

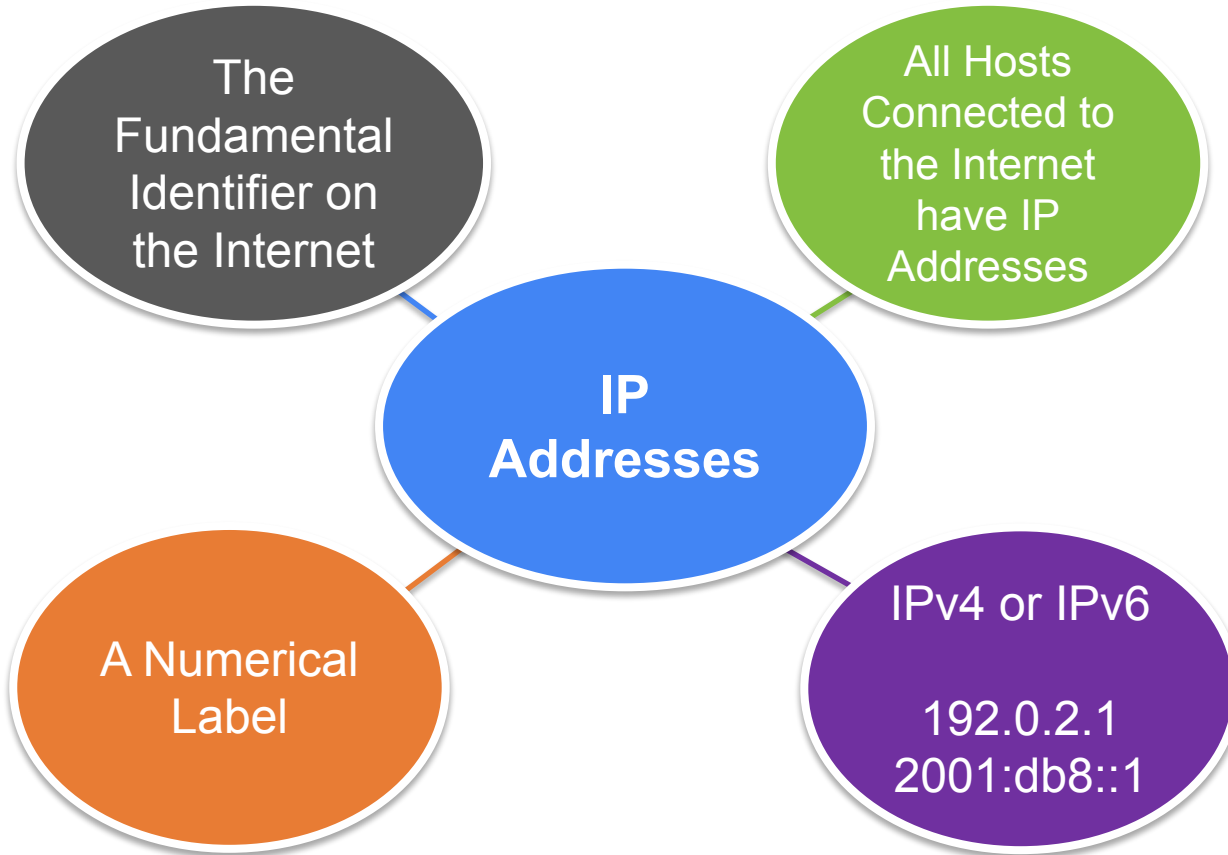
ICANN 78 Root Server System Information Session

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



Why DNS?

Original Problem

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

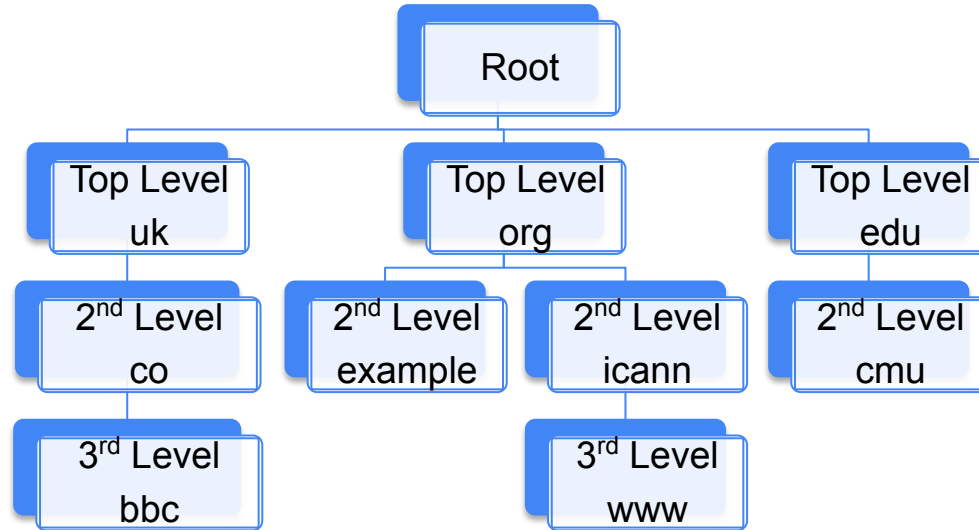
Modern Problem

- 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

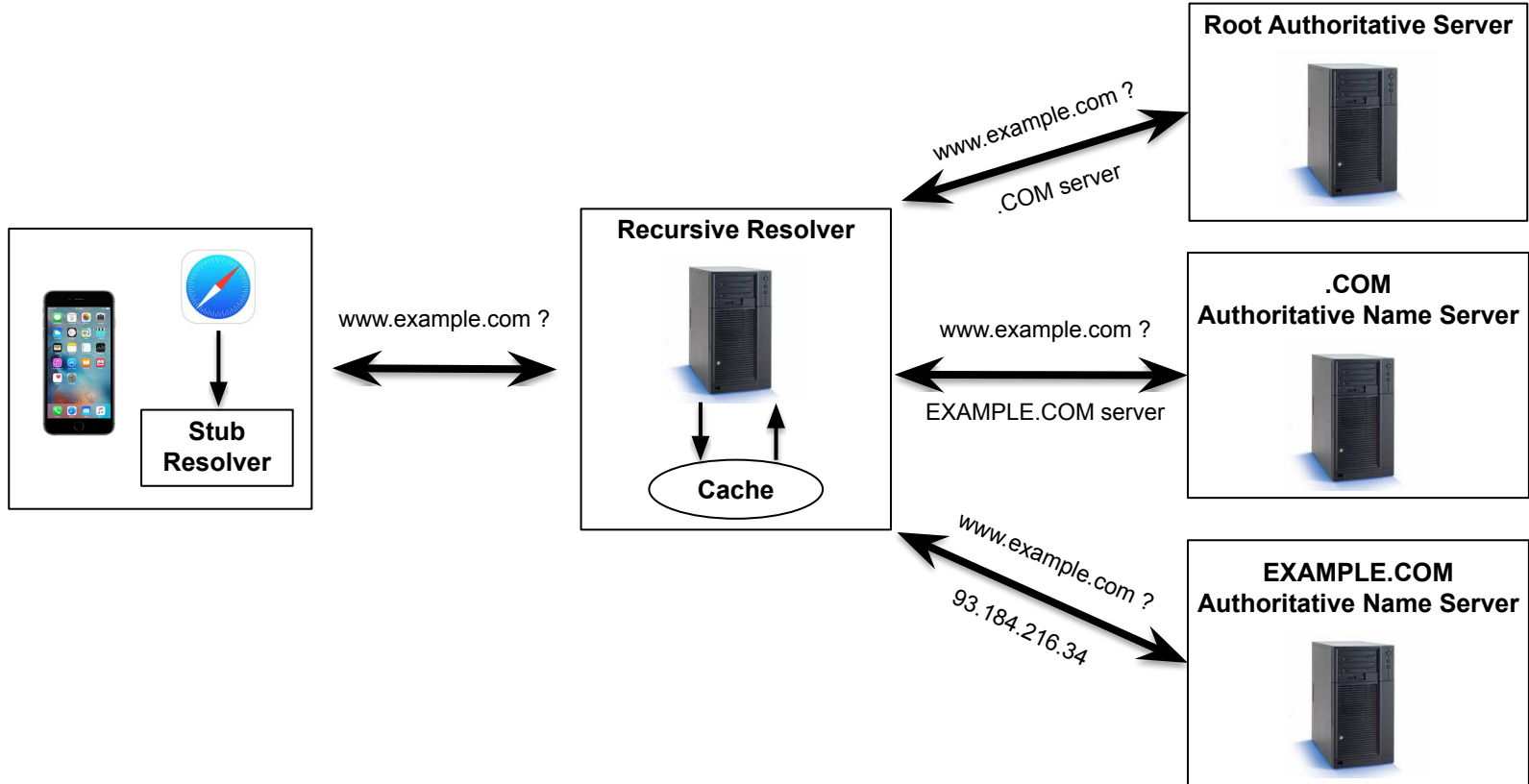


name-to-IP Address
www.example.org ➡ 198.51.100.52

Many Other Mappings
Mail Servers
IPv6
Reverse
Security

A globally distributed, loosely coherent, scalable, dynamic database

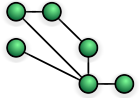
Domain Name Resolution Process



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

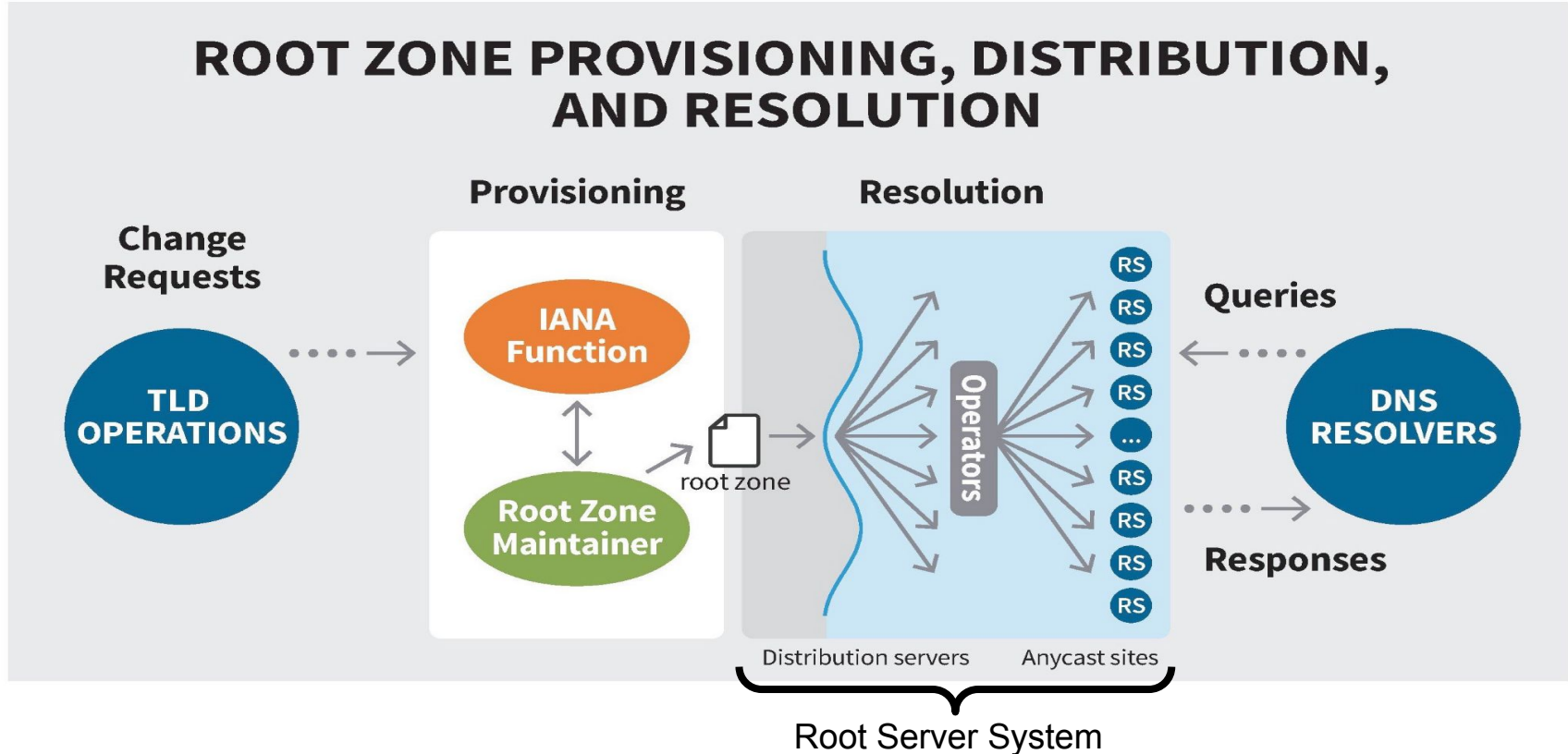
Root Zone

- 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
- The information served by the root servers

Root Server System

- Responds with data from the root zone
- Currently served from 13 IPv4 and 13 IPv6 addresses, from over 1500 instances
- Purely technical role to serve the root zone
- 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

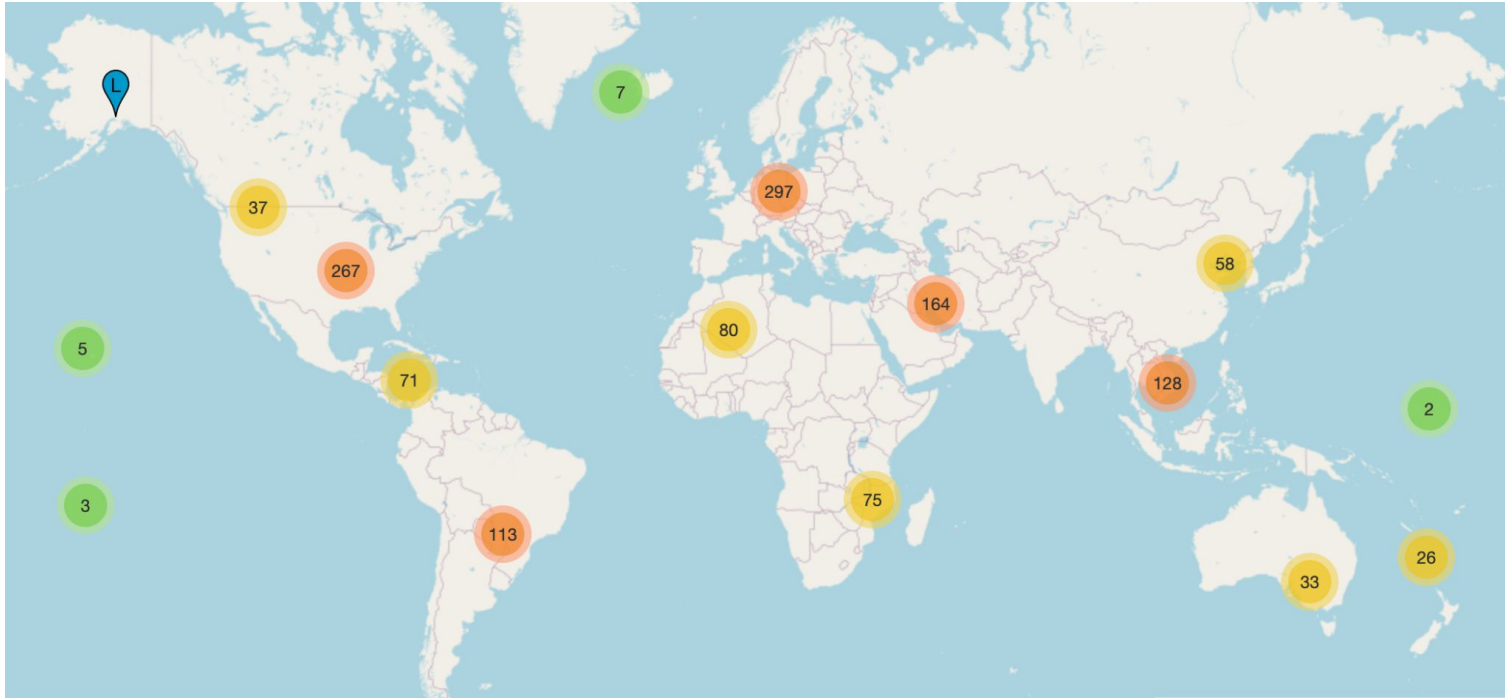
Changes Over Time

- 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	199.9.14.201, 2001:500:200::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 1700 instances around the world – <https://root-servers.org/>

Root Server System Principles

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

Principle 1

- IANA is the source of DNS root data.

Principle 2

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

Principle 3

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

Principle 4

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

Principle 5

- The IETF defines technical operation of the DNS protocol.

Principle 6

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

Principle 7

- RSOs must be transparent.

Principle 8

- RSOs must collaborate and engage with the stakeholder community.

Principle 9

- RSOs must be autonomous and independent.

Principle 10

- RSOs must be neutral and impartial

Principle 11

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 1500 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



Explanation of Anycast

Unicast vs. Anycast

Unicast

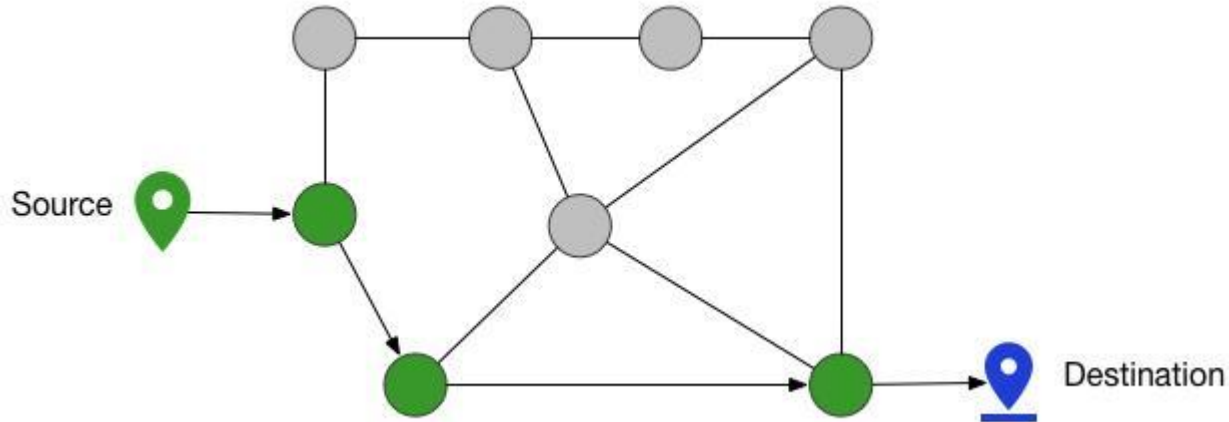
- Packets from sources all go to the same destination
- A single instance serves all sources
- DDoS attack traffic all goes to single instance

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

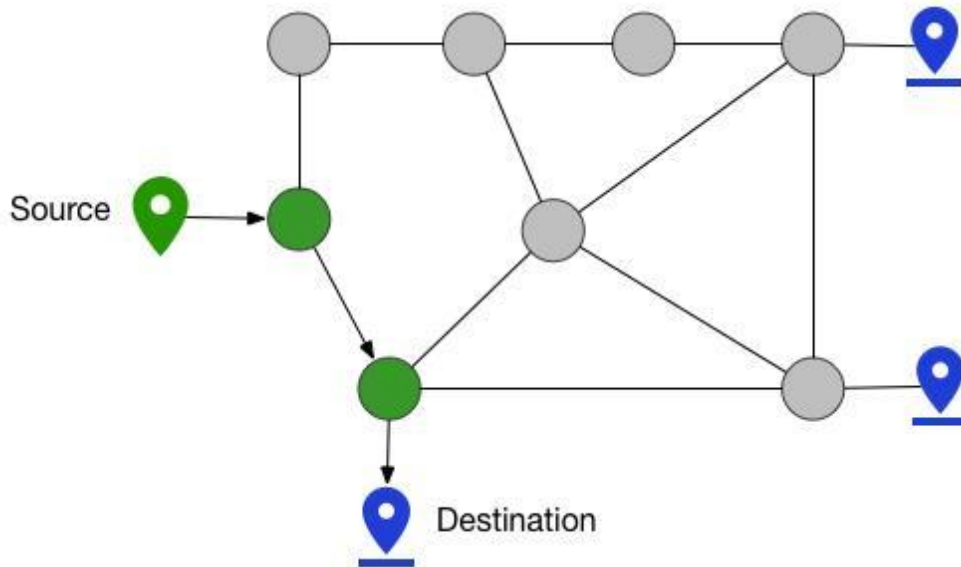
Unicast

Traffic takes shortest route to single destination.



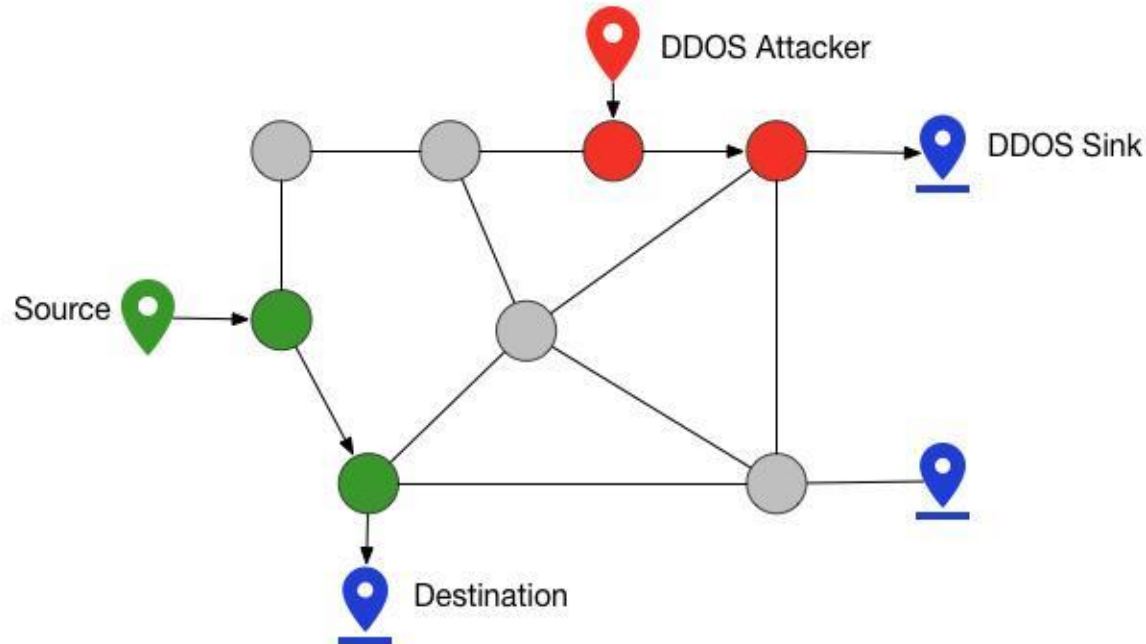
Anycast

- 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

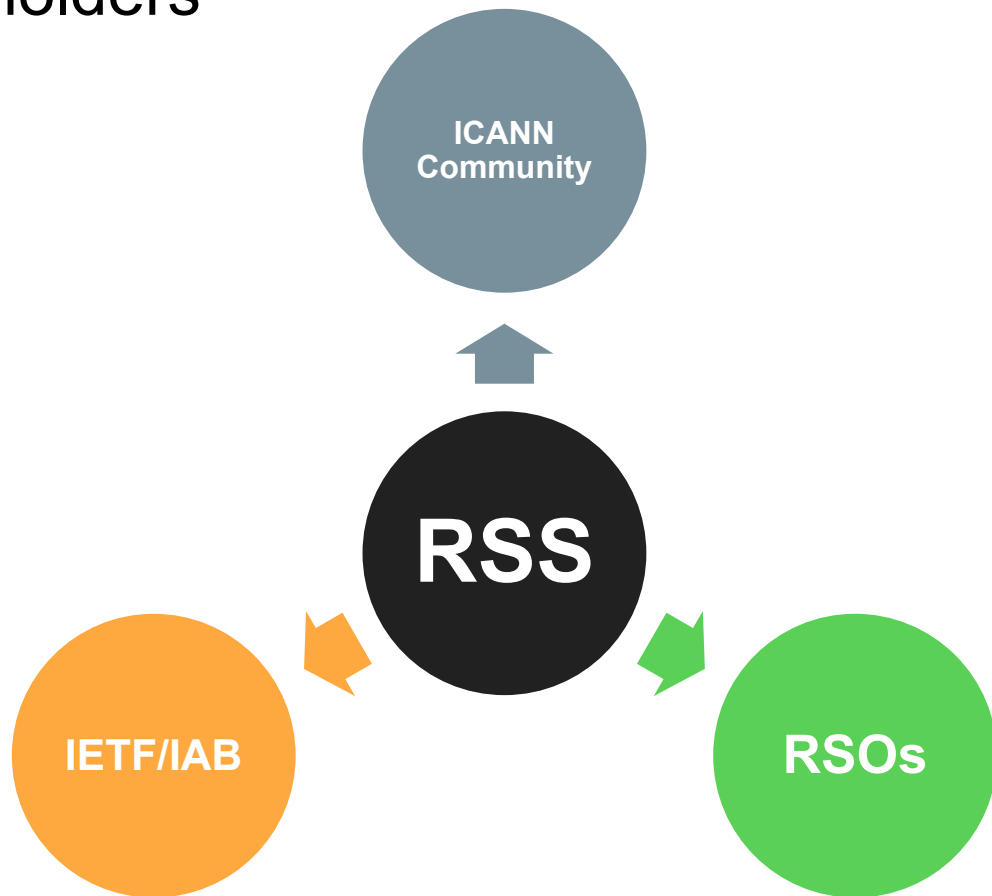
- Members
 - Over 100 DNS Experts
 - Public statements of interest
 - Public credit for individual work
- Purpose
 - DNS experts who bring diverse expertise to publications
 - Transparency of who does the work
 - Framework for getting work done

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