ANALYSIS OF DELAY SCHEDULE

Introduction

When scheduling, the schedule must be:

- ***Reliable***
- ***Reflect the Intended Plan***
- ***Approved***
- ***Free from Mistakes***
- ***Free from Manipulations***

- ***However, project flow of work may not properly executed.***
- ***Hence delay can occur***

Introduction

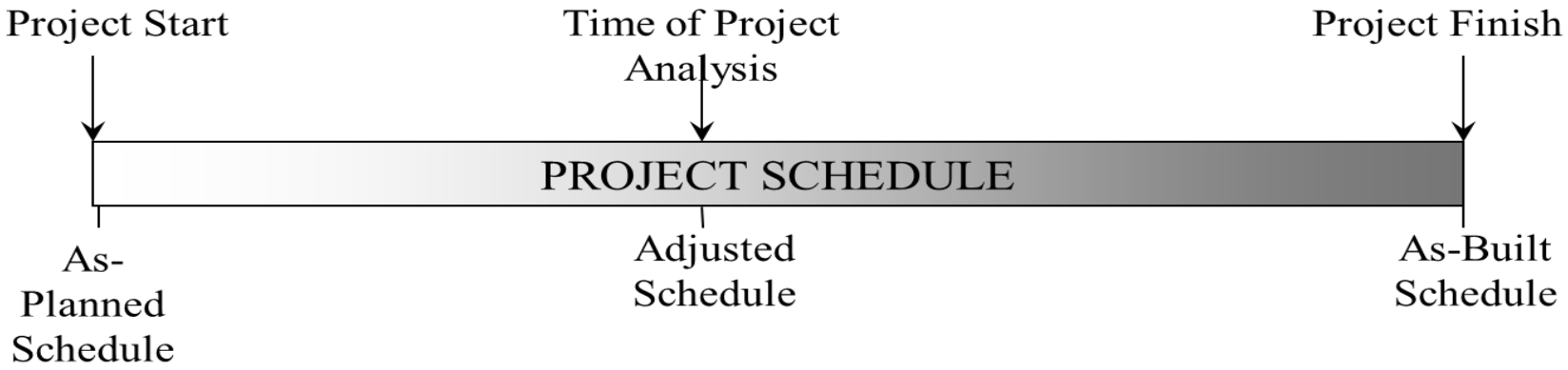
Hence, Schedule can be Manipulated by:

- Reduce or Increase Activity duration.
- Manipulate activities constraints (lag/lead time). Constraint limits the activity start or finish date.
- Manipulate the activity status or history [Activity Actual Start or Finish]
- Change schedule sequencing.
- Schedule the activity based on late start.[This is a feature in Scheduling Software to have all project activities as Critical activity].

Introduction

Three types of project schedule can be idetified:

- ***(As planned schedule):*** **it is schedule at the beginning of project execution.**
- ***(Adjusted schedule):*** **it is schedule during the progress of the project.**
- ***(As build schedule):*** **It is the schedule at the end of project execution**



Introduction

- ***Usually as-built schedule duration is different from as-planned schedule duration,***
- ***Hence, it is required to find who responsible about the delay***

Who Responsible for Delay?

- Contractor
- Owner
- Subcontractors
- Suppliers
- Labor unions
- Utility companies
- Nature

Introduction

Most common causes are

- Differing site conditions
- Change in requirements or design
- Inclement weather
- Unavailability of labor, material, or equipment
- Defective plans or specifications,
- Owner caused delay: permits, owner-supplied, equipment, materials, ..etc.

Project Delay: Defined

Project Delay?

- **A "Delay" is the time during which some part of the project has been extended or not performed due to an unanticipated circumstance.**
- ***It can be critical or non critical***

Project Disruption?

- **Disruption is an interruption in the planned work sequence or flow of work.**
- ***It is distinguished from delay in that the duration of work activities or the overall project completion may not be extended.***

Project Delay: Defined

Critical Delay:

- Delays that result in ***extended*** project completion are known as "critical delays,"

Non Critical Delay:

Delays that do ***not extend*** the project completion date are called "noncritical delays."

Project Delay: Defined

Types of Delay and Responsibility:

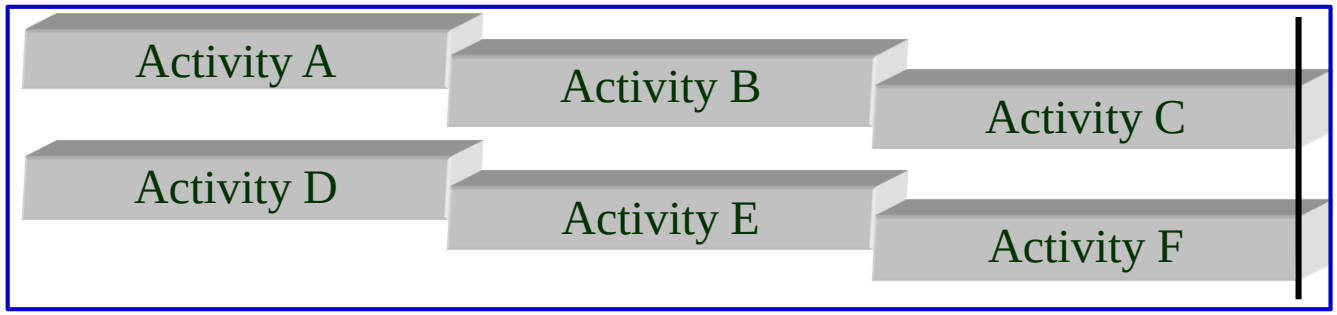
- ***Excusable Delay***
  - ✓ Compensable Delay (***EC***), ***(Owner Responsibility)***
  - ✓ Non-compensable Delay (***EN***), ***(3rd party Responsibility)***
- ***Non-excusable Delay*** (***NE***), ***(Contractor Responsibility)***

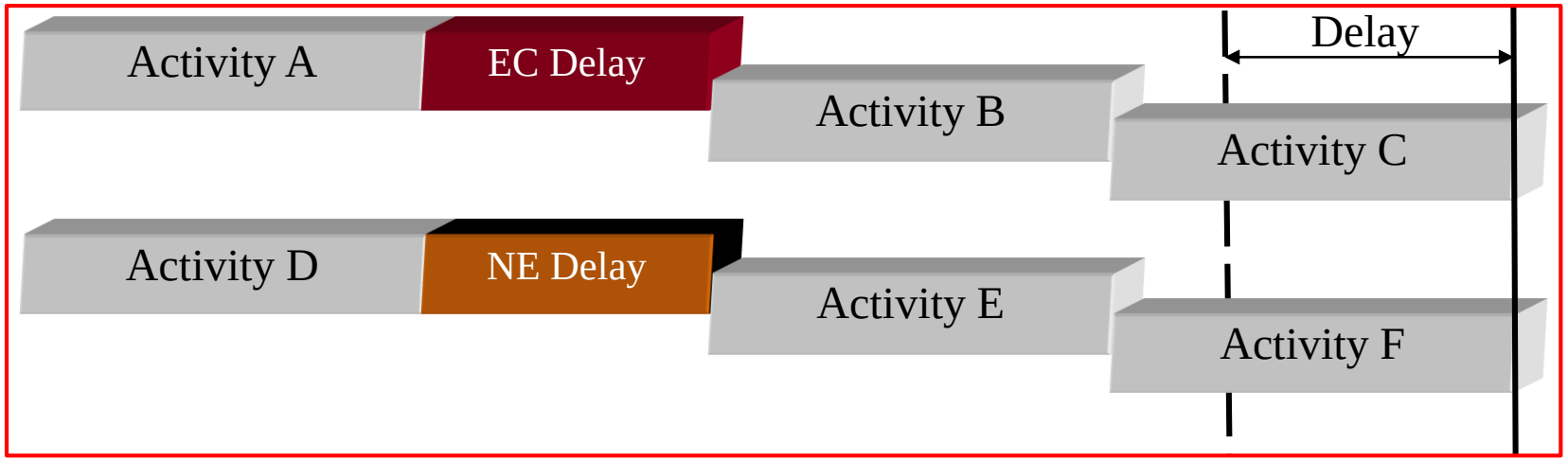
Concurrent Delay:

Delays that happen in ***two or more parallel Critical path activities in the same time period*** are classified as concurrent delays.

Project Delay : Defined

Concurrent Delay Example:





Delay Analysis Schedule Techniques

There are several techniques:

1) ***Day by day technique***
2) Simple Technique (does not consider changing of CP)
   - As-Built Schedule,
   - But-for,
3) More advanced Technique (consider changing of CP)
   - Window/Snapshot,
   - Window/But-for.

Remark: **Only Algorithm of Day-by-Day analysis Technique will be given**

Day by Day Schedule Technique

Algorithm of Day-by-Day analysis Technique

1) **Step (1) Prepare the analysis data**

a) Determine AON network at the beginning of project (as planned schedule).

b) Determine Bar Chart (BC) at the end of the project (as built schedule). Include all delays.

c) Review as built Bar chart day by day from 1st day and identify delay times.

Day by Day Schedule Technique

Algorithm of Day-by-Day analysis Technique

1) Step (1) Prepare the analysis data

d) Build *an analysis table* as follow and fill all delay day by day in *column one*

- (***remark:*** in case of having identical delay events in 2 or more days in the As-Built schedule, you can combine the analysis of these days together in one step, since it will be repeated).

Day(s)	Affected Activity(s) Step(2a)	Critical Activity(s) Step(2b)	Responsibility Step(2c)			Project Duration Step(2e)
			EC Owner	NE Contractor	EN 3rd party	
0			-	-	-	

Day by Day Schedule Technique

Algorithm of Day-by-Day analysis Technique

1) **Step (2)** Carry out ***repeated process*** start with first delay day(s) considering day by day until all delays are considered.

The process is as follow:

a) Identify affected activity(s) at considered delay day(s) and who responsible about the delay.

b) From the affected activity(s) in part (a), identify the critical activity.

Day by Day Schedule Technique

Algorithm of Day-by-Day analysis Technique

2) **Step (2) The process is as follow:**

c) Based on the delay type of responsibility of critical affected activity(s), assign responsibility of delay according to following condition:

i. If there is only one critical delay event, assign the delay responsibility based on the responsible party.

ii. If there is two or more critical delay events in the same analysis day, assign the delay responsibility according to ***concurrent delay rule*** as illustrated in next Table.

Day by Day Schedule Technique

Algorithm of Day-by-Day analysis Technique

Concurrent Delay Rule			
Delay Type	EN (3rd Party)	EC (Owner)	NE (Contractor)
EN (3rd Party)	3rd Party	3rd Party	3rd Party
EC (Owner)	3rd Party	Owner	3rd Party
NE (Contractor)	3rd Party	3rd Party	Contractor

Day by Day Schedule Technique

Algorithm of Day-by-Day analysis Technique

2) **Step (2) The process is as follow:**

d) Fill column 2 to column 5 ***for analysis table***

e) Update AON times and determine the project duration and updated critical path(s). ***Remarks:***

i. If there is a delay on activity start, increase the lag time of finish-start (FS) type and EST of the successor activity is delayed by that delayed time.

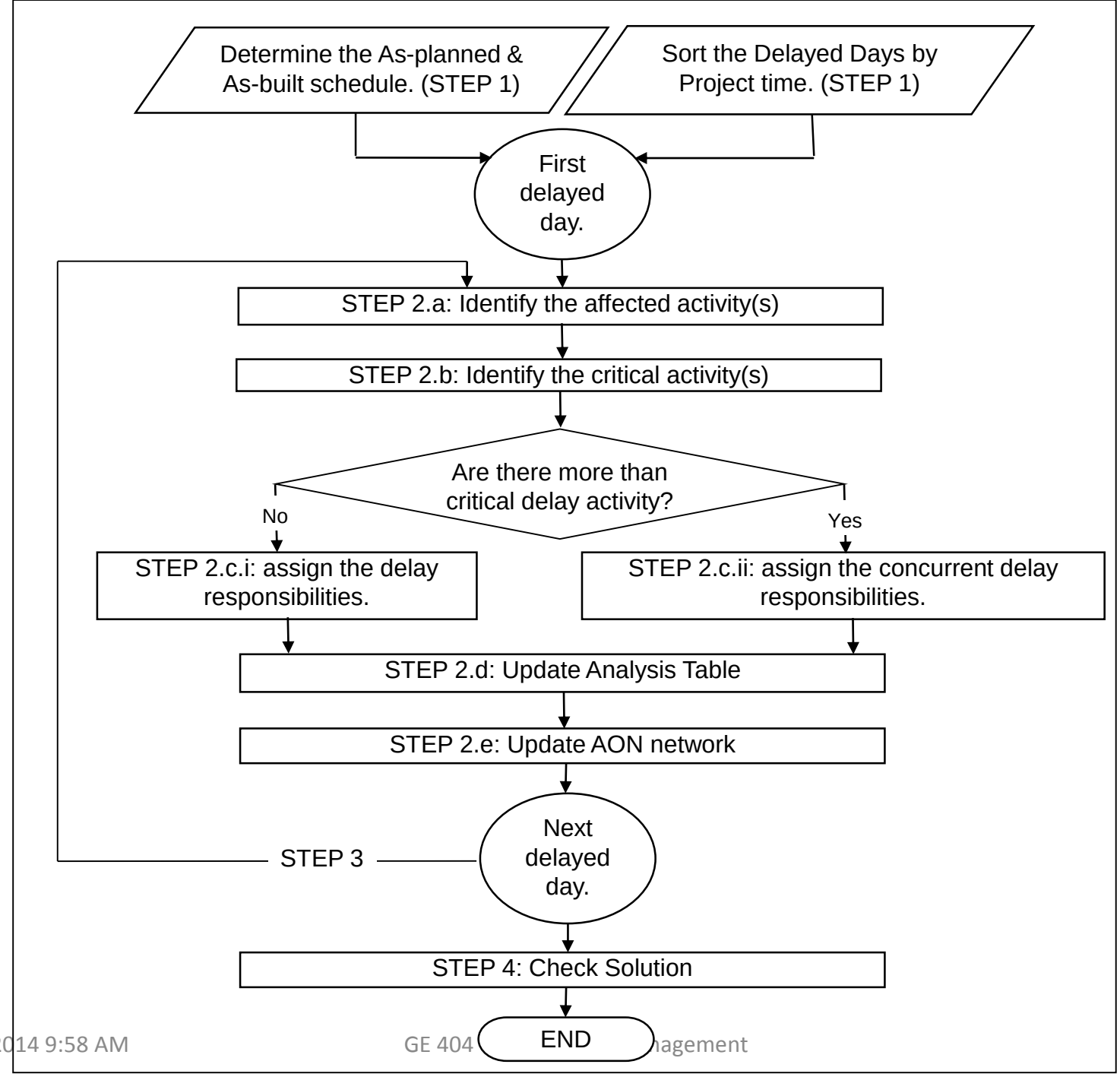
ii. If there is a delay on activity duration, increase the duration of the activity and the EFT of the affected activity is delayed by that delayed time.

Day by Day Schedule Technique

Algorithm of Day-by-Day analysis Technique

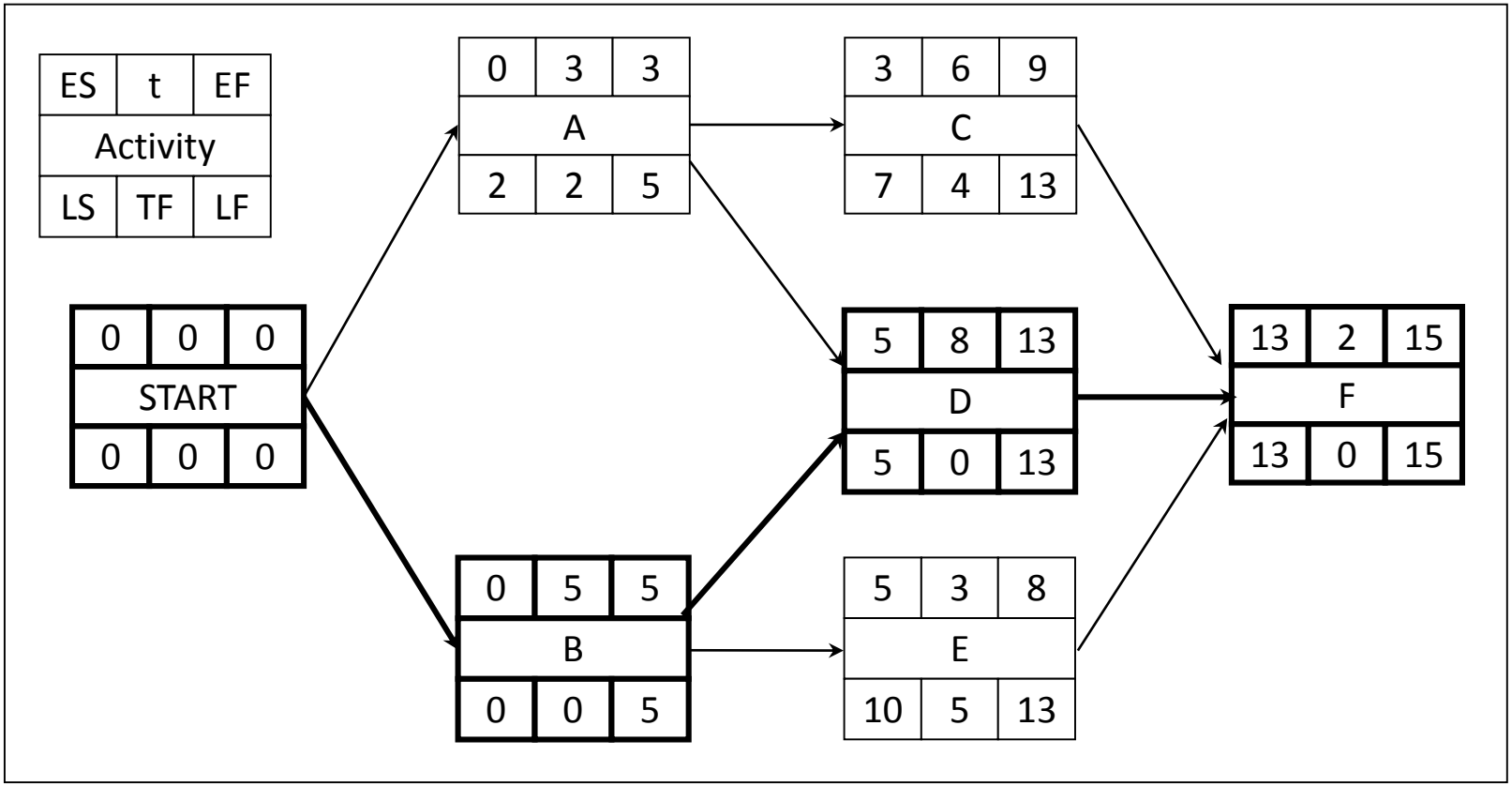
3) **Step (3)** *Repeat step (2) until all delay days are considered*

4) **Step (4)** *Check solution; days extended due delay = sum of days assigned to responsibility.*


Determine the As-planned & As-built schedule. (STEP 1)
Sort the Delayed Days by Project time. (STEP 1)
First delayed day.
STEP 2.a: Identify the affected activity(s)
STEP 2.b: Identify the critical activity(s)
Are there more than critical delay activity?
No
Yes
STEP 2.c.i: assign the delay responsibilities.
STEP 2.c.ii: assign the concurrent delay responsibilities.
STEP 2.d: Update Analysis Table
STEP 2.e: Update AON network
Next delayed day.
STEP 3
STEP 4: Check Solution
END

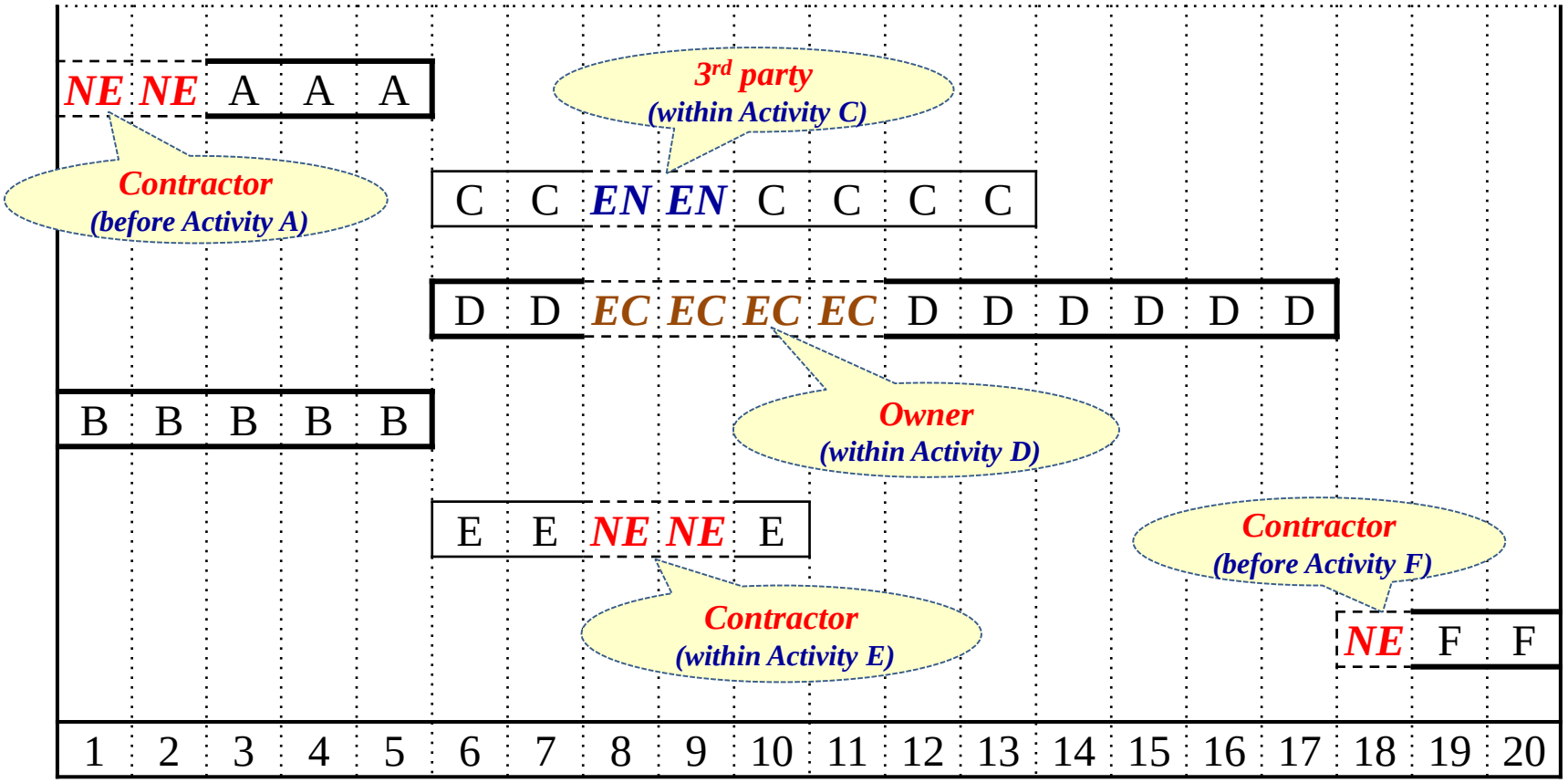
Example 1

The following AON network is the ***As-planned schedule*** of a project:



Example 1

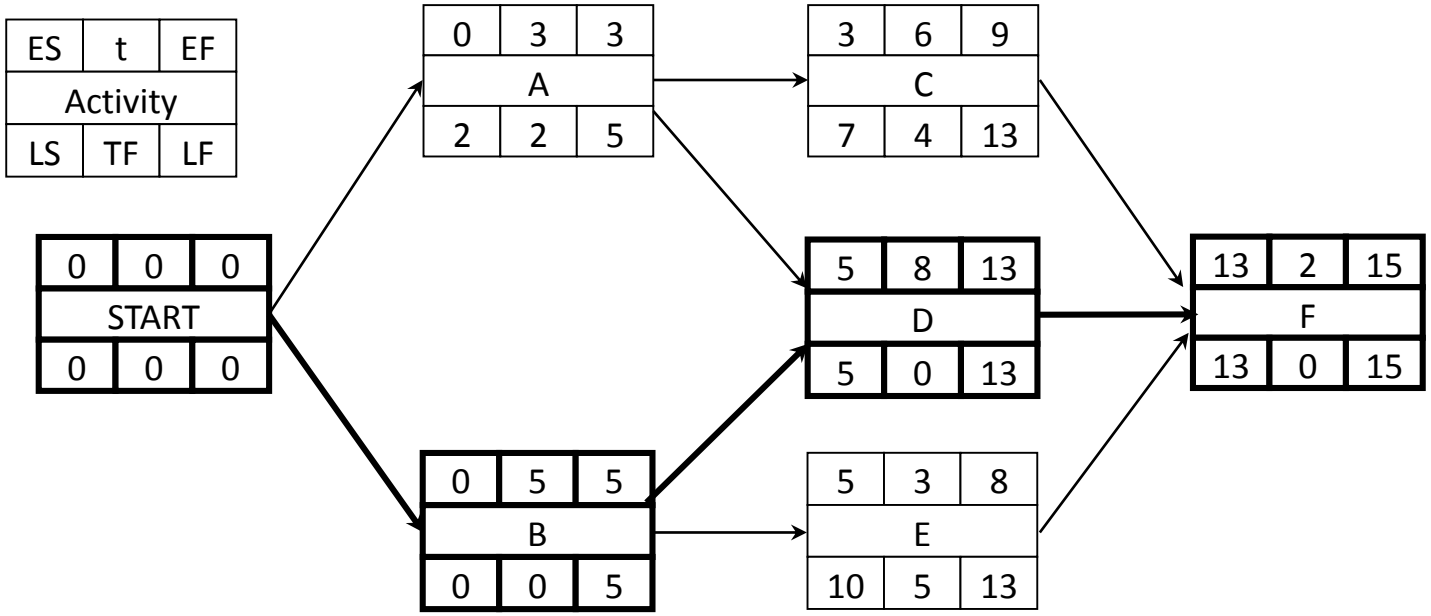
The following ***Bar Chart is the As-Built schedule*** of same project:



Use day-by day analysis technique to analyze schedule delay

Example 1

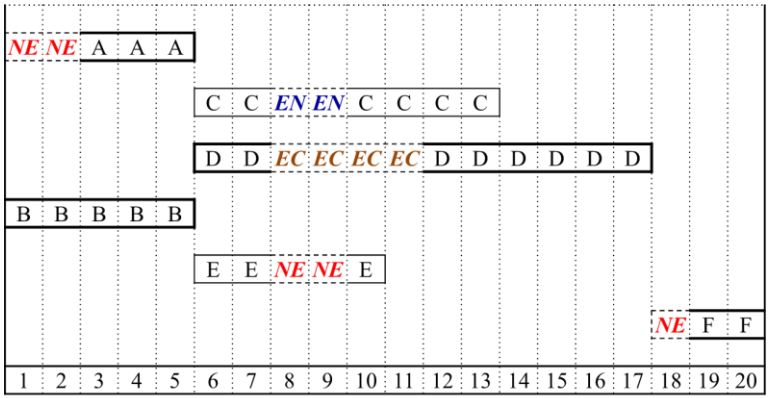
Day 0 Analysis

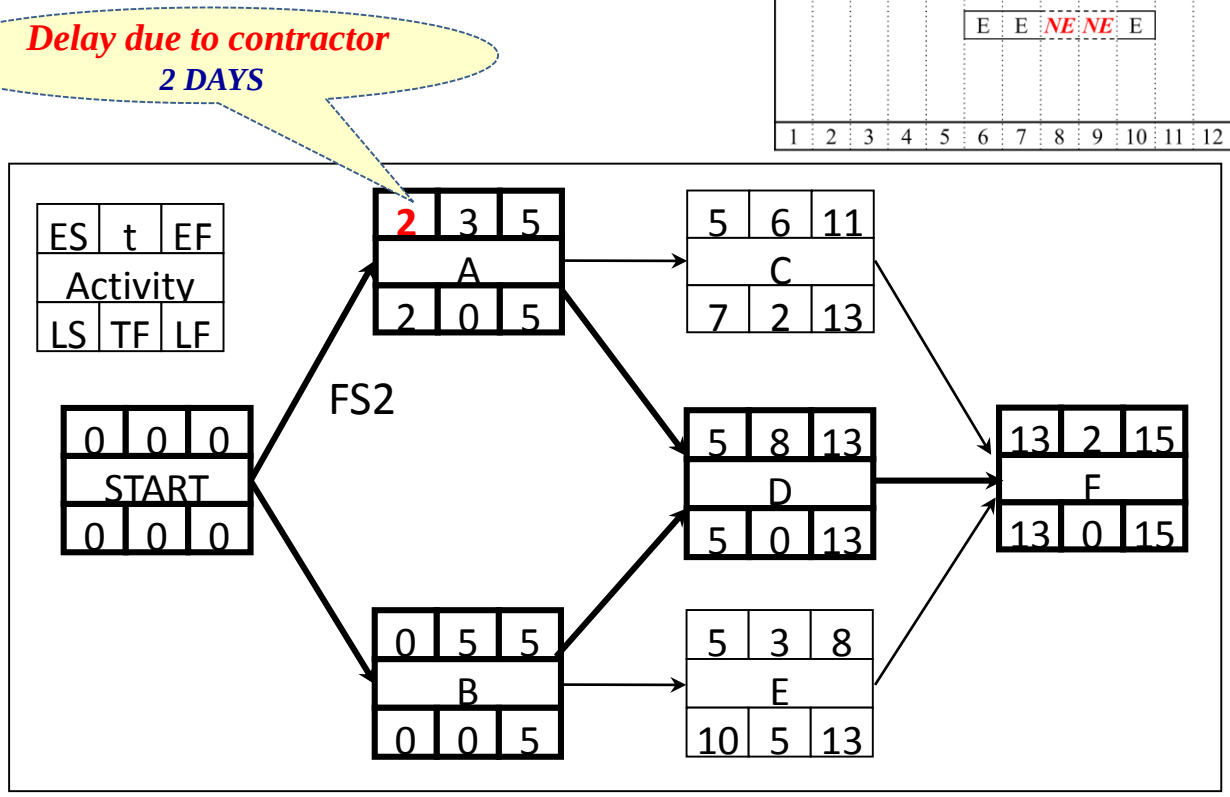


Day(s)	Affected Activity(s)	Critical Activity(s)	Responsibility			Project Duration
			EC (Owner)	*NE* (Contractor)	*EN* (3rd party)	
0	------	--------	0	0	0	15

Example 1

Day 1&2 analysis

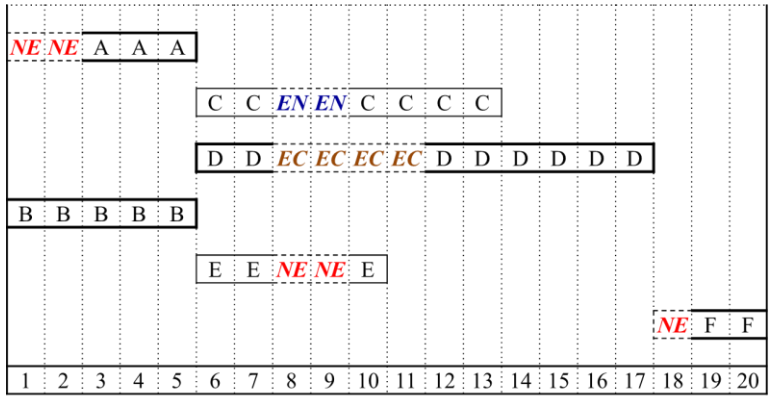


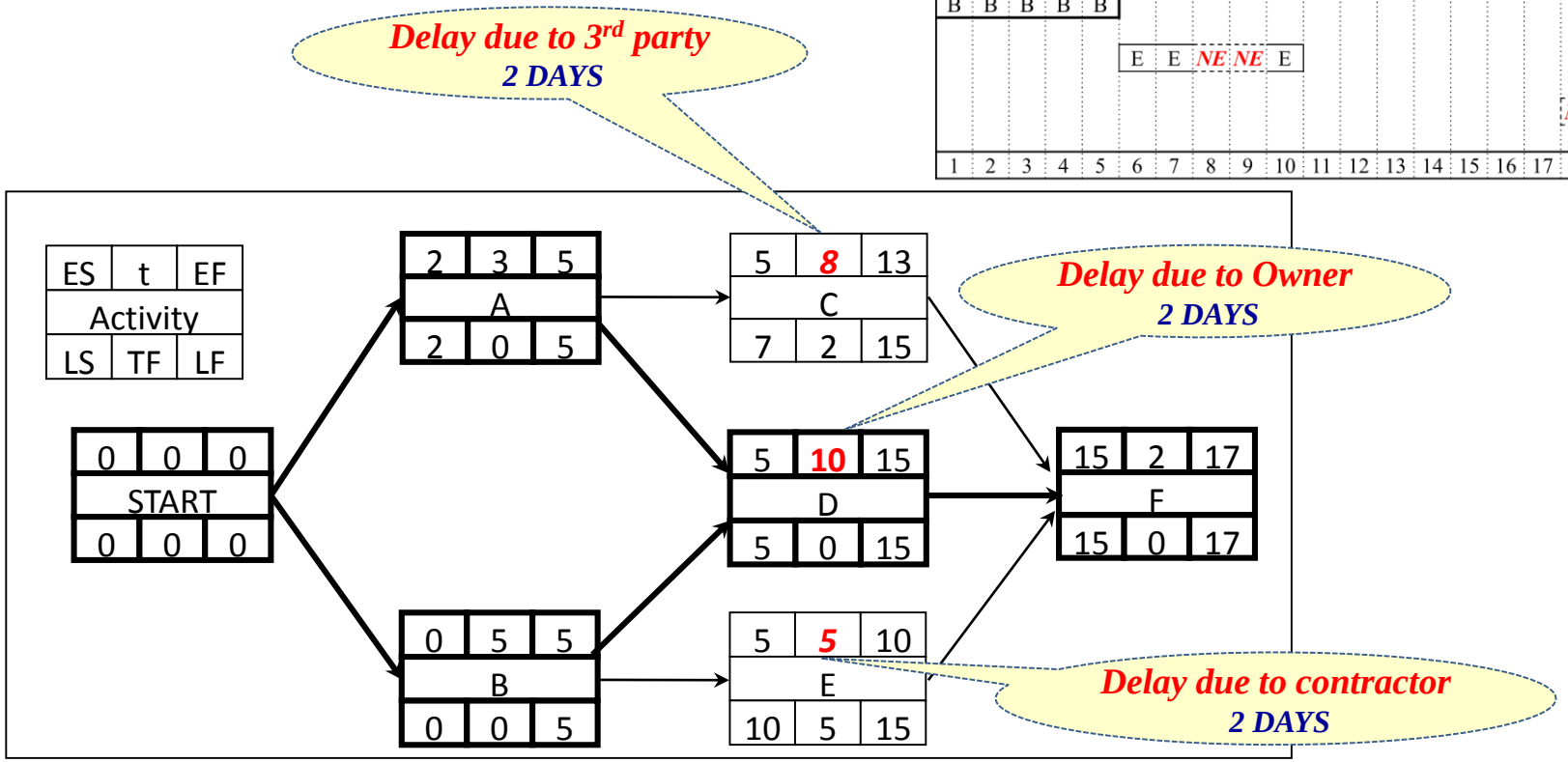


Day(s)	Affected Activity(s)	Critical Activity(s)	Responsibility			Project Duration
			EC (Owner)	*NE* (Contractor)	*EN* (3rd party)	
0	------	--------	0	0	0	15
1&2	A	-------	0	0	0	15

Example 1

Day 8&9 analysis

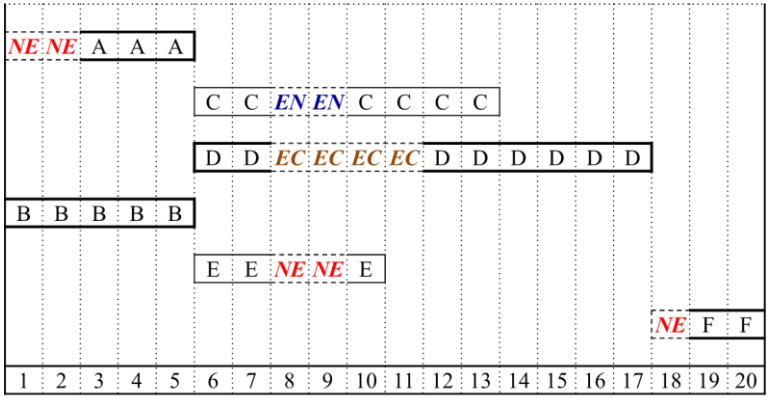


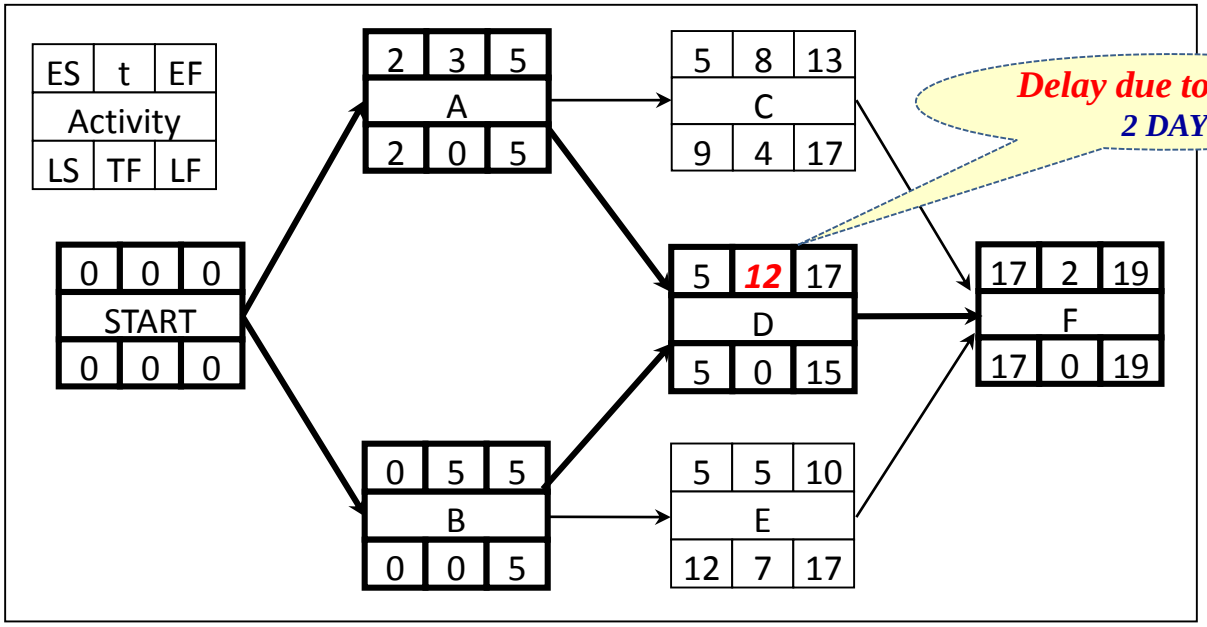


Day(s)	Affected Activity(s)	Critical Activity(s)	Responsibility			Project Duration
			EC (Owner)	*NE* (Contractor)	*EN* (3rd party)	
0	------	--------	0	0	0	15
1&2	A	-------	0	0	0	15
8&9	C, D, E	D *(EC)*	2	0	0	17

Example 1

Day 10&11 analysis

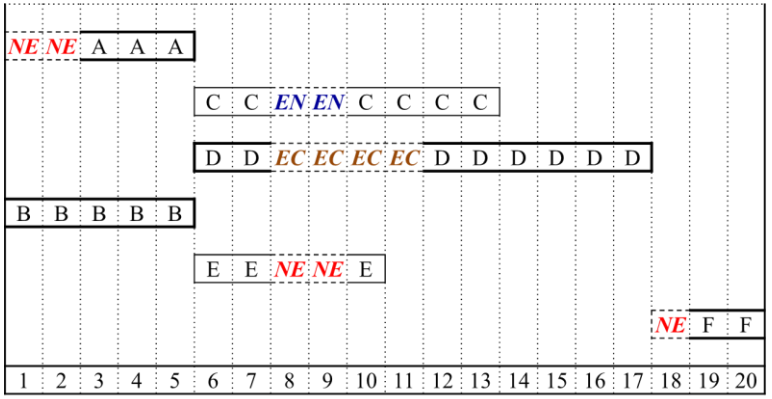


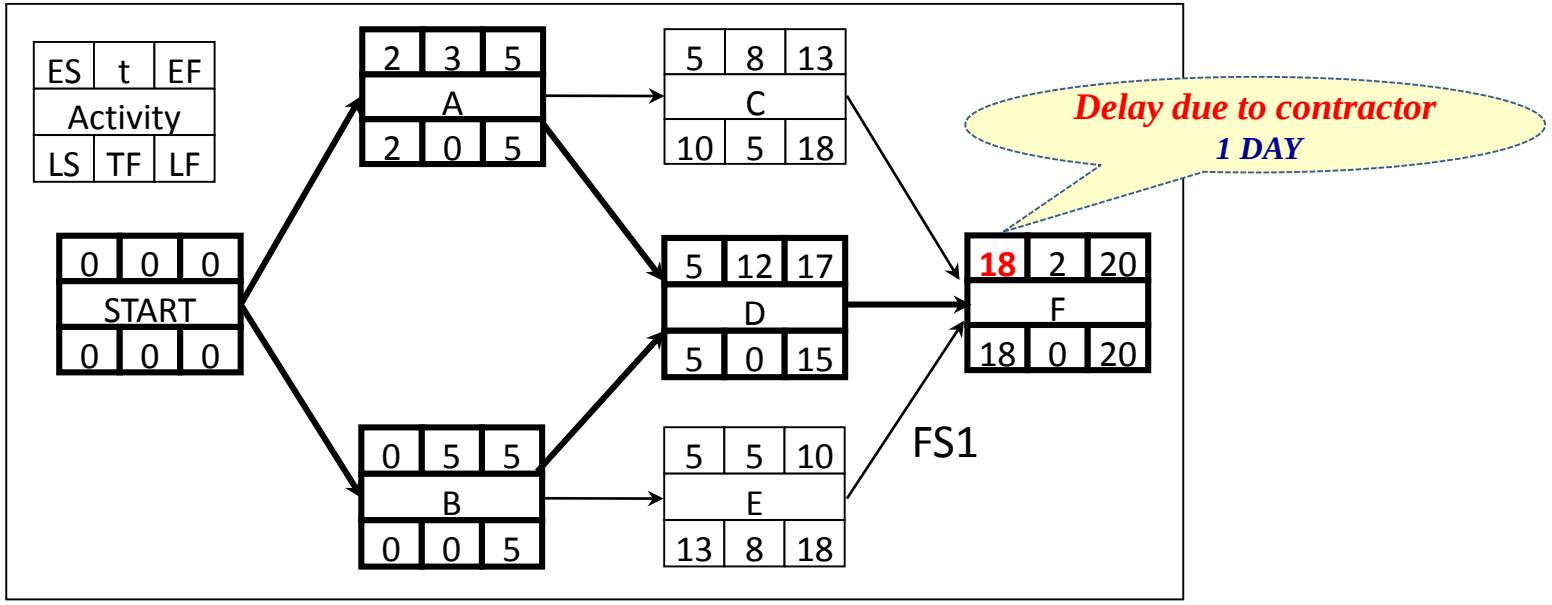


Day(s)	Affected Activity(s)	Critical Activity(s)	Responsibility			Project Duration
			EC (Owner)	*NE* (Contractor)	*EN* (3rd party)	
0	------	--------	0	0	0	15
1&2	A	-------	0	0	0	15
8&9	C, D, E	D *(EC)*	2	0	0	17
10&11	D	D *(EC)*	2	0	0	19

Example 1

Day 18 analysis (FINAL RESULT)

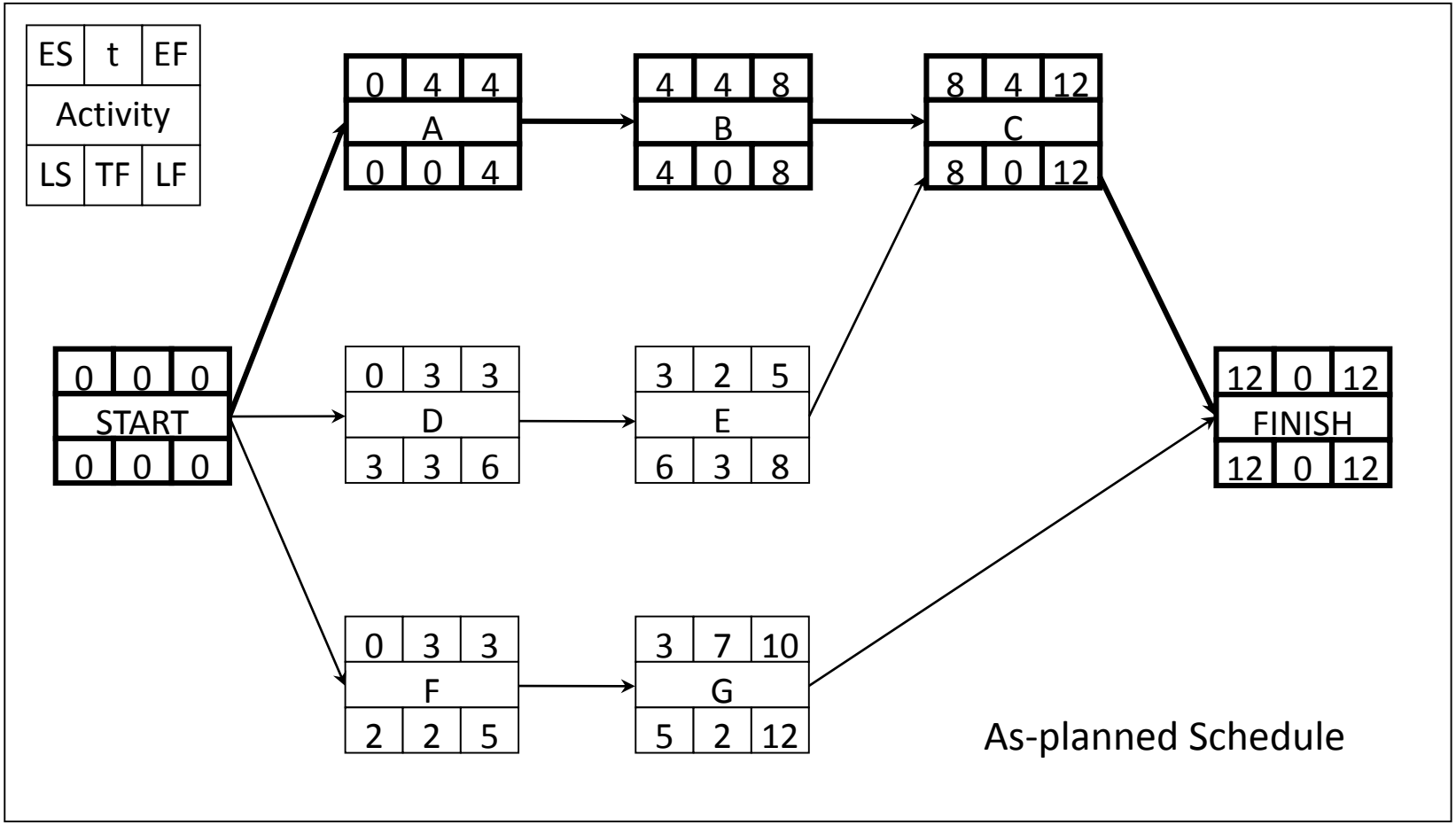




Day(s)	Affected Activity(s)	Critical Activity(s)	Responsibility			Project Duration
			EC (Owner)	*NE* (Contractor)	*EN* (3rd party)	
0	------	--------	0	0	0	15
1&2	A	-------	0	0	0	15
8&9	C, D, E	D *(EC)*	2	0	0	17
10&11	D	D *(EC)*	2	0	0	19
18	F	F *(NE)*	0	1	0	20

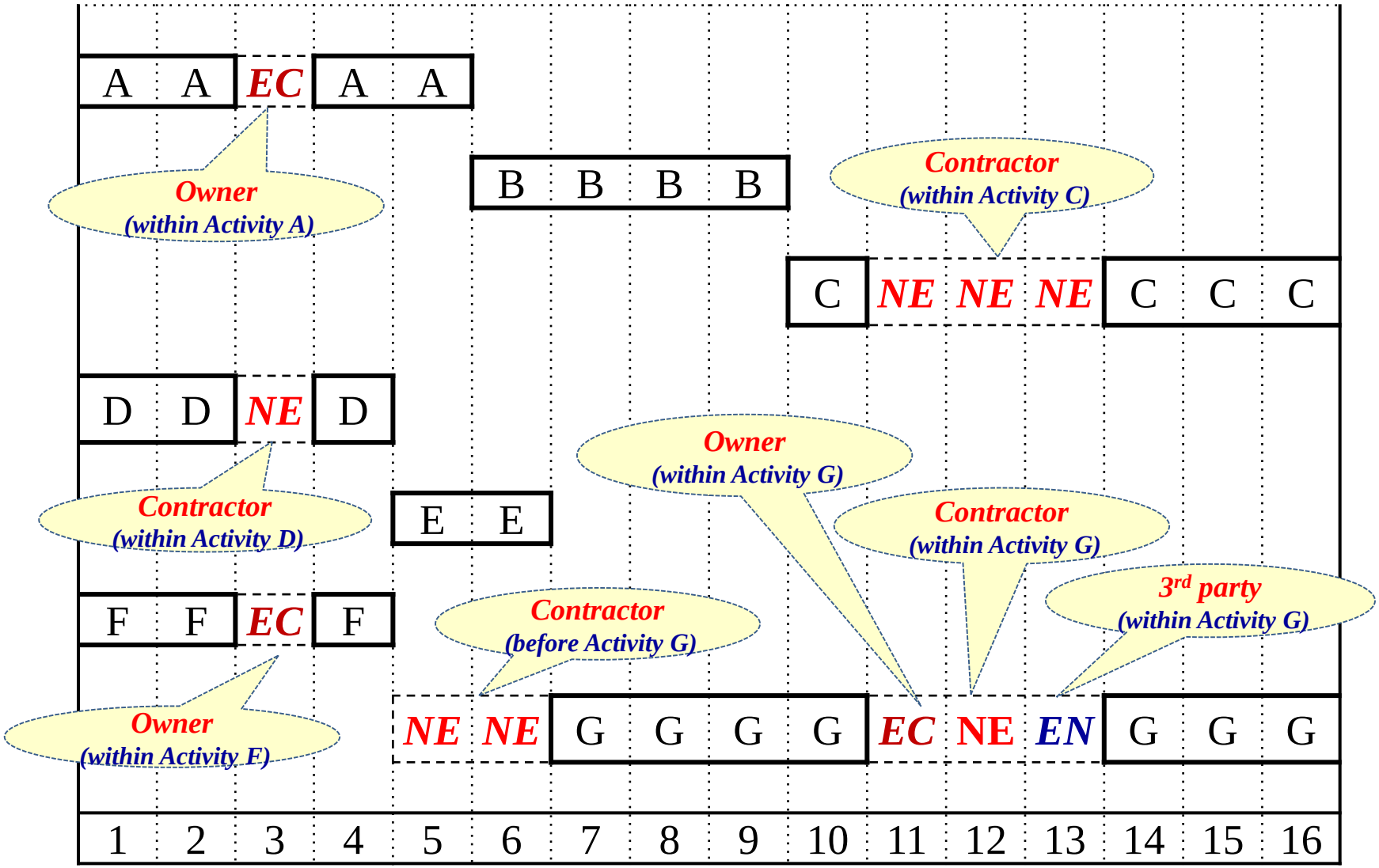
Example 2

Consider the following As-planned and As-built schedule for a project. Determine the delay responsibilities between the owner and the contractor.



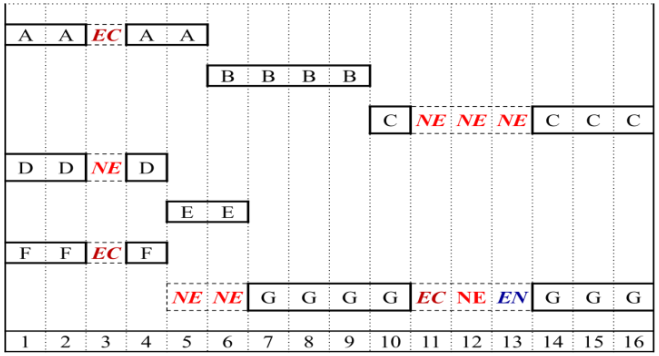
Example 2

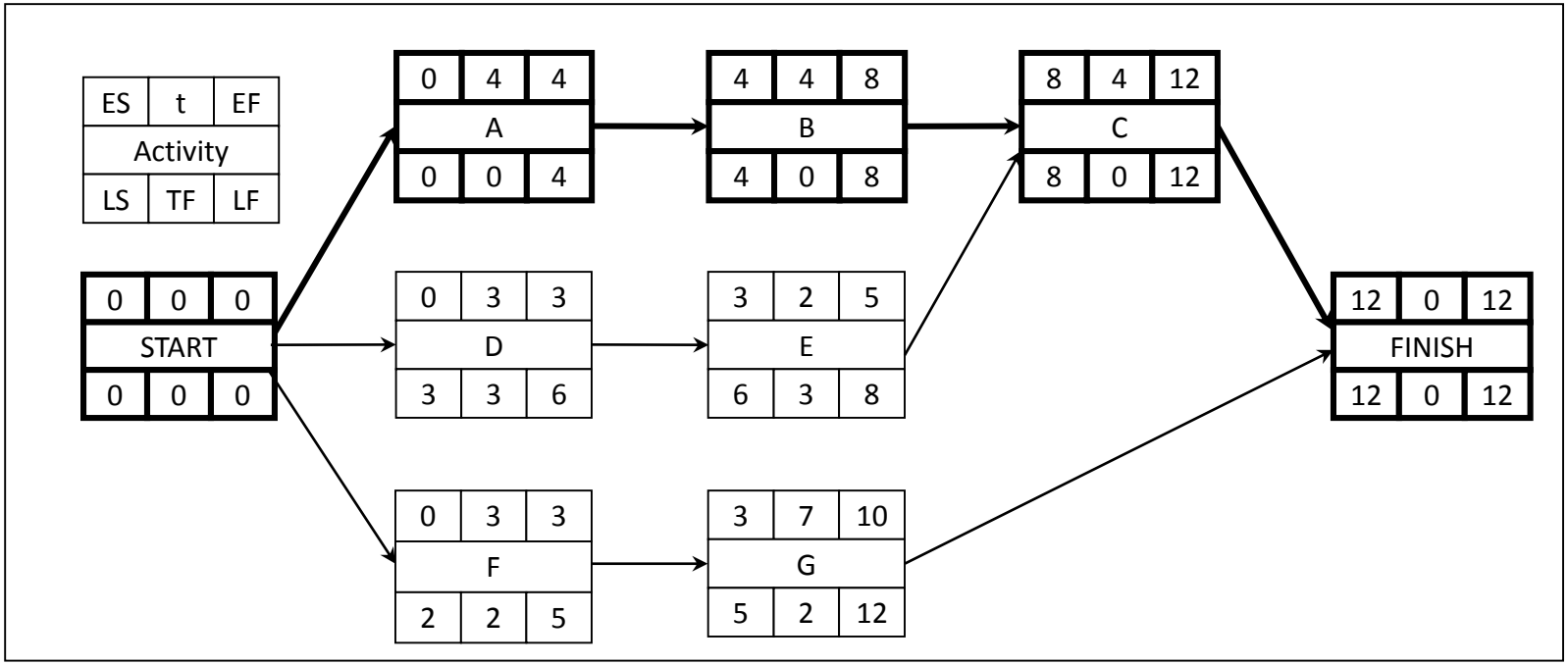
As-Built Schedule



Example 2

Day 0 Analysis

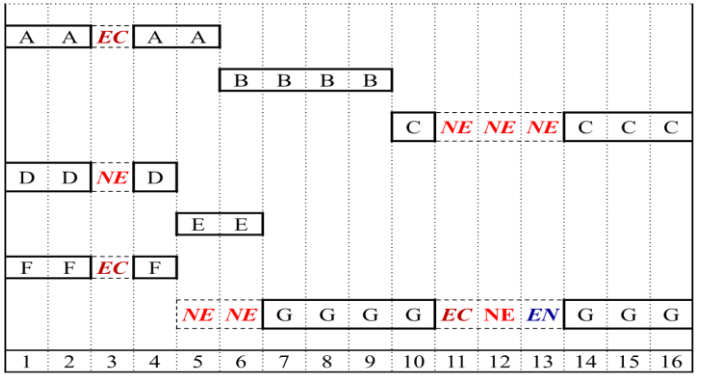


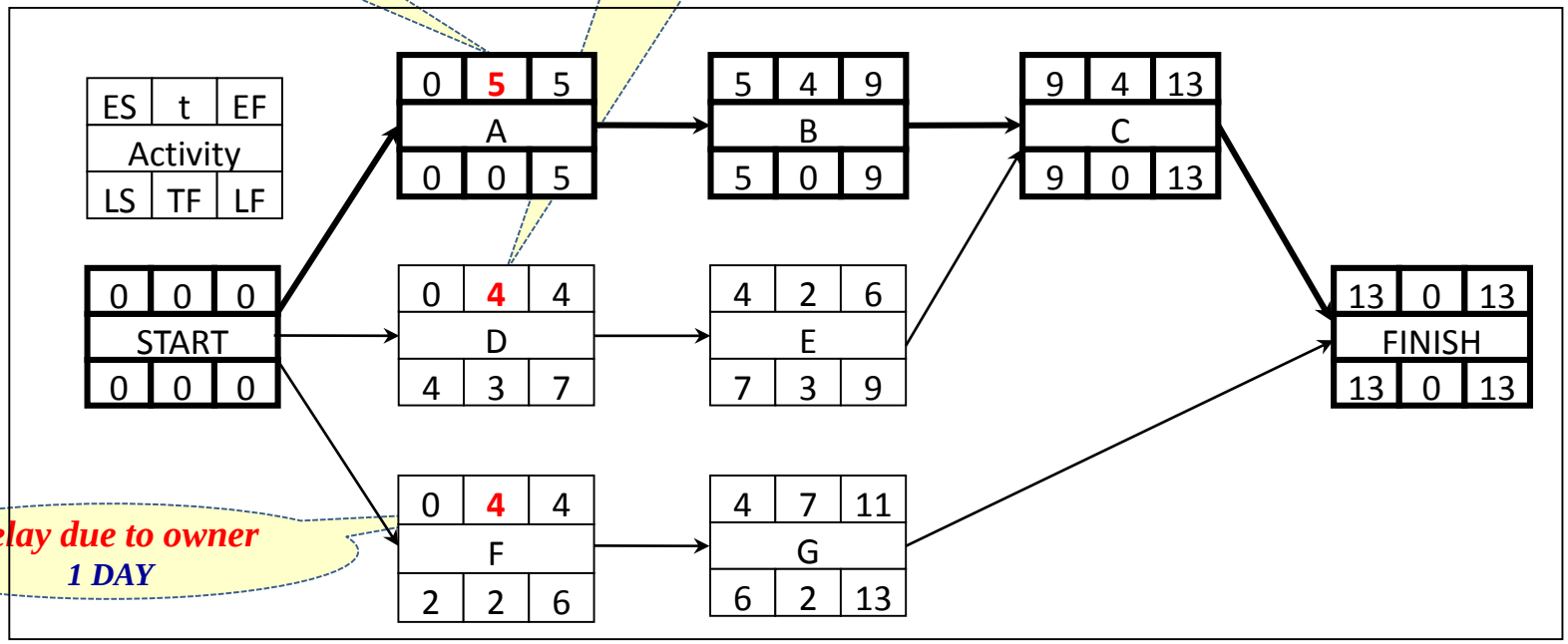


Day(s)	Affected Activity(s)	Critical Activity(s)	Responsibility			Project Duration
			EC (Owner)	*NE* (Contractor)	*EN* (3rd party)	
0	------	--------	0	0	0	12

Example 2

Day 3 Analysis

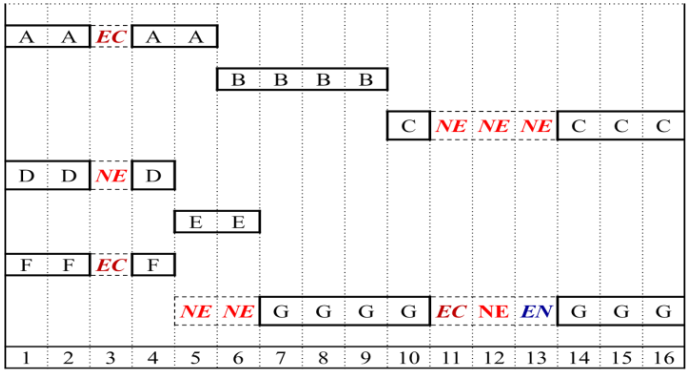


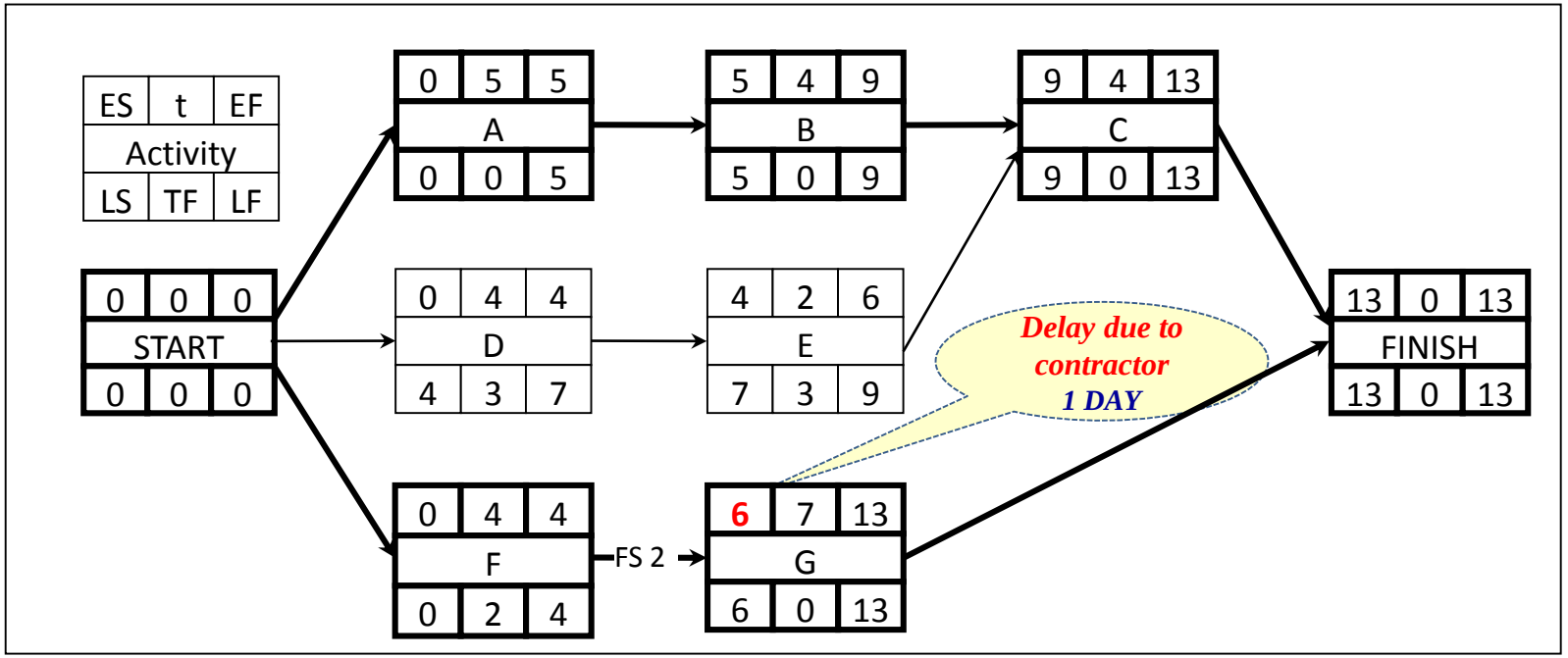


Day(s)	Affected Activity(s)	Critical Activity(s)	Responsibility			Project Duration
			EC (Owner)	*NE* (Contractor)	*EN* (3rd party)	
0	------	--------	0	0	0	12
3	A, D, F	A (*EC*)	1	0	0	13

Example 2

Day 5&6 Analysis

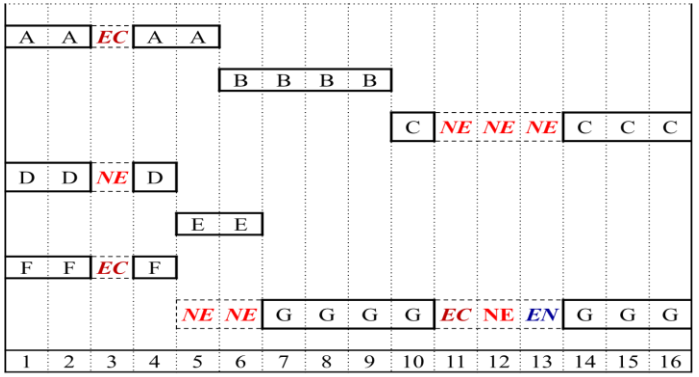




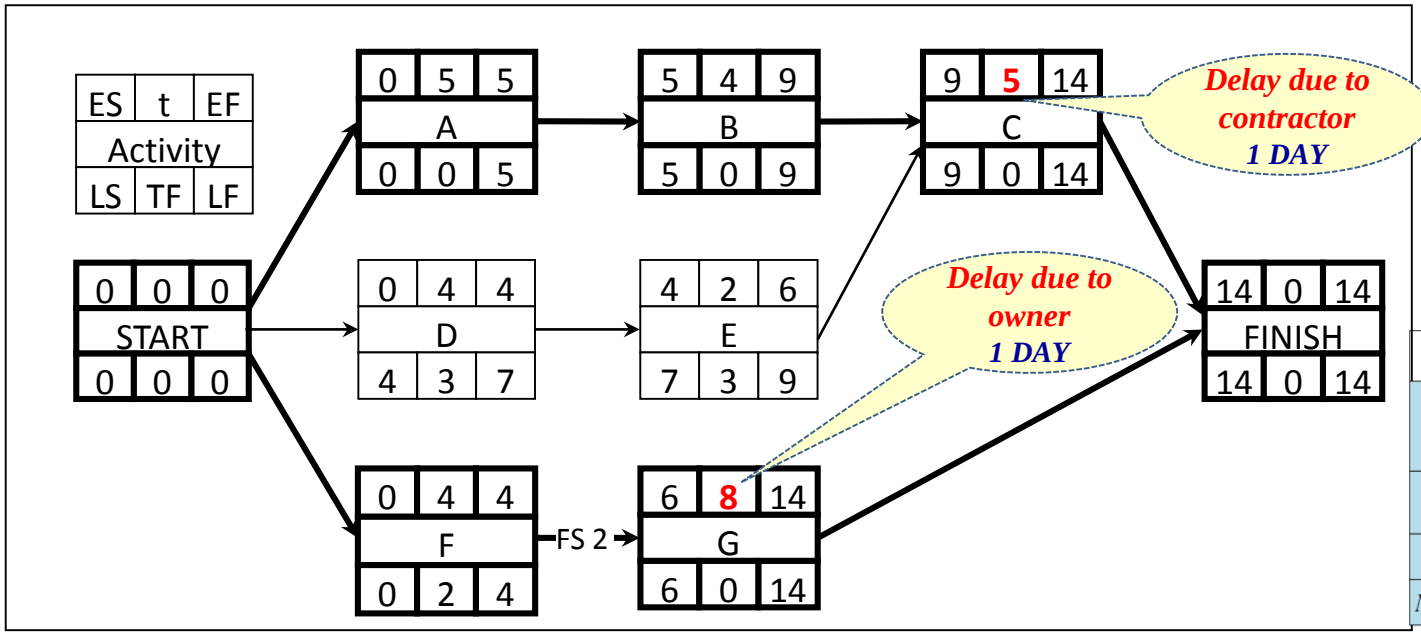
Day(s)	Affected Activity(s)	Critical Activity(s)	Responsibility			Project Duration
			EC (Owner)	*NE* (Contractor)	*EN* (3rd party)	
0	------	--------	0	0	0	12
3	A, D, F	A (*EC*)	1	0	0	13
5&6	G	--------	0	0	0	13

Example 2

Day 11 Analysis



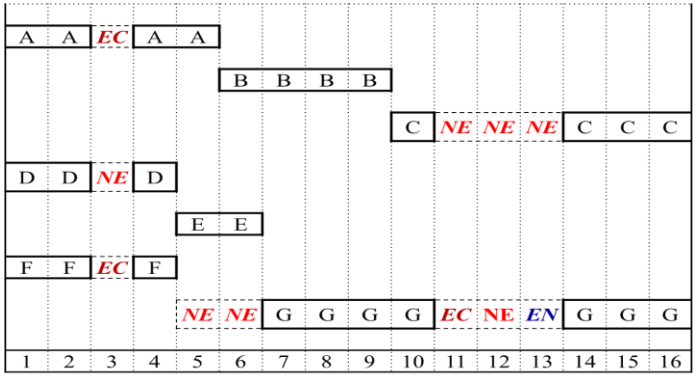
Remark: notice delays of days 11,12,13 are for different reasons for concurrent activities. *Hence, consider day by day analysis and concurrent rule. (If the reason is not either owner or contractor, the reason is 3rd party)*



Concurrent Delay Rule			
Delay Type	*EN (3rd Party)*	*EC (Owner)*	*NE (Contractor)*
EN (3rd Party)	*3rd Party*	*3rd Party*	*3rd Party*
EC (Owner)	*3rd Party*	*Owner*	*3rd Party*
NE (Contractor)	*3rd Party*	*3rd Party*	*Contractor*

Day(s)	Affected Activity(s)	Critical Activity(s)	Responsibility			Project Duration
			EC (Owner)	*NE* (Contractor)	*EN* (3rd party)	
0	------	--------	0	0	0	12
3	A, D, F	A (*EC*)	**1**	0	0	13
5&6	G	--------	0	0	0	13
11	C, G	C(*NE*), G(*EC*)	0	0	**1**	14

Example 2 — Day 12 Analysis



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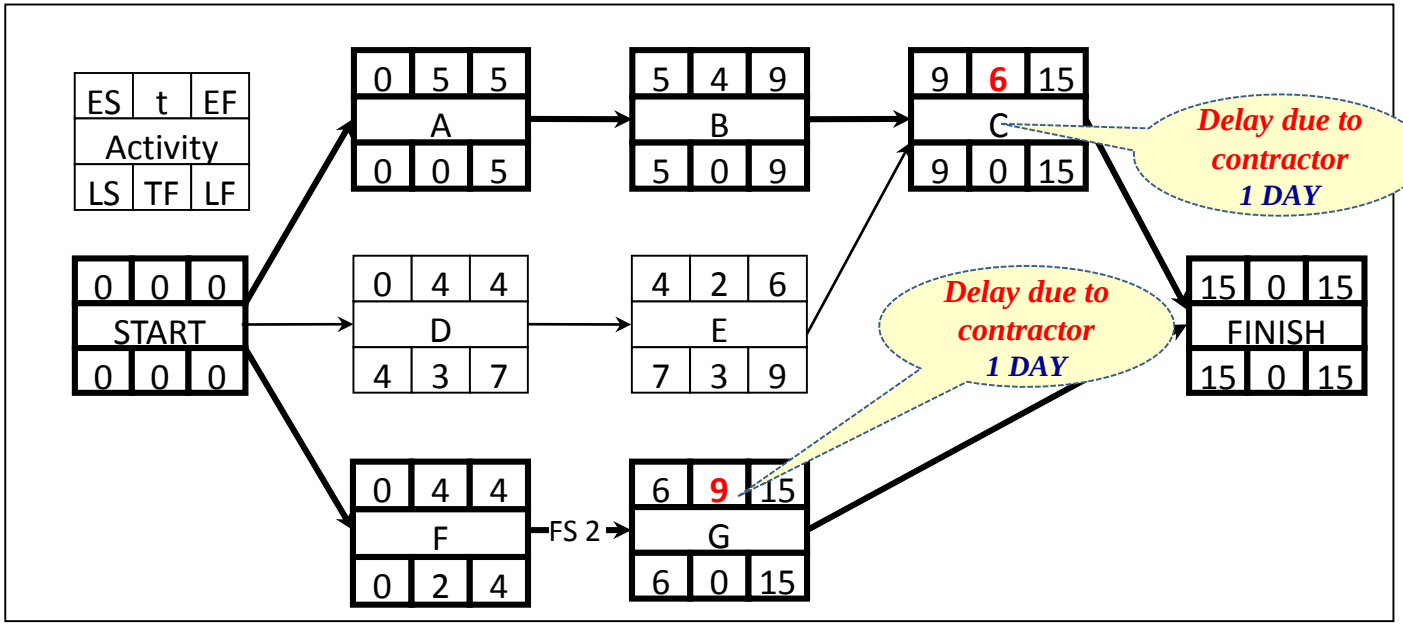
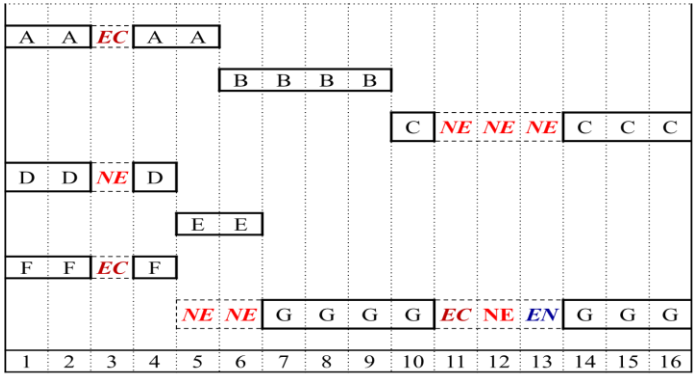


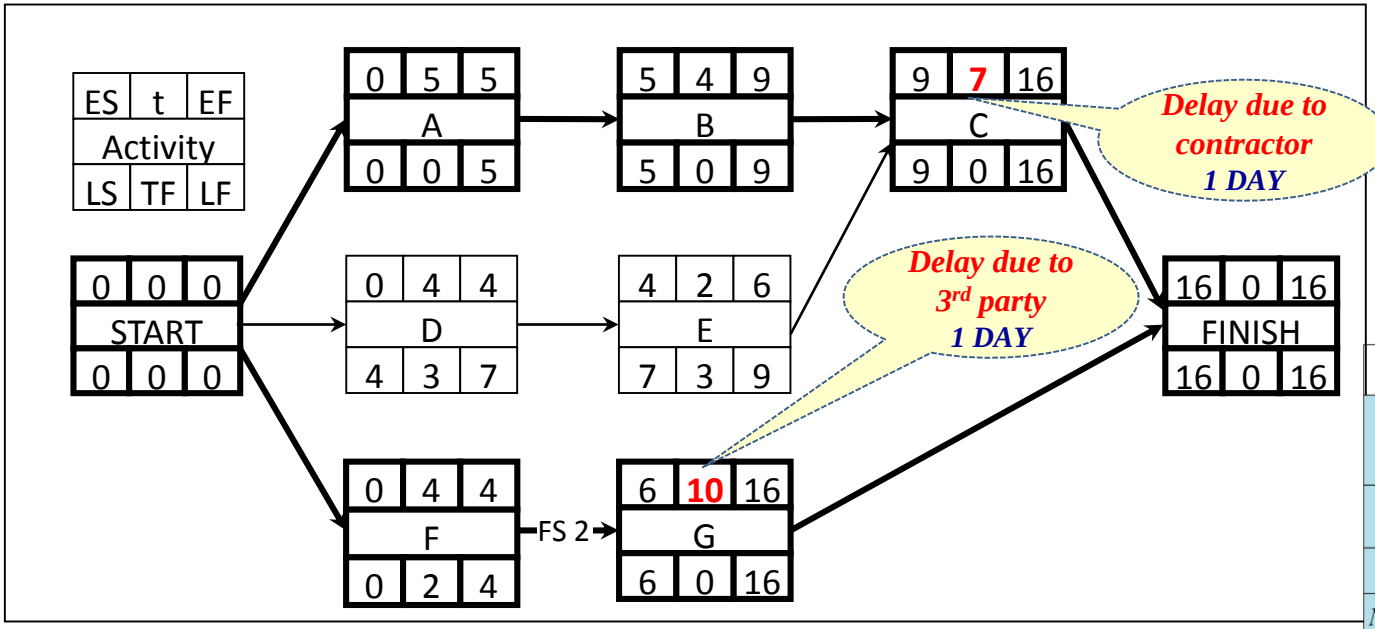
Concurrent Delay Rule			
Delay Type	EN (3rd Party)	EC (Owner)	NE (Contractor)
EN (3rd Party)	3rd Party	3rd Party	3rd Party
EC (Owner)	3rd Party	Owner	3rd Party
NE (Contractor)	3rd Party	3rd Party	Contractor

Day(s)	Affected Activity(s)	Critical Activity(s)	Responsibility			Project Duration
			EC (Owner)	NE (Contractor)	EN (3rd party)	
0	------	--------	0	0	0	12
3	A, D, F	A (EC)	1	0	0	13
5&6	G	--------	0	0	0	13
11	C, G	C(NE), G(EC)	0	0	1	14
12	C, G	C(NE), G(NE)	0	1	0	15

Example 2 — Day 13 Analysis



Remark: notice delays of days 11,12,13 are for different reasons for concurrent activities. *Hence, consider day by day analysis and concurrent rule. (If the reason is not either owner or contractor, the reason is 3rd party)*



(FINAL RESULT)

Concurrent Delay Rule

Delay Type	*EN (3rd Party)*	*EC (Owner)*	*NE (Contractor)*
EN (3rd Party)	*3rd Party*	*3rd Party*	*3rd Party*
EC (Owner)	*3rd Party*	*Owner*	*3rd Party*
NE (Contractor)	*3rd Party*	*3rd Party*	*Contractor*

Day(s)	Affected Activity(s)	Critical Activity(s)	Responsibility			Project Duration
			EC (Owner)	*NE* (Contractor)	*EN* (3rd party)	
0	------	--------	0	0	0	12
3	A, D, F	A (*EC*)	**1**	0	0	13
5&6	G	--------	0	0	0	13
11	C, G	C(*NE*), G(*EC*)	0	0	**1**	14
12	C, G	C(*NE*), G(*NE*)	0	**1**	0	15
13	C, G	C(*NE*), G(*EN*)	0	0	**1**	16

Case Study

Consider the small contract initial planning shown in table (1). During project execution work changes and delays were recorded as shown in table (2).

a) Draw the as-planned and as-built schedule, and

b) Determine how each party is responsible for the contract delayed completion.

Table (1) project plan

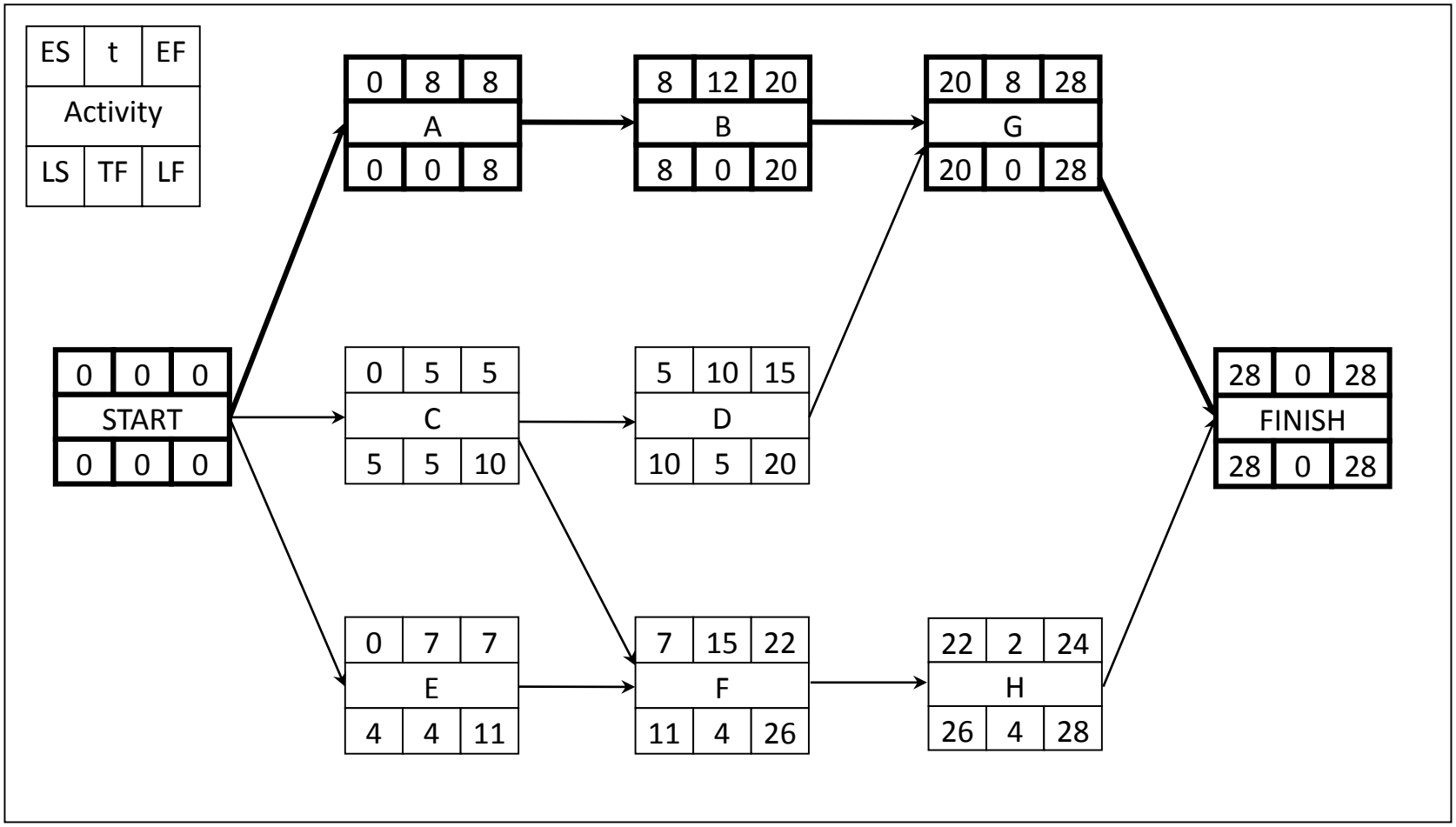
Activity	*Predecessor*	*Duration (day)*
A	-	8
B	A	12
C	-	5
D	C	10
E	-	7
F	C, E	15
G	B, D	8
H	F	2

Table (2) work change carried out

No.	*Category*	*Description*	*Effective dates*	*Delay time*	*Activities affected*
1	Contractor	Equipment not on site	1-2	2	E
2	Contractor	Late supply of materials	9-13	5	B
3	Client	Late inspection	25	1	B
4	Client	Late supply of drawings due design change (20% extra work)	10-12	3	F
5	Contractor	Equipment breakdown	25-26	2	F

Case Study

As-planned Schedule



Case Study

As-Built Schedule