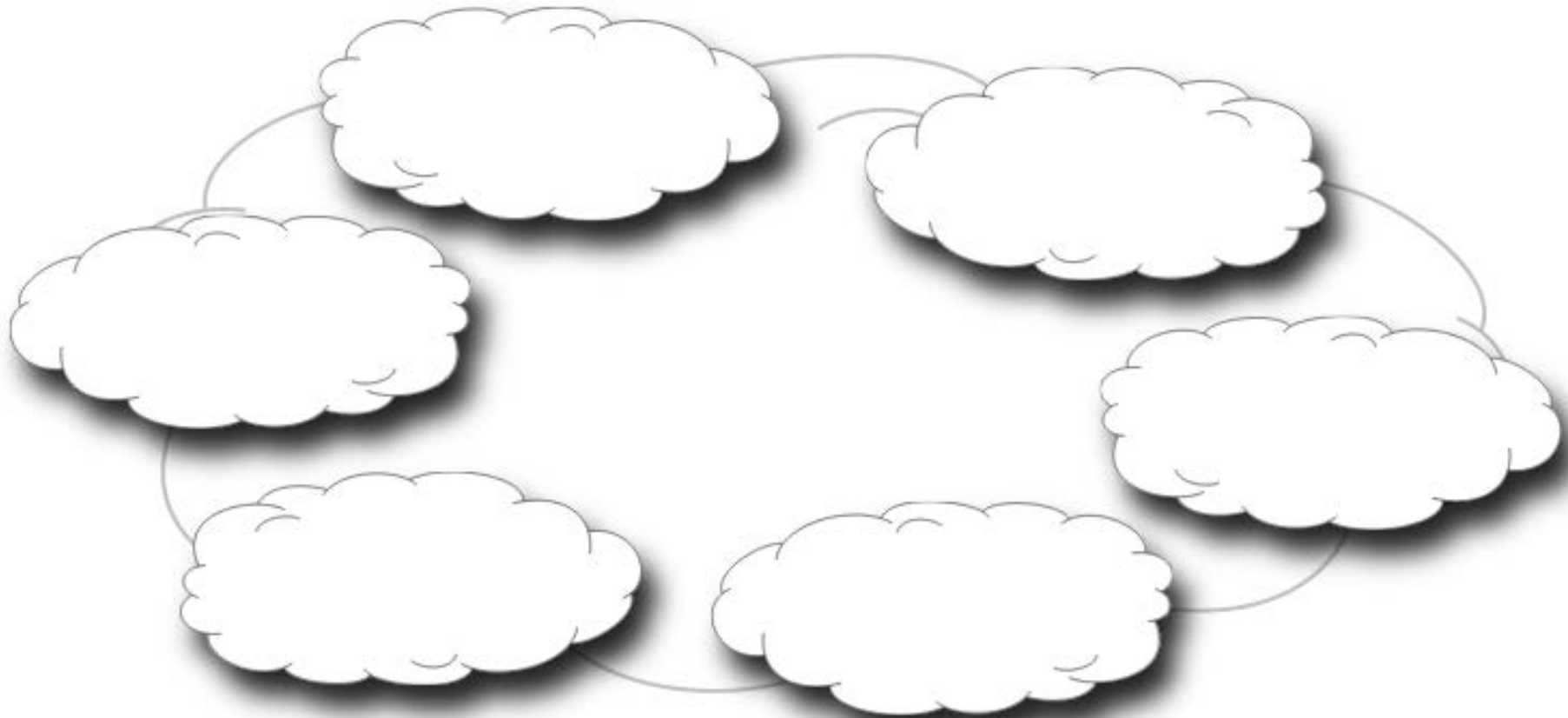
The Internet Ecosystem

Nov, 2018 | Sarajevo

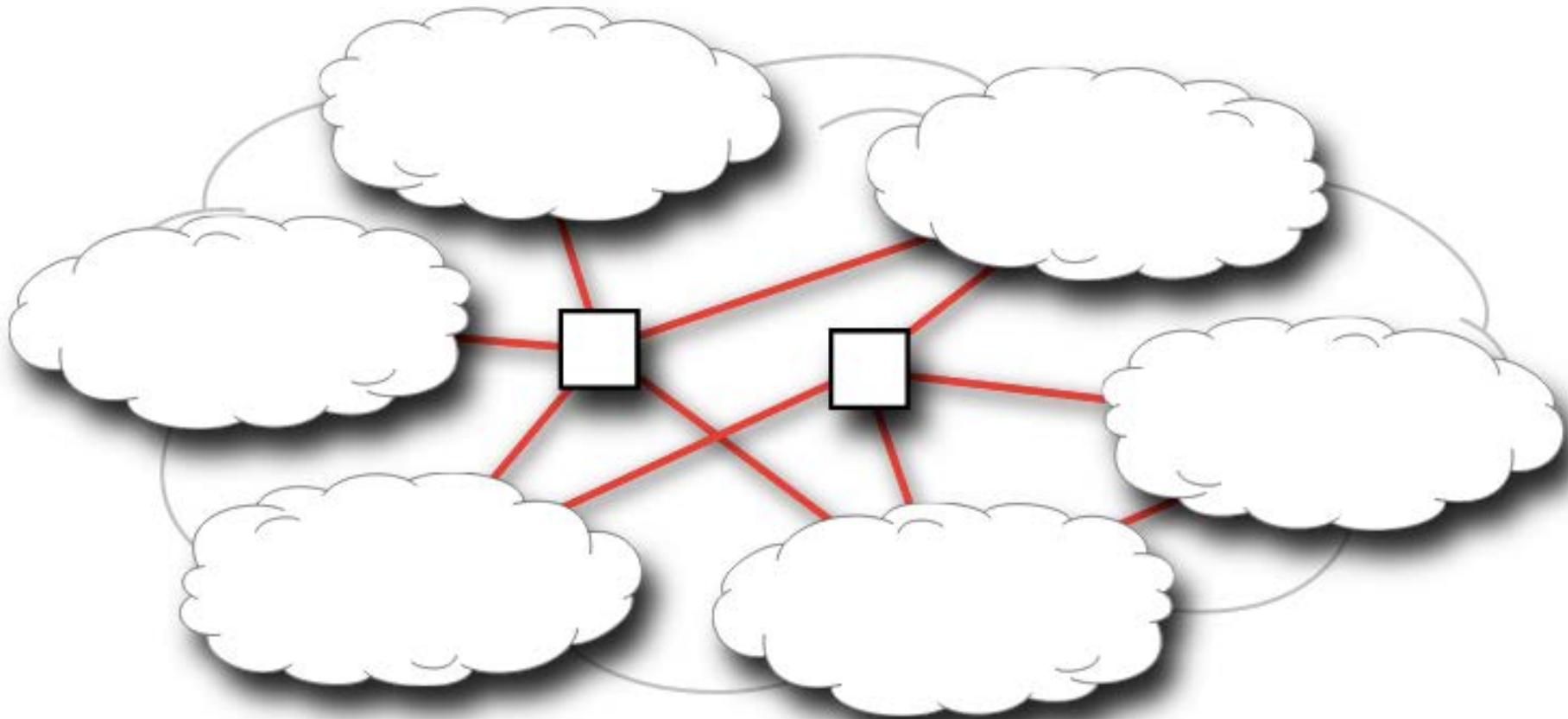
What is the Internet?



What is the Internet?



What is the Internet?



The Internet has roughly 60,000 autonomous networks that are interconnected.



Standards

Rules of Engagement

Standardising Organisations

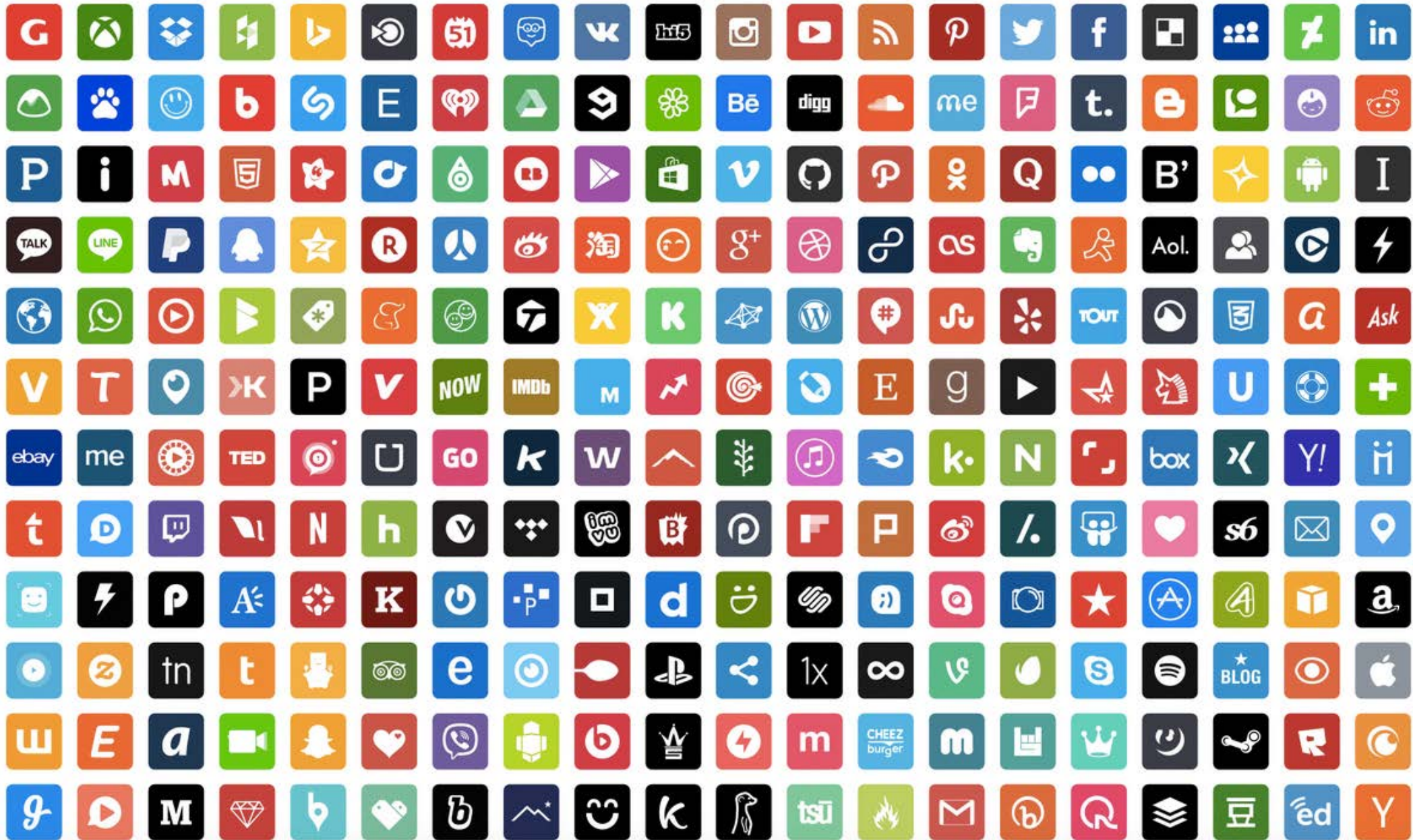


- The Internet Engineering Task Force
- They develop and promote voluntary Internet standards.
- It is an open standards organisation, with no formal membership.
- We believe in: rough consensus and running code.

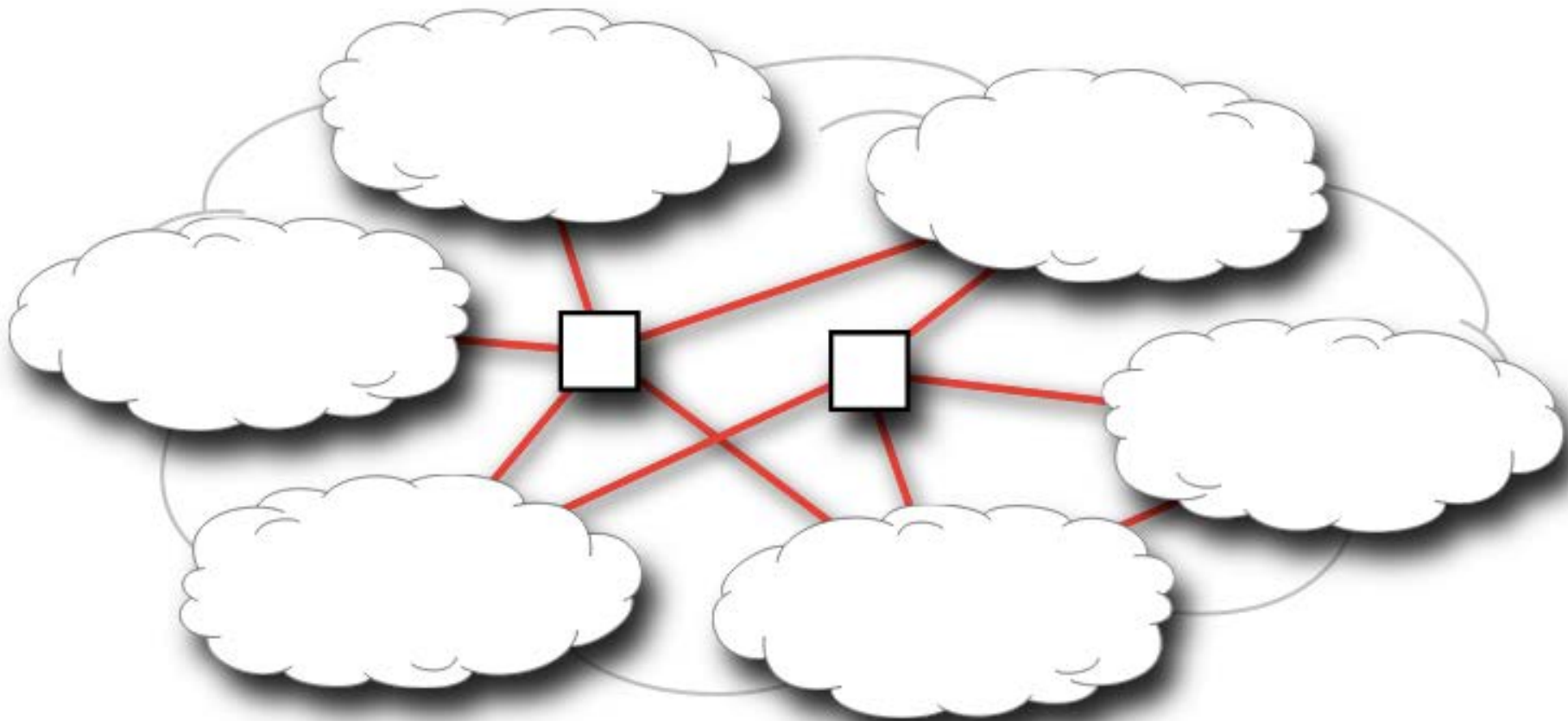
- The World Wide Web Consortium
- They develop open standards to ensure the long-term growth of the Web.



Permissionless innovation



What is the Internet?



The Internet has more than 3 Billion Internet users interconnected.



Identification

Sender and Receiver Addresses

Internet Number Resources



11000000000000000000000001000110101

192.0.2.53



11000000000000000000000001000110100

192.0.2.52

IP version 4 (IPv4)

- Initially deployed: 1 January 1983.
- IPv4 addresses are 32-bit numbers. (4.2 Billion)
- Still the most commonly used version.

Internet Number Resources



192.0.2.52



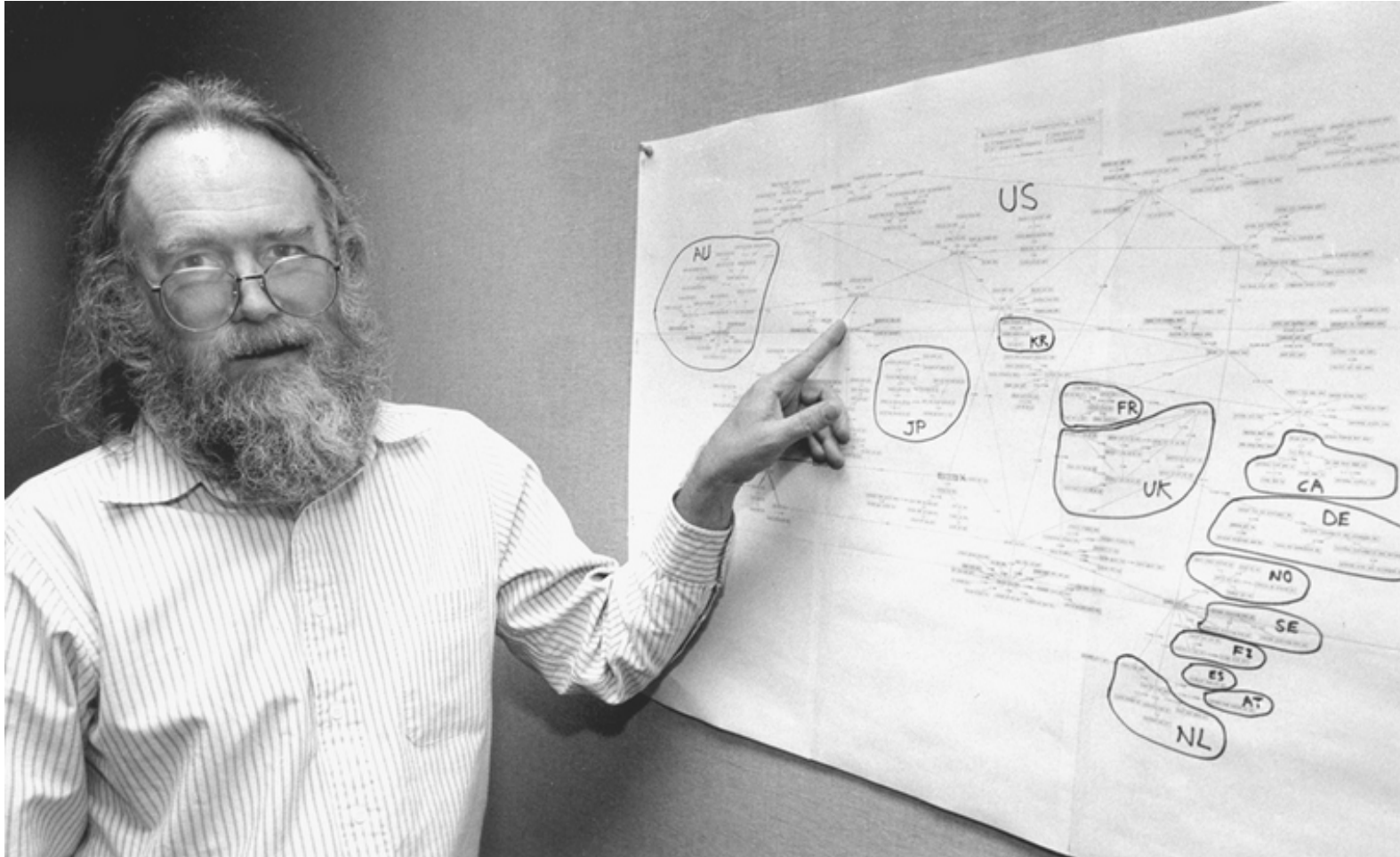
192.0.2.53



192.0.2.52



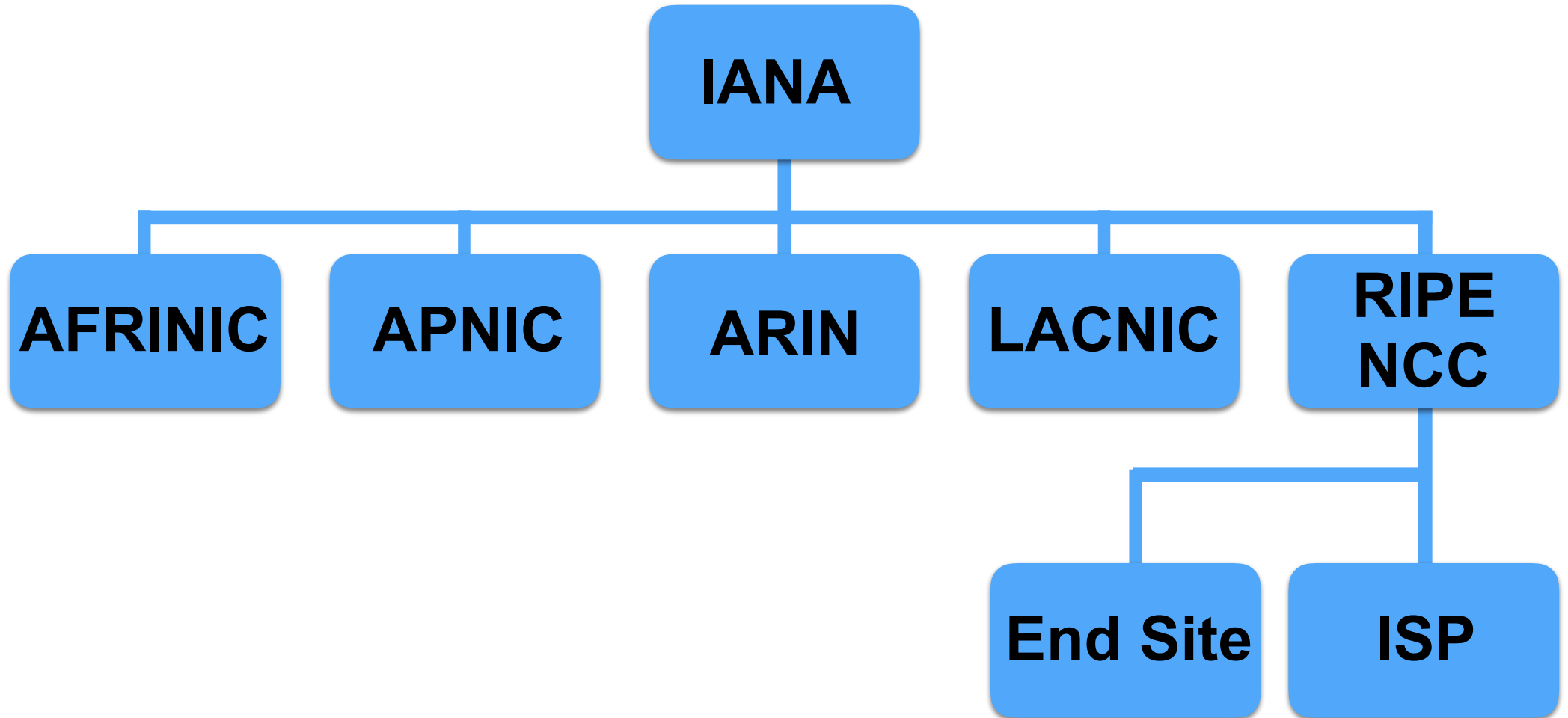
Internet Number Resource Management



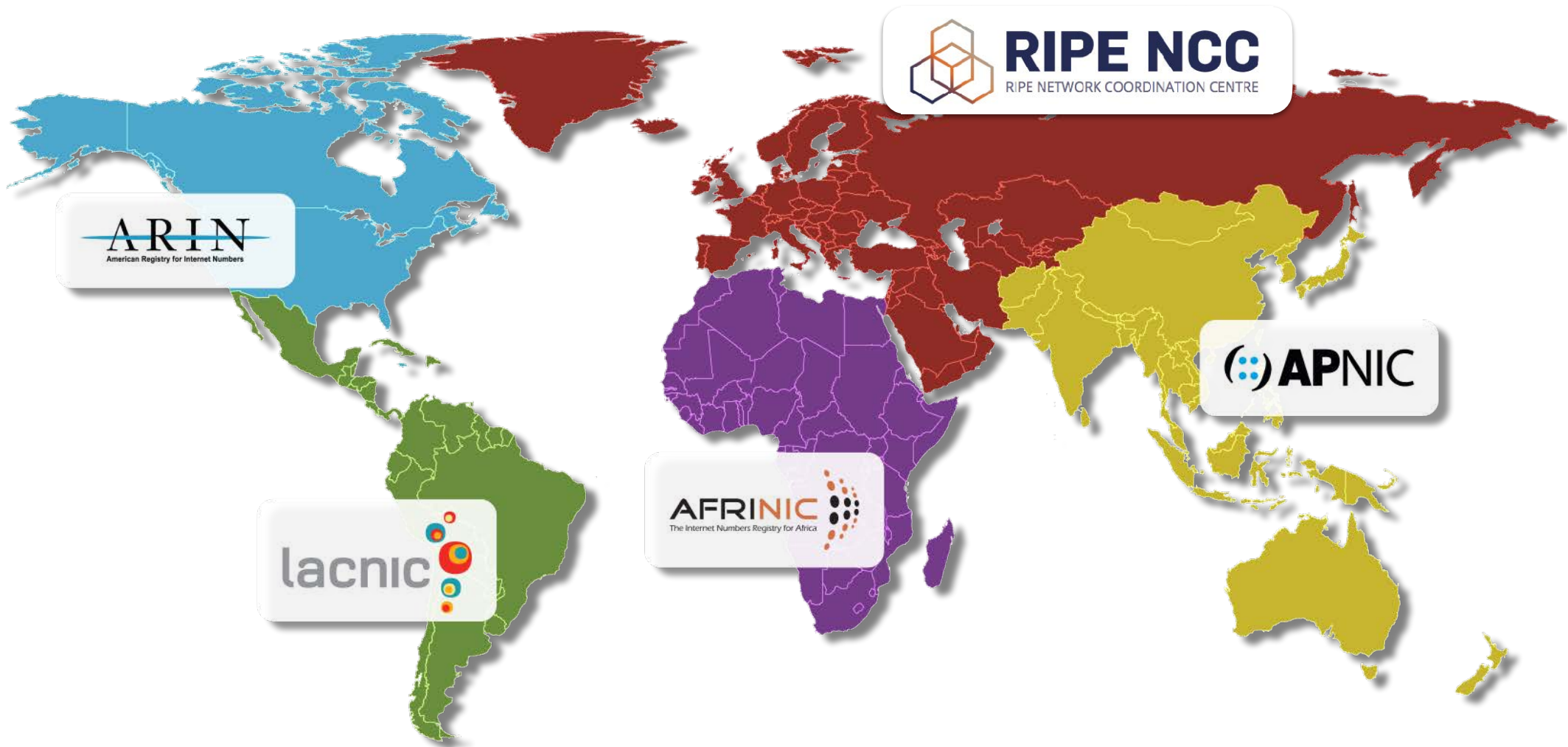
John Postal used to manually distribute IP addresses



Internet Number Resource Management

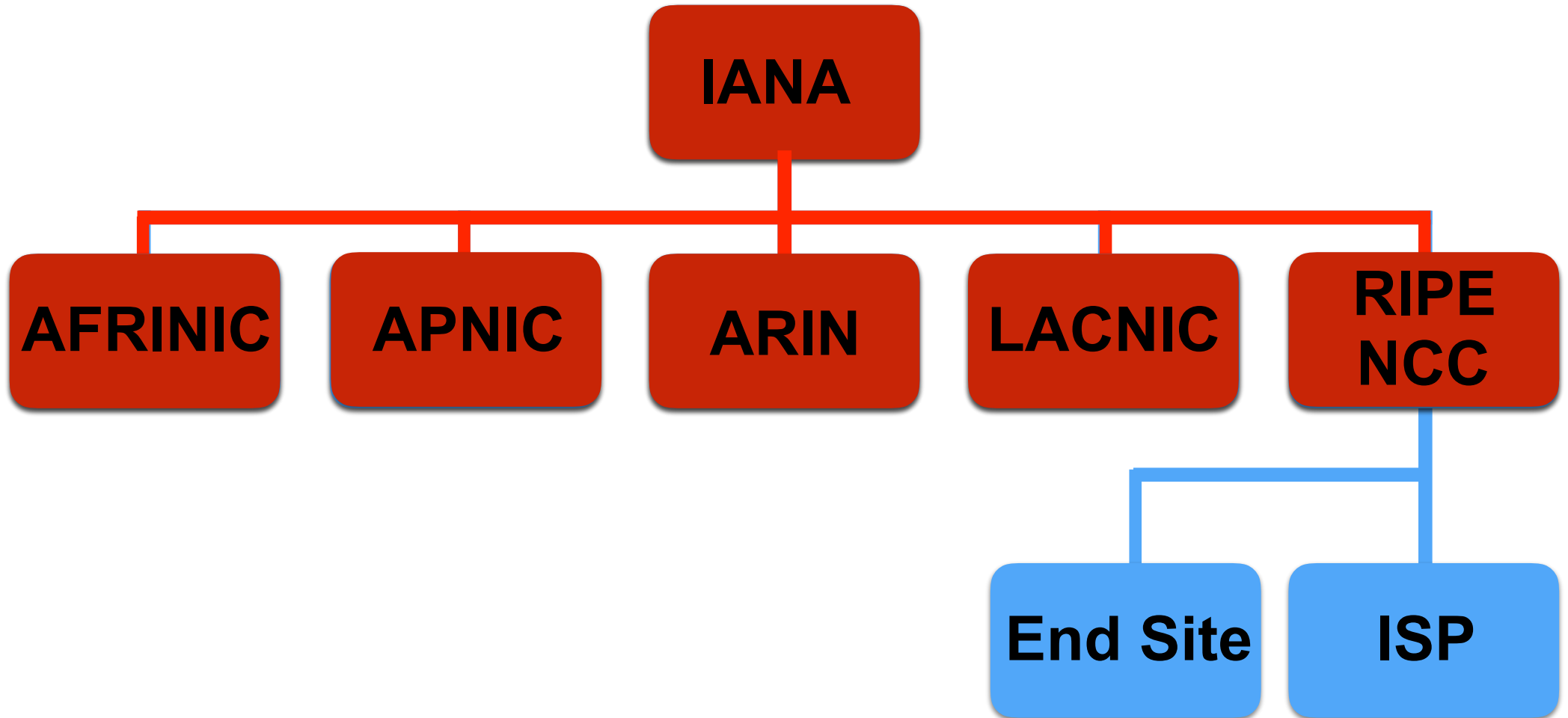


Regional Internet Registry (RIR)



The Regional Internet Registry (RIR) and bottom-up community driven number resource management model

IPv4 Depletion



Internet Protocol version 6 (IPv6)



2001:db8:0:0:0:0:0:2

```
0010 0000 0000 0001
0000 1101 1011 1000
0000 0000 0000 0000
0000 0000 0000 0000
0000 0000 0000 0000
0000 0000 0000 0000
0000 0000 0000 0000
0000 0000 0000 0010
```



```
0010 0000 0000 0001
0000 1101 1011 1000
0000 0000 0000 0000
0000 0000 0000 0000
0000 0000 0000 0000
0000 0000 0000 0000
0000 0000 0000 0000
0000 0000 0000 0000
0000 0000 0000 0001
```

2001:db8:0:0:0:0:0:1



Internet Number Resources

There are two types of IP addresses in active use:

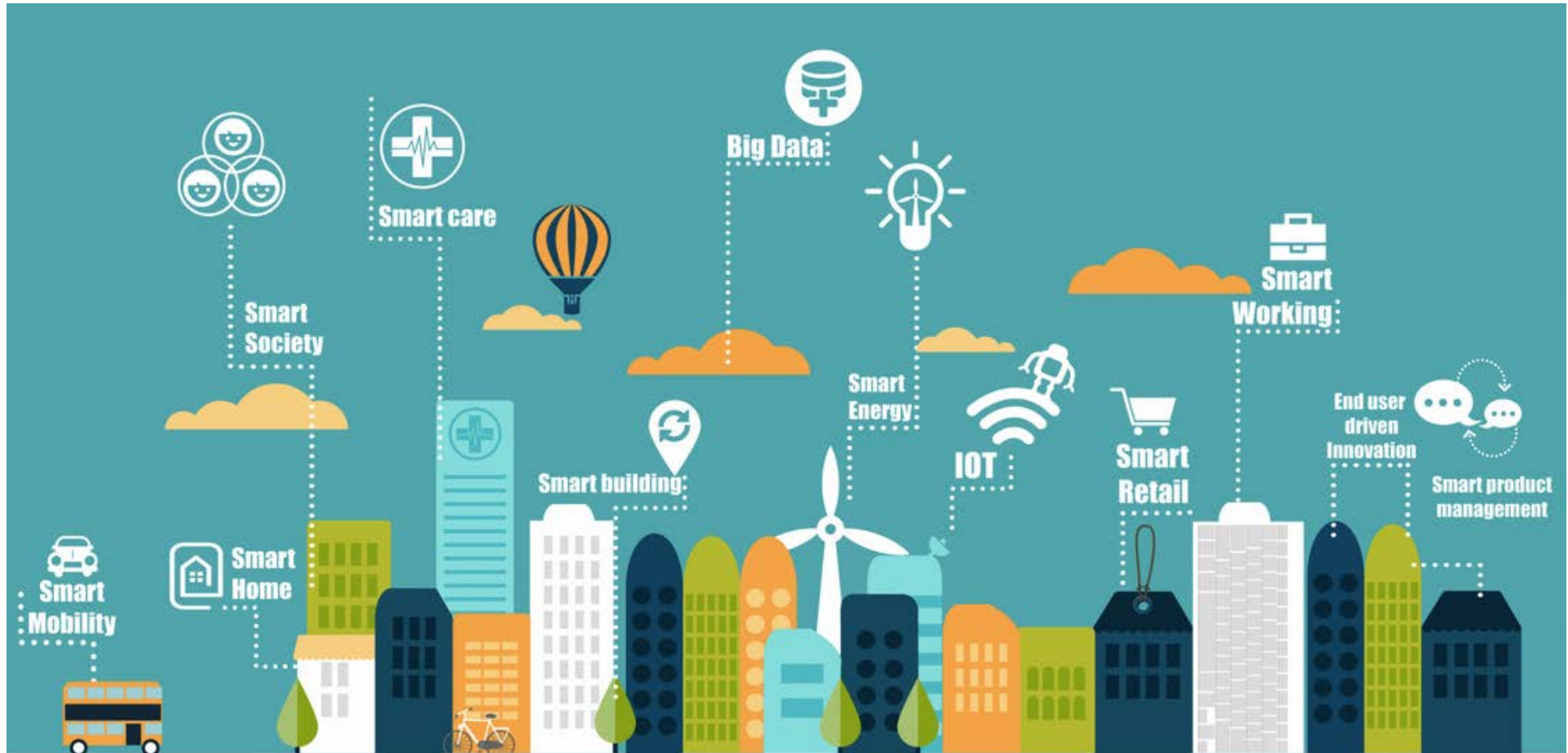
IP version 4 (IPv4)

- Initially deployed: 1 January 1983.
- IPv4 addresses are 32-bit numbers. (4.2 Billion)
- Example: 192.0.2.53
- Still the most commonly used version.

IP version 6 (IPv6)

- Published by the IETF in 1998.
- IPv6 addresses are 128-bit numbers. (340 Trillion Trillion Trillion)
- Example: 2001:0db8:582:ae33::29

Internet of Things (IoT)



The only way to build a scalable and interoperable future with IoT is IPv6

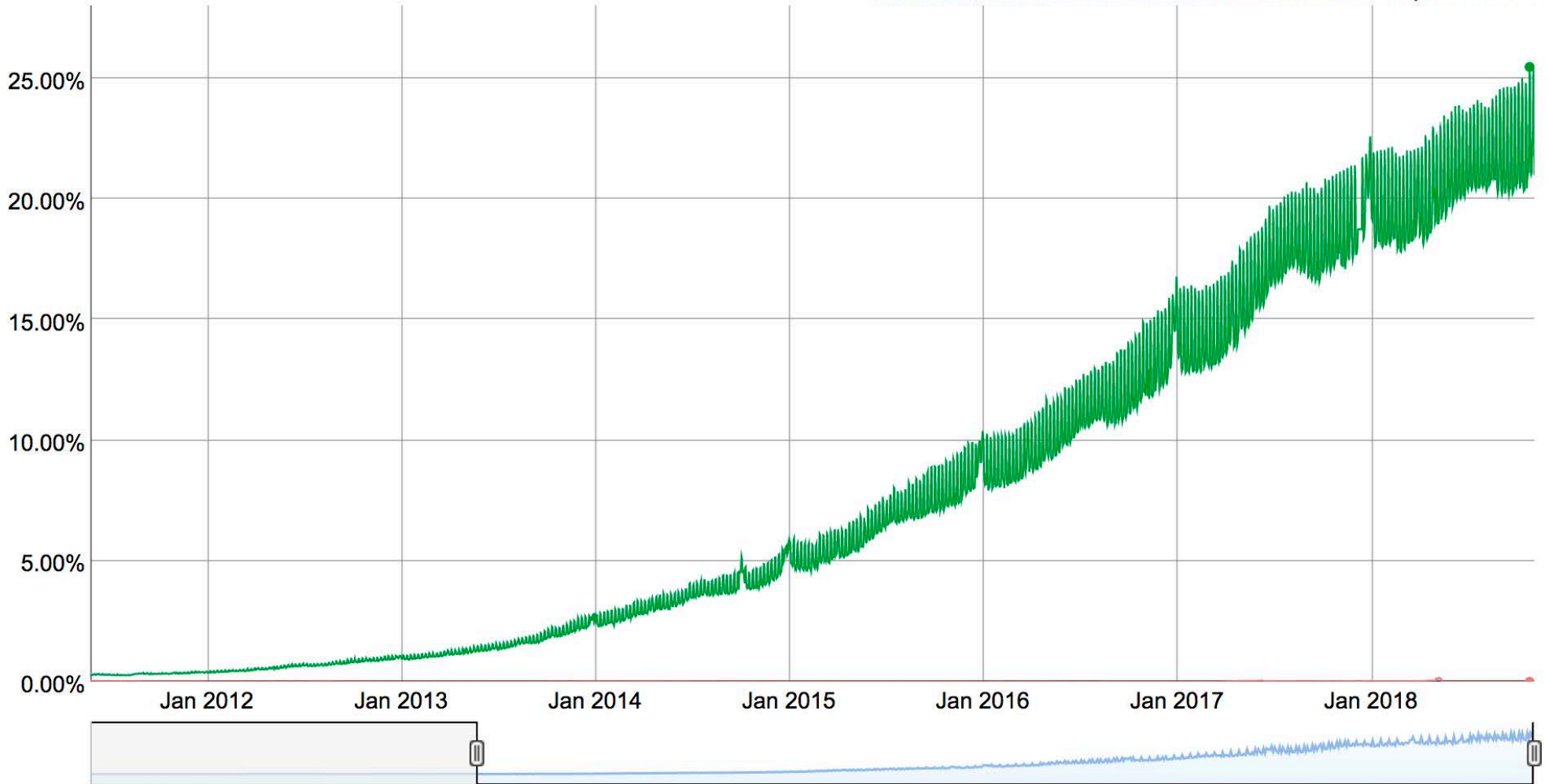
IPv6 Statistics - Google (1)



IPv6 Adoption

We are continuously measuring the availability of IPv6 connectivity among Google users. The graph shows the percentage of users that access Google over IPv6.

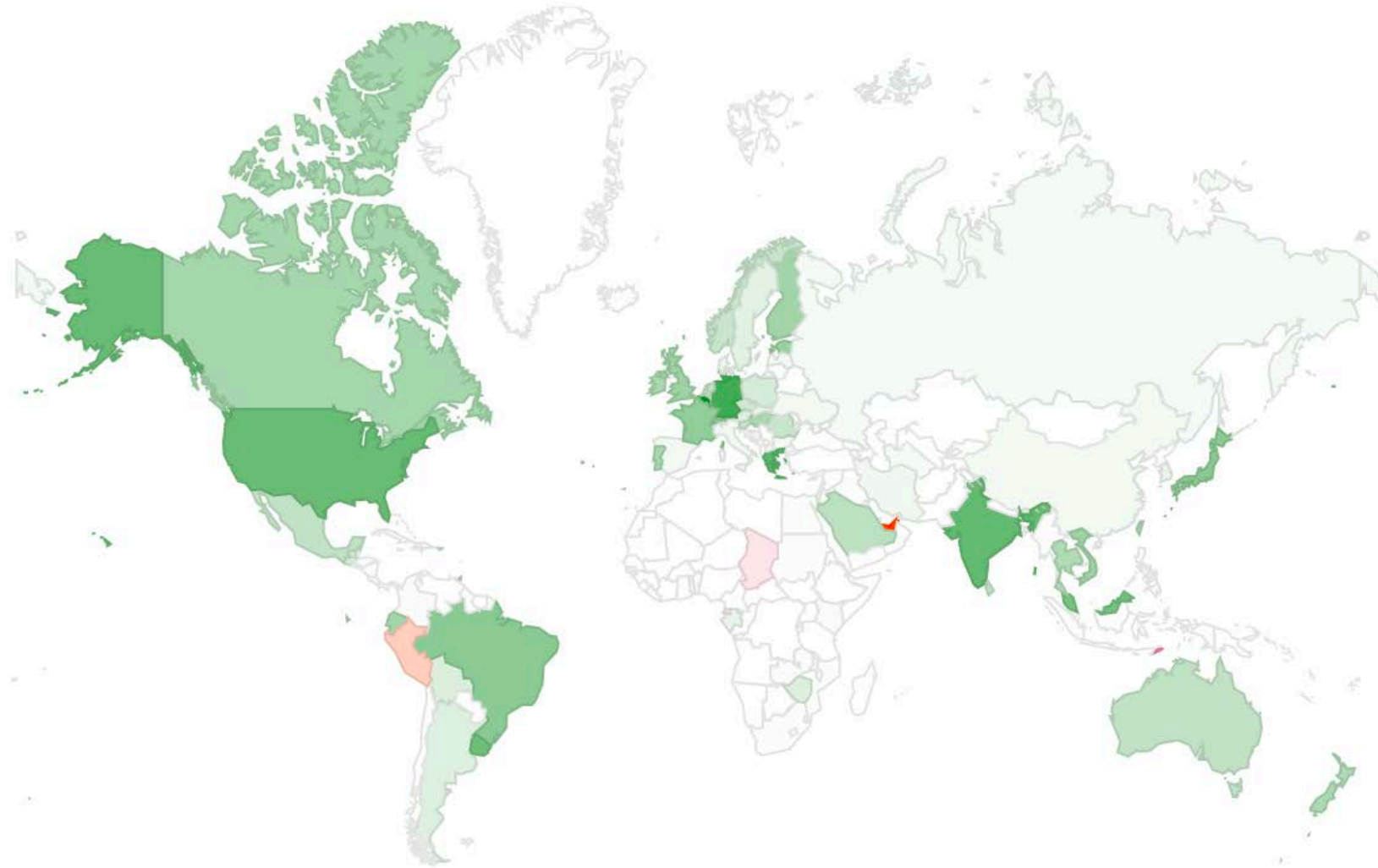
Native: 25.49% 6to4/Teredo: 0.00% Total IPv6: 25.49% | 27 Oct 2018



Percentage of IPv6 users that access Google over IPv6

Source: <https://www.google.com/intl/en/ipv6/statistics.html#tab=ipv6-adoption&tab=ipv6-adoption>

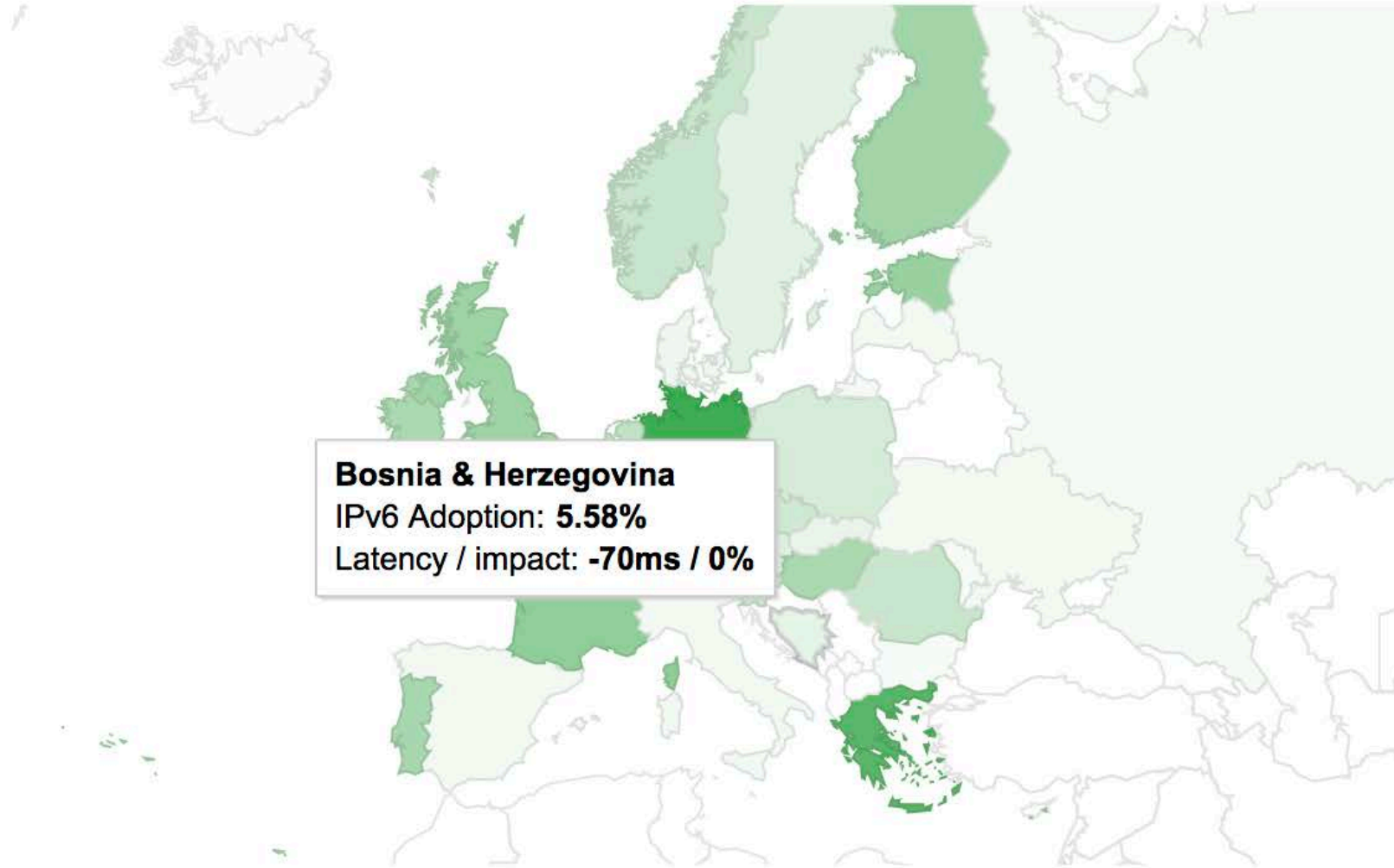
IPv6 Statistics - Google (2)



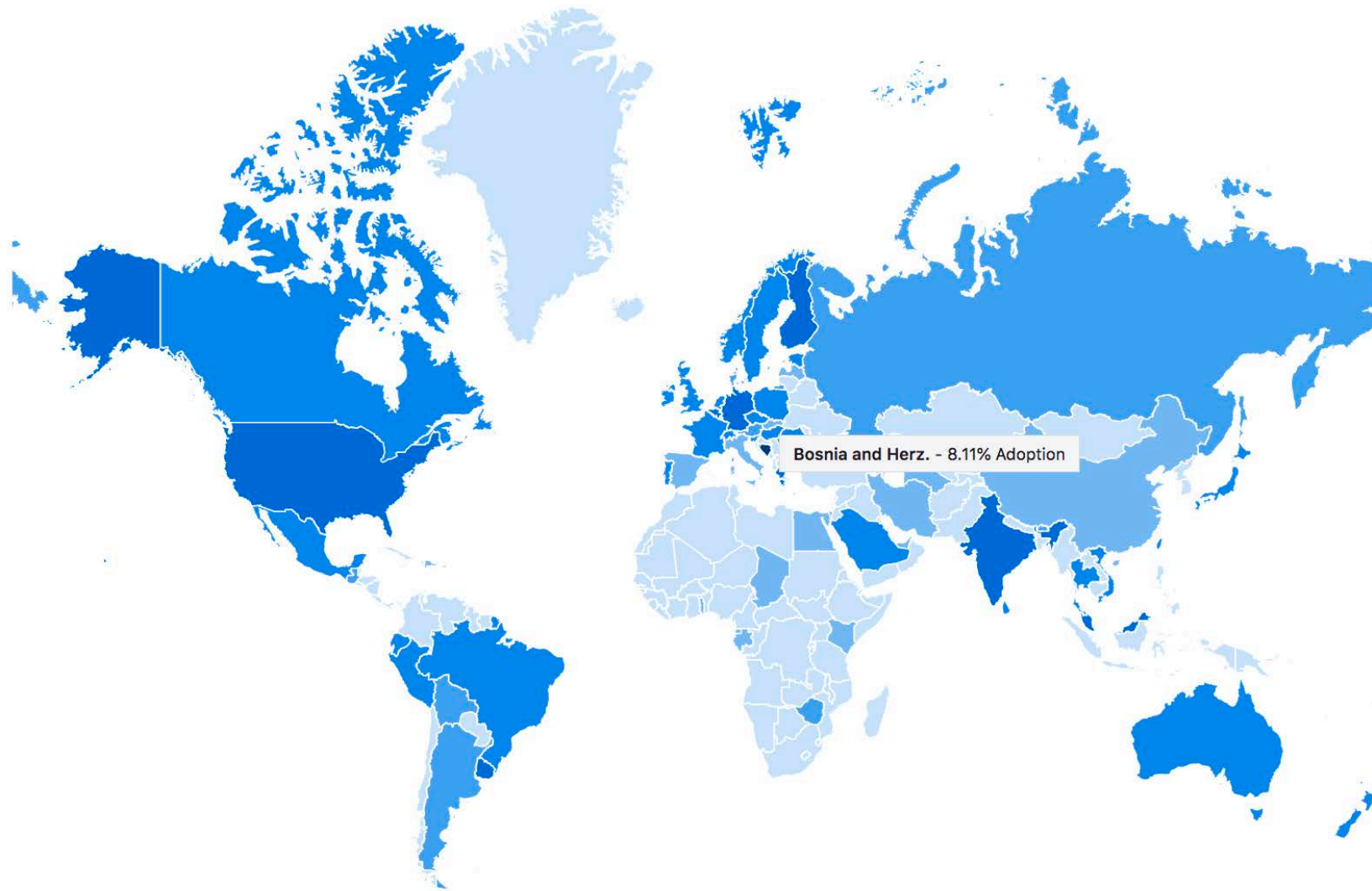
IPv6 Statistics - Google (3)



n



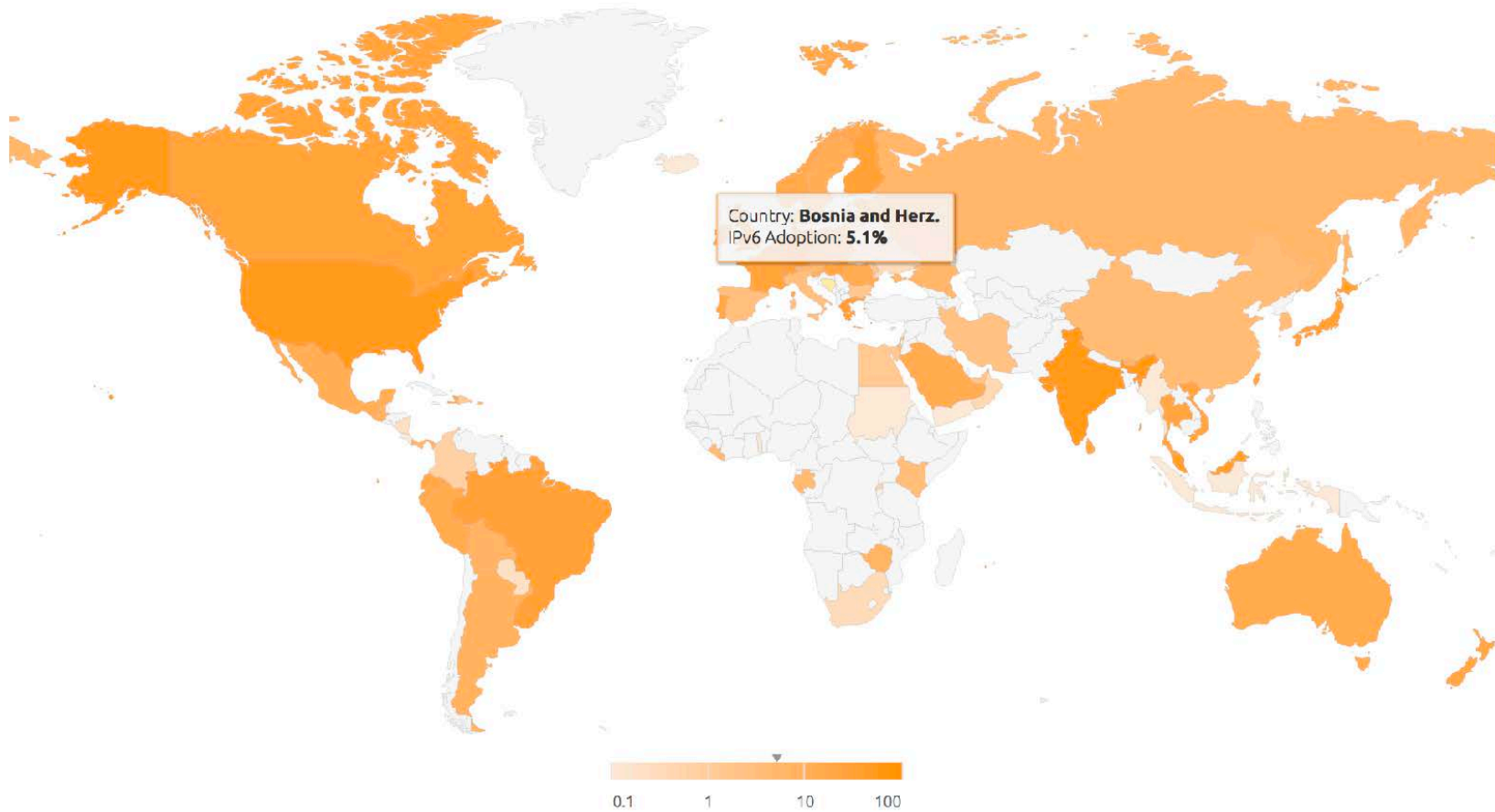
IPv6 Statistics - Facebook



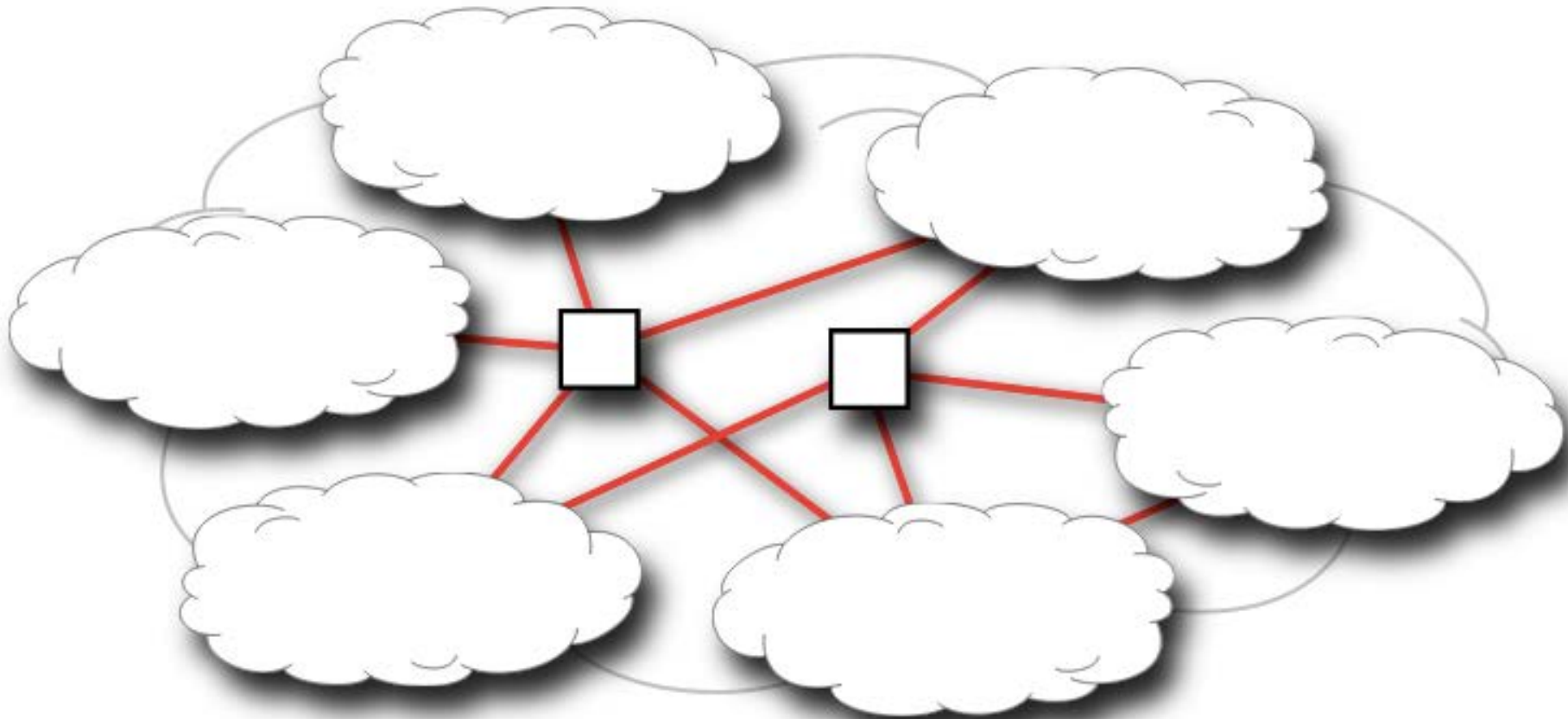
IPv6 Statistics - Akamai



IPv6 Adoption By Country



Autonomous System Numbers



A public AS has a globally unique number, an AS Number, associated with it. This number is used as an identifier of the AS itself.

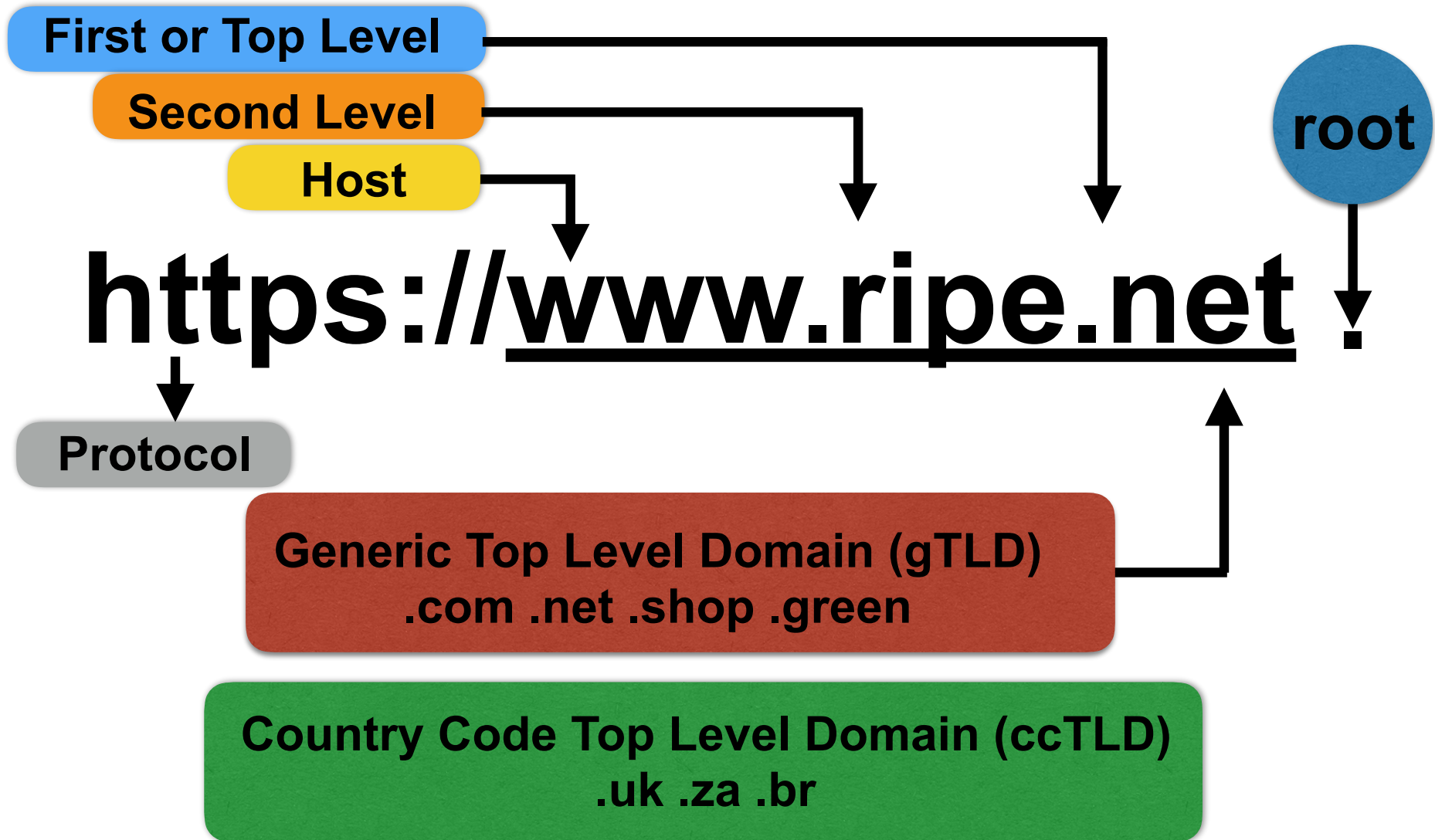


Names

What is in a name?



The Anatomy of a Domain





Internet Number Resources

The Nearest
Root Nameserver

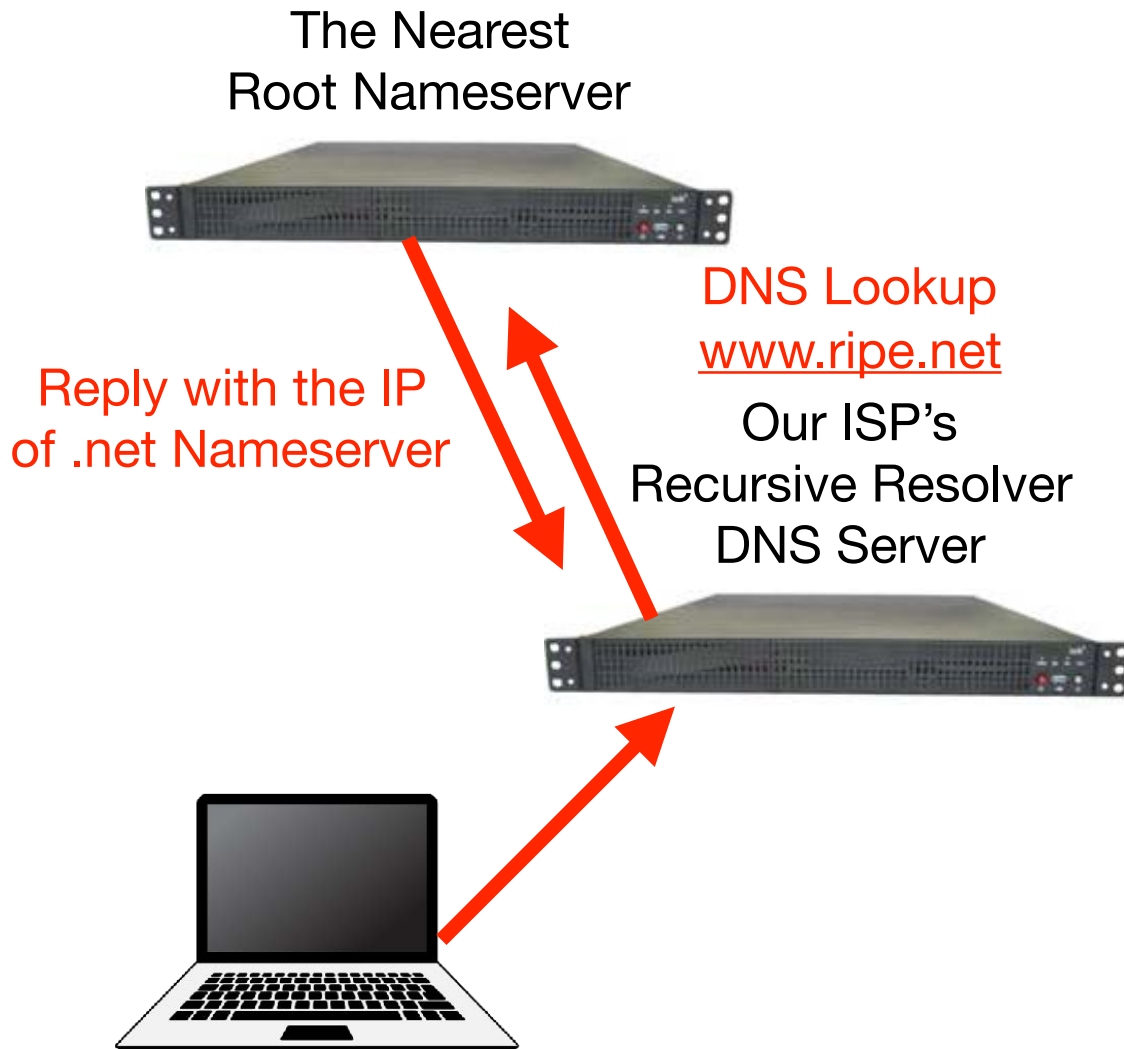


Our ISP's
Recursive Resolver
DNS Server

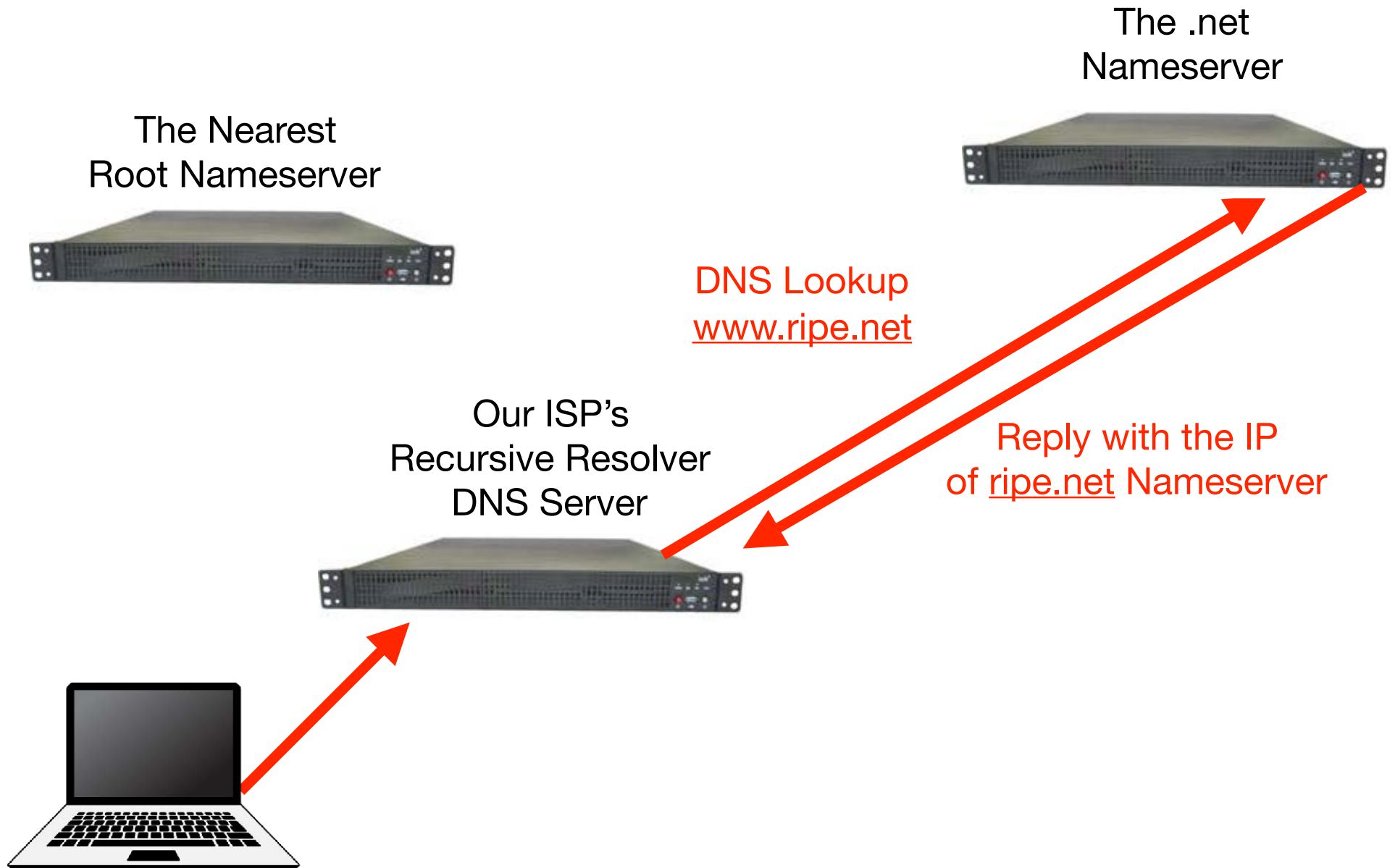


Domain Name Lookup
to resolve www.ripe.net

Internet Number Resources



Internet Number Resources



Internet Number Resources



The Nearest
Root Nameserver



The .net
Nameserver



Our ISP's
Recursive Resolver
DNS Server



DNS Lookup
www.ripe.net

The ripe.net
Nameserver



Reply with the IP
of www.ripe.net



Internet Number Resources



The Nearest
Root Nameserver



The .net
Nameserver



Our ISP's
Recursive Resolver
DNS Server



The ripe.net
Nameserver



Reply with the IP
of www.ripe.net

WWW
Host



Internet Number Resources



The .net
Nameserver



The Nearest
Root Nameserver



Our ISP's
Recursive Resolver
DNS Server



The ripe.net
Nameserver



WWW
Host



HTTPS request to web server by IP address

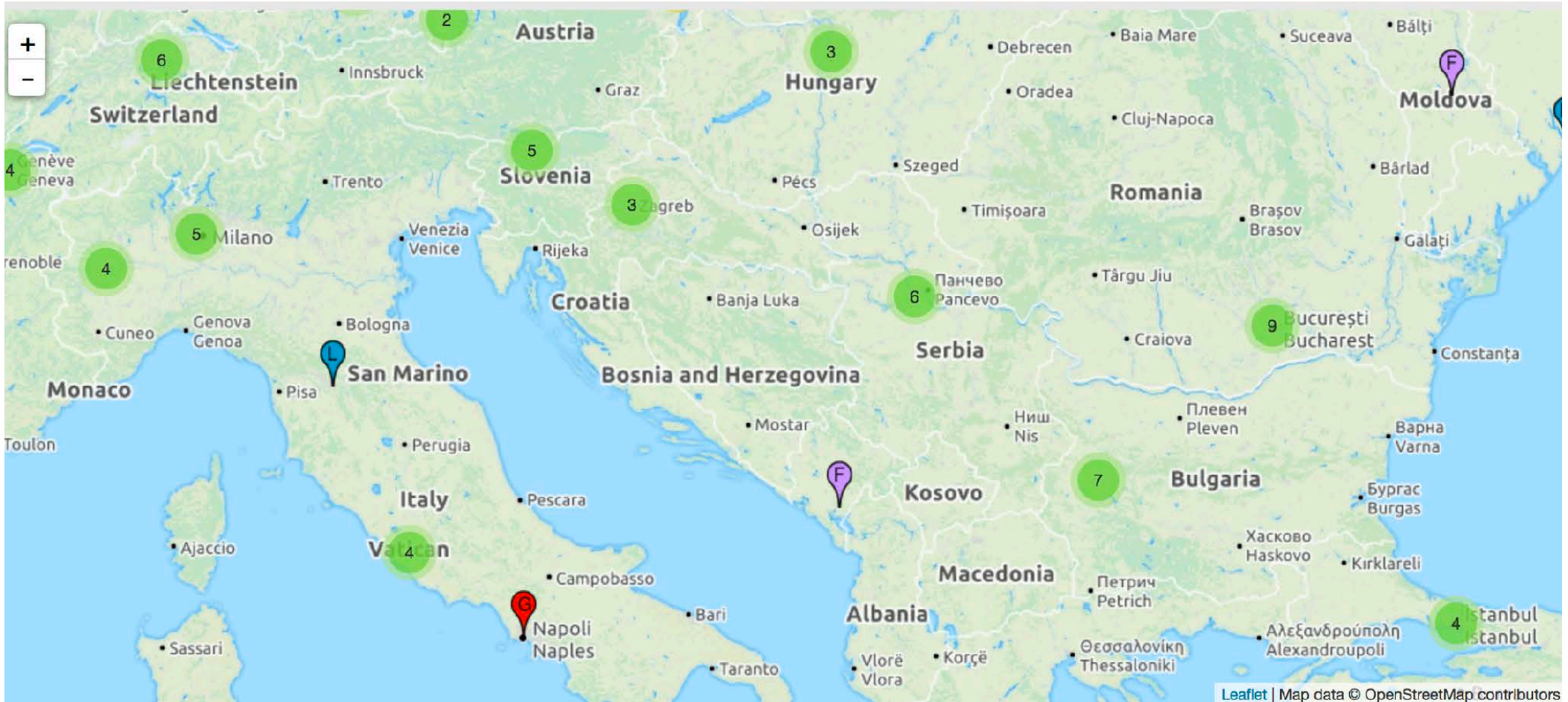
HTTPS reply to content of web page

Root Server Instances (1)



The 13 root name servers are operated by 12 independent organisations.

Root Server Instances (2)



The 13 root name servers are operated by 12 independent organisations.

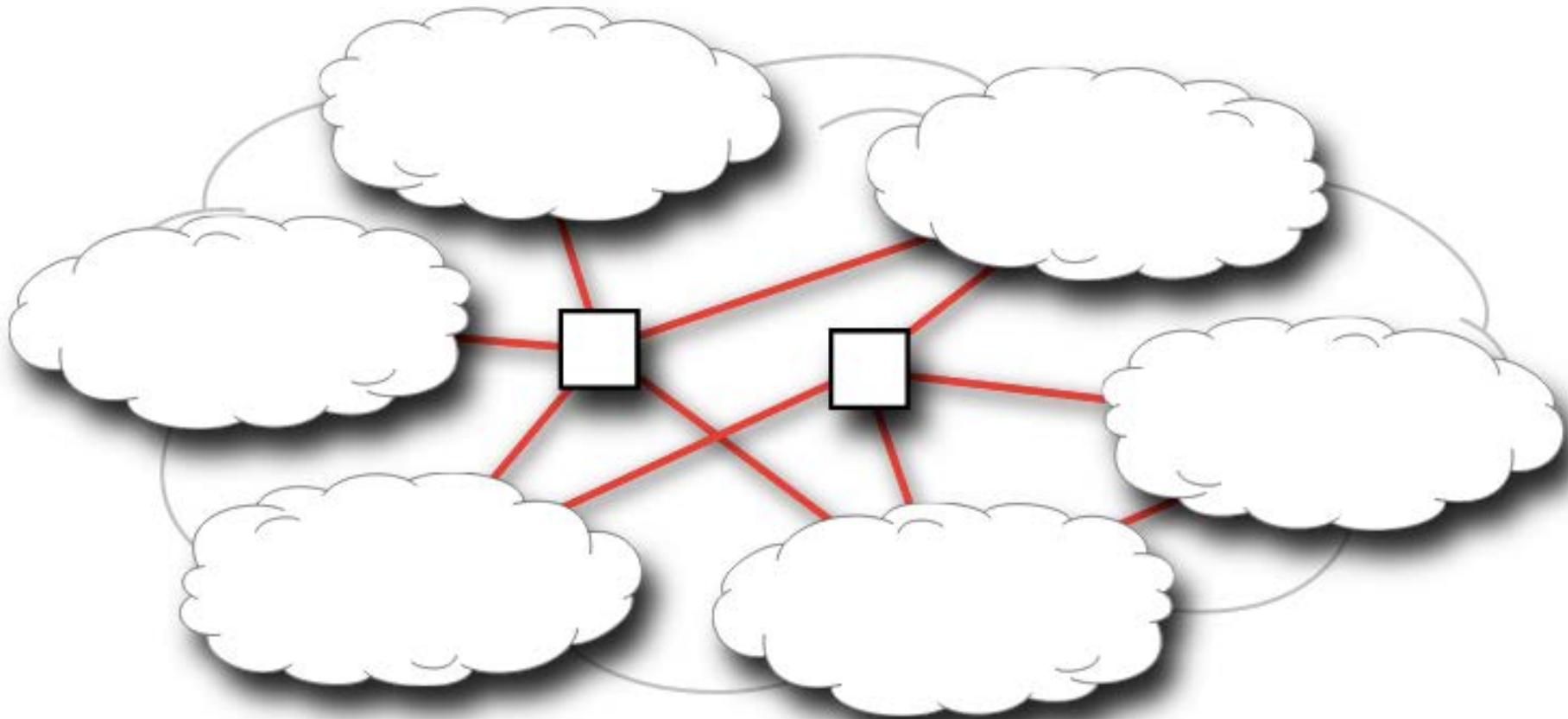


The Internet Corporation for Assigned Names and Numbers

- ICANN is a not-for-profit public-benefit corporation with participants from all over the world dedicated to keeping the Internet secure, stable and interoperable.
- It promotes competition and develops policy on the Internet's unique identifiers.
- Through its coordination role of the Internet's naming system, it does have an important impact on the expansion and evolution of the Internet.



What is the Internet?



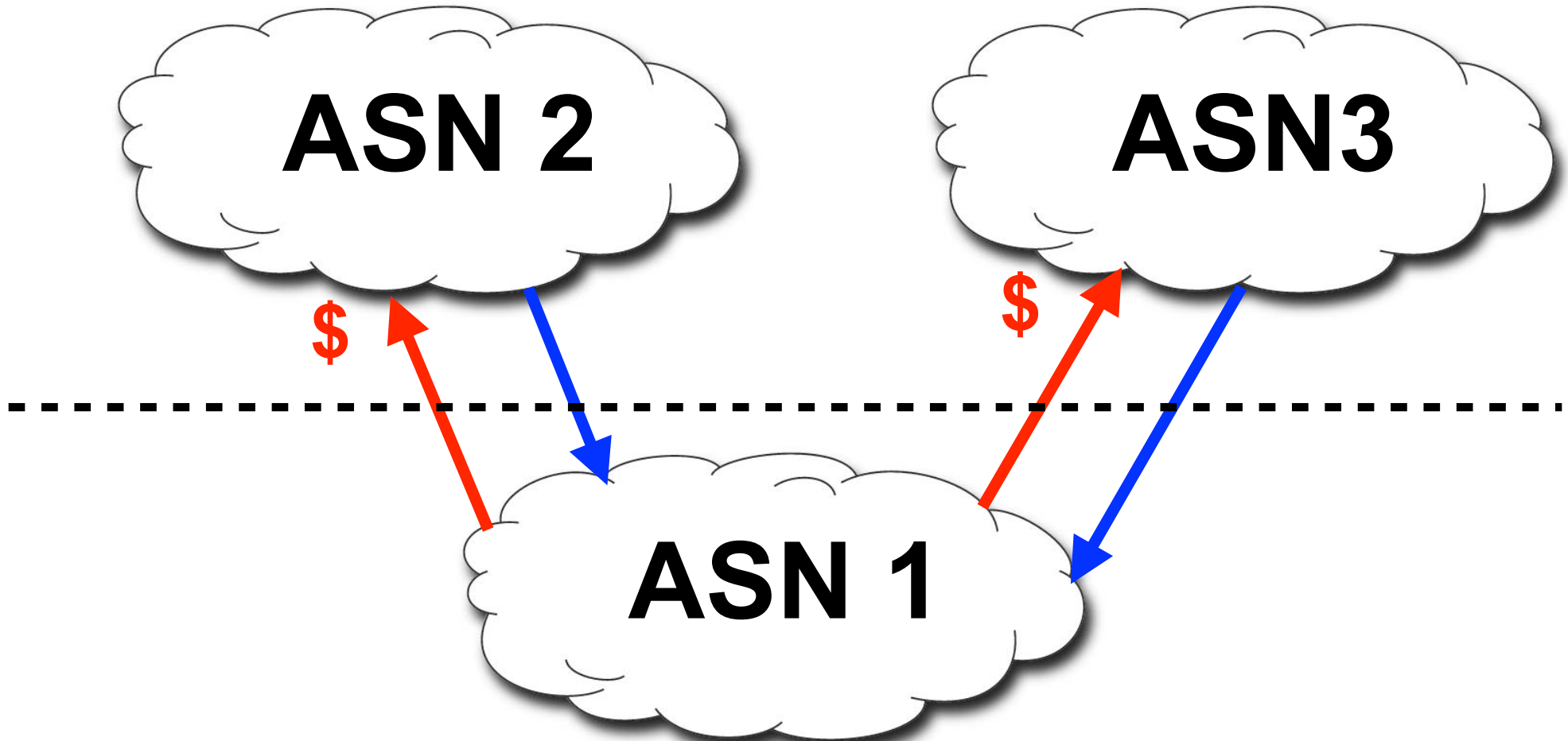
The Internet has roughly 60,000 autonomous networks that are interconnected.



Operators

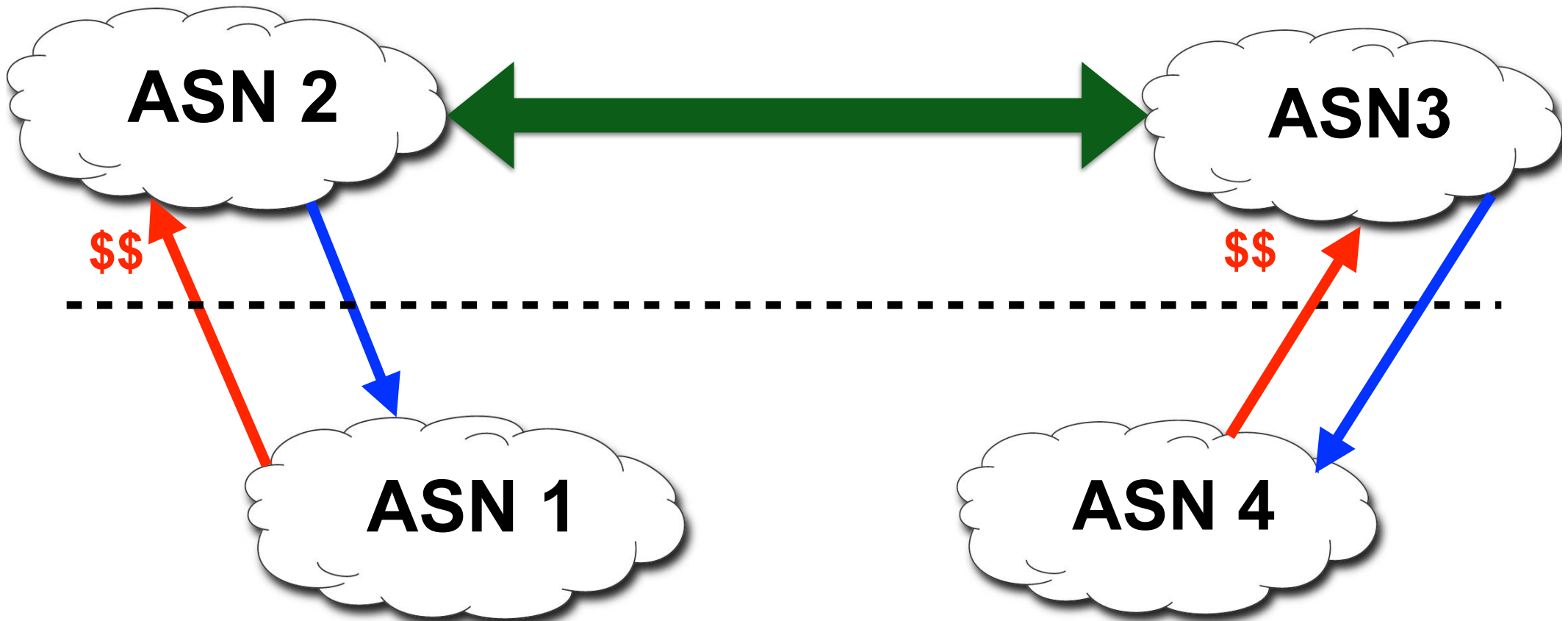
ISPs, IXPs & Enterprise

Connecting to the Internet



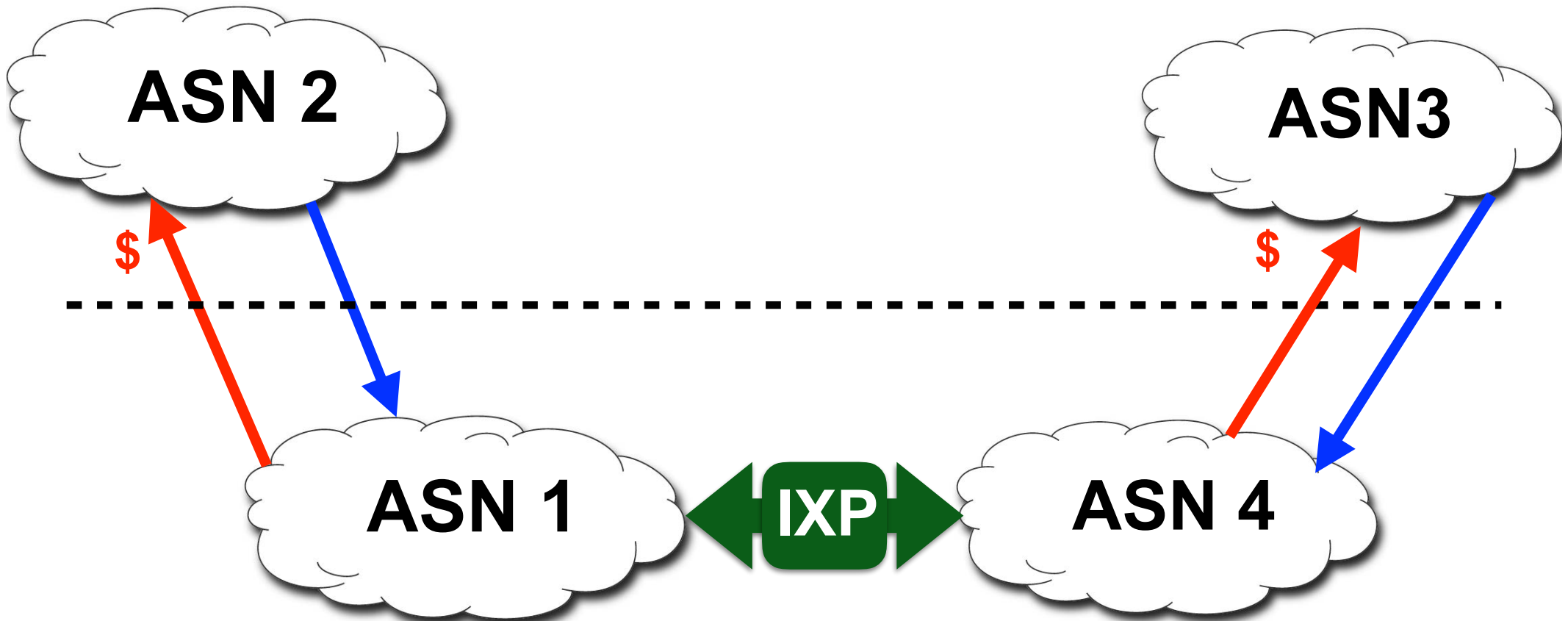
Country

Domestic Traffic Tromboning



Country

Internet Exchange Points (IXPs)



Country

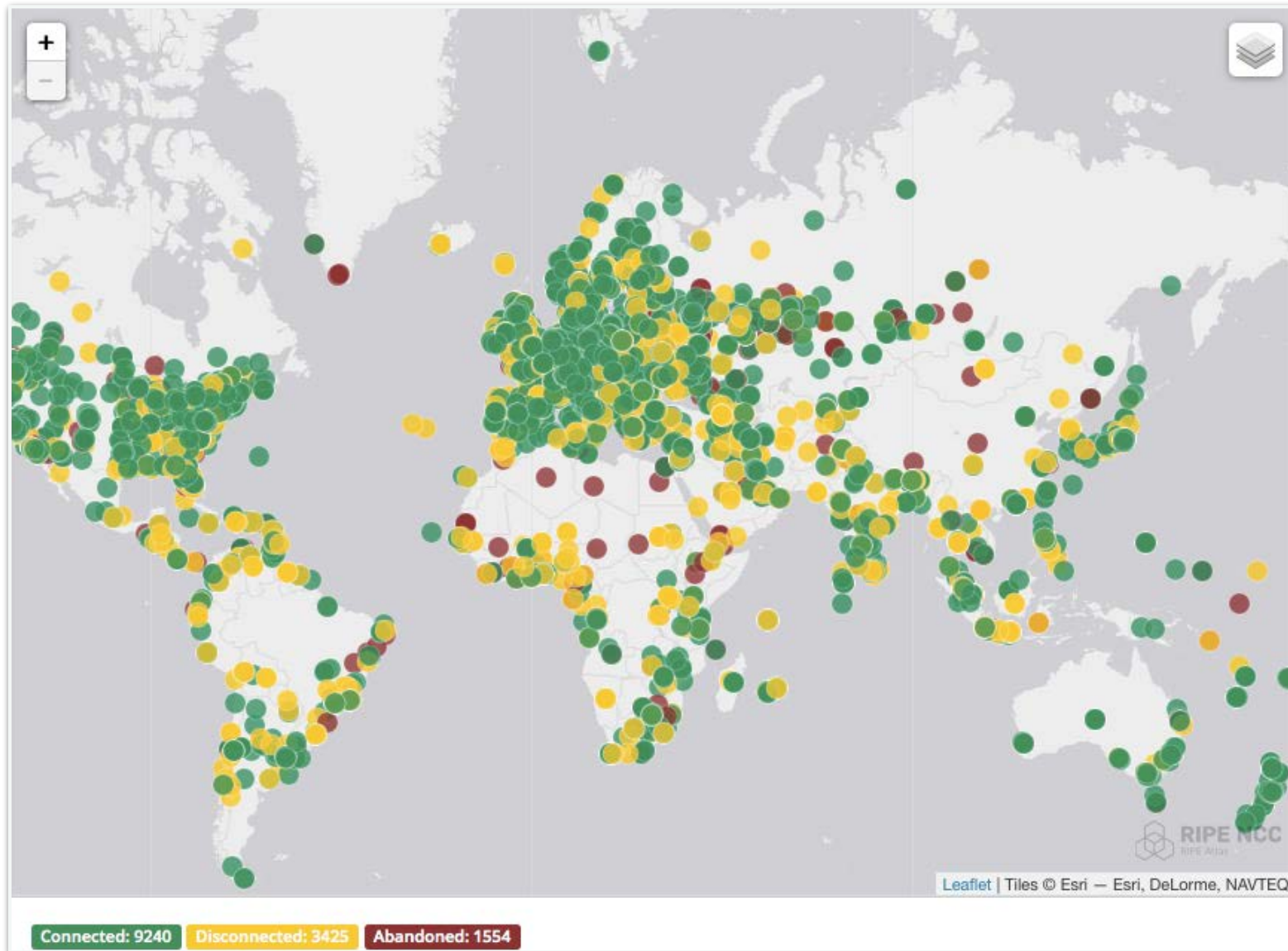


RIPE NCC

RIPE NETWORK COORDINATION CENTRE

IXP-Jedi : A use case for RIPE ATLAS data for IXP operators

RIPE Atlas Coverage



Probes





Credits

- Running a User Defined Measurement costs credits
- You earn these credits by hosting a probe or an anchor
- You can also sponsor probes
- Occasionally we give credits to students and researchers



What can they do?

- Perform Built-in measurements towards the root name servers
- Participate in User Defined Measurements
- Measurements are done from the probe's perspective



Measurements

- Types of measurements
 - Ping
 - Trace route
 - DNS
 - SSL Cert
 - HTTP
 - NTP

Anchors





What can anchors do?

- Anchors can do anything a probe can do
- They participate in Anchoring Measurements
- They can also be a target for a measurement, ie you measure towards an anchor



Security Disclosures

Security of the RIPE Atlas system is important for us. The development team is continually improving the controlling infrastructure as well as the probes themselves, in order to increase its resiliency against issues potentially caused by network problems, misbehaving components or users, or attackers. The architectural design of the system includes many controls to prevent potential overload, unauthorised use, and "takeover" of the network.

For more info please see:

<https://atlas.ripe.net/docs/security/>



Use cases

Examples of RIPE Atlas use

Use cases (1)



Using RIPE Atlas to Validate International Routing Detours

[Anant Shah](#) — 30 Jan 2017

A Quick Look at the Attack on Dyn

[Massimo Candela](#) — 24 Oct 2016

Contributors: [Emile Aben](#)

Using RIPE Atlas to Monitor Game Service Connectivity

[Annika Wickert](#) — 14 Sep 2016

Using RIPE Atlas to Measure Cloud Connectivity

[Jason Read](#) — 06 Sep 2016

Using RIPE Atlas to Debug Network Connectivity Problems

[Stéphane Bortzmeyer](#) — 10 May 2016

RIPE Atlas IXP Country Jedi (1)



- Do paths between ASes stay in country?
- Any difference between IPv4 and IPv6?
- How many paths go via local IXP?
- Could adding peers improve reachability?

- Experimental tool
 - Feature requests welcome!
 - Depends on probe distribution in country

RIPE Atlas IXP Country Jedi (2)

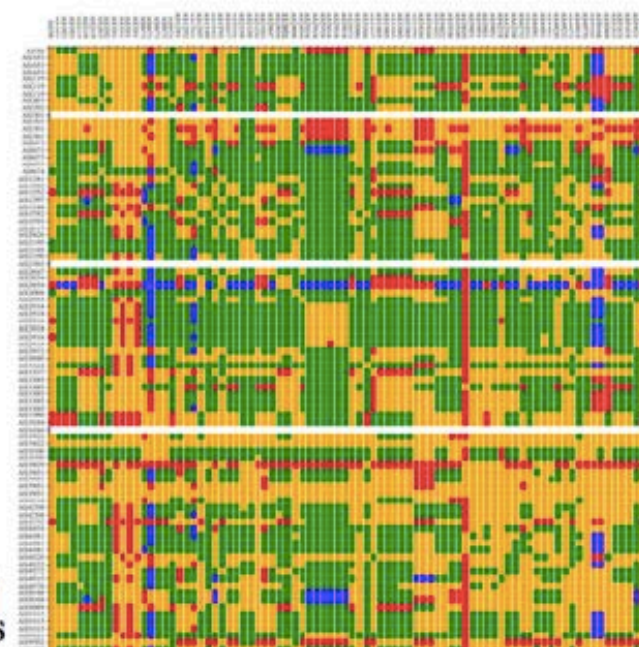


- Methodology
 - Trace route mesh between RIPE Atlas probes
 - Identifying ASNs in country using RIPEstat
 - Identifying IXP and IXP LANs in PeeringDB



Figure 1: Visual representation of IPv4 paths (left) and IPv6 paths (right) between selected RIPE Atlas probes in Sweden

■ IXP IPs: YES, out-of-country IPs: NO
■ IXP IPs: NO, out-of-country IPs: NO
■ IXP IPs: YES, out-of-country IPs: YES
■ IXP IPs: NO, out-of-country IPs: YES



Use Cases (2)



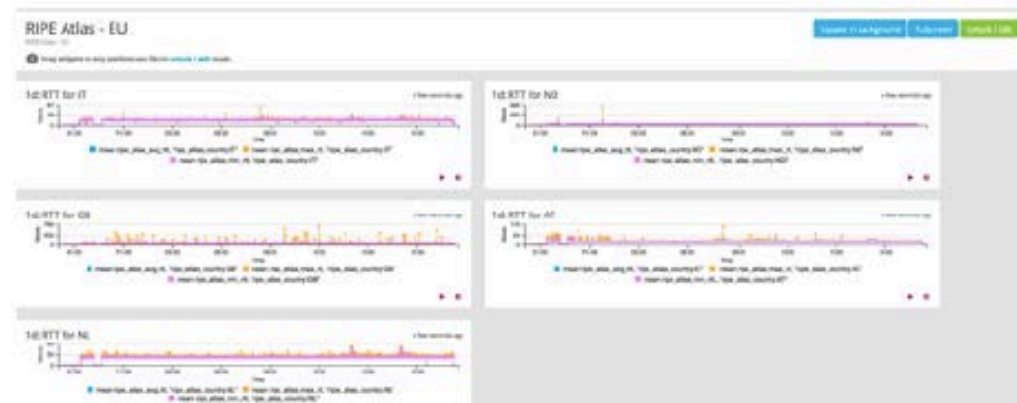
- DDoS Attack on Dyn DNS Servers (Oct. 2016)
 - 10s millions devices - Mirai botnet
 - Legitimate requests



Use Cases (3)



- Monitor Game Service Connectivity (Sept. 2016)
- Requirements:
 - Check General Reachability, Latency, Historical data
 - Supported by an active and helpful community
 - Integrate with their existing logging system
- Track down an outage in one upstream
- Became sponsors



Use Cases (4)



- Amsterdam Power Outage (March 2015)
- When and where the outage was happening



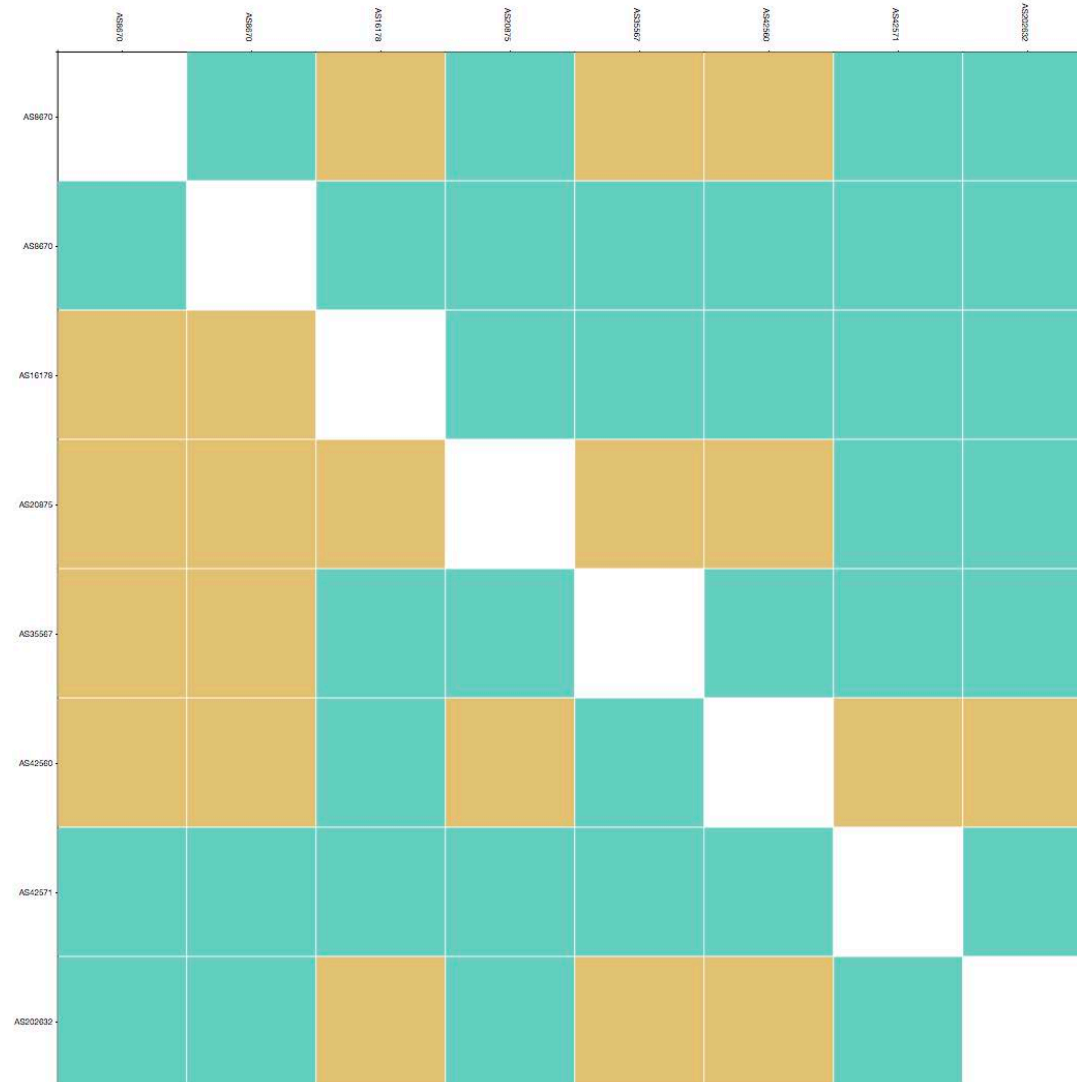
Bosnia and Herzegovina



Mouse click on every box to see the traceroute path. | Showing 7 of 7 ASNs (IPv4). | [Click here for IPv6.](#)

Show Filter ASNs Hide Legend

- IXP IPs: YES, out-of-country IPs: NO
- IXP IPs: YES, out-of-country IPs: YES
- IXP IPs: NO, out-of-country IPs: NO
- IXP IPs: NO, out-of-country IPs: YES



Bosnia and Herzegovina



Mouse click on every box to see the traceroute path. | Showing 0 of 0 ASNs (IPv6). | [Click here for IPv4.](#)

Show Filter ASNs	Hide Legend
------------------	-------------

- IXP IPs: YES, out-of-country IPs: NO
- IXP IPs: YES, out-of-country IPs: YES

- IXP IPs: NO, out-of-country IPs: NO
- IXP IPs: NO, out-of-country IPs: YES

Trace Route (1)



IPv4 Traceroute:

AS(v4) Path:

1) AS8670

v4

msm_id:16775782 prb_id:6366 dst:195.130.45.52 ts:2018-11-01 06:15:07 -00:00

0: (AS8670) travnik.bbone.utic.net.ba (0.715 0.726 0.75) ||

1: (AS8670) travnik.bbone.utic.net.ba (0.493 0.503 0.508) ||

Grey bar: max min RTT of all hops.

Light-blue bar: min RTT of the hop.

Trace Route (2)



IPv4 Traceroute:

AS(v4) Path:

- 1) AS20875
- 2) AS5391
- 3) AS9146
- 4) AS8670

v4

msm_id:16775782 prb_id:1232 dst:195.130.45.52 ts:2018-11-01 06:15:06 -00:00

```
0: ( ) 192.168.2.1 (2.964 3.195 8.734) ||
1: (AS20875) brmo1.tel.net.ba (22.75 23.584 23.982) ||
2: (AS20875) 85.94.145.46 (21.979 22.485 23.104) ||
3: (AS20875) brdrmo-mo1.tel.net.ba (21.673 22.226 22.649) ||
4: (AS5391) 195.29.110.205 (29.699 30.477 30.684) ||
5: (AS5391) gtr11-gdr11-2.ip.t-com.hr (29.861 30.497 31.619) |Zagreb, City of Zagreb, HR|
6: (AS5391) 195.29.110.50 (29.185 30.46 31.4) ||
7: (AS9146) 195.222.34.1 (30.338 30.806 31.316) ||
8: (AS9146) 195.222.34.2 (30.747 30.92 32.442) ||
9: (AS8670) travnik.bbone.utic.net.ba (31.381 31.821 32.921) ||
10: (AS8670) travnik.bbone.utic.net.ba (31.089 31.221 32.845) ||
```

Grey bar: max min RTT of all hops.

Light-blue bar: min RTT of the hop.



Questions

