
How the Internet is/was made

IETF, IANA, ICANN, RIR, NIC

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A thick, solid blue vertical bar is positioned on the right side of the slide, extending from the top of the content area to the bottom.

Internet History



October 11, 2026

Internet History

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1972 - 1980: Internetworking, new and proprietary networks

- 1970: ALOHAnet satellite network in Hawaii
- 1974: Cerf and Kahn - architecture for interconnecting networks
- 1976: Ethernet at Xerox PARC
- late '70s: Proprietary architectures: DECnet, SNA, XNA, ...
- 1979: ARPAnet has 200 nodes

Cerf and Kahn's internetworking principles:

- Minimalism, autonomy - no internal changes required to interconnect networks
- Best-effort service model
- Stateless routing
- Decentralized control

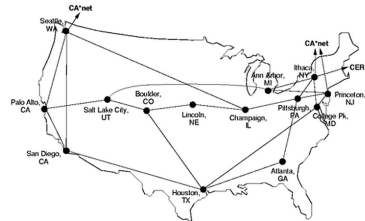
Define today's Internet architecture



1980 - 1990: New protocols, a proliferation of networks

- 1982: SMTP (e-mail) defined
- 1983: Deployment of TCP/IP
- 1983: DNS defined for name-to-IP-address translation
- 1985: FTP (file transfer) defined
- 1988: TCP (congestion control) defined
- New national networks: CSnet, BITnet, NSFnet, Minitel
- 100,000 hosts connected to confederation of networks

NSFNET T1 Network 1991



© Merit Network, Inc.



1990 - 2000: commercialization, the Web, new applications

- Early 1990s: ARPAnet decommissioned
- Early 1990s: Standardization of HTML, HTTP (Web)
- 1991: NSF lifts restrictions on commercial use of NSFnet
- 1994: Mosaic, later Netscape
- 1995: NFSnet decommissioned
- Late 1990's: commercialization of the web

Status quo at the end of 1990s:

- Killer-apps like instant messaging, P2P file sharing on the rise
- Network security to forefront
- Estimated of 50M hosts, 100M+ end users online
- Backbone links at Gbps up and running

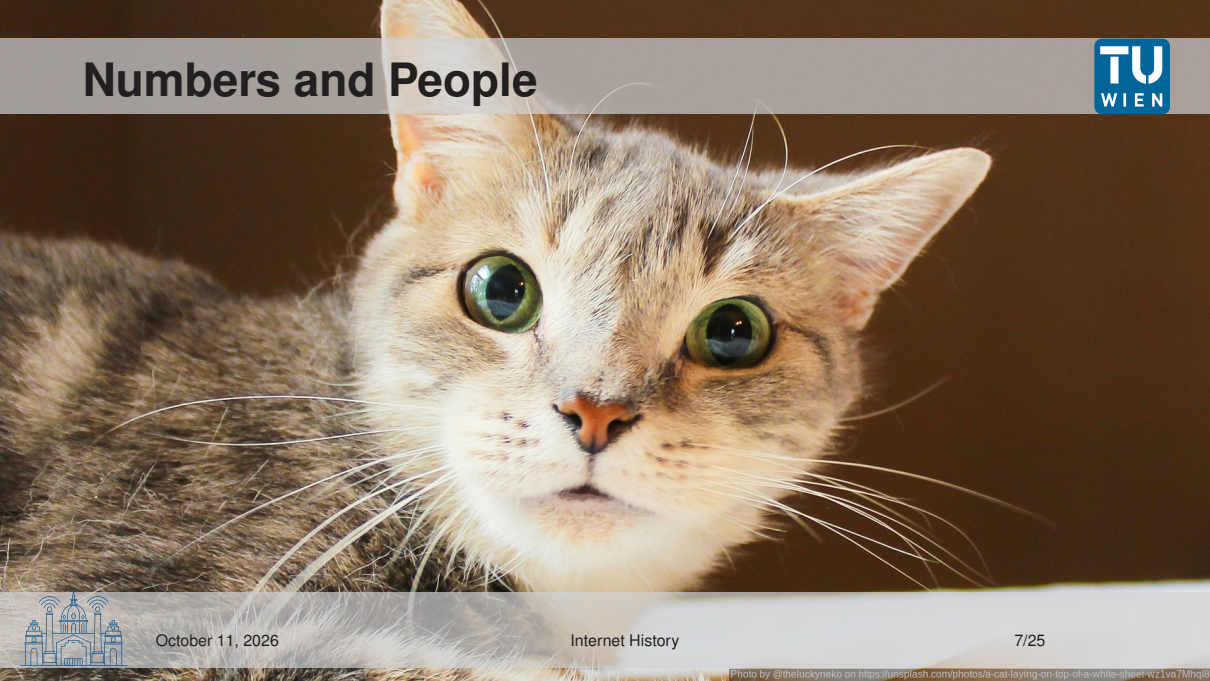


2005 - present: Scale, SDN, mobility, cloud, AI

- Aggressive deployment of broadband home access (10-100's Mbps)
- 2008: Software-defined networking (SDN)
- Increasing ubiquity of high-speed wireless access: 4G/5G, WiFi
- Service providers (Google, FB, Microsoft) create their own networks
- Bypass commercial Internet to connect “close” to end user, providing “instantaneous” access to social media, search, video content, . . .
- Enterprises run their services in “cloud” (e.g., Amazon Web Services, Microsoft Azure)
- Rise of smartphones: More mobile than fixed devices on Internet (2017)
- ~15B devices attached to Internet (2023, statista.com)



Numbers and People



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Internet History

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The Internet Doesn't Run on Protocols alone

- How do people agree on
 - The global Internet ecosystem?
 - Protocol design?
 - Which IP addresses, domains, ... etc to use?
 - What is the role of companies, governments, law enforcement, researchers, users, ... etc?

Emergence of standardization bodies and resource allocation organizations:
IETF, IANA, ICANN, RIR, NIC



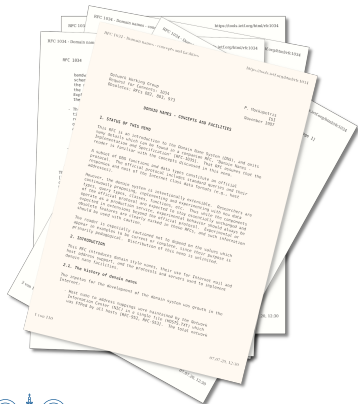
Internet Engineering Task Force (IETF)

- Open standards organization for the Internet
- No formal membership, everyone can take part in the standardization process
- Participants can be volunteers funded by their employers or sponsors
- Organized in Working Groups (WGs) of different topics / areas
- **Rough consensus and running code** without a formal voting process



- Technical and organizational notes about the Internet
- Types: BCP (Best current practices), STD (Standards Track), FYI (informational)
- **Protocols:** RFC4271 (BGP4), RFC2460 (IPv6)
- **Procedures:** RFC2026 (The Internet Standards Process)
- **Concepts:** RFC7705 (AS Migration Mechanisms and Their Effects on the BGP AS_PATH Attribute)
- Sometimes **Humor** (Usually published XXXX-04-01 ;-)):
RFC1149 (A Standard for the Transmission of IP Datagrams on Avian Carriers),
RFC7511 (Scenic Routing for IPv6)





Looking at
<https://tools.ietf.org/rfc/index>
and some RFCs...



Status: Best Current Practice
Obsoletes: [3901](#)
More info: [Datatracker](#) | [IPR](#) | [Info page](#)

Stream: Internet Engineering Task Force (IETF)
RFC: [10001](#)
BCP: 91
Obsoletes: [3901](#)
Category: Best Current Practice
Published: August 2026
ISSN: 2070-1721
Authors: Momoka T. Fiebig
WIDE Project MPI-INF

RFC 10001

Operational Guidelines for DNS Transport in Mixed IPv4/IPv6 Environments

Abstract

This document provides guidelines and documents best current practice for operating authoritative DNS servers, recursive resolvers, and stub resolvers in a mixed IPv4/IPv6 environment. This document recommends that both authoritative DNS servers and recursive resolvers support IPv4 and IPv6. It also provides guidance on how recursive DNS resolvers should select upstream DNS servers, including when IPv4-embedded IPv6 addresses are available.

This document obsoletes RFC 3901.



- **RFC2119:** Key words for use in RFCs to Indicate Requirement Levels
- **RFC8174:** Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words

2.1. Requirements Language

The key words “**MUST**”, “**MUST NOT**”, “**REQUIRED**”, “**SHALL**”, “**SHALL NOT**”, “**SHOULD**”, “**SHOULD NOT**”, “**RECOMMENDED**”, “**NOT RECOMMENDED**”, “**MAY**”, and “**OPTIONAL**” in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.



Internet resources are globally unique identifiers throughout the global Internet.

- AS numbers
- IP prefixes/IP Addresses
- Domain names / FQDNs
- ...

Until 1998 this was handled by one person: Jon Postel¹
Jon Postel didn't scale endlessly...

¹https://en.wikipedia.org/wiki/Jon_Postel



- IANA (Internet Assigned Numbers Authority) functions were performed by Jon Postel
- 1998: ICANN (Internet Corporation for Assigned Names and Numbers) formed and took over IANA functions under contract of the US DOC

2016: ICANN transitioned into a multi-stakeholder model free of U.S. government oversight



At the top: ICANN

Internet Corporation for Assigned Names and Numbers

- Nonprofit organization with multiple stakeholders
- Overseeing body for names and numbers on the Internet
- Global IP address and AS number allocation
- Management of the DNS root zone

Responsible for global rules. But central organization does not scale on the Internet.

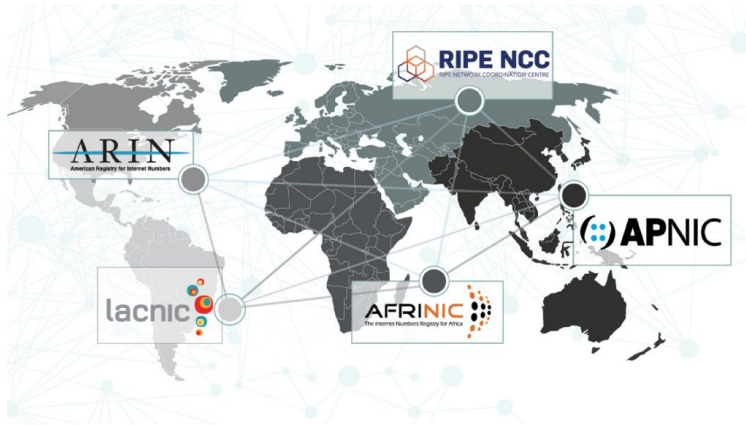


Regional Internet Registries

- Manage Internet **number** resources within a particular geographical region
- Receive resources from ICANN and redistribute within their service region
- They define local policies for the region
- The five big RIRs are united within the NRO (Number Resource Organization)



RIRs by Service Region



Réseaux IP Européens Network Coordination Centre

- Service Region: Europe, West Asia, former USSR (over 75 countries)
- IP address blocks and ASNs are allocated to organizations who are members of the RIPE NCC
- Policy decisions are publicly made within working groups on mailing lists and RIPE meetings
- Everyone (not only RIPE NCC members) can participate in the decision making process



**RIPE
NCC**

RIPE NETWORK
COORDINATION
CENTRE

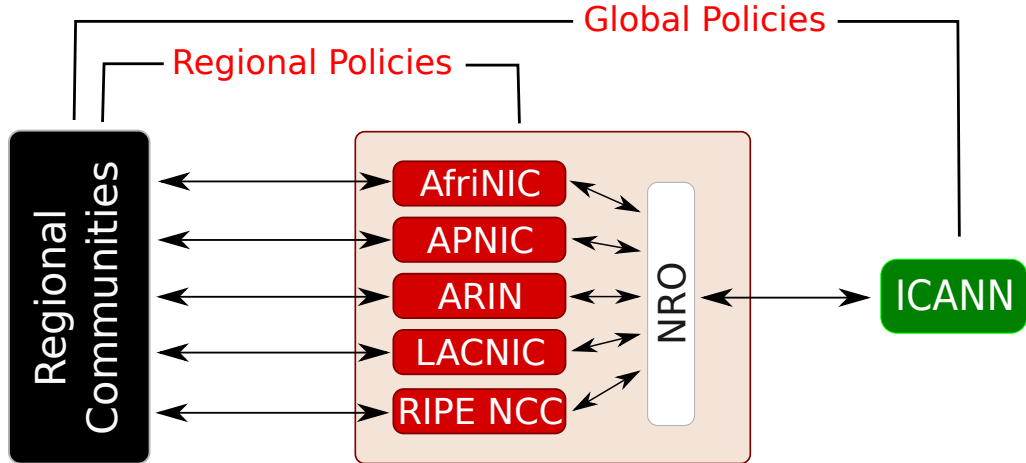


Services offered by RIPE and other RIRs

- Database access (also known as WHOIS service):
 - Registration details of IP address blocks and ASNs
 - Organizations
 - Individuals
 - Contact details
 - Peering policies
- RIPE Meetings
- Publicly available measurement services (RIPE Atlas)
- RPKI Services
 - Route-Origin Validation (ROA)
 - AS Provider Authorization (ASPA)
- Internet operations training
- Publication of policies and best common operational practice documents



Numbers community: Overview



Local Internet Registries

- Organization with an allocated IP address block by a RIR
- ISPs, academic institutions, small enterprises
- LIRs traditionally assign addresses down to their customers
- Member of a RIR
- With the depletion of IPv4 more and more organizations became LIRs which helps to obtain IPv4 addresses



Network Operator Groups

- Informal groups of local network operators
- Forum for exchange between operators about issues/problems/current events in the networking world
- Communication via mailing lists, IRC channels, meetings
- AT:NOG (Austria), DeNOG (Germany), NANOG (North America), UKNOF (UK), NLNOG (Netherlands), INOG (Ireland), ...



- “Guardian” of .at
- Founded in 1998, based in Salzburg
- 100% owned by the non-profit “Internet-Stiftung”
- 30 employees
- .at domains can be registered directly with nic.at or their ~ 300 partners / re-sellers
- .at domains can be registered since 1988
- Universität Wien was the responsible registrar until nic.at was founded.



- The interwork between ICANN, IETF, the RIRs and various registrars is all driven by humans
- Meetings / mailing lists are open for everyone to join and chime in
- Discussions can be of political interest
 - Law and regulations
 - Freedom / sovereignty
 - Financials / business
- Technical details less focused
- Long and heated discussions possible

