Protocol Reference Model

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Protocol Reference Model – why need it?

- Necessary communication functions are ***complex*** in modern communication systems (networks)
  - e.g., *addressing*, *routing*, *error handling*, *congestion control*, *access control or scheduling*, and application specific requirements
- *Layered* approach has been widely adopted for ***organizing*** communication functions.

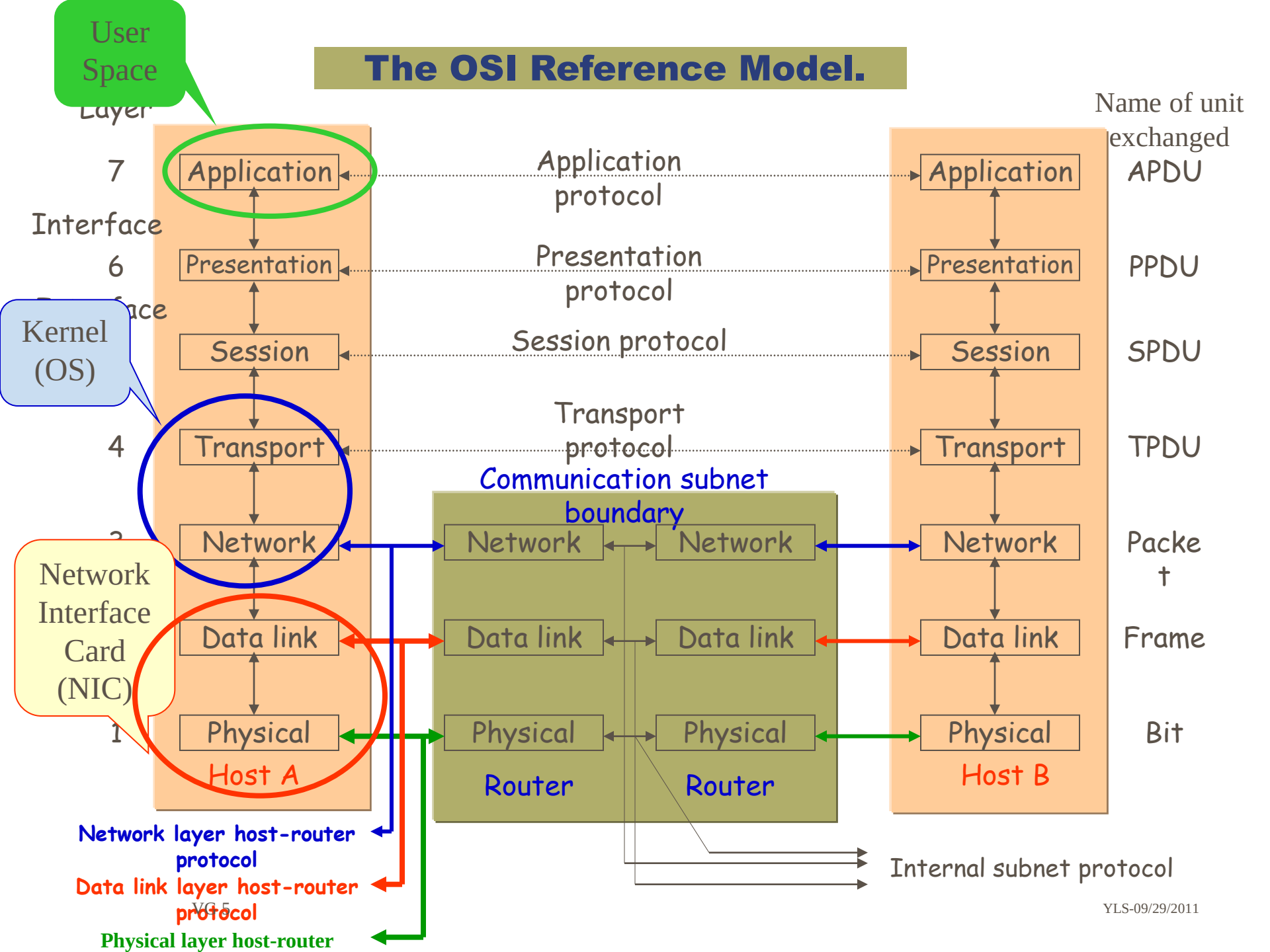
Protocol Reference Model – why need it? (cont'd)

- A *protocol reference model* (PRM) describes the *functions* of the layers and the *relations* of the layers with respect to each other.
- Each type of networks may have its own protocol reference model, e.g.,
  - ISO/OSI Seven Layer PRM
  - Internet TCP/IP protocol suite
  - Wireless network
  - Cable network

ISO/OSI Seven-Layer Protocol Reference Model

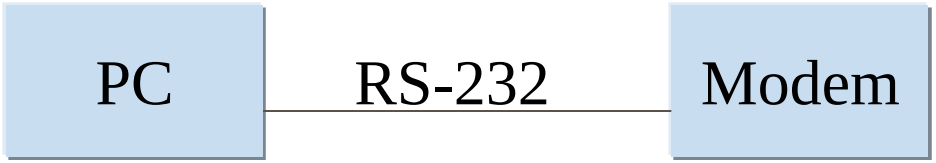
- Physical layer
- Data Link layer
- Network layer
- Transport layer
- Session layer
- Presentation layer
- Application layer

The OSI Reference Model.



Physical Layer

- To transmit raw bits over a communication channel
- Design issues
  - mechanical, electrical, and procedural interfaces and physical transmission medium

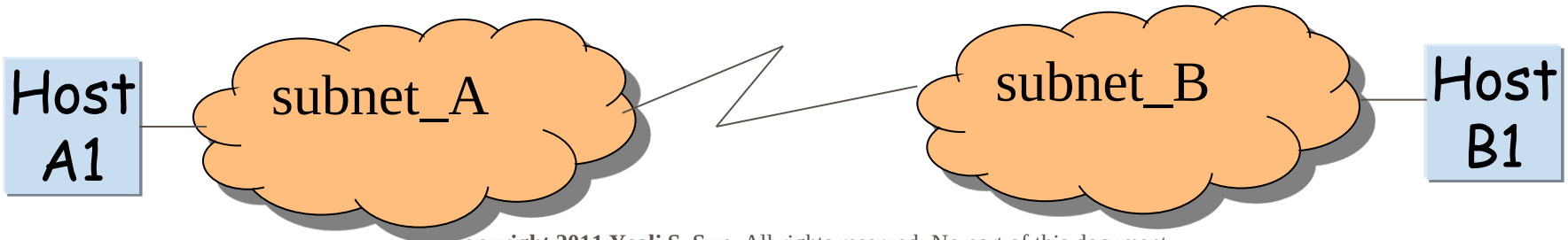


Data Link Layer

- Reliable and efficient transmission of raw bits *between two machines*
- Design issues
  - error detection and recovery, retransmission, frames in sequence, acknowledgment, etc.; frame boundaries; flow control.

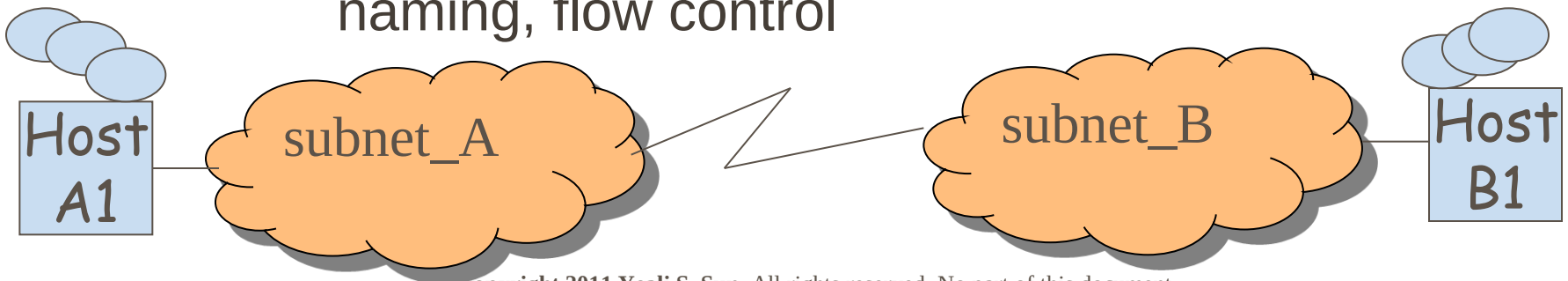
Network Layer

- To control the operation of the subnet/interconnection of networks
- Host-to-host
- Design issues
  - routing, addressing, congestion control, accounting



Transport Layer

- To control and manage messages exchange between communicating processes on machines
- Process-to-prcess
- Design issues
  - reliability, connecting services, efficiency, naming, flow control



Session Layer

- To allow users on different machines to establish sessions between them.
- Design issues
  - dialogue control, token management, synchronization

SIP – Session Initiation Protocol
RTSP – Real-time Streaming Protocol
RSVP – Resource reSerVation Protocol
...

Presentation Layer

- To manage the syntax and semantics (i.e. representation) of the information transmitted
- Design issues
  - abstract data types, encoding/decoding schemes, data compression, data encryption (security)

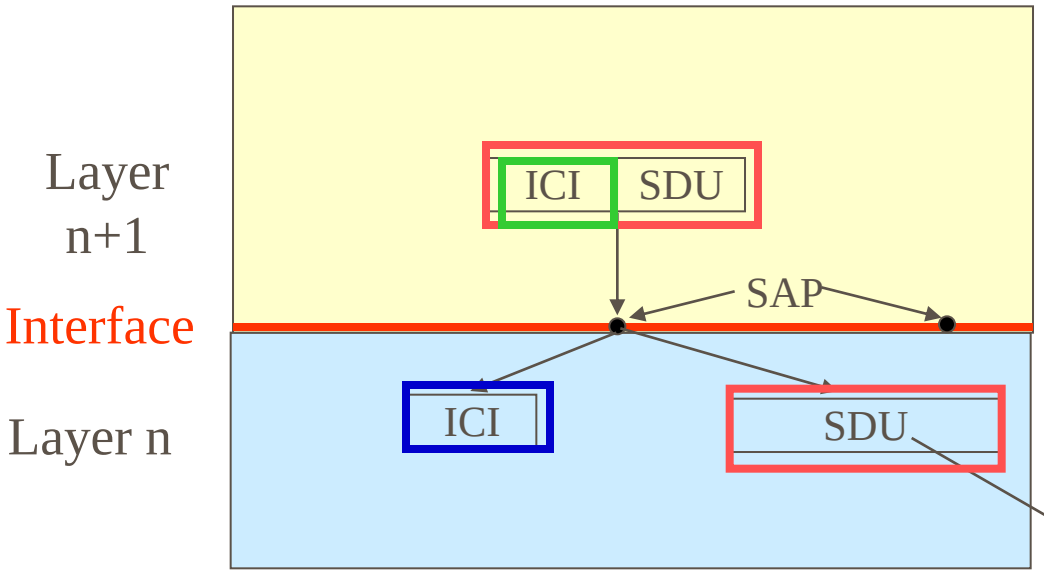
Application Layer

- To support application specific functions for information transfer
  - It contains a variety of protocols, e.g., telnet, ftp, e-mail, etc.

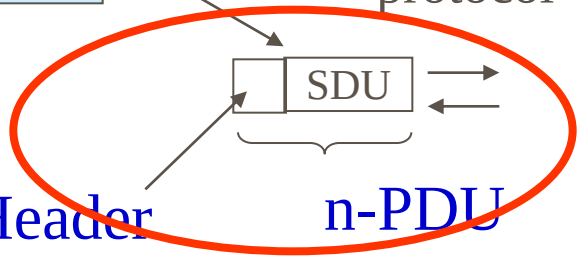
Relation between Layers at an Interface

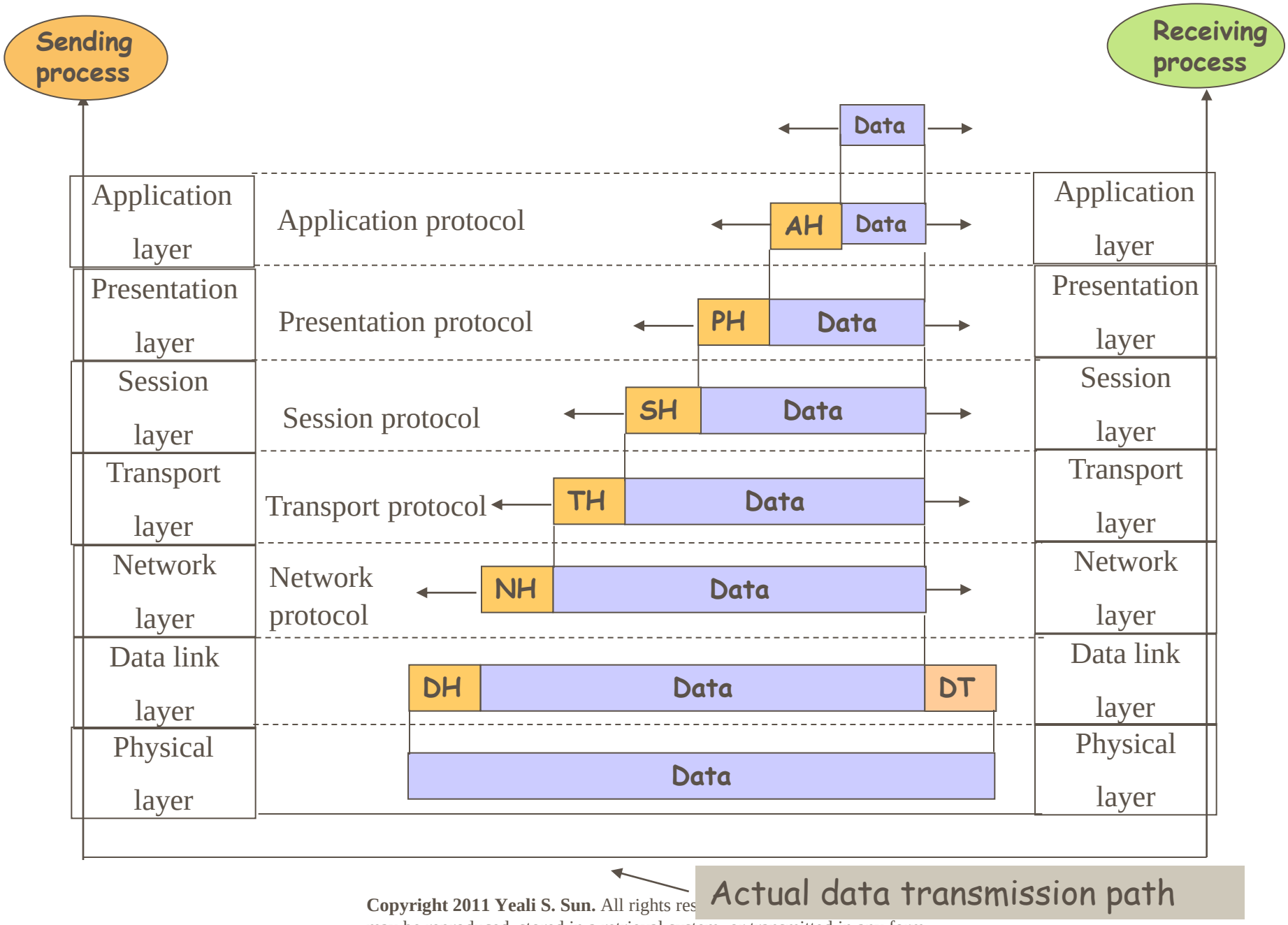
API
(Application Programming Interface)

SAP =Service Access Point
SDU = Service Data Unit
PDU = Protocol Data Unit
ICI = Interface Control Information (header)

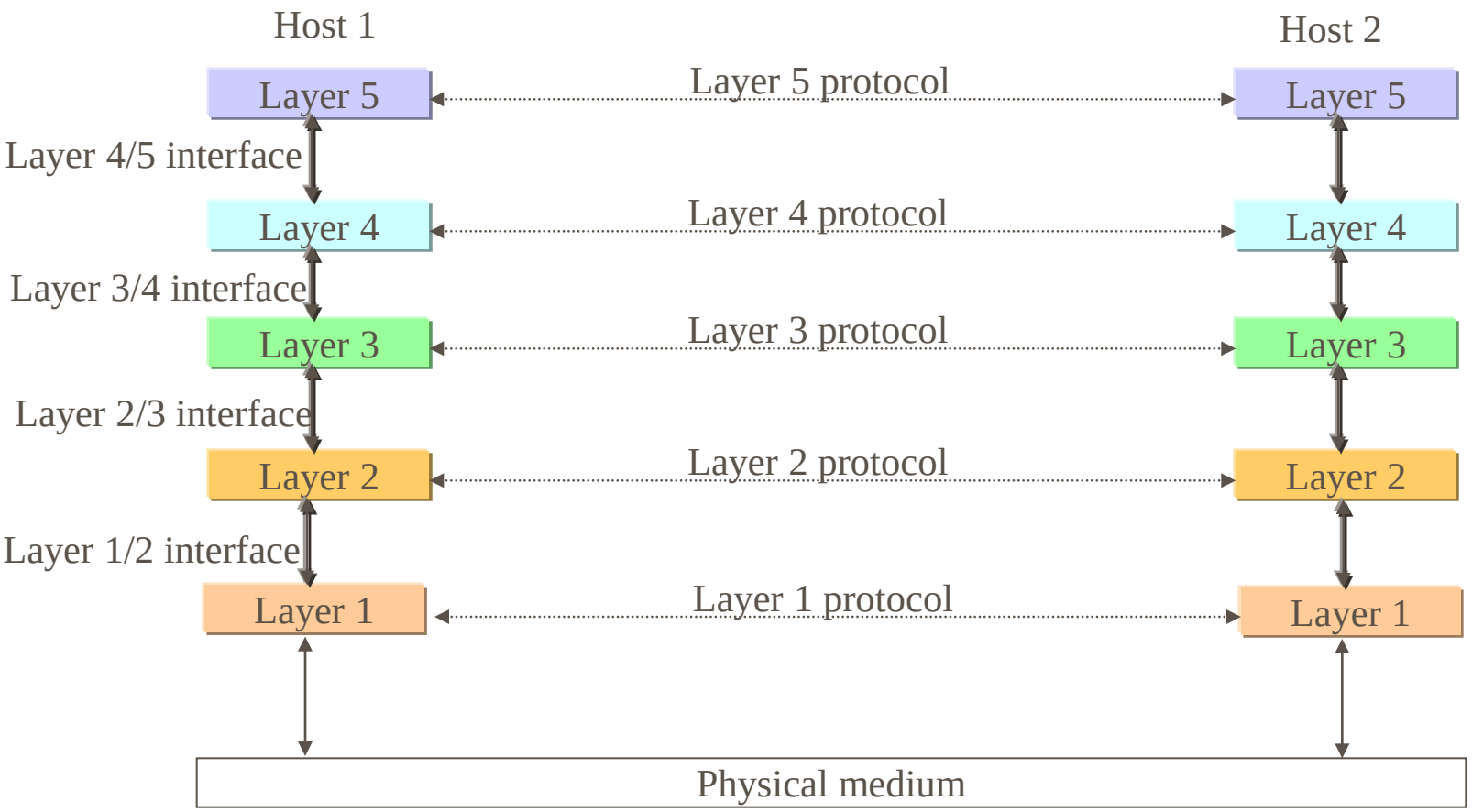


Layer n entities exchange n-**PDU**s in their layer n protocol

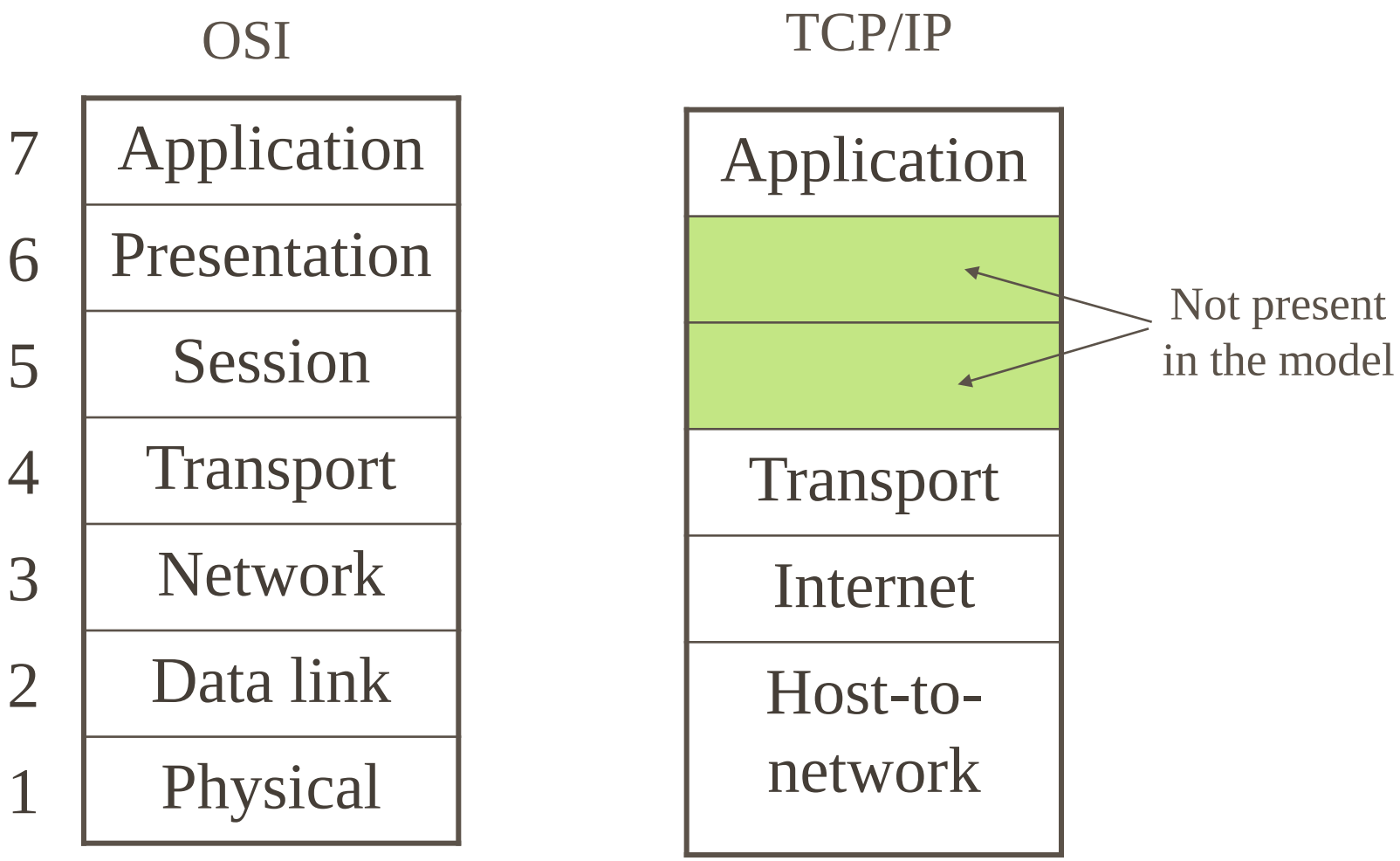




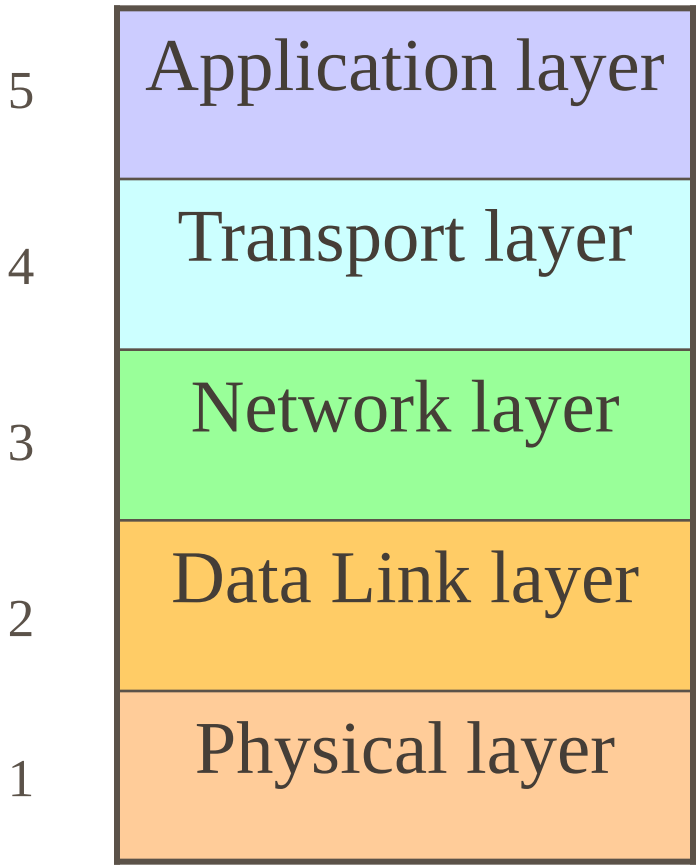
Layers, Protocol, and Interfaces



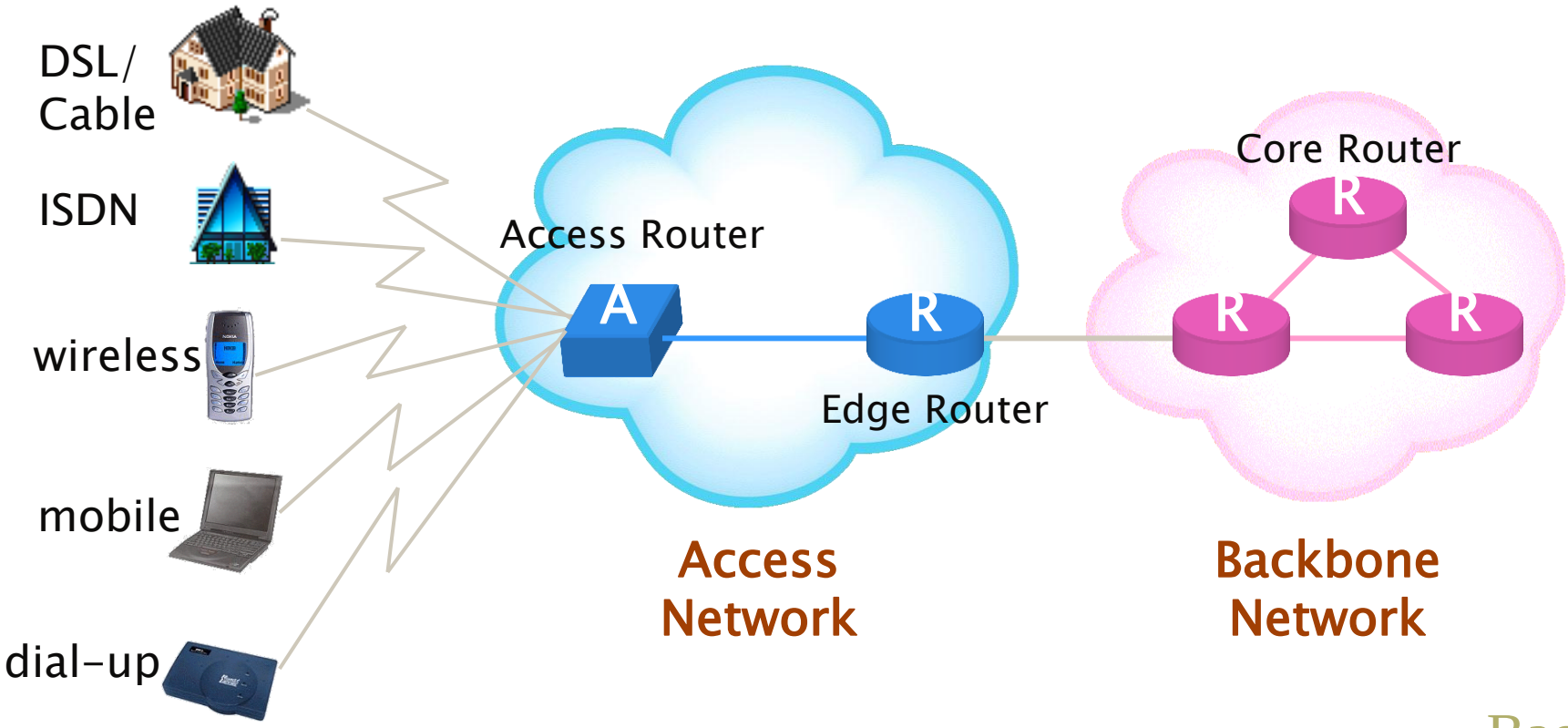
The TCP/IP reference model



Internet Reference Model



Access of the Future

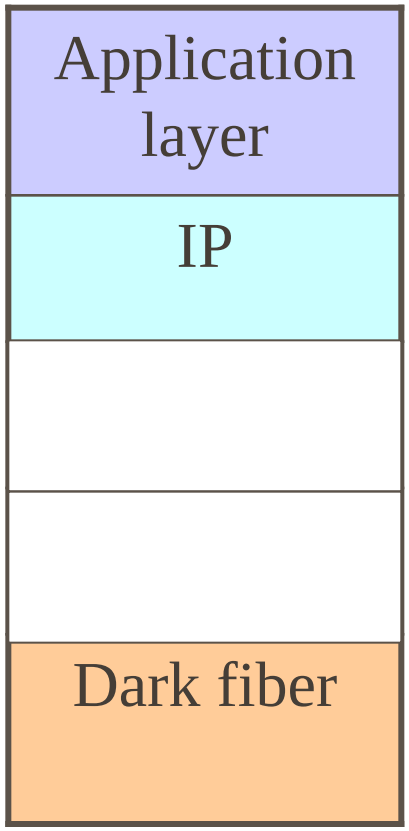


Back

Scalability is the key …

- Scalable Bandwidth – optics
  - POPs: OC-768, 10G Ethernet
- Scalable Networks – IP (IPv4 and IPv6)
- Scalable Services – Content!
  - The more you know about what's inside the packet, the more you can put smart things inside the switch/router.
  - Content distribution and services
  - Facilitate content exchange

Technology Advances/Evolution



- Layered structure, All-layer, vs. Layerless
  - Poor performance
  - Duplicate functions

Terminology

- Services
  - A service is a set of primitives (operations) that a layer provides to the layer above it.
  - Services are defined as part of a layer interface specification
- Protocols
  - A protocol is a set of rules that governs the format and meaning of information exchanged by the peer entities within a layer
- Services vs. protocols is like abstract data types (ADTs) vs. Implementation.

Communication Services

- Connection-Oriented Services
  - Three phases
    - connection establishment, data transfer and connection teardown
  - Example: telephone calls
- Connectionless (datagram) Services
  - Self-addressed messages
  - Messages are independent and may take different routes and may be out of sequence.
  - Examples: postal mail

Connection-Oriented and Datagram Services

- May be provided at the Link Layer, Network Layer, Transport Layer and above.
- Service characteristics
  - reliability - correctness and no data lost
  - examples
    - file transfer
    - electronic mail
    - voice
    - video

Network Standards

- Scope
  - architecture, services, interfaces, protocols, etc.
- Why need standards
  - To achieve compatibility and interoperability between networking systems
    - proprietary, isolated subnetworks
  - To call for ***Open System Interconnection*** or ***Open Networking***

Two kinds of standards

- "de facto" standards
  - specifications that have happened without any formal plan.
  - examples: Internet protocols, IBM PC specifications, UNIX operating system
- "de jure" standards
  - formal, legal standards adopted by some authorized standardization body
  - examples: International Telecommunication Union (ITU) (formal CCITT), ISO, IEEE, ANSI, POSIX, etc.

International Standardization Authorities

- Two classes
  - established by treaty among nations
    - e.g., ITU
  - established by voluntary, nontreaty organizations
    - e.g., ISO
- Telecommunication service providers - a major player
- Telephone networks - the first worldwide communication network
  - aggressively involving
    - Data communications
    - Mobile communications
    - Video communications (Cable TV)

Internetworking Devices

- Repeaters
  - To connect two networks at the Physical Layer
  - To forward bits from one network to another
- Bridges
  - To connect two networks at the Data Link Layer (or Medium Access Control Layer)
  - To selectively forward data link layer frames (protocol data units).
  - Transparent bridge – plug-and-play, self learning network configuration
- Routers
  - To connect two networks at the Network Layer, e.g., IP routers

The end. ☺