SC/CSE 3213 Winter 2013

L7: OSI Reference Model

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Outline

- The OSI Reference Model

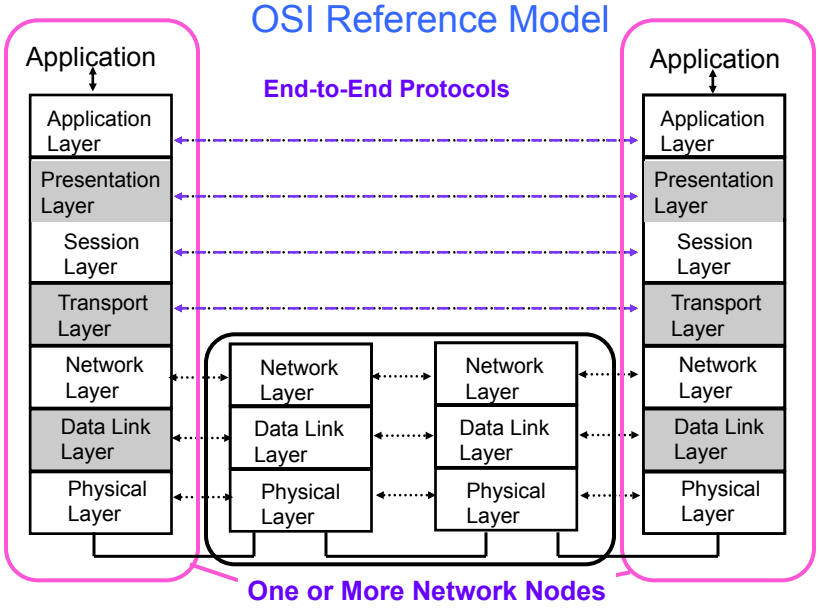
Why Layering?

- Layering simplifies design, implementation, and testing by partitioning overall communications process into parts
- Protocol in each layer can be designed separately from those in other layers
- Layering provides flexibility for modifying and evolving protocols and services without having to change other layers
- Monolithic non-layered architectures are costly, inflexible, and soon obsolete

Open Systems Interconnection (OSI)

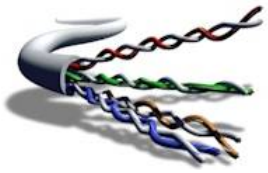
- **Network architecture**:
  - Definition of all the layers
  - Design of protocols for every layer
- By the 1970s every computer vendor had developed its own proprietary layered network architecture
- Problem: computers from different vendors could not be networked together
- Open Systems Interconnection (OSI) was an international effort by the International Organization for Standardization (ISO) to *enable multivendor computer interconnection*

OSI Reference Model



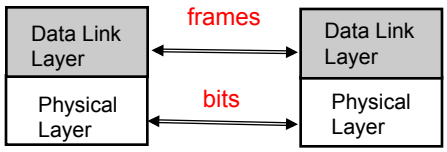
Physical Layer (The Lowest Layer)

- 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



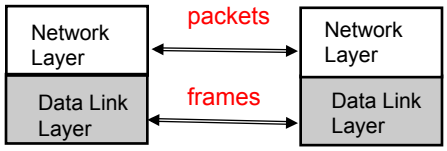
Data Link Layer

- 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



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



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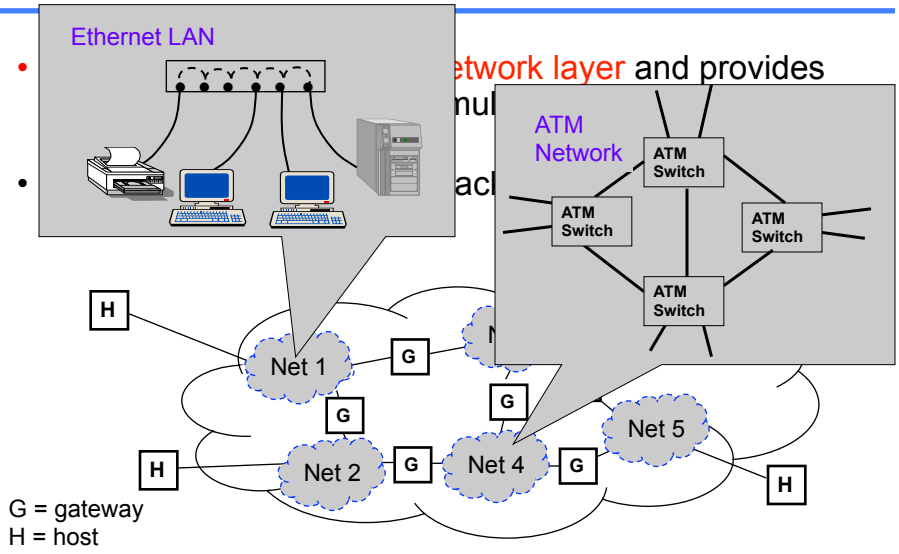
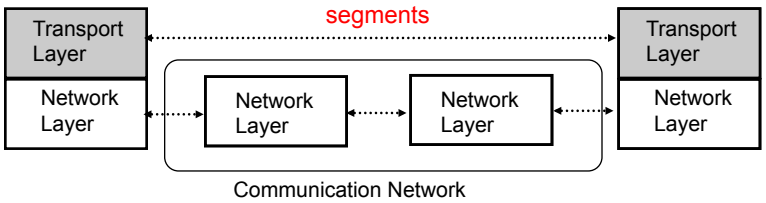


Transport Layer

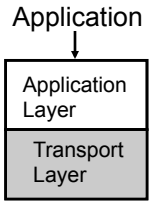
- End-to-end layer
  - split incoming data into smaller segments (datagrams)
  - ensure all pieces arrive correctly at other end
- Service variety
  - error-free point-to-point in order, no order guarantee, broadcasting, etc.
  - relies on lower levels to implement such service
- Multiplexing



Application and Upper Layers

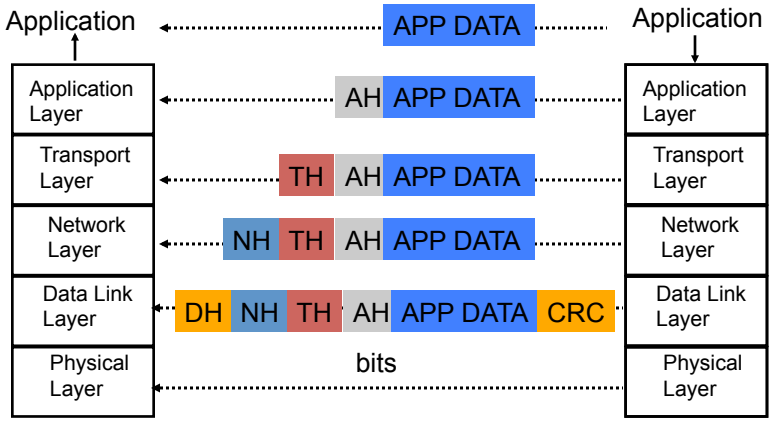
- Application Layer: Provides services that are frequently required by applications: DNS, web access, file transfer, email…
- Presentation Layer: machine-independent representation of data…
- Session Layer: dialog management, recovery from errors, …

Incorporated into Application Layer



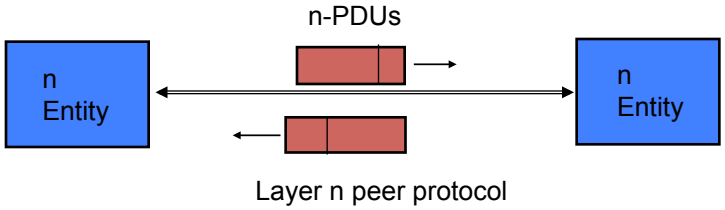
Headers and Trailers

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



OSI Unified View

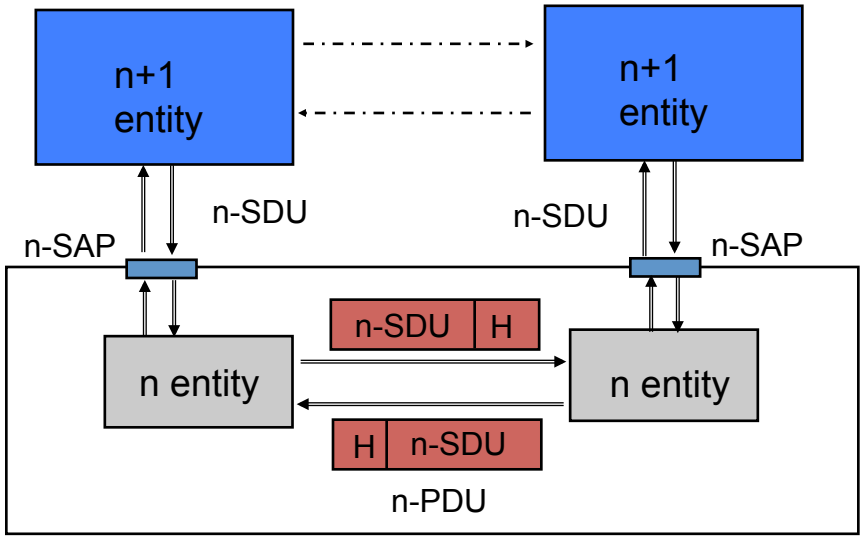
- Layer n in one machine interacts with layer n in another machine to provide a **service** to layer n+1
- The machines use a set of rules and conventions called the layer-n protocol
- The entities comprising the corresponding layers on different machines are called peer processes
- Layer-n peer processes communicate by exchanging Protocol Data Units (PDUs)



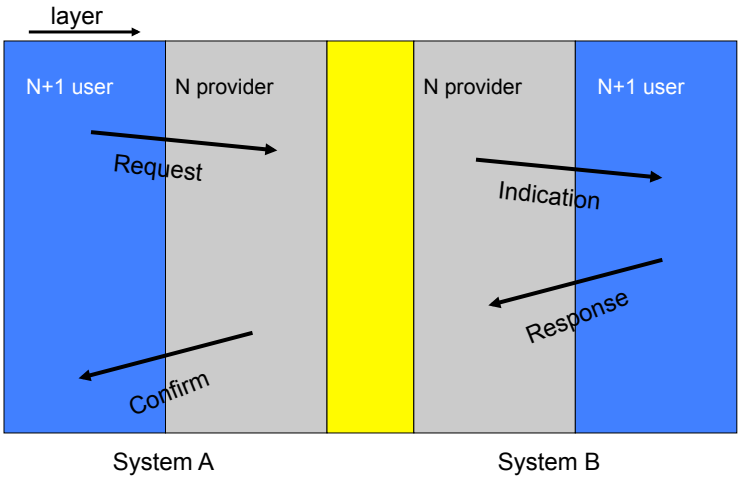
OSI Unified View: Services

- Communication between peer processes is virtual and actually indirect
- Layer n+1 transfers information by invoking the services provided by layer n
- Services are available at Service Access Points (SAPs)
- *Each layer passes data & control information to the layer below it until the physical layer is reached and transfer occurs*
- The data passed to the layer below is called a Service Data Unit (SDU)
- SDUs are encapsulated in PDUs

Layers, Services & Protocols



Interlayer Interaction



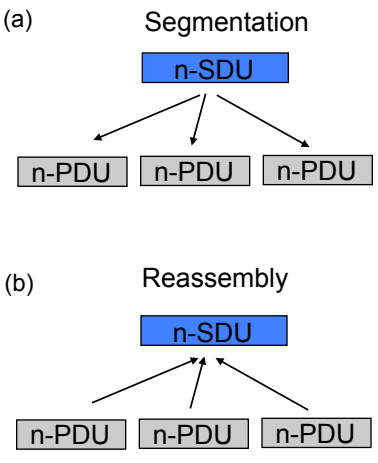
Connection Oriented & Connectionless Services

- Connection-Oriented
  - Three-phases:
    1. Connection setup between two SAPs to initialize state information
    2. SDU transfer
    3. Connection release
  - E.g. TCP, ATM
- Connectionless
  - Immediate SDU transfer
  - No connection setup
  - E.g. UDP, IP

- Layered services need not be of same type
  - TCP operates over IP
  - IP operates over ATM

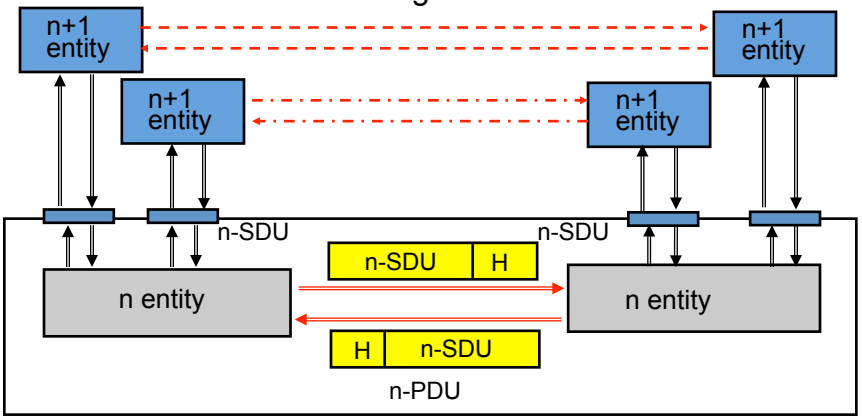
Segmentation and Reassembly

- A layer may impose a limit on the size of a data block that it can transfer for implementation or other reasons
- Thus a layer-n SDU may be too large to be handled as a single unit by layer-(n-1)
- Sender side: SDU is segmented into multiple PDUs
- Receiver side: SDU is reassembled from sequence of PDUs



Multiplexing

- Sharing of layer n service by multiple layer n+1 users
- Multiplexing tag or ID required in each PDU to determine which users an SDU belongs to



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