Example

- Using a hypothetical sample project from Marchewka* we will find Total Float of each task, and Critical Path(s)
- "Total Float" is the amount a task can be delayed without delaying the project, and
- a "Critical Path" is any sequence of tasks from beginning to end, with zero total float for each task
- The following slide gives the required data:
  - the tasks, and their
  - durations and
  - dependencies

* *Jack T. Marchwewka, (2006) "Information Technology Project Management" (more recent editions also available)*

Hypothetical Project
(from Marchewka)

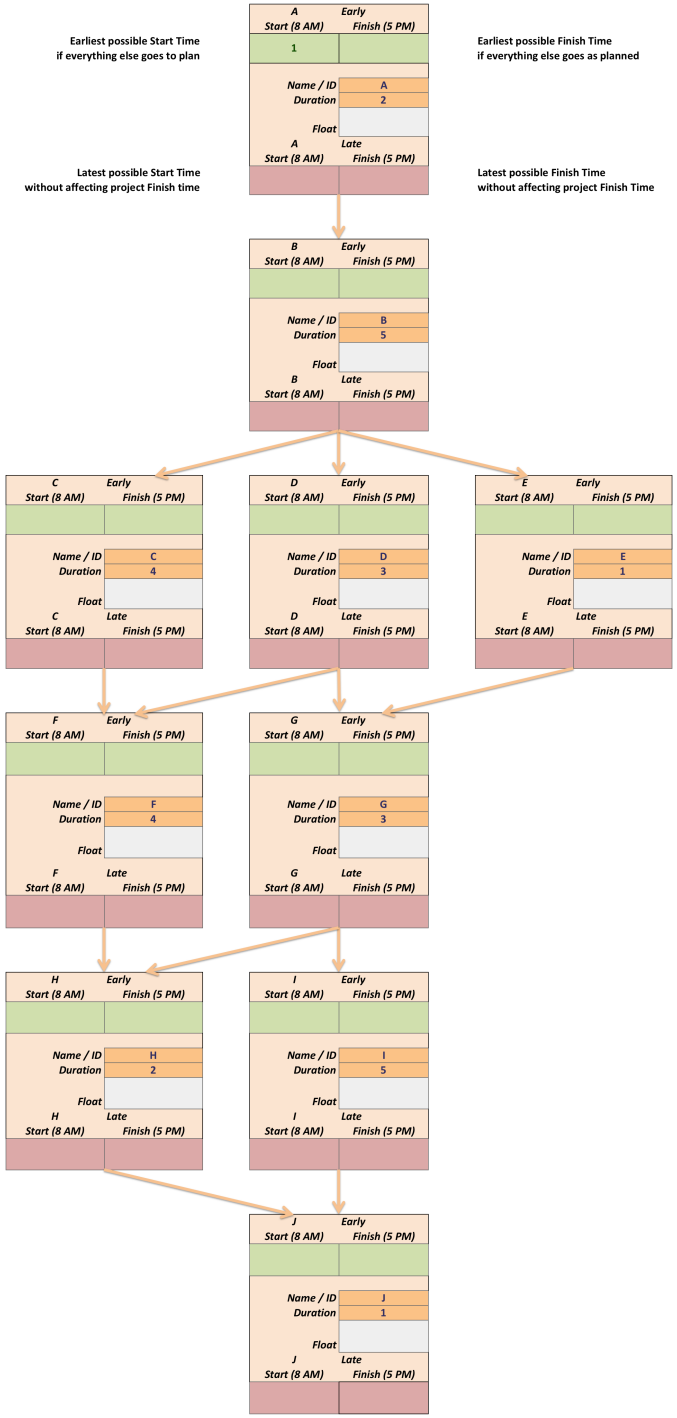
Task	*Predecessors*		*Estimated Duration*
A Evaluate current technology platform			2
B Define user requirements	A		5
C Design web page layouts	B		4
D Set up server	B		3
E Estimate web traffic	B		1
F Test web pages and links	C	D	4
G Move web pages to production environment	D	E	3
H Write announcement of intranet for corporate newsletter	F	G	2
I Train Users	G		5
J Write report to management	H	I	1

Illustration of Critical Path Analysis

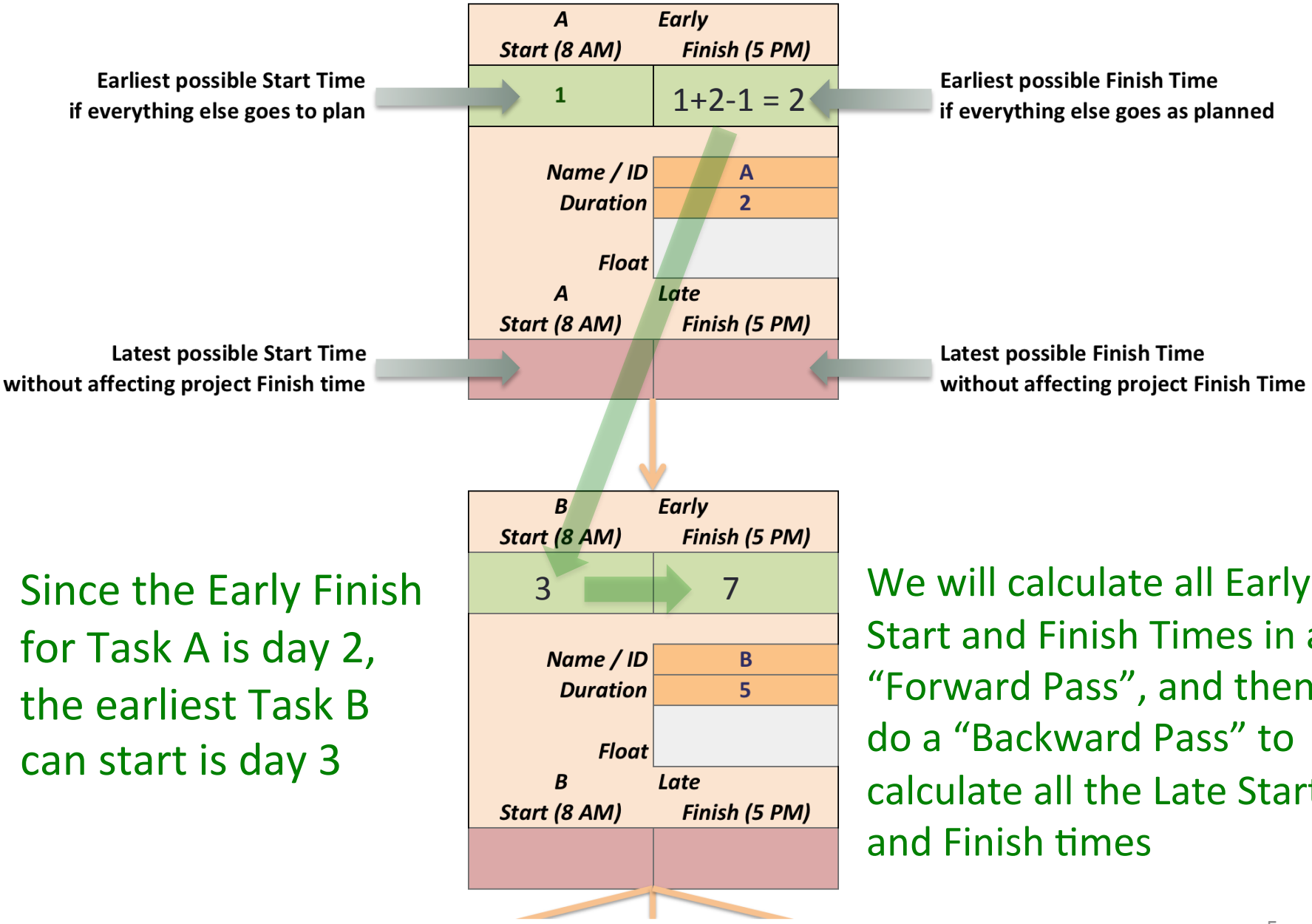
- For the purposes of illustration we will use an "Activity-on-Node" diagram, and find the float of each task using a "forward pass", followed by a "reverse pass"
- Most project management tools will calculate float and Critical Paths automatically, so you rarely need to perform these calculations
- The purpose of the following slides is to explain the underlying principles

"Activity-on-Node Diagram"

- Every Task or Activity is represented by a block containing relevant data
- Dependencies are shown by arrows – in this example all dependencies are Finish-to-Start
- Zoom in to tasks A and B …

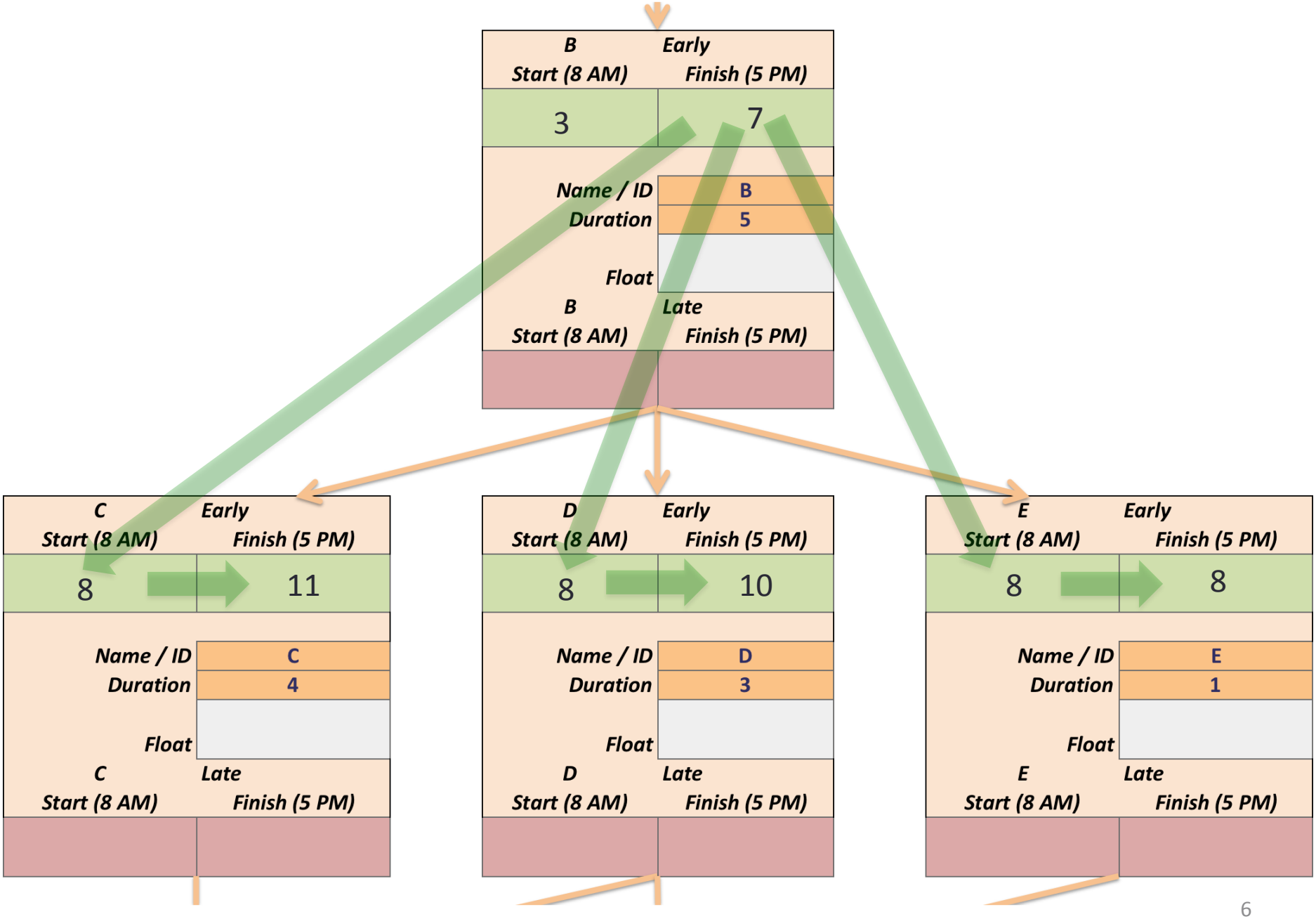


Forward Pass:



Since the Early Finish for Task A is day 2, the earliest Task B can start is day 3

We will calculate all Early Start and Finish Times in a "Forward Pass", and then do a "Backward Pass" to calculate all the Late Start and Finish times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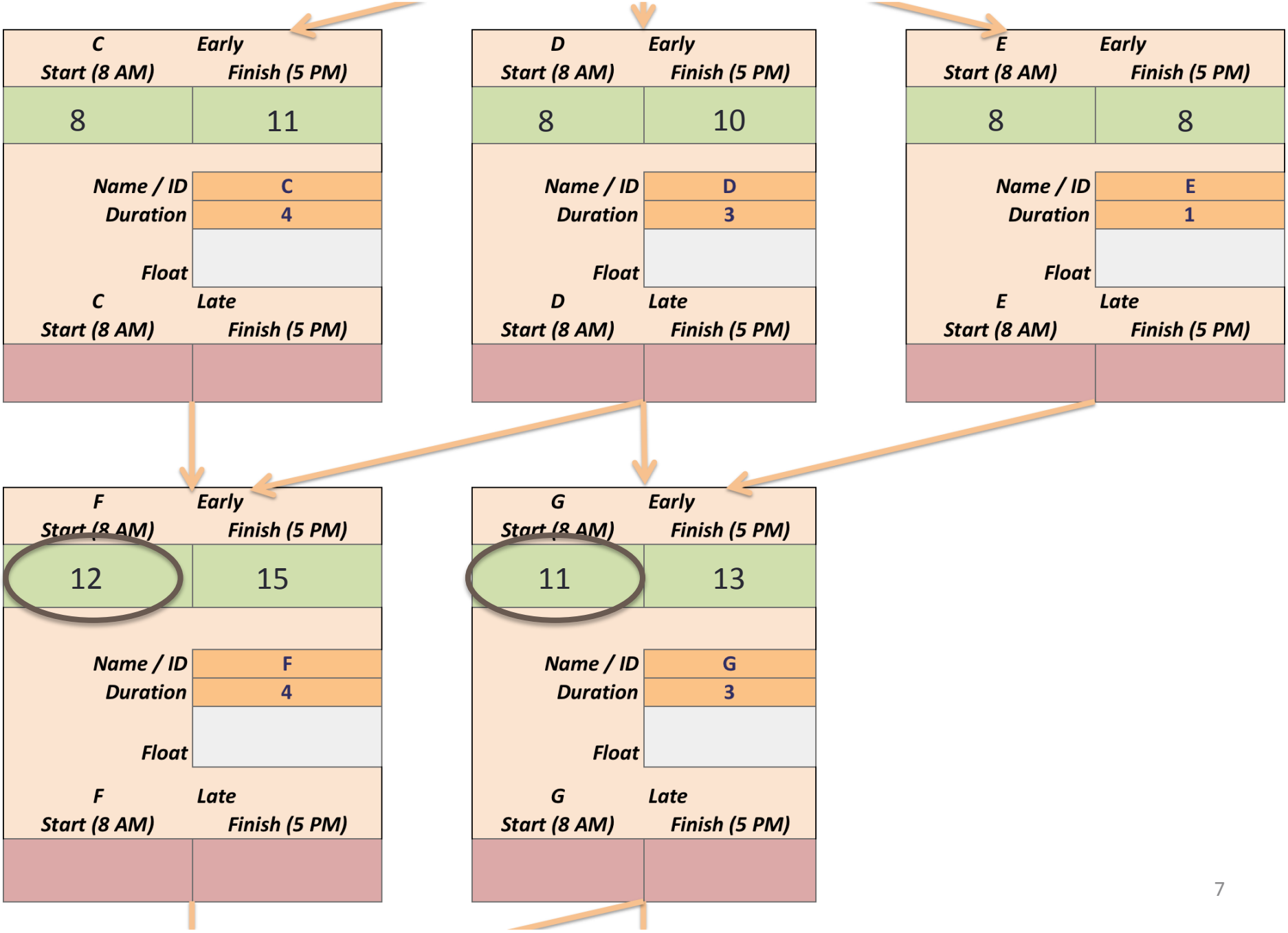
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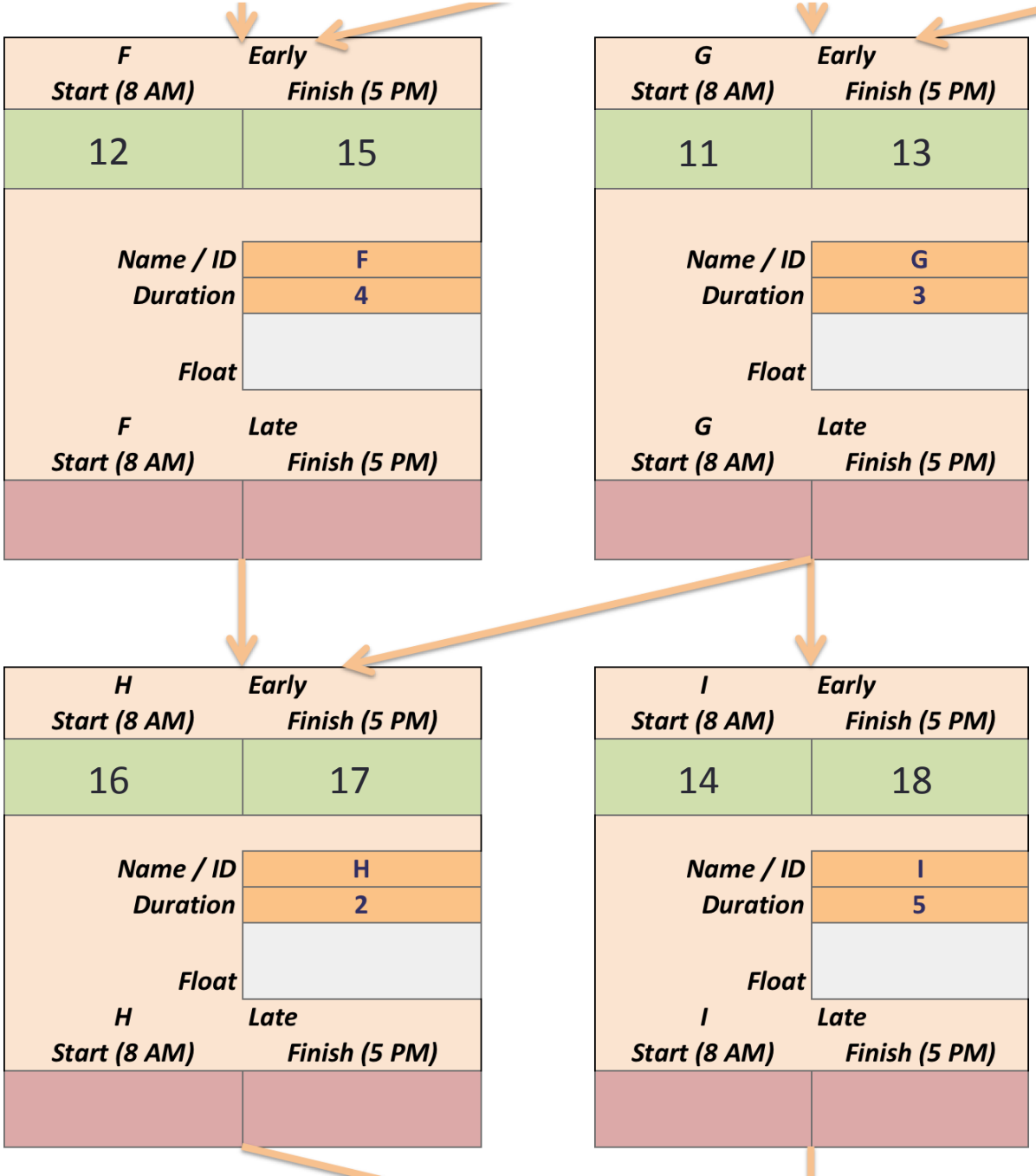
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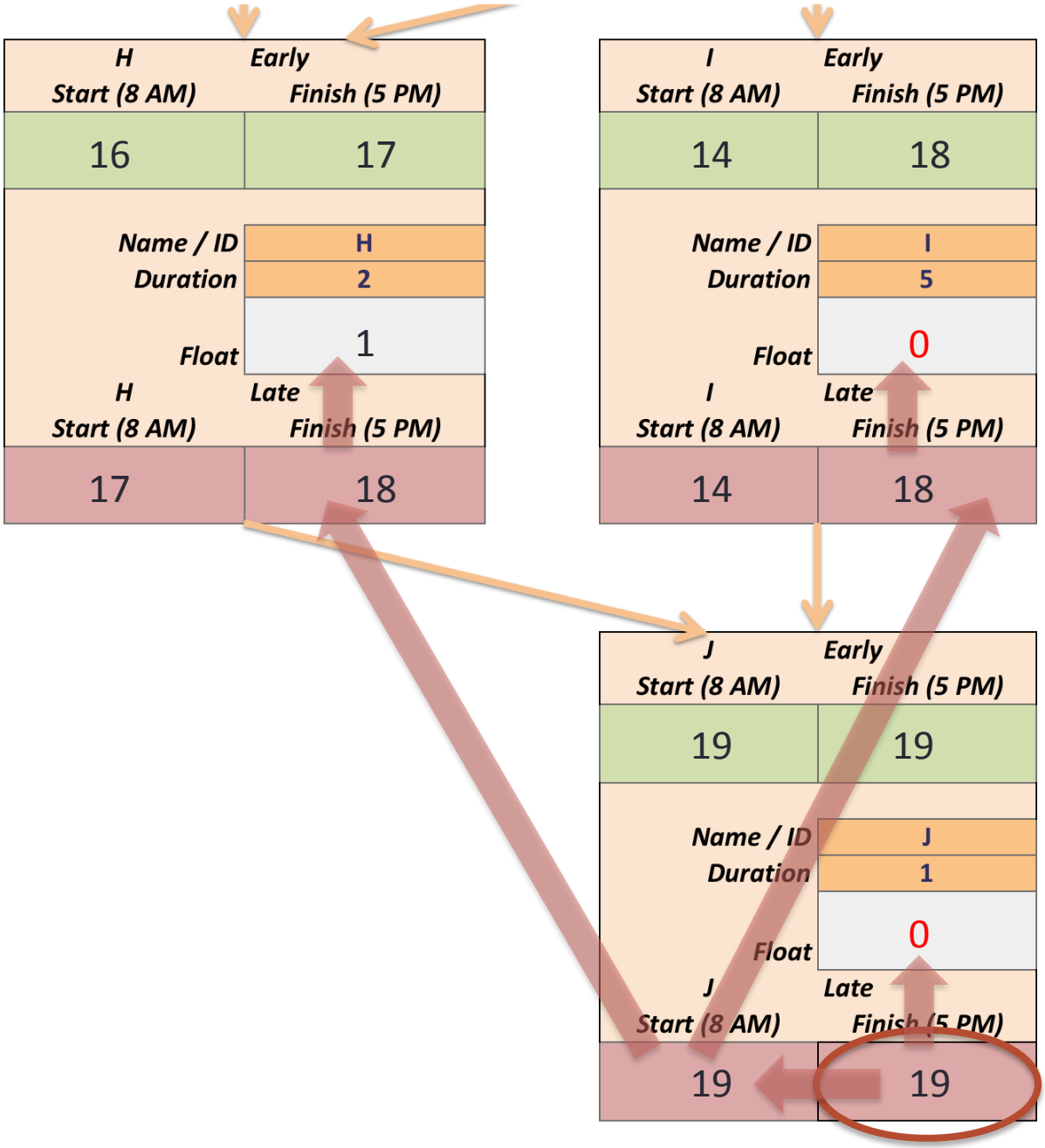
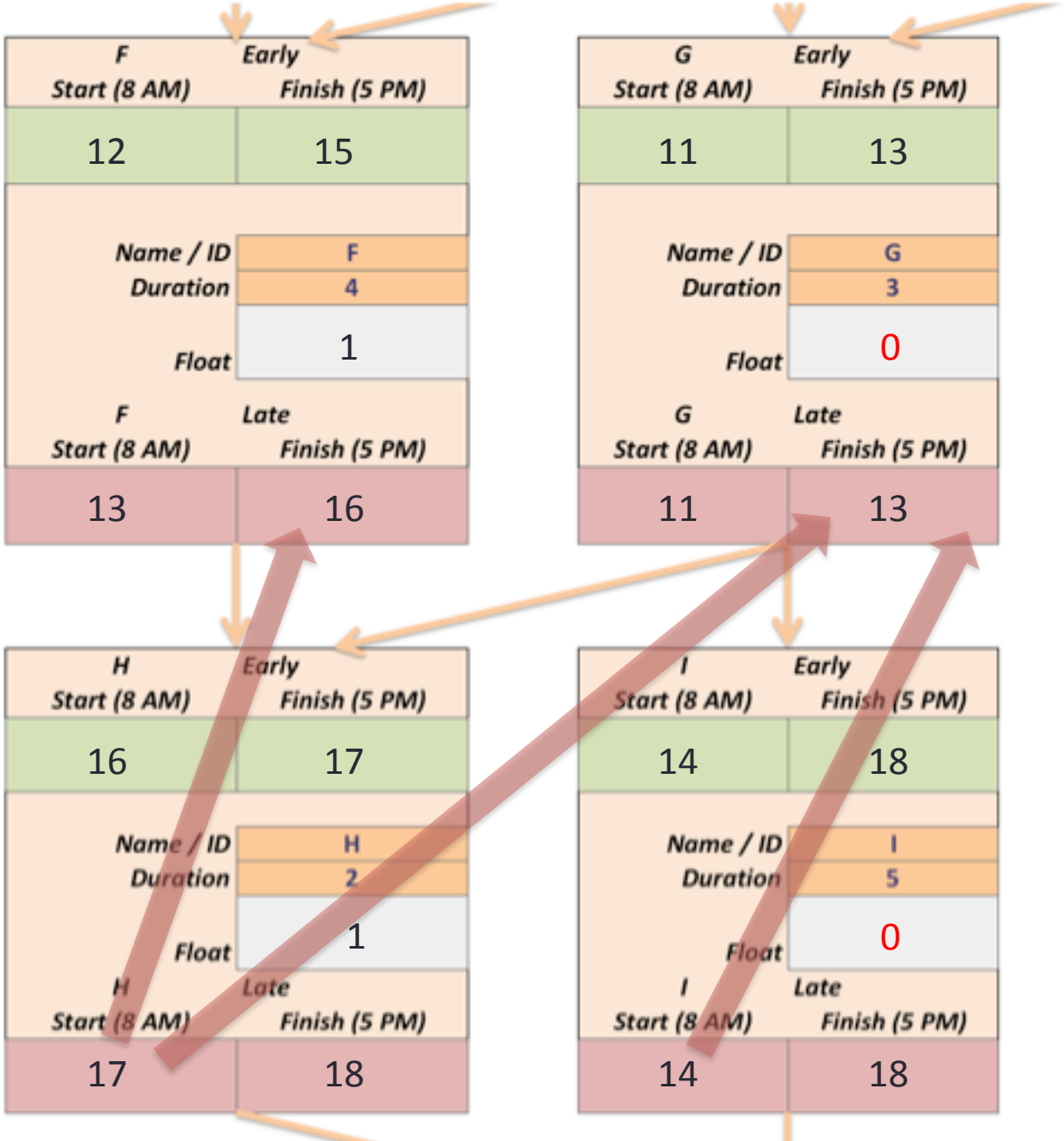


Reverse Pass:

Begin by setting
Late Finish = Early Finish
for the whole project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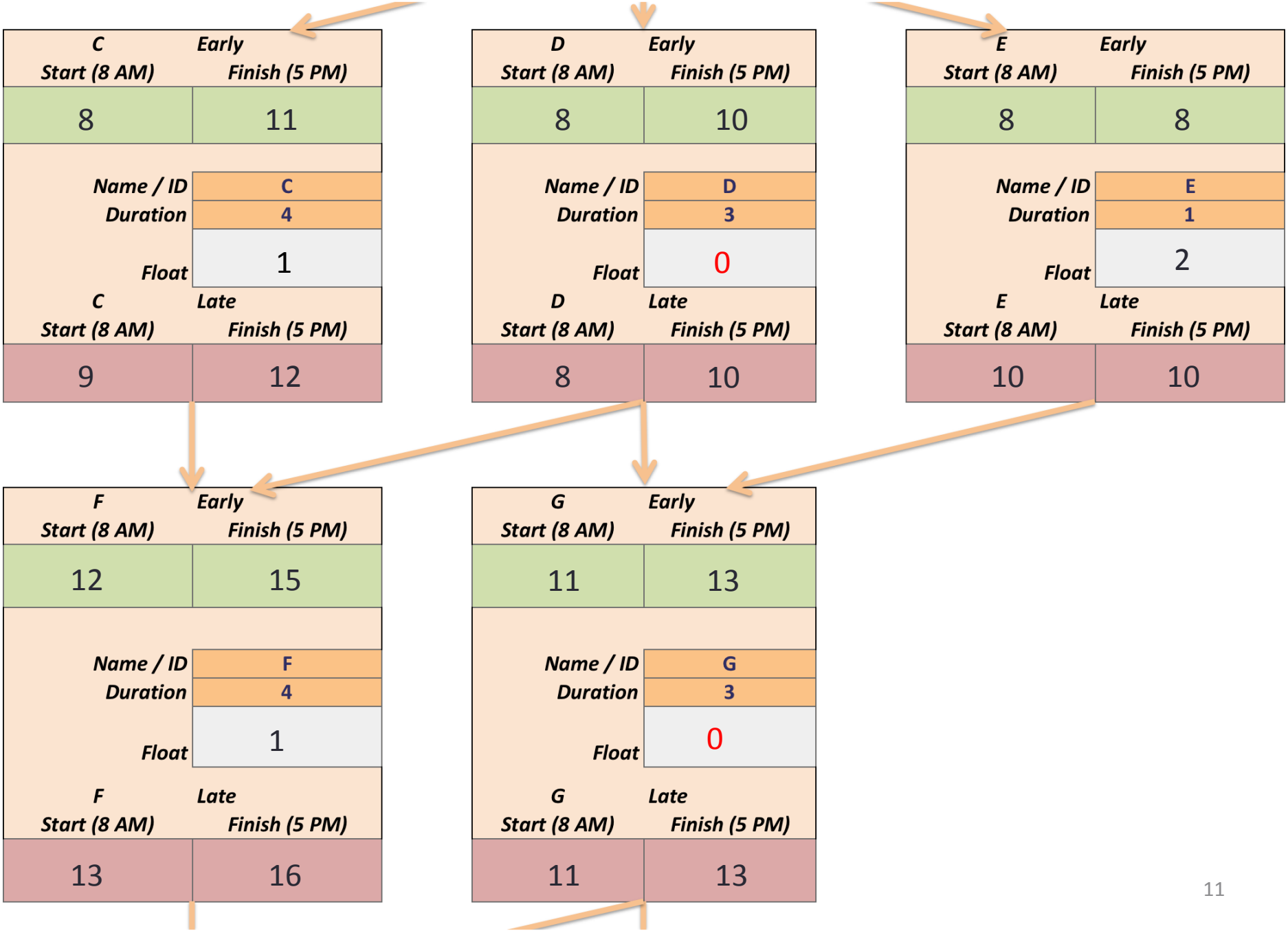
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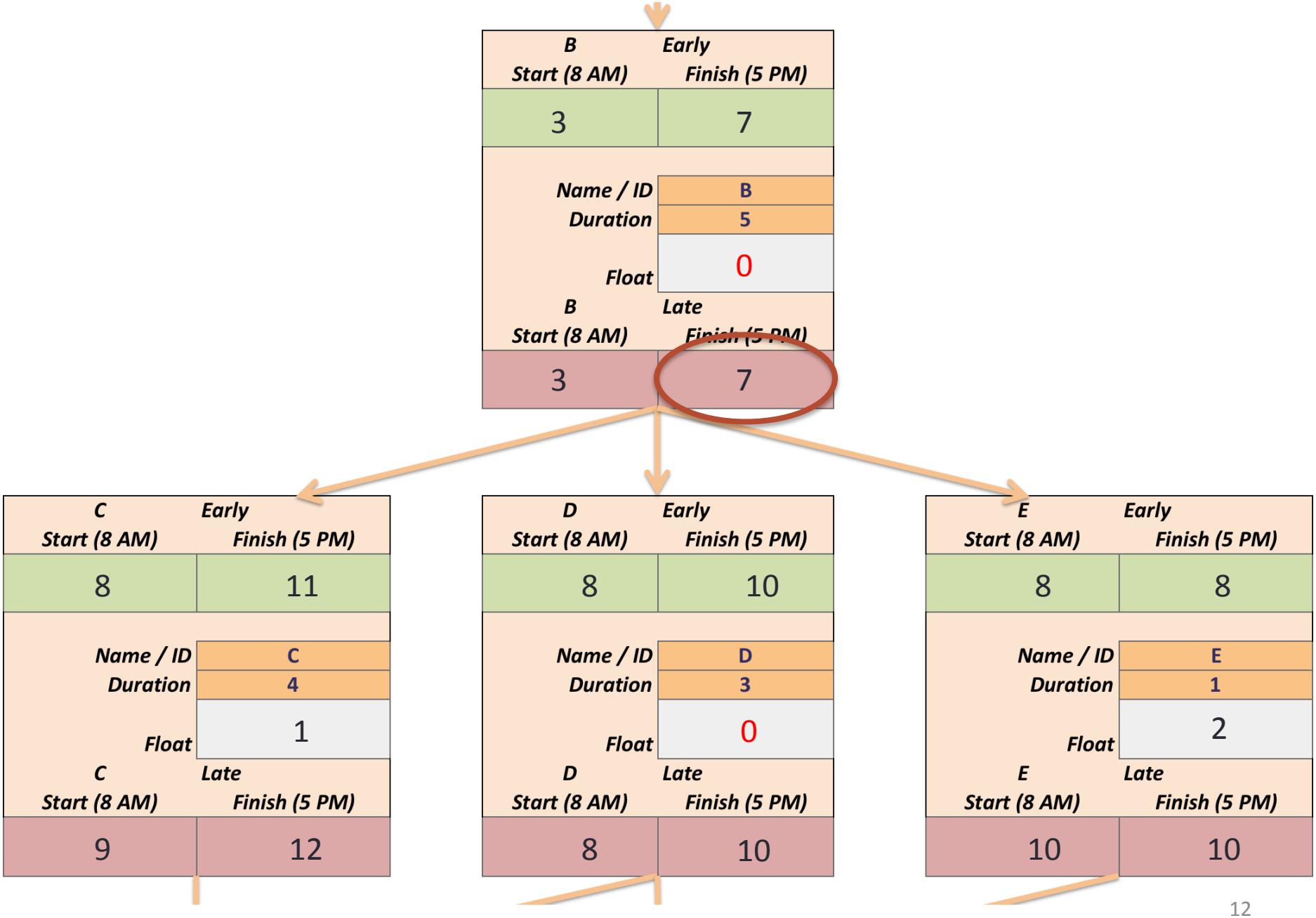
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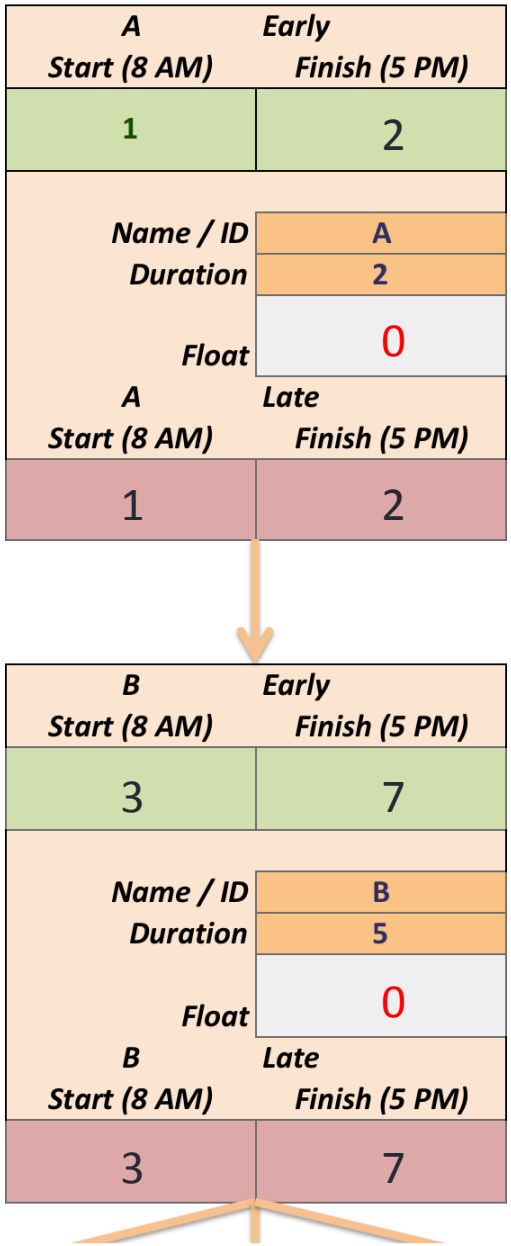
Earliest possible Start Time
if everything else goes to plan



Earliest possible Finish Time
if everything else goes as planned

Latest possible Start Time
without affecting project Finish time

Latest possible Finish Time
without affecting project Finish Time

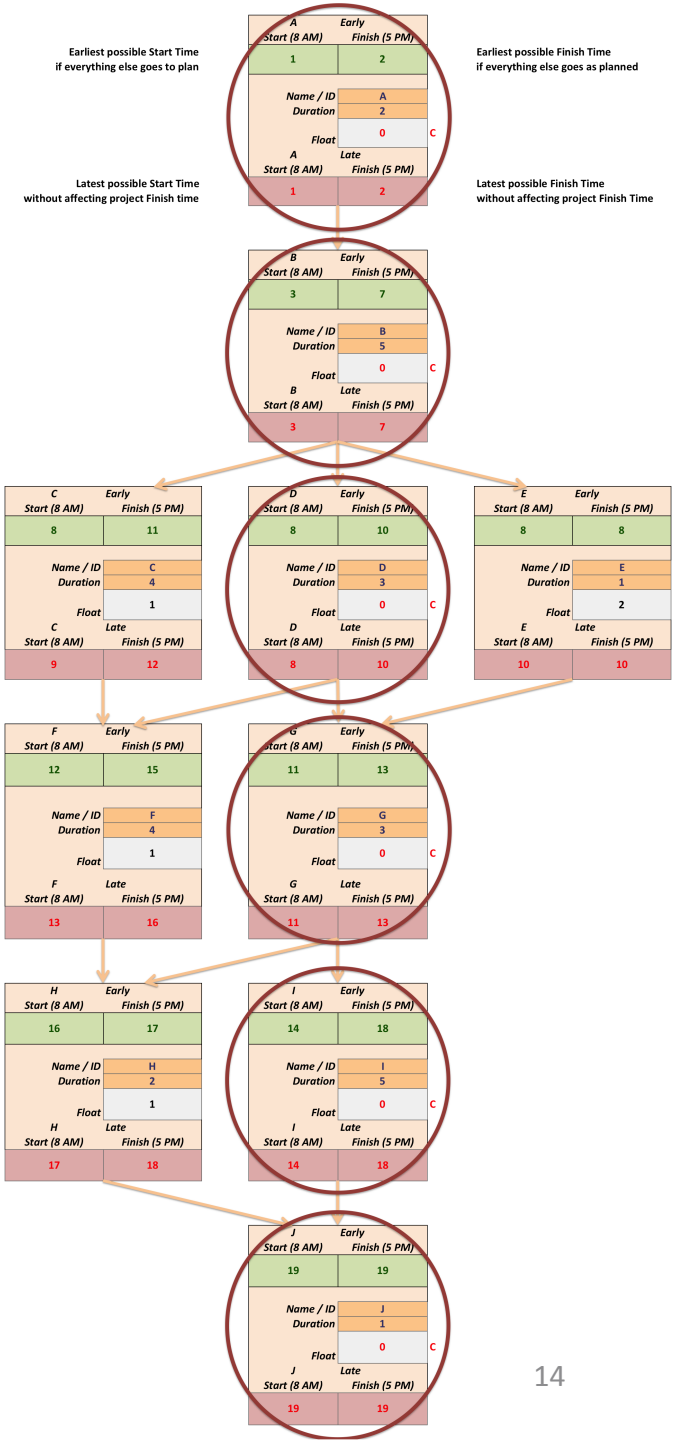
Now let's zoom out again …

Critical Path

Having completed a forward and reverse pass, we now know a critical path (the path may not be unique)

Any delay on any task on that path will delay the completion of the project

All other tasks have some “Total Float”, meaning “the amount they may be delayed without delaying the project”



Some Notes

- Different types of constraints may be included:
  - Start-to-Start, Start-to-Finish, Finish-to-Finish dependencies, as well as Finish-to-Start
  - Constraints on starting time or finishing time of individual tasks (for example: " X cannot start before . . .", or "Y must finish before . . .")
- The problem can be formulated as a Linear Program:
  - Minimize time to completion, subject to equality and inequality constraints on start and finish times

Randomisation

- Of course, as the project proceeds the actual durations may be different from the planned durations. The float of the tasks may change: tasks that were on the critical path may become non-critical, and other tasks may become critical
- In the planning process, one way to account for this variability is by randomising the durations, and using a technique such as Monte-Carlo simulation to find “worst-case” conditions

Correlation

- The baseline assumption for random durations is that all variations are independent
- Unfortunately this is not the case in a typical project – errors tend to be correlated
- There are many root causes for correlation, including:
  - Optimistic estimates of work duration
  - Vested-interested bias – competition for funding
  - Poor risk analysis – unforeseen catastrophes
  - Critical resources – any delay accessing these can cause a delay to many tasks

Critical Chain

- Because critical resources are so often an issue, an alternative analysis called “Critical Chain” is sometimes used
- In this method, the usage of specific resources is tracked, and critical resources are identified and managed
- For further (optional) study, I recommend a web search starting with Wikipedia

Implications for Project Managers

- Critical Path Analysis is an Early-Warning-System – it gives the Project Manager advance warning that some delays occurring early in the project may affect the whole project
- As the project proceeds, criticality may shift from one set of tasks to others, so real-time monitoring and management is essential

A Final Word

- My personal experiences, and those of my colleagues, suggest that very often delays arise from a minority of people who cannot or will not:
  - Plan their activities
  - Commit to delivering results
  - Follow through on their commitments
- These people can be team members, experts on loan, managers, or sponsors!
- So while Critical Path and other analytical tools are useful, in the end people-management is still extremely important