OPSMGT 357 Project Management

Project Network Diagram

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Today's Learning Objectives

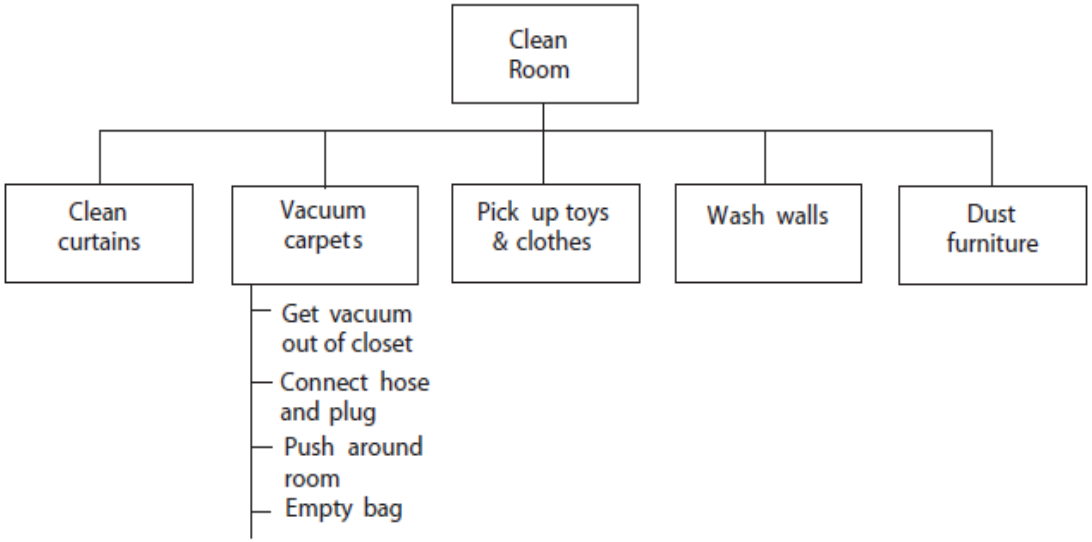
- Understand the rational for WBS and Network diagram
- Understand different types of network diagram
- Be able to calculate project duration and ES,EF,LS,LF
- Be able to identify critical path
- Be able to calculate slack and draw a Gantt chart
- Understand different types of relationships in network diagram
- Be able to calculate ES, EF,LS,LF with lags

Work Breakdown Structure

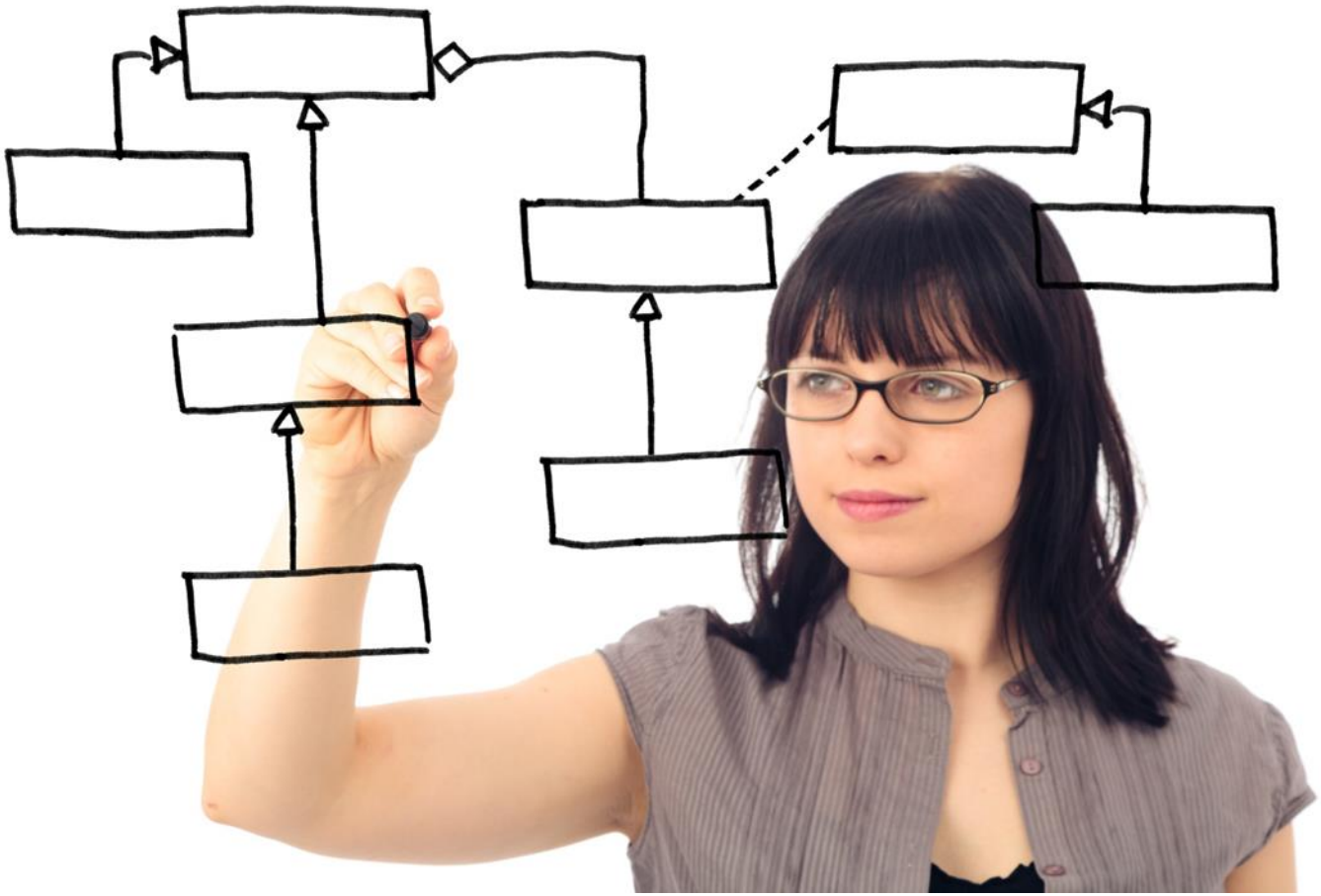
WBS	Task Name
CP1	**Build a Sports Complex**
CP1-1	**Secure funding**
CP1-1.1	Write funding propose
CP1-1.2	Seek sponsors
CP1-1.3	Sign funding agreeme
CP1-2	**Choosing a site**
CP1-2.1	Search Internet for lan
CP1-2.2	Contact real-estate ag
CP1-2.3	Visiting various sites
CP1-2.4	Select the site
CP1-3	**Building activities**
CP1-3.1	**Building sports fiel**
CP1-3.1.4	Site preparation
CP1-3.1.1	Do site shaping w
CP1-3.1.2	Build field
CP1-3.1.3	Test field / WOF &
CP1-3.2	**Building facilities**
CP1-3.2.1	Dig building founda
CP1-3.2.2	Build changing roo
CP1-3.2.3	Install power & wa
CP1-3.2.4	Test building / WOF
CP1-4	**Staff training**
CP1-4.1	Recruit staff
CP1-4.2	Train site staff
CP1-4.3	Qualify sports trainers
CP1-6	Project Complete

[FIGURE 7-1]

WBS DIAGRAM TO CLEAN A ROOM



Identifying Relationships



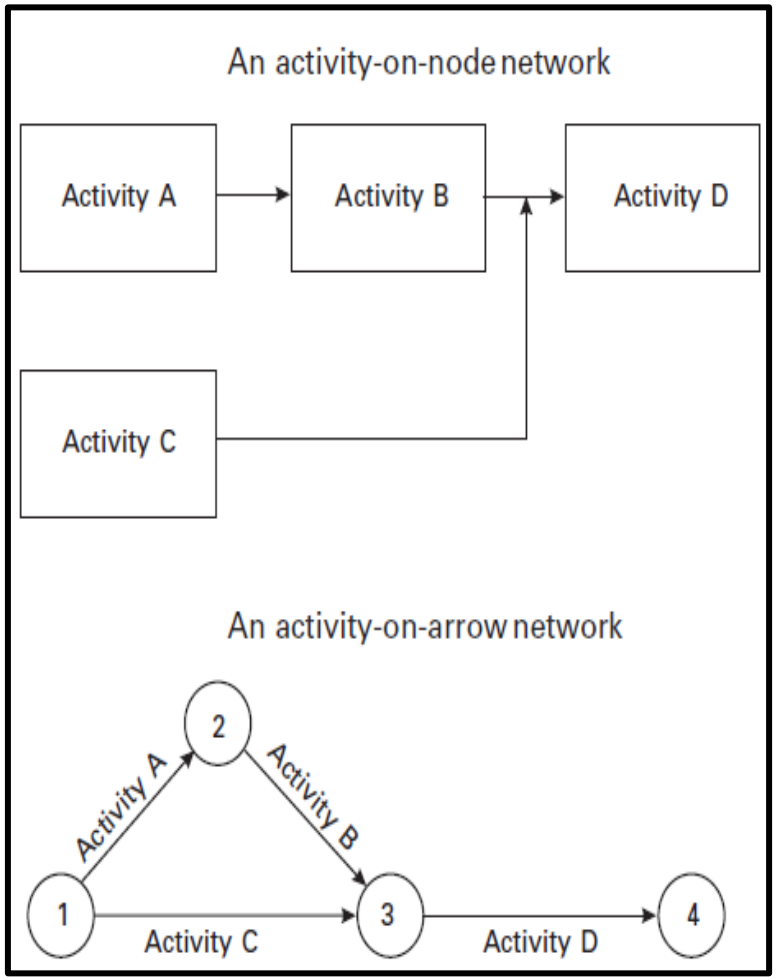
The Project Network

- Project networks are developed from WBS, based on work packages that are the lowest level of WBS. We refer to these work packages as “activities” or “tasks”.
- Project network is a flowchart that graphically depicts the logical sequences, interdependencies, and start and finish times of the project activities along with the longest path(s) through the network—the critical path.
- Networks are built using nodes (boxes) and arrows (lines). The node depicts an activity, and the arrow shows dependency and project flow.
- Project network provides an estimate of the project’s duration and identifies activities that should be carefully monitored in order to avoid being delayed. It help managers to monitor project progress.

The Project Network: Two Approaches

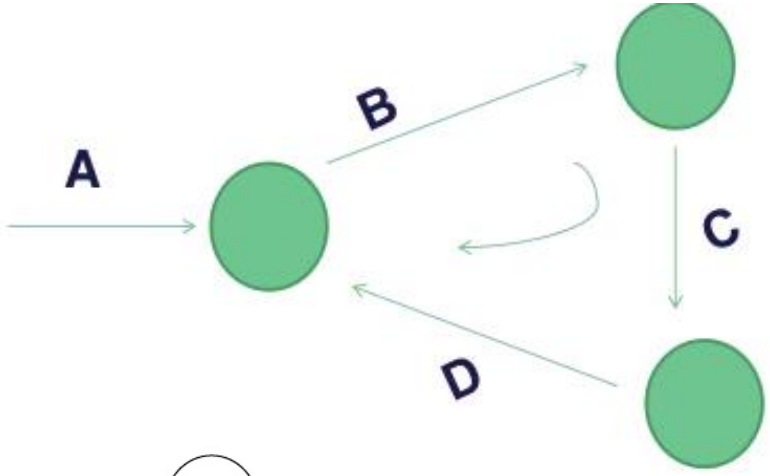
- Activity-on-Node (AON): Uses a node to depict an activity.

- Activity-on-Arrow (AOA): Uses an arrow to depict an activity.

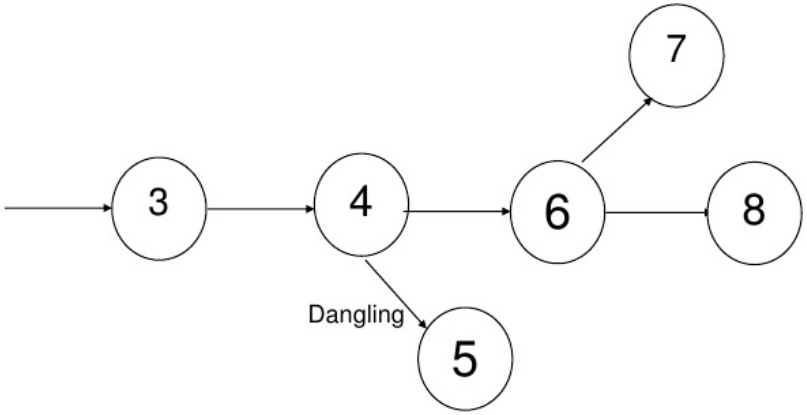


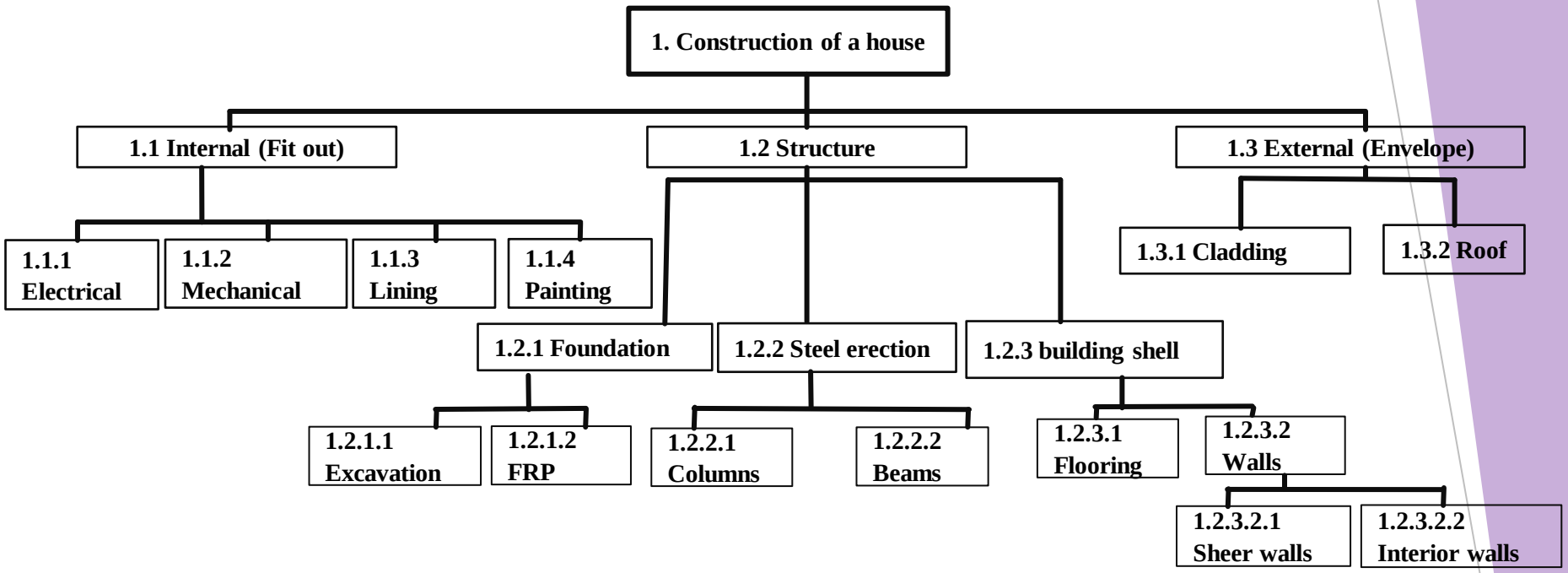
Rules For Constructing AON Networks

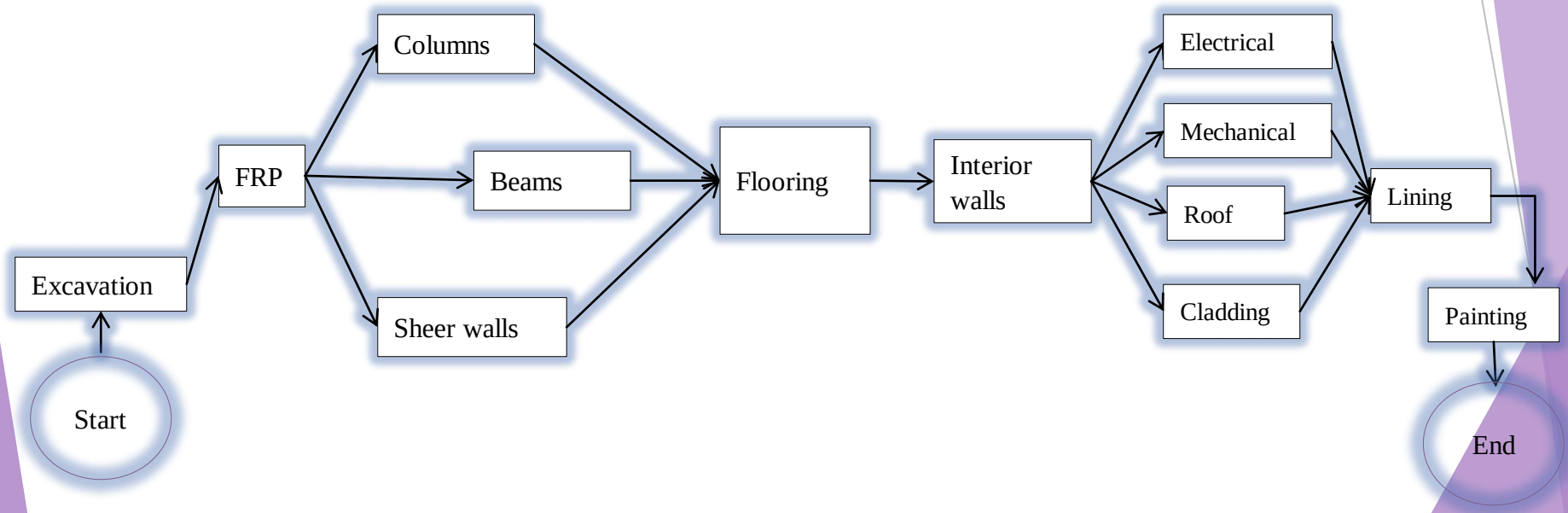
- A project network have start and end: only one start node and only one end node.
- Time moves from left to right
- A network may not contain loops



- A network may not contain dangles




1. Construction of a house
1.1 Internal (Fit out)
1.2 Structure
1.3 External (Envelope)
1.1.1 Electrical
1.1.2 Mechanical
1.1.3 Lining
1.1.4 Painting
1.3.1 Cladding
1.3.2 Roof
1.2.1 Foundation
1.2.2 Steel erection
1.2.3 building shell
1.2.1.1 Excavation
1.2.1.2 FRP
1.2.2.1 Columns
1.2.2.2 Beams
1.2.3.1 Flooring
1.2.3.2 Walls
1.2.3.2.1 Sheer walls
1.2.3.2.2 Interior walls


Start
Excavation
FRP
Columns
Beams
Sheer walls
Flooring
Interior walls
Electrical
Mechanical
Roof
Cladding
Lining
Painting
End

PM Glossary: Important Network Definitions

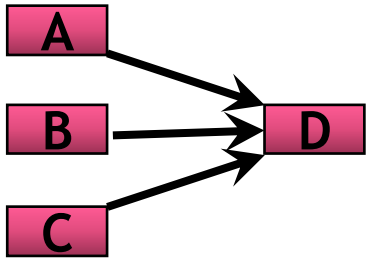
- **Project network**: A flow chart that graphically depicts the logical sequences, interdependencies, and start and finish times of the project activities along with the longest path(s) through the network—the critical path

- **Activity**: An activity always consumes time and usually also consume resources. Examples include paperwork, labor negotiations, machinery operations, and lead times for purchased parts or equipment.

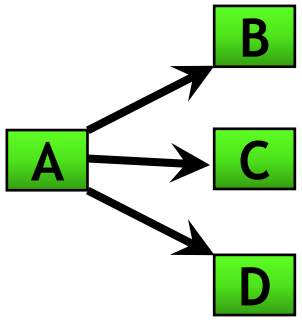
- **Critical path**: The critical path (CP) is the longest activity path(s) through the network that allows for the completion of all activities; the shortest expected time in which the entire project can be completed. Delays on the critical path will delay completion of the entire project. Activities included in this path are referred to as critical path activities.

Project Network

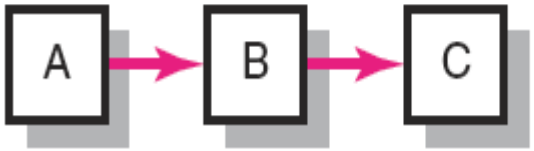
- **Merge Activity:** an activity that has two or more preceding activities on which it depends.



- **Burst Activity**: an activity that has more than one activity immediately following it (more than one dependency arrow flowing from it).

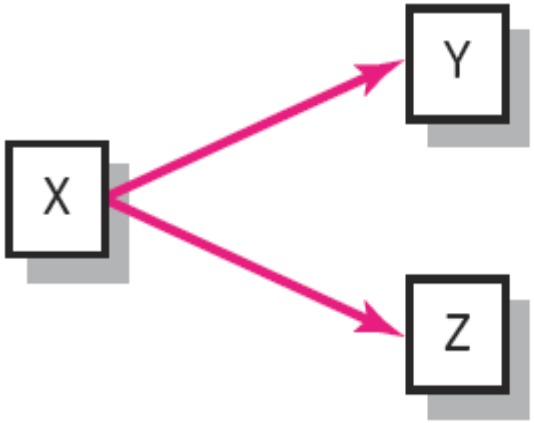


Project Network



A is preceded by nothing
B is preceded by A
C is preceded by B

(A)

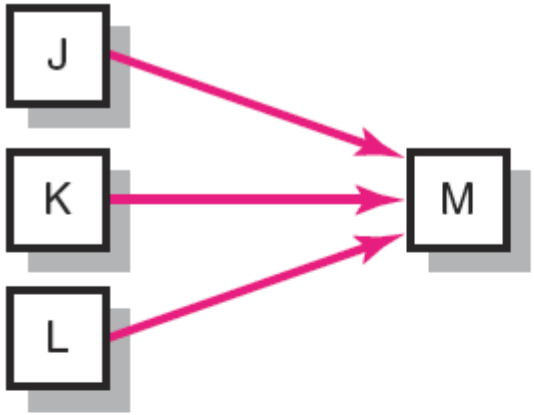


Y and Z are preceded by X

Y and Z can begin at the same time, if you wish

(B)

Project Network

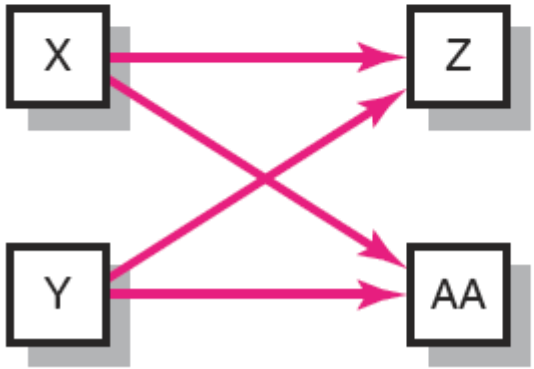


J, K, & L can all begin at the same time, if you wish (they need not occur simultaneously)

but

All (J, K, L) must be completed before M can begin

(C)



Z is preceded by X and Y

AA is preceded by X and Y

(D)

Exercise 1- Draw A Network Diagram

KOLL BUSINESS CENTER
County Engineers Design Department

Activity	Description	Preceding Activity
A	Application approval	None
B	Construction plans	A
C	Traffic study	A
D	Service availability check	A
E	Staff report	B, C
F	Commission approval	B, C, D
G	Wait for construction	F
H	Occupancy	E, G

Network Computation Process

Forward Pass—Earliest Times

- How soon can the activity start? (early start—ES)
- How soon can the activity finish? (early finish—EF)
- How soon can the project finish? (expected time—ET)

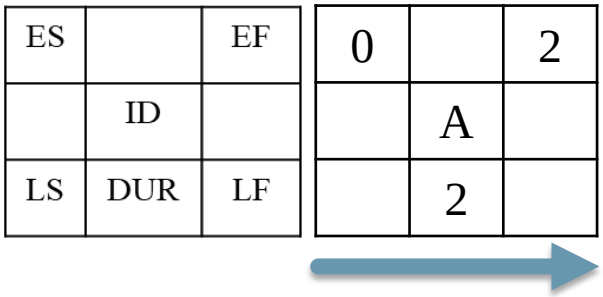
Backward Pass—Latest Times

- How late can the activity start? (late start—LS)
- How late can the activity finish? (late finish—LF)
- Which activities represent the critical path?
- How long can it be delayed? (slack or float—SL)

ES		**EF**
	ID	
LS	**DUR**	**LF**

Forward Pass Computation

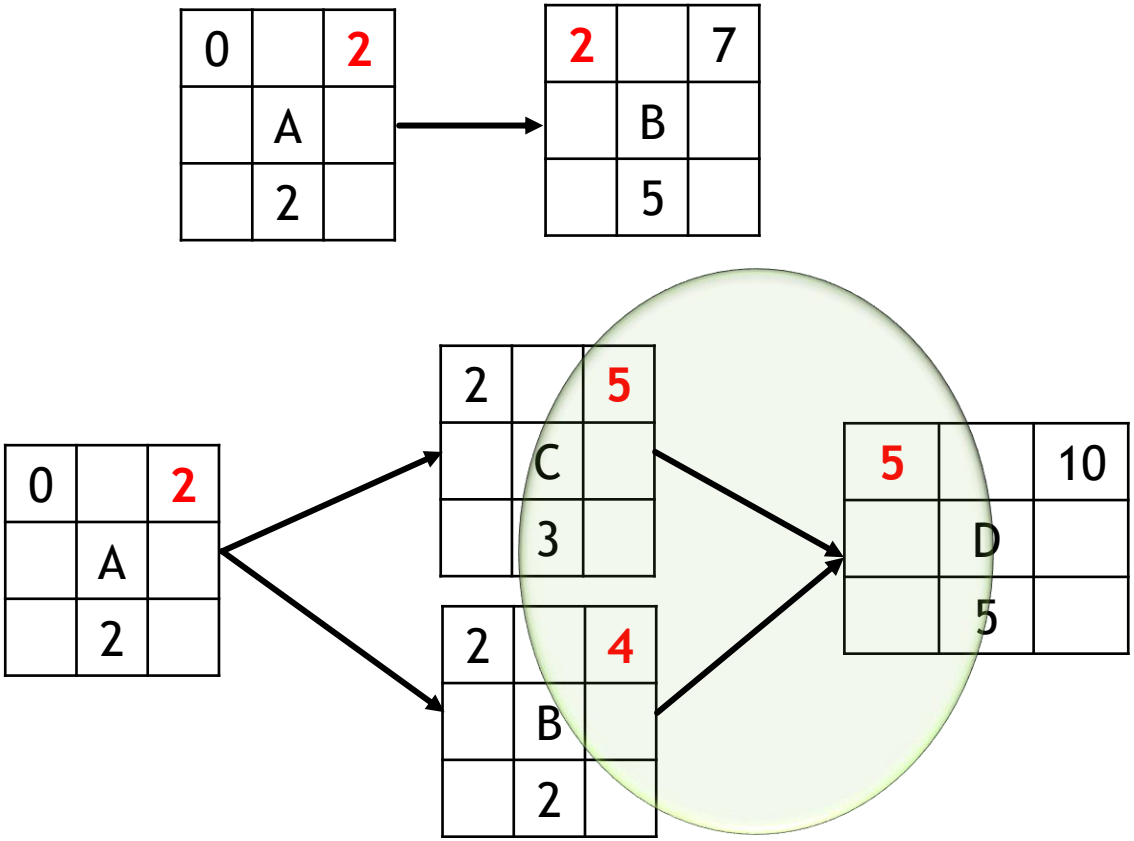
- Add activity times along each path in the network



(ES + Duration = EF)

Forward Pass Computation

Carry the early finish (EF) to the next activity where it becomes its early start (ES) unless the next succeeding activity is a **merge activity**, in which case the largest EF of all preceding activities is selected.

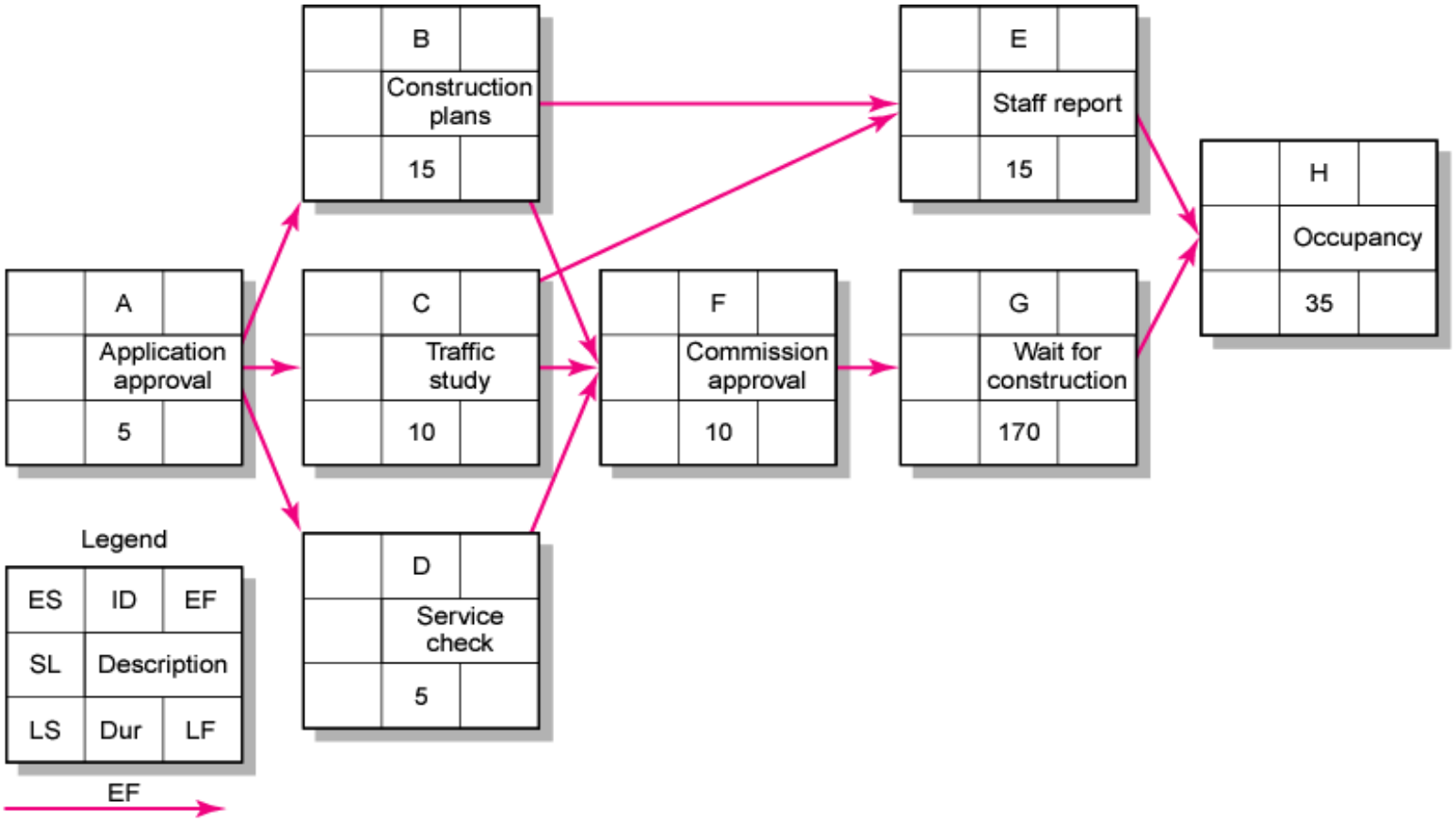


Exercise 2- Calculate The Forward Pass

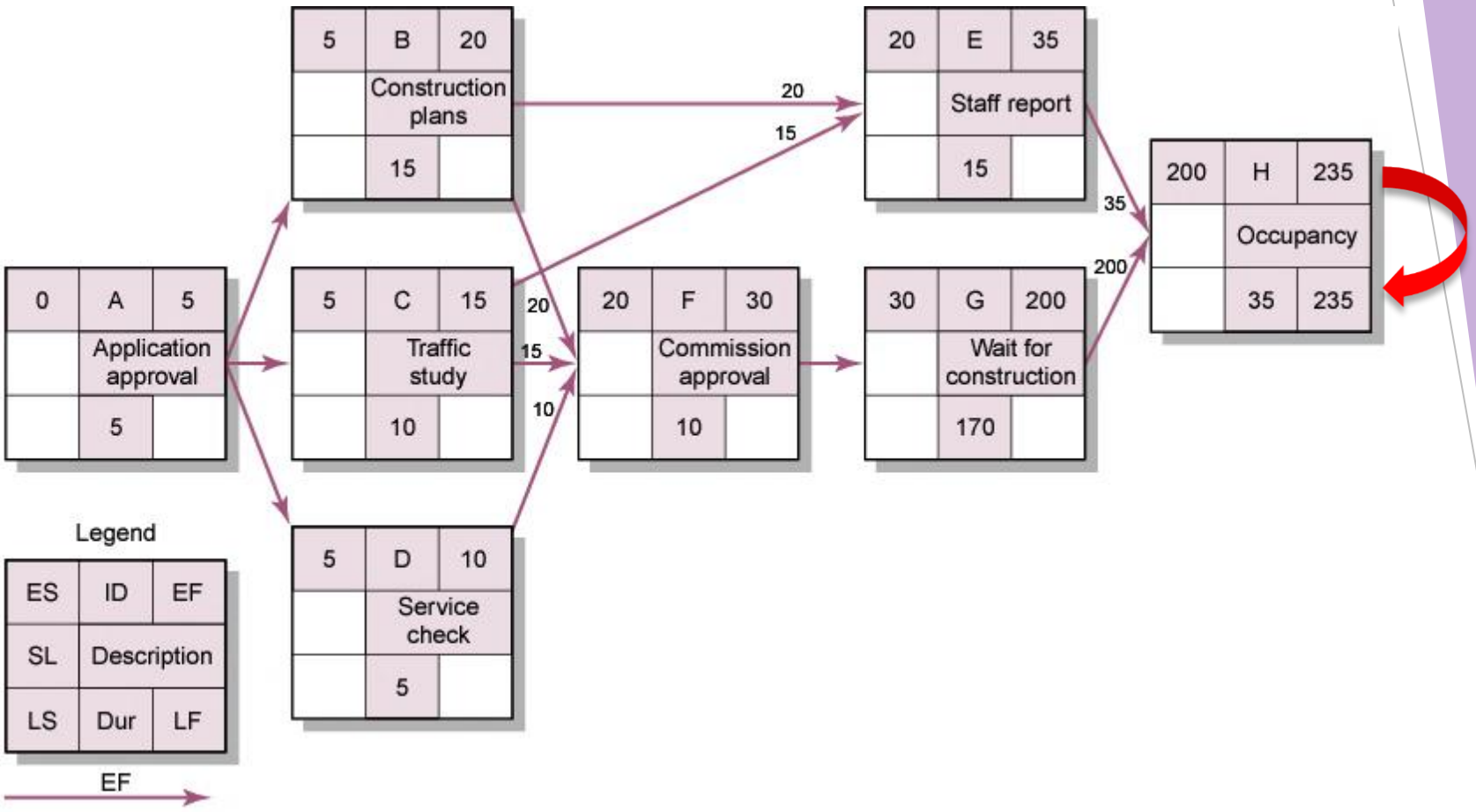
KOLL BUSINESS CENTER
County Engineers Design Department

Activity	Description	Preceding Activity	Activity Time
A	Application approval	None	5
B	Construction plans	A	15
C	Traffic study	A	10
D	Service availability check	A	5
E	Staff report	B, C	15
F	Commission approval	B, C, D	10
G	Wait for construction	F	170
H	Occupancy	E, G	35

Exercise 2- Calculate The Forward Pass

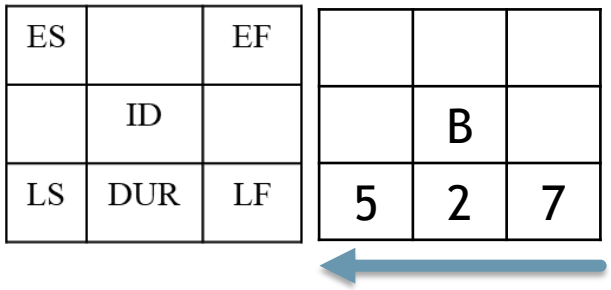


Forward Pass—Earliest Times



Backward Pass Computation

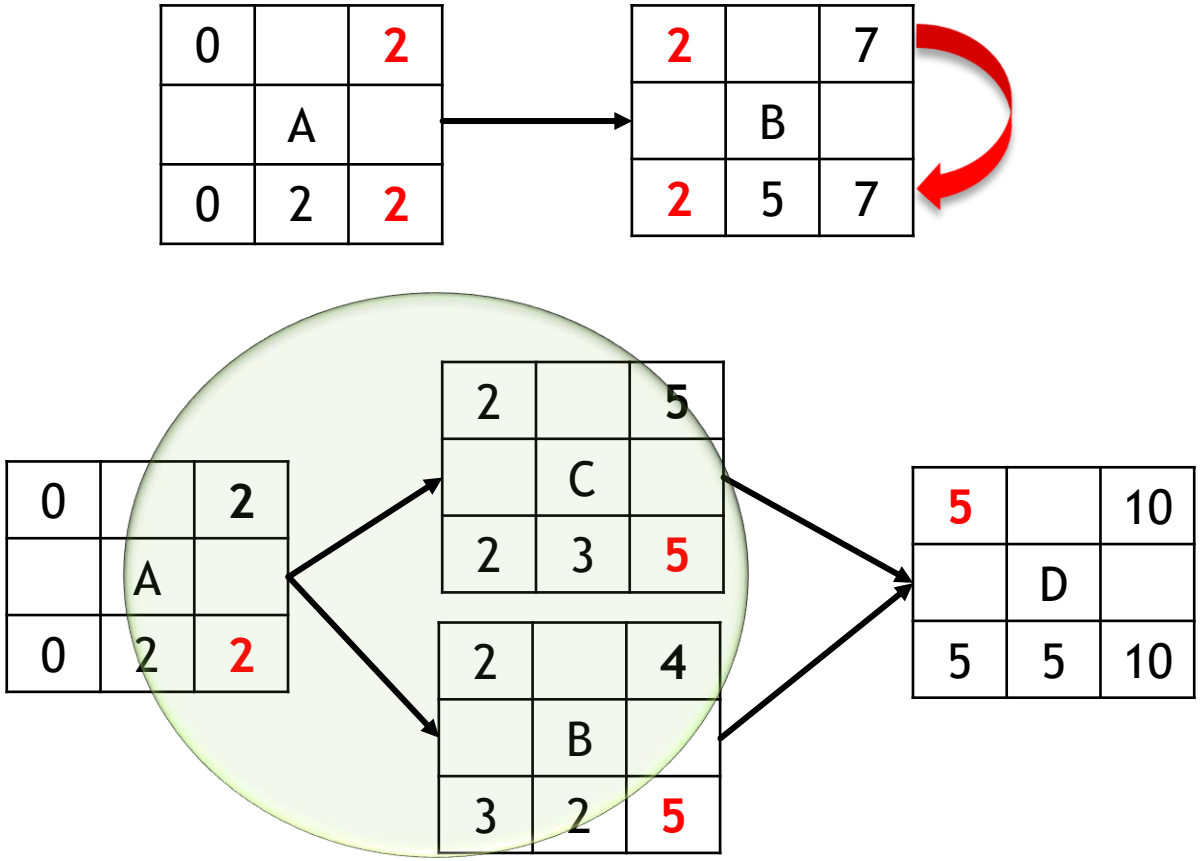
Subtract activity times along each path in the network



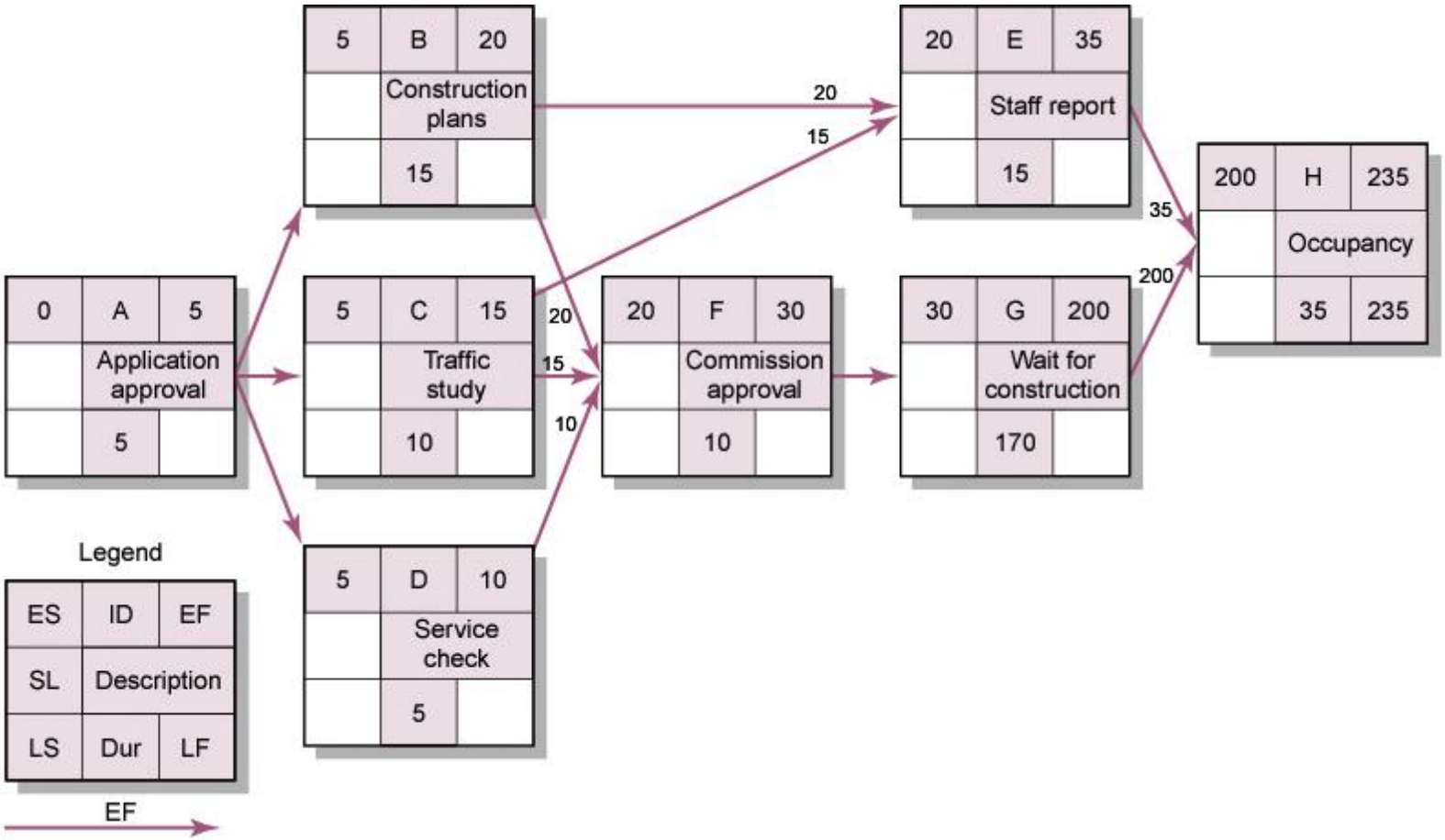
(LF - Duration = LS)

Backward Pass Computation

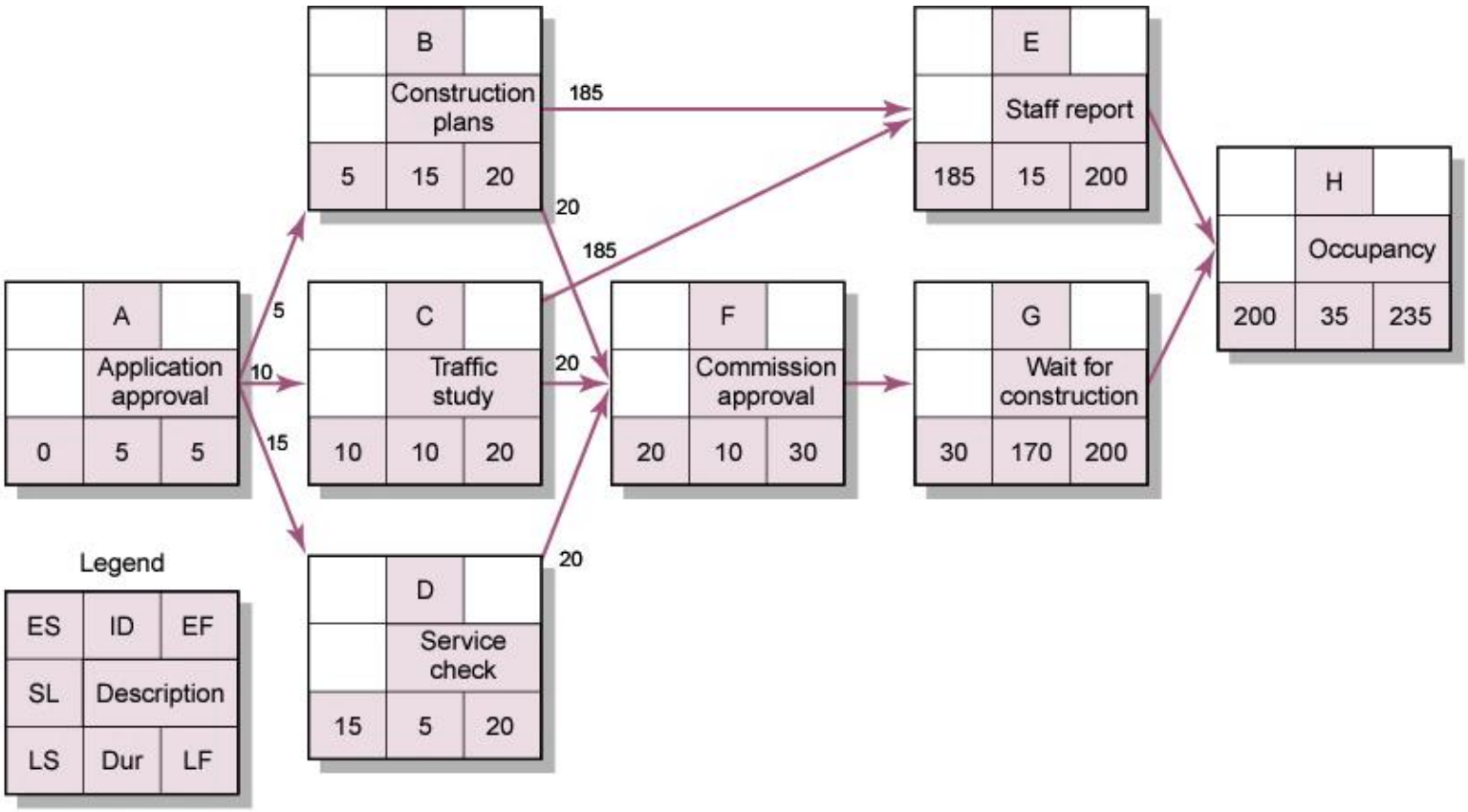
Carry the late start (LS) to the next activity where it becomes its late finish (LF) unless the next succeeding activity is a burst activity, in which case the smallest LF of all preceding activities is selected.



Exercise 2- Calculate The Backward Pass



Backward Pass—Latest Times



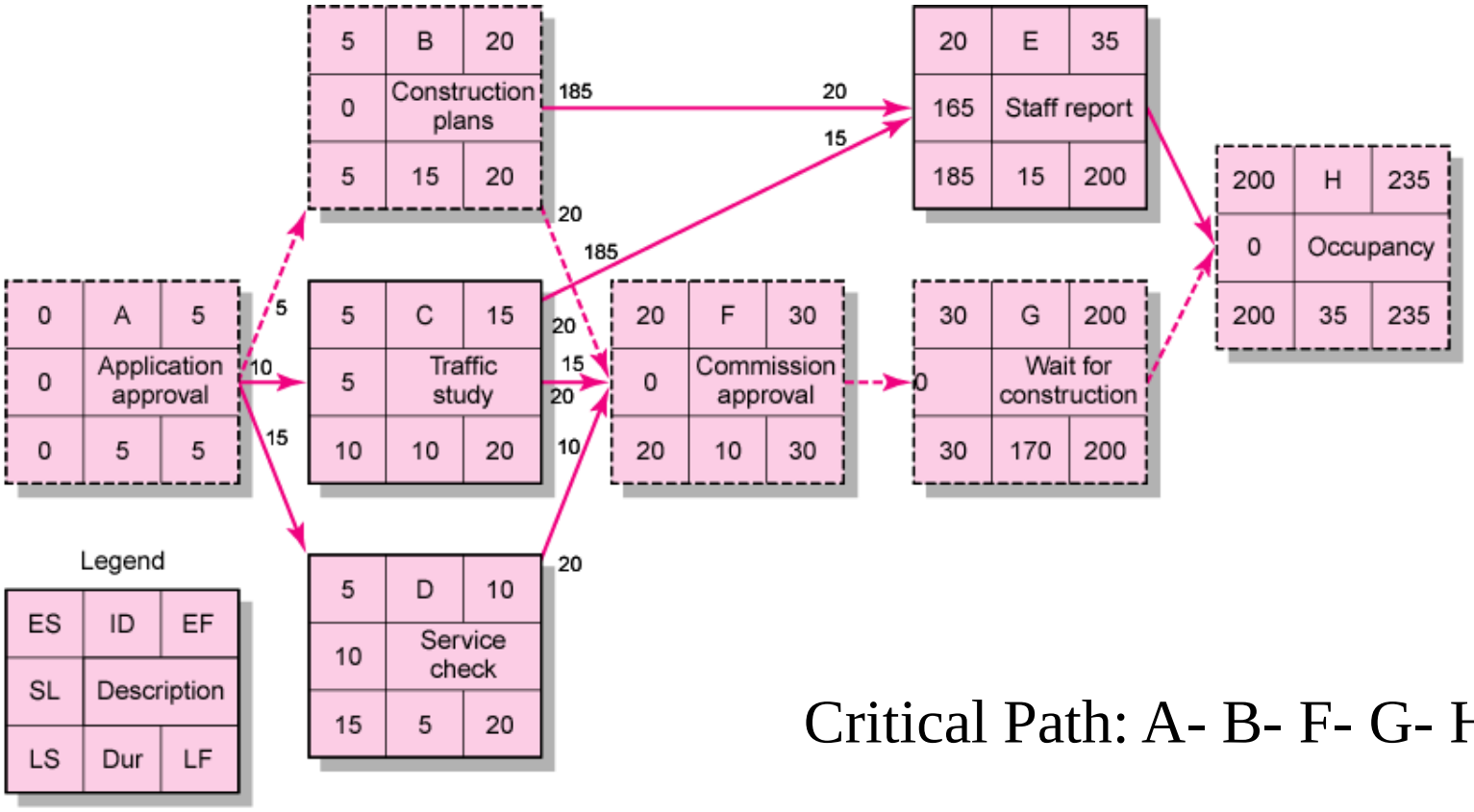
Determining Slack (or Float)

- Slack (or Float): The amount of time an activity can be delayed after the start of a longer parallel activity or activities.

- Total slack: The amount of time an activity can be delayed without delaying the entire project.
  - **TS= LS- ES or TS= LF-EF**

- **The critical path can be identified as those activities that have the <u>total slack of zero</u>.**

Exercise 2- Critical Path



Critical Path: A- B- F- G- H

Critical Path

- The critical path is not the one with all the critical activities; it only accounts for time. There might be other critical (compulsory) activities

- There can be more than one critical path if the lengths of two or more paths are the same

- The critical path can change as the project progresses, if there is a delay that make an alternative path longer

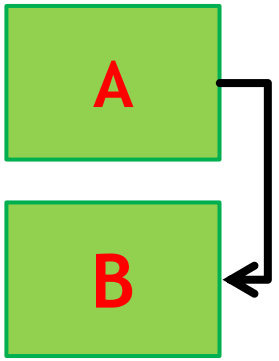
Lag

- The minimum amount of time a dependent activity must be delayed to begin or end.
- Lags can be used to constrain finish-to-start, start-to-start, finish-to-finish, start-to-finish, or combination relationships.

There Are Four Standard Types of Dependencies:

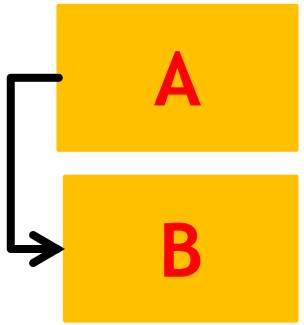
1. Finish to Start (FS): B can't start until A has finished

2. Finish to Finish (FF): B can't finish before A is finished



There Are Four Standard Types of Dependencies:

3. Start to Start (SS): B can't start until A has started



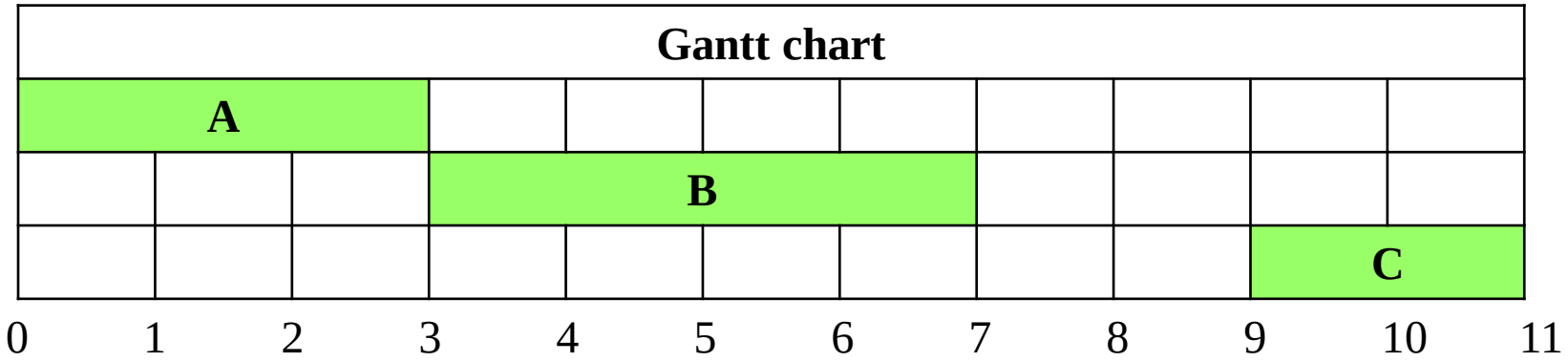
4. Start to Finish (SF): B can't finish until A has started

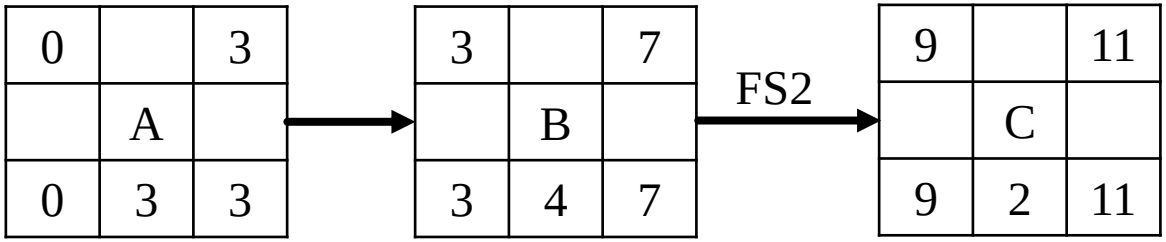
Finish to Start

Activity	Predecessor	Duration
A	-	3
B	A	4
C	B(FS2)	2

Regular finish to start relationship

It means C can't start until 2 days after B has finished

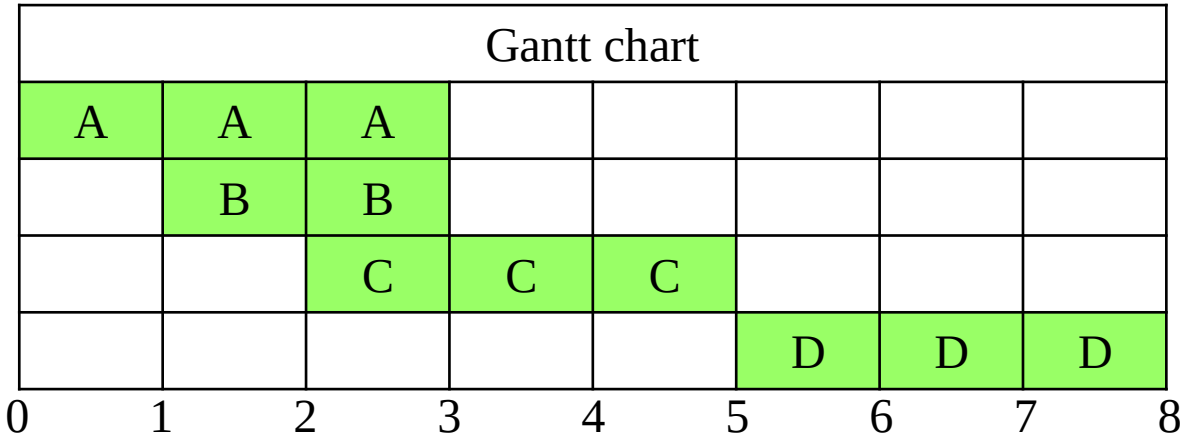


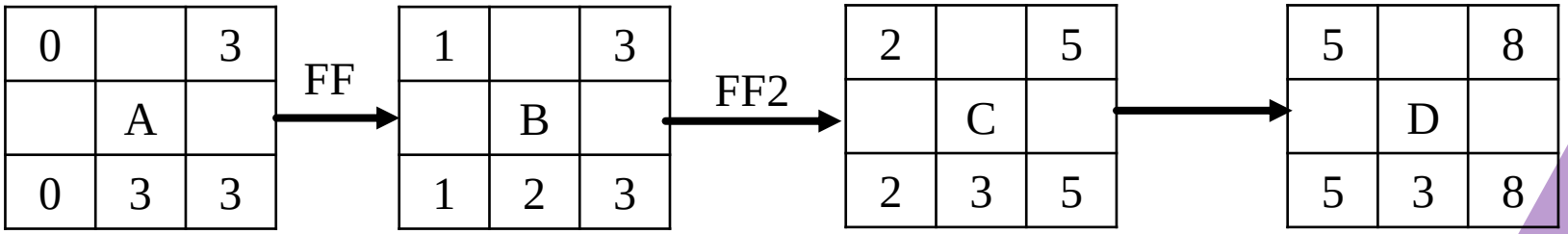


Finish to Finish

Activity	Predecessor	Duration
A	-	3
B	A (FF)	2
C	B (FF2)	3
D	C	3

Activity C can't finish until 2 days after activity B has finished

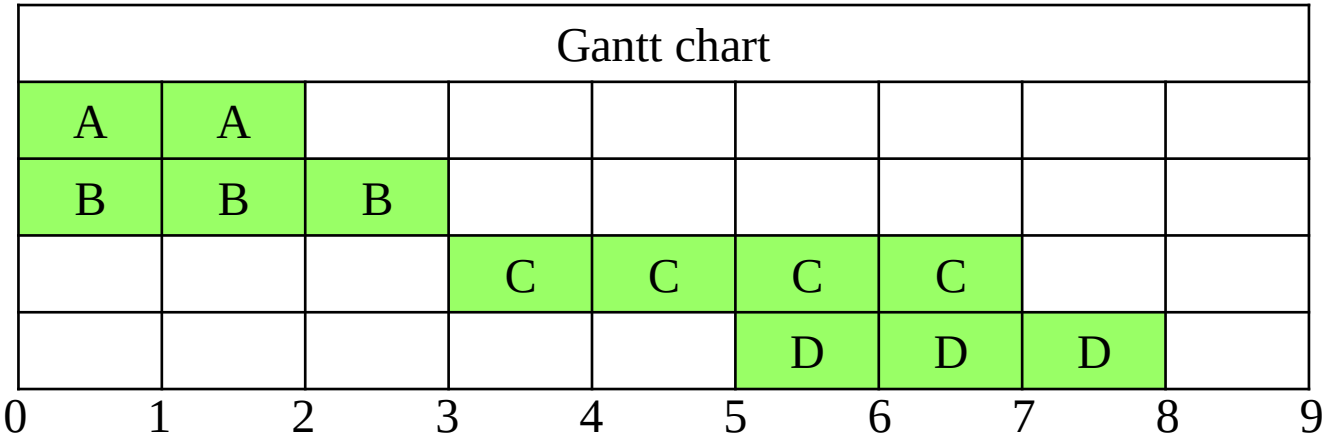


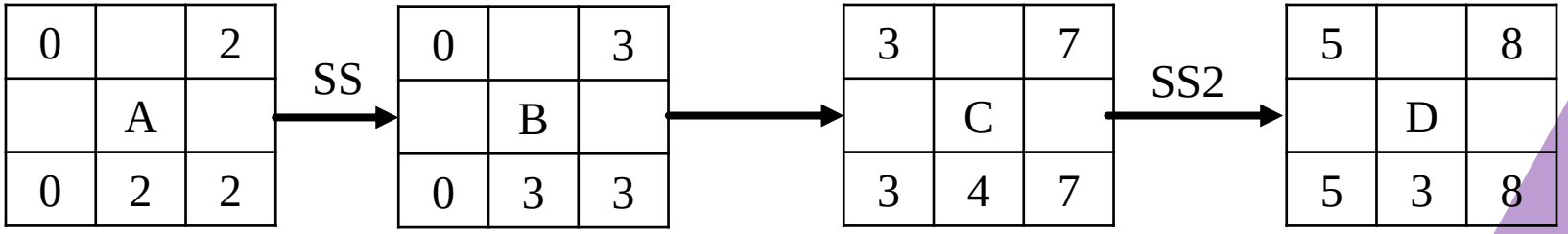


Start to Start

Activity	Predecessor	Duration
A	-	2
B	A (SS)	3
C	B	4
D	C (SS2)	3

Activity D can't start until 2 days after activity C has started

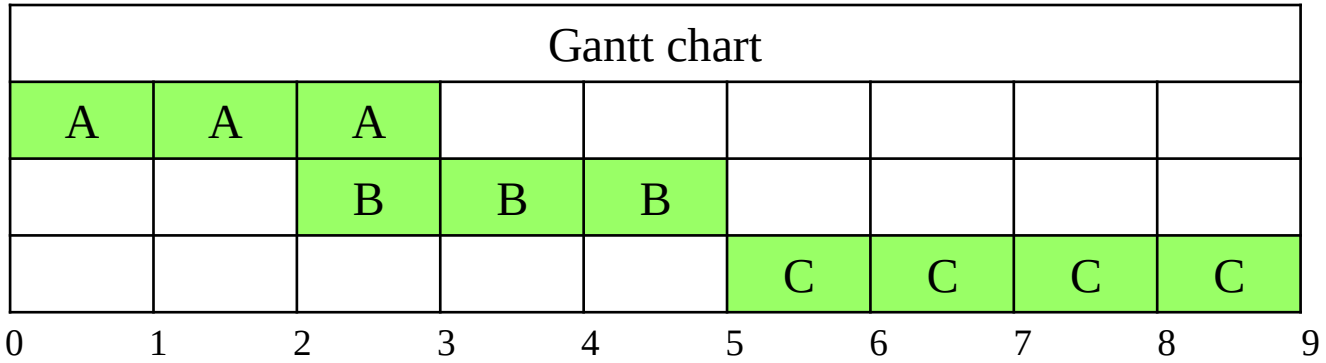


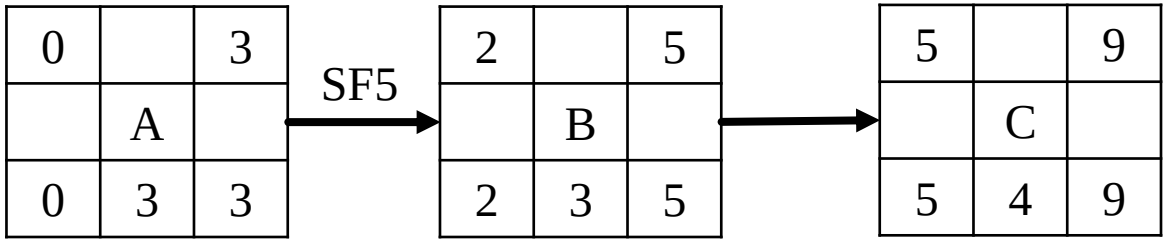


Start to Finish

Activity	Predecessor	Duration
A	-	3
B	A (SF5)	3
C	B	4

Activity B can't finish until 5 days after activity A has started



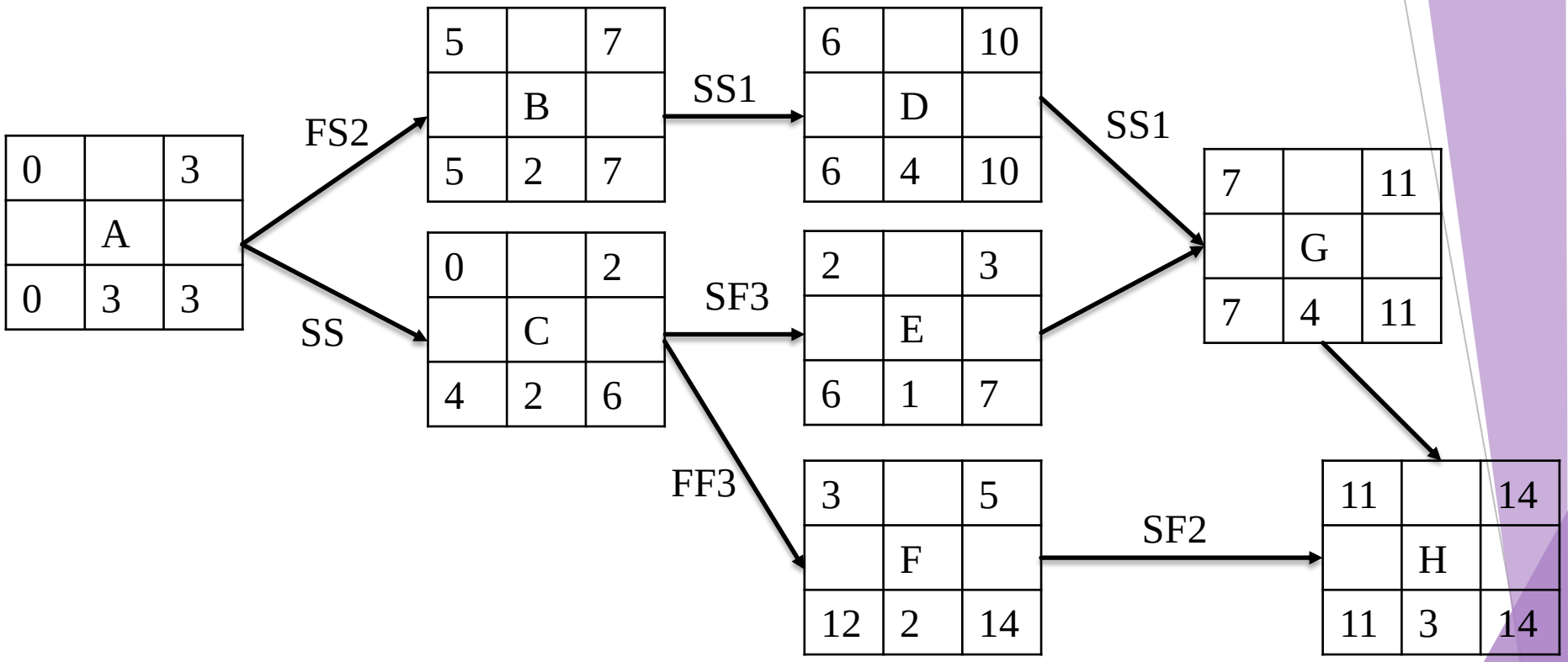


Exercise 3

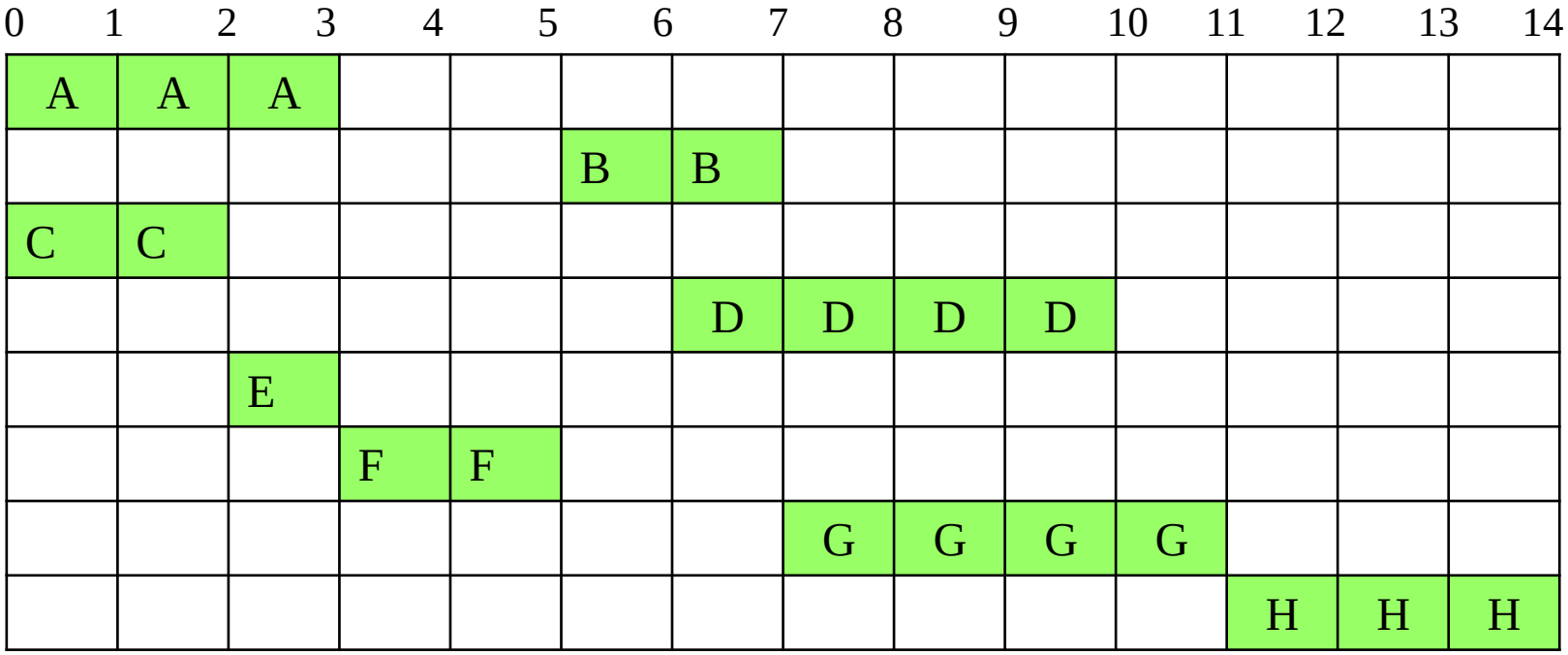
- Find the project duration and critical path
- Draw the project Gantt chart

Activity	Predecessor	Duration
A	-	3
B	A (FS2)	2
C	A (SS)	2
D	B(SS1)	4
E	C(SF3)	1
F	C(FF3)	2
G	D(SS1),E	4
H	F(SF2),G	3

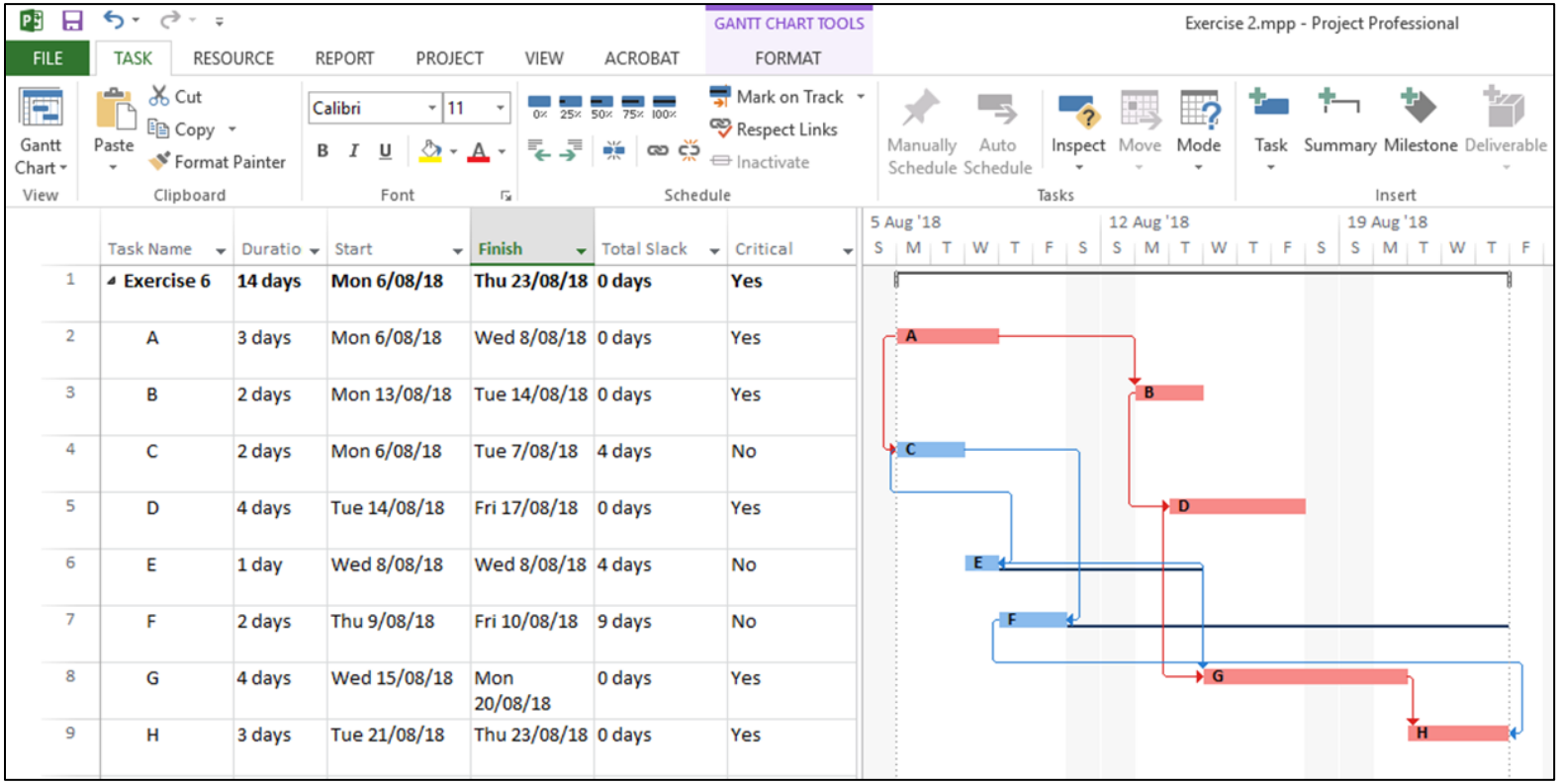
Network Diagram



Gantt Chart



Practice in MSP



	Task Name	Duratio	Start	Finish	Total Slack	Critical
1	**Exercise 6**	**14 days**	**Mon 6/08/18**	**Thu 23/08/18**	**0 days**	**Yes**
2	A	3 days	Mon 6/08/18	Wed 8/08/18	0 days	Yes
3	B	2 days	Mon 13/08/18	Tue 14/08/18	0 days	Yes
4	C	2 days	Mon 6/08/18	Tue 7/08/18	4 days	No
5	D	4 days	Tue 14/08/18	Fri 17/08/18	0 days	Yes
6	E	1 day	Wed 8/08/18	Wed 8/08/18	4 days	No
7	F	2 days	Thu 9/08/18	Fri 10/08/18	9 days	No
8	G	4 days	Wed 15/08/18	Mon 20/08/18	0 days	Yes
9	H	3 days	Tue 21/08/18	Thu 23/08/18	0 days	Yes

Estimating ‘Work Required’ In a Project

- Once tasks have been identified (WBS) the time and resource requirements must be determined.

Estimating is:

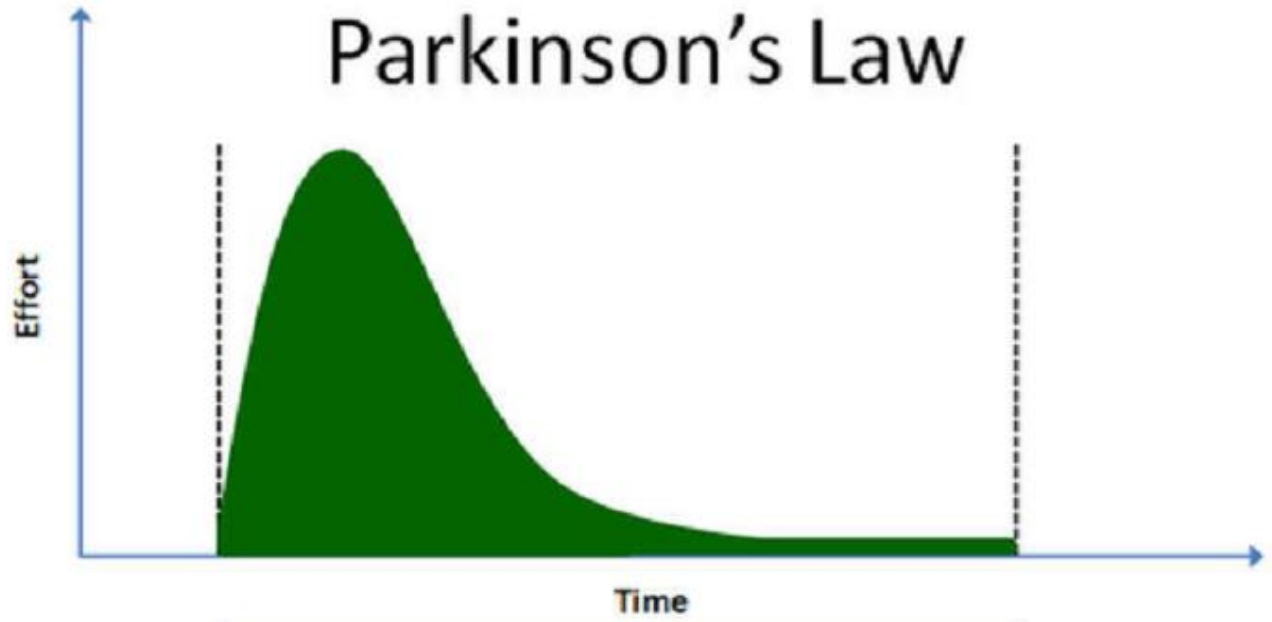
- The process of forecasting or approximating the time and cost of completing project deliverables.
- The task of balancing expectations of stakeholders and need for control while the project is implemented.

Description	Duration
Identify Topic	?
Research topic	
Draft Paper	
Edit Paper	
Create graphics	
References	
Final draft	

Estimating ‘Work Required’ In a Project

- You can not do a time or cost estimate without considering who will actually perform the task.
- You must base the estimate on historical data or mental model

- **Parkinson’s law**: Work expands to fill the time available for its completion.



Why Estimating Time and Cost Are Important For a Project?

- To support good decisions
- To schedule work
- To determine how long the project should take and its cost
- To determine whether the project is worth doing
- To develop cash flow needs
- To determine how well the project is progressing
- To develop time-phased budgets and establish the project baseline

Today's Learning Objectives

- Understand the rational for WBS and Network diagram
- Understand different types of network diagram
- Be able to calculate project duration and ES,EF,LS,LF
- Be able to identify critical path
- Be able to calculate slack and draw a Gantt chart
- Understand different types of relationships in network diagram
- Be able to calculate ES, EF, LS, LF with lags