Domain Name Service (cont.)

- Example: Non-local Domain Name Resolution
  - If we are at Colby and want to open abc.com. This will lead to a recursive domain name resolution.

- DNS tools:
  - nslookup google.com (brief)
  - dig google.com (medium)
  - whois google.com (detailed)
Electronic Mail — SMTP

- Designed for asynchronous message delivery
  - This means that messages can be delivered to the other end of the network, and receivers can read the messages when they are available.
  - It puts a message in a message pool and doesn’t require immediate response.
  - Robustness and reliability should also be considered in the design.

- Two types of agents
  - Message Transfer Agent (MTA)
    - A software transfer a message from one computer to another computer using SMTP
    - They are also called mail servers and often keep mailboxes for email.
    - Has two queues: outgoing message queue, received message queue (inbox)
  - Message User Agent (MUA):
    - A computer program allow users to read, reply to, forward, save, and compose message
    - They are mail clients and can be on the same host as MTA or not.

- From the above figure, we can observe that there are two types of interactions (and protocols) between these two types of agents
  - MTA to MTA (SMTP/ESMTP)
  - MUA to MTA (POP-3/IMAP)

MTA to MTA

- A protocol support MTA to MTA interaction is Simple Mail Transfer Protocol (SMTP): port 25
  - If the mailbox of the message recipient is not hosted locally, the message is forwarded to another MTA. Each relaying MAT adds a Received trace header field to the top of the message header.
  - SMTP is not built with no encryption nor authentication. Since the MUA was hosted on the same host as MTA, it could rely on the system authentication for user access.
Therefore, a “not so simple” mail transfer protocol is needed. **ESMTP** (extended SMTP) addresses the authentication problem, which is adopted by many current emails, and **TLS** (Transport Layer Security) (port 587) is used to address encryption.

---

**SMTP Example**

- We use **gloin** to demonstrate a SMTP communication. In this example, we transmit a message from **gloin** to itself. The MUA is on the same host. We will use the program **mail** to check the received email.

  ```
gloin:~> nc localhost 25
220 gloin.cs.colby.edu ESMTP Postfix (Ubuntu)
helo gloin.cs.colby.edu
250 gloin.cs.colby.edu
mail from: yingli@gloin.cs.colby.edu
250 2.1.0 Ok
rcpt to: yingli@gloin.cs.colby.edu
250 2.1.5 Ok
data
354 End data with <CR><LF>.<CR><LF>
subject: SMTP test
this is a test
.
250 2.0.0 Ok: queued as 1DD9C7C007F
quit
221 2.0.0 Bye

gloin:~> mail
Mail version 8.1.2 01/15/2001. Type ? for help.
"/var/mail/yingli": 1 message 1 new
> N 1 yingli@gloin.cs.c Mon Sep 30 12:27   14/552   SMTP test
& more 1
& quit
Saved 1 message in /personal/yingli/mbox

gloin:~>
```

- The red texts above are the responses from the mail server. The number in each response indicate the status of the mail server.
  - 220: The server is ready
  - 250 Ok: The prior request is completed
  - 354: The server is ready to receive data
  - 221: end the interaction
  - 550: you may receive 550 after rcpt, which means the address is not existed or it's returned by recipient's firewall.

- The green texts are the requests sent by users. The SMTP commands are:
  - helo: reach out the the server
  - mail from: followed by sender's address
  - rcpt to: followed by recipient's address
- data: let the server know that you are going to send the message
- subject: email subject
- .: email body ends with a . on a newline by itself.
- quit: end the interaction

MUA to MTA Communication
- MUA and MTA on the same host in the past
  - MUA and MTA communicate using files
  - use of host’s authentication methods

- MUA and MTA communicate over a network in nowadays
  - SMTP was not designed for retrieving messages
    - it can push message to the server, but cannot pull the message from the server
  - retrieving mail: POP-3 and IMAP (include authentication)
    - POP-3 (post office protocol - version 3): port 110
      - manage messages locally, cannot access messages/folders from different machines
    - IMAP (Internet Mail Access Protocol):  
      - significantly more complex
      - enable manage and organize message on the MTA, so can access folders across machines
      - obtain components of messages, useful for low bandwidth
MIME

- **Problem:** SMTP was designed to deliver **limited length, English text only**
- **Solution:** MIME (Multipurpose Internet Mail Extensions) (but can be use for HTML)
  - make **everything look like text**
  - package the **message** (including text, characters, images, icons, audio, video, etc.) and **mark it with content type** so it can be unpacked and rendered on the receiving end
- Emails are transmitted via SMTP in MIME format.

HTTP Overview

- **URL (Universal Resource Locator)**

- Web page
  - A html file references to various objects such as images, movies, etc.

- HyperText Transfer Protocol (HTTP)
  - defines how web clients request web pages from Web servers and how servers transfer Web pages to clients.
  - **Client and Server architecture**
    - Client side - web browser
    - Server side - web server (Apache, Microsoft Internet Information Server)
  - TCP underneath
  - **stateless protocol**
    - servers maintain no information about the client
    - this means if you take an online survey or purchase online, it’s not the http server keeps your answers or ordered items, but other techniques do that for you.
  - **Non-persistent and persistent connections**
    - Non-persistent
      - set up a TCP connection for each object on a html page
      - those connections may be sequential or parallel. The browser controls the degree of parallelism. (Default 5-10 parallel connections)
    - Persistent (default)
• HTTP/1.1 persistent connection, the server leaves the TCP connection open after sending a response, and close a connection when it isn’t used for a certain time (configurable). Allow back-to-back objects/requests transmission.
• HTTP/2 allows multiple requests and replies to be interleaved in the same connection, and has mechanism for prioritizing HTTP message requests and replies within this connection. (https://www.digitalocean.com/community/tutorials/http-1-1-vs-http-2-whats-the-difference)

HTTP GET Method
- GET
  • let a client requests data from the server
  • e.g., open a website

GET Examples
- In this example, we use nc coupled with a well formatted GET request to retrieve the following webpage on the terminal and investigate the HTTP response.