Project management

Lecture 8

Project Activity Scheduling

Background

Schedule is the conversion of a project action plan into an operating **timetable**

It serves as the basis for **monitoring** project

With the budget, it is one of the major project management **tools**

Work changes daily so a **detailed** plan is essential

Background Continued

Not all activities on a project need to be scheduled to the **same level** of detail

Most scheduling is at the **WBS level**, not the work package level

Only the most **critical** work packages may be shown on schedule

Most scheduling is based on **network** drawings

Network Scheduling

The basic approach of all scheduling techniques is to form a **network** of activity and event relationships

This network should graphically portray the sequential **relations** between the tasks in a project

Tasks that must precede or follow other tasks are then clearly **identified**, in time as well as function

Network Scheduling Advantage

Consistent **framework** for planning, scheduling, monitoring & controlling

Shows **interdependences** of all tasks, work packages, work elements

Shows when **resources** are needed

Ensures proper **communication** between departments and functions

Determines expected **completion** date

Identifies critical **activities** that if delayed, will delay the project completion

Network Scheduling Advantage Continued

Shows which activities can be **delayed**

Determines **start** dates

Shows which tasks must be **coordinated** to avoid resource or timing conflicts

Shows which tasks can run **in parallel**

Relieves some interpersonal **conflict** by clearly showing task dependencies

Allow probabilistic **estimates** of project completion by various dates

Network Techniques: PERT and CPM

With the exception of Gantt charts, the most common approach to scheduling is the use of network techniques such as **PERT** & **CPM**

The Program Evaluation and Review Technique (PERT) was developed by the U.S. Navy in 1958

The Critical Path Method (CPM) was developed by DuPont, Inc during the same time period

Network Techniques: PERT and CPM Continued

PERT has been primarily used for **research** & **development** projects

CPM was designed for **construction** projects and has been generally embraced by the construction industry

The two methods are quite similar and are often **combined** for educational presentation

Network Techniques: PERT and CPM Continued

Initially, CPM & PERT were two different approaches

- CPM used **deterministic** time estimates and allowed project crunching
- PERT used **probabilistic** time estimates

Microsoft Project (and others) have **blended** CPM and PERT into one approach

Terminology

Activity - A specific task or set of tasks that are required by the project, use up resources, and take time to complete

Event - The result of completing one or more activities

Network - The combination of all activities and events that define a project

- Drawn left-to-right
- Connections represent predecessors

Terminology Continued

Path - A series of connected activities

Critical - An activity, event, or path which, if delayed, will delay the completion of the project

Critical Path - The path through the project where, if any activity is delayed, the project is delayed

- There is always a critical path
- There can be more than one critical path

Terminology Continued

Sequential Activities - One activity must be completed before the next one can begin

Parallel Activities - The activities can take place at the same time

Immediate Predecessor - That activity that must be completed just before a particular activity can begin

Activity on Node (AON)

Nodes stand for events

Arrows show precedence

It is used for CPM networks

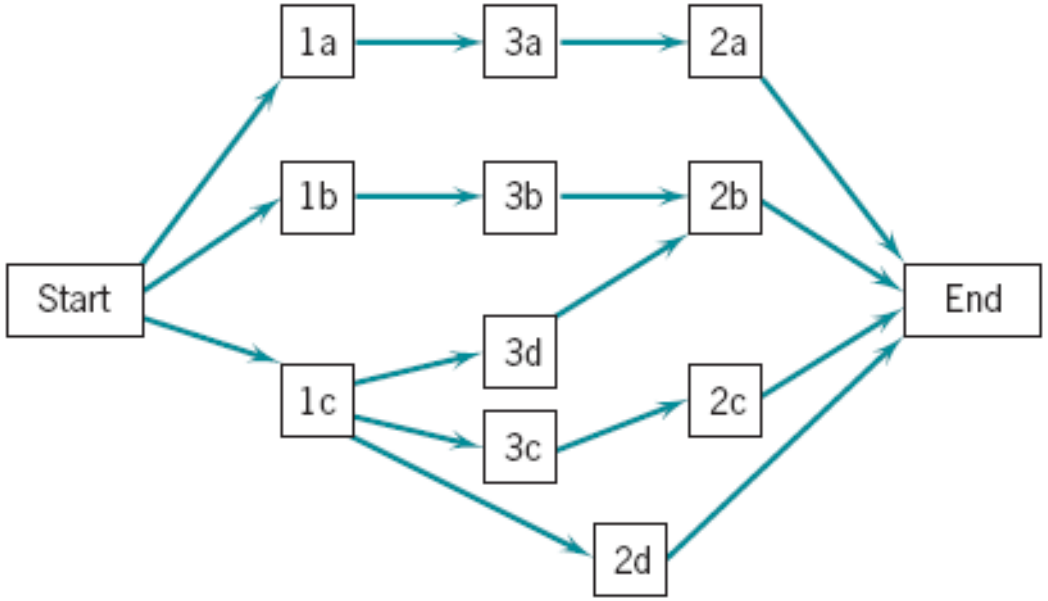


Figure 8-2

Activity on Arrow (AOA)

Arrows represent activities

Nodes stand for events

It is used for PERT networks

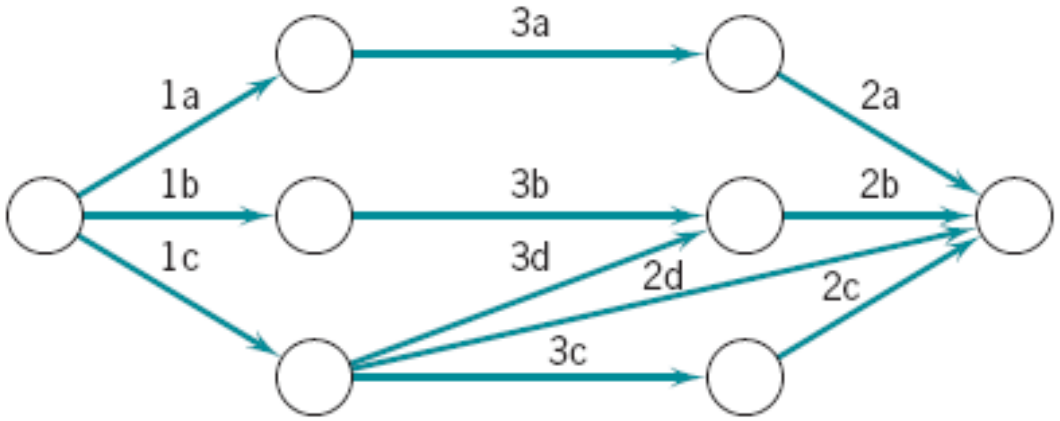


Figure 8-3

Constructing the Network (AON Version)

Begin with **START** activity

Add activities without precedences

- There will always be one
- May be more

Add **activities** that have those activities as precedences

Continue

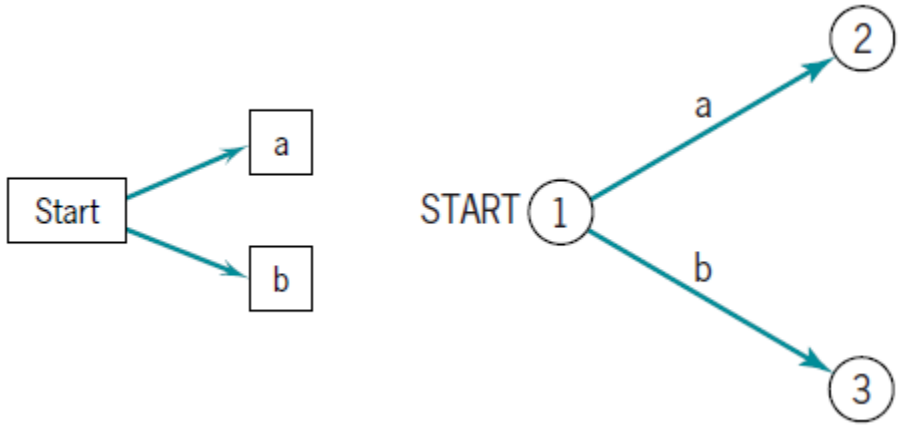


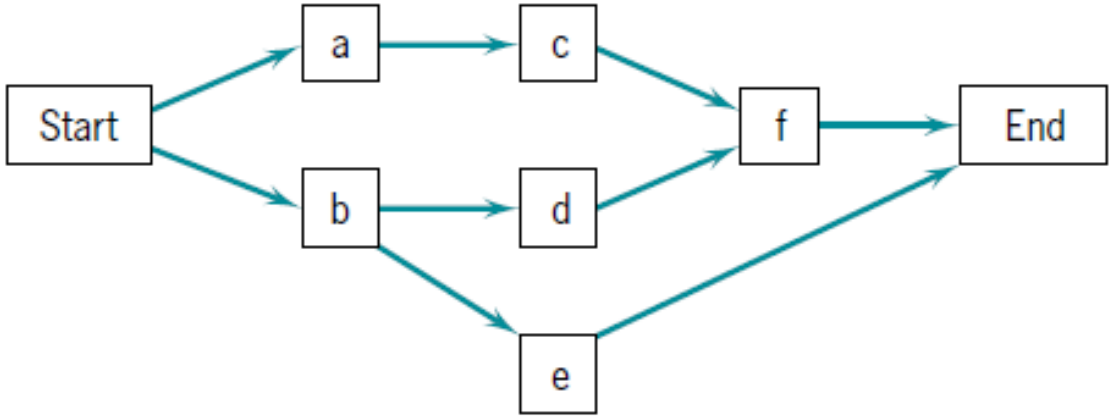
Figure 8-5

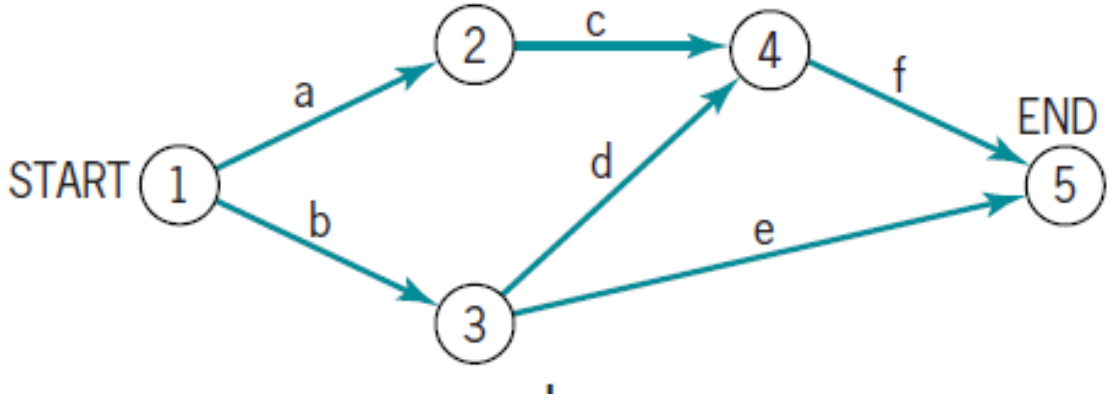
AON and AOA Formats

Tasks	Precedence	Time	Cost	Who Does
a	—	5 days	—	—
b	—	4 days	—	—
c	a	6 days	—	—
d	b	2 days	—	—
e	b	5 days	—	—
f	c,d	8 days	—	—

Figure 8-4

AON and AOA Formats Continued





Gantt Charts

The Gantt chart shows **planned** & **actual** progress for a number of tasks displayed against a horizontal time scale

It is an effective and **easy-to-read** method of indicating the actual current status for each set of tasks compared to the planned progress for each item of the set

It can be helpful in expediting, sequencing, and reallocating resources among tasks

Gantt Charts Continued

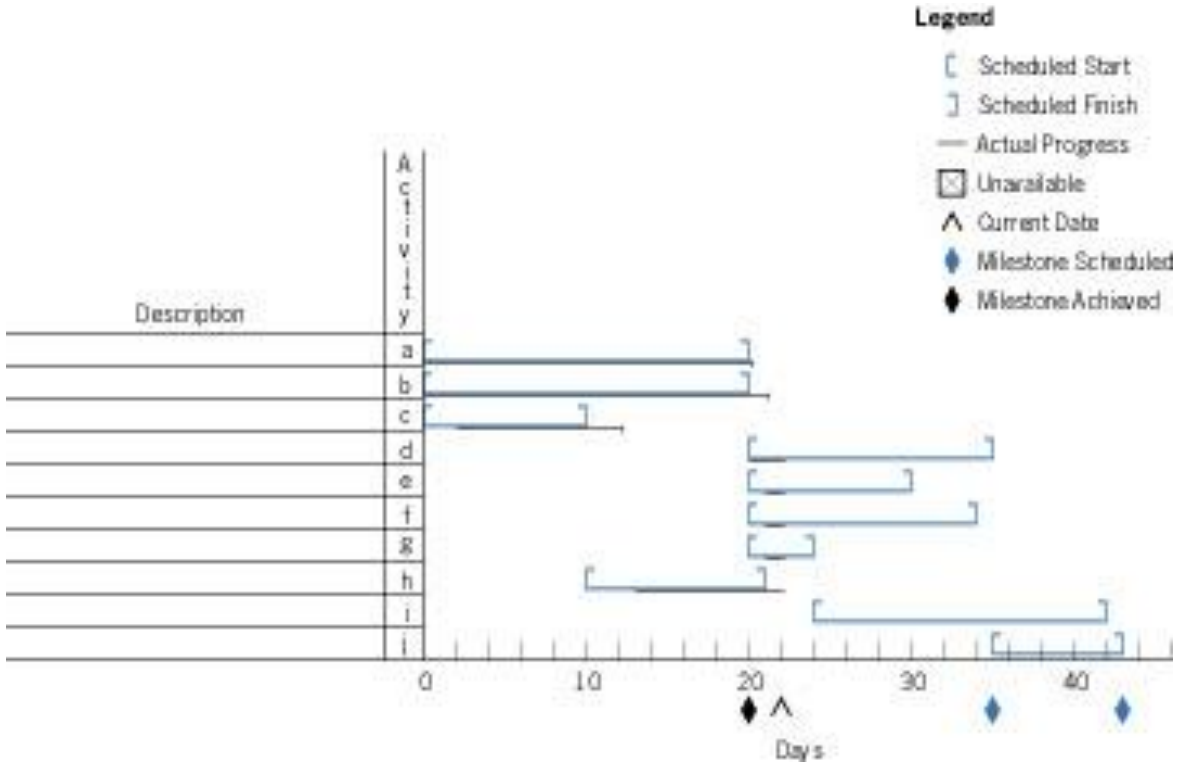


Figure 8-24

Gantt Charts Advantages

- Even though they may contain a great deal of information, they are *easily* **understood**
- While they may require frequent updating, they are *easy* **to maintain**
- Gantt charts provide a clear picture of the current **state** of a project
- They are *easy* **to construct**

Microsoft Project Gantt Chart

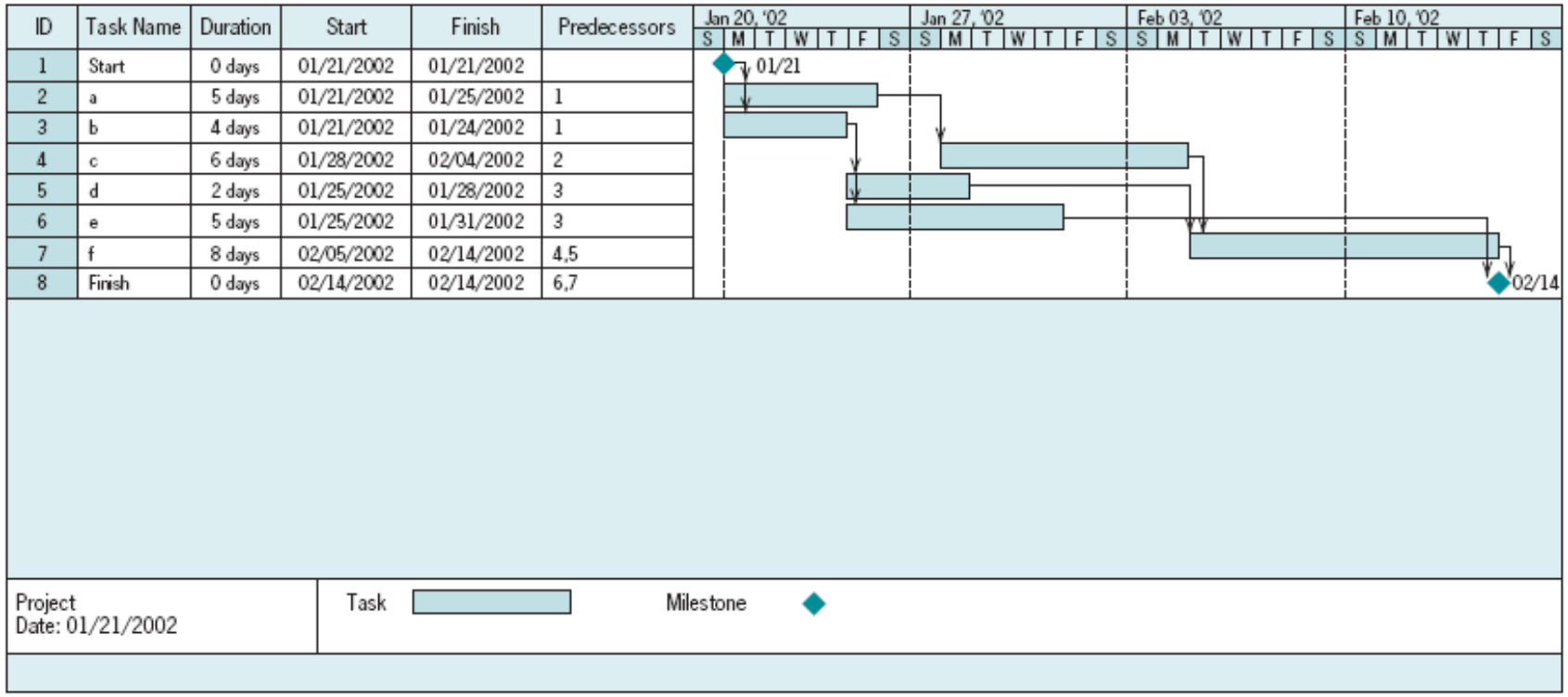


Figure 8-11

Microsoft Project AON Network

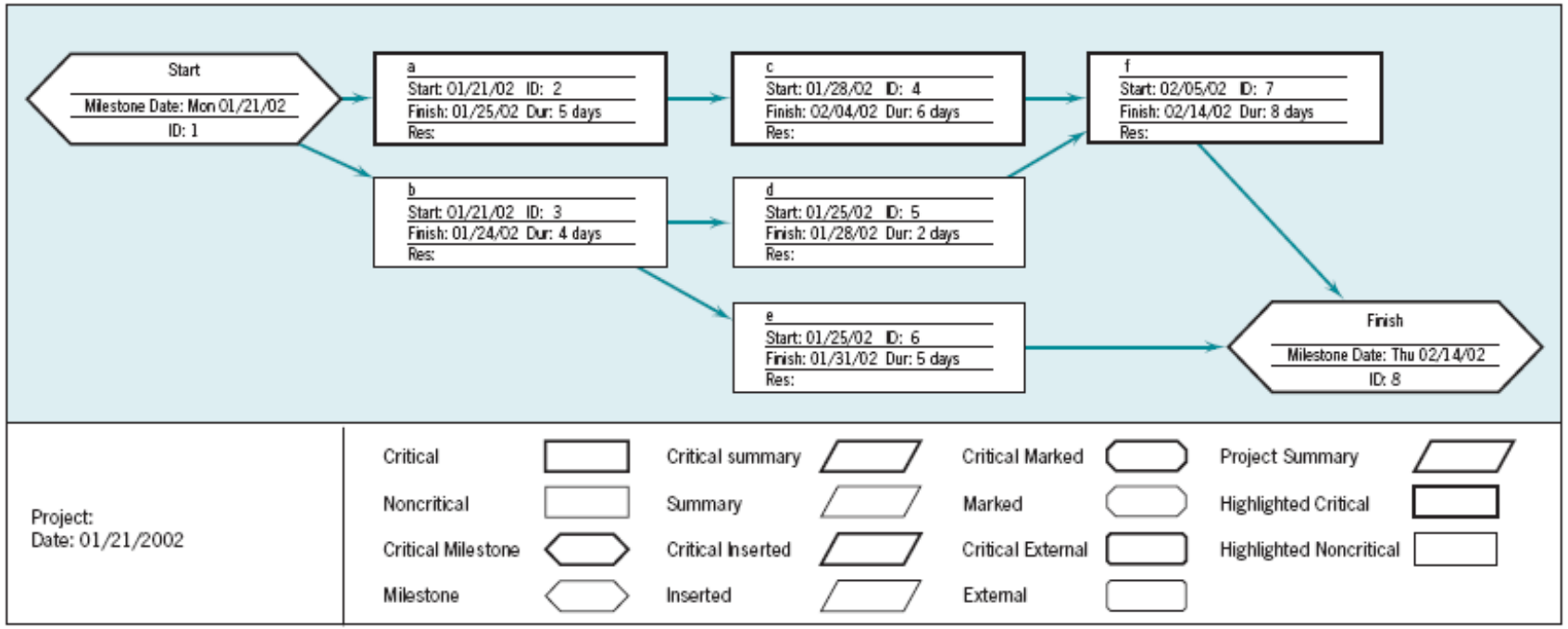


Figure 8-12

Solving the Network

Activity	*Optimistic Time*	*Most Likely Time*	*Pessimistic Time*	*Immediate Predecessor Activities*
a	10	22	22	—
b	20	20	20	—
c	4	10	16	—
d	2	14	32	a
e	8	8	20	b, c
f	8	14	20	b, c
g	4	4	4	b, c
h	2	12	16	c
i	6	16	38	g, h
j	2	8	14	d, e

Table 8-1

The AON Network

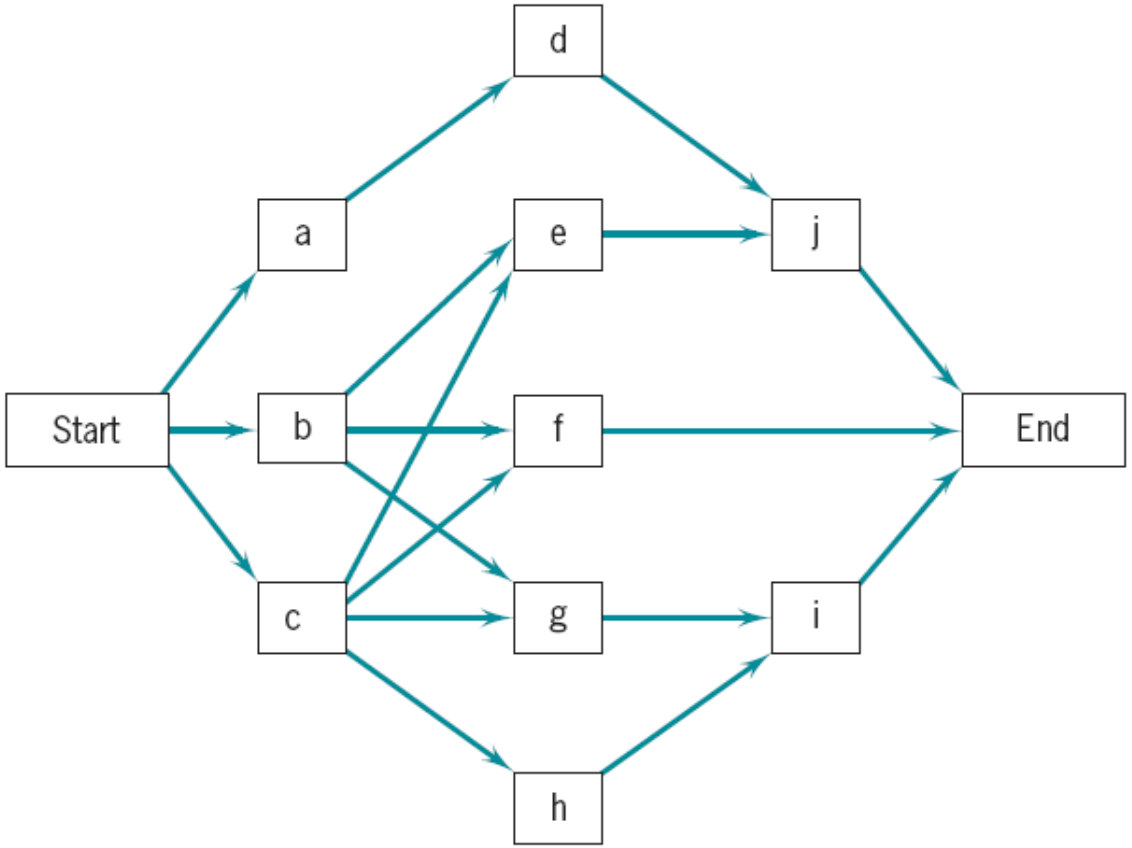


Figure 8-14

Calculating Activity Times

$$TE = \frac{(a + 4m + b)}{6}$$

$$\sigma^2 = \left(\frac{(b - a)}{6} \right)^2$$

$$\sigma = \sqrt{\sigma^2}$$

The Results

Activity	*Expected Time, TE*	*Variance, σ^2*	*Standard Deviation, σ*
a	20	4	2
b	20	0	0
c	10	4	2
d	15	25	5
e	10	4	2
f	14	4	2
g	4	0	0
h	11	5.4	2.32
i	18	28.4	5.33
j	8	4	2

Table 8-2

Distribution of all possible activity times for an activity

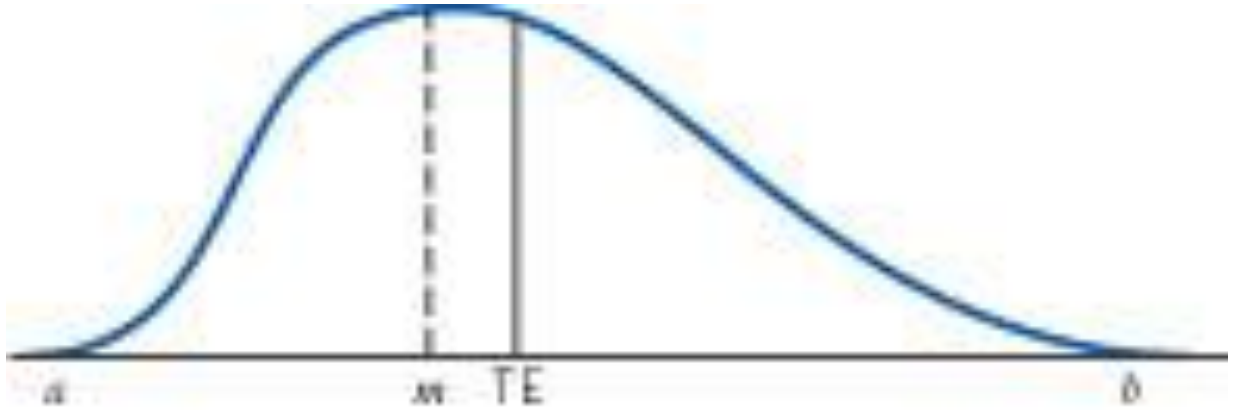


Figure 8-14

Critical Path and Time

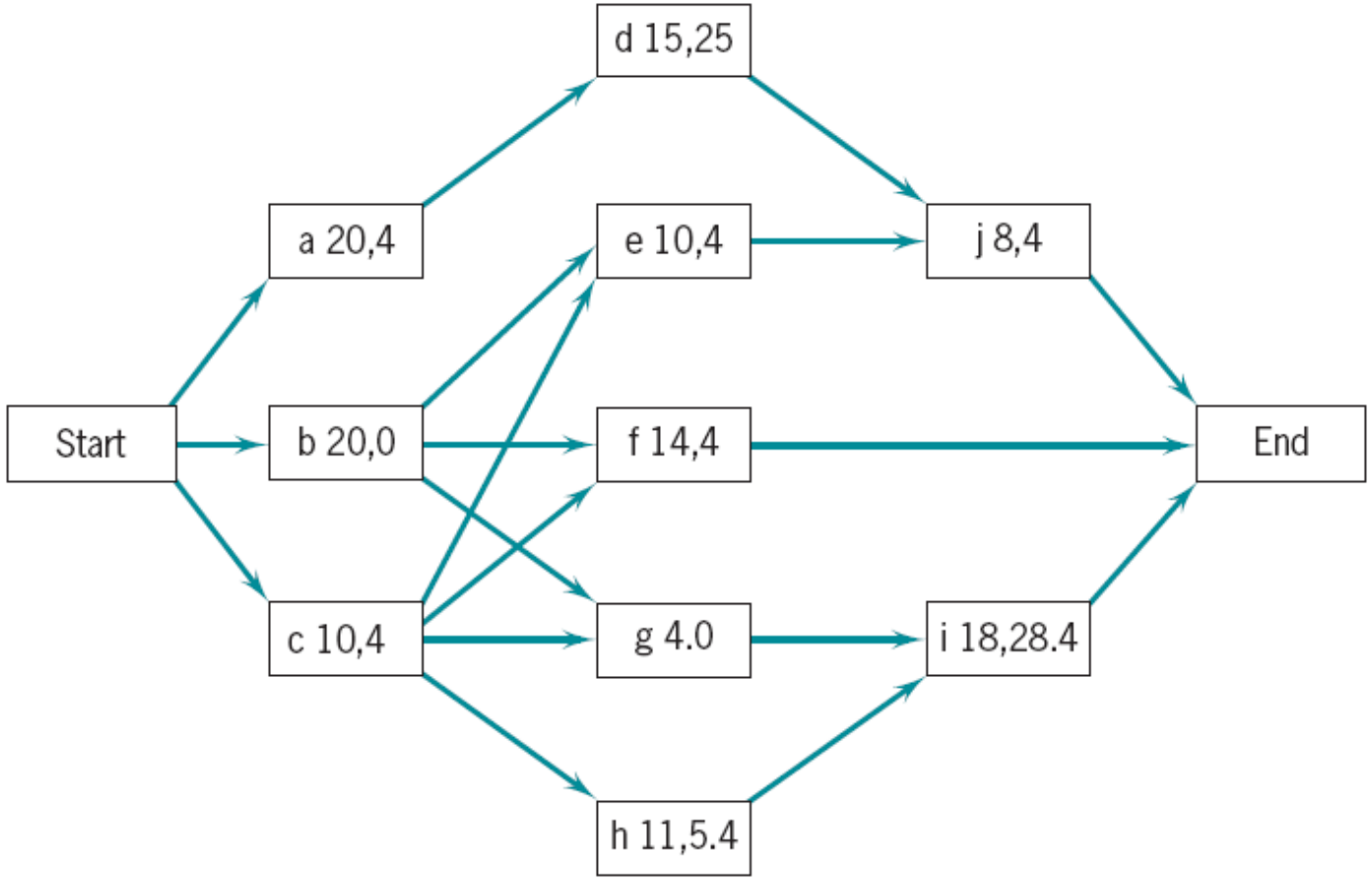


Figure 8-15

Critical Path and Time Continued

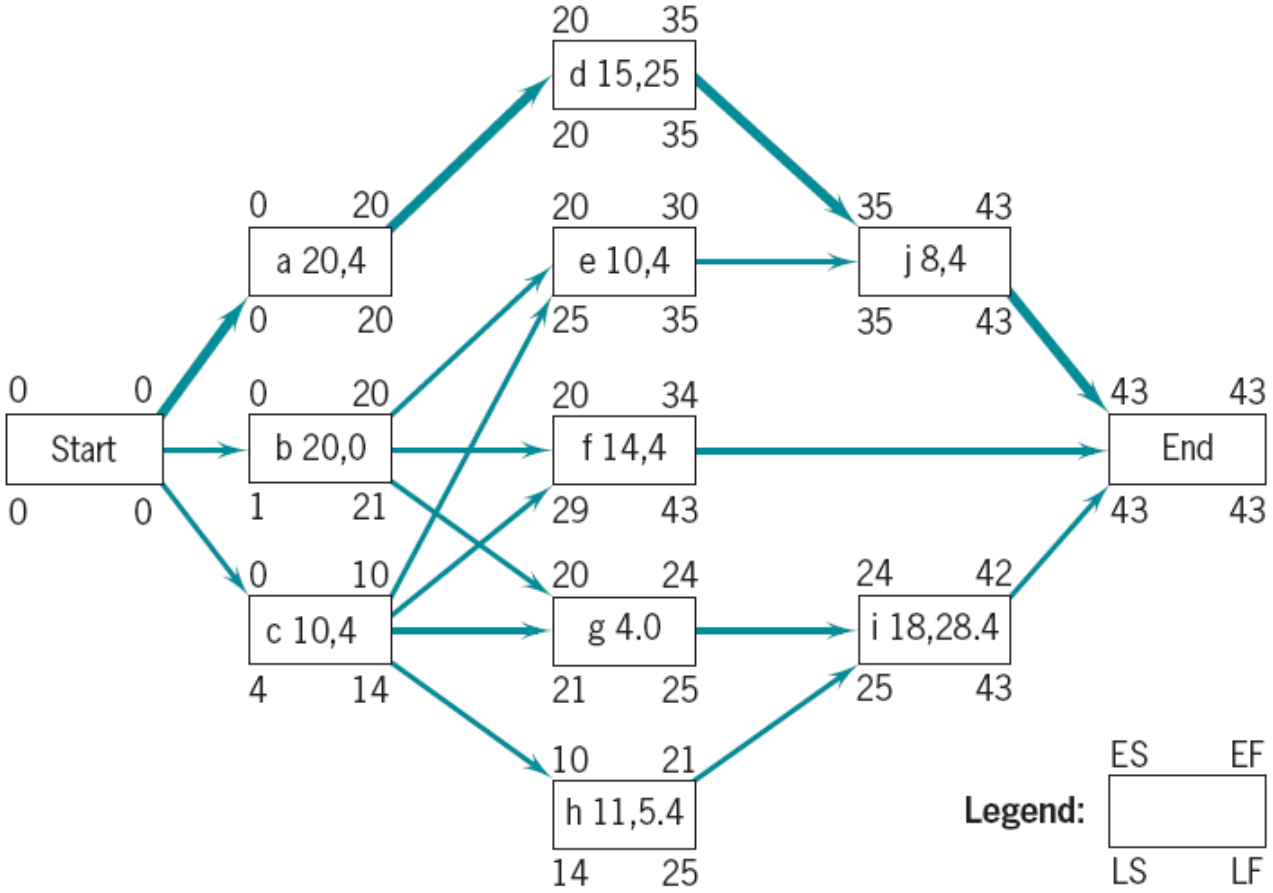


Figure 8-16

Slack

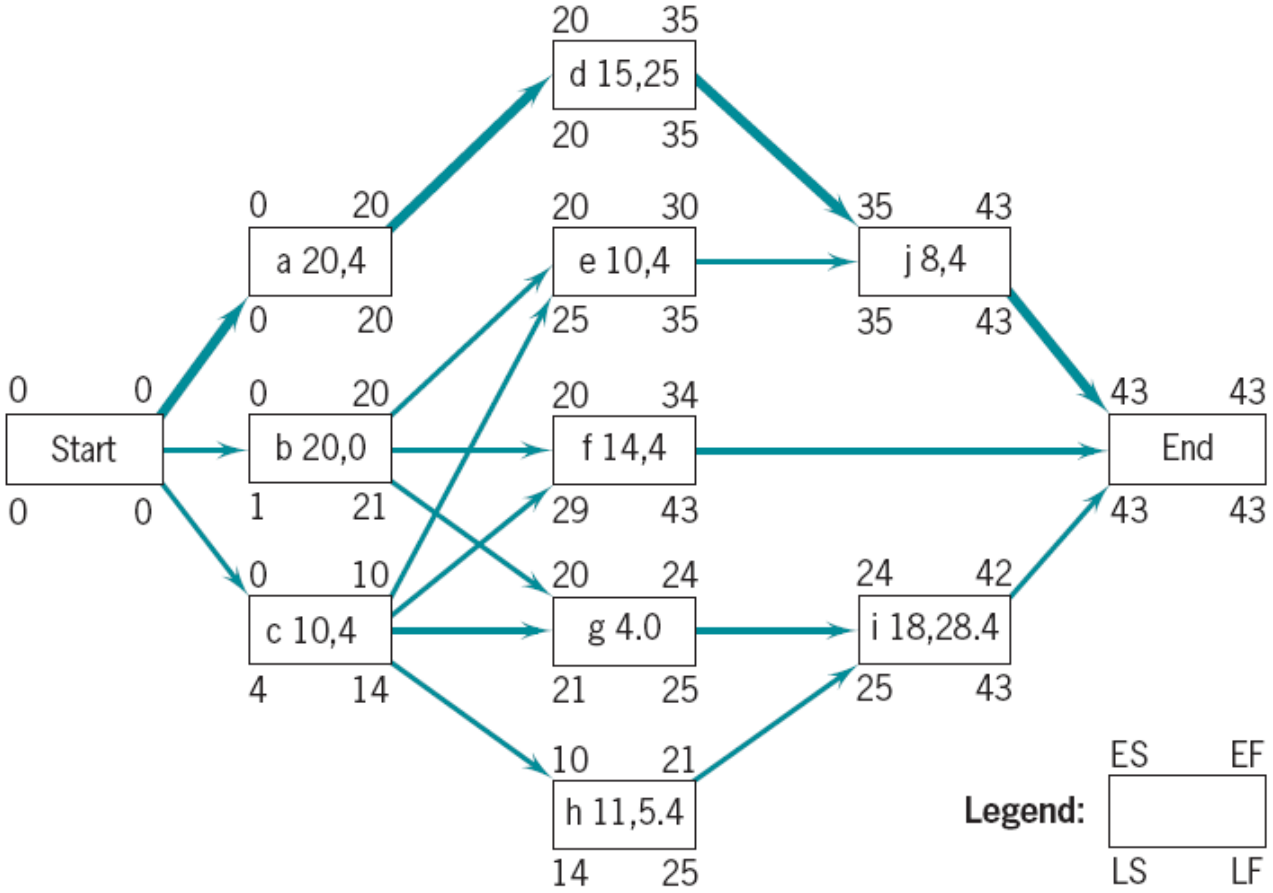


Figure 8-16

Slack Values

Activity	*LS*	*ES*	*Slack*
a	0	0	0
b	1	0	1
c	4	0	4
d	20	20	0
e	25	20	5
f	29	20	9
g	21	20	1
h	14	10	4
i	25	24	1
j	35	35	0

Table 8-3

Precedence Diagramming Conventions

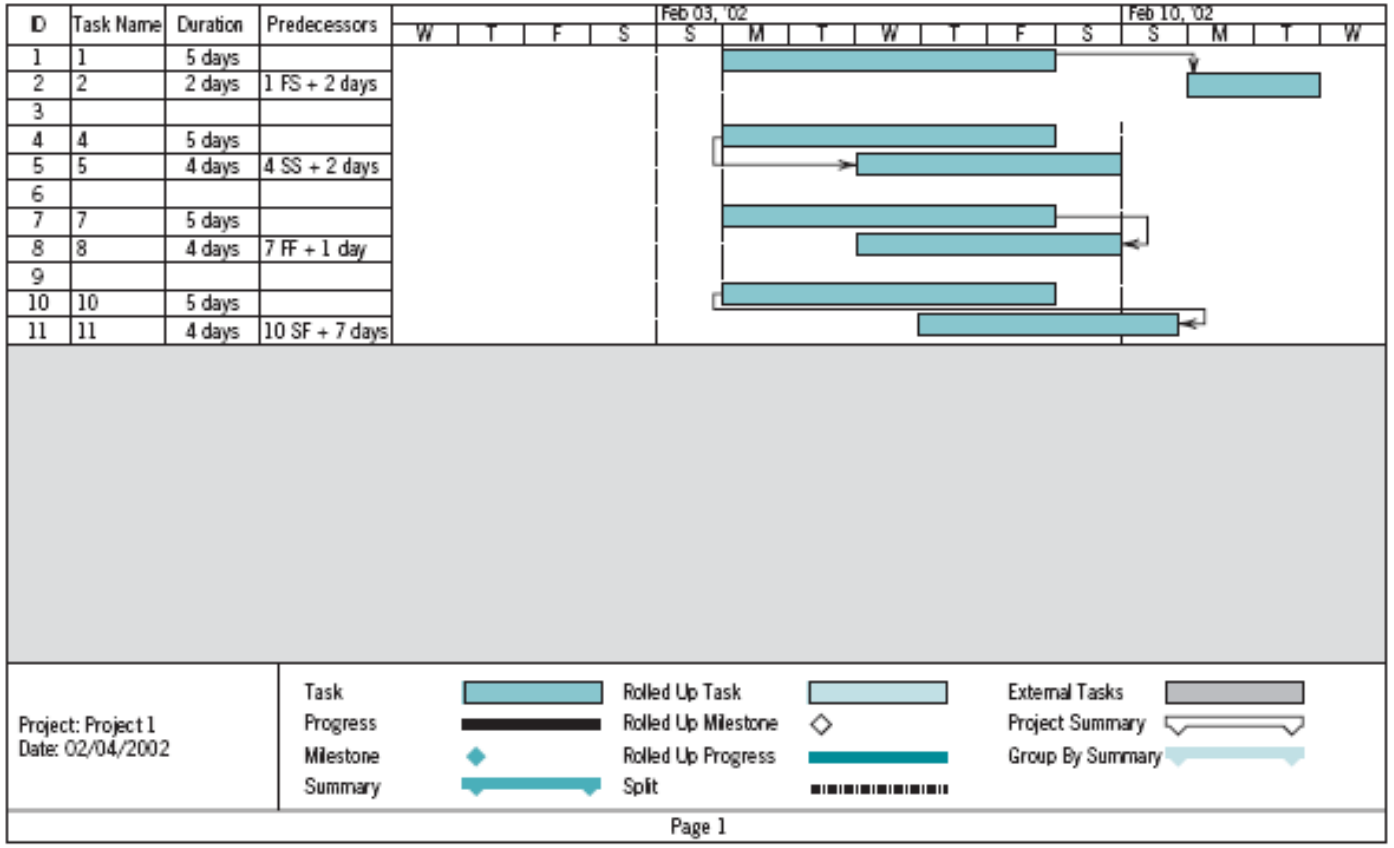


Figure 8-17

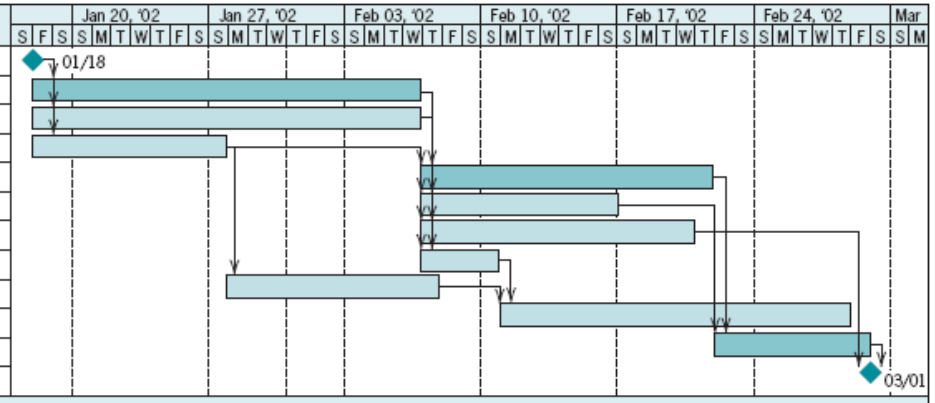
Microsoft Projects

ID	*Task Name*	*Predecessors*	*Duration*	*Optimistic Duration*	*Expected Duration*	*Pessimistic Duration*
1	Start		0 days	0 days	0 days	0 days
2	a	1	20 days	10 days	22 days	22 days
3	b	1	20 days	20 days	20 days	20 days
4	c	1	10 days	4 days	10 days	16 days
5	d	2	15 days	2 days	14 days	32 days
6	e	3, 4	10 days	8 days	8 days	20 days
7	f	4, 3	14 days	8 days	14 days	20 days
8	g	3, 4	4 days	4 days	4 days	4 days
9	h	4	11 days	2 days	12 days	16 days
10	i	9, 8	18 days	6 days	16 days	38 days
11	j	5, 6	8 days	2 days	8 days	14 days
12	Finish	10, 11, 7	0 days	0 days	0 days	0 days

Table 8-4

Gantt Chart

ID	Task Name	Duration	Start	Finish
1	Start	0 days	01/18/2002	01/18/2002
2	a	20 days	01/18/2002	02/06/2002
3	b	20 days	01/18/2002	02/06/2002
4	c	10 days	01/18/2002	01/27/2002
5	d	15 days	02/07/2002	02/21/2002
6	e	10 days	02/07/2002	02/16/2002
7	f	14 days	02/07/2002	02/20/2002
8	g	4 days	02/07/2002	02/10/2002
9	h	11 days	01/28/2002	02/07/2002
10	i	18 days	02/11/2002	02/28/2002
11	j	8 days	02/22/2002	03/01/2002
12	Finish	0 days	03/01/2002	03/01/2002



Project: Table 8-4
Date: 01/18/2002

Task
Critical Task
Progress
Milestone
Summary

Figure 8-18

AON Network

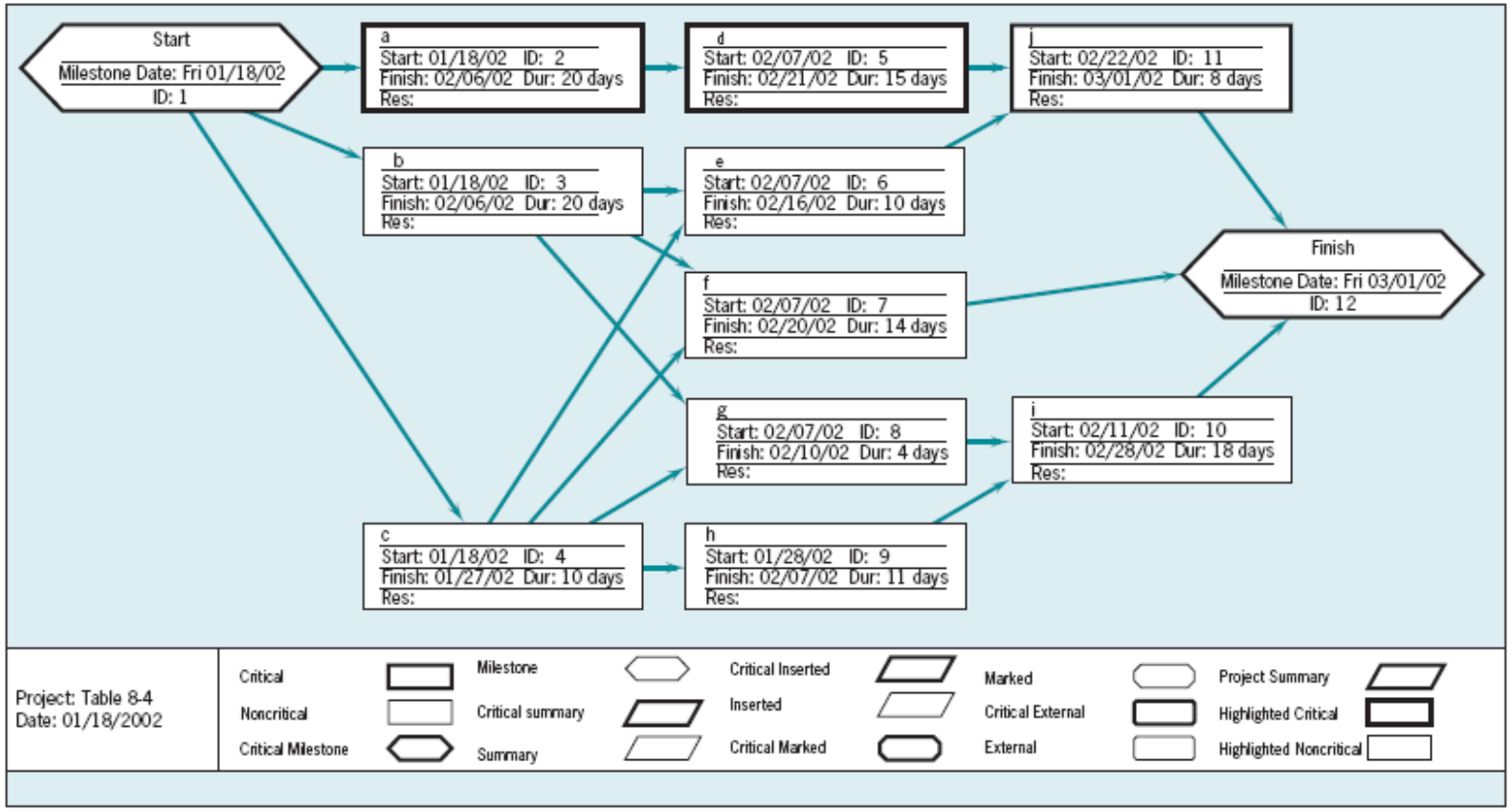


Figure 8-19

Microsoft Project Calendar

Figure 8-23

Uncertainty of Project Completion Time

Assume activities are statistically **independent**

Variance of a set of activities is the **sum** of the individual variances

Interested in variances along **critical** path

Example

$$Z = \frac{(D-\mu)}{\sqrt{\sigma_{\mu}^{2}}} = \frac{(50-43)}{\sqrt{33}} = \frac{7}{5.745} = 1.22$$

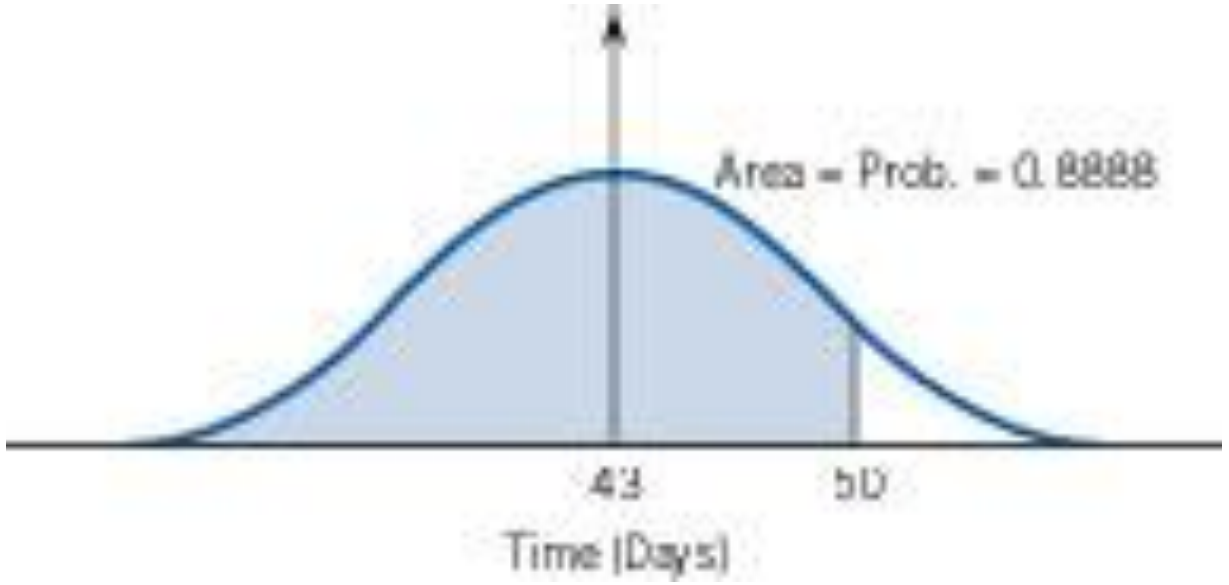


Figure 8-16

Toward Realistic Time Estimates

Calculations are based on 1% chance of beating estimates

Calculations can also be based on 5% or 10%

Changing the percentage requires changing the formulae for the variance

When using 5%, the divisor changes to 3.29

When using 10%, the divisor changes to 2.56