

Project Time Management

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

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

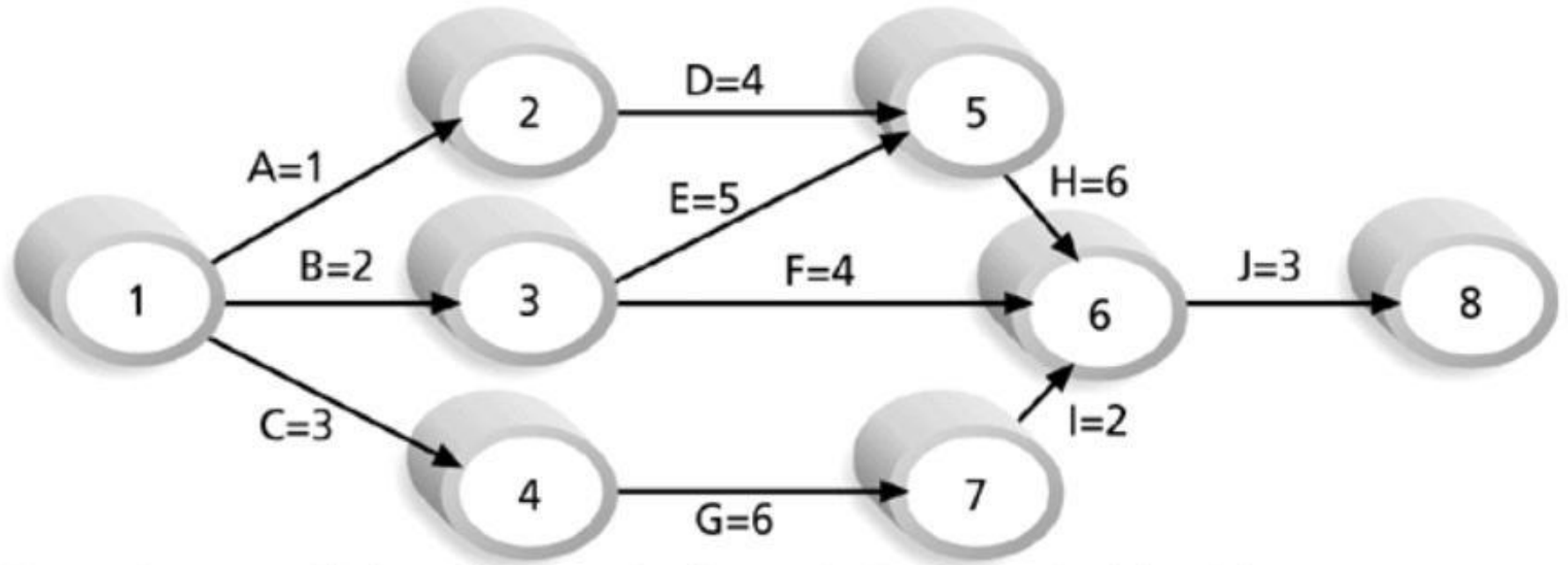
Activity Sequencing

- 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

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.

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

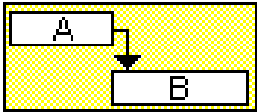
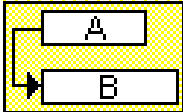
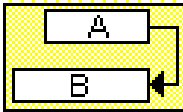
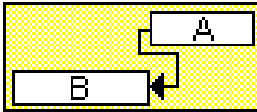
Precedence Diagramming Method (PDM)

- 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

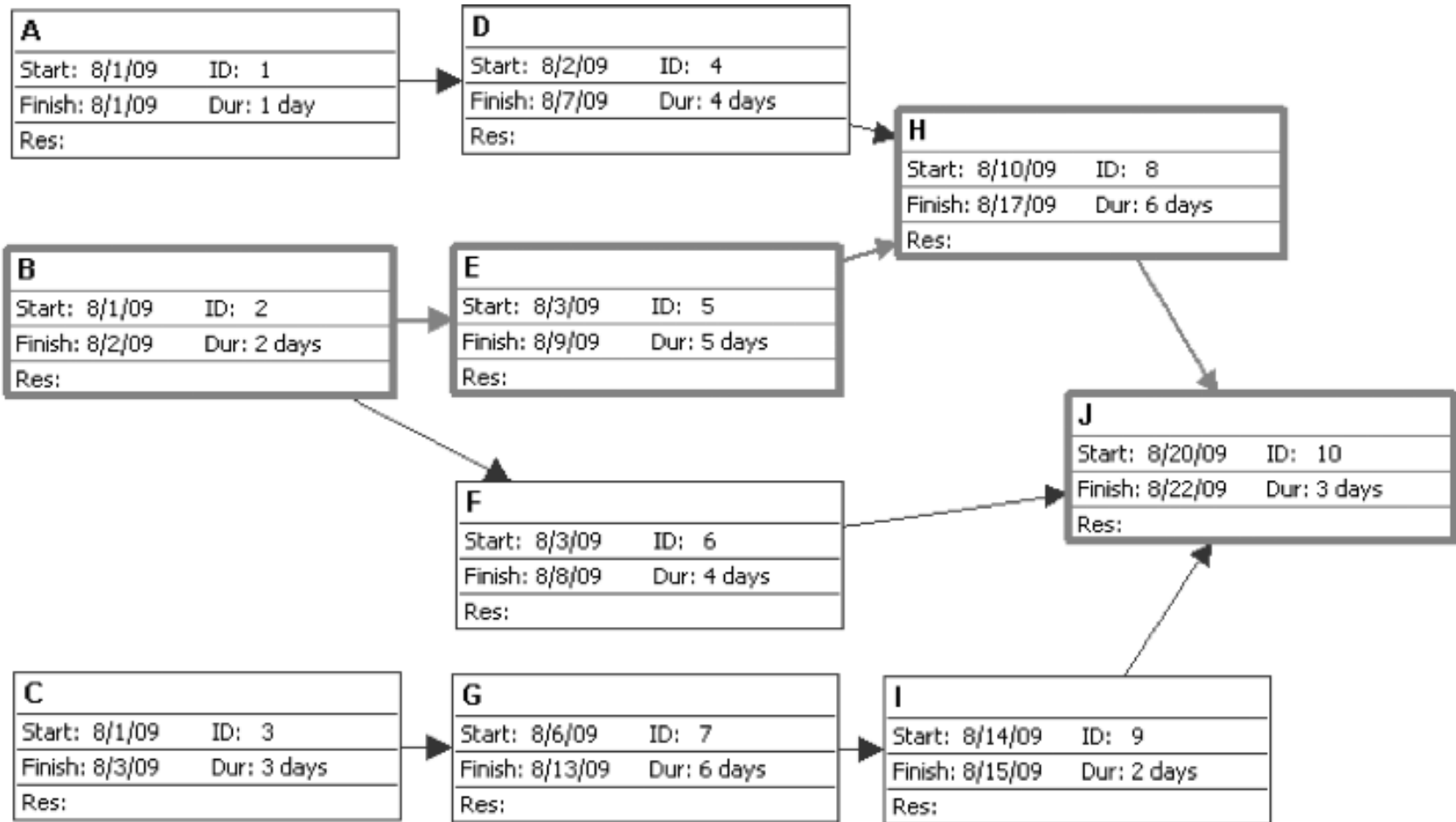
Task Dependency Types

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.

Sample PDM Network Diagram



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

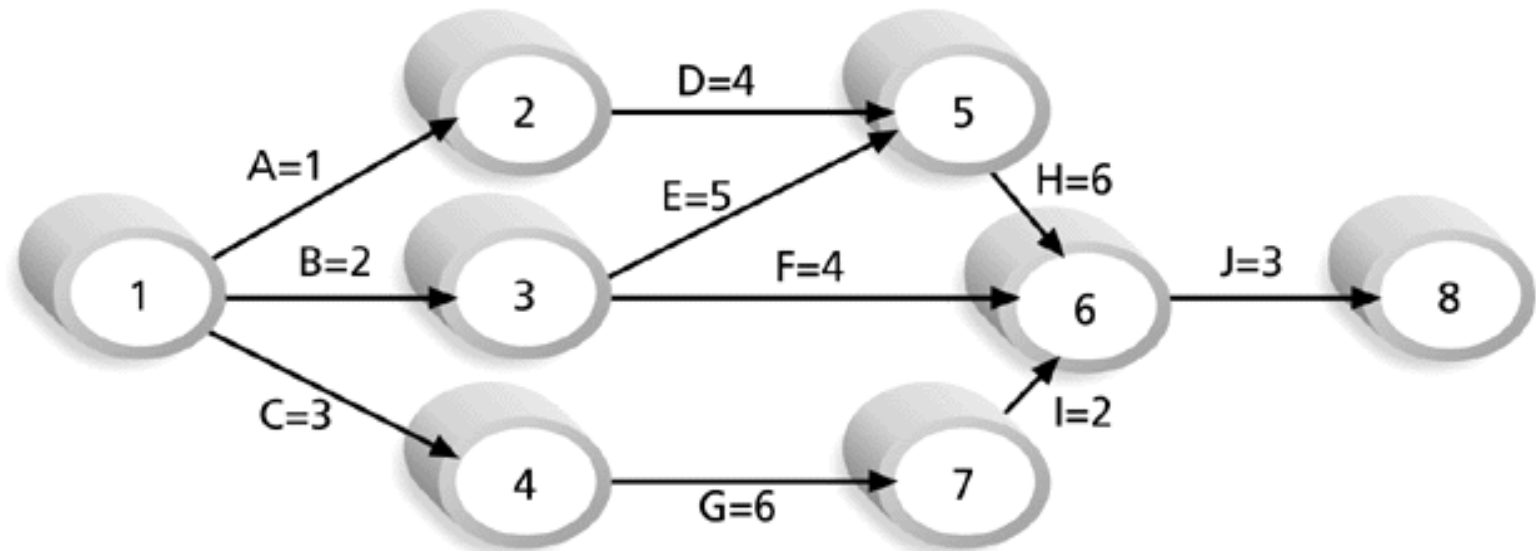
Critical Path Method (CPM)

- **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

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

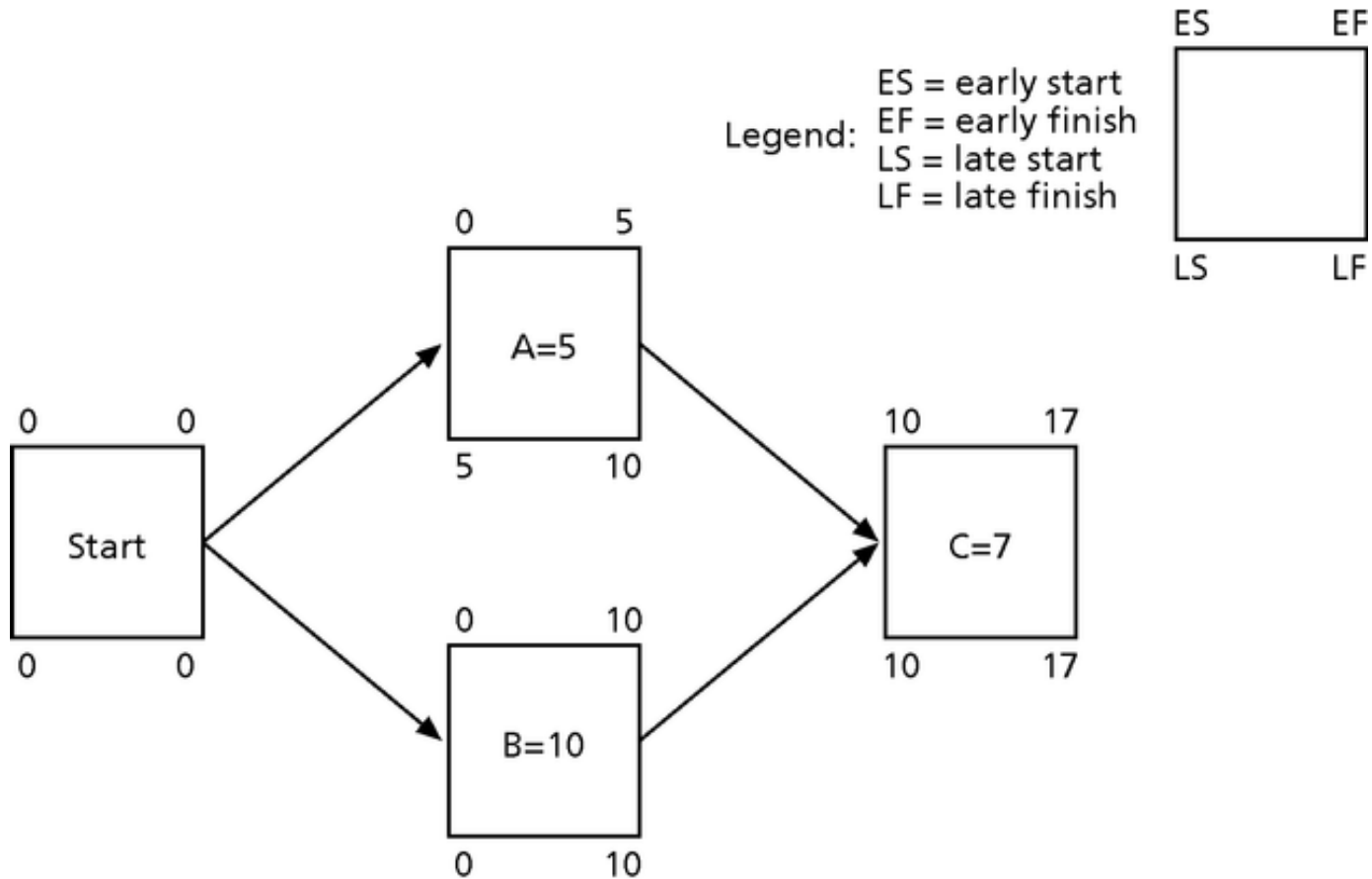
Path 4: C-G-I-J Length = $3+6+2+3 = 14$ days

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.

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

Calculating Early and Late Start and Finish Dates



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

How to Find the Critical Path

- General Foundry's network with expected activity times

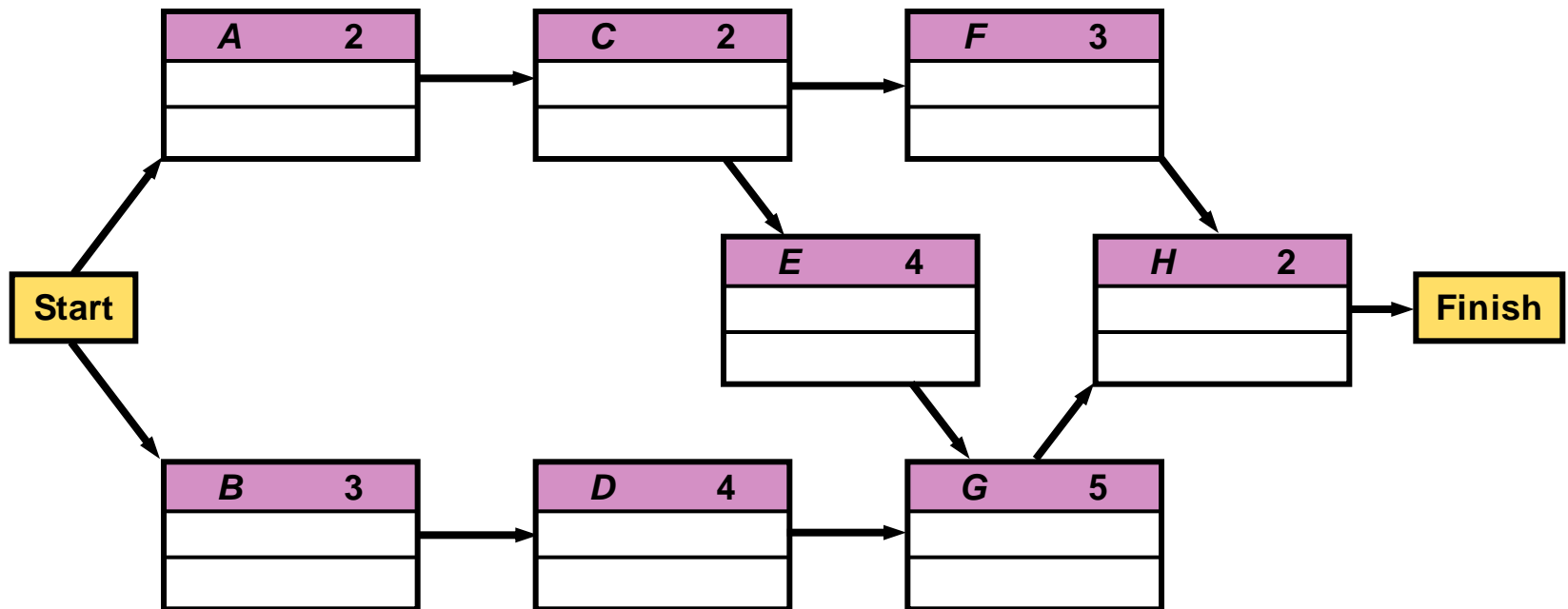


Figure 13.3

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	<i>t</i>
ES	EF
LS	LF

- Earliest times are computed as

**Earliest finish time = Earliest start time
+ Expected activity time**

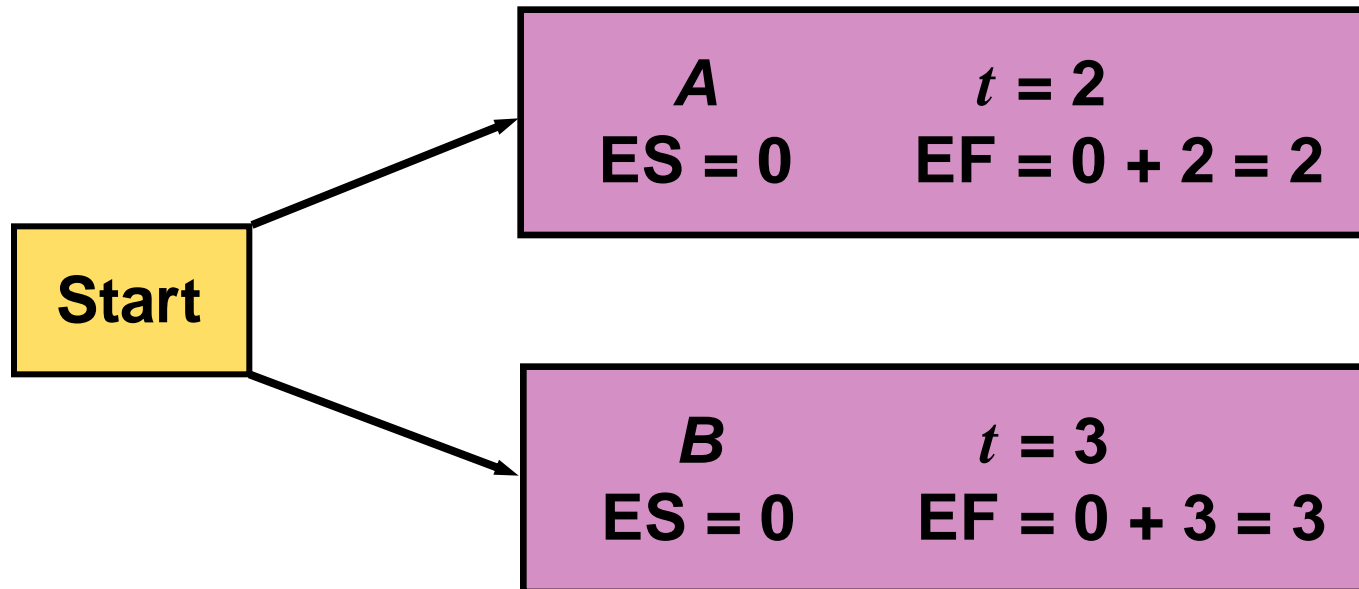
$$\mathbf{EF = ES + t}$$

**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

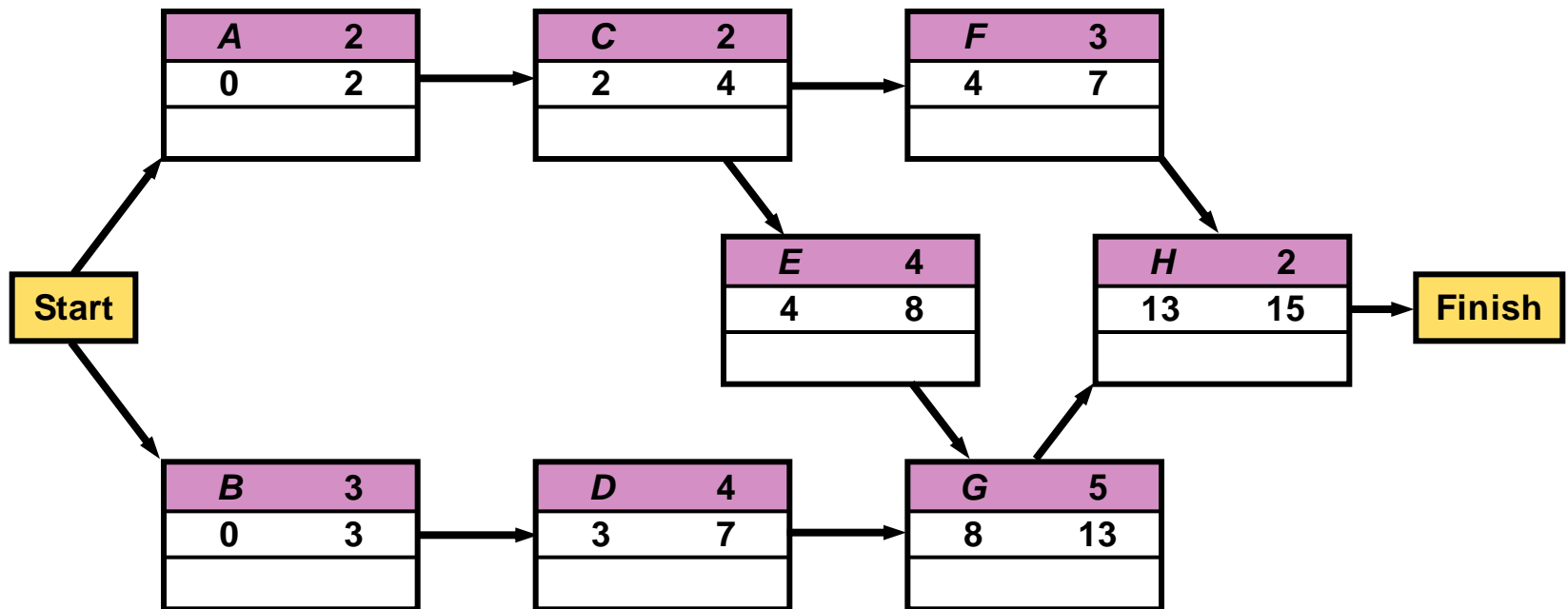


Figure 13.4

How to Find the Critical Path

- Latest times are computed as

**Latest start time = Latest finish time
– Expected activity time**

$$\mathbf{LS = LF - t}$$

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

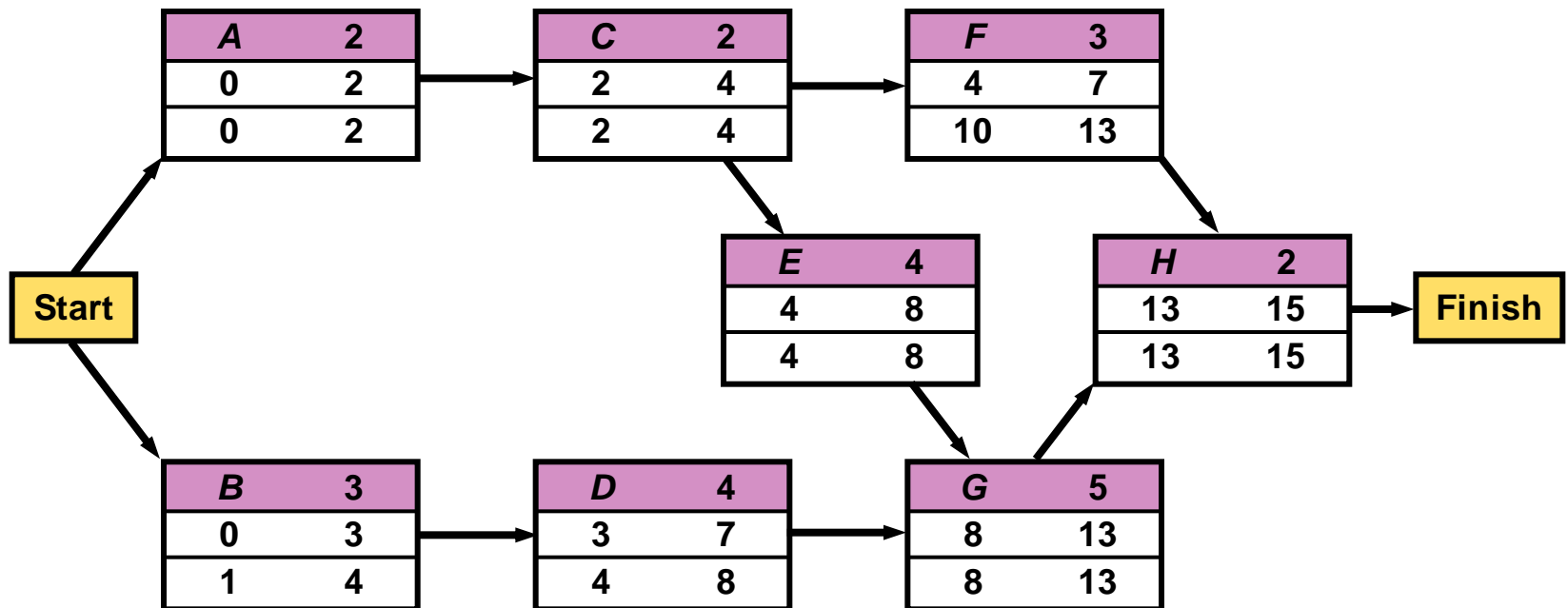
LF = Smallest LS of following activities

- For activity *H*

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

How to Find the Critical Path

- General Foundry's LS and LF times



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

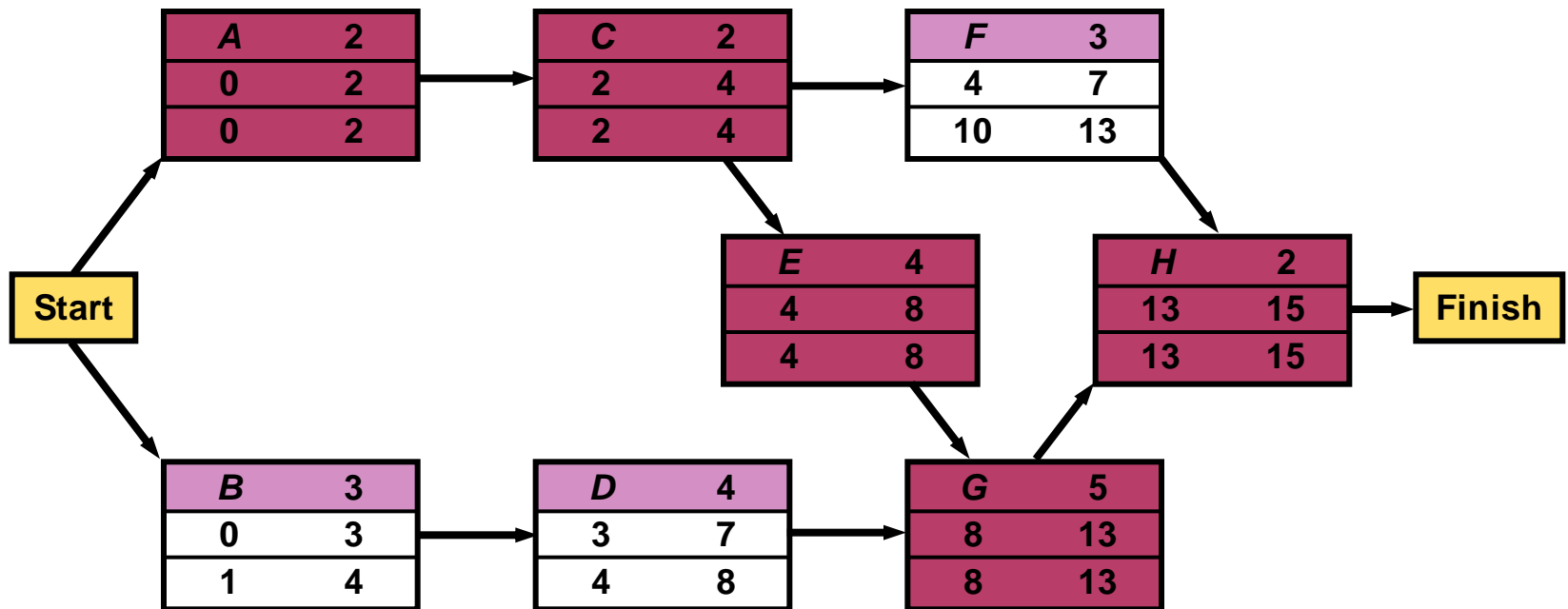
How to Find the Critical Path

- 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?
<i>A</i>	0	2	0	2	0	Yes
<i>B</i>	0	3	1	4	1	No
<i>C</i>	2	4	2	4	0	Yes
<i>D</i>	3	7	4	8	1	No
<i>E</i>	4	8	4	8	0	Yes
<i>F</i>	4	7	10	13	6	No
<i>G</i>	8	13	8	13	0	Yes
<i>H</i>	13	15	13	15	0	Yes

How to Find the Critical Path

- General Foundry's critical path



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

PERT Formula and Example

- PERT weighted average =
$$\frac{\text{optimistic time} + 4 \times \text{most likely time} + \text{pessimistic time}}{6}$$

- Example:

PERT weighted average =
$$\frac{8 \text{ workdays} + 4 \times 10 \text{ workdays} + 24 \text{ workdays}}{6} = \mathbf{12 \text{ days}}$$

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

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