Protocol Layering – Putting It All Together

EE4204: Computer Networks
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Layering - Putting it all Together

- Let's look an example of a Web user visiting the Web Site of NUS, Inc.
- Within the browser application, at the Application layer, the user will type in the URL, typically something like http://www.nus.com/
- While this is the only input the user will provide the application, there is much more information generated by the browser application itself, including:
  - The type of browser being used (e.g., Microsoft Internet Explorer, Netscape)
  - The operating system running on the user's machine
  - The version of the HTTP protocol being used by the browser
  - The language, or languages, supported by the browser (e.g., English, Japanese, etc.)
  - Any Presentation layer standards that are supported by the browser, such as compression types, text formats, and file types

Application Layer Headers

- In terms of HTTP-based Web browser traffic, these pieces of information can be thought of as the Application, Presentation, and Session layers of the OSI model.
- They provide not only the raw data input by the user in the application, but also information needed by the application to ensure successful communication with the end system; in this case, a Web server at NUS, Inc.
- HTTP information for the Web user would look something like:

```
Hypertext Transfer Protocol

GET / HTTP/1.0\r\n
Accept: image/gif, image/x-xbitmap, image/jpeg, image/pjpeg\r\n
Accept-Language: en-gb\r\n
User-Agent: Mozilla/4.0 (compatible; MSIE 5.01; Windows NT
   5.0)\r\n
Host: www.nus.com\r\n
Connection: Keep-Alive\r\n
\r\n
```


From Application to Transport

- The application information is then packaged and passed on to the next layer for transport. HTTP requires a connection-oriented Transport layer protocol to guarantee the delivery of each packet in the session.
- Transmission Control Protocol (TCP) is used in HTTP applications to ensure this successful packet delivery.
- Other applications will make use of different Transport layer protocols. TFTP, for example, uses the User Datagram Protocol (UDP) as its Layer 4 transport because it does not require the guaranteed delivery provided by TCP. Routing updates sent between Layer 3 devices can use OSPF, RIP, or BGP as their Layer 4 transport.
- At the Transport layer, information about the port numbers, sequence numbers, and checksums are included to provide reliable transport.

Transport Layer Headers

- The Layer 4 headers in our example would look something like:

```
Transmission Control Protocol
   Source port: 3347 (3347)
   Destination port: http (80)
   Sequence number: 52818332
   Next sequence number: 52818709
   Acknowledgement number: 3364222344
   Header length: 20 bytes
   Flags: 0x0018 (PSH, ACK)
        0... .... = Congestion Window Reduced (CWR): Not set
        .0.. .... = ECN-Echo: Not set
        ..0. .... = Urgent: Not set
        ...1 .... = Acknowledgment: Set
        .... 1... = Push: Set
        .... .0.. = Reset: Not set
        .... ..0. = Syn: Not set
        .... ...0 = Fin: Not set
   Window size: 17520
   Checksum: 0xb043 (correct)
```


From Transport to Network

- Once the Transport layer information has been added to the head of the packet, it is passed to the Network layer for the Layer 3 headers to be appended.
- The Network layer will include information on the IP addresses of both the client and the end system, and a reference to which Transport layer protocol has been used.
- The Network layer information is used to ensure the correct delivery path from the client to the end system and the ability for the receiver to identify which Transport layer process the frames should be forwarded to once they arrive.

Network Layer Headers

- For the Web user example, the Network layer information would look as follows:

```
Internet Protocol
   Version: 4
   Header length: 20 bytes
   Time to live: 128
   Protocol: TCP
   Header checksum: 0x2df9 (correct)
   Source: 192.168.254.201 (192.168.254.201)
        Destination: 216.239.51.101 (216.239.51.101)
```


From Network to Data Link

- For transmission across the local, physical network, the frame is then passed to the Data Link layer for the addition of the local physical addresses.
- In terms of Ethernet, this would be the Ethernet Media Access Control (MAC) address of the user machine and the MAC address of the default gateway router on the Ethernet network.
- The Layer 2 protocol, such as Ethernet, will also include a reference to which Layer 3 protocol has been used and a checksum to ensure data integrity.
- For the Web user example, the Layer 2 information might look something like:

```
Ethernet II
   Destination: 00:20:6f:14:58:2f (00:20:6f:14:58:2f)
   Source: 00:30:ab:17:0d:1a (00:30:ab:17:0d:1a)
   Type: IP (0x0800)
```