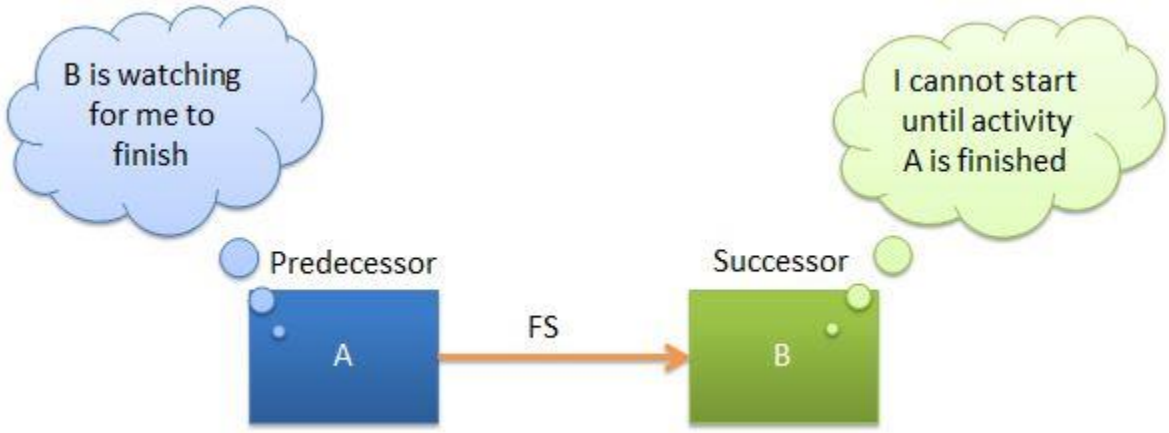
Types of Dependencies In Project Management

Dependencies in project management show the relationship between project activities. When you plan to schedule activities, you as a project manager would figure out the relationship between these activities to figure out the order of the execution of the activities.

There are four types of dependencies in project management. They are

1. Finish-to-start (FS) - Successor activity cannot **start** until the predecessor activity **finish**.
2. Finish-to-finish (FF) - Successor activity cannot **finish** until the predecessor activity **finish**.
3. Start-to-start (SS) - Successor activity cannot **start** until the predecessor activity **start**.
4. Start-to-finish (SF) -Successor activity cannot **finish** until the predecessor activity **start**.

Finish To Start (FS)



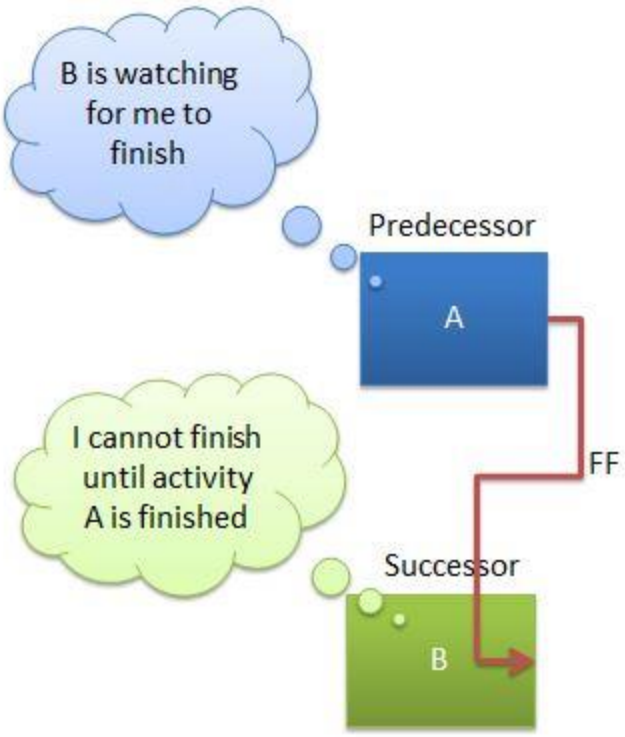
Finish-to-start (FS) is the simplest one among the dependencies in project management. This is the most frequently used dependency when sorting the order of activities in the project.

Activity on arrow diagramming method is limited to show only finish to start (FS) dependencies.

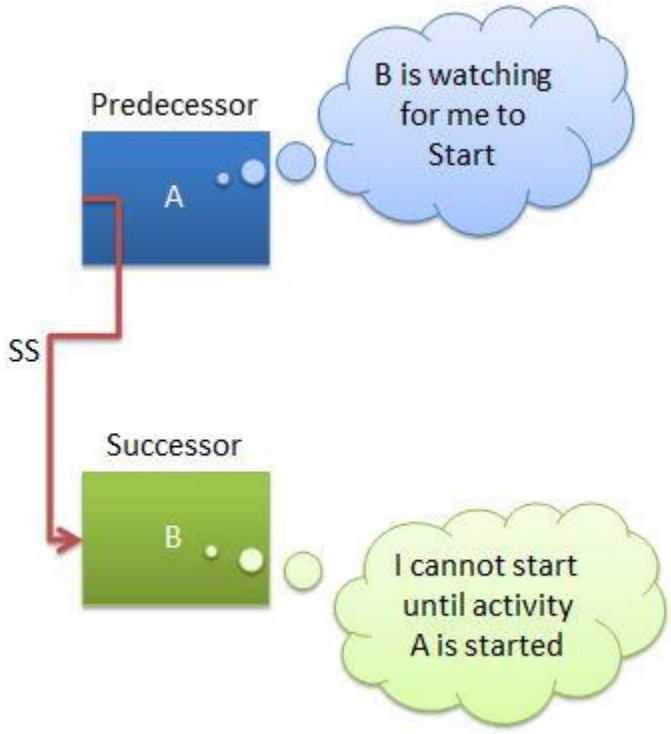
For example in the waterfall SDLC model, the development activity (successor) cannot start until the design finish (predecessor activity).

Finish-to-finish (FF)

For example, the broadcasting activity cannot finish until the tournament finishes. In this case tournament is the predecessor activity and the broadcasting is the successor activity.



Start-to-start (SS)

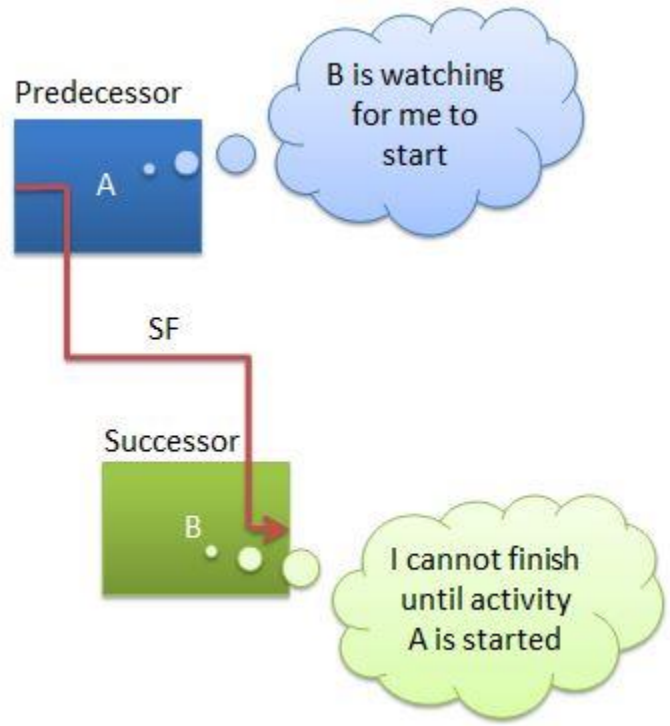


The successor activity B cannot start independently on its own. It has to wait for activity A to start first and then only the activity B can start.

For example, the system analysts' team is going to document the requirements for the new payroll system after at least interviewing some users. In this scenario, start to start dependency is stated as follows.

The system analyst team can't start documenting the requirements until the interviewing process of some users starts.

Start-to-finish (SF)



This is the rarest one among the other dependencies in project management. And hence it is very difficult to visualize this with an example.

Example, the first security guard shift (successor) cannot finish until the second security guard shift (predecessor) starts.

Critical Path Method (CPM)

Critical path method (CPM) is the method, which project manager uses to figure out the critical path in the project.

The Critical path is defined as the longest path in the project. or

Critical path can also be defined as the shortest duration in which the project can complete.

What does it mean?

Critical path means that, the project manager do not have any luxury of delaying the project, when performing the activities on critical path. So every activity on the critical path must complete on time for the project to complete on time. A delay in any of the activities on critical path, will delay the whole project.

Importance of Critical Path for The Project Manager

As project manager your main objective is to look at the activities in the project, for any slippages and to correct them as needed. Especially with respect to critical path the project manager has to understand two points.

1. Understand the critical path and make sure each activity on the critical path is completed on time. Knowing the critical path of the project will help the project manager to use any of schedule compression techniques to keep the critical path activities on track in terms of timelines.
2. Understand the activities which are not on the critical path. This will give a room for the project manager to play with the activities, if there are any delays with any of them. Meaning that this gives project manager some amount of freedom to consider the delays in one or more activities without impact the overall timelines of the project.

How to calculate Float, Free Float, Total Float Using ES, EF, LS and LF

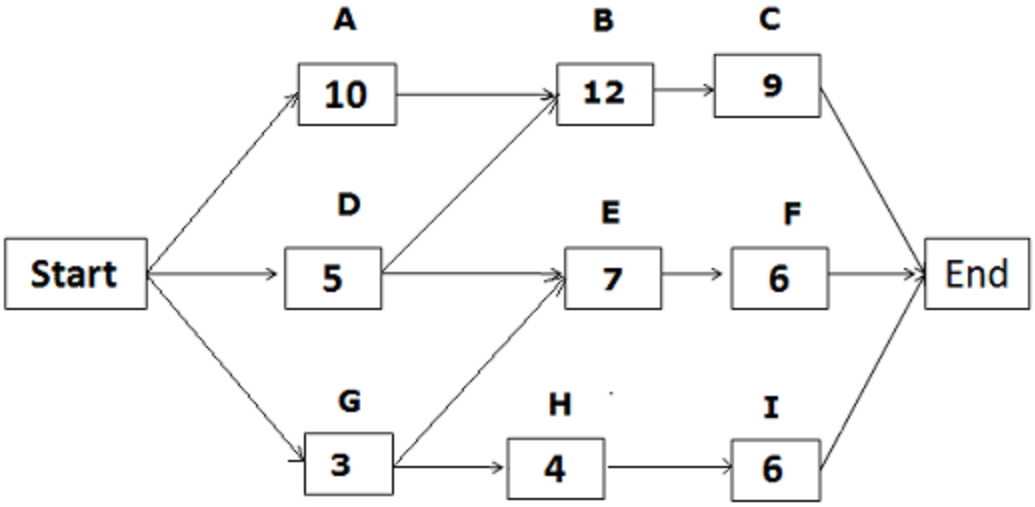
Total Float - is the amount of time an activity can be delayed without delaying the project completion date. On a critical path, the total float is zero.

Total float is often known as the slack.

Free float is the amount of time an activity can be delayed without delaying the Early Start of its successor activity.

Example

Based on the below network diagram below, identify the total paths, critical path, and float for each path.



The above network diagram has five paths; the paths and their duration are as follows:

1. Start -> A -> B -> C-> End, duration: 31 days.
2. Start ->D -> E ->F -> End, duration: 18 days.
3. Start -> D -> B -> C -> End, duration: 26 days.
4. Start -> G ->H ->I -> End, duration: 13 days.
5. Start -> G -> E ->F -> End, duration: 16 days.

Since the duration of the first path is the longest, it is the critical path. The float on the critical path is zero.

The float for the second path "Start ->D -> E ->F -> End" = duration of the critical path – duration of the path "Start ->D -> E ->F -> End"

= 31 – 18 = 13

Hence, the float for the second path is 13 days.

Using the same process, we can calculate the float for other paths as well.

Float for the third path = 31 – 26 = 5 days.
Float for the fourth path = 31 – 13 = 18 days.
Float for the fifth path = 31 – 16 = 15 days.

Calculate Early Start (ES), Early Finish (EF), Late Start (LS), and Late Finish (LF)

We have identified the critical path, and the duration of the other paths, it's time to move on to more advanced calculations, Early Start, Early Finish, Late Start and Late Finish.

Calculating Early Start (ES) and Early Finish (EF)

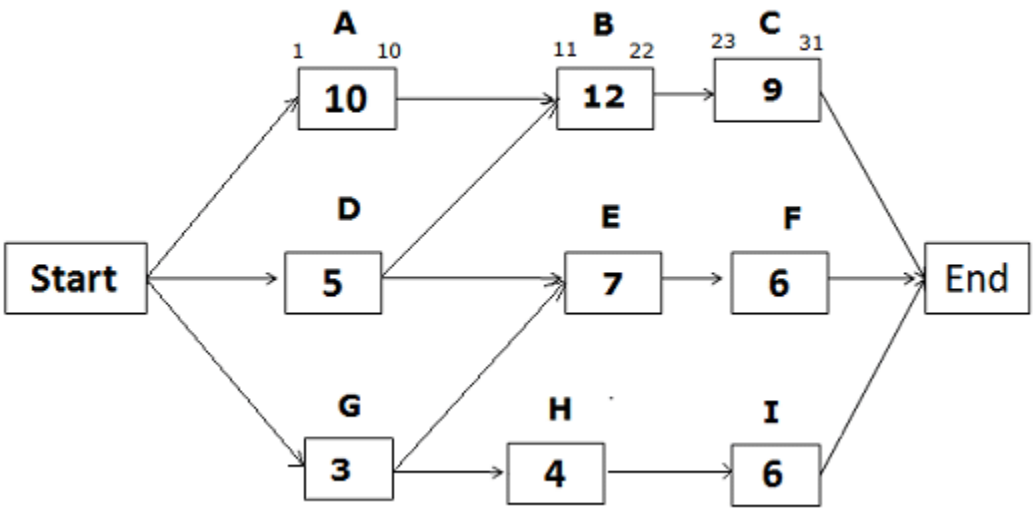
To calculate the Early Start and Early Finish dates, we use forward pass; we will start from the beginning and proceed to the end.

Early Start (ES) for the first activity on any path will be 1, because no activity can be started before the first day. The start point for any activity or step along the path is the end point of the predecessor activity on the path plus one.

The formula used for calculating Early Start and Early Finish dates.

- Early Start of the activity = Early Finish of predecessor activity + 1
- Early Finish of the activity = Activity duration + Early Start of activity – 1

Early Start and Early Finish Dates for the path Start -> A -> B -> C -> End



Early Start of activity A = 1 *(Since this is the first activity of the path)*

Early Finish of activity A = ES of activity A + activity duration – 1
= 1 + 10 – 1 = 10

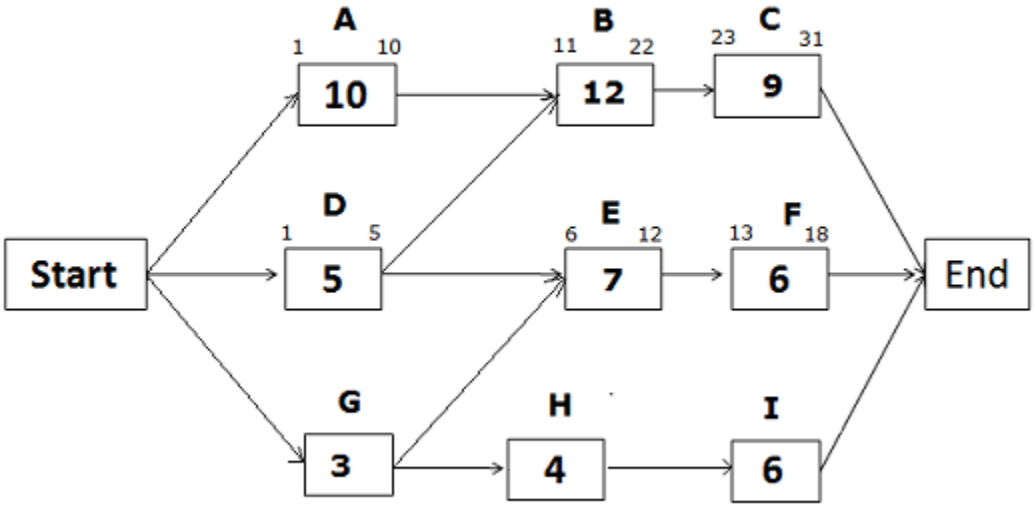
Early Start of activity B = EF of predecessor activity + 1
= 10 +1 = 11

Early Finish of activity B = ES of activity B + activity duration – 1
= 11 + 12 – 1 = 22

Early Start of activity C = EF of predecessor activity + 1
= 22 +1 = 23

Early Finish of activity C = ES of activity C + activity duration – 1
= 23 + 9 – 1 = 31

Early Start and Early Finish Dates for the path Start -> D -> E -> F -> End



Early Start of activity D = 1 *(Since this is the first activity of the path)*

Early Finish of activity D = 1 + 5 – 1 = 5

Early Start of activity E = EF of predecessor activity + 1

Since the Activity E has two predecessor activities, which one will you select? You will select the activity with the greater Early Finish date. Early Finish of activity D is 5, and Early Finish of activity G is 3 *(we will calculate it later).*

Therefore, we will select the Early Finish of activity D to find the Early Start of activity E.

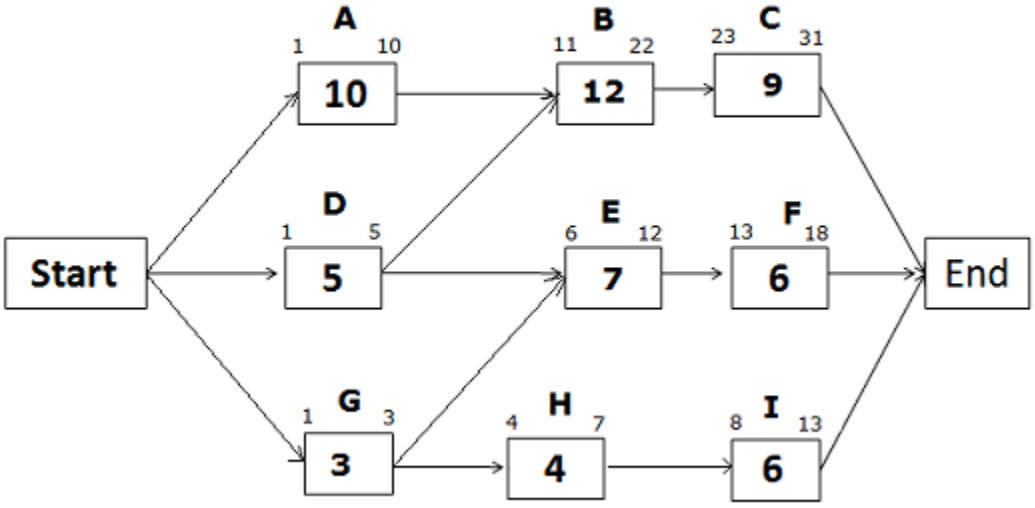
Early Start of activity E = EF of predecessor activity + 1
= 5 + 1 = 6

Early Finish of activity E = 6 + 7 – 1 = 12

Early Start of activity F = 12 + 1 = 13

Early Finish of activity F = 13 + 6 -1 = 18

Early Start and Early Finish Dates for the path Start -> G -> H -> I -> End



Early Start of activity G = 1 *(Since this is the first activity of the path)*
Early Finish of activity G = 1 + 3 – 1 = 3

Early Start of activity H = 3 + 1 = 4
Early Finish of activity H = 4 + 4 – 1 = 7

Early Start of activity I = 7 +1 = 8
Early Finish of activity I = 8 + 6 – 1 = 13

Calculating Late Start (LS) and Late Finish (LF)

We have calculated Early Start and Early Finish dates of all activities. Now it is time to calculate the Late Start and Late Finish dates.

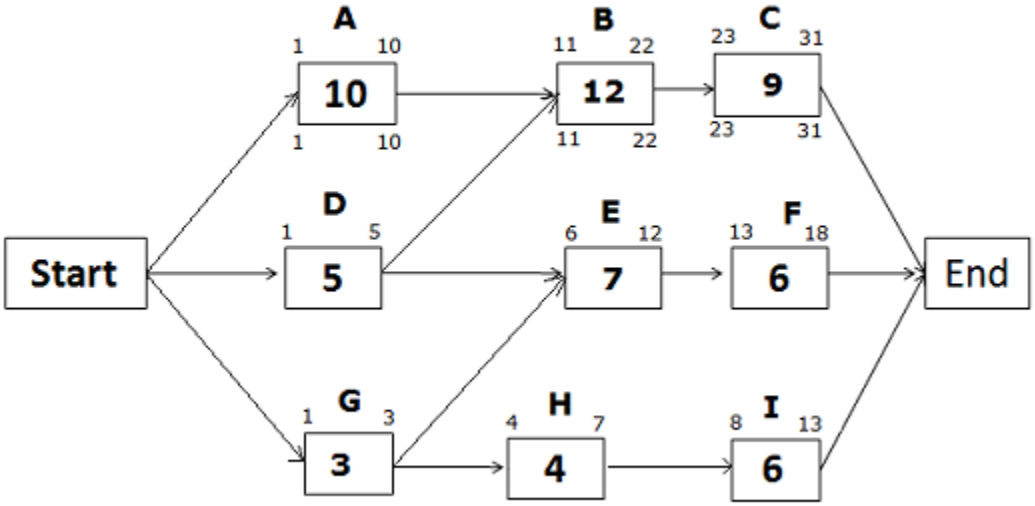
Late Finish of the last activity in any path will be the same as the Last Finish of the last activity on the critical path, because you cannot continue any activity once the project is completed.

The formula used for Late Start and Late Finish dates:

- Late Start of Activity = Late Finish of activity – activity duration + 1
- Late Finish of Activity = Late Start of successor activity – 1

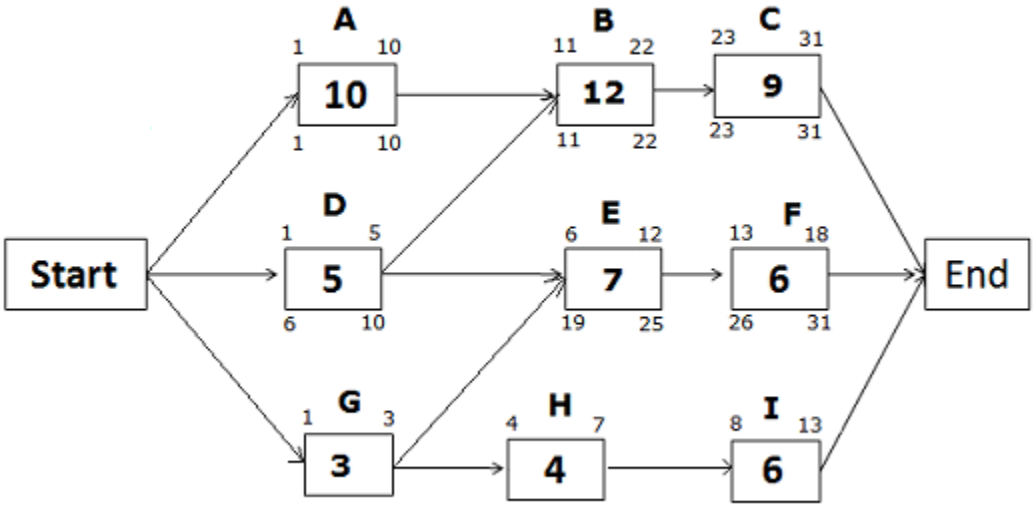
To calculate the Late Start and Late Finish, we use backward pass; i.e. we will start from the last activity and move back towards the first activity.

Late Start and Late Finish Dates for the path Start -> A -> B -> C -> End



On a critical path, Early Start, and Early Finish dates will be the same as Late Start and Late Finish dates.

Late Start and Late Finish Dates for the path Start -> D -> E -> F -> End



Late Finish of activity F = 31 *(because you cannot allow any activity to cross the project completion date)*

Late Start of activity F = LF of activity F – activity duration + 1
= 31 – 6 +1 = 26

Late Finish of activity E = LS of successor activity – 1
= LS of activity F – 1
= 26 – 1 = 25

Late Start of Activity E = LF of activity E – activity duration + 1
= 25 – 7 + 1 = 19

Late Finish of activity D = LS of successor activity – 1

If you look at the network diagram, you will notice that activity D has two successor activities, B and E. So, which activity will you select?

You will select the activity with the earlier(least) Late Start date. Here, Late Start of activity B is 11, and Late Start of activity E is 19.

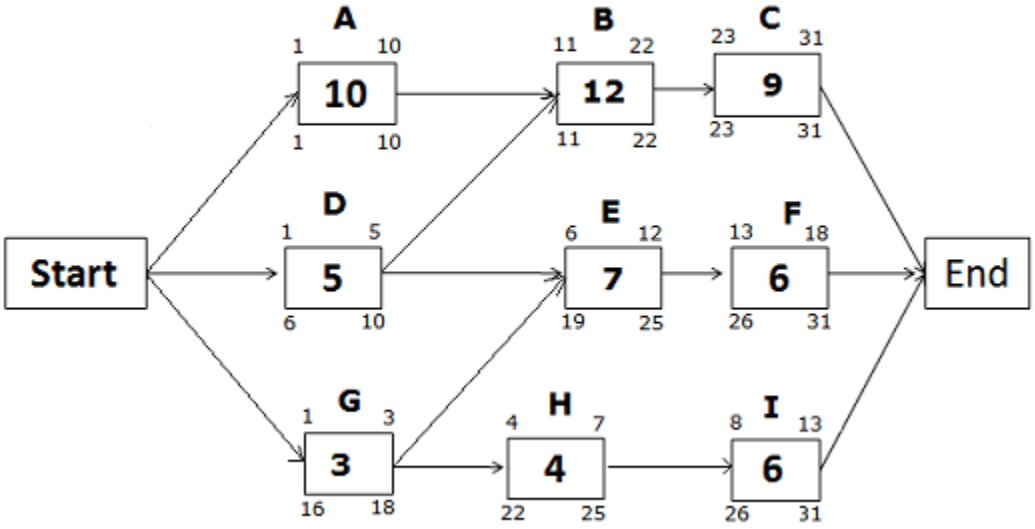
Therefore, you will select activity B which has the earlier Late Start date.

Hence,

Late Finish of activity D = LS of activity B – 1
= 11 – 1 = 10

Late Start of Activity D = LF of activity D – activity duration + 1
= 10 – 5 + 1 = 6

Late Start and Late Finish Dates for the path Start -> G -> H -> I -> End



Late Finish of activity I = 31 *(because you cannot allow any activity to cross the project completion date)*
Late Start of activity I = 31 – 6 + 1 = 26

Late Finish of activity H = 26 – 1 = 25
Late Start of activity H = 25 – 4 + 1 = 22

Late Finish of Activity G = 19 – 1= 18 *(we will choose the late start of activity E, not activity H, because the Late Start of activity E is earlier than the Late Start of activity H)*

Late Start of activity G = 18 – 3 + 1
= 16

Calculate the Free Float

The formula for the Free Float is:

- Free Float = ES of next activity – EF of current activity – 1

Benefits of the Critical Path Method

The following are a few benefits of the critical path method:

- It shows the graphical view of the project.
- It discovers and makes dependencies visible.
- It helps in project planning, scheduling, and controlling.
- It helps in contingency planning.

- It shows the critical path, and identifies critical activities requiring special attention.
- It helps you assign the float to activities and flexibility to float activities.
- It shows you where you need to take action to bring project back on track.

Although the critical path is very useful tool in project planning, it also has some limitations and drawbacks.

Limitations and drawbacks of the Critical Path Method

- Because the critical path method is an optimal planning tool, it always assumes that all resources are available for the project at all times.
- It does not consider resource dependencies.
- There are chances of misusing float or slack.
- Less attention on non-critical activities, though sometimes they may also become critical activities.
- Projects based on the critical path often fail to be completed within the approved time duration.
- The critical path method is also infected with Student Syndrome, where team members do not start the task until the last moment.