OPERATIONAL RESEARCH

(CRITICAL PATH METHOD AND PROJECT EVALUATION REVIEW TECHNIQUES)

Network Analysis

- Network analysis is a universal term provided to some particular techniques utilized for the planning, management and control of projects.
  - Definition of a project (from the Project Management Institute) is:
    - **A project is a temporary endeavour undertaken to create a "unique" product or service.**
  - This definition serves to underline certain elementary characteristics of a project.
    - it is momentary - it has a starting point and a finish point
    - it is therefore "peculiar"

Network Analysis

- Generally, all projects can be divided into:
  - separate *activities* (tasks/jobs) - where each activity has a related lifetime or *completion time* (i.e. the time from the start of the activity to its finish)
  - *precedence relationships* - which manage the order in which we may execute the activities, e.g. in a project concerned with building a house the activity "erect all four walls" must be finished before the activity "put roof on" can start

** The difficulty is to bring all these activities together in a logical manner to complete the project.

Network Analysis

- 2 distinct techniques for Network Analysis originated independently in the late 1950's - these were:
  - PERT (for Program Evaluation and Review Technique); and
  - CPM (for Critical Path Management).

- Network analysis is an essential technique in **PROJECT MANAGEMENT**. It permits us to adopt a ***systematic quantitative structured approach*** to the challenge of handling a project towards fruitful achievement. Additionally, it has a graphical representation, allowing for better comprehension and use by those who are technically less knowledgeable about it.

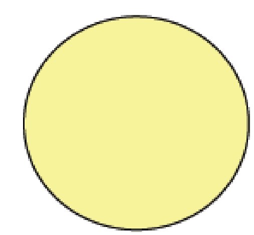
Critical Path Activity (CPA)

- It is a mechanism used to plan activities so that a job can be executed in the most efficient way, thus taking minimum time possible.
- It divides a job into multiple tasks and scrutinize the dependency of them
  - ❖ Example: List the activities that must be completed in order to make a cup of tea
- It is widely used in the Manufacturing and Construction Sector

Parts of the Network

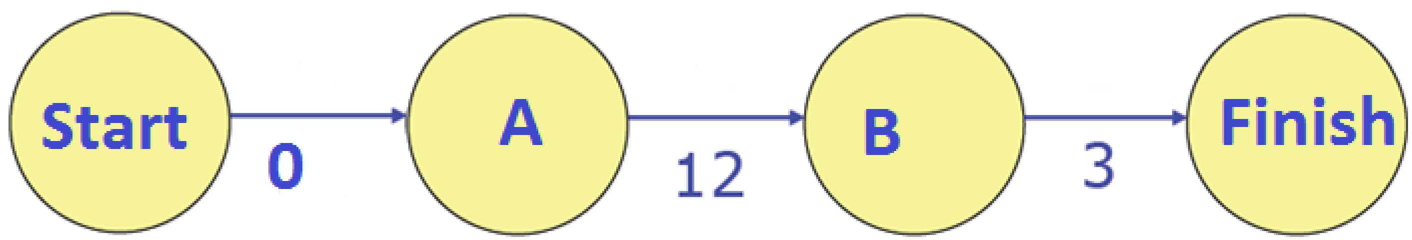
- A network consists of 2 things:
  - An **ACTIVITY**
    - This requires time and/or resources
    - They are drawn as **ARROWS** from left to right
    - The length of the arrow is **NOT** important

  - A **Node**
    - These represent the start and the end of an activity
    - They are represented by **CIRCLES**
    - Every network **MUST** start and end with a node



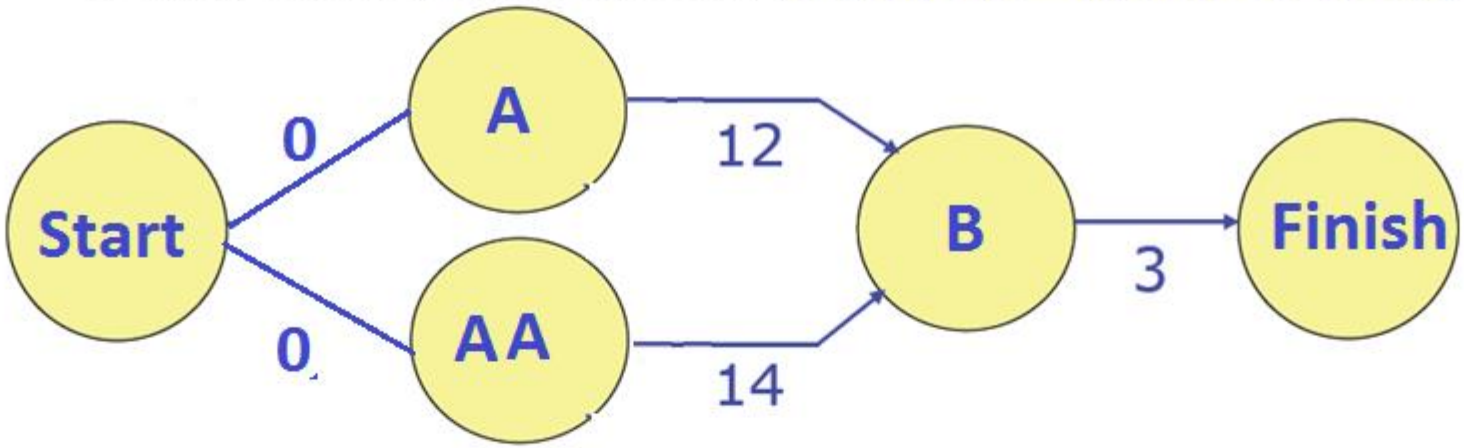
A Simple Network Diagram

- A business wishes to build a new factory
- Before it can do so it needs to:
  - Buy the land (Activity A – will take 12 weeks)
  - Draw up Plans (Activity B – will take 3 weeks)
- A simple network may be drawn to illustrate this scenario:



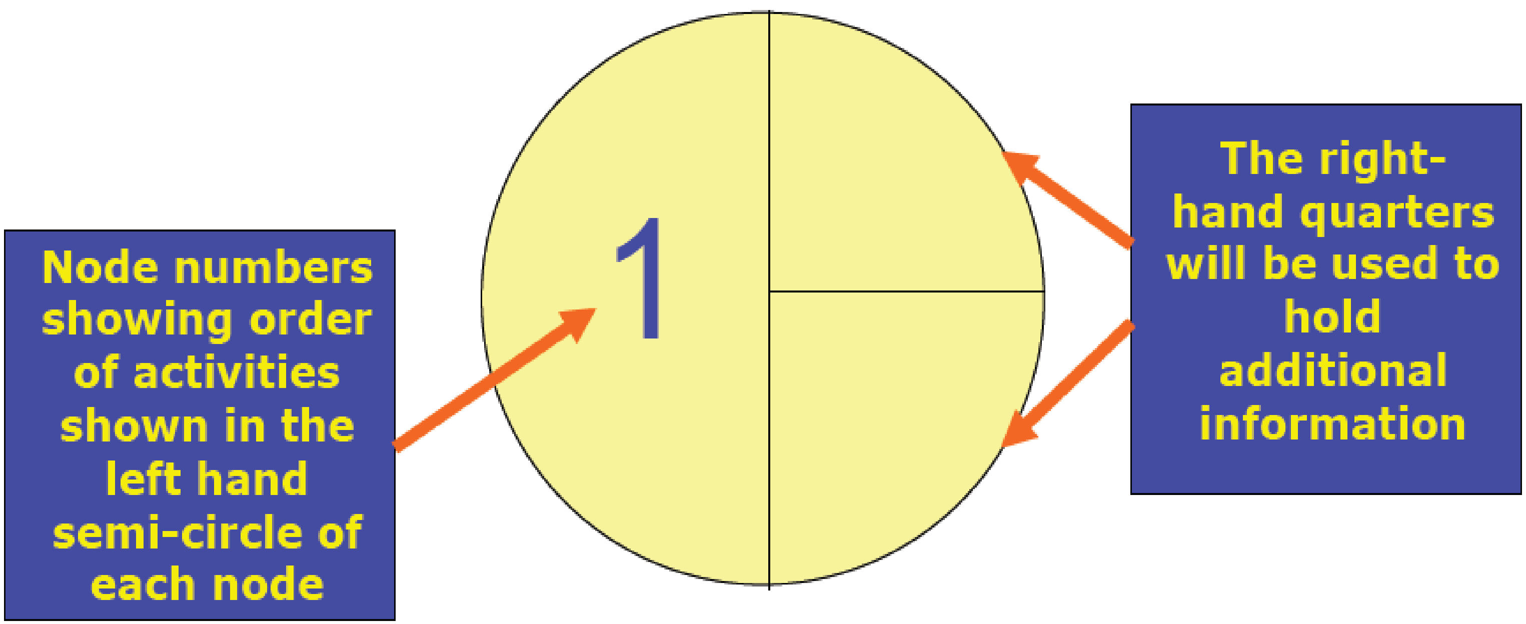
Illustrating Simultaneous Activities

- Of course in reality some activities can be carried out simultaneously
- Using the previous example:
  - Assume that whilst in the process of buying the land the firm wants to apply for planning permission (Activity AA – will take 14 weeks)



Developing the network

- There are a number of problems with our previous example:
  - There is no way of identifying the nodes
  - It doesn't help us identify the crucial activities
- In order to do this the nodes can be developed in order to show more information:



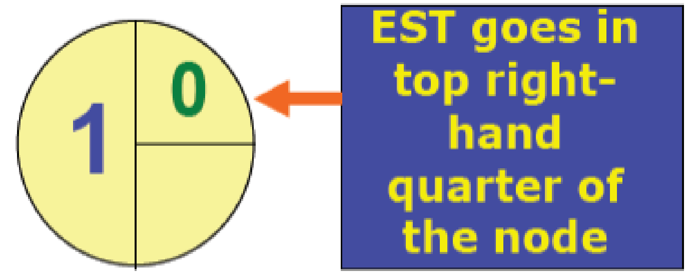
Calculating the earliest start time

- The main reason for drawing a network is to identify the CRITICAL activities
- To do this we must calculate the earliest time at which any given activity can start
  - This is called the **Earliest Start Time (EST)** of the activity
- It is calculated using the following formula:

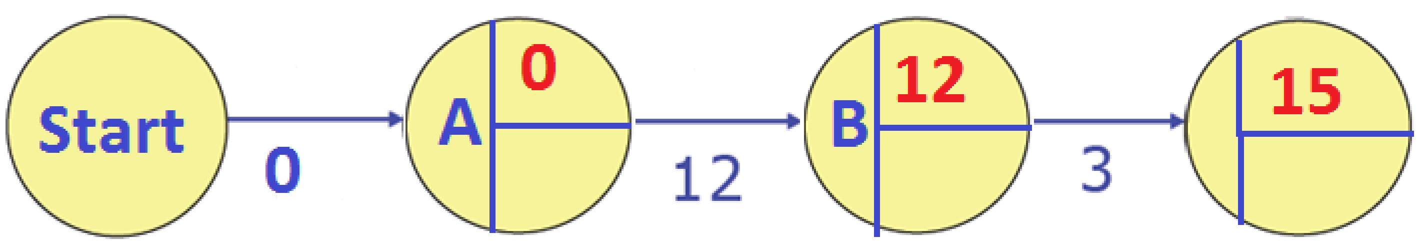
EST = EST of Previous activity + Duration of previous activity

Calculating the earliest start time

- This information is then placed in the top right-hand quarter of the node
- The first node will ALWAYS have an EST of zero

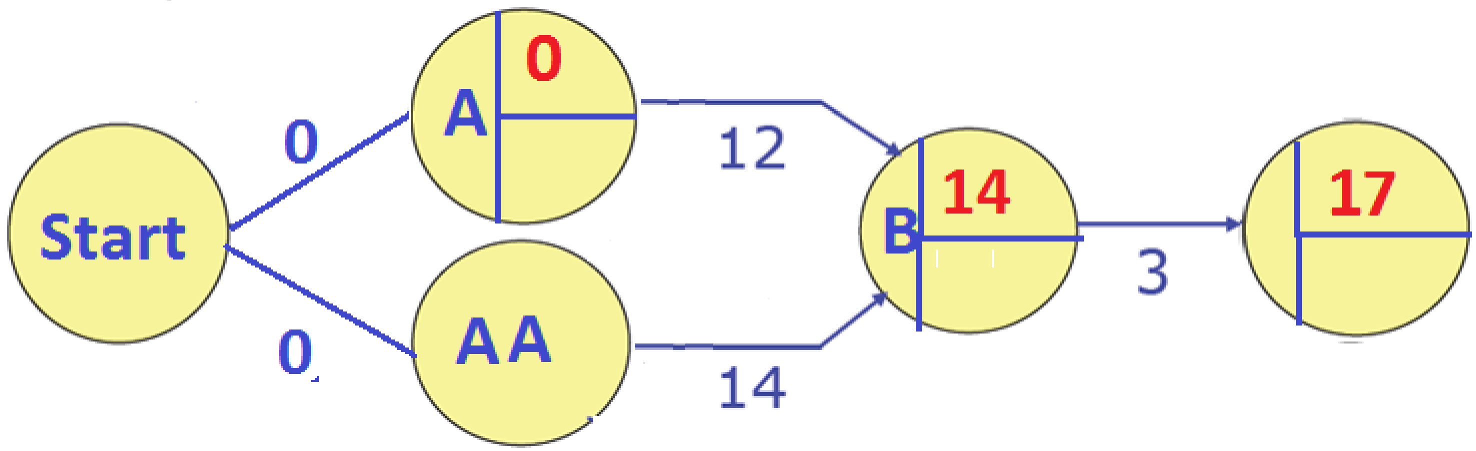


- Using our first simple example, the EST for each activity would be calculated as follows:



The EST & Simultaneous Activities

- When there are simultaneous activities there may be more than one value for the EST



- Since Activity B is DEPENDENT on both Activities A and AA, it cannot start until both are complete
- So we must take the HIGHEST figure
- This means that the EST is 14 weeks

Recap of Earliest Start Time

- The EST of the first activity is always zero
- Calculate the EST by working left to right across a network
- It is calculated using the following formula:

EST = EST of Previous activity + Duration of previous activity

- When there are 2 simultaneous activities the HIGHEST figure is used as the EST

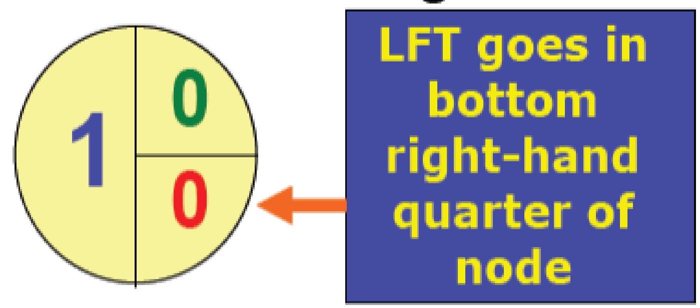
Calculating Latest Finish Time

- There is one final piece of information needed to complete our network diagram
- To identify the CRITICAL activities we must also know the latest time at which any given activity must end
  - This is called the **Latest Finishing Time (LFT)** of the activity
- It is calculated by working BACKWARDS across the network using the following formula:

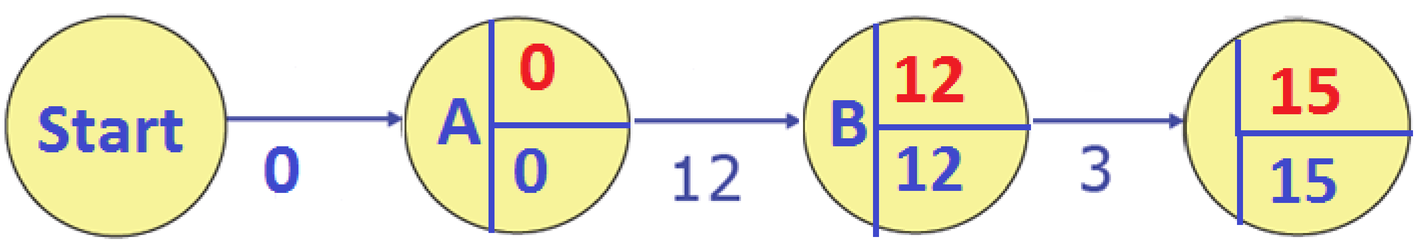
LFT = LFT at end of following activity - Duration of following activity

Calculating Latest Finish Time

- This information is then placed in the bottom right-hand quarter of the node
- The first node will ALWAYS have an LFT of zero



- Using our first simple example, the LFT for each activity would be calculated as follows:

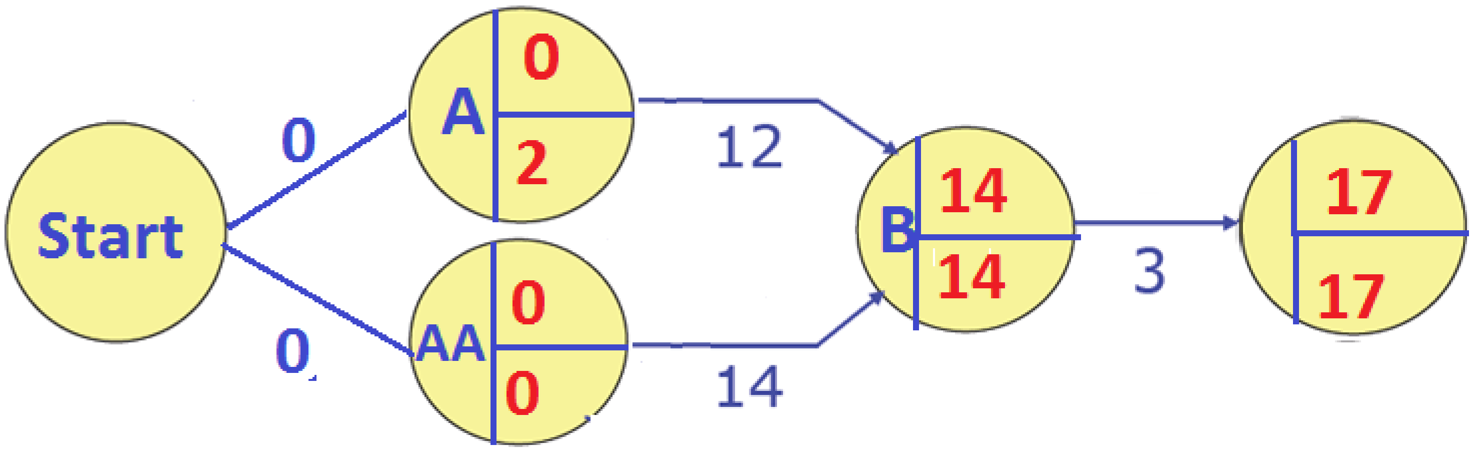


Since the earliest time this project can be finished is 15 weeks then this is also the latest we would like to finish the project. As such:

The EST and LFT of the last node are ALWAYS the same

The LFT & Simultaneous Activities

- When there are simultaneous activities there may be more than one value for the LFT



- If Activity AA starts on week 2 it cannot be completed by week 14
- So we must take the LOWEST figure
- This means that the LFT is week 0

Recap of Latest FinishTime

- The LFT of the last activity is always equal to its EST
- The LFT of the first activity is always zero
- Calculate the LFT by working right to left across a network
- It is calculated using the following formula:

LFT = LFT at end of following activity - Duration of following activity

- When there are 2 simultaneous activities the LOWEST figure is used as the LFT

The float

- The vertices with equal EST and LFT define the **critical path**.

- Another way of identifying the critical path is to define the

  Float time = LFT – EST

Calculating the Float

Activity	EST	LFT	Float
A	0	2	2
AA	0	0	0
B	14	14	0

What does this mean?

- This data tells us:
  - That Activity A can be delayed 2 weeks without delaying Activity B
  - That Activity AA is **CRITICAL** – any delay will hold up the project
  - That Activity B is **CRITICAL** – any delay will hold up the project

Advantages of CPA

- It mandates considerate groundwork (planning) so that the project / activity can be conducted efficiently
- Enhances efficiency and cash flow, for e.g. materials will be ordered only upon the necessity
- Should any issue arise, the discrepancies that can be easily identified, hence allowing room for effective decision-making

Disadvantages of CPA

- Graphical representations can be disruptive, even if there is a software to assist with the production of networks
- The plan will function properly with the consultation of relevant staff, e.g, realistic timeframes
- In order to visually demonstrate the chronology of activities, Gantt charts are recommended.