CS-435
spring semester 2020

Network Technology & Programming Laboratory

University of Crete
Computer Science Department

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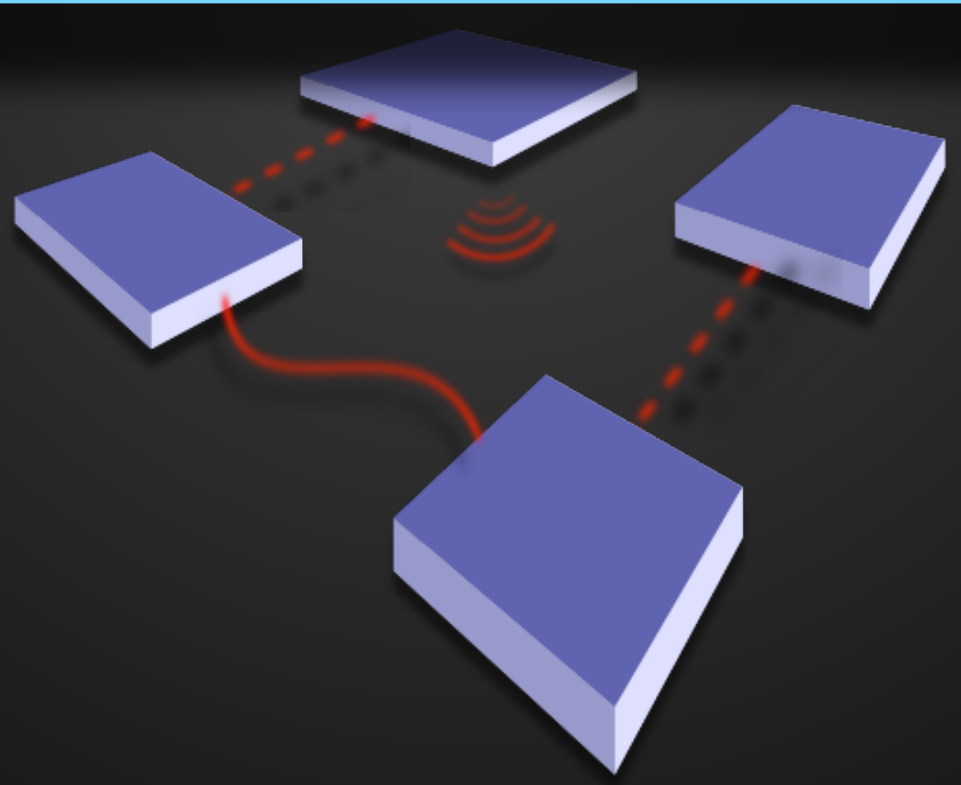


CS-435

Lecture #2 preview:

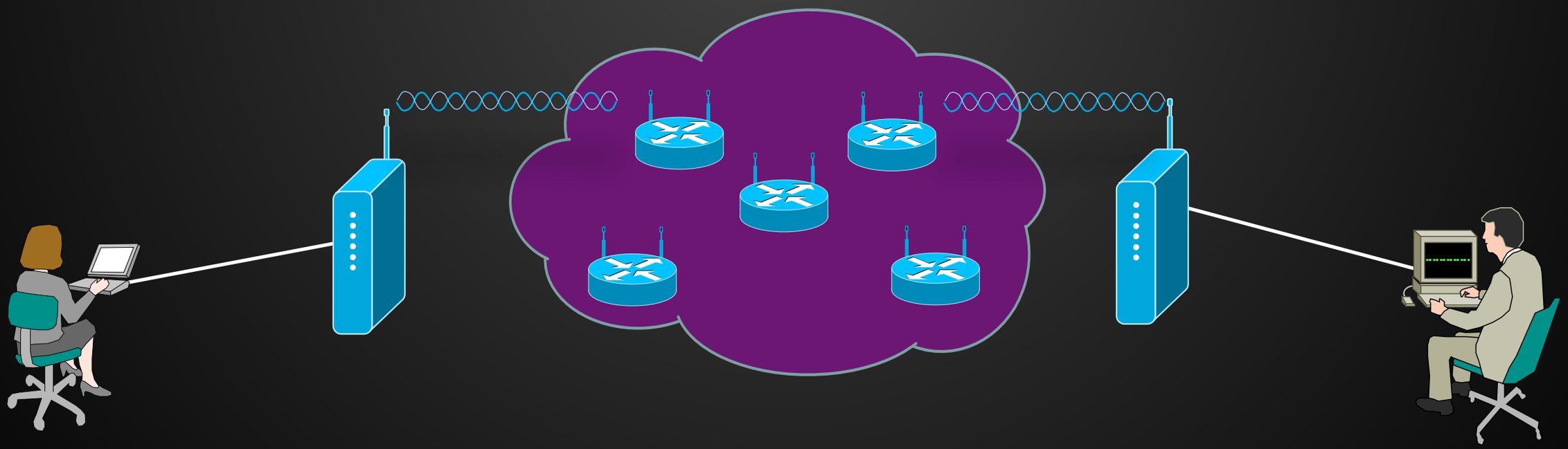
- Data Communications Overview
  - Communications model
  - Tasks in an e2e communication
- Switching Methods & Networks
- The Internet
- OSI Protocol Layers

Typical Communication Model

Source System

Destination System

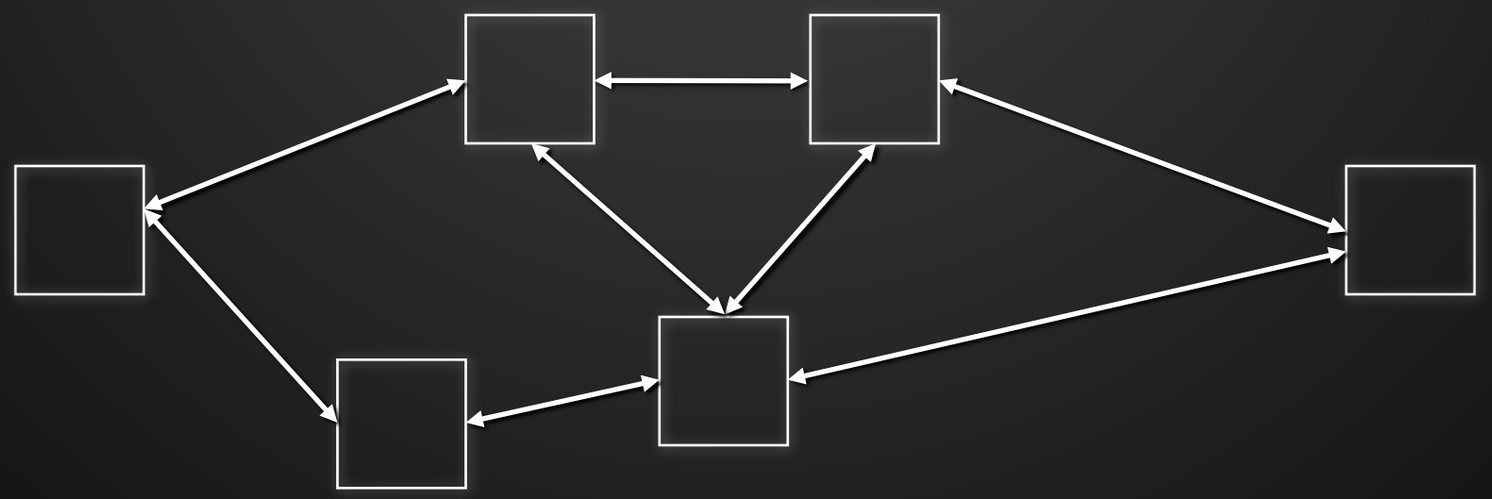
Source → Transmitter → Transmission System → Receiver → Destination



Data Communication vs. Networking

Data Communication is a “single hop” problem

Networking addresses issues of more communicating nodes



the tasks in Communication

- **transmission system utilization:** we need to make efficient use of transmission facilities typically shared among a number of communicating devices

- a device must **interface** with the transmission system

- once an interface is established, some signal **generation** (source coding) is required for communication

the tasks in Communication

- there must be **synchronization** between transmitter and receiver, to determine when a signal begins to arrive and when it ends

- **error detection and correction** are required in circumstances where errors cannot be tolerated

- there is a variety of requirements for communication between two parties that might be collected under the term **exchange/connection management**

the tasks in Networking

- **flow control** is required to assure that the source does not overwhelm the destination by sending data faster than they can be absorbed processed, or forwarded

- **addressing** and **routing**, so a source system can indicate the identity of the intended destination, and can choose an efficient/desired route through this network

- **recovery** allows an interrupted transaction to resume activity at the point of interruption or to condition prior to the beginning of the exchange

the tasks in Networking

- message **formatting** has to do with an agreement between two parties as to the form of the data to be exchanged or transmitted

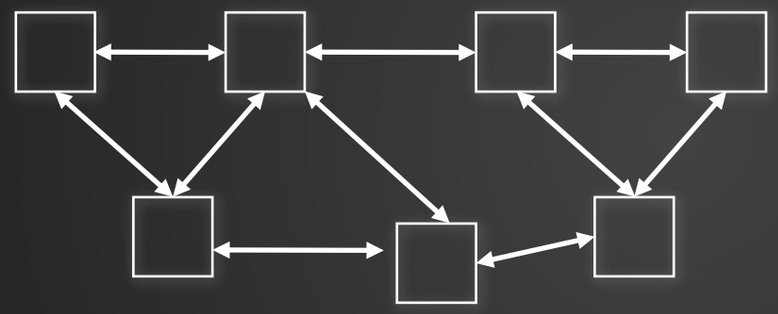
- frequently need to provide some measure of **security** in a data communications system

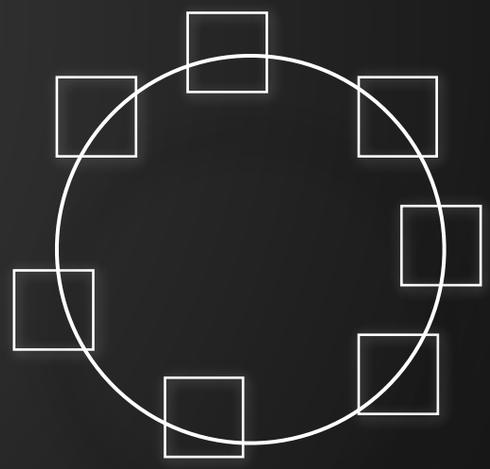
- network **management** capabilities are needed to configure the system, monitor its status, react to failures and overloads, and plan intelligently for future growth

Types of Networks

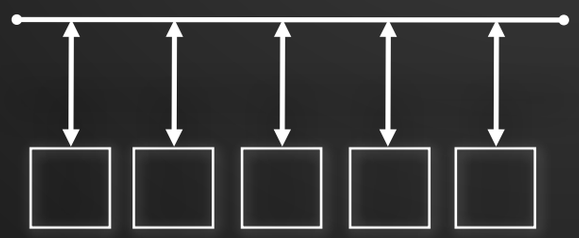
Topological Taxonomy

- Point-to-Point (p2p)





- Broadcast



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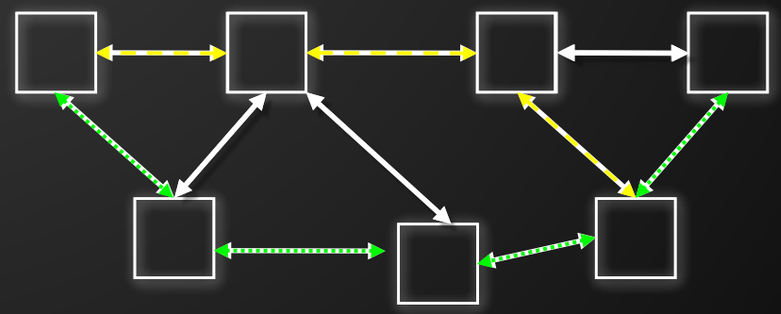
Types of Networks

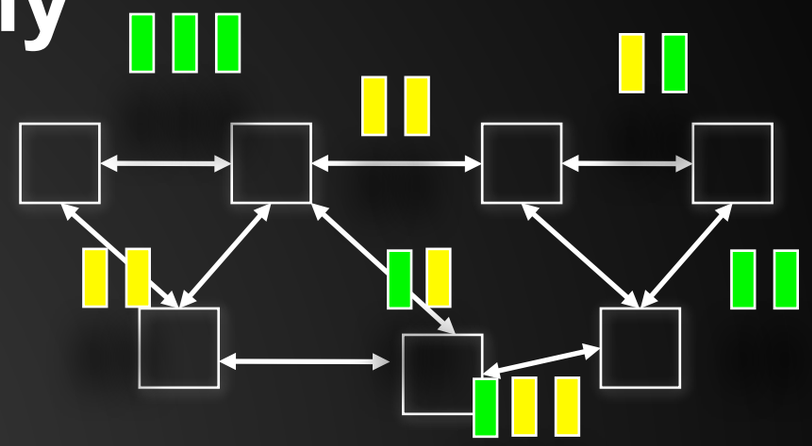
Switching Taxonomy

- Circuit Switching
  - **Dedicated path** between two stations
    - Connected sequence of links between nodes
    - e.g. POTS (telephone network)
  - Communication involves 3 phases
    - Circuit establishment
    - Data transfer
    - Circuit disconnect



Types of Networks

Switching Taxonomy



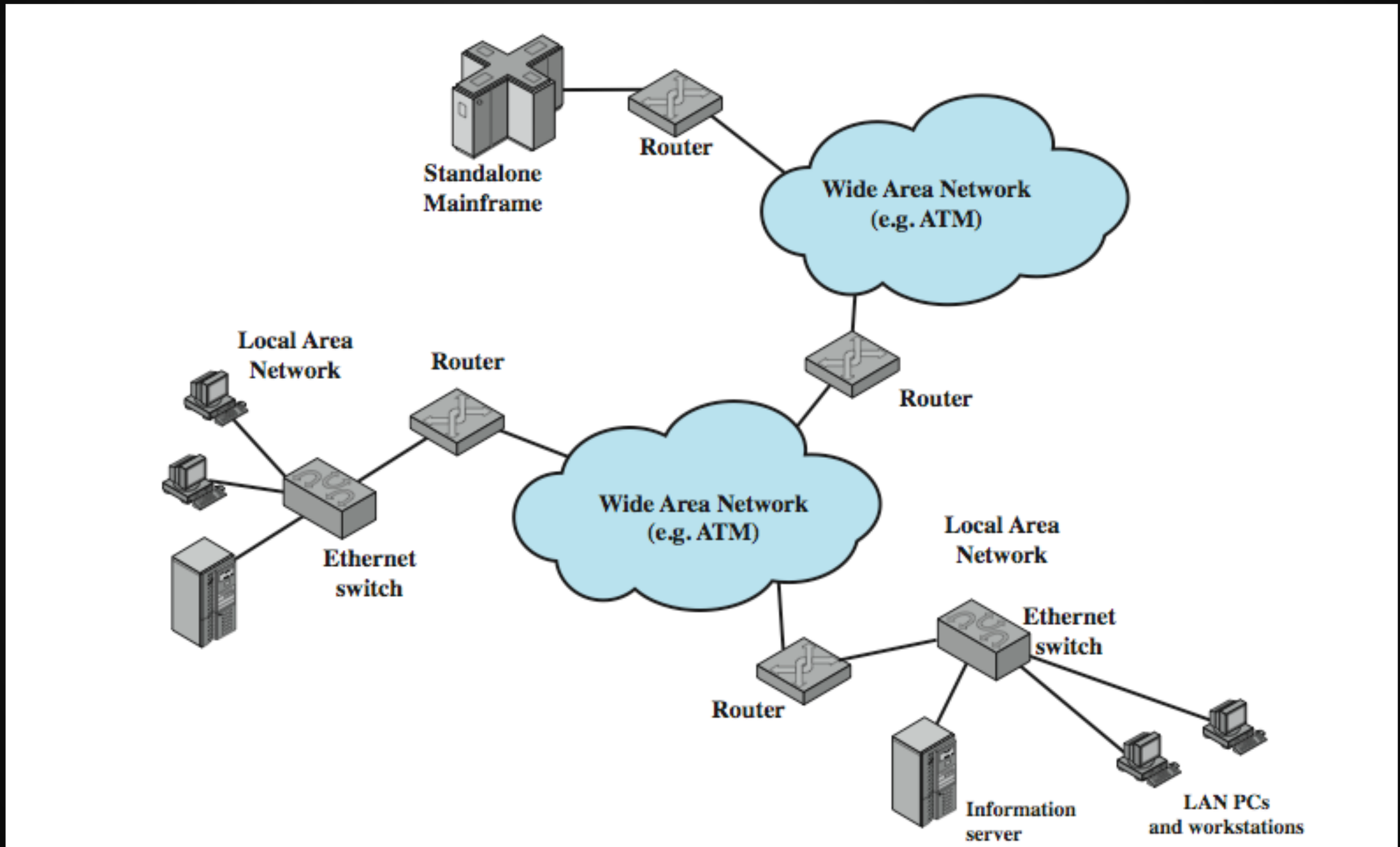
- Packet Switching
  - Data are transmitted in short blocks, called packets
  - Typical upper bound used to be 1000 Bytes…
  - Longer messages broken up (fragmented) into series of packets
    - Each packet contains part (or all for short message) of user's data **plus** some **control information**
    - Control information includes network **routing information**
    - At each node, packet is received, stored briefly, and passed on to the next node
- Transmitting computer sends message as sequence of packets
- Packet includes control information including destination station
- Packets sent to node to which sending station attaches
- Node stores packet briefly, determines next leg of route, and queues packet to go out on that link
- When link is available, packet is transmitted to next node
- All packets eventually work their way through network

Types of Networks

Area Taxonomy

- LAN
    - < 1 km
    - Single owner
- Metropolitan
    - 1km – 50 km
- WAN
    - >50km
- Enterprise (typically Ethernet/WiFi LANs)
- Telecom
    - Access
    - Metro
    - Core (ATM FDDI)

The Internet Elements

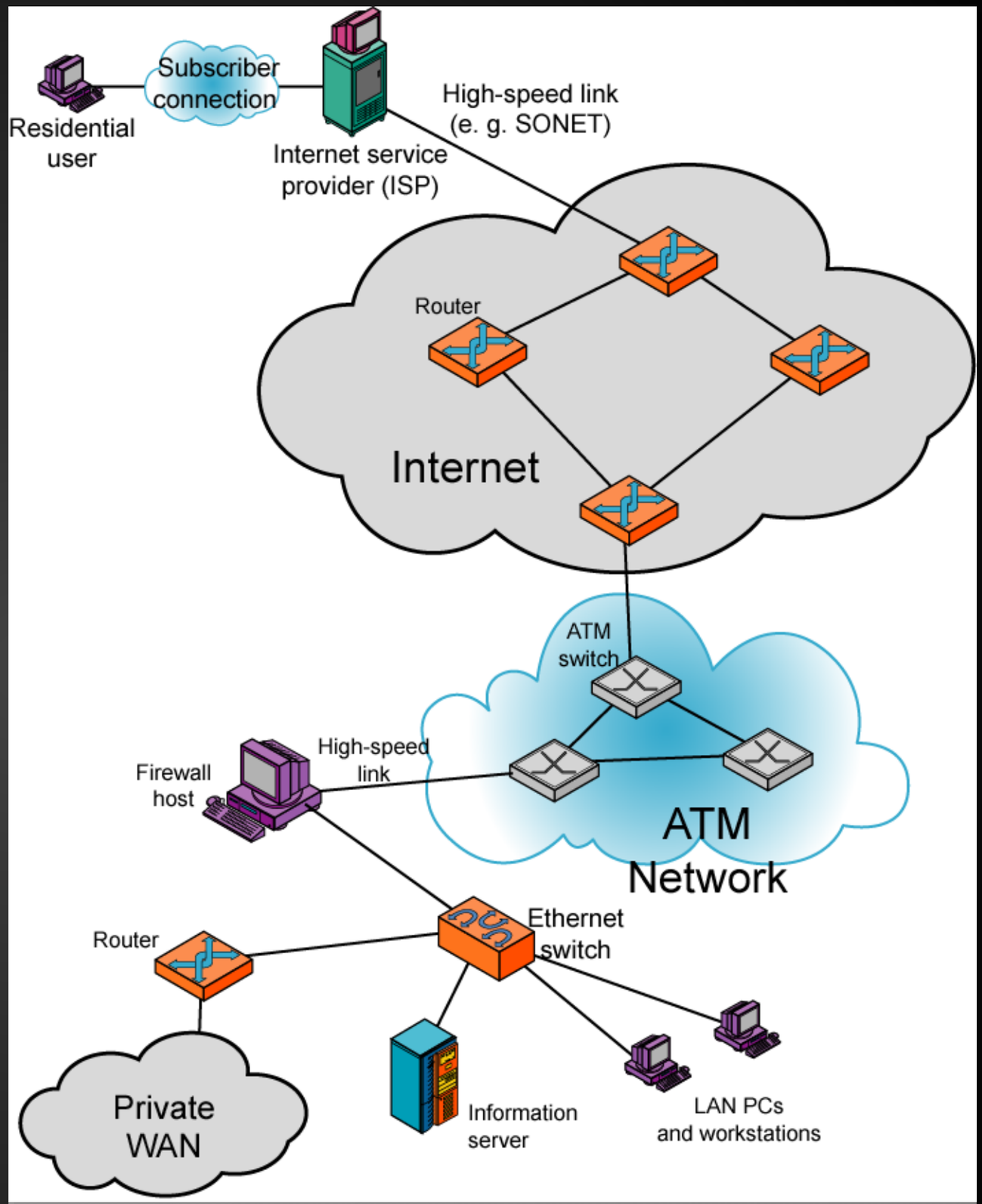


An Example Network configuration

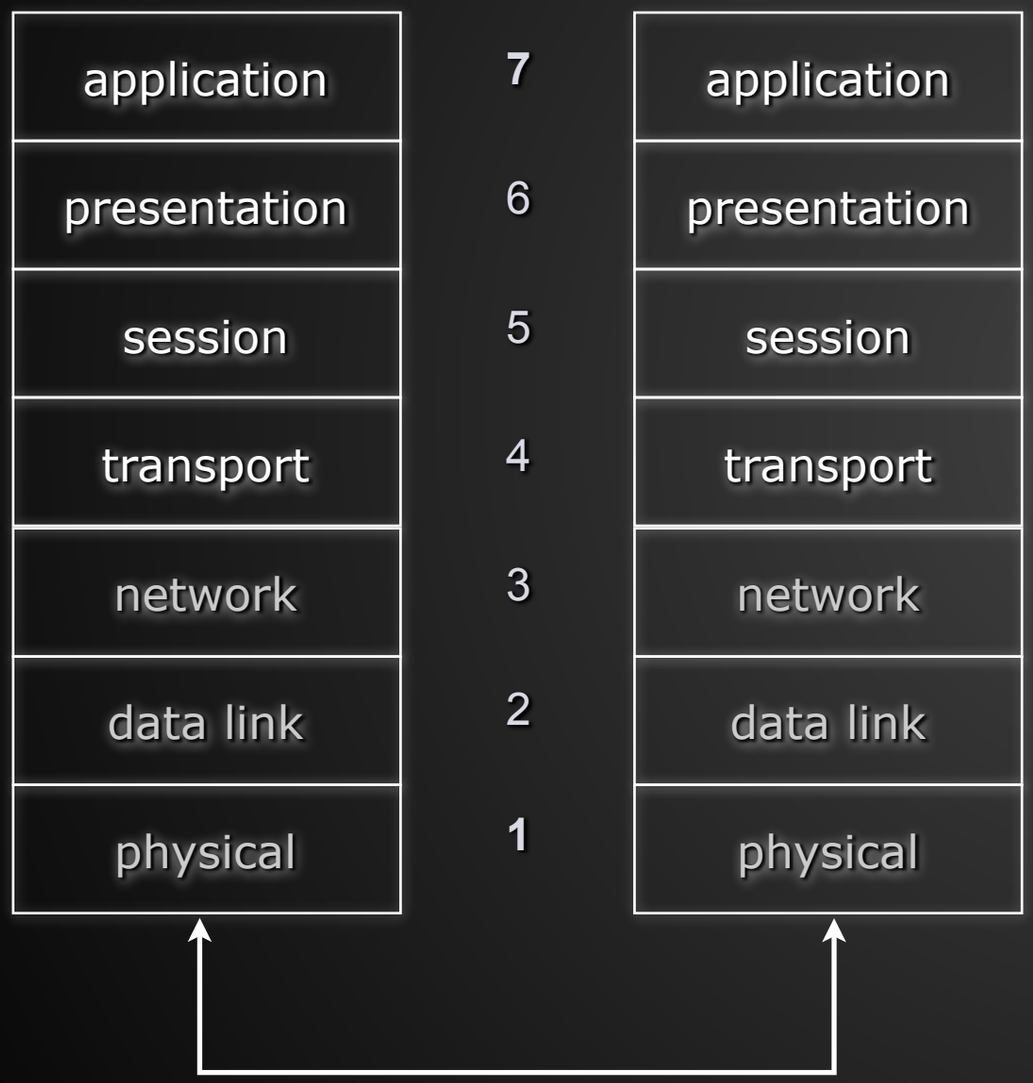
In the upper-left-hand portion of the figure, we see an individual residential user connected to an Internet service provider (ISP) through some sort of subscriber connection.

The Internet consists of a number of interconnected routers that span the globe.

The lower portion shows a LAN implemented using a single Ethernet switch. This is a common configuration at a small business or other small organization.



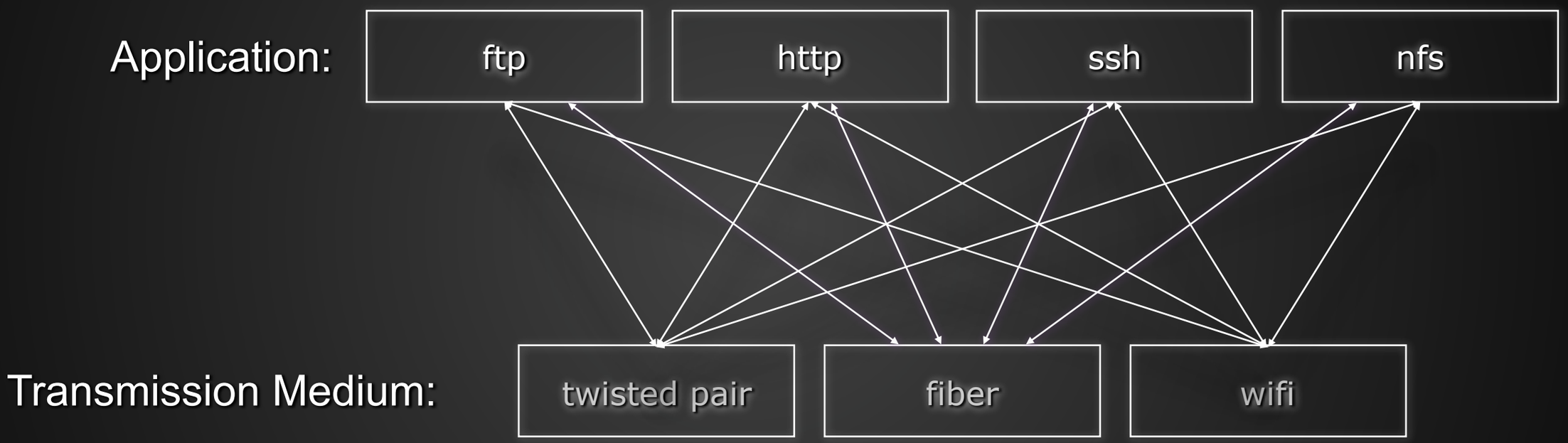
The OSI Protocol Suite



- Produced by ISO and CCITT
- ISO Reference Model
- A general, open standard
- Heavily referenced, but
- Rarely implemented
- What's so magical about the 7 layers after all ???

Why layering?

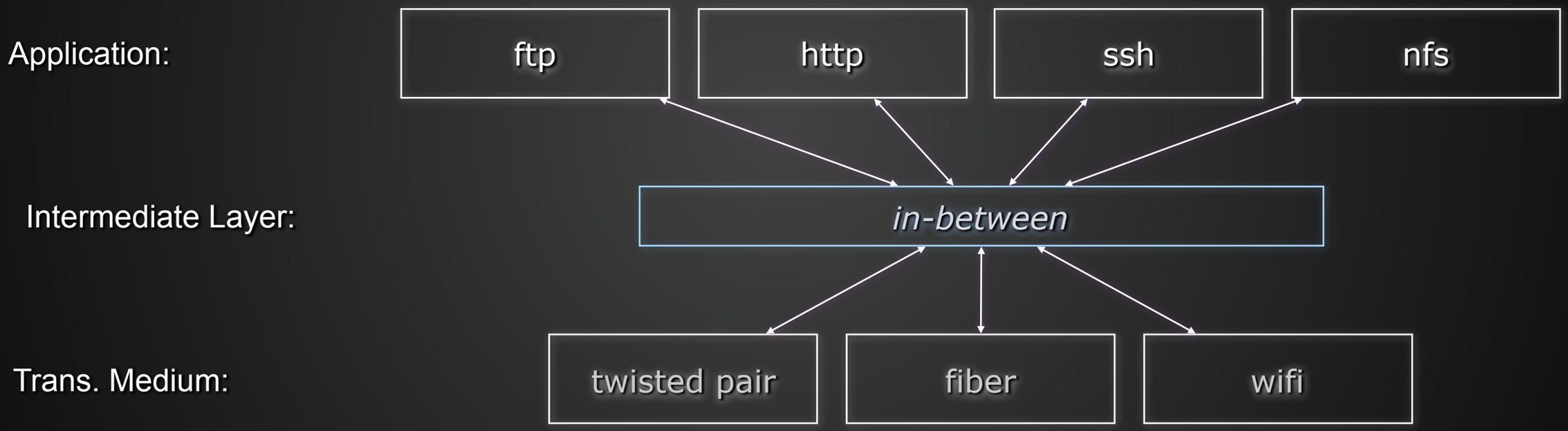
- Without layering :



  - Each application would need to be
    - implemented for every networking technology
    - re-implemented for every new networking technology

Introducing an intermediate layer

- provides a unique abstraction for various network technologies
- uses abstractions to hide complexity



Such abstractions naturally lead to multilevel layering:

Where a service of layer L uses only services of layer L-1

Layering

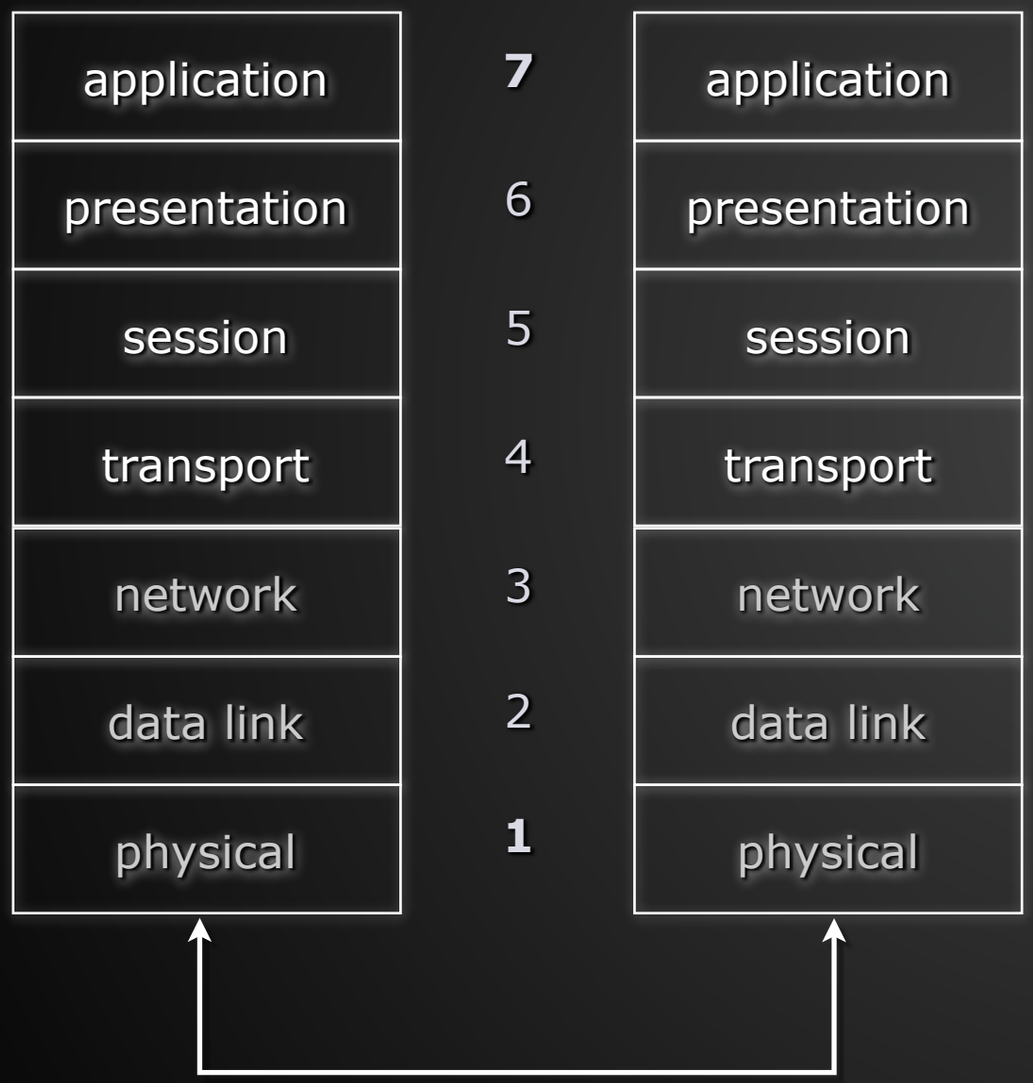
Advantages

- Modularity:
  - protocols easier to manage & maintain
- Abstract functionality
  - lower layers can be changed without affecting the upper layers
- Reusability:
  - upper layers can reuse the functionality provided by lower layers

Disadvantages

- Information hiding
  - inefficient implementations

The OSI Protocol Suite



Service

- what a layer provides

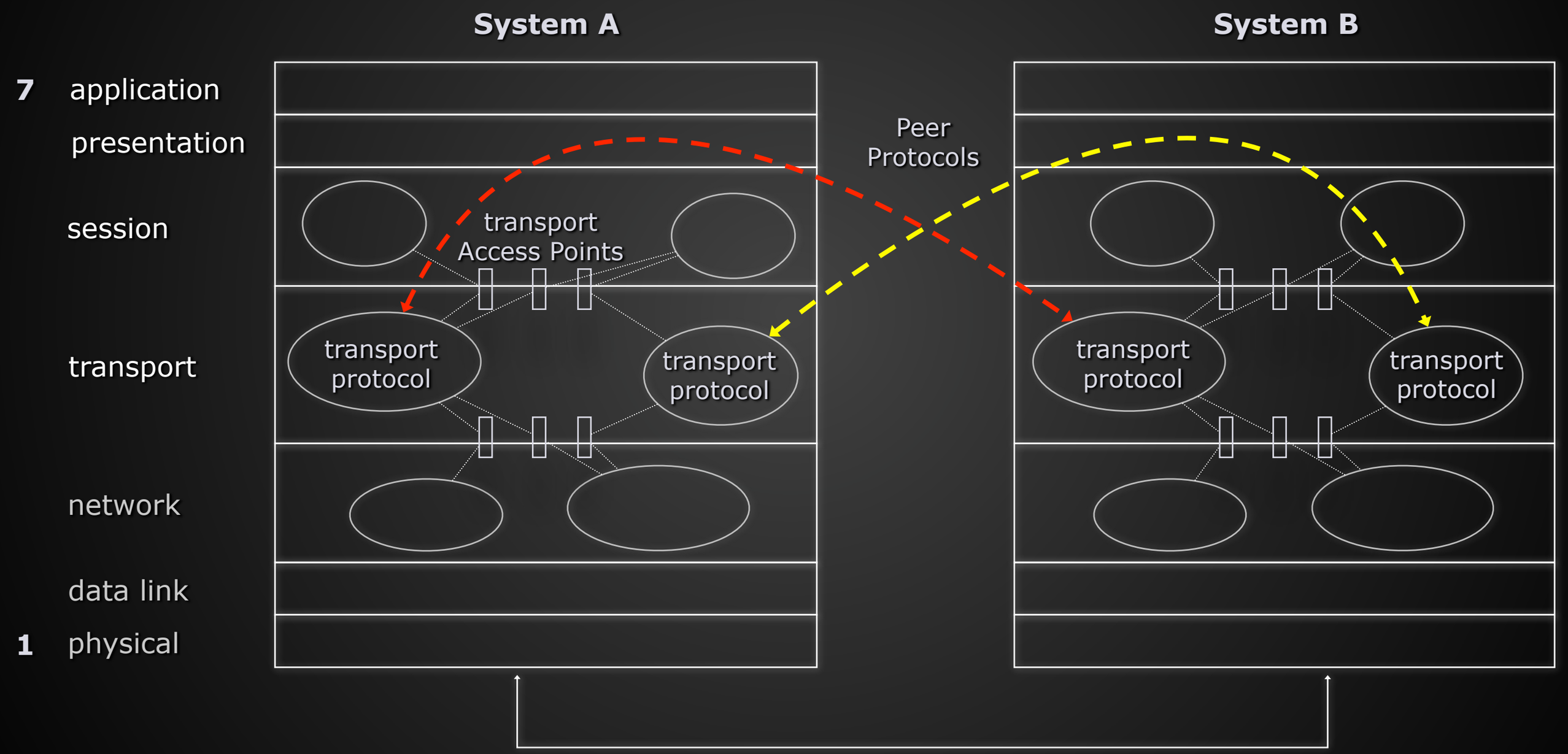
Interface

- how a service can be accessed

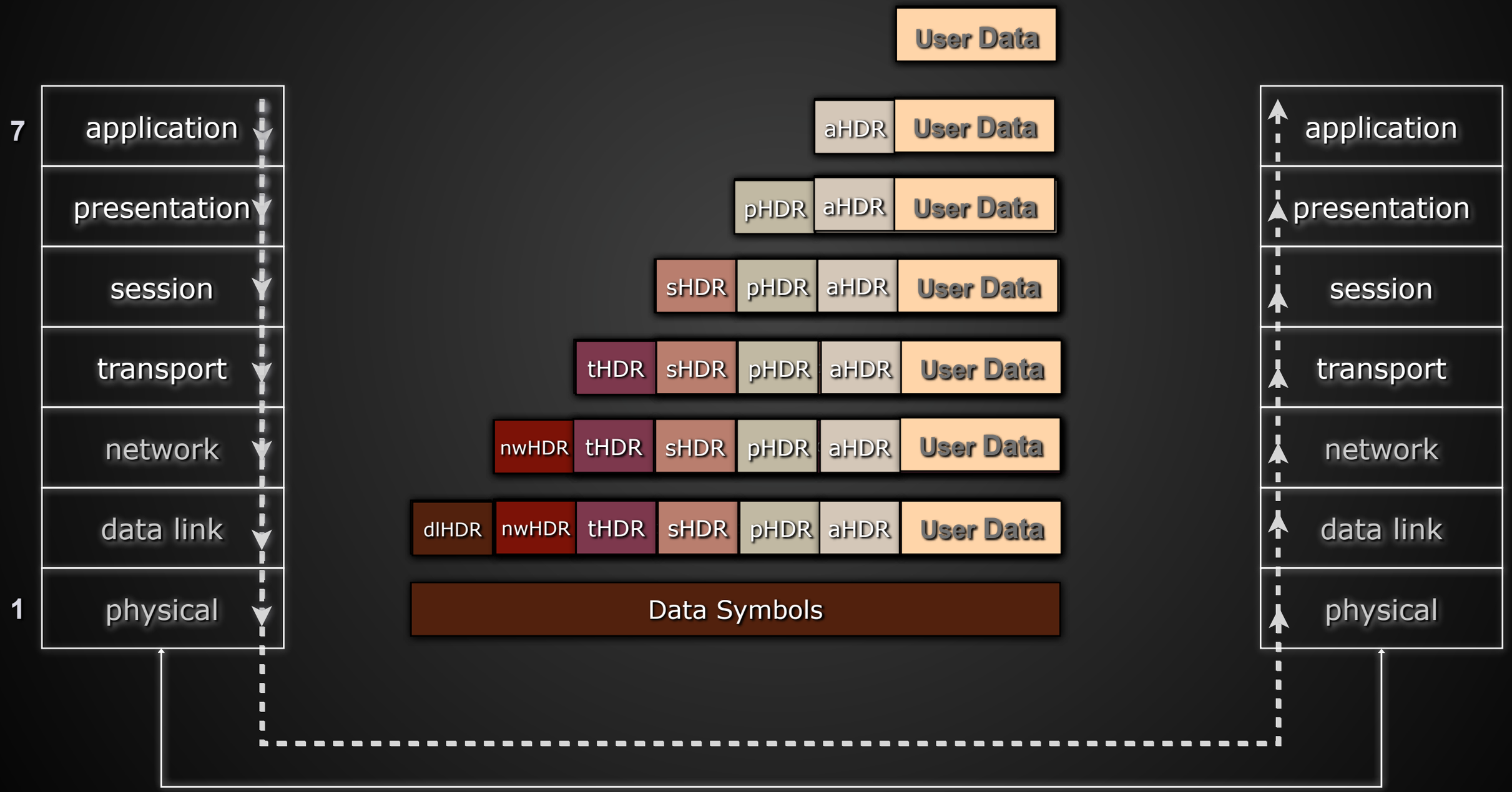
Protocol

- how the service is implemented
- a set of rules and formats that govern the communication between two peers

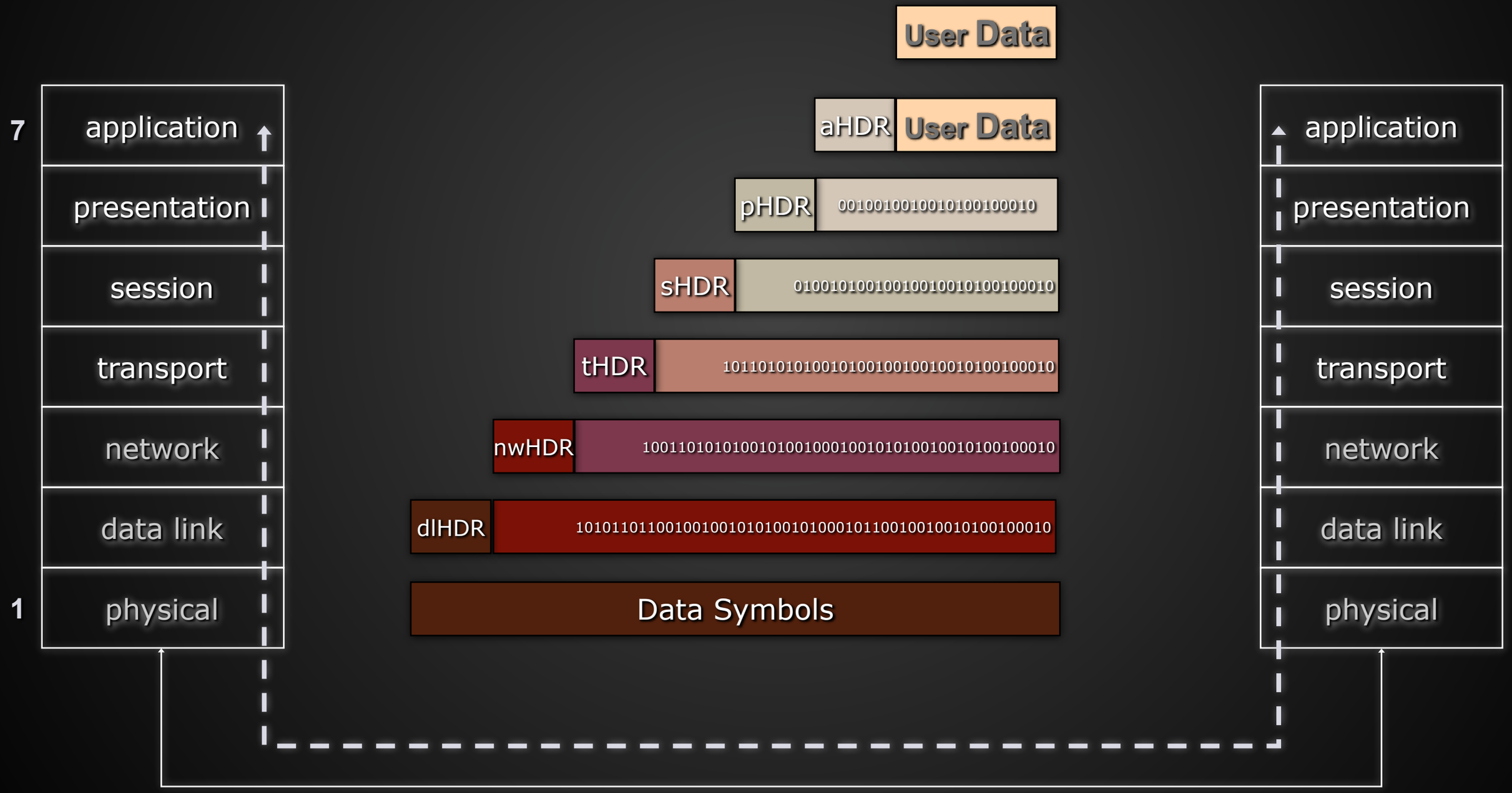
Multiplexing in OSI



7-layer OSI model data encapsulation



7-layer OSI model data encapsulation



The 7 layers in a nutshell .1

1. Physical
   - Physical interface between devices
     - Mechanical
     - Electrical
     - Functional
     - Procedural

2. Data Link (MAC & LLC)
   - Activates, Maintains, Deactivates a reliable link
   - Error detection and control
   - Offers error free transmission

The 7 layers in a nutshell .2

3. Network
   - Transport of information
   - Higher layers do not need to know about underlying technology
   - Not needed on direct links

4. Transport
   - Exchange of data between end systems
   - end-to-end error free
   - In sequence
   - No losses
   - No duplicates
   - Flow control
   - Quality of service

The 7 layers in a nutshell .3

5. Session
   - Control of dialogues between applications
   - Dialogue discipline
   - Grouping
   - Recovery

6. Presentation
   - Data formats and coding
   - Data compression
   - Encryption

7. Application
   - Means for user applications to access the OSI environment

Intermediate Nodes

physical

Repeater / Hub

data link

physical

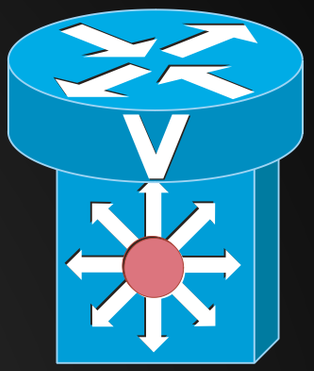
Bridge / Switch

network

data link

physical

Router



application

presentation

session

transport

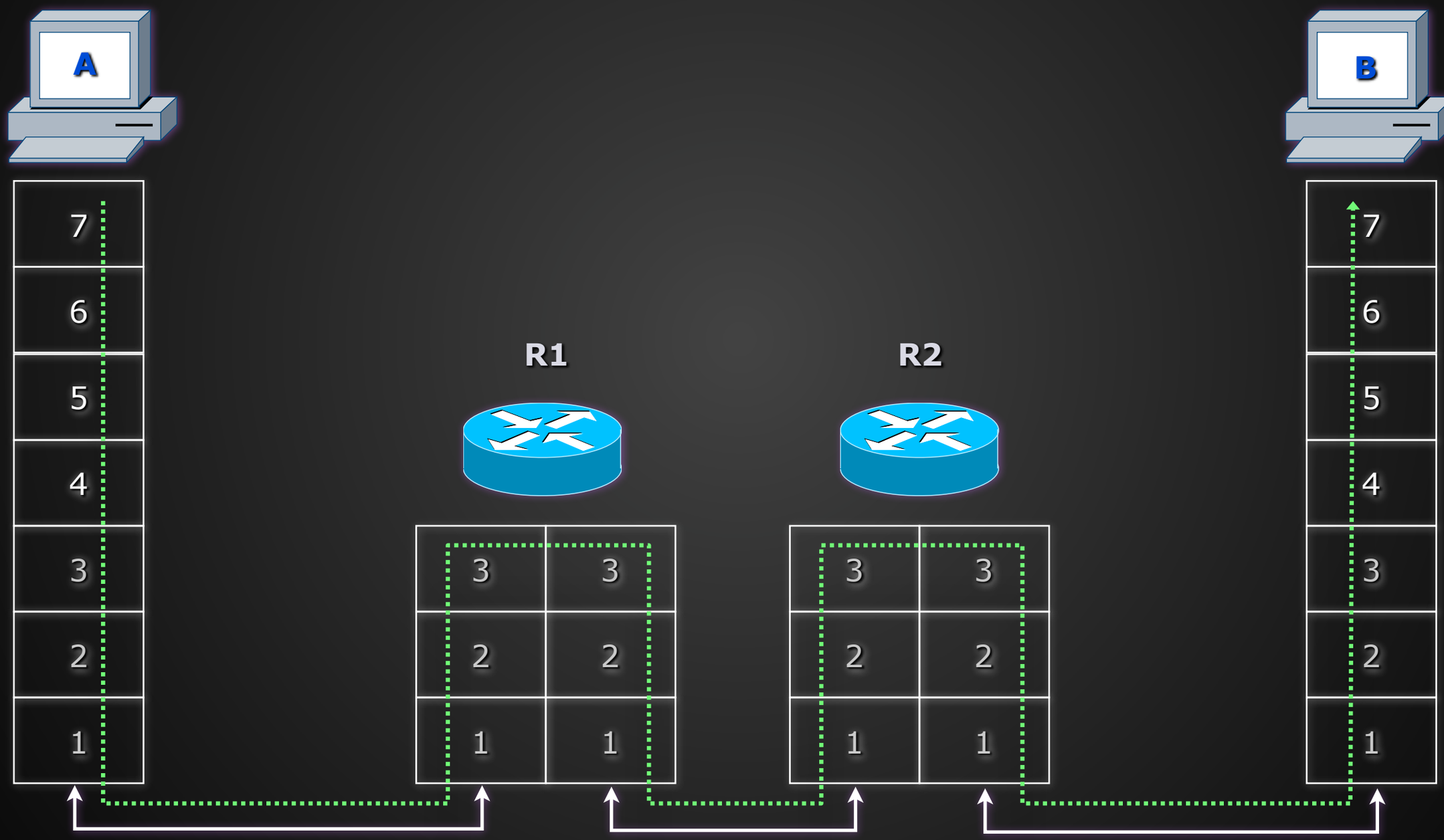
network

data link

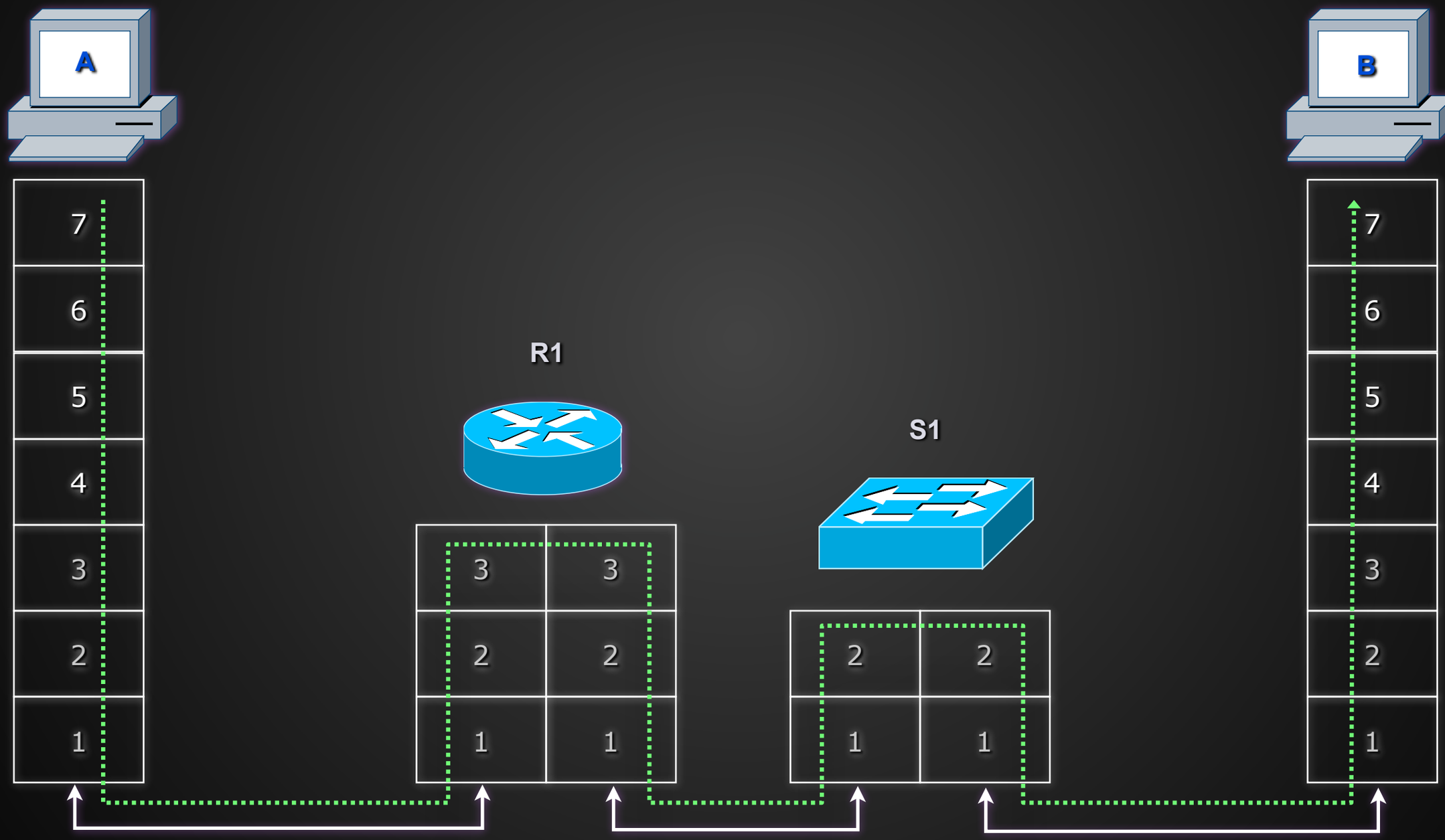
physical

Gateway

What a Router Implements



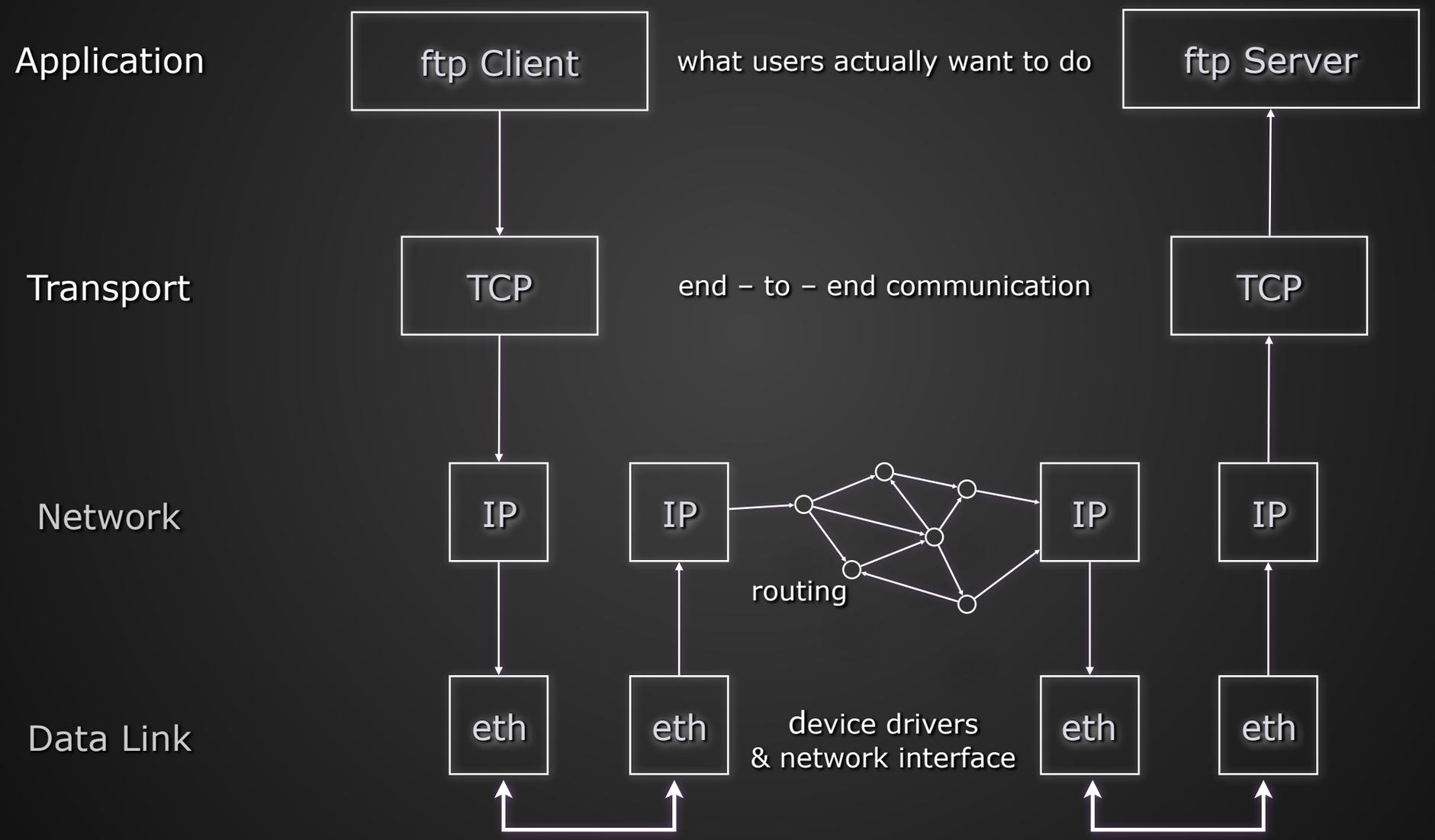
Routers & Switches



The TCP/IP Protocol suite

- Considers four layers
- Forms the basis for the Internet
- An Open System since:
  - the definition of the protocol suite and many of its implementations are publicly available
- Outline of the main protocols
  - Internet Protocol (IP)
  - User Datagram Protocol (UDP)
  - Transmission Control Protocol (TCP)
- Brief sketch of “helper protocols”:
  - ARP, RARP, ICMP, IGMP…

The TCP/IP Protocol suite



The TCP/IP hourglass notion