Review and supplement for Lecture 2

Picture of A Computer System

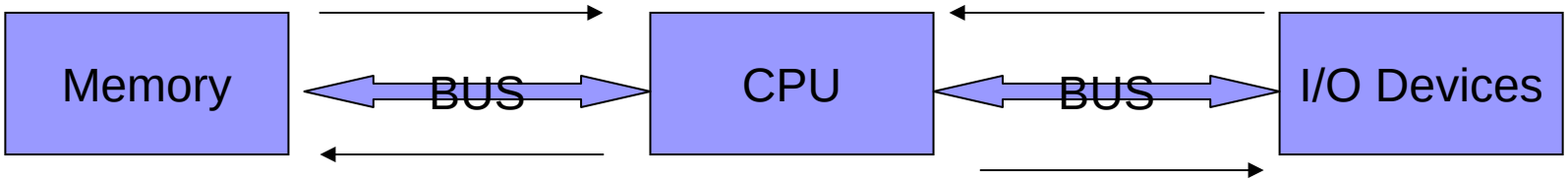
- Hardware
  - Central Processing Unit (CPU, or simply called processor)
  - Memory
    - Internal memory (volatile)
      - CPU registers
      - CACHE
      - RAM (Random Access Memory): computer's main memory (or primary memory)
    - External memory (permanent), also called secondary memory
      - Hard drive
      - Floppy
      - Diskette
  - Input / Output devices: keyboard, mouse, monitor, printer, etc.
- Software
  - Program
  - Operating system
    - Manage the CPU and RAM allocation
    - File system: manage the secondary memory, directory, file
    - I/O devices management
    - Human-machine interface: GUI (Graphical User Interface)
  - Application program: A computer program run on a computer directly targeting a task that the user wishes to perform

The von Neumann Architecture

Instructions:
C ← A + B
D ← A * C
A > B?, A=B?
A ← MEM
MEM ← C

CPU fetches data and instructions from memory

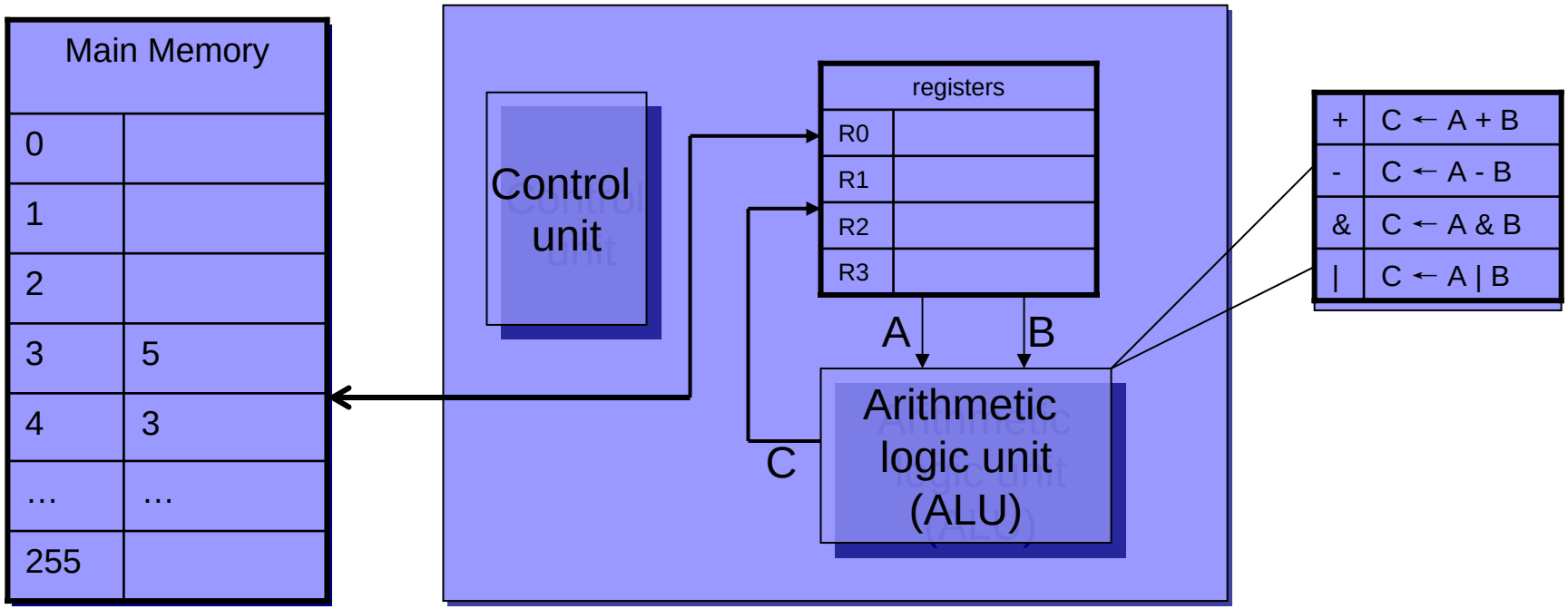
CPU receives data and instructions from keyboard, mouse, …



CPU performs computations, stores results and instructions in memory

CPU performs computations, sends results to screen, speakers, printer, …

CPU and Main memory



Load R0, 3
Load R2, 4
R1 ← R0 - R2
R0 ← R0 + R2 ‘(Overwrite R0)
Store R1, 2
Store R0, R1

[Simulation 1(registers, ALU)]
[Simulation 2(registers, ALU, Memory)]
[Simulation 3(registers, ALU, Memory, Program)]

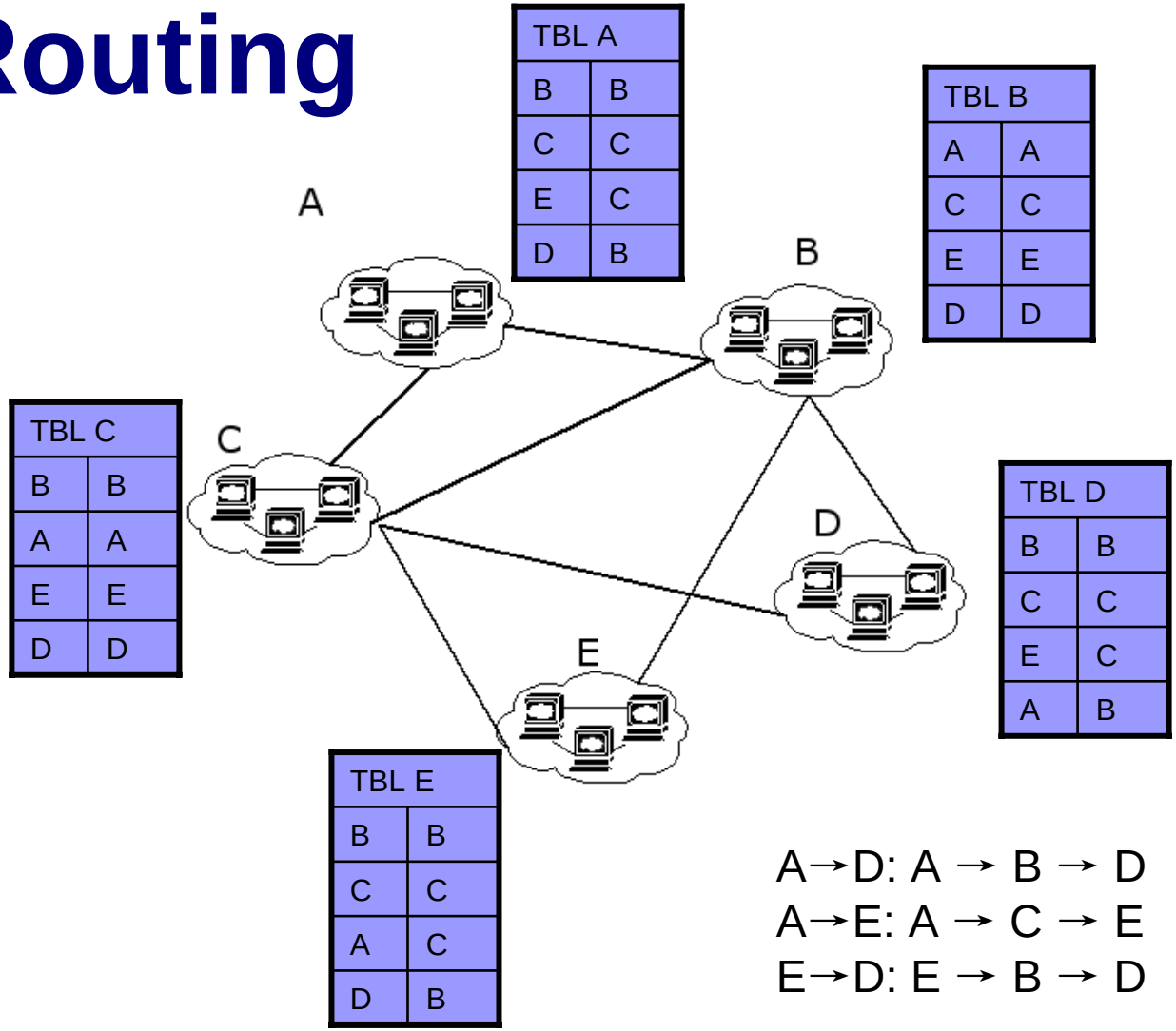
Angle 1: Computer approaches are about organizing things

- Organize the instructions - Programs
- Organize the memory – (instruction memory, directories, files)
- Organize the I/O devices – (not the concern of this course)
- Organize the computers in Internet – (networks, sub-networks)
- Organization requires identifying
  - Identify memory cells – Memory addresses
  - Identify I/O devices – Device addresses
  - Identify computers – IP addresses, Mac addresses
  - etc.
- Organizations are hierarchical
  - A folder may contain sub-folders; a sub-folder may contain further sub-folders, and so on.
  - A program may call sub-program; a sub-program may further call another sub-program, and so on.
  - A network may contain sub-network; a sub-network may further contain another sub-network.

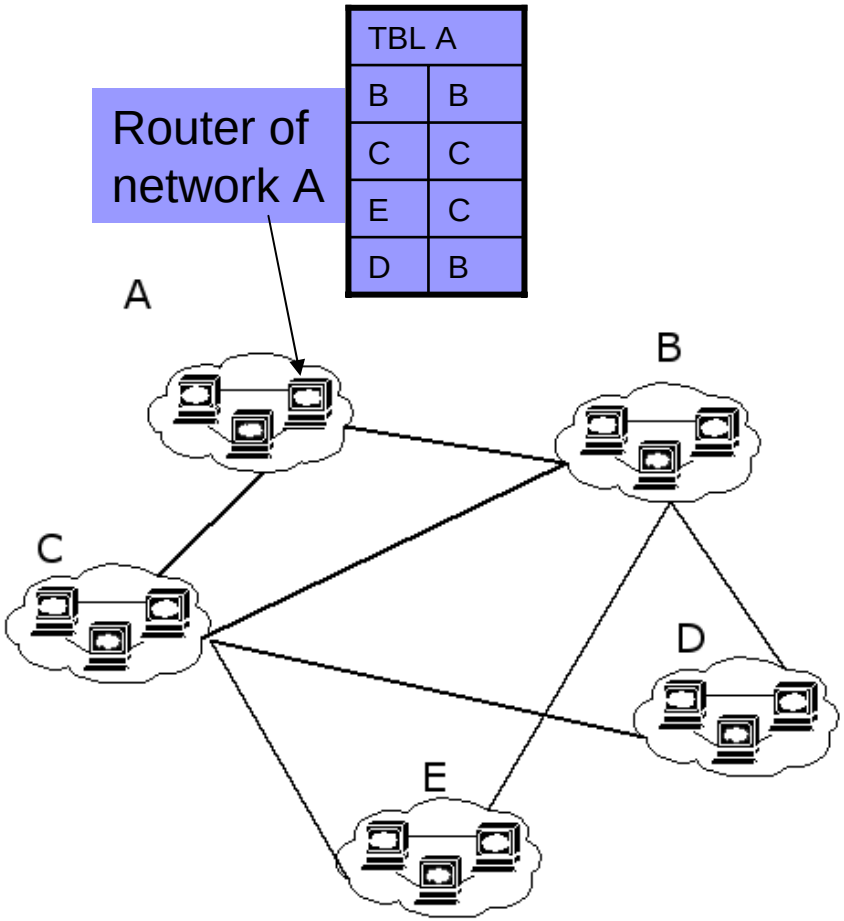
Angle 2: Computer approaches are about mapping

- Memory address maps to memory cell
- IP address maps to computer
- MAC (Ethernet LAN) address maps to computer
- Chain of mapping: IP address ↔ MAC address ↔ Network card ↔ Computer (A long way to map IP address to computer)
- Binary number maps to register: 01 ↔ R1 (use binary number to “name” a register)
- CPU Instruction maps to CPU operations
  - Instruction: R1 ← R2 + R3
  - Operations:
    - Put R2 into bus A
    - Put R3 into bus B
    - Wait for x nanosecond(10^-9) until the result is available in bus C
    - Put content in bus C to R1
- Binary number maps to instruction: 1010000100 01 10 11 ↔ (R1 ← R2 + R3)
  - 1010000100 ↔ add the content in bus A and bus B, then put the result in bus C
  - 01 ↔ Connect bus C to register R1
  - 10 ↔ Connect bus A to register R2
  - 11 ↔ Connect bus B to register R3

Routing

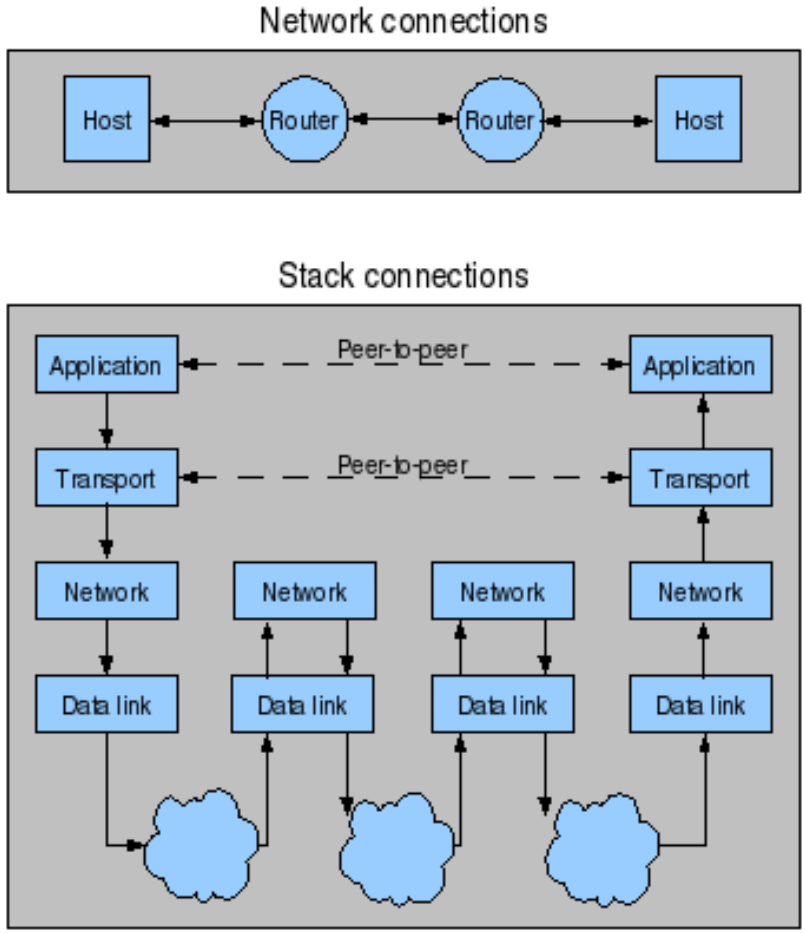

TBL A
B B
C C
E C
D B
TBL B
A A
C C
E E
D D
TBL C
B B
A A
E E
D D
TBL D
B B
C C
E C
A B
TBL E
B B
C C
A C
D B
A
B
C
D
E
A→D: A → B → D
A→E: A → C → E
E→D: E → B → D

Routing inside a sub-network



- Each sub-network has a specified computer called router
- If the destination is within the same sub-network, packets are sent to the destination directly
- If the destination resides in some other sub-network
  - Packets are passed to router
  - The router looks up the routing table, and decide where to relay the packets
  - Then the packets are passing around different routers until they reach the destination

Layers in the Internet protocols



- **Application:** DNS, TLS/SSL, FTP, HTTP, SMTP, …
- **Transportation:** TCP, UDP, …
- **Network: IP (IPv4, IPv6)**
- ARP and RARP operate underneath IP but above the link layer so they belong somewhere in between.
- **Link: Ethernet, Wi-Fi, PPP, FDDI, ATM, Frame Relay, …**

Internet and Networking

- IP address
- Packet switches
- Communication Protocols
- Routing
- History: ARPANET (1960s, military originated)
- DNS, domain name
- URLs
- Email address: tom@gc.cuny.edu
  - tom: the usename of the recipient
  - gc.cuny.edu: domain name to lookup the Mail transfer agent (MTA); the DNS system maps the domain name to the MTA's IP; the MTA is a computer who accept mails for its users.

Using a computer

- You should be familiar with followings
  - Desktop, window, icon, title bar, menu bar
  - Minimize, maximize, restore, scroll bar
  - Mouse: point, click, double click, drag
  - Dialogue box
  - Cut and paste
  - Directories (folders) and files
  - Web browsing, Email