CHAPTER 4
PROJECT SCHEDULE MANAGEMENT

Study Program : Informatics Engineering

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4.1 THE IMPORTANCE OF PROJECT SCHEDULES

Deliver projects on time → one of their biggest challenges and the main cause of conflict

Schedule conflicts is caused by :

- Individual work styles and
- Cultural differences

With all the possibilities for schedule conflicts, it is important for project managers to use good project schedule management.

- Six main processes are involved in project schedule management:

1) Planning schedule management involves determining the policies, procedures, and documentation that will be used for planning, executing, and controlling the project schedule.
2) Defining activities involves identifying the specific activities that the project team members and stakeholders must perform to produce the project deliverables. An activity or task is an element of work normally found on the work breakdown structure (WBS) that has expected duration, cost, and resource requirements.

3) Sequencing activities involves identifying and documenting the relationships between project activities. Requirements, a resource breakdown structure, and project documents updates.
4) Estimating activity durations involves estimating the number of work periods that are needed to complete individual activities.
5) Developing the schedule involves analysing activity sequences, resource requirements, and activity duration estimates to create the project schedule.

6) Controlling the schedule involves controlling and managing changes to the project schedule.

- A project schedule management can be improved by performing processes such as at figure 4.1 and by using some basic project management tools and techniques.
- The tools and techniques to project schedule management, such as Gantt charts, network diagrams, and critical path analysis.

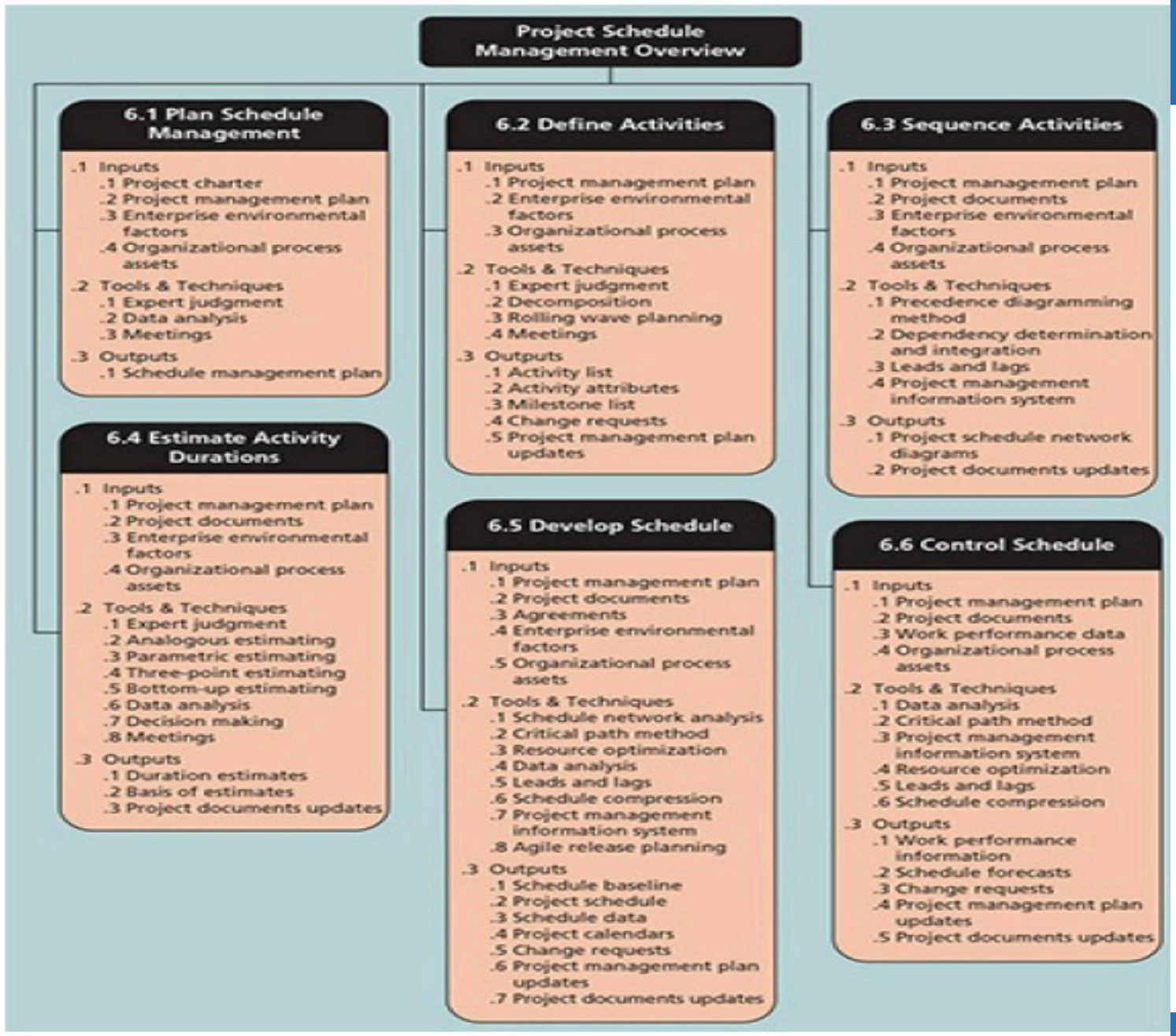


Figure 4.1 Project Schedule Management Overview

4.2 PLANNING SCHEDULE MANAGEMENT

- The first step in project schedule management is planning how the schedule will be managed throughout the life of the project.
- After reviewing the project management plan, project charter, enterprise environmental factors, and organisational process assets, the project team uses expert judgment, analytical techniques, and meetings to develop the schedule management plan.

A schedule management plan includes the following information:

- Project schedule model development: Many projects include a schedule model, which contains project activities with estimated durations, dependencies, and other planning information that can be used to produce a project schedule.
- Level of accuracy and units of measure: This section discusses how accurate schedule estimates should be and determines whether time is measured in hours, days, or another unit.

- Control thresholds: Variance thresholds, such as ±10 percent, are established for monitoring schedule performance.
- Rules of performance measurement: For example, if team members are expected to track the percentage of work completed, this section specifies how to determine the percentages.
- Reporting formats: This section describes the format and frequency of schedule reports required for the project.
- Process descriptions: The schedule management plan also describes how all of the schedule management processes will be performed.

4.3 DEFINING ACTIVITIES

- Defining activities involves identifying the specific actions that will produce the project deliverables in enough detail to determine resource and schedule estimates.
- The project team reviews the project management plan, enterprise environmental factors, and organisational process assets to begin defining activities.
- Outputs of this process include an activity list, activity attributes, a milestone list, change requests, and project management plan updates.

- The activity list is a tabulation of activities to be included on a project schedule. The list should include the activity name, an activity identifier or number, and a brief description of the activity.
- The activity attributes provide schedule-related information about each activity, such as predecessors, successors, logical relationships, leads and lags, resource requirements, constraints, imposed dates, and assumptions related to the activity.

Note : The activity list and activity attributes should agree with the WBS and WBS dictionary.

- A milestone on a project is a significant event that normally has no duration. It often takes several activities and a lot of work to complete a milestone, but the milestone itself is a marker to help in identifying necessary activities.

  Milestones are also useful tools for setting schedule goals and monitoring progress.

4.4 SEQUENCING ACTIVITIES

- Sequencing activities or determining their dependencies.
- Inputs to the activity sequencing process include the project management plan, project documents (like the activity attributes, activity list, assumption log, and milestone list), enterprise environmental factors, and organisational process assets.
- The sequencing process involves evaluating the reasons for dependencies and the different types of dependencies.

4.4.1 DEPENDENCIES

- A dependency or relationship pertains to the sequencing of project activities or tasks.
- For example, does a certain activity have to be finished before another can start?
- Can the project team do several activities in parallel? Can some overlap? Determining these relationships or dependencies among activities is crucial for developing and managing a project schedule.

There are several types of dependencies among project activities:

- Mandatory dependencies are inherent in the nature of the work being performed on a project. They are sometimes referred to as hard logic.

For example, you cannot test code until after the code is written.

- Discretionary dependencies are defined by the project team.

For example, a project team might follow good practice and not start the detailed design of a new information system until the users sign off on all of the analysis work. Discretionary dependencies are sometimes referred to as soft logic and should be used with care because they may limit later scheduling options.

- External dependencies involve relationships between project and non-project activities.

For example, the installation of a new operating system and other software may depend on delivery of new hardware from an external supplier. Even though delivery of the hardware may not be included in the scope of the project, you should add an external dependency to it because late delivery will affect the project schedule.

- Internal dependencies involve relationships between project activities that are generally inside the project team's control.

For example, if software is developed by the team, they can create dependencies such as performing unit testing before system testing.

4.4.2 NETWORK DIAGRAMS

- Network diagrams are the preferred technique for showing activity sequencing.
- A network diagram is a schematic display of the logical relationships among project activities and their sequencing.
- Some people refer to network diagrams as project schedule network diagrams or PERT charts.

Depend on the duration activities character

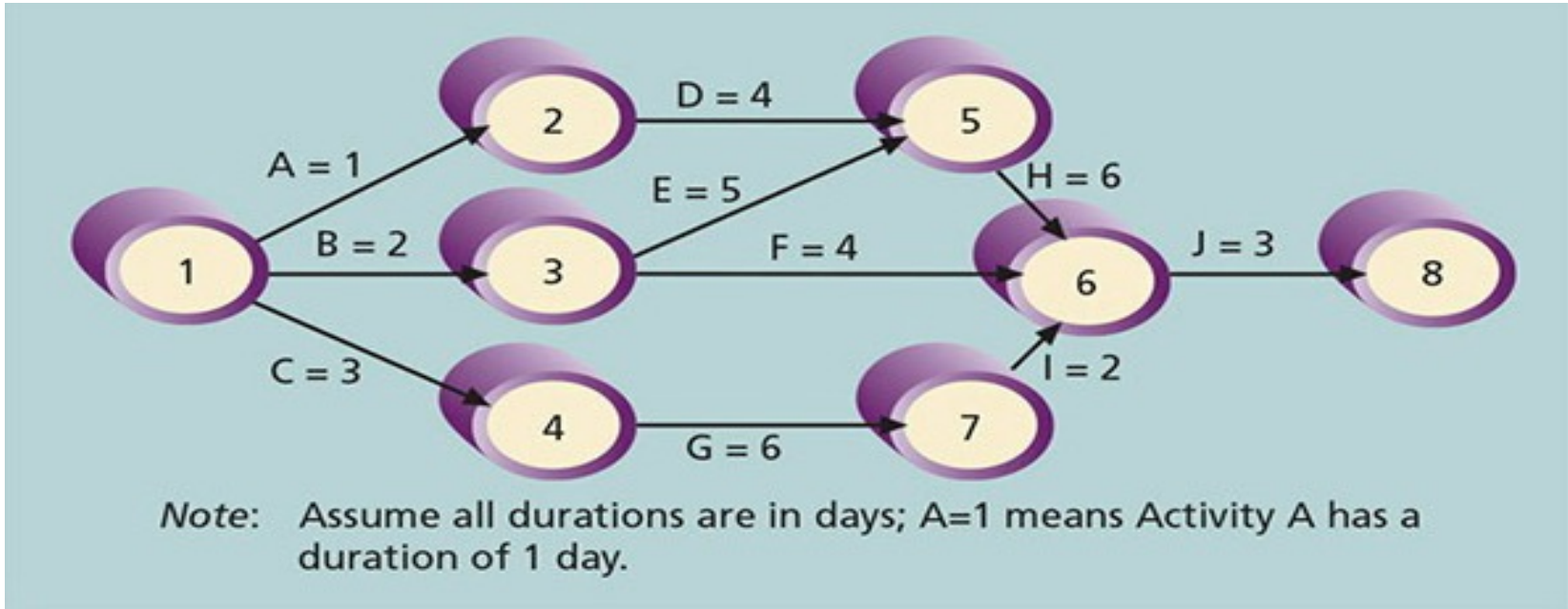


Figure 4.2 A Sample Network Diagram for Project X

- The letters A through J represent activities with dependencies that are required to complete the project.
- These activities come from the WBS and activity definition process described earlier.
- The arrows represent the activity sequencing or relationships between tasks.

- The format of the above network diagram uses the activity-on-arrow (AOA) approach or the arrow diagramming method (ADM) — a network diagramming technique in which activities are represented by arrows and connected at points called nodes to illustrate the sequence of activities.
- A node is simply the starting and ending point of an activity. The first node signifies the start of a project and the last node represents the end.

Note: For large projects with hundreds of activities, it might be simpler to include only activities with dependencies on a network diagram.

4.5 ESTIMATING ACTIVITY DURATIONS

- Duration includes the actual amount of time worked on an activity plus elapsed time.

For example, even though it might take one workweek or five workdays to do the actual work, the duration estimate might be two weeks to allow extra time needed to obtain outside information.

- Do not confuse duration with effort , which is the number of workdays or work hours required to complete a task.
- Duration relates to the time estimate on a calendar, not the effort estimate. In the previous example, you might plan to spend 20 hours reading a book — the effort estimate — and spread that time out over two months — the duration.

- Project team members must also update the estimates as the project progresses. If scope changes occur on the project, the duration estimates should be updated to reflect those changes.

- There are several inputs to activity duration estimates, including the project management plan, project documents, enterprise environmental factors, and organisational process assets.
- One of the most important considerations in making activity duration estimates is the availability of resources, especially human resources.

- Duration estimates are often provided as a discrete number, such as four weeks; as a range, such as three to five weeks; or as a three point estimate.
- A three-point estimate includes an optimistic, a most likely, and a pessimistic estimate, such as three weeks for the optimistic scenario, four weeks for the most likely scenario, and five weeks for the pessimistic scenario.

- The optimistic estimate is based on a best-case scenario, while the pessimistic estimate is based on a worst-case scenario.
- The most likely estimate, as you might expect, is based on a most likely or expected scenario.
- A three-point estimate is required for performing PERT estimates.

4.6 DEVELOPING THE SCHEDULE

- Schedule development uses the results of all the preceding project schedule management processes to determine the start and end dates of the project and its activities.
- Project schedule management processes often go through several iterations before a project schedule is finalised.
- The ultimate goal of developing a realistic project schedule is to provide a basis for monitoring project progress for the time dimension of the project.

- The main outputs of this process are a schedule baseline, project schedule, schedule data, project calendars, change requests, project management plan updates, and project documents updates.

A few of the tools and techniques for schedule development include the following:

- A Gantt chart is a common tool for displaying project schedule information.
- Critical path analysis is a very important tool for developing and controlling project schedules.
- Critical chain scheduling is a technique that focuses on limited resources when creating a project schedule.
- PERT analysis is a means for considering schedule risk on projects.

1. Gantt Charts

Provide a standard format for displaying project schedule information by listing project activities and their corresponding start and finish dates in calendar form.

Gantt charts are sometimes referred to as bar charts because the activities' start and end dates are shown as horizontal bars.

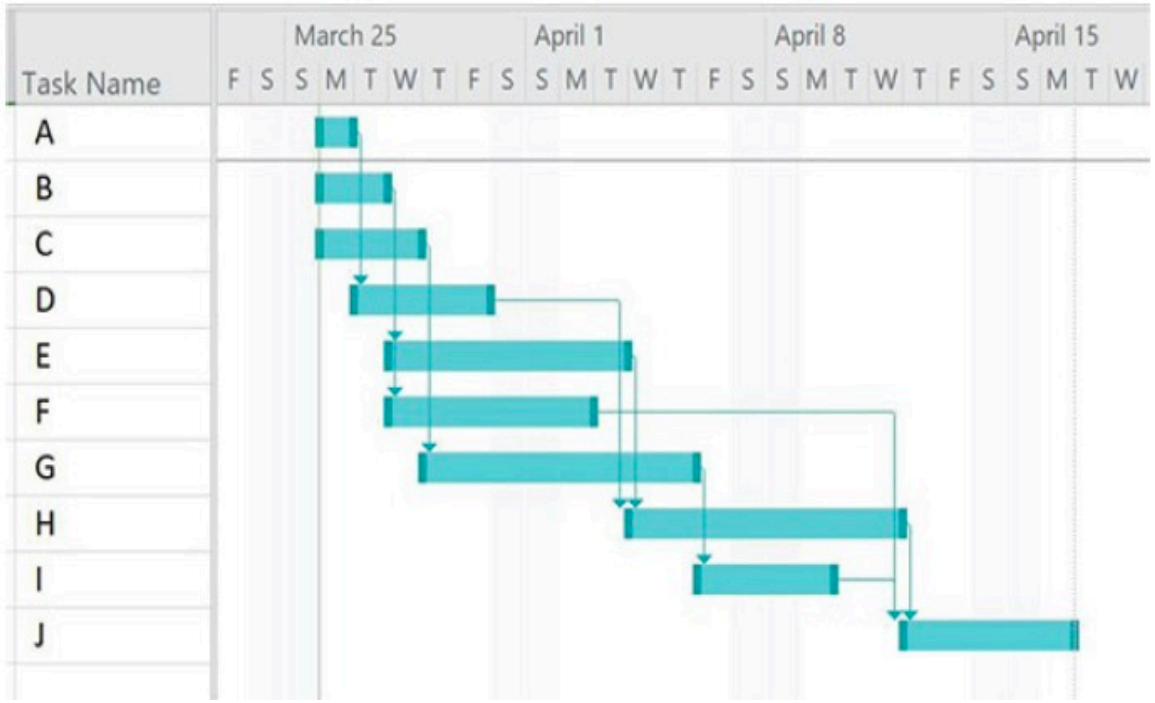


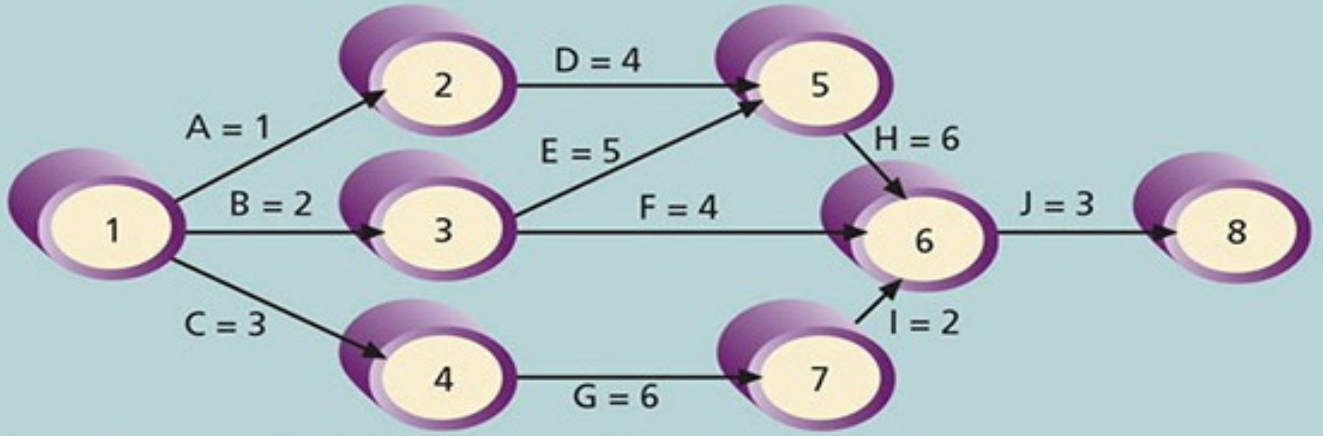
Figure 4.4 Gantt Chart for Project X

2. Critical Path Method

- Many projects fail to meet schedule expectations. Critical path method (CPM) —also called critical path analysis —is a network diagramming technique used to predict total project duration.
- A critical path for a project is the series of activities that determine the earliest time by which the project can be completed.

- It 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.
- The longest path or the path that contains the critical tasks is what drives the completion date for the project.
- You are not finished with the project until you have finished all the tasks.

- Calculating the Critical Path

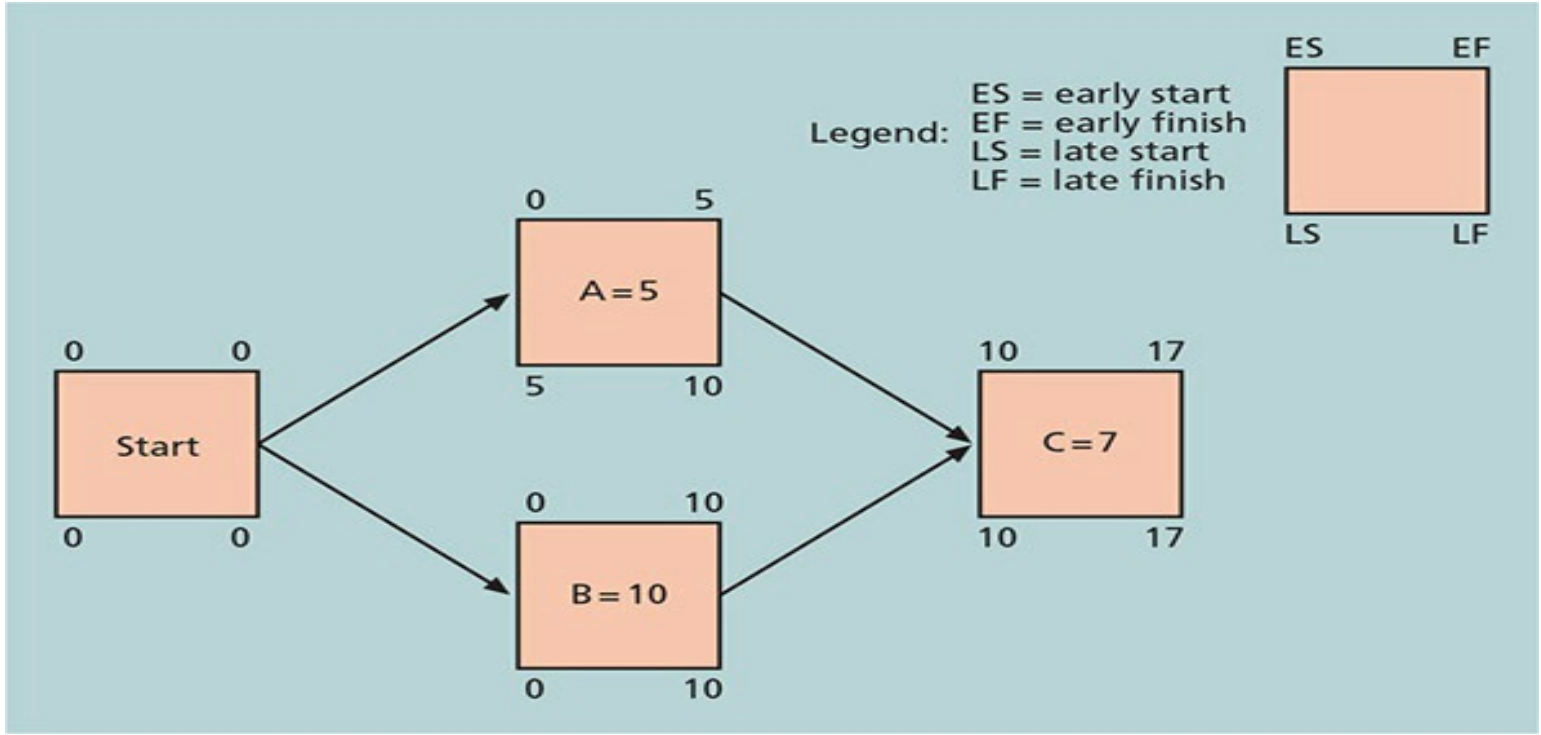


Note: Assume all durations are in days.

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.

- Calculating early and late start and finish dates



	Start	Finish	Late Start	Late Finish	Free Slack	Total Slack
A	3/26/2018	3/26/2018	3/28/2018	3/29/2018	0d	2d
B	3/26/2018	3/27/2018	3/26/2018	3/28/2018	0d	0d
C	3/26/2018	3/28/2018	3/28/2018	4/2/2018	0d	2d
D	3/27/2018	3/30/2018	3/29/2018	4/4/2018	2d	2d
E	3/28/2018	4/3/2018	3/28/2018	4/4/2018	0d	0d

The free and total slack for all activities on the network diagram for Project X

F	3/28/2018	4/2/2018	4/6/2018	4/12/2018	7d	7d
G	3/29/2018	4/5/2018	4/2/2018	4/10/2018	0d	2d
H	4/4/2018	4/11/2018	4/4/2018	4/12/2018	0d	0d
I	4/6/2018	4/9/2018	4/10/2018	4/12/2018	2d	2d
J	4/12/2018	4/16/2018	4/12/2018	4/16/2018	0d	0d

- Knowing the amount of float or slack allows project managers to know whether the schedule is flexible and how flexible it might be.

Program Evaluation and Review Technique (PERT)

- When there is a high degree of uncertainty about the individual activity duration estimates, the network analysis Program Evaluation and Review Technique (PERT) can be used to estimate project duration.
- PERT applies the critical path method (CPM) to a weighted average duration estimate.
- This approach was developed at about the same time as CPM, in the late 1950s, and it also uses network diagrams, which are still sometimes referred to as PERT charts.

4.8 CONTROLLING THE SCHEDULE

- The final process in project schedule management is controlling the schedule. Like scope control, schedule control is a portion of the integrated change control process in project integration management.
- The goal of schedule control is to know the status of the schedule, influence the factors that cause schedule changes, determine that the schedule has changed, and manage changes when they occur.

- The main inputs to schedule control are the project management plan, project documents (like the lessons-learned register, project calendars, project schedule, resource calendars, and schedule data), work performance data, and organizational process assets.

Some of the tools and techniques include the following:

- Data analysis tools, including
  - ✓ Earned value analysis, Project Cost Management
  - ✓ Iteration burndown charts
  - ✓ Performance reviews
  - ✓ Trend analysis
  - ✓ Variance analysis
  - ✓ What-if-scenario analysis

- Critical path method, described earlier in this chapter
- Project management information systems
- Resource optimization, such as resource levelling,
- Project Resource Management
- Leads and lags
- Schedule compression, such as crashing and fast tracking

- The main outputs of schedule control include work performance information, schedule forecasts, change requests, project management plan updates, and project documents updates.