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Address Supporting Organization

“How It Works”

The Regional Internet Registry System



Agenda

- Overview of the Regional Internet Registry System (RIR)
- Policy Development
- Internet Number Resources (IPv4, IPv6 and ASNs)
- Routing
- Noteworthy Developments
- RIR Services and Tools

A background network diagram consisting of a complex web of thin, light blue lines connecting various nodes. Some nodes are represented by small blue dots, while others are larger, multi-layered circles in shades of blue and green, suggesting a hierarchical or central structure. The overall aesthetic is clean and technical, typical of a presentation on networking or technology.

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The Regional Internet Registry (RIR) System

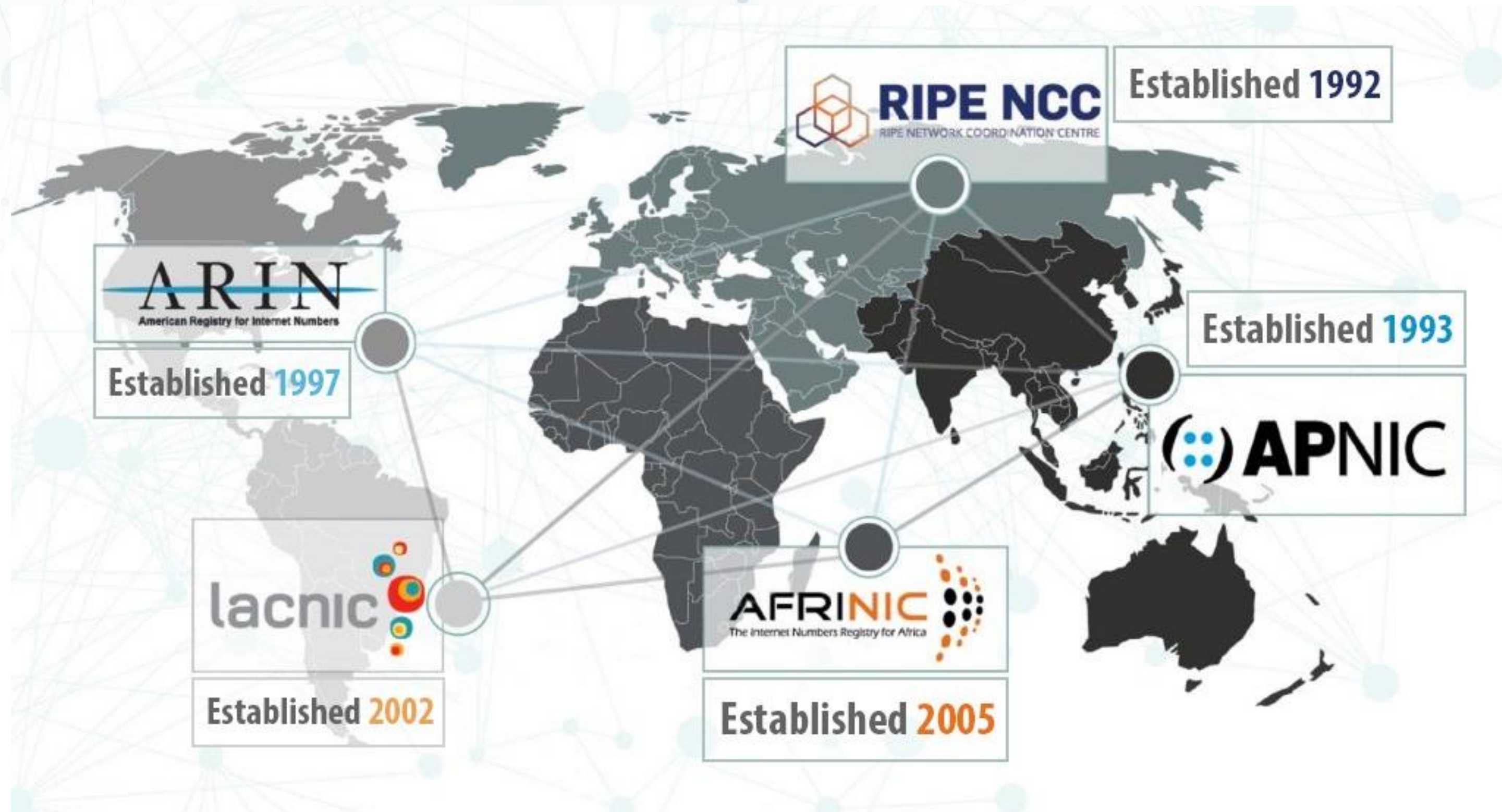
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RIR

Manages the allocation, administration and registration of Internet number resources in a specific region of the world.

The RIRs



Functions of an RIR



Manage and distribute
Internet Number

Resources:

- IPv4 and IPv6 addresses
- Autonomous System numbers (ASNs)



Maintain directory
services including
Whois, Whoas, and
routing registries

Provide reverse DNS



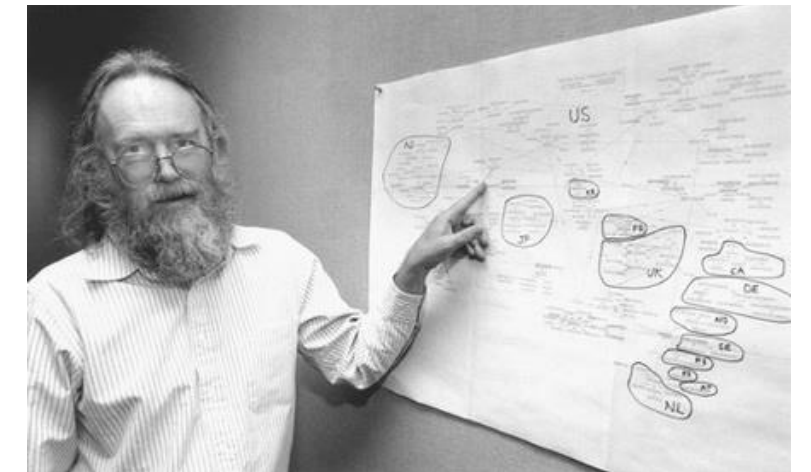
Support Internet
infrastructure through:

- Technical coordination
- Community-driven policy process
- Training and capacity building

Brief History

Internet Number Resource (IP) Administration

- **1980s to 1990s**
 - US DoD contracted administration of **names, numbers, and protocols** to University of Southern California's ISI
 - Contract run by Jon Postel; function called Internet Assigned Numbers Authority (**IANA**)
 - Registration/support contracted to SRI International, later to Network Solutions (NSI)
 - Regionalization begins – **RIR** system forms
 - **IP number resource** administration split from **Domain Name System** (DNS)
 - US Govt separates administration of commercial Internet (**InterNIC**) from the military Internet (**DDN NIC**)



Jon Postel

Early Registrations

Early IP address space referred to as “legacy space”



Internet number
resources
allocated liberally



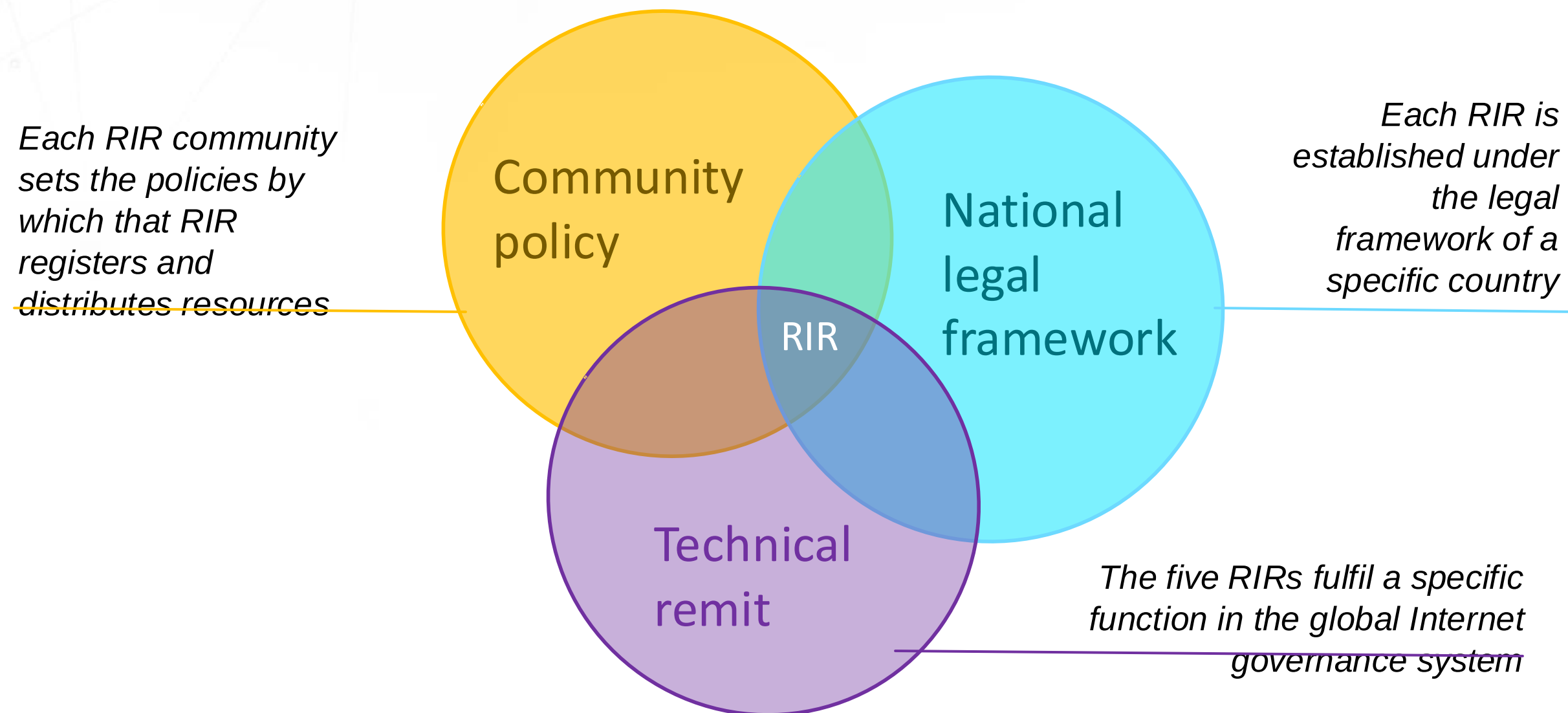
Organizations made
simple request; no
contract required



The Internet rapidly
expanded,
distribution could not
be managed this way

RIR Governance

Each RIR operates in accordance with three factors



The RIRs are...

● Independent

- Not governmental bodies or entities

● Not-for-Profit

- 100% community funded
- Fee for services, not number resources

● Membership-based

- Open to all number resource holders (e.g., Internet service providers (ISPs), governments, corporations)

● Community-developed policies

- Member-elected governing boards
- Open and transparent

Policy Development

Multistakeholder approach



RIR Policy Development Process



Inclusive

Anyone can participate



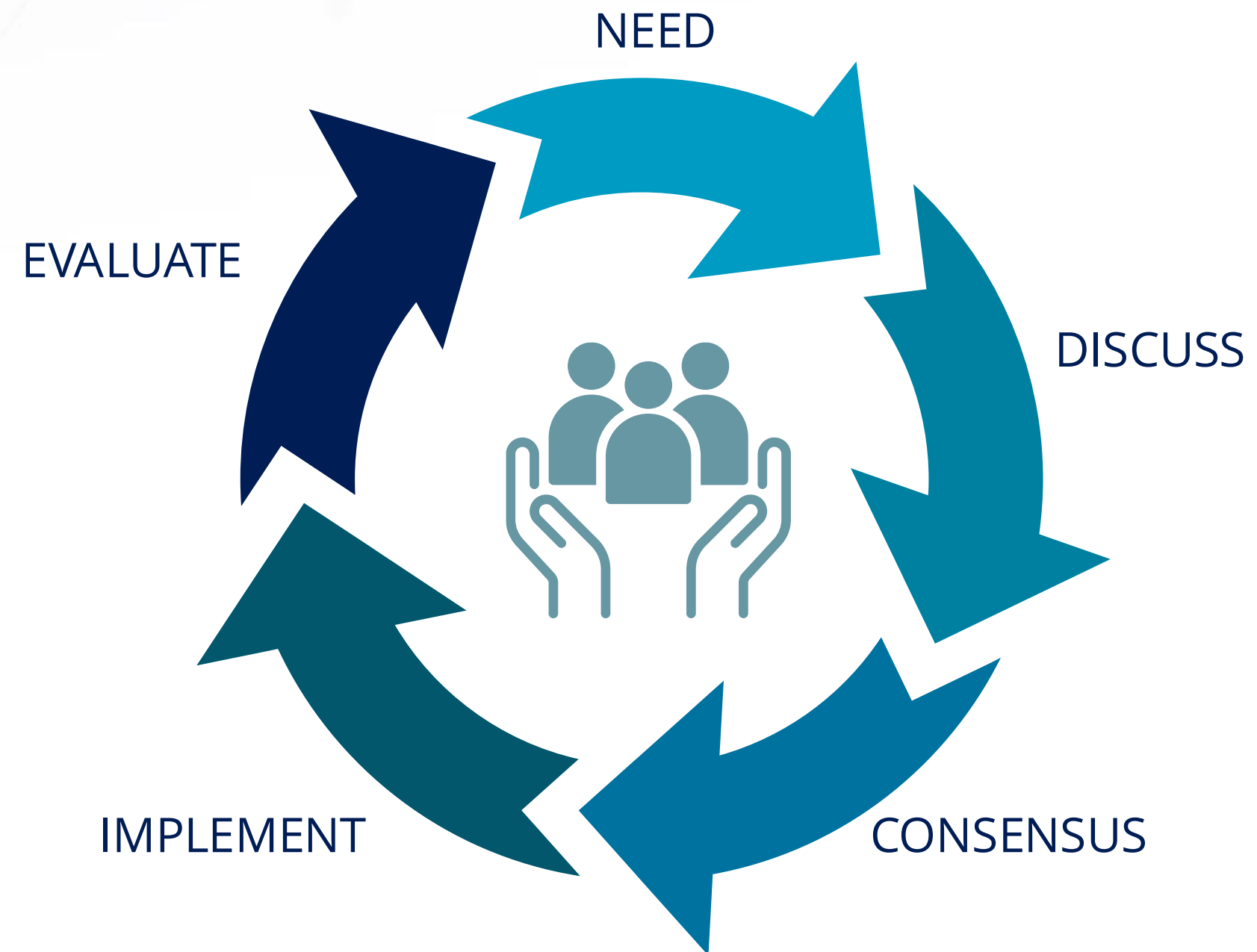
Bottom Up

Internet community
proposes and approves
policies



Transparent

Documented and
published decisions and
policies



Number Resource Organization (NRO)



www.nro.net

To actively contribute to an **open, stable, and secure Internet** by:

- Providing and promoting a coordinated Internet number registry system
- Being an authoritative voice on the multistakeholder model and bottom-up policy process in Internet governance
- Coordinating and supporting joint activities of the RIRs

NRO Publications

- **Global Internet Number Statistics**
 - Internet Number Resources Status Report (updated quarterly)
 - Global stats on IPv4, IPv6, ASN (updated daily)
 - RPKI Adoption Reports by IPv4, IPv6, economy (updated daily)
 - <https://www.nro.net/statistics>
- **Comparative Policy Overview**
 - Updated quarterly
 - Information on RIRs Membership policies (access to delegation and registration services)
 - <https://www.nro.net/rir-comparative-policy-overview>

ICANN Policy Development Stakeholders



Supporting Organisations

ASO: Address Supporting Org.

GNSO: Generic Names Supporting Org.

CCNSO: Country Code Names Support Org.



Advisory Committees

At Large Advisory Committee

DNS Root Server System Advisory Committee

Governmental Advisory Committee

Security and Stability Advisory Committee

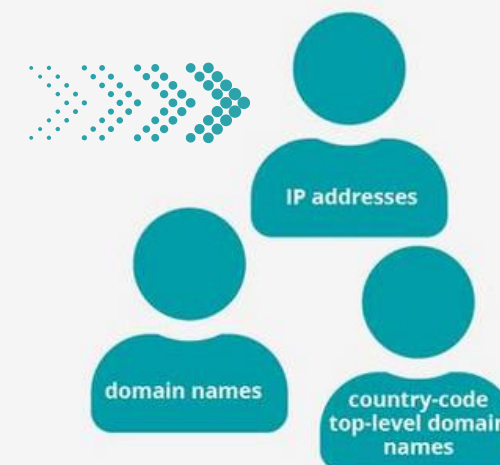


Technical Liaison Group

Works with the organisations developing the basic Internet protocols.

ICANN policy development stakeholders

Supporting organisations



Advisory committees



Technical liaison group



ICANN ASO AC (Address Council)

Who is it:	NRO Number Council
What is it?	Number Resource Advisory Council
How is it Organized?	15 Members [3 From Each Region] – 2 Elected at Large – 1 Appointed by RIR Board • RIR & ICANN Observers
Term of Office	Different for every RIR
What Does it Do?	Advise ICANN Board on Internet Numbers • Overseeing the Global Policy Development Process • Appoint ICANN Board Members (2) • Appoint member to ICANN NomCom (1)

Global Policy Development Process



Internet Number Resources

IPv4, IPv6, Autonomous System Numbers (ASNs)

Internet Protocol (IP) Addresses

IP address – unique numerical address assigned to every device using Internet Protocol to send and receive data

- **IPv4**

- 32-bit addresses; written in dotted decimal
- $2^{32} = \sim 4.4$ billion
- e.g. 205.150.58.7

- **IPv6**

- 128-bit addresses; written in hexadecimal
- $2^{128} = \sim 50$ octillion for each of the roughly 6.5 billion people alive
- e.g. 2001:0503:0C27:0000:0000:0000:0000:0000

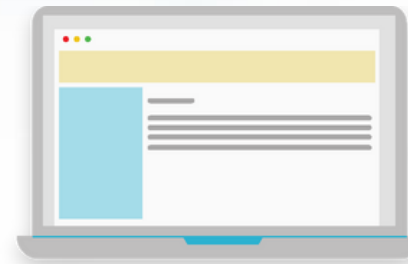
Autonomous System Numbers (ASNs)

- An **autonomous system** is a group of IP networks sharing the same routing policies and administered by a single operator
- Administered under the umbrella of a single entity
- **Routing** is the act of moving information (packets) across an internetwork from a source to a destination
- Network operators must have an **ASN** to control routing within their networks and to exchange routing information with other Internet Service Providers (ISPs)

IP Addresses are *Not* Domain Names

IP address

[Identifier]



e.g. 2001:0db8:85a3:0000:0000:8a2e:0370:7334

- Computers recognize **numbers**
- Identifies a device on the Internet
- Used for routing (moves information across an inter-network from a source to a destination)
- Every device directly connected to the Internet requires a unique IP address

DNS name

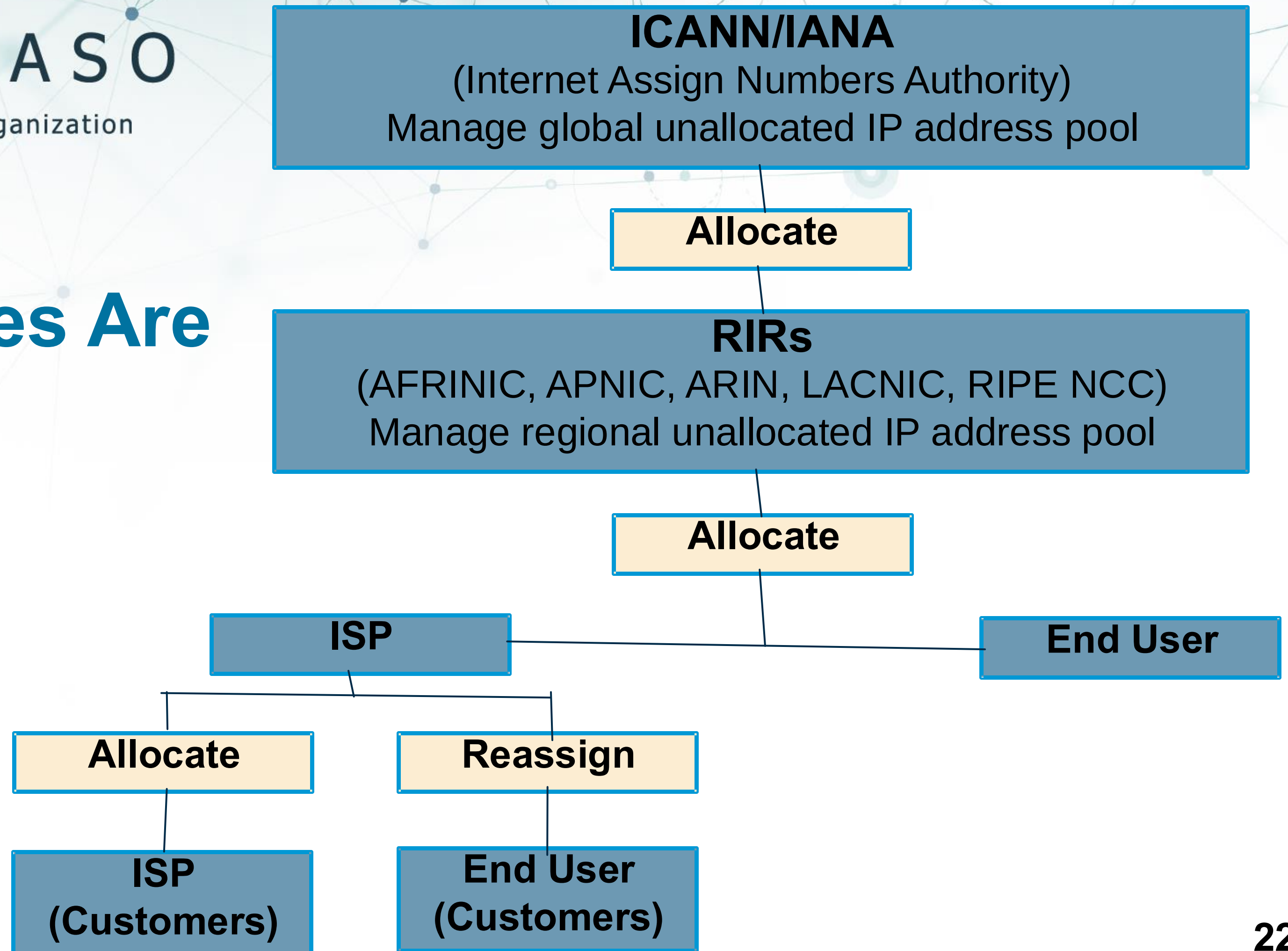
[Reference]



e.g. www.nro.net

- People recognize **names**
- Maps host name to unique IP address
- A means of storing and retrieving information about hostnames and IP addresses in a distributed database

How IP Addresses Are Issued



A background network diagram featuring a complex web of thin, light blue lines connecting various nodes. Some nodes are represented by small dots, while others are larger, multi-layered circles. The overall aesthetic is clean and technical, suggesting a focus on networking or data flow.

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Routing

Core Internet Functions: DNS & Routing

The Internet relies on two critical systems:

- **Routing** – forwards IP data packets between or across multiple networks from source to destination
- **DNS** - translates domain names to IP addresses (forward lookup) and IP addresses to domain names (reverse lookup)

These critical systems are not secure

- Subject to misconfigurations and nefarious activity

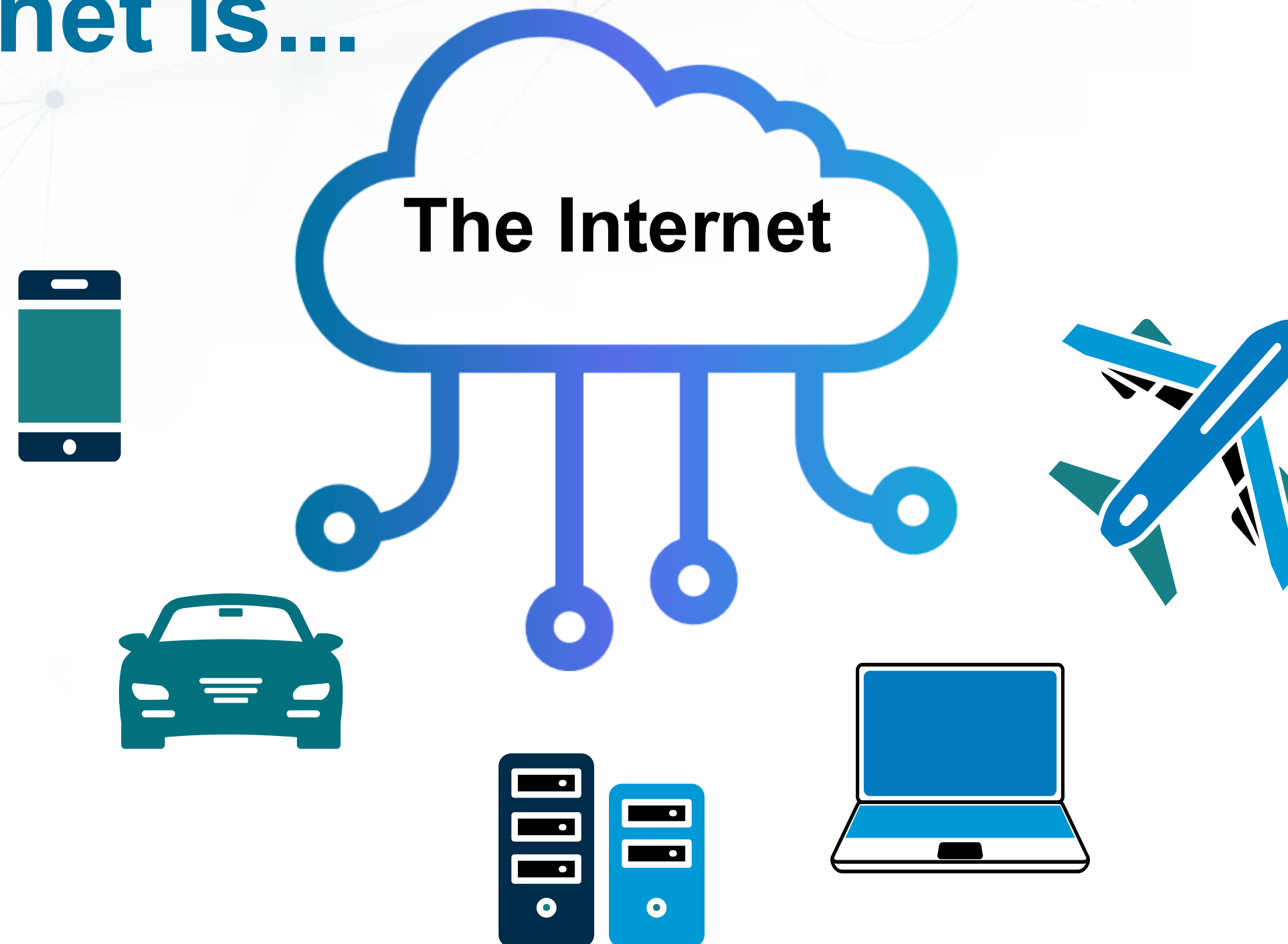
Traditional options for verifying routing

- Internet Routing Registry (IRR)
- Letters of Authority (LOAs)
- Seems "legit" (informal arrangement between ISPs)

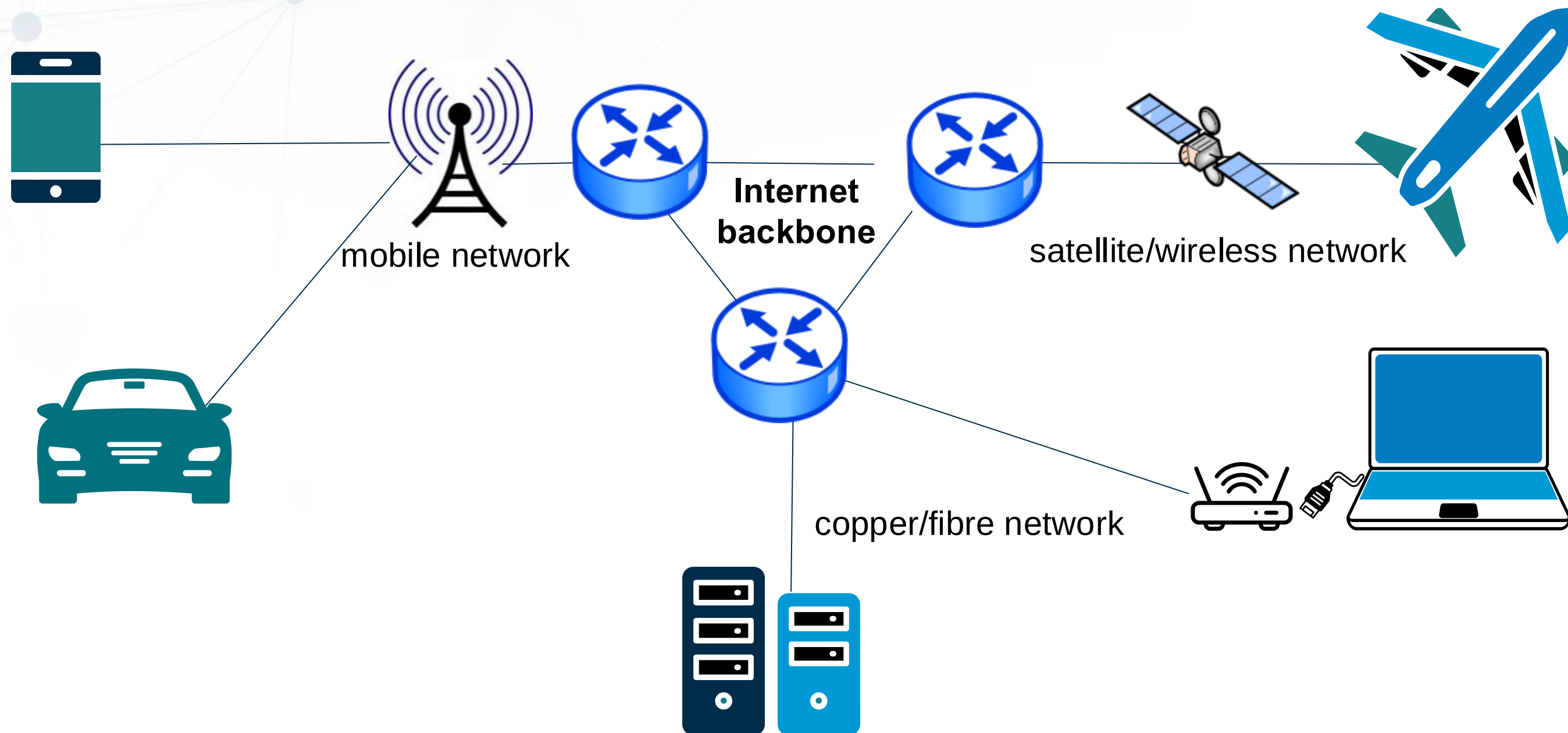
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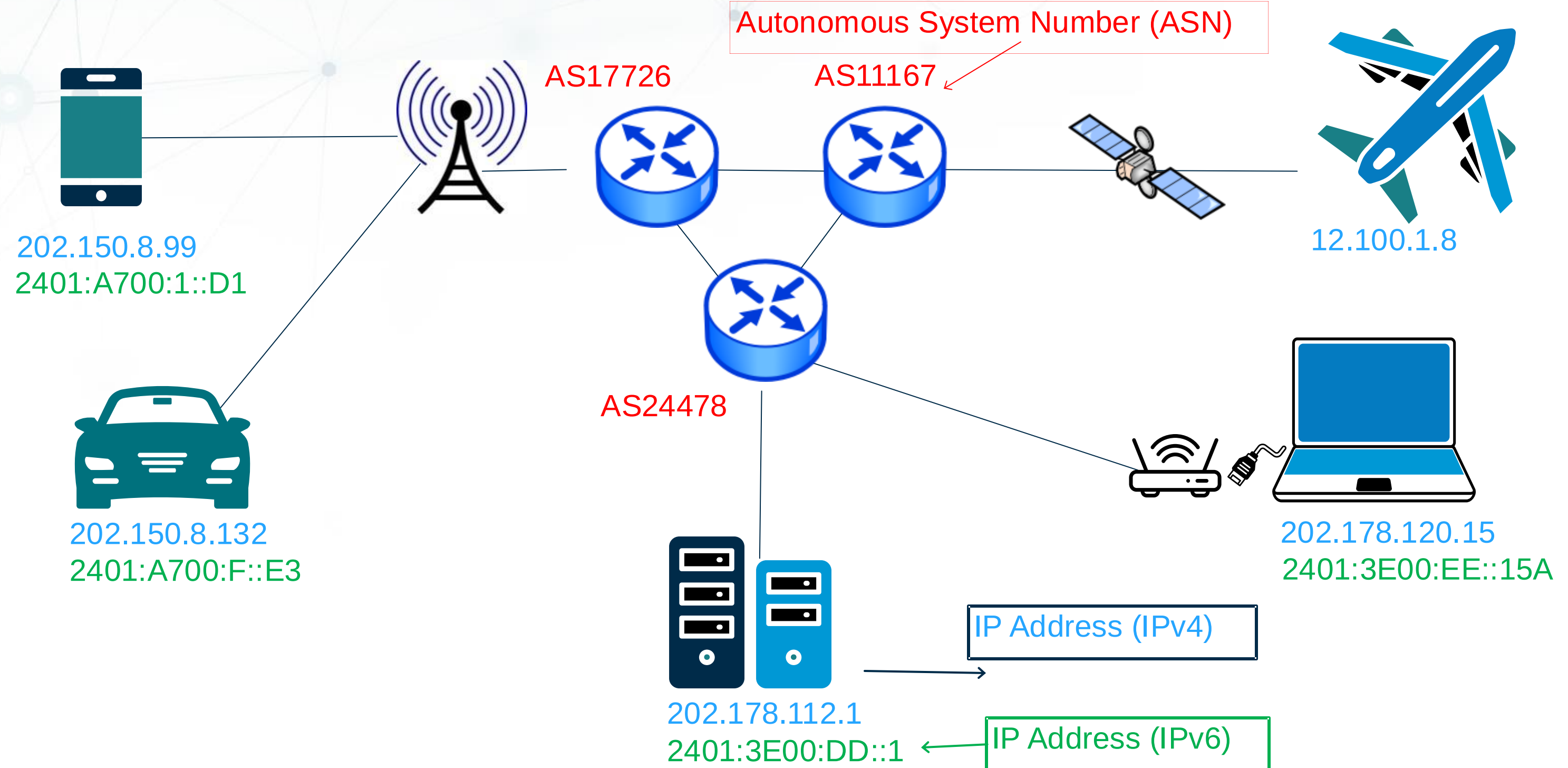
The Internet is...



A Network of Networks



Networks That Use Standard Protocols





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Noteworthy Developments

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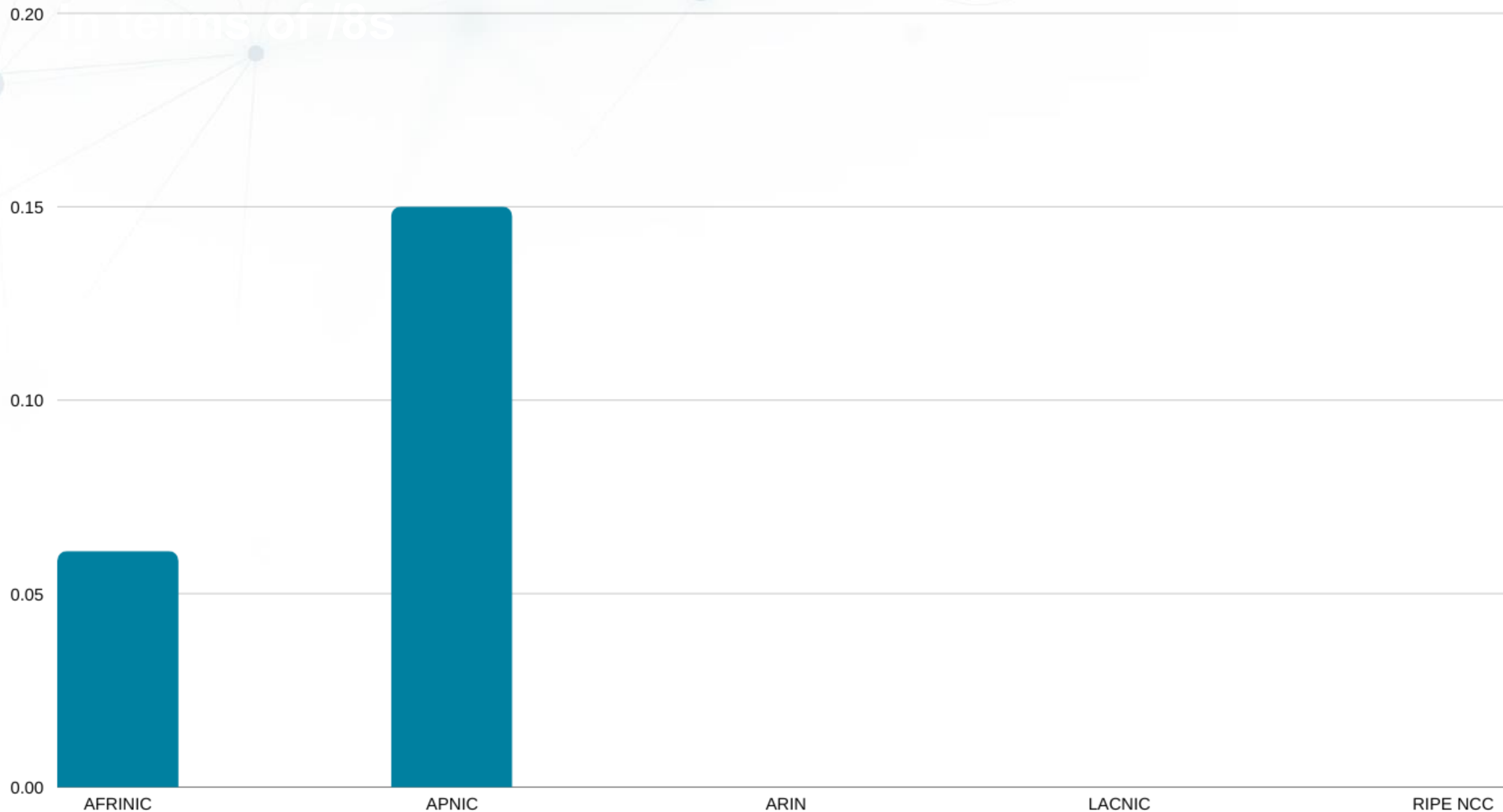
Global IPv4 Depletion at IANA – Feb 2011

Each RIR received its last /8 IPv4 address block from IANA on 3 February 2011



Available IPv4 Space in each RIR

- Measured in /8s



Post IPv4 Depletion

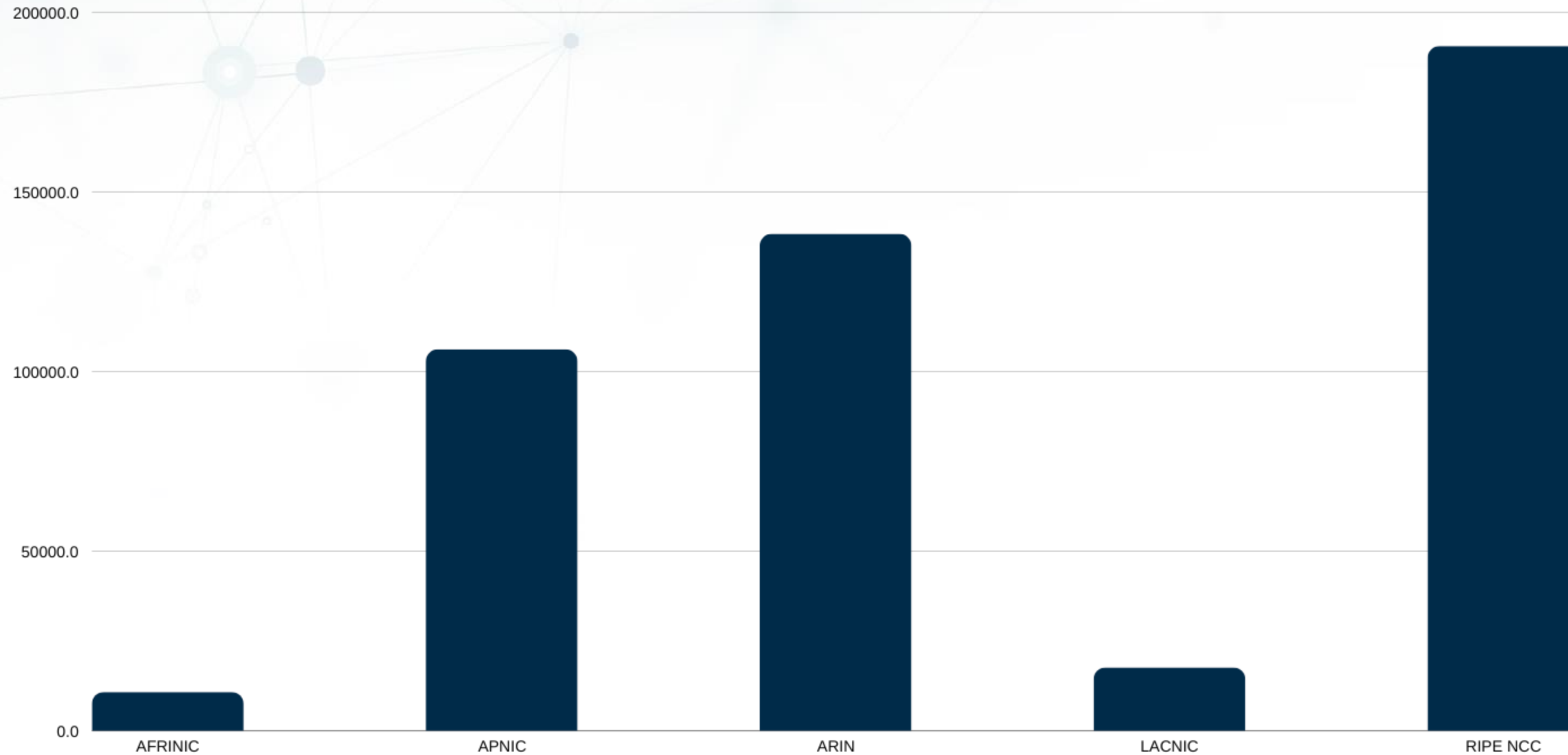
- **Movement to IPv6 has been steady**
 - ISPs rolling out IPv6
 - Steady increase in IPv6 traffic
 - Increase in IPv6 requests
- **Still high demand for IPv4**
 - All RIRs still receiving significant number of IPv4 requests
 - Customers increasingly turning to the IPv4 market for address space
 - Increase in fraudulent requests for IPv4 space
 - Submitting falsified business records, personal ID documents, etc.

IPv6 Deployment



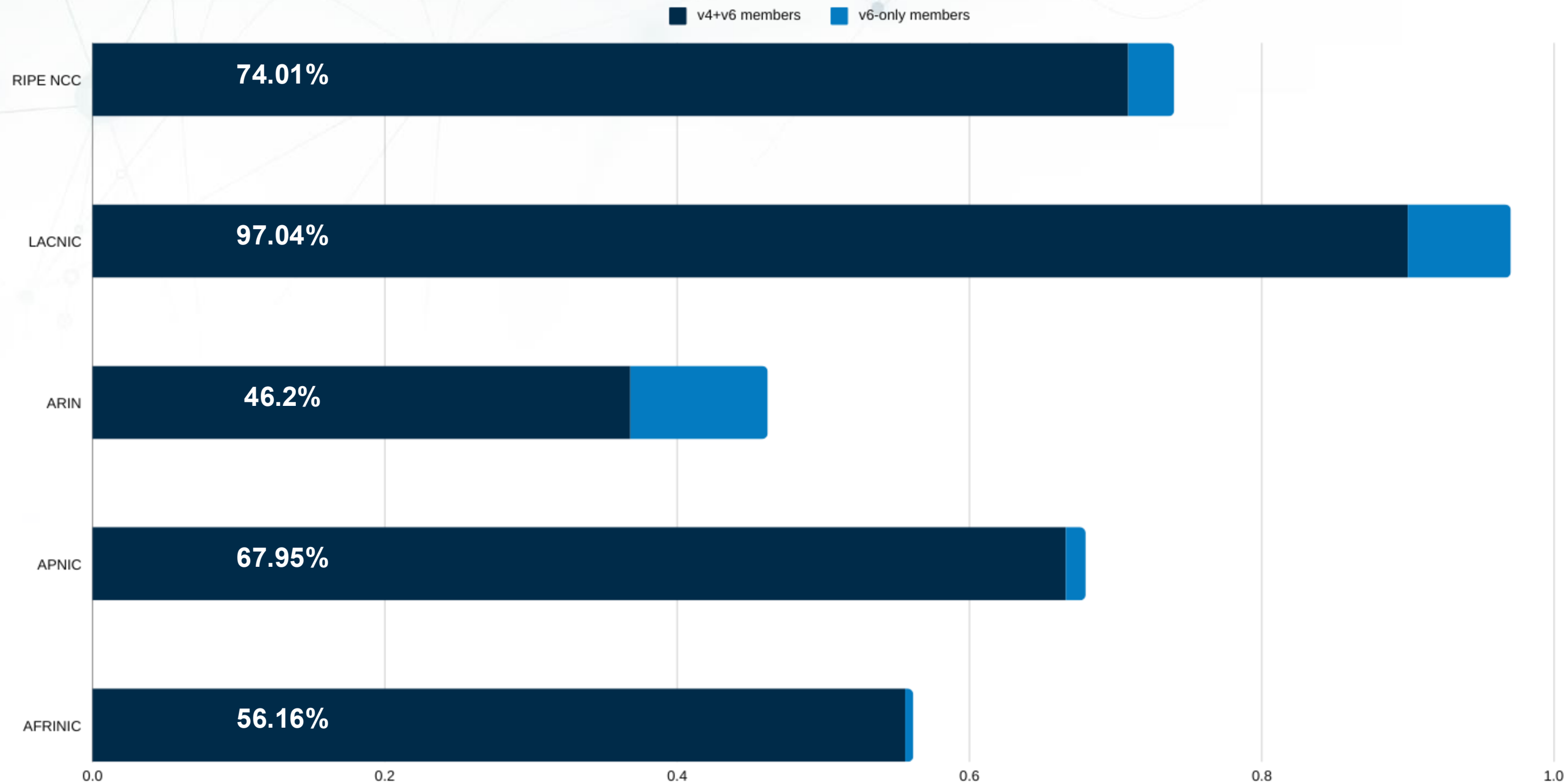
- Per ISOC, in 2023 the rate of IPv6 deployment increased the most it has since 2018, growing from 34% to 39% globally
 - IPv6 deployment has risen an average of 3.5% each year since December 2017
- Google IPv6 statistics show ~40% of global Internet traffic is over IPv6
- APNIC Labs says most significant gains were measured in Asia Pacific region
 - IPv6 deployment across Asia increased from 37.2% at the end of 2022 to 42.3% at the end of 2023
 - Across the same time, Oceania increased from 31.9% to 37.2%

Total IPv6 space (in /32s) each RIR has allocated



As of Q3 2024

Percentage of Members with IPv6 in each RIR

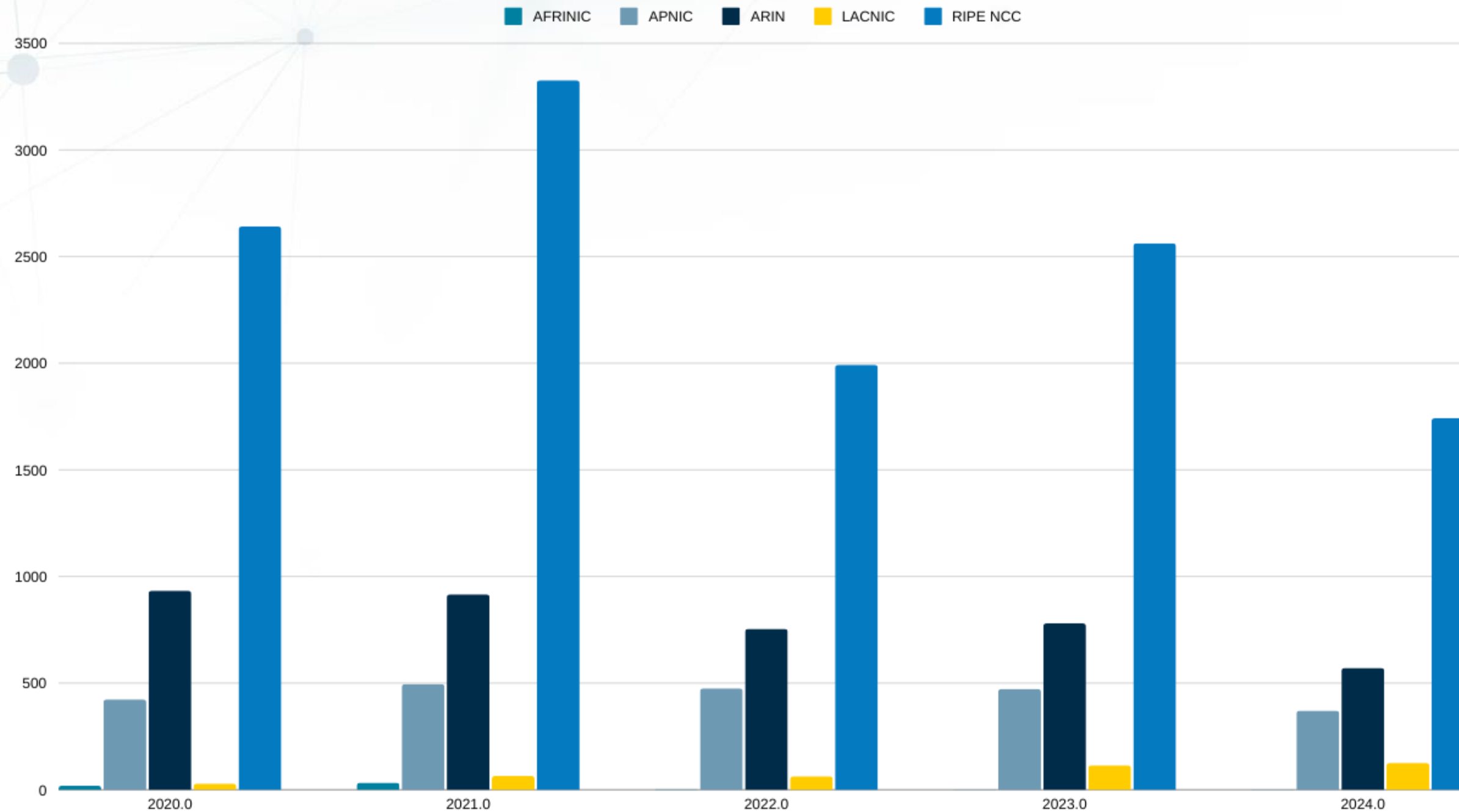


As of Q3 2024

IPv4 Transfer Market

- Developed due to on-going demand for rapidly depleting IPv4 addresses
 - Choices were:
 - Acknowledge IPv4 market transfers through regional policies
 - Watch a black market emerge with no registry interaction
- IPv4 market transfer policies developed by communities
 - Allowed IPv4 holders to transfer space to qualified recipients
- RIR's role
 - Ensure compliance with policies
 - Maintain the accuracy of the registry
 - RIRs not privy to any financial transaction information between parties

Intra-RIR IPv4 Transfers Number of transfers per year



As of Q3 2024

Inter-RIR IPv4 Transfers

Number of transfers

Number addresses transferred

	AFRINIC	APNIC	ARIN	LACNIC	RIPE NCC
AFRINIC		0	0	0	0
APNIC	0		199 1.466M	16 .01717M	479 3.530M
ARIN	0	480 19.787M		27 .02727M	643 24.684M
LACNIC	0	2 .003M	23 .0591M		31 .0622M
RIPE NCC	0	145 2.5622M	283 7.1683M	13 .011M	

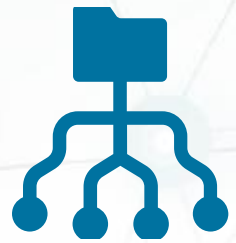
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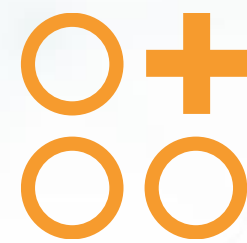
RIR Services and Tools

Whois



Public directory service

- Used to query databases that store registered users of an Internet resource



Differs in usage/content depending on the type of registry

- Number resource registries
- Domain name registries and registrars
- Routing registries



RIR's Whois registry is still publicly accessible

RIR Whois Information

- **Publicly displayed** registration data including:
 - IP number resources issued by RIRs or predecessor registry (“**legacy**” space)
 - Organizations and their contact info (mailing addresses, emails, phone numbers)
 - Original registration date and last updated date
 - Customer reassignment information (ISP ➡ customers)
 - Referential information to authoritative RIR

Future of Whois

Registration Data Access Protocol (RDAP)

- **RDAP** - new protocol for accessing registration data in a machine-readable way
 - Standardization (command, output & error structure)
 - Redirection capabilities (to authoritative server)
 - Support for user identification, authentication and access control
 - Supports Internationalization
- ICANN requires accredited registrars and gTLD registries to implement RDAP (in addition to port 43 WHOIS and web-based WHOIS)
- All RIRs and some DNRs have set up RDAP clients

Routing Security Tools

The RIRs have deployed two technologies to help secure Internet routing:

- Resource Public Key Infrastructure (**RPKI**)
 - Security framework designed to improve/secure the Internet's routing infrastructure
 - Verifies association between resource holders and their number resources
- Validated Internet Routing Registry (**IRR**)
 - Validation mechanisms added to IRR that guarantee routing announcements are published only by an authorized network

Resource Public Key Infrastructure (RPKI)

- Public key infrastructure framework designed to secure the Internet's BGP routing infrastructure
- Cryptographically certifies network resources (AS Numbers & IP address prefixes) and route announcements
- Route Origin Authorizations (**ROAs**) define which AS is authorized to originate a prefix
- Provides stronger validation than existing technologies such as:
 - Internet Routing Registries (IRR)
 - Letters of Authority (LOA)
- All five RIRs (NRO) collaborating on this cross-RIR project

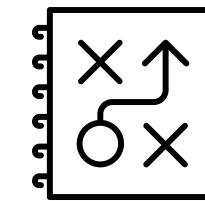
Why is RPKI Important?



Establishes a **level of trust** that the RPKI information is authentic and is confirmed coming from the authorized holder of the resources



The RPKI gives network operators a **method to make better judgments** on which is the valid source (origin) of a route announcement



RPKI can **limit the impact** of a configuration mistake or nefarious activity of a bad actor

RPKI RIR Adoption

% of IP address space covered by RPKI certificates as of 6 Nov 2024

REGION	IPv4 ADOPTION	IPv6 ADOPTION
AFRINIC	70.26	39.50
APNIC	32.18	10.77
ARIN	36.26	60.70
LACNIC	35.58	23.86
RIPE NCC	52.78	52.64

<https://ftp.ripe.net/pub/stats/ripenncc/nro-adoption/latest/rir-adoption.txt>

Internet Routing Registry (IRR)

- Database of Internet route objects operated by individual organizations (e.g., the RIRs)
 - Used to determine and share routing policies and announcements between network operators
- Ensures stability and consistency of Internet-wide routing
 - Provides mechanism for validating contents of announcements
 - Widely deployed to prevent accidental or intentional routing disturbances
 - Susceptible to error or manipulation
- RIRs working individually to add better validation processes to ensure accuracy and enhance security

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Stay Informed



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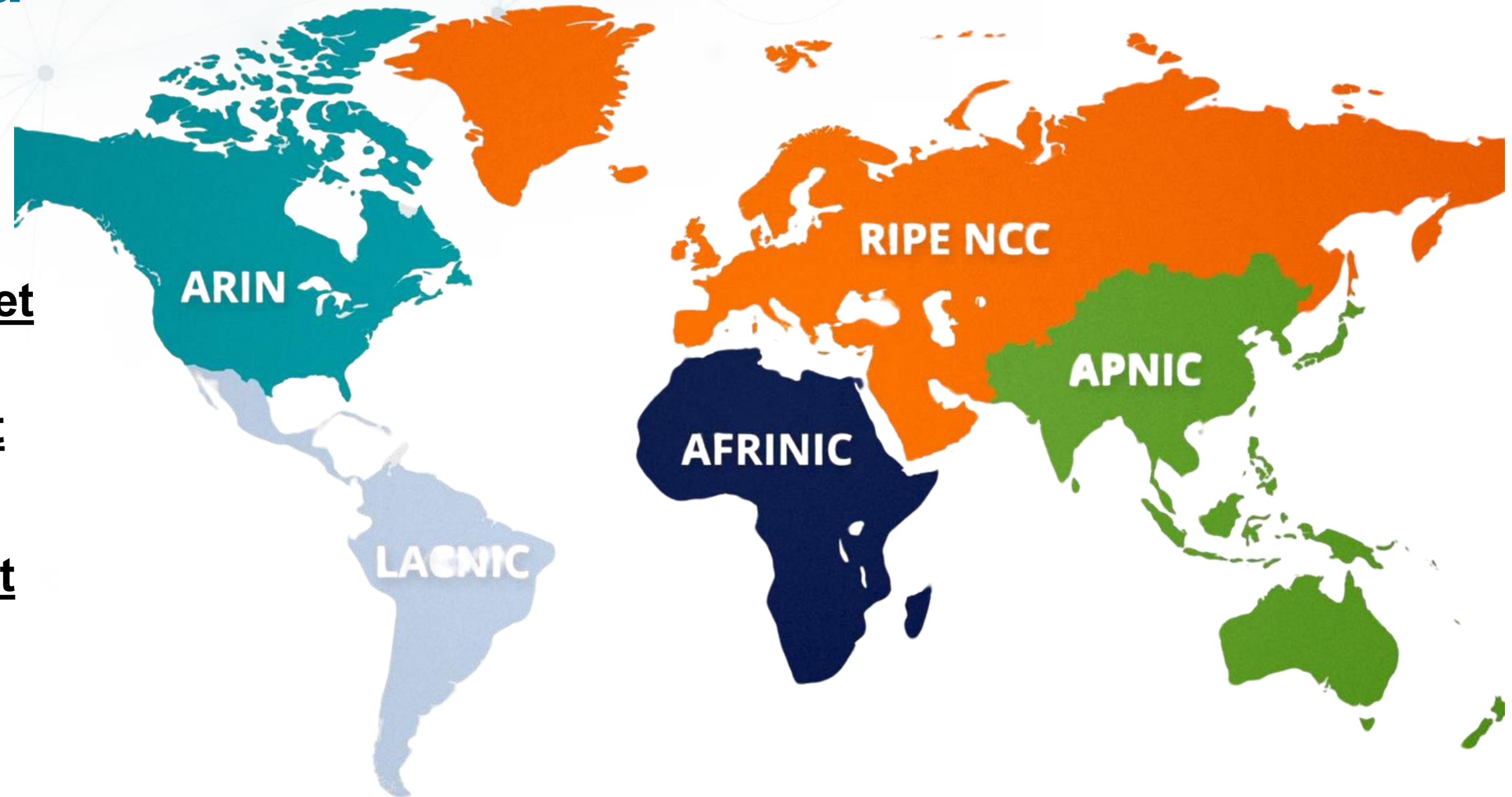
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lacnic.net



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Questions?

