

Internet Governance

CS249i: The Modern Internet



Distributed, but... still needs coordination

Little central coordination between ISPs — everyone makes their own (commercially-driven) decisions — with informal coordination

Other aspects need centralized organization:

- DNS and name registration (e.g., .com and .org)
- IP + MAC allocation
- WHOIS records for IP addresses
- Port Numbers
- Protocol Identifiers

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Unknown

Network Working Group

Jon Postel

Request for Comments : 349

Computer Science

UCLA-NMC

NIC : 10428

30 May 72

Categories : Socket Numbers

References : RFC's 322, 204

Proposed Standard Socket Numbers

I propose that there be a czar (me ?) who hands out official socket numbers for use by standard protocols. This czar should also keep track of and publish a list of those socket numbers where host specific services can be obtained. I further suggest that the initial allocation be as follows:

Sockets	Assignment
0-63	Network wide standard functions
64-127	Host specific functions
128-239	Reserved for future use
240-255	Any experimental function

and within the network wide standard functions the following particular assignment be made:

Socket	Assignment
1	Telnet
3	File Transfer
5	Remote Job Entry
7	Echo
9	Discard

IANA (Internet Assigned Numbers Authority)

Non-profit organization that oversees globally unique identifiers:

- IP Address Allocation
- ASN Allocation
- Protocol IDs
- Time Zone Database

In addition, IANA is responsible for administering data in root nameservers

- Root Zone (including DNSSEC)
- Special Zones (.int, .arpa)

IANA History

IANA emerged organically — was originally run by two individuals, Jon Postel and Joyce Reynolds. UCLA → USC Information Sciences Institute (ISI)

IANA becomes official in ~1988 when DARPA provides funding to USC-ISI to maintain IANA's functions

In 1998, USC transfers control to ICANN, a new non-profit responsible for coordinating Internet namespace and addressing

Jon Postel

RFC788

SIMPLE MAIL TRANSFER PROTOCOL

Jonathan B. Postel

Robustness principle

 6 languages ▾

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From Wikipedia, the free encyclopedia

In [computing](#), the **robustness principle** is a design guideline for software that states: "be conservative in what you do, be liberal in what you accept from others". It is often reworded as: "be conservative in what you send, be liberal in what you accept". The principle is also known as **Postel's law**, after [Jon Postel](#), who used the wording in an early specification of [TCP](#).^[1]

ICANN Today

ICANN originally operated under contract from U.S. Department of Commerce. U.S. relinquished control in March 2016 — now completely independent

- Prior to 2016, DoC provided oversight, verifying changes to DNS
- Also pursuant to an agreement with IETF over their functions

ICANN is managed by a 16-member board of directors:

- 8 members selected by a nominating committee on which all the constituencies of ICANN are represented;
- 6 representatives of its Supporting Organizations,
- 1 at-large seat filled by an at-large organization;
- (1) President / CEO, appointed by the board

ICANN vs. IANA vs. PTI

From 1998 to 2016, ICANN directly managed IANA (under contract from U.S. Government)

In 2016, ICANN established *Public Technical Identifiers (PTI)*, an independent organization that manages the technical operations of IANA

PTI is an affiliate of ICANN and is contacted by ICANN to perform those operations



Domains/TLDs

Top Level Domains (TLDs)

Generic TLDs: originally 7 gTLDs (predate ICANN) from the 1980s:

.com, .org, .net, .int, .edu, .gov, and .mil

Domain names may be registered in { .com, .net, and .org } without restriction; the other four have limited purposes.

Infrastructure TLDs: .arpa used for reverse DNS pointer lookups

ccTLDs: In 1994, IANA started to assign two letter country-code domains

Generic Restricted: (.biz, .name, .pro), can used only for specified purposes

Sponsored: .aero, .asia, .cat, .coop, .jobs, mobi, .tel, .travel, and .xxx can only be used by entities engaged within specific industry; (Added in 2000s)

In 2010, ~22 gTLDs total + ~250 ccTLDs

.gov TLD

<https://github.com/cisagov/dotgov-data>

☰ README.md

.gov data



The [.gov top-level domain](#) is operated so that the online services of US-based government organizations are easy to identify on the internet. In support of that aim, we publish .gov domain data publicly.

This repository contains the official, full list of registered domains in the .gov zone. The US Government's executive, legislative, and judicial branches are represented, as are US-based state, territory, tribal, city, and county governments.

Two files are updated daily (when there is activity):

- [current-full.csv](#) – a CSV of all domains, including federal domains
- [current-federal.csv](#) – a CSV of only federal domains

New gTLD Program

In 2011, ICANN introduced a new TLD program

For a fee of \$185,000, companies can create and control new gTLDs that reflect both brand (e.g., .acme) and product niche (e.g., .widgets).

Today, there are ~1,241 registered TLDs

Full of wonderful additions like...

.pizza, .beer, .george, .sucks, .google, .xyz, .wow, .unicorn, .blue

Who runs Root Servers?

IANA only controls the data in the authoritative root DNS servers.

It does not run the root servers themselves

HOSTNAME	IP ADDRESSES	OPERATOR
a.root-servers.net	198.41.0.4, 2001:503:ba3e::2:30	Verisign, Inc.
b.root-servers.net	199.9.14.201, 2001:500:200::b	University of Southern California, Information Sciences Institute
c.root-servers.net	192.33.4.12, 2001:500:2::c	Cogent Communications
d.root-servers.net	199.7.91.13, 2001:500:2d::d	University of Maryland
e.root-servers.net	192.203.230.10, 2001:500:a8::e	NASA (Ames Research Center)
f.root-servers.net	192.5.5.241, 2001:500:2f::f	Internet Systems Consortium, Inc.
g.root-servers.net	192.112.36.4, 2001:500:12::d0d	US Department of Defense (NIC)
h.root-servers.net	198.97.190.53, 2001:500:1::53	US Army (Research Lab)
i.root-servers.net	192.36.148.17, 2001:7fe::53	Netnod
j.root-servers.net	192.58.128.30, 2001:503:c27::2:30	Verisign, Inc.
k.root-servers.net	193.0.14.129, 2001:7fd::1	RIPE NCC
l.root-servers.net	199.7.83.42, 2001:500:9f::42	ICANN
m.root-servers.net	202.12.27.33, 2001:dc3::35	WIDE Project

Verisign and .com TLD

IANA/ICANN doesn't run the TLDs either — they approve and delegate control by issuing NS records that point to other providers

Historically, SRI and then Network Solutions controlled .com TLD

In 2000, Verisign acquired Network Solutions and became the registry for .com, .net, and .org

Verisign continues to be the provider under ICANN regulation/contract

- ICANN sets terms like the maximum that Verisign can change registrars
 - Was \$7.85 since 2012, \$8.39 since 2021. Will likely rise to \$10.26 by the end of 2026

.Org Dispute

In 2003, Verisign transferred control of .org TLD to the Internet Society (ISOC)

- Widely understood that the reason was to financially support ISOC
- In 2018, PIR's (subsidiary) revenue from .org was over \$92 MM
- Technically, PIR contracts the work out to Afilias, who runs a bunch of TLDs

ISOC tried to sell PIR to PE firm Ethos Capital in 2018 (1.13B), but transfer required ICANN's approval

Significant external concern — including from California AG's Office

ICANN ultimately blocked the transfer

Zone Files

CHANNEL RESOURCES

Top-Level Domain Zone File Information

Top-Level Domain (TLD) zone files are files maintained by Verisign that map active second-level domain names with the Internet Protocol (IP) addresses of the name server for the domain name.

Request Access

ICANN

CZDS Centralized Zone Data Service

Welcome to CZDS!

The Centralized Zone Data Service (CZDS) is an online portal where any interested party can request access to the **Zone Files** provided by participating **generic Top-Level Domains (gTLDs)**.

Please check back often as new gTLDs will be added once they are delegated. If you are looking for the zone file of a TLD that is not listed in CZDS, please contact the Registry Operator directly and ask for their Zone File Agreement. **For reference, ICANN.org maintains a list of Registries.**

** We recommend using **Chrome** browser for the best downloading zone file experience.*



Each of the .com and .net TLDs. The TLD Zone Files do not contain domain names in the hold, pendingdelete, and redemptionperiod. In addition, the TLD Zone Files do not contain domain names that do not have name servers associated with them.

Zone Files

```
$ORIGIN example.com.
@      IN      SOA      ns1.example.com  hm.example.com. (
        2001062502 ; serial
        21600      ; refresh after 6 hours
        3600      ; retry after 1 hour
        604800    ; expire after 1 week
        600      ) ; minimum TTL 10 minutes

        IN      NS      ns1.example.com.
        IN      NS      ns2.example.com.
        IN      TXT     "v=spf1 a mx -all"
        IN      MX     10      mail.example.com.
        IN      A      10.0.1.1
*      IN      A      10.0.1.100
ns1    IN      A      10.0.1.2
ns2    IN      A      10.0.1.3
mail   IN      A      10.0.1.4
www    IN      A      10.0.1.6
www    IN      AAAA   2001:db8::3
www    IN      TXT     "This is our website"
*.web  IN      A      10.0.1.7
ftp    IN      CNAME   www
;
;
;; RRs added for enabling WSEC DNS are reported below
;
*      86400    IN      TXT     "|wsecdns=enabled|" ; WSEC
*.web  86400    IN      TXT     "|wsecdns=enabled|" ; WSEC
_test_._wsecdns_ 86400  IN      TXT     "|wsecdns=enabled|" ; WSEC
;
*_wsecdns_      IN      CNAME   example.com. ; WSEC
*_wsecdns_.ns1  IN      CNAME   ns1      ; WSEC
*_wsecdns_.ns2  IN      CNAME   ns2      ; WSEC
*_wsecdns_.mail IN      CNAME   mail     ; WSEC
*_wsecdns_.www  IN      CNAME   www      ; WSEC
*_wsecdns_.ftp  IN      CNAME   ftp      ; WSEC
;
*_test_._wsecdns_      IN      CNAME   _test_._wsecdns_ ; WSEC
*_test_._wsecdns_.ns1 IN      CNAME   _test_._wsecdns_ ; WSEC
*_test_._wsecdns_.ns2 IN      CNAME   _test_._wsecdns_ ; WSEC
*_test_._wsecdns_.ftp IN      CNAME   _test_._wsecdns_ ; WSEC
*_test_._wsecdns_.www IN      CNAME   _test_._wsecdns_ ; WSEC
```

Zone Files

Zone Files for .com only provide NS records and associated glue records

- They don't know anything about subdomains! How do you find them?

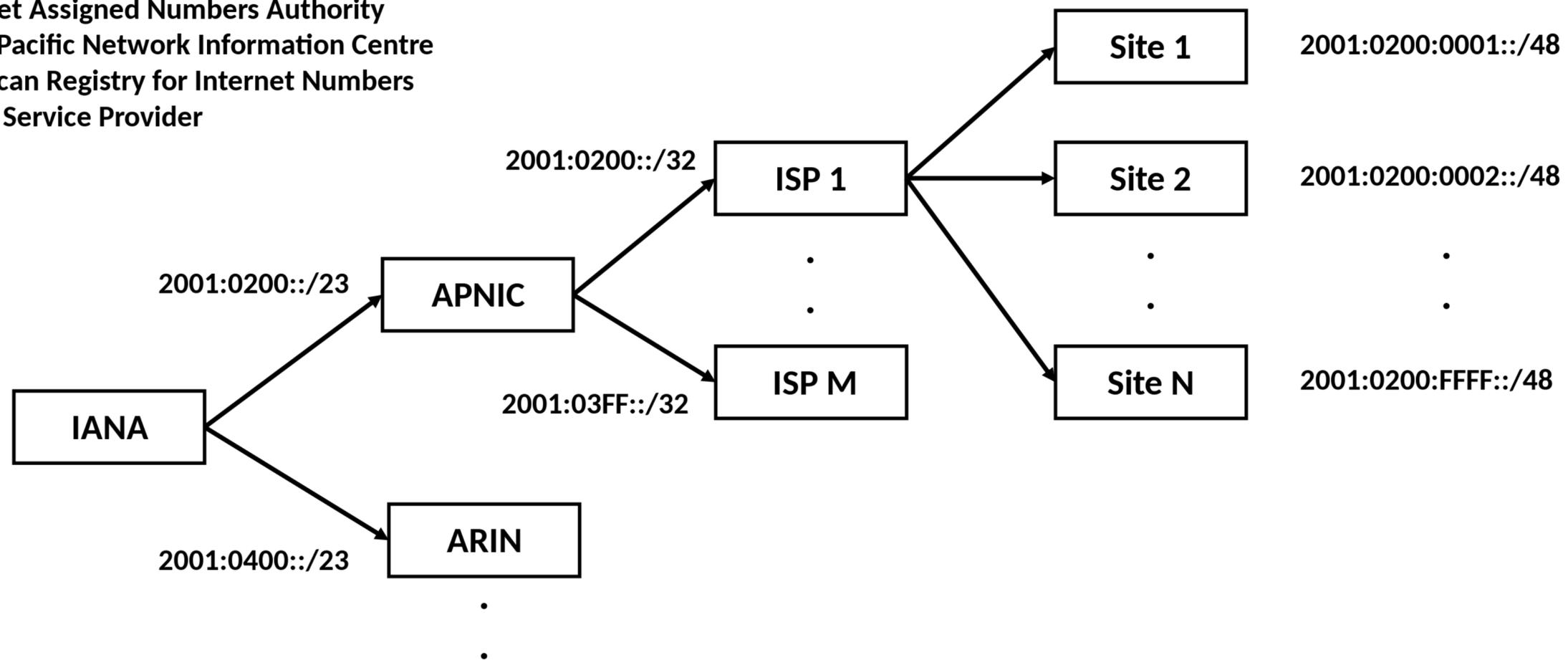


IP Addresses

IP Address Allocation

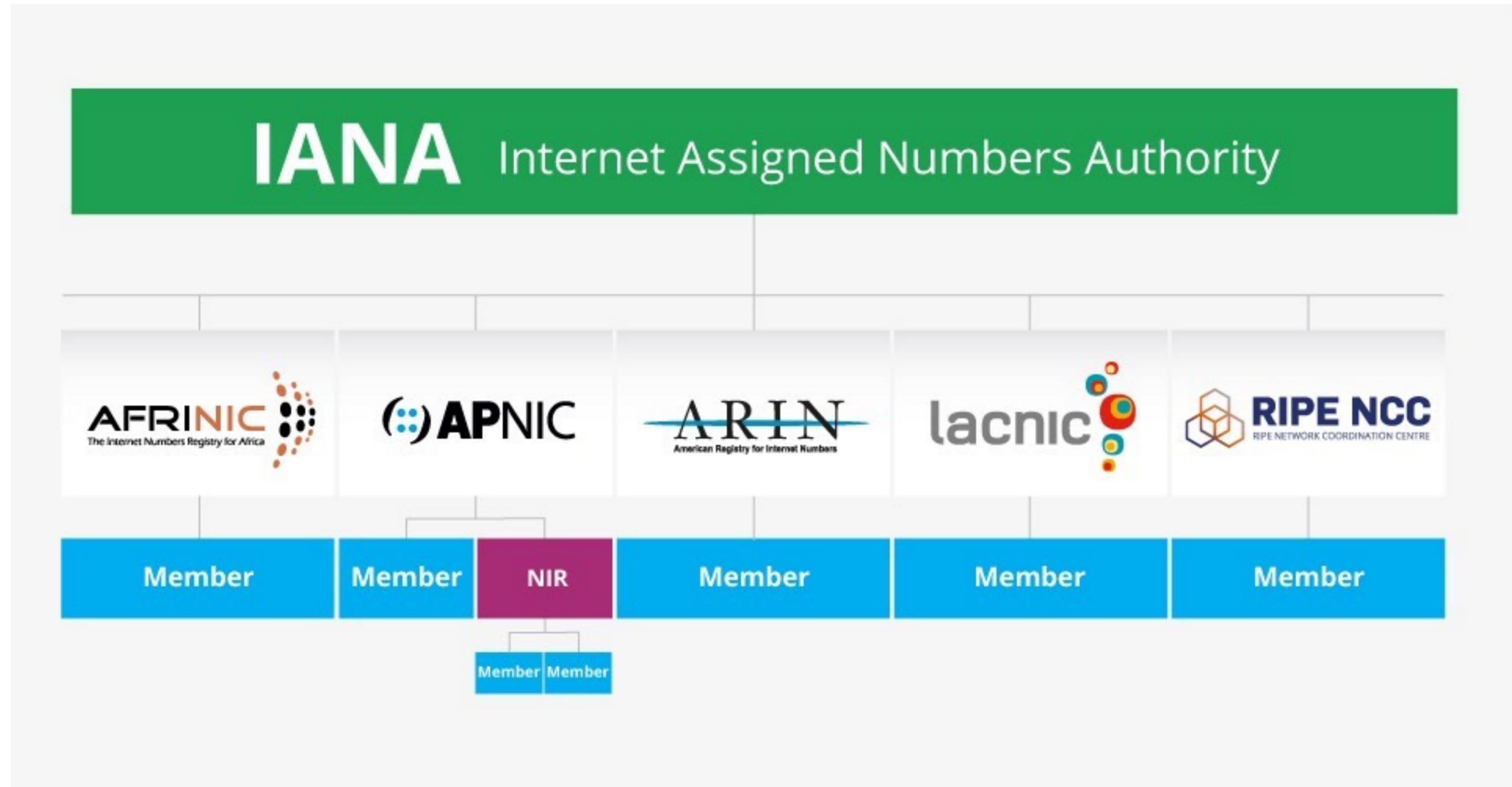
IANA allocates blocks of IP addresses to [regional Internet registries \(RIRs\)](#).

IANA: Internet Assigned Numbers Authority
APNIC: Asia-Pacific Network Information Centre
ARIN: American Registry for Internet Numbers
ISP: Internet Service Provider

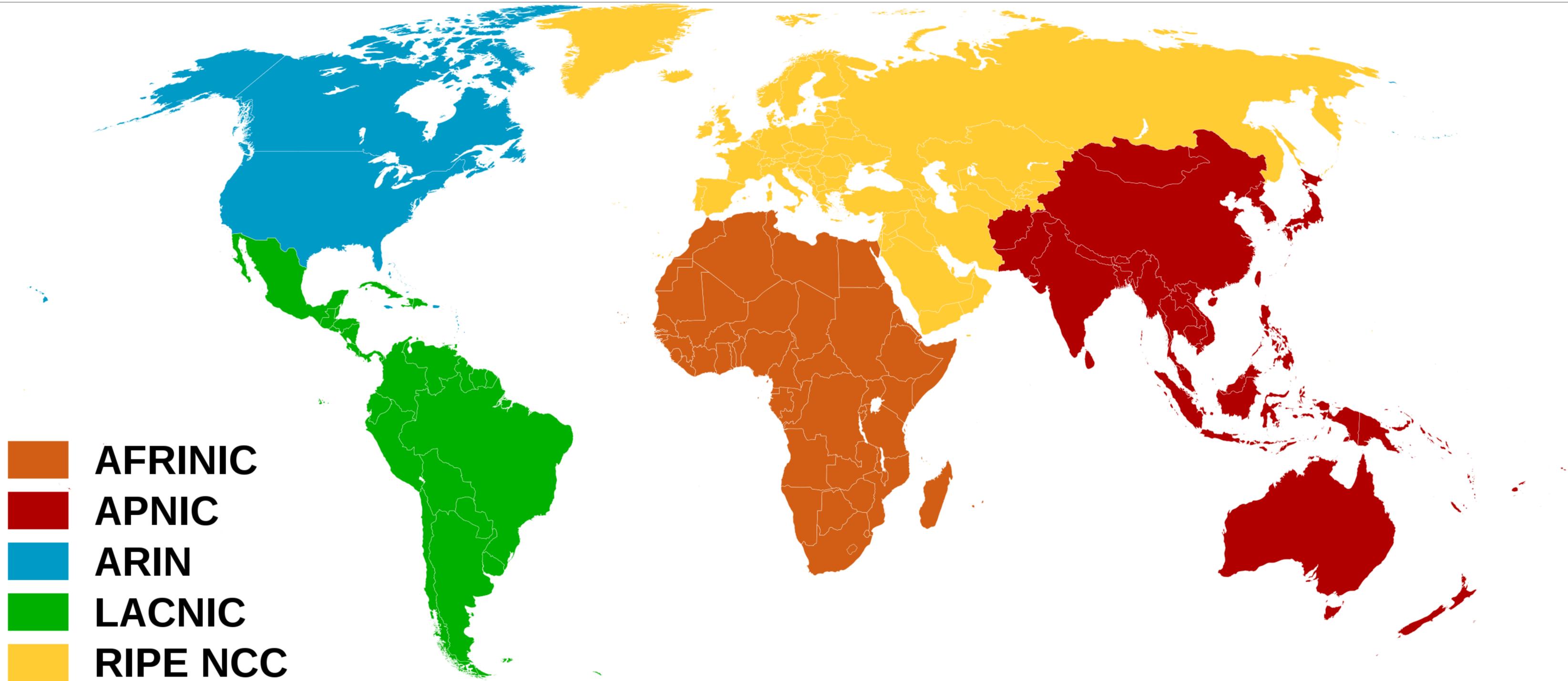


The 5 RIRs are informally liaised through an independent non-profit *Number Resource Organization (NRO)*

Regional Internet Registries

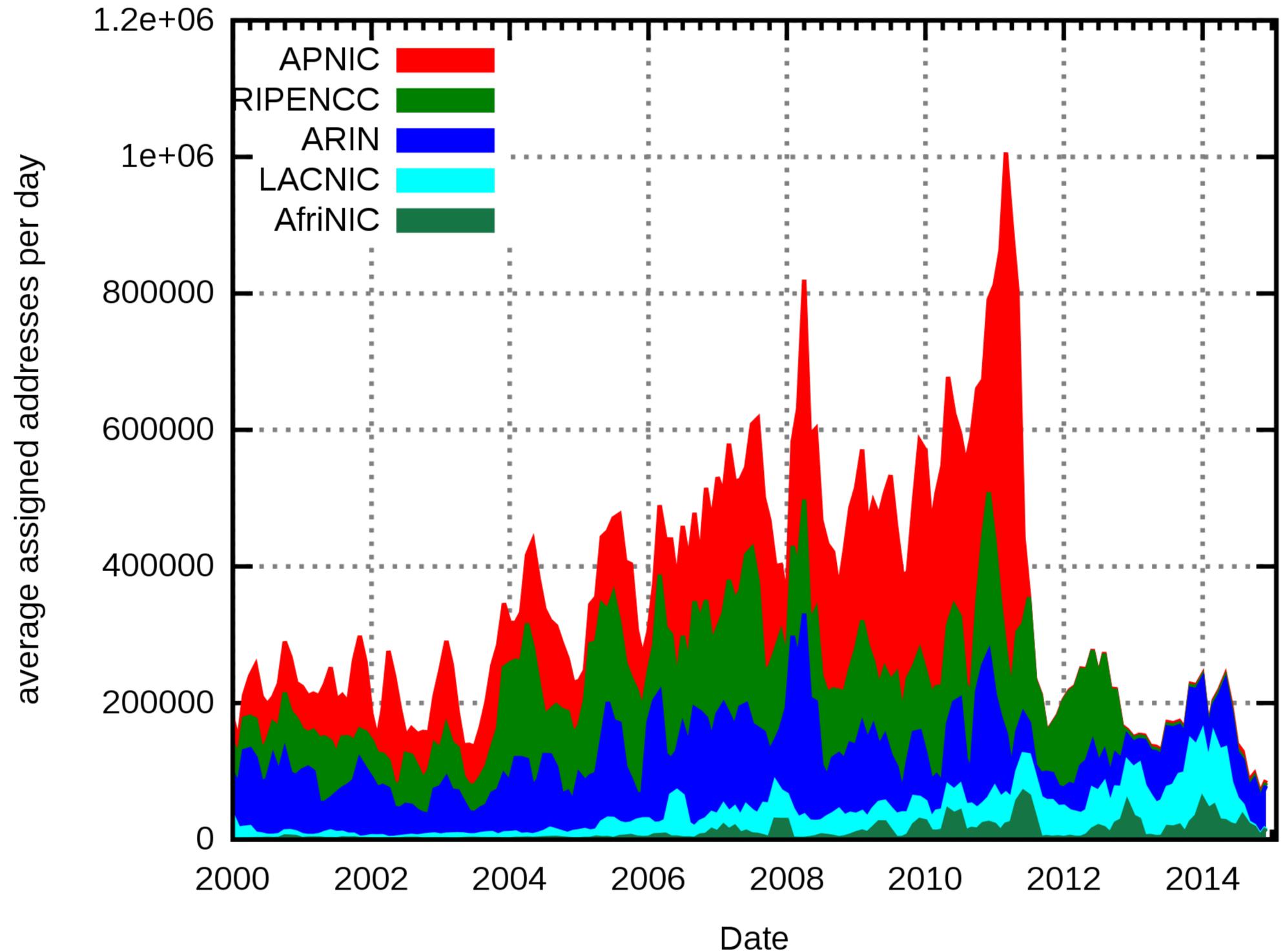


Regional Internet Registries



RIR IPv4 Allocation Rates

RIRs were allocating IPs
at tremendous rate —
especially in Asia



IPv4 Allocations

IANA ran out of unallocated IP blocks in January 2011

RIRs ran out soon after:

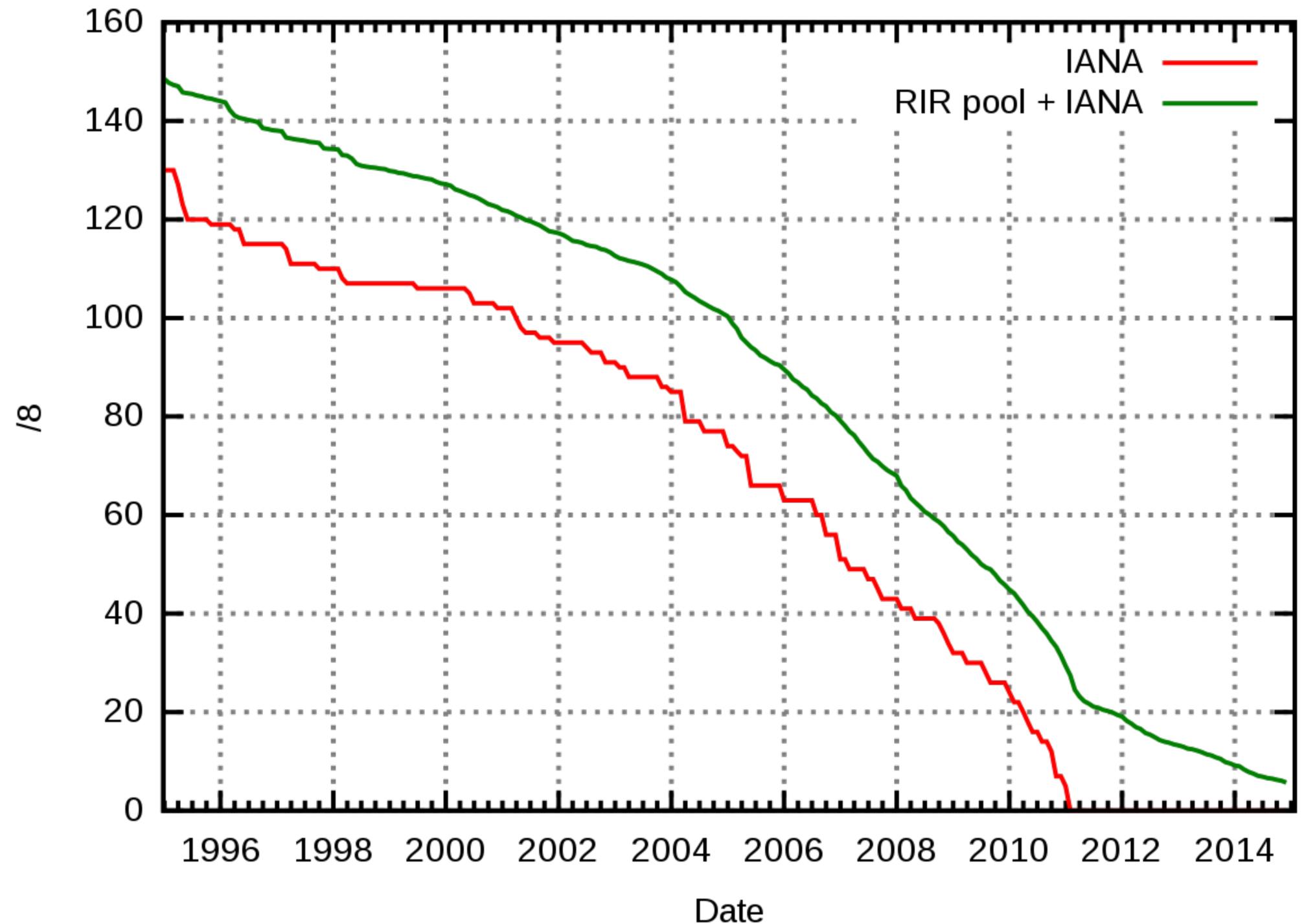
APNIC — April 2011

LACNIC — June 2014

ARIN — Sept 2015

AFRINIC — April 2017

RIPE — Nov 2019



Reclaiming Unused IPv4 Address Space

Some organizations have returned unused address space

- Stanford returned 36.0.0.0/8 and kept only 5 x /16s by 2000
- MIT sold half of 18.0.0.0/8 to Amazon in 2017.
Had only ever used 2 of the 16 million IPs they owned

? How much of IPv4 is advertised? You can check your routing table.



IP Markets

IP Markets

It's permissible to transfer ownership (i.e., sell) IP blocks larger than a /24

Transfers are approved by RIRs (e.g., ARIN or RIPE) – ensures that destination organization has good reason for the number of IPs purchased

<p>BUY NOW</p> <p>/24 Block registered in ARIN</p> <p>Transferable to: ARIN, APNIC, RIPE, LACNIC</p> <hr/> <p>SALE PRICE \$/ADDRESS \$14,080.00 \$55.00</p> <hr/> <p>ENDS IN 17h 17m 40s</p>	<p>BUY NOW</p> <p>/23 Block registered in RIPE</p> <p>Transferable to: ARIN, APNIC, RIPE, LACNIC</p> <hr/> <p>SALE PRICE \$/ADDRESS \$28,160.00 \$55.00</p> <hr/> <p>ENDS IN 17h 26m 8s</p>	<p>BUY NOW</p> <p>/23 Block registered in RIPE</p> <p>Transferable to: ARIN, APNIC, RIPE, LACNIC</p> <hr/> <p>SALE PRICE \$/ADDRESS \$28,160.00 \$55.00</p> <hr/> <p>ENDS IN 17h 26m 34s</p>	<p>BUY NOW</p> <p>/22 Block registered in RIPE</p> <p>Transferable to: ARIN, APNIC, RIPE, LACNIC</p> <hr/> <p>SALE PRICE \$/ADDRESS \$56,320.00 \$55.00</p> <hr/> <p>ENDS IN 17h 34m 39s</p>
<p>BUY NOW</p> <p>/21 Block registered in RIPE</p> <p>Transferable to: ARIN, APNIC, RIPE, LACNIC</p> <hr/> <p>SALE PRICE \$/ADDRESS \$112,640.00 \$55.00</p> <hr/> <p>ENDS IN 1d 17h 45m</p>	<p>BUY NOW</p> <p>/22 Block registered in RIPE</p> <p>Transferable to: ARIN, APNIC, RIPE, LACNIC</p> <hr/> <p>SALE PRICE \$/ADDRESS \$56,320.00 \$55.00</p> <hr/> <p>ENDS IN 3d 17h 35m</p>	<p>BUY NOW</p> <p>/21 Block registered in RIPE</p> <p>Transferable to: ARIN, APNIC, RIPE, LACNIC</p> <hr/> <p>SALE PRICE \$/ADDRESS \$112,640.00 \$55.00</p> <hr/> <p>ENDS IN 3d 17h 44m</p>	<p>BUY NOW</p> <p>/24 Block registered in ARIN</p> <p>Transferable to: ARIN, APNIC, RIPE, LACNIC</p> <hr/> <p>SALE PRICE \$/ADDRESS \$13,568.00 \$53.00</p> <hr/> <p>ENDS IN 17h 15m 16s</p>

<https://auctions.ipv4.global/>



ipv4marketgroup.com

Protocols

IETF: Internet Engineering Task Force

IETF is a standards organization that is responsible for the technical standards that make up the Internet protocol suite

Publish RFCs — Request for Comment — that document individual protocols

There is no membership: Anyone can participate by joining working group mailing list or attending an IETF meeting in person

Until a few years ago, IETF wasn't a real organization — was managed by Internet Society (ISOC) — another non-profit (the one that owns .org)

1. Introduction

Almost every IETF participant knows the aphorism from Dave Clark's 1992 plenary presentation [[Clark](#)] regarding how we make decisions in the IETF:

We reject: kings, presidents and voting.

We believe in: rough consensus and running code.

That is, our credo is that we don't let a single individual dictate decisions (a king or president), nor should decisions be made by a vote, nor do we want decisions to be made in a vacuum without practical experience. Instead, we strive to make our decisions by the consent of all participants, though allowing for some dissent (rough consensus), and to have the actual products of engineering (running code) trump theoretical designs.

Structure of the IETF and inter-related organisations

February 2022

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