











Address Supporting Organization

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.

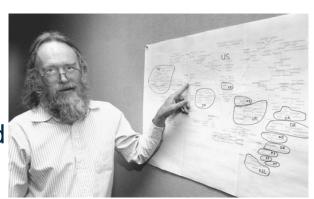
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The Regional Internet Registry System

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Brief HistoryInternet 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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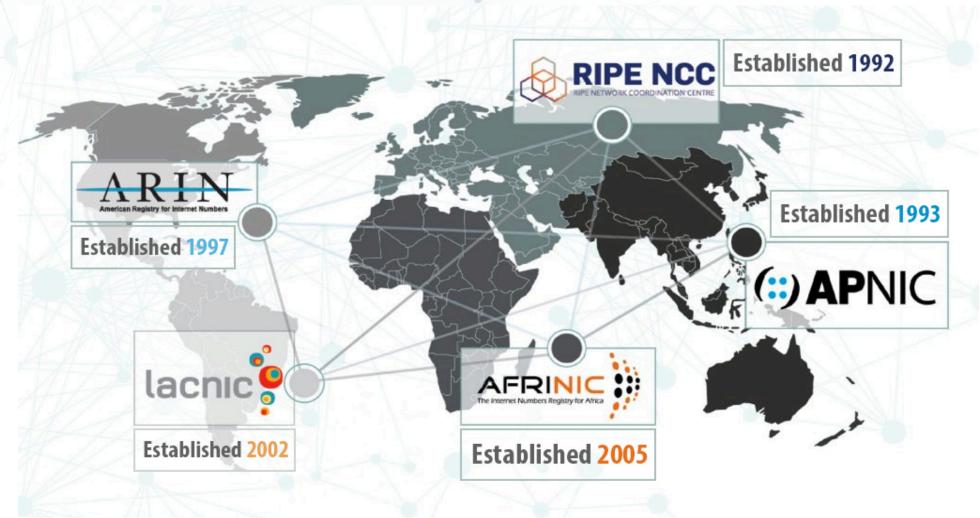
What is an RIR?

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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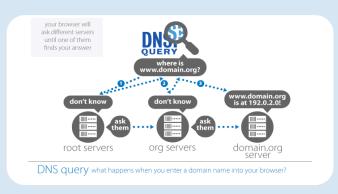
Who Are the RIRs?

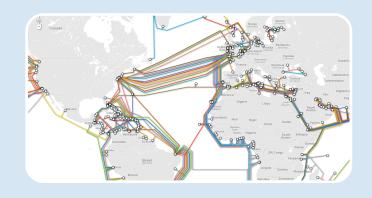


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Core Functions of an RIR







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

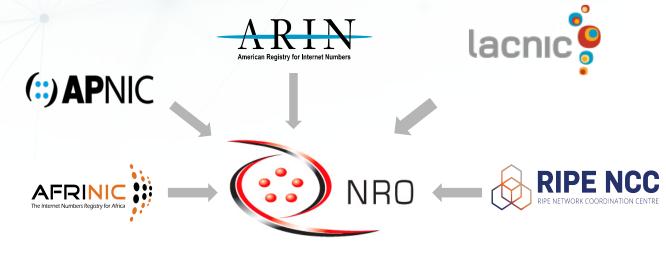
 Open to all holders of number resources (e.g. Internet service providers (ISPs), telecom organizations, governments and corporations)

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

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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

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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)

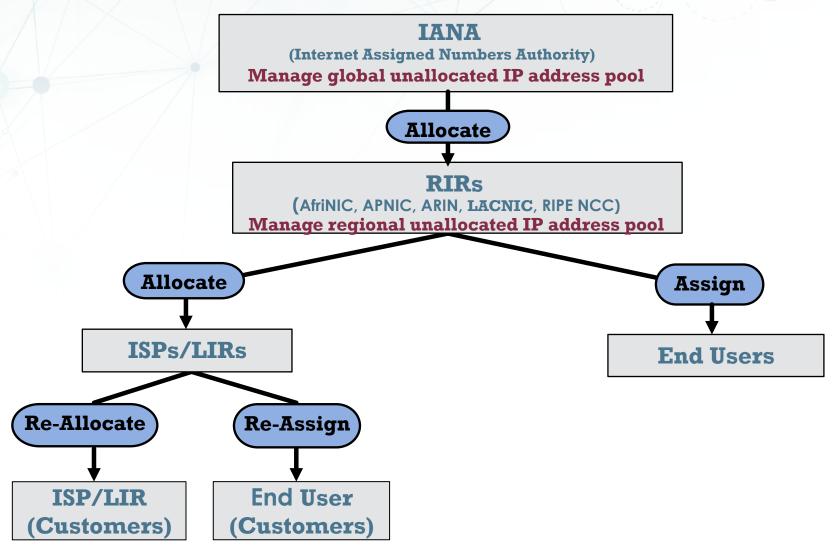
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IP Addresses are Not Domain Names

- 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

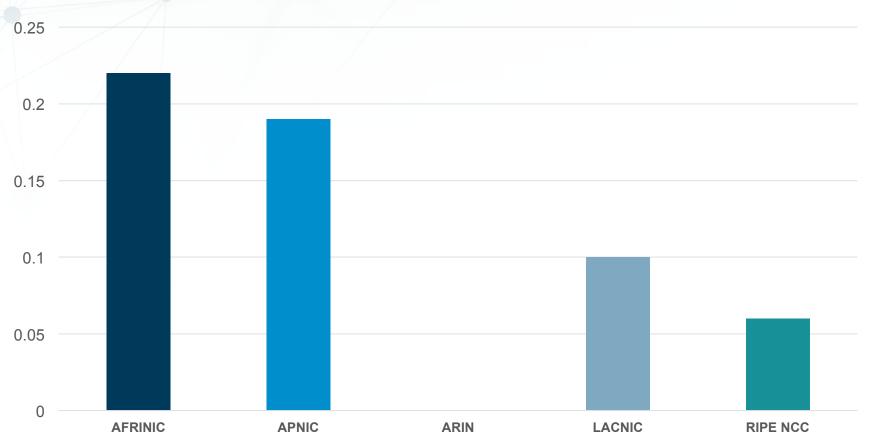
Each RIR received its last /8 IPv4 address block from IANA on 3 February 2011



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IPv4 Space Currently Available in Each RIR

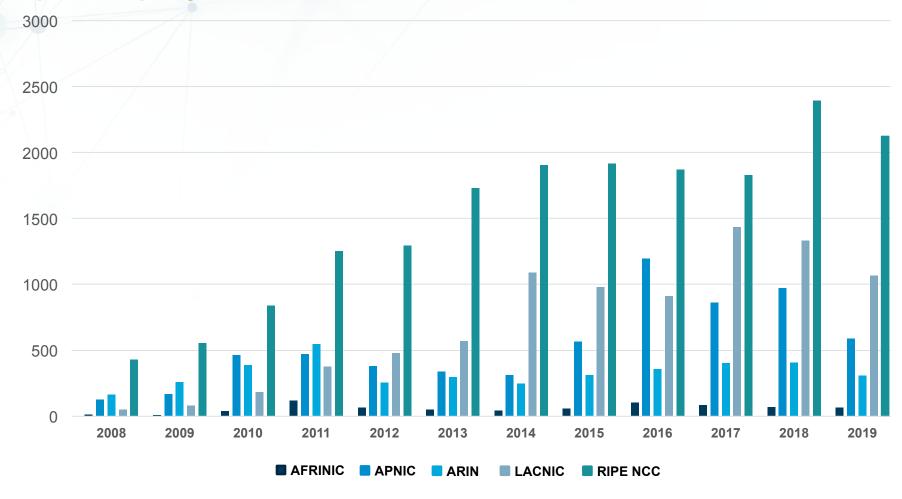
Measured in /8s



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IPv6 Allocations Issued by RIRs

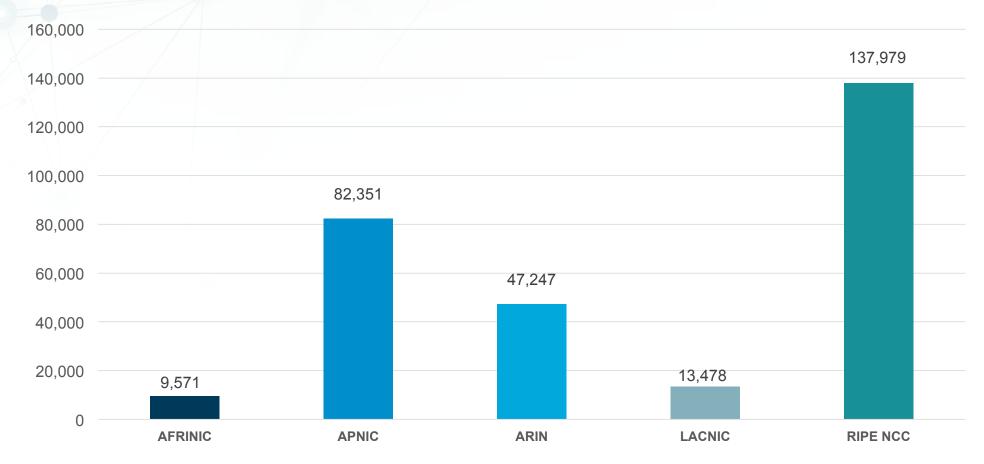
Total prefixes per RIR per year



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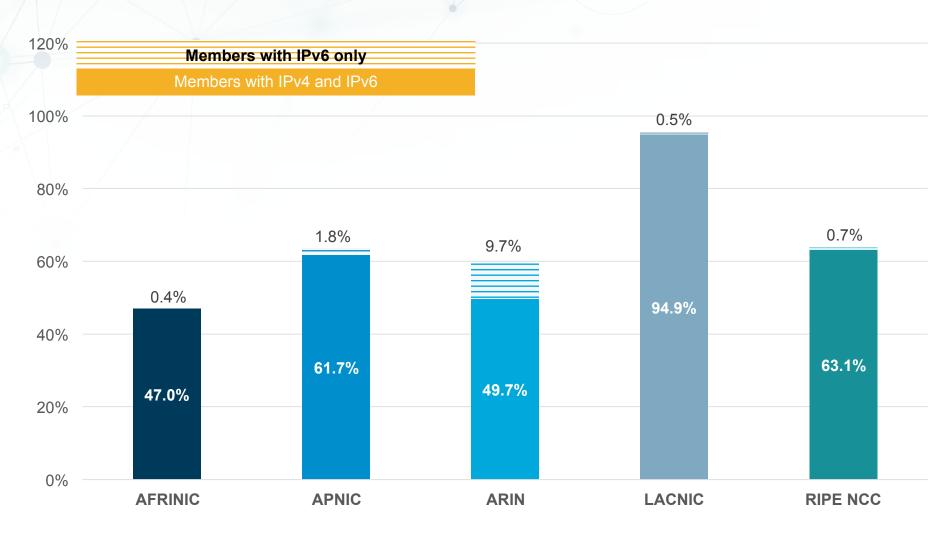
Total IPv6 Space Currently Allocated

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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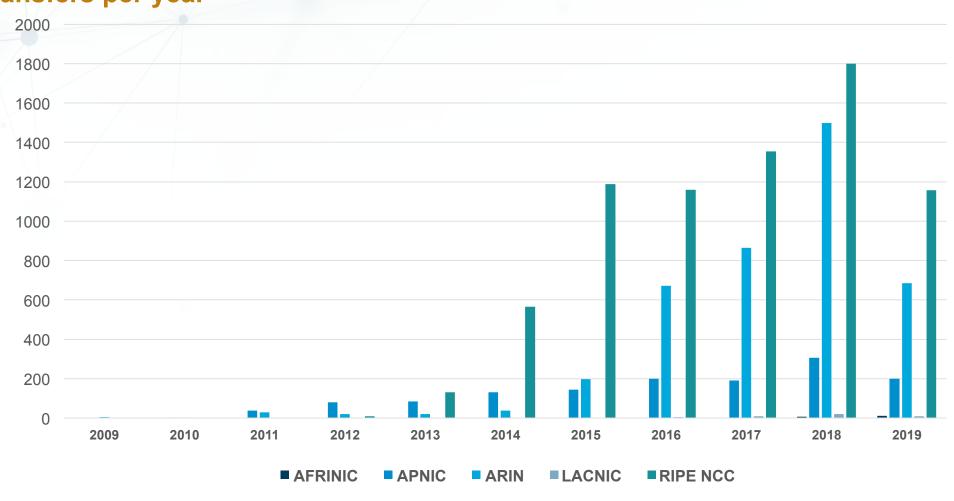
RIR IPv4 Market-Based Transfer Policies

	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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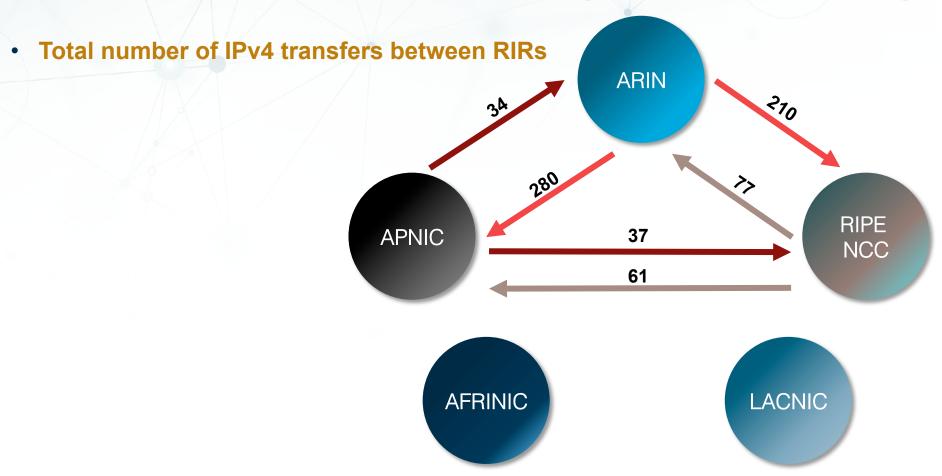
Intra-RIR IPv4 (Market-based) Transfers

Number of transfers per year



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Inter-RIR IPv4 (Market-based) Transfers



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Current Challenges



More fraudulent requests to transfer IPv4 addresses

PIPv4 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

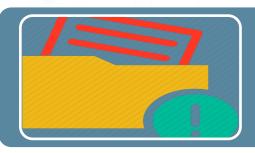
• Unauthorized use of abandoned/un-routed IPv4 addresses

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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 webbased 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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