Software Engineering

Project Scheduling and Tracking

- Why project scheduling
  - Interdependency
    - Relation among tasks
    - Output of a task may be input of another task
  - Assessing progress
- Root causes of late delivery of a software
  - Unrealistic deadline
    - Established by someone outside the software development group
    - Forced to the group
  - Changing customer requirements
    - Schedule not changed
  - Underestimating the effort, resources required
  - Unconsidered risks
  - Technical difficulties
    - Could not be foreseen in advance
  - Human difficulties
    - Could not be foreseen in advance
  - Miscommunication among project staff
    - Results in delay

Project Scheduling and Tracking

- Root causes of late delivery of a software
  - Failure by project management
    - Project is falling behind schedule
    - Lack of action to correct the problem
- Basic principles of project scheduling
  - Compartmentalization
    - Project is compartmentalized into a number of manageable activities and tasks
    - Product and process are decomposed
  - Interdependency
    - Interdependency among each task must be determined
    - Sequential
    - Parallel
  - Time allocation
    - Allocating some number of work units
    - Assigning start date and completion date
  - Effort validation
  - Defined responsibilities
    - Assigning tasks to specific team members

Project Scheduling and Tracking

- Basic principles of project scheduling
  - Defined outcomes
    - Work products
  - Defined milestones
- Degree of rigor
  - Casual
    - Process framework activities
    - Minimum task set
    - Minimized umbrella activities
    - Reduced documentation requirements
  - Structured
    - Process framework activities
    - Umbrella activities necessary to ensure high quality
    - Streamlined documentation
  - Strict
    - Full process
    - All umbrella activities
  - Quick reaction
    - Emergency situation
    - Only tasks essential to maintain good quality

Project Scheduling and Tracking

- Defining a task network/activity network
  - Graphic representation of the task flow for a project
  - Depicts major software engineering tasks

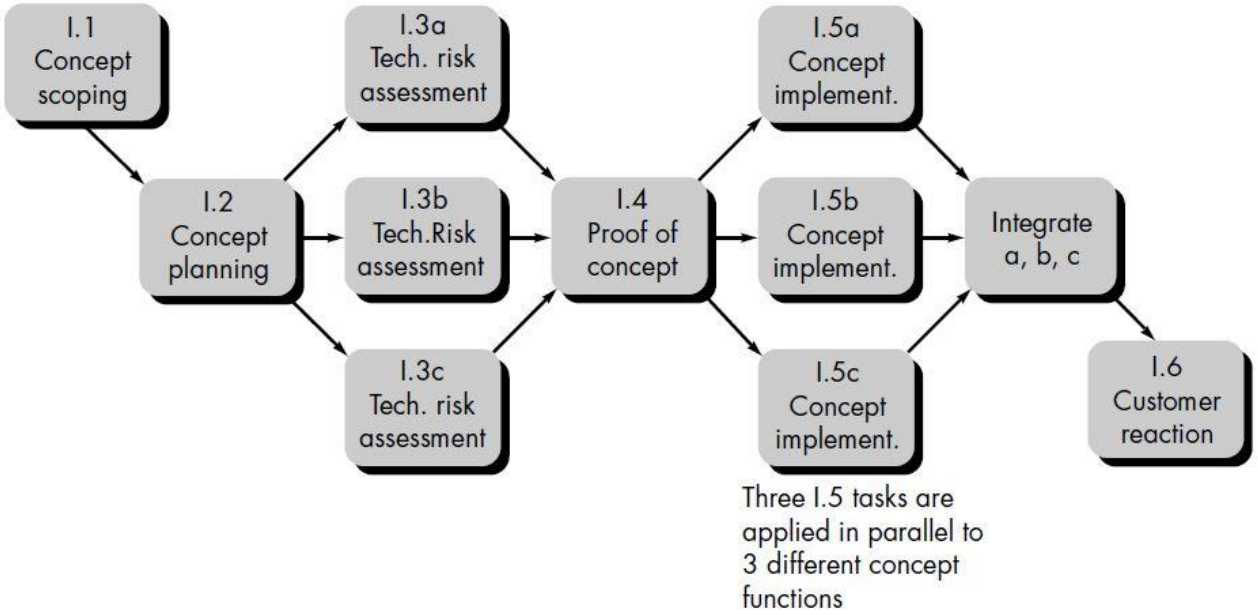

Figure 1: A task network for concept development

Project Scheduling and Tracking

- Timeline chart/Gantt chart

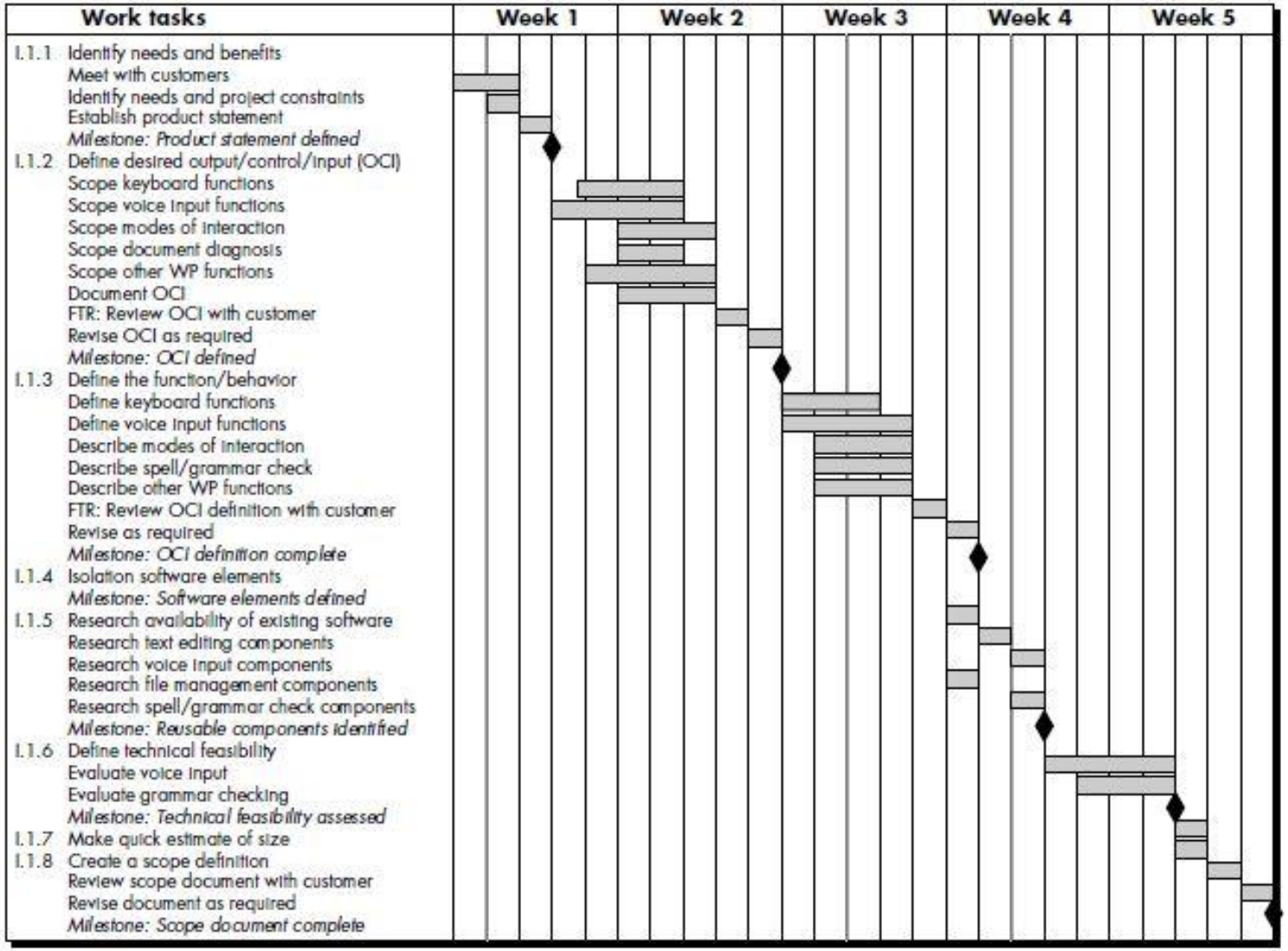

Figure 2: An example timeline chart

Project Scheduling and Tracking

- CPM (Critical Path Method)
  - Unique Start (tail)
  - Unique End (head)

Activity	Immediate Predecessor(s)	Duration (Months)
A	---	2
B	---	5
C	---	4
D	B	5
E	A	7
F	A	3
G	B	3
H	C,D	6
I	C,D	2
J	E	5
K	F,G,H	4
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M	I	12
N	J,K	8

https://www.youtube.com/watch?v=vUMGvpsb8dc&ab_channel=KauserWise

Project Scheduling and Tracking

- CPM (Critical Path Method)

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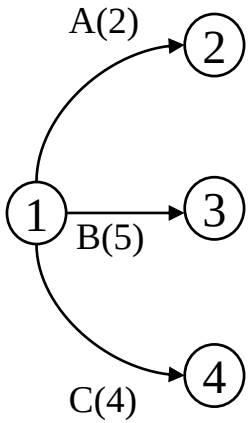

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Project Scheduling and Tracking

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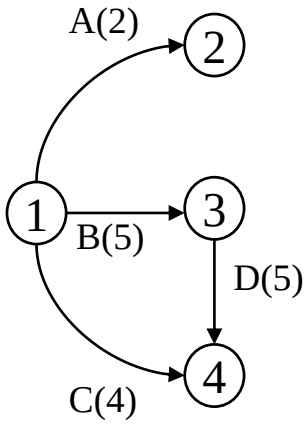

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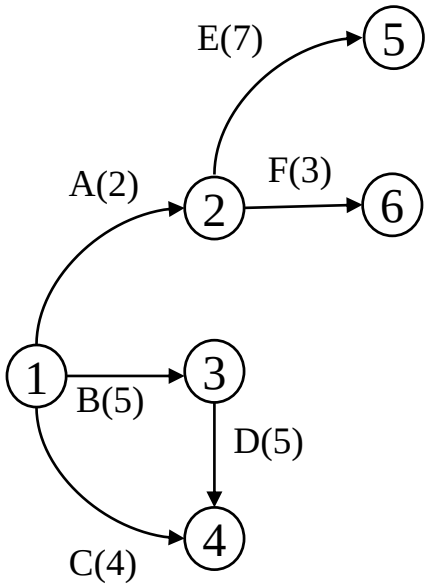

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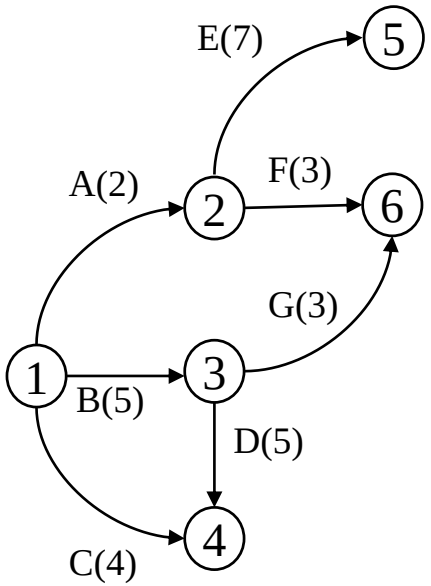

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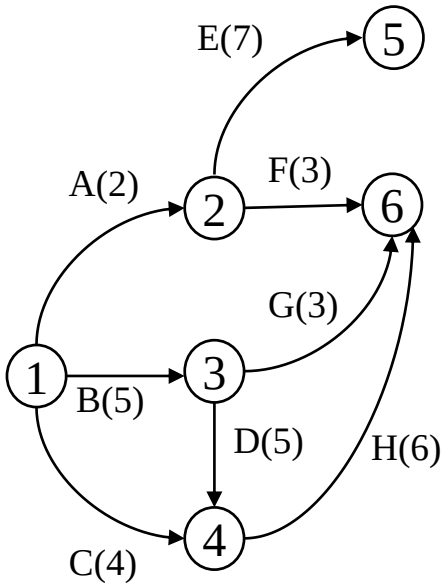

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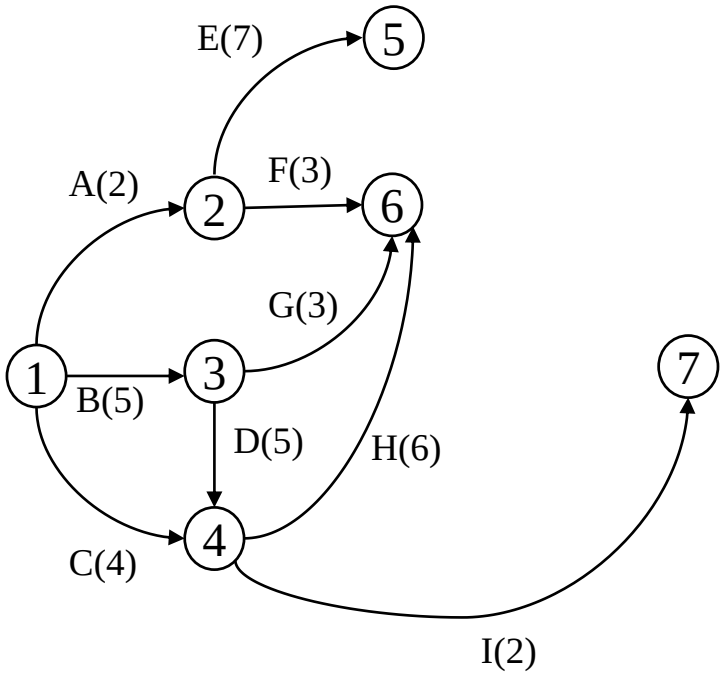

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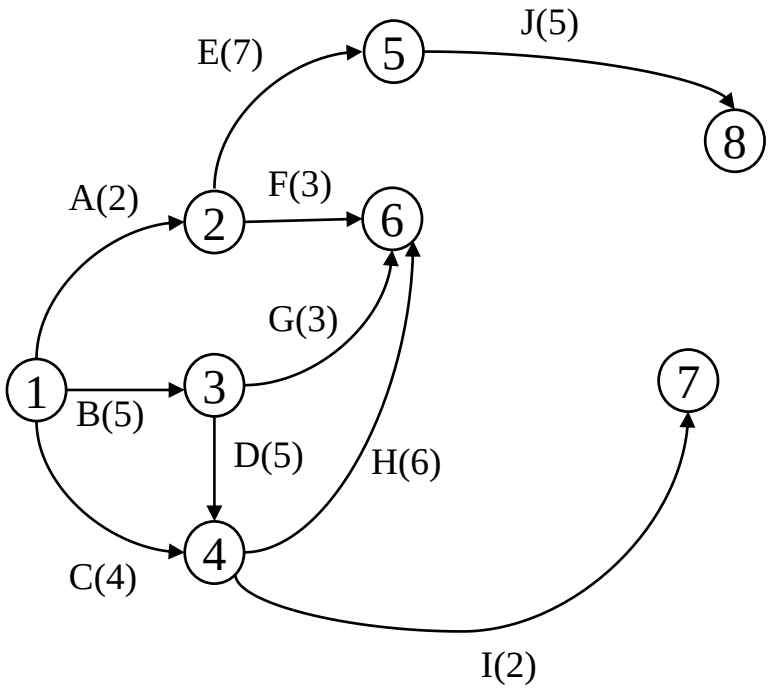

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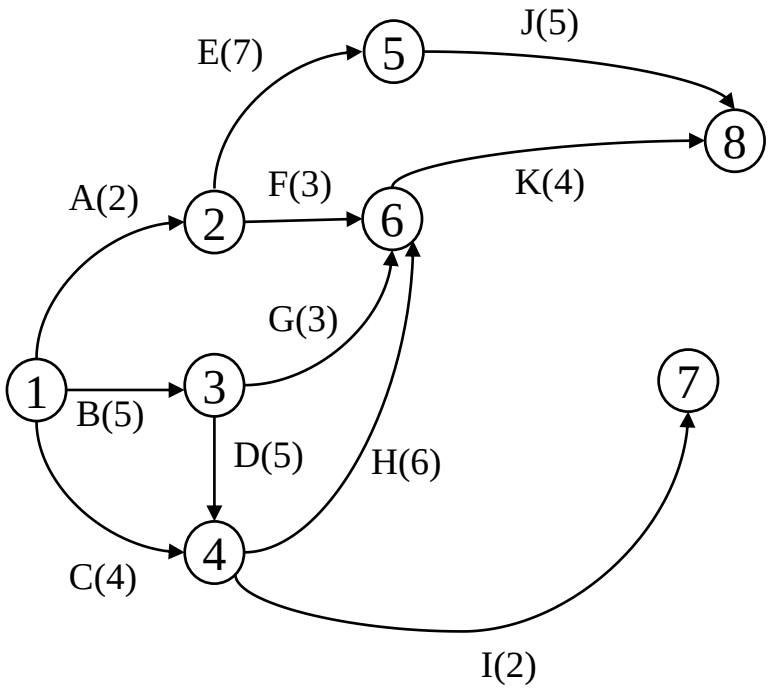

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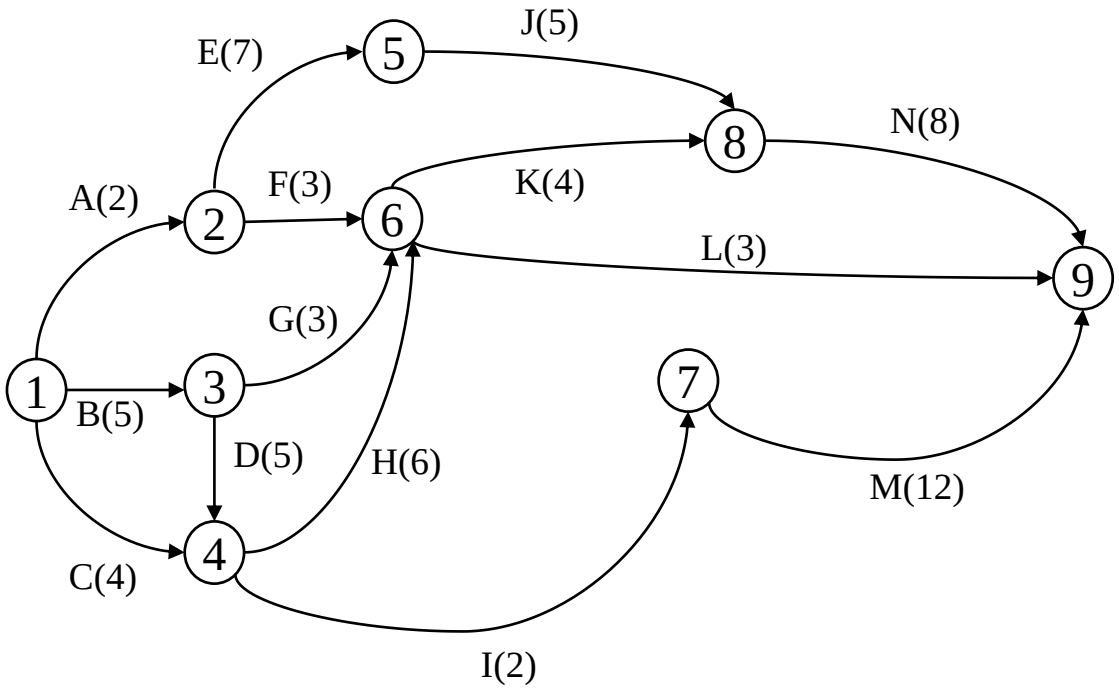

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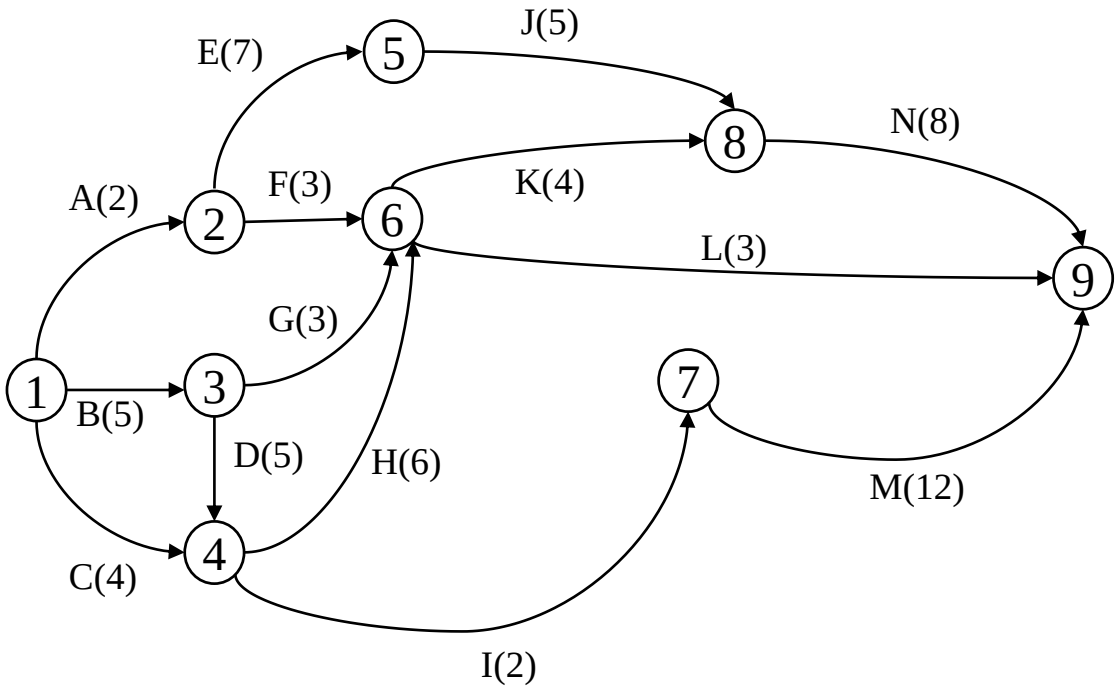

Figure 3: CPM Network

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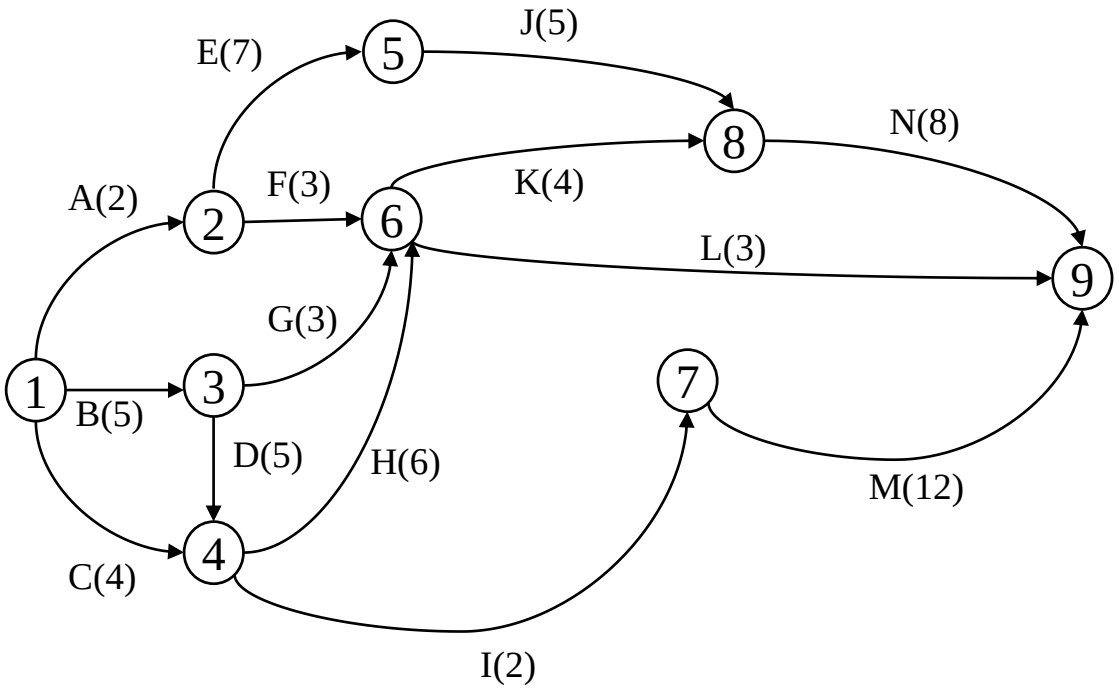
Project Scheduling and Tracking

- CPM (Critical Path Method)
  - Critical Path
    - Longest distance between start and end
    - Earliest Start time (ES) [forward pass]
      - $ES_j = Max_i(ES_i + D_{ij})$
    - Latest Completion time (LC) [backward pass]
      - $LC_i = Min_j(LC_j - D_{ij})$

LC
ES



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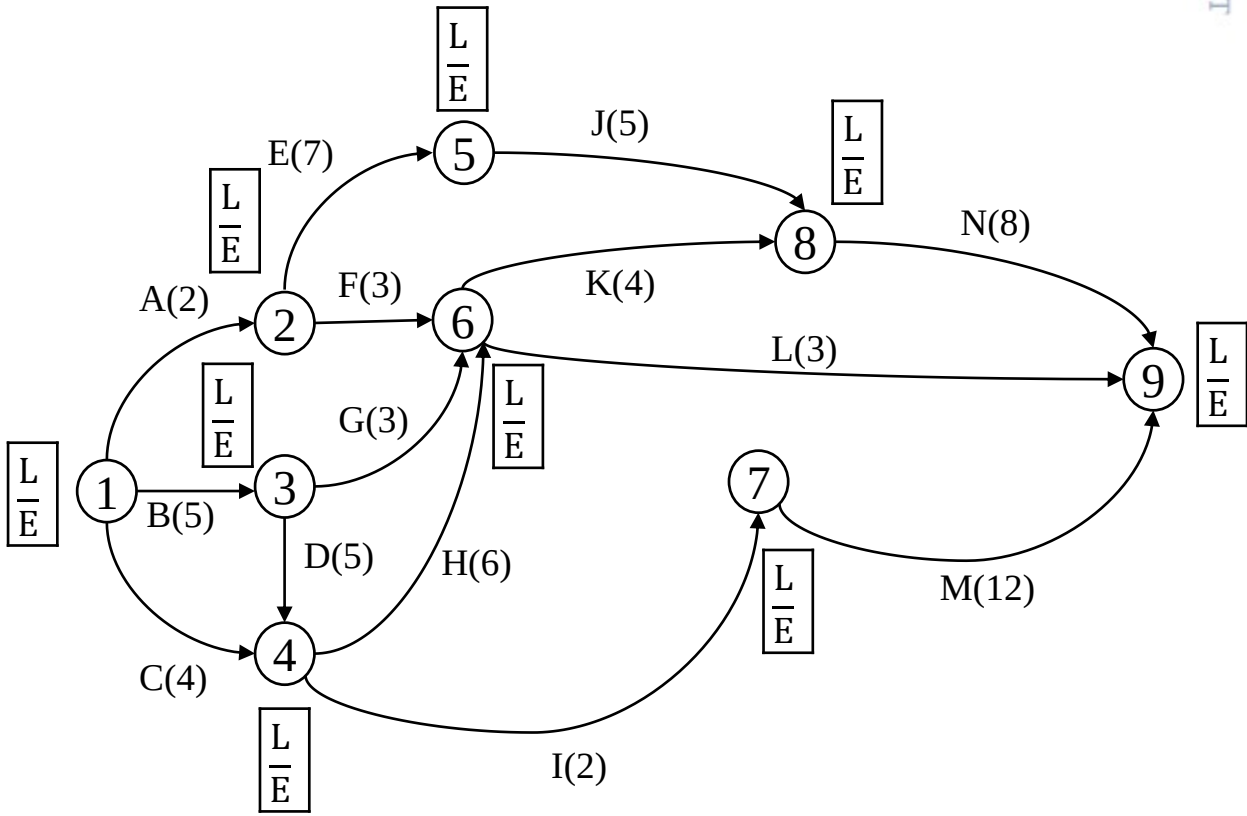

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Project Scheduling and Tracking

- CPM (Critical Path Method)
  - Critical Path
    - ES for Node 1: 0
    - ES for Node 2

      $ES = Max(0 + 2) = 2$
    - ES for Node 3

      $ES = Max(0 + 5) = 5$
    - ES for Node 4

      $ES = Max(0 + 4{,}5 + 5) = 10$
    - ES for Node 5

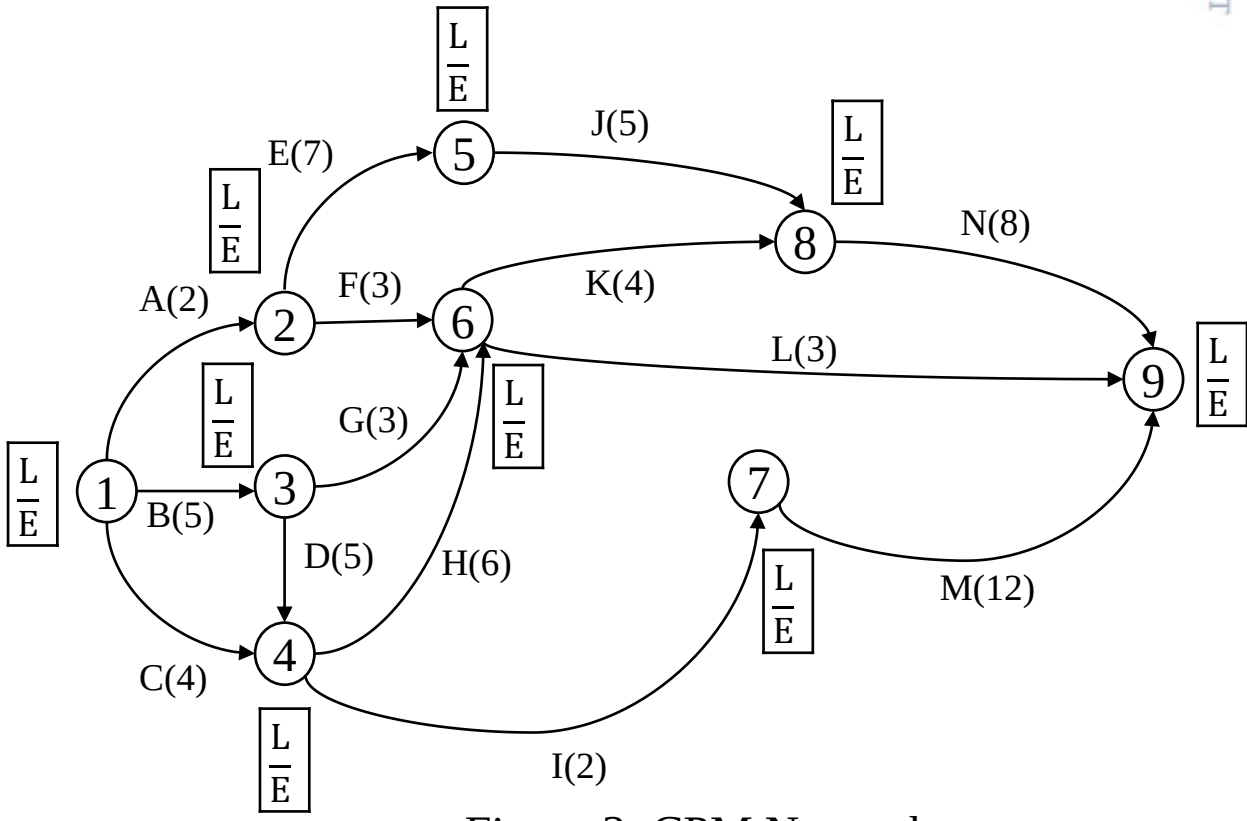
      $ES = 9$
    - ES for Node 6

      $ES = Max(3 + 2{,}3 + 5{,}6 + 10) = 16$
    - ES for Node 7

      $ES = 12$
    - ES for Node 8

      $ES = Max(5 + 9{,}4 + 16) = 20$
    - ES for Node 9

      $ES = Max(8 + 20{,}3 + 16{,}12 + 12) = 28$



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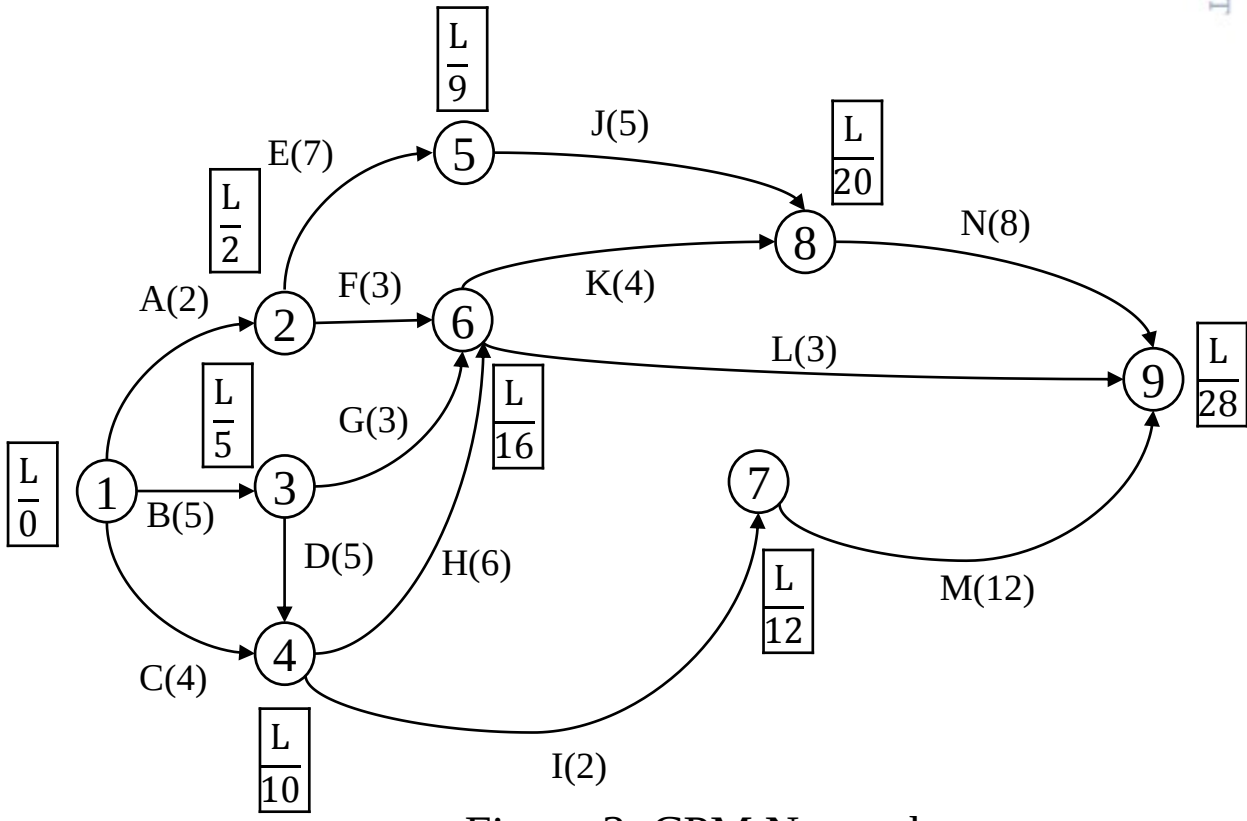
    - ES for Node 8

      $ES = Max(5 + 9{,}4 + 16) = 20$
    - ES for Node 9

      $ES = Max(8 + 20{,}3 + 16{,}12 + 12) = 28$



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Project Scheduling and Tracking

- CPM (Critical Path Method)
  - Critical Path
    - LC for Node 9: 28
    - LC for Node 8

      $\mathrm{LC} = Min(28 - 8) = 20$
    - LC for Node 7

      $\mathrm{LC} = 16$
    - LC for Node 6

      $\mathrm{LC} = Min(20 - 4, 28 - 3) = 16$
    - LC for Node 5

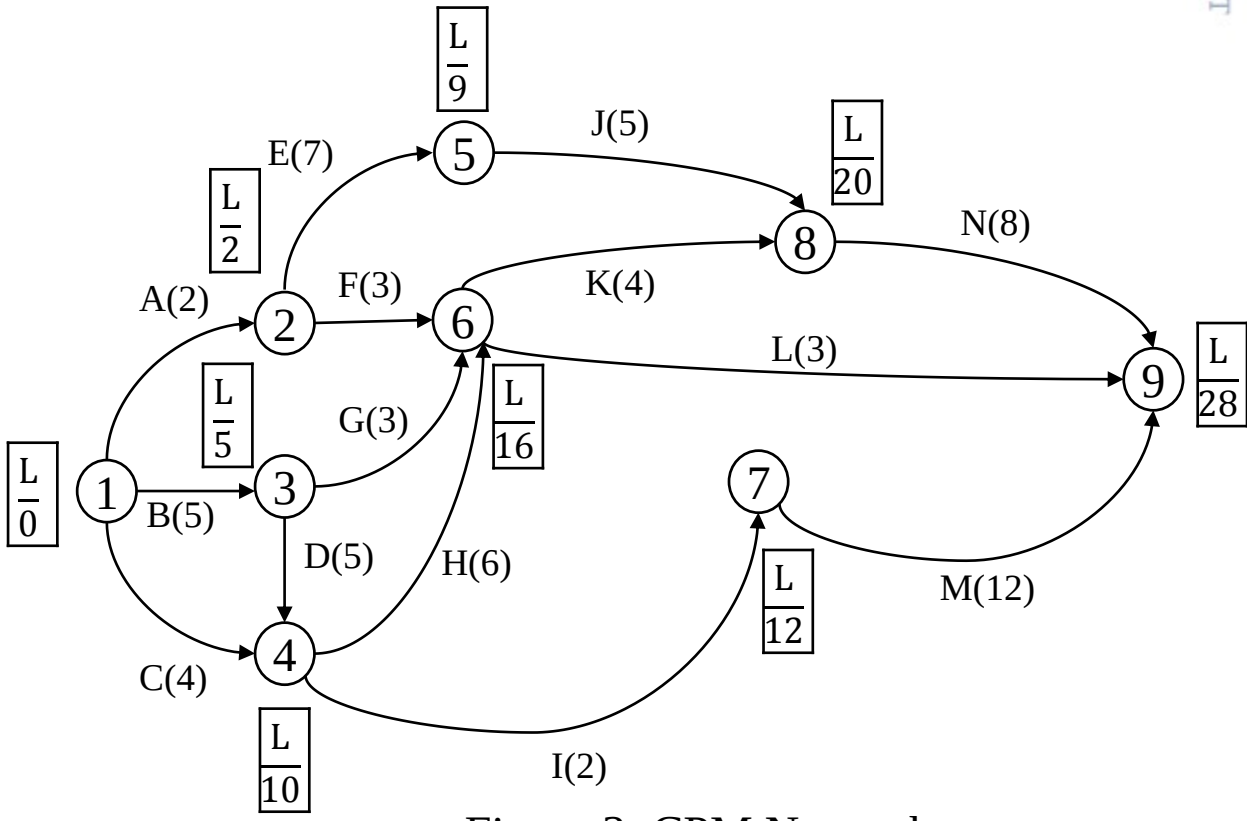
      $\mathrm{LC} = 15$
    - LC for Node 4

      $\mathrm{LC} = Min(16 - 6, 16 - 2) = 10$
    - LC for Node 3

      $\mathrm{LC} = Min(16 - 3, 10 - 5) = 5$
    - LC for Node 2

      $\mathrm{LC} = Min(15 - 7, 16 - 3) = 8$
    - LC for Node 1

      $\mathrm{LC} = Min(8 - 2, 5 - 5, 10 - 4) = 0$



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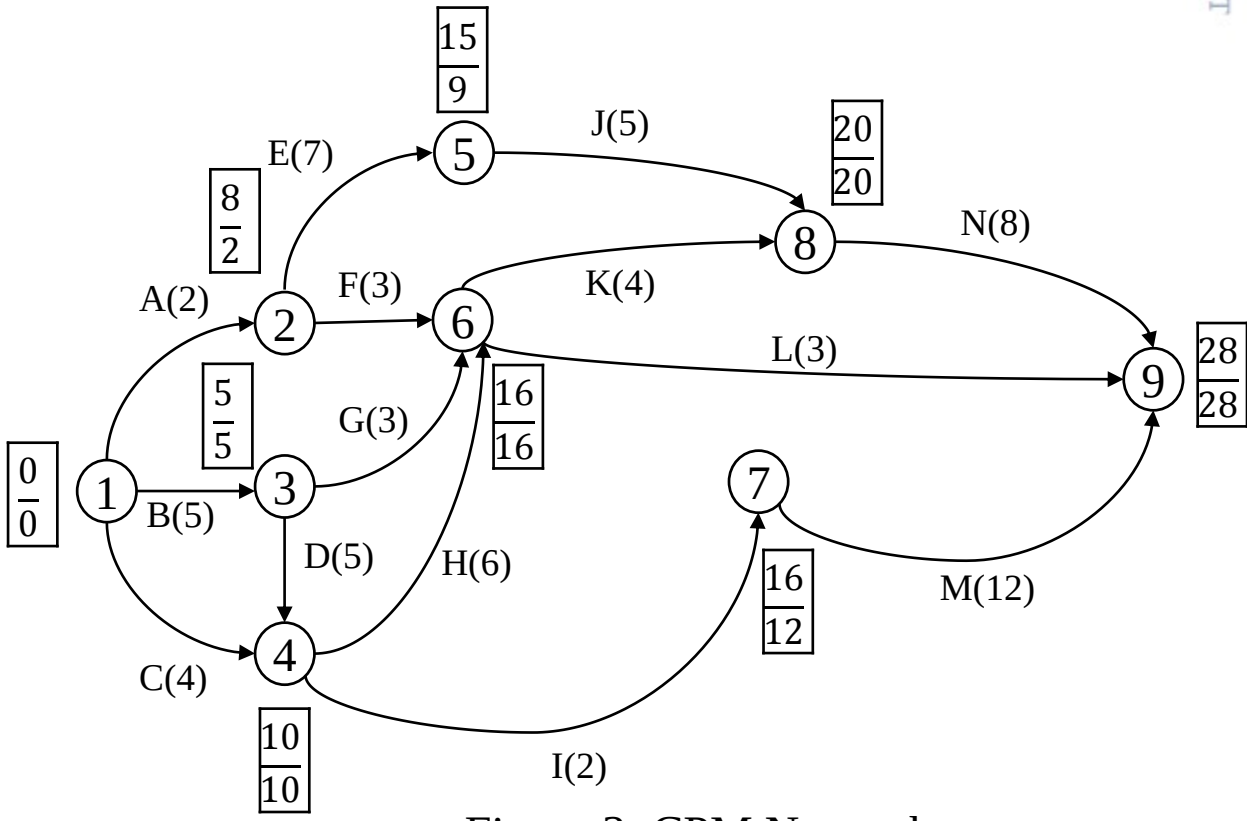

Figure 3: CPM Network

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Project Scheduling and Tracking

- CPM (Critical Path Method)
  - Critical Path
    - $ES_i = LC_i$
    - $ES_j = LC_j$
    - $ES_j - ES_i = LC_j - LC_i = D_{ij}$

    - 1-3
    - 3-4
    - 4-6
    - 6-8
    - 8-9

    - Path
    - 1-3-4-6-8-9
    - B-D-H-K-N

    - Distance (time)
    - 5+5+6+4+8=28 months [expected project completion time]

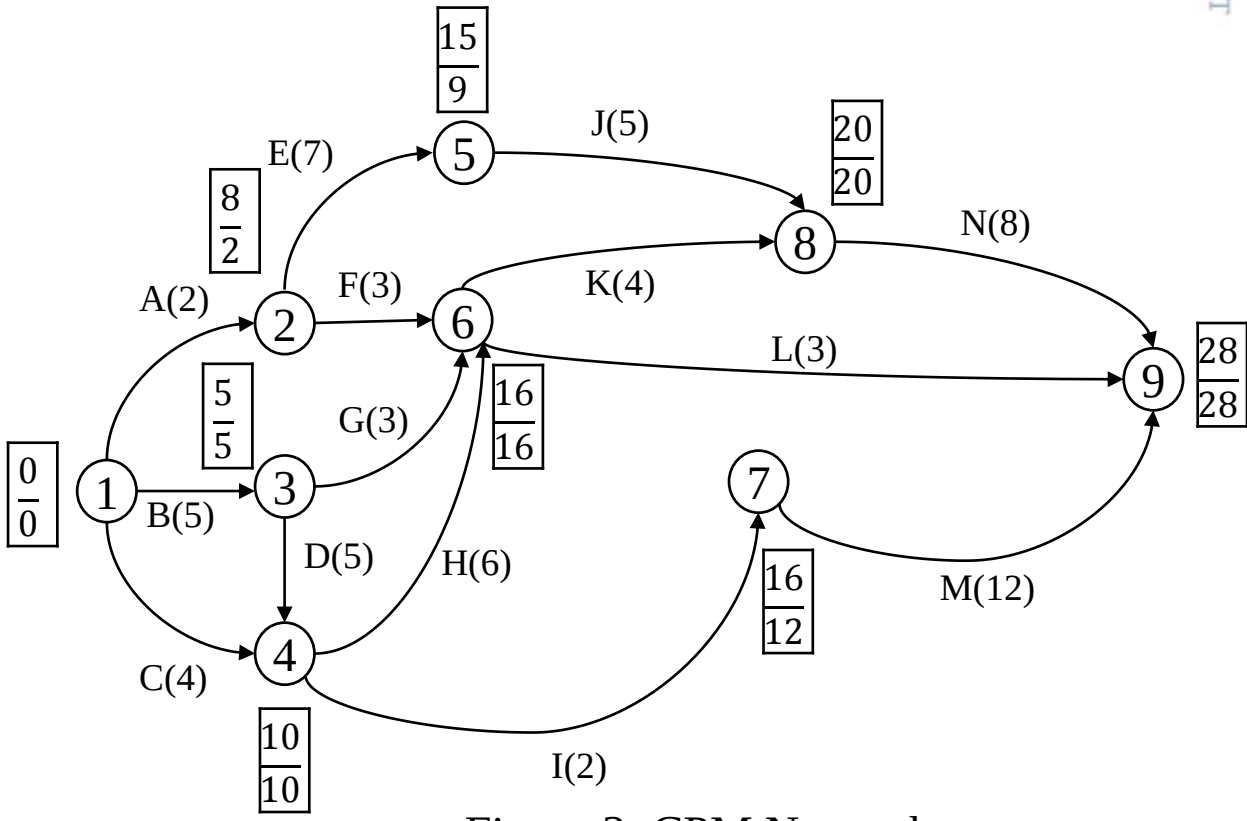

Figure 3: CPM Network

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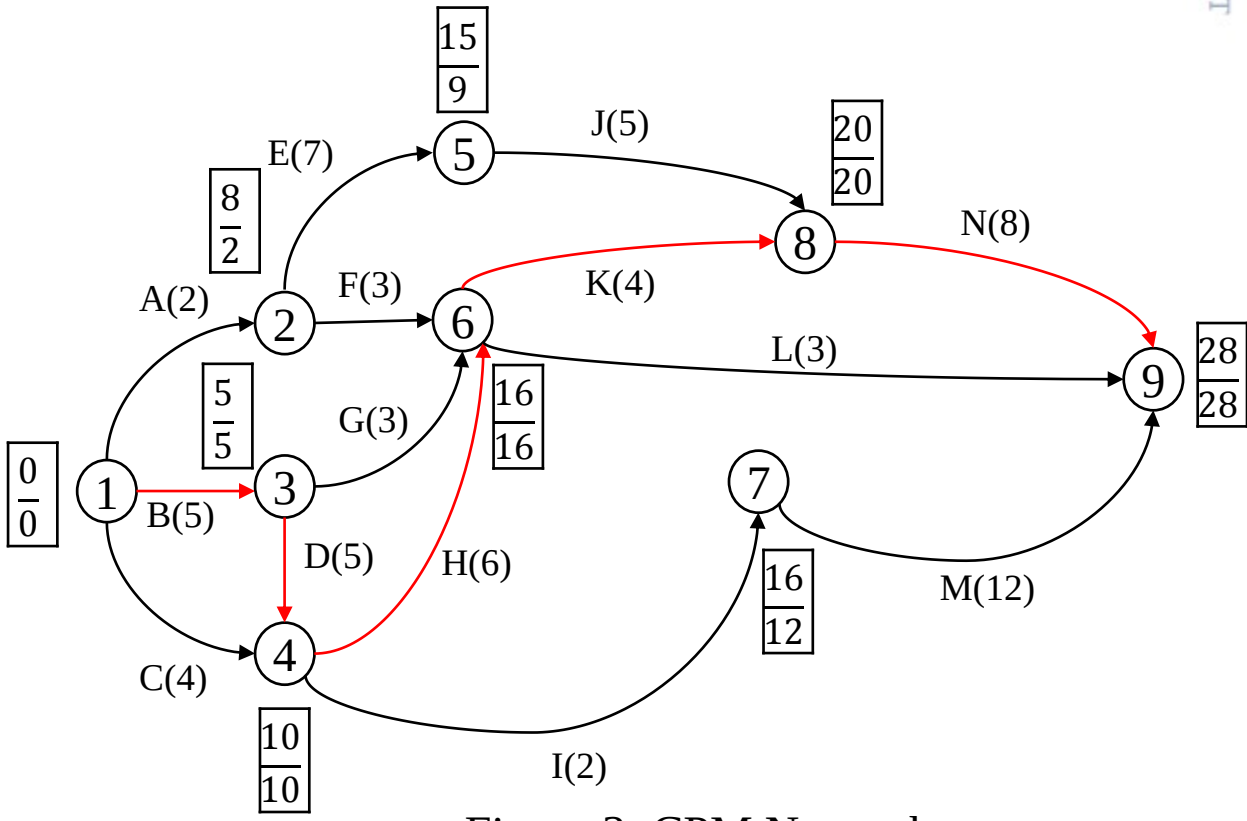
Project Scheduling and Tracking

- CPM (Critical Path Method)
  - Total floats
    - $TF_{ij} = LC_j - ES_i - D_{ij}$
  - Free floats
    - $FF_{ij} = ES_j - ES_i - D_{ij}$

Activity	Duration (Months)	Total Floats	Free Floats
A	2	6 (8-0-2)	0 (2-0-2)
B	5	0 (5-0-5)	0 (5-0-5)
C	4	6 (10-0-4)	6 (10-0-4)
D	5	0 (16-10-6)	0 (16-10-6)
E	7	6 (15-2-7)	0 (9-2-7)
F	3	11 (16-2-3)	11 (16-2-3)
G	3	8 (16-5-3)	8 (16-5-3)



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Project Scheduling and Tracking

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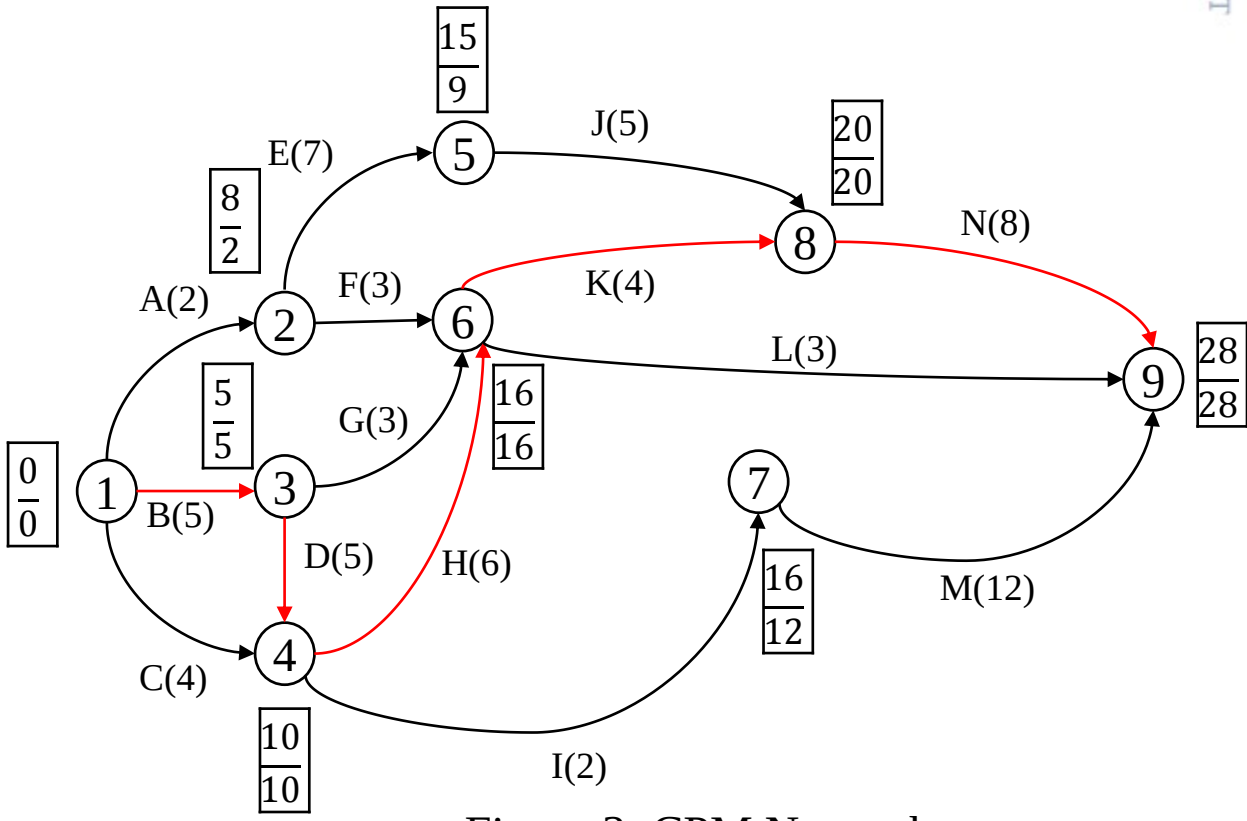
  - Total floats
    - $TF_{ij} = LC_j - ES_i - D_{ij}$
  - Free floats
    - $FF_{ij} = ES_j - ES_i - D_{ij}$

Activity	Duration (Months)	Total Floats	Free Floats
H	6	0 (16-10-6)	0 (16-10-6)
I	2	4 (16-10-2)	0 (12-10-2)
J	5	6 (20-9-5)	6 (20-9-5)
K	4	0 (20-16-4)	0 (20-16-4)
L	3	9 (28-16-3)	9 (28-16-3)
M	12	4 (28-12-12)	4 (28-12-12)
N	8	0 (28-20-8)	0 (28-20-8)



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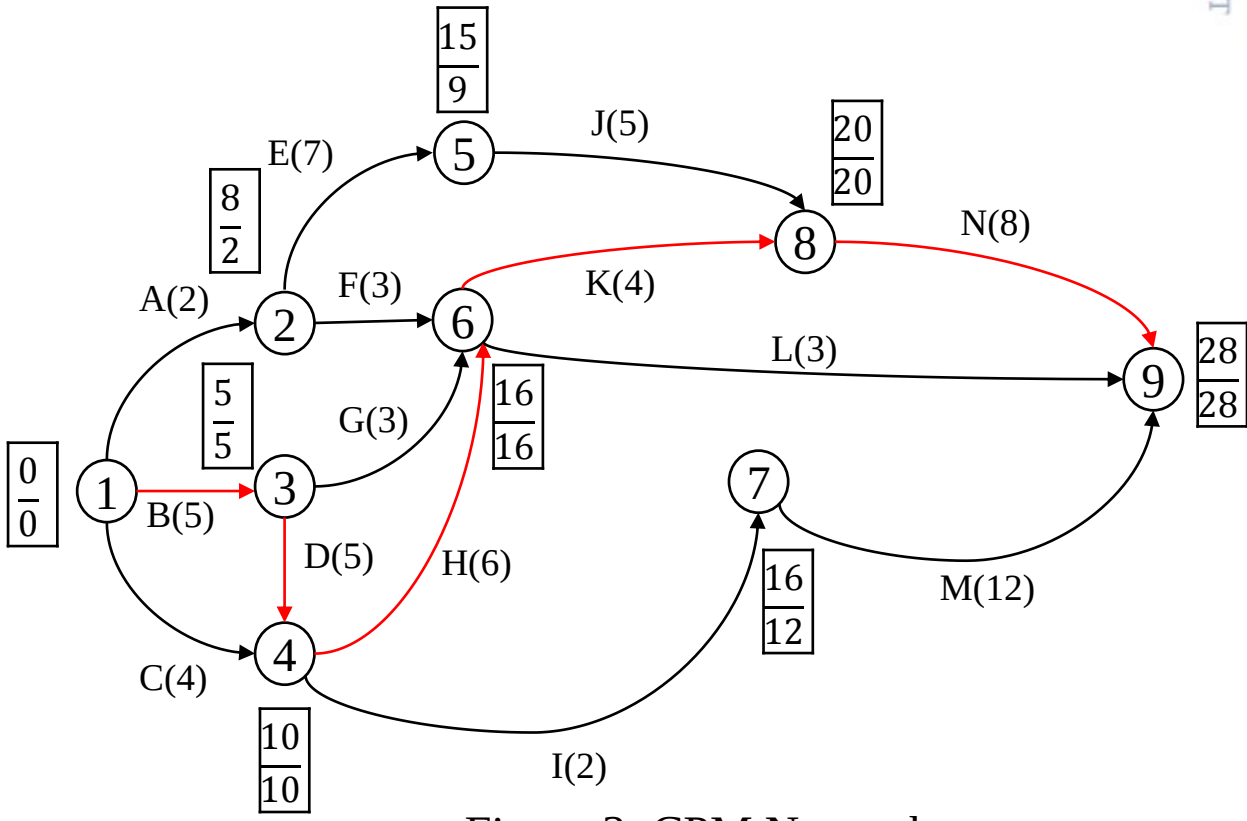
Project Scheduling and Tracking

- CPM (Critical Path Method)

Activity	Duration	Total F.	Free F.
A	2	6 (8-0-2)	0 (2-0-2)
B	5	**0** (5-0-5)	**0** (5-0-5)
C	4	6 (10-0-4)	6 (10-0-4)
D	5	**0** (16-10-6)	**0** (16-10-6)
E	7	6 (15-2-7)	0 (9-2-7)
F	3	11 (16-2-3)	11 (16-2-3)
G	3	8 (16-5-3)	8 (16-5-3)
H	6	**0** (16-10-6)	**0** (16-10-6)
I	2	4 (16-10-2)	0 (12-10-2)
J	5	6 (20-9-5)	6 (20-9-5)
K	4	**0** (20-16-4)	**0** (20-16-4)
L	3	9 (28-16-3)	9 (28-16-3)
M	12	4 (28-12-12)	4 (28-12-12)
N	8	**0** (28-20-8)	**0** (28-20-8)



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