Date: 04-02-2024

CSF421 – Computer Networks – SFQ

Lecture 04 – Application Layer (Electronic Mail + DNS)

Electronic Mail – 3 components → (I) user agents (II) mail servers (III) SMTP

(I) S/W program that is used for composing, editing, reading, forwarding mails

(II) (a) mailbox – incoming messages for the user

(b) message queue – outgoing " .

(III) SMTP betn mail servers & sending emails. → client – sending mail server → server – receiving mail server

Electronic mail uses TCP to reliably transfer emails from C to S. (port 25)

↳ direct transfer – Sending server (C) to Receiving server (S).

Three phases of transfer – (I) SMTP Handshaking

(II) SMTP transfer of messages

(III) SMTP closure

* SMTP – uses persistent connections

– requires message to be in 7-bit ASCII

– (\r\n.\r\n) to determine end of message.

Mail – (I) Header – To, From & Subject

(II) Body – message

Case-01: Client Appn to send/receive ↑ an email – SMTP

Mail Access Protocols –

Push {

* Alice composes her email and sends it to her own dedicated mail server / to the mail server she is connected to. The mail is stored in the server's queue.

* This is done by SMTP. (UA to Mail Server's queue. client-to-server commn)

* The mail from the server is now sent to Bob's dedicated mail server & stored in his server's mailbox. → Push protocol.

* This is also done by SMTP. (Queue to Mailbox, server-to-serve commn)

}

Pull {

* Then the mail is retrived from the server. → pull protocol.

* This is done by POP3, IMAP and HTTP

}

Alice → UA $\xrightarrow{\text{SMTP}}$ Alice's Mail Server (Queue) $\xrightarrow{\text{SMTP}}$ Bob's Mail Server (Mailbox) $\xrightarrow{\text{POP3/IMAP/HTTP}}$ UA → Bob

↓

Case-02: Browser – gmail.com – HTTP (UA [browser] to mail server)

↳ server-to-server – SMTP

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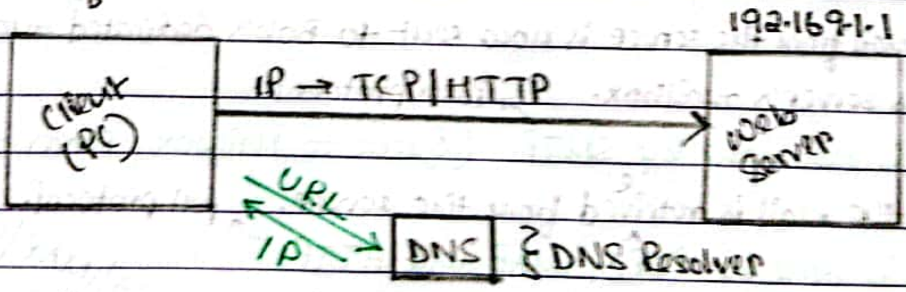
POP3 v/s IMAP {Scenario Based Differences}

	POP3	IMAP
Name	(I) Post office Protocol	(I) Internet Message Access Protocol
Location	(II) Mail downloaded at work station + deleted from the server. *	(II) Keeps all mails at the server in one place.
Access	(III) Accessed w/ one device at a time	(III) Multiple/variety of devices
Update	(IV) Does not allow users to create/delete/modify mailboxes on the mail server.	(IV) Allows to create/delete/update mailboxes on the mail server & create a folder hierarchy of mailboxes
Readability	(V) Only read the message once it has been downloaded.	(V) User can partially read the message before downloading.
Virus	(VI) Kept in workstation, vulnerable to virus	(VI) Kept in server, less vulnerable to virus.
Port Number	(VII) 110	(VII) 143

* download-and-keep : copies of messages on different clients

(*) Domain Name System (DNS)

↳ phonebook of the Internet + automated c/s service



In any network/internet, to identify the devices we use a unique address called the "IP Address" — required to communicate w/ the device/web server

* However, we cannot remember the IP Address so we usually use URLs (text) i.e. specific address like google.com → device cannot understand this; has no existence — IP Address exists → whatever happens in between is done by the "DNS" server.

DNS Server – Finds the IP Address that is mapped to the URL|Specific Address (google.com) → Translation.

* DNS Server contains entries of such URLs w/ their corresponding IPs.

* Returns the IP Address to the client

* client then contacts w/ the web server w/ TCP connection, HTTP and so on.

Steps – User devices runs the client side of the DNS App^{n}.
(S)
Browser extracts hostname from the URL and passes the hostname to the DNS client.

DNS Client sends a query containing the hostname to a DNS Server.

DNS Client receives the IP Address for the hostname.

Browser receives the IP Address from DNS & initiates TCP connection to the HTTP server located at port 80 at that IP Address.

DNS Services

* Hostname to IP Address Translation

* Host Aliasing + Mail Aliasing

* Load Distribution — to reduce server load

↳ Replicated web/mail servers – many IPs correspond to one name

– round robin method to distribute IP to user

* Why not centralize DNS?

– single point of failure

– distance centralized database. (time ↑)

– traffic volm

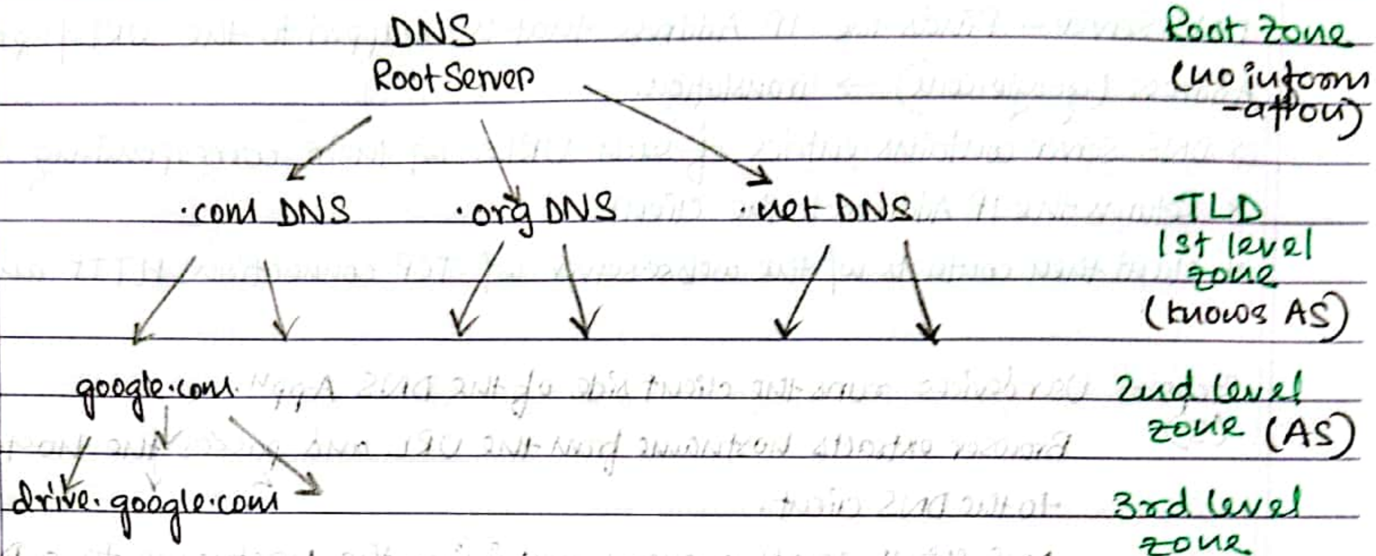
– maintenance

– does not scale

* Solution – Distributed Database (Hierarchial)

(I) Root DNS Server — contains the root zone i.e. a list of TLDs.

(II) Top Level Domains (TLD) — .com, .net, .org etc.



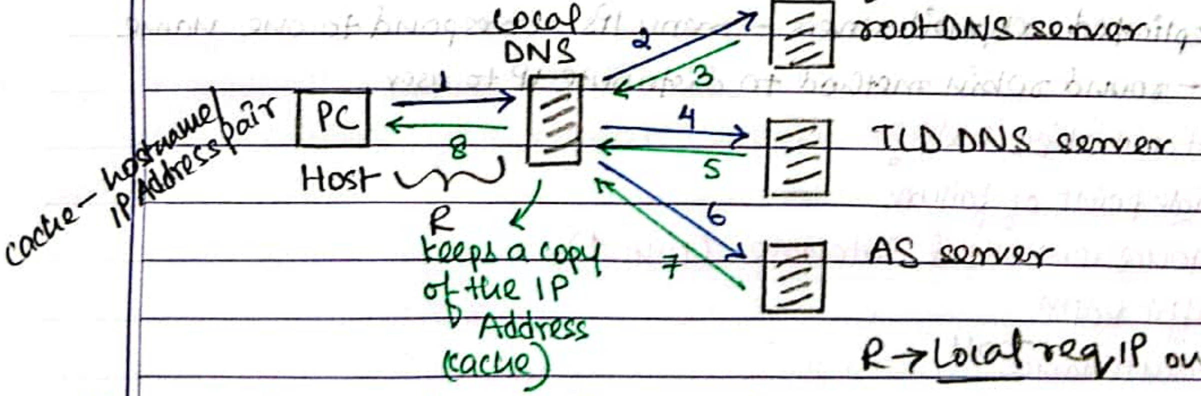
Authoritative DNS servers (AS) – contains the IP Address of the actual website/domain.

(*) Local DNS Server –

- * similar functionality like Proxy servers ; forwards query into hierarchy
- * contact Local DNS before contacting Root DNS for IP Address
- * Each ISP has one Local DNS (default name server)
- * uses DNS cache – caches URL's IP Address (has a time limit)

(*) DNS Name Resolution – Iterated Query :

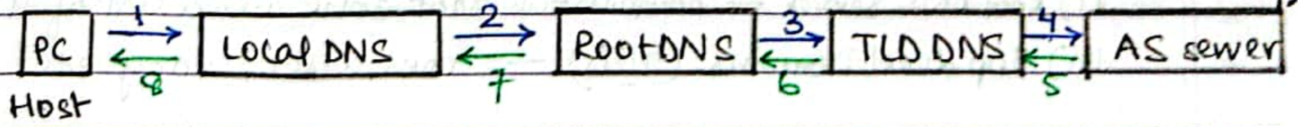
- * contacted server replies w/ name of server to contact


Local DNS
root DNS server
TLD DNS server
AS server
PC
Host
1
2
3
4
5
6
7
8
R
keeps a copy of the IP Address (cache)
cache – hostname/IP Address pair

R → Local req IP on behalf of Host

(*) DNS Name Resolution – Recursive Query :

- * puts burden of name resolution on contacted name server (takes responsibi-lity)



* Puts heavy load at upper levels of hierarchy – root has all the burden.

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Lecture 05 — Domain Name System (DNS)

To get the IP Address, you need to make a request to the DNS server.

Provide an URL and you will get your IP Address

* DNS servers are divided —

request first goes to root DNS servers

↳ root sends you to TLD (AS)

↳ sends you to A-DNS who has the IP Addresses.

* Iterated Query — contacted server replies w/ name of server to contact.
* Recursive Query — puts burden of name resol^n on contacted name server.

↳ root DNS.

* Local DNS and resolvers keep a copy in cache.
* Ex. bracu.ac.bd

root → TLD → TLD → AS
(ac) (bd)

* DNS Records —

RR format → (name, value, type, ttl)

↳ time to live → keeps the cache in local for that time (due to server storage limitations)

* Types —

A : Name – Host Name
Value – IP Address

NS : Name - Domain
Value – Host Name of ANS.

CName : Name – alias name of real/canonical name
Value – cananical name

Actual IP/website — type A has to be used.

MX : Name – Host Name
(only mail server) Value – Name of mail server

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DOS/DDOS – Denial of Service by Server

DNS Spoofing – Ding IP Address