Software Project Management

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Project Scheduling cont…

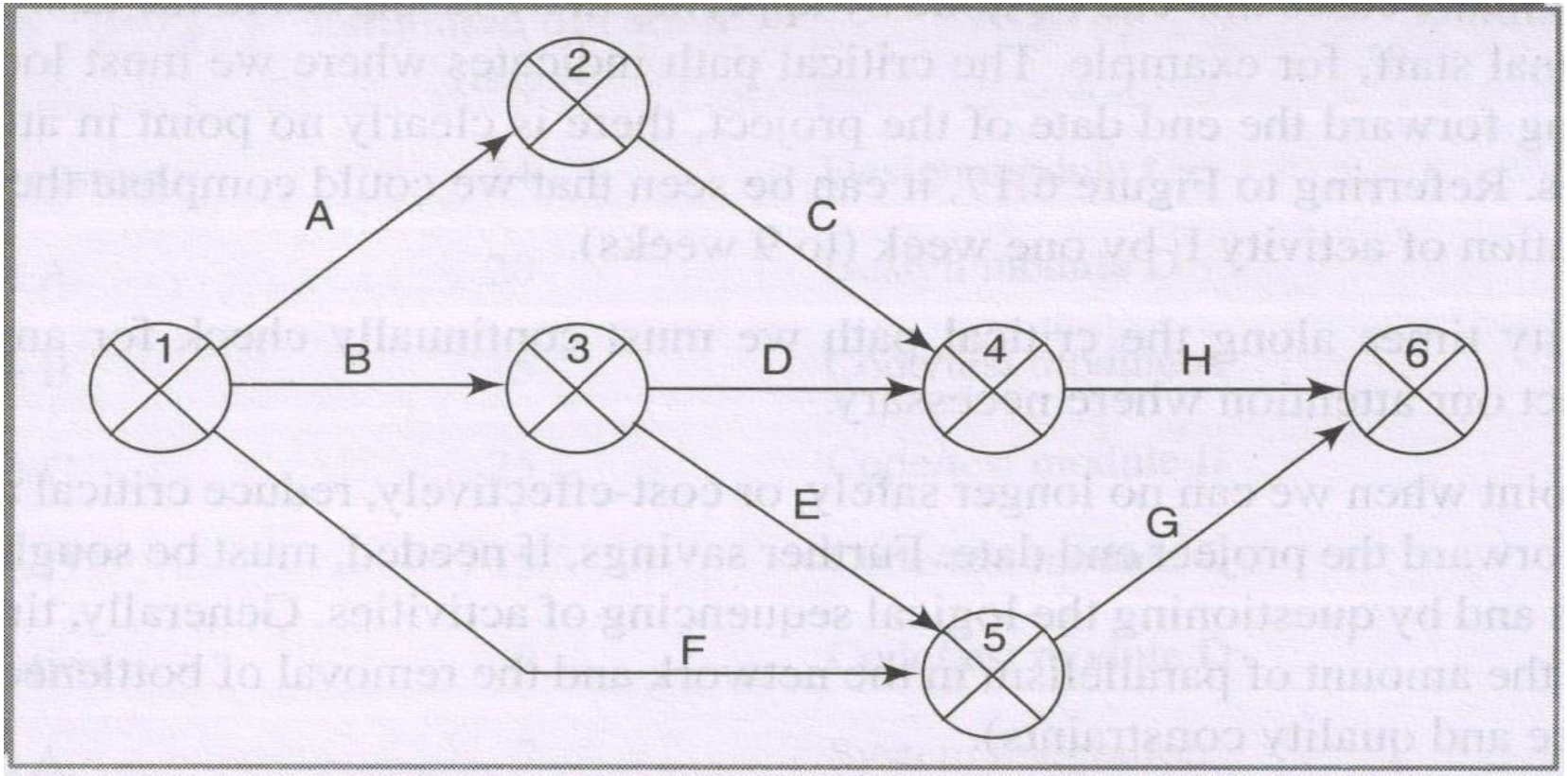
Activity on Edge Network

- Activities are represented by links/edges/arrows.
- Nodes represent activities (or group of activities) starting or finishing.

Example

Activity Label	Activity Name	Duration (Weeks)	Precedence
A	Hardware Selection	6	---
B	System configuration	4	---
C	Install hardware	3	A
D	Data migration	4	B
E	Draft office procedures	3	B
F	Recruit staff	10	---
G	User training	3	E,F
H	Install and test	2	C,D

Corresponding AOE Network



AOE Rules and Conventions

- A project network may have only one start node.
  - This is a requirement of activity on edge networks rather than merely desirable as is the case with activity on node networks.
- A project network may have only one end node.
  - Again, this is a requirement for activity on edge networks.

AOE Rules and Conventions

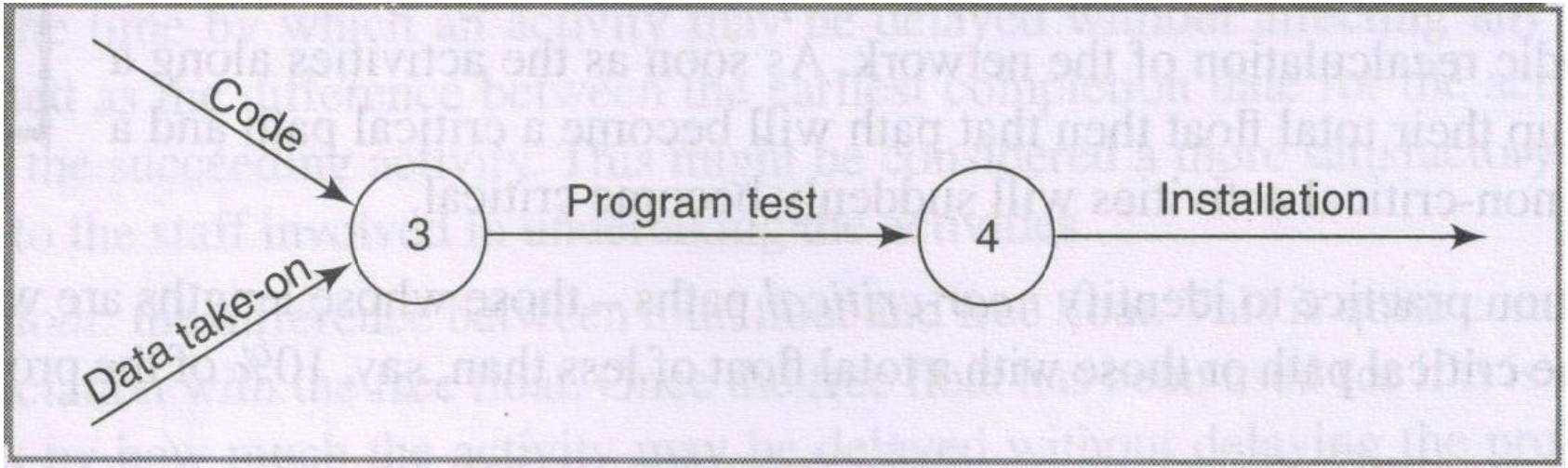
- A link has duration
  - A link represents an activity and in general, activities take time to execute.
  - The links are not drawn in any way to represent the activity durations.
  - The network drawing merely represents the logic of the project
    - The rules governing the order in which activities are to be carried out.

AOE Rules and Conventions

- Nodes have no duration
  - Nodes are events and as such, are instantaneous points in time.
  - The source node is the event of the project becoming ready to start and
    - the sink node is the event of the project becoming completed.
  - Intermediate nodes represent two simultaneous events
    - The event of all activities leading into a node having been completed and
      - the event of all activities leading out of that node being in a position to be started.

AOE Rules and Conventions

- Node 3 is the event that both *coding* and *data take-on* have been completed and activity *program test* is free to start.
- *Installation* may be started only when event 4 has been achieved, that is as soon as *program test* has been completed.

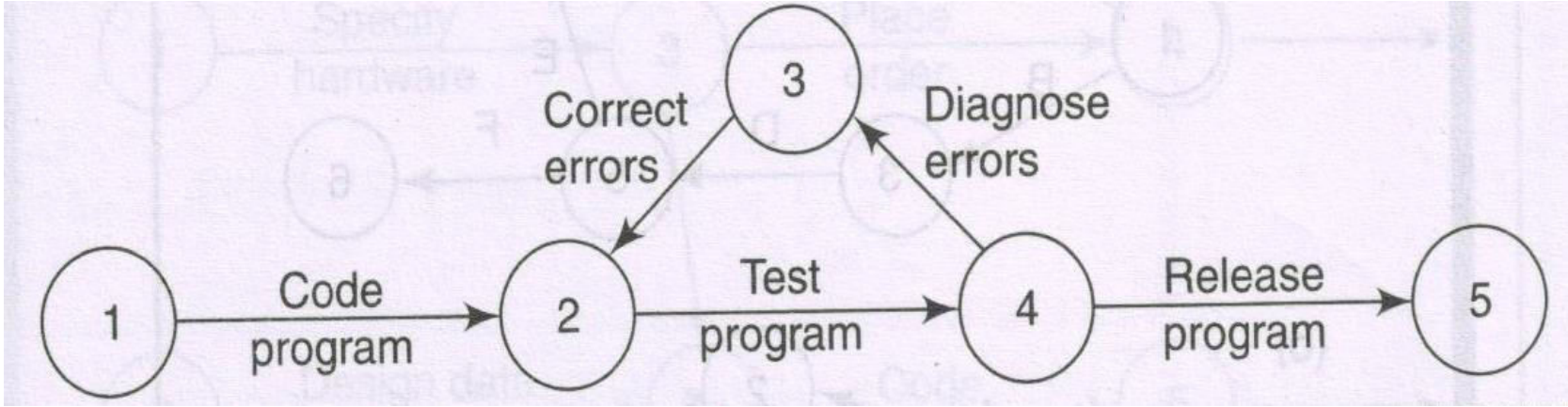


AOE Rules and Conventions

- Time moves from left to right.
  - AOE networks are drawn, if at all possible, so that time moves from left to right.
- Nodes are numbered sequentially.
  - There are no precise rules about node numbering but
    - nodes should be numbered so that head nodes (those at the arrow end of an activity) always have a higher number than tail events (those at the non-arrow end of an activity).
- This convention makes it easy to spot loops.

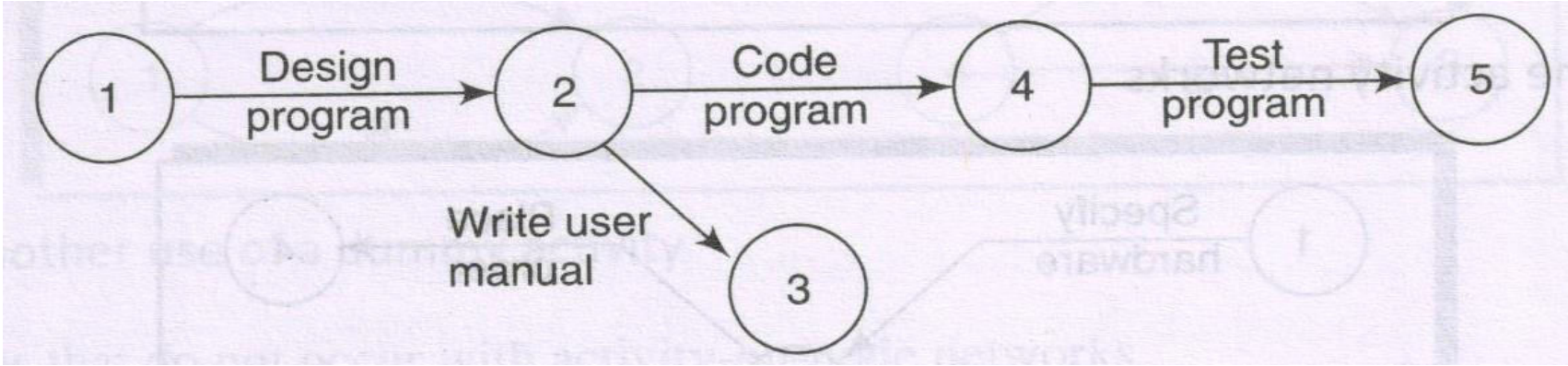
AOE Rules and Conventions

- A network may not contain loops.
  - Loops are either an error of logic or a situation that must be resolved by itemizing iterations of activity groups.
  - A loop represents an impossible sequence.



AOE Rules and Conventions

- A network may not contain dangles.
  - A dangling activity cannot exist
    - as it would suggest there are two completion points for the project.
- Node 5 represents the true project completion point and there are no activities dependent on activity *Write user manual*.



AOE Rules and Conventions

- Then the network should be redrawn so that activity *Write user manual* starts at node 2 and terminates at node 5.
- In practice, we would insert a dummy activity between nodes 3 and 5.
- In other words, all events, except the first and the last, must have
  - at least one activity entering them and
  - at least one activity leaving them and
  - all activities must start and end with an event.

Dummy Activity

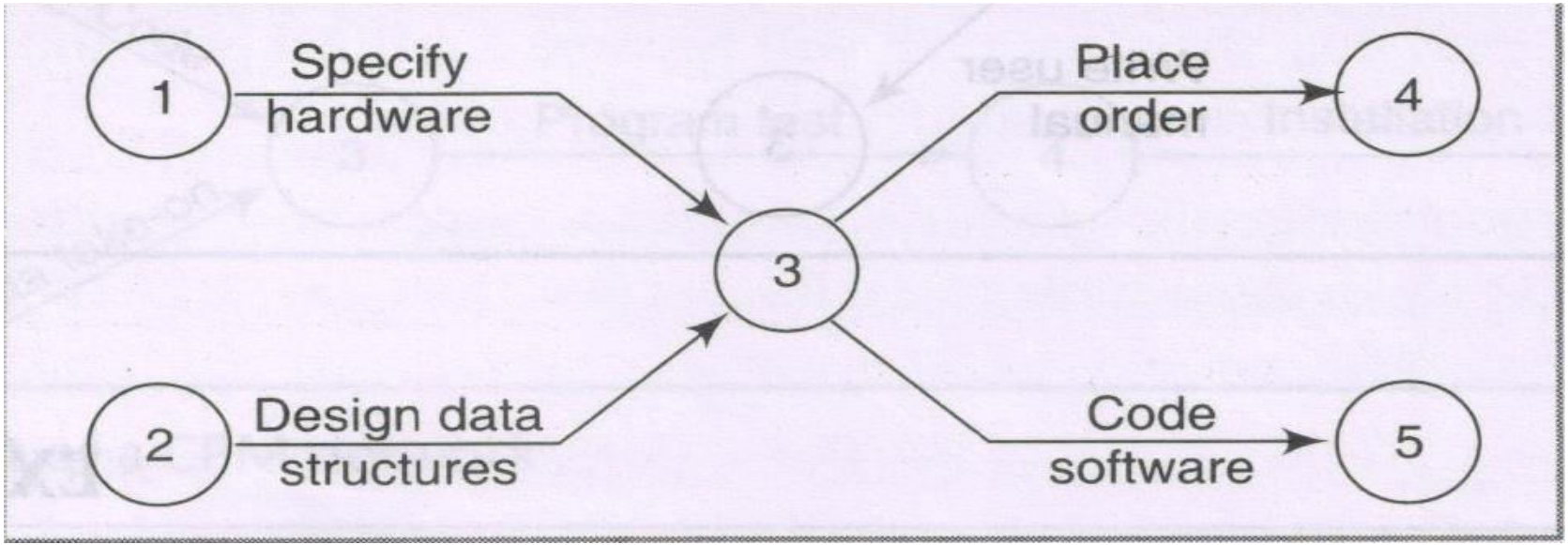
- When two paths within a network have a common event although they are, in other respects, independent,
  - A logical error might occur.

Dummy Activity

- Suppose that, in a particular, it is necessary to specify a certain piece of hardware before placing an order for it and before coding the software.
- Before coding the software, it is also necessary to specify the appropriate data structures, although clearly we do not wait for this to be done before the hardware is ordered.

Dummy Activity

- The following figure models the situation.

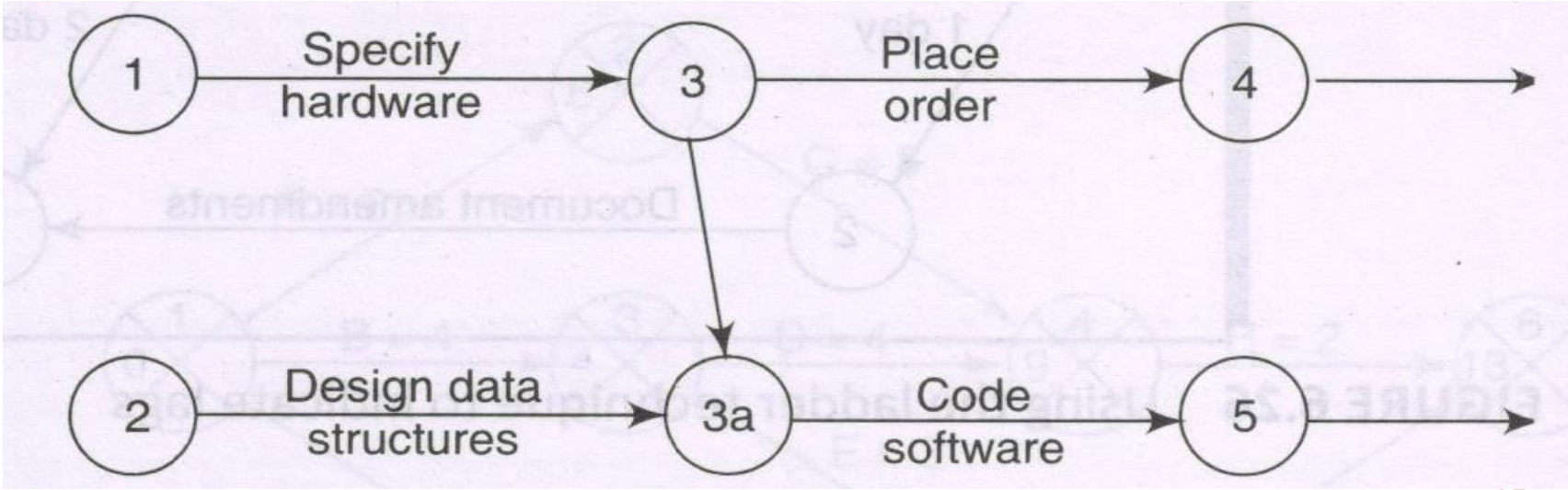


Dummy Activity

- The network is incorrect
  - as it requires both hardware specification and data structure design to be completed before either an order may be placed or software coding may commence.
- The problem is resolved by
  - separating the two (more or less) independent paths and introducing a dummy activity to link the completion of *specify hardware* to the start of the activity *code software*.

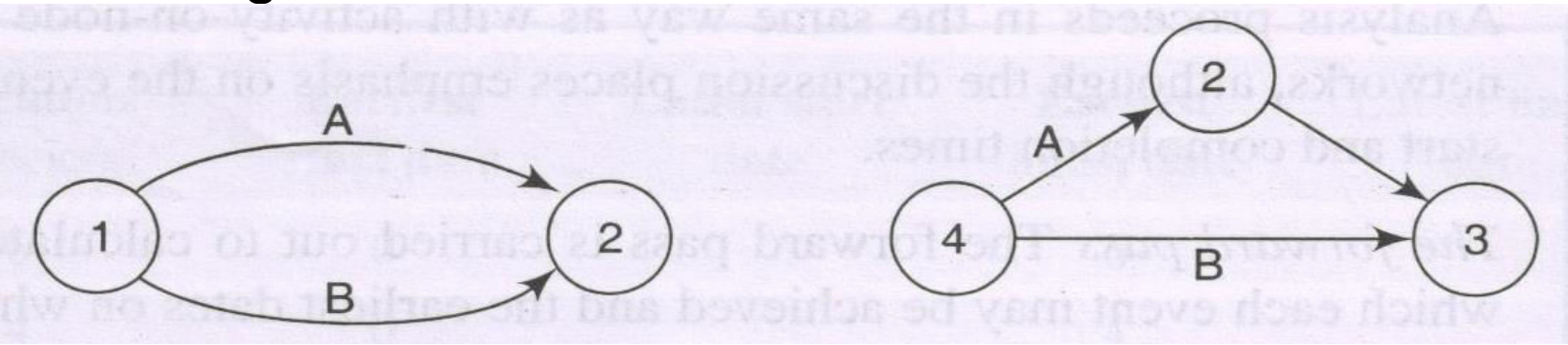
Dummy Activity

- This effectively breaks the link between data structure design and placing the order.



Dummy Activity

- Dummy activities, shown as dotted lines on the network diagram, have a zero duration and use no resources.
- They are often used to aid in the layout of network drawings.

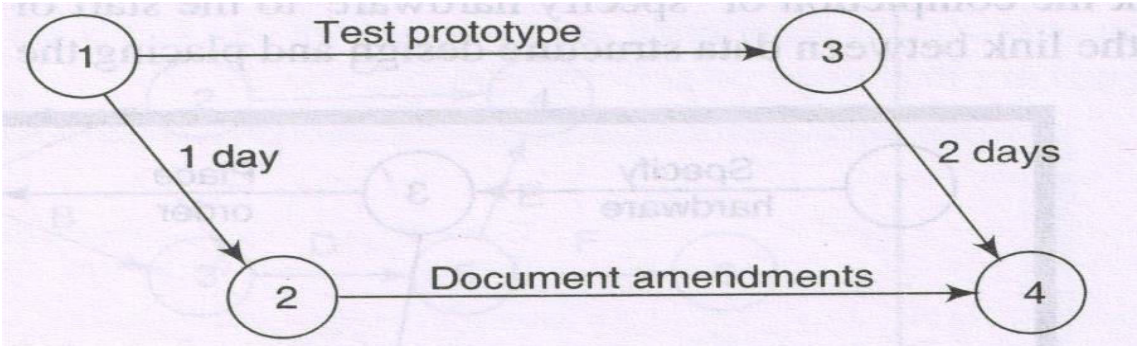


Dummy Activity

- The use of a dummy activity where two activities share the same start and end nodes makes it easier to distinguish the activity end points.
- These problems do not occur with activity on node (AON) network.

Representing lagged activities

- Activity on edge networks are less elegant when it comes to representing lagged parallel activities.
- We need to represent these with pairs of dummy activities as shown below.



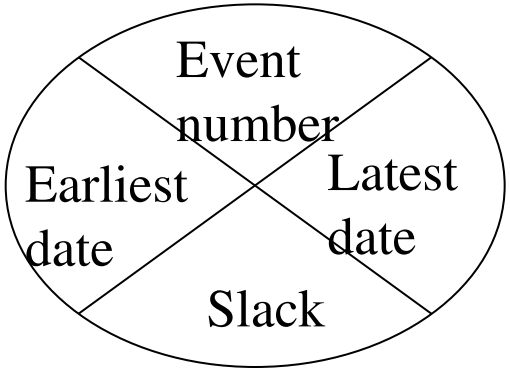
- Where the activities are lagged because a stage in one activity must be completed before the other may proceed, it is likely to be better to show each stage as a separate activity.

Activity labeling

- There are a number of conventions that have been adopted for entering information on an *activity on edge* network.
- Typically, the diagram is used to record information about the events rather than the activities
  - Activity based information (other than labels or description) is generally held on a separate activity table.

Activity labeling

- One of the more common conventions for labeling nodes is
  - to divide the node circle into quadrants and
  - use those quadrants to show
    - the event number,
    - the latest and
    - earliest dates by which the event should occur, and
    - the event slack.



Network Analysis

- Analysis proceeds in the same way as with activity on node networks, although the discussion places emphasis on the events rather than activity start and completion time.

Example

Activity Label	Activity Name	Duration (Weeks)	Precedents
A	Hardware Selection	6	---
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C	Install hardware	3	A
D	Data migration	4	B
E	Draft office procedures	3	B
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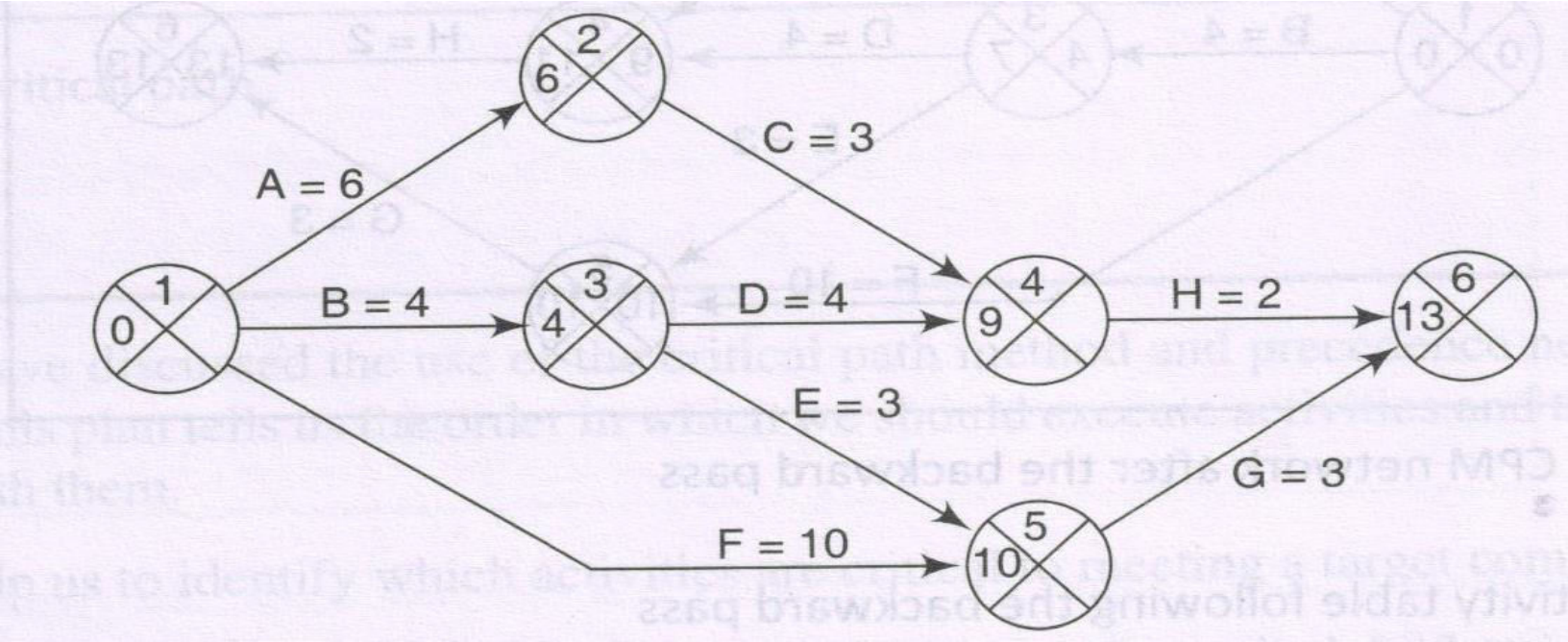
Forward Pass

- The earliest start date for an event is
  - the earliest finish date for all the activities terminating at that event.
- Where more than one activity terminates at a common event
  - we take the latest of the earliest finish dates for those activities.

Forward Pass



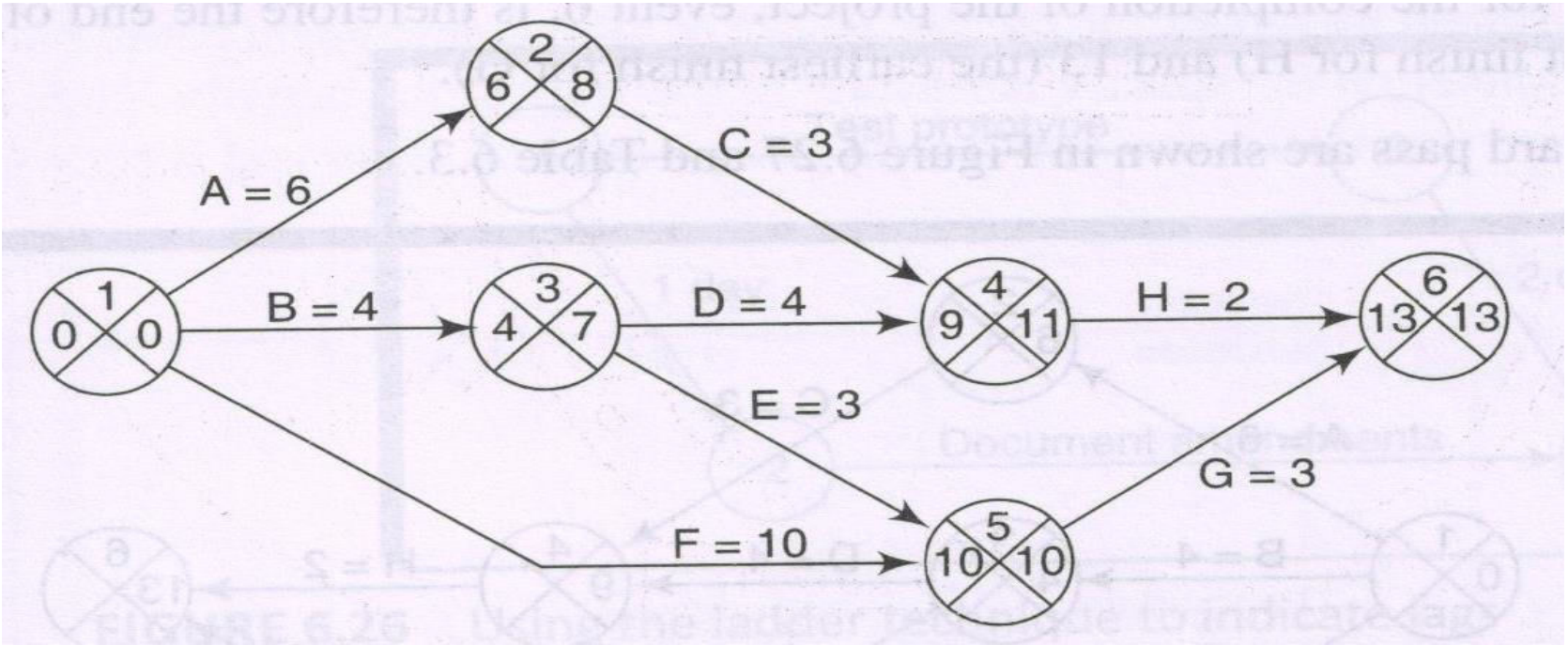
Forward Pass

Activity	Duration (weeks)	Earliest start date	Latest start date	Earliest finish date	Latest finish date	Total float
A	6	0		6		
B	4	0		4		
C	3	6		9		
D	4	4		8		
E	3	4		7		
F	10	0		10		
G	3	10		13		
H	2	9		11		

Backward Pass

- The latest finish date for an event is the latest start date for all the activities that may commence from that event.
- Where more than one activity commences at a common event we take the earliest of the latest start dates fro those activities.

Backward Pass

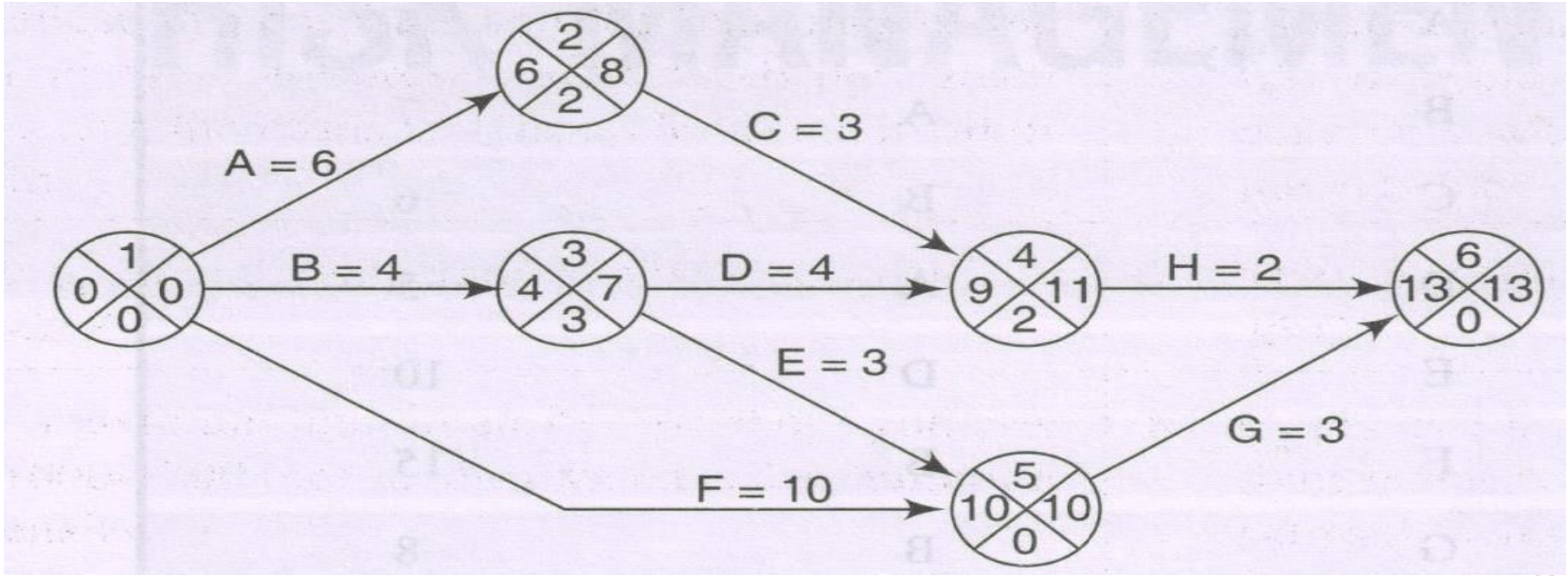


Backward Pass

Activity	Duration (weeks)	Earliest start date	Latest start date	Earliest finish date	Latest finish date	Total float
A	6	0	2	6	8	
B	4	0	3	4	7	
C	3	6	8	9	11	
D	4	4	7	8	11	
E	3	4	7	7	10	
F	10	0	0	10	10	
G	3	10	10	13	13	
H	2	9	11	11	13	

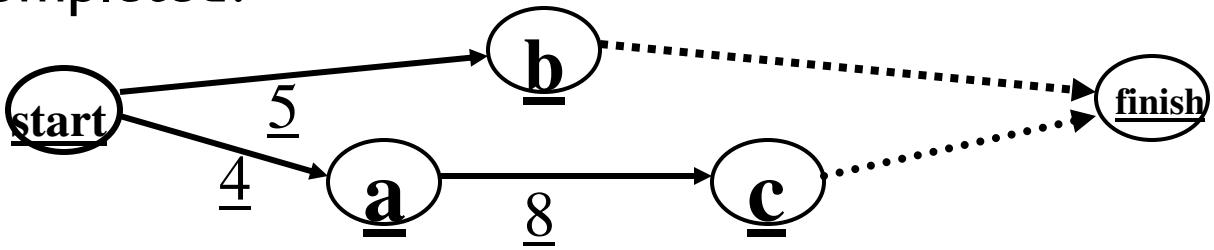
Identifying the critical path

- The critical path is the path joining all nodes with a zero slack time.
- The critical path is the longest path in the network.



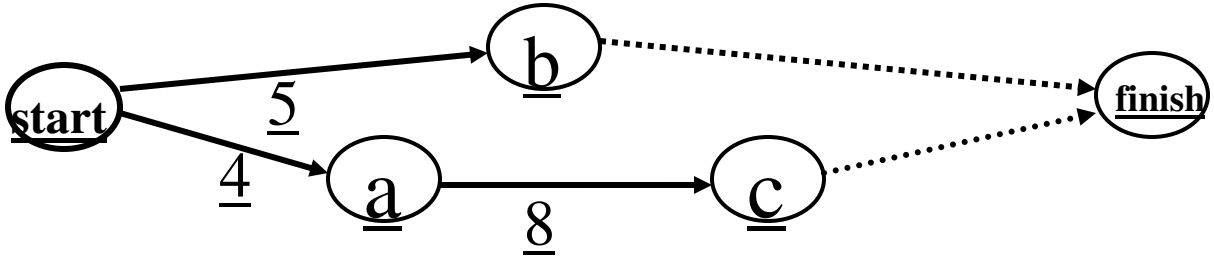
Example

- A project involves three tasks:
  - task a takes 4 hours,
  - task b takes 5 hours
  - task c takes 8 hours.
  - task c cannot commence until task a is completed.
- What is the shortest time in which the project can be completed?



Example

- Clearly, the project continues until task a and then task c complete:
  - which is 12 hours.
  - Task b takes only 5 hours.
  - Task b can have 7 hours of leeway to start and finish.



CPM

- CPM can be used to determine the minimum estimated duration of a project and the slack times associated with various non-critical tasks.
- Thus, any path whose duration equals MT is a critical path.
- There can be more than one critical path for a project.
- Tasks which fall on the critical path should receive special attention by both project manager and the personnel assigned to perform those tasks.

CPM

- One way is to draw the critical paths with a double line instead of a single line or the path may be coloured.
- The critical path may change as the project progresses.
- This may happen when tasks are completed either behind or ahead of schedule.

Summary

- We have discussed Activity-On-Edge Network.
- The rules for constructing Activity-On-Edge Network.
- Solved some examples for finding the critical path in Activity-On-Edge Networks.

References :

1. B. Hughes, M. Cotterell, R. Mall, *Software Project Management*, Sixth Edition, McGraw Hill Education (India) Pvt. Ltd., 2018.
2. R. Mall, *Fundamentals of Software Engineering*, Fifth Edition, PHI Learning Pvt. Ltd., 2018.

Thank you