

# Introducing RSSAC and the DNS Root Server System

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# Part 1: The Root Server System Advisory Committee (RSSAC)

# RSSAC - scope of activity

Purpose:

“... to advise the ICANN community and Board on matters relating to the operation, administration, security, and integrity of the Internet's Root Server System”

– ICANN Bylaws Art 12.2

# RSSAC - ICANN Bylaws Art 12.2

“...to advise the ICANN community and Board on matters relating to the operation, administration, security, and integrity of the Internet's Root Server System. It shall have the following responsibilities:

- A. Communicate on matters relating to the operation of the Root Servers and their multiple instances with the Internet technical community and the ICANN community. The RSSAC shall gather and articulate requirements to offer to those engaged in technical revision of the protocols and best common practices related to the operation of DNS servers.
- B. Communicate on matters relating to the administration of the Root Zone with those who have direct responsibility for that administration. These matters include the processes and procedures for the production of the Root Zone File.
- C. Engage in ongoing threat assessment and risk analysis of the Root Server System and recommend any necessary audit activity to assess the current status of root servers and the root zone.
- D. Respond to requests for information or opinions from the Board.
- E. Report periodically to the Board on its activities.
- F. Make policy recommendations to the ICANN community and Board.”

# RSSAC - composition

- Operator-appointed Members
  - Each Root Server Operator appoints:
    - (a) one primary member plus
    - (b) one alternate member
  - Votes: one per Operator
- Liaisons (non-voting) received from:
  - Internet Assigned Numbers Authority (IANA)
  - Root Zone Maintainer (RZM)
  - Internet Architecture Board (IAB)
  - Security and Stability Advisory Committee (SSAC)
- RSSAC sends liaisons to:
  - ICANN Board
  - Customer Standing Committee (CSC)
  - Root Zone Evolution Review Committee (RZERC)
  - ICANN Nominating Committee
  - Ad hoc ICANN work groups
- RSSAC Caucus:
  - Wider group of subject matter experts (more than 100 members)
  - Membership applications reviewed and confirmed by RSSAC

# RSSAC and policy development

- Characteristics of the forum
  - Structured, open, and transparent
  - Used to develop, express, and obtain feedback on policies and plans concerning the Root Server System
- Nature of RSSAC policy recommendations
  - Restate the long-established normative framework used to operate the Root Server System
  - Suggest continued developments that grow from that existing framework

# Out of scope

- RSSAC is not an enforcement or supervisory body
- RSSAC is not a representative body for the Root Server Operators
- RSSAC is not a representative body for the Root Server System

# RSSAC Statements - examples

- History
  - RSSAC023v2: History of the Root Server System (2020, 47pp)
- Service description
  - RSSAC002v5: RSSAC Advisory on Measurements of the Root Server System (2023, 18 pp)
  - RSSAC057: Requirements for Measurements of the Local Perspective on the Root Server System (2021, 12 pp)



# RSSAC Statements - examples

- Governance related
  - RSSAC037: A Proposed Governance Model for the DNS Root Server System (2018, 50 pp)
  - RSSAC055: Principles Guiding the Operation of the Public Root Server System (2021, 4 pp)
  - RSSAC058: Success Criteria for the RSS Governance Structure (2021, 21 pp)
- Specific advice to the ICANN Board
  - RSSAC038: Advisory [4 recommendations for implementing RSSAC037]
  - RSSAC059: Advisory [3 recommendations for implementing RSSAC058]

# Part 2: Understanding the DNS Root Server System

# Introduction and overview

- GOAL - to increase understanding of:
  - the Root Server System, and
  - the Root Server Operators.
- By explaining:
  - the role and purpose of DNS,
  - the roles of an address resolver and an authoritative server,
  - how, when, and why a resolver consults the Root Server System, and
  - common misunderstandings about the Root Server System.
- Focus - things that leadership officials need to know

# Introducing DNS (the Domain Name System)

- DNS uses human names to find computer addresses
  - Humans know domain names like: `www.amazon.com`
  - Computers need IP addresses like: `18.239.62.181`
  - DNS is how we know “`www.amazon.com`” is “`18.239.62.181`”
  - Numbers can change while names stay the same
- Connected devices need DNS to find other connected things
  - Computers & servers
  - Smart phones, “smart” anything
- DNS questions ask about domain names; answers are IP addresses

# Benefits of DNS

- Human-friendly identifiers
  - `www.example.com` is easier to use than `192.168.45.99`
- Service portability
  - Resource owners control address mapping in their domain
  - DNS follows you to your new online home
- It's a huge distributed network that's easy to use
  - Flexible delegated management of hundreds of millions of directories
  - World's largest distributed database

# Devices get addresses from resolvers

- There are millions of resolvers around the world
- Resolvers can find & read the world's Internet phone books
  - Internet “phone books” are authoritative servers
  - Internet “listings/entries” are zone content / address information

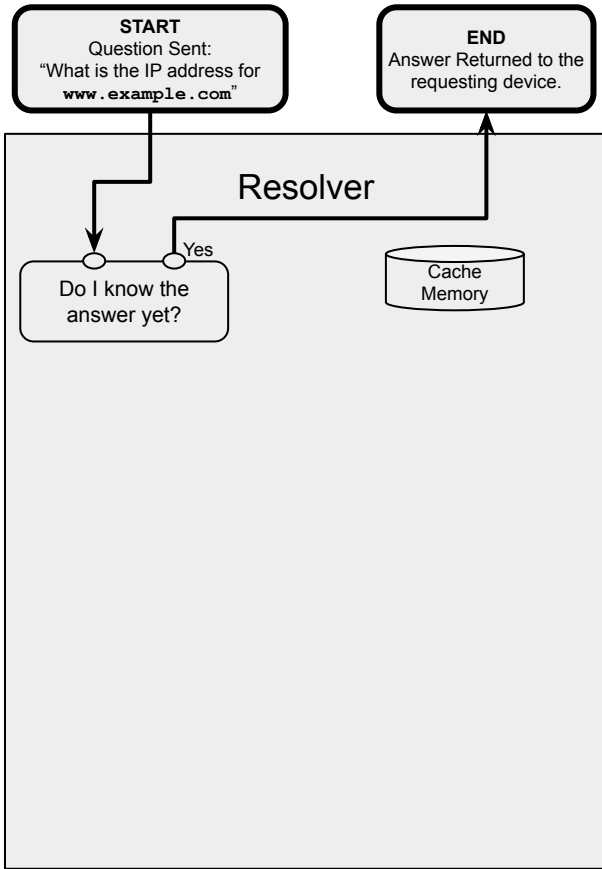
Q: What is the number for `www.amazon.com`?

A: The number for `www.amazon.com` (for now) is `18.239.62.181`

- This happens in milliseconds
- This happens about 500 trillion times every day

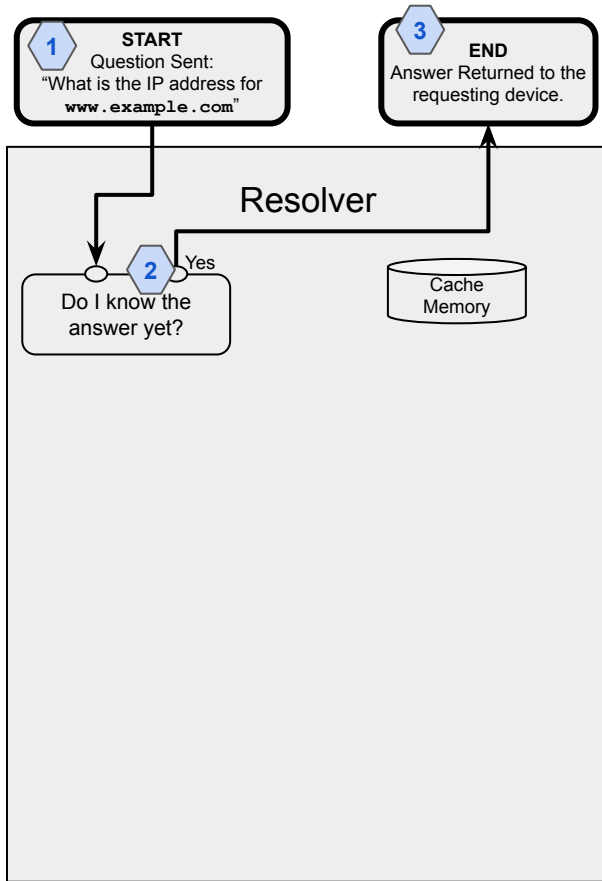
# Resolvers get addresses from authoritative servers

- The resolver remembers addresses
  - This is called caching
  - Sometimes the resolver needs to learn a new number or confirm an old number
- Depending on how much information it needs, a resolver will ask:
  - Case 1: Nobody - resolver constructs the entire answer using only cache memory (most common scenario)
  - Case 2: The domain name's authoritative server only
  - Case 3: The TLD's authoritative server, then the domain name's authoritative server
  - Case 4: The Root Server System, then the TLD's authoritative server, then the domain name's authoritative server



## Case 1: resolver cache memory only



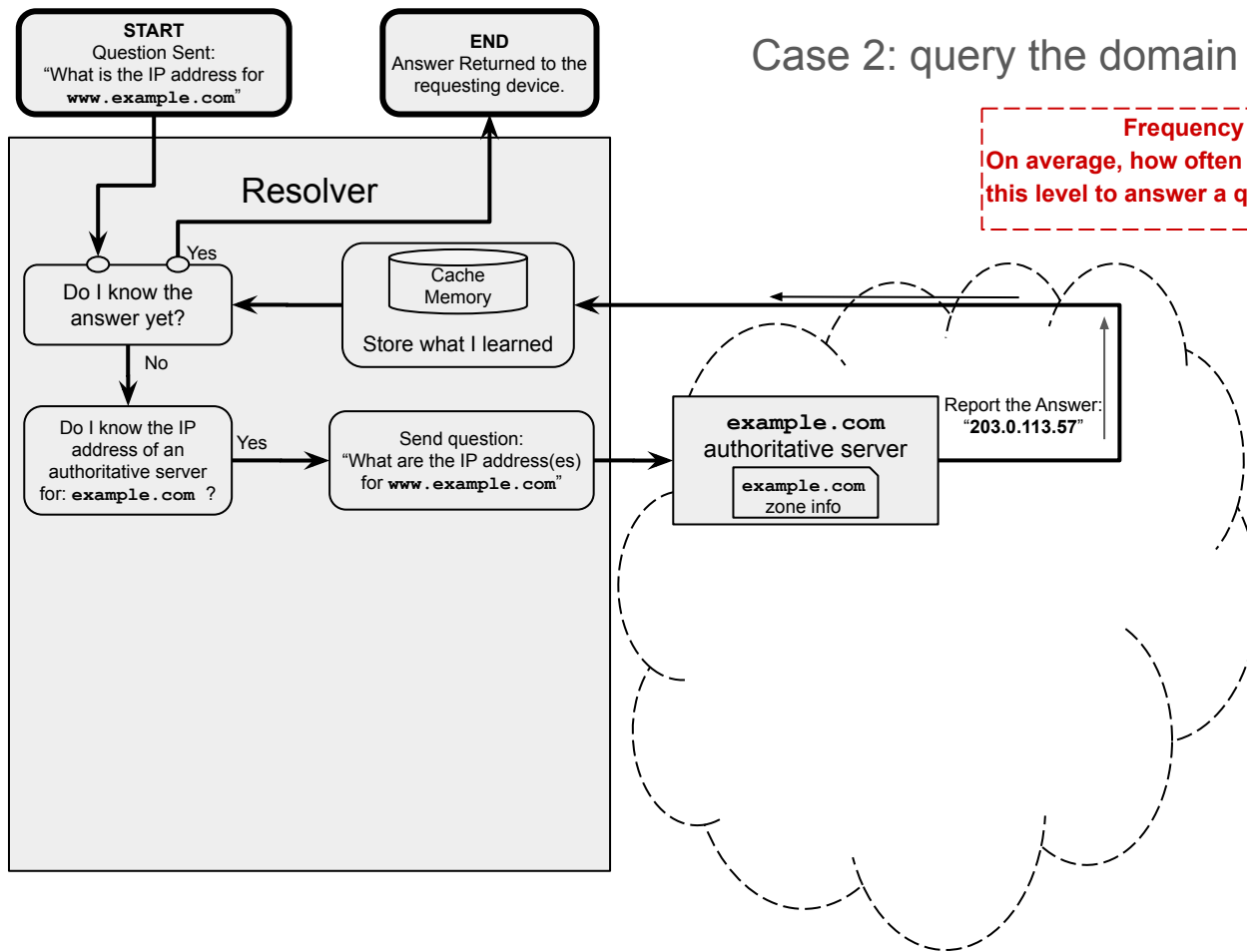


## Case 1: resolver cache memory only

**Frequency (estimates):**  
On average, how often do Resolvers consult at this level to answer a question?

**Routine:**  
> 90% of answers are returned needing cache memory only

## Case 2: query the domain name authoritative server

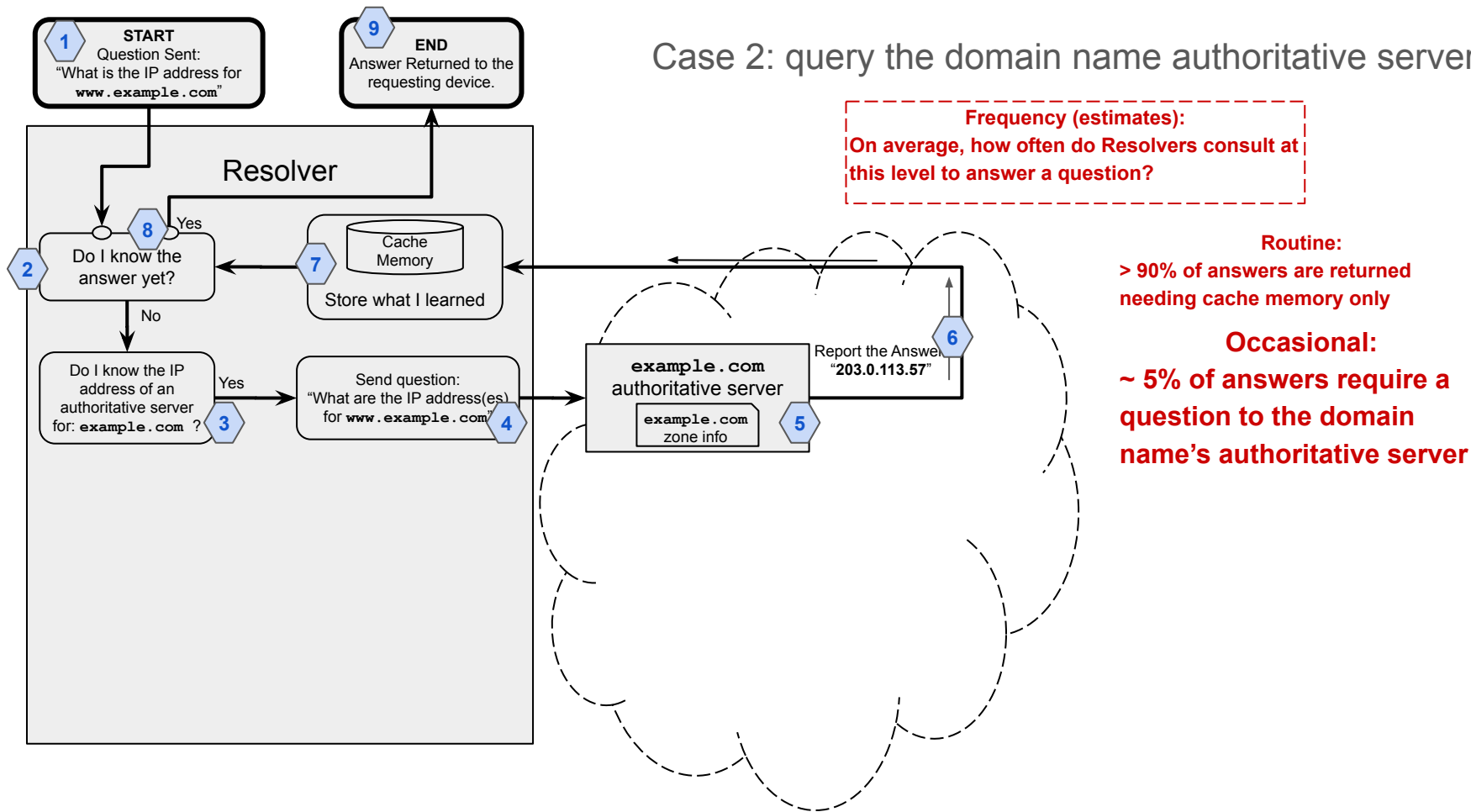


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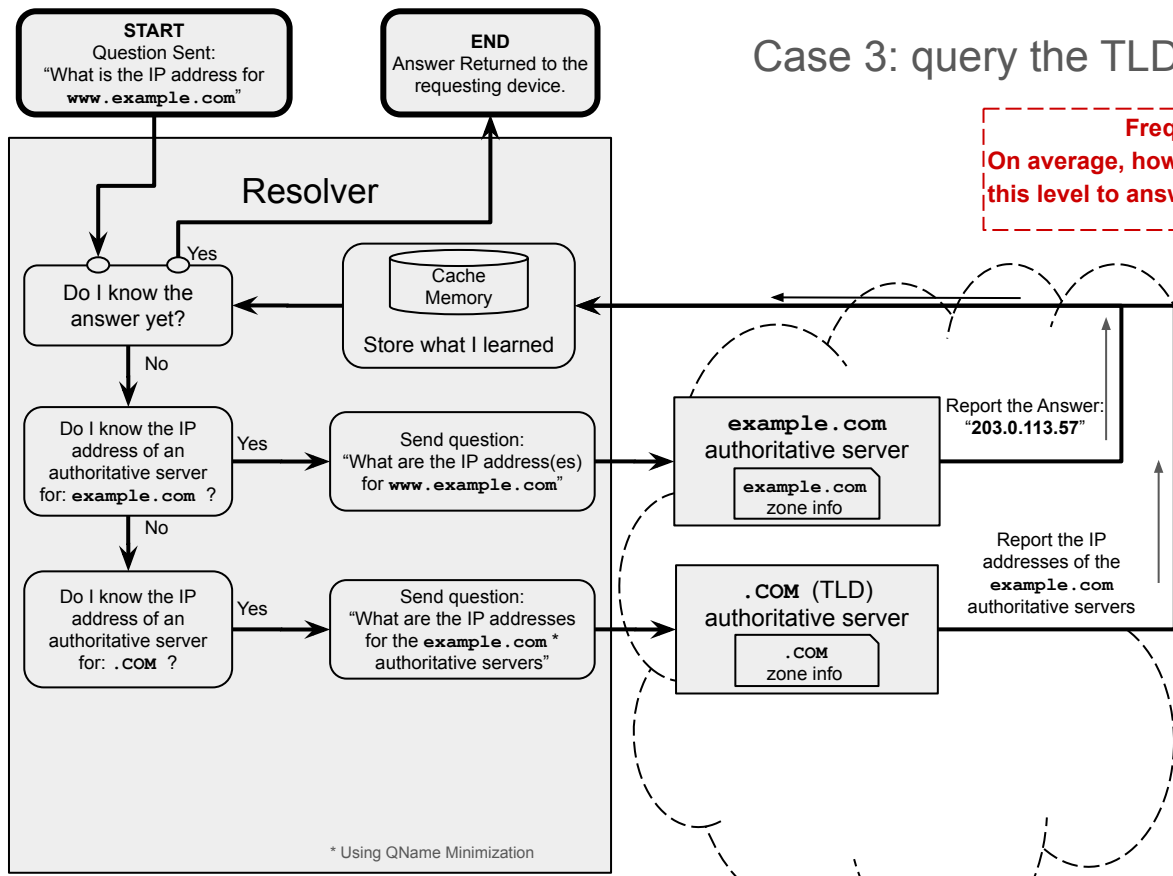
**Routine:**  
> 90% of answers are returned needing cache memory only

**Occasional:**  
~ 5% of answers require a question to the domain name's authoritative server

## Case 2: query the domain name authoritative server



# Case 3: query the TLD authoritative server



**Frequency (estimates):**  
On average, how often do Resolvers consult at this level to answer a question?

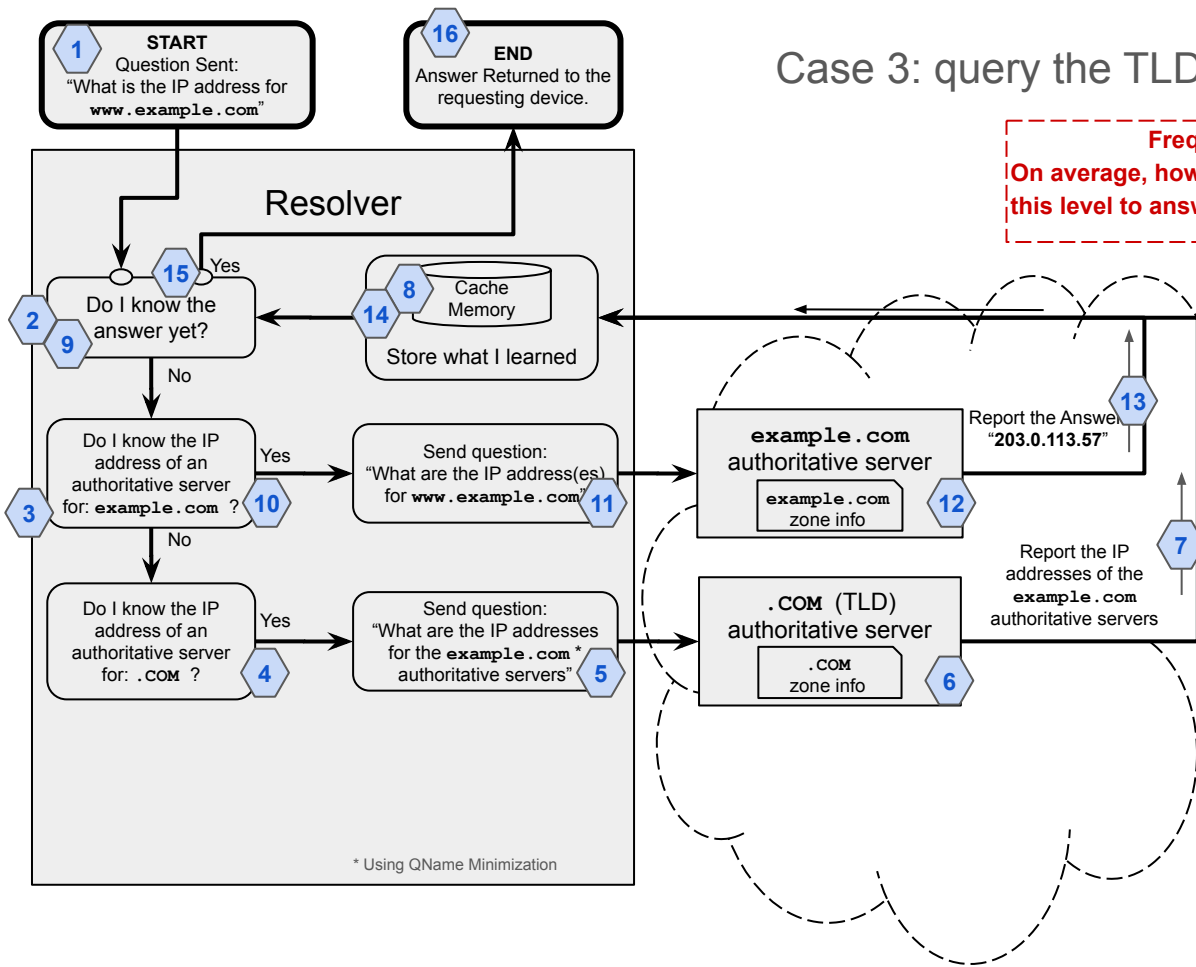
**Routine:**  
> 90% of answers are returned needing cache memory only

**Occasional:**  
~ 5% of answers require a question to the domain name's authoritative server

**Uncommon:**  
~ 2% of answers require a question to the TLD authoritative server

\* Using QName Minimization

# Case 3: query the TLD authoritative server



**Frequency (estimates):**  
 On average, how often do Resolvers consult at this level to answer a question?

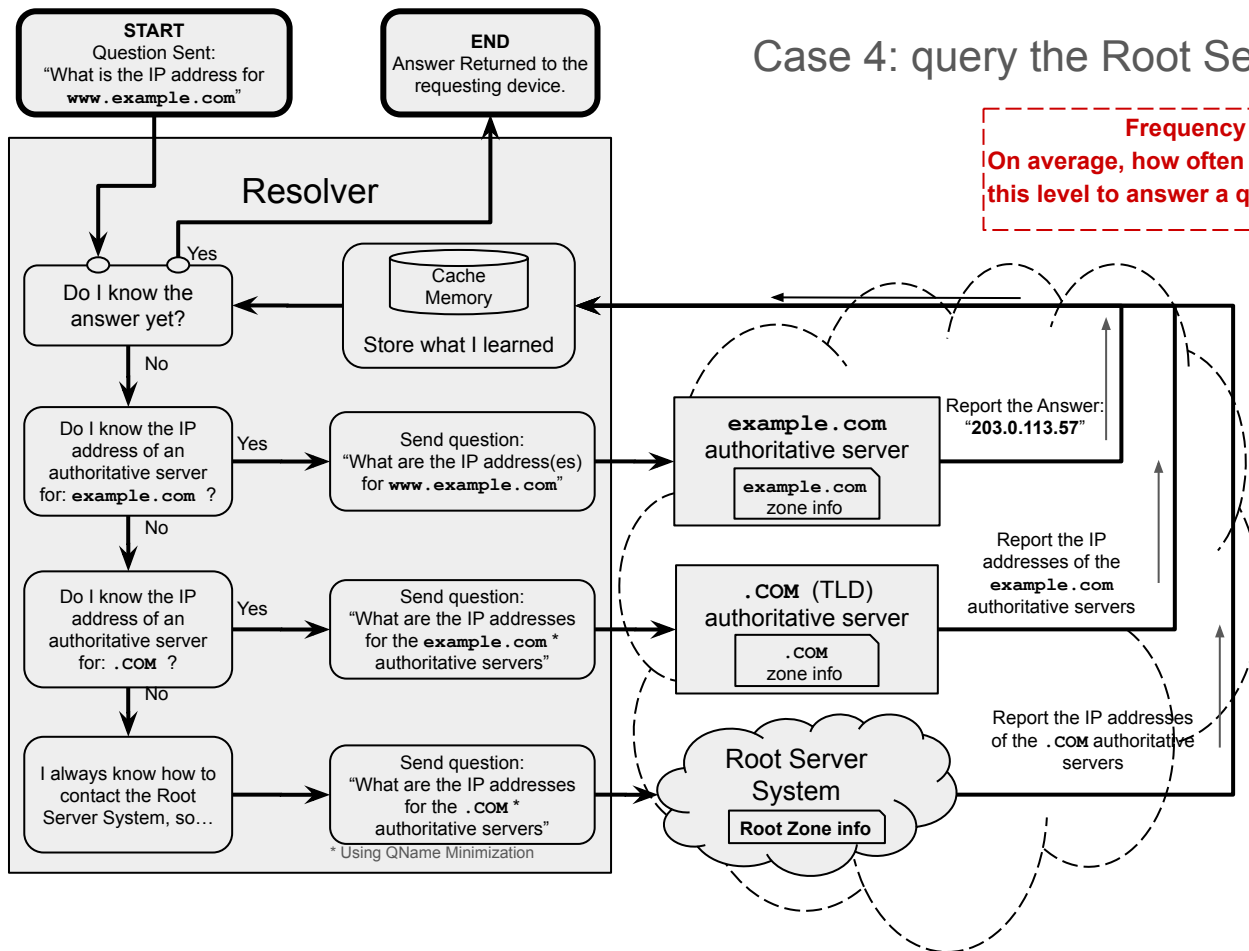
**Routine:**  
 > 90% of answers are returned needing cache memory only

**Occasional:**  
 ~ 5% of answers require a question to the domain name's authoritative server

**Uncommon:**  
 ~ 2% of answers require a question to the TLD authoritative server

\* Using QName Minimization

# Case 4: query the Root Server System



**Frequency (estimates):**  
**On average, how often do Resolvers consult at this level to answer a question?**

**Routine:**  
 > 90% of answers are returned needing cache memory only

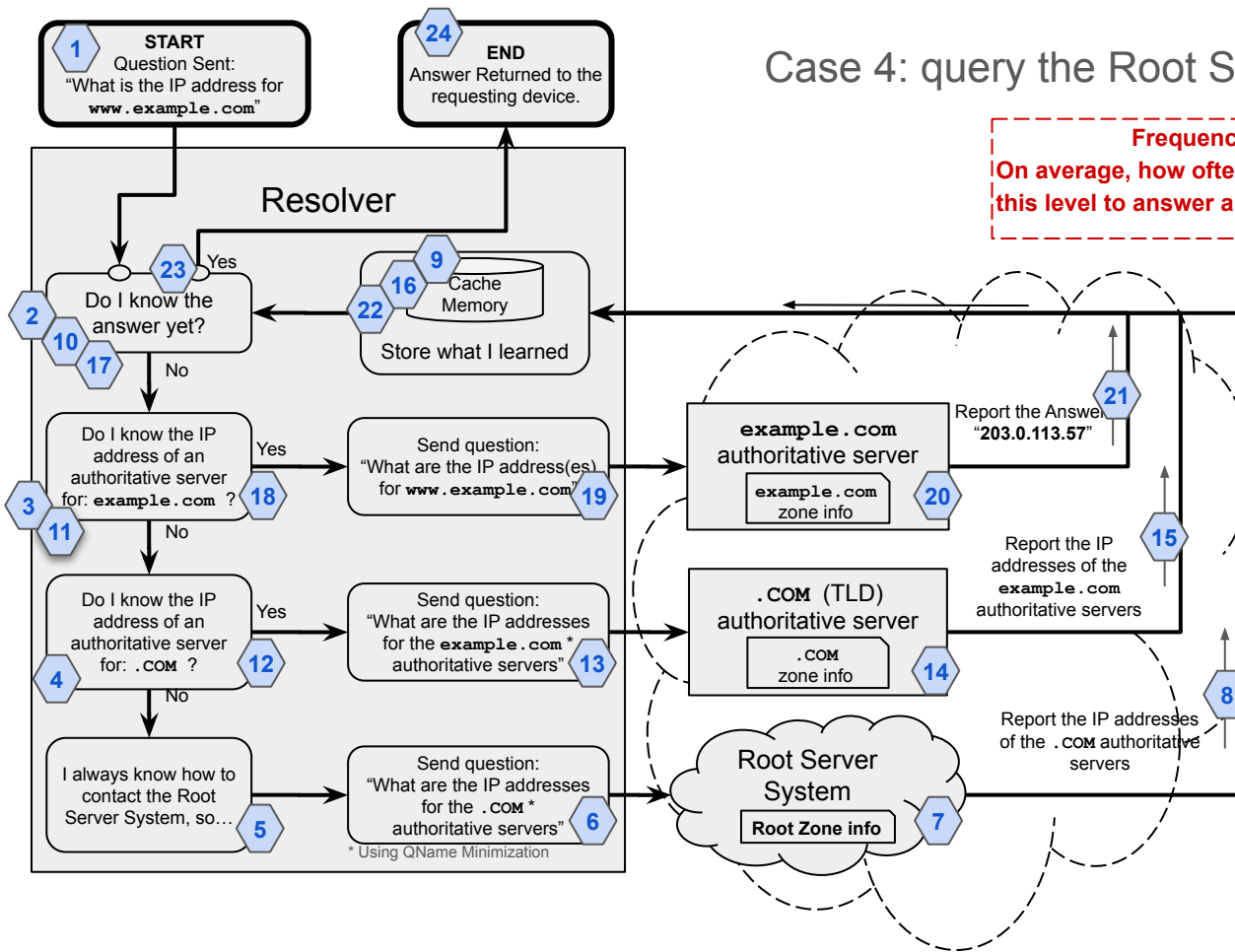
**Occasional:**  
 ~ 5% of answers require a question to the domain name's authoritative server

**Uncommon:**  
 ~ 2% of answers require a question to the TLD authoritative server

**Rare:**  
 ~ 0.02% of answers require a question to the RSS

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# Case 4: query the Root Server System



**Frequency (estimates):**  
On average, how often do Resolvers consult at this level to answer a question?

**Routine:**  
> 90% of answers are returned needing cache memory only

**Occasional:**  
~ 5% of answers require a question to the domain name's authoritative server

**Uncommon:**  
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**Rare:**  
~ 0.02% of answers require a question to the RSS

The Root Zone holds addresses for less than 0.00005% of the world's addressable resources

<b>DNS Layer</b>	<b>Number of unique zones</b>	<b>Typical number of resource addresses</b>	<b>Maintained by</b>
<b>Domain name zones</b>	350,000,000	Varies Each [www.__ ], [mail.__ ], etc.	The domain name registrant
<b>TLD zones</b>	1,450	1,000 - 10,000,000 domains	The TLD registry
<b>Root Zone</b>	1 (one)	1,450 TLDs	IANA/RZM



# In review

- A root server holds a copy of the “Root Zone”  
The Root Zone holds addresses of 1,450 TLD’s like:
  - .com
  - .nl
  - .jobs (and on and on)
- A TLD’s authoritative server knows the address for the next step
  - All names that end in .com, like amazon.com or tiktok.com
  - All names that end in .nl, like google.nl or amsterdam.nl
  - All names that end in .jobs, like tech.jobs or highpay.jobs
- A domain name’s authoritative server knows
  - The answer to the question about www.amazon.com or mail.amazon.com or info.amazon.com
- The resolver finds and returns the answer

In the millisecond world of a resolver, queries to the Root Server System are rare.

# Root Server System:

## Provides address information, not content

- Partial address...
  - Root Server System answers one small part of an address question:  
“Tell me the address of [named] Top Level Domain authoritative server”
- Not Content...
  - Root Server System does not host web or email or any similar internet content
  - Root Server System does not transmit or deliver internet content

**Result: Root Server System does not manage or carry Internet content**

# Root Server System: Not a “gatekeeper” to the Internet

- Root Server System answers questions posed by address resolvers
- Address resolvers usually construct answers using cached memory without sending a question to the Root Server System

**Result: traffic is (almost always) transmitted without the need to wait on the Root Server System**

# Root Server System: Stable Secure & Resilient

- Massively redundant 1,800+ globally distributed server instances
  - Each server instance holds 100% of the Root Zone information
  - Diverse hardware platforms
  - Diverse operating systems
  - Diverse DNS applications
  - Diverse data routing

**Result: No single point of technological failure**

# Root Server System: Stable Secure & Resilient

- Co-operated by 12 autonomous Root Server Operators
  - Each Root Server Operator is independent of the others
  - The Root Server Operators collaborate continuously with one another
  - Force majeure event suffered by one Operator (court injunction, etc) has no operational impact on the others

**Result: No single point of institutional failure**

# Root Server System: Stable Secure & Resilient

- The System has operated since the 1980's
- The System has never suffered a service “blackout”
  - DDoS attackers have tried; they failed, by design

**Result: 30+ years of successful 24x7x365 operation**

# Root Server Operators:

## Do not decide what appears in the Root Zone

- Registrant decides address information for their own domain  
...and provides their authoritative server address to the TLD registry
- TLD registry decides its authoritative server addresses  
... and provides its authoritative server addresses to IANA
- IANA authenticates revisions to TLD authoritative server addresses  
... and provides these to the Root Zone Maintainer (RZM)
- Root Zone Maintainer cryptographically signs the Root Zone  
... and provides the signed Root Zone to Root Server Operators and the World

**Result: System serves the TLD address provided by TLD⇒IANA⇒RZM**



# Summary

- Root Server System ... provides TLD Address Information, not Internet Content
- Root Server System ... does not decide what TLD Address Information appears in the Root Zone
  - TLD Address information provided by TLD ⇒ IANA ⇒ RZM
- Root Server System ... is not a “Gatekeeper”
  - The System has very little (if any) direct interaction with end users
  - End users do not wait on the Root Server System
- The SYSTEM is Resilient
  - No single point of technological failure
  - No single point of institutional failure