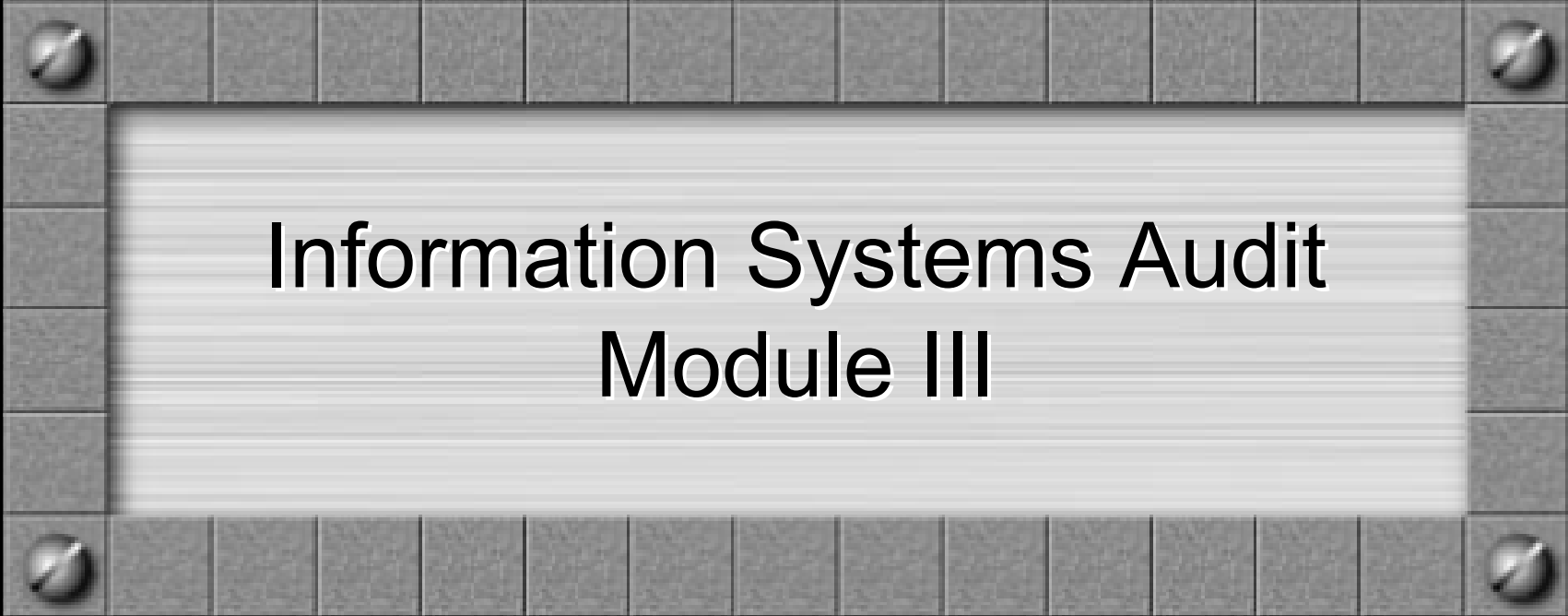




Information Systems Audit Module III

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Introduction

- ✓ About the Course
- ✓ About the Module
 - ▶ Module 3 (5%) 10 Questions
- ✓ About the Material
 - ▶ Source, Organisation
 - ▶ Module 3: Chapter 11-14

About this Presentation

✓ Hardware Architecture

▶ Chapter 11 4

✓ Software Platform

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✓ Database Management Systems

▶ Chapter 13 71

✓ Software Architecture

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Hardware Architecture

Chapter 11

Hardware Architecture

- ✓ This section deals with
 - ✦ Types of Computers
 - ✦ I/O Devices
 - ✦ Hardware Monitoring Procedures

Types of Computers

- ✓ Computers can be generally classified as
 - ✦ Personal computer
 - ✦ Workstation
 - ✦ Minicomputer
 - ✦ Mainframe
 - ✦ Supercomputer

Types of Computers

✓ Personal computer

- ✦ Refers to stand-alone computer equipped with its own central processing unit, memory, storage, software, & other utilities
- ✦ It can be defined as a small, relatively inexpensive computer designed for an individual user
- ✦ It is also referred as a standalone computer

✓ Types

- ✦ Desktop
- ✦ Notebook/Laptop
- ✦ Handheld

Types of Computers

✓ Workstation

- ✦ Computer used for applications requiring a moderate amount of computing power and relatively high quality graphics capabilities
- ✦ In networking, workstation refers to any computer connected to a local-area network

✓ Minicomputer

- ✦ Medium or moderate sized computer
- ✦ Multiprocessing system capable of supporting up to 200 users simultaneously

Types of Computers

✓ Mainframe

- ✦ Large and fast computer with superior data processing capabilities
- ✦ Supports more simultaneous programs than supercomputers
- ✦ Very large and expensive

Types of Computers

✓ Super Computer

- ✦ Largest, fastest, and the most powerful
- ✦ Used for applications requiring massive calculations within a short period of time
- ✦ Application areas include weather forecasting and nuclear energy research

✓ Kiosk

- ✦ Example ATM machines.

Types of Computers

✓ Multi-user/Network

✦ Computer Network

- ▶ A communication system for connecting end-systems
- ▶ Comprises of the following components:
 - ★ Computer
 - ★ Network cable
 - ★ Network Interface Card (NIC)

Types of Computer

✓ Multi-user/Network (Contd.)

✦ Networks can be classified as:

▶ Local Area Network (LAN)

★ Connects computers that are close together

▶ Wide Area Network (WAN)

★ Connects computers in different cities or countries

▶ Metropolitan Area Network (MAN)

★ Connects computers that cover entire city or metropolitan area

I/O Devices

- ✓ Introduction
 - ✦ I/O Devices act as bridge between user and CPU
 - ✦ Input devices feed user input into CPU
 - ✦ Output devices carry results from CPU

I/O Devices

✓ Keyboard

- ✦ Standard input device
- ✦ Series of switches connected to a microprocessor
- ✦ Each keystroke generates a unique signal that allows the computer to identify the key pressed

I/O Devices

✓ Mouse

- ✦ Translates the motion of user's hand into signals
- ✦ A ball inside the mouse rolls as the mouse moves
- ✦ A processor reads the pulses from the infrared sensors and turns them into binary data that the computer understands

I/O Devices

✓ Text Recognition

✦ OCR

- ▶ Acronym for Optical Character Recognition
- ▶ Used by the computer to recognize printed or written text characters
- ▶ Involves photo scanning of the text and translation of character image into character codes

I/O Devices

✓ Voice Recognition

- ✦ Ability of a machine or program to recognize and carry out voice commands
- ✦ Matches a voice pattern against a provided vocabulary

I/O Devices

✓ Smart Card

- ✦ A small electronic device about the size of a credit card that contains electronic memory & an embedded Integrated Circuit (IC)
- ✦ Uses
 - ▶ Storing a patient's medical records
 - ▶ Storing digital cash
 - ▶ Generating network ID's

I/O Devices

✓ Pen

✦ Pen Computer

- ▶ A computer that utilizes an electronic pen rather than a keyboard for input

✦ Light Pen

- ▶ An input device that utilizes a light-sensitive detector to select objects on a display screen

I/O Devices

- ✓ Monitor
 - ✦ Most used output device on a computer
 - ✦ Desktop monitors use CRT
 - ✦ Laptops use LCD / LED
 - ✦ Short term for Monitor - Display

I/O Devices

✓ Tape

- ✦ A magnetically coated strip of plastic on which data can be encoded
- ✦ A sequential-access media
- ✦ Has large storage capacity
- ✦ Has much slower data access capacity
- ✦ Also termed as Streamer or Streaming Tape

I/O Devices

- ✓ Floppy Drive
 - ✦ Used to access floppy disks
 - ✦ Floppy disks are made from thin piece of plastic, coated with a magnetic material on both sides
 - ✦ 1.44 MB and 1.2 MB storage capacities

I/O Devices

- ✓ Hard Drive
 - ✦ Airtight sealed unit with a number of metallic disks mounted on a spindle that rotates at a speed of about 3600 - 7200 RPM
 - ✦ Greater storage capacity
 - ✦ Faster access speed

I/O Devices

✓ CD ROM

- ✦ Most popular and the least expensive type of optical disks
- ✦ Storage up to 650MB - 700 MB
- ✦ Characterized by spin rate that influences the information retrieval speed

I/O Devices

✓ DVD

- ✦ Uses laser to read microscopic pits on a disc
- ✦ Storage up to 17 GB (Double Layer/Double Side)
- ✦ Data retrieval rate
 - ▶ 1,385 KB per second

I/O Devices

- ✓ Scanner
 - ✦ Takes input in graphical form
 - ✦ The basic principle is to analyze an image and process it
 - ✦ Types of Scanners
 - ▶ Flatbed
 - ▶ Sheet-fed
 - ▶ Handheld
 - ▶ Drum scanners

I/O Devices

✓ Printer

- ✦ Output device that produces output on a paper or similar media
- ✦ Types of printers
 - ▶ Dot Matrix Printers
 - ▶ Inkjet Printers
 - ▶ Laser Printers

I/O Devices

✓ Plotter

- ✦ A device that draws pictures on paper based on commands from a computer
- ✦ Expensive
- ✦ Used in Engineering Applications

I/O Devices

✓ Digitizing Tablet

- ✦ An input device that enables the user to enter drawings & sketches into a computer
- ✦ Consists of an electronic tablet & a cursor or pen
- ✦ A cursor is similar to a mouse
- ✦ Tablet contains electronics that enable it to detect movement of the cursor
- ✦ Also called as Digitizer, Graphic Tablet etc.

Components

- ✓ Motherboard/System Board
 - ✦ CPU
 - ▶ Control Unit (CU)
 - ▶ Arithmetic & Logical Unit (ALU)
 - ✦ RAM, ROM, Cache
 - ✦ I/O Connectors
 - ✦ Bus
- ✓ SMPS

Components

✓ Buffers

- ✦ A temporary storage area that resides in RAM
- ✦ Usage
 - ▶ Keeps tracks of changes made to files
 - ▶ Printing documents

✓ Channels

- ✦ A communication path between two computers or devices

Hardware Monitoring Procedures

✓ Maintenance

✦ Information to be recorded

- ▶ Reputable service company information for each hardware resource
- ▶ Schedule for maintenance
- ▶ Cost of maintenance
- ▶ Maintenance performance history

Hardware Monitoring Procedures

✓ Hardware Acquisition Plan

✦ The tender should include

- ▶ Hardware requirements
- ▶ System software requirements
- ▶ Supporting hardware requirements
- ▶ Constraints such as staffing level, existing hardware capacity
- ▶ Adaptability requirements

Hardware Monitoring Procedures

- ✓ Data and Capacity Management
 - ✦ Rapid and secure access to data attributes to the success of any organization
 - ✦ Capacity management is planning of computer resources to ensure efficient and effective use
 - ✦ Capacity planning should include projections validated from the past experience

Summary

- ✓ Computers can be generally classified as Personal computer, Workstation, Mainframe, Minicomputer and Supercomputer
- ✓ I/O Devices act as a bridge between user and CPU
- ✓ Keyboard is the standard input device and Monitor is the standard output device

Summary

- ✓ Rapid and secure access to data attributes to the success of any organization
- ✓ Capacity planning should include projections validated from the past experience



Software Platform

Chapter 12

Software Platform

- ✓ This section deals with
 - ✦ Introduction to System Software
 - ✦ Software Control features, Activity logging & Reporting Options
 - ✦ Access Control, Data Communication, & DBMS Software

Introduction to System Software

✓ System Software

✦ Definition

- ▶ Collection of system programs that perform a variety of functions, such as file editing, & resource accounting, etc

✦ System Program

▶ Definition

- ★ Program required for effective execution of general user program
- ▶ Application software is a computer program written for specific applications.

Introduction to System Software

✓ System Software (contd..)

✦ Types of System Programs

- ▶ File Manipulation
- ▶ Status Information
- ▶ File Modification
- ▶ Program Loading & Execution
- ▶ Communications
- ▶ Application Programs (Some O/s come bundled with these)

Introduction to System Software

✓ System Software (contd..)

✦ Functions

- ▶ Processes input & output commands
- ▶ Provides general library of utility routines
- ▶ Ensures that CPU services each program in rotating sequence or according to priority some scheme
- ▶ Coordinate & control data transmissions to & from computer terminals

Introduction to System Software

✓ Operating System

- ✦ Program that acts as an intermediary between a user & computer hardware
- ✦ Provides an environment in which a user can execute programs
- ✦ Goal
 - ▶ To ease the use of computer system
 - ▶ To efficiently use computer hardware

Introduction to System Software

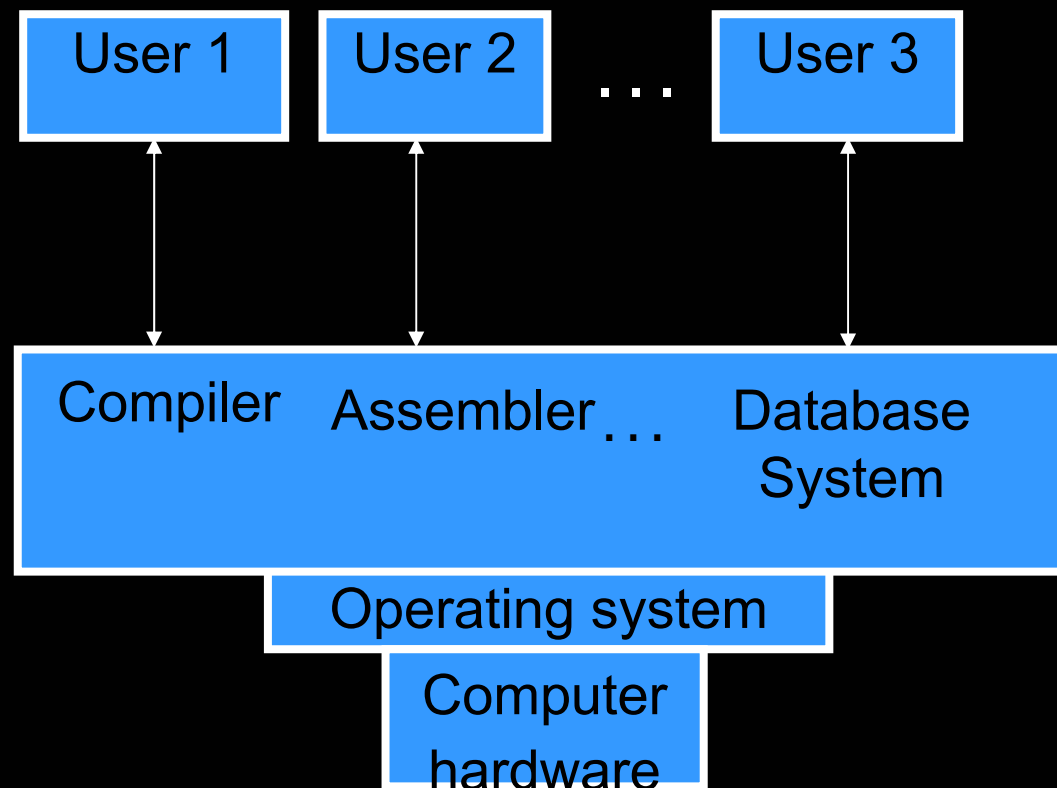
- ✓ Operating System (contd..)
 - ✦ Components of computer system
 - ▶ Hardware
 - ★ Includes CPU, memory, & input/output devices
 - ▶ Operating system
 - ★ Program that acts as interface between computer & hardware

Introduction to System Software

- ✓ Operating System (contd..)
 - ✦ Components of computer system
 - ▶ Application programs
 - ★ Include compilers, database systems, video games, & business programs
 - ▶ Users
 - ★ Include people, machines, and other computers

Introduction to System Software

- ✓ Operating System (contd..)
 - ✦ Structure of Computer System



Introduction to System Software

✓ Operating System (contd..)

★ Operating system can be called as

▶ Resource Allocator

- ★ Acts as manager of resources (hardware & software) & allocates them to specific programs & users

▶ Control Program

- ★ Controls execution of user programs & improper use of the computer

Auditing System Software

- ✓ Tasks during evidence gathering phase
 - ✦ Understand the System
 - ✦ Test quality of data
 - ✦ Test program's ability to maintain data Integrity.
 - ✦ Develop of special audit and utility software
- ✓ Reasons for using Utility Software
 - ✦ Unavailability of GAS
 - ✦ Functional limitations of GAS
 - ✦ Efficiency
 - ✦ Facilitates use of other audit tools

Utility: System Understanding

- ✓ Flow Charters
 - ✦ Flowcharts from source code
- ✓ Hierarchy Charter
 - ✦ Hierarchical function charts from structured code
- ✓ Execution Path Mapper
 - ✦ Shows execution Path through a program
- ✓ Data Structure Charts
 - ✦ Charts from database definitions showing data structure within a DB
- ✓ Data Dictionary
 - ✦ Descriptions data items in a DB

Utility: Data Quality Testing

- ✓ Query Facility
 - ✦ Retrieval of data meeting specified criteria
- ✓ Data Structure Conversion
 - ✦ Maps one data structure into another
- ✓ Pointer Validation Utility
 - ✦ Searches storage for invalid pointers
- ✓ Data Comparison Utility
 - ✦ Compares two sets of data

Utility: Program Quality (Data Integrity) Testing

- ✓ Test Data Generator
 - ✦ Generates test data files with specified attributes
- ✓ Online Debugger
 - ✦ Online changes to code and checkpointing
- ✓ Execution Path Monitor
 - ✦ Whether data has traversed all execution paths
- ✓ Output Analyzer
 - ✦ Examines output for various conditions
- ✓ Test Driver/Manager
 - ✦ Manages overall testing
- ✓ Change Tracker
 - ✦ Monitors changes to program source code libraries

Utility: Software Development

- ✓ Macro Prompter
 - ✦ Inserts standard code
- ✓ Text Editor
- ✓ Online Coding Facility
 - ✦ Interactive program coding
- ✓ Report Generator
- ✓ Code Optimisers
 - ✦ Removes inefficient code
- ✓ Volume Test Facility
 - ✦ Performance of program under stress

Software Control Features

- ✓ To make information available to those who need it & who can be trusted with it, organizations use authentication & authorization
- ✓ Authentication
 - ✦ It is proving that a user is whom he or she claims to be
- ✓ Authorization
 - ✦ Act of determining whether particular user has right to carry out certain activities

Software Control Features (contd..)

- ✓ Protected software must be followed up with back-up capabilities
- ✓ Access privileges can be controlled for each function
- ✓ Ability to verify installed status of software
- ✓ Users can have login name & password to gain access to the system
- ✓ Auditing provides digital footprint of all user activities
- ✓ Data control feature defines what data a specific user can see or access

Software Control features (contd..)

- ✓ Firewall is a system designed to prevent unauthorized access to or from a private network
 - ✦ Types of Firewall Techniques
 - ▶ Packet Filter
 - ▶ Application Gateway
 - ▶ Circuit-level Gateway
 - ▶ Proxy server
- ✓ Database security ensures only authorized users are actually allowed to access the database
 - ✦ Application initiated database access are performed through stored procedures

Software Control features (contd..)

- ✓ Stored procedure a database function consisting of one or more series of SQL commands encapsulated into a single module
- ✓ Advantages of Stored Procedures
 - ✦ Speed
 - ✦ Encapsulation & Maintenance
 - ✦ Security
 - ✦ Database Independence

Software Control features (contd..)

- ✓ Activity Logging & Reporting Options
 - ✦ User can collect information about user activity by enabling log utility
 - ✦ Logs include information about the user
 - ✦ Logging Server Activity
 - ▶ Microsoft Internet Information Server has logging features that let users to capture information about activities on Web Server

Software Control features (contd..)

✓ Activity Logging & Reporting Options (contd..)

✦ To configure logging follow the steps

- ▶ Determine in which directory logs will be stored
- ▶ Specify how often logs are to be collected
- ▶ Select log tools
- ▶ In Internet Service Manager, double-click service to display its property sheets

Software Control features (contd..)

- ✓ Activity Logging & Reporting Options (contd..)
 - ✦ Log to File
 - ✦ Log to SQL/ODBC Database
 - ✦ Viewing Logs in Database

Access Control, Data Comm. & DBMS

✓ Access Control Software

- ✦ Performs user verification, & authorization of user access to system resources

- ✦ Features

- ▶ Create as many users as possible
- ▶ Specify what days & times the computer may be accessed
- ▶ Specify what days & times the internet may be accessed
- ▶ Specify what days & times ANY program may be accessed

Access Control, Data Comm. & DBMS

✓ Access Control Software (contd..)

✦ Features

▶ Internet time expire

- ★ Tells the user when they have one-minute left of internet access

▶ Computer time expire

- ★ Tells the user when they have one-minute left of computer access

▶ Program time expire

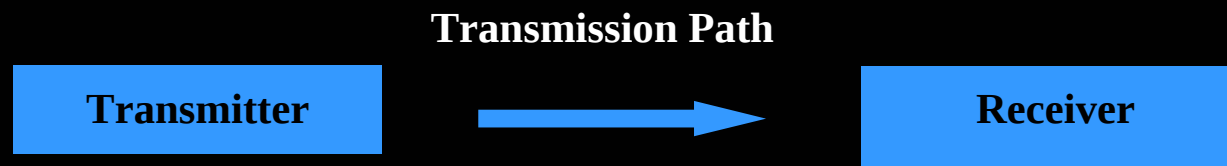
- ★ Tells the user when they have one-minute left of access for that particular application

Access Control, Data Comm. & DBMS

- ✓ Access Control Software (contd..)
 - ✦ Available on minicomputer operating systems
 - ✦ Can be added on to the operating system in large mainframe computer systems & microcomputer systems

Access Control, Data Comm. & DBMS

- ✓ **Data Communication Software**
 - ✦ Used to transmit data from one point to another
 - ✦ Components of data communication system
 - ▶ Transmitter (source)
 - ▶ Transmission Path (channel or line)
 - ▶ Receiver (sink)



Access Control, Data Comm. & DBMS

✓ Data Communication Software (cont..)

✦ Methods of data transmission

▶ Parallel Transmission

- ★ Uses different wires for data transmission

▶ Serial Transmission

- ★ Uses single wire that transmits each data bits continuously & sequentially

Access Control, Data Comm. & DBMS

- ✓ Data Communication Software (contd..)
 - ✦ It converts character or symbol into a coded form
 - ▶ Common Transmission Codes
 - ★ EBCDIC (Extended Binary Coded Decimal Interchange Code)
 - ★ ASCII (American National Standard Code for Information Interchange)

Access Control, Data Comm. & DBMS

✓ DBMS Software

- ✦ Database Management System (DBMS) consists of collection of interrelated data & a set of programs to access that data
- ✦ Factors that led to development of DBMS
 - ▶ Data Isolation
 - ▶ Concurrent access anomalies
 - ▶ Security problems
 - ▶ Integrity problems

Access Control, Data Comm. & DBMS

✓ DBMS Software (contd..)

★ Commonly used DBMS software are

- ▶ Oracle 9i
- ▶ SQL Server 2000
- ▶ Sybase

Summary

- ✓ System software is the collection of system programs that perform a variety of functions, such as file editing, resource accounting, Input/Output management, storage management
- ✓ System programs are categorized into various programs, which include file manipulation, file modification, program-language support, program loading & execution, & application programs

Summary

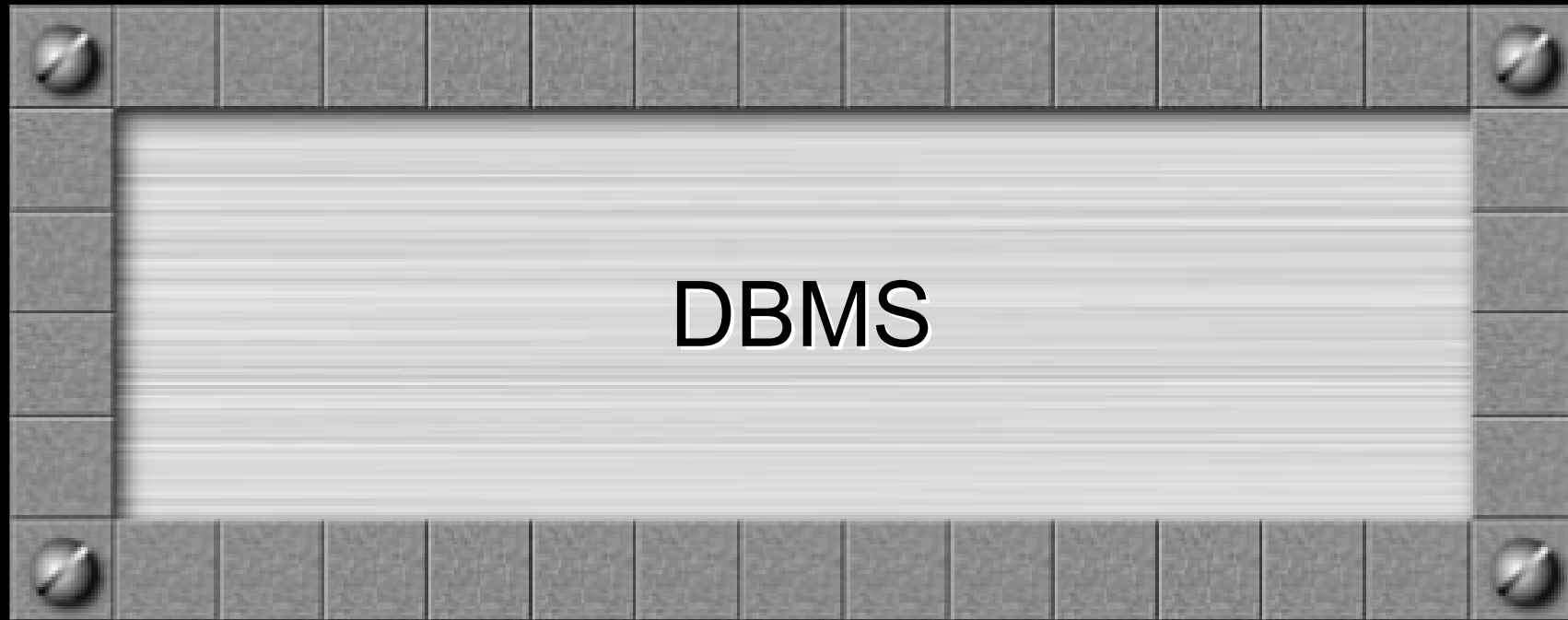
- ✓ An operating system is a program that acts as an intermediary between a user of a computer & the computer hardware. The purpose of an operating system is to provide an environment in which a user can execute programs
- ✓ Some of the software control features include login password, Windows NT & Windows 2000 authentication, audit trails, time & date server, data security, web server security, firewalls, & database security

Summary

- ✓ The user can collect information stored in ASCII files about user activity by enabling log utility. The logs can include information such as who has visited the system, what the visitor viewed, & when the information was viewed last
- ✓ Access control software performs user verification, authorization of user access to system resources

Summary

- ✓ Software used to transmit data from one point to another is termed as Data communication software
- ✓ DBMS software can store data & make use of query languages like SQL to manipulate data



Chapter 13

Database Management System

- ✓ This section deals with
 - ✦ Database Management System Overview
 - ✦ Database Models
 - ✦ Normalization in Databases
 - ✦ Database Administration
 - ✦ Database Security and Controls
 - ✦ Database Recovery

Database Management System Overview

- ✓ DBMS is a collection of interrelated data and a set of programs to access this data
- ✓ A Database System consists of two parts
 - ✦ Database Management System
 - ✦ Database Application
- ✓ DBMS
 - ✦ Is a very large integrated collection of data.
 - ✦ Models real-world enterprise
 - ▶ Entities (e.g., students, courses)
 - ▶ Relationships (e.g., Ramesh is taking ISA)
 - ✦ is a software package designed to store and manage databases.

Database Management System Overview

- ✓ DBMS offers the following services
 - ✦ Data Definition
 - ✦ Data Maintenance
 - ✦ Data Manipulation
 - ✦ Data Display
 - ✦ Data Integrity

Database Management System Overview

✓ Advantages of DBMS

- ✦ Program/Data Independence
- ✦ Reduction of data redundancy
- ✦ Transaction processing efficiency
- ✦ Maximizes data consistency
- ✦ Offers an opportunity to enforce data security
- ✦ Availability of stored data integrity checks
- ✦ Enforces standards
- ✦ All Information at single place
- ✦ Sharing of Data between user departments

Database Management System Overview

✓ Overall System Structure

✦ The functional concepts of a Database System include:

- ▶ File Manager
- ▶ Database Manager
- ▶ Query Processor
- ▶ DML Precompiler
- ▶ DDL Compiler

Database Management System Overview

✓ Overall System Structure

- ✦ Data structures required as part of the physical system implementation
 - ▶ Data Files
 - ▶ Data Dictionary
 - ▶ Indices

Objectives of DBMS

✓ Sharability

- ▶ Multiple users/different processes have access to same data at virtually same time.

✓ Availability

- ▶ Available when it is needed.

✓ Evolveability

- ▶ Change in response to changing needs

✓ Database Integrity

- ▶ Unimpaired especially in a shared environment.

Database Design

- ✓ Logical Design
 - ✦ Information Needs of the User
- ✓ Physical Design
 - ✦ Implementation on specific hardware and software platform.
- ✓ Relationships
 - ✦ One-to-one, One-to-Many, Many-to-Many

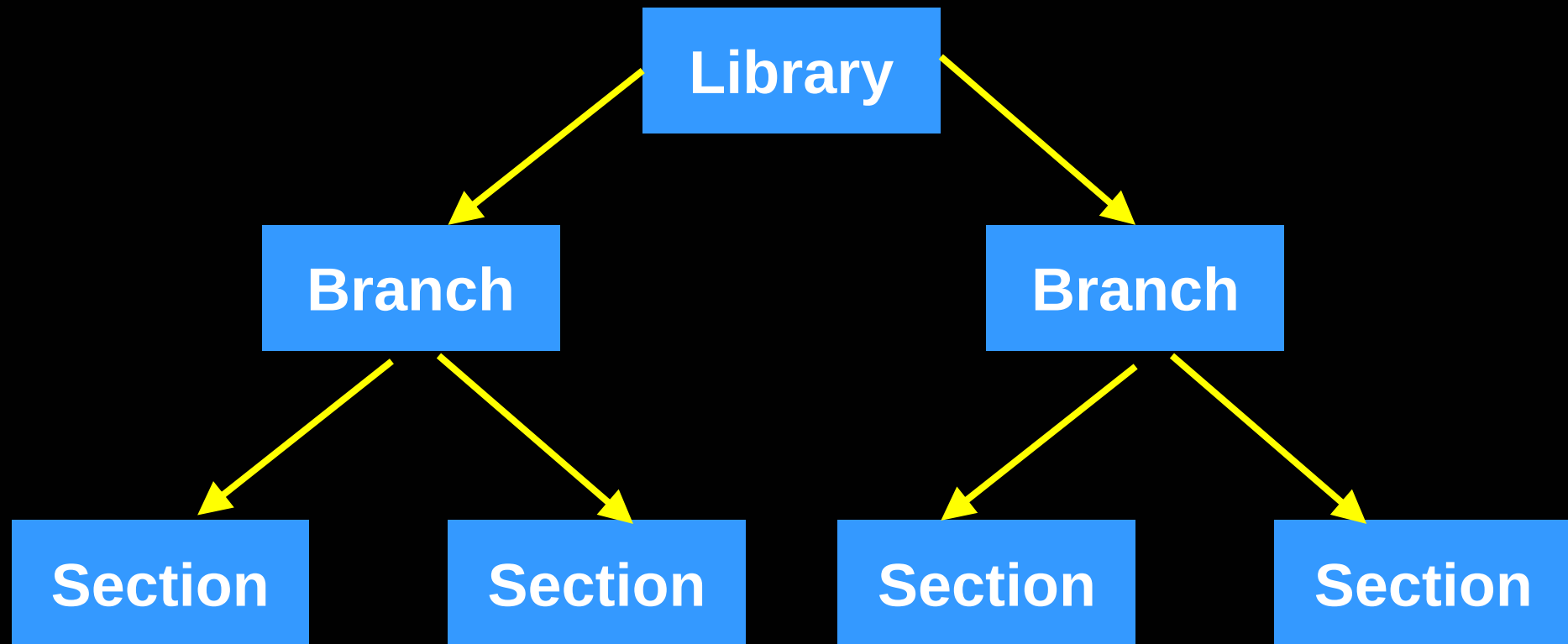
Database Models

- ✓ The four Database Models are
 - ✦ File Management System
 - ✦ Hierarchical Database System
 - ✦ Network Database System
 - ✦ Relational Database System

File Management System

- ✓ First method used to store data in a computerized Database
- ✓ A software used for creating, retrieving, and manipulating files, one file at a time
- ✓ Drawbacks include Data redundancy, Lack of data integrity & Lack of program independence

Hierarchical



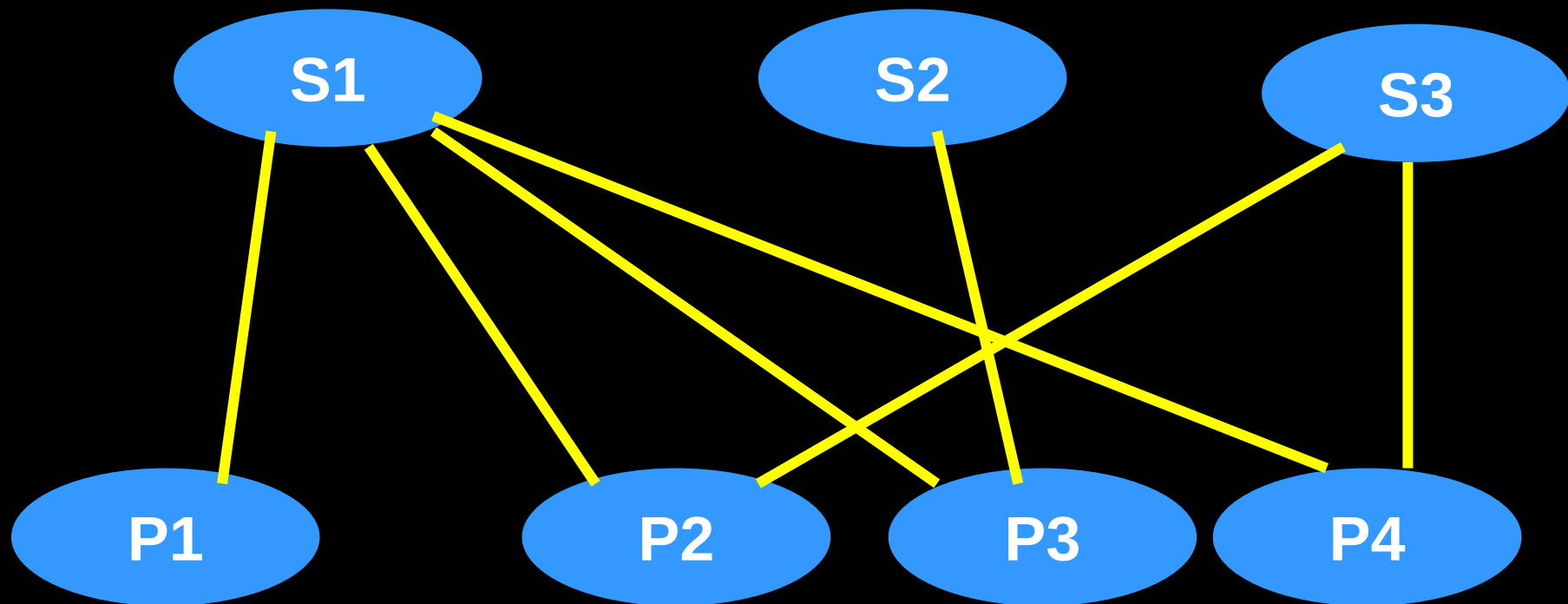
Features of Hierarchical Model

- ✓ This model is like a hierarchical tree structure, used to construct a hierarchy of records in the form of Nodes and Branches
- ✓ Top has only one node called parent
- ✓ Relationships between nodes are called branches
- ✓ Every node has exactly one parent, except root which has not parent
- ✓ A node can have any number of child
- ✓ No loops or cycles

Disadvantages of Hierarchical Model

- ✓ Not flexible enough
- ✓ Not possible to insert a new level without revamping the entire structure
- ✓ Cannot represent Many-Many Relationship

Network Model



Network Model

- ✓ A Network is a graph used to represent a data scheme
- ✓ Consists of Nodes connected together by Edges
- ✓ Features
 - ▶ More than one edge between a given pair of nodes.
 - ▶ No concept of root node.
 - ▶ A node can have more than one parent node.
- ✓ Disadvantages
 - ▶ Generality of an edge not realizable, so directed edges are used.

Relational Model

<i>FName</i>	<i>SName</i>	<i>ISA Reg.#</i>	<i>City</i>	<i>Marks</i>
Mathew	Thomas	223	Chennai	100
Tushar	Khan	706	Delhi	150
Vijay	Jain	435	Delhi	125
Sanjeev	Vora	454	Mumbai	200
Deepa	Jagdish	425	Chennai	190
Anuj	Gupta	455	Delhi	120
Ganesh	Datt	485	Chennai	130
Kunal	Modi	465	Chennai	225

Relational Model

✓ Features

- ✦ Data represented in the form of tables
- ✦ No two rows can be identical
- ✦ All entries in a column belong to the same category
- ✦ Order of rows insignificant
- ✦ Unlimited rows and columns.

Normalization

- ✓ Process of organizing data in a database
- ✓ Unique key for each table
- ✓ Every table is represented in a simple tabular form
- ✓ Makes the database more flexible by eliminating two factors
 - ✦ Redundancy
 - ✦ Inconsistent dependency

Database Administration

✓ Major responsibilities of a DBA (?)

- ✦ Interact with the top management and acquire the necessary hardware and software
- ✦ Interact with people to identify data elements
- ✦ Choose proper data model
- ✦ Identify the relationship type that exists between the data elements
- ✦ Design Data Dictionary
- ✦ Decide the user access privileges
- ✦ Determine the methods for updating data and backups
- ✦ Enforce data integrity and security

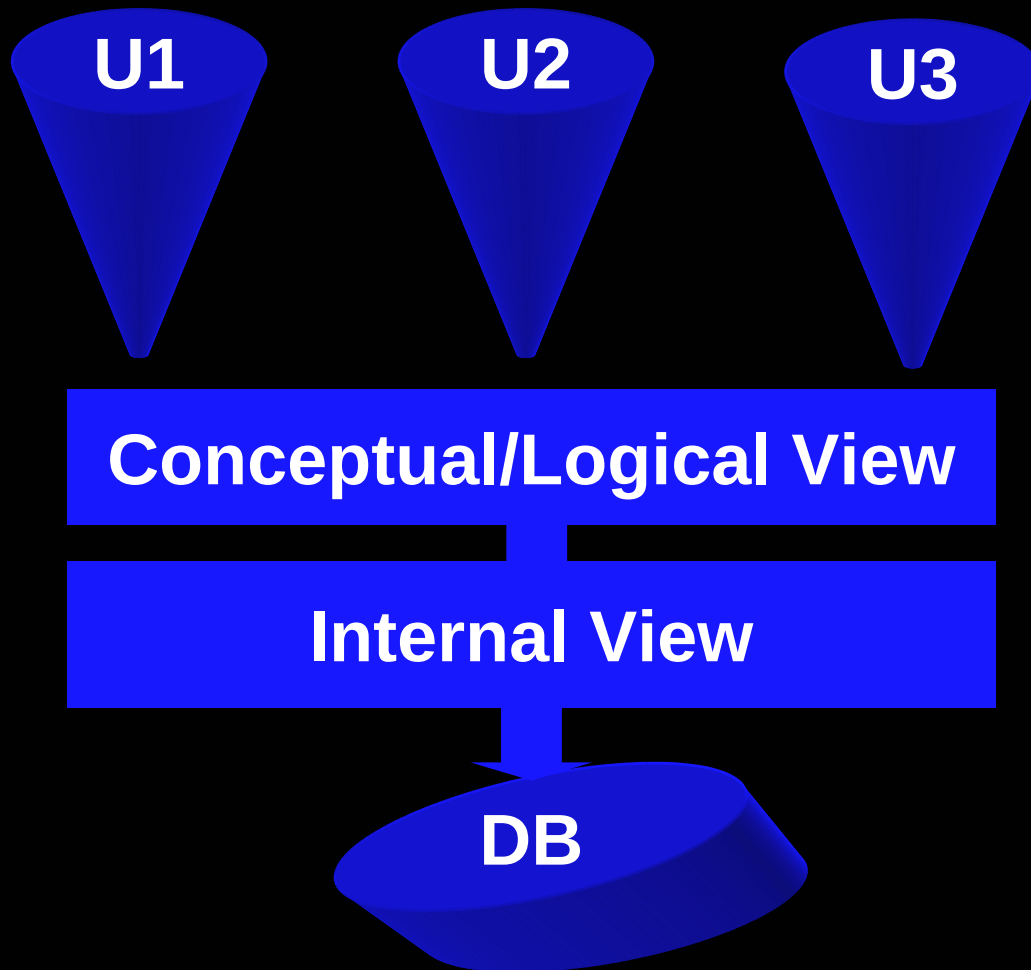
DA Vs. DBA I

<i>Function</i>	<i>DA</i>	<i>DBA</i>
Defining Data	Logical Definition	Physical Definition
Creating Data	Advising users on data collection procedures	Preparing Programs to create data
Redefining	New logical Definitions	New physical Definitions
Retiring	Specifying Policies	Implementing Policies
Making DB available to Users	Determine End user Requirements	Determine Programmers Requirement for Tools

DA Vs. DBA II

<i>Function</i>	<i>DA</i>	<i>DBA</i>
Informing and servicing users	Answering and educating end users	Answering and educating programmers
Maintain Integrity	Developing standards For data definition, existence, concurrency and application controls	Implementing Standards
Monitoring Controls	End-user pattern of DB use	Programmer's pattern of DB use. Performance Statistics. Tuning.

Schemas



Database Administration

- ✓ Architecture of a Database Management system
 - ✦ External Schema
 - ▶ Grammar describing a particular user's view
 - ▶ Subset of the total DB
 - ✦ Conceptual Schema
 - ▶ Grammar describing the entire DB, from a Logical perspective
 - ▶ Amalgam of all external schemas into a complete, accurate and consistent whole.
 - ✦ Internal Schema
 - ▶ How data/knowledge is stored in the DB.

Database Administration

✓ Database Languages

✦ DDL

- ▶ Permits one to declare records, links, fields and keys

✦ DML

- ▶ Assists one to operate on the data in the database

Database Administration

✓ Data Dictionary

- ✦ The Data Dictionary holds all information about the data stored in the database
- ✦ Contains the following information
 - ▶ The way data is defined
 - ▶ Types of data present
 - ▶ Relationship among various entities
 - ▶ Representation formats
 - ▶ Keys for the database
 - ▶ Access rules for every user
 - ▶ People accessing the data

Database Administration

- ✓ Designing the database
 - ✦ In order to design the database, it is essential to identify the needs of the organisation
 - ▶ One-to-One : One entity has only one association
 - ▶ One-to-Many : One entity has many associations
 - ▶ Many-to-Many : Each entity has many associations

Database Security and Controls

✓ Database Security

- ✦ Ensures that only the right person has the right to access the right data
- ✦ Right People
 - ▶ Authentication
 - ▶ Checks whether a user operating upon the database has the right to do so
- ✦ Right Data
 - ▶ Right access to the right data.
 - ▶ Authorization and access control

Authorisation and Access Control

- ✓ The basic model for accessing control usually involves three things
 - ✦ Subject
 - ★ Users
 - ✦ Object
 - ★ Unit of the database
 - ✦ Access Rights
 - ★ Read Only, Write Only, Update etc.
- ✓ Authoriser
 - ✦ Decides which subjects have what access rights on what objects

Authorisation Matrix

	Data 1	Data 2	Data 3	Data 4
User 1	RO	RW	RO	RO
User 2	RO	D	RW	RW
User 3	W	D	RO	RW

Relational Database Security

- ✓ Name-Dependent
- ✓ Content Dependent
- ✓ Context Dependent
- ✓ History Dependent

Name-Dependent Restrictions

- ✦ Users either have access to the named resource or not.
Content-Independent .

Name	Dept	Salary	Address	Rating
Satish	Acctg.	5000	Delhi	5
Harish	R&D	6000	Goa	6
Mathew	Prodn.	7000	Kochi	7
Radha	R&D	8000	Goa	8

Content-Dependent Restrictions

- ✦ Users permitted or denied access to data depending on its contents

Name	Dept	Salary	Address	Rating
Satish	Acctg.	5000	Delhi	5
Harish	R&D	6000	Goa	6
Mathew	Prod.	7000	Kochi	7
Radha	R&D	8000	Goa	8



Context-Dependent Restrictions

- Users are permitted or denied access based on the context in which they are seeking access. E.g. Statistical queries

Name	Dept	Salary	Address	Rating
Satish	Acctg.	5000	Delhi	5
Harish	R&D	21000	Goa	6
Mathew	Prodn.		Kochi	7
Radha	R&D		Goa	8

History-Dependant Restrictions

- ✓ Users are permitted or denied access based on the time series of access and actions they have undertaken

Name	Dept	Salary	Address
Satish	Acctg.	5000	Delhi
Harish	R&D	21000	Goa
Mathew	Prod.		Kochi
Radha	R&D		Goa

R & D
14000

Database Recovery

- ✓ The process of bringing a database from an inconsistent state to a consistent state is known as Recovery
- ✓ Kinds of Failures
 - ✦ Failure of a Statement
 - ✦ Failure of the Program
 - ✦ Failure of the System

Database Recovery

✓ Controlling Failures

✦ System Failures

- ▶ Environmental factors
- ▶ Preventive maintenance
- ▶ System patches/updates

✦ Statement Failures

- ▶ Checking integrity constraints and preconditions before statement execution

✦ Program Failures

Database Recovery

✓ Recovery Techniques

- ✦ While performing recovery, there are two steps that have to be followed
 - ▶ Collecting recovery data
 - ▶ Performing recovery

Database Recovery

- ✓ Recovery Information can be collected from the following
 - ✦ Database Dumps
 - ✦ Savepoints
 - ✦ Journals
 - ✦ Differential Files

Database Dumps

- ✓ Copy of Database
- ✓ Time consuming
- ✓ No operations while a dump is being taken

Savepoints

- ✓ Status of the Program is saved.
- ✓ User-defined

Journals

- ✓ The old value of the data, or
- ✓ The new value of the data, or
- ✓ Both the old and new values
- ✓ Other housekeeping data.

Differential Files

- ✓ Changes made to DB are recorded.
- ✓ Only the new values are entered
- ✓ Changes are not made to DB. All changes made to the DB are captured in the differential file.

Database Recovery

- ✓ Performing Recovery
 - ✦ Recovery from Media Failures
 - ▶ Recovery from the Dump.
 - ✦ Recovery from Other Failures
 - ▶ Savepoint
 - ▶ Journal
 - ▶ Differential File

Logging Strategies

- ✓ Logging input transactions
- ✓ Logging beforeimages of the record changed
- ✓ Logging afterimages of the record changed

Logging input transactions

- ✓ Recovery involves reprocessing update transactions from the time of last dump up until the database was damaged.

Logging beforeimages

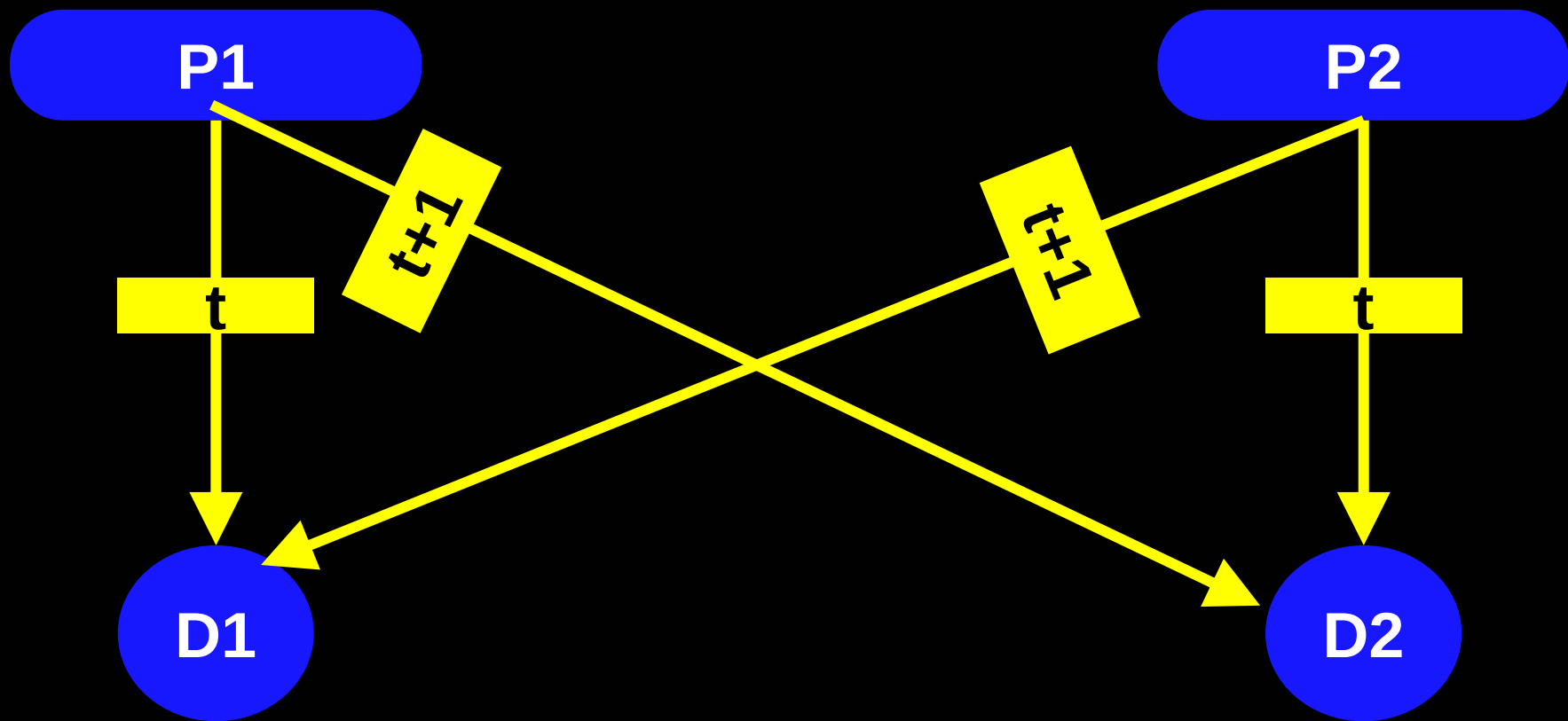
✓ To facilitate rollback

- ✦ Before record is updated its image before the update is logged.
- ✦ If a transaction fails before it commits (fails in flight) the DB can be rolled back to the last commit.
- ✦ Beforeimages are used to replace existing records

Logging afterimages

- ✓ To facilitate rollforward.
 - ✦ All afterimages associated with a transaction are written to the log before the associated updates are applied permanently to the DB.
 - ✦ When failure occurs, rollforward is then undertaken upto the last commit point written to the log.

Deadlock



Conditions for Deadlock-I

✓ Lockout

- ▶ One process can exclude the other

✓ Concurrency

- ▶ Two or more process run concurrently

✓ Additional Request

- ▶ While holding exclusive control of one resource, a process can request for exclusive control of another

Conditions for Deadlock-II

✓ No preemption

- ▶ One process cannot force the other to release a resource prior to finishing with the resource

✓ Circular Wait

- ▶ A circular chain of process exists.

Preventing Deadlocks

- ✓ Transaction Properties
- ✓ 2-Phase Locking protocol

Transaction Properties (ACID) -I

✓ Atomicity

- ▶ Actions are indivisible
- ▶ All or nothing

✓ Consistency

- ▶ Transaction must preserve Consistency
- ▶ Transaction not reflected in DB unless committed
- ▶ Commitment is a two phase process

Transaction Properties (ACID) -II

✓ Isolation

- ▶ No interference between transactions
- ▶ Events within a transaction must be transparent to other transactions even if they are operating concurrently.

✓ Durability

- ▶ After commitment changes to the DB must survive any subsequent failure of the DB

2Phase Locking - I

- ▶ Before a transaction can read an item, it obtains a “read-lock” on the data item. Similarly before a transaction can write, it must obtain a “write-lock”.
- ▶ Different transaction not allowed to have conflicting locks. A read and a write OR a two writes not allowed.
- ▶ When a transaction releases a lock it cannot obtain additional locks. Thus, a transaction must commit changes before releasing all locks.

2Phase Locking - II

- ✓ Growing Phase

- ▶ Transaction acquires locks without releasing locks

- ✓ Shrinking Phase

- ▶ When a transaction releases a lock it irrevocably releases all locks.

- ✓ Locks can be released if:

- ▶ The transaction commits
 - ▶ It is unable to acquire all locks.

Distributed Database

✓ Replicated

- ▶ All instances of the of the data must be locked before update
- ▶ All version of the data must be consistent

✓ Partitioned

- ▶ Location of the data item to be identified and then locked.

Summary

- ✓ DBMS is essentially a collection of interrelated data and a set of programs to access this data
- ✓ The functional concepts of a Database System include File Manager, Database Manager, Query Processor, DML Precompiler, DDL Compiler

Summary

- ✓ The four Database Models are File Management System, Hierarchical Database System, Network Database System & Relational Database System
- ✓ Normalization is a process of organizing data in a database

Summary

- ✓ Database Security ensures that only the right person has the right to access the right data
- ✓ The process of bringing a database from an inconsistent state to a consistent state is known as Recovery



Software Architecture

Chapter 14

Software Architecture

- ✓ This section deals with
 - ✦ Object Oriented Technology
 - ✦ Software Programming
 - ✦ Phases in Software Development Process
 - ✦ Audit & Evaluation Techniques

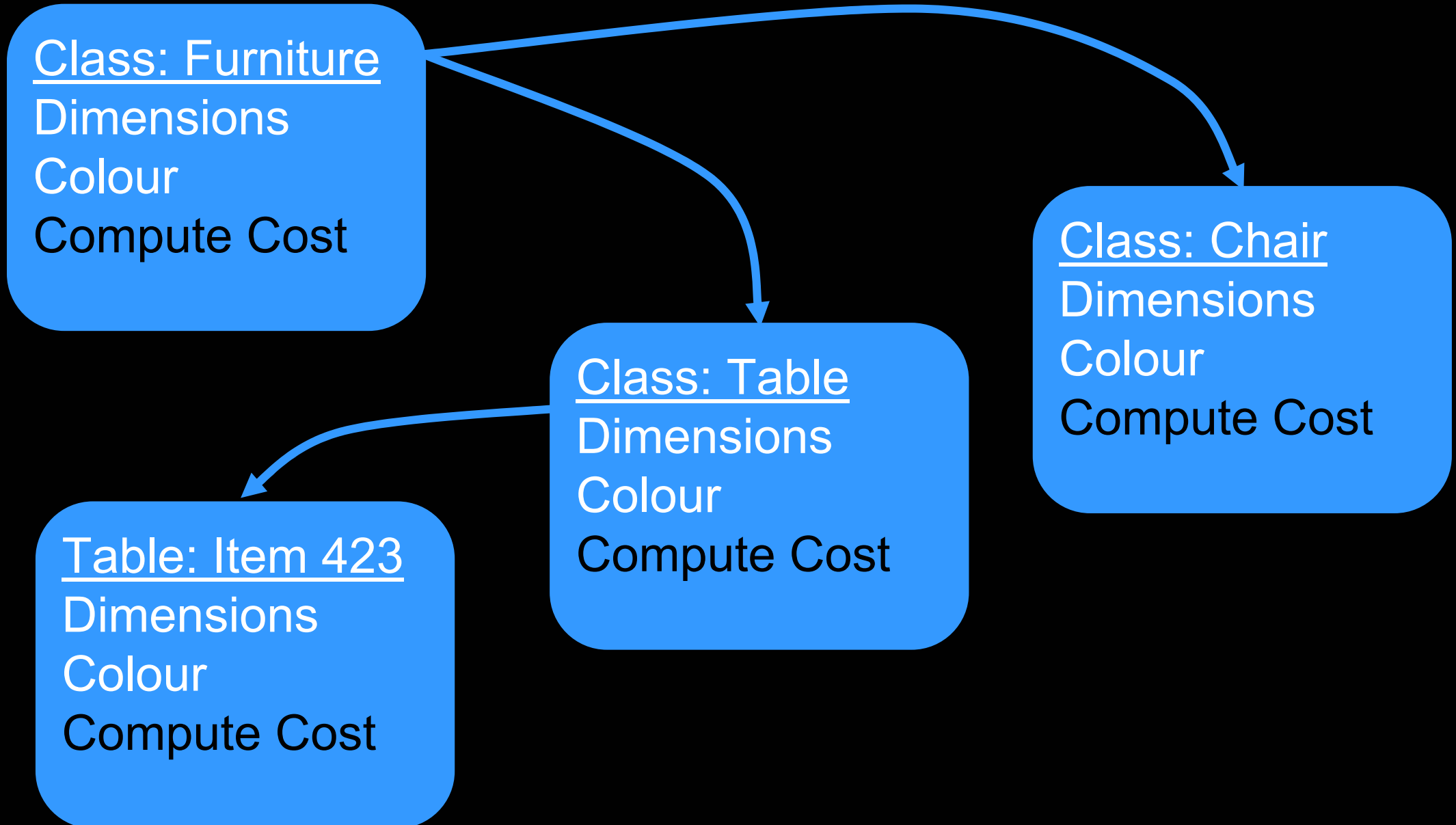
OO Technology: Introduction

- ★ An entity or item can be represented as an object
- ★ An entity or item can be:
 - ▶ Numbers
 - ▶ Persons
 - ▶ Cities
 - ▶ Components
- ★ Applicable in areas ranging from artificial intelligence to office information systems

OO Technology: Terminology

- ✓ Encapsulation
 - ✦ Information hiding
- ✓ Classes
 - ✦ Grouping of similar objects
- ✓ Inheritance
 - ✦ Sharing of properties of a class by all subclasses
- ✓ Messages
 - ✦ Communication by passing messages
- ✓ Polymorphism
 - ✦ Different objects responding differently to the same message

OO Technology: Introduction

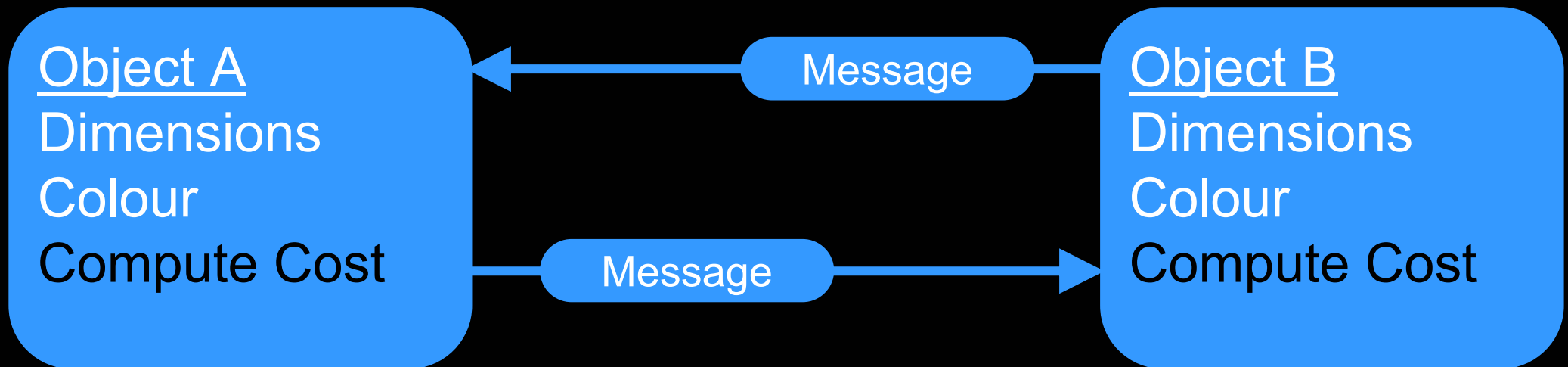


Object-oriented Systems

- ✓ A collection of objects interacting & communicating through message passing
- ✓ Key concepts:
 - ✦ Class
 - ▶ Defines template for creation of objects
 - ▶ Template contains general description shared by objects
 - ▶ Description includes data & operations associated with objects of that class
 - ✦ Object
 - ▶ Consists of data & operations acting upon data
 - ✦ Messages
 - ▶ Means of communication between objects

OO Technology: Introduction

- ✓ Message passing between objects is illustrated in the following diagram



Object-Oriented Programming

- ✓ Decomposing a problem in terms of objects, classes & relationships between them
- ✓ Steps involved in object-oriented programming
 - ✦ Identify objects & classes
 - ✦ Identify operations on objects
 - ✦ Establish interfaces to each object type
 - ✦ Implement operations

Object-Oriented Programming (contd.)

✓ Benefits

- ✦ Easy understanding of design
- ✦ Provides high level specification of the application
- ✦ Provides one consistent model for all activities of product development
- ✦ Promotes reusable software development
- ✦ Promotes easy extension of application system

Software Programming

- ✓ Program Library Management Systems
 - ✦ Provide functional capabilities to facilitate effective & efficient management of the data center software inventory
 - ✦ Library management system capabilities include:
 - ▶ Integrity Capabilities
 - ▶ Update Capabilities
 - ▶ Reporting Capabilities
 - ▶ Interface Capabilities

Software Programming

- ✓ Online programming facilities
 - ✦ Programmers can code & compile programs interactively with computer from a terminal
 - ✦ Includes
 - ▶ Client/Server System
 - ▶ Distributed System

Client/Server System

- ✓ Consists of two different types of computers
 - ✦ Client computers
 - ✦ Server computers
- ✓ Advantages
 - ✦ High performance & scalability
 - ✦ Reduces network traffic & improves network performance
 - ✦ Allows consolidation of data in one place
 - ✦ Allows to save backup copies of data & to restore that data

Distributed System

- ✓ Composed of number of autonomous processors, storage devices, & databases
- ✓ Advantages
 - ✦ Higher performance
 - ✦ Resource sharing
 - ✦ Scalability
 - ✦ Reliability

Utility Programs

✓ Definition

- ✦ Programs required by the system during normal processing operations

✓ Uses

- ✦ Understand application systems
- ✦ Ease testing data quality
- ✦ Test the ability of program to function correctly & maintain data integrity
- ✦ Assist in fast program development
- ✦ Improve operational efficiency

Job Scheduling Software

- ✓ Required to maximize CPU utilization & throughput, to minimize turnaround time & waiting time
- ✓ Allows user to organize, automate & manage recurring jobs
- ✓ Advantages
 - ✦ Job information is setup only once
 - ✦ Maintains records of all jobs
 - ✦ Reporting facility
 - ✦ Recovery facility

Types of Programming Languages

- ✓ First-Generation Languages
 - ✦ Machine code & assembly language
- ✓ Second-Generation Languages
 - ✦ Broad usage, enormous software libraries
 - ✦ Example:
 - ▶ FORTRAN
 - ▶ COBOL
 - ▶ ALGOL

Types of Programming Languages

- ✓ Third-Generation Languages
 - ✦ Strong procedural & data structuring capabilities
 - ✦ Divided into three broad categories
 - ▶ General-purpose high-order languages
 - ▶ Object-oriented languages
 - ▶ Specialized languages

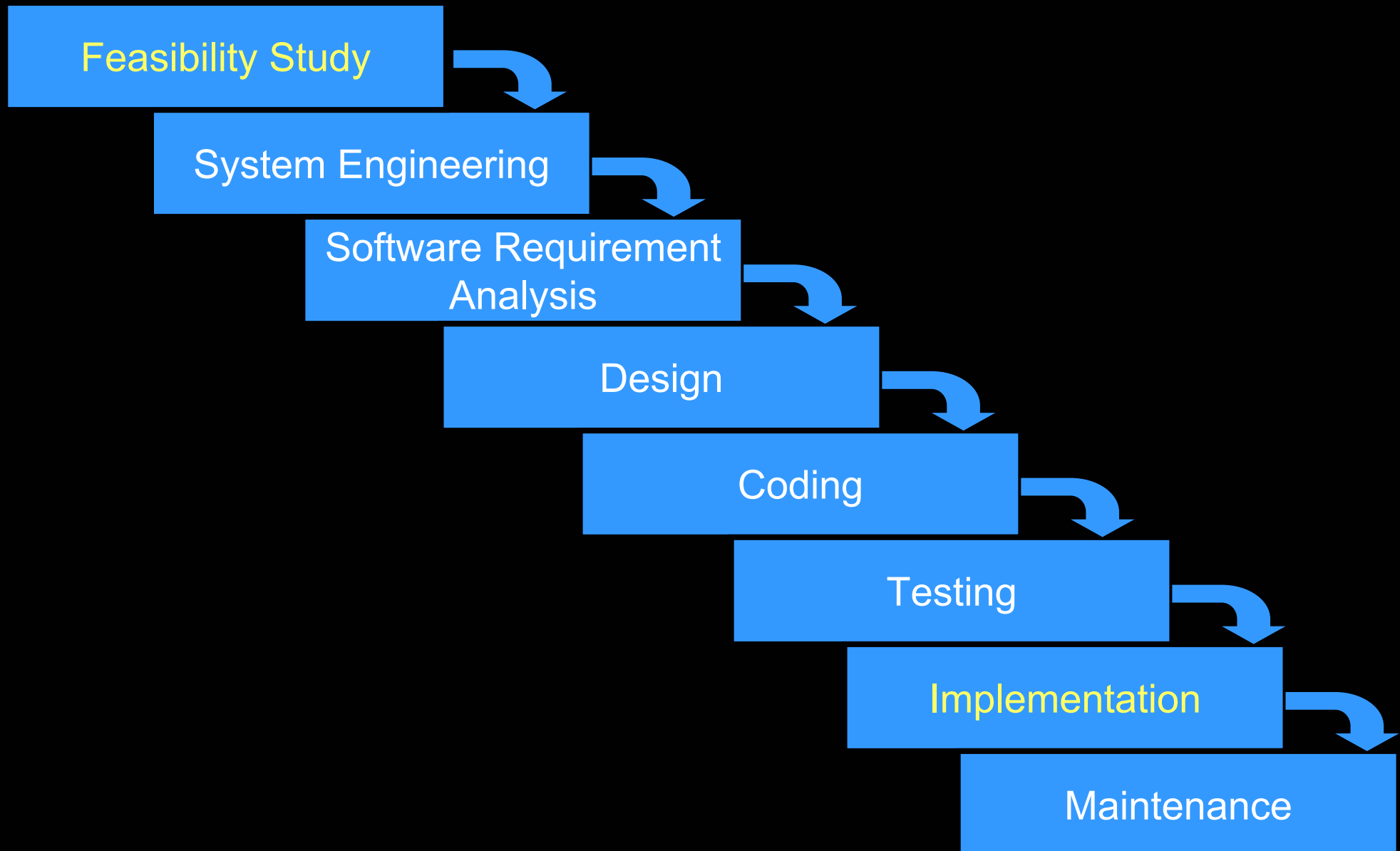
Types of Programming Languages

- ✓ Fourth-Generation Languages
 - ✦ Contain distinct syntax for control & data structure representation
 - ✦ Includes
 - ▶ Query languages
 - ▶ Program Generators

Phases in Software Development Process

- ✓ Activities of software development process
 - ✦ Understanding the problem
 - ✦ Deciding a plan for a solution
 - ✦ Coding the planned solution
 - ✦ Testing the actual program
- ✓ Classical life cycle model
 - ✦ Oldest & widely used paradigm
 - ✦ Demands a systematic, sequential approach

The Classical Life Cycle



The Classical Life Cycle

- ✓ System Engineering & analysis
 - ✦ Encompasses requirements gathering at system level
- ✓ Software Requirement analysis
 - ✦ Requirements for both system & software are documented & reviewed
- ✓ Design
 - ✦ Focuses on data structure, software architecture, procedural detail & interface characterization

The Classical Life Cycle

- ✓ Coding
 - ✦ Translates design into machine-readable form
- ✓ Testing
 - ✦ Focuses on logical internals & functional externals of software
- ✓ Maintenance
 - ✦ Steps to control change

Prototyping

- ✓ Definition

- ✦ Process that enables the developer to create a model of the software that must be built

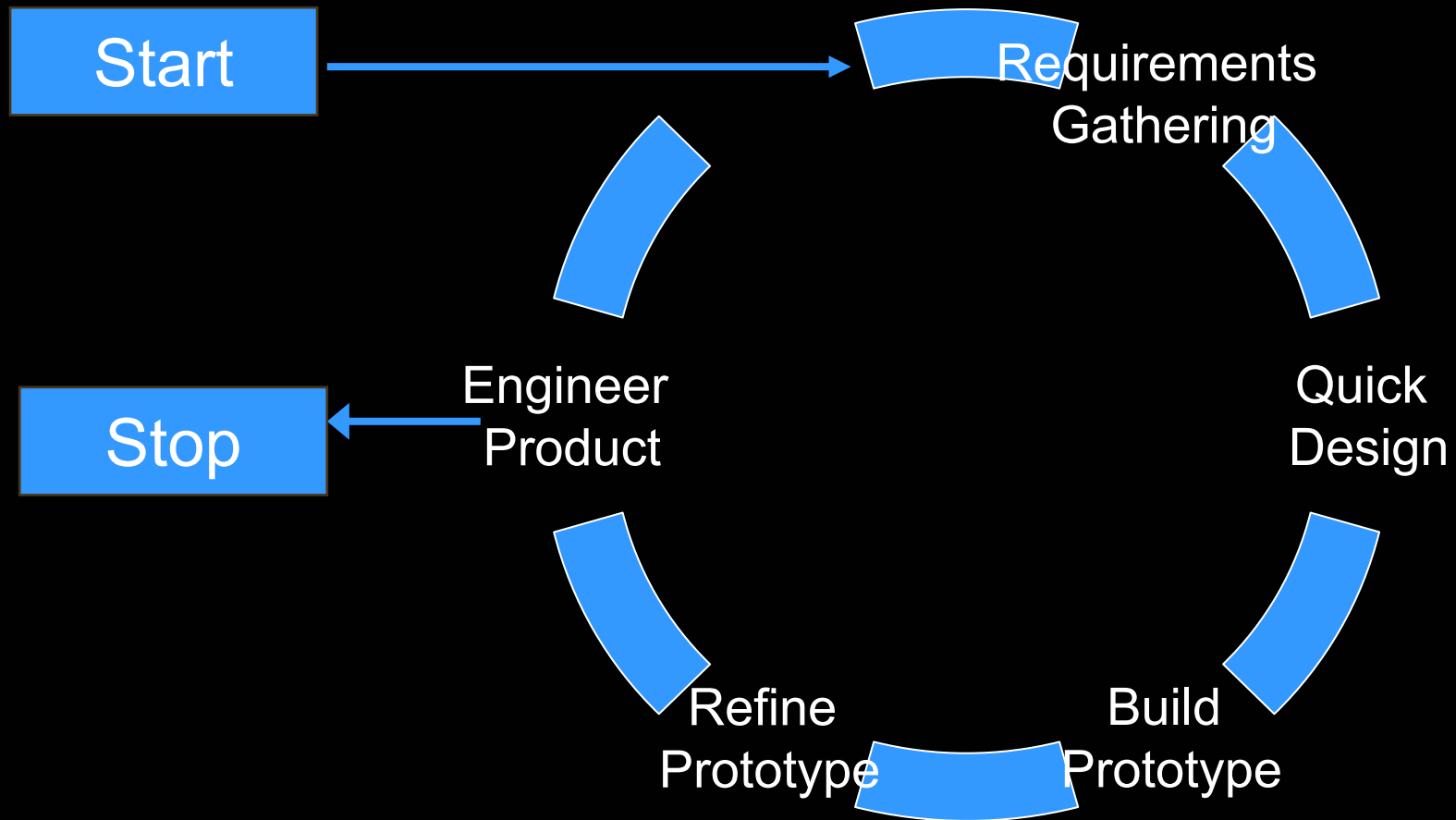
- ✓ Takes any of the three forms:

- ✦ Paper prototype
 - ✦ Working prototype
 - ✦ Existing prototype

Prototyping

- ✓ Sequence of events
 - ✦ Requirements gathering
 - ✦ Quick design
 - ✦ Construction of prototype
 - ✦ Customer Evaluation
 - ✦ Refining prototype
 - ✦ Risk analysis

Prototyping



Requirement Analysis

- ✓ Definition
 - ✦ A software engineering task that lies between system level software allocation & design
- ✓ Consists of five steps:
 - ✦ Problem recognition
 - ✦ Evaluation & synthesis
 - ✦ Modeling
 - ✦ Specification
 - ✦ Review

Requirement Analysis (contd.)

✓ System Analyst

✦ Definition

- ▶ A person who analyzes & designs system of optimum performance

✦ Prerequisites of System analyst

- ▶ Ability to grasp abstract concepts
- ▶ Ability to understand the user environments
- ▶ Ability to apply hardware/software system elements
- ▶ Ability to communicate well

Software Alternative Analysis

- ✓ Criteria for selecting or rejecting Alternatives
- ✓ Software cost
- ✓ Requirements & constraints in order to use the software
- ✓ Capabilities & limitations of the software
- ✓ Alternative approaches that may satisfy the defined requirements
- ✓ Financial stability & technical expertise of software suppliers

Software Implementation

- ✓ Begins after completion of development & testing
- ✓ To be considered in every step of system development
- ✓ Types of implementation
 - ✦ Parallel implementation
 - ★ Old & new systems are processed concurrently
 - ✦ Discrete implementation
 - ★ Old system is terminated as the new system is begun

Change Control Procedures

- ✓ Change Control
 - ✦ One of the tasks of software quality assurance
- ✓ Software Quality Assurance
 - ✦ A planned & systematic pattern of actions that are required to ensure quality in software
 - ✦ Applied during software development & maintenance phase

Change Control Procedures

- ✓ **Software Configuration Management**
 - ✦ Set of activities developed to manage change throughout the software life cycle. They are:
 - ▶ Identify change
 - ▶ Control change
 - ▶ Implement change
 - ▶ Report change
 - ✦ **Baselines**
 - ▶ Software configuration concept that helps to control change.
 - ▶ Point after review, correction and approval.

Audit & Evaluation Techniques

✓ Software Reviews

- ✦ Filter for software engineering process
- ✦ Serve to detect errors that can be removed

✓ Formal Technical Reviews (FTR)

- ✦ Software quality assurance activity performed by software engineering practitioners
- ✦ Objectives
 - ▶ To detect errors in function, logic & implementation
 - ▶ To verify that the software under review meets requirements
 - ▶ To ensure that software has been represented according to predefined standards
 - ▶ To make projects more manageable

Audit & Evaluation Techniques

✓ Review Guidelines

- ✦ Must be established in advance, distributed to all reviewers, agreed upon & then followed for FTR

✓ Review Checklist

- ✦ FTR are performed during each step in software development process

Software Reviews

- ✓ **Software Requirement Analysis**
 - ✦ Focuses on system requirements & consistency
 - ✦ Focuses on correctness of analysis model
- ✓ **Software Design**
 - ✦ Focuses on data design, architectural design, & procedural design
 - ✦ Types of design reviews
 - ▶ Preliminary design review
 - ▶ Design walkthrough

Software Reviews (contd.)

✓ Software Coding

- ✦ Errors can be introduced in software as design is translated into programming language
- ✦ Review can be an effective means for finding translation errors

Software Reviews (contd.)

✓ Software Testing

- ✦ Completeness & effectiveness of testing are improved by reviewing test plans & procedures

✓ Maintenance

- ✦ To determine whether request for change has been documented, evaluated & approved

Summary

- ✓ In an object-oriented representation, a unified entity or item can be represented as an object.
- ✓ Programmers can code & compile programs interactively with the computer from a terminal using online programming facility
- ✓ Programs that are frequently required by the system during normal processing operations are termed as utility programs

Summary

- ✓ Job scheduling software allows user to organize, automate, and manage recurring jobs
- ✓ Different types of programming languages include First, Second, Third & Fourth Generation Languages
- ✓ Prototyping is a process that enables developer to create a model of the software that must be built

Summary

- ✓ Requirement analysis is a software engineering task that lies between system level software allocation & software design
- ✓ Formal technical review is a software quality assurance activity that is performed by software engineering practitioners



Thank You

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