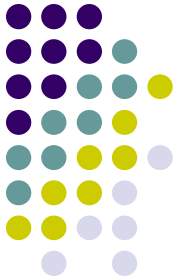
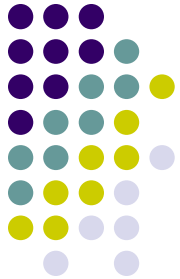


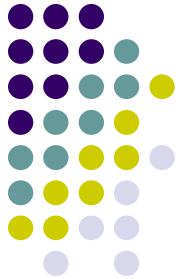
Chapter 4
Project Time Management

4.1.Project Time Management Processes



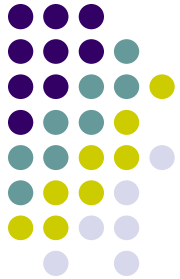
- Project time management involves the processes required to ensure timely completion of a project. Processes include:
  - Activity definition
  - Activity sequencing
  - Activity duration estimating
  - Schedule development
  - Schedule control

4.2.Activity Definition



- Project schedules grow out of the basic document that initiate a project
  - Project charter includes start and end dates and budget information
  - Scope statement and WBS help define what will be done
- Activity definition involves developing a more detailed WBS and supporting explanations to understand all the work to be done so you can develop realistic duration estimates

4.3.Activity Sequencing

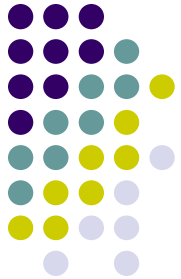


- Involves reviewing activities and determining dependencies

  - Mandatory dependencies: inherent in the nature of the work being done (hard logic). They often involve physical limitations. (On a construction project, it is impossible to erect the superstructure until after the foundation has been built; on an electronics project, a prototype must be built before it can be tested.)

  - Discretionary dependencies: defined by the project team (soft logic). Discretionary dependencies are usually defined based on knowledge of:

4.3.Activity Sequencing



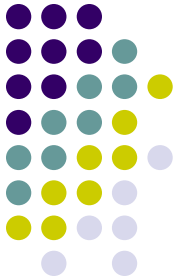
- “Best practices” within a particular application area.
- Some unusual aspect of the project where a specific sequence is desired, even though there are other acceptable sequences.

- External dependencies: involve relationships between project and non-project activities.

For example, the testing activity in a software project may be dependent on delivery of hardware from an external source.

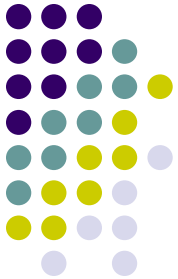
- You *must* determine dependencies in order to use critical path analysis

a) Project Network Diagrams



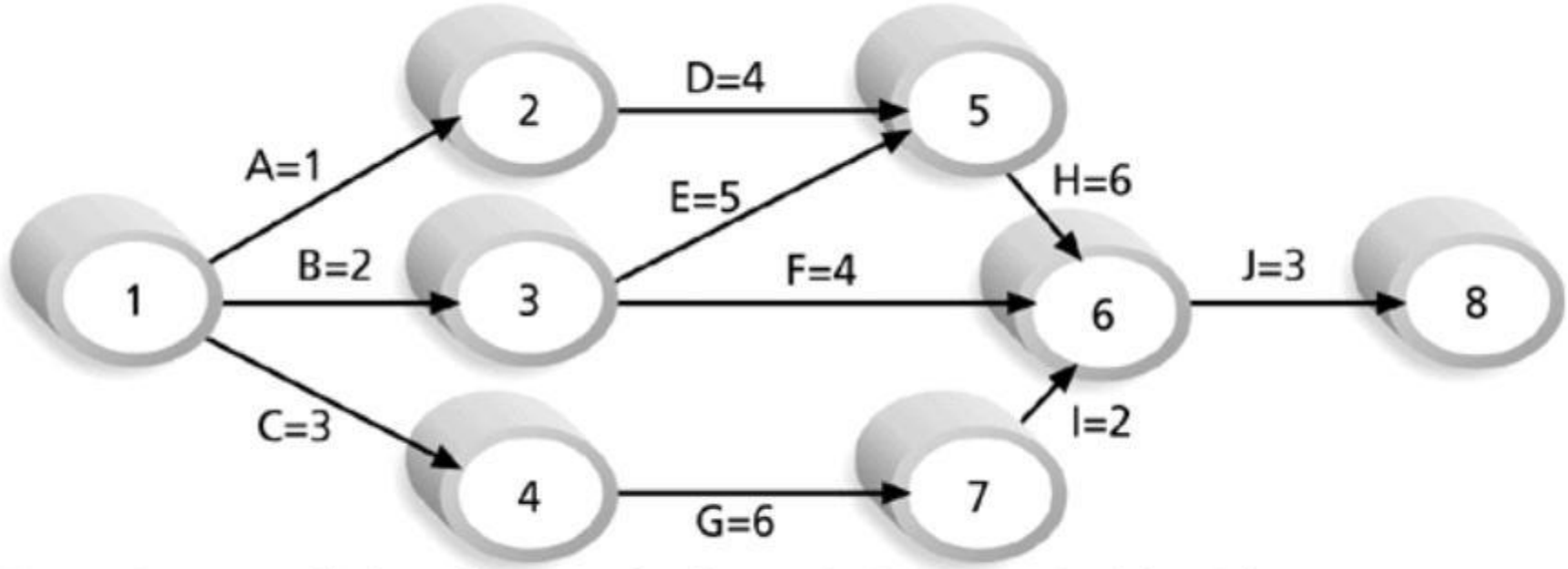
- Project network diagrams are the preferred technique for showing activity sequencing
- A project network diagram is a schematic display of the logical relationships among, or sequencing of, project activities
- A project network diagram may be produced manually or on a computer
- It may include full project details, or have one or more summary activities (hammocks)
- The diagram should be accompanied by a summary narrative that describes the basic sequencing approach. Any unusual sequences should be fully described

* Arrow Diagramming Method (ADM)



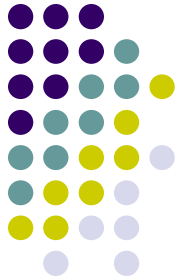
- Also called activity-on-arrow (AOA) project network diagrams
- Activities are represented by arrows
- Nodes or circles are the starting and ending points of activities
- Can only show finish-to-start dependencies
- Can be done manually or on a computer

Figure 4-1. Sample Activity-On-Arrow (AOA) Network Diagram for Project X



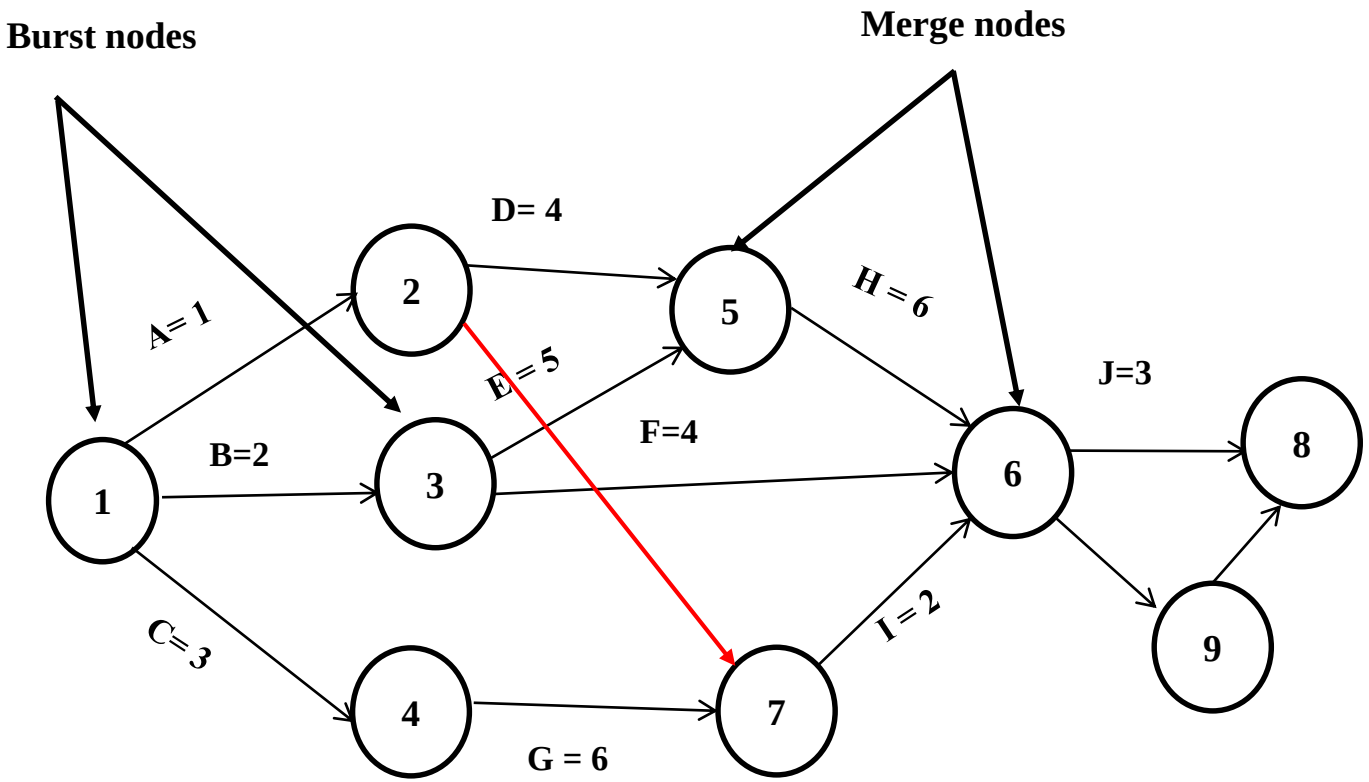
Note: Assume all durations are in days; A=1 means Activity A has a duration of 1 day.

* Process for Creating AOA Diagrams ( )

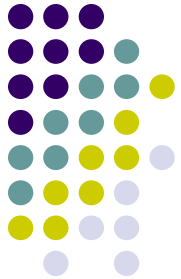


1. Find all of the activities that start at node 1. Draw their finish nodes and draw arrows between node 1 and those finish nodes. Put the activity letter or name and duration estimate on the associated arrow
2. Continue drawing the network diagram, working from left to right. Look for bursts and merges. *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

* Process for Creating AOA Diagrams ( )

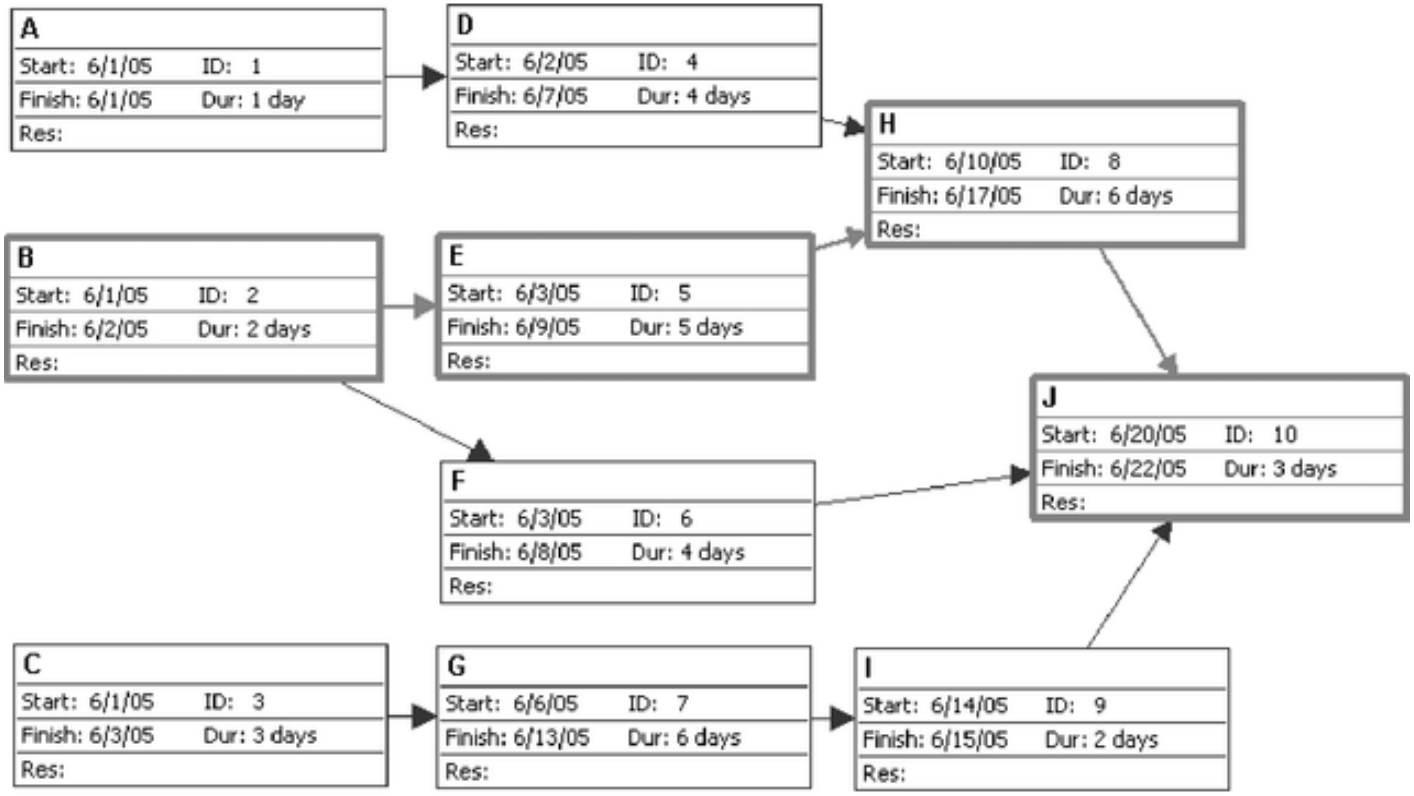


* Precedence Diagramming Method (PDM)



- Also called activity-on-node (AON)
- 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
- Can be done manually or on a computer

Figure 4-2. Sample PDM Network Diagram

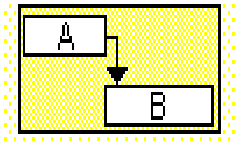


Precedence Diagramming Method (PDM) Network Diagram for Project X

b) Task Dependency Types

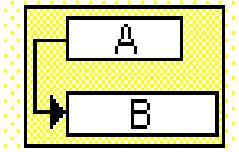
There are four kinds of task dependencies in Microsoft Project:

- Finish-to-start (FS)



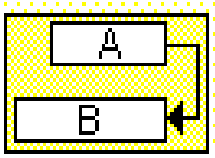
Task (B) cannot start until task (A) finishes

- Start-to-start (SS)



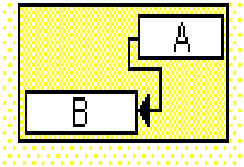
Task (B) cannot start until task (A) starts

- Finish-to-finish (FF)



Task (B) cannot finish until task (A) finishes

- Start-to-finish (SF) are rarely used



Task (B) cannot finish until task (A) starts

Example:

FS: - Installing the network cards before connecting PCs to the Internet.

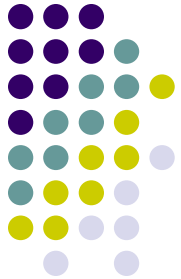
- We cannot provide user training until after SW or a new system, has been installed.

SS: - We cannot start MS Word or other applications until after Windows start.

FF: - Quality control effort cannot finish before production finishes.

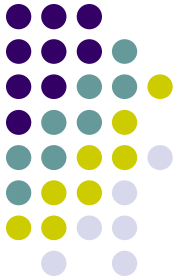
SF: The start of the new shift of the security guard signal the finish shift of the current security guard. If the next shift security guard didn’t turn up (arrive), the first shift security guard has to continue his duty.

4.4.Activity Duration Estimating



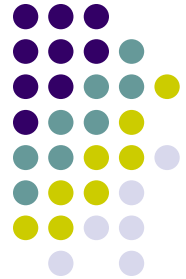
- After defining activities and determining their sequence, the next step in time management is duration estimating
- Duration includes the actual amount of time worked on an activity *plus* elapsed time
- Effort is the number of workdays or work hours required to complete a task. Effort does not equal duration
- People doing the work should help create estimates, and an expert should review them

4.5. Schedule Development



- Schedule development uses results of the other time management processes to determine the start and end date of the project and its activities
- 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 (bar charts), PERT analysis, critical path analysis, and critical chain scheduling

a) Creating Tasks (uses MS Project)



MS Project enables you to create three types of tasks:

- ***General tasks***: are the usual tasks that are independent and have no special characteristics related to their duration or time

  Ex: analysis: A, B

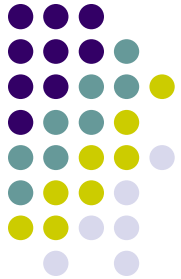
- ***Milestone tasks***: are the second type of task that you can create using MS Project. These tasks have no duration. They serve as markers or reference nodes for significant accomplishments in a project.

  Ex: Analysis Complete

- ***Recurring tasks***: occur repeatedly at regular intervals.

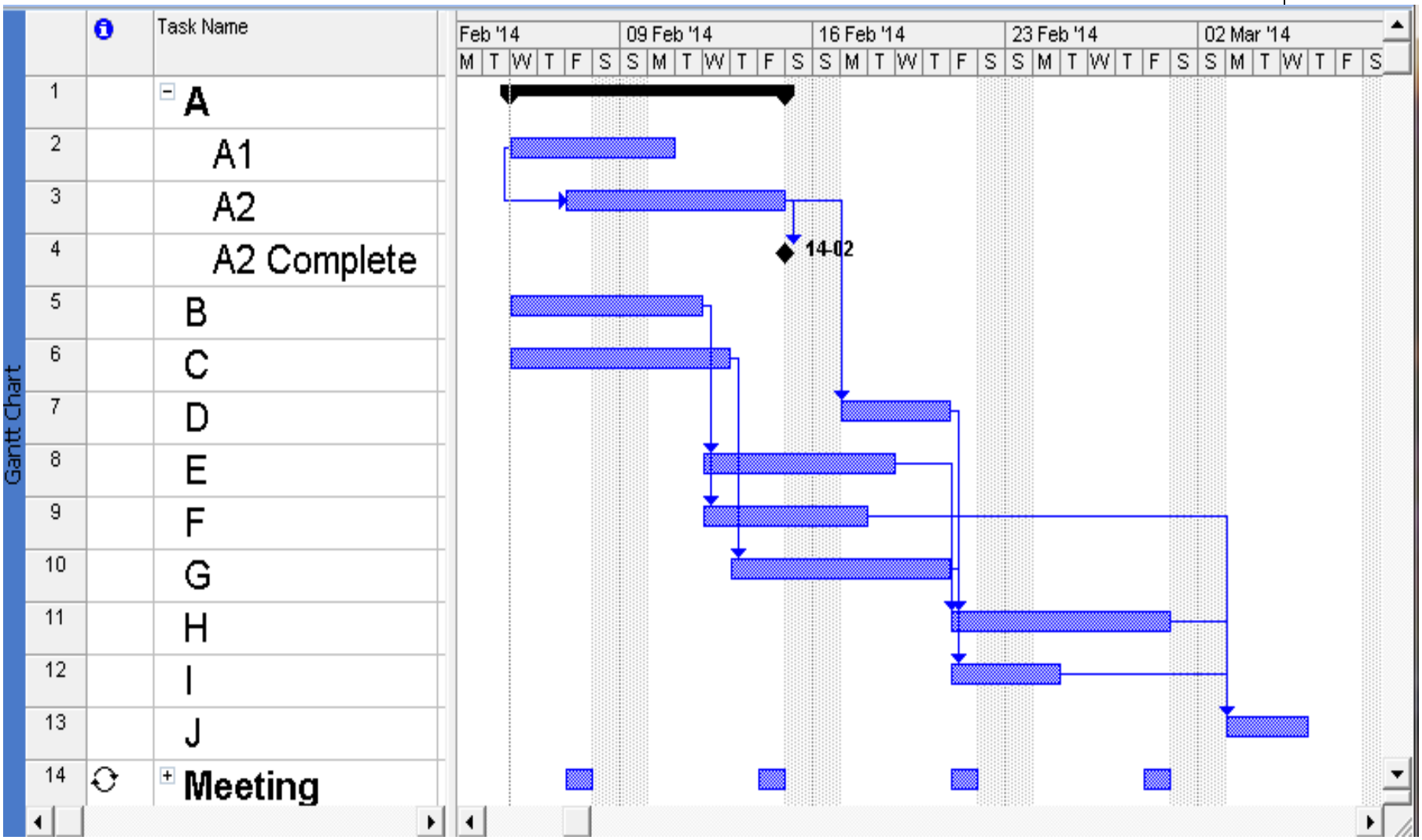
  For example, a weekly project meeting with all the team members is a recurring task.

b) Gantt Charts

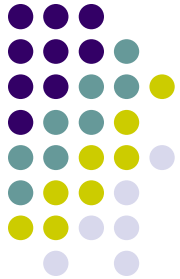


- Gantt charts provide a standard format for displaying project schedule information by listing project activities and their corresponding start and finish dates in a calendar format
- Symbols include:
  - A black diamond: milestones or significant events on a project with zero duration
  - Thick black bars: summary tasks
  - Lighter horizontal bars: tasks
  - Arrows: dependencies between tasks

Gantt Chart for Project X

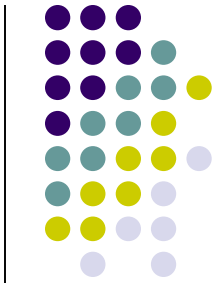


c) Critical Path Method (CPM)



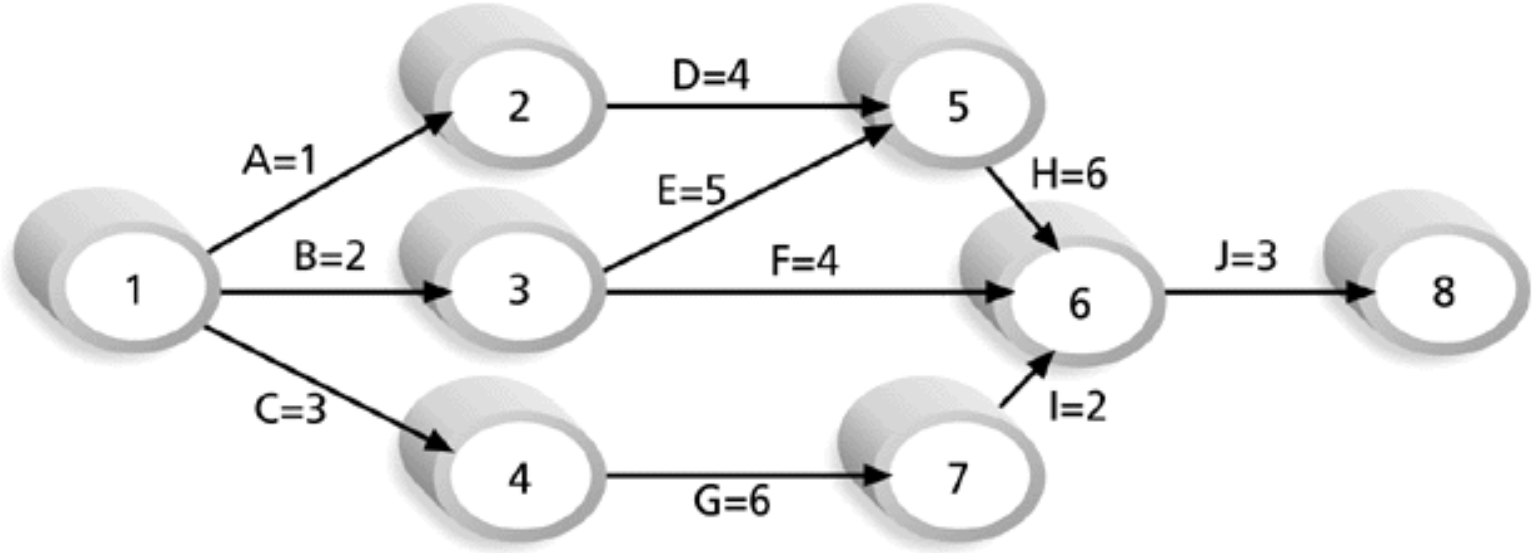
- CPM is a project network analysis technique used to predict total project duration
- A critical path for a project is the series of activities that determines the *earliest time* by which the project can be completed
- The critical path is the *longest path* through the network diagram and has the least amount of slack or float

* Finding the Critical Path



- First develop a good project network diagram
- Add the durations for all activities on each path through the project network diagram
- The longest path is the critical path

Determining the Critical Path for Project X

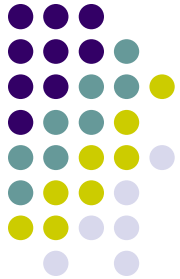


Note: Assume all durations are in days.

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

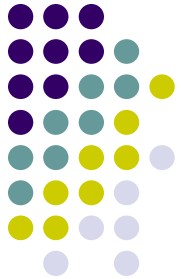
Since the critical path is the longest path through the network diagram, Path 2, B-E-H-J, is the critical path for Project X.

* More on the Critical Path



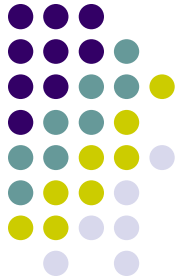
- If one or more activities on the critical path takes longer than planned, the whole project schedule will slip *unless* corrective action is taken
- Misconceptions:
  - The critical path is not the one with all the critical activities; it only accounts for time.
  - There can be more than one critical path if the lengths of two or more paths are the same
  - The critical path can change as the project progresses

* Using Critical Path Analysis to Make Schedule Trade-offs



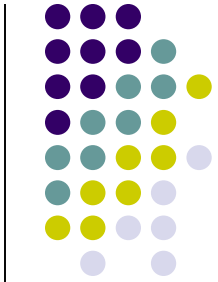
- Knowing the critical path helps you make schedule trade-offs
- ***Free slack or free float*** is the amount of time an activity can be delayed without delaying the early start of any immediately following activities
- ***Total slack or total float*** is the amount of time an activity may be delayed 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*** through the network diagram determines the late start and finish dates

* Free Slack, Total Slack and Late Start, Late Finish for Project X



Task	Duration	Start	Finish	Late Start	Late Finish	Free Slack	Total Slack
A	1 day						
B	2 days						
C	3 days						
D	4 days						
E	5 days						
F	4 days						
G	6 days						
H	6 days						
I	2 days						
J	3 days						

* Techniques for Shortening a Project Schedule



- Shorten durations of critical tasks by adding more resources or changing their scope
- *Crashing* tasks by obtaining the greatest amount of schedule compression for the least incremental cost.

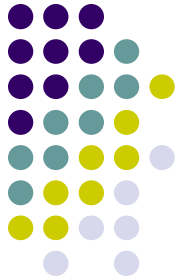
  - Advantage: can shorten the time it takes to finish a project.

  - Disadvantage: It often increases total project costs
- *Fast tracking* tasks by doing them in parallel or overlapping them.

  - Advantage: like crashing.

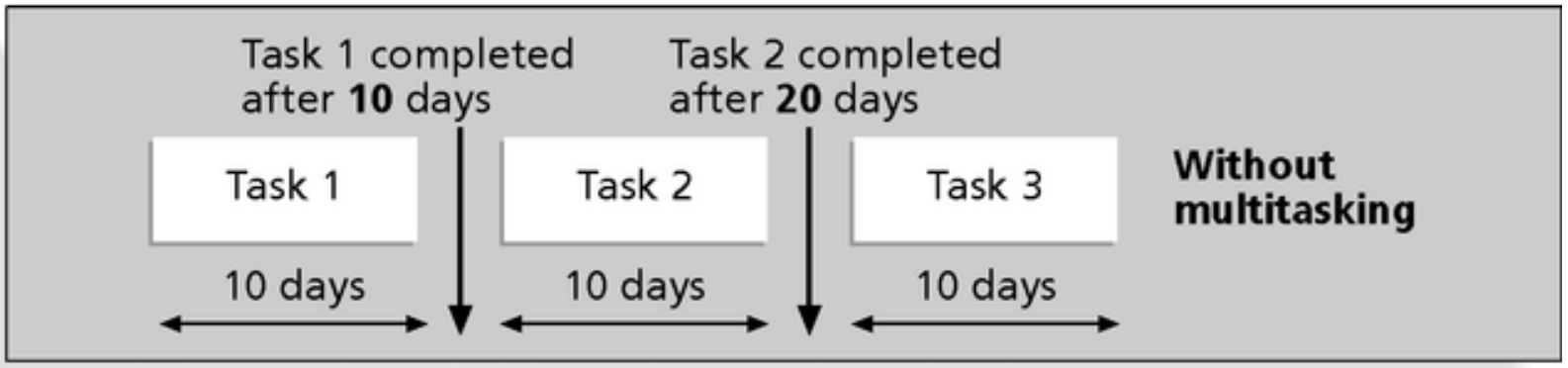
  - It can end up lengthening the project schedule since starting some tasks too soon often increases project risk and results in rework

d) Critical Chain Scheduling

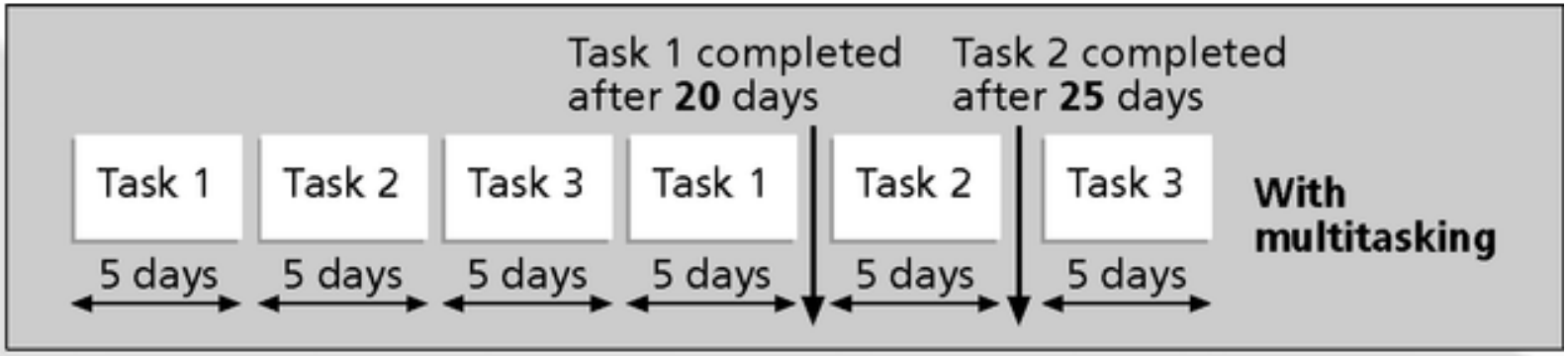


- Critical chain scheduling is a method of scheduling that takes limited resources into account when creating a project schedule and includes buffers to protect the project completion date
- Critical chain scheduling assumes resources do not multitask because it often delays task completions and increases total durations

Multitasking Example

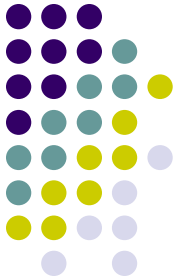


Three Tasks Without Multitasking



Three Tasks With Multitasking

e) Program Evaluation and Review Technique (PERT)



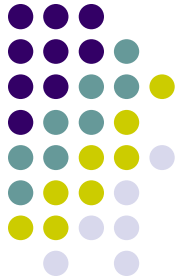
- PERT is a network analysis technique used to estimate project duration when there is a high degree of uncertainty about the individual activity duration estimates
- PERT uses probabilistic time estimates based on using optimistic, most likely, and pessimistic estimates of activity durations

  - The optimistic time is the shortest time period within which an activity can end if everything goes well.

  - The most likely time is the estimate of the normal time that an activity takes to complete.

  - The pessimistic time is the time that an activity takes to complete if everything that can go wrong goes wrong

PERT Formula



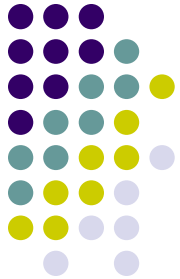
- PERT weighted average formula:

$$T_e = \frac{T_o + 4T_m + T_p}{6}$$

Where:

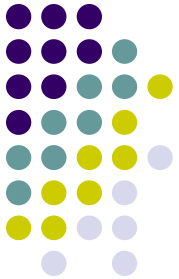
- T_e is the expected time,
- T_o is the optimistic time,
- T_m is the most likely time, and
- T_p is the pessimistic time required to complete an activity.

Example:



Tasks	Optimistic Time Estimate (person days)	Most Likely Time Estimate (person days)	Pessimistic Time Estimate (person days)	Expected Time Estimate (person days)
Requirements analysis and project planning	7	10	13	10
Setting up the environment	3	6	9	6
Software construction	48	83	100	80
Unit testing	20	28	33	28
System testing	4	5	6	5
User training	10	15	20	15
User documentation	23	28	45	30
Data migration	18	18	30	20
Conducting user acceptance test	14	21	22	20

4.6. Controlling Changes to the Project Schedule

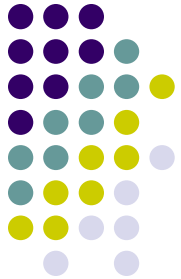


- Perform reality checks on schedules
- Allow for contingencies
- Don’t plan for everyone to work at 100% capacity all the time
- Hold progress meetings with stakeholders and be clear and honest in communicating schedule issues

* **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