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Chapter 6:
Project Time Management

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Learning Objectives

- Understand the importance of project schedules and good project time management
- Define activities as the basis for developing project schedules
- Describe how project managers use network diagrams and dependencies to assist in activity sequencing
- Explain how various tools and techniques help project managers perform activity duration estimating and schedule development
- Use a Gantt chart for schedule planning and tracking schedule information

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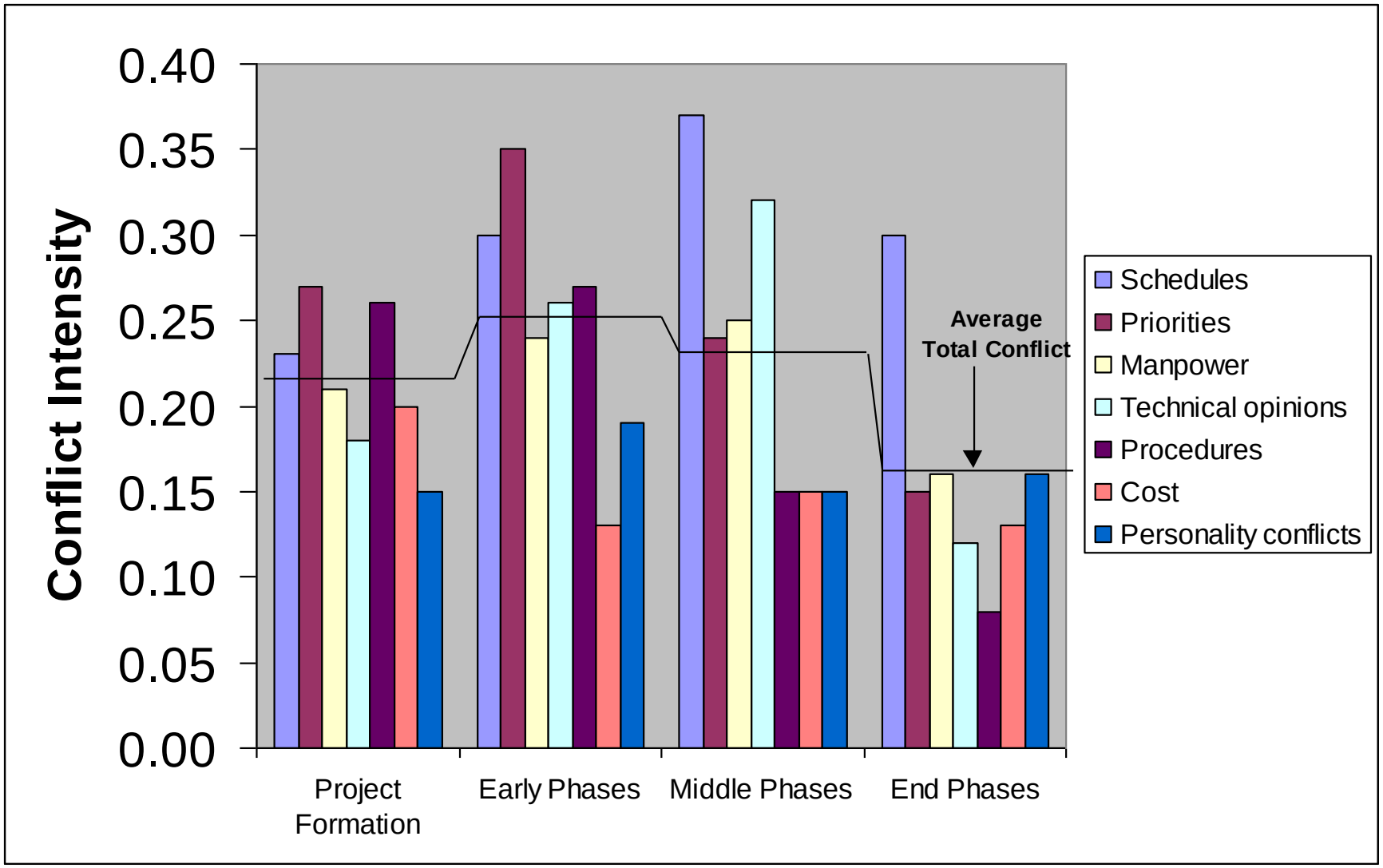
Learning Objectives

- Understand and use critical path analysis
- Describe how to use several techniques for shortening project schedules
- Explain the basic concepts behind critical chain scheduling and Program Evaluation and Review Technique (PERT)
- Discuss how reality checks and people issues are involved in controlling and managing changes to the project schedule
- Describe how software can assist in project time management

Importance of Project Schedules

- Managers often cite delivering projects on time as one of their biggest challenges
- Average time overrun from 1995 CHAOS report was 222%; improved to 163% in 2001 study
- Time has the least amount of flexibility; it passes no matter what
- Schedule issues are the main reason for conflicts on projects, especially during the second half of projects

Figure 6-1. Conflict Intensity Over the Life of a Project



Project Time Management Processes

- Project time management involves the processes required to ensure timely completion of a project. Processes include:
  - Activity definition
  - Activity sequencing
  - Activity duration estimating
  - Schedule development
  - Schedule control

Activity Definition

- Project schedules grow out of the basic document 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 duration estimates

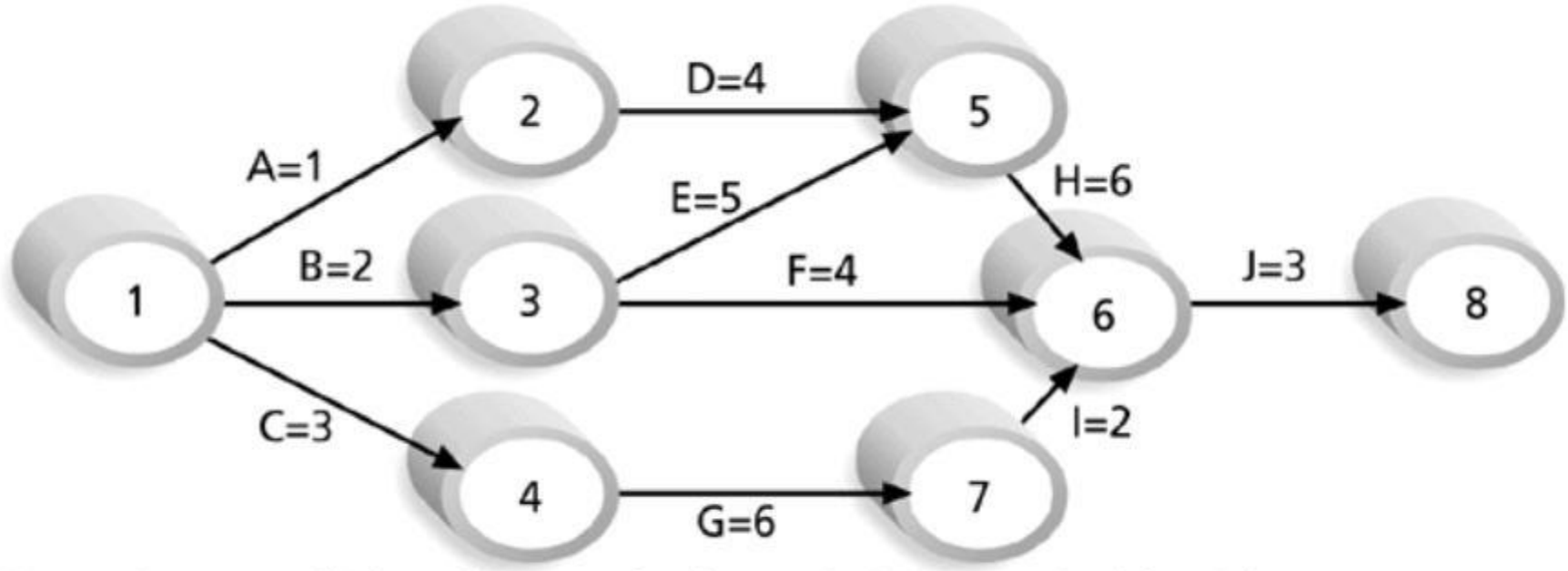
Activity Sequencing

- Involves reviewing activities and determining dependencies
  - Mandatory dependencies: inherent in the nature of the work; hard logic
  - Discretionary dependencies: defined by the project team; soft logic
  - External dependencies: involve relationships between project and non-project activities
- You *must* determine dependencies in order to use critical path analysis

Project Network Diagrams

- Project network diagrams are the preferred technique for showing activity sequencing
- A project network diagram is a schematic display of the logical relationships among, or sequencing of, project activities

Figure 6-2. 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) project 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. Continuing 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
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

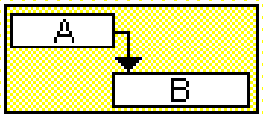
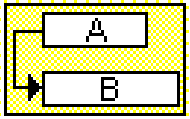
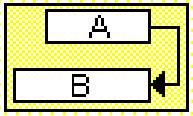
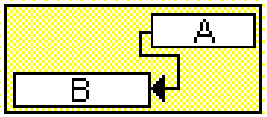
Precedence Diagramming Method (PDM)

- 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 6-3. 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.

Sample PDM Network Diagram

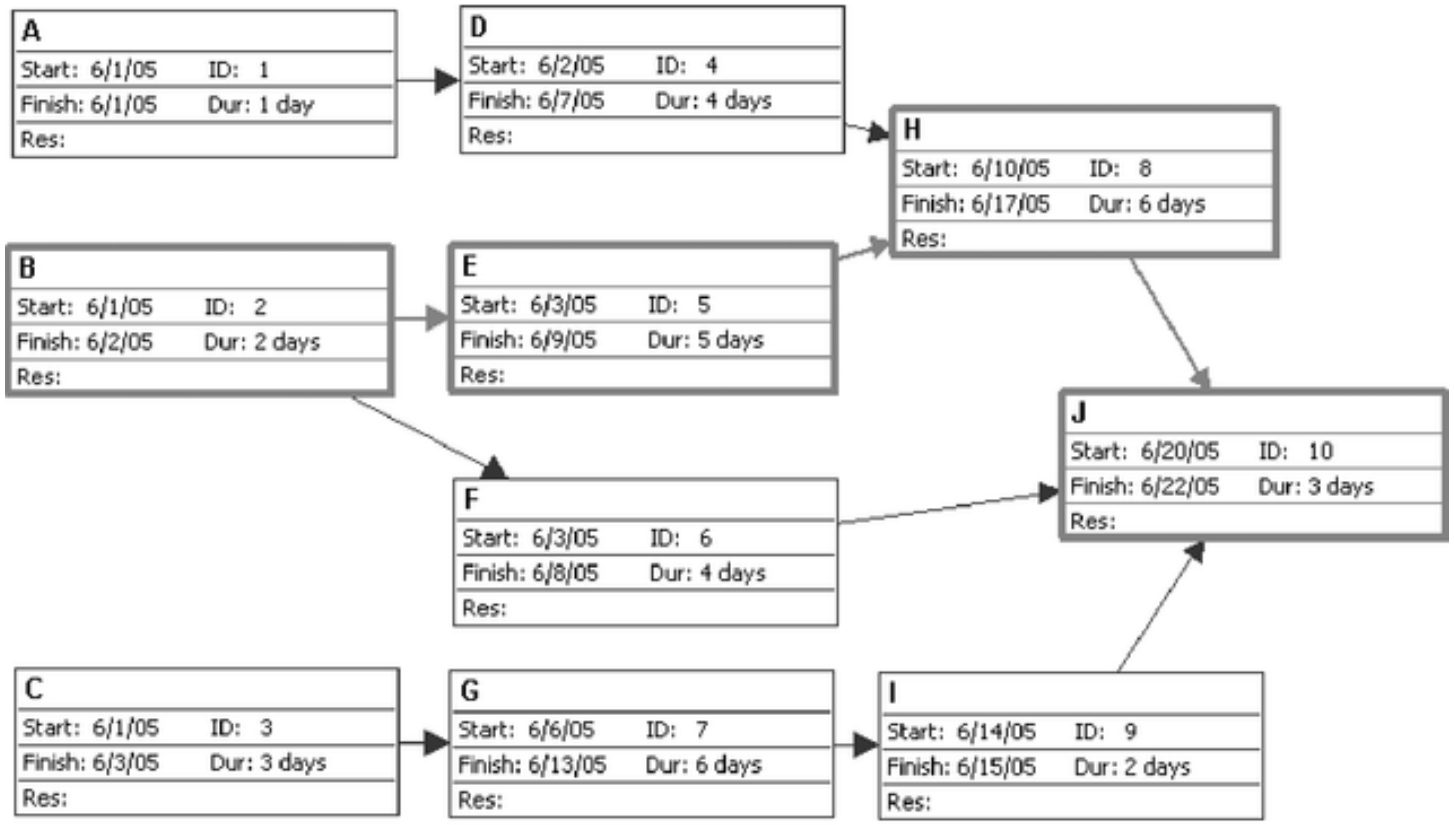


Figure 6-4. Sample Precedence Diagramming Method (PDM) Network Diagram for Project X

Activity Duration Estimating

- After defining activities and determining their sequence, the next step in time management is 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 equal duration
- People doing the work should help create estimates, and an expert should review them

Schedule Development

- Schedule development uses results of the other time management processes to determine the start and end date of the project and its activities
- 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, PERT analysis, critical path analysis, and critical chain scheduling

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:
  - A black diamond: milestones or significant events on a project with zero duration
  - Thick black bars: summary tasks
  - Lighter horizontal bars: tasks
  - Arrows: dependencies between tasks

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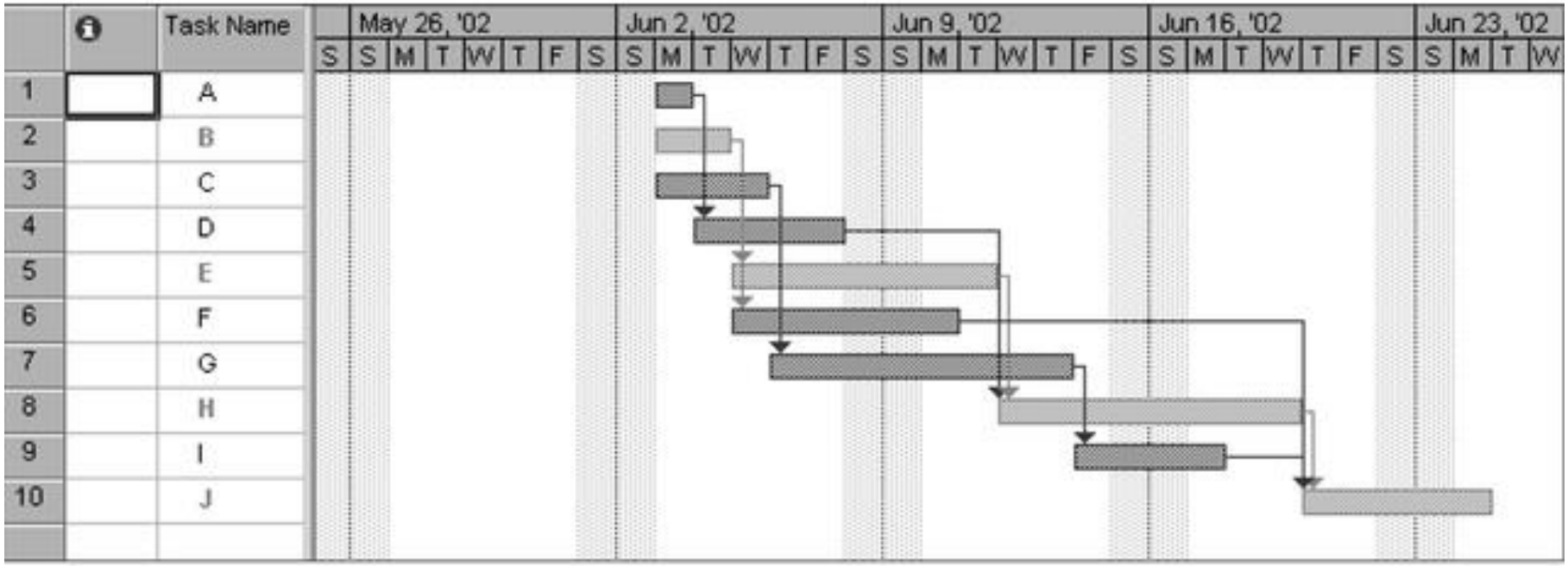
Figure 6-5. Gantt Chart for Project X



Gantt Chart for Software Launch Project

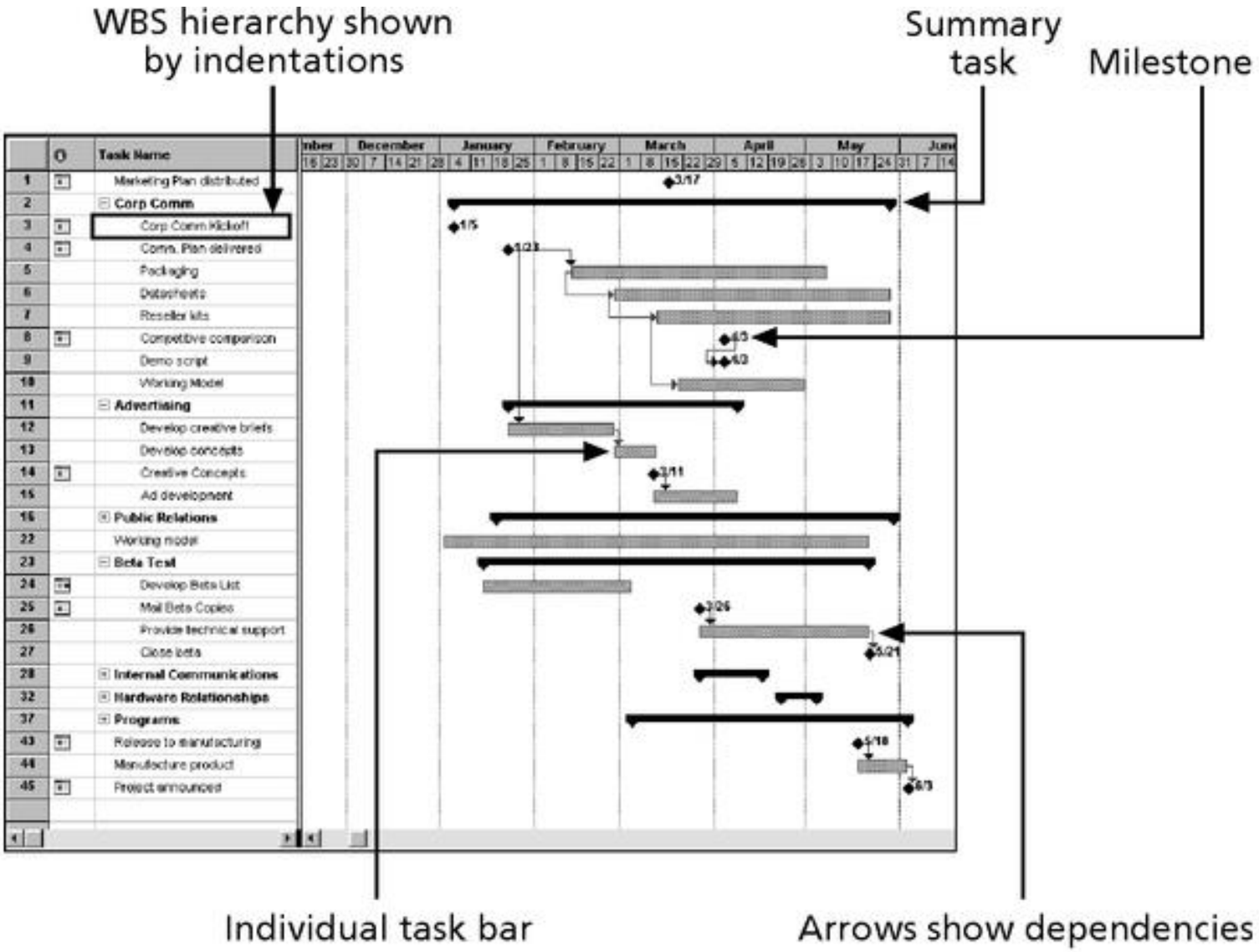


Figure 6-6. Gantt Chart for Software Launch Project

Milestones

- Milestones are significant events on a project that normally have zero duration
- You can follow the SMART criteria in developing milestones that are:
  - Specific
  - Measurable
  - Assignable
  - Realistic
  - Time-framed

Sample Tracking Gantt Chart

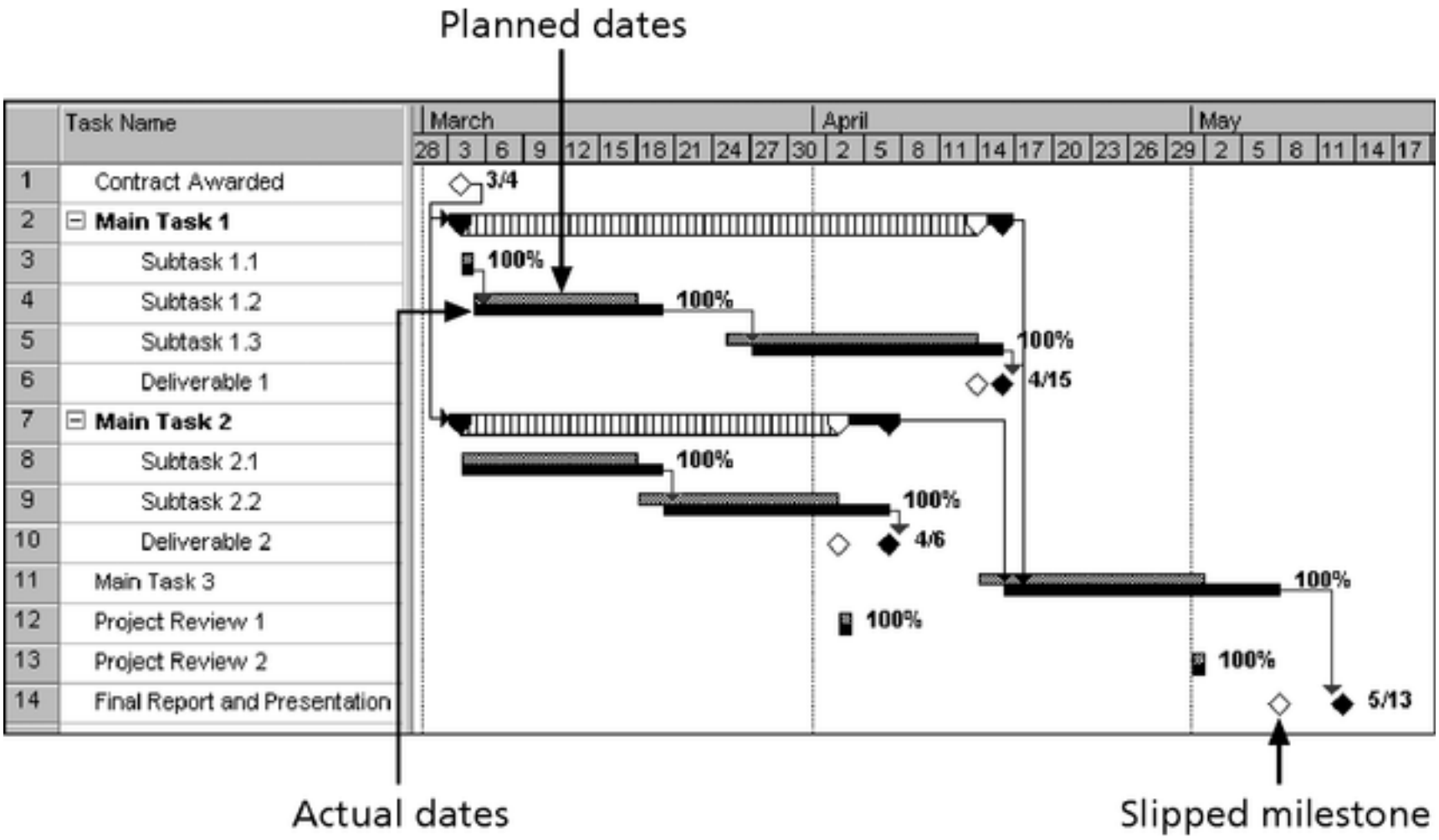


Figure 6-7. Sample Tracking Gantt Chart

Critical Path Method (CPM)

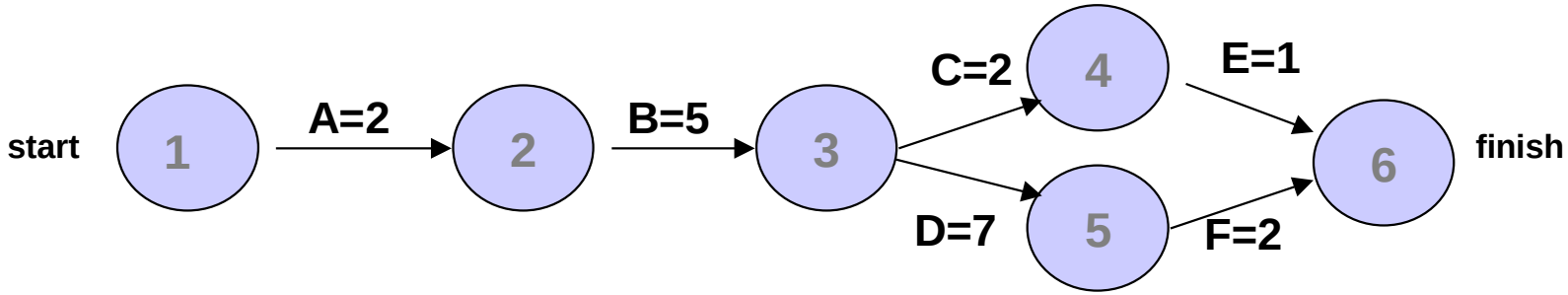
- CPM is a project network analysis technique used to predict total project duration
- A critical path for a project is the series of activities that determines the *earliest time* by which the project can be completed
- The critical path is the *longest path* through the network diagram and has the least amount of slack or float

Finding the Critical Path

- First develop a good project network diagram
- Add the durations for all activities on each path through the project network diagram
- The longest path is the critical path

Simple Example of Determining the Critical Path

- Consider the following project network diagram. Assume all times are in days.



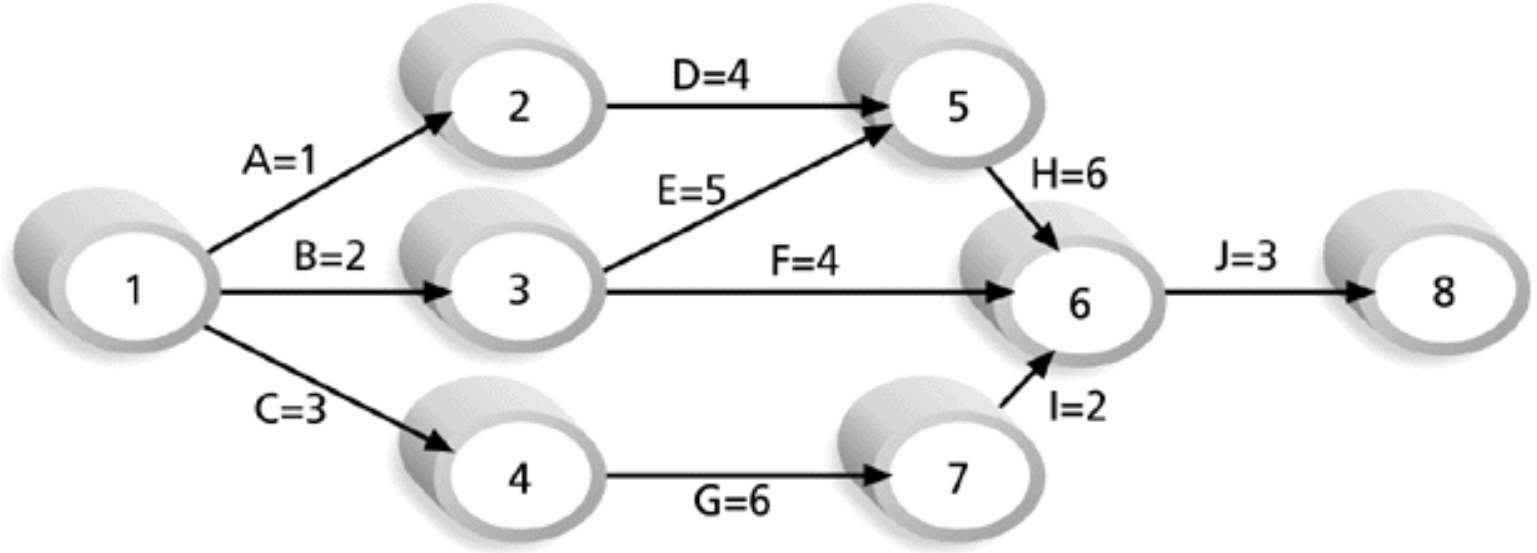
a. How many paths are on this network diagram?

b. How long is each path?

c. Which is the critical path?

d. What is the shortest amount of time needed to complete this project?

Figure 6-8. 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

- If one or more activities on the critical path takes longer than planned, the whole project schedule will slip *unless* corrective action is taken
- Misconceptions:
  - 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 Park
  - 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

- Knowing the critical path helps you 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

Calculating Early and Late Start and Finish Dates

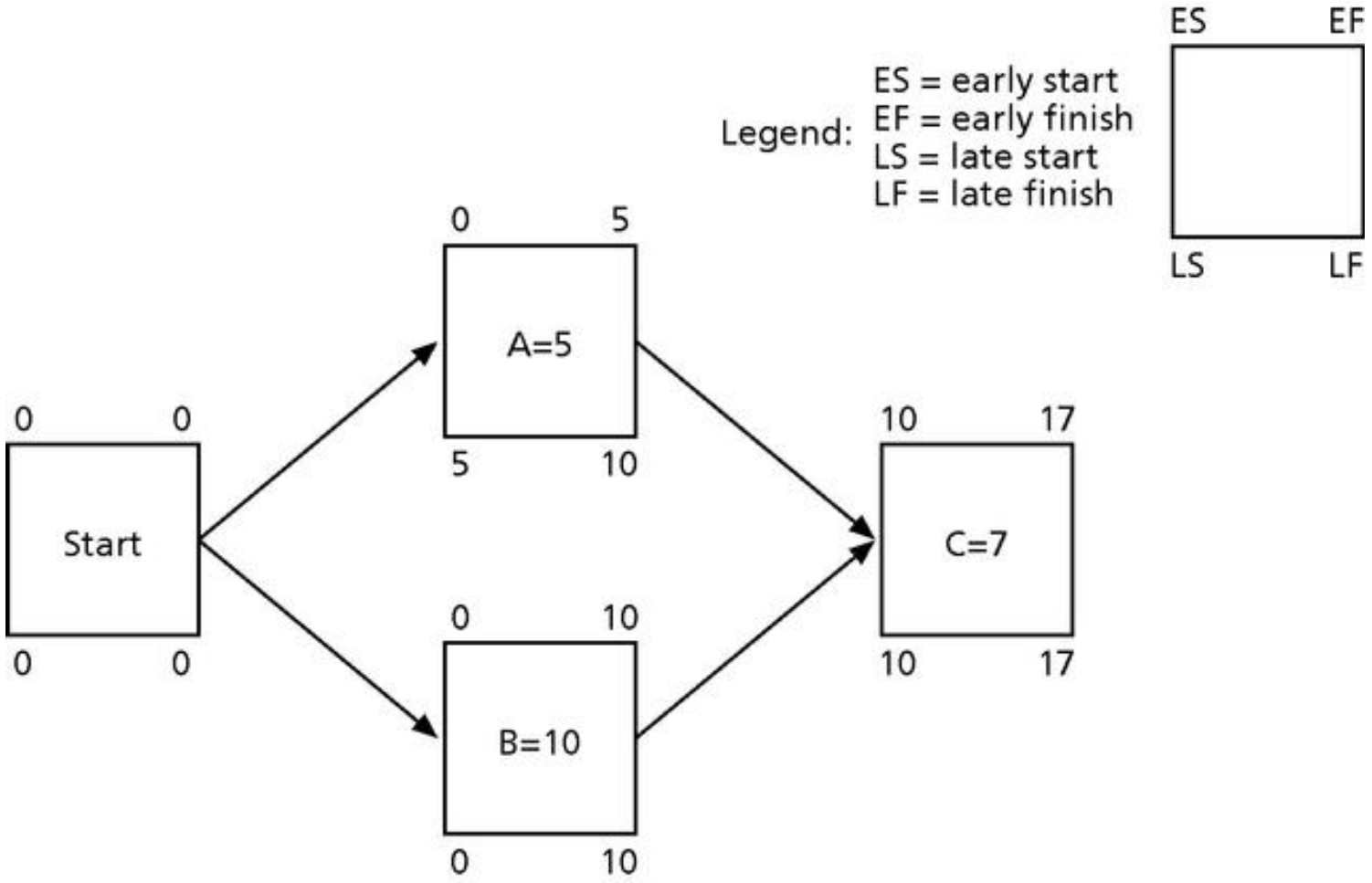


Figure 6-9. Calculating Early and Late Start and Finish Dates

Project 2002 Schedule Table View Showing Free and Total Slack

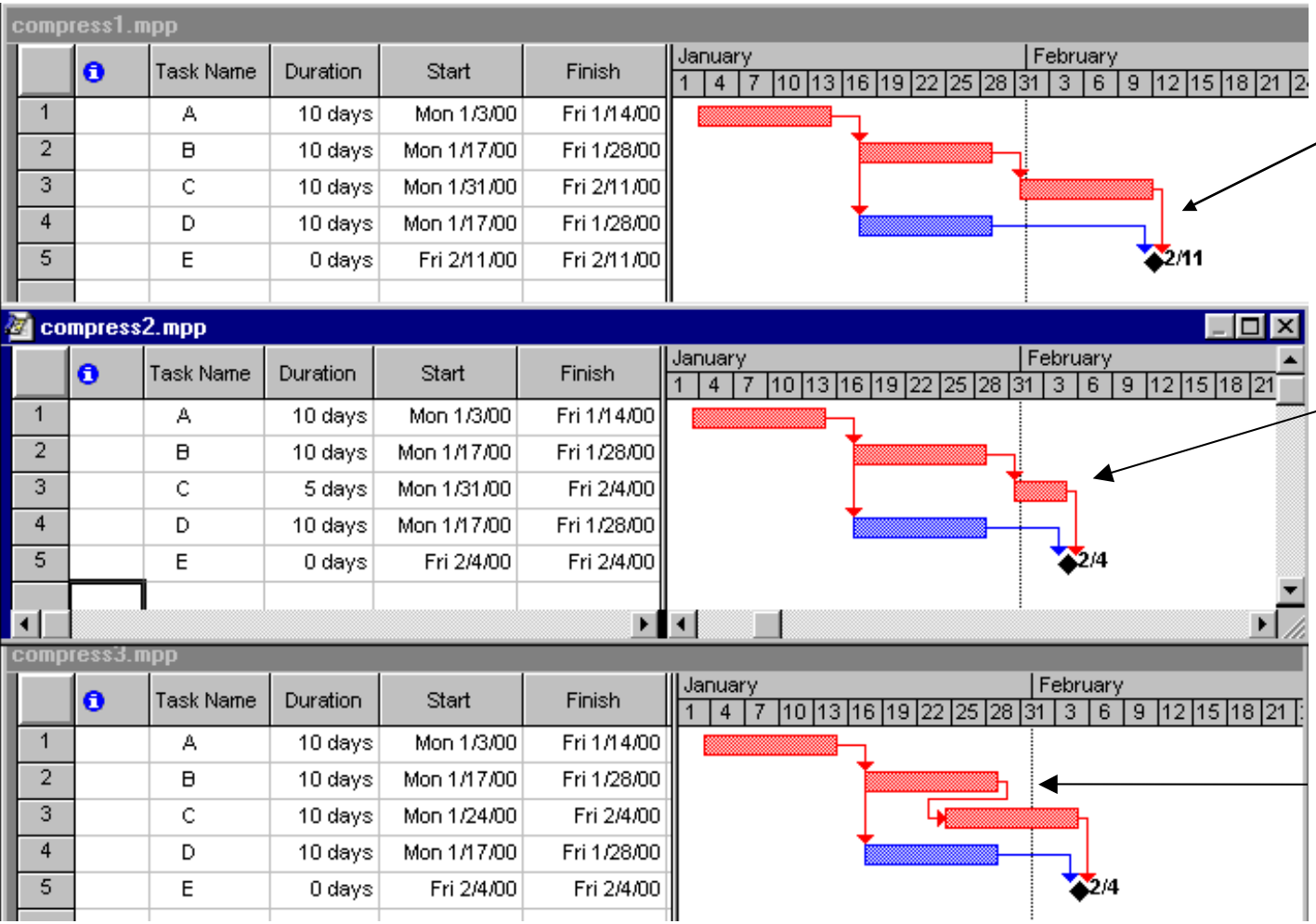
Table 6-1: Free and Total Float or Slack for Project X

Task	Start	Finish	Late Start	Late Finish	Free Slack	Total Slack
A	6/2/05	6/2/05	6/4/05	6/4/05	0d	2d
B	6/2/05	6/3/05	6/2/05	6/3/05	0d	0d
C	6/2/05	6/4/05	6/4/05	6/6/05	0d	2d
D	6/3/05	6/6/05	6/5/05	6/10/05	2d	2d
E	6/4/05	6/10/05	6/4/05	6/10/05	0d	0d
F	6/4/05	6/9/05	6/13/05	6/18/05	7d	7d
G	6/5/05	6/12/05	6/9/05	6/16/05	0d	2d
H	6/11/05	6/18/05	6/11/05	6/18/05	0d	0d
I	6/13/05	6/16/05	6/17/05	6/18/05	2d	2d
J	6/19/05	6/23/05	6/19/05	6/23/05	0d	0d

Techniques for Shortening a Project Schedule

- Shorten durations of critical tasks by adding more resources or changing their scope
- *Crashing* tasks by obtaining the greatest amount of schedule compression for the least incremental cost
- *Fast tracking* tasks by doing them in parallel or overlapping them

Crashing and Fast Tracking



Original schedule

Shortened duration thru crashing

Overlapped Tasks or fast tracking

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Many Horror Stories Related to Project Schedules

- Creating realistic schedules and sticking to them is a key challenge of project management
- Crashing and fast tracking often cause more problems, resulting in longer schedules
- Organizational issues often cause schedule problems. See example of needing to take more time to implement Customer Relationship Management (CRM) software so users accept it

Importance of Updating Critical Path Data

- It is important to update project schedule information
- 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

Critical Chain Scheduling

- Technique that addresses the challenge of meeting or beating project finish dates and an application of the Theory of Constraints (TOC)
- Developed by Eliyahu Goldratt in his books *The Goal* and *Critical Chain*
- Critical chain scheduling is a method of scheduling that takes limited resources into account when creating a project schedule and includes buffers to protect the project completion date
- Critical chain scheduling assumes resources do not multitask because it often delays task completions and increases total durations

Multitasking Example

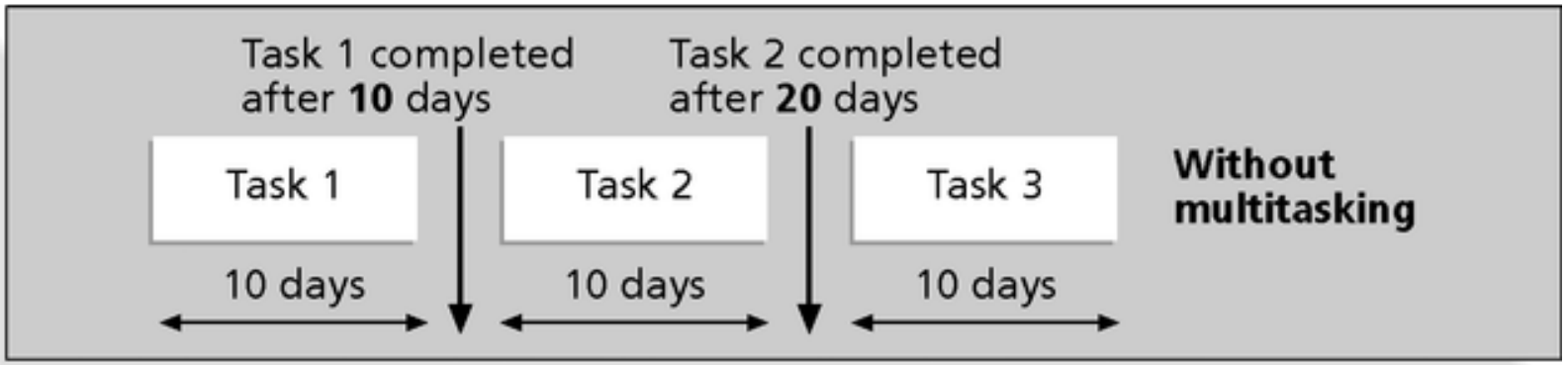


Figure 6-10a. Three Tasks Without Multitasking

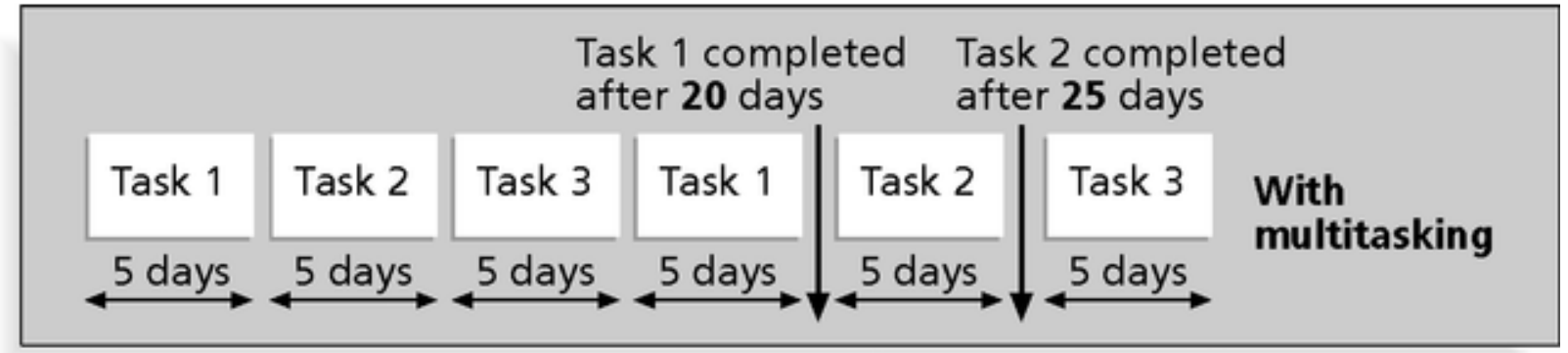
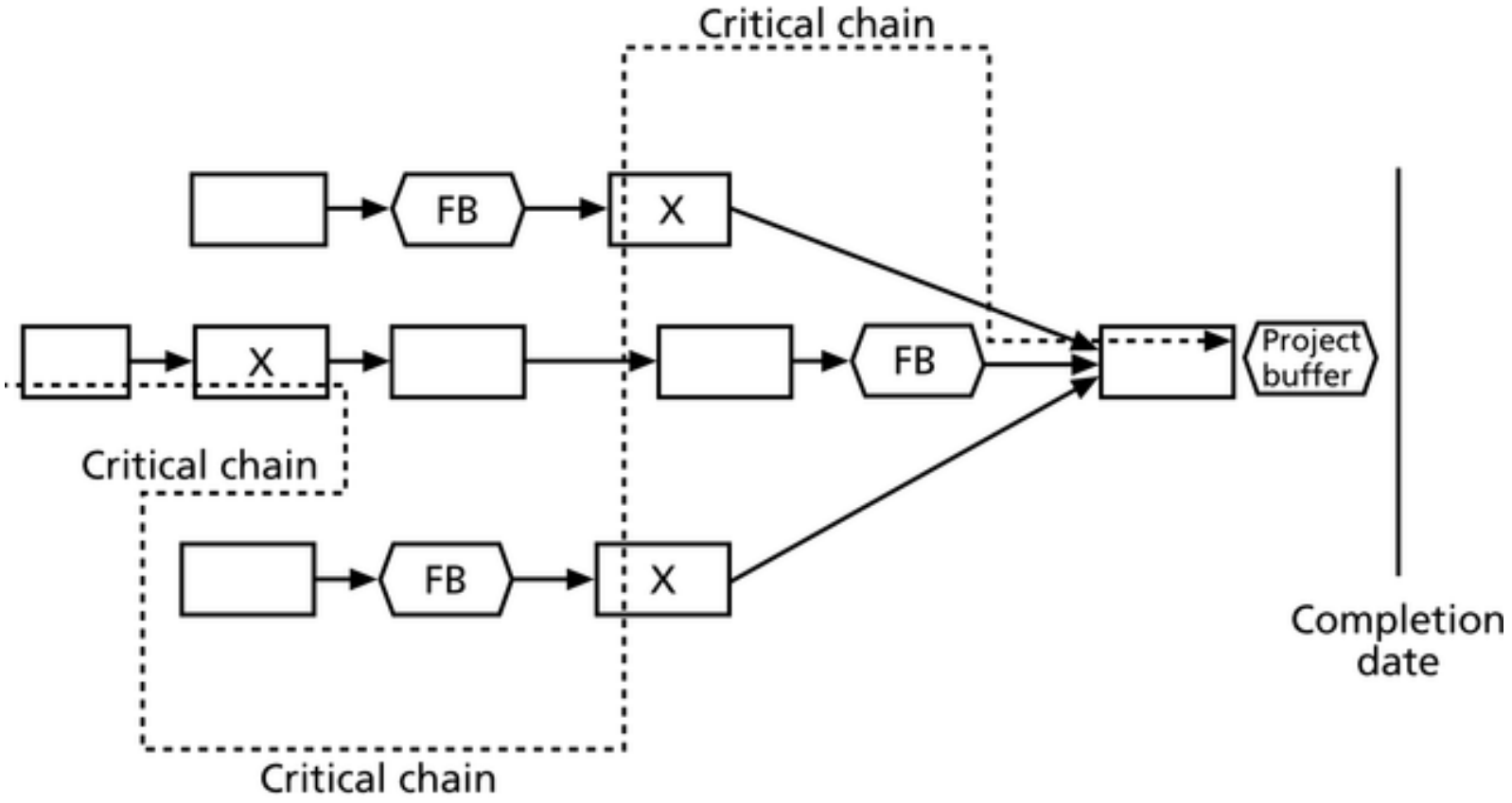


Figure 6-10b. Three Tasks With Multitasking

Buffers and Critical Chain

- A buffer is additional time to complete a task
- **Murphy's Law** states that if something can go wrong, it will, and **Parkinson's Law** states that work expands to fill the time allowed. In traditional estimates, people often add a buffer and use it if it's needed or not
- Critical chain schedule removes buffers from individual tasks and instead creates
  - A project buffer, which is additional time added before the project's due date
  - Feeding buffers, which are addition time added before tasks on the critical path

Figure 6-11. Example of Critical Chain Scheduling



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 based on using optimistic, most likely, and pessimistic estimates of activity durations

PERT Formula and Example

- PERT weighted average formula:

$$\frac{\text{optimistic time} + 4\text{X most likely time} + \text{pessimistic time}}{6}$$

- Example:

PERT weighted average =

$$\frac{8 \text{ workdays} + 4 \text{ X } 10 \text{ workdays} + 24 \text{ workdays}}{6} = 12 \text{ days}$$

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

Controlling Changes to the Project Schedule

- 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

Working with People Issues

- Strong leadership helps projects succeed more than good PERT charts
- Project managers should use
  - empowerment
  - incentives
  - discipline
  - negotiation

What Went Right?

Chris Higgins used the discipline he learned in the Army to transform project management into a cultural force at Bank of America. Higgins learned that taking time on the front end of a project can save significant time and money on the back end. As a quartermaster in the Army, when Higgins' people had to pack tents, he devised a contest to find the best way to fold a tent and determine the precise spots to place the pegs and equipment for the quickest possible assembly. Higgins used the same approach when he led an interstate banking initiative to integrate incompatible check processing, checking account, and savings account platforms in various states…He made the team members analyze, plan, and document requirements for the system in such detail that it took six months just to complete that phase. But the discipline up front enabled the software developers on the team to do all of the coding in only three months, and the project was completed on time.

Using Software to Assist in Time Management

- Software for facilitating communications helps people exchange schedule-related information
- Decision support models help analyze trade-offs that can be made
- Project management software can help in various time management areas

Table 6-2. Project 2000 Features Related to Project Time Management

Reports	Views and Table Views	Filters
• Overview reports: critical tasks and milestones • Current activities reports: unstarted tasks, tasks starting soon, tasks in progress, completed tasks, should have started tasks, and slipping tasks • Assignment reports: who does what when	• Gantt chart, PERT chart, Tracking Gantt, schedule, tracking, variance, constraint dates, and delay	• All tasks, completed tasks, critical tasks, incomplete tasks, and milestone tasks

Words of Caution on Using Project Management Software

- Many people misuse project management software because they don't understand important concepts and have not had good training
- You must enter dependencies to have dates adjust automatically and to determine the critical path
- You must enter actual schedule information to compare planned and actual progress