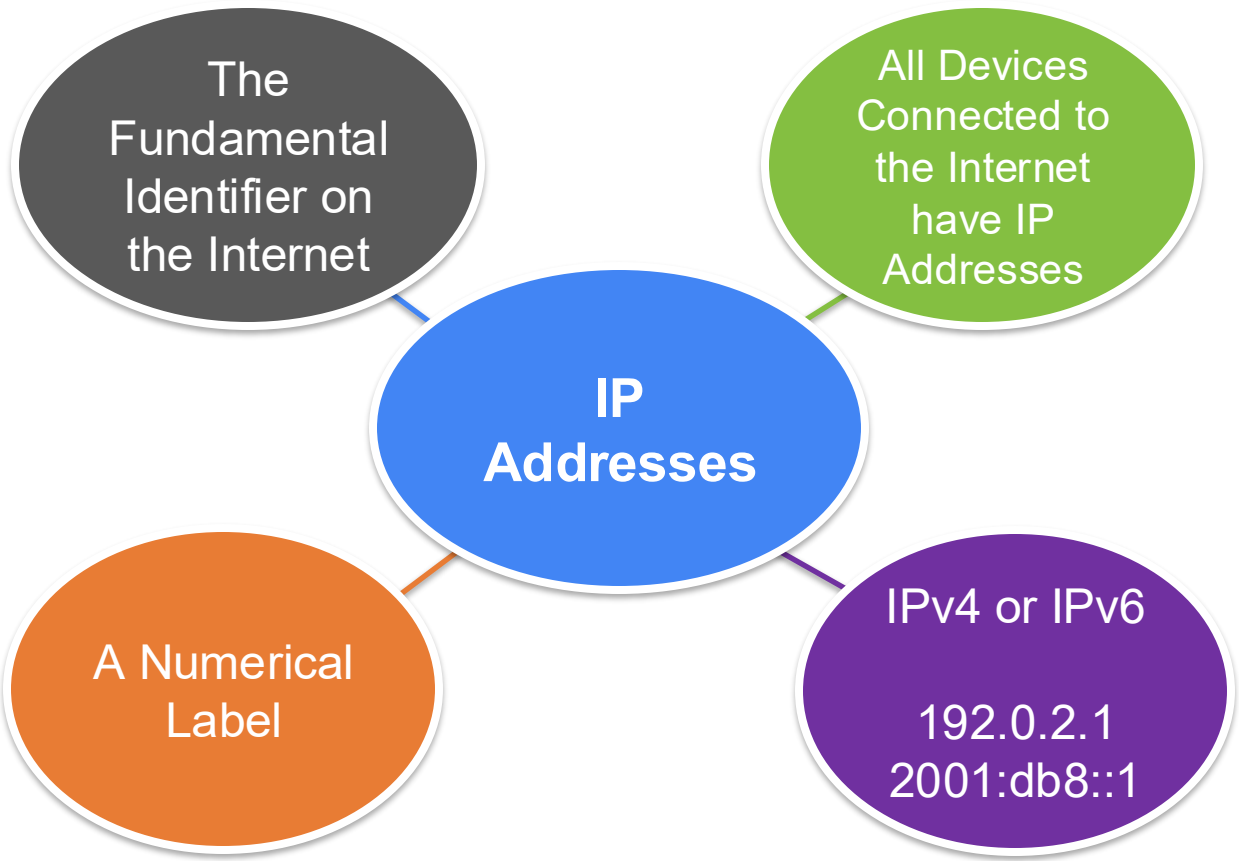
ICANN 84 Root Server System Information Session

Root Server System Advisory Committee (RSSAC)

Agenda

- The Domain Name System
- Anycast
- The Root Server System Today
- The RSSAC and RSSAC Caucus
- Principles and Governance
- The Root Server System and You

The Domain Name System


The Fundamental Identifier on the Internet
All Devices Connected to the Internet have IP Addresses
IP Addresses
A Numerical Label
IPv4 or IPv6
192.0.2.1
2001:db8::1

Why DNS?

Original Problem

- IP addresses are hard to remember.
- IP addresses often change.

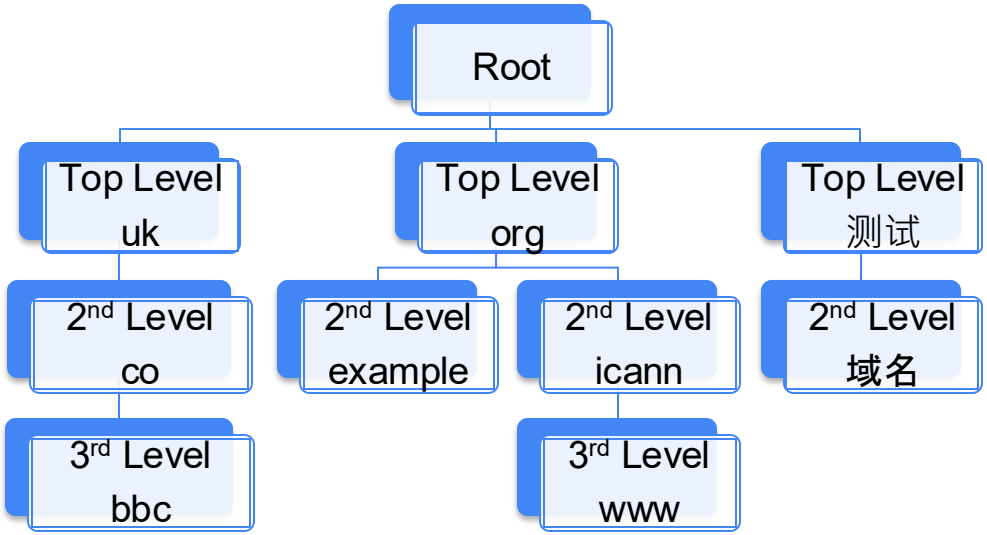
Modern Problem

- IP addresses may be shared.
- Multiple IP addresses may serve as entry points to a single service. Which IP address to use?

The DNS solves these problems

The Domain Name System

A protocol for translating names into other identifiers



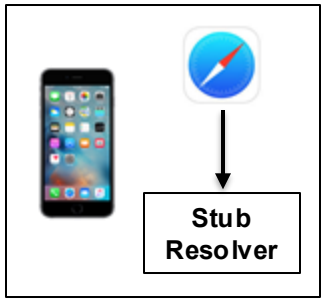
Name → IPv4 Address

www.example.org → 198.51.100.52

Many Other Mappings

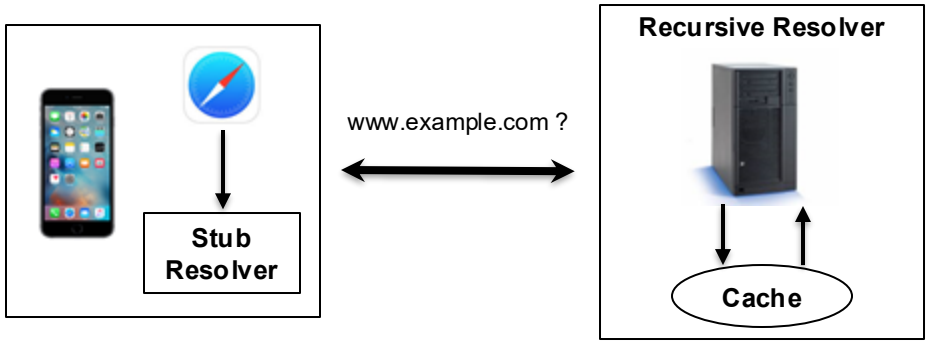
IPv6 Addresses
eMail Servers
Encryption Keys

Domain Name Resolution Process



The user visits www.example.com

Domain Name Resolution Process



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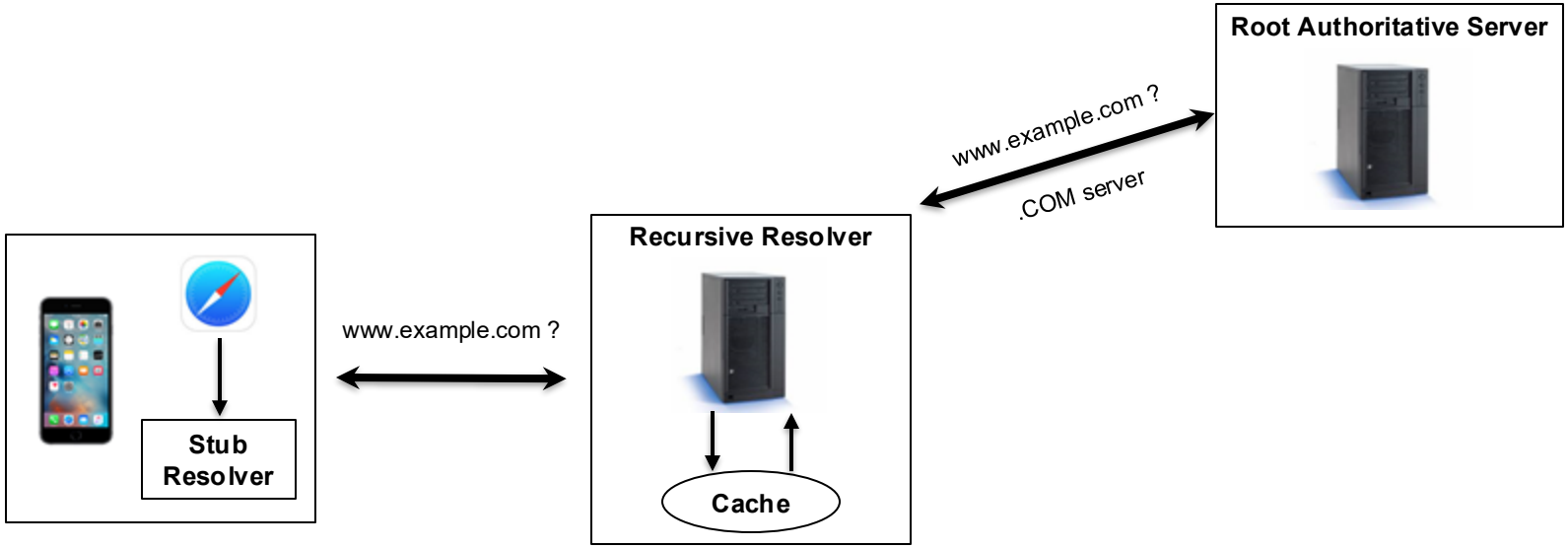
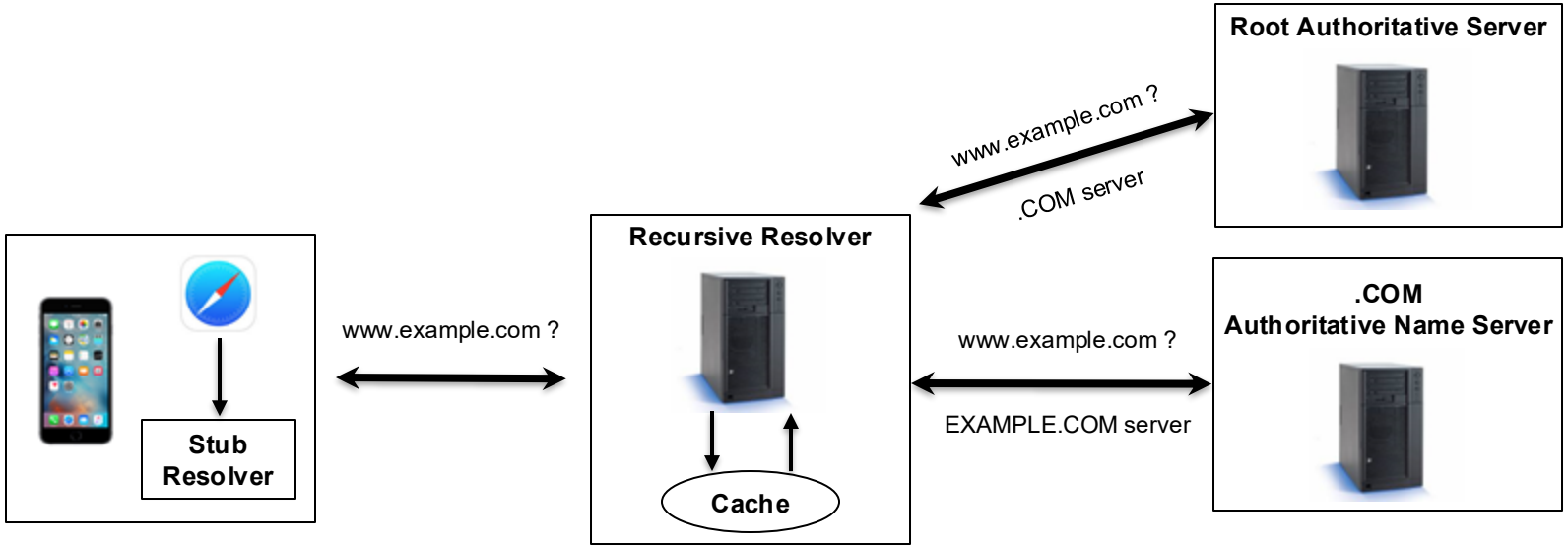
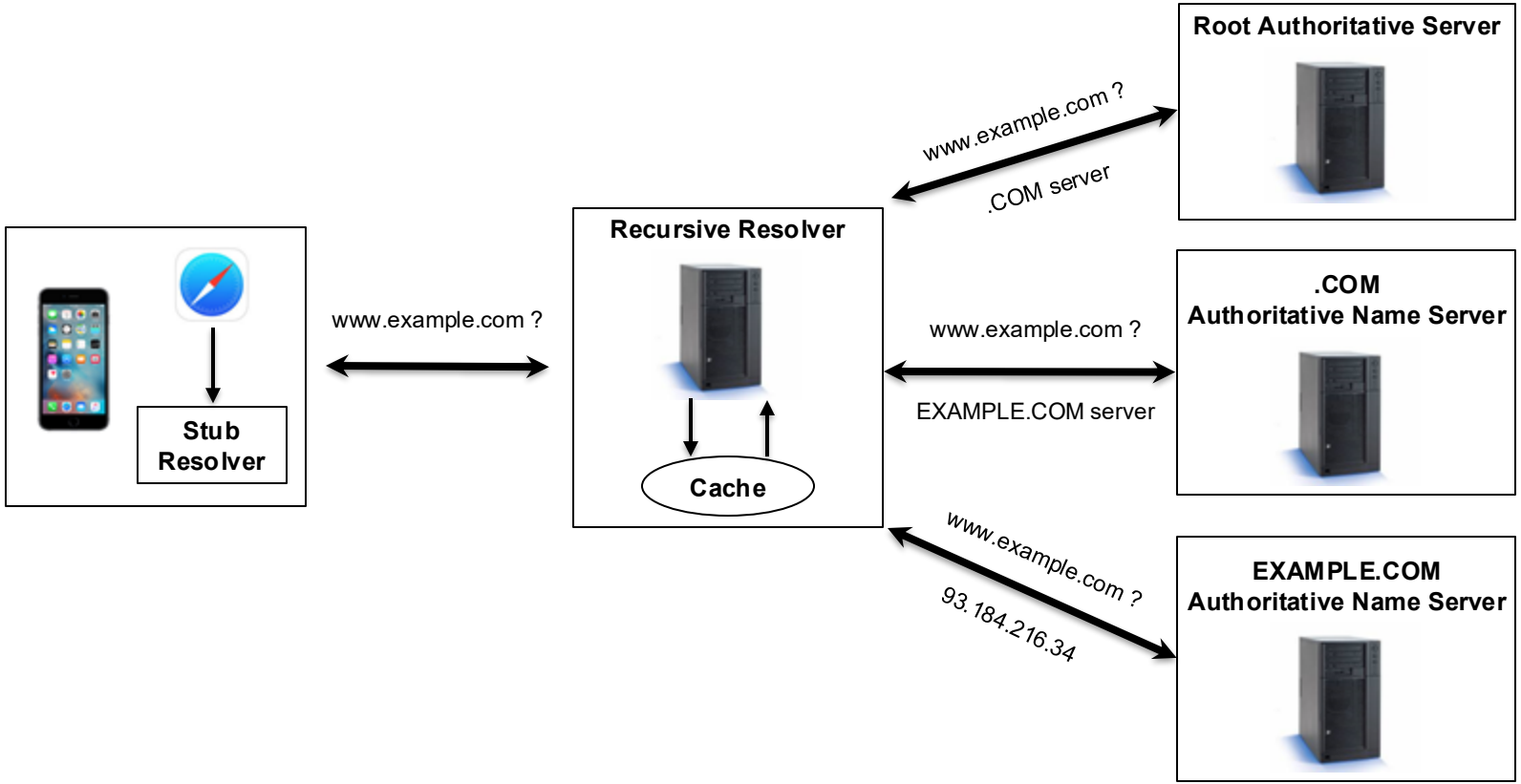


Domain Name Resolution Process



Domain Name Resolution Process



Caching and DNS Resolution

- Recursive resolvers remember answers to queries they receive
  - New queries can then be served from cache

- Every DNS record has a time-to-live (TTL) value
  - This determines how long resolvers can cache this information

- Root servers only serve information about top-level-domain (TLD) servers
  - TLD information has TTLs of one or two days
  - Resolvers do not need to ask again for these records until the TTL expires

Some Modern Refinements to DNS

Security 	• DNS Security Extensions (DNSSEC) • Cryptographic signatures on DNS data • Eliminates risk of “spoofing” when in use • Resolver should validate the answers
Privacy 	• Queries can leak potentially sensitive information • Standards work is ongoing to address this • Query name minimization should only send the TLD to root servers
Resilience 	• Multiple servers share a single IP address • Improves latency and resilience • Protects against DDoS attacks

Anycast

Unicast vs. Anycast

Unicast

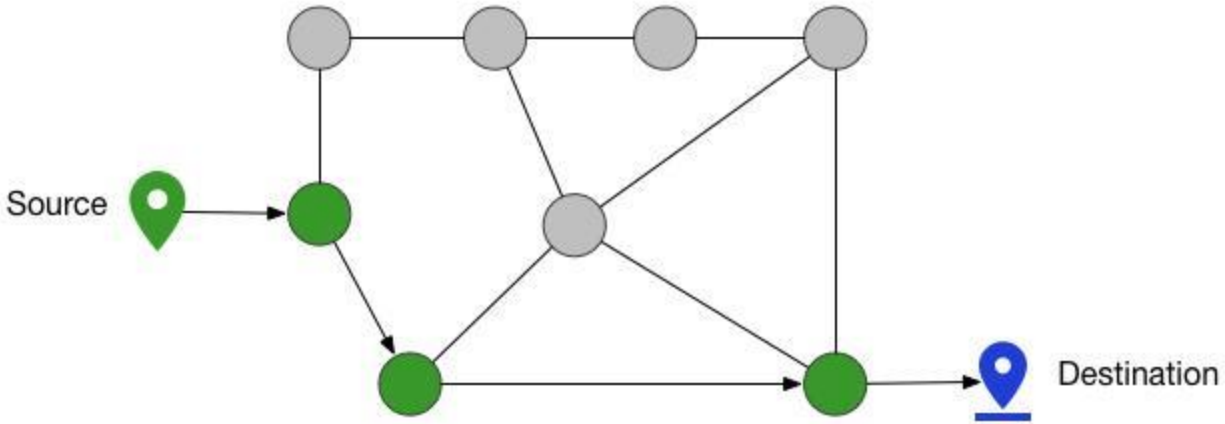
- Packets from sources all go to the same destination
- A single instance serves all sources
- DDoS attack traffic all goes to single instance

Anycast

- Multiple instances serve the same data to all sources
- Sources reach a destination based on intermediate routing policies
- Sources may get the data faster
- DDoS attack traffic is sent to the closest instance

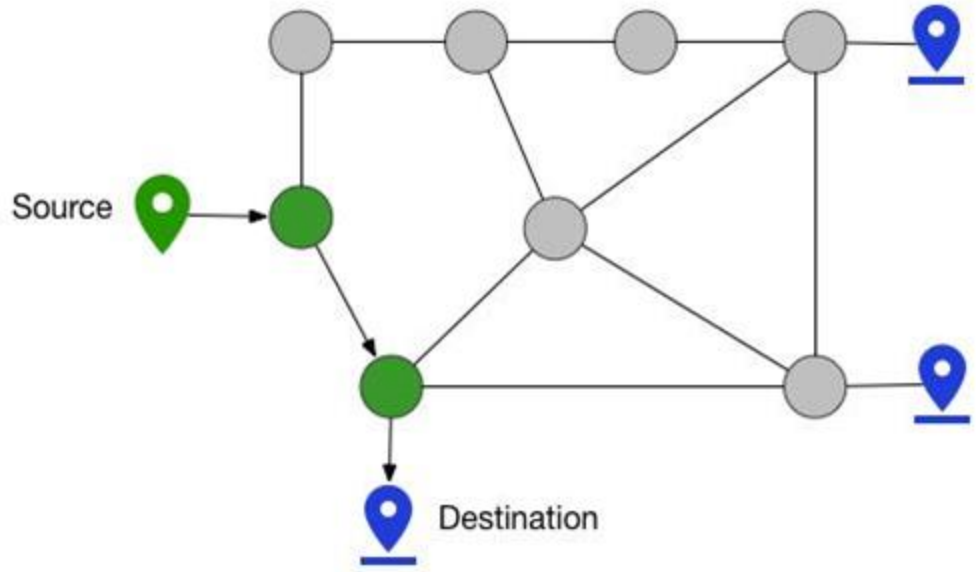
Unicast

Traffic takes shortest route to single destination.



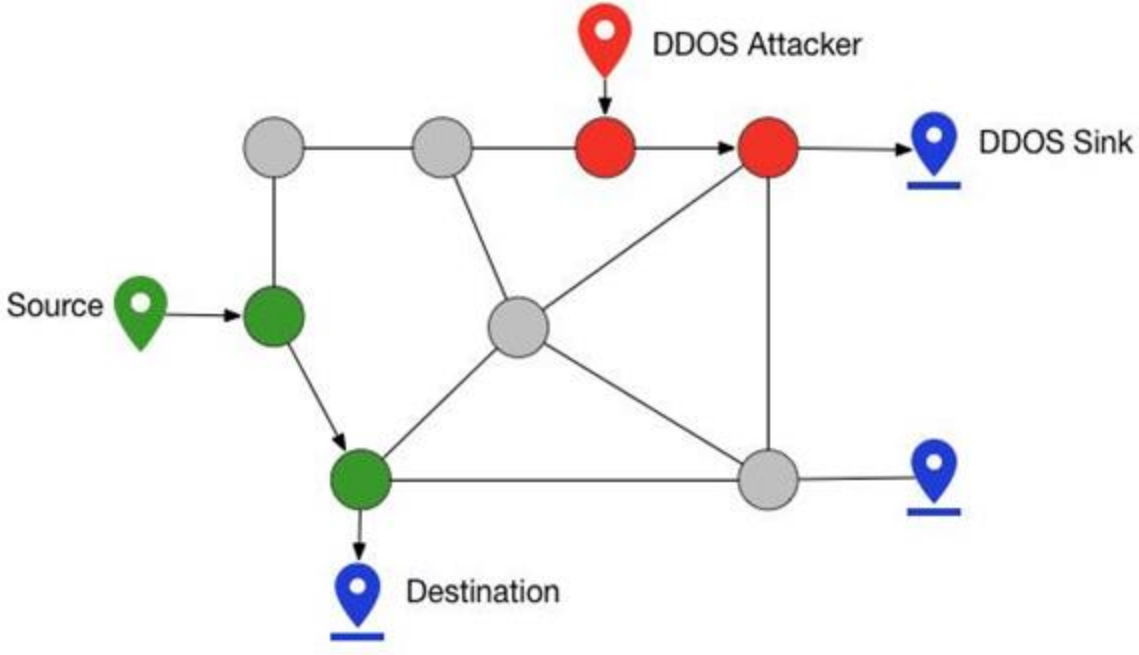
Anycast

- Traffic takes shortest route to closest destination.
- Intermediate routing policies determine the destination for a source.
- Path is shortened and data is delivered more quickly.



Anycast Under DDoS Attacks

- DDoS attack traffic also takes shortest route to closest destination, thus gets distributed across all destinations.



The Root Server System Today

Definitions

- Internet Assigned Numbers Authority (IANA)
  - Manager of the DNS root zone.
- Root Zone
  - The zone at the top of the DNS hierarchy. It has no parent and contains only the names and addresses of the TLD name servers.
- Root Server System (RSS)
  - The set of root servers that collectively serve the root zone.

Definitions (continued)

- Root Server Operator (RSO)
  - An organization responsible for managing the root service on IP addresses specified in the root zone.
- Root Server Instance / Root Server **Anycast** Instance
  - A network location responding to DNS queries on a root server operator's IP address.
- Root Server System Advisory Committee (RSSAC)
  - ICANN advisory committee composed of representatives from the root server operators and liaisons.

Root Server Identifiers

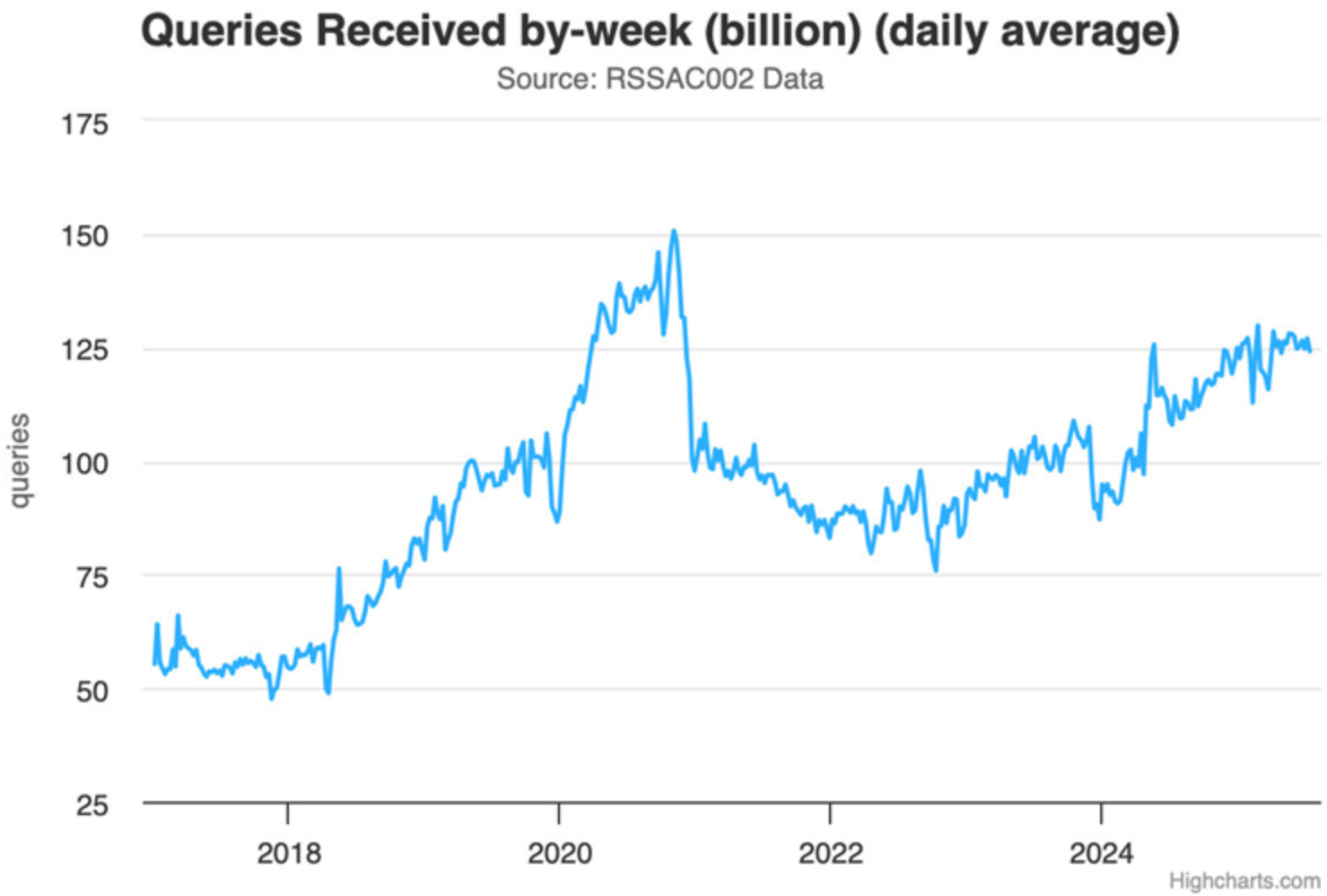
Hostname	IP Addresses	Operator
a.root-servers.net	198.41.0.4, 2001:503:ba3e::2:30	Verisign, Inc.
b.root-servers.net	170.247.170.2, 2801:1b8:10::b	University of Southern California / ISI
c.root-servers.net	192.33.4.12, 2001:500:2::c	Cogent Communications
d.root-servers.net	199.7.91.13, 2001:500:2d::d	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 DOD Defense Information Systems Agency
h.root-servers.net	198.97.190.53, 2001:500:1::53	US Army DEVCOM Army Research Laboratory
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

Growth of the Root Server System

1984 - 1985	4 Root Servers	USC-ISI (x2), SRI (DDN NIC), BRL (now ARL)
1987	7 Root Servers	Growth of NSFNet (UMD, NASA, RPI)
1991	8 Root Servers	First RSO based outside of North America (KTH)
1993	9 Root Servers	Registration duties assigned by NSF (NSI)
1998	13 Root Servers	Renaming of root servers to accommodate up to 13 identifiers
2001 - Present	Anycast introduced	13 physical instances grew to >1900

The Root Server System Today

Over 1900 instances around the world – https://root-servers.org/


Queries Received by-week (billion) (daily average)
Source: RSSAC002 Data
175
150
125
100
75
50
25
queries
2018
2020
2022
2024
Highcharts.com

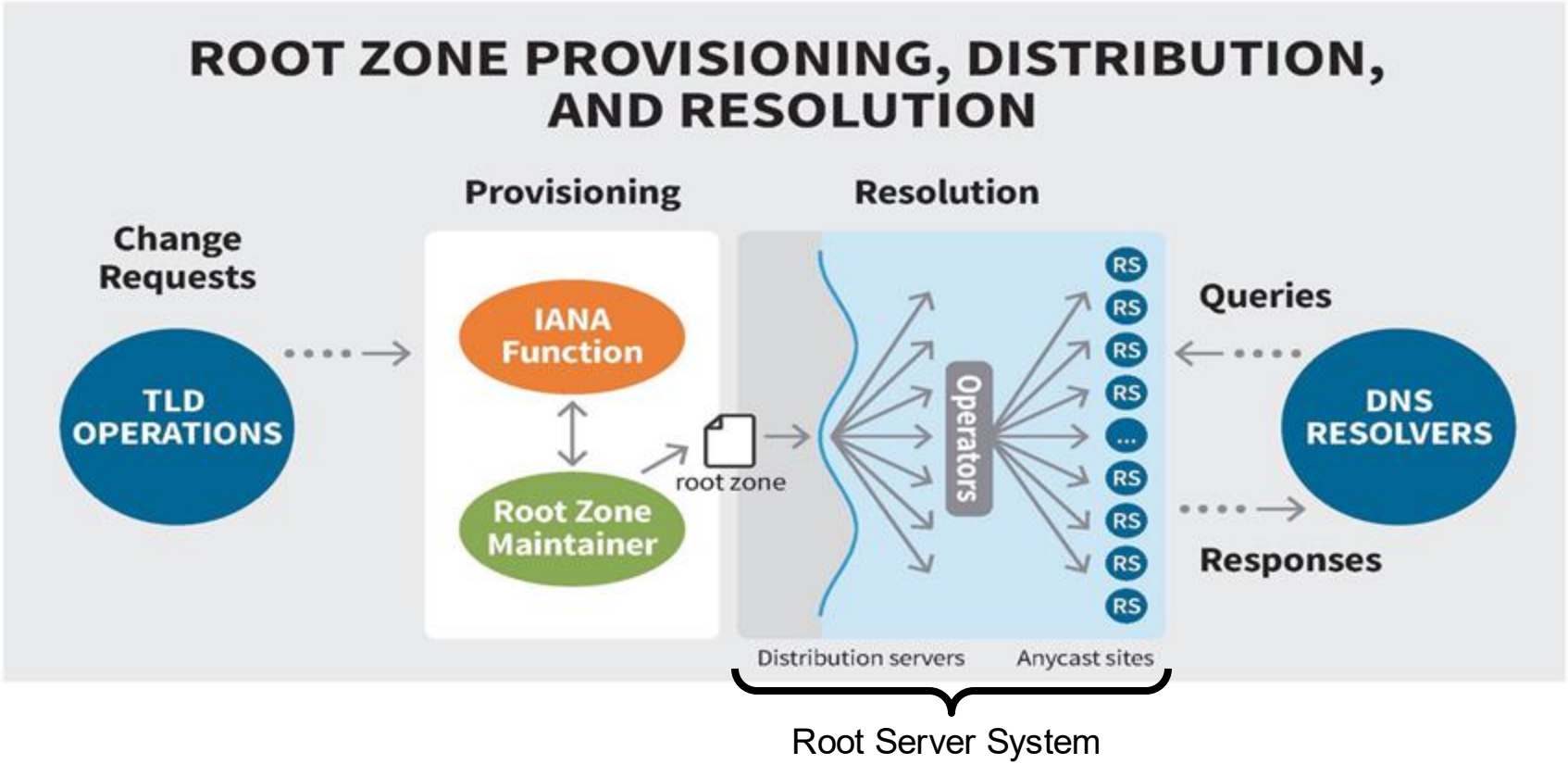
Myths of the Root Server System

Myth	**Reality**
Root servers control where Internet traffic goes.	Routers control where Internet traffic goes.
Most DNS queries are handled by a root server.	Most DNS queries are handled without the need of a root server.
Administration of the root zone is handled by RSOs.	Administration of the root zone is handled by IANA.
The root server identifiers have special meaning.	None of the root server identifiers are special.
There are only 13 root servers.	There are more than 1900 instances globally, but only 13 technical identifiers.
The root server operators conduct operations independently.	The collective root server operators coordinate root service operation as a whole.
Root server instances receive the entire DNS query	With increased deployment of QNAME Minimization, root servers frequently only receive the TLD portion of a query.

Root Zone vs. Root Server System

Root Zone	Root Server System
● The information served by the root servers ● The starting point: the list of TLDs and their nameservers ● Managed by ICANN, per community policy ● Compiled & distributed by the Root Zone Maintainer to all root server operators	● Responds with data from the root zone ● Currently implemented via 13 IPv4 and 13 IPv6 addresses, from over 1900 instances ● Purely technical role to serve the root zone ● Responsibility of the root server operators

Root Zone Administration and Resolution



The RSSAC and RSSAC Caucus

What is RSSAC?

- The role of the Root Server System Advisory Committee (“RSSAC”) is to advise the ICANN community and Board on matters relating to the operation, administration, security, and integrity of the Internet's Root Server System.

- (This is a very narrow scope!)

What RSSAC Does and Does not Do

- RSSAC is a committee that produces advice – primarily to the Board but also to other ICANN bodies and other organizations involved in the overall DNS business.

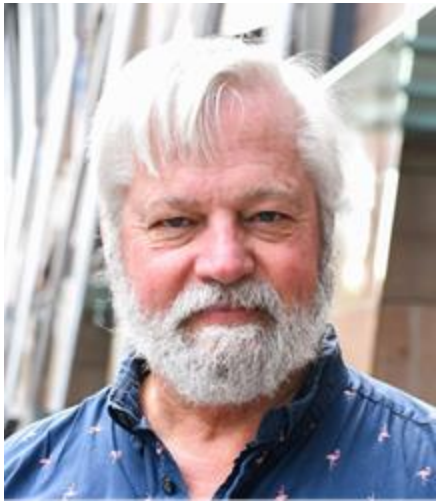
- Root Server Operators are represented inside RSSAC, but RSSAC does not involve itself in operational matters.

RSSAC Organization

- RSSAC is composed of
  - Primary representatives from each root server operator
  - Alternative representatives from each root server operator
  - Incoming liaisons from other bodies

- RSSAC Caucus
  - Body of volunteer subject matter experts
  - Members confirmed by RSSAC based on statement of interest

RSSAC Leadership



RSSAC Chair

Jeff Osborn

Internet Systems Consortium

RSSAC Vice-Chair

Hans Petter Holen

RIPE NCC

RSSAC Liaisons

- Incoming Liaisons
  - IANA Functions Operator (PTI)
  - Root Zone Maintainer (Verisign)
  - Internet Engineering Task Force appointed by Internet Architecture Board
  - Security and Stability Advisory Committee

- Outgoing Liaisons
  - ICANN Board
  - ICANN Nominating Committee
  - Customer Standing Committee
  - Root Zone Evolution Review Committee

RSSAC Caucus

- Members
  - Over 100 DNS Experts
  - Public statements of interest
  - Public credit for individual work

- Purpose
  - DNS experts who bring diverse expertise to publications
  - Transparency of who does the work
  - Framework for getting work done

Principles and Governance

Root Server System Principles

Principle 1
- To remain a global network, the Internet requires a globally unique public namespace.

Principle 2
- IANA is the source of DNS root data.

Principle 3
- The RSS must be a stable, reliable, and resilient platform for the DNS service to all users.

Principle 4
- Diversity of the root server operations is a strength of the overall system.

Principle 5
- Architectural changes should result from technical evolution and demonstrated technical need.

Principle 6
- The IETF defines technical operation of the DNS protocol.

Principle 7
- RSOs must operate with integrity and an ethos demonstrating a commitment to the common good of the Internet.

Principle 8
- RSOs must be transparent.

Principle 9
- RSOs must collaborate and engage with the stakeholder community.

Principle 10
- RSOs must be autonomous and independent.

Principle 11
- RSOs must be neutral and impartial

See RSSAC037 and RSSAC055 for more details on these principles

Principles 2 and 4

2. IANA is the source of DNS root data
    - Every instance of the root server system serves the same data
    - That data originates from the IANA
    - The DNS is a hierarchy with a single globally unique root
    - All clients of the root server system are treated equally

4. Diversity of the root server operations is a strength of the overall system
    - Diversity in RSOs' operational models and organizational structures increases the resiliency of the overall system

Principles 9 and 10

9. RSOs must **collaborate** and **engage** with their stakeholder community

- An RSO must collaborate openly with other operators, participate in group meetings and activities, engage at the IETF in the technical standardization process, and respond to stakeholder questions in a timely manner.

10. RSOs must be autonomous and **independent**

- An RSO should have autonomy and independence in architecting and operating their service, while also adhering to standards and service expectations.

Evolution of Root Server System Governance

- There is currently no process for adding or removing RSOs
- In June 2018 the RSSAC published RSSAC037
  - A proposal to evolve the governance of the RSS and improve accountability
  - Stated the Principles Guiding the Operation of the Root Server System
- Root Server System Governance Working Group (RSS GWG)
  - Developing a governance model that preserves the 11 guiding principles, including diversity, collaboration, and independence
  - Includes representation from many root server system stakeholders, including the RSOs
  - RSS GWG sessions are open to observers at ICANN meetings
- ICANN public comment on the proposed model closed September 22, 2025

Composition of the Root Server System Governance Working Group

1 Member from each RSO

2 Members from Registries Stakeholder Group

2 Liaisons from the Board

2 Members from ccNSO

1 Liaison from the Root Zone Maintainer

2 Members appointed by Internet Architecture Board

1 Liaison from IANA

The Root Server System and You

The Root Server System and your Network

- Use a DNSSEC validating resolver
  - Ensures signed data is unmodified
- Participate in DNS technical communities
  - Network Operating Groups (eg. NANOG, APRICOT, RIPE)
  - RSSAC Caucus
  - Internet Engineering Task Force (IETF)
- Interested in hosting an Anycast instance?
  - Talk to an RSSAC member after this presentation
  - Send mail to ask-rssac@icann.org

Additional Resources

- The RSSAC
  - Main Webpage, https://rssac.icann.org/
  - RSSAC FAQ, https://www.icann.org/en/rssac/faq
  - General Questions, ask-rssac@icann.org

- The RSSAC Caucus
  - Main webpage, https://www.icann.org/en/rssac/caucus
  - How to Join, https://www.icann.org/en/rssac/caucus/how-to-join