Week 1 – Introduction to Networking Continued

COMP90007 Internet Technologies

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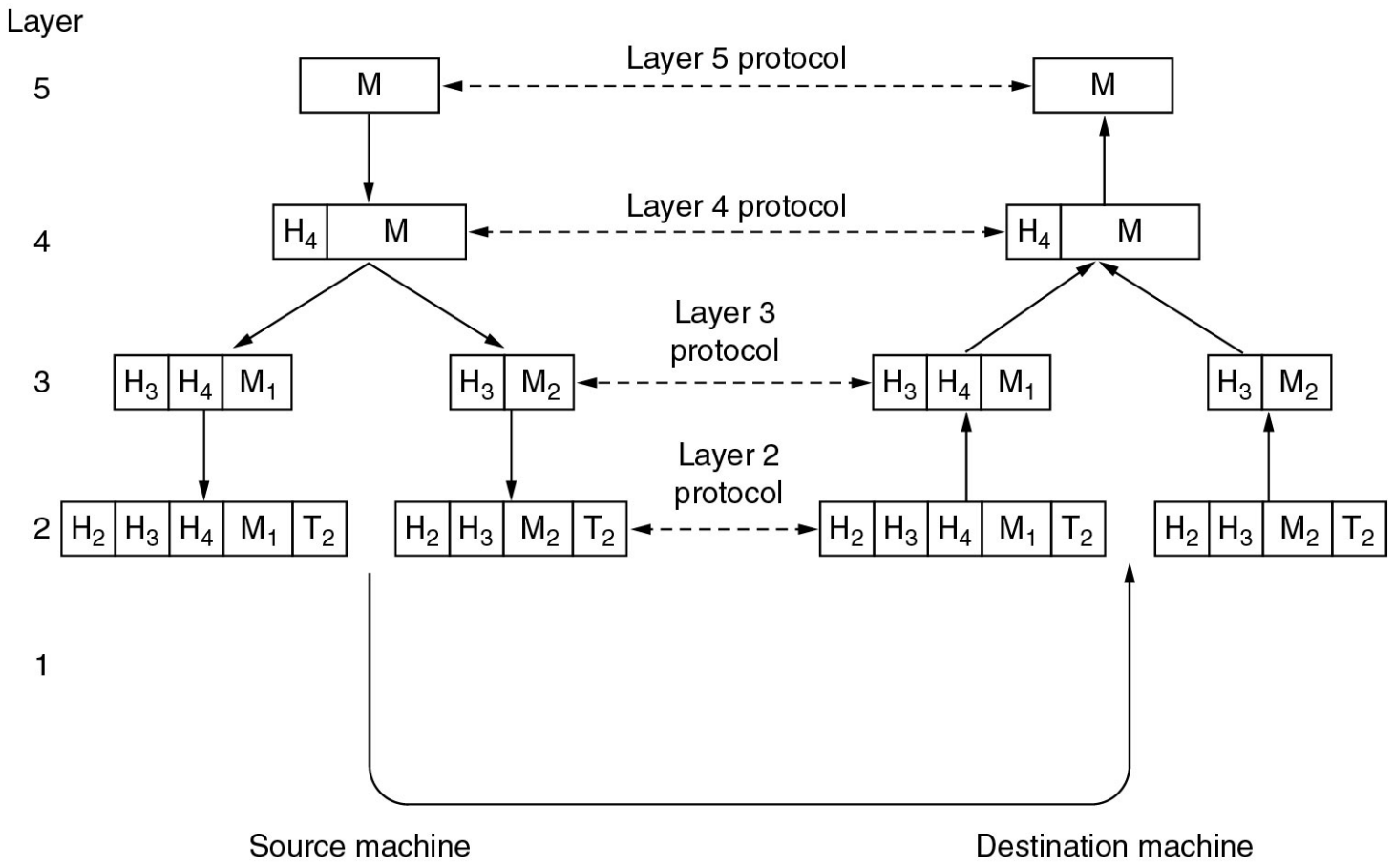
Semester 2, 2020

Recap: Protocol Hierarchies

- Example information flow supporting virtual communication in layer 5



Services

- Choice of service type has a corresponding impact on the reliability and quality of the service

- Connection-Oriented vs. Connectionless
  - Connection-Oriented: connect, use, disconnect (similar to telephone service). Negotiation inherent in connection setup
  - Connectionless: just send (similar to postal service)

Connection-Oriented and Connectionless

- Six different types of services

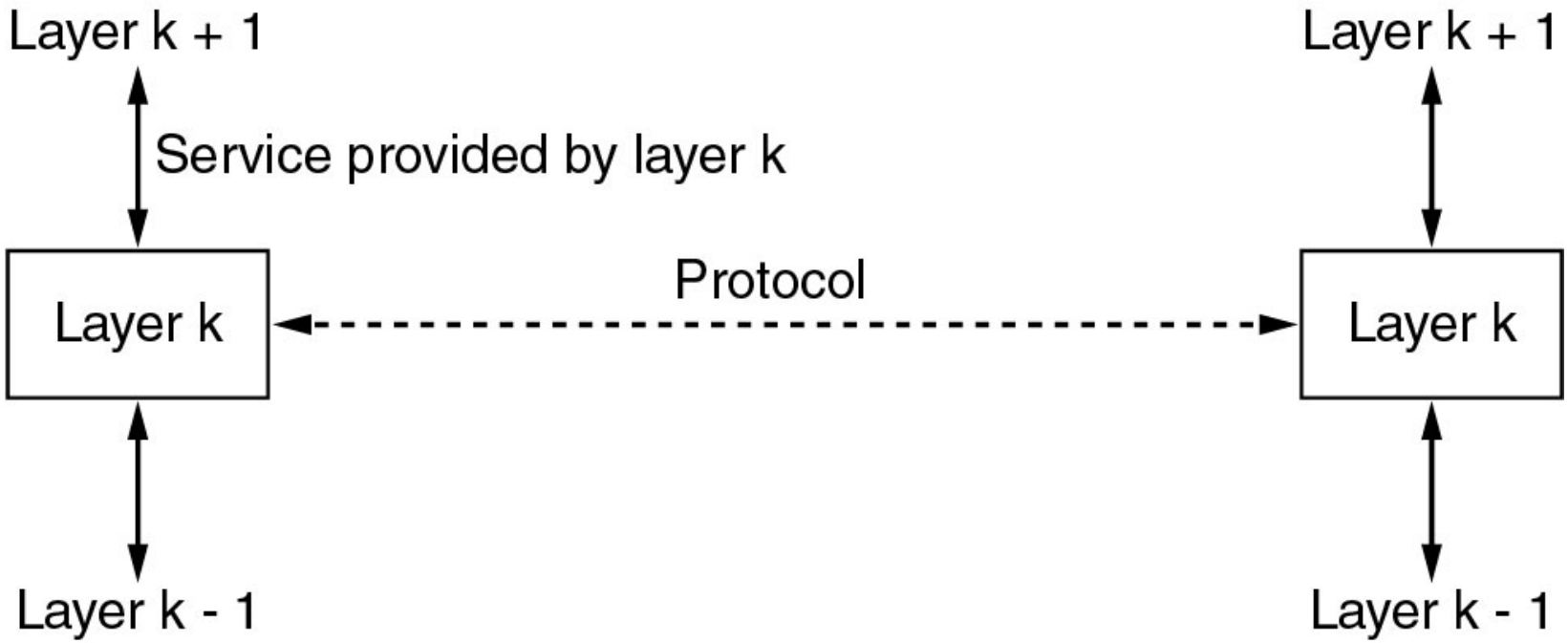
	Service	Example
Connection-oriented	Reliable message stream	Sequence of pages
	Reliable byte stream	Remote login
	Unreliable connection	Digitized voice
Connection-less	Unreliable datagram	Electronic junk mail
	Acknowledged datagram	Registered mail
	Request-reply	Database query

Service Primitives

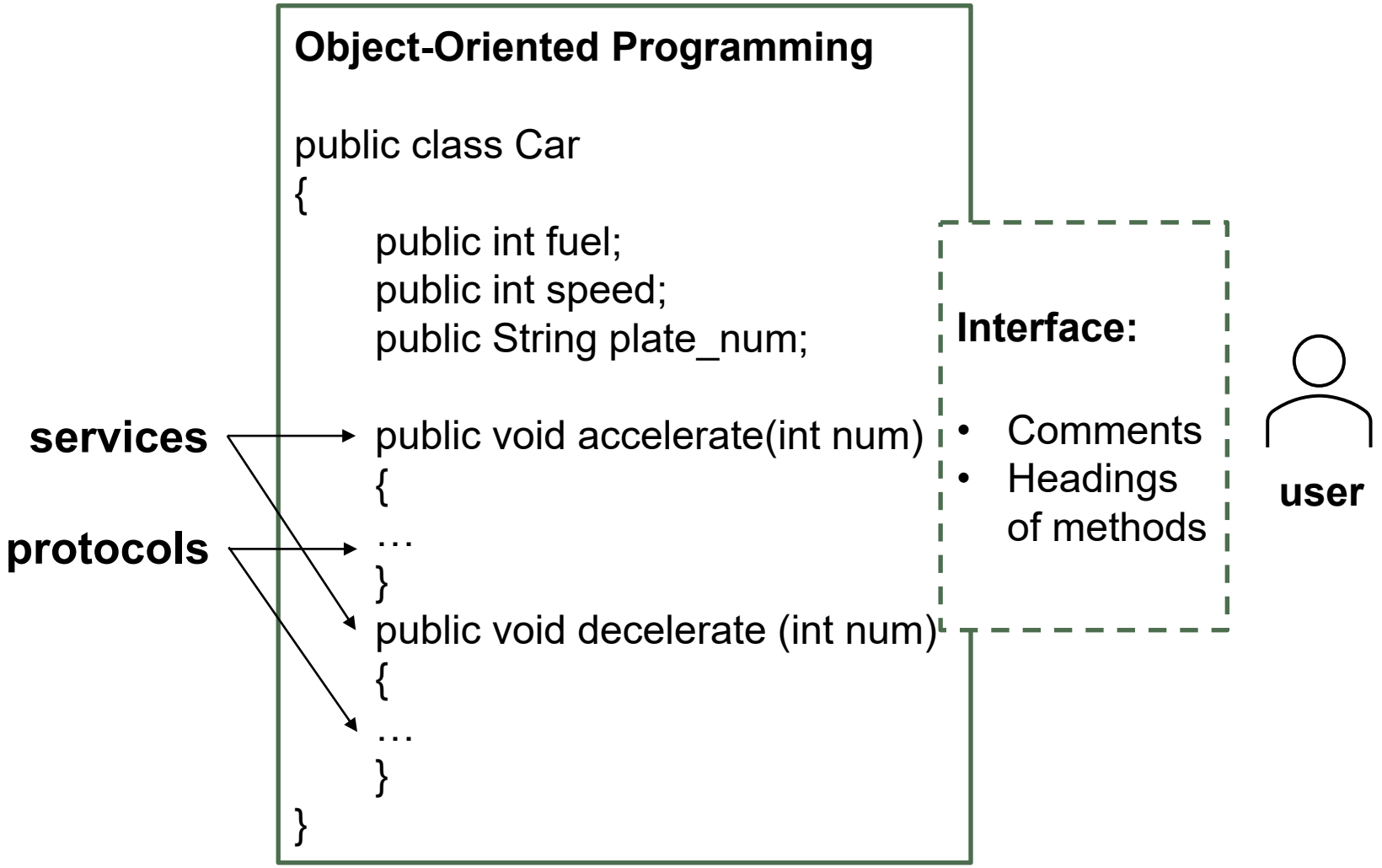
- Primitives are a formal set of operations for services
- The number and type of primitives in any particular context depends on the nature of service - in general more complex services require more service primitives
- Six service primitives for implementing a simple connection-oriented service

Primitive	Meaning
LISTEN	Block waiting for an incoming connection
CONNECT	Establish a connection with a waiting peer
ACCEPT	Accept an incoming connection from a peer
RECEIVE	Block waiting for an incoming message
SEND	Send a message to the peer
DISCONNECT	Terminate a connection

Relationship of Services and Protocols



Relationship of Services and Protocols



Relationship of Services and Protocols

- **Service = set of primitives that a layer provides to a layer above it**
  - Provided through the interfaces between layers (service provider vs service users)
  - Defines what operations the layer is prepared to perform on behalf of its users
  - It says nothing about how these operations are implemented

- **Protocol = a set of rules governing the format and meaning of packets that are exchanged by peers within a layer**
  - Packets sent between peer entities

Reference Models

- The OSI Reference Model
- The TCP/IP Reference Model
- A Comparison of OSI and TCP/IP
- A Critique of the OSI Model and Protocols
- A Critique of the TCP/IP Reference Model

Why do we need a reference model?

- A reference model provides a ***common baseline for the development*** of many services and protocols by independent parties
- Since networks are very complex systems, a reference model can serve to ***simplify the design process***
- It's engineering *best practice* to have an ***"abstract" reference model***, and corresponding implementations are always required for validation purposes

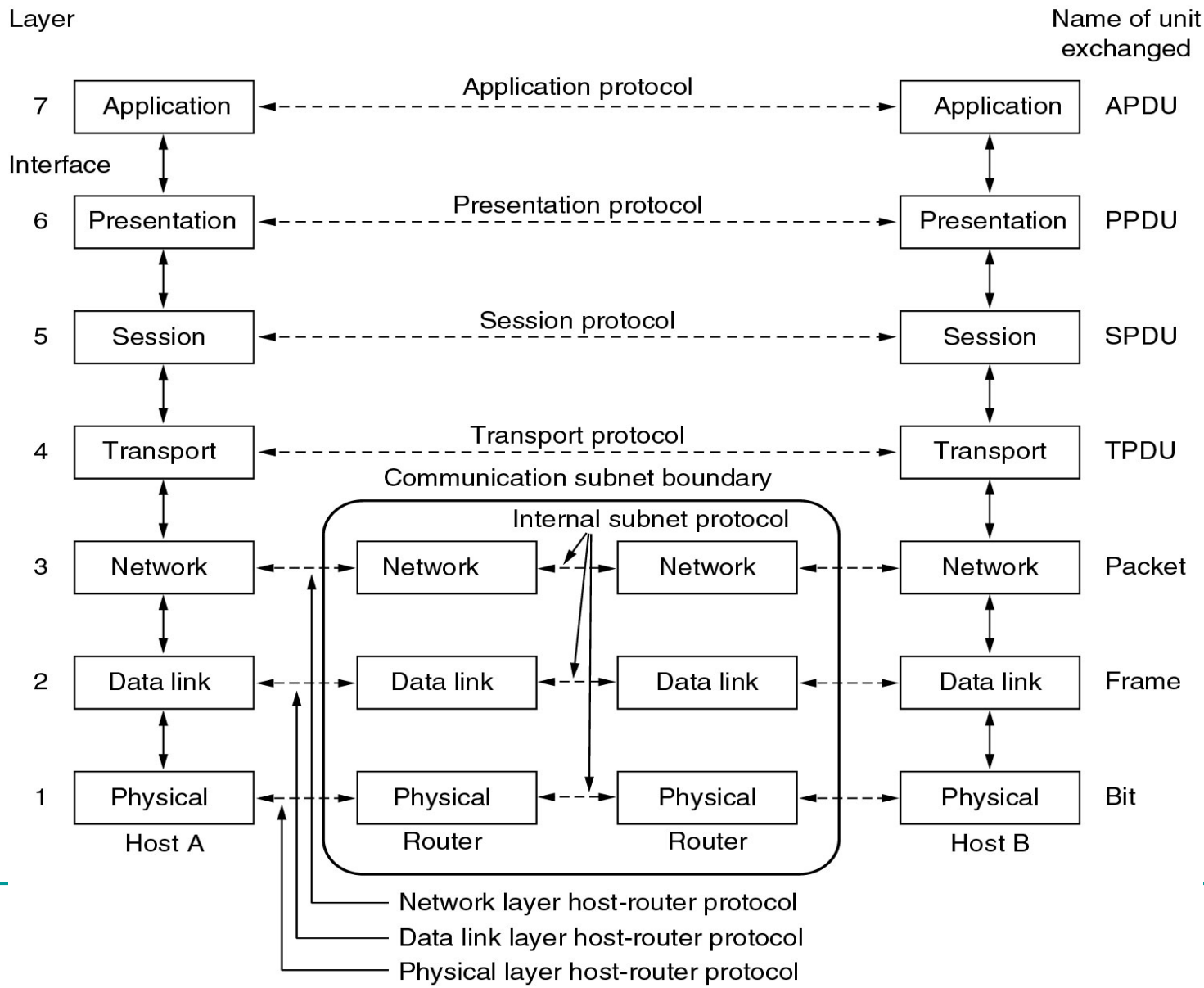
OSI Reference Model

- Open Systems Interconnection (OSI)
- ISO, John Day (revised 1995)
- 7 Layers
- Layer divisions based on principled decisions

OSI Layer Division Principles

1. A layer should be created where a different **abstraction** is needed.
2. Each layer should **perform a well defined function.**
3. The layer boundaries should be chosen to **minimise the information flow across the interfaces.**
4. The number of layers should be **large enough that** distinct functions need not to be thrown together in the same layer out of necessity; and **small enough that** the architecture does not become unwieldy.
5. The function of each layer should be chosen with a view toward defining **internationally standardised protocols.**

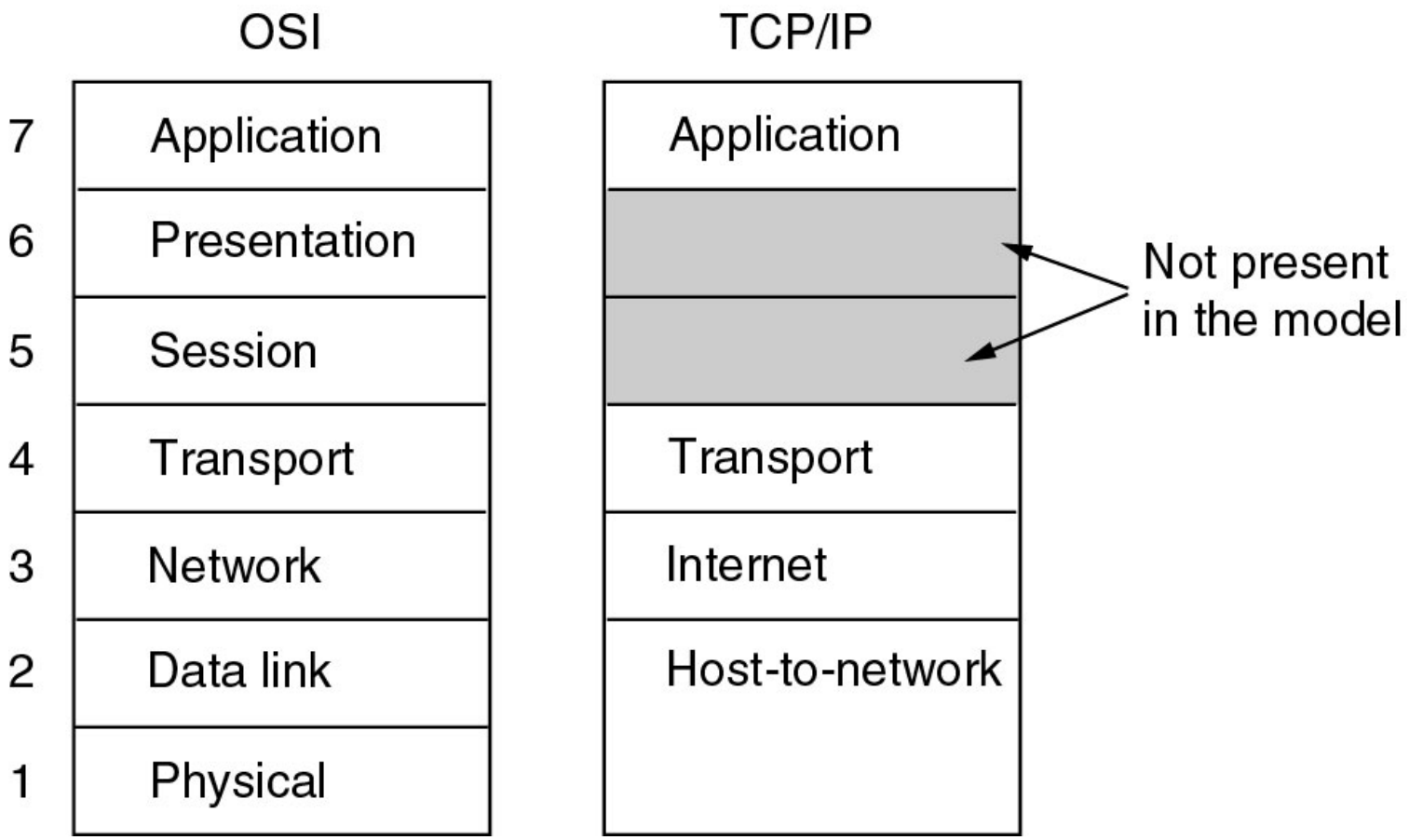
OSI Reference Model



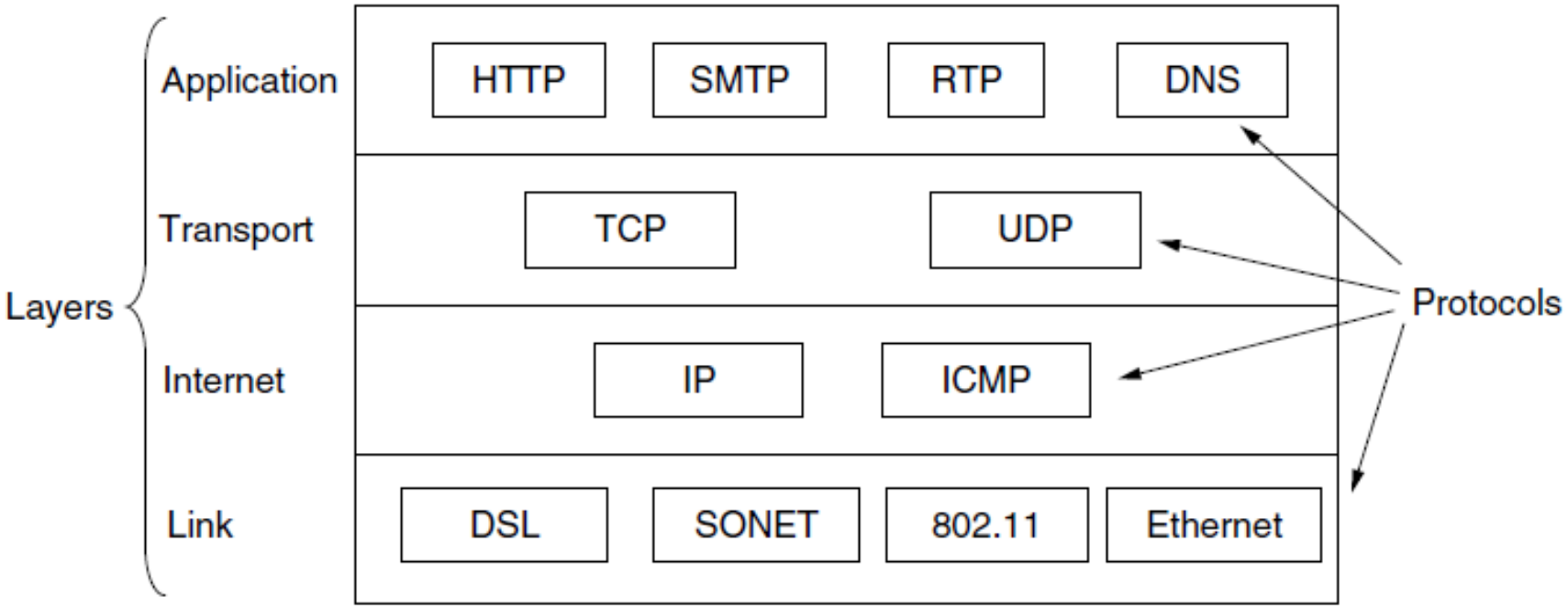
TCP/IP Reference Model

- Transmission Control Protocol/Internet Protocol
- Vint Cerf & Bob Kahn (1974)
- 4 layers

TCP/IP Reference Model (2)



TCP/IP Reference Model (3)



Comparing OSI and TCP/IP Models

- Different numbers of layers
- OSI distinguishes the following three concepts explicitly
  - Services
  - Interfaces
  - Protocols
- TCP/IP has successful protocols

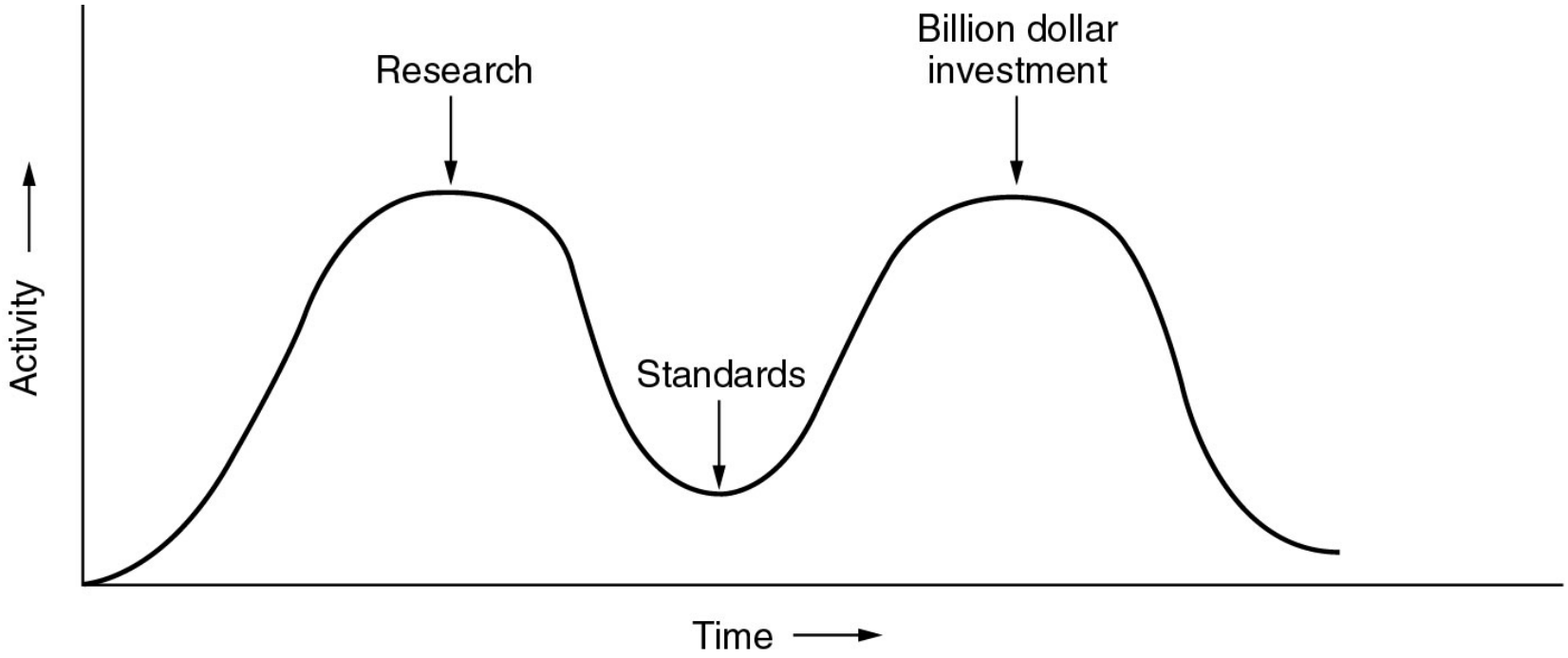
A Critique of the OSI Model

Why OSI did not take over the world?

- Bad timing
- Bad technology
- Bad implementations
- Bad politics

A Critique of the OSI Model: Bad Timing

- When is good timing for a standard?



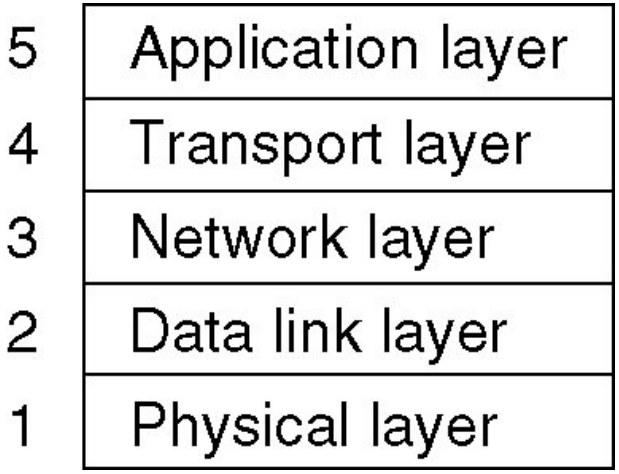
A Critique of the TCP/IP Model

Problems:

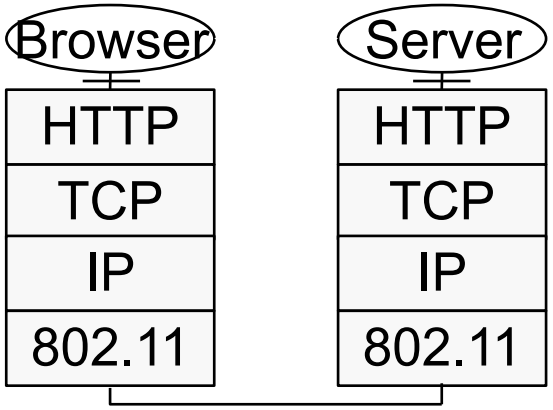
- Not a general model
- Service, interface, and protocol not distinguished
- Host-to-network “layer” not really a layer – interface between network and data link layers
- No mention of physical and data link layers
- Minor protocols deeply entrenched, hard to replace

Hybrid Model

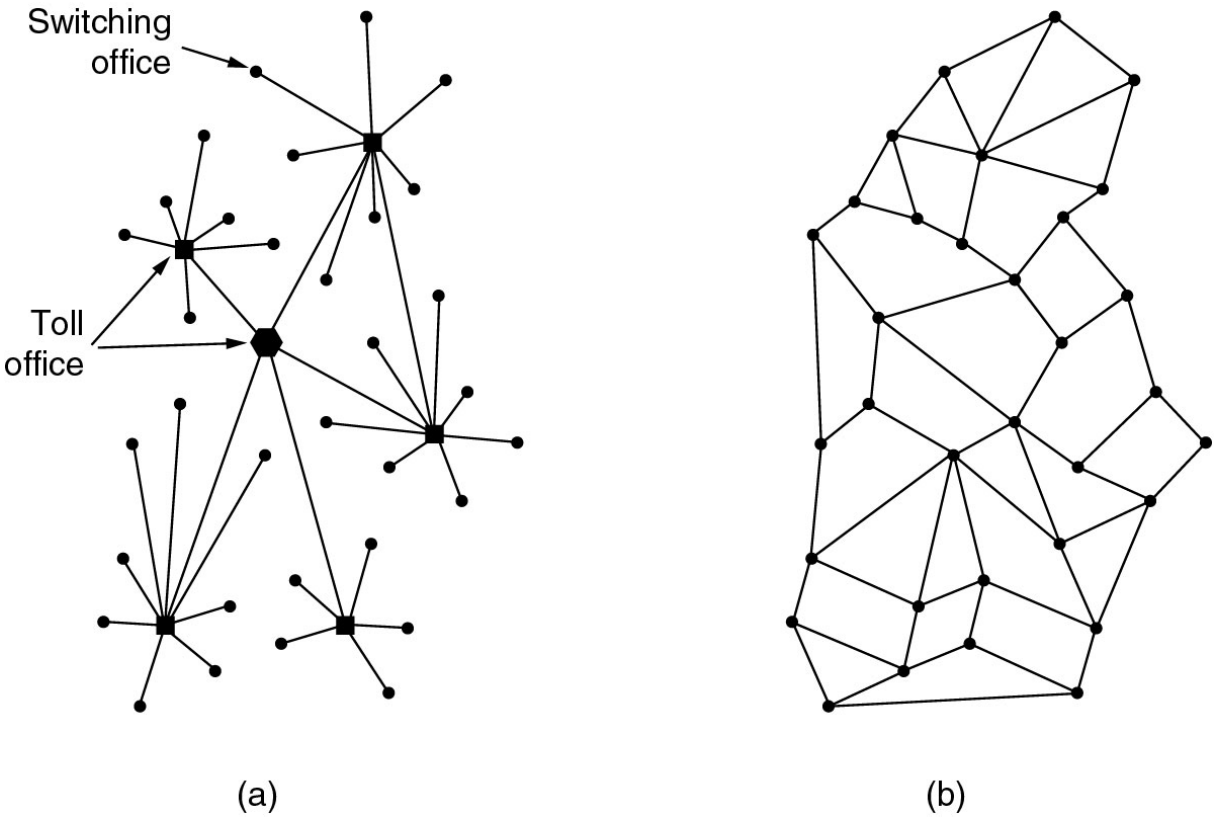
- The hybrid reference model to be used in this semester



A typical network scenario

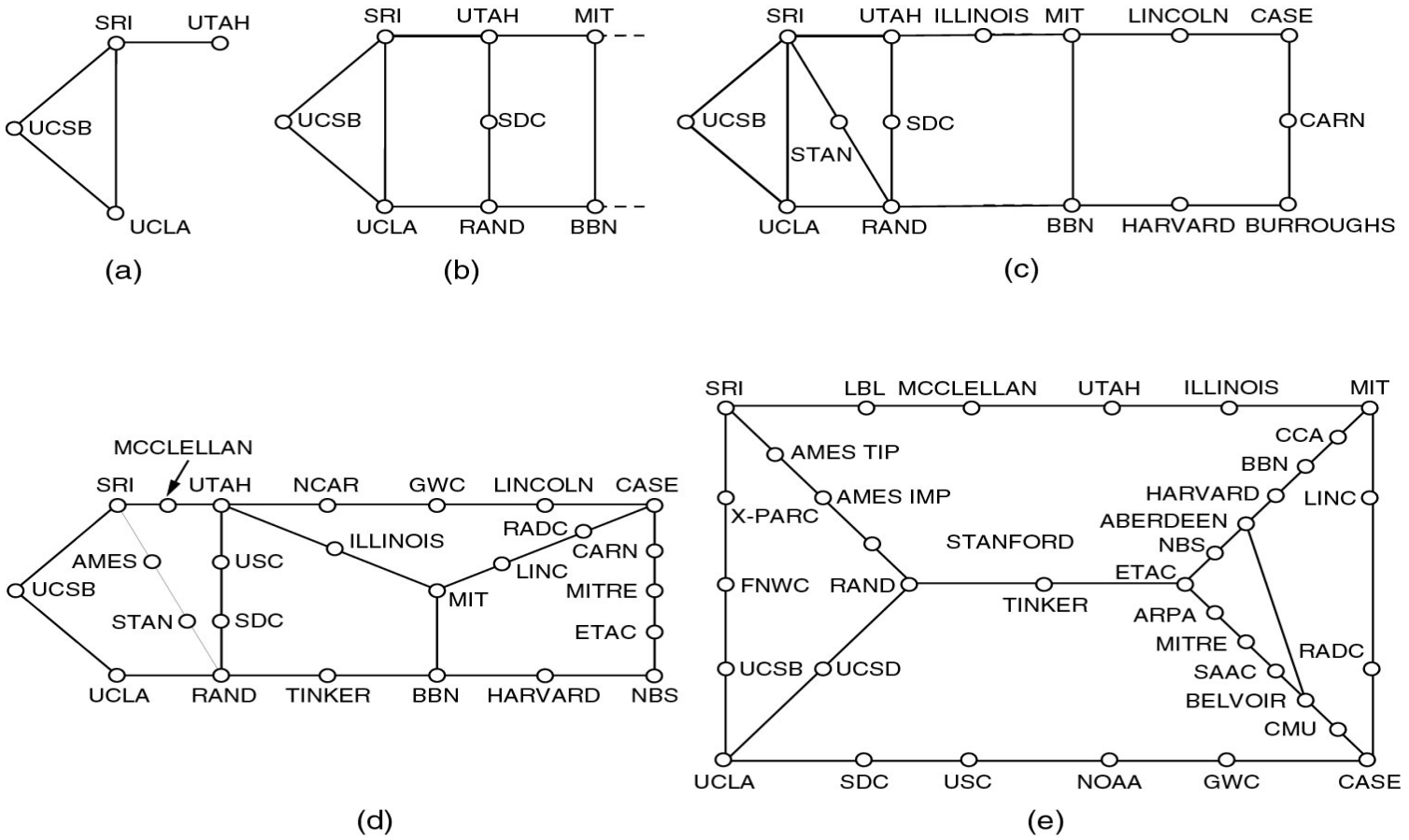


Origins of Internet: The ARPANET



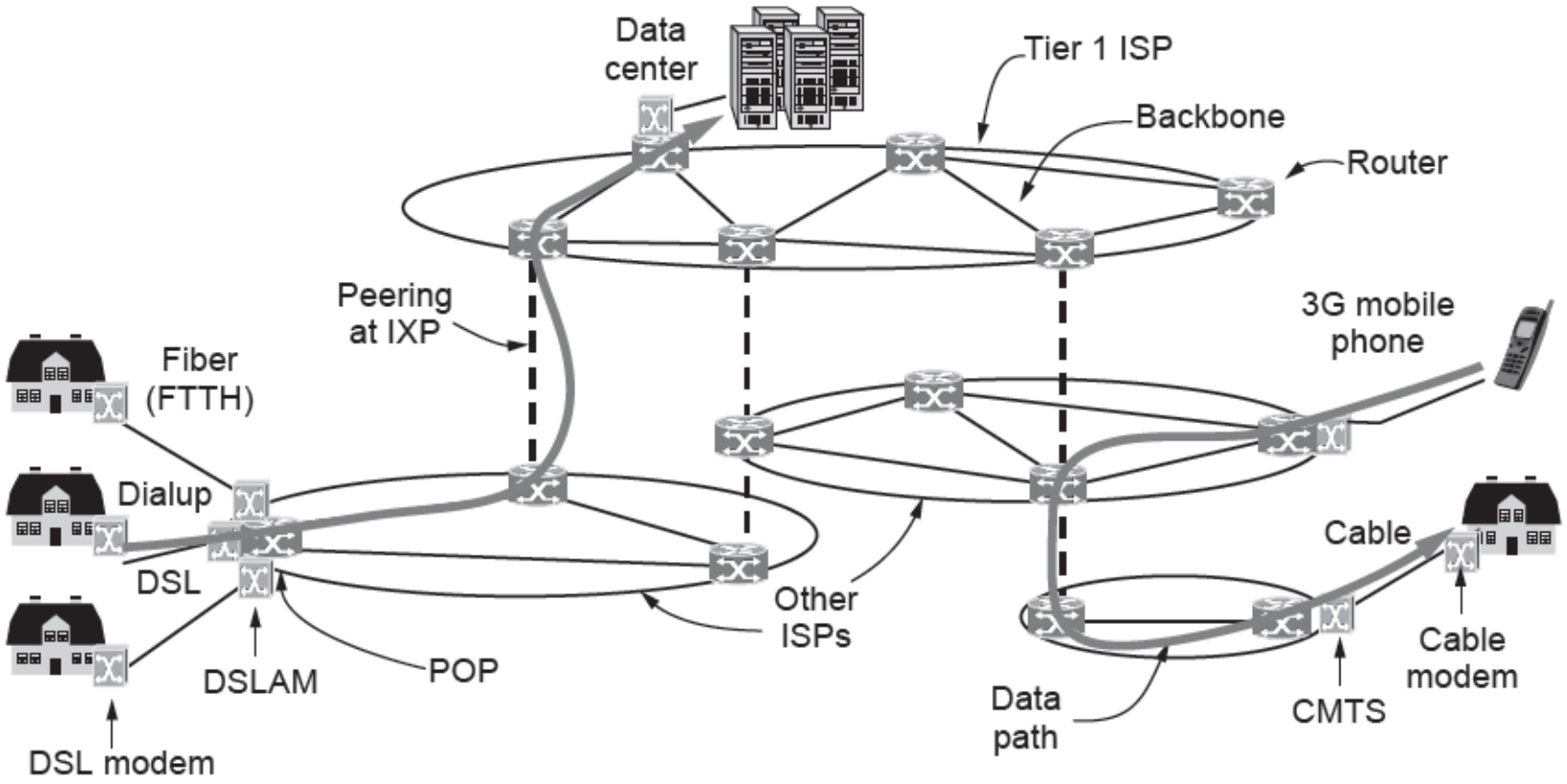
- **(a)** Structure of the telephone system.
- **(b)** Baran's proposed distributed switching system.

The ARPANET



- Growth of the ARPANET (a) December 1969. (b) July 1970.
- (c) March 1971. (d) April 1972. (e) September 1972.

Architecture of the Internet



Network Standardisation

Body	Area	Examples
ITU (International Telecommunication Union)	Telecommunications	ADSL PON MPEG4
IEEE (Institute of Electrical and Electronics Engineers)	Communications	Ethernet WiFi
IETF (Internet Engineering Task Force)	Internet	HTTP/1.1 DNS
W3C (The World Wide Web Consortium)	Web	HTML5 standard