INTRODUCTION TO NETWORKS

Recap

- Project
- Project Management
- Project Life Cycle
- Stages of Project
- Feasibility Study
- Detailed Project Report

Projects Vary in Complexity

So When We Say Project What Do We Mean?

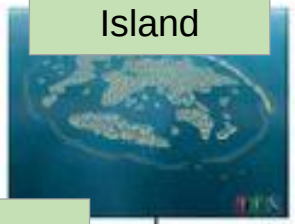
Arboriculture

Leisure Tea

Review Bd Mtg

House Constr

World Island



Dream Liner

Submarine Bldg

HR Mgt → **Event Mgt** → **SW Devp** → **Infra Devp** → **Complex Ops**

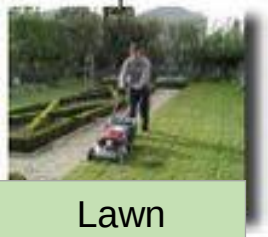
Local Gp Mtg

Kitchen

Mass Rally

Software Devp Park

Int'l Space Stn



Lawn Mowing

Boat Construction

Building Constr

Large Rail Yards

Tunnelling

Dealing With Complex Situations

- Large projects may be complex in nature
- Resolved by a systematic approach
- Plan, organize, direct and control

Coord & Control

Manage

Ensure Availability

Identify

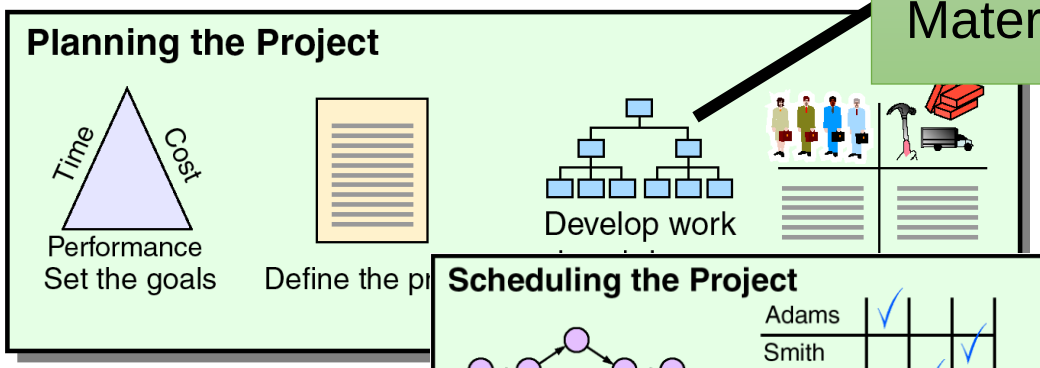
Scheduling in Project

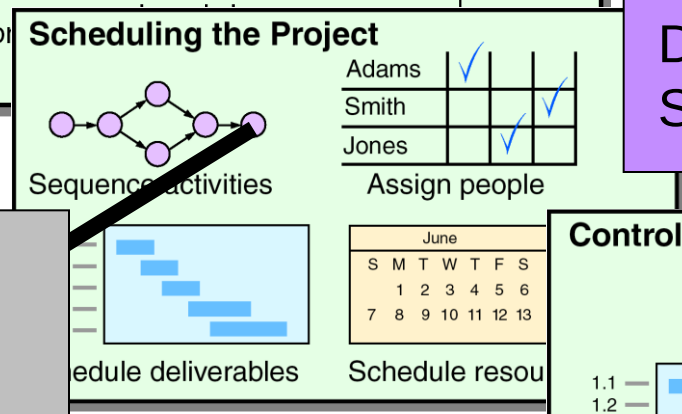
- Project scheduling is part of project management, which relates to the use of schedules to plan and subsequently report progress and apply control within the project environment.

  - Activities are finished in correct order and on time.
  - Project is within budget.
  - Project meets quality goals.
  - People receive info and direction.

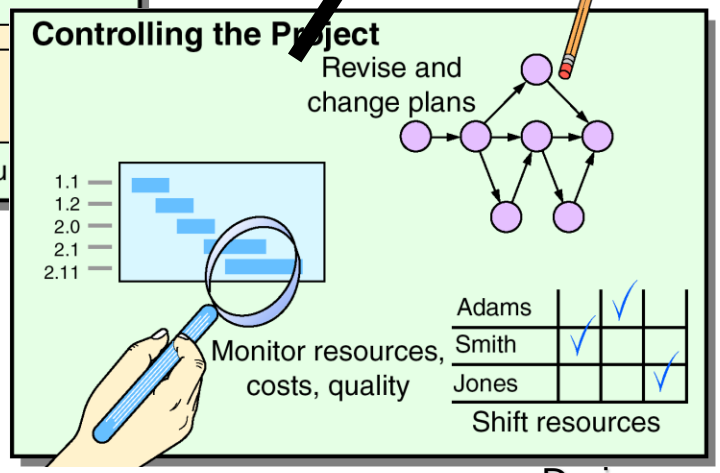
Planning, Scheduling, and Controlling

Time / Cost estimates
Engineering diagrams
Cash flow charts
Material availability details





Budgets
Delayed activities report
Slack activities report



Gantt/Bar charts
Milestone charts
CPM/PERT
Cash flow schedules

Before project | Start of project | During project

Timeline

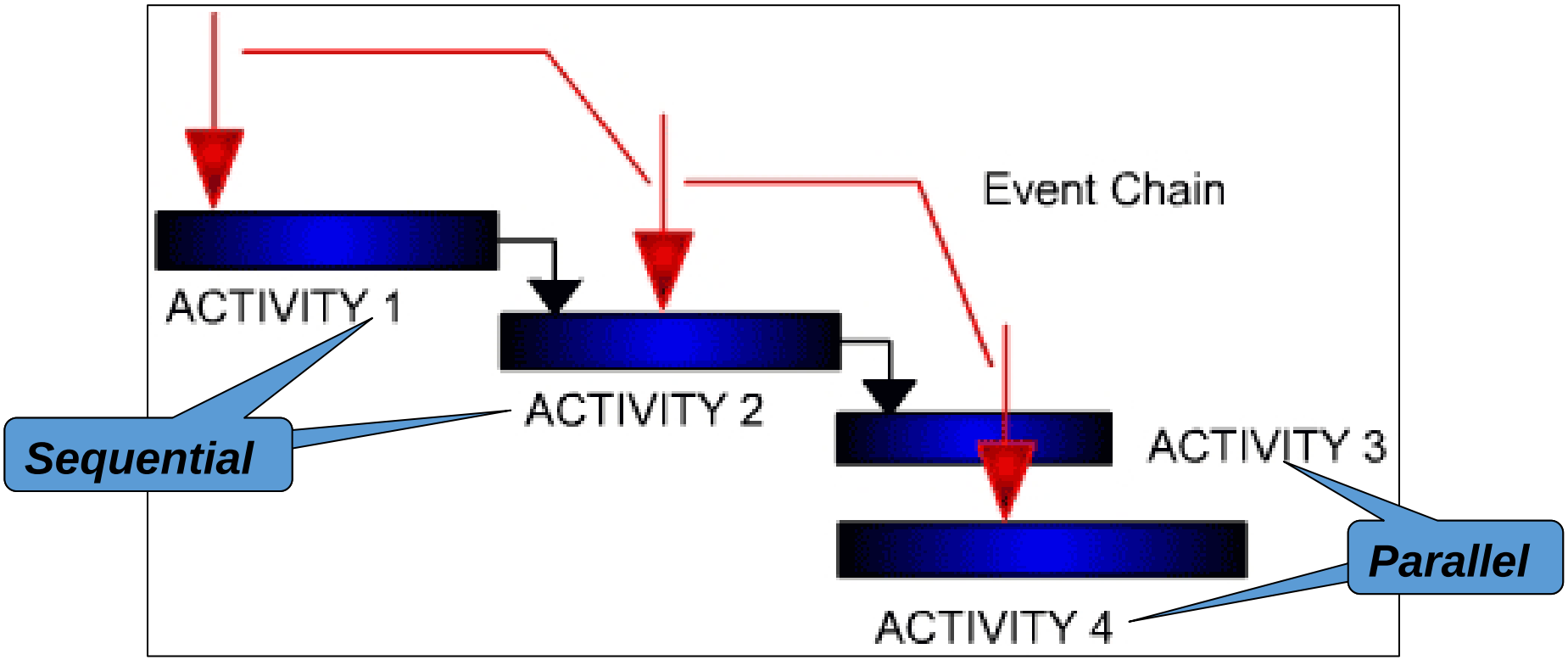
Events and Activities

Event

Activity

Duration

Work Logic / Sequence

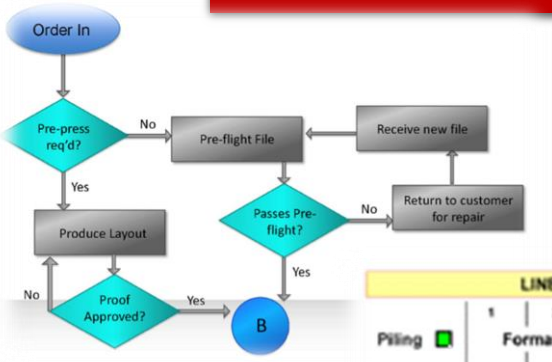


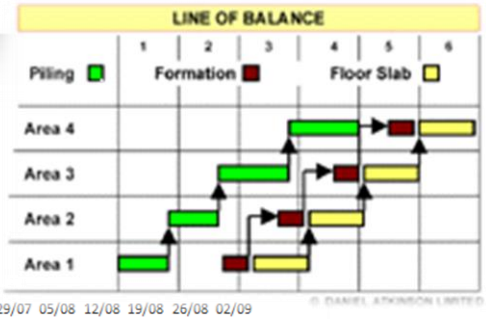
A complex task can be broken into smaller **activities;**

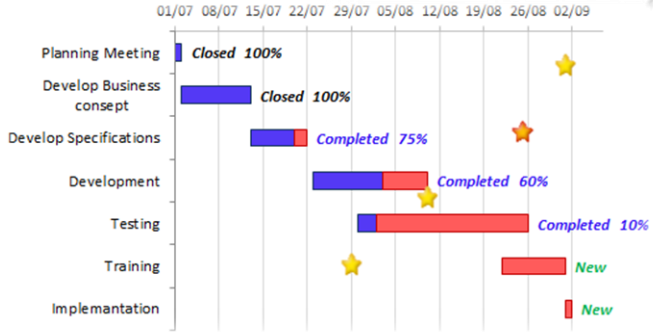
All activities will follow a specific **sequence of events;**

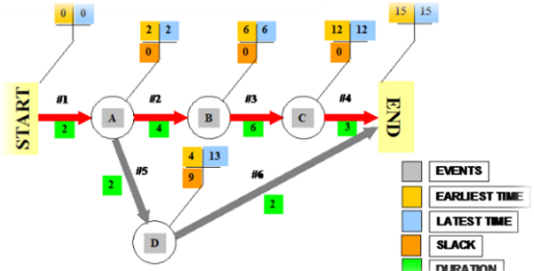
Each activity will have specific **duration, resources, cost**

Scheduling Tools and Techniques



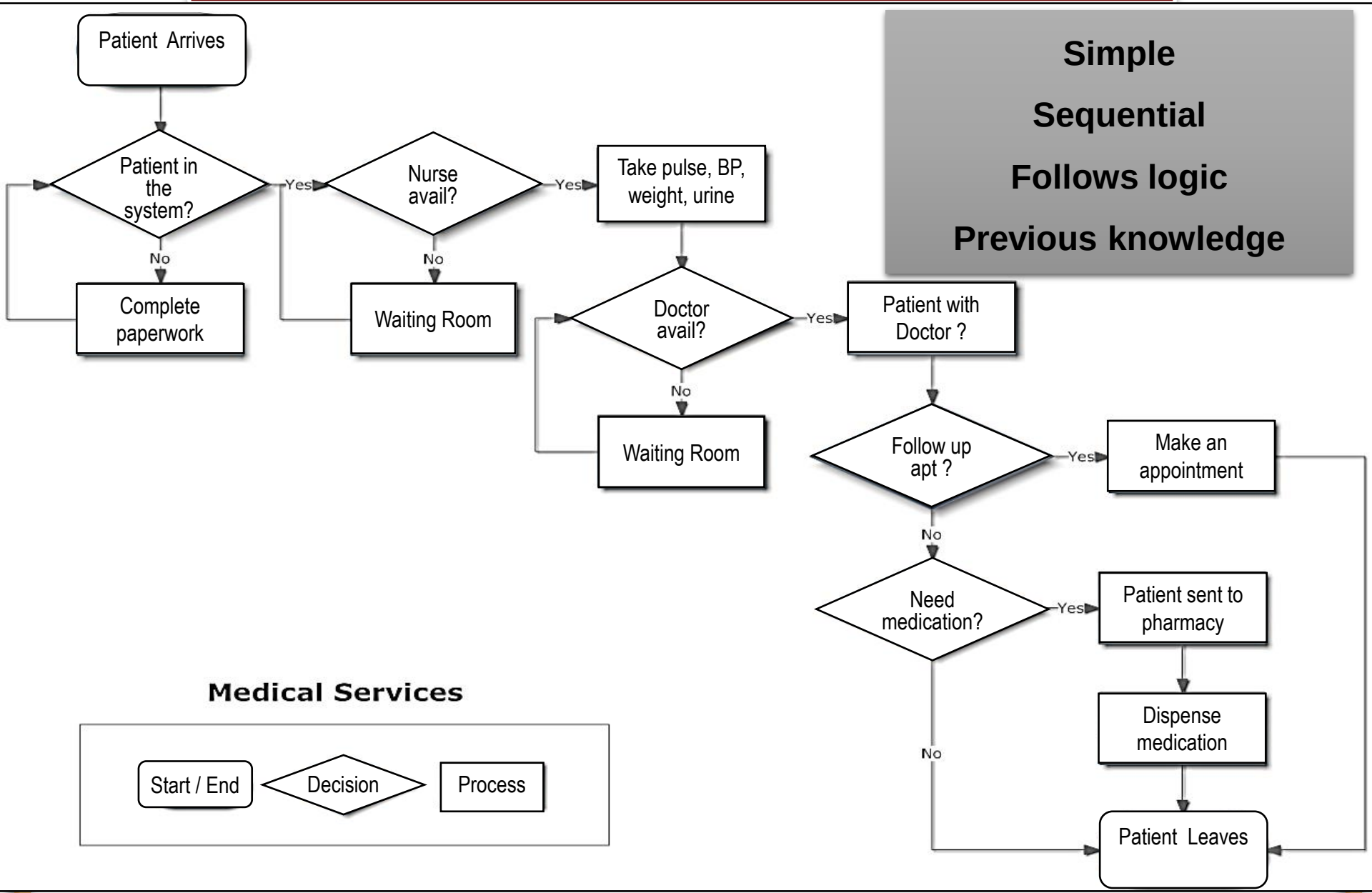






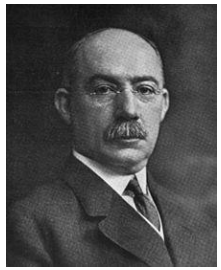
- ☑ ***The Flow Chart***
- ☑ ***Gantt Chart***
- ☑ ***The Milestone Chart***
- ☑ ***Networks***
  - ☑ ***AOA***
  - ☑ ***AON***

Flow Chart


Patient Arrives
Patient in the system?
Yes
No
Complete paperwork
Nurse avail?
Yes
No
Waiting Room
Take pulse, BP, weight, urine
Doctor avail?
Yes
No
Waiting Room
Patient with Doctor ?
Follow up apt ?
Yes
Make an appointment
No
Need medication?
Yes
Patient sent to pharmacy
Dispense medication
No
Patient Leaves
Simple
Sequential
Follows logic
Previous knowledge
Medical Services
Start / End
Decision
Process

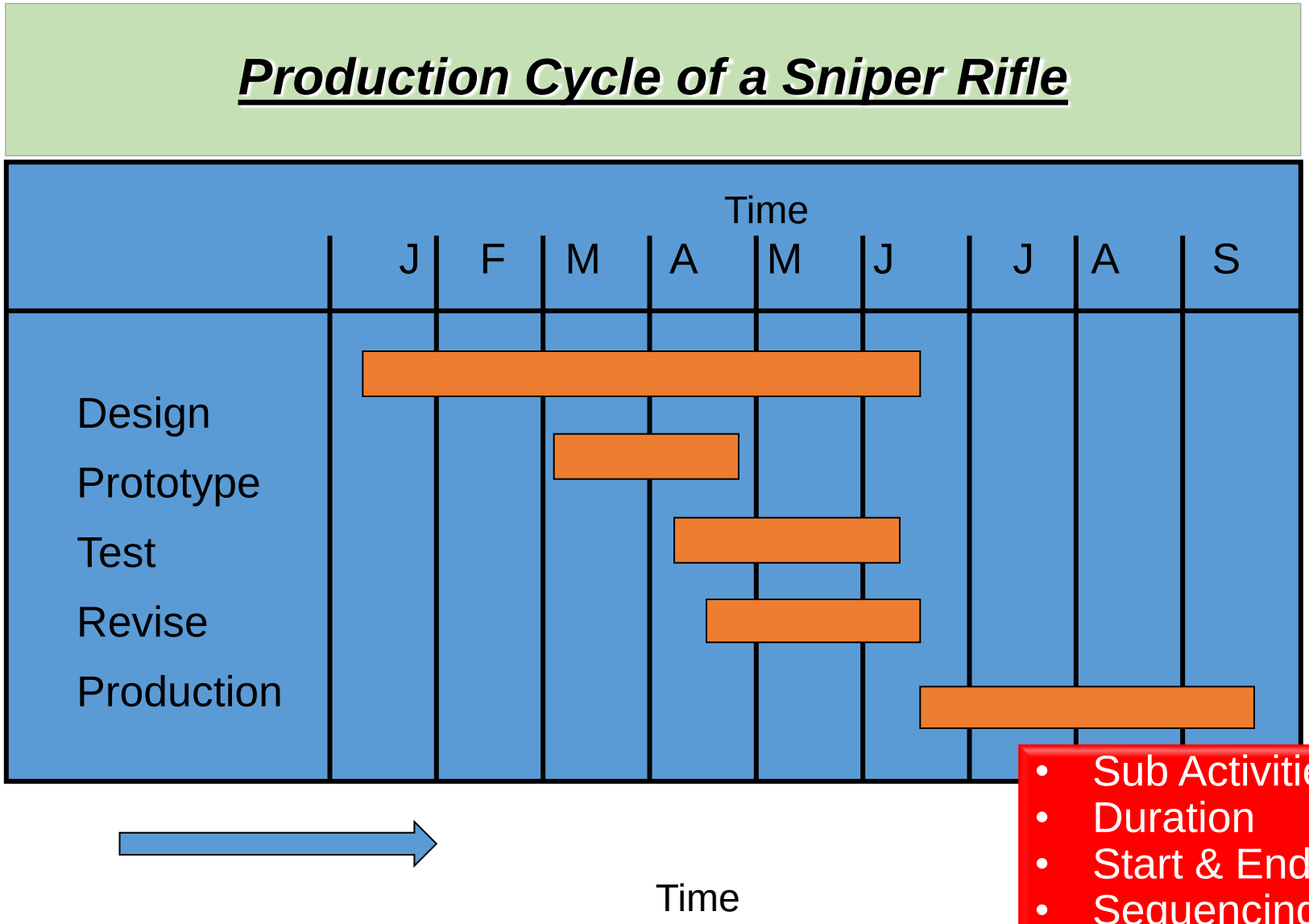
Gantt Chart

- Named after its originator Henry Gantt
- Pictorial timeline illustration of work stages of the project on a bar graph, showing -
  - individual tasks / activity (vertical axis)
    - subdivided into work units (WCP)
    - according to activity duration (horizontal axis)
  - when each activity will start and finish



- PM tool for planning and controlling a work schedule and recording its progress

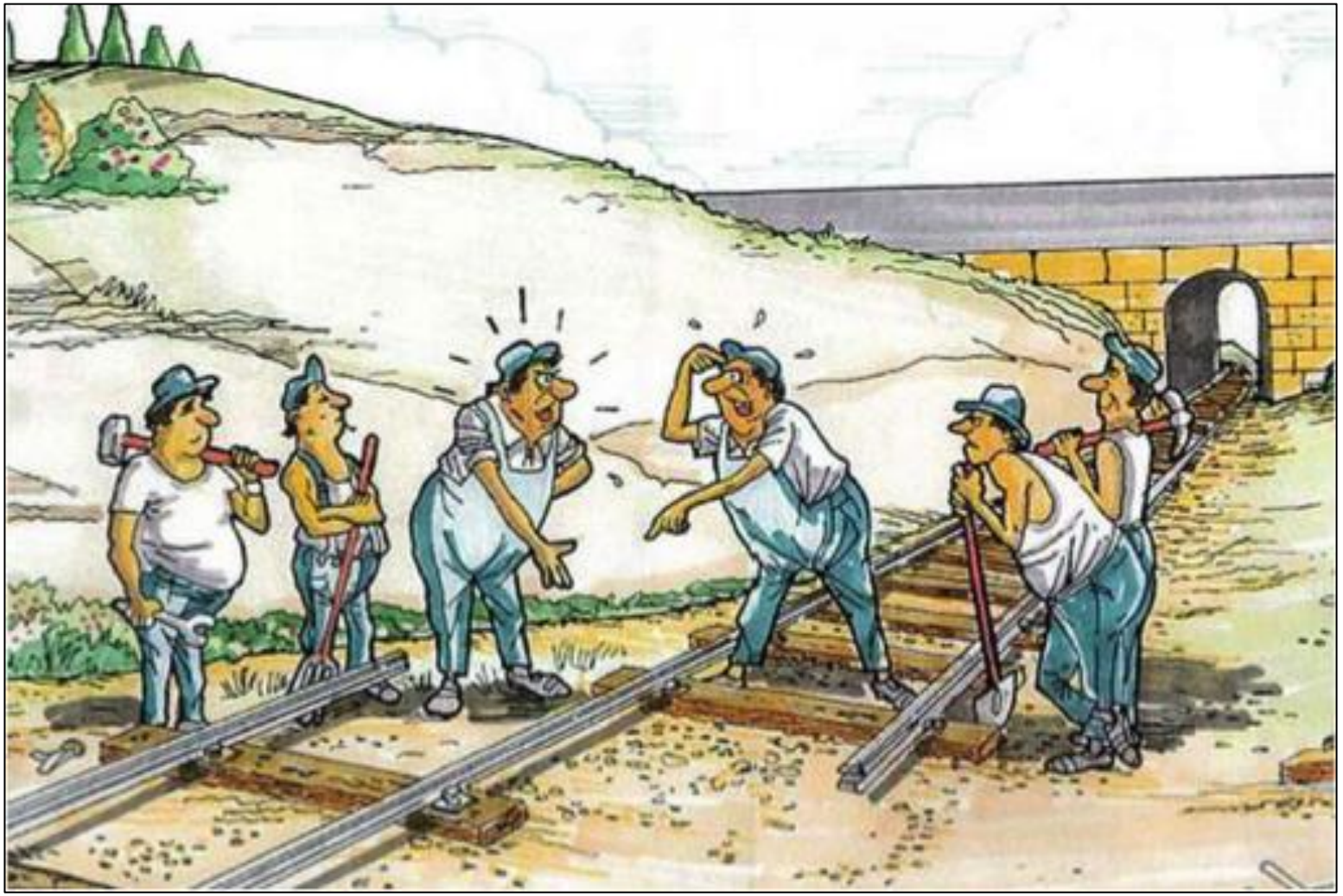
Simple Gantt Chart (Bar Chart)



Disadvantages of Simple Gantt Charts (Bar Chart)

- Activity work flow inter-relationships?
- Resource requirement?
- Cost of resources?
- Effect of delay of a sub task on the entire project?
- Project Duration?

No Communication !



I Work …… You Work ……
… BUT …… What was the overall plan!

Overcoming Disadvantages

- Eliminated by NETWORK TECHNIQUE
  - By showing inter-dependence of various activities

Evolution of Network Concept

Network techniques developed in 1950's

For planning and control of projects

CPM by DuPont & Remington Rand Univac for chemical plants (1957)

PERT by US Navy Special Office with Lockheed Martin and Booz, Allen & Hamilton - Polaris missile pgme (1958)

Consider activity relationships and inter-dependencies

Each uses a different estimate of activity times

CPM (Critical Path Method)

Used for jobs that have some past experience

Like plant maint /overhaul, building constr

Tasks with precedence - where activity time estimates can be predicted with considerable certainty

Focus is on arriving at an optimum project schedule that minimises the cost

Tasks where time estimates are certain
DETERMINISTIC

PERT (Program Evaluation Review Technique)

*One-time **unique tasks** –*
construction of dams, refineries, bridges etc.

Focus is on minimizing time required at optimum cost

*Tasks of **huge proportion** –*
construction / devp of ships / tanks / aircrafts

Tasks where time estimates tend to be quite uncertain
PROBABILISTIC

***R&D projects** –*

development of radars / missiles/spl software

*Organizing **large events** –*
conferences / rallies

Stages in Application of PERT/CPM

Drawing the network	• *Identify all essential events / activities.* • *Establish interrelationships to satisfy sequencing.*
Network Analysis	• *Time required for completing each activity.* • *Determine project duration and critical activity.* • *Compute the probability of completing the Project or part project in a given specified time.*
Resource Allocation and Scheduling	• *Translate plan into a time schedule based on resources required.* • *Examine economics (expedite the activities by incurring additional cost) before finalizing the schedule.*
Project control	• *Periodic updating to monitor Project progress.* • *Amending schedules to ensure timely completion.*

Networks

A simple concept to map and understand work flows of the project

Gives a clearer picture of the required sequence of events and activities

Activities are linked together in the logical sequence they need to be carried out

Why Planning by Networks ?

Diagrammatic cum analytical approach

Eliminates ambiguity

Assists all levels of mgt to :-

- ***Define the work to be carried out.***
- ***Produce better work schedules.***
- ***Establish budgets.***
- ***Monitor progress.***
- ***Control project cost by evaluating cost progress and predicting final project costs.***

Steps in making networks

Define the project and prepare the WBS...WCP

Develop relationships among the activities

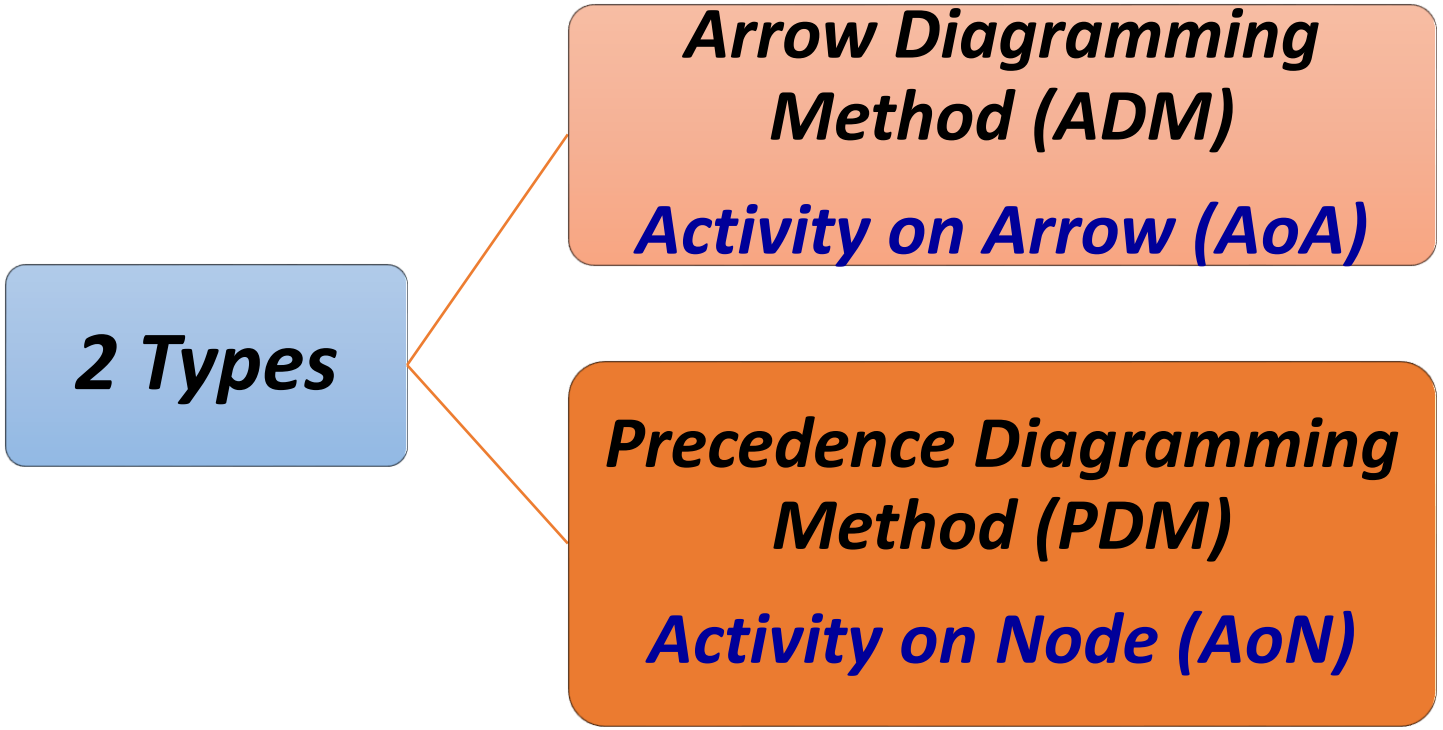
Draw the network connecting all activities

Assign time & cost estimates to each activity

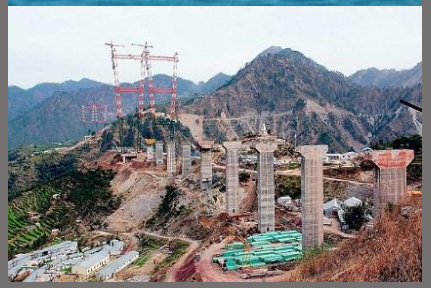
Compute the longest time path through the network – 'CRITICAL PATH'

Use the network to help plan, schedule, monitor, and control the project

Network Diagrams



AOA NETWORKS

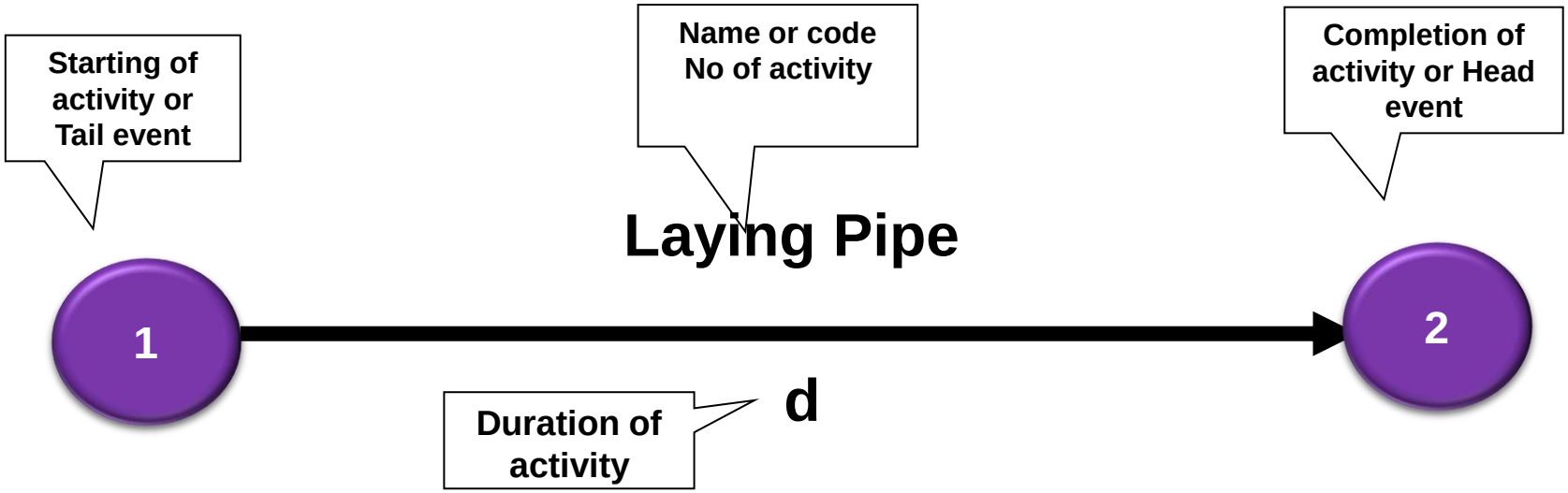


Activity

Work content required to be achieved to complete a task.

Clearly defined proj element, a job or a task.

Takes time , consumes resources.

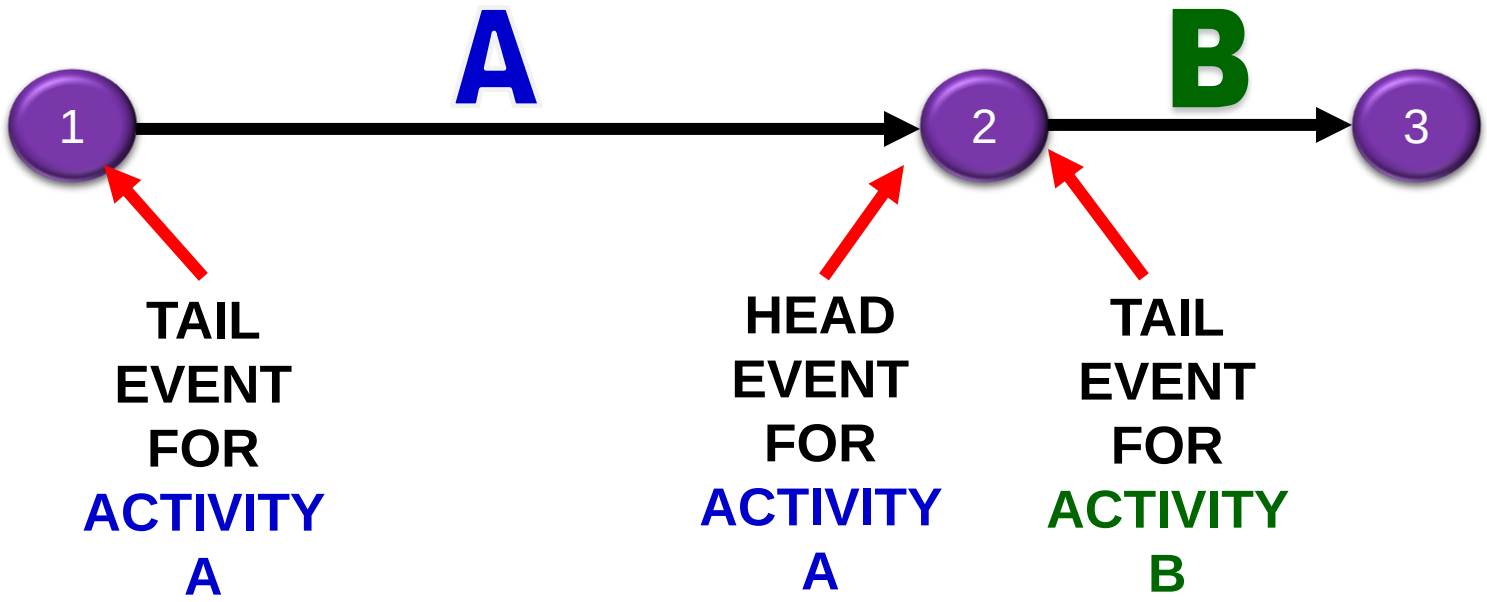


Length (and slope) of the arrow has no significance.

Event

An event or a node is a point in time when certain activity(s) start or end.

Takes NO time, consumes NO resources.



It is denoted by a circle with a number

No two activities can have same Head AND Tail events

Identification – Event/ Activity

Inspection started

Writing a report

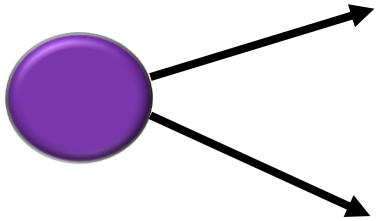
Machinery arrived

Construction of Runway

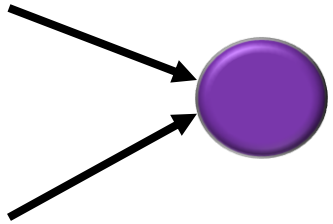
Bde attack phase 1 completed

Types of Events

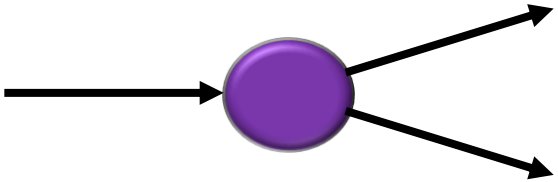
Start Event



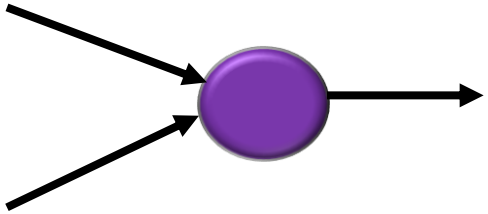
End Event



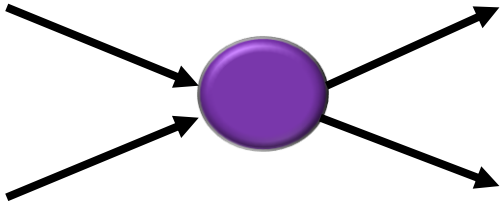
Burst Event



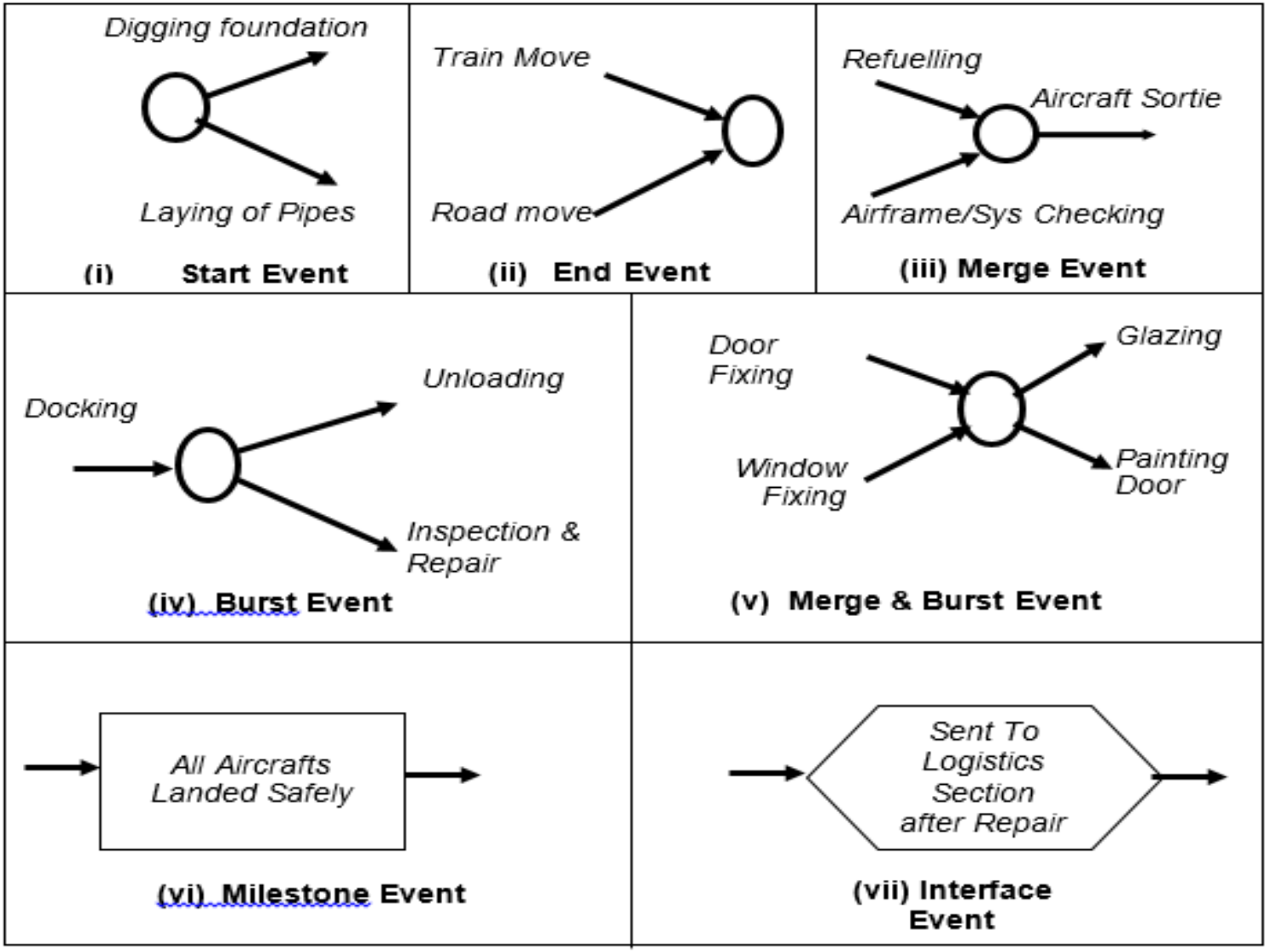
Merge Event



Merge- Burst Event



Types of Events

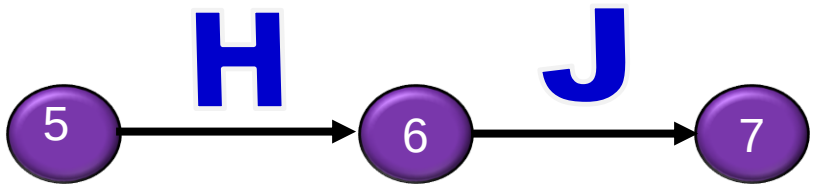


Activity Relationship

Inter-relationship among activities by indicating its precedence - immediate preceding or succeeding activity, usually expressed as:-

- **J follows H**
- **H is followed by J**
- **H controls J**
- **J is controlled by H**
- **J > H**

All mean same



Dummy Activity

- **An imaginary activity that does** not consume any time or resource.
- **Used to represent a connection between events in order to maintain a logic in the network.**
- There are two types of dummy activities :-
  - Logic Dummy.
  - Identity Dummy.
- **It is denoted by a dotted arrow.**

Dummy Activity

- Identity Dummy
  - It helps keep the designation of each activity unique or different from another

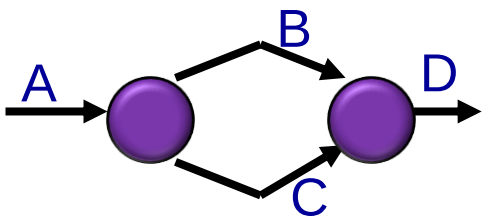
- Logic Dummy
  - It helps maintain logic i.e. correct precedence of a given relationship

Dummy Activity

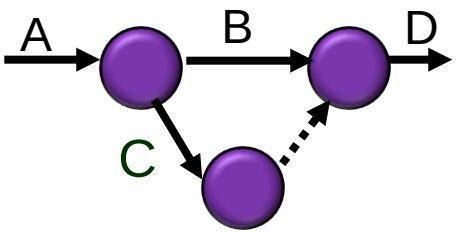
Identity Dummy

When indep activities have same head and tail events.

B >A
C >A
D > B,C



WRONG

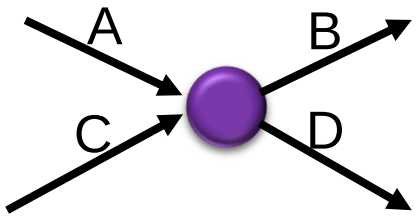


RIGHT

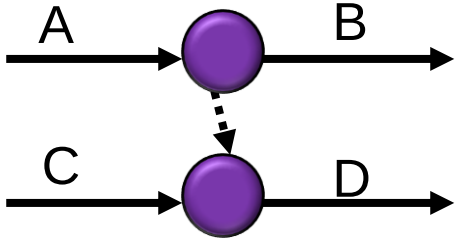
Logic Dummy

When two activities converge at a common event but are indep of one another.

B > A
D > A, C



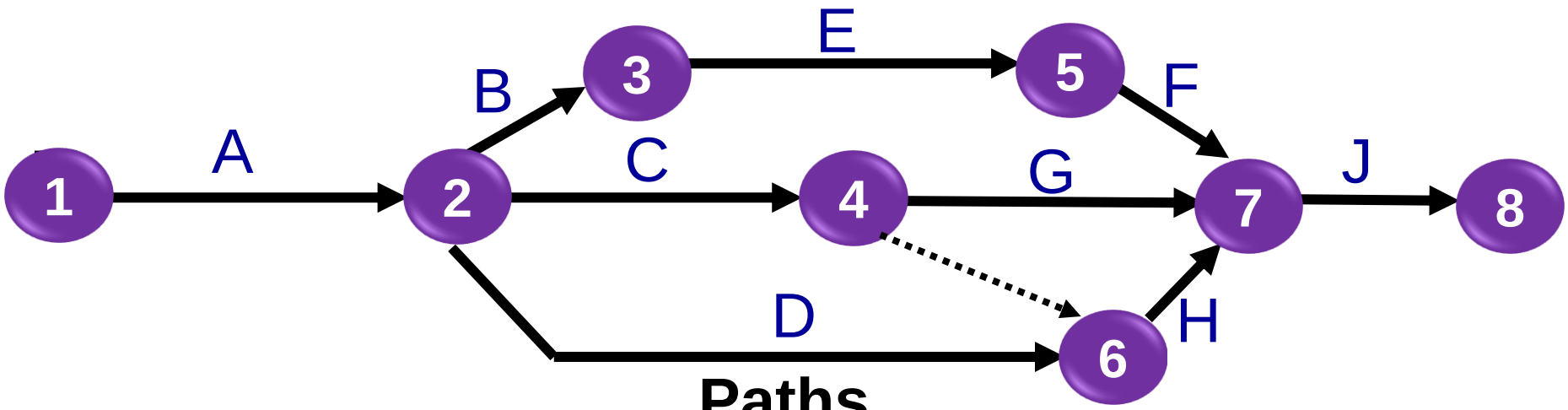
WRONG



RIGHT

Path

A path is defined as an unbroken chain of activities from the initial node to some other node, generally to the last node indicating the end or completion of the project.



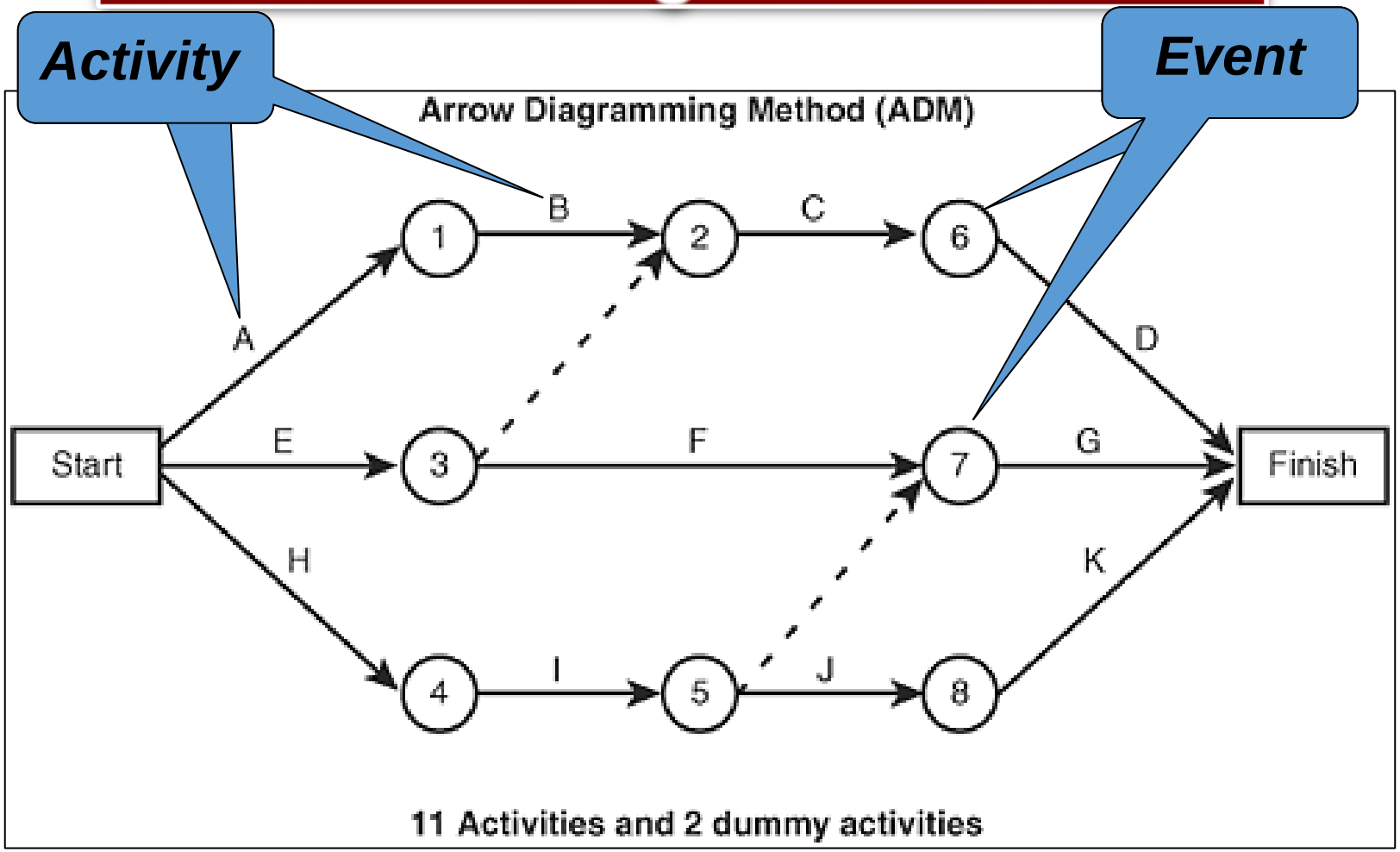
Paths

- **A-B-E-F-J**
- **A-C-G-J**
- A-C-H-J
- **A-D-H-J**

ADM (AOA) Network Diagram

- Representation
  - Activities – Arrows
  - Events – Circles (one activity to another)
  - Duration – along the Arrow
- Also called Activity On Arrow
- Can Show only Finish to Start relationships

ADM (AOA) Network Diagram



Shows how tasks will flow from beginning to end

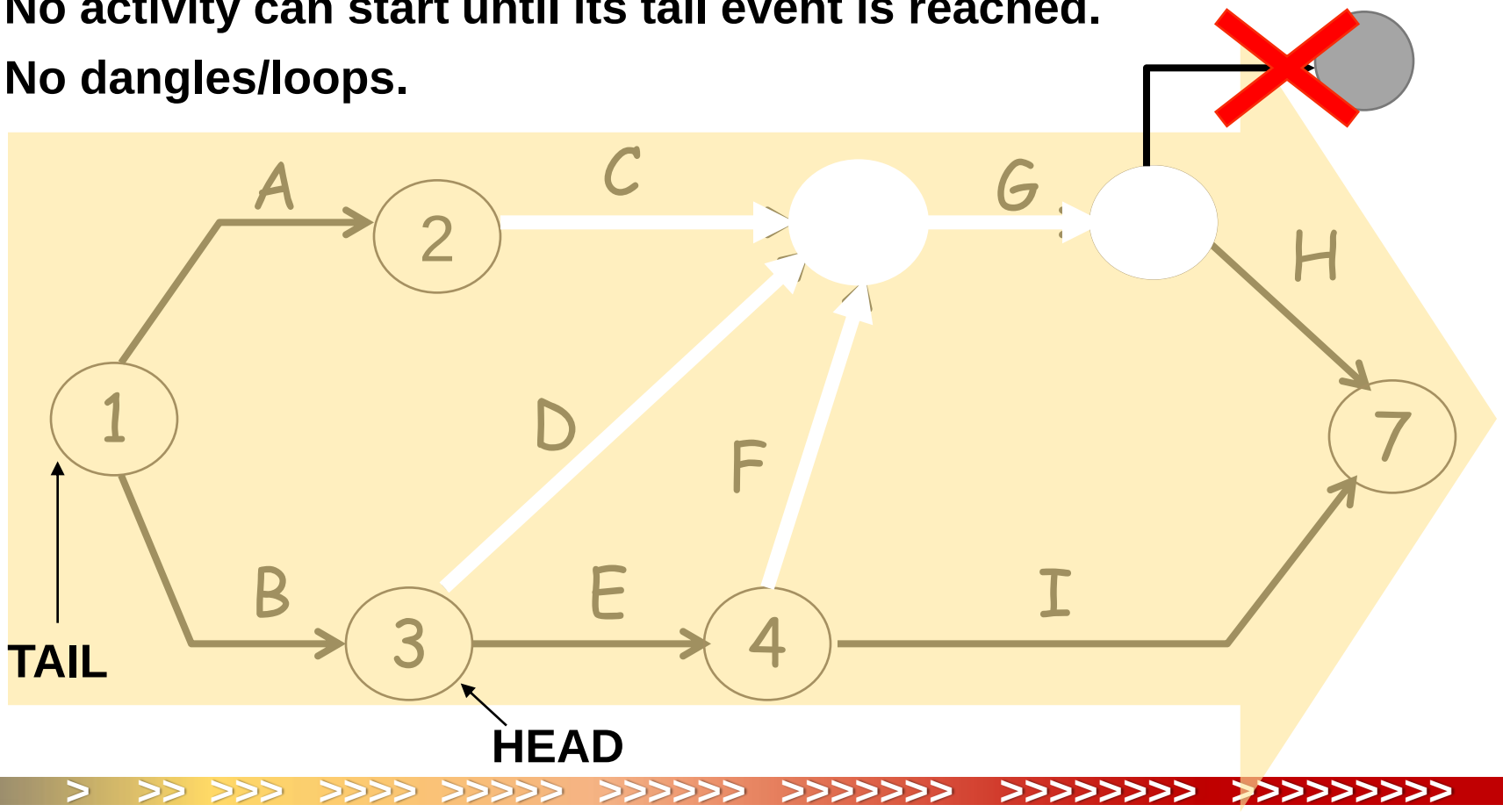
Depicts correct sequence of tasks & their relationships

Gen Rules for Drawing Networks

- Only one Start & one End Node.
- List Activities.
- Decide precedence relationships.
- Logic flow from left to right.
- No crossing of arrows/ loops, No danglers
- If Start of an activity is hanging, connect to ‘Start’ of the project.
- Finish of all the activities should be controlling some activity.
- If not, then connect to ‘Finish’ of the project.

AoA Network Logic

- TIME flows from left to right.
- Identity No of HEAD event is bigger than TAIL event.
- An event cannot occur unless all activities leading to it are completed.
- No activity can start until its tail event is reached.
- No dangles/loops.



Lets Draw

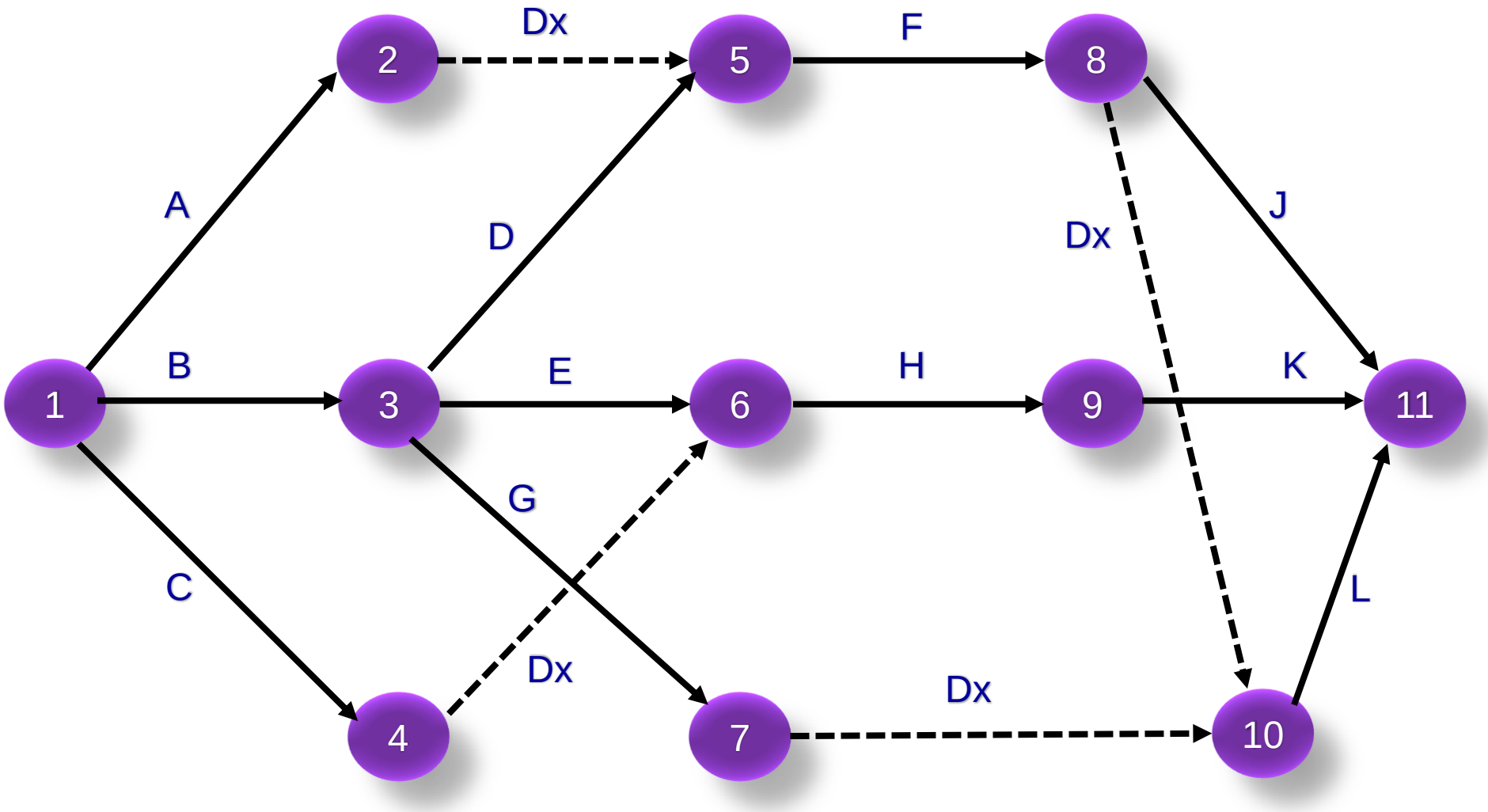
- Project Data ….
  - **A, B, C start the project**
  - **D, G, E follow B**
  - **F follows A, D**
  - **H follows C, E**
  - **J follows F**
  - **K follows H**
  - **L follows F, G**
  - **J, L, K end the project**

Draw an AoA Network for the Project

Tabulating Network Data

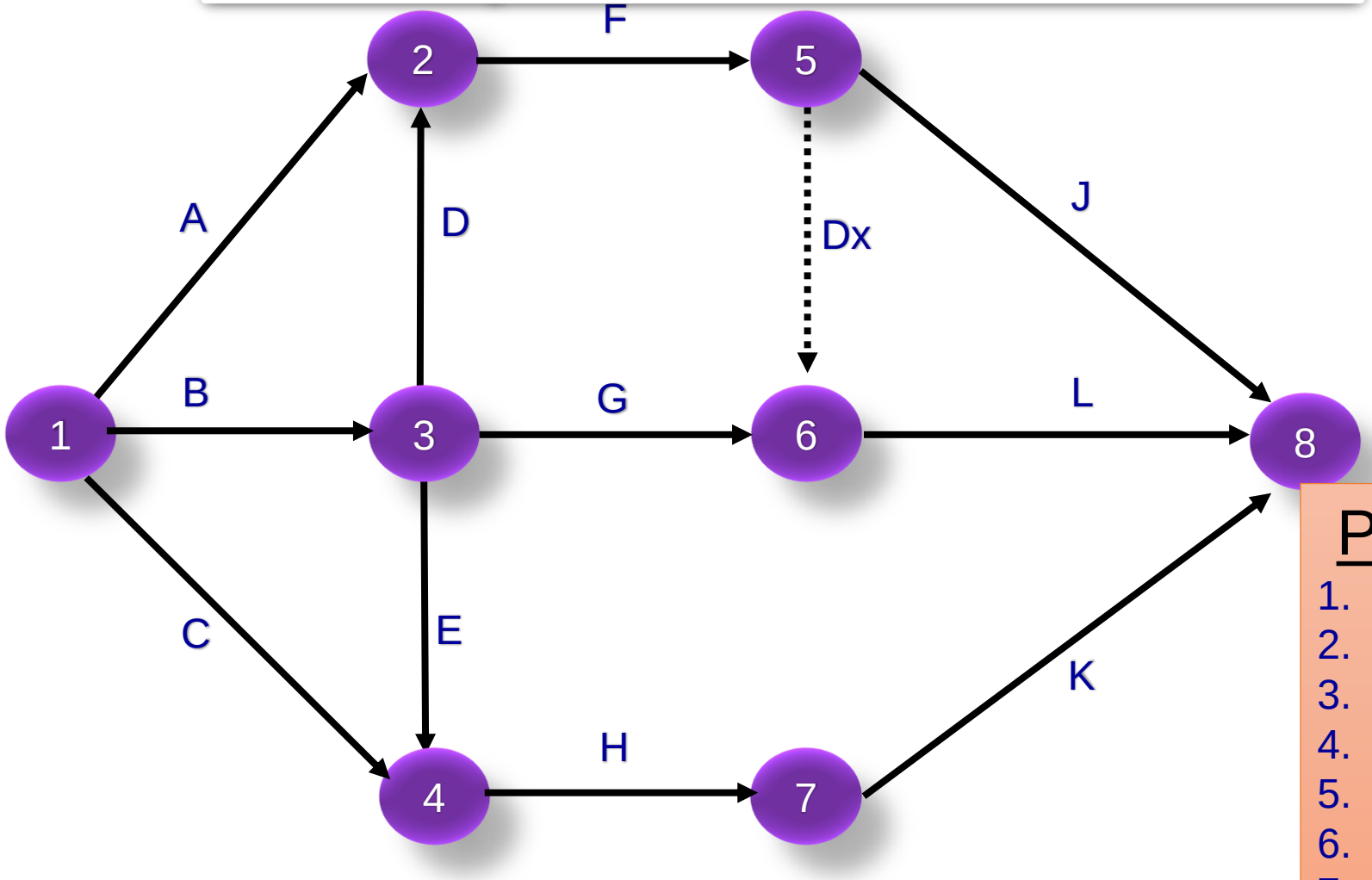
Activity	Dependency	Remarks	Duration
A	-	Starts Project	6
B	-	Starts Project	4
C	-	Starts Project	8
D	Follows B	-	8
E	Follows B	-	6
F	Starts after A & D	-	2
G	Controlled by B	-	10
H	After C and E	-	12
J	After F	Ends Project	8
K	Follows H	Ends Project	6
L	>F and >G	Ends Project	4

Lets Draw Possible AoA Network .....



Too many cross overs … complex!

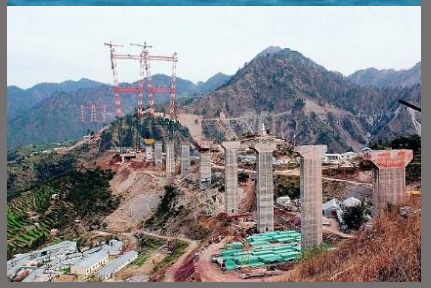
Lets Draw Simpler AoA Network …



Paths?

1. A-F-J
2. A-F-L
3. B-D-F-J
4. B-D-F-L
5. B-G-L
6. B-E-H-K
7. C-H-K

NETWORK ANALYSIS



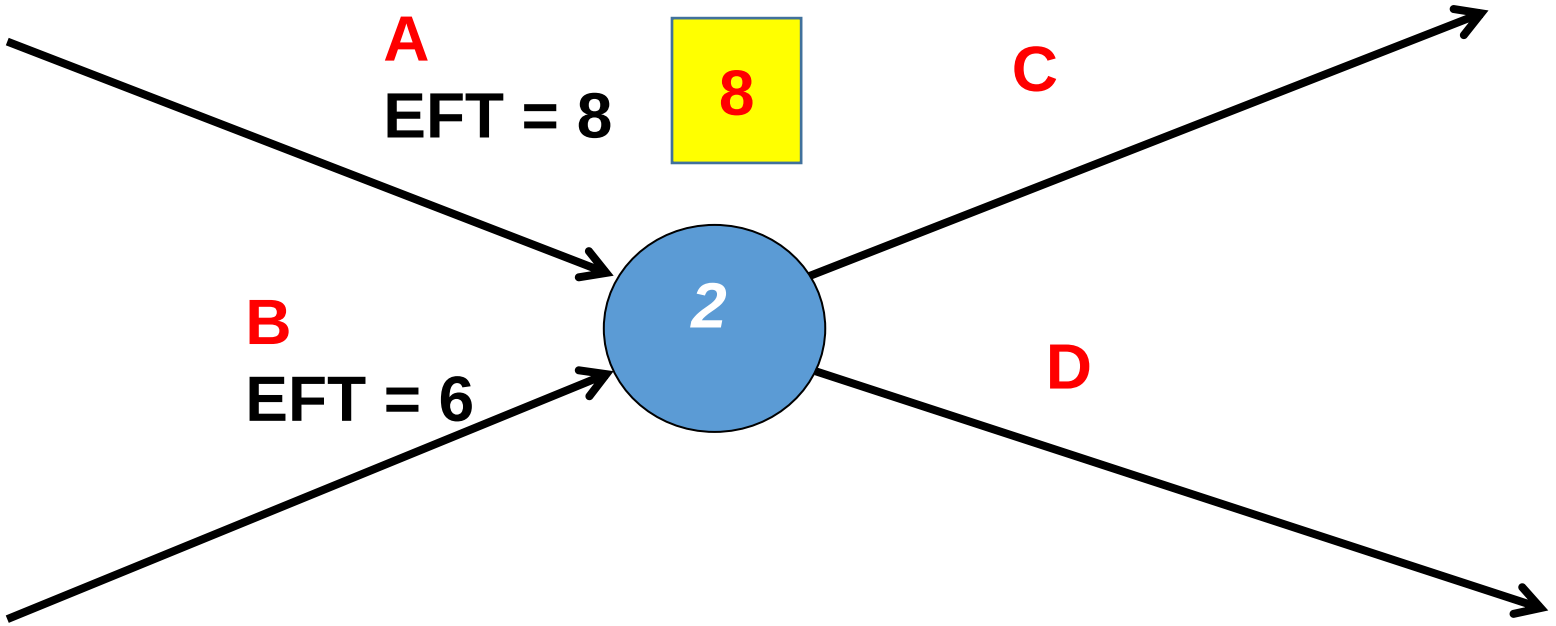
Time Features of Event / Activity

Event

- Duration - Nil
- Earliest Occurrence - EOT
- Latest Occurrence - LOT

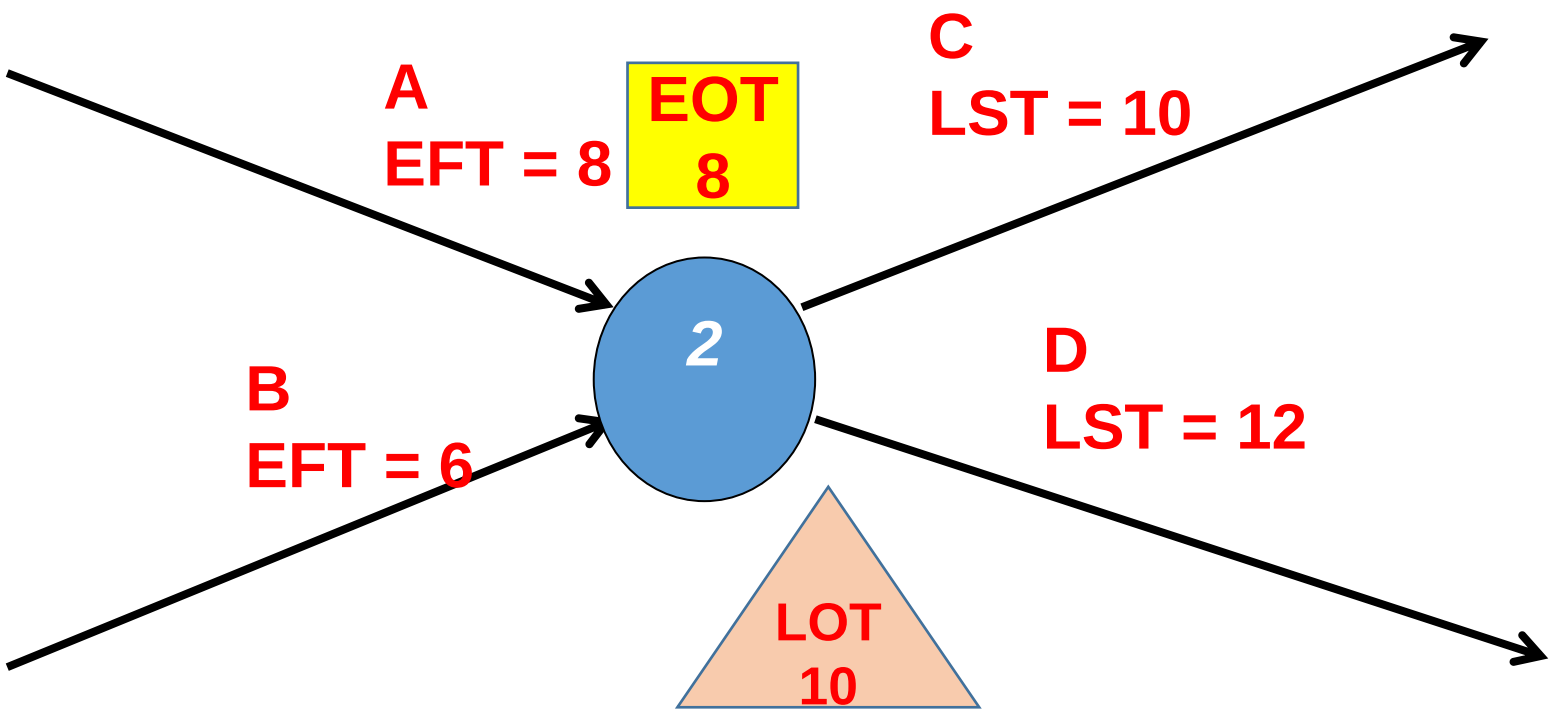
Earliest Occurrence Time

- EOT of an event corresponds to the largest of the earliest finish time of the activities ending at the event.
- Denoted in a square box above an event.



Latest Occurrence Time

- LOT of an event corresponds to the smallest of the latest start time of the activities starting at the event.
- Denoted by Triangle below.



Analysis Of Networks

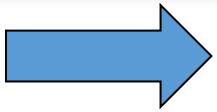
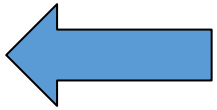
- **Earliest possible time an event can take place (EOT)**
- **Latest allowable time by which an event must take place (LOT)**
- **Project Duration**
- **Critical Path and critical activities**
- **Time cushion (slack / float) available for other activities**

Assist mgt in :-

- Scheduling
- Monitoring
- Controlling

The Project

Forward & Backward Pass Computation

- Forward Pass 
  - **Earliest Occurrence Time (EOT)**
  - **Project Duration**
- Backward Pass 
  - **Latest Occurrence Time (LOT)**
  - **Critical Path**

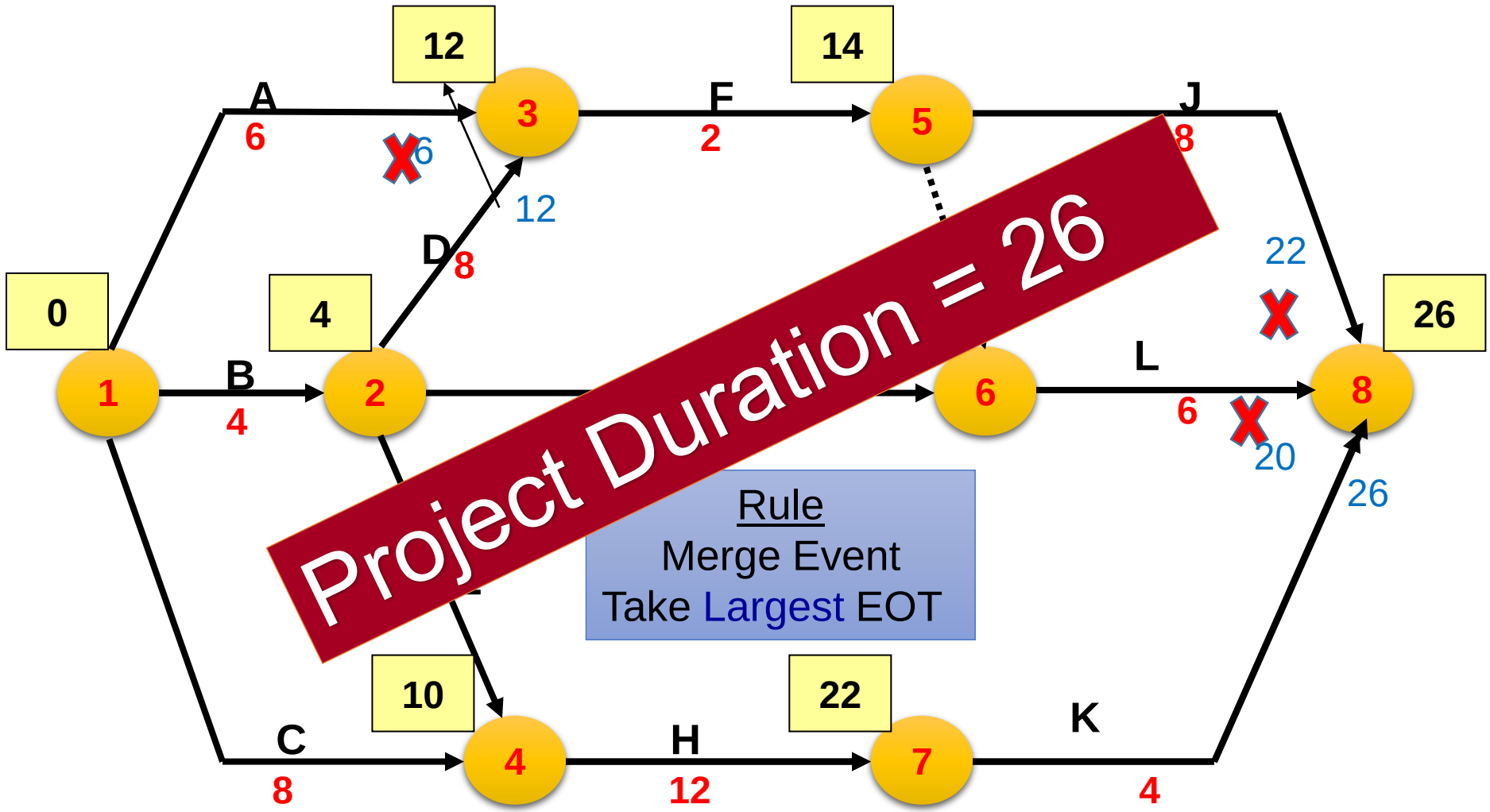
Occurrence Times associated with Events.

Start & Finish Times associated with Activities.

Analyse Network

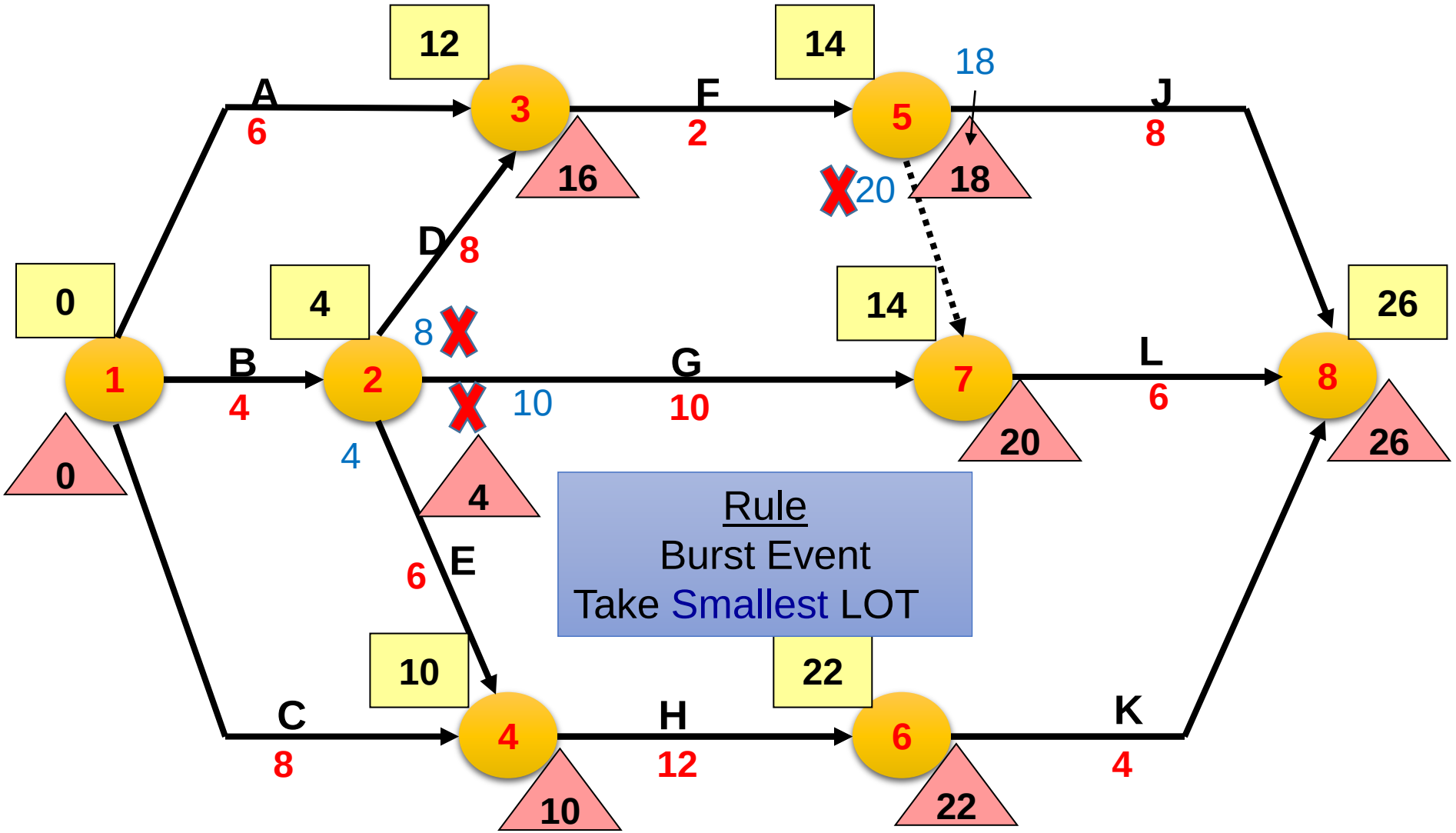
Activity	Dependency	Remarks	Duration
A	-	Starts Project	6
B	-	Starts Project	4
C	-	Starts Project	8
D	Follows B	-	8
E	Follows B	-	6
F	Starts after A & D	-	2
G	Controlled by B	-	10
H	After C and E	-	12
J	After F	Ends Project	8
K	>F and >G	Ends Project	6
L	Follows H	Ends Project	4

Forward Pass



EOT of Head Event= EOT of Tail Event + Duration

Backward Pass

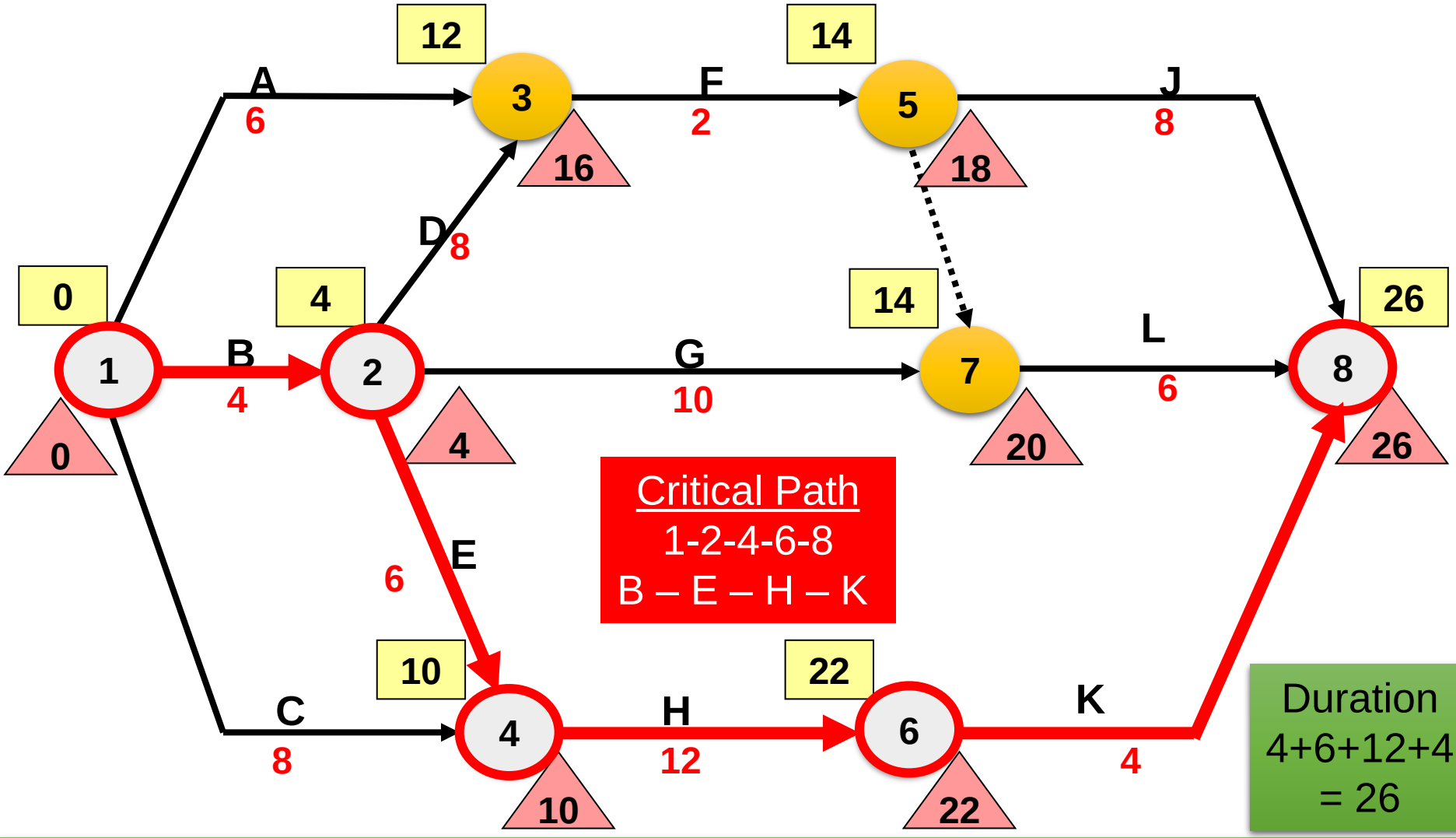


LOT of Tail Event= LOT of Head Event - Duration

Critical Events, Path, Activity

Critical Event	• ***Event with same Earliest & Latest Occurrence Time (EOT = LOT)***
Critical Path	• ***Path connecting critical events from start to end - Longest path.***
Critical Activities	• ***All activities on the critical path.***

Critical Events, Path, Activities



Project Duration = sum of durations of all activities on the Critical Path

Any delay in Critical Activity causes a delay in proj completion

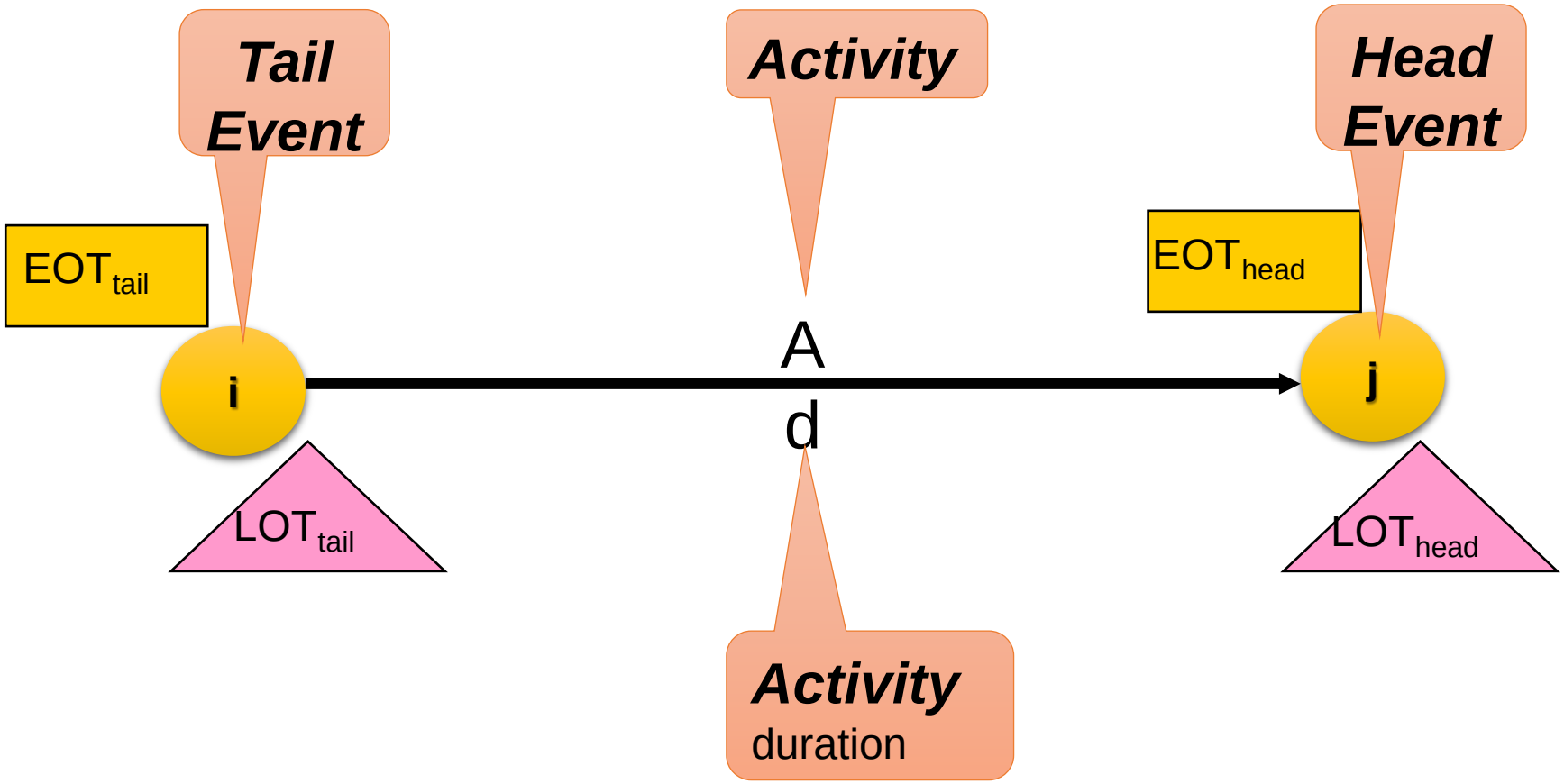
Floats

- Refer to the amount of time cushion, or scheduling flexibility, that is associated with activities on the project schedule.
- Float may occur when there are two or more activities happening concurrently.
- Utilisation
  - To economize & consume resources efficiently.
  - Appraise the effect of slippages.

Types of Float

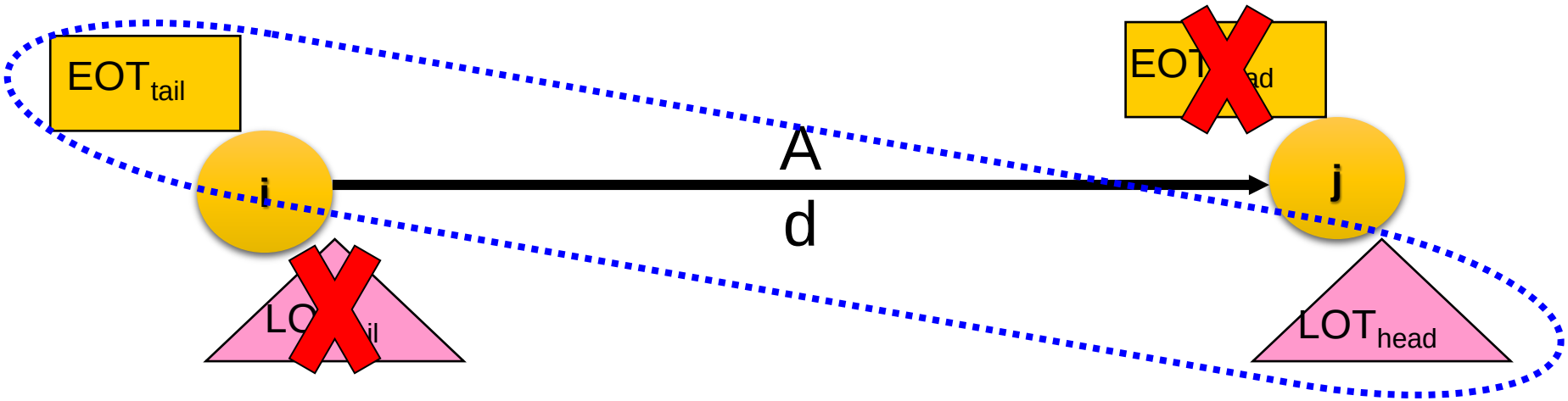
1. *Total Float*
2. *Free Float*
3. *Independent Float*

Recap – Event Timings



Total Float

- Spare time available on any given activity if,
  - the tail event occurred at its earliest time, and
  - the head event at its latest time.



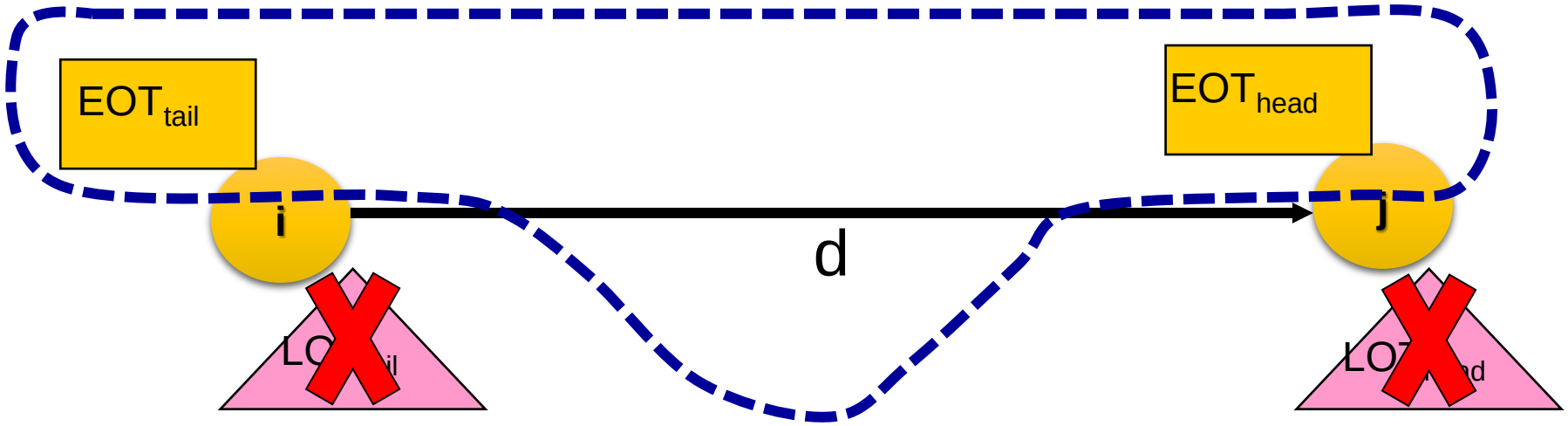
$$TF = LOT_{head} - d - EOT_{tail}$$

Represents the amount of time an activity can be delayed **without delaying the overall project duration**

Full utilisation may affect both preceding and succeeding activities

Free Float

- Spare time available on an activity if,
  - both the tail and head events occurred at their earliest times.

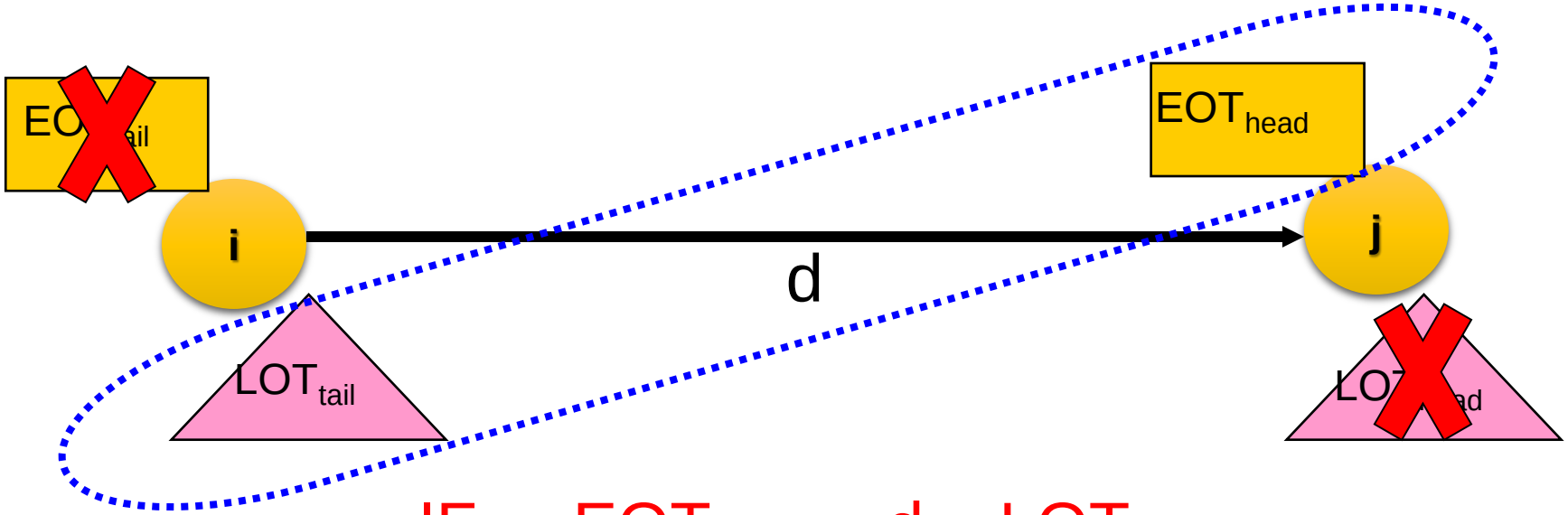


$$FF = EOT_{head} - d - EOT_{tail}$$

Represents the amount of time that a schedule activity can be delayed **without delaying the early start date of any immediate successor activity within the network path**

Independent Float

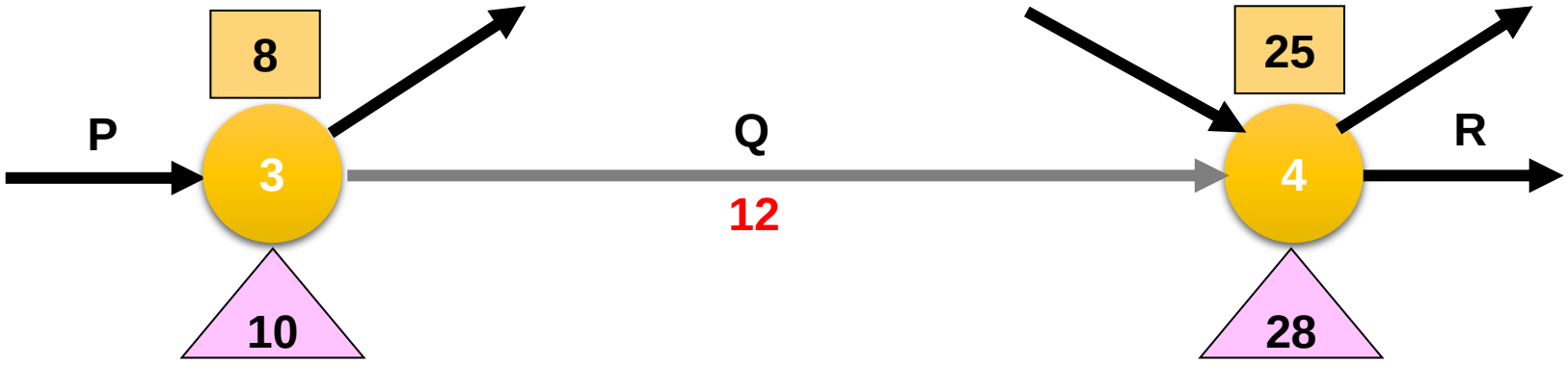
- Spare time available on an activity if,
  - the tail event occurred at its latest time, and
  - the head event at the earliest time

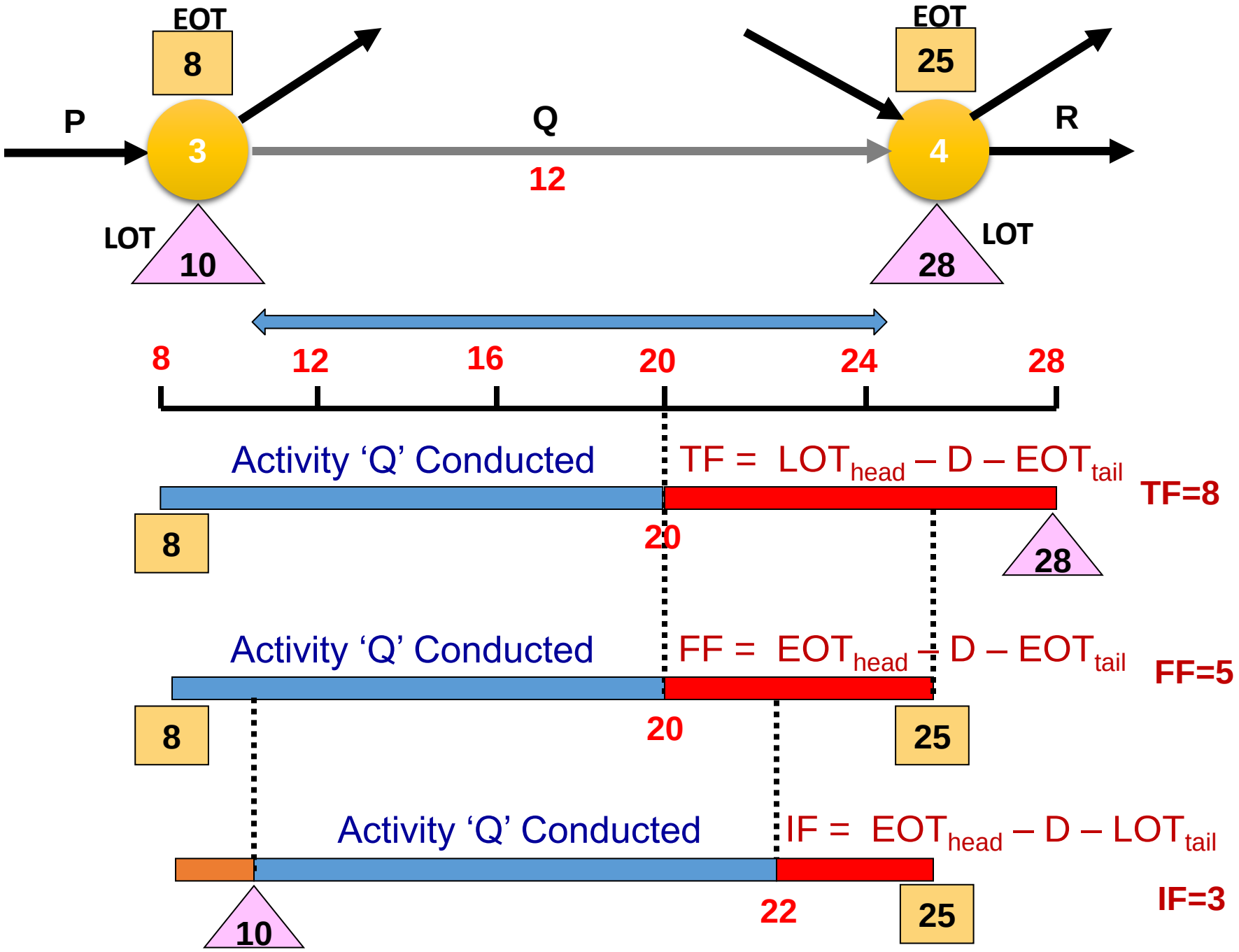


$$IF = EOT_{head} - d - LOT_{tail}$$

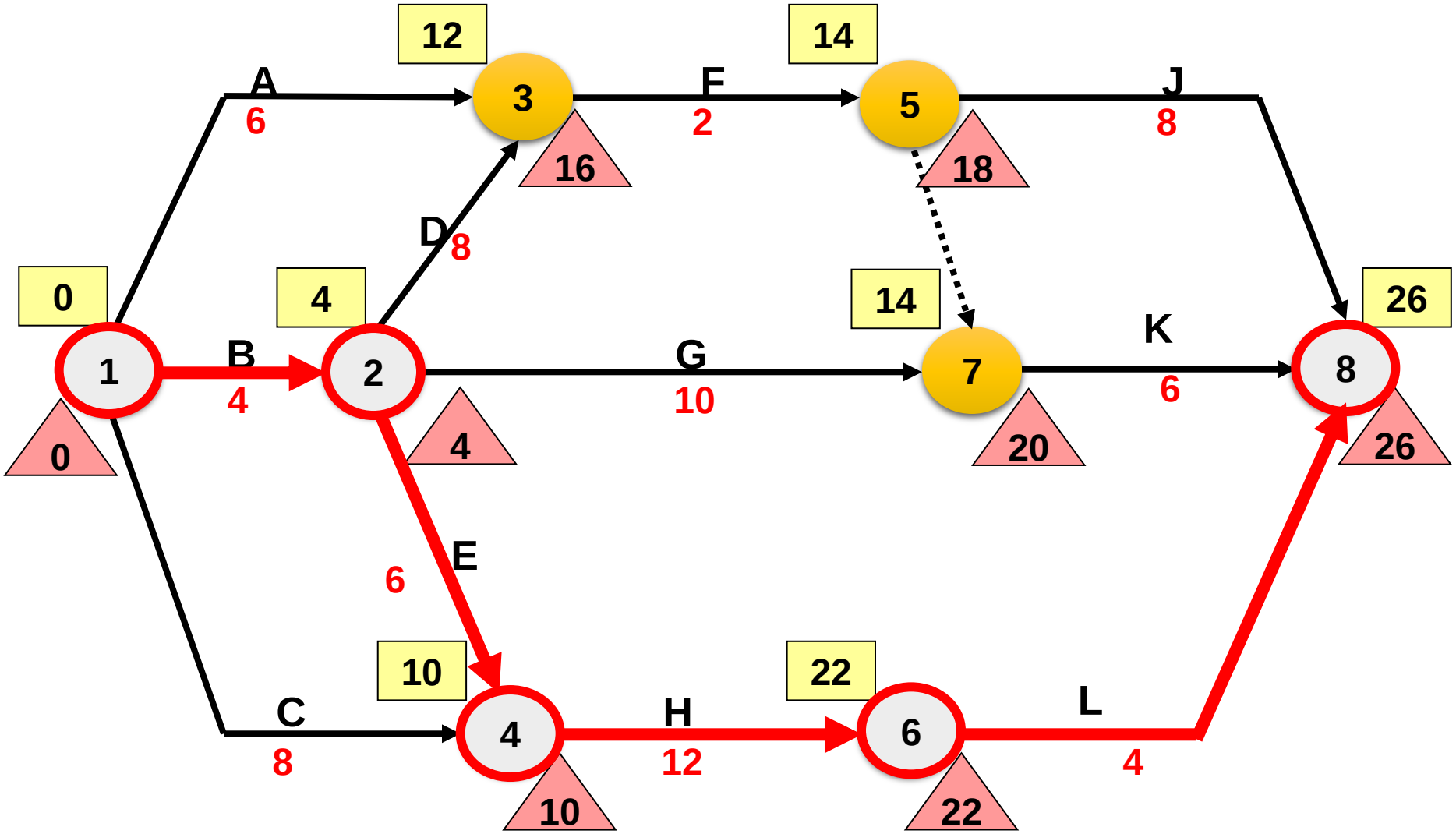
Full utilisation will NOT affect both preceding and succeeding activities

Calculation of Float



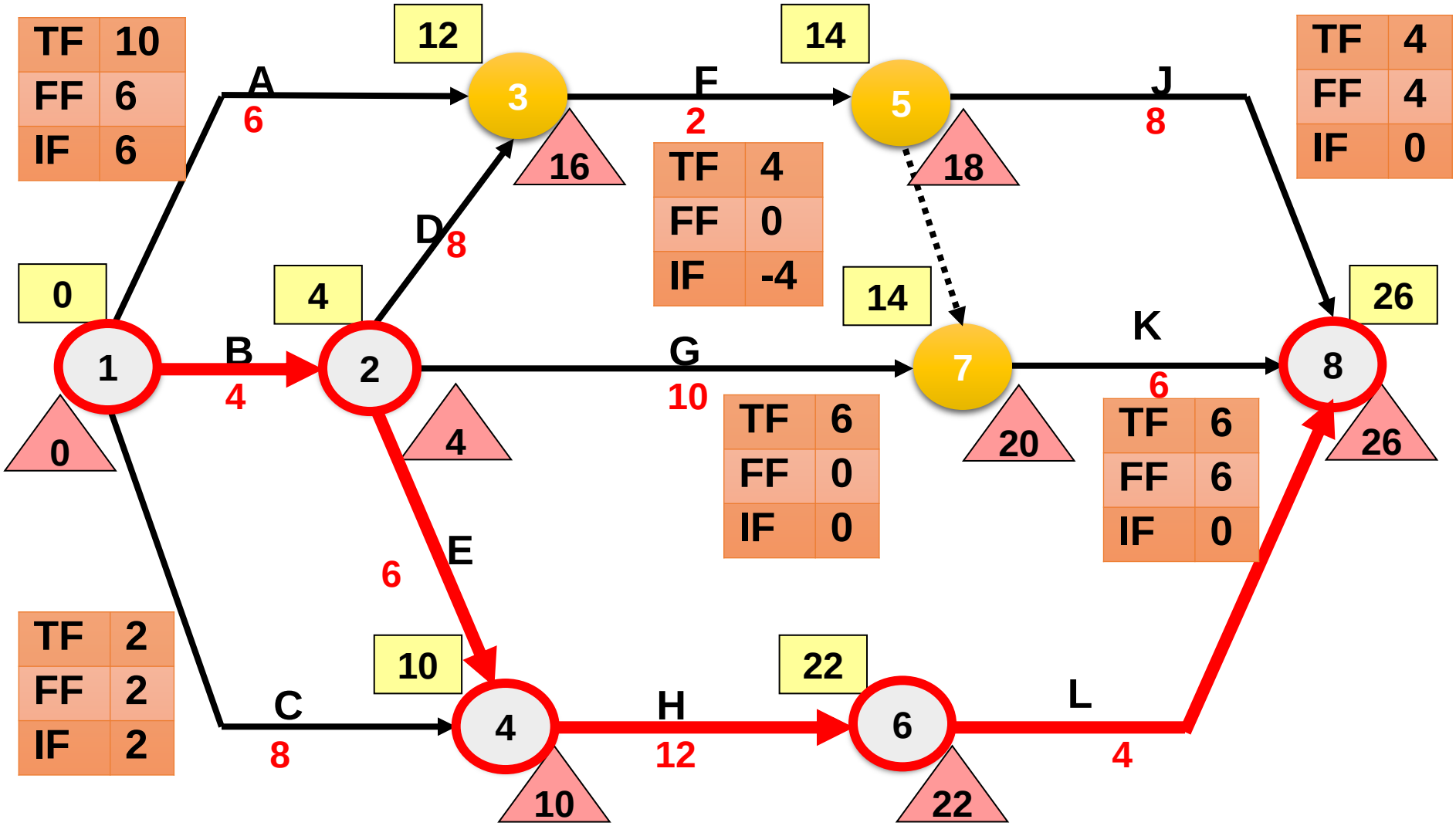

EOT
8
EOT
25
P
3
Q
12
4
R
LOT
10
LOT
28
8
12
16
20
24
28
Activity ‘Q’ Conducted
TF = LOThead – D – EOTtail
TF=8
8
20
28
Activity ‘Q’ Conducted
FF = EOThead – D – EOTtail
FF=5
8
20
25
Activity ‘Q’ Conducted
IF = EOThead – D – LOTtail
IF=3
10
22
25

Floats : Lets Draw



Determine the Total, Free & Independent Floats in the Project Schedule

Analyse Schedule Flexibility : Lets Draw



Float utilization – appraise the impact of slippages along a Path