EECS 3213 Fall 2014

L6: OSI Reference Model

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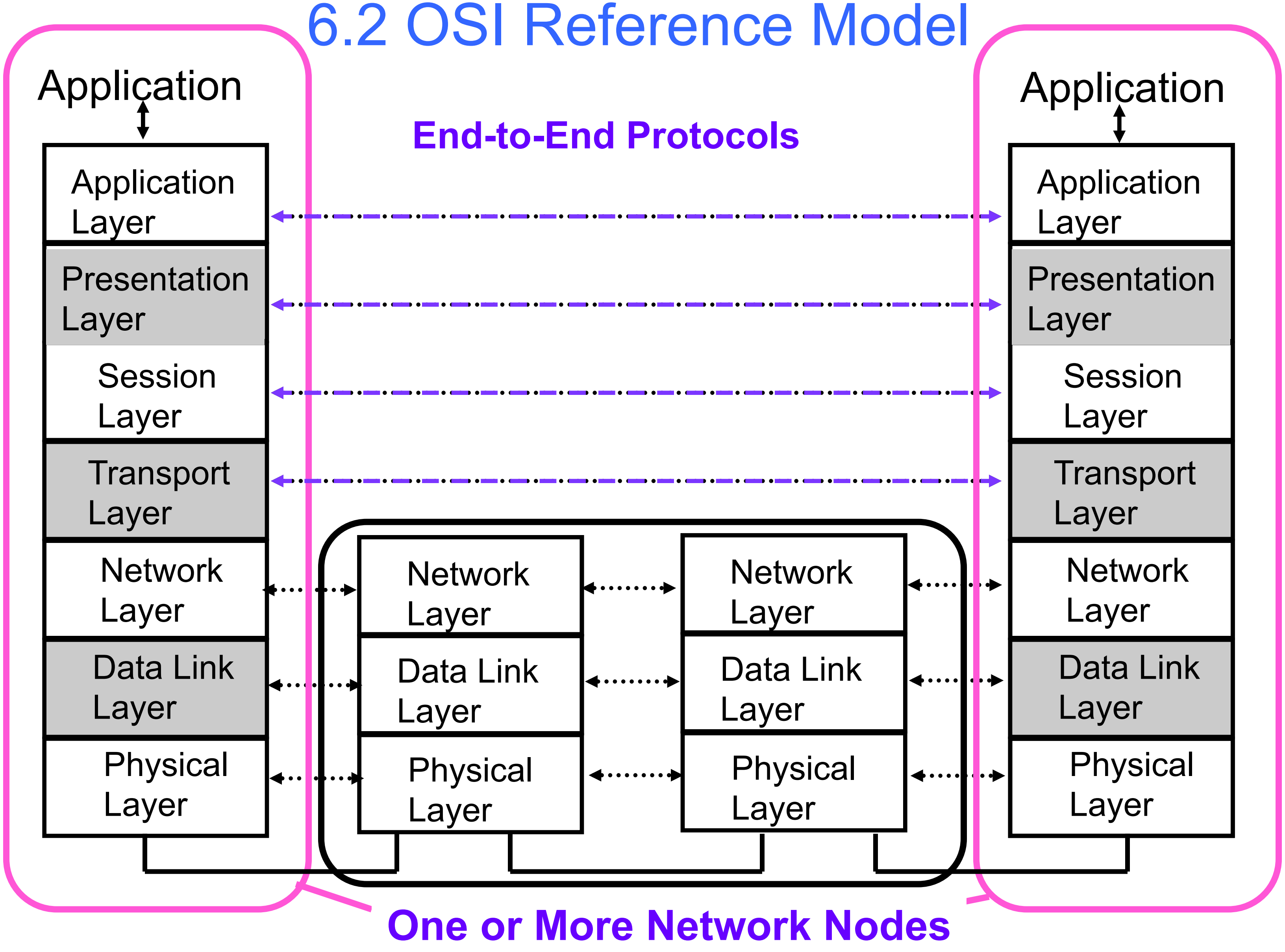
Outline

- The OSI Reference Model
  - An organized way of thinking about network design (from low-level to high-level considerations)
  - Although it was once intended to be literally applied to specific networks it failed to be adopted (other than as a general design guide)
    - Actual protocols associated with this design are not in general use
- Architectures
- Protocol stacks
- General terminology
- Interfaces

6.1 Network Architectures

- Complex networks need modular and layered design
  - As we have said many times already
- In general this set of layers is called the network architecture
  - The layers communicate with a set of rules called protocols
  - And the set of protocols used (by the layers) is the protocol stack
- Two important architectures are:
  - OSI Reference Model
    - Technically not “architecture”
    - Does not specify exact services and protocols (or at least no one uses them)
    - Mainly specifies what each layer should do
  - TCP/IP Reference Model

6.2 OSI Reference Model

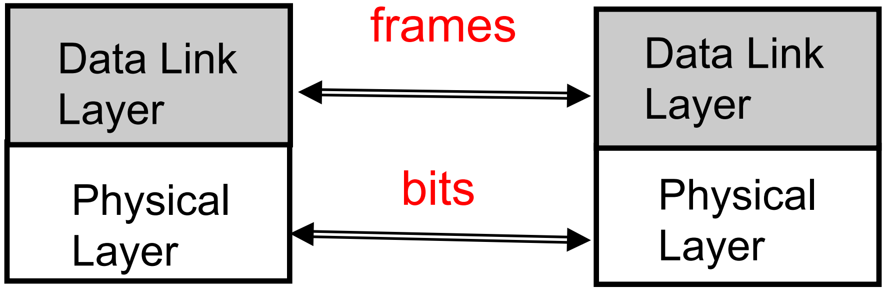


6.3 Physical Layer (The Lowest Layer)

- Transfers bits across link (*make sure a 1 arrives as a 1 and 0 arrives as a 0*)
- Definition & specification of the physical aspects of a communications link
- Typical Considerations:
  - What electrical signals to represent 1/0
  - How long a bit lasts
  - Simultaneous transmission in both directions
  - How a connection is set up/torn down
  - How many pins in a connector
  - What each pin is for

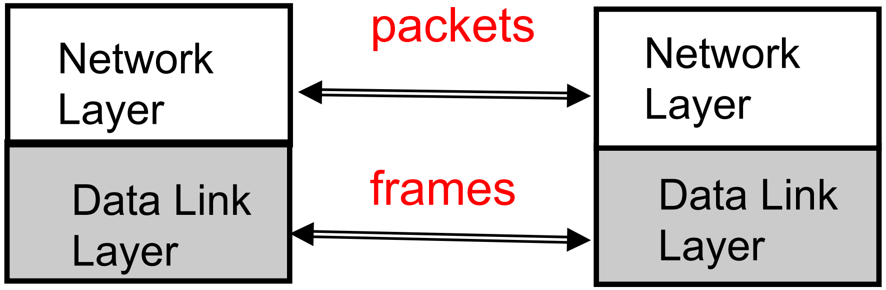
6.4 Data Link Layer

- Main Job: Make the transmission appear error free
  - Breaks up messages into frames (~100-1000 bytes)
  - Detects errors within frames
  - Allows for acknowledgement of each frame and retransmission
- Flow control
  - Keeps fast TX from swamping slow RX
- Medium access control (MAC)
  - How to control access to shared medium



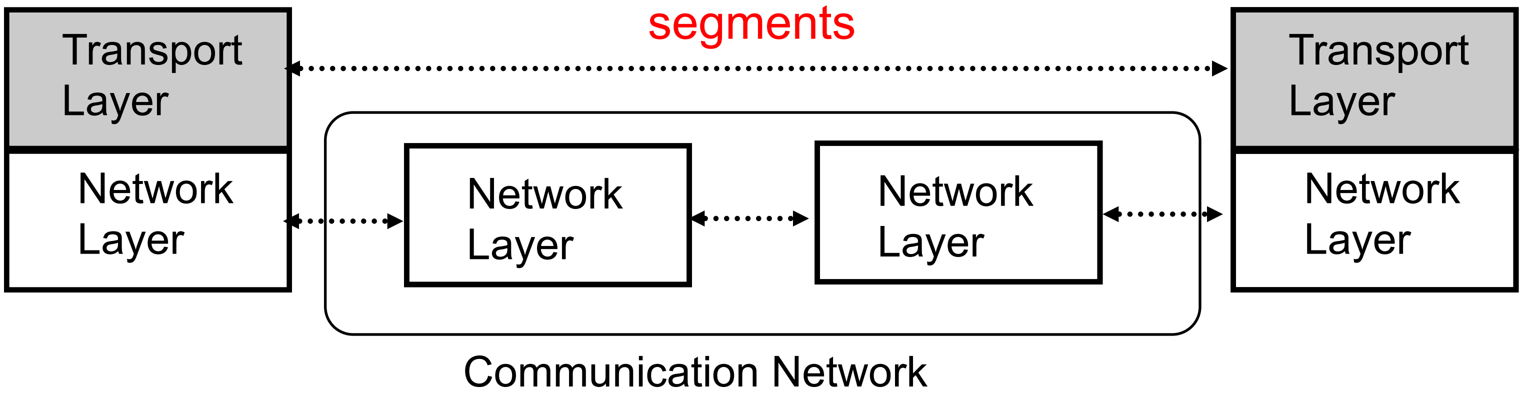
6.5 Network Layer

- Transfers packets across multiple links and/or multiple networks (i.e. routing from source to destination)
- Hierarchical addressing (to locate network nodes)
- Nodes jointly execute routing algorithm to determine paths across the network
- Congestion control to deal with traffic surges



6.6 Transport Layer

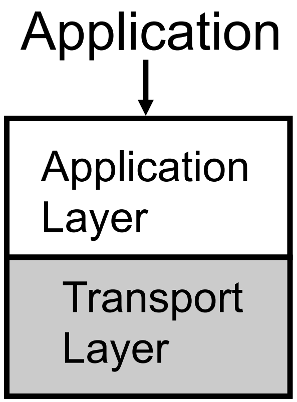
- End-to-end layer
  - split incoming data into smaller segments (datagrams)
  - ensure all pieces arrive correctly at other end
- Service variety
  - error-free point-to-point in order, no order guarantee, broadcasting, etc.
  - relies on lower levels to implement such service
- Multiplexing



6.7 Application and Upper Layers

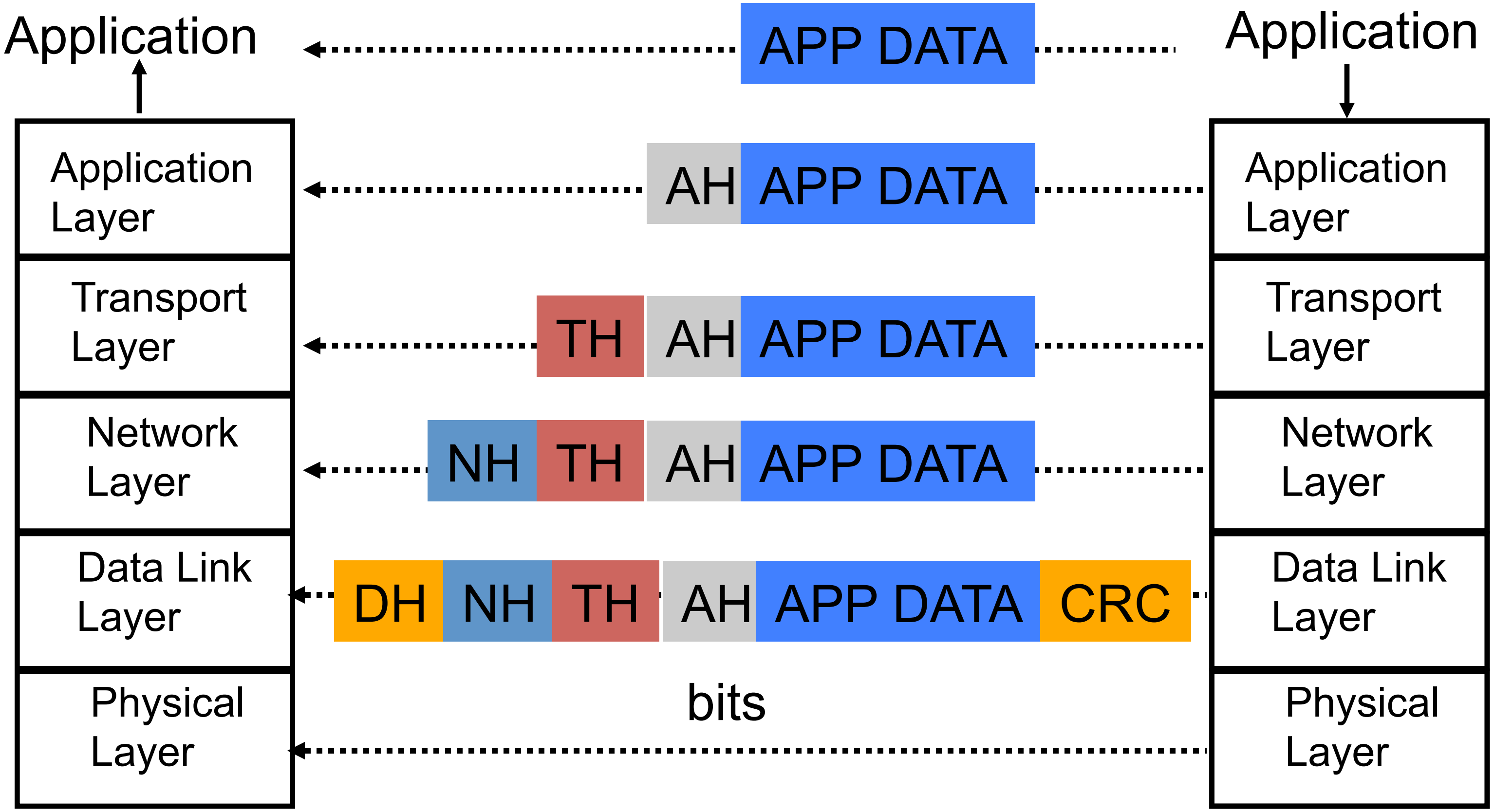
- Application Layer: Provides services that are frequently required by applications: DNS, web access, file transfer, email…
- ~~Presentation Layer: machine-independent representation of data…~~
- ~~Session Layer: dialog management, recovery from errors, …~~

Incorporated into Application Layer



6.8 Headers and Trailers

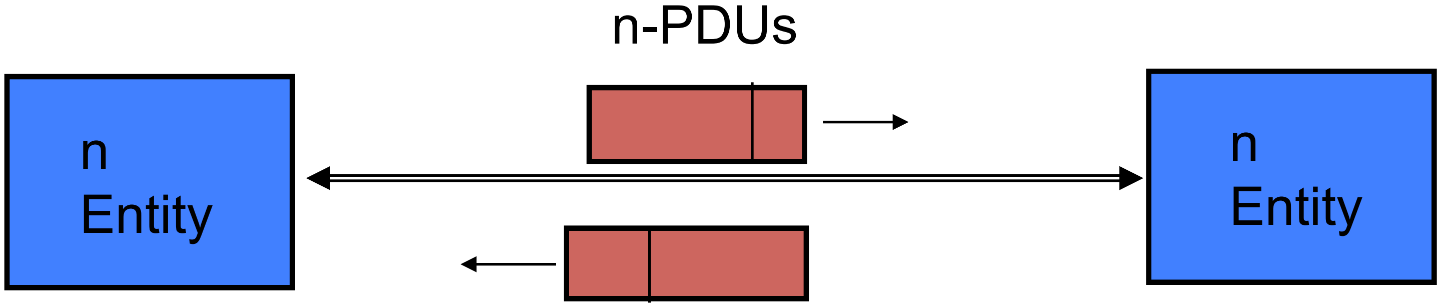
- Each protocol uses a header that carries addresses, sequence numbers, flag bits, length indicators, etc…
- CRC check bits may be appended for error detection



6.9 Layers in Action

6.10 OSI Unified View: Layers

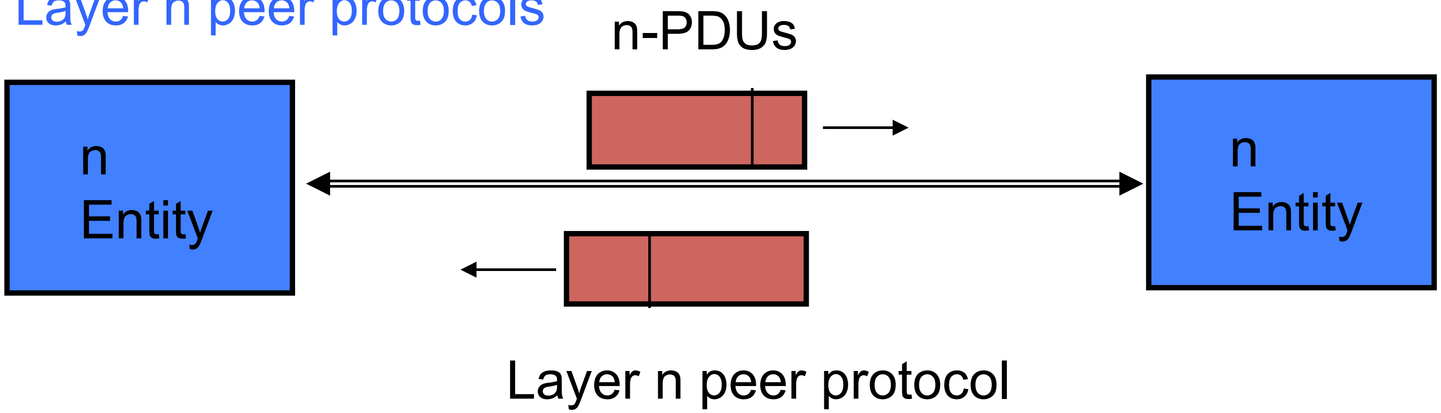
- The entities comprising the corresponding layers on different machines are called peer processes
- Layer-n peer processes communicate by exchanging Protocol Data Units (PDUs)



- Communication is virtual and indirect
  - *Each layer passes data & control information to the layer below it until the physical layer is reached and transfer occurs*
- PDU header contains control and user information
  - Age, size, error check, address

OSI Unified View: Protocols

- Peer processes interact according to a set of rules
  - Layer n peer protocols

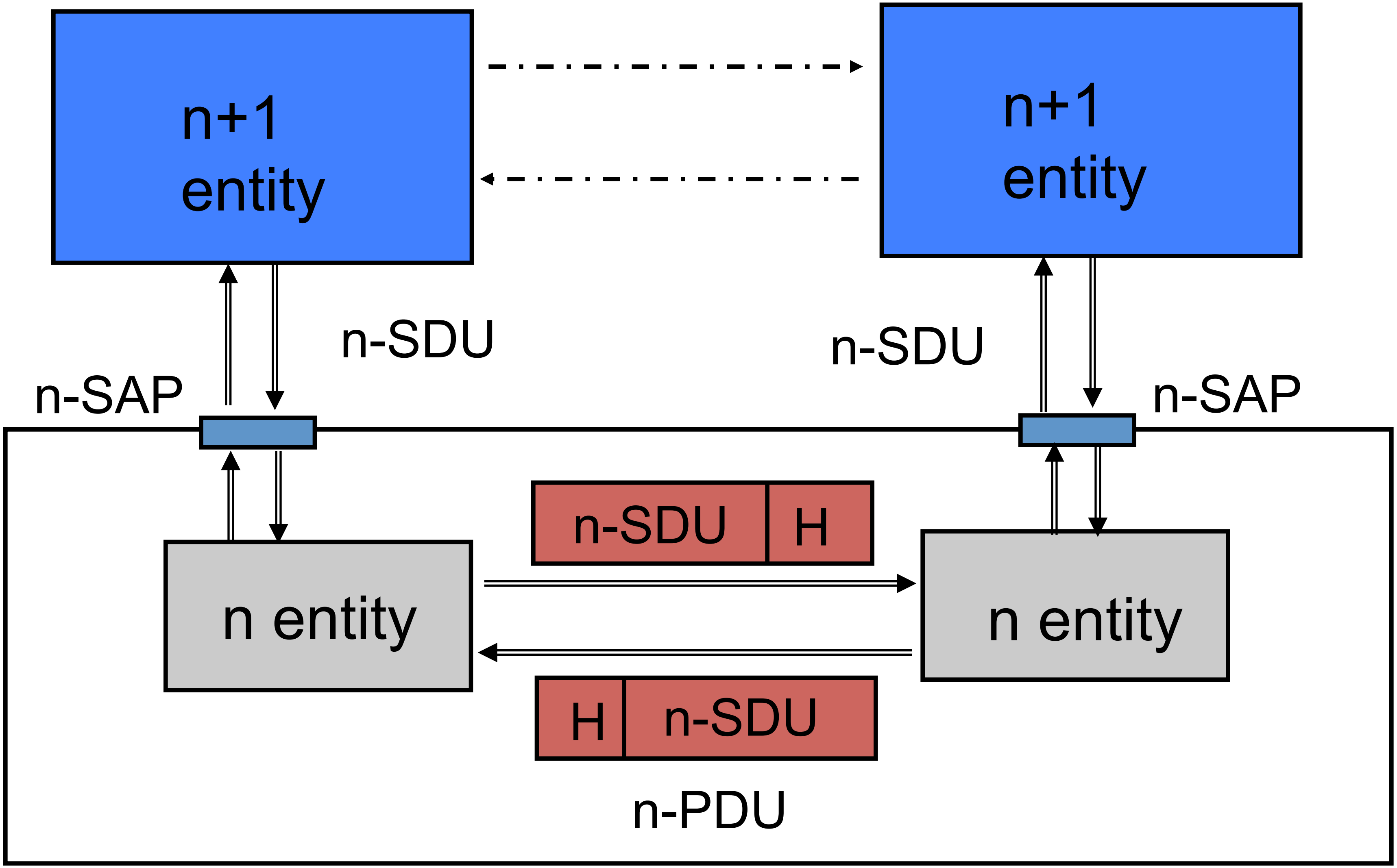


- These rules govern the format and meaning of PDUs
  - e.g. HTTP’s “GET" PDU has certain structure and invokes certain protocol-based responses

OSI Unified View: Services

- Layer n+1 entities communicate by invoking the services provided by layer n
- Services are available at Service Access Points (SAPs)
  - A service interface
- The data passed to the layer below is called a Service Data Unit (SDU)
  - *Each layer passes data & control information to the layer below it until the physical layer is reached and transfer occurs*
- SDUs are encapsulated in PDUs

Layers, Services & Protocols

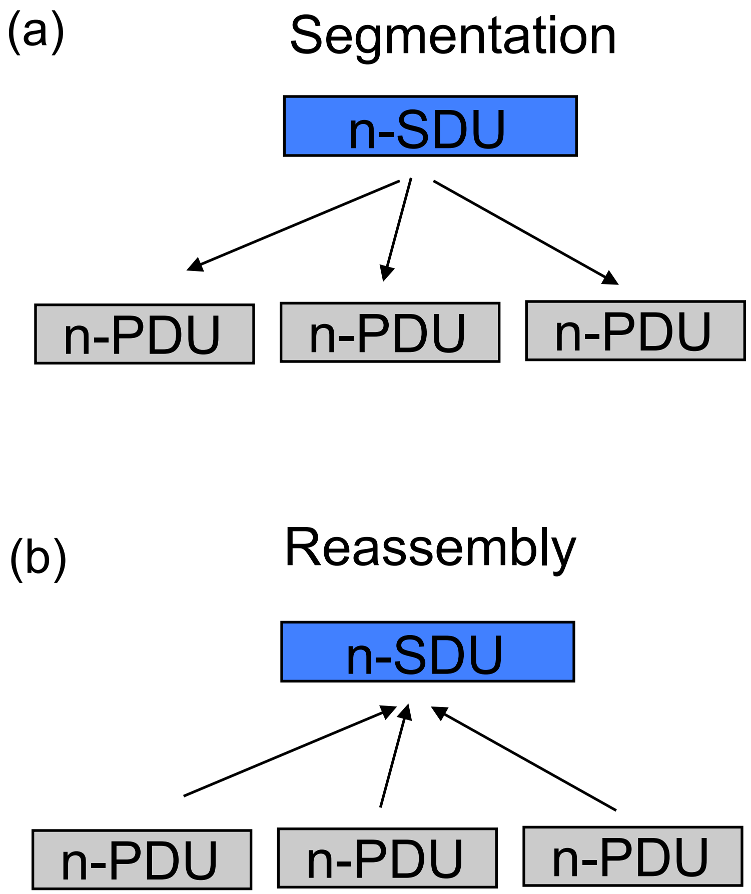


Service Primitives

- Service is formally specified by a set of primitives
  - Primitives: Structures used for passing user-data and control parameters between layers
  - Primitives are available to processes to access the service

6.11 SDU/PDU Partitioning

- Segmentation and reassembly



6.12 Interface Scenarios

- Multiplexing & De-Multiplexing
- Splitting (Inverse Multiplexing) & Recombining

OSI Summary

- Layers: related communications functions
  - Application Layer: HTTP, DNS
  - Transport Layer: TCP, UDP
  - Network Layer: IP
- Services: a protocol provides a communications service to the layer above
  - TCP provides connection-oriented reliable byte transfer service
  - UDP provides best-effort datagram service
- Each layer builds on services of lower layers
  - HTTP builds on top of TCP
  - DNS builds on top of UDP
  - TCP and UDP build on top of IP