IOWA

CS3640

Application Layer (5): Email & SMTP

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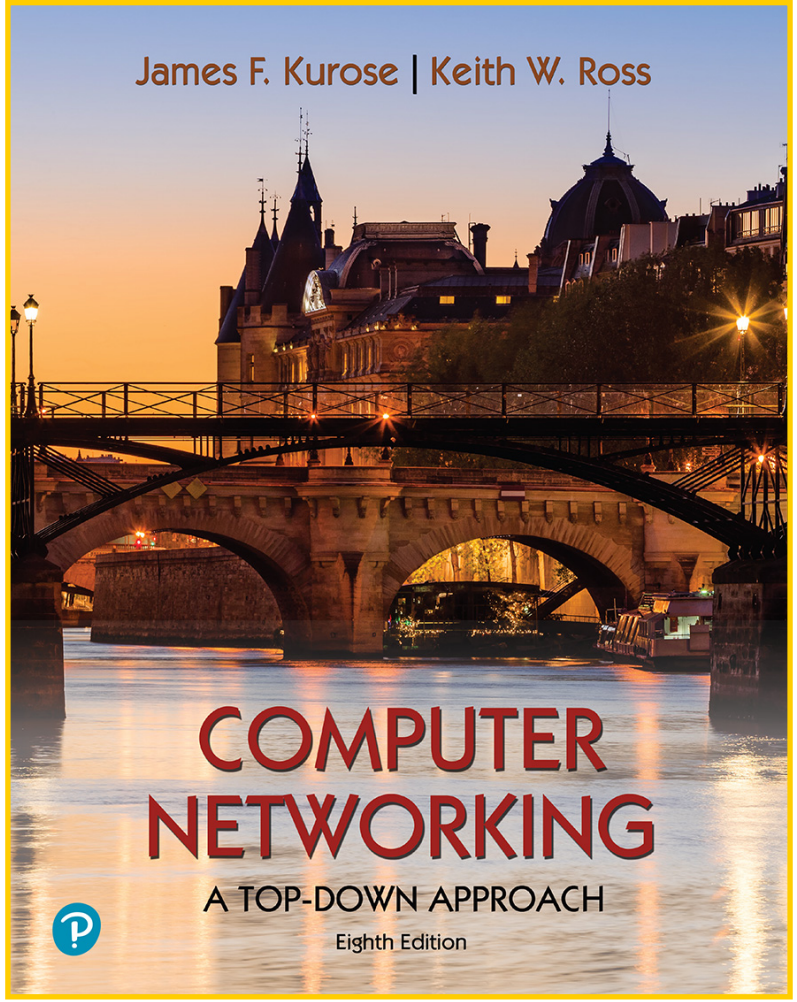
Lecture goals

Understand the protocols and mechanics of electronic mail

- *Email infrastructure*
- *SMTP*
- *IMAP*



Chapter 2.3

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A brief history of electronic mail

1965: MIT's time sharing system, CTSS, introduces the MAIL command. It allows its users to send messages asynchronously to each other

1971: Ray Tomlinson writes the first mail program for ARPANET. To separate ARPANET users (~50) from their machines (~15), Tomlinson proposes user@host syntax

1976: Jimmy Carter uses emails in his presidential campaign

1992: Emails get the ability to "attach" non-ASCII content

2020: ~246 billion emails are sent everyday!

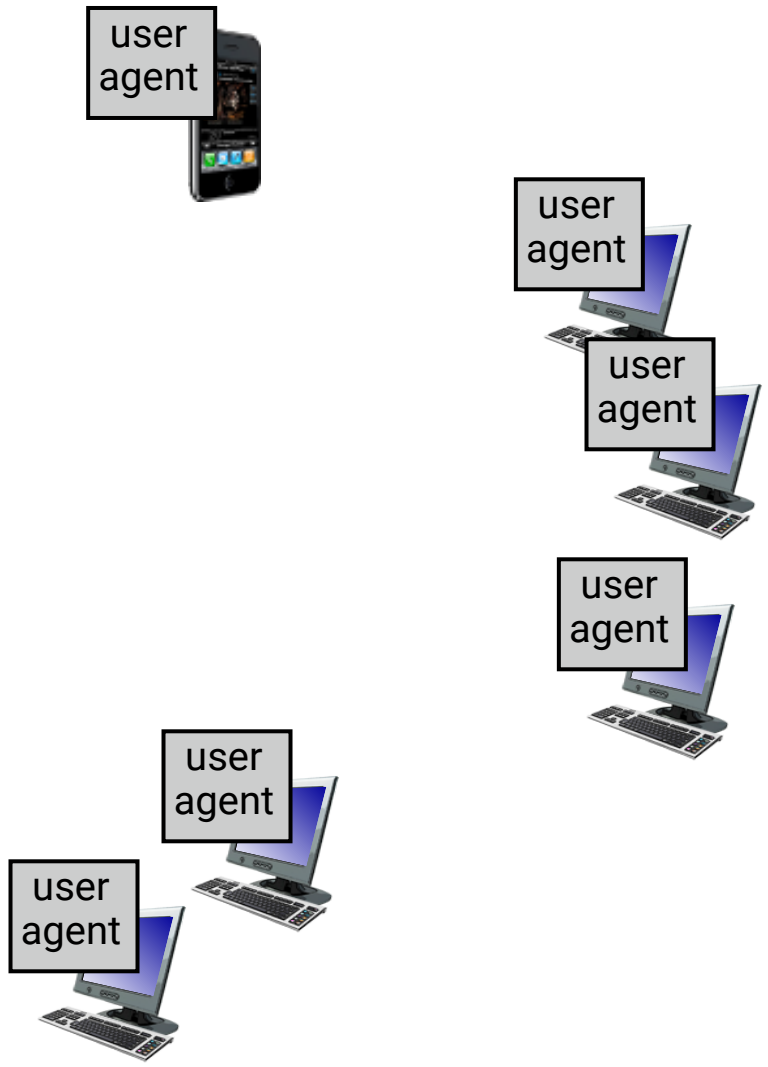
E-mail Infrastructure

Three major components

- user agents
- mail servers
- email protocols

1. User Agents (UA)

- the client app of the email system
- allow users to read, reply to, forward, save and compose emails
- E.g., Outlook, Mail.app, iPhone Mail



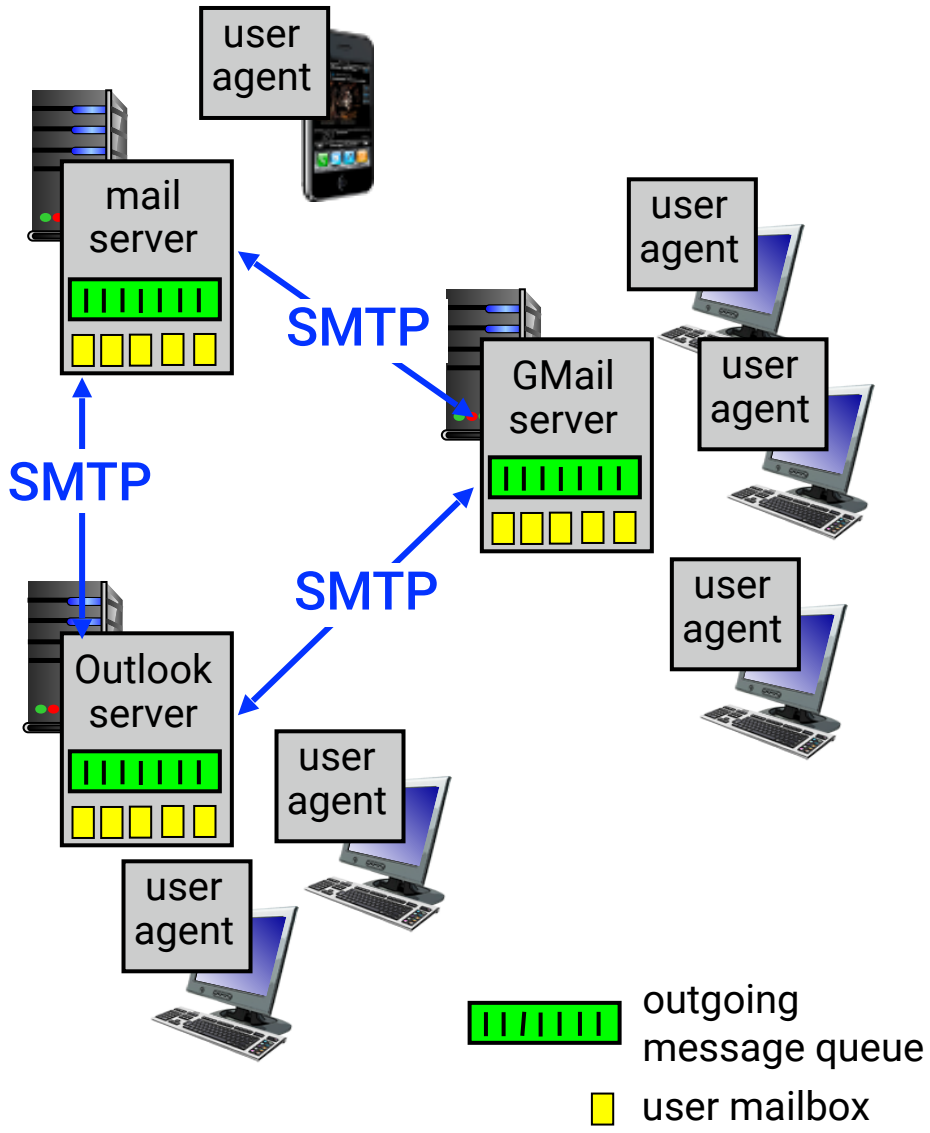
E-mail Infrastructure

2. Mail Servers

- offer email as a service
- creates a mailbox for each user, where it stores their incoming mails
- message queue of outgoing (to be sent) mail messages

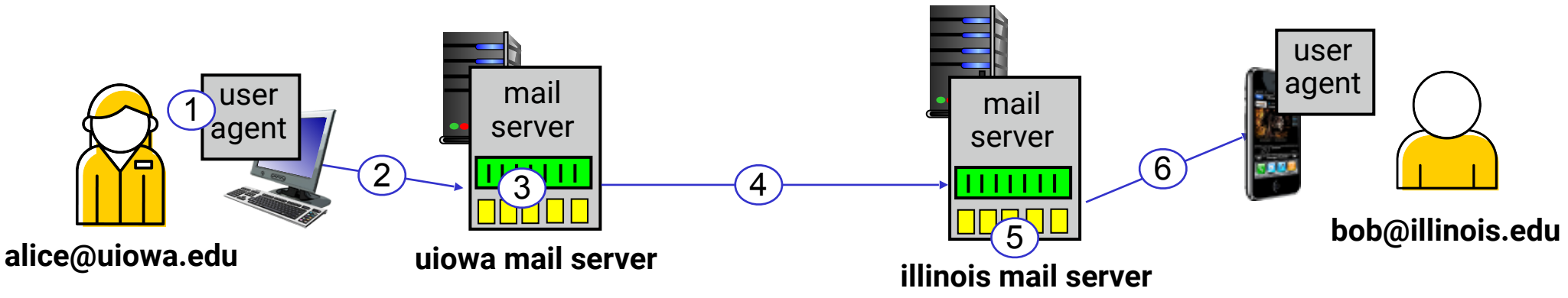
3. Email Protocols

- SMTP for sending emails to mail servers
- IMAP for retrieving emails from a mail server



Email in action

1. Alice uses her UA to compose an email message to bob@illinois.edu
2. Alice's UA sends message to her uiowa mail server using SMTP; server places it in the message queue
3. uiowa mail server opens a TCP connection with illinois mail server
4. uiowa server (i.e., SMTP client) sends the message to illinois server (SMTP server) over the TCP connection
5. illinois mail server places the received message in Bob's mailbox
6. Bob uses his UA to retrieve the message at a later time



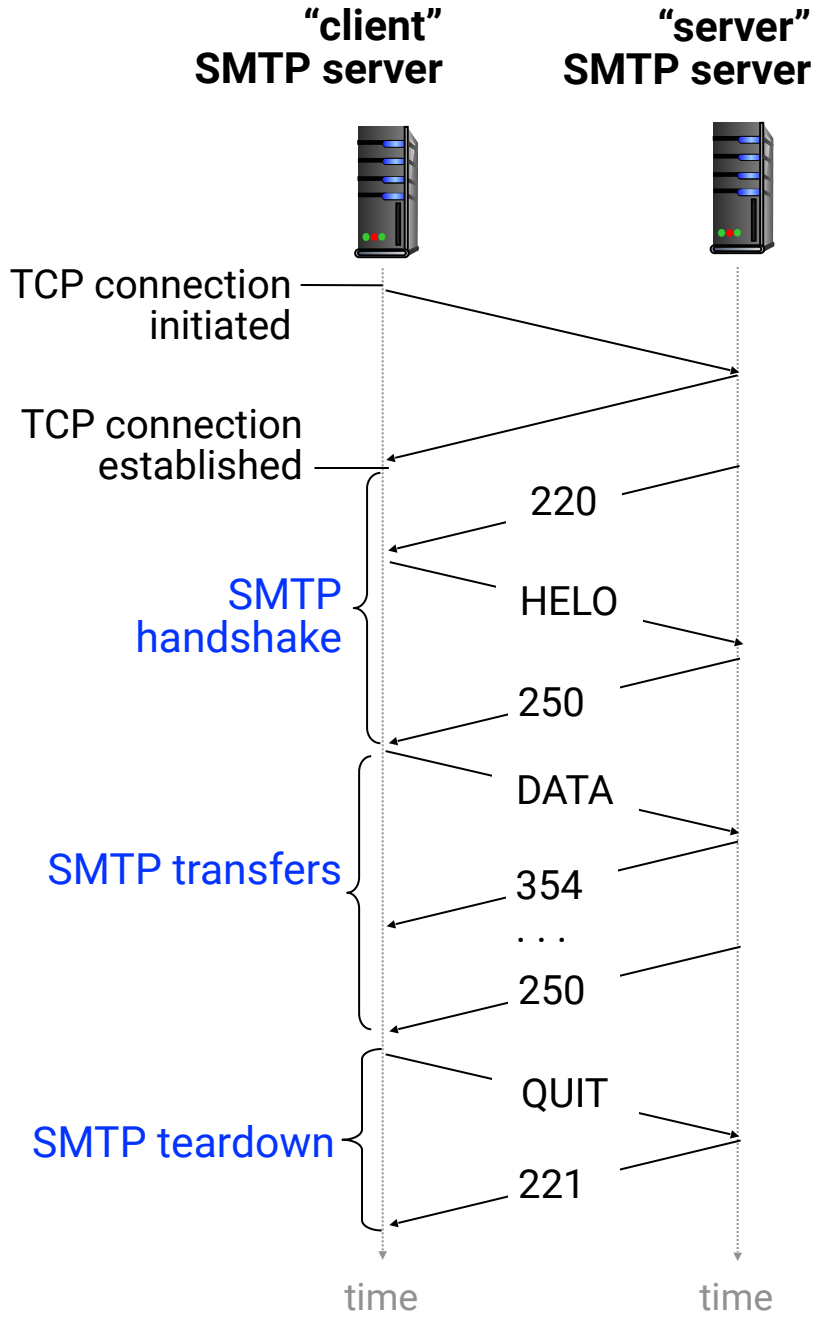
SMTP

SMTP

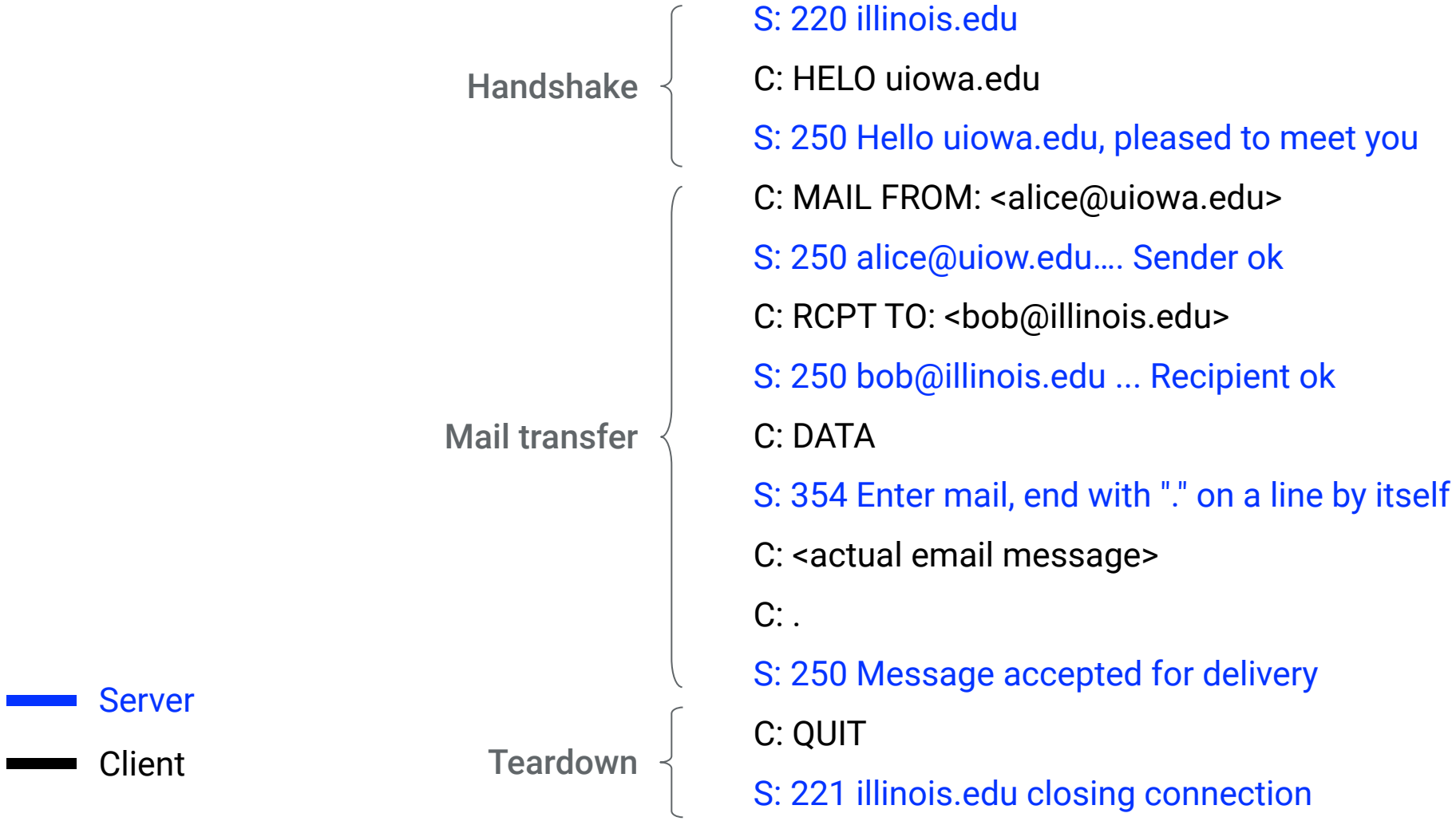
- Protocol for pushing email messages to a mail server
- Defined in RFC 5321 *(original RFC 821 created in 1982)*
- Uses client-server model and ASCII syntax
- Uses TCP for reliable transfer
- SMTP servers listen on port 25

Three phases of SMTP dialog

- SMTP handshake
- SMTP transfer
- SMTP closure



SMTP interaction



SMTP response codes

2XX Positive completion

211 *System status, or system help reply*
214 *Help message*
220 *Service ready*
221 *Goodbye*
235 *Authentication succeeded*
250 *Requested mail action completed*
251 *User not local; will forward*
252 *Cannot verify the user, but it will try to deliver*

3XX Positive intermediate

334 *Server challenge*
354 *Start mail input*

4XX Negative transient

421 *Service not available,*
432 A password transition is needed
450 *Mailbox unavailable*
451 Requested action aborted: local error
451 *IMAP server unavailable*
452 *Requested action not taken: insufficient storage*
454 *Temporary authentication failure*
455 *Server unable to accommodate parameters*

5XX Negative permanent

500 *Syntax error, command unrecognized*
502 *Command not implemented*
503 *Bad sequence of commands*
504 *Command parameter is not implemented*
521 *Server does not accept mail*
523 *Encryption Needed*
530 *Authentication required*
534 *Authentication mechanism is too weak*
535 *Authentication credentials invalid*
554 *Message too big for system*
556 *Domain does not accept mail*

Email Format

- Formatting of the email is described in RFC 2822
- Think of this as what HTML is for HTTP

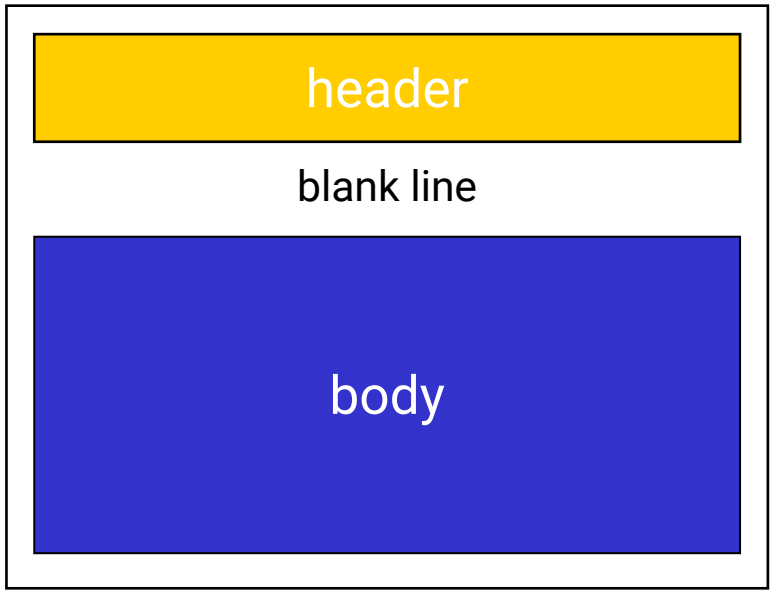
Header

- **From:** alice@uiowa.edu
- **To:** bob@illinois.edu
- **Subject:** Catch up at B1G this week?

These lines, within the body of the email message are different from SMTP's *MAIL FROM:*, *RCPT TO:* commands

Body

Actual message in ASCII format

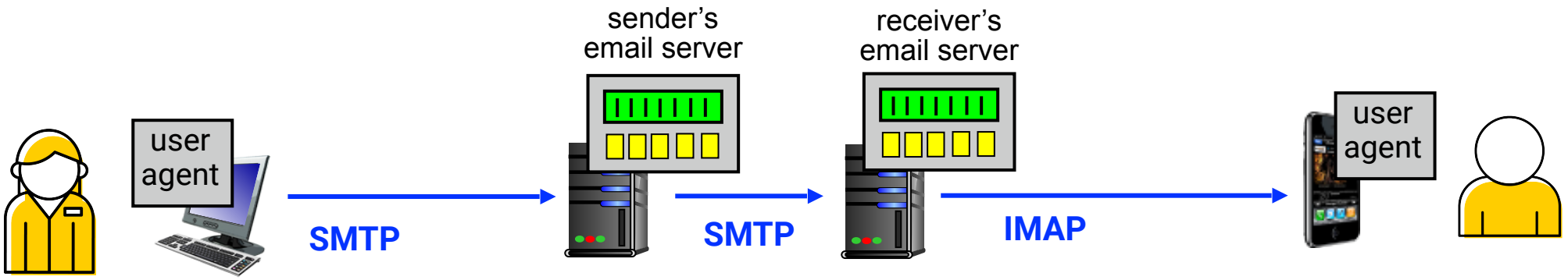


Observations

SMTP	HTTP/1.0
client pushes the content	client pulls the content
uses a persistent connection for sending multiple emails	initiates separate connections per object
requires content to be in ASCII	allows arbitrary coded content
follows a client-server model	follows a client-server model
stateless across invocations	stateless across invocations
human readable commands, headers, and status codes	human readable commands, headers, and status codes

IMAP

Retrieving Emails



SMTP is used to push e-mail messages from sender's server to receiver's server

How about sending emails to your mail server?

- Yes, SMTP could be used to push the emails

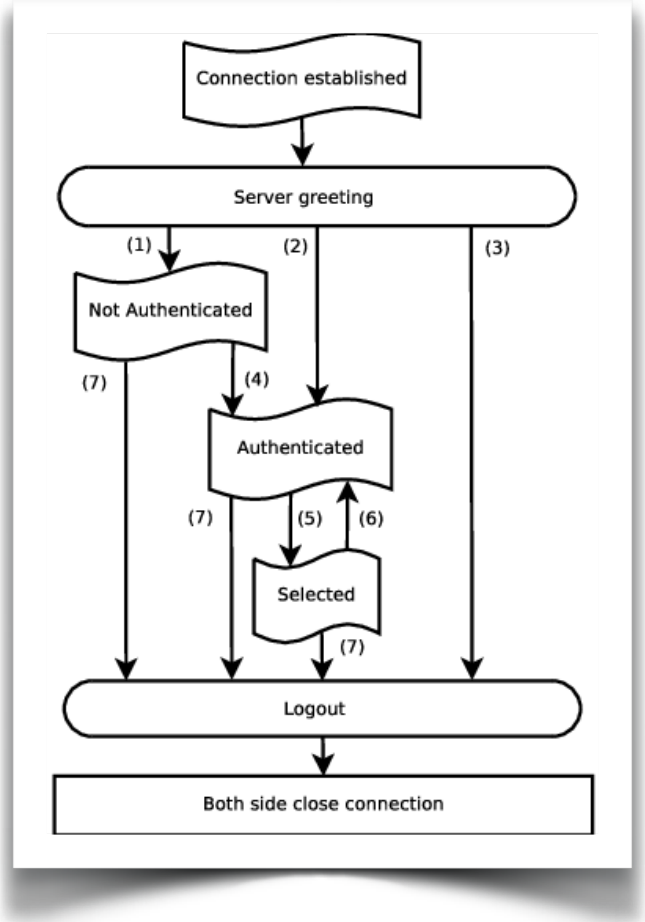
How about retrieving emails from the server?

- SMTP cannot be used ∵ it requires the UA to be available all the time
- Solution: **Internet Mail Access Protocol** (RFC 3501)
- Example, *Apple Mail client* or *Microsoft Outlook client*

IMAP

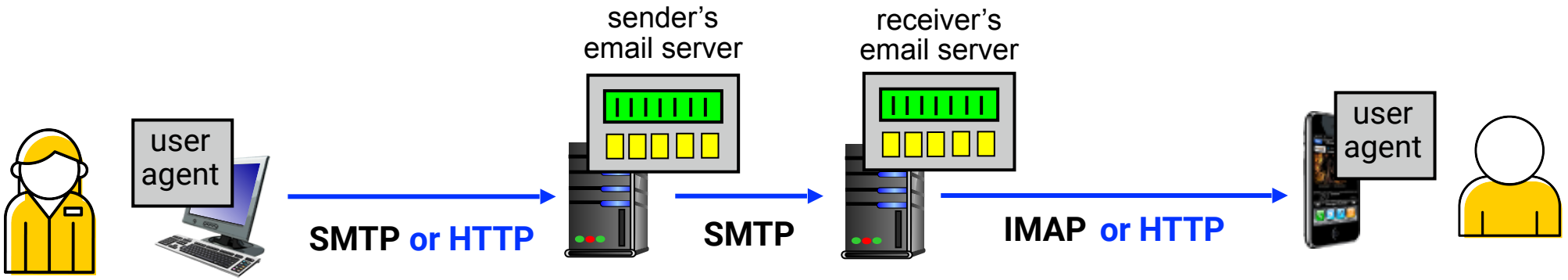
- Defined in RFC 3501 *(original RFC 1064 created in 1988)*
- **Goal**: permit a complete management of an email inbox
- Supports simultaneous access to an inbox by multiple clients. E.g., from home and office
- Uses unique mail-ids, flags to keep track of email state. E.g., whether an email has been read, replied to, or deleted
- Allows features such as server-side searches, storage management etc.
- Clients maintain persistent open TCP connections to be notified of new incoming mails

IMAPv4 state transition diagram



courtesy: Cesarini et.al., ERLANG 2008

Retrieving Emails



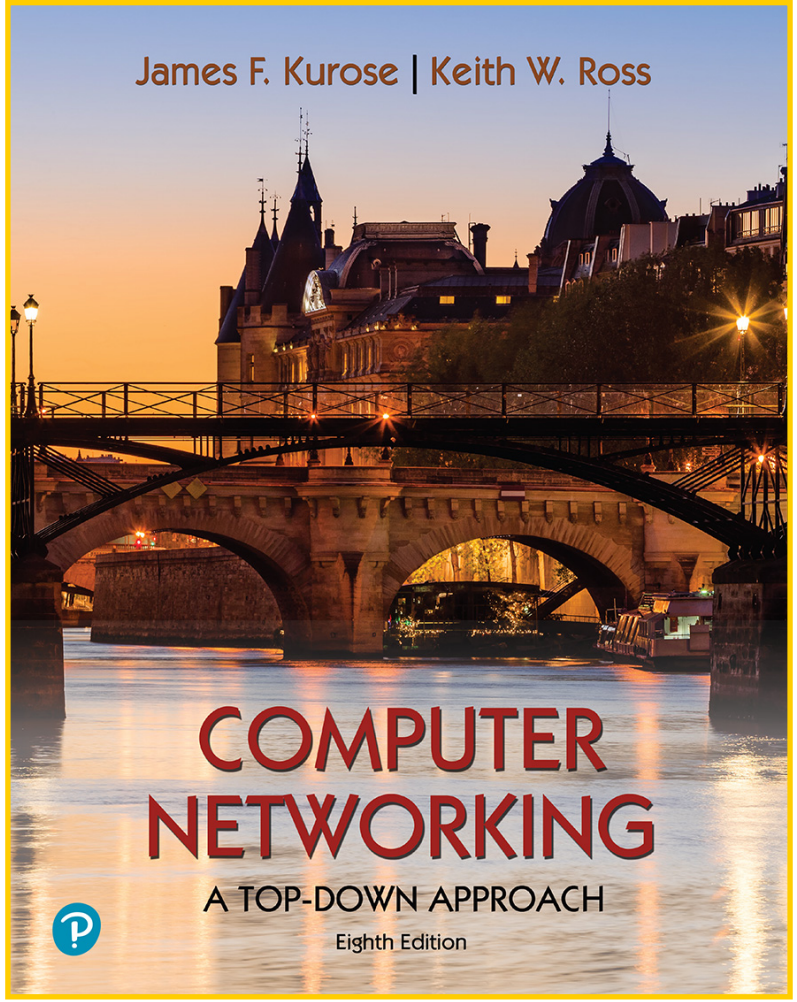
There is another way to retrieve emails from the server!

- Web-based Emails
- Email server also acts as an HTTP server and talks to UA, which is now an HTTP client
- But wait… can't we use HTTP interface to send mails as well?
- Sure, this is what web-based email services like *Gmail* and *Outlook365* do

Next lecture

how to build client-server applications that communicate using sockets

- *Socket programming*
- *TCP sockets*
- *UDP sockets*



Chapter 2.7

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Spot Quiz (ICON)