Announcements
Distributed Computing
Distributed Computing

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- Computation is performed in parallel by many computers.
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**Characteristics of distributed computing:**

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- Coordination is enabled by messages passed across a network.
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Distributed computing for large-scale data processing:
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Distributed computing for large-scale data processing:

• Databases respond to queries over a network
• Data sets can be partitioned across multiple machines (next lecture)
Network Messages
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Computers communicate via messages: sequences of bytes transmitted over a network
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• Protocols are designed to be implemented by many different programming languages on many different types of machines
Internet Protocol
The Internet Protocol
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Where to send error reports
Where to send the packet

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</table>

The packet knows its size

Where to send error reports

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E.g., 192.168.1.1

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- **Max length:** 216 = 65,536
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<td>Protocol</td>
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Decremented on forwarding

Packets can't survive forever

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Where to send error reports

The packet knows its size

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• Ordered, reliable transmission of arbitrary byte streams
• Implemented using the IP. Every TCP connection involves sending IP packets
• Each packet in a TCP session has a sequence number:
  ▪ The receiver can correctly order packets that arrive out of order
  ▪ The receiver can ignore duplicate packets
• All received packets are acknowledged; both parties know that transmission succeeded
• Packets that aren't acknowledged are sent repeatedly

The socket module in Python implements the TCP
TCP Handshakes
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Computer A
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Computer A

Computer B
Message Sequence of a TCP Connection

- Computer A
- Synchronization request
- Computer B
Message Sequence of a TCP Connection

Computer A

Synchronization request

Acknowledgement & synchronization request

Computer B
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5. Acknowledgement
6. Data message from B to A
7. Acknowledgement
8. Termination signal
9. Acknowledgement & termination signal
10. Acknowledgement
Client/Server Architecture
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- Internet file and resource transfer: HTTP, FTP, email, etc.
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