Project Time Management

Learning Objectives

- Understand the importance of project schedules and good project time management
- Discuss the process of planning schedule management
- Define activities as the basis for developing project schedules
- Describe how project managers use network diagrams and dependencies to assist in activity sequencing
- Understand the relationship between estimating resources and project schedules
- Explain how various tools and techniques help project managers perform activity duration estimates

Learning Objectives

- Use a Gantt chart for planning and tracking schedule information, find the critical path for a project, and describe how critical chain scheduling and the Program Evaluation and Review Technique (PERT) affect schedule development
- Discuss how reality checks and discipline are involved in controlling and managing changes to the project schedule
- Describe how project management software can assist in project time management and review words of caution before using this software

Importance of Project Schedules

- Managers often cite delivering projects on time as one of their biggest challenges
- Time has the least amount of flexibility; it passes no matter what happens on a project
- Schedule issues are the main reason for conflicts on projects, especially during the second half of projects

Individual Work Styles and Cultural Differences Cause Schedule Conflicts

- One dimension of the Meyers-Briggs Type Indicator focuses on peoples' attitudes toward structure and deadline
- Some people prefer to follow schedules and meet deadlines while others do not
- Difference cultures and even entire countries have different attitudes about schedules

Project Time Management Summary

Planning
Process: **Plan schedule management**
Outputs: Schedule management plan
Process: **Define activities**
Outputs: Activity list, activity attributes, milestone list, project management plan updates
Process: **Sequence activities**
Outputs: Project schedule network diagrams, project documents updates
Process: **Estimate activity resources**
Outputs: Activity resource requirements, resource breakdown structure, project documents updates
Process: **Estimate activity durations**
Outputs: Activity duration estimates, project documents updates
Process: **Develop schedule**
Outputs: Schedule baseline, project schedule, schedule data, project calendars, project management plan updates, project documents updates

Monitoring and Controlling
Process: **Control schedule**
Outputs: Work performance information, schedule forecasts, change requests, project management plan updates, project documents updates, organizational process assets updates

Project Start → **Project Finish**

Planning Schedule Management

- The project team uses expert judgment, analytical techniques, and meetings to develop the schedule management plan
- A schedule management plan includes:
  - Project schedule model development
  - The scheduling methodology
  - Level of accuracy and units of measure
  - Control thresholds
  - Rules of performance measurement
  - Reporting formats
  - Process descriptions

Defining Activities

- An **activity** or **task** is an element of work normally found on the WBS that has an expected duration, a cost, and resource requirements
- Activity definition involves developing a more detailed WBS and supporting explanations to understand all the work to be done so you can develop realistic cost and duration estimates

Identifying the Activities of a Project

- To determine optimal schedules we need to
  - Identify all the project's activities.
  - Determine the precedence relations among activities.
- Based on this information we can develop managerial tools for project control.

Identifying Activities, Example

KLONE COMPUTERS, INC.

- KLONE Computers manufactures personal computers.
- It is about to design, manufacture, and market the Klonepalm 2016 palmbook computer.

KLONE COMPUTERS, INC

- There are three major tasks to perform:
  - Manufacture the new computer.
  - Train staff and vendor representatives.
  - Advertise the new computer.
- KLONE needs to develop a precedence relations chart.
- The chart gives a concise set of tasks and their immediate predecessors.

KLONE COMPUTERS, INC

	Activity	Description
Manufacturing activities	A	Prototype model design
	B	Purchase of materials
	C	Manufacture of prototype model
	D	Revision of design
	E	Initial production run
Training activities	F	Staff training
	G	Staff input on prototype models
	H	Sales training
Advertising activities	I	Pre-production advertising campaign
	J	Post-redesign advertising campaign

KLONE COMPUTERS, INC

From the activity description chart, we can determine immediate predecessors for each activity.

Activity A is an immediate predecessor of activity B, because it must be compete just prior to the commencement of B.

KLONE COMPUTERS, INC

Precedence Relationships Chart

Activity	Immediate Predecessor	Estimated Completion Time
A	None	90
B	A	15
C	B	5
D	G	20
E	D	21
F	A	25
G	C,F	14
H	D	28
I	A	30
J	D,I	45

KLONE COMPUTERS, INC. - Continued

- Management at KLONE would like to schedule the activities so that the project is completed in minimal time.
- Management wishes to know:
  - The earliest and latest start times for each activity which will not alter the earliest completion time of the project.
  - The earliest finish times for each activity which will not alter this date.
  - Activities with rigid schedule and activities that have slack in their schedules.

Activity Lists and Attributes

- An **activity list** is a tabulation of activities to be included on a project schedule that includes
  - the activity name
  - an activity identifier or number
  - a brief description of the activity
- **Activity attributes** provide more information such as predecessors, successors, logical relationships, leads and lags, resource requirements, constraints, imposed dates, and assumptions related to the activity

Milestones

- A **milestone** is a significant event that normally has no duration
- It often takes several activities and a lot of work to complete a milestone
- They're useful tools for setting schedule goals and monitoring progress
- Examples include obtaining customer sign-off on key documents or completion of specific products

Sequencing Activities

- Involves reviewing activities and determining dependencies
- A **dependency** or **relationship** is the sequencing of project activities or tasks
- You *must* determine dependencies in order to use critical path analysis

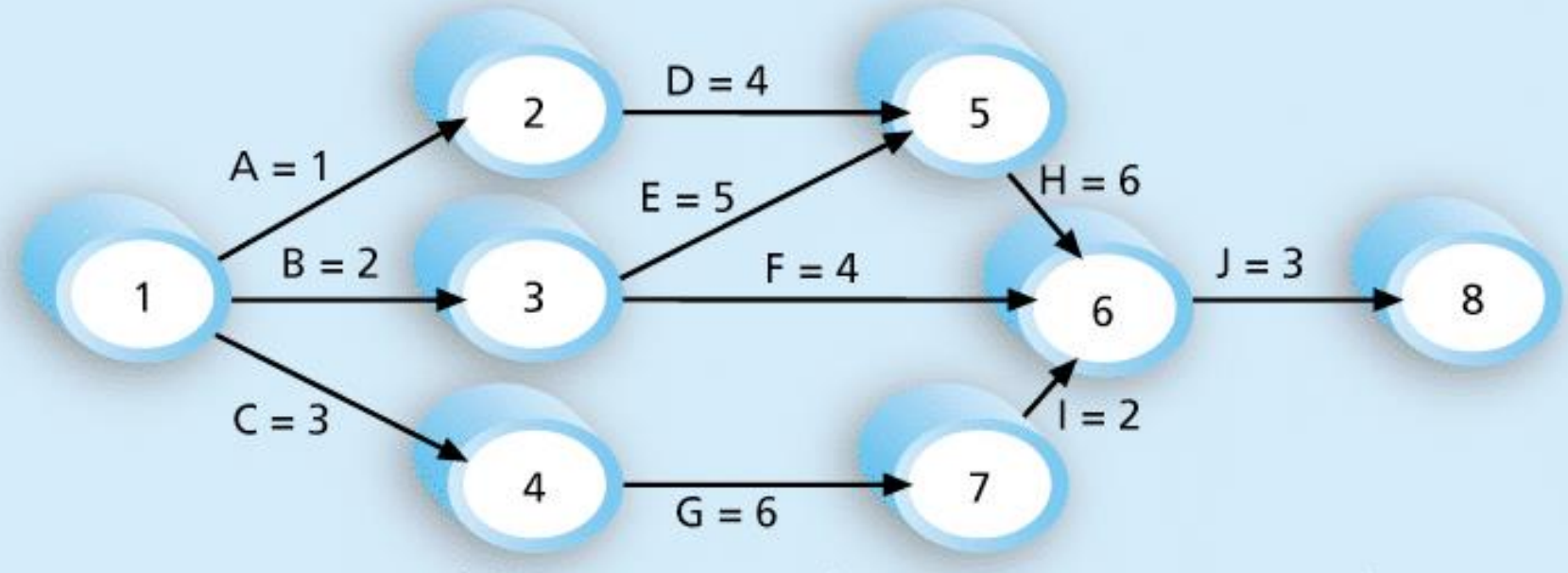
Three types of Dependencies

- **Mandatory dependencies:** inherent in the nature of the work being performed on a project, sometimes referred to as hard logic
- **Discretionary dependencies:** defined by the project team, sometimes referred to as soft logic and should be used with care since they may limit later scheduling options
- **External dependencies:** involve relationships between project and non-project activities

Network Diagrams

- Network diagrams are the preferred technique for showing activity sequencing
- A **network diagram** is a schematic display of the logical relationships among, or sequencing of, project activities
- Two main formats are the arrow and precedence diagramming methods

Network Diagram for Project X



Note: Assume all durations are in days; A=1 means Activity A has a duration of 1 day.

Arrow Diagramming Method (ADM)

- Also called activity-on-arrow (AOA) network diagrams
- Activities are represented by arrows
- Nodes or circles are the starting and ending points of activities
- Can only show finish-to-start dependencies

Process for Creating AOA Diagrams

1. Find all of the activities that start at node 1. Draw their finish nodes and draw arrows between node 1 and those finish nodes. Put the activity letter or name and duration estimate on the associated arrow
2. Continuing drawing the network diagram, working from left to right. Look for bursts and merges. **Bursts** occur when a single node is followed by two or more activities. A **merge** occurs when two or more nodes precede a single node
3. Continue drawing the project network diagram until all activities are included on the diagram that have dependencies
4. As a rule of thumb, all arrowheads should face toward the right, and no arrows should cross on an AOA network diagram

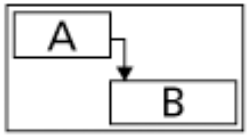
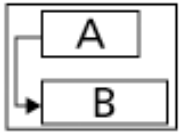
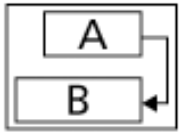
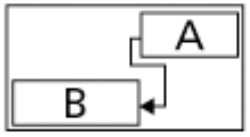
Precedence Diagramming Method (PDM)

- Activities are represented by boxes
- Arrows show relationships between activities
- More popular than ADM method and used by project management software
- Better at showing different types of dependencies

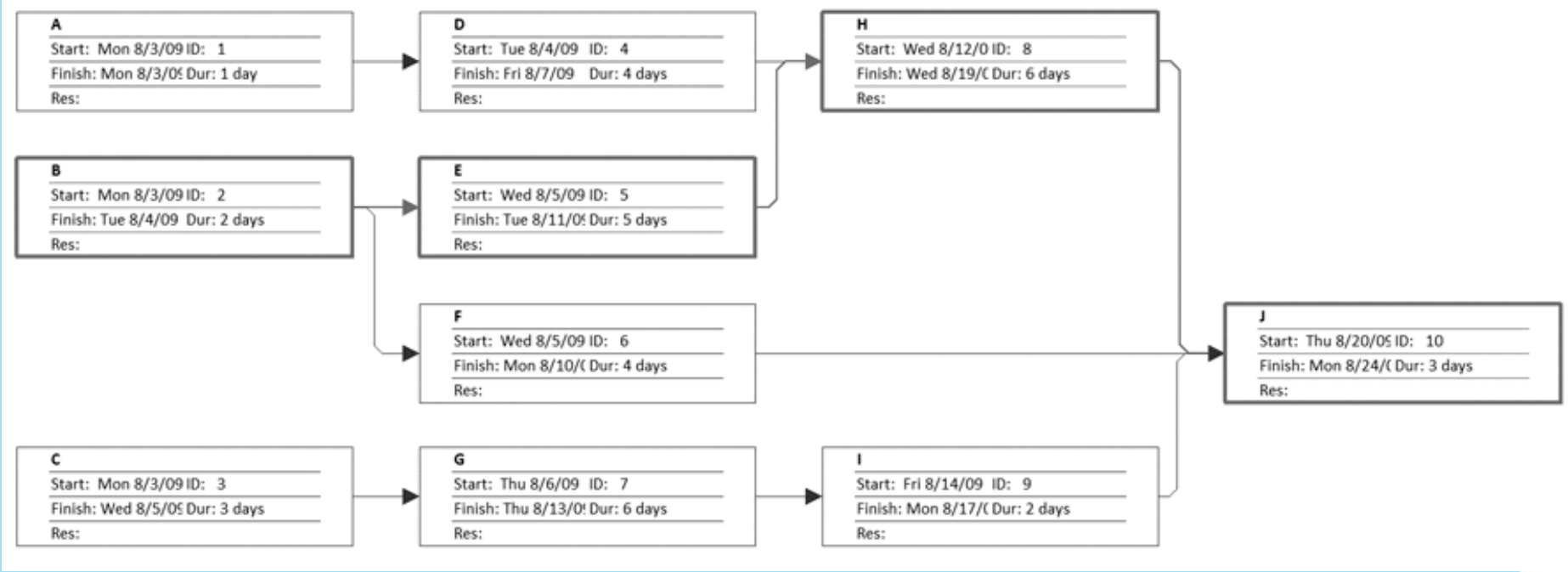
Task Dependency Types

Task dependencies

The nature of the relationship between two linked tasks. You link tasks by defining a dependency between their finish and start dates. For example, the "Contact caterers" task must finish before the start of the "Determine menus" task. There are four kinds of task dependencies in Microsoft Project.

Task dependency	Example	Description
Finish-to-start (FS)		Task (B) cannot start until task (A) finishes.
Start-to-start (SS)		Task (B) cannot start until task (A) starts.
Finish-to-finish (FF)		Task (B) cannot finish until task (A) finishes.
Start-to-finish (SF)		Task (B) cannot finish until task (A) starts.

Sample PDM Network Diagram



Estimating Activity Resources

- Before estimating activity durations, you must have a good idea of the quantity and type of resources that will be assigned to each activity; **resources** are people, equipment, and materials
- Consider important issues in estimating resources
  - How difficult will it be to do specific activities on this project?
  - What is the organization's history in doing similar activities?
  - Are the required resources available?
- A **resource breakdown structure** is a hierarchical structure that identifies the project's resources by category and type

Activity Duration Estimating

- **Duration** includes the actual amount of time worked on an activity *plus* elapsed time
- **Effort** is the number of workdays or work hours required to complete a task
- Effort does not normally equal duration
- People doing the work should help create estimates, and an expert should review them

Three-Point Estimates

- Instead of providing activity estimates as a discrete number, such as four weeks, it's often helpful to create a **three-point estimate**
  - an estimate that includes an optimistic, most likely, and pessimistic estimate, such as three weeks for the optimistic, four weeks for the most likely, and five weeks for the pessimistic estimate

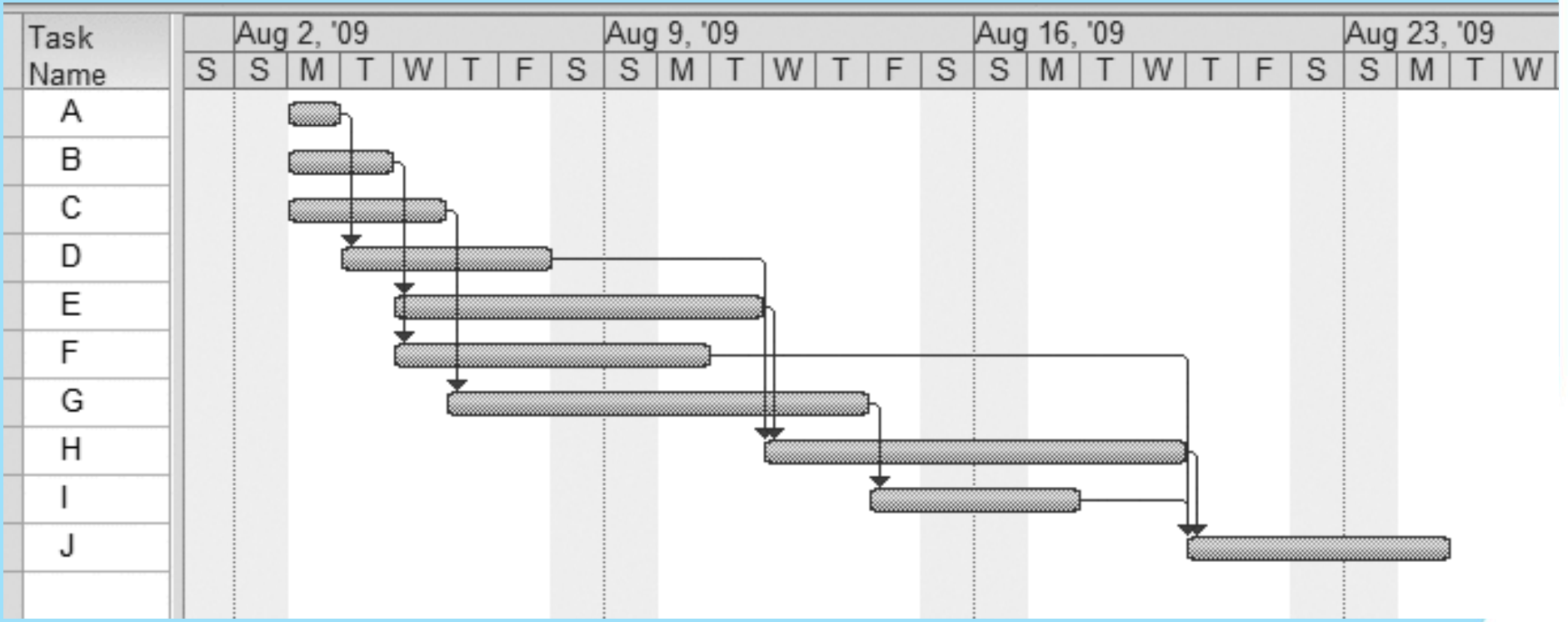
Developing the Schedule

- Uses results of the other time management processes to determine the start and end date of the project
- Ultimate goal is to create a realistic project schedule that provides a basis for monitoring project progress for the time dimension of the project
- Important tools and techniques include Gantt charts, critical path analysis, and critical chain scheduling, and PERT analysis

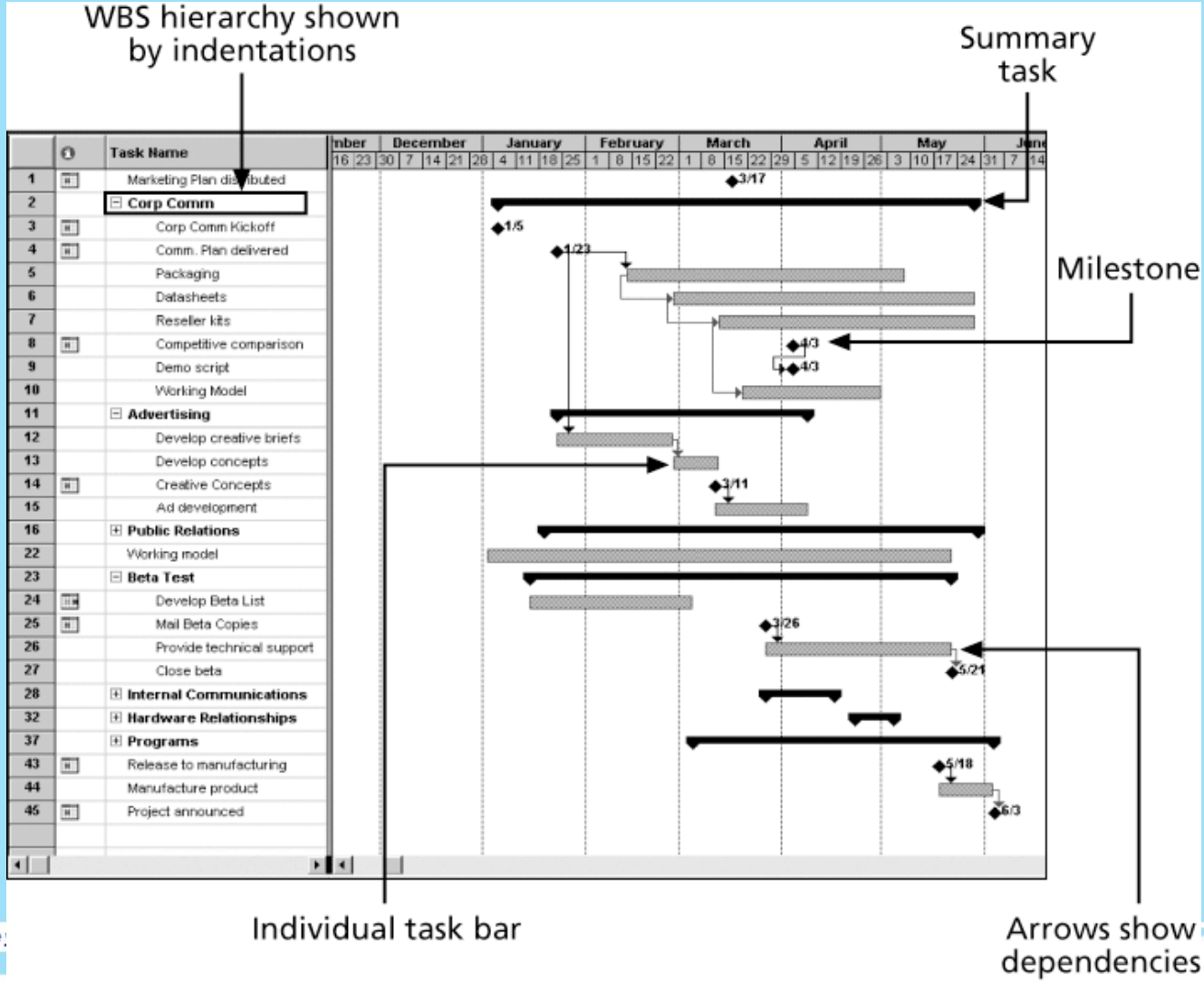
Gantt Charts

- **Gantt charts** provide a standard format for displaying project schedule information by listing project activities and their corresponding start and finish dates in a calendar format
- Symbols include:
  - A black diamond: a milestones
  - Thick black bars: summary tasks
  - Lighter horizontal bars: durations of tasks
  - Arrows: dependencies between tasks

Gantt Chart for Project X



Gantt Chart for Software Launch Project



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Adding Milestones to Gantt Charts

- Many people like to focus on meeting milestones, especially for large projects
- Milestones emphasize important events or accomplishments on projects
- Normally create milestone by entering tasks with a zero duration, or you can mark any task as a milestone

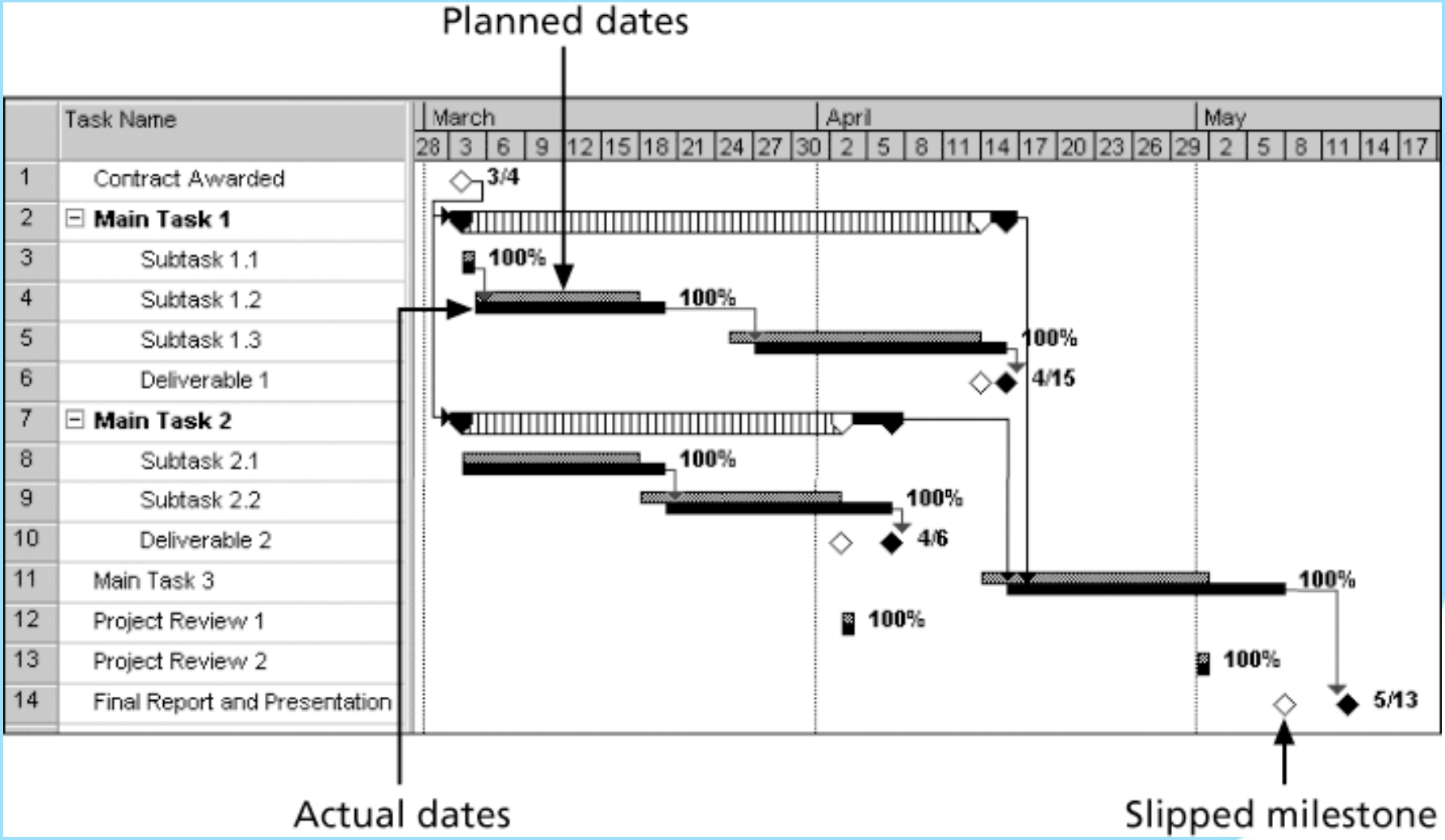
SMART Criteria

- Milestones should be
  - **S**pecific
  - **M**easurable
  - **A**ssignable
  - **R**ealistic
  - **T**ime-framed

Best Practice

- Schedule risk is inherent in the development of complex systems. Luc Richard, the founder of www.projectmangler.com, suggests that project managers can reduce schedule risk through project milestones, a best practice that involves identifying and tracking significant points or achievements in the project. The five key points of using project milestones include the following:
  1. Define milestones early in the project and include them in the Gantt chart to provide a visual guide
  2. Keep milestones small and frequent
  3. The set of milestones must be all-encompassing
  4. Each milestone must be binary, meaning it is either complete or incomplete.
  5. Carefully monitor the critical path

Sample Tracking Gantt Chart



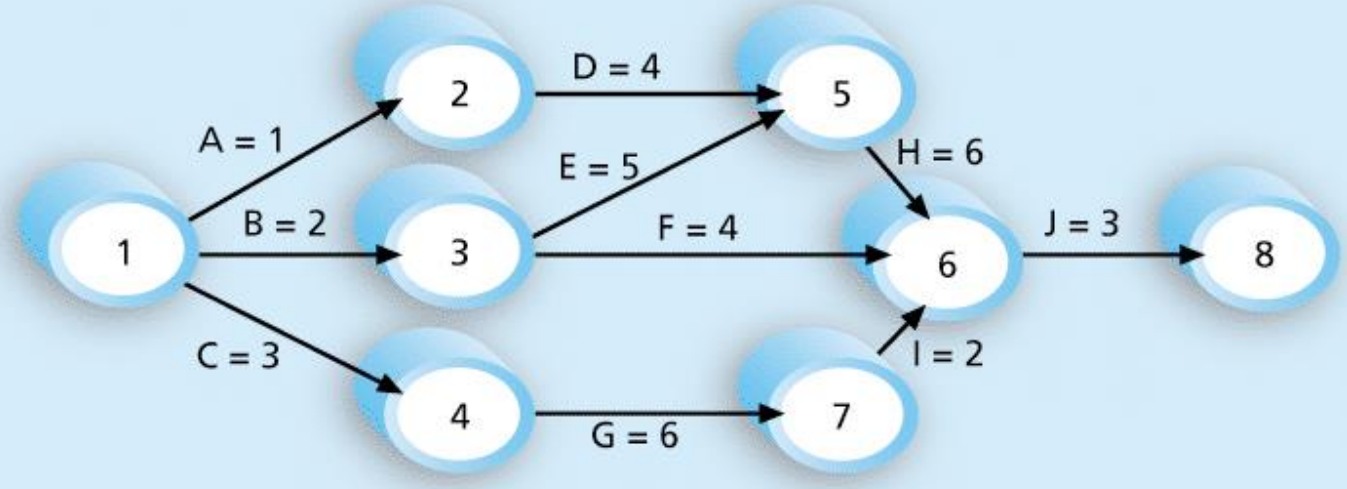
Critical Path Method (CPM)

- **CPM** is a network diagramming technique used to predict total project duration
- A **critical path** for a project is the series of activities that determines the *earliest time* by which the project can be completed
- The critical path is the *longest path* through the network diagram and has the least amount of slack or float
- **Slack** or **float** is the amount of time an activity may be delayed without delaying a succeeding activity or the project finish date

Calculating the Critical Path

- First develop a good network diagram
- Add the duration estimates for all activities on each path through the network diagram
- The longest path is the critical path
- If one or more of the activities on the critical path takes longer than planned, the whole project schedule will slip *unless* the project manager takes corrective action

Determining the Critical Path for Project X



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

Since the critical path is the longest path through the network diagram, Path 2, B-E-H-J, is the critical path for Project X.

More on the Critical Path

- The critical path is *not* the one with all the critical activities; it only accounts for time
- There can be more than one critical path if the lengths of two or more paths are the same
- The critical path can change as the project progresses

Lets try this out….

Task	Duration	Dependent on…
A	1 week	-------
B	1 day	A
C	2 weeks	B
D	2 weeks	A
E	2 weeks	D
F	2 weeks	D
G	3 weeks	E
H	1 weeks	F
I	1 week	G
J	1 day	C,H
K	1 week	E
L	1 week	E
M	1 week	L
N	1 week	I,J,K,M

Using Critical Path Analysis to Make Schedule Trade-offs

- **Free slack** or **free float** is the amount of time an activity can be delayed without delaying the early start of any immediately following activities
- **Total slack** or **total float** is the amount of time an activity may be delayed from its early start without delaying the planned project finish date
- A **forward pass** through the network diagram determines the early start and finish dates
- A **backward pass** determines the late start and finish dates

Slack Times

- Activity start time and completion time may be delayed by planned reasons as well as by unforeseen reasons.
- Some of these delays may affect the overall completion date.
- To learn about the effects of these delays, we calculate the **slack time**, and form the **critical path**.

Slack Times

– Slack time is the amount of time an activity can be delayed without delaying the project completion date, assuming no other delays are taking place in the project.

Slack Time = LS - ES = LF - EF

Slack time in the Klonepalm 2016 Project

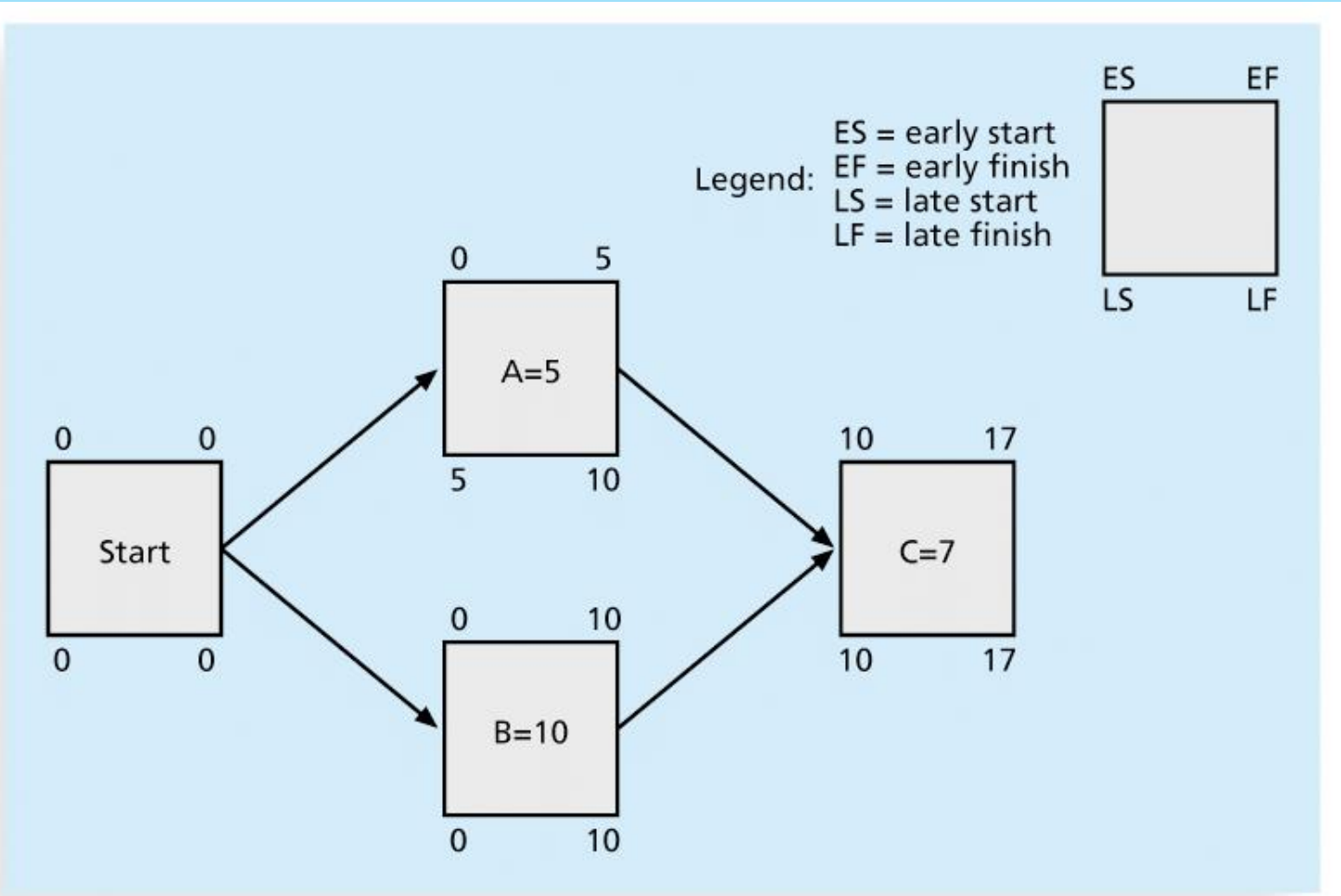
Activity	LS - ES	Slack
A	0 -0	0
B	95 - 90	5
C	110 - 105	5
D	119 - 119	0
E	173 - 149	24
F	90 - 90	0
G	115 - 115	0
H	166 - 149	17
I	119 - 90	29
J	149 - 149	0

Critical activities must be rigidly scheduled

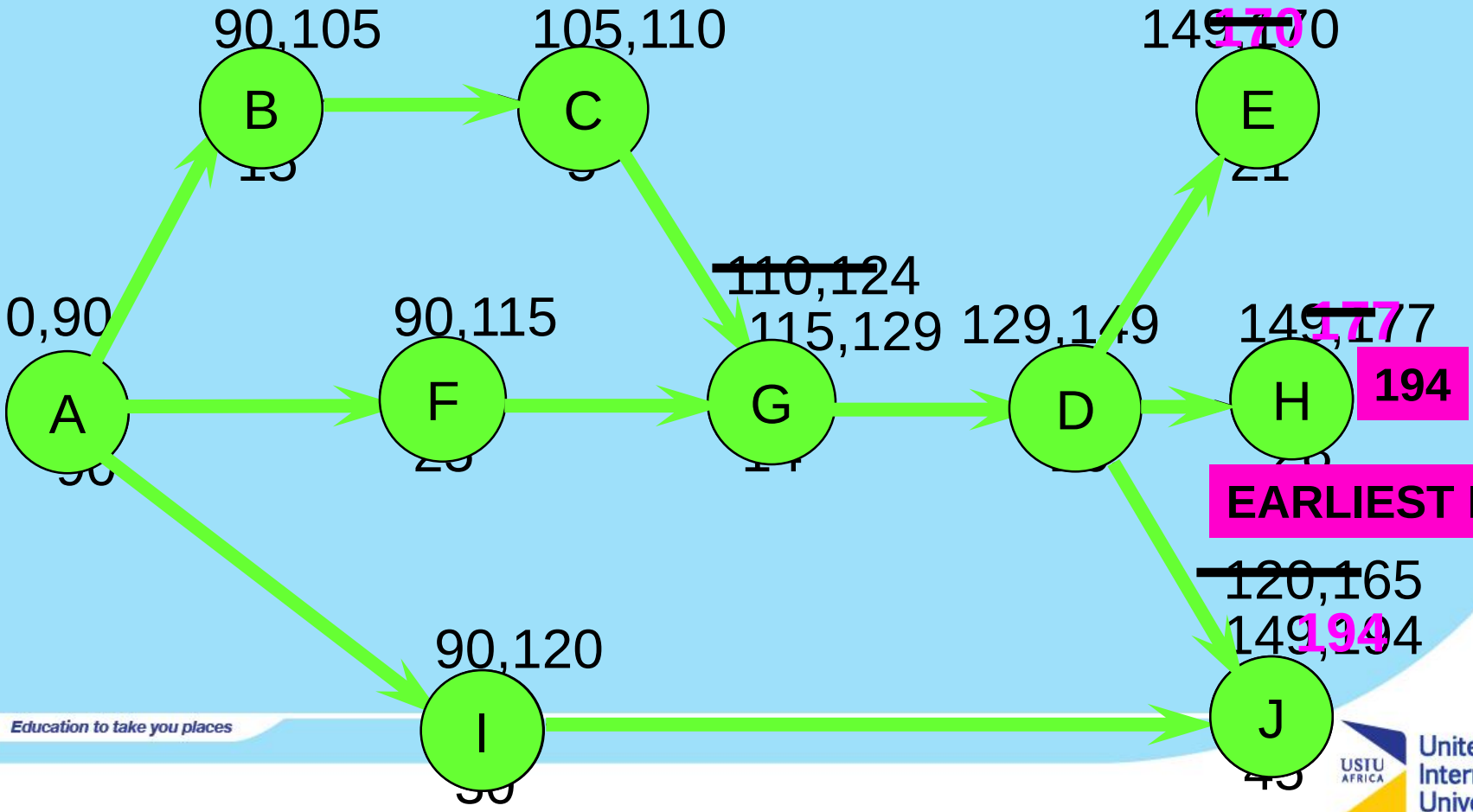
Earliest Start Time / Earliest Finish Time

- Make a forward pass through the network as follows:
  - Evaluate all the activities which have no immediate predecessors.
    - The earliest start for such an activity is zero ES = 0.
    - The earliest finish is the activity duration EF = Activity duration.
  - Evaluate the ES of all the nodes for which EF of all the immediate predecessor has been determined.
    - ES = Max EF of all its immediate predecessors.
    - EF = ES + Activity duration.
  - Repeat this process until all nodes have been evaluated
    - EF of the finish node is the earliest finish time of the project.

Calculating Early and Late Start and Finish Dates



Earliest Start / Earliest Finish –Forward Pass



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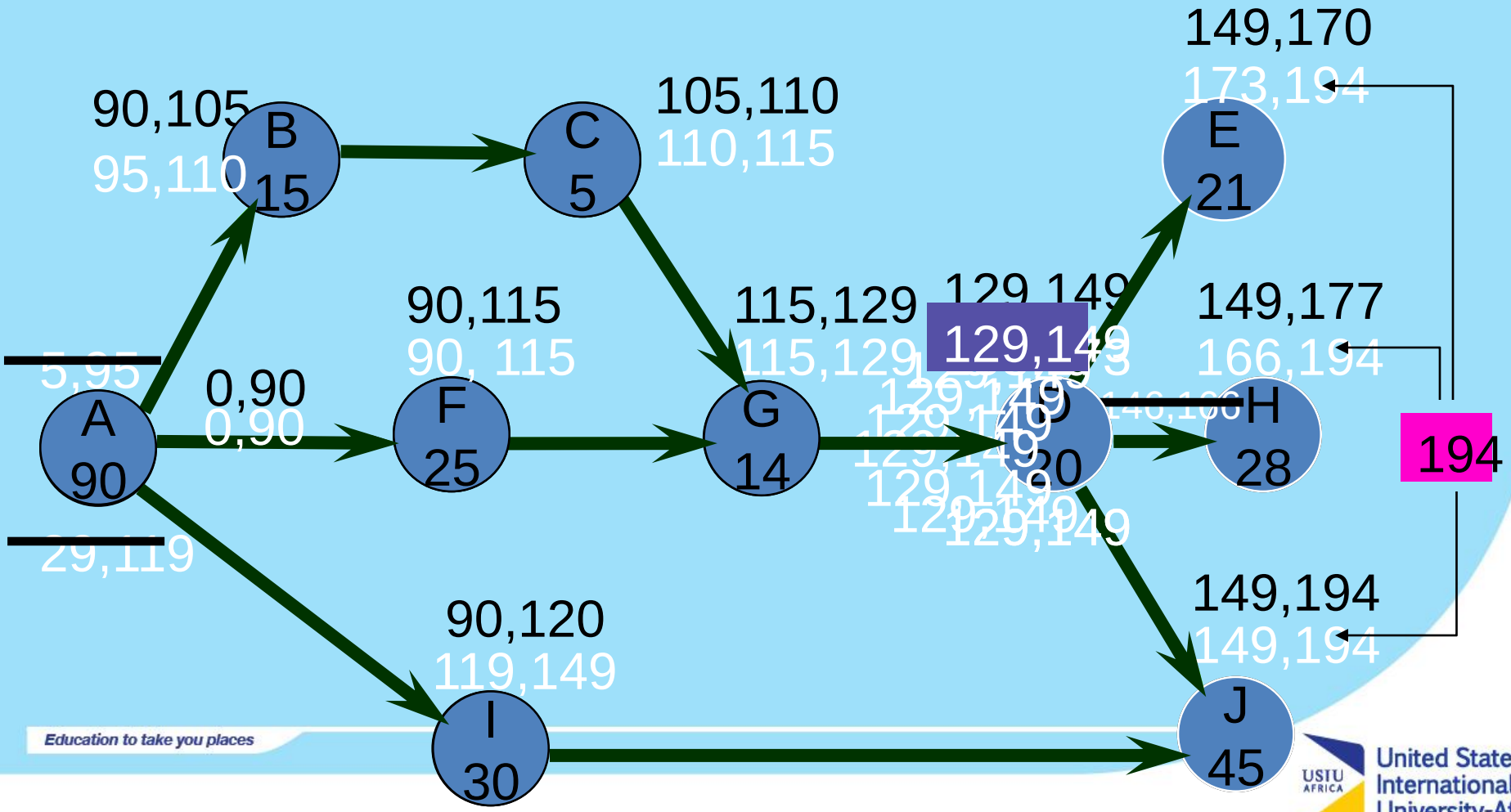
Latest start time / Latest finish time

- Make a backward pass through the network as follows:
  - Evaluate all the activities that immediately precede the finish node.
    - The latest finish for such an activity is LF = minimal project completion time.
    - The latest start for such an activity is LS = LF - activity duration.
  - Evaluate the LF of all the nodes for which LS of all the immediate successors has been determined.
    - LF = Min LS of all its immediate successors.
    - LS = LF - Activity duration.
  - Repeat this process backward until all nodes have been evaluated.

Latest Start / Latest Finish –Backward Pass



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Using the Critical Path to Shorten a Project Schedule

- Three main techniques for shortening schedules
  - Shortening durations of critical activities/tasks by adding more resources or changing their scope
  - **Crashing** activities by obtaining the greatest amount of schedule compression for the least incremental cost
  - **Fast tracking** activities by doing them in parallel or overlapping them

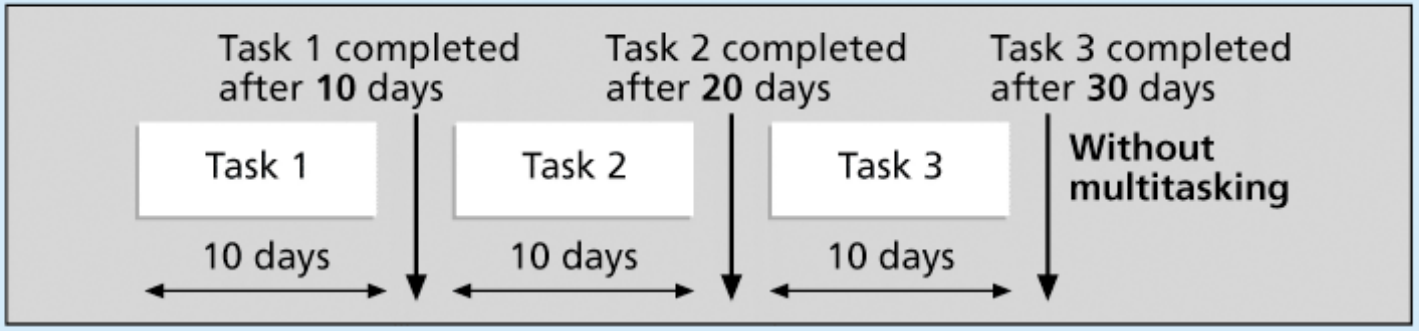
Importance of Updating Critical Path Data

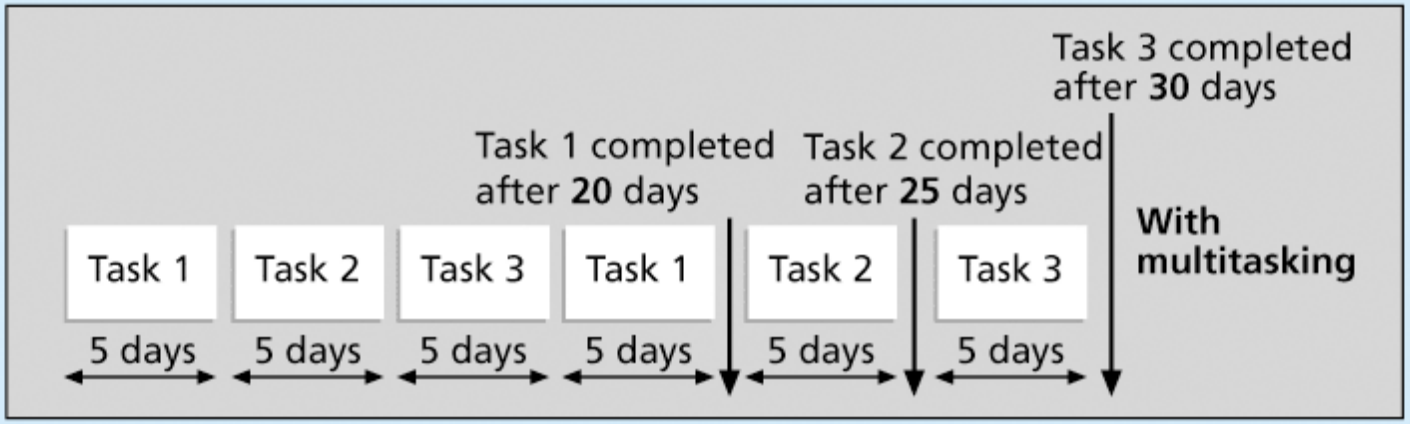
- It is important to update project schedule information to meet time goals for a project
- The critical path may change as you enter actual start and finish dates
- If you know the project completion date will slip, negotiate with the project sponsor

Critical Chain Scheduling

- **Critical chain scheduling**
  - a method of scheduling that considers limited resources when creating a project schedule and includes buffers to protect the project completion date
- Uses the **Theory of Constraints (TOC)**
  - a management philosophy developed by Eliyahu M. Goldratt and introduced in his book *The Goal*.
- Attempts to minimize **multitasking**
  - when a resource works on more than one task at a time

Multitasking Example





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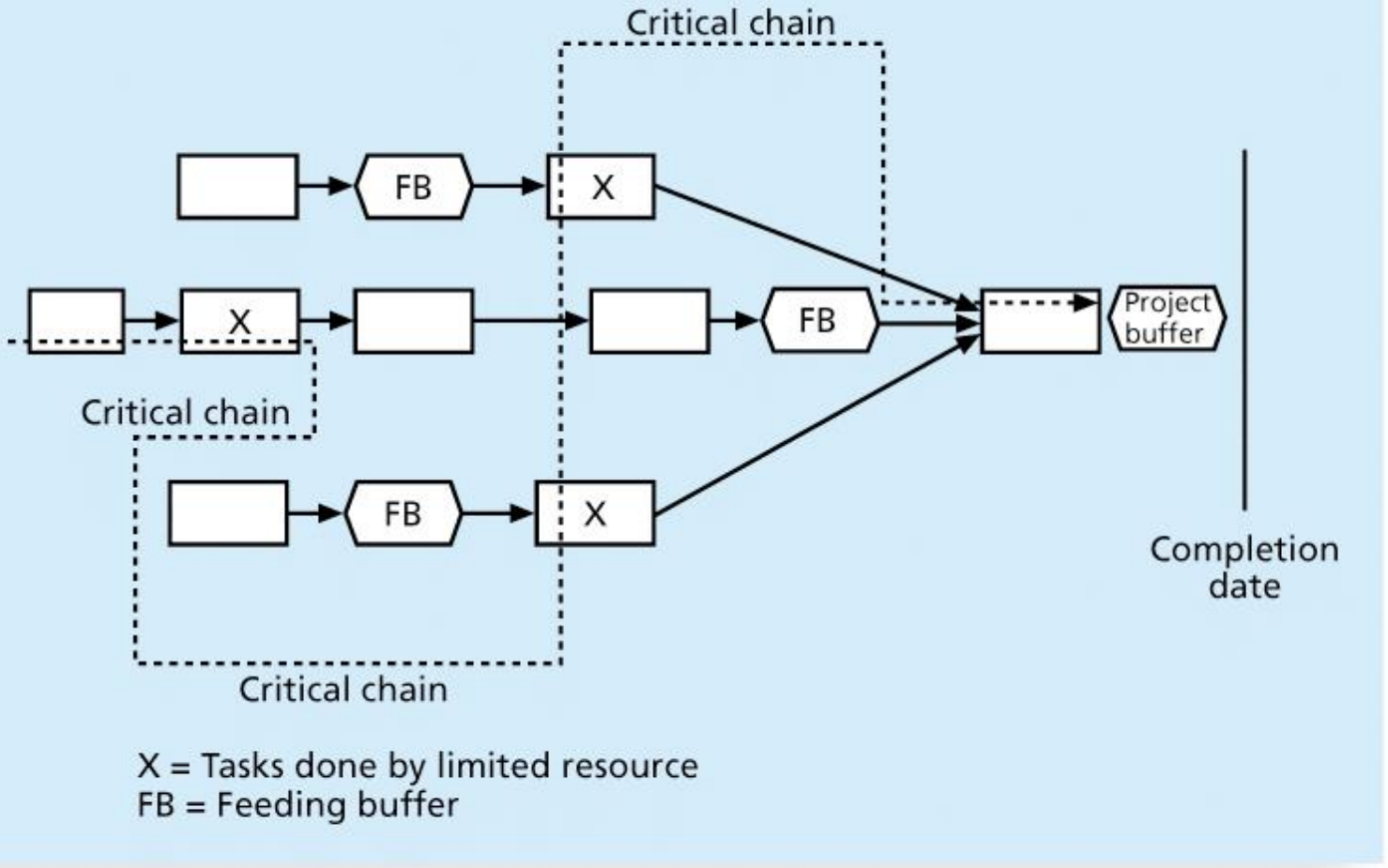
Buffers and Critical Chain

- A **buffer** is additional time to complete a task
- **Murphy's Law** states that if something can go wrong, it will
- **Parkinson's Law** states that work expands to fill the time allowed
- In traditional estimates, people often add a buffer to each task and use it if it's needed or not
- Critical chain scheduling removes buffers from individual tasks and instead creates
  - a **project buffer** or additional time added before the project's due date
  - **feeding buffers** or additional time added before tasks on the critical path

Example of Critical Chain Scheduling



Program Evaluation and Review Technique (PERT)

- **PERT** is a network analysis technique used to estimate project duration when there is a high degree of uncertainty about the individual activity duration estimates
- PERT uses **probabilistic time estimates**
  - duration estimates based on using optimistic, most likely, and pessimistic estimates of activity durations, or a three-point estimate

PERT Formula and Example

- PERT weighted average **=**

$$\frac{\text{optimistic time} + 4\text{X most likely time} + \text{pessimistic time}}{6}$$

- Example:

PERT weighted average =

$$\frac{8 \text{ workdays} + 4 \text{ X } 10 \text{ workdays} + 24 \text{ workdays}}{6} = \textbf{12 days}$$

where optimistic time= 8 days

most likely time = **10 days**, and

pessimistic time = 24 days

Therefore, you'd use **12 days** on the network diagram instead of 10 when using PERT for the above example

Schedule Control Suggestions

- Perform reality checks on schedules
- Allow for contingencies
- Don’t plan for everyone to work at 100% capacity all the time
- Hold progress meetings with stakeholders and be clear and honest in communicating schedule issues

Controlling the Schedule

- Goals are to know the status of the schedule, influence factors that cause schedule changes, determine that the schedule has changed, and manage changes when they occur
- Tools and techniques include
  - Progress reports
  - A schedule change control system
  - Project management software, including schedule comparison charts like the tracking Gantt chart
  - Variance analysis, such as analyzing float or slack
  - Performance management, such as earned value

Reality Checks on Scheduling

- First review the draft schedule or estimated completion date in the project charter
- Prepare a more detailed schedule with the project team
- Make sure the schedule is realistic and followed
- Alert top management well in advance if there are schedule problems

Working with People Issues

- Strong leadership helps projects succeed more than good PERT charts
- Project managers should use
  - empowerment
  - incentives
  - discipline
  - negotiation

Using Software to Assist in Time Management

- Software for facilitating communications helps people exchange schedule-related information
- Decision support models help analyze trade-offs that can be made
- Project management software can help in various time management areas

Words of Caution on Using Project Management Software

- Many people misuse project management software because they don't understand important concepts and have not had training
- You must enter dependencies to have dates adjust automatically and to determine the critical path
- You must enter actual schedule information to compare planned and actual progress

Summary

- Project time management is often cited as the main source of conflict on projects, and most IT projects exceed time estimates
- Main processes include
  - Plan schedule management
  - Define activities
  - Sequence activities
  - Estimate activity resources
  - Estimate activity durations
  - Develop schedule
  - Control schedule