

BS EN 16601-60:2014



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Space project management

Part 60: Cost and schedule management

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National foreword

This British Standard is the UK implementation of EN 16601-60:2014. It supersedes BS EN 13290-7:2001 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ACE/68, Space systems and operations.

A list of organizations represented on this committee can be obtained on request to its secretary.

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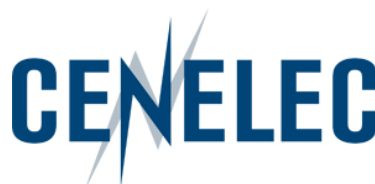
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Foreword

This document (EN 16601-60:2014) has been prepared by Technical Committee CEN/CLC/TC 5 "Space", the secretariat of which is held by DIN.

This standard (EN 16601-60:2014) originates from ECSS-M-ST-60C.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2015, and conflicting national standards shall be withdrawn at the latest by February 2015.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 13290-7:2001.

This document has been developed to cover specifically space systems and has therefore precedence over any EN covering the same scope but with a wider domain of applicability (e.g. : aerospace).

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Cost and schedule management is defined as a collective system of organized processes and actions in support of project management. It allows optimal use to be made of human resources, facilities, materials and funds, thereby achieving a successful completion of the space project with respect to

- cost targets,
- timely completion, and
- technical performance.

To this end, costs and activities are planned and actively controlled, with special care being given to the identification of critical situations that can lead to an adverse impact on the project cost and schedule, so that the relevant recovery actions can be proposed.

1

Scope

The requirements specified herein apply to, and affect the customer and supplier at all levels.

This standard may be tailored for the specific characteristics and constraints of a space project in conformance with ECSS-S-ST-00.

2

Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this ECSS Standard. For dated references, subsequent amendments to, or revisions of any of these publications do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to apply.

EN reference	Reference in text	Title
EN 16601-00-01	ECSS-S-ST-00-01	ECSS system – Glossary of terms
EN 16601-10	ECSS-M-ST-10	Space project management – Project planning and implementation
EN 16601-80	ECSS-M-ST-80	Space project management – Risk management

Terms, definitions and abbreviated terms

3.1 Terms from other standards

For the purpose of this Standard, the terms and definitions from ECSS-S-ST-00-01 apply, in particular for the following terms:

cost breakdown structure

estimate (cost) at completion

estimate (cost) to completion

3.2 Terms specific to the present standard

3.2.1 **cost reimbursement contract**

generic type of business agreement in which payments are depending upon incurred costs

3.2.2 **cost estimating**

process helping in the determination of the expected costs of a project

3.2.3 **critical path**

chain of activities critical to the timely completion of the project

3.2.4 **direct manpower cost**

manpower cost charged to the project using the agreed rates

3.2.5 **economic conditions**

reference period of time during which a set of financial elements (e.g. hourly rates and overheads) are applicable

NOTE Reference economic conditions are those prevailing when the decision to commit to the project is taken. Current economic conditions are the conditions prevailing when the service is provided.

3.2.6 **fixed price contract**

generic type of business agreement in which payments are defined in the business agreement in the form of milestone payment plan(s), and depend upon the achievement of the relevant contractual milestones

3.3 Abbreviated terms

For the purpose of this Standard, the abbreviated terms from ECSS-S-ST-00-01 and the following apply:

Abbreviation	Meaning
AIV	assembly, integration and verification
CBCP	current baseline cost plan
CBS	cost breakdown structure
CCN	contract change notice
CCS	country/company structure
CIL	critical items list
CPM	critical path method
CR	cost reimbursement
CWP	control work package
DCP	development cost plan
DIL	deliverable items list
EAC	estimate at completion
EC	economic conditions
ETC	estimate to completion
FP	fixed price
FFP	firm fixed price
G&A	general & administrative
MPP	milestone payment plan
MTA	milestone trend analysis
MTC	milestone trend chart
OBCP	original baseline cost plan
PDM	precedence diagram method
PMAC	payment milestone achievement certificate
PEF	price escalation formula
PSS	procedure standard specification
PT	product tree
WBS	work breakdown structure

4

Cost and schedule management common principles

4.1 Objectives and relationships

Cost and schedule management is a major factor in the effective, responsible and proactive controlling of projects. It provides a common working baseline for the planning and expenses and across the participants of the project. It ensures a uniform basis and common understanding of the project planning, cost and manpower targets for use by all participants.

The main objectives of Cost and Schedule management are to:

- plan accurately the phasing of procurements, expenses and resources for the project;
- highlight any deviations and hence propose remedial actions, with the aim of completing the project within the given time and financial constraints.

Schedule management includes the activities to accomplish timely completion of the project, i.e.:

- Schedule definition, including activity definition and sequencing, activity duration estimating and schedule baseline establishment;
- Schedule control, including the comparison between the current working schedule and the baseline schedule;
- Schedule reporting.

Cost management includes the activities to complete the project within the approved budget, i.e.

- Cost estimating and planning;
- Cost control;
- Cost reporting.

The main structures to perform these activities are the:

- Work breakdown structure;
- Cost breakdown structure;
- Business agreement structure;
- Country/company structure.

Figure 4-1 presents an overall functional analysis of cost and schedule management.

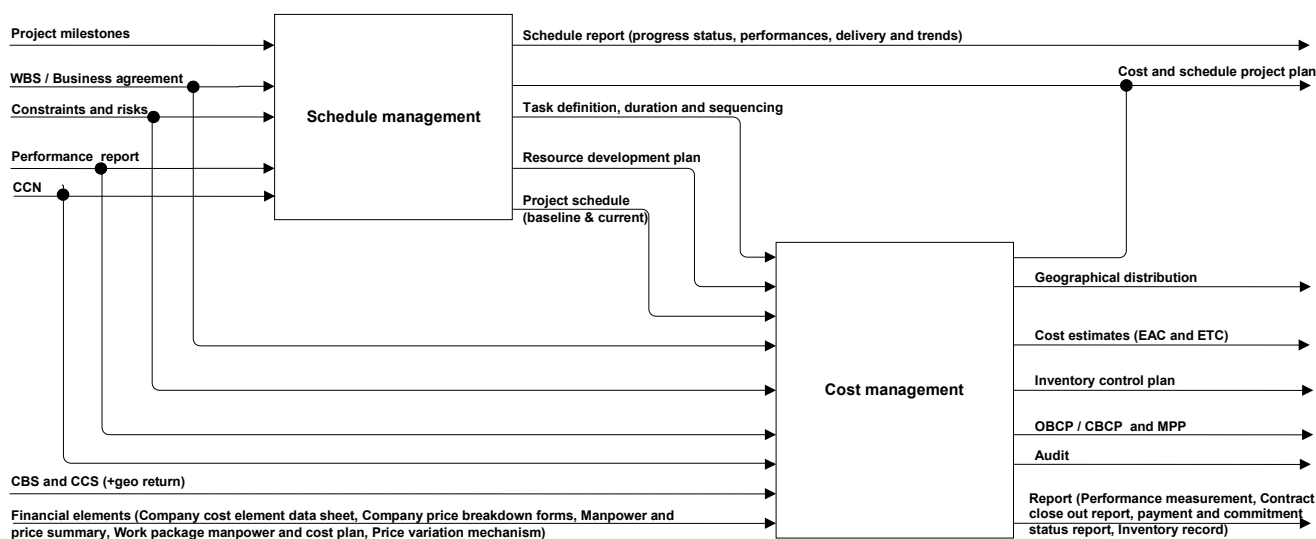


Figure 4-1: Overall functional analysis

4.2 Project structure

4.2.1 Work breakdown structure

A general introduction into the Work Breakdown Structure (WBS) is provided in ECSS-M-ST-10.

In the specific context of Cost and Schedule management, the WBS is used as a common tool in the project, assisting its participants in:

- Conducting tender comparisons and business agreement negotiations;
- Optimizing the distribution of work amongst the different suppliers;
- Monitoring the schedule of the project:

A network of events (e.g. start, complete) and activities (e.g. design, develop and operate) takes place. The logical relationships between the activities allow the producing and completing of the WBS deliverables. Resources (e.g. labour skill, and materials) and responsible organizations (e.g. mechanical engineering department, fabrication department, supplier) can then be identified for each activity.

The scope and complexity of the work and the management needs for schedule visibility influence the frequency of schedule reporting and their associated levels of detail.

- Estimating, planning and monitoring the cost:

By breaking down the total product tree into successively smaller elements and support functions, management can verify that all activities identified in the WBS actually contribute to the project objectives. In addition, using WBS elements to plan for the work serves as the basis for estimating and scheduling resource needs.

An estimate based on WBS elements helps to plan, coordinate, and control the various project activities that both the customer and the suppliers are conducting. The WBS also provides a common framework for tracking the evolution of estimates, hence forecasting the total cost of the project more accurately.

Proper use of the WBS for technical, schedule, and cost management allows the defining of work and related resources, ensuring that all work is included without duplication of effort. In addition, the WBS is used to accumulate performance data and associated variances to evaluate progress in terms of performance.

To perform data reporting, the WBS is broken down into work-packages. All defined work-packages reflect the total work scope.

Any reporting to the customer is performed using Control work-packages, which are agreed between the customer and the supplier and reflected in the corresponding business agreement. All defined Control work-packages also reflect the total work scope.

4.2.2 Cost breakdown structure

The Cost Breakdown Structure (CBS) defines a set of cost categories used to break down all the costs of the project. It provides a common framework for all cost management activities among suppliers for the same project.

The total cost planned for each work package is broken down per cost category (e.g. labour, non-labour, subcontracts). For each cost category, the distinction between direct and indirect costs is identified by each supplier to the customer.

4.2.3 Business agreement Structure

A Business Agreement Structure is a specific type of organization chart, the purpose of which is to identify the project reporting relationships between the respective customers and suppliers. It shows which suppliers are responsible for which work packages, as depicted in Figure 4-2.

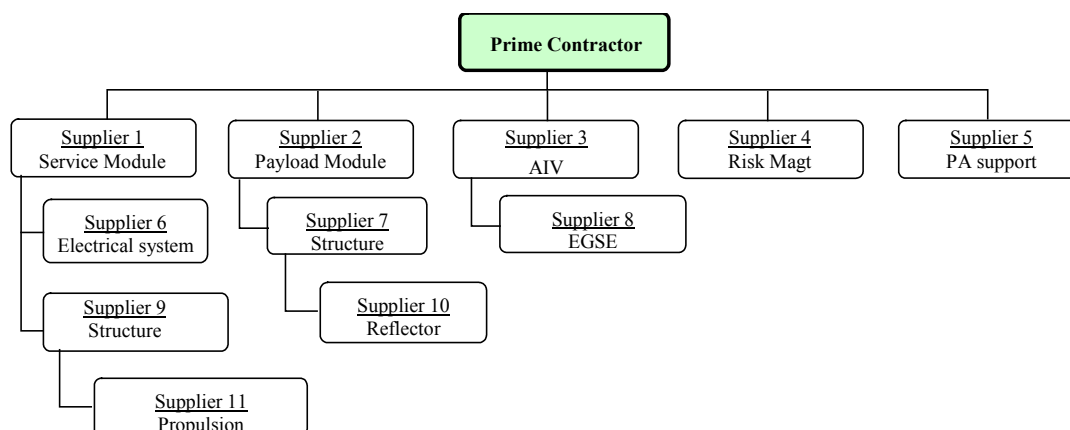


Figure 4-2: Business agreement structure example

By relating work packages in the WBS to business agreements in the Business Agreement Structure, contractual responsibilities can be traced. It facilitates the cost management process by providing the means to ensure that all impacts (e.g. liability, financial, technical or schedule) of a change in the business agreement are properly assessed at all levels of the contractual hierarchy (see Figure 4-3).

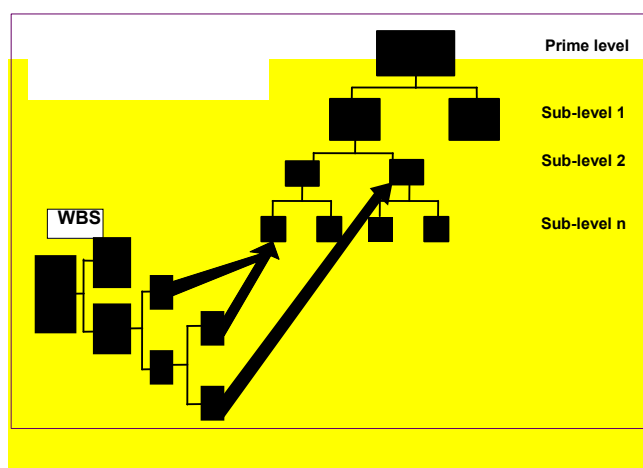


Figure 4-3: Business agreement structure schematic

4.2.4 Country/Company structure

The Country/Company Structure (CCS) shows the relationships between each company's business agreement for a project and the countries in which the corresponding work is performed. By identifying the relationships between work packages in the WBS and business agreements in the CCS, reports can be generated to illustrate how each supplier's work is distributed per country, e.g. for geographical return purposes.

In the case of projects where it is simple to identify the countries in which the works are performed, the CCS is combined with the Business Agreement Structure.

4.3 Business agreement types

4.3.1 General

The way to manage the cost and schedule aspects of a project depends on the business agreement type. There are two basic types: Fixed Price and Cost Reimbursement, which are broken down as defined below.

4.3.2 Fixed price contracts

- a. Firm fixed price: the price of the business agreement is not subject to any adjustment or revision by reason of the actual costs incurred by the supplier in the performance of his business obligations.
- b. Fixed price with variation: the price of the business agreement is not subject to any adjustment or revision by reason of the actual costs incurred by the supplier in the performance of his business obligations, except for the update to current economic conditions by applying an agreed price variation mechanism.
- c. Fixed unit price: the price of the business agreement is defined per unit price of the various supplies and services.

4.3.3 Cost reimbursement contracts

- a. Cost plus fixed fee: it is a cost-reimbursement type of business agreement which provides for the payment of a fixed fee to the supplier. Its implementation mechanism is described in the business agreement and generally includes the following elements:
 - a target cost for the whole project;
 - the above-mentioned fixed fee, which does not vary with actual cost;
 - a cost sharing scheme, defining applicable incentives and penalties depending on how the actual cost spent for the whole project compares with agreed target cost.
- b. Cost plus incentive fee: it is a cost-reimbursement type of business agreement which provides for the payment of a target fee, which is the fee to be paid to the supplier if the business agreement is executed in accordance with targets specified in the business agreement. Its amount is adjusted depending on whether the supplier's execution of the project is below or above the specifications fixed for the above-mentioned targets.
- c. Time and material: it is a cost-reimbursement type of business agreement of which the price is determined on the basis of the following elements:
 - average hourly rates or hourly rates per category, including direct as well as indirect charges, general administrative overhead and profit, either for personnel or for the hire of facilities including operating personnel;

- material and supplies at cost, which can be increased by a percentage for material handling charges to the extent that they are clearly excluded from the hourly rate;
- disbursements or payments made to third parties for services rendered in the fulfilment of the business agreement to the extent that they are clearly excluded from the hourly rate (e.g. travel expenses, transport, computer charges, etc.). Disbursements are approved by the customer and, unless otherwise provided in the business agreement, are reimbursed at their invoice value without any additional charges.

4.3.4 Ceiling price to be converted into fixed price

When the parties intend to conclude a firm fixed price contract or a fixed price contract with price variation, and if at the time of concluding the contract there is not sufficient basis for assessing a fixed price, they can conclude a business agreement with a ceiling price to be converted into a fixed price. Such a business agreement stipulates a ceiling, which the business agreement price cannot exceed and within which the supplier commits to deliver in full the supplies and services stipulated in the business agreement. If an agreement on the fixed price cannot be reached prior to completion of the business agreement, the business agreement price is determined, within the limit of the defined ceiling, in accordance with the procedure of cost reimbursement contract.

4.4 Risk management

4.4.1 General description

Risk management is a systematic process of identifying, analysing, and responding to risks of a project during its entire life cycle (early definition, development, implementation and exploitation phases). It allows maximising of the probability and consequences of positive events and minimizing the probability and consequences of adverse events for project objectives. The approach to risk management is described in detail in ECSS-M-ST-80.

Assuming that the technical and quality requirements are strictly observed and met, any project risk, irrespective of the category to which it belongs, eventually has a cost or schedule impact if it occurs. Cost and schedule management of a project is supported by an appropriate risk assessment, in order to allow the relevant decisions to be taken early enough in the course of the project development. Developing technical back-up solutions early enough during the project life can seem costly because they are redundant by definition with the primary solution. It can, however, in the long-term turn out to be the cheapest project solution. Proper conduct of risk analysis therefore allows optimization of the overall cost of a project and the risks taken to achieve it.

4.4.2 Risk register

Risk elements of explicit relevance to cost and schedule management are listed in the Risk Register (see ECSS-M-ST-80). They include, without being limited to:

- programmatic constraints: (Fixed launch date? If project involves cooperation, with which political risk? Missing skills and staff complement?),
- technological challenges (e.g. necessity of new technologies, although not mature at start of the project),
- cost driving elements,
- financial and geographical return constraints,
- penalty and incentive schemes.

4.4.3 Lessons learned

Performing a critical assessment of the project upon its completion allows both the customer and supplier to define together the strengths and weaknesses of the different options chosen during its different phases.

The resulting lessons learned cover separately all support functions to properly conduct a project (e.g. management, control, engineering, product assurance, and AIV). They are an essential input to the risk management of future projects.

5

Schedule management principles

5.1 Schedule definition

5.1.1 General

To support proactive project management, the work to be performed for a project is planned to a level of detail commensurate with the project phase for which the schedule is established.

Developing a network of activities, milestones and relationships between them allows for effective schedule analysis, risk evaluation and mitigation. The identification of the critical path helps to anticipate the definition of corrective measures on such critical activities so as to avoid schedule drift.

Schedule reporting, including critical path, between supplier and customer provides the necessary overall visibility of the project status at any time.

5.1.2 Activities definition / Activities sequencing

The network of activities is derived from the agreed Work Breakdown Structure (WBS). The activities are put in sequence linked by relationships reflecting the logical dependencies that exist between the activities. Project activity overall logic is described in a technical manner in the System Engineering Management Plan (see ECSS-E-ST-10) and Design and Development Plan (see ECSS-M-ST-10).

A duration is estimated for each network of activities. Duration estimation is commonly based on a mixture of previous experiences, expert opinions, supplier information and common sense. The risk analysis process provides valuable input to define the required schedule contingencies. Schedule contingencies are usually allocated to the last activity within a project phase or sub-project phase.

Once the activity identification, network logic and durations have been performed and the customer requirements (e.g. key milestones) duly taken into account, the resulting network is analysed using an agreed project calendar taking into account working hours, working days and company holidays and available critical resources such as personnel, machines, tools and facilities.

This iterative process results in a schedule that is validated, logical, complete and compliant with the business agreement.

5.1.3 Key milestones

For overall visibility, key milestones are established in the schedule following their agreement between customer and supplier.

Depending on the project phase, the following key milestones, as a minimum, are included in the schedule and linked to the identified activities:

- Start and end of the project phases;
- Design reviews including supplier design reviews such as Preliminary Design Reviews (PDR), Critical Design Reviews (CDR);
- Production reviews such as Manufacturing Readiness Reviews (MRR), Major Inspection Points (MIP);
- Test reviews like Test Readiness Reviews (TRR);
- Delivery Review Boards (DRB);
- Business agreement milestones such as Payment Milestones;
- Delivery dates for Customer Furnished Equipment.

5.1.4 Resource allocation

Project resource allocation covers all resource types and takes into account periods of unavailability of each identified resource.

By this means, critical periods of under-load or over-load are identified in advance, and non-critical activities can be rescheduled to suit the availabilities.

During the process of schedule development all critical resources are taken into account.

During the project lifetime, the supplier uses the current working schedule and the updated resource allocation for such internal processes as:

- capacity planning,
- progress measurement methods, and
- booking of critical resources like tooling, machines and facilities.

For cost reimbursement contracts, the overall resource allocation is used as input for the development cost plan (see clause 6.3.2).

5.2 Schedule control

5.2.1 Baseline schedule

The baseline schedule describes the activities and their sequences that meet the project objectives for timely completion of the project or project phase. It is developed by the supplier and agreed by the contractual parties and is the reference for schedule reporting and performance measurement.

The baseline schedule is coherent with the agreed product tree and describes the flow of the work as defined in the WBS.

The definition of the baseline schedule follows the principles given in clause 5.1. The level of detail of the baseline schedule depends on the level of detail of the Work Breakdown Structure. The baseline schedule contains the customer constraints, activities and milestones of the suppliers

As a minimum, the baseline schedule contains:

- key milestones,
- descriptions of the activities,
- start and finish dates of activities,
- duration of activities, and
- identification of the critical path activities.

The baseline schedule is included in the project business agreement. The impact of any agreed change on schedule dates and logic is included in the updated version of the baseline schedule.

5.2.2 Current working schedule

The current working schedule documents the actual status of completed and planned activities and of the planned activity sequence. For completed activities, actual dates are given and for future activities the planned dates are used. The current schedule identifies the most realistic view of the project status given by the supplier to the customer, and hence does not necessarily reflect an agreed and accepted project status.

The current working schedule is identical in its structure, level of detail and content, to the baseline schedule (see clause 5.2.1). It conforms to the principles described in clause 5.1.

At the start of the project, the baseline schedule is identical to the working schedule, as no progress has been made (both schedules show only the planned status of the project). As the project progresses, the current working schedule can differ from the baseline schedule due to the progress made, reflected by updating the status of activities and the activity sequence.

The current working schedule reflects the following information:

- up-to-date status of activities;
- up-to-date status of key milestones;
- suppliers' procurement status.

The comparison between the current working schedule and the baseline schedule forms the basis for the overall project progress assessment. If the current working schedule shows delays against the baseline schedule, the necessary corrective actions are identified, assessed and implemented so as to converge back to the baseline schedule.

5.2.3 Performance evaluation

The current working schedule is compared to the baseline schedule and the resulting differences assessed by the supplier. This includes the status of the completed activities and the current forecast of future activities and milestones.

Elements of this evaluation are:

- actual achievement dates of business agreement milestones (such as Payment Milestones),
- actual work progress,
- actual activity duration,
- actual contingencies,
- changes in or of the critical path.

The commonly used project schedule presentation is the Gantt chart (or Bar chart). In a Gantt chart each activity is represented by a bar, the length of which corresponds to the duration of the activity. The links between the bars are shown with arrows as illustrated below. The critical path is typically highlighted. Customer and supplier agree on the way the activities are grouped in the Gantt chart presentation. The activities can be grouped in conformance with the Work Breakdown Structure, product tree, project phase, customer supplier hierarchy or other preferred sequence.

Figure 5-1 shows an example of a Gantt chart.

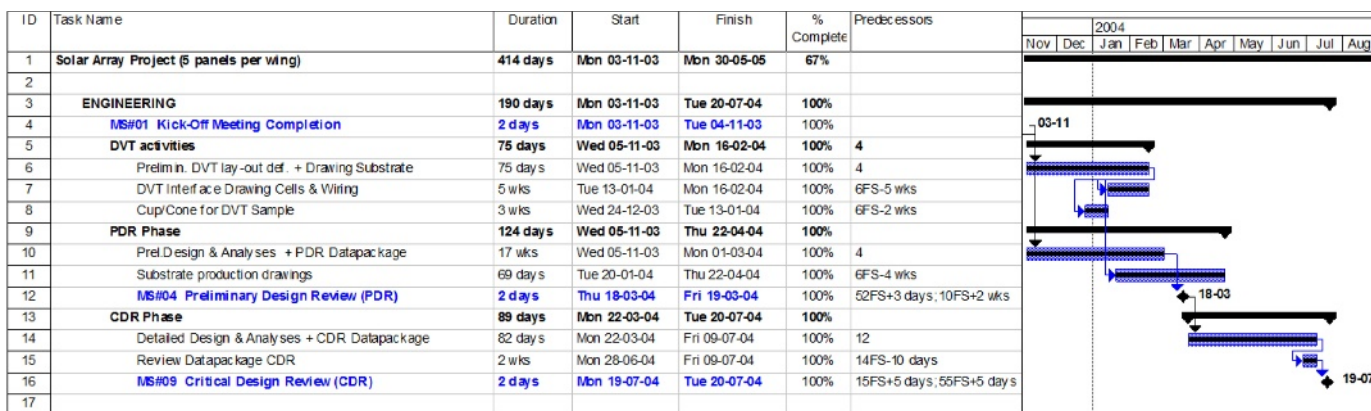


Figure 5-1: Gantt chart example

The evolution of the planned dates for key milestones within the project lifetime results in a trend analysis, which is one key method of assessing the project status. Different representations of trend analysis exist, of which the following are two examples:

A Milestone Trend Chart (MTC) allows the performing of milestone trend analysis (MTA). In an MTC, the dates of milestones are drawn in a graph versus the reporting dates of the schedule. The slope of the graph indicates whether the considered milestone progresses consistently (zero slope), is delayed (positive slope) or accelerated (negative slope). Figure 5-2 shows one example of an MTC illustration with a number of milestones.

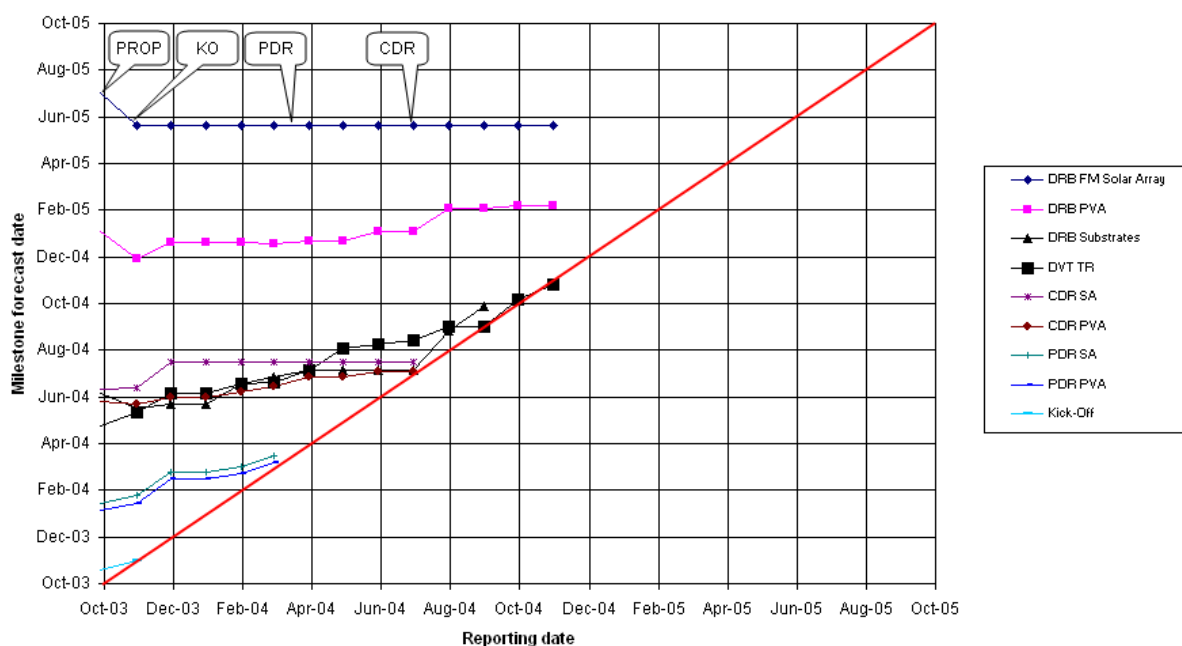


Figure 5-2: Milestone trend chart example

Figure 5-3 shows an example of a Milestone List.

A concise overview of the project is obtained through a “traffic light” presentation by comparing the baseline and current working schedule for each identified milestone.

In the following list the traffic light is defined as:

- green: on schedule with more than 10 days margin
- yellow: current date within +/- 10 days of baseline date
- red: current date more than 10 days later than baseline

Milestone	Baseline	Current	
Finish of development	1/ Jun 04	8/ Jun 04	●
Design review	1/ Nov 04	10/ Oct 04	●
Start manufacturing	1/ Feb 05	25/ Jan 05	●
Delivery	1/ Jul 05	20/ Aug 05	●

Figure 5-3: Milestone list example

5.3 Schedule reporting

5.3.1 General

Schedule reporting helps to satisfy the information requirements for schedule control and performance measurement. It provides clarity regarding the project status and progress. It supports the work of achieving the project objectives and supports the decision making process of the actors at all levels of the project.

Schedule reporting is implemented within the supplier's organization and between the supplier and customer. The form, content, level of detail and frequency of the schedule reporting are defined in the customer/supplier business agreement.

5.3.2 Schedule progress information

The baseline schedule constitutes the reference for schedule control and progress reporting. The supplier reports periodically to the customer in the current working schedule on the progress achieved. Both baseline and current working schedules are maintained by the supplier.

The following items are reported as a minimum:

- Activities started, together with their actual start date;
- Activities completed, together with their actual finish date;
- Forecast completion dates for activities in progress;
- Validity assessment of the defined sequences, relationships and constraints of planned activities.

Evolution of major project events selected as key milestones are reported in conjunction with the above information and is commonly presented in the form of a milestone trend chart (as defined in clause 5.2.3 above).

Reported items are based on work packages and corresponding schedules.

During the project phases, project reviews are held (see ECSS-M-ST-10). They include formal presentations and reports on project progress and evaluation.

The supplier formally notifies the customer, independently from the nominal reporting cycle, within a short time notice agreed upon between the parties:

- any event that can significantly affect the achievement of the agreed schedule objectives, and
- any situation resulting in a substantial schedule change.

Any reported schedule information is accompanied with a description of assumptions and resulting effects. Causes of deviations from baseline schedule are explained, and remedy actions are proposed.

5.3.3 Reporting system and tools

There are different schedule reporting means to ensure effective communication between supplier and customer concerning project progress and evaluation, and to initiate or support decision making, e.g.:

- Progress meetings including minutes of meeting and action item lists (see ECSS-M-ST-10)
- Progress reports (see ECSS-M-ST-10)
- Reviews (see ECSS-M-ST-10)
- Trend report (see clause 5.2)
- Problem notification report
- Comparison of planned and actual data
- Gantt charts (see clause 5.2)
- Traffic light representation of the milestone status (see clause 5.2).