UNIT 2
Project Time Management

syllabus

- **Project time management:**
the importance of project schedules,
 planning schedule management,
- **Project scheduling with resource constraints:**
resource leveling and resource allocation,
- **Project scheduling and planning tools**:
work breakdown structure,
LRC,
Gantt charts,
CPM/PERT Network

The Importance of Project Schedules

- Managers often cite delivering projects on time as one of their biggest challenges

- Time has the least amount of flexibility; it passes no matter what happens on a project

- Individual work styles and cultural differences may also cause schedule conflicts

- Different cultures and even entire countries have different attitudes about schedules

- **Project time management processes**
    - Planning schedule management
    - Defining activities
    - Sequencing activities

    - Estimating activity resources
    - Estimating activity durations
    - Developing the schedule
    - Controlling the schedule

Project Time Management Processes

- **Activity definition**: identifying the specific activities that the project team members and stakeholders must perform to produce the project deliverables

- **Activity sequencing**: identifying and documenting the relationships between project activities

- **Activity resource estimating**: estimating how many **resources** a project team should use to perform project activities

Project Time Management Processes

- **Activity duration estimating**: estimating the number of work periods that are needed to complete individual activities

- **Schedule development**: analyzing activity sequences, activity resource estimates, and activity duration estimates to create the project schedule

- **Schedule control**: controlling and managing changes to the project schedule

Figure : Project Time Management Summary

Planning

Process: **Activity definition**

Outputs: Activity list, activity attributes, milestone list, requested
changes

Process: **Activity sequencing**

Outputs: Project schedule network diagram, requested changes,
updates to the activity list and attributes

Process: **Activity resource estimating**

Outputs: Activity resource requirements, resource breakdown structure
requested changes, and updates to activity attributes
resource calendars

Process: **Activity duration estimating**

Outputs: Activity duration estimates, updates to activity attributes

Process: **Schedule development**

Outputs: Project schedule, schedule model data, schedule baseline,
requested changes, and updates to resource requirements,
activity attributes, the project calendar, project
management plan

Monitoring and Controlling

Process: **Schedule control**

Outputs: Performance measurements, requested changes, recommended
corrective actions, and updates to the schedule model data,
schedule baseline, organizational process assets, activity list
and attributes, the project management plan

Project Start   **Project Finish**

Planning schedule management:

- Determines the policies ,procedures & documentation
- That help in planning , executing,& controlling project schedule.
- The main output of this process is schedule management plan

Defining activities:

•Identifying the specific activities that the project team member & stockholder must perform to produce the project deliverables.

•An activity or task is an element of work normally found on the work break down structure that has expected duration, cost,& resources.

•Output of this: activity list,activity attributes, milestone list & project management plan updates

Sequencing activities:

•Identifying & documenting the relationships between project activities.

•Output includes: project schedule network diagrams & project documents updates

Estimating activity resources :

•Estimate how many resources, people, equipment ,& materials -project team should use to perform project activity.

•Output: activity resource requirements, resource breakdown structure, project document updates.

Estimating activity duration:

•Estimate the number of work periods that needed to complete individual activity

•Output: activity duration estimates & documents updates

Developing the schedule:

•Analyzing activity sequence ,activity resources estimates, &activity duration estimate to create project schedule.

•Output: schedule baseline ,project schedule, schedule data,project calender, project management plan updates, project documents update.

Controlling the schedule:

•Controlling & managing changes to the project schedule.

•Output: work performance information, schedule forecasts, change request ,project management plan updates, documents update, organizational process assets updates.

Planning Schedule Management

- Elements of a schedule management plan
    - Project schedule model development
    - Scheduling methodology
    - Level of accuracy and units of measure
    - Control thresholds
    - Rules of performance measurement
    - Reporting formats
    - Process descriptions

Activity Definition

- Project schedules grow out of the basic documents that initiate a project

- Project charter includes start and end dates and budget information

- Scope statement and WBS help define what will be done

- Activity definition involves developing a more detailed WBS and supporting explanations to understand all the work to be done so you can develop realistic cost and duration estimates

Activity Lists and Attributes

- An **activity list** is a tabulation of activities to be included on a project schedule that includes:
    - The activity name
    - An activity identifier or number
    - A brief description of the activity

- **Activity attributes** provide more information such as predecessors, successors, logical relationships, leads and lags, resource requirements, constraints, imposed dates, and assumptions related to the activity

Milestones

- A **milestone** is a significant event that normally has no duration

- It often takes several activities and a lot of work to complete a milestone

- They're useful tools for setting schedule goals and monitoring progress

- Examples include obtaining customer sign-off on key documents or completion of specific products

Activity Sequencing

- Involves reviewing activities and determining dependencies

- A **dependency** or **relationship** is the sequencing of project activities or tasks

- You *must* determine dependencies in order to use critical path analysis

# Three Types of Dependencies

- **Mandatory dependencies**: inherent in the nature of the work being performed on a project, sometimes referred to as hard logic

- **Discretionary dependencies**: defined by the project team; sometimes referred to as soft logic and should be used with care since they may limit later scheduling options

- **External dependencies**: involve relationships between project and nonproject activities

Network Diagrams

• Network diagrams are the preferred technique for showing activity sequencing

• A **network diagram** is a schematic display of the logical relationships among, or sequencing of, project activities

• Two main formats are the arrow and precedence diagramming methods

Figure : Sample Activity-on-Arrow (AOA) Network Diagram for Project X
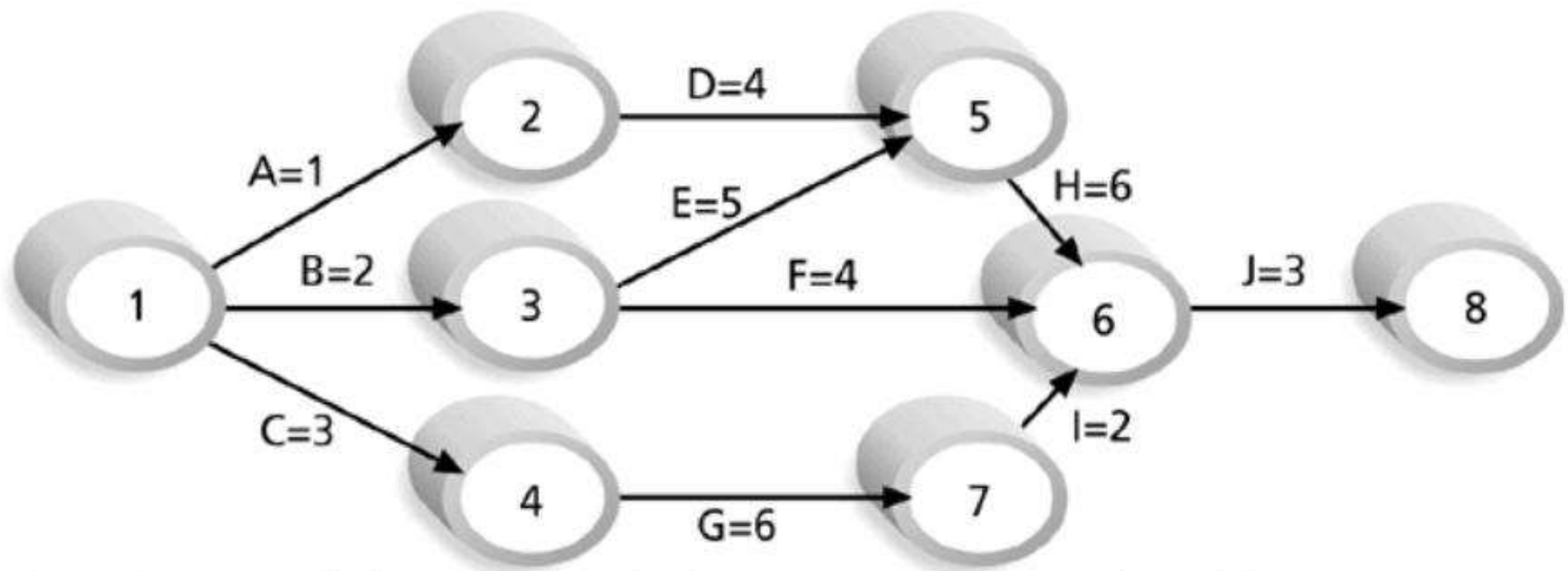
Note: Assume all durations are in days; A=1 means Activity A has a duration of 1 day.

Arrow Diagramming Method (ADM)

- Also called activity-on-arrow (AOA) network diagrams
- Activities are represented by arrows
- Nodes or circles are the starting and ending points of activities
- Can only show finish-to-start dependencies

Process for Creating AOA Diagrams

1. Find all of the activities that start at node 1: Draw their finish nodes and draw arrows between node 1 and those finish nodes; put the activity letter or name and duration estimate on the associated arrow

2. Continue drawing the network diagram, working from left to right: Look for bursts and merges
   - **Bursts** occur when a single node is followed by two or more activities
   - A **merge** occurs when two or more nodes precede a single node

Process for Creating AOA Diagrams

3. Continue drawing the project network diagram until all activities are included on the diagram that have dependencies.

4. As a rule of thumb, all arrowheads should face toward the right, and no arrows should cross on an AOA network diagram

Precedence Diagramming Method (PDM)

- Activities are represented by boxes
- Arrows show relationships between activities
- More popular than ADM method and used by project management software
- Better at showing different types of dependencies

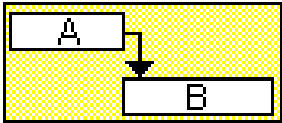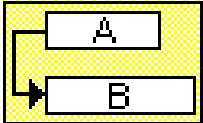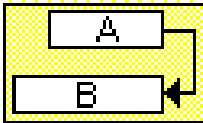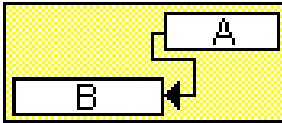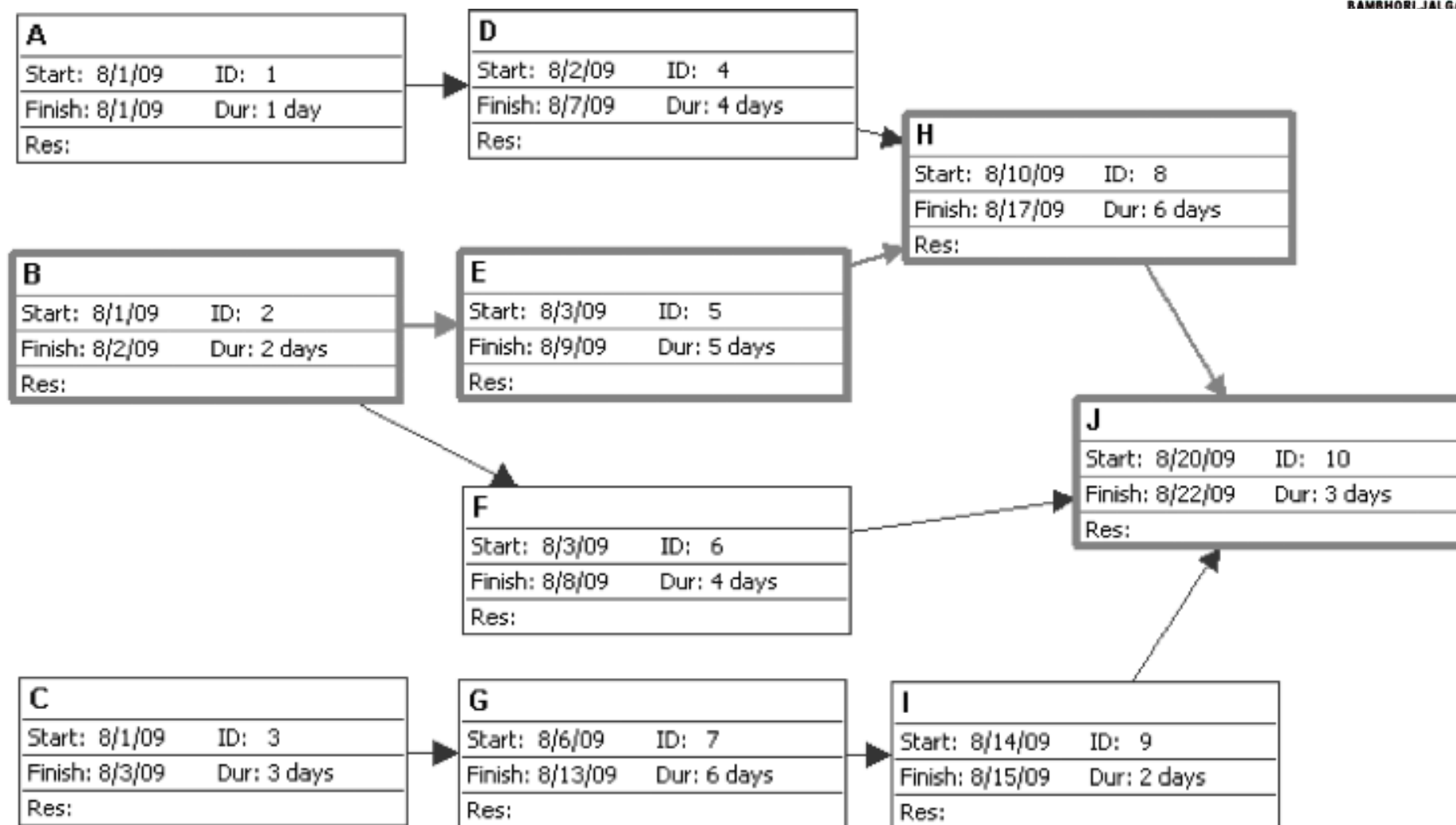# Figure: Sample PDM Network Diagram

Figure : Task Dependency Types

Task dependencies

The nature of the dependencies between linked tasks. You link tasks by defining a dependency between their finish and start dates. For example, the "Contact caterers" task must finish before the start of the "Determine menus" task. There are four kinds of task dependencies in Microsoft Project:

Task dependency	Example	Description
Finish-to-start (FS)		Task (B) cannot start until task (A) finishes.
Start-to-start (SS)		Task (B) cannot start until task (A) starts.
Finish-to-finish (FF)		Task (B) cannot finish until task (A) finishes.
Start-to-finish (SF)		Task (B) cannot finish until task (A) starts.

Activity Resource Estimating

- Before estimating activity durations, you must have a good idea of the quantity and type of resources that will be assigned to each activity

- Consider important issues in estimating resources
    - How difficult will it be to do specific activities on this project?
    - What is the organization's history in doing similar activities?
    - Are the required resources available?

- A **resource breakdown structure** is a hierarchical structure that identifies the project's resources by category and type

Activity Duration Estimating

- **Duration** includes the actual amount of time worked on an activity *plus* elapsed time
- **Effort** is the number of workdays or work hours required to complete a task
- Effort does not normally equal duration
- People doing the work should help create estimates, and an expert should review them

Three-Point Estimates

- Instead of providing activity estimates as a discrete number, such as four weeks, it's often helpful to create a **three-point estimate**

  - An estimate that includes an optimistic, most likely, and pessimistic estimate, such as three weeks for the optimistic, four weeks for the most likely, and five weeks for the pessimistic estimate

- Three-point estimates are needed for PERT and Monte Carlo simulations

Schedule Development

- Uses results of the other time management processes to determine the start and end date of the project

- Ultimate goal is to create a realistic project schedule that provides a basis for monitoring project progress for the time dimension of the project

- Important tools and techniques include Gantt charts, critical path analysis, critical chain scheduling, and PERT analysis

Scheduling & Planning Tools

- Work Break Down Structure

- LRC

- Gantt Charts

- CPM/PERT network

work breakdown structure

• In project management and systems engineering, is a deliverable oriented decomposition of a project into smaller components.

• A work breakdown structure element may be a product, data, a service, or any combination.

• A WBS also provides the necessary framework for detailed cost estimating and control along with providing guidance for schedule development and control

Example of outlined WBS.

Project Name			
	Task 1		
		Subtask 1.1	
			Work Package 1.1.1
			Work Package 1.1.2
		Subtask 1.2	
			Workpackage 1.2.1
			Workpackage 1.2.2
	Task 2		
		Subtask 2.1	
			Workpackage 2.1.1
			Workpackage 2.1.2

3. Creating the Work Breakdown Structure (WBS)

- A WBS is a deliverable-oriented grouping of the work involved in a project that defines the total scope of the project

- WBS is a foundation document that provides the basis for planning and managing project schedules, costs, resources, and changes

- Decomposition is subdividing project deliverables into smaller pieces

- A work package is a task at the lowest level of the WBS
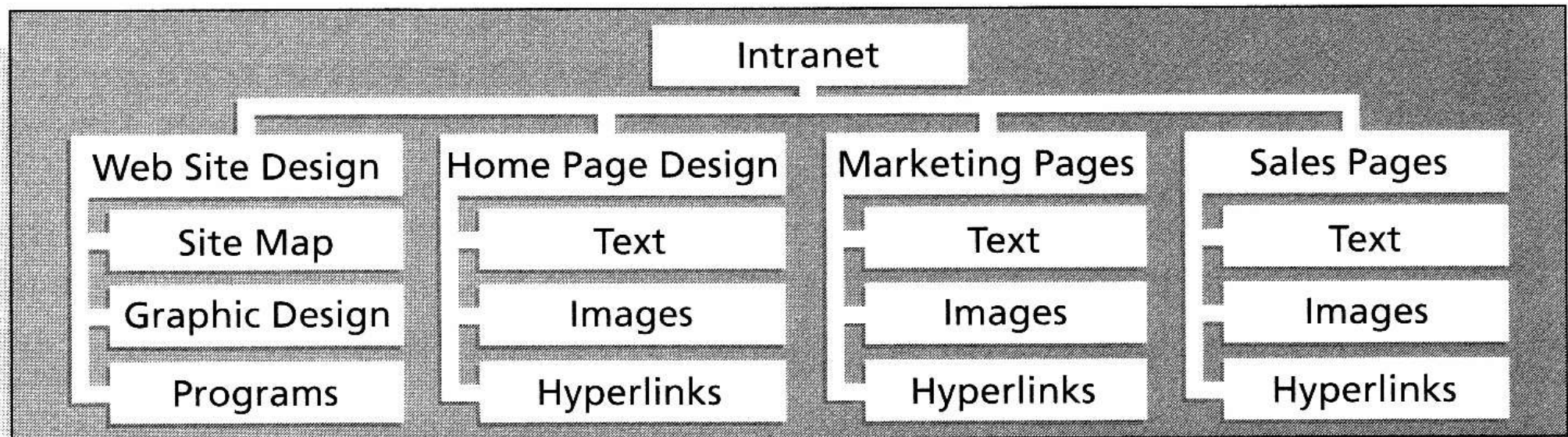
WBS Organized by Product

Figure 4-6a. Sample Intranet WBS Organized by Product
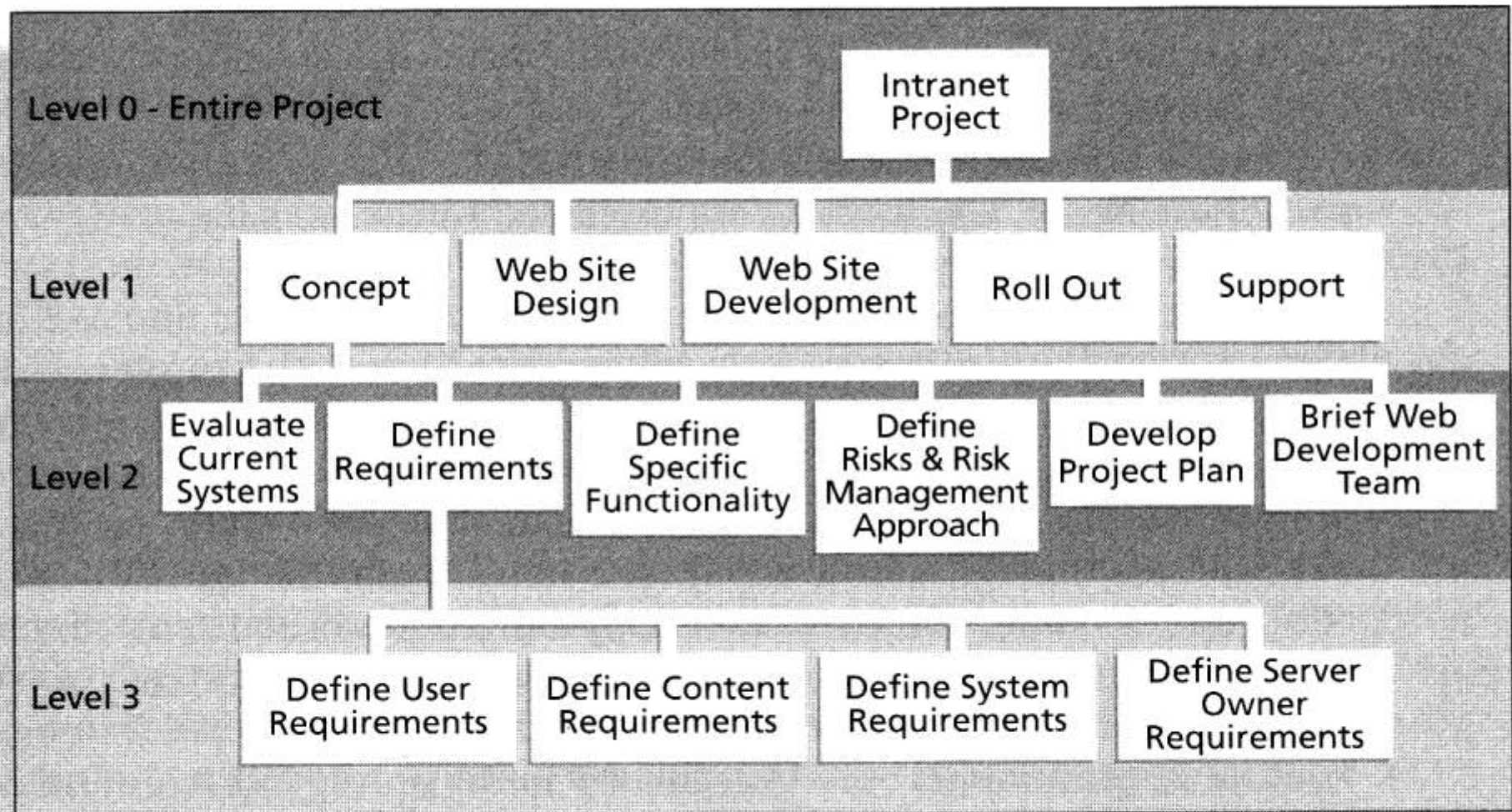
WBS Organized by Phase

Figure 4-6b. Sample Intranet WBS Organized by Phase

WBS in Tabular Form

Table 4-3: Intranet WBS in Tabular Form

1.0 Concept

    1.1 Evaluate current systems

    1.2 Define Requirements

        1.2.1 Define user requirements

        1.2.2 Define content requirements

        1.2.3 Define system requirements

        1.2.4 Define server owner requirements

    1.3 Define specific functionality

    1.4 Define risks and risk management approach

    1.5 Develop project plan

    1.6 Brief Web development team

2.0 Web Site Design

3.0 Web Site Development

4.0 Roll Out

5.0 Support

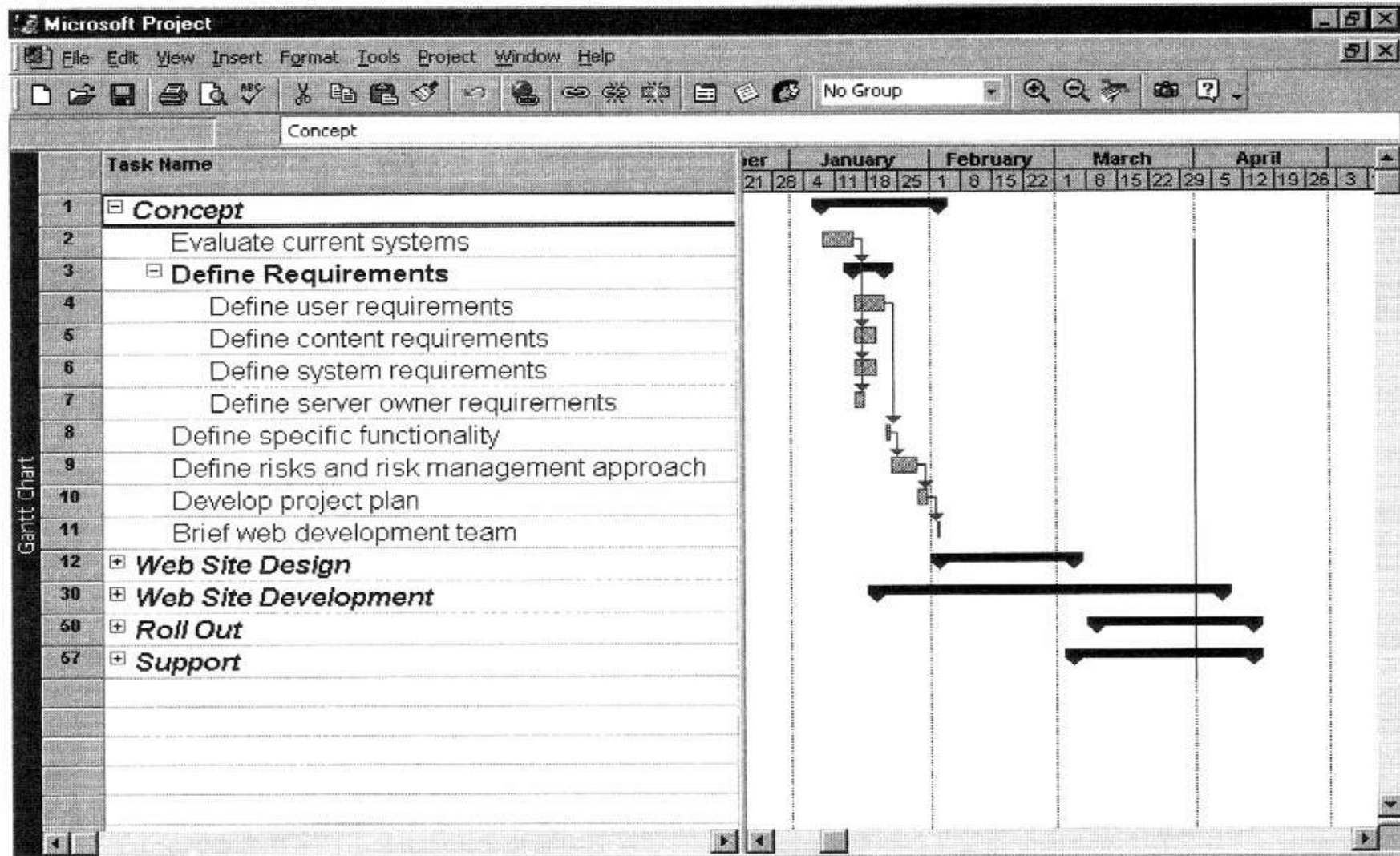# WBS and Gantt Chart in MSProject

Figure 4-7. Intranet WBS and Gantt Chart in Microsoft Project

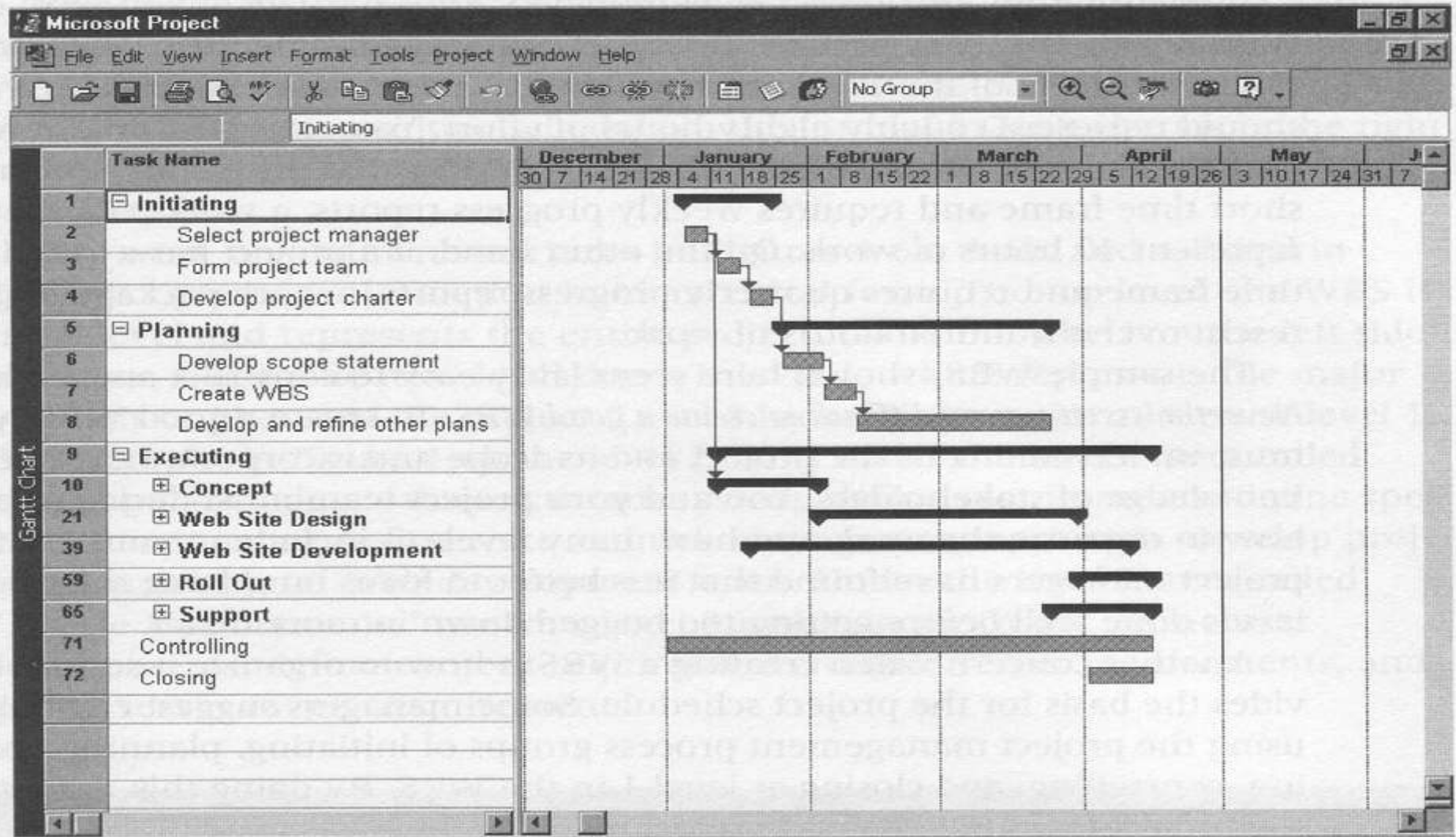# Scope Definition - WBS and Gantt Chart Organized by Process Groups

Figure 4-8. Intranet WBS and Gantt Chart Organized by Project Management Process Groups

Approaches to Developing WBSs

1. **Using guidelines**: some organizations, like the DOD, provide guidelines for preparing WBSs
2. **The analogy approach**: review WBSs of similar projects and tailor to your project
3. **The top-down approach**: start with the largest items of the project and break them down
4. **The bottom-up approach**: start with the specific tasks and roll them up
5. **Mind-mapping approach**: mind mapping is a technique that uses branches radiating out from a core idea to structure thoughts and ideas

Sample Mind-Mapping Approach for Creating a WBS

Project 2007 File with WBS Generated from a Mind Map
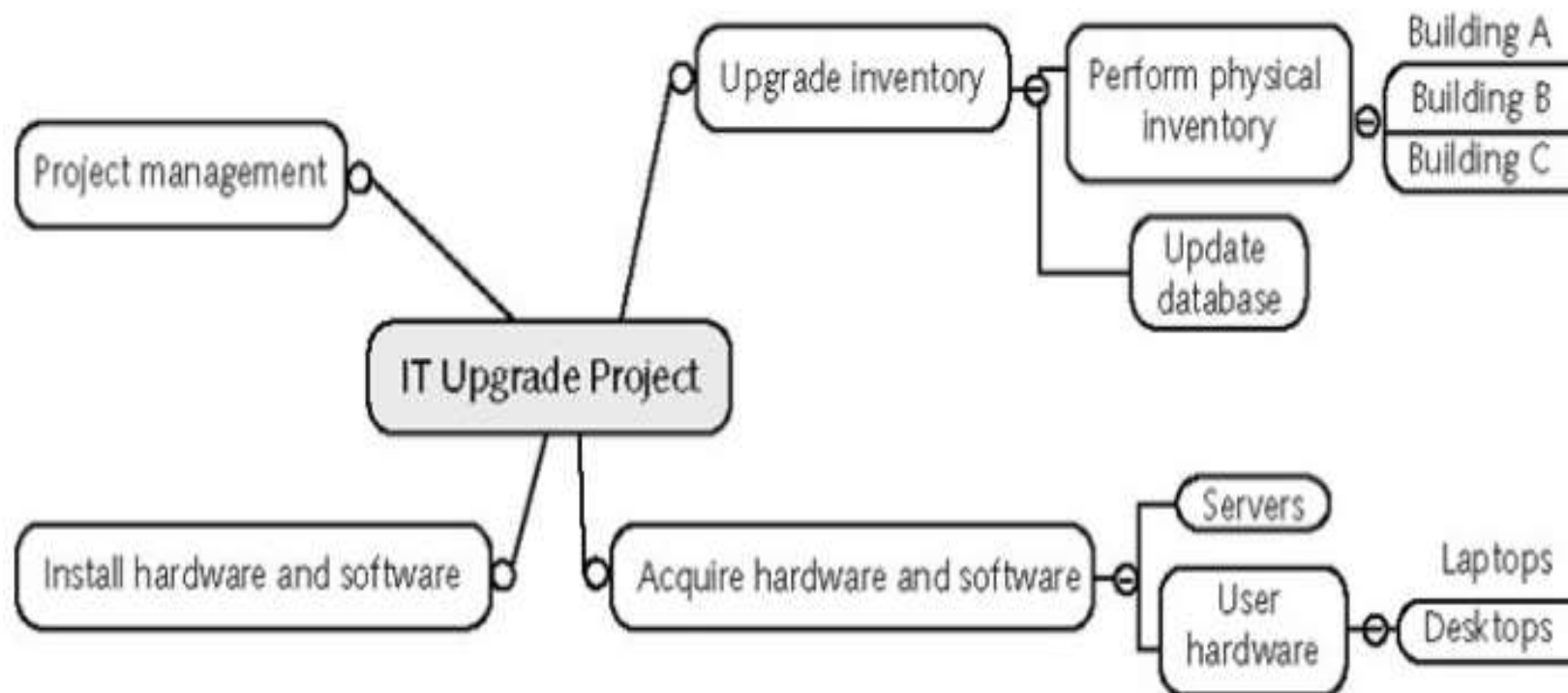
The WBS Dictionary and Scope Baseline

- Many WBS tasks are vague and must be explained more so people know what to do and can estimate how long it will take and what it will cost to do the work

- A WBS dictionary is a document that describes detailed information about each WBS item

- The approved project scope statement and its WBS and WBS dictionary form the scope baseline, which is used to measure performance in meeting project scope goals

WBS Dictionary Entry March 20

Project Title: Information Technology (IT) Upgrade Project

WBS Item Number: 2.2

WBS Item Name: Update Database

Description: The IT department maintains an online database of hardware and software on the corporate Intranet. However, we need to make sure that we know exactly what hardware and software employees are currently using and if they have any unique needs before we decide what to order for the upgrade. This task will involve reviewing information from the current database, producing reports that list each department's employees and location, and updating the data after performing the physical inventory and receiving inputs from department managers. Our project sponsor will send out a notice to all department managers to communicate the importance of this project and this particular task. In addition to general hardware and software upgrades, the project sponsors will ask the department managers to provide information for any unique requirements they might have that could affect the upgrades. This task also includes updating the inventory data for network hardware and software. After updating the inventory database, we will send an e-mail to each department manager to verify the information and make changes online, as needed. Department managers will be responsible for ensuring that their people are available and cooperative during the physical inventory. Completing this task is dependent on WBS Item Number 2.1, Perform Physical Inventory and must precede WBS Item Number 3.0, Acquire Hardware and Software.

Advice for Creating a WBS and WBS Dictionary

- A unit of work should appear at only one place in the WBS

- The work content of a WBS item is the sum of the WBS items below it

- A WBS item is the responsibility of only one individual, even though many people may be working on it

- The WBS must be consistent with the way in which work is actually going to be performed; it should serve the project team first and other purposes only if practical

Advice for Creating a WBS and WBS Dictionary (continued)

- Project team members should be involved in developing the WBS to ensure consistency and buy-in

- Each WBS item must be documented in a WBS dictionary to ensure accurate understanding of the scope of work included and not included in that item

- The WBS must be a flexible tool to accommodate inevitable changes while properly maintaining control of the work content in the project according to the scope statement

Advice for Creating a WBS

• A unit of work should appear at only one place in the WBS.

• The work content of a WBS item is the sum of the WBS items below it.

• A WBS item is the responsibility of only one individual, even though many people may be working on it.

• The WBS must be consistent with the way in which work is actually performed, serve the project team first and other purposes if practical.

Advice for Creating a WBS

- Project team members should be involved in developing the WBS to ensure consistency and buy-in.

- Each WBS item must be documented to ensure accurate understanding of the scope of work included and not included in that item.

- The WBS must be flexible tool to accommodate inevitable changes while properly maintaining control of the work content in the project.

PURPOSE OF WBS

It is to structure an assigned project into various activities in order that:

- Detailed planning can be performed
- Costs and budgets can be established
- Objectives can be linked to available resources in a logical manner
- Specific authority and responsibility can be assigned

WORK BREAKDOWN STRUCTURE

- Can be developed using a top-down or bottom-up approach

- Can be hardware-related, function-related, or a combination

- Depth of WBS must balance out management effort against planning accuracy (influences technical and cost control)

- For accuracy purposes the WBS should be taken down several levels

- The WBS must be structured for objective control & evaluation

Linear Responsibility chart

- The design team has to decide who will take responsibility for each task. This is achieve by building **linear responsibility chart(LRC).**

- LRC is very important documen**t translating "What" of the WBS into** "Who" of responsibility.

- In LRC the **rows show**: the **task & subtasks.**

- And the **column shows**: **Team members name.**

- **Rows of each participant for particular task is shown in the intersection**

- Team leader need not always have the primary responsibility of every task.

- LRC can be used to let stackholders in a project understand what they are expected to do.

Linear Responsibility Chart (LRC)

- Structure
  - Row for each task
  - Column for each participant
- Indicates type of responsibility (primary, consulting, reviewing, etc.) for each task
  - Who is responsible
  - Who is involved

Simplified Linear Responsibility Chart

	Vice-president	General manager	Project manager	Manager engineering	Manager software	Manager manufacturing	Manager marketing	Subprogram manager manufacturing	Subprogram manager software	Subprogram manager hardware	Subprogram manager services
Establish project plan	6	2	1	3	3	3	3	4	4	4	4
Define WBS		5	1	3	3	3	3	3	3	3	3
Establish hardware specs		2	3	1	4	4	4				
Establish software specs		2	3	4	1		4				
Establish interface specs		2	3	1	4	4	4				
Establish manufacturing specs		2	3	4	4	1	4				
Define documentation		2	1	4	4	4	4				
Establish market plan	5	3	5	4	4	4	1				
Prepare labor estimate			3	1	1	1		4	4	4	4
Prepare equipment cost estimate		3	1	1	1			4	4	4	4
Prepare material costs			3	1	1	1		4	4	4	4
Make program assignments			3	1	1	1		4	4	4	4
Establish time schedules		5	3	1	1	1	3	4	4	4	4

1 Actual responsibility
2 General supervision
3 Must be consulted
4 May be consulted
5 Must be notified
6 Final approval

Gantt Charts

- **Gantt charts** provide a standard format for displaying project schedule information by listing project activities and their corresponding start and finish dates in a calendar format
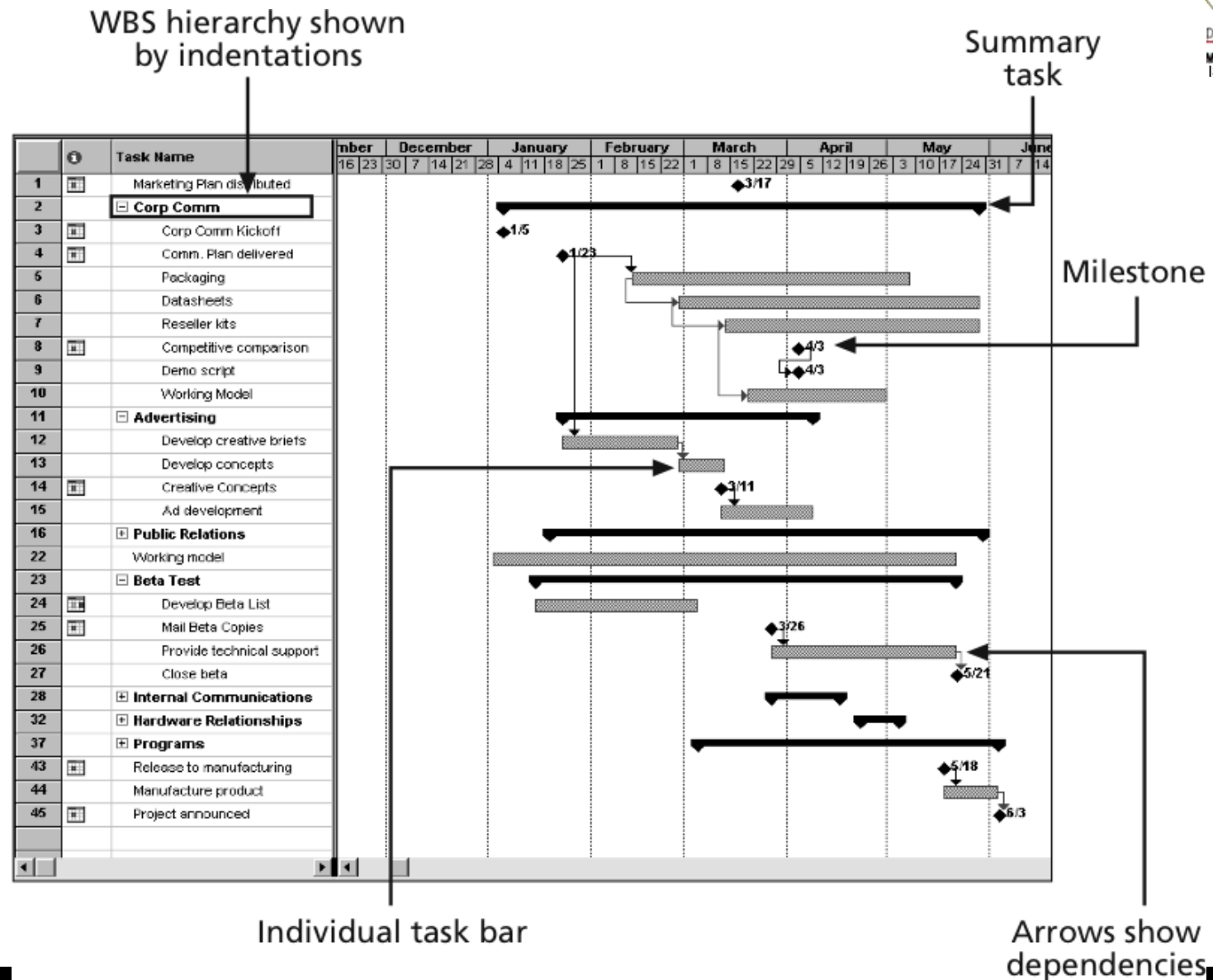
- Symbols include:
    - Black diamonds: milestones
    - Thick black bars: summary tasks
    - Lighter horizontal bars: durations of tasks
    - Arrows: dependencies between tasks

Figure: Gantt Chart for Project X
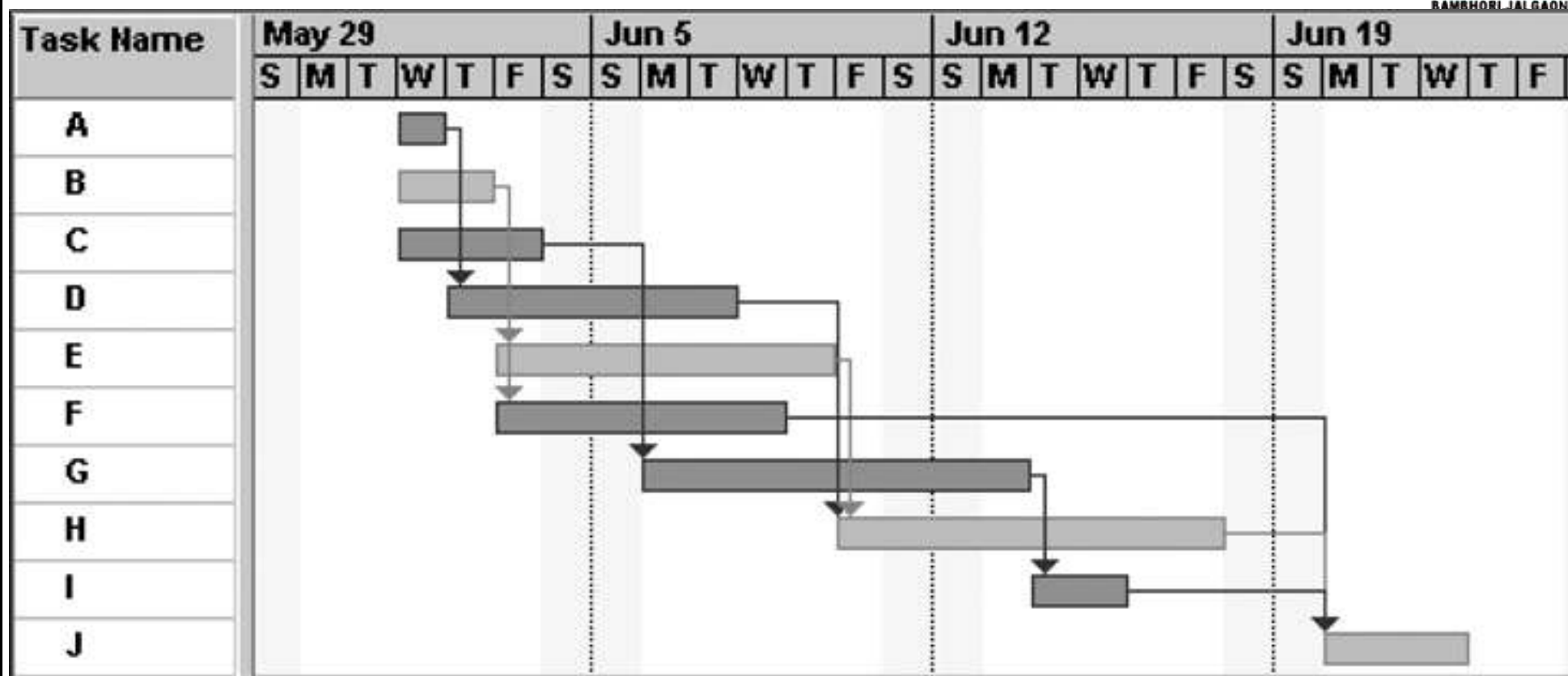
Note: Darker bars would be red in Project 2007 to represent critical tasks

Figure: Gantt Chart for Software Launch Project

Figure: Gantt Chart for Software Launch Project

Adding Milestones to Gantt Charts

- Many people like to focus on meeting milestones, especially for large projects

- Milestones emphasize important events or accomplishments on projects

- Normally create milestone by entering tasks with a zero duration, or you can mark any task as a milestone

SMART Criteria

- Milestones should be:
  - **S**pecific
  - **M**easurable
  - **A**ssignable
  - **R**ealistic
  - **T**ime-framed

Figure : Sample Tracking Gantt Chart
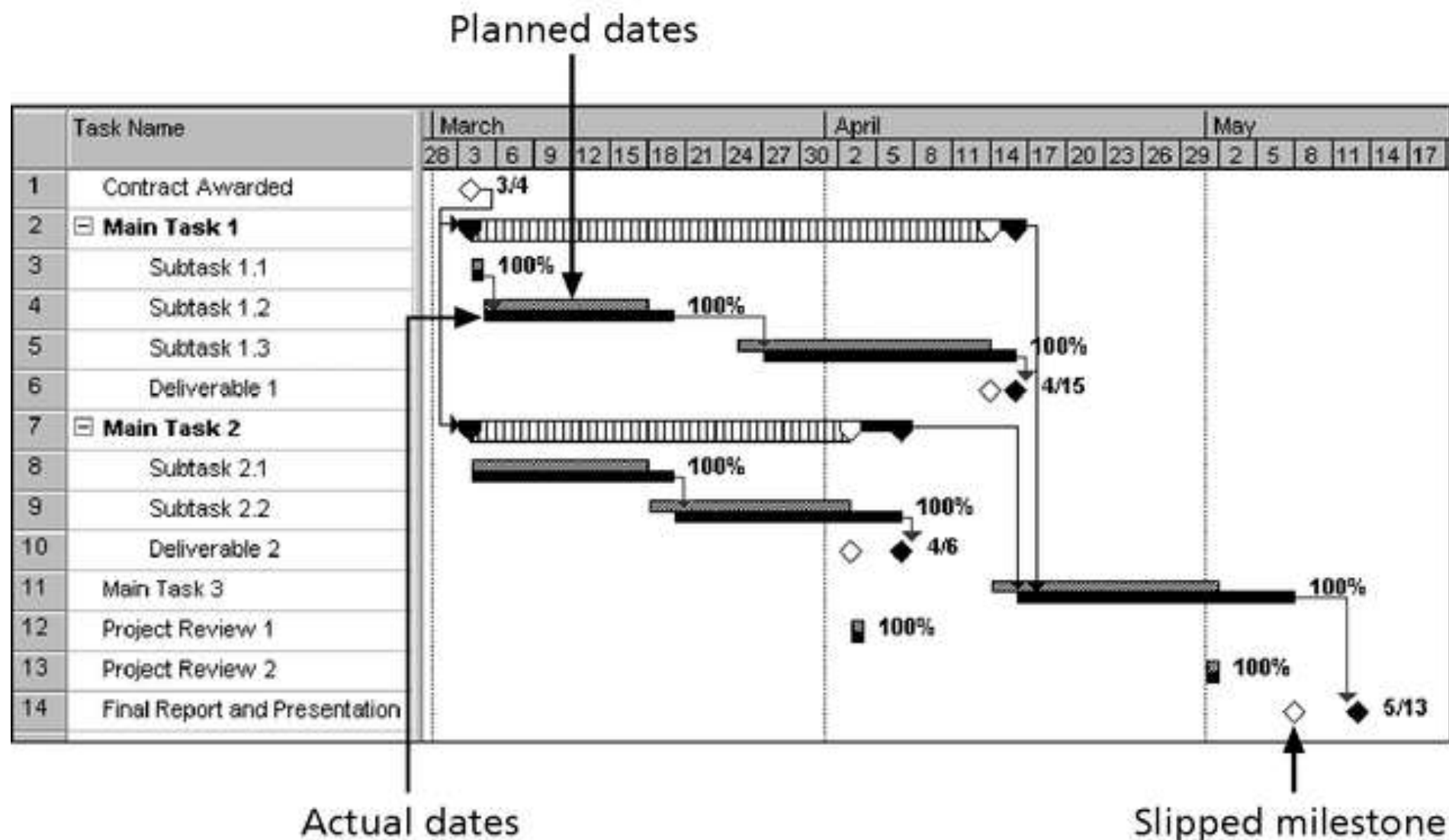
Critical Path Method (CPM)

- **CPM** is a network diagramming technique used to predict total project duration

- A **critical path** for a project is the series of activities that determines the *earliest time* by which the project can be completed

- The critical path is the *longest path* through the network diagram and has the least amount of slack or float

- **Slack** or **float** is the amount of time an activity may be delayed without delaying a succeeding activity or the project finish date

Calculating the Critical Path

- First develop a good network diagram

- Add the duration estimates for all activities on each path through the network diagram

- The longest path is the critical path

- If one or more of the activities on the critical path takes longer than planned, the whole project schedule will slip *unless* the project manager takes corrective action

Figure : Determining the Critical Path for Project X
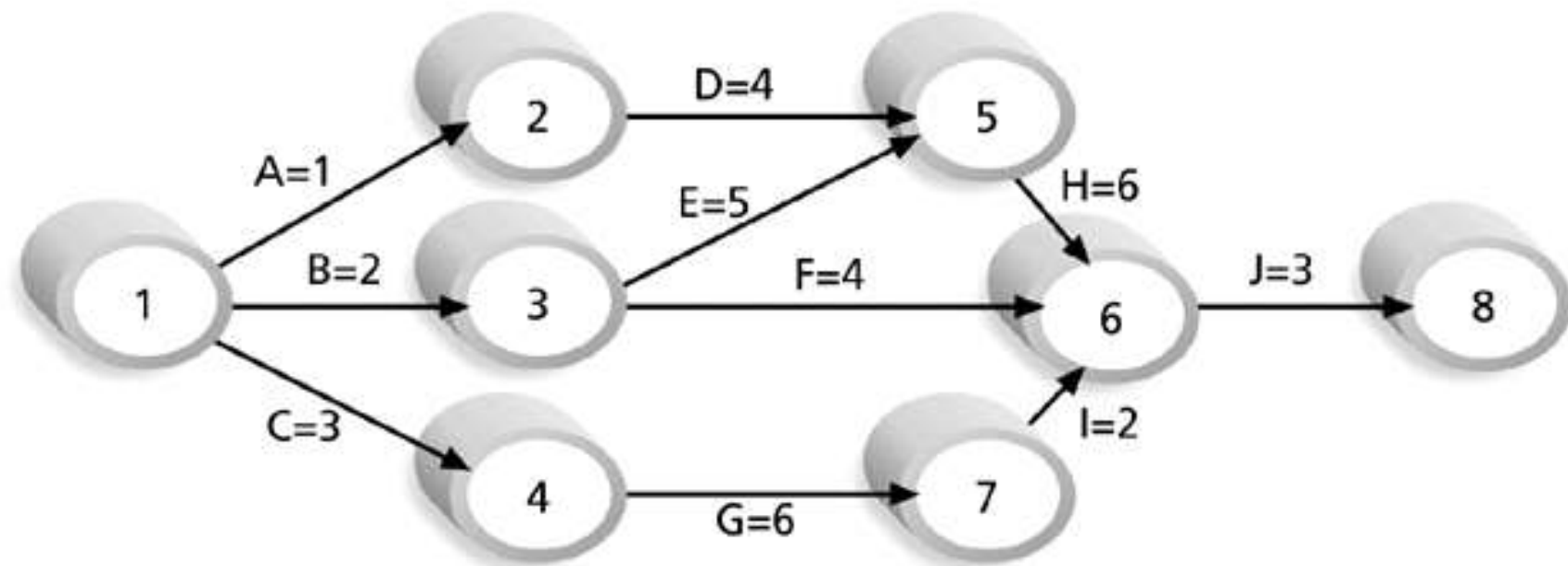
Note: Assume all durations are in days.

Path 1:	A-D-H-J	Length = 1+4+6+3 = 14 days
Path 2:	B-E-H-J	Length = 2+5+6+3 = 16 days
Path 3:	B-F-J	Length = 2+4+3 = 9 days
Path 4:	C-G-I-J	Length = 3+6+2+3 = 14 days

Since the critical path is the longest path through the network diagram, Path 2, B-E-H-J, is the critical path for Project X.

More on the Critical Path

- A project team at Apple computer put a stuffed gorilla on the top of the cubicle of the person currently managing a critical task

- The critical path is *not* the one with all the critical activities; it only accounts for time

- Remember the example of **growing grass** being on the critical path for Disney's Animal Kingdom

- There can be more than one critical path if the lengths of two or more paths are the same

- The critical path can change as the project progresses

Using Critical Path Analysis to Make Schedule Trade-offs

•**Free slack** or **free float** is the amount of time an activity can be delayed without delaying the early start of any immediately following activities

•**Total slack** or **total float** is the amount of time an activity may be delayed from its early start without delaying the planned project finish date

•A **forward pass** through the network diagram determines the early start and finish dates

•A **backward pass** determines the late start and finish dates

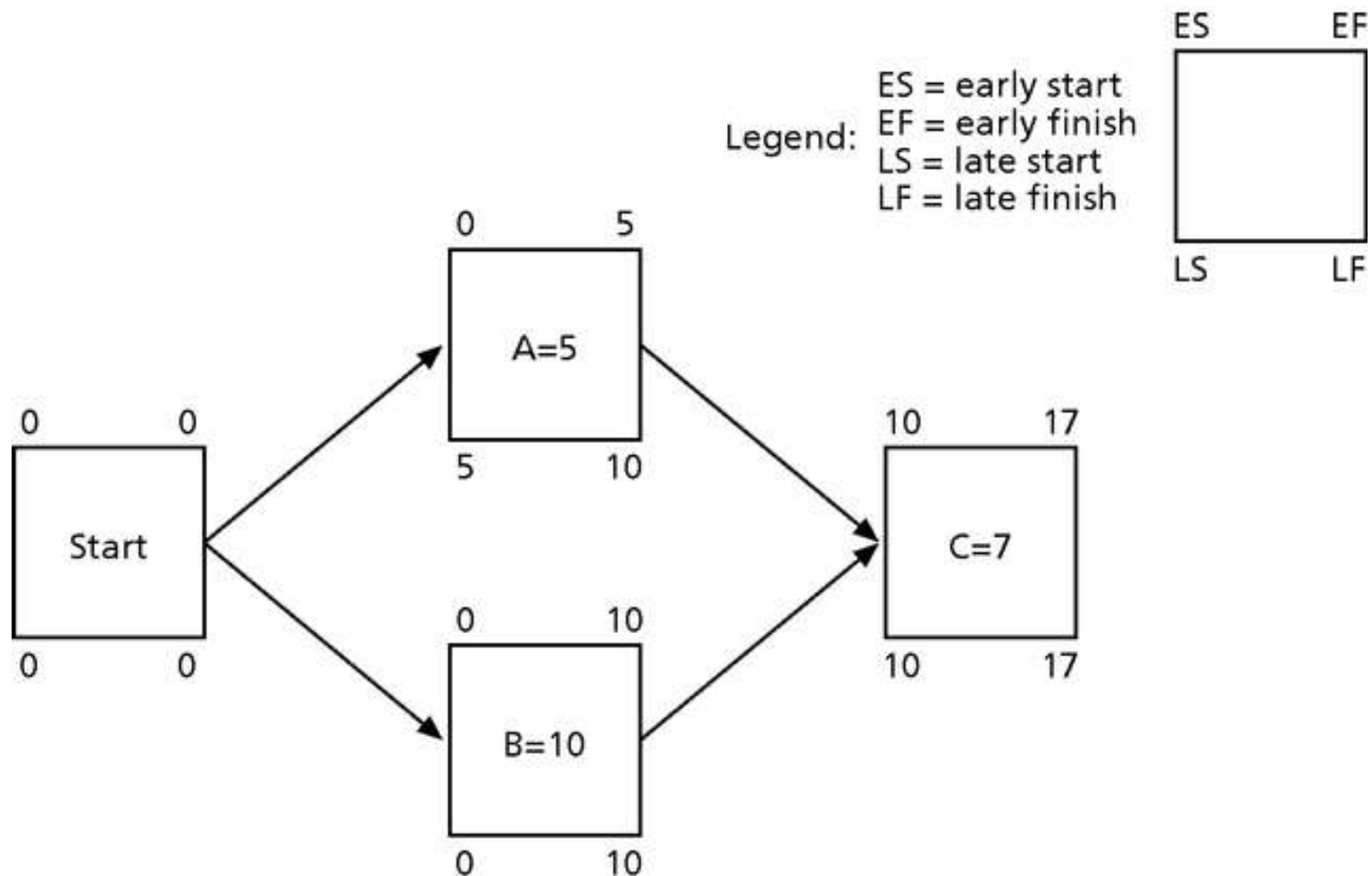# Figure : Calculating Early and Late Start and Finish Dates

Legend:
ES = early start
EF = early finish
LS = late start
LF = late finish

Table: Free and Total Float or Slack for Project X

Task Name	Start	Finish	Late Start	Late Finish	Free Slack	Total Slack
A	8/1/09	8/1/09	8/3/09	8/3/09	0d	2d
B	8/1/09	8/2/09	8/1/09	8/2/09	0d	0d
C	8/1/09	8/3/09	8/3/09	8/7/09	0d	2d
D	8/2/09	8/7/09	8/8/09	8/9/09	2d	2d
E	8/3/09	8/9/09	8/3/09	8/9/09	0d	0d
F	8/3/09	8/8/09	8/14/09	8/17/09	7d	7d
G	8/8/09	8/13/09	8/8/09	8/15/09	0d	2d
H	8/10/09	8/17/09	8/10/09	8/17/09	0d	0d
I	8/14/09	8/15/09	8/18/09	8/17/09	2d	2d
J	8/20/09	8/22/09	8/20/09	8/22/09	0d	0d

Using the Critical Path to Shorten a Project Schedule

- Three main techniques for shortening schedules
  - Shortening durations of critical activities/tasks by adding more resources or changing their scope

  - **Crashing** activities by obtaining the greatest amount of schedule compression for the least incremental cost

  - **Fast tracking** activities by doing them in parallel or overlapping them

Importance of Updating Critical Path Data

- It is important to update project schedule information to meet time goals for a project

- The critical path may change as you enter actual start and finish dates

- If you know the project completion date will slip, negotiate with the project sponsor

Program Evaluation and Review Technique (PERT)

- **PERT** is a network analysis technique used to estimate project duration when there is a high degree of uncertainty about the individual activity duration estimates

- PERT uses **probabilistic time estimates**

Duration estimates based on using optimistic, most likely, and pessimistic estimates of activity durations, or a three-point estimate

PERT Formula and Example

- PERT weighted average **=**

optimistic time + 4X most likely time + pessimistic time

$$6$$

- Example:

PERT weighted average =

8 workdays + 4 X 10 workdays + 24 workdays   = **12 days**

$$6$$

where optimistic time= 8 days,
most likely time = **10 days**, and
pessimistic time = 24 days

   Therefore, you'd use **12 days** on the network diagram instead of 10 when using PERT for the above example

Schedule Control

- Perform reality checks on schedules
- Allow for contingencies
- Don't plan for everyone to work at 100% capacity all the time
- Hold progress meetings with stakeholders and be clear and honest in communicating schedule issues

Schedule Control (continued)

- Goals are to know the status of the schedule, influence factors that cause schedule changes, determine that the schedule has changed, and manage changes when they occur

- Tools and techniques include:
  - Progress reports
  - A schedule change control system
  - Project management software, including schedule comparison charts like the tracking Gantt chart
  - Variance analysis, such as analyzing float or slack
  - Performance management, such as earned value

Reality Checks on Scheduling

- First review the draft schedule or estimated completion date in the project charter

- Prepare a more detailed schedule with the project team

- Make sure the schedule is realistic and followed

- Alert top management well in advance if there are schedule problems