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“How It Works”
The Regional Internet Registry System

AFRINIC
The Internet Numbers Registry for Africa

APNIC

ARIN
American Registry for Internet Numbers

lacnic

RIPE NCC
RIPE NETWORK COORDINATION CENTRE

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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

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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.

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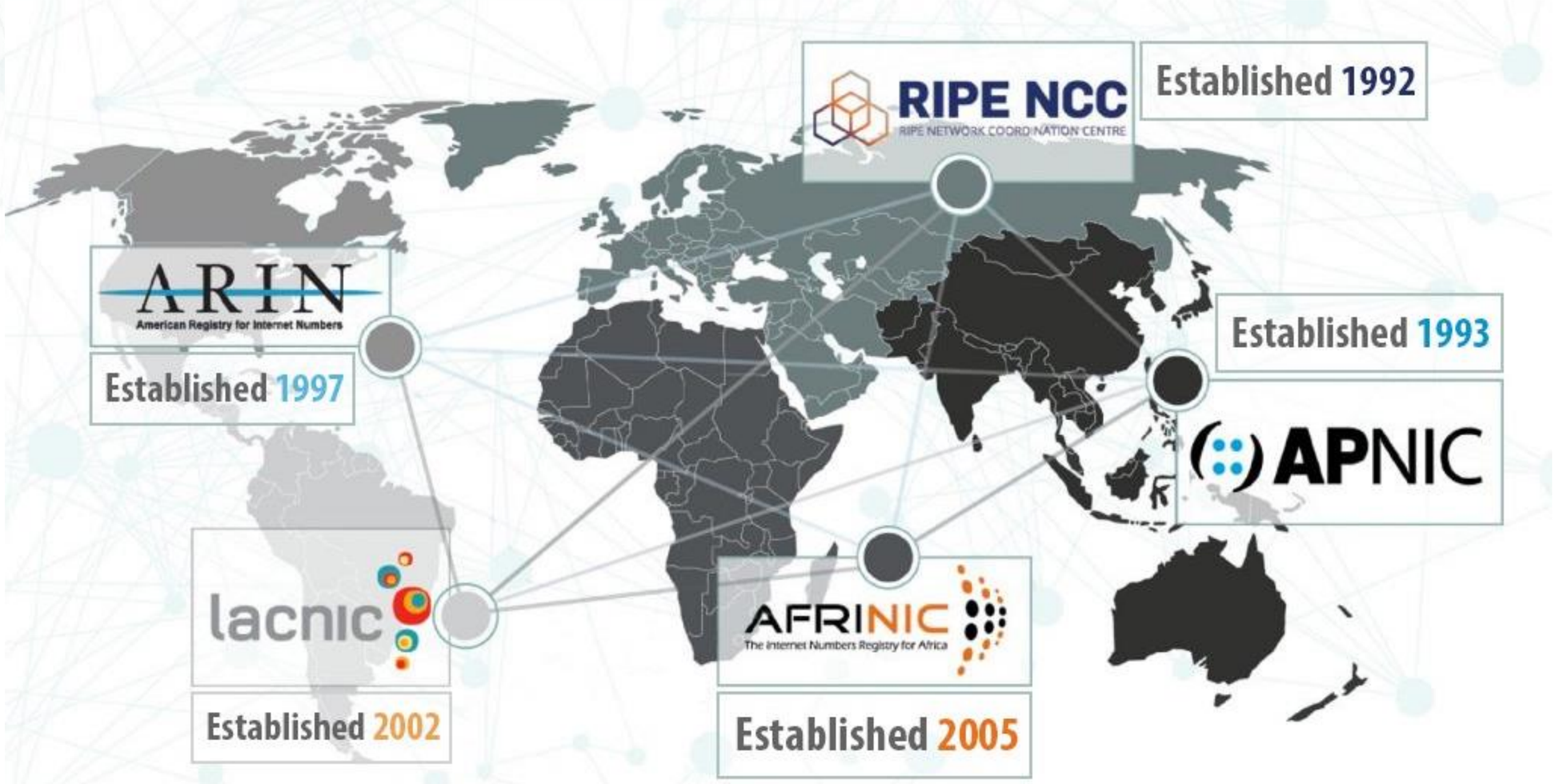
The RIRs



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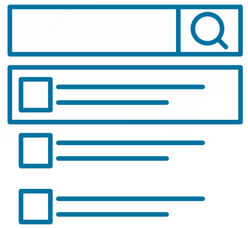
Functions of an RIR

Manage and distribute Internet Number Resources:

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



Maintain directory services including:
Whois, Whowas, and routing registries

Provide reverse DNS

Support Internet infrastructure through:

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

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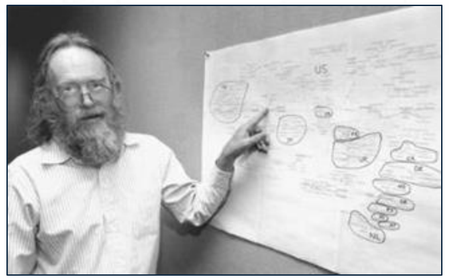
Internet Foundation



1980s-1990s

US DoD

Jon Postel

Network Solutions

US Government separates commercial from military.

Regionalization begins

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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

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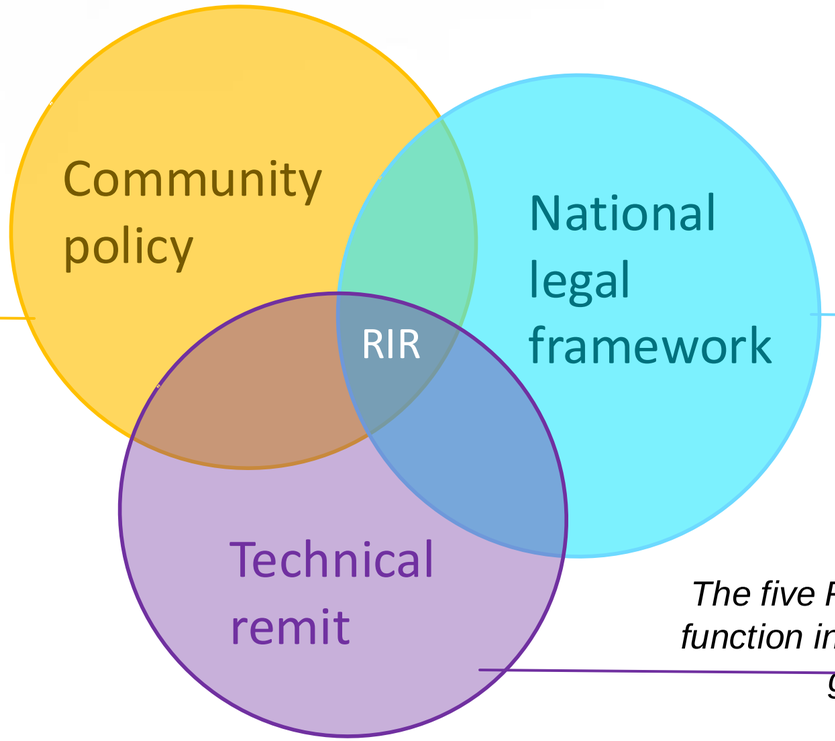
RIR Governance

Each RIR operates in accordance with three factors

Each RIR community sets the policies by which that RIR registers and distributes resources



Each RIR is established under the legal framework of a specific country

The five RIRs fulfil a specific function in the global Internet governance system

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Core Functions

Non-profit, member-based organizations

Manage, distribute, and register Internet Number Resources

Maintain directory services

Support Internet infrastructure through technical coordination

Facilitate community-driven policy development

Important Key Elements of an RIR

Independent

Nonprofit

Membership based

Community Regulated

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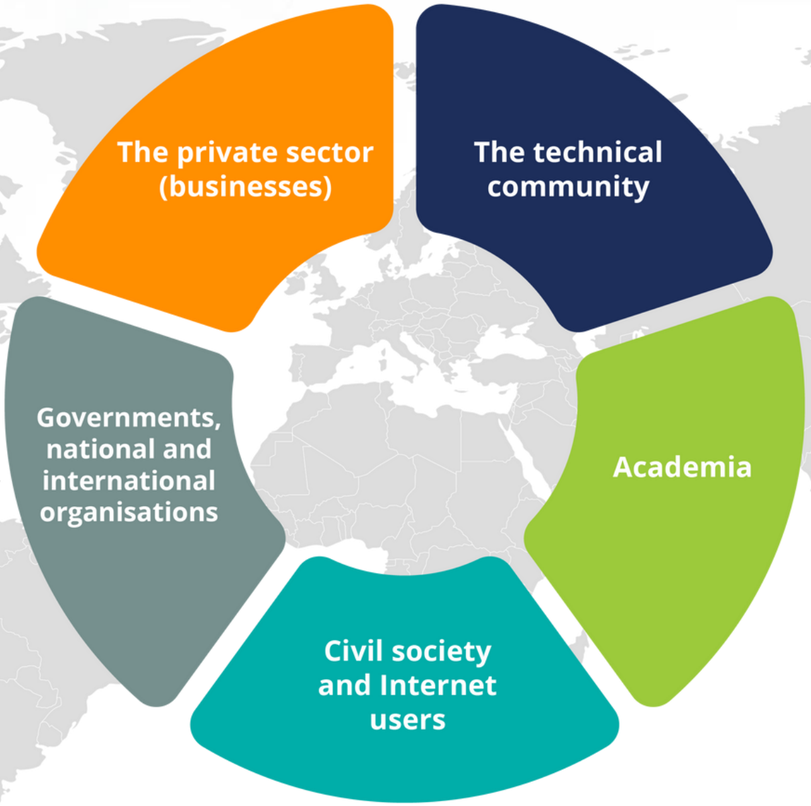
Policy Development

Multistakeholder approach



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RIR Policy Development Process

Inclusive

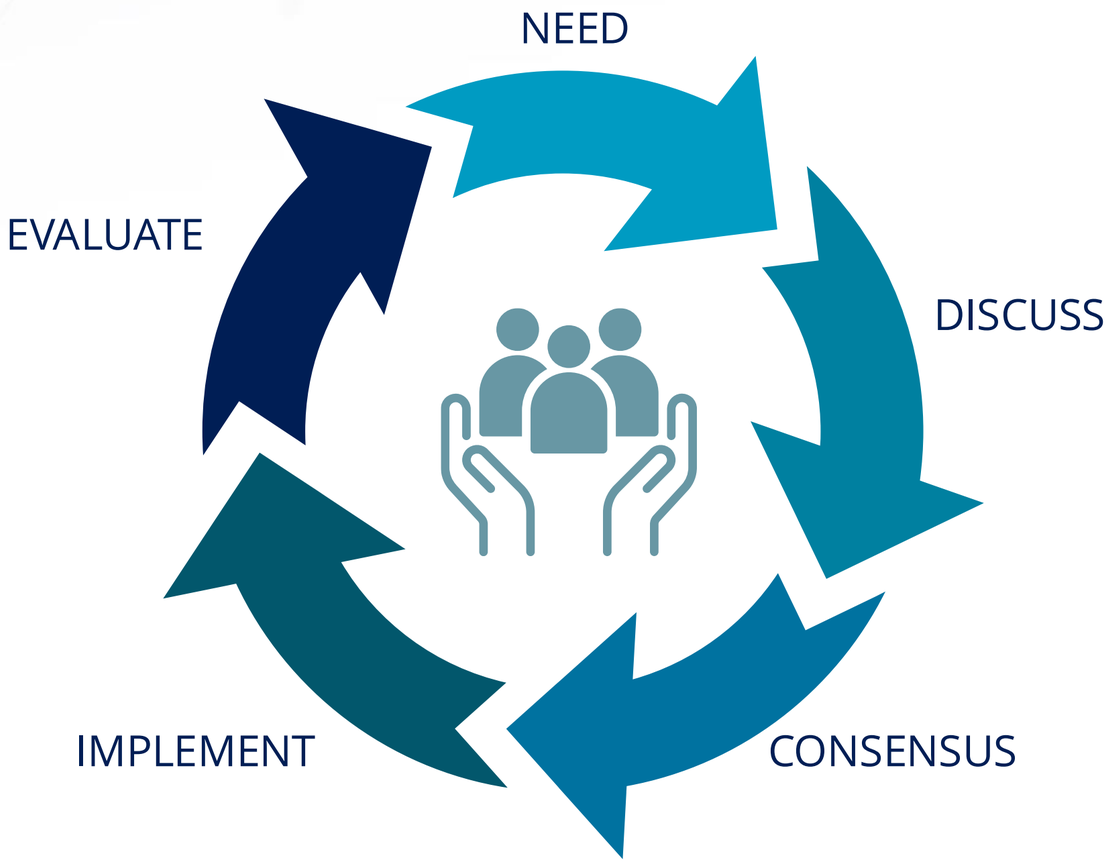
Anyone can participate

Bottom Up

Internet community proposes and approves policies

Transparent

Documented and published decisions and policies



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Number Resource Organization (NRO)

www.nro.net

ARIN American Registry for Internet Numbers · AFRINIC The Internet Numbers Registry for Africa · APNIC · lacnic INTERNET PARA TODOS, INTERNET DE TODOS · RIPE NCC

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

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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

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ICANN Policy Development Stakeholders

Supporting Organisations

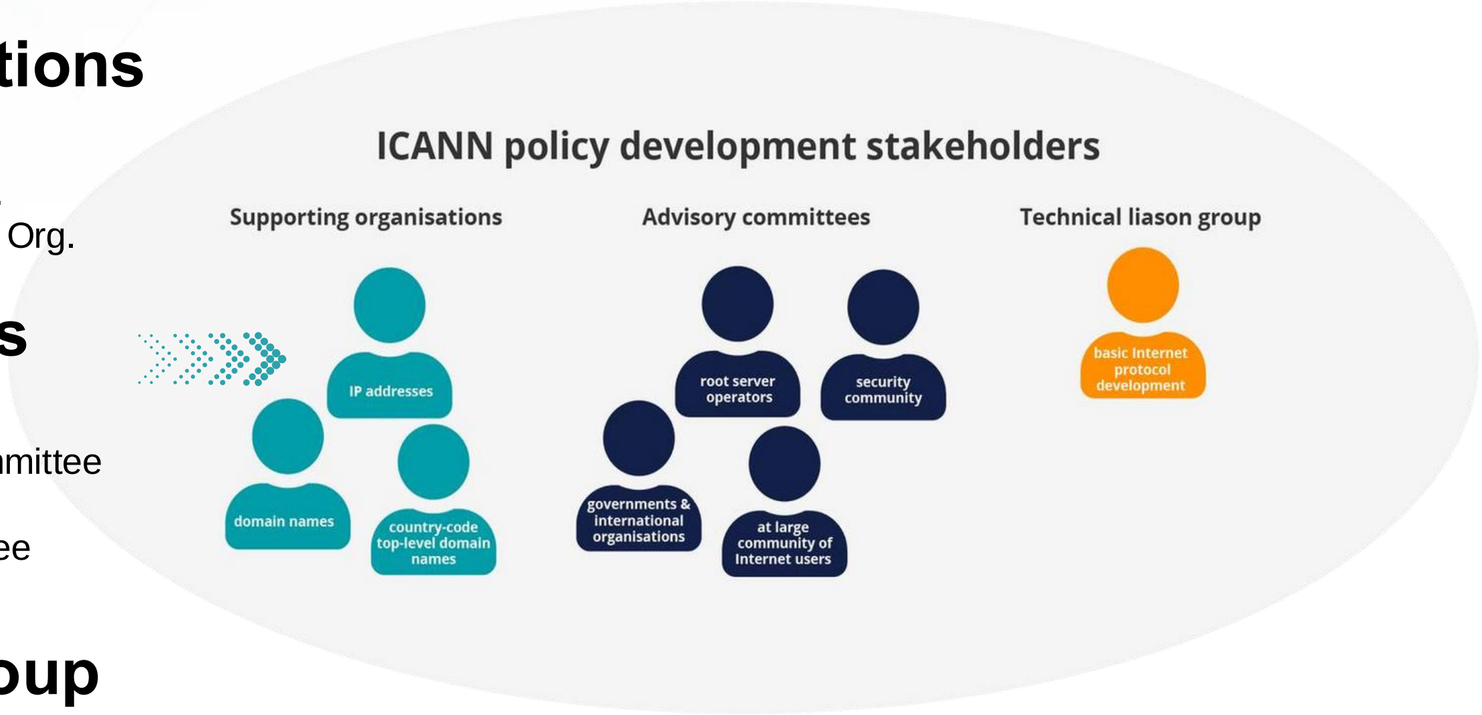
ASO: Address Supporting Org.
GNSO: Generic Names Supporting Org.
CCNSO: Country Code Names Support Org.

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.



https://www.icann.org/community

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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)

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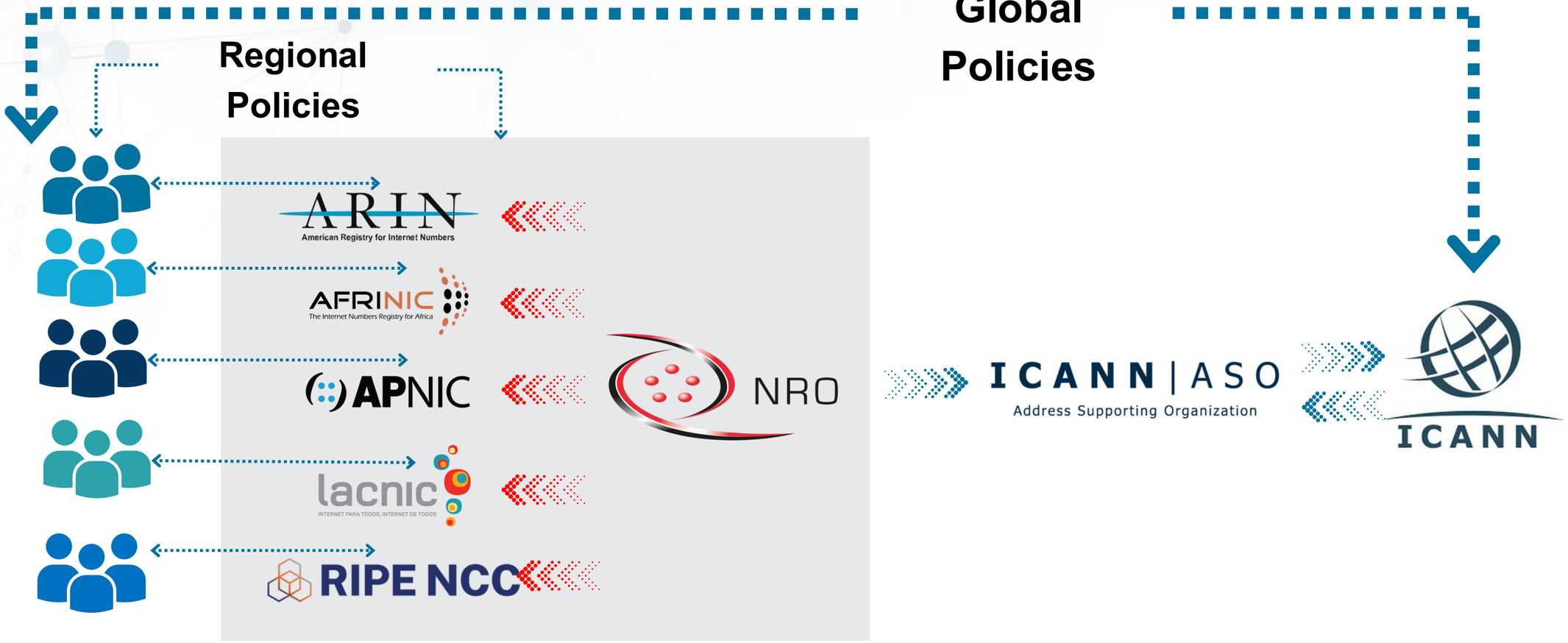
Global Policy Development Process



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Internet Number Resources

IPv4, IPv6, Autonomous System Numbers (ASNs)

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IPv4

32-bit addresses;

Written in dotted decimal

2^32

Example:

205.150.58.732

IPv6

128-bit addresses;

Written in hexadecimal

2^128

Example:

2001:0503:0C27:0000:0000:0000:0000

IP Addresses

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Autonomous System Numbers (ASNs)

Globally unique numbers used to exchange routing information with neighboring autonomous systems

Group of IP networks administered under the umbrella of a single entity

Network operators must have an ASN to control routing within their network and to exchange routing information with other Internet Service Providers

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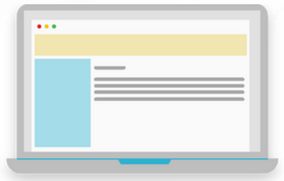
IP Addresses are *Not* Domain Names

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

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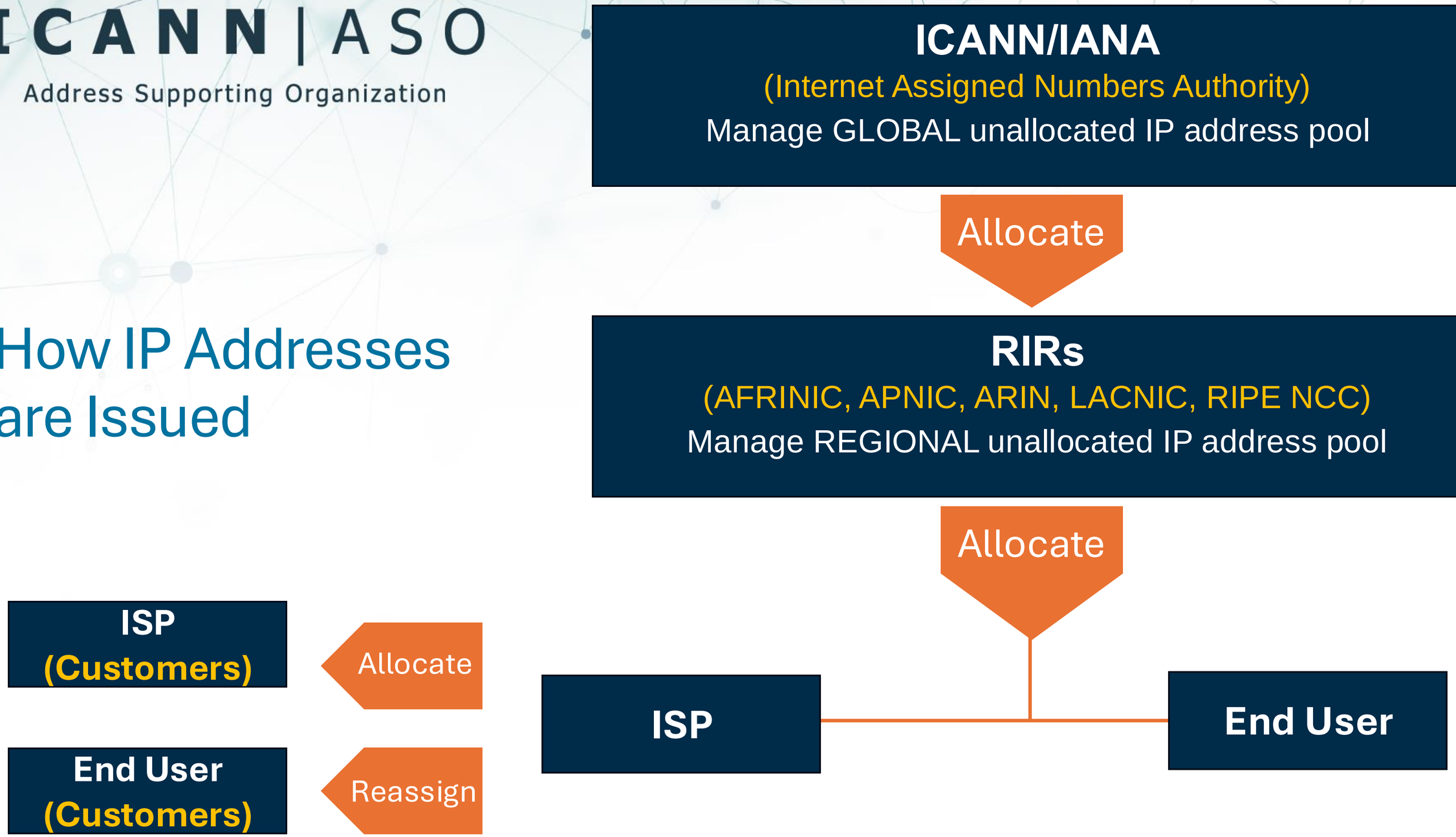
How IP Addresses are Issued



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Routing

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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...

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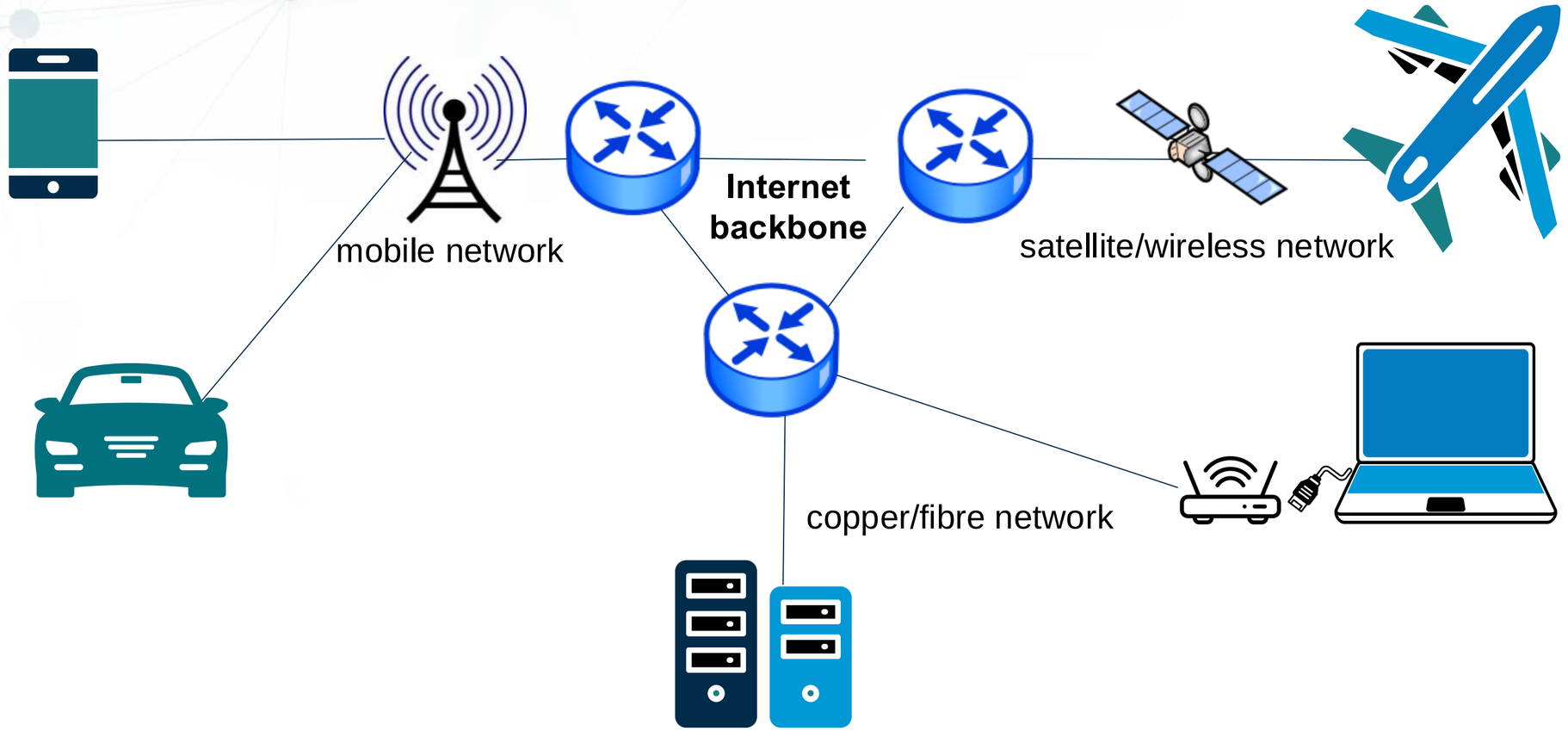
A Network of Networks



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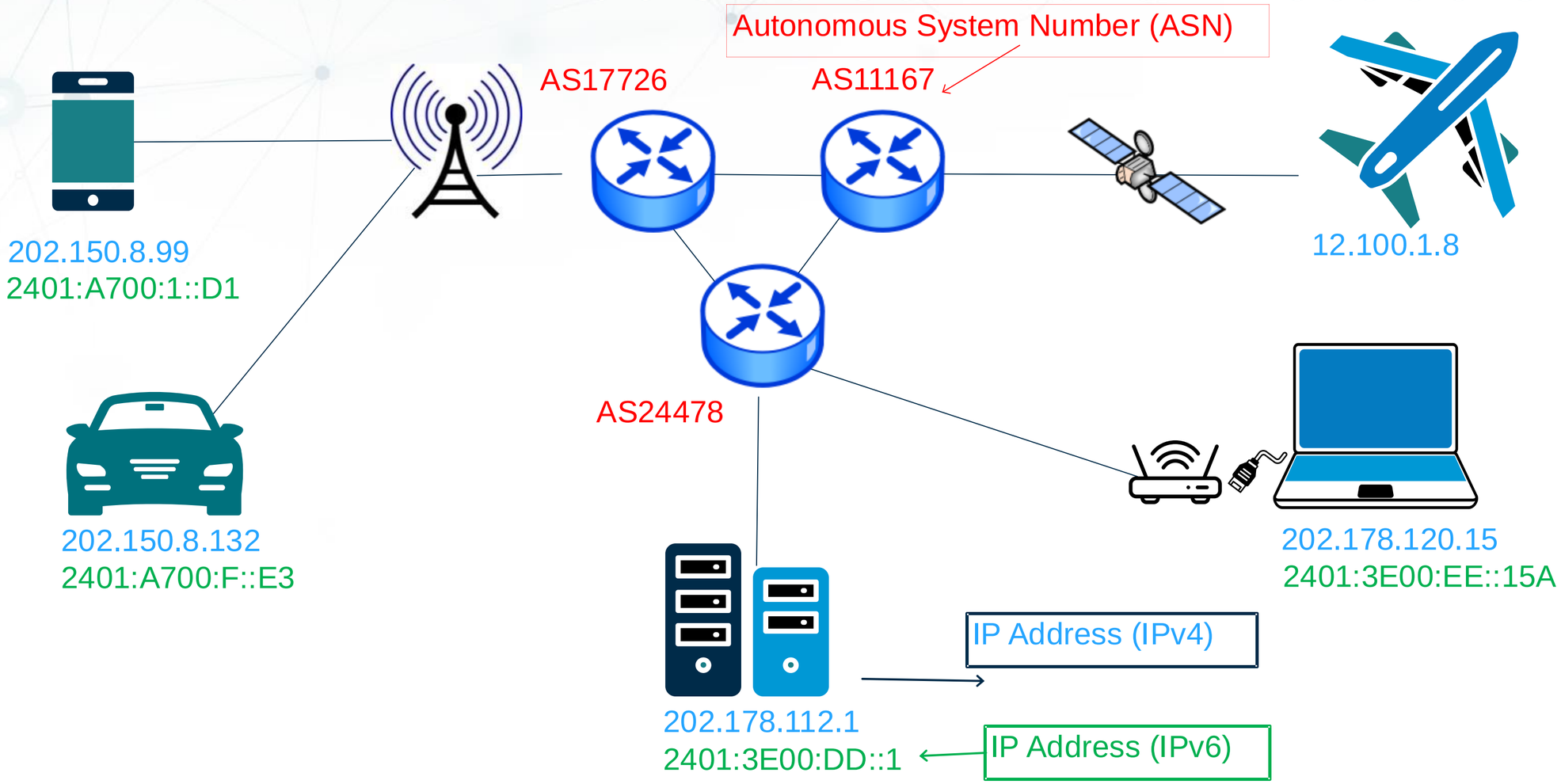
Networks That Use Standard Protocols



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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

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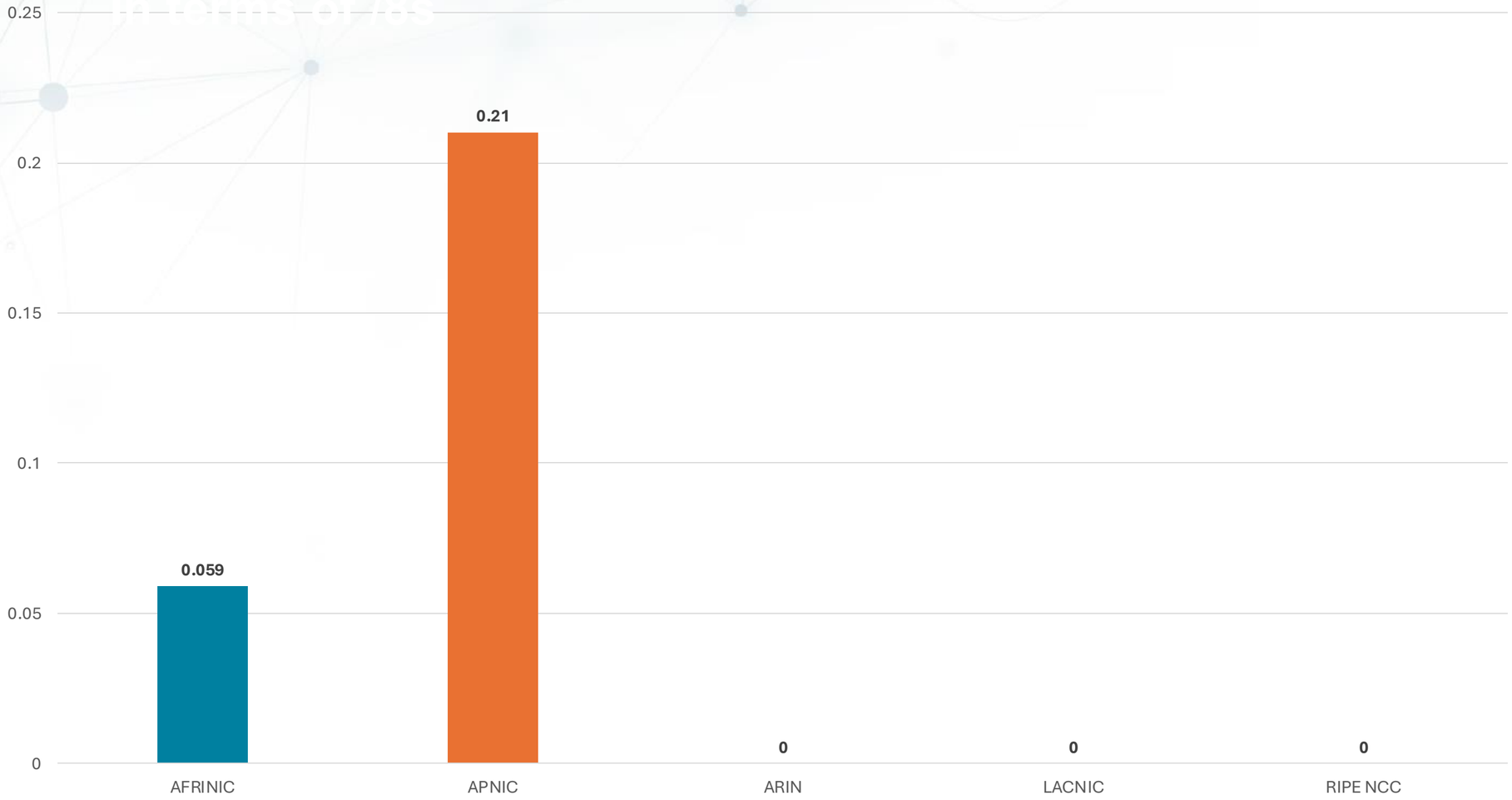
Available IPv4 Space in each RIR

Measured in /8s

As of Q4 2024



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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.

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IPv6 Deployment

- Per ISOC the rate of IPv6 deployment is at 41% Worldwide
  - Source https://pulse.internetsociety.org/en/technologies/
- Google IPv6 statistics show ~44% of global Internet traffic is over IPv6
  - Source https://www.google.com/intl/en/ipv6/statistics.html

As of Feb 2025

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

As of Q4 2024

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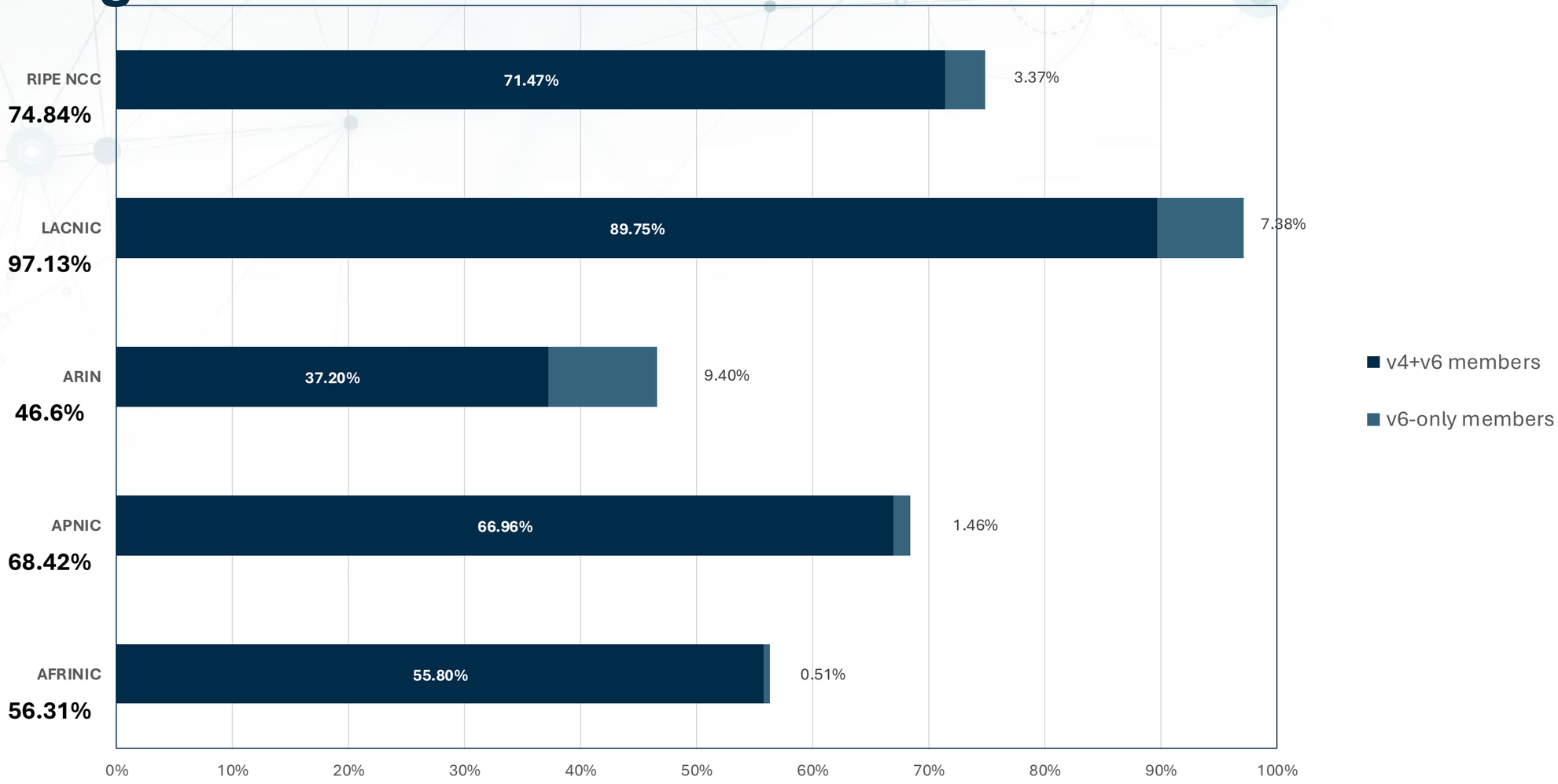
Percentage of Members with IPv6 in each RIR



As of Q4 2024

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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

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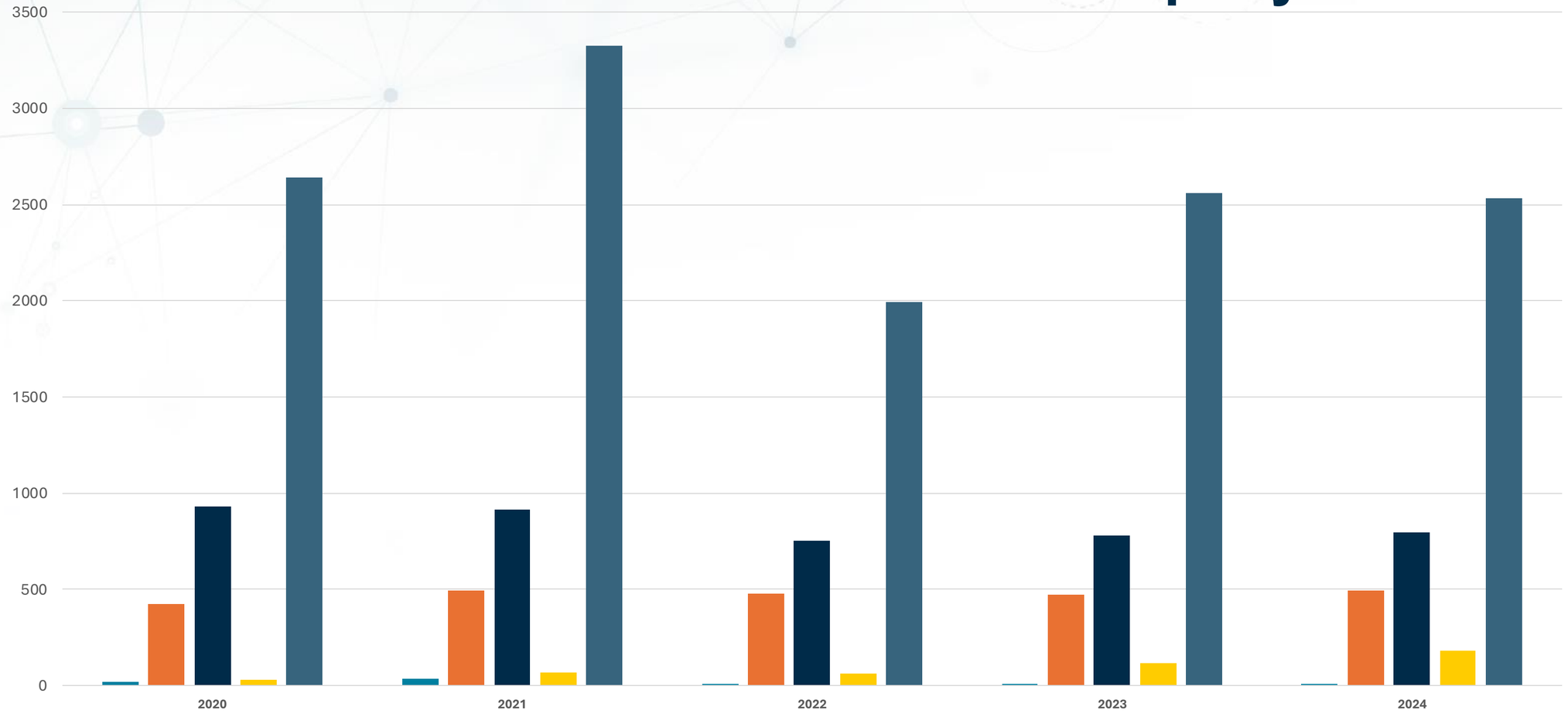
Intra-RIR IPv4 Transfers Number of transfers per year



As of Q4 2024

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Inter-RIR IPv4 Transfers

Number of transfers / Number addresses transferred

	AFRINIC	APNIC	ARIN	LACNIC	RIPE NCC
AFRINIC		0	0	0	0
APNIC	0		216 / 1.744M	18 / .02178M	535 / 3.695M
ARIN	0	489 / 19.863M		29 / .03034M	670 / 27.312M
LACNIC	0	5 / .0076M	24 / .0693M		35 / .0648M
RIPE NCC	0	152 / 2.5942M	298 / 8.245M	15 / .01356M	

As of Q4 2024

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RIR Services and Tools

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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

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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

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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

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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

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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

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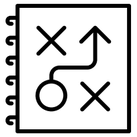
Why is RPKI Important?

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

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RPKI RIR Adoption

% of IP address space covered by RPKI certificates as of 1 March 2025

REGION	IPv4 ADOPTION	IPv6 ADOPTION
AFRINIC	32.45	10.76
APNIC	36.55	18.20
ARIN	38.23	60.72
LACNIC	53.92	54.88
RIPE NCC	71.20	40.41

https://ftp.ripe.net/pub/stats/ripencc/nro-adoption/latest/rir-adoption.txt

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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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NRO RPKI Program:
Securing the Internet routing system, together

Purpose: “**To provide a more consistent and uniformly secure, resilient and reliable RPKI service**”

Why is it important?

1. It creates a space for structured **coordination and collaboration** on RPKI among the RIRs
2. Current **diversity/inconsistency** among RIRs’ RPKI implementations
3. Some RPKI challenges/concerns need to be addressed by the five RIRs **in alignment**

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NRO Program Objectives

Progress towards improved transparency, robustness, and security of the RPKI system

- Building on 2024 work:
  - Key aspects of robustness documented
  - TA configuration problem statement and potential solutions

Increased consistency of the RPKI system user experience

- Building on 2024 work:
  - Documentation of baseline for RPKI services/features offered by each RIR
  - User research with users interacting with multiple RIRs

The technical community is kept informed and engaged throughout the program.

- RPKI Program updates presented at relevant events
- Blog articles in RIR blogs
- Etc.

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Stay Informed

ARIN American Registry for Internet Numbers — arin.net

AFRINIC The Internet Numbers Registry for Africa — afrinic.net

APNIC — apnic.net

lacnic INTERNET PARA TODOS, INTERNET DE TODOS — lacnic.net

RIPE NCC — ripe.net

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Questions?