ITS323/CSS331

Networking &
Protocol Arch.

Layering

TCP/IP

Examples

Networking and Protocol Architectures

ITS323: Introduction to Data Communications
CSS331: Fundamentals of Data Communications

Sirindhorn International Institute of Technology
Thammasat University

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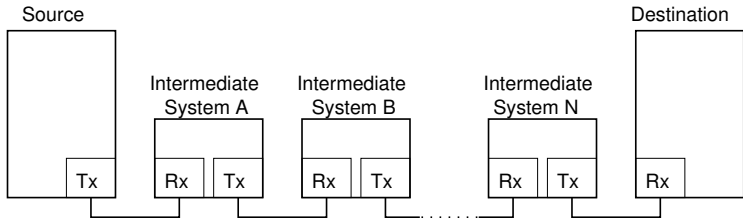
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Data Communications Across a Link
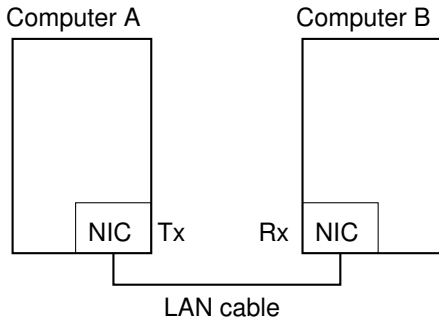
- Converting data (e.g. bits) into signals to be sent across the link (Physical layer)
- Ensuring link is ready for data transmission, reliable/efficient transmission of data (Data link layer)

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Data Communications Across a Network

- ▶ Data traverses multiple links; each link may have its own Physical and Data Link layer protocols

- ▶ How do intermediate systems receive/send data? How to select which intermediate systems to send via? (Network layer)

- ▶ What happens if failures within intermediate systems? How to create applications without knowing the details of underlying network and technologies?

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Layers

Divide-and-Conquer

- ▶ As data communications is complex, separate tasks into layers
- ▶ Design and implement protocols for each layer

Advantages

- ▶ Simplify design and implementation
- ▶ Change/upgrade protocols without modifying the whole system
- ▶ Select implementations from different vendors

Disadvantages

- ▶ Sub-optimal designs, overheads of each layer

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General Layered Architecture
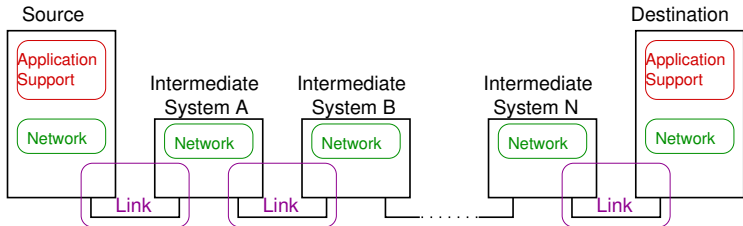
- Layers to support:
    - Communications across a link
    - Communications across a network
    - Applications to operate efficiently on end devices
- Different specific layered architectures have been developed
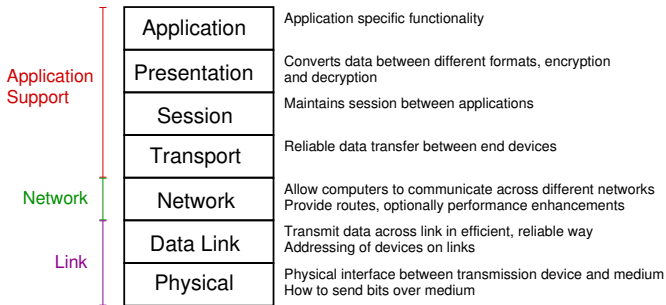- Some are standards (e.g. OSI); others are loosely defined (e.g. Internet stack)

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OSI 7-layer Protocol Architecture

Layer	Description
Application	Application specific functionality
Presentation	Converts data between different formats, encryption and decryption
Session	Maintains session between applications
Transport	Reliable data transfer between end devices
Network	Allow computers to communicate across different networks Provide routes, optionally performance enhancements
Data Link	Transmit data across link in efficient, reliable way Addressing of devices on links
Physical	Physical interface between transmission device and medium How to send bits over medium

Application Support: Application, Presentation, Session, Transport

Network: Network

Link: Data Link, Physical

- ISO developed Open Systems Interconnection (ISO) in 1970's
- TCP/IP became more popular; but concepts and terminology still used today
- Others: IBM SNA, Appletalk, Novel IPX; SS7, UMTS, IEEE 802, . . .

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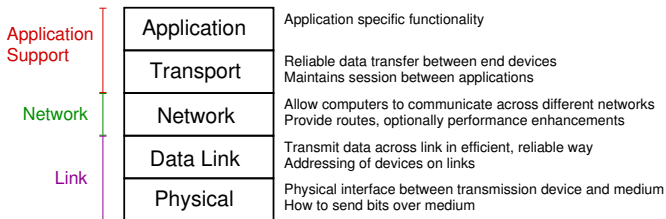Layering and Protocol Architectures

TCP/IP Protocol Architecture

Example of TCP/IP Operation

TCP/IP Protocol Architecture

- ARPANET used two key protocols, TCP and IP; together (as well as other related protocols) referred to as TCP/IP protocol suite
- Used in global Internet today
- Many protocol standardised by Internet Architecture Board (IAB) and Internet Engineering Task Force (IETF)
- No official protocol architecture; generally divided into 5 layers
- Different names: TCP/IP protocol architecture, TCP/IP protocol suite, Internet stack, . . .

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TCP/IP 5-layer Protocol Architecture

Application Support	Application	Application specific functionality
	Transport	Reliable data transfer between end devices Maintains session between applications
Network	Network	Allow computers to communicate across different networks Provide routes, optionally performance enhancements
Link	Data Link	Transmit data across link in efficient, reliable way Addressing of devices on links
	Physical	Physical interface between transmission device and medium How to send bits over medium

- There is no standard definition of the layers
- Sometimes have different names, and overlap between functionality

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Layers and Devices

- One or more protocols are implemented in each layer in a device
- End devices (hosts) implement all layers in stack
- Intermediate devices usually do not implement all layers
- May refer to device by highest layer it implements, e.g. "layer 2 device"
    - Modems, amplifiers and repeaters are related to physical layer, layer 1 devices
    - Layer 2 switches, Ethernet switches, WiFi access points are layer 2 devices
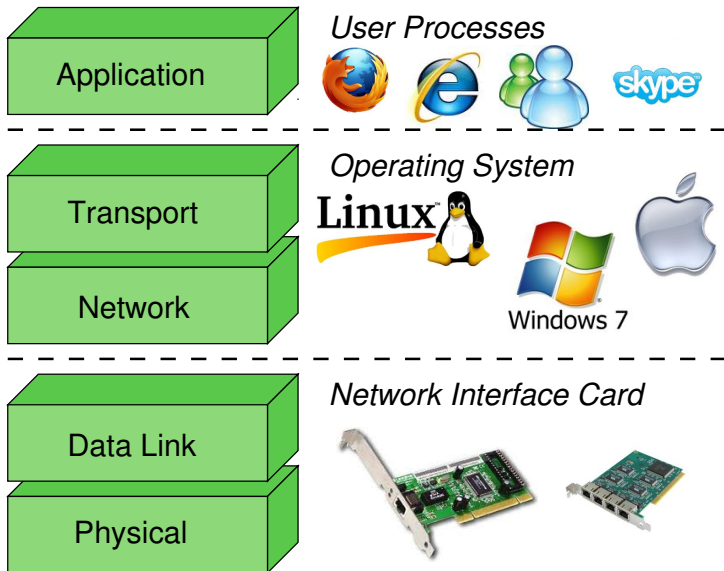   - Routers are layer 3 devices

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Implementing Layers

User Processes

Application

Operating System

Transport

Network

Windows 7

Network Interface Card

Data Link

Physical

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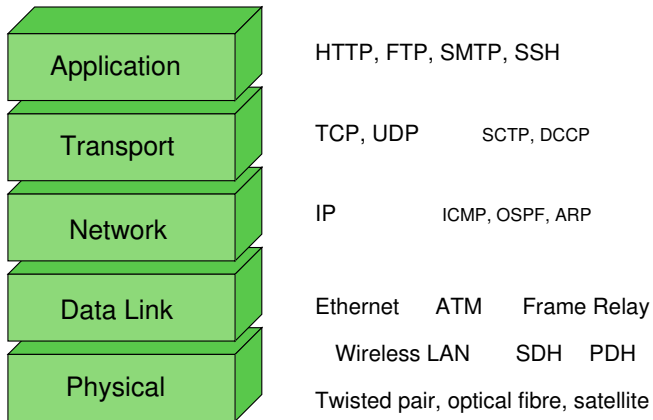Networking &
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Example Protocols in the TCP/IP

| Application | HTTP, FTP, SMTP, SSH |

| Transport | TCP, UDP   SCTP, DCCP |

| Network | IP   ICMP, OSPF, ARP |

| Data Link | Ethernet   ATM   Frame Relay
Wireless LAN   SDH   PDH |

| Physical | Twisted pair, optical fibre, satellite |

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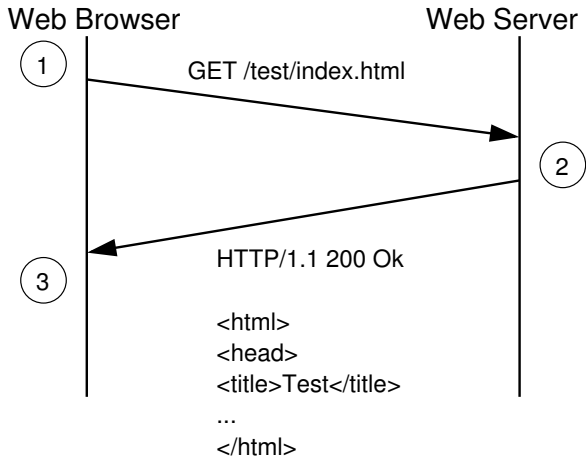Protocol Arch.

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Example Application: Web Browsing with HTTP

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Encapsulation in TCP/IP

Example: web browser has requested web page from server;
server needs to send the page requested back to browser