Two Methods to Calculate the Forward and Backward Passes in a Network Diagram

How do you calculate starts and finishes for your project activities? If you are like most project managers, you use project scheduling software to perform the calculations—the software does the work for you. For the Project Management Professional (PMP)® exam, however, you need to know how to perform these calculations without the aid of software.

There are two methods you can use to determine starts and finishes. One is easy to use for the exam–the One Method, while the other works well in real life–the Zero Method. It's important to learn both of these methods.

The titles of these methods refers to the early start number used for calculating—either a one or a zero. Although the starts of these two methods are different, they both calculate the same finishes. Let's take a look at how these methods work, along with the assumptions associated with each one.

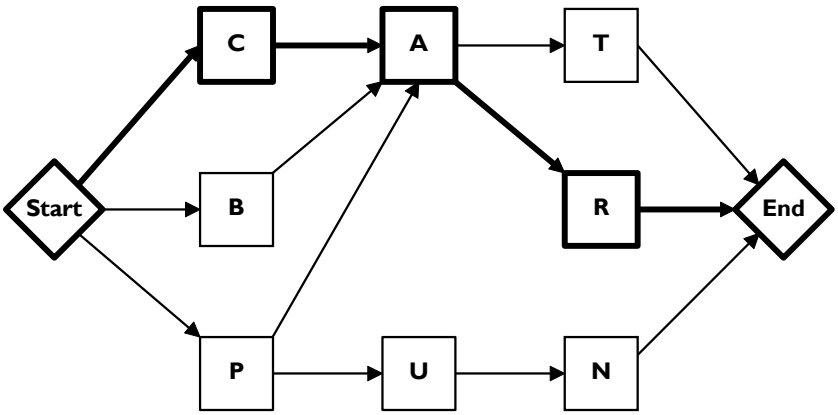
Because there are different assumptions associated with each method, you need to think of the methods in different ways to fully grasp the concepts. This differentiation may cause some confusion if you do not fully understand a forward pass and a backward pass.

> One Method assumption: All starts are at the beginning of a time period, and all finishes are at the end of a time period.
>
> Zero Method assumption: All starts and ends are at the end of a time period.

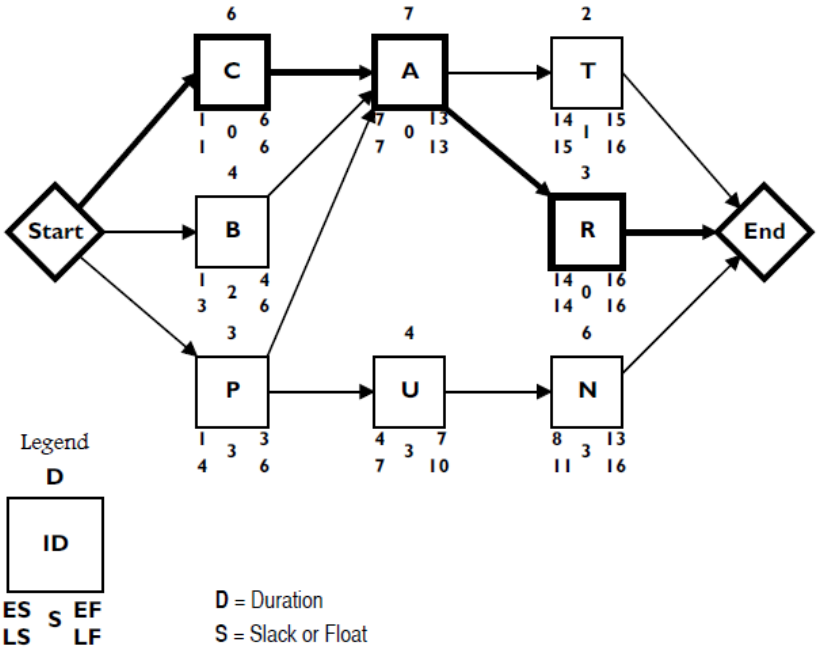
One Method

Let's start with the more intuitive method—the One Method. This calculation, for most people, is the easiest to understand. Remember: the starts are all at the beginning of a time period, and the finishes are at the end of a time period.

Activity	Predecessor	Estimate in weeks
Start	–	0
C	Start	6
B	Start	4
P	Start	3
A	C,B,P	7
U	P	4
T	A	2
R	A	3
N	U	6
End	T,R,N	0



Based on the above chart and network diagram, you can determine that the critical path is Start–C–A–R–End. Using the One Method and starting with activity C, the earliest it can begin is at the beginning of week one, so Early Start (ES) = 1. To find the Early Finish (EF), you count the ES and continue counting to reach the duration of the activity. In this case, you start with 1 and then continue to count until you have counted the duration, which is 6. So the ES = 1, and the EF = 6 for activity C. This technique works well for many people who like to use a simple method to calculate forward and backward passes. Others who prefer to have a standard formula can use EF = ES + D – 1 for the forward pass.



Now we can move on to the next activity you would increment by one, making activity A's ES = 7. We need to consider convergence as well as duration. Both activity C and B must be complete before we can start activity A. The EF of C = 6, and the EF of B = 4. Since both activities have to be complete, we use the later EF of the two activities, which is 6. We then increment this number by one. The ES of A is the beginning of week 7, as shown on the network diagram. You can use the same simple counting method to determine that the EF of activity A is the end of week 13. You continue in this manner, watching for convergence, until you have completed all the activities on the network. You will then have completed the forward pass.

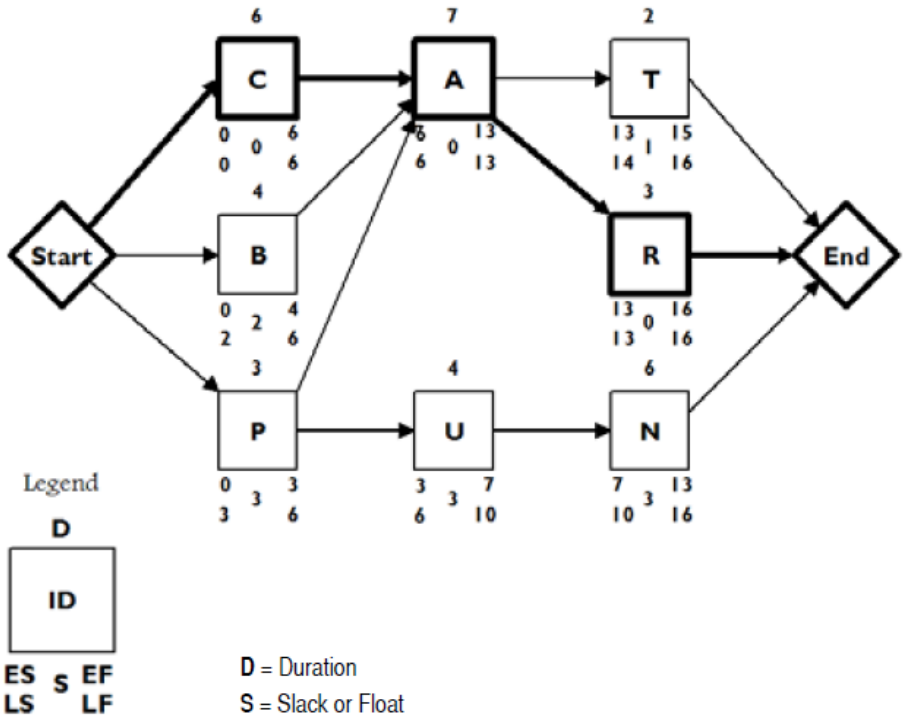
Once you have finished the forward pass, you can begin the backward pass. You start by using the duration of the critical path (as calculated above) for the late finishes (LF) of the final activities. In this example, activities T, R, and N would be included.

Let's focus on activity T first. For this activity, the LF is at the end of week 16. You can count backward from 16 to determine the Late Start (LS) for T. Since the duration is only 2 for this activity, you stop counting at 15. Therefore, the LS of T is at the beginning of week 15. You then decrement this number by one to find the LF of the previous activity. Be careful here as well, as there is a convergence of two paths back into activity A. You need to consider the LS of both activities T and R before you can determine the LF of activity A. In this case, activity T's LF is the beginning of week 15 and activity R's LS is the beginning of week 14. On the backward pass, use the earlier of the two LS numbers. Thus, the LF of activity A is 14 decremented by one, which equals the end of week 13. Continue this process, watching for path convergence, until you reach the start of the project. For those who like formulas, LS = LF – D + 1 for the backward pass.

The differences between the LF and EF or the LS and ES for each activity are the same number. This number represents the activity's float.

Zero Method

Now let's look at the Zero Method. Remember the starts and finishes both represent the end of a time period. In this case, they represent the end of a week. Based on the same network diagram, the earliest the activity can begin is at the end of week zero. Therefore, Early Start (ES) = 0. To find the Early Finish (EF), just add the duration to the ES (formula: EF = ES + D). In this case, you start with 0 and add 6, so the ES = 0 and the EF = 6 for activity C. This technique is a simple method to use on the exam as it is fast and, by using it, you are less prone to make mathematical errors. To determine the ES of the next activity, just use the EF from the previous activity.



With the Zero Method, you'll also need to consider convergence. Both activity C and B must be complete before you can start activity A. The EF of C = 6, and the EF of B = 4. Since both activities have to be complete, use the later EF of the two, which is 6. You then carry this number to the ES of activity A. So the ES of A is the end of week 6. Next, add the duration of activity A to determine that the EF of activity A is the end of week 13. Continue in this manner, watching for convergence, until you have completed all the activities on the network. You will then have completed the forward pass.

As with the One Method, once you have finished the forward pass, you can begin the backward pass. Start by using the duration of the critical path for the late finishes (LF) of the final activities. In this example, it includes activities T, R, and N.

Let's focus on activity T. If the LF of activity T is at the end of week 16, you can just subtract the duration of T to determine the activity's Late Start (LS) (formula: LS = LF – D). Therefore, subtract 2 from 16 to get 14. As a result, activity T's LS is the end of week 14. Then carry this number over to find the LF of the previous activity. Again, be careful here, since there is a convergence of two paths back into activity A. You need to consider the LS of both activities T and R before you can determine the LF of activity A. In this case, activity T's LF is the end of week 14 and activity R's LS is the end of week 13. On the backward pass, use the earlier of the two LS numbers. Thus, the LF of activity A is the end of week 13. Continue this process, watching for path convergence, until you reach the start of the project.

As with the One Method, the differences between the LF and EF or LS and ES for each activity are the same number. This number represents the activity's float.

How can you tell which method you are using? Here is a quick check to help you figure it out.

> You are using the One Method if:
> You increased the finish number by one to calculate the start of the next activity on your critical path.
>
> You are using the Zero Method if:
> The finish is the same number as the start of the next activity on your critical path.

Because the Zero Method uses the same number for the finish and start of adjacent activities, it makes the calculations for the exam simpler than the One Method. However, the One Method is more intuitive and is more applicable to the real world. Ultimately, the method you use is up to you, but it is helpful to understand each method for the exam.