Can't See the Forest for the Trees?

How to Effectively Manage Complex Project Schedules.

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Abstract

Since 1999 a Project Management Office (PMO) has been operating at Freescale Semiconductor Israel (formerly Motorola Semiconductor Israel). To support project managers and teams the PMO implemented standard project management processes and tools. To date one of the major challenges faced by the PMO has been how to effectively control an extremely complex project schedule comprised of hundreds or even thousands of activities. The challenge was overcome through the development and implementation of a managerial system for the analysis and control of project schedules. The solution was "*keep it simple*" as this, together with proper managerial processes, supports all managerial levels in effective project execution. The paper begins with a description of project planning and control processes. Then the processes and solutions involved in implementing the Drill-Down Schedule Analysis System are described. Thereafter technical aspects of the implementation and, finally, the benefits of system implementation are discussed.

Introduction

Freescale Semiconductor Israel (FIL), formerly Motorola Semiconductor Israel (MSIL), is Freescale Semiconductor's largest design center. FIL established a Project Management Office (PMO) in 1999 (Brokman & Kfir, 2001). During the course of work, particularly the planning and control phases, it became apparent that effort estimates of longer than three weeks were not completely accurate. These revelations arose during work with technical project managers on creating and tracking detailed project plans. It was found that, during the control phase, engineers were unable to guarantee their ability to make a timely delivery, greater surety arose approximately two to three weeks prior to expected completion. Applying this garnered information to 50 man-year projects resulted in hundreds of activities per project plan. Effective management of such vast and complex plans was a challenge. The following issues arose:

- How to easily extract knowledge contained in a multiple activity database in order to help managers make correct and timely decisions.
- How to generate varying views of different levels for organization decision makers.
- How to save technical project managers the effort spent on studying standard Project Management tools and processing complex schedules?
- How to easily analyze and present a multiple critical path situation?
- How to identify schedule slippage in a very dynamic environment? How to distinguish between continuous slippage and a one-time delay?
- Is it possible to implement Critical Chain Project Management (CCPM) scheduling principles (Goldratt, 1997; Leach, 2000) without using a special CCPM-compatible scheduling tool?

This paper is relevant for those who face these or similar problems.

Planning and Control Process Overview

In order to address the issues noted above, the Drill-Down Schedule Analysis System was developed to complement existing planning and control processes. To understand the system's significant contribution, the planning and control process is briefly described below.

The planning phase includes four parallel sub-processes: scope definition, definition of the product development methodology, resource planning and development of a schedule/work plan. To create a comprehensive and reliable project plan the aforementioned sub-processes should progress simultaneously. The following deliverables are products of the planning process: base work plan with delivery date commitments, a product development methodology template and an Organization Breakdown Structure.

Planning Phase Sub-Processes:

- The **scope definition** sub-process defines project contents and goals. Project team responsibilities and required external team receivables necessary for project execution are outlined. The maturity level of the scope definition determines the credibility of the project plan.
- The **definition of the product development methodology** - a detailed WBS and activity network - are defined and reviewed by the project's management team. This yields agreed upon uniform templates to be used later in the detailed project plan. At this stage reuse of previous project methodologies is more efficient.
- **Resource planning** starts by naming the project’s management team. Afterwards an Organization Breakdown Structure (OBS) is defined and approved and decisions are taken regarding project staffing for the varied skill disciplines. The OBS needs to be balanced in terms of the number of teams and engineers reporting to each team leader, required skills and experience levels.
- **Development of a schedule/work plan** integrates the previously noted sub-processes into a comprehensive and detailed schedule. The schedule considers external receivables commitments, agreed upon development methodology as well as approved resources. This is an iterative process that involves tradeoff analyses between project scope, development methodology, available resources and schedule constraints.

Typically a detailed work plan consists of two to three weeklong tasks (see Introduction, above). Due to the length and complexity of FIL development projects it is difficult to assign named resources to all project tasks. Consequently, long-term tasks are assigned to generic skills (e.g., circuit design engineer) and take into account available resources per skill. Initial short term tasks (coming two to three months) are assigned to named resources. As a result, each resource receives an individual work plan that notes his/her tasks over the coming two to three months.

The planning process can last up to two months. Its duration is dependant on project complexity in addition to the scope definition’s maturity level. Immature scope definitions lead to unnecessary planning iterations and, in all likelihood, hamper closure of the planning stage.

The control phase includes two recurrent cycles - monthly plan review and weekly status review. The monthly plan review cycle is held on either a monthly or bi-monthly basis for each project team. The main objective is to expand an individual's plan by additional two to three months. Updated work plans should be aligned with current project priorities. The plans are reviewed by the project manager and presented to the team members whose feedback may lead to modifications. Lastly, each team member commits to his/her personal plan objectives.

The weekly status review is designed to update the previous week’s progress. Each team member updates his/her weekly progress via a web timecard. Both actual invested task efforts as well as estimated time to complete the task are reported. These reports, approved by the team leaders, are retrieved into the master project plan and modifications occur. Finally, the project manager reviews the status of the current plan.

System Overview

The system was designed to meet the following requirements:

- Simplify the project activity network and present it in a straightforward manner by using a top-down approach to schedule analysis.
- Satisfy senior management and project managers with an intuitive user-friendly tool that does not require in-depth knowledge of PM scheduling tools, PM methodology or project activity networks.
- Act as an automated tool showing real-time data.
- A graphical representation of milestone status vs. commitment dates, including trend analysis capability.
- Utilize a common database that is accessible to multiple users.
- Support the CCPM scheduling method.
- Use standard software tools to develop the system.

The Drill-Down Schedule Analysis System is a *Decision Support System* for senior management and project managers. The system interfaces with a standard PM scheduling tool and utilizes a milestone database in order to automatically generate analysis views. The system's concept is to represent the project activity network with a hierarchical *milestone tree*. The tree is built top-down from general milestones such as project completion, via high-level project milestones, down to detailed milestones (Exhibit 1). Each milestone in the *tree* affects a higher-level milestone.

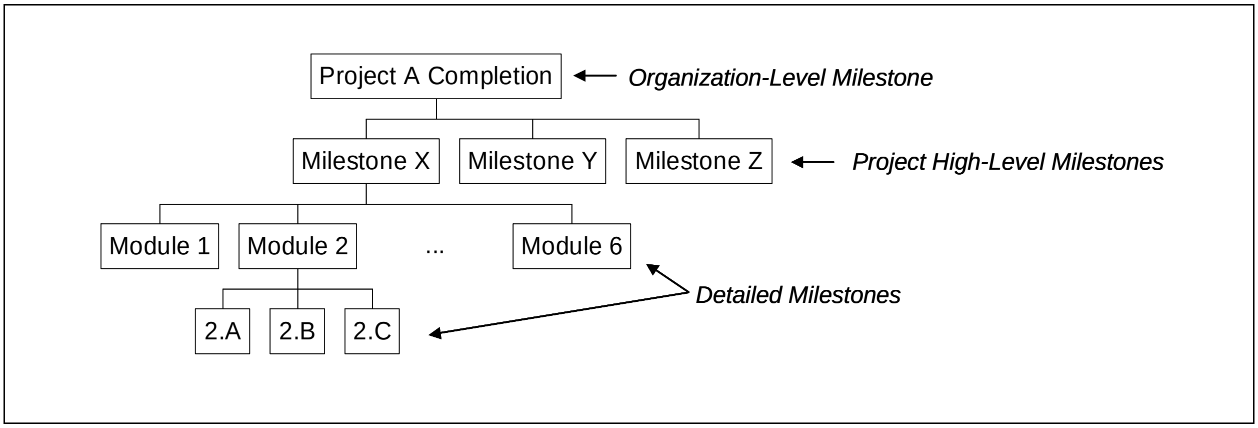


Exhibit 1 – Example of a Project Milestone Tree

The system, a simple navigation mechanism for moving up and down the *milestone tree*, enables users to explore and analyze the project schedule. Users may choose between two system views: ***Status View*** and ***Trend View***. The *status view* displays a snapshot of milestone schedule status. The *trend view*, utilizing historical schedule data, enables analysis of milestone schedule stability against its commitment date over time. When CCPM scheduling is applied, both view types show the balance of a particular buffer per milestone - divided into three color-coded control zones.

The system start-up screen (Exhibit 2) is an organization's multi-project view wherein each project is represented by a single milestone (usually its completion date). This view provides senior managers with the updated status of an organization's major projects. Herein managers may perform trend analysis on a specific project by using the *trend view* or drill-down to view high-level milestones. Depending upon project complexity and *milestone tree* structure, further drill-down may help focus on a specific problematic milestone. At any navigation stage users can select a milestone from the *status view* and perform a trend analysis - this may help identify an imminent slippage and distinguish between a continuous slippage versus a one-time delay.

Exhibit 2 - *Status View*: Organization-Level Milestones

The example featured in Exhibit 3 illustrates a trend view that has, as a starting point, an organization-level status view (Exhibit 2). *A project D completion milestone was selected for trend analysis performance (Exhibit 3). The milestone has been ahead of schedule since 1/12/03, the beginning of the analysis time frame (left side of the chart), until the present (point B). A one-time leap occurring on 25/12/03 (point A) saw the milestone pushed ahead by almost a month to 29/4/04. The situation was rectified a week later.*

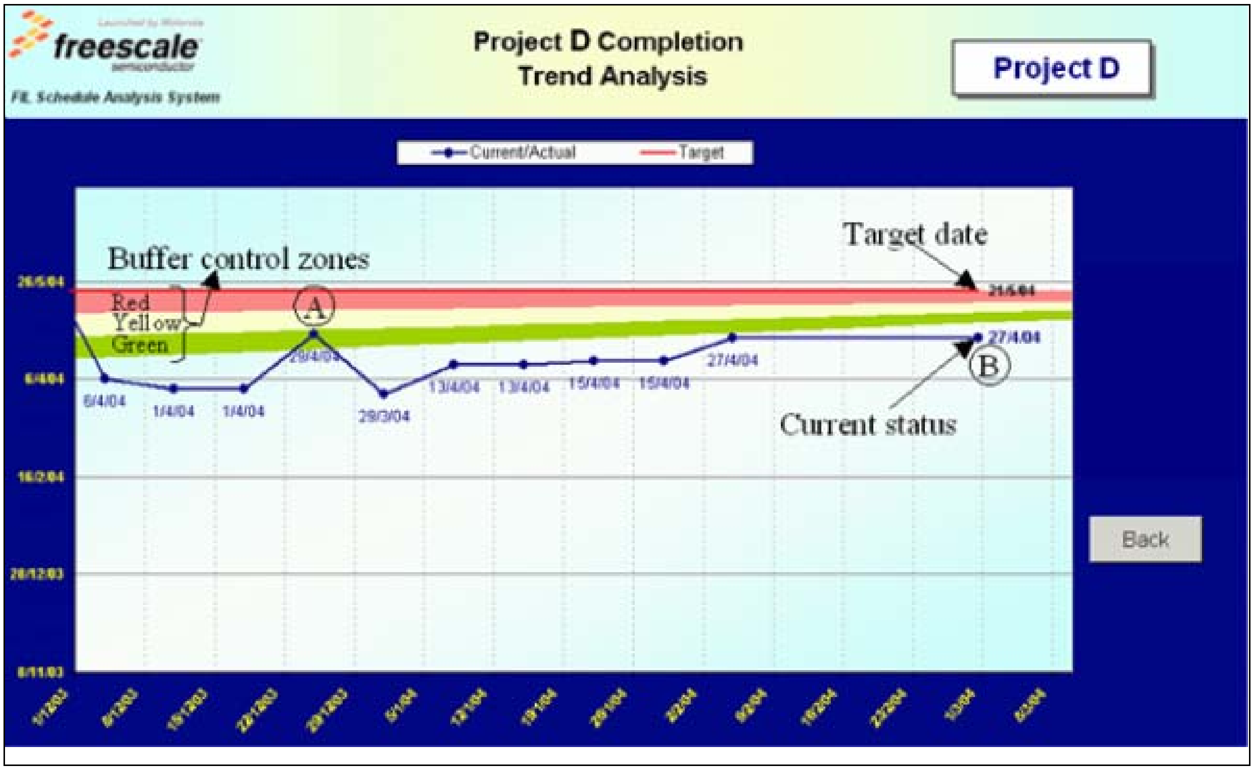


Exhibit 3 - *Trend View* Example

When drilling-down to lower levels of the *milestone tree* the system helps detect current critical milestones as well as milestones which, if overlooked, may become critical.

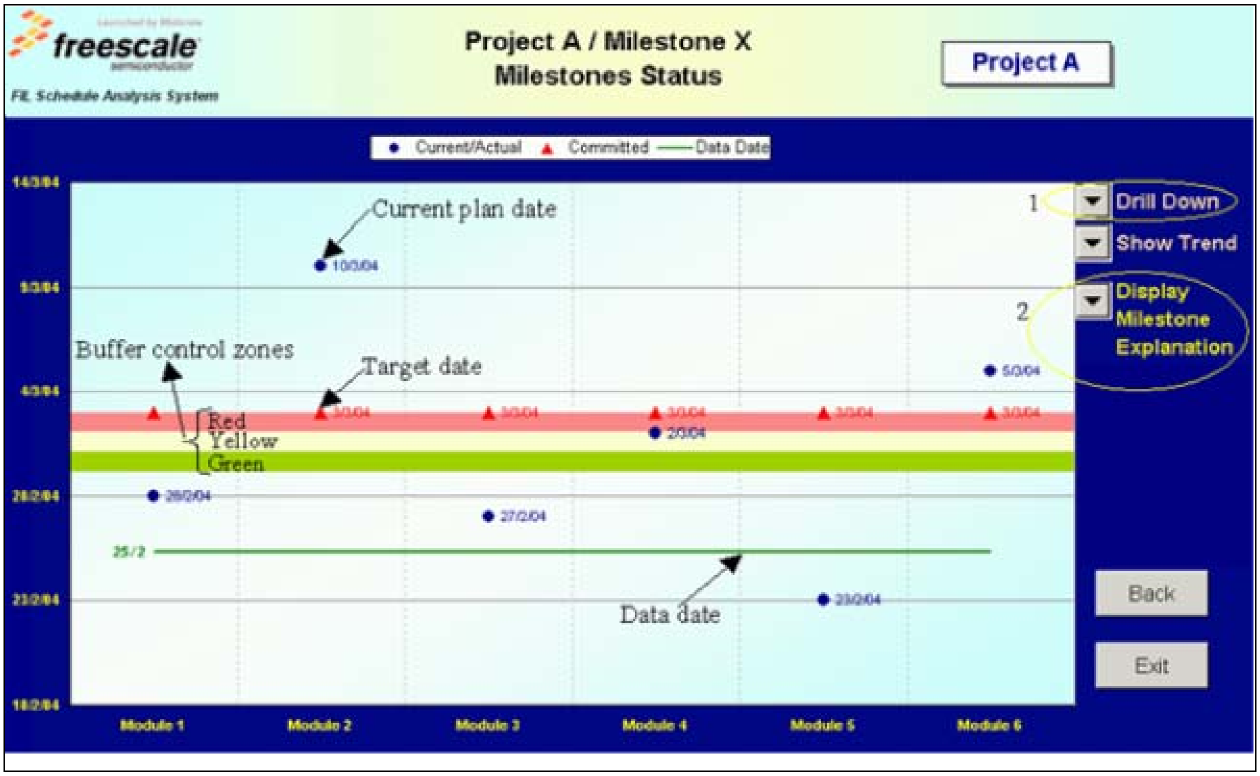


Exhibit 4 - Status View: Project High-Level Milestones

Example: *a drill-down was performed on high-level milestone X (Exhibit 4) revealing the presence of six gating milestones. The milestone target completion date was 3/3/04. Module 2 was the critical milestone (10/3/04) for delaying milestone X. However, the chart also shows that module 6 was behind schedule (5/3/04). A regular critical-path analysis would probably have missed this detail.*

The Drill-Down Schedule Analysis System provides varying detail levels suited to specific managerial requirements - from a multi-project view for top management to detailed project views for project managers and team leaders. The easy-to-use navigation mechanism and structured top-down analysis approach allows users to easily comprehend project status and identify main issues without using a standard PM scheduling tool.

Entering a project into the system requires a comprehensive understanding of the activity network in addition to a technical understanding of the system. The system does not replace the project activity network but it does, while entering data, help enforce uniform schedule templates. Activity networks should be defined in a manner that allows representation in a *milestone tree*. There are two major stages involved in managing a project in the system: **Project Setup** and **Project Tracking**.

Project Setup includes the following:

- Building a modular project activity network.
- Defining milestones in detail and setting target dates; setting the buffer ratio when CCPM scheduling is used.
- Defining the *milestone tree*.

Project Tracking is transparent. Regular schedule updates are performed using a standard PM scheduling tool that automatically updates the system with real-time data. The next section discusses technical aspects of the Drill-Down Schedule Analysis System.

Technical Overview

The Drill-Down Schedule Analysis System is comprised of three major components (Exhibit 5):

- A standard Project Management scheduling tool.
- A central Microsoft Access® database (linked to the PM scheduling tool).
- A Microsoft Excel® spreadsheet that is installed on each user's desktop and connected to the central database via an ODBC driver.

In both the Access® database and the Excel® spreadsheet, Visual Basic for Applications (VBA)® macros are used to automate the system and enable interactive functionality. The Access® database has two functions – storing a hierarchical milestone tree for each project and retrieving real-time data from the scheduling tool. A Graphical User Interface (GUI), built into Microsoft Excel® and linked to the Access® database, generates automated views.

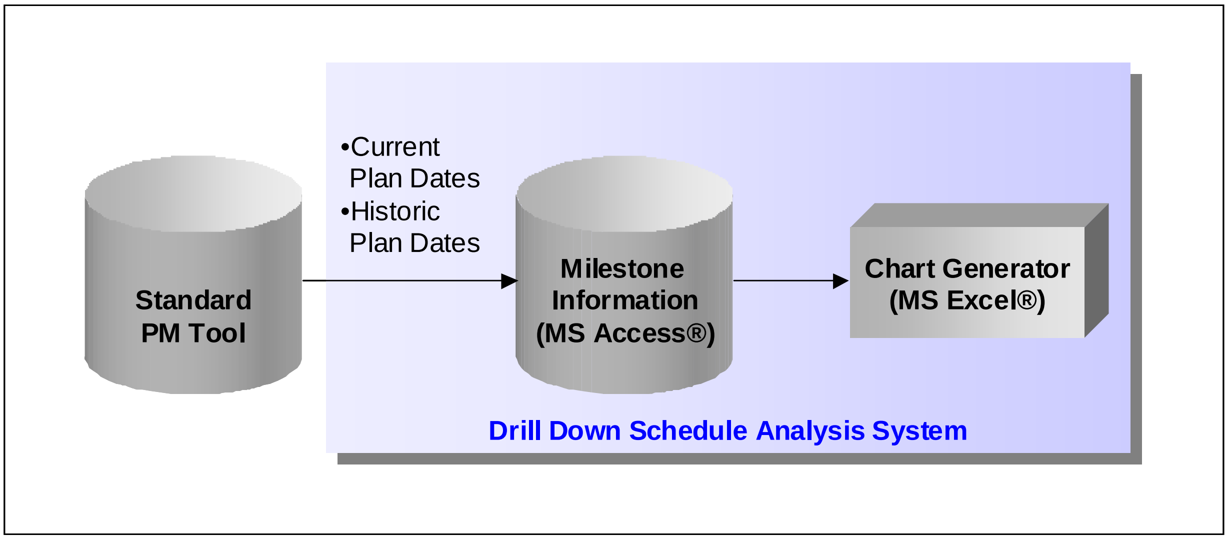
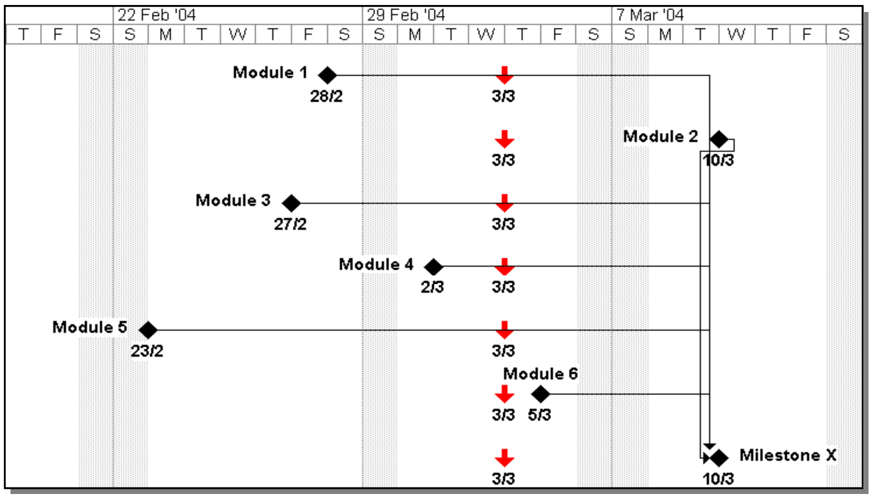


Exhibit 5 - The System Data Model

The ***milestone tree,*** a hierarchical structure of project milestones, must be defined in order to enable the system's drill-down capability. Aside from one high-level milestone per project, e.g. final delivery, a parent milestone is defined for each milestone. The *milestone tree* structure should be aligned with the project activity network in order to reflect real critical paths of the project plan.

Example (Exhibit 6): *Six milestones ('module 1'…' module 6') are completed prior to the completion of high-level 'milestone X'. In such a case, the milestone tree table defines 'milestone X' as the parent milestone of the module 1'…'module 6' milestones.*

The *milestone tree* display is configurable. As a project progresses, specific milestones or even entire branches may either be hidden or displayed. For example, it is possible to display in detail the milestones of the coming two to three months while, at the same time, showing only the high-level milestones for the rest of the project.



Milestone	Milestone Parent
Module 1	Milestone X
Module 2	Milestone X
Module 3	Milestone X
Module 4	Milestone X
Module 5	Milestone X
Module 6	Milestone X

Exhibit 6 - From Gantt Chart to Milestone Tree Definition

Additional data required for each milestone includes description, detailed description and completion target date. The current and previous completion dates are saved in the database during scheduled tool updates.

As noted above, the system generates two views, *Status View* and *Trend View*. The *Status View* (Exhibit 4) shows all the milestones linked to a particular *parent milestone*. Milestone names appear on the x-axis while their dates are found on the y-axis. The target date is represented by a red triangle and the current planned date (or actual completion date if applicable) is marked by a blue circle.

Note that when using the CCPM method the system enables graphical representation of the relative remaining buffer, per milestone. The aforementioned buffer type is graphically divided into three equal control zones: green, yellow and red. Relative buffer size calculations are based upon buffer ratio and the time remaining until the target date[1]. A horizontal line represents the data date, i.e. date of the last data update. This adds a time perspective to the view and helps identify milestones already completed (those below the line) as well as those that are not.

The system allows additional drill-downs for *parent milestones* - those milestones appearing in the *Drill-down* list (Exhibit 4, circle 1). Another useful feature is the *Display Milestone Explanation* button (Exhibit 4, circle 2). This button opens a message box featuring a detailed description of a selected milestone.

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[1] $$\textit{Remaining Buffer Size} = \frac{\textit{Remaining Days to Target}}{1 + \dfrac{1}{\textit{Buffer Ratio}}}$$

The *Trend View* (Exhibit 3) shows the performance history of a particular milestone. A data point appears for each revision plan. The revision data date and revision plan date are represented as x and y values, respectively. Use of the CCPM scheduling method allows the system to calculate and draw the remaining buffer zones - the buffer is reduced as progress is made along the data date axis. The trend analysis time frame is a system parameter and, as such, may be changed.

Conclusion

Freescale Semiconductor Israel implements the Drill-Down Schedule Analysis System in all of its complex development projects. The system and its deployment process effectively address the issues outlined above. Organizations deploying the Drill-Down Schedule Analysis System will appreciate its instrumental capabilities. Below is a review of the system's major advantages:

- Simplifies complex project schedules through use of a top-down approach. The approach is based on a hierarchical *milestone tree* that represents the activity network.
- Managers, not necessarily familiar with standard PM tools, can access a straightforward project status overview. Real schedule issues become apparent with a few simple mouse clicks. Managers prefer a top-down approach and graphical system views as opposed to regular Gantt charts.
- Varying managerial levels can simultaneously access the same database from their desktops but each selects his/her desired view and level of detail.
- Managers may access a cross-section view of project-gating milestones, milestones that illustrate several potential critical paths. When the activity network and *milestone tree* are well defined, the system may actually be used as a checklist tool for “go” and “no go” decisions.
- The *trend view* helps monitor milestone status over a given time period. Acting as a complement to the *trend view*, the three color-coded buffer zones serve as a control chart that enables managers to foresee potential slippage and act proactively to prevent it.
- The uniform milestone definition, dictated by the *milestone tree*, is instrumental for an efficient planning process and speedier closure of the project plan. Milestone definition uniformity improves the project team's involvement and commitment to project goals. It creates a positive competitive environment that contributes to project success.

Overall, the Drill-Down Schedule Analysis System improves the planning process, speeding up the convergence of vast and complex project schedules. The Drill-Down Schedule Analysis System supports the project control process by providing managers with higher and simpler visibility that should lead to the early identification of potentially problematic issues and their proactive resolution.

References

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