ISCET

Advanced Project Management

2

Scope management – Time management

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Scope Management

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- Scope management

Processes required to ensure that the project includes all the work required – and only the work required – to complete the project successfully

Product scope: the features and functions that characterize a product, service, or result

Project scope: the work that needs to be accomplished to deliver a product, service, or result with the specified features and functions

Scope management

- Scope management

  1. Plan scope management
  2. Collect requirements
  3. Define scope
  4. Create WBS
  5. Validate scope
  6. Control scope

  Output: scope baseline

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Scope: Work Breakdown Structure

The **Work Breakdown Structure** is a hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables

The WBS organizes and defines the total scope of the project, and represents the work specified in the current approved project scope statement

The planned work is contained within the lowest level of WBS components, which are called **work packages**

A work package can be used to group the activities where work is scheduled and estimated, monitored, and controlled

In the context of the WBS, work refers to work products or deliverables that are the result of activity and not to the activity itself

Every work must be included in the WBS; nothing can be left out – **100% rule**.

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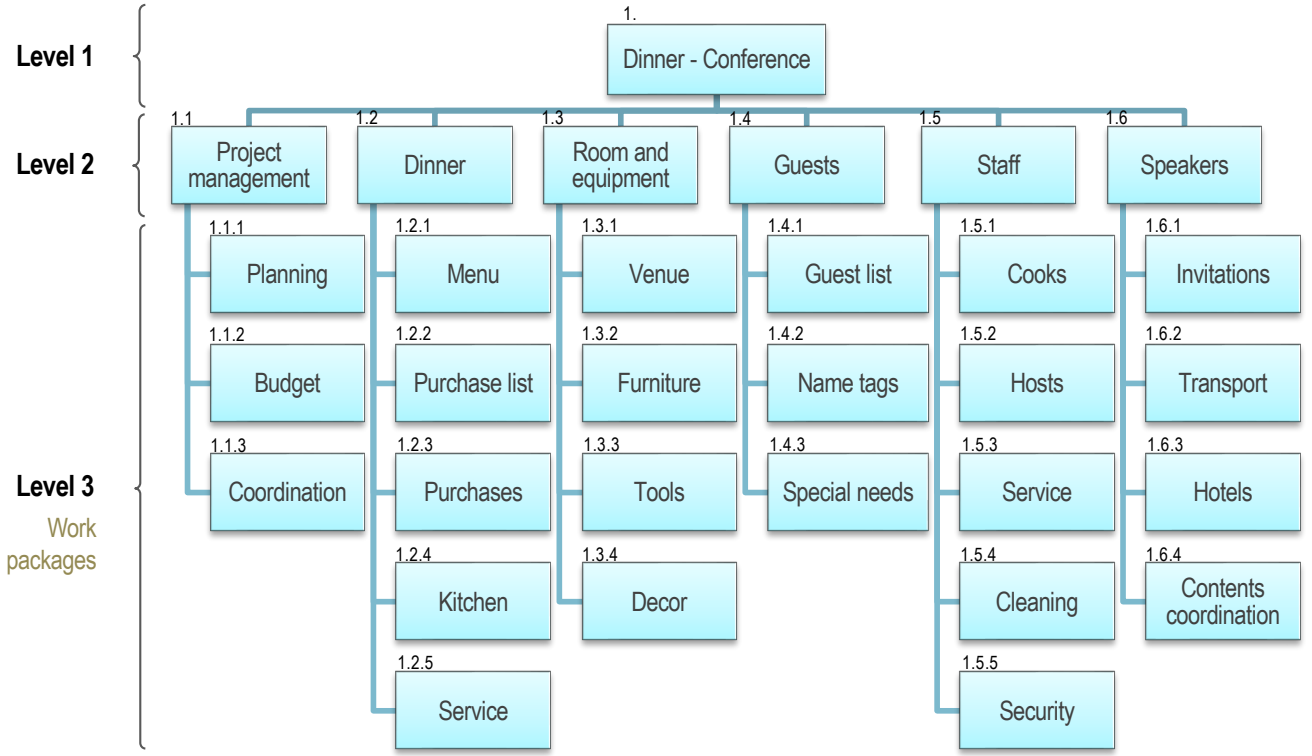
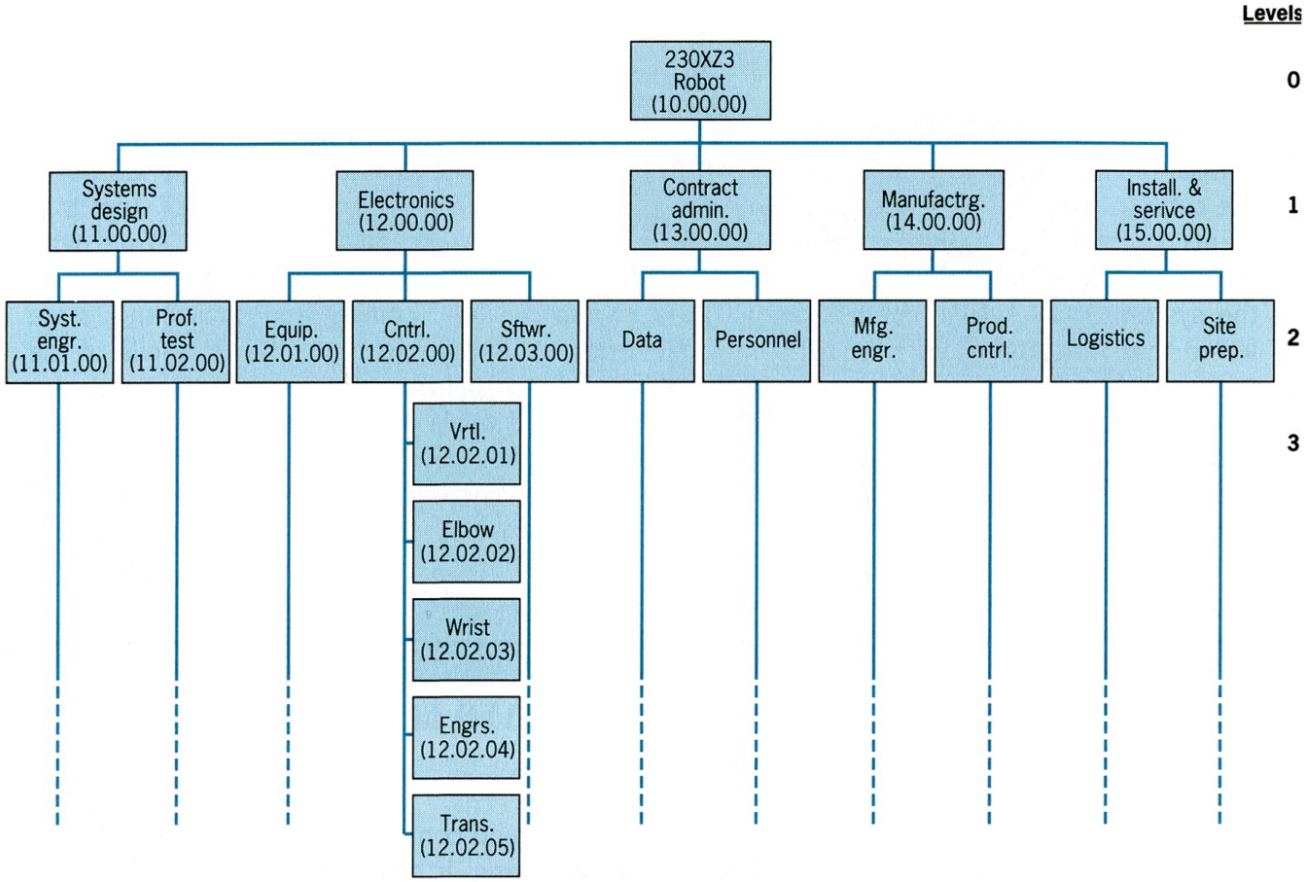
Work Breakdown Structure



Scope management

Work Breakdown Structure



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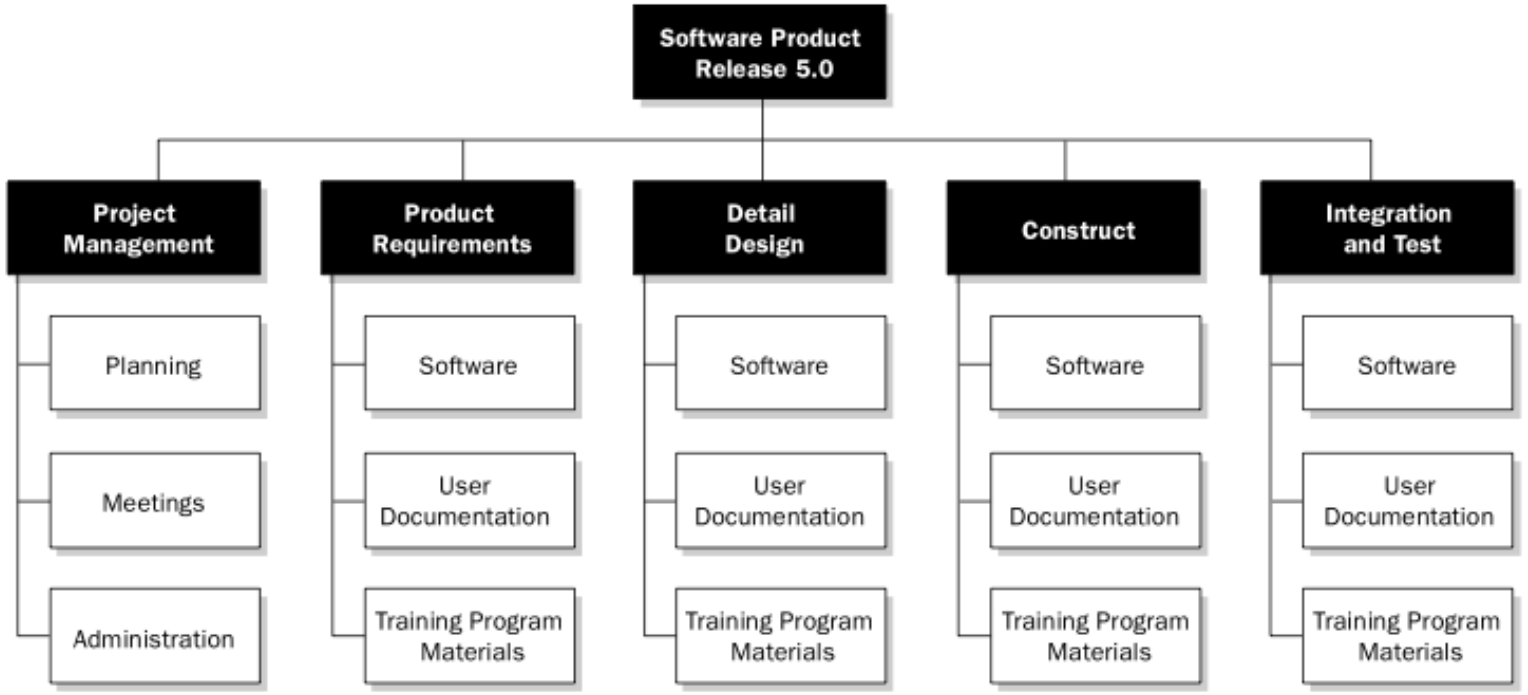
Work Breakdown Structure



Time Management

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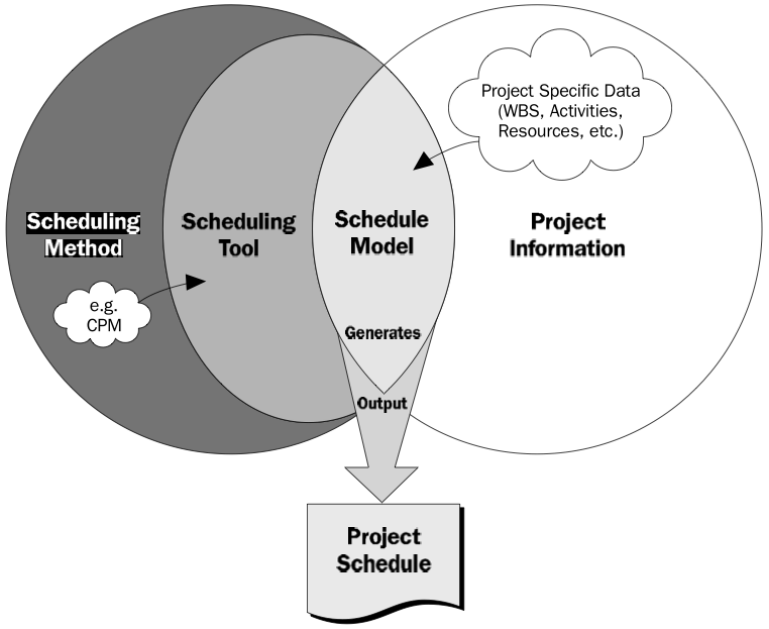
- Processes required to manage the timely completion of the project:
  1. Plan schedule management
  2. Define activities
  3. Sequence activities
  4. Estimate activity resources
  5. Estimate activity durations
  6. Develop schedule
  7. Control schedule



PMBOK, PMI.

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1. Plan schedule management

- The process of establishing the policies, procedures, and documentation for planning, developing, managing, executing, and controlling the project schedule

- Tools: expert judgment, analytical techniques, meetings
- Output: schedule management plan
  - Project schedule model development; level of accuracy; units of measure; organizational procedures links; project schedule model maintenance; control thresholds; rules of performance measurement; reporting formats; process descriptions

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2. Define activities

- Process of identifying and documenting the specific actions to be performed to produce the project deliverables
- The key benefit of this process is to break down work packages into activities that provide a basis for estimating, scheduling, executing, monitoring, and controlling the project work

- Tools: decomposition, roll wave planning, expert judgment
- Output: activity list (w/ scope of work description and attributes), and milestone list

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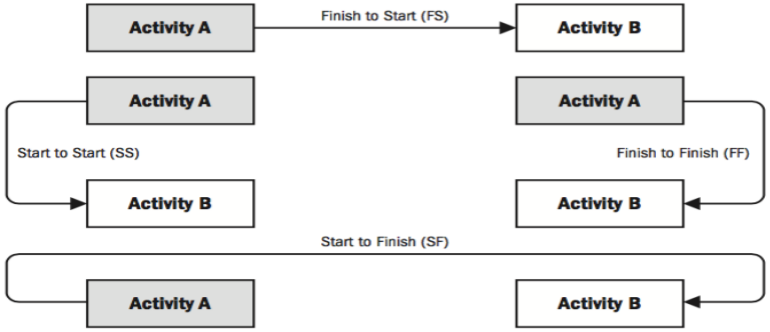
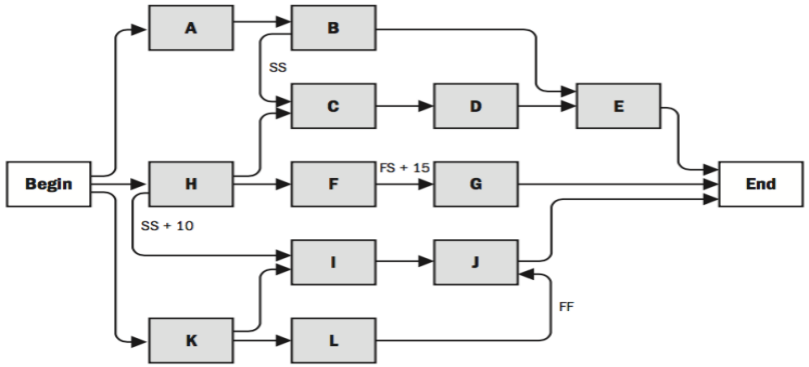
3. Sequence activities

- Process of identifying and documenting relationships among the project activities
- Precedence diagrams, network diagrams





O **caminho crítico** é a sequência de atividades mais longa do projeto – logo, a que determina a sua duração total. Pode haver mais do que um caminho crítico. As atividades sem **folga total** são **atividades críticas**

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4. Estimate activity durations

- Process of estimating the number of work periods needed to complete individual activities with estimated resources
  - Expert judgment
  - Analogous estimating
  - Parametric estimating
  - Three-point estimating (triangular or beta distribution)
  - Group decision-making techniques (brainstorming, Delphi, etc.)
  - Reserve analysis

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5. Develop schedule

- Process of analyzing activity sequences, durations, resource requirements, and schedule constraints to create a project schedule model with planned dates for completing project activities
  - Schedule network analysis, Critical path method, Critical chain method
  - Resource optimization techniques (leveling, smoothing)
  - Modeling techniques (what-if scenario analysis, simulation)
  - Leads and lags
  - Schedule compression (crashing, fast tracking)

- Output: time baseline, calendar

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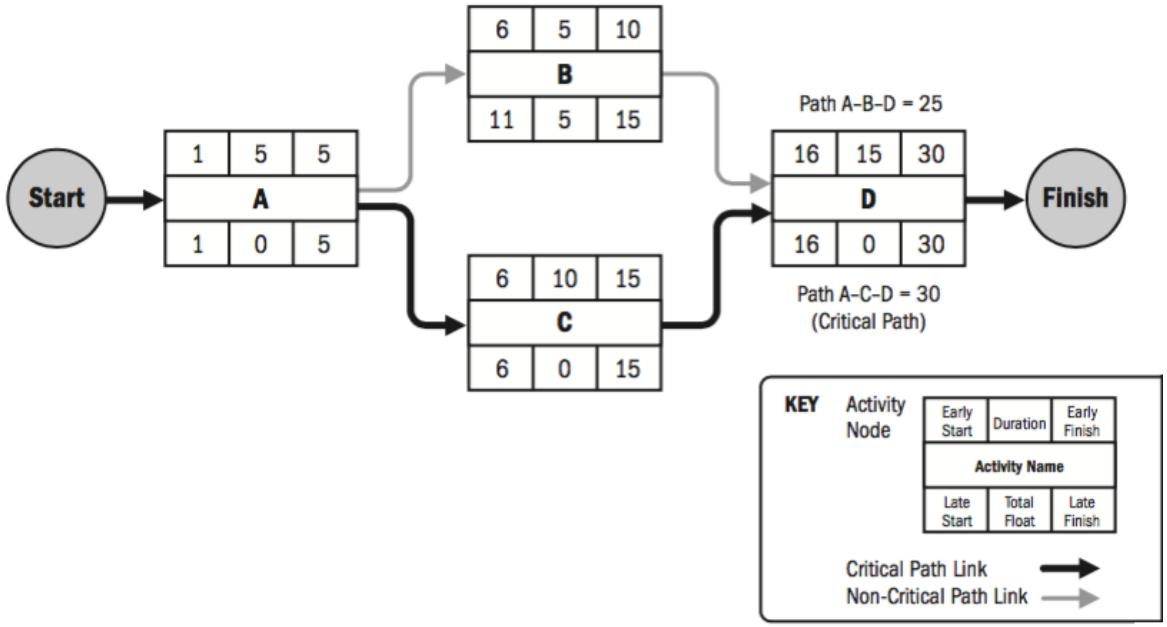
5. Develop schedule

- Tools: Critical path method



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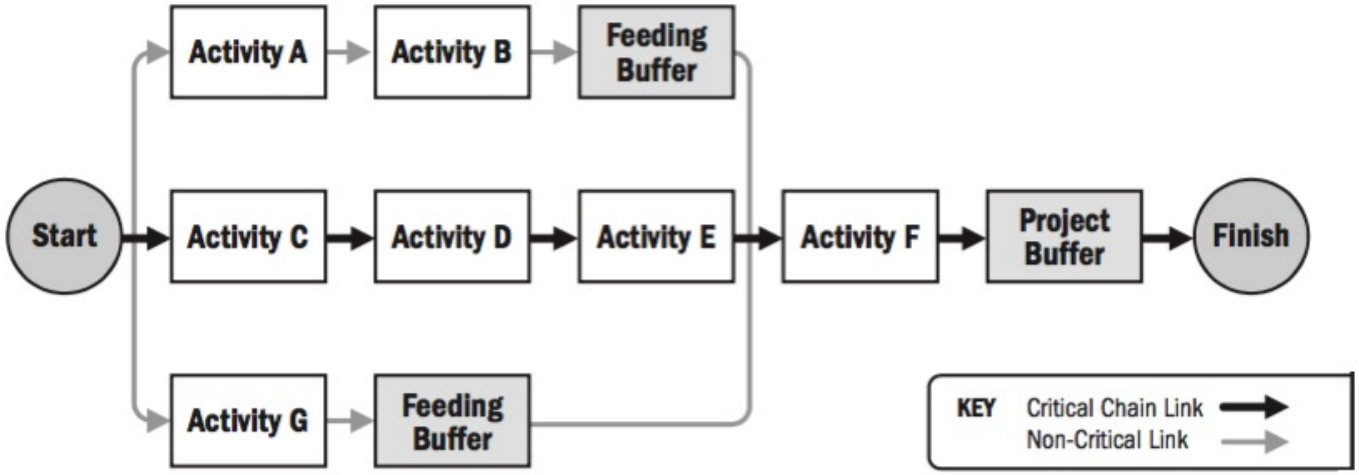
5. Develop schedule

- Tools: critical chain method



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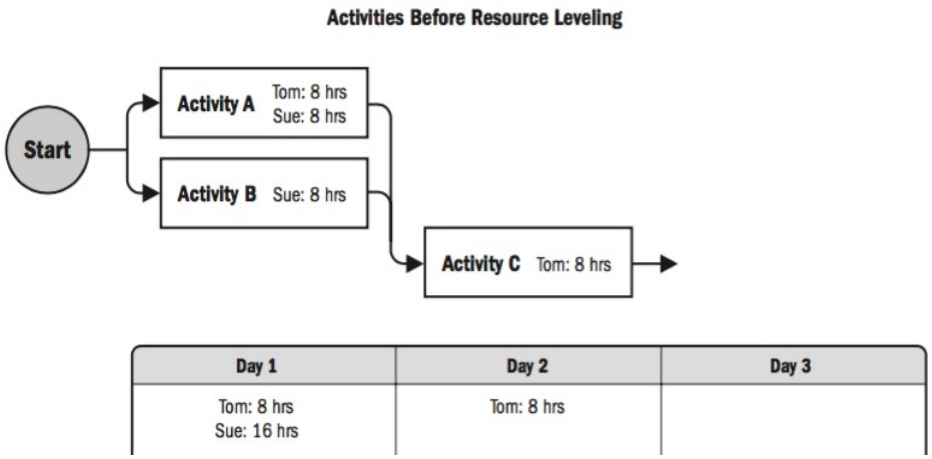
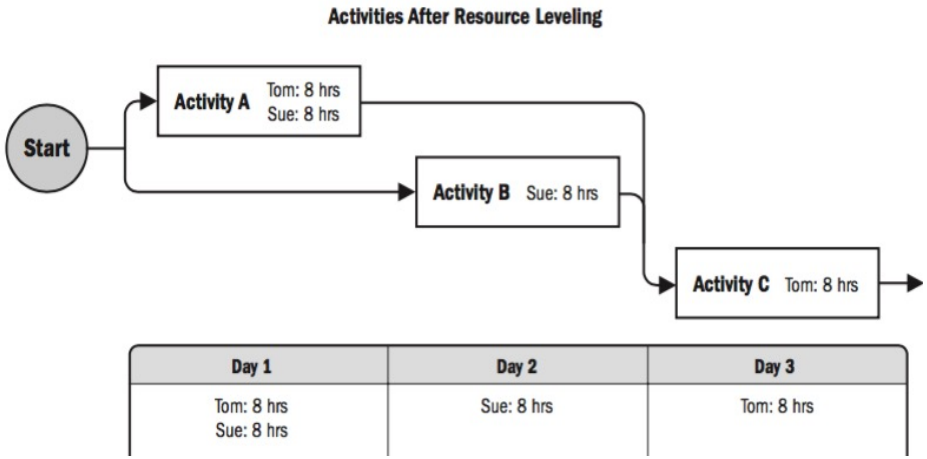
5. Develop schedule

- Tools: resource leveling





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5. Develop schedule

- Overloads
  - **Resource leveling**: start and finish dates are adjusted based on resource constraints with the goal of balancing demand for resources with the available supply
  - **Resource smoothing**: adjusts the activities of a schedule model such that the requirements for resources on the project do not exceed certain predefined resource limits
- Compression
  - **Crashing**: Used to shorten the schedule duration for the least incremental cost by adding resources
  - **Fast tracking**: activities/phases normally done in sequence are performed in parallel for at least a portion of their duration

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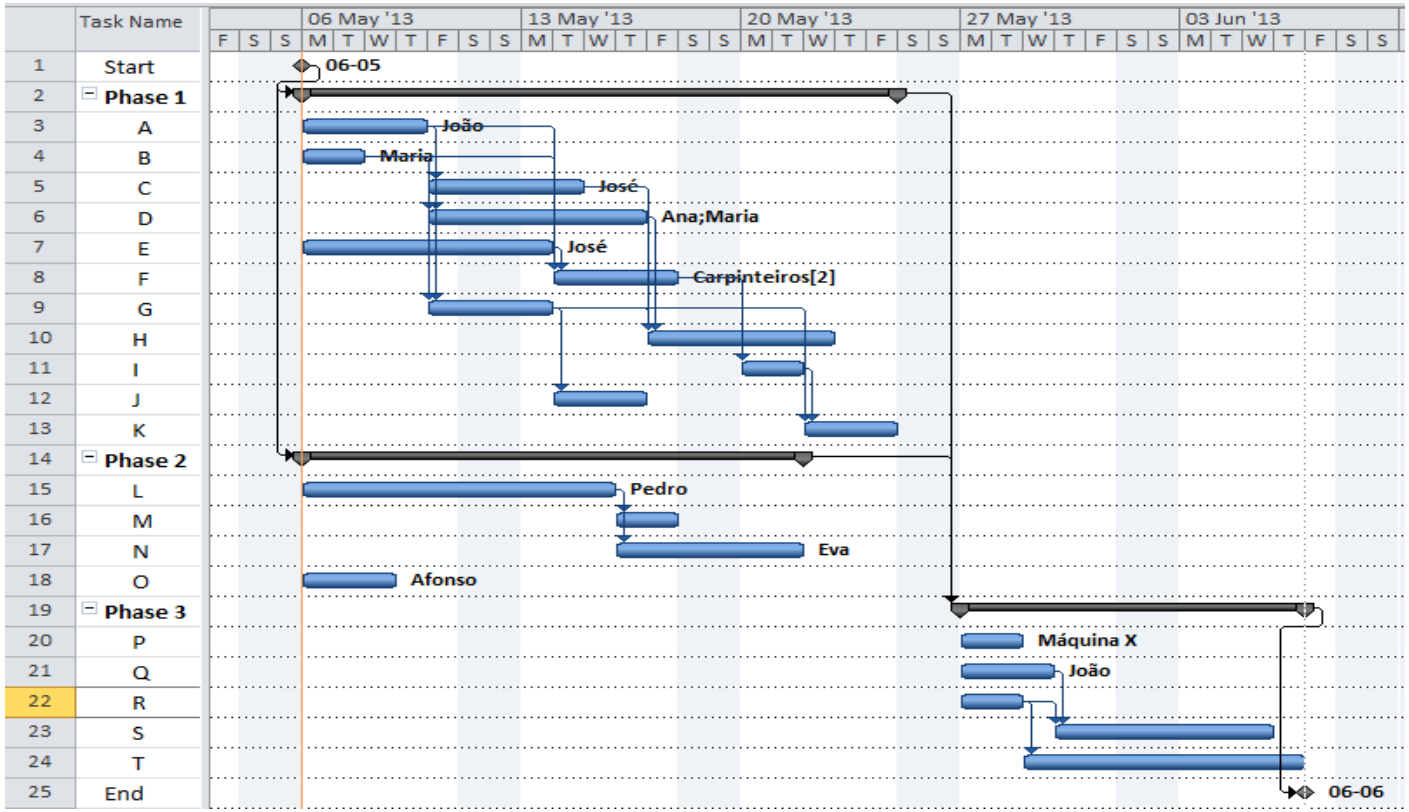
5. Develop schedule

- Outputs: Gantt chart



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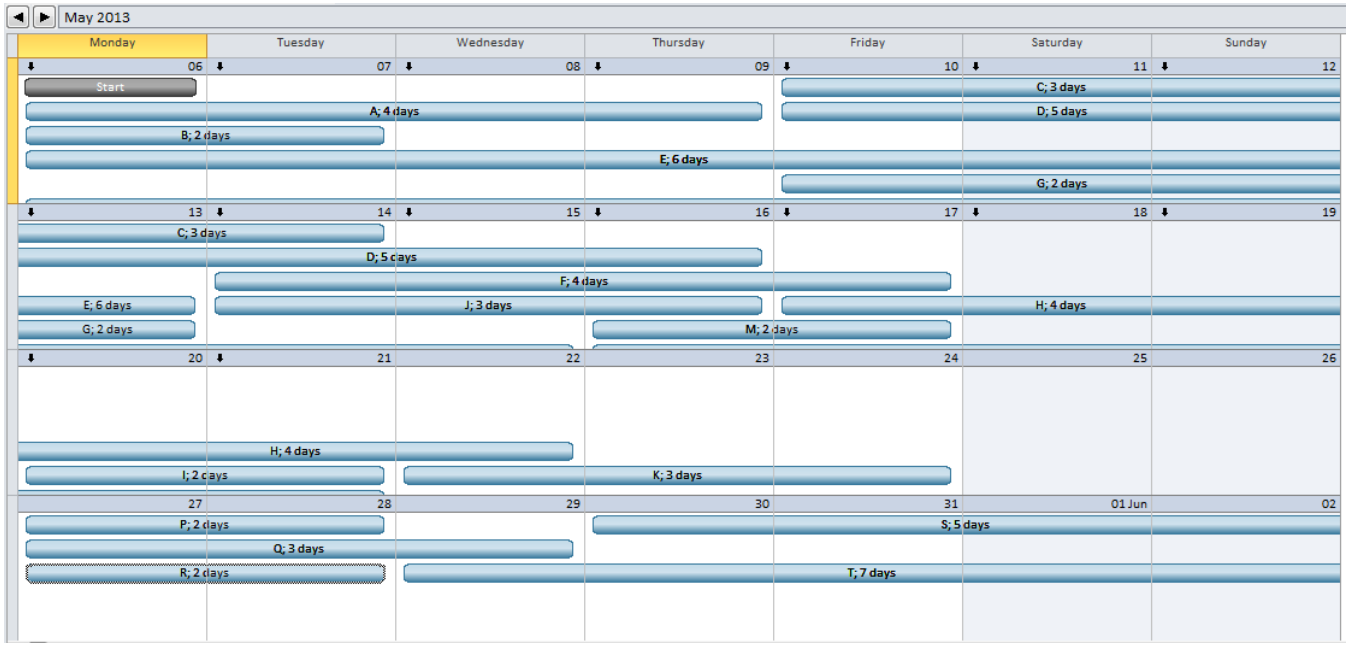
5. Develop schedule

- Outputs: Calendar



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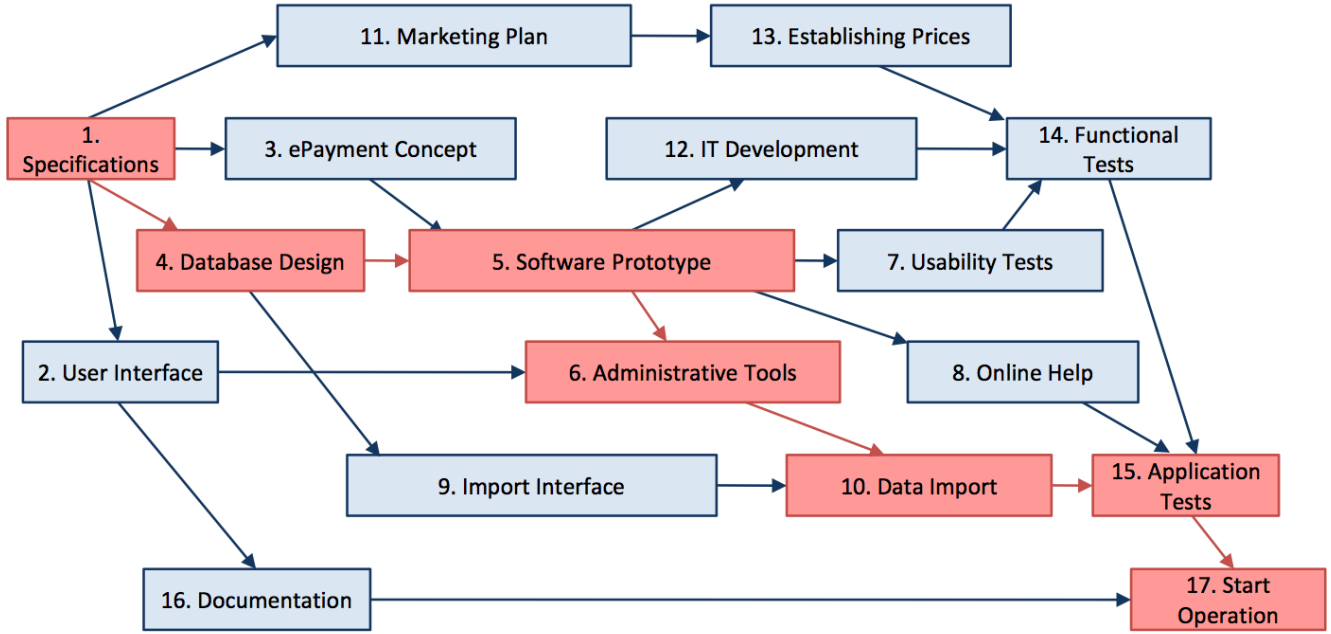
5. Develop schedule

- Outputs: Network diagram



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6. Control schedule

- Process of monitoring the status of project activities to update project progress and manage changes to the schedule baseline to achieve the plan
- The key benefit of this process is that it provides the means to recognize deviation from the plan and take corrective and preventive actions and thus minimize risk

Time Management

Scheduling

Crashing

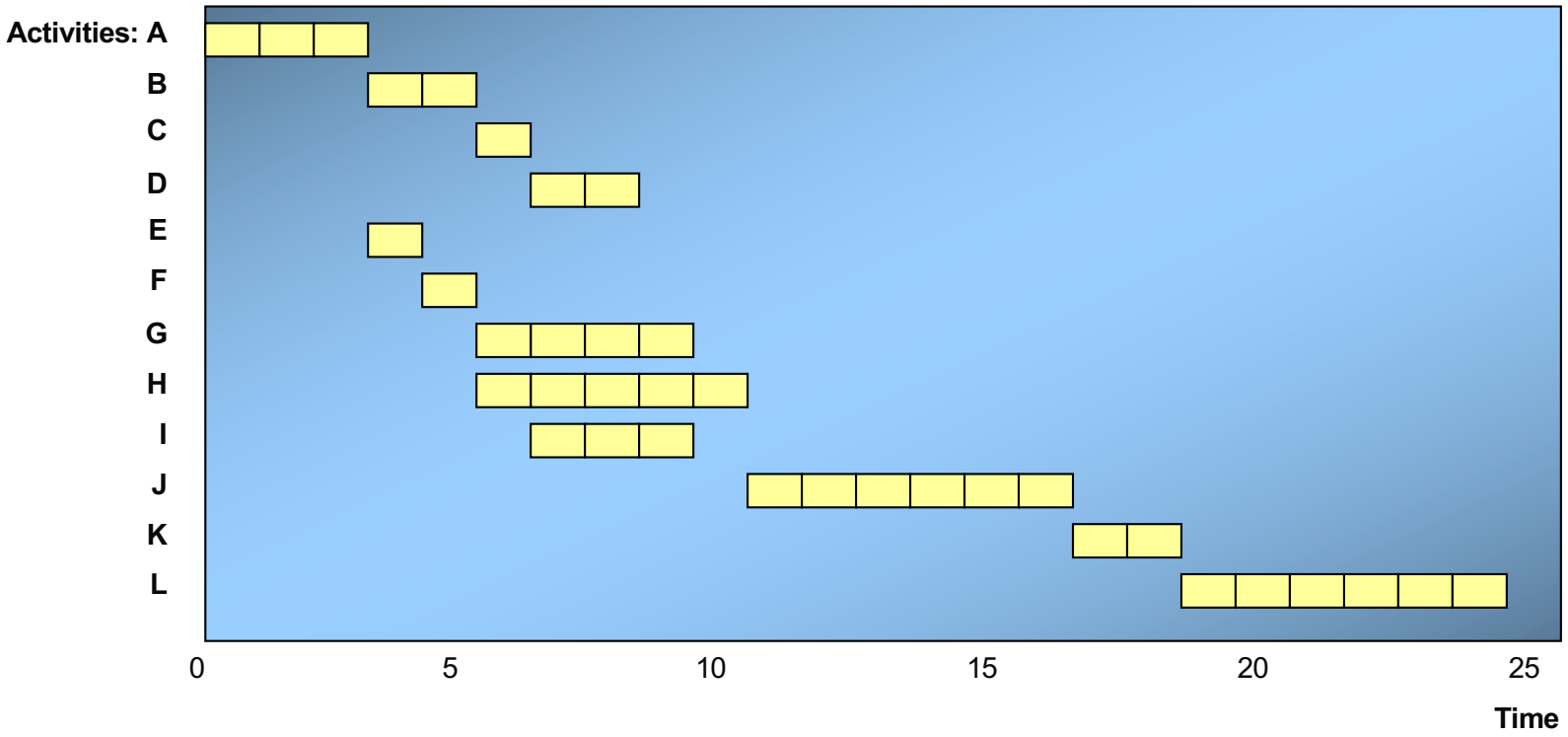
Resource leveling

Time planning

- Gantt chart
  - Henry Gantt developed (1917) a system of presenting schedule information (bar chart)
  - The Gantt chart shows the planned and actual progress for the tasks of the project displayed against a a horizontal time scale
  - Probably the best means of communication
  - Difficult to predict the impact of task delays in complex projects

Time planning

- Gantt chart:



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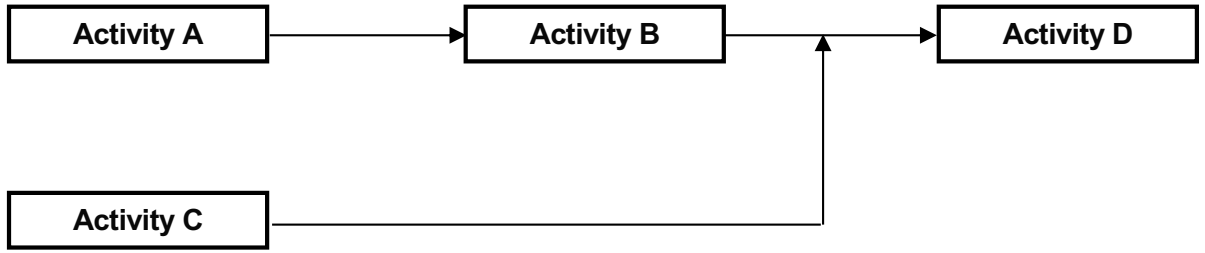
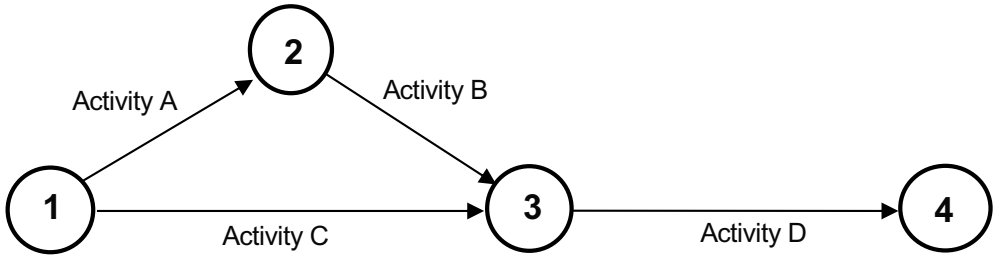
- Network diagrams
  - Network of activity and event relationships that graphically portrays the sequential relations between the tasks in a project
  - CPM: Critical Path Method (DuPont and Remington Univac Division)
  - PERT: Performance Evaluation and Review Technique (US Navy in cooperation with Booze-Allen Hamilton and the Lockheed Corp. – Polaris missile/submarine project, 1958)
  - … network diagrams !

- Network diagrams

Network diagram **AOA**



Network diagram **AON**



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- Network diagrams
  - **AON** or **AOA?**
    - AOA - activities-on-arrows: nodes (circles) are events
    - AON - activities-on-nodes: nodes are activities; arcs represent their sequence. Events are not enhanced, unless they are milestones.
    - Both diagrams lead to the same conclusion - same critical path(s) and duration

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- Network diagrams
  - Network of activity and event relationships that graphically portrays the sequential relations between the tasks in a project
  - Tasks that must precede or follow other tasks are clearly identified
  - Consistent framework for planning, scheduling, monitoring, and controlling
  - It illustrates the interdependence of all tasks, work packages, and work units
  - It denotes the times when specific resources must be available for work on a given task
  - Finds the expected project completion date

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- Network diagrams
  - **Activity**: a specific task or set of tasks that are required by the project, use resources, and take time to complete
  - **Event**: the result of completing one or more activities; an identifiable end state occurring at a particular time
  - **Network**: the combination of all activities and events that define the project and the activity precedence relationships

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- Network diagrams
  - **Path**: a series of connected activities (events) between any two events (activities) in the network
  - **Critical:** activities, events, or paths, which, if delayed, will delay the completion of the project
  - **Critical path:** sequence of critical tasks (and critical events) that connect the project's start event to its finish date

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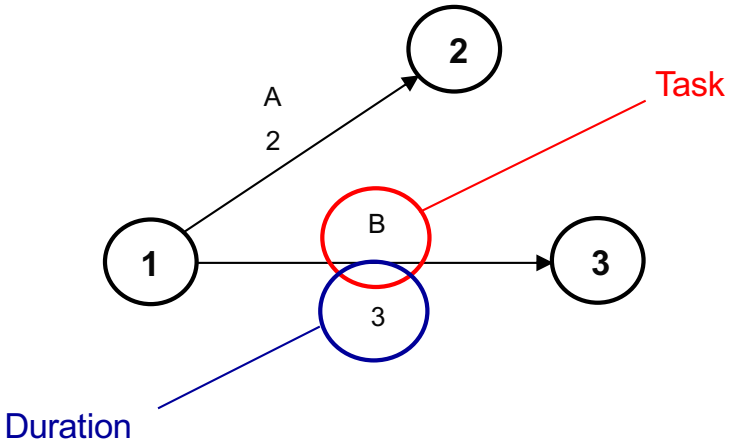
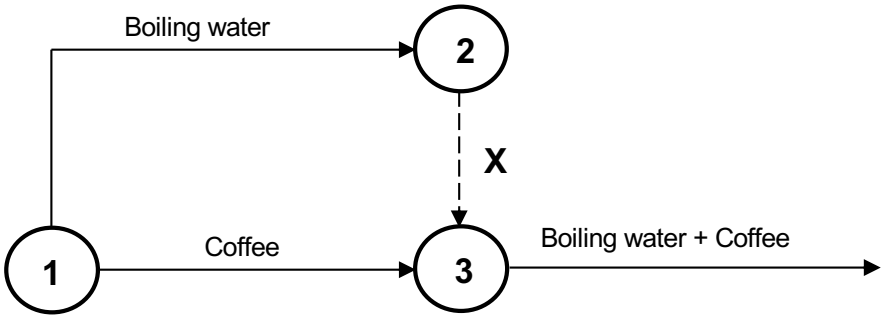
- Network diagrams
  - Some rules…:
    - Networks are drawn starting on the left and proceeding to the right
    - Arrowheads placed on the arcs are used to indicate the direction of the flow – that is, to show the proper dependencies
    - Before an event can be achieved, all activities that immediately precede it must be completed (predecessors)
    - An event represents an instant in time when each and every predecessor activity is complete
    - Events themselves have no time duration and use no resources

- AOA network diagram



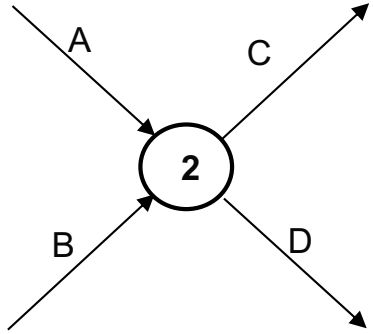
- AOA network diagram

Dummy activities: identity

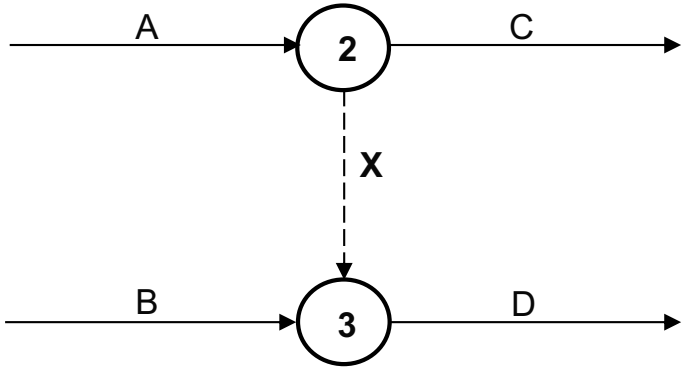


- AOA network diagram

Dummy activities: logical



Both C and D are preceded by A and B



C is preceded by A; D is preceded by A and B

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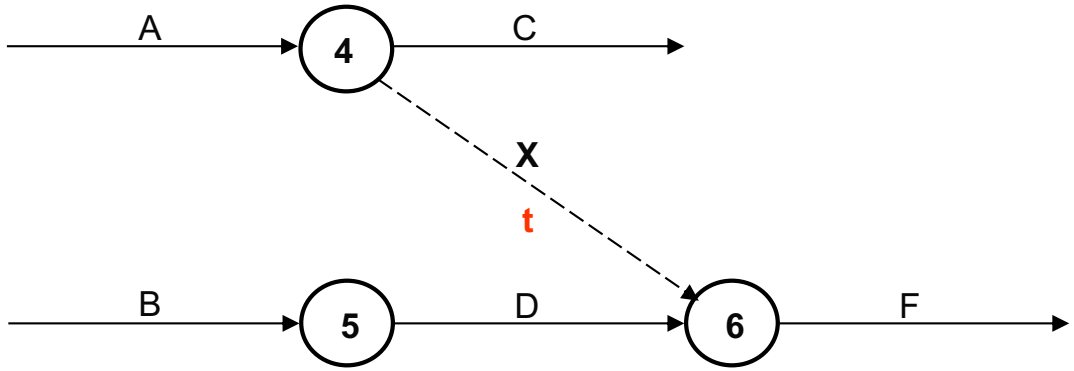
- AOA network diagram

Dummy activities: time transit



*A and D precede F, but after the conclusion of A, a delay **t** is necessary*

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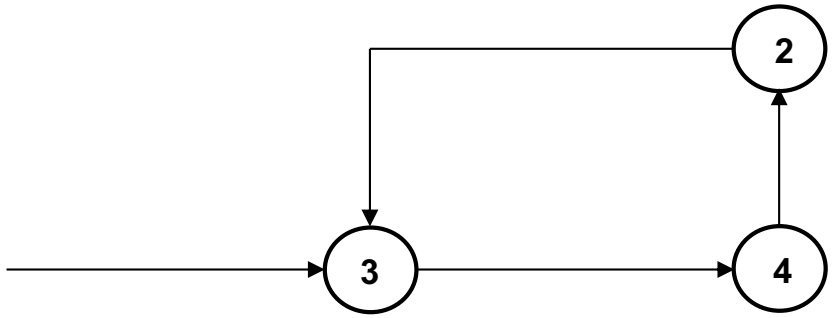
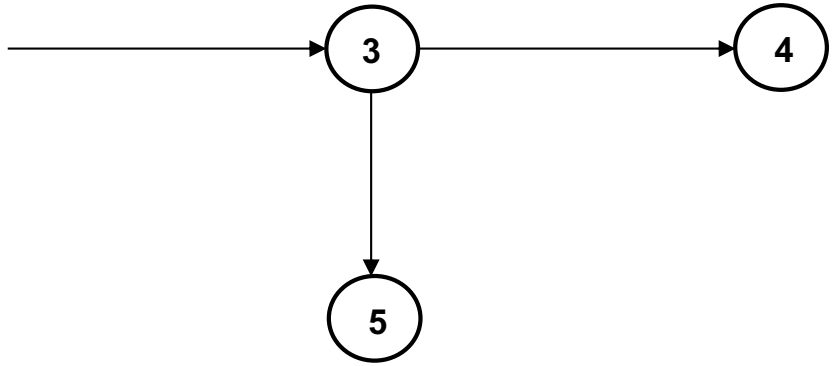
- AOA network diagram

Errors to avoid:

Looping



Dangling



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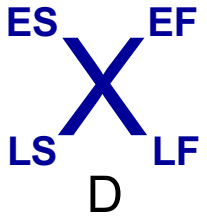
- AOA network diagram
  - D activity duration
  - ES early start
  - EF early finish
  - LS late start
  - LF late finish



$$D = EF - ES = LF - LS$$

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- AOA network diagram
  - Total slack: period of time a task can be delayed without delaying the project

$$S_{i,j} = LS_{i,j} - ES_{i,j} = LF_{i,j} - EF_{i,j}$$

  - Free slack: period of time a task can be delayed without delaying the succeeding tasks and the project

$$\text{Free slack} = \min_{\forall_i} (ES_j) - LF_{i,j}$$

  - If slack = 0: critical task

- AOA network diagram
    - Rule:
        - The Early start (ES) of a task starting on a node is the highest Early finish (EF) among the preceding tasks converging on that node

- AOA network diagram
    - Rule:
        - The Late finish (LF) of a task converging on a node is the lowest Late start (LS) among the succeeding tasks emerging from that node

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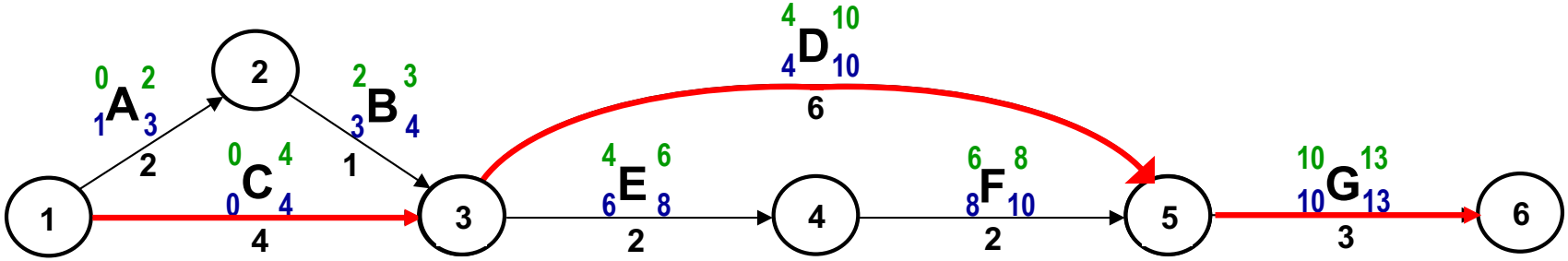
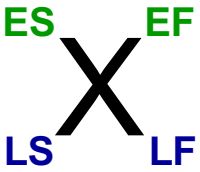
- AOA network diagram: example

Activity	Duration	Predeces.	Resources
A	2	-	X
B	1	A	X; Y
C	4	-	Y
D	6	B,C	X
E	2	B,C	Y
F	2	E	X; Y
G	3	D,F	X

Time planning

- AOA network diagram: example

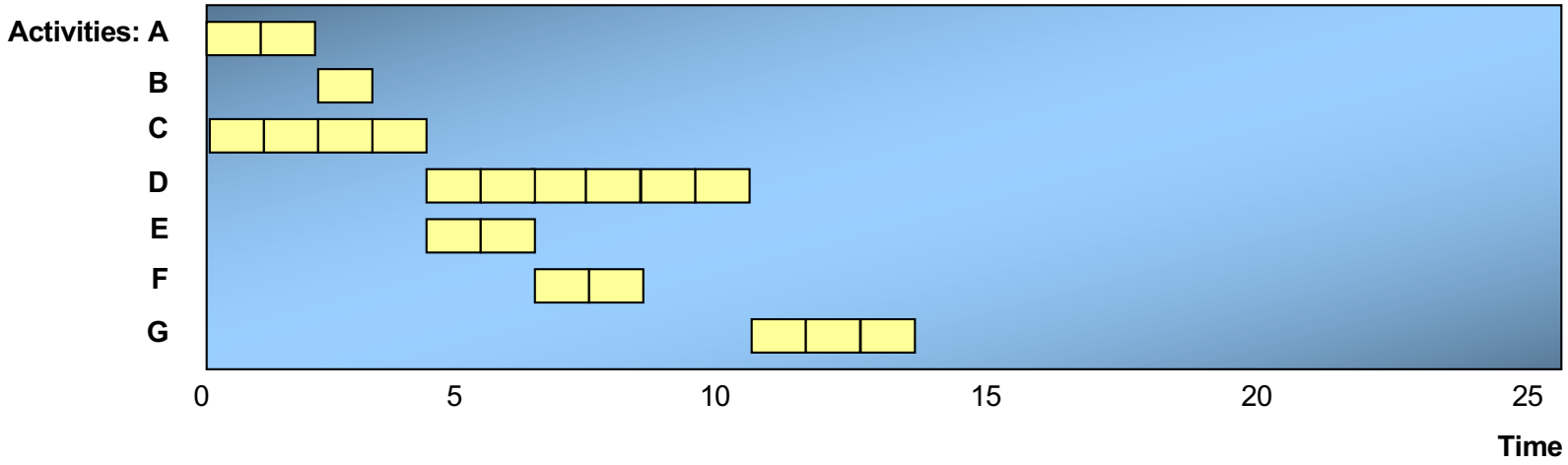




Critical path: C - D - G

Time planning

- AOA network diagram: example



Total duration: **13**

Time planning

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- AOA network diagram: example

Activity	Duration	Predeces.	ES	EF	LS	LF	TS	FS	Critical?
A	2	-	0	2	1	3	1	0	
B	1	A	2	3	3	4	1	1	
C	4	-	0	4	0	4	0	0	✓
D	6	B,C	4	10	4	10	0	0	✓
E	2	B,C	4	6	6	8	2	0	
F	2	E	6	8	8	10	2	2	
G	3	D,F	10	13	10	13	0	0	✓

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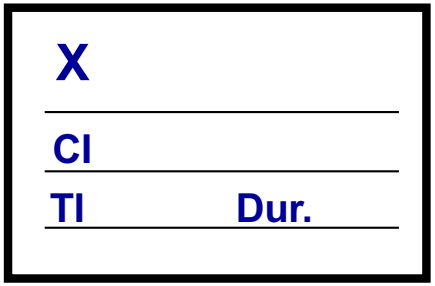
- AON network diagrams



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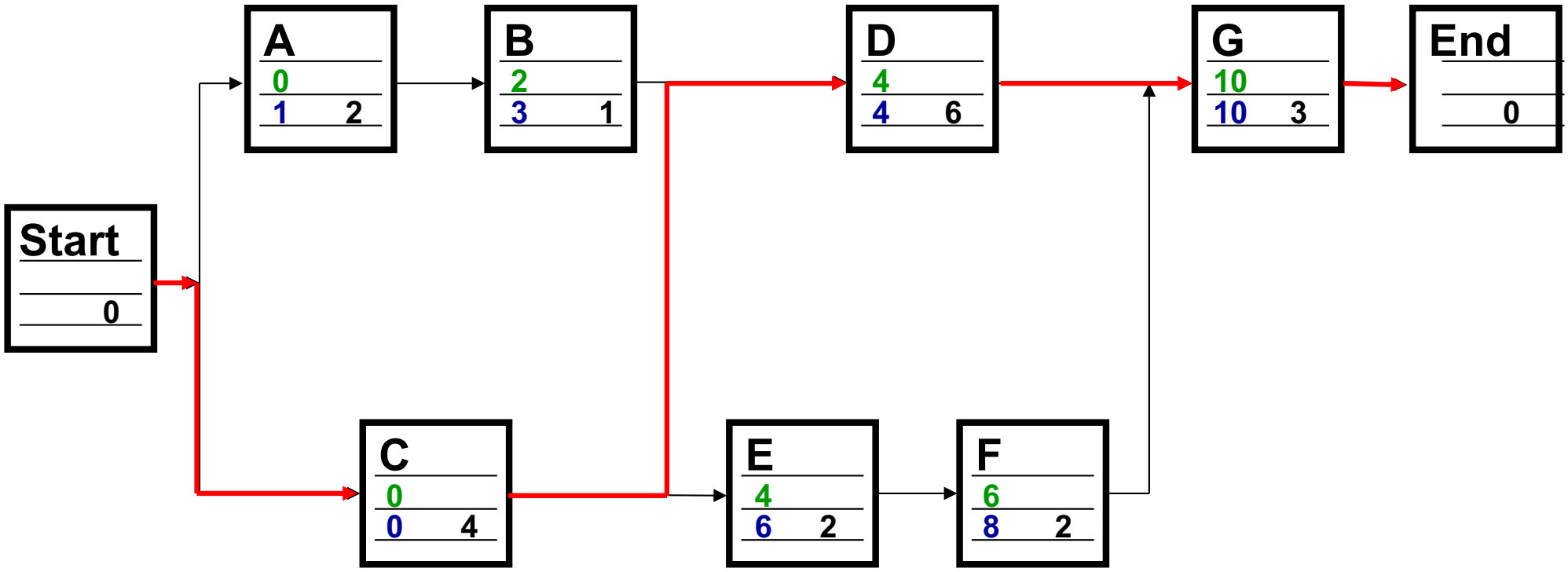
- AON network diagrams: example



Critical path: C - D - G

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- Compressing duration: Crashing method
  - Sometimes activities can be crashed at an extra cost to speed up completion time
  - Crashing critical activities' durations in each and every critical path of the network
  - **Crashing method**: step-by-step method (iterative). In each iteration, reduce 1 time unit of a critical task duration in every critical path
  - Preparing each step: identify which tasks' completion time can be reduced – determine duration limits and extra costs
  - Whenever there are alternatives, use the economic criteria to select which task to accelerate

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- Crashing – example:

Activity	Duration	Predeces.	Maximum acceleration	Additional cost per working day
A	2	-	0	-
B	1	A	0	-
C	4	-	2	20
D	6	B,C	3	60
E	2	B,C	1	5
F	2	E	0	-
G	3	D,F	0	-

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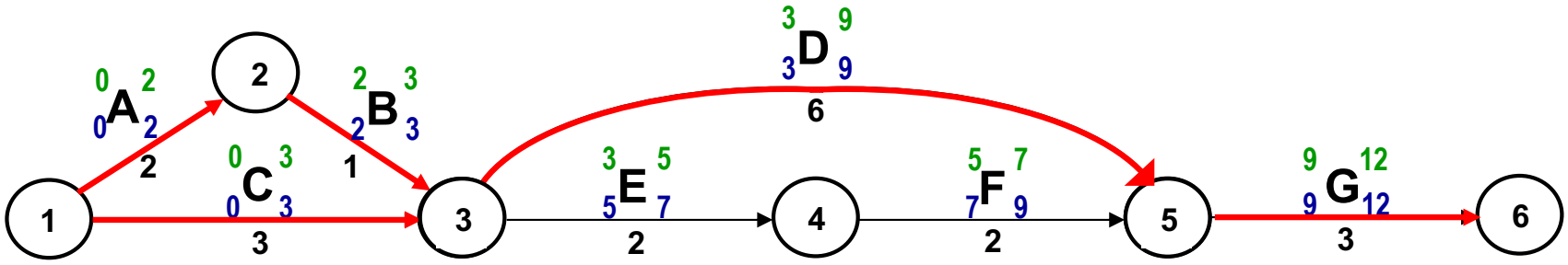
- Crashing – example:

Step 1: accelerate C (1 day)

Extra cost = 10

Project total duration = 12

Critical path(s): C – D – G; A – B – D - G



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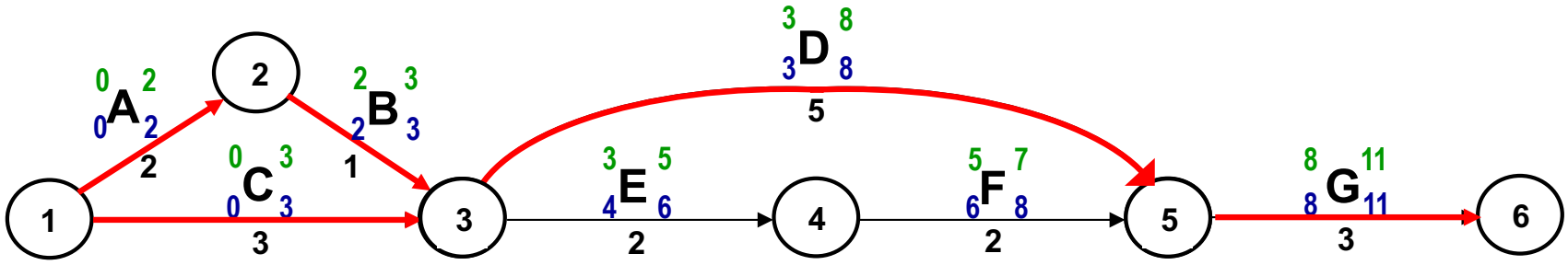
- Crashing – example:

Step 2: accelerate D (1 day)

Extra cost = 20

Project total duration = 11

Critical path(s): C – D – G; A – B – D - G



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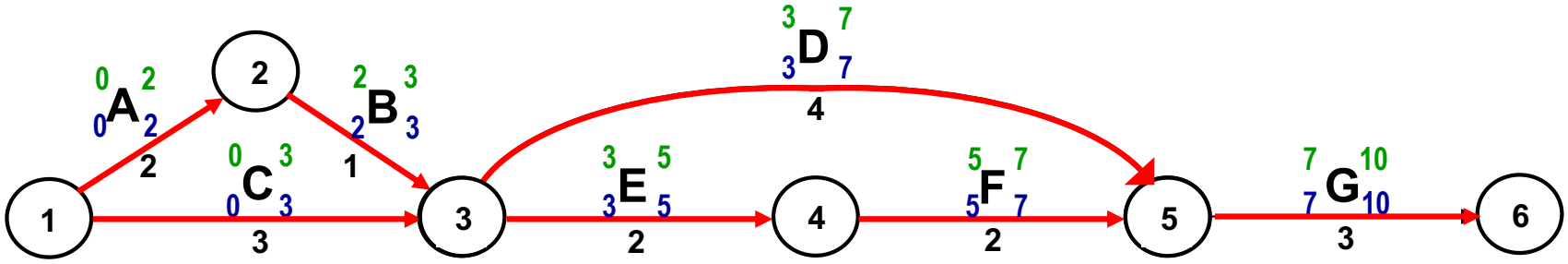
- Crashing – example:

Step 3: accelerate D (1 day)

Extra cost = 20

Project total duration = 10

Critical path(s): C – D – G; A – B – D – G; A–B–E-F-G; C-E-F-G



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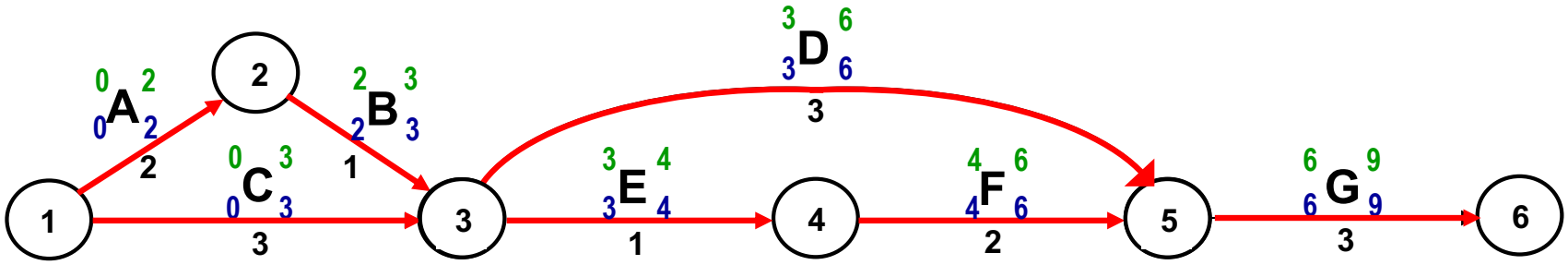
- Crashing – example:

Step 4: accelerate D and E (1 day)

Extra cost = 20 + 5 = 25

Project total duration = 9

Critical path(s): C – D – G; A – B – D – G; A–B–E-F-G; C-E-F-G



C could be accelerated another day, but that woudn't accelerate the critical path A-B-E-F-G: the method ends now.

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- Resource leveling