Computer Science - II
(Complementary)

Dr Binu P Chacko
Principal
Prajyoti Niketan College
Pudukad, THRISSUR

Computer Networks

- Large number of separate-interconnected computers

Uses/Goals

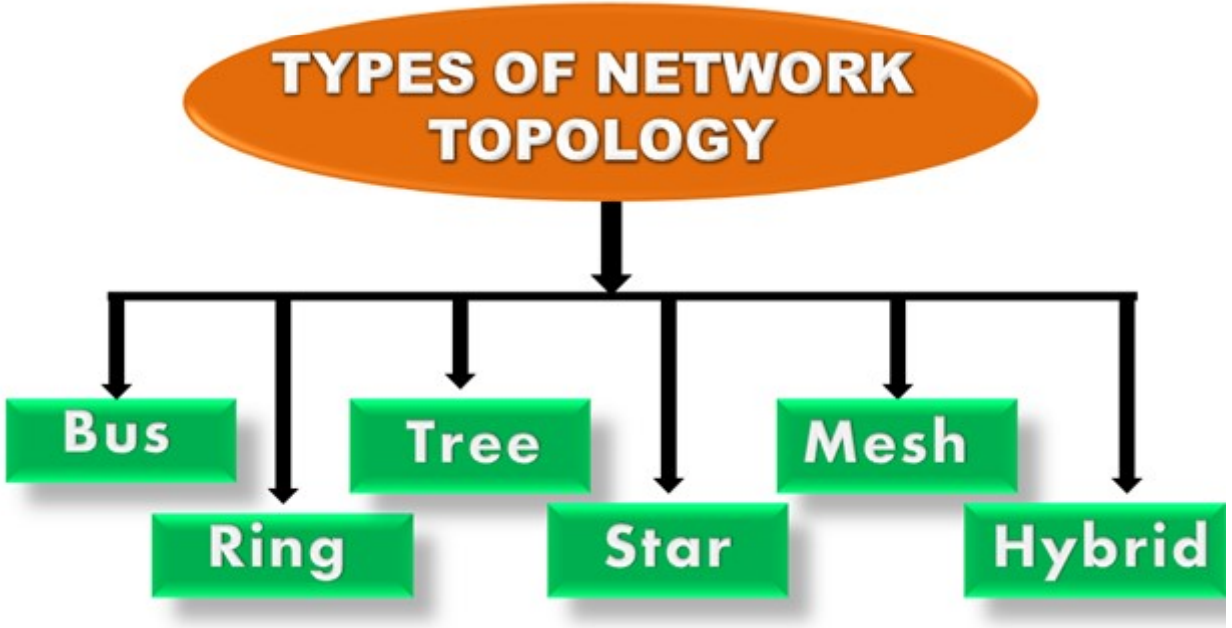
- Network for companies: *Resource sharing*, *High reliability* by having alternative sources of supply, *Saving money* compared to mainframe, *Powerful communication media* (online document)
- Network for People: Access to remote information, Person-to-person communication (email), Interactive entertainment
- Social Issues

Types of Network

- LAN: connect PCs within a building/campus
- Restricted in size, transmission technology (all machines are connected to single cable), topology (Ethernet, Ring)
- MAN: television network
- DQDB (Distributed Queue Double Bus) standard – computers are connected to 2 unidirectional buses
- WAN: large geographical area, country or continent
- Host run user programs; they are connected to subnet
- Subnet = transmission lines + switching elements (router)
- They carry messages from host to host

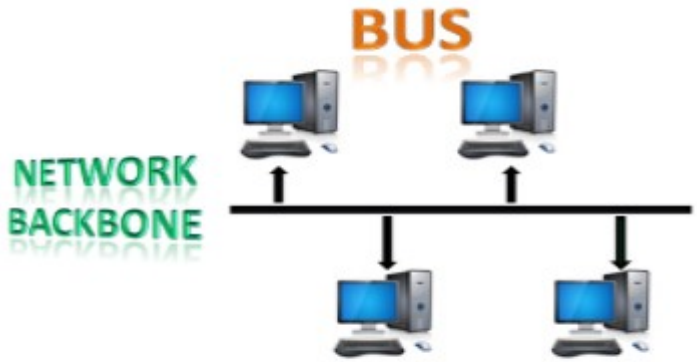
Network Topology

- Topology defines the structure of the network of how all the components are interconnected to each other



Bus

- All nodes are connected through a single cable
- All nodes will receive the message send from a node
- Adv: low cost cables (coaxial or twisted pair), moderate data speed, familiar technology, limited failure
- DisAdv: extensive cabling, Signal interference when two nodes send signals simultaneously, Addition of new devices will slow down the network, loss of signal

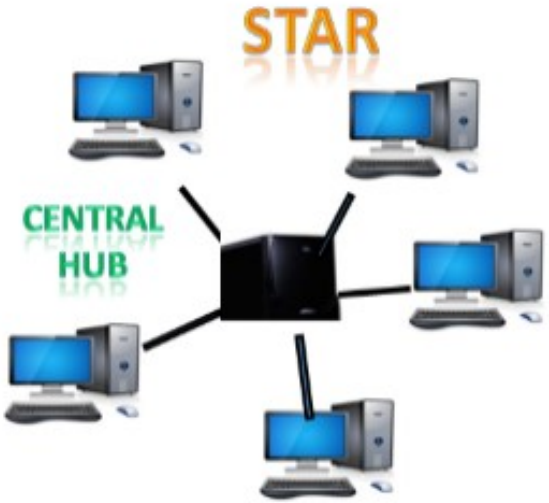


Ring

- Data flows in clockwise direction continuously
- Adv: Inexpensive
- DisAdv: failure of one station leads to the failure of network
- Delay in communication as the number of nodes increases

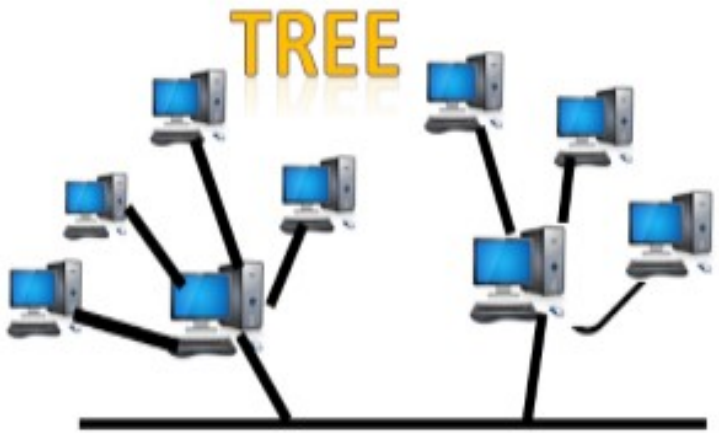
Star

- Every node (client) is connected to a server
- RJ-45 cables and hubs or switches are used
- Adv: efficient Troubleshooting, limited Failure, Cost effective, easily Expandable, Speed up to 100 mbps
- DisAdv: central point of failure



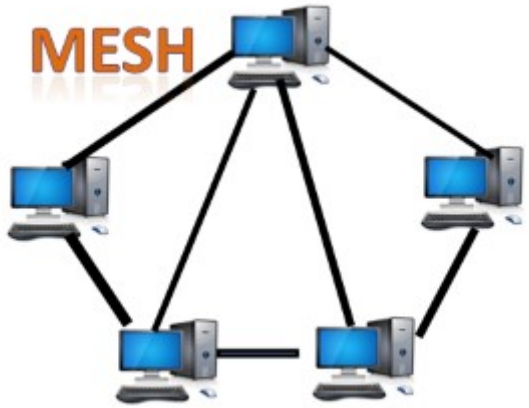
Tree

- Bus topology + star topology (in a hierarchical fashion)
- Adv: support for Broadband transmission, easily Expandable/Manageable, Error detection and correction are easy, limited Failure
- DisAdv: Costly, failure in Main Bus cable affect the entire network



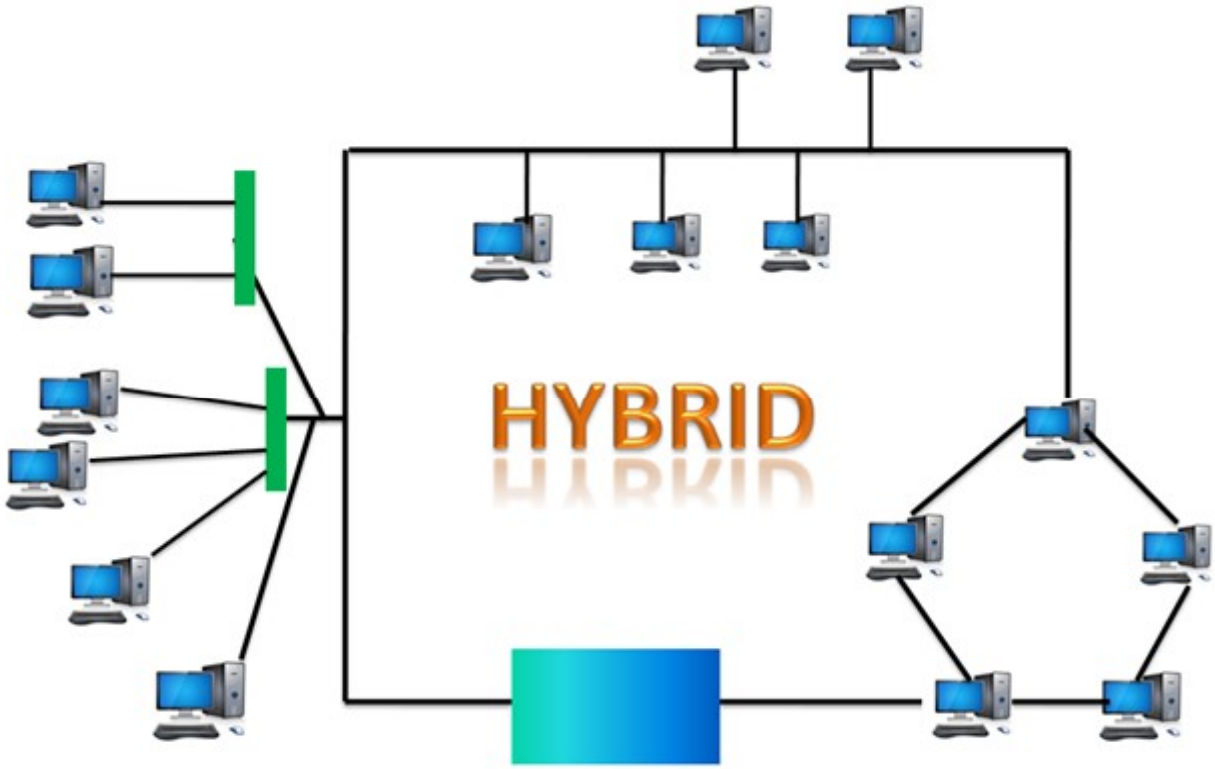
Mesh

- Computers are interconnected with each other (exists multiple paths)
- Used in wireless networks, E.g. Internet
- Adv: Reliable, Fast communication, easier Reconfiguration
- DisAdv: Costly, difficult to Manage, reduces Efficiency due to redundant connection

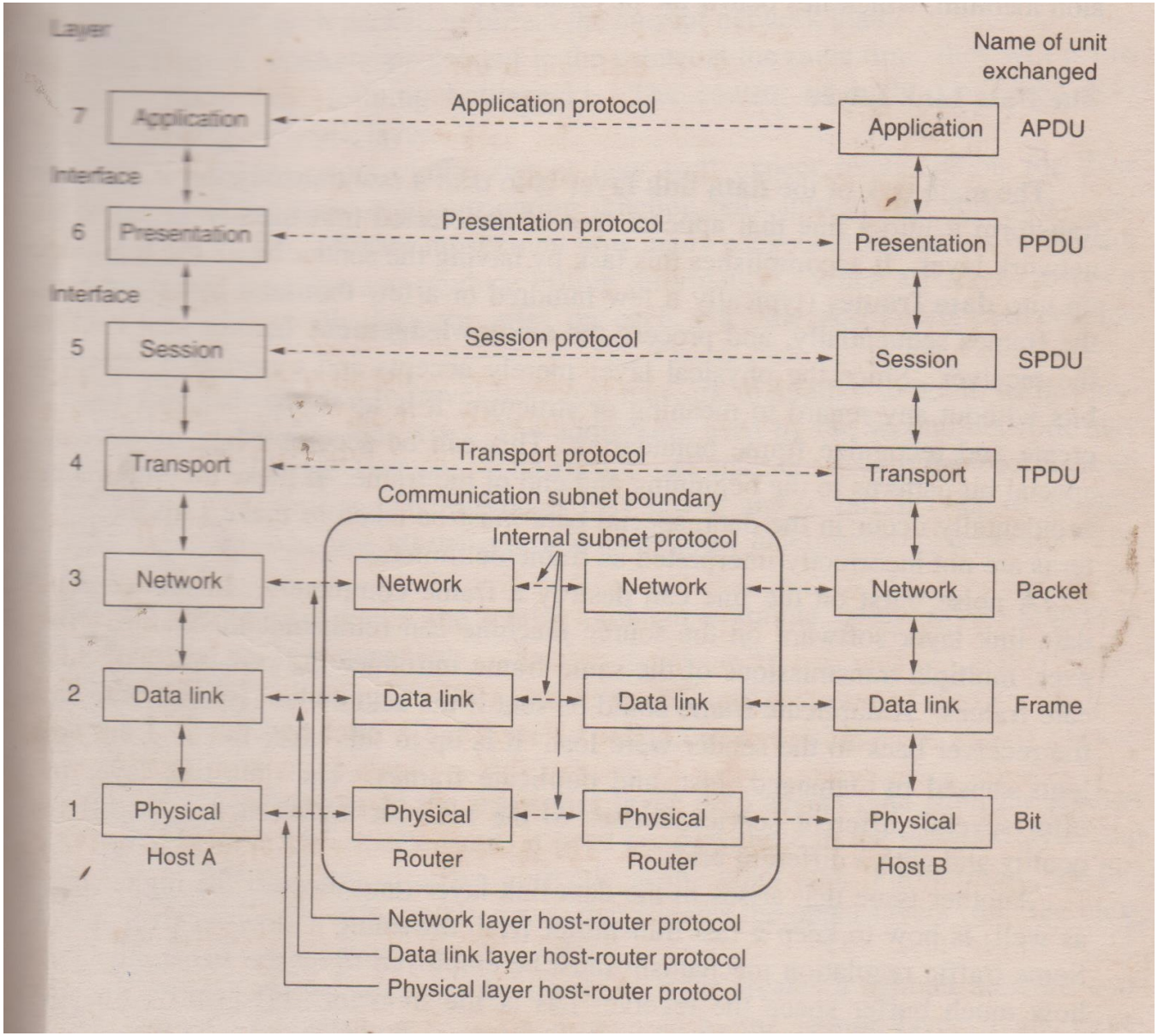


Hybrid

- Adv: Reliable, Scalable, Flexible and Effective
- DisAdv: complex Design, Costly infrastructure /hub



OSI model


Layer
Name of unit exchanged
7
Application
Application protocol
Application
APDU
Interface
6
Presentation
Presentation protocol
Presentation
PPDU
Interface
5
Session
Session protocol
Session
SPDU
4
Transport
Transport protocol
Transport
TPDU
Communication subnet boundary
Internal subnet protocol
3
Network
Network
Network
Network
Packet
2
Data link
Data link
Data link
Data link
Frame
1
Physical
Physical
Physical
Physical
Bit
Host A
Router
Router
Host B
Network layer host-router protocol
Data link layer host-router protocol
Physical layer host-router protocol

7 layers

- Physical layer: concerned with transmitting raw bits over a communication channel
- How many volt is required to represent 0 and 1? How many μs a bit will last? Whether transmission may proceed simultaneously in both direction?
- Deals with mechanical, electrical, and procedural interfaces and physical transmission media

Cont…

- Data link layer: task is to take a raw transmission facility to the network layer
- Sender break the input data into data frames, transmit the frames sequentially, and process acknowledgement frames from receiver
- Solve the problem of damaged, lost, and duplicate frames using acknowledgement mechanism
- A special sublayer will deal access to shared channel

Cont…

- Network layer: controlling the operation of subnet
- Determine how packets are routed from source to destination
- Control the presence of too many packets in the subnet at the same time
- Allow heterogeneous networks to be interconnected

Cont…

- Transport layer: accept data from session layer, split up into smaller units, and pass to network layer
- Creates multiple network connections to improve throughput OR multiplex several transport connections onto same network connection to reduce the cost
- Establish and delete connections across the network
- Determine type of service to provide – a) deliver messages in the order in which they are sent, b) deliver messages with no guarantee about the order, c) broadcast messages to multiple destinations

Cont…

- Session layer: allows users on different machines to establish sessions between them
- i.e., to allow a user to log into a remote timesharing system or to transfer a file between two machines
- Allow traffic to go in one/both directions
- Token management – only the side holding token may perform critical operation
- Synchronization – after a crash, only the data transferred after the last checkpoint have to be repeated

Cont…

- Presentation layer: Concerned with syntax and semantics of the information transmitted
- i.e., encoding data in a standard form
- Manages abstract data structures and converts from representation used inside the computer to the network standard representation and back
- Application layer: to deal with different terminal types
- For this define an abstract network virtual terminal that editors and programs can be written to it. Then a software in the application layer maps the functions of this terminal onto real terminal
- Transfer file between different file systems

Internet Protocol Stack

- Application layer: responsible for communication between applications (web browser, email client) running on two different systems
- Protocols used – HTTP (for transferring web documents), FTP (for transferring files), SMTP (for transferring email), DNS (for translation of domain names into IP address)

Cont…

- Transport layer: responsible for collecting application layer messages and transfer it to network layer (sending end)
- Collects messages from network layer and passes it to application layer (receiving end)
- These end-points are called sockets. Port number is used to identify it
- Segment – unit of data at transport layer (header + message)
- Protocols – TCP (connection oriented: first establish the connection and then transmit the data), User Datagram Protocol (connectionless: jest send the data without checking it)

Cont…

- Network layer: responsible for transferring data from one system to another. Take care of routing of data on intermediate routers
- Datagram – data packet at network layer (packet from transport layer + header + trailer)
- Protocols – IP (uses IP addresses to identify systems); IPv4 (32-bit IP address), IPv6 (128-bit IP address)
- Internet Control Message Protocol – request the sender to resend the data if data is not received or received in wrong order

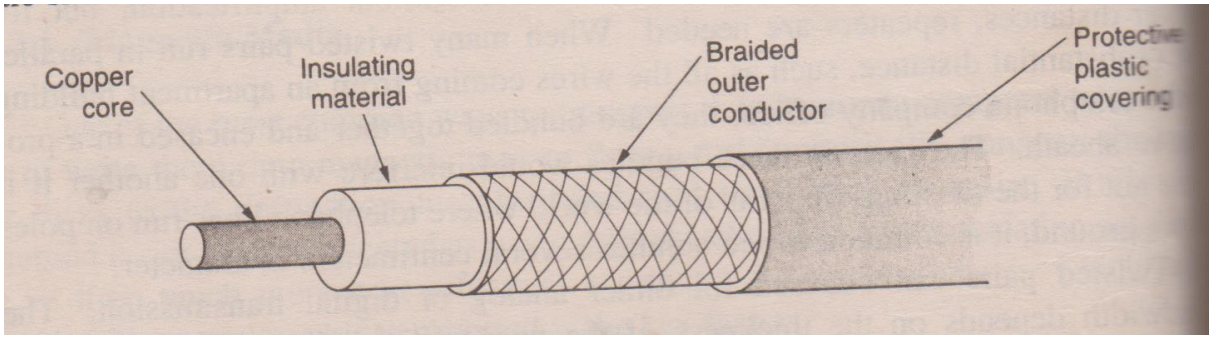
Cont…

- Link layer: responsible for communication between devices such as routers, switches and other computers
- Implemented in NIC, ethernet, Wi-Fi
- Frame – data packet at link layer (header + packet from network layer)
- Physical layer: responsible for breaking data frame into bits, converting it into a form (light pulses, radio waves, electric pulses) that can be transmitted over the communication line, and transferring it (sending end)
- Collect stream bits and reassembles it into data frame and pass onto link layer (receiving end)

Communication Media

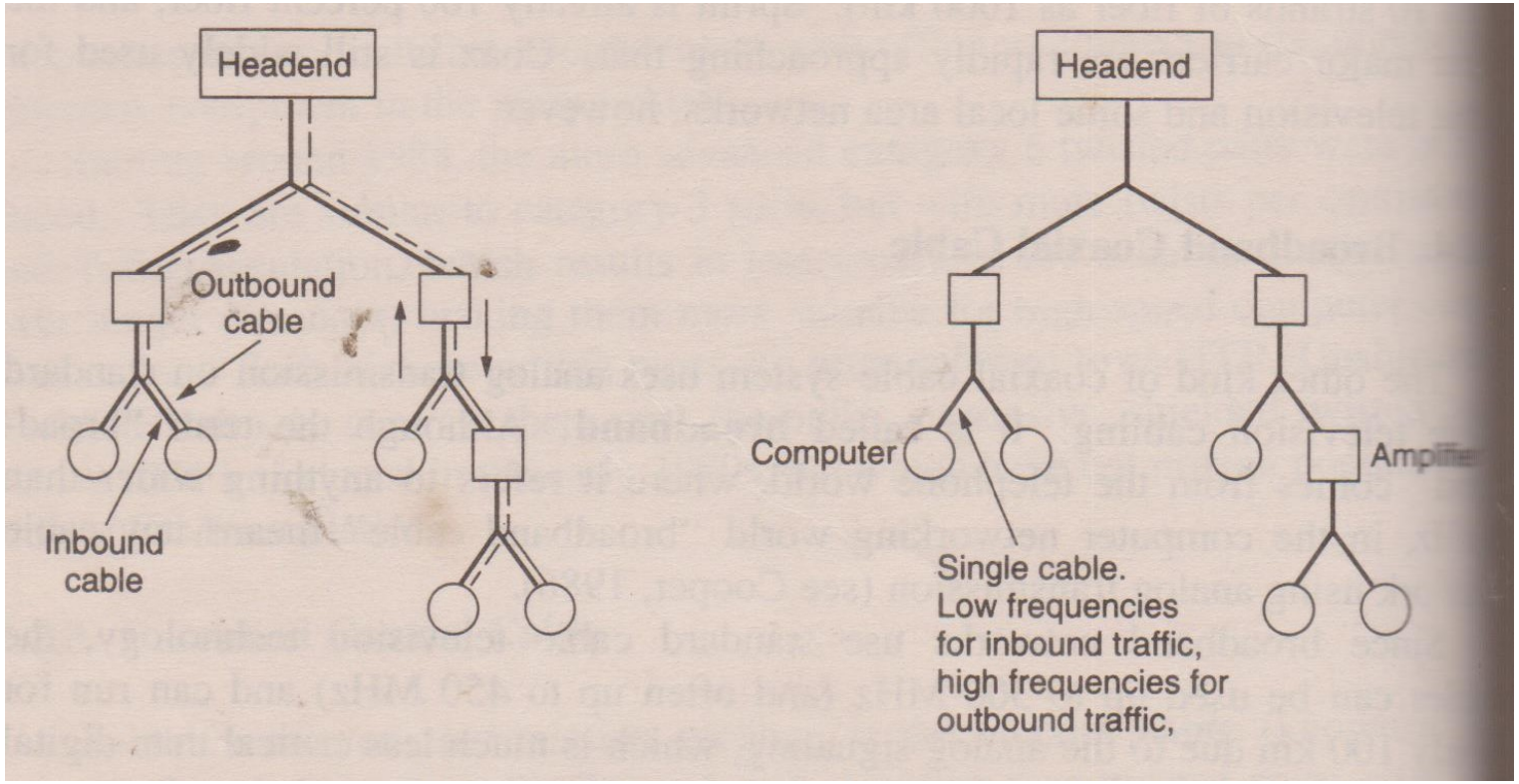
- Twisted pair: consists of two insulated copper wires of 1mm thick twisted like a DNA molecule
- It can run many KM without amplification. *Repeaters* are required for longer distance
- Bandwidth depends on the thickness and distance traveled
- Used for analog or digital transmission; low cost
- Category 3 – four twisted pairs are grouped together in a plastic sheath
- Category 5 – more twists/cm and Teflon insulation; quality signal over longer distance; for high-speed computer communication

Cont…



- Coaxial cable: better shielding; for longer distance at high speed; high bandwidth (1 to 2 Gbps for 1 km) and excellent noise immunity
- Used for cable TV
- 50-ohm cable for digital transmission (baseband)
- 75-ohm cable for analog transmission (broadband)
- Used up to 300 MHz and 100km
- It is divided into multiple channels – used for analog TV, CD-quality audio, digital bit stream

Cont…



Broadband Network

Cont…

- Fiber optics: components – light source, transmission medium (ultra-thin fiber of glass), detector
- Detector generate electrical pulse when light falls on it
- Attach light source at one end and a detector at other end of optical fiber. This system accepts electrical signal, convert and transmits it by light pulses, and then reconverts the output to an electrical signal at the receiving end
- Multimode fiber – any light ray incident on the boundary of the medium above the critical angle will be reflected internally, and many rays will be bouncing at different angles. Each ray is said to have a different mode
- If fiber's diameter is reduced, the light can propagate in a straight line, yielding a *single-mode fiber*
- Expensive and can be used for longer distance

Microwave Transmission

- Microwave communication is used for long-distance telephone communication, cellular telephone, TV distribution. It is inexpensive
- Above 100 MHz, the waves travel in straight lines. Concentrating all energy into a small beam using a parabolic antenna gives a much higher SNR
- As the distance between microwave towers increases, repeaters are required (for 100m high tower, repeater can be placed at 80km)
- Microwaves don't pass through the buildings
- Multipath fading: some waves may be refracted off low-lying atmospheric layers and get delayed and cancel the signal (weather and frequency dependent)
- Bands up to 10 GHz are in use; at 8 GHz, absorption by water
- Industrial/Scientific/Medical bands: 2.4-2.484 GHz, 902-928 MHz, 5.725-5.85 GHz. These bands are used for cordless telephone, door opener, wireless speaker, security gate

Communication Satellite

- Launched in 1962
- It contains several transponders which amplifies the incoming signal, and then rebroadcasts it at another frequency
- Geosynchronous satellite: satellite period is 24hours at an altitude of 36,000km above equator
- Satellite bands – C, Ku, Ka – different in downlink and uplink frequencies
- VSAT: low-cost microstation, 1m antenna
- Hub: large, high-gain antenna to relay traffic between VSATs
- Properties: transit time is 250 to 300 ms
- Same cost to send message to multiple stations
- Encryption required for security purpose
- Low-orbit satellite: to provide telecommunication service using hand-held devices (Iridium satellites - 750km altitude)
- Each satellite has a number of spot beams (elliptical shape) to scan earth as the satellite moves

Database Management System

- Database: collection data about an enterprise
- DBMS consists of collection of interrelated data and a set of programs to access those data
- Data model: a collection of conceptual tools for describing data, data relationships, data semantics, and consistency constraints

Data Models

- Object-based logical models: E-R model, object-oriented model, semantic model, functional model
- Physical model
- Record-based logical model: relational model, network model, hierarchical model
- Database is structured in fixed-format records of several types. Each record type defines a fixed number of fields, or attributes, and each field is of fixed length

Relational Model

- Relational database consists of a collection of tables
- A row in a table represents a relationship among a set of values. A table is a collection of such relationships
- Domain: set of permitted values of the attribute
- Several attributes may have same domain
- A domain is atomic if elements of the domain are considered to be indivisible units (no subparts)
- Table (relation), row (tuple); t[classNo] or t[1]; t ϵ r
- Null value – value is unknown or doesn't exist
- Relation schema: Class-schema = (classNo, name, age)
- Relation: class(Class-schema)
- Use common attribute in relation schemas to relate tuples of distinct relations

Cont…

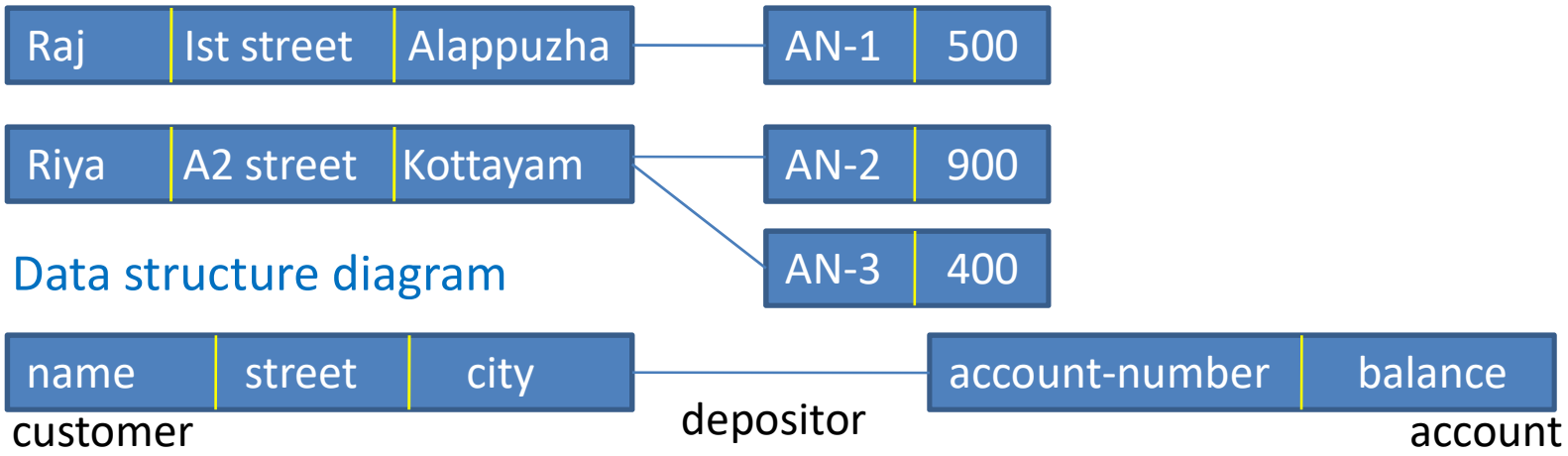
- Keys - Set of attributes to uniquely identify a tuple
- Super key: {adNo, classNo}, {adNo}
- Candidate key: {adNo}, {phoneNo} - minimal super key
- Primary key: {adNo} – can't be null
- Alternate key (secondary key): {phoneNo} - candidate key other than primary key
- Foreign key: act as a primary key in one table and a secondary key in another table
- Combines two or more relations
- It needn't follow uniqueness constraint
- Query language: a language in which a user requests information from the database
- Procedural language: user instructs the system to perform a sequence of operations on the database
- Nonprocedural language: user requests the information desired without giving a specific procedure

Network Model

- Network database consists of a collection of records connected to one another through links. Each record is a collection of fields (attributes)
- **type** customer = **record**
  name: string;
  street: string;
  city: string;

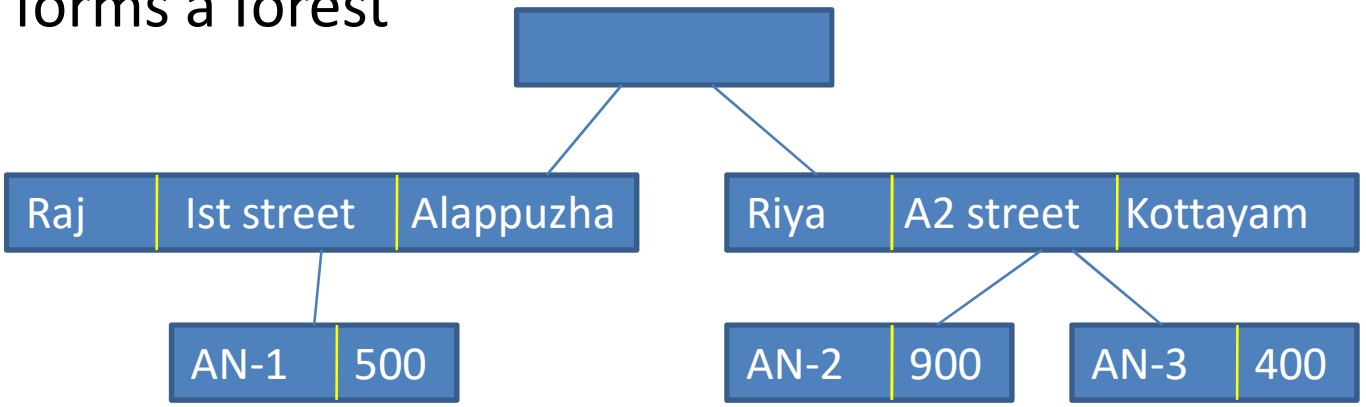
end

type account = **record**
account-number: string;
balance: integer;
end

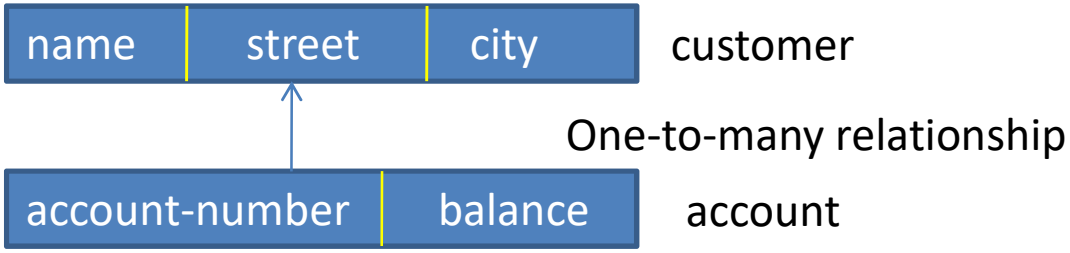


Hierarchical Model

- Hierarchical database consists of a collection of records that are connected through links
- It is a collection of rooted trees (database tree), and hence forms a forest



Tree-structure diagram



HTML

- Language of www pages
- Tim Berners Lee in 1989
- HTML, HTML+ (1993, Dave Raggett), HTML 2.0 (1994, Dan Cannolly), HTML 3.2 (1997, Tables)
- HTML 4.0: style sheets, scripting, frames, embedding objects, Unicode; HTML5 (2008)

Tags

- <basefont color="blue" size="5" face="arial">
- **<font** size="6" color="red" face="times new roman"**>….**
- <big>…..</big>
- <I>….</I>
- <body>: alink, link, vlink, bgcolor, text (colours), background (URL)
- ….
- <cite> To give citation (reference) </cite>
- **<div** style="border:1px solid pink;padding:20px;font-size:20px"**>** ….
- <EM>….</EM>
- ^{..Superscript..}
- _{..Subscript..}

Table

- **<figure>….**
- **<figcaption>….**
- **<img** src="E:/images/animal.png" height="180" w idth="300" alt="animal image"**>**
- <table border=“1”>…..
- <caption>…..</caption>
- <tr>….
- <th colspan=“2”>…
- <th rowspan=“2”>….
- <td style=“padding:10px”>…

Cont…

- <Marquee direction="(left, right, up, down)">….many attributes
- <pre width="10">…pre formatted text </pre>
- <q> …small quotation..</q>
- <small>...less font size..</small>
- <s> …strike through..</s>
- <del> ..strike..</del>
- <mark> …highlighted text…</mark>
- …important text…
-
 … line break
- <header> …header text .. </header>
- <footer> ..footer text .. </footer>

Lists

- <ol type="1, I, i, a, A" start="7" reversed> …ordered list
  - ..item1..
  - …..
-
- …unordered list
  - …item1…
  - ……..
-
- <dl> …..description list
  - <dt> …data term…</dt>
  - <dd>..data definition..</dd>
  - ……
- <dl>

Links

- <A href=http://prajyotiniketan.edu.in>
  Prajyoti Niketan College </A>
- Charset = “UTF-8”
- Hreflang=“en-us”
- Target=“_blank|_self|_top|_

Processor Management

- Process (task): basic unit of CPU scheduling - created by OS kernel
- Main program and its procedures (functions) together constitute a process
- Def: A process is a program in execution, represented by the tuple (process id, code, data, register values, PC value)
- Process creation: OS performs the following actions
- Create PCB for the process
- Assign process ID and priority
- Allocate resources
- Set up process environment
- Initialize resource accounting information

Process States

- Running: CPU is allocated to the process
- Blocked: process is waiting for a request or an event to occur
- Ready: for execution if CPU is allocated
- Terminated: finished execution
- PCB: PCB pointer, Process ID, Priority, Process state, PSV (PSR, Registers), Event information, Memory allocation, Resources held
- Process scheduling consists of scheduling, dispatching (set up execution of the selected process), context save (save the status of the process when its execution is to be suspended)
- Scheduling policies: FCFS, SJN, Deadline scheduling

Process Synchronization

Two kinds of synchronization for concurrent processes

- Control synchronization: to coordinate the activities of the processes w.r.t one another
- Data access synchronization: to ensure the consistency of shared data
- A *race condition* on a data item arises when many processes simultaneously update its value
- A critical section for a data item *d* is a section of code which can't be executed concurrently with itself or with other critical sections for *d*

Device Management

- Controlling I/O devices using device controller program
- OS communicates with device controller via drivers
- Device driver bridges processes and device controller

Functions

- Keep track of status, data, location, uses, etc.
- It enforces pre-determined policies and decides which process receives the device when and for how long
- It improves the performance of devices
- It allocates and de-allocates the device

Types of Devices

- Dedicated devices: some devices are allocated to only one task. *DisAdv*: more idle time
- Shared devices: disk could be shared by multiple processes simultaneously
- Virtual devices: dedicated devices have been transformed into shared devices using spooling program

File System

- File is a collection of related information stored on secondary storage
- File operations: Create, Open, close, append, read, write, delete, truncate
- File directory is a collection of files

File allocation methods

- Continuous allocation: continuous set of blocks are allocated to a file
- File allocation table records starting block and file size
- Dis Adv: External fragmentation – Soln: memory compaction, virtual memory
- It is necessary to declare file size at file creation time

Cont…

- Non-continuous allocation: each allocated block contains a pointer to the next block in the chain
- DisAdv: internal fragmentation, file truncates if pointer is lost, supports only sequential access
- Indexed allocation: FAT contains a separate one-level index for each file
- No external fragmentation, most popular file allocation
- Memory fragmentation: existence of unusable memory areas in a computer system

Batch Processing System

- Batch is a sequence of jobs
- A job is a sequence of job steps, each job step being the execution of a program
- Batch processing is implemented by batch monitor
- The *turn around time* of a user job is the time since its submission to the time its output becomes available to the user
- Batch processing aims at improving utilization efficiency of computer system, rather than at improving user service

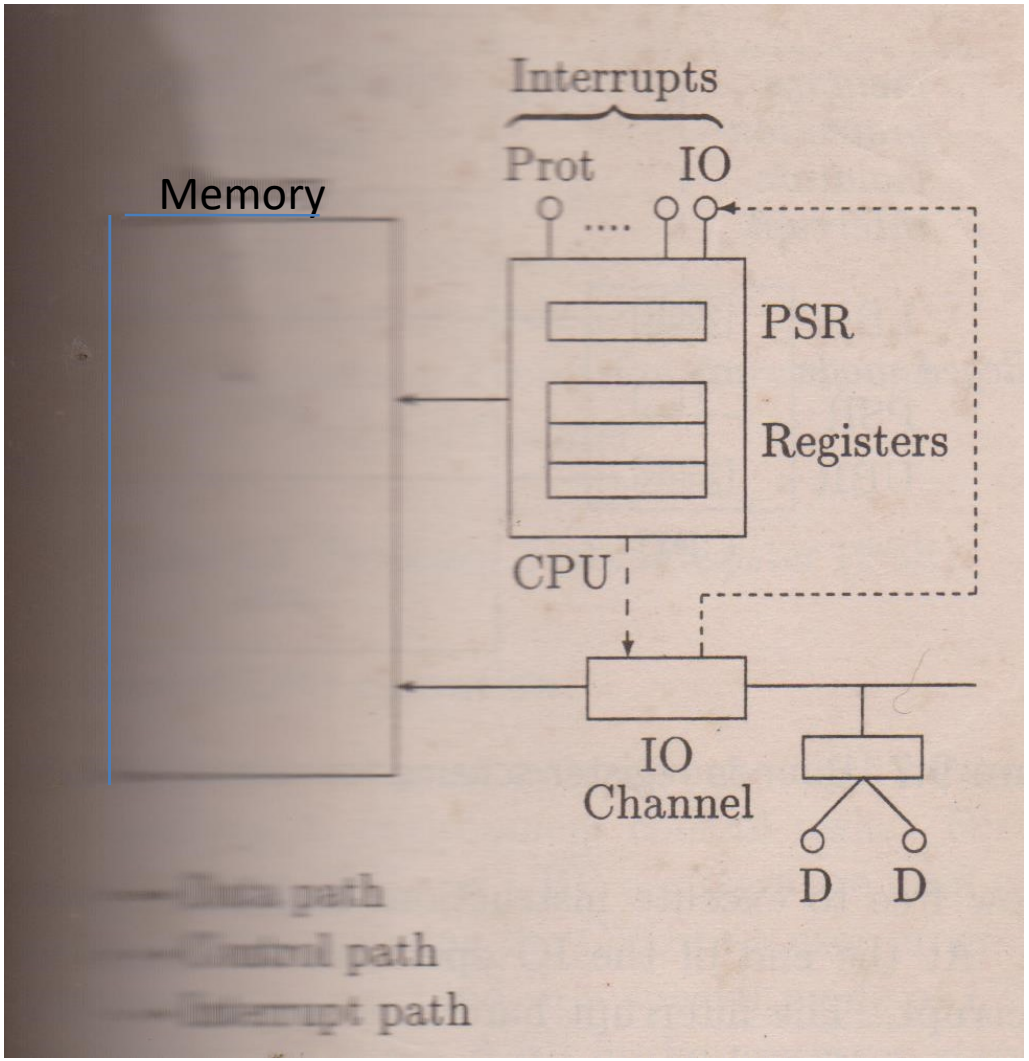
Functions

- Scheduling: the activity of determining which service request should be handled next by a server
- FCFS – always initiate the next job in the batch
- Memory management: system area & user area
- System area contains resident and transient parts of the batch monitor
- Sharing and protection: control statements and command interpreter

Multiprogramming

- Goal: improve the system utilization by exploiting the concurrency between CPU and IO subsystem
- *Throughput* of a system is the number of jobs completed by it per unit time
- Multiple user jobs simultaneously in the memory
- Hardware support: IO channels and interrupt hardware
- Memory protection – LBR & UBR
  - MPVI and termination of the job
- Privileged mode of CPU operation – MP supervisor executes in this mode
  - PSR (IM, P, IC, MPI, PC)

Cont…


Interrupts
Prot
IO
Memory
PSR
Registers
CPU
IO
Channel
D
D
path
path
path

Functions

Scheduling

- Classification of jobs: CPU-bound job & IO-bound job
- Assign high priority to IO bound jobs
- Controlling degree of MP

Memory management

- Memory allocated to a job must not be smaller than the size of largest program in the job

Time Sharing System

- Fast response time for interactive users of computer system
- Response time: the time since the submission of computational request by a user till its results are reported to the user

Functions of TS supervisor

- Scheduling: Round robin scheduling, Time slicing
- No program can monopolize the CPU, program priority changes with time
- Program preemption: forced removal of a program from CPU (timer interrupt)
- Memory management: Swapping – technique of temporarily removing inactive programs from computer memory (swap out) – increases OS overheads

Real Time System

- Real time application is an application which requires timely response from the computer system for the correctness of its functioning
- RT OS helps to fulfill *Worst case response time* requirements of an application
- Multitasking provides the advantage of overlapping CPU and IO activities of different tasks
- Priority driven or deadline scheduling
- Programmer defined interrupts
- E.g: PSOS, RT Linux, Lynx, VRTX
- Satellite communication: copy samples from buffer to temp_area, Write into disk file, Do house keeping operations

Distributed System

- a computing environment in which various components are spread across multiple computers on a network
- Reduce risk due to single point of failure
- Operate via internet (cloud), client-server systems, Peer-to-peer systems
- E.g.: telecommunication network, reservation system

Characteristics

- Scalability: ability to grow as the size of the workload increases
- Concurrency: Distributed system components run simultaneously
- Fault tolerance: If one node fails, the remaining nodes can continue to operate without disrupting the overall computation.
- Transparency: allowing users to interact with a single logical device rather than being concerned with the system's architecture
- Heterogeneity: nodes and components are with different hardware, middleware, software and operating systems
- Replication: enable shared information and messaging

SQL

- Table holds data as in spreadsheet

Data types

- CHAR(255)
- VARCHAR/VARCHAR2(4000): store variable length alphanumeric data
- LONG: to store 2GB variable length character string (only one in a table)
- DATE: date (DD-MON-YY) and time in 24 hour format
- NUMBER(38, S)
- RAW/LONG RAW: to store images of size 255 bytes and 2 GB respectively

Commands

- CREATE TABLE “COLLEGE”.”STUDENT” (“ADNO” VARCHAR2(4), “NAME” CHAR(15));
- INSERT INTO STUDENT (ADNO, NAME) VALUES (‘4201’, ‘Subash’);
- INSERT INTO STUDENT VALUES (‘4202’, ‘Ayana’);
- SELECT * FROM STUDENT;
- SELECT ADNO, NAME FROM STUDENT;
- SELECT * FROM STUDENT WHERE ADNO=‘4201’;
- SELECT DISTINCT ADNO FROM STUDENT;
- Avoids duplication
- SELECT * FROM STUDENT ORDER BY ADNO [DESC];
- SELECT * FROM TAB;

Cont…

- RENAME STUDENT TO ALUMNI;
- DESCRIBE ALUMNI;
- CREATE TABLE SALES (PID, PNAME, PRICE) AS SELECT ID, NAME, PRICE FROM PRODUCT;
- INSERT INTO SALES SELECT * FROM PRODUCT;
- DELETE FROM PRODUCT WHERE ID LIKE ‘P%’;
- TRUNCATE TABLE PRODUCT;
- DROP TABLE PRODUCT;
- UPDATE SALES SET GST = 12 WHERE GST < 12;
- ALTER TABLE STUDENT ADD (ADDRESS VARCHAR(30));
- ALTER TABLE STUDENT DROP COLUMN ADDRESS;
- ALTER TABLE STUDENT MODIFY (NAME VARCHAR(20));

Cont…

- create table class (cno integer, name varchar(10), dob date, wt float);
- insert into class (cno, name,dob, wt) values (1, 'Raj', '31-may-83',45.5);
- insert into class values (2, ‘Rajan', '13-aug-95',67.0);