



CSCI 3171 - Network Computing Protocol Layers and Service Models

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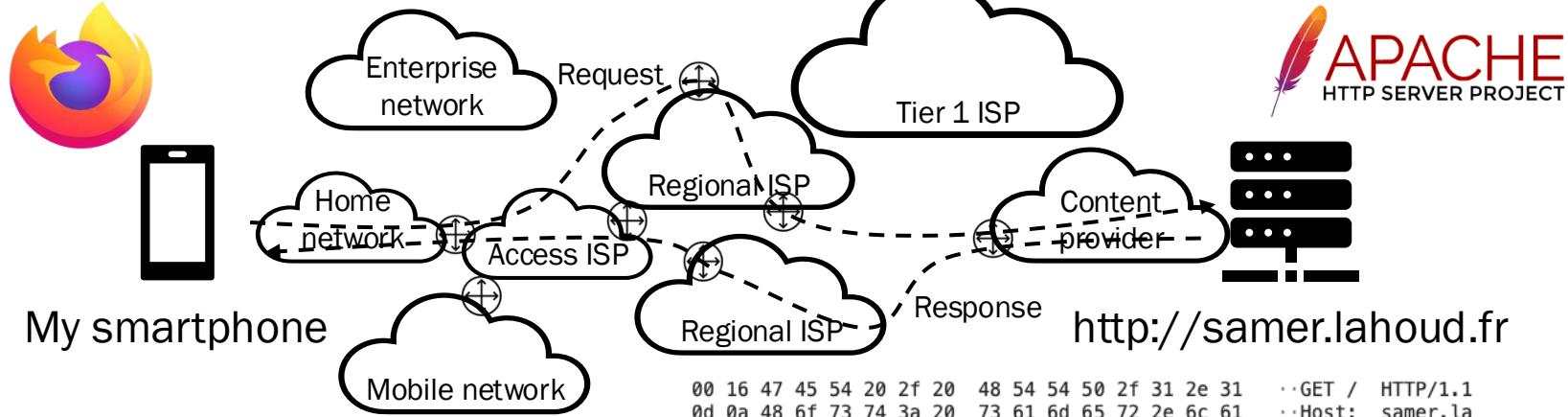


Goal and Roadmap

- Goal:
 - *Big picture* of the Internet
 - Introduction to terminology
- Overview and roadmap
 - What is the Internet? What is a protocol?
 - Network edge: hosts, access network, physical media
 - Network core: packet switching
 - Performance: loss, delay, throughput
 - Packet and circuit switching
 - Protocol layers, service models
 - Internet structure and challenges



Protocol Layers and References Models



```
00 16 47 45 54 20 2f 20 48 54 54 50 2f 31 2e 31 ··GET / HTTP/1.1
0d 0a 48 6f 73 74 3a 20 73 61 6d 65 72 2e 6c 61 ··Host: samer.la
68 6f 75 64 2e 66 72 0d 0a 55 70 67 72 61 64 65 houd.fr ··Upgrade
2d 49 6e 73 65 63 75 72 65 2d 52 65 71 75 65 73 -Insecur e-Reques
74 73 3a 20 31 0d 0a 41 63 63 65 70 74 3a 20 74 ts: 1 ··Accept: t
65 78 74 2f 68 74 6d 6c 2c 61 70 70 6c 69 63 61 ext/html , applica
74 69 6f 6e 2f 78 68 74 6d 6c 2b 78 6d 6c 2c 61 tion/xht ml+xml,a
```

- Networks are complex: Devices, services, applications, protocols, packet switches, links
- Is there any structure of networks and how to organize our discussion of networks?



Example: Organization of Air Travel



— End-to-end transfer of person plus baggage —→

Ticket (purchase)

Baggage (check)

Gates (load)

Runway takeoff

Airplane routing

Ticket (complain)

Baggage (claim)

Gates (unload)

Runway landing

Airplane routing

Airplane routing

- How would you define and discuss the system of airline travel?
 - A series of steps, involving many services



Example: Organization of Air Travel



- Layers: each layer implements a service
 - Via its own internal-layer actions
 - Relying on services provided by layer below



What Is a Layer?

- Layer = a part of a system with well-defined interfaces to other parts
- Two layers interact only through the interface between them
- One layer interacts only with layer above and layer below



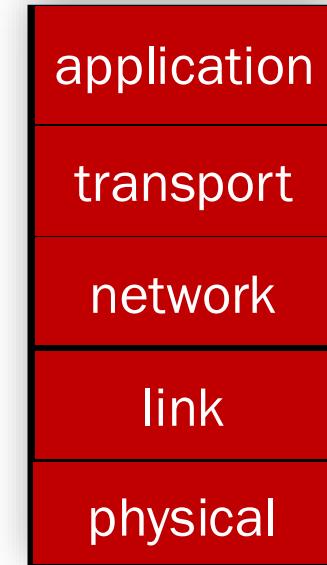
Why Layering?

- Approach to designing/discussing complex systems
- Explicit structure allows identification, relationship of system's pieces
 - Layered reference model for discussion
- Modularization eases maintenance, updating of system
 - Change in layer's service implementation: transparent to rest of system
 - e.g., change in gate procedure does not affect rest of system



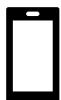
Layered Internet Protocol Stack

- Application: supporting network applications
 - HTTP, IMAP, SMTP, DNS
- Transport: process to process data transfer
 - TCP, UDP
- Network: routing of datagrams from source to destination
 - IP, routing protocols
- Link: data transfer between neighboring network elements
 - Ethernet, WiFi
- Physical: bits on the wire

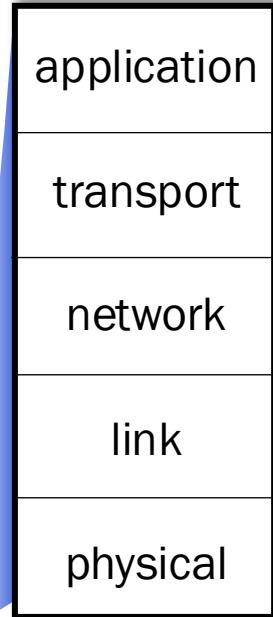




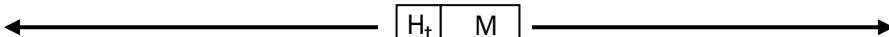
Services, Layering and Encapsulation



source

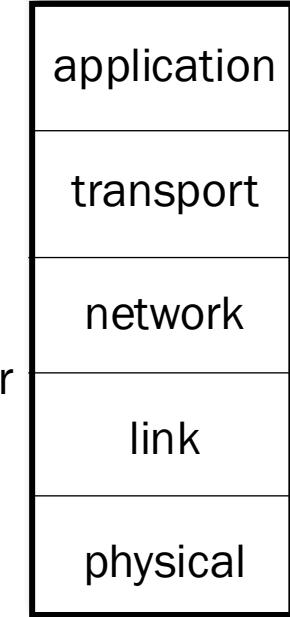


Application exchanges messages to implement some application service using services of transport layer



Transport-layer protocol transfers M (e.g., reliably) from one process to another, using services of network layer

- Transport-layer protocol encapsulates message, M, with transport layer header H_t to create a segment
 - H_t used by transport layer protocol to implement its service



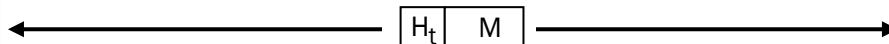
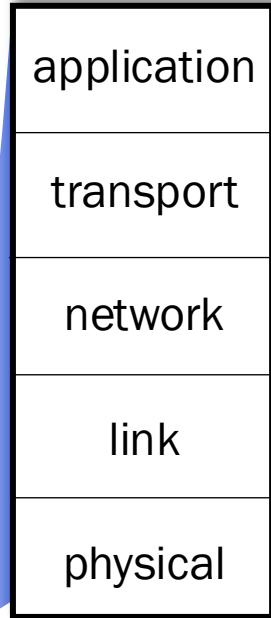
destination



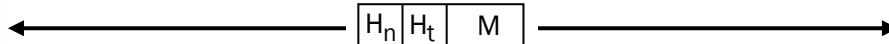
Services, Layering and Encapsulation



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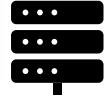
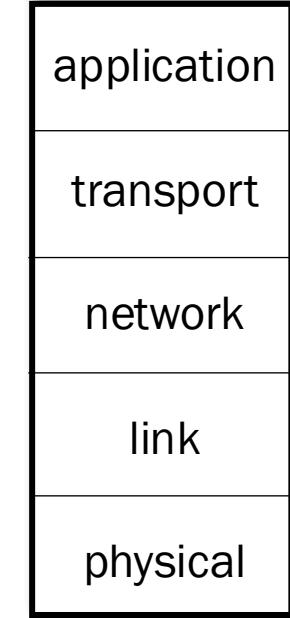


Transport-layer protocol transfers M (e.g., reliably) from one process to another, using services of network layer



Network-layer protocol transfers transport-layer segment [H_t | M] from one host to another, using link layer services

- Network-layer protocol **encapsulates** segment [H_t | M] with network layer header H_n to create a **datagram**
 - H_n used by network layer protocol to implement its service



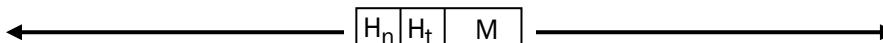
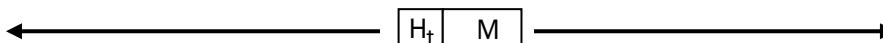
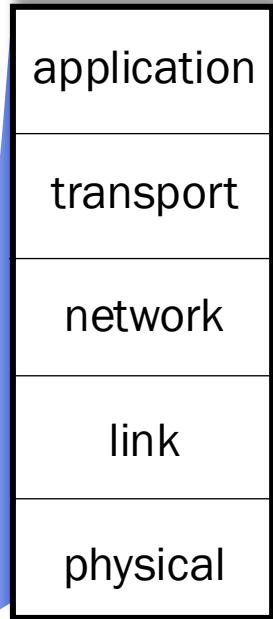
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Services, Layering and Encapsulation



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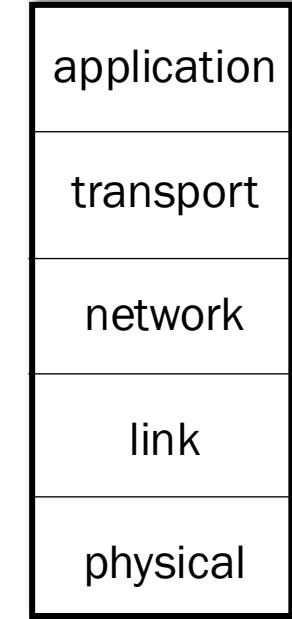


Network-layer protocol transfers transport-layer segment
[H_t | M] from one host to another, using link layer



Link-layer protocol transfers datagram [H_n] [H_t | M] from host to neighboring host, using network-layer services

- Link-layer protocol **encapsulates** network datagram [H_n] [H_t | M], with link-layer header H_l to create a **frame**



destination



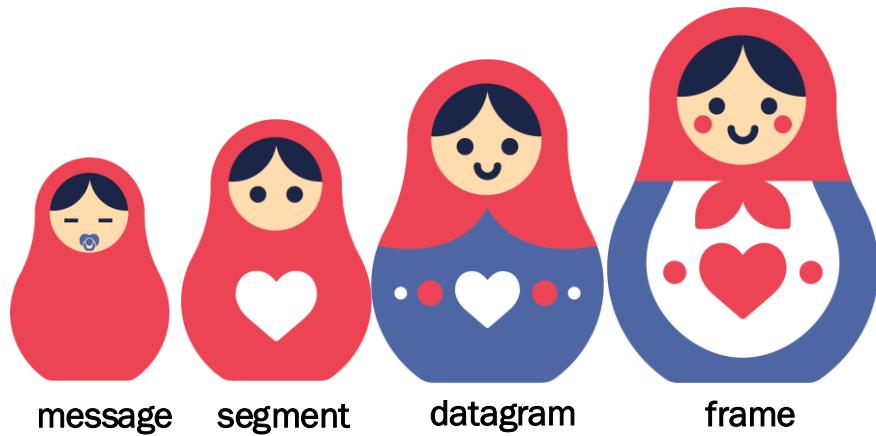
Layers and Encapsulation

- Each layer manipulates only the header of the same layer
- Encapsulation = adding a new header
- Decapsulation = remove a header



Encapsulation

- Matryoshka dolls (stacking dolls)





Services, Layering and Encapsulation

