SGS 4613 REMOTE SENSING PROJECT MANAGEMENT

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Topic 5
PERT AND CPM NETWORKS

History

- **Late 1950s**
  - Program Evaluation and Review Technique (PERT)
    - U.S. Navy, Booz-Allen Hamilton, and Lockeheed Aircraft
    - Probabilistic activity durations
  - Critical Path Method (CPM)
    - Dupont De Nemours Inc.
    - Deterministic activity durations

The Language of PERT/CPM

- **Activity**
  - task or set of tasks
  - use resources
- **Event**
  - state resulting from completion of one or more activities
  - consume no resources or time
  - predecessor activities must be completed

The Language of PERT/CPM *continued*

- **Milestones**
  - events that mark significant progress
- **Network**
  - diagram of nodes and arcs
  - used to illustrate technological relationships
- **Path**
  - series of connected activities between two events

The Language of PERT/CPM *concluded*

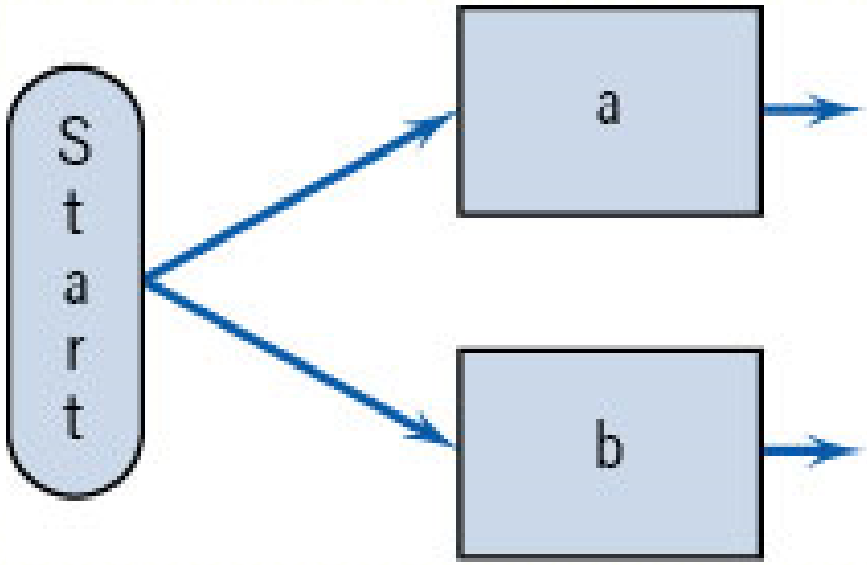
- **Critical Path**
  - set of activities on a path that if delayed will delay completion of project
- **Critical Time**
  - time required to complete all activities on the critical path

Building the Network

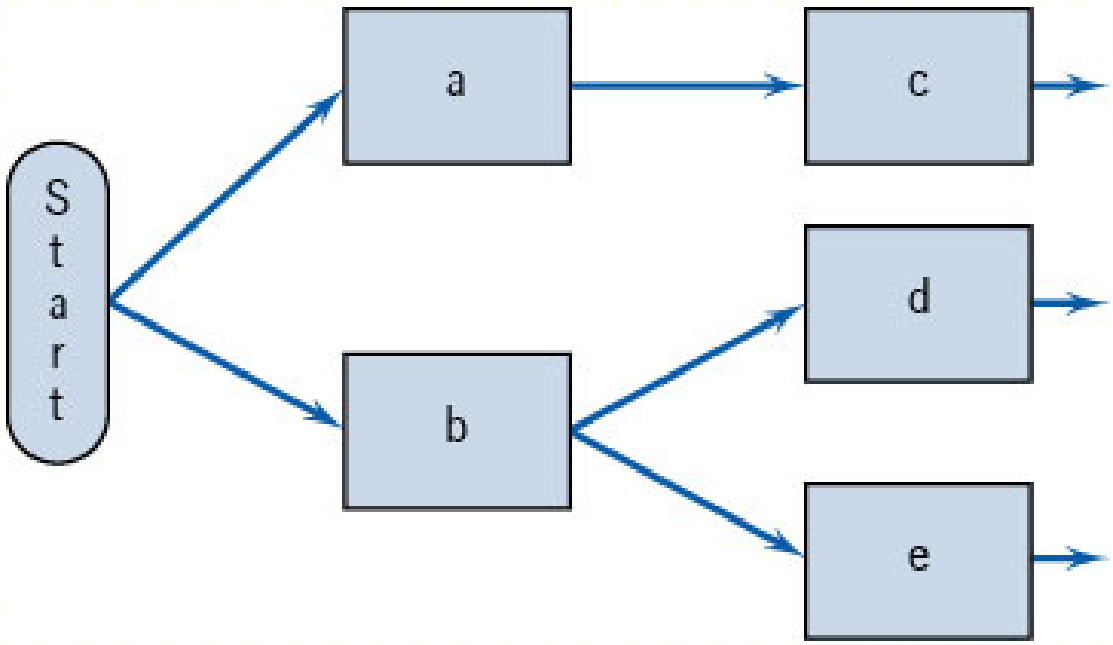
Sample Set of Project Activities and Precedences

Task	Predecessor
a	--
b	--
c	a
d	b
e	b
f	c, d
g	e

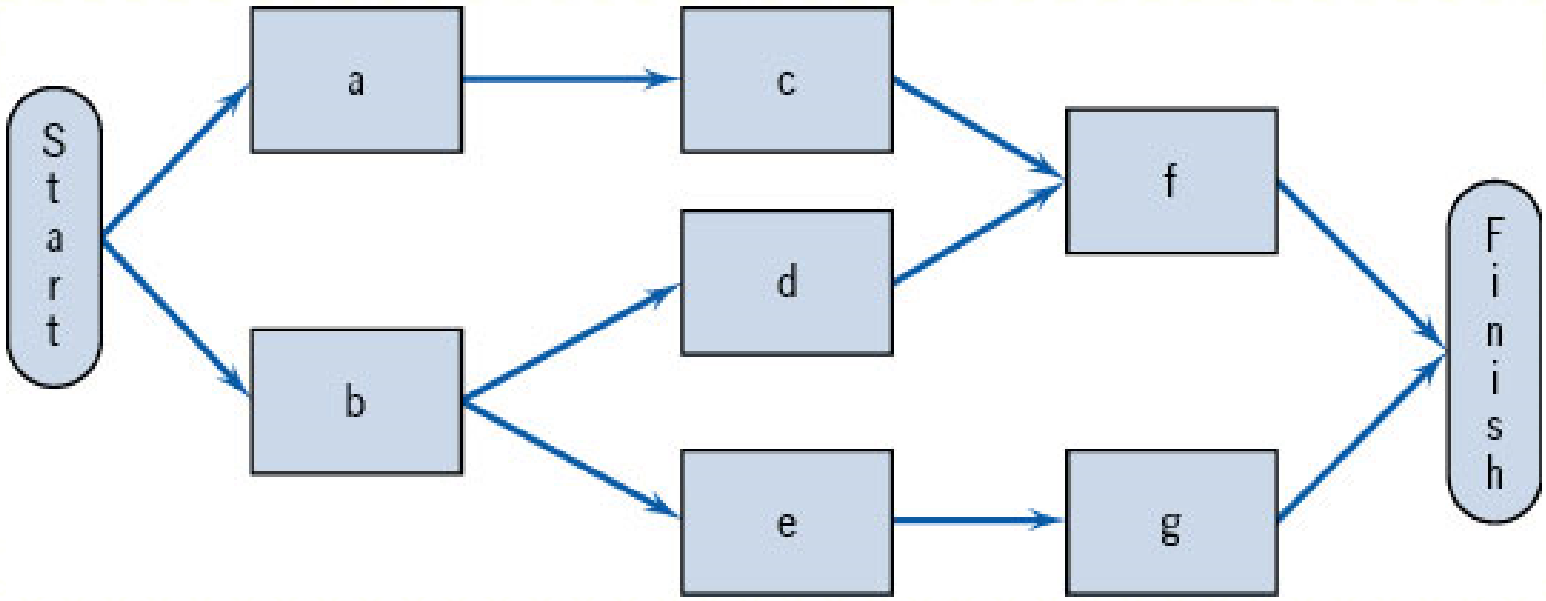
Stage 1 of a Sample AON Network



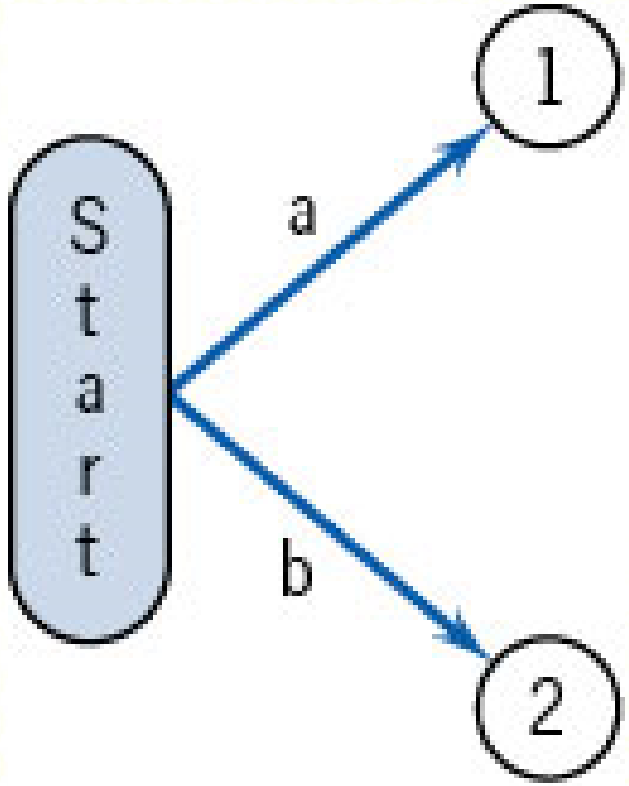
Stage 2 of a Sample AON Network



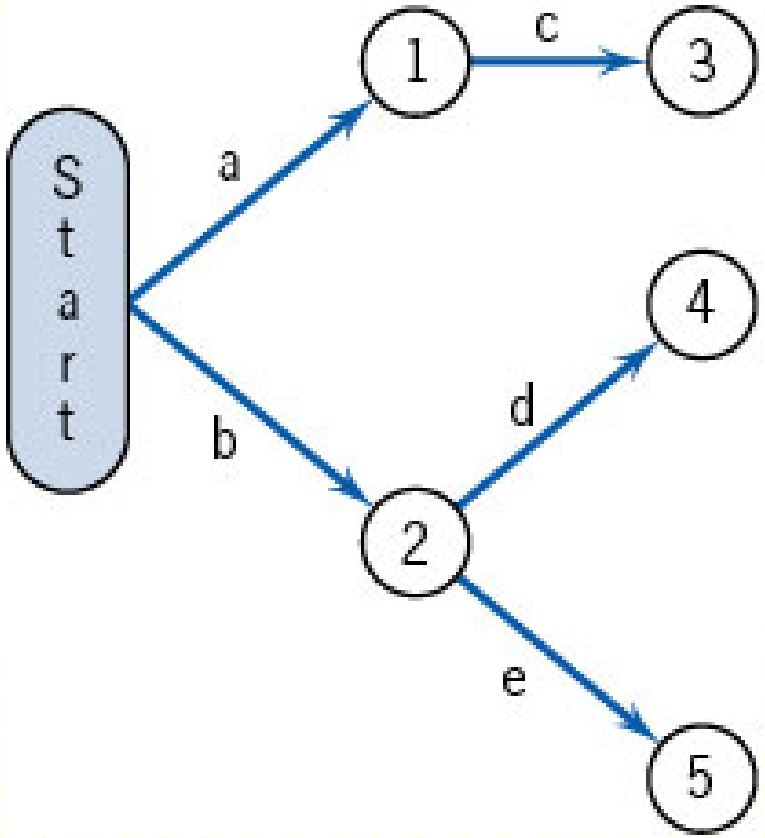
A Completed Sample AON Network



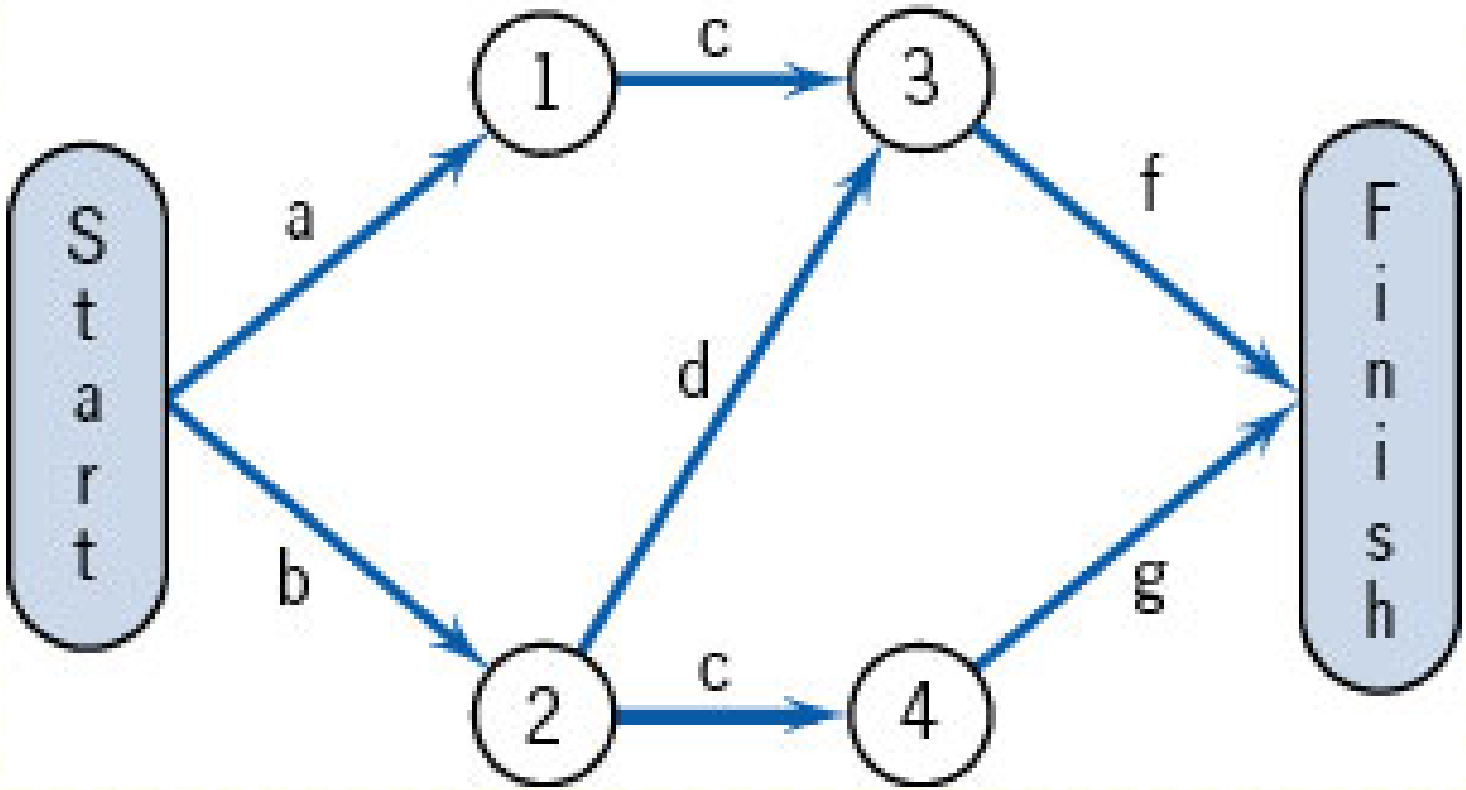
Stage 1 of a Sample AOA Network



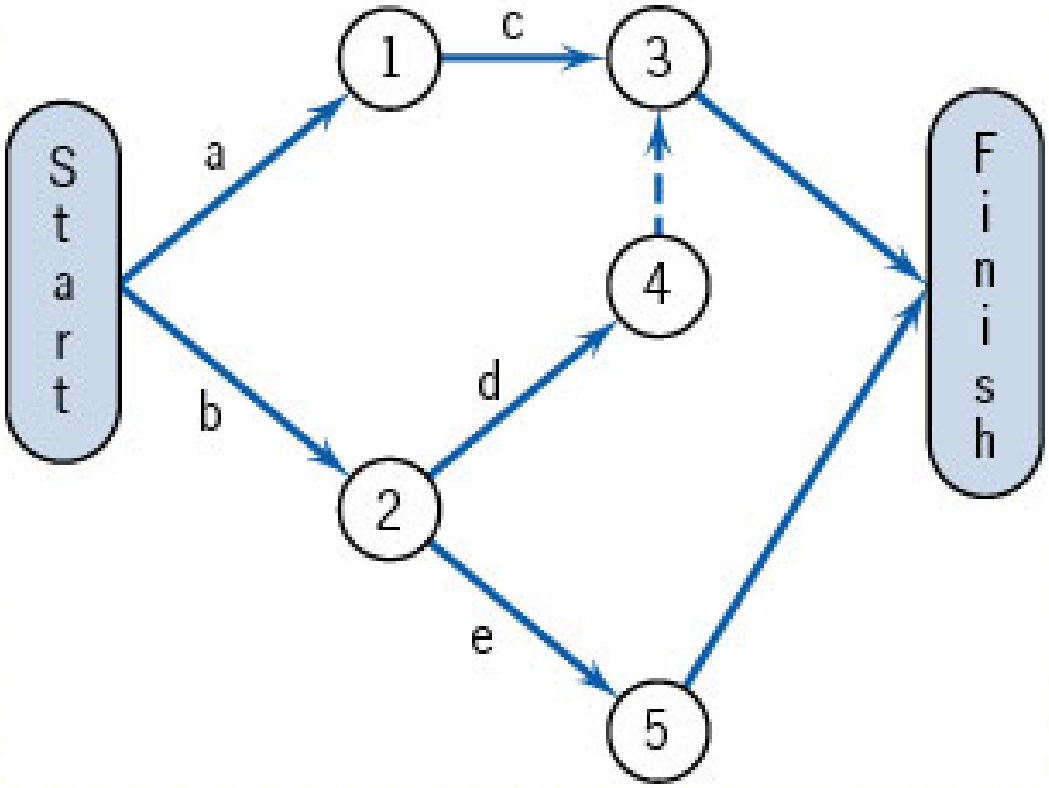
Stage 2 of a Sample AOA Network



A Completed Sample AOA Network



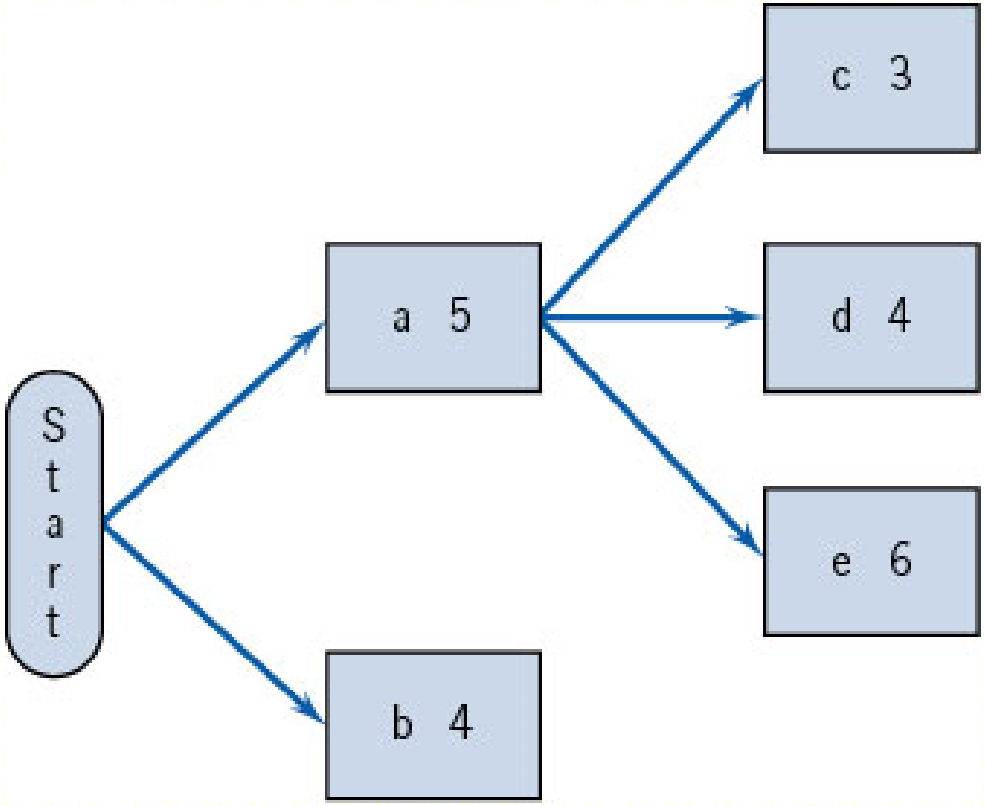
A Completed Sample AOA Network Showing the Use of a Dummy Task



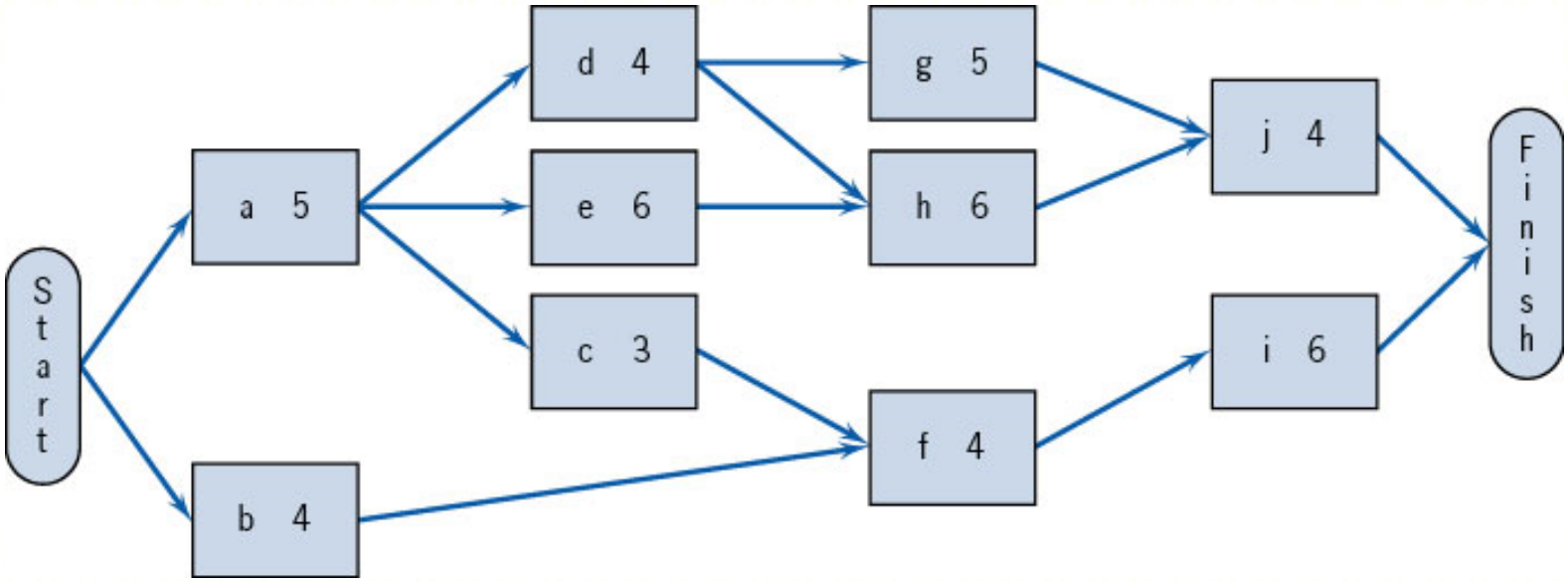
Sample Problem for Finding the Critical Path and Critical Time

Activity	Predecessor	Duration
a	--	5 days
b	--	4
c	a	3
d	a	4
e	a	6
f	b, c	4
g	d	5
h	d, e	6
i	f	6
j	g, h	4

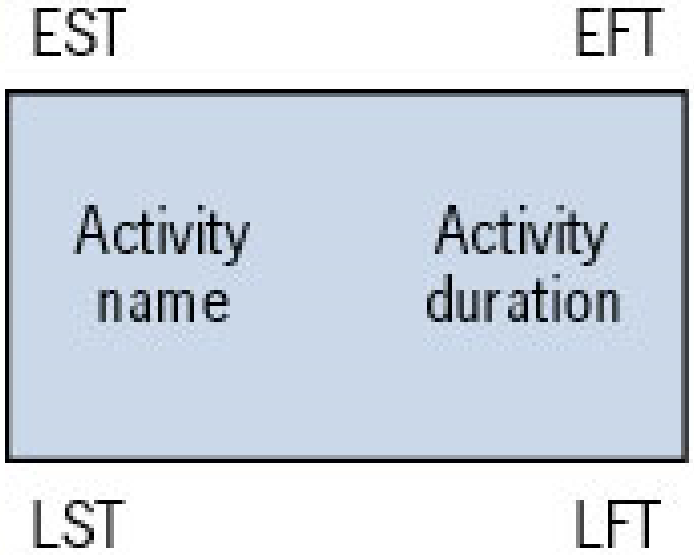
Stage 1 of a Sample Network



A Complete Network

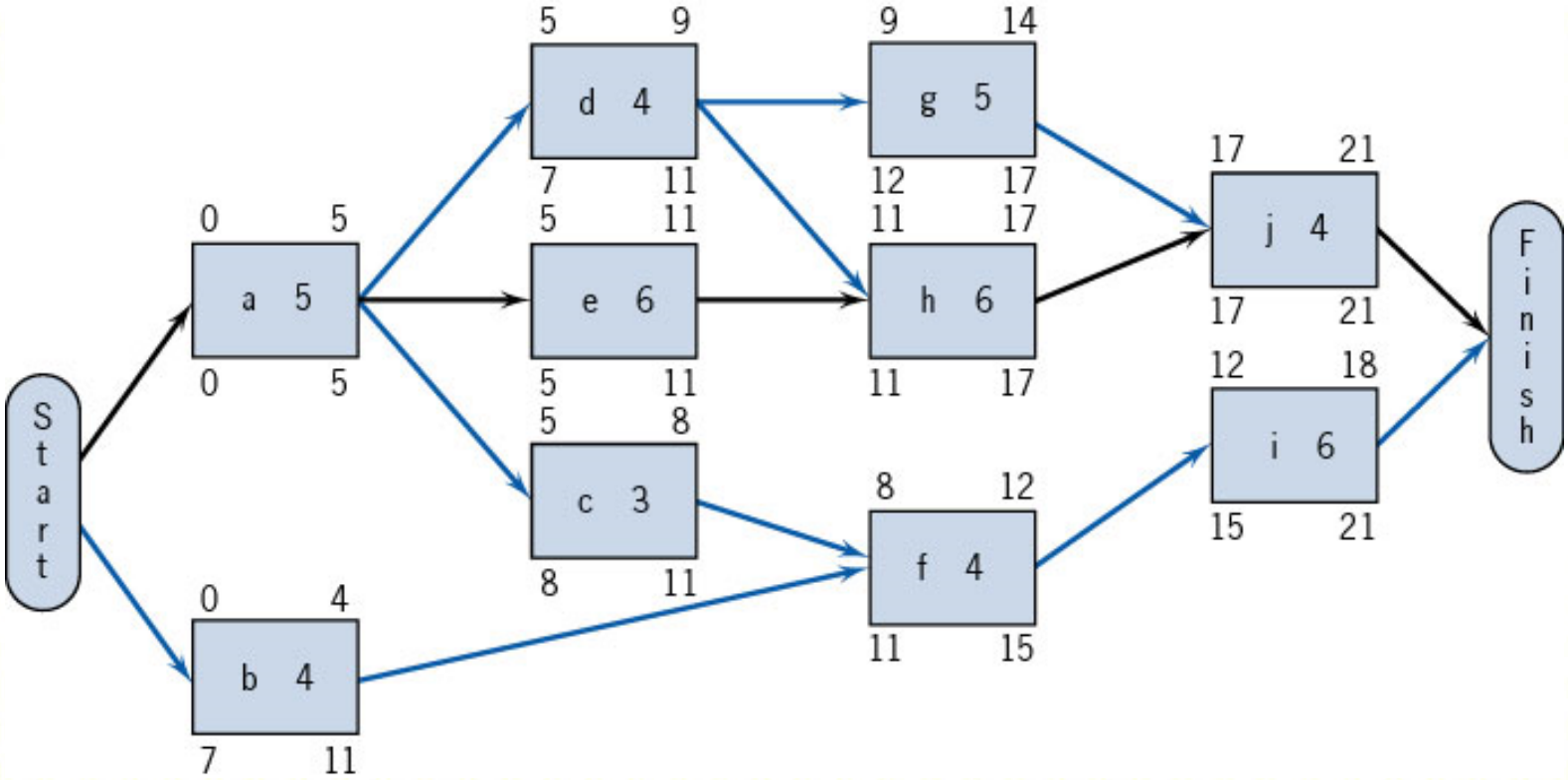


Information Contents in an AON Node



EST—Earliest start time
EFT—Earliest finish time
LFT—Latest start time
LFT—Latest finish time

The Critical Path and Time for Sample Project

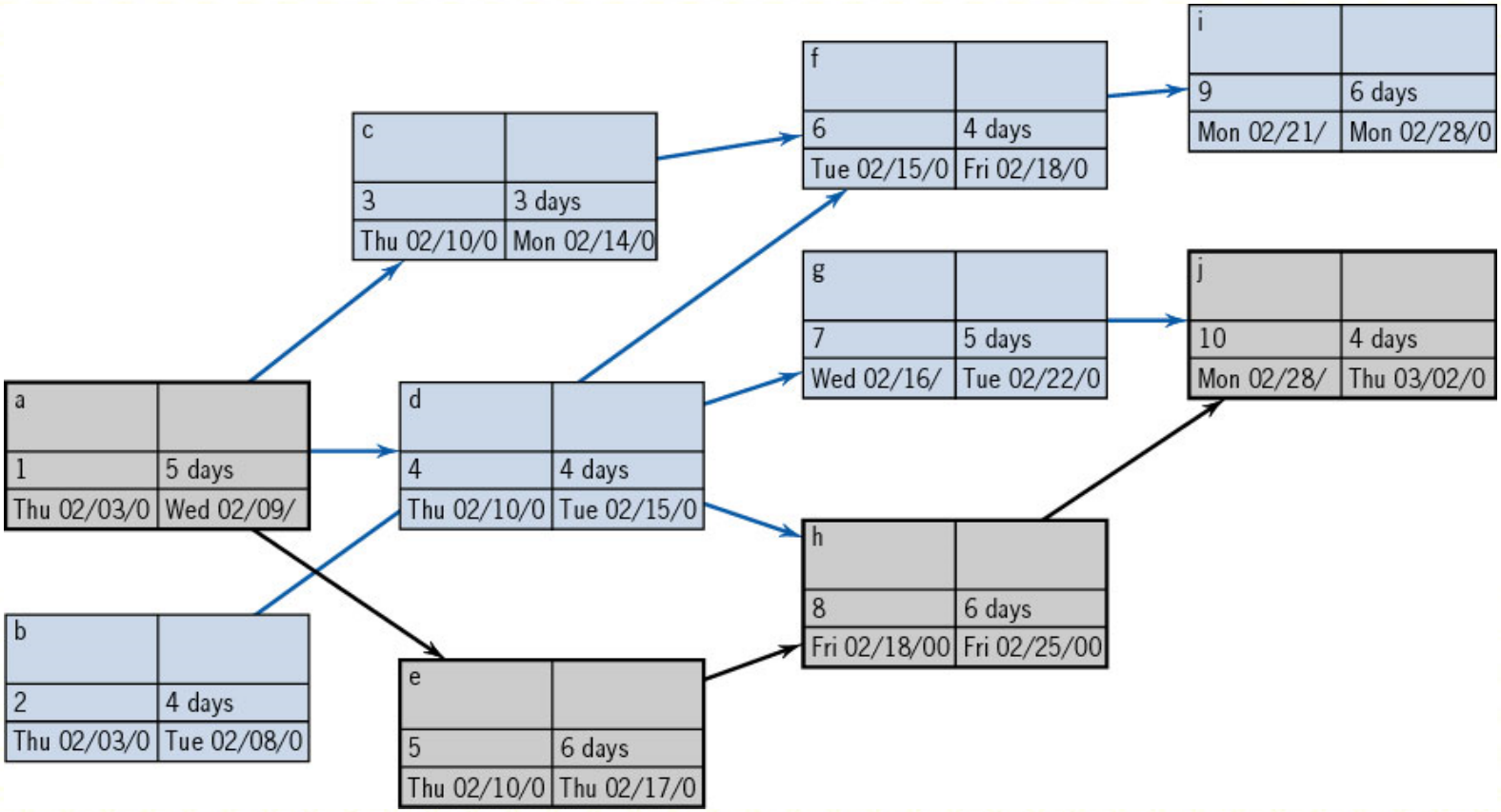


Calculating Activity Slack

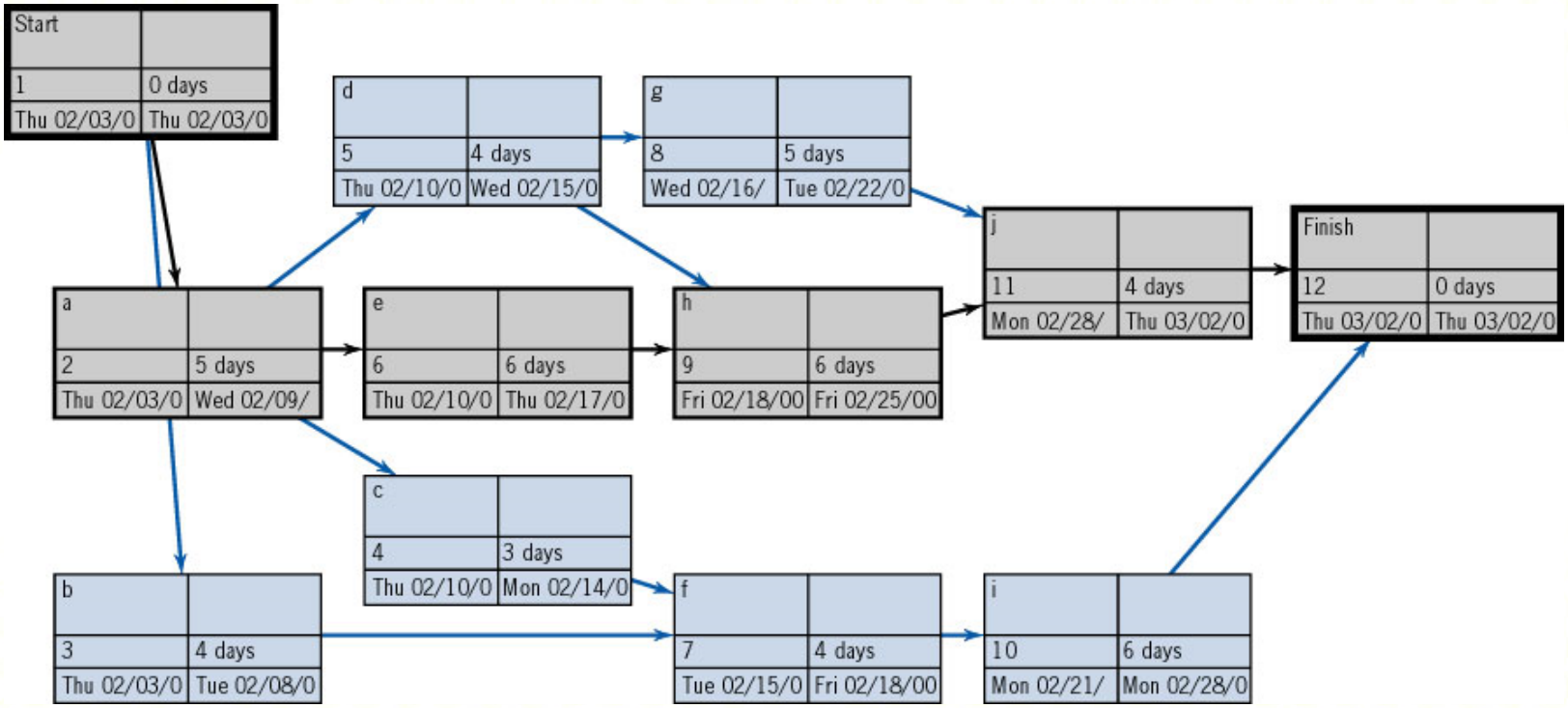
- **Slack or Float**

  LST - EST = LFT - EFT = Slack

An MSP Version of PERT/CPM Network



A Modified Version of MSP Network

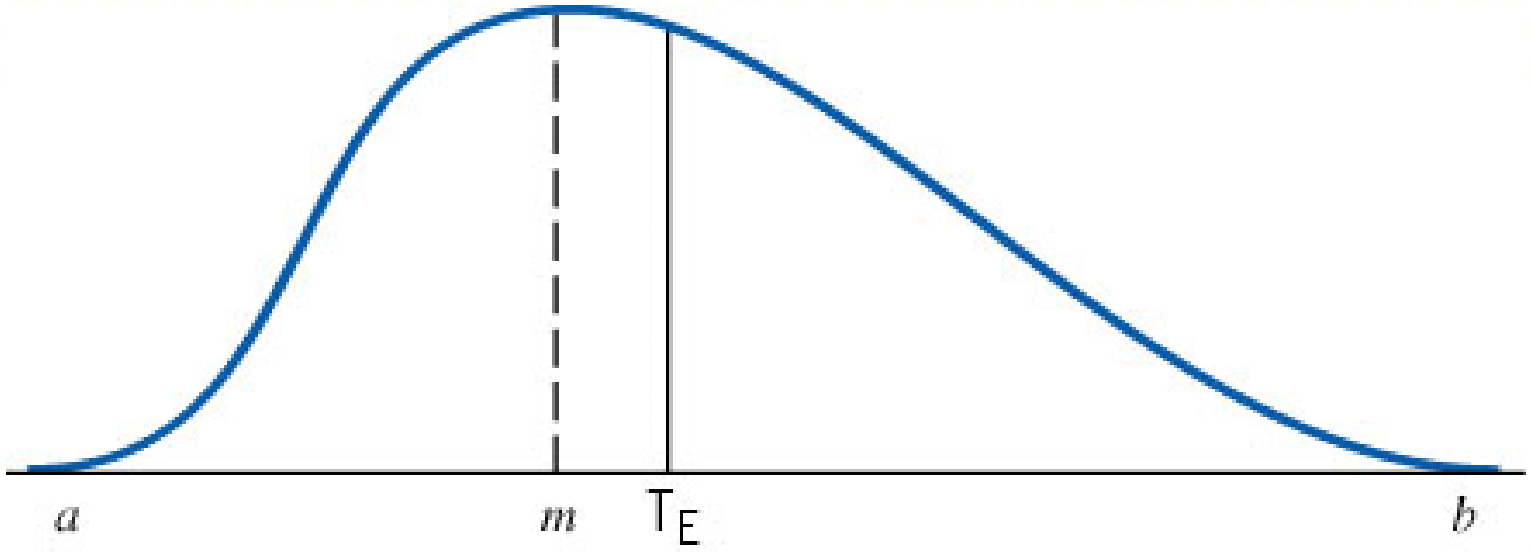


PROJECT UNCERTAINTY AND RISK MANAGEMENT

Calculating Probabilistic Activity Times

- **Three Time Estimates**
  - pessimistic (a)
  - most likely (m)
  - optimistic (b)

The Statistical Distribution of all Possible Times for an Activity



Activity Expected Time and Variance

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

$$\sigma = \frac{(b - a)}{6}$$

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

95 Percent Level

- **Task will be *a* or lower 5 percent of the time**
- **Task will be *b* or greater 5 percent of the time**

$$\sigma = \frac{(b-a)}{3.3}$$

90 Percent Level

- **Task will be *a* or lower 10 percent of the time**
- **Task will be *b* or greater 10 percent of the time**

$$\sigma = \frac{(b-a)}{2.6}$$

95 Percent Level (Alternative Interpretation)

- **Task will be between a and b 95 percent of the time**

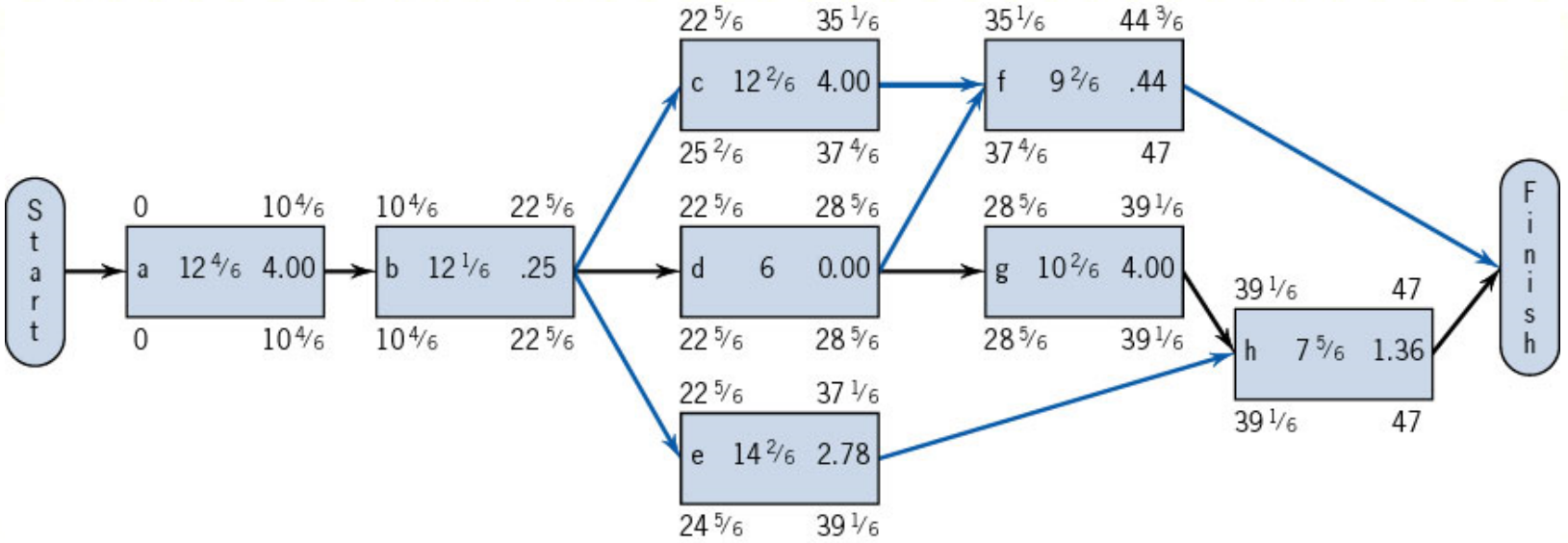
$$\sigma = \frac{(b-a)}{3.92}$$

90 Percent Level (Alternative Interpretation)

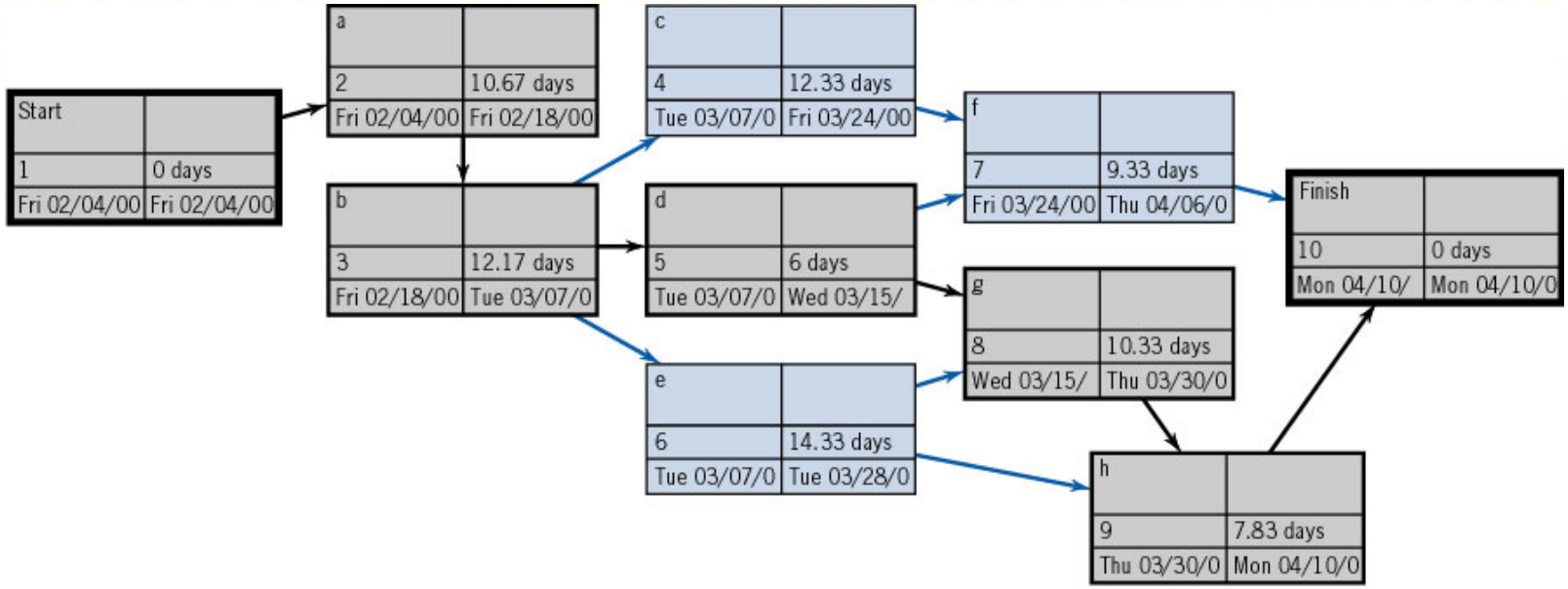
- **Task will be between a and b 90 percent of the time**

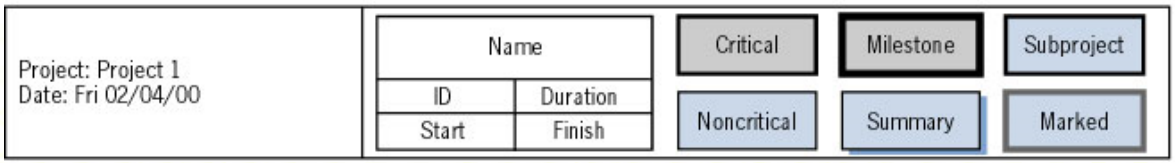
$$\sigma = \frac{(b-a)}{3.29}$$

An AON Network

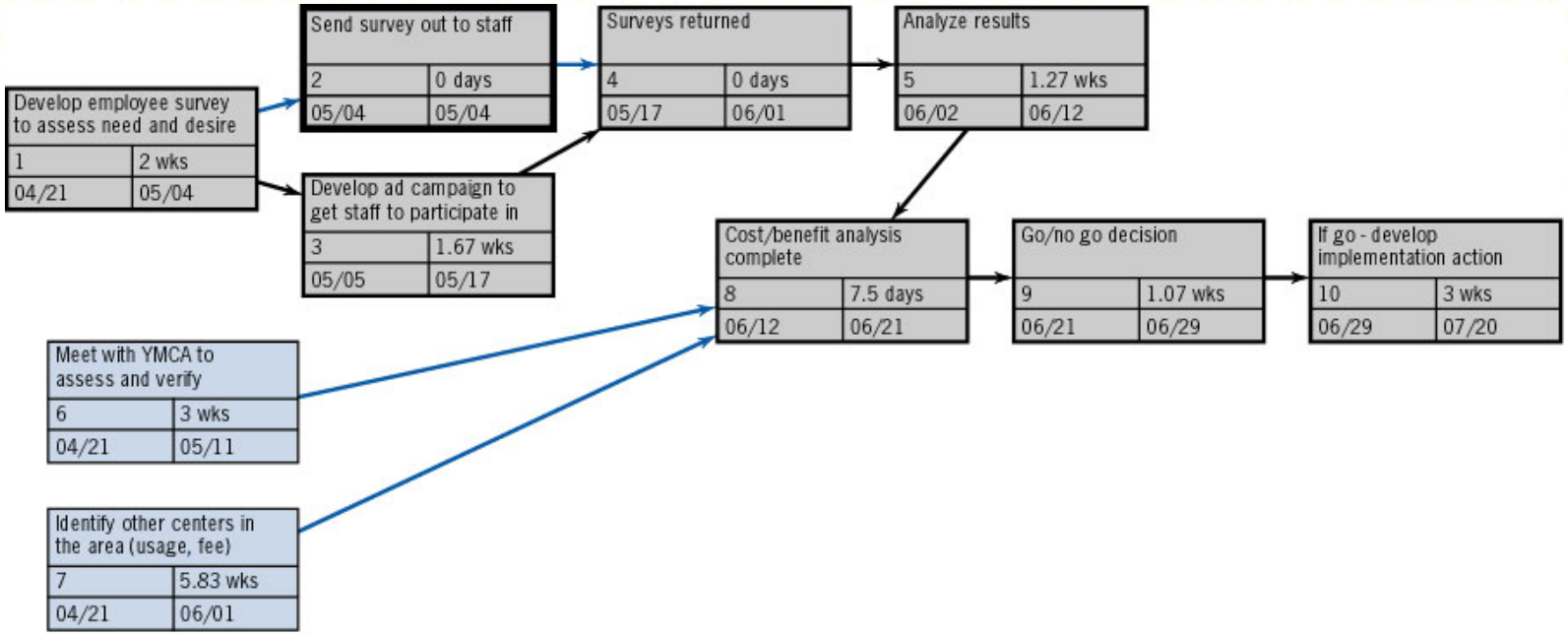


An MSP Version of a Sample Problem Network





A Pert/CPM Network for the Day Care Project



PERT view

An MSP Calendar for the Day Care Project, 4/16/00 to 5/27/00

Project started date: 04/21
Project completion date: 07/20

Day Care Center Investigation

Apr 16, '00 – May 27, '00

Sunday	Monday	Tueday	Wednesday	Thursday	Friday	Saturday
16	17	18	19	20	21	22
					Develop employee survey to assess ne	
					Meet with YMCA to assess and verify p	
23	24	25	26	27	28	29
Develop employee survey to assess need and desire, 2 wks						
Meet with YMCA to assess and verify proposal for service, 3 wks						
30	01	02	03	04	05	06
Develop employee survey to assess need and desire, 2 wks					Develop employee survey to assess ne	
				Send survey out t		
Meet with YMCA to assess and verify proposal for service, 3 wks						
07	08	09	10	11	12	13
Develop ad campaign to get staff to participate in survey, 1.67 wks						
Meet with YMCA to assess and verify proposal for service, 3 wks						
14	15	16	17	18	19	20
Develop ad campaign to get staff to participate in survey, 1.67 wks				Surveys returned, 11.67 days		
21	22	23	24	25	26	27
Surveys returned, 11.67 days						

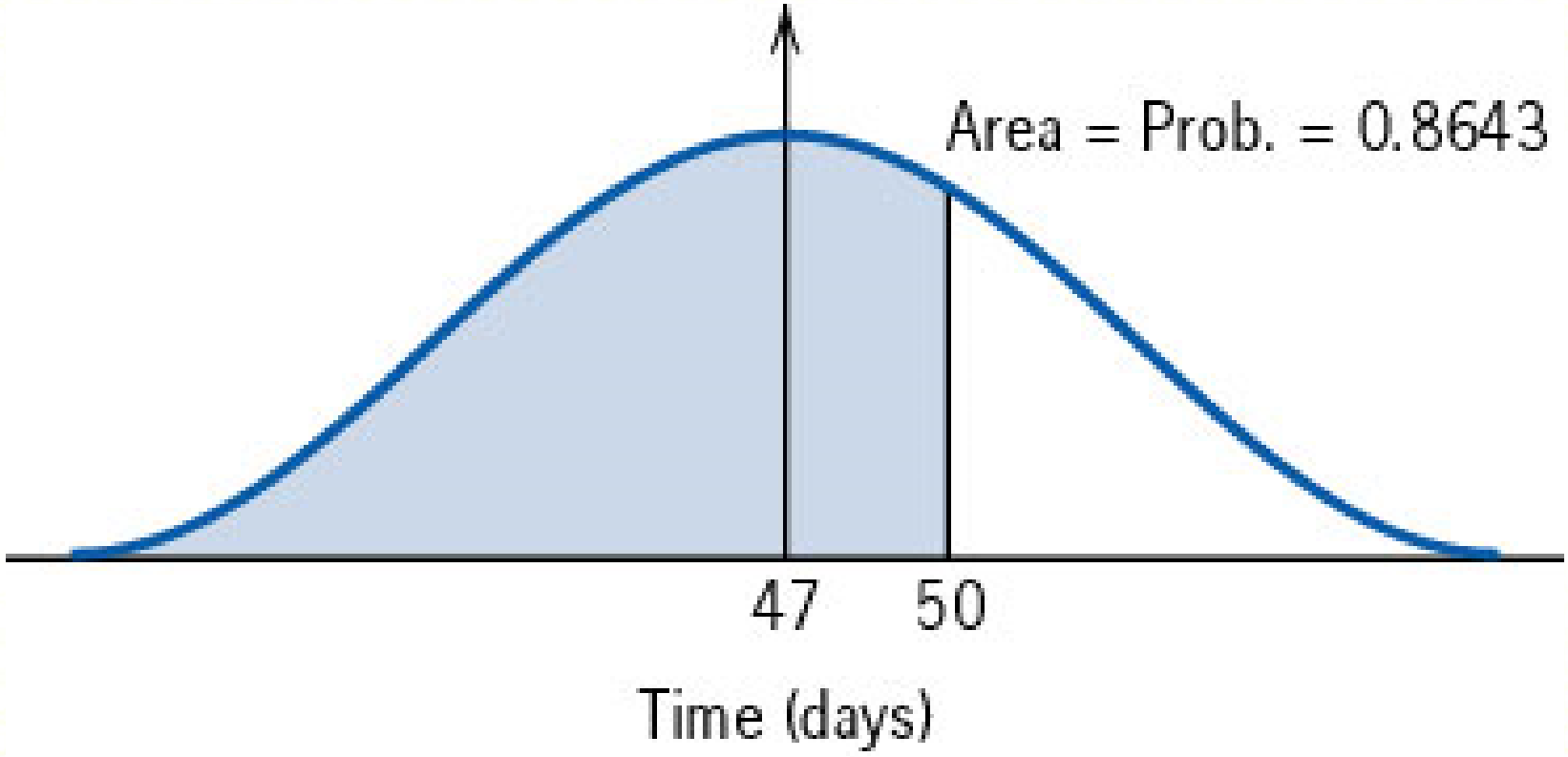
Project plan calender view

The Probability of Completing the Project on Time

$$Z = \frac{(D - \mu)}{\sqrt{\sigma_{\mu}^{2}}}$$

$$=\text{NORMDIST}(D,\mu,\sigma_{\mu},\text{TRUE})$$

The Statistical Distribution of Completion Times of the Path a-b-d-g-h



Selecting Risk and Finding D

$$D = \mu + Z\sqrt{\sigma_{\mu}^{2}}$$

NORMINV (probability, μ, σ_{μ}, TRUE)

SIMULATION

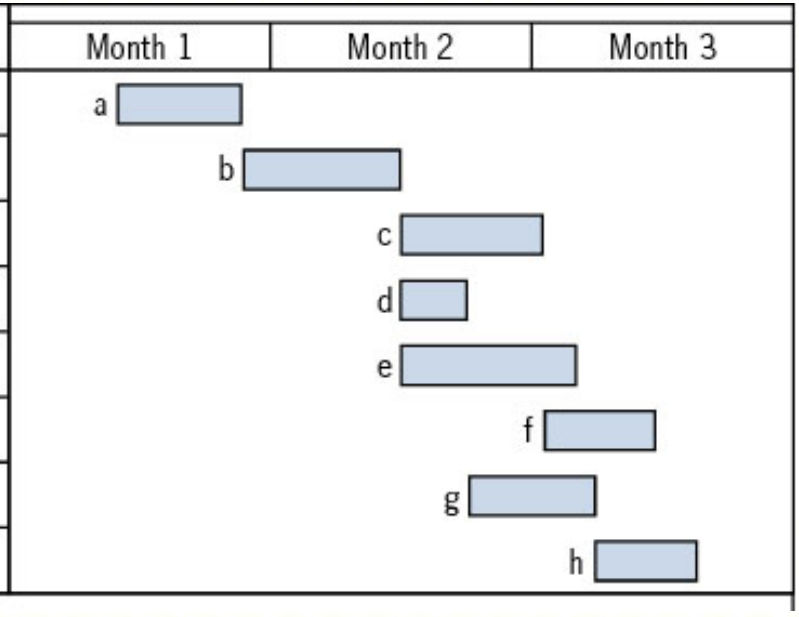
Traditional Statistics Versus Simulation

- **Similarities**
  - must enumerate alternate paths
- **Differences**
  - simulation does not require assumption of path independence

THE GANNT CHART

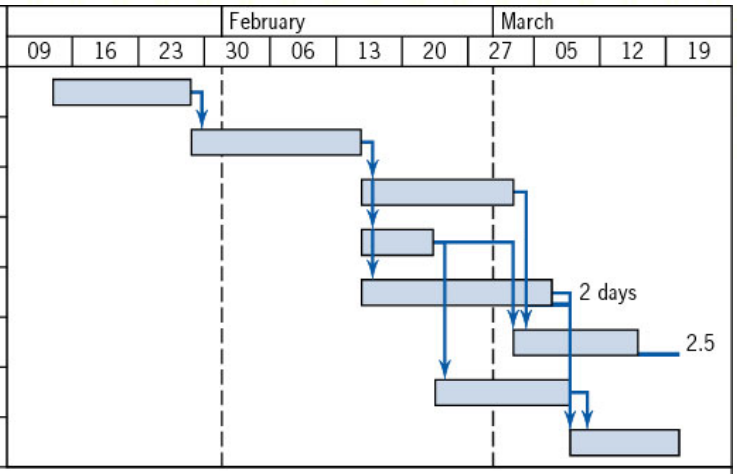
A Gantt Chart of a Sample Project

WBS	Task	Duration	Predecessors
1	a	10.67 days	
2	b	12.17 days	1
3	c	12.33 days	2
4	d	6 days	2
5	e	14.33 days	2
6	f	9.33 days	3, 4
7	g	10.33 days	4
8	h	7.83 days	5, 7



A Gantt Chart of Sample Project Showing Critical Path, Path Connections, Slack, EST, LST, EFT, and LFT

WBS	Task	Estimate dur	Start	Finish	Late start	Late finish
1	a	10.67 days	01/14	01/28	01/14	01/28
2	b	12.17 days	01/28	02/15	01/28	02/15
3	c	12.33 days	02/15	03/03	02/18	03/07
4	d	6 days	02/15	02/23	02/15	02/23
5	e	14.33 days	02/15	03/07	02/17	03/09
6	f	9.33 days	03/03	03/16	03/07	03/20
7	g	10.33 days	02/23	03/09	02/23	03/09
8	h	7.83 days	03/09	03/20	03/09	03/20

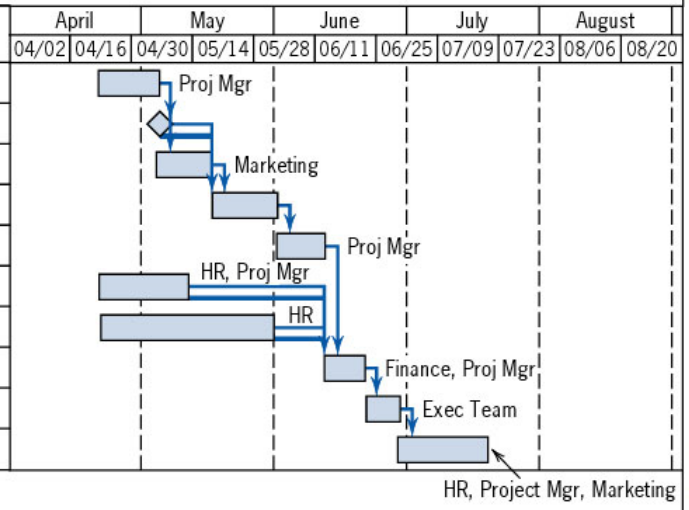


Critical path and stack shown

A Gantt Chart of a Day Care Project Showing Expected Durations, Critical Path, Milestone, and Resource Requirements

Day Care Service Investigation Project Plan

ID	Task Name	Predecessors	TE Duration
1	Develop employee survey to assess need and desire		2 wks
2	Send survey out to staff	1	0 days
3	Develop ad campaign to get staff to participate in survey	1	1.67 wks
4	Surveys returned	2, 3	11.67 days
5	Analyze results	4	1.27 wks
6	Meet with YMCA to assess and verify proposal service		3 wks
7	Identify other centers in the area (usage, fee structure, etc.)		5.83 wks
8	Cost/Benefit analysis complete	6, 7, 5	7.5 days
9	Go/No Go decision	8	1.07 wks
10	If Go – develop implementation action plan	9	3 wks



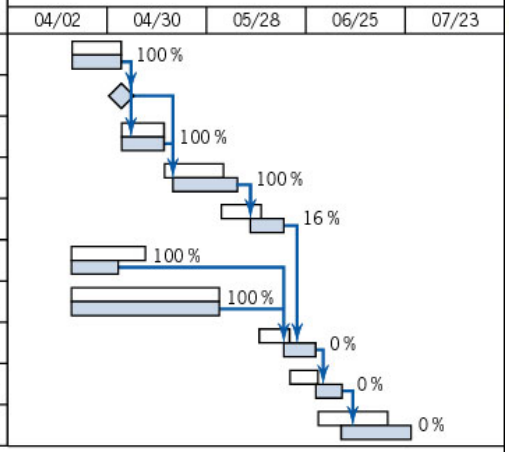
Critical path, slack, and resources sho | Task | Critical task | Milestone | Slack

Project start date: 04/21
Project finish date: 07/20

A Progress Report on a Day Care Project Showing Actual Progress Versus Baseline

Day Care Investigation

ID	Task Name	Actual Dur.	Baseline Dur.	Start	Finish	Baseline Start	Baseline Finish
1	Develop employee survey to assess need and desire	2 wks	2 wks	04/21	05/04	04/21	05/04
2	Send survey out to staff	0 days	0 days	05/04	05/04	05/04	05/04
3	Develop ad campaign to get staff to participate in survey	1.67 wks	1.67 wks	05/05	05/17	05/05	05/17
4	Surveys return	2.33 wks	11.67 wks	05/19	06/05	05/17	06/01
5	Analyze results	0.2 wks	1.27 wks	06/09	06/19	06/02	06/12
6	Meet with YMCA to assess and verify proposal for service	2 wks	3 wks	04/21	05/04	04/21	05/11
7	Identify other centers in the area (usage, fee structure, etc.)	5.83 wks	5.83 wks	04/21	06/01	04/21	06/01
8	Cost/Benefit analysis	0 days	7.5 days	06/19	06/28	06/12	06/21
9	Go/No Go decision	0 wks	1.07 wks	06/28	07/06	06/21	06/29
10	If Go – develop implementation action plan	0 wks	3 wks	07/06	07/27	06/29	07/20



Project start date: 04/21
Project current date: 10/04

Task
Progress
Baseline task
Completed milestone
Milestone

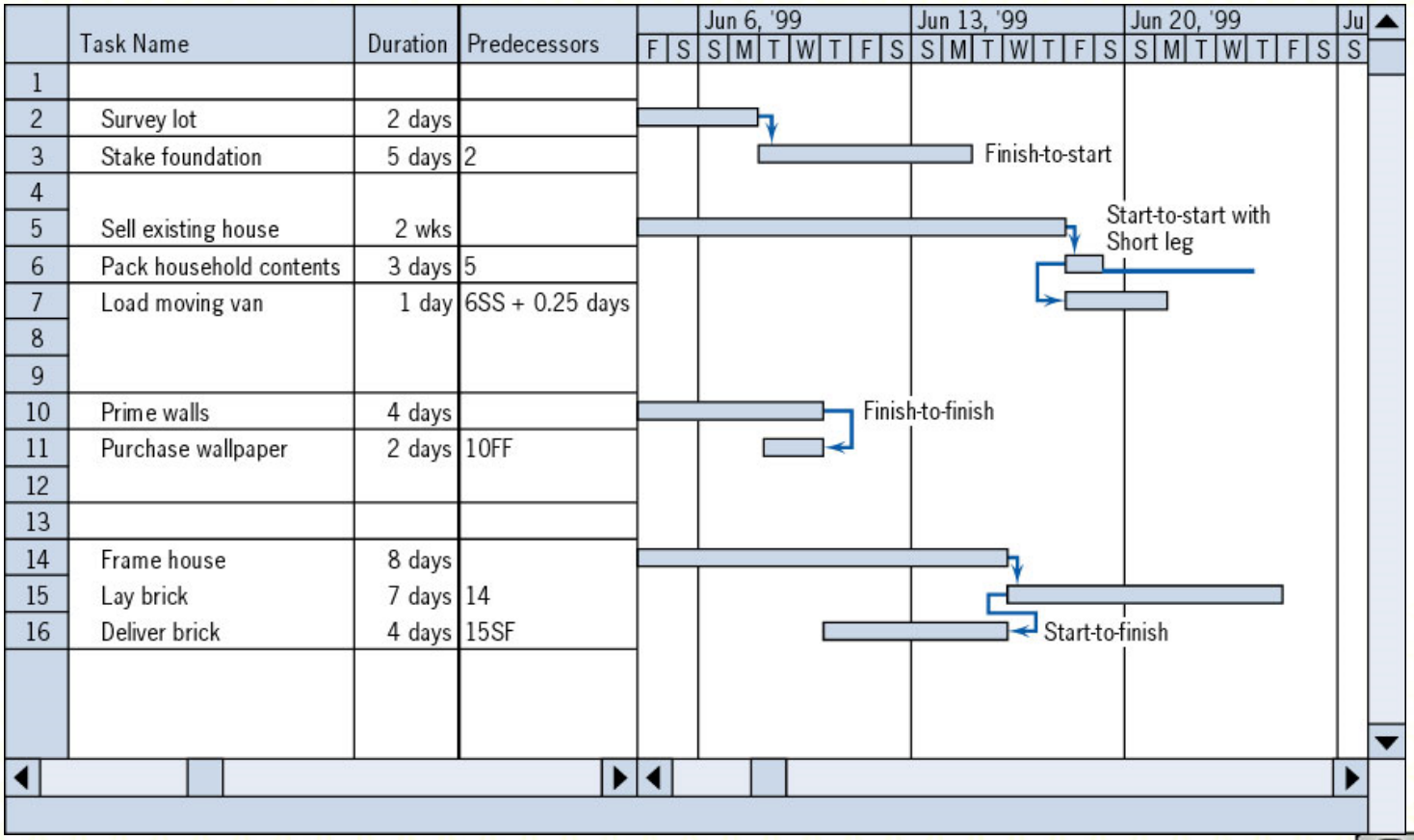
Progress shown

EXTENSIONS TO PERT/CPM

Precedence Diagramming

- Finish-to-start linkage
- Start-to-start linkage
- Finish-to-finish linkage
- Start-to-finish linkage

Precedence Diagramming Conventions



Other Methods

- **Graphical Evaluation and Review Technique (GERT)**
  - combines flowgraphs, probabilistic networks, and decision trees
  - allows loops back to earlier events and probabilistic branching

Reference

- **Meredith, R. J. & Mantel, J. S. (1995). *Project Management – A Managerial Approach*. John Wiley & Sons, 5th Edition.**