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IMP / IMS Step by Step

Building the Integrated Master Plan and Integrated Master Schedule from Proposal and Successful Execution

Building, deploying, and executing an IMP / IMS requires change in the conventional paradigm of project planning and controls and the management processes. This change starts by measuring progress as the completion of Accomplishment Criteria (AC) and the fulfillment of Significant Accomplishments (SA). This progress is described through the assessment of physical percent complete rather than measuring progress through the passage of time and consumption of resources.

This change means planning *Vertically* for each Program Event (PE), from the exit criteria of Work Packages to their Accomplishment Criteria (AC), to the Significant Accomplishments (SA), to the PE. Only then, can planning take place *Horizontally* for the dependencies between Program Events. As well, a change takes place in conventional approach to Program Events. These Program Events are more than milestones. They are maturity assessment points in the program, where pre-defined deliverables are assessed to assure Technical Performance is being met against the pre-defined metrics. As well that the pre-defined levels of risk are being retired or mitigated as planned.

All these changes mean defining the technical and programmatic performance measures for the critical AC describing what "done" looks like prior to starting the work.

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Motivation of this Guide

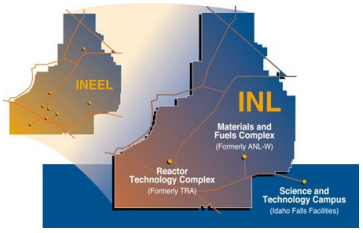
"If a profession is to sharpen its skills, to develop new skills and applications, and to gain increasing respect and credibility, then theory and practice must be closely related" – Martin Shrub

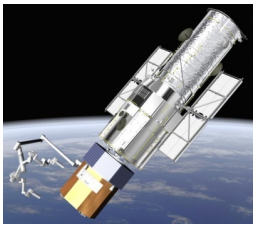
Source Background

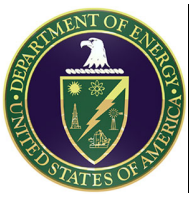
The materials in this guide originate from a variety of sources and experiences in developing IMP/IMS and applying them from the proposal phase through the execution phase of programs. All diagrams and some of the text are taken from public sources, many of which are government standards. Every attempt has been made to provide full credit to these public sources.

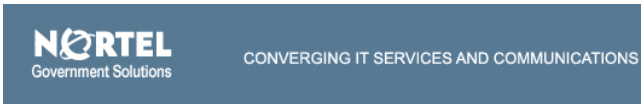
The field experience of developing and deploying IMP/IMS includes:

- Rocky Flats Environmental Technology Site (CH2M Hill)
- Western Area Power Authority proposal (CH2M Hill)
- Oak Ridge National Laboratories K–25 Reclamation (CH2M Hill)
- Idaho National Laboratory Reclamation proposal (CH2M Hill)
- Hubble Robotic Service Mission proposal and execution (Lockheed Martin Space Systems Company)
- Crew Exploration Vehicle (renamed Orion) proposal and execution (Lockheed Martin Space Systems Company)
- GPS III OCX Ground System (Raytheon)
- Joint Precision Approach Landing System (JPALS) proposal (Honeywell Defense and Space)
- Ares Instrument Unit (Avionics Ring) proposal (Ball Aerospace and Technology Company)









The Official Motivations for the IMP/IMS Approach

Part 2.B.3 Acquisition Strategies, Exit Criteria, and Risk Management

- Event driven acquisition strategies and program plans must be based on rigorous, objective assessments of a program's status and the plans for managing risk during the next phase and the remainder of the program.
- The acquisition strategy and associated contracting activities must explicitly link milestone decision reviews to events and demonstrated accomplishments in development, testing, and initial production.
- The acquisition strategy must reflect the interrelationships and schedule of acquisition phases and events based on the logical sequence of demonstrated accomplishments not on fiscal or calendar expediency.

There is no single source for the mandatory use of IMP/IMS in the same way Earned Value and an IMS. However, the IMP references It start with the EVMS standards, and is supported by DID 81861 and the Systems Engineering approach of Event Based Performance Measurement.

Many proposals call for an "Event Based Plan," and provide the mandatory Events. The offeror is requested to provide an IMP and connect this to the IMS.

DoD Inst 5000.2, Operation of Defense Acquisition System, May 12, 2003

- EVM is a regulatory Information Requirement
- Implement EVM Guidelines in ANSI/EIA–748C

Defense Acquisition Handbook June 7, 2016, Chapter 11.3.1.4.2 (Replaced DoD 5000.2–R)

- Guidance on previous policy
- Revised EVM contents in Chapter 11

Basic Requirements for EVMS

- Earned Value Management System (EVMS) in compliance with ANSI/EIA–748 is required on all cost or incentive contracts equal to or greater than $20M.
- A formally validated and accepted EVMS is required for cost or incentive contracts equal to or greater than $50M.
- EVM may be imposed on contracts less than $20M as a risk–based decision of the program manager based on a cost/benefit analysis.

DFARS Clauses

- Notice of Earned Value Management System (MAR 2005), DFARS 252.242–7001.
- Earned Value Management System (MAR 2005), DFARS 252.242–7002.

Data Requirements

- For contracts greater than $20M
  - Integrated Program Management Report (IPMR) DI-MGMT-81861
  - Integrated Master Schedule (IMS) (DID DI–MGMT–81861) is required
- A product–oriented Contract Work Breakdown Structure (CWBS) in accordance with the DoD WBS Handbook (MIL–STD–881C) and the CWBS DID (DI–MGMT–81334D) is mandatory when EVM is implemented and a IPMR and an IMS are required.
- For contracts that require Contractor Cost Data Reports (CCDRs), the CWBS will be developed, approved, and maintained in accordance with DoD 5000.4–M–1, Cost and Software Data Reporting Manual, and the CWBS DID.
- A single CWBS will be developed and maintained for all contractor reporting.
- A Contract Funds Status Report (CFSR) (DI–MGMT–81468) is required.
- No specific dollar thresholds are established for the CFSR, but application to contracts of less than $1.5M should be carefully evaluated.

More Guidance

- Systems Engineering Handbook, A Guide for system life-cycle-processes and activities, Fourth Edition,

- DFARS 252.242–7001 and 252.242–7002 will be applied to all contracts requiring EVM in the interim period until the new DFARS clauses are approved and published.
- However, for contracts equal to or greater than $20M but less than $50M the SOW must contain a special statement that excludes the requirement for the Government to formally validate/accept the contractor's management system (no validation review).

The Concept of Event Based Planning as "Strategy Making"

Every project manager is looking for a "winning" strategy to manage projects.

- Programmatic architecture defines the creation of increasing value as the schedule moves from left to right. The evaluation of this increasing value is performance through review and evaluation events. At each Event the predefined maturity and its associated value is evaluated for compliance with the plan.
- These Events are capability assessment points in the program. These Events are mini-"Authorizations to Proceed." At each Event, the program is assessed for its planned maturity as defined in the Review Entry and Exit criteria. A source of this criterion through CDR can be found at the NAVAIR site.
- The capabilities available at each event can be substantiated using Significant Accomplishments (SA) and their Accomplishment Criteria (AC).
- Completion of each Significant Accomplishment and their Accomplishment Criteria are the physical measures of the existence of the capability. This is the definition of Physical Percent Complete.
- The program's work tasks produce the products or services that enable the capabilities needed by the program.
- The critical concept is that no work should be performed that does not result in the increasing maturity of a capability
- Identifying this work should be performed for a needed capability for each program event. This is the connection between vertical (IMP) and horizontal (IMS).
- The IMS describes the work required to produce the Significant Accomplishments (SA). The assessment that this work has resulted in an acceptable conclusion is defined in the narrative of the Accomplishment Criteria (AC).
- The strategy for successfully completing the program is stated in the logical sequences of the Significant Accomplishments. As the SAs move through their logical sequence, the products and services they produce increase in their maturity for each Program Event (PE).

Strategy Making, IMP/IMS and a Systems Engineering Process

Building products or providing services using IMP/IMS within a systems engineering context is a step by step process:

1. Create a vision of the outcome – this is usually described in the Concept of Operations
2. Analyze the current situation – performance an Analysis of Alternatives
3. Determine a strategy for moving from the current situation to the outcome – what "maturity increasing" activities must be performed to move forward
4. Select the systems development activities needed to make this move – these are the Significant Accomplishments for each Program Event
5. Draft a plan based on these activities – arrange the SAs in a logical sequence for each Program Event
6. Perform a pilot set of activities to confirm they result in desirable outcomes
7. Evaluate these results – "test" the logic of the SAs to assure increasing maturity will result
8. Execute the processes in steps 6 and 7 until the outcome is reached – develop the Accomplishment Criteria for each SA and the top activities for each AC.

This extremely simple minded approach is the basis of all credible development activities. The challenge comes in finding how the details of each step are to be defined, developed, executed. This is the purpose of this document.

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1 First Principles of IMP/IMS

The terms *Integrated*, *Master*, *Plan*, and *Schedule* have special meaning in the IMP/IMS paradigm. These meanings are different from traditional project management usage:

- **Integrated** – vertical and horizontal traceability between the planned work, the Program Events, and the customer requirements defined in the RFP, Statement of Work, Statement of Objectives and the supporting documents (CDRLs, DRDs and DIDs).
- **Master** – the *all in* plan and schedule defined at three levels of detail.
- **Plan** – the *strategy* for completing the project. This plan represents the increasing maturity of the program through Program Events (PE), Significant Accomplishments (SA), and their Accomplishment Criteria (AC).
- **Schedule** – the sequence of work activities needed to fulfill the Accomplishment Criteria (AC).

- The Integrated Master Plan / Integrated Master Schedule (IMP/IMS) defines and tracks the increasing maturity of a Program through programmatic and technical performance measures.
- The IMS is a vertically integrated execution schedule traceable to the Integrated Master Plan (IMP).
- Once this vertical traceability has been established, the horizontal dependencies can be defined.
- The IMP is an Event Based plan, not a time based schedule. The IMS is time based representation of the achievements needed for the defined program maturity of deliverables described in the Program Events

Managing projects using IMP/IMS is new to many organizations and "old hat" to others. From the current US Department of Defense Guideline:

- The IMP and IMS are business tools that enhance the management of development, acquisition, modification, and sustainment programs. They provide a systematic approach to program planning, scheduling, and execution. They are equally applicable to competitive and sole source procurements with industry, as well as Government in-house efforts. They provide a tool for improved day–to–day program execution and for ongoing insight into program status by both Government program office personnel and contractor personnel. They help develop and support "what–if" exercises and to identify and assess candidate problem workarounds.
- The IMP is an event–based plan consisting of a hierarchy of program events, with each event being supported by specific accomplishments, and each accomplishment associated with specific criteria to be satisfied for its completion. The IMP is normally part of the contract and thus contractually binding. The IMP is a narrative explaining the overall management of the program.

The Integrated Master Plan (IMP) and the associated Integrated Master Schedule (IMS) are composed of five (5) tiers shown in **Figure 1**.

Program Events – are periodic assessments of the program's maturity through reviews or physical demonstration of the Significant Accomplishments.
Significant Accomplishments – are the *Entry Criteria* for the Program Events.
Accomplishment Criteria – are the *Exit Criteria* for the work effort. The AC describes what "done" looks like for the collection of Tasks. Each AC is the terminal activity for this collection of Tasks in the network of activities.
Tasks – are the first level work effort (Work Packages) needed to fulfill the Accomplishment Criteria. These Tasks are "self-contained" within the ACs and produce the deliverables that fulfill the "exit criteria." Their duration defines the duration of the AC. Care is needed to understand and deploy this approach to avoid having tasks that span more than one Program Event. If this is the case, the Tasks

Figure 1 – The IMP and the IMS are a hierarchy of Program descriptions, each connected through a single parent and multiple children. This "well formed" tree topology is critical to the measurement of *increasing maturity* of the program.

and the resulting ACs and SAs must be split into smaller collections of work that remain within the boundaries of the Project Event. This is a critical concept in the development of the Vertical IMS traceability.

All work in the IMS is vertically traceable to the Program Events – this is the definintion of a well formed plan

Supplemental Schedules – detailed execution schedules for each task within an Accomplishment Criteria (AC). The first level tasks within the AC are usually the top level activities of a Work Package. The supplemental schedules are *private* schedules usually held by the CAMs, describing the details of how these Work Package activities will be executed. The details of these supplemental schedules are many times the basis of the physical percent complete reporting system for the Work Package.

Increasing Levels of Detail Connects Physical Progress with Increasing Maturity

The IMP/IMS paradigm contains four levels of increasing detail. All levels are needed for success. No level cab be skipped or be missing. All milestones, deliverables, maturity assessment points must be traceable through all levels of the IMP/IMS.

- **Program Master Schedule (PMS)** – Presents the Contract Period of Performance (POP), Program Events (PE), Key Milestones, Major Program Deliverables, and Reports Progress at a Summary Level. The Program Master Schedule includes the First Level WBS and Significant, Measurable Events for Each Level–Two WBS Element.
- **Integrated Master Plan (IMP)** – Identifies Program Events (PE), Significant Accomplishments (SA), and Accomplishment Criteria (AC). The Program Master Schedule establishes the Structure, Parameters & Basis for the Integrated Master Schedule (IMS) Development.
- **Integrated Master schedule (IMS)** – The IMS is a logic network schedule of program planned activities keyed to the IMP's accomplishment criteria. The IMS is the basis of the performance measurement system; common element integrating cost, schedule, and performance. The IMS is constructed to provide integrated planning to the work package task level, provides horizontal and vertical traceability for this work and summarization of information and critical path identification and analysis.
- **Supplemental Schedules** – are created – as needed – to provide lower levels of detail within the AC schedules. The supplemental schedules are summarized in the IMS and are part of the program's Performance Measurement Baseline (PMB). The Supplemental Schedules support control account schedules and the management of day–to–day operations. These schedules are held by the CAMs and are not on baseline. However, these schedules are critical to the execution of the IMS, since they contain the details of how the program will be executed at the day–to–day level.

The Core Concept of Event Based Scheduling is Measuring Planned Maturity

The challenge in developing a credible plan and the supporting schedules is to ensure that all identified activties move the program forward in a measureable way. The "units of measure" of this movement must be meaningful to all the program's participants and be assessible through the performance management processes by the Program Planning and Controls (PP&C) staff. The first impulse is to use the Work Breakdown Structure (WBS) as the means of organizing the program plan and schedules. Event based planning and scheduling provides an alternative approach for several benefits:

- Measuring the increasing maturity of the products and services produced by the work effort must be directly connected to the value produced by the program for the customer. This is sometimes referred to a *Capabilities Based Planning*. The program plan states what *capabilities* will be available at what time, how these capabilities will be described and assessed and how these measures will be made visible in the plans and schedules.
- By isolating all work to Accomplishment Criteria "containers," the measurement of progress can be described by the *Exit Criteria* of this collection of work. This removes the default concept of measuring progress by the passage of time and consumption on money.

Product v. Functional goes to the core of defining "what does done look like?"

In the Functional approach to planning, "done" means the conclusion of the allotted time period of performance. This is not literally true, since deliverables result in the task effort performed by the functional units. In the Product approach to planning, "done" is defined upfront in the SA/AC descriptions. The accomplishments and the criteria state explicitly what must be "done" in order to complete an Event. This inversion of the definition of "done," from the passage of time and reaching a milestone, to the description of the deliverables creates a new vocabulary for planning. Approaching each planning activity from the view of "what does done look like?" is the starting point of IMP/IMS. Once the answers to this question are developed, the planning of task durations becomes straight forward – well as straight forward as possible – since the outcome has been defined.

- The "hard part" is IMP/IMS is changing our habits of defining the tasks first – instead we must define "what done looks like" first and only then define how to get to "done."
- Defining the events, the accomplishments that result from the event, the criteria for assessing the maturity of the accomplishment is the cycle of an IMP/IMS planner.
- Gathering the raw materials for IMP/IMS is straight forward if approached in an iterative / incremental manner.
- The difficulty is avoiding the natural tendency to arrange the raw materials in a time phased order by work effort.
- Continually asking the question, "What does done look like" reinforces the IMP/IMS approach. If you are not asking questions and getting answers for "what does done look like" on event boundaries then you are not doing IMP/IMS.

The Beneficial Outcome of Using IMP/IMS to Manage a Program

During the actual program execution, the IMP and IMS provide a framework for insight into the contractor's performance for both the program or project office and for the contractor's management team. The IMP and IMS when properly integrated with EVM through a sound technical management approach as documented enables the program or project office to:

The term Integrated Master Schedule (IMS) should not be confused with a "schedule." The IMS is derived from the Integrated Master Plan (IMP). Without this derivation – direct traceability of Tasks to the Accomplishment Criteria, the Significant Accomplishments, and the Program Event – the "schedule" is not integrated. It is simply a schedule. Possibly a useful schedule. But not an Integrated Master.
Schedule.

Without the discipline of vertical integration, the "schedule" turns into the all too familiar rat's nest of tasks. The structural integrity, visible flow of increasing maturity and credibility is described in a robust, resilient, and risk tolerant schedule is then lost.

- Identify and assess actual progress versus the planned progress – this is done through the Earned Value processes at the Task level. Each Task in an AC has some EV measurement. This should be predominately 0/100 measures for short to moderate duration tasks. Some firms limit task duration to 45 elapsed days for the current rolling wave. The culture of this approach may not be in every firm, but limited the duration to some reasonable time is critical to successfully managing performance. The assessment of actual performance must come from ***Physical Percent Complete***. This means defining up front how the Earned Value (BCWP) will be recognized for each task and the Work Package as a whole. The simple formula of Percent Complete X BCWS is fine as a percent compete. However, the "percent complete" cannot be an opinion. It needs to be an assessable measure of the actual physical progress of the Task.
- Monitor the program critical path and help develop workarounds to problem areas – the concept of a Critical Path is more than the path through the program with zero (0) or small Total Slack. It needs to be the "logical" critical path defined by the subject matter experts. This definition then needs to be reflected in the IMS.
- Assess program maturity – program maturity is best assessed through *Technical Performance Measures* (TPM). Systems engineering uses technical performance measurements to balance cost, schedule, and performance throughout the life cycle. Technical performance measurements compare actual versus planned technical development and design. They also report the degree to which system requirements are met in terms of performance, cost, schedule, and progress in implementing risk handling. Performance metrics are traceable to

user–defined capabilities. The IMS then connects actual versus planned progress (through the physical percent complete) with the technical actual versus planned progress.

- Assess the status of risk management activities based on the inclusion of the program risk mitigation activities in the IMP and IMS – this programmatic risk starts with the modeled variance in the duration of tasks. This variance can be defined by a Most Likely, Optimistic, and Pessimistic estimate. This has calibration issues, since each person supplying these estimates has a different opinion of what is meant by optimistic, pessimistic, and even most likely. An ordinal ranking method is more reliable but itself needs calibration
- Assess the progress on selected Key Performance Parameters (KPPs) and Technical Performance Measures (TPMs) – the units of measure for the Technical Performance Measure needs to be connected with the Key Performance Parameters of the Integrated Master Schedule. This connection answers the questions: *how are we doing against our plan*?
- Provide an objective, quantitative basis for the performance assessment – the IMP and IMS should be the basis of objective and quantitative performance programmatic measures of the aspects of the program. This means that the simple passage of time and consumption of resource is *not* a good measure of this performance. Only by predefining the "units of measure," starting with the technical performance measures, can the IMS be considered credible?
- Develop and support "what–if" scenarios, and to identify and assess candidate problem workarounds – alternative paths, cost models, and risk adjusted estimates to complete are the raw materials for the "what if" assessment of the IMS.
- Provide better insight into potential follow–on efforts that were not part of the original contract award. For example, the contractor should be able to more clearly define the activities, new interfaces, and other clarifying information necessary for a potential program increment or contract option.

Changing the Program Planning Paradigm from Horizontal to Vertical

Building an IMP / IMS requires a change in the normal paradigm of project management. This change means stopping the measurement of progress as the passage of time and consumption of funding to measuring progress by the completion of Accomplishment Criteria and the fulfillment of Significant Accomplishments.

It means moving from horizontal scheduling to vertical planning. These words are probably meaningless at this point. The role of this step–by– step guide is to provide an understanding of this concept, the benefits to the project management, and the processes needed to deliver these benefits. In many cases, the horizontal schedules are the starting point for the program. This occurs for several reasons:

- The program started without an IMP or a real IMS. They first built a horizontal schedule in the manner of "shop floor" schedule. This is usually for the Period of Performance of the Program.
- The program was inherited from a higher or lower level process. Either as a subcontractor or a part of on IPT team, the schedule is focused on the functional aspects of the program.

In many cases, the conversation from horizontal to vertical is required or desired. The effort to do this conversation involves several steps:

- Identify the Program Events and where in the schedule these events take place.
- Identify which work in the schedule "lands" on which event. If there is work that crosses an Event boundary, then it will need to be "broken" into two (2) parts. One that "lands" on the Event and one that restarts at the completion of the Event.

Work Breakdown Structure Paradigm versus the IMP/IMS Paradigm

- Work Breakdown Structure –The WBS provides a basic framework for identifying each element of a project in increasing levels of detail. In essence, it describes the way work is performed. The WBS also provides a coherent method for reporting progress toward plan goals. If the schedule is WBS focused, cost tracking is possible, work packages can be defined, and the outcomes of these work packages can be made visible. However, the increasing of the maturity of the program is not explicitly visible from the outside.
- Integrated Master Plan – The IMP is an event–based plan depicting the overall structure of the program and the key processes, activities, and milestones. It defines accomplishments and criteria for each event. With the IMP, the increasing maturity of the program is stated explicitly in the Significant Accomplishments (SA) and their

Accomplishment Criteria (AC). The WBS can be assigned to the Tasks in each AC so cost can be traced to specific work.

The IMP should be constructed from the logical decomposition of the Program Events, Significant Accomplishments, and their Accomplishment Criteria – not from the Work Breakdown Structure. This approach causes problems with the traditionalist, because they see the world through the WBS. The WBS and the CWBS are cost accounting structures, not program maturity assessment structures. The WBS and CWBS are important program performance measurement processes – they capture costs and assign these costs to the produced products and services. However, the WBS and CWBS does not provide any measurement of progress in terms of increasing maturity. That is the role of the IMP and the supporting IMS.

Constructing the IMP and IMS with the WBS in mind may be required by contract, since separation of the work may be driven by the cost accounting processes. Resisting the lure of WBS and CWBS structuring is difficult. Ask the question – how does this structure reveal the increasing maturity of the program? What are the units of measure of this maturity in terms meaningful to the customer? How can the structure show the flow of maturity using a single notation?

1.1 IMP/IMS Features and Benefits

> If you wish to persuade me, you must think my thoughts, feel my feelings, and speak my words. — Cicero, Roman Statesman (106 BC)

The IMP and IMS focus on specific areas of the program, which have been shown to be problems with more traditional approaches. The primary focus is on program maturity Event based planning provides a “singularly” focused process allowing each IPT to answer the question – “what do I need to do for a specific event?” For example PDR: List all the accomplishments needed for PDR? What activities need to performed for each of these accomplishments? When all the activities are completed, the criteria satisfied, and the accomplishments completed then a measurement of “maturity” can take place?

Features of IMP/IMS	Benefits to the Program
Provides an understanding and alignment of required tasks with events starting with the proposal	Drives down cost of execution by connecting changes with the impact of changes that occur early in the program life cycle when costs are lower are made visible from day one.
Integrates relationships of products and development processes	Improves management visibility by connecting activities with events Permits better understanding of risk and how it impacts cost, schedule, performance
A disciplined approach to planning and implementation activities	Provides a framework for using integrated tools, teams, and processes with vertical traceability Serves as foundation for systematic programmatic improvement efforts
Iterative planning, tracking, and reporting process	Allows program flexibility – on ramps and off ramps tied to events Highlights details early – ties maturity events with activities
Event–Driven Planning	Relates program events in terms of success – Accomplishments and Criteria Reduces risk by ensuring that maturity of the plan is incrementally demonstrated prior to starting follow–on activities
Increases visibility of entire program to the program team	Improves measurable maturity and impact analysis Promotes program buy–in and team commitment through shared events Fosters proactive management at all levels through measurable outcomes
Resource and Earned Value Loadable	Provides foundation for Earned Value Reporting and EVMS
Key customer events included	Encourages a win–win attitude with customers
Clear communication of how the team views the program	Improves effectiveness through a common set of tools, measurements and defined outcomes

Table 1 – The use of IMP/IMS provides direct benefits to the program not found in traditional approaches. Each of these benefits needed to be tested in practice by defining the Program Management Plan (PMP) processes that produce the behaviors needed to deliver the benefits. Simply stating the benefits are present is not sufficient. And actual plan to deliver the benefits is needed.

1.2 IMP/IMS is a Systems Engineering Process not a Scheduling Process

Building the Integrated Master Plan (IMP) and Integrated Master Schedule (IMS) is a Systems Engineering process. This means that systems engineering processes are used to construct the IMP and the supporting IMS. The processes of Systems Engineering

While this may seem a bit out of place in a planning and scheduling discussion, the concept of *Programmatic Architecture* fits well with the concept of *Systems Architecture*. It is the Systems approach that is the basis on building the Integrated Master Plan (IMP). This approach defines and answers questions like:

> *Systems engineering is the intellectual, academic, and professional discipline whose principle concern is the responsibility of practicing Systems Engineers in a system design and acquisition project to ensure that all requirements for the system are satisfied through the life cycle(s) of the system.*
>
> — Wayne Wymore, Professor Emeritus of Systems and Industrial Engineering, University of Arizona

- How does the program define Technical Performance Measures? How will these TPMs be connected to the IMS?
- What are the units of measure of *maturity*?
- What is the unit of measure of credibility, as in: "Do we have a credible schedule?" In addition, if we claim we do: "How can it be proven to others?"

Systems Thinking is the Basis of a Success IMP/IMS Development and Deployment

The principles of Systems Engineering are founded on concepts important to the development of the IMP and IMS:

- System exists throughout the natural and man–made world, wherever we have complex behavior "emerging" from the interaction between things.
- We can only fully understand such behavior by considering "complete systems" as they interact within their "natural" environment.

To solve complex "System Problems" we must engineer complete "System Solutions," through a combination of:

- The ability to understand, describe, predict, specify, and measure the ways in which elements of a complex system affect whole system behavior.
- The ability to apply "Traditional" engineering knowledge to create, modify or use system elements to manipulate or maintain whole system behavior.
- The ability to organize, manage and resource projects in such a way as to achieve the above aims, within realistic constraints of cost, time, and risk.

What is a System – from the View of Systems Engineering?

A system is – *A set of Interacting Elements that form an Integrated Whole with a Common Goal or Purpose*.

Some more important concepts in Systems Engineering applicable to IMP/IMS:

- **Holism** – considers the Whole–System, in its environment, through its Whole–Life. The IMP shows the entire period of performance for the Program. Each Program Event then has SAs and ACs for this performance period as well. With the IMP in place, the whole is integrated from the parts. The IMS can then show the dependencies and work activities to cause the ACs and SAs to appear.
- **System of Interest** – collection of elements with a common identity, e.g. product, organization. The IMP is focused on the increasing maturity of the delivered products. Using the WBS to collect costs for product activities
- **Viable system** – must include everything needed to maintain its existence and achieve its goals.

The consequences of this Holistic approach exposed the notion that the viability of the product relies on interactions outside of its immediate (product) boundary. Those systems are engineered with the context of one or more "containing systems."

As well, the concept of "emergence" becomes important. The system as a whole exhibits a property which is meaningful only when attributed to the "whole" and not to its parts. The emergent properties vary with environment and relationships with other systems.

The consequences of emergence are that there is no guarantee from optimizing the parts of the system, or even from the components independently. Changing the elements or their interactions within the system may affect its properties, which can cause emergent property to change on a number of levels. [1]

A General Systems Lifecycle is represented in the Flow of the IMP and its IMS

Understanding how IMP/IMS provides value to the management of projects starts with a general lifecycle model for programmatic aspects of the project. The assumption is that programmatic architecture is equivalent to the technical architecture in terms of interfaces, coupling and cohesion, and value stream flow.

- **State the problem** – by identifying the customer, the customer's needs, establishing the need for change, discovering requirements, and defining the system functions.
- **Investigate alternatives** – based on cost, schedule, and risk as measures of effectiveness
- **Model the system** – should be developed for alternative product designs. The modeling processes allow alternative assessment of schedule changes, sensitivity of change on cost and schedule that show the effect of delays or accelerations of the product development.
- **Integrate** – the systems, business, and people so they interact smoothly.
- **Launch the system** – by running the system (processes) to produce the products
- **Assess performance** – using figure of merit, technical performance measures, and metrics.
- **Reevaluate** – by observing outputs and using this information to modify the system, its inputs, products or processes

The US Department of Defense has a top-level project lifecycle, shown **Figure 2**. This "picture" is the highest level of sequence for a program. When the discussion turns to "where are we in the Big Picture?" the answer can be, "we're in SDD headed to Milestone C." For the actual development of an IMP/IMS, this level of understanding is not very interesting. However, for a proposal team, it is important to understand what procurement guidance is applicable for what phase of the program. For SDD programs there are difference guides for the outcomes than for a post–Milestone–C program.

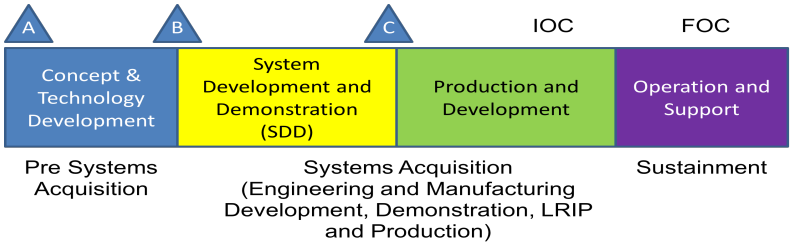


Figure 2 – The DOD 5000.02 process model needs to be understood in order to define the types of maturity assessment processes for Accomplishment Criteria. "Done" has a different definition in a Concept and technology Development program than it does for a Product and Deployment Program and even more different for an Operational Support program.

[1] There is a counter example to this in Wayne Wymore's "Subsystem Optimization Implies Systems Suboptimization: Not!" referenced in "The Synthesis of Optimal System Design Solutions," *Systems Engineering*, Volume 6, Issue 2, pp. 92–105, 10 March 2003.

Putting These Concepts to Work in IMP/IMS

The Integrated Master Plan (IMP) describes the strategy for completing the program as planned – on budget, on schedule, and compliant with Measures of Effective, Measures of Performance, Technical Performance Measures, and Key Performance Parameters.

This is the role of a PLAN.

As such it represents the "Architecture" of the Program. The Programmatic Flow of increasing maturity of the individual components of the program. These individual components – the Program Events – interact with each other as a "System" of activities. The IMP process provides a disciplined approach to develop, implement, update, maintain, and manage a Program through a single, comprehensive plan. The IMP is used to accomplish upfront planning and commitment, provide a basis for subsequent detailed planning and scheduling, measure program progress, and provide management with verification of progress enabling informed decisions.

The boundaries between these components are the Program Events and the horizontal dependencies between these events.

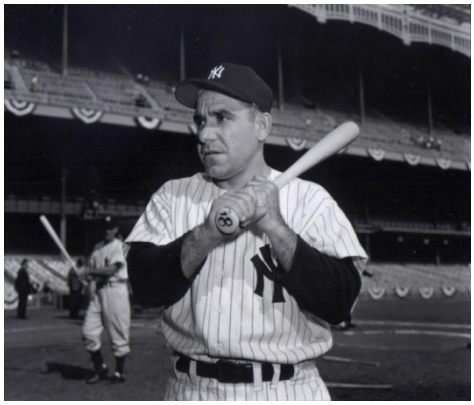
1.3 Step by Step for Building the Integrated Master Plan (IMP)

There are several starting points for building the Integrated Master Plan. The first is to put the IMP in the context of a proposal and the execution of that proposal after award. The second shows the step by step activities needed to build the IMP in response to a proposal.

- Building the IMP is more than a process; it is a way of thinking.
- The IMP represents the programmatic architecture and the implementation strategy for delivering the products and services represented by that architecture.
- The IMP is the logical flow of the product's increasing maturity, measured in units meaningful to the customer

First let us look at the context of an overall program and how the IMP fits. **Figure 3** describes an "overview" of the IMP/IMS from beginning of the proposal process to the execution of the program. While this overview appears simple and straight forward there are many subtle aspects not shown here. **Figure 3** is really a "data flow" of information between the stages of the IMP/IMS development process. Much more understanding is needed before the value produced by IMP/IMS can be produced.

The steps shown in **Figure 3** are notional in one aspect, but are actual processes in practice. More than just a simple statement about building requirements or constructing the CWBS Dictionary is needed for a successful IMP/IMS. In fact many of the failures of IMP/IMS come from assuming the simple or notional examples can be put into practice.



This is a good time to be reminded of Yogi Berra's quote:

In theory there is no difference between Theory and Practice.
In Practice there is.

So the only way forward is to build and rebuild the IMP and IMS, testing them against the requirements and other assessments of "Credibility."

The IMP states what "done" looks like in Measures of Effectiveness (MoE) of the delivered products or services. At each Program Event, the Significant Accomplishments (SA) defines what maturity levels must be achieved before the Program Event can be considered met.

For each Significant Accomplishment, work must be performance to meet the Accomplishment Criteria (AC). These are defined by the Measures of Performance (MoP). This "exit criteria" for the Packages of Work in the Integrated Master Schedule (IMS) are "entry" criteria for the SAs.

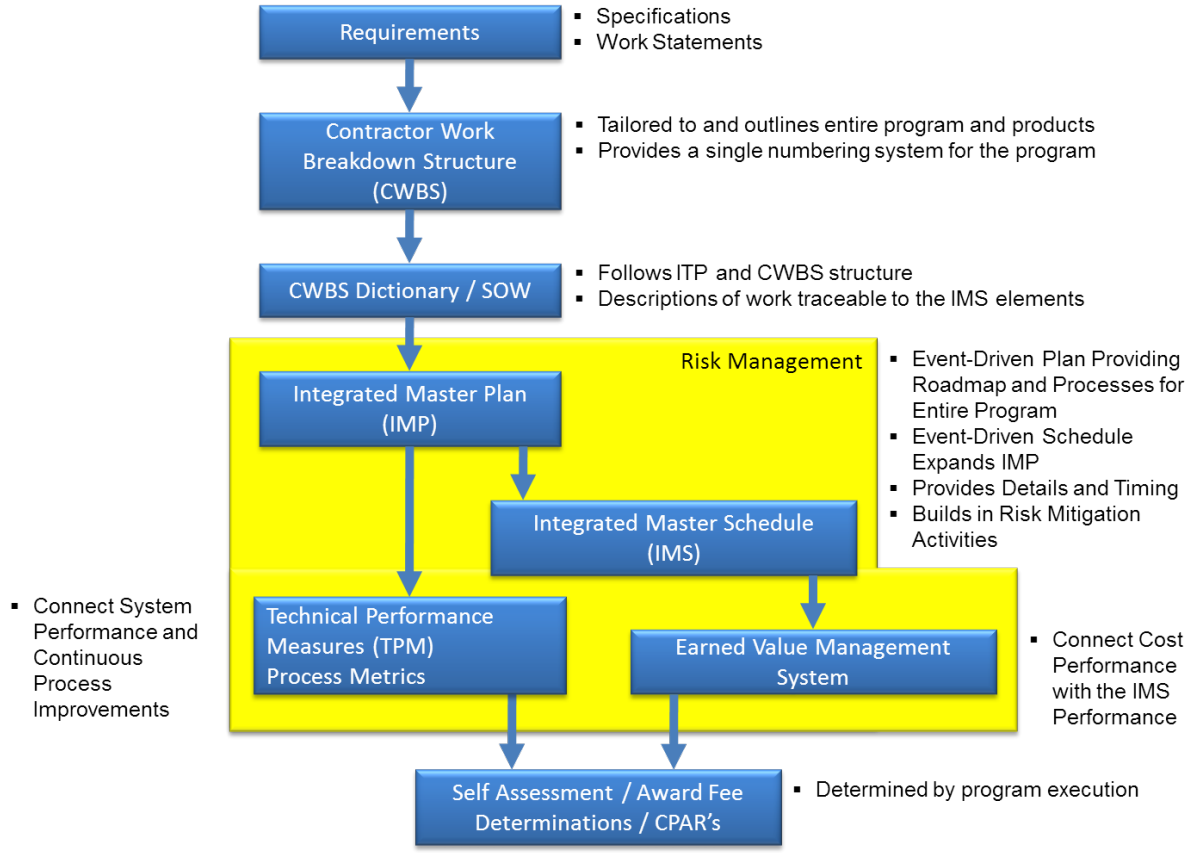


Figure 3 – The Integrated Master Plan (IMP) and Integrated Master Schedule (IMS) are part of an overall Programmatic Architecture that starts with the RFP and ends with the execution of the program. The IMP and the supporting IMS are the framework for the execution of the program as well the framework for the programmatic win themes of the proposal.

IMP IMS	Development Steps
Understand the Product	▪ Identify Customer, the business processes, political aspects of the customer and any other attributes. ▪ Compile customer requirements from SOO, SOW, CDRLs and other applicable documents. These documents define the master schedule and the deliverables around this schedule. ▪ Document the ground rules and assumptions that describes how the Program Events, Significant Accomplishments and their Accomplishment Criteria. ▪ Clarify the product requirements by cross references all the customer document through the Concept of Operations (ConOps).
Develop Product Structure	▪ Create Top Level CWBS that describes the product structure first, then the IPTs that will deliver those products. ▪ Assess structure for completeness and workability by asking "how will the components of the product structure come together during the execution of the program?" ▪ Is the assembling in a tree structure from the bottom to the top? Or is it scattered all over the WBS/CWBS. If it is the latter, the WBS will be nothing but trouble during execution. ▪ Write the CWBS dictionary. This is a narrative stating what is being delivered for each element of the CWBS. It is from these descriptions that lower level work efforts will be defined. ▪ Define Teams – in terms of IPTs – who will deliver the products ▪ Develop the top level SOW task statement to assure the cross reference between the CWBS and SOW
Form Integrated Product Teams	▪ Form teams and define leaders and key resources. These teams are accountable for deliverables described in the WBS/CWBS. ▪ Validate and extend the SOW, CWBS and CWBS dictionary across the IPTs for each product or process.
Create Integrated Master Plan	▪ Select Key events and decision points using government provided Events and program maturity assessment points that assure maturity is increasing and risk and being reduced. ▪ Write the event descriptions describing the measurable outcomes of each event in terms of maturity assessment and risk reduction. ▪ Development the Significant Accomplishments (SA) and Accomplishment Criteria (SA) for each Program Event in a top down manner, with the focus on describing the increasing maturity of the products resulting from the work held in the ACs. ▪ Develop the vertical logic between the PE/SA/AC describing the logical flow of increasing maturity, the physical assessment of the product's performance against the Technical Performance Criteria, and the dependencies between each Accomplishment Criteria. ▪ Write the IMP process narratives in the form of a product specification. ▪ Prepare a logic flow diagram for the SAs, showing increasing maturity of the products
Create Integrated Master Schedule	▪ Define high level Work Packages from the ACs. One WP / AC if possible ▪ Decompose tasks within the WP on a single work sheet ▪ Define the logic and dependencies between the ACs first. Only then connect task dependencies ▪ Apply the schedule constraints ▪ Establish work package and supporting task durations ▪ Add resources at the work package level ▪ Asses the critical paths ▪ Perform schedule risk assessment
Generate Basis of Estimate	▪ Receive flow down of requirements and the cost estimating processes around them ▪ Determine appropriate methods of defining costs ▪ Estimate the hours ▪ Review and adjust the costs to match the allocations

Table 2 – Each step in the development of the IMP builds an increasing fidelity of the final product.

Understand the Product

Defining the program framework starts with understanding the product, the customer and the processes that will be used to deliver the product. By first identifying all the discrete work scope and categorizing them into – who, what, when, where, why and how categories, the pro duct structure can emerge.

Develop Product Structure

The product structure starts with the Work Breakdown Structure (WBS).

A Program WBS "… shall be established that provides a framework for program and technical planning, cost estimating, resource allocations, performance measurements, and status reporting." DODD 5000.2R

The WBS establishes the primary portioning of the product and work needed to produce the product. The WBS outlines the products and services to be provided by the program in a "structured" manner where each product and or service is traceable to its parent product and or service. The result is a "Product Tree" that decomposes the program structure to a level where risks are made visible. This is usually Level 3 in the WBS.

The WBS defines the logical structure of the program. Summary points for assessing technical and programmatic risk and the physical progress of the work activities. It is critical to not let the WBS be a representation of the organizational structure of the program. If this is done the ability to measure physical progress through the production of products or services is lost.

Form Integrated Product Teams (IPTs) and Align Their Work Efforts

"We trained hard, but it seemed that every time we were beginning to form up into teams, we would be reorganized. I was to learn later in life that we tend to meet any new situation by reorganizing; and a wonderful method it can be for creating the illusion of progress while producing confusion, inefficiency and demoralization." – Petronius Arbiter (210 B.C.)

Align the Work Between the IPTs

- Our team structure needs to reflect the most cost-efficient way of organizing the work
- Our team structure needs to be sized according to the work required
- Our teams must not be too big or too small to be functional
- Our team structure needs to account for vertical (product) and horizontal (process, system) integration
- Our team structure must not unnecessarily complicate integration or production
- Our team structure must have clear scope borders — know where one team's scope ends and another team's scope begins

Integrate across the products to deliver the system-level configurations and data to the customer:

- Integrate, analyze, assemble, and test configurations made up of modules developed and delivered by IPTs
- Integrate program / system level data and CDRL items
- Electronic Information System (EIS) or Integrated Data Environment (IDE) [both terms used in RFPs]

Own and audit the common program infrastructure resources employed by multiple teams:

- Processes
- Tools
- Databases
- Facilities
- Equipment

Create Integrated Master Plan (IMP)

Events are:

- Project unique, key transition points between major program activities
- Points of convergence across the entire program
- Key decision points where it is necessary to assess progress in achieving objectives before proceeding
- May include major DoD milestone reviews, program design reviews, tests, deliveries, and other key progress demonstration or risk mitigation points
- Should be well distributed over the program/project period, and not inordinately clustered
  - Not desirable to have too long a period pass without checking critical program progress
  - Avoid this by including an event such as a "Production In-Process Review" to gain timely program progress visibility

Event definitions include the purpose and expected results. Events may be tied in the contract to award or incentive fee payments so they may affect the client's cash flow too.

Create Integrated Master Schedule (IMS)

The Integrated Master Schedule is derived directly from the IMP. It is not – nor should ever be – built bottom up during the first round of IMS construction. In the IMP/IMS paradigm, all the work needed to move the program forward in its maturity is defined by the Significant Accomplishments and their Accomplishment Criteria. Once these are defined in the IMP, the physical work needed to produce the Accomplishment Criteria is obvious.

It is at this point the IMS construction can start. The IMS is built with some simple steps:

- Identify each Accomplishment Criteria (AC) by name from the IMP
- Build a single page data capture sheet that provides a limited number of "lines" for entering the tasks for the AC. This sheet will contain the following information
  - The name of the task
  - The duration of the task
  - The ordinal risk ranking of the task
  - The predecessors and successors "within" the AC
  - The predecessor that starts the AC – this is the external AC that starts the current AC.

Generate the Basis of Estimate (BOE)

From the constructed IMS the next step is to determine the cost for this work. This can be derived in several ways:

- Resource load the IMS in some simple way
- Export the periods of performance for each work package into the Basis of Estimate tool and develop the cost profiles

1.4 Creating a Fully Integrated IMP/IMS

Connecting the RFP's SOW to the CWBS to the IMP and the IMS and to the BOE's is the ideal example of a fully integrated system describing the programmatic architecture of any project. The example of a fully integrated IMP and IMS shown in Figure 4 is an *ideal* example and not usually found in practice. However, at a minimum the understanding of how each component of the integrated system relates to others.

- The term "integrated" in the IMP and IMS paradigm means vertical and horizontal integration of the work activities.
- Vertical connectivity shows how the planned maturity for each Program Event (PE) is achieved.
- Horizontal connectivity shows how the work effort produces this maturity for the Program Event (PE) and across Program Events.

By first connecting the Significant Accomplishments vertically, the maturity assessment of the product or services can be defined for each Program Event. Once vertically connected, horizontal connections describe the work sequencing processes needed to produce this increasing maturity.

Figure 4 describes the relationships between the program elements.

- Statement of Work (SOW)
- Contractor Work Breakdown Structure (CWBS)
- Integrated Master Plan (IMP)
- Integrated Master Schedule (IMS)
- Basis of Estimate (BOE)

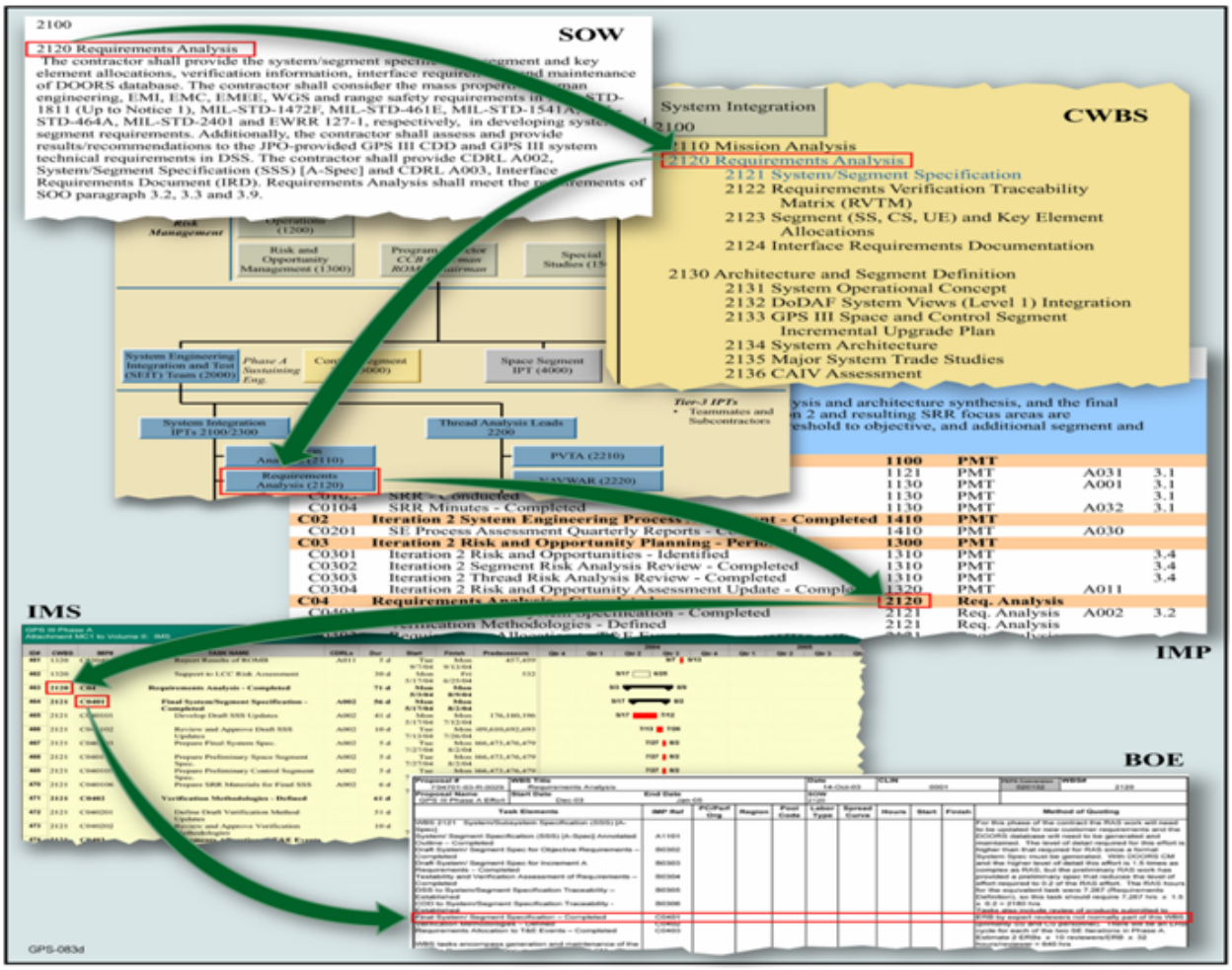


Figure 4 – Connecting the Statement of Work to the Contract Work Breakdown Structure, to the Integrated Master Plan, to the Integrated Master Schedule and finally to the Basis of Estimate. The traceability between these artifacts should be the IMP/IMS number. However, in many cases, this is not possible. The WBS is the next best trace number, if the WBS is well formed. In the absence of a well formed WBS, the IMP/IMS number is the best hope of connecting the programmatic aspects with the technical maturity aspects of a program.

1.5 Some Definitions Needed for IMP/IMS

The terms used in the IMP/IMS domain may be new to the traditional planner. These terms are specific and well defined. Resist redefining them for your local use. In many domains, the definition of these terms is provided by the customer in the RFP or some guidance document.

Here are some examples of definitions used in the Integrated Master Plan (IMP):

- Program Event (Event):
  - "Events should be envisioned as program reference points or milestones at which the Contractor and Government jointly assess program status."

  - "An event is a program assessment point that occurs at the culmination of significant program activities: accomplishments and criteria."
  - “An IMP event is a key program milestone defined by the customer or the provider, which defines progress at a specific point in time. IMP events mark the conclusion/initiation of intervals of major project activity and serve as decision–oriented measures of project activity related to the project’s maturity assigned to a specific subsystem or organizational element.”
  - “An Event is a program assessment point which occurs at the culmination of significant program activities (Accomplishments and Criteria).”
- Significant Accomplishment (Accomplishment)
  - "For each event, the Offeror shall state what progress is to be measured at the event. This breakdown of principal tasks and activities become the Offeror's accomplishments."
  - "An accomplishment is the desired result(s) prior to or at completion of an event that indicates a level of the program's progress."
  - “Significant accomplishments are critical efforts that must be completed prior to completing an event. The accomplishments shall be sequenced in a manner that ensures a logical path is maintained throughout the effort and tracks against key events.”
- Accomplishment Criteria (Criteria)
  - "For each accomplishment, the Offeror shall state how progress is to be measured. Criteria should be stated using objective methods to verify that the accomplishment has been achieved. The Offeror should be able to document that the criteria have been satisfied. In total the criteria shall demonstrate that the accomplishment has been achieved."

Criteria provide definitive evidence that a specific accomplishment has been completed.

  - “Accomplishment Criteria are measurable and useful indicators demonstrating the required level of maturity and or progress has been achieved. Accomplishment Criteria include the use of Technical Performance Measures and other metrics wherever possible to provide measurable criteria. Preferably the accomplishment criteria should avoid the use of percent completed and avoid citing data item report numbers rather than identifying and summarizing results.”

Program Event (PE) Maturity Assessment

The Program Event is a Maturity Assessment point in the Program. It asks and answers questions: Do we understand the technical aspects of the program to a sufficient level at this point in time to proceed for?

- Preliminary Design – define the attributes of “preliminary” as appropriate for the program.
- Critical Design – critical design usually means the products or services are ready for first production runs. Define the units of measure of this “readiness”
- Integrated Baseline – are the cost, schedule, and technical baseline aligned and ready for execution?
- Flight Readiness – are the products ready to “go flying”

There are many "check lists" for these Program Events. One place to look for these are the NAVAIR and Defense Acquisition University y library site. The post–CDR events need similar check list.

Significant Accomplishment (SA) Maturity Assessment

For each Program Event (PE) a statement about the progress will be measures is contained in the Significant Accomplishments. Significant Accomplishments define the Entry Criteria for the Program Events:

- What is the maturity of the work products needed to successfully conduct the PE?

Specific knowledge about design, testing, performance, or other behaviors of the system

- What program activities must have been conducted to successfully conduct the PE?

Specific process steps that must be performed prior to the Program Event.

Review, document production, meetings, "states" of relationships, organizational processes

There are both **Product** and **Process** maturity assessments that must take place as "entry" criteria.

Accomplishment Criteria (AC) Maturity Assessment

For each Significant Accomplishment progress needs to be described in terms of tasks completed and the measurement of those tasks. The Accomplishment Criteria (AC) documents the Exit Criteria for the collection of tasks that move a product or service to the next level of maturity.

- What is the maturity of the products produced from the work tasks for each AC?
- How is this maturity assessed within the metrics of the Technical Performance Measures (TPM)?

Tasks are the Raw Material for the IMS

This is where the heavy lifting takes place. The work performed to deliver the "exit criteria" – the Accomplishment Criteria (AC) which forms the "entry criteria" (the Significant Accomplishments) for the Program Event are the work activities defined in the Integrated Master Schedule (IMS)

The tasks that compose the Integrated Master Schedule (IMS) are defined through various examples:

- "The Offeror shall provide an Integrated Master Schedule (IMS) in Annex X that delineates the Offeror's planned schedule for all activities, events, milestones, and critical paths associated with all program efforts in accordance with DID DI–MGMT 81650. The IMS shall include the program schedule with technical tasks and activities necessary to complete the work effort scoped within the IMP. The program's critical path(s), based on critical path analyses, shall be identified in the IMS. The Offeror shall develop the IMS in accordance with MIL–HDBK 881A (as a guide). The Offeror shall provide in the submitted IMS all contractors tasks, events, milestones which should be traceable to the contract WBS and contractor's cost management systems. The IMS shall be developed by logically networking (predecessor and successor logic) all discrete Contractor and principle subcontractor, critical subcontractor, and team member activities from contract award through program completion."
- "The IMS is an integrated, master schedule containing the networked, detailed tasks necessary to support the events, accomplishments, and criteria of the IMP, if applicable. The IMS should be a logical network–based schedule, based on sound technical planning, that is directly traceable to the contractor's cost and schedule reporting instrument used to address variances."

1.6 Increasing Maturity is the Only Measure of Progress

Measure the increasing maturity of the program work products and process as the indicator of progress.

This is done by first identifying the Program Event where maturity assessment will take place. Using the DoD 5000.2 guidelines, this usually means

- Contract Award (CA) or Authorization to Proceed (ATP)
- System Requirements Review (SRR)
- Integrated Baseline Review (IBR)
- System Functional Review (SFR)
- Preliminary Design Review (PDR)
- Critical Design Review (CDR)
- Test Readiness Review (TRR)
- Flight or some kind of Operational Test (FT)

- Defining the expected maturity of the products or services at each assessment point in the project is the basis of a credible performance measurement paradigm.
- Measuring the increase in maturity using Technical Performance Measures (TPM) or tangible deliverables defines the units of measure of success.
- Using past tense verbs to describe progress has a powerful effect on the commitments to the outcome.

When speaking to the increasing maturity of the program, we need to use the right semantics. The wording in the next picture is an approach for this wording. For each Program Event, Significant Accomplishment, and Accomplishment Criteria a past tense verb is needed. This approach is unsettling at first. But once put into practice it changes how work is discussed and progress is measured.

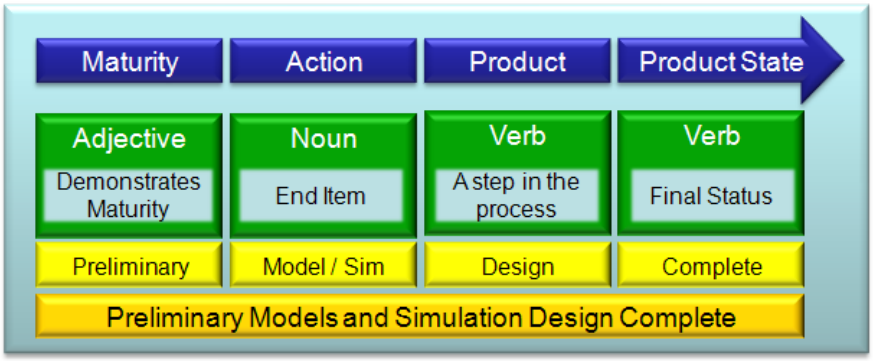


Figure 5 – The content of the IMP elements (Event, Accomplishment, Criteria) makes use of a sentence ending in a past tense verb. There are a limited number of these verbs of most IMPs. They defined the state of the product or service that results from the activities that compose the Accomplishment Criteria – the tasks of the IMS. Learning to speak in the past tense of the basis of the IMP. Describing what "done" looks like requires a past tense verb be connected with "done."

Data Dictionary of IMP/IMS Verbs

The best way out of these semantics discussions is to have a pre–defined data dictionary for the verbs in the IMP and IMS. Many RFP provides this dictionary and there are sources of verbs in other places.

Verb	Definition
Approved	The subject item, data, or document has been submitted to the Government and the Government has notified the contractor that it is acceptable. For some data items, it is specified that no response constitutes approval.
Available	The subject item is in place or the subject process is operational. The subject data or document is added to the Data Accession List and is accessible through Program/Project Assets or other media.
Acquired	Procured and/or fabricated and available
Completed	The subject item, data, document, or process is prepared or concluded and reviewed and accepted by the IPT or responsible team.
Analyzed	The subject parameter(s) has been technically evaluated through equations, charts, simulations, prototype testing, reduced data, etc.
Conducted	The subject meeting or review has been held with all required program participants. The presentation charts or minutes are available through Program/Project baseline along with assigned action items.
Defined	The subject item, data, document, or process is described in an appropriate description document that is available through Program/Project Assets or other media.
Deficiencies Corrected	New designs and/or procedures to correct documented deficiencies to requirements have been identified and incorporated into
Delivered	The appropriate user accepted the subject configuration item, data, or document.
Documented	Properly recorded items or activities requiring formal paperwork; completed reports and review by appropriate technical or management personnel. (If soft copy is available, it is made accessible on Program/Project Assets.
Demonstrated	The subject configuration item, data, or document demonstrates requirements compliance through verification or validation.
Drafted	An initial version (usually of a document) has been created which will require updating to finalize.
Ended	Complete; over
Established	The subject item is created and set in place in a manner consistent with its intended use, after review and acceptance by the IPT. The subject item has been set and documented.
Finalized	The subject data or document received contractor approvals, was distributed, and is available through Program/Project Assets or other media. Last set of planned revisions has been made or final approval has been obtained.
Implemented	The procedure or process is executed regularly, in accordance with established practice.
Initiated	The subject policy, approach, or procedure has started.
Installed	The subject item, system, or system provisions have been attached to their structural interfaces and to each other per their designs.
Integrated	The subject item or system has been consolidated into an entity (e.g., data requirements, document, and

Verb	Definition
	configuration item) by appropriately combining separate requirements, functional disciplines, and configuration item considerations.
Generated	Required information has been placed into written form.
Identified	Made known and documented
Implemented	Put in place and/or begun
Loaded	The subject software item has been entered into the appropriate processor or processors' memory space to allow program execution.
Mated	The subject structural item or modules and installed systems provisions have been attached at their interfaces per their designs.
Operational	The product or elements have been "delivered, tested, and certified ready for operation by the customer.
Ready	The subject configuration item was delivered to and accepted by the requiring IPT.
Reduced	The risk of the subject item is lowered according to the criteria established in the Risk Management Plan and approved by Risk Management Board (ROMB).
Refined	Next level of detail has been added or updates made.
Released	The subject item, data, or documents are complete, have contractor management approval, and are under revision control.
Retired	The risk of the subject item has been lowered sufficiently for the RMB to be removed from the program's risk list.
Submitted	Formally submitted to the Government
Tested	The subject item, element, or process has been exercised under appropriate conditions in accordance with test plans, procedures, and measurements with an analysis of the data generated.
Updated	The subject item, process, data or document has been re–evaluated using later information, and adjustments have been incorporated.
Validated	The subject item, process, data, or document has been confirmed by objective evidence (e.g., tested using existing, accepted/approved procedures, instructions, or checklists) to have been accurately derived or determined, or has met all requirements for its intended use and performs its intended function(s). The Contractor/Customer team usually performs this certification.
Verified	The subject item has been evaluated against its specified requirements and characteristics and proven to meet documented requirements using analyses, demonstrations, inspections, or tests.

Table 3 – Sample definitions of IMP verbs. Sometime the RFP provides a list of these verbs. Sometimes the verbs come from the standard procedures of the firm. In all cases, a dictionary of verbs is needed and should be limited to those verbs that describe actual outcomes meaningful to the customer and the provider.

One example of why the dictionary shown in **Table 3** is useful is in the simple use of the word *completed*. Many use the word *Completed* when they should use *Complete*. *Complete* is the state of the effort. Subtleties like this may seem wasteful but are critically important for the integrity of the IMP and IMS.

Action verbs used in the Integrated Master Schedule (IMS) Tasks

Another source of verbs for the IMP elements comes from the INCOSE Systems Engineering Glossary

Verb	Definition
Allocate	Apportion for a specific purpose or to a particular thing
Analyze	Solve by analysis
Annotate	Provide with comments
Apply	Put to use
Ascertain	Find out with certainty
Assess	Appraise critically.
Attend	Be present at
Audit	Officially examine
Build	Make by putting together
Calculate	Find out by computation
Certify	Endorse officially to attest conformance to set standards

Verb	Definition
Chair	Preside as chairman of
Co-chair	Chair jointly
Collect	Bring together into one body or place by careful selection
Compare	Find out likeness or differences
Conduct	Guide, lead, direct
Consider	Think about, decide
Construct	Put together, build
Contribute	Share in a joint effort (suggests furthering an end)
Control	Direct, regulate
Coordinate	Bring into a common action. movement or condition smoothly
Create	Cause to be, make
Define	Make clear, settle the limits; determine precise meaning of
Demonstrate	Prove or make clear by reasoning or evidence, illustrate, explain
Design	Perform an original act
Determine	Resolve, settle, decide
Develop	Bring into being or activity
Differentiate	Make a distinction between
Down select	Select a smaller number or group than originally existing
Egress	To depart from a mission, target, or threat area
Erect	Put together, set upright
Establish	Make firm, prove beyond dispute, gain acceptance of
Estimate	Approximate an opinion of
Evaluate	Find or fix the value of; examine and judge (non monetary)
Evolve	Develop gradually, work out
Examine	Scrutinize to determine the nature, condition or quality of
Explore	Examine for discovery
Extract	Take out, deduce, select
Fabricate	Build, manufacture, invent
Form	Give shape to, establish
Formulate	Put together and express
Generate	Produce, cause to be
Incorporate	Unite thoroughly with something existing, blend
Ingress	To enter into a mission, target, or threat area
Initiate	Begin, take the first step of something that is to continue
Input	Feed information into a computer
Inquire	Ask, make a search of
Inspect	Examine carefully or officially; scrutinize for error or defect
Install	Place, put into position
Institute	Set up; establish, begin
Integrate	Add parts to make whole
Interpret	Explain the meaning of
Investigate	Search into, examine closely
Judge	Decide, form an estimate of
Maintain	Keep in an existing state, preserve from failure or decline
Make	Cause to come into being
Manage	Succeed in accomplishing, direct, achieve one's purpose

Verb	Definition
Manufacture	Fabricate from raw materials
Notice	Comment upon, review
Observe	Inspect, watch
Organize	Integrate, arrange in a coherent unit
Originate	Initiate, give rise to
Participate	Take part in an undertaking, activity or discussion
Perform	Do, carry out, accomplish
Plan	Devise a scheme for doing or arranging activities to achieve an objective
Prepare	Make ready, put into written form
Prioritize	Assign priority
Probe	Investigate thoroughly
Process	Subject to a special process or treatment
Produce	Give birth or rise to
Provide	Supply what is needed for sustenance or support
Pursue	Seek, obtain, or accomplish
Reason	Think, influence another's actions
Recommend	Advise, attract favor of
Record	Set down in writing, or act of recording electronic reproduction
Resolve	Reduce by analysis, clear up
Review	Inspection, examination or evaluation
Scan	Look through hastily, survey from point to point
Scrutinize	Examine closely with attention to minute detail
Search	Examine to find something
Seek	Try to discover, make an attempt
Select	Take by preference from a number or group, make a choice
Solve	Find an answer
Study	Carefully examine or analyze
Support	Assist, help
Trace	Copy, or find by searching
Track	Observe or plot the path of
Update	Bring up to date
Validate	Verify, substantiate, and grant official sanction to.

Table 4 – Action verbs to be used as the first word for each Task in the IMS. These verbs complement the verbs used at the end of the description of the IMP elements.

1.7 Logical Flow of Tasks within the Integrated Master Schedule (IMS)

The linking of tasks starts with vertical linking of the AC collection of tasks.

- Assign all tasks to As Late As Possible (ALAP) when building the Vertical Linking and the initial Horizontal linking. This allows a visible indication if the work fits "in the box" for each Program Event.
- Link all tasks to their respective ACs and the ACs to their respective SAs and the SAs to the Program Event

1.8 Decomposing the System

There are several approaches to decomposing the system:

- Pure top down flow from a single system into sub–systems and sub– sub– systems.
- Interfaces definitions between disparate systems managed through Interface Control Documents (ICD) in some way.
- Functional decomposition through different engineering disciplines
- Never should the decomposition be in a horizontal manner. Only a vertical approach should be used to develop the IMP and resulting IMS.

There are many sources for this material. The following figure describes most of these and how they are arranged to produce the IMP and the IMS.

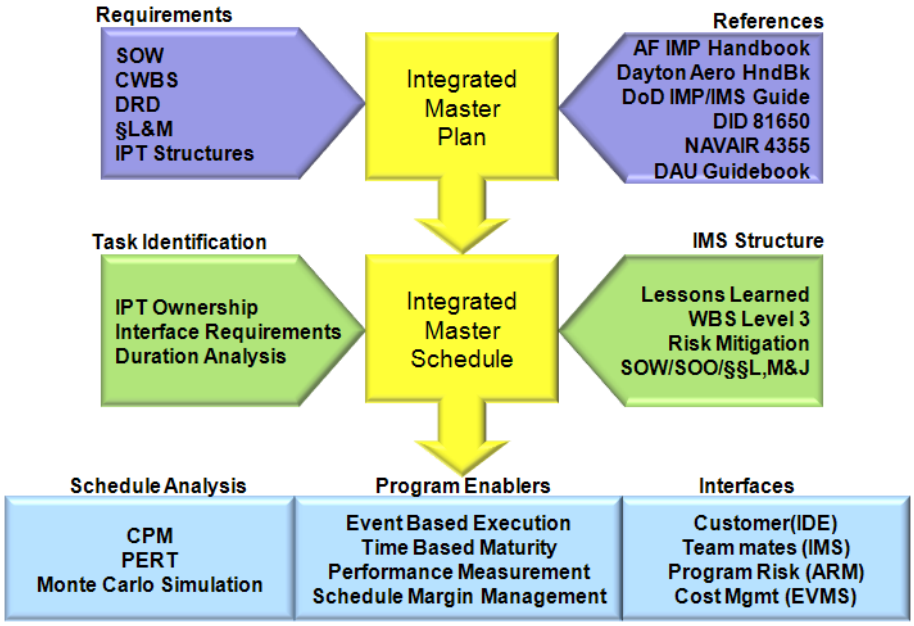


Figure 6 – The source of guidance and materials for building the IMP and the IMS comes from a variety of sources. Some of official guidance from the government. Some from the RFP and many from training and guidance sources available on the web, through courses and books.

Sources of Information for the IMP and IMS

Another view of the source materials for the IMP and IMS is the DoD Version of PMBOK in Figure 7. This “notional” concept can actually be put into practice. The key is to make sure the WBS structure does not dominate the topology of the IMS. Instead, focus on the product deliverables as part of an “increasing maturity” process flow.

This structure is the guiding framework for the IMP/IMS integration and emphasizes the fact that while the WBS/CWBS is critical, the Program Events and the decomposition of the Significant Accomplishments and Accomplishment Criteria are the real drivers of the IMS.

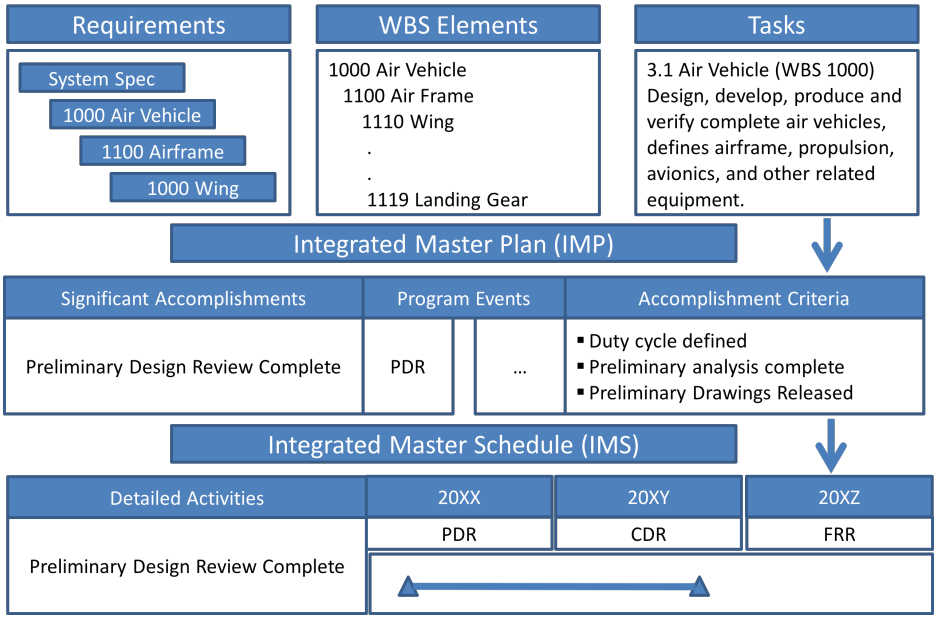


Figure 7 – The flow from requirements to WBS to tasks is replicated in the IMP and IMS. This traceability of critical in both the proposal environment, mandated by the §L and §M guidelines and the execution environment for the EVMS collection of physical progress to plan.

Subsystems in DOORS or Some Requirements Management System

If DOORS is used for the systems engineering requirements flowdown, then this is a good place to look for the structure of the program through a systems engineering point of view.

Using the DOORS export the Requirements Tree can be exported. This requirements tree can then be used to structure the "product oriented" IMP elements past CDR, where the work is focused on delivering hardware or software.

Work Break Down Structure (WBS)

If there is a product WBS that decomposes the system properly into subsystems – and does NOT model the functional activities or functional departments.

Remember the WBS is ***NOT*** the IMP. The WBS is a cost accounting and cost collection process. Starting with the WBS leads to an IMP that is focused cost, not on defining the increasing maturity of the program.

Define the Program Events, their SAs and ACs – then add the WBS numbers to collect the costs of performing the work in the ACs.

Logical Process Flow

In every program, there is some kind of logical process flow to get from the contract award to the final product and contract close out.

Defining this process flow is critical to defining the IMP. This can be done in several ways:

- The best way is to convene a group of subject matter experts that understand how the product is designed, build, manufactured, and used. They can layout the process flow. With this layout, program events can be allocated to the various stages of the process flow.
- Using the government's program events, assign SAs and ACs from the process flow. This a reverse engineering approach, but very useful.

1.9 Process Flow of the IMP and IMS Elements

The flow between the IMP and IMS elements is focused on demonstrating increasing maturity of the program. With this approach, the measurement of the program performance can take place using Earned Value measures of the deliverables produced by the Accomplishment Criteria. While Earned Value traditionally is applied to the Tasks within the Accomplishment Criteria, additional insight can be gained through the assessment of the ACs. These literally become the "accomplishment criteria" is measuring the increasing maturity.

- Connections between the IMP/IMS elements define how maturity is measured.
- Fully defining each element and its interface is required – no missing elements are allowed.
- The vertical and horizontal flows – together – are needed for success.

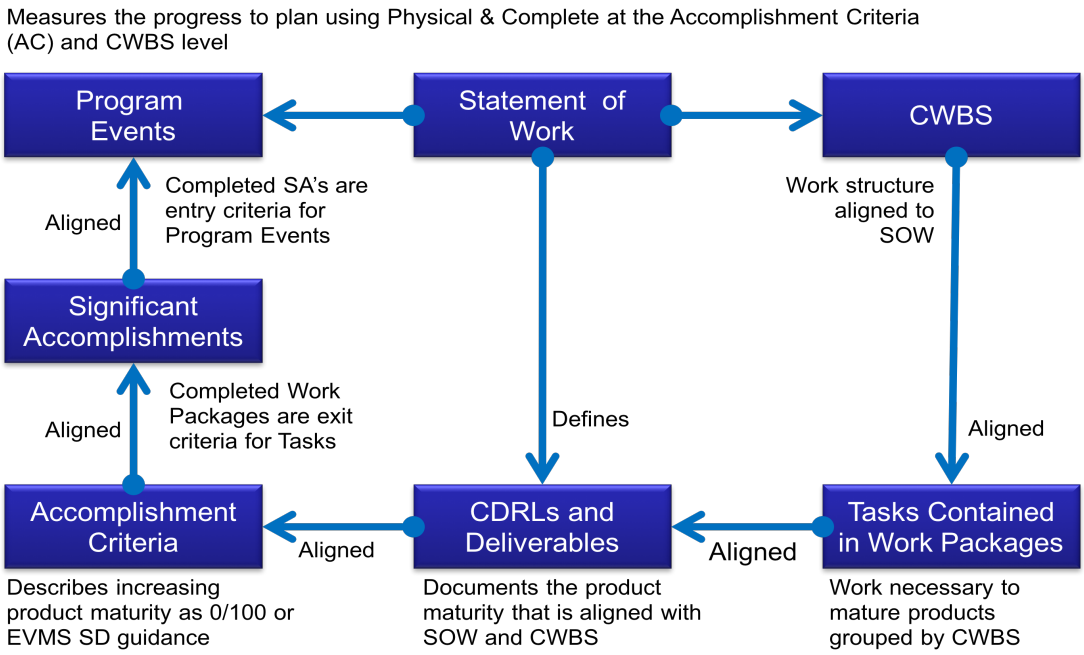


Figure 8 – The connections between the IMP and IMS elements are used to demonstrate the increasing mature of the program. These flows can also be connected to the Cross Reference Matrix (CRM) required in most proposals. As well traceability for program performance (EVMS measures) is provided through the IMP and IMS elements from various points of view.

These connections are critical to the structural integrity of the IMS. There may be other attributes – SOW, SOO, IPT and the like, but the core connections are shown above. This allows the IMS to be "picked up" as an IMS or a WBS structure. The WBS can be used as a grouping field for the Activities, SAs, ACs and PEs if the summary tasks are ignored. This is another reason to structure the IMS first as a Vertical topology. Then the connections between work, the Exit Criteria of that work (AC) and the entry criteria for the Events – SAs can be separated from the WBS. While the WBS is very important to the cost accounting function and the cost structure for the customer, it has little value to the assessment of the increasing maturity of the IMS.

This understanding is usually not found at first, when the concept of IMP/IMS is introduced. At first the concept of a CDRL as the deliverable is hard to grasp. Especially for those coming from the functional or production planning domain. Through PDR, the "product" of the program of represented in its physical form by the contents of the CDRL's. it is the CDRL that is delivered at the review meetings.

There may be long lead items, test software of hardware at PDR, but the majority of what "done" looks like at PDR and possibly CDR and 100% at SRR and SFR is the content of the CDRL documents.

1.10 Link Vertically within an Event

Capturing, building and linking each individual Program Event FIRST provides several benefits:

- Each program event is treated as an individual project. This is actually the case many times, when the Program is canceled at PDR.
- Development of each event individual focuses the team of the "increasing maturity paradigm of the IMS. By defining the "event grade" deliverables, the developers of the IMS can reveal what is really taking place to increase the maturity of the program.
- By separating the development of the IMS into Program Events, parallel effort can be used by the planners to build the IMS

Down Side of Linking Vertically First

While the vertical linking is critical to the success of the IMP/IMS, there are some downsides to this approach.

- The subject matter experts (SME) need to be visited multiple times, once for each Program Event.
- Interdependencies between events that are not tied to the completion on the event.
- Each AC must be self contained.
- Each AC must be split if it produces an output before it is complete.

These sound like impediments to using the IMP in production environment. But the benefits far outweigh the effort needed to build and maintain the IMP/IMS. When a Performance Based Earned Value approach is taken to the measuring progress to plan, each AC is equivalent to a Work Package. In the PBEV approach no partial completion is allowed. The Work Package is either 0% down or 100% done. This is extreme of course, so 50% can be given when the work package starts and 50% given when it ends.

In all cases, using AC's as the description of the "exit criteria" for the work directly connects the plan with the measurement of "done."

In the End This is the Way to Proceed

By capturing individual events first, the logical flow of the program in terms of maturity can be discovered.

This approach also minimizes the natural tendency to build a "shop floor" schedule. When horizontal linking is first used, tasks are strung together across the life of the program and the concept of an Event is forever lost.

When Event isolation is forced on the planners, this tendency is removed. Only late in the development of the IMS should horizontal linking take place. At this it becomes clear what the "real" dependencies are and where they should be.

Vertical Example

The example below is a vertical linking from Tasks, to ACs, to SAs, to the Program Event. There are placeholders within each Summary Bar that represents the PE, SA, or AC. These are the points that collect the "children" from below. Linking these vertically FIRST is the basis of arranging the IMS.

In this simple example an Accomplishment Criteria and its Tasks are linked to the Significant Accomplishments and then to the Program Event. The dependency coming from below `Task1.1.4` is a dependency from another AC, shown in the **Figure 9.**

	Task Name	Start	Finish
1	**– Program Event**	**Wed 8/29/07**	**Fri 9/7/07**
2	(PE) Program Event Completed	Fri 9/7/07	Fri 9/7/07
3	**– Significant Accomplishment 1**	**Wed 8/29/07**	**Fri 9/7/07**
4	(SA) Significant Accomplishment Completed 2	Fri 9/7/07	Fri 9/7/07
5	**– Accomplishment Criteria 1.1**	**Tue 9/4/07**	**Fri 9/7/07**
6	(AC) Accomplishment Criteria Completed	Fri 9/7/07	Fri 9/7/07
7	Task 1.1.1	Tue 9/4/07	Tue 9/4/07
8	Task 1.1.2	Wed 9/5/07	Wed 9/5/07
9	Task 1.1.3	Thu 9/6/07	Thu 9/6/07
10	Task 1.1.4	Fri 9/7/07	Fri 9/7/07

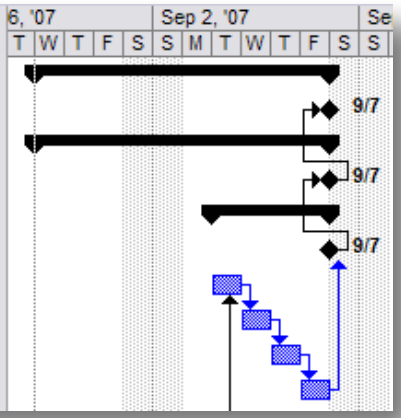


Figure 9 – The connections of tasks within the AC must land on the place holder for the AC. Because Microsoft Project does not allow linkage to Summary Tasks (Primavera calls these hammock task), an ersatz task is needed to "hold the place" of the AC. The same is the case for the SA and PE. With these place holders and complete "network" can be constructed for the IMS and IMP. No widows or orphans for any element.

In **Figure 10,** the dependencies between tasks are actually made through the ACs. There can be no Task to Task linking in IMP/IMS, since the completion of an AC is the pre–condition for starting the next AC. This forces the vertical linking while providing a minimal set of horizontal links.

	Task Name	Start	Finish
1	**– Program Event**	**Wed 8/29/07**	**Fri 9/7/07**
2	(PE) Program Event Completed	Fri 9/7/07	Fri 9/7/07
3	**– Significant Accomplishment 1**	**Wed 8/29/07**	**Fri 9/7/07**
4	(SA) Significant Accomplishment Completed 2	Fri 9/7/07	Fri 9/7/07
5	**– Accomplishment Criteria 1.1**	**Tue 9/4/07**	**Fri 9/7/07**
6	(AC) Accomplishment Criteria Completed	Fri 9/7/07	Fri 9/7/07
7	Task 1.1.1	Tue 9/4/07	Tue 9/4/07
8	Task 1.1.2	Wed 9/5/07	Wed 9/5/07
9	Task 1.1.3	Thu 9/6/07	Thu 9/6/07
10	Task 1.1.4	Fri 9/7/07	Fri 9/7/07
11	**– Accomplishment Criteria 1.2**	**Wed 8/29/07**	**Mon 9/3/07**
12	(AC) Accomplishment Criteria Completed	Mon 9/3/07	Mon 9/3/07
13	Task 1.2.1	Wed 8/29/07	Wed 8/29/07
14	Task 1.2.2	Thu 8/30/07	Thu 8/30/07
15	Task 1.2.3	Fri 8/31/07	Fri 8/31/07
16	Task 1.2.4	Mon 9/3/07	Mon 9/3/07

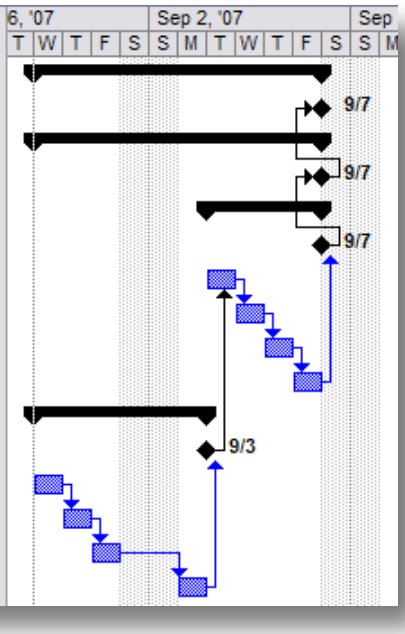


Figure 10 – The linkage to the SA and then to the PE is done in the same way the linkage from the Tasks within the AC. This linkage is critical in maintaining the vertical nature of the IMP while providing the basis for the horizontal connections of the IMS. Both Vertical and Horizontal connections are needed in the end.

1.11 Link Horizontally within an Event

Within a Program Event, the horizontal connections take place between the ACs. This does not mean AC to AC linkage – this would be a Finish–to–Finish connection. Since the AC represents the Exit Criteria for the Tasks within the AC, connecting AC–to–AC is illogical.

Linking between ACs is done by the following steps:

- The completion of an AC is the start of a successor AC. The first task in the successor AC starts that AC from the completion of the predecessor AC.
- Link the completion of an AC to a starting task of a successor AC. This Finish–to– Start relationship states that when one set of tasks of complete another set can start.
- In the successor AC, there may need to be a single "collector" task titled "start AC", that is starting point for the AC.

Finish to Start Relationships are Preferred

The current DCMA guidance for a “Green” IMS is to limit the number of non–Finish to Start relationships. Before the 14–Point assessment arrived in 2009, the motivation for Finish to Start had to overcome the tendencies to use leads, lags, and other relationships to get the schedule to “play nice” with the needs of the CAMs.

- The relationship above may not be the first logical approach. Some type of intermediate connection may be desirable. This is usually done with a "lag" relationship from the Finish– to– Start.
- This should not be done for several reasons:
- The Lead and Lag relationships hide the connections between ACs
- These relationships cause "odd" outcomes for the Monte Carlo modeling
- The logical path through the network is disrupted by these offset relationships
- In order to fix this situation, the AC should be broken up to define only the Finish– to–Start relationships. This can be done is a simple rule:

Only 100% complete products (defined by the Exit Criteria of the AC) can be used to start any successor work. When it is time to start linking horizontally, start with the dependencies associated with the completion of a predecessor event. For example

- A Task in CDR that depends on PDR can use the completion of PDR as a successor. This Finish to Start between the task and PDR makes it clear that the work in CDR starts after the completion of PDR.
- There are cases where something in CDR needs to start before PDR completes. Identify the Event that is the predecessor prior to PDR to link to.

Within a Program Event, the horizontal connections take place between the ACs. This does not mean AC to AC linkage – this would be a Finish–to–Finish connection. Since the AC represents the Exit Criteria for the Tasks within the AC, connecting AC– to–AC is illogical. Linking between ACs is done by the following steps:

- The completion of an AC is the start of a successor AC
- Link the completion of an AC to a starting task of a successor AC. This Finish–to– Start relationship states that when one set of tasks of complete another set can start.
- In the successor AC, there may need to be a single "collector" task titled "start AC", that is starting point for the AC.

In both cases, when the tasks are turned to As Soon As Possible (ASAP), there will not be the proper positioning of the start dates. The figure below is an example of linking horizontally between two Accomplishment Criteria. No Task to Task linking is allowed. Only AC to Task connections are allowed, as shown below.

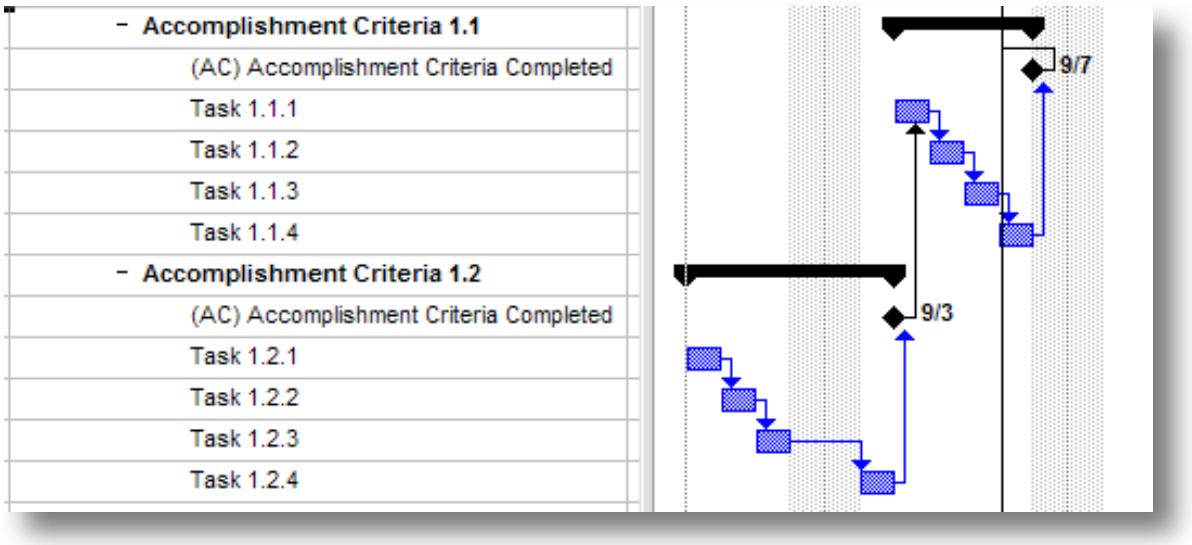


Figure 11 – Connections between Accomplishment Criteria – The only horizontal connections, others than the start of a collection of tasks from an SA or PE, is made from the predecessor AC to the first task in the Successor AC. In this way, the dependencies between collections of work are isolated to the completion of the previous collection of work. This topology improves the visibility into "done" and isolates partially completed work from be consumed by downstream activities resulting in "re work" once it is completed.

Finish to Start Relationships are actually the Rule

- The relationship above may not be the first logical approach. Some type of intermediate connection may be desirable. This is usually done with a "lag" relationship from the Finish– to– Start.
- This should not be done for several reasons:
- The Lead and Lag relationships hide the connections between ACs
- These relationships cause "odd" outcomes for the Monte Carlo modeling
- The logical path through the network is disrupted by these offset relationships
- In order to fix this situation, the AC should be broken up to define only the Finish– to–Start relationships. This can be done is a simple rule:

Only 100% complete products (defined by the Exit Criteria of the AC) can be used to start any successor work. If less than 100% maturity (for the expected level at this point in the program) is used, several outcomes occur:

- Earned Value must be evaluated as a percent complete through an interview or opinion process. the o/100 evaluation cannot be used.
- The successor work event starts (entry criteria) with partial or incomplete results from the predecessor effort. This usually results in rework.
- The logical flow of product maturity is not clearly visible. Earned Value is therefore disconnected from physical percent complete. The Physical Percent Complete is best represented by a 0% / 100% evaluation of the effort. "You're either done or you're not done."

By using Finish to Start and 0/100, each work effort is separable in its evaluation of progress to plan.

1.12 Link Horizontally across Events

With the individual Event ACs linked in a way that describes the logical flow of work, the next step is to connect the Events horizontally. There may be the case that each Event is initiated by the previous Event. This would be the "ideal" condition. No Event should start without the "permission" received from the exit of previous event is the "ideal" condition. This may not always be the case and there are likely dependencies between Events.

There are three popular ways to link between individual Event files

- Build a SND/RCV file – as a separate file, which contains the connections between two other files. These links are the predecessor/successor path which include the file system path name

- Hard code the events in each file – defined for each file with the due or send dates defined as Must Finish On or Must Start On.
- Indicate the dependencies in separate files and link them in the consolidated file – then use a macro to make the connections between these files when they are assembled into a master file.

There some fundamental weaknesses in each approach:

- The Get/Put file has limits on the field size in the predecessor and successor fields. For long path names, this limitation very quickly runs out of space. Once the 255 character limit has been reached the field cannot linger be edited through the User Interface of MSFT Project.
- The Hard Coded approach required continuous management of the dates for each file. This does work when there are a set of "master dates" for all portions of the program.
- The interconnections are not "set" until the "master file" is assembled. This approach work best for a IMP/IMS proposal development where there are a minimal number of interconnections between Program Events. For an execution schedule, this is a bigger issue.

The example Figure 12 shows how to build the connections using SND and RCV indicators, that are then used by a Macro to make the connections (predecessor and successor connections) when the two files are inserted into a master file.

As an aside – the inserted files should not be inserted and Projects, but the two summary tasks – the preamble Program Events and the Event Body – are copied and pasted into the Master File. This allows each file and its contents to be at the proper level.

Linking Horizontally Across Events Using «SND» and «RCV» fields

There are many approaches to building the inter–Event links. A simple one is to do this mechanically – especially for a proposal IMS – using text fields. In **Figure 12**, Text 21 and Text 22 are the two places where the interconnections are made.

- Text21 is the Sender Field – this contains a concatenation of the Event Letter and the UID
- Text22 is the Receiver Field – this contains the name from Text21 that is the receiver

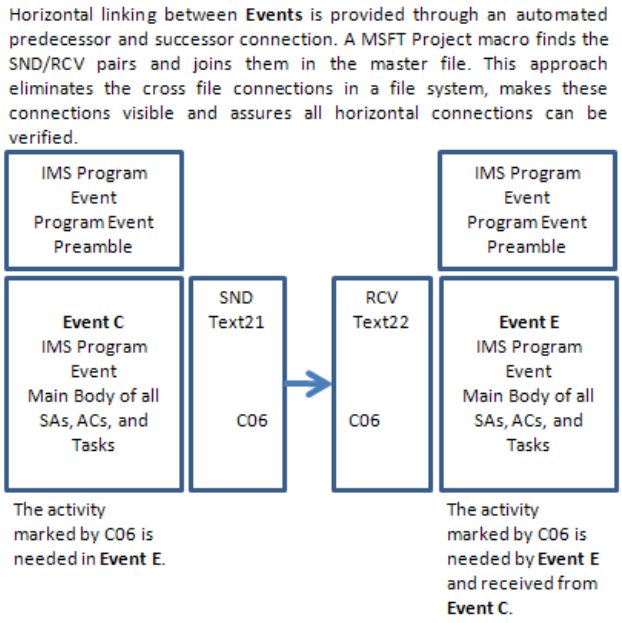


Figure 12 – the horizontal connections between program files – the individual Program Events – is made through a Send (SND) and Receive (RCV) field. These connections are then made into actual predecessor and successor connections in a Master File through a VBA macro that locates matching pairs and inserts the proper linkage.

There are many concepts built around the notion of «SND» and «RCV» fields. A critically important one though is the use of the «DELIVERABLES» type in Microsoft Project Server 2007.

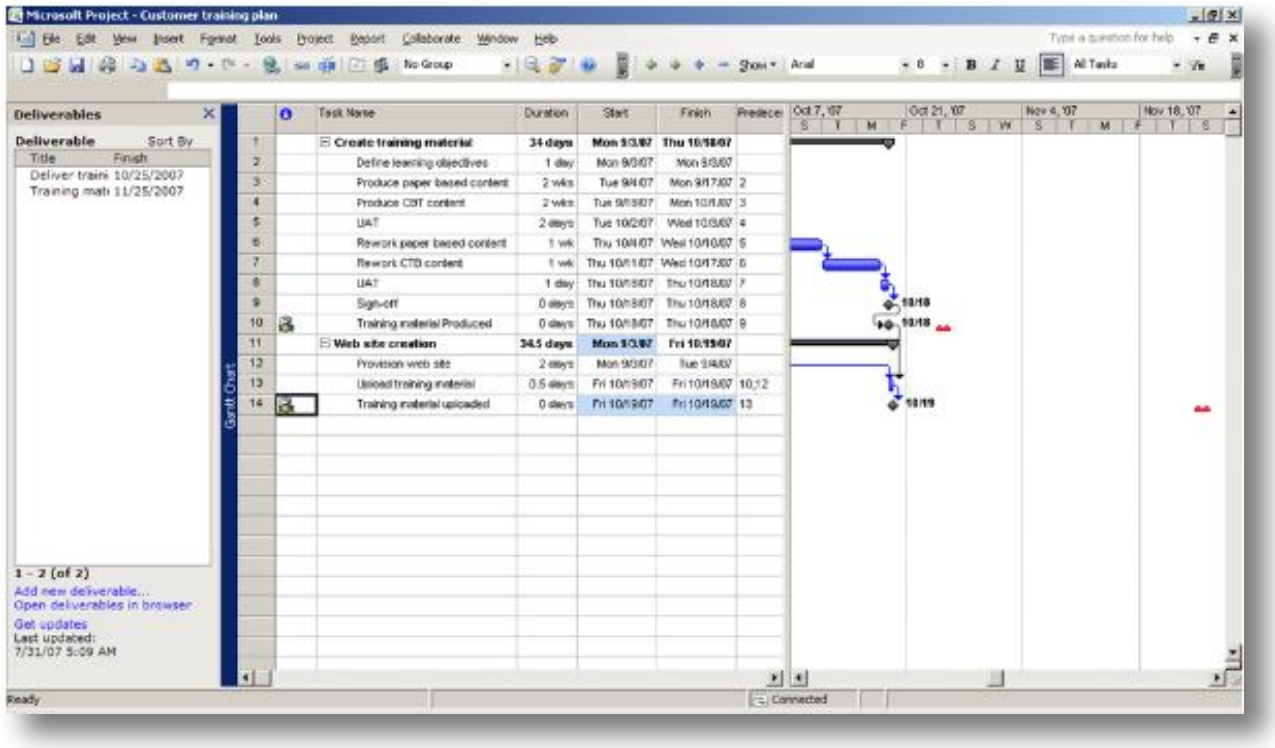


Figure 13 – Microsoft Project Server 2007 provides an "out of the box" solution to the inter-file dependency issues described above – the DELIVERABLES field. This approach can replace the Visual Basic macros needed to connect the files.

The fundamental problem that is trying to be solved with the Visual Basic coding approaches is that the individual files are "out of synch" in regards to their inter–file dependencies. The Project Server approach removes this issue by "keeping the dependencies" in–synch at all times. At least when they are out–of–sync, alters all the planners of the problem so they can fix it.

1.13 Integrating the IMP and IMS with Earned Value

The connection between the IMP, the IMS, and Earned Value is a critical aspect of a successful program management process. Starting with the IMP, the definition of increasing product or service maturity is defined through the Program Events (PE), Significant Accomplishments (SA), and Accomplishment Criteria (AC). For each Accomplishment Criteria a set of Tasks delivers the products or services that are assessed by the AC. These tasks are sequenced within the AC and between ACs. These Tasks form the Integrated Master Schedule (IMS).

- Showing the increasing maturity is the role of the Integrated Master Plan (IMP).
- Showing how this increasing maturity will be achieved is the role of the Integrated Master Schedule (IMS).
- Measuring the increasing maturity is the role of the Earned Value Management System.

Connecting all four of these elements of the IMP/IMS is the measure of the physical percent complete of the Tasks, the resulting completion of the Accomplishment Criteria, the Significant Accomplishments, and finally the Program Event. The units of measure of the physical percent complete are applied to the "planned value" of the tasks. This Planned Value is the budgeted cost for work performed (BCWS). With the Physical Percent Complete and the BCWS, the "Earned Value" or BCWP can be calculated. It is the Earned Value that is used to measure the progress of the project. **Table 5** describes the 10 steps needed to successfully deploy an Earned Value Management System.

These steps are based on Earned Value Management (EVM) principles and form the basis of any Performance Measurement Baseline process. In the end measuring performance in IMP/IMS is an Earned Value Management

System process, where physical percent complete is equated to the calculated BCWP of each Work Package and the detailed tasks contained in that Work Package.

Steps in Implementing Earned Value	Details required to successfully implement the Earned Value Management processes and connect them to the IMP/IMS framework	IMP/IMS Implementations
Define Work Scope	***100 percent of the project's work scope is defined using a work breakdown structure (WBS)*** The most critical and most challenging requisite to employing earned value is to define the project's total work scope. If what constitutes 100 percent is not defined, how can a measure of the project's performance be determined? Without a 100% reference point, it cannot be ascertained whether 10%, 20%, or 25% of the planned work has been completed. The WBS is to the project manager what the organization chart is to the executive—it allows the project manager to define a project by laying out all the assigned work and decomposing each task into measurable work packages.	***Total work is defined in the IMS connected to the IMP.*** No work on the project can be performed without being defined in the IMS. Each Accomplishment Criteria (AC) defines the Exit Criteria for the defined work in terms of 100% complete.
Create an Integrated Master Schedule	***Combine critical processes, defined work scope, schedule, and estimated resources, into an Integrated Master Schedule with detailed measurements of progress held in a Control Account Plans (CAP)*** Earned value project management is implemented within detailed CAP, which constitutes a formal bottom–up project planning process. The individual CAP represents the integration of all critical processes such as work scope, planning, scheduling, estimating, and authorization. The performance measurement takes place within the detailed CAP, and the total project's performance is the summation of what was reflected in the detailed CAPs. In essence, each project CAP is a subproject of the total project that is managed, measured, and controlled by a CAP manager.	***The IMS describes the flow of work as it supports the increasing maturity of the program*** This is not the same as a "schedule" of the work in a horizontal sense. Those types of schedules can be used at the lowest levels of the program, but only for sequencing the activities of something like manufacturing and assembly. This can be used where progress is measured by the passage of time and consumption of resources. The IMS must show the increasing maturity in terms of deliverables with a pre-defined value (Earned Value). Only then can physical percent complete have meaning to the measure of performance.
Formally Schedule Control Account Plan (CAP)	***Each defined CAP must be planned and scheduled with a formal scheduling system*** This is the single most critical tool required to implement earned value. The project's scheduling system will portray the approved work scope, which is carefully placed into a specific timeframe for performance. In earned–value vernacular, this scheduled work will constitute the project's *planned value.* As performance takes place on the project, the portion of the planned value that is physically accomplished becomes the earned value. Both the planned value and the resulting earned value must use the same metrics to measure their performance. The project's scheduling system is, therefore, critical to the employment of earned value because it is the vehicle to represent the project's scope, planned value, and earned–value measurement. The *project master schedule* is vital to the project because it constitutes the project manager's specified planned value for everyone to follow.	***Each CAP is foot and tied with the Significant Accomplishments and Accomplishment Criteria for the deliverables accountable for in the CAP*** CAPs are more than collections of budgets for the planned work packages. They are descriptions of how that allocated budget will be applied to produce the defined outcomes in the Work Breakdown Structure (WBS) through the work efforts of the IMS.
Assign Each CAP	**Each defined CAP must be assigned to a permanent**	***The critical success factor for the IMP/IMS***

Steps in Implementing Earned Value	Details required to successfully implement the Earned Value Management processes and connect them to the IMP/IMS framework	IMP/IMS Implementations
to an Accountable Manager for Performance	**functional executive for performance. This assignment effectively commits the executive to oversee the performance of each CAP.** Projects are by their nature transient within any firm's permanent organizational structure—they are authorized, implemented, and performed, then eventually go out of existence. Many (perhaps most) of those who manage the detailed performance that takes place within the CAPs will not carry the formal title of "manager" within the firm's permanent organizational structure; rather, many or most of these CAP managers are functional employees temporarily assigned and matrixed into the project by one of the permanent functional organizations. To secure a firm commitment from the functional executives who have the authority and resources to make the plan happen, it is wise to have each of the defined project CAPs essentially adopted by a senior function person with a title such as vice president, director, or manager.	***paradigm is to assign a "business manager" for the planned work. This manager is parallel to the Technical Management*** Finance and Business Operations is equivalent to the Technical Management of the program. Assigning business responsibility outside the technical responsibility provides the separation of concerns needed to assure that both technical progress and business performance are being made on the program. The Performance Measurement Baseline (PMB) is the shared document used by both business and technical management.
Establish a Baseline that Summarizes CAPs	***A total project performance measurement baseline must be established, which represents the summation of the detailed CAPs.*** The next required step is to form a total baseline against which project performance may be measured. Such baselines must include all defined CAPs plus any management (contingency) reserves that may be held by the project manager. If management reserves are not given to the project manager but are instead controlled by a senior management committee, they should be excluded from the project performance baseline. On a commercial–type contract, the baseline may include such things as indirect costs—and even profit or fee—to match the total authorized project funds. Internal projects will typically not contain indirect costs, profits, or management reserves. Most internal project baselines will be the sum of the defined CAPs.	
Measure Performance Against Schedule	***Periodically, measure the project's schedule performance against its planned master project schedule.*** The formally issued and controlled project master schedule constitutes the project's planned scope. Each task described on the project master schedule can be loaded with estimated resources, such as hours or dollars, which are embedded within the authorized CAPs. As performance takes place within the CAPs, you can quantify the relationship between the value of the work scheduled as compared to the value of the work accomplished. The difference between the work scheduled and work accomplished constitutes the *schedule variance* in earned value. A negative schedule variance means that the value of the work accomplished does not match the value of the work scheduled, i.e., the project is falling behind in its scheduled work. Each behind–schedule task can be	***Performance measurement starts and end with measures of Physical Percent Complete*** Each work package must be compliant with the Earned Value Management System Description. This usually defines how progress is being measured for the Work Package.

Steps in Implementing Earned Value	Details required to successfully implement the Earned Value Management processes and connect them to the IMP/IMS framework	IMP/IMS Implementations
	assessed regarding its criticality to the project. If the late task is on the critical path, or if the task carries a high risk to the project, efforts can be made to get the late task back on schedule. Conversely, if a task has positive variance or is not considered a high risk to the project, added resources should not be spent to accelerate its performance.	
Measure Cost Efficiency Against the Costs Incurred	***Periodically measure the project's cost performance efficiency rate, which represents the relationship between the project's earned value performed and the costs incurred to achieve the earned value.*** The single most important benefit of employing earned value is the cost efficiency readings it provides. The difference between the value of work performed and the costs incurred to accomplish the work provides the cost–efficiency factor. If you are spending more on the project than it receives in value, this reflects an overrun condition. Absolute overruns have been found to be nonrecoverable. Overruns expressed as a percentage value have been found to deteriorate unless the project takes aggressive actions to mitigate the condition. Perhaps of greatest benefit, the cost efficiency rate has been found to be usably stable from the 15 percent point of a project completion and progressively more stable as it goes from the 20 percent to 30 percent to 40 percent completion point. Therefore, the cost efficiency factor is an important metric for any project manager or enterprise executive to monitor.	
Forecast Final Costs Based on Performance	***Periodically, forecast the project's final cost requirements based on its performance against the plan.*** One of the more beneficial aspects of the earned–value concept is its ability to independently forecast the total required funds at the end of a project, commonly called the "estimate at completion." Based on project performance against the plan, a project manager can accurately estimate the total funds required to finish the job within a finite range of values. These statistical estimates are something like a grass–roots sanity check against estimates based more on wishful thinking because they provide a more realistic estimate of the values needed to finish the job—unless someone has a preconceived notion of what that value should be. As reflected in Figure 1, if the earned–value statistical estimates are greater than the "official" project estimates to complete the project, someone in a senior management position should reconcile these professional differences of opinion.	
Manage Remaining Work	***Continuously manage the project's remaining work.*** The results achieved to date on a project, good or bad, are in effect "sunk costs"—gone forever. Thus, any improvements in performance must come from future work—tasks ahead of the latest status date. Earned value allows the project manager to accurately measure the cost and schedule performance achieved to date. If	

Steps in Implementing Earned Value	Details required to successfully implement the Earned Value Management processes and connect them to the IMP/IMS framework	IMP/IMS Implementations
	the results thus far are less than desired, the project manager can exert a more aggressive posture on all future work. Earned value, because it allows the project to accurately quantify the value of its work achieved, allows the project manager to also quantify the value of the work ahead to stay within the objectives set by management.	
Manage Baseline Changes	***Continuously maintain the project's baseline by managing all changes to the baseline.*** The project performance measurement baseline put in place at the start of the project is only as good as the management of all proposed changes to the baseline during the duration of the project. Any performance baseline becomes invalid if it fails to incorporate changes into the approved baseline either by the addition to or elimination of added work scope. All new changes of project work must be addressed either by the approval or rejection of changes. For the initial baseline to remain valid, every change must be closely managed. Maintaining a baseline is as challenging as the initial definition of the project scope at the start of the project.	

Table 5 – These 10 processes must be implemented in order for Earned Value to be useful in the IMP/IMS environment. These concepts are taken directly from "Earned Value Project Management: A Powerful Tool for Software Projects," Quentin Fleming and Joel Koppelman, *Cross Talk*, July 1998

1.14 Summary

- Build each Program Event by asking "what must be accomplished to successfully complete the event?" This is a top down development of the Significant Accomplishments.
- Ask "what are the exit criteria for the "yet to be defined" work that allow the Significant Accomplishments to realized?
- What is the logical order for these Significant Accomplishments? That is, how does the increasing maturity of the Significant Accomplishments flow though the program? What accomplishments must be accomplished first? Show this flow in the form of a map moving from left to right. This looks like a flow chart, but it's a maturity flow chart. Figure 15 is an example.
- With this IMP in place, define the work needed to deliver the outcomes from each Accomplishment Criteria. These are naturally the high level Work Packages. Each work package produces a 100% complete – complete to the define level of maturity for that specific program event – deliverable (initial, preliminary, critical, final, first article, engineering design unit, test ready, initial operations, final operations).

2 Process Flow to Build The Integrated Master Plan (IMP)

Building the Integrated Master Plan is a step by step process. Each step is needed for a successful IMP. Each step should be performed in the right sequence, although this is probably never the case in practice.

But it is critical to understand how each step builds the maturity of the IMP itself as well as builds the description of the increasing maturity of the product or service described by the IMP.

It will be repeated many times to come, don't make changes to this process unless you've been down the road of IMP/IMS construction and have had a successful conclusion – a winning proposal, a "Blue" IMS at IBR, or any other external acknowledge that you're now an "IMP/IMS-er"

- Building the IMP requires discipline, rigor, skill, and experience.
- Following the steps in **Figure 3** is the starting point for the discipline and rigor.
- Deviations to **Figure 3** usually result in a disappointing result. In other words "don't change the process unless you have the skill and experience to know the different between a good change and a bad change.

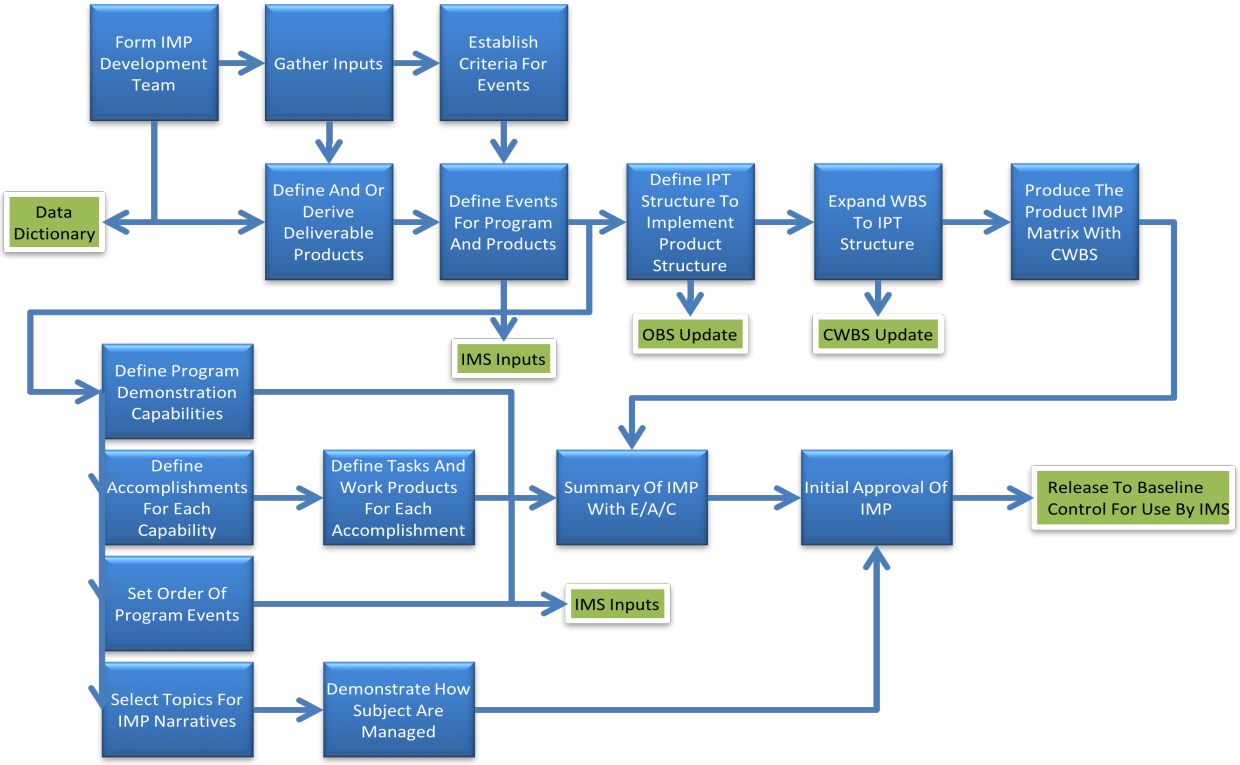


Figure 14 – the process flow for developing the IMP should be strictly followed. It has been shown that not following this flow leads to confusion and rework of the IMP elements. Each step must be evaluated for its completeness and suitability for use. If this is not done, rework and lost work will result. In the proposal environment, time and resources are limited. Managing the proposal as a "time boxed" project is the starting point for success.

Form the IMP Team

This team is the Program and Technical architecture leaders of the project. This team is the "thought leaders" of how the program will proceed. If it's a proposal, then this conversation is driven by the RFP, win themes and all the CDRL, DRD, DID and other DoD 5000.2 procurement processes and documents. If this is a commercial program, then the Business Case and the Business Strategy (from the Balanced Scorecard) drives this conversation. The output of this effort is a data dictionary, which:

- Defines the contents of each WBS elements to a level detail that cost estimators and planner can determine.
- WBS Element 1.5.4.5. – Systems Integration Test Equipment Planning – This element includes the effort to identify requirements and specify types and quantities of test equipment needed to support the System Integration and Test process. It does not include the design or procurement of such equipment, which is covered in Element 1.5.4.6.

Gather Inputs from the Systems Engineers in terms of Systems Behaviors

Review the requirements for the program through all the sources. This includes:

- 5000.2 SETR (Systems Engineering Technical Review) - SETRs are an integral part of the systems engineering process and life cycle management, and are consistent with existing and emerging commercial/industrial standards. These reviews are not the place for problem solving, but to verify that problem solving has been accomplished. Along with the SETR is a Program Management Risk Assessment check list. This can be used to verify all the elements of the Program Event have been addressed. This check list can be found at http://www.navair.navy.mil/kms/41G/
- SOO / SOW
- CDRLS
- Section L and Section M – Section L is the guide to preparing the proposal. It will contain instructions on formatting, needed data, page limits, and the structure of the responding volumes. Section M is the evaluation procedures for the proposal. The evaluation factors and subfactors are listed.
- Concept of Operations
- Government milestones (DoD 5000.2 process flow)

Establish Criteria for the Accomplishments – Entry Criteria for the Accomplishments

The Event dictionary describes the outcome of each event. NAVAIR and DAU have definitions and checklists for each event through CDR. These criteria

Define and or Derive Deliverable products

From the Statement of Work (SOW), CDRL, or other documents, determine the deliverables for the Program Event (PE), Significant Accomplishments (SA), and Accomplishment Criteria (AC). These deliverables must be tangible, measureable artifacts of the work effort. They must be “things” that can be seen, touched, measured, weighed, or in some way “made evident.” They are physically the “evidentiary materials” of the work effort.

As such, the test of a deliverable is never the completion of the effort or the consumption of the resources. It is something physically complete. An “object” that has been produced by the work effort. A new state of the program. So form of visible, tangible difference in the program.

Define Events for Program and Products

DoD 5000.02 provides sample events. Start with these. There will be others. Many RFP’s allow the proposal to define events that indicate increasing maturity that are not part of the DoD 5000.2 sequence of events. Another good source of Program Events and their detailed descriptions is the NAVAIR Systems Engineering Technology Review (SETR), http://www.navair.navy.mil/kms/41G/. There are handbooks and check lists for each Program Event. This can be used as starting points for the entry criteria for the event to augment the technical Significant Accomplishments.

There is a CD that can be order (for free) from NAVAIR. This should be the starting point for IMP development.

Define IPT Structure to Implement Product Structure

Define

Expand WBS to IPT Structure

The WBS

Produce the Product IMP Matrix with the CWBS

The Product IMP

Define Program Demonstration capabilities

Program capabilities

Define accomplishments for each capability

Each capability

Set the order of the program events

Order of program events

Select topics for IMP narratives

IMP narratives

Define tasks and work products for each accomplishment

Task and work products

Demonstrate how subject are managed

Managing subjects

Summary of IMP with E/A/C

Summarize the IMP

Initial approval of the IMP

Approval of the IMP

Example IMP

The figure below is an example IMP. This example shows an indented schedule with the summary tasks hidden. The rows are zero (0) duration activities which represent the PE/SA/AC elements of the IMP.

IMP Code	PE - SA - AC
A	(PE) Program Event Completed
A.01	(SA) Significant Accomplishment Completed 2
A.01.01	(AC) Accomplishment Criteria Completed 1.1
A.01.02	(AC) Accomplishment Criteria Completed 1.2
A.02	(SA) Significant Accomplishment Completed 2
A.02.01	(AC) Accomplishment Criteria Completed 2.1
A.02.02	(AC) Accomplishment Criteria Completed 2.2

Figure 15 – a sample of an IMP produced from a Microsoft Project file. This view is taken from the place holders in the file that represent the individual IMP elements. The IMP numbering is inserted by a macro as well as the prefix in front of each IMP phrase. The phrase contents are taken from the summary tasks in the Gantt view of the file.

The Program Event is in a single file, with 2 Significant Accomplishments (cleverly names SA1 and SA2). Each SA has 2 Accomplishment Criteria (AC1.1, AC1.2 and AC2.1, AC2.2).

While this may look too simple, a real IMP is structure is constructed in the same way.

2.1 Defining the Program Events

Identifying Program Events starts with the governments events defined in the RFP and reference documents.

There are three basic phases of these events:

- From contract award to Critical Design Review
- From CDR to Initial Product complete
- From initial product to full rate product
- Major program events are opportunities to gauge program status...

There is no set requirement for what will be defined as a milestone or event, but MIL Standard 1521B contains the traditional major program events and serves as a good starting point.

- Each Program Event is a transition point
- Each Significant Accomplishment is an interim or critical activity that must be completed prior to the Program Event (PE)
- Each Accomplishment Criteria (AC) is a measureable indicator that demonstrates that the work in the IMS has been completed as defined in the IMP dictionary.

- An "event" is a key point in the program where we can measure progress to determine whether it is appropriate to proceed to the next series of activities. Interim status reviews may need to be inserted to prelude excessive time between events.
- Events allow us to ask permission of the customer to proceed. As such, we must structure the SAs and ACs toward this goal and most importantly getting the proper answer to – *can we proceed to the nest event?*

Statement of Work (SOW)

From the Statement of Work (SOW)

RFP Section L & M

Section L & M of the RFP

Internal IMP/IMS Process

Internal IMP/IMS processes

IEEE

IEEE Systems Management

NAVAIRINST 4355.19

NAVAIR 4355.19

DoD 5000.21A

DoD 5000.21A

NAVAIR Systems Engineering Handbook Supplement

NAVAIR Systems Engineering Handbook Supplement

NAVAIR Acquisition Guide 2003

NAVAIR Acquisition Guide 2003

EIA–632 Processes for System Engineering

EIA–632 Processes for System Engineering

MIL–STD–1521B

MIL–STD–1521B

2.2 Defining the Significant Accomplishment for each Program Event

The Significant Accomplishments (SA) or "Accomplishments" are the entry criteria of the Program Events. As entry criteria the SA's should:

- Describe the conditions for the successful completion of the Program Event. For example for PDR – what are the Accomplishments needed for a success.

- Significant Accomplishments (SA) define the "Entry" criteria for the Program Event.
- The logical flow of the SAs shows the increasing maturity of the deliverables needed to successfully complete the Program Event (PE).
- The maturity of these deliverables is defined by the "Event Dictionary."

One effective way of capturing the SAs is through a mini–kaizen process that defines the SA process flow for each Program Event Program Event. This is done using a "swimlane" approach where the SAs flow from left to right and top to bottom, terminating on a Program Event. Each SA is linked to "downstream" SAs to create the process flow that assures the increasing maturity of the Program Event.

The following figure shows the outcome from one such mini–kaizen process. For the Program Event Ascent Aerodynamics Confirmed, there are 11 Significant Accomplishments, each arranged in the sequence needed to increase the maturity of this event and describe to flow of work contained in the Accomplishment Criteria and the supporting Tasks.

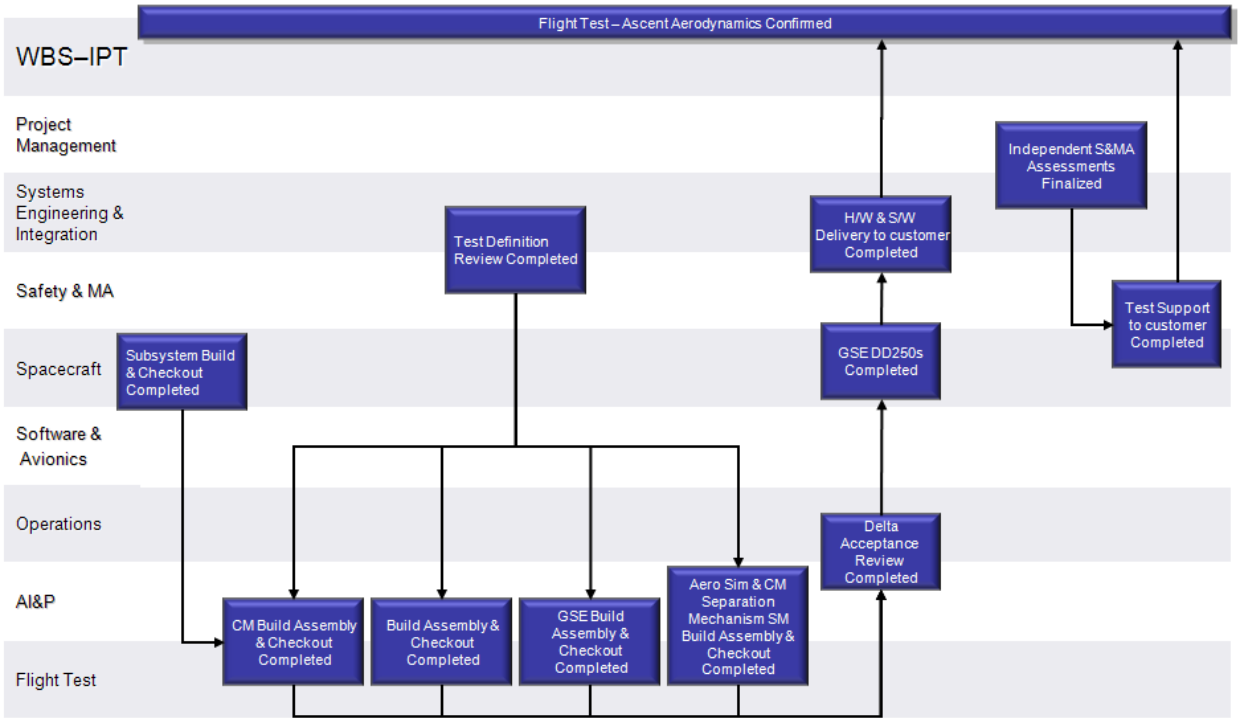


Figure 16 – defining the Significant Accomplishments for a Program Event in this way shows both the increasing maturity and the IPT streams that produce this maturity. The development of this "picture" of the Program Event takes place using a Mini–Product Kaizen. Systems Engineering and Planning and Controls sit in a room and work out the process flow of the SAs for the Event. From this structure, the IMP can be developed directly. This is a much better approach then just listing the SAs and the resulting ACs in a linear manner.

Systems and Subsystems

The allocation of Systems and Subsystems starts with a Systems Engineering view of the program. The interdependencies between the Systems and Subsystems, drive the structure of the Integrated Master Plan (IMP).

The definitions of interfaces, defines the coupling and cohesion measures between these system elements. The IMP needs to identify these interfaces, their impact on the credibility of the IMP, and the visible connections as the program moves from left to right in its maturity.

IPT flows

Each Integrated Product Team is the basis of the flow of value for each Program Event. The IPT "swim lanes" are the structure to identify the interdependencies between the Significant Accomplishments. These IPT's are usually allocated from external firms – actual IPTs, internal Centers of Excellence, or specific engineering disciplines.

The IPT flow concept presents the organizational elements of the Program Event mapped against the Significant Accomplishments. These connections are developed through a Programmatic Systems Architecture Development Kaizen meeting

Product Maturity

The flow of maturity is the real purpose of the IMP. The challenge is to define what the measures of maturity in units of measure that are meaningful to PP&C for capturing Physical Percent Complete and the system engineering staff in the description of the development of the program.

This effort starts with capturing what Significant Accomplishments from each IPT are needed for the Program Event. These are the "entry" criteria.

Work Products

Test Steps or Artifacts

2.3 Defining the ACs for each SA

Subsystems

CDRLS, DID, DRD

Systems Engineering Guidebooks

3 Building the Integrated Master Schedule (IMS)

With the IMP in head, it's time to start the first cut at the Integrated Master Schedule. This is an iterative and incremental process, just like the IMP. With the definitions of the IMP and IMS elements, let us look at a simple – and notional – picture of the IMP and the IMS.

Each Significant Accomplishment (SA) and its Accomplishment Criteria (AC) defines the "flow of increasing maturity" for the program. The IMS shows the work needed to produce this flow. Remembering each AC is the exit criteria for the collection of tasks that produce the increasing flow of maturity. The first step is to create a Work Package from each Accomplishment Criteria. These work packages may be too large or too small, but in the first iteration this step produces value.

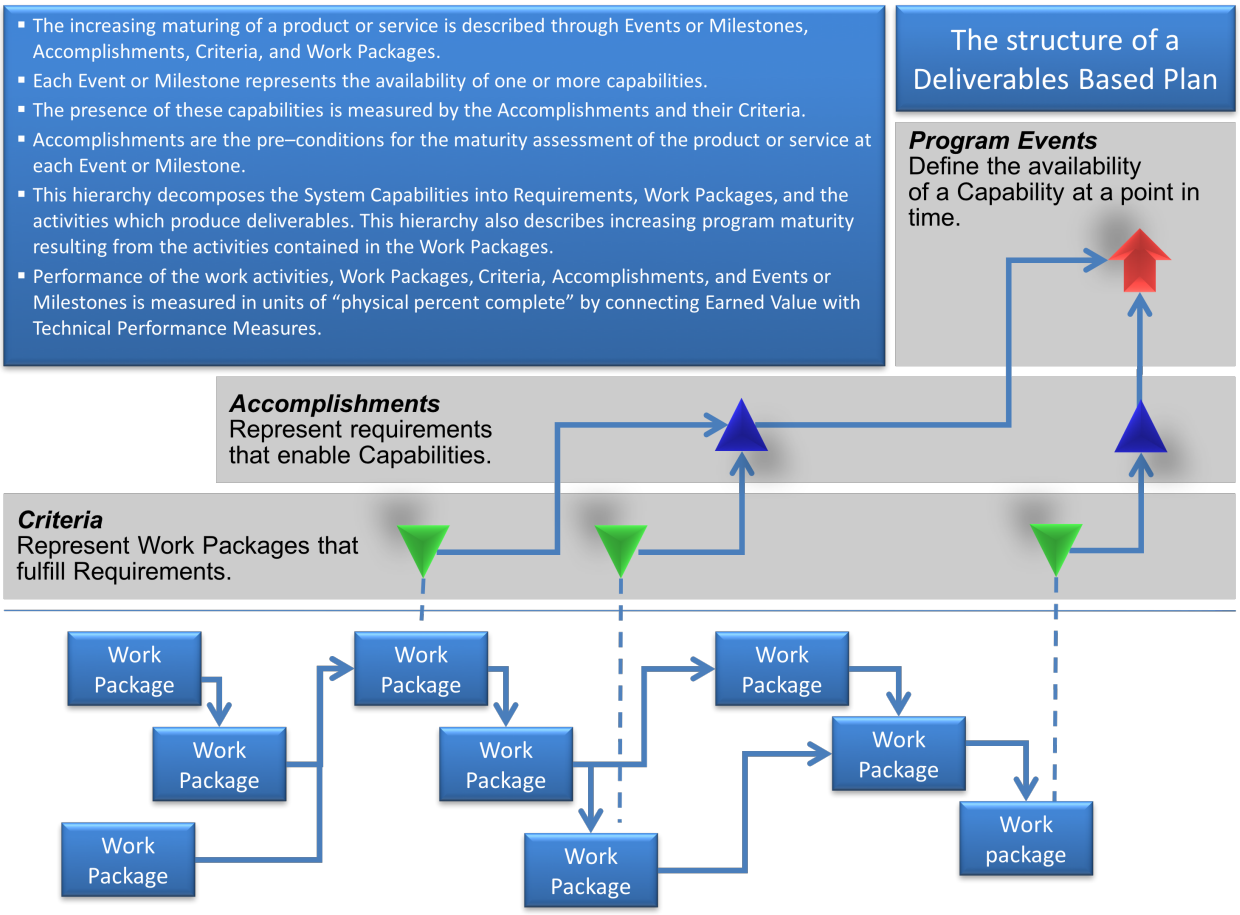


Figure 17 – The notional concept of an IMP and an IMS describes the Tasks needed to complete the Accomplishment Criteria (AC). These Accomplishment Criteria in turn define the increasing maturity of the work products in support of the Significant Accomplishments.

The Integrated Master Plan (IMP) should cover the following:

- The Technical Solution
  - Understanding the Problem –The Background of the situation describing why there is a problem and what needs to be solved. The Scope of the program. The Program Objectives
  - Description of Solution – a written discussion of the proposed solution
  - Deliverables – the CLINs, CDRLs, the reviews
- The Management Solution
  - The Organizational Structure of the Suppliers and the Customer
  - Management Plans described in the WBS, SOW, IMP/IMS and the risk associated with these
  - The Management Processes, including quality, risk, product development
  - The Contracting Elements including Price, the Terms and Conditions, any Warranties

- The Capabilities Solution
  - Past Performance Relative to this program and any Key Supplier's data that described past performance
  - Facilities and Equipment needed to successfully deliver the product including Internal and Key Suppliers
  - Any Key Personnel IPT Lead Names and Resumes and the Key Supplier's Lead Names and Resumes
- The Cost Solution
  - Supplier Costs
  - Material Costs
  - Capital Expenditures
  - Engineering and other Labor Costs

3.1 Building a CDRLs plan

The CDRLs deliverables plan is usually a huge mess. CDRLs are assigned delivery dates before, during, and after Program Events. Different version or revisions of the CDRLs are due at different points in the program. Keeping track of all these moving parts, starts with the understanding of what the CDRLs actually say in the body of their text about delivery. Several approaches can be taken:

- Build a database that keeps track of all the dependencies
- Build a schedule that describes the delivery of the CDRLs

This may appear over kill but it is not. The CDRL compliance is a critical factor through PDR. Also the CDRL's are the actual deliverables through PDR, since up to that point the program rarely produces are hardware or software products – just designs, models, trade studies and other paper based assessments.

- Through PDR the majority of the work is building the deliverables from the CDRLs
- Building the initial plan of the "planned outcomes" from the CDRLs – as their maturity is defined – is the starting point
- Each CDRL should be assigned to a single AC and be connected to a single PE for the defined maturity level.

Inside the CDRLs are references to other dependencies like dates, review cycles and the like.

3.2 The Integrated Master Schedule (IMS)

The IMS is a living document that is continuously updated to reflect the progress of the program or project. The IMS should: [Guide 05]

- Maintain consistency with the IMP
- Illustrate the interrelationships among events, accomplishments, criteria, and tasks
- Indicate the start and completion dates and duration for each event, accomplishment, criterion and task
- Provide for critical path analysis
- Provide the ability to sort schedules multiple ways (e.g., by event, by Integrated Product Team (IPT), or by WBS)
- Provide schedule updates on a regular basis, indicating completed actions, schedule slips, and rescheduled actions
- Provide the capability for the Government, contractor, or support contractors to perform "what if" schedule exercises without modifying the master program schedule
- Maintain consistency with the work package definitions and the Earned Value Management System (EVMS)
- Be traceable between the WBS items supported by each IMS task
- Be vertically and horizontally traceable to the cost and schedule reporting instrument (e.g., Cost Performance Report (CPR))

- The IMS is an integrated, networked, multi-layered schedule of program tasks to complete the work effort captured in the IMP.
- The IMS should include all IMP events and accomplishments and support each accomplishment closure criteria.
- The IMS is a performance forecasting tool as well as a Master Schedule and Risk identification tool.
- The IMS connects the IMP, which shows the increasing maturity of the program with the activities needed to produce the evidence that maturity is increasing.

An Example IMS

The Integrated Master Schedule is derived from the Integrated Master Schedule. The example below is similar to the simple IMP in the previous section:

	J_IMP Ref Code (T4)	Task Name
2	A	(PE) Program Event Completed
4	A.01	(SA) Significant Accomplishment Completed
6	A.01.01	(AC) Accomplishment Criteria Completed 1.1
7	A.01.01.001	Task 1.1.1
8	A.01.01.002	Task 1.1.2
9	A.01.01.003	Task 1.1.3
10	A.01.01.004	Task 1.1.4
12	A.01.02	(AC) Accomplishment Criteria Completed 1.2
13	A.01.02.001	Task 1.2.1
14	A.01.02.002	Task 1.2.2
15	A.01.02.003	Task 1.2.3
16	A.01.02.004	Task 1.2.4

The IMS is Event Based

This sounds like a restatement of the obvious, but it is more subtle than that:

- Event Based means there is one schedule for each Event.
- Each Event is held in a separate, self-contained schedule.
- All the work that goes into a single Event is in a single schedule.
- This repeated theme needs to be repeated all the time – Event Based Planning is a different paradigm from horizontal, functional planning.

3.3 Structuring the IMS

Do not structure the IMS by WBS. Build the IMS from the ACs, then assign the WBS numbers to the Tasks in the IMS.

These assignments may reveal the ill–logical structure of the WBS

With the WBS assignments, the IMS can be Grouped to look like a WBS structured project plan.

4 The Work Breakdown Structure (WBS)

The Work Breakdown Structure (WBS) is one of the most misused, misapplied, troublesome concepts in program management. The first step in building the IMP and the resulting IMS is to resist the temptation to start with the WBS. The WBS is a tool that defines a project and groups the project's discrete work elements in a way that helps organize and define the total work scope for the project. A WBS element may be a product, a service, or data associated with either of these. The WBS provides the framework for detailed cost estimating and control along with providing guidance for supplemental schedule development and control. Before the IMP and IMS are developed, the WBS takes a secondary role in structuring the program from the performance measurement point of view.

It is important to remember that the WBS is primarily a cost collection mechanism. The IMP and IMS are program maturity assessment mechanisms. The two should not be mixed until the IMP is defined and the IMS elements identified. Only then should the WBS elements be assessed.

Each descending level of the WBS represents an increasing level of detailed definition of the project work. As you

Statement Of Work (SOW)

The Statement of Work (SOW) is the starting point for the WBS assignments. In many cases, the RFP will provide a WBS, which the contractor is required to turn into a CWBS. In most of these case the WBS is not as well formed as the authors of the RFP think it is. This is not because they have not worked hard to construct the WBS. It is because they are not usually on the "product construction" side of the WBS and the CWBS and cannot see the details of how to make it better.

Accomplishment Criteria

CDRLs

In the IMS each Accomplishment Criteria is associated with a CDRL (DRD in some other domains).

This doesn't mean that's all that is associated with the AC, but CDRLs are one–to– one with ACs. The reason for this is:

- The production of a CDRL represents the outcome of some effort that is documented by the CDRL.
- The CDRL is a deliverable to the government and the AC is the exit criteria for that effort.
- each AC is associated with a CDRL
- multiple CDRL version traceable horizontally through the Program Events

Physical Products

The products and services of the project must be identified at the AC level of the IMS.

One way to start this is with the WBS if it is a product WBS. Matching the Product IMS against the System Decomposition – usually held in some sort of requirements management system, like DOORS – is the source of these product elements

4.1 To Indent or Not Indent That is the Question

Assumptions

The IMS and the IMP the supports it need to be a fully formed network of activities. The paths through the IMS must be fully connected. No Widows or Orphans in this network. To do this, the IMP and the IMS need to be fully connected. That is all activities in the IMP and IMS must be in a single logical network. This is important for several reasons:

- The Monte Carlo simulation of the IMS uses the IMP elements as collection nodes
- The proposal wording about the credibility of the IMS is supported by starting with the vertical connections of the Program Events

There are two approaches to building the IMS

- Indented
- Unindebted
- Indented

The indented IMS has summary tasks. These summaries are the logical places for the PE/SA/AC elements of the IMP. The problem is these summary tasks cannot be linked to form a network for the IMS

4.2 Capturing the AC contents

The tasks in the ACs can be captured in several ways:

- Simple entry into the MPP file
- Entry into a separate worksheet

The Separate Worksheet Approach

This process has several advantages and some disadvantages

- The work of defining the Tasks for the ACs can take place in parallel. This speeds the entry, since the subject matter experts (SME) can work independent from the planners
- The worksheet narrow to focus to single ACs. The SMEs are not diverted into "big picture" issues, but instead work only on the effort needed for each AC as a package – a "lump of work."
- The capturing of the work is incremental. The worksheets are gathered over time into a "pile of work," managed by one of more planners independent of the authors of the AC worksheets. This "staging" of the work supports the parallel nature of the processes, buffers the collection process by removing the real time need to enter data when the knowledge is available.
- The independent data capturing and storage (in a spread sheet of Word file) protects the data in case of a "crash" of MSFT Project.

There are some disadvantages as well

The format of the data capture sheet many vary, but it needs to match the entry of the tasks in Project. Usually this format includes:

- Task description
- Duration
- Predecessors and Successors within the AC
- WBS, SOW, CDRL, etc

Maintaining the integrity of this format requires care and management. Random data forms cannot be used, since the process of cut and paste" is the only way to save time.

Durations

Most Earned Value Management System Descriptions limit the duration of Work Packages to 60 calendar days or less for the majority of work on the current rolling wave. With this guidance, the Accomplishment Criteria (AC), this is a starting point to bounding the duration of the work efforts.

For Planning Packages, this bound is larger, but some rational for the duration of Work Packages needs to be in place.

Duration Confidence

The capturing of task and Accomplishment Criteria (AC) durations needs to be based on a Most Likely estimate and an ordinal ranking of the variance on this estimate.

4.3 Building the IMS

Building IMS from the IMP starts with gathering the tasks that define the completion of the Accomplishment Criteria (AC).

This effort must also collect "risk adjusted" duration for each task as well as the dependencies between tasks.

What is needed from each IPT Lead in order to build the Integrated Master Schedule in a truly integrated manner is:

- Task name – a two line description of what work must be performed to complete the AC. Keep this simple with a present tense verb and include the deliverable and its maturity
- Duration – this is usually 10– to 45 days for the first rolling wave of tasks. Nothing less than 30 days for tasks beyond the first rolling wave. One guide is to not have the AC cross more than one (1) accounting period. This may appear overly detailed but it drives the measurement of Earned Value. All Level of Effort tasks should be kept in a separate IMS file. Try to limit the number of tasks to around 10 per AC for the first round of capturing work effort for each AC.
- Sequence of execution, with predecessors and successors within the AC. This sequence should follow the Finish to Start approach for the ACs themselves.[2]
- Some form of ordinal risk ranking for each task to provide guidance
- Assembling the IMS from the IMP requires care and discipline. This is not the time the *throw things together.*

[2] There is a community that thinks the Finish to Start (FS) relationship approach is overly constraining to their "scheduling style." The primary reason for FS relationships is to prevent the propagation of incomplete work as the basis of starting new work. This philosophy of "finishing your previous work before starting the next job" is the basis of a credible schedule as well as a credible quality assurance process – technical risk reduction. The objections to this FS approach come from a variety of sources. (1) It is more work on the part of the planners. Two tasks with a Start-to-start Plus 30 days, is much easier than figuring out what actually starts the second task other than the passage of time; (2) It allows the responsible party (usually the CAM) to hide the details of the dependencies on the two tasks. This may be for good reason – she does not actually know what the dependencies are expect that one starts 30 days after the other; and finally (3) it's just plain easier to do and therefore is the minimum effort.

The result is a schedule that has "hidden" dependencies." This is bad for several reasons: (1) Seeing these dependencies can only take place by looking in the predecessor or successor fields of MS Project; (2) The dynamic nature of the schedule (freeness for the tasks to move) is restricted in the Monte Carlo Simulations; (3) The drawing of the PERT process flow is no longer linear from left to right, but the flow goes backward.

- Gather tasks for each AC – link tasks intra–AC first. The last task in the AC must "tree" to the AC placeholder. The first task in the AC is left unattached for the moment until all the ACs have been defined.
- Assess the Event duration by "treeing" all the ACs to their respective SAs and the SAs to the Program Event. Then the inter–AC linking can start.

Figure 18 shows how the tasks are linked within the Accomplishment Criteria first before proceeding to do any other – inter-AC – linking.

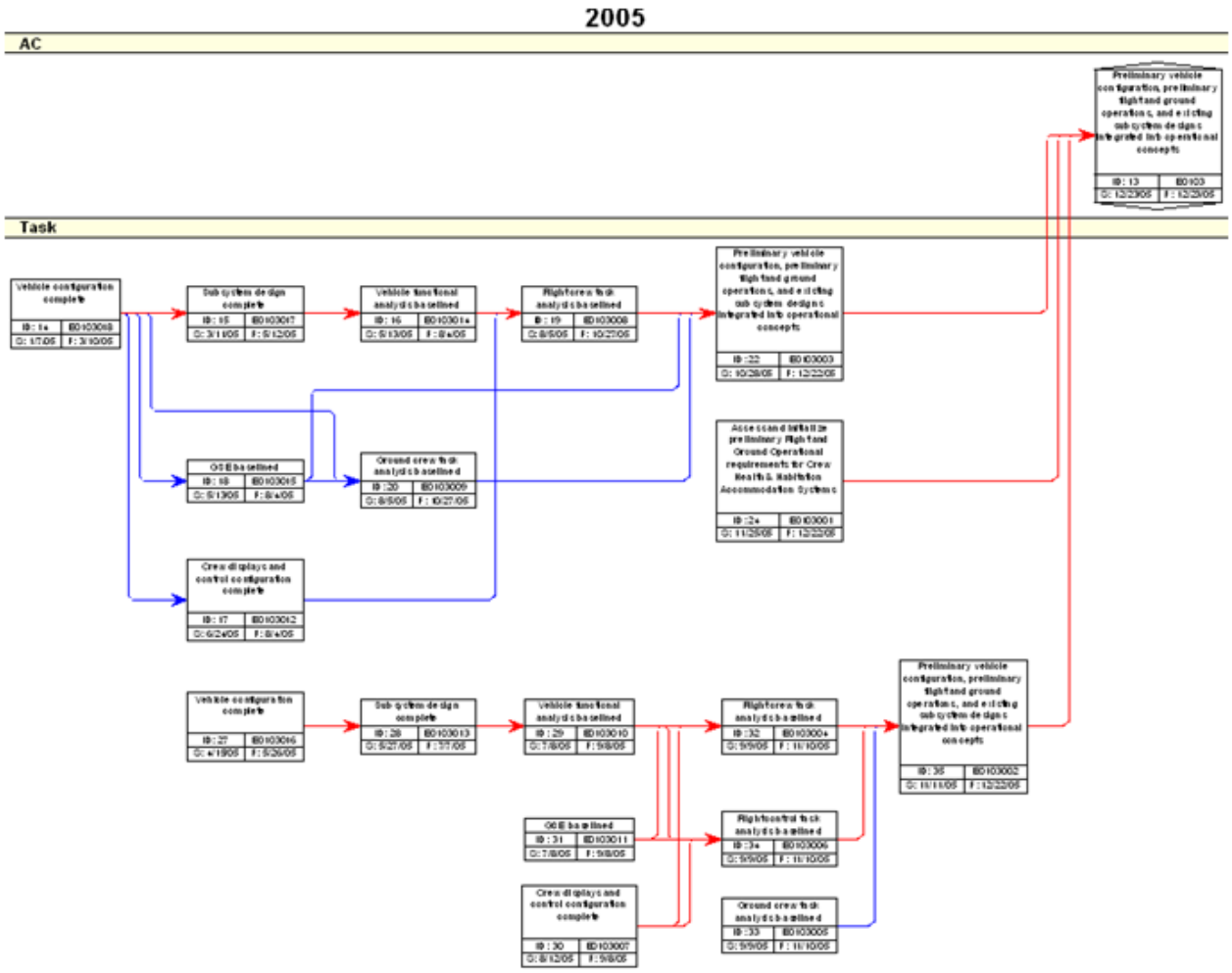


Figure 18 – Linking the tasks to the Accomplishment Criteria within each AC first is the process used to maintain the integrity of the AC before starting to link between ACs. This structure is the basis of individual Work Packages that can then be measured with Physical Percent Complete for the Work Package and Apportioned Milestones within the Work Package itself.

In this approach there is no Task to Task linking – only AC to Task, SA to Task, PE to Task, or External predecessor to Task. If AC to AC links were made, they would be Finish–to–Finish, which not make sense.

Building Credibility into the Integrated Master Schedule

Each AC must produce a result that is a 100% “assessable” item. No partial percent complete assessment is allowed

Focus on the maturation assessment, in the same way as SA/AC maturity statements. For an active rolling wave:

- Each task should have a duration of 10 to 40 days. In many EVMS System Descriptions, the Work Packages are limited to 60 calendar days or 45 work days. This adheres to the concept of Work Packages crossing only one accounting period.

- For Planning Packages the Work Package durations can be longer and the details of their content vaguer. But a critical path to the end of the contract must go through the Planning Packages. So consideration of their content must be performed
- Each task has a duration sufficiently detailed to assigned resources and defines the completion performance metrics
- But not so narrowly defined to limit the rearrangement of tasks when the planning Package is turned into an execution package.

Linking tasks to Accomplishment Criteria defines the foundation for Work Packages:

- An Accomplishment Criteria will have its tasks linked to each other within the AC first, then from another AC (predecessor) or to a task in another AC (successor). When the "last" task(s) in the collection of tasks is complete, the AC will be 100% complete
- Task dependencies within the AC must be Finish–to–Start The initiation of the "first" task in the collection of tasks should be started by the completion of a previous AC as a 1st choice If this is not possible, the "first" task can be started by the completion of a previous task in another AC, but this should not be the first choice. If all the tasks are defined for the completion of an AC first, then it should be obvious how to start this collection.
- Get the collection defined, linked, and connected to the completion of the AC first and only then start linking the ACs together.

4.4 Connecting Cost and Schedule

In some cases, cost and schedule needs to be joined for the proposal. Always cost and schedule will be connected at IBR (Integrated Baseline Review). The approach to avoiding disconnects goes like this:

- Define the IMP – PE/SA/AC to some level of confidence before ever starting the Basis of Estimates (BOE)
- With the AC's determine the cost of the work inside the AC
- Use the WBS assignments within the ACs, but develop costs on an AC by AC basis.
- Develop the tasks for each AC from the BOE and vice versa

With this approach, the BOEs and the detailing of the ACs can keep in sync. As well when the periods of performance change in the IMS, they can be communicated to the BOE team by IMP/IMS number. This way simple adjustments can be made.

5 Integrating Cost and Schedule

The kiss of death for a proposal, and later on an execution project, is to allow the cost and schedule to become disconnected. Once this takes place, the effort to produce the proposal or manage the execution is not only doubled it may be tripled.

- Integrating cost and schedule starts with the schedule, NOT the cost.
- Schedule drives cost.
- The WBS and CWBS are used for cost accounting NOT for structuring the program. That is the role of the IMP.
- This is the inverse of most approaches. And this inverted approach (cost first) is the common source of disconnects between the period of performance for cost and schedule. A disconnect that take months to sort out.

The first step in developing cost is to establish the IMP to the AC level and have it frozen long enough to get a cost baseline in place. This effort requires the Systems Engineer's and their Systems Engineering processes to allocate activities to each Program Event, sequence them at the SA level, allocate ACs for each SA, and match this structure to the WBS and CWBS for cost allocation.

With the ACs allocated, the cost team can answer the question – "how much does this AC cost?" Using the AC, the "lump of work" represented by the AC can be defined. This approach provides critical items:

- The BOE's are organized by IMP/IMS as well as by WBS
- The periods of performance for the BOEs start with the AC arrangement. Although the IMP does not have time, when the IMS is developed, the period of performance can be reverse engineered by into the IMP and then back to the BOEs.
- Since the BOEs are isolated to the ACs, any movement of the AC from the IMS would be reflected in the BOE. Keeping them in synchronization removes most of the disconnects produced when cost and schedule.

5.1 Dollarized RAM

The Responsibility Assignment (Accountability) Matrix needs to have dollars assigned to each member. A structure called the Responsibility Assignment Matrix (RAM) is developed by integrating the Organization Breakdown Structure (OBS) with the Contract Work Breakdown Structure (CWBS). This matrix displays the CWBS on one axis and the OBS on the second axis.

The proper integration of the two structures (CWBS and OBS) into the RAM will create a home for each work statement of the contract and provide a disciplined framework so that organizing, planning, budgeting, measurement monitoring, and reporting of the performance measurement can be correctly implemented. Each intersection point on the RAM defines a possible requirement for one or more specific scopes of contractual work to be performed by the responsible functional organization. This intersection point, envisioned as a third axis within the RAM, defines a point where one or more Task Plans may be formed and a point at which work is organized, scheduled, budgeted and its progress monitored, measured and reported. The fourth axis of the RAM when properly implemented allows for the use of a unique Task Plan for each phase of the contract as it progresses through time.

By inserting the budgets defined for each Task Plan into the designated location of the RAM the "Dollarized" RAM is created. This budget information is normally summed beginning from the Task Plan level through each level of the RAM. The information is displayed for audit purposes during System Implementation reviews for the customer. The dollarized RAM is a mechanical method of footing and cross footing all of the distributed budgets to assure the Project Management Office that the budgets have been properly allocated.

5.2 Cross Reference of all Materials

Most RFP's require a full Cross Reference Matrix (CRM)

5.3 Resource Assignments, Loading and Leveling

There are several approaches of building a resource loaded schedule

- Labor codes at the highest level
- Labor codes by specific subsystem or system type

5.4 Establishing the Earned Value

Establishing a Performance Management Baseline (PMB) is a critical step for the IMS. This PMB may be "proposal grade," or "execution grade" depending on the phase of the project. In either case, the PMB must be developed through the following processes

- Define Work Scope
- Create an Integrated Bottom-Up Plan
- Formally Schedule CAPs
- Assign Each CAP to an Executive for Performance
- Establish a Baseline that Summarizes CAPs
- Measure Performance Against Schedule
- Measure Cost Efficiency Against the Costs Incurred
- Forecast Final Costs Based on Performance
- Manage Remaining Work
- Manage Baseline Changes
- Summary

Define Work Scope

Defining 100 percent of the project's work scope using a work breakdown structure (WBS) is the starting point. This is a difficult task for any project, and particularly so for software projects. Yet, if you do not define what constitutes 100 percent of the assumed work, how can you measure the project's performance in a definitive way? Without a 100 percent reference point, how can anyone ascertain whether you have completed 10 percent, 20 percent, or 25 percent of a job? Realistically, no one can define a new job with absolute precision, but you must make some intelligent assumptions about a new project to quantify the work with sufficient confidence that the defined effort can be planned, scheduled, and estimated with some degree of certainty. Anything less, and management must commit to a job by authorizing a "blank check" for the project. How does one define a job when specific details are often lacking? There are no absolute answers, but one of the most useful of all tools available to any project manager is the WBS. The WBS is to the project manager what the organization chart is to the executive-it allows the project manager to define a new endeavor by laying out all the assumed work, then decomposing each task into measurable work packages. Once the WBS is assumed to constitute a reasonable portrayal of the new project, it can be used to take the next steps in the project planning process, including the make-or-buy analysis, risk assessment, planning, scheduling, estimating, and authorization to proceed.

Create an Integrated Bottom-Up Plan

All critical processes, including defined work scope, schedule, and estimated resources, into an integrated bottom-up plan of detailed measurement cells called Control Account Plans (CAPs) are combined into a single baseline master schedule. Earned value project management is implemented within detailed CAPs, and constitute formal bottom-up project planning. The individual CAPs represent the integration of all critical processes including work scope, planning, scheduling, estimating, and authorization. The performance measurement takes place within the

detailed CAPs, and the total project's performance is the summation of the detailed CAPs. Each project CAP is a subproject of the total project that is managed, measured, and controlled by a CAP manager.

Formally Schedule Control Account Plans

Each of the defined Control Account Plans is planned and scheduled with a formal scheduling system. This the single most critical tool required to implement earned value. The project's scheduling system portrays the approved work scope, which is placed in a specific timeframe for performance – the Period of Performance (PoP). This scheduled work constitutes the project's planned value. As performance proceeds on the project, the portion of the planned value that is physically accomplished becomes the earned value (BCWP = Percent Complete × BCWS). Both the planned value (BCWS)(PV) and the resulting earned value (BCWP)(EV) must use the same metrics to measure their performance. The project's scheduling system is critical to the use of earned value because it represents the project's scope, planned value, and earned-value measurement. The project master schedule is vital to the project since it constitutes the project manager's specified planned value for everyone to follow.

Assign Each CAP to an Executive for Performance

Each of the defined CAPs is assigned to a permanent functional executive for performance. This assignment commits the executive to oversee the performance of each CAP. Projects are transient within any permanent organizational structure – they are authorized, implemented, and performed, then eventually go out of existence. Many of those who manage the detailed performance within the CAPs will not carry the formal title of “manager” within the permanent organizational structure. Many or most of these CAP managers are functional staff temporarily assigned and matrixed into the project by one of the permanent functional organizations. To secure a firm commitment from the functional executives who have the authority and resources to make the plan happen, it is wise to have each of the defined project CAPs essentially adopted by a senior function person with a title such as vice president, director, or manager.

Establish a Baseline that Summarizes CAPs

A project performance measurement baseline (PMB) is established, which represents the summation of the detailed CAPs. The next step forms a baseline against which project performance may be measured. Such baselines must include all defined CAPs plus any management (contingency) reserves that may be held by the project manager. If management reserves are not given to the project manager but are instead controlled by a senior management committee, they should be excluded from the project performance baseline. On a commercial-type contract, the baseline may include such things as indirect costs-and even profit or fee-to match the total authorized project funds. Internal projects will typically not contain indirect costs, profits, or management reserves. Most internal project baselines will be the sum of the defined CAPs.

Measure Performance Against Schedule

Periodically, the project's schedule performance is measured the against the planned master project schedule. The formal and controlled project master schedule constitutes the project's planned scope. Each task described on the project master schedule should be resource loaded. As performance takes place within the CAPs, the relationship between the value of the work scheduled is compared to the value of the work accomplished. The difference between the work scheduled and work accomplished is the schedule variance in earned value. A negative schedule variance means that the value of the work accomplished does not match the value of the work scheduled, i.e., the project is falling behind in its scheduled work. Each behind-schedule task can be assessed as to its criticality to the project. If the late task is on the critical path, or if the task carries a high risk to the project, efforts can be made to get the late task back on schedule. Conversely, if a task has positive variance or is not considered a high risk to the project, added resources should not be spent to accelerate its performance.

Measure Cost Efficiency Against the Costs Incurred

Periodically measure the project's cost performance efficiency rate, that represents the relationship between the project's earned value performed and the costs incurred to achieve the earned value. The single most important benefit of employing earned value is its cost efficiency readings. The difference between the value of work performed and the costs incurred to accomplish the work provides the cost-efficiency factor. If the project is spending more than it receives in value, this is an overrun condition. Absolute overruns are likely to be nonrecoverable. Overruns expressed as a percentage value have been found to deteriorate unless the project takes aggressive actions to mitigate the condition. The cost efficiency rate has been found to be usably stable from the 15 percent point of a project completion and progressively more stable as it goes from the 20 percent to 30 percent to 40 percent completion point. Therefore, the cost efficiency factor is an important metric for any project manager or enterprise executive to monitor.

Forecast Final Costs Based on Performance

Periodically, forecasts of the project's final cost requirements based on its performance against the plan, must be produced. Earned-value provides the ability to independently forecast the total required funds at the end of a project, commonly called the “estimate at completion” (EAC). Based on project performance against the plan, a project manager can estimate the total funds required to finish the job. These statistical estimates are a grass-roots sanity check against estimates based more on wishful thinking because they provide a more realistic estimate of the values needed to finish the job-unless someone has a preconceived notion of what that value should be. If the earned-value statistical estimates are greater than the “official” project estimates to complete the project, someone in a senior management position should reconcile these professional differences of opinion.

Manage Remaining Work

The project's remaining work must be continuously managed. The results achieved to date on a project, good or bad, are in effect “sunk costs” – costs gone forever. Any improvements in performance must come from future work ahead of the latest status date. Earned value allows the project manager to accurately measure the cost and schedule performance achieved to date. If the results are less than desired, the project manager can exert an aggressive posture on all future work. Earned value, because it allows the project to accurately quantify the value of its work achieved, allows the project manager to quantify the value of the work ahead to stay within the objectives set by management.

Manage Baseline Changes

The project's baseline must be continuously maintained by managing all changes. The project performance measurement baseline is only as good as the management of all proposed changes to the baseline during the duration of the project. Any performance baseline becomes invalid if management fails to incorporate approved changes by the addition to or elimination of added work scope. All changes of project work are addressed by the approval or rejection of changes. For the initial baseline to remain valid, every change must be closely managed. Maintaining a baseline is as challenging as the initial definition of the project scope at the start of the project.

Summary

The earned value project management concept has been demonstrated to be an effective technique in the management of major projects. Unfortunately, most of the experience with the concept has been restricted to those applications where the U.S. government has imposed the technique on major new systems acquisitions for which it retains the risk of cost growth.

The best opportunities for earned-value employment may well lie in the management of thousands of smaller projects that are being directed by people who may be unaware of earned value. The EVMS concept should be considered when the risk of cost growth resides with a project manager, or a lump sum or fixed price contract is

used, and on all In–house funded developmental projects where a firm commitment is made to management. It should be considered when a project manager can benefit from an early warning cost signal in time to alter the ultimate direction of a project. Software projects can especially benefit from the employment of a simple earned-value approach.

6 Working on an Execution Team

With a winning proposal, the IMP and the IMS will become part of the execution strategy for the program. The IMP is part of the contract and the first level IMS elements are connected directly to this contractual obligation, so they are part of the contract by implication. This why it is critical for several things to have happened during the proposal development of the IMP/IMS:

- Use the IMP to drive the first tier IMS to an Event Based Plan.
- Only then, develop the needed horizontal schedules for execution. This will be classified as "supplemental schedules" and kept in the CAM notebooks.
- If the horizontal schedules "leak" above the supplemental level, then the IMP and IMS will be a "rats nest" of tasks and the vertical integration will have been lost.

- The IMP properly describes the increasing maturity of the program in a way that separates the vertical work from the horizontal dependencies. If the IMS is a "rat's nest" of tasks, that cross Event boundaries, then the traceability to the IMP is impaired. The natural inclination of the "old school" schedulers is to build a "manufacturing schedule" as the IMS and label the elements with IMP identifiers. This can be done of course, but it is a waste of time for everyone. DO NOT DO THIS. Stick to the pure structure of the IMP and the first tier IMS as Event Based Planning

6.1 Integrating the Individual Event Schedules

The primary issue with the execution of the IMS is managing the individual events as a continuous project. during the execution of the program, functional areas operate in parallel across the program event boundaries, while at the same time producing products and services that are connected to the individual program events.

Both the vertical (Event Based) and horizontal (Functional Based) connections must be maintained during the execution of the program. This possess several problems:

- Much of the execution work crosses Program Events, so linkages from the Functional network to the Program Events must be provided
- Program Event work must be defined in order to determine the Physical Percent Complete for each event

So some compromise needs to take place. This is usually done in stages.

- From contract award to PDR the majority of the deliverables are built around CDRLs. These documents have specific "maturity" assessments targeted to PDR. This is a natural candidate for Event Based Planning. Each

6.2 Defining the Functional Technical flows

6.3 Executing the Performance Measurement Baseline

6.4 Business Rhythms

6.5 IMS Architecture and Execution

7 Working on a Proposal Team

There are several important activities on a proposal team when building the IMP and IMS. First, there needs to be a deep understanding of the "attributes" of a person working on a proposal team. These are not the same of someone working on an execution team. It's not that the execution team person can't bring value to the proposal team, it's that the proposal team demands more of someone, than just executing on a day to day basis.

If this is not understood up front, it becomes difficult to add this understanding while underway. By that time, the expectations have been set or have been missing and more effort is needed to get back on track.

- Proposals are "mini-projects" with deliverables, schedules, resources, and clear requirements.
- The proposal that requirements and IMP/IMS can use an IMP/IMS to build the proposal.
- Staff working a proposal must have a different approach to their work than an execution team.

Attributes of a Team Member	Outcome
0% / 100% completion of assigned activity	The measure of progress speaks only in physical percent complete. If you leave work on the table at the end of the day or the end of the week, you are "behind" schedule. If you leave 10% remaining a week, in 5 weeks you are 50% behind schedule.
Focus all your efforts on the "coming due" deliverables before moving to the next set of activities.	Until the "coming due" items are complete and delivered, it is of no value to work on anything else. To do so simply mortgages the future with incomplete work.
Think about the simplest approach to the plan that connects the work in series with as few dependencies as possible	"Better is the enemy of good enough." Designing and deploying a "better" process, system, or deliverable simply wastes time. Once the "good enough" outcome has been achieved, it can be made "better." To do otherwise means you will not only be late you will be non-compliant.
Members work with a "Plan of the Day" and "Plan of the Week"	Iterative and incremental deliverables on fine grained boundaries are the key to success. This approach connects with the 100% complete requirement
The "Plan of the Day" and "Plan of the Week" is a tightly controlled list.	No random additions, even if they may be good ideas. Do only that work which moves the project (proposal) forward. Challenge each addition to the list for its contributed value.
Divide and conquer the work effort. Maintain "separation of concerns" for all work activities.	Each member has specific assignments. No overlap during normal work process. 100% dedication to the assigned work activities. Only when extra help is needed does a member pick up the slack for other members.

Table 6 – Not everyone is "wired up" to work on a proposal team. The success criteria for a proposal team member starts with some training on how the manage a proposal, which can be found in books and the class room as well as formal "on the job" training with a proposal management firm. However, more importantly are the personality attributes of a proposal team member.

A Check List for Executing the Proposal Development Process

This list is continuously growing, but here is a start.

IMP/IMS Proposal Development Process	Implementation Details
Build the IMP and IMS by event. This cannot be emphasized enough. There is no other viable way to do this. To do otherwise jeopardizes the integrity of the IMS for large programs.	By focusing on each event – from left to right – 100% of each event can be done and then the team can move on. This is the core concept of incremental and iterative development of anything. Once this is understood the process of building the IMP and the related IMS will flow smoothly
When you get 100% of something done, then you	By not finishing 100% of an event – with the information

IMP/IMS Proposal Development Process	Implementation Details
do not have to go back and work on it again. If you leave behind 10% work, and do that 10 times, you are 100% behind.	at that time – you are mortgaging the future with a debt that cannot be paid back. This approach is the same for the daily processes.
Always keep past version of each file in an Archive.	Label the files in some logical manner. Putting the date in the file name is NOT the way to do it. It clutters the name and is redundant, since the date is in the file properties. Use a Revision Number – Rev 02 for example. Name the files the name of the Event – Program Name–PDR–E09 – is a good way. In the heat of battle, having confusing or non–intuitive naming conventions is a serious source of error.
Structure the individual files and use tools to make the connections between them	Create a Master Events file. This contains the Program Events, their names and codes – C – Preliminary Design Review (PDR). Set the date for the event from the RFP or government assigned date. This Master Events file is then inserted into each individual event file for linkage.
In each individual Event File have only one (1) program event. Use a macro to define the event code.	By having only one Program Event per file the work can be divided between several planners and the processes of developing the IMP and the related IMS executed in parallel
Have a single person responsible for keeping the files "clean" in terms of the preamble Program Events, the Master Event file, and the naming conventions inside the individual event files.	This person is the sole owner on the baseline. He or she allocate out ownership on a temporary basis for updating and editing. But the true baseline comes from only one place.

7.1 Iterative and Incremental development of the IMP/IMS

Development of the IMP and IMS is an iterative and incremental process. It is not a "big bang" or more importantly, it is not a partially complete "big bag." The principles of iterative software development have direct application for the proposal – at the end of each iteration (possibly a week and maybe a day) – there is 100% complete, functioning and compliant work products. The IMP/IMS Lead needs to be "ruthless" about this, otherwise the team will be late from day one.

IMP Development

- Start with the government RFP and standard Program Events. Put these in a database or project template file.
- Assess the logical sequence of these Events
- Build a description of the Events from a variety of sources. These are found in the DAU DoD Procurement Desktop
- NAVAIR 4355.19C
- Build the SAs and ACs

IMS Development

- Build the IMS by Event. This is not an optional suggestion, it is mandatory. This places the burden of capturing the IMS elements on the CAMs not on the IMS developers. The CAMs may object to this, but it is critical that each Event be standalone and can be developed in parallel.
- Start with capturing the work within each AC. This work should be limited to 10 to 15 lines of tasks and can be physically captured in a Work or Excel file. Be careful with Excel, since there is a bug in Microsoft Project when cutting and pasting from Excel, when that Excel file has an external URL connection. Project hangs.
- Develop the AC logic structure first and avoid any inter-AC development until the logical flow between the ACs is completely defined.
- With the AC logic in place on the "white board," make the inter-AC connections in the Finish-to-Start manner.

7.2 Focus On Only Three (3) Things A Day For The Team

There is a natural tendency to make long lists of things to do. Continuously talk about this list, focus on the top three things, and do not succumb to trying to handle all the things at once. Three is not a magic number. It can be some other number. However, if the number of things to do is not managed to a small list, it will grow without bound.

There needs to be a parking lot for all the items, but only the top three are on the to–do list. Then everyone has a chance to contribute while the team can stay focused on the "coming due" items. This is a core skill for any team, especially a proposal team. Do not let the team members violate this axiom. As a IMP/IMS developer use the concept of events, accomplishments, and criteria for the IMP/IMS in the development of the IMP and IMS for the proposal – the cobbler's children *should* have shoes.

7.3 Have Automation

There can be great advantage of automation of the IMP/IMS process during the proposal. However, care is needed not to get wrapped up in the development of tools. Have a "tool smith" be the person doing the work. Remember to keep it simple. Below are some examples of automation that adds value and reduces risk:

- IMP/IMS numbering – a macro that auto–numbers the IMP/IMS number is mandatory in a fluid proposal environment. This macro should allow the definition of the IMP/IMS format, the starting Program Event identification and be smart enough to know what to number and what not to re–number
- Cross reference database for all the SOO, SOW, CDRL, IPT, etc items in the IMS – a central repository for all the cross reference items is needed. Keeping the straight is the job of a piece of software not a person. There should be a single person accountable for the integrity of the contents of the Database
- Build the IMP from the MSFT project file using a View that colors the rows for the proper identification – formatting is actually important. Treat the discussion of format in the same way you treat the content discussion. Color, fonts and styles, indents and the like all communicate information
- Use a common data storage location – managing change control and the official version of the IMP and IMS is critical. Maintain version numbering is critical. Anyone violating the version control protocol can cause big delays in the development of the IMS in a proposal and serious sets back on an execution project. Even with a Project Server, versioning can be broken. Every team members needs to be accountable for managing the files that represent the IMP and IMS
- Project Server – a Microsoft Project Server can be used to advantage for proposals and execution. However, this tool cannot be managed by a group. A systems administrator is needed. The Enterprise Global is the place for all formats, macros, views, table and everything configurable.
- eProjects – a file based repository can be used as well. Clear and concise rules about folders, naming, versioning, and other change impacts must be established. Something as subtle as a file naming convention can add or detract from the productivity of the team
- Share drive – share drives are the least desirable approach
- Have a daily backup of the primary storage serve – you cannot have too many backups. But backups start with version control and mandatory check–in at the end of the day. The end of the day can be "sun rise" the next day, but no team member should considered the MSFT Project files their "property," to be kept on desktop or laptop computers. The files belong to the "team," treat them as community property.

7.4 Working On A Team

There are many things to be considered in working with a team on a proposal or on an execution program. Here's some that have gotten in the way in the past. This list is probably endless...

Communication

- Have a simple protocol for communicating between the team members. Who leads, who follows, who's responsible for keeping notes.

- When using a speaker phone, have a good one. Speak only in short, clear and concise phrases about the topic at hand. Almost all speaker phones are half–duplex, so if you are hogging the phone by yammering on endlessly, then others can't speak, break into your conversation and add any value.
- Speak slowly and clearly on the speaker phone. Be aware of how imperfect the conversation is across the wire. Talking fast, in abbreviated phrases just confuses the conversation.
- Talk only about the agenda topics until they are completed. Resist the temptation to move into other areas until the current topic is completed, all on the phone agree it is completed and there is an "actionable outcome" from the conversation.

Sharing the Load

- There is a fine line between being helpful, being controlling, and being a pain. Find out first if the person actually wants help before deciding they need help.
- Let everyone be accountable for their assigned outcomes. On a proposal and during execution, clear and concise accountability is mandatory. This means a RAM for the team. However, with the RAM all team members must respect the RAM. "Answering the mail" for others is actually no helpful.

Be Accountable

- A team is defined as "a group of individuals who hold each other mutually accountable for a shared outcome."
- Remind yourselves every morning – at the standup – of what it means to be on a team.

Focusing on Deliverables

- With the team in place, decide each morning what is due at the end of the day.
- Make a mutually accountable agreement to "get this done," by the end of the day.
- The primary role of the IMP/IMS Lead is to define and manage the daily work load and make sure these are the right deliverables and that this list can be accomplished during the day, the week

7.5 Never Leave the Room Without It …

- Negative slack in the IMS – remove negative slack in 24 hours. If it stays, it will become "stuck" and be harder to get out. This is the case for proposals as well as execution processes.
- Backup the daily work – always backup in depth. Even MSFT Project Server crashes once in a while. Make the version control process be part of the backup, with numbering of the files to match the day and the incremental versions within the day. Be ruthless about managing the backups and the version numbers.
- Check the three "to–do" list items to see what was accomplished. Do not add anything to the list without first completing something on the list – have all the lists you want, but have a "must finish today" list derived from those. It is simply bad time management to keep adding to the list without a plan to reduce the count of items. This is "death by a thousand cuts."
- Checking to see if anyone needs help with their plans – building the IMP and IMS is a team sport. Pick up the slack for those falling behind. Do not let that person be a martyr, insist on helping.

7.6 Better Is The Enemy Of Good Enough

There is a tendency to try to make it better. This is the kiss of death for a proposal team and an execution team.

- Ask the team "what is 'good enough?'" Decide what it means to be "done" at the end of each day, each week, and each delivery period.
- Manage this "done definition" in a ruthless manner is a Critical Success Factor. This is annoying to many people, but it is important to the process to stay focused
- One common trait for many people new to the IMP/IMS and the Professional Planning Community is "Adult ADD." This is the "shiny penny" syndrome.
- Using the TO DO list with the top three items is one way to address the A-ADD syndrome. The other way is to build an IMP/IMS for the IMP/IMS and measure maturity of the proposal products

7.7 Vertical Linking

Vertically linking the files depends on the approach to structuring:

- Un–indented (or even the indented) files indicate which IMP/IMS component by a flag
  Flag – PE

  Flag2 – SA

  Flag3 – AC

  Flag4 – Task
- Indented files indicate which IMP/IMS component by the outline level
  Flags can be set for filters and formatting. The outline code indicates the IMS level

  Outline 1 – PE

  Outline 2 – SA

  Outline 3 – AC

  Outline 4 – Tasks

In this approach, the summary tasks cannot be used as the IMP elements. A separate "place holder" for the IMP element must be used. This can be created by a macro or by hand. It will have the same name as the summary tasks. If it is an AC, the tasks in that AC are linked to each other and one task must be linked to the AC as a successor.

All ACs must be linked to SAs and successors and the SAs linked to the PE as a successor. This vertical tree is the topological structure of the program event.

Building the Files Independently

When building the files independently there needs to be a single place where the Program Events are defined and this is included in each independent file.

This is an example of vertically linking using these files:

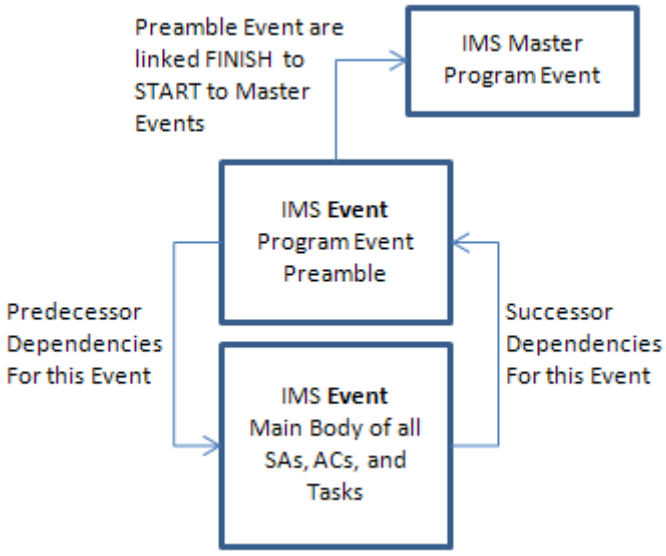


Figure 19 – one approach that has worked well in the past is to have a "preamble" on the front of each Program Event file that contains the Event names, dates, and deadlines. This information should be kept in a separate MSFT Project file and updated through a macro, either from a database our an internal process. Single source – multiple use keeps everything straight. Linking from within the body of the Program Event file is the way to isolate the events. Then the preamble is linked to the Master Program Event file when all the files are assembled into a single Master File

A "Preamble" is placed in each individual file that has the Program Events defined, there planned dates (set to MUST FINISH ON), and their Line number that will appear in the individual file for reference. Since this file is the first element in each individual file, the ID numbers will always be the same. These ID numbers are a "cheat sheet" when working in the MSFT Project view or the PERT Chart expert view to remember the ID for Predecessor and Successor entries.

This file should be maintained by a single person and kept with the collection of the other IMS files in a single folder with the title of the Program.

Little details like this are critically important when under deadline or when confusion reigns during an update to the IMS. Even when something like SharePoint or Project Server is used careful attention to organization details pays off many times over. Find the neatest, more organized person on the team and assign them this role

7.8 Horizontal Linking

Horizontal linking can take place in two ways:

- Inside the Event, links between ACs take place from the predecessor AC to the success task that starts the next AC.
- Outside the Event there are several ways
- There can be a SND/RCV file
- There can be two fields (SND and RCV in text fields) that indicate the receiver and sender of a dependency.
- The later approach is better for proposals, the former for execution.
- In both case there should NEVER be a link from task to task within an Event or across Events.

Linking Across Program Events

Linking across Program Events can be done in several ways:

- Live connections – using some sort of SND/RCV file, where the dependencies are made through predecessor and successor connection that pass through a separate file.
- Assembled connections – identifying the connections in each file with a SND and RCV index that is then assembled into a master file.
- Hard coded connection – where each file has a static set of dependencies include in the file that define the dependencies.

All three approaches are viable, but a decision needs to be made when to use each one.

8 References

The following materials must be read and absorbed as well as the contents of this guide. This may be a daunting task for the beginner, but over time many of the concepts described in this guide will be clearer and a deeper understanding of the difficulties of applying IMP/IMS in on immature program will emerge.

- "Integrated Master Plan and Integrated Master Schedule Preparation and Use Guide," Version 0.9, October 21, 2005.
  This Guide amplifies the event-based technical approach directed by policy in the February 20, 2004, USD(AT&L) Memorandum, "Policy for Systems Engineering in DoD," and October 22, 2004, USD(AT&L) Memorandum, "Policy Addendum for Systems Engineering;" complies with the Earned Value Management (EVM) policy directed in the March 7, 2005, USD(AT&L) Memorandum, "Revision to DoD Earned Value Management Policy;" and complements the guidance provided in the *Defense Acquisition Guidebook*.