Course Details	
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Year	3rd Year B.Sc.
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Topic no	25
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SME	Priyadarshini R
ID	Aditya Shetty

E-Learning Module on PERT

Learning Objectives

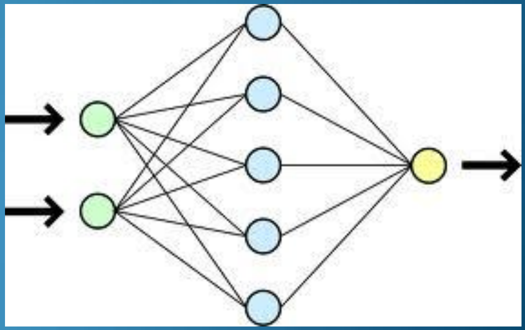
By the end of this session, you will be able to:

- Explain the importance of using PERT
- Explain the PERT network techniques

Introduction

Complex projects require a series of activities, some of which must be performed sequentially and others that can be performed parallel with other activities.

The collection of series and parallel task can be modeled as a network.



Introduction

The program evaluation and review technique is a network model that allows randomness in activity completion time.

The Program (or Project) Evaluation and Review Technique, commonly abbreviated as PERT.

Introduction

PERT is a statistical tool, used in project management, that is designed to analyze and represent the tasks involved in completing a given project.

First developed by the United States Navy in the 1950s, it is commonly used in conjunction with the critical path method (CPM).

Introduction

The Navy's Special Projects Office, charged with developing the Polaris-Submarine weapon system and the Fleet Ballistic Missile capability, has developed a **statistical technique** for measuring and forecasting progress in research and development programs

Introduction

The Program Evaluation and Review Technique (code-named PERT) is applied as a decision-making tool designed to save time in achieving end-objectives, and is of particular interest to those engaged in research and development programs for which time is a critical factor.

Introduction

The new technique takes recognition of three factors that influence successful achievement of research and development program objectives:

- Time
- Resources
- Technical performance specifications

Introduction

PERT employs time as the variable that reflects planned resource-applications and performance specifications.

With units of time as a common denominator, PERT quantifies knowledge about the uncertainties involved in developmental programs requiring effort at the edge of, or beyond, current knowledge of the subject - effort for which little or no previous experience exists..

Introduction

The technique is a management control tool that,

- Sizes up the outlook for meeting objectives on time
- Highlights danger signals requiring management decisions
- Reveals and defines both criticalness and slack in the flow plan or the network of sequential activities that must be performed to meet objectives
- Compares current expectations with scheduled completion dates and computes the probability for meeting scheduled dates
- Simulates the effects of options for decision - before decision

Introduction

PERT is a method to analyze the involved tasks in completing a given project, especially

- The time needed to complete each task
- To identify the minimum time needed to complete the total project.

Introduction

It is more of an event-oriented technique rather than start- and completion-oriented, and is used more in projects where time is the major factor rather than cost.

Introduction

It is applied to very large-scale, one-time, complex, non-routine infrastructure and Research and Development projects.

This project model was the first of its kind, a revival for scientific management, founded by **Frederick Taylor** (Taylorism) and later refined by **Henry Ford** (Fordism). **DuPont's** critical path method was invented at roughly the same time as PERT.

PERT - Terminologies

PERT event:
A point that marks the start or completion of one or more activities.

It consumes no time and uses no resources.

When it marks the completion of one or more tasks, it is not "reached" (does not occur) until all of the activities leading to that event have been completed.

PERT - Terminologies

Predecessor event:
An event that immediately precedes some other event without any other events intervening.

An event can have multiple predecessor events and can be the predecessor of multiple events.

PERT - Terminologies

Successor event:
An event that immediately follows some other event without any other intervening events.

An event can have multiple successor events and can be the successor of multiple events.

PERT - Terminologies

PERT activity:
The actual performance of a task which consumes time and requires resources (such as labor, materials, space, machinery).

It can be understood as representing the time, effort, and resources required to move from one event to another.

A PERT activity cannot be performed until the predecessor event has occurred.

PERT - Terminologies

Optimistic time (O):
The minimum possible time required to accomplish a task, assuming everything proceeds better than is normally expected

Pessimistic time (P):
The maximum possible time required to accomplish a task, assuming everything goes wrong (but excluding major catastrophes).

Most likely time (M):
The best estimate of the time required to accomplish a task, assuming everything proceeds as normal.

PERT - Terminologies

Expected time (TE):

The best estimate of the time required to accomplish a task, accounting for the fact that things don't always proceed as normal (the implication being that the expected time is the average time the task would require if the task were repeated on a number of occasions over an extended period of time).

$$\mathbf{TE = (O + 4M + P) \div 6}$$

PERT - Terminologies

Float or slack:
It is a measure of the excess time and resources available to complete a task.

It is the amount of time that a project task can be delayed without causing a delay in any subsequent tasks (free float) or the whole project (total float).

Positive slack would indicate ahead of schedule; **Negative slack** would indicate behind schedule; and **zero slack** would indicate on schedule

PERT - Terminologies

Critical path:
The longest possible continuous pathway taken from the initial event to the terminal event.

It determines the total calendar time required for the project; and, therefore, any time delays along the critical path will delay the reaching of the terminal event by at least the same amount.

PERT - Terminologies

Critical activity:
An activity that has total float equal to zero.

An activity with zero float is not necessarily on the critical path since its path may not be the longest.

PERT - Terminologies

Lead time:
The time by which a predecessor event must be completed in order to allow sufficient time for the activities that must elapse before a specific PERT event reaches completion.

PERT - Terminologies

Lag time:
The earliest time by which a successor event can follow a specific PERT event.

Fast tracking:
Performing more critical activities in parallel.

Crashing critical path:
Shortening duration of critical activities.

PERT - Implementation

The first step to scheduling the project is to determine the tasks that the project requires and the order in which they must be completed.

Easy to record	Difficult to record
• When building a house, the land must be graded before the foundation can be laid	• When there are two areas that need to be graded, but there are only enough bulldozers to do one

PERT - Implementation

Additionally, the time estimates usually reflect the normal, non-rushed time.

Many times, the time required to execute the task can be reduced for an additional cost or a reduction in the quality.

PERT - Implementation

Steps in the PERT planning process:

PERT planning involves the following steps:

1. Identify the specific activities and milestones
2. Determine the proper sequence of the activities
3. Construct a network diagram
4. Estimate the time required for each activity
5. Determine the critical path
6. Update the Pert chart as the project progresses

PERT - Implementation

Steps in the PERT planning process:

1. Identifying activities and milestones:
The **activities** are the task required for completion of the project & the **milestones** are the events marking beginning and end of one or more activities.

It is helpful to list the task in a table that in later steps can be expanded to include information on sequence and duration

PERT - Implementation

Steps in the PERT planning process:

2. Determine activity sequence:
This step may be combined with the activity identification step since the activity sequence is evident for some tasks.

Other tasks may require more analysis to determine the exact order in which they must be performed.

PERT - Implementation

Steps in the PERT planning process:

3. Construct the network diagram:
Using the activity sequence information, a network diagram can be drawn showing the sequence of the serial and parallel activities.

For original activity on arc model, the activities are depicted by arrowed lines and milestones are depicted by bubbles or circles.

If done manually several drafts may be required to correctly portray the relationships among activities.

Software packages simplify this step by automatically converting tabular activity information into a network diagram.

PERT - Implementation

Steps in the PERT planning process:

4. Estimate activity times:
Weeks are commonly used unit of time for activity completion, but any consistent unit of time can be used.

A distinguishing feature of PERT is its ability to deal with uncertainty in activity completion of times.

For each activity, the model generally includes three time estimates.

- Optimistic time
- Most likely time
- Pessimistic time

The expected time may be displayed on the network diagram.

PERT - Implementation

Steps in the PERT planning process:

5. Determine the critical path:
The critical path is determined by adding the times for the activities in each sequence and determine the longest path in the project.

The critical path determines the total calendar time required for the project.

If the activities outside the critical path speed up or slow down, the total project time does not change.

PERT - Implementation

Steps in the PERT planning process:

The amount of time that a non-critical path activity can be delayed without delaying the project time is called a **slack time**.

If the critical path is not immediately obvious, it may be helpful to determine the following four quantities for each activity.

- ES is the earliest start time
- EF is the earliest finish time
- LS latest start time
- LF is latest finish time

PERT - Implementation

Steps in the PERT planning process:

These times are calculated using the expected time for the relevant activities.

The earliest start and finish times of each activity are determined by working forward through the network and determining the earliest time at which an activity can start and finish considering its predecessors activities.

PERT - Implementation

Steps in the PERT planning process:

The latest start and finish times are the latest time an activity can start and finish without delaying the project time.

They are found by working backwards through the network diagram.

The difference between the earliest and the latest time of each activity is the activity's slack.

The critical path then is the Path through the network in which none of the activities have slack.

PERT - Implementation

Steps in the PERT planning process:

Since the critical path determines the completion date of the project, the project can be accelerated by adding the resources to decrease the time for the activities in the critical path.

Such a shortening of the project sometimes is referred to as project crashing.

PERT - Implementation

Steps in the PERT planning process:

6. Update as project progresses:
Make adjustments on the PERT chart as the project progresses.

As the project unfolds, the estimated times can be replaced with actual times.

In cases where there are delays, additional resources may be needed to stay on schedule and the pert char may be modified to reflect the new situation.

PERT - Advantages

- PERT chart explicitly defines and makes visible dependencies (precedence relationships) between the work breakdown structure (commonly WBS) elements
- PERT facilitates identification of the critical path and makes this visible
- PERT facilitates identification of early start, late start, and slack for each activity

PERT - Advantages

- PERT provides for potentially reduced project duration due to better understanding of dependencies leading to improved overlapping of activities and tasks where feasible
- The large amount of project data can be organized & presented in diagram for use in decision making

PERT - Disadvantages

- There can be potentially hundreds or thousands of activities and individual dependency relationships
- PERT is not easily scalable for smaller projects
- The network charts tend to be large and unwieldy requiring several pages to print and requiring special size paper

PERT - Disadvantages

- The lack of a timeframe on most PERT/CPM charts makes it harder to show status although colours can help (e.g., specific colour for completed nodes)
- When the PERT/CPM charts become unwieldy, they are no longer used to manage the project.

PERT chart – What it is

A PERT chart is a graphic representation of a project's schedule, showing the sequence of tasks, which tasks can be performed simultaneously, and the critical path of tasks that must be completed on time in order for the project to meet its completion deadline.

PERT chart – What it is

The chart can be constructed with a variety of attributes, such as

- Earliest and latest start dates for each task
- Earliest and latest finish dates for each task
- Slack time between tasks

A PERT chart can document an entire project or a key phase of a project.

PERT chart – What it is

The chart allows a team to avoid unrealistic timetables and schedule expectations, to help identify and shorten tasks that are bottlenecks, and to focus attention on most critical tasks.

PERT chart – When to use it

Because it is primarily a project-management tools, a PERT chart is most useful for planning and tracking entire projects or for scheduling and tracking the implementation phase of a planning or improvement effort.

PERT chart – How to use it

Identify all tasks or project components.

Make sure the team includes people with firsthand knowledge of the project so that during the brainstorming session all component tasks needed to complete the project are captured.

Document the tasks on small note cards.

PERT chart – How to use it

Identify the **first task** that must be completed.

Place the appropriate card at the extreme left of the working surface.

Identify any other tasks that can be started simultaneously with task #1. Align these tasks either above or below task #1 on the working surface.

PERT chart – How to use it

Identify the **next task** that must be completed.

Select a task that must wait to begin until task #1(or a task that starts simultaneously with task #1) is completed.

Place the appropriate card to the right of the card showing the preceding task.

PERT chart – How to use it

Identify **any other tasks** that can be started simultaneously with task #2.

Align these tasks either above or below task #2 on the working surface.

Continue this process until all component tasks are sequenced.

PERT chart – How to use it

Identify **task durations**.

Using the knowledge of team members, reach a consensus on the most likely amount of time each task will require for completion.

Duration time is usually considered to be elapsed time for the task, rather than actual number of hours/days spent doing the work.

Document this duration time on the appropriate task cards.

PERT chart – How to use it

Construct the PERT chart. Number each task, draw connecting arrows, and add task characteristics such as duration, anticipated start date, and anticipated end date.

Determine the critical path. The project's critical path includes those tasks that must be started or completed on time to avoid delays to the total project. Critical paths are typically displayed in red.

PERT chart - Example

The construction of a cottage requires the performance of certain tasks.

Code of task	Task	Duration (weeks)	Prerequisites task
A	Masonary	7	-
B	Carpentry for roof	3	A
C	Roof	1	B
D	Sanitary and electrical Installation	8	A
E	Front	2	D,C
F	Windows	1	D,C
G	Garden	1	D,C
H	Ceiling	3	F
J	Painting	2	H
k	Moving in	1	E, g, j

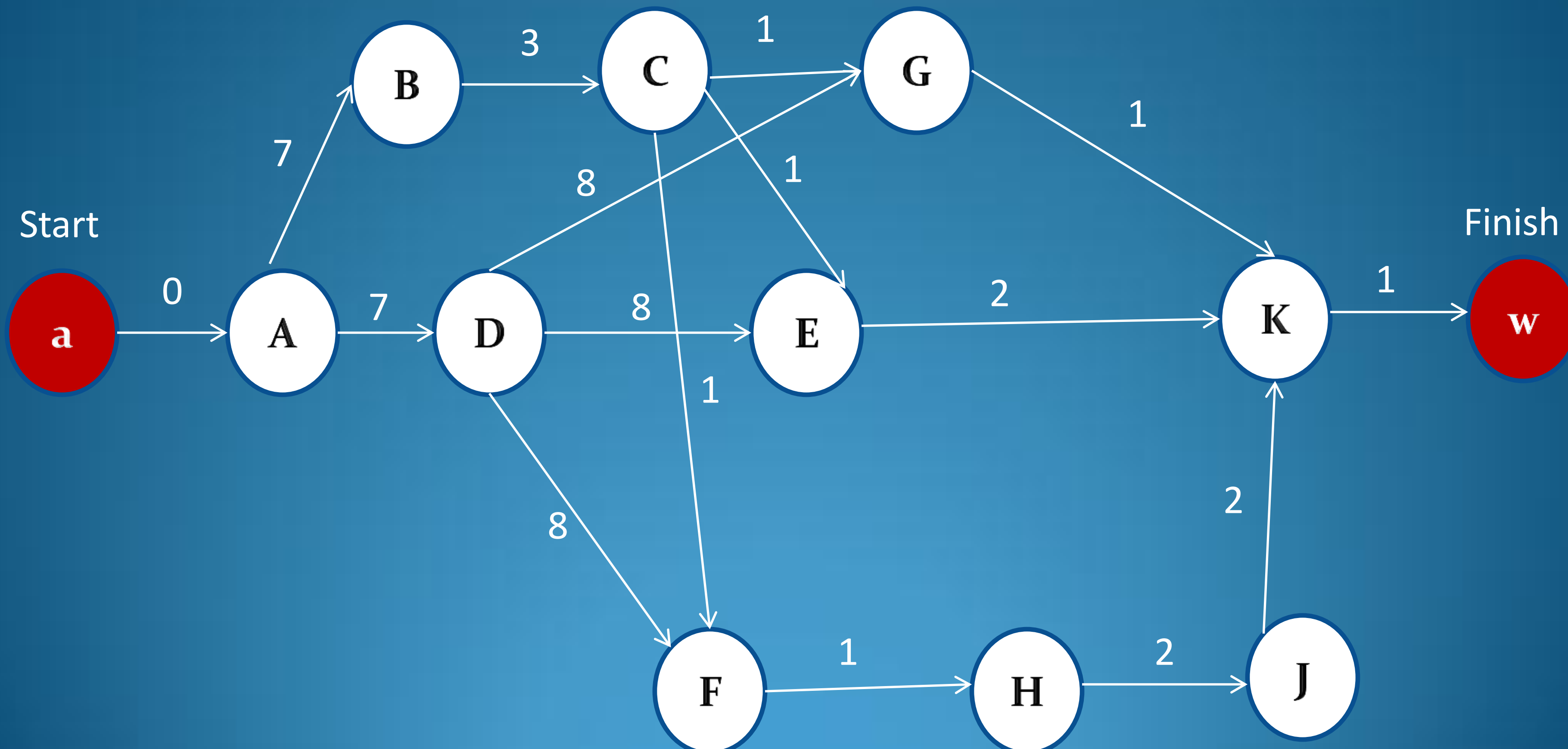
PERT chart - Example

The start task (a) and finish task (W) are added, a is linked to task A and w is linked to task K.

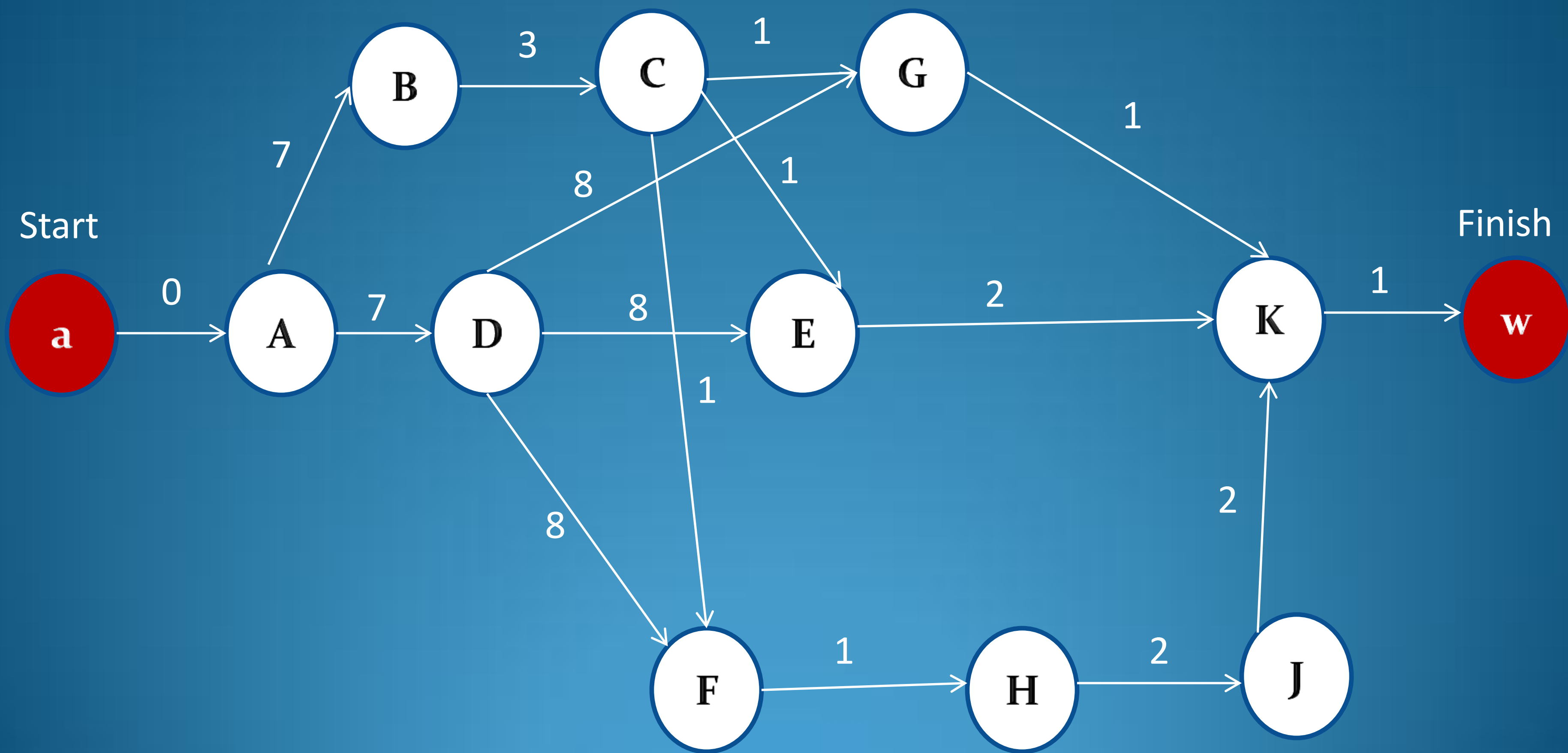
Let S be the set of all tasks and consider the partial order relation R defined on S as follows:

for all tasks x and y in S,xRy $\Leftrightarrow$ x = y or x precedes y.

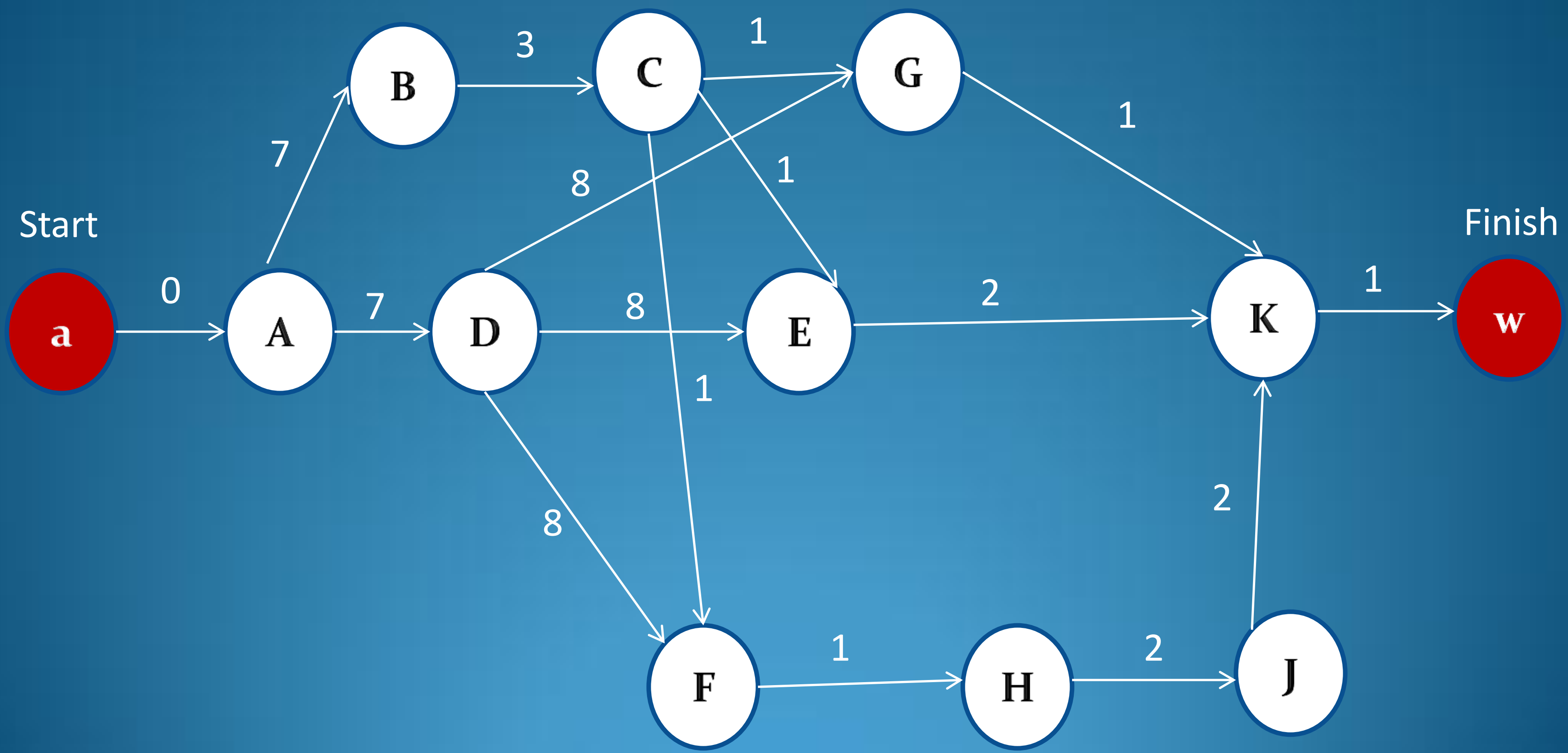
PERT chart - Example



PERT chart - Example



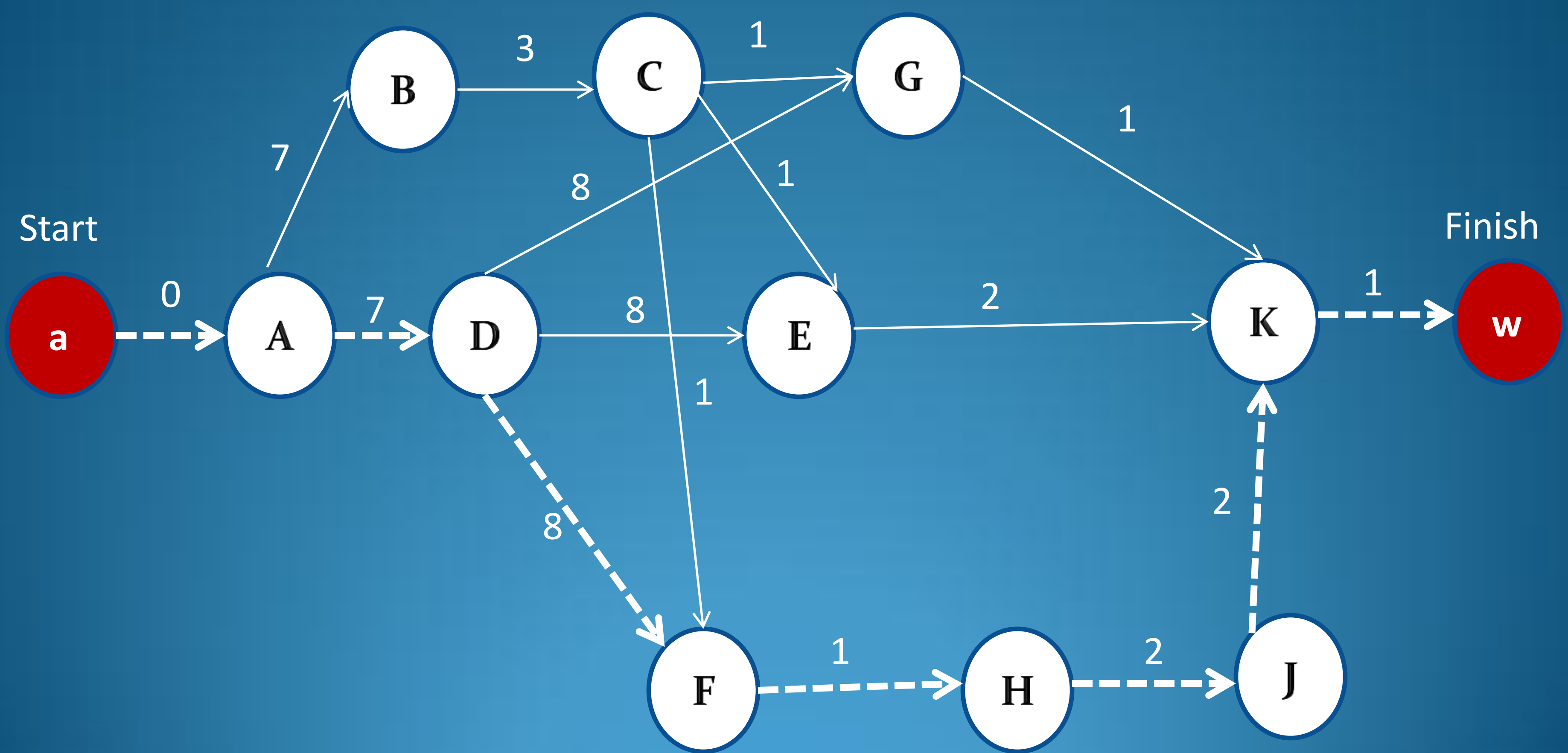
PERT chart - Example



PERT chart - Example

Task	Earliest start time
Start (a)	0
A	0
B	7
C	10
D	7
E	15
F	15
G	15
H	16
J	18
k	20
Finish (w)	21

PERT chart - Example



PERT chart - Example

If we delay any work in this path, we delay in the project finish time.

That means delay in performing any of these tasks in the path cause delay in the time required to finish the project, and for these reason, this path is known as **critical path**.

PERT chart - Example

The tasks outside the critical path can be delayed by certain amount of time.
For example: Task E is not on critical path and it is followed by task K. If we delay E by 3 week than its earliest start time, then we can start the task K as per its earliest start time because K must be started after finishing J which takes 20 weeks. We can finish task E in 20 weeks by delaying 3 weeks.

In the opposition if we delay work on the critical path, we delay the time to complete the project.
For example: 3 weeks delay in task J cause 3 weeks delay to start K, and K start after 3 weeks than its earliest start time and these cause three week delay to complete the project.

Now if we finish task J earlier by one week then we can also reach task K earlier by one week and finish it off. And finally the overall project is also finished one week before.