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"How It Works" The Regional Internet Registry System

IP Address Allocation

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)
- Internet Number Resources (IPv4, IPv6 and ASNs)
- Routing
- Development since IPv4 Depletion
  - IPv4 Depletion
  - IPv6 Transition
  - IPv4 transfer market
- Resource Public Key Infrastructure

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The Regional Internet Registry (RIR) System

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What is an RIR?

A Regional Internet Registry (RIR) manages the allocation and registration of Internet number resources in a particular region of the world and maintains a unique registry of all IP numbers issued.

***Number resources include IP addresses (IPv4 and IPv6) and autonomous system (AS) numbers**

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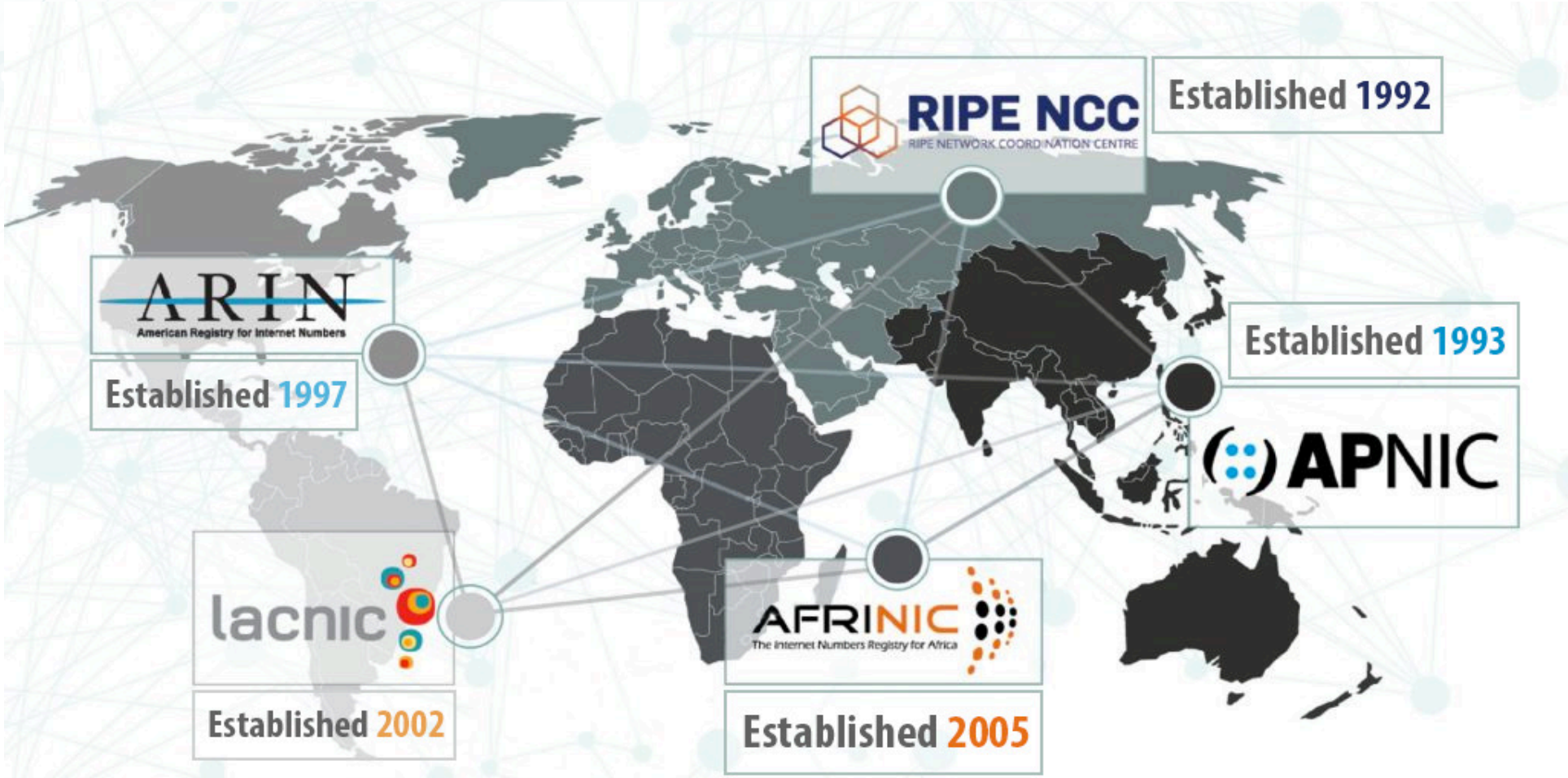
Who Are the RIRs?



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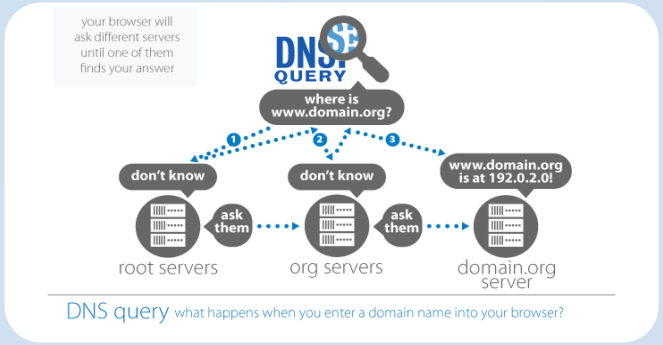
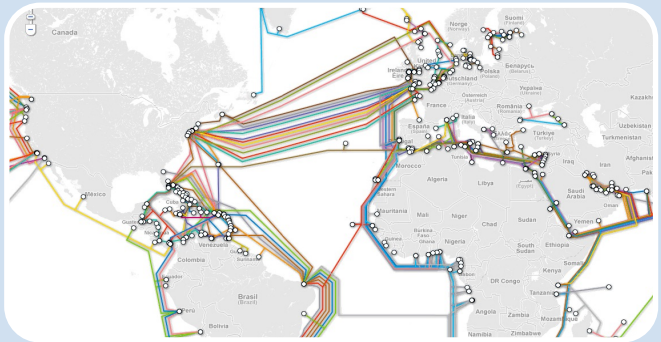
Core Functions of an RIR





Manage and distribute Internet Number Resources (IPv4 & IPv6 addresses and 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 & capacity building

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The RIRs are…

Independent
- Self-governed

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

Membership
- Such as Internet service providers (ISPs), Telecom organizations, academia governments and corporations

Community
- Community develops policies
- Open and transparent

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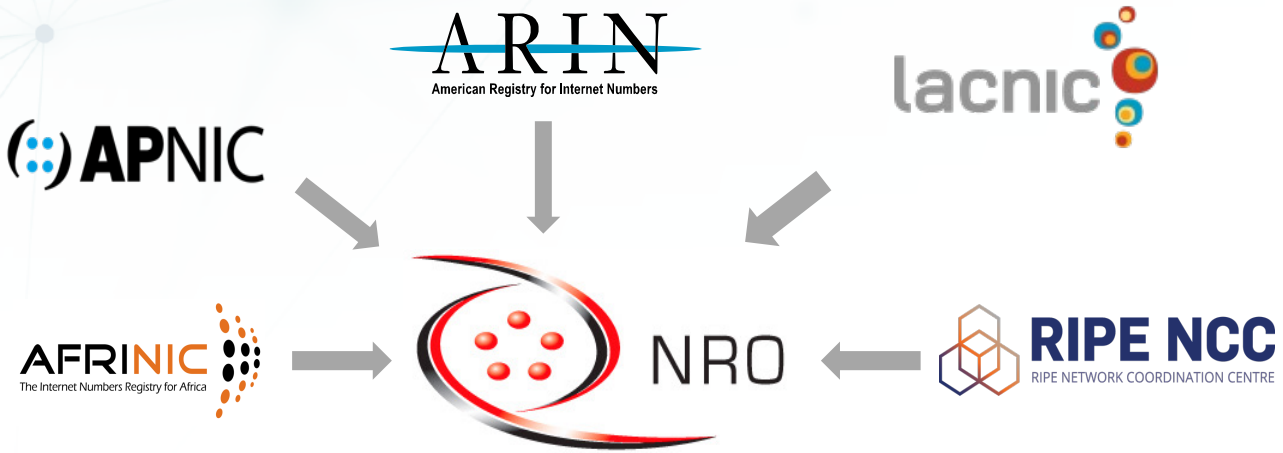
Number Resource Organization (NRO)



- **Mission**
  - To coordinate and support joint activities of the Regional Internet Registries (RIRs) to provide and promote the Joint Internet Numbers Registry
- **Vision**
  - To be the flagship and global leader for collaborative Internet number resource management as a central element of an open, stable and secure Internet

https://www.nro.net/

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Number Resource Organization

- NRO MoU, 24 Oct 2003

- Addendum signed in July 2020 which include the below agreements:
  - Not to take action that would violate Internet Number Registry System (INRS) uniqueness.
  - To take effective measures to promote Internet INRS.
  - To publish INRS entries publicly, so as to enable timely global Internet operations.
  - To cooperate together in the provision of consistent, effective global INRS

https://www.nro.net

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NRO

- **Number Resource Organization**
- **NRO Executive committee**
  - Oscar Robles (Chair) - LACNIC
  - John Curran (Vice Chair – Secretary) - ARIN
  - Hans Petter Holen (Treasurer) – RIPE NCC
  - Paul Wilson – APNIC
  - *Vacant* - AFRINIC
- **NRO Permanent Secretariat**
  - Hosted by APNIC
  - Executive Secretary: German Valdez – Based in APNIC
  - Consultant: Laureana Pavon – Based in LACNIC

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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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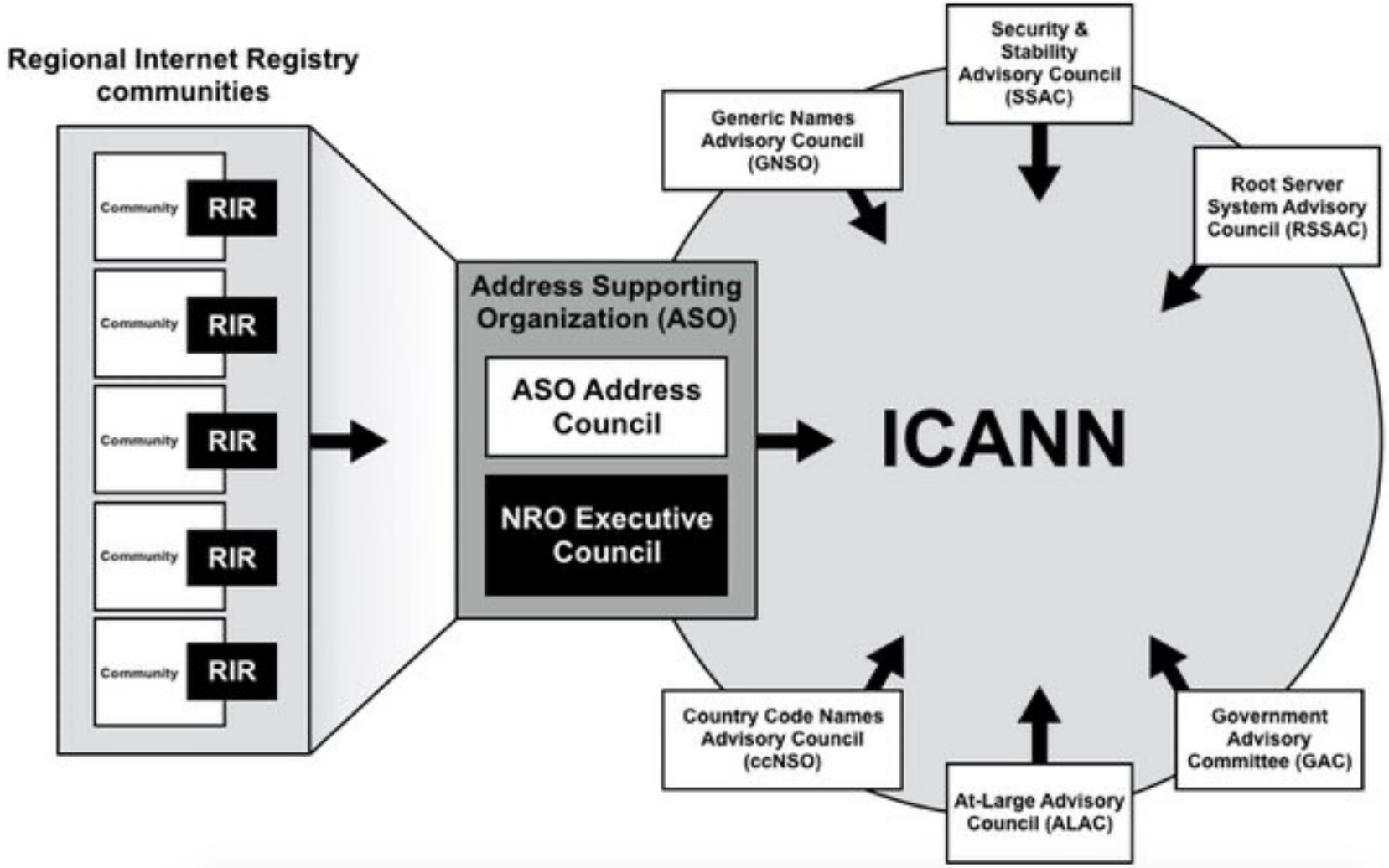
ASO in the ICANN Structure



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2024 Address Council Members

REGION	Member	Term
AFRINIC – The Internet Numbers Registry for Africa	Vacant	
APNIC	Gaurav Kansal **Nicole Chan* [Vice Chair]** Di Ma	Jan 2023 – 31 Dec 2024 Jan 2024 – 31 Dec 2024 Jan 2024 – 31 Dec 2025
ARIN – American Registry for Internet Numbers	Kevin Blumberg* Nick Nugent Chris Quesada	Jan 2024 – 31 Dec 2026 Jan 2023 – 31 Dec 2025 Jan 2022 – 31 Dec 2024
lacnic	Esteban Lescano* Jorge Villa **Ricardo Patara [Vice Chair]**	Apr 2023 – 31 Mar 2024 Jan 2024 – 31 Dec 2026 Jan 2022 – 31 Dec 2024
RIPE NCC – RIPE NETWORK COORDINATION CENTRE	Constanze Bürger Sander Steffann **Hervé Clément* [Chair]**	Dec 2023 – 31 Dec 2025 Jan 2022 – 31 Dec 2024 Jan 2024 – 31 Dec 2026

* Appointed by RIR Board

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Summary ASO & NRO

- **ASO – Address Supporting Organisation** is a part of the ICANN Structure
- **NRO – Number Resource Organisation**
  - Serving as the coordinating mechanism of the RIRs to act collectively
  - Serves as the Address Supporting Organisation
- **ASO Address Council** (role filled by NRO Numbers Council)
    - Oversees Global Policy Development Process
    - Appoint ICANN board members
    - Advice ICANN Board
- **NRO Executive Council**
  - The NRO Executive Council represents the NRO in all matters.

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Internet Number Resources

IPv4, IPv6, Autonomous System Numbers (ASNs)

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Internet Protocol (IP) Addresses

- **IP address** – unique numerical address assigned to every device connected to a TCP/IP network that facilitates moving data across the network
  - **IPv4**
    - 32-bit addresses; written in dotted decimal
    - 2^32= ~4.4 billion
    - e.g. 205.150.58.7
  - **IPv6**
    - 128-bit addresses; written in hexadecimal
    - 2^128= ~50 octillion for each of the roughly 6.5 billion people alive
    - e.g. 2001:0503:0C27:0000:0000:0000:0000:0000

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Autonomous System Numbers (ASNs)

- Globally unique numbers used to exchange routing information between neighboring autonomous systems (AS) and to identify the AS itself
  - An ***autonomous system*** is a group of IP networks 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*** *t*o control routing within their networks and to exchange routing information with other Internet Service Providers (ISPs)

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IP Addresses are *Not* Domain Names

- IP Address [Identifier] – **e.g. 192.128.10.0**
  - Computers recognize ***numbers***
  - Unique number identifies computer on Internet
  - Used for routing (moving information across an inter-network from a source to a destination)
  - Every device directly connected to the Internet requires the use of 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 data base

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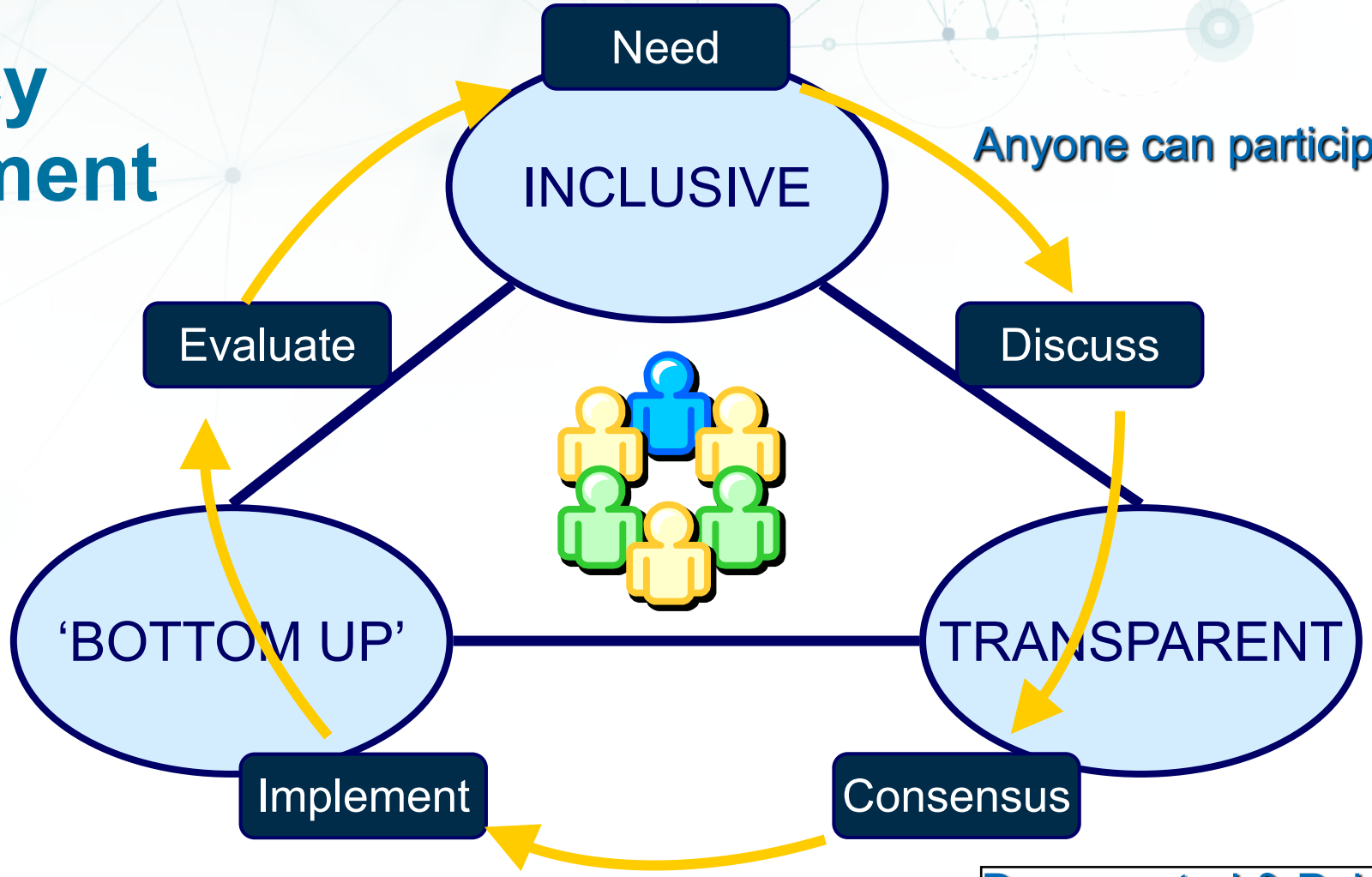
RIR Policy Development Process



Internet Community
Proposes & Approves Policy

Documented & Published
Decisions, Polices, & PDP

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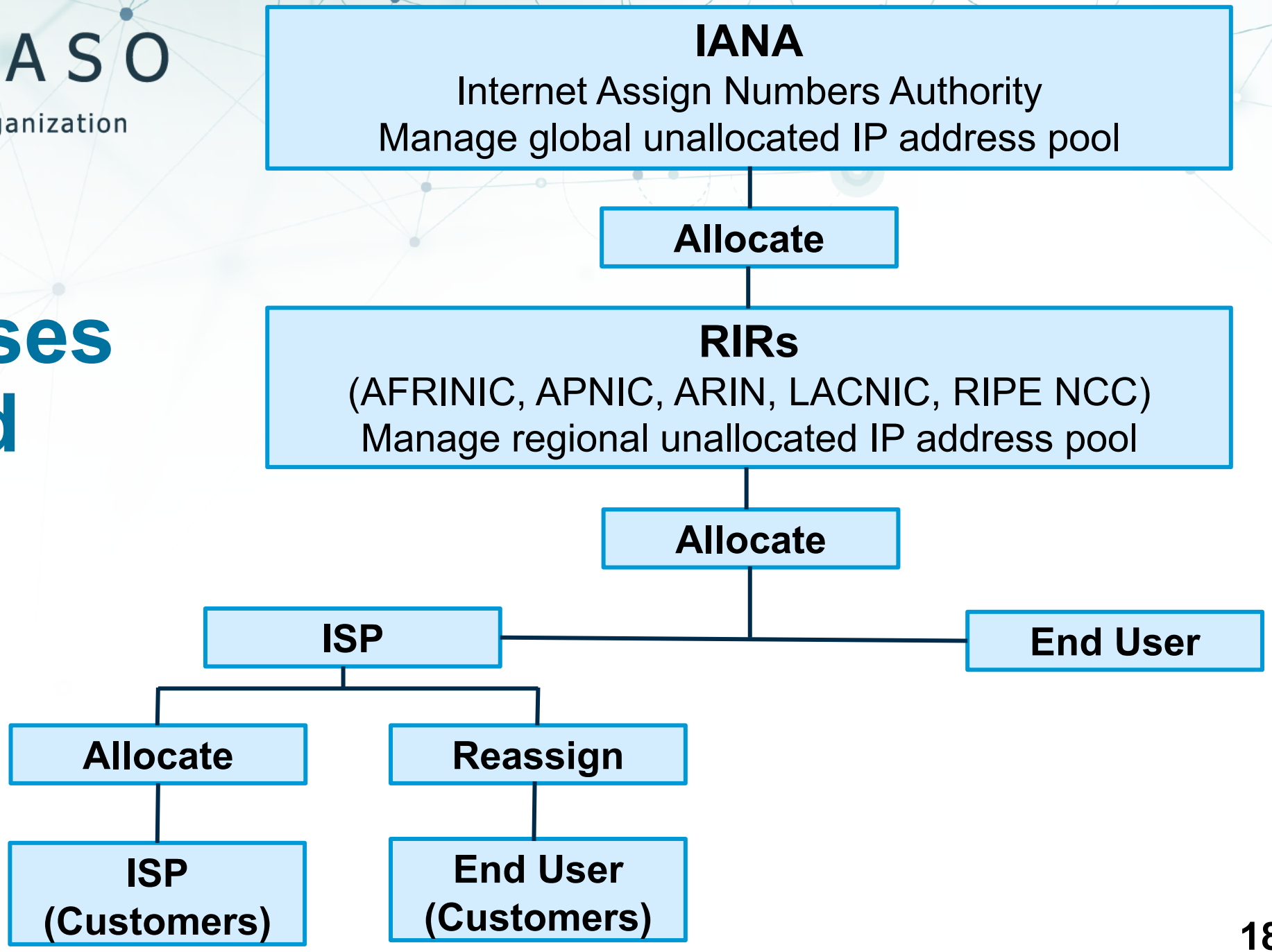
How IP Addresses Are Issued



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Routing

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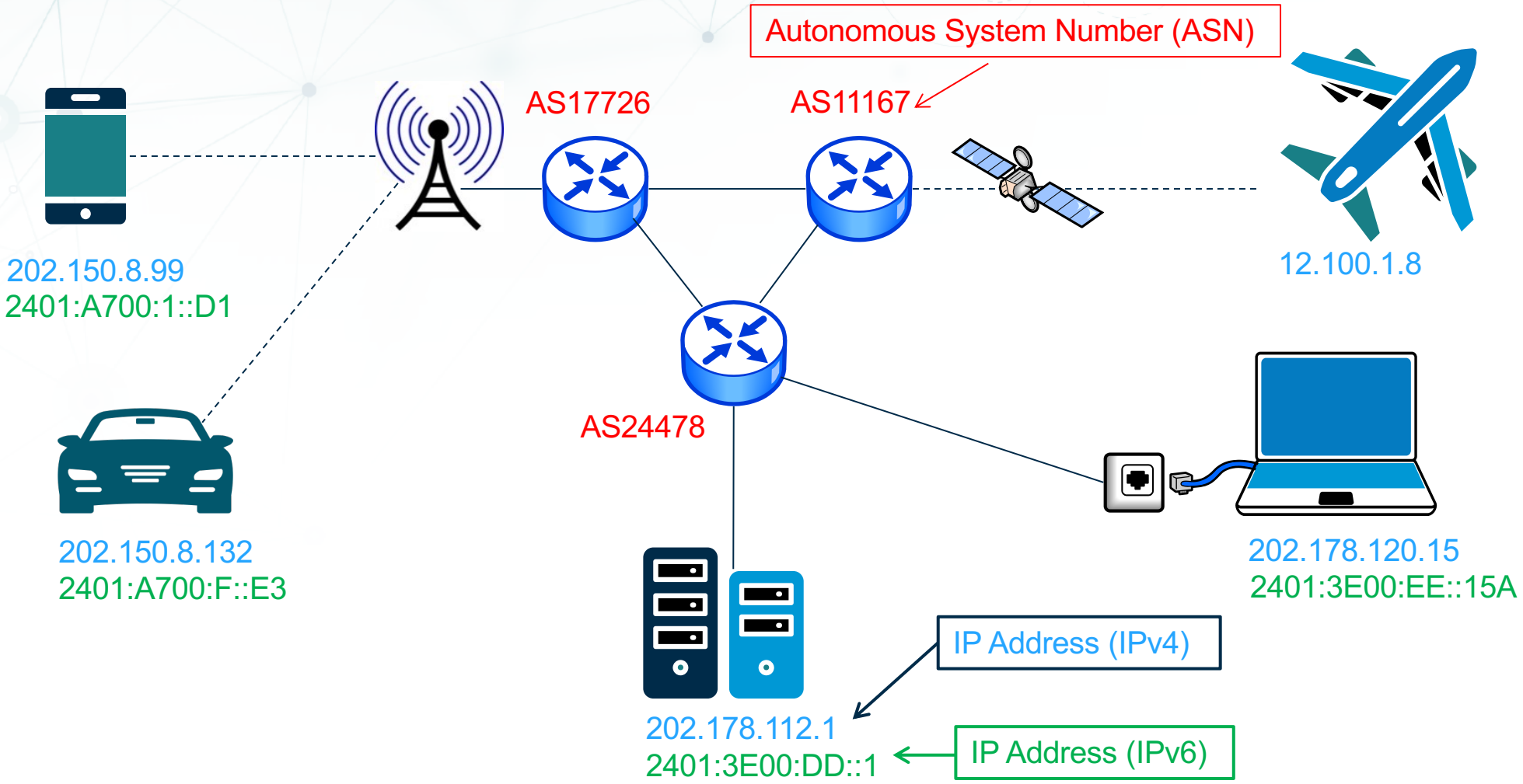
Networks That Use Standard Protocols



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Development since IPv4 Depletion

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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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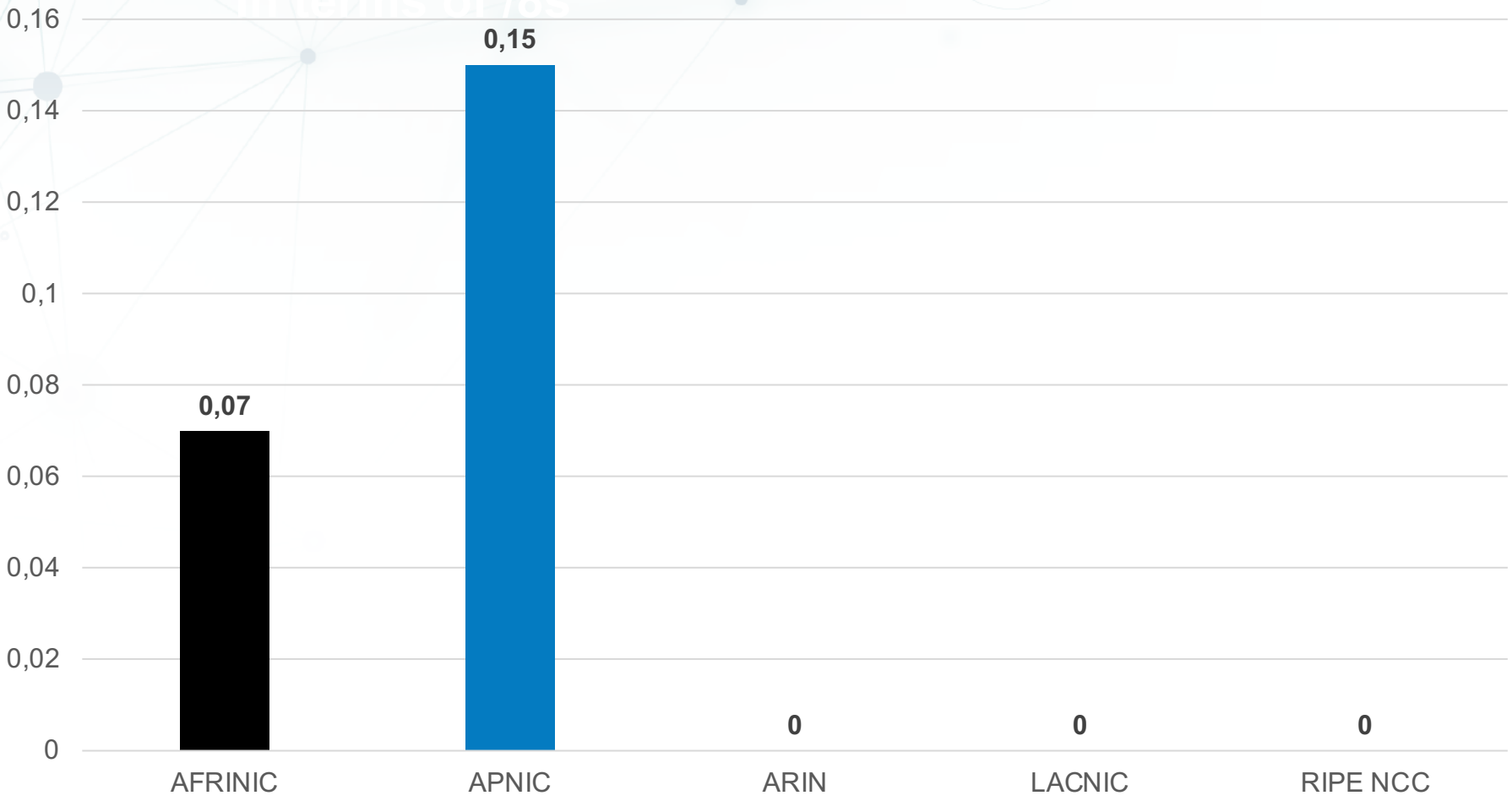
Available IPv4 Space in each RIR

- **Measured in /8s**



As of 12/23

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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, 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%

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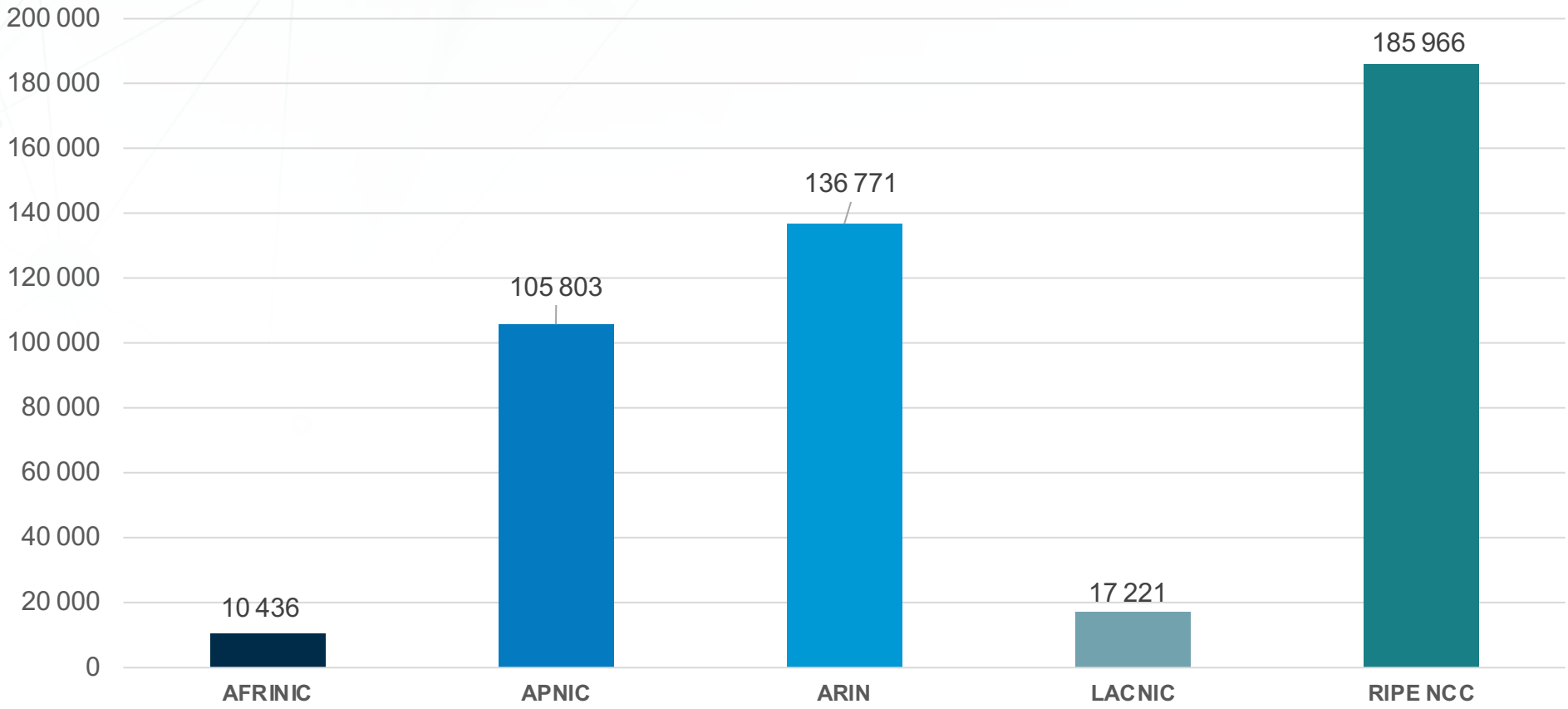
Total IPv6 Space Currently Allocated

- **Total IPv6 space (in /32s) each RIR has allocated as of 12/23**



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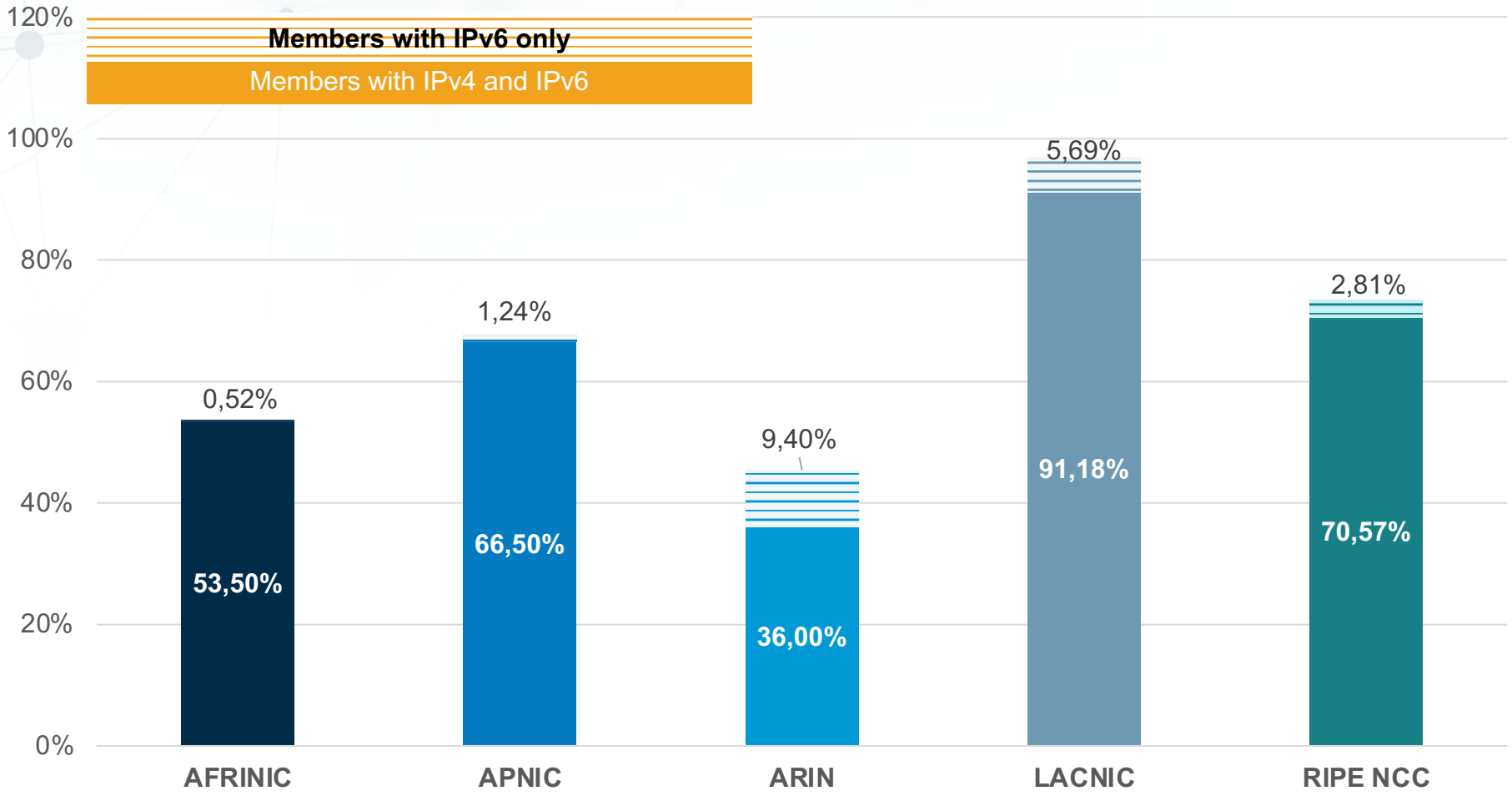
Percentage of Members with IPv6



As of 12/23

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IPv4 Transfer Market

- Developed due to on-going demand for rapidly depleting IPv4 addresses
  - Necessitated RIR policy changes
  - Choices were:
    - Facilitate IPv4 market transfers, ensure accurate registry data
    - Watch a black market emerge with no registry interaction
- Needs-based IPv4 market transfer policies developed by communities
  - Allowed IPv4 holders to transfer space to qualified recipients
- RIR's role
  - Ensure compliance with needs-based policies
  - Maintain the accuracy of the registry
    - RIRs not privy to any financial transaction information between parties

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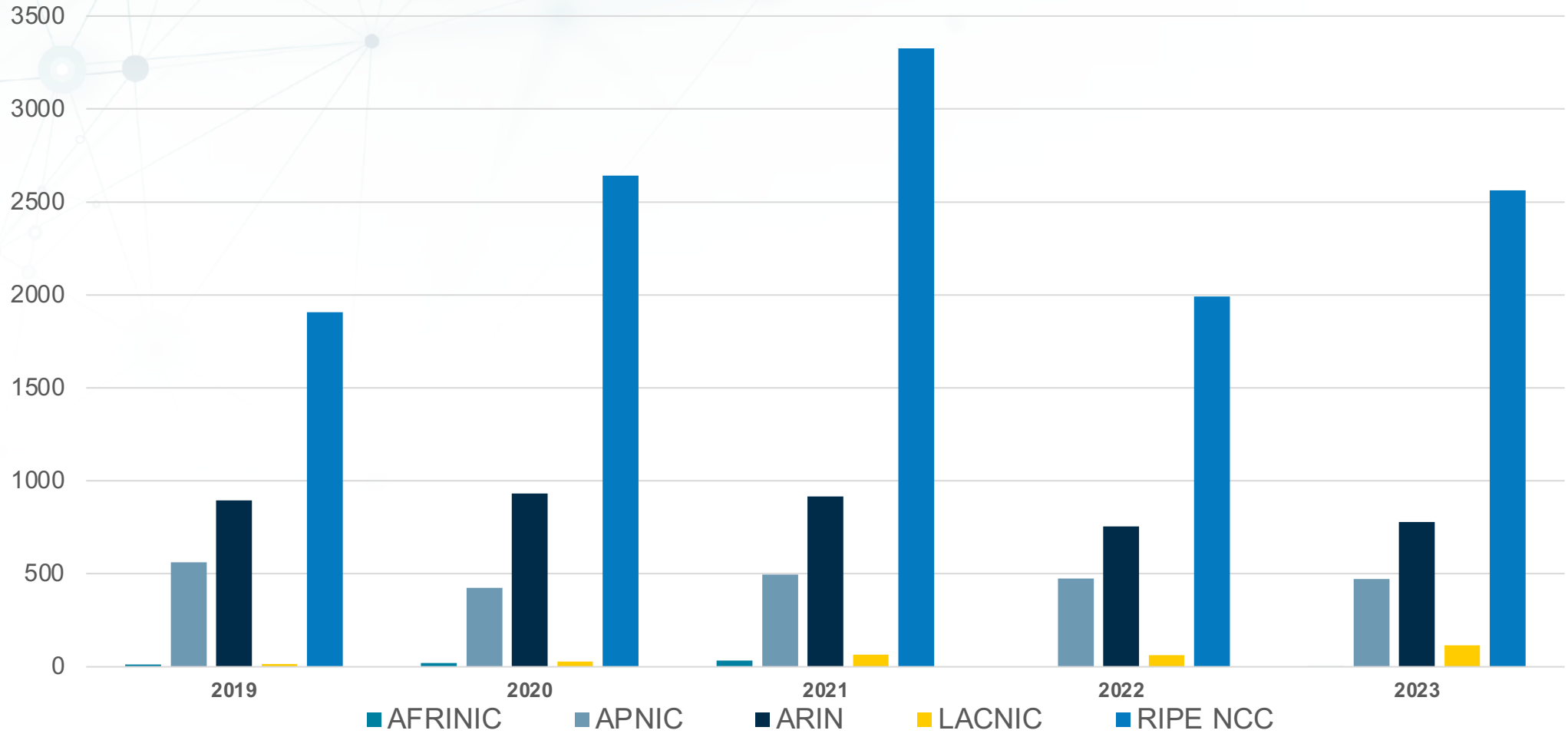
Intra-RIR IPv4 Transfers

- Number of transfers per year as of 12/23



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Inter-RIR IPv4 Transfers

- Total number of IPv4 transfers between RIRs as of 12/23

# of transfers / # of addresses transferred	Recipient RIR: AFRINIC	APNIC	ARIN	LACNIC	RIPE NCC
Source RIR: AFRINIC		0	0	0	0
APNIC	0		159 / 1.32M	5 / .00743M	341 / 2.363M
ARIN	0	468 / 19.67M		25 / .026M	576 / 19.44M
LACNIC	0	1 / .002M	21 / .055M		29 / .054M
RIPE NCC	0	140 / 2.524M	230 / 4.074M	10 / .008M	

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Resource Public Key Infrastructure

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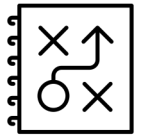
Why is RPKI Important?

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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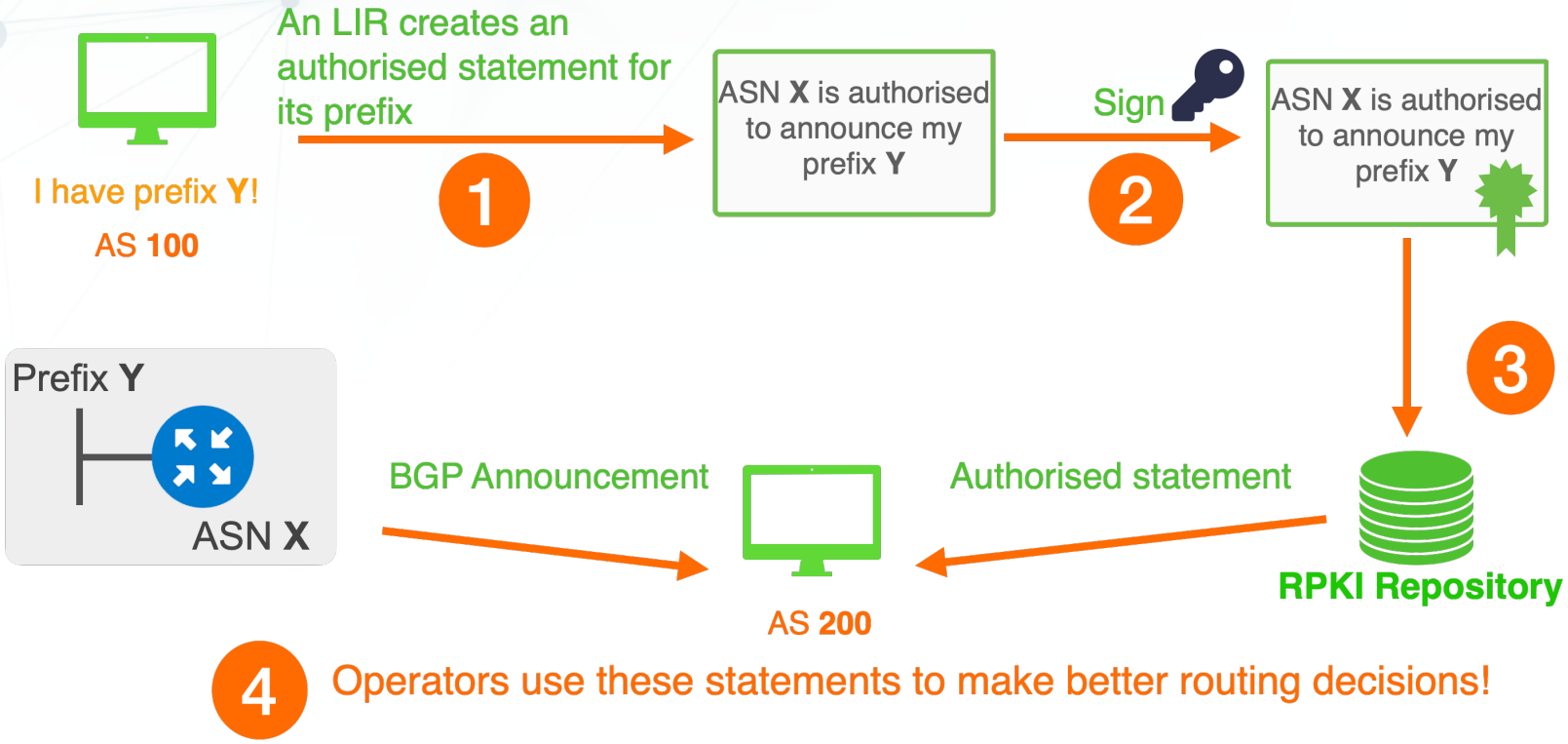
Resource Public Key Infrastructure (RPKI)



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RPKI RIR Adoption

% of IP address space covered by RPKI certificates as of 12 Feb 2024

REGION	IPv4 ADOPTION	IPv6 ADOPTION
AFRINIC	28.65	7.89
APNIC	34.75	23.63
ARIN	31.42	63.23
LACNIC	50.31	49.38
RIPE NCC	66.48	38.18

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

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For More Information

APNIC	• https://www.apnic.net
AFRINIC	• https://www.afrinic.net
RIPE NCC	• https://www.ripe.net
ARIN	• https://www.arin.net
LACNIC	• https://www.lacnic.net

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