

NETWORK DIAGRAMS AND SCHEDULE ANALYSIS

Network diagrams are schematic displays of project schedule activities and the interdependencies between these activities. When developed properly, this graphical view of a project's activities conveys critical schedule characteristics required to effectively analyze and adjust schedules – thus resulting in accurate and feasible schedules. This document addresses what should be considered in the development of a network diagram, how network diagrams are created, and how they may be analyzed to identify necessary corrective actions and ensure optimal schedule definition.

NETWORK DIAGRAM CREATION

Network diagrams can be created manually but are also available as project views in project scheduling tools such as Microsoft Project. (See Microsoft Project, View→ More Views → Network Diagram).

Inputs:

- **Project Scope Statement** – The schedule definition required in network diagram development must be based on the approved scope documented in the Project Scope Statement. If network diagram and schedule definition does not account for all required deliverables in scope, the resulting network diagram and schedule will not accurately reflect the time necessary to complete the work.
- **Work Breakdown Structure (WBS)** – The Project Team must include WBS project work in the network diagram to ensure comprehensive reflection of project activities.
- **Historical Project Information** – The accuracy of network diagram/schedule estimation is strengthened by actual schedule metrics from past projects. Project teams should consider past level of effort and duration for comparable project activities.
- **WBS Dictionary** – The WBS Dictionary defines task durations, dependencies, predecessor and successor relationships, and resources – all of which need to be defined prior to network diagram creation to ensure that the network diagram accurately reflects the schedule required to successfully complete the project.
- **Resource Calendars** – The Project Team should develop and utilize a resource calendar that includes holidays and personnel availability. Creation of this calendar prior to network diagram creation will ensure that the schedule accounts for actual working time.

Procedure:

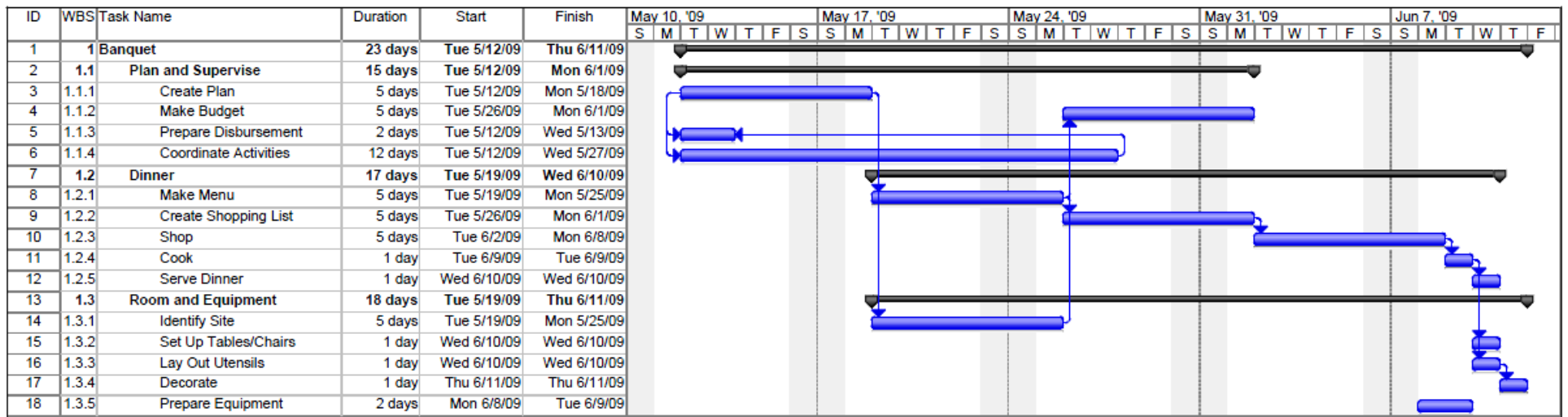
- **Consider all inputs and enter all activity definition, sequencing, and duration information into a software tool such as Microsoft Project.** If using this tool, ensure all tasks are linked.

- Confirm all tasks are linked with accurate dependencies and with resource names identified for each task.

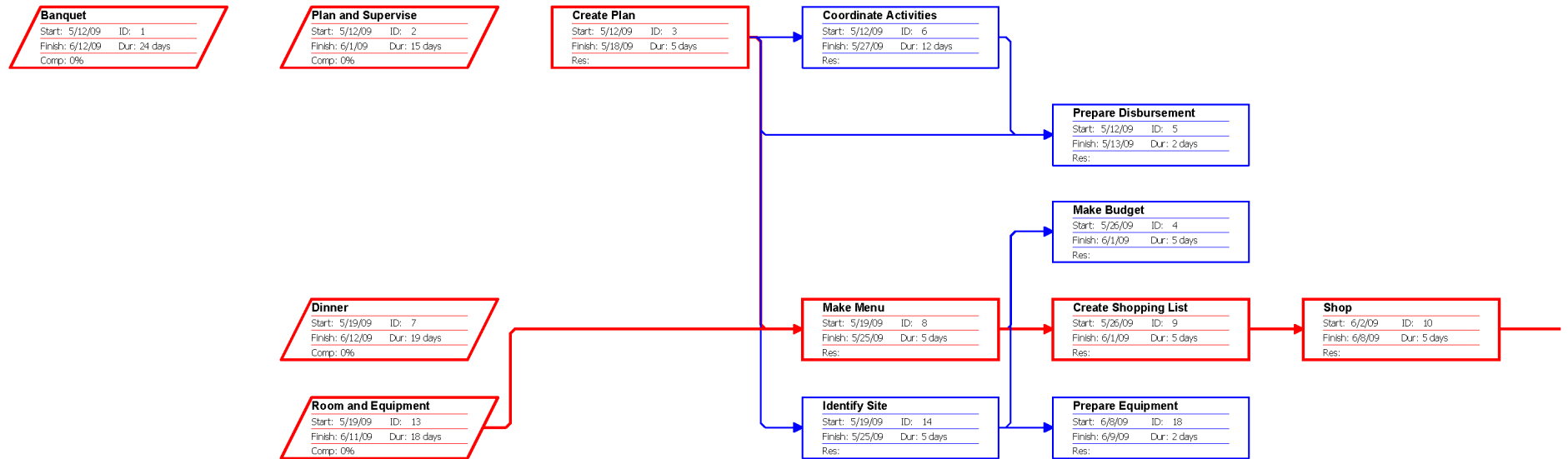
Output:

- Microsoft Project Plan with task dependencies, predecessors and successors defined, and resources applied to tasks

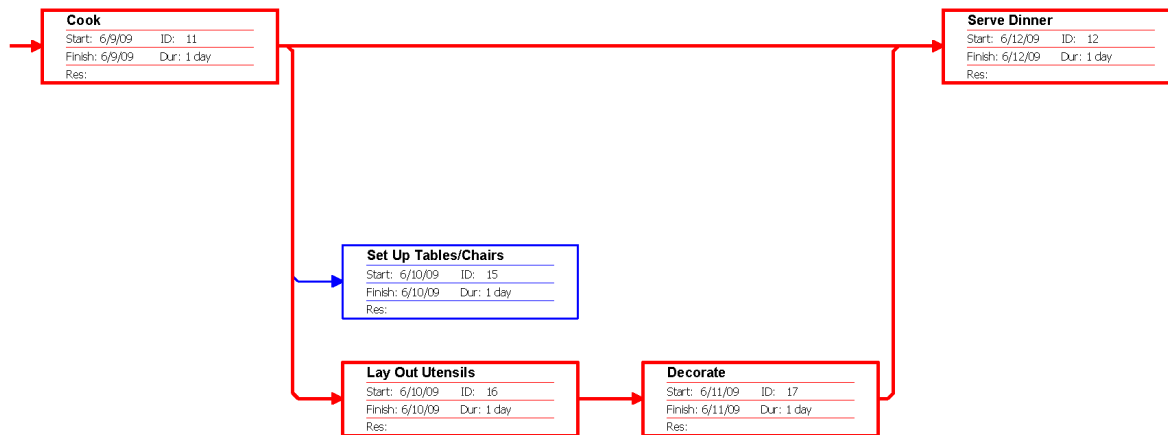
Below is a sample network diagram. To illustrate the relationship between a Gantt chart and a Network Diagram, we have provided the Gantt of activities and the Network Diagram view.



Sample Gantt Chart



Correlating Network Diagram Page 1



Correlating Network Diagram Page 2

SCHEDULE NETWORK ANALYSIS

Schedule network analysis, as defined by the *Project Management Body of Knowledge (PMBOK)*, is a technique used by project managers to analyze schedule information and generate realistic and optimal project schedules. This analysis should be performed upon completion of the draft schedule and network diagram and after each schedule update. Schedule network analysis involves:

- Identifying the schedule impact of task dependencies
- Identifying critical path tasks and understanding the impact of the critical path on the schedule. Software tools such as Microsoft Project automatically display critical path tasks once project information such as tasks, dependencies, and durations are identified in the tools.
- Analyzing the effects of schedule constraints and externally imposed dates
- Understanding which tasks can experience delays without delaying the overall schedule
- Conducting “what if” analysis of various activity durations (for example, what if the testing activities take twice as long as is currently planned?)
- Assessing resource allocation and leveling to prevent resource over-allocation
- Assessing fast tracking or crashing options to ensure optimal schedule performance

Analytical Techniques:

PMBOK describes the following techniques to perform schedule network analysis. For more detail regarding analytical techniques, which provide valuable information necessary for effective schedule definition, see *PMBOK*, fourth edition, Section 6.5.2. Most scheduling tools include features that allow utilization of these techniques with minimal effort.

- **Critical Path Method** – The critical path method calculates the longest path of planned activities to the end of the project – the “critical path” – and the earliest and latest date that each activity can start and finish without extending the project. Any activity delay on the critical path impacts the planned project completion date. A network diagram visually conveys the critical path. This visibility into the critical path allows project managers to prioritize activities and take appropriate corrective actions to meet schedule deadlines.

An understanding of the critical path also allows project managers visibility as to which schedule activities are flexible – that is, those activities that are not on the critical path. By looking at a network diagram, project managers can determine when they have float or slack,

which is the amount of time that any given schedule activity can be delayed without causing a delay to the start date of subsequent activities (free float) or to the project completion date (total float). Knowing when a project has float allows a Project Manager to understand what tasks may slip and by how much before they have an impact on the project schedule.

- **Critical Chain Method** – The basis for the critical chain method is the same as the basis for the critical path method but with one key difference; the critical chain method accounts for resource limitations. By adding resource limits to the analysis, the result is that critical path is generally longer. The resource-constrained critical path is known as the critical chain. If resources are allocated in the scheduling tool, the network diagram will display the critical chain. Using the critical chain method involves adding duration buffers to project schedules to protect the targeted finish date from slippage. Duration buffers are added to the schedule as non-work schedule activities – one at the end of the critical chain and others at the end of each sequence of tasks that feeds into the critical chain. As a result, “buffer” time is integrated throughout the project schedule to account for duration uncertainty. Later in the project, project teams monitor project progress by reviewing the consumption rate of the buffers.
- **Resource Leveling** – Resource leveling is the process of changing schedule resource allocation to resolve over-allocations or conflicts. Resource leveling is applied to a schedule that has already been analyzed by the critical path method. This technique is used to adjust a project schedule if shared resources are only available at certain times, or in limited quantities, or if a Project Manager wants to maintain resource usage at a constant level. Resource leveling is often used to correct resource over-allocations and will often change the critical path. The network diagram should be recreated after resource leveling to assess the updated critical path.
- **What-If Scenario Analysis** – This analysis examines the schedule impact of various scenarios, such as the delayed delivery of a major deliverable. What-if scenario analysis may include simulation that calculates multiple project durations with different sets of activity assumptions. Multiple network diagrams may be generated to visually convey the impact of varying scenarios. Project managers can use the results of this analysis to determine schedule feasibility under adverse conditions and prepare relevant contingency plans.

Schedule Compression Techniques:

As a result of network diagram analysis, project teams may identify a need to compress the schedule. Schedule compression shortens the project schedule in order to meet schedule deadlines without reducing the project scope. Schedule compression techniques include crashing and fast tracking. If utilized, project teams should recreate and reassess the network diagram to ensure that no new schedule issues have emerged.

- **Crashing** – Crashing involves either adding resources or increasing work hours (overtime, weekends) to shorten task duration. Shorter task durations typically result in higher task costs, so project teams must determine, prior to crashing, whether the total costs savings is enough to justify the higher costs. Crashing almost always requires cost increases because it usually necessitates new tasks. Crashing is a controversial technique because adding project resources can increase project complexity or risk and may ultimately have a negative impact on the schedule. Crashing does not involve reducing project scope or eliminating project tasks.
- **Fast Tracking** – Fast tracking is a schedule compression technique in which project phases or activities usually conducted sequentially are performed in parallel to reduce duration. Care must be taken to ensure that parallel work does not create additional work or increase risk. Fast tracking frequently results in increased complexities in task dependencies, so additional project controls must be implemented to ensure ongoing and accurate insight into schedule performance.