

RSSAC and the DNS Root Server System

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Overview

Part 1

Root Server System Advisory Committee (RSSAC)

Part 2

Understanding the DNS Root Server System

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
- RSSAC receives liaisons (non-voting) 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 RSSAC as a forum for discussion
 - 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 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: **40.81.95.116**
 - DNS is how we know `tata.com` is **40.81.95.116**
 - 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
- Major ones include Cloudflare 1.1.1.1 and Google 8.8.8.8
- Resolvers can find & read the world's Internet phone books
 - Internet “phone books” are authoritative servers
 - Internet “listings/entries” are zone content / address information

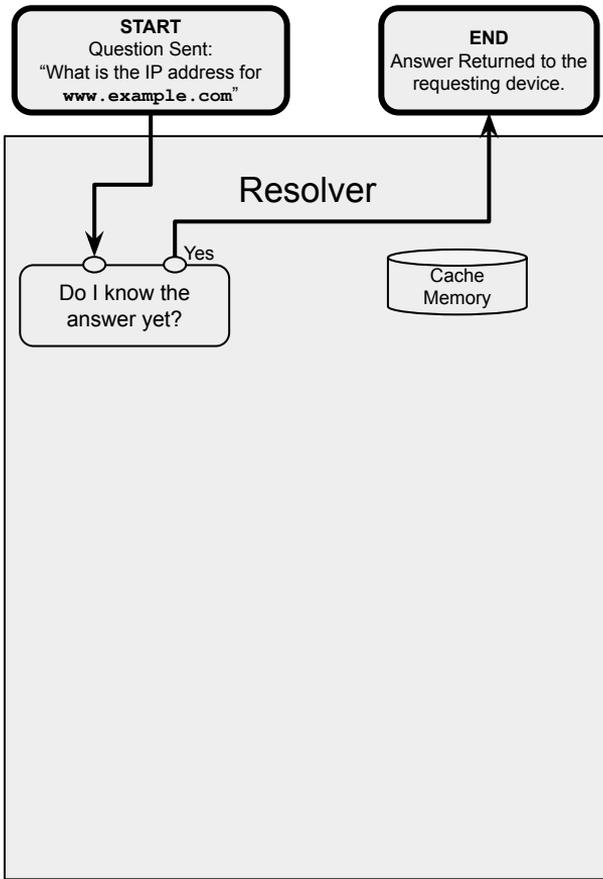
Q: What is the number for **tata.com**?

A: The number for **tata . com** (for now) is **40.81.95.116**

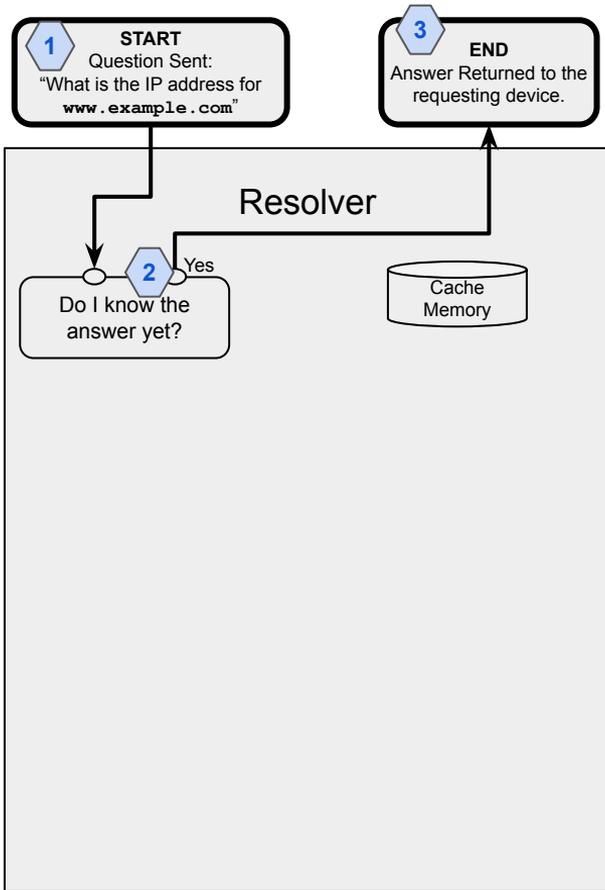
- This happens in milliseconds
- This happens about 500 trillion times every day

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

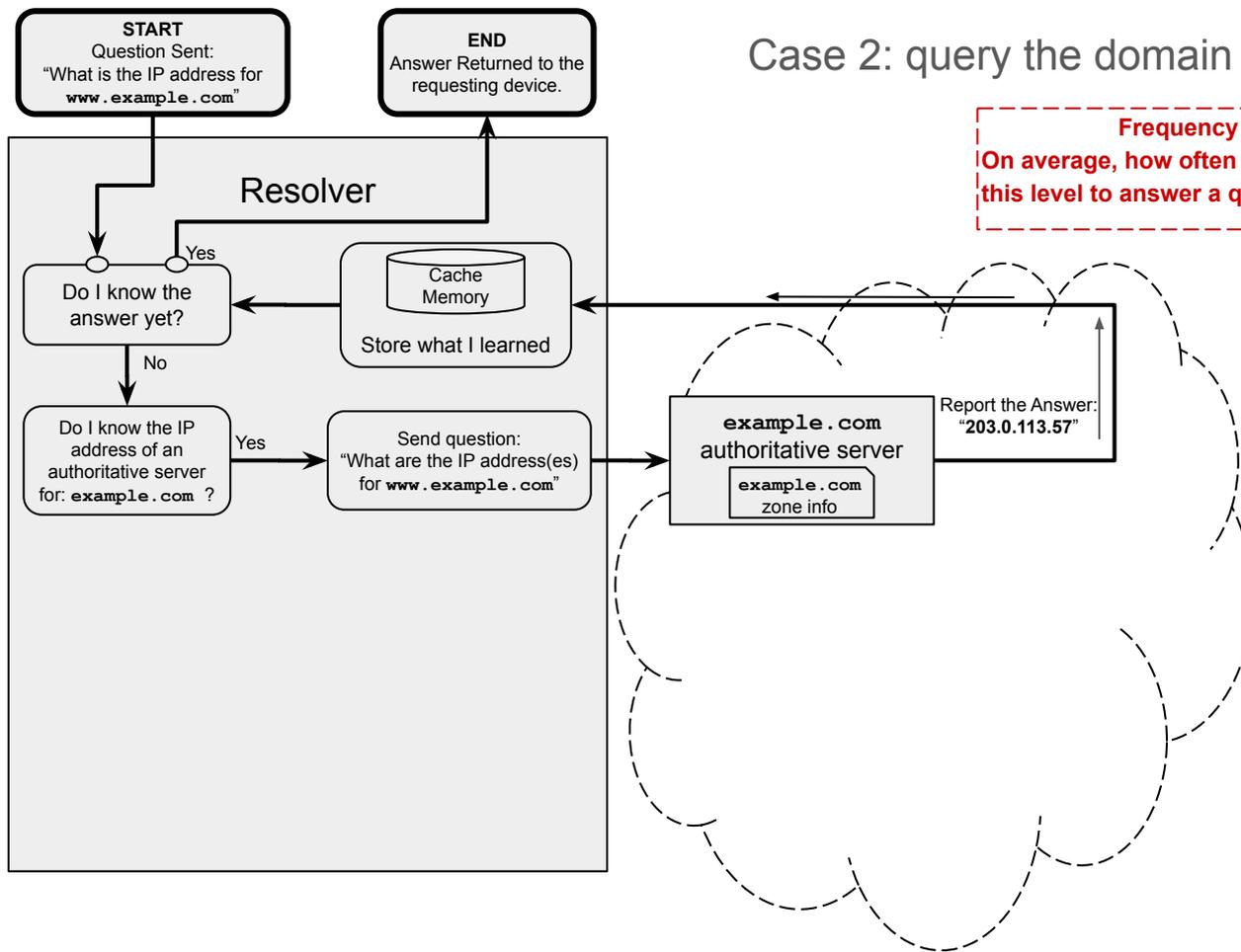


Case 1: resolver cache memory only

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

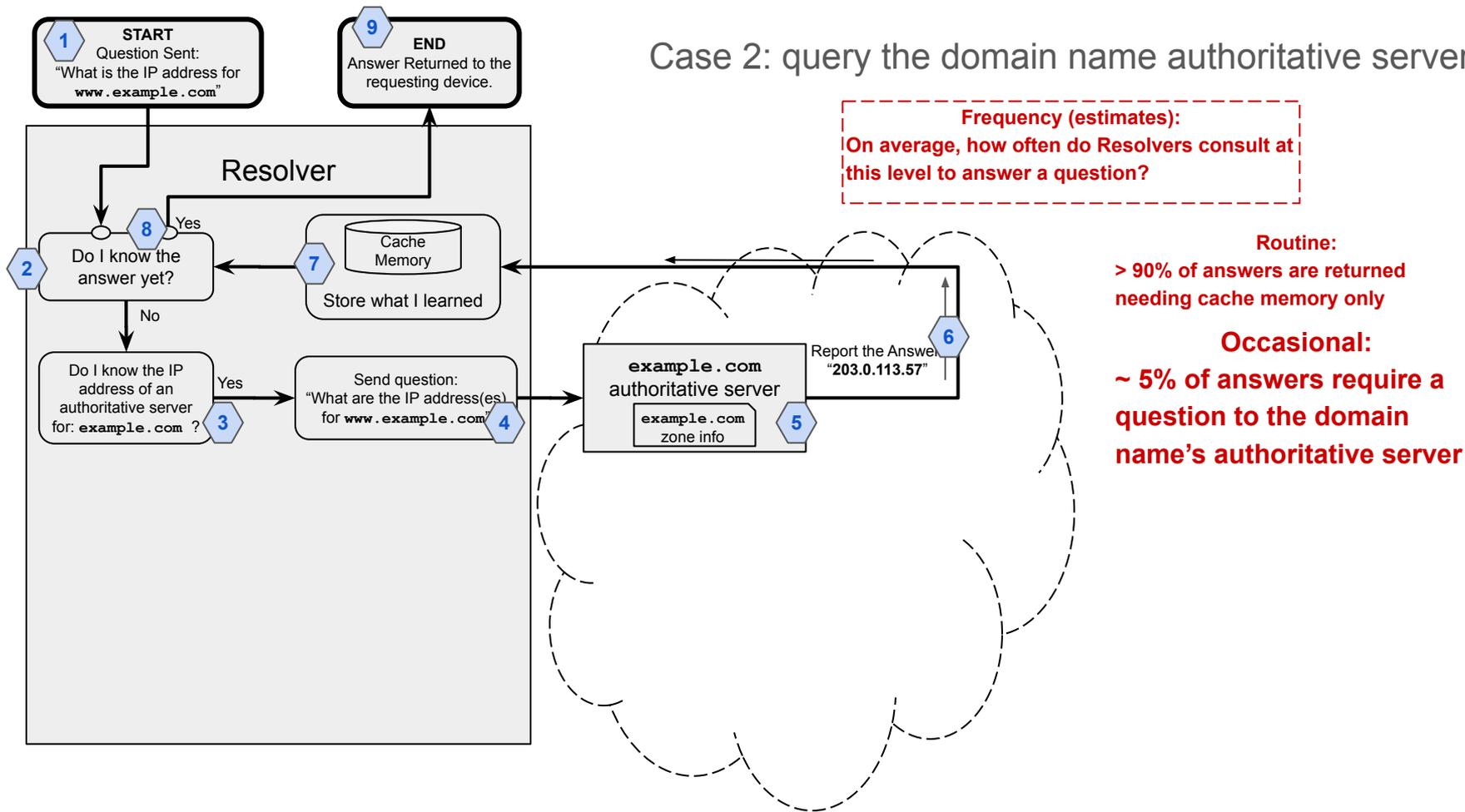


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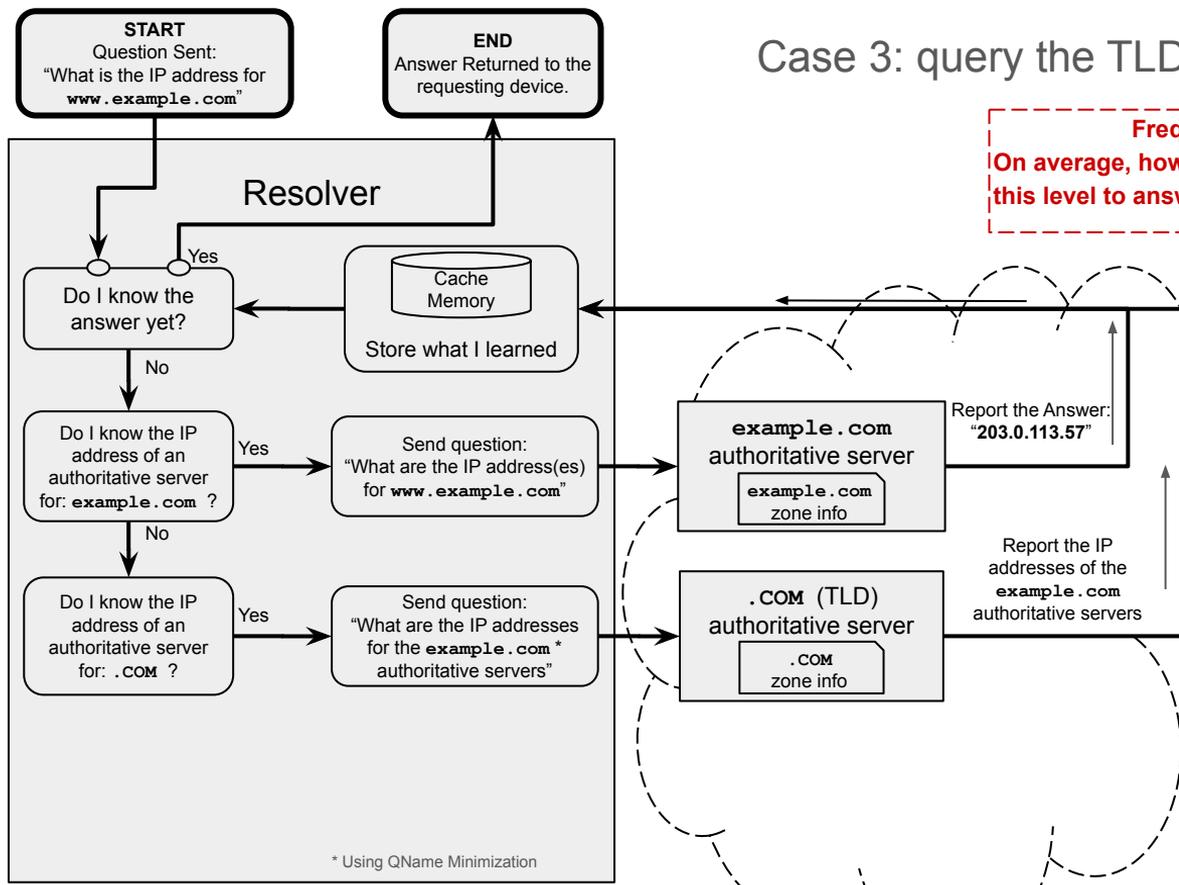
Routine:
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Occasional:
~ 5% of answers require a question to the domain name's authoritative server

Case 2: query the domain name authoritative server



Case 3: query the TLD authoritative server



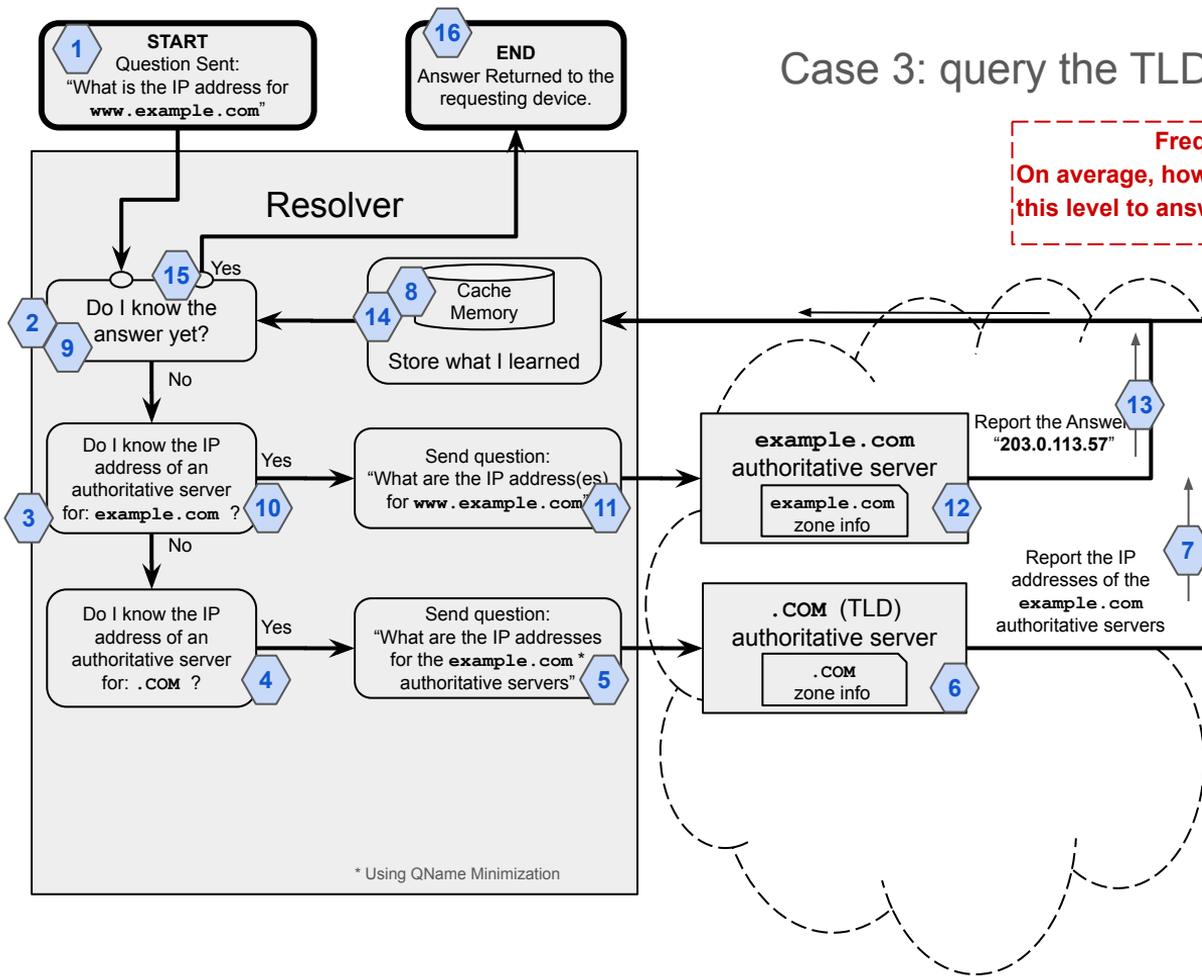
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On average, how often do Resolvers consult at this level to answer a question?

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

Case 3: query the TLD authoritative server



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

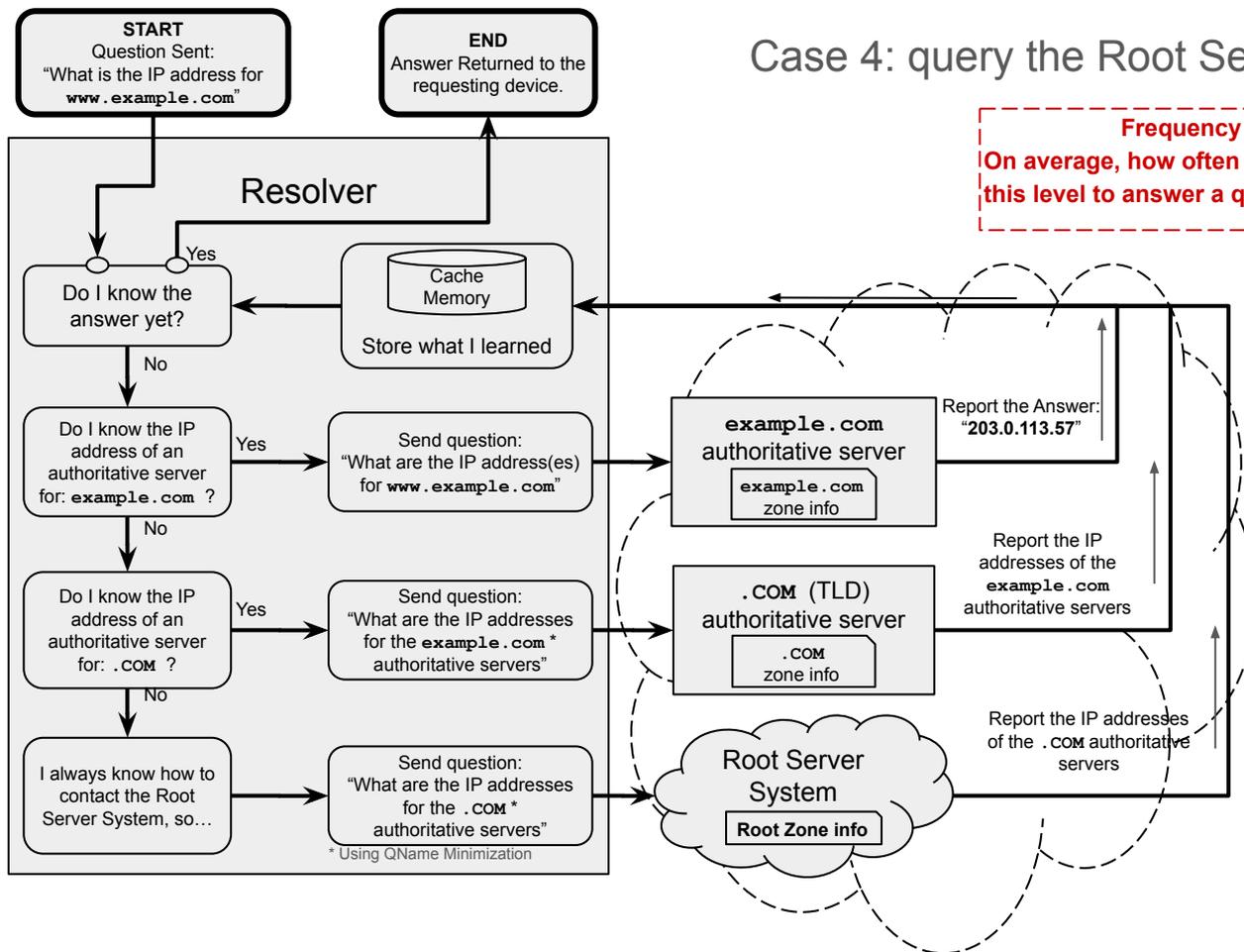
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* Using QName Minimization

Case 4: query the Root Server System



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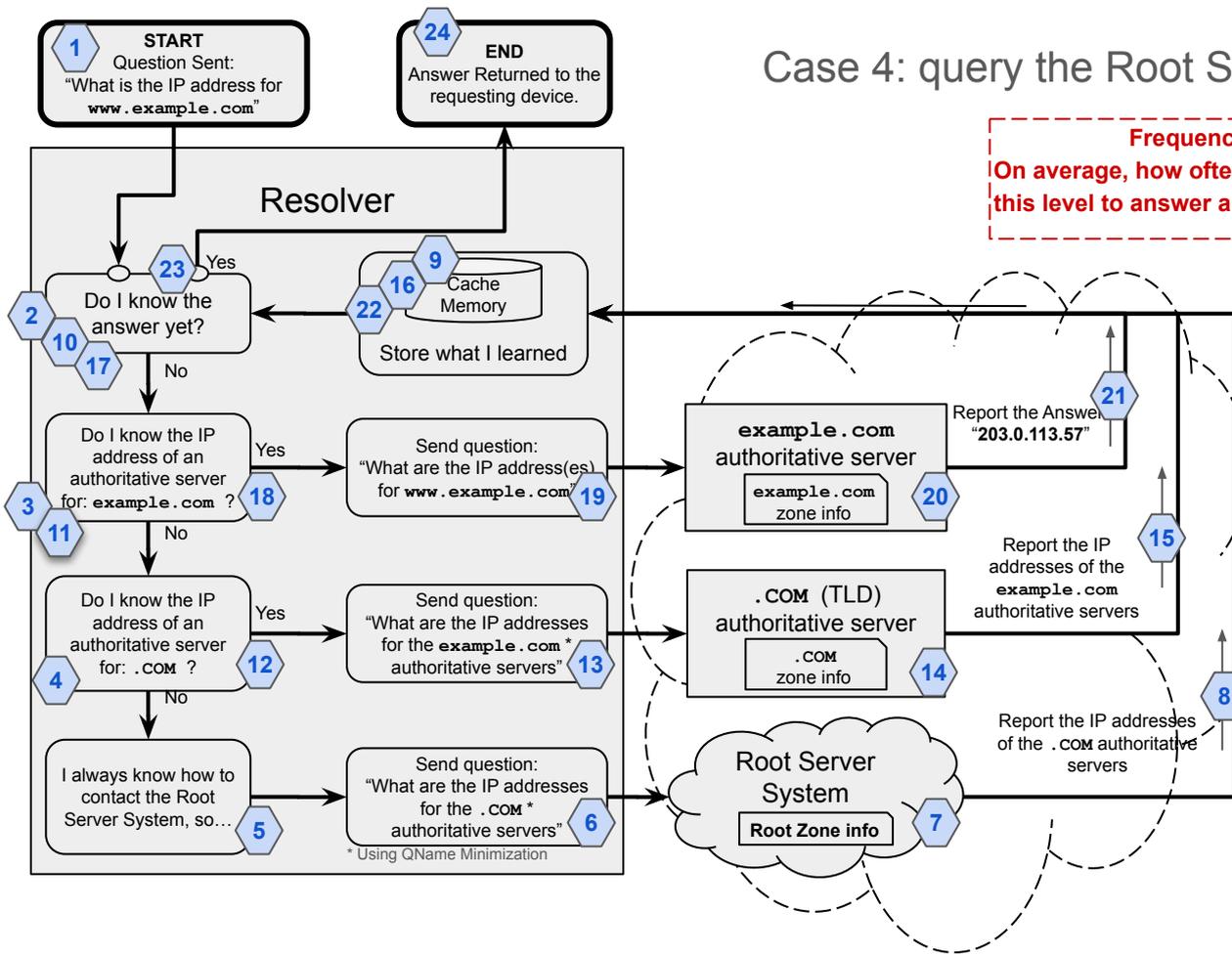
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Rare:
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The Root Zone holds addresses for less than 0.00005% of the world's addressable resources

DNS Layer	Number of unique zones	Typical number of resource addresses	Maintained by
Domain name zones	350,000,000	Varies Each [www.__], [mail.__], etc.	The domain name registrant
TLD zones	1,450	1,000 - 10,000,000 domains	The TLD registry
Root Zone	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 Registry authoritative servers like:
 - **.com** server
 - **.in** server
 - **.ai** server (and on and on)
- A TLD’s authoritative server knows the address for the next step
 - **.com**: all names in that zone like **amazon.com** or **tiktok.com**
 - **.in**: all names in that zone like **flipkart.in** or **onlinesbi.in**
 - **.ai**: all names in that zone like **claude.ai** or **perplexity.ai**
- A domain name’s authoritative server knows
 - The answer to the question about **tata.com** or **mail.tata.com** or **info.tata.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 1,900+ 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 Server Address Information, not Internet Content
- Root Server System ... does not decide what TLD Server Address Information appears in the Root Zone
 - TLD Server 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