RIPE NCC
RIPE NETWORK COORDINATION CENTRE

Internet Numbers

The Regional Internet Registries

Mirjam Kühne | MEAC-SIG 2019 | July 2019

Agenda

- **Background**
  - Short introduction to packet networking
- **Practice**
  - Internet number distribution
- **Future**
  - The need for an IPv6 transition

Background

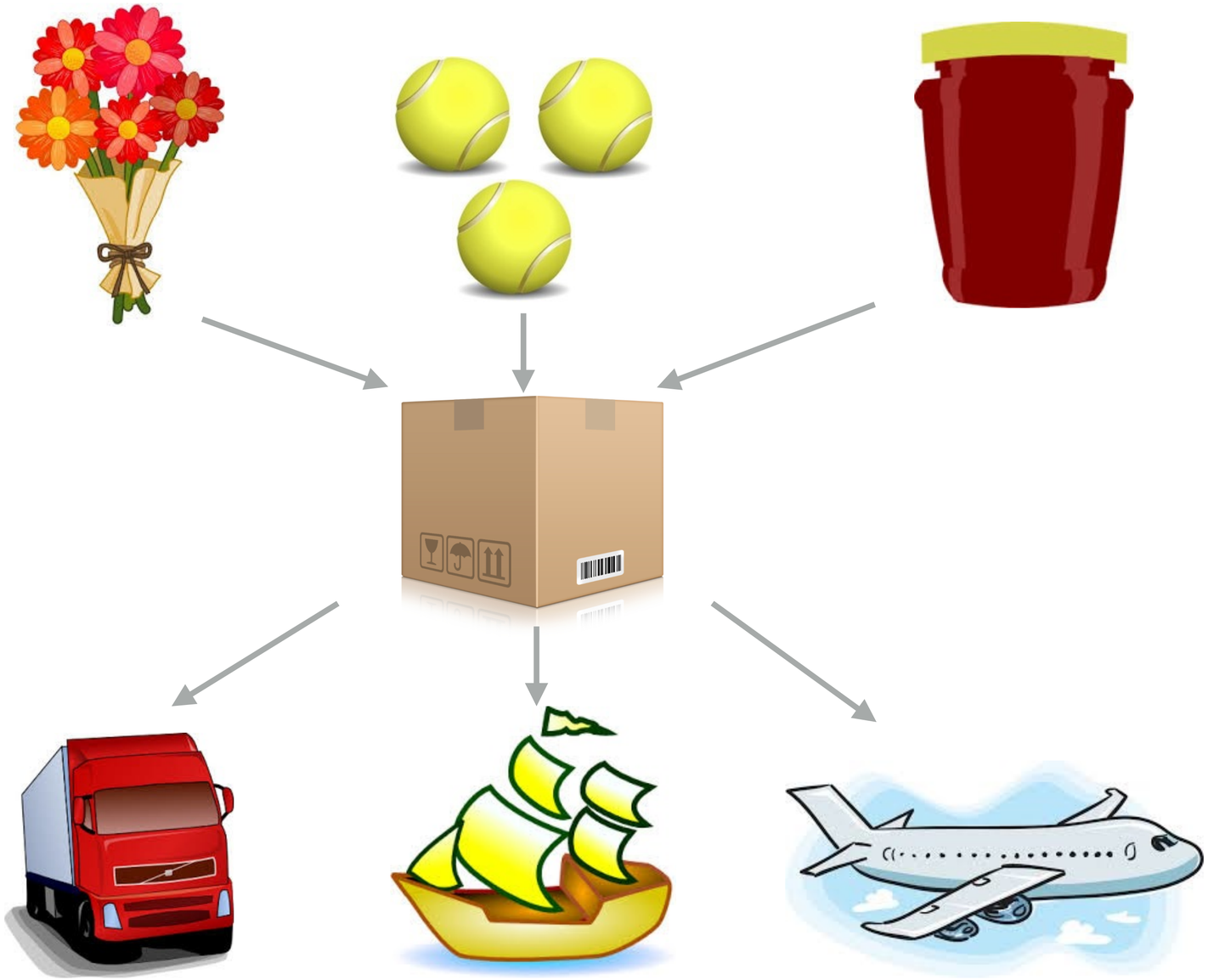
Packet Networking

The telephone network

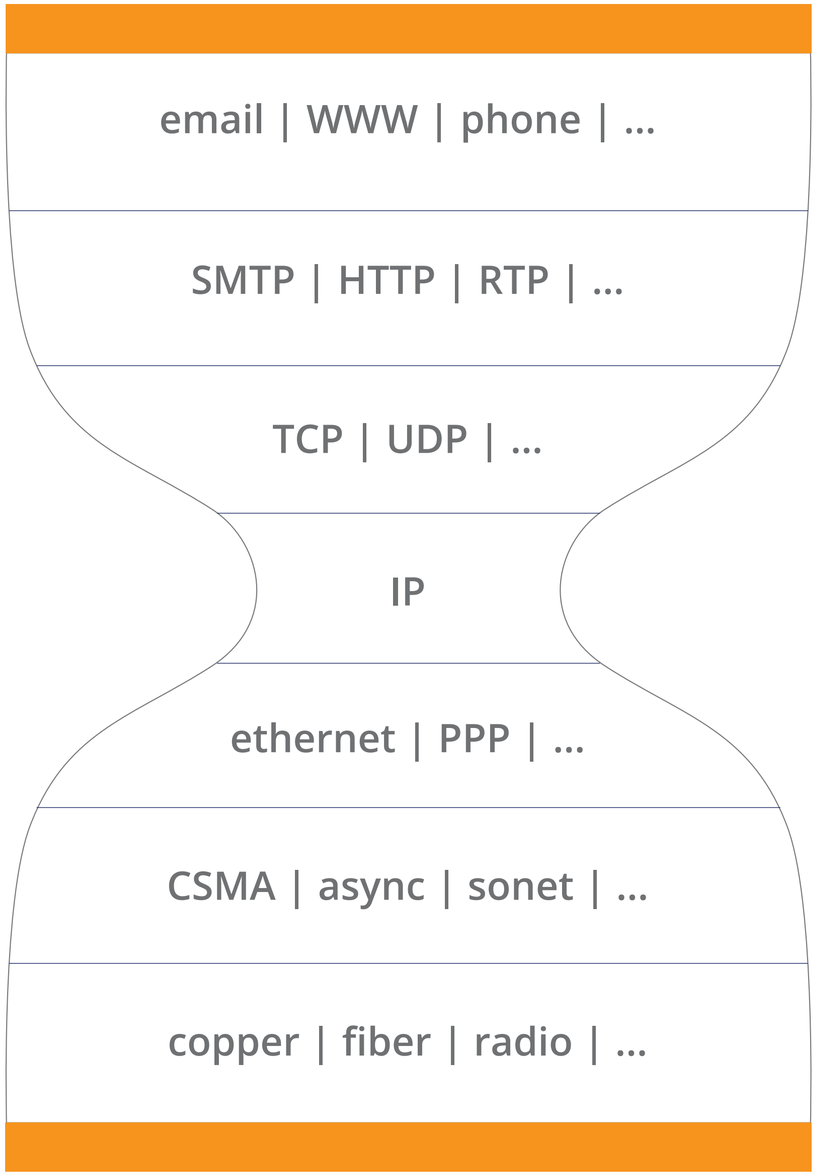
Sweden, early 20th century

Alternative solution?

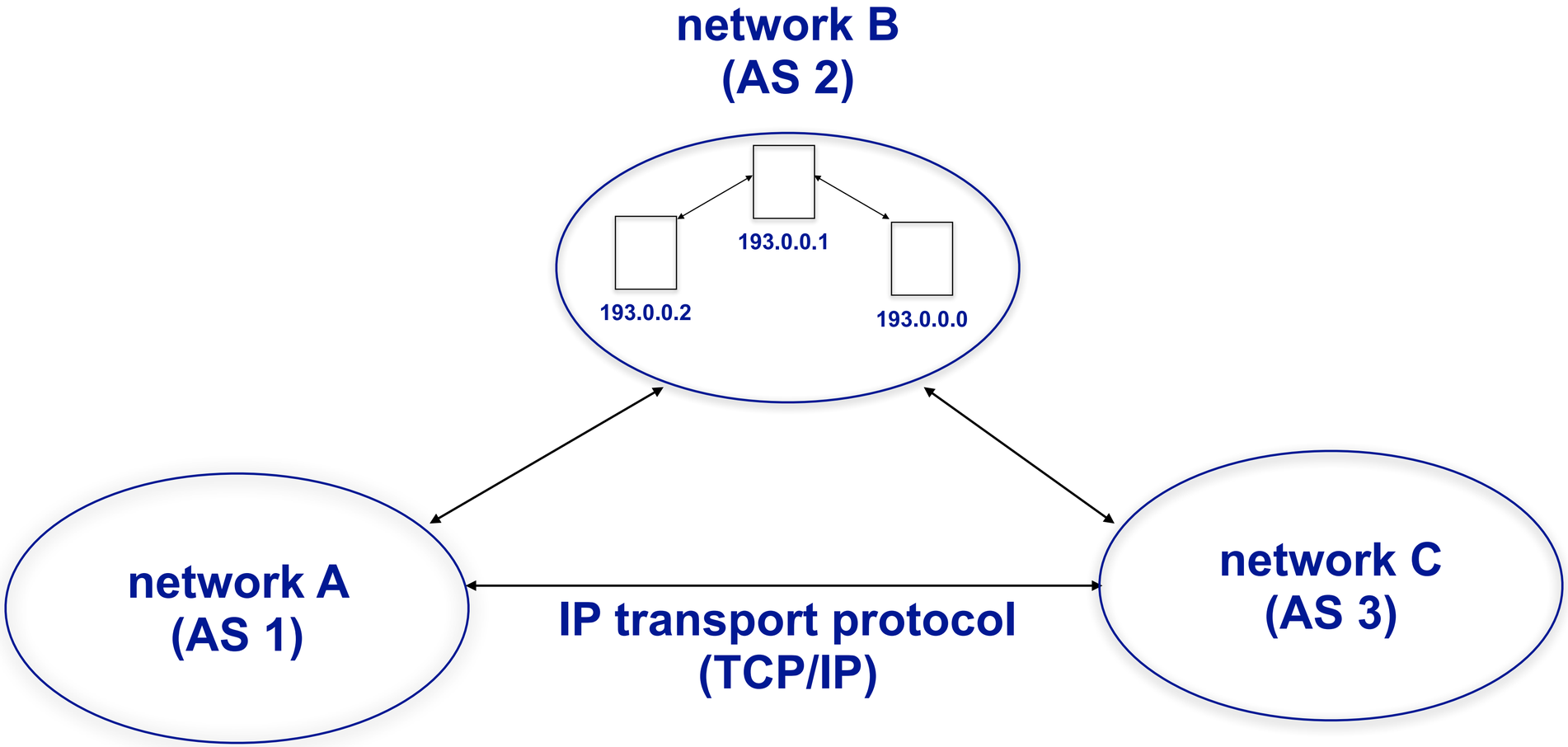
Packets



IP packets

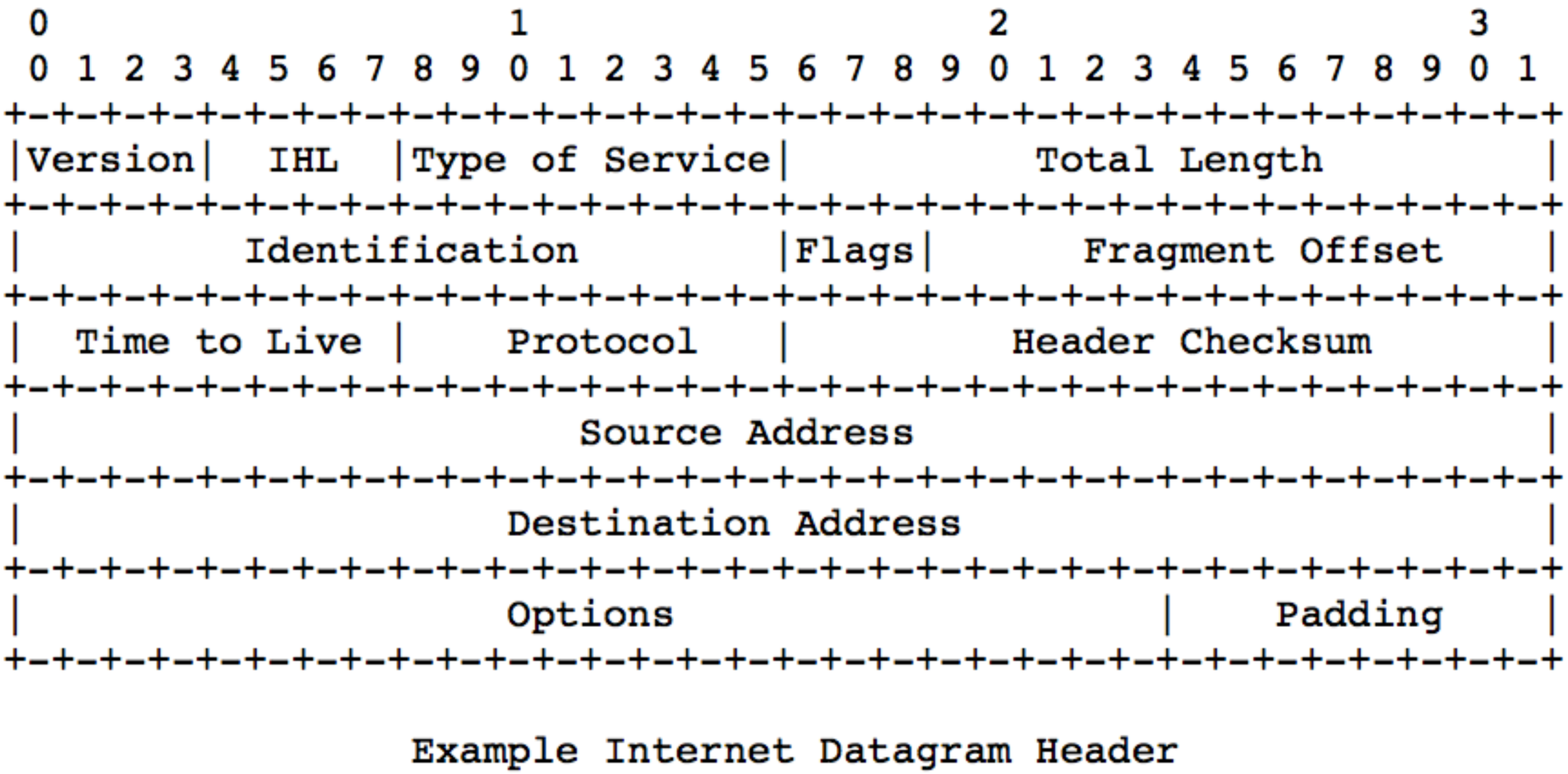

email | WWW | phone | ...
SMTP | HTTP | RTP | ...
TCP | UDP | ...
IP
ethernet | PPP | ...
CSMA | async | sonet | ...
copper | fiber | radio | ...

Network of networks

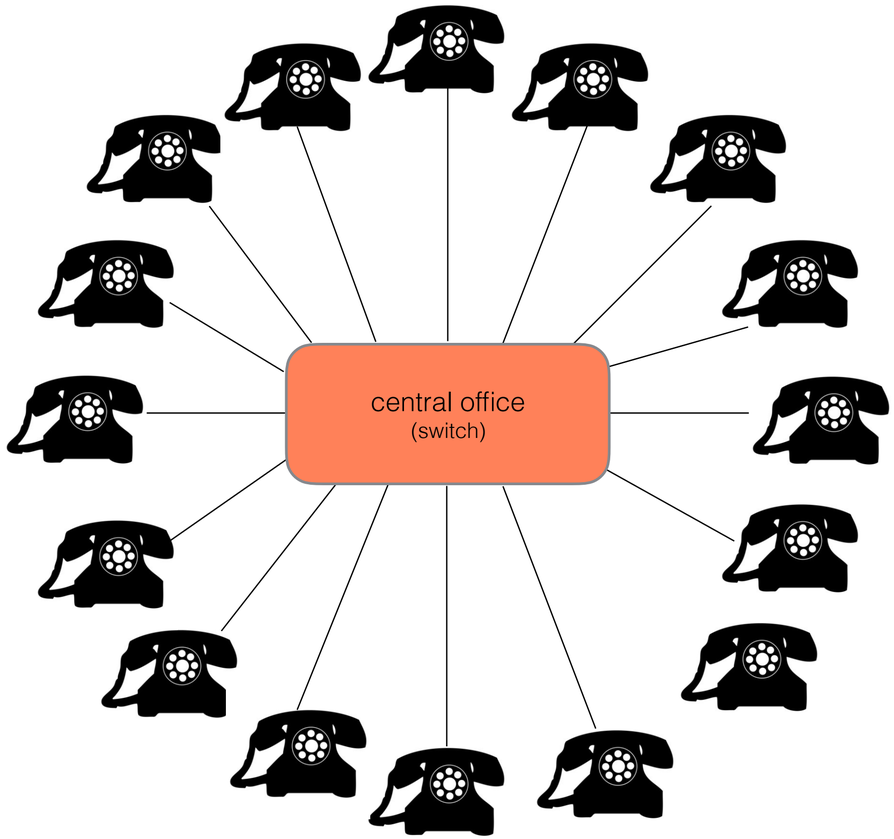


Packet label

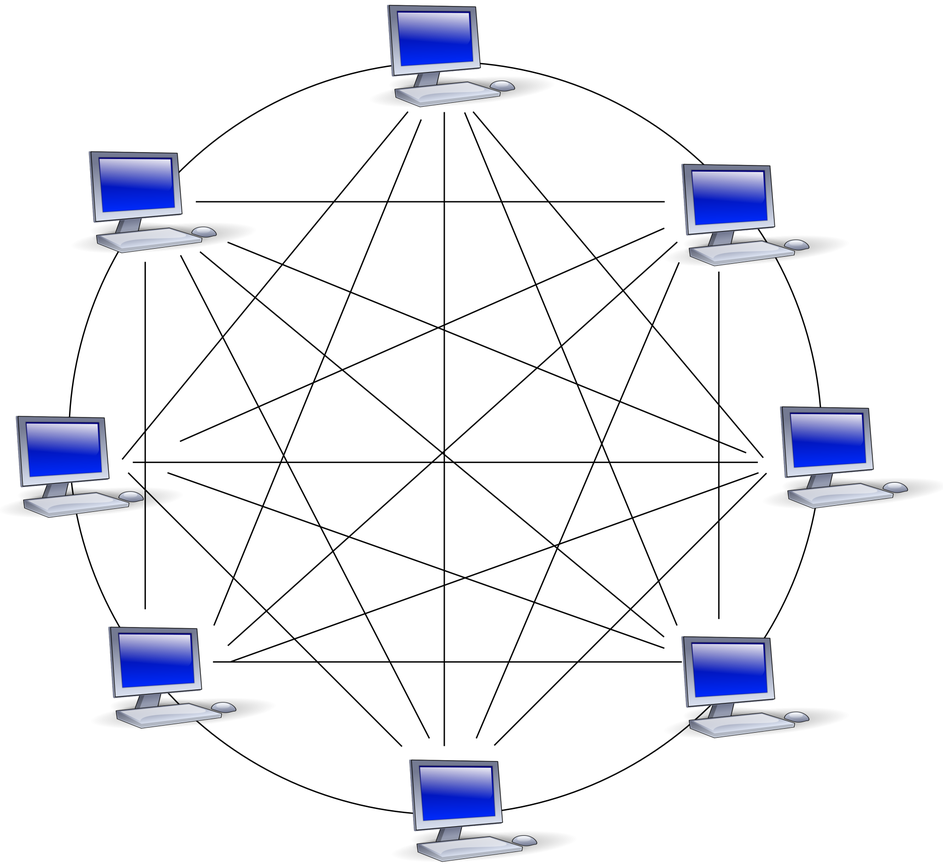
Address label



Example Internet Datagram Header



Centralised
(Telephone system)

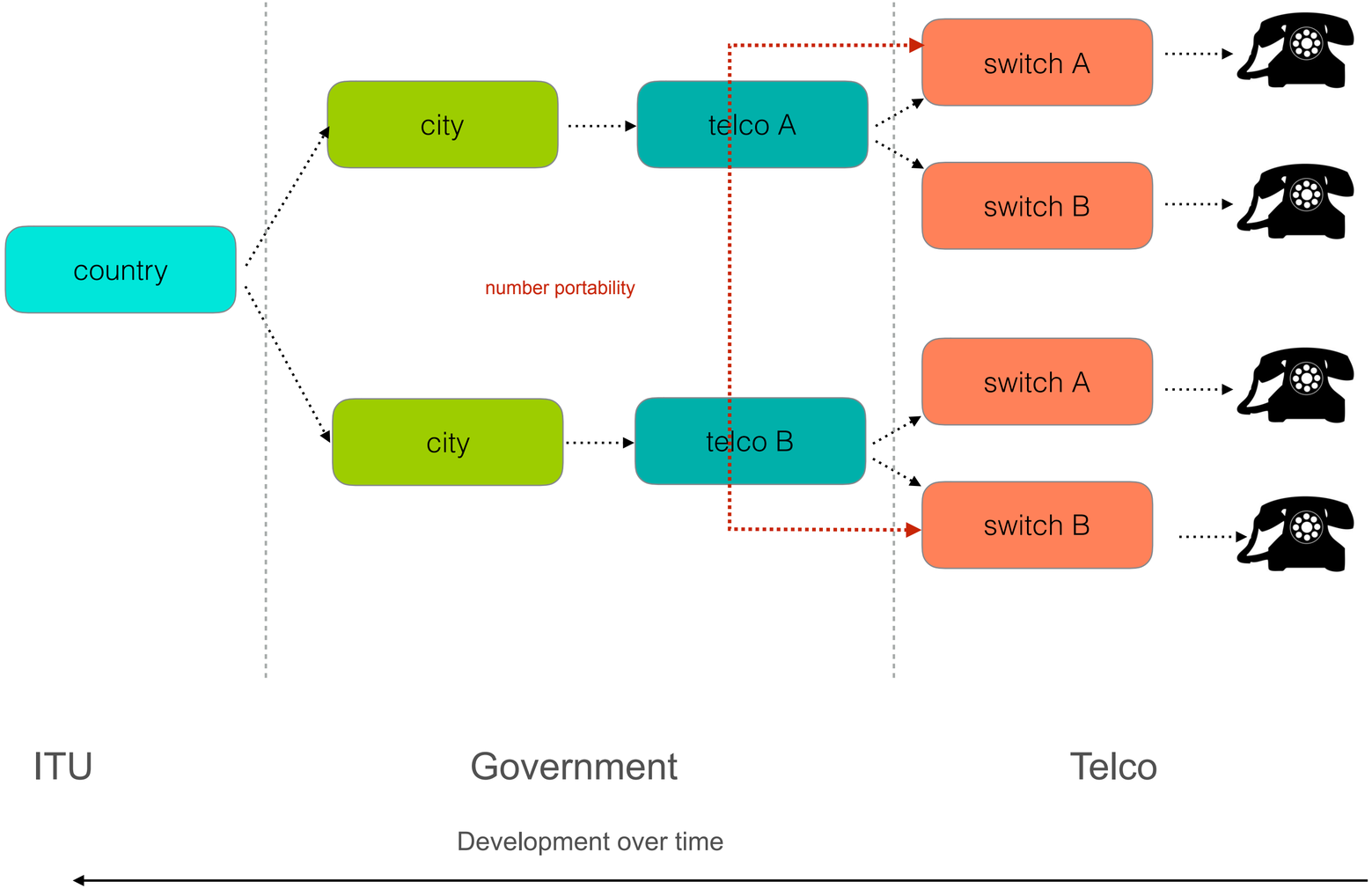


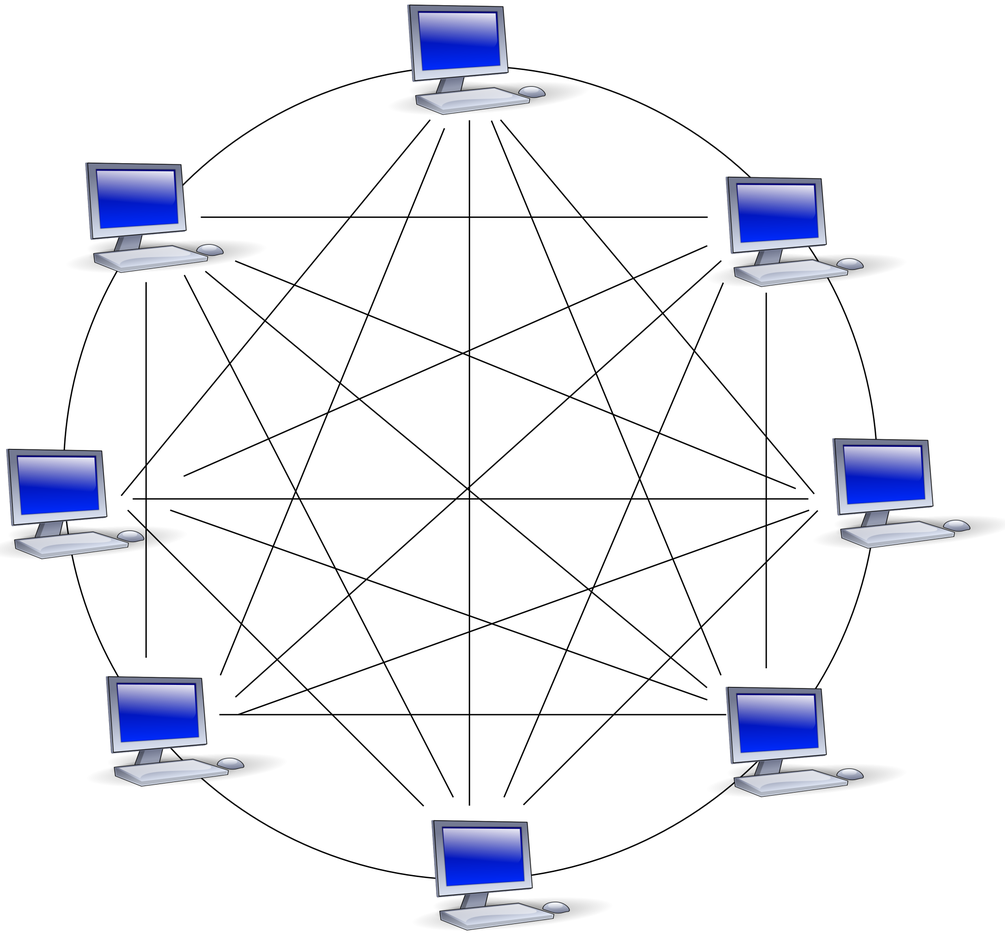
Decentralised
(The Internet)

What if I need a number

(or an address)

The telephone system





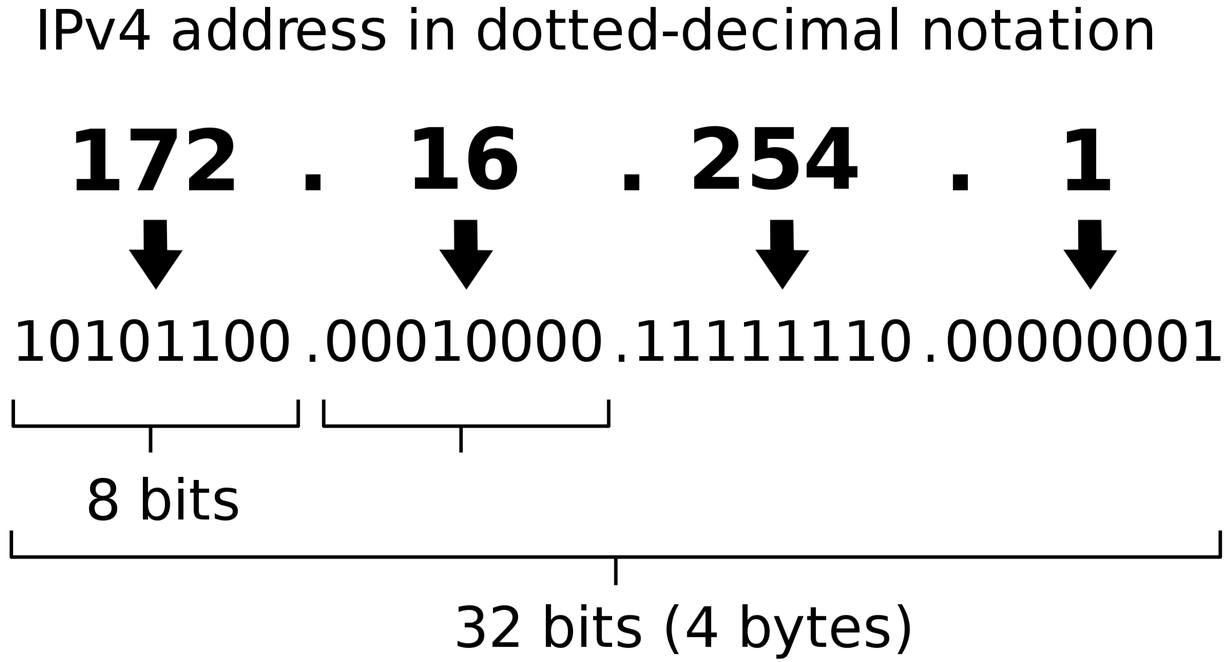
?

Internet Number Resources

The Regional Internet Registries

IPv4 address

- Unique identifiers
- 4.2 billion address



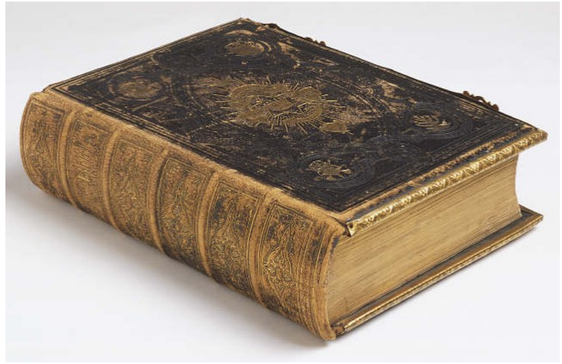
- www.ripe.net = 193.0.1.153

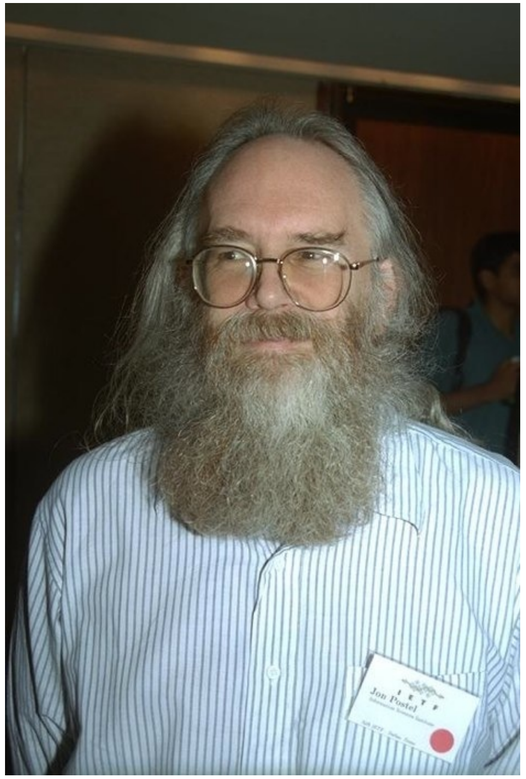
Address distribution

- **Addresses have to be unique**
  - otherwise packets cannot be delivered
- **Addresses have to be registered**
  - So you know who uses what (important for technical coordination)

Early address distribution

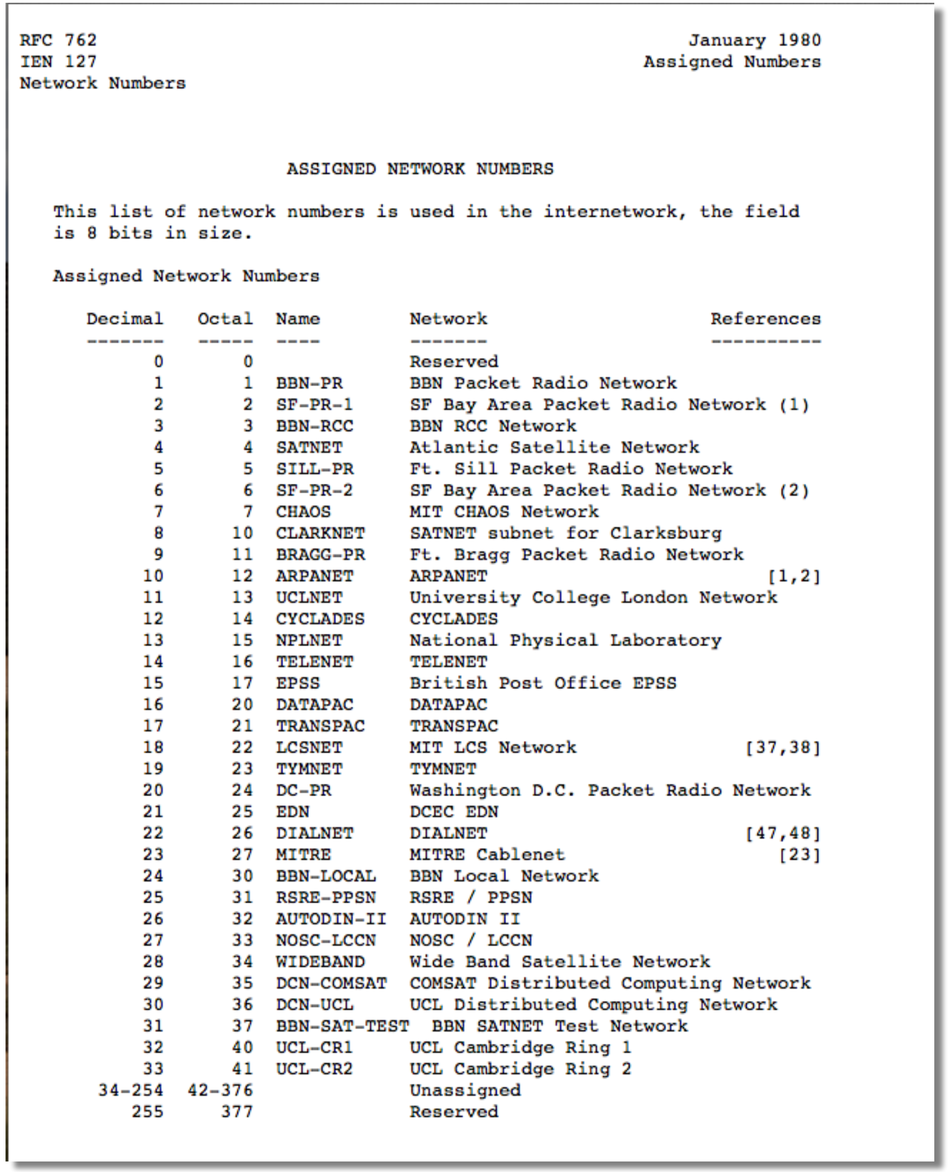
- RFC Editor
- Authored many RFCs
- First member of ISOC
- Administrator of .us
- Root server operator
- Internet Assigned Numbers Authority (IANA)





Jon Postel (1943 - 1998)

IANA Registry



RFC 762 January 1980
IEN 127 Assigned Numbers
Network Numbers

ASSIGNED NETWORK NUMBERS

This list of network numbers is used in the internetwork, the field is 8 bits in size.

Assigned Network Numbers

Decimal	Octal	Name	Network	References
0	0		Reserved	
1	1	BBN-PR	BBN Packet Radio Network	
2	2	SF-PR-1	SF Bay Area Packet Radio Network (1)	
3	3	BBN-RCC	BBN RCC Network	
4	4	SATNET	Atlantic Satellite Network	
5	5	SILL-PR	Ft. Sill Packet Radio Network	
6	6	SF-PR-2	SF Bay Area Packet Radio Network (2)	
7	7	CHAOS	MIT CHAOS Network	
8	10	CLARKNET	SATNET subnet for Clarksburg	
9	11	BRAGG-PR	Ft. Bragg Packet Radio Network	
10	12	ARPANET	ARPANET	[1,2]
11	13	UCLNET	University College London Network	
12	14	CYCLADES	CYCLADES	
13	15	NPLNET	National Physical Laboratory	
14	16	TELENET	TELENET	
15	17	EPSS	British Post Office EPSS	
16	20	DATAPAC	DATAPAC	
17	21	TRANSPAC	TRANSPAC	
18	22	LCSNET	MIT LCS Network	[37,38]
19	23	TYMNET	TYMNET	
20	24	DC-PR	Washington D.C. Packet Radio Network	
21	25	EDN	DCEC EDN	
22	26	DIALNET	DIALNET	[47,48]
23	27	MITRE	MITRE Cablenet	[23]
24	30	BBN-LOCAL	BBN Local Network	
25	31	RSRE-PPSN	RSRE / PPSN	
26	32	AUTODIN-II	AUTODIN II	
27	33	NOSC-LCCN	NOSC / LCCN	
28	34	WIDEBAND	Wide Band Satellite Network	
29	35	DCN-COMSAT	COMSAT Distributed Computing Network	
30	36	DCN-UCL	UCL Distributed Computing Network	
31	37	BBN-SAT-TEST	BBN SATNET Test Network	
32	40	UCL-CR1	UCL Cambridge Ring 1	
33	41	UCL-CR2	UCL Cambridge Ring 2	
34-254	42-376		Unassigned	
255	377		Reserved	

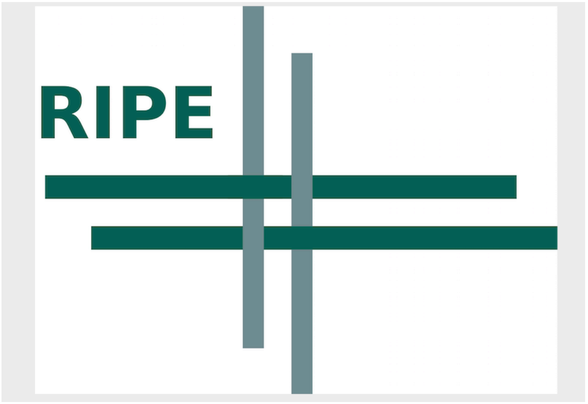
Does this scale?

IETF: Take a regional approach

- **Identified the need for distributed system (RFC 1174 - 1990)**
  - The need for a more scalable system
  - Delegate responsibility to regional entities?
- **Definition of those entities (RFC 1466 - May 1993)**
  - Legitimised by networks in the area (users of addresses)
  - Well established organisation (not only be a registry)
  - Stable, reliable and suitable to provide timely service
  - Implement the rules set by the community
  - Coordinate with the IANA in distributing resources

Réseaux IP Européens RIPE

- **Established in April 1989**
- **Objective**
  - to ensure the necessary administrative and technical coordination to allow the operation and expansion of a pan-European IP network (ripe-001)
- **Coordination amongst the European networks**
- **Exchanging experiences and seek efficiencies**
- **Open to anybody**
- **Not a legal entity**



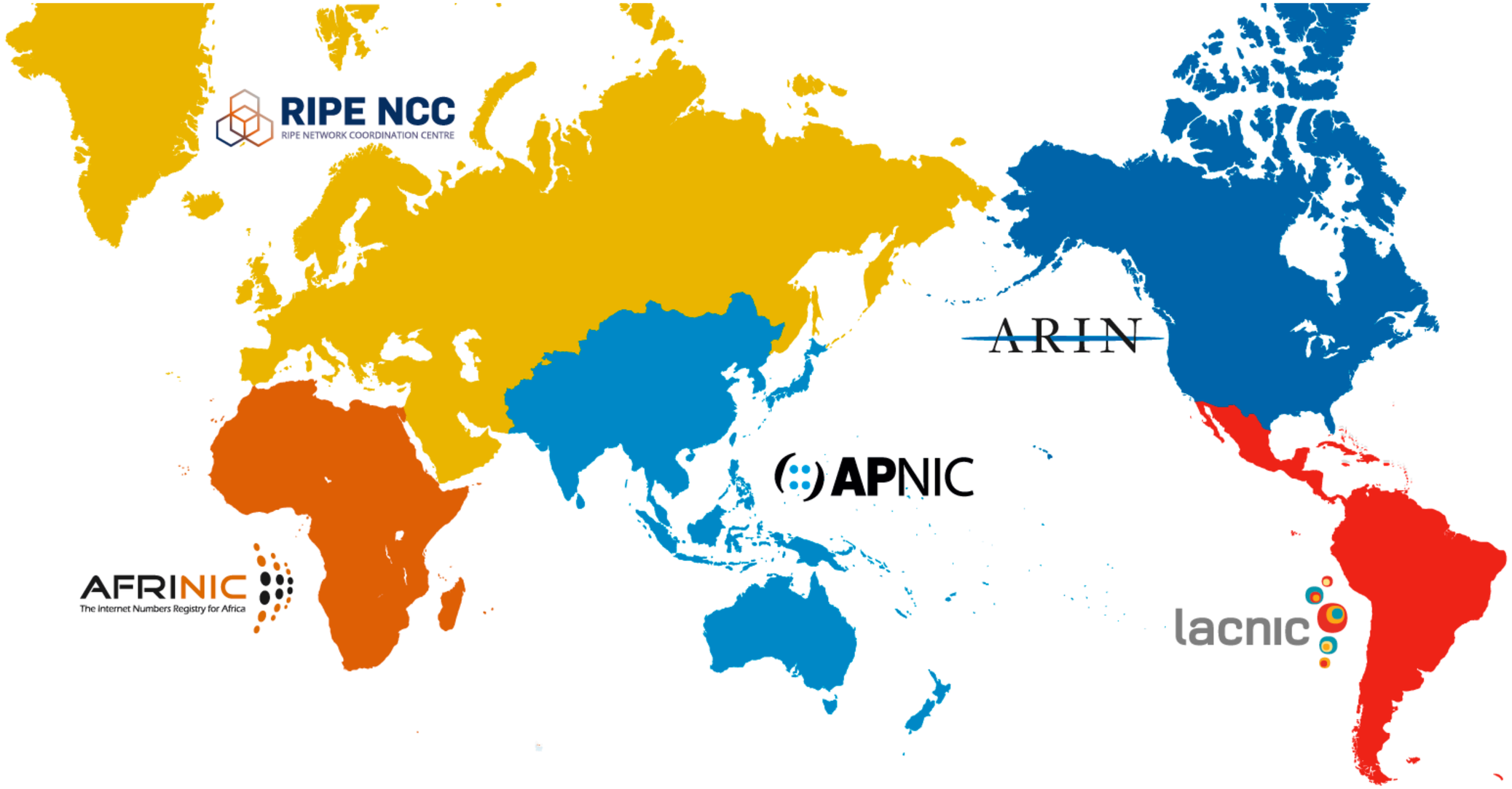
RIPE Network Coordination Centre

- **Established in 1992 by RIPE community**
  - Initially part of RARE (association of research networks)
- **Secretariat to the RIPE community**
  - Organises meetings
  - Operates mailing lists
  - Maintains contact database (who uses what IP address)
- **Well suited to become one of those new registries**
- **Legal entity since 1992**

The RIPE NCC: first RIR

- **Association in Amsterdam**
- **Membership organisation**
  - 20,000 members
- **Receives large address blocks from IANA**
- **Distributes on to members**
  - Implements (policies) set by RIPE
  - Maintains records in RIPE Database

RIR Service Regions

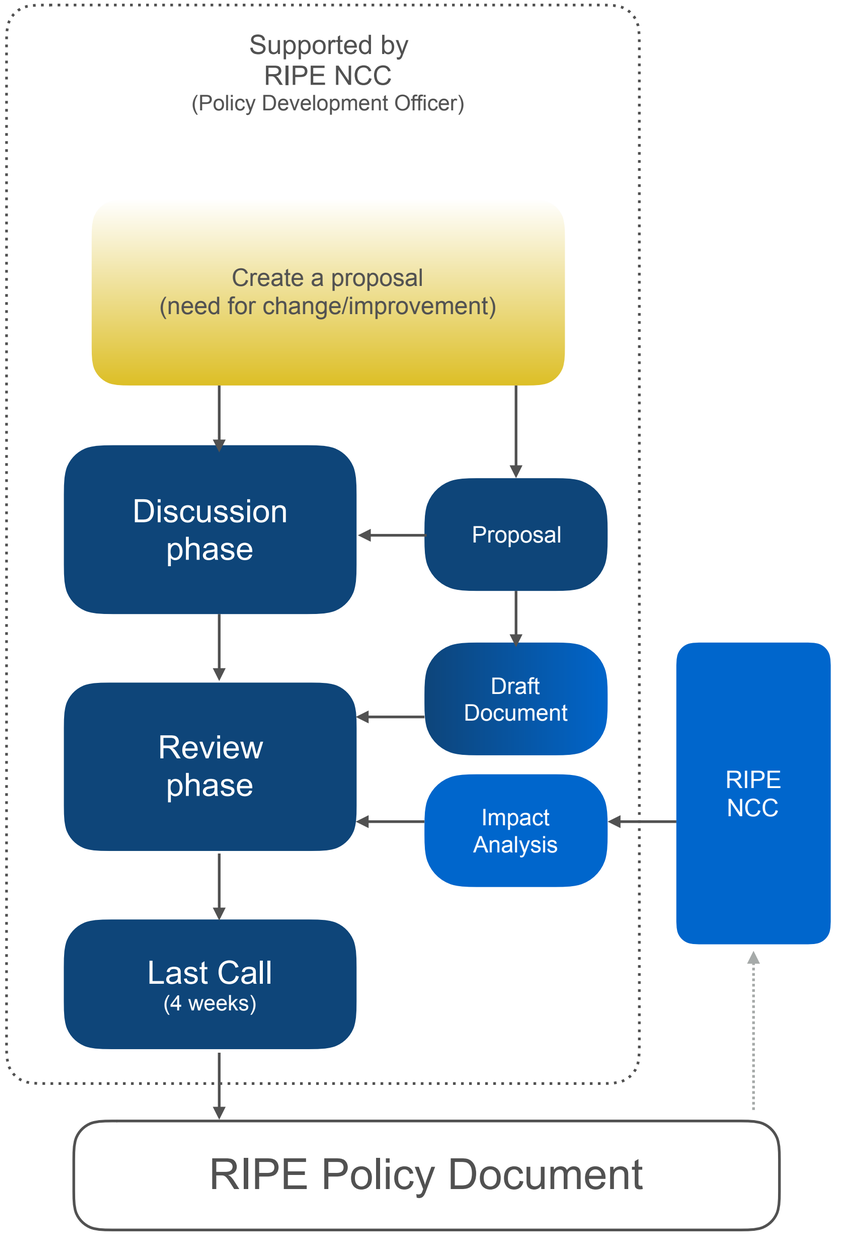


Five RIRs

- **All membership based not-for-profit**
  - Funded by membership fees
  - Distribute IPv4, IPv6 and Autonomous System Numbers
- **Policies set by regional community**
  - Open, inclusive and consensus based
  - Implemented by the Regional Internet Registry
- **Global coordination via the Number Resource Organisation**
  - NRO Number Council forms the ASO in ICANN

RIPE Policy Development

- **Process described in ripe-642**
- **Decisions made on mailing lists**
  - Face-to-face meetings help
- **Rough consensus**
  - Similar to IETF process
  - No voting or counting
  - Anonymous



RIPE Working Groups

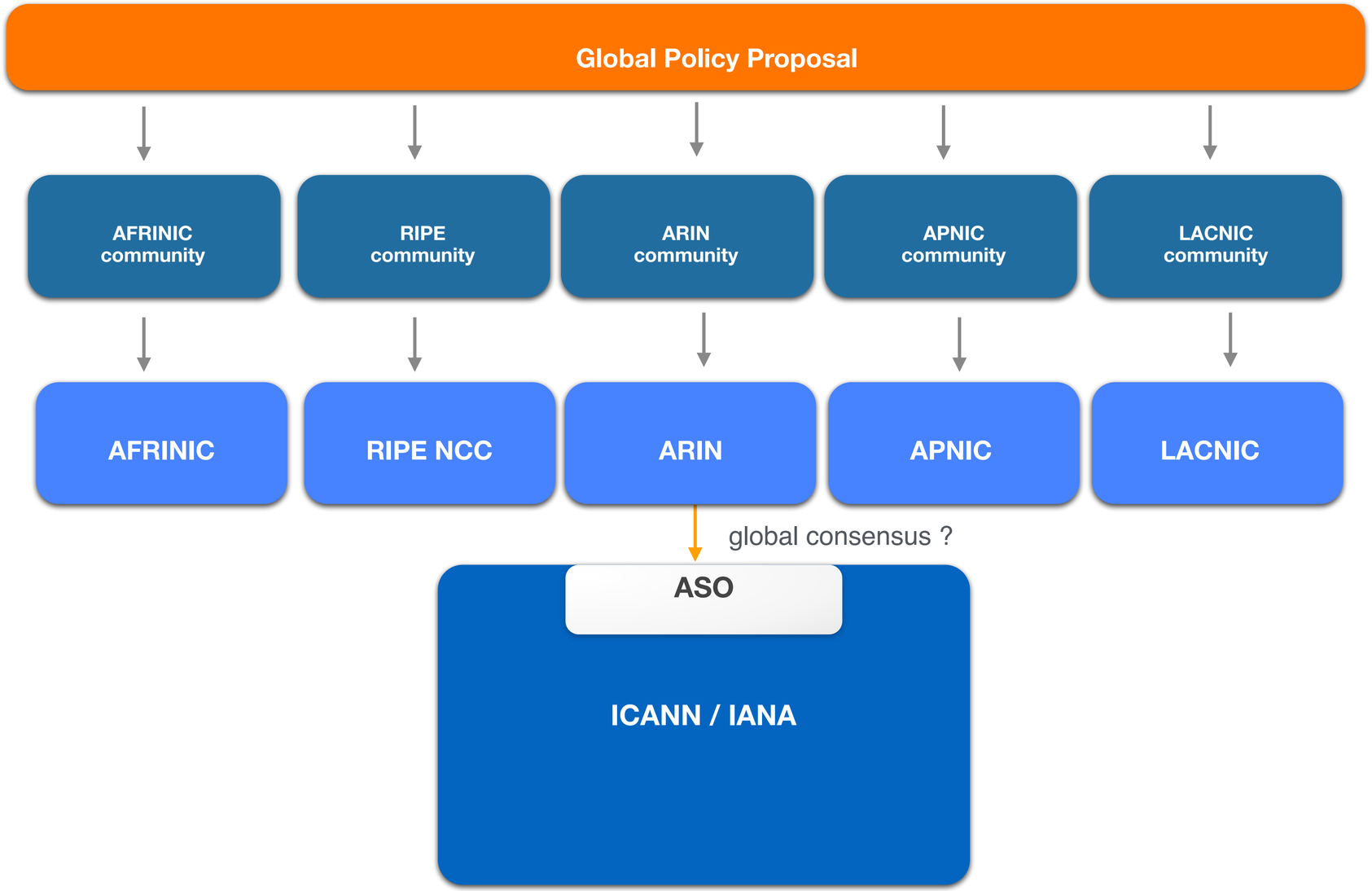
- Address Policy
- RIPE Database
- DNS
- Connection
- Anti-Abuse
- IPv6
- Cooperation

Most of them build policy

between technical and governments

What about IANA?

The RIR Hierachy



Benefits of regional approach

- **We are very close to our users (stakeholders)**
  - Easier communications
  - Easier to maintain accurate registry
- **Policies can adapt to regional differences**
  - Different stages of Internet development
  - Different priorities amongst stakeholders
- **Overlap exists between community members**
  - All policy development is open to everyone
  - No requirement to be from inside the region

IPv6

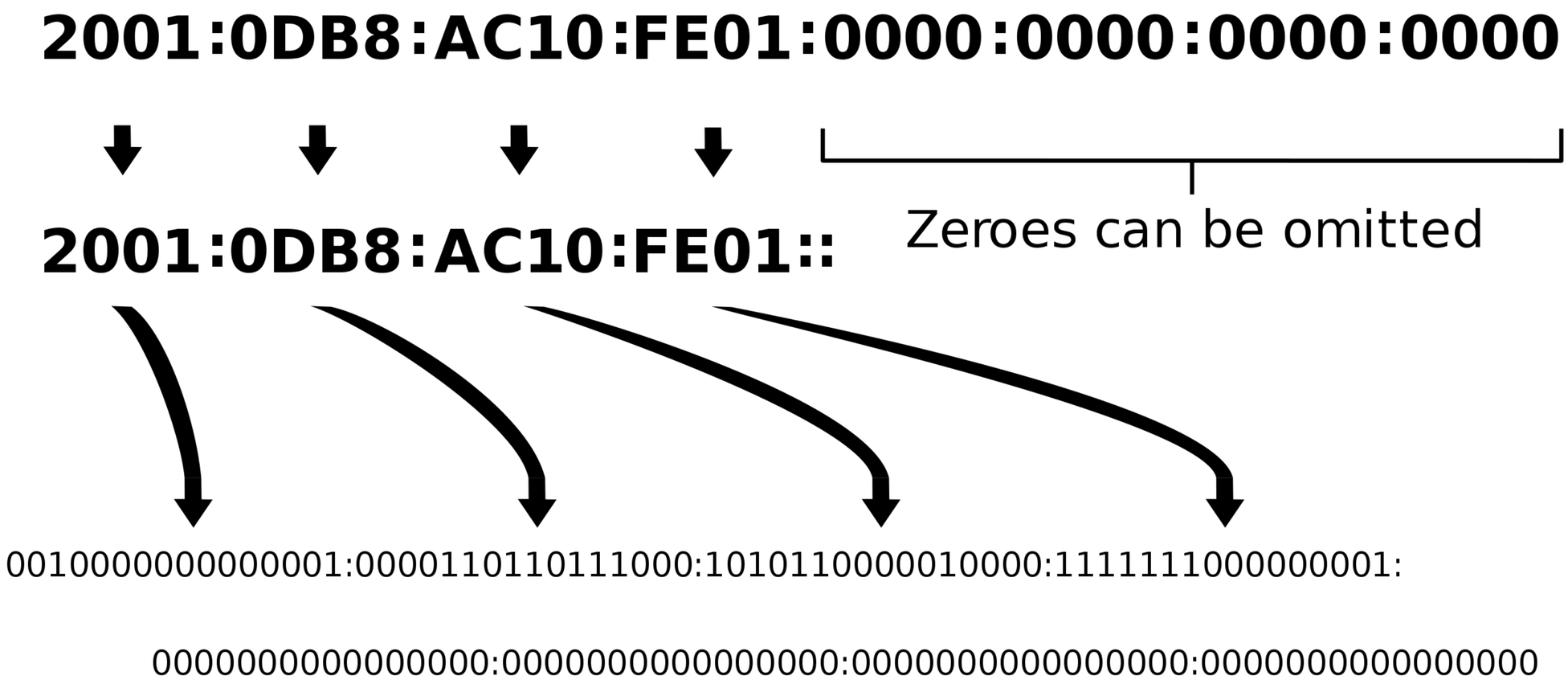
Running of out IPv4

IPv4 has 4.2 billion addresses

Problem? The IETF to the rescue!

- **We need a solution to expand the address space**
  - 4.2 billion isn’t enough
- **The IETF made a call for “IP Next Generation”**
  - Several proposals made
  - Ultimately resulted in IPv6, standardised in 1995
  - Revised standard released in 1998
  - Consolidated standard (revision) in July 2017 (RFC 8200)

IPv6 addresses



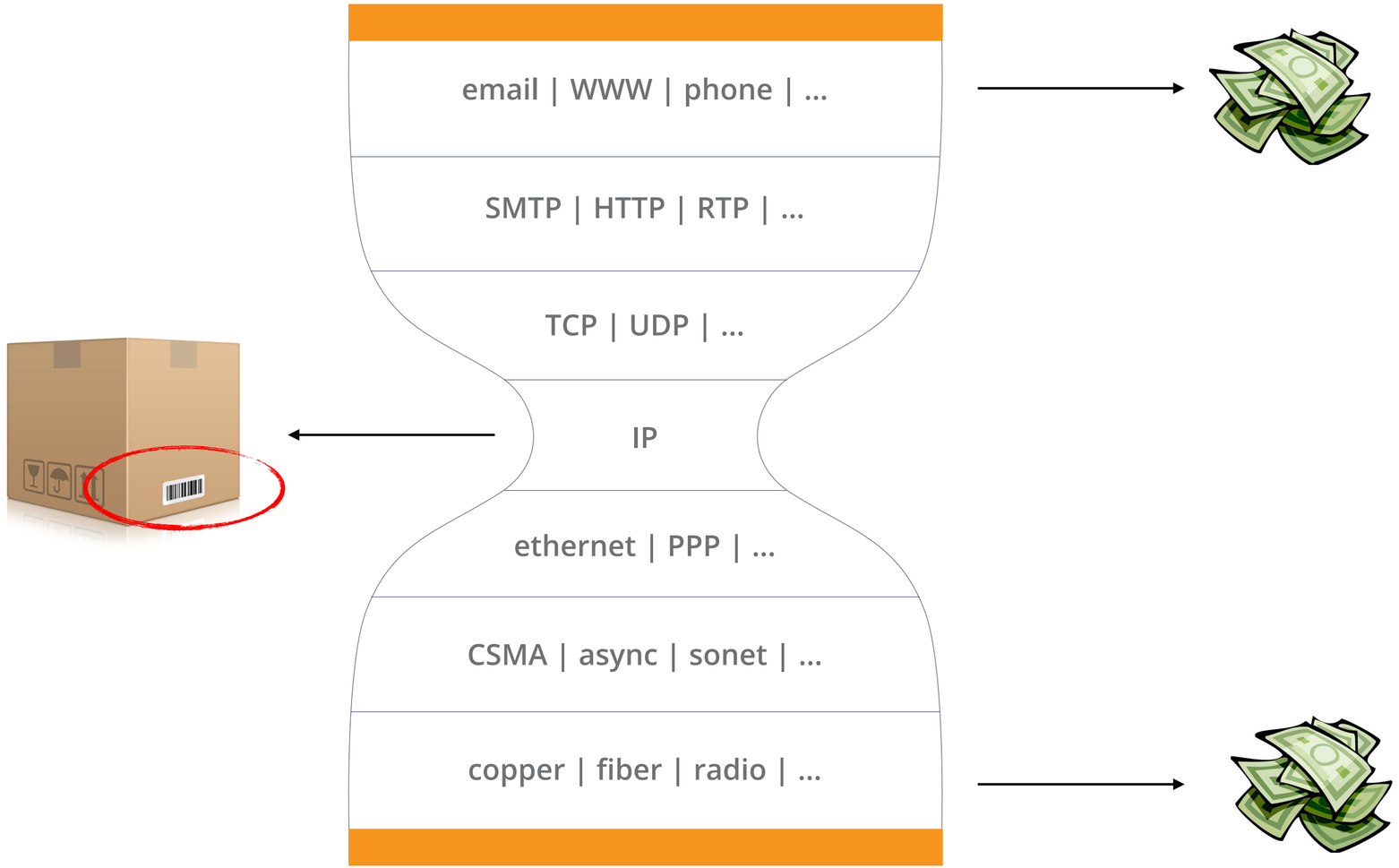
IPv6 Protocol Basics

- **Functional the same as IPv4**
  - “Same cardboard box, slightly bigger label on it”
- **Address has 128 bits (IPv4 uses 32 bits)**
  - 2^128 addresses available
  - 340282366920938463463374607431768211456 options
- **It is not backwards compatible**
  - Many IPv4-to-IPv6 transition technologies available

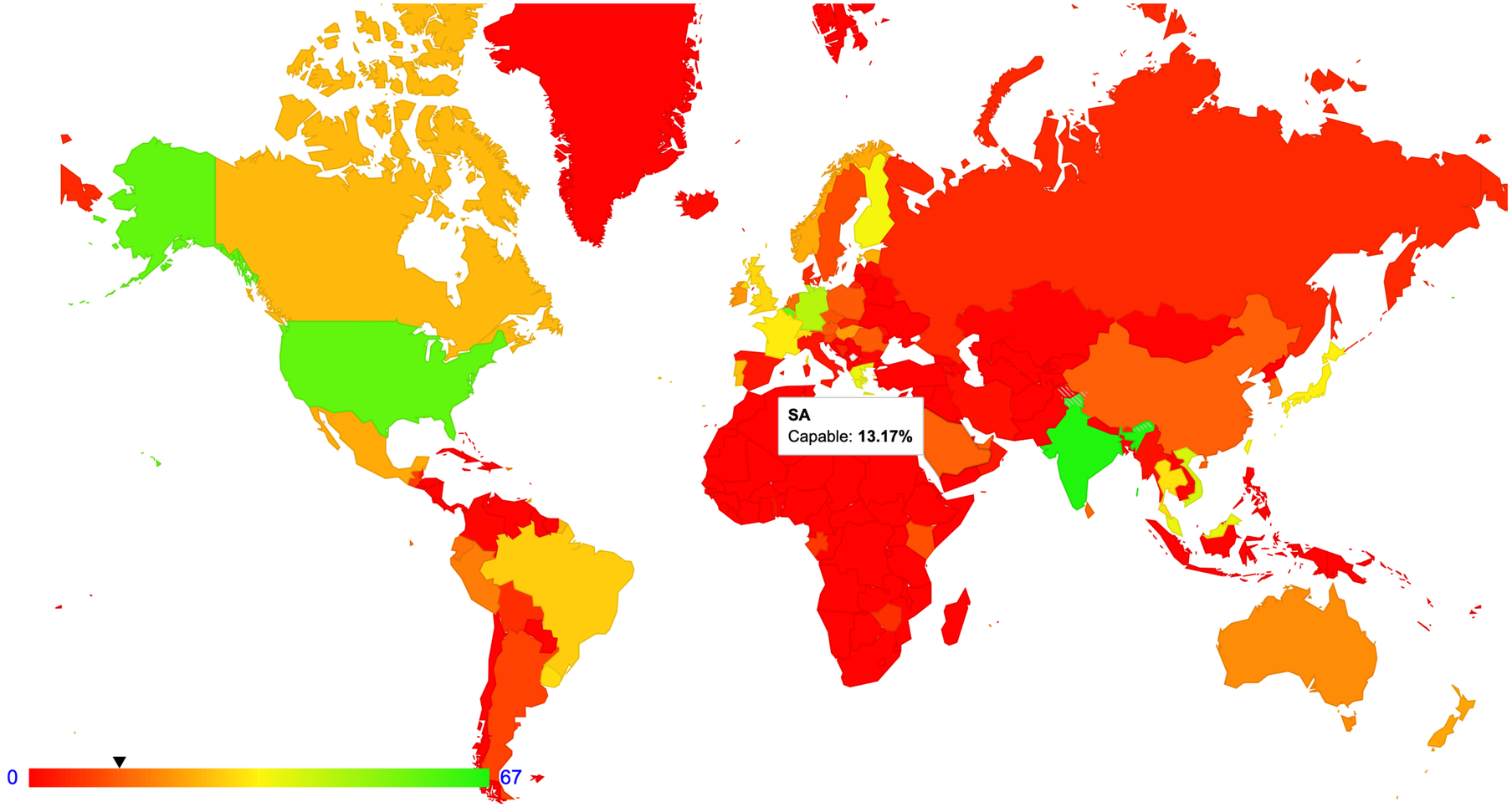
Deploying IPv6: the plan

- **IPv6 and IPv4 are not interoperable**
  - Dual-stack
  - You can “retrofit” IPv6 onto existing IPv4 networks
- **Devices that have both can choose to use either IPv4 or IPv6**
  - Depending on the peer’s capability
  - When both are available: use IPv6
  - IPv4 will slowly fade away

The challenge: IPv6 is invisible



Current state of IPv6 deployment



Source: APNIC Labs (http://labs.apnic.net)

What if we don’t deploy IPv6?

Network Address Translation

- **IP addresses can be shared on a network**
  - Just as more people can live at the same address
- **Network Address Translation (NAT)**
  - Common method to share an IP address
  - Mapping one global address to multiple internal ones
  - Internal addresses only have to be unique locally

Drawbacks of Address Sharing

- **It breaks the “openness” of the Internet**
  - No longer allows for any-to-any communication
  - Forces everybody back into client-server models
  - Protocol developers have to compensate for NAT
- **Inhibitor to “permission-less innovation”**
  - You are left to the developer or operator of the NAT
  - NAT becomes a gateway to a “walled garden”
- **NATs are expensive to scale**

Shameless Plug: RACI

- **RIPE Academic Cooperation Initiative**
  - Provides fellowships to our meetings for academics
  - Build a network of people doing Internet research
- **Present your work to the RIPE community**
  - Instant feedback from network operators
  - Test your ideas and gather input
- **See https://www.ripe.net/raci**
  - Always open for applications

Main take-aways

- **An IP address is just a number**
- **Needs to be unique and registered**
- **Policy is made by community**
  - Those that need and use the addresses
- **All RIRs are not-for profit membership organisations**
- **IPv6 ensures future-growth and innovation**

Questions

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