CSE 550: Systems for all

Au 2022

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Building a global network to rule them all

1. Accommodate all applications
2. Accommodate all networking technologies
What should networks do for apps?

- Make and break connections
- Find a path through the network
- Transfers information reliably
- Transfers arbitrary length information
- Send as fast as the network allows
- Shares bandwidth among users
- Secures information in transit
- Lets many new hosts be added
- ...

Example networking technologies

• WiFi (802.11) – few rooms
• Ethernet – building
• Optical fibers – continents and oceans
• Coaxial cables – metro area
• Cellular (2G, 3G, 4G, 5G) – few KMs
• Bluetooth – personal space
• Twisted pair – metro area
• Satellite – space
• ...

Need modularity to help manage complexity and support reuse
# Networking layers (OSI)

<table>
<thead>
<tr>
<th>Layer</th>
<th>Function</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application (7)</td>
<td>Services that are used with end user applications</td>
<td>SMTP,</td>
</tr>
<tr>
<td>Presentation (6)</td>
<td>Formats the data so that it can be viewed by the user</td>
<td>JPG, GIF, HTTPS, SSL, TLS</td>
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<td></td>
<td>Encrypt and decrypt</td>
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</tr>
<tr>
<td>Session (5)</td>
<td>Establishes/ends connections between two hosts</td>
<td>NetBIOS, PPTP</td>
</tr>
<tr>
<td>Transport (4)</td>
<td>Responsible for the transport protocol and error handling</td>
<td>TCP, UDP</td>
</tr>
<tr>
<td>Network (3)</td>
<td>Reads the IP address form the packet</td>
<td>Routers, Layer 3 Switches</td>
</tr>
<tr>
<td>Data Link (2)</td>
<td>Reads the MAC address from the data packet</td>
<td>Switches</td>
</tr>
<tr>
<td>Physical (1)</td>
<td>Send data on to the physical wire</td>
<td>Hubs, NICS, Cable</td>
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</tbody>
</table>
Networking layers (Internet)

Application
(includes Presentation, Session)

Transport Network

Link, Physical

SMTP HTTP RTP DNS

TC UDP

IP

Ethernet 3G

Cable DSL 802.11

“Narrow waist”
Design philosophy of Internet

Principles that help *explain* the Internet design

- Not explicitly articulated when the network was being designed

More generally: Building systems is about trade-offs

- Prioritize some goals over others

Q: What are the design goals of the road network?
End-to-end argument

What functionality to put in the network?
- E2E: As little as possible

Q: When does the principle fail or does not help?
Over to Benedikt and Milan