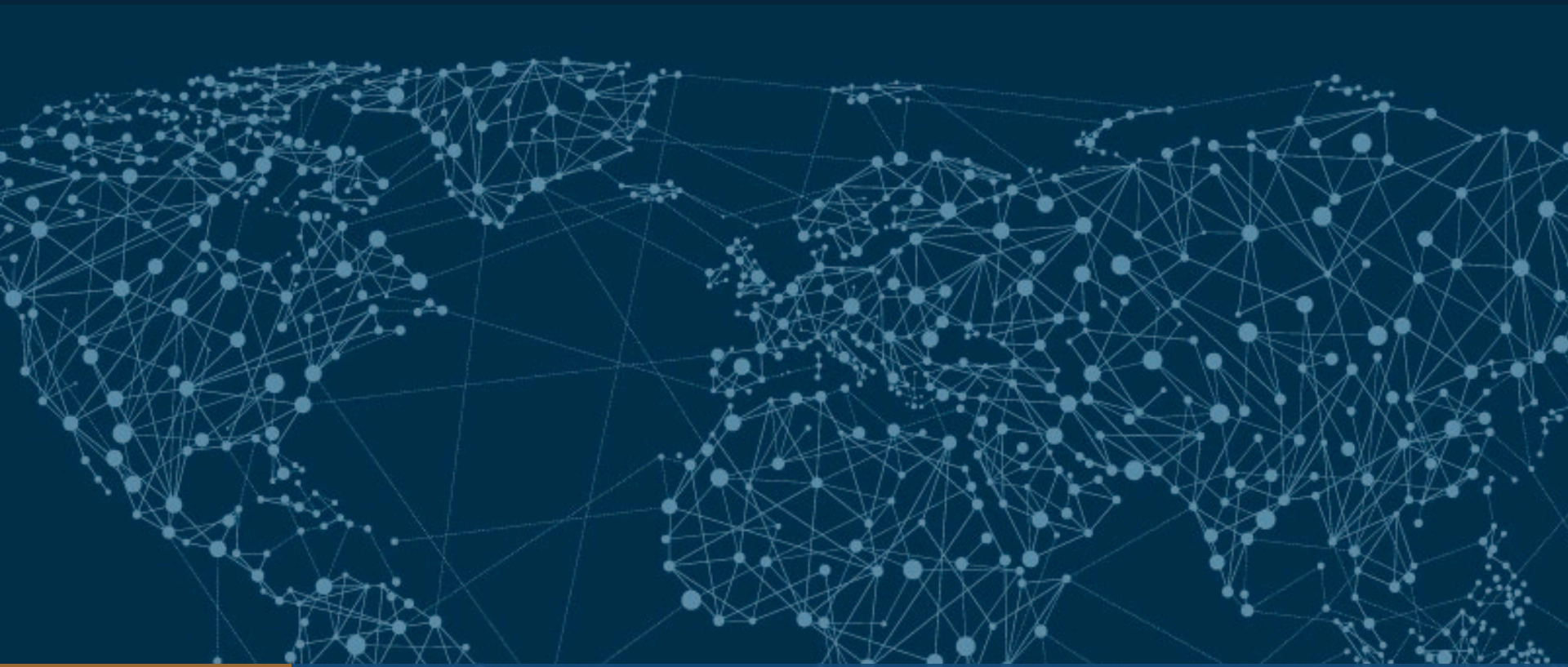
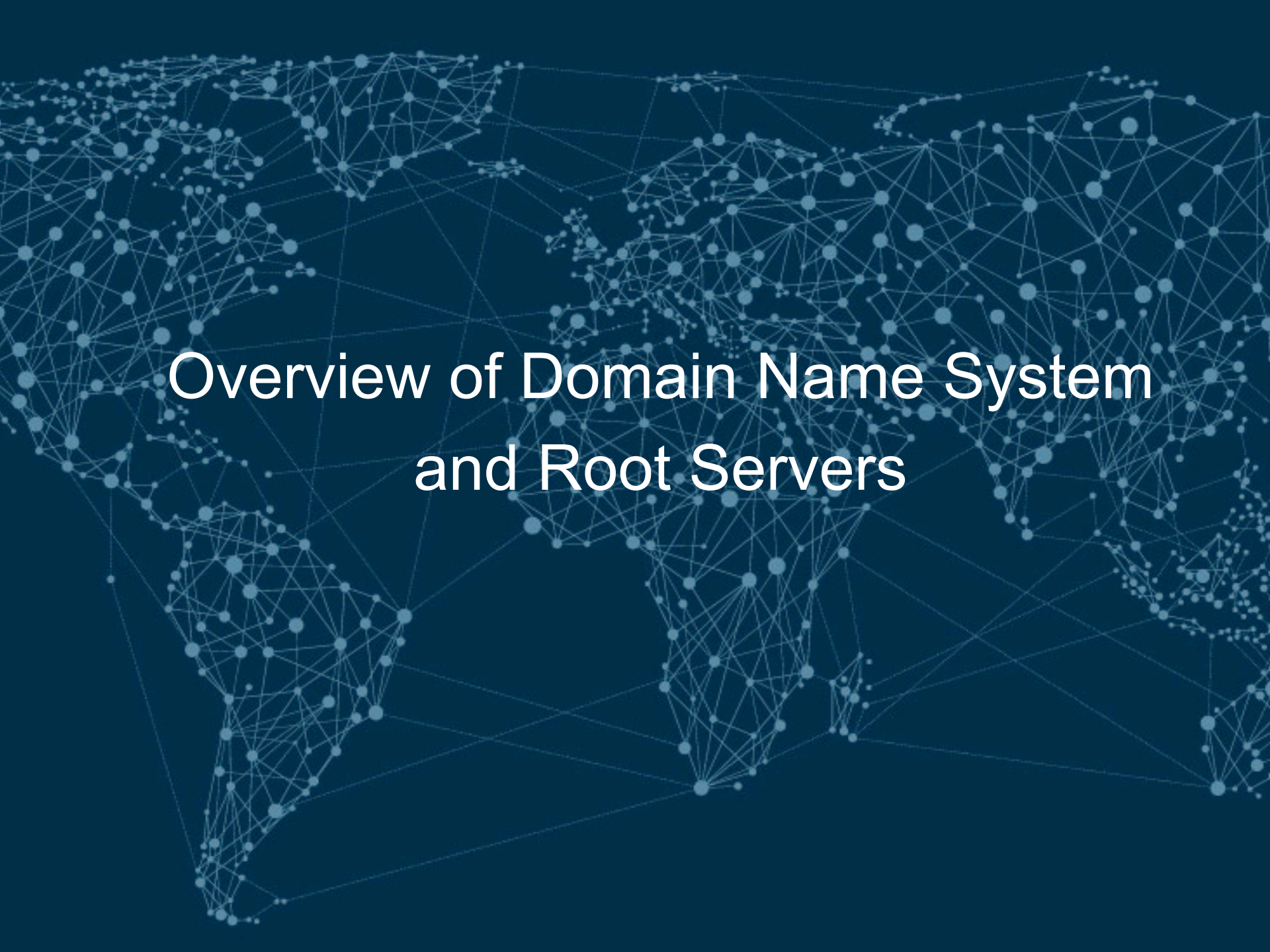


Tutorial on Root Server System

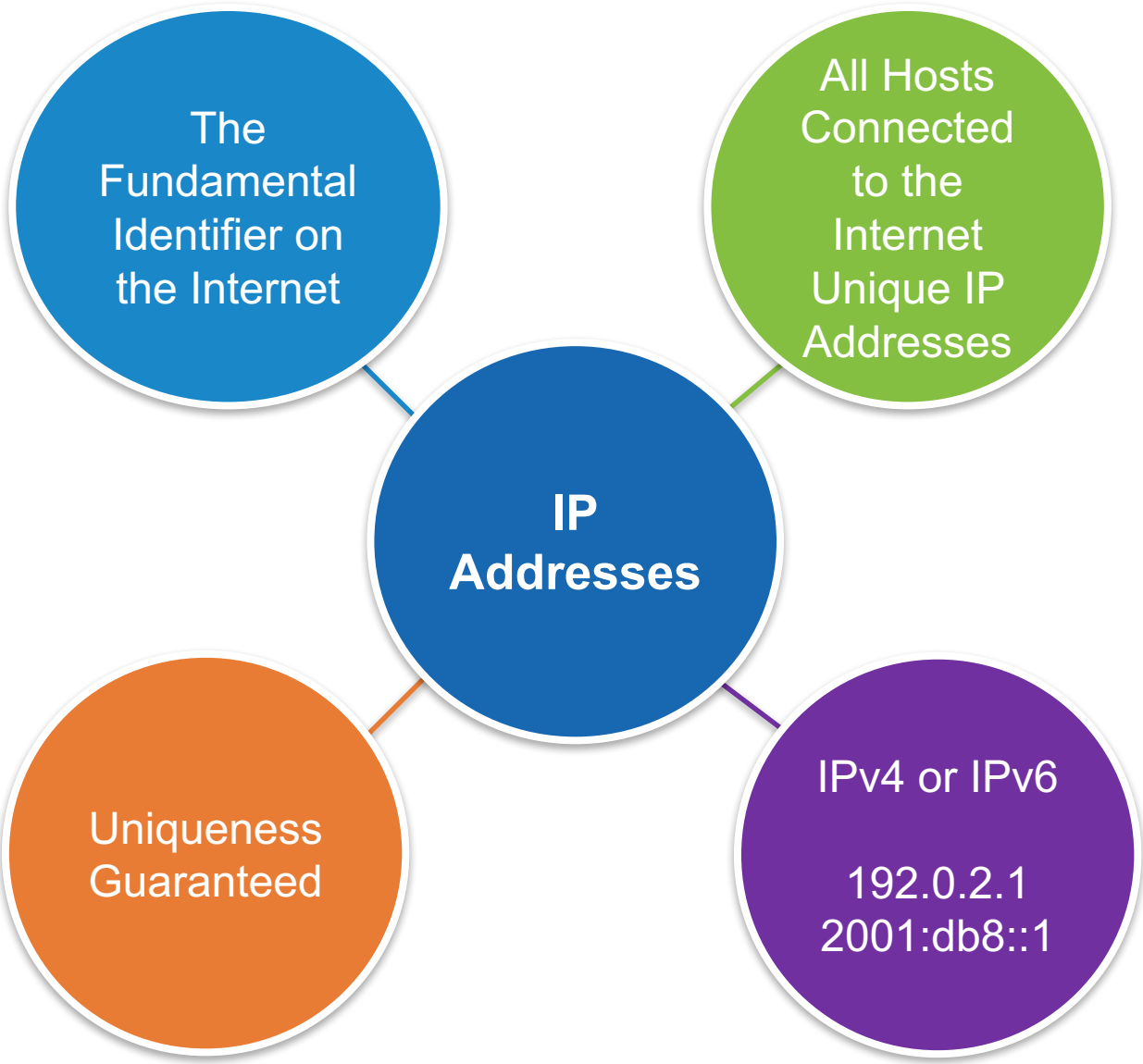
Root Server System Advisory Committee | March 2017

Outline

- Overview of Domain Name System
- Root Server System Today and Its Features
- Explanation of Anycast
- RSSAC and Recent RSSAC Activities


Overview of Domain Name System
and Root Servers

Recap: Identifiers on the Internet



Why DNS?

Original Problem

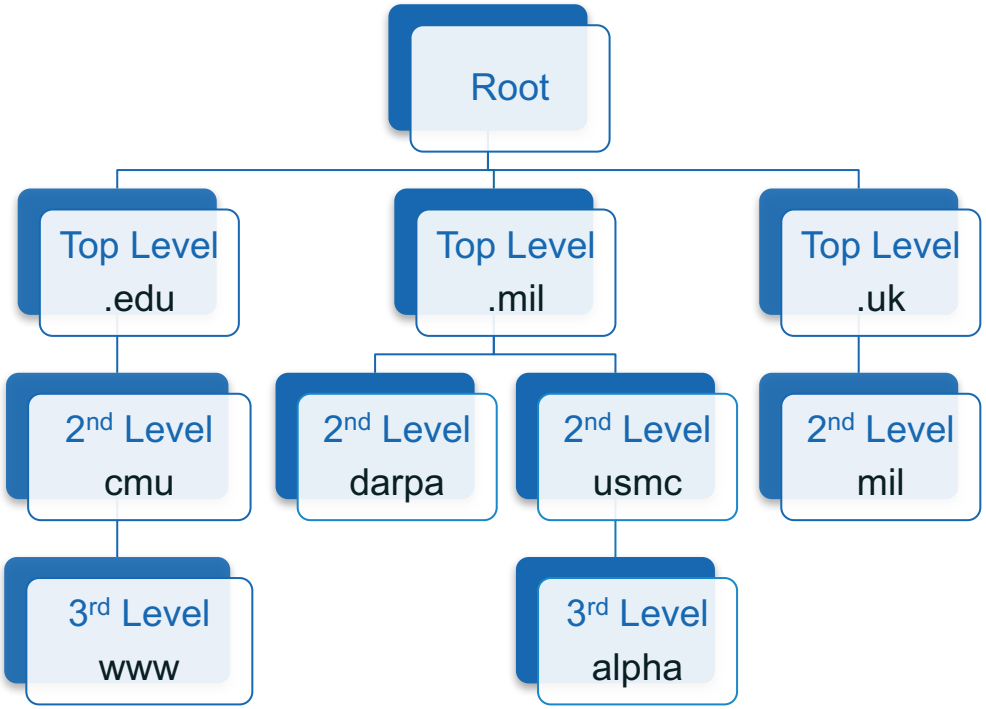
- IP addresses are hard to remember.
- IP addresses often change.

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 Domain Name System

A look up mechanism for translating objects into other objects



name-to-IP Address

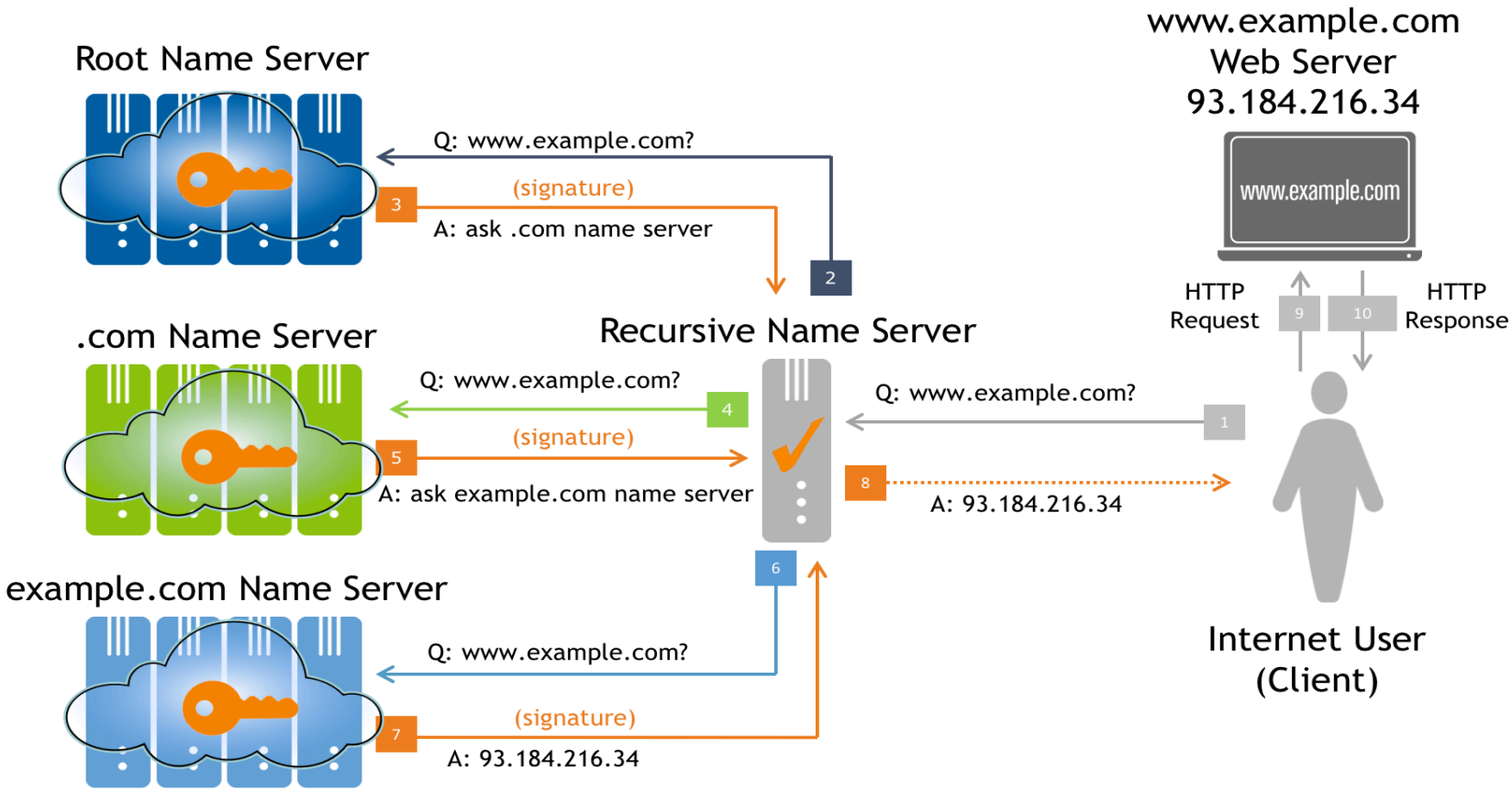
www.example.org ➡ 198.51.100.52

Many Other Mappings

Mail Servers
IPv6
Reverse

A globally distributed, loosely coherent, scalable, dynamic database

Domain Name Resolution Process



- Root Servers are at the entry point to the system.
- Caching is used throughout to avoid repetitive queries.
- The DNS resolution precedes the actual transaction the users want to do (web, mail, voip call, etc.).

Domain Name Resolution Process

Root servers only know who needs to be asked next.

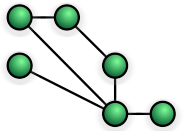
.com → list of .com servers

.net → list of .net servers

.org → list of .org servers

Caching of previous answers means there is less need to query the root servers after the first question.

Some Modern Refinements to DNS

DNSSEC (security extensions) 	• Cryptographic signatures on DNS data • Reduces risk of "spoofing" • Resolver should validate the answers
Privacy Enhancements 	• Queries can leak information • Standards being created to reduce this
Anycast 	• Multiple servers share a single IP address • Improves latency and resilience • Protects against DDoS attacks

Root Zone vs. Root Servers

Root Zone

- The starting point: the list of TLDs and nameservers
- Managed by ICANN, per community policy
- Compiled & distributed by the Root Zone Maintainer to all root server operators
- The database content in the root servers

Root Servers

- Respond with data from the root zone
- Currently distributed from 13 identities from over 600 instances at physical locations worldwide [a-m].root-servers.net
- Purely technical role = serve the root zone
- Responsibility of the root server operators

Root Server Operators

Twelve different professional engineering groups focused on:

- Reliability and stability of the service
- Accessibility for all Internet users
- Technical cooperation
- Professionalism

Diverse organizations and operations:

- Technically
- Organizationally
- Geographically

Root Server Operators

Operators are NOT involved in:

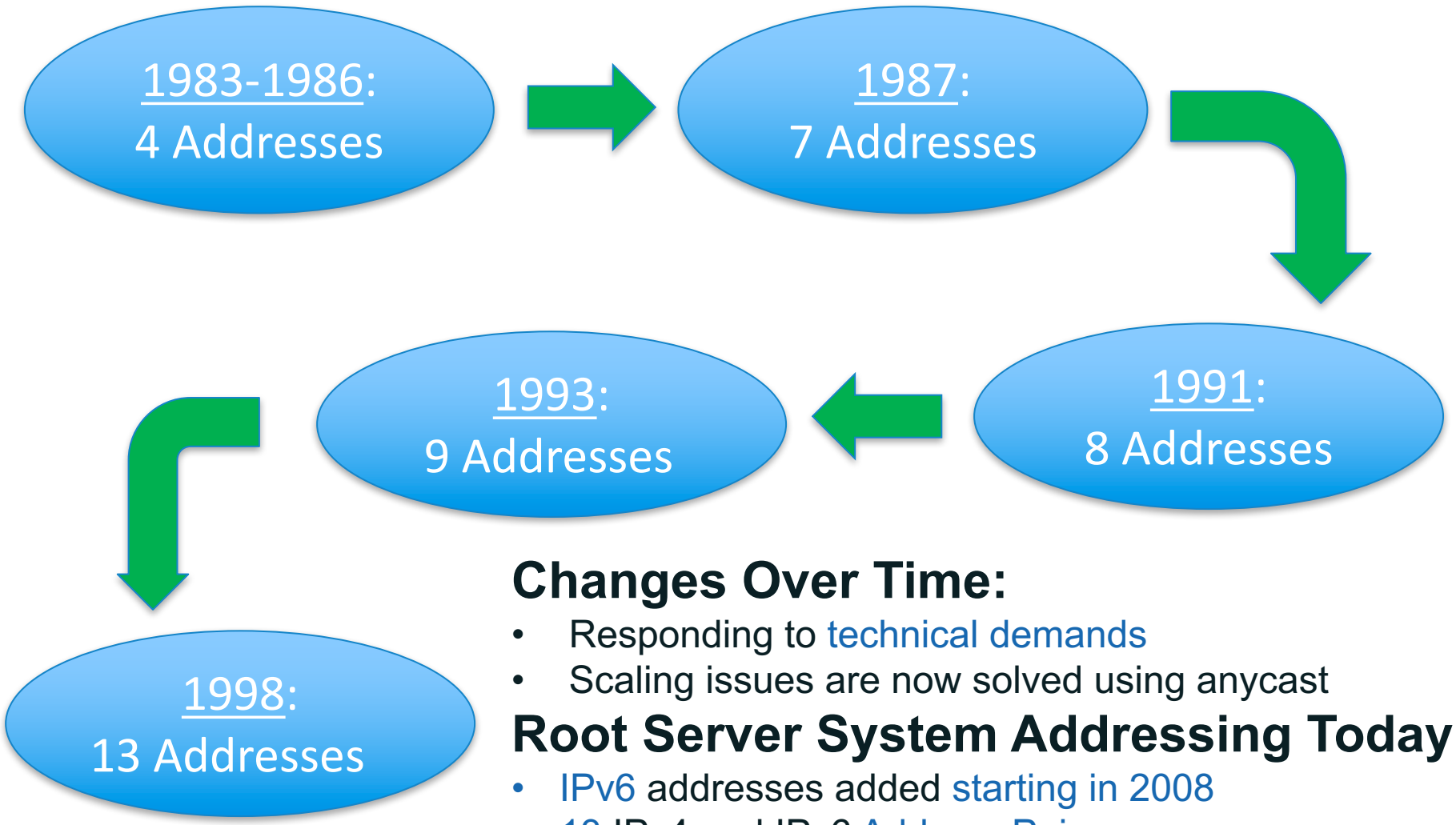
- Policy making
- Data modification (publishers, not authors or editors)

Operators ARE involved in:

- Careful operational evolution of service (expansion as the Internet expands)
- Evaluating and deploying suggested technical modifications
- Making every effort to ensure stability, robustness and reachability


Root Server System Today & Features

Growth of the Root Server System



Changes Over Time:

- Responding to technical demands
- Scaling issues are now solved using anycast

Root Server System Addressing Today:

- IPv6 addresses added starting in 2008
- 13 IPv4 and IPv6 Address Pairs
- Served from 600+ International Instances

Agreed Upon Root Server System Principles

Foundation Principles of the Root Server System:

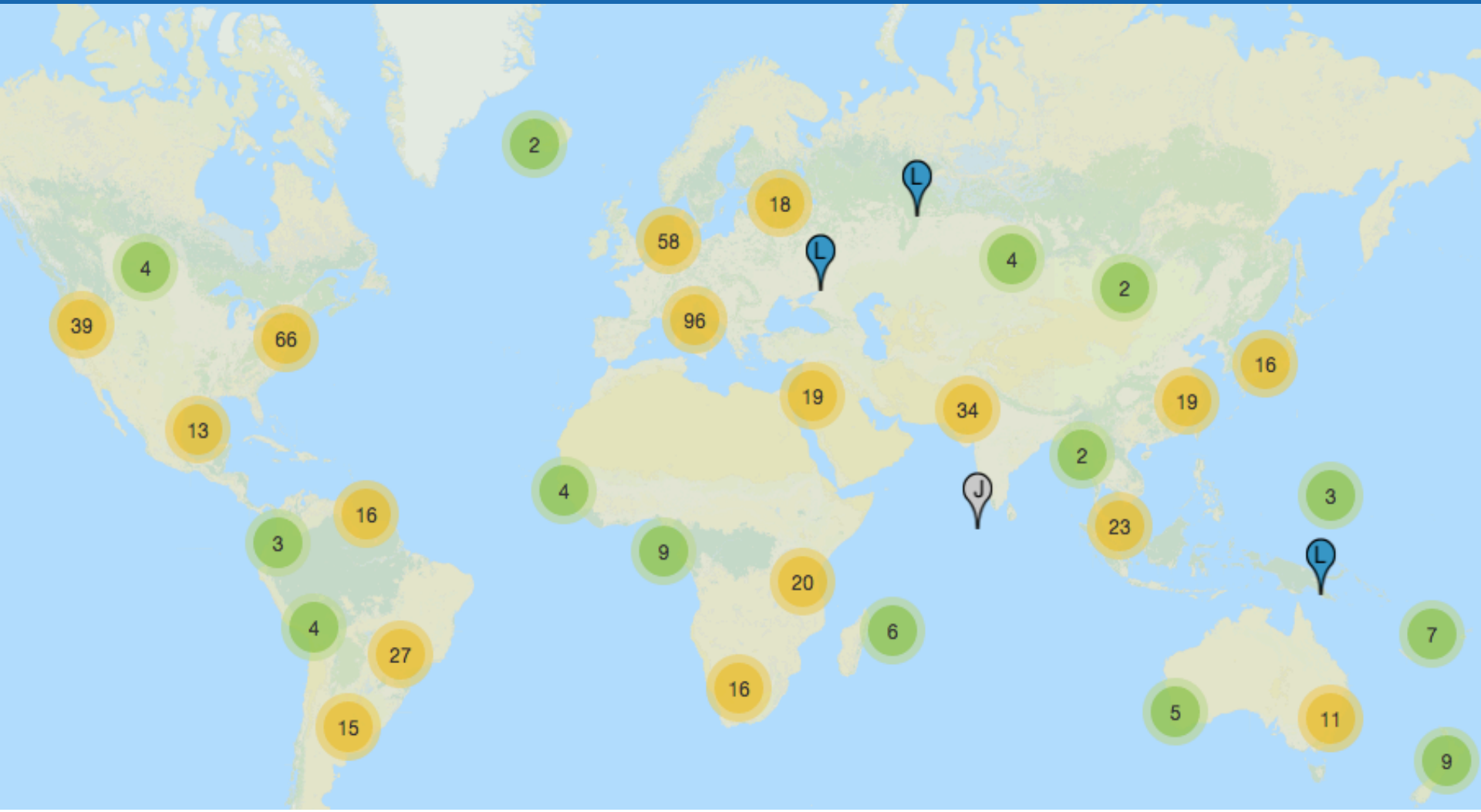
- Provides a stable, reliable, and resilient and platform for the Domain Name System
- Operates for the common good for all the Internet
- The IANA is the source of the DNS root data
- Architectural changes have been made based on the results of technical evaluation and demonstrated technical need
- Technical operation and expectations of the DNS is defined by the IETF

Note: RSSAC 024 contains significantly more detail on the History of the Root Server System

Root Server Identifiers Today - 2017

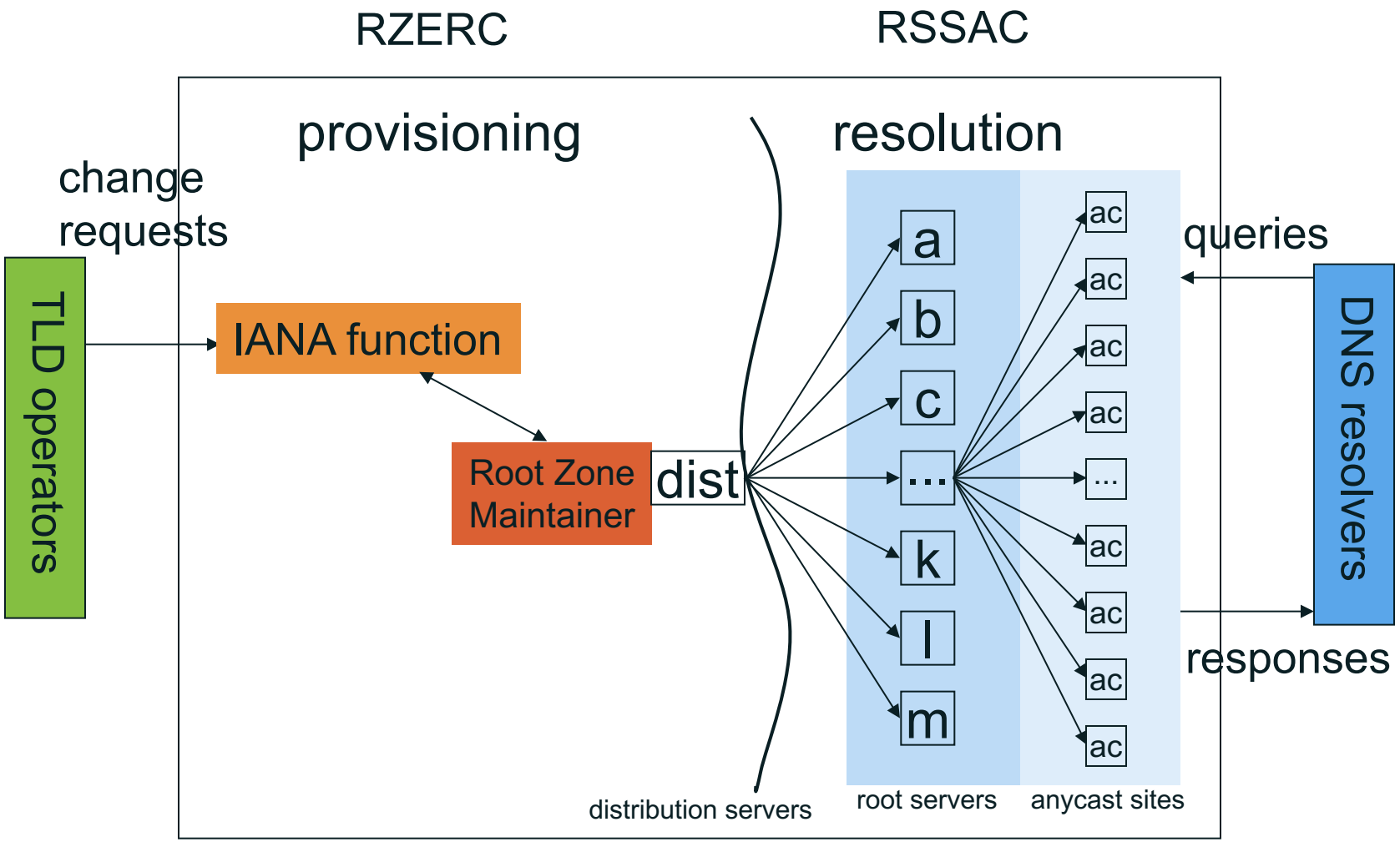
Hostname	IP Addresses	Manager
a.root-servers.net	198.41.0.4, 2001:503:ba3e::2:30	VeriSign, Inc.
b.root-servers.net	192.228.79.201, 2001:500:84::b	University of Southern California (ISI)
c.root-servers.net	192.33.4.12, 2001:500:2::c	Cogent Communications
d.root-servers.net	199.7.91.13, 2001:500:2d::d	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

Root Servers Today - 2017



Over 600 instances around the world – http://root-servers.org/

Root Zone Management
Post to IANA Stewardship Transition



Features of Root Server Operators

Diversity of...

- Organizational Structure
- Operational History
- Hardware and Software
- Funding Models

Shared best practices...

- Physical System Security
- Overprovisioning of Capacity
- Professional and Trusted Staff

Features of Root Server Operators

Cooperation through...

- Industry Meetings - (ICANN, IETF, RIPE, NANOG, DNS-OARC, APNIC, ARIN, AFNOG)
- Use Internet based collaboration tools
- Transparency

Coordination through...

- Permanent Infrastructure to Respond to Possible Emergencies - (phone bridges, mailing lists, secure credentials)
- Periodic Activities to Support Emergency Response Capabilities
- Established Internet Bodies - (RSSAC/ICANN, IETF, DNS-OARC)

Responses to an Evolving Internet

As the Internet evolves new requirements are put on the DNS system

- Root Zone Operators Analyze and Adopt New Uses and Protocol Extensions on the Service
  - IDNs, DNSSEC, IPv6
- Increasing Robustness, Responsiveness and Resilience
  - Wide deployment of distributed Anycast (600+ instances worldwide)

Myths Corrected

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 handled 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 identities have special meaning.	None of the root server identities are special.
There are only 13 root servers.	There are more then 600 servers globally, but only 13 technical identities.
The root server operators conduct operations independently.	The collective root server operators coordinate root service cloud operation as a whole.
The root server operators only receive the TLD portion of a query	The root server operators receive the entire query (www.example.com)


Explanation of Anycast

Unicast vs. Anycast

Unicast

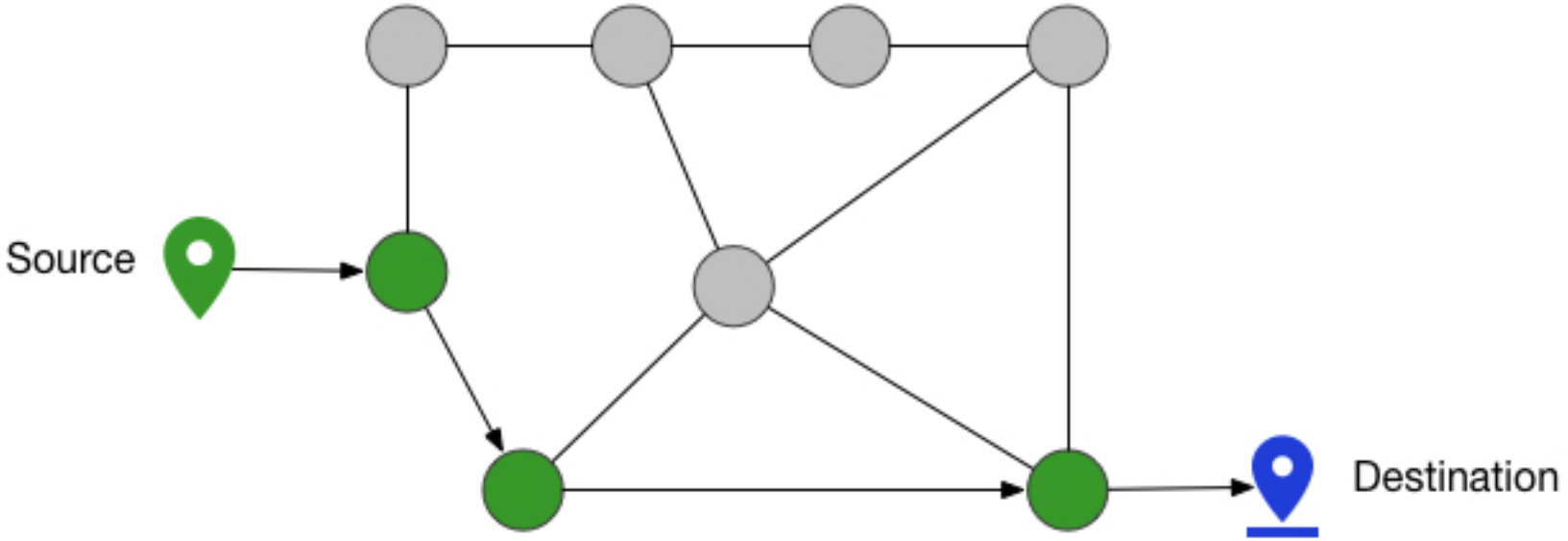
- Packets from sources all go to the same destination
- A single instance serves all sources
- DDoS attack traffic all goes to single instance

Anycast

- Multiple instances serve the same data to all sources
- Sources use destination based on intermediate routing policies
- Sources get the data faster
- DDoS attack traffic is sent to the closest instance
  - (Frees other instances to service genuine traffic)
  - (Distributes the overall impact of the attack)

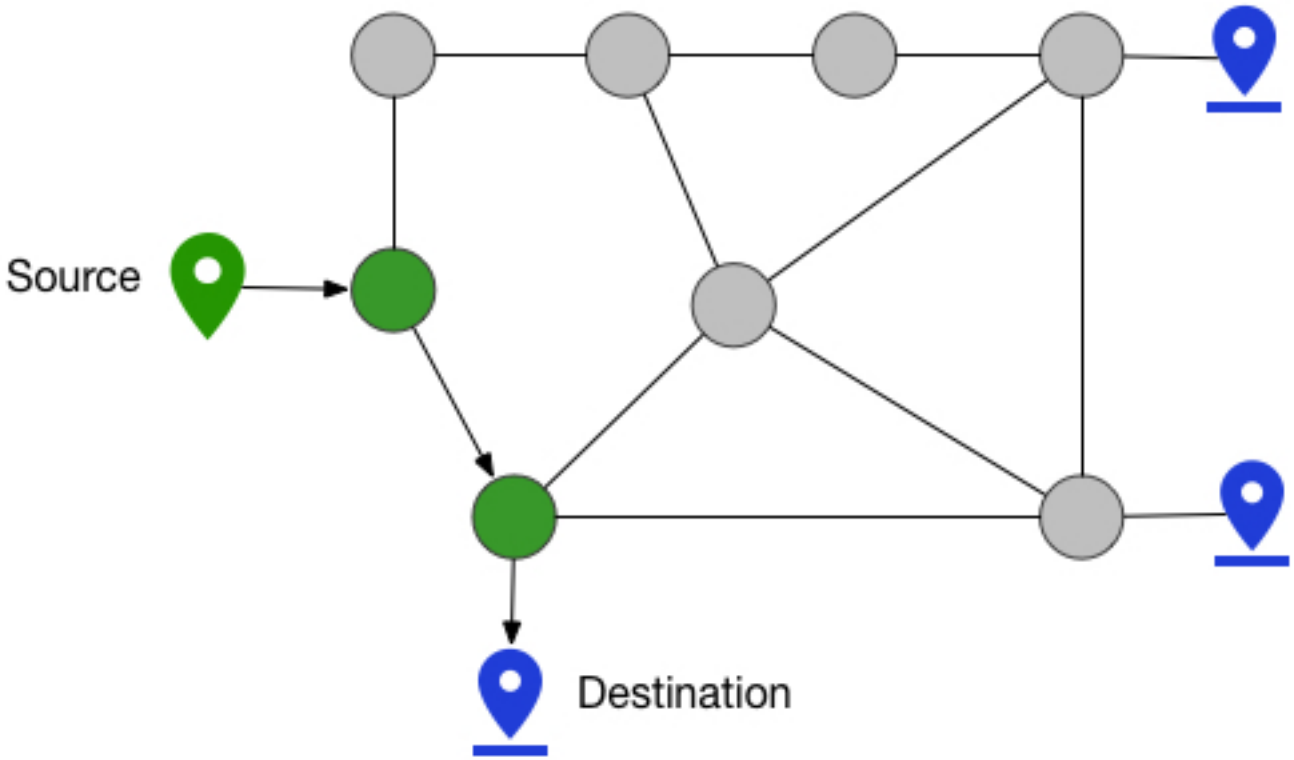
Unicast

Traffic takes shortest route to single destination.



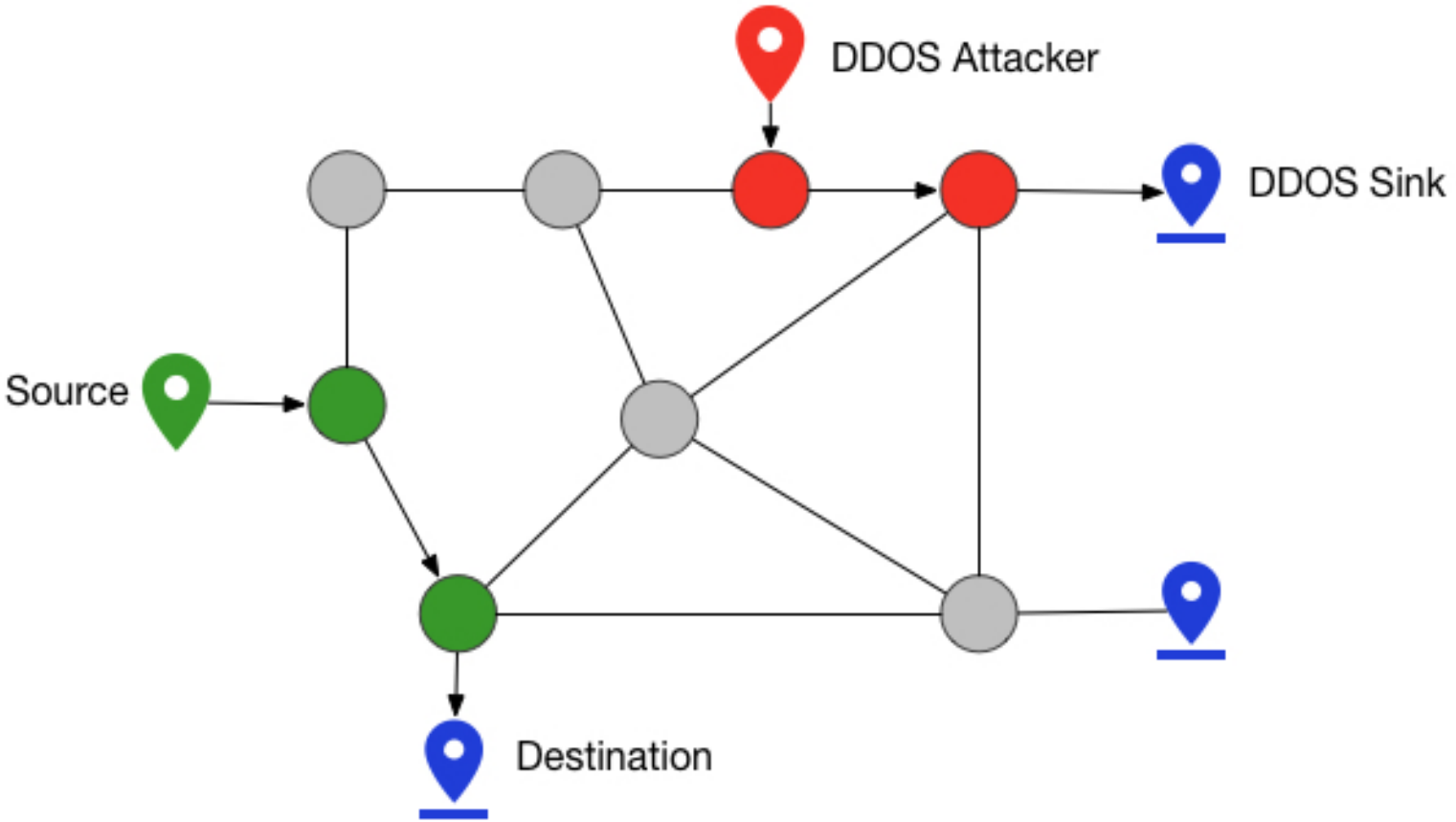
Anycast

- 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 Attack

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



The Root Server System and Your Networks

- Want 3-4 nearby instances
  - Increasing peering connections
  - Host a root server instance
- Deploy RFC7706 technology or configuration
  - Increases caching
- Turn on DNSSEC validation in resolvers
  - Ensures you are getting unmodified IANA data
- Participate in and contribute to RSSAC Caucus
  - Where technical advice is created


RSSAC and Recent RSSAC Activities

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.

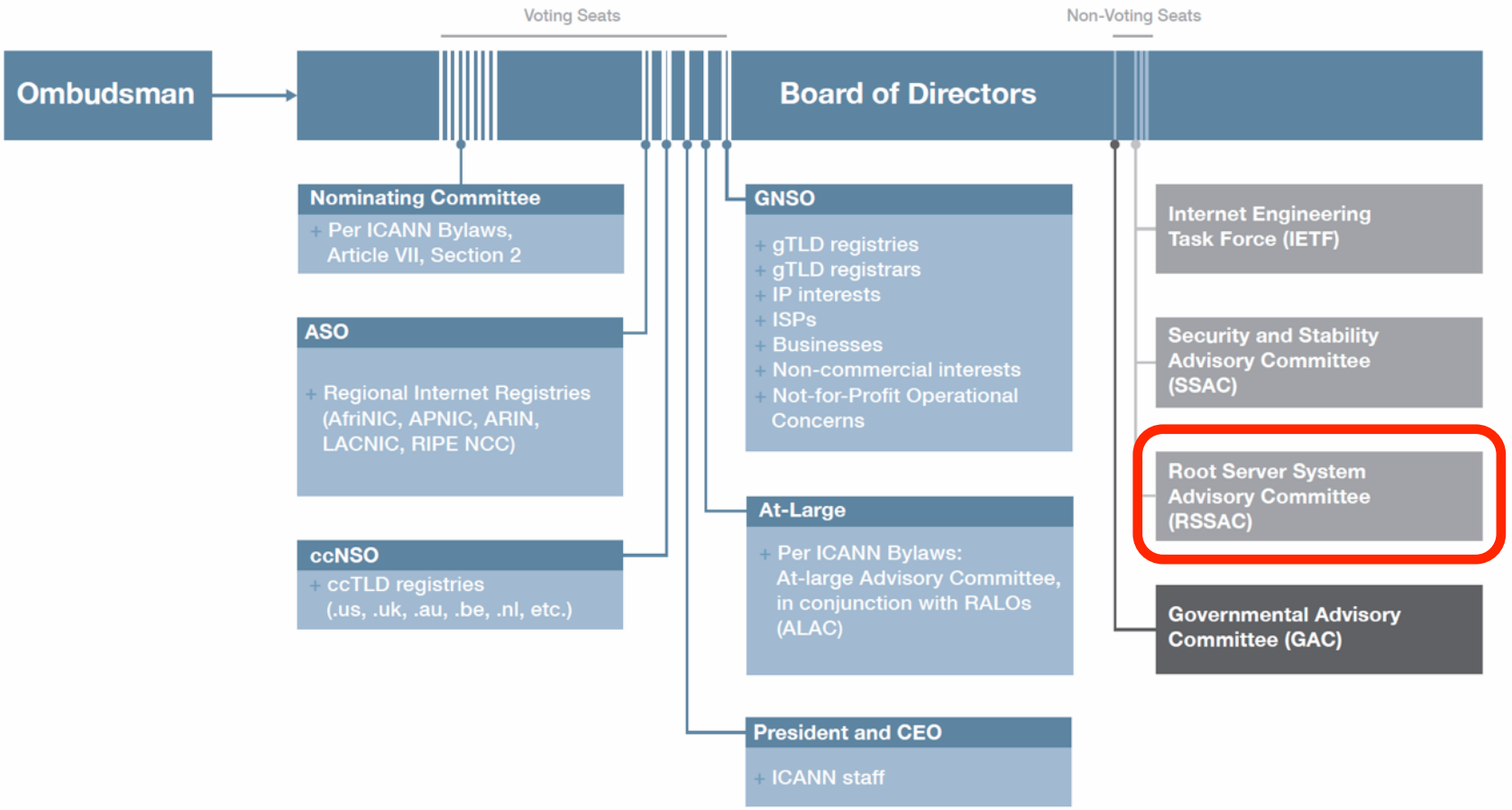
- (This is a very narrow scope!)

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 is here ...



RSSAC Organization

- RSSAC is composed of
  - Appointed representatives of the root server operators
  - Alternates to these
  - Liaisons
- RSSAC Caucus
  - Body of volunteer subject matter experts
  - Members confirmed by RSSAC based on statement of interest

RSSAC Co-chairs

Brad Verd
Verisign
A/J-root

Tripti Sinha
University of Maryland
D-root

RSSAC Liaisons

- IANA Functions Operator (PTI)*
- Root Zone Maintainer (Verisign)*
- Internet Architecture Board*
- Security and Stability Advisory Committee*
- ICANN Board**
- ICANN Nominating Committee**
- Customer Standing Committee**
- Root Zone Evolution Review Committee**

* Inward Facing Liaison

**Outward Facing Liaison

https://www.icann.org/groups/rssac

RSSAC Caucus

- Members
  - 85 Technical Experts as of March, 2017
  - 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

- To apply, email rssac-membership@icann.org.

RSSAC Recent Publications

- RSSAC026 – RSSAC Lexicon
- RSSAC025 – RSSAC October 2016 Workshop Report
- RSSAC024 – Key Technical Elements of Potential Root Operators
- RSSAC023 – History of the Root Server System

- Please attend the RSSAC Public Meeting to hear additional details

RSSAC Current Work

- Technical Analysis of the Naming Scheme Used for Individual Root Servers

- Best Practices for the Distribution of Anycast Instances of the Root Name Service

Transparency

RSSAC

- Establishment of a Caucus
- Publishing minutes & workshop reports
- Public RSSAC & Caucus Calendar
- RSSAC Public Meetings
- Meetings with other ICANN community groups
- Tutorials
- Liaison relationships
- Operational procedures: RSSAC000

RSOs

- Publishing Minutes
- RSSAC002 statistics
- Participating in RSSAC
- Public web page
  - www.root-servers.org
- Individual web pages
- Public letters with IANA
- Collaborative reports on major events
- RSSAC can respond to technical RSS questions

Questions?

- **For more information on the RSSAC**
- Main webpage:
  https://www.icann.org/groups/rssac
- RSSAC Publications:
  https://www.icann.org/groups/rssac/documents

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