



## Lecture 3 - What is DNS

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### 1. DNS (Domain Name System)

#### What is DNS?

DNS is a system that **converts domain names (google.com) into IP addresses (142.250.195.78)**.

Humans remember names, computers understand numbers → DNS bridges the gap.

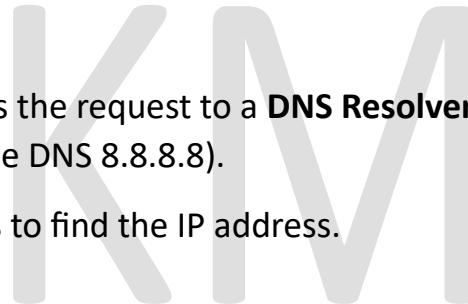
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### 2. How DNS Works (Step-by-Step)

When you type **google.com** in a browser:

#### Step 1: DNS Resolver

- Your device sends the request to a **DNS Resolver** (usually provided by your ISP or Google DNS 8.8.8.8).
- The resolver tries to find the IP address.



#### Step 2: Check Cache

- Resolver checks if the IP is already stored in **DNS cache**.
  - If yes → returns instantly (fast response).
  - That's why **DNS cache should be cleared regularly** to remove outdated data.
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#### Step 3: Root Server

- If not cached, resolver contacts a **Root DNS Server**.
- Root servers know where TLD servers are located.

There are only **13 sets** of root servers worldwide (A–M).

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## **Step 4: TLD Server (Top Level Domain Server)**

- Handles domains like:
    - .com
    - .in
    - .org
    - .net
  - TLD tells the resolver which **Authoritative DNS server** holds the actual record.
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## **Step 5: Authoritative DNS Server**

- Stores final DNS records.
  - Example: Google's DNS server returns the actual IP of google.com.
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## **Step 6: IP Sent to Client**

- Resolver sends IP back to your browser.
  - Browser connects to that server.
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## **Why DNS Is Used?**

- Humans cannot remember IP addresses.
  - Helps load websites faster.
  - Organizes the internet naming system.
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## **Daily-Life Example**

- Typing **youtube.com** instead of its complex IP address.
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### **3. Public DNS Servers**

#### **Google DNS:**

- **8.8.8.8** (most famous open DNS)

#### **Cloudflare DNS:**

- **1.1.1.1**
  - Faster than Google DNS in many regions.
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### **4. Binary to Decimal Conversion**

Each octet of an IP is **8 bits**, so maximum value = **255**  
(11111111 in binary)

#### **Why it cannot exceed 255?**

Because 8 bits can represent values from **0 to 255** only.

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### **5. Ping (Packet Internet Groper)**

#### **What is Ping?**

- A tool used to **check connectivity** between your device and a server.

#### **How it works?**

- Sends an ICMP echo request.
- If the server replies → connection is alive.

#### **Why used?**

- To check delay, connectivity issues, or packet loss.

#### **Example**

- ping google.com  
Used by network engineers daily.
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## 6. IPv4 Limitations

$C^32 = \sim 4.29$  Billion IPs

Total IPv4 addresses  $\approx$  4.29 billion.

### Major Authorities:

- **IANA (Internet Assigned Numbers Authority)**  
→ Manages global IP ranges.
- **RIR (Regional Internet Registries)**  
→ Assign IPs to countries and ISPs.

### Problem:

Even these organizations couldn't manage IP shortage →

→ So **IP Classes** were created.





## 1 CHAPTER SUMMARY

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### 1. What is DNS?

**DNS (Domain Name System)** is a system that converts **human-readable domain names** into **machine-readable IP addresses**.

- 🧠 Humans remember names → Computers understand numbers
- ➡ DNS acts as a **translator / bridge**

📌 Example:

google.com → 142.250.195.78

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### 2. How DNS Works (Step-by-Step)

When you type **google.com** in your browser



#### Step 1: DNS Resolver

- Your system sends request to a **DNS Resolver**
- Usually provided by:
  - ISP
  - Google DNS → **8.8.8.8**

📌 Resolver's job: *Find the correct IP address*

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#### Step 2: DNS Cache Check

- Resolver checks its **cache**
- If IP exists → instant reply ⚡
- If outdated → problem occurs

✍ That's why **clearing DNS cache** is important

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### ● Step 3: Root DNS Server

- If not cached, resolver contacts **Root DNS Server**
- Root servers know **where TLD servers are**

🌐 Only **13 sets of root servers (A–M)** exist worldwide

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### ● Step 4: TLD Server (Top Level Domain)

Handles domains like:

- .com
- .in
- .org
- .net

📌 TLD server tells:

➡ *Which Authoritative DNS server has the final record*

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### ● Step 5: Authoritative DNS Server

- Stores **actual DNS records**
  - Returns the **final IP address**
- 📌 Example: Google's authoritative DNS gives IP of google.com
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### ● Step 6: IP Returned to Client

- Resolver sends IP to browser
  - Browser connects to the server
  - Website loads 🎉
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## ❓ Why DNS Is Used?

- ✓ Humans can't remember IPs
- ✓ Faster website loading
- ✓ Organized Internet naming system

### 💻 Daily Life Example:

Typing **youtube.com** instead of complex IP numbers 🌐

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## 🌐 3. Public DNS Servers

### 🌐 Google DNS

- **8.8.8.8**
- Reliable & widely used

### 🌐 Cloudflare DNS

- **1.1.1.1**
- Faster & privacy-focused 🚀

## 🔢 4. Binary to Decimal Conversion (IP Basics)

- Each IP octet = **8 bits**
- Maximum value of 8 bits:  
•  $11111111 = 255$

📌 So IP range per octet = **0 – 255**

❓ Why not more than 255?

👉 Because **8 bits = 256 values (0–255)**

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## 📡 5. Ping (Packet Internet Groper)

### 🔍 What is Ping?

A network tool used to **check connectivity** between your device and a server.

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## How Ping Works

- Sends **ICMP Echo Request**
  - Server replies with **Echo Reply**
  - If reply received → connection alive 
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## Why Ping Is Used?

- ✓ Check network connectivity
- ✓ Measure delay (latency)
- ✓ Detect packet loss

 Example:

ping google.com

 Used daily by network engineers

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## 6. IPv4 Limitations

### IPv4 Address Space

- IPv4 uses **32 bits**
- Total IPs:

$2^{32} \approx 4.29 \text{ Billion}$

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### Major IP Authorities

#### ◆ IANA

- Internet Assigned Numbers Authority
- Manages global IP address pool

#### ◆ RIR

- Regional Internet Registries

- Allocate IPs to countries & ISPs
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## ✗ Problem: IP Shortage

Even IANA & RIR couldn't handle demand 😱

→ Result:

- IPv4 exhaustion
  - Introduction of **IP Classes** (temporary solution)
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## 🎯 2 CONCLUSION

DNS is the **phonebook of the Internet** 📖🌐

Without DNS:

- ✗ Websites won't load
- ✗ Internet becomes unusable

This chapter builds:

- ✓ Core networking knowledge
- ✓ Cyber Security fundamentals
- ✓ Real-world troubleshooting skills

👉 **DNS knowledge is mandatory for Networking, Cyber Security & Cloud roles** 💼🔥

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 **3 MIND MAP**

## Lecture 3 – DNS

- |
  - |— DNS
    - |— Domain → IP
    - |— Human ↔ Computer bridge
  - |— DNS Working
    - |— Resolver
    - |— Cache
    - |— Root Server
    - |— TLD Server
    - |— Authoritative Server
    - |— IP to Client
  - |— Public DNS
    - |— Google → 8.8.8.8
    - |— Cloudflare → 1.1.1.1
  - |— IP Basics
    - |— Binary
    - |— Max value → 255
  - |— Ping
  - |— ICMP

- |   └— Connectivity
- |   └— Latency
- |
- └— IPv4 Limitation
  - └— 2<sup>32</sup> addresses
  - └— IANA
  - └— RIR
- └— IP shortage

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## INTERVIEW QUESTIONS & ANSWERS

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### ❓ Q1. What is DNS?

#### ✓ Answer:

DNS converts domain names into IP addresses so computers can locate servers easily.

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### ❓ Q2. Why DNS is required?

#### ✓ Answer:

Because humans remember names while computers communicate using IP addresses.

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### ❓ Q3. Explain DNS working?

#### ✓ Answer:

Client → Resolver → Cache → Root → TLD → Authoritative → IP returned.

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### ❓ Q4. What is DNS Resolver?

#### ✓ Answer:

A server that finds the IP address for a domain name on behalf of the client.

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### ❓ Q5. What is DNS Cache?

#### ✓ Answer:

Temporary storage of DNS records to improve speed and reduce load.

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### ❓ Q6. What are Root DNS Servers?

#### ✓ Answer:

They direct queries to appropriate TLD servers. There are 13 root server sets worldwide.

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**?** Q7. What is TLD?

**✓ Answer:**

Top Level Domain like .com, .org, .in.

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**?** Q8. What is an Authoritative DNS Server?

**✓ Answer:**

It stores the final and correct DNS records of a domain.

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**?** Q9. What is Google DNS?

**✓ Answer:**

A public DNS server with IP **8.8.8.8**.

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**?** Q10. What is Cloudflare DNS?

**✓ Answer:**

A fast and privacy-focused public DNS server **1.1.1.1**.

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**?** Q11. Why IP octet max value is 255?

**✓ Answer:**

Because 8 bits can represent values from 0 to 255 only.

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**?** Q12. What is Ping?

**✓ Answer:**

A tool that checks connectivity using ICMP echo requests.

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**?** Q13. Which protocol does Ping use?

**✓ Answer:**

ICMP (Internet Control Message Protocol).

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**?** Q14. What does Ping check?

**✓ Answer:**

Connectivity, latency, and packet loss.

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**?** Q15. What is IPv4?

**✓ Answer:**

A 32-bit IP addressing system with around 4.29 billion addresses.

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**?** Q16. Why IPv4 addresses are limited?

**✓ Answer:**

Because 32-bit addressing allows only  $2^{32}$  combinations.

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**?** Q17. What is IANA?

**✓ Answer:**

An organization that manages global IP address allocation.

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**?** Q18. What is RIR?

**✓ Answer:**

Organizations that distribute IP addresses region-wise.

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**?** Q19. What problem occurred due to IPv4?

**✓ Answer:**

IP address exhaustion.

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**❓ Q20. How DNS is important for Cyber Security?**

**✓ Answer:**

DNS is used in phishing detection, malware control, and traffic filtering.

