

Packets, Frames, Messages, ...

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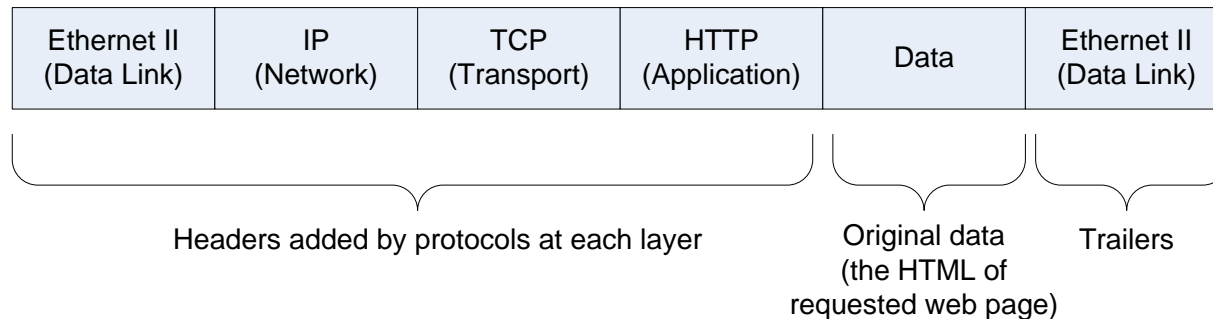
Terminology

- For physical layer, we were interested in transmitting bits
- For data link layer and above, those bits are normally grouped together in some way
 - The names of the groups vary between layers, textbooks, protocols, ...
 - We will try to use the following terminology:
 - Data Link layer: **Frames**
 - Network layer: **Datagrams**
 - Transport layer: **Segments**
 - Application layer: **Messages**
 - Alternatively, a general name applicable to any layer may be a **Packet**
- Each protocol at each layer processes the **Packet** from the higher layer, often adding a **Header** (and/or **Trailer**), then sending to the lower layer

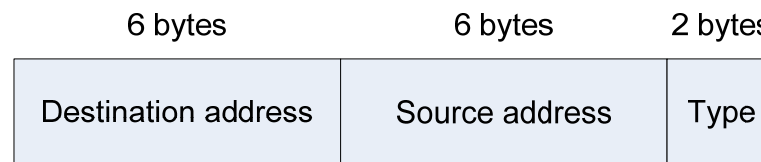


Packets, Headers and Fields

- Packet sent from web server to my computer (web browser)



- The format of a header is defined by a protocol
 - A header consists of fields, usually of a fixed length
 - For some protocols the fields are fixed, and others the number of fields may vary
 - Example: Ethernet II header format (14 bytes in length)



Packets, Headers and Fields

- Information is encoded in fields as binary data, however we will often show an easy-to-remember ASCII name which illustrates the meaning of the binary data

- Example: Ethernet type field (2 bytes)

Binary	Hexadecimal	Meaning
0000100000000000	0800	Internet Protocol version 4
0000100000000110	0806	Address Resolution Protocol
1000000010011011	809B	AppleTalk

- Example: TCP control bits (6 bits)

Binary	Hexadecimal	Meaning
000000	00	Packet is only data
010000	10	Packet also contains ACK
000010	02	Packet is synchronise (SYN)
010010	12	Packet is SYN and ACK



Example packet showing headers and fields

Ethernet II

Destination: AsustekC_5a:e5:89 (00:17:31:5a:e5:89)
Source: D-Link_be:34:df (00:50:ba:be:34:df)
Type: IP (0x0800)

Internet Protocol

Version: 4
Header length: 20 bytes
Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00)
Total Length: 1500
Identification: 0xdce1 (56545)
Flags: 0x04 (Don't Fragment)
Fragment offset: 0
Time to live: 62
Protocol: TCP (0x06)
Header checksum: 0x3ea4 [correct]
Source: 10.10.6.11 (10.10.6.11)
Destination: 10.10.1.120 (10.10.1.120)

Transmission Control Protocol

Source port: http (80)
Destination port: 1273 (1273)
Sequence number: 1 (relative sequence number)
[Next sequence number: 1461 (relative sequence number)]
Acknowledgement number: 399 (relative ack number)
Header length: 20 bytes
Flags: 0x10 (ACK)
Window size: 6912 (scaled)
Checksum: 0xe210 [validation disabled]

Hypertext Transfer Protocol

...



```

HTTP/1.1 200 OK\r\n
Date: Mon, 07 Jul 2008 02:17:42 GMT\r\n
Server: Apache/2.2.4 (Ubuntu) Phusion_Passenger/1.0.5 PHP/5.2.3-lubuntu6.3\r\n
Last-Modified: Tue, 17 Jun 2008 04:03:16 GMT\r\n
ETag: "3c22d3-a01-d2d9e900"\r\n
Accept-Ranges: bytes\r\n
Content-Length: 2561
Keep-Alive: timeout=15, max=100\r\n
Connection: Keep-Alive\r\n
Content-Type: text/html\r\n
\r\n

```

Line-based text data: text/html

```

<!DOCTYPE html\r\n
    PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"\r\n
    "http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">\r\n
<html xmlns="http://www.w3.org/1999/xhtml" lang="en" xml:lang="en">\r\n
<head>\r\n
<title>Introduction to Data Communications (ITS 323) - Overview</title>\r\n
<link rel="StyleSheet" href="../css/site.css" type="text/css" />\r\n
</head>\r\n
<body>\r\n
\r\n
<h1>Introduction to Data Communications (ITS 323)</h1>\r\n
\r\n
<h2>Welcome</h2>\r\n
\r\n
<p>\r\n
This course aims to introduce you to the fundamentals of data and \r\n
computer communications. You will learn how and why the tasks of sharing \r\n
information between computing devices is organised into layers, and then \r\n
for each layer learn the basic techniques used for data communication. \r\n
Examples using present day technologies, especially Internet-related, \r\n
will be given. This course gives broad coverage of data communications: \r\n
more specific coverage of technologies is given in subsequent courses \r\n
(e.g. ITS325, ITS413). \r\n
</p>\r\n
\r\n
<dl>\r\n
<dt>Lecturer</dt>\r\n
<dd>Dr Steven Gordon (<a href="..">contact details</a></dd>\r\n
\r\n
<dt>Lecture Times</dt>\r\n

```



Example packet in bytes (shown as hexadecimal and ASCII)

```
00 17 31 5a e5 89 00 50 ba be 34 df 08 00 45 00    ..1Z...P..4...E.
05 dc dc e1 40 00 3e 06 3e a4 0a 0a 06 0b 0a 0a    ....@.>.>.....
01 78 00 50 04 f9 2f 52 2a 91 49 5b b7 02 50 10    .x.P../R*.I[..P.
00 36 e2 10 00 00 48 54 54 50 2f 31 2e 31 20 32    .6....HTTP/1.1 2
30 30 20 4f 4b 0d 0a 44 61 74 65 3a 20 4d 6f 6e    00 OK..Date: Mon
2c 20 30 37 20 4a 75 6c 20 32 30 30 38 20 30 32    , 07 Jul 2008 02
3a 31 37 3a 34 32 20 47 4d 54 0d 0a 53 65 72 76    :17:42 GMT..Serv
65 72 3a 20 41 70 61 63 68 65 2f 32 2e 32 2e 34    er: Apache/2.2.4
20 28 55 62 75 6e 74 75 29 20 50 68 75 73 69 6f    (Ubuntu) Phusio
6e 5f 50 61 73 73 65 6e 67 65 72 2f 31 2e 30 2e    n_Passenger/1.0.
35 20 50 48 50 2f 35 2e 32 2e 33 2d 31 75 62 75    5 PHP/5.2.3-lubu
6e 74 75 36 2e 33 0d 0a 4c 61 73 74 2d 4d 6f 64    ntu6.3..Last-Mod
69 66 69 65 64 3a 20 54 75 65 2c 20 31 37 20 4a    ified: Tue, 17 J
75 6e 20 32 30 30 38 20 30 34 3a 30 33 3a 31 36    un 2008 04:03:16
20 47 4d 54 0d 0a 45 54 61 67 3a 20 22 33 63 32    GMT..ETag: "3c2
32 64 33 2d 61 30 31 2d 64 32 64 39 65 39 30 30    2d3-a01-d2d9e900
22 0d 0a 41 63 63 65 70 74 2d 52 61 6e 67 65 73    "..Accept-Ranges
3a 20 62 79 74 65 73 0d 0a 43 6f 6e 74 65 6e 74    : bytes..Content
2d 4c 65 6e 67 74 68 3a 20 32 35 36 31 0d 0a 4b    -Length: 2561..K
65 65 70 2d 41 6c 69 76 65 3a 20 74 69 6d 65 6f    eep-Alive: timeo
75 74 3d 31 35 2c 20 6d 61 78 3d 31 30 30 0d 0a    ut=15, max=100..
43 6f 6e 6e 65 63 74 69 6f 6e 3a 20 4b 65 65 70    Connection: Keep
2d 41 6c 69 76 65 0d 0a 43 6f 6e 74 65 6e 74 2d    -Alive..Content-
54 79 70 65 3a 20 74 65 78 74 2f 68 74 6d 6c 0d    Type: text/html.
0a 0d 0a 3c 21 44 4f 43 54 59 50 45 20 68 74 6d    ...<!DOCTYPE htm
6c 0d 0a 20 20 20 20 20 50 55 42 4c 49 43 20 22    l..      PUBLIC "
2d 2f 2f 57 33 43 2f 2f 44 54 44 20 58 48 54 4d    -//W3C//DTD XHTML
4c 20 31 2e 30 20 54 72 61 6e 73 69 74 69 6f 6e    L 1.0 Transition
61 6c 2f 2f 45 4e 22 0d 0a 20 20 20 20 20 22 68    al//EN"..      "h
74 74 70 3a 2f 2f 77 77 77 2e 77 33 2e 6f 72 67    ttp://www.w3.org
```



A closer look ...

- First 14 bytes (in hexadecimal):
 - 00 17 31 5a e5 89 00 50 ba be 34 df 08 00
 - In binary:
00000000 00010111 00110001 01011010 11100101 10001001
00000000 01010000 10111010 10111110 00110100 11011111
00001000 00000000
- What does it mean?
 - This is the Ethernet header
 - First 6 bytes: destination MAC address (00:17:31:5a:e5:89)
 - Second 6 bytes: source MAC address (00 50 ba be 34 df)
 - Last 2 bytes: type of payload (0800 = IPv4)

