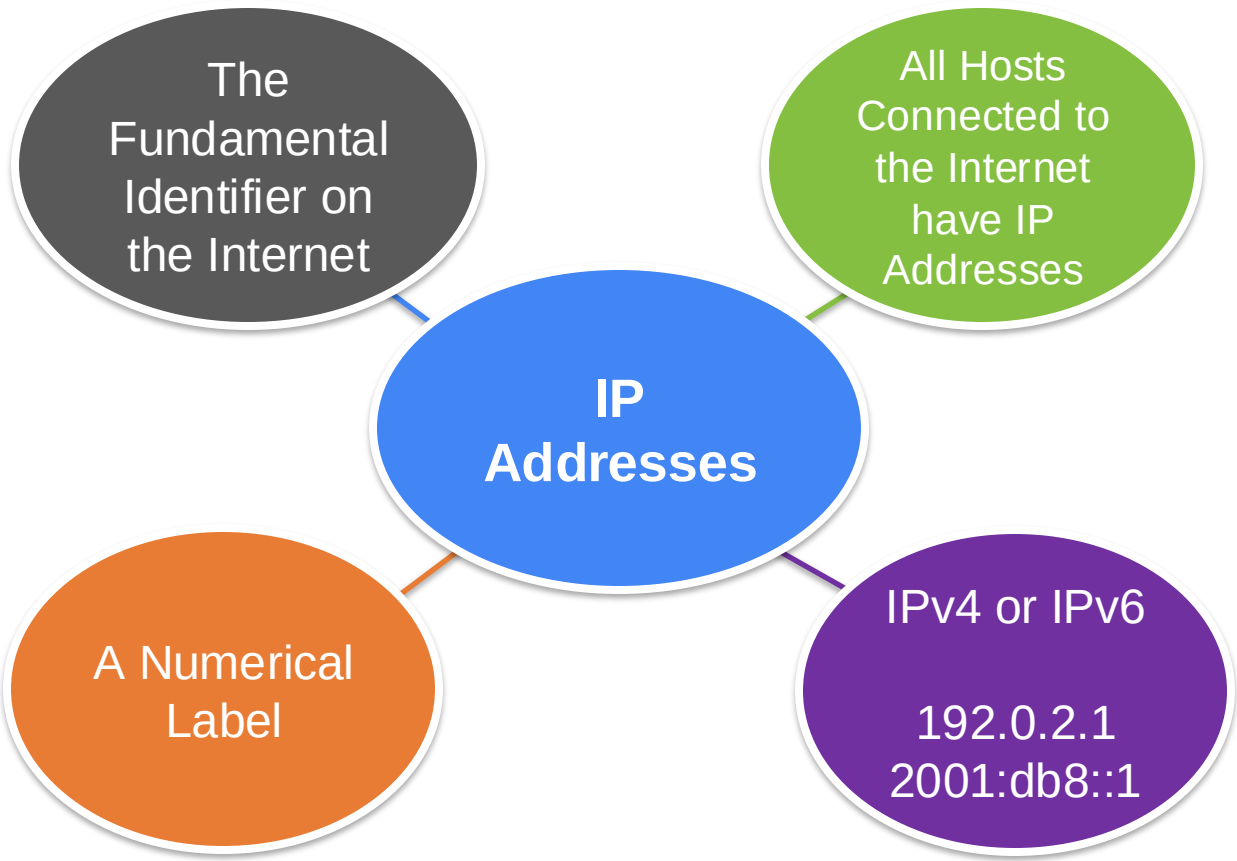
# ICANN81 Root Server System Information Session

Root Server System Advisory Committee (RSSAC)

# Agenda

- Overview of the Domain Name System
- Root Server System Today
- Explanation of Anycast
- RSSAC and RSSAC Caucus
- Root Server System Governance Evolution

# Overview of the Domain Name System


The Fundamental Identifier on the Internet
All Hosts 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.

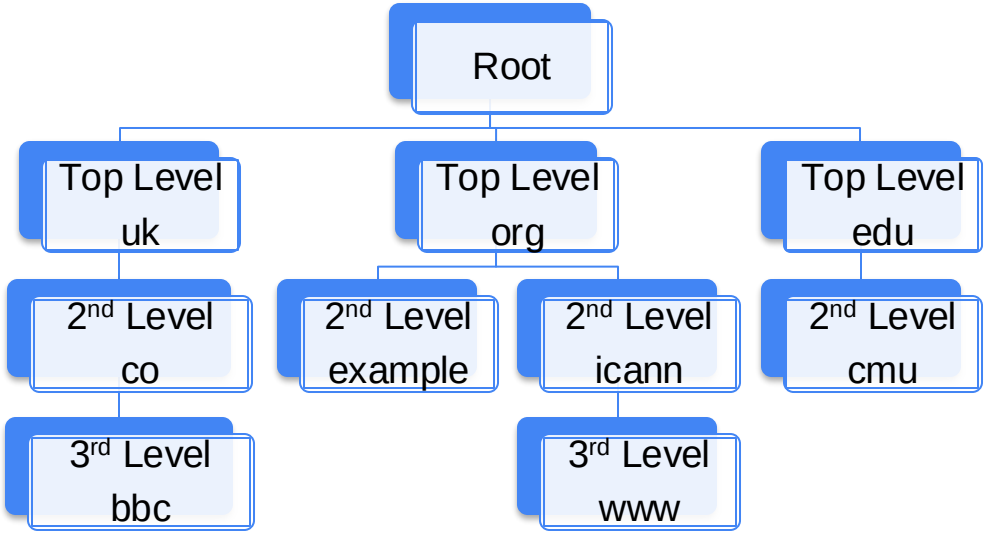
## Modern Problem

- IP addresses may also 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 look up mechanism for translating objects into other objects




**name-to-IP Address**

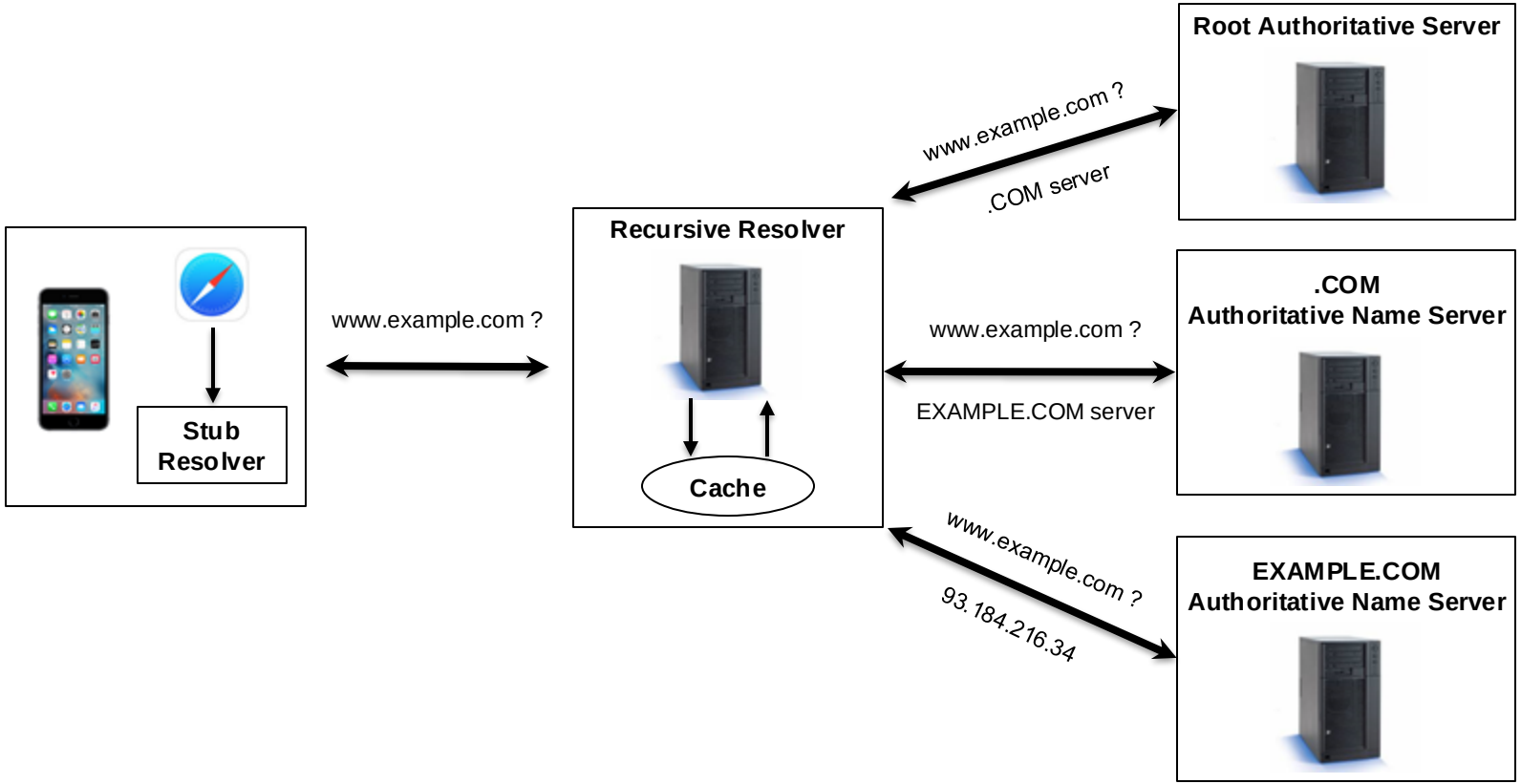
www.example.org → 198.51.100.52

**Many Other Mappings**

Mail Servers
IPv6
Reverse
Security

A globally distributed, loosely coherent, scalable, dynamic database

# 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 records in the root zone have TTL values of one or two days
  - Resolvers do not need to ask again for these records until the TTL expires

# Some Modern Refinements to DNS

| | |
|---|---|
| **DNSSEC**<br>(security extensions)<br>  | • Cryptographic signatures on DNS data<br>• Eliminates risk of “spoofing” when in use<br>• Resolver should validate the answers |
| **Privacy Enhancements**<br>  | • Queries can leak potentially sensitive information<br>• Standards work is ongoing to address this<br>• Query name minimization, DNS-over-TLS (DoT) & DNS-over-HTTPS (DoH) |
| **Anycast**<br>  | • Multiple servers share a single IP address<br>• Improves latency and resilience<br>• Protects against DDoS attacks |

# Root Server System Today

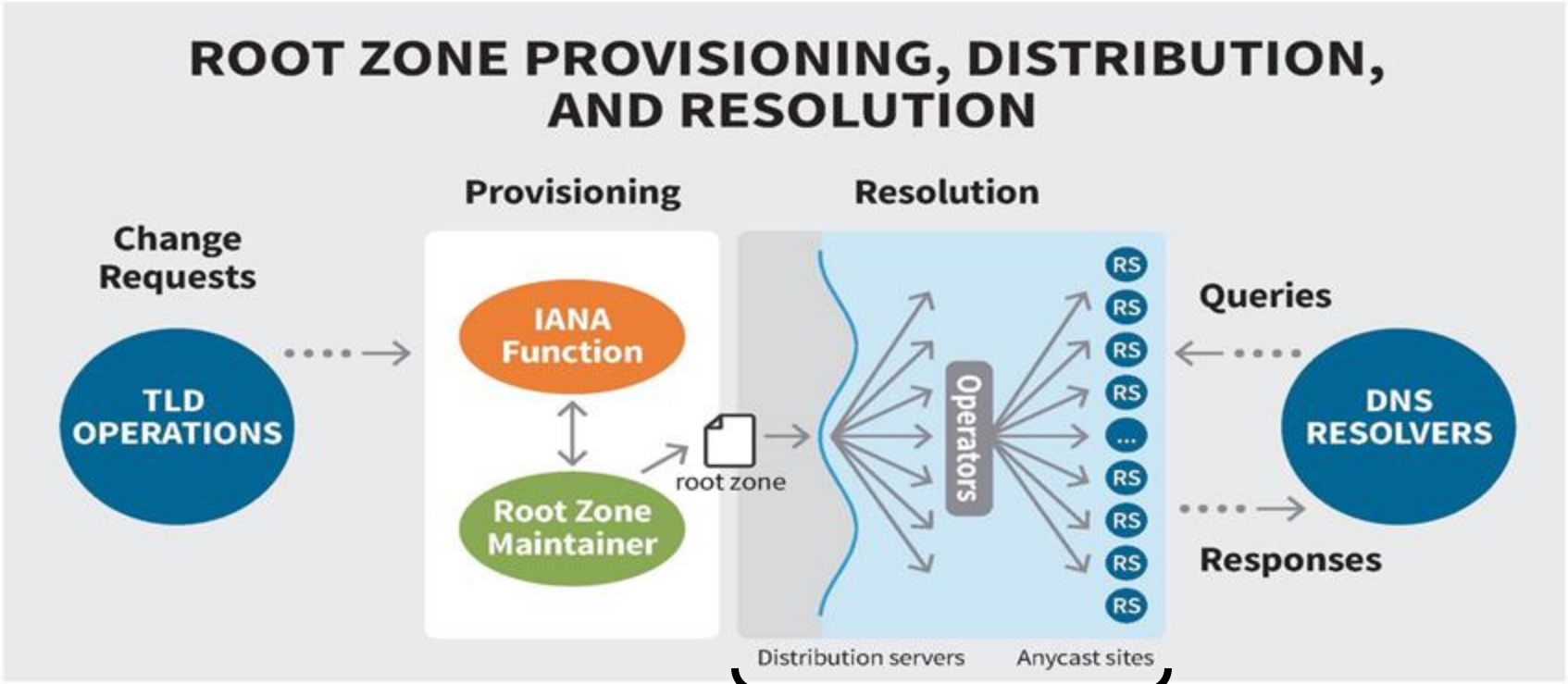
# Useful Definitions

- Root Zone
  - The DNS zone at the top of the DNS hierarchy. It has no parent and contains all the information necessary to contact the TLDs.
- Root Server System (RSS)
  - The set of root servers that collectively serve the root zone.
- Root Server Operator (RSO)
  - An organization responsible for managing the root service on IP addresses specified in the root zone.
- Root Server Anycast Instance
  - One 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 Zone vs. Root Server System

| Root Zone | Root Server System |
| --- | --- |
| ● The starting point: the list of TLDs and their nameservers<br>● Managed by ICANN, per community policy<br>● Compiled & distributed by the Root Zone Maintainer to all root server operators<br>● The information served by the root servers | ● Responds with data from the root zone<br>● Currently served from 13 IPv4 and 13 IPv6 addresses, from over 1800 instances<br>● Purely technical role to serve the root zone<br>● Responsibility of the root server operators |

# Root Zone Administration and Resolution



# 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 >1500 |

**Changes Over Time**

- Responding to technical demands
- Scaling issues are now addressed with anycast
- See RSSAC023 for a detailed history of the RSS

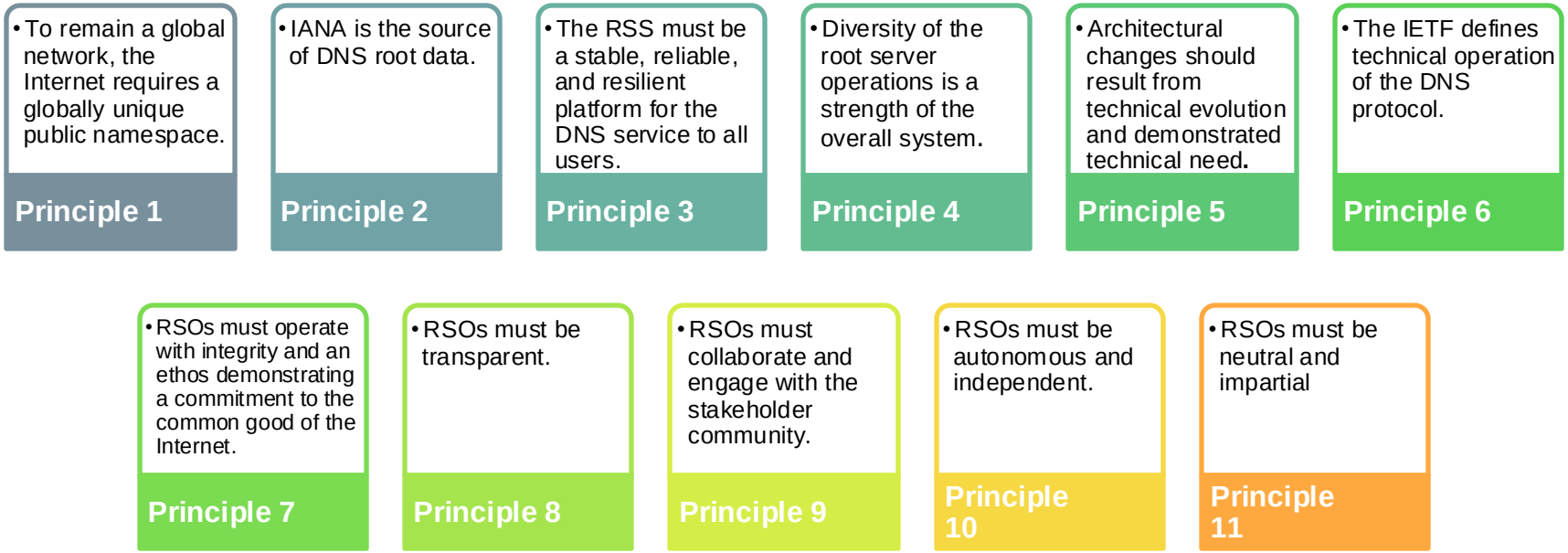
# Root Server Identifiers

| 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 Department of Defence (NIC) |
| 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 |

# The Root Server System Today


Over 1800 instances around the world – https://root-servers.org/

# Root Server System Principles




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**

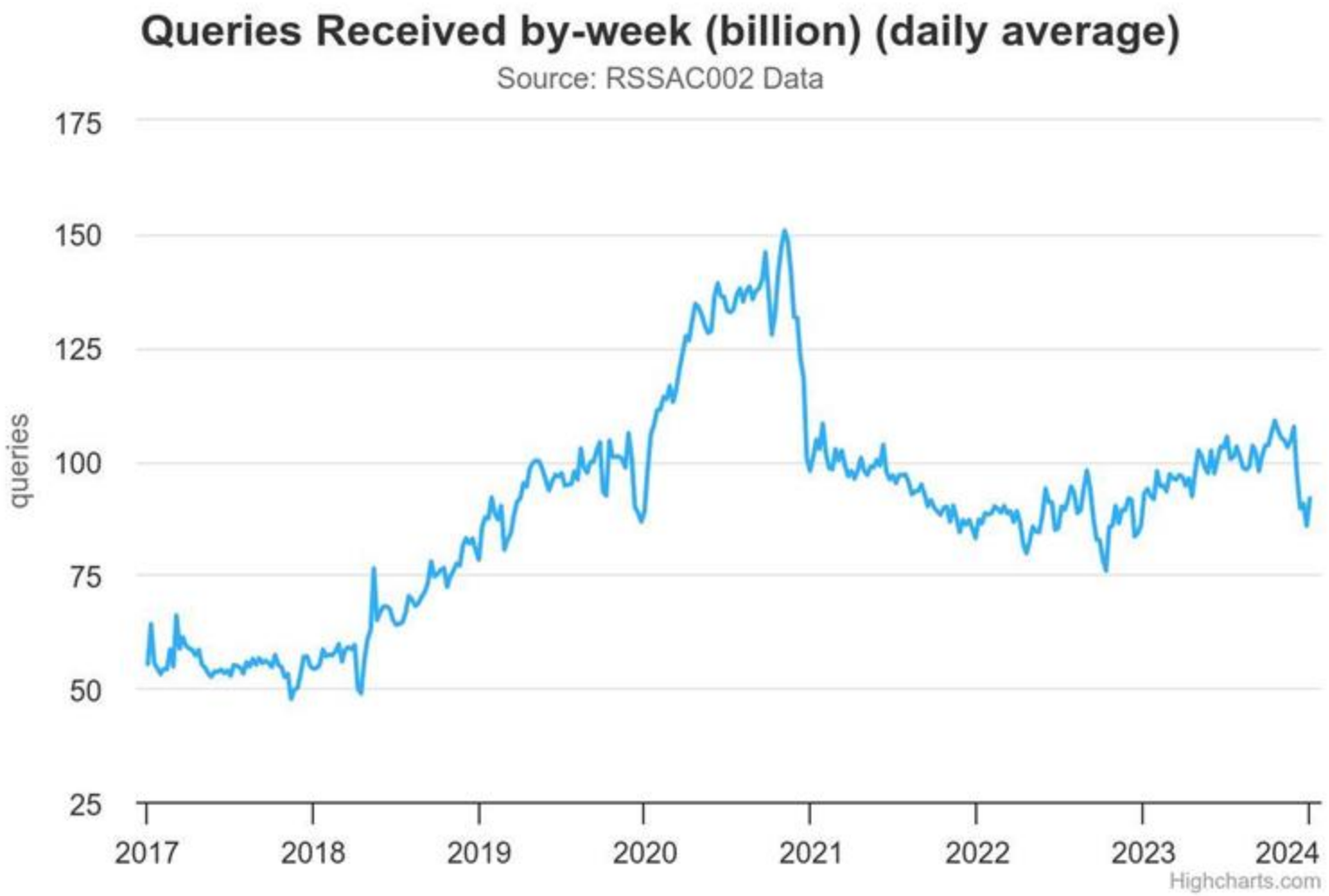
- An RSO should have autonomy and independence in architecting and operating their service, while also adhering to standards and service expectations.

# 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 NOT even seen by a root server. |
| Administration of the root zone and service provision are the same thing. | Administration of the root zone is separate from service provision. |
| 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 1800 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. |

# The Root Server System and your Network

- Check your routes to instances
  - Typically want 3-4 nearby instances
- Use a DNSSEC validating resolver
  - Ensures signed data is unmodified
- Participate in DNS technical communities
  - 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


Queries Received by-week (billion) (daily average)
Source: RSSAC002 Data
175
150
125
100
75
50
25
queries
2017
2018
2019
2020
2021
2022
2023
2024
Highcharts.com

# Explanation of Anycast

# Unicast vs. Anycast

## Unicast

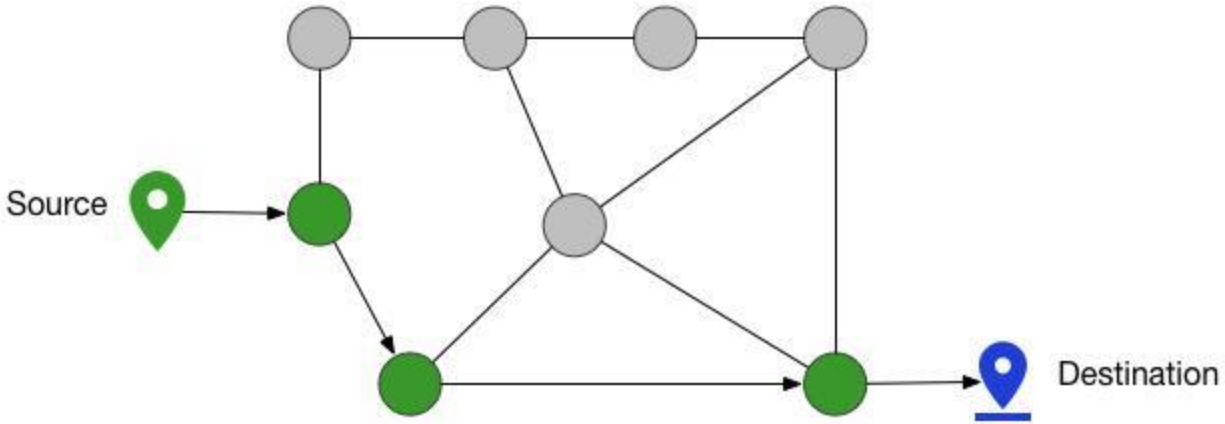
- Packets from sources all go to the same destination
- A single instance serves all sources
- DDoS attack traffic all goes to single instance

## 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

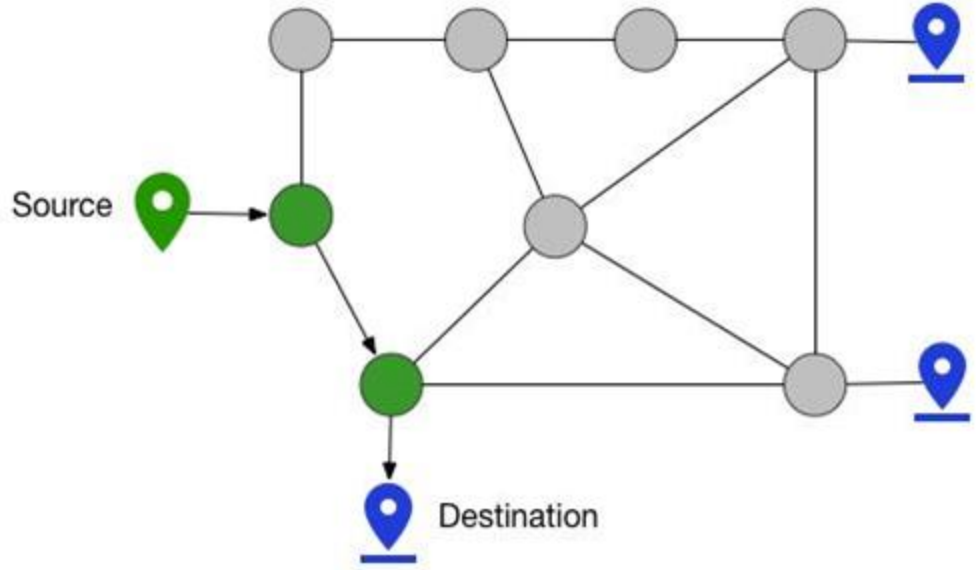
# Unicast

Traffic takes shortest route to single destination.



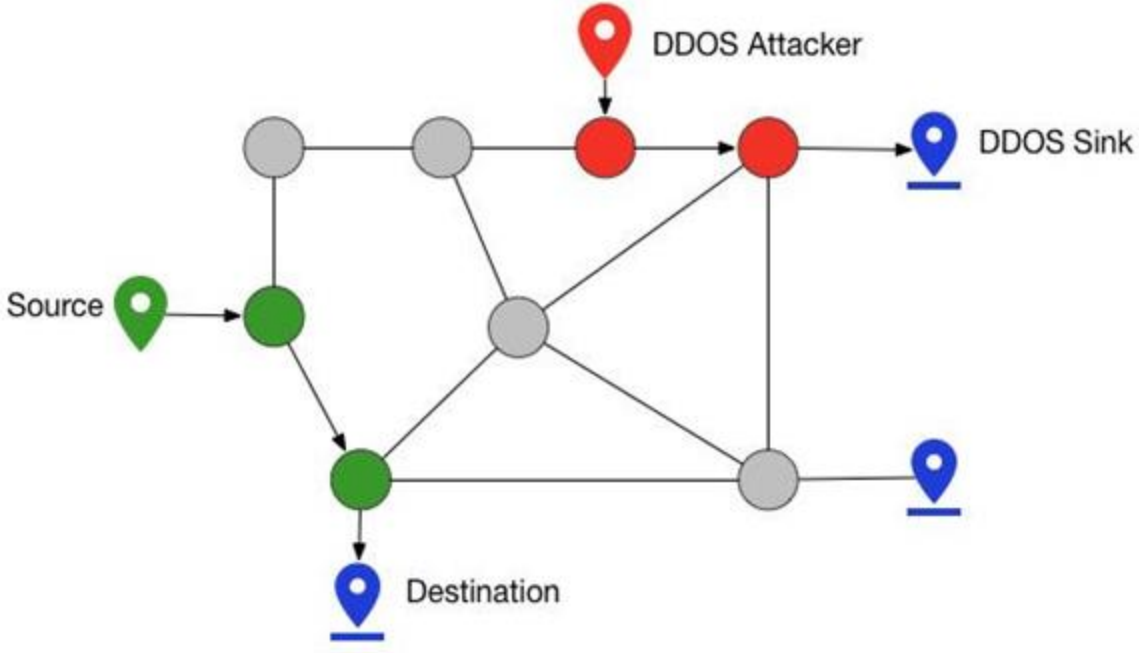
# Anycast

- 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.



# RSSAC and the 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.

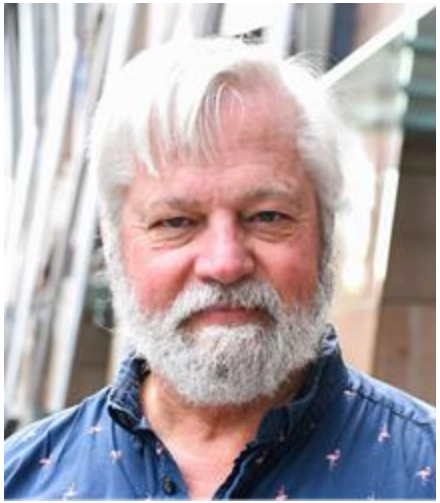
- (This is a very narrow scope!)

# 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.

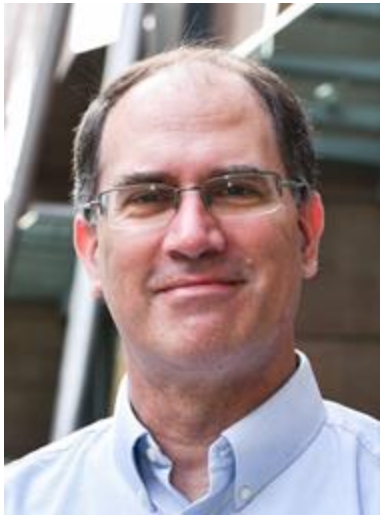
# RSSAC Leadership



RSSAC Chair

Jeff Osborn

Internet Systems Consortium



RSSAC Vice-Chair

Ken Renard

US Army DEVCOM Army Research Laboratory

# 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 Liaisons

- Incoming Liaisons
  - IANA Functions Operator (PTI)
  - Root Zone Maintainer (Verisign)
  - 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

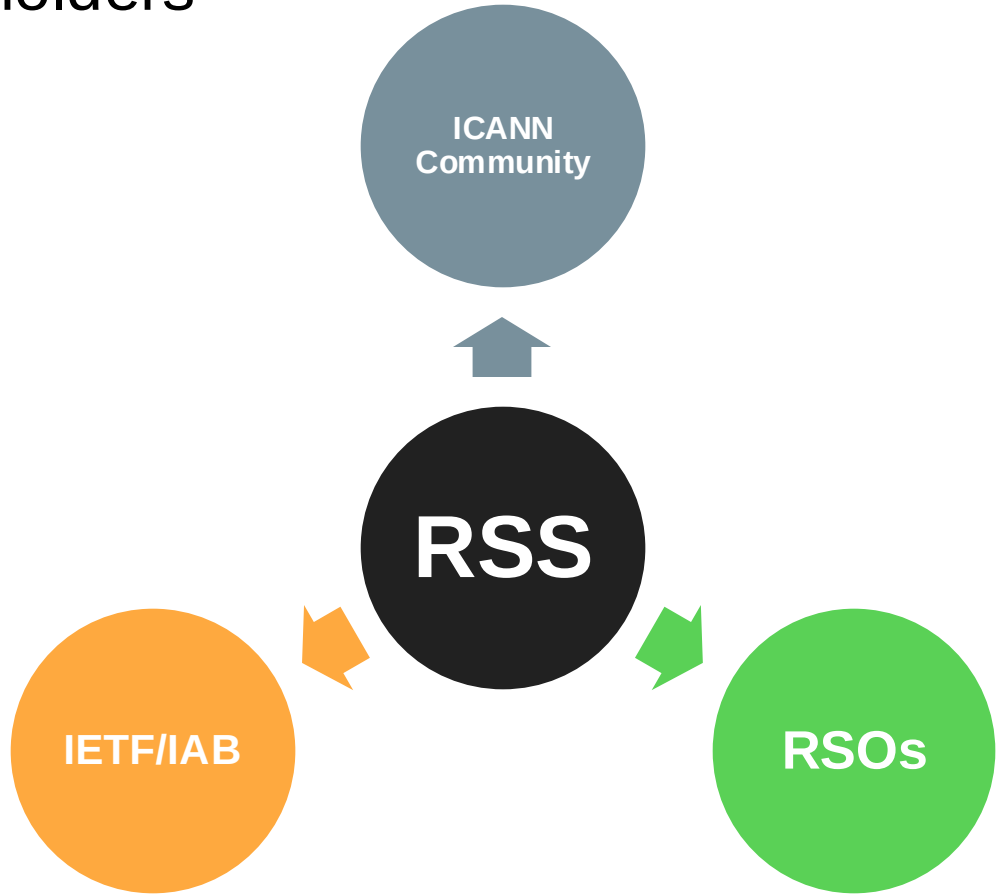
- Purpose
  - DNS experts who bring diverse expertise to publications
  - Transparency of who does the work
  - Framework for getting work done

# Root Server System Governance Evolution

# Evolution of Root Server System Governance

- There is currently no process for adding or removing RSOs
- In June 2018 the RSSAC published RSSAC037
  - A proposed approach to governance of the RSS, including the ability to add/remove RSOs to the RSS
  - 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
  - The eventual model will be open for public comment via ICANN
  - RSS GWG sessions are open to observers at ICANN meetings

# RSS Stakeholders



# Composition of the Root Server System Governance Working Group

# Questions?

- **For more information on the RSSAC**
- Main webpage
  - https://www.icann.org/groups/rssac
- Frequently Asked Questions
  - https://www.icann.org/groups/rssac/faq
- For general questions
  - ask-rssac@icann.org

- **For more information on the RSSAC Caucus**
- Main webpage
  - https://www.icann.org/groups/rssac-caucus
- To apply send email to
  - rssac-membership@icann.org