Diversity, Collaboration, and Independence in the Root Server System

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Background on the Root Server System

Agenda Item #1

ICANN | RSSAC
Root Server System Advisory Committee

Definitions from RSSAC026

- ⊙ 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 under it.
- ⊙ Root Service
  - ○ The collective services provided by all the server instances managed by all of the root server operators.
- ⊙ Root Server System (RSS)
  - ○ The set of root server anycast instances that collectively implements the root service.
- ⊙ Root Server Identifier (RSI)
  - ○ A root server identifier is the DNS name associated with a root server operator that appears in the root zone and root hints file. For example, "c.root-servers.net"
- ⊙ Root Server Anycast Instance
  - ○ One network location responding to DNS queries on a root server operator's IP address.
- ⊙ Root Server Operator (RSO)
  - ○ An organization responsible for managing the root service on IP addresses specified in the root zone and the root hints file.
- ⊙ 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

VS

Root Server System

- Responds with data from the root zone

- Currently distributed from 26 IP addresses, 13 IPv4 and 13 IPv6, from over 1500 instances

- Purely technical role to serve the root zone

- Responsibility of the root server operators

The Root Server System and the DNS

- ⊙ Recursive resolvers query root servers to find TLD nameservers
  - ○ Caching of answers means once information about a TLD is known, it is unnecessary to ask a root server again up to 2 days

- ⊙ All root servers contain the same information
  - ○ This can be verified with DNSSEC validation

- ⊙ Receives ~90B queries per day

- ⊙ Operational stability is paramount
  - ○ Changes and growth are conservative

Root Zone Administration versus Operation

ROOT ZONE PROVISIONING, DISTRIBUTION, AND RESOLUTION
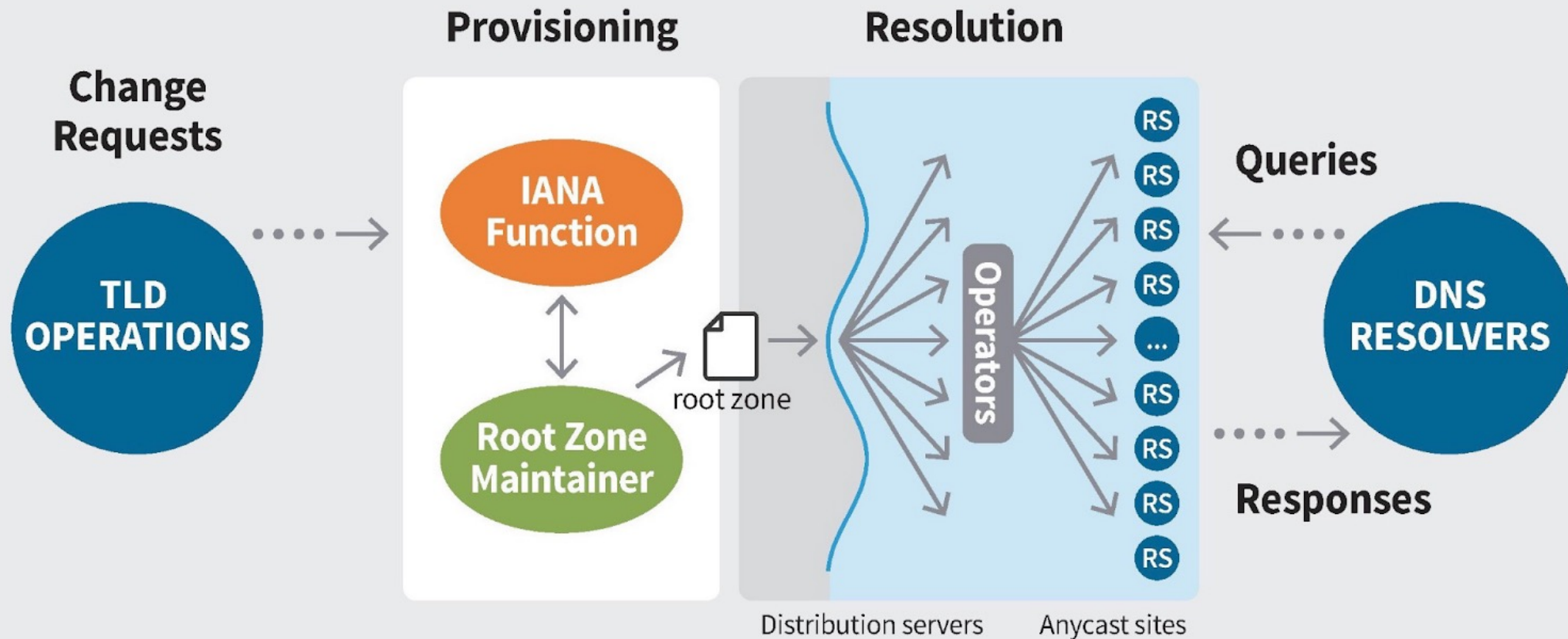
Growth of the Root Server System

1984 - 1985	4 Root Servers	USC-ISI (x2), SRI (DDN NIC), BRL
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 detailed history of the RSS

The Root Server System Today
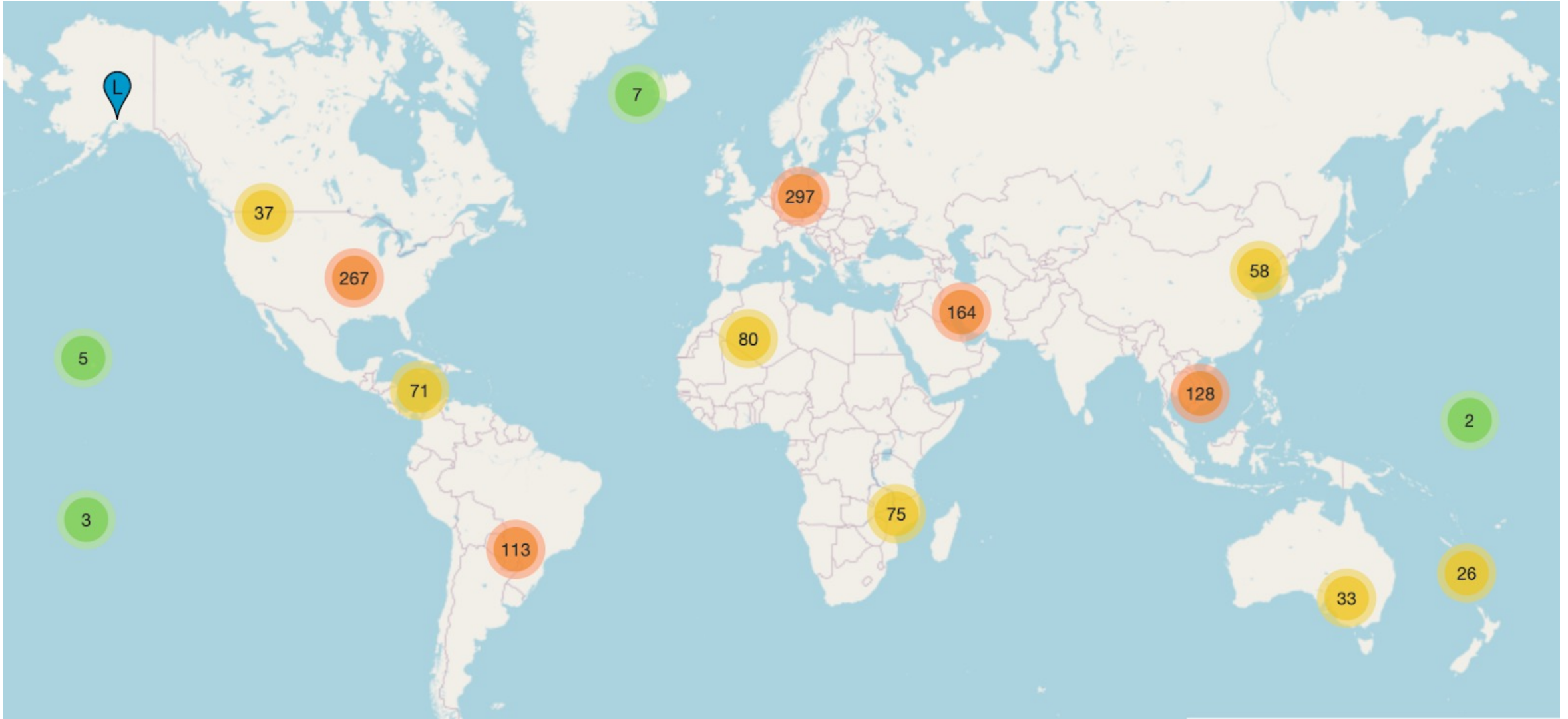
Over 1500 instances around the world – https://root-servers.org/

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 (Research Lab)
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

Diversity, Collaboration, and Independence in the Root Server System

Agenda Item #2

Principles Guiding the Operation of the Root Server System

1. To remain a global network, the Internet requires a globally unique public namespace.
2. IANA is the source of DNS root data.
3. The RSS must be a stable, reliable, and resilient platform for the DNS service to all users.
4. Diversity of the root server operations is a strength of the overall system.
5. Architectural changes should result from technical evolution and demonstrated technical need.
6. The IETF defines technical operation of the DNS protocol.
7. RSOs must operate with integrity and an ethos demonstrating a commitment to the common good of the Internet.
8. RSOs must be transparent.
9. RSOs must collaborate and engage with their stakeholder community.
10. RSOs must be autonomous and independent.
11. RSOs must be neutral and impartial.

Focus on Principles 4,9, and 10

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.

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.

Diversity, Collaboration, and Independence in the Root Server System

Diversity

Organizational Diversity

⦿ RSOs are from a diverse set of organizational types
  ○ Academic, commercial, non-profit, government
  ○ Different management philosophies, organizational structures, security policies
  ○ All have a common goal for reliable, stable root service **of the singular IANA root**

⦿ Different legal jurisdictions
  ○ Different countries, industry, government
  ○ Prevents one governing body from influencing or damaging the RSS
  ○ Failure of one RSO will not affect entire RSS (RSSAC021)

⦿ Conduct their business in different ways
  ○ RSOs may choose to enter into contracts on their own to support their service
  ○ Failure of a single economy or commercial market does not affect the entire RSS

Technical Diversity

- RSOs use diverse infrastructures
  - Network providers
  - Physical locations and infrastructure
  - Physical security, power grid, etc
  - Hardware
  - Software implementations (for example: OS and resolver)
  - Tools (e.g. static collection, system management)
  - Systems administration procedures

- Reduces "shared fate" of common elements

- Wide topographic (geographic) distribution of instances helps mitigate the effects of DoS attacks

- RSOs coordinate to ensure technical diversity

Diversity, Collaboration, and Independence in the Root Server System

Collaboration and Engagement

Collaboration Among RSOs

- RSOs collaborate on shared operational issues
  - Abnormal events such as traffic changes, unusual queries, anomalous patterns
  - Share information on software bugs or security vulnerabilities that may affect multiple operators

- RSOs maintain regular communications channels

- RSOs maintain emergency communications channels (tested regularly)

- Root-Ops
  - A regular meeting of RSOs to discuss technical and operational issues

- Root Server System Advisory Committee (RSSAC)
  - An ICANN advisory committee with representatives from all RSOs

Engagement with the Community

- RSOs participate in technical communities, standards bodies and policy-making forums
  - Internet Engineering Task Force
  - ICANN through the Root Server System Advisory Committee (RSSAC)
    - Outreach to various ICANN SO/ACs

- RSSAC Caucus
  - Over 100 DNS experts that help craft RSSAC publications
  - Diverse expertise represented among the membership
  - RSSAC solicits input and advice through the RSSAC Caucus
  - To apply, email rssac-membership@icann.org
    - https://www.icann.org/groups/rssac-caucus

- Presentations such as this one

Diversity, Collaboration, and Independence in the Root Server System

RSO Independence

Organizational Independence

- RSOs are independent from overarching entities

- RSOs are independent from each other
  - RSOs are currently not funded for their service as a root operator
    - Discussions in the Root Server System Governance Working Group (RSS GWG) are considering how to fund the RSS to ensure its long term viability
  - Organizational funds or proceeds from other services are used to fund operations

- Each RSO has independent Continuity-of-Operations (COOP) plans
  - Personnel, duty hours, on-call hours, etc

Technical Independence

- RSOs design their infrastructure independently, adhering to the same set of service standards

- RSOs adopt new technologies independently
  - IPv6, anycast
  - RPKI, encrypted transports

- Scheduled service interruptions, maintenance, and upgrades are done independently
  - Scheduled such that they have limited to no operational impact on the root service
  - RSOs collaborate and keep each other informed of scheduled maintenance

Evolution of the Root Server System

Agenda Item #3

Evolution of the Root Server System

- 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

The Root Server System and Your Networks

- Check your routes to instances
  - Typically want 3-4 *nearby* instances

- Turn on DNSSEC validation in resolvers
  - Ensures signed data is unmodified

- Participate in and contribute to the RSSAC Caucus
  - Where technical advice is created

- Interested in hosting an Anycast instance?
  - Talk to an RSSAC member after this presentation
  - Send mail to ask-rssac@icann.org

Q&A

Agenda Item #4

Thank you!

Further Reading

- RSSAC023: History of the Root Server System
  - Evolution and growth of the RSS
  - History of each of the RSOs

- RSSAC037: A Proposed Governance Model for the DNS Root Server System
  - Defines eleven principles for the operation and evolution of the Root Server System
  - Proposes an initial governance model (the RSSAC037 Model) for the Root Server System and its operators
  - Demonstrates how the model works through a set of scenarios on designation and removal of operators

- RSSAC042: RSSAC Statement on Root Server Operator Independence
  - Clarified and provided further information about principle 10 from RSSAC037, which states that "RSOs must be autonomous and independent."

- RSSAC055: Principles Guiding the Operation of the Public Root Server System
  - Restated the eleven principles from RSSAC037 and provided further clarification on each.