NSCOM01

TCP-based Network Application Protocols

3rd Term– AY2022 – 2023

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SPIRAL REVIEW: TRANSPORT SERVICES

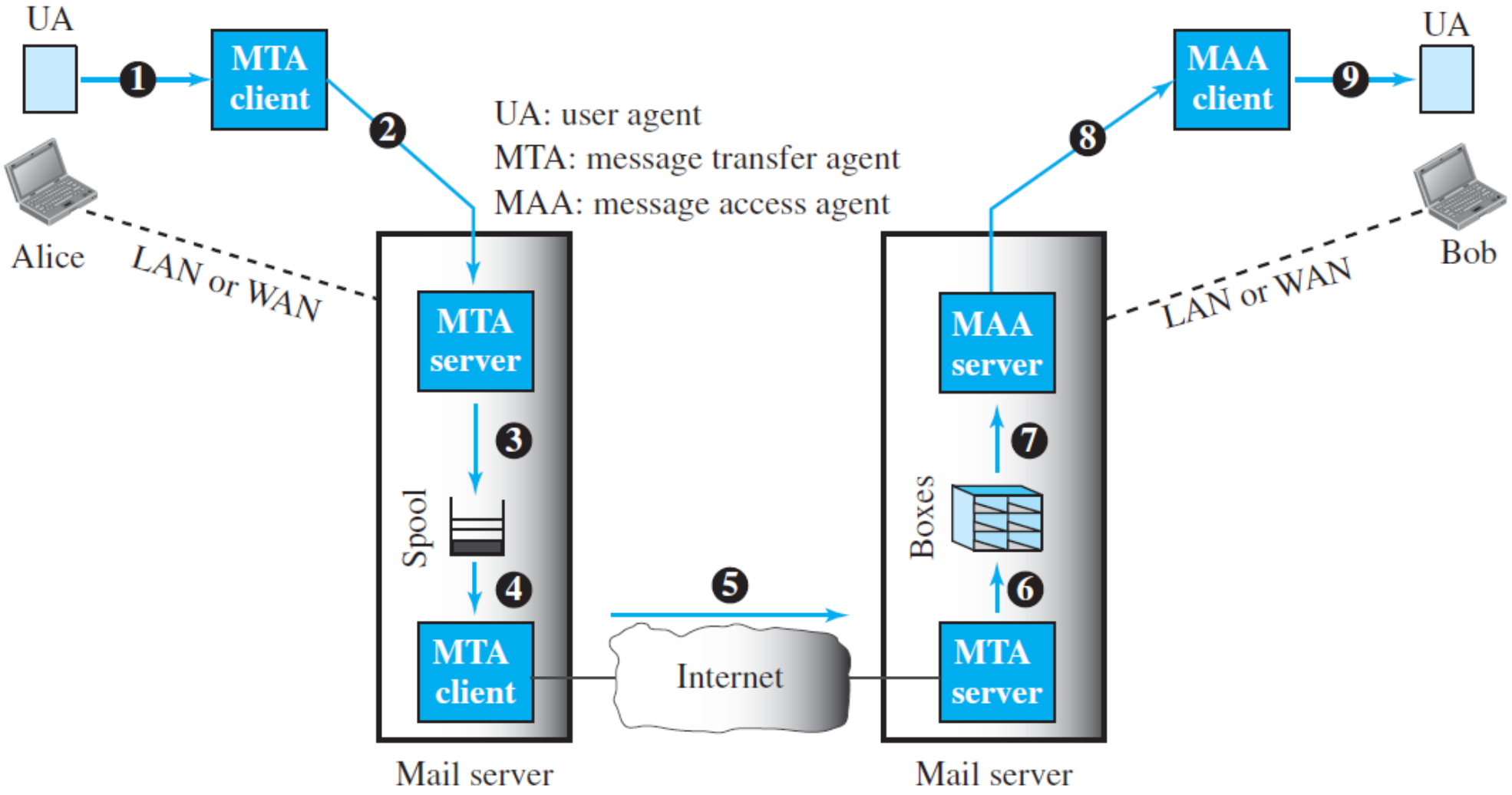
- **The Transport Control Protocol (TCP) is a connection-oriented transport protocol used in TCP/IP networks**
- **Provides reliable communication between pairs of processes (TCP users) across a variety of reliable and unreliable networks**
  - Features:
  1. Stream-oriented – Data is sent in segments but handled as streams
  2. Connection Oriented – Includes mechanisms to establish, track state and terminate a connection between 2 hosts
  3. Guaranteed delivery – packets are acknowledged by receiving hosts
  4. Flow control - Data transmission adapts to network conditions and host capability
  5. Ordered delivery – Segments may arrive out of-order but are reassembled in the correct sequence

EMAIL

ELECTRONIC MAIL

- **It allows users to exchange electronic messages**
- **E-mail is considered one-way transaction**
- **It uses intermediate servers**
- **Store-and-Forward method of sending, storing and retrieving electronic messages**
- **Relies on three separate protocols**
  - SMTP – Simple Mail Transfer Protocol (sending)
  - POP – Post Office Protocol (retrieving)
  - IMAP – Internet Message Access Protocol (retrieving)

COMMON SCENARIO



USER AGENT

- **a.k.a. “mail reader”**
- **composing, editing, reading mail messages**
  - e.g., Outlook, iPhone mail client
- **outgoing, incoming messages stored on server**

MAIL SERVERS

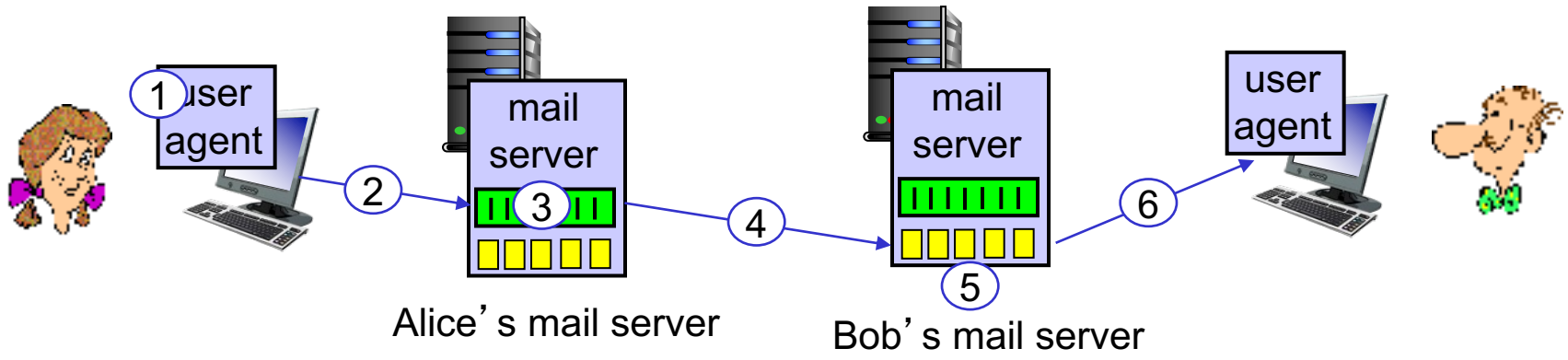
- **mailbox contains incoming messages for user**
- **message queue of outgoing (to be sent) mail messages**
- **SMTP protocol between mail servers to send email messages**
  - client: sending mail server
  - "server": receiving mail server

RFC 5321

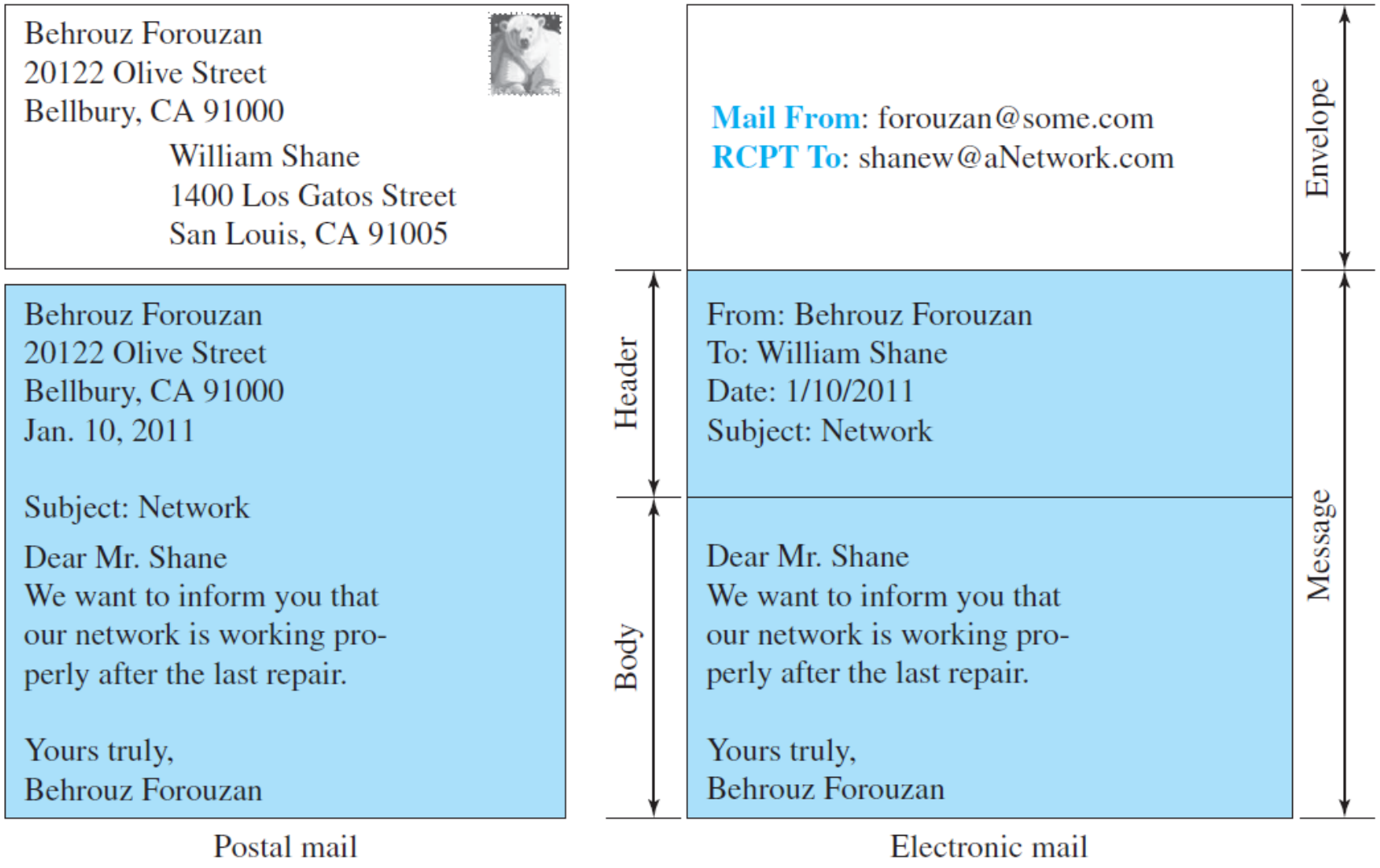
- **uses TCP to reliably transfer email message from client (mail server initiating connection) to server, port 25**
- **direct transfer: sending server (acting like client) to receiving server**
- **three phases of transfer**
  - handshaking (greeting)
  - transfer of messages
  - closure
- **command/response interaction (like HTTP)**
  - commands: ASCII text
  - response: status code and phrase
- **messages must be in 7-bit ASCI**

SCENARIO

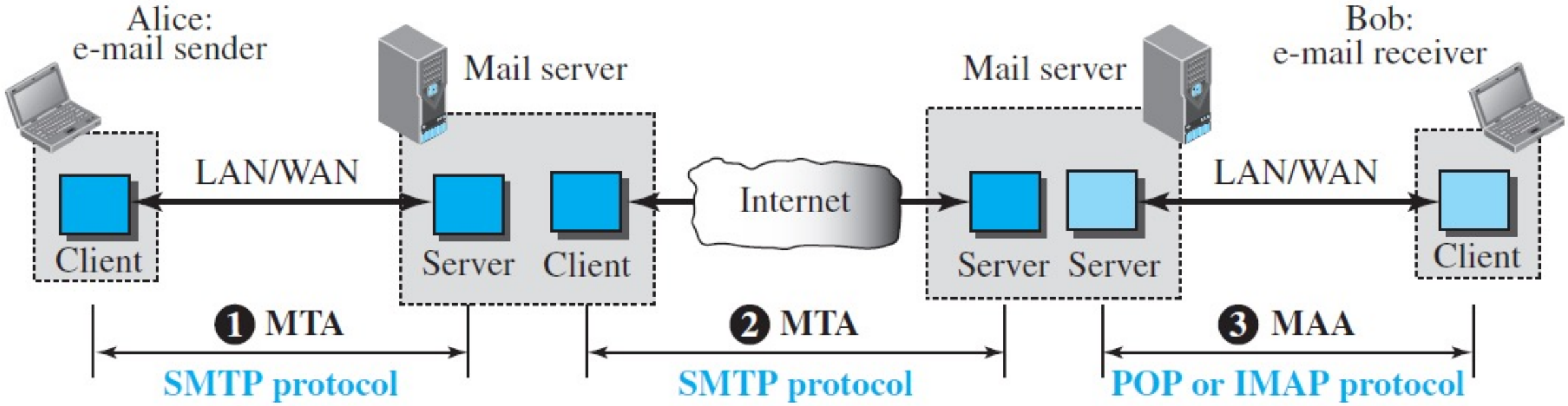
1) Alice uses UA to compose e-mail message “to” bob@someschool.edu
2) Alice’s UA sends message to her mail server; message placed in message queue
3) client side of SMTP opens TCP connection with Bob’s mail server
4) SMTP client sends Alice’s message over the TCP connection
5) Bob’s mail server places the message in Bob’s mailbox
6) Bob invokes his user agent to read message



FORMAT


Behrouz Forouzan
20122 Olive Street
Bellbury, CA 91000
William Shane
1400 Los Gatos Street
San Louis, CA 91005
Behrouz Forouzan
20122 Olive Street
Bellbury, CA 91000
Jan. 10, 2011
Subject: Network
Dear Mr. Shane
We want to inform you that
our network is working pro-
perly after the last repair.
Yours truly,
Behrouz Forouzan
Mail From: forouzan@some.com
RCPT To: shanew@aNetwork.com
Envelope
Header
From: Behrouz Forouzan
To: William Shane
Date: 1/10/2011
Subject: Network
Body
Dear Mr. Shane
We want to inform you that
our network is working pro-
perly after the last repair.
Yours truly,
Behrouz Forouzan
Message
Postal mail
Electronic mail

PROTOCOLS


Alice:
e-mail sender
Mail server
Mail server
Bob:
e-mail receiver
LAN/WAN
Internet
LAN/WAN
Client
Server
Client
Server
Server
Client
1 MTA
2 MTA
3 MAA
SMTP protocol
SMTP protocol
POP or IMAP protocol

SMTP COMMANDS

Keyword	*Argument(s)*	*Description*
HELO	Sender's host name	Identifies itself
MAIL FROM	Sender of the message	Identifies the sender of the message
RCPT TO	Intended recipient	Identifies the recipient of the message
DATA	Body of the mail	Sends the actual message
QUIT		Terminates the message
RSET		Aborts the current mail transaction
VRFY	Name of recipient	Verifies the address of the recipient
NOOP		Checks the status of the recipient
TURN		Switches the sender and the recipient
EXPN	Mailing list	Asks the recipient to expand the mailing list
HELP	Command name	Asks the recipient to send information about the command sent as the argument
SEND FROM	Intended recipient	Specifies that the mail be delivered only to the terminal of the recipient, and not to the mailbox
SMOL FROM	Intended recipient	Specifies that the mail be delivered to the terminal *or* the mailbox of the recipient
SMAL FROM	Intended recipient	Specifies that the mail be delivered to the terminal *and* the mailbox of the recipient

SMTP RESPONSES

Code	*Description*
	Positive Completion Reply
211	System status or help reply
214	Help message
220	Service ready
221	Service closing transmission channel
250	Request command completed
251	User not local; the message will be forwarded
	Positive Intermediate Reply
354	Start mail input
	Transient Negative Completion Reply
421	Service not available
450	Mailbox not available
451	Command aborted: local error
452	Command aborted; insufficient storage
	Permanent Negative Completion Reply
500	Syntax error; unrecognized command
501	Syntax error in parameters or arguments
502	Command not implemented
503	Bad sequence of commands
504	Command temporarily not implemented
550	Command is not executed; mailbox unavailable
551	User not local
552	Requested action aborted; exceeded storage location
553	Requested action not taken; mailbox name not allowed
554	Transaction failed

CONNECTION ESTABLISHMENT

- **After a client has made a TCP connection to the wellknown port 25, the SMTP server starts the connection phase. This phase involves the following three steps:**
  1. The server sends code 220 (service ready) to tell the client that it is ready to receive mail. If the server is not ready, it sends code 421 (service not available).
  2. The client sends the HELO message to identify itself, using its domain name address. This step is necessary to inform the server of the domain name of the client.
  3. The server responds with code 250 (request command completed) or some other code depending on the situation.

MESSAGE TRANSFER

- **After connection has been established between the SMTP client and server, a single message between a sender and one or more recipients can be exchanged. This phase involves eight steps. Steps 3 and 4 are repeated if there is more than one recipient.**

1. The client sends the MAIL FROM message to introduce the sender of the message. It includes the mail address of the sender (mailbox and the domain name). This step is needed to give the server the return mail address for returning errors and reporting messages.
2. The server responds with code 250 or appropriate code.
3. The client sends the RCPT TO message, which includes the mail address of the recipient.
4. The server responds with code 250 or some other appropriate code.
5. The client sends the DATA message to initialize the message transfer.

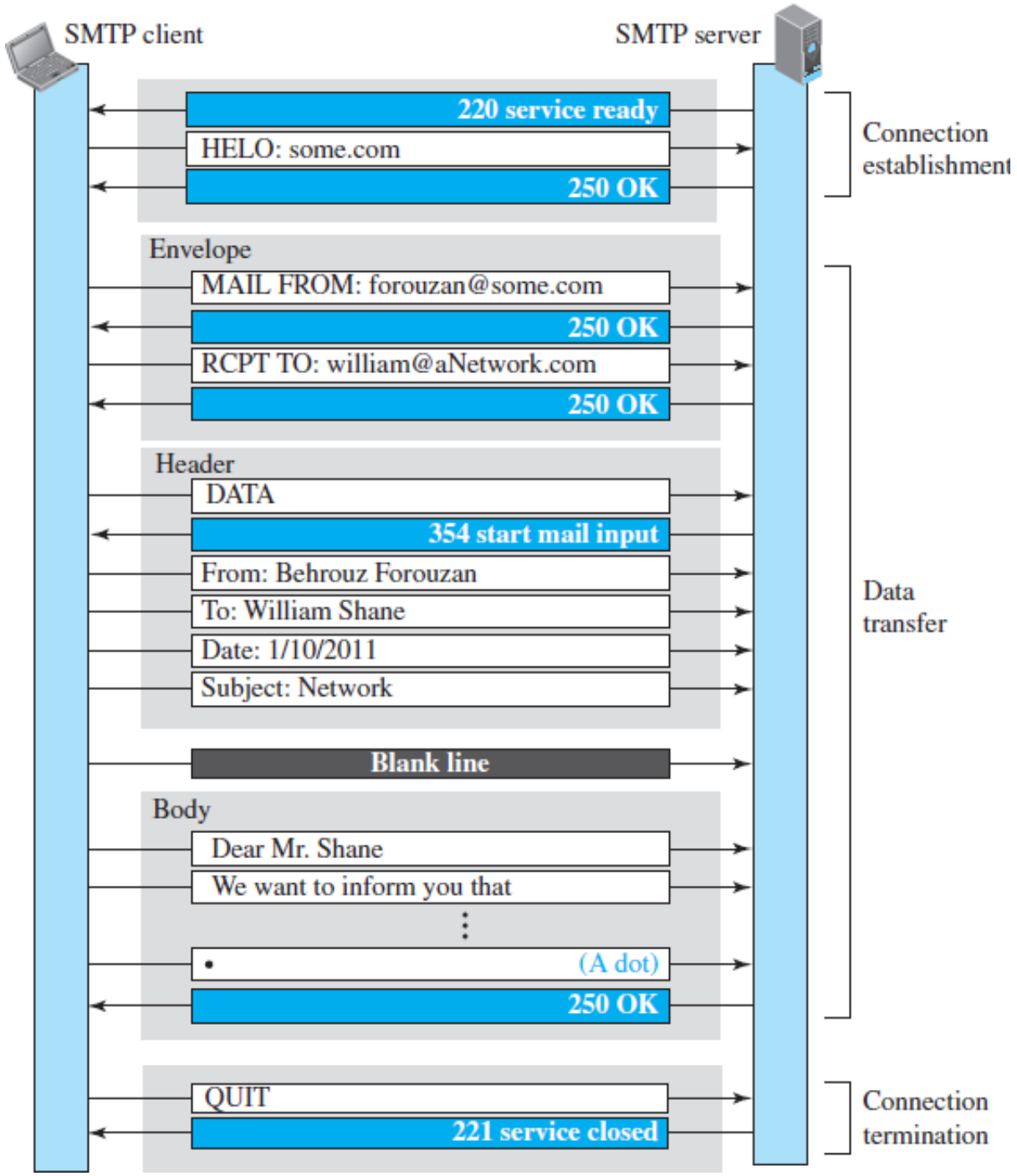
MESSAGE TRANSFER

- **After connection has been established between the SMTP client and server, a single message between a sender and one or more recipients can be exchanged. This phase involves eight steps. Steps 3 and 4 are repeated if there is more than one recipient.**

6. The server responds with code 354 or appropriate code.
7. The client sends the contents of the message in consecutive lines. Each line is terminated by a two-character end-of-line token. The message is terminated by a line containing just one period.
8. The server responds with code 250 (OK) or some other appropriate code.

CONNECTION TERMINATION

- **After the message is transferred successfully, the client terminates the connection**
  1. The client sends the QUIT command.
  2. The server responds with code 221 or some other appropriate code.

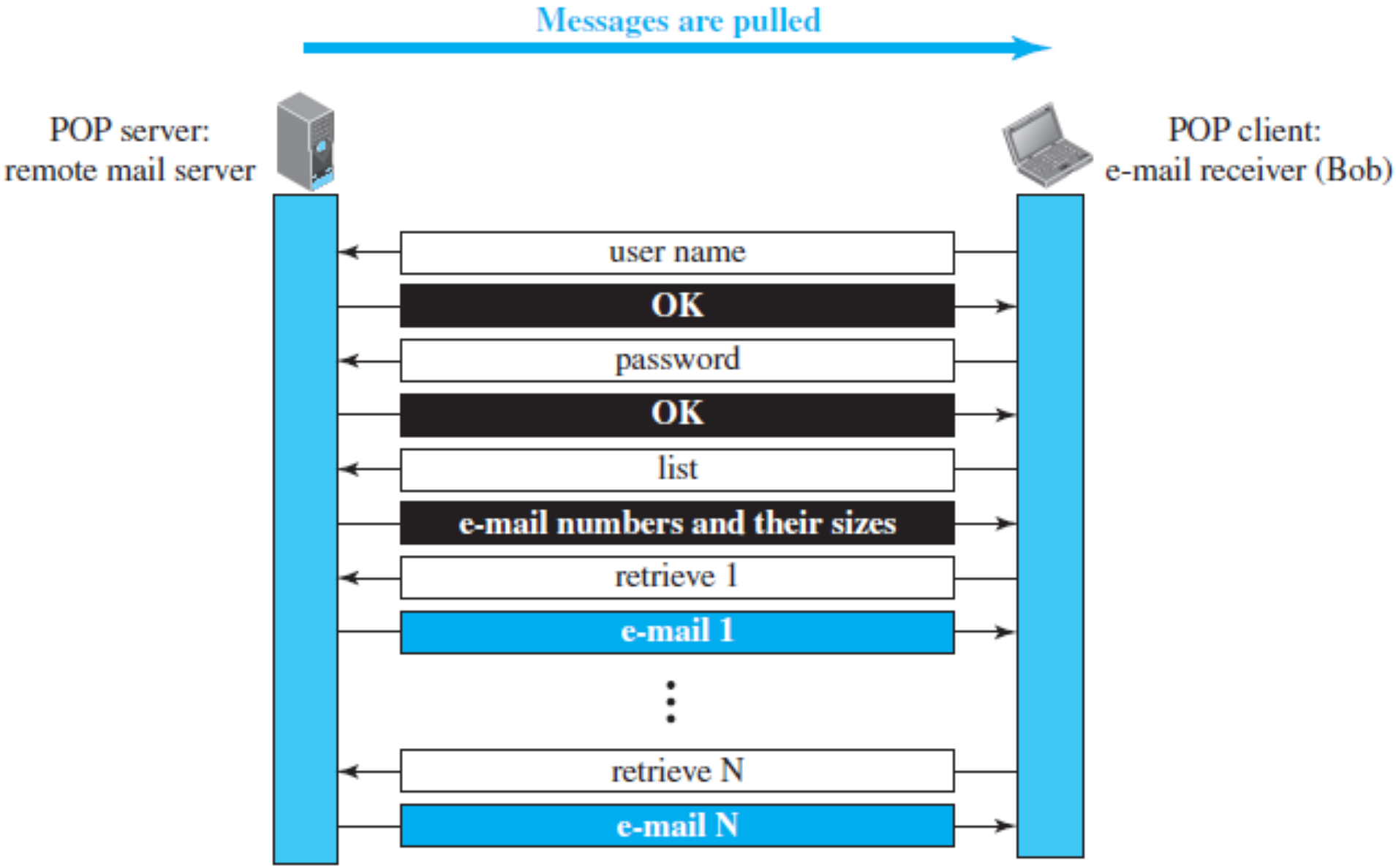

SMTP client
SMTP server
220 service ready
HELO: some.com
250 OK
Connection establishment
Envelope
MAIL FROM: forouzan@some.com
250 OK
RCPT TO: william@aNetwork.com
250 OK
Header
DATA
354 start mail input
From: Behrouz Forouzan
To: William Shane
Date: 1/10/2011
Subject: Network
Blank line
Body
Dear Mr. Shane
We want to inform you that
•
(A dot)
250 OK
Data transfer
QUIT
221 service closed
Connection termination

MESSAGE ACCESS AGENT

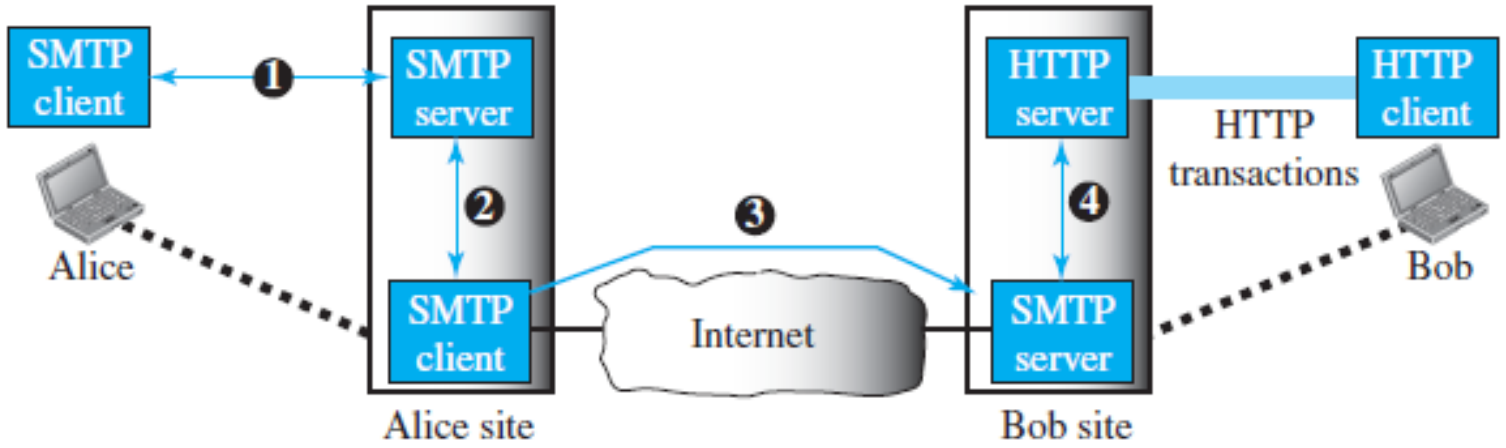
- **It uses ‘PULL’ protocol to retrieve messages from the server**
- **Two message access protocols:**
  - POP3
  - IMAP4

POP3

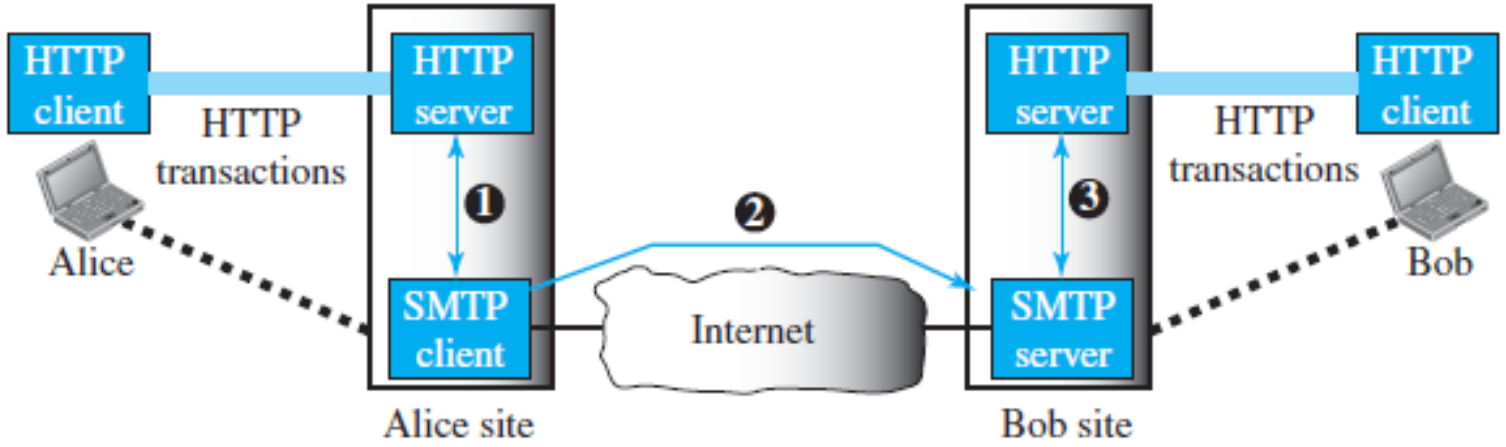
- Installed on the recipient computer
- POP3 server software installed on the mail server
- Mail access starts with the client when the user needs to download its e-mail from the mailbox on the mail server
- The client opens a connection to the server on TCP port 110.


Messages are pulled
POP server:
remote mail server
POP client:
e-mail receiver (Bob)
user name
OK
password
OK
list
e-mail numbers and their sizes
retrieve 1
e-mail 1
retrieve N
e-mail N

WEB-BASED MAIL



Case 1: Only receiver uses HTTP



Case 2: Both sender and receiver use HTTP

IMAP4

- **It has more features than POP3**
- **Features**
  - A user can check the e-mail header prior to downloading.
  - A user can search the contents of the e-mail for a specific string of characters prior to downloading.
  - A user can partially download e-mail. This is especially useful if bandwidth is limited and the e-mail contains multimedia with high bandwidth requirements.
  - A user can create, delete, or rename mailboxes on the mail server.
  - A user can create a hierarchy of mailboxes in a folder for e-mail storage.

MESSAGE FROM DPO

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