Project Scheduling and Tracking

Project Scheduling and Tracking

- ***Scheduling***

It is the process of deciding:

- In what sequence a set of activities will be performed.
- When they should start and be completed.

- ***Tracking***

It is the process of determining:

- How well you are sticking to the cost estimate and schedule.

Some Basic Project Management Terminology

Deliverable: **some concrete thing which is to be delivered, to the client or internally to the development team; e.g.**

- Specifications reports
- Executable program
- Source code

Task/Activity**: something we have to do during the project; e.g.**

- Defining user requirements
- Coding a module
- Doing system testing

Each task or activity will take some length of time

- Referred to as *duration* of task
- Sometimes measured in days, weeks, etc.
- Sometimes measured in person-days, person-weeks, etc.
- *Person-day* = number of people X number of days
  - Example: 12 person days for writing all code could mean 1 person 12 days or 4 people 3 days
  - Note: not always true that a task that takes 1 programmer 12 days would take 12 programmers 1 day

Dependencies and Milestones

For a given task or activity, may be impossible to start it without some other task(s) or activity(ies) having been completed; e.g.

- Cannot start coding without completing design
- Cannot start system testing without completing code integration and test plan

If task B cannot start without A being completed, we say

- B depends on A
- There is a dependency between A and B

***Milestone*: some achievement which must be made during the project; e.g.**

- Delivering some deliverable
- Completing some task

Note, delivering a deliverable may be a milestone, but not all milestones are associated with deliverables

Setting and Making Deadlines

***Deadline* time by which milestone has to be met**

- Some deadlines are set by the client
- Others are set by us on project to make sure project stays on track

To set a deadline for completing task T, we must consider how long it will take to:

- Complete the tasks that task T depends on
- Complete task T itself

If we miss a deadline, we say (euphemistically) "the deadline has slipped"

- This is virtually inevitable

Important tasks for project managers

- Monitor whether past deadlines have slipped
- Monitor whether future deadlines are going to slip
- Allocate or reallocate resources to help make deadlines

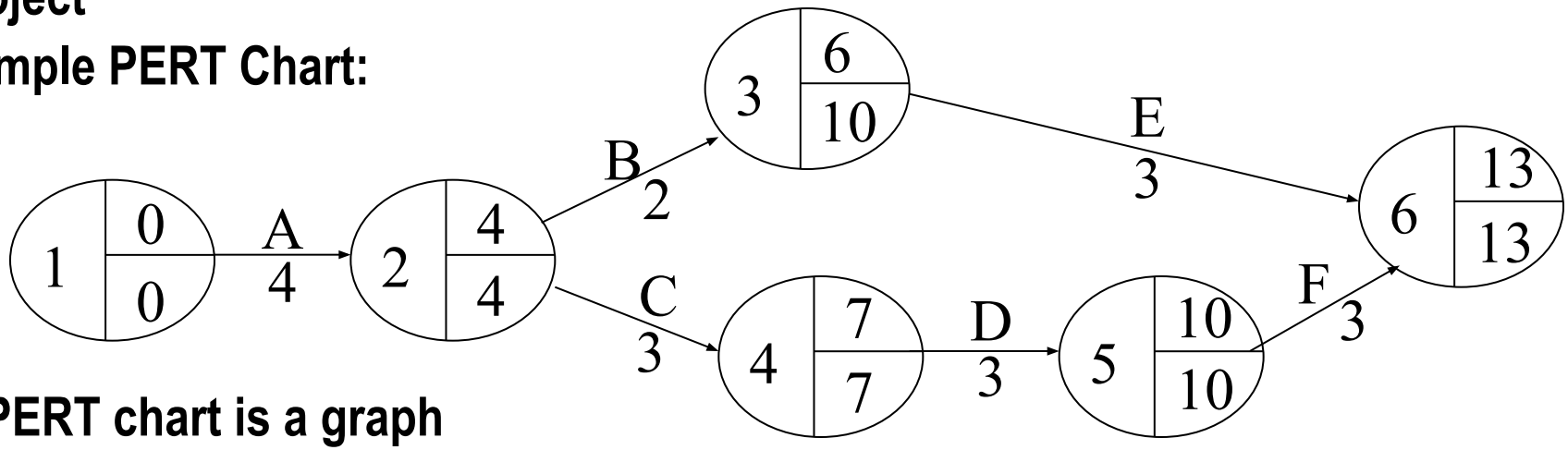
PERT chart and Gantt charts help project managers do these things (among others)

PERT Charts

PERT = Project Evaluation and Review Technique

PERT chart = graphical representation of the scheduling of events in a project

Sample PERT Chart:



A PERT chart is a graph

- Edges are tasks/activities that need to be done
- Nodes are the events or milestones

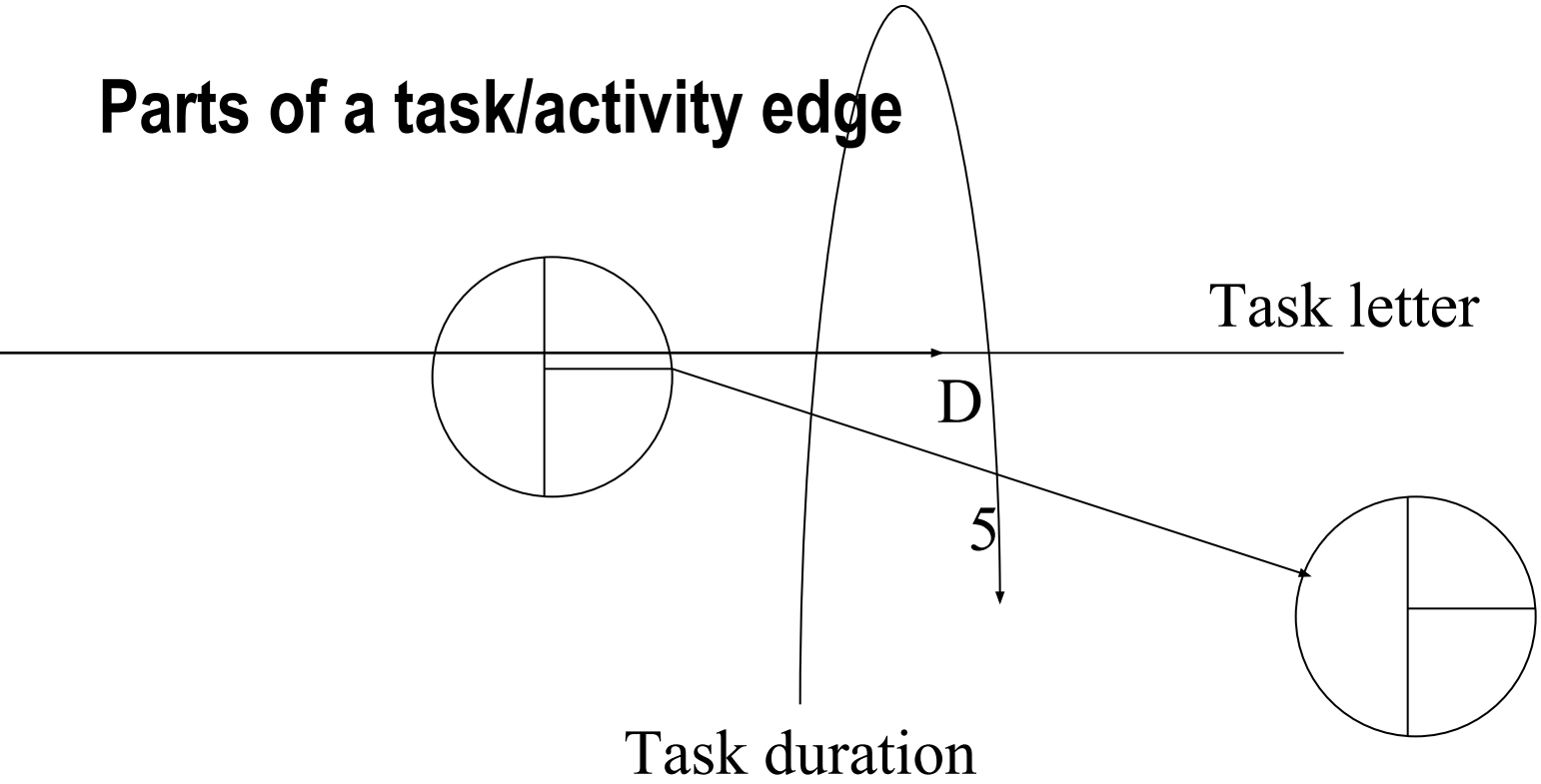
Task edge T from event node E1 to event node E2 signifies:

- Until event E1 happens, task T cannot be started
- Until task T finishes, event E2 cannot happen

Events often simply represent completion of tasks associated with arrows entering it

PERT Chart Task Edges

Parts of a task/activity edge



Task letter:

- Often keyed to a legend to tell which task it represents

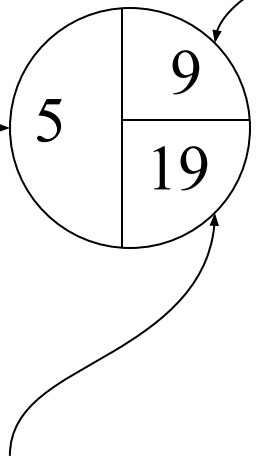
Task duration = how long (e.g. days, hours) task will take

PERT Chart Event Nodes

Event Number:

Sequence number assigned

Only task edges indicate dependencies



Earliest Completion Time (ECT):

Earliest time this event can be achieved, given durations and dependencies

Latest Completion Time (LCT):

Latest time that this event could be safely achieved

Building a PERT Chart

Steps:

1. **Make a list of all project tasks (and events if possible).**
2. **Find interrelated task dependencies (what task has to be completed before other tasks)**
3. **Draw initial PERT without durations, ECTs or LCTs**
4. **Estimate duration of each task**
5. **Fill in durations**
6. **Calculate ECTs and LCTs**

- We will do this for an example system:
  - Generic software system with 3 modules

Example: Generic Software Project

TASK ID	Task Description
A	Specification
B	High Level Design
C	Detailed Design
D	Code/Test Main module
E	Code/Test DB module
F	Code/Test UI module
G	Write test plan
H	Integrate/System Test
I	Write User Manual
J	Typeset User Manual

- **To start PERT chart: identify dependencies between tasks**

Dummy Tasks

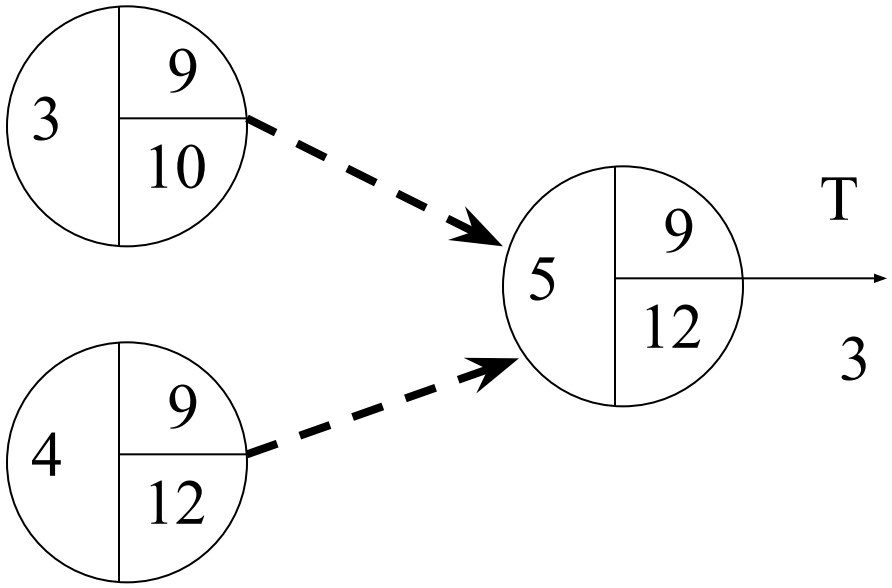
Sometimes it is necessary to use *dummy tasks*:

- Shows the dependency between 2 events where no activity is performed

Example:

- Events 3, 4 signify the compilation of separate modules.
- Create an event 5 to signify “all modules compiled together”.

Denote dummy tasks using dash lines

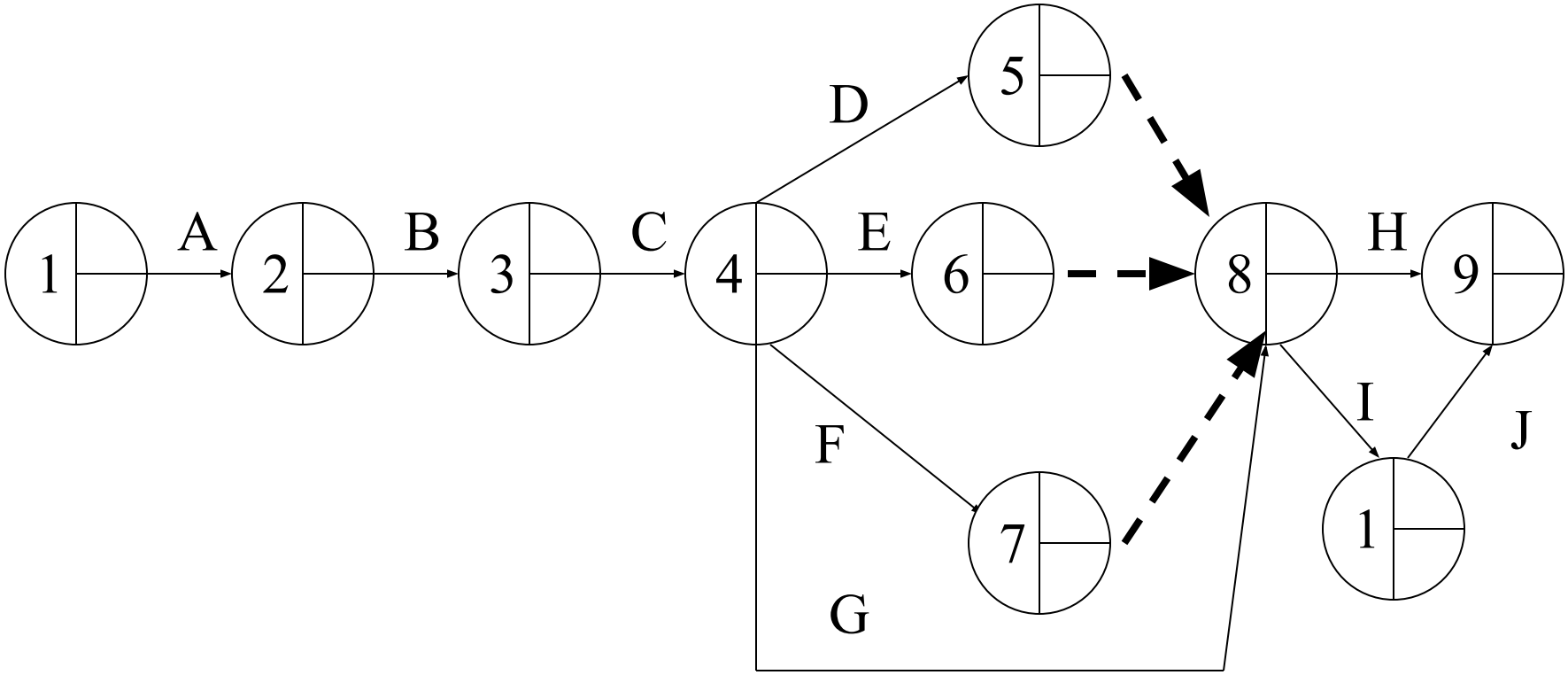


Example: Tasks with Dependencies

To start the PERT, identify the dependencies amongst tasks

TASK ID	Task Description	Preceed ID	Succ. ID
A	Specification	1	2
B	High Level Design	2	3
C	Detailed Design	3	4
D	Code/Test Main	4	5
E	Code/Test DB	4	6
F	Code/Test UI	4	7
G	Write test plan	4	8
	Dummy Task	5	8
	Dummy Task	6	8
	Dummy Task	7	8
H	Integrate/System Test	8	9
I	Write User Manual	8	10
J	Typeset User Manual	10	9

Software Example: Skeleton PERT Chart



Note: dummy tasks connecting events 5, 6 and 7 to 8

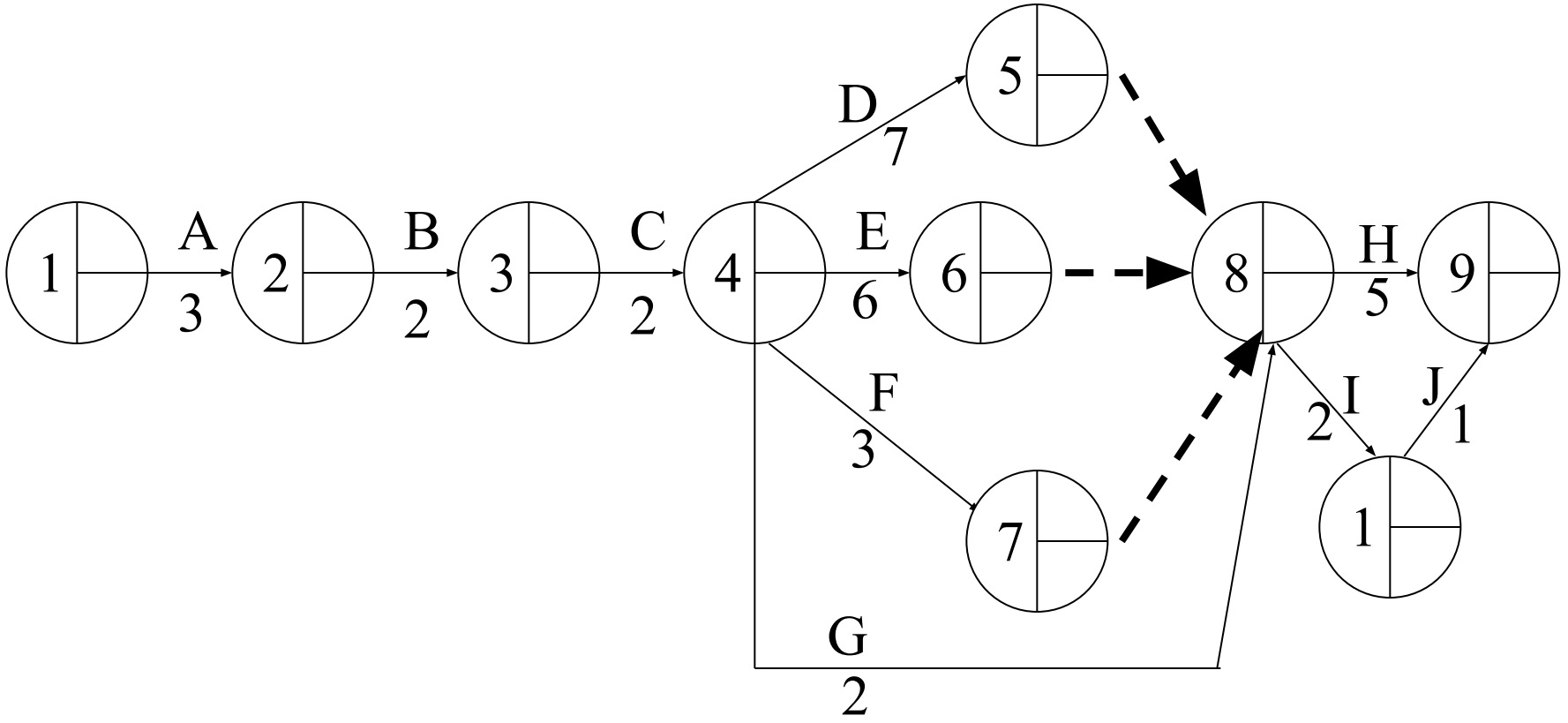
Estimating Durations

Suggestions for estimating durations of tasks:

- Don’t just make up a number
- Look at previous similar tasks from other projects and use those as guidelines
- Try to identify factors such as difficulty, skill level
  — Each weighting factor will help you make a better estimate

  Factors to consider:
- Difficulty of task
- Size of team
- Experience of team
- Number, attitude and availability of end users
- Management commitment
- Other projects in progress

PERT Chart With Durations



- Say we have estimated durations of all tasks (in days)
- New PERT chart, with durations filled in:
- Note, dummy tasks (dashed lines) always have a duration of zero

PERT Chart calculationss

Calculate Earliest Completion Time and Latest Completion Time

- Beginning at start of project, ECT for task = ECT for preceding node + duration
- Beginning at end of project, LCT for task = LCT for following node - duration

Calculate Slack Time for Each Task

- Slack for Task= LCT - ECT (Slack time can be defined as the amount of time an task can be delayed without causing another task to be delayed or impacting the completion date of your project.)

Determine Critical Path

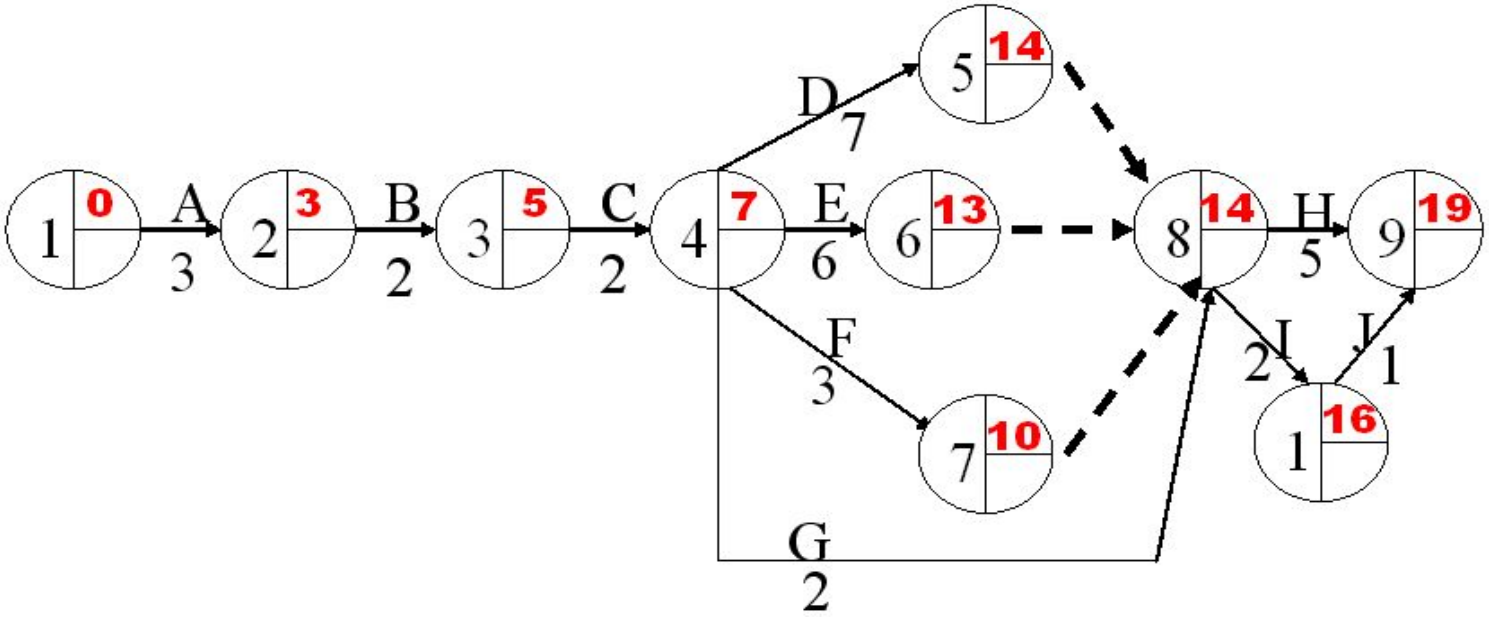
- Longest Time Path
- Zero Slack

Calculating ECTs

ECT = earliest time event can be completed, To calculate:

- For an event not depending on others: ECT = 0
  - — Usually this is the first event
- For an event E depending on one or more others:
  - — Calculate ECTs of event(s) that E depends on
  - — Add duration(s) of task(s) leading to E
  - — If E depends on more than one event, take MAX

Proceed left to right ( ) through the chart

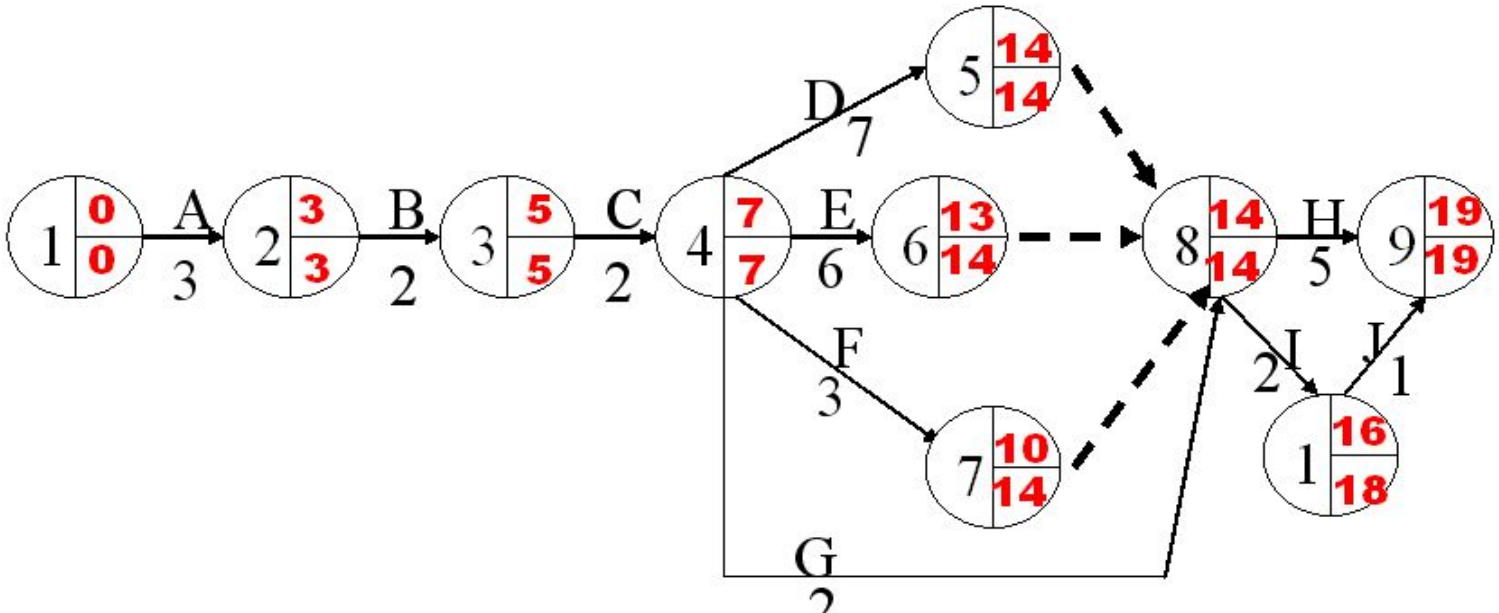


Calculating LCT

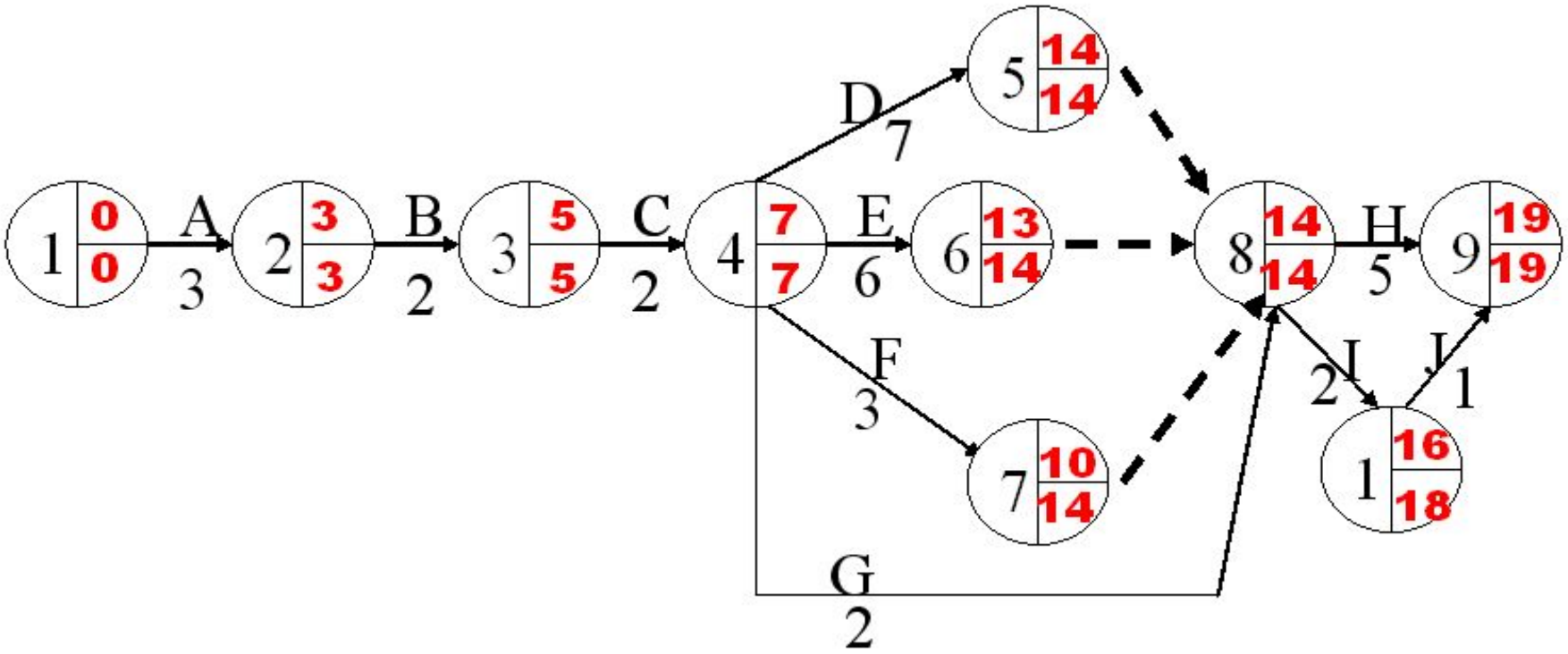
LCT = latest time event can be completed, while still finishing last task at indicated time, To calculate:

- For an event which no other events depend on: LCT = ECT
  - — Generally there will only be one such event
- For an event E which one or more others depend on:
  - — Calculate LCTs of event(s) that depend on E
  - — Subtract duration(s) of task(s) leading from E
  - — If more than one event depends on E, take MINIMUM

Proceed ri



Critical Path



Red line is the critical path

What does it represent?

Uses of PERT Charts

We can use PERT charts for:

- Determining the estimated time to complete a project
- Deriving actual project dates
- Allocating resources
- Identifying potential and current problems (is one task behind schedule?, can we shuffle people?)

Critical Path: **Path through chart such that if any deadline slips, the final deadline slips (where all events have ECT = LCT (usually there is only one)**

In software example:

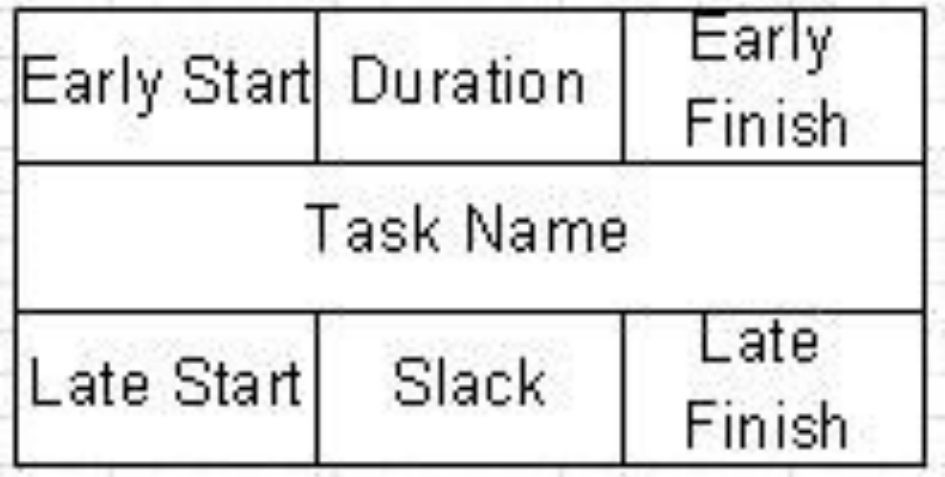
- Task I is not on the critical path: even if we don't finish it until time 18, we're still okay
- Task D is on the critical path: if we don't finish it until for example, time 16, then:
  - We can't start task H (duration 3) until time 16
  - So we can't complete task H until time 21

We can use PERT charts for

- Identifying the critical path
- Reallocating resources, e.g. from non-critical to critical tasks.

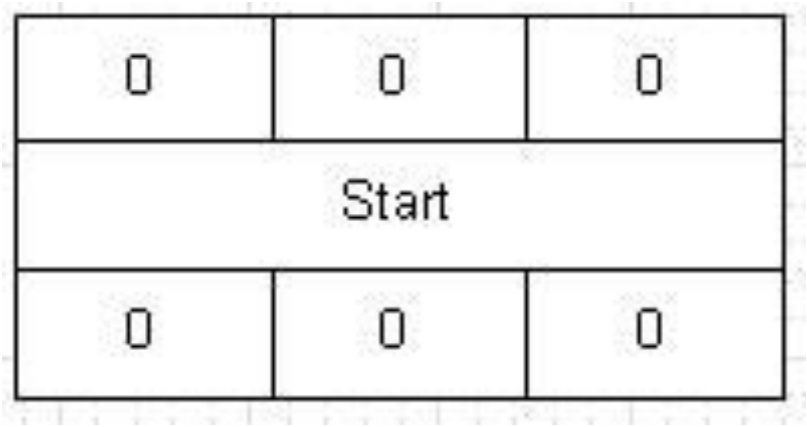
AON (activity on node)

- The second type of PERT diagram is called AON (activity on node).
- In such diagram the information about the task duration is denoted in the diagram node and each task is represented in the form of rectangle with the definite set of fields.
- These are the task name, duration, early and late starts and early and late finishes of the task and also the float for execution of the given task.

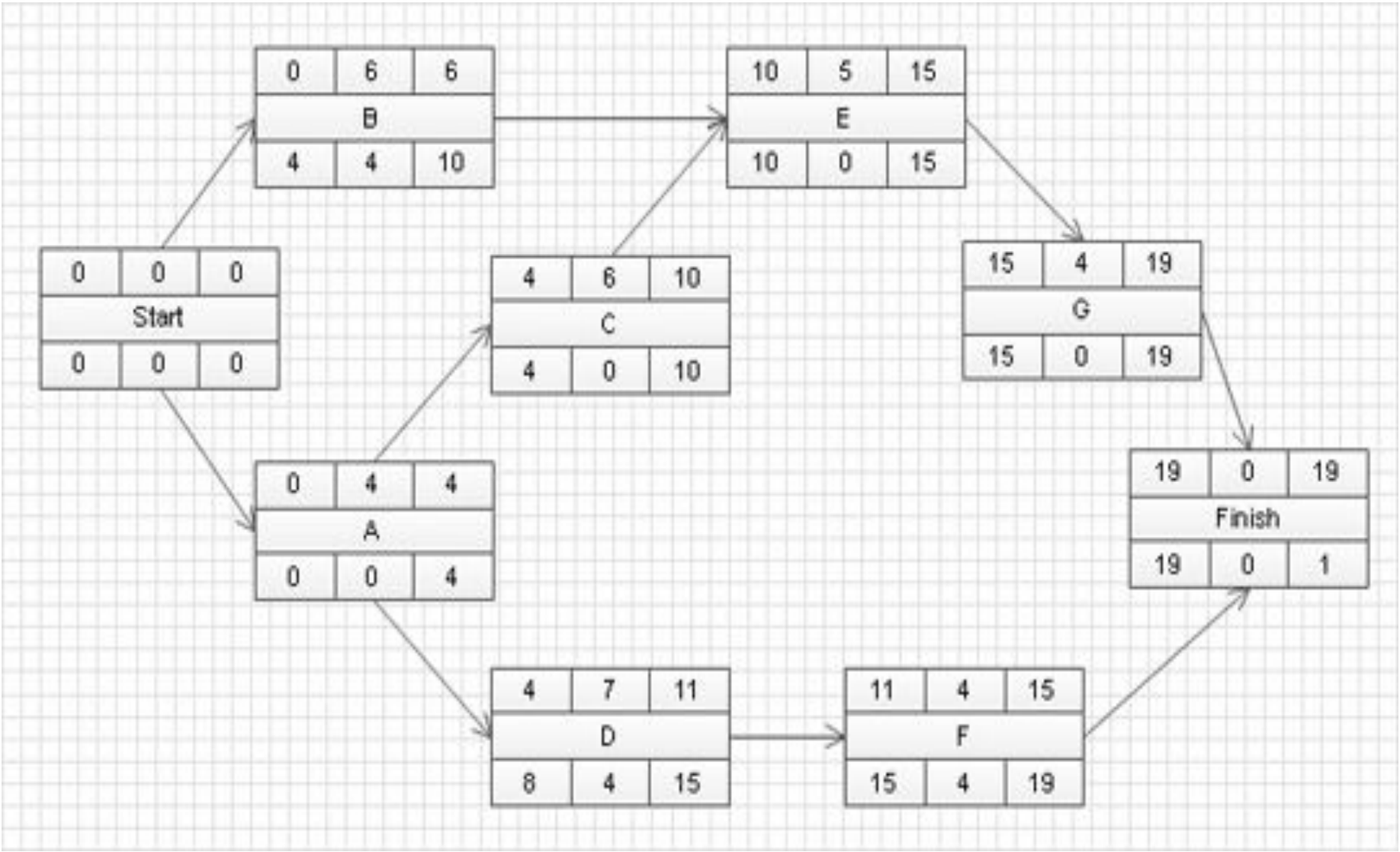


AON (activity on node)

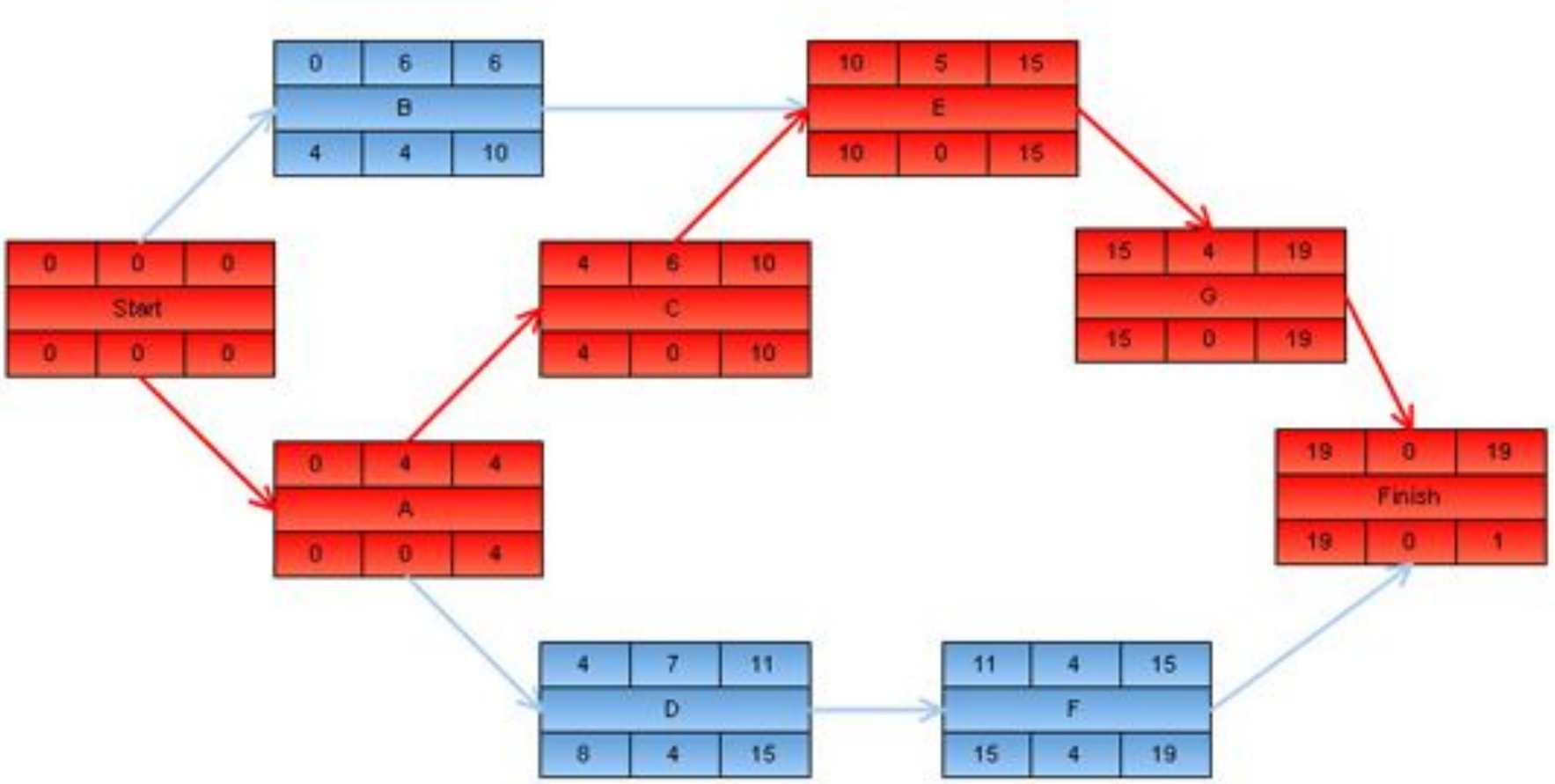
- PERT diagram starts from the task which does not have duration and does not use resources and presents just a project start. This is done to denote the common start of the project as starting from the first day of the project several tasks are starting simultaneously. Analogously PERT diagram finishes with the task “finish”.
- No task is able to start before the preceding task is finished. Also each task may represent a separate project with its subtasks, which can be displayed on a separate diagram.



Example


0 6 6
B
4 4 10
10 5 15
E
10 0 15
0 0 0
Start
0 0 0
4 6 10
C
4 0 10
15 4 19
G
15 0 19
0 4 4
A
0 0 4
19 0 19
Finish
19 0 1
4 7 11
D
8 4 15
11 4 15
F
15 4 19

Example



Task appeared on the calculated critical path are marked out with red color. This way any person is able to see at once tasks which require special attention.

Gantt Charts

- Visual scheduling tool
- Graphical representation of information
- Named after Henry Gantt who invented them in 1917
- Show dependencies between tasks, personnel, and other resources allocations
- Track progress towards completion
- Depicts some of the same information as on a PERT chart
- Also depicts new information

Building and Using a Gantt Chart

Steps for building a Gantt Chart

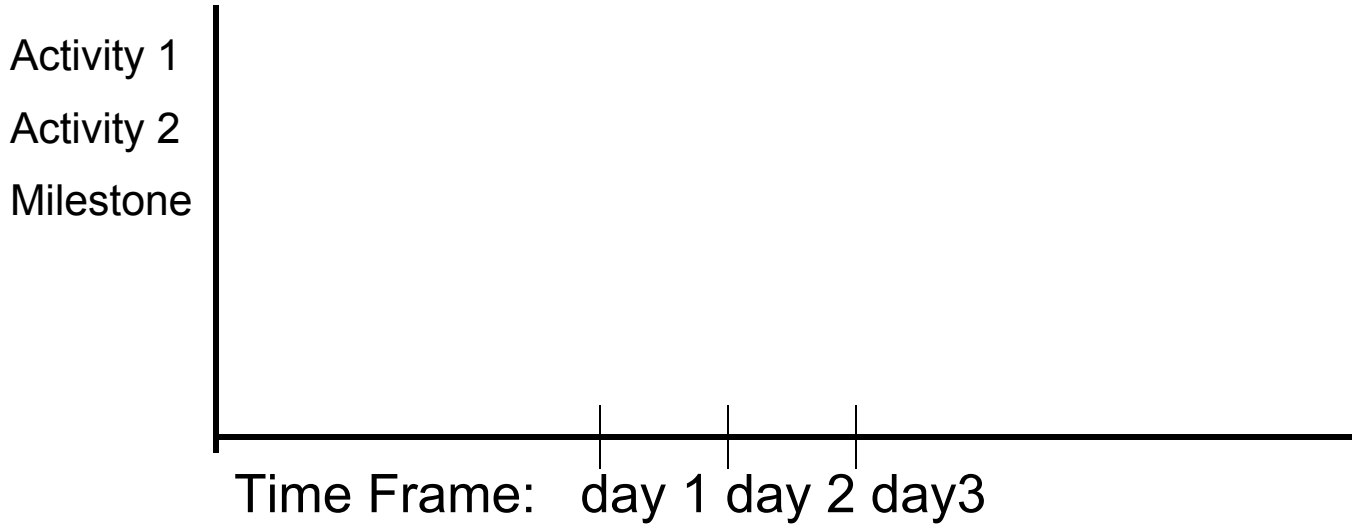
1. Identify the tasks to be scheduled
2. Determine the durations of each task
3. List each task down the vertical axis of chart
    1. In general, list tasks to be performed first at the top and then move downward as the tasks will happen
4. Use horizontal axis for the dates
5. Determine start and finish dates for activities
    1. Consider which tasks must be completed or partially completed before the next task

To use the Gantt chart to report progress:

- If the task has been completed, completely shade in the bar corresponding to the task
- If the task has been partially completed, shade in the percentage of the bar that represents the percentage of the task that has been completed
- Unshaded bars represents tasks that have not been started.

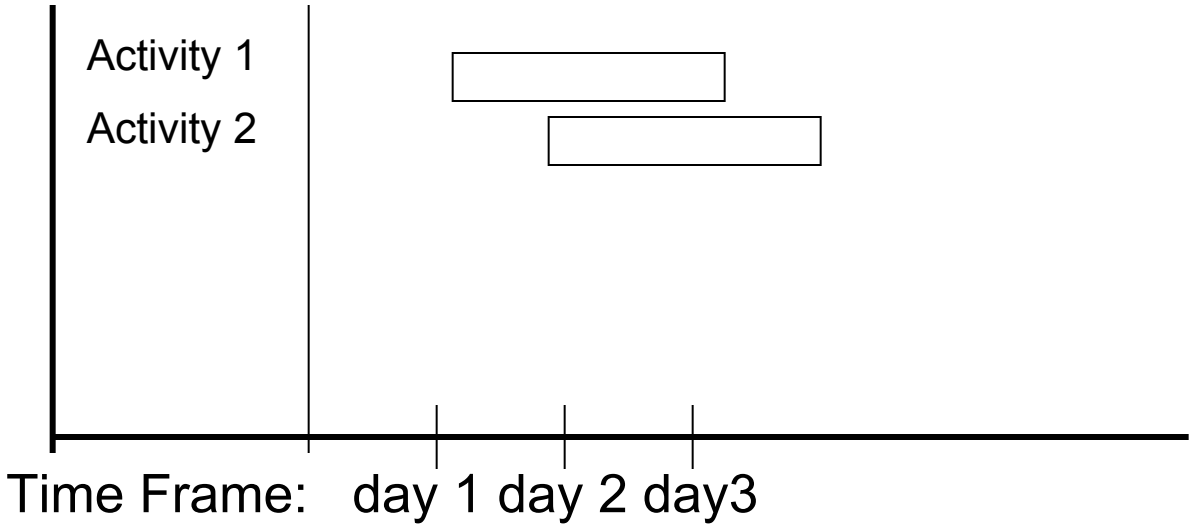
Building a Gantt Chart

- List all tasks and milestones from the project along the vertical axis
- List time frame along the horizontal axis



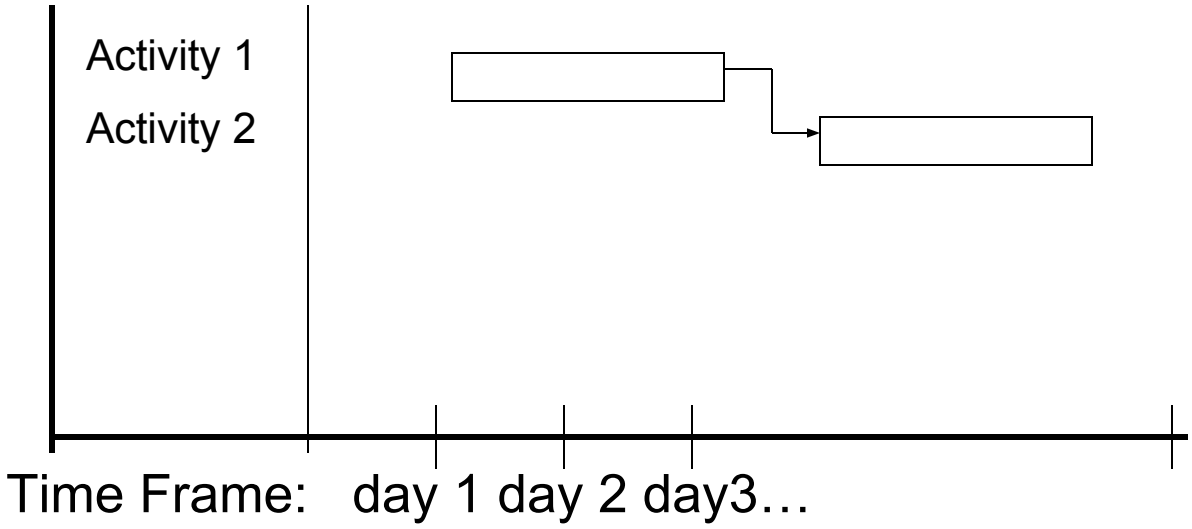
Building a Gantt Chart

- Activities: Create box the length of each activity time duration
  - E.g., activity one is scheduled from day1-day3



Building a Gantt Chart

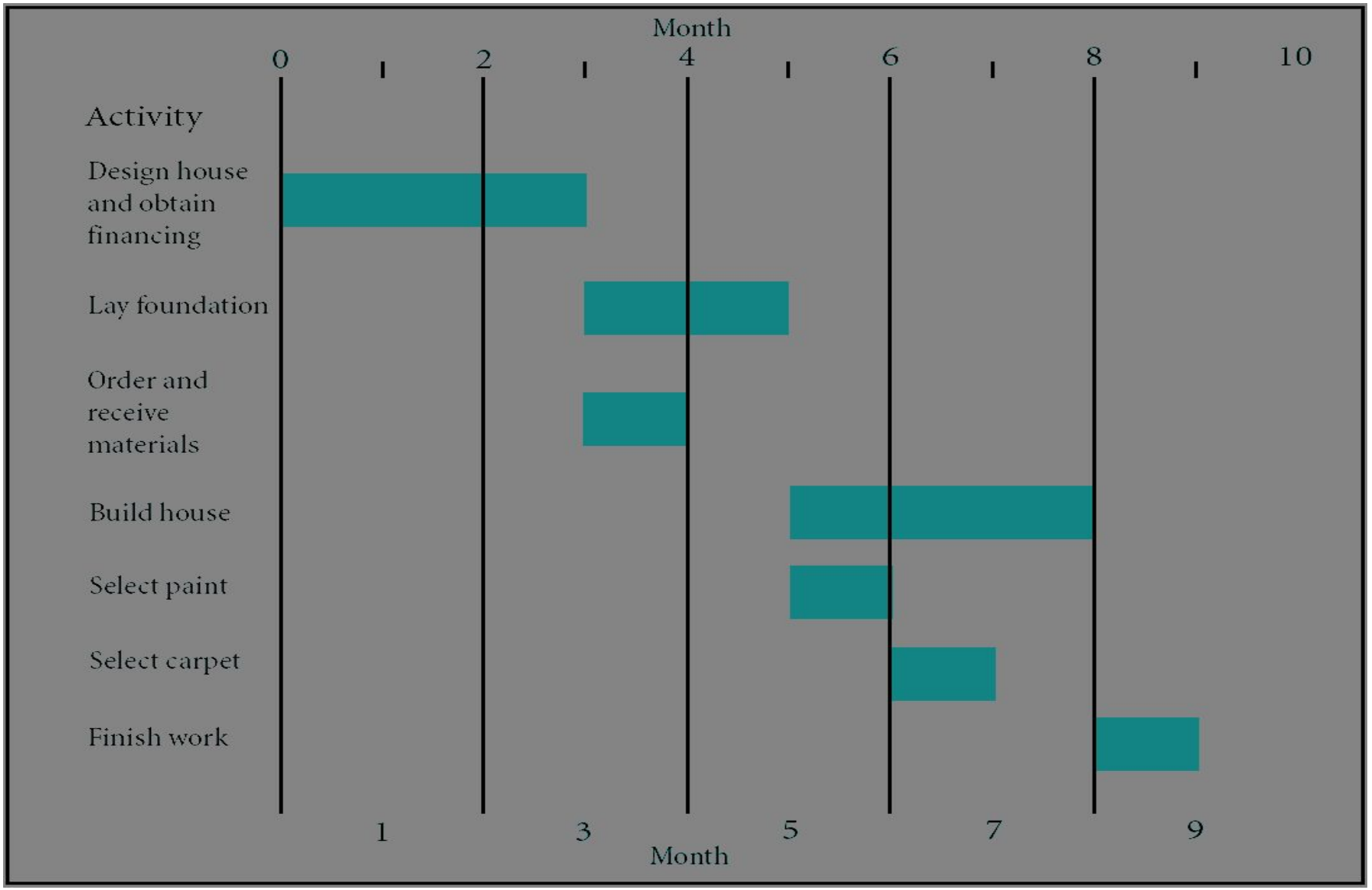
- Dependencies: Show dependencies between activities with arrows
  - E.g., activity 2 cannot start until activity 1 is complete



Sequence of Activities of The Project - House Building

Number	Activity	Predecessor	Duration
1	Design house and obtain financing	--	3 months
2	Lay foundation	1	2 months
3	Order and receive materials	1	1 month
4	Build house	2,3	3 months
5	Select paint	2, 3	1 month
6	Select carper	5	1 month
7	Finish work	4, 6	1 month

Gantt Chart for House Building Project



A Gantt chart

Gantt Charts

- ✔ **Establish a *time-phased network***
- ✔ **Can be used as a *tracking tool***

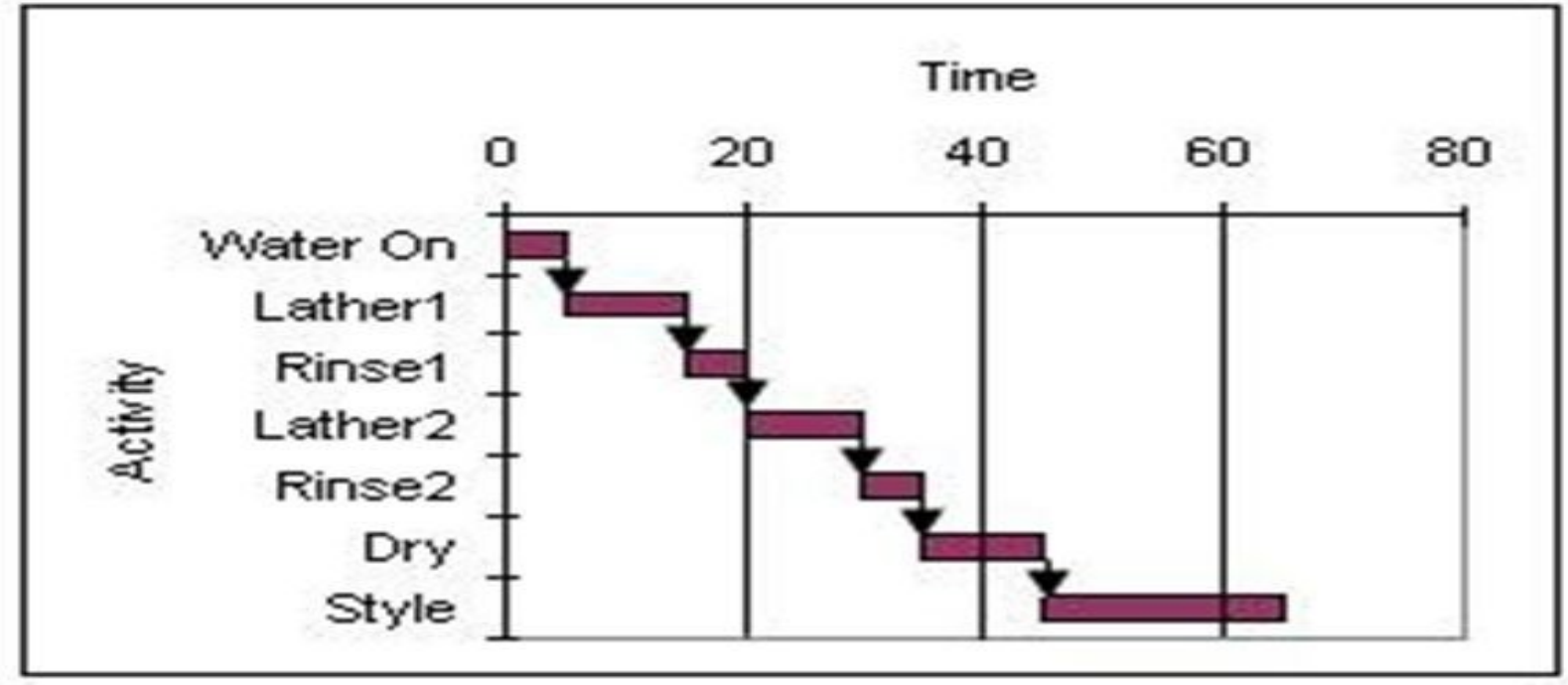
<u>Benefits of Gantt charts</u>

1. **Easy to *create* and *comprehend***
2. **Identify the schedule *baseline* network**
3. **Allow for *updating* and *control***
4. **Identify *resource needs***

Gantt Charts – Example

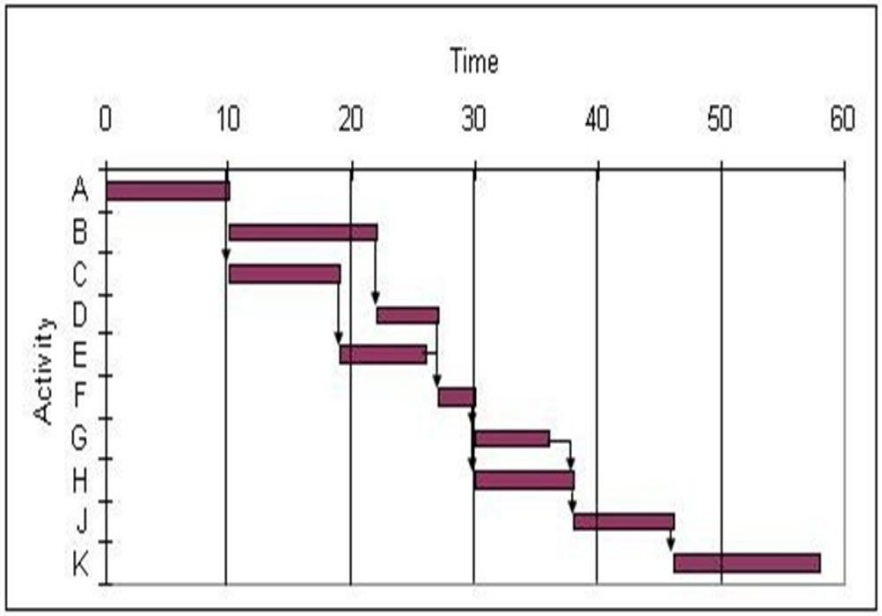
Consider the Gantt chart shown below where the time scale is in minutes and all activities are performed on an early start basis. How much slack is available in the project?

Answer: Nil



Gantt Charts – Resource Allocation Example

Use the Gantt chart and the activity list to determine when resource 5 is free.

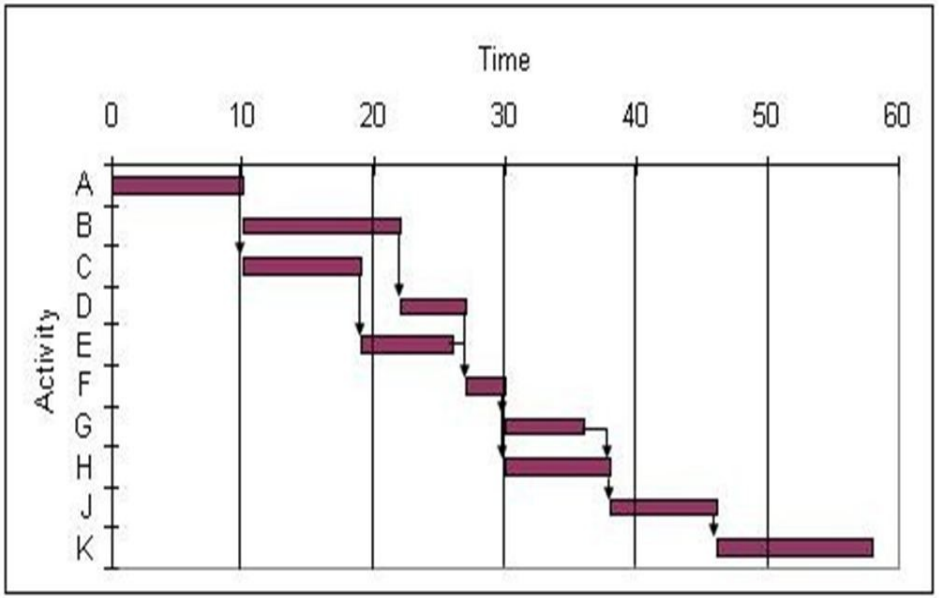


Activity	Resources	Activity	Resources
A	1	F	1
B	5	G	2
C	4	H	5
D	3	J	3
E	2	K	4

A) between 0 and 15
B) between 15 and 30
C) between 30 and 45
D) between 45 and 60
Answer: D

Gantt Charts – Resource Allocation Example

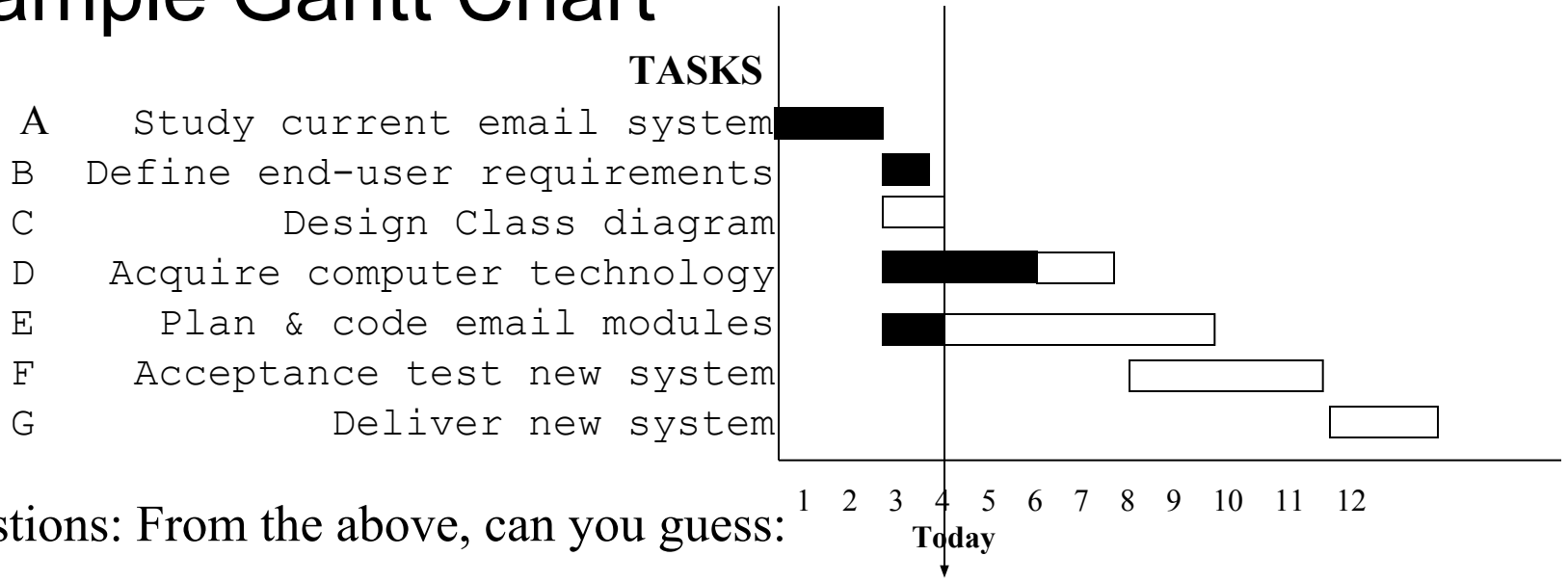
Use the Gantt chart and the activity list to determine when resource 2 is free.



Activity	Resources	Activity	Resources
A	1	F	1
B	5	G	2
C	4	H	5
D	3	J	3
E	2	K	2

A) between 0 and 15
B) between 15 and 30
C) between 30 and 45
D) between 45 and 60
Answer: A

Example Gantt Chart



Questions: From the above, can you guess:

- Which, if any, tasks should have been completed by today and aren't even started? _____
- Which, if any, tasks have been completed? _____
- Which, if any, tasks have been completed ahead of schedule:? _____
- Which, if any, tasks are on or ahead of schedule? _____
- Which, if any, tasks are behind schedule? _____

PERT vs. Gantt

PERT chart

- All us to show dependencies explicitly
- Allow us to calculate critical path
- Can tell us how one task falling behind affects other tasks

Gantt charts

- Allow us to record progress of project
- Allow us to see what tasks are falling behind
- Allow us to represent overlapping tasks

Project Management Tools, e.g. MS Project

- Allow us to specify tasks, dependencies, etc
- Allow us to specify progress on tasks, etc
- Can generate either PERT or Gantt charts (whichever we want) from data entered

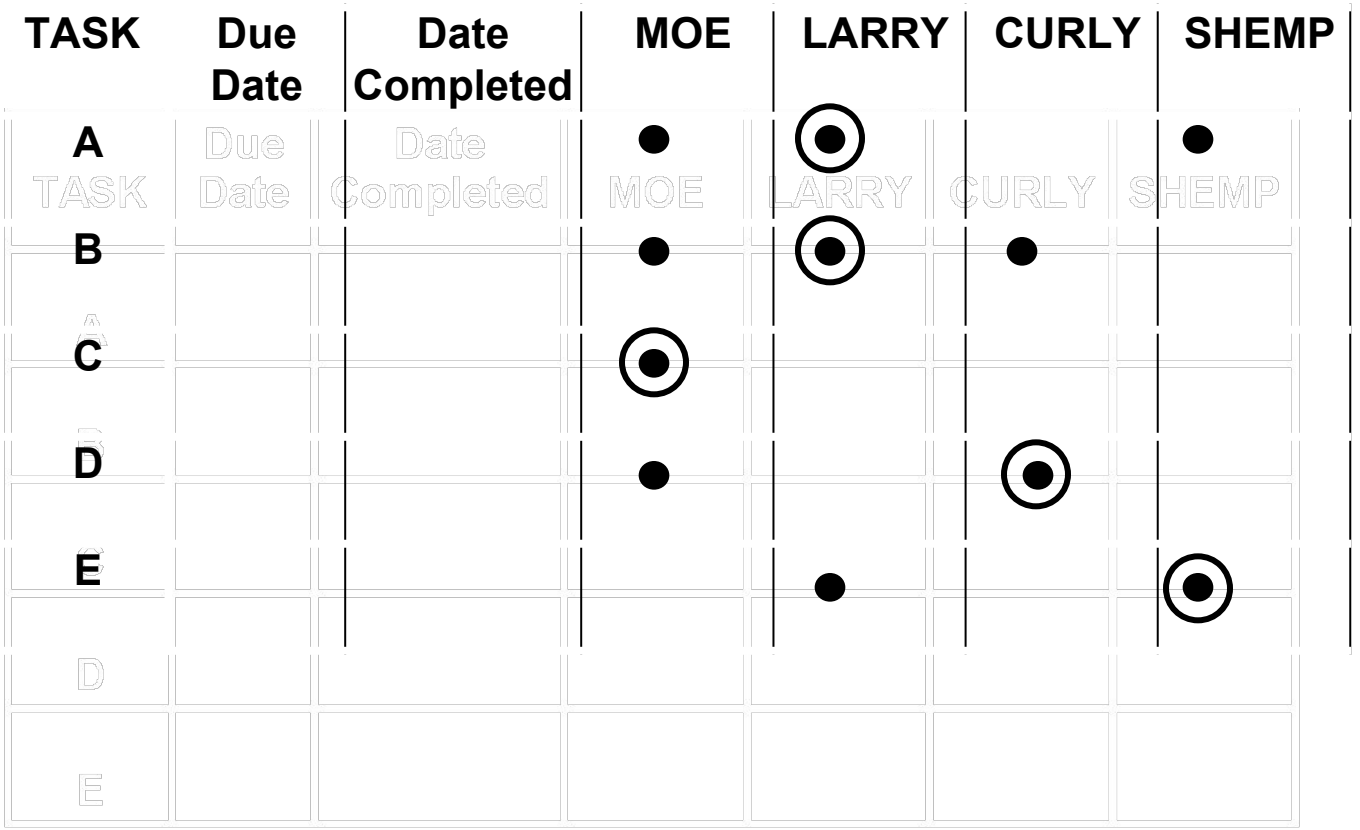
Resource Planning

LINK TO TIME PLANNING

Personnel

- In-House
- Vendors and Subcontractors
- Circle-dot chart

Circle-dot Chart



Resource Planning - continued

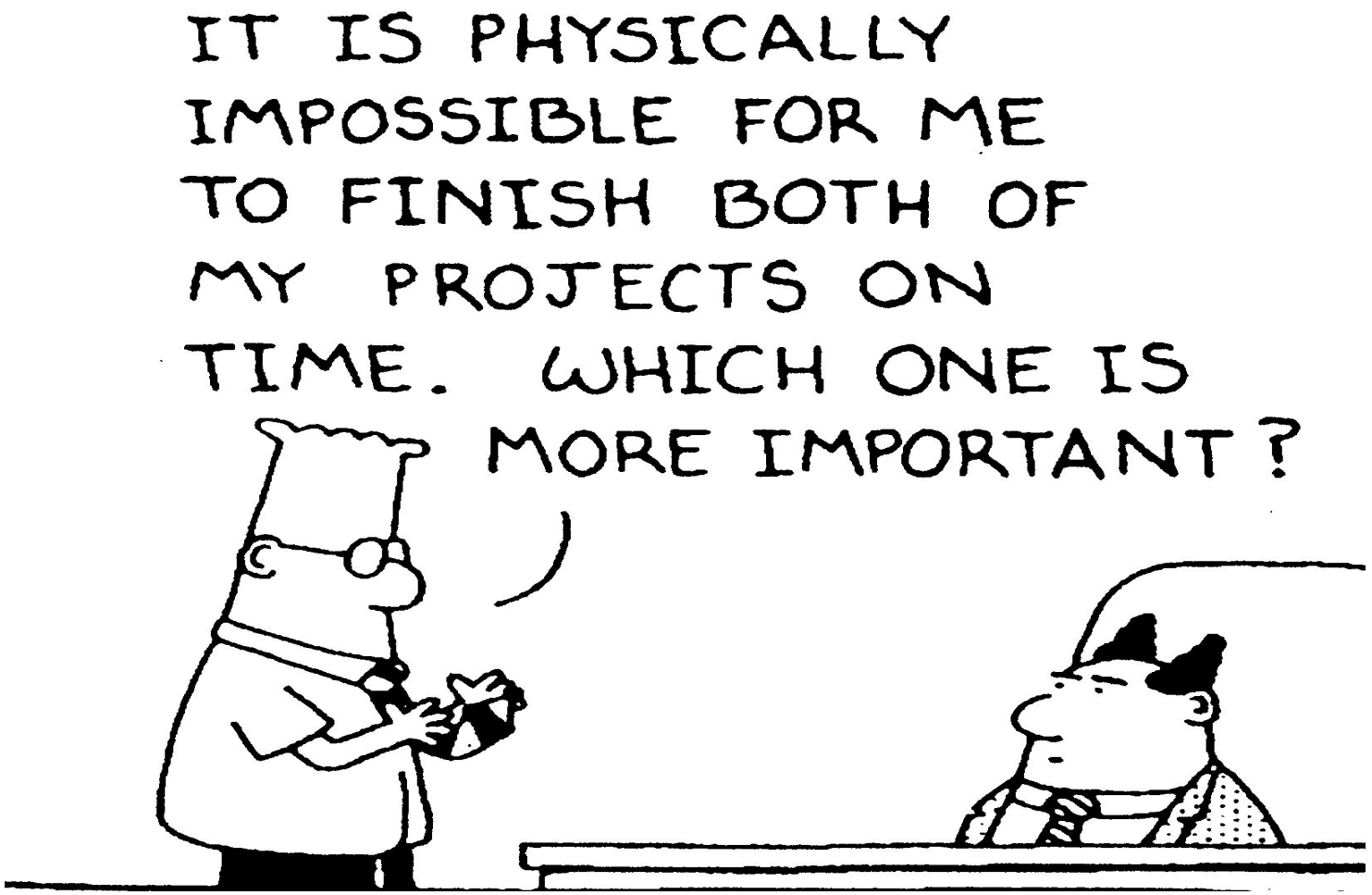
Equipment and Facilities

- May Need to Add Dummy Tasks for Critical Resources
- Downtime for Expected Maintenance or Failure

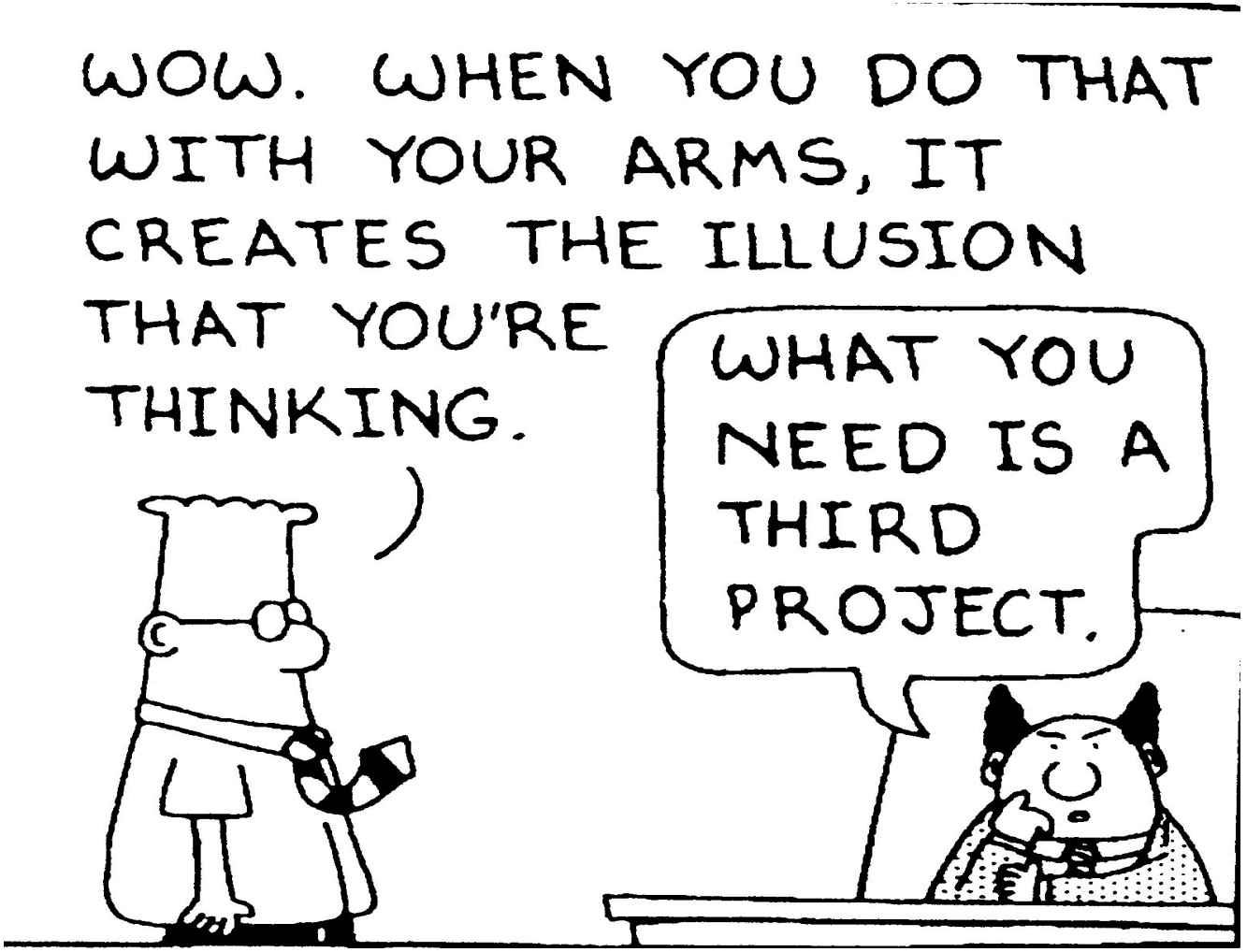
Budget

- Often Not Under Direct Control of Project Team
- Contingency Funds
- Variable Value of Money
  - Inflation
  - International Currency

Project Management is …



… a Balancing Act



Difficulties and Risks in Project Management

- Accurately estimating costs is a constant challenge
  - *Follow the cost estimation guidelines.*
- It is very difficult to measure progress and meet deadlines
  - *Improve your cost estimation skills so as to account for the kinds of problems that may occur.*
  - *Develop a closer relationship with other members of the team.*
  - *Be realistic in initial requirements gathering, and follow an iterative approach.*
  - *Use earned value charts to monitor progress.*

Difficulties and Risks in Project Management

- It is difficult to deal with lack of human resources or technology needed to successfully run a project
  - *When determining the requirements and the project plan, take into consideration the resources available.*
  - *If you cannot find skilled people or suitable technology then you must limit the scope of your project.*

Difficulties and Risks in Project Management

- Communicating effectively in a large project is hard
  - *Take courses in communication, both written and oral.*
  - *Learn how to run effective meetings.*
  - *Review what information everybody should have, and make sure they have it.*
  - *Make sure that project information is readily available.*
  - *Use 'groupware' technology to help people exchange the information they need to know*

Difficulties and Risks in Project Management

- It is hard to obtain agreement and commitment from others
  - — *Take courses in negotiating skills and leadership.*
  - — *Ensure that everybody understands*
    - *The position of everybody else.*
    - *The costs and benefits of each alternative.*
    - *The rationale behind any compromises.*
  - — *Ensure that everybody's proposed responsibility is clearly expressed.*
  - — *Listen to everybody's opinion, but take assertive action, when needed, to ensure progress occurs.*

Review

Draw a PERT Chart for the following activities:

Activity	Description	Predecessor	Estimated Time
A	Drive home	None	0.5
B	Wash Clothes	A	4.0
C	Pack	B	0.5
D	Go to bank	A	1.0
E	Pay bill	D	0.5
F	Pack car	C,E	0.5
G	Drive to bus	F	0.5