

ACTIVITY NODE CALCULATIONS

Activity node techniques are basic techniques in schedule management. They were first introduced in space projects during the 1950's. Today almost every project management software has an activity node calculation feature.

When doing activity node diagrams, project's activities (list of tasks), their dependencies and durations need to be known.

Typically when activity node diagrams are built, every project activity is started as early as possible. That way the earliest start and the earliest finish of each activity can be calculated. In addition the longest path of dependent activities (= critical path) and the total duration of the project can be detected.

In the second phase activities can be scheduled to the latest possible start, so that the total duration of the project doesn't change. That way the latest start and the latest finish of each activity can be obtained.

The difference of each activity's earliest and latest start tells how much slack (float) there is available for each activity.

As a result of activity node calculations the following timelines for each activity can be obtained:

- Earliest start (ES)
- Earliest finish (EF)
- Latest start (LS)
- Latest finish (LF)
- Free slack/free float (FF)
- Total slack/total float (TF)

Total slack is the amount of time, inside which the start of an activity can be transferred without changing the total duration of the project.

Free float is the amount of time, inside which a start of an activity can be transferred without transferring the start of any other activity.

Drawing and calculating activity node diagram (example)

Activity node diagram can be made with computer program (that is the easiest way if you know how to use these programs), by drawing (e.g. flip board) or by calculating with block diagram (example below).

Activity	Duration	Predecessor	Dependency-type	Lag / lead
A	2 d			
B	1 d	A	FS	0
C	6 d	A	FS	0
D	6 d	C	FS	0
E	4 d	B	FS	0
F	2 d	A	FS	0
G	3 d	D,E,F,H	FS	0
H	2 d			

"Guide"

ES	TF	EF
No	<u>Activity</u>	
D		
LS	FF	LF

ES = Earliest Start

LS = Latest Start

TF = Total Float

No = Activity Number

EF = Earliest Finish

LF = Latest Finish

FF = Free Float

D = Activity Duration

Lag (lead) is modification of a logical relationship, which directs a delay in the successor task. For example in a finish-to-start dependency with a 10-day lag, the successor activity cannot start until 10 days after the predecessor has finished.

Activity node calculation with block diagram is done in the following manner:

Start to finish calculation (earliest start (ES))

1. The first activity is given value $ES = 0$. This is also the earliest start (ES) of every activity that starts at the same time as the first activity.
2. Earliest finish (EF) of the first and all the other activities, which start at the same time, is calculated. They are obtained by adding the duration of the activity to the earliest start ($EF = ES + D$)
3. Timing of the succeeding activity:

FS (finish to start) dependency: Earliest start of the succeeding activity is the earliest finish of the preceding activity plus possible lag.

FF (finish to finish) dependency: Earliest finish (EF) of the succeeding activity is the earliest finish (EF) of the preceding activity plus possible lag.

SS (start to start) dependency: Earliest start (ES) of the succeeding activity is the earliest start of the preceding activity plus possible lag.

Earliest finish (EF) of the succeeding activity (earliest start (ES) in FF dependency) is calculated by adding (subtracting) duration of the activity to the earliest start (ES) (from the earliest finish (EF)) of the activity.

4. This is continued until all activities of the activity diagram have been calculated. Notice that if there are many preceding activities for one activity, its timing can be calculated only after every activity chain, which precedes it has been calculated. The latest of the preceding chains of activities determines its final timing.
5. Earliest finish of the last activity is the earliest possible finish of the project.

Finish to start calculation (latest start (LS))

1. Latest finish of all the activities that end to the last activity is the same as previously calculated latest finish of the last activity.
2. Latest start (LS) of the activities is obtained by subtracting duration of the activity from the latest finish.
3. Timing of the succeeding activity:

FS (finish to start) dependency: Latest finish (LF) of the preceding activity is the latest start (LS) of the succeeding activity minus possible lag.

FF (finish to finish) dependency: Latest finish (LF) of the preceding activity is the latest finish of the succeeding activity minus possible lag.

SS (start to start) dependency: Latest start (LS) of the preceding activity is the latest start of the succeeding activity minus possible lag.

Latest start (LS) of the preceding activity (latest finish (LS) in SS dependency) is calculated by subtracting (adding) the duration of the activity from the latest finish (LF) (to the latest start (LS)) of the activity.

4. This is continued until all the activity chains from finish to start have been calculated. Näin jatketaan kunnes kaikki toimintaverkon tehtäväketjut on käyty läpi lopusta alkuun. Notice that if there are many preceding activities for one activity, its timing can be calculated only after every activity chain, which precedes it has been calculated. The earliest (longest) of the preceding chains of activities determines its final timing.

If all the calculations are correct the first activity obtains the value 0.

Calculation of floats (slacks)

Every activity has now two values. The difference between them is the total float of the activity

$$TF = LS - ES = LF - EF$$

Free float is the amount of time, inside which a start of an activity can be transferred without transferring the start of any other activity and it is calculated in:

Finish to start dependency:

$$FF = \text{earliest succeeding activity's ES} - \text{activity's EF}$$

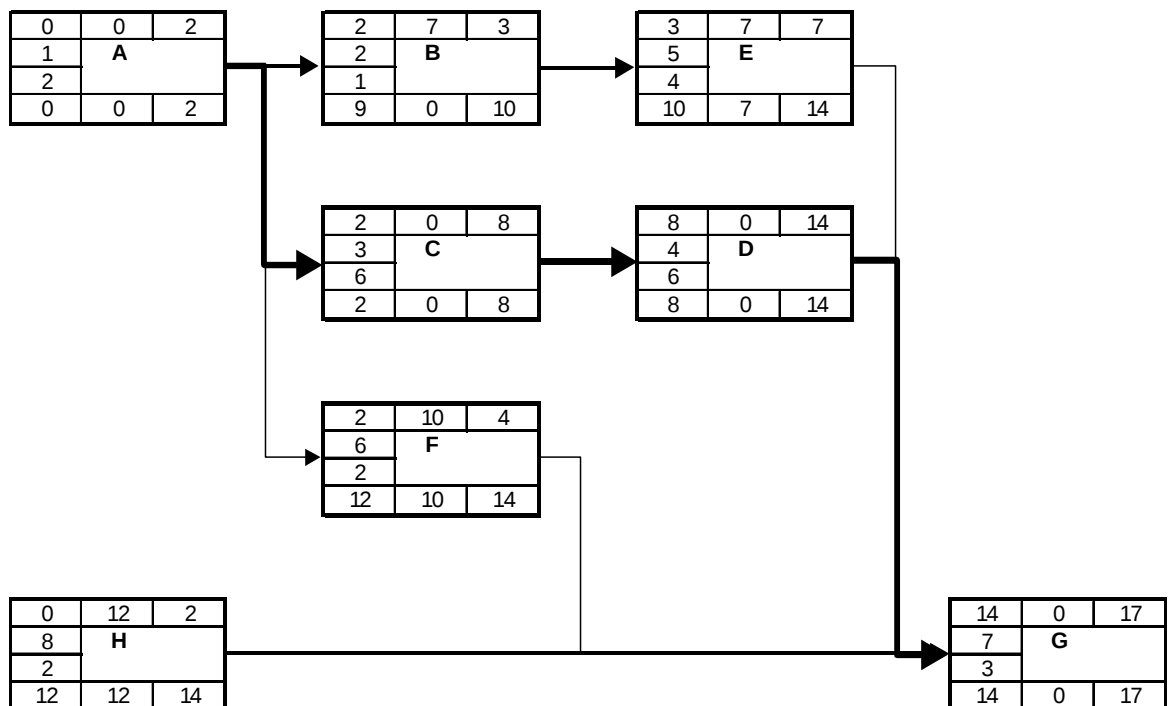
Finish to finish dependency:

$$FF = \text{earliest succeeding activity's EF} - \text{activity's EF}$$

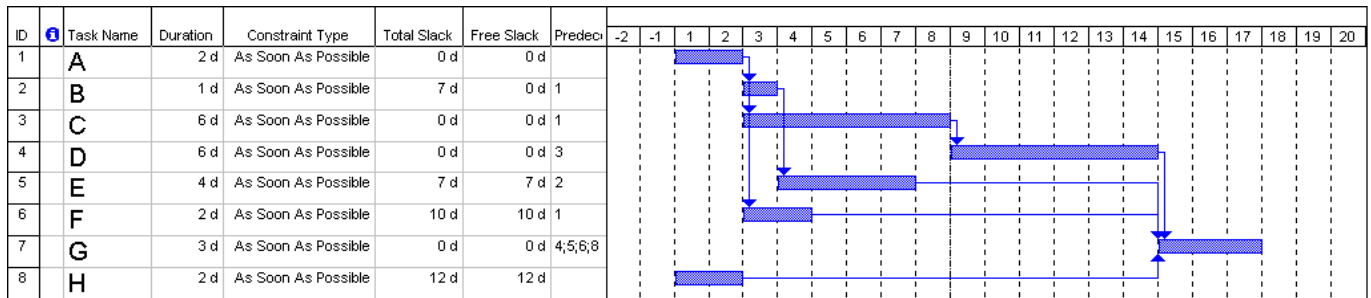
Start to start dependency:

$$FF = \text{earliest succeeding activity's ES} - \text{activity's ES}$$

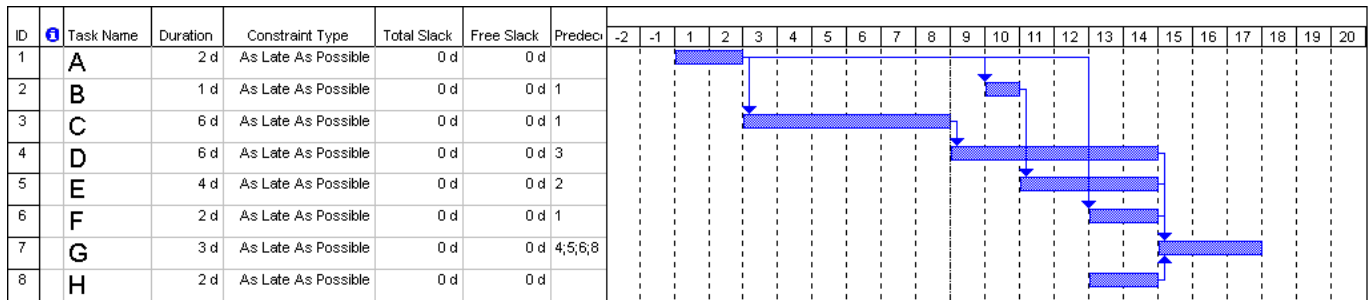
Activity node diagram without graphic demonstration of timing:



A Gantt chart based on activity node diagram, using the earliest possible start of the activities:



A Gantt chart based on activity node diagram, using the latest possible start of the activities:



A Gantt chart with floats:

