Course Details	
Subject	Statistics
Year	3rd Year B.Sc.
Paper no	15
Paper Name	Operation Research
Topic no	27&28
Topic name	Project Planning with PERT and CPM; Drawing of Project Network
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E-Learning Module on Project Planning with PERT and CPM; Drawing of Project Network

Learning Objectives

By the end of this session, you will be able to:

- Explain the importance of using PERT and CPM techniques for project management
- Explain the phases of any project and various activities that need to be done during these phases
- Construct network diagrams with single and time estimates of activities involved in a project

Introduction

A project is an endeavor to create a unique product or service.

It is specific, timely, usually multi-disciplinary and always conflict-ridden.

A project defines a combination of interrelated activities that must be executed in a certain order before the entire task can be completed.

Introduction

An activity in a project is usually viewed as a job requiring time and resources for its completion.

Projects are a part of an overall programme and are broken down into well-defined set of tasks (jobs), subtasks and further if desired, all of which must be completed within a specified time, along with a minimum cost.

Introduction

Example of projects include,

Introduction

Such projects involve a large number of interrelated activities (or task) that must be completed in a specified time, in a specified sequence (or order) and require resources such as personnel, money materials, facilities and/or space.

Introduction

The main objectives before starting any project is to schedule the required activities in an efficient manner so as to complete it on or before a specified time limit at a minimum cost of its completion.

Hence, before starting any project it is necessary to prepare a plan for scheduling and controlling the various activities (or tasks) involved in the given project.

Introduction

This will help in undertaking the project, possibly identifying bottlenecks and even discovering alternate work-plan for the project.

One of the most challenging jobs that any manager can take on is the management of a large-scale project that requires coordinating numerous activities throughout the organization.

Introduction

A myriad of details must be considered in planning how to coordinate all these activities, in developing a realistic schedule, and then in monitoring the progress of the project.

Introduction

The techniques of operations research used for planning, scheduling and controlling large and complex projects are often referred as to network analysis, network planning and scheduling techniques.

Introduction

All these techniques are based on the representation of the project as a network of activities.

A network is a graphical plan consisting of a certain configuration of arrows and nodes for showing the logical sequence of various activities to be performed to achieve project objectives.

Introduction

Project management has evolved as a field with the development of two analytical techniques for planning, scheduling, and controlling of projects.

Fortunately, two closely related operations research techniques, PERT (program evaluation and review technique) and CPM (critical path method), are available to assist the project manager in carrying out these responsibilities.

Introduction

These techniques make heavy use of networks to help plan and display the coordination of all the activities.

They also normally use a software package to deal with all the data needed to develop schedule information and then to monitor the progress of the project.

Introduction

The project evaluation and review technique (PERT) and the critical path method (CPM) techniques were developed by two groups almost simultaneously.

Introduction

CPM was developed by E. I. Du Pont de Nemours & Company as an application to construction projects and was later extended to a more advanced status by Mauchly Associates

PERT was developed by the U.S. Navy by a consulting firm for scheduling the research and development activities for the Polaris missile program.

PERT and **CPM** were independently developed in the late 1950s.

Introduction

Ever since, they have been among the most widely used OR techniques.

However, they also had a great deal in common, and the two techniques have gradually merged further over the years.

Introduction

In fact, today's software packages often include all the important options from both original versions.

Project management software, such as MS Project, now is widely available for these purposes.

Consequently, practitioners now commonly use the two names interchangeably, or combine them into the single acronym PERT/CPM, as we often will do.

Introduction

We will make the distinction between them only when we are describing an option that was unique to one of the original version.

Although PERT and CPM were developed independently, they are similar in principle.

Today, PERT and CPM actually comprise one technique and the differences, if any, are only historical.

Consequently, both technique are referred to as “project scheduling” techniques and play an important role.

Significance of using PERT/CPM

1. A network diagram helps to translate highly complex project into a set of simple and logically arranged activities and therefore:
    a. Helps in the clarity of thoughts and actions
    b. Helps in clear and unambiguous communication developing from top to bottom and vice versa among the people responsible for executing the project

Significance of using PERT/CPM

2. Detailed analysis of a network helps project in charge to peep into the future, because
    a. Difficulties and problems that can be reasonably expected to crop up during the course of execution can be foreseen well ahead of its actual execution
    b. Delays and hold ups during course of execution are minimized. Corrective action can also be taken well in time.

Significance of using PERT/CPM

3. Isolates activities that control the project completion and therefore, results in expeditious completion of the project

4. Helps in the division of responsibilities and therefore, enhance effective coordination among different departments/agencies involved

5. Helps in timely allocation of resources to various activities in order to achieve optimal utilization of resources

Uses of PERT/CPM in projects

1. Construction of a new plant

2. Research and development of a new product

3. NASA space exploration projects

4. Movie productions

5. Building a ship

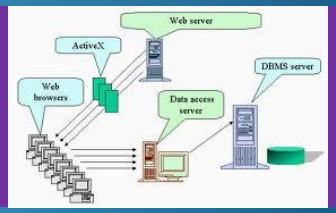
Uses of PERT/CPM in projects

6. Government-sponsored projects for developing a new weapons system

7. Relocation of a major facility

8. Maintenance of a nuclear reactor

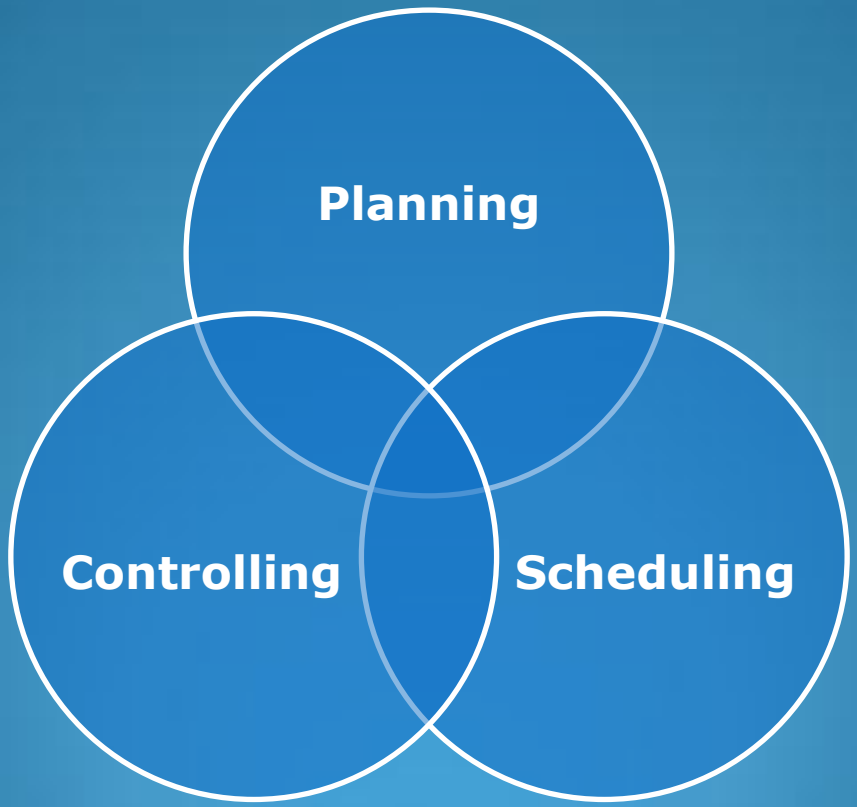
9. Installation of a management information system



10. Conducting an advertising campaign

Phases of Project management

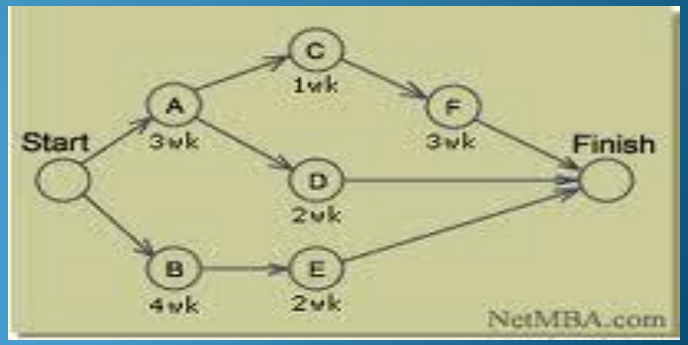
In general Project management by PERT-CPM consists of three basic phases:



Phases of Project management

Project planning phase:

In order to visualize the sequencing or Precedence requirement of the activities in a project, it is helpful to draw a network diagram.



Phases of Project management

The following tips are adopted for the project planning phase:

i. Identify the various activities (task or work element) to be performed in the project, that is, develop a work breakdown structure (WBS)

ii. Determine the requirement of resources such as men, materials, machines, money, etc., for carrying out activities listed above

Phases of Project management

The following tips are adopted for the project planning phase:

iii. Determining the time estimates for these activities

iv. Assign responsibility for each work package. The work packages corresponds to the smallest work efforts defined in a project and forms the set of elemental tasks that are the basis for planning, scheduling and controlling the project

Phases of Project management

The following tips are adopted for the project planning phase:

v. Allocate resources to work packages

vi. Develop work performance criteria

vii. Establish control channels for project personnel

Phases of Project management

Project scheduling phase:

Once all work packages (that is tasks) have been identified and given unique names or identifiers, scheduling the project, that is when each of the activities are required to be performed, is taken up.

It prepares an analysis by estimate of the likelihood of the project to be completed on or before the specified time.

Phases of Project management

Project scheduling phase:

The various steps involved during this phase are listed below:

i. Identify all the people who will be responsible for each task

ii. Estimates the expected duration(s) of each activity, taking into consideration the resources required for their execution in the most economic manner

iii. Specify the interrelationship (that is precedence relationship) among various activities

Phases of Project management

Project scheduling phase:

The various steps involved during this phase are listed below:

iv. Develop a network diagram, showing the sequential interrelationship between various activities. For this, tips such as what is required to be done; why it must be done; can it be dispensed with; how to carry out the job; what must precede it; what has to follow; what can be done concurrently, may be followed.

Phases of Project management

Project scheduling phase:

The various steps involved during this phase are listed below:

v. Based on these time estimates, calculate the total duration of the project, identify the critical path; calculate floats; carry out resources smoothing (or leveling) exercise for critical (or scare) resources, taking into account the resource constraints (if any)

Phases of Project management

Project control phase:

Project control refers to the evaluation of the actual progress (status) against the plan.

If significant differences are observed, then the scheduling and resource allocation decisions are changed in order to update and revise the uncompleted part of the project.

Phases of Project management

Project control phase:

In other words remedial (modifying planning) or reallocation of resources (cost minimization) measures are adopted in such cases.

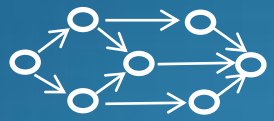
Phases of Project management

Project Planning

WBS

Project Scheduling

Precedence network



Gantt chart

Schedule Selection

Allocation of resource

Project Control

Actual task performance data

Deviation from plan

Periodic cost reports

Implementation of plan

Phases of Project management

These adjustments are helpful to aggregate work packages into subsystems and track the progress of these subsystems as part of the reporting and review procedures.

In this way, it is less likely that a project manager will lose sight of the forest because of too many trees.

PERT/CPM Components

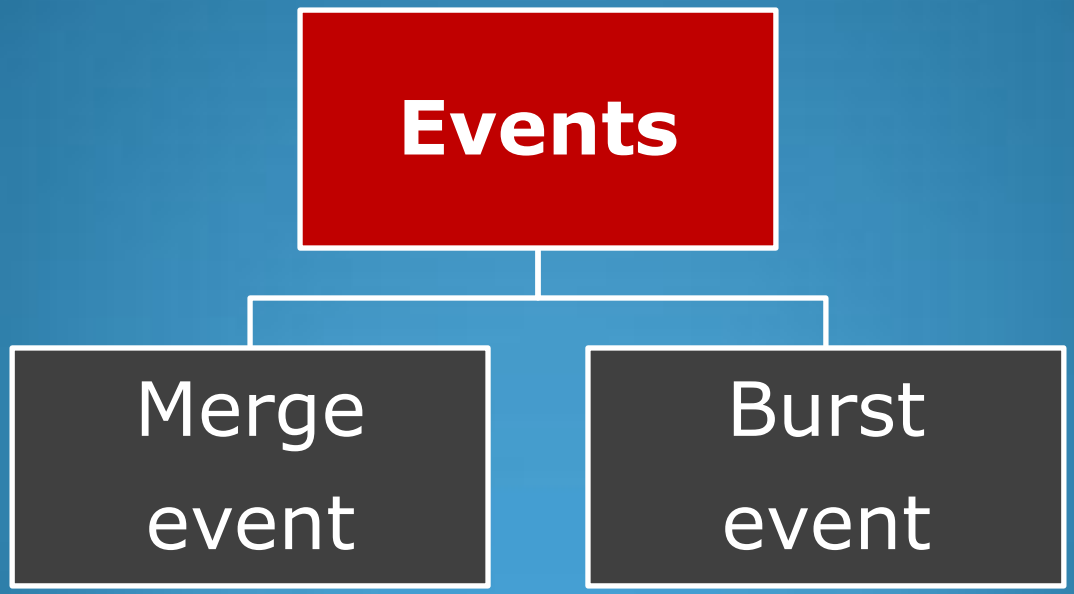
Events:

Events in the network diagram represent the project milestones, such as the start or the completion of an activity (task) or activities, and occur at a particular instant of time at which some specific part of the project has been or is to be achieved.

PERT/CPM Components

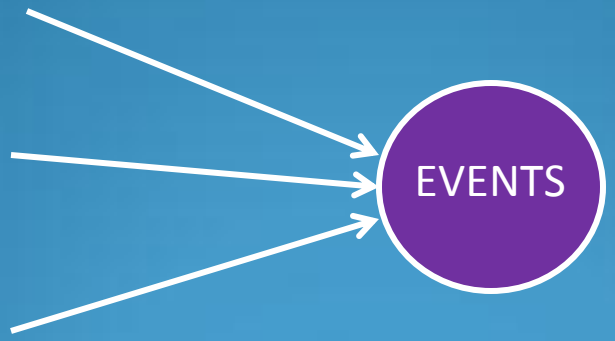
Events:

Events are commonly represented by circles (nodes) in the network diagram.



PERT/CPM Components

Merge events: An event which represents the joint completion of more than one activity is known as a merge event.



PERT/CPM Components

Burst event: An event that represents the initiation (beginning) of more than one activity is known as burst event

PERT/CPM Components

Events in the network diagram are identified by numbers.

Each event should be identified by a number lighter than the one allotted to its immediately preceding event to indicate progress of work.

The numbering of events in the network diagram must star from the left (start of the project) to the right (completion of the project) and top to bottom. Care should be taken that there is no duplication in the numbering.

PERT/CPM Components

Activities:

Activities in the network diagram represent project operations (or tasks) to be conducted.

As such each activity except dummy requires resources and takes a certain amount of time for completion.

PERT/CPM Components

Activities:

An arrow is commonly used to represent an activity with its head indicating the direction of progress in the project.

Activities are identified by the numbers of their starting (tail or initial) event and ending (head or terminal) event.

PERT/CPM Components

Activities (Example):

Consider an arrow (i, j) between two events

- The tail event i represents the start of the activity
- The head event j represents the completion of the activity

PERT/CPM Components

Predecessor activity: An activity which must be completed before one or more other activities start is known as predecessor activity.

Successor activity: An activity which starts immediately after one or more of other activities are completed is known as successor activity

Dummy activity: An activity which does not consume either any resource and/or time is known as dummy activity.

PERT/CPM Components

Activities:

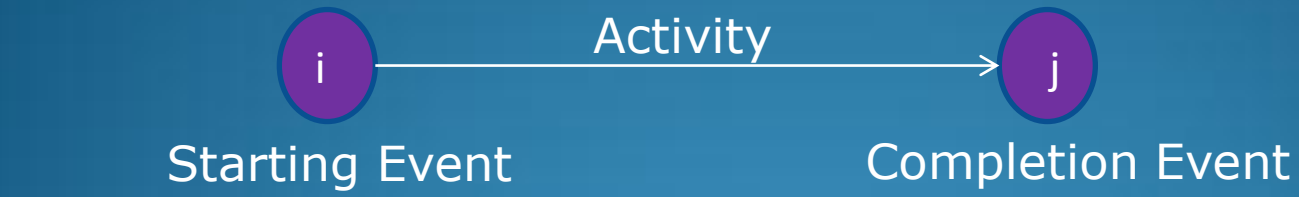
A dummy activity in the network is added only to establish the given precedence relationship among the activities of the project.

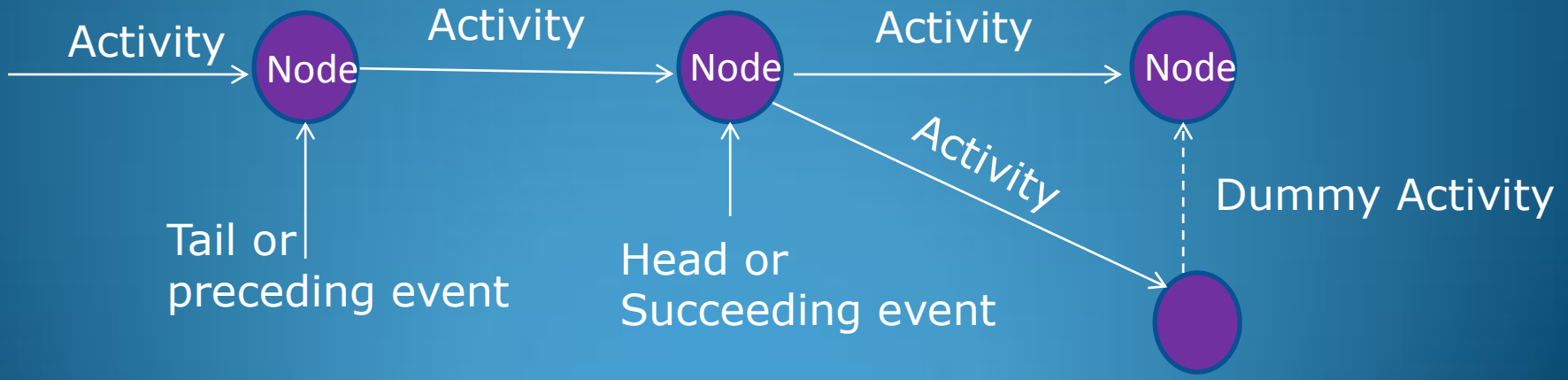
It is needed when,

a. Two or more parallel activities in a project have the same head and tail events
b. Two or more activities have some (but not all) of their immediate predecessor activities in common

PERT/CPM Components

Activities:





PERT/CPM Components

Activities:

Network models use the following two types of precedence network to show precedence requirements of the activities in the project:

Arrow on node (AON) network

Activity on Arrow (AOA) network

PERT/CPM Components

Activity-on-Node (AON) network: In this type of precedence network each node (or circle) represents a specific task while the arcs represent the ordering between tasks.

AON network diagrams place the activities within the nodes, and the arrows are used to indicate sequencing requirements

PERT/CPM Components

Activity-on-Node (AON) network: Generally, these diagrams have no particular starting and ending nodes for the whole project.

The lack of dummy activities in these diagrams always make them easier to draw and to interpret.

PERT/CPM Components

Activity-on-Arrow (AOA) network: In this type of precedence network at each end of the activity arrow is a node (or circle).

These nodes represent points in time or instants, when an activity is starting or ending.

PERT/CPM Components

Activity-on-Arrow (AOA) network:
The arrow itself represents the passage of time required for that activity to be performed.

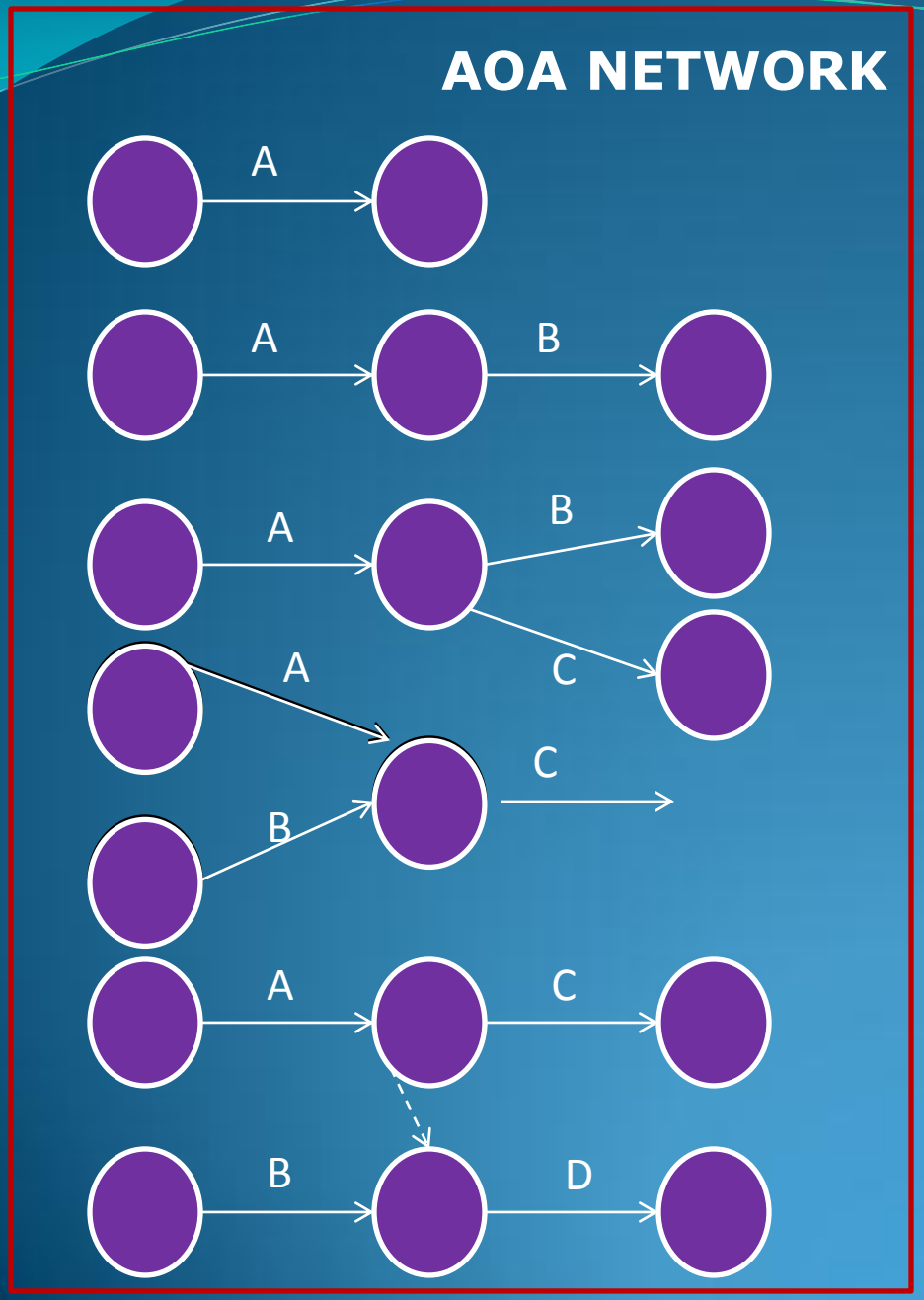
This diagram then works its way from left to right, ending with a single ending node, where all activities with no followers come together.

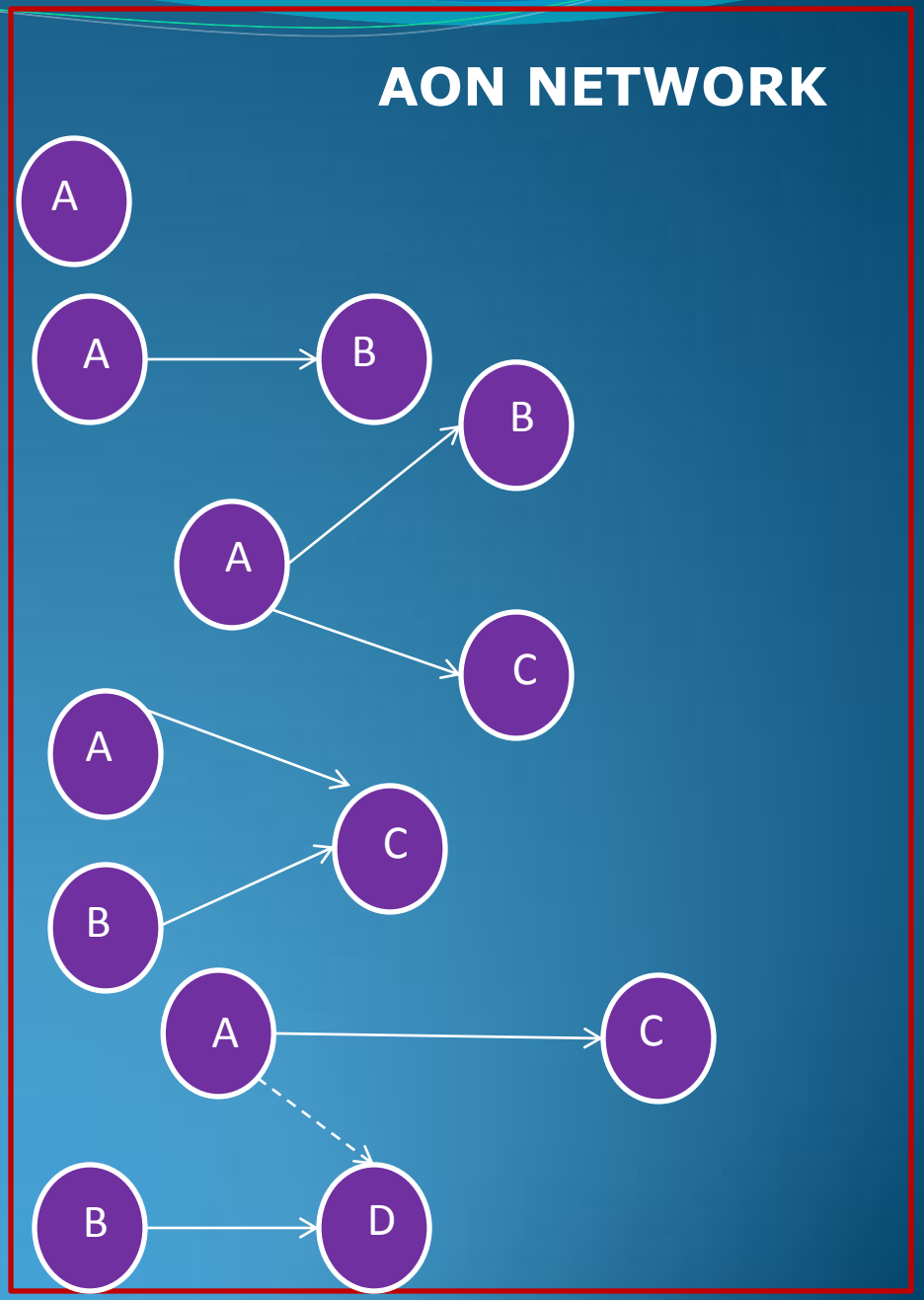
PERT/CPM Components

Advantages of using AOA

- Many computer programs are based on AOA networks
- AOA diagrams can be superimposed on a time scale with the arrow drawn, the correct length to indicate the time requirement
- AOA diagrams give a better sense of the flow of time throughout a project

PERT/CPM Components





Rules for AOA network construction

i. In network diagram, arrows & circles represent activities and events respectively. The length of an arrow is of no significance

ii. Each activity should be represented only by one arrow and must start and end in a circle called event. The tail of an activity represents the start, and head the completion of work

Rules for AOA network construction

iii. The event numbered 1 denotes the start of the project and is called **initial event**. All activities emerging (or taking off) from event 1 should not be preceded by any other activity or activities. An event carrying the highest number denotes the **completion event**. A network should have only one initial event and only one **terminal event**.

Rules for AOA network construction

iv. The general rule for numbering the event is that the head event should always be numbered larger than the number at its tail. That is, events should be numbered such that for each activity (I, j), where I is less than j

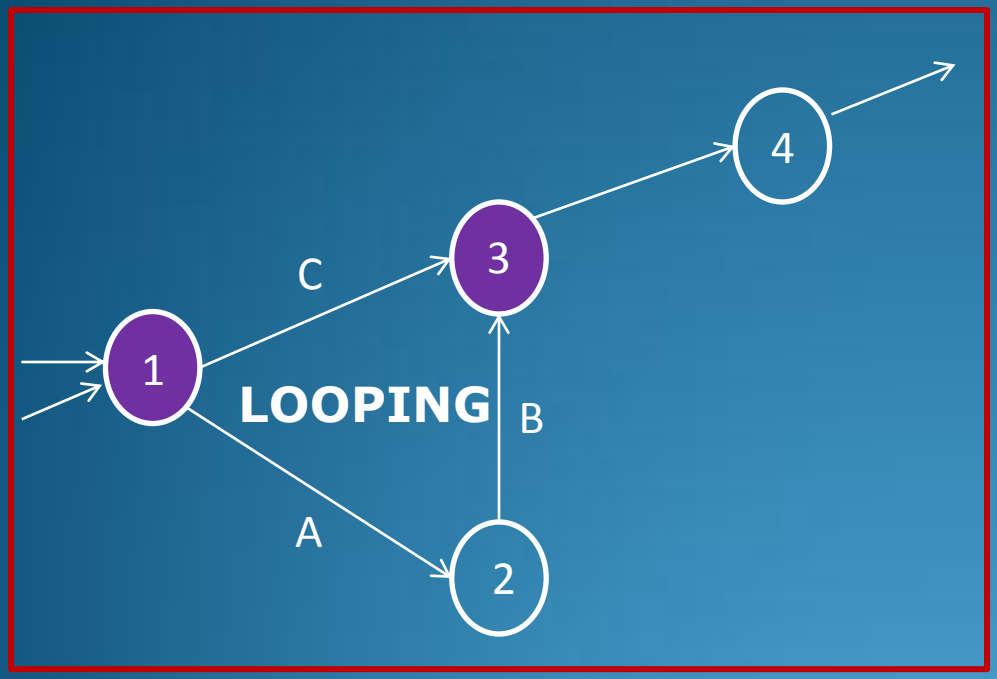
Rules for AOA network construction

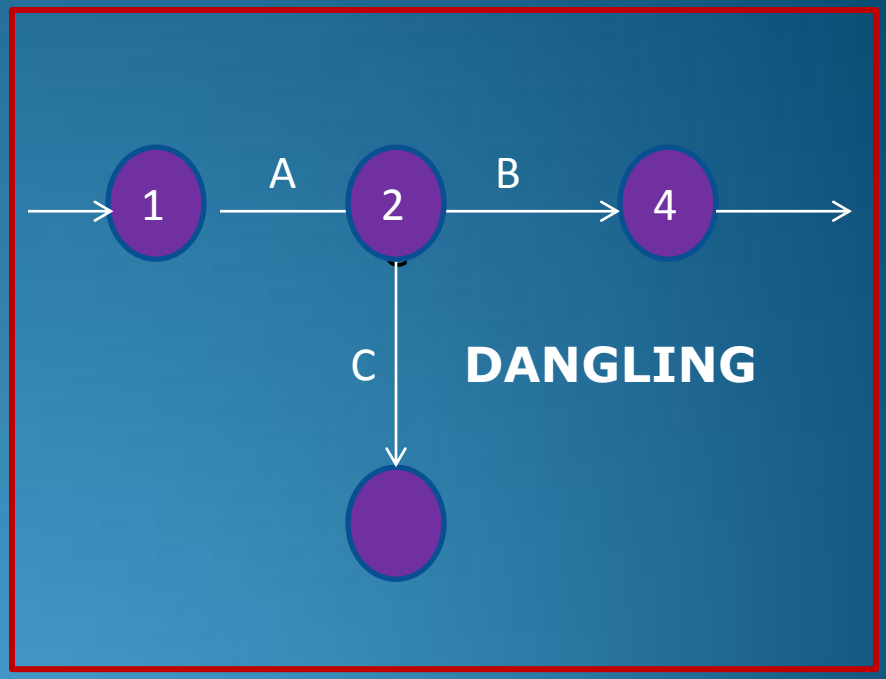
v. An activity must be uniquely identified by its starting and completion event, which implies that:
    a. An event number should not get repeated or duplicated
    b. Two activities should not be identified by the same completion event
    c. Activities must be represented either by their symbols or by the corresponding ordered pair of starting-completion events

Rules for AOA network construction

vi. The logical sequence (or interrelationship) between activities must follow these rules:
    a. An event cannot occur until all its incoming activities have been completed
    b. An activity cannot start unless all the preceding activities, on which it depends, have been completed
    c. Though a dummy activity does not consume either any resource or time, even then it has to follow the rules a and b

Errors and dummies in network:





Looping and dangling: Looping (cycling) and dangling are considered as faults in a network. Therefore, these must be avoided.

Errors and dummies in network:

i. A case of endless loop in a network diagram, which is also known as looping is shown in the diagram where activities, A, B and C form a cycle. Due to precedence relationships, it appears that every activity in looping is a predecessor of itself. In this case it is difficult to number three events associated with activity A, B and C so as to satisfy the rule of constructing the network

Errors and dummies in network:

ii. A case of disconnect activity before the completion of all activities, which is also known as dangling, is shown in the diagram. In this case activity C does not give any result as per the rules of the network. The dangling may be avoided by adopting rule 5 of the constructing network

Dummy Activity:

The following are the two cases in which the use of dummy activity may help in drawing the network correctly, as per the various rules.

i. When two or more parallel activities in a project have the same head and tail events, which are two events connected with more than one arrow. In the figure, activities B and C have a common predecessor – activity A. At the same time, they have activity D as a common successor

Dummy Activity:

To arrive at correct network, a dummy activity for the ending event B, to show that D may not start before B and C, is completed. This is shown in the figure.

Dummy Activity:

ii. When two chains of activities have a common event, yet are wholly or partly independent of each, as shown in the figure. A dummy which is used in such a case, to establish proper logic relationships, is also known as dummy activity

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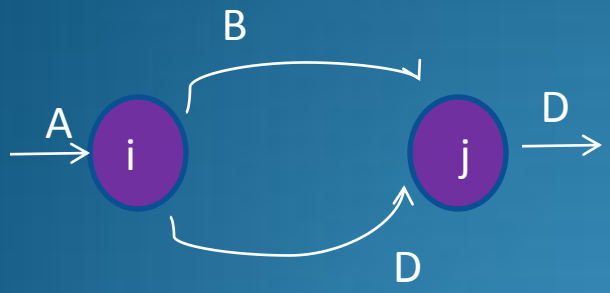
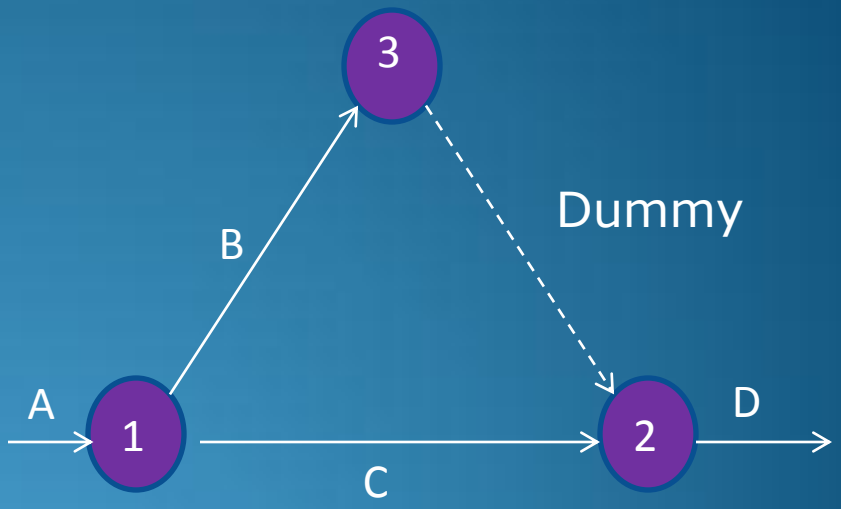
PERT/CPM Components

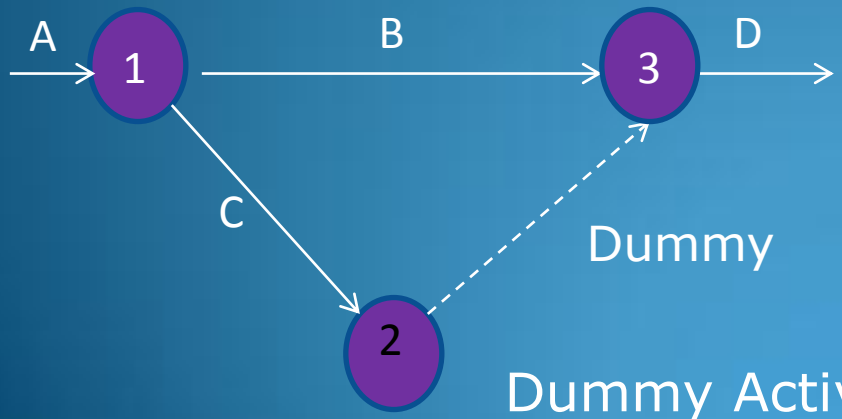
Activities:



Parallel Activities



Dummy Activity



Dummy Activity

Dummy Activity:

In the figure if head event of C and E do not depend on the completion of activities A and B, then the network can be redrawn, as shown in the figure. Otherwise, the pattern of the previous figure must be adhered to.

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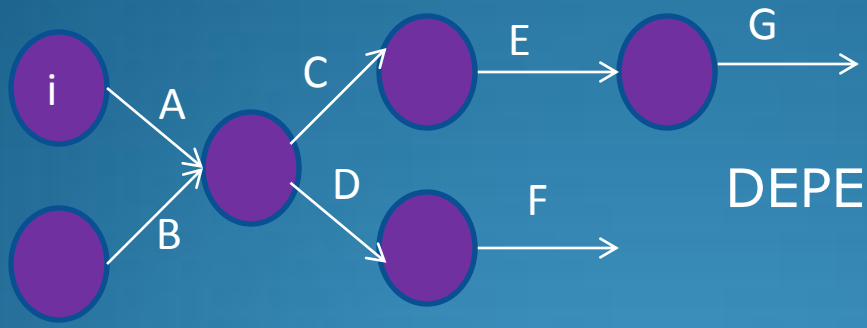
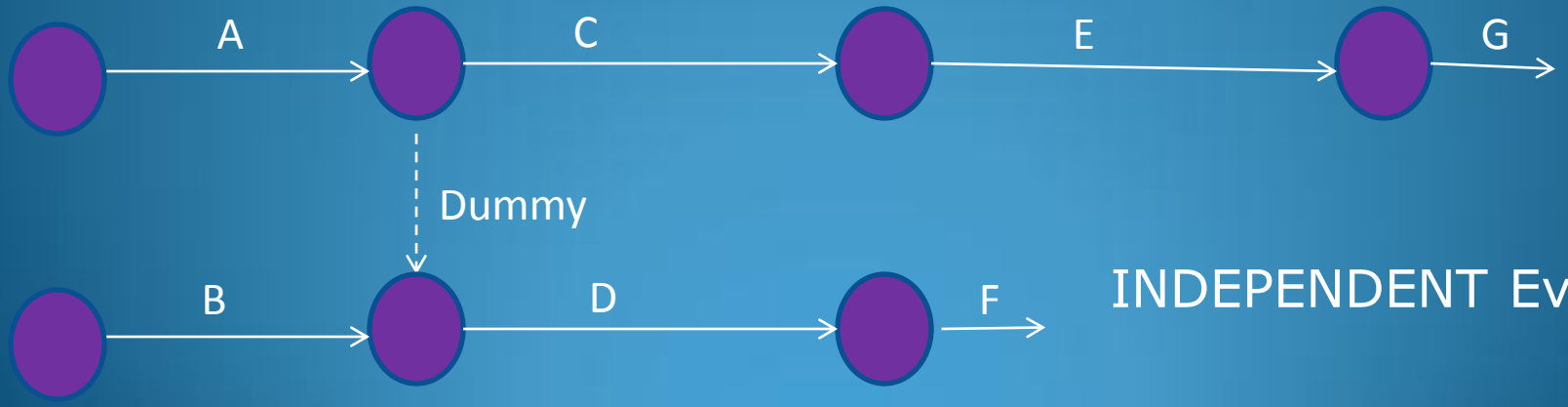
PERT/CPM Components

Activities:



DEPENDENT Event



INDEPENDENT Event