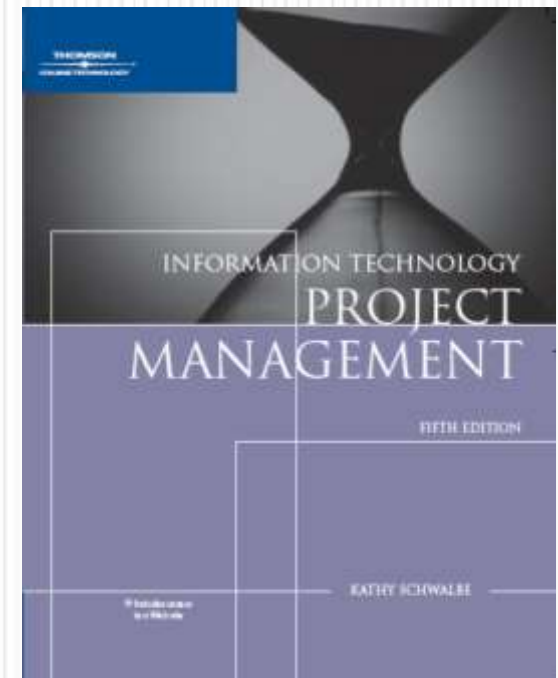# Chapter 6:
Project Time Management

Information Technology Project Management, Fifth Edition

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

- Schedule issues are the main reason for conflicts on projects, especially during the second half of projects

Individual Work Styles and Cultural Differences Cause Schedule Conflicts

- One dimension of the Meyers-Briggs Type Indicator focuses on peoples' attitudes toward structure and deadline

- Judgment type people prefer to follow schedules, meet deadlines and have closure. Perception types prefer to keep things open and flexible; deadlines are a signal to start rather than to complete a project

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

Media Snapshot

- In contrast to the 2002 Salt Lake City Winter Olympic Games, planning and scheduling was very different for the 2004 Summer Olympic Games held in Athens, Greece

- Many articles were written before the opening ceremonies predicting that the facilities would not be ready in time

- Many people were pleasantly surprised by the amazing opening ceremonies, beautiful new buildings, and state-of-the-art security and transportation systems in Athens

- The Greeks even made fun of critics by having construction workers pretend to still be working as the ceremonies began

Project Time Management Processes

- **Activity definition**: identifying the specific activities/tasks 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
- **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

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**

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Project Time Management

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 Definition

- The basis for creating a project schedule is derived from four project time management processes
  - Activity definition – further defining the scope
  - Activity sequencing – further defining the time
  - Activity resource and activity duration (further defining the time and cost)

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 <u>significant</u> event that normally has no duration
  - Not every deliverable or output created for a project is a milestone
- 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 such as software modules or the installation of new hardware

Project Time Management

What Went Wrong?

- At the U.S. Federal Bureau of Investigation (FBI), poor time management was one of the reasons behind the failure of Trilogy, a "disastrous, unbelievably expensive piece of vaporware, which was more than four years in the (un)making. The system was supposed to enable FBI agents to integrate intelligence from isolated information silos within the Bureau."*

- In May 2006, the Government Accounting Agency said that the Trilogy project failed at its core mission of improving the FBI's investigative abilities and was plagued with missed milestones and escalating costs

*Roberts, Paul, "Frustrated contractor sentenced for hacking FBI to speed deployment," *InfoWorld Tech Watch, (July 6, 2006).*

Project Time Management

Activity Sequencing

- After defining project activities, the next step is activity sequencing
  - Involves reviewing the activity list and attributes, project scope statement, milestone list and approved change requests to determine the relationships between activities
- 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
  - Don't start detailed design work until users sign-off on all the analysis – good practice but can delay project
- **External dependencies**: involve relationships between project and non-project activities
  - Delivery of new hardware; if delayed can impact project schedule

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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

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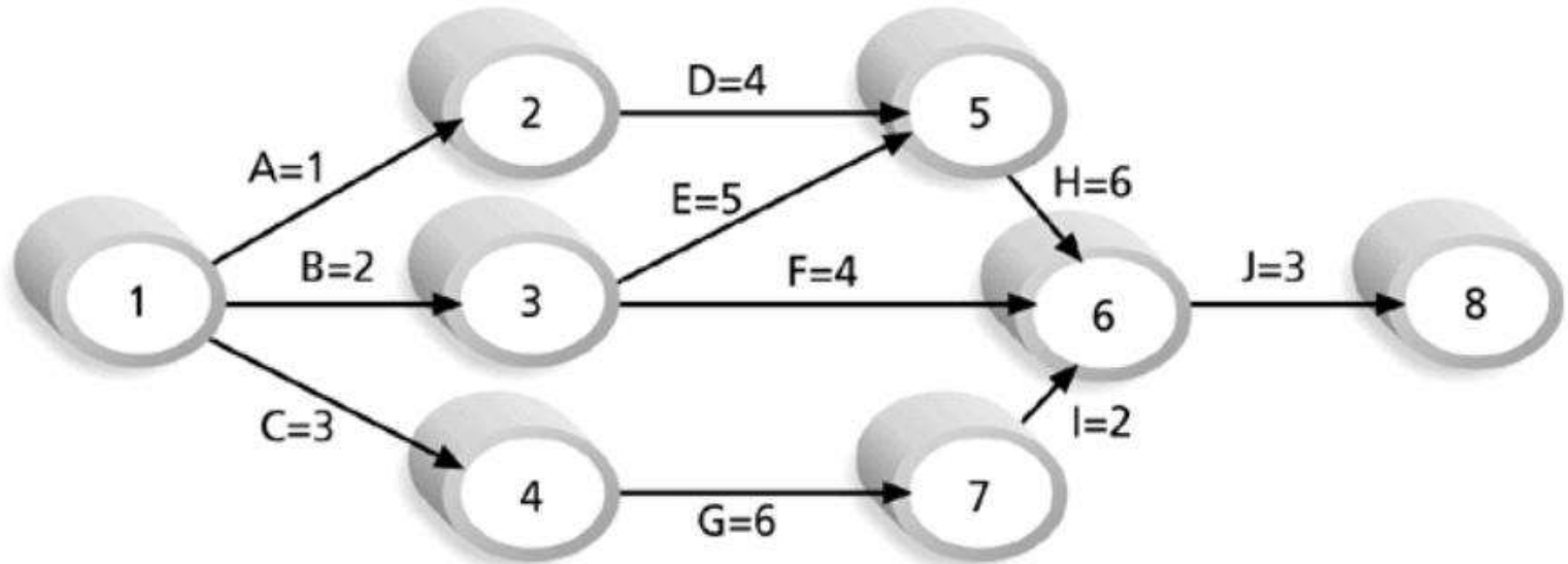
Note: Assume all durations are in days; A=1 means Activity A has a duration of 1 day.

Project Time Management

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
- Can omit activities that have no 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

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
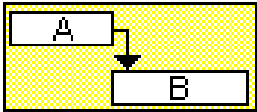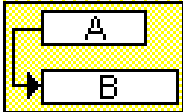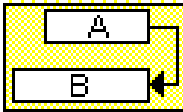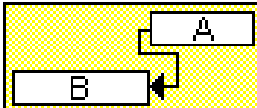
Project Time Management

Precedence Diagramming Method (PDM)

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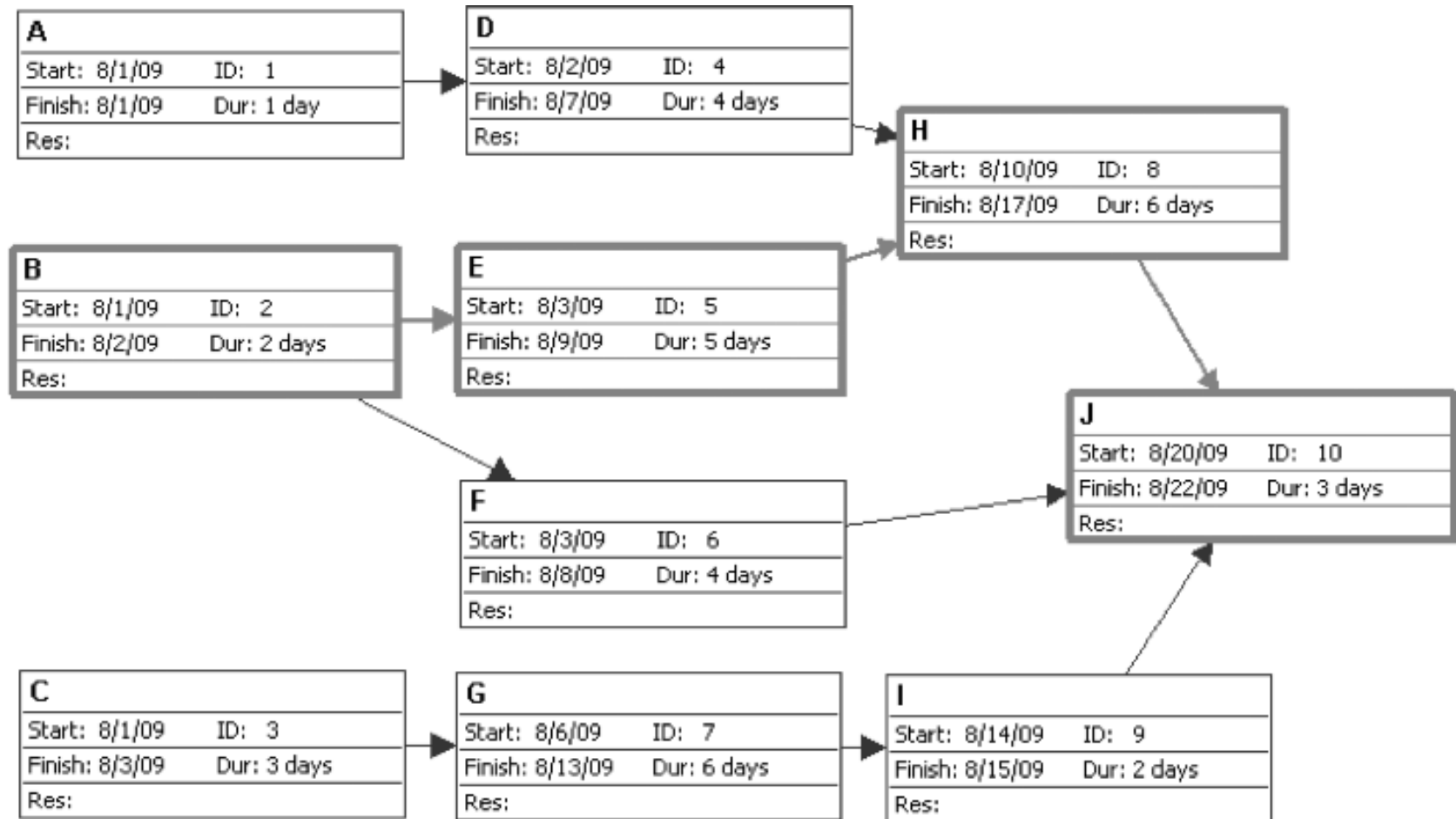- Better at showing different types of dependencies

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.

Project Time Management

Sample PDM Network Diagram

A	
Start: 8/1/09	ID: 1
Finish: 8/1/09	Dur: 1 day
Res:	

D	
Start: 8/2/09	ID: 4
Finish: 8/7/09	Dur: 4 days
Res:	

H	
Start: 8/10/09	ID: 8
Finish: 8/17/09	Dur: 6 days
Res:	

B	
Start: 8/1/09	ID: 2
Finish: 8/2/09	Dur: 2 days
Res:	

E	
Start: 8/3/09	ID: 5
Finish: 8/9/09	Dur: 5 days
Res:	

J	
Start: 8/20/09	ID: 10
Finish: 8/22/09	Dur: 3 days
Res:	

F	
Start: 8/3/09	ID: 6
Finish: 8/8/09	Dur: 4 days
Res:	

C	
Start: 8/1/09	ID: 3
Finish: 8/3/09	Dur: 3 days
Res:	

G	
Start: 8/6/09	ID: 7
Finish: 8/13/09	Dur: 6 days
Res:	

I	
Start: 8/14/09	ID: 9
Finish: 8/15/09	Dur: 2 days
Res:	

Project Time Management

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 or need to be acquired?

- 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
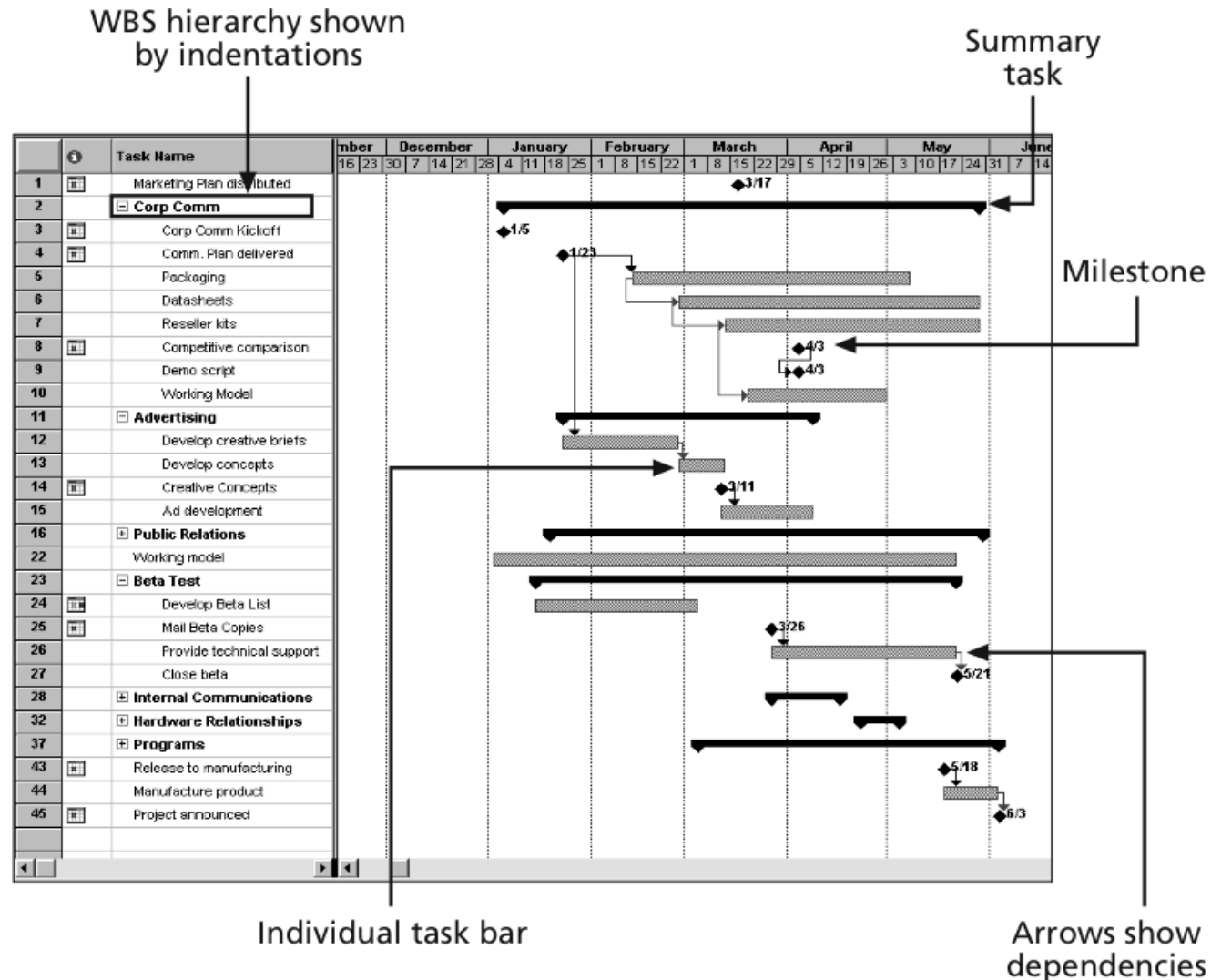
Gantt Charts

- **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 6-5: Gantt Chart for Project X
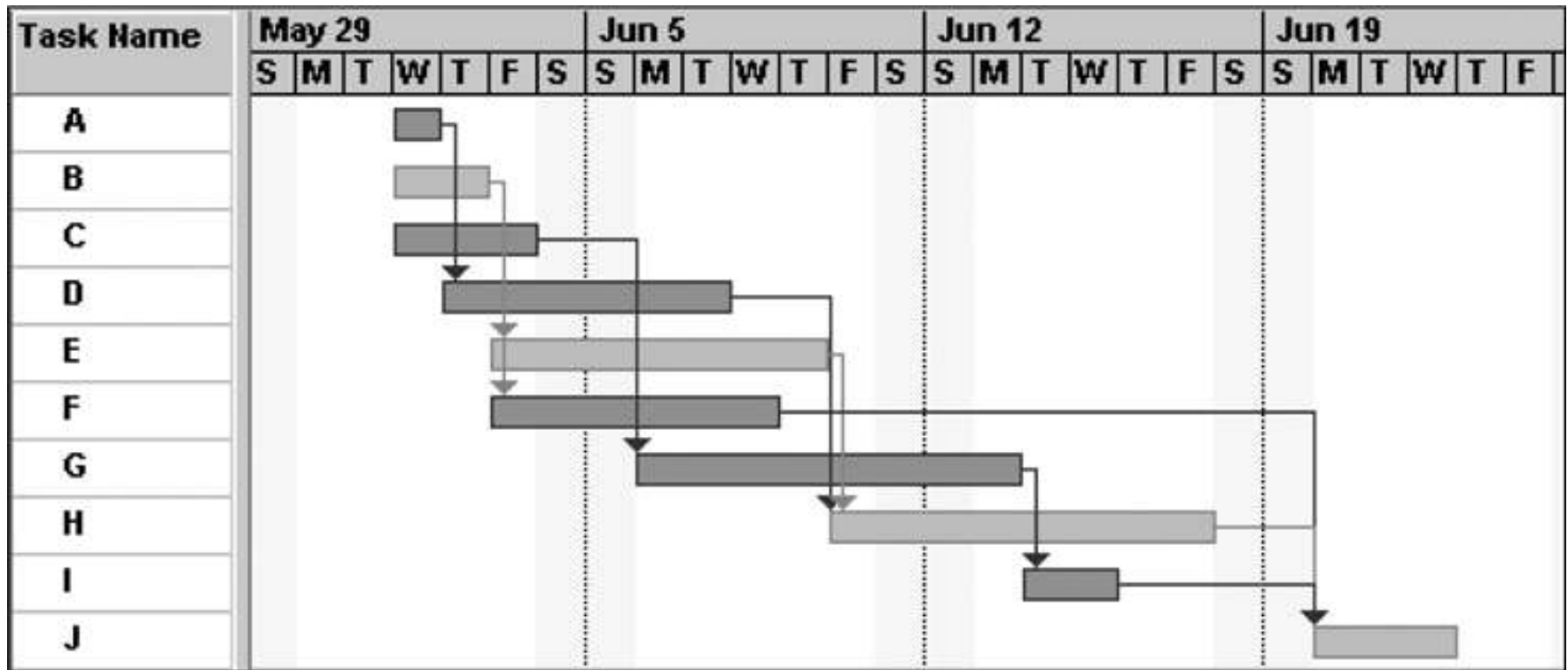
Note: Darker bars would be red in Project 2007 to represent critical tasks

Project Time Management

Gantt Chart for Software Launch Project

WBS hierarchy shown by indentations

Summary task

Milestone

Individual task bar

Arrows show dependencies

	❶	Task Name
1	▦	Marketing Plan distributed
2		⊟ **Corp Comm**
3	▦	Corp Comm Kickoff
4	▦	Comm. Plan delivered
5		Packaging
6		Datasheets
7		Reseller kits
8	▦	Competitive comparison
9		Demo script
10		Working Model
11		⊟ **Advertising**
12		Develop creative briefs
13		Develop concepts
14	▦	Creative Concepts
15		Ad development
16		⊞ **Public Relations**
22		Working model
23		⊟ **Beta Test**
24	▦	Develop Beta List
25	▦	Mail Beta Copies
26		Provide technical support
27		Close beta
28		⊞ **Internal Communications**
32		⊞ **Hardware Relationships**
37		⊞ **Programs**
43	▦	Release to manufacturing
44		Manufacture product
45	▦	Project announced

Project Time Management

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

Project Time Management

Best Practice

- Schedule risk is inherent in the development of complex systems

- Luc Richard, the founder of www.projectmangler.com, suggests that project managers can reduce schedule risk through project milestones, a best practice that involves identifying and tracking significant points or achievements in the project

Best Practice (continued)

- The five key points of using project milestones include the following:

  1. Define milestones early in the project and include them in the Gantt chart to provide a visual guide

  2. Keep milestones small and frequent

  3. The set of milestones must be all-encompassing

  4. Each milestone must be binary, meaning it is either complete or incomplete

  5. Carefully monitor the critical path

Sample Tracking Gantt Chart

Project Time Management
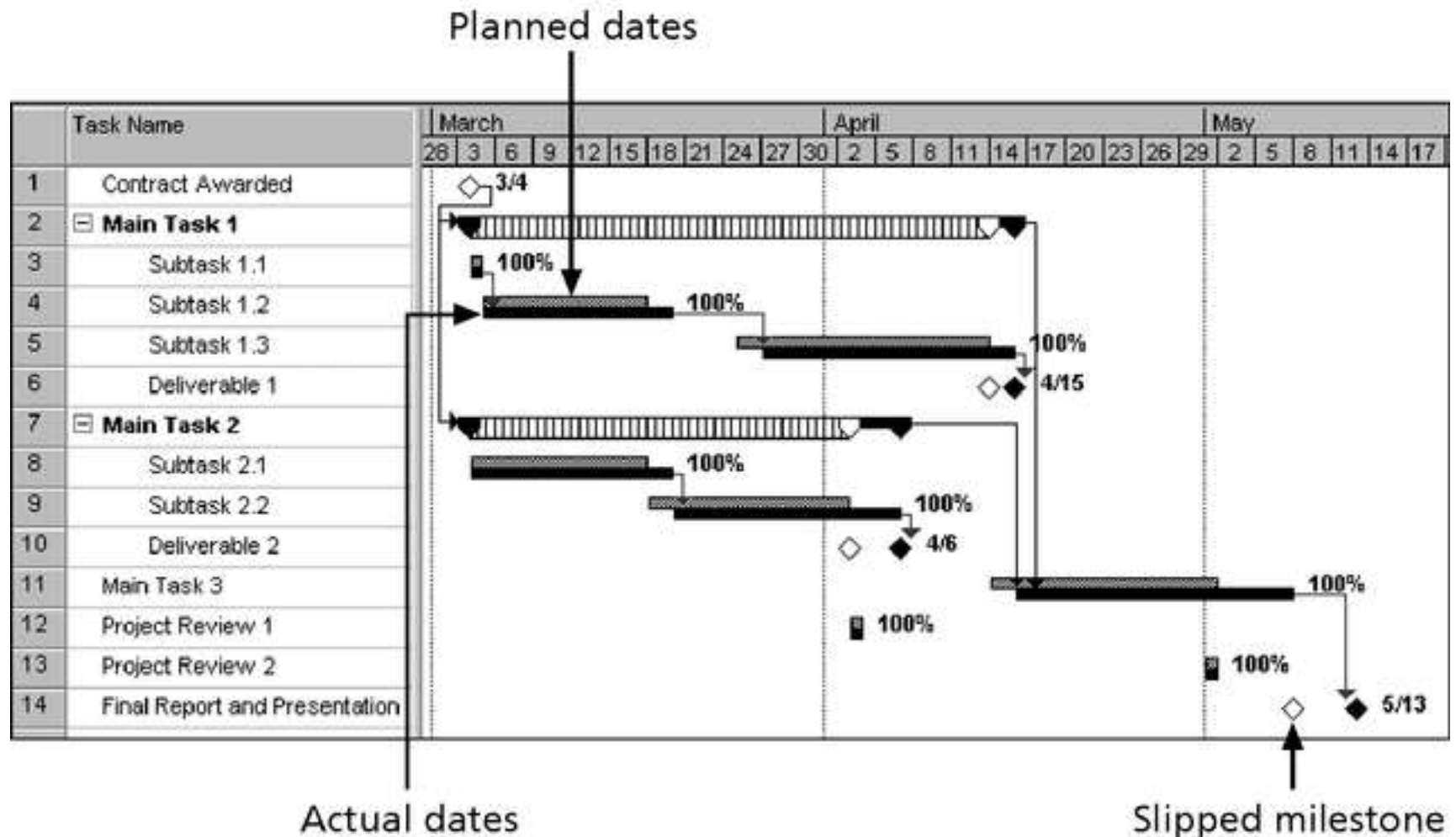
Critical Path Method (CPM)

- **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

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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

Project Time Management

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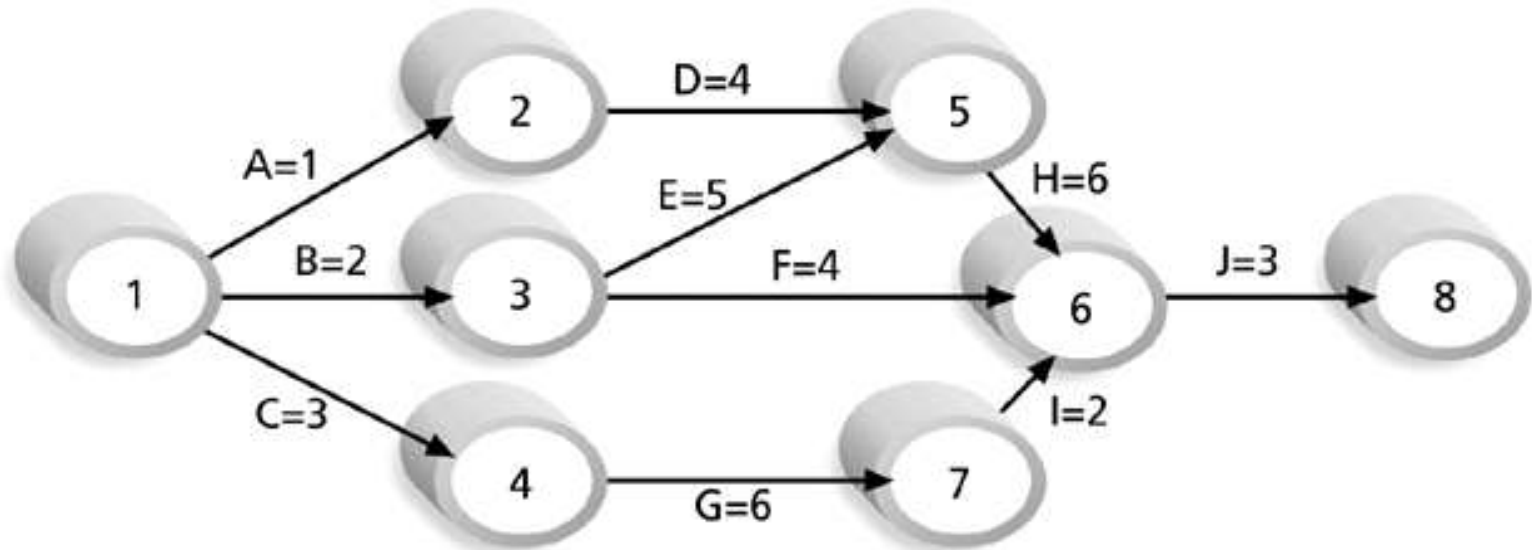
Note: Assume all durations are in days.

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.
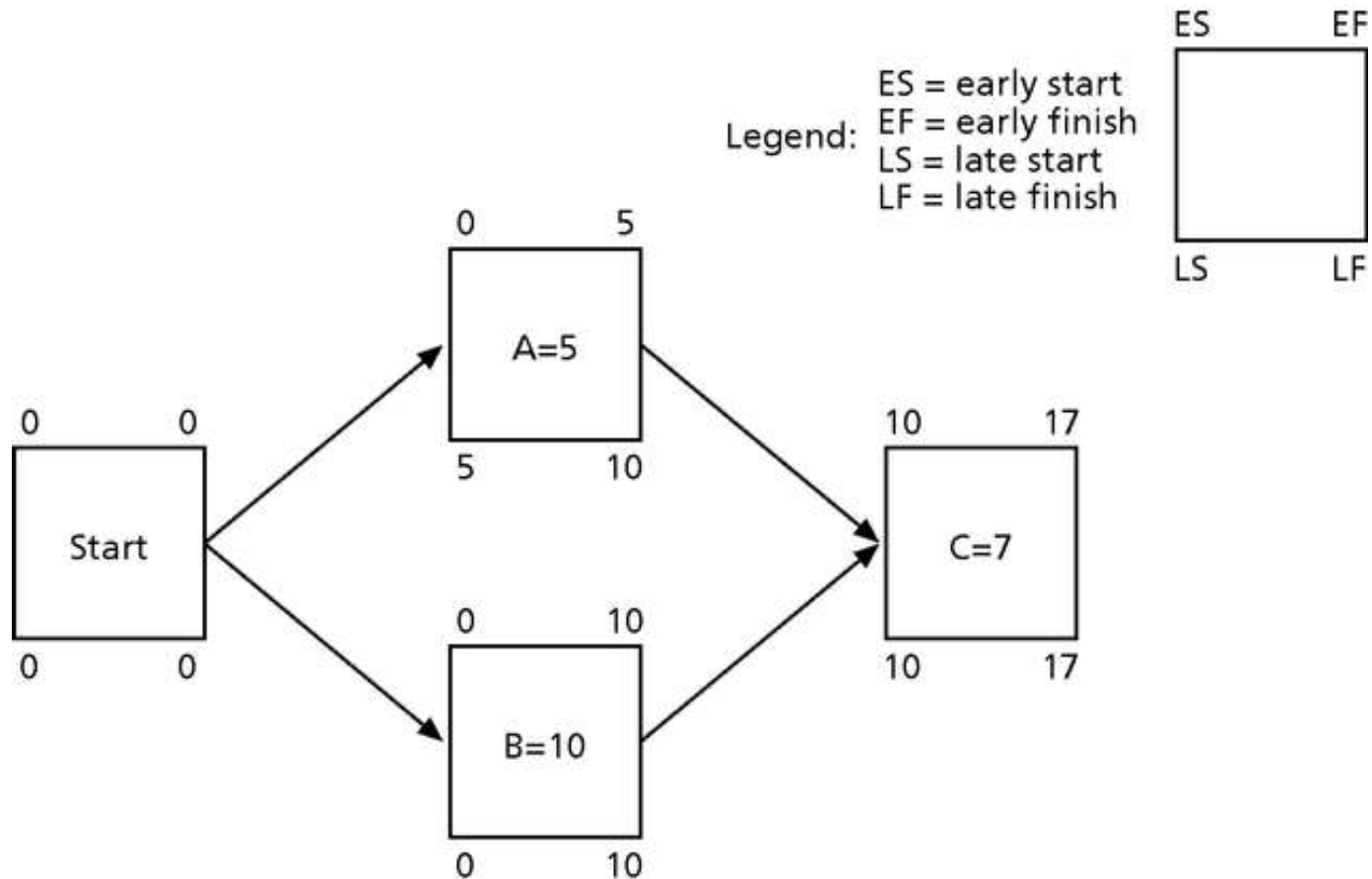
Project Time Management

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

Project Time Management

Calculating Early and Late Start and Finish Dates

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

Project Time Management

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

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How to Find the Critical Path

- General Foundry's network with expected activity times
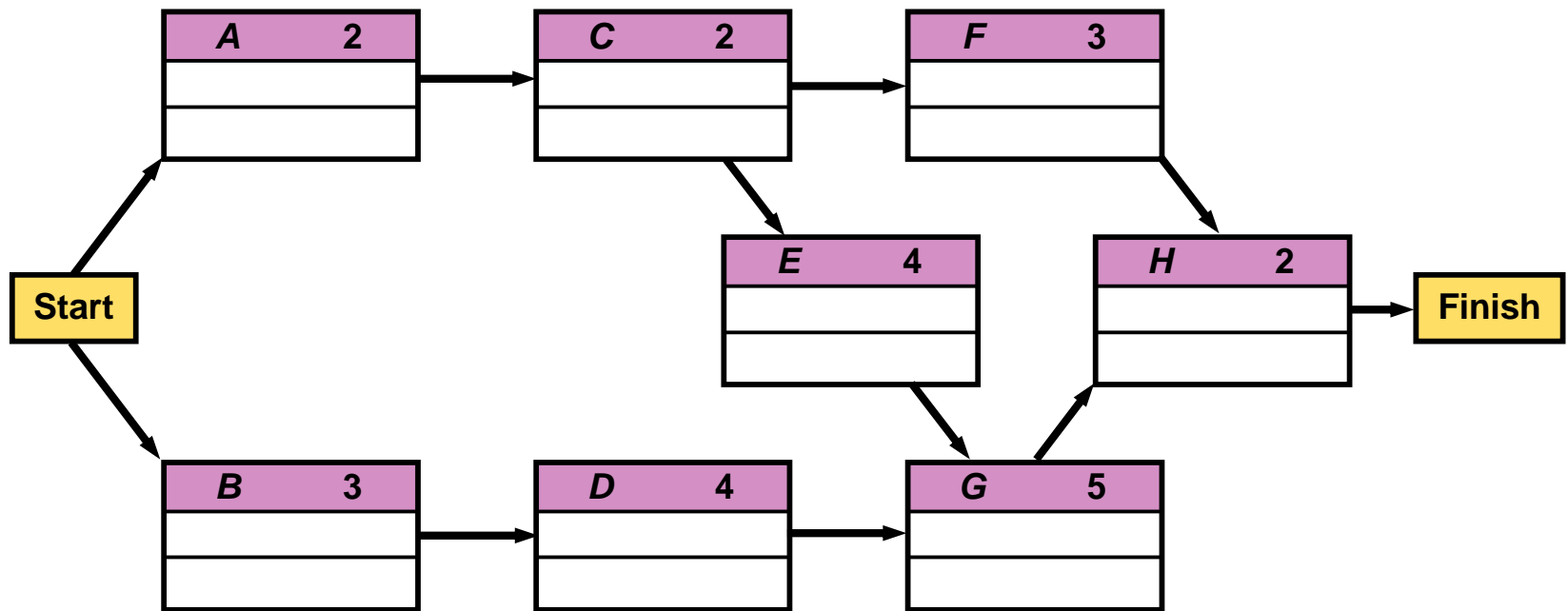
Figure 13.3

How to Find the Critical Path

- To find the critical path, need to determine the following quantities for each activity in the network

1. *Earliest start time* (*ES*): the earliest time an activity can begin without violation of immediate predecessor requirements

2. *Earliest finish time* (*EF*): the earliest time at which an activity can end

3. *Latest start time* (*LS*): the latest time an activity can begin without delaying the entire project

4. *Latest finish time* (*LF*): the latest time an activity can end without delaying the entire project

How to Find the Critical Path

- In the nodes, the activity time and the early and late start and finish times are represented in the following manner

ACTIVITY	t
ES	EF
LS	LF

- Earliest times are computed as

Earliest finish time = Earliest start time + Expected activity time

EF = ES + t

Earliest start = Largest of the earliest finish times of immediate predecessors

ES = Largest EF of immediate predecessors

How to Find the Critical Path

- At the start of the project we set the time to zero
- Thus ES = 0 for both *A* and *B*
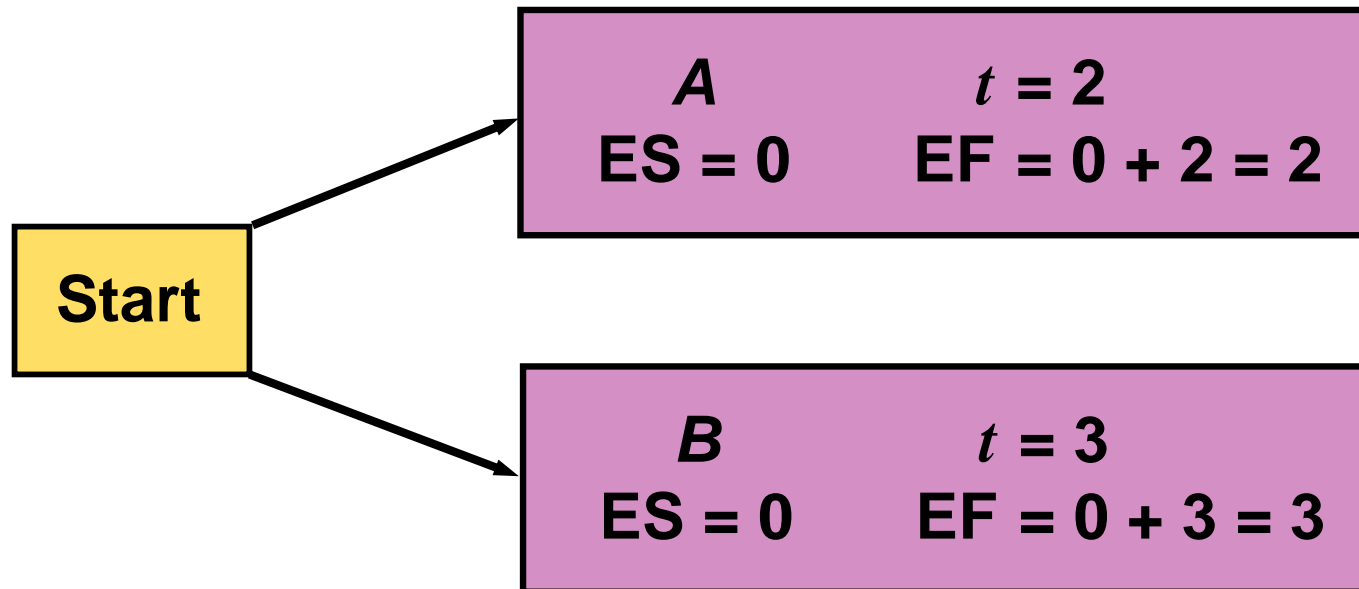
How to Find the Critical Path

- General Foundry's ES and EF times
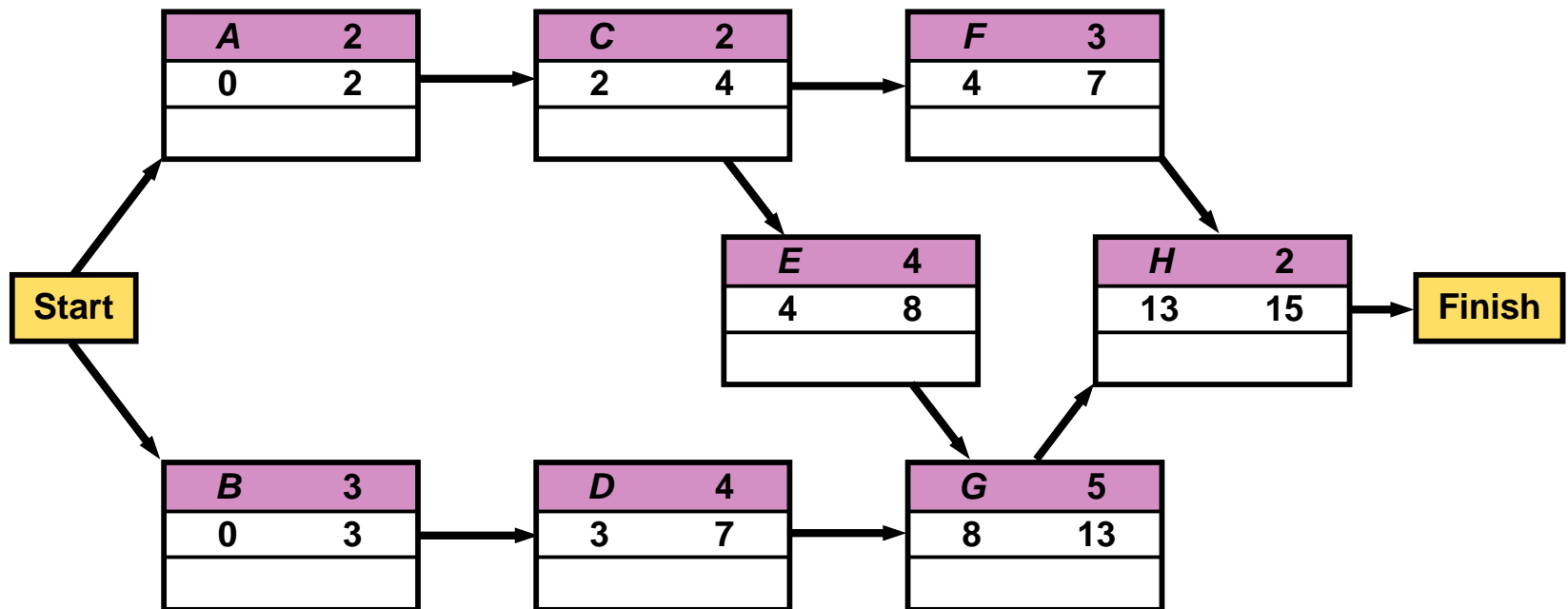
Figure 13.4

How to Find the Critical Path

- Latest times are computed as

Latest start time = Latest finish time
– Expected activity time

$$LS = LF - t$$

Latest finish time = Smallest of latest start times
for following activities

$$LF = \text{Smallest LS of following activities}$$

- For activity *H*

$$LS = LF - t = 15 - 2 = 13 \text{ weeks}$$

How to Find the Critical Path

- General Foundry's LS and LF times
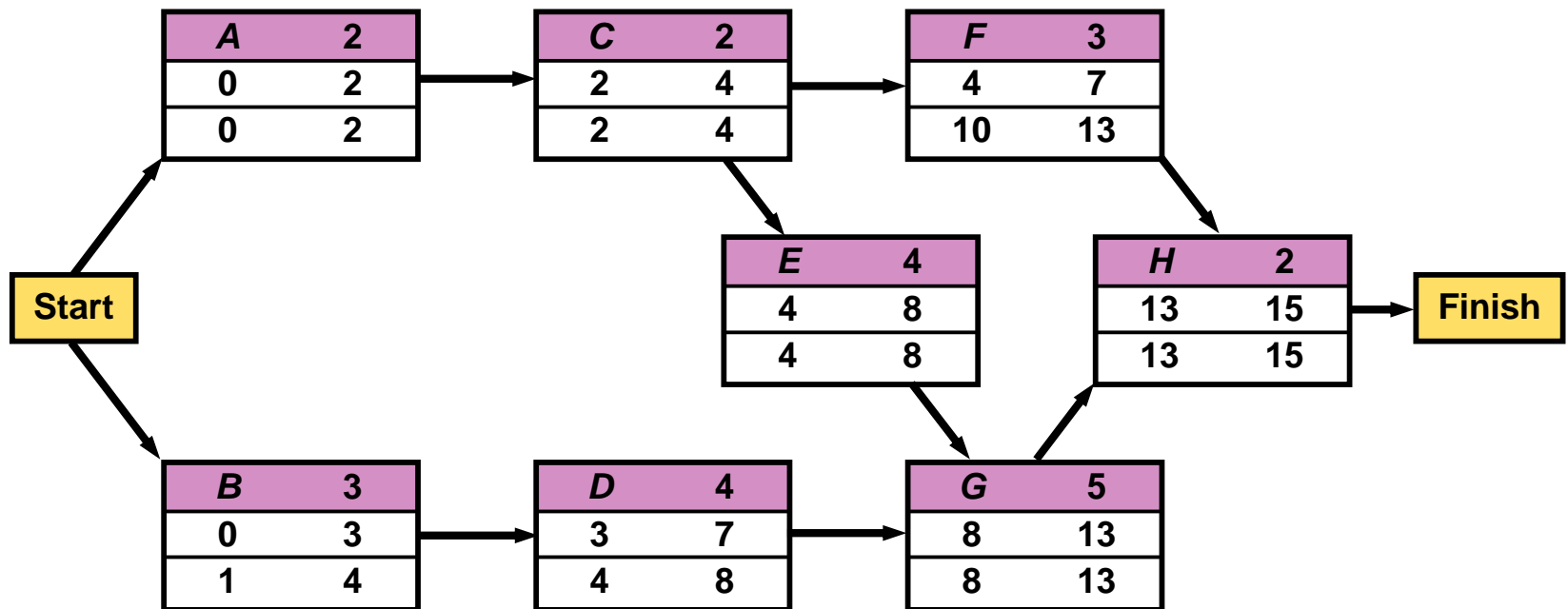
Figure 13.5

How to Find the Critical Path

- Once ES, LS, EF, and LF have been determined, it is a simple matter to find the amount of *slack time* that each activity has

$$\text{Slack} = \text{LS} - \text{ES}, \ \text{ or } \ \text{Slack} = \text{LF} - \text{EF}$$

- From Table 13.3 we see activities *A*, *C*, *E*, *G*, and *H* have no slack time
- These are called *critical activities* and they are said to be on the *critical path*
- The total project completion time is 15 weeks
- Industrial managers call this a boundary timetable

How to Find the Critical Path

- General Foundry's schedule and slack times

ACTIVITY	EARLIEST START, ES	EARLIEST FINISH, EF	LATEST START, LS	LATEST FINISH, LF	SLACK, LS – ES	ON CRITICAL PATH?
A	0	2	0	2	0	Yes
B	0	3	1	4	1	No
C	2	4	2	4	0	Yes
D	3	7	4	8	1	No
E	4	8	4	8	0	Yes
F	4	7	10	13	6	No
G	8	13	8	13	0	Yes
H	13	15	13	15	0	Yes

Table 13.3

How to Find the Critical Path

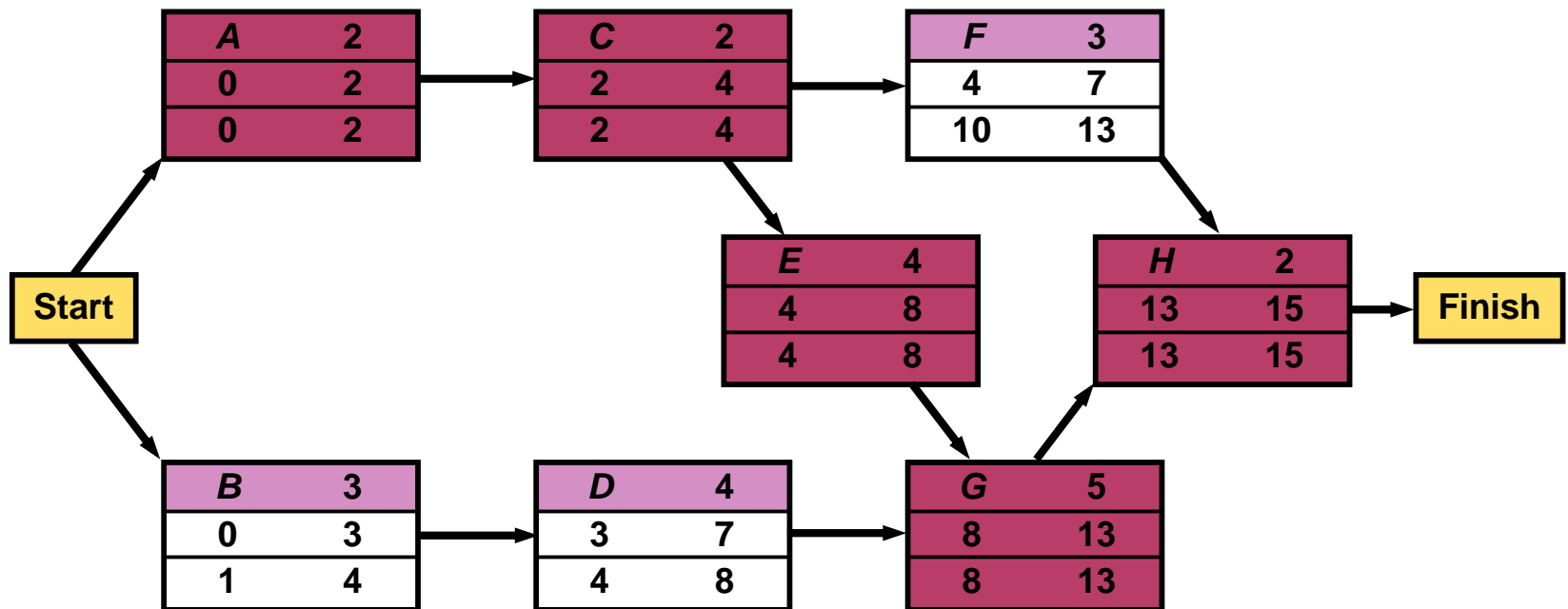- General Foundry's critical path

Figure 13.6

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
    - A 2 week task with one person working 50% could be shortened to 1 week if the person is assigned 100% - no increase in cost
    - Or, a temporary worker could be hired to work in parallel with the other worker to speed up the task (at a cost)

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Project Crashing

- Projects will sometimes have deadlines that are impossible to meet using normal procedures
- By using exceptional methods it may be possible to finish the project in less time than normally required
- However, this usually increases the cost of the project
- Reducing a project's completion time is called *crashing*

Project Crashing

- Crashing a project starts with using the *normal time* to create the critical path
- The *normal cost* is the cost for completing the activity using normal procedures
- If the project will not meet the required deadline, extraordinary measures must be taken
- The *crash time* is the shortest possible activity time and will require additional resources
- The *crash cost* is the price of completing the activity in the earlier-than-normal time

Four Steps to Project Crashing

1. Find the normal critical path and identify the critical activities

2. Compute the crash cost per week (or other time period) for all activities in the network using the formula

$$\textbf{Crash cost/Time period} = \frac{\textbf{Crash cost – Normal cost}}{\textbf{Normal time – Crash time}}$$

Four Steps to Project Crashing

3. Select the activity on the critical path with the smallest crash cost per week and crash this activity to the maximum extent possible or to the point at which your desired deadline has been reached

4. Check to be sure that the critical path you were crashing is still critical. If the critical path is still the longest path through the network, return to step 3. If not, find the new critical path and return to step 2.

General Foundry Example

- General Foundry has been given 14 weeks instead of 16 weeks to install the new equipment
- The critical path for the project is 15 weeks
- What options do they have?
- The normal and crash times and costs are shown in Table 13.9
- Crash costs are assumed to be linear and Figure 13.11 shows the crash cost for activity *B*
- Crashing activity *A* will shorten the completion time to 14 but it creates a second critical path B,D,G,H because when you recalculate the LF and LS times for B and D they now match the EF and ES
- Any further crashing must be done to both critical paths

General Foundry Example

- Normal and crash data for General Foundry

	TIME (WEEKS)		COST ($)		CRASH COST	CRITICAL
ACTIVITY	NORMAL	CRASH	NORMAL	CRASH	PER WEEK ($)	PATH?
A	2	1	22,000	23,000	1,000	Yes
B	3	1	30,000	34,000	2,000	No
C	2	1	26,000	27,000	1,000	Yes
D	4	3	48,000	49,000	1,000	No
E	4	2	56,000	58,000	1,000	Yes
F	3	2	30,000	30,500	500	No
G	5	2	80,000	86,000	2,000	Yes
H	2	1	16,000	19,000	3,000	Yes

Table 13.9

General Foundry Example

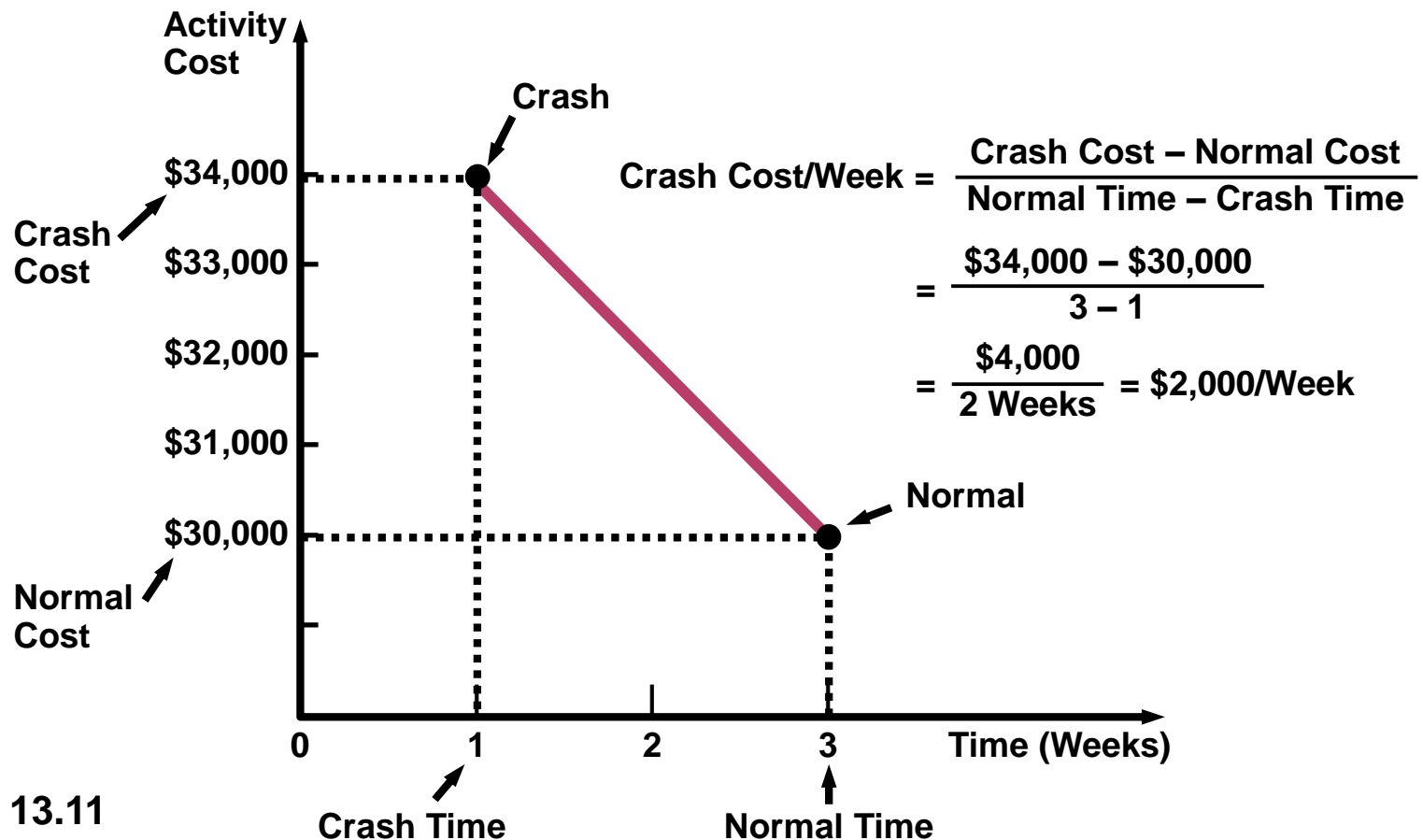- Crash and normal times and costs for activity *B*

Figure 13.11

Using the Critical Path to Shorten a Project Schedule

- **Fast tracking** activities by doing them in parallel or overlapping them instead of doing them in sequence
  - Instead of waiting for all analysis to be completed before starting coding, some coding could begin for those tasks that have been fully analyzed
  - Drawback – starting a task too soon could lengthen the project because other tasks whose analysis has not been completed could impact this task and cause rework

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, be proactive and negotiate with the project sponsor and stakeholders

Critical Chain Scheduling

- **Critical chain scheduling**
  - A method of scheduling that considers limited resources when creating a project schedule and includes buffers to protect the project completion date
- Based on the **Theory of Constraints (TOC)**
  - A management philosophy developed by Eli Goldratt and introduced in his book *The Goal* and *Critical Chain*
    - Like a chain with its weakest link, any complex system at any point in time often has only one aspect or constraint that limits its ability to achieve more of its goal
    - For the system to attain any significant improvements, that constraint must be identified and the whole system must be managed with it in mind
      - For example, two tasks originally scheduled to be done in parallel, require the same resource 100% of the time. CCS acknowledges that either one of the tasks must be delayed or a similar resource must be found in order to keep to the original schedule

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Critical Chain Scheduling

- Attempts to minimize **multitasking**
  - When a resource works on more than one task at a time – people are assigned to multiple tasks within the same project or different tasks on multiple projects
  - Someone assigned to three tasks, tries to please everyone and works a little on each task and then goes back to finish the first one
    - This can actually delay the completion of tasks as compared to working on each task in sequence
    - Multitasking also often involves wasted setup time, which increases total duration
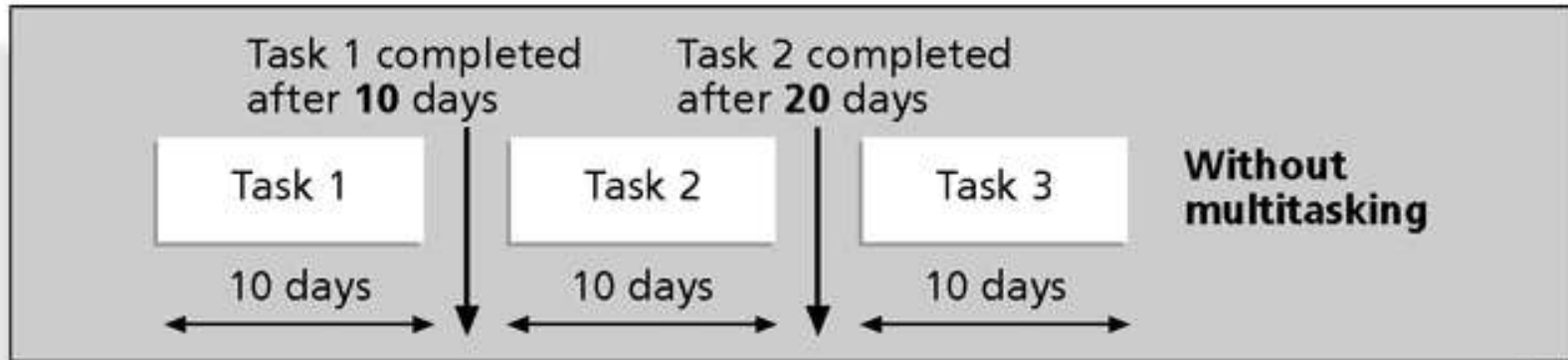
Multitasking Example

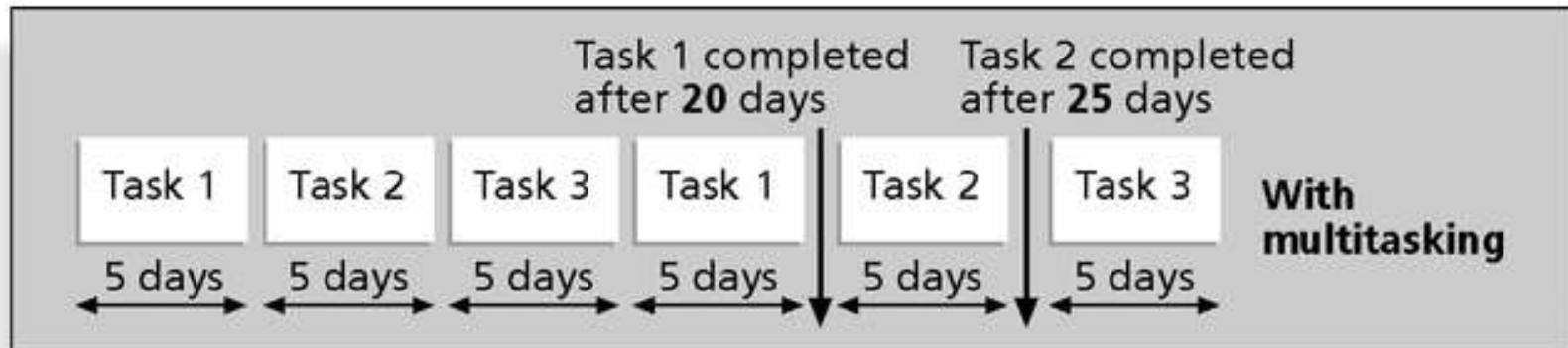Figure 6-10a. Three Tasks Without Multitasking

Figure 6-10b. Three Tasks With Multitasking

Project Time Management

Critical Chain Scheduling

- Critical Chain Project Management (CCPM), developed by Eliyahu M. Goldratt, is a method of planning and managing projects that puts more emphasis on the resources required to execute project tasks.

- This is in contrast to the more traditional Critical Path and PERT methods, which emphasize task order and rigid scheduling.

- A Critical Chain project network will tend to keep the resources levelly loaded, but will require them to be flexible in their start times and to quickly switch between tasks and task chains to keep the whole project on schedule.

  - Typically, CCPM case studies report 95% on-time and on-budget completion when CCPM is applied correctly.
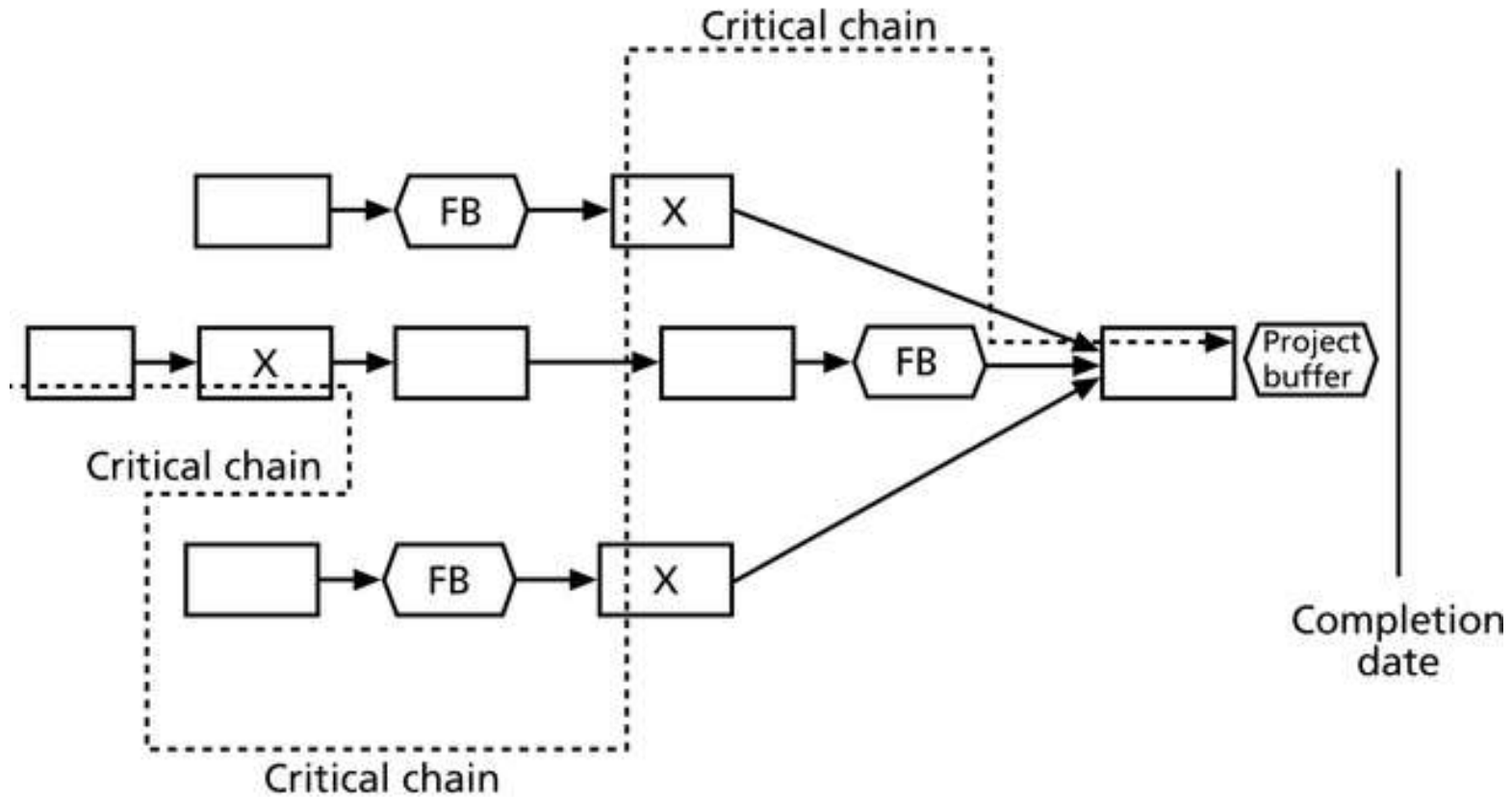
Buffers and Critical Chain

- In traditional estimates, people often add a buffer to each task and use it if it's needed or not
- A **buffer** is additional time to complete a task
  - This time is added to when there is multitasking, distractions, interruptions, fear that estimates will be reduced and Murphy's Law
    - **Murphy's Law** states that if something can go wrong, it will
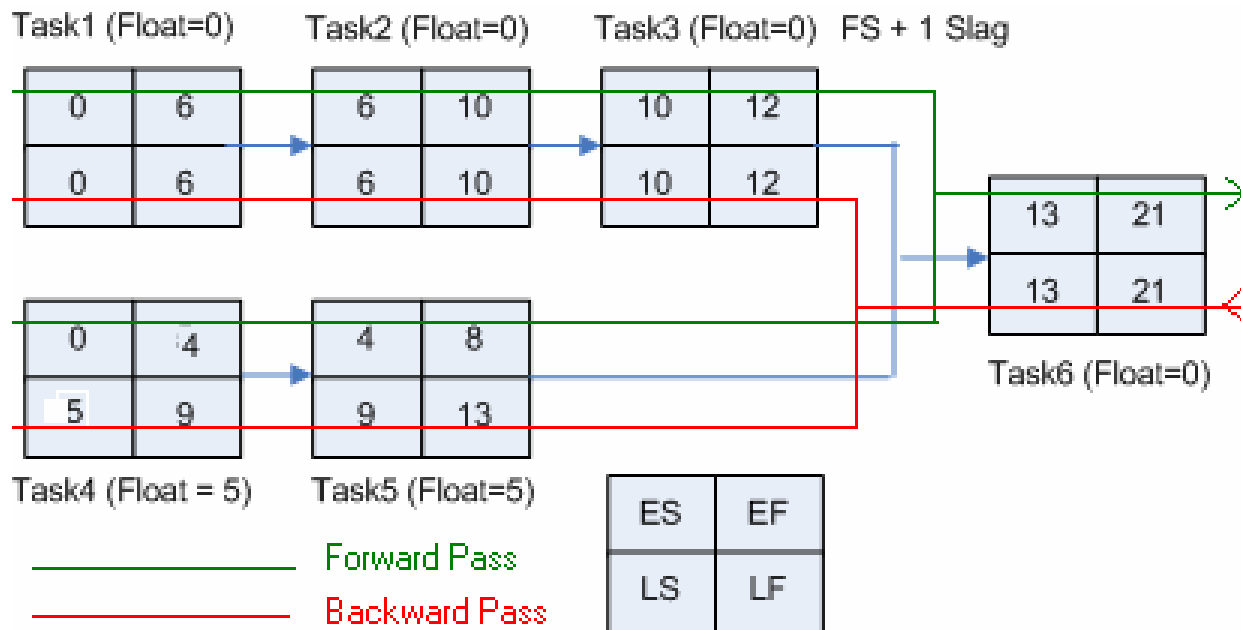
Project Time Management

Buffers and Critical Chain

- Critical chain scheduling removes buffers from individual tasks and instead creates:
  - A **project buffer** or additional time added before the project's due date
  - **Feeding buffers** or additional time added before tasks on the critical path that are preceded by non-critical-path tasks
- The tasks estimates in critical chain scheduling should be shorter than traditional estimates because they do not include their own buffers
  - Not having tasks buffers should mean less occurrence of **Parkinson's Law** - work expands to fill the time allowed
  - Feeding and project buffers protect the date that really needs to be met – the project completion date

*Project Time Management*

Example of Critical Chain Scheduling

X = Tasks done by limited resource
FB = Feeding buffer

Project Time Management

Example of Critical Chain Scheduling

Task1 (Float=0)   Task2 (Float=0)   Task3 (Float=0)   FS + 1 Slag

0	6
0	6

6	10
6	10

10	12
10	12

13	21
13	21

0	4
5	9

4	8
9	13

Task6 (Float=0)

Task4 (Float = 5)   Task5 (Float=5)

—— Forward Pass
—— Backward Pass

ES	EF
LS	LF

Critical Path = Task1+Task2+Task3+
Lag+ Task6 =
5+4+2+1+8 = **21 Days.**

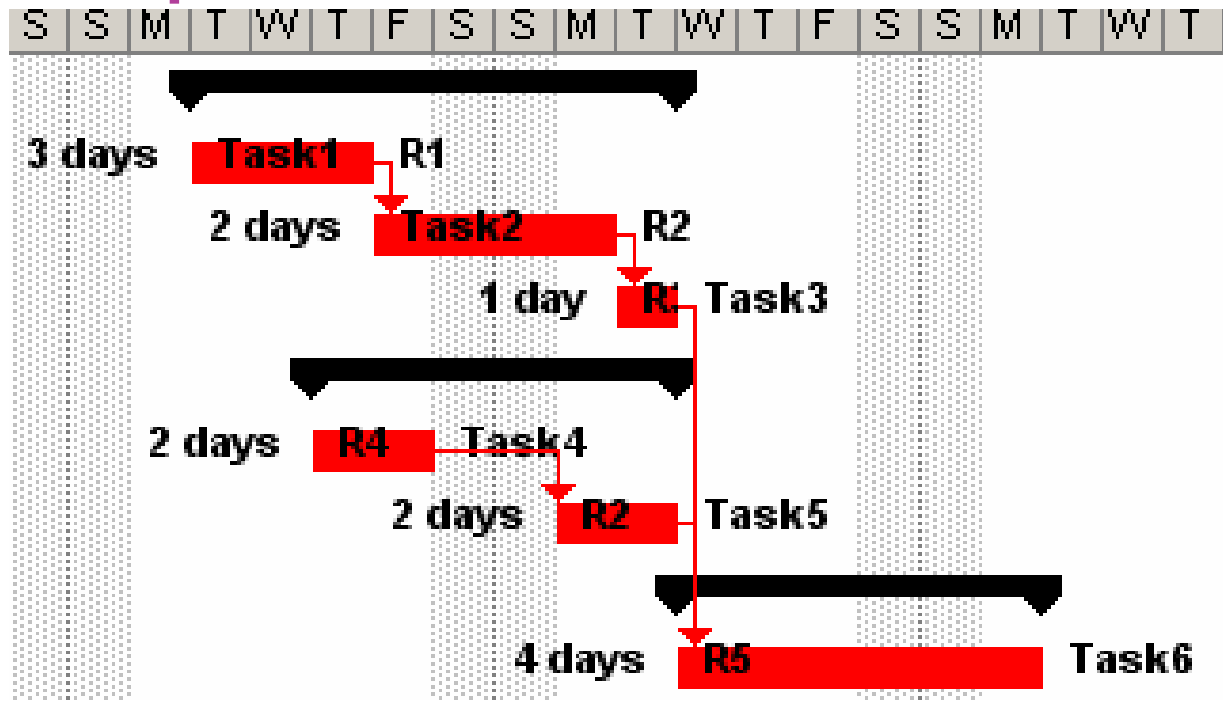| Task	Successor	Duration	Resource	Lag
Task1	Task2	6	R1	0
Task2	Task3	4	R2	0
Task3	Task6	2	R3	FS+1
Task4	Task5	4	R4	0
Task5	Task6	4	R2	0
Task6	–	8	R5	0

FS = Finish to Start

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Example of Critical Chain Scheduling
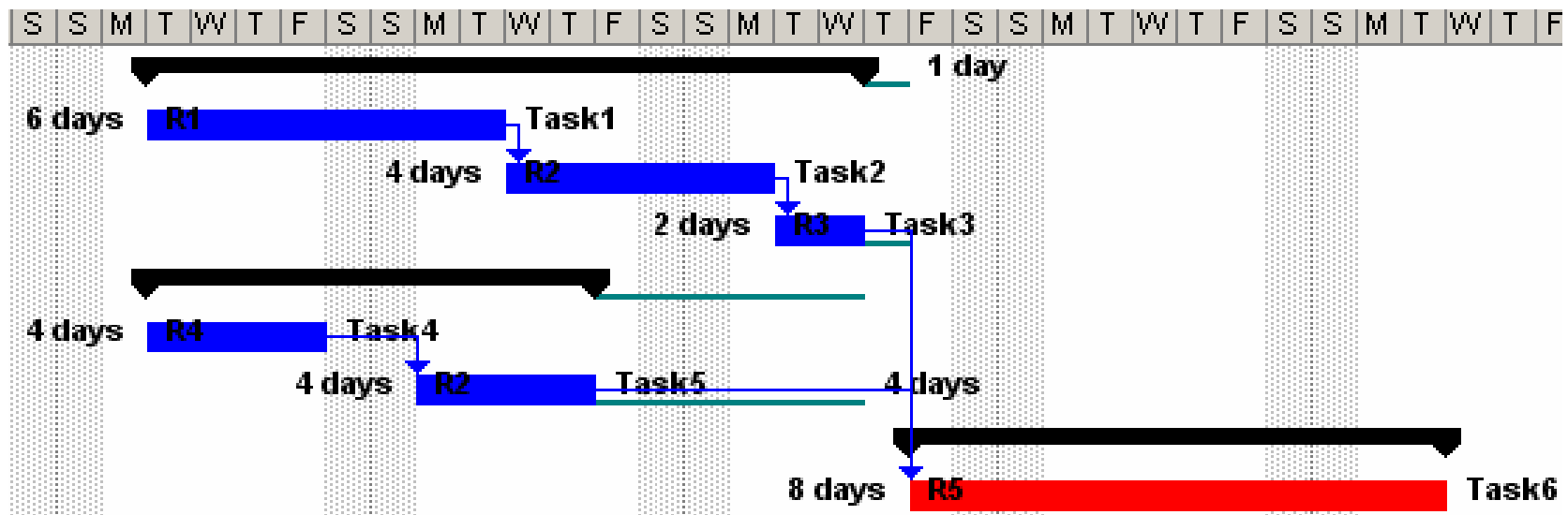
Critical Path = Task1+Task2+Task3+
Lag+ Task6 =
 5+4+2+1+8 = **21 Days.**

Example of Critical Chain Scheduling

Remove safety time and reduce tasks durations by 50%.
Project Duration = Task1+Task2+Task3+ Task6 = 3+2+1+4 = 10 Days.
Note:
• All safety time durations are removed. For example 1 day lag after Task 2 and 4 days after Task5 are removed.
• All tasks durations are reduced to half (50%). For example Task 1 is 3 Days instead of 6 days.

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Example of Critical Chain Scheduling
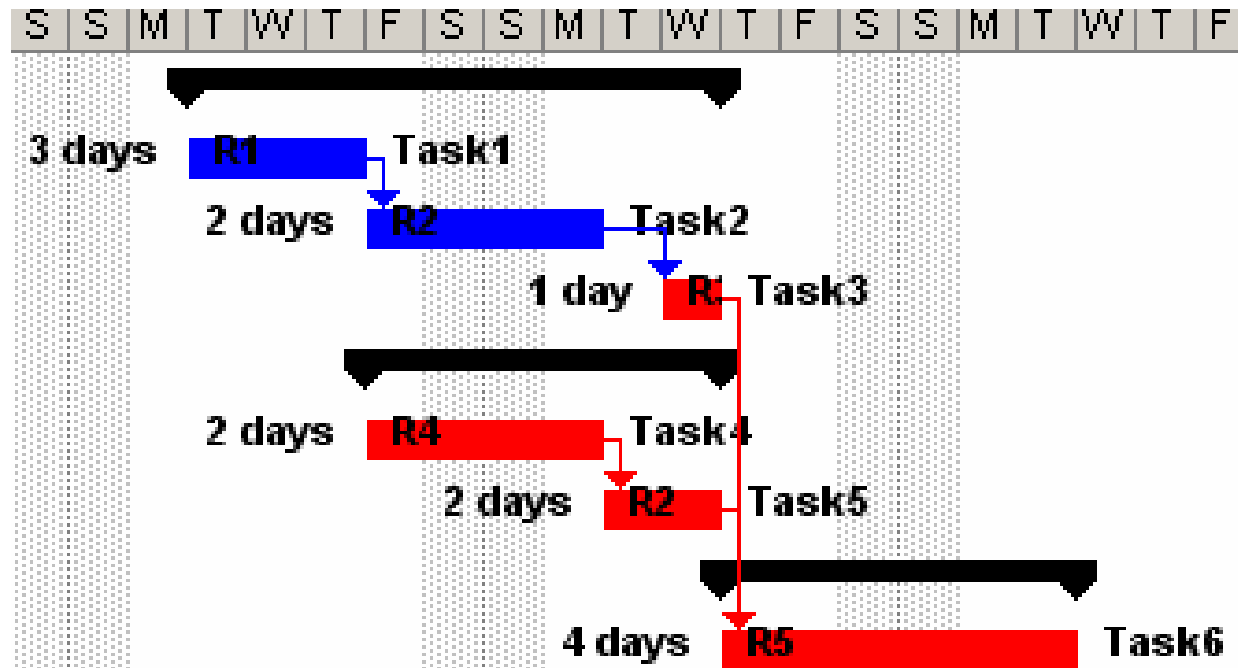
Create schedule on Late Finish dates and Remove resource constraints and identify critical chain.

Project Duration = Task1+Task2+Task5+ Task6 = 3+2+2+4 = 11 Days.

Note:
- Task3, Task4 and Task 5 are moved to start from Late Finish dates.
- Task2 and Task5 are to be done by resource R2 and so that aligned to remove resource constraints.

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Example of Critical Chain Scheduling
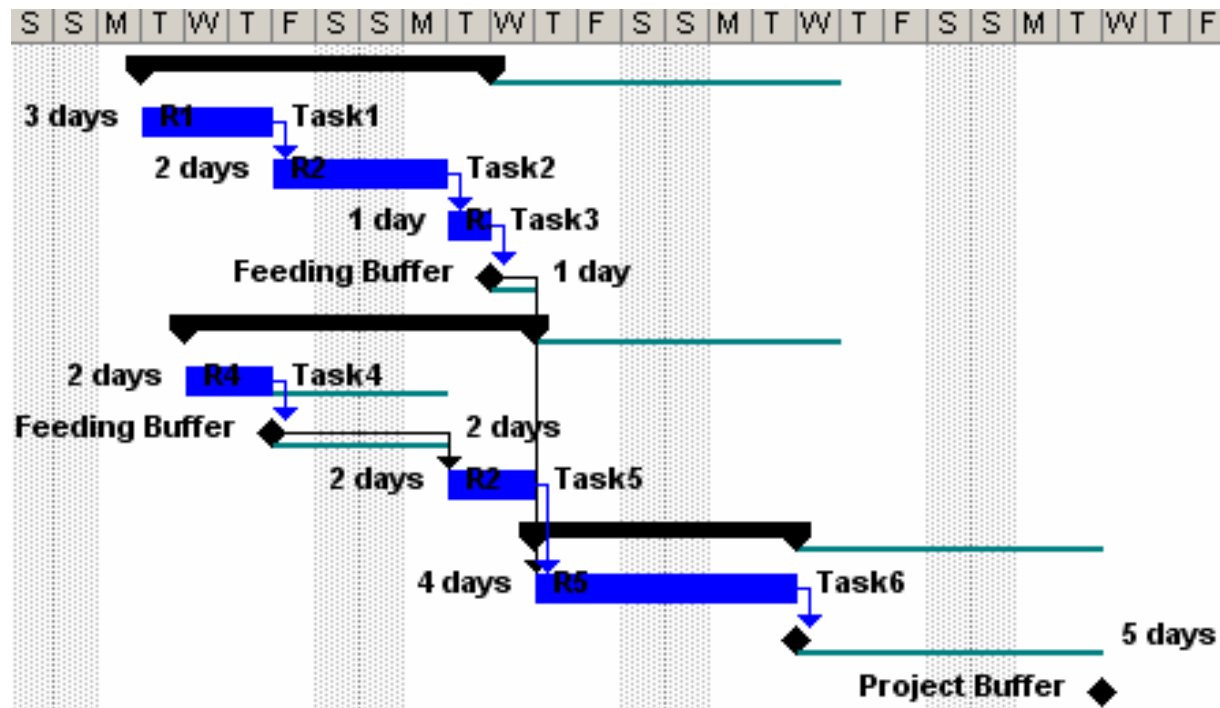
Add Project Buffer of 50% of the tasks duration and add Feeder buffer to non critical chain.
Project Duration = Task1+Task2+Task5+ Task6 + PB = 3+2+2+4+5 = 16 Days.
Note:
• Project Buffer (PB) = 50% of Project Duration (11 Days) = 5.5 Days = 5 Days (Rounded).
• Feeder Buffer (FB) for non critical tasks on chain. For example Task 4 is added 2 days FB.

Comparison of CPM and CCPM results

- According to the results we found above, project duration by CPM traditional approach is 21 days and the project duration for the same amount of work by using CCPM is 16 Days.

- Using CCPM:
  - Project Duration can be reduced by 25-40%.
  - Resources can be utilized effectively.
  - Project is fully focused on both critical and non critical tasks

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 attempts to address the risk associated with duration estimates by developing schedules that are more realistic
    - It involves more work than CPM since it requires several duration estimates

Project Time Management

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

Project Time Management

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 (chapter 7)

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
- Verify schedule progress – just because a team member says a task was completed on time doesn't always mean that it was

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 U.S. Army to transform project management into a cultural force at Bank of America; he used the same approach he did for packing tents when he led an interstate banking initiative

- 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

- However, because of his discipline with time management and planning, the software developers on the team finished all of the coding in only three months, and the project was completed on time*

*Melymuke, Kathleen, "Spit and Polish," *ComputerWorld (February 16, 1998).*

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

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 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

Project Time Management