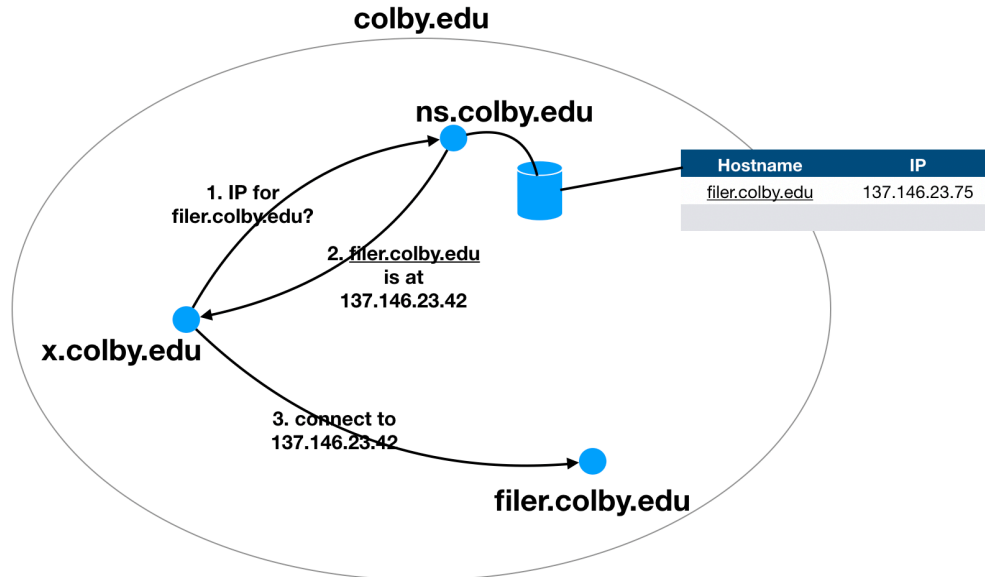


Application Layer (III)

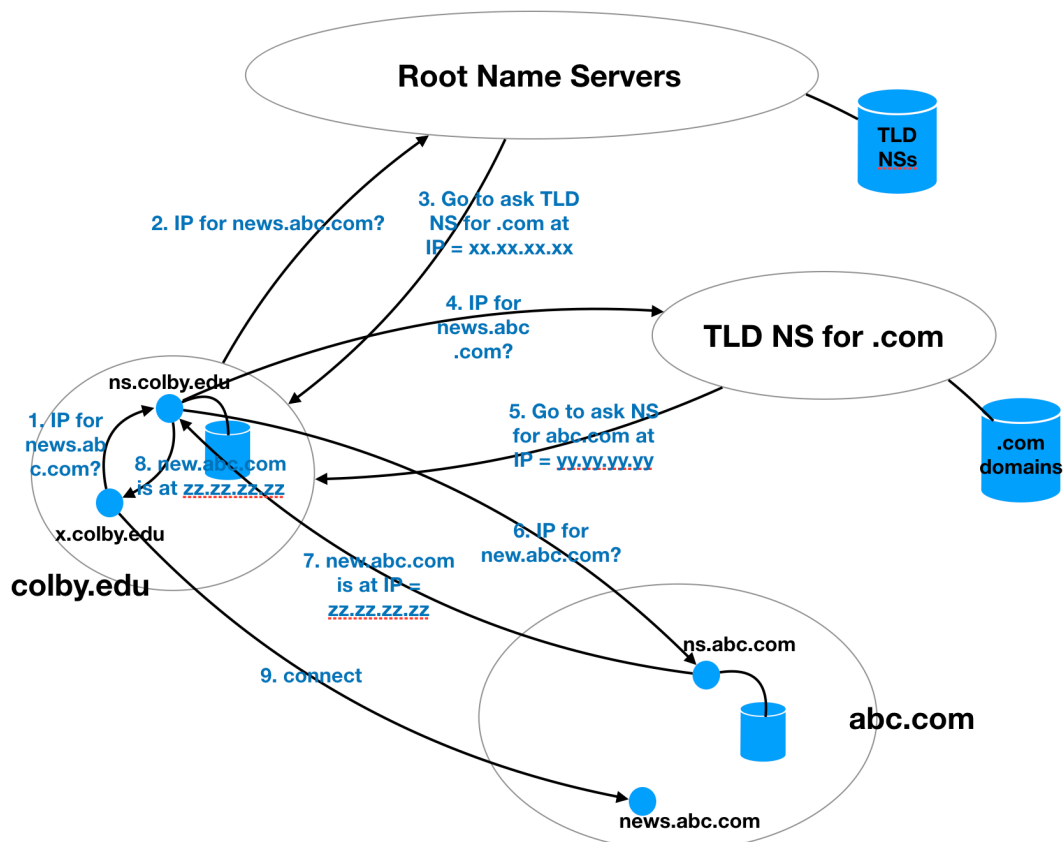
Domain Name Service (cont.)

- If you are asked to implement a system to provide domain name service, there are two possible solutions, centralized database and fully distributed database. Which solution you will select?
 - If choosing the centralized one, the system has to face the possibility of a single point of failure, large traffic volume, distant centralized database, and maintenance challenges (as it's a huge database).
 - So, the fully distributed solution will be a better solution.
- The system to provide domain name service is actually a distributed redundant, hierarchical database.
 - Root Name Servers
 - 13 logical root name servers are operated by 12 independent organizations
 - logical names in the form letter.root-servers.net, where letter ranges from a to m
 - each operator uses redundant computer equipment to provide reliable service
 - all (except B-root) operate in multiple geographical locations using anycast addressing
 - Top-level domain (TLD) servers
 - There is a TLD server cluster for each of the top-level domain (com, org, net, edu, and gov, and uk, fr, ca and jp)
 - Verisign Global Registry Services maintains the TLD servers for .com
 - Educause maintains the TLD servers for .edu
 - Authoritative DNS server
 - Every organization with publicly accessible hosts (e.g. web servers and mail servers) on the Internet must provide publicly accessible DNS records.
 - Implement own server or pay to have these records stored in an authoritative DNS server
 - Most universities and companies implement and maintain their own primary and secondary (backup) authoritative DNS servers.
 - Local DNS server
 - not strictly belong to the hierarchy
 - default name server, close to the host, may be in the same LAN
 - act as a proxy
 - can be used for DNS caching
- Query delegation
 - iterative (non-recursive): local domain name resolution
 - recursive: domain name resolution

- Example: Local Domain Name Resolution
 - If we are at Colby and want to connect to filer.colby.edu. This will lead to a local domain name resolution using Colby local DNS server.
 - ns.colby.edu(Colby local DNS server, 137.146.28.78) filer.colby.edu(137.146.23.75)



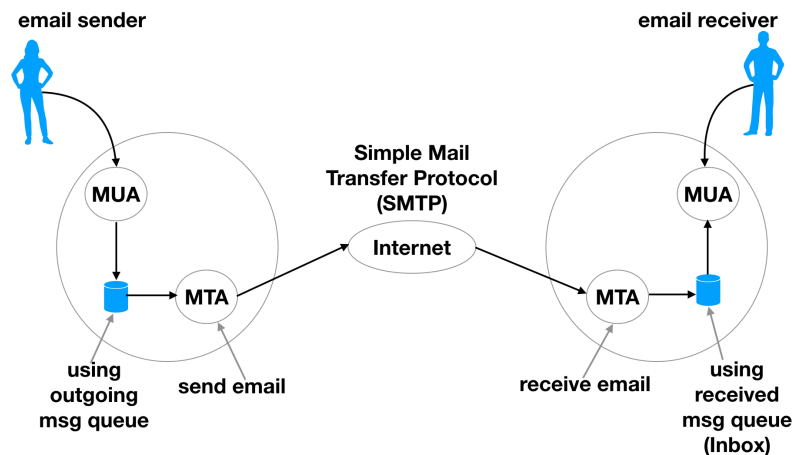
- Example: Non-local Domain Name Resolution
 - If we are at Colby and want to open abc.com. This will lead to a recursive domain name resolution.



- 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

Disclaimer: Notes adapted from the textbook and online resources.