SEN319 Software Project Management (Fall 2023)

Project Schedule Management

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Agenda

- **PM Knowledge Areas**
- **Project Constraints**
- **Project Schedule Management**
- **Project Schedule Management Processes**
- **Plan Schedule Management**
- **Define Activities**
- **Sequence Activities**
- **Estimate Activity Durations**
- **Develop Schedule**
- **Control Schedule**

PM Knowledge Areas

Integration	• Coordinate activities across all project management areas and process groups
Scope	• Ensure the project work includes all elements required to complete the work
Schedule	• Ensure the project work is completed in a timely way
Cost	• Plan, estimate, manage and control project finances
Quality	• Ensure the project delivers a quality output that is fit for purpose
Resource	• Secure, manage and monitor use of resources throughout the project
Communications	• Ensure communications on the project are planned and carried out appropriately
Risk	• Identify, assess and manage risk
Procurement	• Carry out purchasing and contracting as required
Stakeholder	• Identify and engage stakeholders throughout the project

Project Constraints

Main Constraints:
- **Scope**
- **Time**
- **Cost**

Additional Constraints:
- **Quality**
- **Resources**
- **Risk**

Project Schedule Management

- **Project Schedule Management includes the processes required to manage the timely completion of the project.**

- **In this Knowledge Area (KA) the Work packages from the WBS are taken and broken down into activities.**

- **Once all the activities are found and documented, they are sequenced the way they would be done in the real world and in accordance to the technical and management objectives.**

- **Once the activities are sequenced then the skills and resources needed for different activities are estimated (*but the resource estimation is done in a different KA called "Resource Management"*).**

- **After this, the duration of the activities are also estimated.**

Project Schedule Management Processes

Project Schedule Management				
Initiating	Planning	Executing	Monitoring & Controlling	Closing
	1. Plan Schedule Management 2. Define Activities 3. Sequence Activities 4. Estimate Activity Durations 5. Develop Schedule		6. Control Schedule	

Project Schedule Management Processes

1. **Planning schedule management** involves determining the policies, procedures, and documentation that will be used for planning, executing, and controlling the project schedule.

2. **Defining activities** involves identifying the specific activities that the project team members and stakeholders must perform to produce the project deliverables. An activity or task is an element of work normally found on the work breakdown structure (WBS) that has expected duration, cost, and resource requirements.

3. **Sequencing activities** involves identifying and documenting the relationships between project activities.

4. **Estimating activity durations** involves estimating the number of work periods that are needed to complete individual activities.

5. **Developing the schedule** involves analyzing activity sequences, resource requirements, and activity duration estimates to create the project schedule.

6. **Controlling the schedule** involves controlling and managing changes to the project schedule.

Plan Schedule Management

- **Plan Schedule Management is the process of establishing the policies, procedures, and documentation for planning, developing, managing, executing, and controlling the project schedule.**

- **The key benefit of this process is that it provides guidance and direction on how the project schedule will be managed throughout the project.**

- **This process is performed once or at predefined points in the project.**

Plan Schedule Management

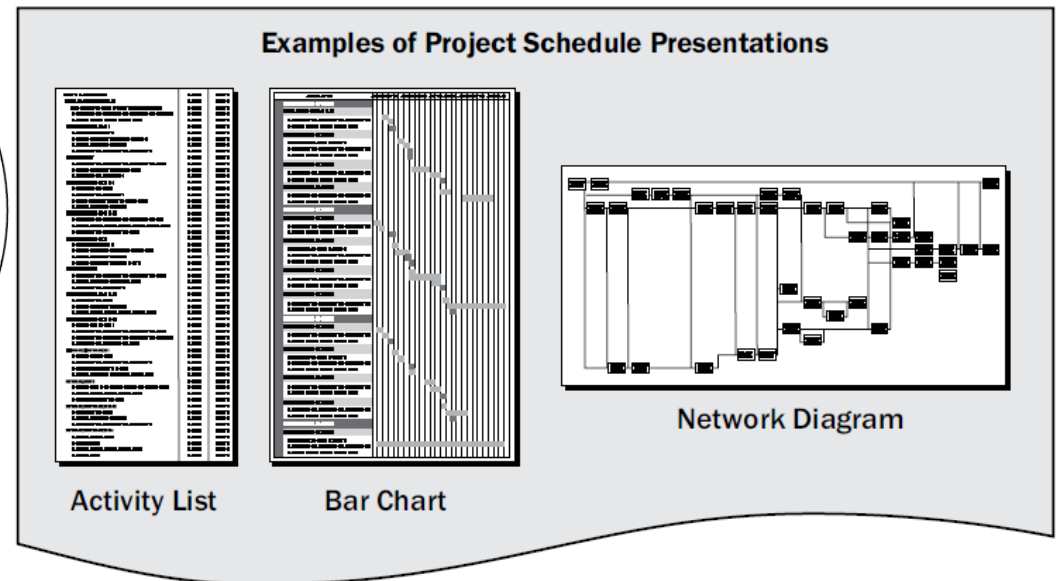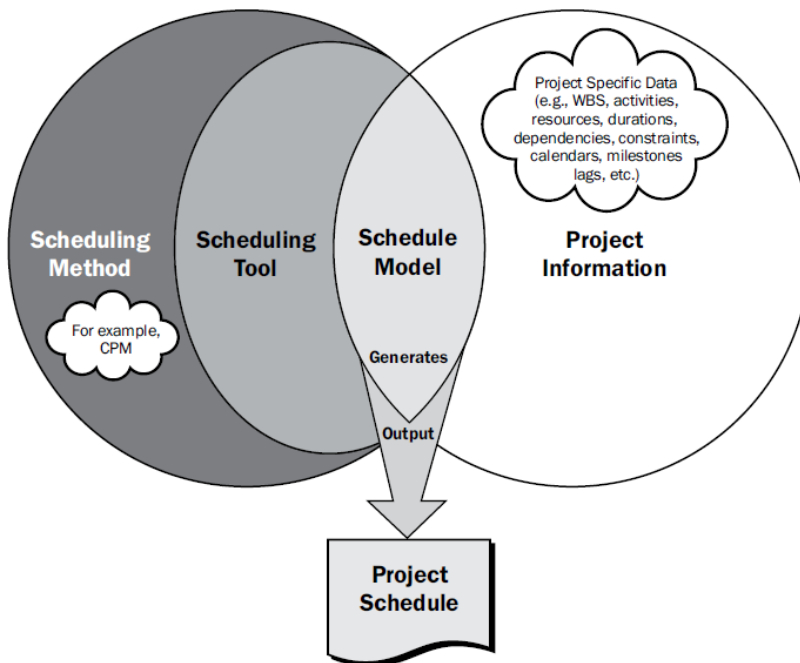| Inputs	Tools & Techniques	Outputs

.1 Project charter
.2 Project management plan
  • Scope management plan
  • Development approach
.3 Enterprise environmental factors
.4 Organizational process assets
	.1 Expert judgment
	.2 Data analysis
	.3 Meetings
		.1 Schedule management plan

Plan Schedule Management

Plan Schedule Management

Output: Schedule Management Plan

- **Project schedule model development**: The scheduling methodology and the scheduling tool to be used in the development of the project schedule model.
- **Release and iteration length**: When using an adaptive life cycle, the time-boxed periods for releases, waves, and iterations are specified.
- **Level of accuracy**: The level of accuracy specifies the acceptable range used in determining realistic activity duration estimates and may include an amount for contingencies.
- **Units of measure**: Hours, days etc.
- **Project schedule model maintenance**: The process used to update the status and record progress of the project in the schedule model during the execution of the project is defined.
- **Control thresholds**: The amount of delay that would be considered worrisome and trigger corrective or preventive actions.
- **Rules of performance measurement**: How to determine performance.
- **Reporting formats**: The formats and frequency for the various schedule reports are defined.

Define Activities

- **Define Activities is the process of identifying and documenting the specific actions to be performed to produce the project deliverables.**

- **The key benefit of this process is that it decomposes work packages into schedule activities that provide a basis for estimating, scheduling, executing, monitoring, and controlling the project work.**

- **This process is performed throughout the project.**

- **Defining activities involves identifying the specific actions that will produce the project deliverables in enough detail to determine resource and schedule estimates.**

- **The project team reviews the project management plan, enterprise environmental factors, and organizational process assets to begin defining activities.**

Define Activities

Inputs	Tools & Techniques	Outputs

.1 Project management plan
   • Schedule management plan
   • Scope baseline
.2 Enterprise environmental factors
.3 Organizational process assets
	.1 Expert judgment
	.2 Decomposition
	.3 Rolling wave planning
	.4 Meetings
		.1 Activity list
		.2 Activity attributes
		.3 Milestone list
		.4 Change requests
		.5 Project management plan updates
		   • Schedule baseline
		   • Cost baseline

Define Activities

Key Concepts

- **Activity list is a tabulation of activities to be included on a project schedule.**
- **The list should include the activity name, an activity identifier or number, and a brief description of the activity.**

Activity ID	Activity Description	Estimated Duration (days)	Preceding Activities	Activity Owner
A	Activity	3		PM
B	Sub-Activity	4	A	Team Member
C	Sub-Activity	6	A	Team Member
D	Activity	2	B, C	PM

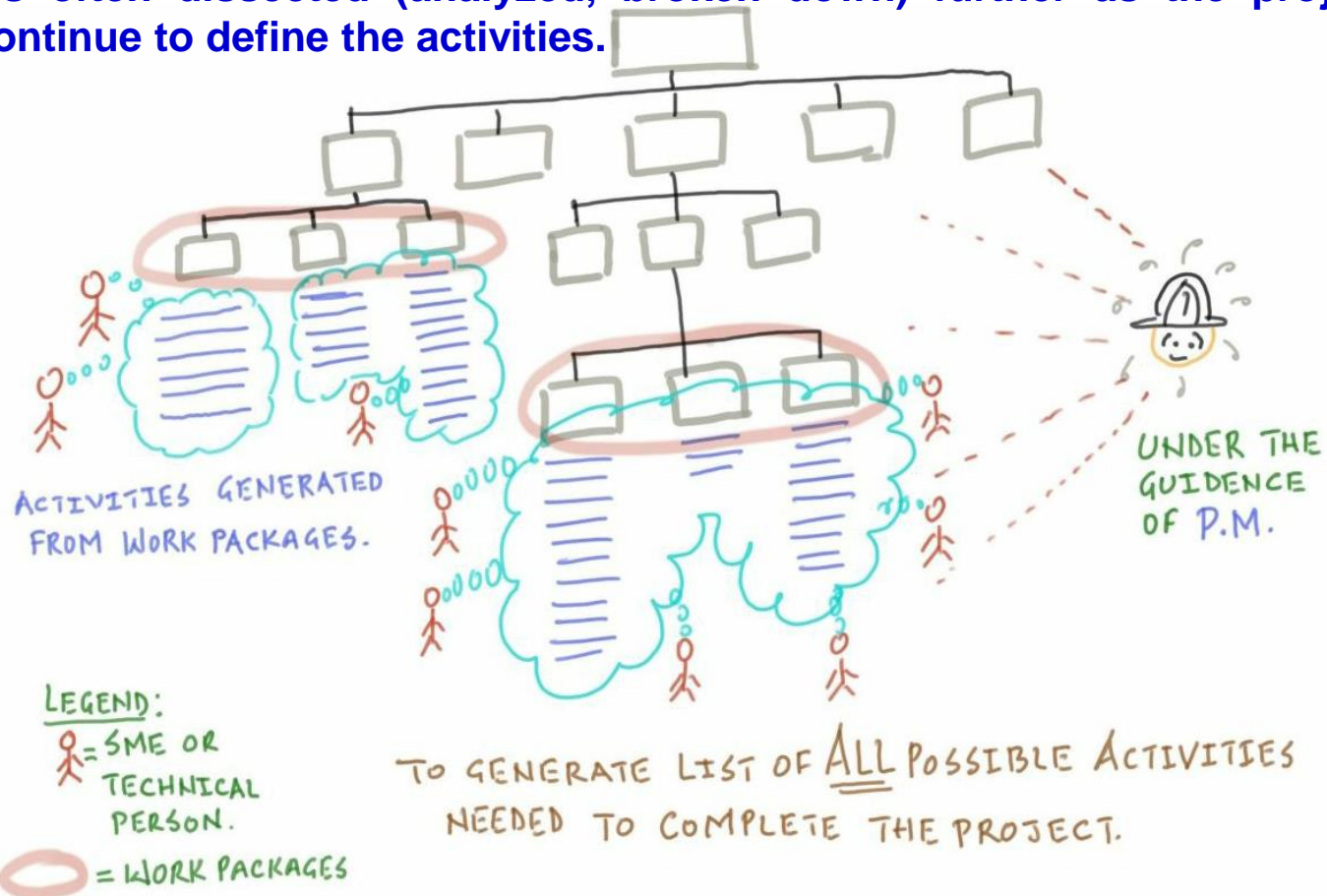# Define Activities

Key Concepts

- A **milestone** is a significant point or event that normally <u>has no duration</u>.

- It often takes several activities to complete a milestone, but the milestone itself is a marker to help in identifying necessary activities.

- Milestones typically mark completion of a phase, or a group of activities or an initiative.

- To make milestones meaningful, some people use the **SMART** criteria to help define them.
- The SMART criteria:
  - Specific
  - Measurable
  - Assignable
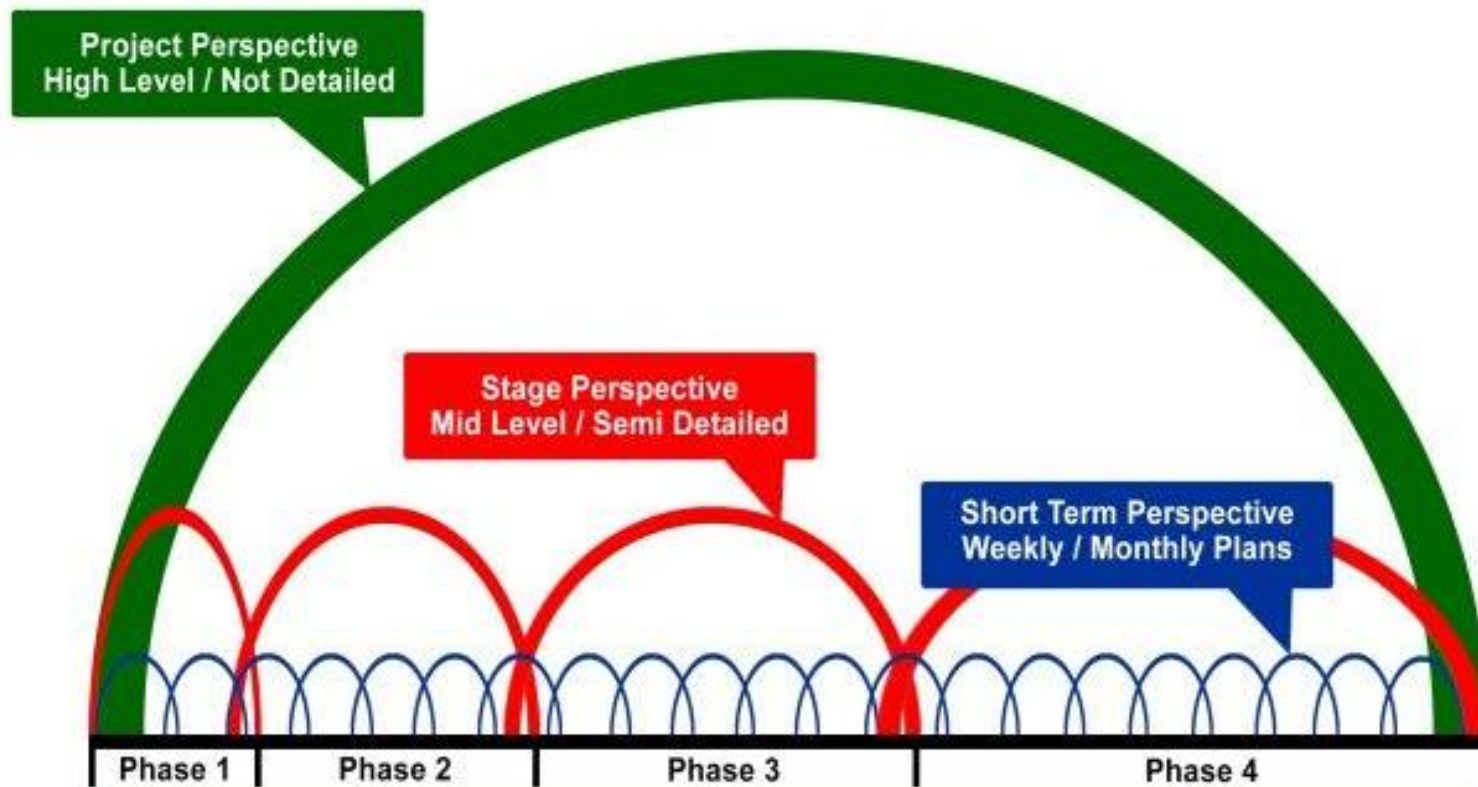 - Realistic
  - Time-framed

Define Activities

- **The goal of defining activities is to ensure that the project team completely understands all the work it must do as part of the project scope so they can start scheduling the work.**

- **The WBS is often dissected (analyzed, broken down) further as the project team members continue to define the activities.**

Define Activities

Tools and Techniques: Rolling Wave Planning

- **Rolling wave planning** is an iterative planning technique in which the work to be accomplished in the near term is planned in detail, while work further in the future is planned at a higher level.

Project Perspective
High Level / Not Detailed

Stage Perspective
Mid Level / Semi Detailed

Short Term Perspective
Weekly / Monthly Plans

Phase 1   Phase 2   Phase 3   Phase 4

Define Activities

Outputs

Activity List
For projects that use rolling wave planning or agile techniques, the activity list will be updated periodically as the project progresses.

Activity Attributes
Extend the description of the activity by identifying multiple components: ID, activity descriptions, predecessor activities, successor activities, logical relationships, resources, imposed dates, constraints, assumptions etc.

Milestone List
Identifies all project milestones and indicates whether the milestone is mandatory, such as those required by contract, or optional, such as those based on historical information. Milestones have zero duration because they represent a significant point or event.

Others
- **Change requests**
- **Project Management Plan Updates**

Sequence Activities

- **Sequence Activities is the process of identifying and documenting relationships among the project activities.**

- **The key benefit of this process is that it defines the logical sequence of work to obtain the greatest efficiency given all project constraints.**

- **This process is performed throughout the project.**

Sequence Activities

Inputs

.1 Project management plan
- Schedule management plan
- Scope baseline

.2 Project documents
- Activity attributes
- Activity list
- Assumption log
- Milestone list

.3 Enterprise environmental factors

.4 Organizational process assets

Tools & Techniques

.1 Precedence diagramming method

.2 Dependency determination and integration

.3 Leads and lags

.4 Project management information system

Outputs

.1 Project schedule network diagrams

.2 Project documents updates
- Activity attributes
- Activity list
- Assumption log
- Milestone list

Sequence Activities

Activity Dependencies

Mandatory Dependencies	Discretionary Dependencies
Legally or contractually required or inherent in the nature of the work. *(Ex.: You cannot erect the superstructure until after the foundation has been built, you cannot test code until after the code is written.)*	Defined by the project team. *(Ex.: Project team might follow good practice and not start the detailed design of a new information system until the users sign off on all of the analysis work.)*

| External Dependencies	Internal Dependencies
Involve relationships between project and non-project activities. *(Ex.: Installation of a new operating system may depend on delivery of new hardware from an external supplier. Even though delivery of the hardware may not be included in the scope of the project, you should add an external dependency to it because late delivery will affect the project schedule.)*	Involve relationships between project activities that are generally inside the project team's control. *(Ex.: If the team cannot test a machine until they assemble it, there is an internal mandatory dependency. The project management team determines which dependencies are internal during the process of sequencing the activities.)*

Sequence Activities

Activity Dependencies

- A **dependency** or **relationship** pertains to the sequencing of project activities or tasks.

  - For example, does a certain activity have to be finished before another can start?

  - Can the project team do several activities in parallel?

  - Can some overlap?

- Determining these relationships or dependencies among activities is crucial for developing and managing a project schedule.
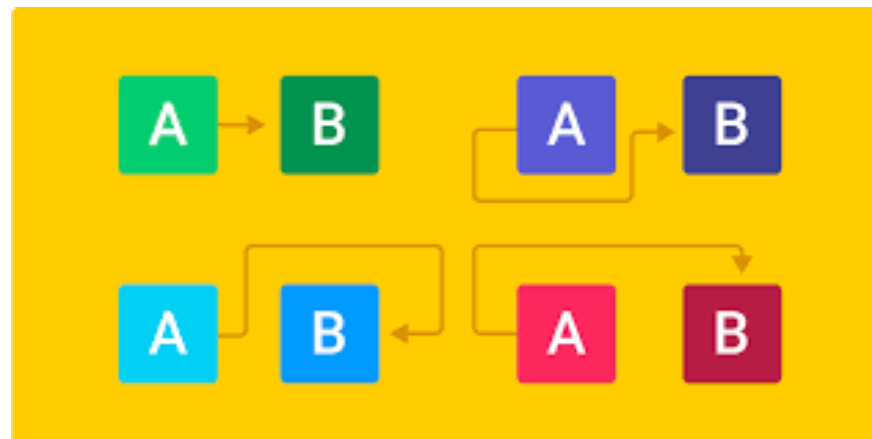
Sequence Activities

Tools and Techniques: Precedence Diagramming Method (PDM)

- PDM is a technique used for constructing a schedule model in which activities are represented by nodes and are graphically linked by one or more logical relationships to show the sequence in which the activities are to be performed.
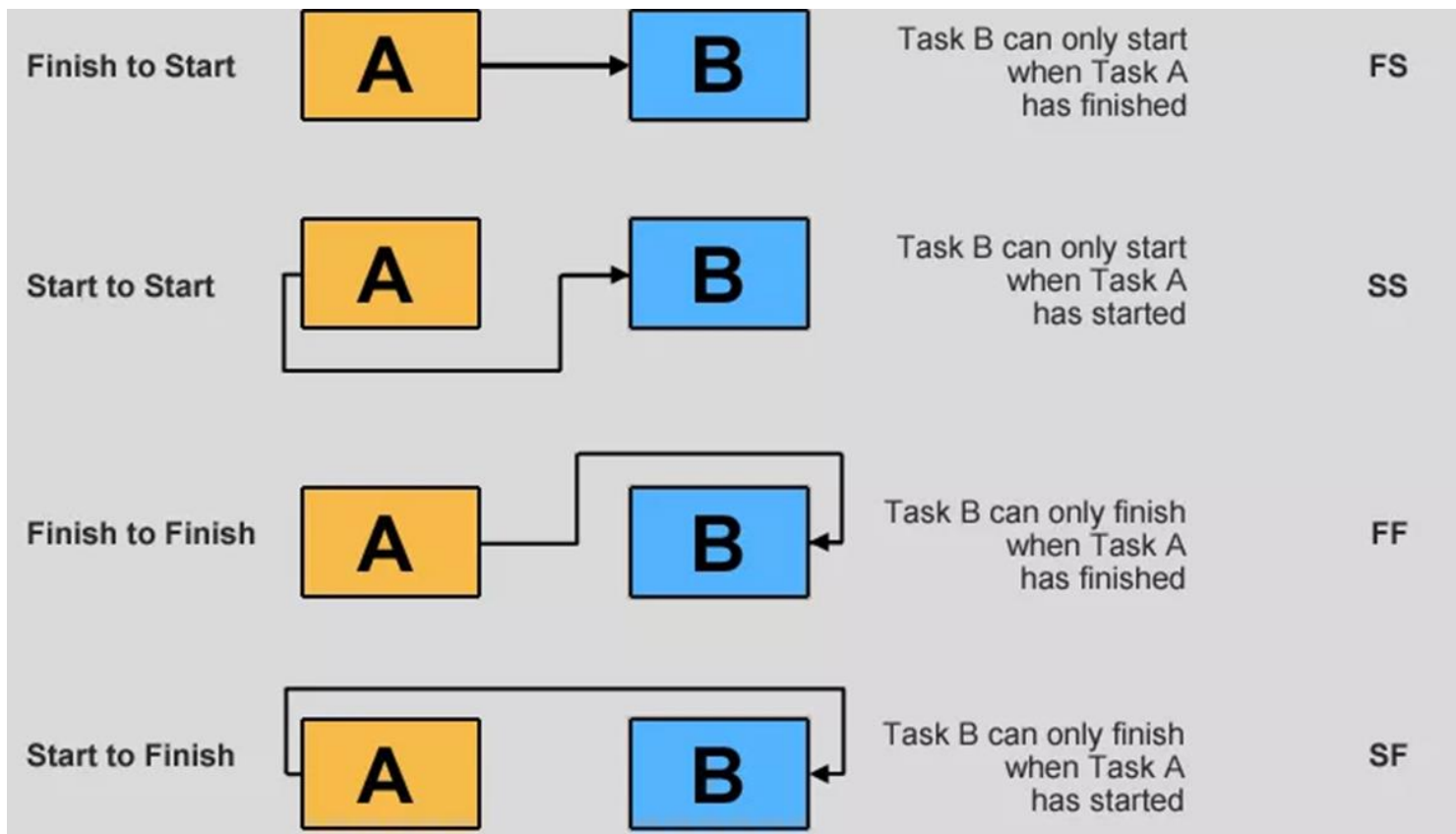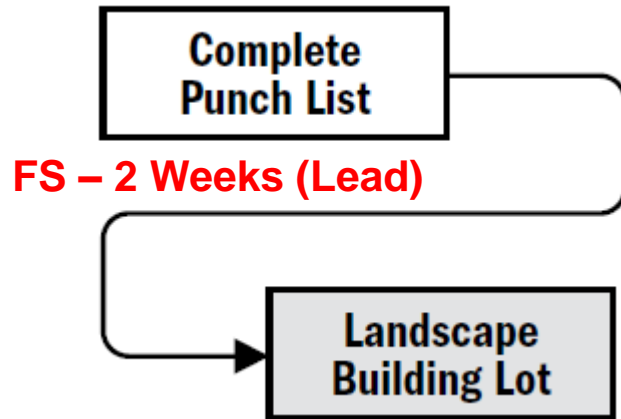
Sequence Activities

Tools and Techniques: Network Diagrams

- **Network diagrams are the preferred technique for showing activity sequencing.**
- **A network diagram is a schematic display of the logical relationships among project activities and their sequencing.**
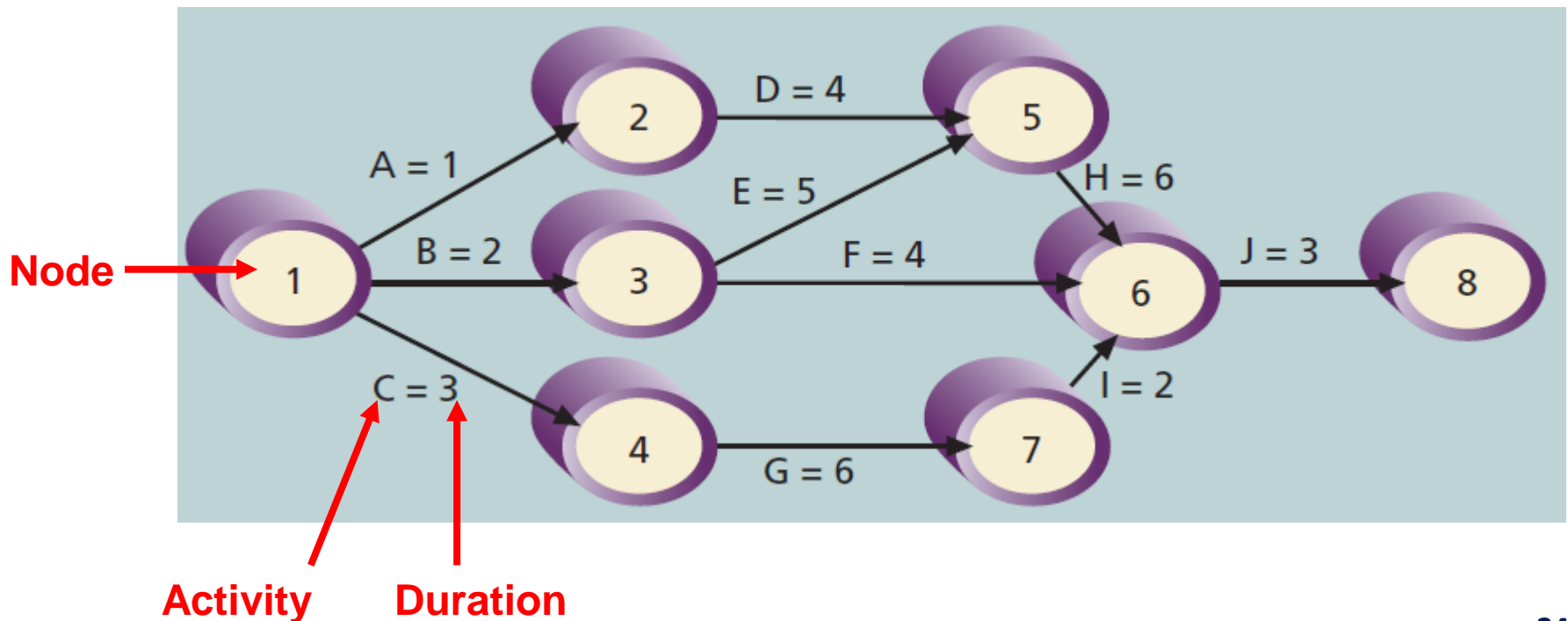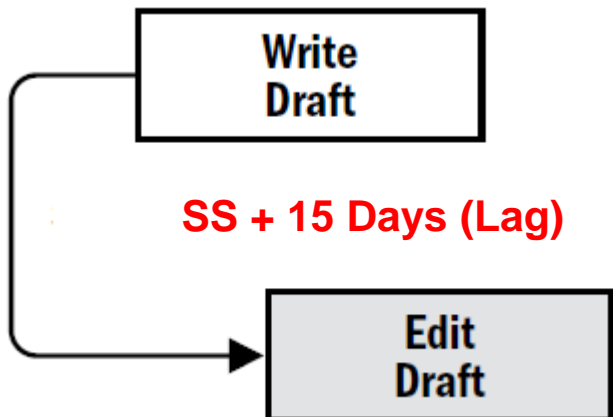
Sequence Activities

Tools and Techniques: Terminology: Lead and Lag

FS – 2 Weeks (Lead)

A **lead** is the amount of time a successor activity can be <u>advanced</u> with respect to a predecessor activity.

(*For example, on a project to construct a new office building, the landscaping could be scheduled to start 2 weeks before the scheduled punch list completion.*)
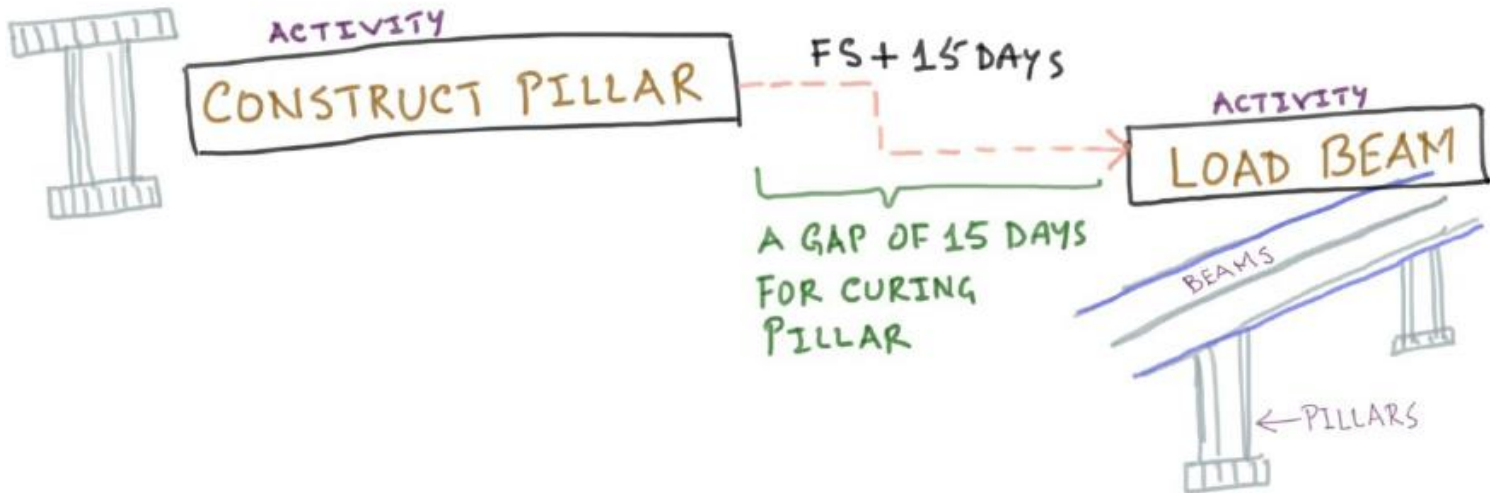

SS + 15 Days (Lag)

A **lag** is the amount of time a successor activity will be <u>delayed</u> with respect to a predecessor activity.

(*For example, a technical writing team may begin editing the draft of a large document 15 days after they begin writing it. This can be shown as a start-to-start relationship with a 15-day lag*)
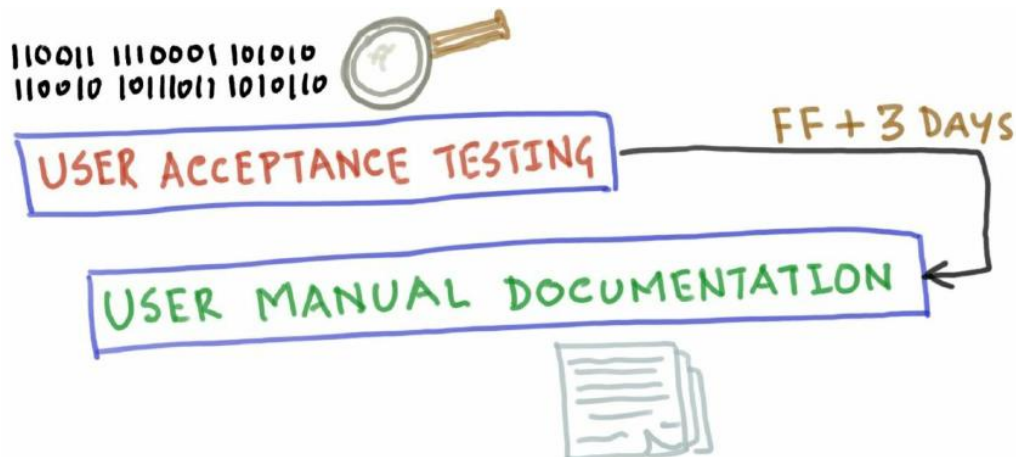
Sequence Activities

Tools and Techniques: Examples for Lead and Lag

Infrastructure Example

ACTIVITY
CONSTRUCT PILLAR
FS + 15 DAYS
ACTIVITY
LOAD BEAM
A GAP OF 15 DAYS FOR CURING PILLAR
BEAMS
← PILLARS

IT Example

110011 1110001 101010
110010 1011101 1010110
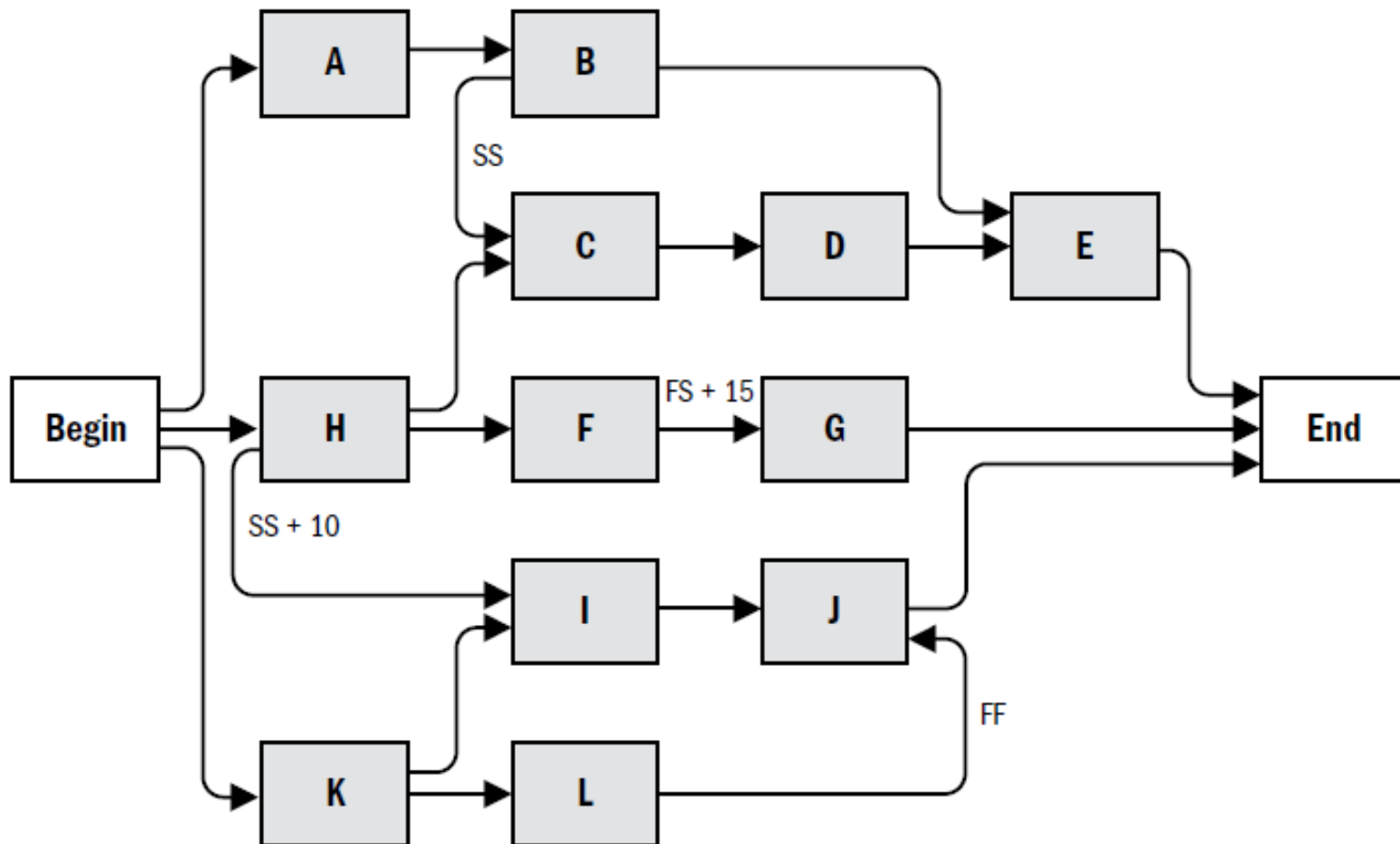USER ACCEPTANCE TESTING
FF + 3 DAYS
USER MANUAL DOCUMENTATION

Sequence Activities

Tools and Techniques: Project Schedule Network Diagram (Example)

Estimate Activity Durations

- After working with key stakeholders to define activities and determine their dependencies, the next process in project schedule management is to estimate the duration of activities.
- Estimate Activity Durations is the process of estimating the number of work periods needed to complete individual activities with estimated resources.
- **The key benefit of this process is that it provides the amount of time each activity will take to complete.**
- **This process is performed throughout the project.**

Estimate Activity Durations

Inputs

.1 Project management plan
- Schedule management plan
- Scope baseline

.2 Project documents
- Activity attributes
- Activity list
- Assumption log
- Lessons learned register
- Milestone list
- Project team assignments
- Resource breakdown structure
- Resource calendars
- Resource requirements
- Risk register

.3 Enterprise environmental factors

.4 Organizational process assets

Tools & Techniques

.1 Expert judgment
.2 Analogous estimating
.3 Parametric estimating
.4 Three-point estimating
.5 Bottom-up estimating
.6 Data analysis
- Alternatives analysis
- Reserve analysis
.7 Decision making
.8 Meetings

Outputs

.1 Duration estimates
.2 Basis of estimates
.3 Project documents updates
- Activity attributes
- Assumption log
- Lessons learned register

Estimate Activity Durations

Effort = Duration x Resources

40 Person-Days = 10 Days   x   4 persons

Effort, which is the number of workdays or work hours required to complete a task.

Duration includes the actual amount of time worked on an activity *plus* elapsed time.

Tools and Techniques: Parametric Estimating

Tools and Techniques: Three Point Estimating

- **Most likely (tM):** This estimate is based on the duration of the activity, given the resources likely to be assigned, their productivity, realistic expectations of availability for the activity, dependencies on other participants, and interruptions.
- **Optimistic (tO):** The activity duration based on analysis of the best-case scenario for the activity.
- **Pessimistic (tP):** The duration based on analysis of the worst-case scenario for the activity.

Expected Duration: $tE = (tO + tM + tP) / 3$

Develop Schedule

- **Develop Schedule is the process of analyzing activity sequences, durations, resource requirements, and schedule constraints to create a schedule model for project execution and monitoring and controlling.**
- **The key benefit of this process is that it generates a schedule model with planned dates for completing project activities.**
- **This process is performed throughout the project.**
- **Schedule development uses the results of all the preceding project schedule management processes to determine the start and end dates of the project and its activities.**

Develop Schedule

Inputs

.1 Project management plan
- Schedule management plan
- Scope baseline

.2 Project documents
- Activity attributes
- Activity list
- Assumption log
- Basis of estimates
- Duration estimates
- Lessons learned register
- Milestone list
- Project schedule network diagrams
- Project team assignments
- Resource calendars
- Resource requirements
- Risk register

.3 Agreements

.4 Enterprise environmental factors

.5 Organizational process assets

Tools & Techniques

.1 Schedule network analysis
.2 Critical path method
.3 Resource optimization
.4 Data analysis
- What-if scenario analysis
- Simulation
.5 Leads and lags
.6 Schedule compression
.7 Project management information system
.8 Agile release planning

Outputs

.1 Schedule baseline
.2 Project schedule
.3 Schedule data
.4 Project calendars
.5 Change requests
.6 Project management plan updates
- Schedule management plan
- Cost baseline
.7 Project documents updates
- Activity attributes
- Assumption log
- Duration estimates
- Lessons learned register
- Resource requirements
- Risk register

Develop Schedule

Tools and Techniques: Critical Path Method (CPM)

- **CPM is a network diagramming technique used to predict total project duration.**

- **Even though the critical path is the longest path, it represents the shortest time required to complete a project.**

- **Slack or float is the amount of time an activity may be delayed without delaying a succeeding activity or the project finish date.**
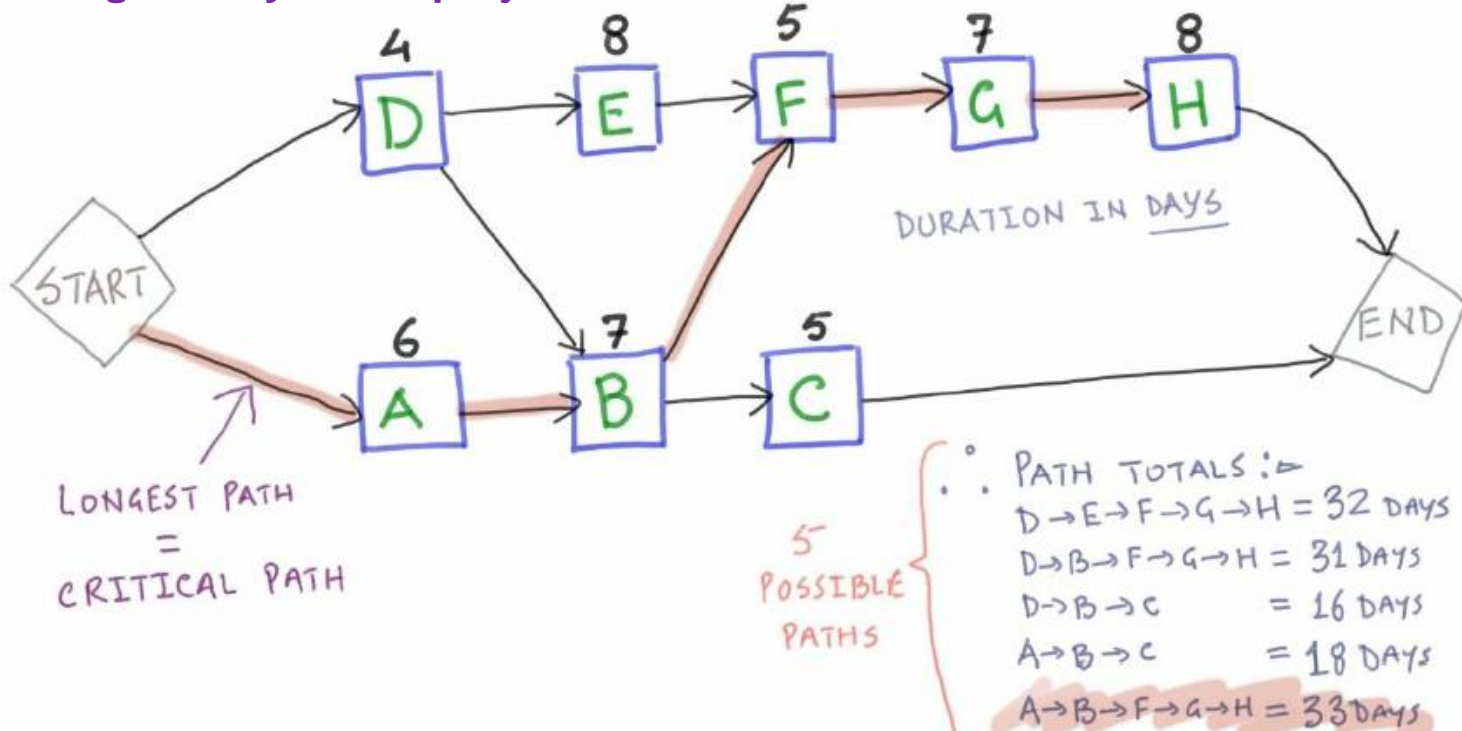
Tools and Techniques: **Critical Path Method (CPM)**

# Do Not Confuse!

- **Some people think the critical path includes the most critical activities, but it is concerned only with the time dimension of a project.**

- **Even though the critical path is the longest path, it represents the shortest time required to complete a project.**

  - **In some areas, such as transportation modeling, identifying the shortest path in network diagrams is the goal. For a project, however, each task or activity on the critical path, as well as other paths, must be done in order to complete the project. It is not a matter of choosing the shortest path.**

Tools and Techniques: Critical Path Method (CPM)
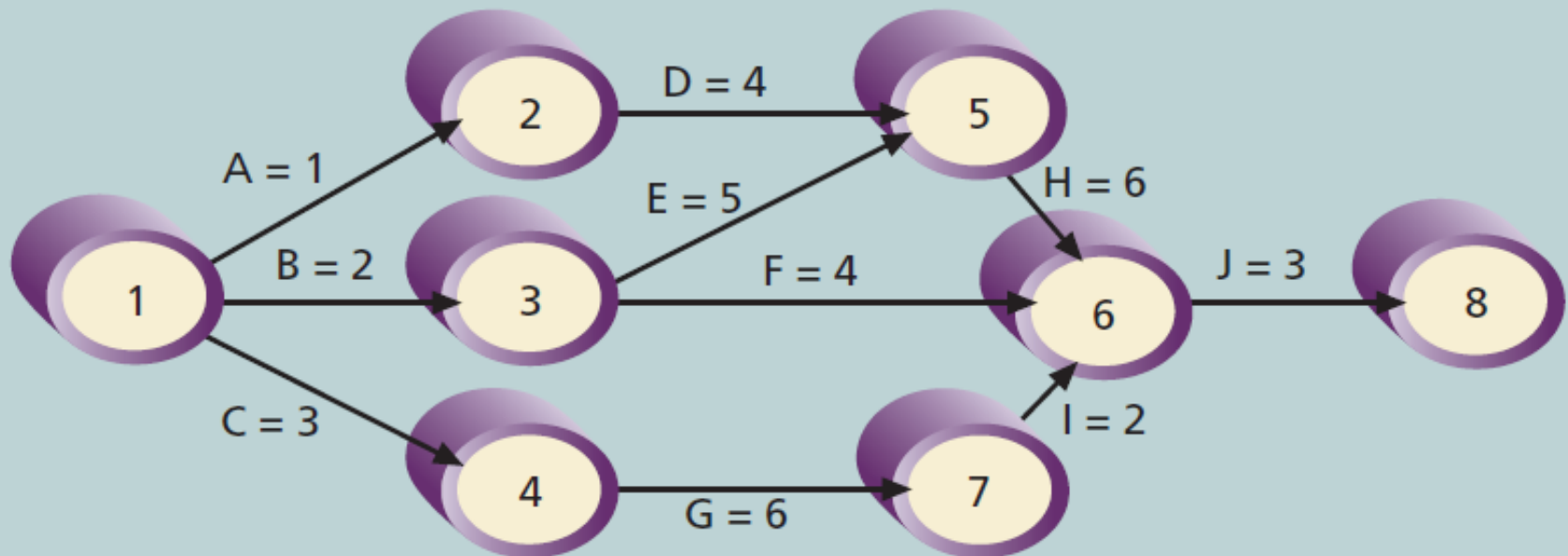
Note: Assume all durations are in days.
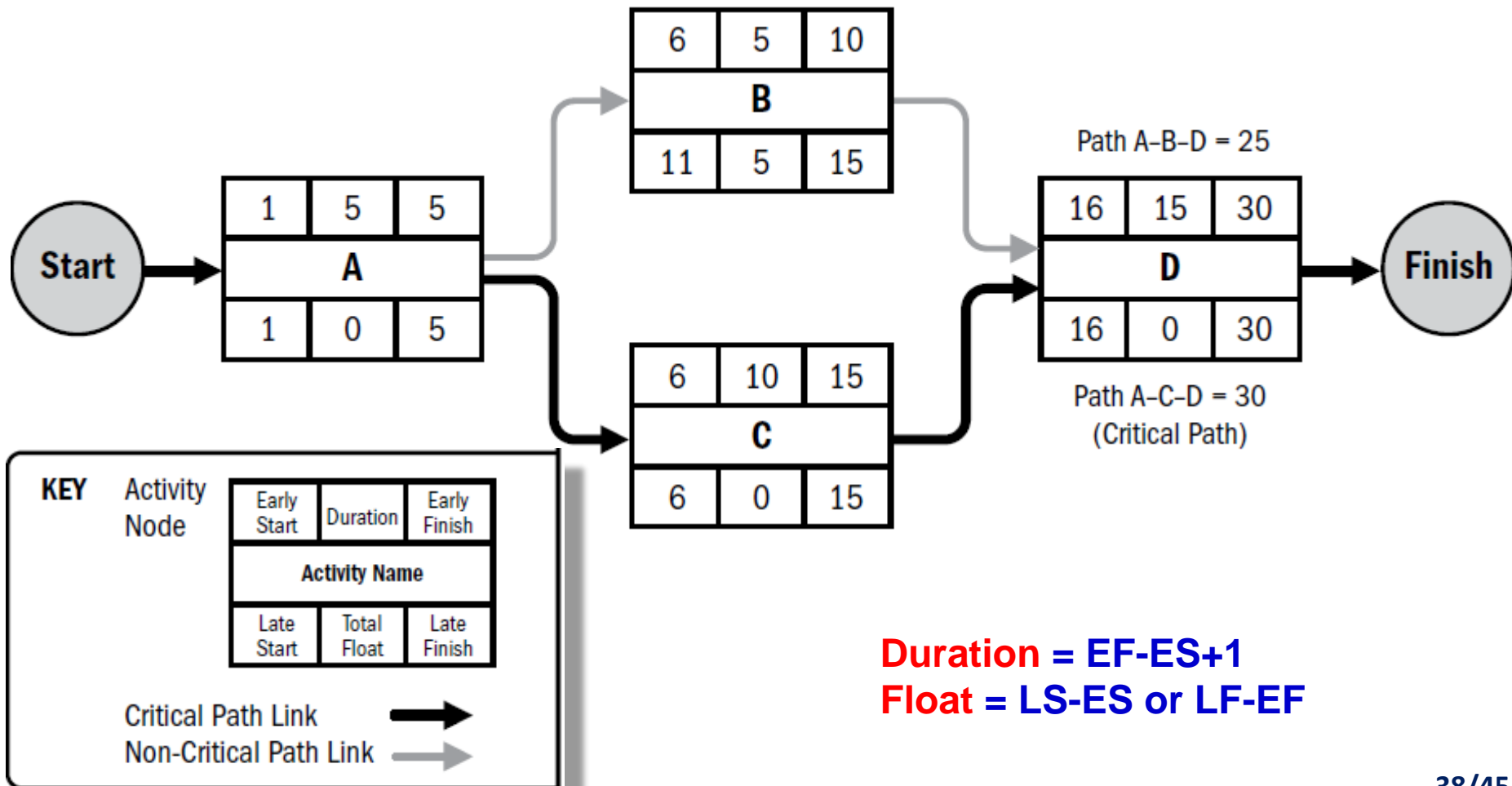
Path 1:	A-D-H-J	Length = 1+4+6+3 = 14 days
Path 2:	B-E-H-J	Length = 2+5+6+3 = 16 days
Path 3:	B-F-J	Length = 2+4+3 = 9 days
Path 4:	C-G-I-J	Length = 3+6+2+3 = 14 days

Tools and Techniques: Critical Path Method (CPM)

6	5	10
B		
11	5	15

Path A–B–D = 25

1	5	5
A		
1	0	5

Start

16	15	30
D		
16	0	30

Finish

6	10	15
C		
6	0	15

Path A–C–D = 30
(Critical Path)

KEY Activity Node

Early Start	Duration	Early Finish
Activity Name		
Late Start	Total Float	Late Finish

Critical Path Link ➡
Non-Critical Path Link ➡

Duration = EF-ES+1
Float = LS-ES or LF-EF

Tools and Techniques: Critical Path Method (CPM)

| Activity	Predecessor	Duration (days)
A	-	3
B	A	4
C	A	2
D	B	5
E	C	1
F	C	2
G	D,E	4
H	F,G	3
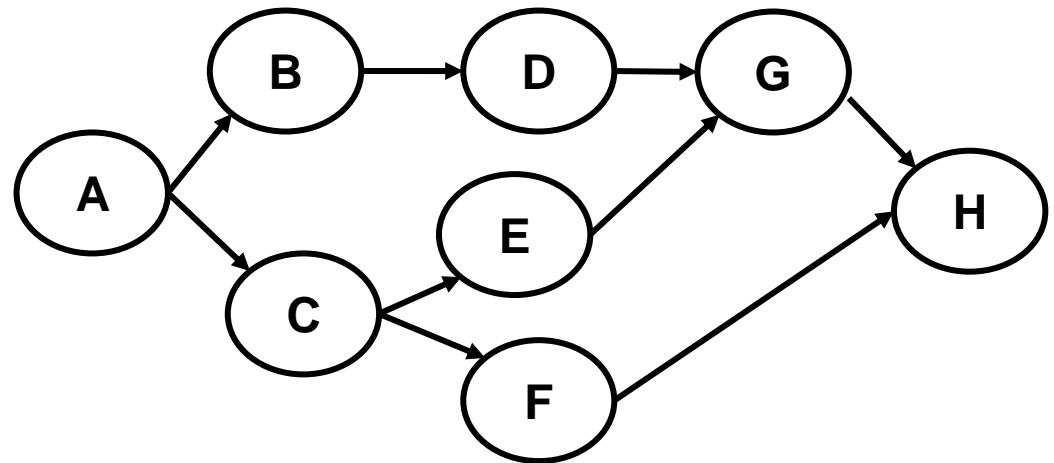
Tools and Techniques: Critical Path Method (CPM)
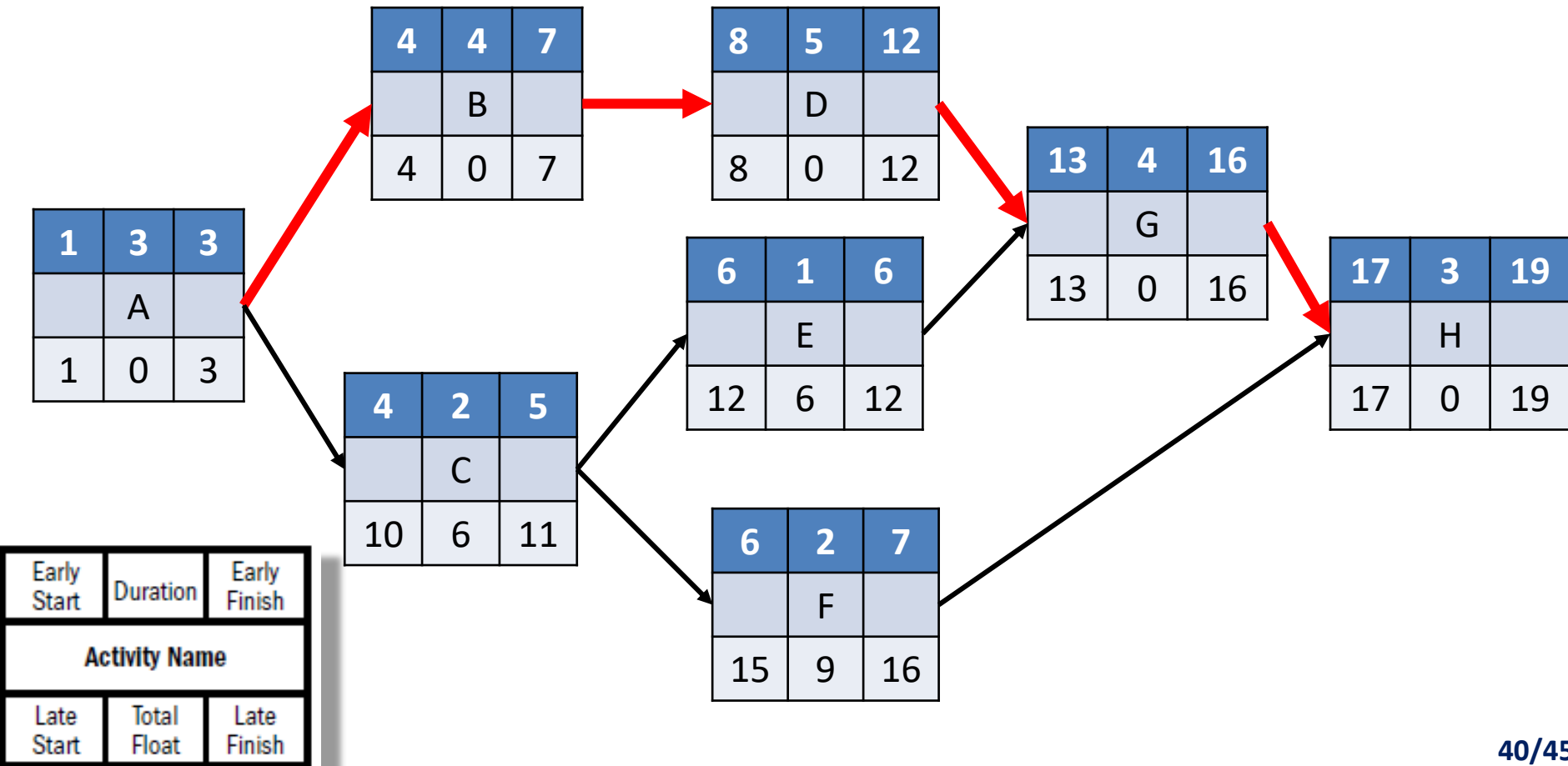
Develop Schedule

Tools and Techniques: Gantt Chart

- **Gantt charts provide a standard format for displaying project schedule information by listing project activities and their corresponding start and finish dates in calendar form.**
- **Gantt charts are sometimes referred to as bar charts because the activities' start and end dates are shown as horizontal bars.**
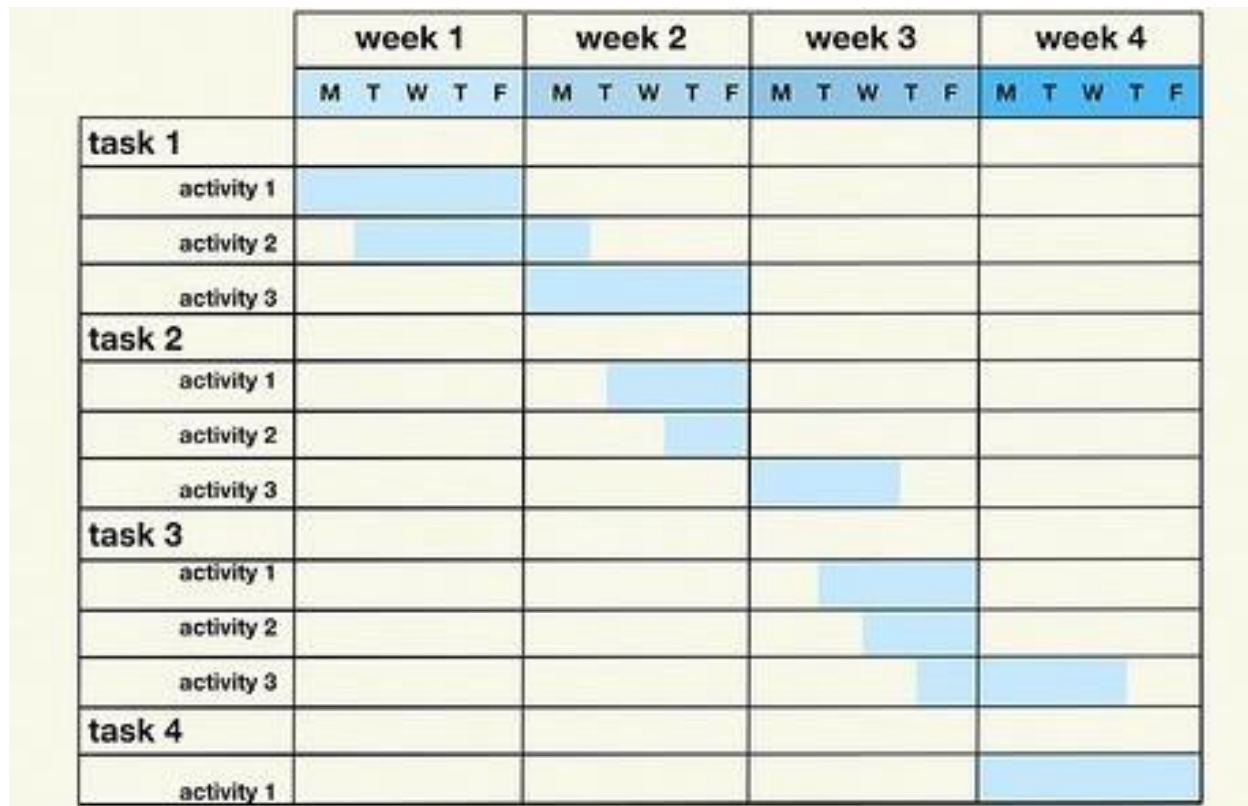
Develop Schedule

Tools and Techniques: PERT

- **Program Evaluation and Review Technique (PERT) technique is used when there is a high degree of uncertainty about the individual activity duration estimates.**

- **PERT applies the critical path method (CPM) to a weighted average duration estimate.**

- **This approach was developed at about the same time as CPM, in the late 1950s, and it also uses network diagrams, which are still sometimes referred to as PERT charts.**

- **PERT uses probabilistic time estimates instead of one specific or discrete duration estimate, as CPM does.**

PERT weight average =

$$\text{PERT weight average} = \frac{\text{Optimistic time} + 4 \times \text{Most likely time} + \text{Pessimistic time}}{6}$$

Control Schedule

- **The final process in project schedule management is controlling the schedule.**

- **Control Schedule is the process of monitoring the status of the project to update the project schedule and managing changes to the schedule baseline.**

- **The key benefit of this process is that the schedule baseline is maintained throughout the project.**

- **This process is performed throughout the project.**

- **Like scope control, schedule control is a portion of the integrated change control process in project integration management.**

- **The goal of schedule control is to know the status of the schedule, influence the factors that cause schedule changes, determine that the schedule has changed, and manage changes when they occur.**

Control Schedule

Inputs

.1 Project management plan
- Schedule management plan
- Schedule baseline
- Scope baseline
- Performance measurement baseline

.2 Project documents
- Lessons learned register
- Project calendars
- Project schedule
- Resource calendars
- Schedule data

.3 Work performance data

.4 Organizational process assets

Tools & Techniques

.1 Data analysis
- Earned value analysis
- Iteration burndown chart
- Performance reviews
- Trend analysis
- Variance analysis
- What-if scenario analysis

.2 Critical path method

.3 Project management information system

.4 Resource optimization

.6 Leads and lags

.7 Schedule compression

Outputs

.1 Work performance information

.2 Schedule forecasts

.3 Change requests

.4 Project management plan updates
- Schedule management plan
- Schedule baseline
- Cost baseline
- Performance measurement baseline

.5 Project documents updates
- Assumption log
- Basis of estimates
- Lessons learned register
- Project schedule
- Resource calendars
- Risk register
- Schedule data

Thank you…

Hasan ÇİFCİ