Software Engineering

Project Planning

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Chair of Programming Methodology

Spring Semester 10

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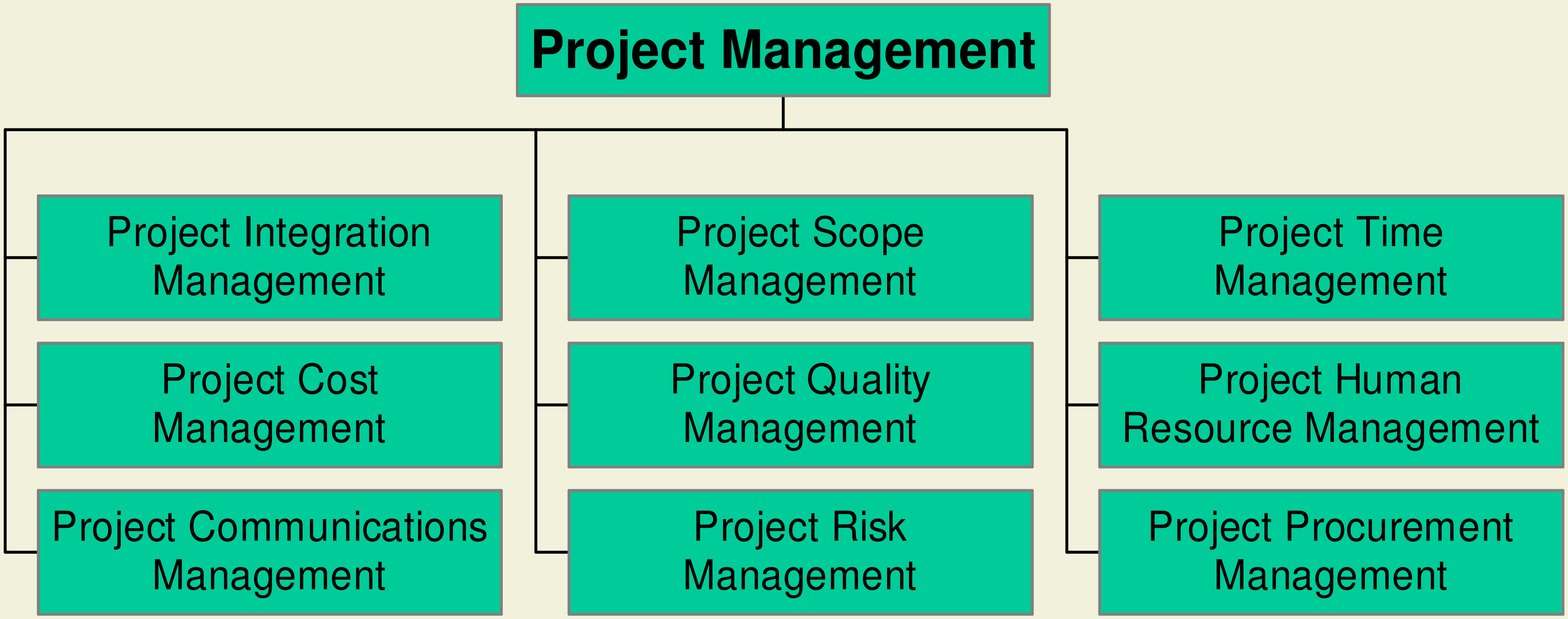
Why Do We Need a Project Plan?

- Unique product or service
- Guide project execution
- Document project planning assumptions
- Document planning decisions regarding alternatives chosen
- Facilitate communication among stakeholders
- Provide baseline for progress measurement and project control

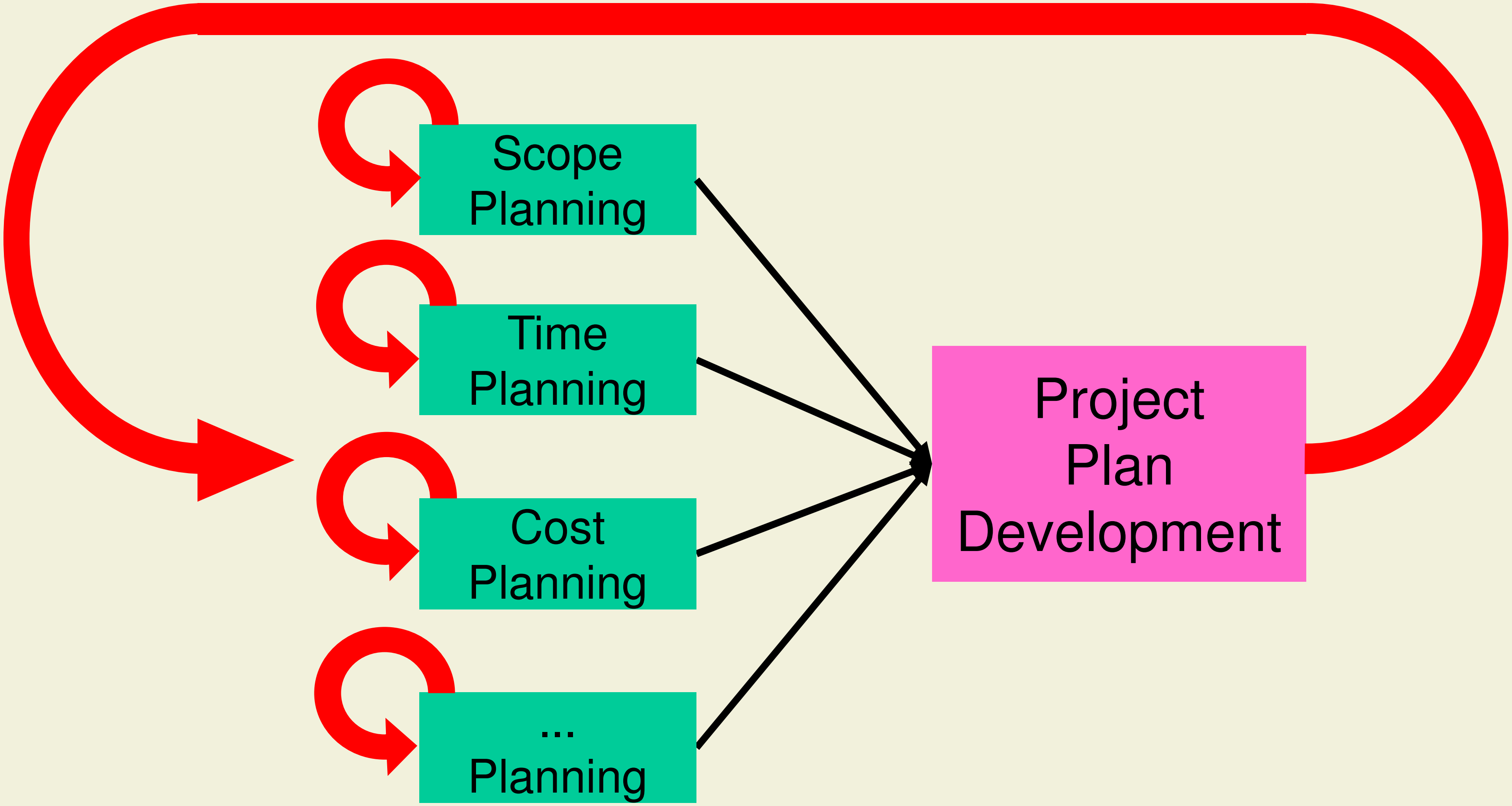
Aspects of Project Planning



Project Management

- Project Integration Management
- Project Cost Management
- Project Communications Management
- Project Scope Management
- Project Quality Management
- Project Risk Management
- Project Time Management
- Project Human Resource Management
- Project Procurement Management

Planning Iterations



Scope Planning

Time Planning

Cost Planning

... Planning

Project Plan Development

Assumptions

- Definition:
  Assumptions are factors that, for planning purposes, are considered to be true, real, or certain
- Assumptions affect all aspects of project planning, and are part of the progressive elaboration of the project
- Project teams frequently identify, document, and validate assumptions as part of their planning process
- Assumptions generally involve a degree of risk

Constraints

- Definition:
  Constraints are factors that limit the project team's options
- A single project may contain cost, time, human resource, technical, and other constraints
- Examples
  - External deadlines (e.g., Y2K, Euro)
  - Fixed upper limits for budget
  - Dependencies on other projects, etc.

Project Plan Document

- A formal, approved document
- A project plan is not just a schedule!
- Contains
    - Project management approach
    - Scope, schedule, cost estimates, resources, responsibilities
    - Subsidiary management plans for scope, schedule, cost, quality, etc.
    - Performance measurement baselines for scope, schedule, and cost
    - Open issues and pending decisions

Baseline

- Definition:
  The originally approved plan plus or minus approved changes.

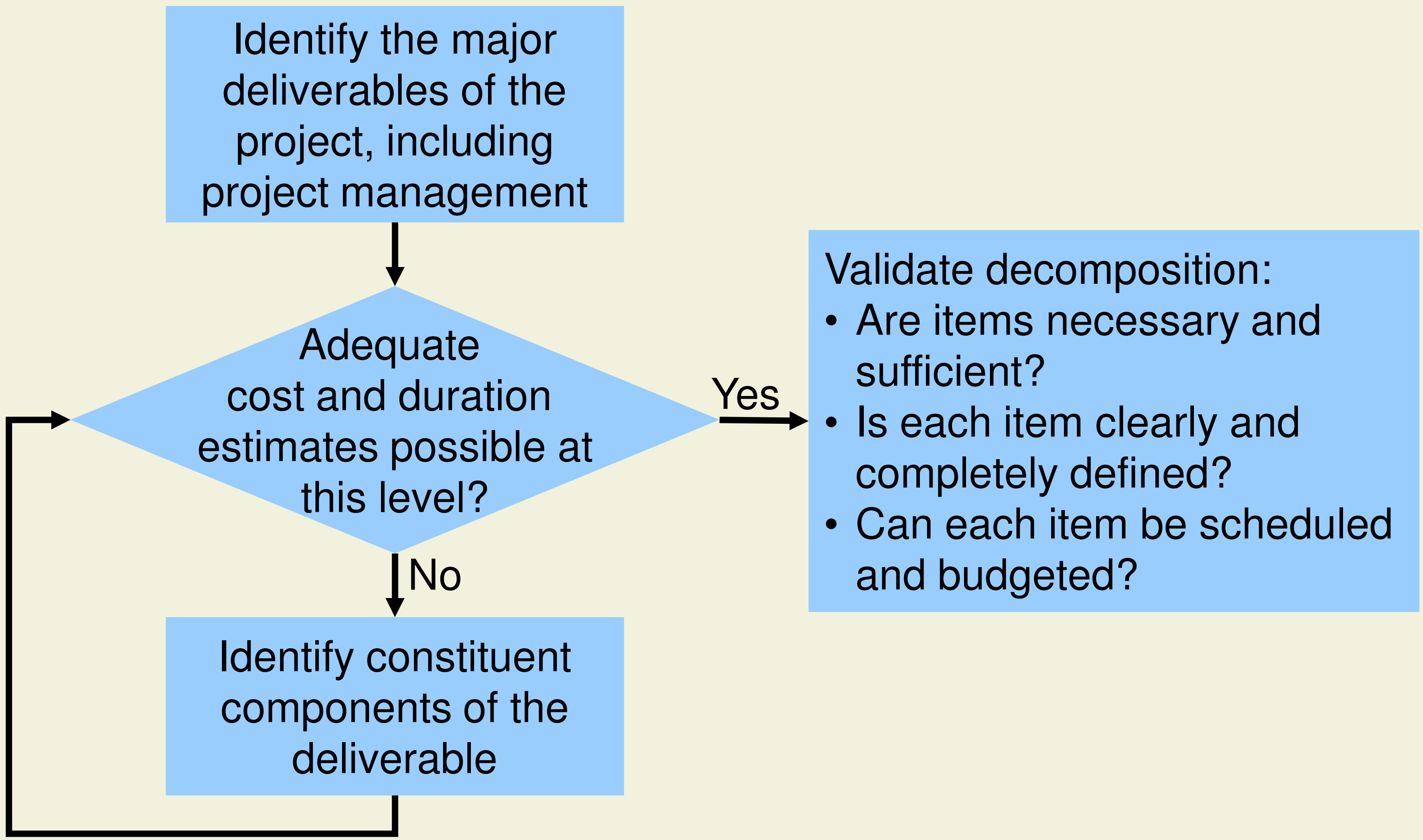
- Baselines are used to compare the actual performance and forecasts of the project with the original plan

10. Project Planning

10.1 Scope Planning

10.2 Scheduling

Decomposition of Deliverables



Identify the major deliverables of the project, including project management

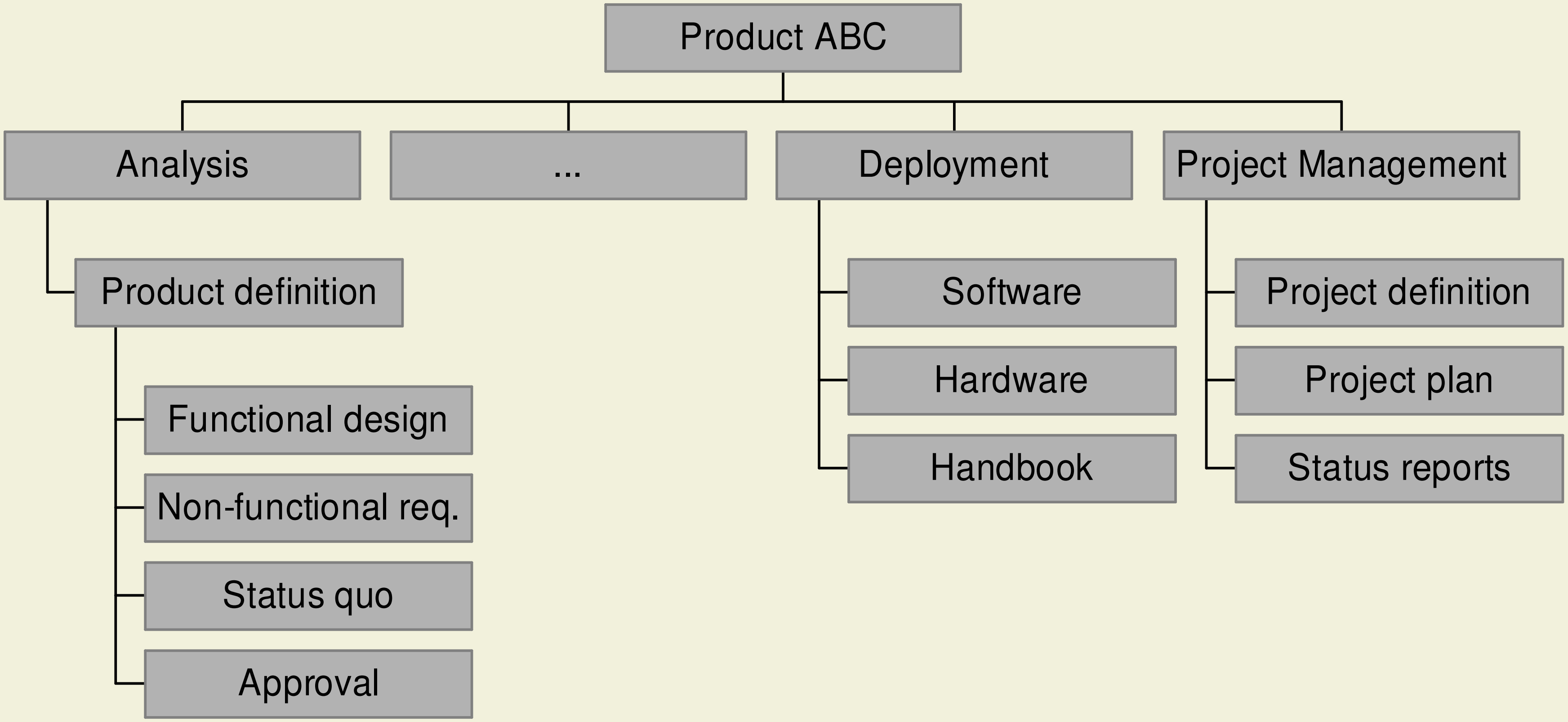
Adequate cost and duration estimates possible at this level?

Identify constituent components of the deliverable

Validate decomposition:

- Are items necessary and sufficient?
- Is each item clearly and completely defined?
- Can each item be scheduled and budgeted?

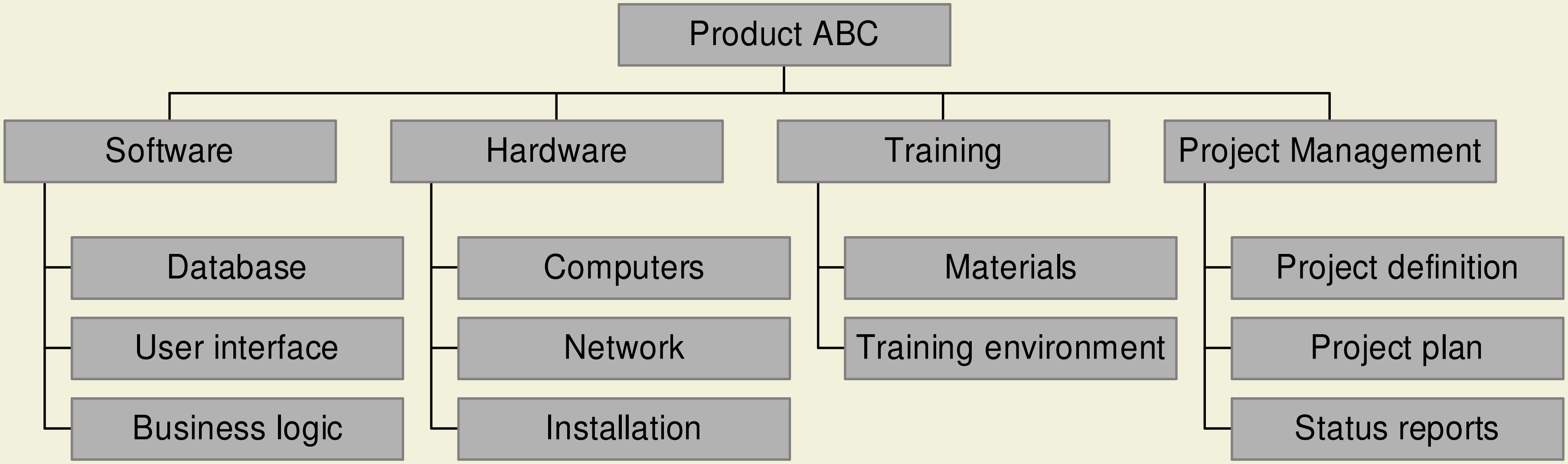
Decomposition Example 1



Product ABC

- Analysis
  - Product definition
    - Functional design
    - Non-functional req.
    - Status quo
    - Approval
- ...
- Deployment
  - Software
  - Hardware
  - Handbook
- Project Management
  - Project definition
  - Project plan
  - Status reports

Decomposition Example 2

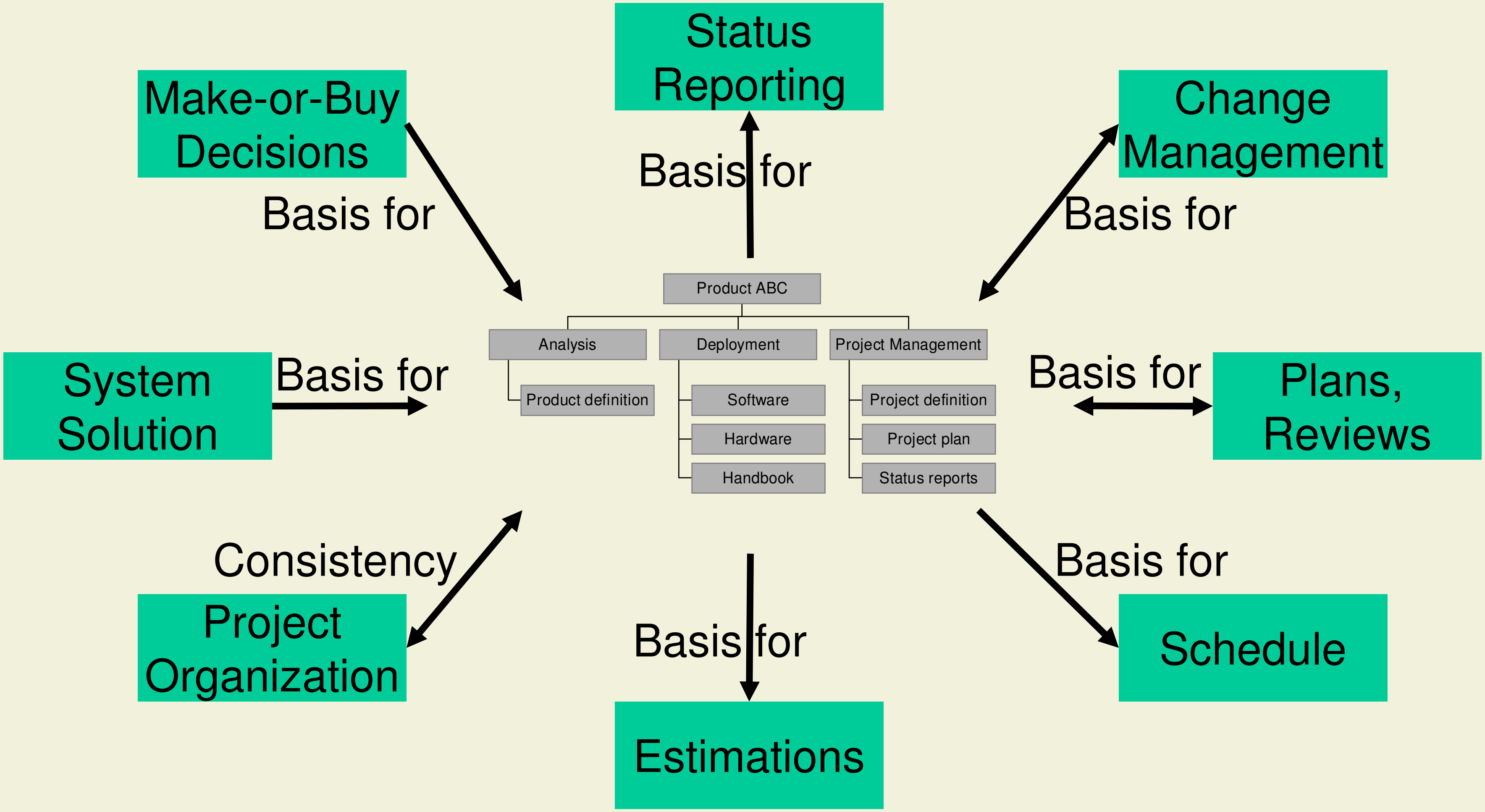

Product ABC

- Software
  - Database
  - User interface
  - Business logic
- Hardware
  - Computers
  - Network
  - Installation
- Training
  - Materials
  - Training environment
- Project Management
  - Project definition
  - Project plan
  - Status reports

Work Breakdown Structure (WBS)

- Definition:
  A deliverable-oriented, hierarchical grouping of project elements that organizes and defines the total work scope of the project. Each descending level represents an increasingly detailed definition of the project

WBS Relationships



10. Project Planning

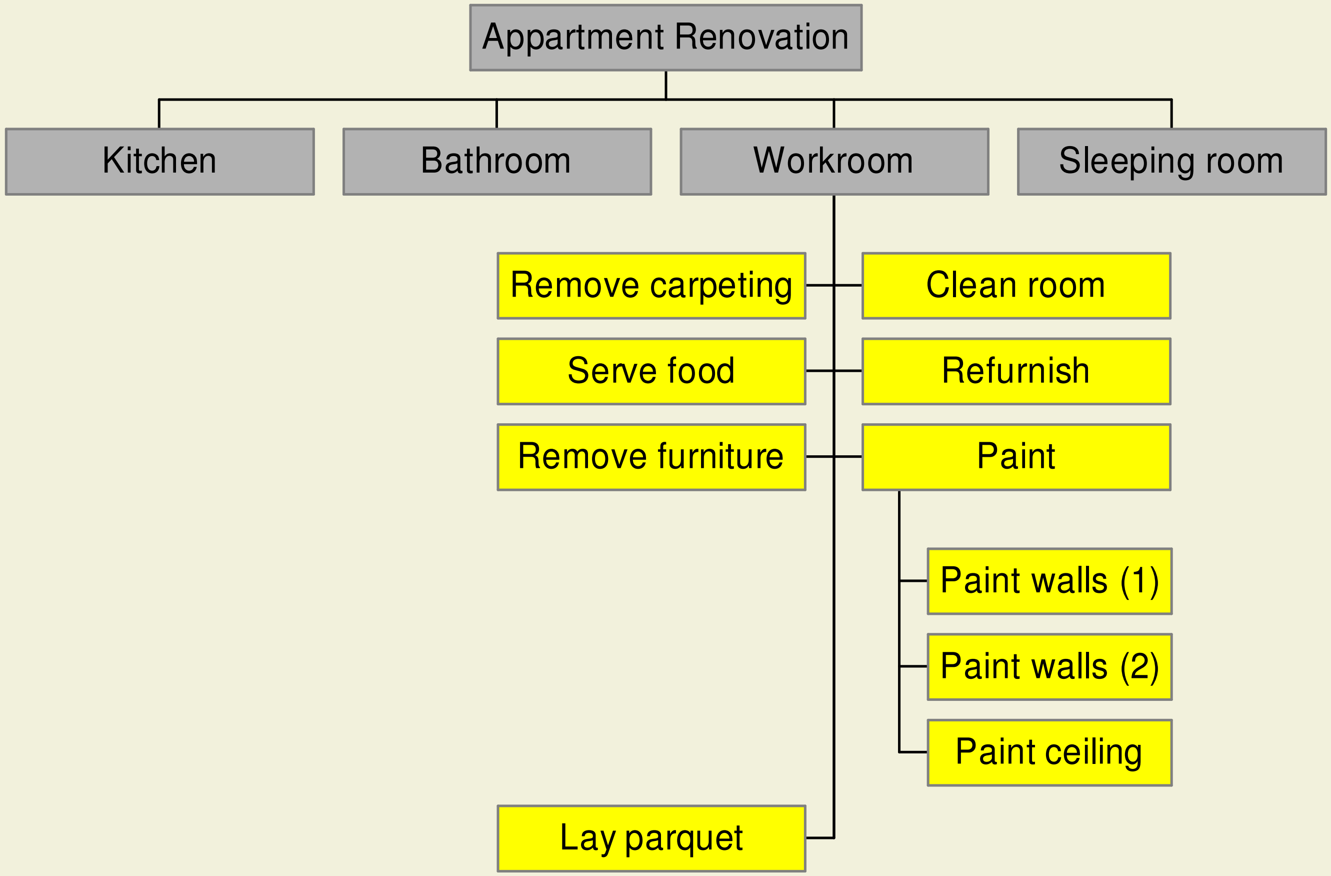
10.1 Scope Planning

10.2 Scheduling

Purpose of Scheduling

- Track the progress of the project
- Determine how possible changes might affect the project
- Communication
  - Will the activities be completed in time?
  - When are which resources needed?
  - When will major milestones be reached?

Activities



- Appartment Renovation
  - Kitchen
  - Bathroom
  - Workroom
    - Remove carpeting
    - Clean room
    - Serve food
    - Refurnish
    - Remove furniture
    - Paint
      - Paint walls (1)
      - Paint walls (2)
      - Paint ceiling
    - Lay parquet
  - Sleeping room

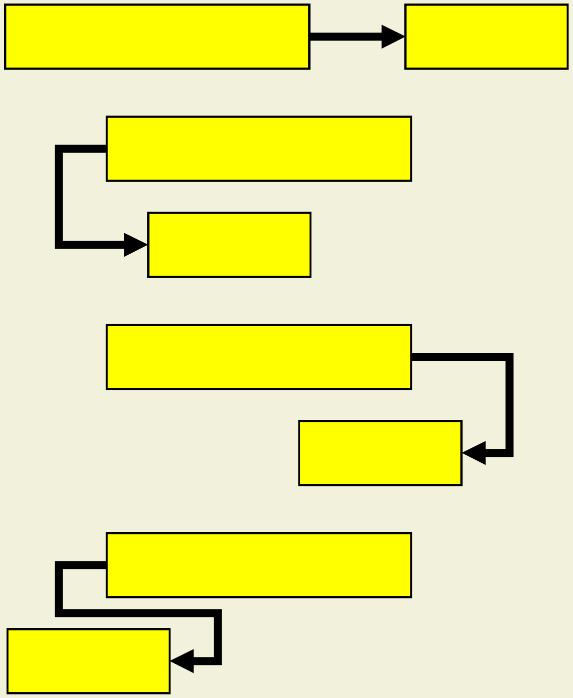
- Rule of thumb: 40 to 80 person hours per activity

Milestones

- Definition:
  A significant event in the project, usually completion of a major deliverable
- Milestones have no effort or duration
- Milestones do not have resources
- Example: Painting completed

Dependencies

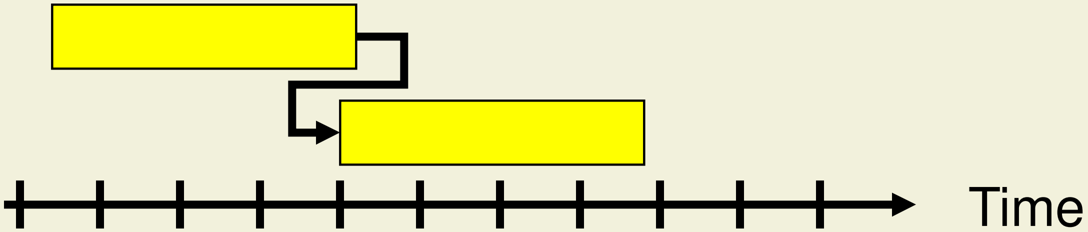
- Logical relationships among activities
  - Finish-to-Start (FS)
  - Start-to-Start (SS)
  - Finish-to-Finish (FF)
  - Start-to-Finish (SF)



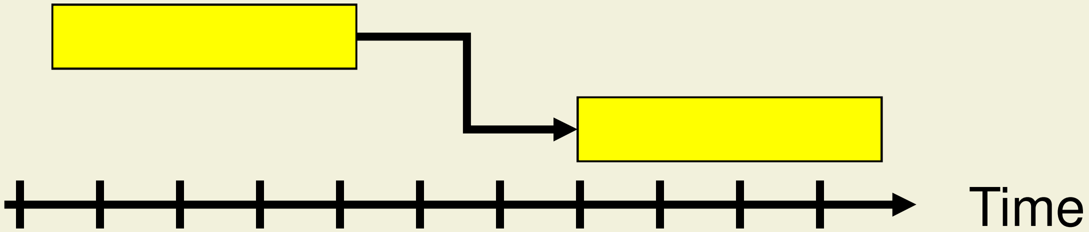
- Dependencies can be mandatory (hard logic) discretionary (soft logic), or external

Lag and Lead

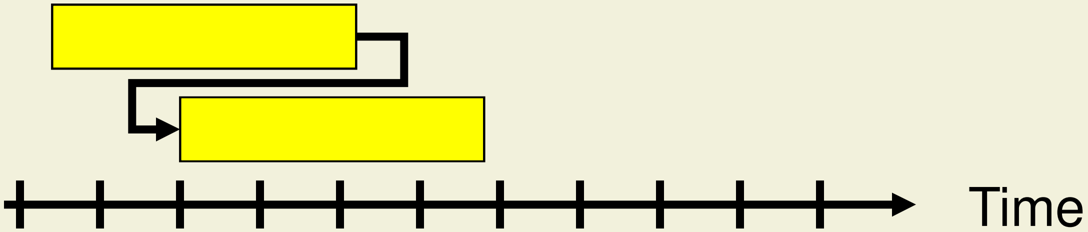
- Modify a logical relationship to direct a delay or acceleration of the successor task
- No modifier



- Lag (+3 units)



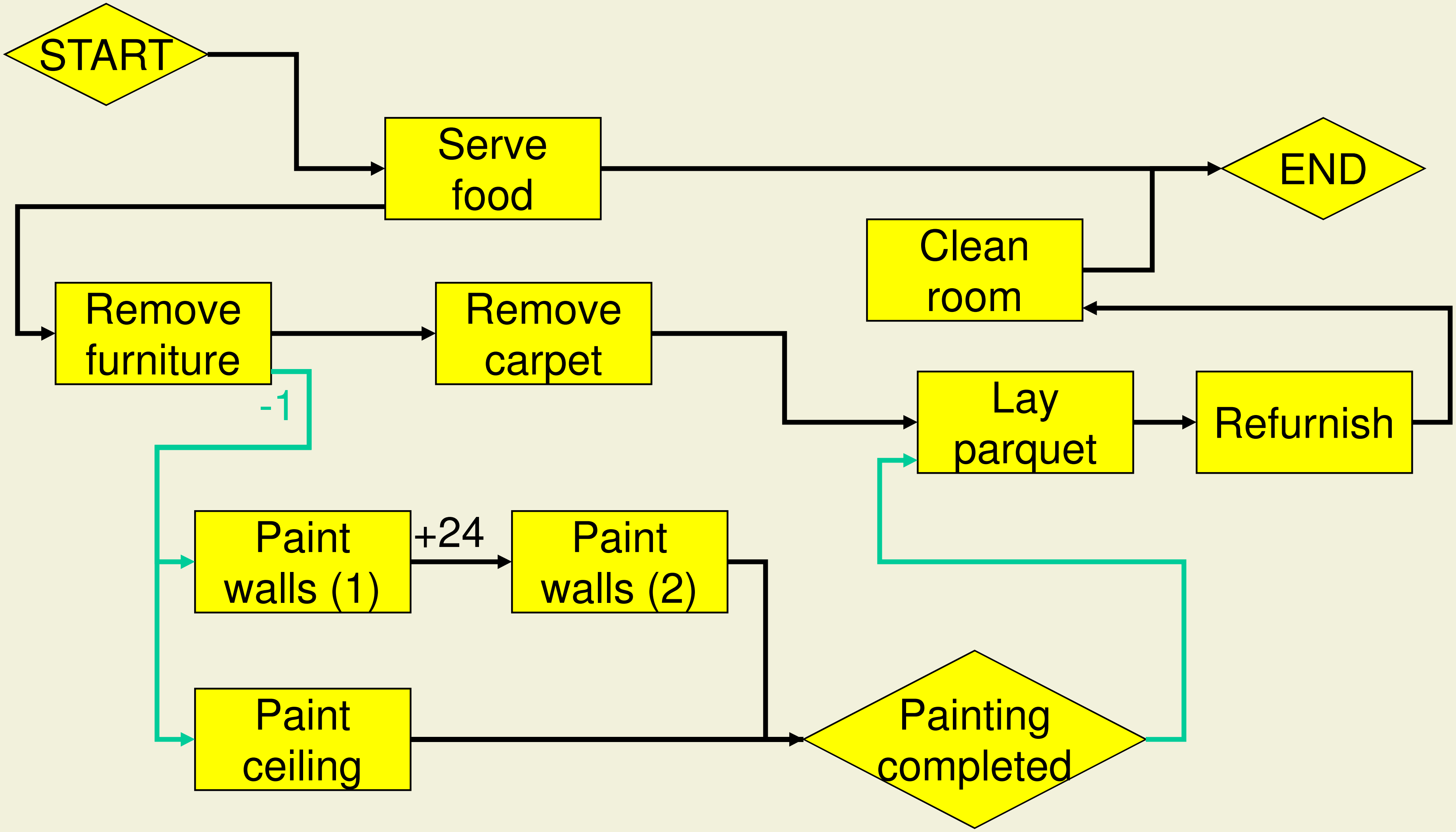
- Lead (-2 units)



Network Diagrams

- Precedence Diagramming Method
  - Show all activities (depicted by boxes)
  - Show the logical flow (depicted by arrows)
  - Clearly illustrate dependencies
- Rules
  - Each activity has at least one predecessor and successor (start and end as milestones)
  - No loops, no dangling arrows
- Other network diagramming methods
  - Arrow diagramming method (activity-on-arrow)
  - Conditional diagramming methods

Network Example



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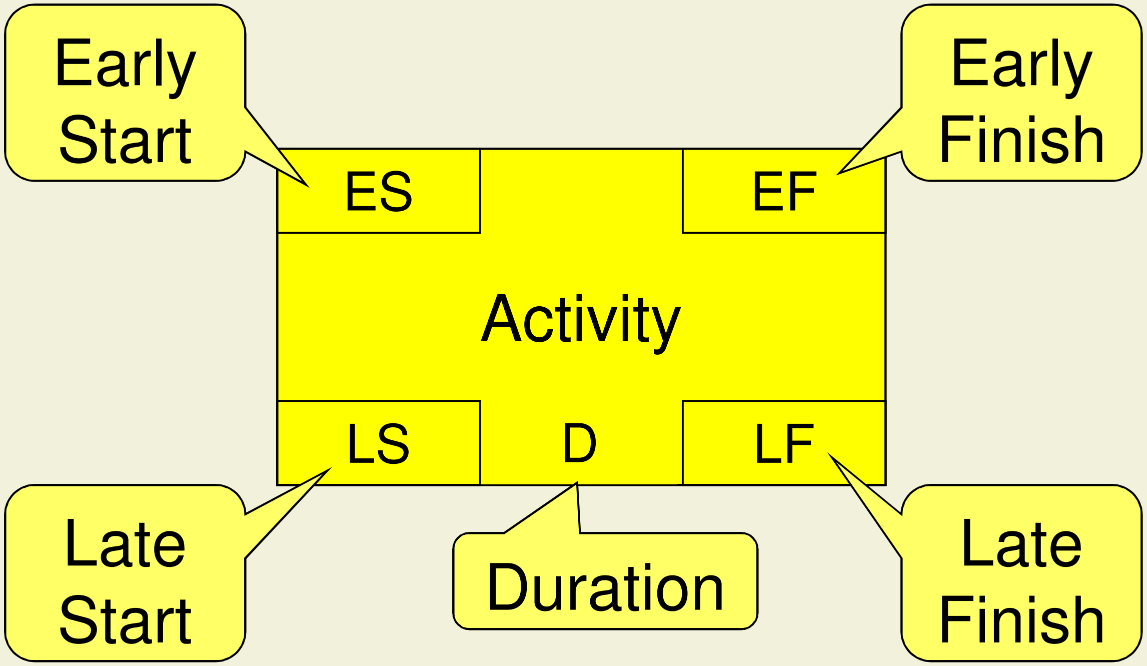
Computing a Schedule

- A schedule consists of the planned dates for all activities and milestones
- Notation



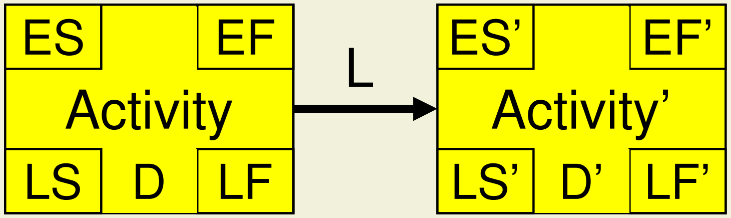
Forward Pass

- Determines overall project duration
- First activity starts on time unit 0
- Calculation of the early start and early finish dates
- For Activity A:

  $ES(A) = MAX_{P \in predecessors(A)} ES_P(A)$

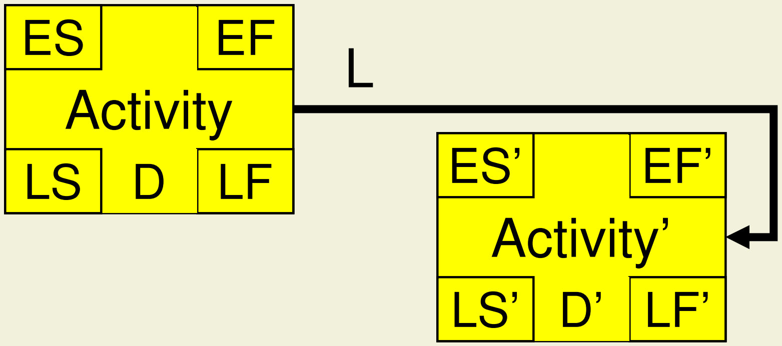
  $EF(A) = ES(A) + Duration(A)$

Calculating Early Start



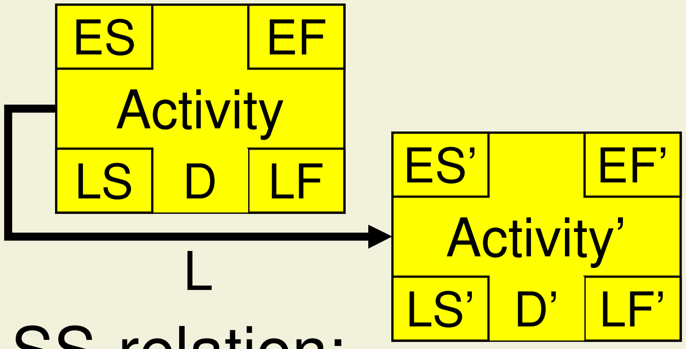
FS-relation:

ES' := EF + L



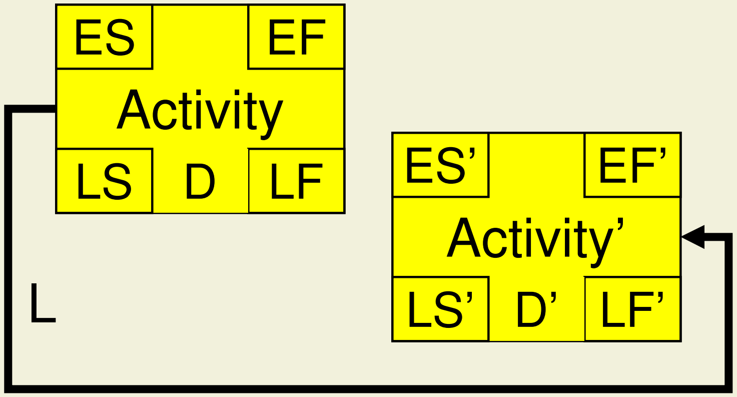
FF-relation:

ES' := EF + L – D'



SS-relation:

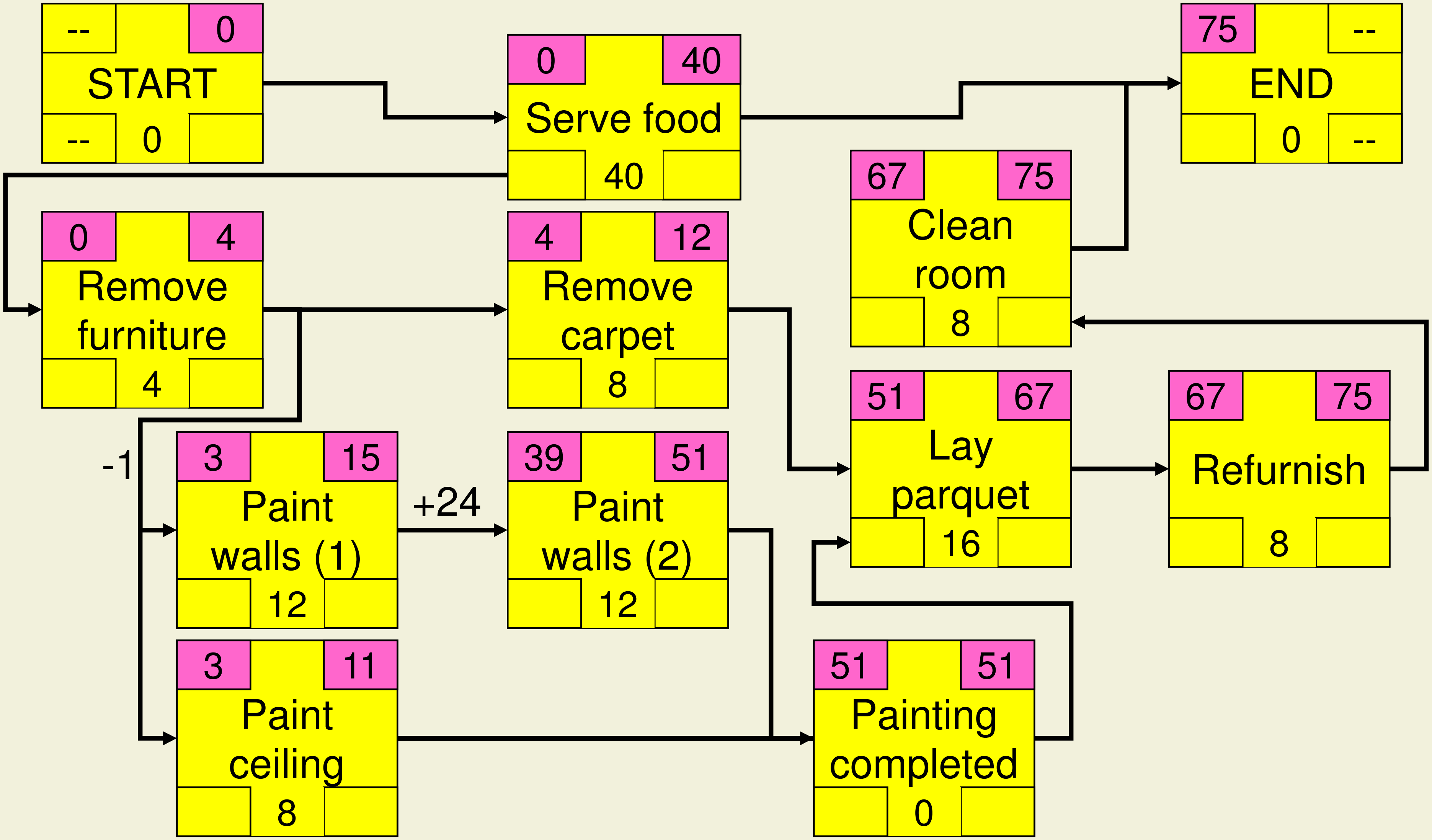
ES' := ES + L



SF-relation:

ES' := ES + L – D'

Forward Pass Example



-- 0
START
-- 0

0 40
Serve food
40

75 --
END
0 --

67 75
Clean room
8

0 4
Remove furniture
4

4 12
Remove carpet
8

51 67
Lay parquet
16

67 75
Refurnish
8

-1

3 15
Paint walls (1)
12

+24

39 51
Paint walls (2)
12

3 11
Paint ceiling
8

51 51
Painting completed
0

Backward Pass

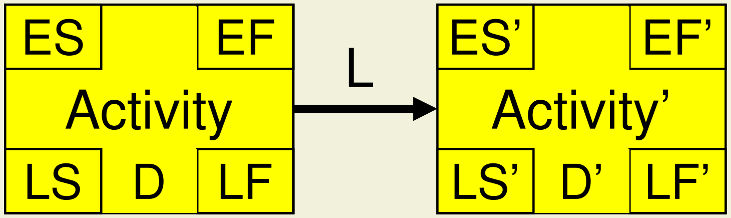
- Determines latest possible dates for each activity that do not delay the overall project
- Last activity ends at time unit of project duration
- Calculation of the late start and late finish dates
- For Activity A:

  $\mathrm{LF}(A) = \mathrm{MIN}_{P \in \mathrm{successors}(A)} \mathrm{LF}_P(A)$

  $\mathrm{LS}(A) = \mathrm{LF}(A) - \mathrm{Duration}(A)$

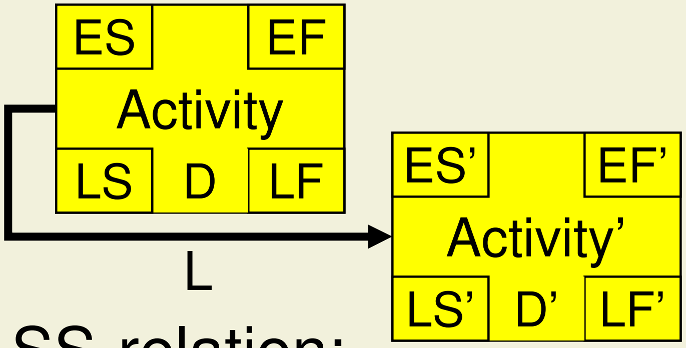
- The logic is “inverted”
  - early ↔ late, start ↔ finish, + ↔ -, primed ↔ unprimed

Calculating Late Finish



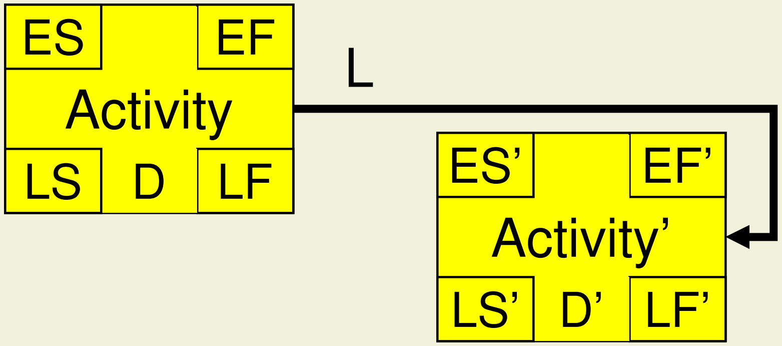
FS-relation:

LF := LS’ – L



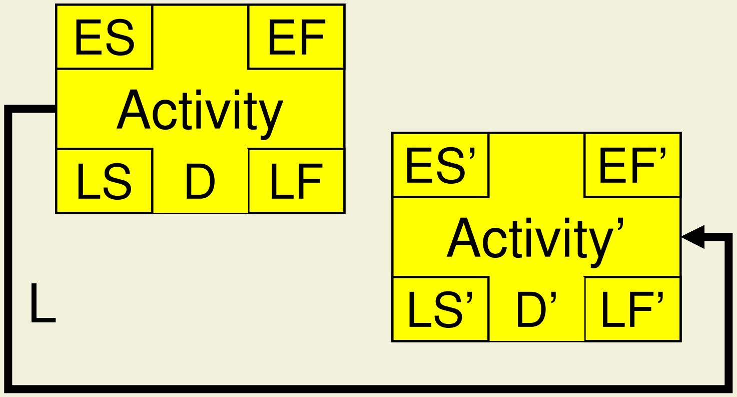
SS-relation:

LF := LS’ – L + D



FF-relation:

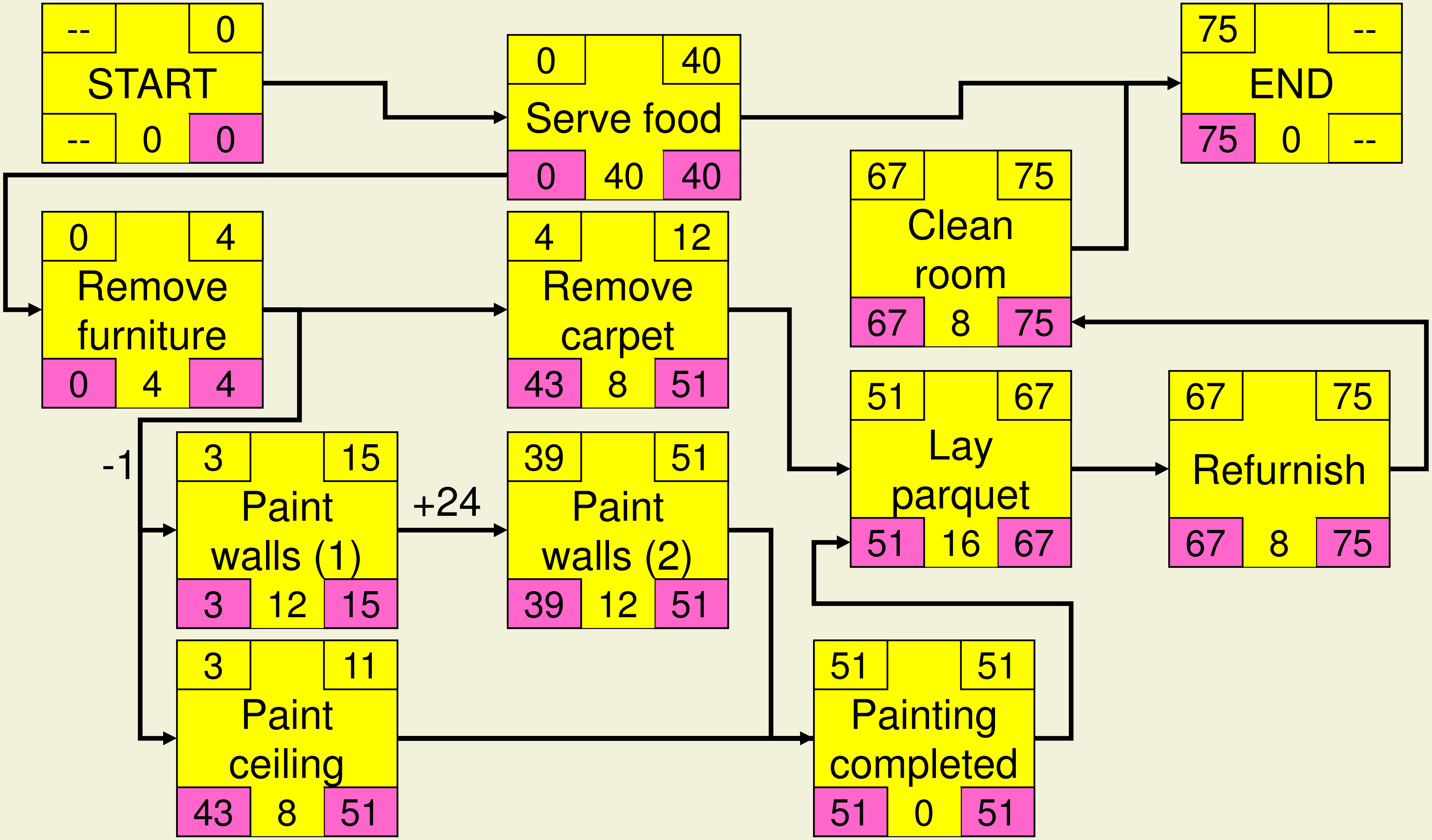
LF := LF’ – L



SF-relation:

LF := LF’ – L + D

Backward Pass Example



-- | | 0
START
-- | 0 | 0

0 | | 40
Serve food
0 | 40 | 40

75 | | --
END
75 | 0 | --

67 | | 75
Clean room
67 | 8 | 75

0 | | 4
Remove furniture
0 | 4 | 4

4 | | 12
Remove carpet
43 | 8 | 51

51 | | 67
Lay parquet
51 | 16 | 67

67 | | 75
Refurnish
67 | 8 | 75

-1

3 | | 15
Paint walls (1)
3 | 12 | 15

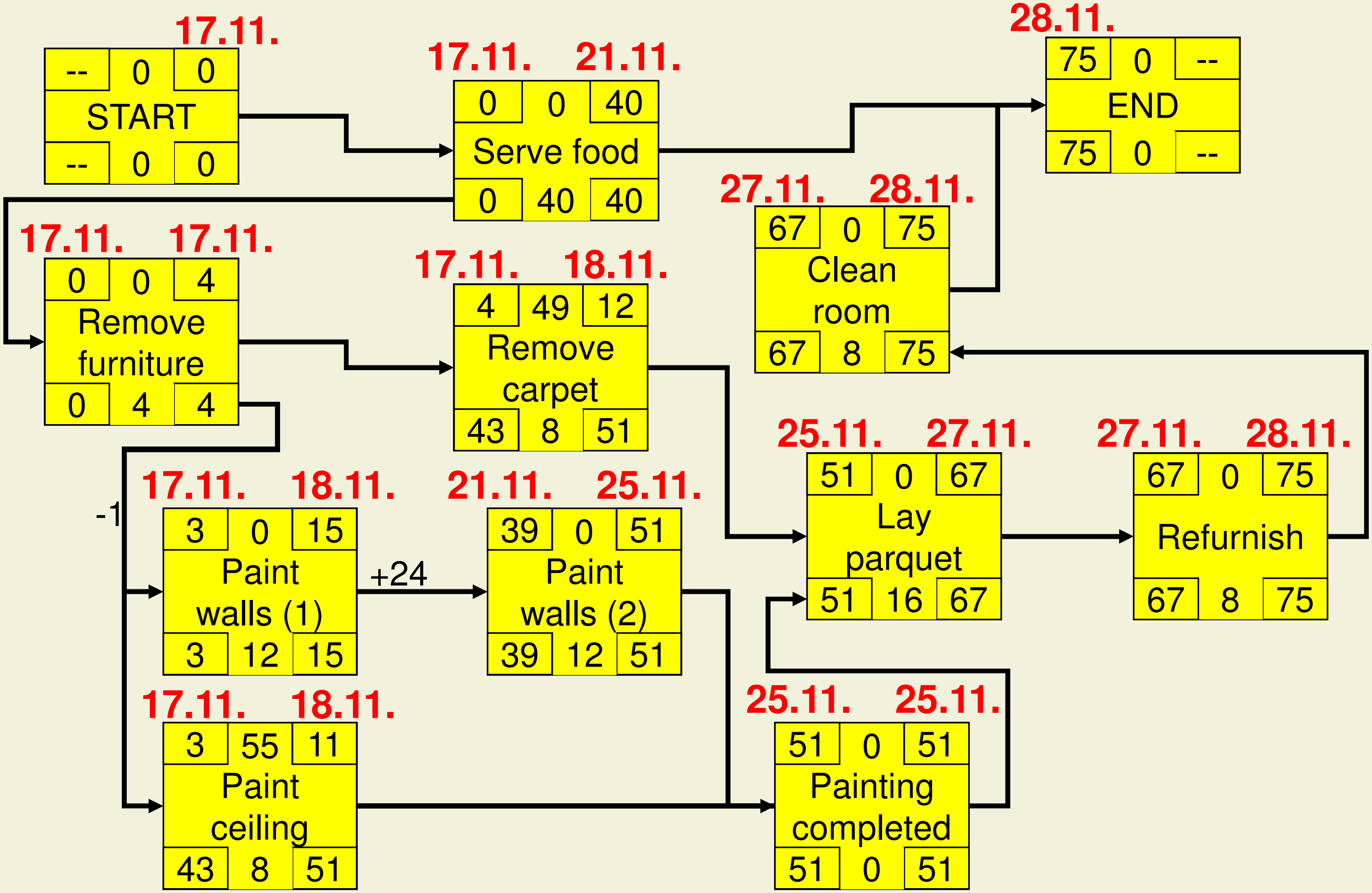
+24

39 | | 51
Paint walls (2)
39 | 12 | 51

3 | | 11
Paint ceiling
43 | 8 | 51

51 | | 51
Painting completed
51 | 0 | 51

Network Diagrams with Dates



17.11.
-- | 0 | 0
START
-- | 0 | 0

17.11. 21.11.
0 | 0 | 40
Serve food
0 | 40 | 40

28.11.
75 | 0 | --
END
75 | 0 | --

17.11. 17.11.
0 | 0 | 4
Remove furniture
0 | 4 | 4

17.11. 18.11.
4 | 49 | 12
Remove carpet
43 | 8 | 51

27.11. 28.11.
67 | 0 | 75
Clean room
67 | 8 | 75

17.11. 18.11.
3 | 0 | 15
Paint walls (1)
3 | 12 | 15

21.11. 25.11.
39 | 0 | 51
Paint walls (2)
39 | 12 | 51

25.11. 27.11.
51 | 0 | 67
Lay parquet
51 | 16 | 67

27.11. 28.11.
67 | 0 | 75
Refurnish
67 | 8 | 75

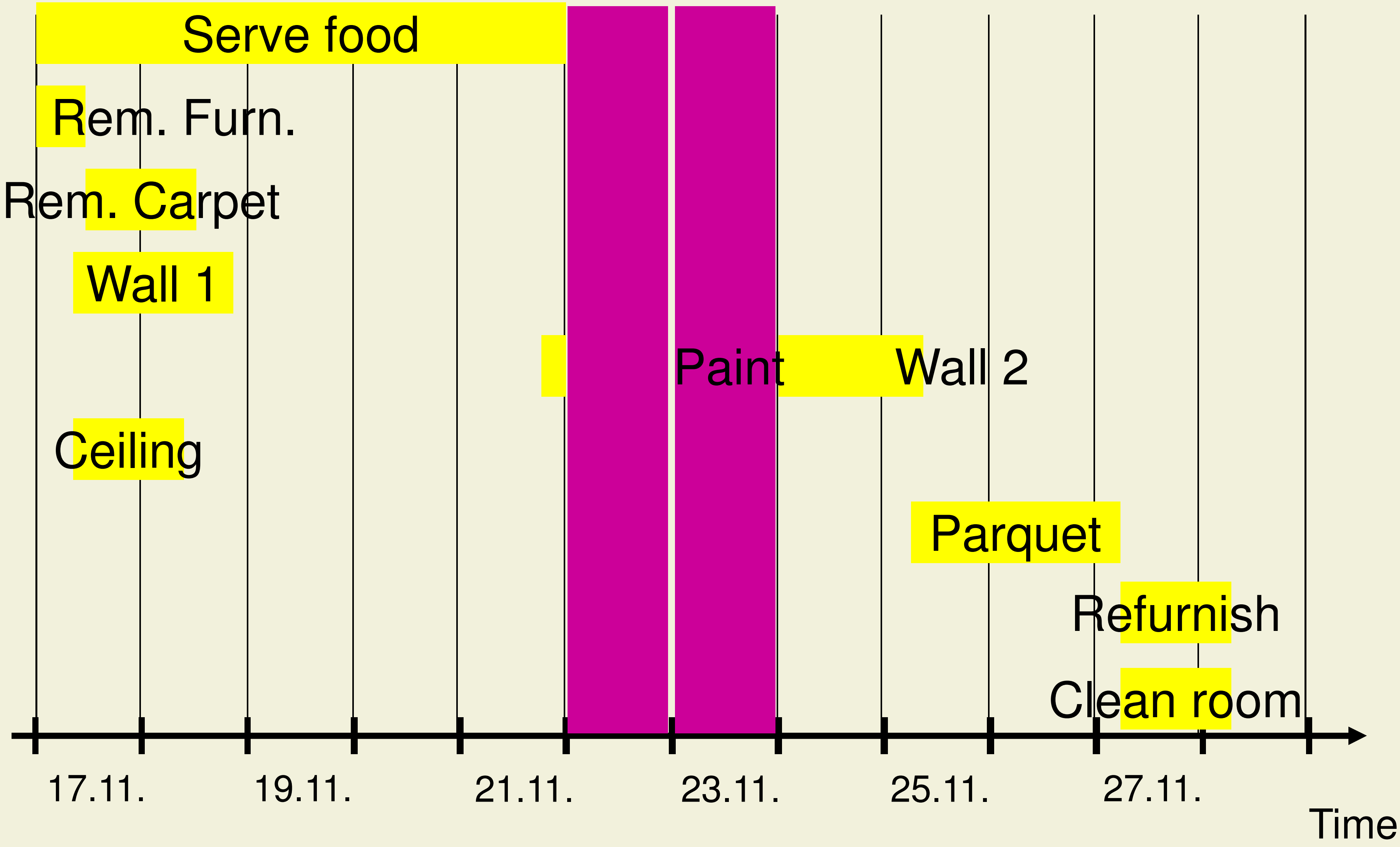
17.11. 18.11.
3 | 55 | 11
Paint ceiling
43 | 8 | 51

25.11. 25.11.
51 | 0 | 51
Painting completed
51 | 0 | 51

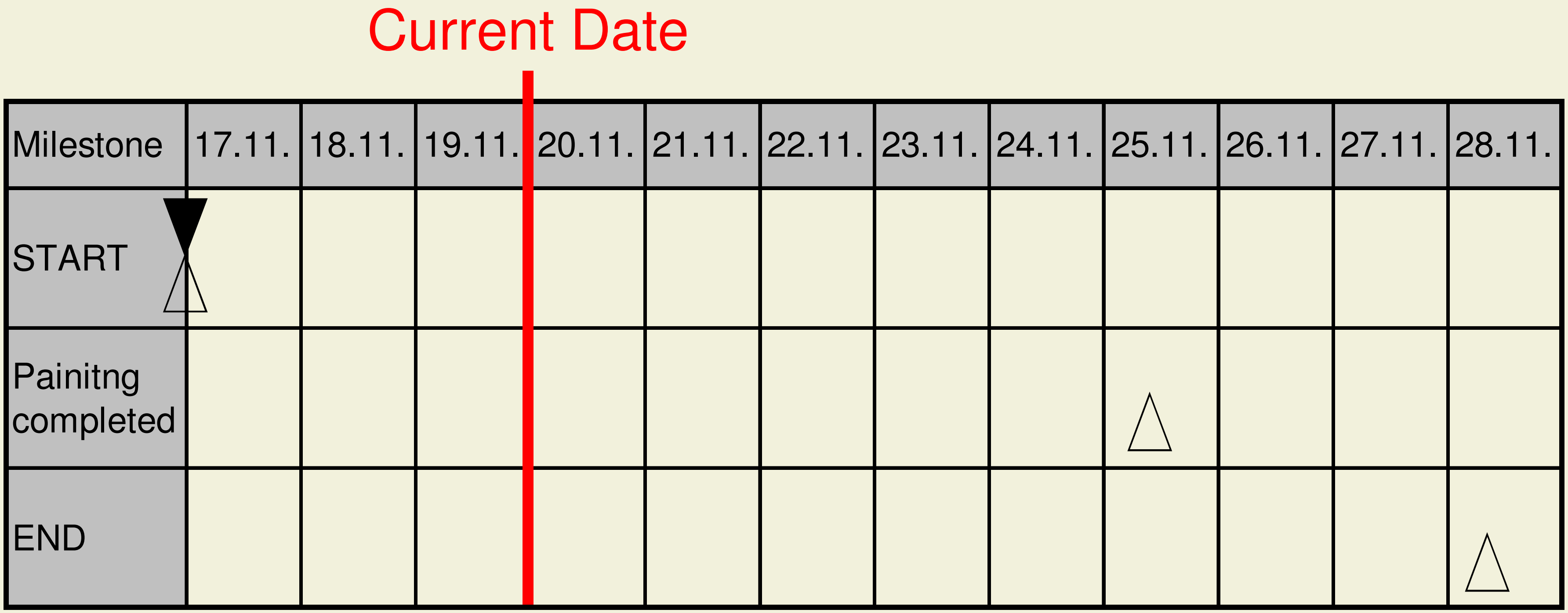
-1

+24

Bar (Gantt) Charts



Milestone Charts



Current Date

Milestone	17.11.	18.11.	19.11.	20.11.	21.11.	22.11.	23.11.	24.11.	25.11.	26.11.	27.11.	28.11.
START	▼ △											
Painitng completed									△			
END												△

Planned △ Actual ▼

Diagramming Methods

- Network diagrams
    - Show dependencies and workflow
    - Purpose: planning
- Gantt charts
    - Show dates and durations
    - Purpose: reporting and progress tracking
- Milestone charts
    - Show major events
    - Purpose: reporting to management and customer

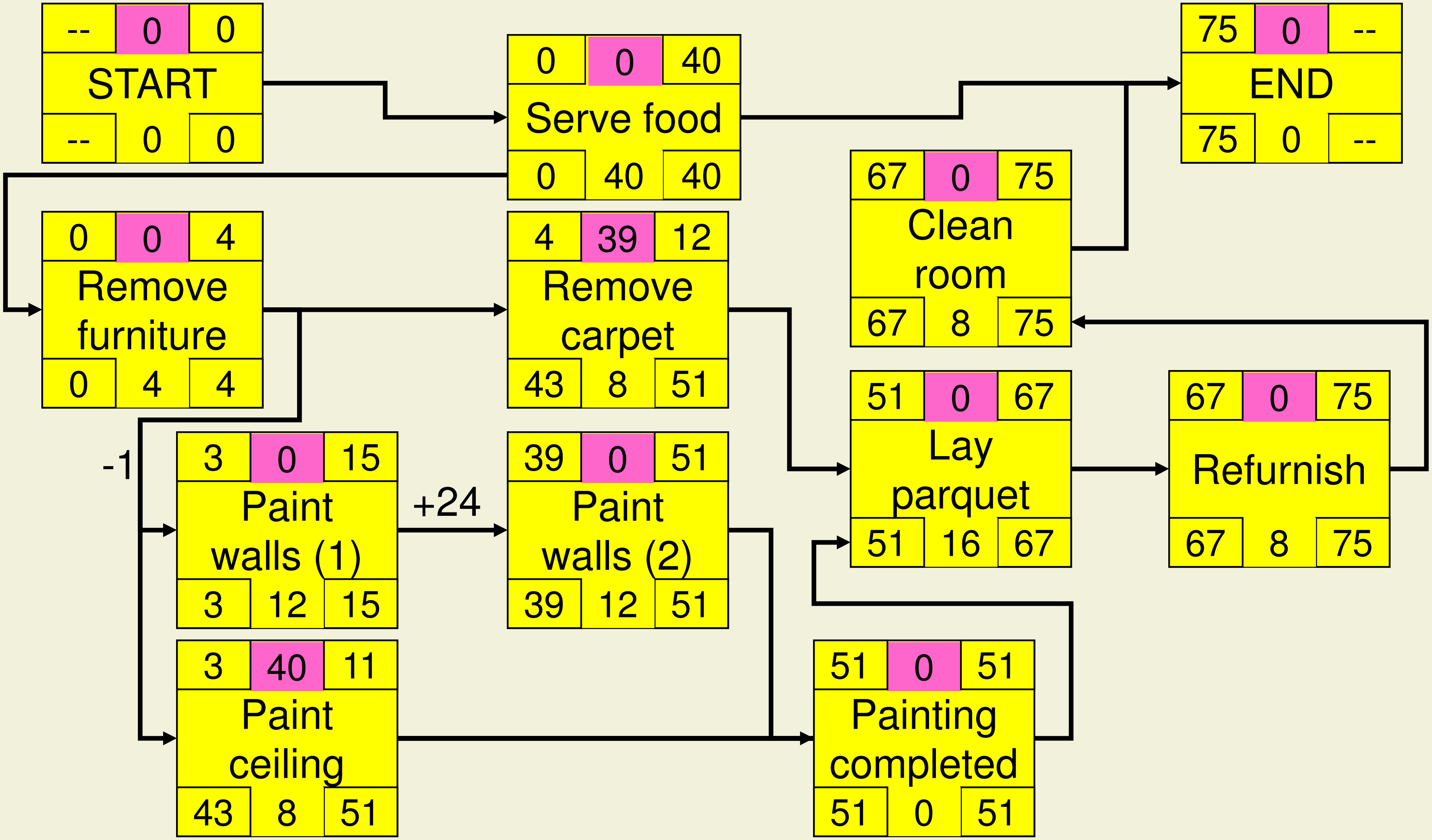
Analyzing a Schedule

- Identify schedule risks
- Determine if deliverables will be made on time
- Check resource usage
- Find potentials for compressing the schedule
- Consistency

Float

- Definition:
  The amount of time that an activity may be delayed from its early start without delaying the project finish date
- Float = LF – EF = LS – ES
- Interpretation
  - Float > 0: Time is available
  - Float = 0: Situation is critical
  - Float < 0: Project is behind
- Sometimes called *Total Float*, *Slack*, or *Total Slack*

Float Example



-- 0 0
START
-- 0 0

0 0 40
Serve food
0 40 40

75 0 --
END
75 0 --

67 0 75
Clean room
67 8 75

0 0 4
Remove furniture
0 4 4

4 39 12
Remove carpet
43 8 51

51 0 67
Lay parquet
51 16 67

67 0 75
Refurnish
67 8 75

-1

3 0 15
Paint walls (1)
3 12 15

+24

39 0 51
Paint walls (2)
39 12 51

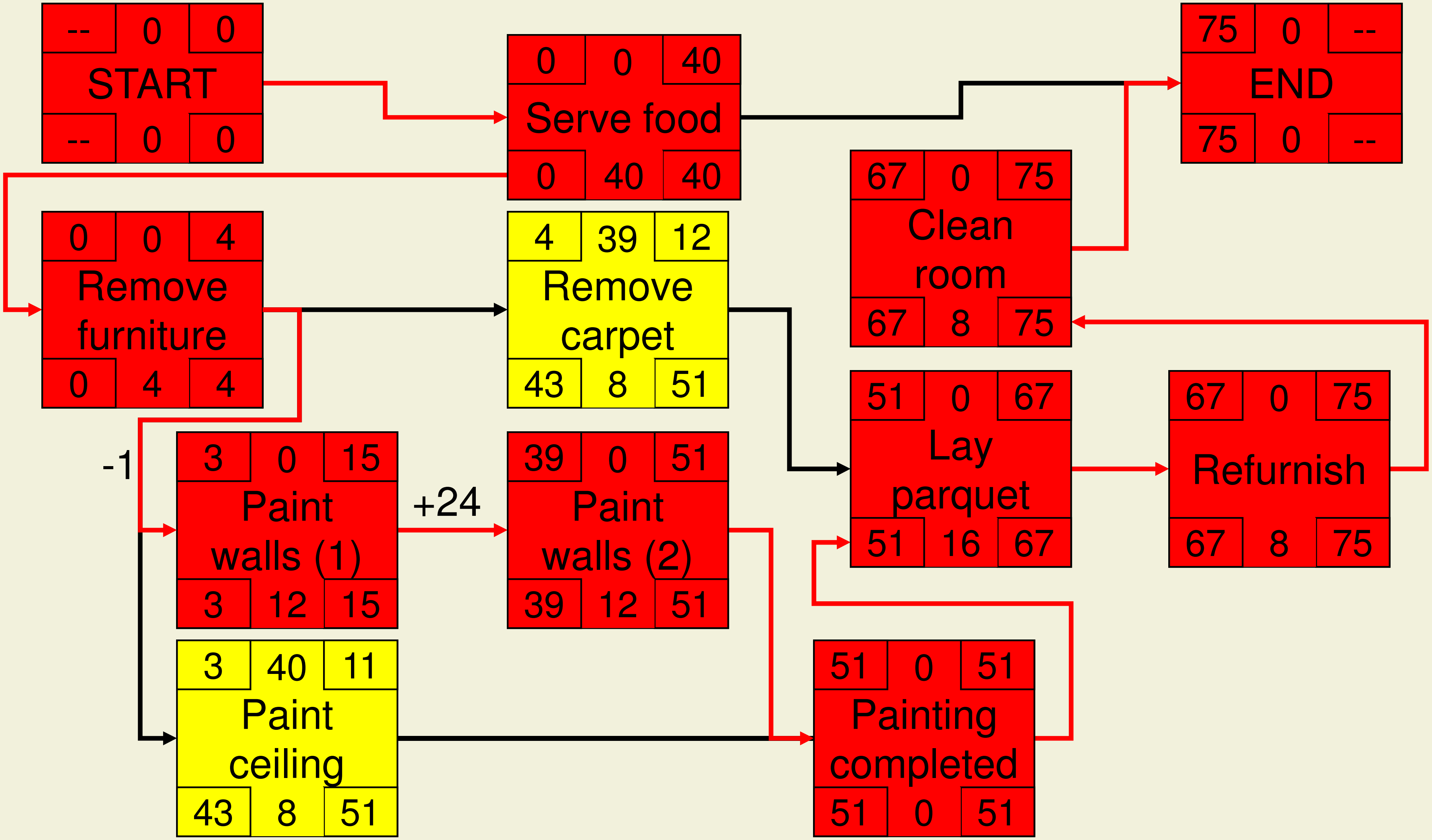
3 40 11
Paint ceiling
43 8 51

51 0 51
Painting completed
51 0 51

Critical Path

- Definition:
  The series of activities that determines the duration of the project (the longest path through the network)
- Sum of float on critical path is zero (or negative)
- Critical path is important
  - To shorten project duration
  - To focus progress control
  - To identify schedule risks
- There can be several critical paths in a project

Critical Path Example



-- 0 0
START
-- 0 0

0 0 40
Serve food
0 40 40

75 0 --
END
75 0 --

0 0 4
Remove furniture
0 4 4

4 39 12
Remove carpet
43 8 51

67 0 75
Clean room
67 8 75

51 0 67
Lay parquet
51 16 67

67 0 75
Refurnish
67 8 75

-1

3 0 15
Paint walls (1)
3 12 15

+24

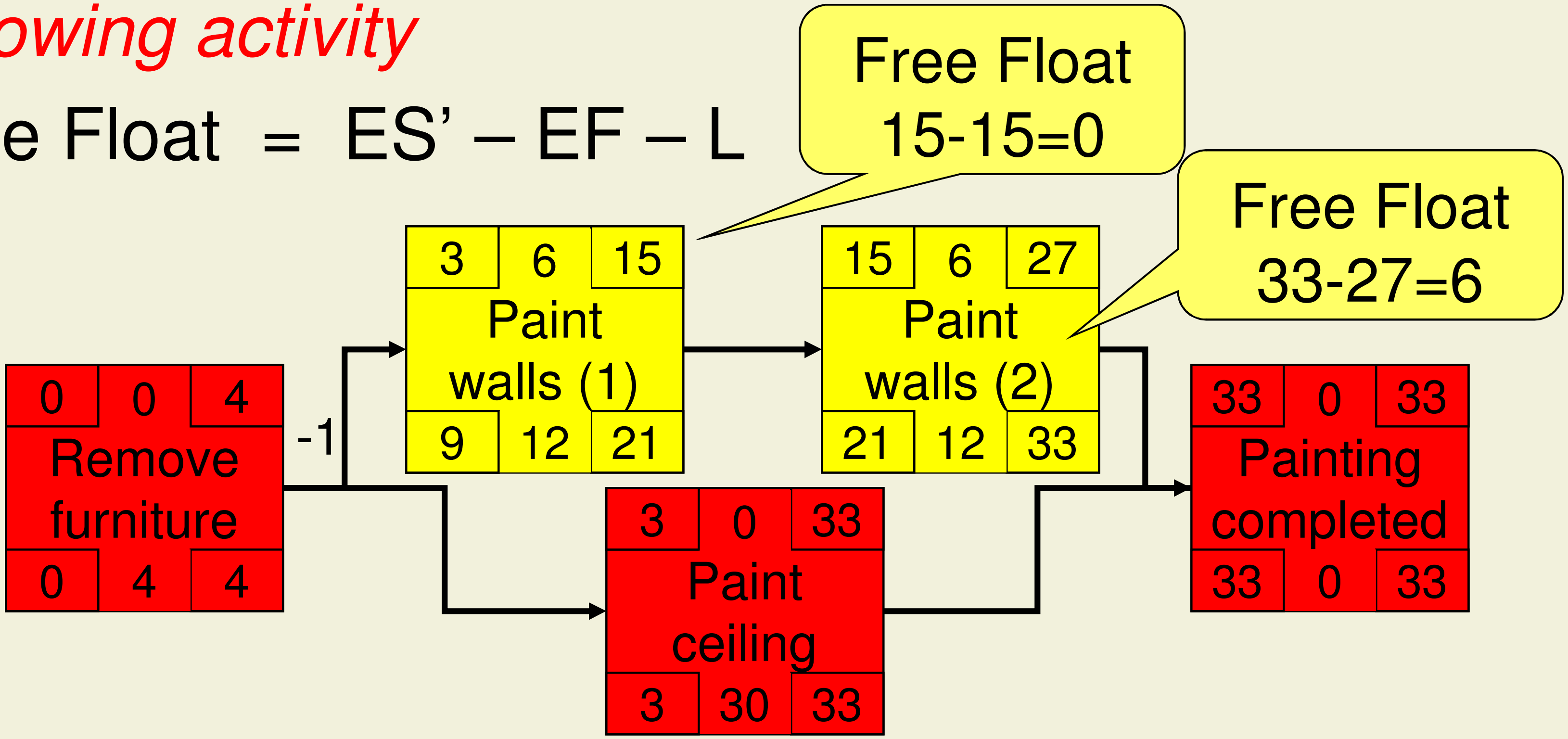
39 0 51
Paint walls (2)
39 12 51

3 40 11
Paint ceiling
43 8 51

51 0 51
Painting completed
51 0 51

Free Float

- Definition:
  The amount of time that an activity can be delayed without delaying the early start of any immediately following activity
- Free Float = ES’ – EF – L



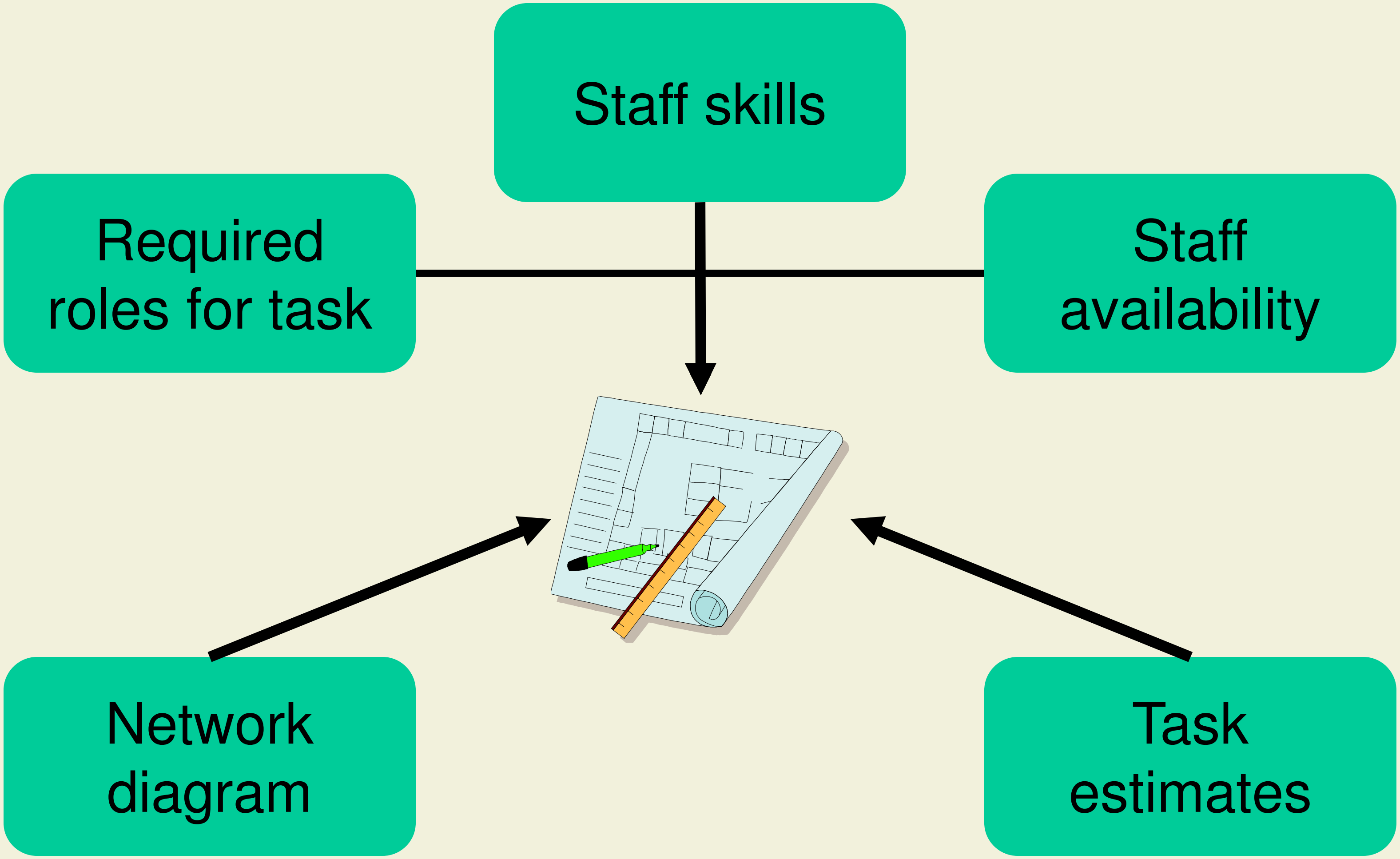
Schedule Compression

- Fast tracking to shorten critical path
    - Do activities in parallel instead of in sequence
    - Problem: increases risk
- Crashing the network
    - Add resources to the critical path (e.g., from non-critical activities)
    - Problem: Law of diminishing returns
- Increasing productivity by different technology
- Extended hours and weekends should not be considered during planning
    - You will need them during project execution anyway

Resource Leveling

- Common results of critical path method
  - More resources required than available
  - Changes of resource levels are not manageable
- Analysis: Resource histograms
- Heuristic: Resource-based method
  - Allocate scarce resources to critical path first
- Resource leveling usually leads to longer project duration

Consistency



Staff skills

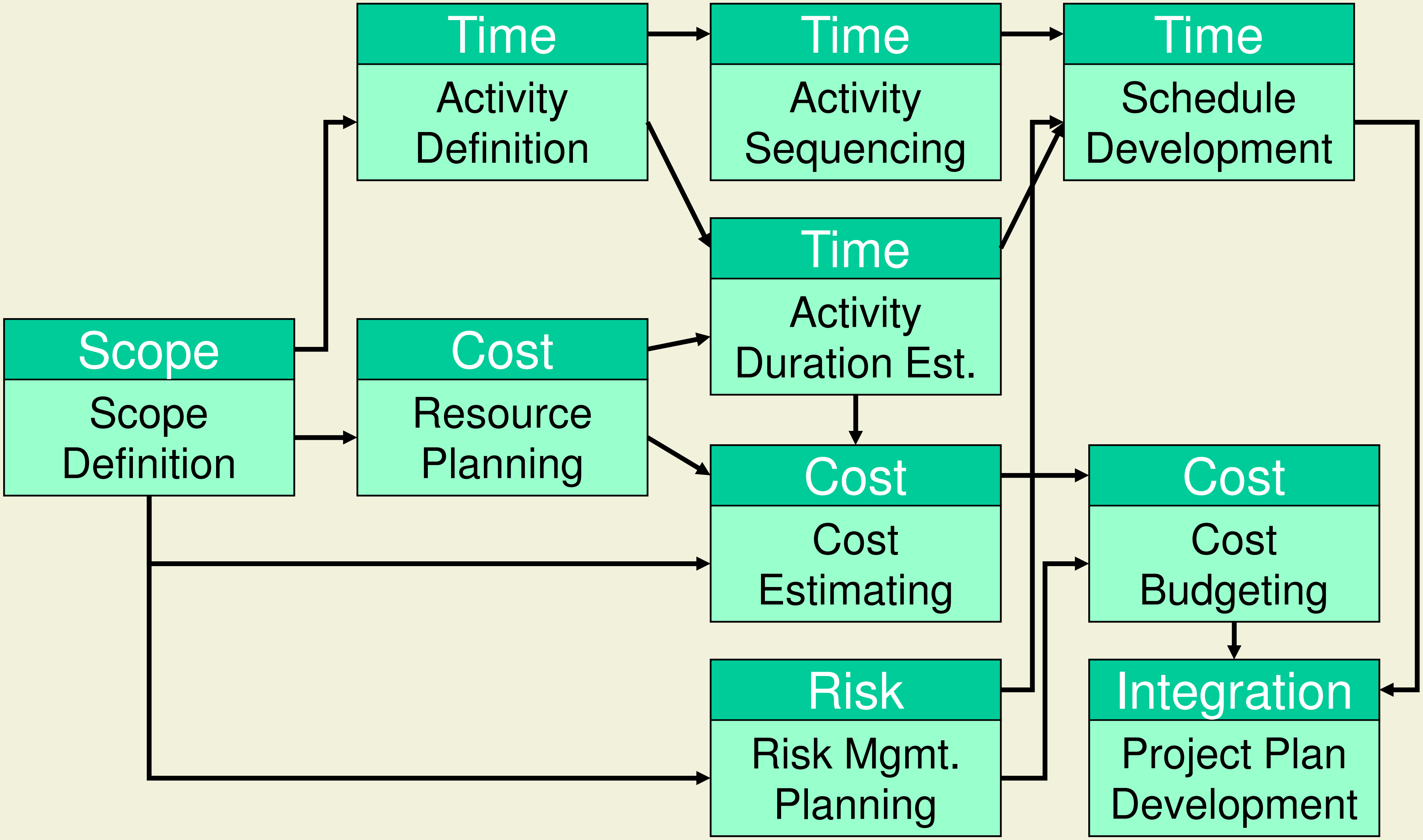
Required roles for task

Staff availability

Network diagram

Task estimates

Main Planning Processes


Time
Activity Definition
Time
Activity Sequencing
Time
Schedule Development
Time
Activity Duration Est.
Scope
Scope Definition
Cost
Resource Planning
Cost
Cost Estimating
Cost
Cost Budgeting
Risk
Risk Mgmt. Planning
Integration
Project Plan Development