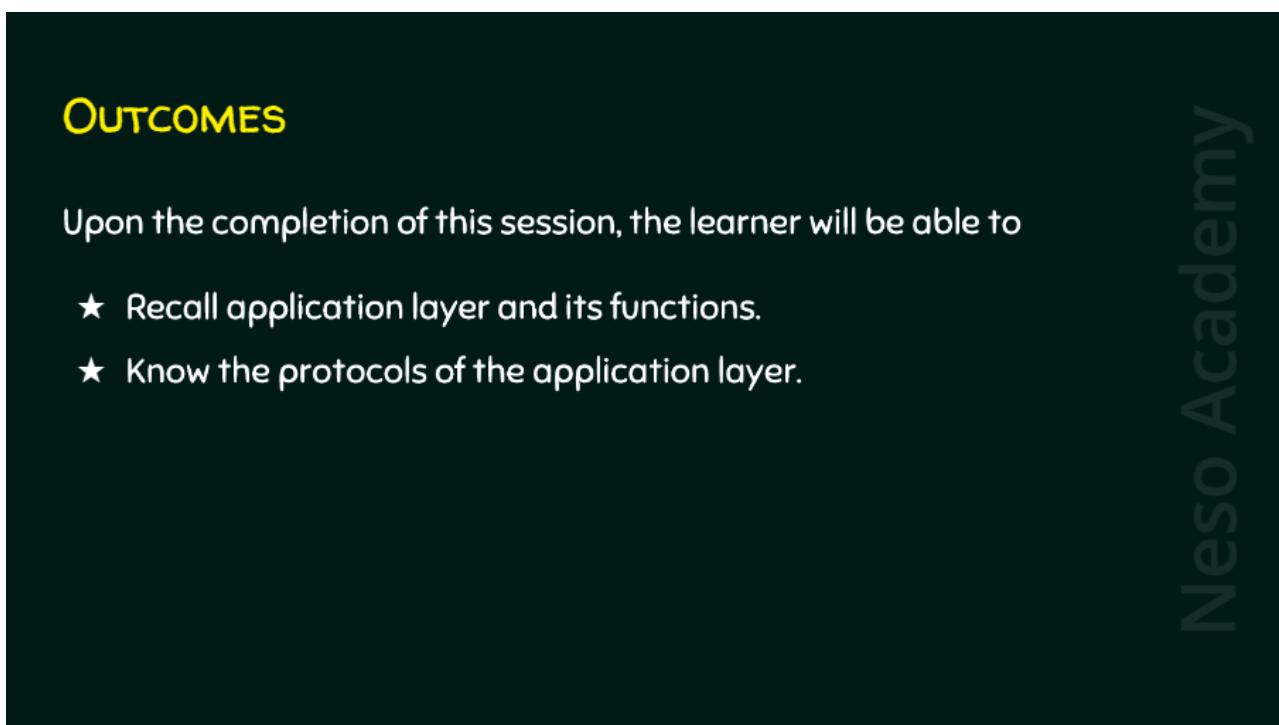


# Application Layer & Security | Neso Academy

 [nesoacademy.org/cs/06-computer-networks/ppts/08-applicationlayer&security](https://nesoacademy.org/cs/06-computer-networks/ppts/08-applicationlayer&security)



Application Layer & Security Neso Academy CHAPTER - 8



## OUTCOMES

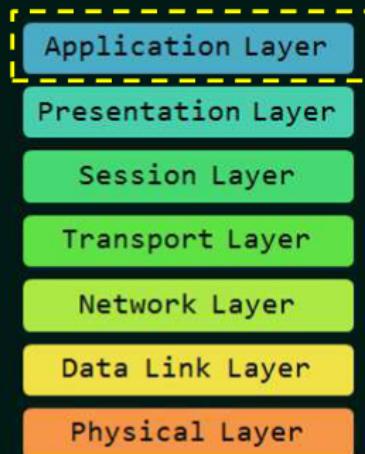
Upon the completion of this session, the learner will be able to

- ★ Recall application layer and its functions.
- ★ Know the protocols of the application layer.

Outcomes ★★ Neso Academy

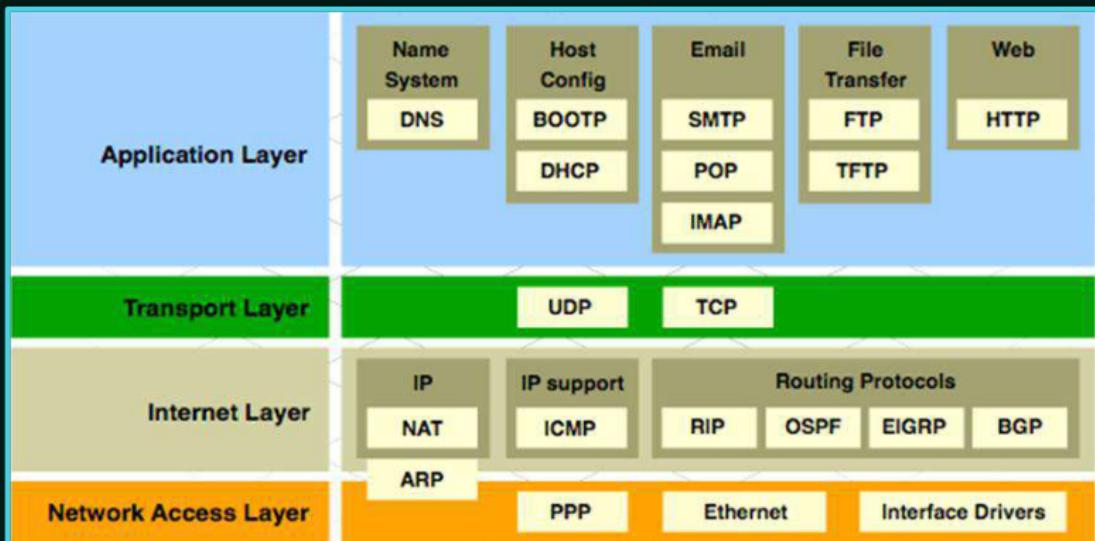
# Neso Academy

## LAYERS IN OSI REFERENCE MODEL



Layers in OSI Reference ModelNeso Academy

## THE TCP/IP PROTOCOL SUITE



The TCP/IP Protocol SuiteNeso Academy

## APPLICATION LAYER

- ★ The application layer enables the user, whether human or software, to access the network.
- ★ It provides user interfaces and support for services.
- ★ Applications need their own protocols.

### Examples:

- Electronic mail
- File Access and Transfer
- Access to system resources
- Surfing the World Wide Web
- Network Management etc.,

★★★□□□□□Application LayerNeso Academy

## APPLICATION LAYER PROTOCOLS

- ★ Telecommunications Network (TELNET)
- ★ File Transfer Protocol (FTP)
- ★ Trivial File Transfer Protocol (TFTP)
- ★ Simple Mail Transfer Protocol (SMTP)
- ★ Simple Network Management Protocol (SNMP)
- ★ Domain Name System (DNS)
- ★ Hypertext Transfer Protocol (HTTP)

★★★★★★Application Layer ProtocolsNeso Academy

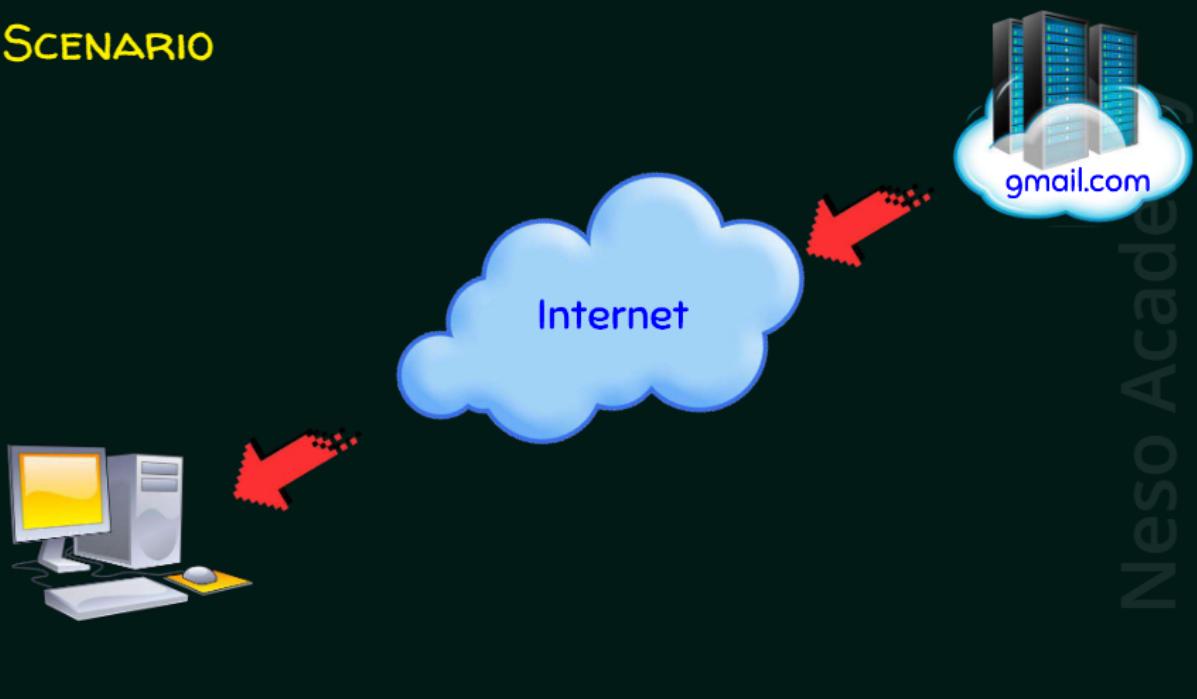
## OUTCOMES

Upon the completion of this session, the learner will be able to

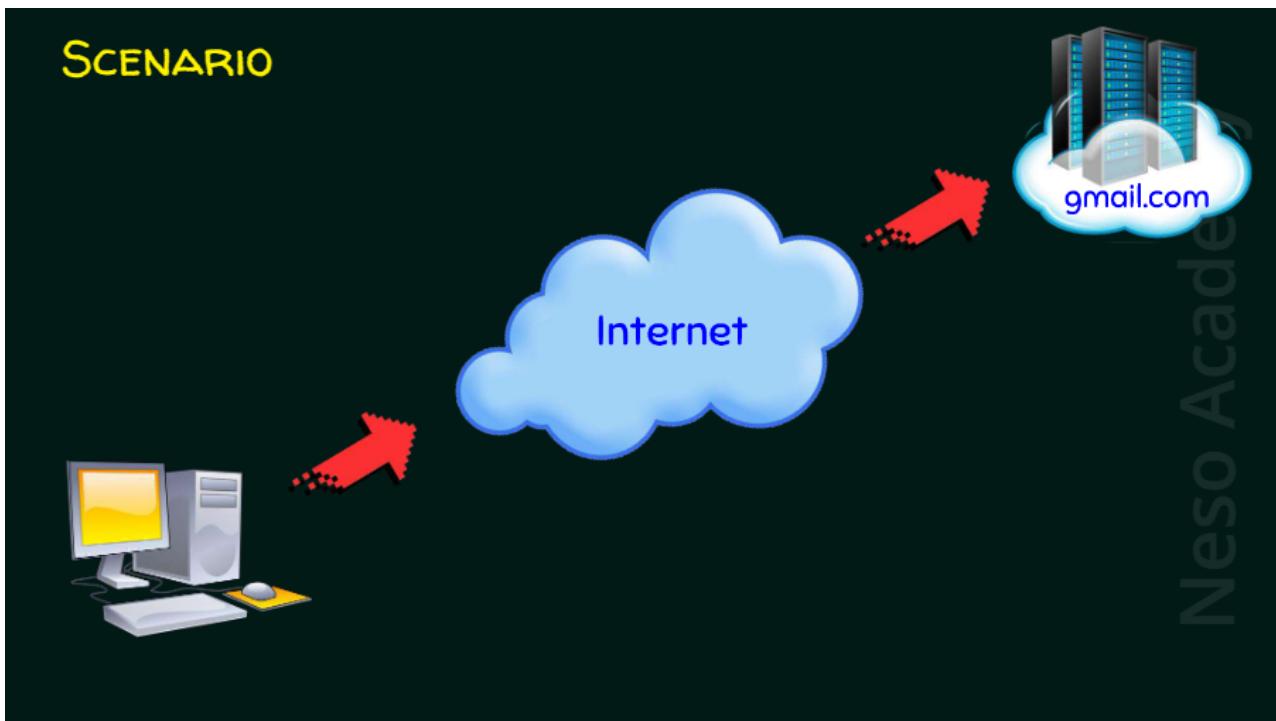
- ★ Know the need for DNS in the internet.

Outcomes★Neso Academy

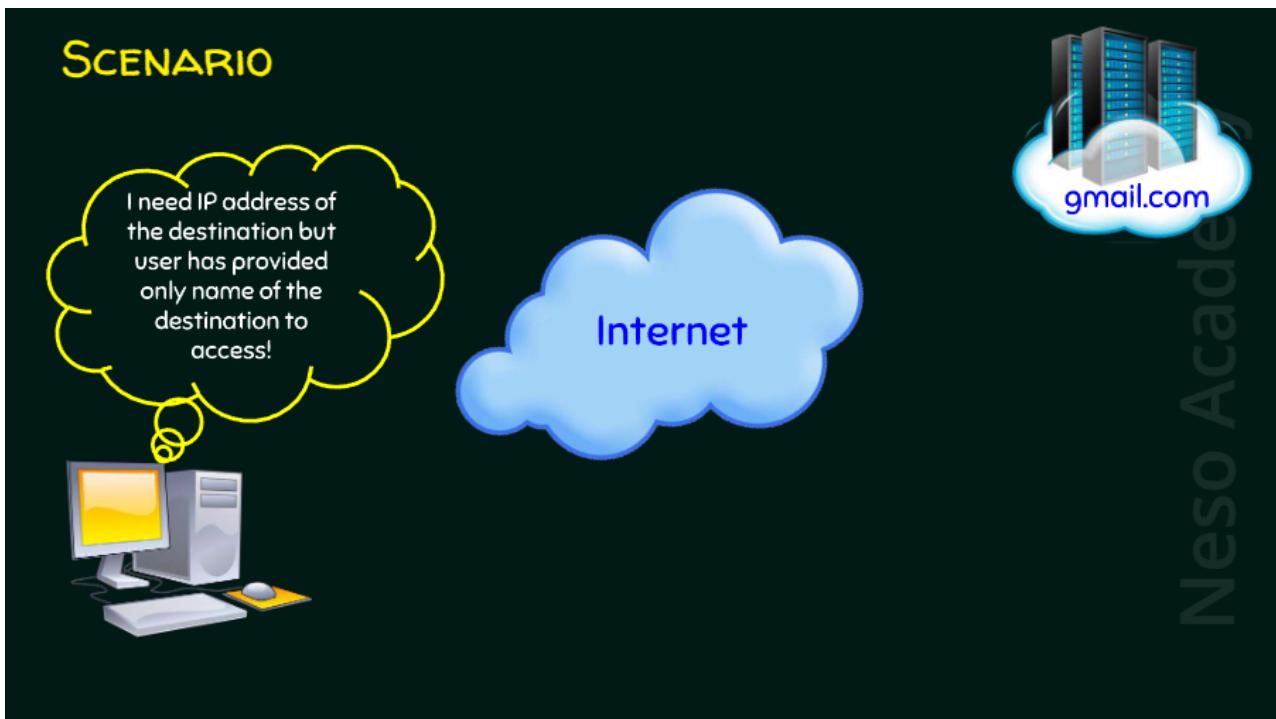
## SCENARIO



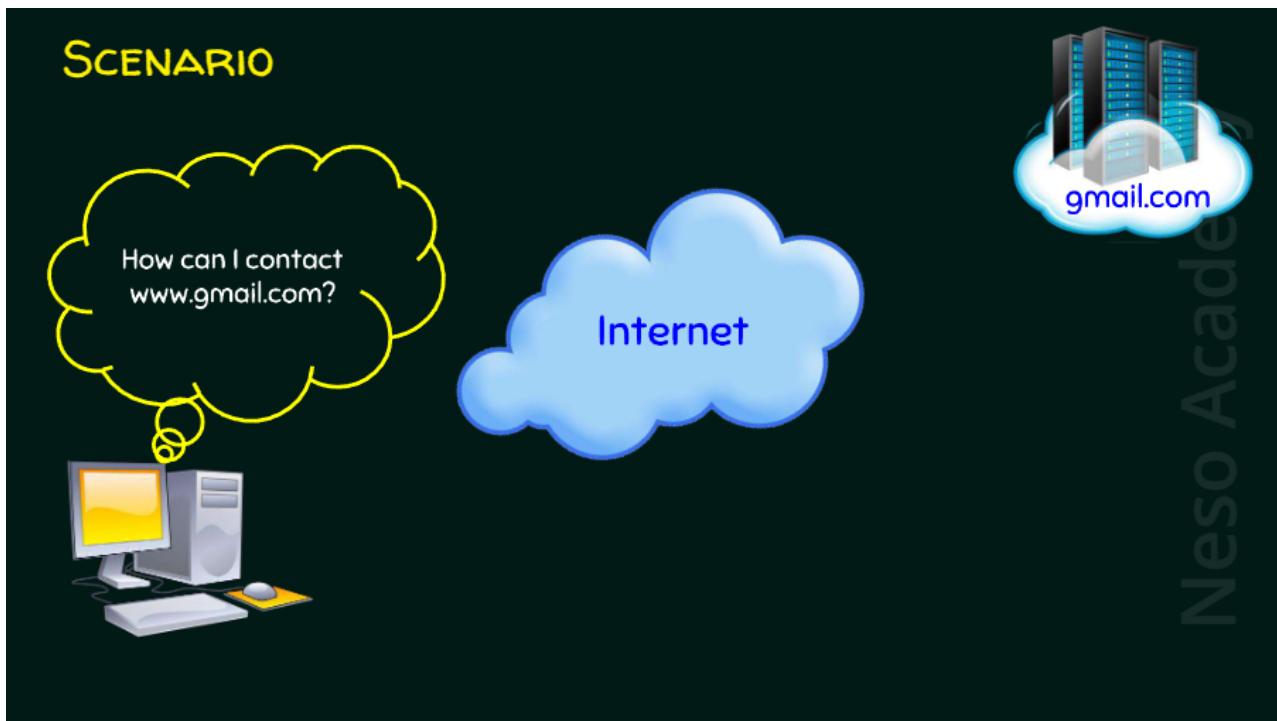
ScenarioNeso Academy



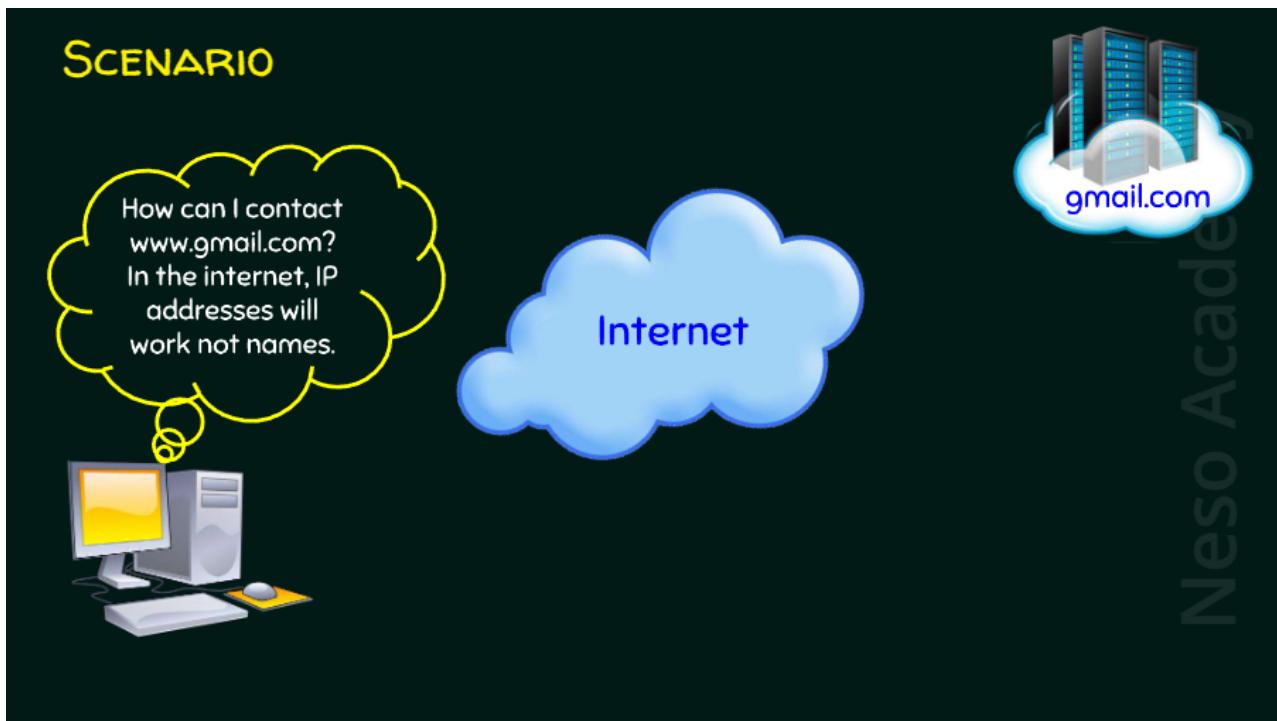
ScenarioNeso Academy



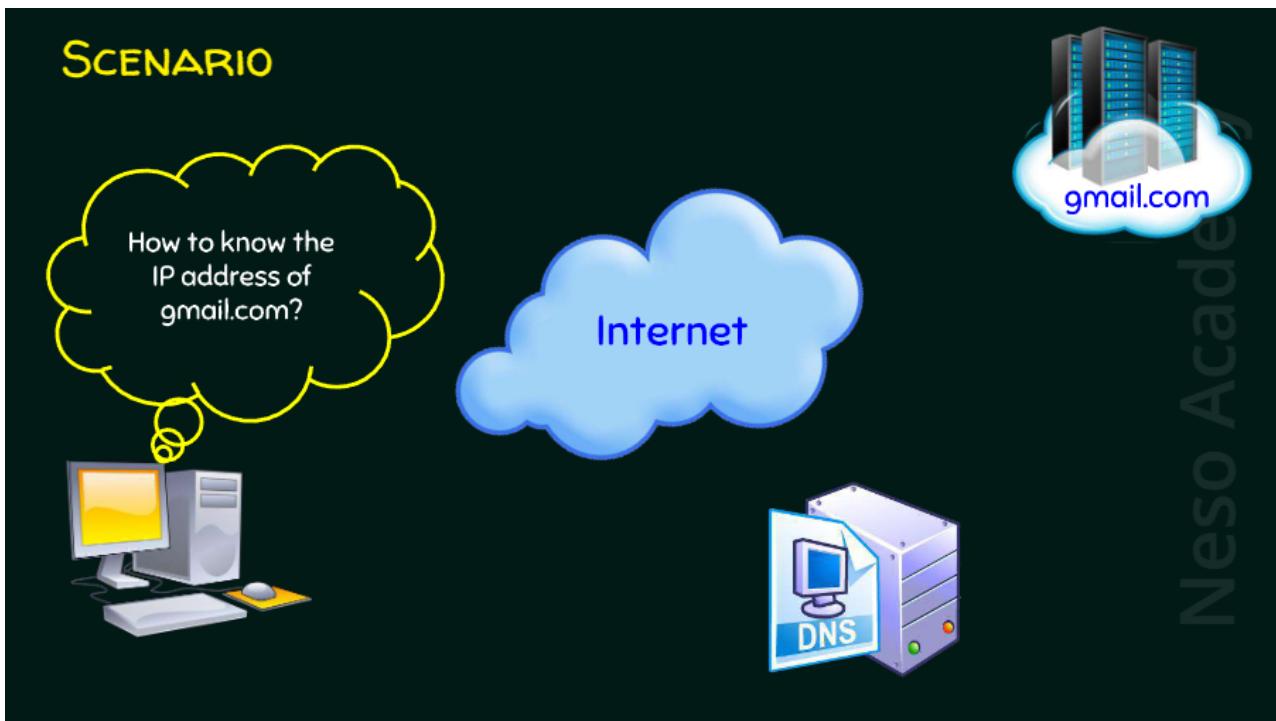
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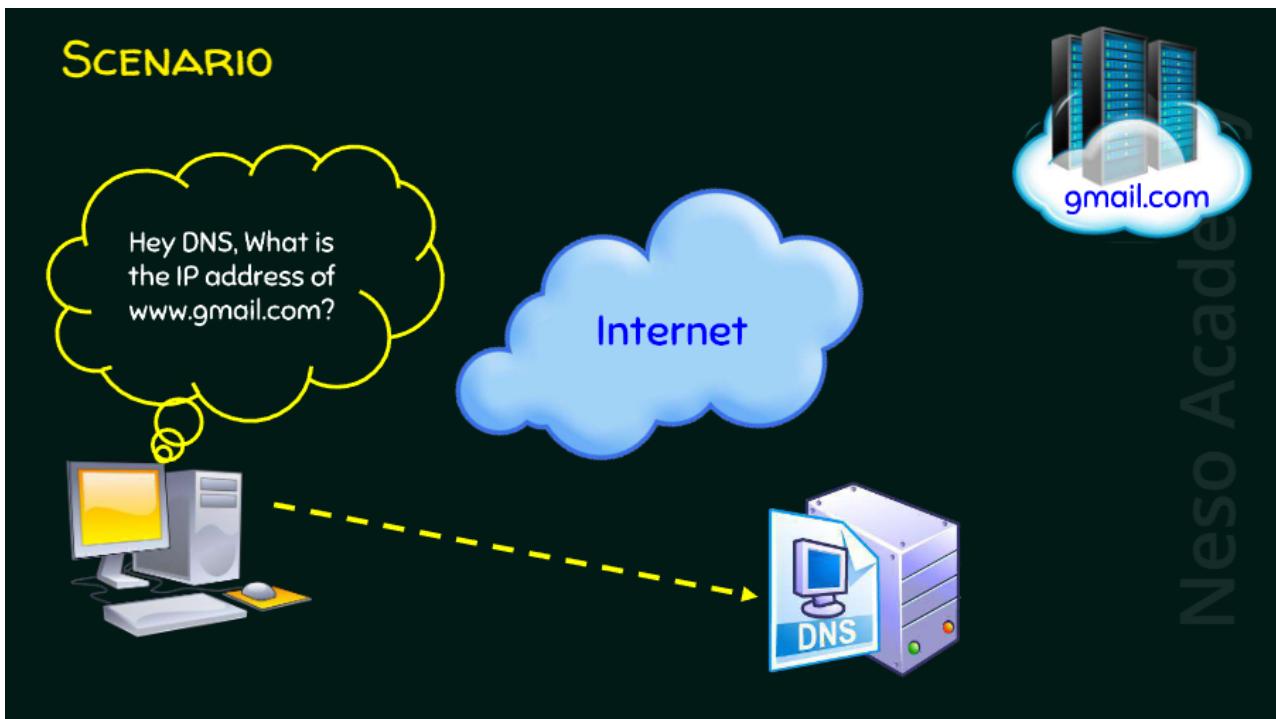
ScenarioNeso Academy



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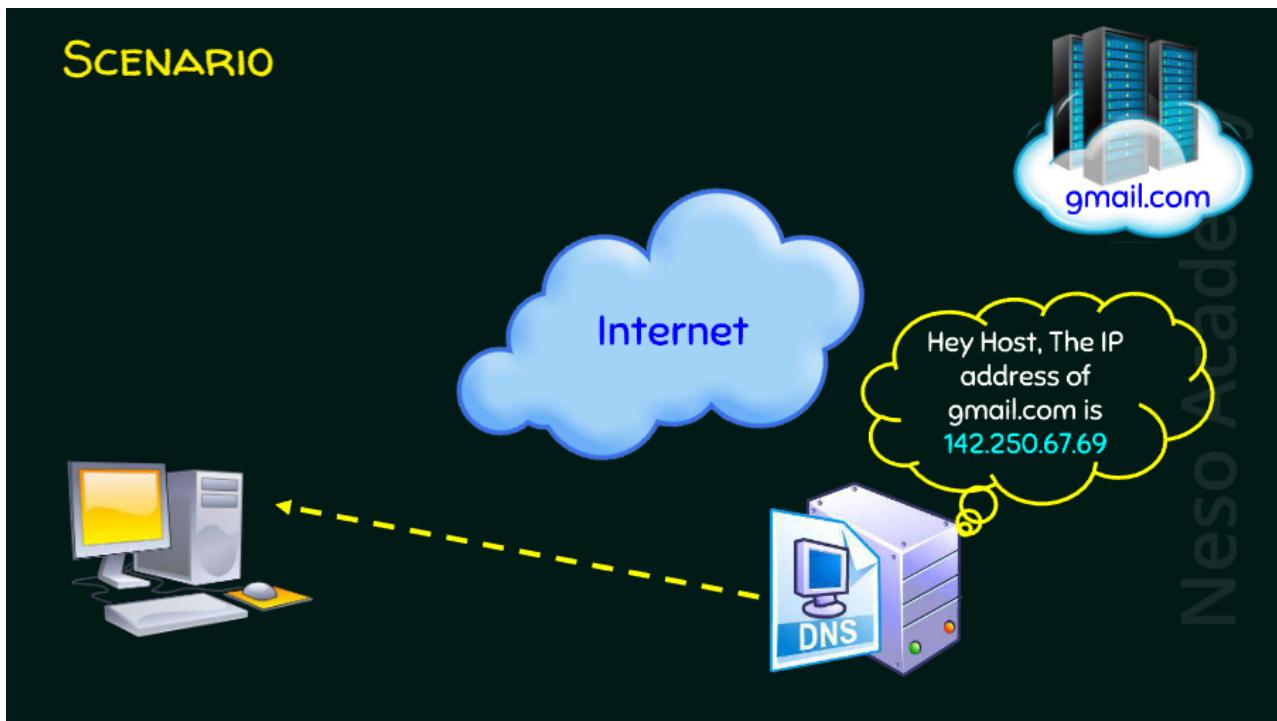


ScenarioNeso Academy



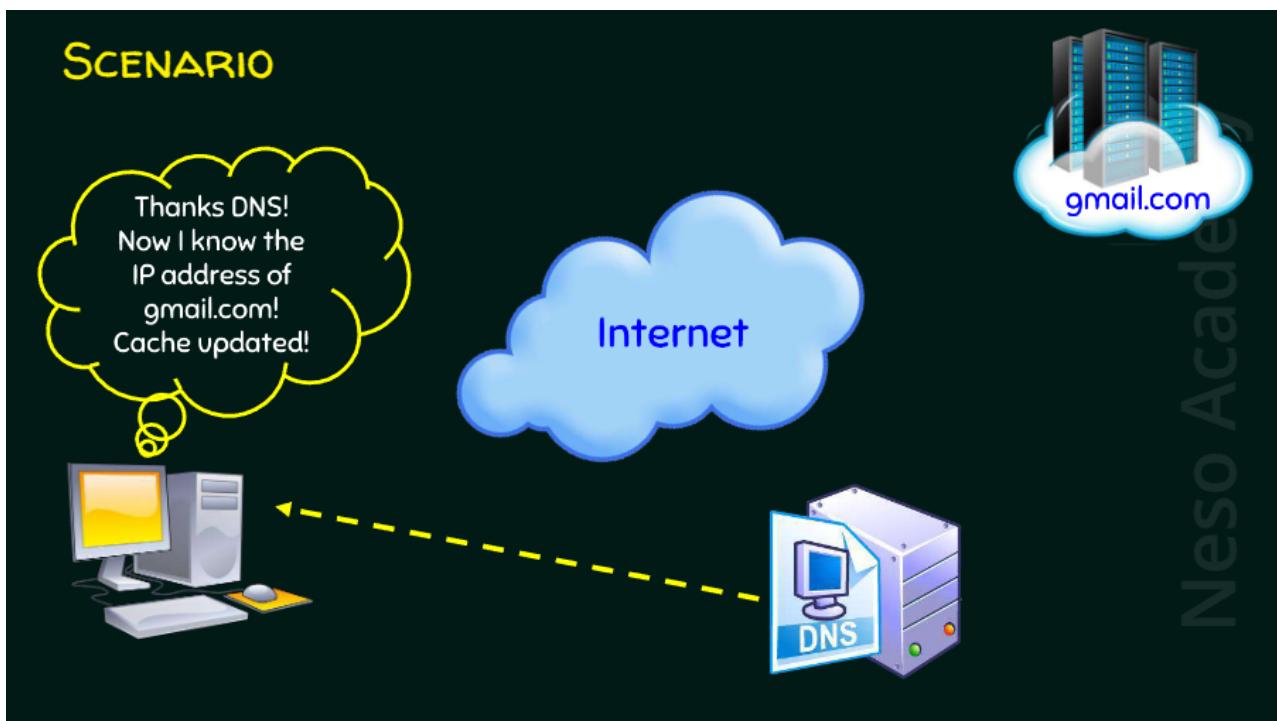
ScenarioNeso Academy

## SCENARIO

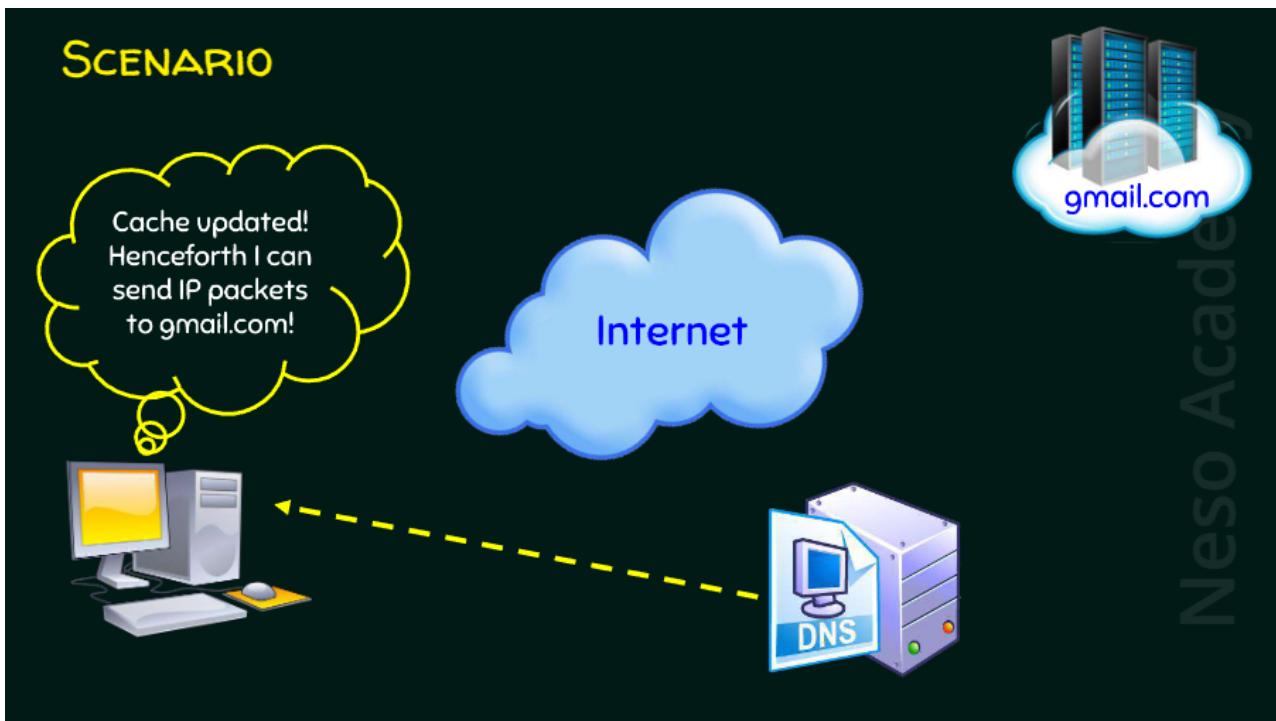


ScenarioNeso Academy

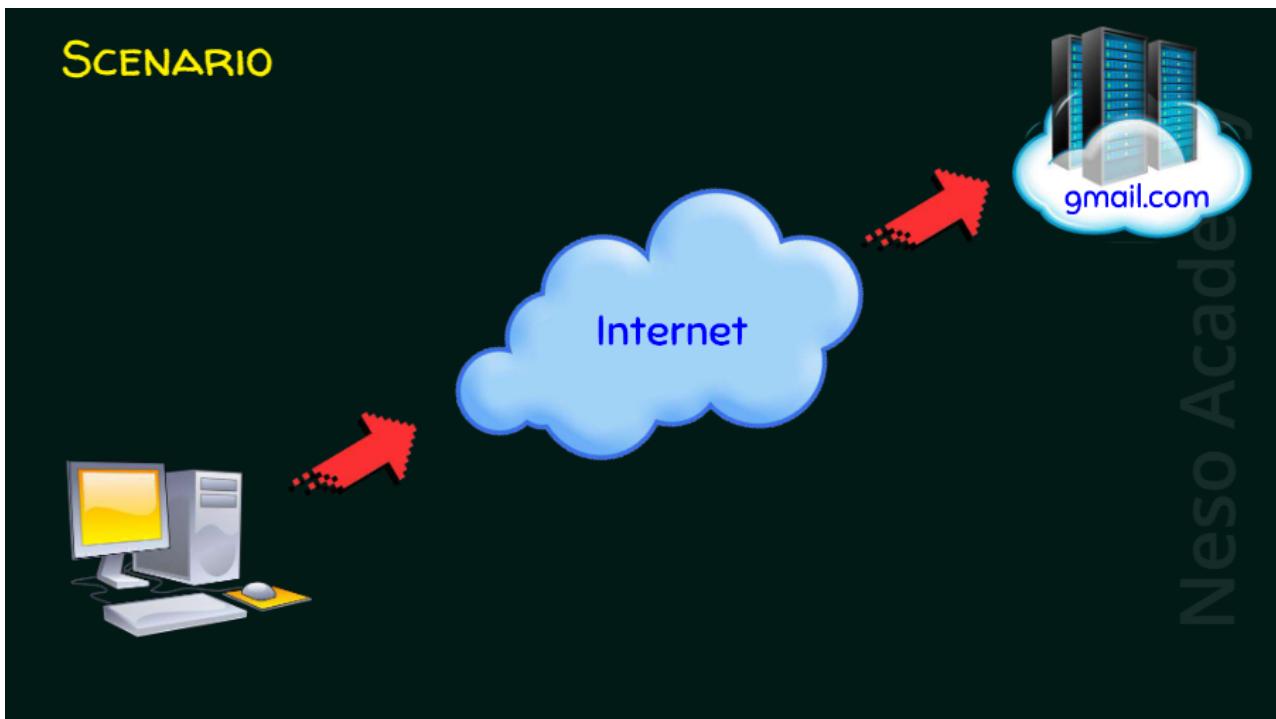
## SCENARIO



ScenarioNeso Academy

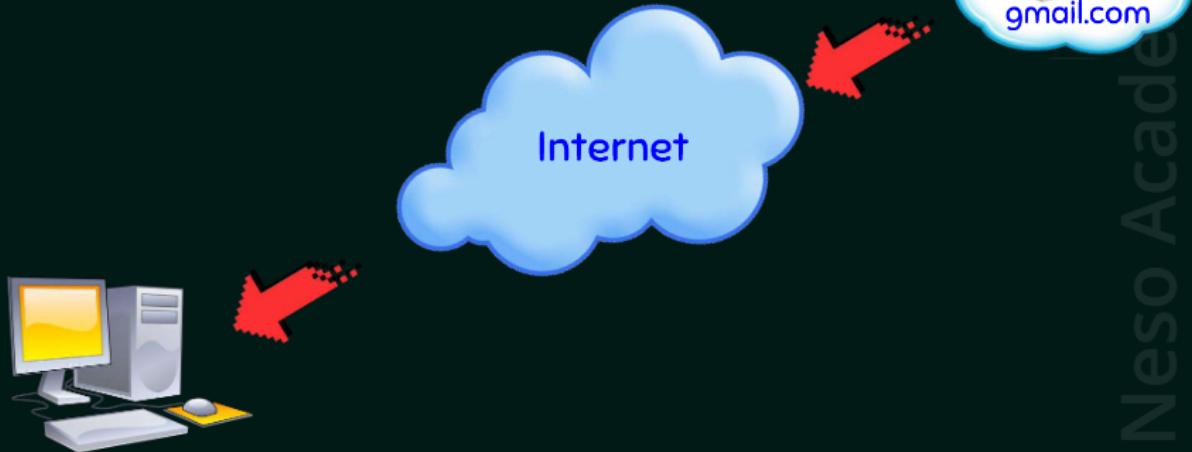


ScenarioNeso Academy



ScenarioNeso Academy

## SCENARIO



Neso Academy

ScenarioNeso Academy

## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Know about the basic working of DNS.
- ★ Understand the need for host address over host names.
- ★ Understand the working of name server with an example.

Neso Academy

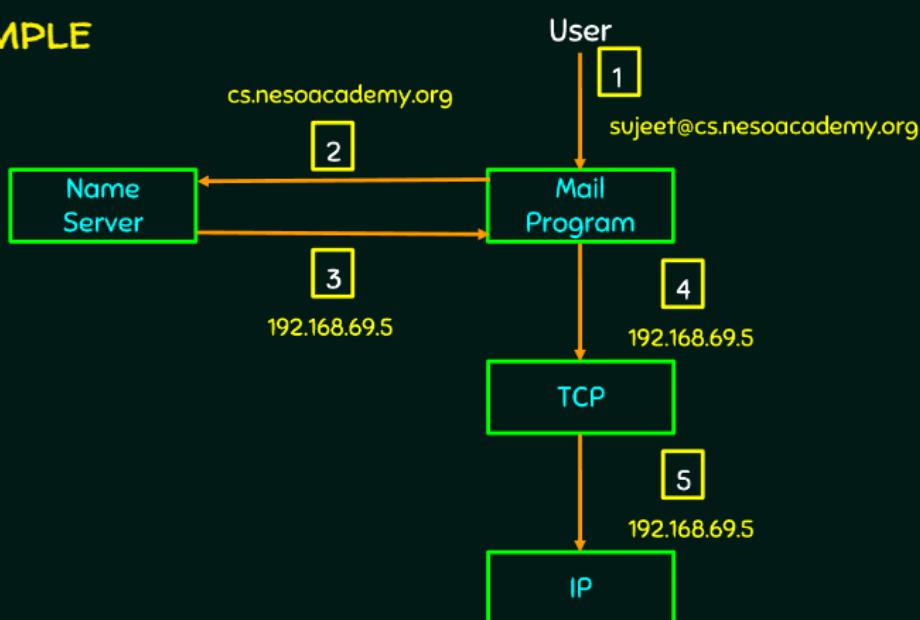
Outcomes★★★Neso Academy

## DOMAIN NAME SYSTEM (DNS)

- ★ DNS = Domain Name System.
- ★ Hierarchical and decentralized service.
- ★ Names – Human friendly.
- ★ IP Addresses – Router friendly.
- ★ Names or IP addresses – Unique.
- ★ FQDN – Fully Qualified Domain Name.
  - myhost.example.com.
- ★ Translate hostnames into host addresses.
- ★ Name servers – Client Server Model.

Domain Name System (DNS) ★★★★★★ ○ ★★ Neso Academy

### EXAMPLE



Example Neso Academy

## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Understand how domain hierarchy is partitioned into zones.
- ★ Understand the hierarchy of name servers.
- ★ Know about the 5-tuple representation of resource record.

Outcomes ★★★ Neso Academy

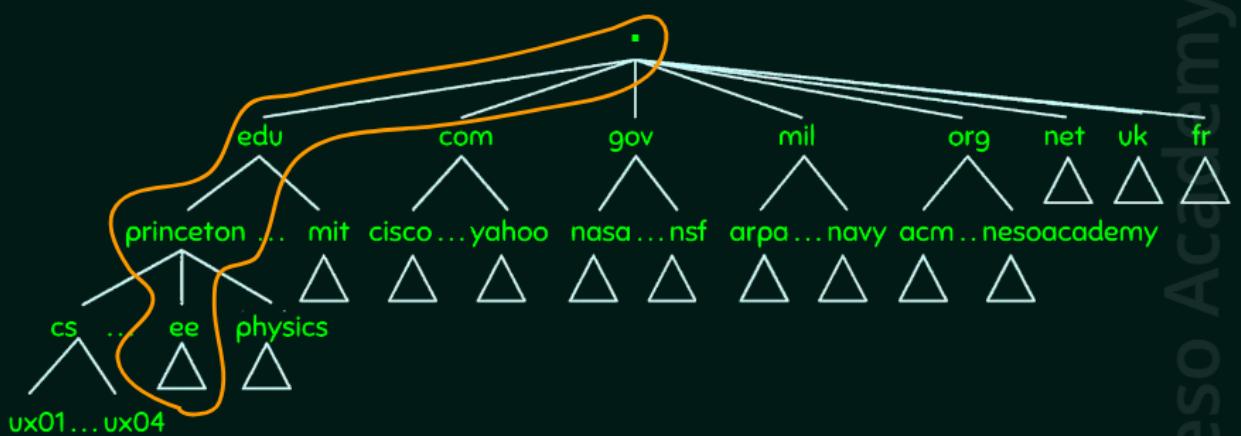
## A QUOTE . . .

*Now this is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning.*

-Winston Churchill

A Quote . . . Neso Academy

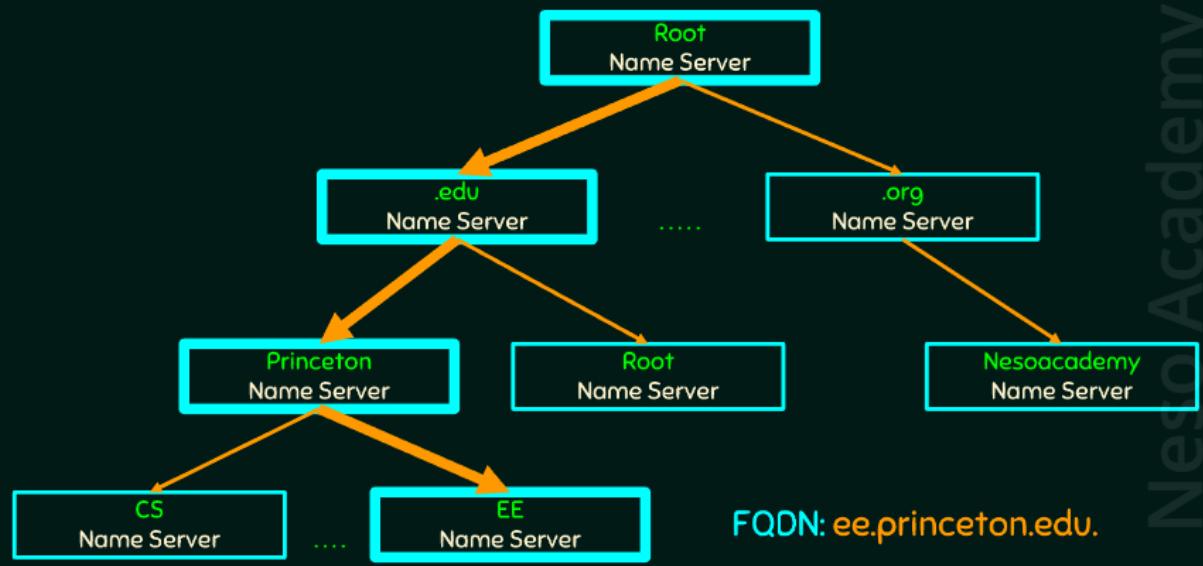
## DOMAIN HIERARCHY PARTITIONED INTO ZONES



FQDN: ee.princeton.edu.

Domain hierarchy partitioned into zones.Neso Academy

## HIERARCHY OF NAME SERVERS



Hierarchy of name serversNeso Academy

## NAME SERVER

- ★ Each name server implements the zone information as a collection of resource records.
- ★ A resource record is a **name-to-value binding**.
- ★ A 5-tuple representation.
- ★ <Name, Value, Type, Class, TTL>

Examples (TTL ignored):

1. <edu, a3.nstld.com, NS, IN>
2. <a3.nstld.com, 192.5.6.32, A, IN>
3. <penguins.cs.princeton.edu, 128.112.155.166, A, IN>

Name server★★★★Neso Academy

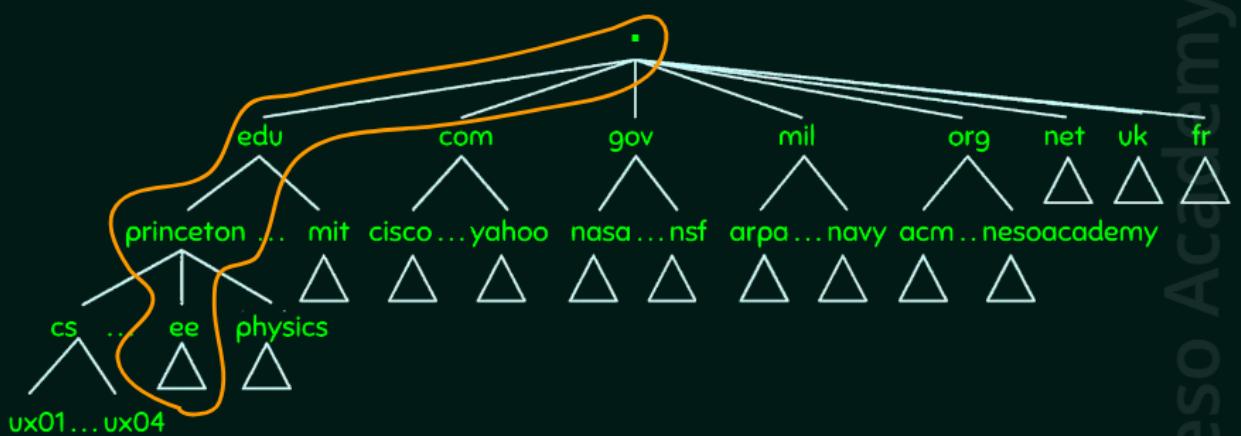
## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Understand the name resolution process.
- ★ Know types of name servers in DNS.

Outcomes★★Neso Academy

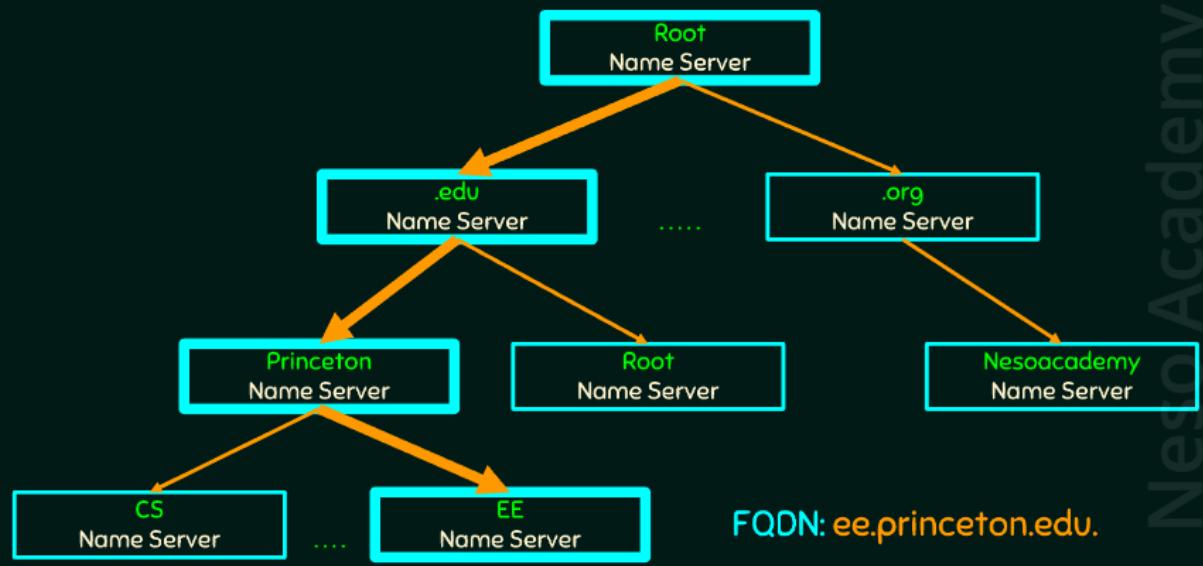
## DOMAIN HIERARCHY PARTITIONED INTO ZONES



FQDN: ee.princeton.edu.

Domain hierarchy partitioned into zones.Neso Academy

## HIERARCHY OF NAME SERVERS

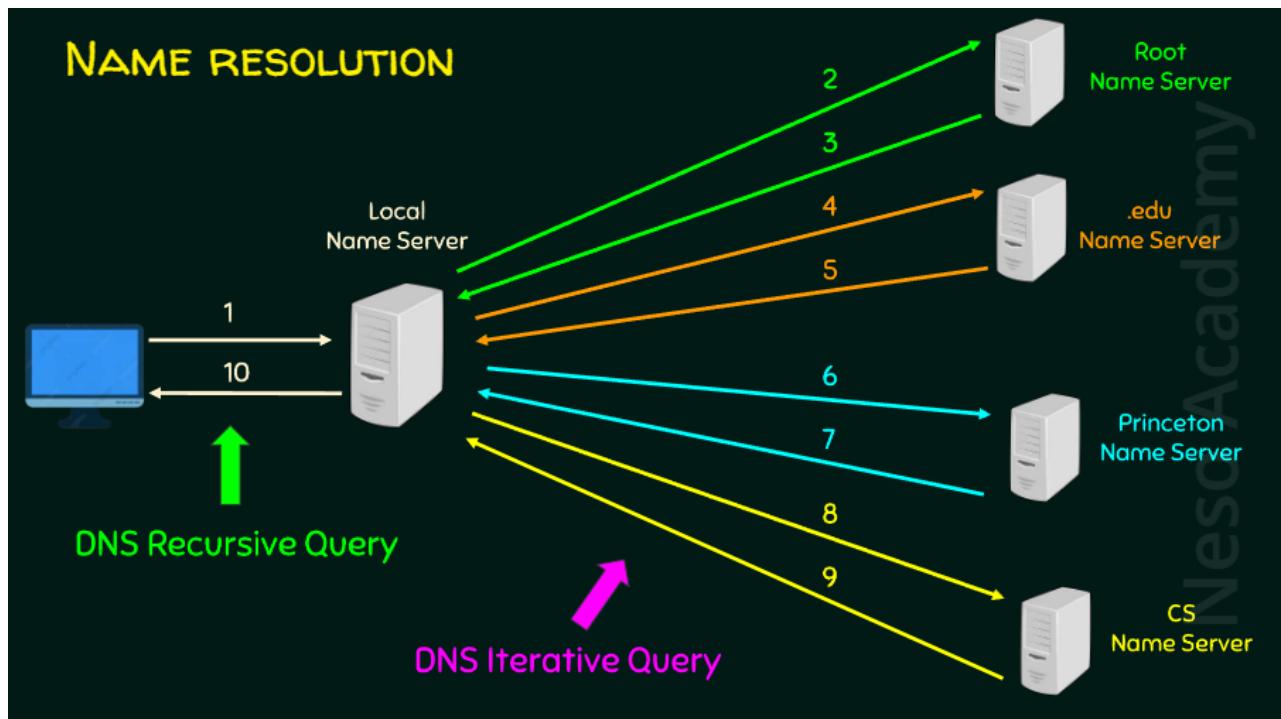


Hierarchy of name serversNeso Academy

## NAME RESOLUTION

- ★ Not all clients know about the root servers.
- ★ DNS resolver.
- ★ Resolving a name actually involves a client querying the local server.
- ★ DNS Recursive query and DNS Iterative query resolution.

Name resolution★★★★Neso Academy



Name resolutionNeso Academy

## QUESTION 1

The Protocol Data Unit (PDU) for the application layer in the Internet stack is

[GATE CS 2012]

- A) Segment
- B) Datagram
- C) Message ✓
- D) Frame

Question 1✓Neso Academy

## QUESTION 2

Identify the correct order in which the following actions take place in an interaction between a web browser and a web server.

1. The web browser requests a web page using HTTP.
2. The web browser establishes a TCP connection with the web server.
3. The web server sends the requested web page using HTTP.
4. The web browser resolves the domain name using DNS.

[GATE CS 2014]

- A) 4, 2, 1, 3 ✓
- B) 1, 2, 3, 4
- C) 4, 1, 2, 3
- D) 2, 4, 1, 3

Question 2✓Neso Academy

## QUESTION 3

If a server has no clue about where to find the address for a hostname then \_\_\_\_\_.

- A) server asks to the root server ✓
- B) server asks to its adjacent server
- C) request is not processed
- D) none of the mentioned

Question 3✓Neso Academy

## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Understand the basics of SNMP.
- ★ Know the three key components of SNMP.
- ★ Know the architecture of SNMP.
- ★ Know how the exchange of information is done in SNMP.

Outcomes★★★★Neso Academy

## SNMP – MANAGED DEVICES

- ★ Managed devices – Unidirectional or Bidirectional.
- ★ Managed devices that typically support SNMP include
  - Cable modems
  - Routers
  - Switches
  - Servers
  - Workstations
  - Printers

SNMP -Managed Devices★★★★★■■■■■Neso Academy

## SNMP

- ★ Simple Network Management Protocol.
- ★ Network monitoring.
- ★ SNMP collects, and organizes information about managed devices on IP networks.
- ★ SNMP can modify that information to change device behavior.
- ★ An SNMP-managed network consists of three key components:
  - Managed devices
  - Agent
  - Network Management Station (NMS)

SNMP★★★★★■■■■■Neso Academy

## SNMP

- ★ Simple Network Management Protocol.
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- ★ An SNMP-managed network consists of three key components:
  - Managed devices
  - **Agent**
  - Network Management Station (NMS)

SNMP★★★★■■■Neso Academy

## SNMP – AGENT

- ★ Agent – Managed devices.
- ★ An agent is a network-management software module that resides on a managed device.
- ★ An agent has local knowledge of management information and translates that information to or from an SNMP-specific form.

SNMP -Agent★★★Neso Academy

## SNMP

- ★ SNMP = Simple Network Management Protocol.
- ★ Network monitoring.
- ★ SNMP collects, and organizes information about managed devices on IP networks.
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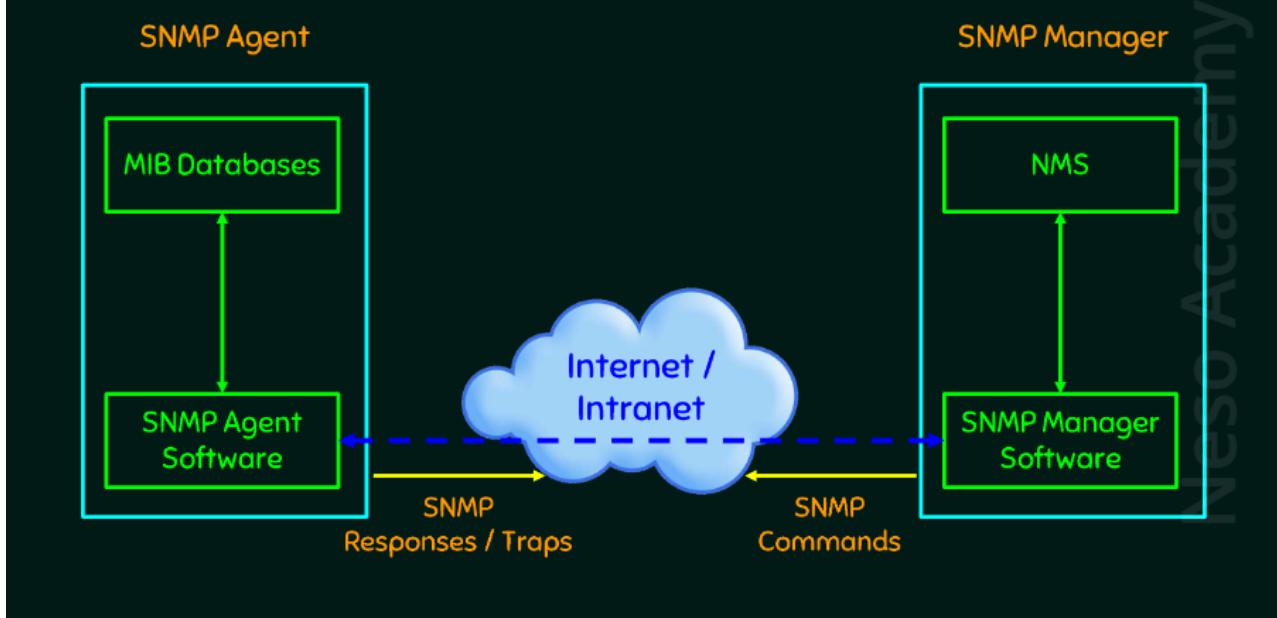
SNMP★★★★■■■Neso Academy

## SNMP – MANAGER

- ★ NMS - Manager.
- ★ A network management station executes applications that monitor and control managed devices.
- ★ NMSs provide the bulk of the processing and memory resources required for network management.
- ★ One or more NMSs may exist on any managed network.

SNMP -Manager★★★★Neso Academy

## SNMP ARCHITECTURE



SNMP Architecture Neso Academy

## EXCHANGE OF INFORMATION IN SNMP

- ★ SNMP Polling.
- ★ SNMP Traps.

Exchange of information in SNMP ★★Neso Academy

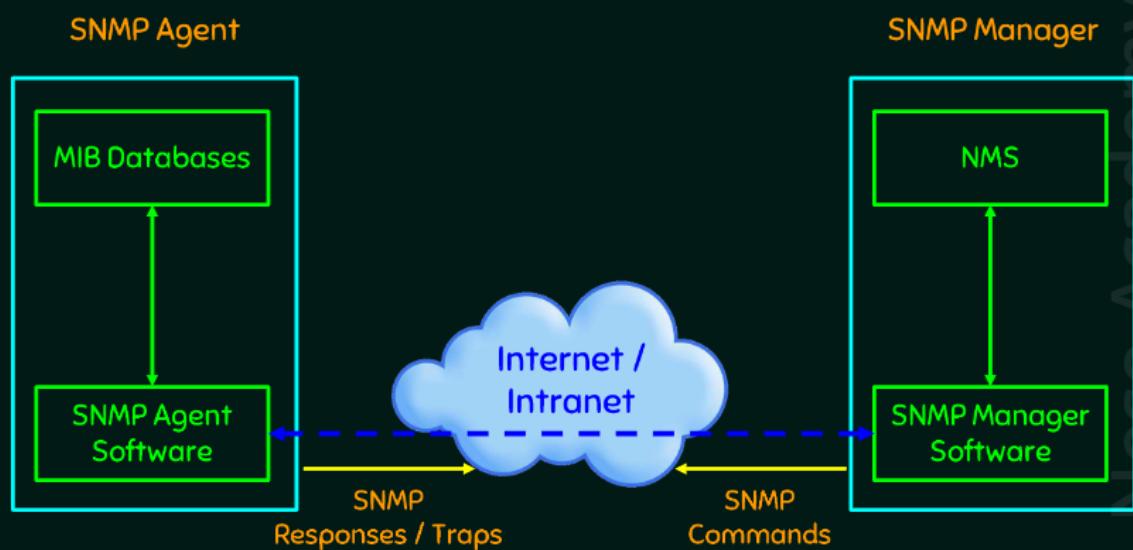
## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Understand the architecture of SNMP.
- ★ Know about MIB.
- ★ Know SNMP protocol details.
- ★ Know various security implications with SNMP.

Outcomes ★★★ Neso Academy

## SNMP ARCHITECTURE



SNMP Architecture Neso Academy

## SNMP – MIB

- ★ SNMP agents – **Variables**.
- ★ Active management tasks - Configuration changes - Remote modification of these variables.
- ★ The variables accessible via SNMP are organized in hierarchies.
- ★ SNMP itself does not define which variables a managed system should offer.
- ★ Rather, SNMP uses an extensible design which allows applications to define their own hierarchies.

SNMP -MIB★★★★★Neso Academy

## SNMP – MIB

- ★ These hierarchies are described as a **Management Information Base (MIB)**.
- ★ MIBs describe the structure of the management data of a device subsystem.
- ★ They use a hierarchical namespace containing **Object Identifiers (OID)**.
- ★ Each OID identifies a variable that can be read or set via SNMP.
- ★ MIBs use the notation defined by Structure of Management Information Version 2.0

SNMP -MIB★★★★★Neso Academy

## PROTOCOL DETAILS

- ★ All SNMP messages are transported via UDP.
- ★ Seven SNMP PDUs.
  - GetRequest
  - SetRequest
  - GetNextRequest
  - GetBulkRequest
  - Response
  - Trap
  - InformRequest

Protocol Details ★★★★★★★ Neso Academy

## SNMP VERSIONS

1. SNMPv1
  2. SNMPv2c
  3. SNMPv3
- ★ SNMPv1 and v2 are vulnerable to IP spoofing attacks
- ★ Security was one of the biggest weakness of SNMP until v3.
- ★ Authentication in SNMP Versions 1 and 2 amounts to nothing more than a password (community string) sent in clear text between a manager and agent.

SNMP Versions ★★★ Neso Academy

## SNMP VERSIONS

The security approach in v3 targets :

- ★ Confidentiality
- ★ Integrity
- ★ Authentication

SNMP Versions ★★★Neso Academy

## SNMP SECURITY IMPLICATIONS

- ★ Using SNMP to attack a network.
- ★ SNMP authentication.
- ★ SNMP autodiscovery.

SNMP Security Implications★★★Neso Academy

## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Understand the basics of http.
- ★ Understand the advantages of having https over http.

Outcomes ★★ Neso Academy

## APPLICATION LAYER PROTOCOLS REVISITED

Three application layer protocols involved in everyday work or play include:

- ★ HTTP to browse the web.
- ★ Simple Mail Transfer Protocol (SMTP) to enable users to send email.
- ★ Post Office Protocol (POP) to enable users to receive email.

Application Layer Protocols Revisited ★★★ Neso Academy

## HTTP



Neso Academy

HTTPNeso Academy

## HTTP

Example URL: <http://www.cisco.com/index.html>

1. First, the browser interprets the three parts of the URL:
  - i. http (the protocol or scheme)
  - ii. www.cisco.com (the server name)
  - iii. index.html (the specific file name requested)
2. Browser checks with a name server to convert www.cisco.com into a numeric address
3. Using the HTTP protocol requirements sends a GET request to the server and asks for the file index.html
4. Server sends the HTML code for this web page
5. Browser deciphers the HTML code and formats the page

Neso Academy

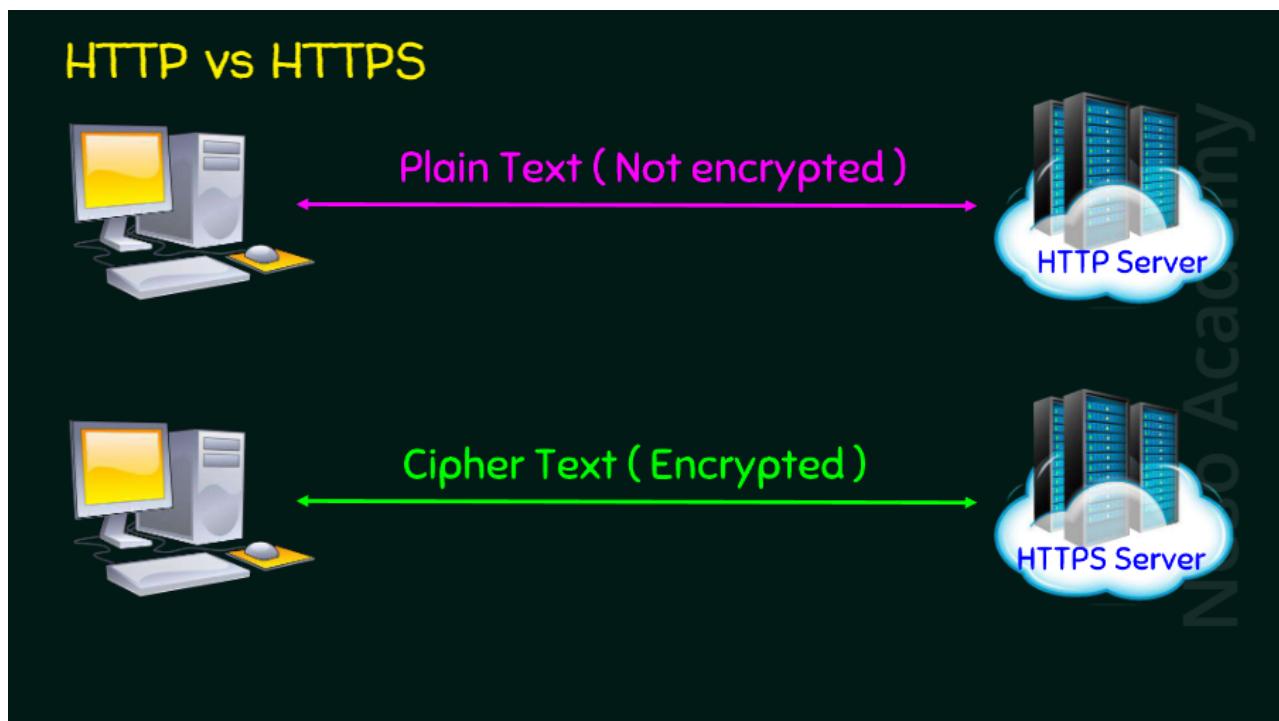
HTTPNeso Academy

## HTTP

- ★ Developed to publish and retrieve HTML pages
- ★ Used for data transfer
- ★ Specifies a request/response protocol
- ★ Three common message types are GET, POST, and PUT
  - GET is a client request for data
  - POST and PUT are used to send messages that upload data to the web server

Neso Academy

HTTP★★★★■Neso Academy



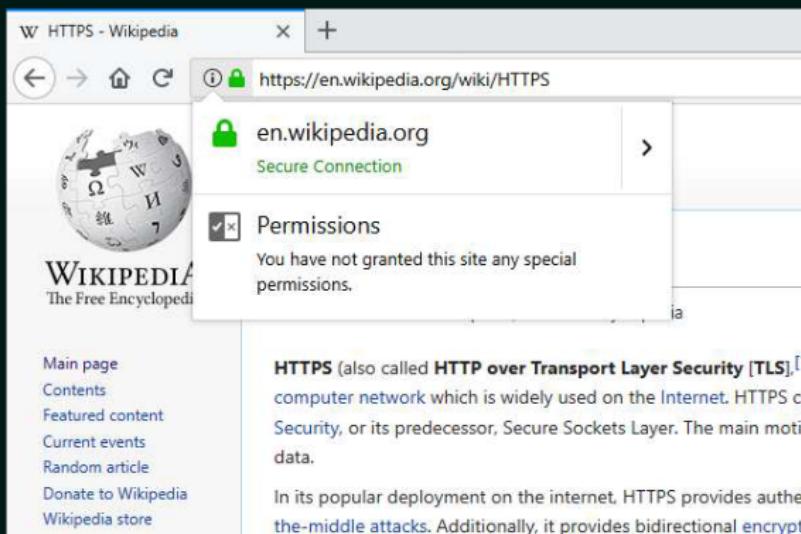
HTTP vs HTTPS Neso Academy

## HTTPS

- ★ HTTP Secure or HTTP over SSL or HTTP over TLS
- ★ Encrypted
- ★ Secured
- ★ Cipher Text
- ★ Certificate Authority (CA)

HTTPS ★★★★ Neso Academy

## HTTPS



HTTPSNeso Academy

## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Understand the role of E-mail protocols.
- ★ Know about the E-mail protocols such as SMTP, POP3 and IMAP.

Outcomes ★★ Neso Academy

## E-MAIL PROTOCOLS

- ★ Typically use an application called a Mail User Agent (email client).
- ★ Allows messages to be sent.
- ★ Places received messages into the client's mailbox.
- ★ Email client provides the functionality of both protocols within one application.
- ★ E-mail protocols
  - SMTP – Simple Mail Transfer Protocol
  - POP – Post Office Protocol
  - IMAP – Internet Message Access Protocol

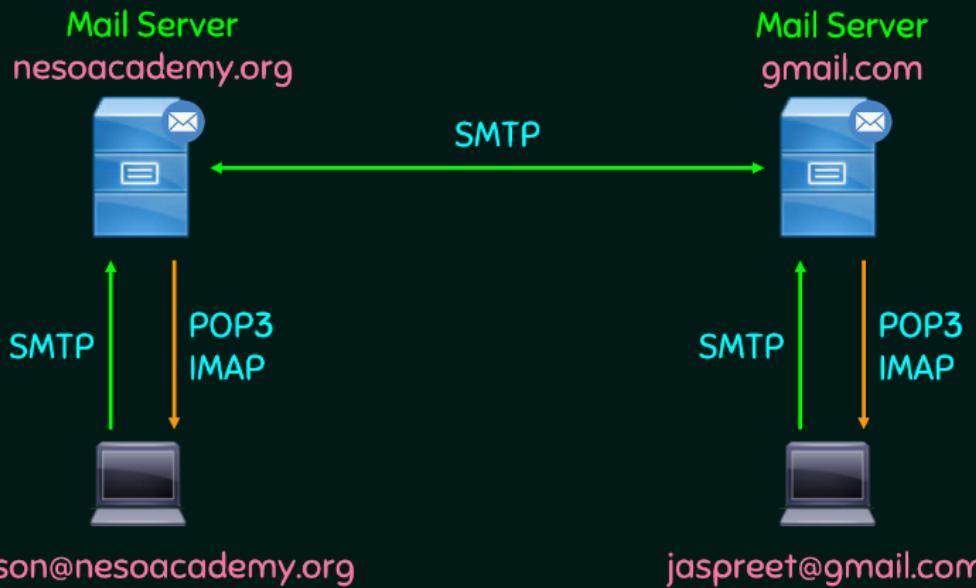
E-mail Protocols ★★★★■■■ Neso Academy

## SMTP, POP AND IMAP

- ★ SMTP – Send email from either a client or a server.
- ★ POP – Receive email messages from an email server.
- ★ IMAP – Receive email messages from an email server.

SMTP, POP and IMAP★★★Neso Academy

## SMTP, POP AND IMAP



SMTP, POP and IMAPNeso Academy

## SMTP

- ★ Transfers mail reliably and efficiently.
- ★ Message must be formatted properly.
- ★ SMTP processes must be running on both the client and server.
- ★ Message header must have a properly formatted recipient email address and a sender.
- ★ SMTP uses port 25.

SMTP★★★★★Neso Academy

## POP

- ★ Enables a workstation to retrieve mail from a mail server.
- ★ E-mail is downloaded from the server to the client and then deleted on the server.
- ★ POP uses port 110.
- ★ POP does not store messages.
- ★ POP3 is desirable for an ISP, because it alleviates their responsibility for managing large amounts of storage for their email servers.

POP★★★★★Neso Academy

## IMAP

- ★ Retrieves email messages.
- ★ Unlike POP, when the user connects to an IMAP-capable server, copies of the messages are downloaded to the client application.
- ★ Original messages are kept on the server until manually deleted.

IMAP★★★Neso Academy

### QUESTION 1

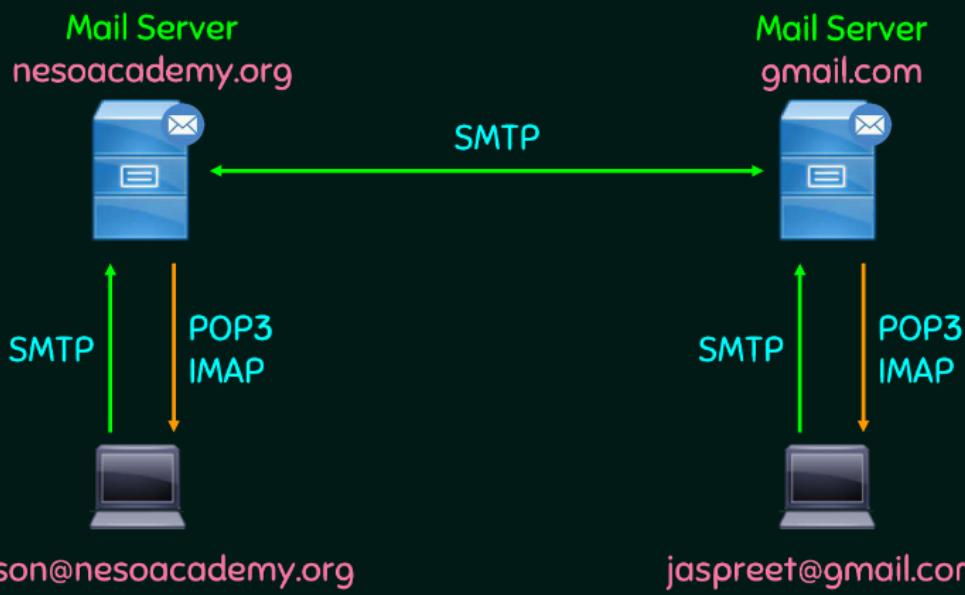
Which of the following protocol pairs can be used to send and retrieve e-mails (in that order)?

[GATE CS 2019]

- (A) IMAP, POP3
- (B) SMTP, POP3
- (C) SMTP, MIME
- (D) IMAP, SMTP

Question 1Neso Academy

## SMTP, POP AND IMAP



SMTP, POP and IMAP  
Neso Academy

### QUESTION 1

Which of the following protocol pairs can be used to send and retrieve e-mails (in that order)?

[GATE CS 2019]

- (A) IMAP, POP3 ✗
- (B) SMTP, POP3 ✓
- (C) SMTP, MIME ✗
- (D) IMAP, SMTP ✗

Question 1 ✗✓✗✗ Neso Academy

## QUESTION 2

Consider different activities related to email:

- m1: Send an email from a mail client to a mail server
- m2: Download an email from mailbox server to a mail client
- m3: Checking email in a web browser

Which is the application level protocol used in each activity?

[GATE CS 2011]

- (A) m1: HTTP m2: SMTP m3: POP ✗
- (B) m1: SMTP m2: FTP m3: HTTP ✗
- (C) m1: SMTP m2: POP m3: HTTP ✓
- (D) m1: POP m2: SMTP m3: IMAP ✗

Question 2 ✗ ✗ ✓ ✗ Neso Academy

## QUESTION 3

Identify the correct sequence in which the following packets are transmitted on the network by a host when a browser requests a web page from a remote server, assuming that the host has just been restarted.

[GATE CS 2016]

- (A) HTTP GET request, DNS query, TCP SYN ✗
- (B) DNS query, HTTP GET request, TCP SYN ✗
- (C) DNS query, TCP SYN, HTTP GET request ✓
- (D) TCP SYN, DNS query, HTTP GET request ✗

Question 3 ✗ ✗ ✓ ✗ Neso Academy

## HOMEWORK

Which of the following transport layer protocols is used to support electronic mail?

[GATE CS 2012]

- (A) SMTP
- (B) IP
- (C) TCP
- (D) UDP

Homework★Neso Academy

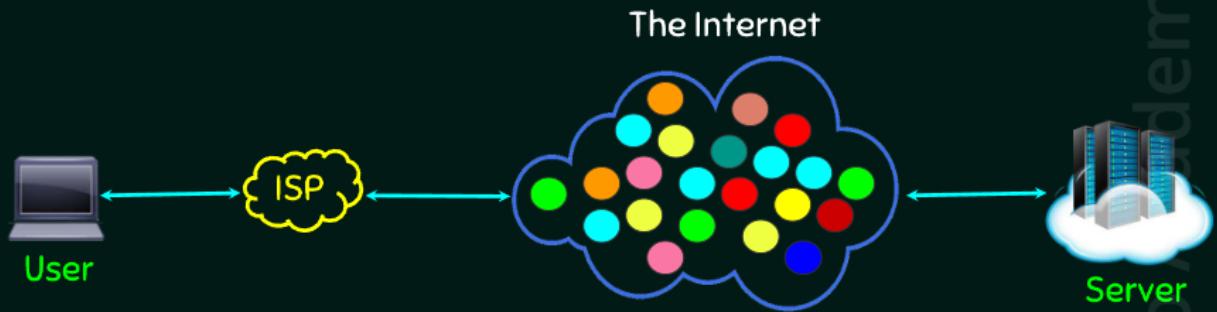
## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Understand the need for network security in computer networks.

Outcomes★Neso Academy

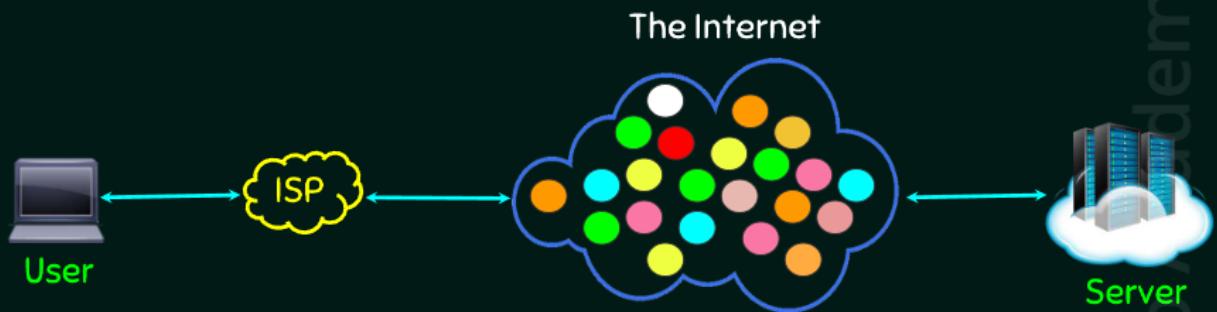
## NEED FOR NETWORK SECURITY



Neso Academy

Need for network securityNeso Academy

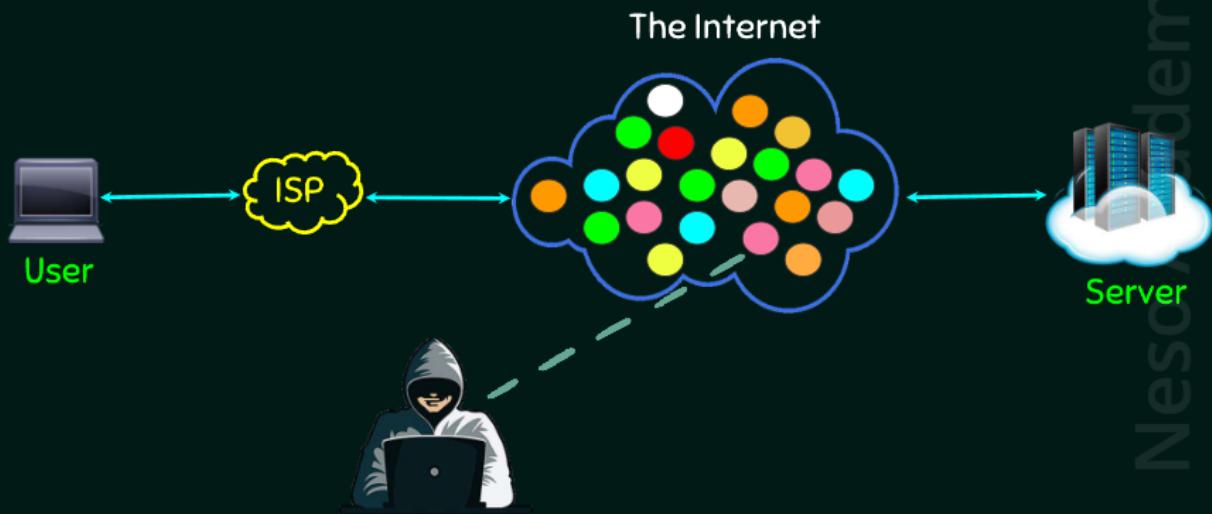
## NEED FOR NETWORK SECURITY



Neso Academy

Need for network securityNeso Academy

## NEED FOR NETWORK SECURITY



Need for network security Neso Academy

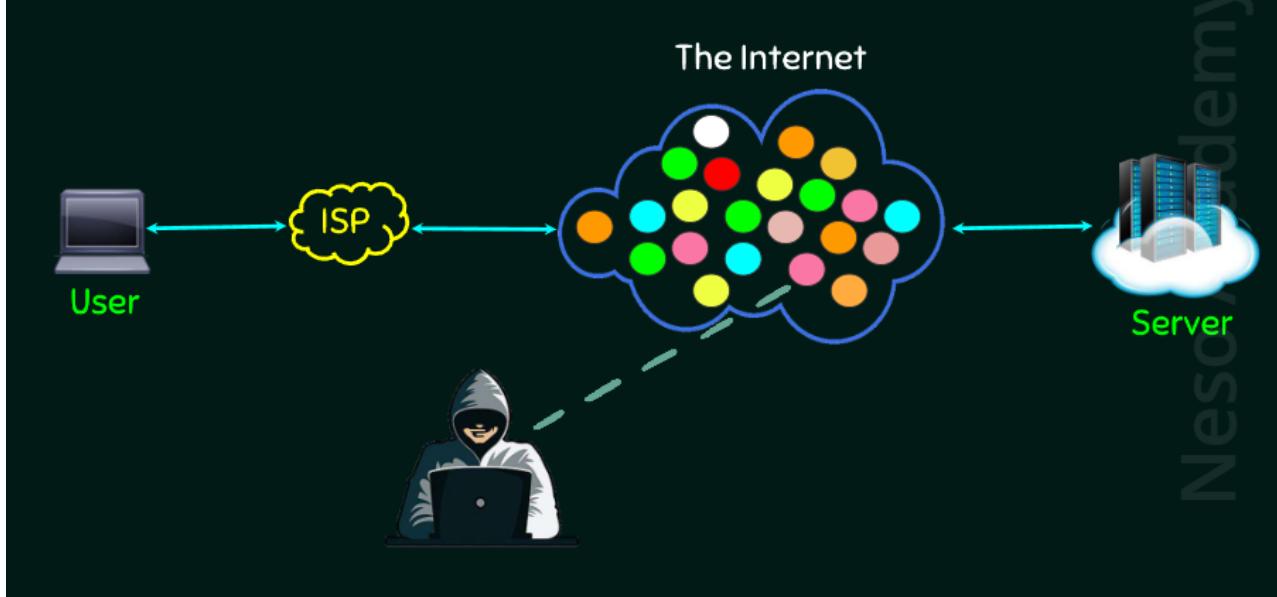
## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Understand the basics of cryptography.
- ★ Know about symmetric and asymmetric cryptography.
- ★ Know the key terms in cryptography.

Outcomes ★★★ Neso Academy

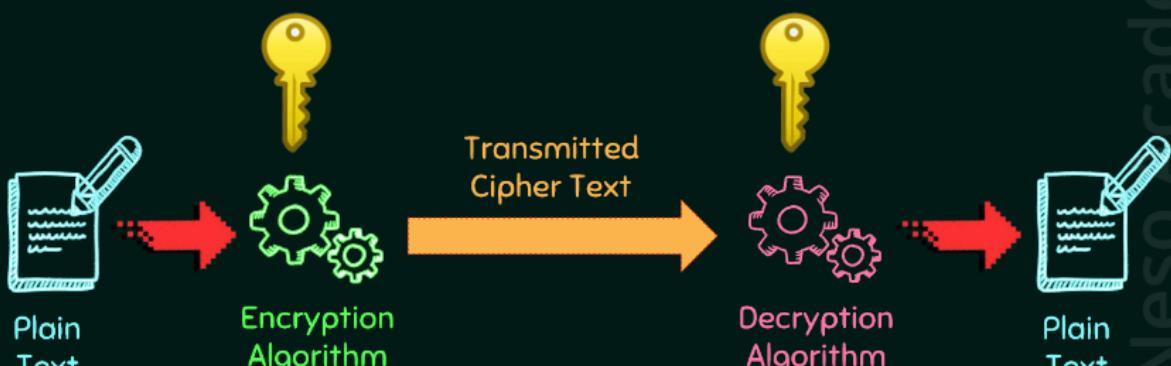
## NEED FOR NETWORK SECURITY



Need for network securityNeso Academy

## CRYPTOGRAPHY

*"The art or science encompassing the principles and methods of transforming an intelligible message into one that is unintelligible, and then retransforming that message back to its original form."*



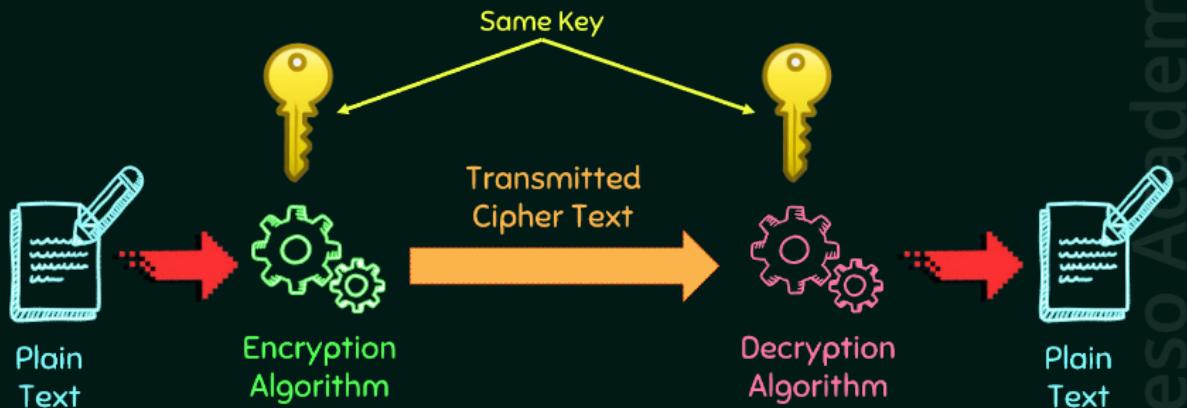
CryptographyNeso Academy

## TYPES OF CRYPTOGRAPHY

- ★ Symmetric Cryptography (Private Key Cryptography)
- ★ Asymmetric Cryptography (Public Key Cryptography)

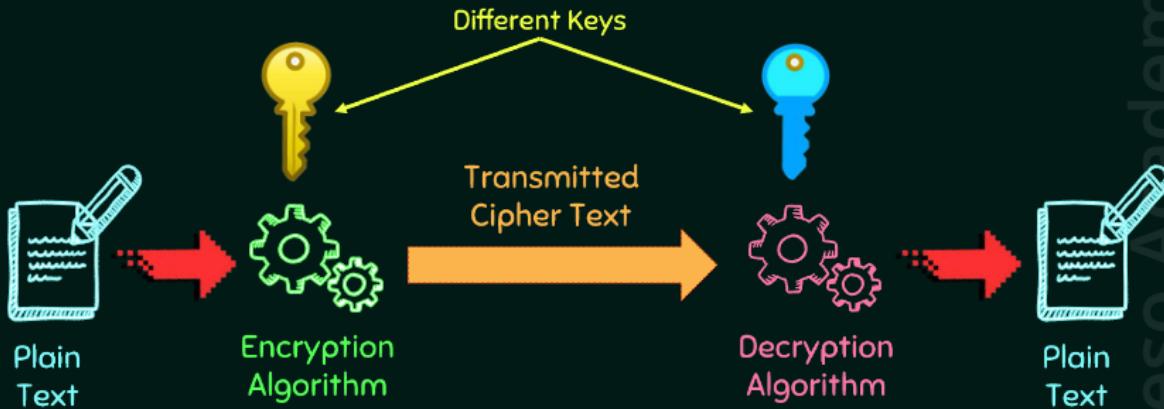
Types of Cryptography ★★ Neso Academy

## SYMMETRIC CRYPTOGRAPHY



Symmetric Cryptography Neso Academy

## ASYMMETRIC CRYPTOGRAPHY



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Asymmetric CryptographyNeso Academy

## EXAMPLES

### Symmetric Cryptography (Private Key Cryptography)

- ★ DES
- ★ AES
- ★ RC4

### Asymmetric Cryptography (Public Key Cryptography)

- ★ RSA
- ★ ECC
- ★ Diffie-Hellman

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★★★★★ExamplesNeso Academy

## KEY TERMS

- ★ Cryptography
- ★ Plaintext
- ★ Cipher text
- ★ Cipher (Encryption Algorithm)
- ★ Key
- ★ Cryptanalysis (code breaking)
- ★ Cryptology = Cryptography + Cryptanalysis

Key Terms★★★★★Neso Academy

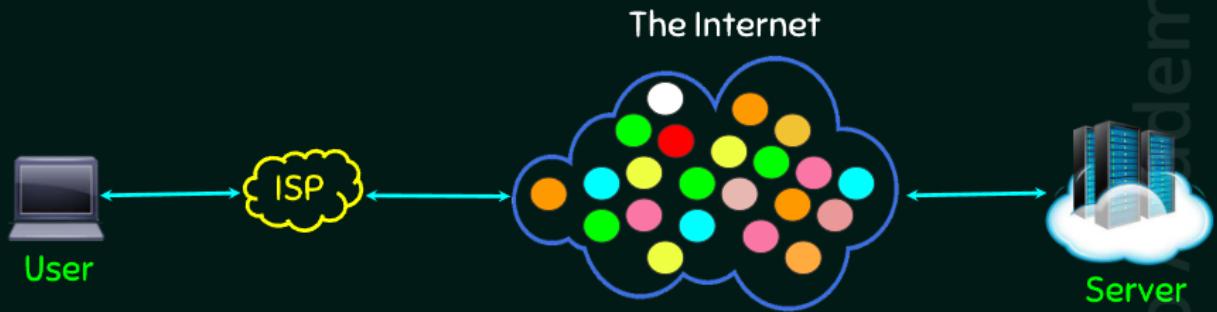
## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Understand the OSI security architecture.
- ★ Know about security attacks.
- ★ Know about security services.
- ★ Know about security mechanisms.

Outcomes★★★★Neso Academy

## NEED FOR NETWORK SECURITY



Need for network security Neso Academy

## THE OSI SECURITY ARCHITECTURE

- ★ Security Attacks
- ★ Security Mechanisms
- ★ Security Services

The OSI security architecture ★★★ Neso Academy

## SECURITY ATTACKS

- ★ Passive Attack
- ★ Active Attack

Security Attacks★★Neso Academy

## SECURITY SERVICES

- ★ Authentication
- ★ Access Control
- ★ Data Confidentiality
- ★ Data Integrity
- ★ Nonrepudiation
- ★ Availability

Security Services★★★★★Neso Academy

## SECURITY MECHANISMS

- ★ Encipherment
- ★ Digital Signature
- ★ Access Control
- ★ Data Integrity
- ★ Authentication Exchange
- ★ Traffic Padding
- ★ Routing Control
- ★ Notarization

Security Mechanisms★★★★★Neso Academy

## TARGET AUDIENCE

- ★ Undergraduate students
- ★ Preparing for GATE or other competitive exams
- ★ Preparing for networking interview
- ★ Prerequisite to CCNA international certification course
- ★ Demystify networking technologies and jargons

★★★★★Target AudienceNeso Academy



## SYLLABUS

- ★ Chapter 1: Fundamentals
- ★ Chapter 2: Data Link Layer
- ★ Chapter 3: Network Layer
- ★ Chapter 4: Transport Layer
- ★ Chapter 5: Application Layer
- ★ Chapter 6: Network Security

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★★★★★ Syllabus Neso Academy

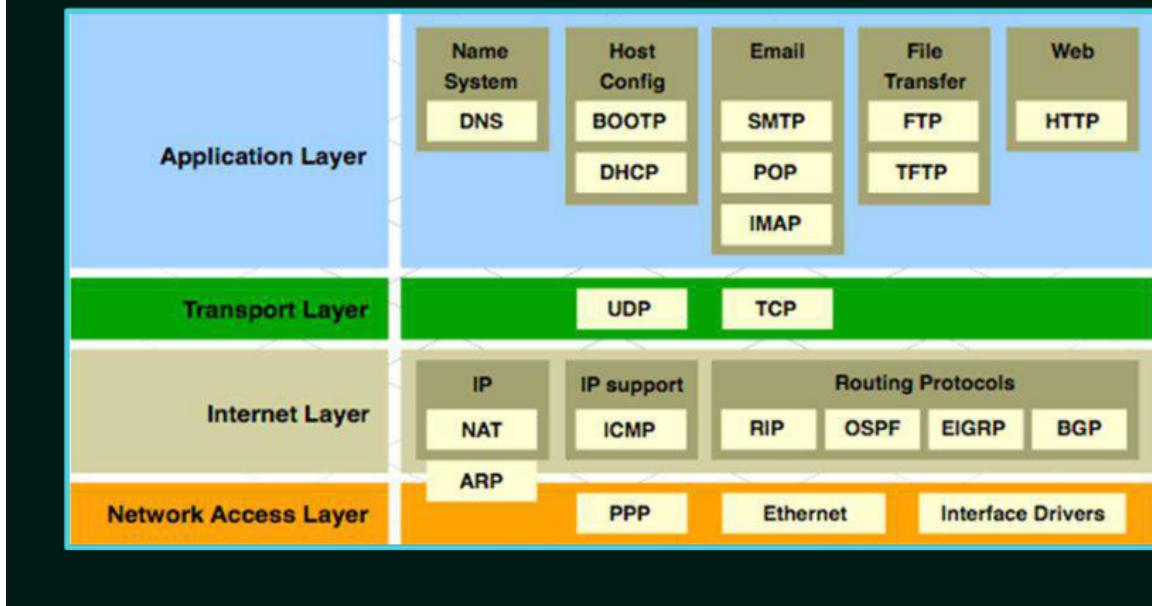
## OSI REFERENCE MODEL

Application Layer	FTAM, Mail Services and Directory Services.
Presentation Layer	Translation, Encryption and Compression.
Session Layer	Dialog control and Synchronization.
Transport Layer	Port Addressing, Segmentation and Reassembly, Connection Control, Flow control and Error Control
Network Layer	Logical Addressing and Routing.
Data Link Layer	Framing, Physical Addressing, Flow Control, Error Control, and Access Control.
Physical Layer	Physical characteristics of the media, Representation of bits, Data rate, Synchronization of bits, Line configuration, Physical topology and Transmission mode.

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OSI Reference Model Neso Academy

## THE TCP/IP PROTOCOL SUITE



The TCP/IP protocol suite Neso Academy

## PEDAGOGY



Lecture (equivalent to chalk and talk)



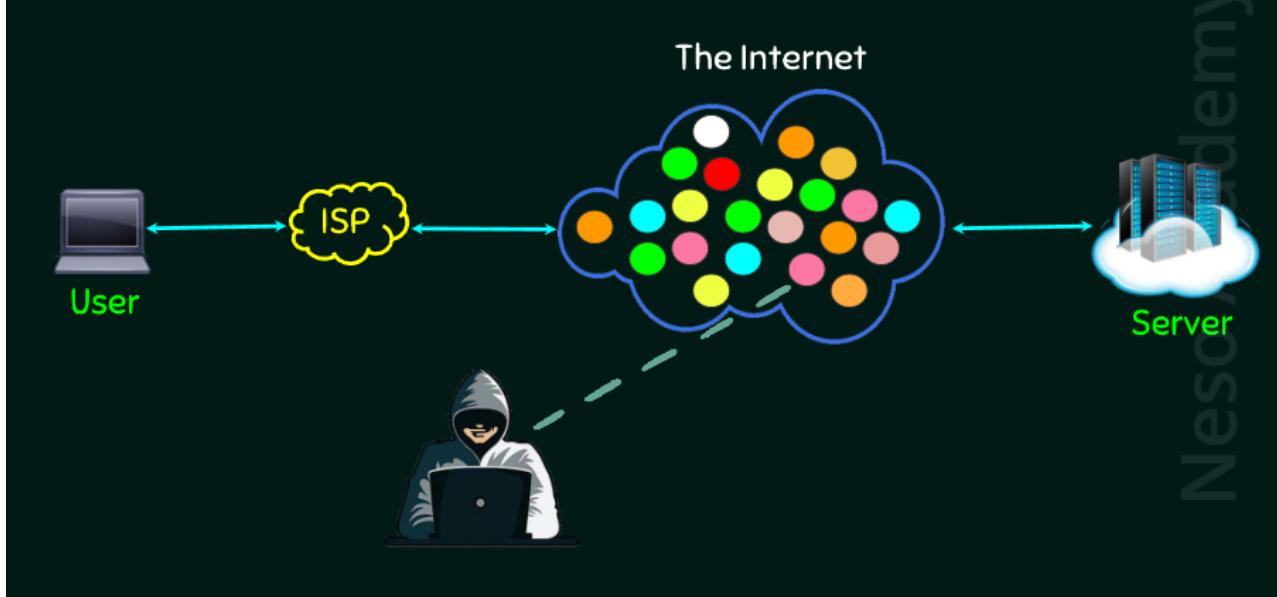
Problem Solving



Simulation using Cisco packet tracer and real time captures

Pedagogy Neso Academy

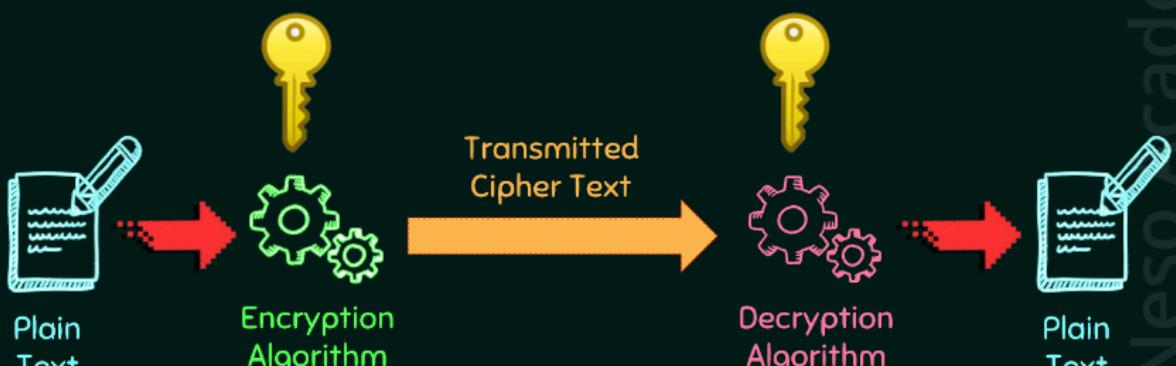
## NEED FOR NETWORK SECURITY



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## CRYPTOGRAPHY

*"The art or science encompassing the principles and methods of transforming an intelligible message into one that is unintelligible, and then retransforming that message back to its original form."*



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THANK YOU!

Thank you!Neso Academy