Internet Governance
CS249i: The Modern Internet
Distributed, but… still needs coordination

Little central coordination between ISPs — everyone makes their own commercial decisions

Other aspects need centralized organization

- DNS and name registration (e.g., .com and .org)
- IP + MAC allocation
- WHOIS
- Port Numbers
- Protocol Identifiers
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 0-63: Network wide standard functions
- Sockets 64-127: Host specific functions
- Sockets 128-239: Reserved for future use
- Sockets 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:

- 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

ICANN originally operated under contract from U.S. Department of Contract. 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

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 PTI 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
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 ~1,500 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.
Verisign and .com TLD

IANA/ICANN doesn't run the TLDs themselves — 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:

- Sets terms like the maximum that Verisign can change registrars.
  - Was $7.85 since 2012, 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
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

Diagram:

IANA
- 2001:0200::23
  - APNIC
    - 2001:03FF::/32
      - ISP 1
        - Site 1: 2001:0200:0001::/48
        - Site 2
      - ISP M
        - Site N: 2001:0200:FFFF::/48
  - 2001:0400::23
    - ARIN
Regional Internet Registries

IANA  Internet Assigned Numbers Authority

AFRINIC  APNIC  ARIN  lacnic  RIPE NCC

Member  Member  NIR  Member  Member  Member
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

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.

https://auctions.ipv4.global/ ipv4marketgroup.com