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"How It Works" The Regional Internet Registry System

Leslie Nobile

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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Overview

- The Regional Internet Registry System
- Internet Number Resource Primer: IPv4, IPv6 and ASNs
- Significant happenings at the RIR
  - IPv4 Depletion and IPv6 Transition
  - IPv4 transfer market
  - Increase in fraudulent activity
- RIR Tools, technologies, etc.

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The Regional Internet Registry System

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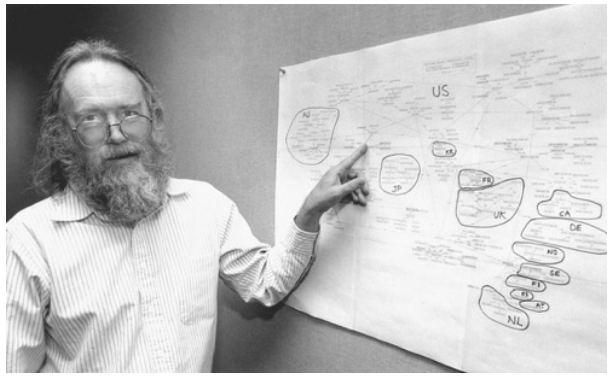
Brief History
Internet Number Resource Administration

- **1980s to 1990s**
  - Administration of names, numbers, and protocols contracted by US DoD to ISI/Jon Postel (eventually called **IANA**)
    - Registration/support of this function contracted to SRI International and then to Network Solutions
- Regionalization begins - Regional Internet Registry system forms
- IP number resource administration split off from domain name administration
- US Govt separates administration of commercial Internet (**InterNIC**) from the military Internet (**DDN NIC**)



Jon Postel

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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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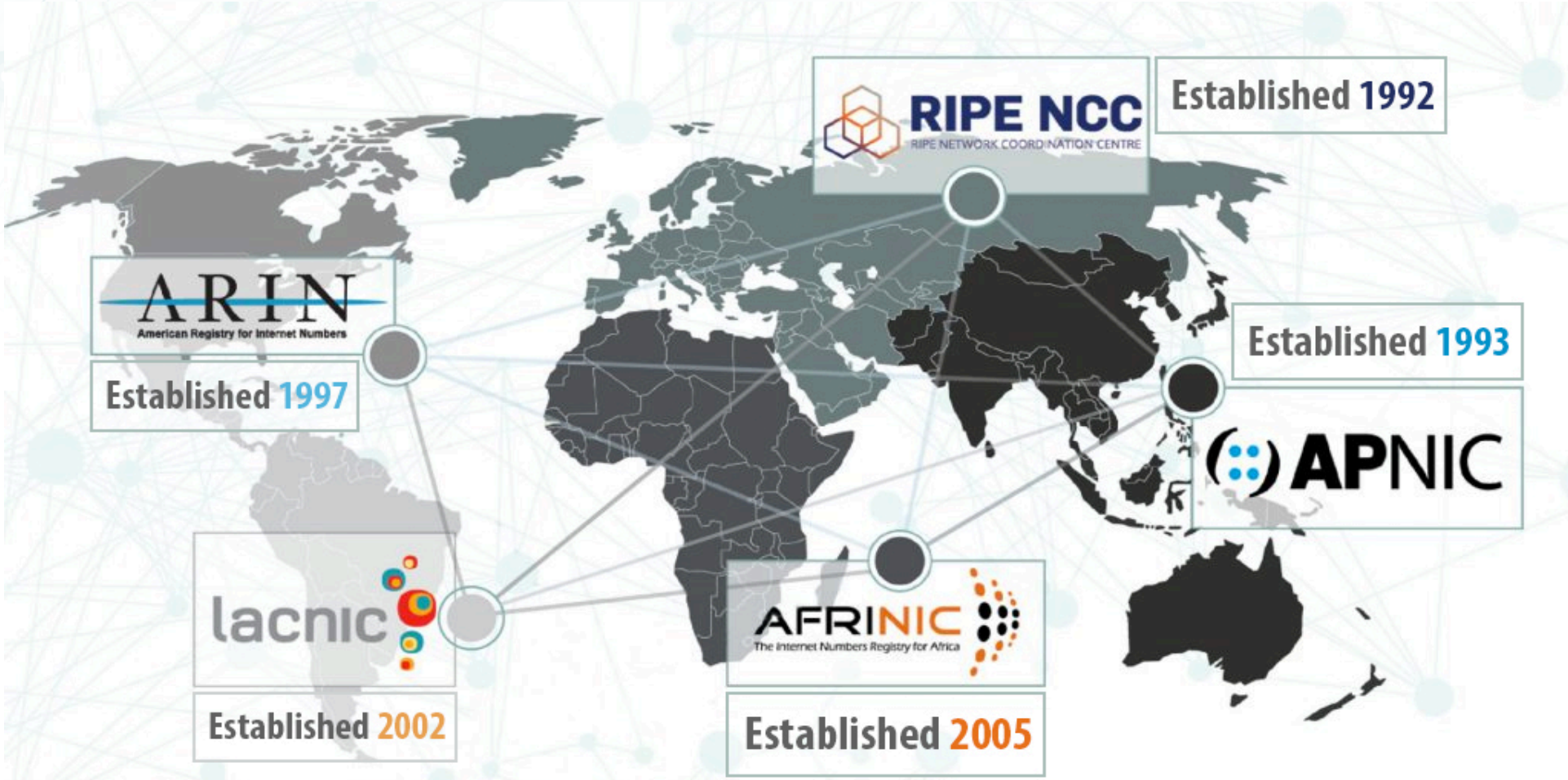
Who Are the RIRs?



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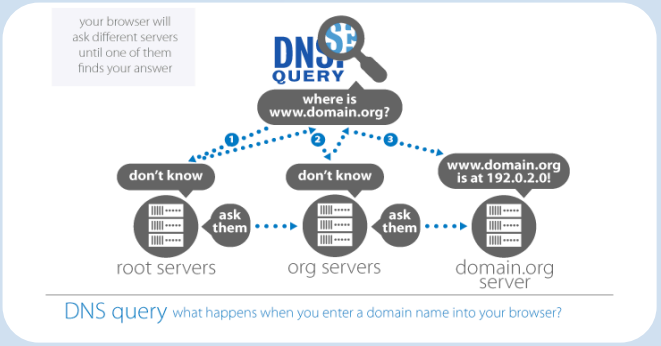
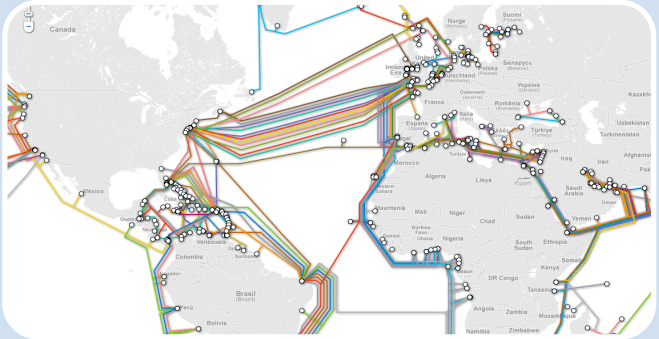
Core Functions of an RIR





Manage, distribute and register Internet Number Resources (IPv4 & IPv6 addresses and Autonomous System numbers (ASNs)

-Maintain directory services including Whois and routing registries

-Provide reverse DNS

-Support Internet infrastructure through technical coordination

-Facilitate community driven policy development process

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The RIRs are…

Independent	• No government oversight
Not-for-profit	• 100% community funded • Fee for services, not number resources
Membership-based	• Open to all holders of number resources (e.g. Internet service providers (ISPs), telecom organizations, governments and corporations)
Community Regulated	• Community developed policies • Member-elected governing boards • Open and transparent

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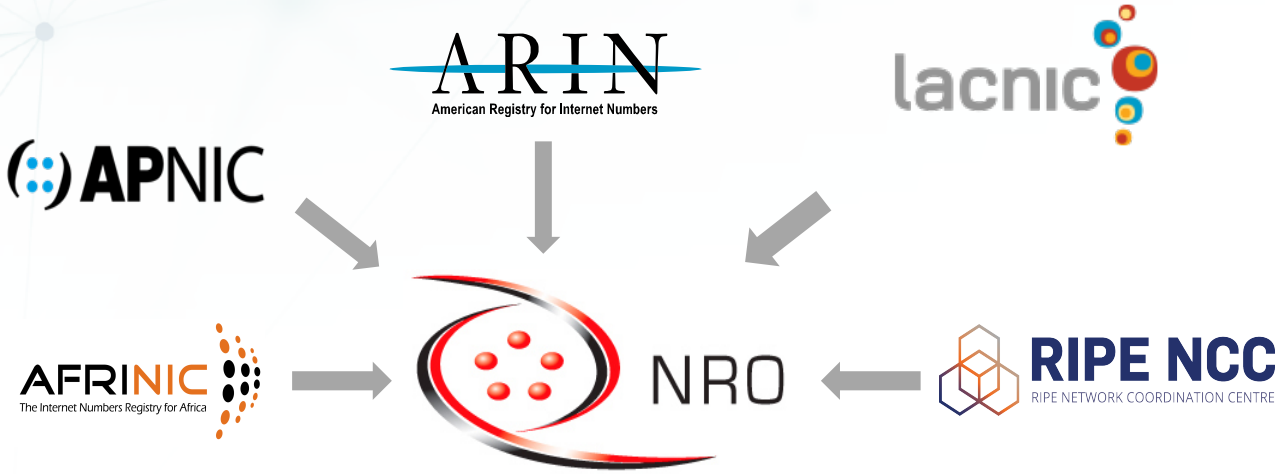
The Number Resource Organization (NRO)



- Acts as a focal point for Internet community input into the RIR system
- Promotes and protects bottom-up policy process & unallocated number resource pool

https://www.nro.net/

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Internet Corporation for Assigned Names and Numbers (ICANN)

Mission	Structure	Organization
◆ Top Level Technical Coordination of the Internet ❖ Names ❖ Numbers ❖ Root Servers	◆ Non Profit ◆ Self-Regulatory ◆ Global	◆ Supporting Organizations – ccNSO – gNSO – **ASO** ◆ Advisory Committees

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Internet Number Resource Primer

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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*** to 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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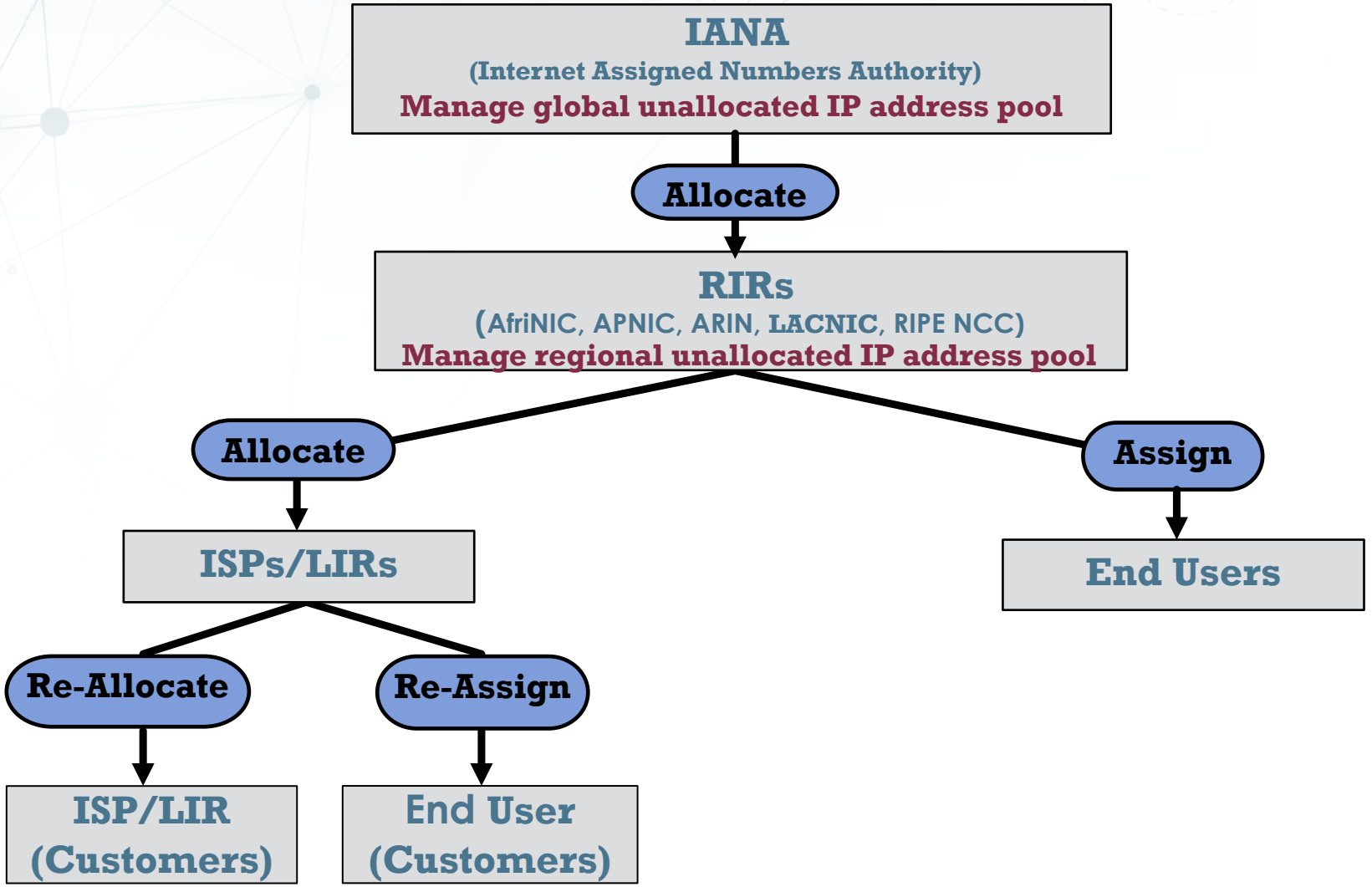
How Are IP Addresses Issued?



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Significant Happenings at the RIRs

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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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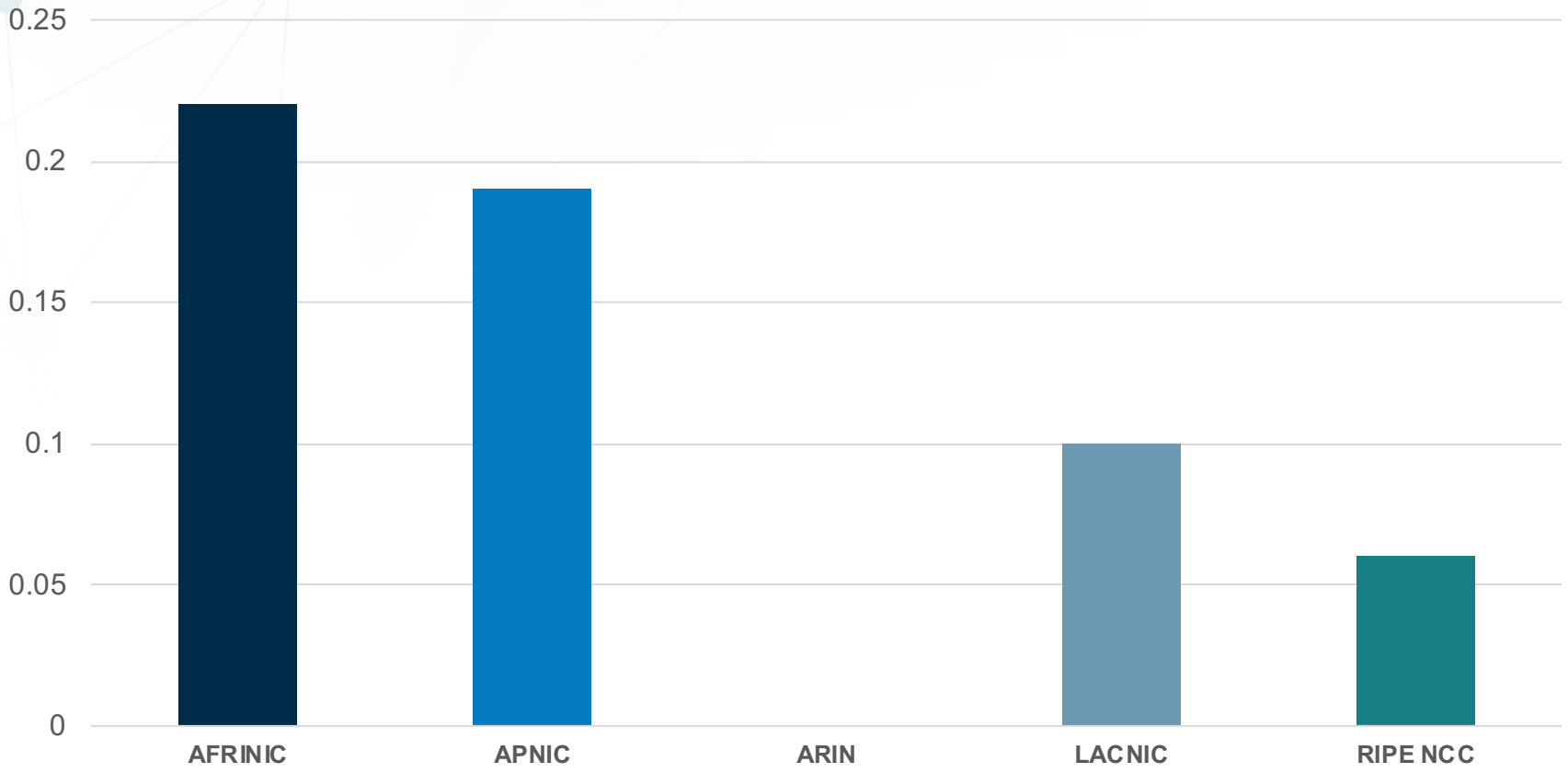
IPv4 Space Currently Available in Each RIR

- **Measured in /8s**



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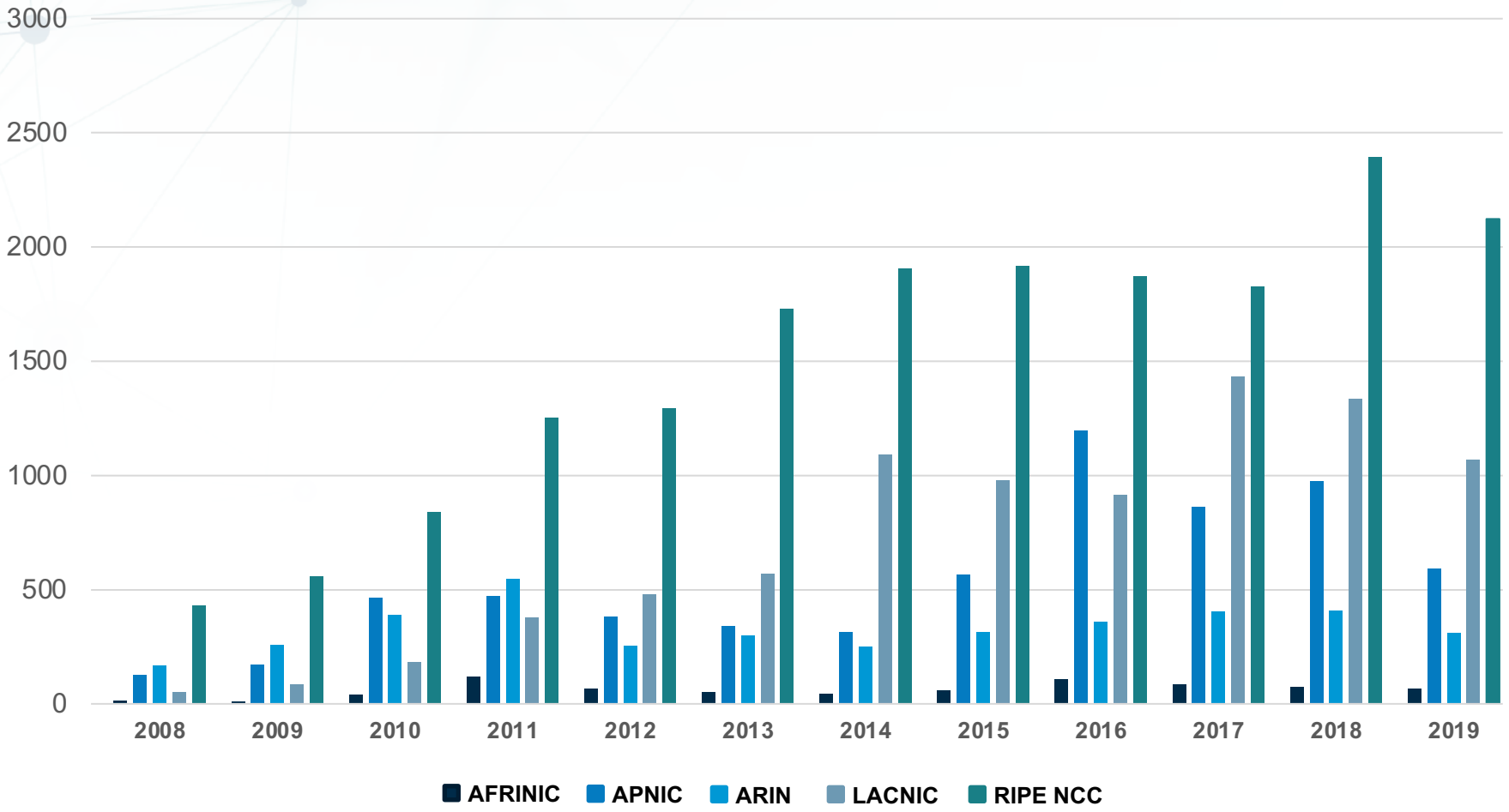
IPv6 Allocations Issued by RIRs

- **Total prefixes per RIR per year**



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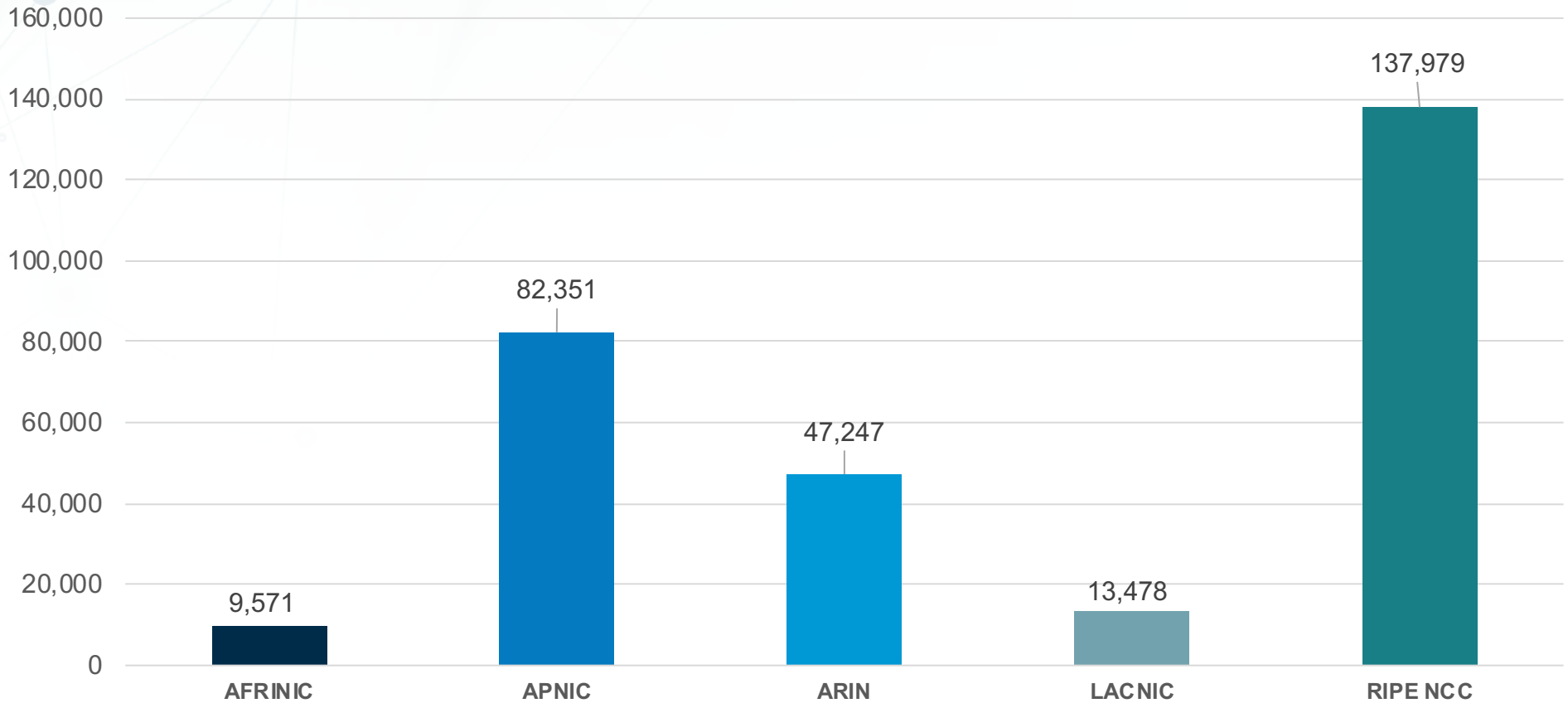
Total IPv6 Space Currently Allocated

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



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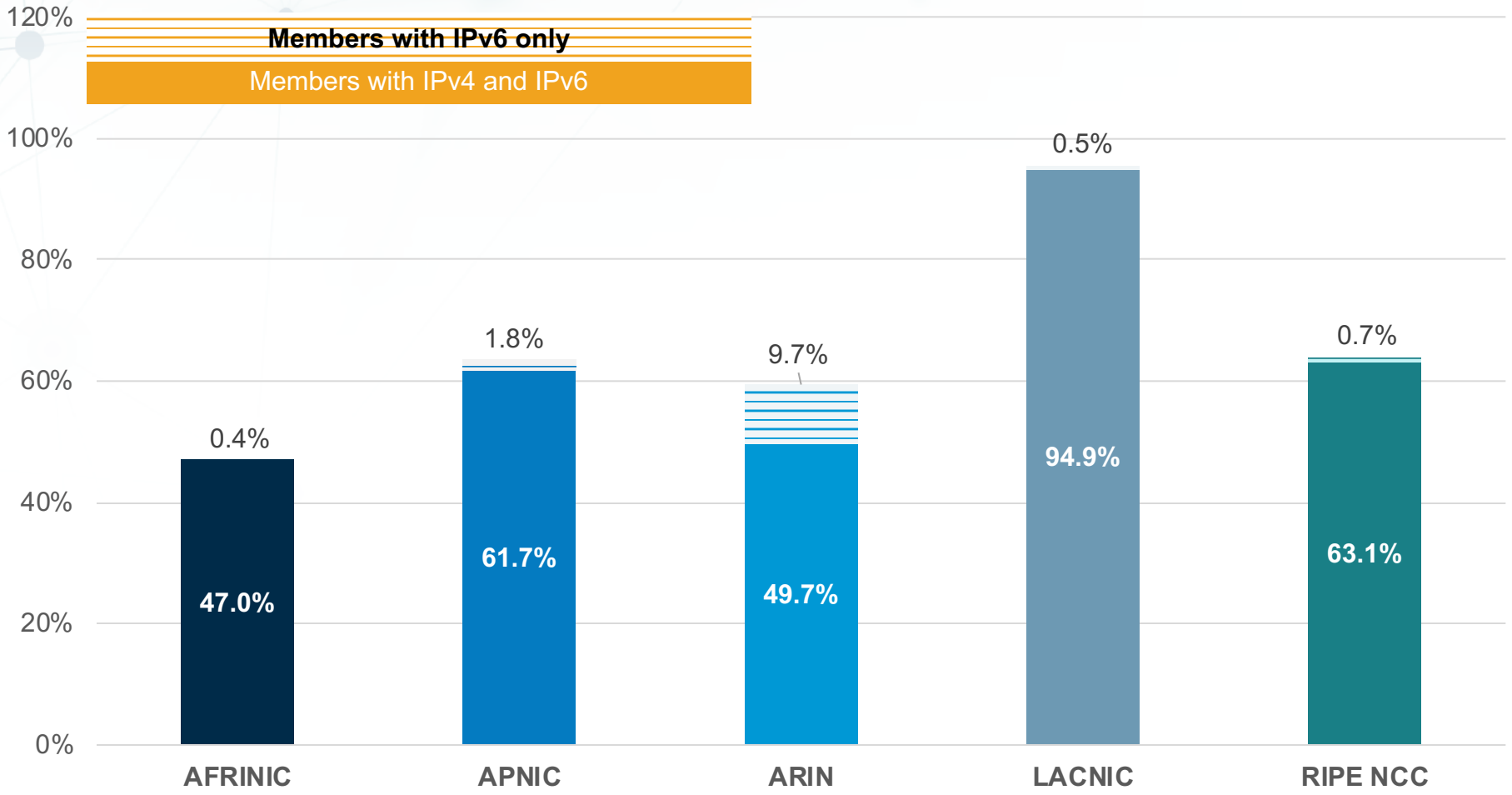
Percentage of Members with IPv6



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Current Observations

- **Movement to IPv6 has been slow but steady**
  - ISPs slowly 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
    - Purchasing space and using RIR transfer policies to update RIR registries
    - Purchasing space outside the registry system (not updating RIR registries)
    - Leasing/Letters of Authority

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Emergence of IPv4 Transfer Market

- On-going demand for/decreasing supply of IPv4 addresses necessitated RIR policy changes
- Choices were:
  - Facilitate IPv4 market transfers and ensure accurate registry data
  - Watch a black market emerge with no registry interaction
- 5 RIRs implemented needs-based IPv4 market transfer policies that allow IPv4 resource registrants to transfer space to qualified recipients
  - RIR's role is to ensure full compliance with needs-based policies and to update and maintain the accuracy of the registry
  - The RIRs not privy to any financial transaction information between transferring parties

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RIR IPv4 Market-Based Transfer Policies

	Intra-RIR transfer policy	Inter-RIR transfer policy	Pending Inter-RIR transfer policy
AFRINIC	Yes	No	Multiple versions in discussion
APNIC	Yes	Yes	
ARIN	Yes	Yes	
LACNIC	Yes	Pending	Policy will be implemented in Q2 2020
RIPE NCC	Yes	Yes	

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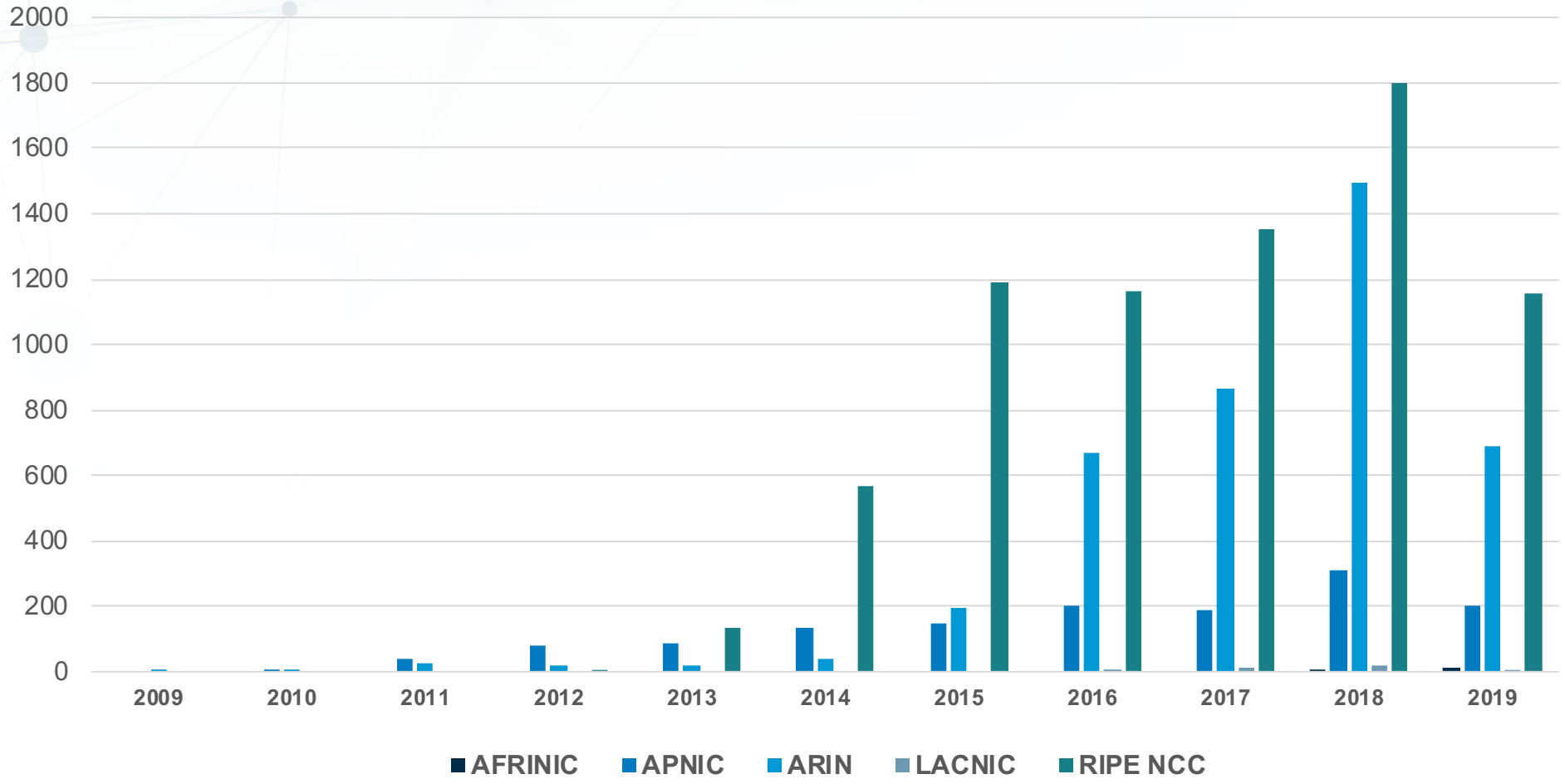
Intra-RIR IPv4 (Market-based) Transfers

- **Number of transfers per year**



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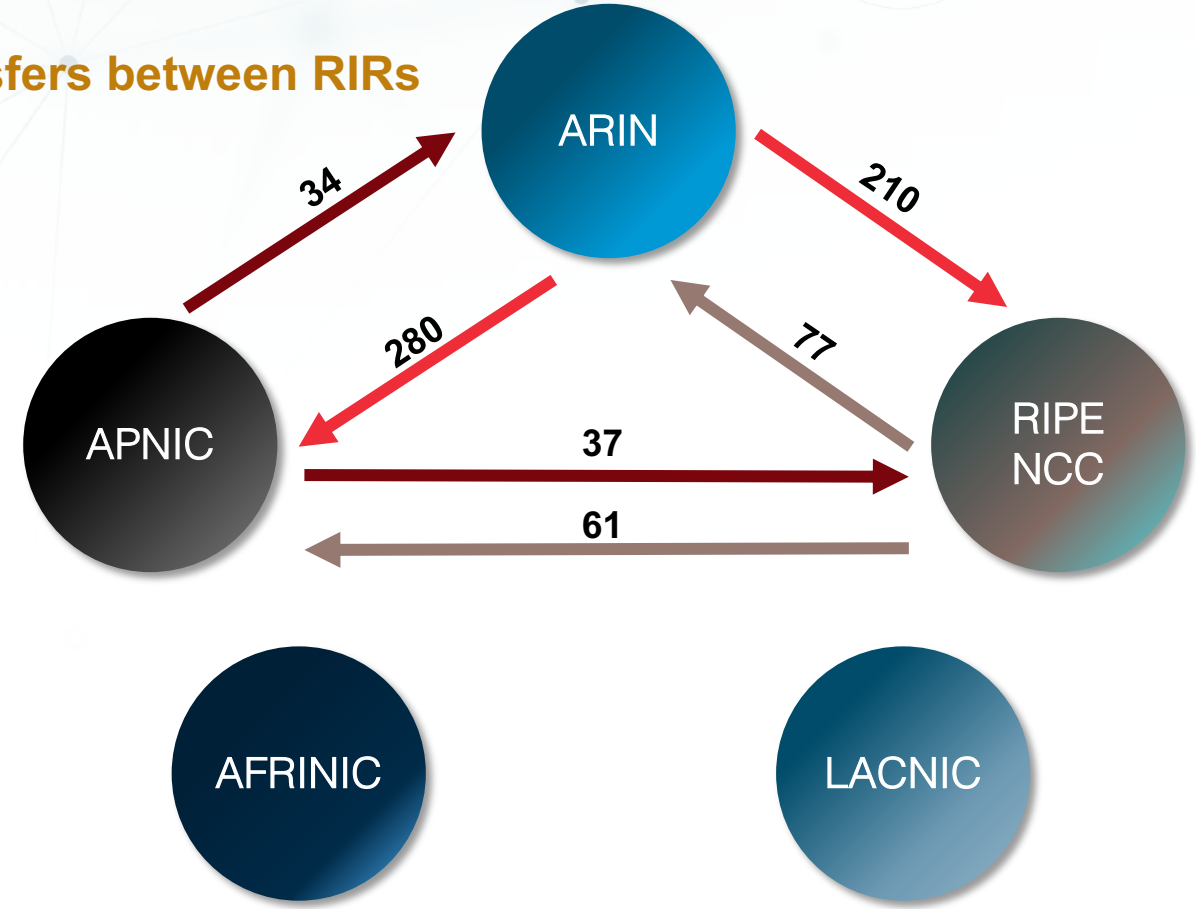
Inter-RIR IPv4 (Market-based) Transfers

- **Total number of IPv4 transfers between RIRs**



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Current Challenges

More fraudulent requests to transfer IPv4 addresses

- *IPv4 addresses have increasing market value as supply depletes*

Hijacking of IPv4 addresses & ASNs

- *Fraudulent Whois changes; Target dormant/out of date records*
- *Submit falsified documents (e.g. passports)*
- *Set up shell companies*

Route Hijacking

- *Unauthorized use of abandoned/un-routed IPv4 addresses*

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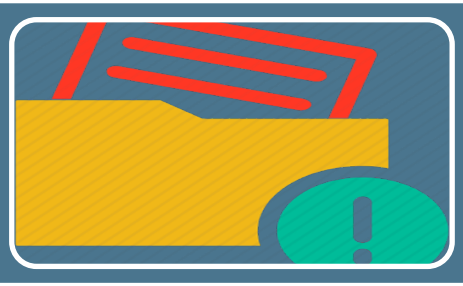
Current Challenges

Leasing/buying/selling of IPv4 address space (outside of registry system)



People not validating their contact information in Whois

Carrier Grade NAT

Difficult to identify individual subsbribers

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RIR Tools,Technologies, etc.

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WHOIS

What Information Does it Include?

- Publicly available registration information about
  - IP addresses and AS numbers issued by an RIR
  - IP addresses and AS numbers issued prior to the establishment of the RIRs (**legacy space**)
  - Original registration date and last updated date
  - Organizations that hold these resources (ORGs)
  - Points of Contact for resources or organizations (POCs)
  - Customer reassignment information (from ISPs to their customers)
- Referential information
  - To the authoritative RIR

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Registration Data Access Protocol (RDAP)

- New protocol for accessing registration data in a machine readable way
  - Standardized command, output and error structure
  - Redirection capabilities - query will route to the authoritative server to return data
  - Support for user identification, authentication and access control (e.g limited access for anonymous users and full access for authenticated users)
  - Supports Internationalization
- ICANN accredited registrars and gTLD registries will be required to implement RDAP in addition to port 43 WHOIS and web-based WHOIS
- All RIRs have set up RDAP clients

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Resource Public Key Infrastructure (RPKI)

- Public key infrastructure framework designed to secure the Internet's routing infrastructure, specifically BGP
  - **Cryptographically certifies network resources**
    - AS Numbers
    - IP Addresses
  - **Also certifies route announcements**
    - Route Origin Authorizations (**ROAs**) allow you to authorize the IP block to be routed
- Provides stronger validation than existing technologies such as:
  - Internet Routing Registries
  - Letters of Authority
- 5 RIRs (NRO) collaborating on this cross-RIR project

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RPKI RIR Activation

REGION	ACTIVE ENTITY COUNT
AFRINIC	139
APNIC	2253
ARIN	806
LACNIC	1409
RIPE NCC	9613
Totals	14,220

**Number of organisations that have resources with RPKI certificates as of 23 October 2019

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RPKI RIR Adoption

REGION	IPv4 ADOPTION	IPv6 ADOPTION
AFRINIC	5.63%	4.7%
APNIC	9.52%	8.76%
ARIN	5.74%	1.62%
LACNIC	21.93%	5.15%
RIPE NCC	39.03%	26.44%

Percentage of address space that is covered by RPKI certificates as of 23 October 2019

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Internet Routing Registry (IRR)

- Database of Internet route objects, operated by individual organizations (e.g. RIRs) used for determining and sharing route information
  - Network operators publish their routing policies and routing announcements in the IRR
- Ensures stability and consistency of Internet-wide routing by sharing information between network operators
  - Provides mechanism for validating contents of BGP announcements
  - Widely deployed to prevent accidental or intentional routing disturbances
- This highly distributed/decentralized exchange of route announcements/route policy is susceptible to error or manipulation
- RIRs working individually to add better validation processes to ensure accuracy and enhance security

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