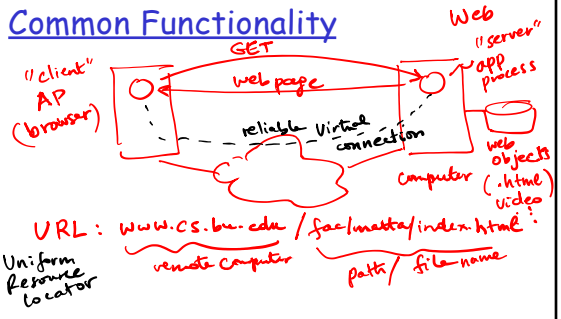
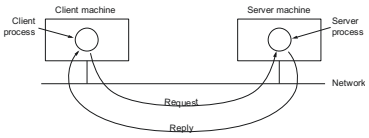
Common Functionality



11

Common Functionality



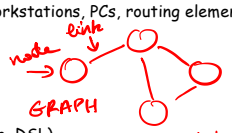
- Specify remote machine
- Connect to it (possibly some handshaking)
- Transfer data
- Close connection

12

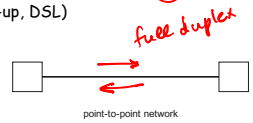
Requirements: (1) Connectivity

- Building blocks
  - ***links***: copper wire, coax cable, optical fiber, radio, …
  - ***nodes***: general-purpose workstations, PCs, routing elements, …

"Link bit rate" in bits per sec. (bps) "capacity"



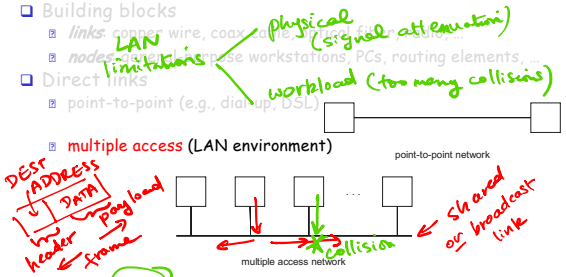
- Direct links
  - point-to-point (e.g., dial-up, DSL)



13

Requirements: (1) Connectivity

- Building blocks
  - *links*: copper wire, coax, optical fiber, radio, ...
  - *nodes*: switches, enterprise workstations, PCs, routing elements, ...
- Direct links
  - point-to-point (e.g., dial-up, DSL)
  - multiple access (LAN environment)

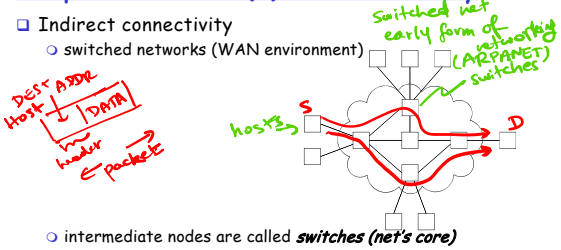


Need MAC (Medium Access Control) protocol to control access to the shared medium (e.g., shared Ethernet, HFC upstream channel, wireless)

14

Requirements: (1) Connectivity

- Indirect connectivity
  - switched networks (WAN environment)

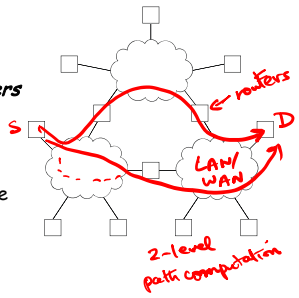


  - intermediate nodes are called ***switches (net's core)***
  - end nodes are called ***hosts*** or ***end-systems (net's edge)***
  - packet switching: send/receive messages (***packets***)
    - may need fragmentation/reassembly
  - store-and-forward

15

Requirements: (1) Connectivity

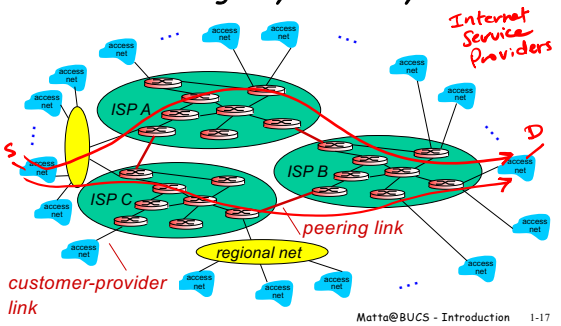
- internetworks
- nodes that connect networks are called ***routers*** or ***gateways***
- A network can be defined recursively as two or more nodes connected by a physical link, or by two or more nodes connected by one or more networks



16

Requirements: (1) Connectivity

- *Net's core managed by a hierarchy of ISPs*



17

Requirements: (1) Connectivity

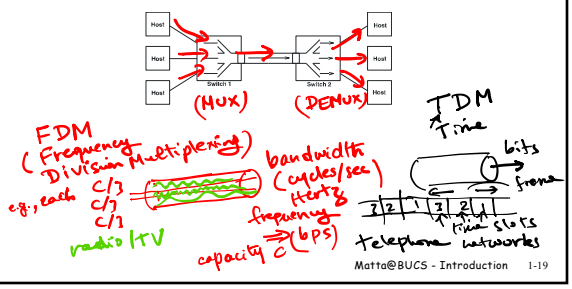
- Addressing and routing
  - address: byte-string that identifies a node; usually unique
  - routing: process of determining how to forward messages toward the destination node based on its address
  - types of addresses
    - **unicast**: node-specific
    - **broadcast**: all nodes on the network
    - **multicast**: some subset of nodes on the network
    - **anycast**: any node from a subset of nodes

Two-level constrained path computation (NSP Level)

18

Requirements: (2) Cost-effective Resource Sharing

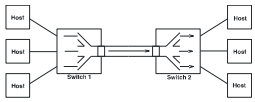
- Must share (***multiplex***) network resources (nodes and links) among multiple users



19

Requirements: (2) Cost-effective Resource Sharing

- Must share (***multiplex***) network resources (nodes and links) among multiple users

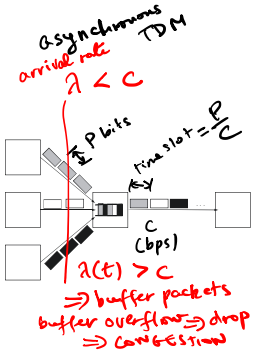


- Common Multiplexing Strategies
  - Frequency-Division Multiplexing (FDM): pre-assign frequencies
  - Time-Division Multiplexing (TDM): pre-assign time slots

20

Requirements: (2) Cost-effective Resource Sharing

- ***Statistical Multiplexing***
- Time-division, but on demand rather than fixed (no waste)
- Reschedule link on a per-packet basis
- Packets from different sources interleaved on the link
- Buffer packets that are ***contending*** for the link
- Packet queue may be processed FIFO, but not necessarily
- Buffer overflow, causing ***packet drop (loss)***, is called ***congestion***



21