

Internet Engineering

241-461

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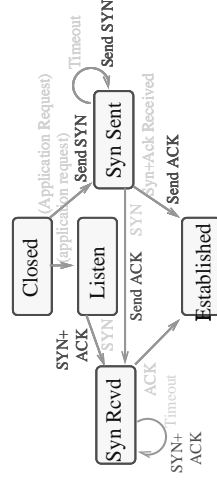
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TCP Simultaneous Open

◇ Both systems want to open connection

- At approximately the same time
- Before either has seen SYN from the other



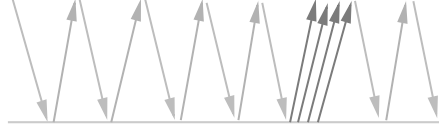
The End Problem

◇ Dealing with the last packet is hard

- What if it gets lost ?
- Can we acknowledge it?
- If we do,
 - Which packet is the last packet?
- ◇ Common transport protocol problem
 - ISO Transport simply aborts connection
 - Anything not received is discarded

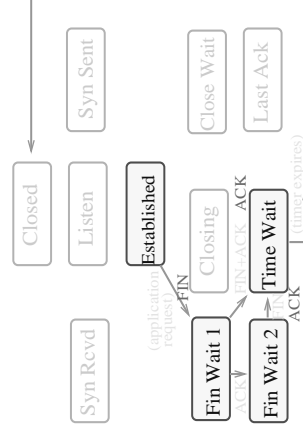
TCP Close requirements

- ◇ Applications so far
 - E-mail (SMTP)
 - Web (HTTP)
- ◇ E-Mail
 - No real requirement
- ◇ Web
 - Uses End-Of-Connection
 - ▷ Means end of data transfer
 - Many other applications similar
 - Must close carefully



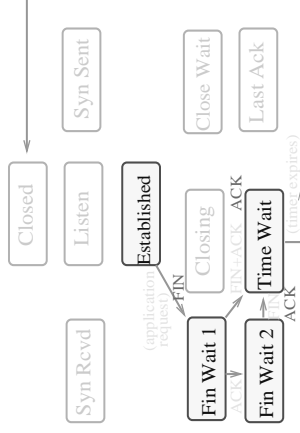
Greeting
Hello, my name is ...
Nice to meet you
I have mail from ...
Sender is OK
The recipient is ...
Recipient address is OK
Here is the message
Please send it now
The message
including headers
I have the message
Goodbye
Goodbye

TCP Initial Close



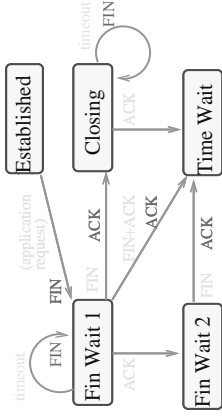
- ◇ Application asks to close
- ◇ TCP sends FINISH
 - Magic "data" like SYN
- ◇ No more data may be sent after FIN
 - FIN is always the last data sent (biggest SEQ number)
- ◇ FIN must be acknowledged
 - Like all other data

TCP Initial Close (2)



- ◇ FIN-WAIT-1 state
 - Sent FIN
 - Waiting for ACK
- ◇ FIN-WAIT-2 state
 - Transmitted FIN has been ACKnowledged
 - Connection now one way
 - ▷ Can continue receiving data
 - And acknowledge it
 - No more can be transmitted

TCP Initial Close (2)



◇ CLOSING state

- Sent FIN
 - Not yet ACKnowledged
- Received FIN
 - Other system is also closing

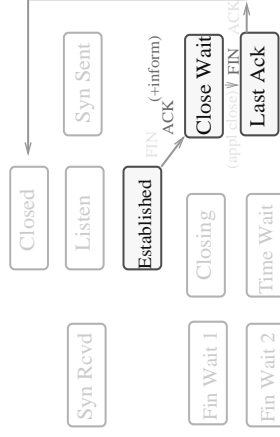
◇ TIME WAIT state

- Sent FIN and received FIN
- ACKnowledged other system's FIN

◇ Are we not done?

- Is this not just CLOSED state?

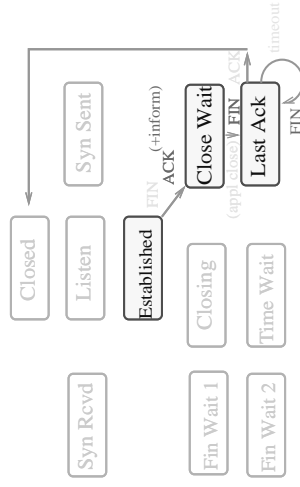
Receiving FIN while ESTABLISHED



◇ CLOSE WAIT state

- Have received FIN from other system
 - And ACKnowledged it
 - Send End-Of-Connection to Application
- Another one-way connection state
 - We cannot receive any more
 - No new data
 - We can still send
- Wait until application says it is done

Receiving FIN while ESTABLISHED (2)

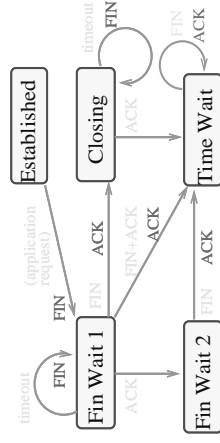


◇ LAST ACK state

- Were half-closed in CLOSE WAIT state
- Application tells us it is done
- We send FIN
 - Wait in LAST ACK to get ACK for FIN
- When ACK arrives
 - We are done
 - Back to CLOSED state

TIME WAIT

◇ Why TIME WAIT ?



- Everything has happened?
- But that is at our system
 - What do we know about other system?
- ◇ Other system
 - Received our FIN - ACKnowledged it
 - Sent its own FIN - We ACKnowledged it
 - Did that ACK arrive?
 - How do we know?