Software Project Management

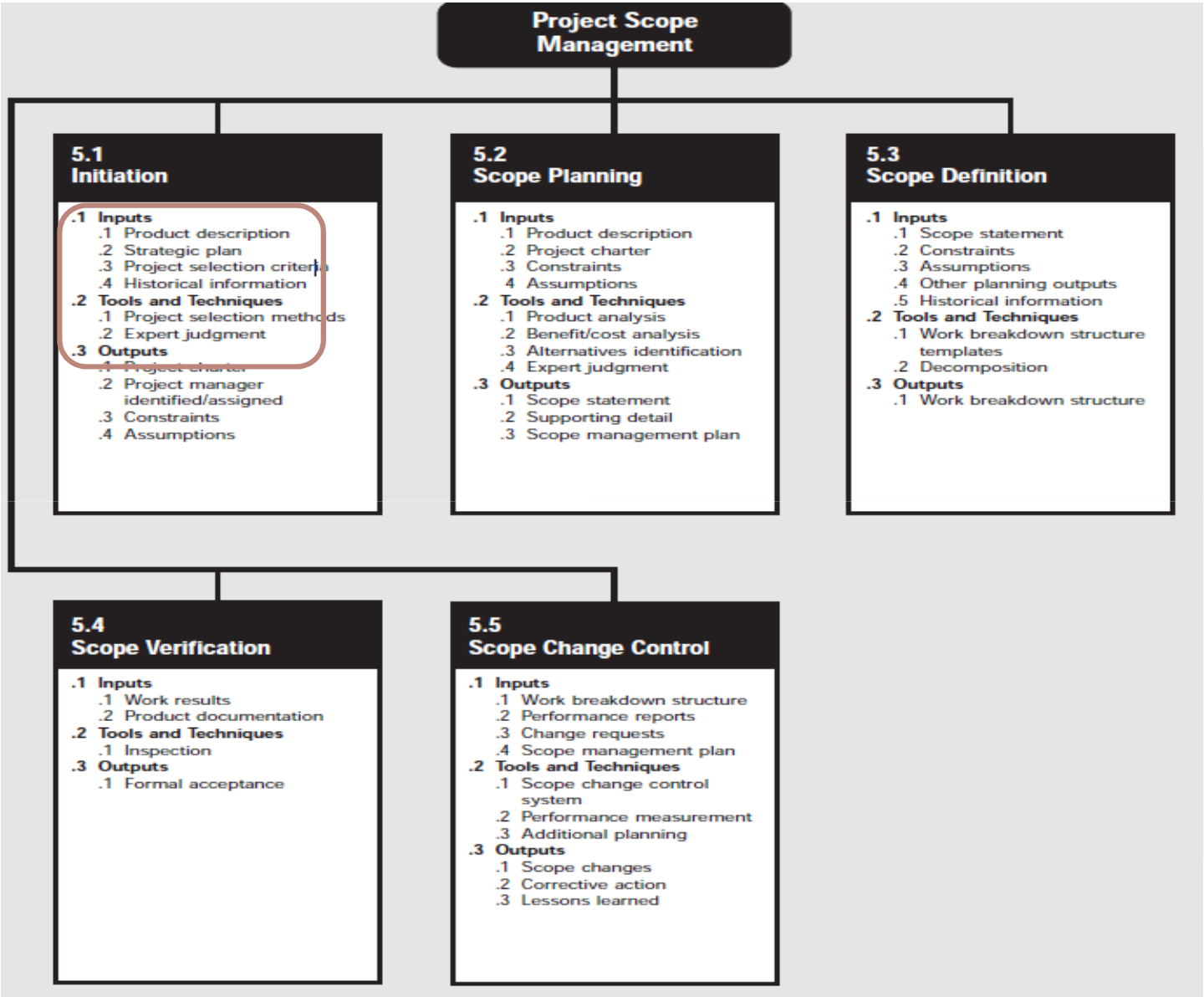
Unit 2 – Part 2

Dr.M.Paul Arokiadass Jerald

Unit II – Syllabus Overview

- Project Planning -Integration Management - Introduction - Project plan development – Plan Execution - Scope Management - Introduction - **methods for selecting projects - project charter - scope statement** – work breakdown structure - Stepwise Project Planning - overview - Main steps in project planning.
- Project Scheduling-Time Management- Importance of project schedules- Schedules and activities - Sequencing and scheduling activity - Project Network Diagrams -Network planning models- Duration Estimating and schedule development- Critical path analysis- Program evaluation and review Techniques

2.6 Project Selection



Project Selection

- Profit optimization is the ultimate goal.
- Project Selection is done to
  - to decide whether a project is viable.
  - to decide if the project at hand is worth approving.

Project Selection Methods

- Two Project Selection Methods
  1. Benefit Measurement Methods

     Used for small projects that are not very complex

  2. Constrained Optimization Methods

     Used for a large complex project

Project Selection Methods

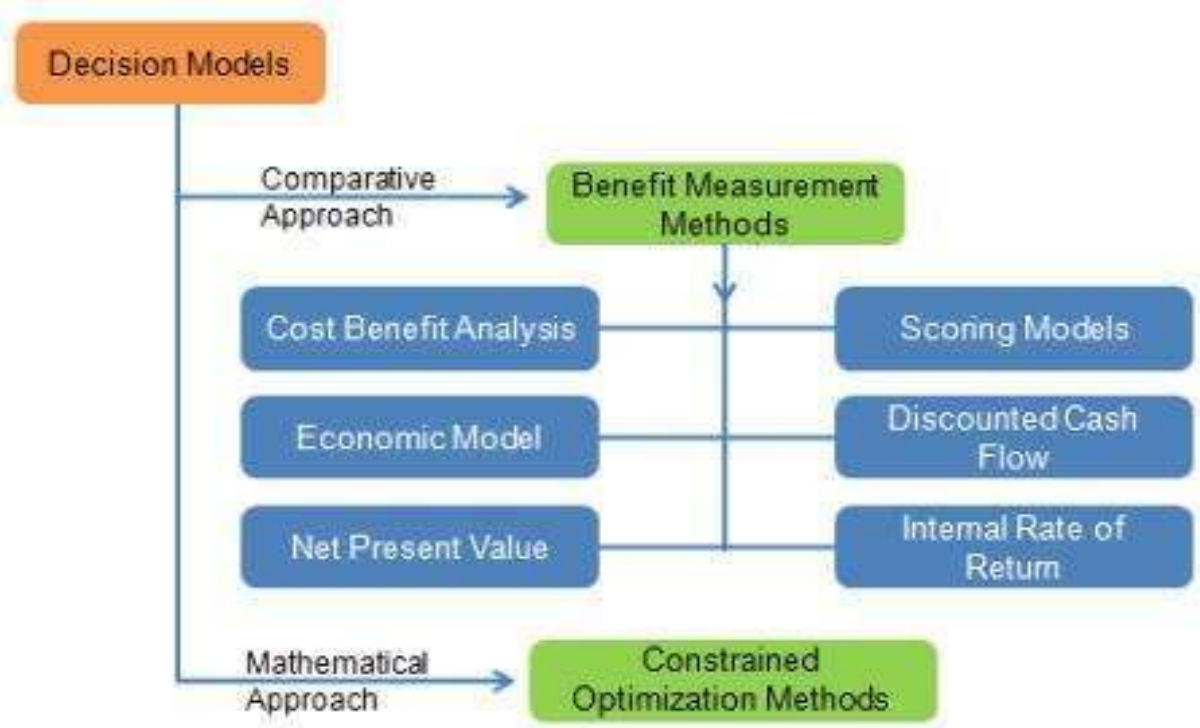
Project Selection Methods - Comparison

Benefit Measurement Methods	Constrained Optimization Methods
Compare and contrast projects against each other	**Mathematically model the project outcomes**

• Murder Board
• Peer Review
• Scoring Models
• Economic Models:
  ◦ Present Value and Net Present Value
  ◦ Internal Rate of Return
  ◦ Payback
  ◦ Benefit Cost Ratio
	• Constrained Optimization Models:
	  ◦ Linear Programming
	  ◦ Integer Programming
	  ◦ Dynamic Programming
	  ◦ Multi-objective programming

Reference : **Project Integration Management**

Project Decision Models



Criteria in Project Selection

- Value of one project would need to be compared against the other projects.
- Common techniques used in comparison :
  - Give each project scores based on how they **rate** in each of these criteria and then choose the project with the highest score.
  - **Discounted Cash flow method,** the future value of a project is ascertained by considering the present value and the interest earned on the money. The higher the PV, better it would be for organization.
  - The rate of returns **(IRR)** : Money received as return of investment, look for a high rate of return from the project.

Criteria in Project Selection

- The mathematical approach is commonly used for larger projects.
- The constrained optimization methods require several calculations in order to decide on whether or not a project should be rejected.
- Cost-benefit analysis is used by several organizations to assist them to make their selections. In this method, to consider all the positive aspects of the project which are the benefits and then deduct the negative aspects (or the costs) from the benefits.
- Based on the results received for different projects, choose which option would be the most viable and **financially rewarding**.

Project Selection

- Questions to be asked
  - Would this decision help to increase organizational value in the long run?
  - How long will the project last ?
  - Would it be able to cut down on costs ?

2.7 Project Charter

- Project Charter refers to a statement of objectives in a project.
- This statement also sets out detailed project goals, roles and responsibilities, identifies the main stakeholders, and the level of authority of a project manager.
- It acts as a guideline for future projects as well as an important material in the organization's knowledge management system.
- The project charter is a short document that would consist of new offering request or a request for proposal.

Project Charter

A Document that officially acknowledges the existence of a Project

Developed by Corporate executive or Sponsor

Defines responsibilities and boundaries of Project Manager and Project

Role of Project Charter

- It documents the reasons for undertaking the project.
- Outlines the objectives and the constraints faced by the project.
- Provides solutions to the problem in hand.
- Identifies the main stakeholders of the project.
- industry best practices.

Benefits of Project Charter

Following are the prominent benefits of Project Charter for a project:

- It improves and paves way for good customer relationships.
- Project Charter also works as a tool that improves project management processes.
- Regional and headquarter communications can also be improved to a greater extent.
- By having a project charter, project sponsorship can also be gained.
- Project Charter recognizes senior management roles.
- Allows progression, which is aimed at attaining industry best practices.

Elements in Project Charter

- Project charter is a project planning tool, aimed at resolving an issue or an opportunity, the below elements are essential for a good charter project.
- For an effective charter project, it needs to address these key elements:
- **Identity** of the project.
- **Time**: the start date and the deadline for the project.
- **People** involved in the project.
- Outlined **objectives** and set targets.

Elements in Project Charter

- Detailed description of a problem or an opportunity.
- The return expected from the project.
- Results that could be expected in terms of performance.
- The expected date that the objectives is to be achieved.
- Clearly defined roles and responsibilities of the participants involved.
- Requirement of resources that will be needed for the objectives to be achieved.
- Barriers and the risks involved with the project.
- Informed and effective communication plan.

Business Case in Project Charter

- A business case should set out the benefits gained from carrying out a project charter.
- Benefits need not only be in terms of finance such as revenue, cost reduction, etc., but also the benefit that the customer receives.
- Following are the characteristics of a good business case:
- The reasons of undertaking the project.
- The benefits gained from undertaking the project now.
- The consequences of not doing the project.
- The factors that would conclude that it fits the business goals.

Project Scope

- As the name denotes, it refers to the scope that the project will give the business if they undertake the project.
- Before doing a project, the following concerns need to be addressed:
  - The within scope and out of scope needs to be considered.
  - The process that each team will focus upon.
  - The start and end points for a process.
  - Availability of resources.
  - Constraints under which the team will work.
  - Time limitations .
  - The impact on the normal workload if the project is to be undertaken.

Communication Plan

The Need for a Good Communication Plan **:** utmost necessity when it comes to planning a project.

- When creating a communication plan, the project manager needs to take the following into consideration:
- **Who -** responsibility of each individuals participating in the project.
- **What -** the motive and the reason for communication plan.
- **Where -** location where the receiver could find information.
- **When -** the duration and the frequency of the communication plan.
- **How -** the mechanism which is used to facilitate the communication.
- **Whom -** The receivers of the communication.

Project Charter - Conclusion

- The project charter is not only a tool that is used for planning projects but also a communication mechanism that acts as a reference.
- A well-planned project with an effective communication plan will definitely bring in success for the project undertaken at hand.
- Project Charter should be one of the frequently referred documents in a project and the entire project team needs to be aware of the content of the Project Charter.

A3 PROJECT CHARTER: <TITLE>

Date: <date>
Sponsor: <sponsor>

CONTEXT / ISSUES

- What is the issue and why is it important to tackle now?
- What is the purpose, the business reason for choosing this project?
- What are the anticipated benefits to customers and staff from the project?
- What performance measure needs to improve?
- Have you been to the Gemba?
- What process/program/customer data do you have regarding the problem (time, cost, quality)? Show facts and processes visually using charts, graphs, maps, etc.
- When did the problem start?
- Where is the problem occurring?
- What is the extent or magnitude of the problem?

GOALS

- What specific, measurable , attainable, relevant, time-bound results do you want or need to accomplish?
- Show visually how much, by when, and with what impact.
- NOTE: Be careful not to state a solution as a goal!

SCOPE (IN BOUNDS)

- What is the first step and last step in the process?
- What is the program and geographic area?
- NOTE: Be mindful of what you can realistically accomplish with available resources and time.

SCOPE (OUT OF BOUNDS)

- What is off the table due to resources?
- What are the givens or assumptions for the project?
- Record out of scope issues in a "Parking Lot"

CUSTOMERS/STAKEHOLDERS

- Who is the end-user customer?
- Who are other stakeholders who have a role or interest in the success of the process?

TEAM MEMBERS

- Team Leader:
- Team Members:

CUSTOMER REQUIREMENTS (CTQ)

- What do customers/stakeholders expect and require from the process? What are their critical to quality (CTQ) requirements?
- What legal requirements (laws, rules) govern the process?

VISION OF SUCCESS

- What outcomes or results do you want to see?
- What does success look like for our customer?
- What does success look like for other stakeholders (staff, partners)?

PROJECT MILESTONES & SCHEDULE

Project Milestones	Owner	Proposed Date	Actual Date
1. Set project scope and goals (prepare Project Charter, engage team, collect data)	Sponsor/Team Leader, Facilitator		
2. Understand the current situation	Facilitator/ Team		
3. Analyze the current situation (root causes)	Facilitator/ Team		
4. Define a vision of success	Facilitator/ Team		
5. Generate, evaluate and select improvements	Team/ Sponsor		
6. Implement changes and make adjustments	Team Leader/ Staff		
7. Measure performance	Sponsor/Team Leader		
8. Document standard work and lessons learned	Team		
9. Sustain improvement	Team Leader/Process Owner		

RESOURCES

- Time commitment for a 4 day Kaizen, excluding time to implement changes: Sponsor (6-10 hrs.); Team Leader (40 hrs.); Team Members (32 hrs.); Facilitator (40-50 hrs.)
- External Resources:
- Equipment:
- Materials:

A3 PROJECT CHARTER: <TITLE>

Date: <date>
Sponsor: <sponsor>

CONTEXT / ISSUES

GOALS

SCOPE (IN BOUNDS)

SCOPE (OUT OF BOUNDS)

CUSTOMERS/STAKEHOLDERS

TEAM MEMBERS

- Team Leader:
- Team Members:

CUSTOMER REQUIREMENTS (CTQ)

VISION OF SUCCESS

P

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Scope Statement Contents

- Project title, Name of the person who developed the document , Sponsor Project manager, his/her responsibilities and levels of authority
- Project description
- Project objectives
- Project justification
- Project product Client/sponsor's expectations
- Critical success factors Assumptions and Constraints
- Specific exclusions (what will not be produced by the project)
- Main activities and strategies
- Main deliverables , Basic budget Deliverables and milestone plan
- Register of changes in the document Approvals

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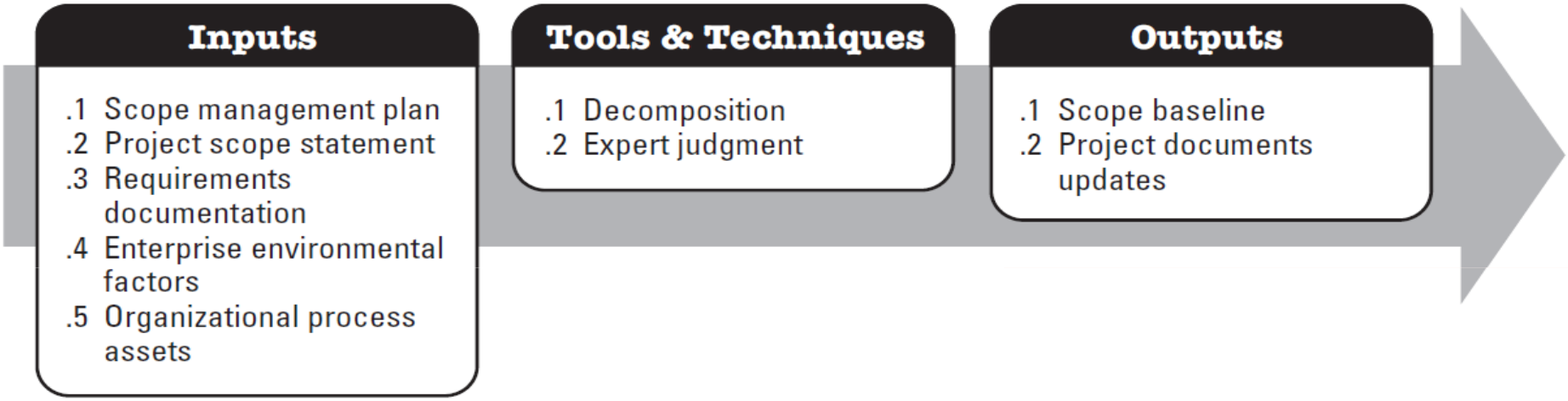
Work Breakdown Structure

- WBS is
  - hierarchical decomposition of the total scope of work
  - carried out by the project team
  - to accomplish the project objectives and create the required deliverables.

- WBS involves
  - identifying the main tasks
  - break each main task down into subtasks
  - The subtasks can further be broken down into lower level tasks.

WBS Process (in Scope Management)



Create WBS: Inputs, Tools & Techniques, and Outputs

WBS Process

1. **Create WBS: Inputs**
   - Scope Management Plan
   - Project Scope Statement
   - Requirements Documentation
   - Enterprise Environmental Factors
   - Organizational Process Assets
2. **Create WBS: Tools and Techniques**
   - Decomposition
   - Expert Judgment
3. **Create WBS: Outputs**
   - Scope Baseline
   - Project Documents Updates

Reasons for creating a WBS in a project:

- ✓ Accurate and readable project organization.
- ✓ Accurate assignment of responsibilities to the project team.
- ✓ Indicates the project milestones and control points.
- ✓ Helps to estimate the cost, time and risk.
- ✓ Illustrate the project scope, so the stakeholders can have a better understanding of the same.

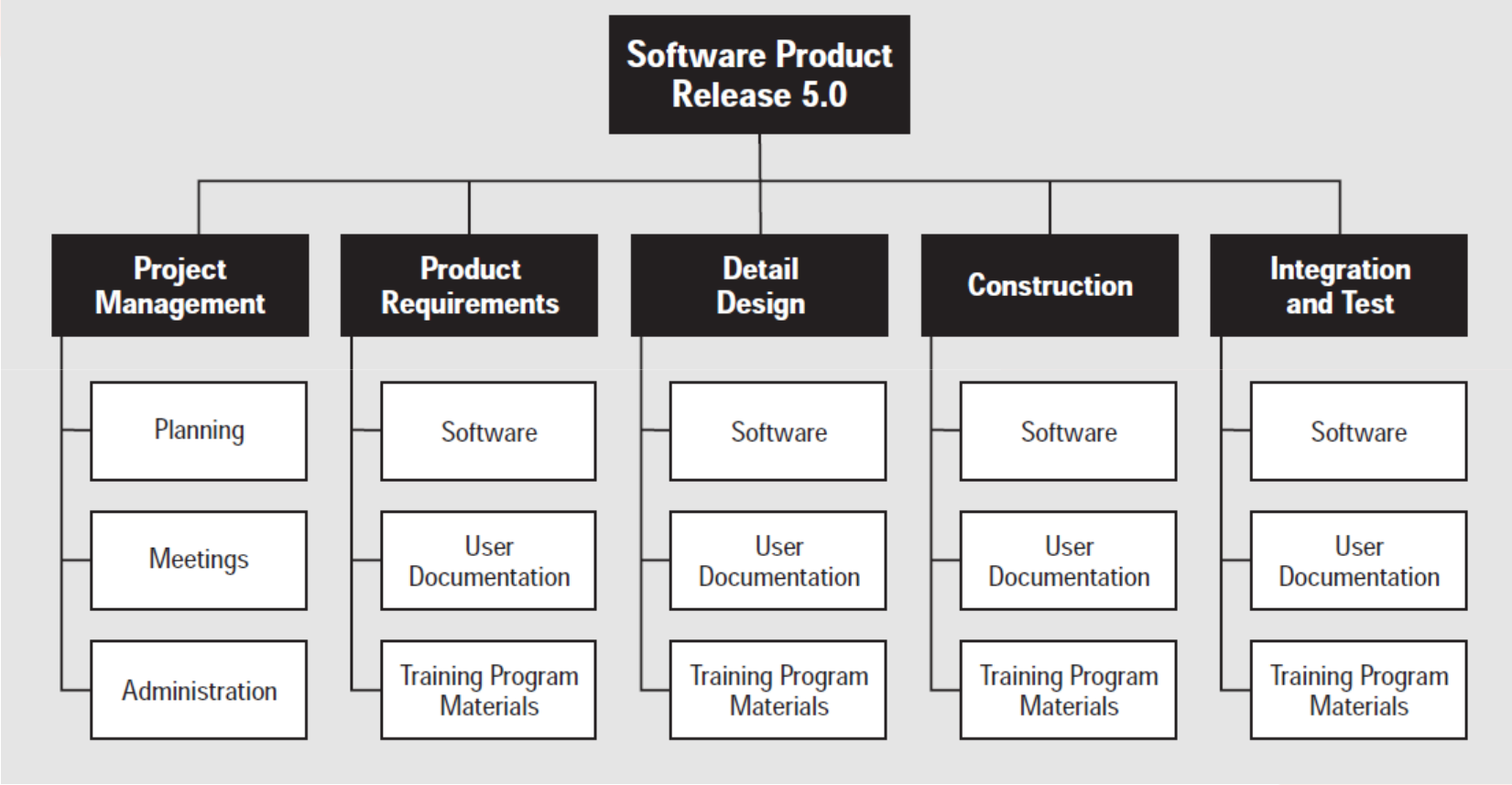
WBS Dictionary

- **WBS dictionary.** The WBS dictionary provides detailed information for WBS elements(**detailed deliverable, activity, and** scheduling information).
- Information in the WBS dictionary may include :
  - Code of account identifier,
  - Description of work,
  - Assumptions and constraints,
  - Responsible organization,
  - Schedule milestones,
  - Associated schedule activities,
  - Resources required,
  - Cost estimates,
  - Quality requirements,
  - Acceptance criteria,
  - Technical references, and
  - Agreement information.

Approaches of WBS

- **Topdown approach :**the use of organization-specific guidelines, and the use of WBS templates.
- **A bottom-up approach :** used during the integration of subcomponents.
- The WBS structure can be represented in a number of forms, such as:
  - Using phases of the project life cycle as the second level of decomposition, with the product and project deliverables inserted at the third level
  - Using major deliverables as the second level of decomposition
  - Incorporating subcomponents which may be developed by organizations outside the project team, such as contracted work.

Sample WBS for Software



Reference : A Guide to the Project Management Body of Knowledge

Design goals for WBS

- Some important goals of WBS are:
- Giving visibility to important work efforts.
- Giving visibility to risky work efforts.
- Illustrate the correlation between the activities and deliverables.
- Show clear ownership by task leaders.

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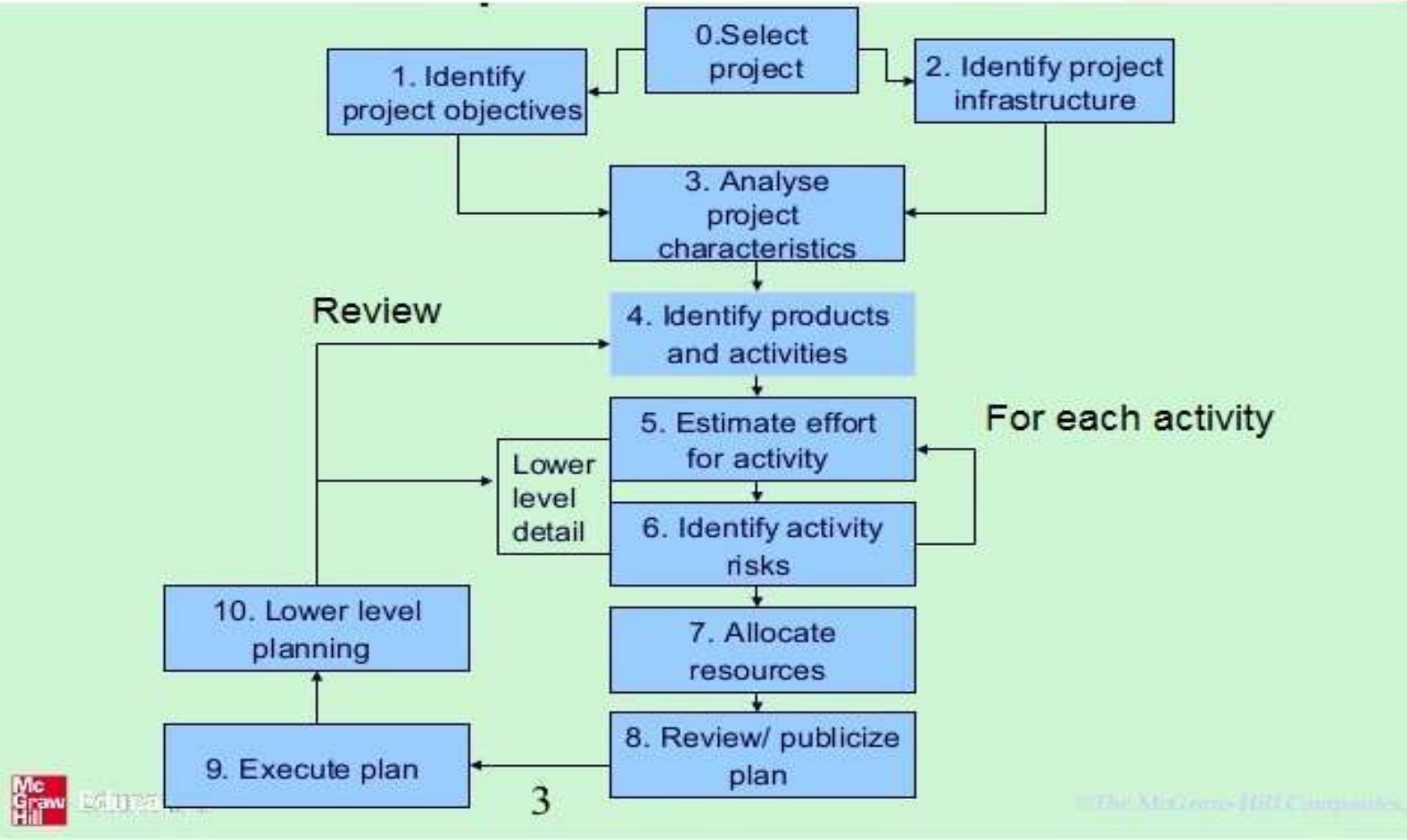
Stepwise Project Planning

- **Project planning** is often used to organize different areas of a **project**, including **project plans**, work loads and **the management** of teams and individuals.
- **The logical dependencies** between tasks are defined **using** an activity network diagram that enables identification of **the** critical path.
- The framework described is called the Stepwise method to help to distinguish it from other methods.

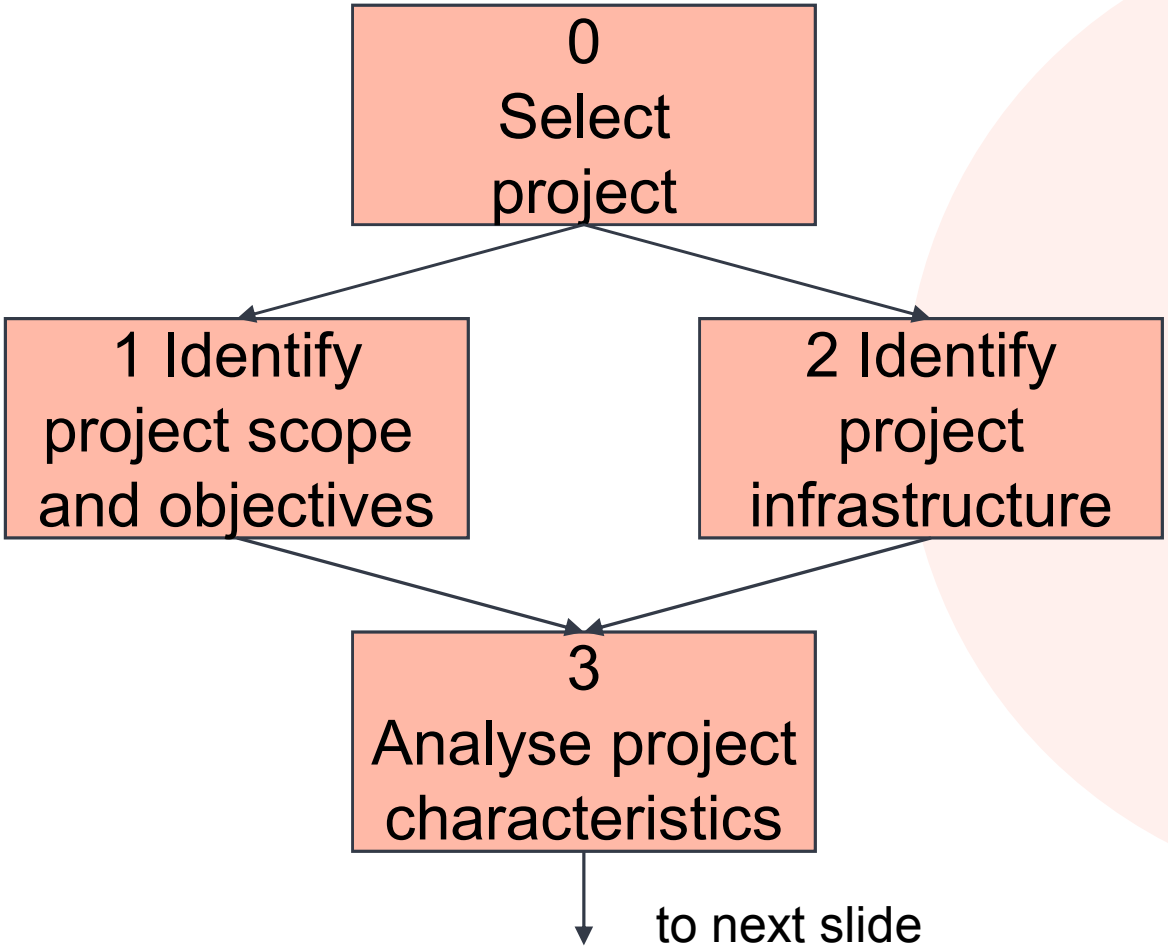
Stepwise Project Planning



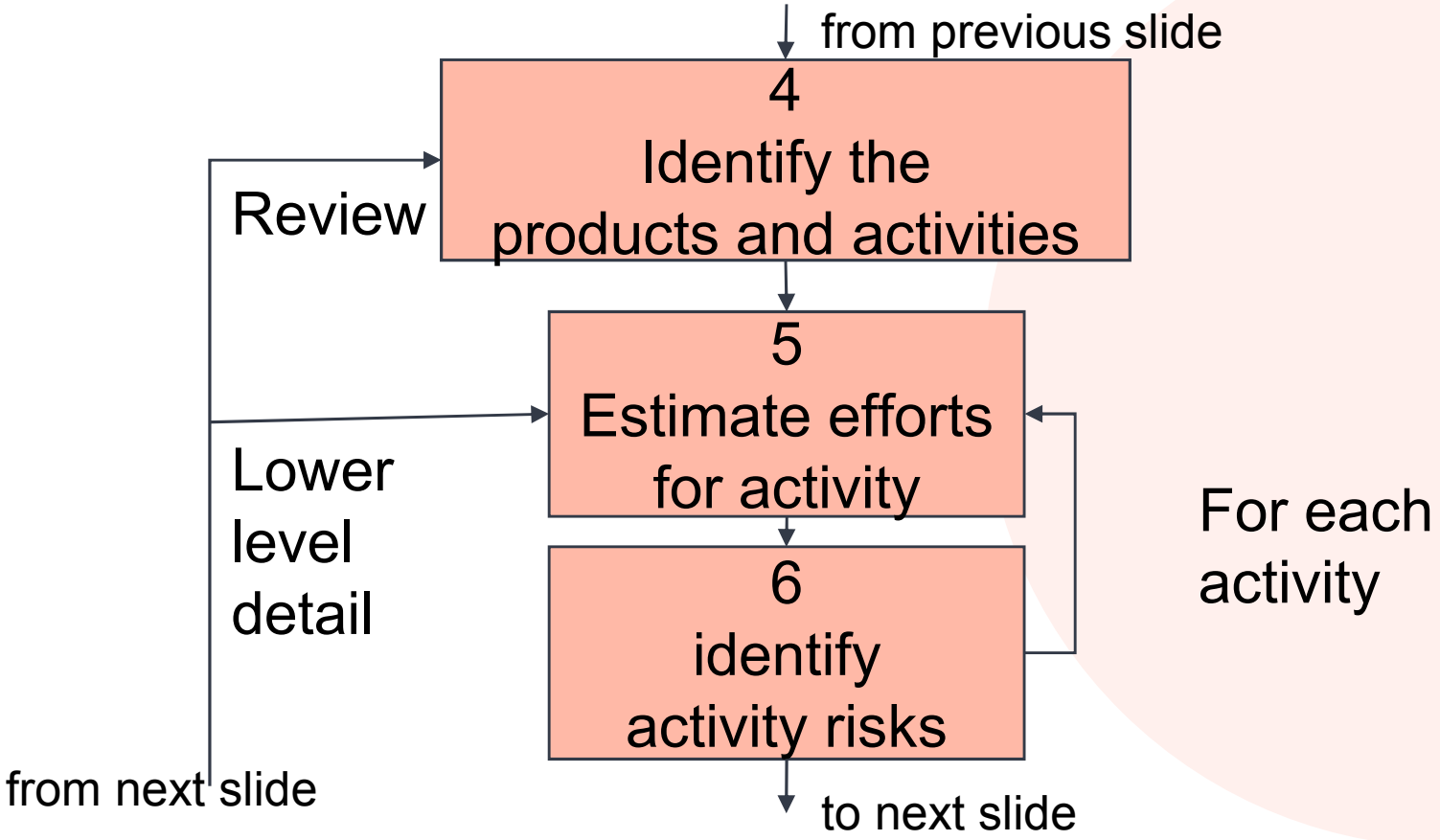
Steps in Project Planning

Step 0: Select project
Step 1: Identify project scope and objectives
Step 2: Identify project infrastructure
Step 3: Analyze project characteristics
Step 4: Identify project products and activities
Step 5: Estimate effort for each activity
Step 6: Identify activity risks
Step 7: Allocate resources
Step 8: Review/publicize plan
Step 9: Execute plan
Step 10: Execute lower levels of planning

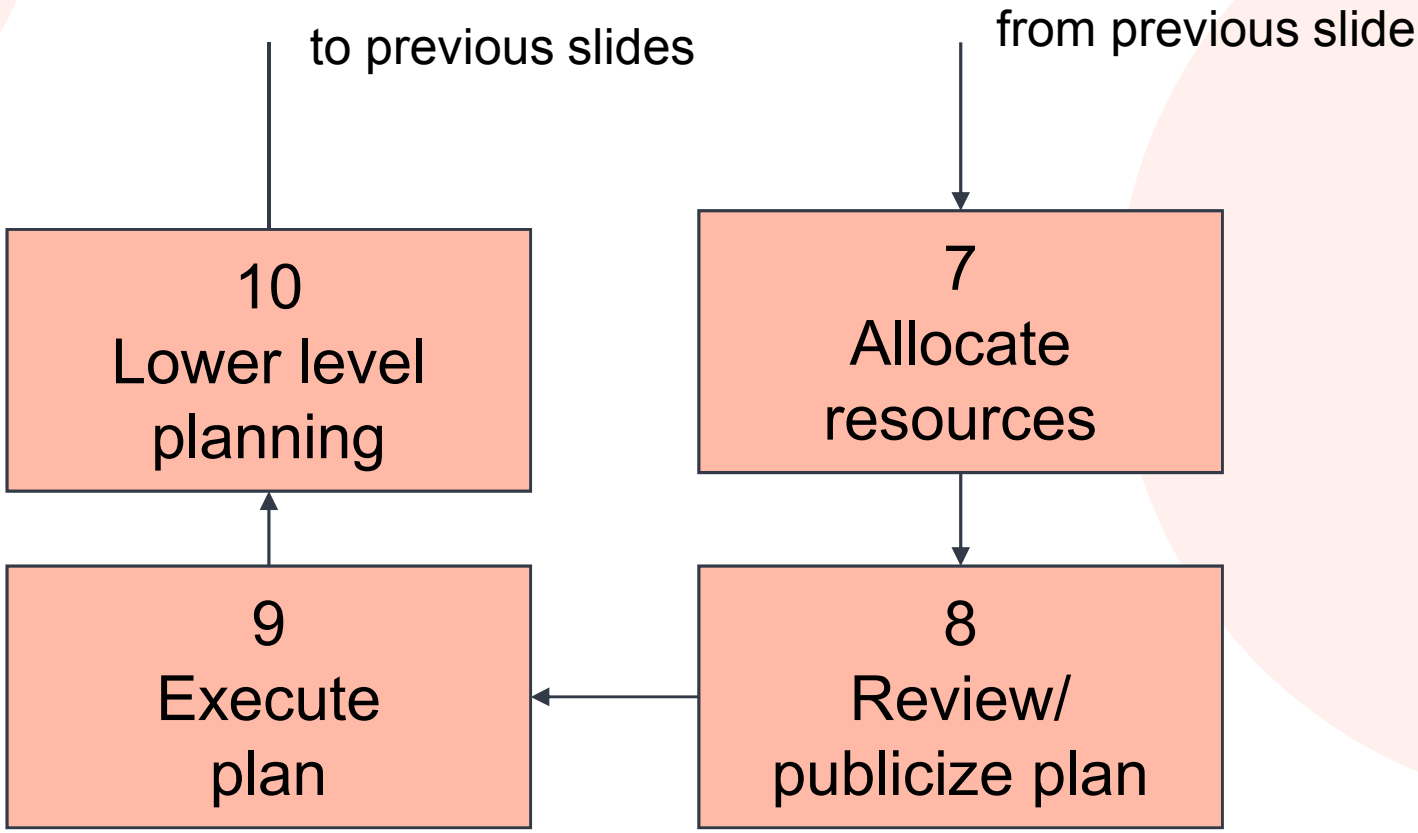
Step Wise Planning – 1/3



Step Wise Planning – 2/3



Step Wise Planning – 3/3



Step 1: Identify Project Scope and Objectives

- Step 1.1 : Identify objectives and practical measures of the effectiveness in meeting those objectives
- Step 1.2 : Establish a project authority
  - To ensure the unity of purpose among all persons concerned

Step 1: Identify Project Scope Objectives (contd)

- Step 1.3 Identify all stakeholders in the project and their interests
- Step 1.4 Modify objectives in the light of stakeholder analysis
- Step 1.5 Establish methods of communication between all parties

Step 2: Identify Project Infrastructure

- Step 2.1 Identify relationship between the project and strategic planning
  - To determine the order of related projects (in the organization) being carried out
  - To establish a framework within which the system fits
  - To ensure the hardware and software standards are followed

Step 2: Identify Project Infrastructure (contd)

- Step 2.2 Identify installation standards and procedures
  - more appropriate name: “Identify standards and procedures related to the software project”
- Step 2.3 Identify project team organization

Step 3: Analyse Project Characteristics

- Step 3.1 Distinguish the project as either objective-driven or product-driven
- Step 3.2 Analyse other project characteristics (including quality-based ones)
- Step 3.3 Identify high level project risks
- Step 3.4 Take into account user requirements concerning implementation

Step 3: Analyse Project Characteristics (contd)

- Step 3.5 Select general lifecycle approach in the light of the above
- Step 3.6 Review overall resource estimates

  Up to this stage,
  - the major risks of the project are identified
  - the overall approach of the project is decided
  - So, it is a good place to re-estimate the required effort and other resources for the project

Step 4: Identify Project Products and Activities

- Step 4.1 Identify and describe project products
  - Identify all the products related to the project
  - Account for the required activities
- Step 4.2 Document generic product flows
  - To document the relative order of the products
- Step 4.3 Recognize product instances

Step 4: Identify Project Products and Activities (contd)

- Step 4.4 Produce an ideal activity network
  - Activity network shows the tasks that have to be carried out as well as their sequence of execution for the creation of a product from another
- Step 4.5 Modify the ideal to take into account need for stages and checkpoints
  - To check compatibility of products of previous activities

Step 5: Estimate Effort for Each Activity

- Step 5.1 Carry out bottom-up estimates
  - need to estimate staff effort, time for each activity, and other resources
- Step 5.2 Revise plan to create controllable activities
  - need to break a task into a series of manageable sub-tasks

Step 6: Identify Activity Risks

- Step 6.1 Identify and quantify the risks of each activity
- Step 6.2 Plan risk reduction and contingency measures where appropriate
- Step 6.3 Adjust overall plans and estimates to take account of risks

Step 7: Allocate Resources (Staffing)

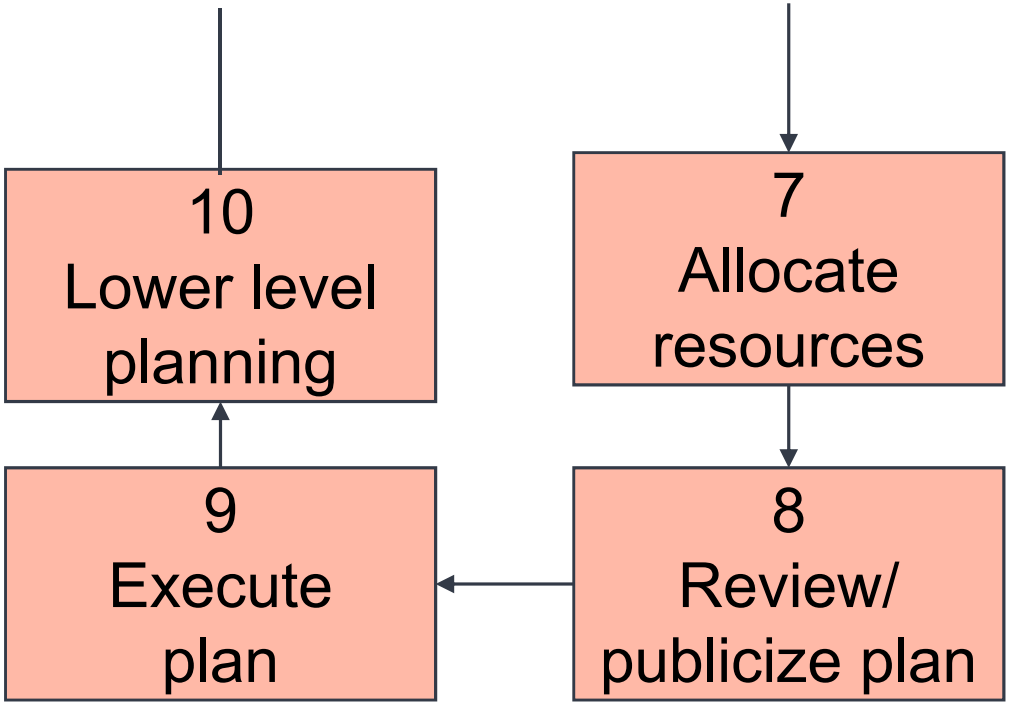
- Step 7.1 Identify and allocate resources
  - type of staff needed for each activity
  - staff availabilities are identified
  - staff are provisionally allocated to task
- Step 7.2 Revise plans and estimates to take into account resource constraints
  - staffing constraints
  - staffing issues

Step 8: Review/publicize Plan

- Step 8.1 Review quality aspects of the project plan
  - To ensure each activity is completed with a quality product
  - Each activity should have ‘exit requirements’.
  - This ensures the quality of the product on each activity.
- Step 8.2 Document plans and obtain agreement
  - all parties understand and agree to the commitments in the plan

Step 9 and Step 10

- Step 9: Execute plan
- Step 10: Execute lower levels of planning



Project Vs Activity

- A project is composed of a number of related activities
- A project may start when at least one of its activities is ready to start
- A project will be completed when all of its activities have been completed

Project Vs Activity (cont'd)

- An activity must have a clear start and a clear stop
- An activity should have a duration that can be forecasted
- Some activities may require that other activities are completed before they can begin

Activity Planning

- A project plan is a schedule of activities indicating the start and stop for each activity
  - Also provide the project and resource schedules
- The start and stop of each activity should be visible and easy to measure
- Each activity should have some ‘deliverables’ for ease of monitoring

Activity Planning (cont'd)

- During planning, managers consider:
  - Resource availability
  - Resource allocation
  - Staff responsibility
  - Project Monitoring
  - Cash flow forecasting
  - Re-planning of the project towards the pre-defined goal

Different Levels of Plans

- Project Schedule: a plan that shows
  - 1. the dates when each activity should start and stop
  - 2. when and how much of the resources will be required
- Activity Plan: a plan that describes
  - how each activity will be undertaken

Project Schedule in 4 Stages

Stage 1: Ideal Activity Plan

- An activity plan without any constraints

Stage 2: Risk consideration for each activity

Stage 3: Resource consideration for whole project

Stage 4: Schedule production and publication

Various Approaches Towards Identifying Activity

- Activity-based approach
- Product-based approach
- Hybrid approach

Activity-based Approach

- Use *Work Breakdown Structure* (WBS) to generate a task list
- WBS involves
  - identifying the main tasks
  - break each main task down into subtasks
  - The subtasks can further be broken down into lower level tasks.

Product-based Approach

- Product Breakdown Structure (PBS)
  - To show how a system can be broken down into different products for development
- Product Flow Diagram (PFD)
  - To indicate, for each product, which products are required as ‘inputs’

Hybrid Approach

- A mix of the activity-based approach and the product-based approach
- More commonly used approach
- The WBS consists of
  - a list of the products of the project; and
  - a list of activities for each product

Hybrid Approach - Example

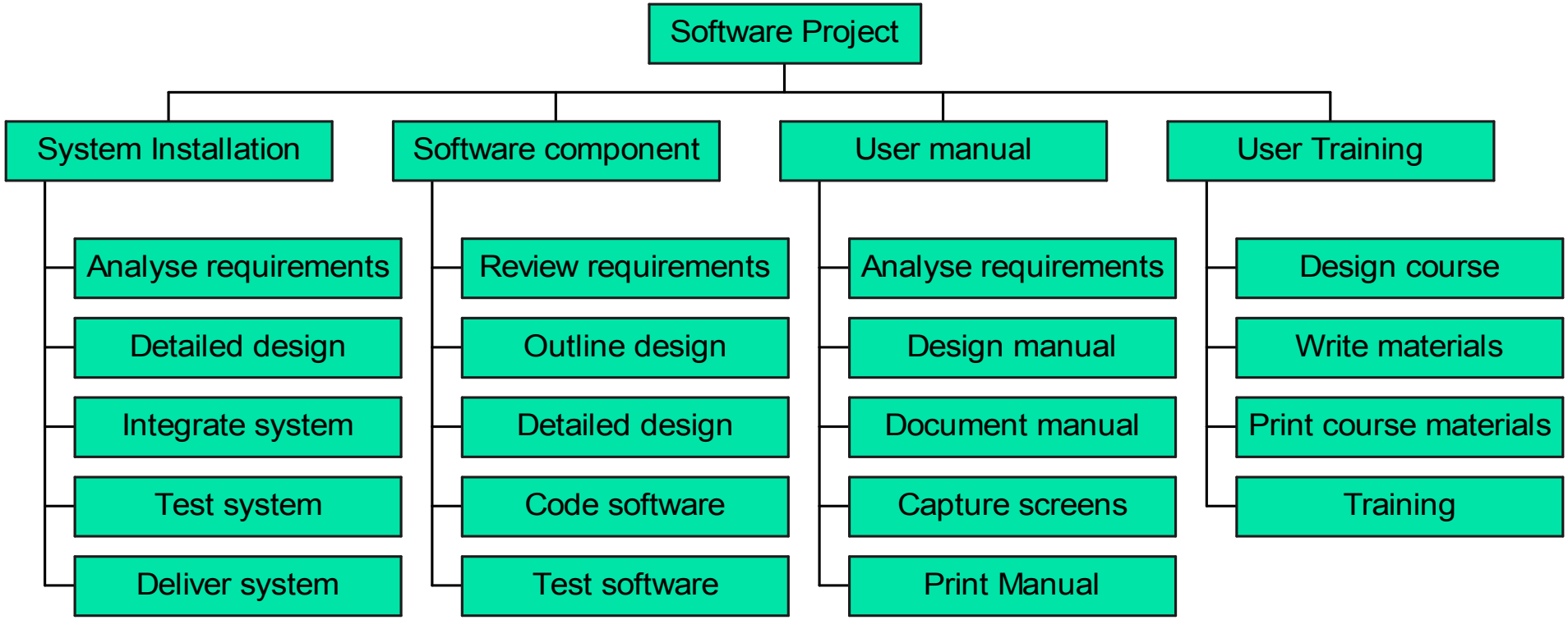


Figure 6.5 of the Hughes book.

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- Hughes, B., and Cotterell, M. (1999) *Software Project Management*, 2nd edition, McGraw-Hill.
- Pfleeger, S.L. (1998) *Software Engineering: Theory and Practice*, Prentice Hall.
- Harold Kerzner, Frank P. Saladis, Project Management Workbook and PMP/CAPM Exam Study Guide, Wiley Publishers (2006)

Software Project Management

Schedules and Activity Planning

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1. NETWORK PLANNING MODELS

- Sequencing the tasks according to their logical relationship, and then scheduling them taking into account resources and other factor
- Modeling the project's activities and their relationship as a network
  - Time flows from left to right
  - Originally developed in the 1950's
- Two Popular Methods :
  - CPM (Critical Path Method)
  - PERT (Progam Evaluation and Review Techniques)

2. CRITICAL PATH METHOD (CPM)

- CPM is a project network analysis technique used to predict total project duration
- Developed by Du Pont Chemical Company and published in 1958
- Primary objectives:
  - Planning the project so that it can be completed as quickly as possible
  - Identifying those activities where their delays is likely to affect the overall project completion date

CRITICAL PATH METHOD (CPM)

- 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
- Capture the activities and their inter-relationships using a graph
  - Lines are used to represent the activities
  - Nodes are used to represent the start and stop of activities

FINDING THE CRITICAL PATH

Step 1 : Develop a project network diagram

Step 2 : Add the durations for all activities on each path through the project network diagram

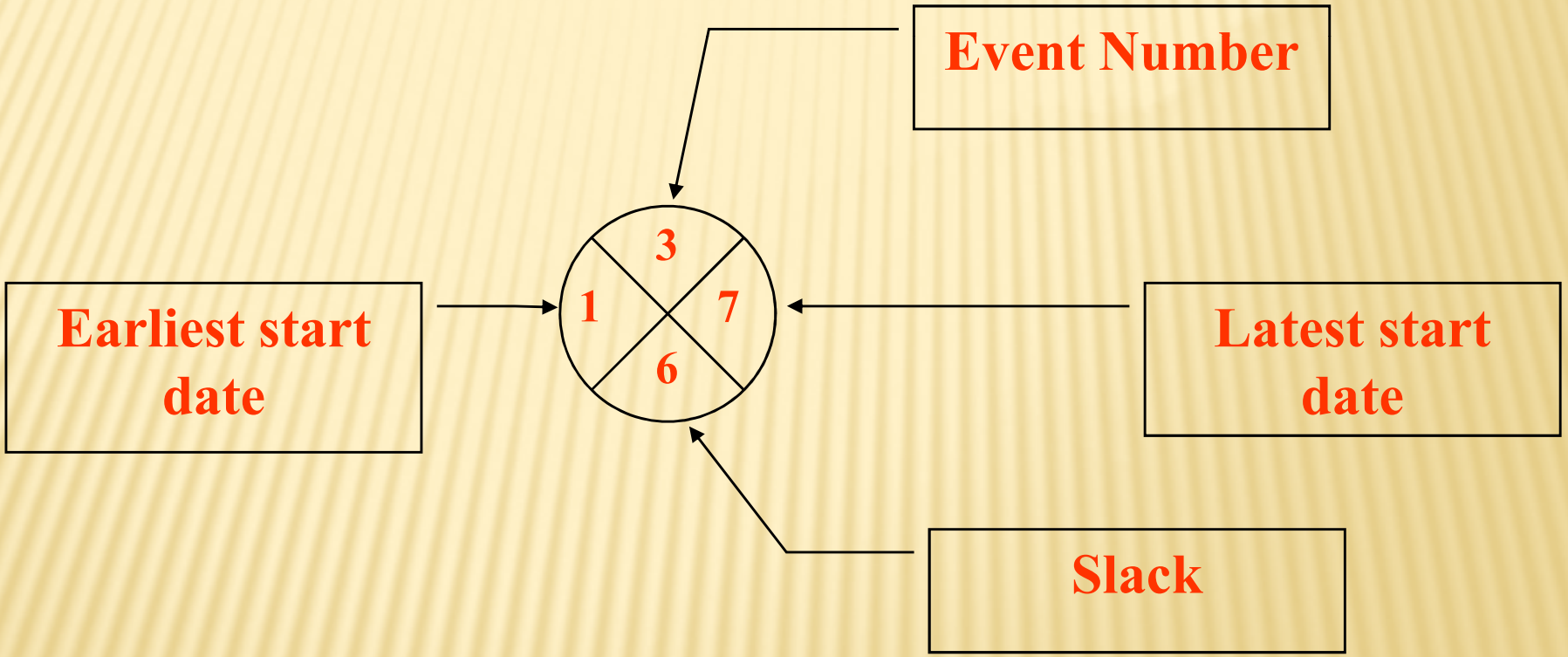
Step 3 : Identifying critical path and critical event

- Critical event: an event that has zero *slack*
- Critical path: The longest path - a path joining those critical events

CRITICAL PATH METHOD (CONT'D)

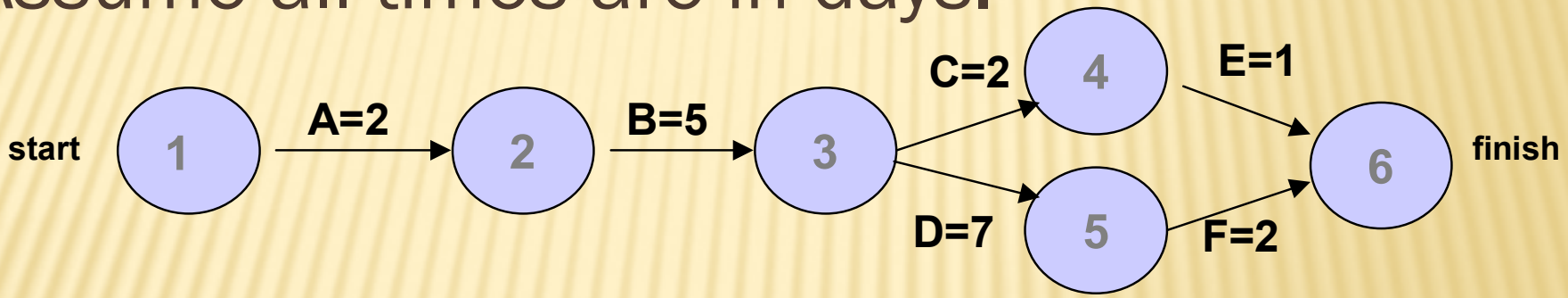
- Adding time dimension
  - The forward pass
    - calculate the earliest start dates of the activities
    - To calculate the project completion date
  - The backward pass
    - calculate the latest start dates for activities
    - identify the critical path from the graph

NOTATIONS USED IN A CPM



EXAMPLE 1 : DETERMINING CRITICAL PATH

- Consider the following project network diagram. Assume all times are in days.



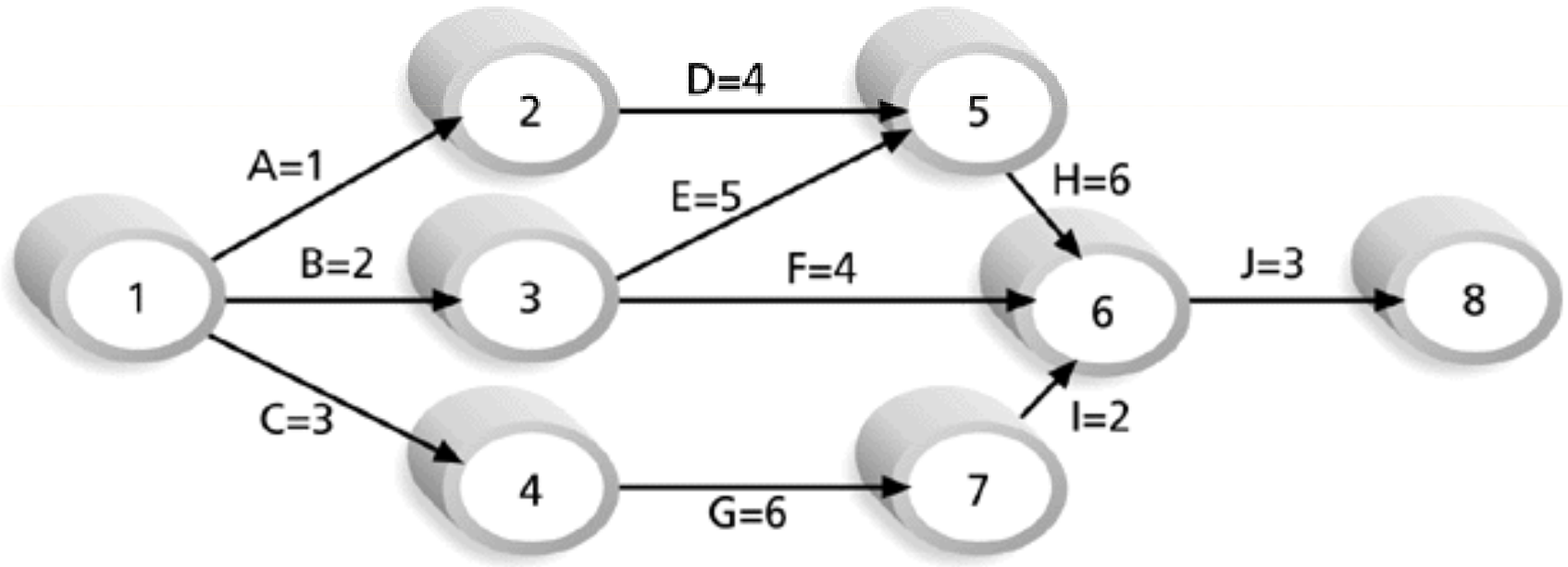
a. How many paths are on this network diagram?

b. How long is each path?

c. Which is the critical path?

d. What is the shortest amount of time needed to complete this project?

EXAMPLE 2 : DETERMINING CRITICAL PATH

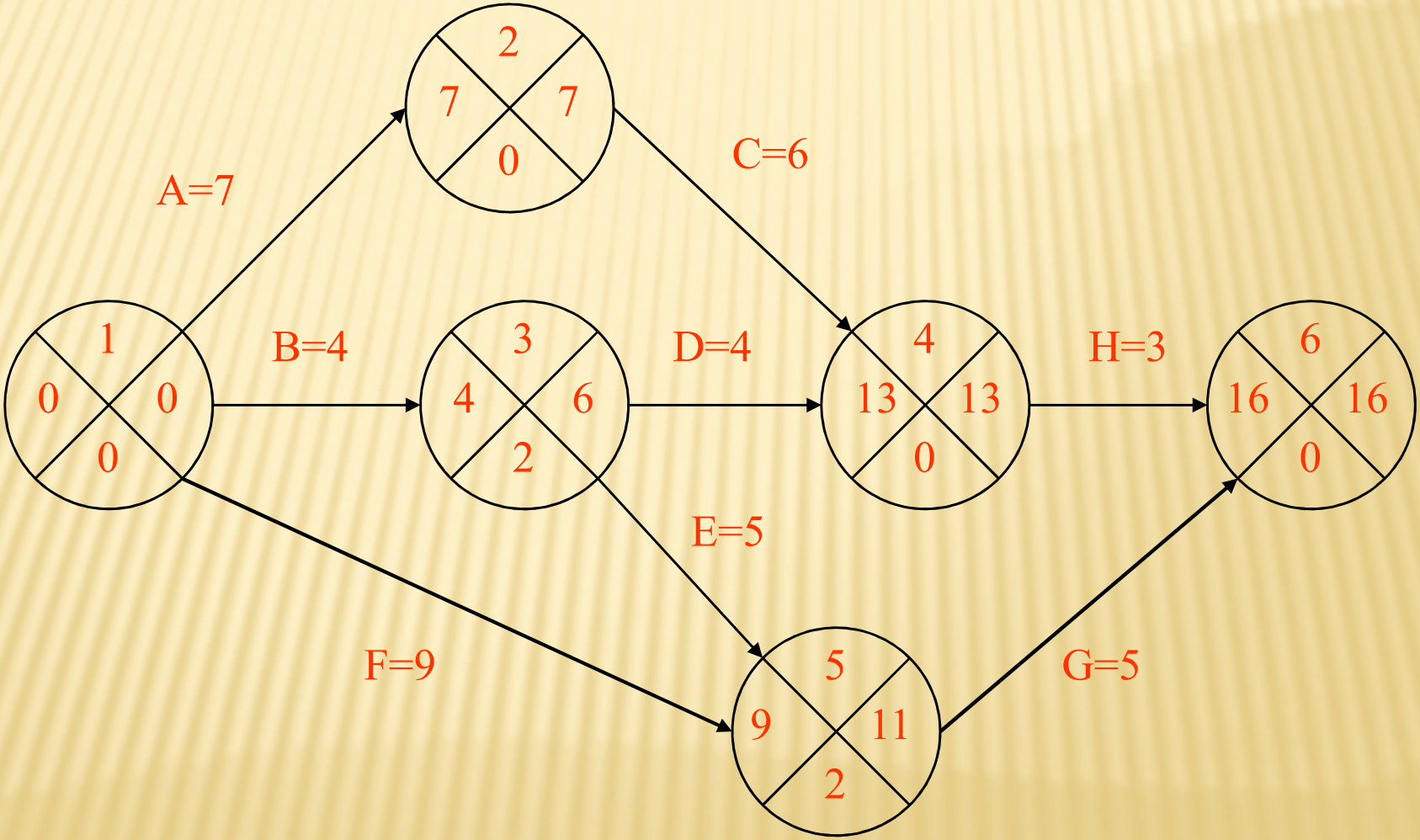


Note: Assume all durations are in days.

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.

EXAMPLE TO CONSTRUCT A CPM



ACTIVITY FLOAT

- Time allowed for an activity to delay
- 3 different types:
  - Total float (without affecting the completion of the project)

    = latest start date – earliest start date
  - Free float (without affecting the next activity)

    = earliest start date of *next* activity – latest end date of *previous* activity
  - Interfering float (= total float - free float)

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

IDENTIFYING THE CRITICAL PATH
THE CRITICAL PATH [1/3]

- *Critical path*: One path through the network that defines the duration of the project
- Any delay to any activity of this critical path will delay the completion of the project

IDENTIFYING THE CRITICAL PATH
THE CRITICAL PATH [2/3]

- Activity's *float*: the difference between an activity's earliest start date and its latest start date (or, equally, the difference between its earliest and latest finish dates)
  - A measure of how much the start date or completion of an activity may be delayed without affecting the end date of the project
- *Activity span*: the difference between the earliest start date and the latest finish date
  - Measure of maximum time allowable for the activity

ACTIVITY FLOAT
OTHER MEASURES OF ACTIVITY FLOAT

- *Free float*: the time by which an activity may be delayed without affecting subsequent activity
  - The difference between the earliest completion for the activity and the earliest date of the succeeding activity
- *Interfering float*: the difference between total float and free float
  - Tells us how much the activity may be delayed without delaying project end date

SHORTENING THE PROJECT DURATION

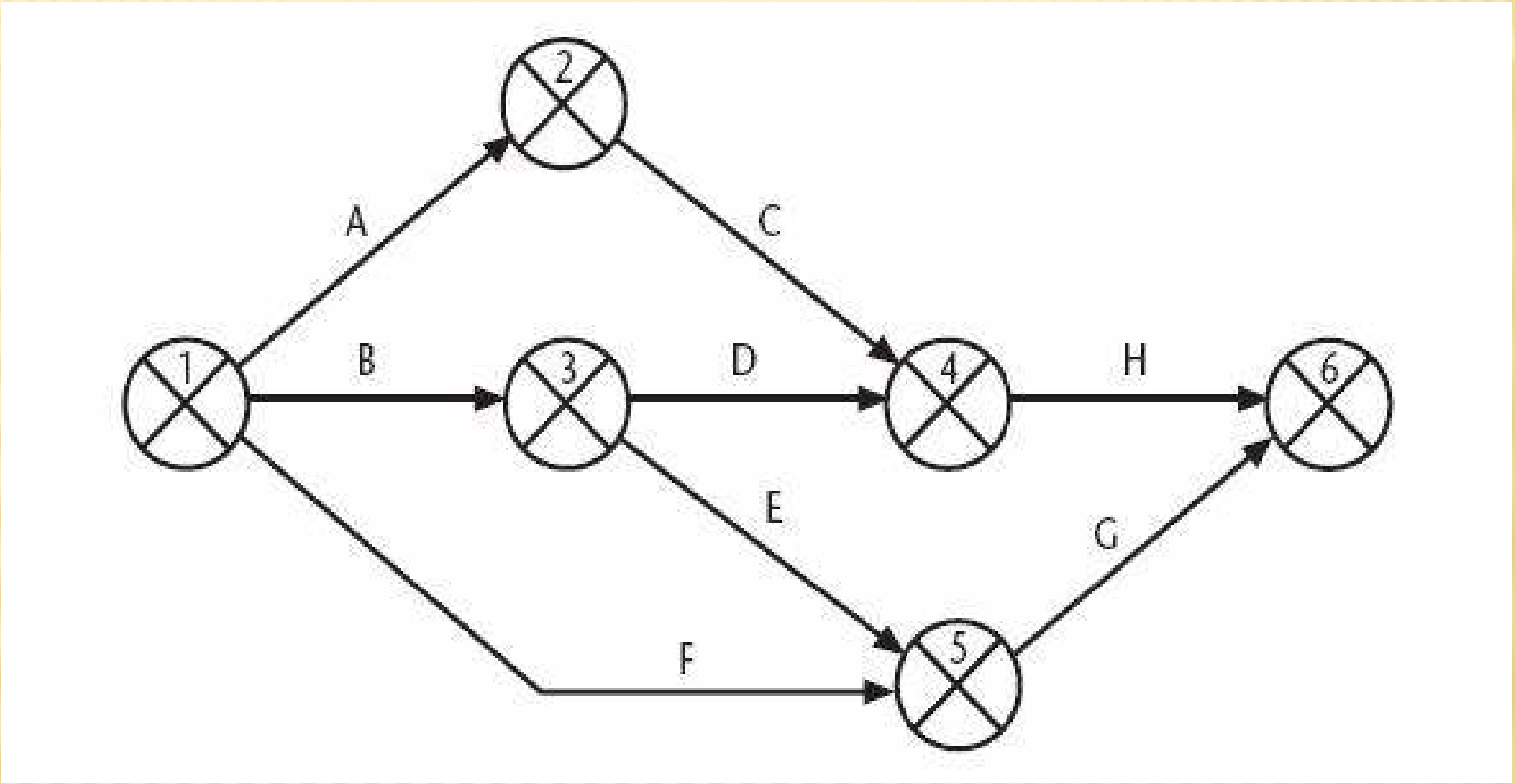
- Reduce activity duration
  - Applying more resources to the task
    - Working overtime
    - Procuring additional staff
- The critical path indicates where we must look to save time
  - From previous example, we can complete the project in week 12 by reducing the duration of activity F by one week

ACTIVITY-ON-ARROW NETWORKS

- Originally used by CPM and PERT methods
- Now less common than activity-on-node, still used and introduces an additional useful concept – that of *events*
- Activities are represented by links (or arrows) and the nodes represent events

ACTIVITY-ON-ARROW NETWORKS

ACTIVITY-ON-ARROW NETWORK OF THE EXAMPLE PROJECT



ACTIVITY-ON-ARROW NETWORKS
ACTIVITY-ON-ARROW RULES AND CONVENTIONS [1/2]

- A project network may have only one start node
- A project network may have only one end node
- A link has duration
- Nodes have no duration
- Time moves from left to right
- Nodes are numbered sequentially

ACTIVITY-ON-ARROW NETWORKS NETWORK ANALYSIS

- Analysis proceeds in the same way as with activity-on-node networks
  - The discussion places emphasis on the events rather than activity start and completion time
- Stages
  - The forward pass
  - The backward pass
  - Identifying the critical path

EXAMPLE OF ESTIMATED ACTIVITY DURATION OF A PROJECT

Id.	Activity Name	Duration (weeks)	Precedents
A	Hardware selection	7	
B	Software design	4	
C	Hardware Installation	6	A
D	Coding	4	B
E	Data Preparation	5	B
F	User Documentation	9	
G	User Training	5	E,F
H	System Installation	3	C,D

1. THE FORWARD PASS
THE CALCULATION OF EARLIEST START DATE [1/4]

- Activities A, B and F may start immediately
  - The earliest date for their start is zero
- Activity A will take 6 weeks
  - The earliest it can finish is week 6
- Activity F will take 10 weeks
  - The earliest it can finish is week 10

THE FORWARD PASS
THE CALCULATION OF EARLIEST START DATE [2/4]

- Activity C can start as soon as A has finished
  - Its earliest start date is week 6
  - It will take 3 weeks, so the earliest it can finish is week 9
- Activities D and E can start as soon as B is complete
  - The earliest they can each start is week 4
  - Activity D will take 4 weeks, so the earliest it can finish is week 8
  - Activity E will take 3 weeks, so the earliest it can finish is week 7

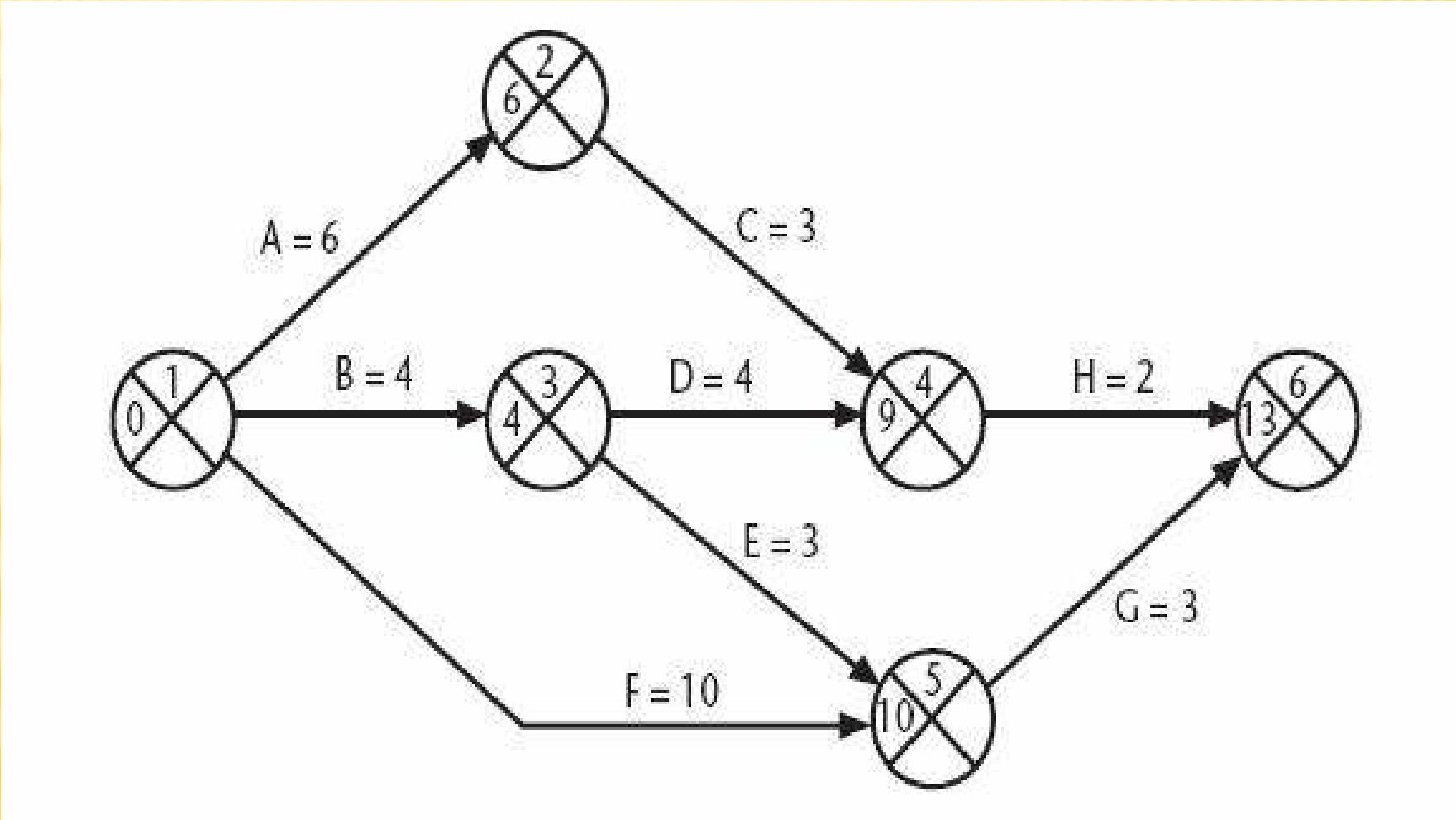
THE FORWARD PASS
THE CALCULATION OF EARLIEST START DATE [3/4]

- Activity G cannot start until both E and F have been completed
  - It cannot start until week 10 - the later of weeks 7 (activity E) and 10 (for activity F)
  - It takes 3 weeks and finishes in week 13
- Similarly, activity H cannot start until week 9 – the later of the two earliest finished dates for the preceding activities C and D

THE FORWARD PASS
THE CALCULATION OF EARLIEST START DATE [4/4]

- The project will be complete when both activities H and G have been completed
  - The earliest project completion date will the later of weeks 11 and 13 – that is, week 13

ACTIVITY-ON-ARROW NETWORKS
THE CPM NETWORK AFTER THE FORWARD PASS



ACTIVITY-ON-ARROW NETWORKS
THE ACTIVITY TABLE AFTER THE FORWARD PASS

Activity	*Duration (week)*	*Earliest start date*	*Latest start date*	*Earliest finish date*	*Latest finish date*	*Total float*
A	6	0		6		
B	4	0		4		
C	3	6		9		
D	4	4		8		
E	3	4		7		
F	10	0		10		
G	3	10		13		
H	2	9		11		

THE BACKWARD PASS
THE LATEST ACTIVITY DATES CALCULATION [1/3]

- The latest completion date for activities G and H is assumed to be week 13
- Activity H must therefore start at week 11 at the latest (13-2) and the latest start date for activity G is week 10 (13-3)
- The latest completion date for activities C and D is the latest date at which activity H must start – that is week 11
  - The latest start date of week 8 (11-3), and week 7 (10-3) respectively

1.2 THE BACKWARD PASS
THE LATEST ACTIVITY DATES CALCULATION [2/3]

- Activities E and F must be completed by week 10
  - The earliest start dates are weeks 7 (10-3) and 0 (10-10) respectively
- Activity B must be completed by week 7 (the latest start date for both activities D and E)
  - The latest start is week 3 (7-4)

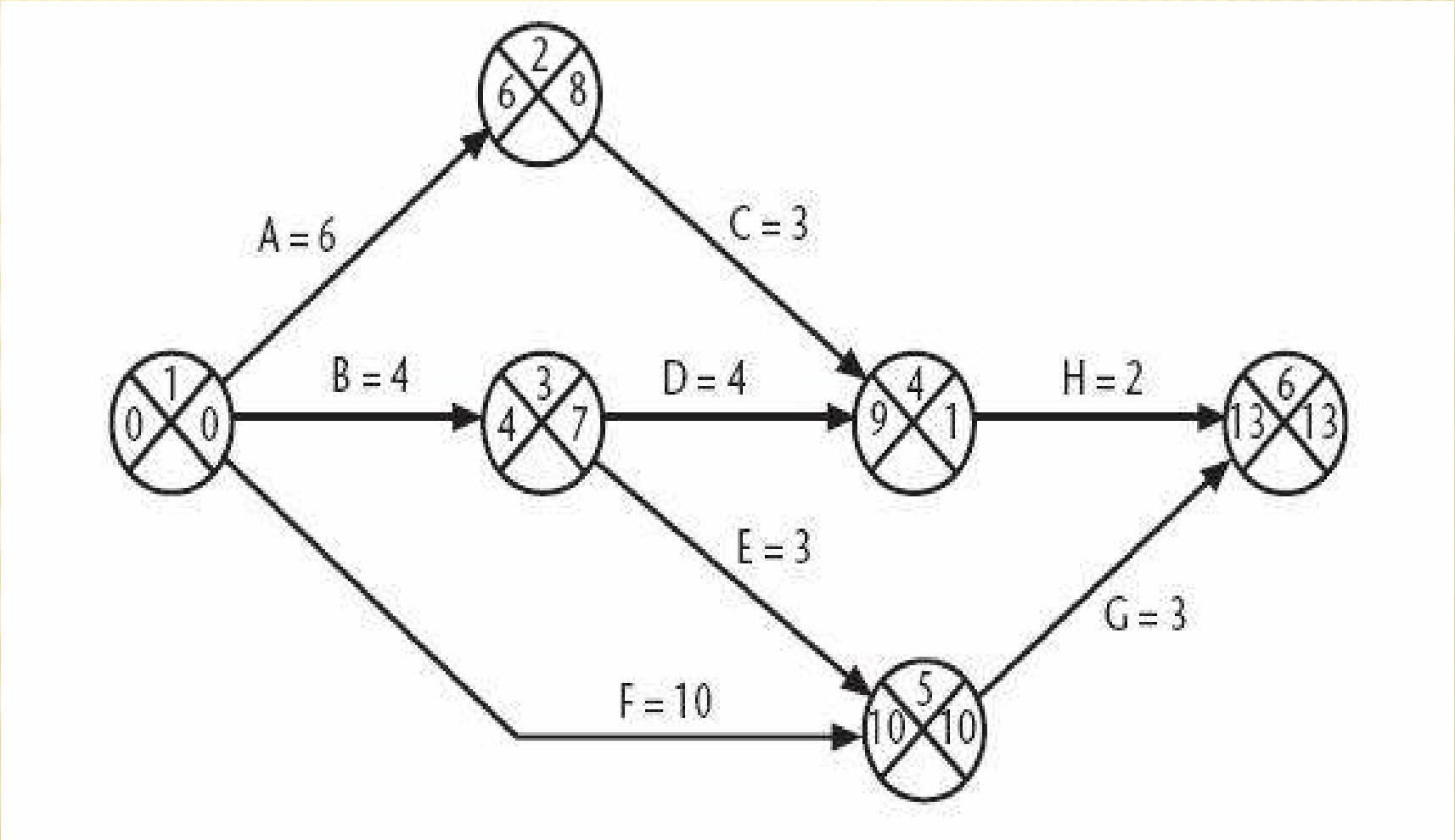
THE BACKWARD PASS
THE LATEST ACTIVITY DATES CALCULATION [3/3]

- Activity A must be completed by week 8 (the latest start date for activity C)
  - Its latest start is week 2 (8-6)
- The latest start date for the project start is the earliest of the latest start dates for activities A, B and F
  - This week is week zero
  - It tells us that if the project does not start on time it won't finish on time

ACTIVITY-ON-ARROW NETWORKS
THE BACKWARD PASS

- Calculate the latest date at which each event may be achieved, each activity started and finished, without delaying the end of the project
- The latest date for an event is the latest date by which all immediately following activities must be started for the project to be completed on time

ACTIVITY-ON-ARROW NETWORKS
THE CPM NETWORK AFTER THE BACKWARD PASS



ACTIVITY-ON-ARROW NETWORKS
THE ACTIVITY TABLE AFTER THE BACKWARD PASS

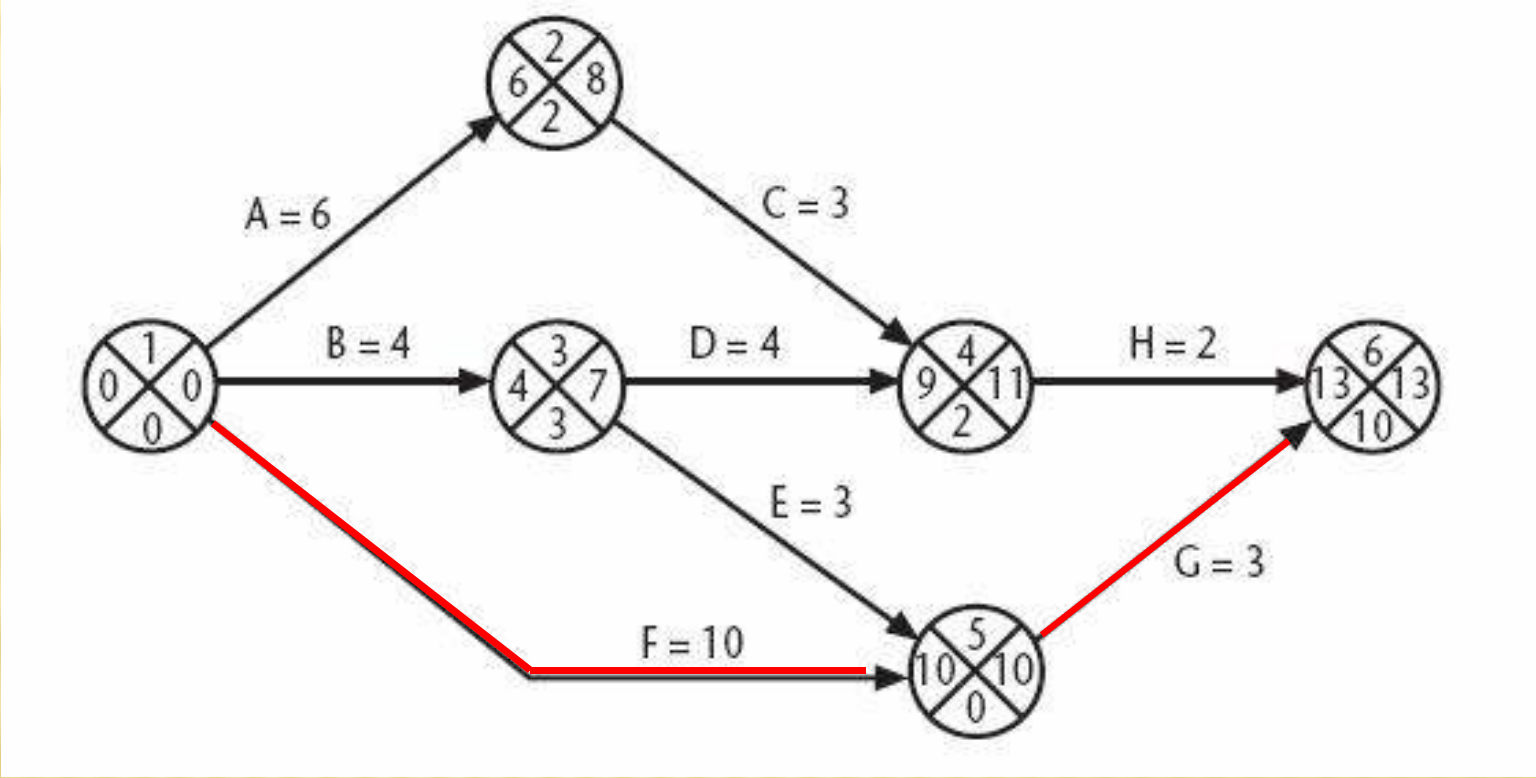
Activity	*Duration (week)*	*Earliest start date*	*Latest start date*	*Earliest finish date*	*Latest finish date*	*Total float*
A	6	0	2	6	8	
B	4	0	3	4	7	
C	3	6	8	9	11	
D	4	4	7	8	11	
E	3	4	7	7	10	
F	10	0	0	10	10	
G	3	10	10	13	13	
H	2	9	11	11	13	

ACTIVITY-ON-ARROW NETWORKS
IDENTIFYING THE CRITICAL PATH

- The critical path is identified in a way similar to that used in activity-on-node networks
- A different concept is used: *slack*
- A *slack* is the difference between the earliest date and the latest date for an event
  - It is a measure of how late an event may be

ACTIVITY-ON-ARROW NETWORKS
THE CRITICAL PATH

- The critical path is the path joining all nodes with a zero slack



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:
  - 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

7. 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 attempts to address the risk associated with duration estimates by developing schedules that are more realistic
    - It involves more work than CPM since it requires several duration estimates

PERT FORMULA AND EXAMPLE

- PERT weighted average =

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

- Example:

PERT weighted average =

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

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

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

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