ICT Project Management

Chapter 4: Project Planning Phase – Project Time Management

4.1. Introduction

Project time management involves the processes required to ensure timely completion of a project.
Processes include:

1. Activity definition
2. Activity sequencing
3. Activity duration estimating
4. Schedule development
5. Schedule control

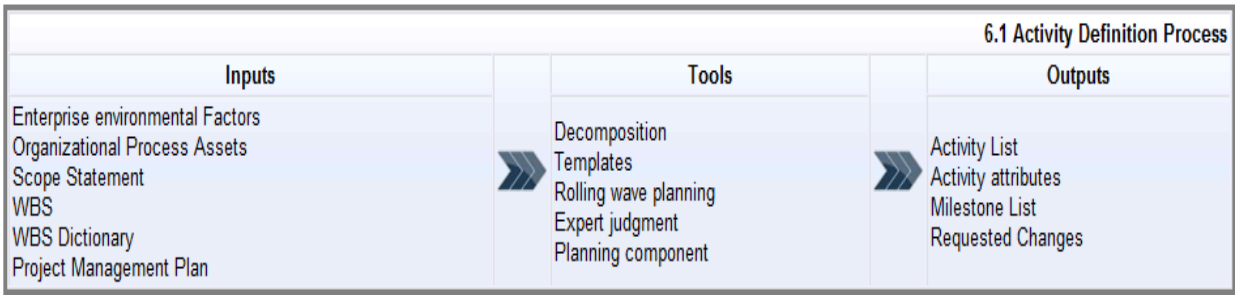
4.2. Activity definition

Activity definition involves identifying the specific activities that the project team members and stakeholders must perform to produce the project deliverables. The main goal of this process is to ensure that the project team has complete understanding of all the work they must do as part of the project scope so they can start scheduling the work

The outputs of this process are

1. Activity list:
2. Activity attributes:
3. Milestone list
4. Requested changes;

- An activity or task is an element of work normally found on the Work break down structure (WBS), that has an expected duration, a cost and resource requirements. The should have the activity name, an activity identifier or number, brief description of the activity
- Activity attributes: schedule related information about each activity, such as predecessor, successor, logical relationship, leads and lags, owner, resource requirement assumptions related to the activity
- A Milestone in a project is a significant event that normally has no duration. It normally takes several activities and a lot of work to complete a milestone, and it acts as a marker to help in identifying necessary activities. It is also a useful tool for setting schedule goals and monitoring progress.
  Milestones should be:
  - ✓ **S**pecific
  - ✓ **M**easurable
  - ✓ **A**ssignable
  - ✓ **R**ealistic
  - ✓ **T**ime-framed



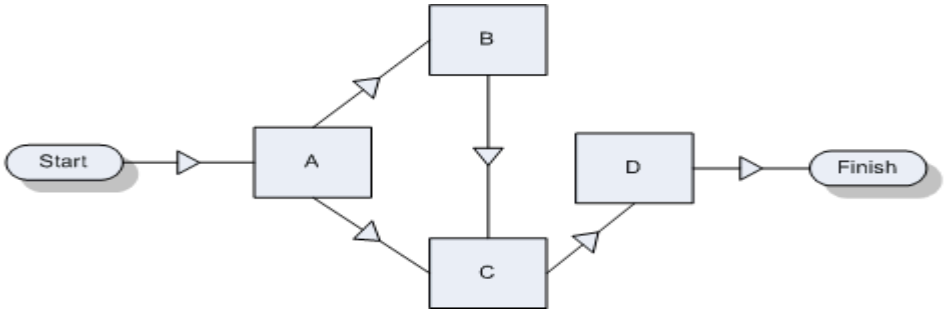
4.3. Activity Sequencing:

The project activities defined and listed can't all start at one time, some activities will occur after others and thus the process involves reviewing the activity list and attributes, project scope statement, milestone list, and approved change request to determine the relationships between activities. It also involves evaluating the reasons for dependencies and the different types of dependencies.

4.3.1. Dependencies

A dependency or relationship relates to the sequencing of project activities or tasks. There are three categories of dependencies;

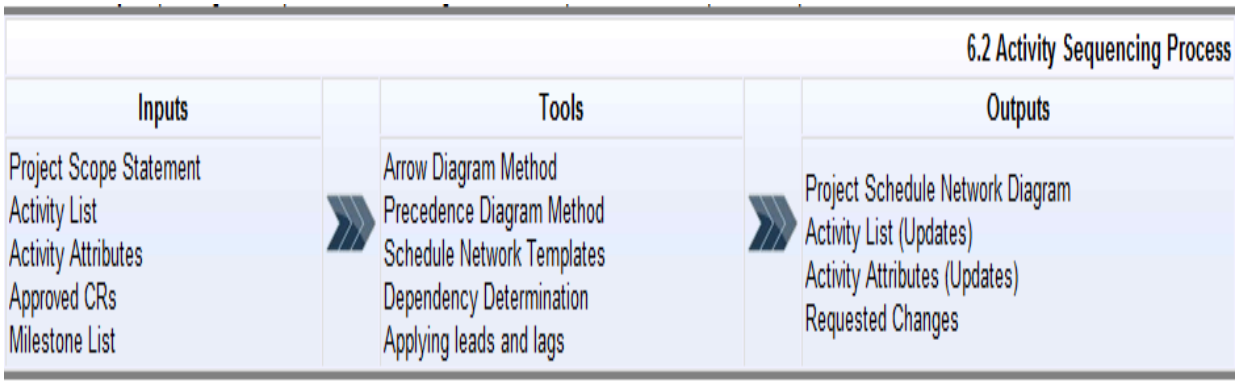
1. Mandatory dependencies: inherent in the nature of the work being performed; normally referred to as hard logic e.g one cannot test the program code before the code is written
2. Discretionary dependencies: defined by the project team, referred to as soft logic, eg. not moving to the next phase of a project before the previous phase has been signed off by the users.
3. External dependencies: involve relationships between project and non-project activities



There are 4 types of Activity dependencies

1. Finish to Start: Preceding activity must finish before successor starts.
2. Finish to Finish: Preceding activity must finish to finish successor activity.
3. Start to Start: Preceding Activity must start to Start Successor
4. Start to Finish: Preceding Activity must Start before successor can finish. For example, Get an approval to start constructing a house. But in this dependency we start construction and get an approval before finishing the construction. Rarely used dependency.

Activity sequencing allows the use of project schedule tools such as Network diagrams and critical path analysis. The main output is the project Network diagram / PERT charts



4.3.2. Activity Resource Estimation:

Involves estimating how many resources (people, equipment and materials) a project team should use to perform project activities.

Issues to consider 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?

Main output is the activity resource requirements, a resource breakdown structure, requested changes, and updates to activity attributes and resource calendars.

Resource breakdown structure is a hierarchical structure that identifies the project's resources by category and type. It defines assignable resources such as personnel, from a functional point of view; it identifies "who" is doing the work. The total resources define the Top Level, and each subsequent level is a subset of the resource category (or level) above it. Each descending (lower) level represents an increasingly detailed description of the resource until small enough to be used in conjunction with the Work Breakdown Structure (WBS) to allow the work to be planned, monitored and controlled.

4.4. Activity Duration Estimating

Estimating the number of work periods that are needed to complete individual activities.
The main goal for "Activity Duration Estimating" process is to provide effort estimation for all activities developed in during Activity Definition Process. Also know as Effort estimation, means how many hours/days are required to complete an activity. Duration is totally different than the work effort

- Effort: is the number of workdays or work hours required to complete a task
- Duration: includes the actual amount of time worked on an activity *plus* elapsed time

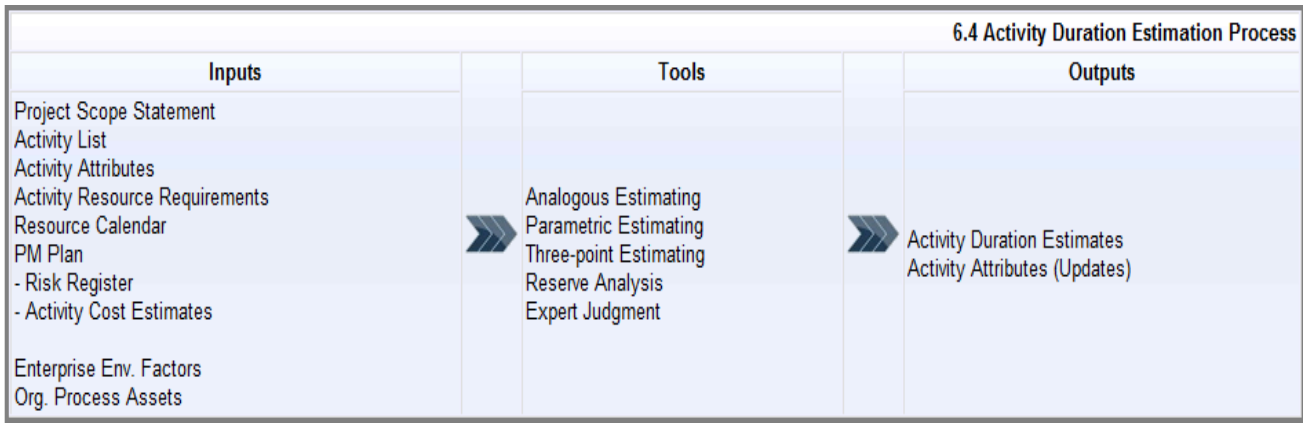
Effort does not normally equal duration
People doing the work should help create estimates, and an expert should review them

There are several techniques that are used in real world to estimate the effort. Out of all Expert judgment is the most important technique. Which is the core technique used in all other forms. Some subject matter expert should know what it takes to do it. PMBOK suggest few other techniques to refine the Expert judgment

- Analogous Estimating
- Parametric Estimating
- Three-point estimating
- Reserve Analysis

1. **Analogous Estimating:** Comparing to similar activity on the other project is the concept of this technique. This particular technique requires historical data to compare. In cases where there is no historical data, you would rely on other techniques and can't perform Analogous Estimating
2. **Parametric Estimating**: Dependent on various parameters used for an activity. Multiplication of base unit of a parameter times of parameter size would give effort. For example 100 lines of code can be developed in 8 hours; then to develop 1000 lines of code it will take 80 hours. And if you need this in a week's duration you will assign 2 resources.
3. **Three-point estimation**: Here you take pessimistic, optimistic, and realistic estimates for an activity. This approach can produce most close estimate than single Expert Judgment estimate. Normally average of these 3 estimates and Standard deviation are used.

Outputs include activity duration estimates and updates to activity attributes.



4.5. Schedule Development.

Involves analysing the activity sequence, activity resource estimates and activity duration estimates to create the project schedule.

- 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

Milestones should be shown. These are points in time, denoting the completion of a specified part of the project, such as a phase/stage transition, and they need to be clearly identified. They are a useful method of communicating progress to the customer, the management and the Project Team(s). In some cases payment by the customer may be linked to specific milestones. In these circumstances, criteria for achieving the milestone must be specified and agreed to by the customer.

4.5.1. Benefits of Schedule Management:

- It can be used as basis for monitoring, controlling and tracking.
- How to use resources effectively and in most efficient way
- Which activities are crucial to finish the project (Critical Path)

4.6. Project Schedule Representation Techniques

When producing a schedule, the following techniques should be considered:

a) **Precedence Diagrams (Network Diagrams);** A precedence diagram is a method used to show the sequence of tasks, in the form of a network, which identifies the interdependencies between tasks.

b) **Critical Path Method;** Critical Path Method (CPM) is a scheduling method, also based on a network that identifies the single chain of tasks through the schedule that will take the longest to complete or achieve. CPM incorporates the word `critical` because, if this sequence of tasks and milestones is not complete on time, the project will not finish on schedule. Planned start and finish dates should be added and the logic of the diagram should be configured to minimise the impact of the critical path.

c) **Bar/Gantt Chart;** A bar chart/Gantt chart can be used to show the network of tasks against a project calendar, taking into account the length of the working day, holidays, and other factors. It will also facilitate the mapping of resource availability against the activities and skills required and for resource levelling to take place.

d) **Resource Levelling;** Resource levelling techniques distribute the use of resources over time to minimise the variation in manpower, equipment, or money to be expended. The central idea of resource levelling is to reschedule tasks and milestones within the limits of available slack to achieve a better distribution of resources. The resource levelling procedure should not allow the duration of a project to increase.

e) **Slack/Stretch** Slack, once commonly know as float, can be used to calculate the amount of time over and above that is required that is required to complete the task or milestone. Stretch is a factor used to

calculate the amount of calendar time required, to complete a specified amount of effort. The stretch factor can take account of non-project overheads, such as holidays.

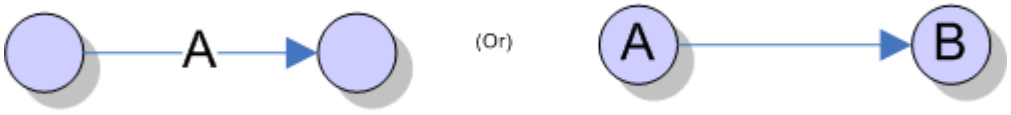
f) **Project Evaluation and Review Techniques (PERT);** PERT is a time-focused, network-based planning system, which is used for projects where meeting the schedule is more sensitive than costs.

4.6.1. Network Diagrams

Project Network Diagrams: A project network diagram is a schematic display of relationships among, or sequencing of, project activities. It is the preferred technique for showing activity sequencing.

Drawing Sequencing Diagrams also called **Network Diagrams**: Many methods are provided but 2 methods are most common and another method is worth mentioning.

1. Activity on Node
2. Activity on Arrow



- **Activity on Node (AON) or Precedence Diagram Method (PDM)**: Nodes represent activities and draw arrows to show the dependencies. The above Sequence diagram is an example of this method.
- **Activity on Arrow (AOA) or Arrow Diagram Method (ADM)**: Nodes are transition points (Dependencies) and Arrows represents the activities. Some time this is so confusing to understand. In those cases those nodes are given a names and activities are treated as processes.

Activity - on- Arrow (AOA)

- 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

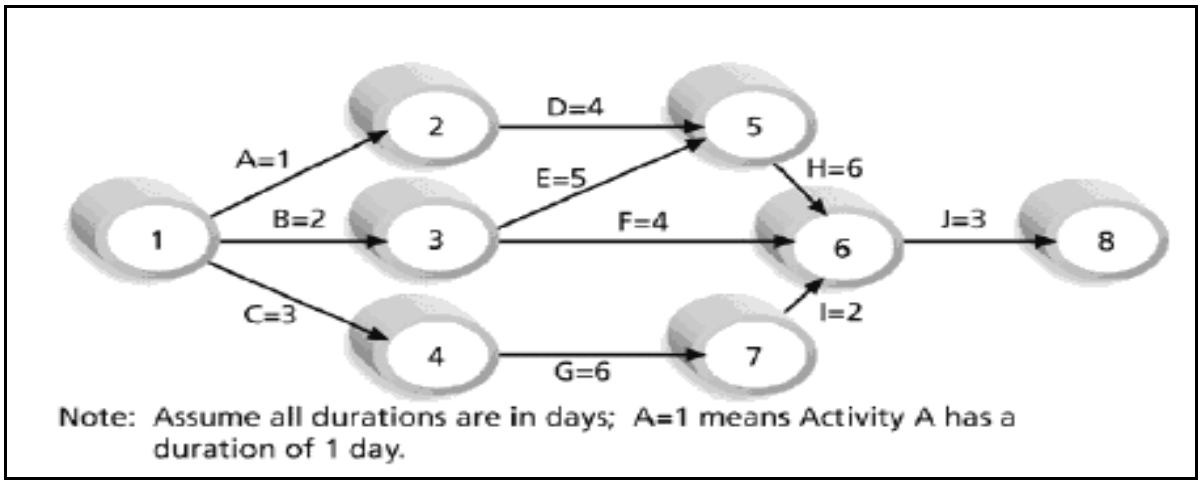
Process for Creating AOA Diagrams

- 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
- 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
- Continue drawing the project network diagram until all activities are included on the diagram that have dependencies
- As a rule of thumb, all arrowheads should face toward the right, and no arrows should cross on an AOA network diagram

Example

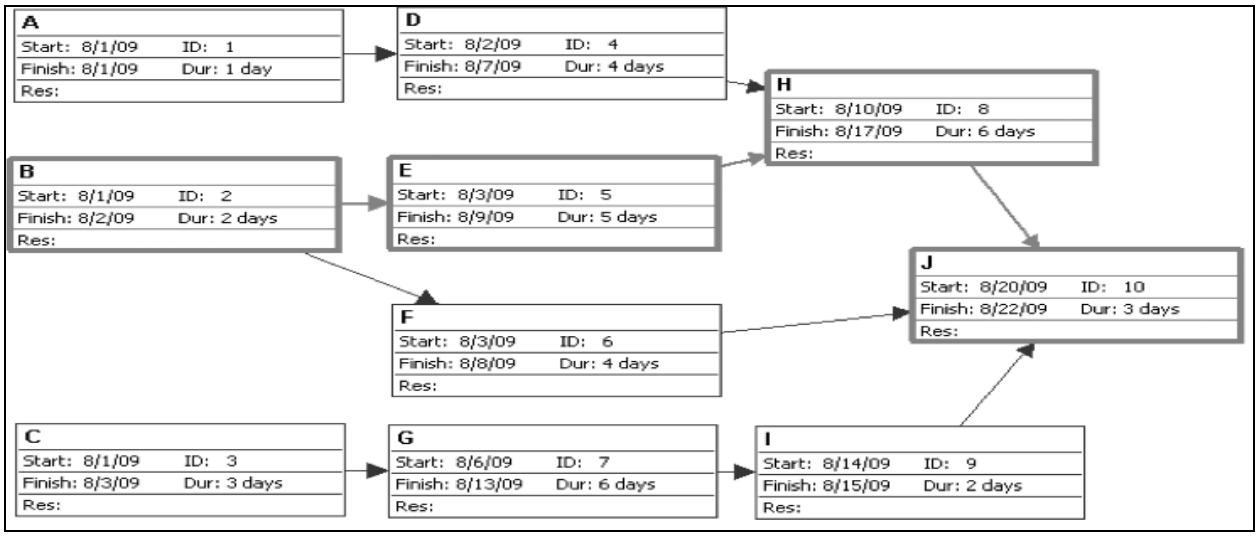
Work Break down structure

Activity	Predecessor	Duration (Days)
A	-	1
B	-	2
C	-	3
D	A	4
E	B	5
F	B	4
G	C	6
H	D, E	6
I	G	1
J	F,G,H,	3



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



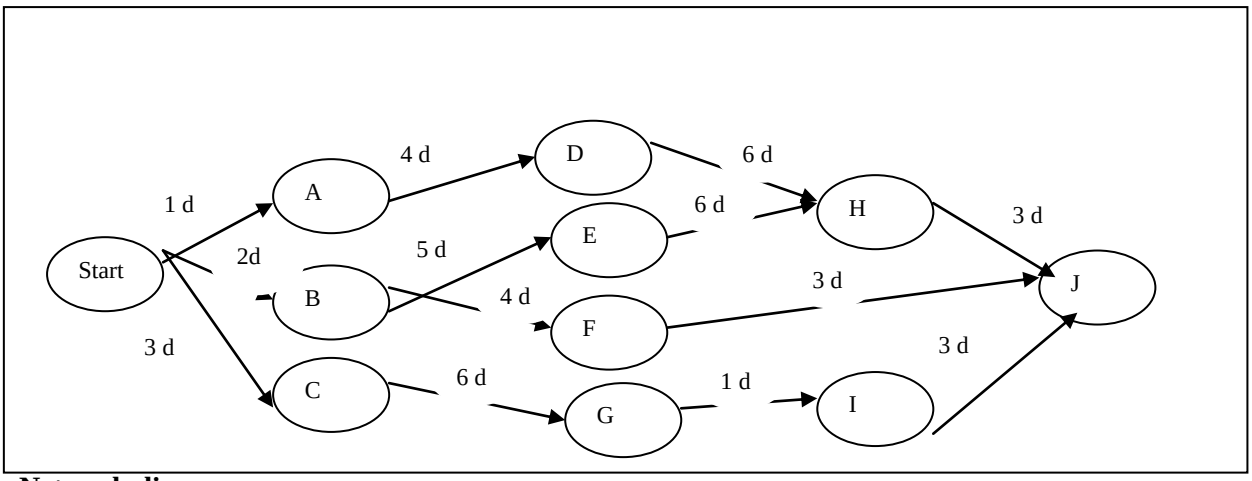
4.6.2. Critical Path Method

Critical Path Method (CPM) is a scheduling method, also based on a network diagramming technique that identifies the single chain of tasks through the schedule that will take the longest to complete or achieve. CPM incorporates the word `critical` because, if this sequence of tasks and milestones is not complete on time, the project will not finish on schedule. Planned start and finish dates should be added and the logic of the diagram should be configured to minimize the impact of the critical path.

- 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

Example for Calculating the Critical path

Activity	Predecessor	Duration (Days)
A	-	1
B	-	2
C	-	3
D	A	4
E	B	5
F	B	4
G	C	6
H	D, E	6
I	G	1
J	F,G,H,	3

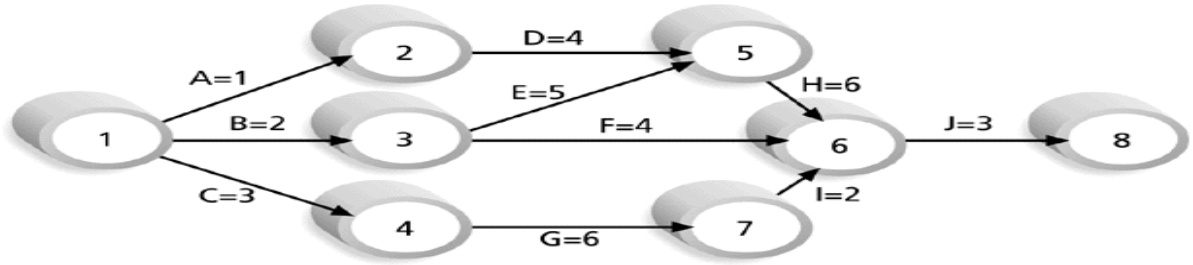


Network diagram

Path 1: A –D – H - J 14 Days
Path 2: B – E – H – J 16 Days
Path 3: B – F – J 9 Days
Path 4: C – G – I – J 14 Days

Path 2 is the longest and thus the critical path for the project

Or



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.

6.5 Schedule Development Process

Inputs	Tools	Outputs
Project Scope Statement Activity List Activity Attributes Project Schedule Network Diagrams Activity Resource Requirements Resource Calendars Activity Duration Estimates PM Plan - Risk Register Org. Process Assets	Schedule Network Analysis CPM (Critical Path Method) Schedule Compression What-If Scenario Analysis Resource Leveling Critical Chain Method Adjusted Leads and Lags Schedule Model Applying Calendars PM Software	Project Schedule Schedule Model Data Schedule Baseline Resource Requirements (Updates) Activity Attributes (Updates) Project Calendar (Updates) Requested Changes Schedule Management Plan (Updates) - PM Plan (Updates)

4.6.3 Slack/Stretch

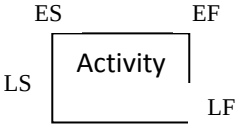
Using critical path Analysis to make schedule trade-offs

A technique Project managers can use to make schedule trade-offs is determining the project slack time. **Slack** or **float** is the amount of time an activity may be delayed without delaying a succeeding activity or the project finish date. It tells how much of flexibility you have within the project schedule. It is important to have flexibility. There are 2 types of internal slacks and one external slacks for any project.

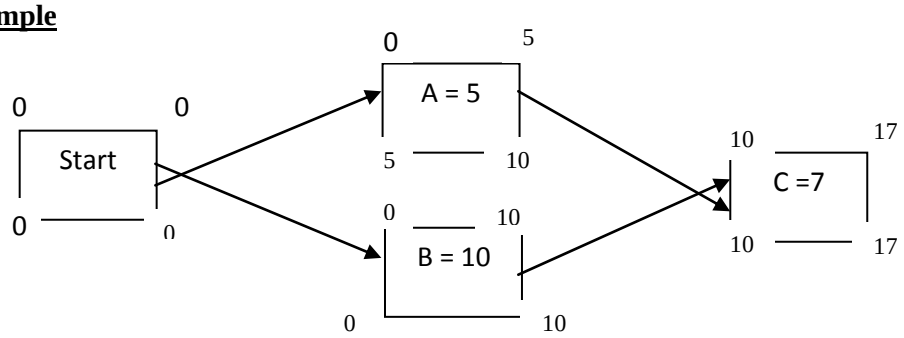
- **Free Slack**: The amount of time an activity can be delayed without delaying the early start-time of any immediately following activities.
- **Total Slack:** the amount of time an activity can be delayed from its early start date without delaying the planned project finish-date.
- **Project Slack**: The amount of time a project can delay without delaying other projects within program

Methods used to determine the Slack time

- Using a forward pass to determine the early start (ES) and early finish (EF) dates for an activity
- Using the backward pass to determine the late start (LS) and late finish (LF) dates for an activity



Example



- Activity A takes 5 days
- Activity B takes 10 days
- Activity C takes 7 days
- **Critical path = B-C = 17 Days**

Activity A has a slack time of 5 Days

- Earliest start date = day 0
- Latest start date = day 5
- Earliest finish date = day 5
- Latest finish date = day 10

NB. Activities on Critical Path doesn't have flexibility that is ZERO SLACK.

Critical Chain Scheduling

Used to address the challenge of meeting or beating project finish dates. Based on theory of constraints (TOC), it is a method of scheduling that considers limited resources when creating a project schedule and includes buffer to protect the project completion date.

It assumes that resources do not multitask and requires prioritization of the activities on the schedule so that the resources can know which task take priority.

Using the Critical Path to Shorten a Project Schedule

Three main techniques for shortening schedules

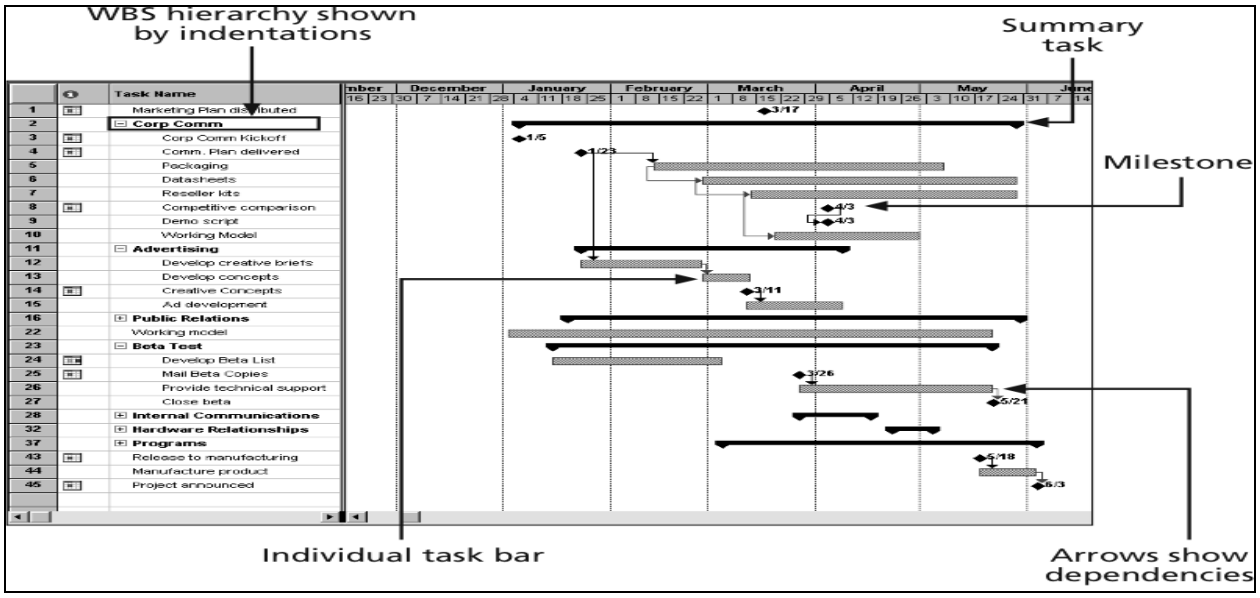
a) Shortening durations of critical activities/tasks by adding more resources or changing their scope
b) Crashing activities by obtaining the greatest amount of schedule compression for the least incremental cost
    - A 2 week task with one person working 50% could be shortened to 1 week if the person 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)
c) 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

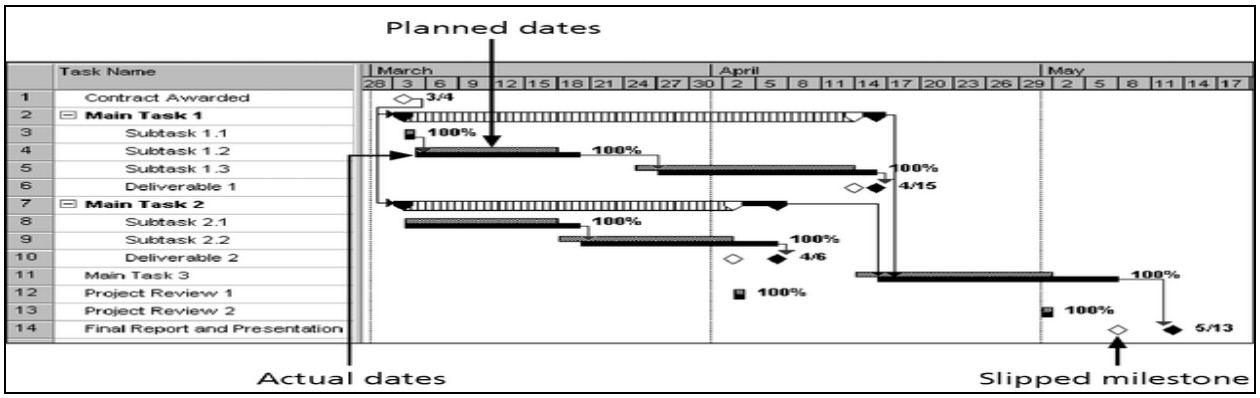
4.6.4. Gantt Chart

A bar chart/Gantt chart can be used to show the network of tasks against a project calendar, taking into account the length of the working day, holidays, and other factors. It will also facilitate the mapping of resource availability against the activities and skills required and for resource levelling to take place.

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





The Gantt chart can be used to compare the baseline or planned project schedule to the Actual project schedule, thus showing project delay, slipped milestones etc

4.6.5. 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. It applies the critical path method to a weighted average duration estimate.

PERT is intended for very large-scale, one-time, non-routine, complex projects with a high degree of inter-task dependency, projects which require a series of activities, some of which must be performed sequentially and others that can be performed in parallel with other activities.

The main objective of PERT is to facilitate decision making and to reduce both the time and cost required to complete a project.

- PERT uses probabilistic time estimates
  - ✓ Duration estimates based on using optimistic, most likely, and pessimistic estimates of activity durations, or a three-point estimate, instead of one specific or discrete duration 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 such as the weighted average for the duration estimate of each activity using the formula

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 =

$$\frac{8 \text{ workdays} + (4 \times 10 \text{ workdays}) + 24 \text{ workdays}}{6} = \textbf{12 days}$$

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

4.7. Project Schedule Control

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

4.7.4. 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