10

Project Management

PowerPoint presentation to accompany
Heizer and Render
Operations Management, Eleventh Edition
Principles of Operations Management, Ninth Edition

PowerPoint slides by Jeff Heyl

Bechtel Projects

- Constructing 30 high-security data centers worldwide for Equinix, Inc. ($1.2 billion)
- Building and running a rail line between London and the Channel Tunnel ($4.6 billion)
- Developing an oil pipeline from the Caspian Sea region to Russia ($850 million)
- Expanding the Dubai Airport in the UAE ($600 million), and the Miami Airport in Florida ($2 billion)

Bechtel Projects

- Building liquid natural gas plants in Yemen ($2 billion) and in Trinidad, West Indies ($1 billion)
- Building a new subway for Athens, Greece ($2.6 billion)
- Constructing a natural gas pipeline in Thailand ($700 million)
- Building 30 plants for iMotors.com, a company that sells refurbished autos online ($300 million)
- Building a highway to link the north and south of Croatia ($303 million)

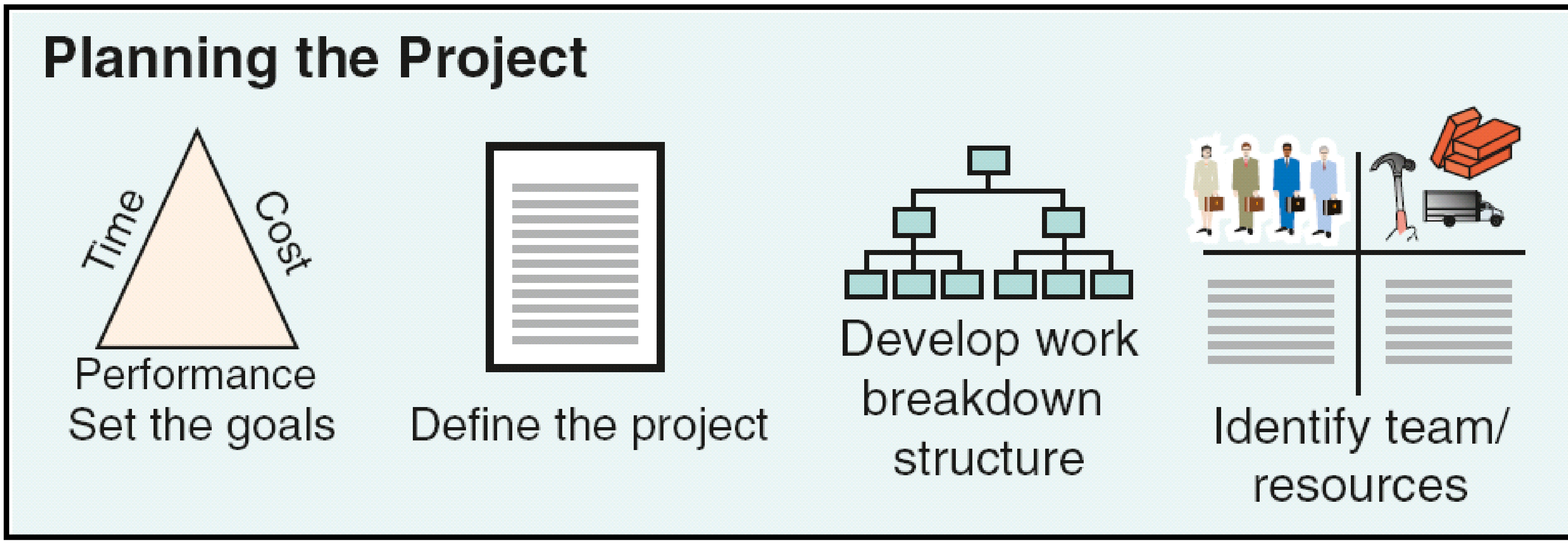
Project Characteristics

- Single unit
- Many related activities
- Difficult production planning and inventory control
- General purpose equipment
- High labor skills

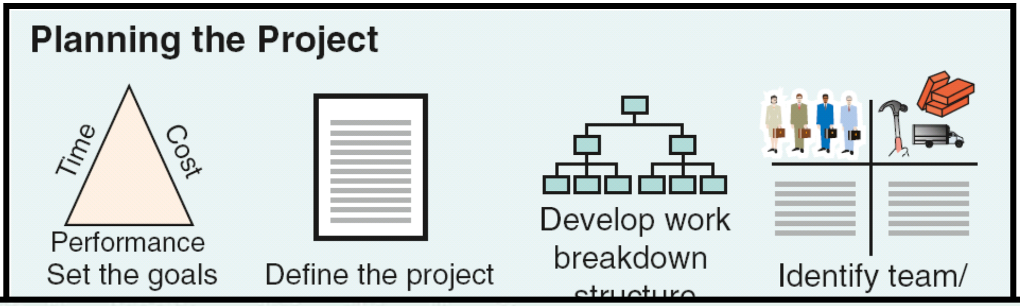
Management of Projects

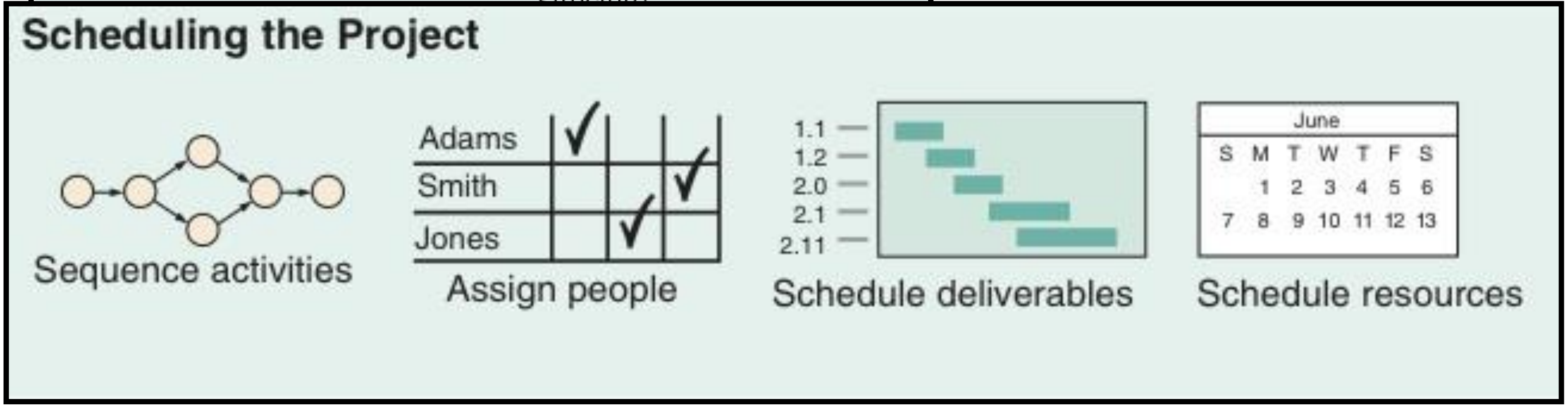
1. *Planning* - goal setting, defining the project, team organization
2. *Scheduling* - relate people, money, and supplies to specific activities and activities to each other
3. *Controlling* - monitor resources, costs, quality, and budgets; revise plans and shift resources to meet time and cost demands

Project Planning, Scheduling, and Controlling

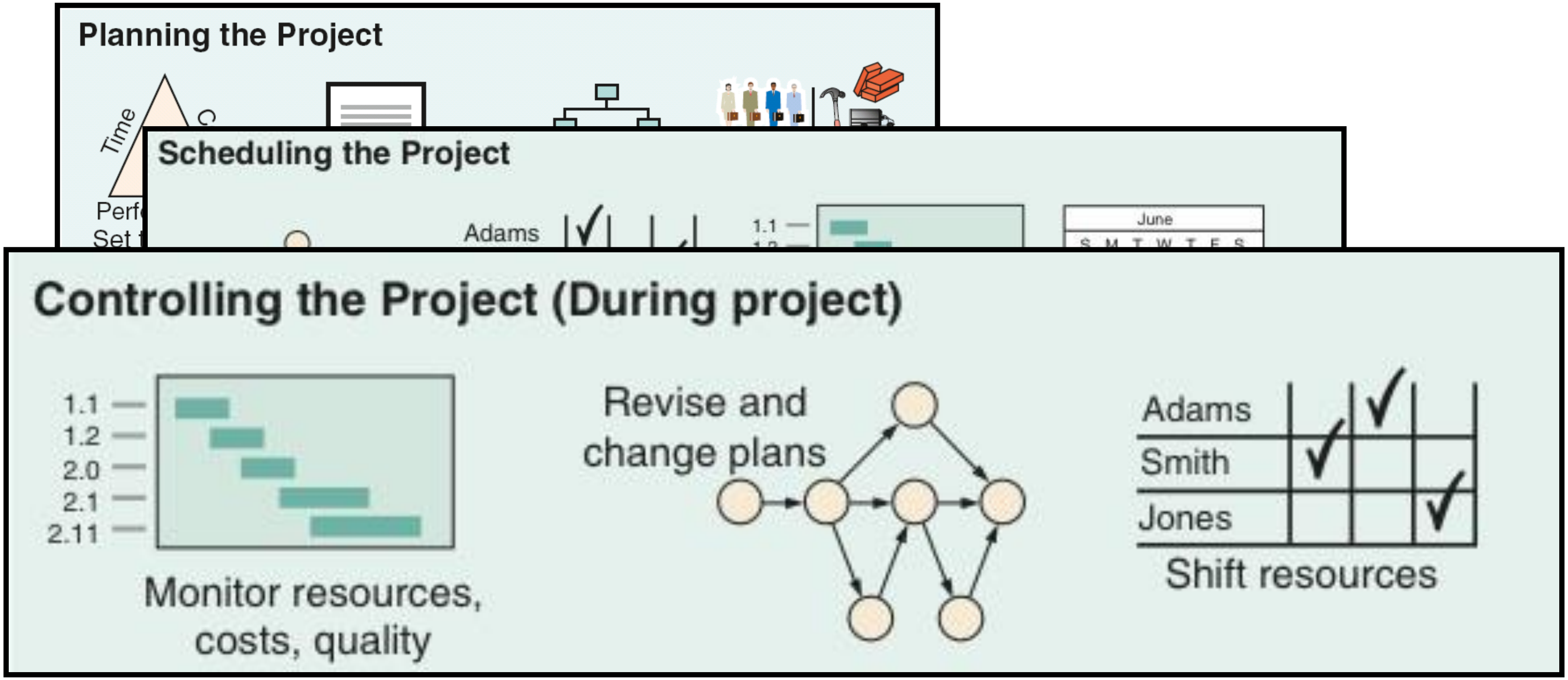


Project Planning, Scheduling, and Controlling





Project Planning, Scheduling, and Controlling



Project Planning, Scheduling, and Controlling

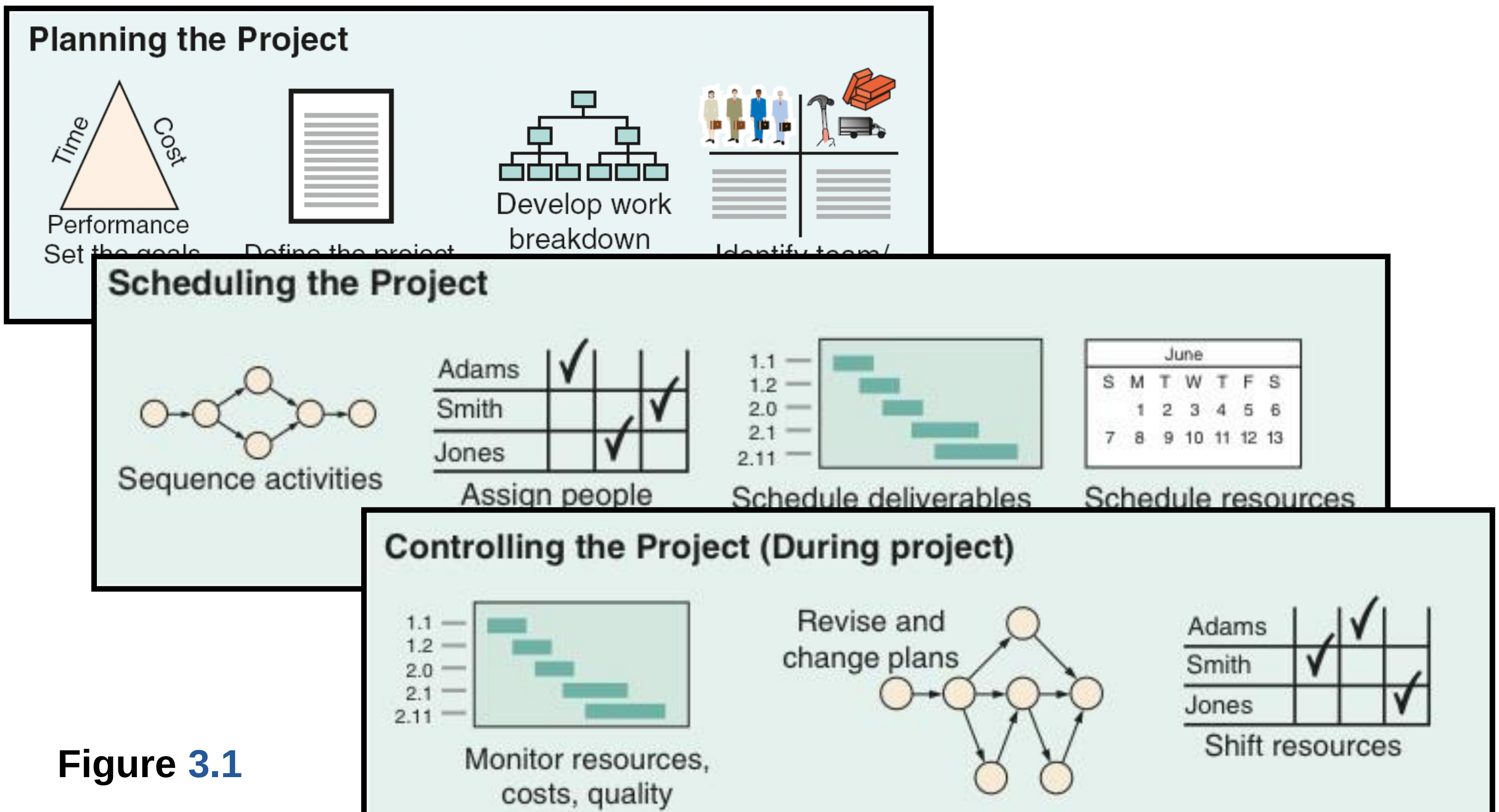
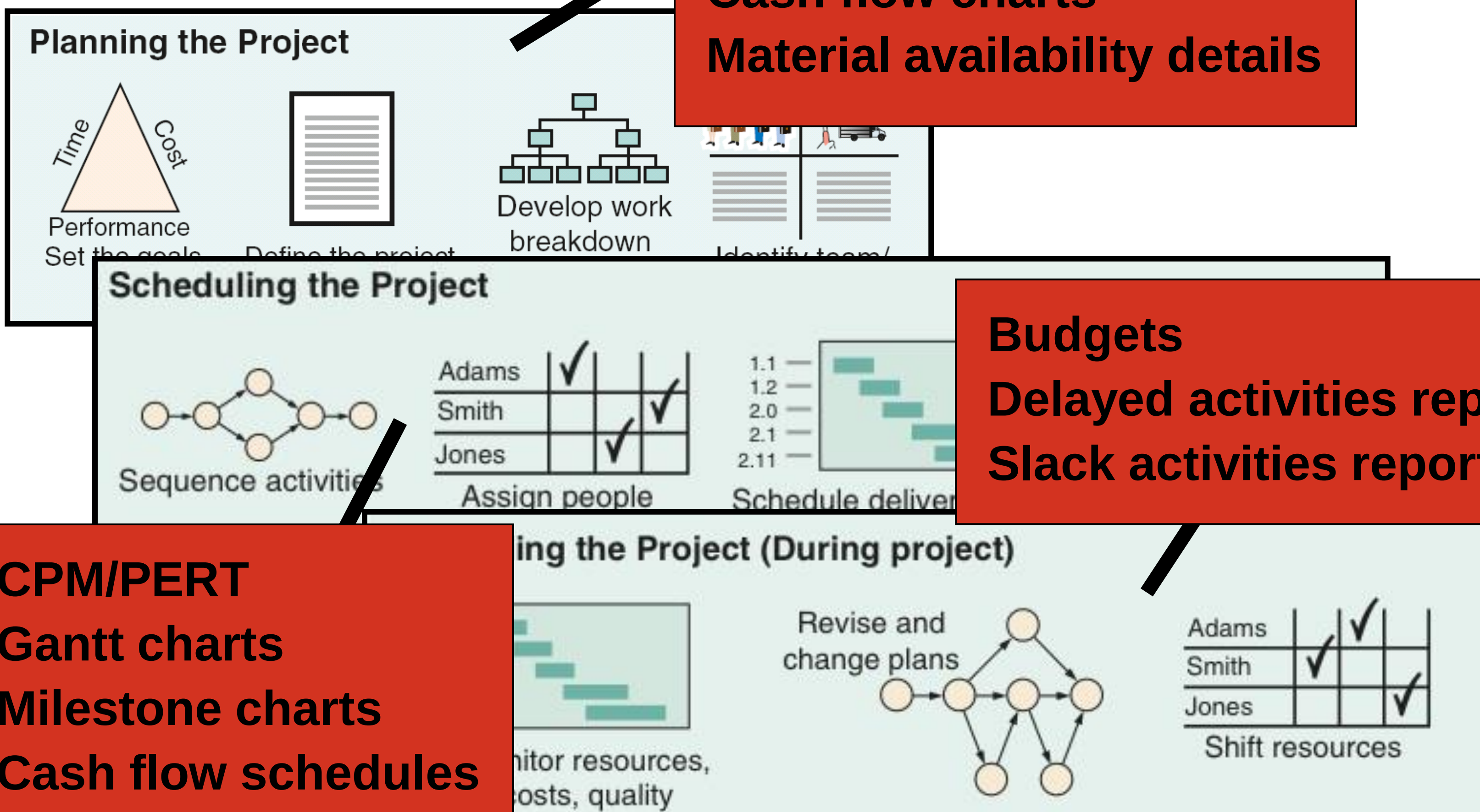


Figure 3.1

Project Planning, Scheduling, and C

Time/cost estimates
Budgets
Engineering diagrams
Cash flow charts
Material availability details

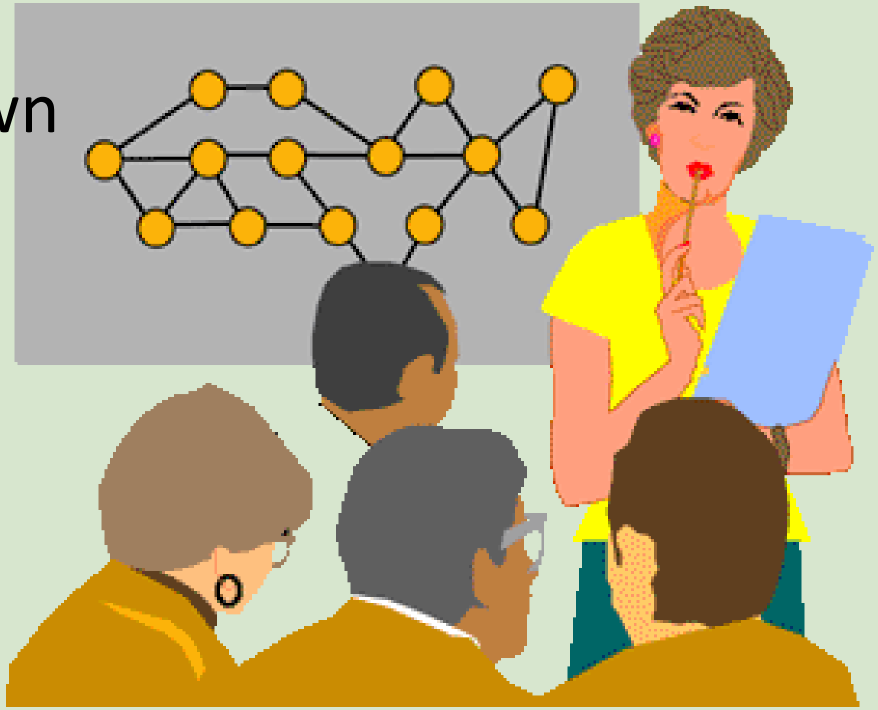


Budgets
Delayed activities report
Slack activities report

CPM/PERT
Gantt charts
Milestone charts
Cash flow schedules

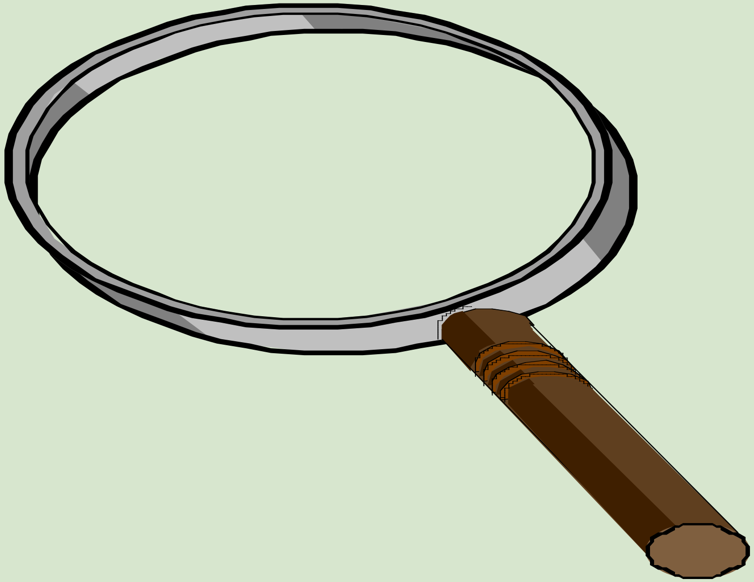
Project Planning

- Establishing objectives
- Defining project
- Creating work breakdown structure
- Determining resources
- Forming organization



Project Organization

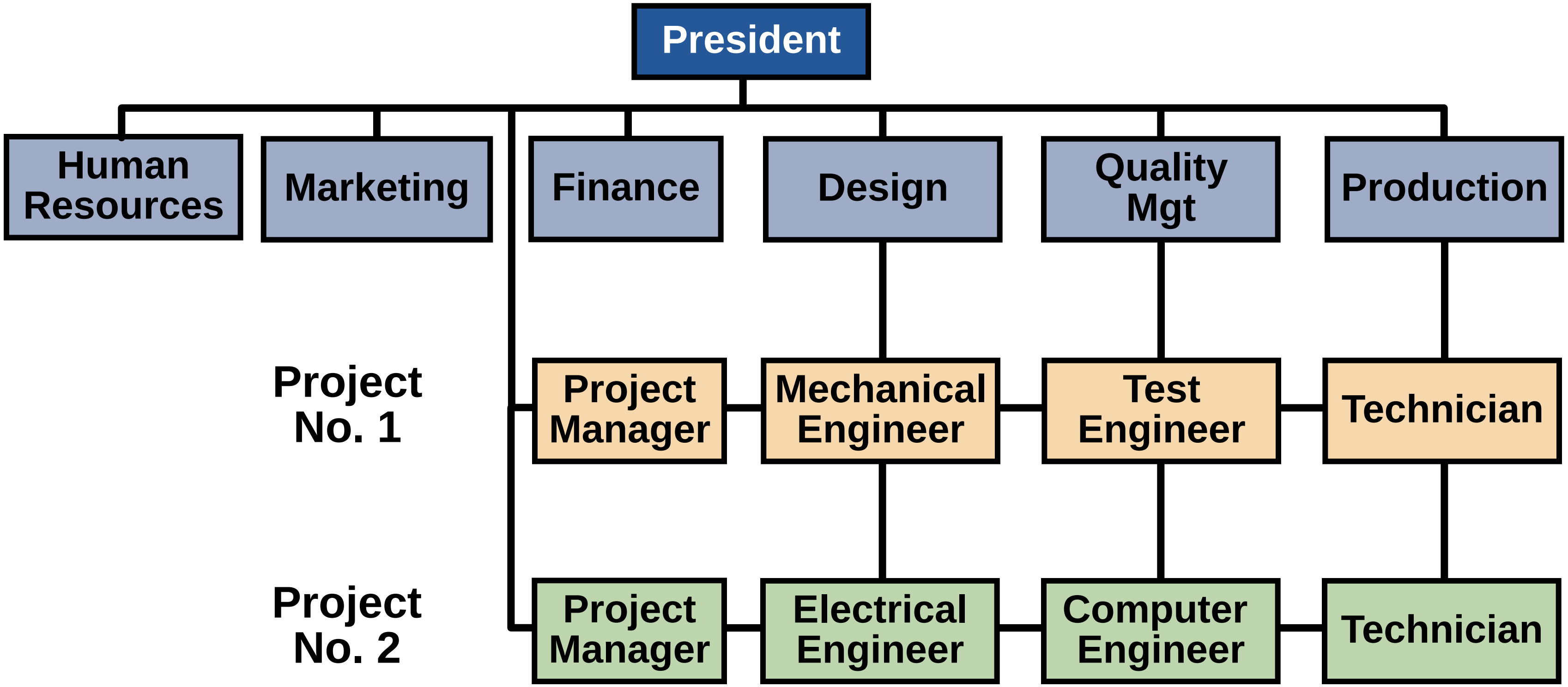
- Often temporary structure
- Uses specialists from entire company
- Headed by project manager
  - Coordinates activities
  - Monitors schedule and costs
- Permanent structure called 'matrix organization'



Project Organization Works Best When

1. Work can be defined with a specific goal and deadline
2. The job is unique or somewhat unfamiliar to the existing organization
3. The work contains complex interrelated tasks requiring specialized skills
4. The project is temporary but critical to the organization
5. The project cuts across organizational lines

A Sample Project Organization



The Role of the Project Manager

Highly visible
Responsible for making sure that:

1. All necessary activities are finished in order and on time
2. The project comes in within budget
3. The project meets quality goals
4. The people assigned to the project receive motivation, direction, and information

The Role of the Project Manager

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3. The project mee
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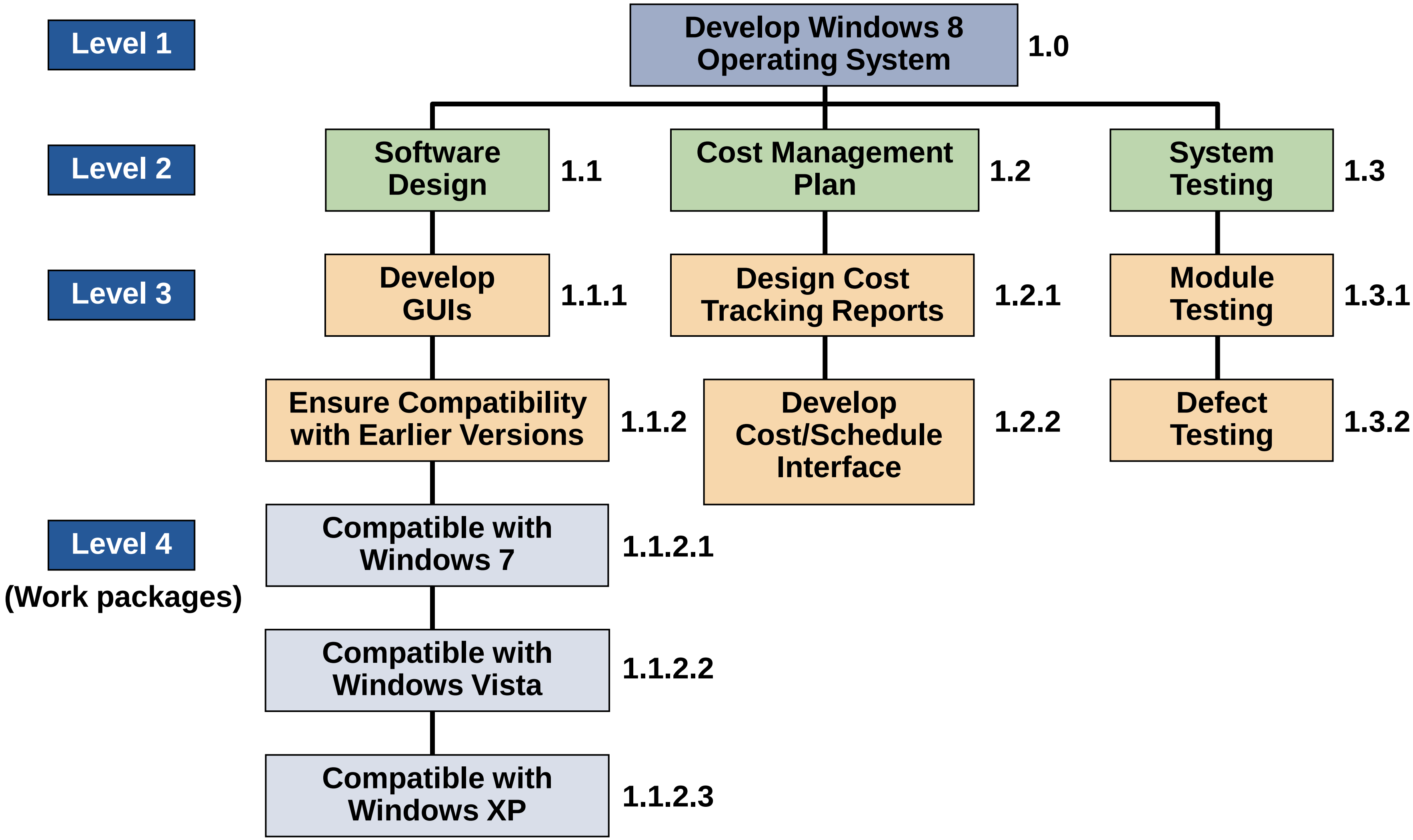
Project managers should be:

- **Good coaches**
- **Good communicators**
- **Able to organize activities from a variety of disciplines**

Work Breakdown Structure



Project Scheduling Techniques

1. Ensure that all activities are planned for
2. Their order of performance is accounted for
3. The activity time estimates are recorded
4. The overall project time is developed

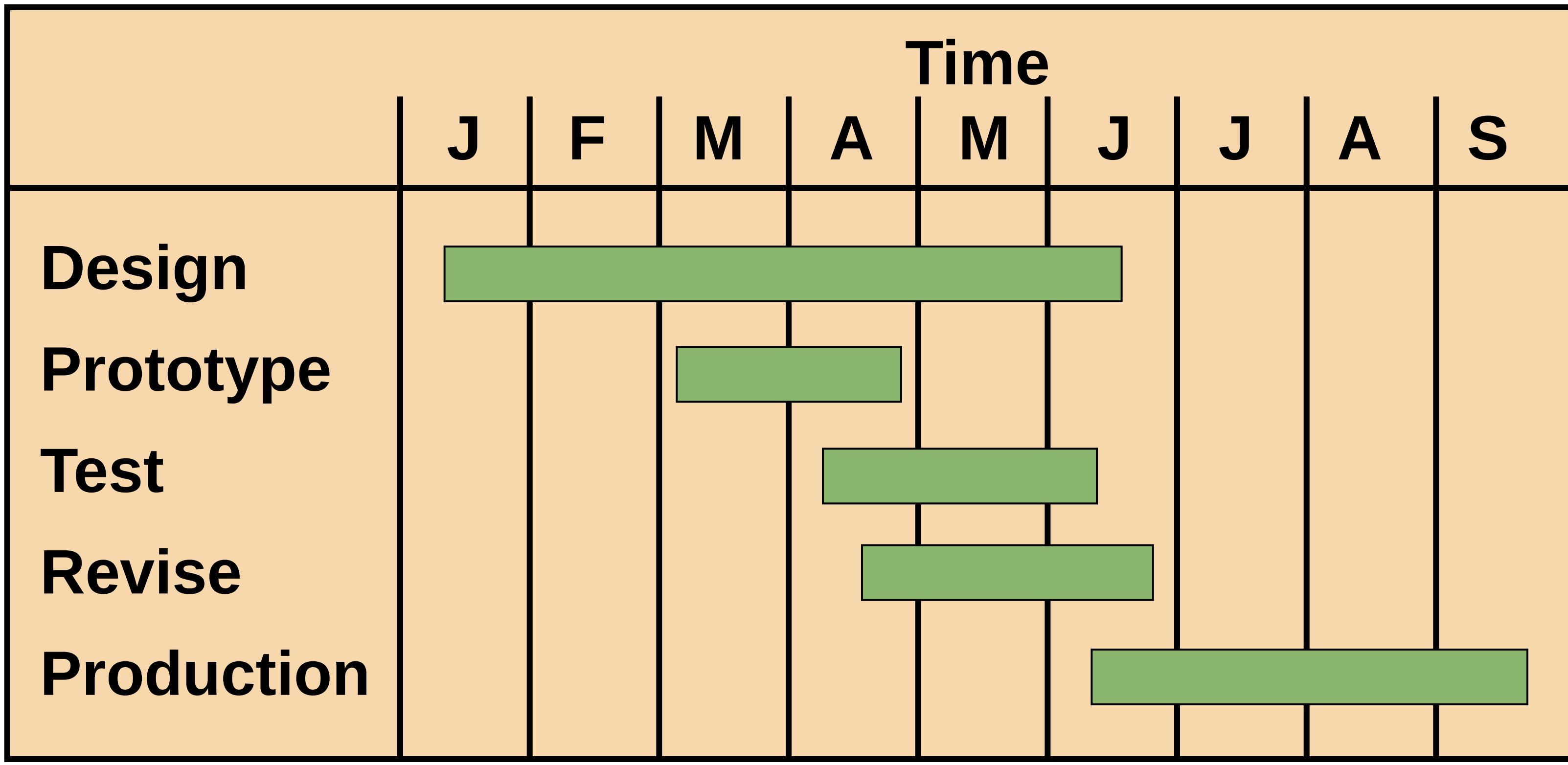
Purposes of Project Scheduling

1. Shows the relationship of each activity to others and to the whole project
2. Identifies the precedence relationships among activities
3. Encourages the setting of realistic time and cost estimates for each activity
4. Helps make better use of people, money, and material resources by identifying critical bottlenecks in the project

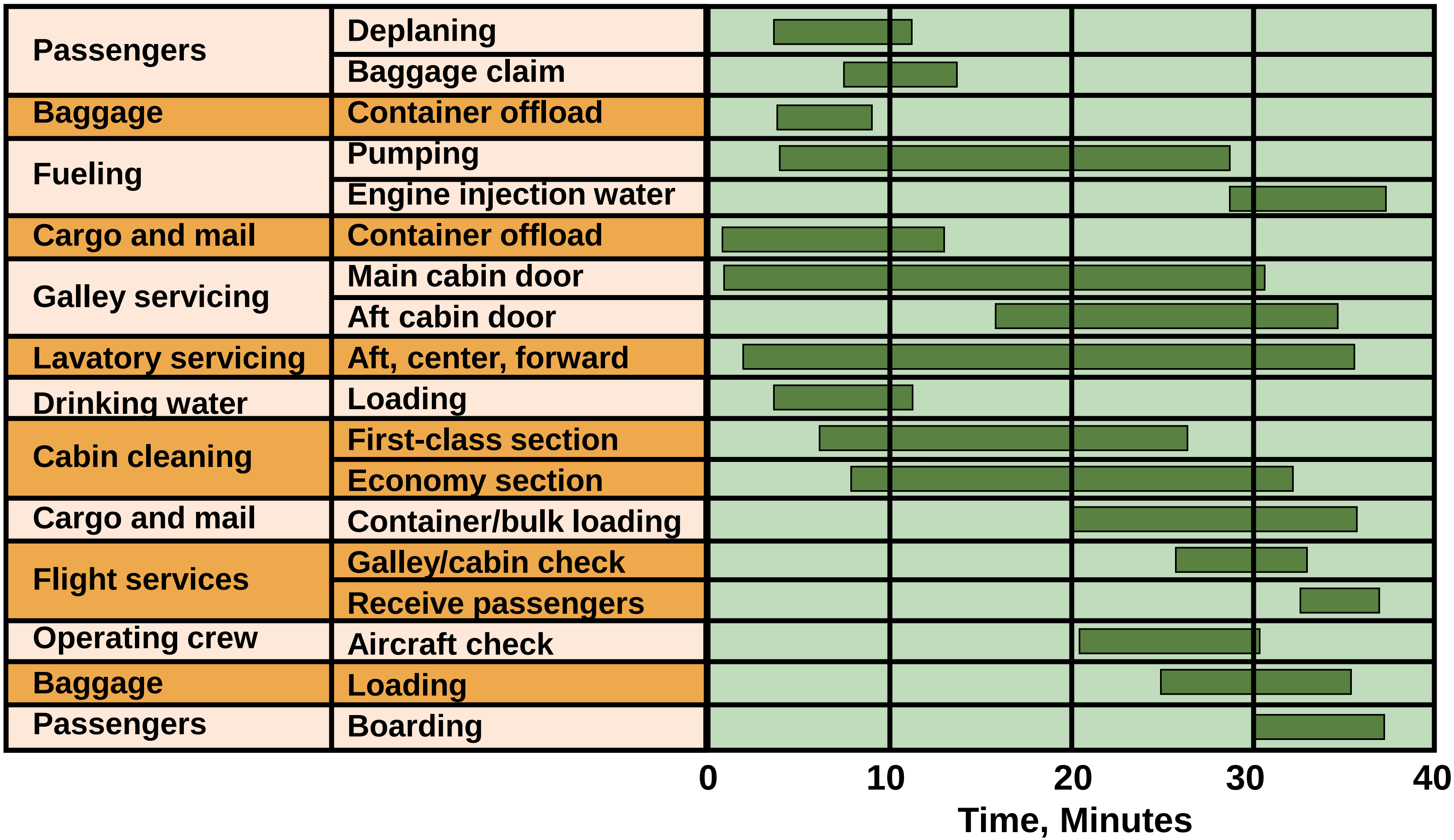
Project Management Techniques

- Gantt chart
- Critical Path Method (CPM)
- Program Evaluation and Review Technique (PERT)

A Simple Gantt Chart



Service For a Delta Jet



Project Controlling

- Close monitoring of resources, costs, quality, budgets
- Feedback enables revising the project plan and shift resources
- Computerized tools produce extensive reports

Project Management Software

There are several popular packages for managing projects

- Primavera
- MacProject
- MindView
- HP Project
- Fast Track
- Microsoft Project

Project Control Reports

- Detailed cost breakdowns for each task
- Total program labor curves
- Cost distribution tables
- Functional cost and hour summaries
- Raw materials and expenditure forecasts
- Variance reports
- Time analysis reports
- Work status reports

PERT and CPM

- Network techniques
- Developed in 1950s
    - CPM by DuPont for chemical plants (1957)
    - PERT by Booz, Allen & Hamilton with the U.S. Navy, for Polaris missile (1958)
- Consider precedence relationships and interdependencies
- Each uses a different estimate of activity times

Six Steps PERT & CPM

1. Define the project and prepare the work breakdown structure
2. Develop relationships among the activities - decide which activities must precede and which must follow others
3. Draw the network connecting all of the activities
4. Assign time and/or cost estimates to each activity
5. Compute the longest time path through the network – this is called **the critical path**
6. Use the network to help plan, schedule, monitor, and control the project

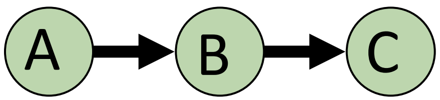
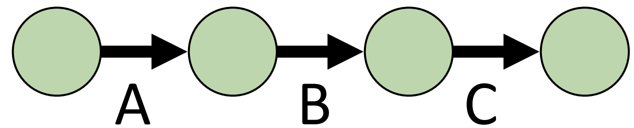
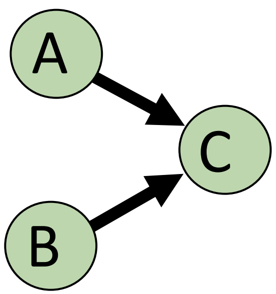
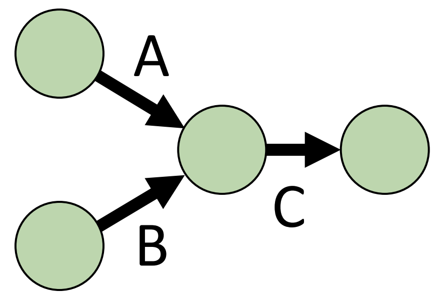
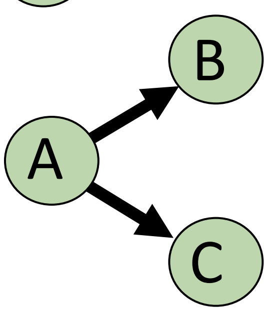
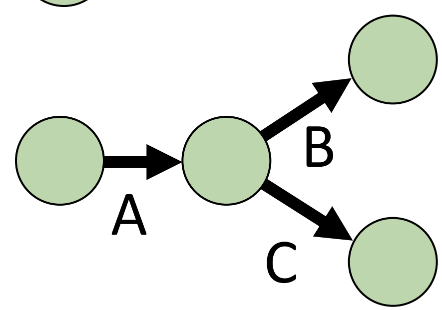
Questions PERT & CPM Can Answer

1. When will the entire project be completed?
2. What are the critical activities or tasks in the project?
3. Which are the noncritical activities?
4. What is the probability the project will be completed by a specific date?

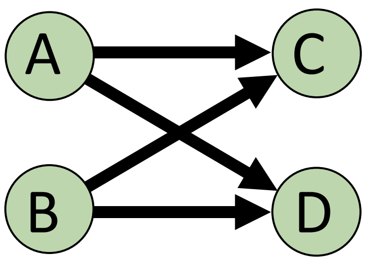
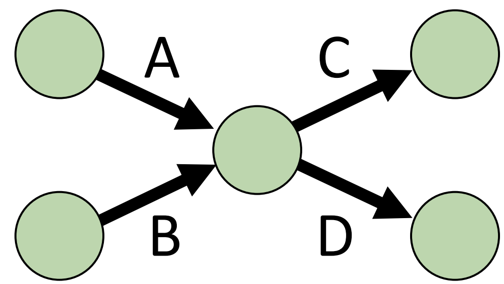
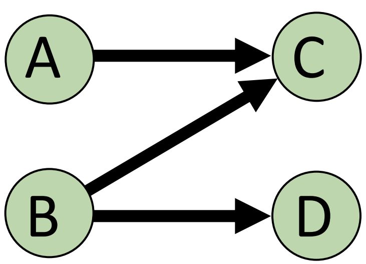
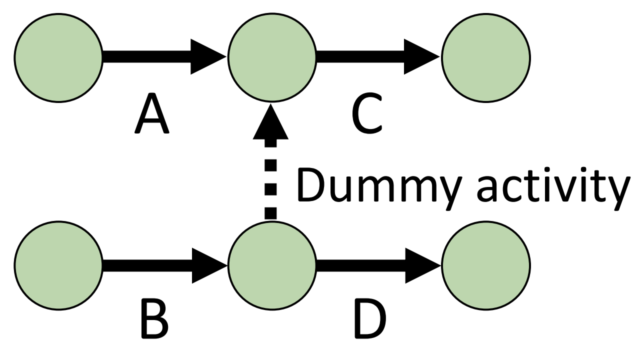
Questions PERT & CPM Can Answer

5. Is the project on schedule, behind schedule, or ahead of schedule?
6. Is the money spent equal to, less than, or greater than the budget?
7. Are there enough resources available to finish the project on time?
8. If the project must be finished in a shorter time, what is the way to accomplish this at least cost?

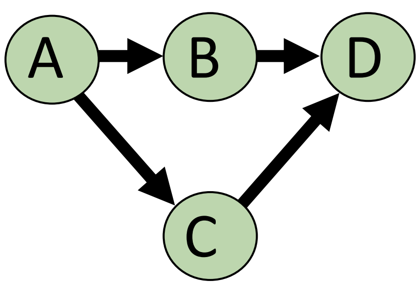
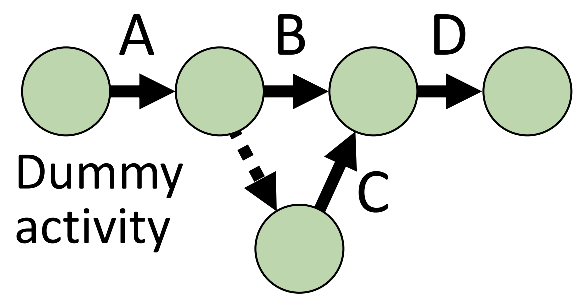
A Comparison of AON and AOA Network Conventions

	Activity on Node (AON)	Activity Meaning	Activity on Arrow (AOA)
(a)		A comes before B, which comes before C	
(b)		A and B must both be completed before C can start	
(c)		B and C cannot begin until A is completed	

A Comparison of AON and AOA Network Conventions

	Activity on Node (AON)	Activity Meaning	Activity on Arrow (AOA)
(d)		C and D cannot begin until both A and B are completed	
(e)		C cannot begin until both A and B are completed D cannot begin until B is completed A dummy activity is introduced in AOA	

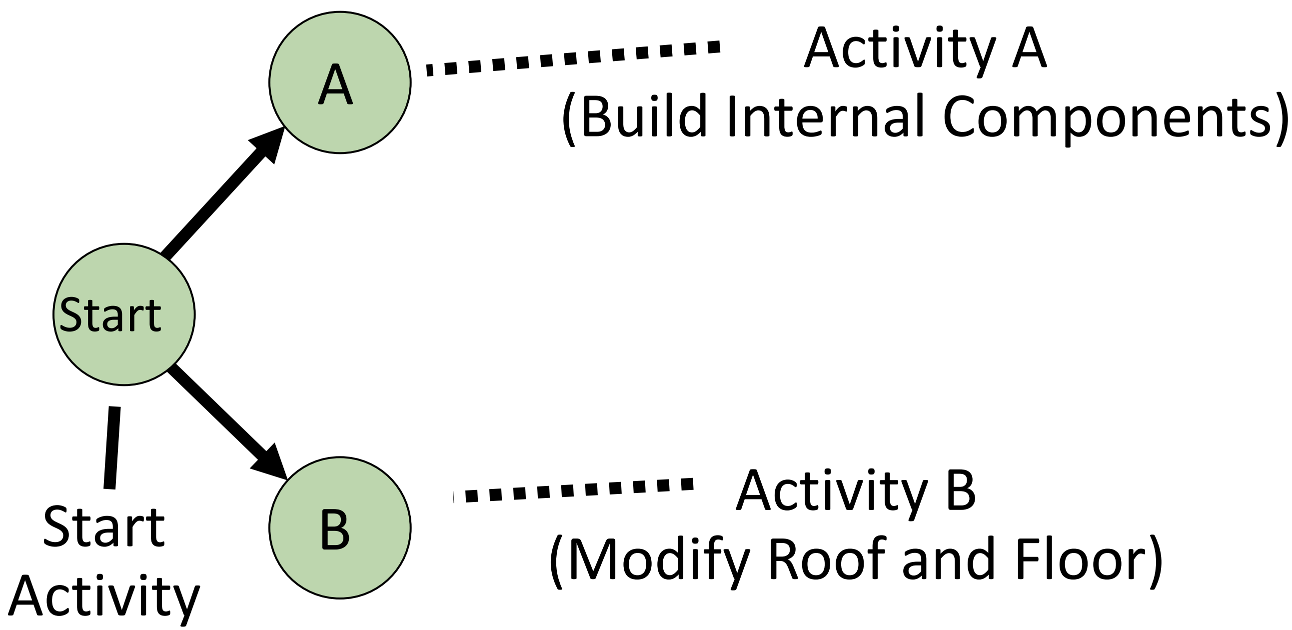
A Comparison of AON and AOA Network Conventions

	Activity on Node (AON)	Activity Meaning	Activity on Arrow (AOA)
(f)		B and C cannot begin until A is completed D cannot begin until both B and C are completed A dummy activity is again introduced in AOA	

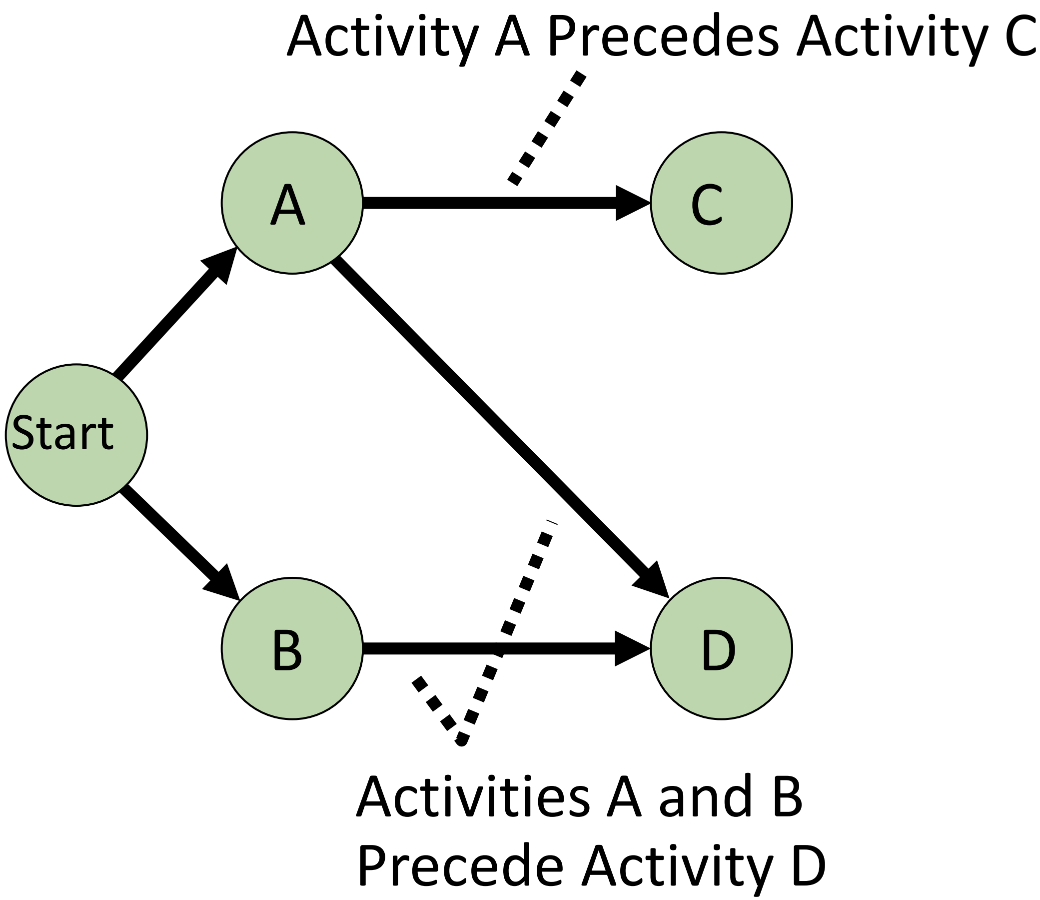
AON Example

Table	Milwaukee Paper Manufacturing's Activities and Predecessors	
ACTIVITY	DESCRIPTION	IMMEDIATE PREDECESSORS
A	Build internal components	—
B	Modify roof and floor	—
C	Construct collection stack	A
D	Pour concrete and install frame	A, B
E	Build high-temperature burner	C
F	Install pollution control system	C
G	Install air pollution device	D, E
H	Inspect and test	F, G

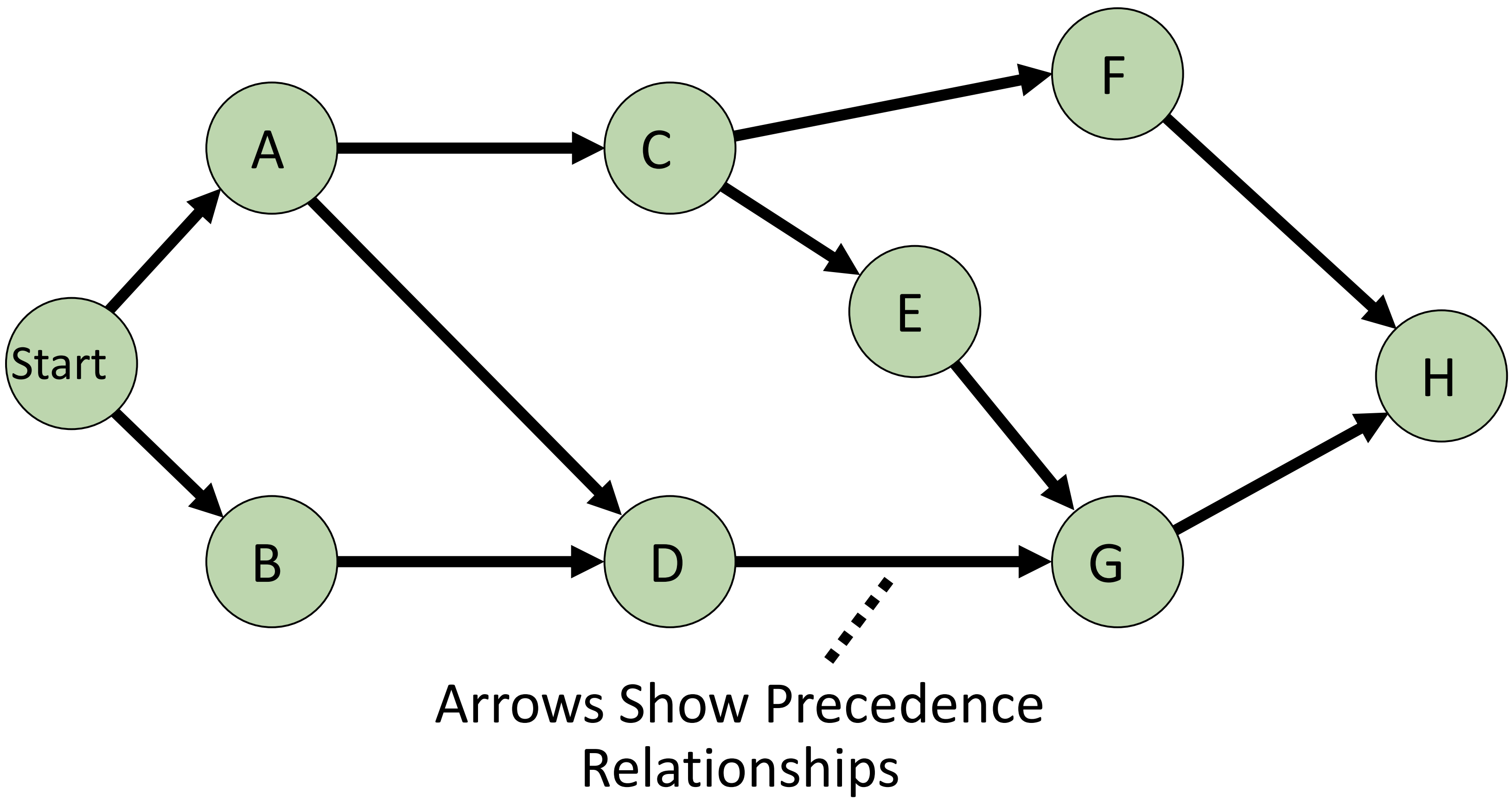
AON Network for Milwaukee Paper



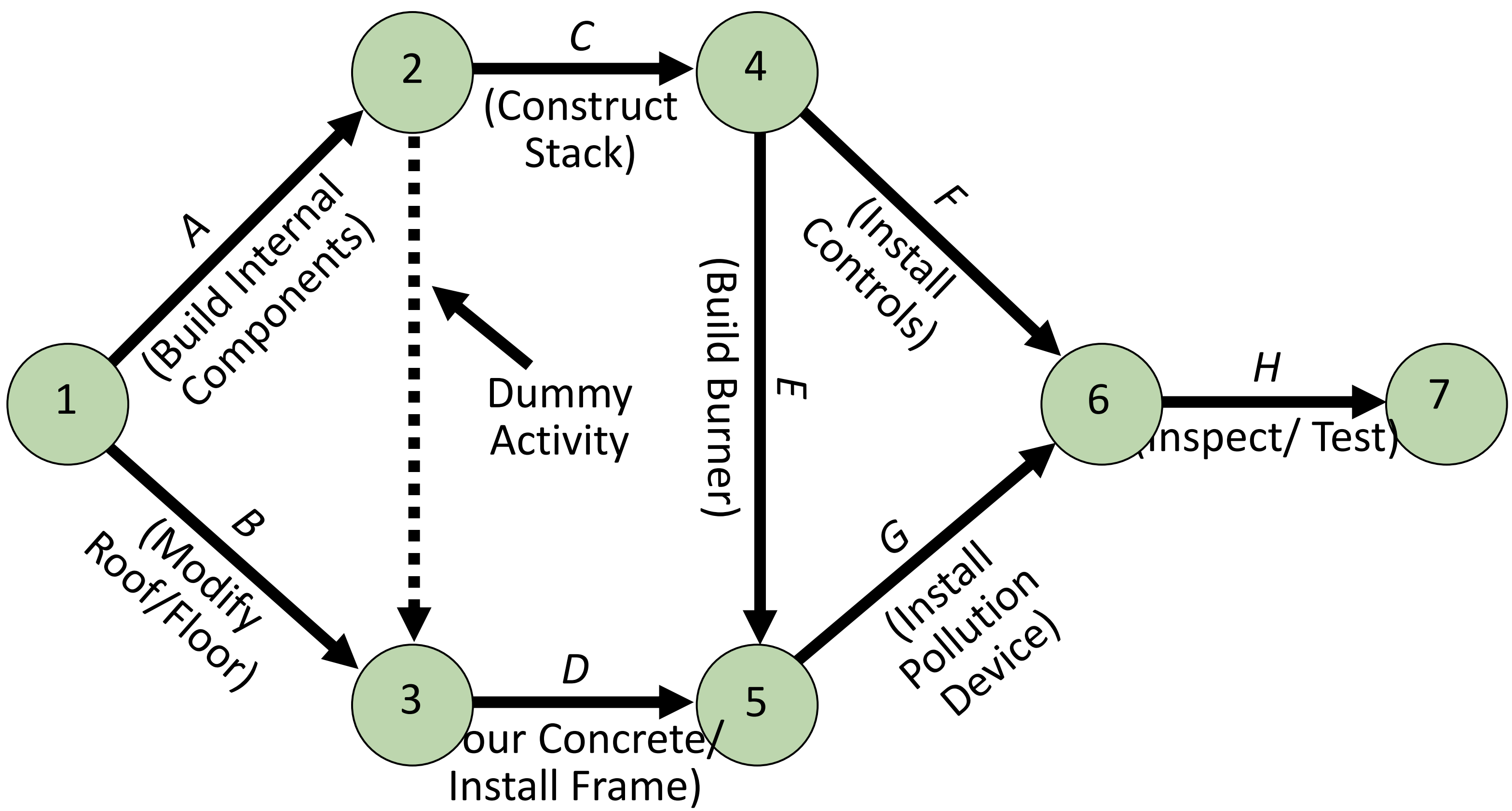
AON Network for Milwaukee Paper



AON Network for Milwaukee Paper



AOA Network for Milwaukee Paper



Determining the Project Schedule

Perform a Critical Path Analysis

- The critical path is the longest path through the network
- The critical path is the shortest time in which the project can be completed
- Any delay in critical path activities delays the project
- Critical path activities have no slack time

Determining the Project Schedule

Table Time Estimates for Milwaukee Paper Manufacturing

ACTIVITY	DESCRIPTION	TIME (WEEKS)
A	Build internal components	2
B	Modify roof and floor	3
C	Construct collection stack	2
D	Pour concrete and install frame	4
E	Build high-temperature burner	4
F	Install pollution control system	3
G	Install air pollution device	5
H	Inspect and test	2
	Total time (weeks)	25

Determining the Project Schedule

Perform a Critical Path Analysis

Earliest start (ES) = earliest time at which an activity can start, assuming all predecessors have been completed

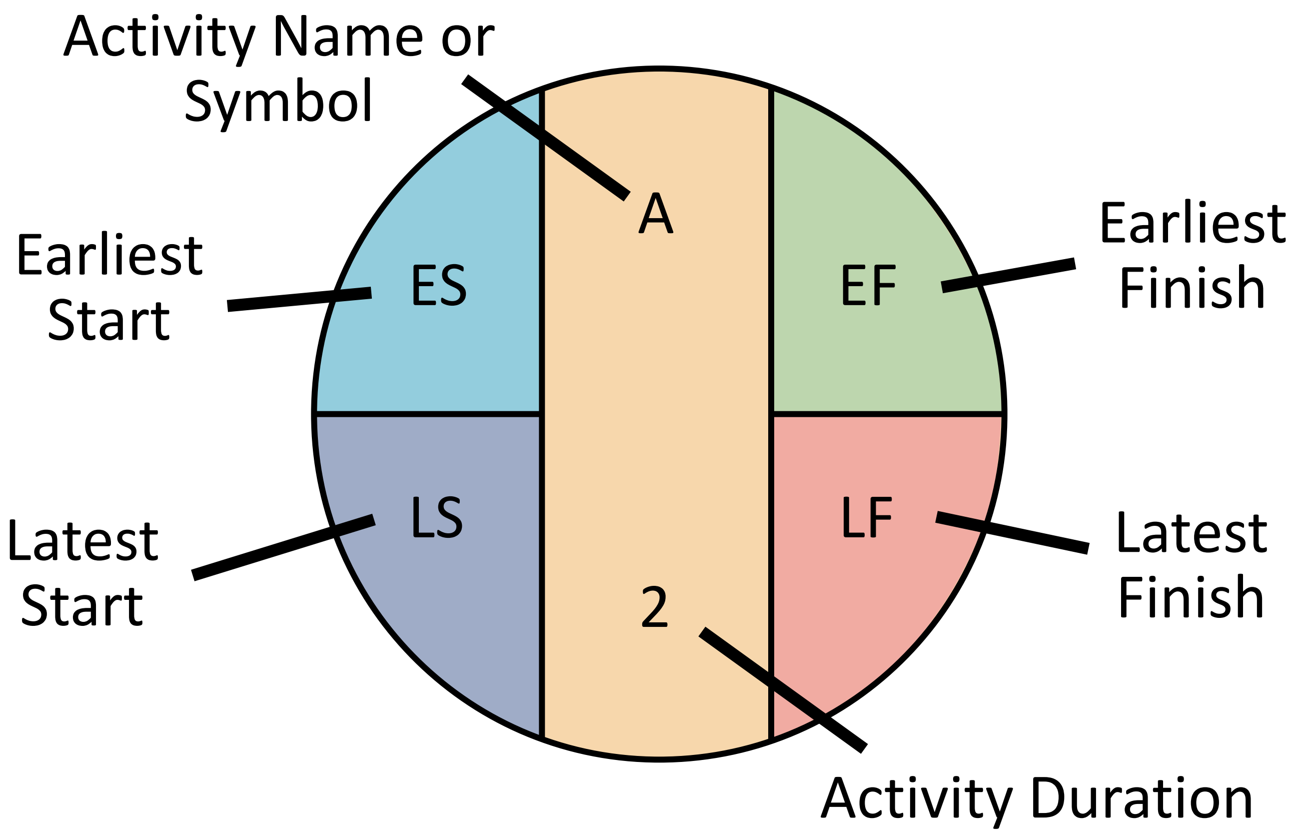
Earliest finish (EF) = earliest time at which an activity can be finished

Latest start (LS) = latest time at which an activity can start so as to not delay the completion time of the entire project

Latest finish (LF) = latest time by which an activity has to be finished so as to not delay the completion time of the entire project

Determining the Project Schedule

Activity Format



Forward Pass

Begin at starting event and work forward

Earliest Start Time Rule:

- If an activity has only a single immediate predecessor, its ES equals the EF of the predecessor
- If an activity has multiple immediate predecessors, its ES is the maximum of all the EF values of its predecessors

ES = Max {EF of all immediate predecessors}

Forward Pass

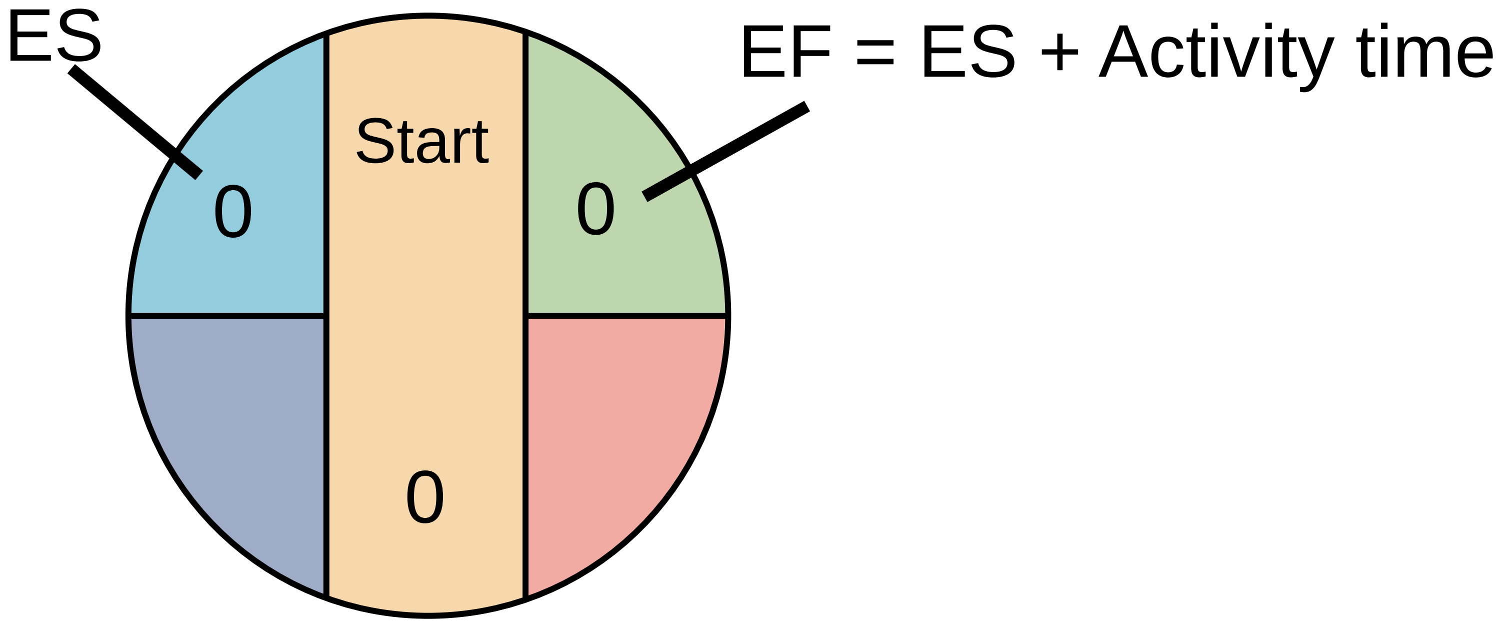
Begin at starting event and work forward

Earliest Finish Time Rule:

The earliest finish time (EF) of an activity is the sum of its earliest start time (ES) and its activity time

$$EF = ES + \text{Activity time}$$

ES/EF Network for Milwaukee Paper



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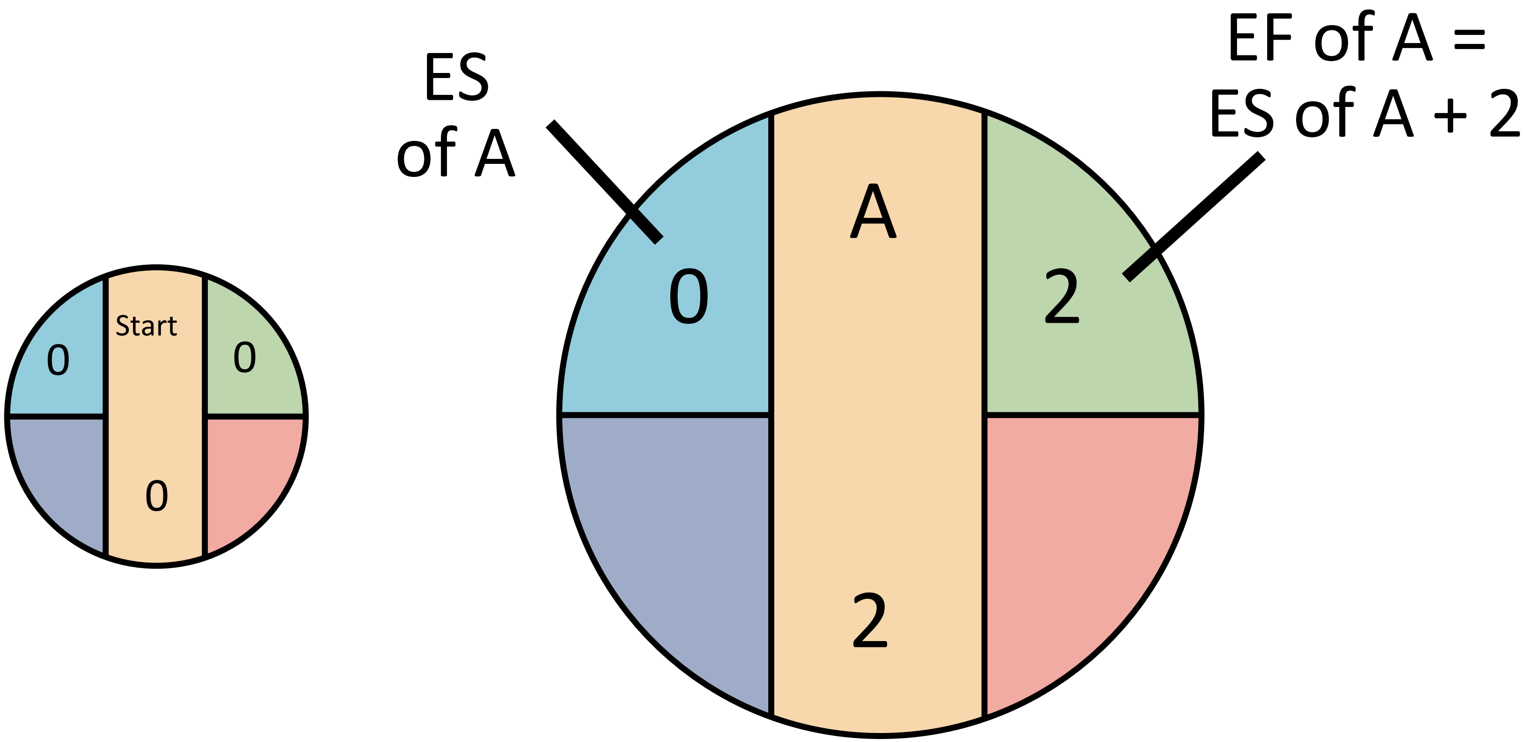

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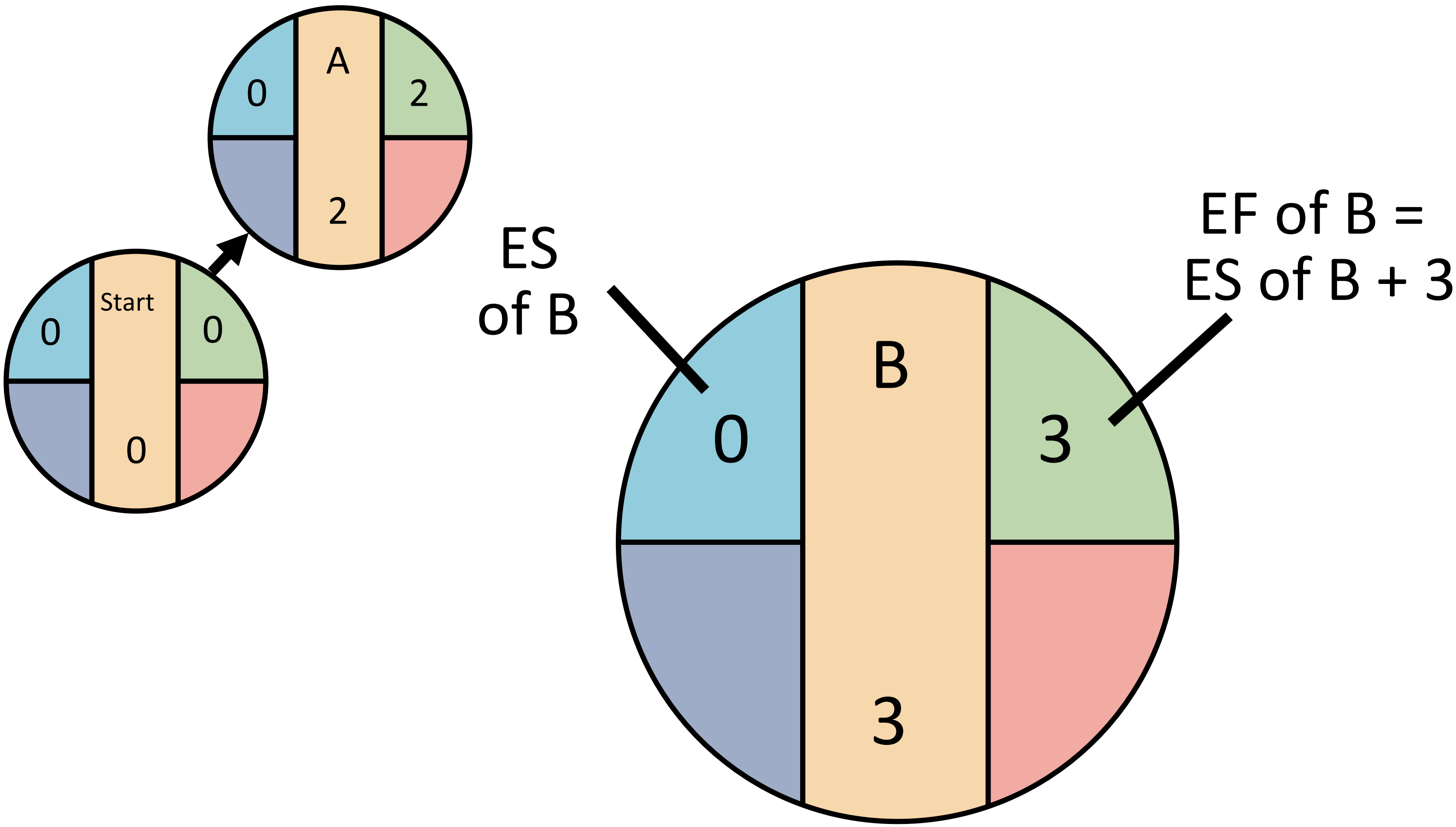

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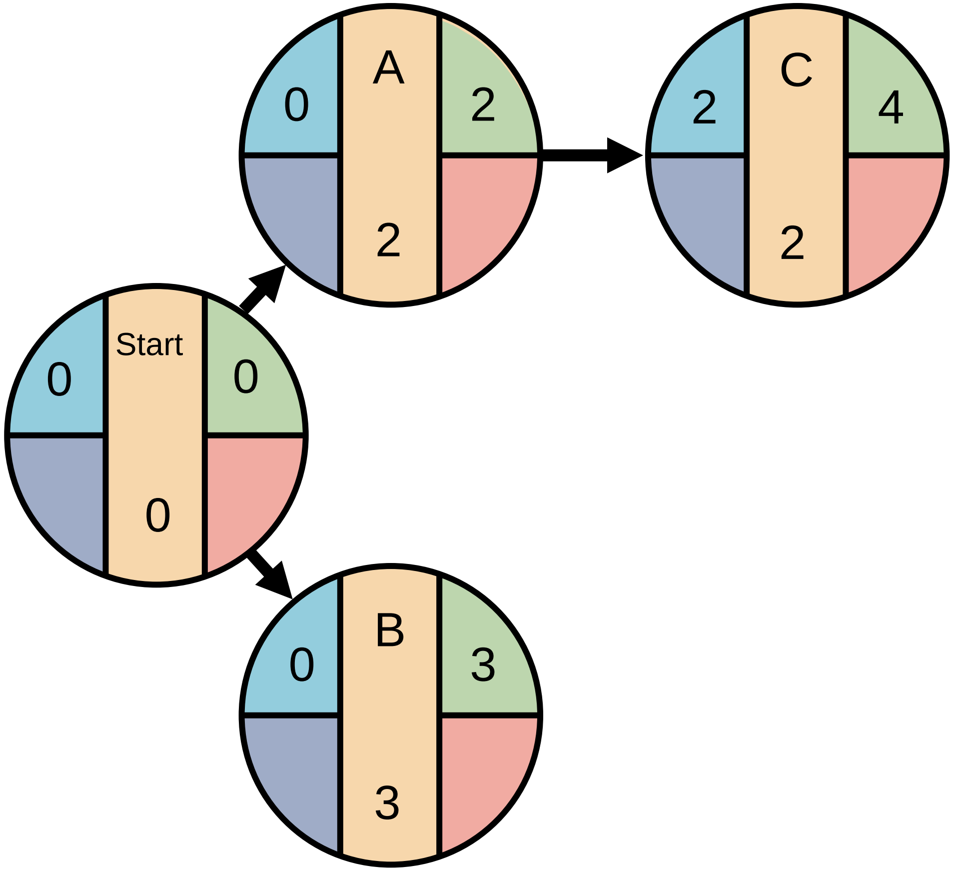

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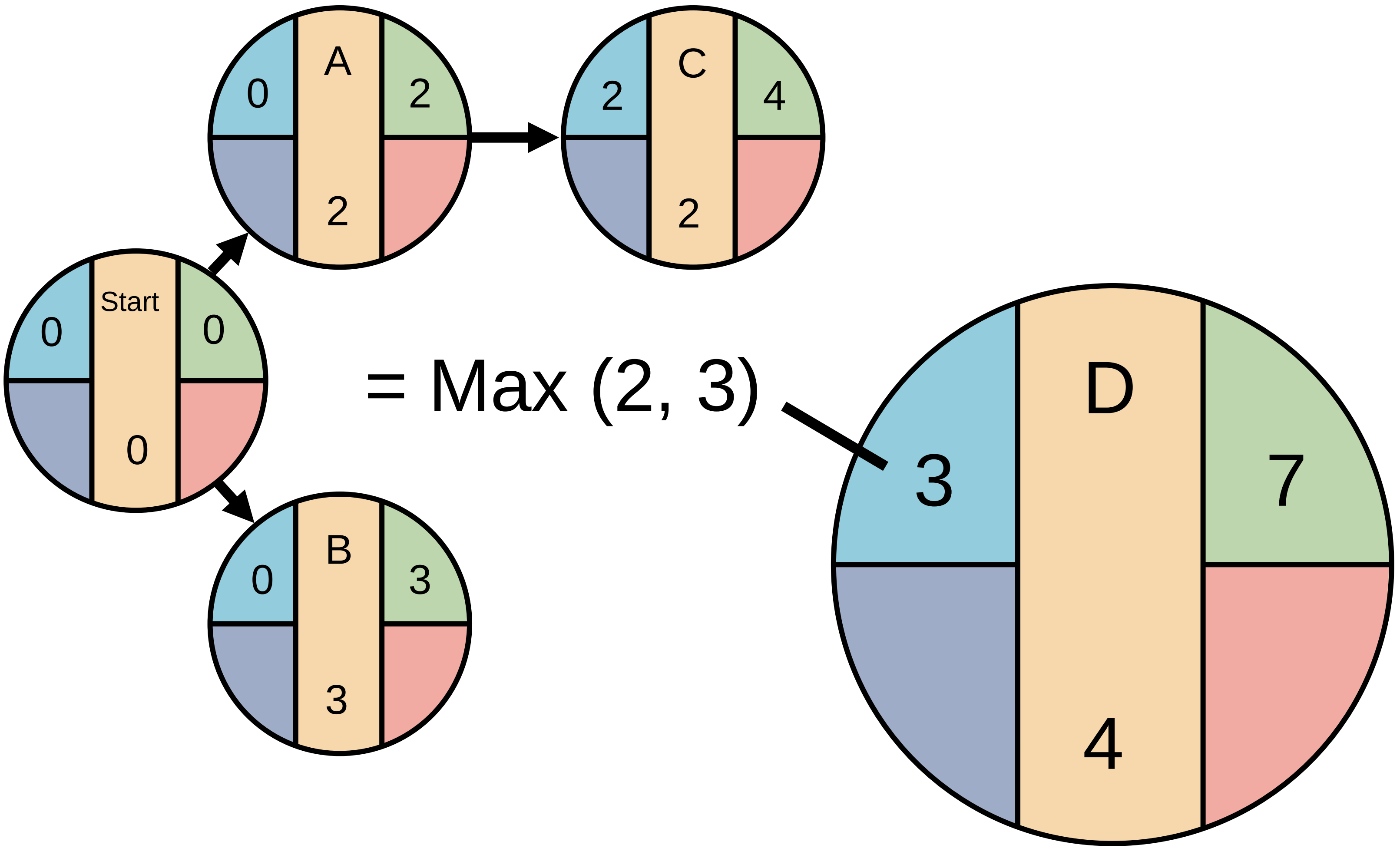
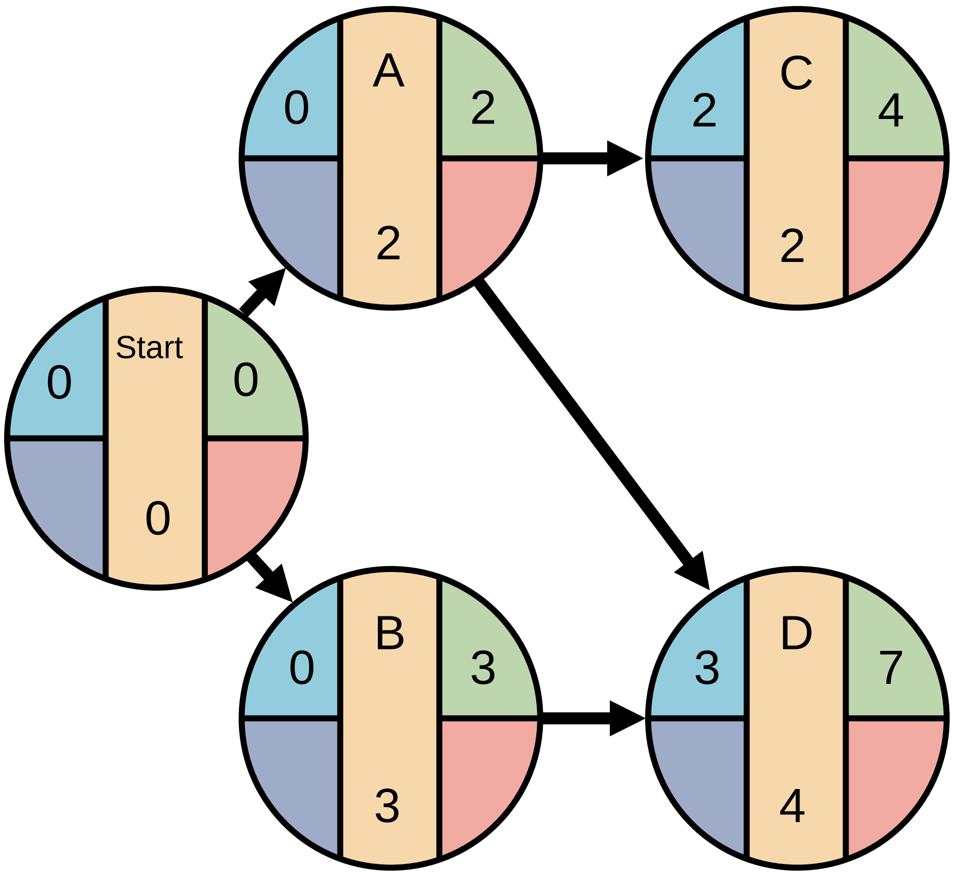


ES/EF Network for Milwaukee Paper



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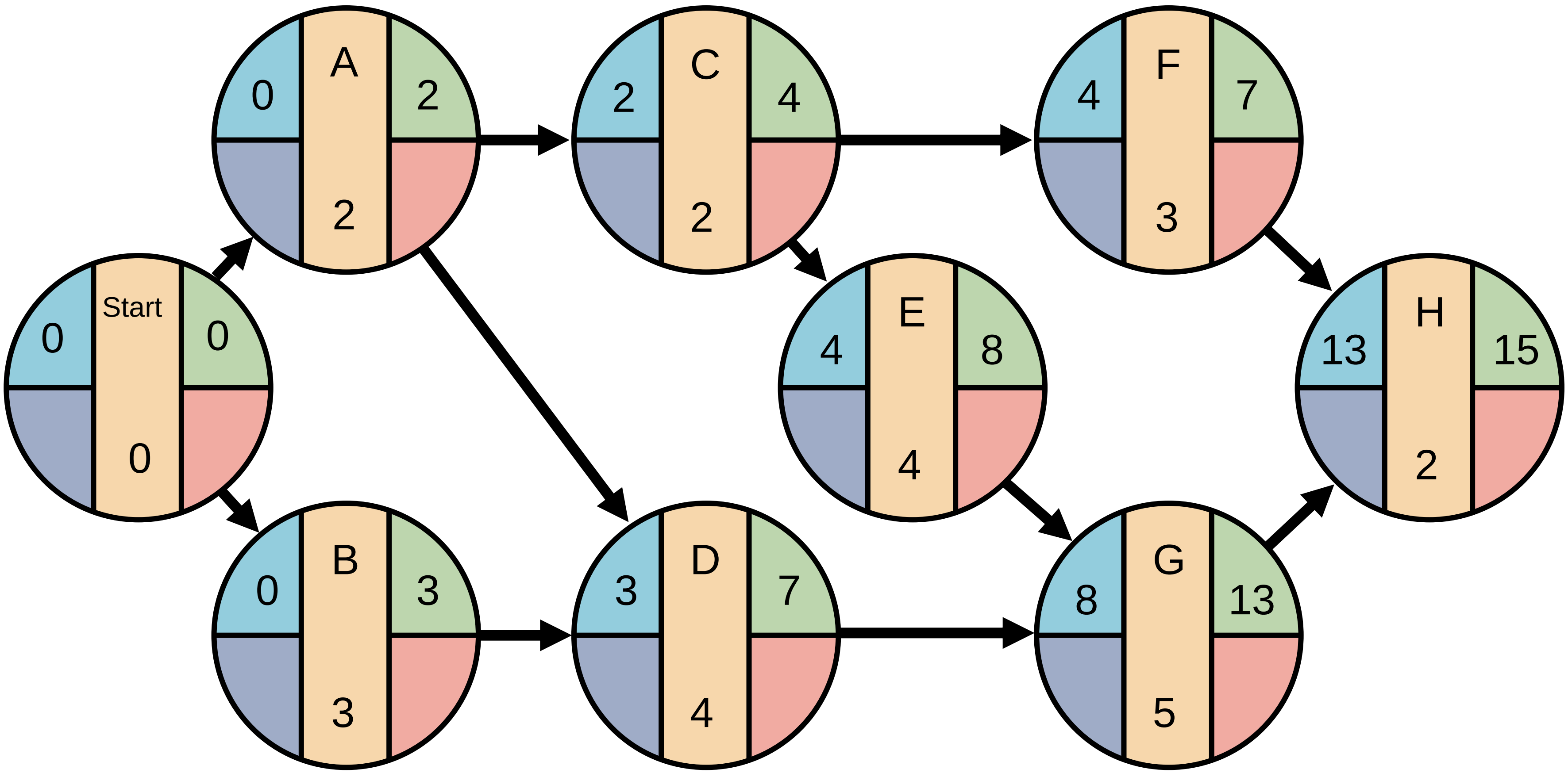


Backward Pass

Begin with the last event and work backwards

Latest Finish Time Rule:

- If an activity is an immediate predecessor for just a single activity, its LF equals the LS of the activity that immediately follows it
- If an activity is an immediate predecessor to more than one activity, its LF is the minimum of all LS values of all activities that immediately follow it

LF = Min {LS of all immediate following activities}

Backward Pass

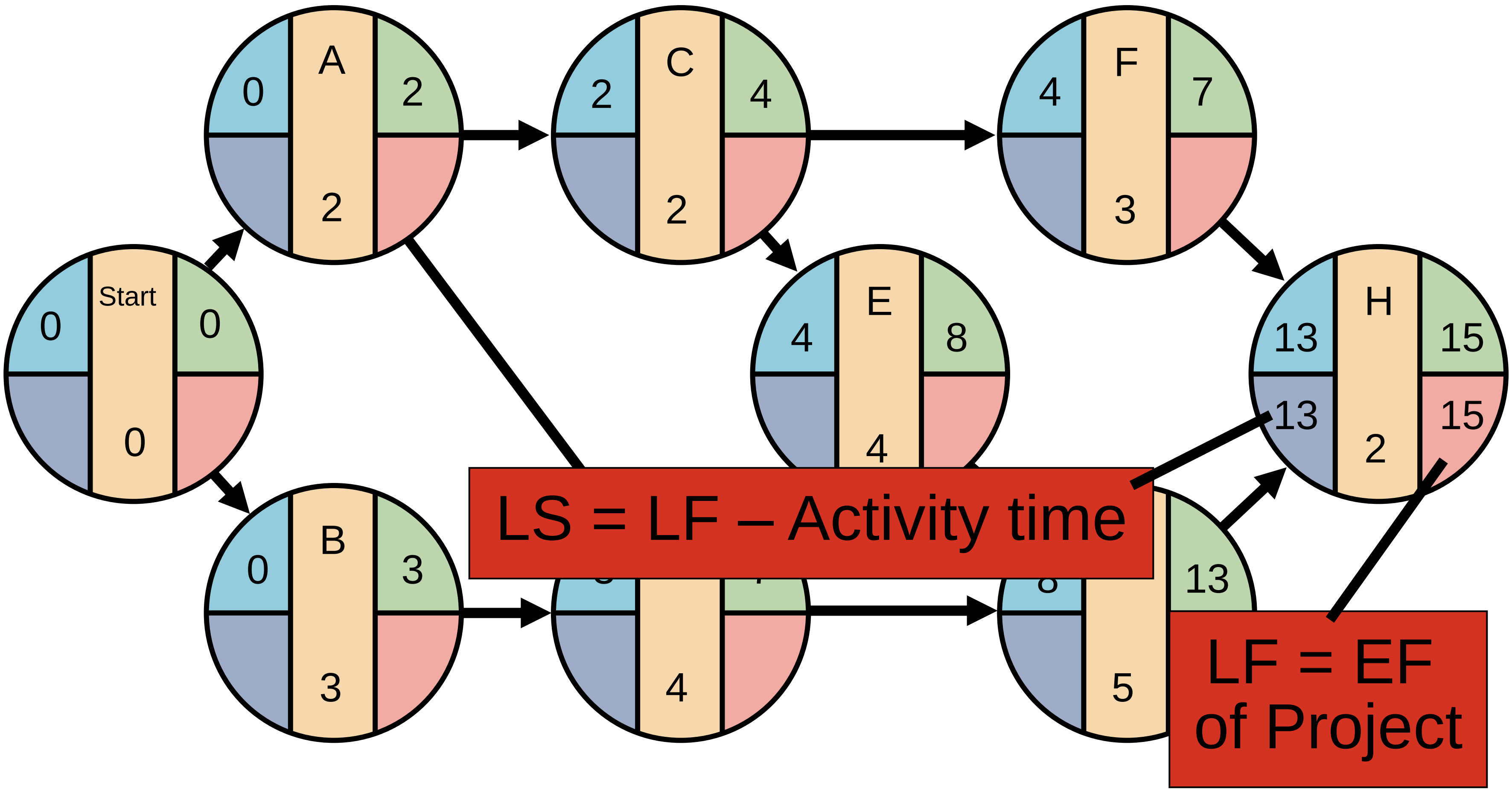
Begin with the last event and work backwards

Latest Start Time Rule:

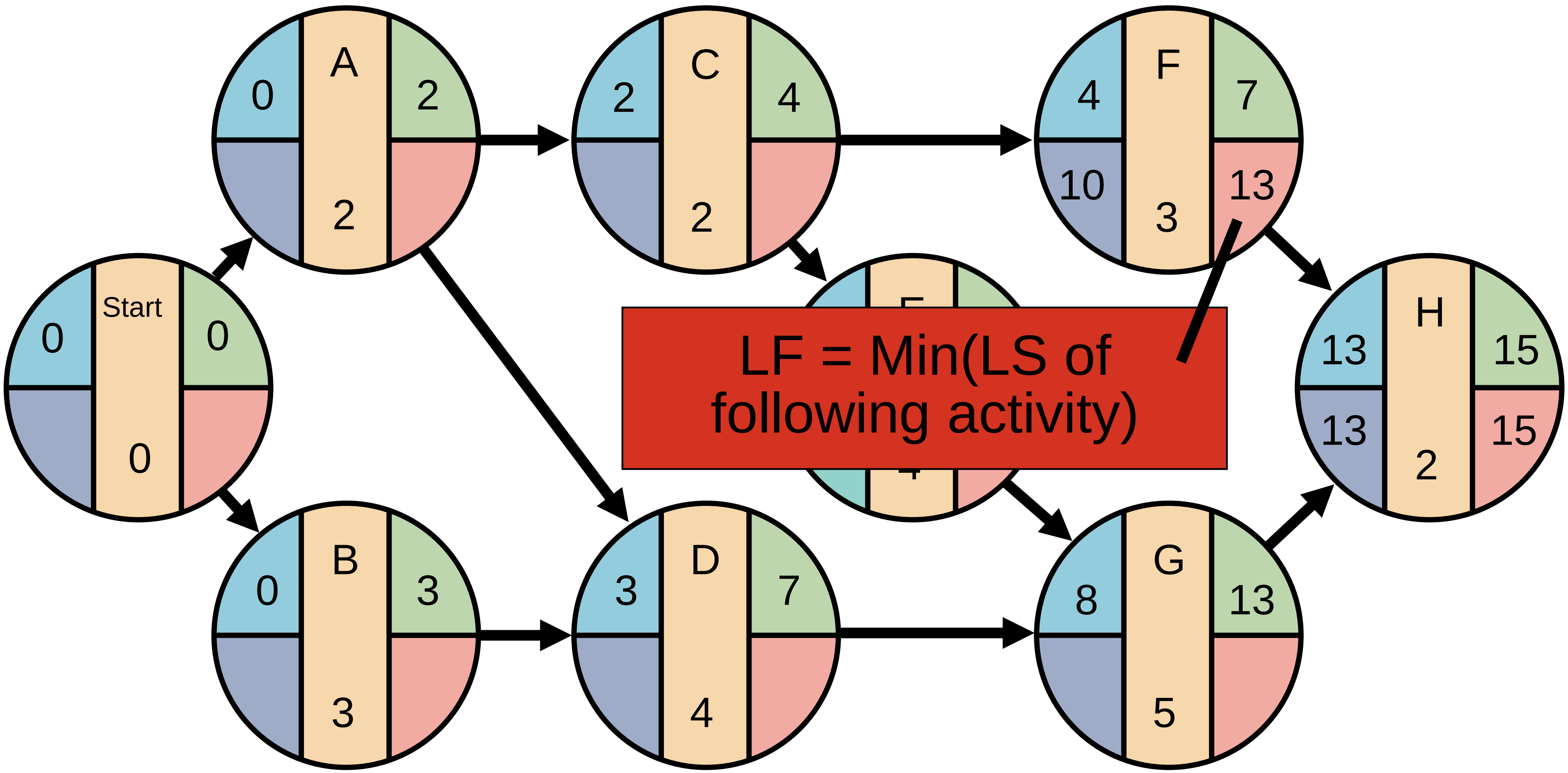
- The latest start time (LS) of an activity is the difference of its latest finish time (LF) and its activity time

$$LS = LF – \text{Activity time}$$

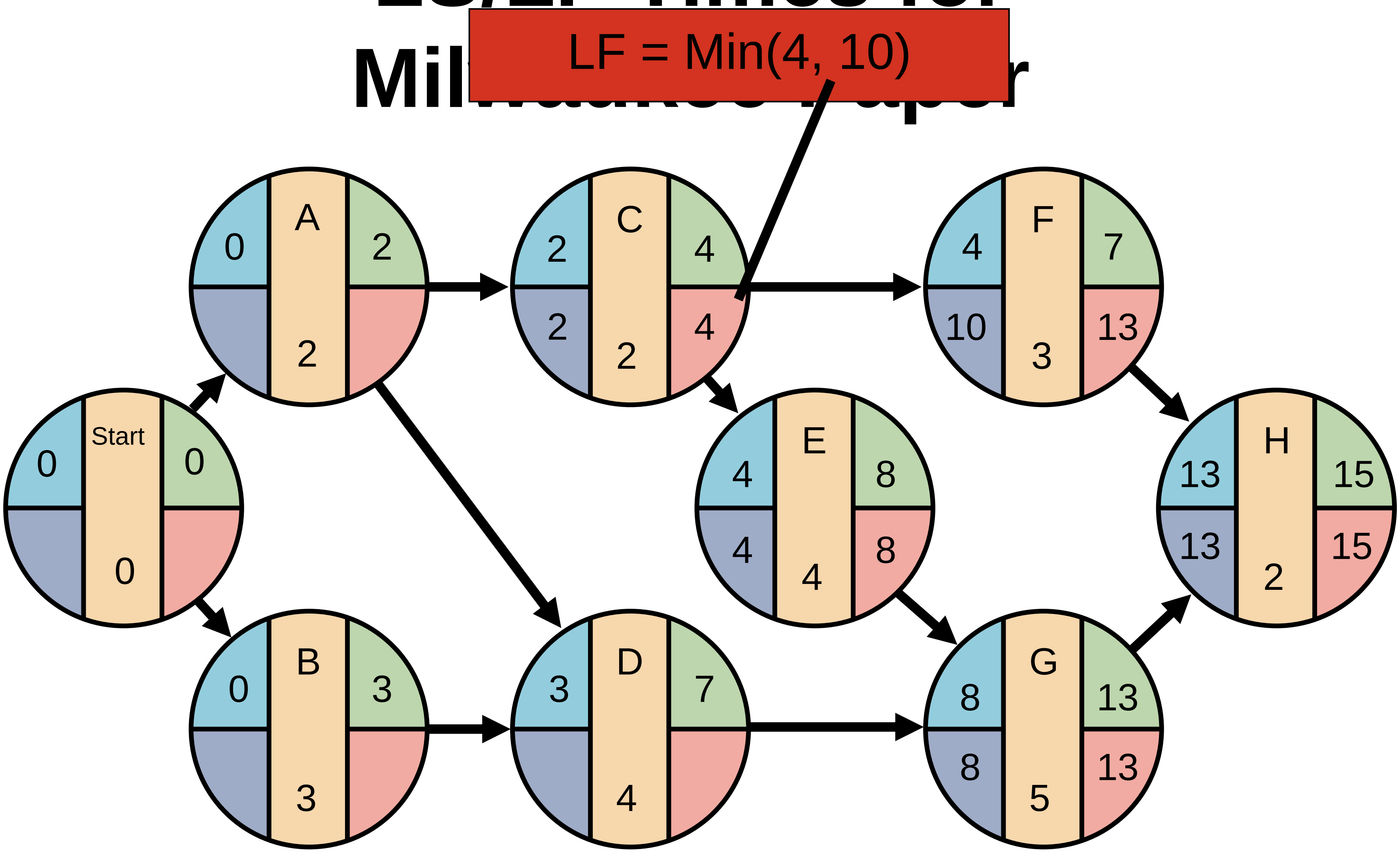
LS/LF Times for Milwaukee Paper



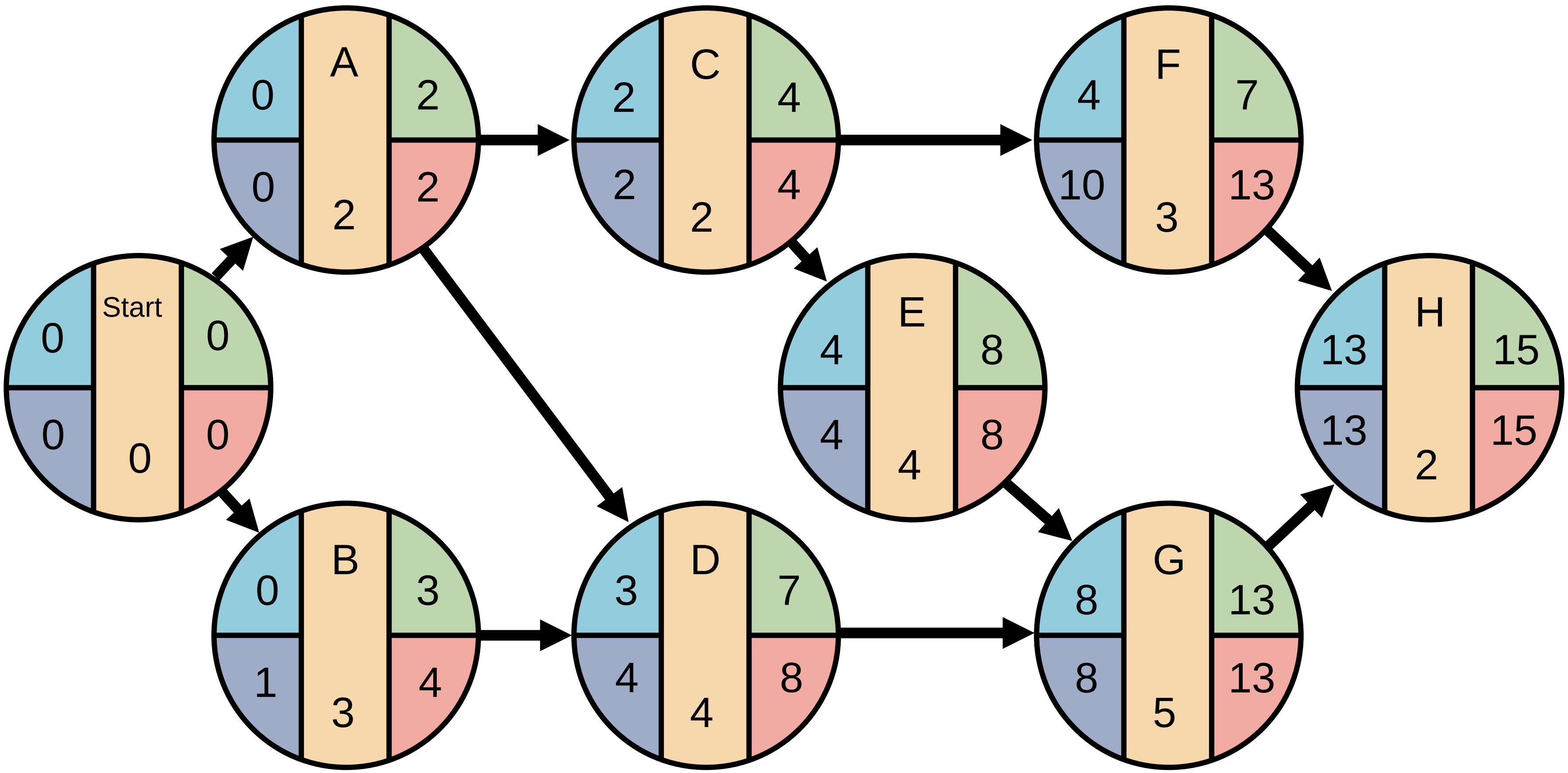
LS/LF Times for Milwaukee Paper



LS/LF Times for Mil



LS/LF Times for Milwaukee Paper



Computing Slack Time

After computing the ES, EF, LS, and LF times for all activities, compute the slack or free time for each activity

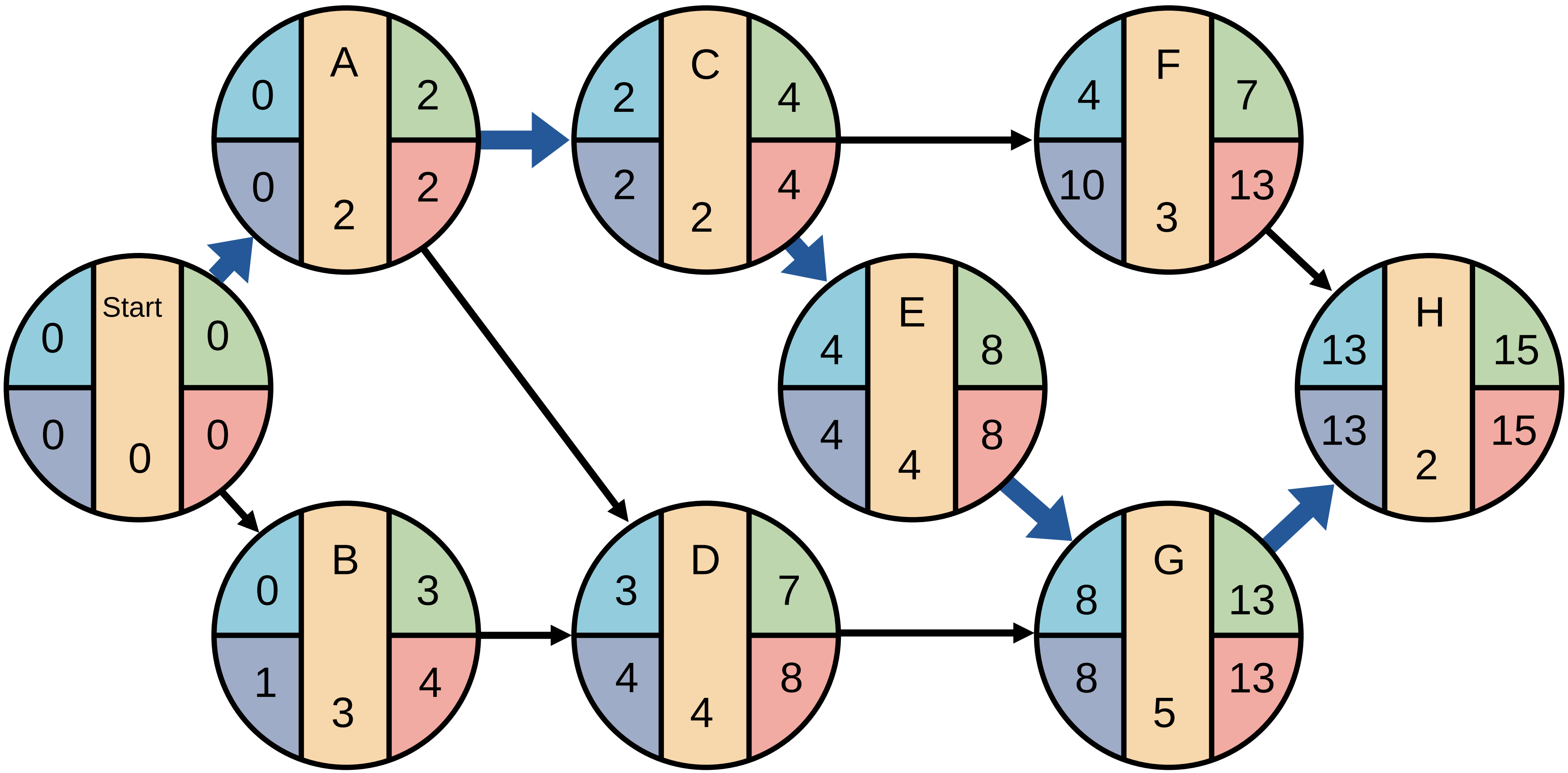
- Slack is the length of time an activity can be delayed without delaying the entire project

Slack = LS – ES or Slack = LF – EF

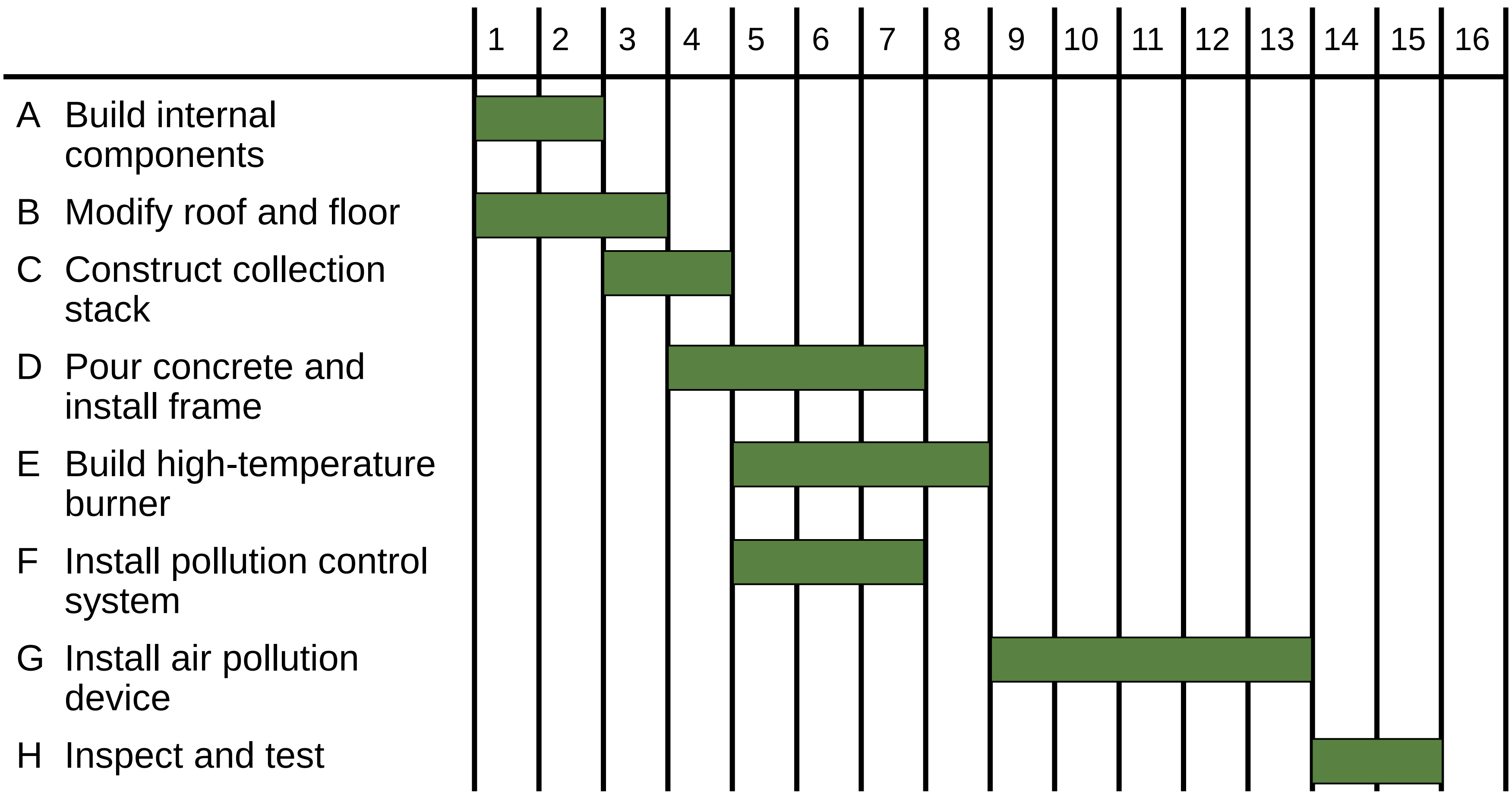
Computing Slack Time

TABLE 3.3	Milwaukee Paper's Schedule and Slack Times					
ACTIVITY	EARLIEST START ES	EARLIEST FINISH EF	LATEST START LS	LATEST FINISH LF	SLACK LS – ES	ON CRITICAL PATH
A	0	2	0	2	0	Yes
B	0	3	1	4	1	No
C	2	4	2	4	0	Yes
D	3	7	4	8	1	No
E	4	8	4	8	0	Yes
F	4	7	10	13	6	No
G	8	13	8	13	0	Yes
H	13	15	13	15	0	Yes

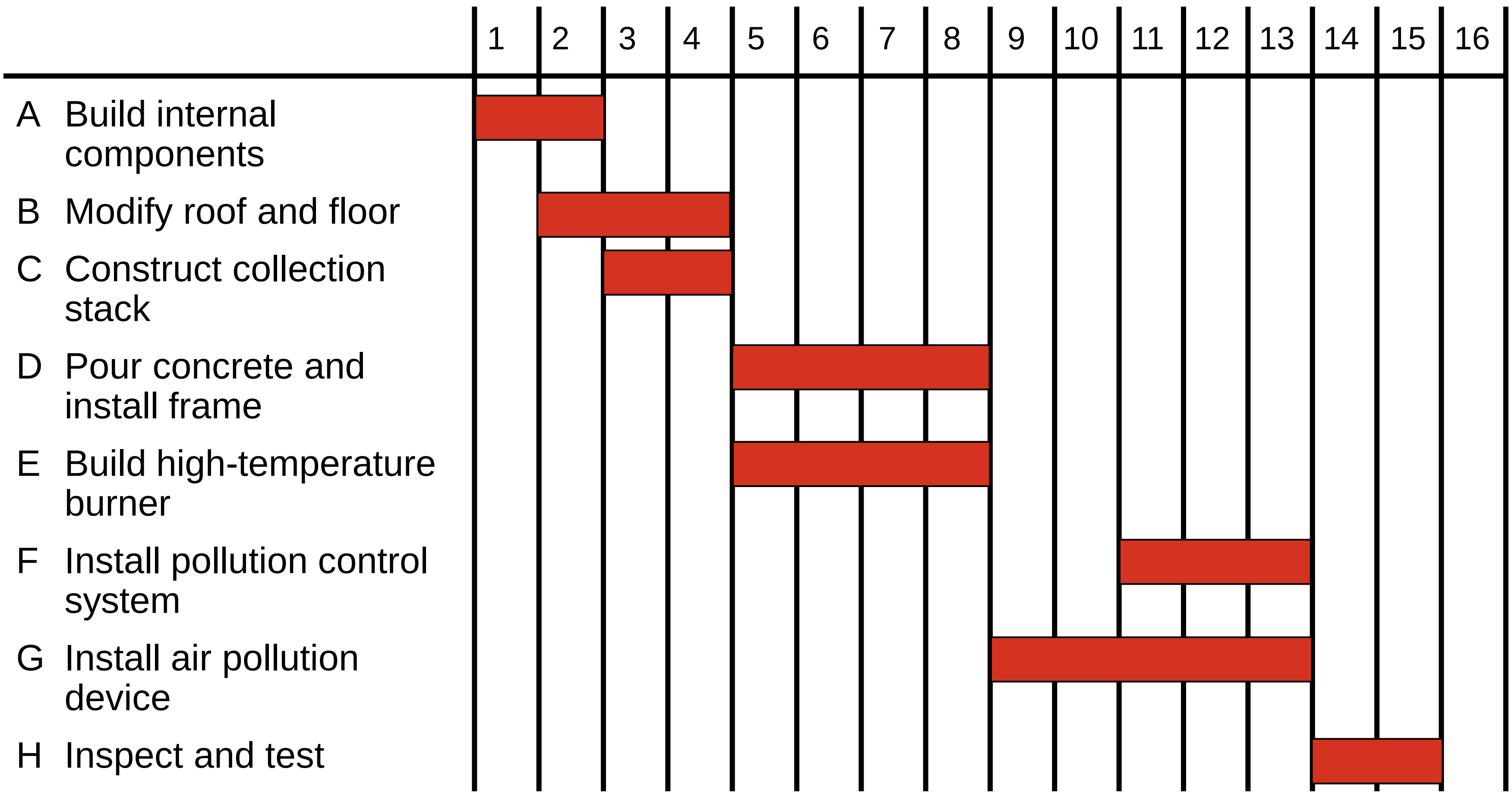
Critical Path for Milwaukee Paper



ES – EF Gantt Chart for Milwaukee Paper



LS – LF Gantt Chart for Milwaukee Paper



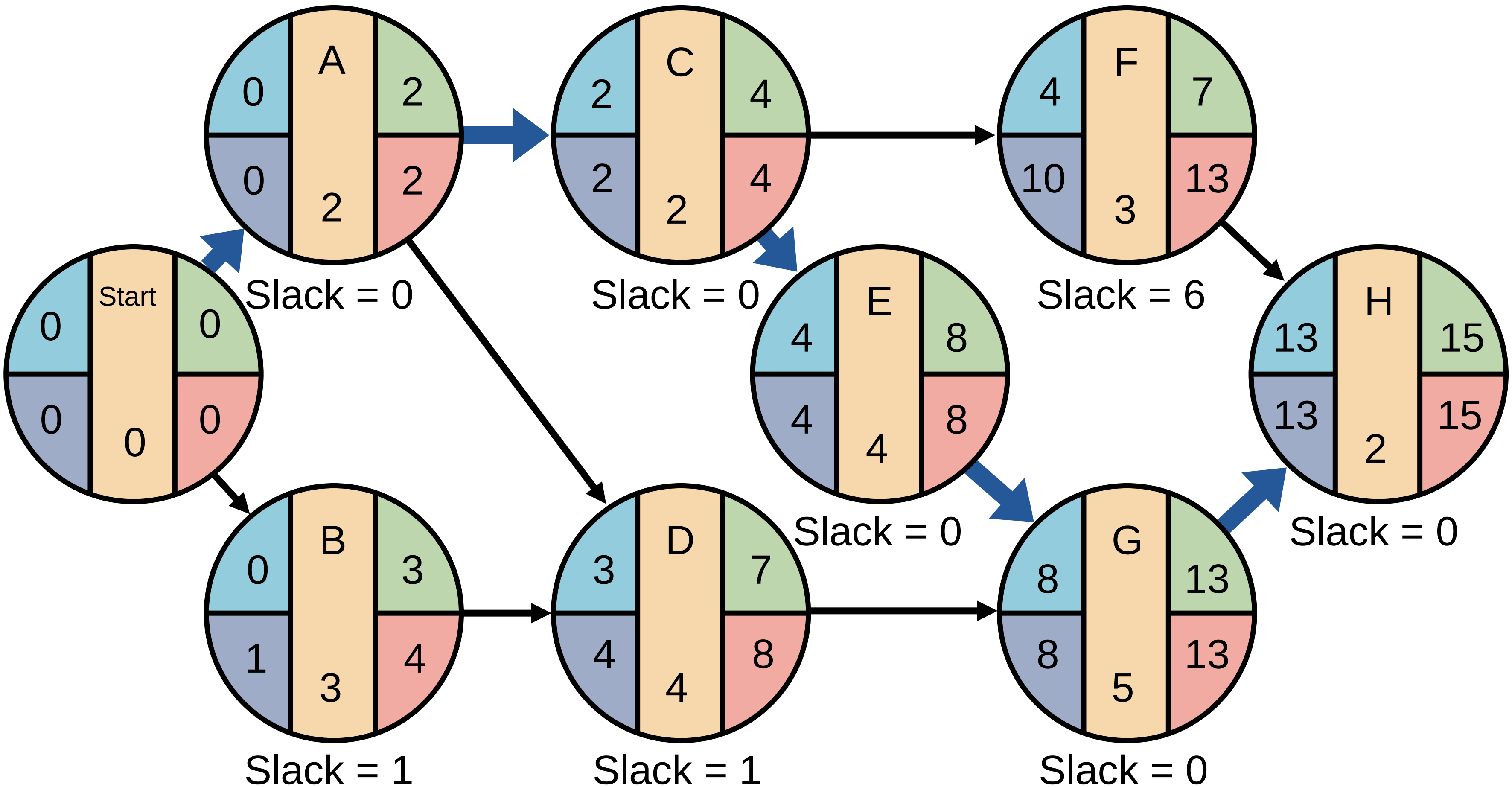
Variability in Activity Times

- CPM assumes we know a fixed time estimate for each activity and there is no variability in activity times
- PERT uses a probability distribution for activity times to allow for variability

Variability in Activity Times

- Three time estimates are required
  - **Optimistic time** (*a*) – if everything goes according to plan
  - **Pessimistic time** (*b*) – assuming very unfavorable conditions
  - **Most likely time** (*m*) – most realistic estimate

Critical Path and Slack Times for Milwaukee Paper



Advantages of PERT/CPM

1. Especially useful when scheduling and controlling large projects
2. Straightforward concept and not mathematically complex
3. Graphical networks help highlight relationships among project activities
4. Critical path and slack time analyses help pinpoint activities that need to be closely watched

Advantages of PERT/CPM

5. Project documentation and graphics point out who is responsible for various activities
6. Applicable to a wide variety of projects
7. Useful in monitoring not only schedules but costs as well

Limitations of PERT/CPM

1. Project activities have to be clearly defined, independent, and stable in their relationships
2. Precedence relationships must be specified and networked together
3. Time estimates tend to be subjective and are subject to fudging by managers
4. There is an inherent danger of too much emphasis being placed on the longest, or critical, path

Terima Kasih
рахмат
danke
謝謝
ngiyabonga
spas
teşekkür ederim
Баярлалаа
mersi
kia ora
barka
welalin
tack
mahalo
tapadh leat
спасибо
faafetai lava
vinaka
dank je
misaotra
paldies
grazzi
kiitos
dankie
спасибі
blagodaram
matondo
gracias
хвала
nanni
nandri
dhanyavad
thank you
asante
manana
bedankt
bayarlalaa
gràcie
hvala
mauruuru
köszönöm
akun
dankon
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obrigada
tenki
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djiere dieuf
tau
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dziękuję
дякую
mamnun
chokrane
chnorakaloutioun
gratias ago
gràcies
sulpáy
taiku
go raibh maith agat
sobodi
dėkuji
sagolun
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najis tuke
ありがとう
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তোমাকে ধন্যবাদ
감사합니다
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