Lecture 7

Internet

By

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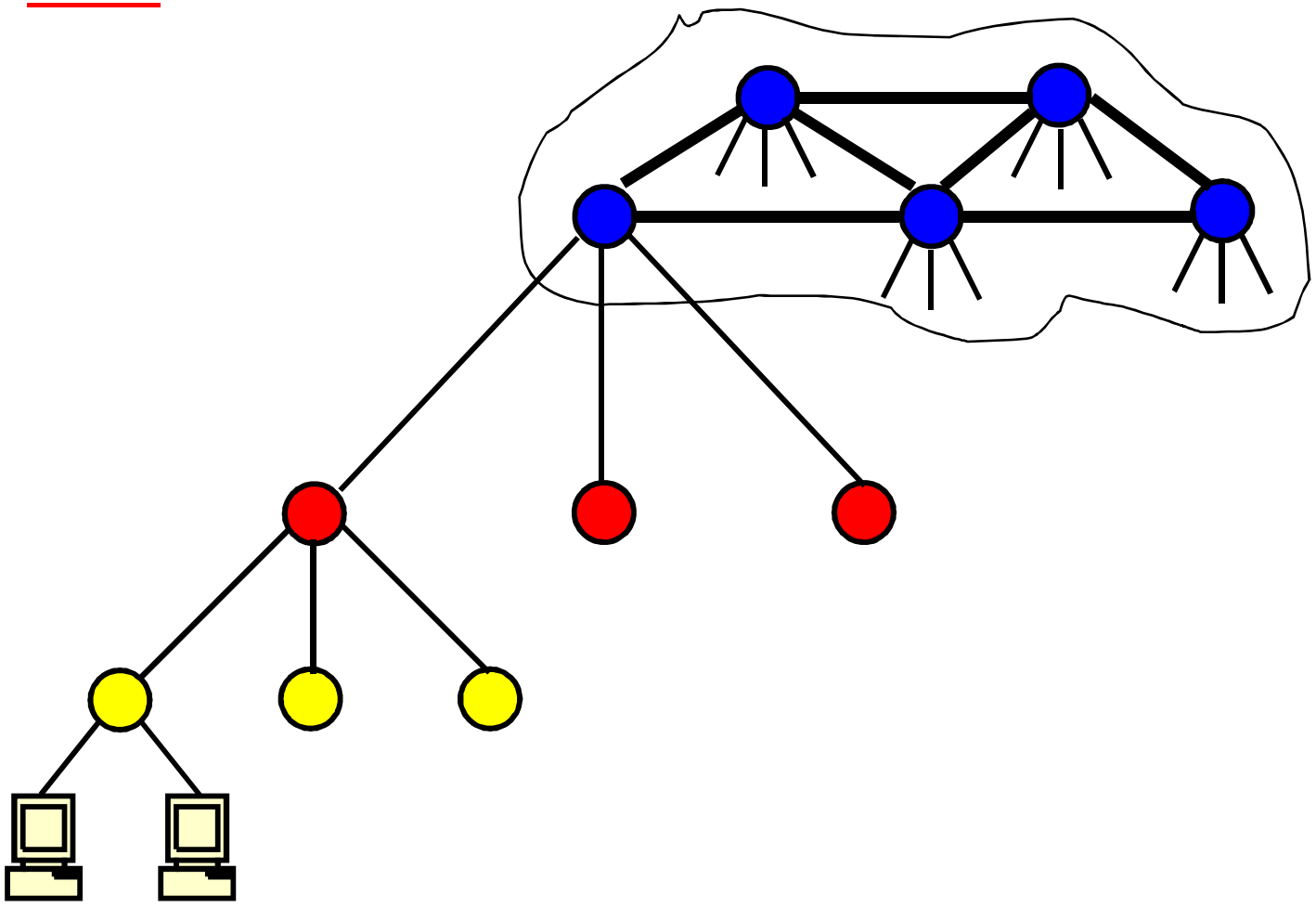
A Brief History

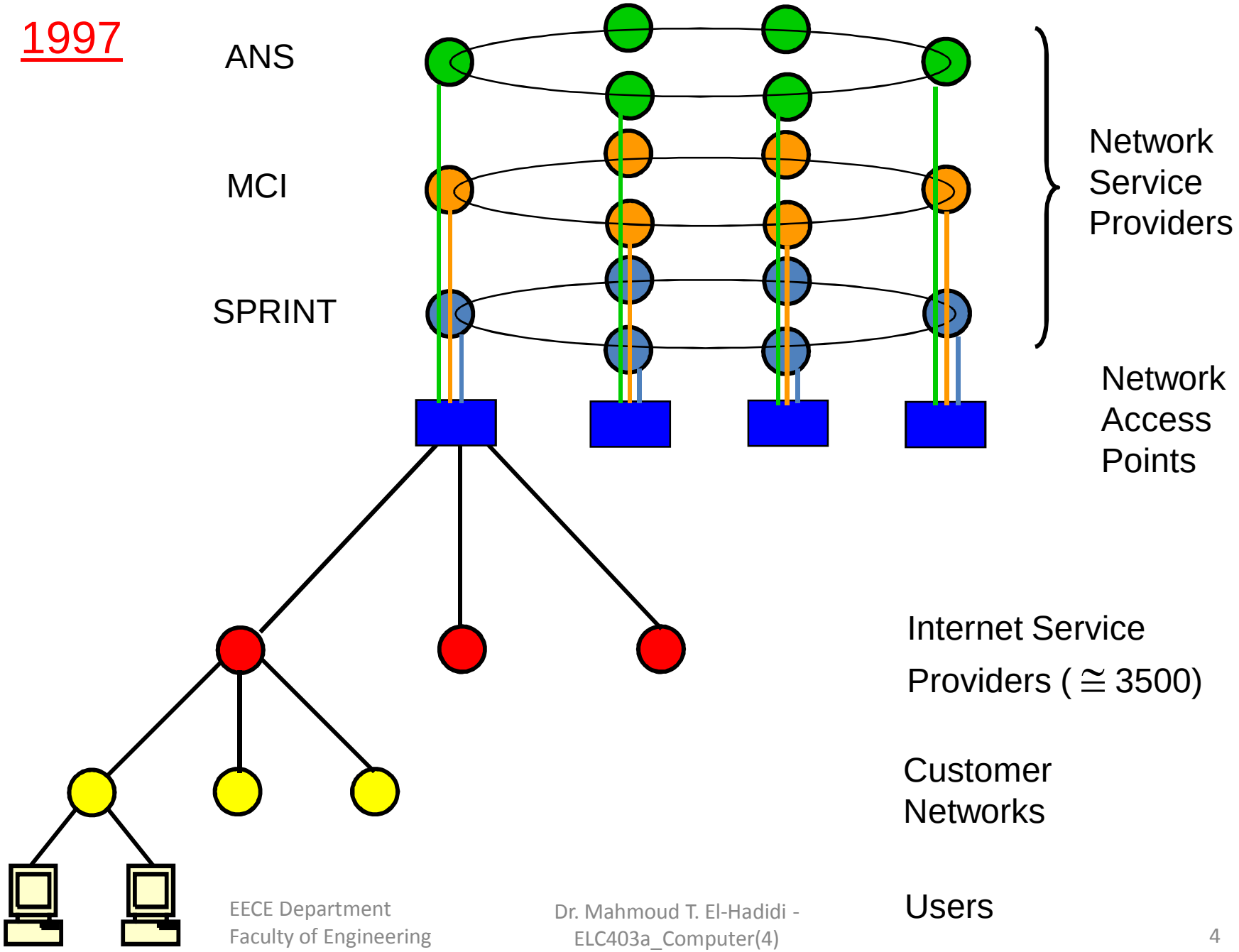
1962	Paul Baran of RAND Corporation proposes packet switching as a robust networking mechanism
1969	Advanced Research Projects Agency (ARPA) of the Department of Defense funds a project on packet switched NW's, called ARPANET.
1974	Vint Cerf and Bob Khan publish the basic mechanism of TCP
1982	The protocol of TCP/IP is defined for ARPANET
1986	NSFNET, the backbone at 56 kbps of Internet, is created by the National Science Foundation (NSF)
1992	The World Wide Web (WWW), designed by Tim Berners-Lee, is released by CERN (European Organization for Nuclear Research)

Hierarchical Structure of Internet (in USA)

1990

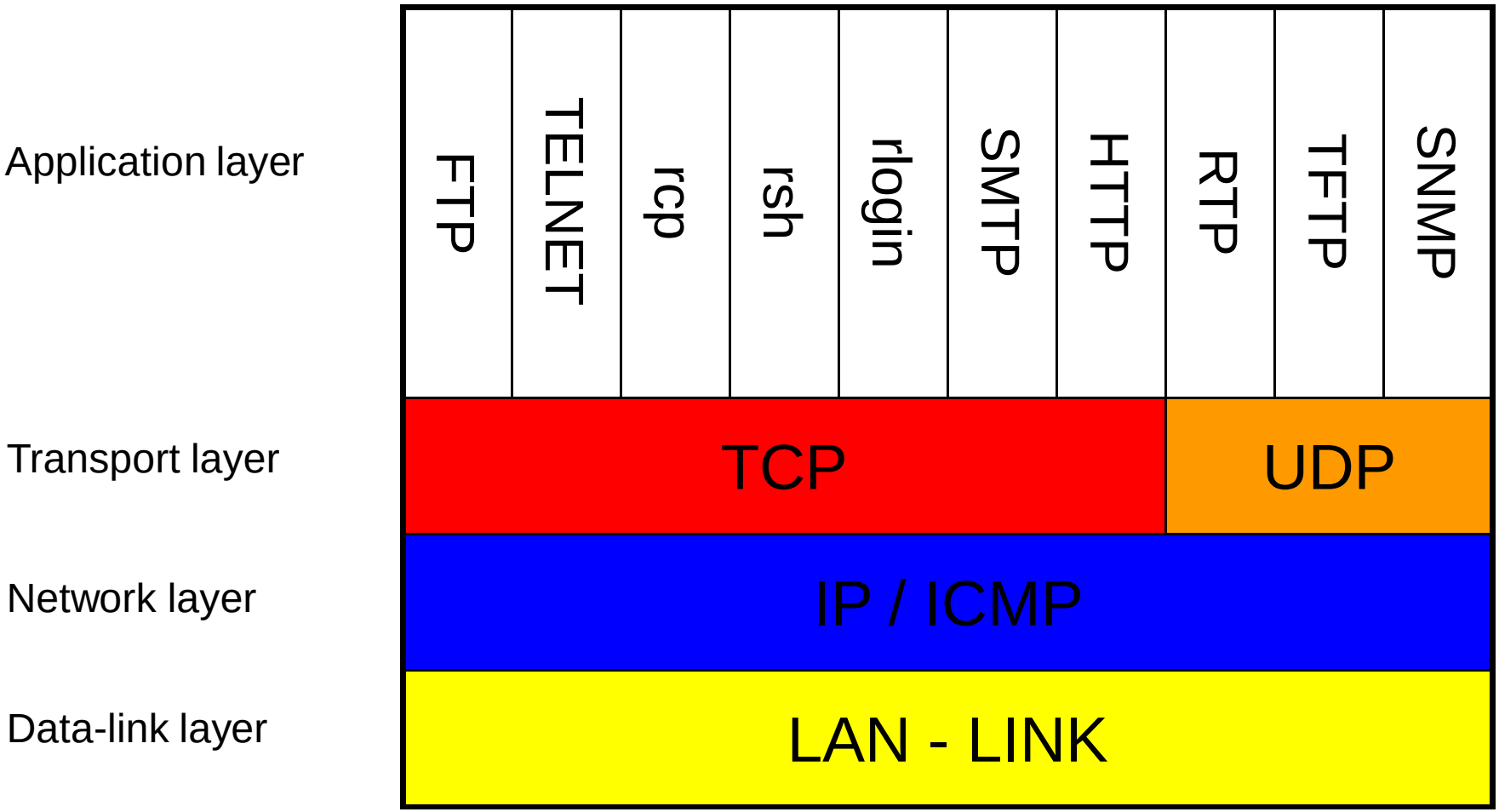


1997


ANS
MCI
SPRINT
Network
Service
Providers
Network
Access
Points
Internet Service
Providers (≅ 3500)
Customer
Networks
Users

Architecture

Layered network architecture



LAN-Link

- Two nodes bet. which pkts are transferred, can be interconnected by:

  same physical link – several physical links

- Main characteristics of a link :

  * MTU (Maximum Transfer Unit)

  ≡ Max. size of a pkt a link can transmit

  1500 bytes for Ethernet - 512 bytes for SLIP using dial-up line

  * PER (Packet Error Rate)

    Small for wired links (fraction of 1%)

    Large for wireless links

  * Transmission Rate

9.6 kbps (slow modem) → 622 Mbps (ATM) → 1 Gbps (Giga Ethernet)

Network layer

- It supervises : addressing of nodes – routing of pkts.
- It uses : Internet Protocol (IP) to deliver pkts.
  Internet Control Message Protocol (ICMP) to supervise delivery of pkts.
- IP allows pkts. to have size up to 64 kbytes
  ==> If pkt. size > MTU,
  IP fragments pkt. into segments < or = MTU
- An IP node (i.e. router) forwards a pkt. by looking up entries of routing table corresponding to address in IP pkt.

Network layer (continued)

- Underlying concept of routing table :
    * Keep as min. inform. as necessary to forward pkt.
    * Inform. in table deductible from NW topology
      (but is independent of current connections)
      ==> in case of node (router) failure, pkt. can still be forwarded. (i.e. NW is robust)

Transport layer

- It supervises : end-to-end delivery of pkts.
- It is implemented at the two ends of a transmission path (but not by the intermediate nodes i.e. routers)
- Two protocols are used :
    * User Datagram Protocol (UDP)
        - Supervises delivery of each pkt. in sense that if pkt arrives incorrectly, UDP discards it.

Transport layer (continued)

* Transmission Control Protocol (TCP)

- Supervises delivery of a sequence of pkts in sense that
  if pkt. arrives incorrectly, discard it
  (called Class 0)
- Establish a virtual circuit, then
  if a pkt. arrives incorrectly, retransmit it <== error control
  if pkts. cause congestion, slow Transm. Rate <== flow control
  (called Class 5)

- Since sophisticated functions are performed only at end-systems (& not at the intermediate nodes)

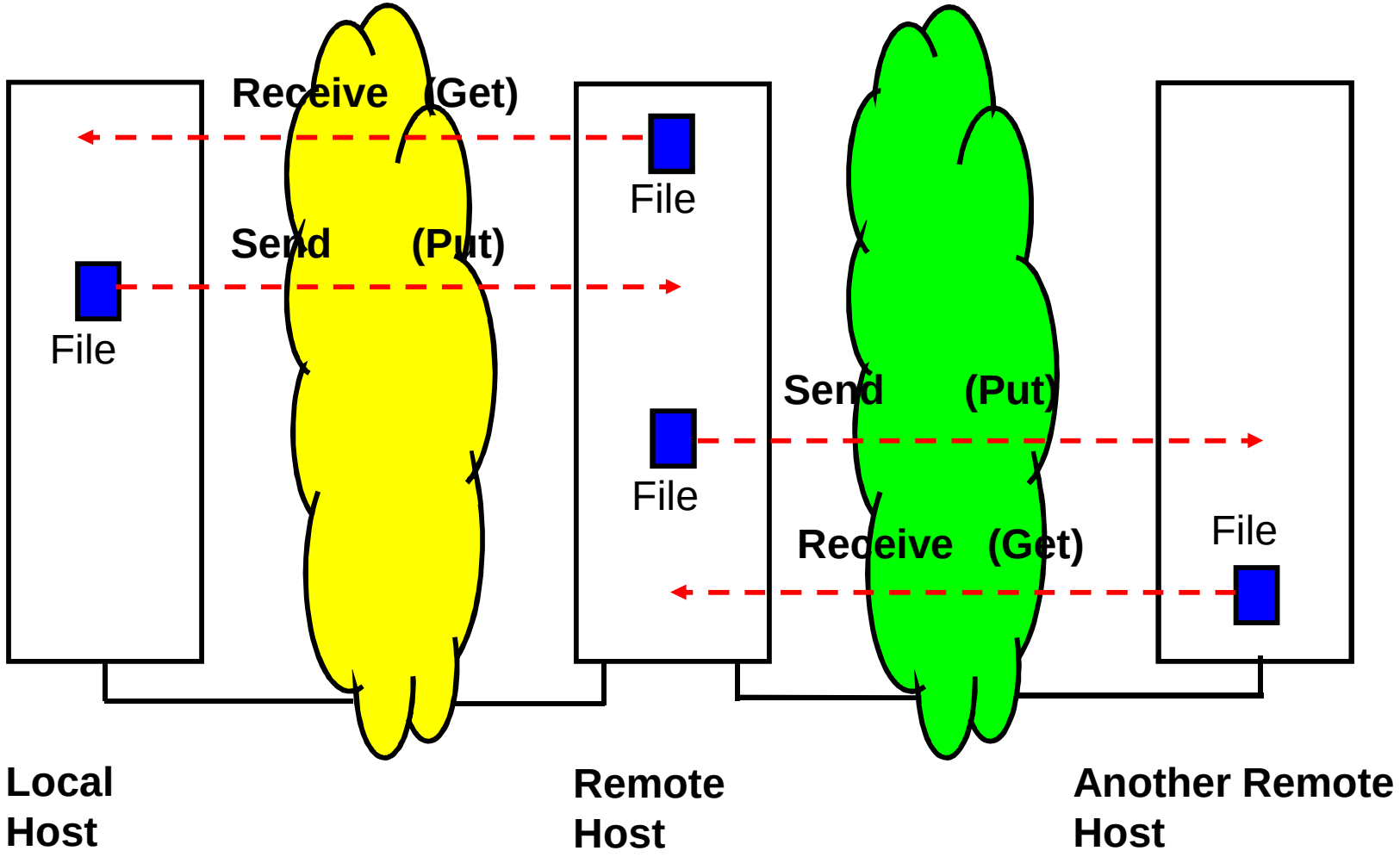
==> easy to scale up the system

Application layer

- It implements :
  - Information transfer services
  - + accessory services needed by user applications
- Some applications rely on TCP protocol, e.g. :
  - File Transfer Protocol (FTP) service
  - TELNET service
  - Simple Mail Transfer Protocol (SMTP) service
  - Hyper Text Transfer Protocol (HTTP) service
- Other applications rely on UDP protocol, e.g. :
  - Real Time Protocol (RTP) service
  - Trivial File Transfer Protocol (TFTP) service
  - Simple Network Management Protocol (SNMP) service

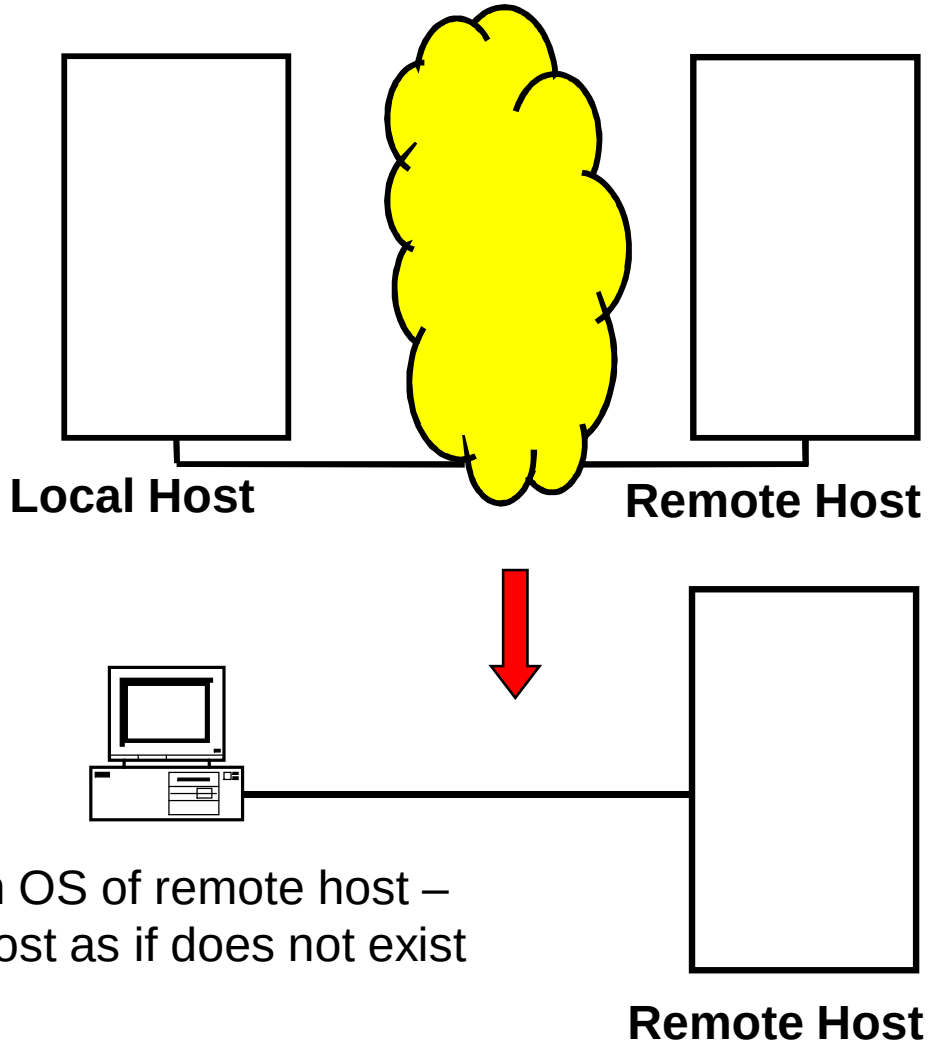
Application layer (continued)

- FTP (file manipulation services)

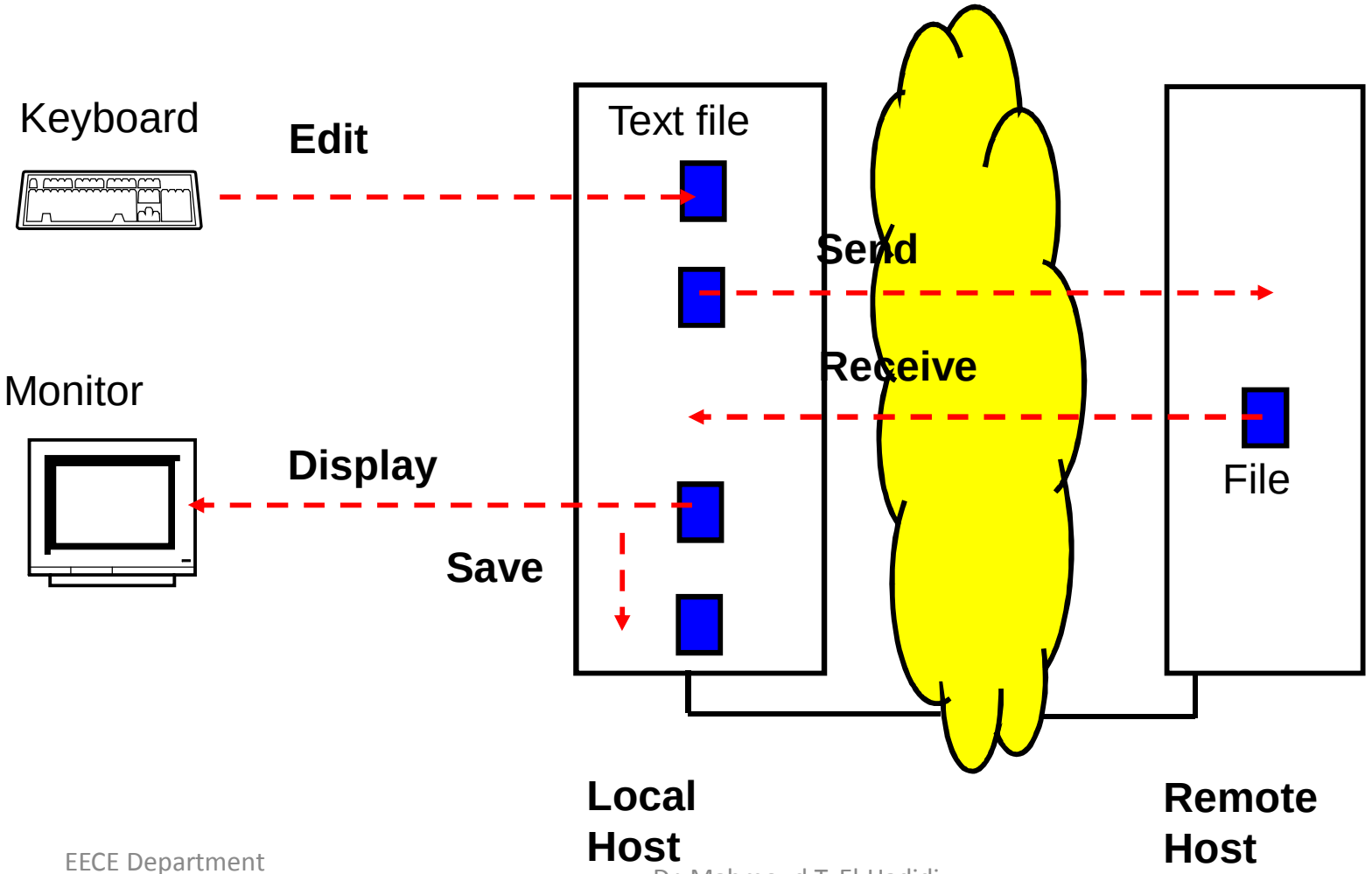


Application layer (continued)

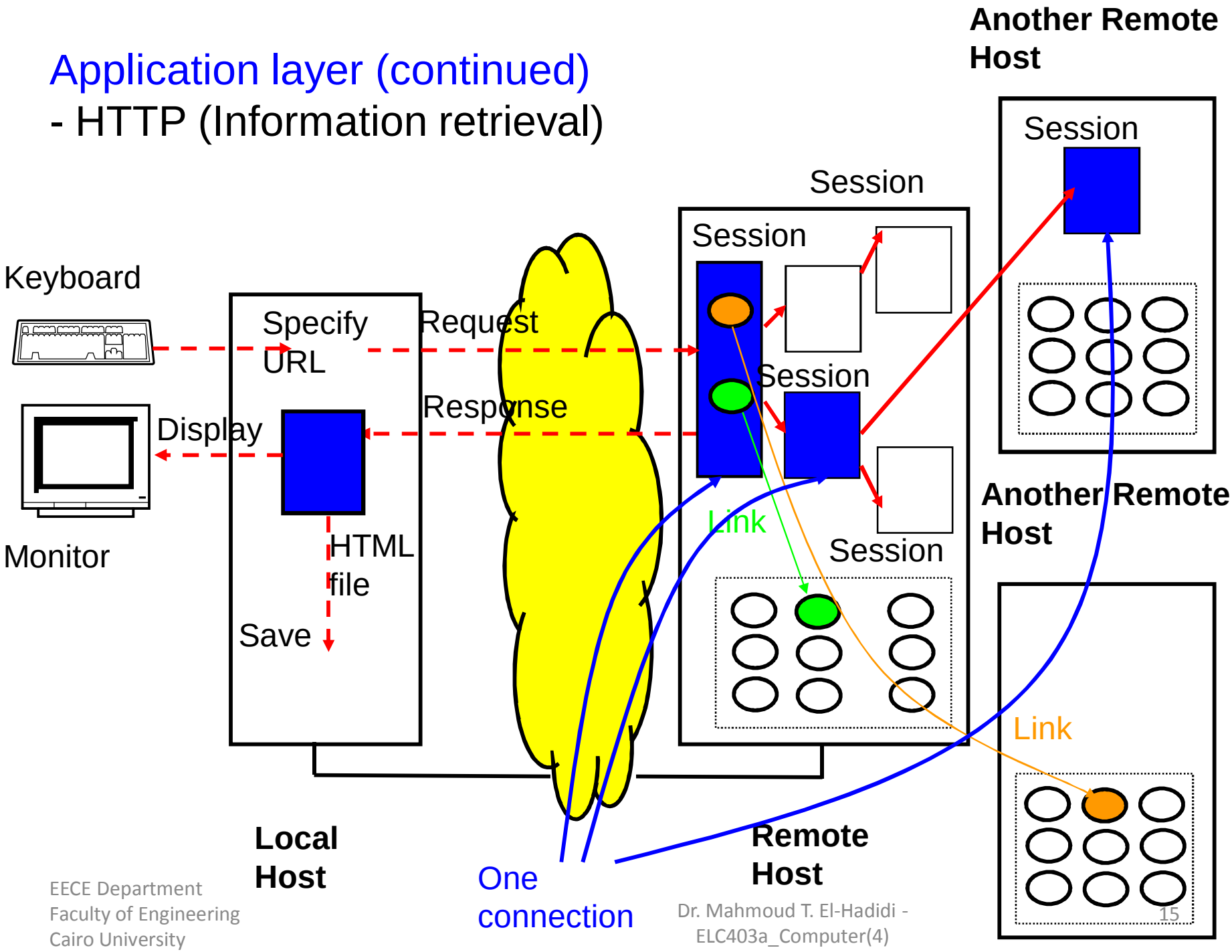
- TELNET (virtual terminal functions)



Application layer (continued)
- SMTP (E-Mail functions)

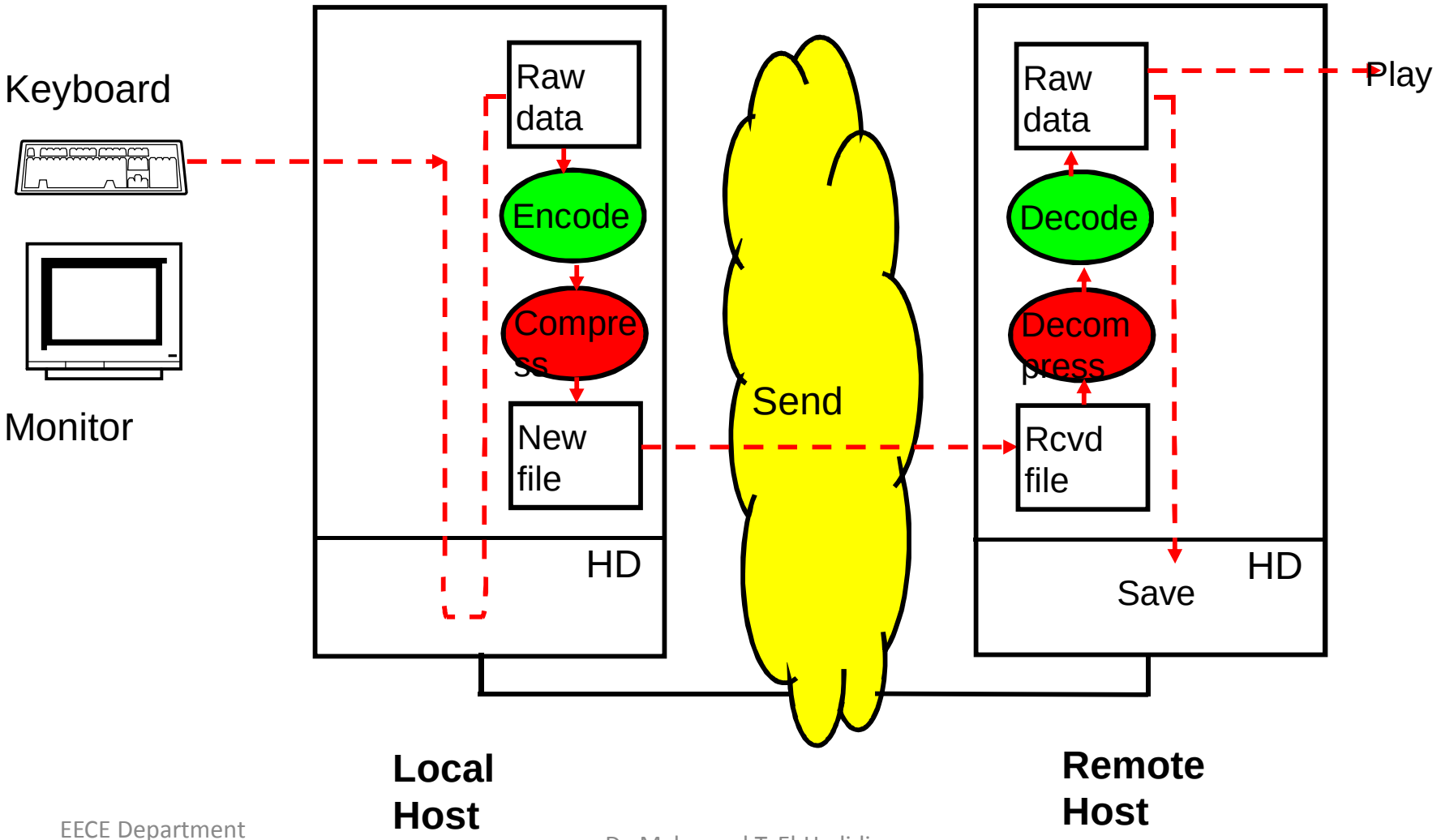


Application layer (continued)
- HTTP (Information retrieval)



Application layer (continued)

- RTP (Exchange of Real Time Information)



Names and Addresses

Names

In a NW, nodes (terminal or intermediate) have names & addresses

- For Internet :

  names have hierarchical structure
  (based on that of name granting authority)
  addresses have hierarchical structure
  (which is geographic)

- Names :

 * Should be unique for each host
 * Should be possible to translate into NW address

Names (continued)

- To facilitate looking up for a name & its corresponding address (as in telephone directory) :

  * Names are grouped into domains
  * A Domain Name Server (DNS) keeps a list of the names in the domain

- When a host wants to get the address corresponding to a name, it contacts the name server responsible for its local domain.

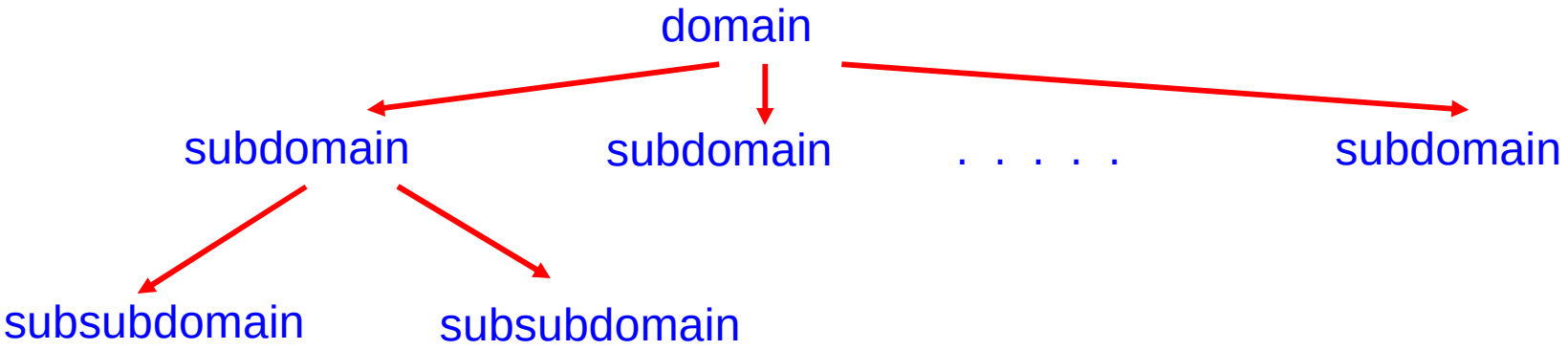
  * If it has the name, it replies with its address
  * If it does not have the name, it communicates with the server responsible for that name, to finally reply with req'd address

- Typical domains are :

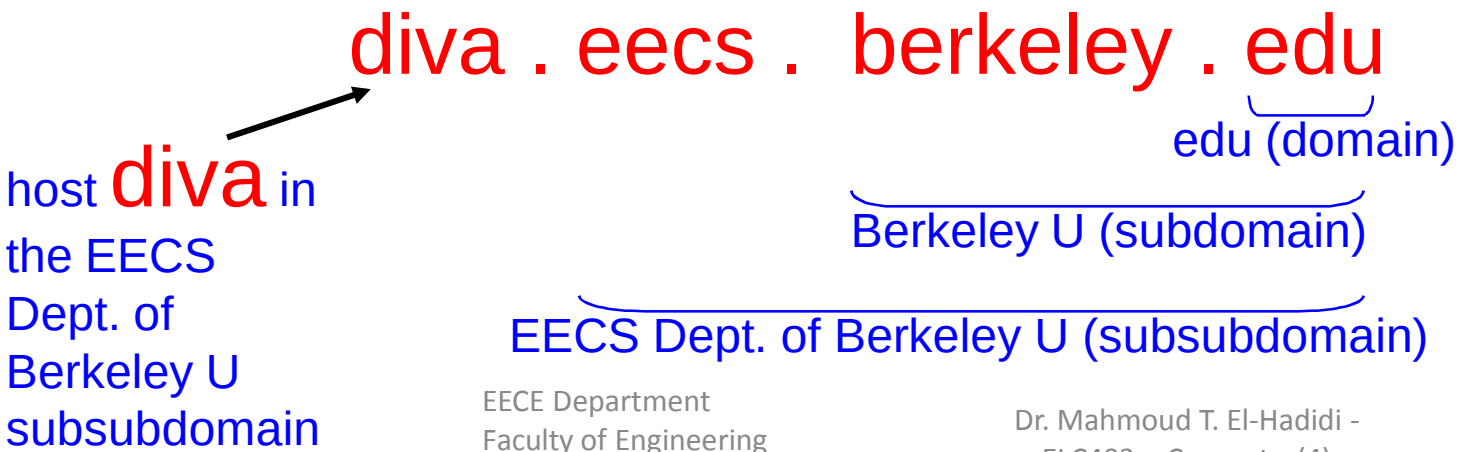
com	edu	gov	org	uk
private companies	educational institutions	government agencies	nonprofit organizations	United Kingdom

Names (continued)

- To systematize procedure for reaching the name server containing desired name, a domain is divided into a hierarchy :



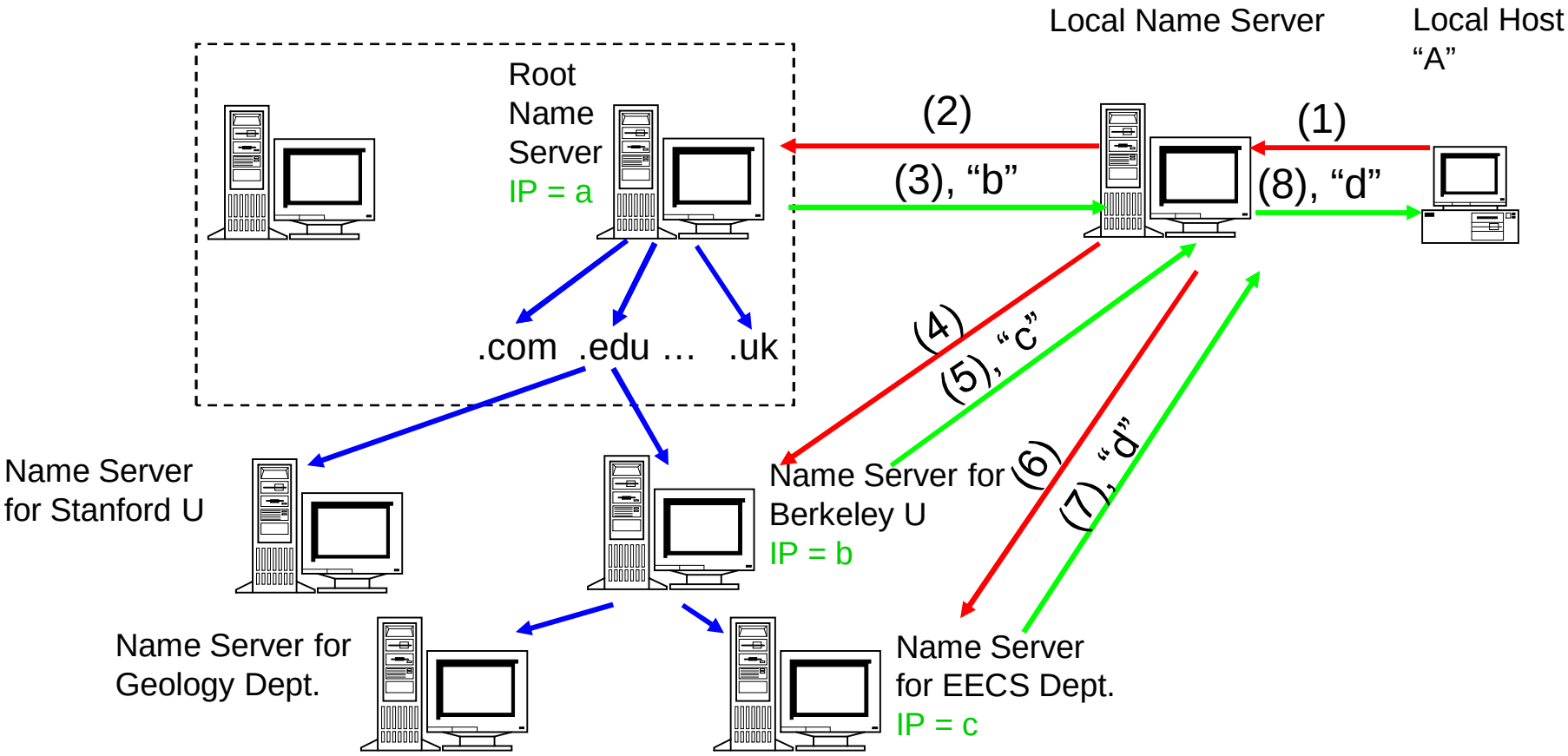
- Simultaneously, names are constructed to reflect this hierarchy. E.g. :



Names (continued)

- Example :

Obtaining the NW address “d” for host “diva.eecs.berkeley.edu” by a host A in France



Names (continued)

Remark

* To access a resource (e.g. a file on a host), an identifier for the resource is used.
* The common identifier is the URL (Uniform Resource Locator).
* A URL consists of :
  - a protocol (e.g. http, ftp. telnet)
  - a network, host (e.g. www.eecs.berkeley.edu)

computer network

  - a path name for file in directory of computer (e.g./~wlr)

The complete URL for the resource is then :

www . eecs . berkeley . edu / ~wlr

URL (Uniform Resource Locator)

DNS (Domain Name System)