

Protocol Layers

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Protocol "layers" and reference models

Networks are complex, with many "pieces":

- hosts
- routers
- links of various media
- applications
- protocols
- hardware, software

Question: is there any hope of organizing structure of network?

and/or 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/discuss the system of airline travel?

a series of steps, involving many services

Example: organization of air travel

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ticket (purchase)	ticketing service	ticket (complain)	
baggage (check)	baggage service	baggage (claim)	
gates (load)	gate service	gates (unload)	
runway takeoff	runway service	runway landing	
airplane routing	routing service	airplane routing	

layers: each layer implements a service

- via its own internal-layer actions
- relying on services provided by layer below





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 doesn't affect rest of system





- application: supporting network applications
 - HTTP, IMAP, SMTP, DNS
- transport: process-process data transfer
 - TCP, UDP
- network: routing of datagrams from source to destination
 - IP, routing protocols
- link: data transfer between neighboring network elements
 - Ethernet, 802.11 (WiFi), PPP
- physical: bits "on the wire"

application
transport
network
link
physical

Services, Layering and Encapsulation



application transport network link physical

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

application transport network link physical destination

source

Services, Layering and Encapsulation



application transport network link physical

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

H_n H_t M

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

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

application transport network link physical destination

source



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Services, Layering and Encapsulation

application H₊ transport network $H_n | H_t$ Network-layer protocol transfers transport-layer segment [H₊ | M] from one *host* to another, using link layer services link $H_1 \mid H_n \mid H_t$ Link-layer protocol transfers datagram [H_n| [H_t |M] from host to neighboring host, using network-layer services physical link-layer protocol encapsulates network datagram [H_n| [H_t |M], with link-layer header H₁ to create a link-layer frame

application
transport
network
link

destination

source







