# Project Management

1LT McPartland

# Terminal Learning Objective

- **ACTION: Apply Project Management techniques.**
- **CONDITIONS: Given a classroom environment, student workbook, and TM 3-34.42 (Construction Project Management) and TM 3-34.41**
- **STANDARDS: Demonstrate, without error, the following technical skills:**
  - Receive and interpret a construction directive
  - Develop an activities list
  - Determine sequential relationships among activities
  - Construct a logic network
  - Estimate resource requirements
  - Compute a time analysis
  - Prepare an Early Start Schedule
  - Employ project control measures
  - Resource constrain a construction project

# Safety, Risk and Environmental Concerns

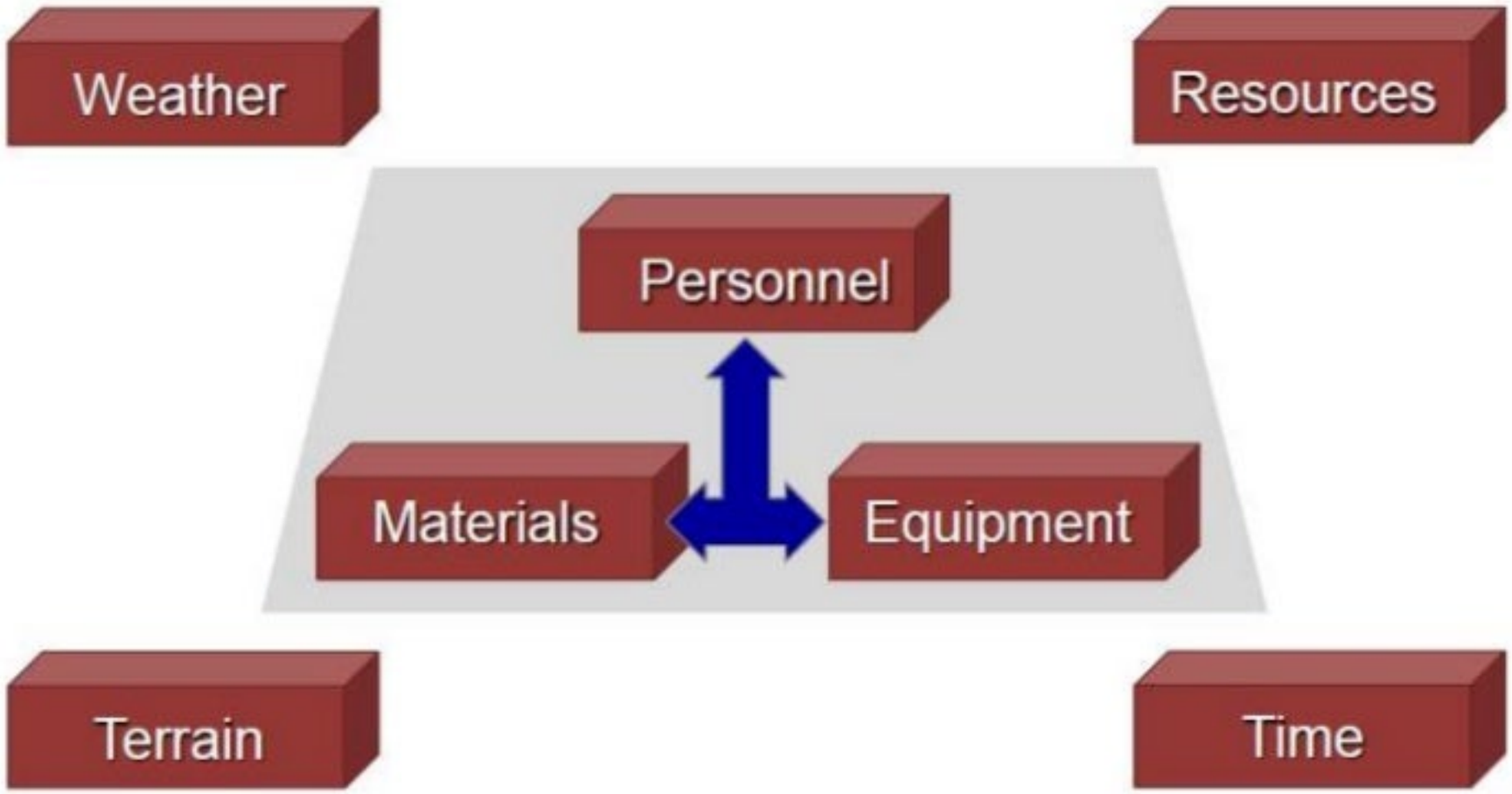
- Safety Requirements: None
- Risk Assessment Level: Low
- Environmental Considerations: None
- Evaluation: Practical Exercise

# Introduction to Project Management

# Management Theory

- Management
  - The process of getting things done through people.
- Project Management
  - The application of knowledge, skills, tools, and techniques to project activities to meet the project requirements.

# System Management Model



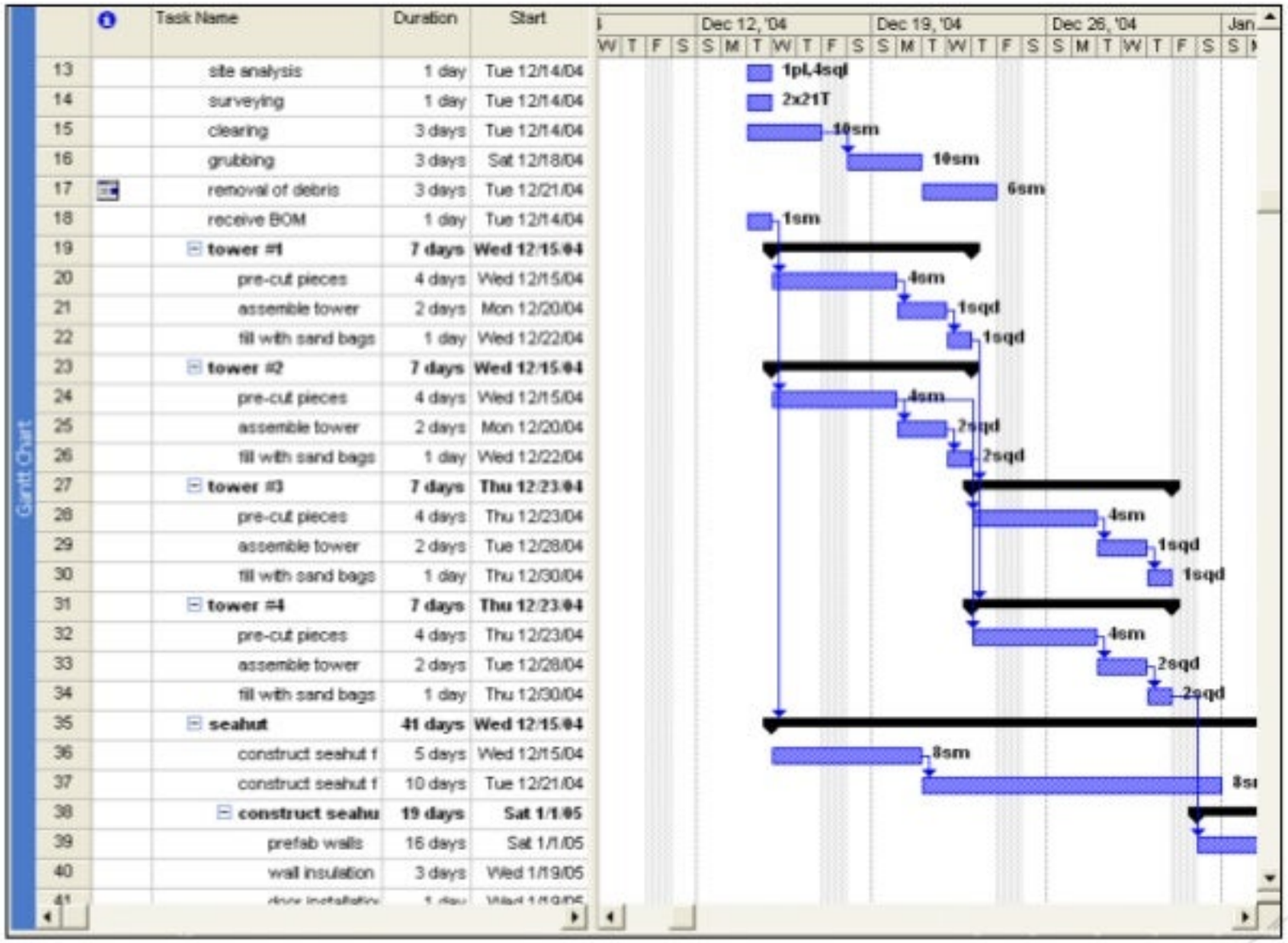
# Management and Scheduling Tools

- Gantt Charts
  - MS Project
- Critical Path Method
  - Logic Diagram
  - Precedence Diagrams
- Man-Day Estimating Calculations
  - Man-Day (MD)=Work performed by 1 person in 8 hours
- Resource Leveling

# Gantt Chart

- Used for planning and monitoring project progress
- The Military uses Level I, II, and III Gantt Charts based on the required level of detail
- The Army uses MS Project in order to produce Gantt Charts
- They can also be created by hand, see Chapter 3 of TM 3-34.42

# Gantt Chart in MS Project



# Critical Path Method

- Step-by-step system for process planning and synchronization.
- Comprised of a logic network and a precedence diagram
- Provides an accurate, timely, and easily understood picture of the project
- Can be used for both combat and construction tasks

# Military Construction Management

- Functions of Military Construction Managers are universal, although they may differ in details from one level to another.
- The managerial functions are:
  - *Planning*
  - *Scheduling*
  - *Monitoring/Controlling*
- It is essential that the project manager understand the objectives, plans, and policies of superiors

# Project Management Process

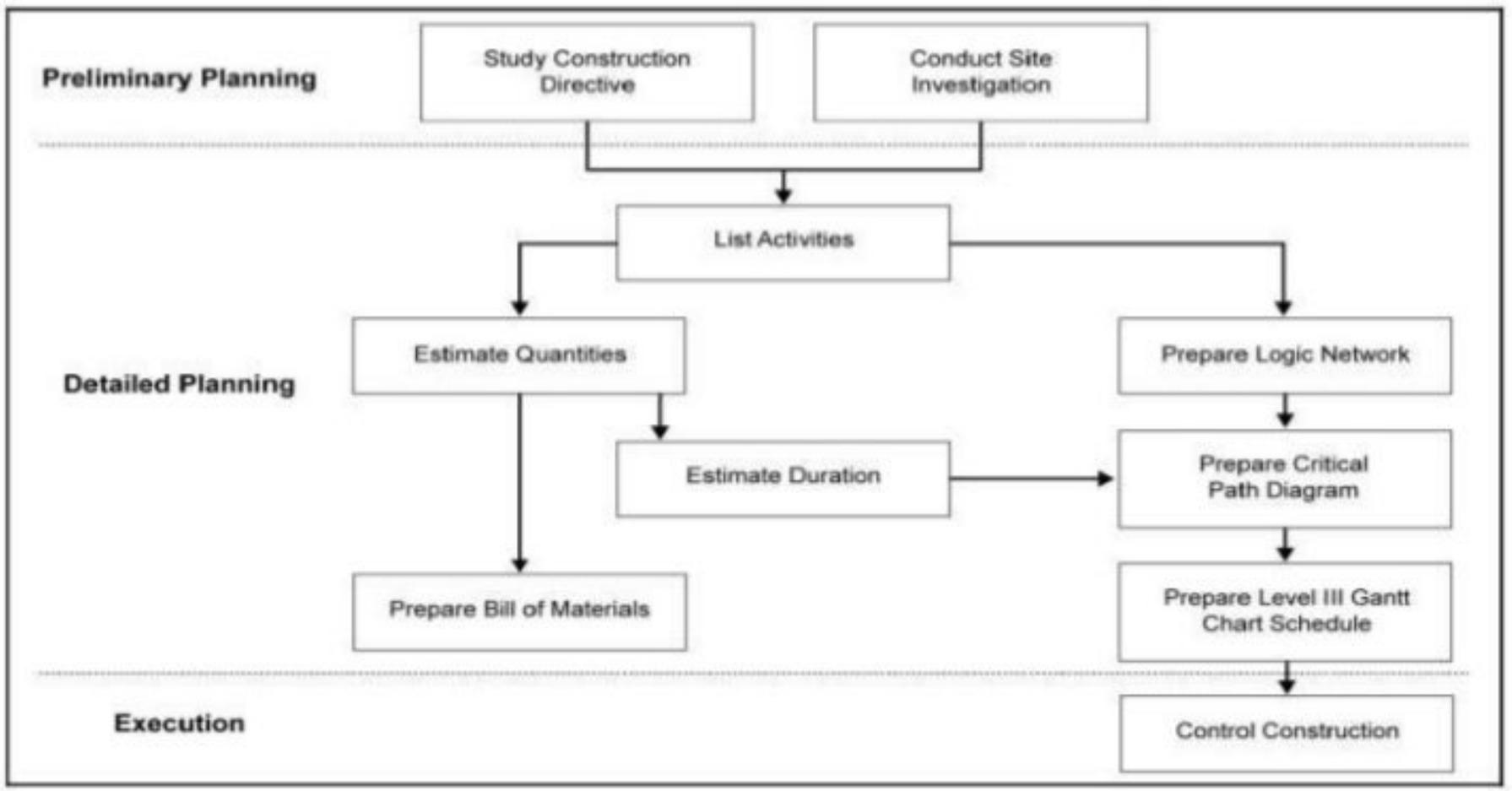



Figure 1-2. Project Management Process

# Organization and Roles

| | |
|---|---|
| Project Manager | Platoon Leader |
| Project Supervisor | Platoon Sergeant |
| Crew Leader | Squad Leader |
| Crew | Soldiers |
| SMEs within Unit | QA/QC (Warrant Officer)<br>Safety NCO<br>Environmental Officer<br>Materials NCO |
| Construction Team | Client/Customer<br>Contracting Office<br>DPW<br>Engineer (BN S3-C)<br>Other (Post Safety, Fire Chief, Security, etc) |

# Project Model

- Military construction projects follow a six-phase model.
- The duration and amount of effort for each phase depends on the scope and complexity of the project.

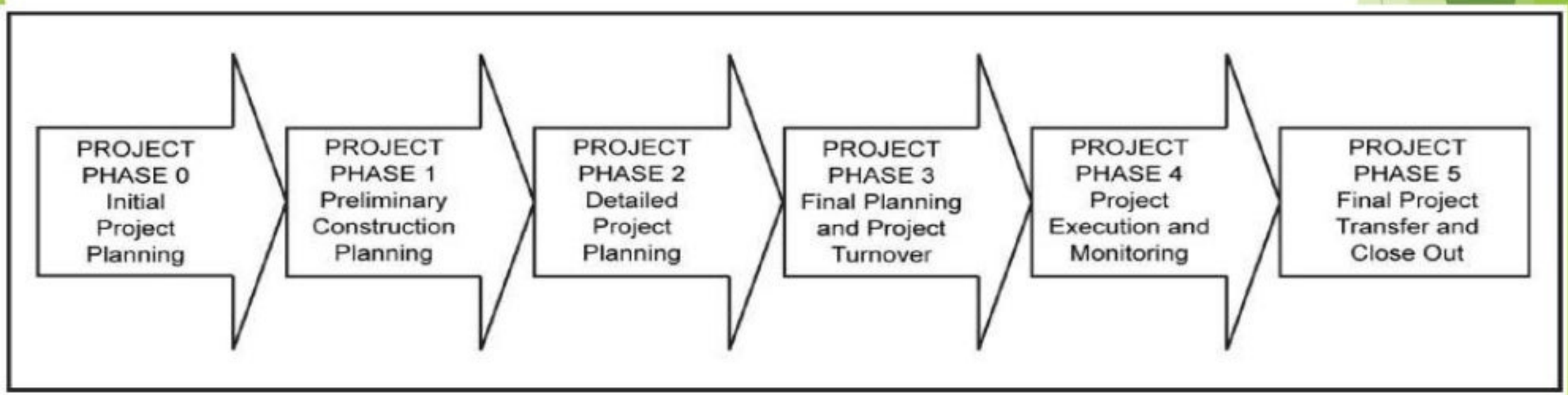



Figure 1-1. Construction Project Phasing Model

# Enabling Learning Objectives

- Receive and interpret a construction directive
- Develop an activities list
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- Employ project control measures
- Resource constrain a construction project

# Construction Directive

- Comes in the form of an OPORD, FRAGO, or WARNO
- Initiates Project Management Process
- Should include at a minimum:
- Mission
  - Commander's Intent
  - Location
  - Time
  - Design/Plans
  - Manpower
  - Equipment
  - Materials
  - Priority
  - Reporting Requirements

# Interpret Construction Directive

- Determine Task Organization
- Determine Project Planning Timeline
- Conduct a Preplanning Conference
- Review Plans and Specifications
- Review/Create Bill of Materials
- Identify Special Training or Equipment Requirements

# Conduct Site Investigation

- Provides opportunity to verify existing conditions represented in construction plans
- It is important to record notes and take pictures of the site
- If a pre-construction site visit is not feasible, it is important to use all other available resources to obtain information on the physical location of the project

# Site Visit Considerations

- Some key characteristics of the location to take note of include:
  - Terrain
  - Drainage
  - Accessibility
  - Natural Resources
  - Existing Facilities
  - Weather
  - Soils

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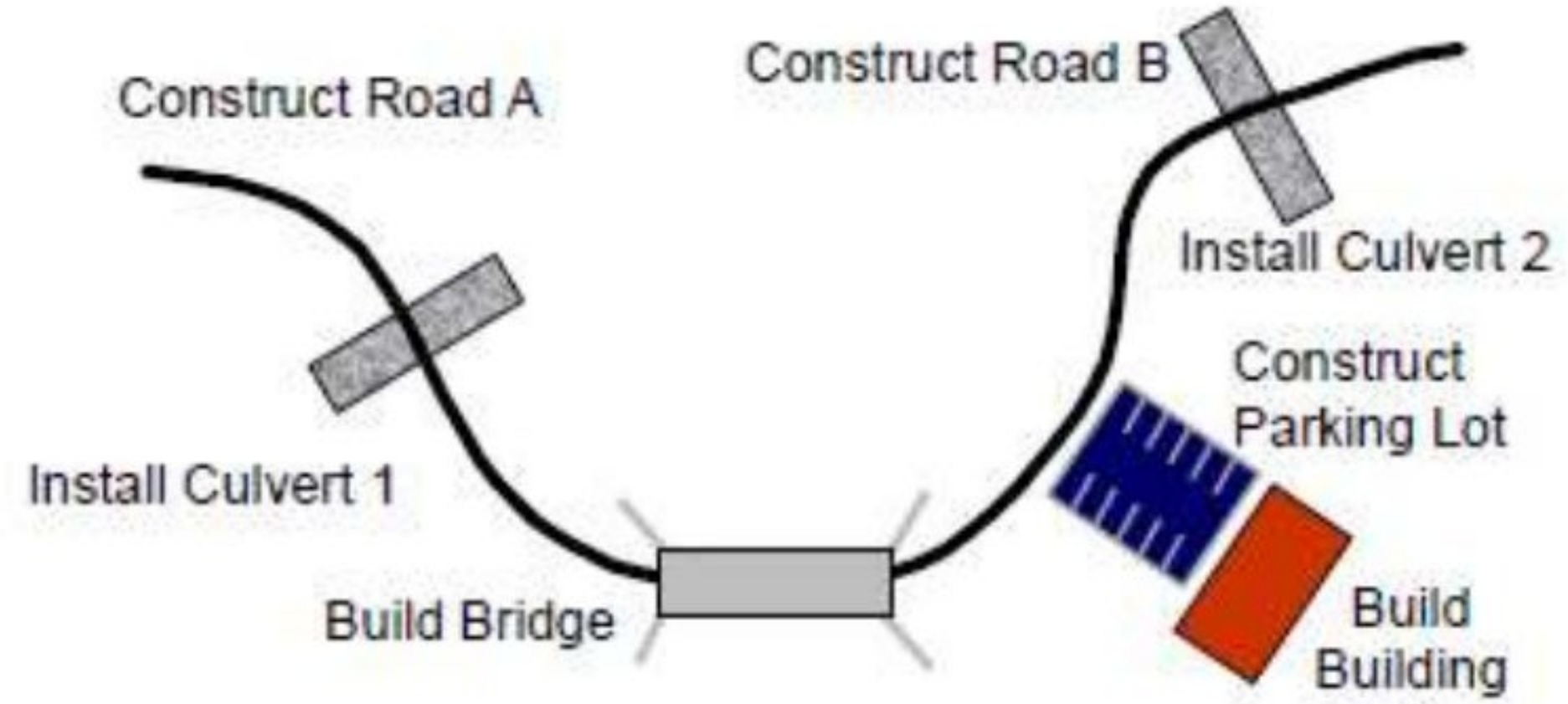
# Master Activity List

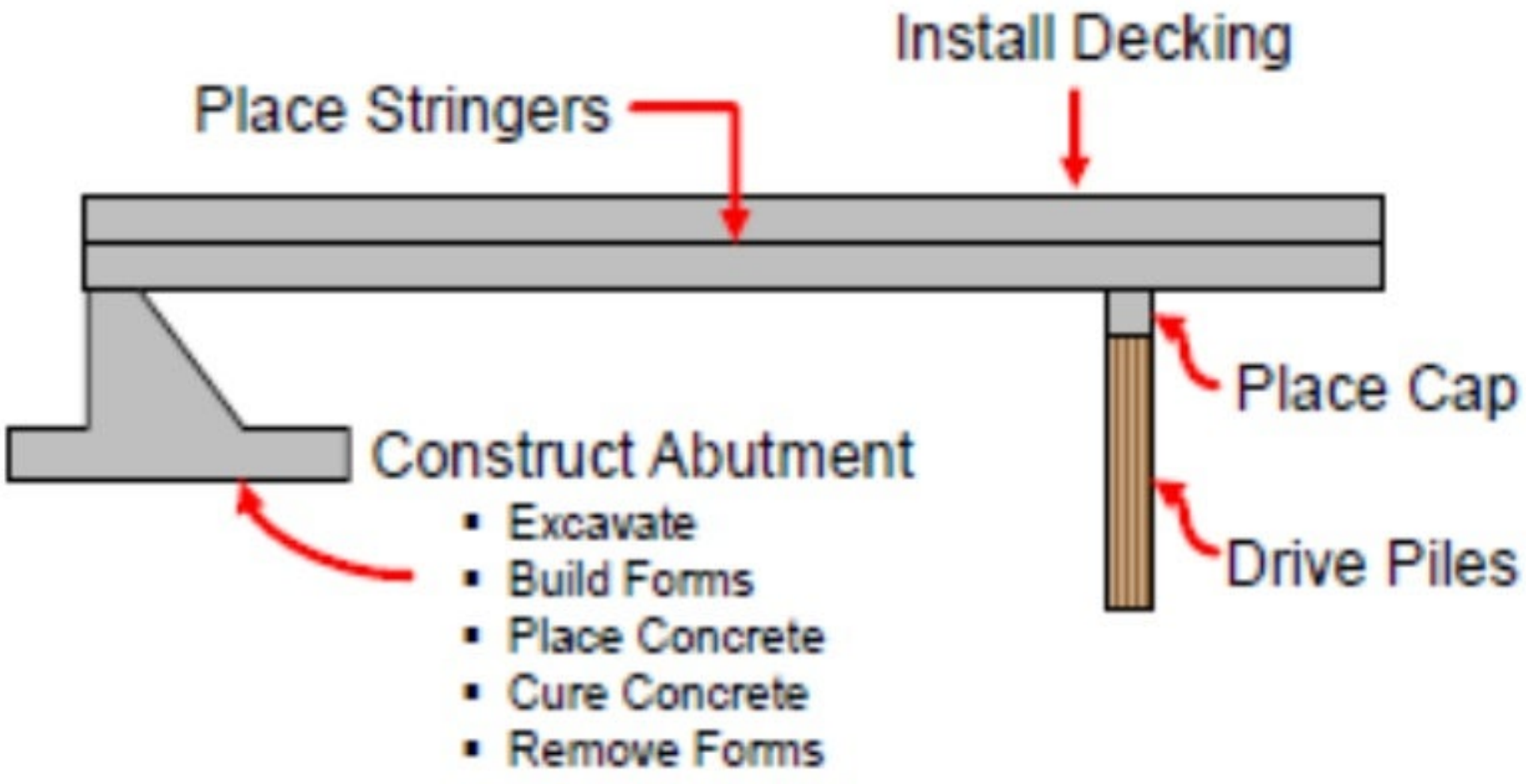
- Study plans and specifications
- Construct the project mentally
- Appendix C of TM 3-34.41 is a good place to start
- Understand the degree of detail required
  - BDE, BN, CO, Platoon, Squad

# Low Degree of Detail



# High Degree of Detail

- Project: Construct Bridge



# Make an Activity List

- When making an activity list DO NOT consider the following:
  - Time
  - Soldier Availability
  - Order of Construction
  - Material
  - Equipment

# Number Master Activities

| MASTER ACTIVITY | DESCRIPTION | MASTER ACTIVITY | DESCRIPTION |
|---|---|---|---|
| 00 | Procurement and contracting | 23 | Heating, ventilating, and air conditioning |
| 01 | General requirements | 25 | Integrated automation |
| 02 | Existing conditions | 26 | Electrical |
| 03 | Concrete | 27 | Communications |
| 04 | Masonry | 28 | Electronic safety and security |
| 05 | Metals | 31 | Earthwork |
| 06 | Wood, plastics, and composites | 32 | Exterior improvements |
| 07 | Thermal and moisture protection | 33 | Utilities |
| 08 | Openings | 34 | Transportation |
| 09 | Finishes | 35 | Waterway and marine construction |
| 10 | Specialties | 40 | Process integration |
| 11 | Equipment | 41 | Material processing and handling equipment |
| 12 | Furnishings | 42 | Process heating, cooling, and drying equipment |
| 13 | Special construction | 43 | Process gas and liquid handling, purification and storage equipment |
| 14 | Conveying systems | 44 | Pollution control equipment |
| 21 | Fire suppression | 45 | Industry-specific manufacturing equipment |
| 22 | Plumbing | 48 | Electrical power generation |

Figure 1-3. Master Activities

Page 3 of Student Work Book

# In Class Practical Exercise

- Develop an activities list of at least 8 activities for the project depicted on pages 4 through 5 of your student workbook.
- Page 6 of the workbook can be used to record your list.

# PE Potential Solution

1. Dig Trench 1
2. Dig Trench 2
3. Assemble Culvert 1
4. Assemble Culvert 2
5. Install Culvert 1
6. Install Culvert 2
7. Backfill Culvert 1
8. Backfill Culvert 2

# Enabling Learning Objectives

- Receive and interpret a construction directive
- Develop an activities list
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- Resource constrain a construction project

# Project Management

- Each Activity must be examined to determine:
  - Which activities must be finished before this one begins?
  - Which other activities may either start or finish at the same time as this one?
  - Which activities cannot begin until this one is finished?

# Activity Relationships

| Activities | Preceded Immediately By (PIB) |
|---|---|
| A. Wake Up | |
| B. Take Shower | |
| C. Leave House | |
| D. Drive to Work | |
| E. Start Car | |
| F. Get Dressed | |

Page 7 of Student Work Book

| Activities | Preceded Immediately By (PIB) |
| --- | --- |
| A. Dig trench #1 | |
| B. Dig trench #2 | |
| C. Assemble #1 | |
| D. Assemble #2 | |
| E. Install #1 | |
| F. Install #2 | |
| G. Backfill #1 | |
| H. Backfill #2 | |

# Enabling Learning Objectives

- Receive and interpret a construction directive
- Develop an activities list
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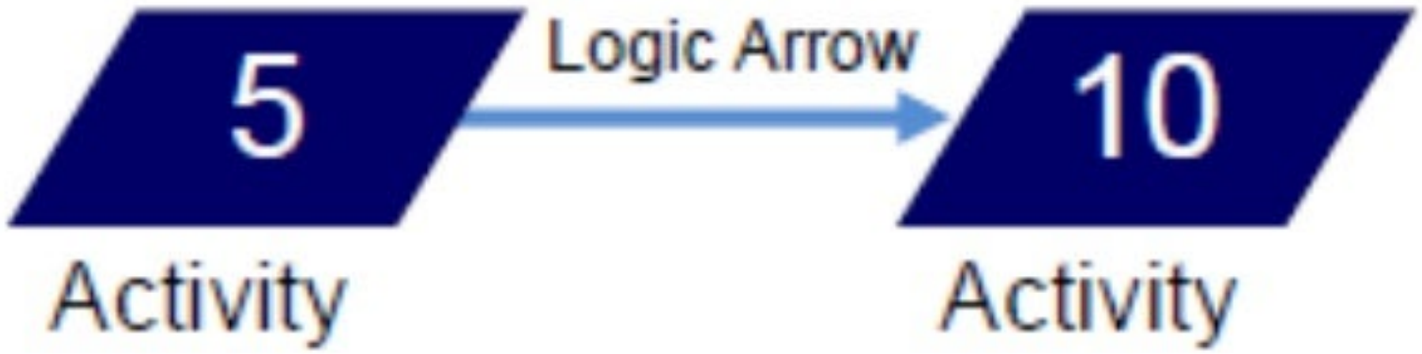
# Logic Network/Diagram

- Graphical illustration of the construction activity sequence from start to finish and the interdependencies among activities
- Ensures that no items/tasks overlooked during the planning phase
- Not concerned with activity durations or crew sizes at this point
- Write each activity on a piece of paper/post-it note and draw lines between the tasks are dependent on each other

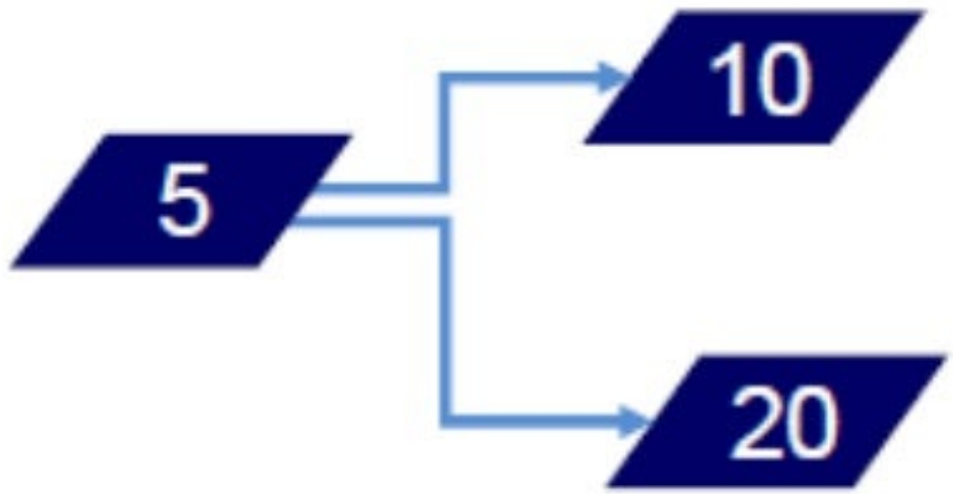
# Logic Network



# Logic Network


Activity 20 cannot start until activities 5 and 10 are complete.

# Logic Network



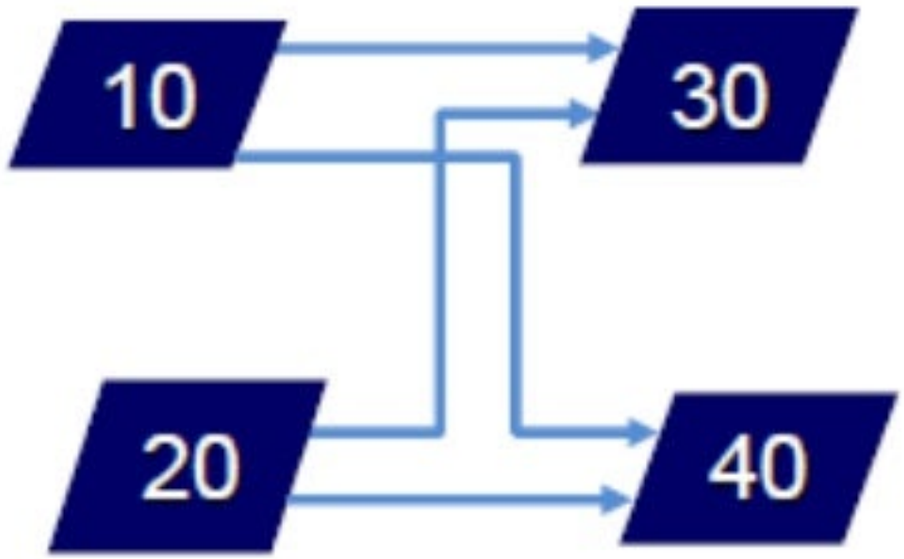

Activities 10 and 20 cannot start until activity 5 is complete.

# Logic Network


Activities 10 and 20 must be completed before 30 can start.

40 can start immediately after 20 is complete.

# Logic Network

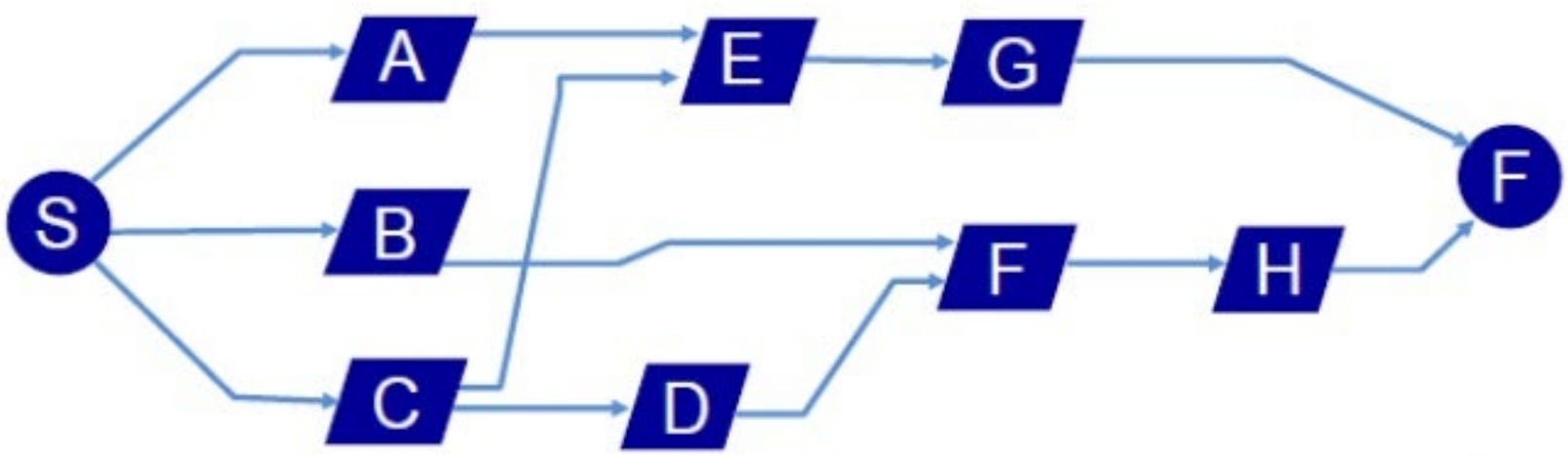



Activities 30 and 40 cannot start until activities 10 and 20 are complete.

# Culvert P.E.

| Activities | PIB |
|---|---|
| A. Dig trench #1 | None |
| B. Dig trench #2 | None |
| C. Assemble #1 | None |
| D. Assemble #2 | C |
| E. Install #1 | A, C |
| F. Install #2 | B, D |
| G. Backfill #1 | E |
| H. Backfill #2 | F |

- Step 1: Draw the start node
- Step 2: Draw activities preceded by NONE
- Step 3: After each of the starting activities, place the activities that immediately follow it.
- Step 4: Continue using this methodology until all activities have been diagrammed.
- Step 5: Draw the finish node.



# Activity Nodes

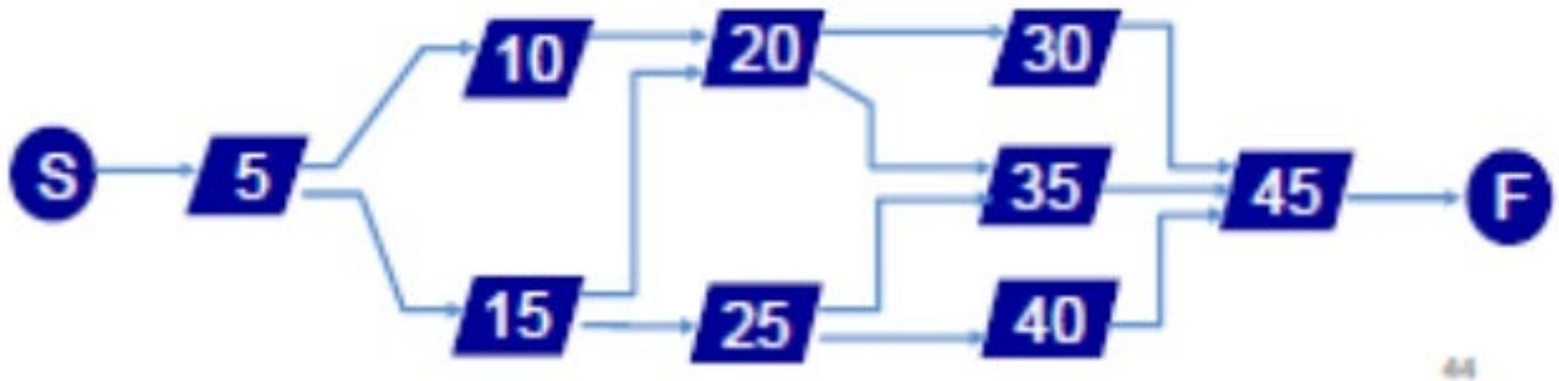
- A rectangle/ parallelogram representing an activity
- Contains all of the necessary information for the activity

# Node Numbering

- Node Numbering Rules:
  - Every activity node number must be different.
  - The activity node number at the head of the logic arrow must be greater than the number at the tail of the arrow.
  - Normally use increments of five or ten

# Student Workbook P.E. 2

| Activities | PIB |
|---|---|
| 5 | None |
| 10 | 5 |
| 15 | 5 |
| 20 | 10,15 |
| 25 | 15 |
| 30 | 20 |
| 35 | 20,25 |
| 40 | 25 |
| 45 | 30,35,40 |




Page 7 of Student workbook

# Summary

- Receive and interpret a construction directive
- Develop an activities list
- Determine sequential relationships among activities (PIB list)
- Construct a logic network

# Enabling Learning Objectives

- Receive and interpret a construction directive
- Develop an activities list
- Determine sequential relationships among activities
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- Estimate resource requirements
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# Duration and Resource Requirements

# Man-Day Estimating

- Man-Day (MD) is a unit of work performed by one person in 8 hours
- The MD is a set standard and does not change
- The number of hours for an assigned workday may change, but a MD is always 8 hours

# Man-Day Estimating

- What are some resources for estimating work rates?
  - TMs and FMs
  - Experience
  - Manufacturer's Data
  - Civilian Text
  - Unit Records

# Work Rates in TM 3-34.41

- Organized by divisions of work and provides estimating information and data for various construction tasks.
- Tables provide Labor in units of man-hours (1 hour of labor per man)

# Man-Day Estimating

- Activity Estimation:
  - Determine Best Technology
  - Determine Work Rate
  - Determine Quantity of Work
  - Determine Crew Size
  - Determine Efficiency
  - Calculate:
    - Standard Effort
    - Troop Effort
    - Duration

# Determine the Multiplier

- Guidance for the multiplier may come from the production tables in Chapter 5
- Factors greater than one indicate less efficiency
- Factors less than one indicate greater efficiency
- Factors that may influence the multiplier include:
  - Workload, Project Site Area, Labor, Supervision, Job Conditions, Weather, Equipment, Operational Environment
- Unless a multiplier is noted in Chapter 5 or specific circumstances are known, use 1.0

# Determine Man-Day Equivalent

- Man- Day Equivalent (ME) is the actual man-hours worked “swinging hammers” on the jobsite during a workday
- Does not include lunch, breaks, or travel time to/from the jobsite
- Calculated by dividing the length of the work day by 8 (number of hours in a MD)
- Will often come from the higher headquarters in the construction directive

# Determine Availability Factor

- Availability Factor (AF) is the amount of time a military engineer is actually on the job.
- The AF takes into account that not all Soldiers are available all the time for various reasons
- Provided by higher headquarters for planning purposes and typically varies between 60-90%
- Typical percentage for contingency construction and theater engagement detachments is 90%

# Enabling Learning Objectives

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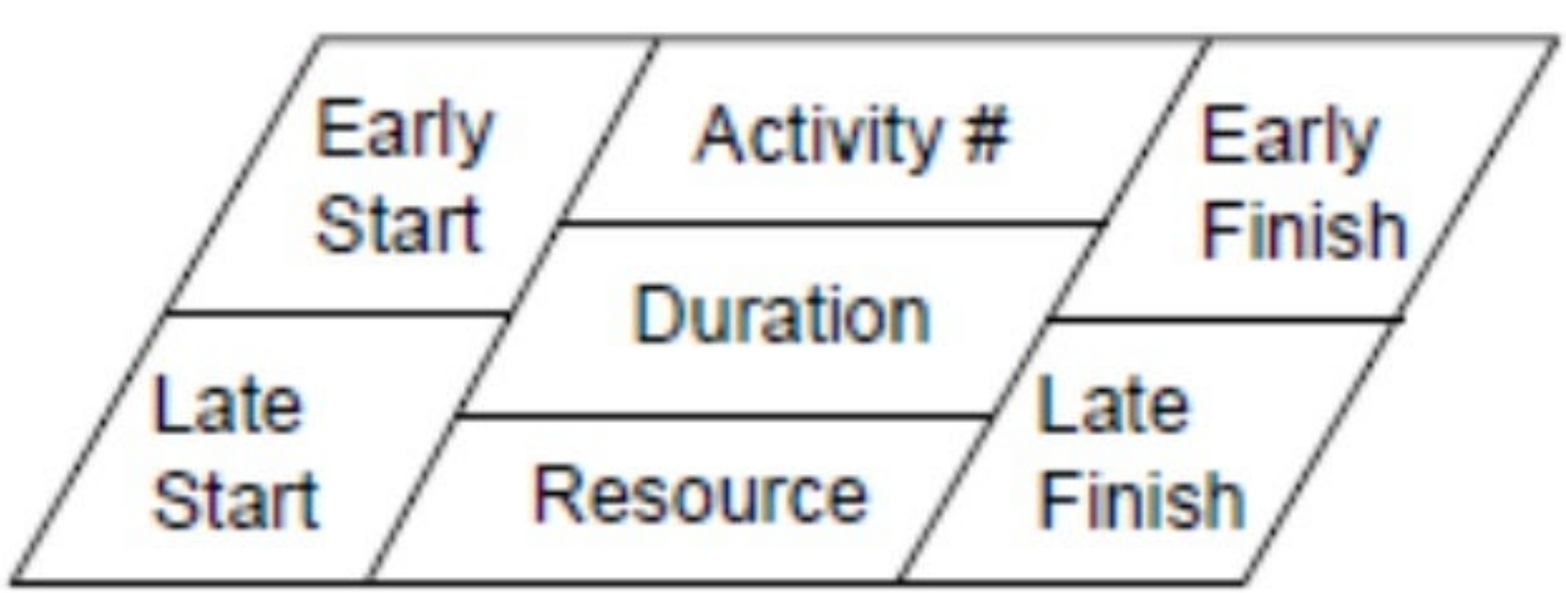
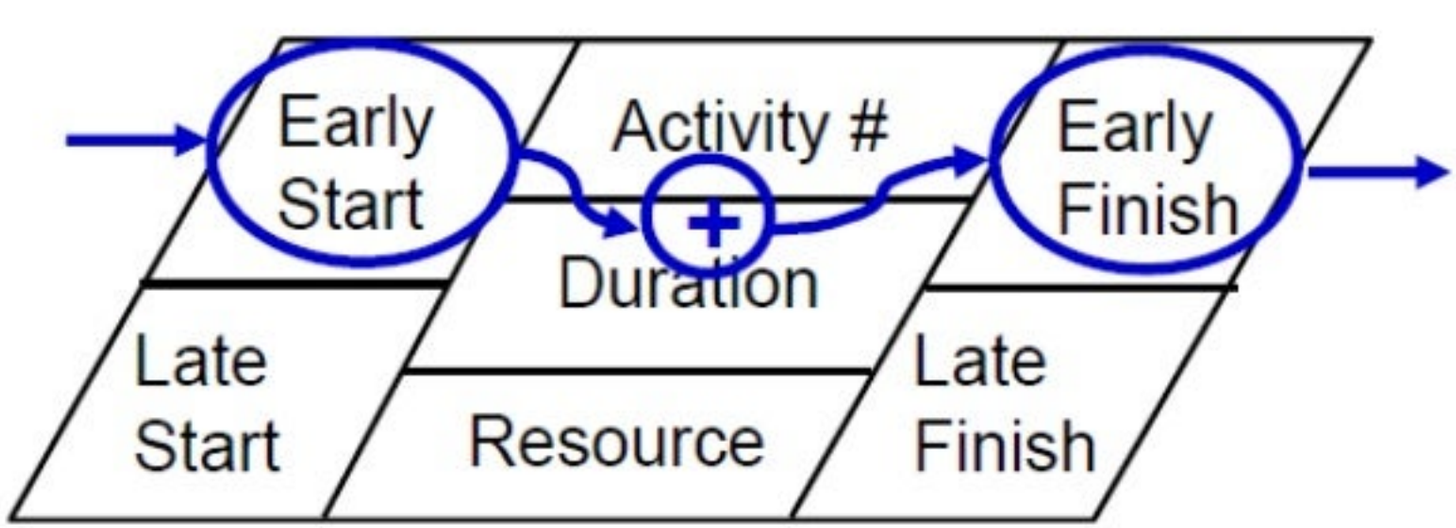
# Activity on the Node Time Analysis



# Forward Pass Time Analysis

Early Start (ES) + Duration = Early Finish (EF)



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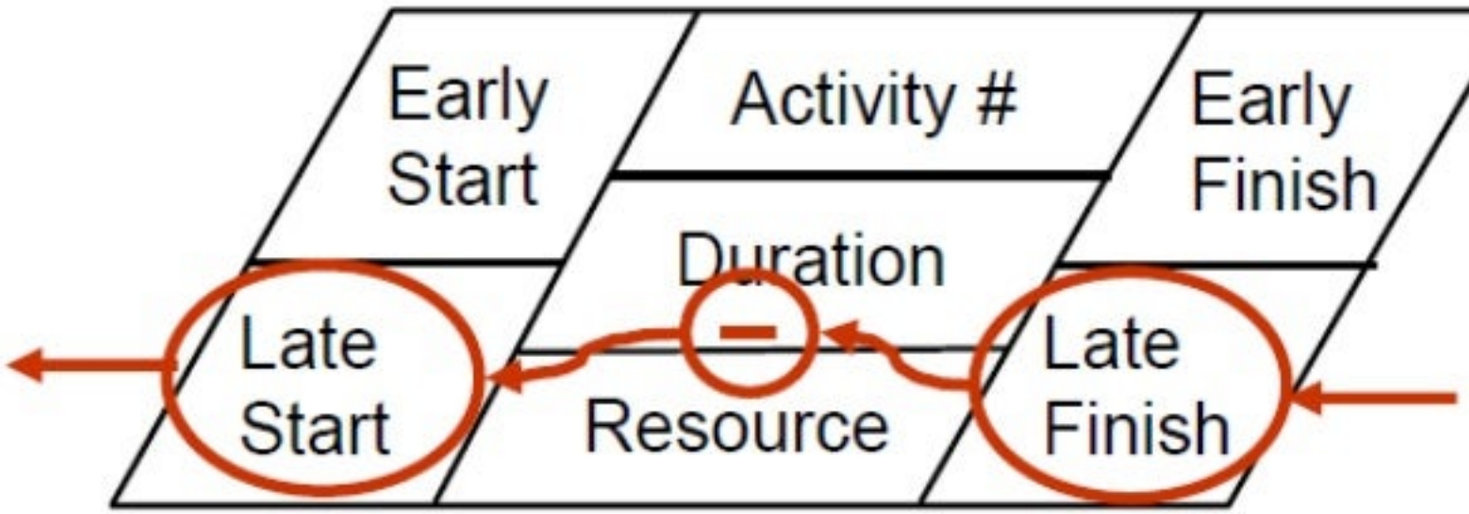
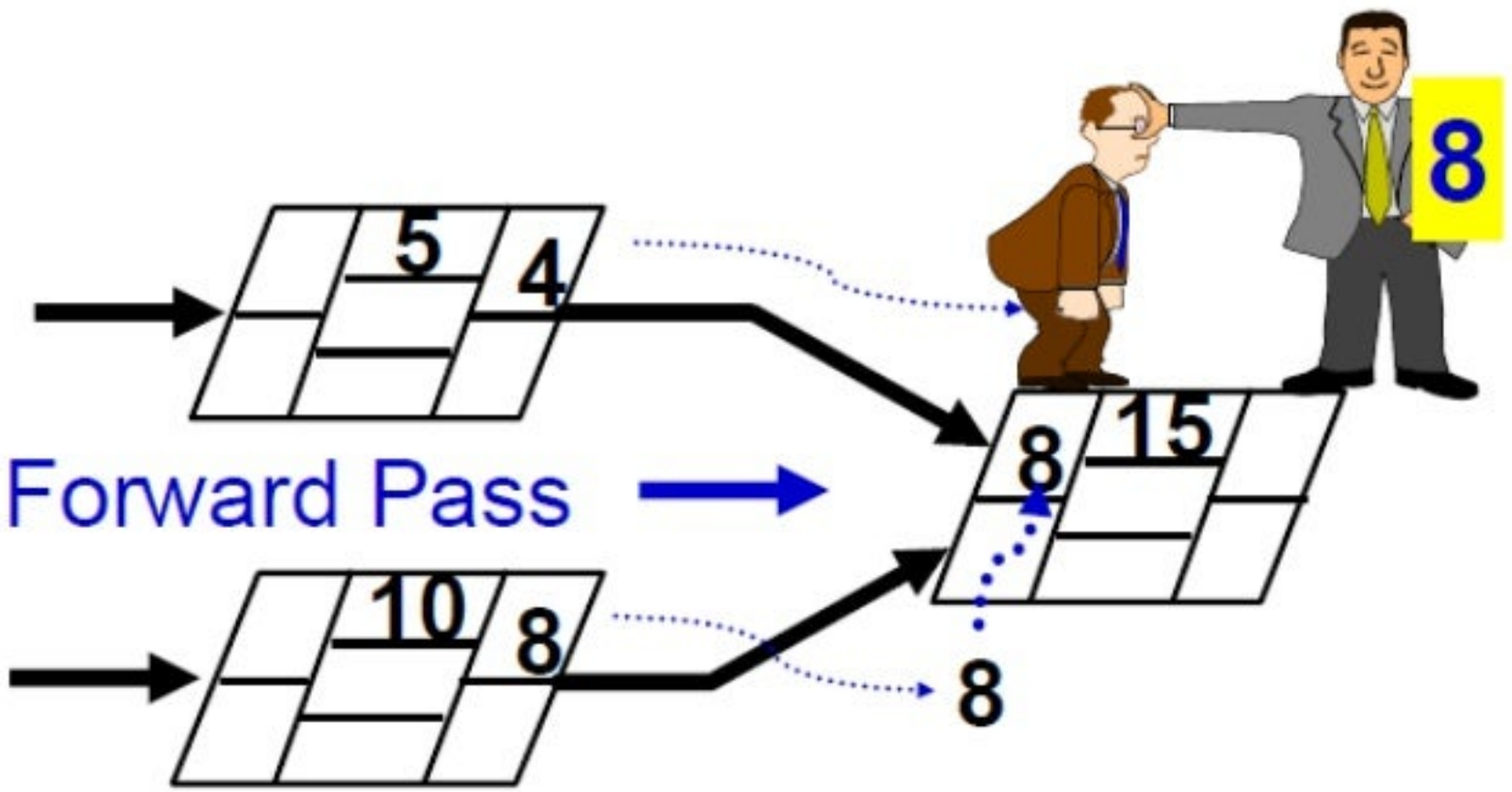


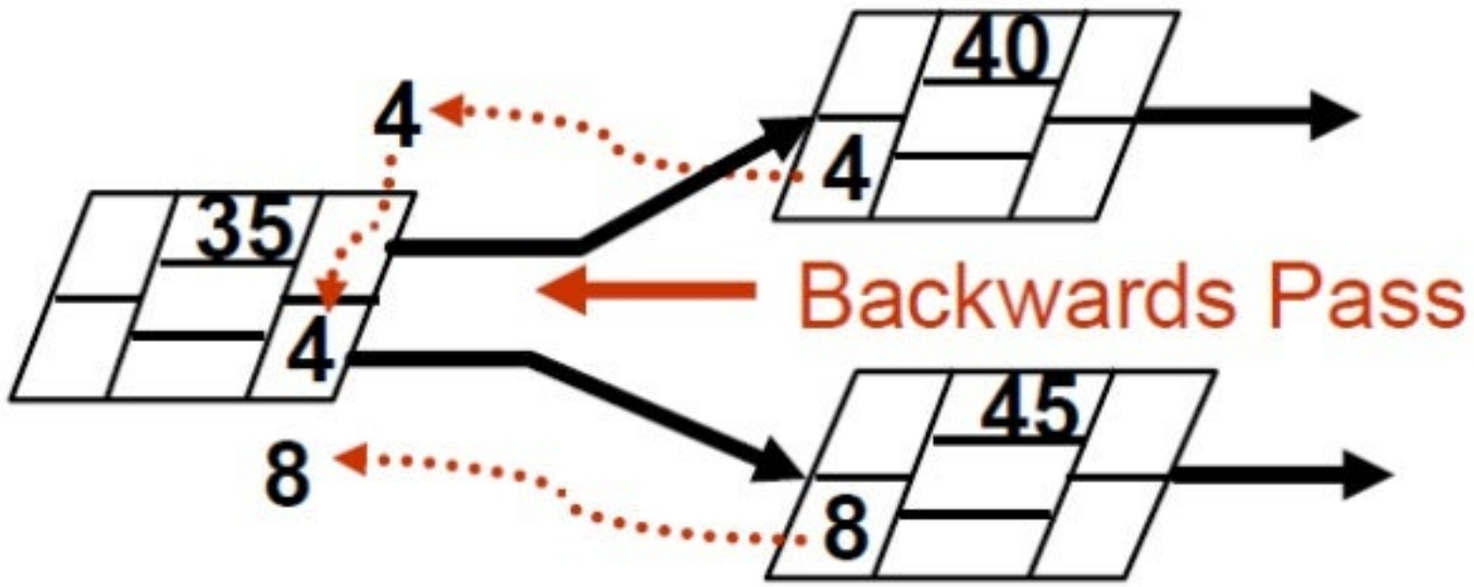

Late Finish (LF) - Duration = Late Start (LS)

# Time Analysis Rules




- On the forward pass: CHOOSE THE LARGEST

# Time Analysis Rules




- On the backwards pass: CHOOSE THE SMALLEST

# Critical Activities and Critical Path

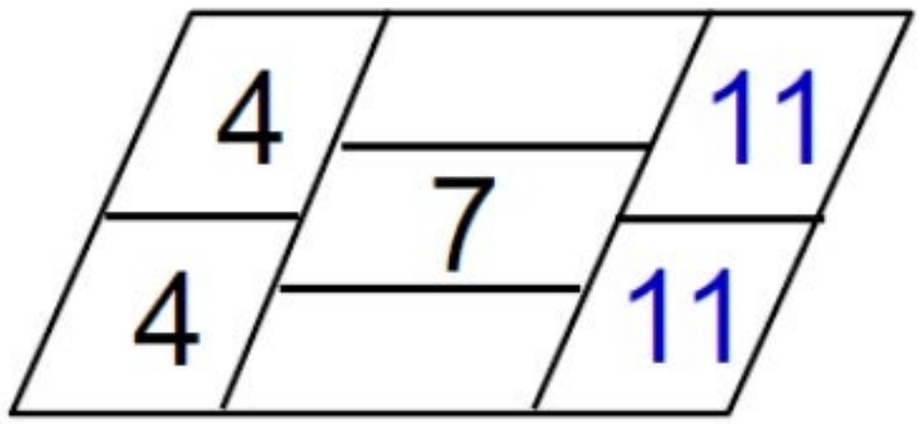
- A critical activity, if delayed by any amount of time, delays the entire project's completion
- Critical activities when linked together form the critical path from start to finish.
- The critical path allows the project manager to focus on the activities which must not slip.

# Critical Path

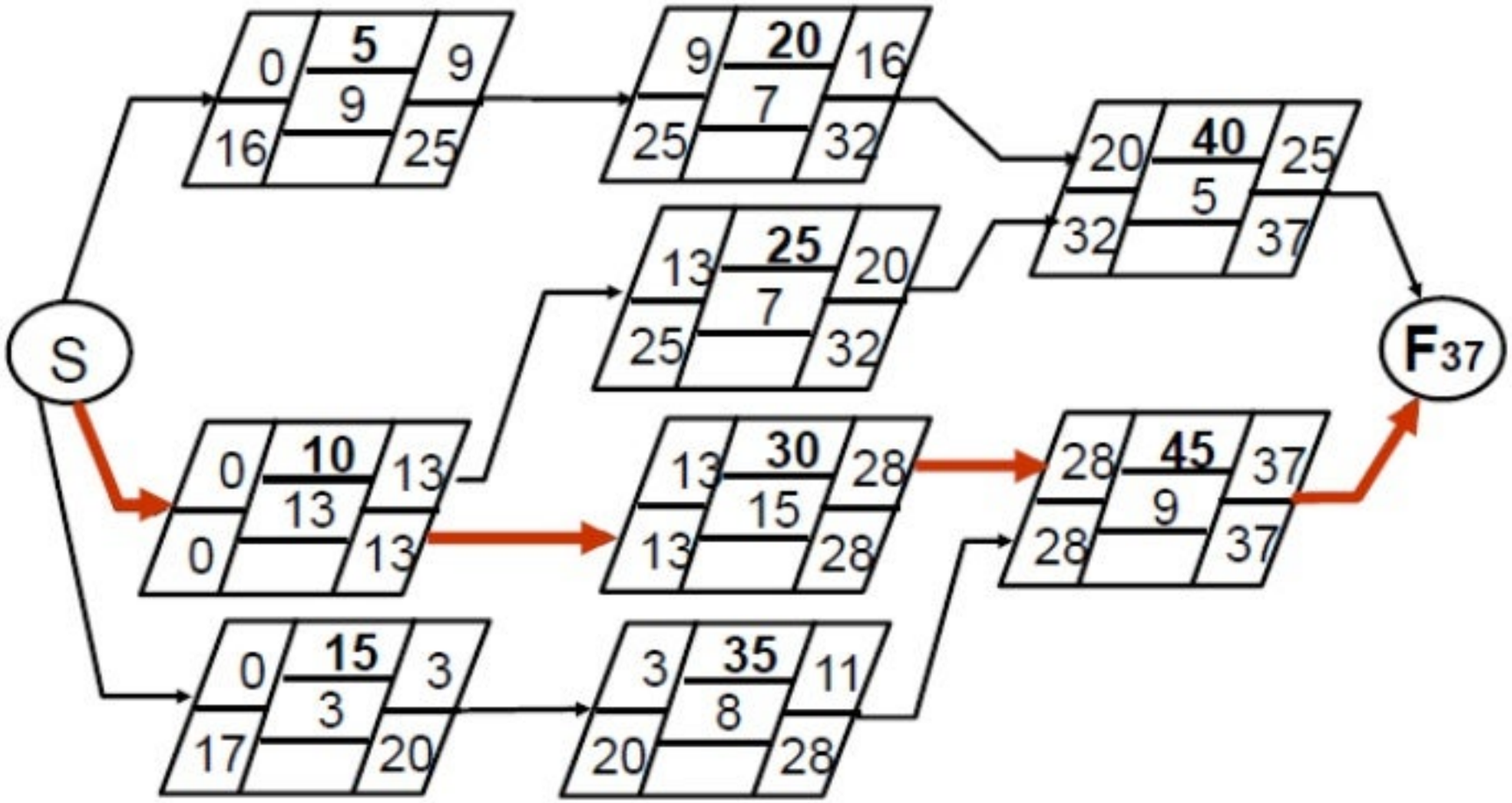
- Characteristics of the Critical Path:
  - Must be continuous
  - Determines project duration
  - Indicated on the logic diagram (double lines, bold lines, highlighted)
  - All of its activities will not have any float

# Critical Path

1. ES=LS
2. EF=LF
3. The path between two critical activities is also critical only if the EF and LF equals the ES and LS of the next critical activity



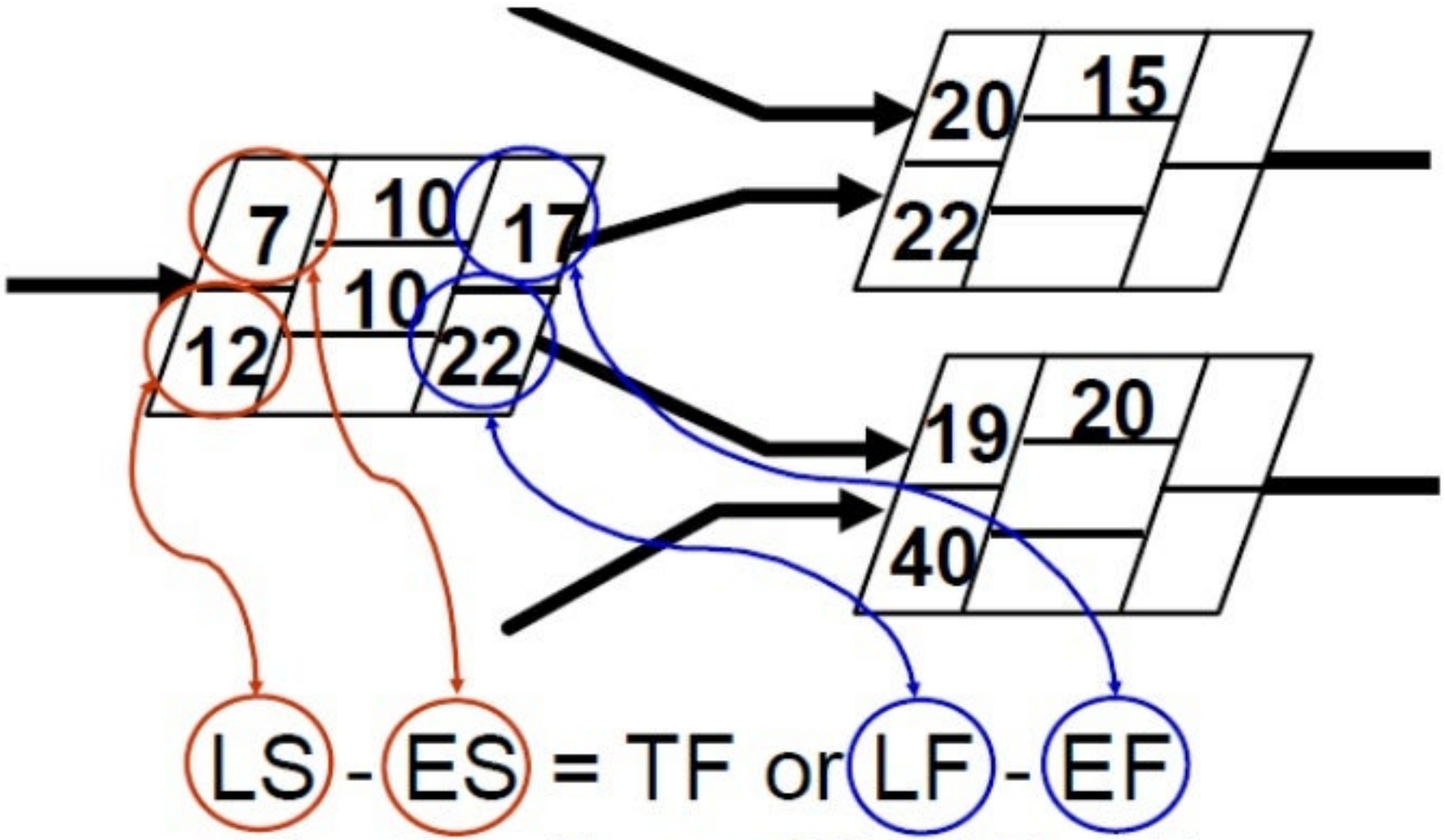
# Critical Path



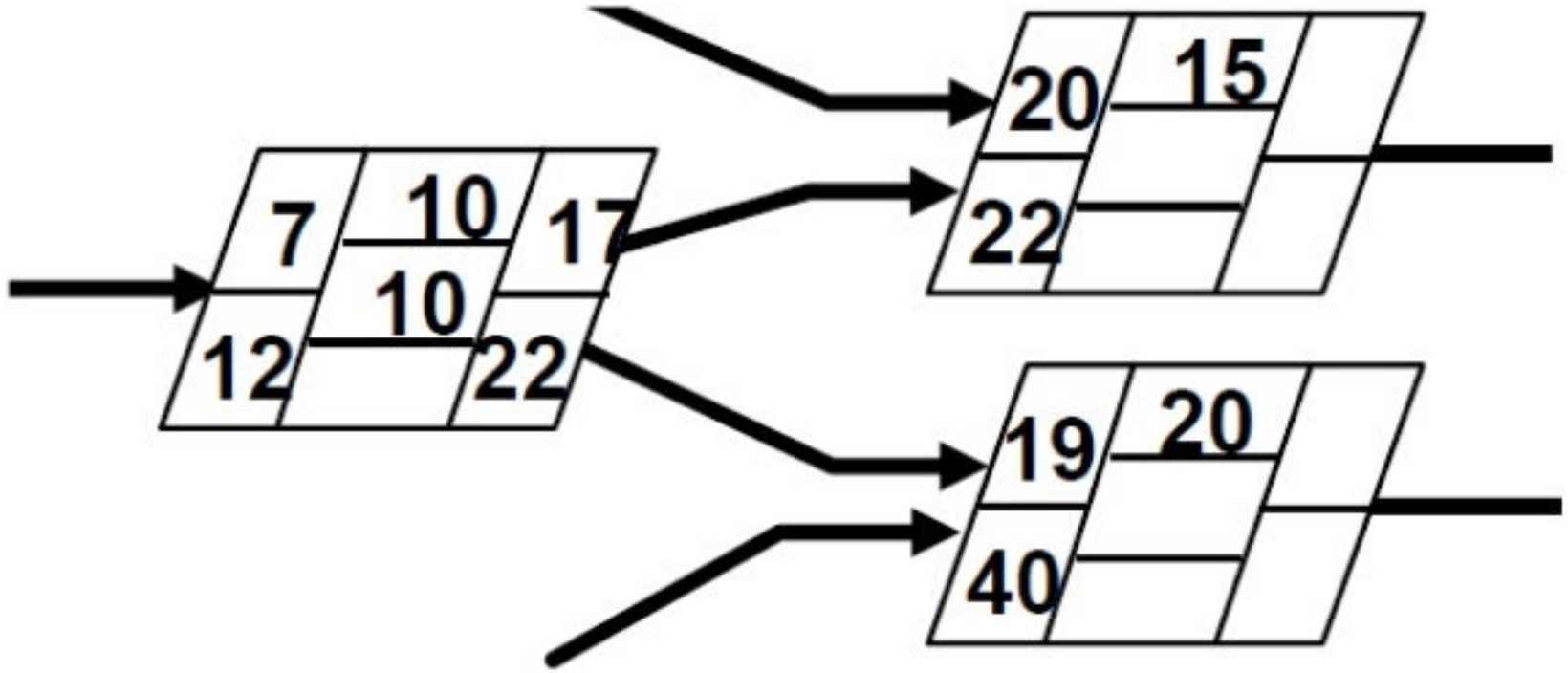
# Float

- Total Float (TF): The amount of time an activity may be delayed without delaying the project.
- Interfering Float (IF): The float which if an activity is delayed into will cause a delay in one or more activities.
- Free Float (FF): The float which if an activity is delayed into will not cause any other activity to be delayed.

# Determining Total Float

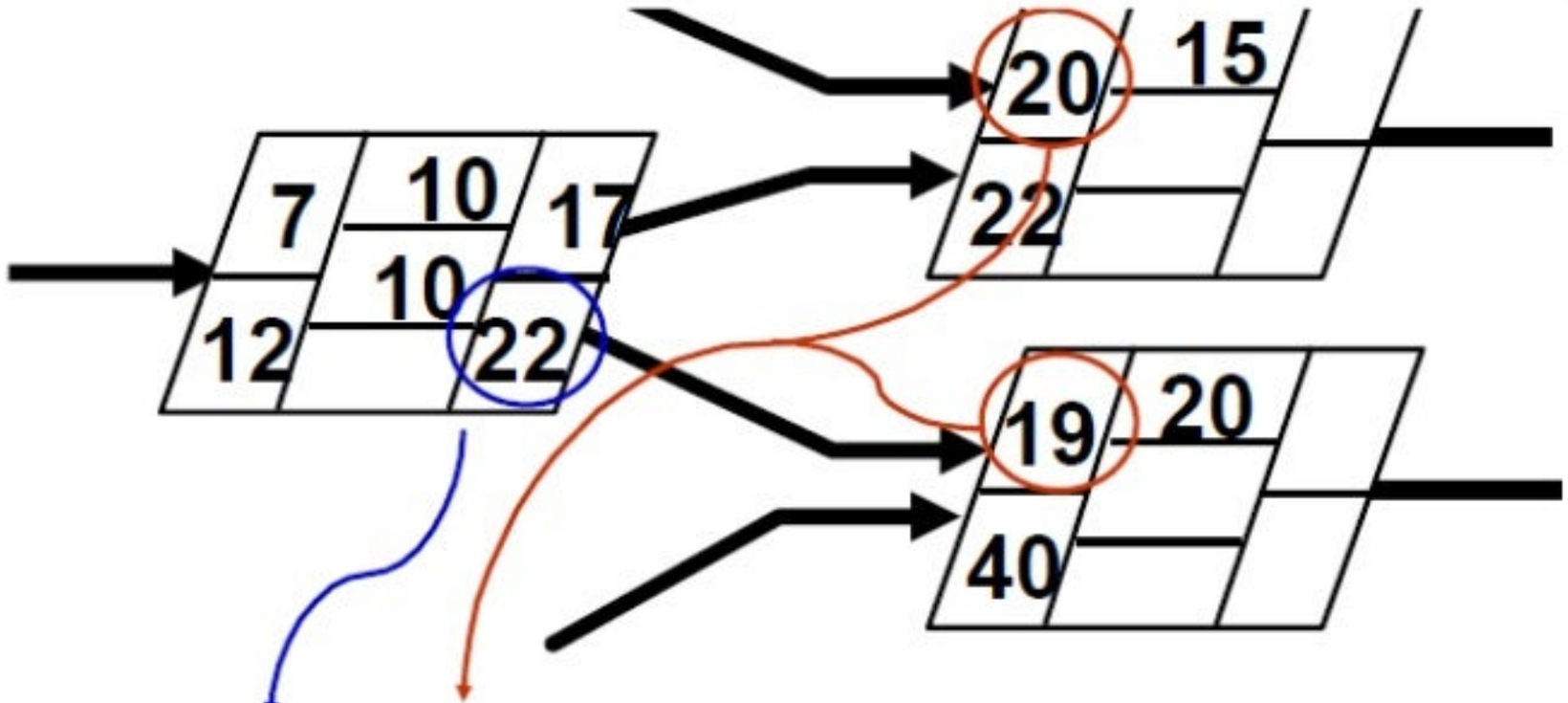


# Determining Interfering Float (IF)




IF = LF – (Smallest ES of following nodes)

# Determining Interfering Float (IF)




IF = 22 - 19 = 3

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# Early Start Schedule

- The next step is to create an Early Start Schedule
- It is coupled with the logic diagram, to create a graphical representation of necessary planning information (Gantt Chart)

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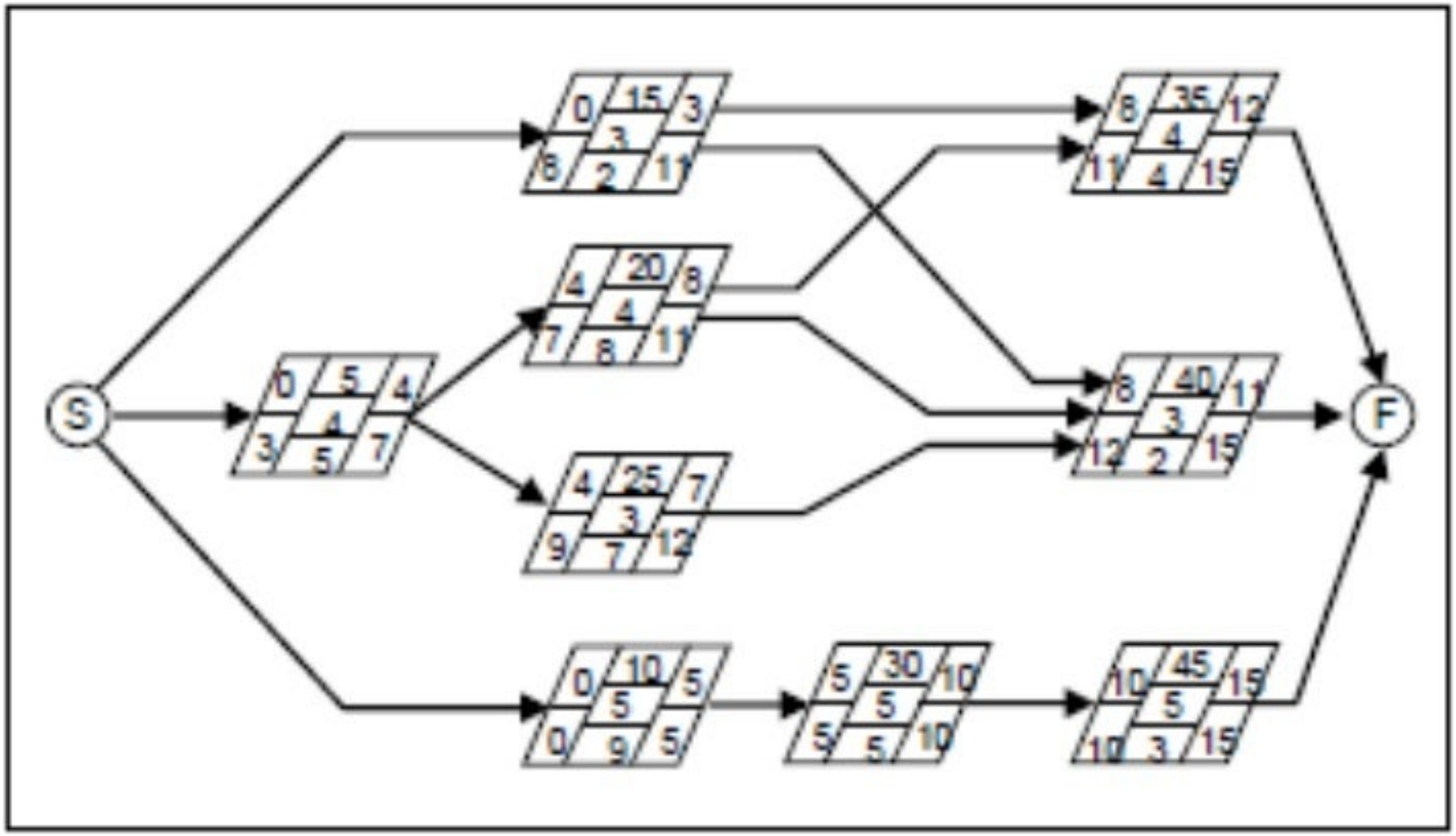
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12 2 15
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5 30 10
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5 5 10
10 45 15
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10 3 15

| NETWORK NUMBER | EARLY START SCHEDULE | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
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| NETWORK NUMBER | EARLY START SCHEDULE | | | | | | | | | | | | | | | | | |
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| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 5 | | | | | | | | | | | | | | | | | | |
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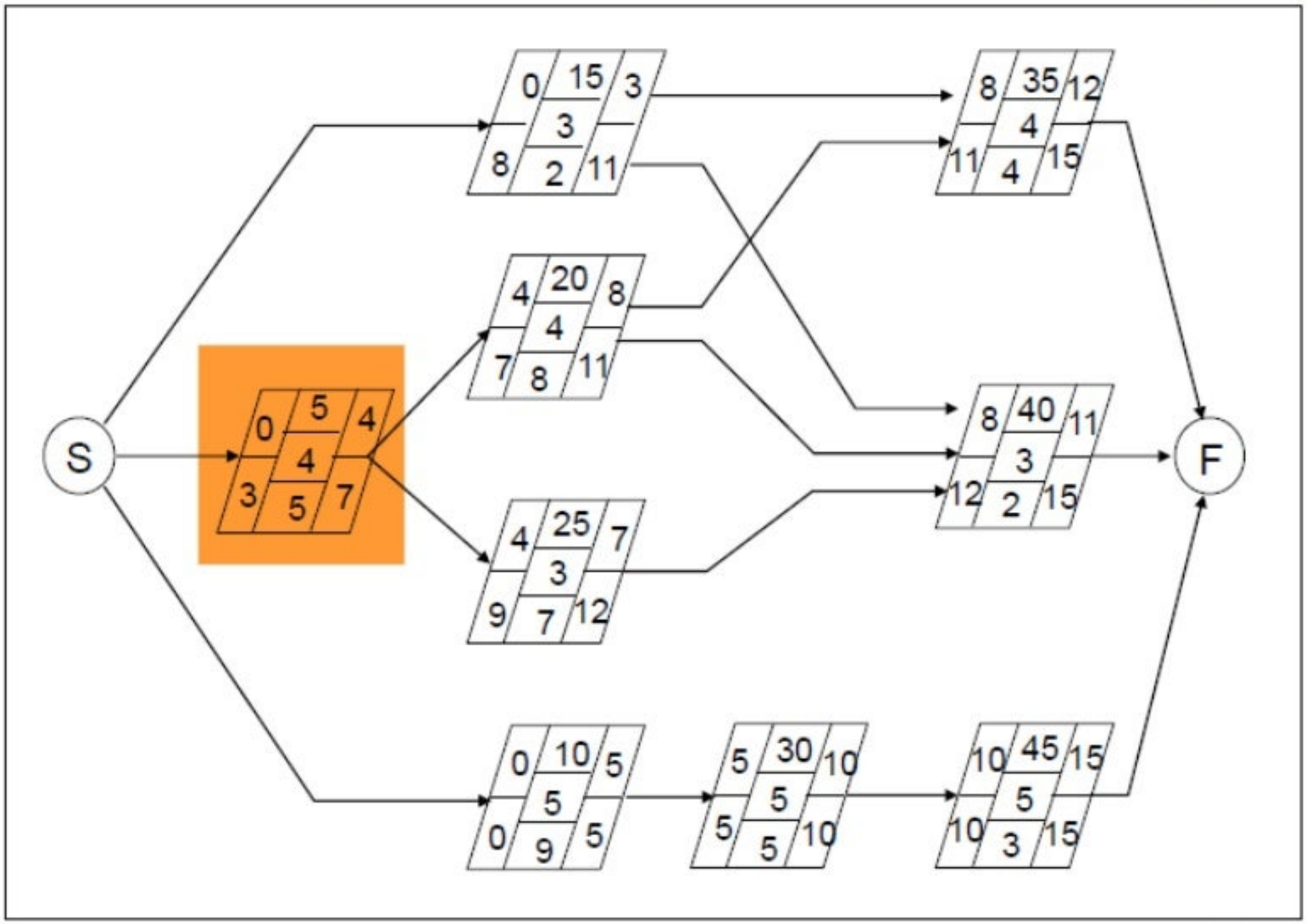
**STEP 1: LIST ACTIVITIES**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3 5 7
0 15 3
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5 5 10
8 35 12
4
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8 40 11
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12 2 15
10 45 15
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10 3 15
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| NETWORK NUMBER | EARLY START SCHEDULE | | | | | | | | | | | | | | | | | |
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| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 5 (20, 25) | | | | | | | | | | | | | | | | | | |
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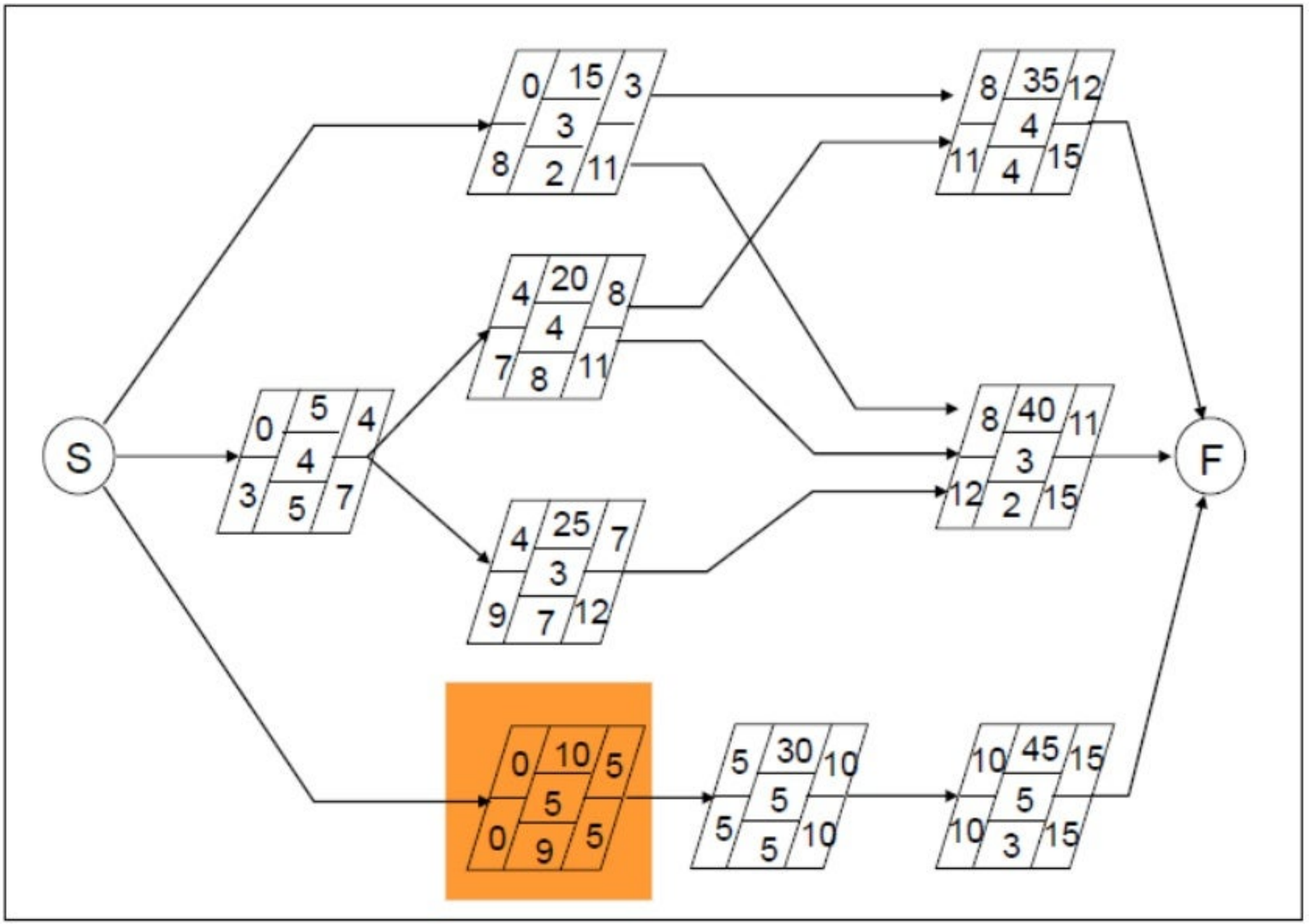
Activities which follow this activity

Activity Number listed sequentially

## STEP 1: LIST ACTIVITIES


S
0 15 3
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8 2 11
0 5 4
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3 5 7
4 20 8
4
7 8 11
4 25 7
3
9 7 12
8 35 12
4
11 4 15
8 40 11
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12 2 15
0 10 5
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5 30 10
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5 5 10
10 45 15
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10 3 15
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| NETWORK NUMBER | EARLY START SCHEDULE | | | | | | | | | | | | | | | | | |
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| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 5 (20, 25) | | | | | | | | | | | | | | | | | | |
| 10 (30) | | | | | | | | | | | | | | | | | | |
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STEP 1: LIST ACTIVITIES

| NETWORK NUMBER | EARLY START SCHEDULE | | | | | | | | | | | | | | | | | |
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| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 5 (20, 25) | | | | | | | | | | | | | | | | | | |
| 10 (30) | | | | | | | | | | | | | | | | | | |
| 15 (35, 40) | | | | | | | | | | | | | | | | | | |
| 20 (35, 40) | | | | | | | | | | | | | | | | | | |
| 25 (40) | | | | | | | | | | | | | | | | | | |
| 30 (45) | | | | | | | | | | | | | | | | | | |
| 35 (F) | | | | | | | | | | | | | | | | | | |
| 40 (F) | | | | | | | | | | | | | | | | | | |
| 45 (F) | | | | | | | | | | | | | | | | | | |
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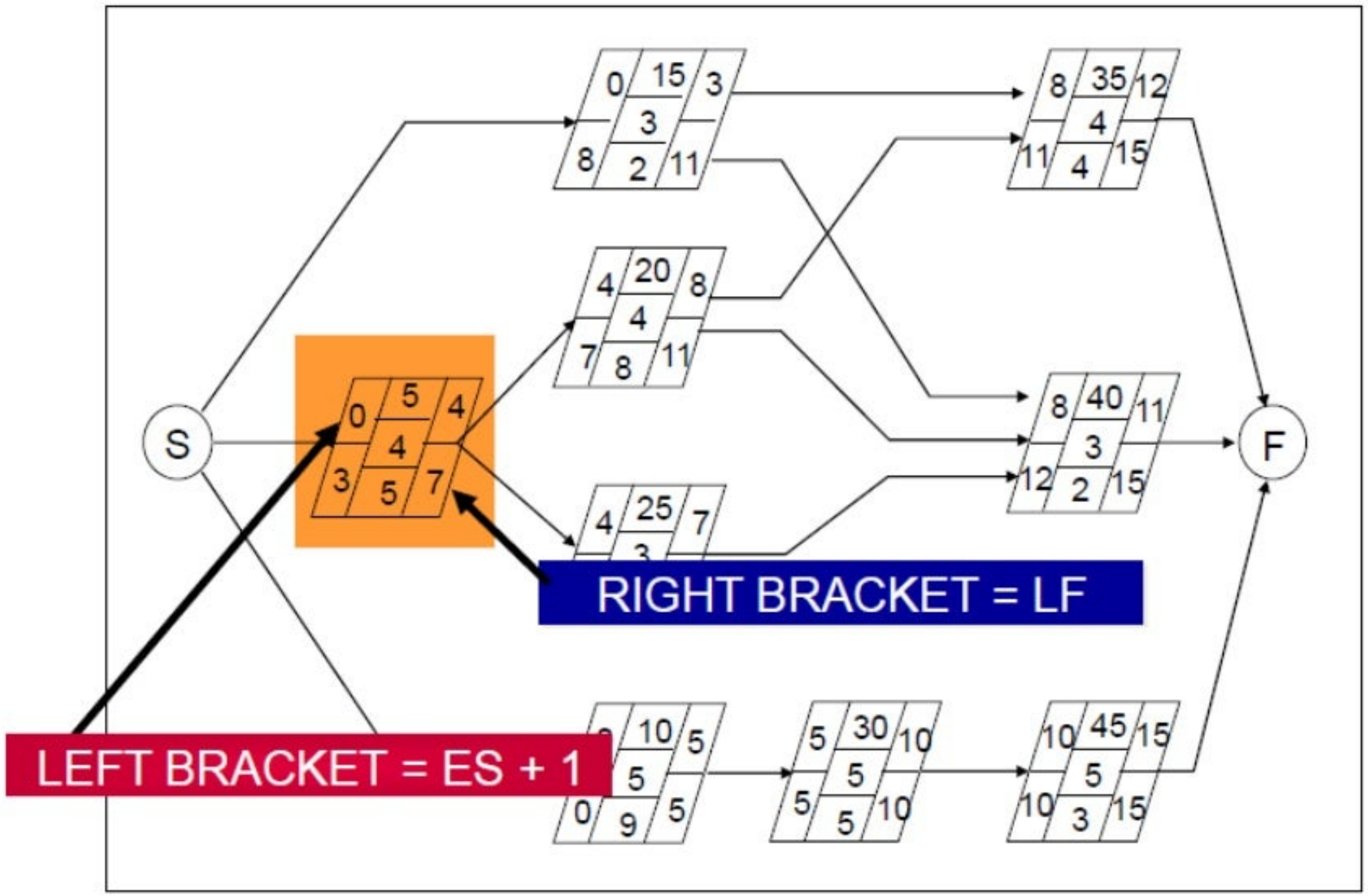
STEP 1: LIST ACTIVITIES


S
0 5 4
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3 5 7
0 15 3
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8 2 11
4 20 8
4
7 8 11
4 25 7
3
8 35 12
4
11 4 15
8 40 11
3
12 2 15
F
RIGHT BRACKET = LF
LEFT BRACKET = ES + 1
10 5
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0 9 5
5 30 10
5
5 5 10
10 45 15
5
10 3 15

| NETWORK NUMBER | EARLY START SCHEDULE | | | | | | | | | | | | | | | | | |
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| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 5 (20, 25) | [ | | | | | | ] | | | | | | | | | | | |
| 10 (30) | | | | | | | | | | | | | | | | | | |
| 15 (35, 40) | | | | | | | | | | | | | | | | | | |
| 20 (35, 40) | | | | | | | | | | | | | | | | | | |
| 25 (40) | | | | | | | | | | | | | | | | | | |
| 30 (45) | | | | | | | | | | | | | | | | | | |
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| 40 (F) | | | | | | | | | | | | | | | | | | |
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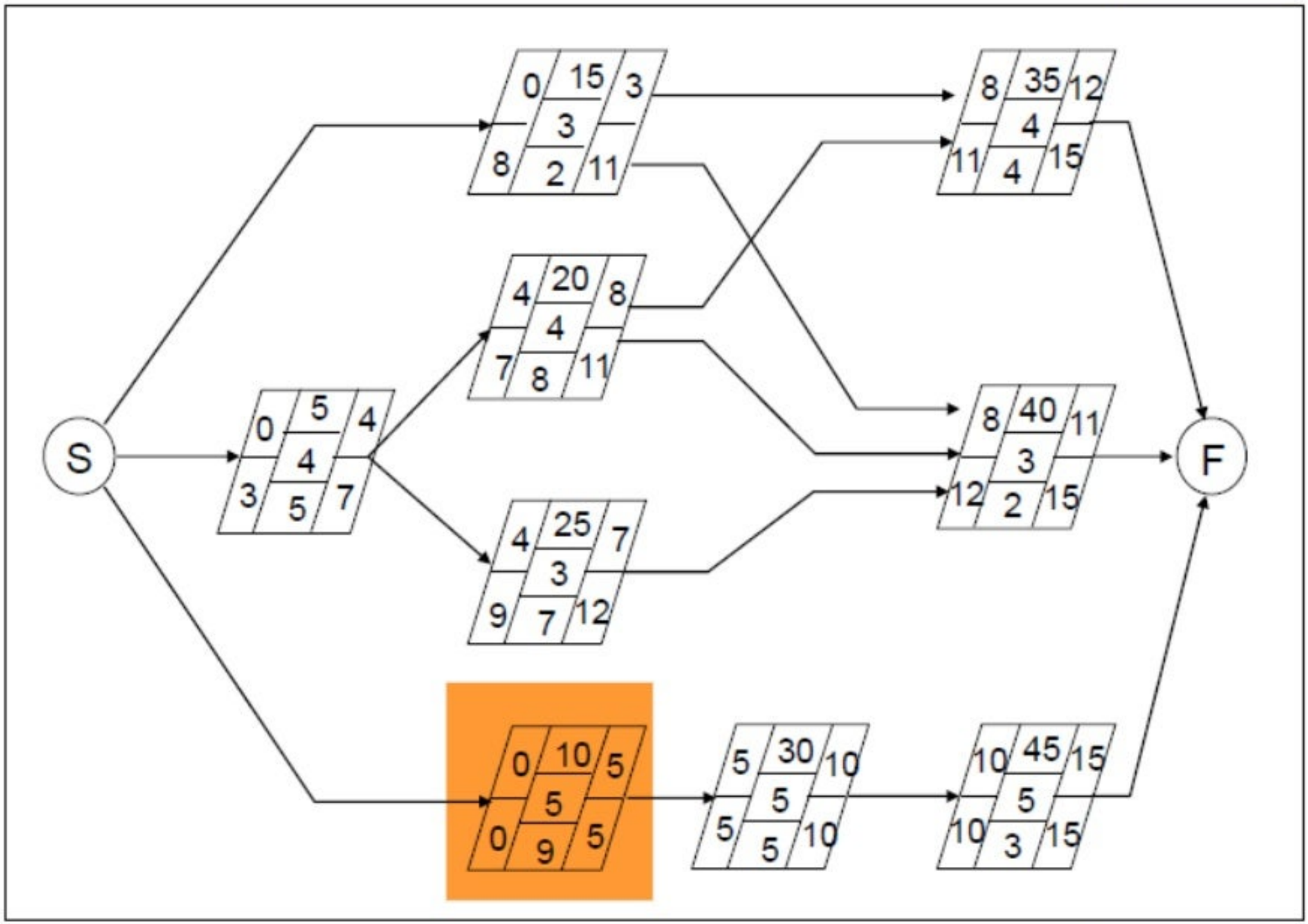
RIGHT BRACKET = LF

LEFT BRACKET = ES + 1

STEP 1: LIST ACTIVITIES

STEP 2: MARK TIME FRAMES


S
0 15 3
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8 2 11
4 20 8
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4 25 7
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9 7 12
0 10 5
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8 40 11
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12 2 15
5 30 10
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5 5 10
10 45 15
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10 3 15
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| NETWORK NUMBER | EARLY START SCHEDULE | | | | | | | | | | | | | | | | | |
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| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 5 (20, 25) | [ | | | | | | ] | | | | | | | | | | | |
| 10 (30) | [ | | | | ] | | | | | | | | | | | | | |
| 15 (35, 40) | | | | | | | | | | | | | | | | | | |
| 20 (35, 40) | | | | | | | | | | | | | | | | | | |
| 25 (40) | | | | | | | | | | | | | | | | | | |
| 30 (45) | | | | | | | | | | | | | | | | | | |
| 35 (F) | | | | | | | | | | | | | | | | | | |
| 40 (F) | | | | | | | | | | | | | | | | | | |
| 45 (F) | | | | | | | | | | | | | | | | | | |
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| STEP 1: LIST ACTIVITIES | | | | | | | | | | | | | | | | | | |
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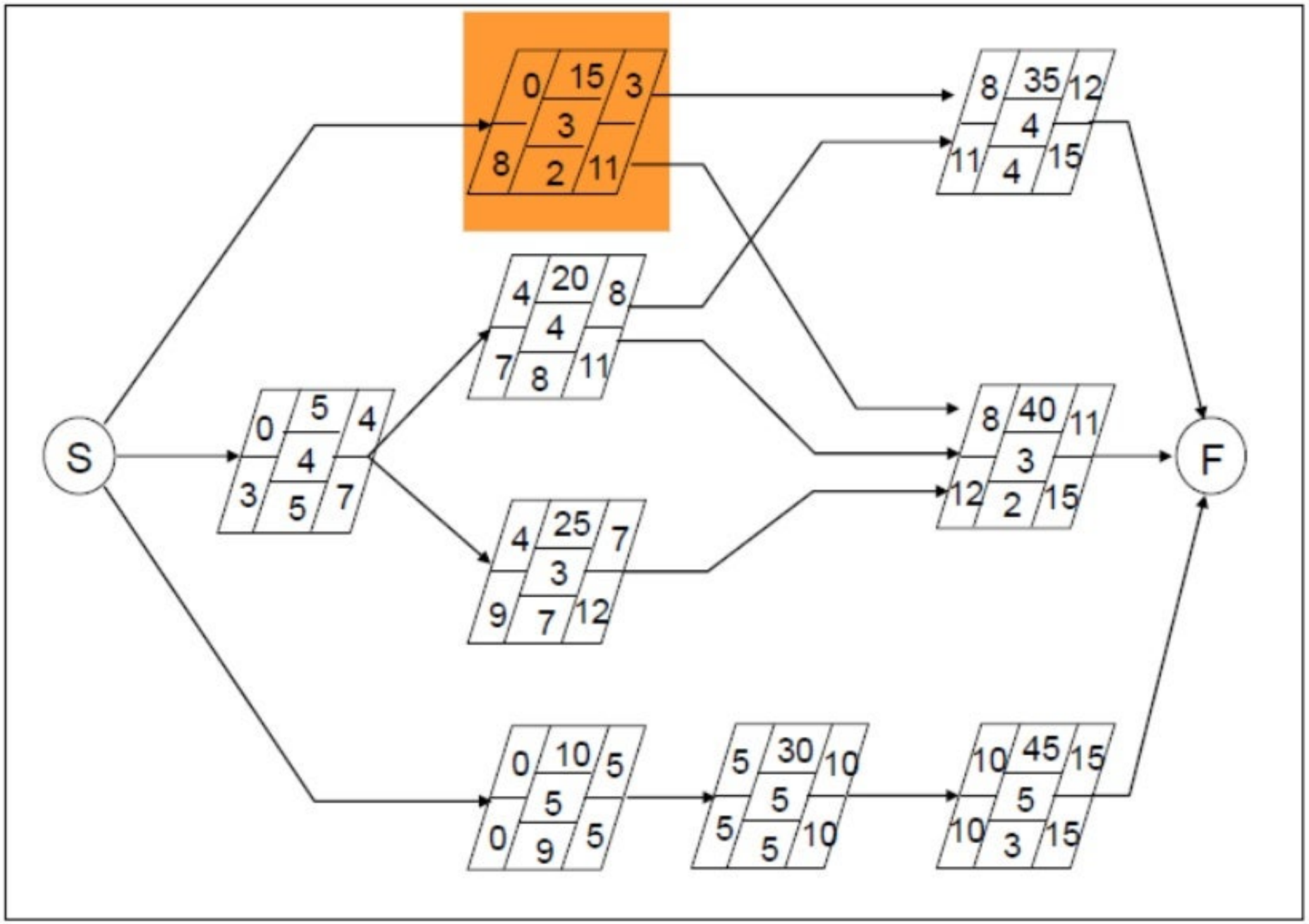
STEP 2: MARK TIME FRAMES


S
0 15 3
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8 2 11
0 5 4
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4 20 8
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7 8 11
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8 35 12
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| NETWORK NUMBER | EARLY START SCHEDULE | | | | | | | | | | | | | | | | | |
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| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 5 (20, 25) | [ | | | | | | ] | | | | | | | | | | | |
| 10 (30) | [ | | | | ] | | | | | | | | | | | | | |
| 15 (35, 40) | [ | | | | | | | | | | ] | | | | | | | |
| 20 (35, 40) | | | | | [ | | | | | | ] | | | | | | | |
| 25 (40) | | | | | [ | | | | | | | ] | | | | | | |
| 30 (45) | | | | | | [ | | | | ] | | | | | | | | |
| 35 (F) | | | | | | | | | [ | | | | | | ] | | | |
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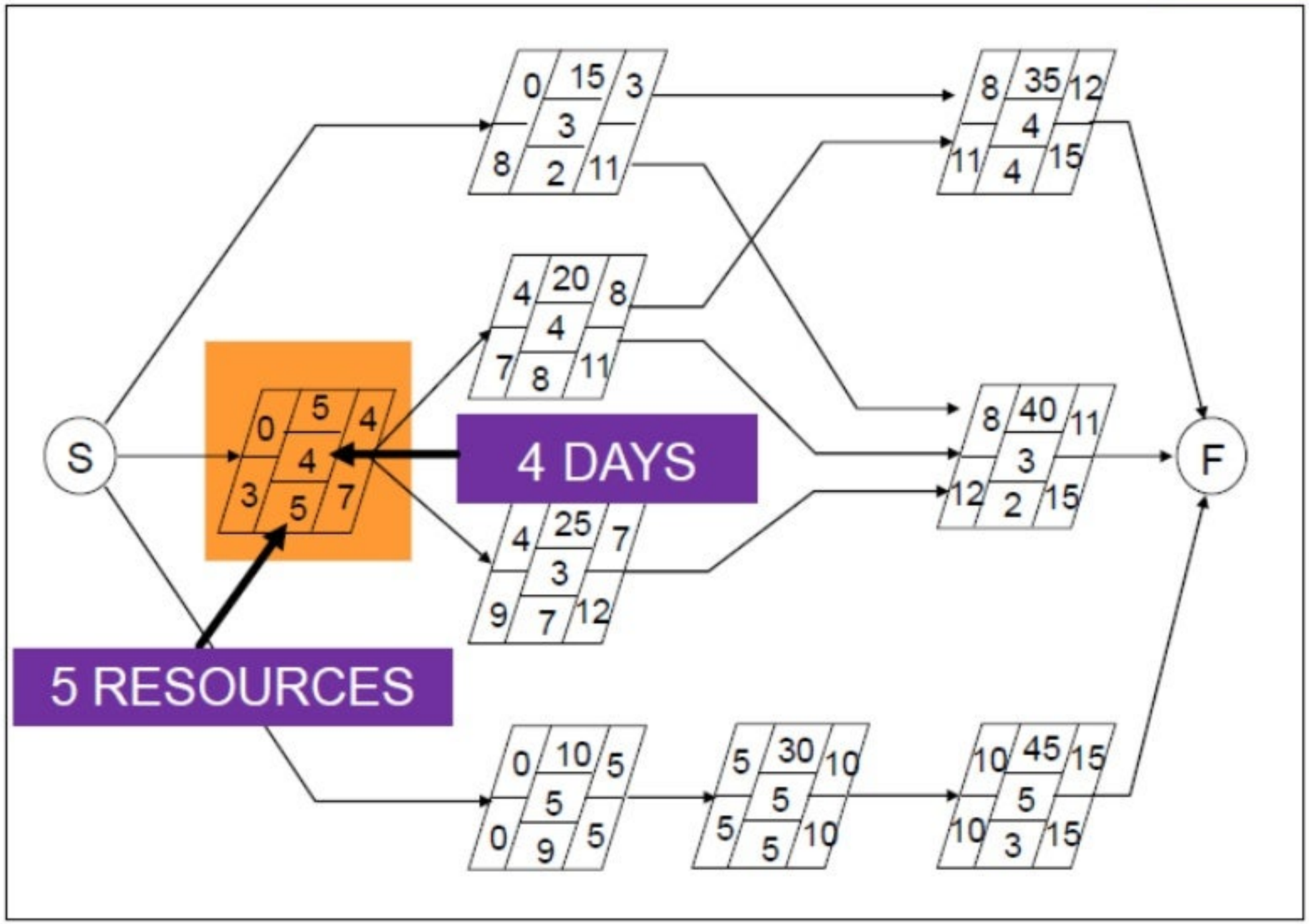
STEP 1: LIST ACTIVITIES

STEP 2: MARK TIME FRAMES

STEP 3: SCHEDULE RESOURCES


0 15 3
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8 2 11
8 35 12
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11 4 15
4 20 8
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7 8 11
S
0 5 4
4
3 5 7
4 DAYS
8 40 11
3
12 2 15
F
4 25 7
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9 7 12
5 RESOURCES
0 10 5
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| NETWORK NUMBER | EARLY START SCHEDULE | | | | | | | | | | | | | | | | | |
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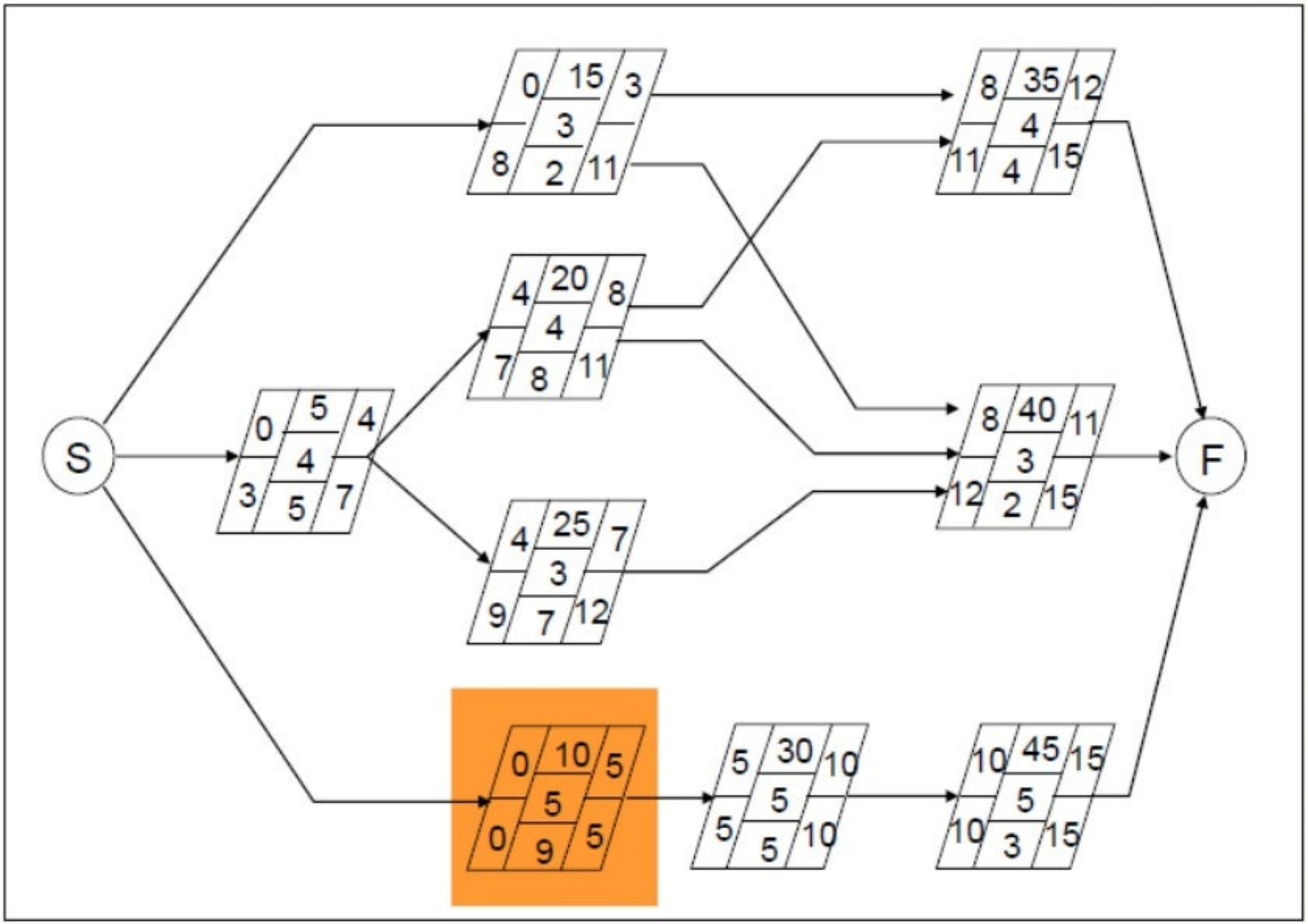
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 5 (20, 25) | [ 5 | 5 | 5 | 5 | | | ] | | | | | | | | | | | |
| 10 (30) | [ | | | | ] | | | | | | | | | | | | | |
| 15 (35, 40) | [ | | | | | | | | | | ] | | | | | | | |
| 20 (35, 40) | | | | | [ | | | | | | ] | | | | | | | |
| 25 (40) | | | | | [ | | | | | | | ] | | | | | | |
| 30 (45) | | | | | | [ | | | | ] | | | | | | | | |
| 35 (F) | | | | | | | | | [ | | | | | | ] | | | |
| 40 (F) | | | | | | | | | [ | | | | | | ] | | | |
| 45 (F) | | | | | | | | | | | [ | | | | ] | | | |

STEP 1: LIST ACTIVITIES

STEP 2: MARK TIME FRAMES

STEP 3: SCHEDULE RESOURCES


S
0 15 3
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8 2 11
8 35 12
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11 4 15
4 20 8
4
7 8 11
0 5 4
4
3 5 7
8 40 11
3
12 2 15
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4 25 7
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9 7 12
0 10 5
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0 9 5
5 30 10
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5 5 10
10 45 15
5
10 3 15

| NETWORK NUMBER | EARLY START SCHEDULE | | | | | | | | | | | | | | | | | |
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| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 5 (20, 25) | [ 5 | 5 | 5 | 5 | | | ] | | | | | | | | | | | |
| 10 (30) | [ 9 | 9 | 9 | 9 | 9 ] | | | | | | | | | | | | | |
| 15 (35, 40) | [ | | | | | | | | | | ] | | | | | | | |
| 20 (35, 40) | | | | | [ | | | | | | ] | | | | | | | |
| 25 (40) | | | | | [ | | | | | | | ] | | | | | | |
| 30 (45) | | | | | | [ | | | | ] | | | | | | | | |
| 35 (F) | | | | | | | | | [ | | | | | | ] | | | |
| 40 (F) | | | | | | | | | [ | | | | | | ] | | | |
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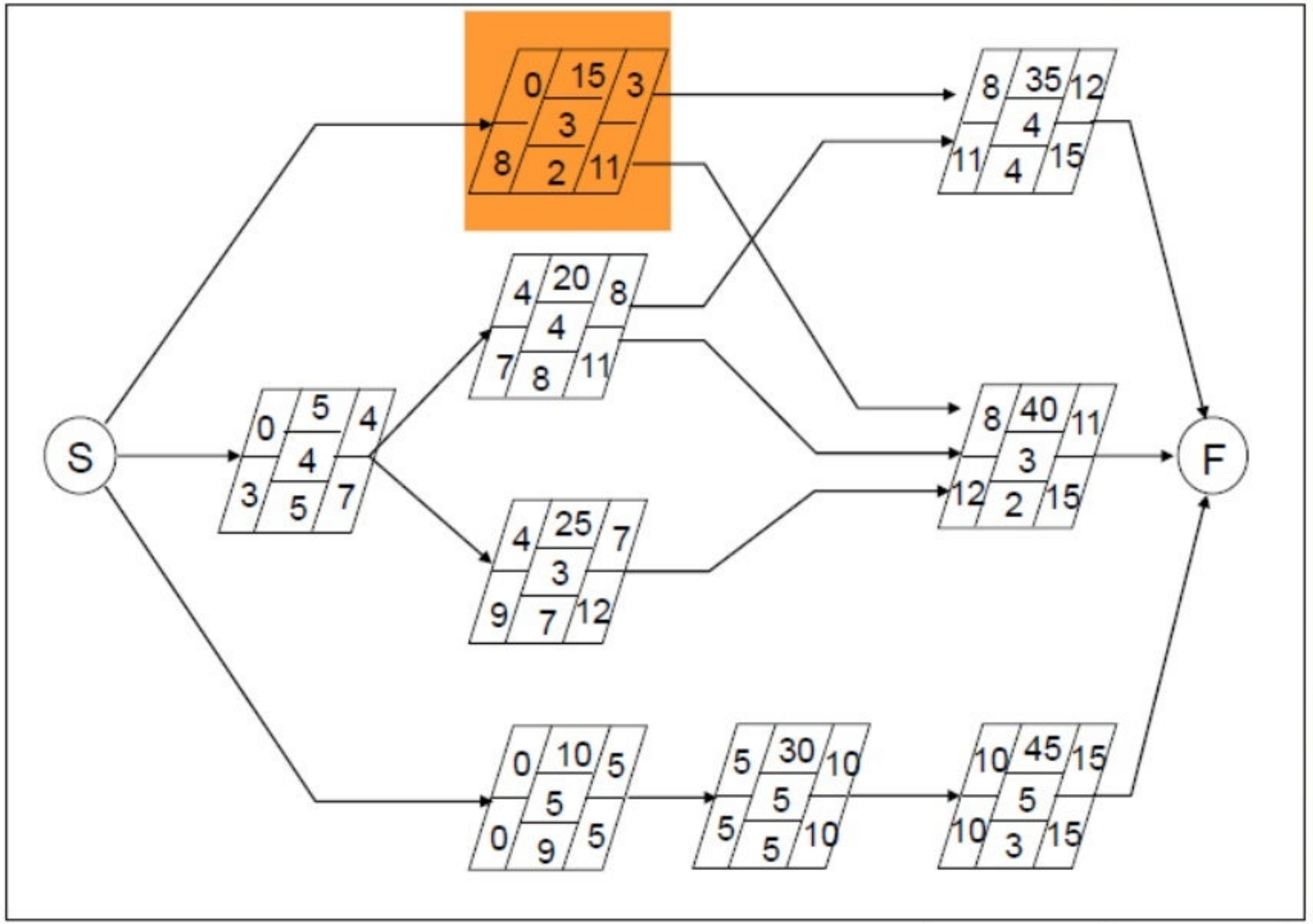
STEP 1: LIST ACTIVITIES

STEP 2: MARK TIME FRAMES

STEP 3: SCHEDULE RESOURCES


S
0 15 3
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0 5 4
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3 5 7
4 20 8
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7 8 11
4 25 7
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9 7 12
0 10 5
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11 4 15
8 40 11
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5 30 10
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5 5 10
10 45 15
5
10 3 15
F

| NETWORK NUMBER | EARLY START SCHEDULE | | | | | | | | | | | | | | | | | |
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| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 5 (20, 25) | [ | | | | | | ] | | | | | | | | | | | |
| 10 (30) | [ | | | | ] | | | | | | | | | | | | | |
| 15 (35, 40) | [ | | | | | | | | | | ] | | | | | | | |
| 20 (35, 40) | | | | | [ | | | | | | ] | | | | | | | |
| 25 (40) | | | | | [ | | | | | | | ] | | | | | | |
| 30 (45) | | | | | | [ | | | | ] | | | | | | | | |
| 35 (F) | | | | | | | | | [ | | | | | | ] | | | |
| 40 (F) | | | | | | | | | [ | | | | | | ] | | | |
| 45 (F) | | | | | | | | | | [ | | | | | ] | | | |
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| STEP 1: LIST ACTIVITIES | | | | | | | | | | | | | | | | | | |
| STEP 2: MARK TIME FRAMES | | | | | | | | | | | | | | | | | | |
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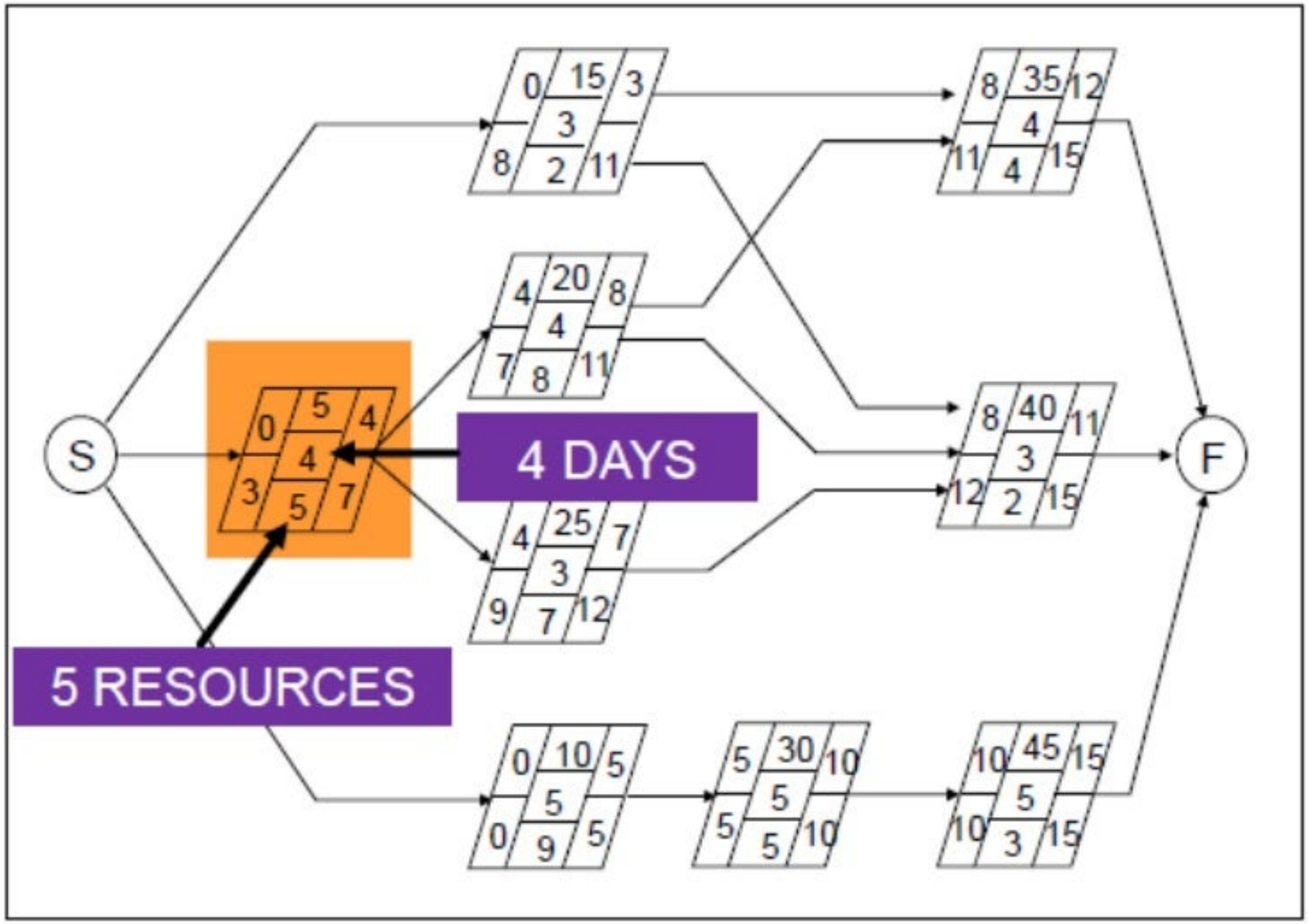
STEP 3: SCHEDULE RESOURCES


S
0 5 4
4
3 5 7
4 DAYS
5 RESOURCES
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8 2 11
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7 8 11
4 25 7
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9 7 12
0 10 5
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0 9 5
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5 5 10
8 35 12
4
11 4 15
8 40 11
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10 45 15
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10 3 15
F

| NETWORK NUMBER | EARLY START SCHEDULE | | | | | | | | | | | | | | | | | |
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| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 5 (20, 25) | [ 5 | 5 | 5 | 5 | | | ] | | | | | | | | | | | |
| 10 (30) | [ | | | | ] | | | | | | | | | | | | | |
| 15 (35, 40) | [ | | | | | | | | | | ] | | | | | | | |
| 20 (35, 40) | | | | | [ | | | | | | ] | | | | | | | |
| 25 (40) | | | | | [ | | | | | | | ] | | | | | | |
| 30 (45) | | | | | | [ | | | | ] | | | | | | | | |
| 35 (F) | | | | | | | | | [ | | | | | | ] | | | |
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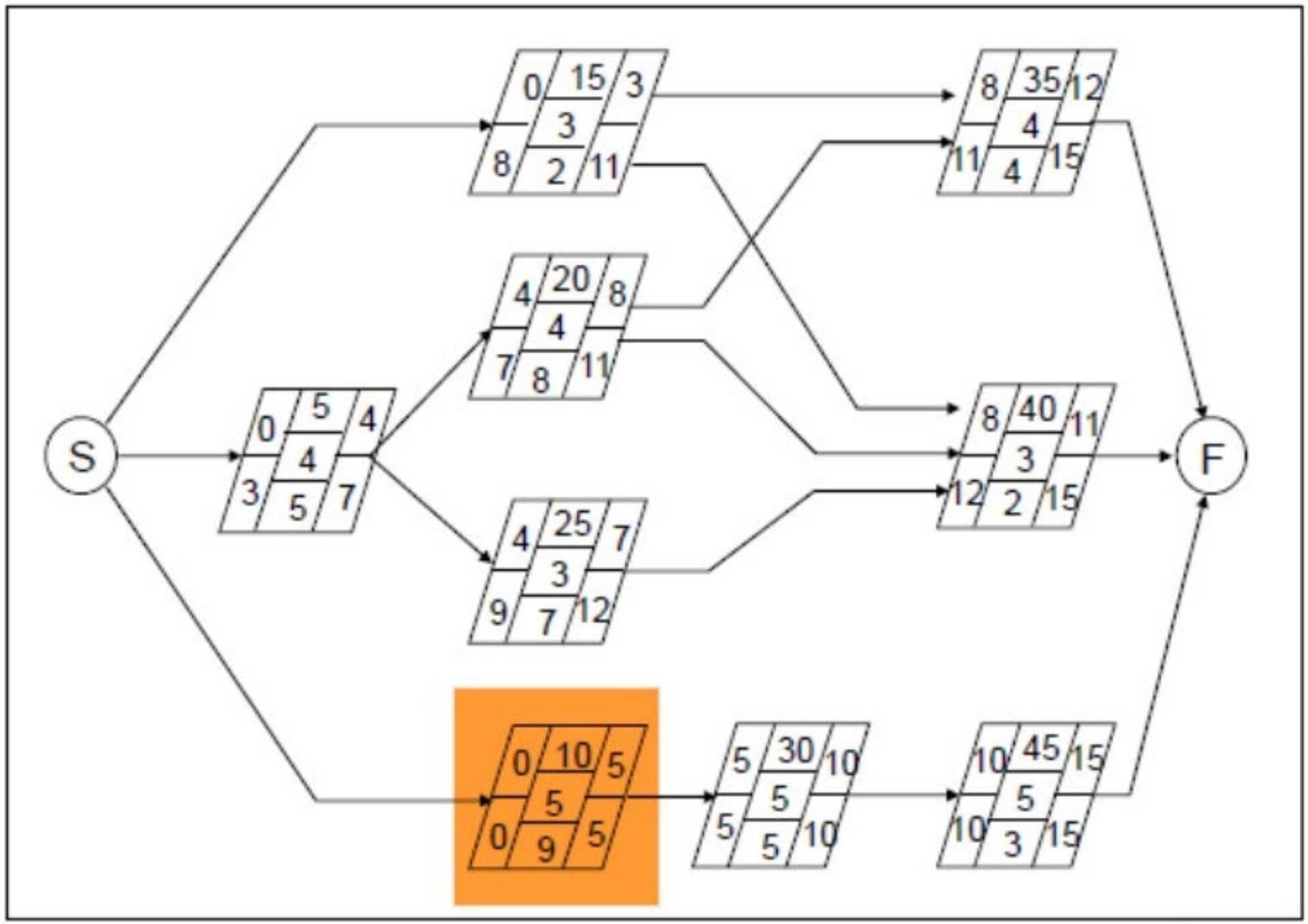
STEP 1: LIST ACTIVITIES

STEP 2: MARK TIME FRAMES

STEP 3: SCHEDULE RESOURCES


S
0 15 3
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4 20 8
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7 8 11
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9 7 12
0 10 5
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8 35 12
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8 40 11
3
12 2 15
5 30 10
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5 5 10
10 45 15
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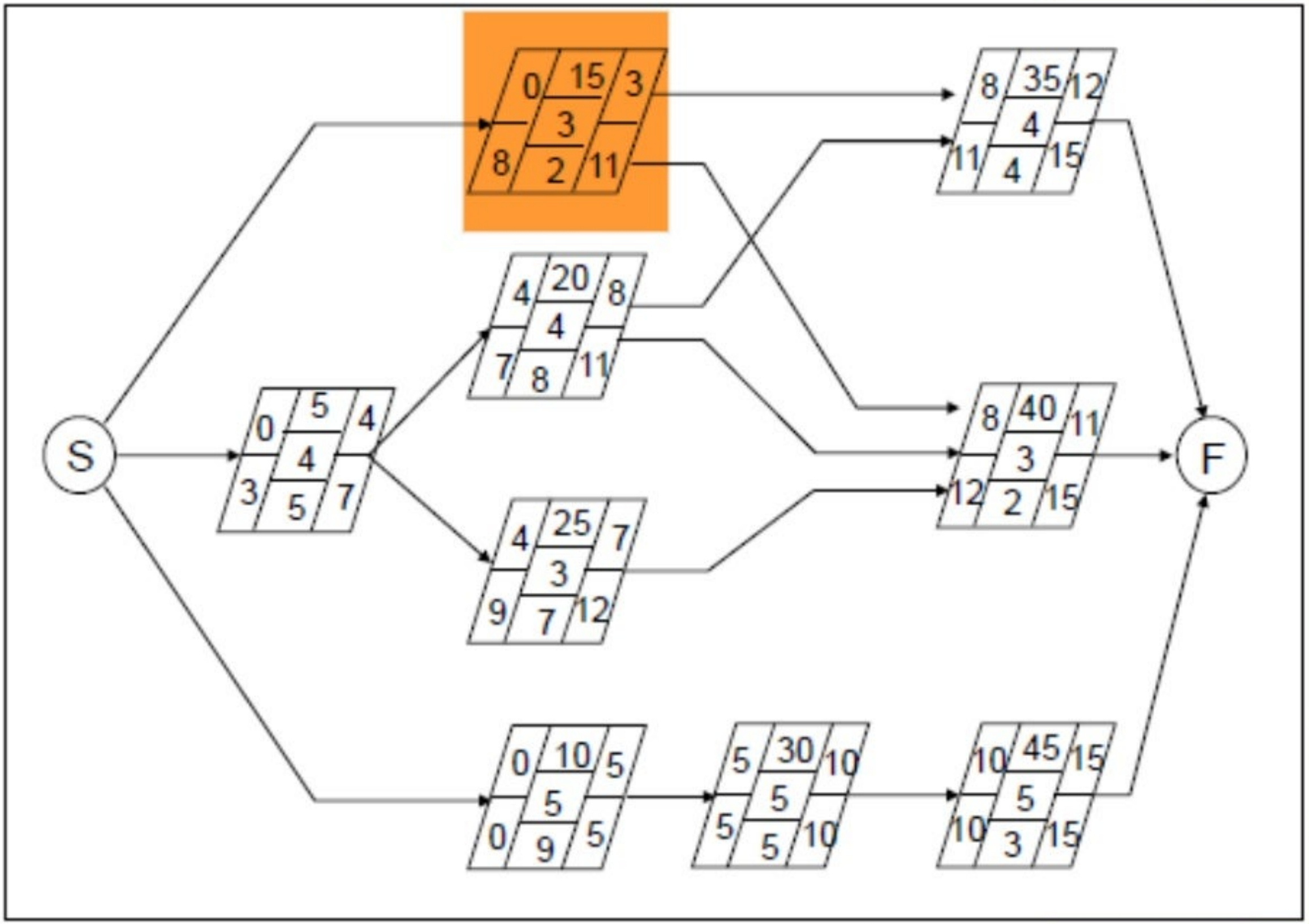
10 3 15
F

| NETWORK NUMBER | EARLY START SCHEDULE | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 5 (20, 25) | [ 5 | 5 | 5 | 5 | | | ] | | | | | | | | | | | |
| 10 (30) | [ 9 | 9 | 9 | 9 | 9] | | | | | | | | | | | | | |
| 15 (35, 40) | [ | | | | | | | | | | ] | | | | | | | |
| 20 (35, 40) | | | | | [ | | | | | | ] | | | | | | | |
| 25 (40) | | | | | [ | | | | | | | ] | | | | | | |
| 30 (45) | | | | | | [ | | | | ] | | | | | | | | |
| 35 (F) | | | | | | | | | [ | | | | | | ] | | | |
| 40 (F) | | | | | | | | | [ | | | | | | ] | | | |
| 45 (F) | | | | | | | | | | | [ | | | | ] | | | |

STEP 1: LIST ACTIVITIES

STEP 2: MARK TIME FRAMES

STEP 3: SCHEDULE RESOURCES


S
0 15 3
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8 2 11
4 20 8
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7 8 11
0 5 4
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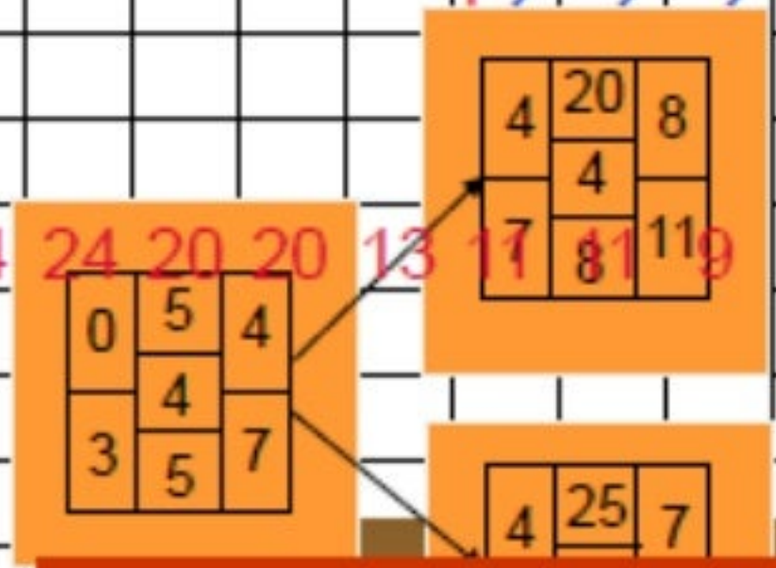
3 5 7
4 25 7
3
9 7 12
0 10 5
5
0 9 5
8 35 12
4
11 4 15
8 40 11
3
12 2 15
5 30 10
5
5 5 10
10 45 15
5
10 3 15
F

| NETWORK NUMBER | EARLY START SCHEDULE | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 5 (20, 25) | [5 | 5 | 5 | 5 | X | X | X] | | | | | | | | | | | |
| 10 (30) | [9 | 9 | 9 | 9 | 9] | | | | | | | | | | | | | |
| 15 (35, 40) | [2 | 2 | 2 | | | | | | X | X | X] | | | | | | | |
| 20 (35, 40) | | | | | [8 | 8 | 8 | 8 | | | ] | | | | | | | |
| 25 (40) | | | | | | | | | | | | | | | | | | |
| 30 (45) | | | | | | | | | | | | | | | | | | |
| 35 (F) | | | | | | | | | | | | | | | | | | |
| 40 (F) | | | | | | | | | [2 | 2 | 2 | | | | | | | |
| 45 (F) | | | | | | | | | | | | 3 | 3 | 3 | 3] | | | |
| TOTAL | 16 | 16 | 16 | 14 | 24 | 20 | 20 | 13 | 11 | 11 | 9 | 7 | 3 | 3 | 3 | | | |

TF = 3 - 0 = 3, IF = 7 - 4 = 3

TF = 8 - 0 = 8
IF = 11- 8 = 3

TOTAL FLOAT = LS - ES OR LF - EF
INTERFERING FLOAT = LF - SMALLEST ES OF FOLLOWING ACTIVITIES




STEP 1: LIST ACTIVITIES

STEP 2: MARK TIME FRAMES

STEP 3: SCHEDULE RESOURCES

STEP 4: DETERMINE FLOAT

STEP 5: SUM THE RESOURCES

# Enabling Learning Objectives

- Receive and interpret a construction directive
- Develop an activities list
- Determine sequential relationships among activities
- Construct a logic network
- Estimate resource requirements
- Compute a time analysis
- Prepare an Early Start Schedule
- Employ project control measures
- Resource constrain a construction project

# Project Control

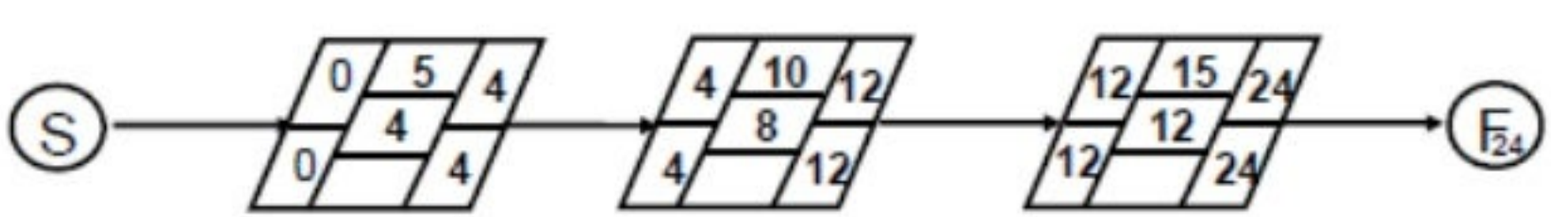
- Project Control is based on two elements:
  - Lag Factors
  - Regaining the Schedule

# Lag Factors

- Allow us to accurately reflect logic of some activities.
- Lag Factors are shown as a percent.
- Activity 10 cannot begin until activity 5 is 25% complete.

# Redefine the Logic

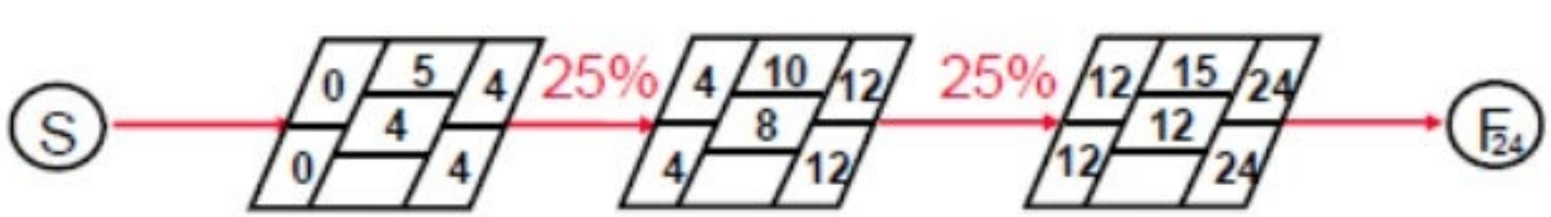
ORIGINAL LOGIC




| Activity | Description |
|---|---|
| 5 (10) | Clear and Grub |
| 10 (15) | Prepare subbase |
| 15 | Base Course |

# Redefine the Logic

ORIGINAL LOGIC

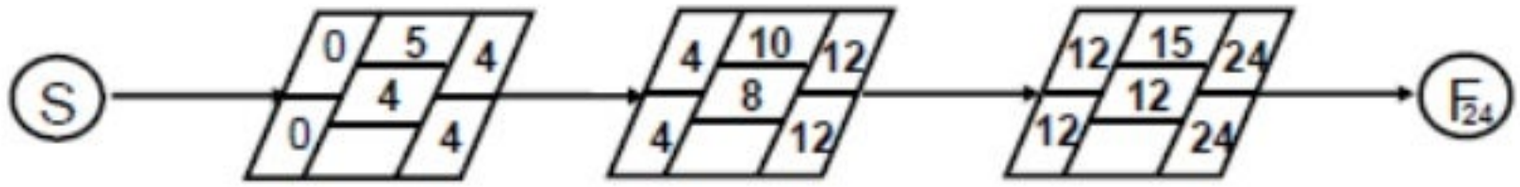



INTRODUCE 25% LAG FACTORS

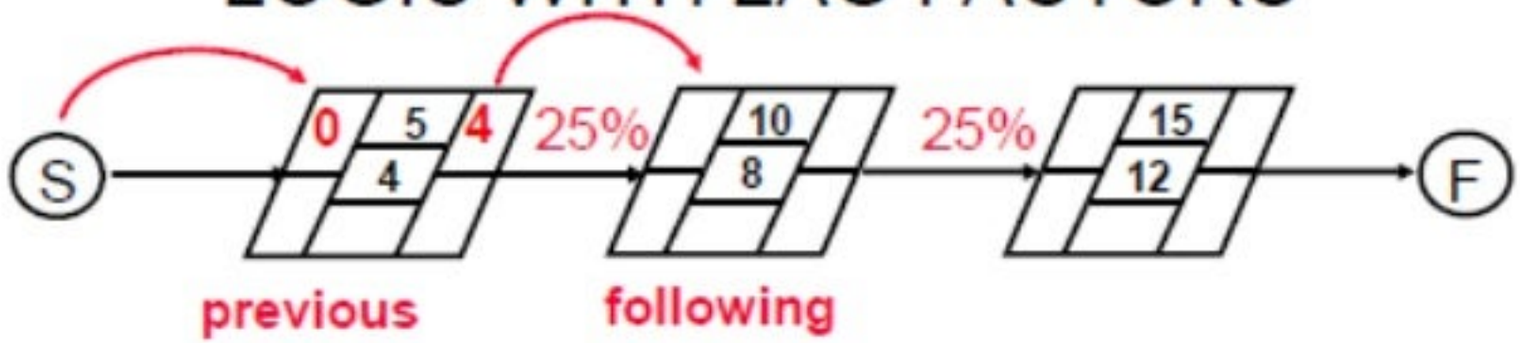
| Activity | Description |
|---|---|
| 5 (10)<br>10 (15)<br>15 | Clear and Grub<br>Prepare subbase<br>Base Course |

# Redefine the Logic

ORIGINAL LOGIC



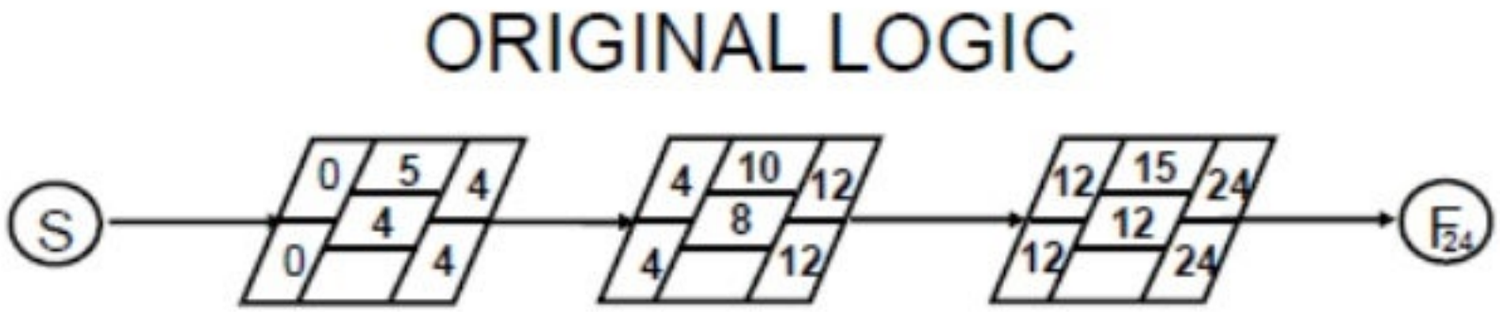

LOGIC WITH LAG FACTORS

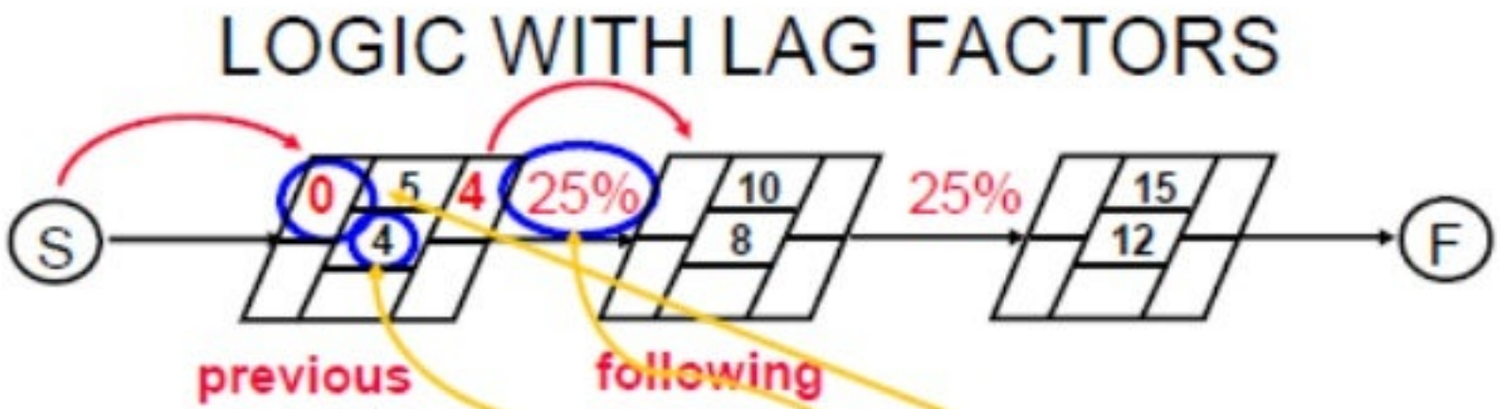



**FORWARD PASS EQUATION:**

**ES (following) = DURR (prev) X % LAG + ES (prev)**

# Redefine the Logic



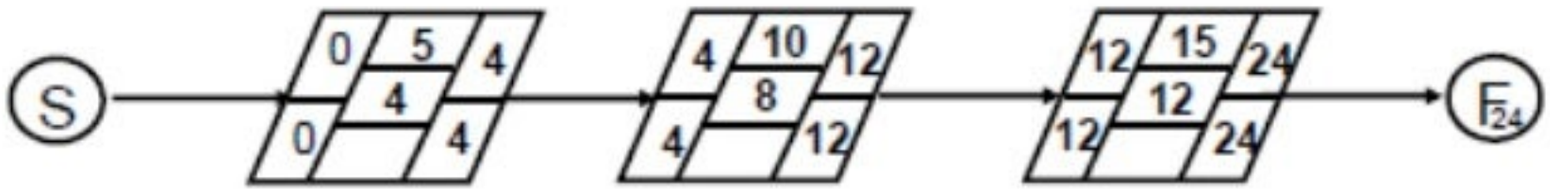




**ES (following) = DURR (prev) X % LAG + ES (prev)**

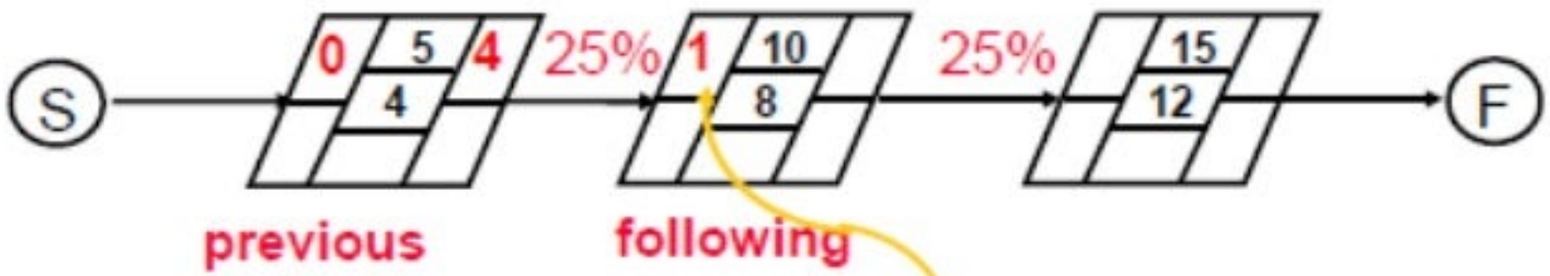
**ES (10) = 4 X 0.25 + 0**

# Redefine the Logic

ORIGINAL LOGIC



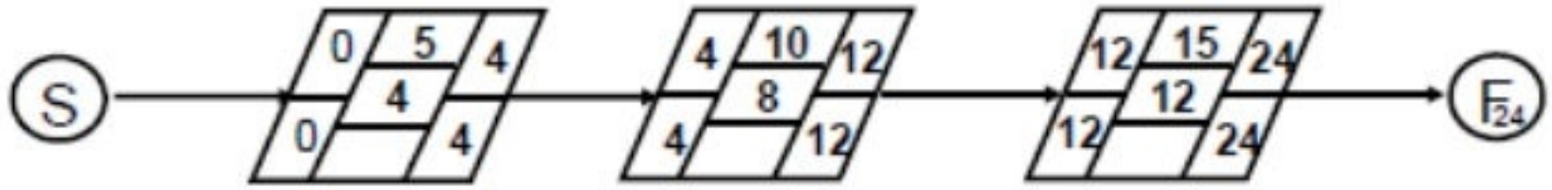

LOGIC WITH LAG FACTORS



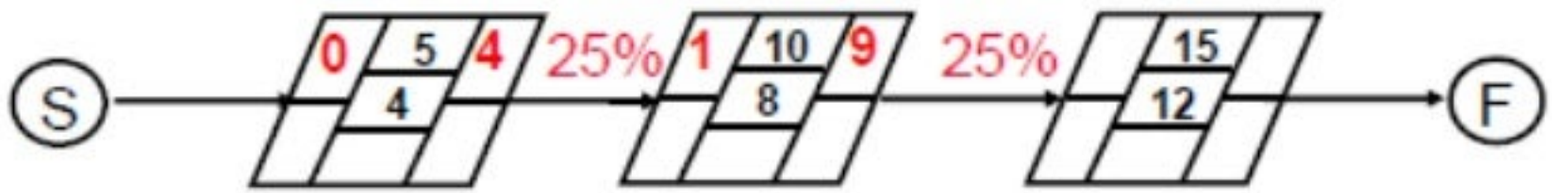

**ES (10) = 4 X 0.25 + 0 = 1**

# Redefine the Logic

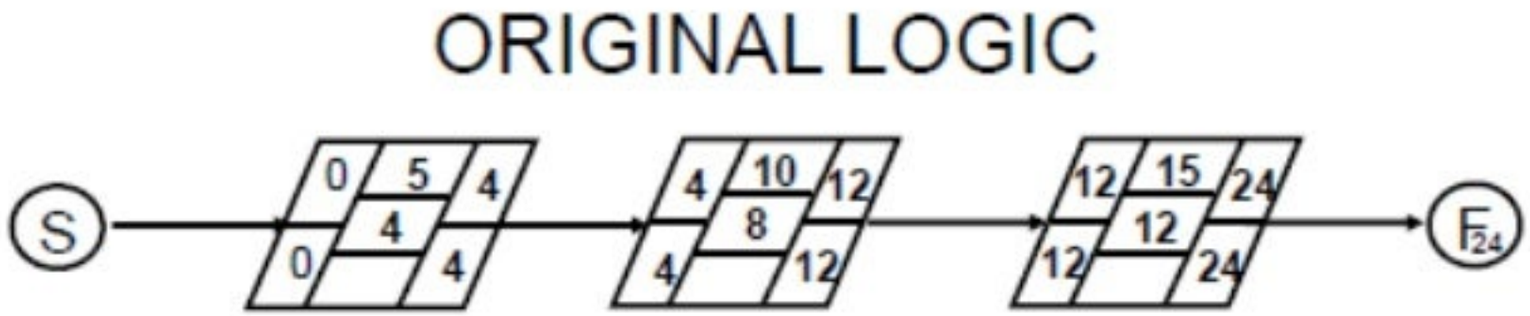
ORIGINAL LOGIC

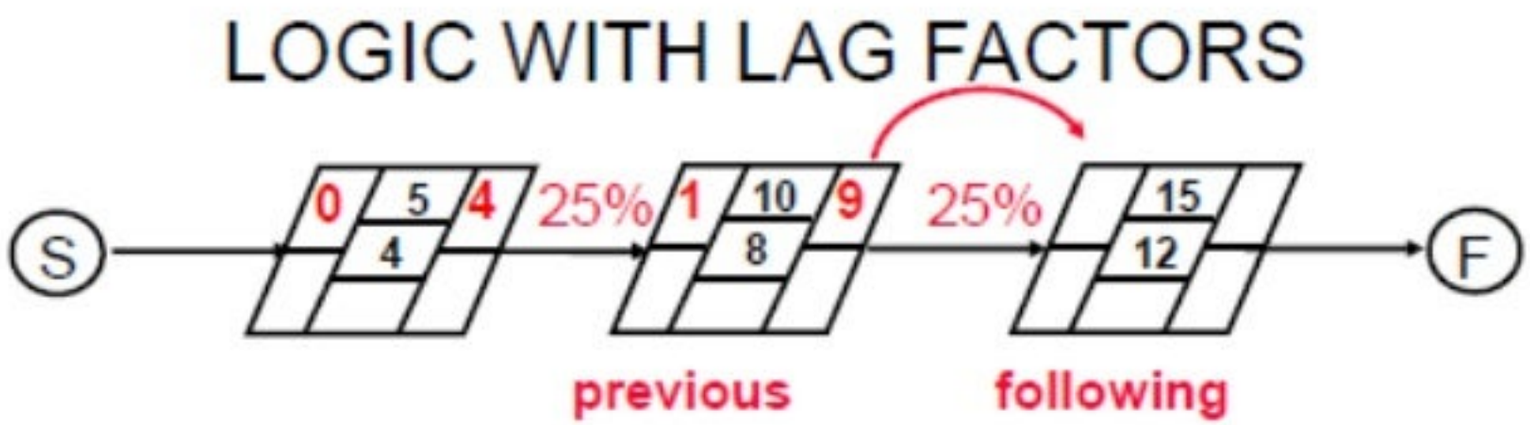



LOGIC WITH LAG FACTORS



# Redefine the Logic

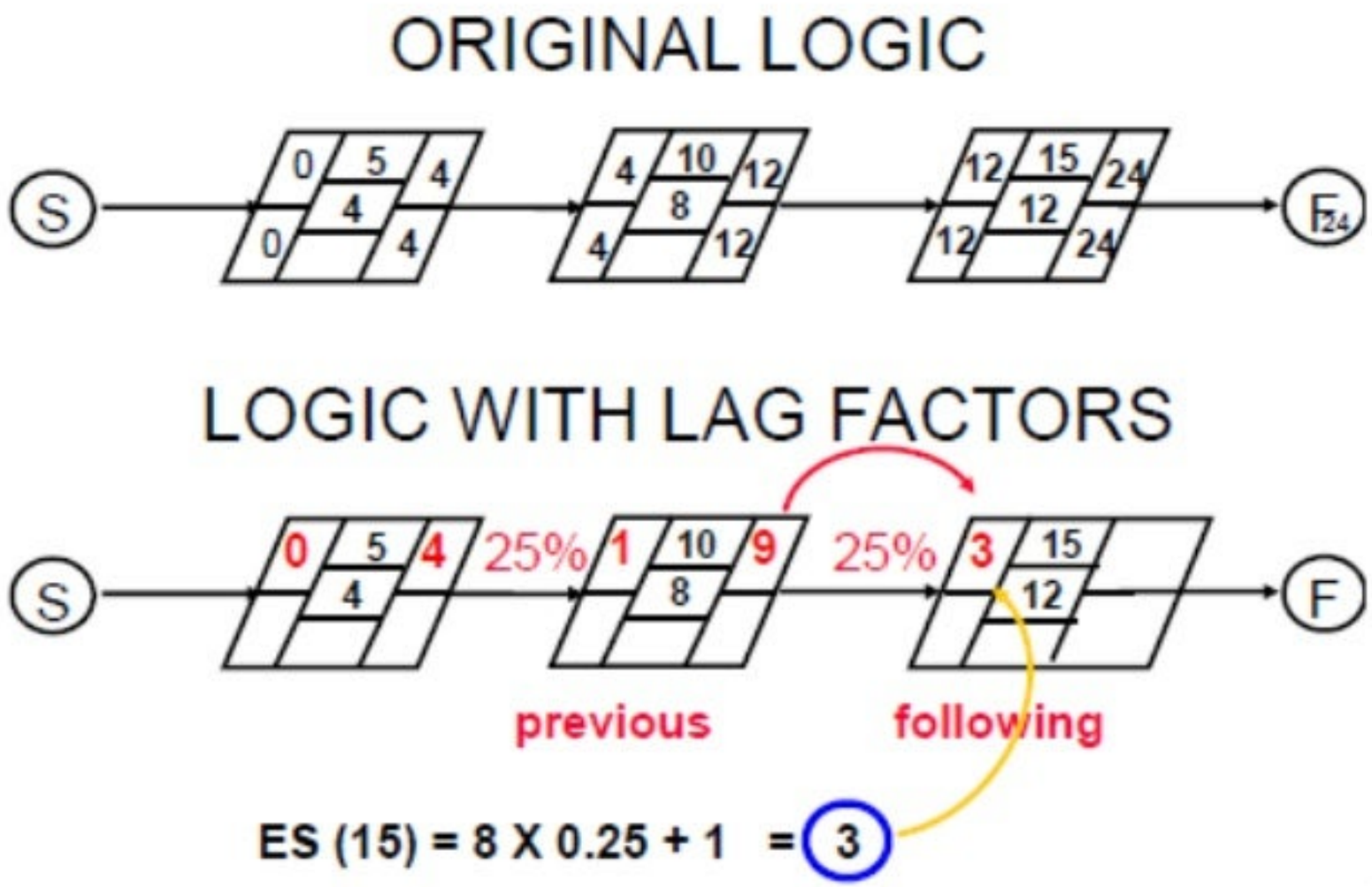



**ES (15) = DURR (10) X % LAG + ES (10)**

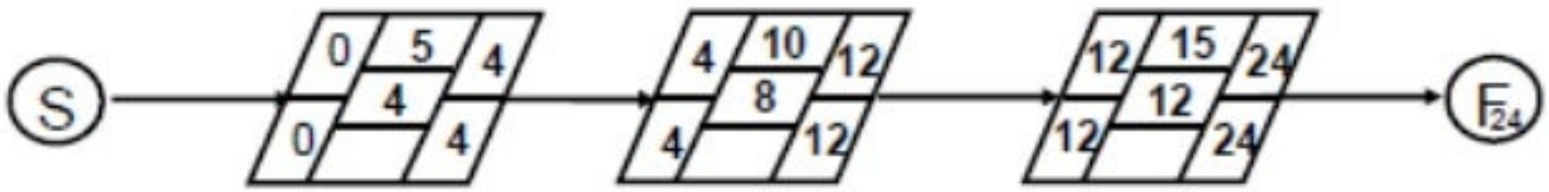
**ES (15) = 8 X 0.25 + 1**

# Redefine the Logic

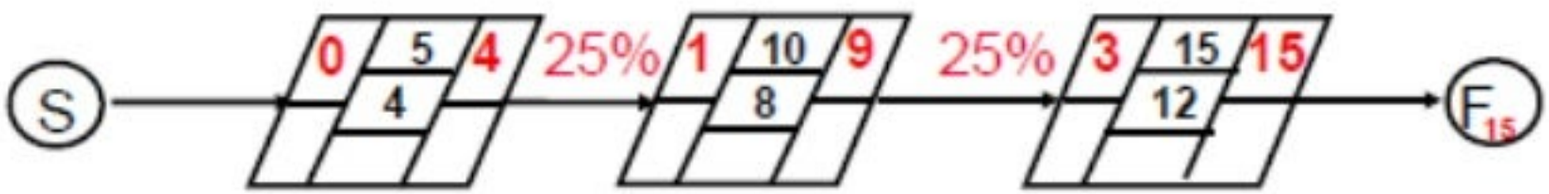


# Redefine the Logic

ORIGINAL LOGIC

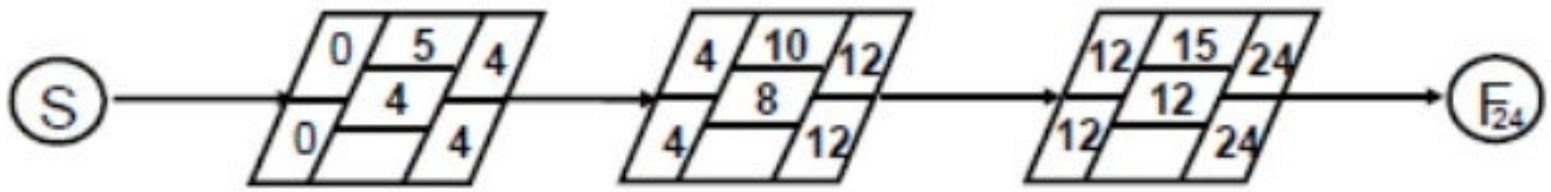



LOGIC WITH LAG FACTORS

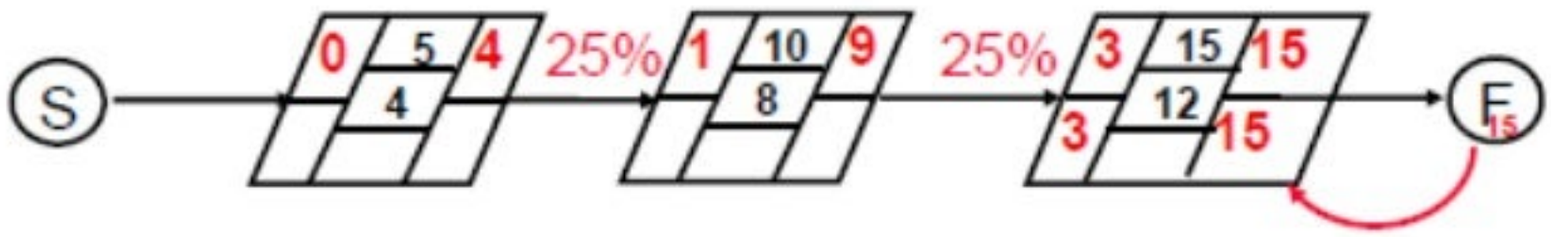


# Redefine the Logic

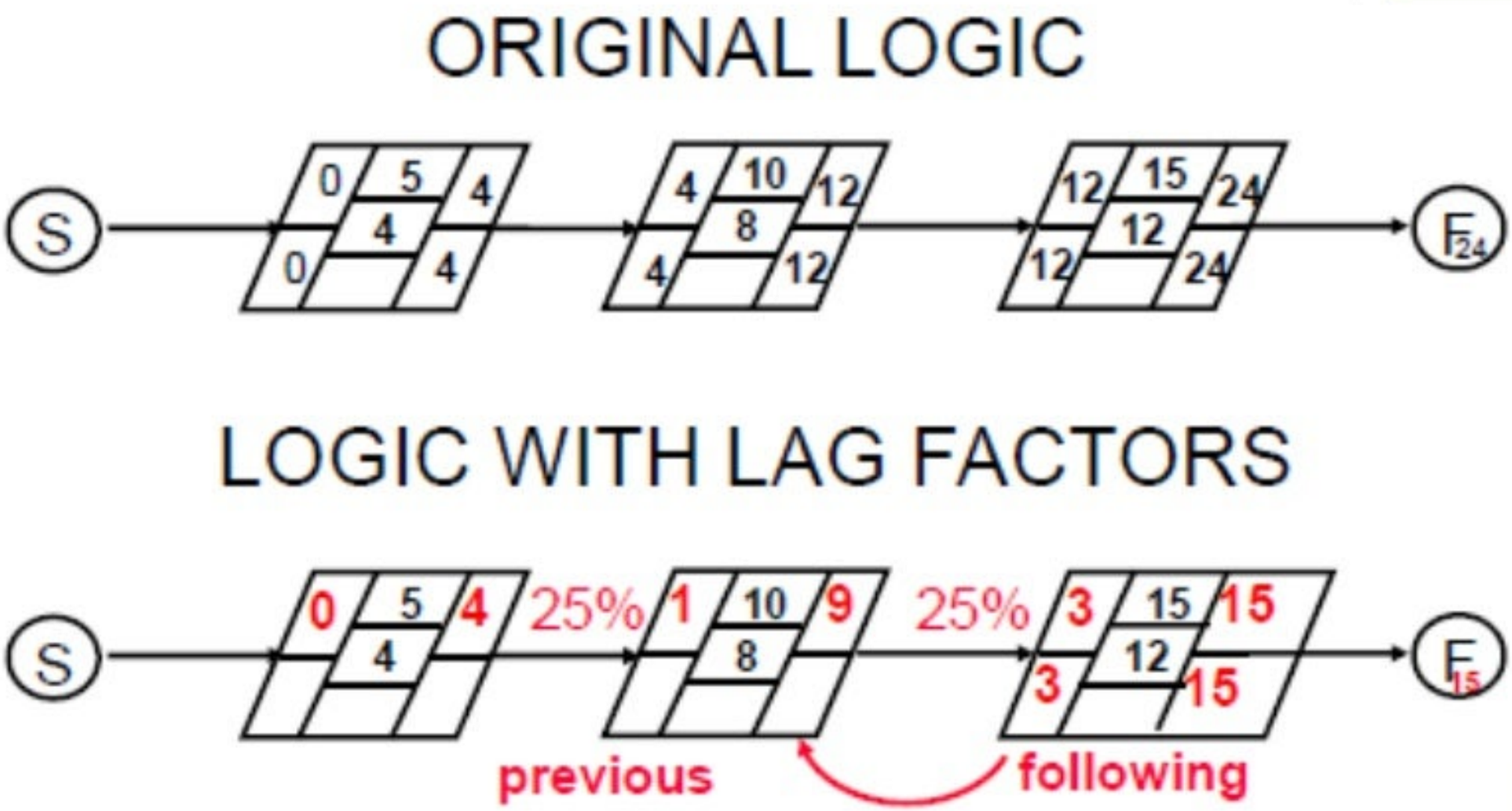
ORIGINAL LOGIC




LOGIC WITH LAG FACTORS



# Redefine the Logic

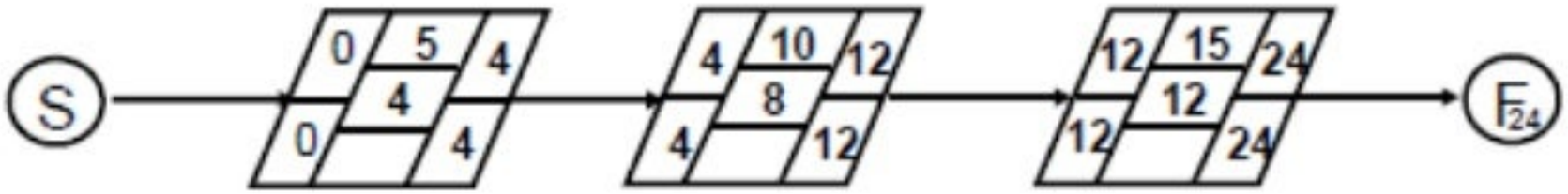



**BACKWARDS PASS EQUATION:**

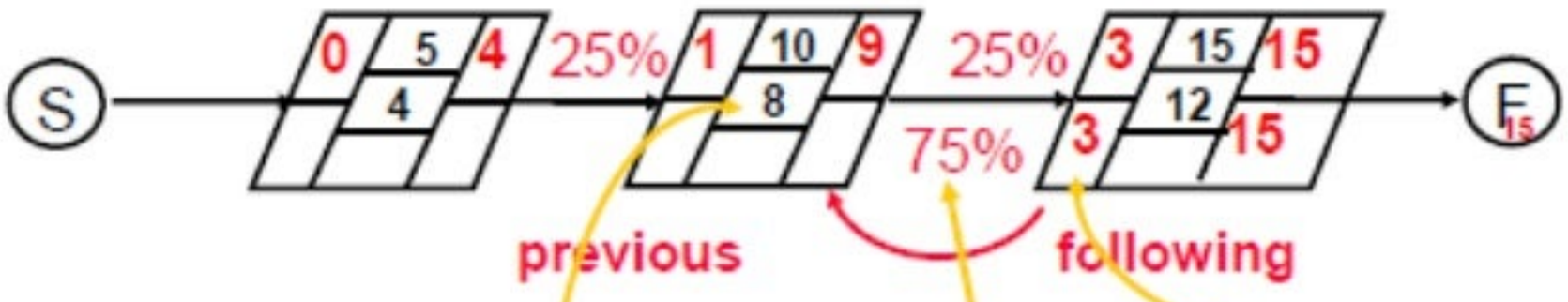
**LF (prev) = DUR(prev) X (100 - % LAG from forward pass) + LS (follow)**

# Redefine the Logic

ORIGINAL LOGIC




LOGIC WITH LAG FACTORS

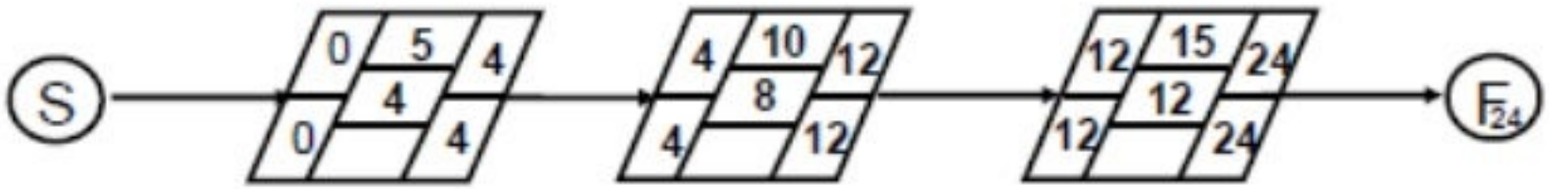



**LF (prev) = DURR (prev) X (100% - % LAG) + LS (following)**

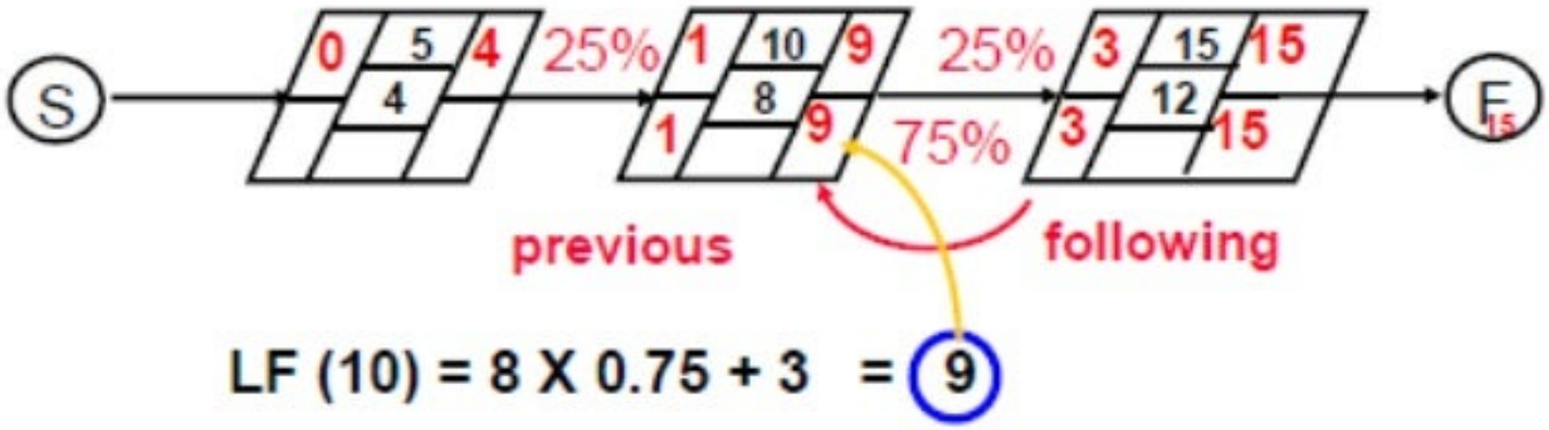
**LF (10) = 8 X 0.75 + 3**

# Redefine the Logic

ORIGINAL LOGIC

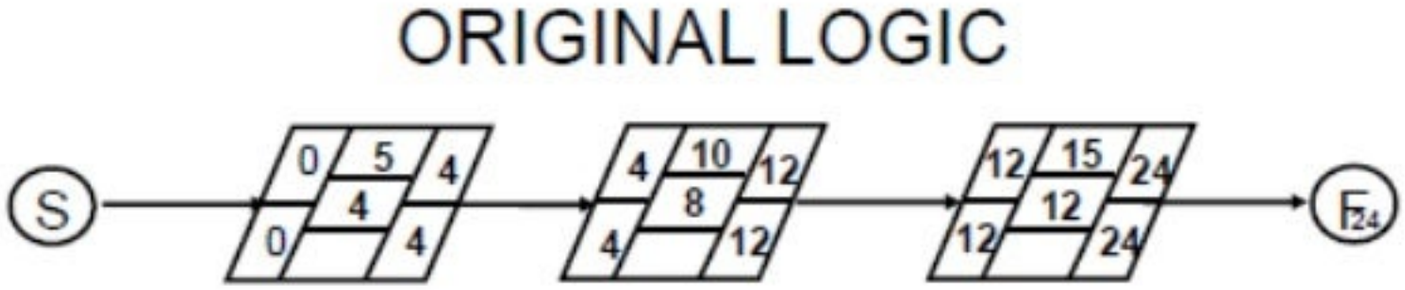


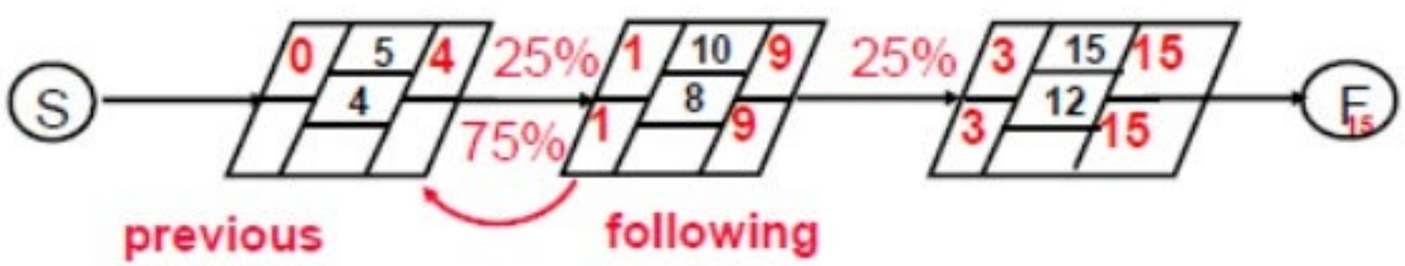

LOGIC WITH LAG FACTORS




LF (10) = 8 X 0.75 + 3 = 9

# Redefine the Logic



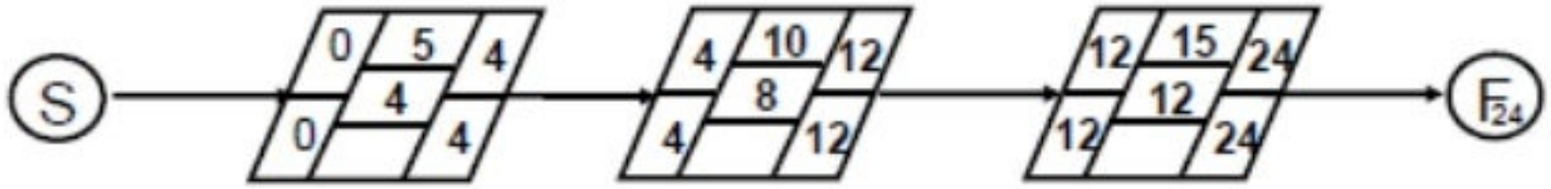




**LF (prev) = DURR (prev) X (100% - % LAG) + LS (following)**

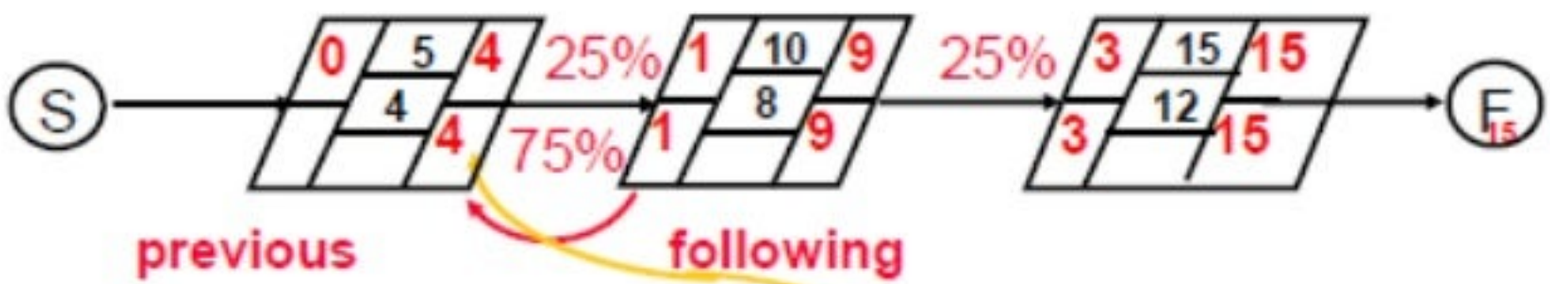
**LF (10) = 4 X 0.75 + 1**

# Redefine the Logic

ORIGINAL LOGIC



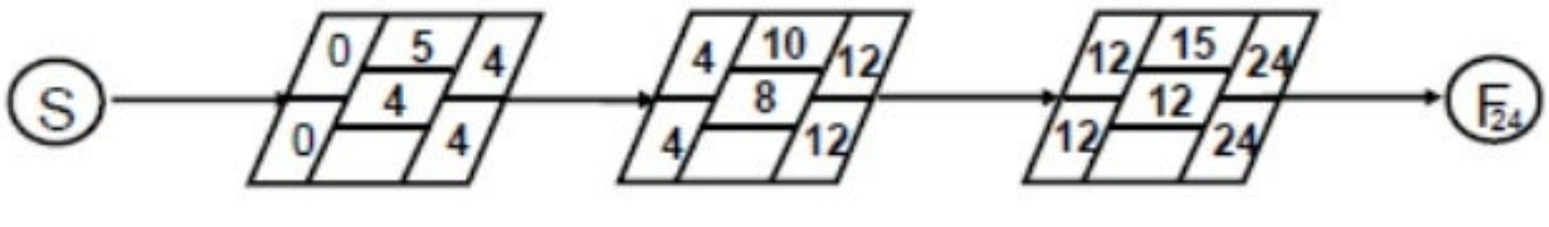

LOGIC WITH LAG FACTORS



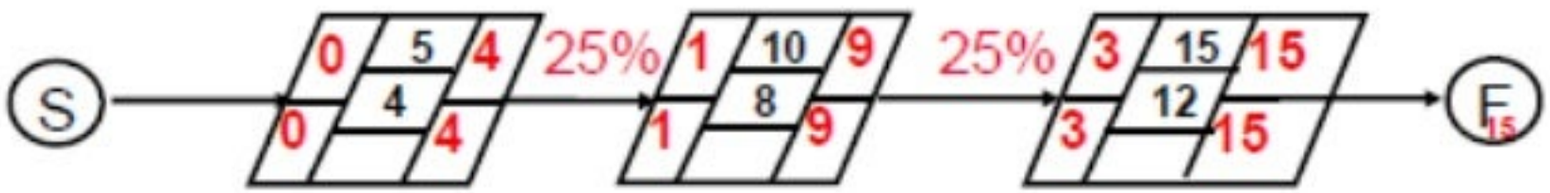

LF (5) = 4 X 0.75 + 1 = 4

# Redefine the Logic

ORIGINAL LOGIC




LOGIC WITH LAG FACTORS



# Project Crashing

# Project Crashing

- Trying to complete a project earlier than originally planned.
- Getting a project back on schedule that has been delayed.

# Project Crashing Methods

- Work longer hours
- Work double shifts
- Work weekends
- Change the technology
- Apply more resources to the project

# Project Crashing

- REMEMBER
- No matter which method or methods you use to crash your project...

**The project duration will decrease ONLY if you shorten the activities on the CRITICAL PATH !!!**

# Project Crashing Considerations

- Safety
- Efficiency
- Morale
- Cost
- Logistics/Maintenance
- Quality Control

# Enabling Learning Objectives

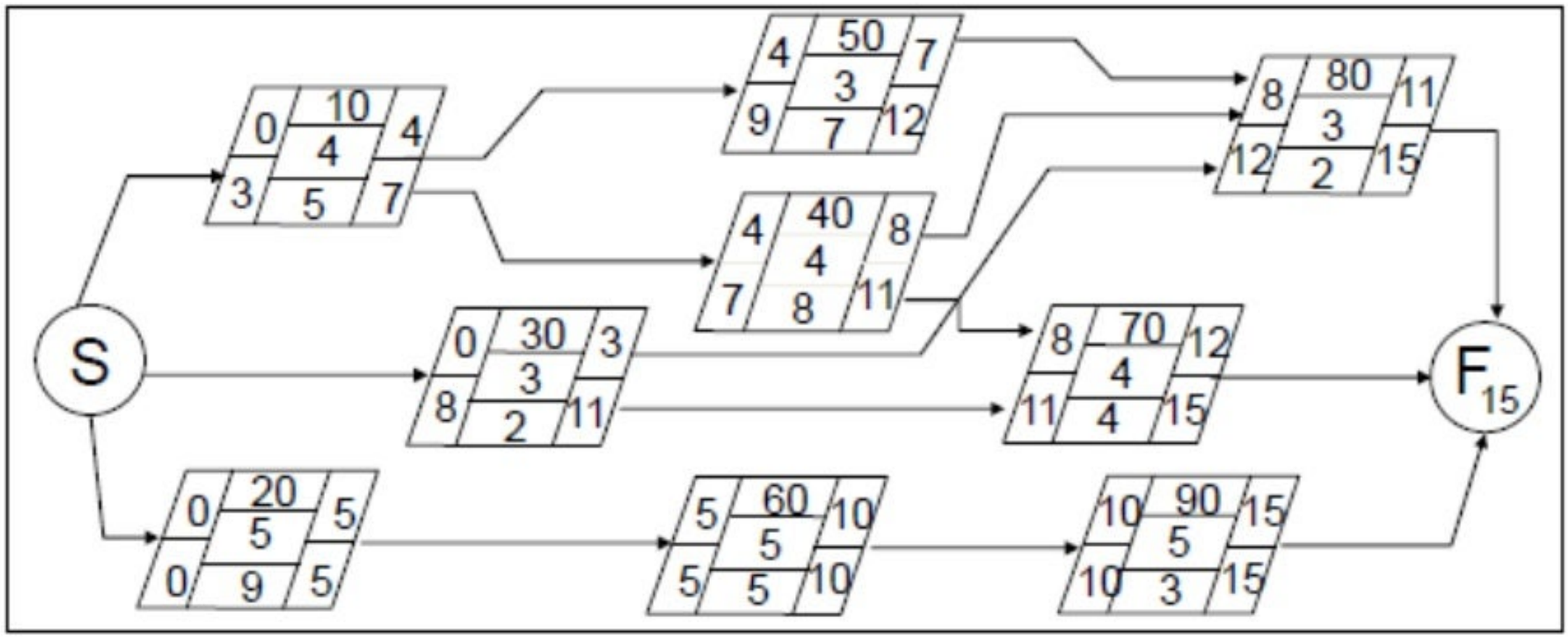
- Receive and interpret a construction directive
- Develop an activities list
- Determine sequential relationships among activities
- Construct a logic network
- Estimate resource requirements
- Compute a time analysis
- Prepare an Early Start Schedule
- Employ project control measures
- Resource constrain a construction project

# Resource Constraining

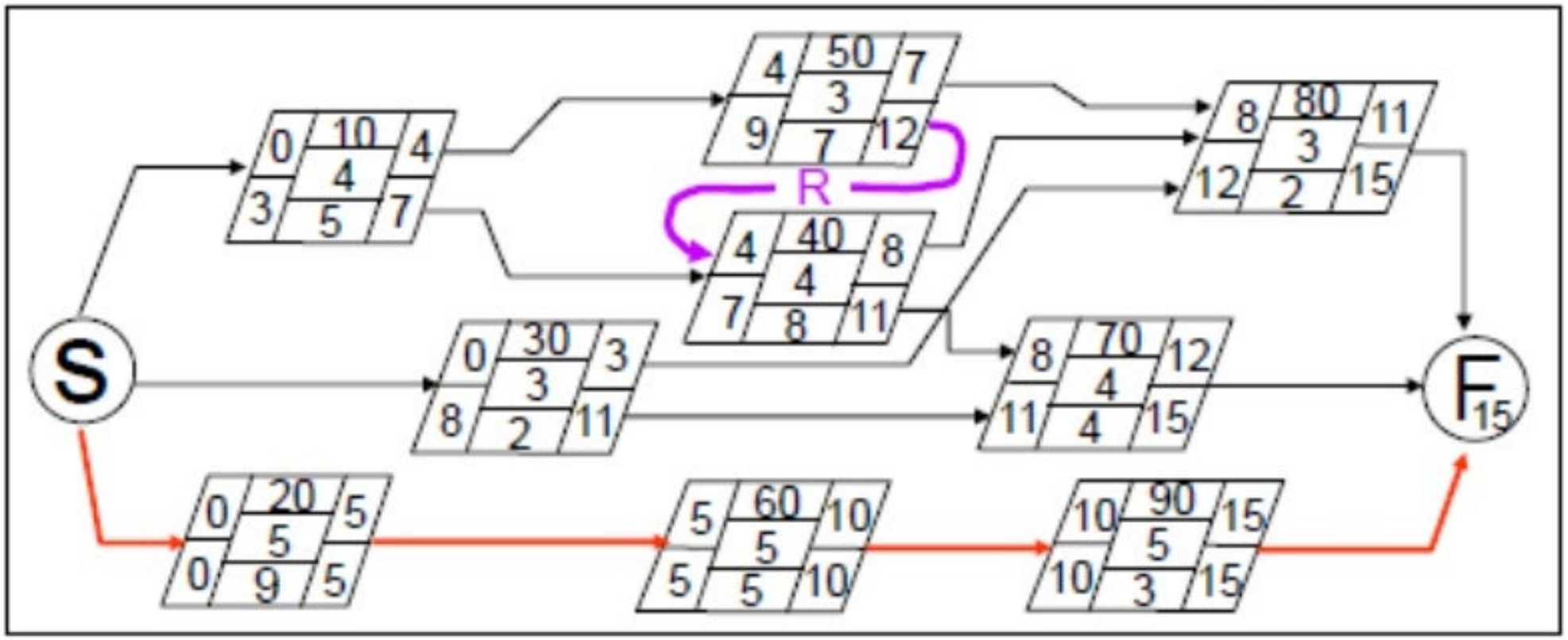
- When daily equipment and personnel requirements exceed what is available, the Project Manager must **Resource Constrain** the project to affect project duration as little as possible.
- To resource constrain a project the project manager completes the following:
  - Resource constrain the ES schedule
  - Update the logic network
  - Update the ES schedule

# Resource Constraining

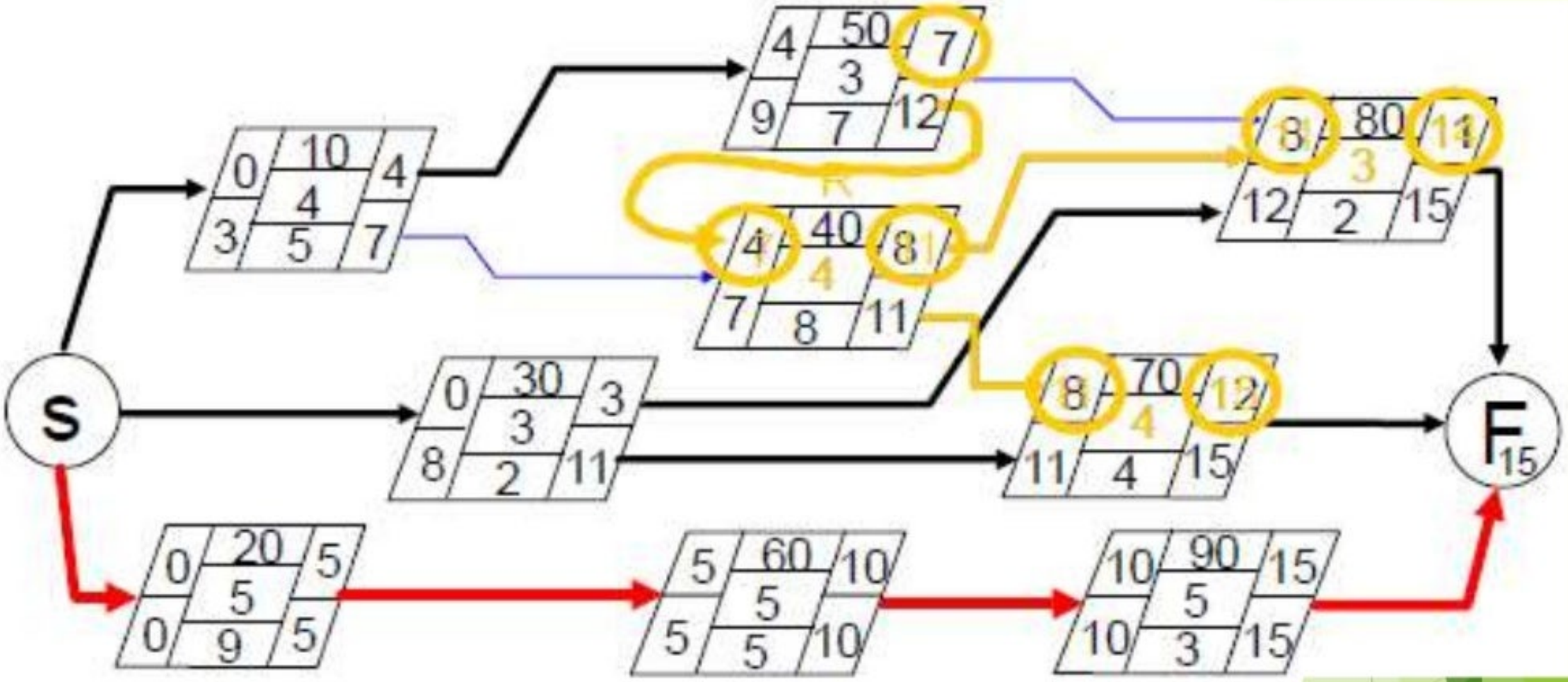
- To resource constrain follow the 12 Step Sequence found in your Student Workbook and Appendix D of TM 3-34.42



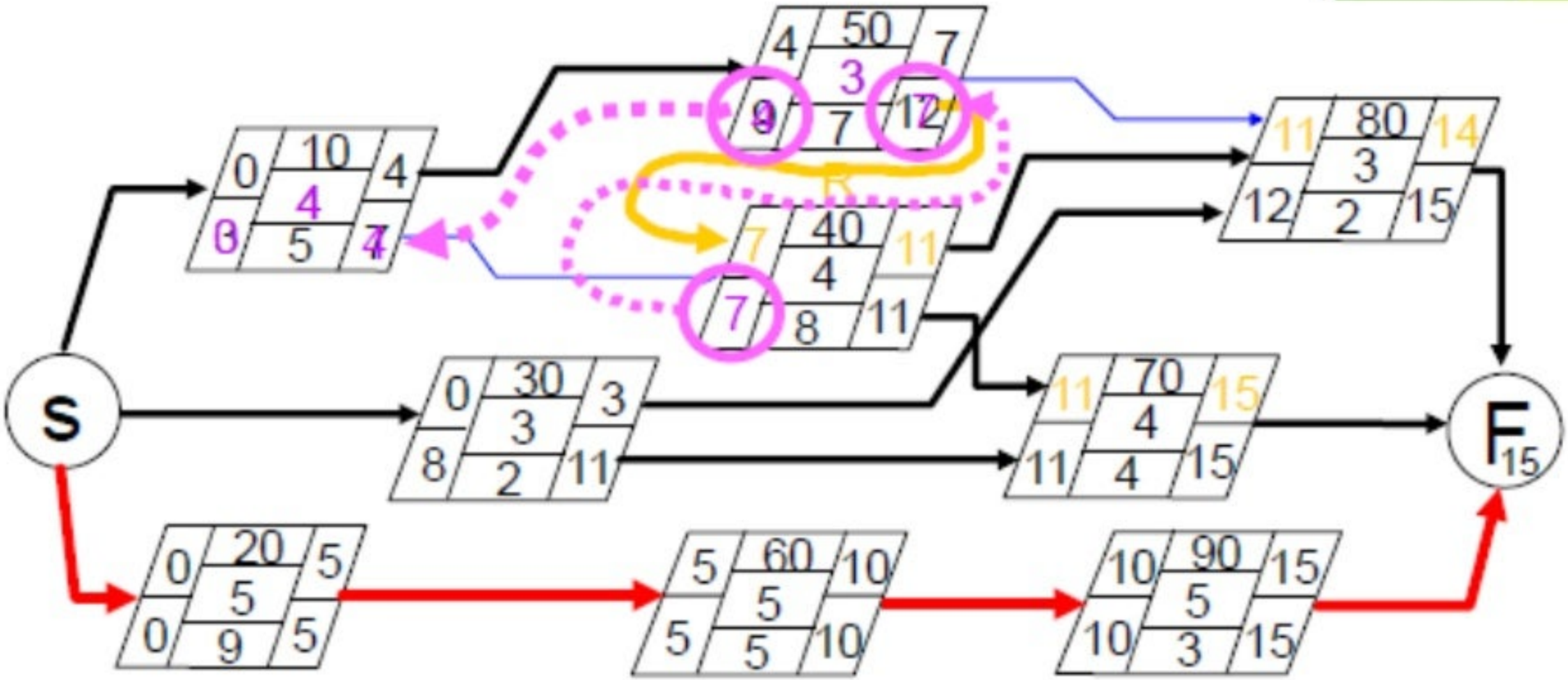

| NETWORK NUMBER | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 (40,50) | [5 | 5 | 5 | 5 | X | X | X] | | | | | | | | | | |
| 20 (60) | [9 | 9 | 9 | 9 | 9] | | | | | | | | | | | | |
| 30 (70,80) | [2 | 2 | 2 | | | | | | X | X | X] | | | | | | |
| 40 (70,80) | | | | | [8 | 8 | 8 | 8 | X | X | X] | | | | | | |
| 50 (80) | | | | | [7 | 7 | 7 | | X | X | X | X] | | | | | |
| 60 (90) | | | | | | [5 | 5 | 5 | 5 | 5] | | | | | | | |
| 70 | | | | | | | | | [4 | 4 | 4 | 4 | | | ] | | |
| 80 | | | | | | | | | [2 | 2 | 2 | | | | ] | | |
| 90 | | | | | | | | | | | [3 | 3 | 3 | 3 | 3] | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| TOTAL | 16 | 16 | 16 | 14 | 24 | 20 | 20 | 13 | 11 | 11 | 9 | 7 | 3 | 3 | 3 | | |



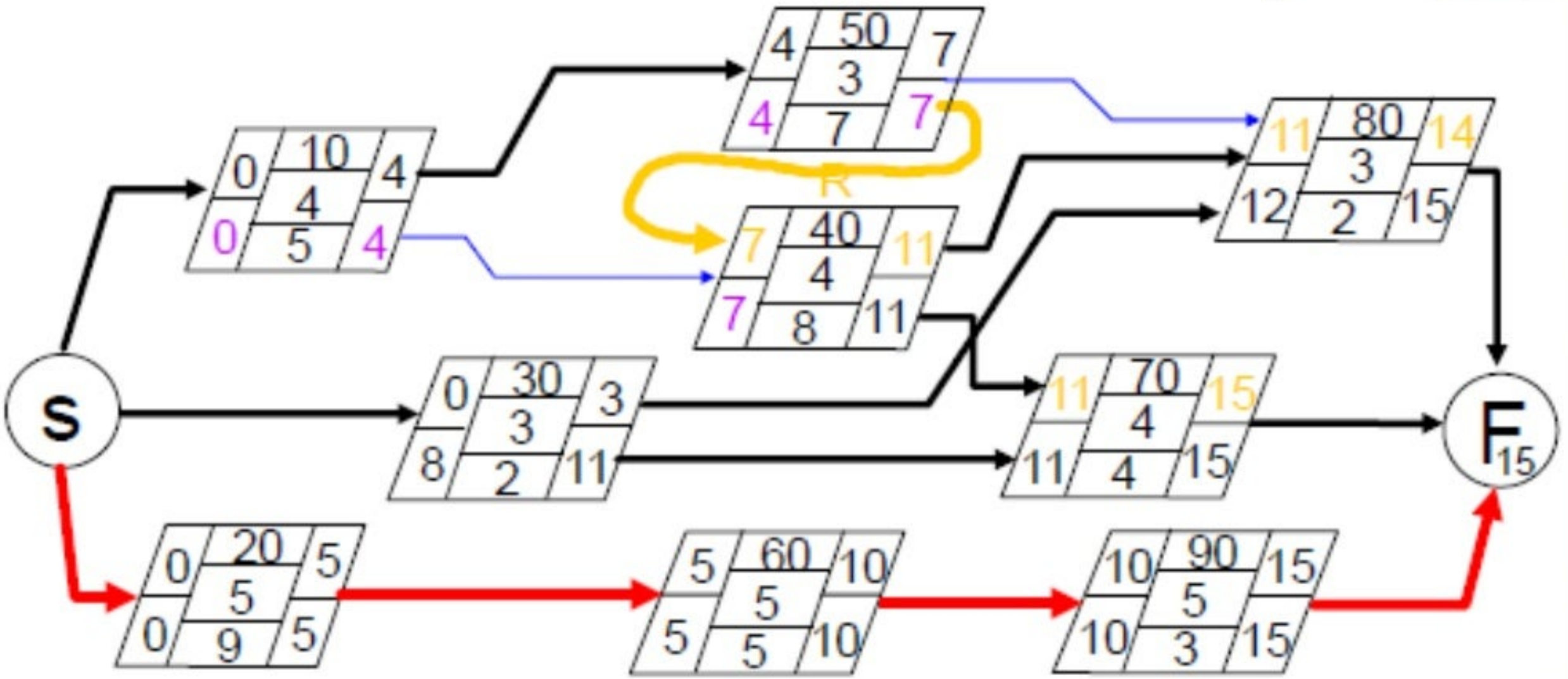

| NETWORK NUMBER | EARLY START SCHEDULE | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 10 (40, 50) | 5 | 5 | 5 | 5 | X | X | X | | | | | | | | | | | |
| 20 (60) | 9 | 9 | 9 | 9 | 9 | | | | | | | | | | | | | |
| 30 (70, 80) | 2 | 2 | 2 | | | | | | X | X | X | | | | | | | |
| 40 (70, 80) | | | | | 8 | 8 | 8 | 8 | 8 | 8 | 8 | R | | | | | | |
| 50 (80) | | | | | 7 | 7 | 7 | | X | X | X | X | | | | | | |
| 60 (90) | | | | | | 5 | 5 | 5 | 5 | 5 | | | | | | | | |
| 70 | | | | | | | | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | L | | |
| 80 | | | | | | | | | 2 | 2 | 2 | 2 | 2 | 2 | | L | | |
| 90 | | | | | | | | | | | 3 | 3 | 3 | 3 | 3 | | | |
| | | | | | | | | | | | | | | | | | | |
| TOTAL | 16 | 16 | 16 | 14 | 24 | 20 | 20 | 13 | 11 | 11 | 9 | 7 | 8 | 8 | 8 | | | |
| | | | | | 16 | 12 | 12 | 13 | 13 | 13 | 11 | 9 | 9 | 9 | 7 | | | |



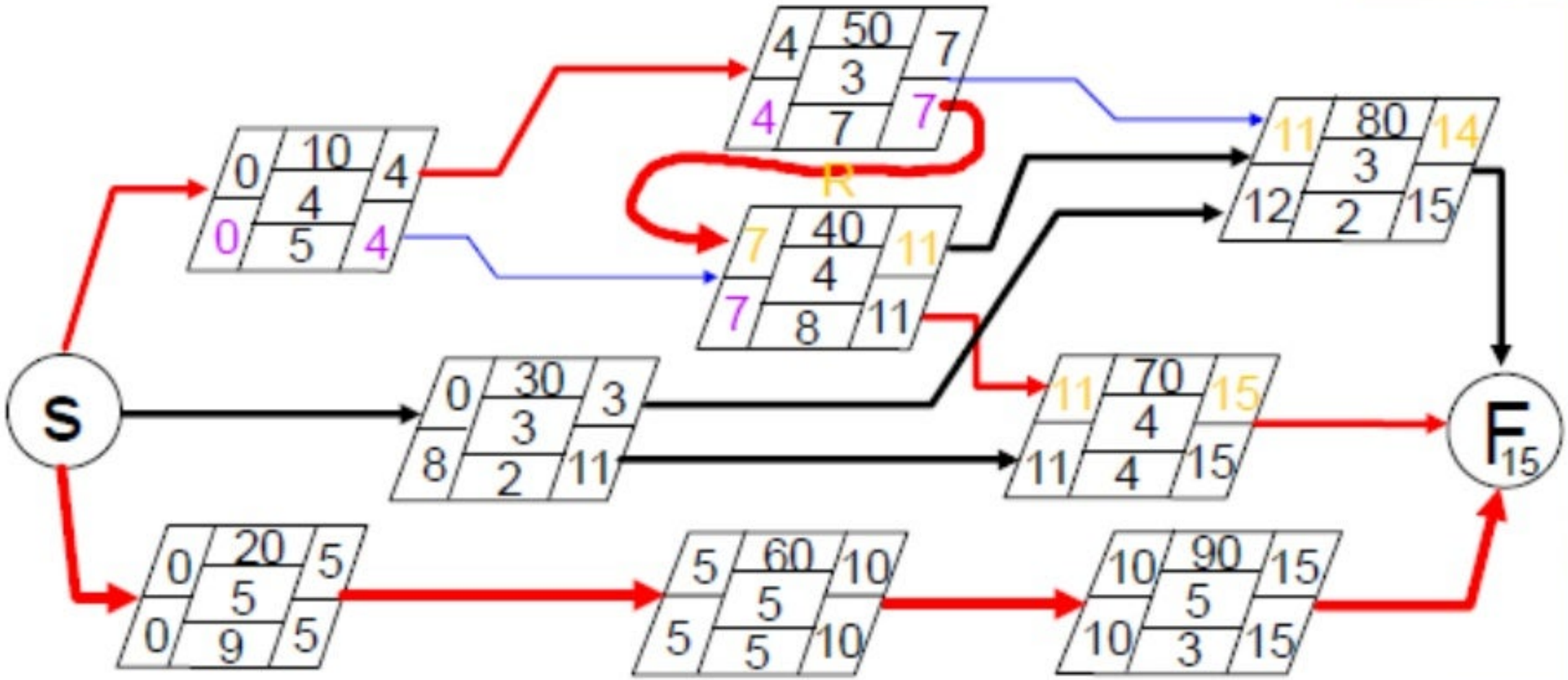

- **Conduct a new time analysis. Forward Pass.**




- **Conduct a new time analysis. Backward Pass.**




- **Conduct a new time analysis. What else has changed?**




- **The Critical Path added a new path**

# EARLY START SCHEDULE

| NETWORK NUMBER | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 (40, 50) | [5 | 5 | 5 | 5 | X | X | X] | | | | | | | | | | | |
| 20 (60) | [9 | 9 | 9 | 9 | 9] | | | | | | | | | | | | | |
| 30 (70, 80) | [2 | 2 | 2 | | | | | | X | X | X] | | | | | | | |
| 40 (70, 80) | | | | | [8 | 8 | 8 | 8 | X | X | X] | R | | | | | | |
| 50 (80) | | | | | [7 | 7 | 7 | | X | X | X | X] | | | | | | |
| 60 (90) | | | | | | [5 | 5 | 5 | 5 | 5] | | | | | | | | |
| 70 | | | | | | | | | [4 | 4 | 4 | 4 | 4 | 4 | 4] | L | | |
| 80 | | | | | | | | | [2 | 2 | 2 | 2 | 2 | 2 | ] | L | | |
| 90 | | | | | | | | | | | [3 | 3 | 3 | 3 | 3] | | | |
| | | | 16 | 14 | 24 | 20 | 20 | 18 | 11 | 11 | 9 | 7 | 8 | 8 | 8 | | | |
| | | | | | 16 | 12 | 12 | 13 | 13 | 13 | 11 | 9 | 9 | 9 | 7 | | | |

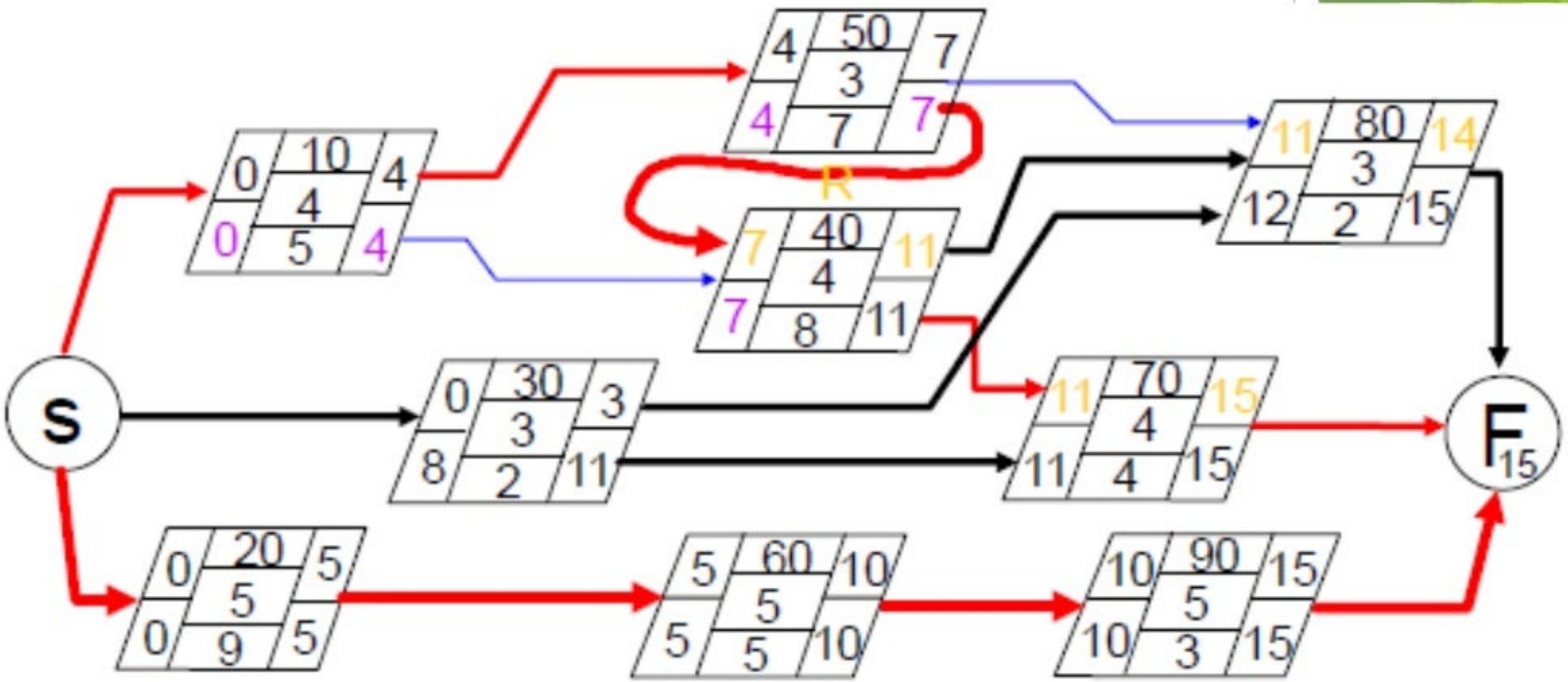
Phase Three: Update the ES schedule.

# EARLY START SCHEDULE

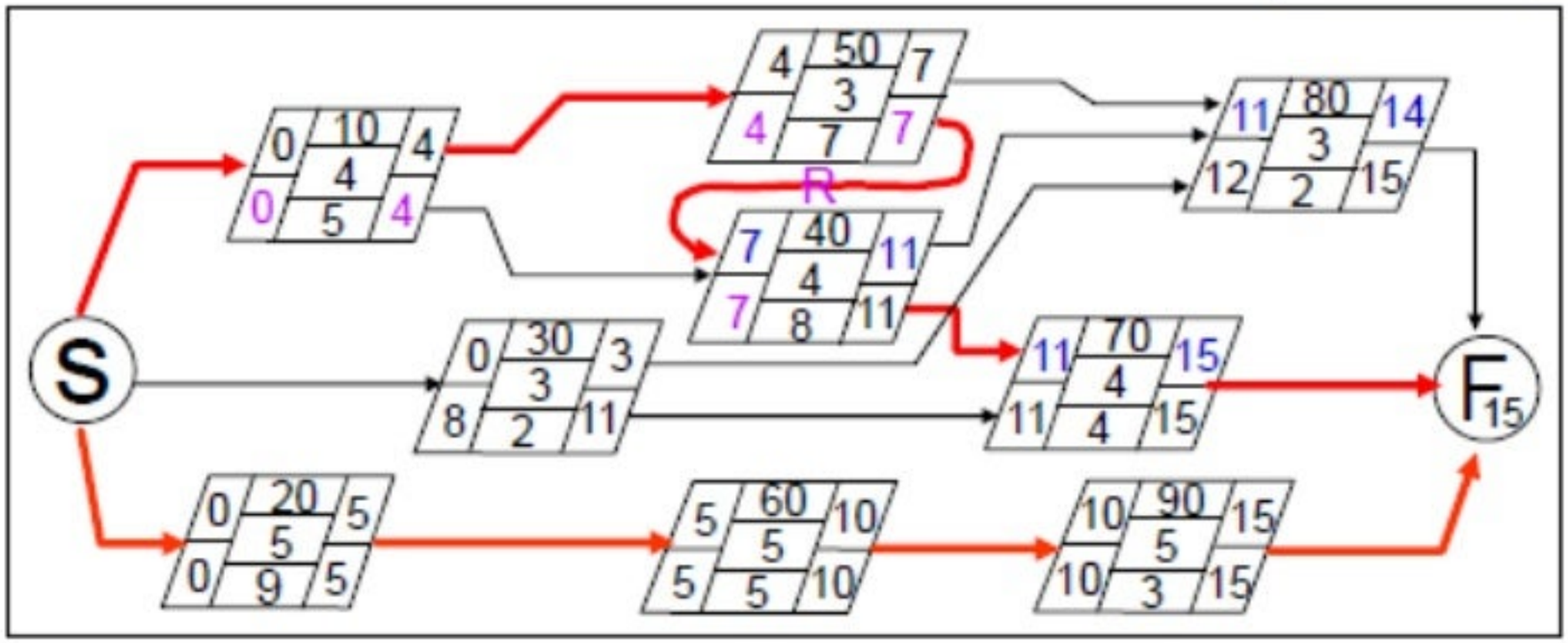
| NETWORK NUMBER | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 (40, 50) | [5 | 5 | 5 | 5 | X | X | X] | | | | | | | | | | | |
| 20 (60) | [9 | 9 | 9 | 9 | 9] | | | | | | | | | | | | | |
| 30 (70, 80) | [2 | 2 | 2 | | | | | | X | X | X] | | | | | | | |
| 40 (70, 80) | | | | | [8 | 8 | 8 | 8 | X | X | X] | R | | | | | | |
| 50 (40, 80) | | | | | [7 | 7 | 7 | | X | X | X | X] | | | | | | |
| 60 (90) | | | | | | [5 | 5 | 5 | 5 | 5] | | | | | | | | |
| 70 | | | | | | | | | [4 | 4 | 4 | 4 | 4 | 4 | 4] | L | | |
| 80 | | | | | | | | | [2 | 2 | 2 | 2 | 2 | 2 | ] | L | | |
| 90 | | | | | | | | | | | [3 | 3 | 3 | 3 | 3] | | | |
| | | | 16 | 14 | 24 | 20 | 20 | 18 | 11 | 11 | 9 | 7 | 8 | 8 | 8 | | | |
| | | | | | 16 | 12 | 12 | 13 | 13 | 13 | 11 | 9 | 9 | 9 | 7 | | | |

Step 10: List dependent activities.
New follow-on activity for each dummy arrow!

# Which activities have changed?



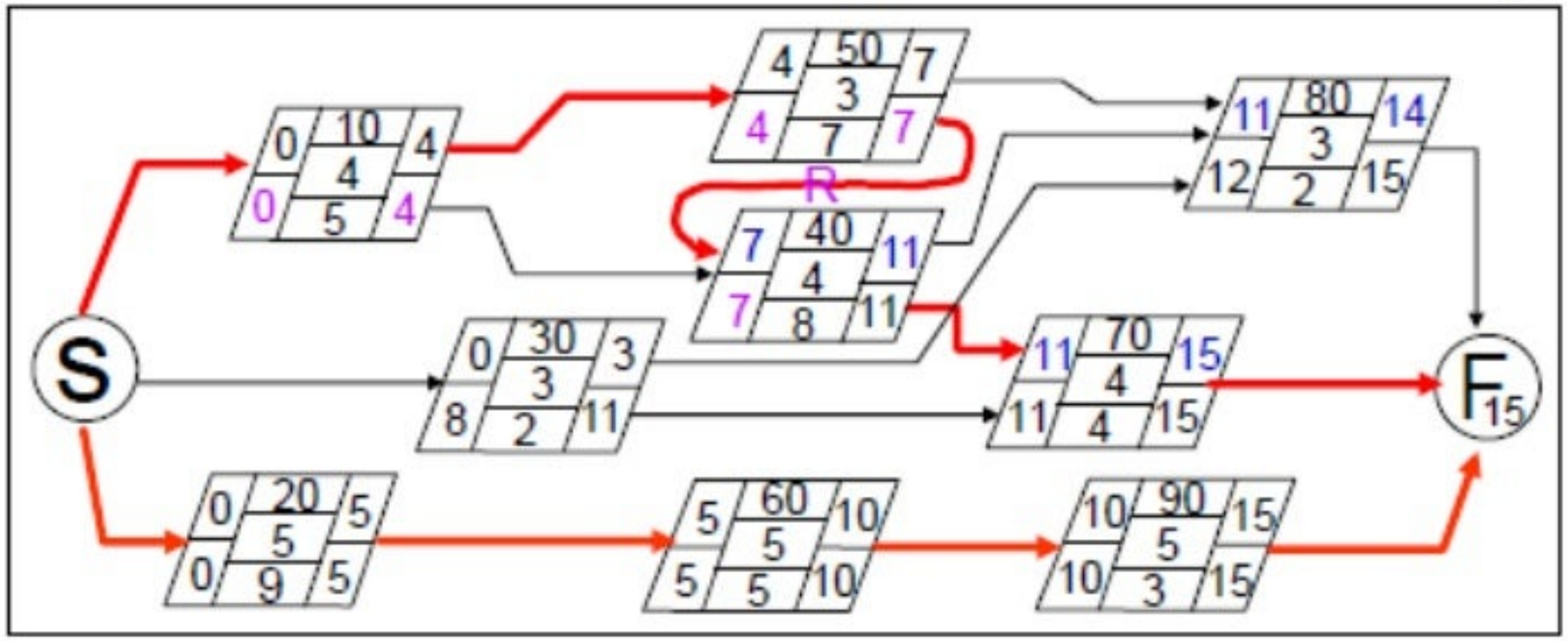

**10, 40, 50, 70, 80**




Step 11:
Adjust time frames.

Activities 10,40,50, 70,80

| NETWORK NUMBER | EARLY START SCHEDULE | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 10 (40, 50) | 5 | 5 | 5 | 5 | X | X | X | | | | | | | | | | | |
| 20 (60) | 9 | 9 | 9 | 9 | 9 | | | | | | | | | | | | | |
| 30 (70, 80) | 2 | 2 | 2 | | | | | | X | X | X | | | | | | | |
| 40 (70, 80) | | | | | 8 | 8 | 8 | 8 | X | X | X | R | | | | | | |
| 50 (40, 80) | | | | | 7 | 7 | 7 | | X | X | X | X | | | | | | |
| 60 (90) | | | | | | 5 | 5 | 5 | 5 | 5 | | | | | | | | |
| 70 | | | | | | | | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | L | | |
| 80 | | | | | | | | | 2 | 2 | 2 | 2 | 2 | 2 | | L | | |
| 90 | | | | | | | | | | | 3 | 3 | 3 | 3 | 3 | | | |
| | | | | | | | | | | | | | | | | | | |
| TOTAL | 16 | 16 | 16 | 14 | 24 | 20 | 20 | 13 | 14 | 11 | 9 | 7 | 5 | 5 | 5 | | | |
| | | | | | 16 | 12 | 12 | 13 | 13 | 11 | 9 | 9 | 7 | 3 | 3 | | | |




| NETWORK NUMBER | EARLY START SCHEDULE | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 10 (40, 50) | [5 | 5 | 5 | 5] | X | X | X | | | | | | | | | | | |
| 20 (60) | [9 | 9 | 9 | 9 | 9] | | | | | | | | | | | | | |
| 30 (70, 80) | [2 | 2 | 2 | | | | | | E | E | E | | | | | | | |
| 40 (70, 80) | | | | | [8 | 8 | 8 | 8] | 8 | 8 | 8 | R | | | | | | |
| 50 (40, 80) | | | | | [7 | 7 | 7 | X | X | X | X | X] | | | | | | |
| 60 (90) | | | | | | [5 | 5 | 5 | 5 | 5] | | | | | | | | |
| 70 | | | | | | | | | 4 | 4 | 4 | [4 | 4 | 4 | 4 | L | | |
| 80 | | | | | | | | | 2 | 2 | 2 | [2 | 2 | 2 | | L | | |
| 90 | | | | | | | | | | | [3 | 3 | 3 | 3 | 3] | | | |
| | | | | | | | | | | | | | | | | | | |
| TOTAL | 16 | 16 | 16 | 14 | 24 | 20 | 20 | 13 | 11 | 11 | 9 | 7 | 5 | 5 | 3 | | | |
| | | | | | 16 | 12 | 12 | 13 | 13 | 13 | 11 | 9 | 9 | 9 | 7 | | | |

We are now done with the ESS!

# Project Execution

- Management
- Jobsite Organization
- Quality Control
- Material Management
- Tool/ Equipment Management

# Project Execution Management

- Project Board
  - Displayed at jobsite (see next slide)
- Daily briefings to crew
  - Production goals and Safety
- Project Logbook/ Daily Reports
  - Track materials, man hours, equipment, etc
- Updated Gantt Chart

# Jobsite Organization

- Creates a safer work environment
- Results in increased productivity
- Reduces the loss, pilferage, damage, and deterioration of staged materials
- Minimizes the time spent daily on minor production decisions by the project manager

# Quality Control (QC)

- Project managers and supervisors perform and direct activities to develop an individual project QC plan
- The requirements emerge from the project plans and specifications
- Level of QC will depend on the size, complexity, cost, and risk associated with the project
- Requirements must be specific and measurable

# Material Management

- Project Manager must maintain financial awareness
- Track the ordering, storage, and usage of all materials

# Tool and Equipment Management

- The platoon leader is signed for the tools and equipment within the platoon
- Ensure accountability of tools and equipment is maintained
- Proper licensing
- PMCS and other required maintenance

# Summary

- Receive and interpret a construction directive
- Develop an activity list for a construction project
- Determine sequential relationships among activities
- Construct a logic network for a construction project
- Calculate duration estimates for activities
- Compute a time analysis for a project
- Prepare an early start schedule
- Employ project control measures on a construction project
- Resource constrain a construction project