31272 Project Management and the Professional

Lecture 8: : Schedule Management

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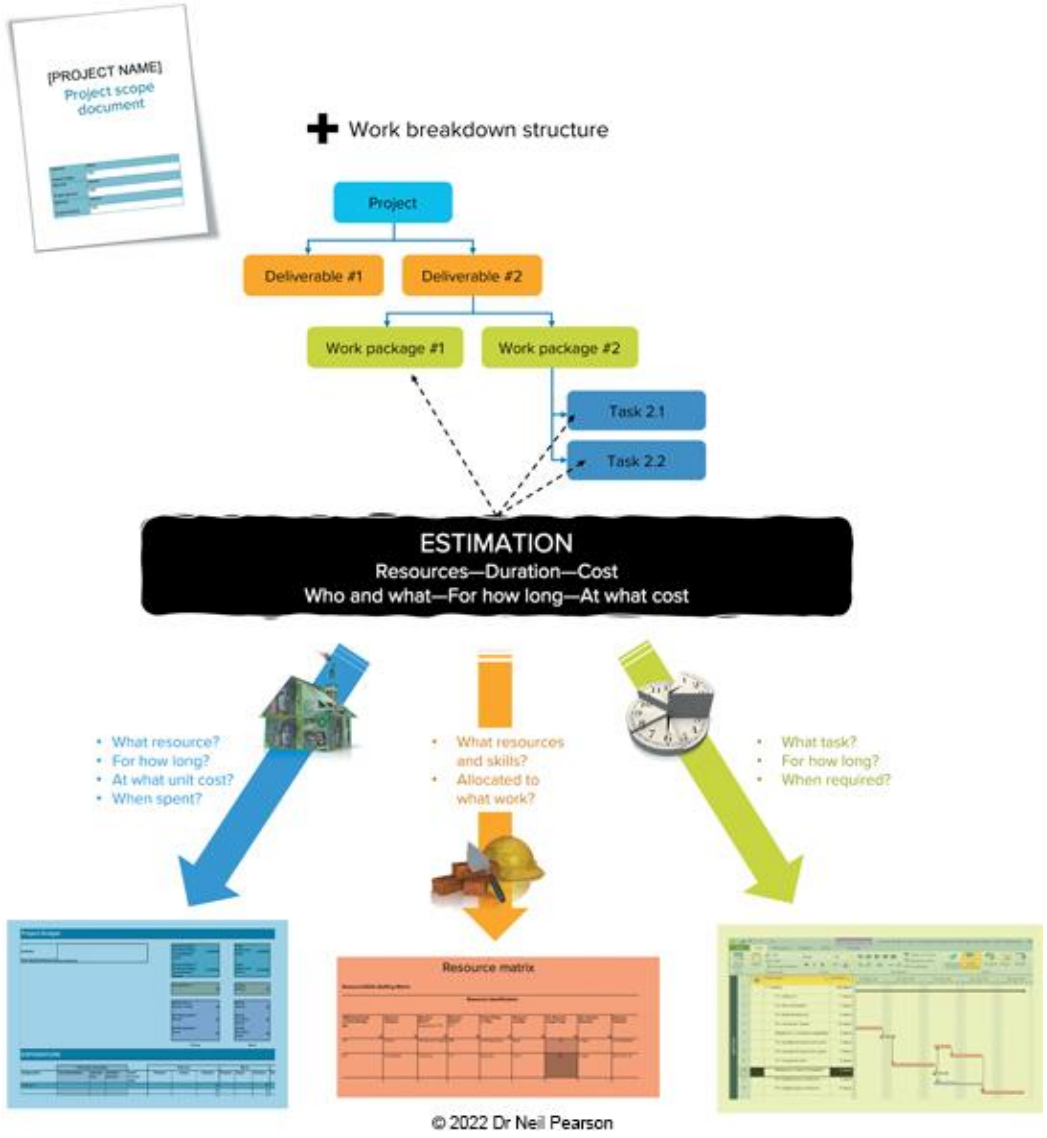
Objectives and Topics

- Use of Network Diagrams vs Gantt
- Milestones
- Critical Path
- Some sources of project delay

Project schedule



Scheduling workflow

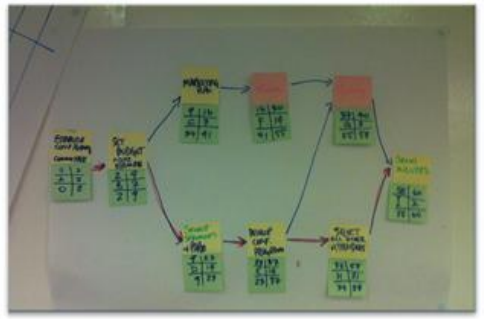
Traditional planning

- WBS
- Develop AON
- Schedule

Contemporary planning

- WBS
- Schedule
- Review-generated AON

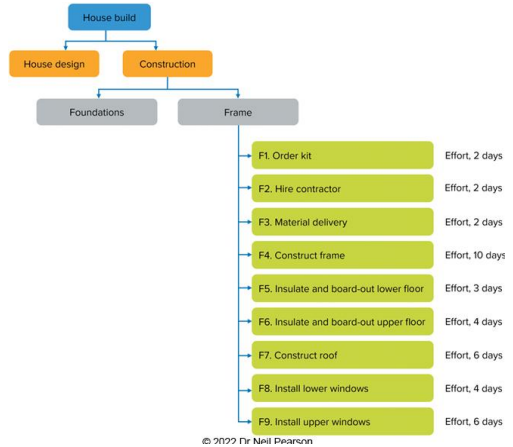
Work breakdown structure (WBS) plus estimating information



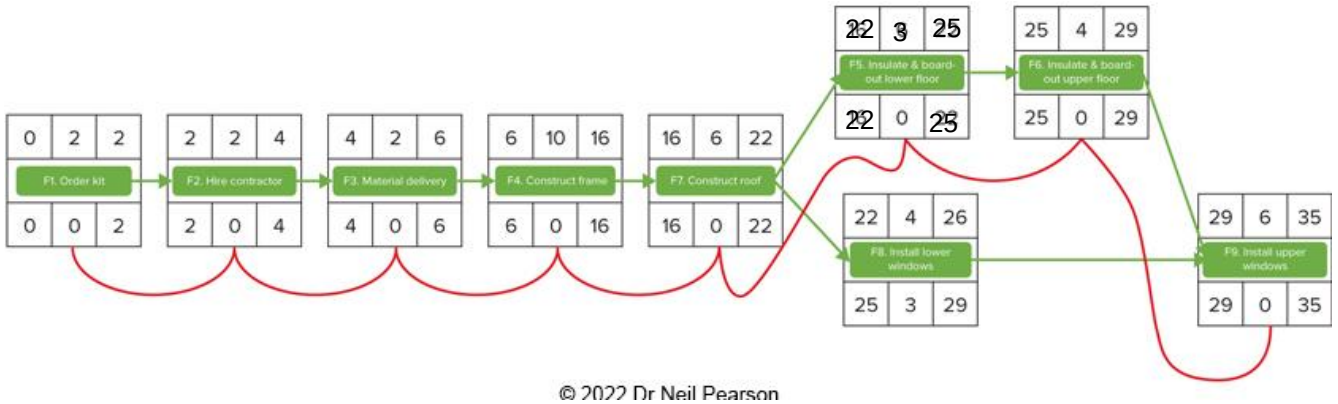
Activity on node (AON) network diagram

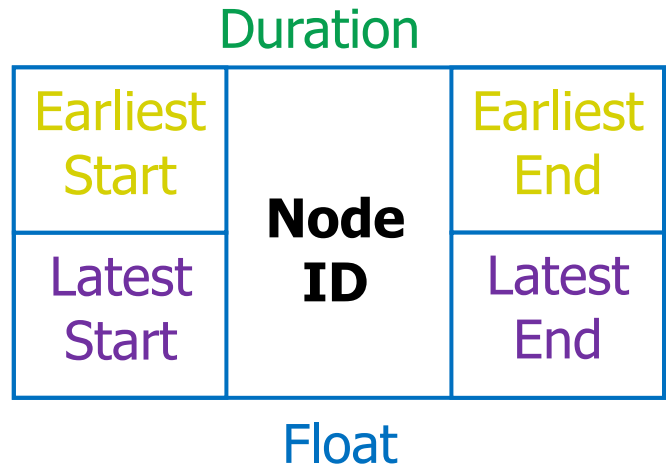
Project schedule, Gantt chart

WBS to activity on node (AON)



Through the steps indicated in the text…
(Figures 11.4 -11.13)
ERROR in textbook fig 11.13 – task F5,
Fig 11.11 and fig 11.12 – task 1



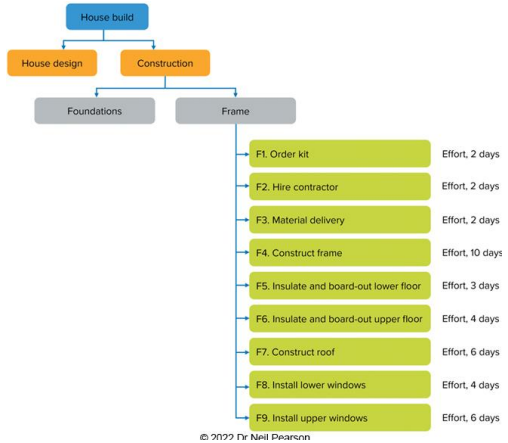


Terminology—critical path

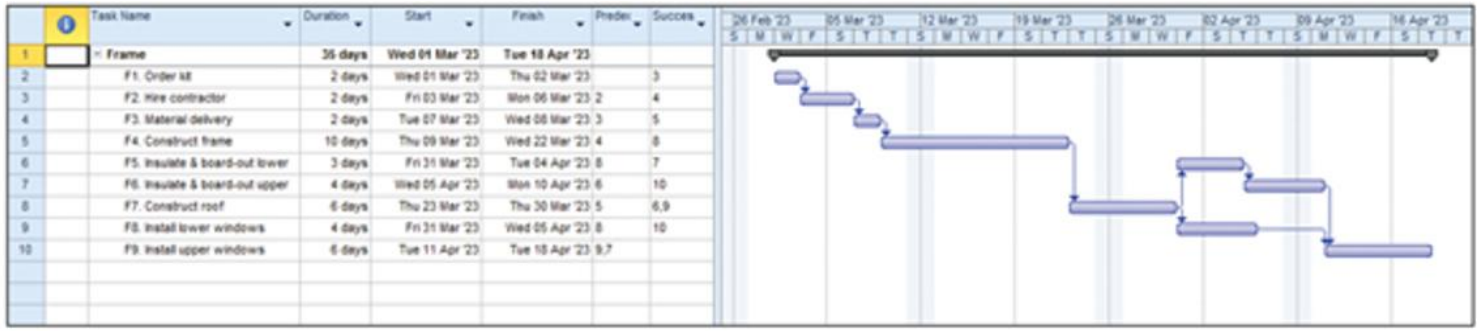
The critical path is the longest path through the project network, but the shortest time in which the project can be completed.

From WBS to schedule

From WBS to schedule (cont'd)



Through the steps indicated in the text…



	Task Name	Duration	Start	Finish	Predec	Succes
1	Frame	35 days	Wed 01 Mar '23	Tue 18 Apr '23		
2	F1. Order kit	2 days	Wed 01 Mar '23	Thu 02 Mar '23		3
3	F2. Hire contractor	2 days	Fri 03 Mar '23	Mon 06 Mar '23	2	4
4	F3. Material delivery	2 days	Tue 07 Mar '23	Wed 08 Mar '23	3	5
5	F4. Construct frame	10 days	Thu 09 Mar '23	Wed 22 Mar '23	4	8
6	F5. Insulate & board-out lower	3 days	Fri 31 Mar '23	Tue 04 Apr '23	8	7
7	F6. Insulate & board-out upper	4 days	Wed 05 Apr '23	Mon 10 Apr '23	6	10
8	F7. Construct roof	6 days	Thu 23 Mar '23	Thu 30 Mar '23	5	6,9
9	F8. Install lower windows	4 days	Fri 31 Mar '23	Wed 05 Apr '23	8	10
10	F9. Install upper windows	6 days	Tue 11 Apr '23	Tue 18 Apr '23	9,7	

Terminology—relationship types

FS—Finish-Start. Activity B cannot start before Activity A has finished.

A

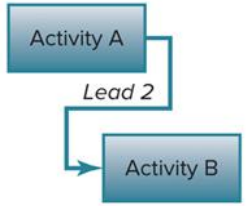
Example

You have two activities, “Activity A—Dig foundations” and “Activity B—Pour concrete”.

“Activity B—Pour concrete” cannot begin until the “Activity A—Dig foundations” has been completed.

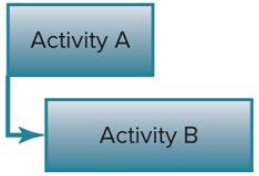
FS—Finish-Start. There is a lag of 19 days before Activity B can start.

B



FS—Finish-Start. There is a lead of 2 days where Activity B can overlap with Activity A.

C



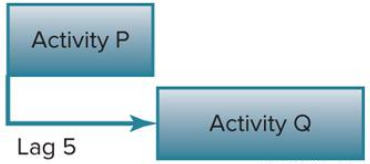
SS – Start-Start. Activity B cannot start until Activity A starts. The dependent activity can begin anytime after the activity that it depends on begins. The SS link type does not require that both activities begin simultaneously.

A

Example

You have two activities, “Activity A—Pour concrete” and “Activity B—Level concrete”.

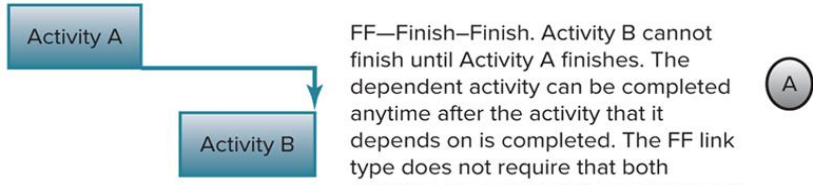
“Activity B—Level concrete” cannot begin until the “Activity A—Pour concrete” begins.



Activity Q cannot start until 5 days after activity P has begun.

B

Terminology—relationship types (cont'd)



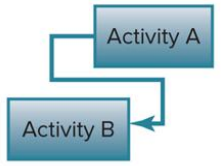
FF—Finish–Finish. Activity B cannot finish until Activity A finishes. The dependent activity can be completed anytime after the activity that it depends on is completed. The FF link type does not require that both activities be completed simultaneously.

A

Example
You have two activities, "Activity A—Add wiring" and "Activity B—Inspect electrical".

"Activity B—Inspect electrical" cannot be completed until the "Activity A—Add wiring" has been completed.

B

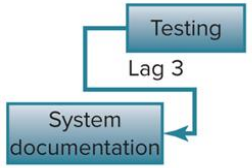


The dependent activity (B) cannot be completed until the activity that it depends on (A) begins.
The dependent activity can be completed any time after the activity that it depends on begins. The SF link type does not require that the dependent activity be completed concurrent with the beginning of the activity on which it depends.

A

Example:
The roof trusses for your construction project are built offsite. Two of the activities in your project are "Activity A—Assemble roof" and "Activity B—Truss delivery".

"Activity A—Assemble roof" cannot be completed until "Activity B—Truss delivery" activity begins.



System documentation cannot end until 3 days after testing has started.

B

Advanced scheduling techniques

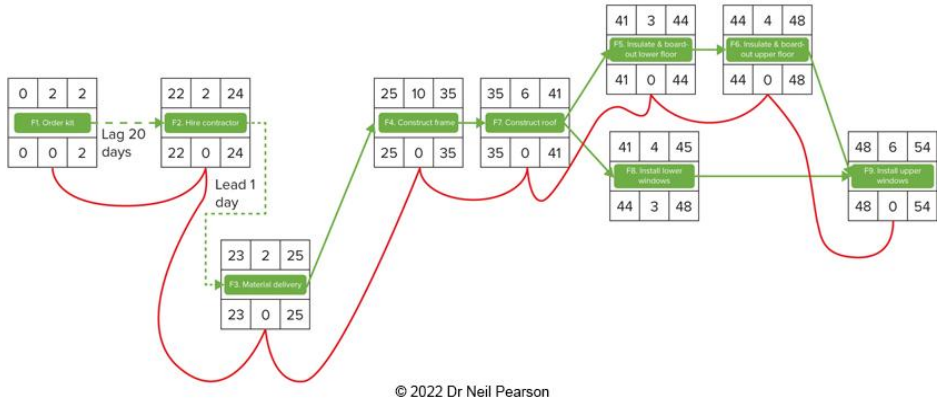
- **Total slack** tells us the amount of time a task can be delayed without delaying the project. Stated differently, total slack is the amount of time a task can exceed its early finish date without affecting the project end date or an imposed completion date.
- **Free float** (or **free slack**) is how long a task can be delayed without delaying the ES of the successor task.
- Uncertainty and the project schedule: A more advanced technique known as the *Monte Carlo* technique can assist if there is uncertainty (or risk) in relation to tasks on the schedule, in particular those on the critical path.
- Risk: Once a project schedule has been optimised after resource allocation, the residual (or baseline) schedule should have a risk assessment carried out.

Advanced scheduling techniques (cont'd)

- **Sensitivity**: Sensitivity is used against a number of different techniques in advanced scheduling. However, some project leaders apply the word *sensitivity* to the critical path. For example, for a network with only one critical path with non-critical tasks, having significant total float would be described as *insensitive*. A network which has perhaps multiple critical paths, which are similar in criticality, and any non-critical tasks have limited total float, would be described as *sensitive*.
- **Dangler paths**: When developing a project schedule as a project leader (or scheduler), we need to be mindful of not having what we refer to as *dangler paths*, paths that go nowhere (i.e. a path that comes to a dead end and has not been linked to a succeeding task). Dangler paths should be picked up and a relationship with a succeeding task in the network should be established.

Advanced scheduling techniques (cont'd)

- **Laddering**: Laddering is where a long task may have other associated tasks that can take place before the long task completes 100 per cent. In such cases we need to take the long task and break it into smaller repetitive tasks, each with its associated sub-tasks.
- **Leads and lags:** The use of leads and lags has been developed to offer greater flexibility in schedule (and network) development. There are two types: delay (lag) and overlap (lead).



Advanced schedule efficiency techniques

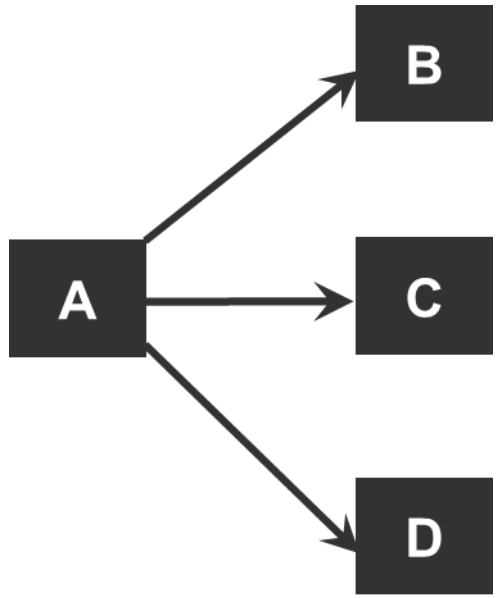
Technique	Primarily applied to . . .	Comments	Typically impacts
Crashing	Time	Adding resources to a work package and/or task to reduce the duration (not effort).	Cost
Fast-tracking	Time	Seeking schedule efficiencies by resequencing activities from sequential to parallel; thus, saving time.	Risk
Outsourcing project work	Time	Engaging an outsourced provider because they have a large quantity of a resource to throw at the problem being solved; therefore, can complete in a swifter manner.	Cost, Risk
Scheduling overtime	Time	Using the existing workforce, extending their hours to get over a short-term hurdle.	Cost, Risk
Doing it twice—fast, and then correctly	Cost	Put in place a temporary cheaper solution until the more permanent solution can be deployed.	Cost, Risk, Time
Reducing project scope	Scope	Reducing the scope of the baselined project, removing the least-priority items.	Risk, Cost, Time, potentially Quality
Compromising quality	Quality	Reducing the quality of the end product, service or result. Must be customer led as they will be signing off deliverables against the revised quality criteria.	Risk, Quality

Network types

- Activity-on-Node (AON)

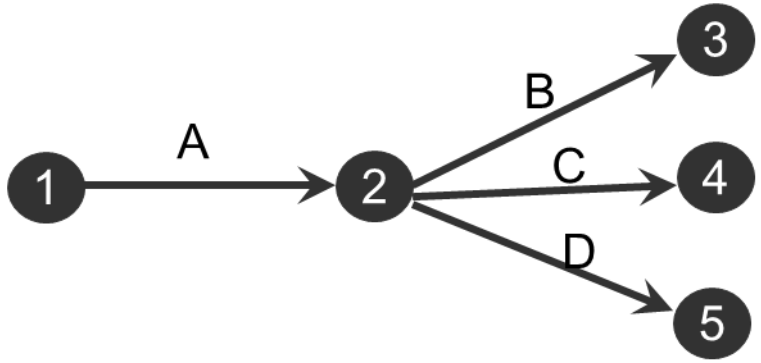
  Precedence diagrams

  Uses a node to depict an activity

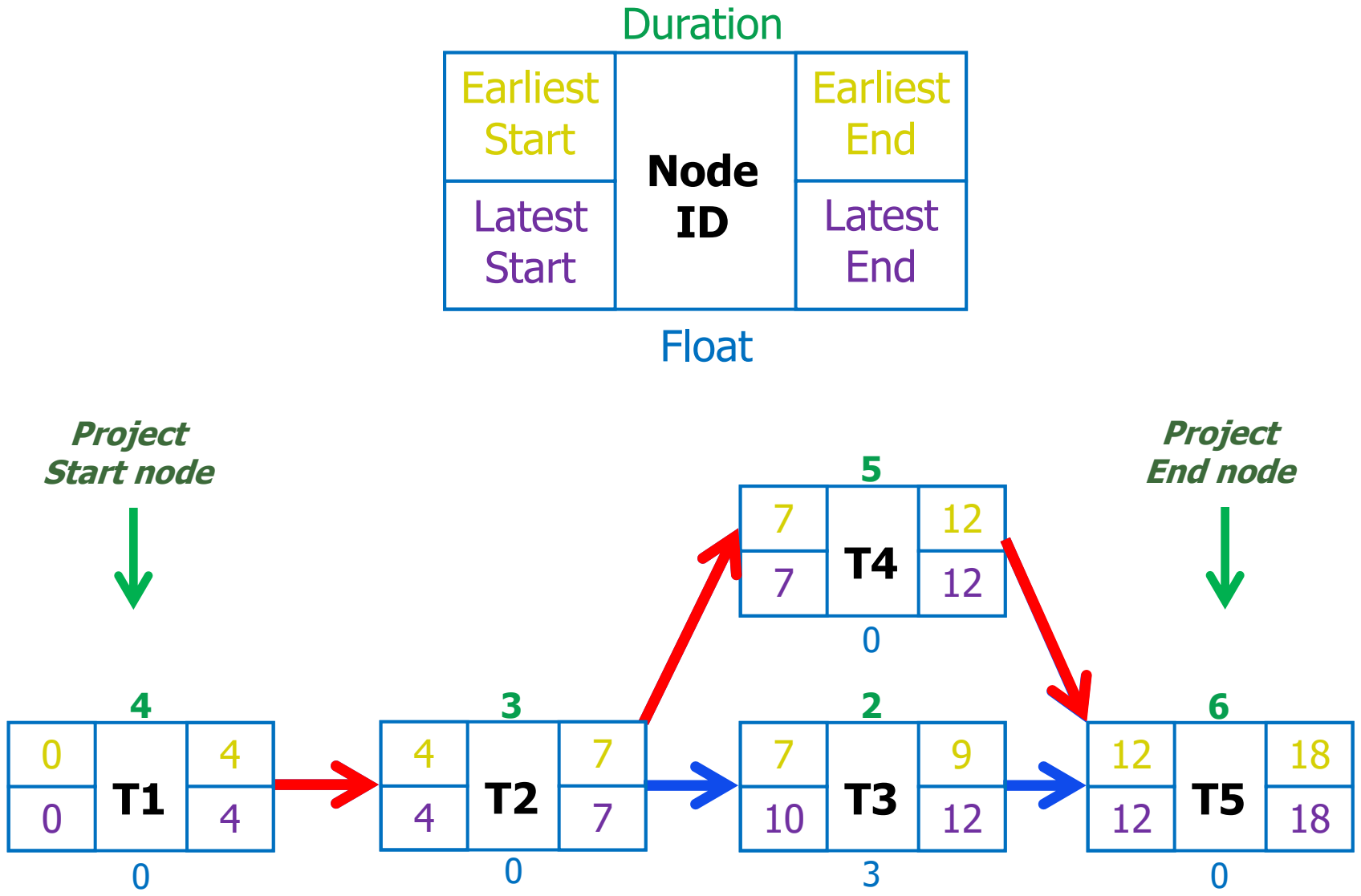


- Activity-on-Arrow (AOA)

  Uses an arrow to depict an activity



AON


Duration
Earliest Start
Node ID
Earliest End
Latest Start
Latest End
Float
Project Start node
Project End node
4
0
0
T1
4
4
0
3
4
4
T2
7
7
0
5
7
7
T4
12
12
0
2
7
10
T3
9
12
3
6
12
12
T5
18
18
0

Critical Path Method (CPM)

- Calculating the Critical Path
  - Forward Pass = The Earliest Start
  - Backward Pass = The Latest Start
  - Float (slack) = Latest Start - Earliest Start

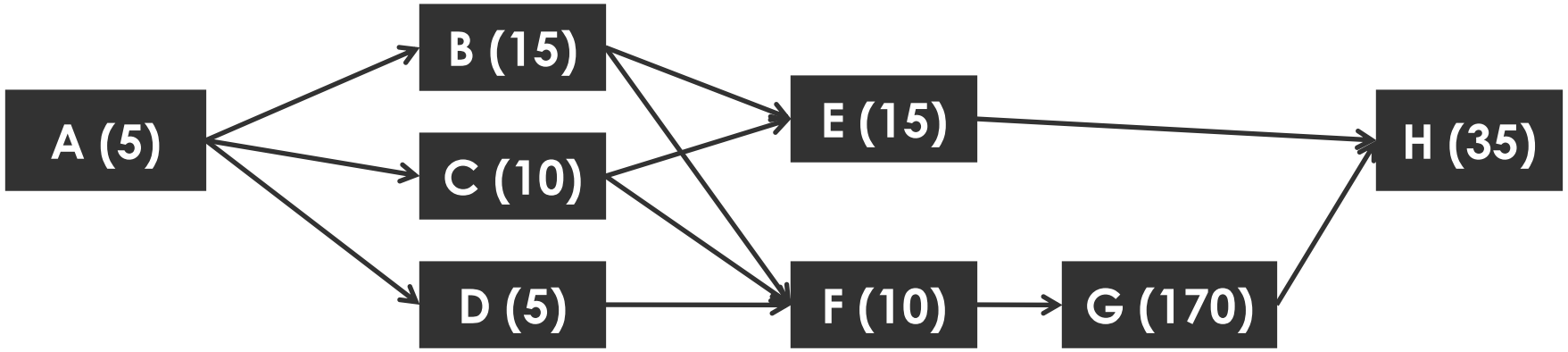
Float = 0 -> task is probably on Critical Path!

Rules of AON Network Display Diagrams

- There is only ONE start node and ONE end node
- Time moves from left to right
- Nodes are labelled sequentially (if possible)
- On forward pass take the bigger number
- On backward pass take the smaller number
- Network may NOT contain loops (node can’t lead back to itself)
- Network may NOT contain dangles (except start/end, each node must have >= one activity preceding and >= one following it)

Network Information

Activity	Description	Preceding Activity	Activity Duration (Days)
A	Application approval	None	5
B	Construction plans	A	15
C	Traffic study	A	10
D	Service availability check	A	5
E	Staff Report	B,C	15
F	Commission approval	B,C,D	10
G	Construction Period	F	170
H	Occupancy	E,G	35



Forward Pass Computation

- Add activity times along each path in the network (EF = ES + Duration).
- Carry the early finish (EF) to the next activity where it becomes its early start (ES)
- unless…
  The next succeeding activity is also succeeding another activity with a larger EF, in which case the largest EF of all preceding activities is selected.

Backward Pass Computation

Subtract activity times along each path in the network

(LS = LF – Duration).

Carry the late start (LS) to the next activity where it becomes its late finish (LF)

unless...

There is a succeeding activity that has a smaller LS, in which case the smallest LS of all succeeding activities is selected.

Determining Float (or Slack)

Total Float (or Total Slack)

The time available to delay completion of an activity without affecting project duration

TF = LST – EST or LFT - EFT

The critical path is the network path(s) that has (have) the least float (usually zero).

Free Float (or Free Slack)

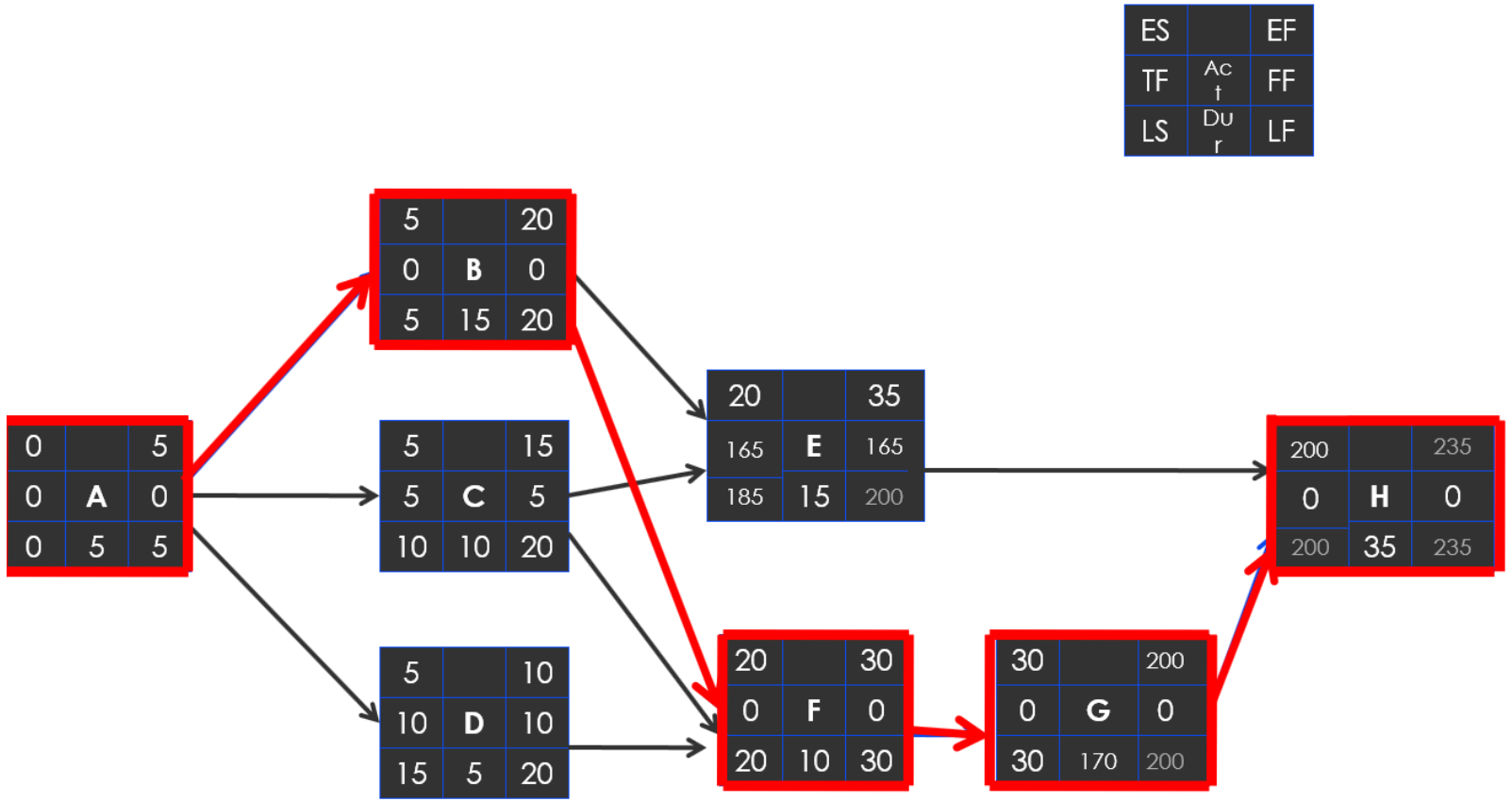
The time available to delay the start of an activity without delaying the Earliest Start of connected successor activities

FF = (Minimum) EST (of next activity) – EFT (of this activity)

FF cannot be > than TF

Critical path

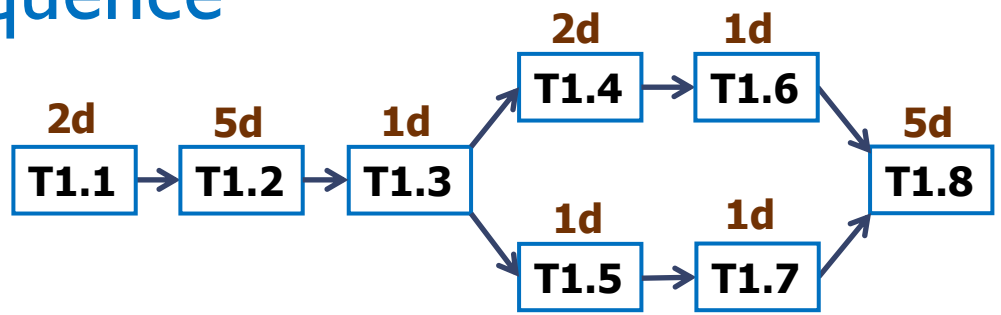
Activity	Description	Preceding Activity	Activity Duration (Days)
A	Application approval	None	5
B	Construction plans	A	15
C	Traffic study	A	10
D	Service availability check	A	5
E	Staff Report	B,C	15
F	Commission approval	B,C,D	10
G	Construction Period	F	170
H	Occupancy	E,G	35



Bottom-Up Estimate Constructed from WBS

1 Test Results Report	18 days (accumulated)
1.1 Review test plan with client	2 day
1.2 Carry out test plan	5 days
1.3 Analyze results	1 days
1.4 Prepare test results report	2 days
1.5 Prepare test results presentation	1 day
1.6 Present test results report to client	1 day
1.7 Present test results presentation to client	1 day
1.8 Address any software issues or problems	5 days

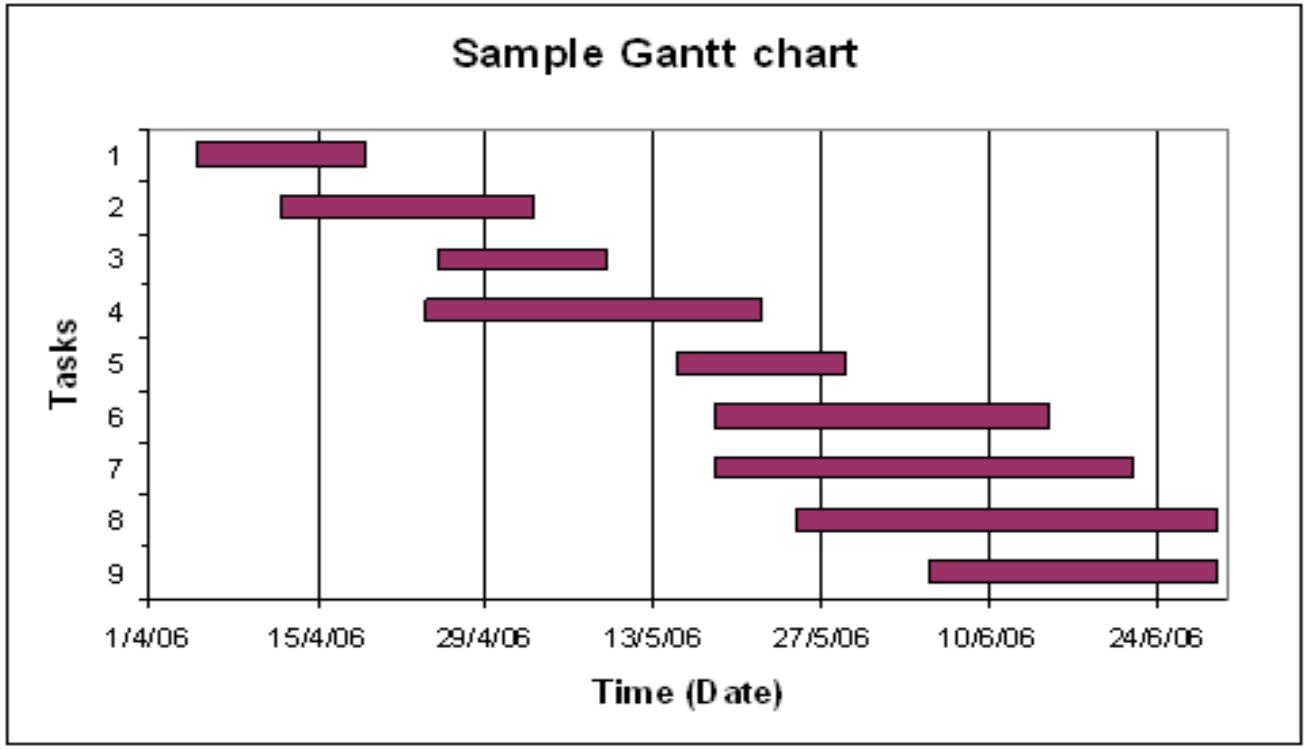
Work Sequence



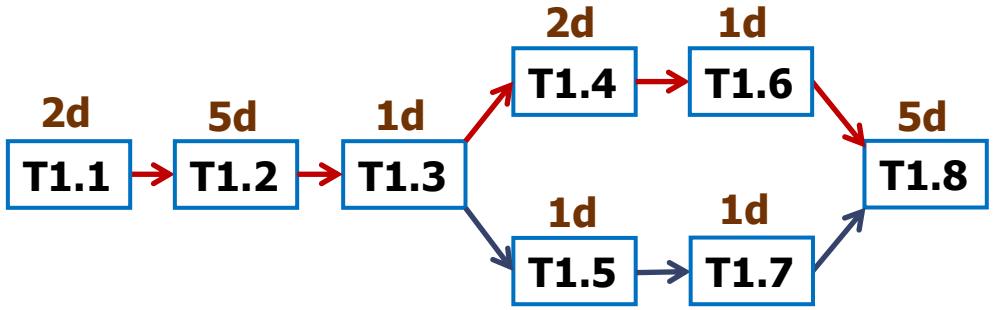
16 days (elapsed)

Activity Schedule as Gantt Chart

- Gantt is standard for displaying project schedule information
- Task list with start and finish dates in calendar format

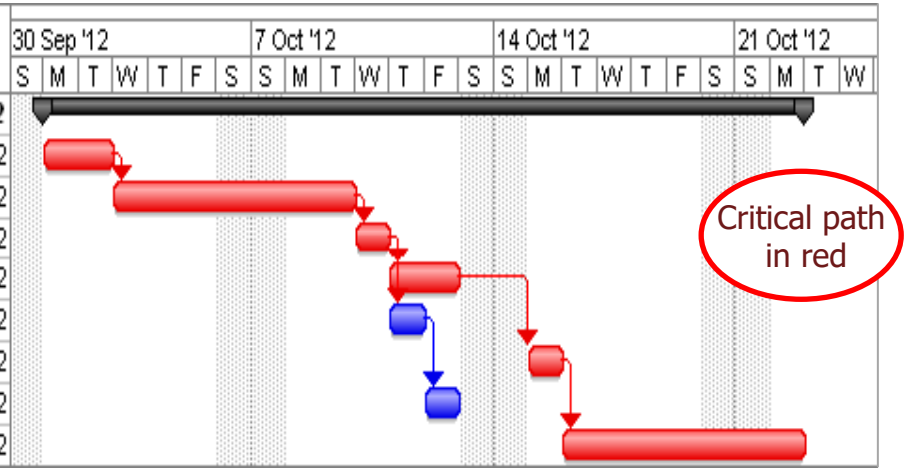


Network Diagram vs. Gantt Chart



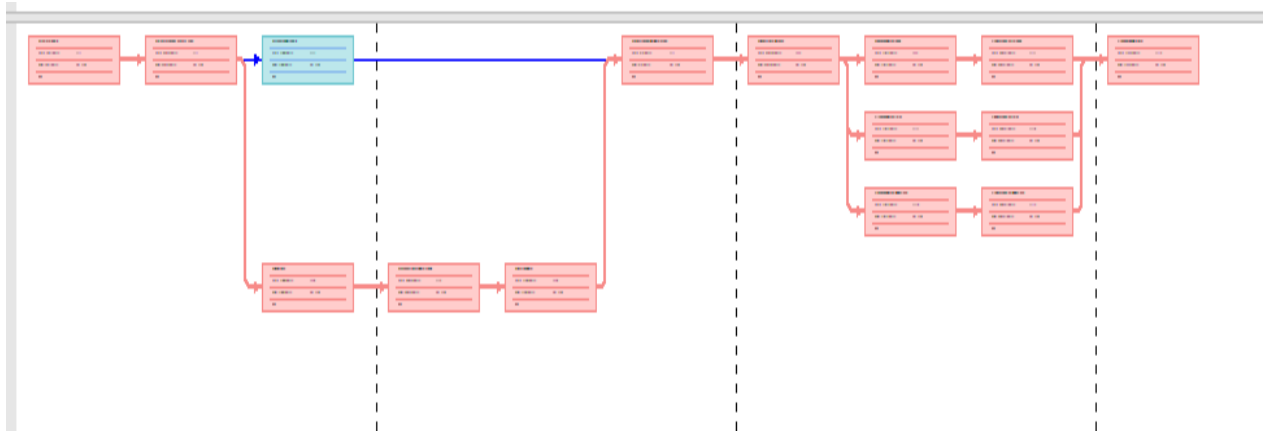
16 days (elapsed)

ID	Task Name	Duration	Start	Finish
1	**1 Test Results Report**	**16 days**	**Mon 1/10/12**	**Mon 22/10/12**
2	1.1 Review test plan with client	2 days	Mon 1/10/12	Tue 2/10/12
3	1.2 Carry out test plan	5 days	Wed 3/10/12	Tue 9/10/12
4	1.3 Analyse results	1 day	Wed 10/10/12	Wed 10/10/12
5	1.4 Prespare test results report	2 days	Thu 11/10/12	Fri 12/10/12
6	1.5 Prepare test results presentation	1 day	Thu 11/10/12	Thu 11/10/12
7	1.6 Present test results report to client	1 day	Mon 15/10/12	Mon 15/10/12
8	1.7 Present test results presentation to client	1 day	Fri 12/10/12	Fri 12/10/12
9	1.8 Address any software issues or problems	5 days	Tue 16/10/12	Mon 22/10/12

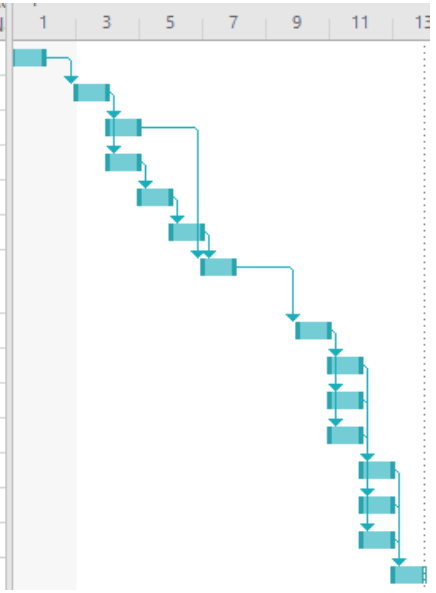


Network Diagram: Car Wash Project

T01	Park car in yard
T02	Locate sponges, buckets, soap
T03	Take supplies to yard
T04	Get hose
T05	Connect hose to water supply
T06	Turn on water
T07	Wet sponges with water + soap
T08	Wet the car with hose
T09	Sponge wash car body
T10	Sponge wash car windscreen
T11	Sponge wash car tyres
T12	Rinse soap from car body
T13	Rinse soap from windscreen
T14	Rinse soap from tyres
T15	Wipe and polish the car



Task Name	Du	St	F	Prede	N
T01 Park car in yard	1 day	Sat 1	Sat		
T02 Locate sponges, buckets, soap	1 day	Mon	Mo	1	
T03 Take supplies to yard	1 day	Tue	Tue	2	
T04 Get hose	1 day	Tue	Tue	2	
T05 Connect hose to water supply	1 day	Wed	We	4	
T06 Turn on water	1 day	Thu	Thu	5	
T07 Wet sponges with water + soap	1 day	Fri 7/04	Fri 7/0	3,6	
T08 Wet the car with hose	1 day	Mon	Mo	7	
T09 Sponge wash car body	1 day	Tue	Tue	8	
T10 Sponge wash car windscreen	1 day	Tue	Tue	8	
T11 Sponge wash car tyres	1 day	Tue	Tue	8	
T12 Rinse soap from car body	1 day	Wed	We	9	
T13 Rinse soap from windscreen	1 day	Wed	We	10	
T14 Rinse soap from tyres	1 day	Wed	We	11	
T15 Wipe and polish the car	1 day	Thu	Thu	12,13,14	



Network Diagram vs. Gantt Chart

Advantages of Network Display Diagrams

- Focus on activity **sequence** and **precedence** over schedule
- Easy visual of activities, durations, slack and critical path
- Useful on complex projects and with inexperienced PM / team
- Excellent for activity parallelism and as communication tool

Advantages of Gantt Charts

- Maps activities to a **real-time** calendar schedule
- Easy to compare back to a project baseline
- Provides a common reference mode - used in all projects
- Primary tool of a project manager so most will understand it

Best to use both (but NDD too often put aside)

Estimation and Causes of Project Delay

- Deliberately overestimating activity durations (padding)
- Project manager safety margins (padding the padding)
- Anticipating cuts from management (add padding to offset potential cuts to padding)

Plus

- Failure to pass along positive early finish on activities
- Negative consequences of multitasking (switch time overlooked)
- Delays passed along from activity path merging
- ‘Student syndrome’