GEP – Project Management

PROJECT MANAGEMENT

Module 2: Basic aspects of project management

2.3. Time management

Department of Management
Barcelona School of Informatics (FIB)

Time management

1. Introduction
2. Processes: planning and organization
3. Scheduling tools
4. Processes: acting and controlling

1. Introduction

What is time management?

- **Definition**: planning, scheduling and implementing project activities so that the total time between start and finish is as expected.
- Time **management** → processes that involve
  - Planning and organization

  - Performance and control: monitoring
- **Planning and scheduling**
  - Plan: strategic level → What/How/When with respect to the project
  - Scheduling → techniques that transform the project plan into a real schedule, taking into account resources, costs, etc.

2. Processes: planning and organization

Definition of activities

- Matrix of processes (life cycle/types of process; see Module 2.2)
- A review process is required.
  - Subdivide processes into more specific activities, if required.
  - Group small tasks into activities that are easier to control.
  - Activity/Control ratio.
    - ✓ Adapt the number of activities so that they are easy to monitor.
    - ✓ Avoid formalizing very short tasks → they require a lot of effort to control.

2. Processes: planning and organization

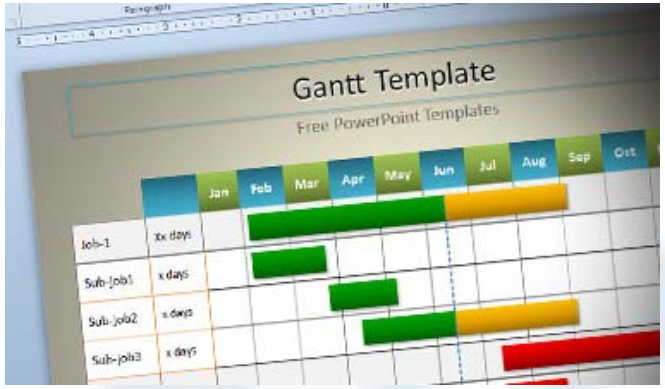
Ordering or sequencing activities

- Establish precedence relationships between activities: **Finish-to-Start**
  - Activity A should be executed before activities B and C
- Establish dependence relationships between activities
  - Activity D cannot be started until activities B and C are completed
  - Three types of dependencies
    - ✓ Finish-to-Start *(precedence)*
    - ✓ Start-to-Start *(dependence relating to the parallel execution of activities)*
    - ✓ Finish-to-Finish *(dependence relating to the parallel execution of activities)*

In your project deliverable, you should explain the time dependencies between the identified activities (you only need to work with precedence relationships [Finish-to-Start])

2. Processes: planning and organization

Time estimation (I)



- Based on…
  - Experience
  - Information from the past
  - Simulations
- Dynamic model of estimation based on experience and information from the past
  - Classify tasks into three levels of risk: High / Medium / Low
  - Calculate the deviation of each activity
  - Calculate the total deviation at each level of risk
  - Recommended ratios for software development:
    - ✓ High: 250%
    - ✓ Medium: 150%
    - ✓ Low: 110%

2. Processes: planning and organization

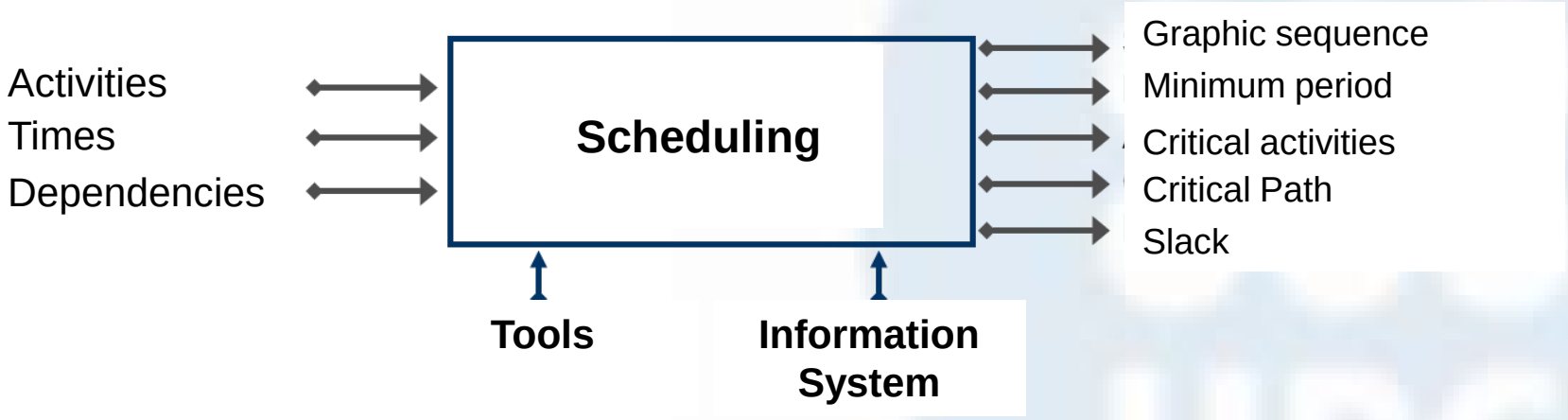
Time estimation (II)

- Distribution of effort in a “software engineering” project
  Project Scheduling and Tracking. Why Are Projects Late?
  (http://people.cs.aau.dk/~ivan/SOE2000/SOE08.pdf)
  - **40% - 50%**: Front-end activities
    - ✓ *Client communication*
    - ✓ *Analysis and design*
    - ✓ *Review and modification*
  - **15% - 20%**: Construction
    - ✓ *Code generation*
  - **30% - 40%**: Tests and installation
    - ✓ *Unit testing and installation*
    - ✓ *White box, black box*

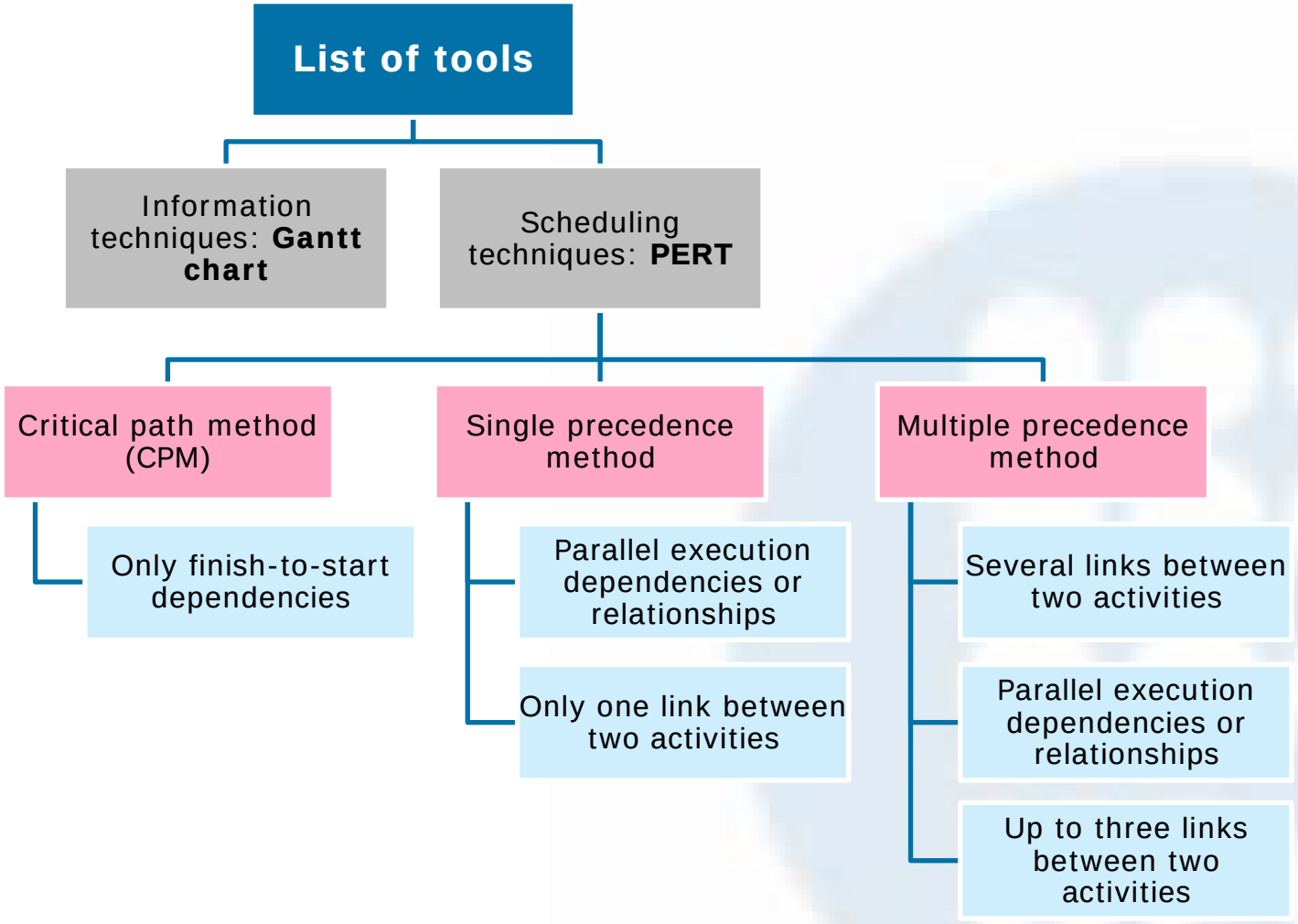
2. Processes: planning and organization

Scheduling of times

- Scheduling is a tool used in the planning process.
- A model is created for the entire project or for one of its phases, to obtain the following results:
  - Iterative construction
  - Facilitates control and changes due to unforeseen events



3. Scheduling tools



3. Scheduling tools

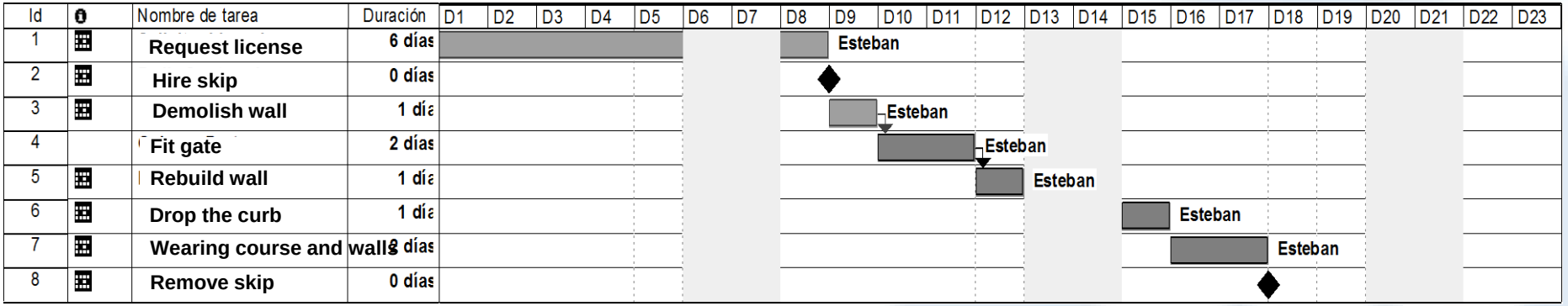
Gantt chart > Examples

- **Example 1**: A builder is contracted to make a gate in the wall around our home, so we can park the car in the garden.
  - The activities are shown in the chart.
  - The limitations are:
    - ✓ *Nothing can be done until the license is obtained.*
    - ✓ *The gate cannot be fitted until a section of the wall has been demolished.*
    - ✓ *The ends of the wall cannot be rebuilt until the gate has been fitted.*
    - ✓ *The skip must be available on the day that the wall is demolished.*
  - The project takes 17 days, including weekends and holidays.
  - It is good practice to associate a cost with each activity.

3. Scheduling tools

Gantt chart > Example

- Solution Example 1



3. Scheduling tools

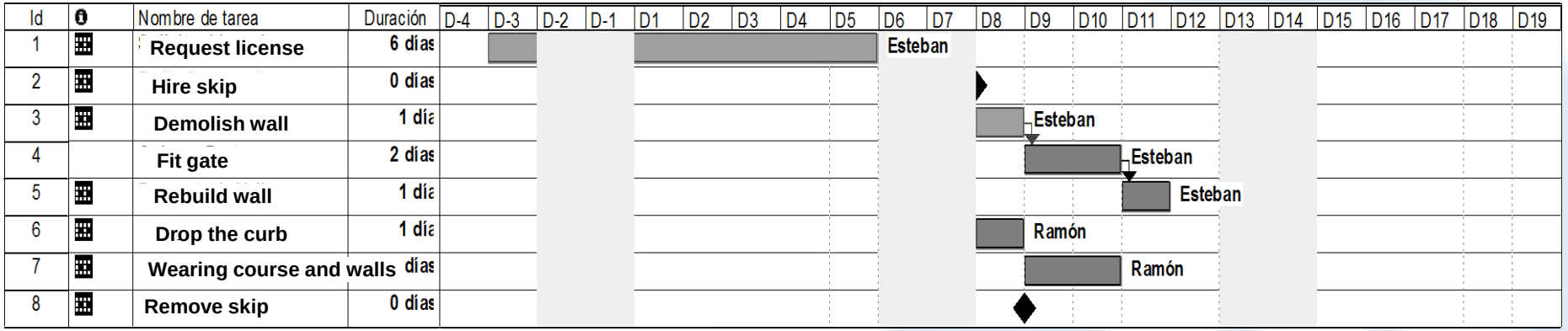
Gantt chart > Examples

- **Example 2**: Redesign the Gantt chart to obtain a schedule in which all the activities are completed before day 12.
  - Observations:
    - ✓ *A second person can be hired to carry out some of the tasks.*
    - ✓ *Once the license has been received, the work should be completed in a week (five working days).*
    - ✓ *The skip hire is charged by the hour. It is better to remove it once the wall has been demolished and the curb dropped.*

3. Scheduling tools

Gantt chart > Examples

- Solution Example 2



- Implications
  - 3 days of work are gained in exchange for paying Ramón 3 day's pay.
  - Skip hire is cut from 9 days to 1 day.
  - How much money does this optimization cost? → Time / cost ratio.

3. Scheduling tools

Gantt chart > Conclusions

- **Utility**
  - Helps to detect and reduce waiting times and dead times
  - Helps to balance work load between people
  - Clearly shows how the project has been planned
  - Limited in terms of the provision of corrective measures, if deadlines are not met
- **Advantages**
  - Very well-known
  - Simple
  - Good for overviews
- **Disadvantages** (and general disadvantages of information methods)
  - Does not provide information on the best sequence of activities
  - Does not allow us to deduce the effect of a delay in one of the activities

3. Scheduling tools

PERT techniques

- **PERT** = ***P**roject **E**valuation **R**eview **T**echnique*
  - This is a development of the Critical Path Method (CPM)
  - Improved PERT methods
    - ✓ *Single precedence method*
    - ✓ *Multiple precedence method*
- All of these methods use a **graph** to represent the project
- **Objective**: schedule a project with minimum time and cost
  - Define the time dependencies between activities
  - Find the shortest execution time
  - Determine critical and non-critical activities
    - ✓ *Identify the critical path (sequence of critical activities)*
    - ✓ *Detect and quantify the slack times of non-critical activities*
  - Optimization tool

3. Scheduling tools

PERT techniques > Methodology

- **Draw the graph**
  - You must know the Construction elements
  - You must know the Construction rules
  - Calculate the earliest start dates (**MIC**) for each activity.
  - You must know the rules for calculating the MIC.
- Calculate the latest start dates (**MAC**) for each activity.
  - You must know the rules for calculating the MAC.
- **Analysis**: Critical Path and Slack Times
  - Critical Path: define and calculate
  - Slack Time: define and calculate

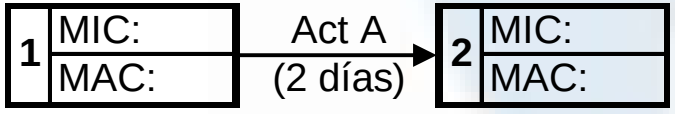
3. Scheduling tools

PERT techniques > Elements of the graph

- **Nodes**: the instant that occurs at the start or finish of a task
  - Has three pieces of data:
    - ✓ *Identifier: arbitrary*
    - ✓ *Earliest start date (MIC): calculated once the graph has been drawn.*
    - ✓ *Latest start date (MAC): calculated once the graph has been drawn.*
  - Representation:

Id	MIC: n
	MAC: m (n<=m)

- **Arrows**: activity that starts and finishes at the instants defined by the surrounding nodes.
  - Has two pieces of data:
    - ✓ *Name of the activity*
    - ✓ *Duration*
  - Representation:

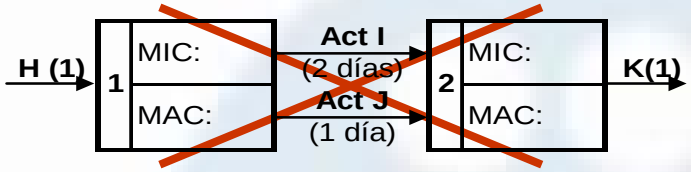


3. Scheduling tools

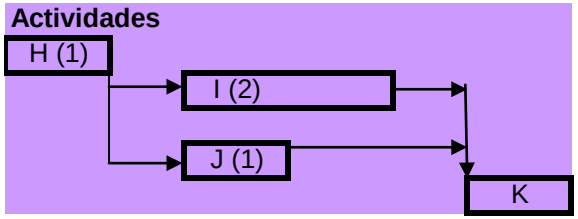
PERT techniques > Rules for constructing the graph

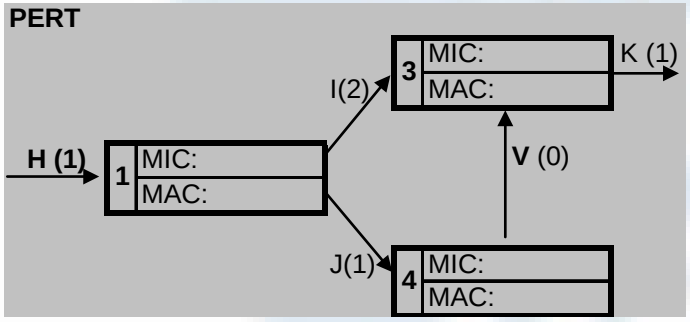
- There can only be one start node and one finish node.
  - Start node: does not have any arrows pointing to it.
  - Finish node: does not have any arrows pointing away from it.

- Two nodes cannot be joined by more than one arrow.



- Fictitious tasks, of 0 duration, can be added to avoid illegal constructions or to represent dependencies between tasks.

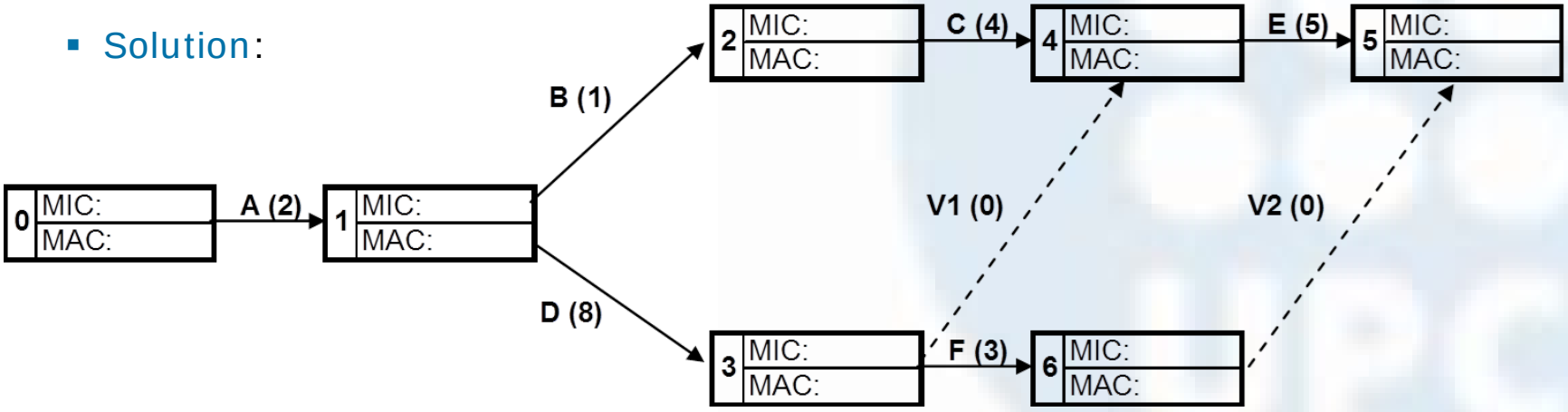




3. Scheduling tools

PERT techniques > Example 3

- There are 6 activities: A, B, C, D, E and F
- Respective durations: 2, 1, 4, 8, 5 and 3 days
- Time dependencies (finish–to-start type):
  - A must finish before B and D start (A < B, D)
  - B < C
  - C < E
  - D < E, F
- Solution:



3. Scheduling tools

PERT techniques > Calculate the MIC

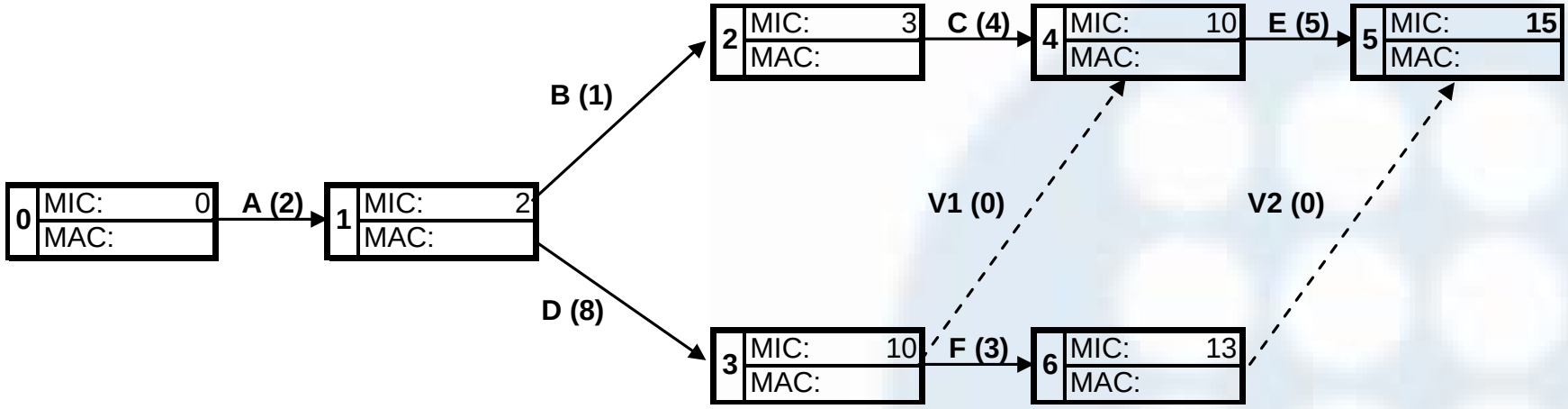
- If we calculate the earliest start date of each activity for each event, from left to right, the MIC can be calculated for the finish node. This gives us the shortest execution time for the project.
- Calculation rules:

1. Calculated from left to right.
2. The **start event** will have a **MIC** of **0** per construction.
3. The MIC of the following events will be calculated by adding up the duration of the activities between the start event and the finish event.
4. If there are various activities at one node, the MIC will be the **maximum** of those calculated according to rule 3.

3. Scheduling tools

PERT techniques > Example 4

- In Example 3, what is the shortest execution time of the project?
- Solution:



3. Scheduling tools

PERT techniques > Calculate the MAC

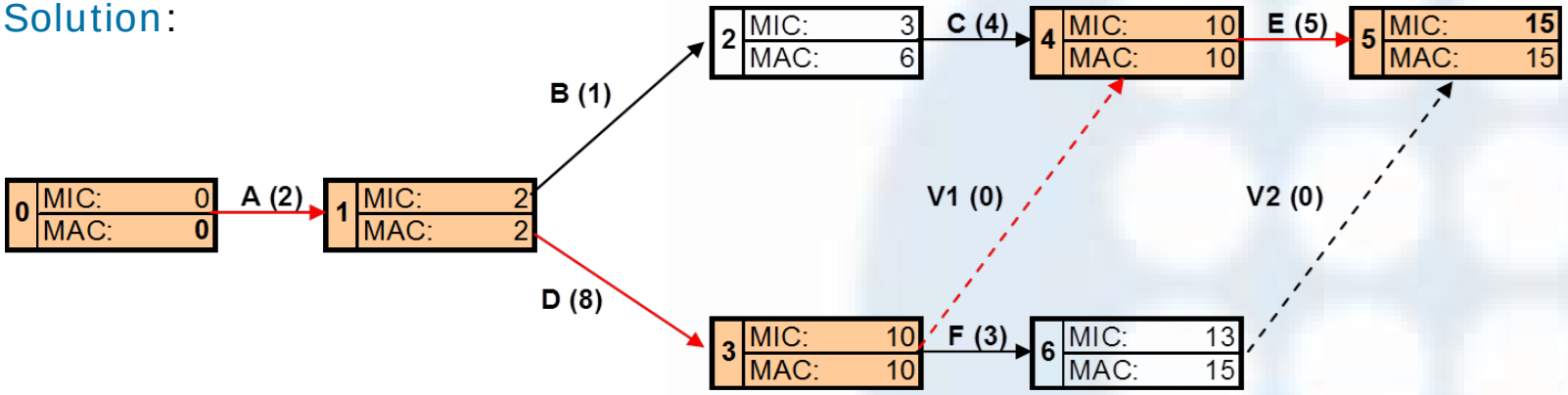
- The latest start date for an activity calculated for one node of the graph represents the latest date that the following activity should start, so that the shortest execution time is not exceeded.
- Calculation rules:

1. Calculated from right to left.
2. The **finish event** will have a **MAC equal** to the **MIC** per construction.
3. The MAC of an event to the left is calculated as the MAC of an event to the right, minus the duration of the activity that joins them.
4. If various activities are started at one node, the MAC will be the **minimum** of those calculated according to Rule 3.

3. Scheduling tools

PERT techniques > Example 5

- On the basis of Example 4…
  - Calculate the MAC
  - What are the key activities?
  - What is the critical path?
- Solution:



  - Critical activities: A, D, E (no delays are possible: MAC=MIC)
  - Critical path: A-D-E (any delay in these activities means that the project cannot be completed in 15 days)

3. Scheduling tools

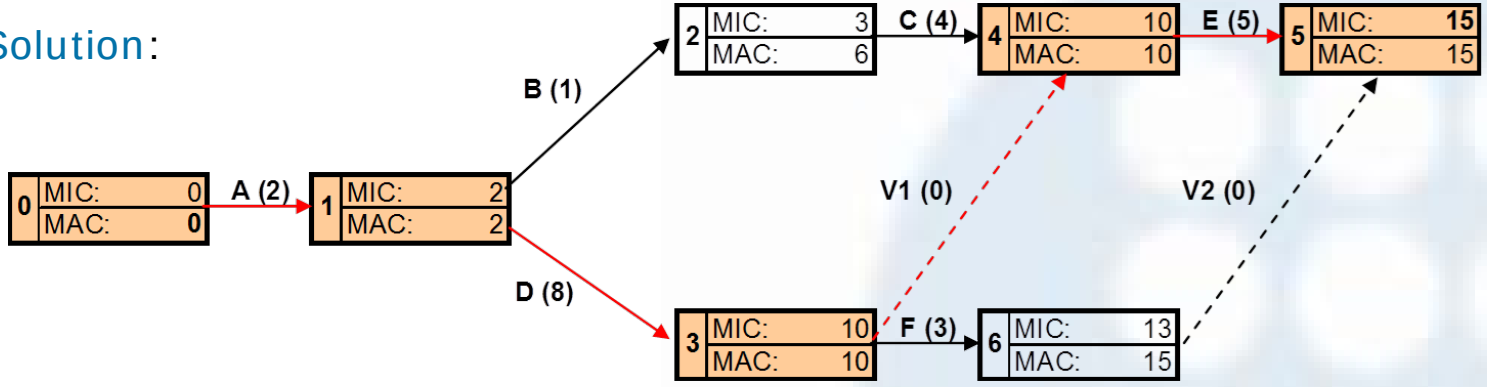
PERT techniques > Analysis: critical path and slack times

- **Critical activities**: those that cannot be delayed.
  - Activities whose start and finish events have the same MIC and MAC.
  - **Critical path**: the sequence of critical activities.
  - A delay in some of the activities in the critical path means that the shortest execution time will not be achieved.
- **Non-critical activities**: those in which there can be a slight delay, without affecting the shortest execution time.
  - Activities that have a different MIC and MAC for the start and finish events.
  - **Slack time**: the time margin that could be added to non-critical activities without causing a delay in the entire project.
  - Calculation of the slack time of an activity (or path):
    - ✓ *H(Path, nStart, nFinish) = MAC(nFinish) – MIC(nStart) i - Time(path)*
    - ✓ *H(ActC, n2, n4) = MAC(n4) – MIC(n2) – Time(ActC) = 10 – 3 – 4 =* ***3***

3. Scheduling tools

PERT techniques > Example 6

- On the basis of Example 3...
  - What is the slack time of activity B and activity F?
  - What is the slack time of path BC?
- Solution:



  - H(ActC,n2,n4) = MAC(n4) – MIC(n2) – Time(ActC) = 10 – 3 – 4 = 3
  - H(ActB,n1,n2) = MAC(2) – MIC(1) – Time(ActB) = 6 – 2 – 1 = 3
  - H(ActF,n3,n6) = MAC(n6) – MIC(n3) – Time(ActF) = 15 – 10 – 3 = 2
  - H(PathBC,n1,n4) = MAC(4) – MIC(1) – Time(PathBC) = 10 – 2 – (1 + 4) = 3
  - 3 units of delay time to distribute between B and C

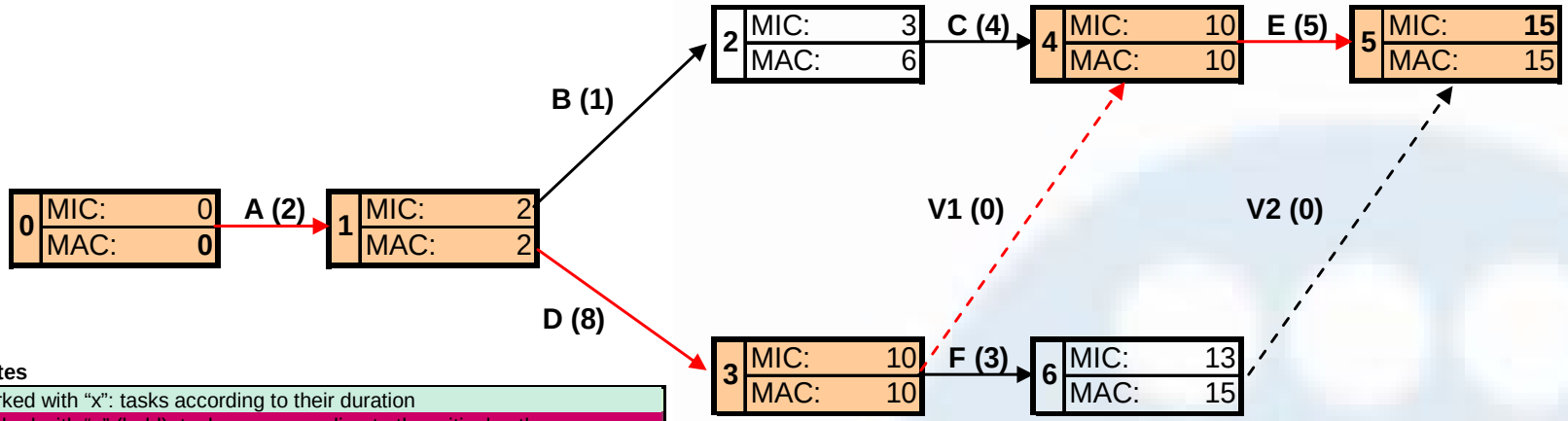
3. Scheduling tools

PERT techniques > Conclusions

- **Utility**
  - Can be used to calculate the shortest execution time of a project
  - Can be used to detect Critical Activities → Critical Path
  - Can be used to calculate and simulate future situations, if the time of an activity is considered a random variable
- **Advantages**
  - Very well-known
  - Accurately establishes time dependencies
  - Easy-to-use applications and software are available that calculate and draw PERT
- **Disadvantages**
  - You need to be a specialist to understand it
  - Fictitious elements: virtual activities
  - Only one kind of relationship between activities → Improvements
    - ✓ *Single precedence method: parallel execution of activities.*
    - ✓ *Multiple precedence method: more than one link between two activities.*

3. Scheduling tools

Conversion of PERT to GANTT



Notes

Marked with "x": tasks according to their duration
Marked with "**x**" (bold): tasks corresponding to the critical path
Marked with "o": slack times (of the last tasks)

Estimations	T	C	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
A	2		**x**	**x**																	A
B	1				x	o	o	o													B
C	4					x	x	x	x	o	o	o									C
D	8				**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**									D
E	5												**x**	**x**	**x**	**x**	**x**				E
F	3												x	x	x	o	o				F

3. Scheduling tools

For more information on the construction of PERTs

See the document:

- Module 2.3 – Improved construction of PERTS.pdf

4. Processes: acting and controlling

Monitoring and control

- Compare real times with scheduled times
- In practice:
  - Enter the real times into the model
  - Analyse the consequences: slack times (margins), critical path
  - Anticipate problems
- Take a decision
  - Decide on changes

Material

The material in this module was written by:

- Ferran Sabaté, professor in the Department of Management, UPC

References

- Castro, M. et al. (2007). *Gestión de proyectos con Microsoft Project 2007*. Madrid: RA-MA, DL.
- Nokes, S.; Greenwood, A. (2007). *La Guía definitiva de la gestión de proyectos: la vía rápida de todo ejecutivo para cumplir a tiempo y dentro del presupuesto*. Madrid: Prentice Hall Financial Times.
- Rodríguez, J.R.; García, J.; Lamarca, I. (2007). *Gestión de Proyectos Informáticos: métodos, herramientas y casos*. Barcelona: Editorial UOC.

Online tools (free)

- GANTTER (*Chrome web store*)