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NESDIS WORK BREAKDOWN STRUCTURE HANDBOOK

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National Environmental Satellite, Data, and Information Service (NESDIS)

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Prepared by:

SPENCER.DAVID.DWIGHT.1173662960 Digitally signed by SPENCER.DAVID.DWIGHT.1173662960 Date: 2020.12.15 15:08:56 -05'00'

David Spencer
Office of Systems Architecture
and Advanced Planning

Date

Approved by:

GRIFFIN.VANESSA.L.1204308663 Digitally signed by GRIFFIN.VANESSA.L.1204308663 Date: 2020.12.15 14:14:25 -05'00'

Vanessa Griffin
Director, Office of Systems Architecture
and Advanced Planning

Date

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1. Introduction

1.1. Purpose

The purpose of this document is to provide program/project teams with necessary instruction and guidance in the best practices for Work Breakdown Structure (WBS) and WBS dictionary development and use for project implementation and management control. This handbook can be used for all types of National Environment Satellite, Data, and Information Service (NESDIS) projects and work activities. The products of these work efforts may be hardware, software, data, or service elements (alone or in combination). The aim of this document is to assist project teams in the development of effective work breakdown structures that provide a framework of common reference for all project elements.

Benefits of using an effective WBS include, but are not limited to, providing a basis for assigned project responsibilities, providing a basis for project schedule and budget development and tracking, simplifying a project by dividing the total work scope into manageable units, and providing a common reference for all project communication.

1.2. Applicability

This document applies to NESDIS Headquarters, Offices, programs, employees, and contractors involved in the creation, adaption, and management of WBSs and related project tasks.

1.3. Authority

NESDIS-PD-1110.1, NESDIS Systems Engineering and Program Management Policy

1.4. Applicable Documents

a. NASA/SP-2016-3404 Rev. 1, NASA Work Breakdown Structure Handbook.
b. NOAA CWIP Policy, Construction Work-In-Progress Policy (March 2017) and Appendix F: Policy for Reporting Construction Work-In-Progress and Capitalization of NESDIS Satellites, Their Component Sensors and Related Assets.
c. NESDIS-PR-1210.1, NESDIS Project Management Procedural Requirements.
d. NESDIS-PR-1220.1, NESDIS Project Approval Process.

2. WBS Overview

2.1. Definition

A WBS is a product-oriented family tree that identifies the hardware, software, services, and all other work required to achieve an end-project objective. The purpose of a WBS is to subdivide the project's work content into manageable segments with increasing level of detail to facilitate planning and control of cost, schedule, and technical content. A WBS is developed early in the project development cycle per NESDIS PD 1110, NESDIS Systems Engineering and Program Management Policy. It identifies the total project work to be performed, which includes not only all in-house work content, but also all work to be performed by contractors, international partners, universities, or any other performing entities. The WBS must contain science work, product development, operations, and maintenance costs where applicable. Work scope not contained in the project WBS should not be considered part of the project.

A WBS is developed by first identifying the system or project end-item to be structured, and then successively subdividing it into increasingly detailed and manageable subsidiary work products or elements to the level of detail necessary to effectively manage the project. Most of these elements are the direct result of work (e.g., assemblies, subassemblies, and components), while others are simply the aggregation of selected products into logical sets (e.g., buildings and utilities, operations, and maintenance) for management control purposes. Because WBS element/product completion can be verified, a WBS provides a solid basis for technical, schedule, and cost plans and status.

2.2. WBS Hierarchy

The project WBS structure should encompass the entire project's approved scope of work. It usually consists of multiple levels of products along with associated work content definitions that are contained in a companion document called the WBS Dictionary. All projects have the capability of subdividing the work content down to any level necessary for management and insight. Note that the NESDIS Financial System currently limits the ability to capture costs to the use of project and task codes. However, the NESDIS Office of the Chief Financial Officer (OCFO) maintains the Financial Management Data System (FMDS), which can ingest additional information to track, monitor, and display WBS information at any level the program requires. These three levels of the WBS are defined below.

- Level 1 is the entire project.
- Level 2 elements are the major operational product elements along with key common, enabling products that are integral to the overall asset. Level 2 elements should be discrete to a single end asset (e.g., do not mix instrument costs for multiple flight models in a single WBS).
- Levels 3 contains further definable subdivisions of the products contained in the level 2 elements (e.g., subsystems, components, documents, and functionality).

Levels 1 and 2 of the WBS are defined by the official WBS provided by the NESDIS Chief Financial Officer (CFO). It is incumbent upon the Project Manager (PM) to obtain the latest

official version from the CFO. There are numerous terms used to define level 3 and succeeding levels of the WBS below the system level. Some typical examples used for hardware and software product elements are subsystem, subassembly, component, module, functionality, equipment, and part. Project management personnel should use the subdivisions and terms that most effectively and accurately depict the hierarchical breakdown of project work into meaningful products.

A properly structured WBS will readily allow complete aggregation of cost, schedule, and performance data from lower elements up to the project or program level without allocation of a single element of work scope to two or more WBS elements. WBS elements should be identified by a clear, descriptive title and by a numbering scheme as defined by the project that performs the following functions:

- Identifies the level of the WBS element, and
- Identifies the higher-level element into which the element will be integrated.

Figure 1 depicts how work scope can be arranged as hierarchical WBS levels of work within a project. All project effort must be included, including all in-house, contracted, international partner, university, and any other performing entity implementations. Enabling organizational common products must also be reflected appropriately with a project WBS (e.g., Project Management and Systems Engineering).

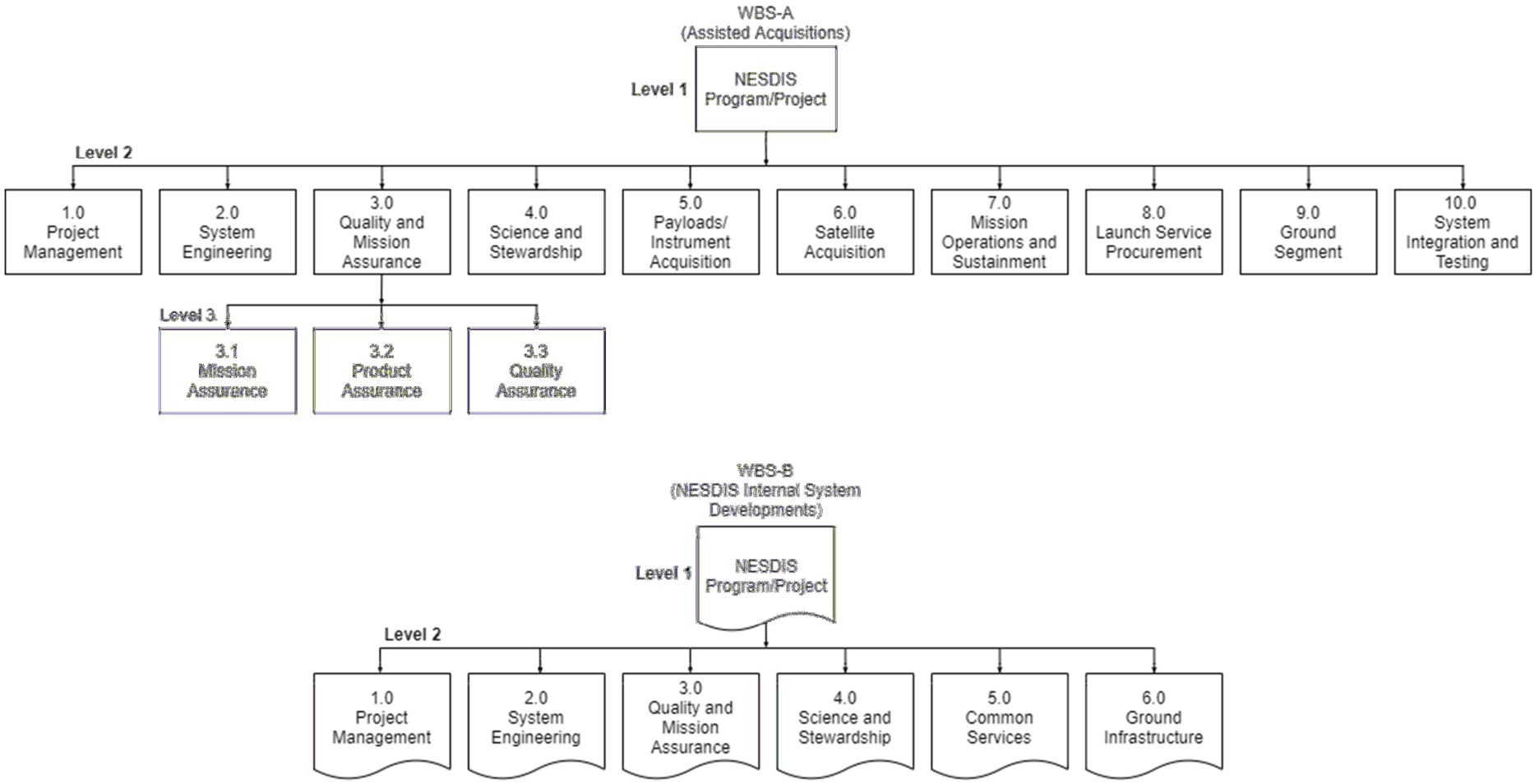

Figure 1: Example Hierarchy of WBS Levels

Note that this is not the official NESDIS WBS. Please obtain the latest WBS from NESDIS CFO.

NESDIS WBS-A projects are mainly those that involve assisted acquisitions, whereas WBS-B projects are those that have been generically adapted for NESDIS systems and projects.

The WBS helps to ensure that project costs are applied to the correct work scope being implemented by the project. This process is necessary for carrying out successful Earned Value Management (EVM) processes. The top two levels of a project WBS are dictated and controlled by NESDIS CFO through a standard WBS template. WBS levels 3 and lower are developed by the project and should be controlled by project management personnel. In cases where prime contractors, assisted acquisitions, or partnerships are involved, their elements fit within the overall WBS for the project and must be traceable to the appropriate upper-level elements controlled by the NESDIS PM.

2.3. Development Guidelines

Only one WBS is prepared for each project, which includes in-house and all other efforts. While there is no single "right way" to prepare and utilize a WBS, there are some generally recommended guidelines that should be followed. Considering the following general guidance will assist in creating and implementing an effective WBS.

1. The WBS is prepared as early as project definition will permit.
2. A preliminary WBS is initially developed early in project formulation to define the top levels of a WBS. These preliminary elements should reflect the entire scope of work contained in the overall project life cycle including project definition, development, and operations.
3. A single WBS is used for both technical and management aspects of a project.
4. Both high-level and detailed WBS planning should involve all stakeholders to ensure that proper planning is done and that all parties agree on the final WBS prior to approval.
5. When a project is authorized, the WBS becomes formalized as the project outline. Changes to it must be formally approved by the program office.
6. As the project scope of work changes, the WBS is revised to reflect changes that are formally approved through the configuration control process.
7. Not all top-level WBS elements have to be subdivided to the same level of detail. As associated element risk, cost, and/or complexity increases, further breakdown may be necessary to ensure responsible tracking.

While most project WBS structures are different at lower levels, the above guidance can help guarantee that level 1 and 2 WBS elements are consistent across NESDIS projects. This ensures proper and recommended WBS characteristics exist for all projects.

2.4. Summary

As previously discussed, a WBS defines all work to be performed for project completion. It is a product-oriented structure, not an organizational structure. To develop and maintain a WBS, you must have a clear understanding of the project's objectives and the end item(s) or end product(s) of the work to be performed. The WBS provides a common reference for all project communication, both internally within the team and externally to project stakeholders. The WBS also provides a means of rolling up project data to any desired level for analysis and

oversight. Because of its product orientation, a WBS provides the framework to plan, track, and assess the project's technical, schedule, and cost performance.

3. WBS Development and Control

3.1. WBS and the Project Life Cycle

A preliminary WBS is developed early in the conceptual stages of the project. It is established as soon as program management personnel believe the project has reached a stage of definition where it is feasible. It is used to assist in the preparation of the project plan. The preliminary project planning process is an iterative process. During its early phases, the preliminary WBS may be revised as necessary. Once the project is established with sufficient and stable scope definition, then the work elements can be adequately planned and established at the necessary levels of detail. Once approved, the WBS cannot be revised except through the formal approval process at major transitional points in the project.

3.2. WBS Activities and Responsibilities

The PM is responsible for developing and maintaining the WBS and the WBS Dictionary. The WBS evolves from an iterative analysis of:

1. Project objectives,
2. Functional design criteria,
3. Project scope,
4. Technical performance requirements,
5. Proposed methods of performance, and
6. Risk and complexity. (Note: Cost and schedule changes may impact scope, which could drive modifications to the WBS.)

As stated earlier, a project WBS, while being predominantly product-oriented, must also reflect all the effort that is in the approved scope of work. Because of this, common elements of work must be included that are not necessarily product-oriented. This effort is typically accomplished by “enabling organizations,” such as project management, systems engineering, etc. The WBS should be developed by the project team and approved by the PM. This development must be a coordinated effort involving the following groups:

1. Systems Engineering,
2. Project Management,
3. Business Management, and
4. Technical Disciplines.

Projects with scopes of work to be implemented by predominantly in-house civil servants and associated support contractors must also reflect their total effort with appropriate hierarchical subdivided WBS elements. This subdivision of work must extend down to the point where work is actually accomplished.

3.3. Development Considerations

The following items should be considered when developing a WBS:

1. Compatibility with internal management systems,
2. Consistency with the NESDIS CFO accounting system,
3. Correlation with other technical or programmatic requirements,
4. Number of levels,
5. All-inclusiveness,
6. Change control, and
7. Control Account (CA) levels for charging costs.

Following is a brief discussion of each consideration. Guidance on creating checklists to aid in the WBS development process are found in Section 3.4c.

a. Number of Levels

The hierarchical structure of a WBS is an important consideration. Project work is performed to satisfy technical objectives established for each product or sub-product identified as a WBS element. As each product is subdivided into greater depth within a WBS, each element's technical complexity and resource requirement are reduced. The number of levels and elements in the structure is generally dependent upon the size and complexity of the total effort, the degree of technical uncertainty, organizational structures concerned, and management's judgment of need.

Figure 2 illustrates a hierarchical subdivision of work that is product oriented down to a level where work is planned, costs are charged, and management insight is maintained.

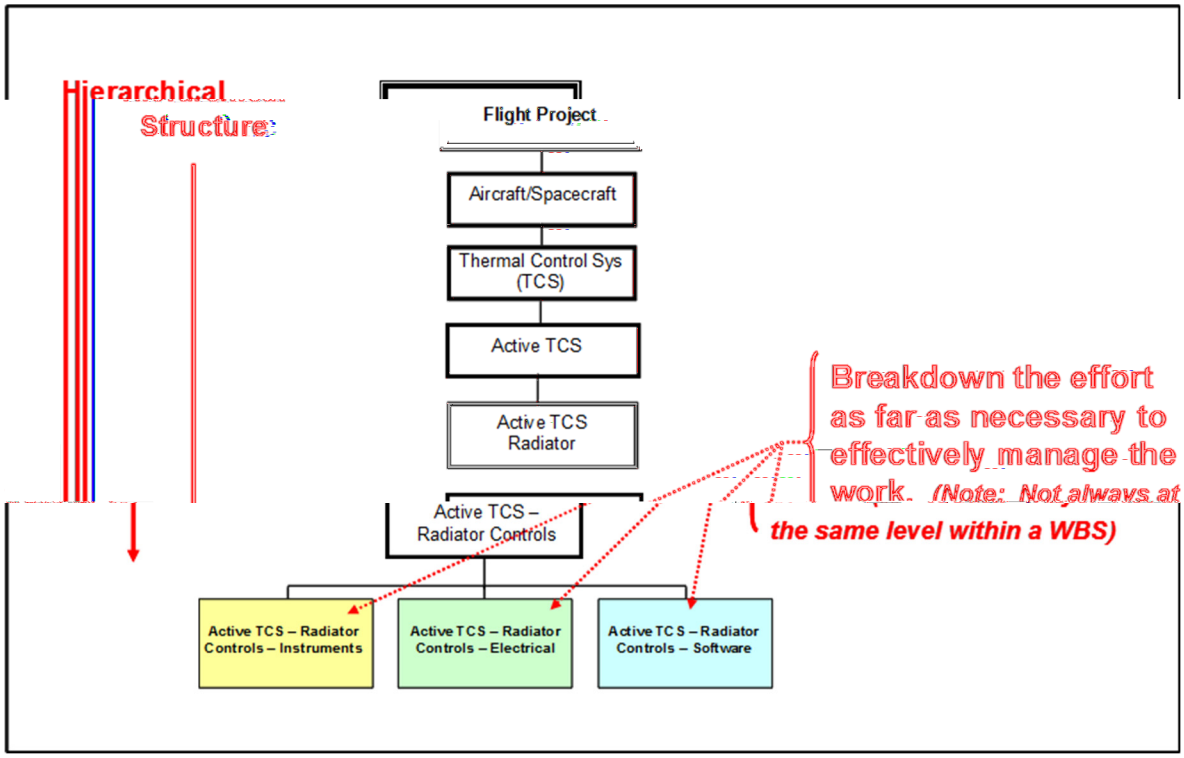

Figure 2: Example of Work Breakdown and Hierarchy

As the end product is decomposed into smaller sub-products at lower WBS levels, the work effort required by each element can eventually be identified and relatable to an appropriate

functional organization. At some level on each WBS branch, management will assign responsibility for technical, schedule, and cost performance. It is at this intersection of WBS element and organization unit that a CA is usually established, work is scheduled, budget is planned, cost is collected, and performance is measured, recorded and controlled. To do this, the technical content and requirements for each work product must be clearly specified and documented. As project work is accomplished, actual completion and technical requirements can be verified.

The WBS level at which a CA is established is primarily a function of the size of the project and the type of product. The responsible organization level is a function of the management span of control and upper management's desire to delegate technical, schedule, and cost responsibility for WBS elements to lower management levels. *It should be understood that all CAs do not have to be established at the same level within the WBS structure.* A CA, if needed, may be subdivided further into Work Packages (WPs) and Planning Packages (PPs). A WP provides further detail on work content that is considered near-term, while a PP defines far-term work at a summary level. Each product branch within the WBS only needs to be subdivided as far as needed to allow for adequate management, insight, and control.

“Control Account”, “Work Package”, and “Planning Package” are terms typically associated with EVM. EVM is covered in NESDIS-HBK-1224.1, Project Cost and Schedule Status Tracking. However, due to many projects requiring EVM implementation, and since there is such a close and important relationship between the WBS, CA, WP, and PP, this topic will be addressed briefly in this document. It should be clearly understood by project teams involved in up-front project planning that the quality and format of their WBS will correlate directly to how well they will be able to implement usable and meaningful EVM practices.

A CA generally consists of one or more WPs and may include one or more PPs. A WP is the unit of work required to complete a specific job such as a test, a report, a design, a set of drawings, a service, or fabrication of a piece of hardware. A PP is a logical aggregation of work within a CA containing far-term effort, which can be identified and budgeted in early baseline planning at a higher level, but cannot yet be adequately defined into a WP. The WBS must be extended at a minimum to the CA level, however, if lower insight is needed to enhance or satisfy management needs, then WPs or PPs may be included within the WBS. If EVM is a project requirement, then careful early coordination with the financial analyst is required to ensure that the WBS contains the needed levels of element detail. Additionally, the financial analyst will ensure that the correct WBS element codes are established as CAs and then activated within the NESDIS Financial System to accept actual costs. This will enable the project to have the capability to gather actual project costs at the necessary level of WBS detail to allow for meaningful performance measurement. Figure 3 shows the relationships between CAs, WPs, PPs, WBS, and Organizational Breakdown Structure (OBS) and their roles in the project management process.

Generally, the guidance provided in the above paragraphs will also apply to the WBS elements being performed by a contractor, partner, assisted acquisition, or any other non-NESDIS performing entity. Non-NESDIS WBS elements will normally begin at level 3 or 4. Non-NESDIS

performing entities should also extend their hierarchical elements in a predominantly product-oriented fashion.

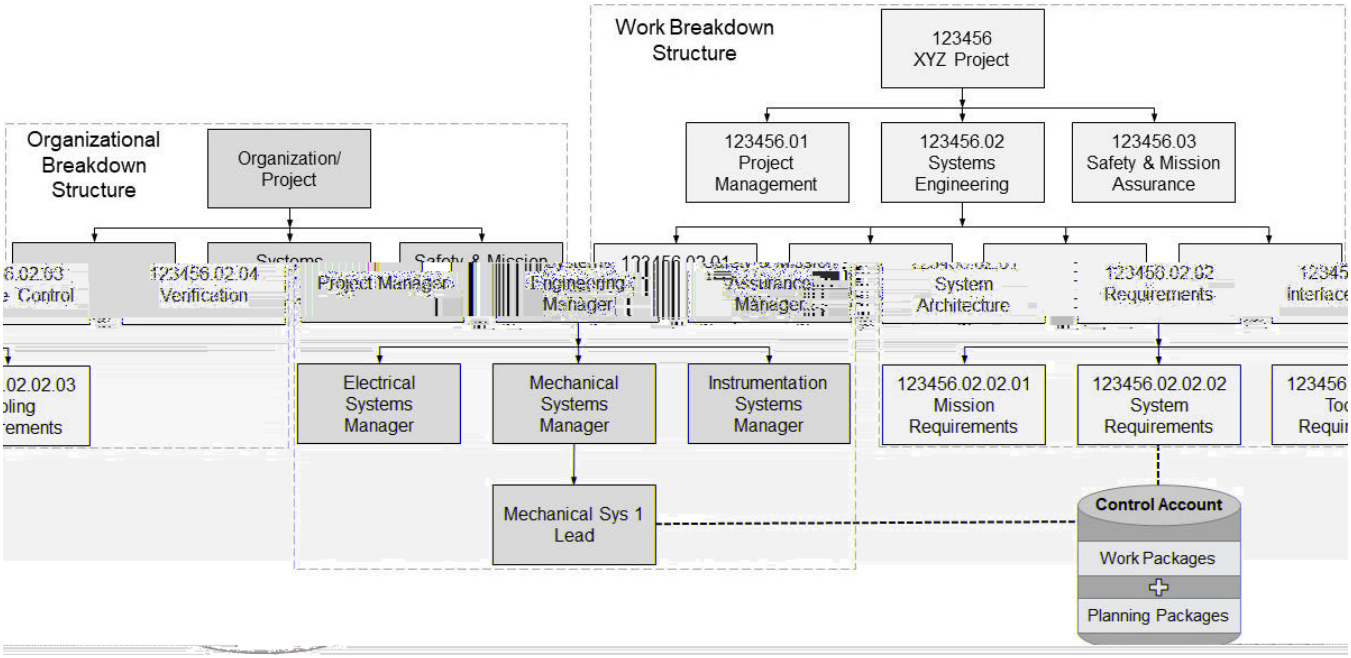

Figure 3: Relationships between the WBS, OBS, CA, WP, and PP

When identifying CAs, the performing entities must be allowed to establish organizational responsibilities at meaningful and appropriate levels. The CA brings together all aspects of the implementer's management control systems, including technical definition, budgets, estimates, schedules, work assignments, accounting, progress assessment, risk and problem identification, and associated corrective actions.

b. Change Control

WBS development is an iterative process. While strong efforts should be placed on early and accurate WBS planning, after a baseline is established, WBS revisions will likely still occur from expansion or contraction of project scope, and the movement of a project through its various stages (i.e., engineering, development, and operation). Whenever the baseline WBS is revised, formal documentation of the revision must be maintained according to the project's configuration management process to include the associated change rationale and PM approval.

Changes may occur as the products of the work effort are more accurately defined or when a revised product structure (resulting from technically different requirements or a more cost effective approach to satisfy the requirements) is used. The WBS and WBS Dictionary should also be revised to reflect changes resulting from contract negotiations. Each PM is ultimately responsible for establishing and controlling the approved WBS baseline.

3.4. WBS Development Techniques

The following techniques can be helpful in the development of a project WBS:

1. Preparing functional requirement block diagrams,
2. Preparing element tree diagrams,
3. Preparing a WBS dictionary,
4. Using development checklists, and
5. Using WBS templates.

a. Preparing Functional Requirement Block Diagrams

A good place to begin developing a preliminary WBS is by listing the functional requirements for the new product or system. If the number of requirements is large, group them into similar categories. Create a parent or end product at the top of your list or graphic. Then, create subordinate major groupings of functional requirements with similar characteristics. Next, subdivide the major groupings into smaller groupings that have natural dividing points. Finally, translate this functional block diagram into a product structure.

In order to translate the functional block diagram into a product structure, begin at the top level with the desired end product that is completely integrated. At the first subordinate level, using the functional block diagram, create a major system block for each related functional block or blocks. The translation may result in a one-to-one, one-to-many, or many-to-one relationship between the functional blocks and major system blocks. Create subsystem or other subordinate blocks that further define the major system blocks as necessary. Continue this process until the product structure is complete and all functional requirements are accounted for. The result is your initial WBS.

b. Preparing Element Tree Diagrams

WBS tree diagrams are routinely developed to provide a visual display of a WBS. A pictorial view of the overall WBS aids all project staff in understanding how lower-level project components support and contribute to higher-level components. This type of diagram is often called a "family tree" or a “product tree” diagram.

Examples of WBS tree diagrams are shown below. Figure 4 shows a portion of a Flight Project WBS structure with several key recommended development practices noted. Figure 5 illustrates a sample portion of a WBS for a software development project that focuses on software products subdivided by their functionality.

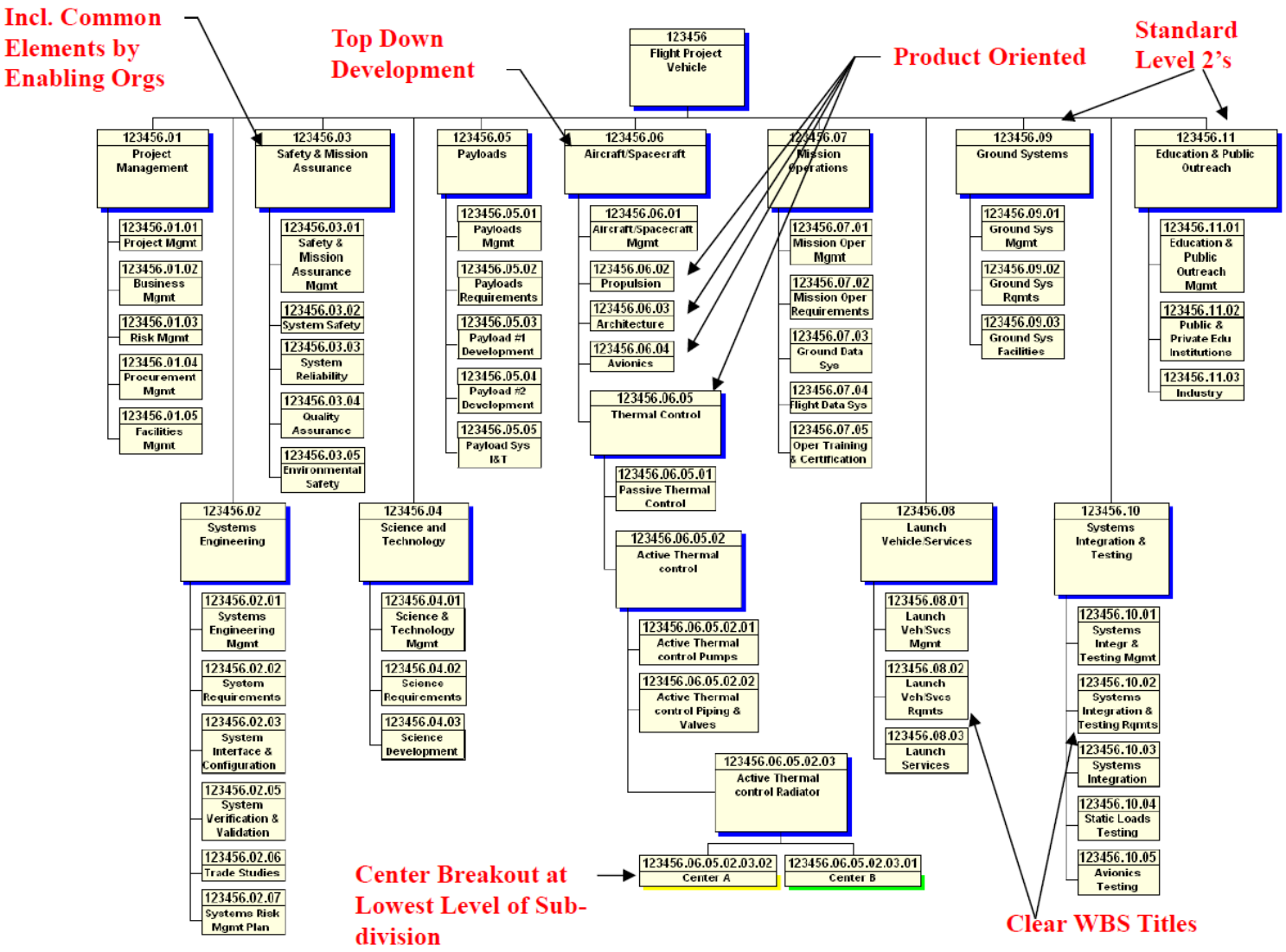

Figure 4: Partial WBS Tree Diagram Illustrating Recommended Practices

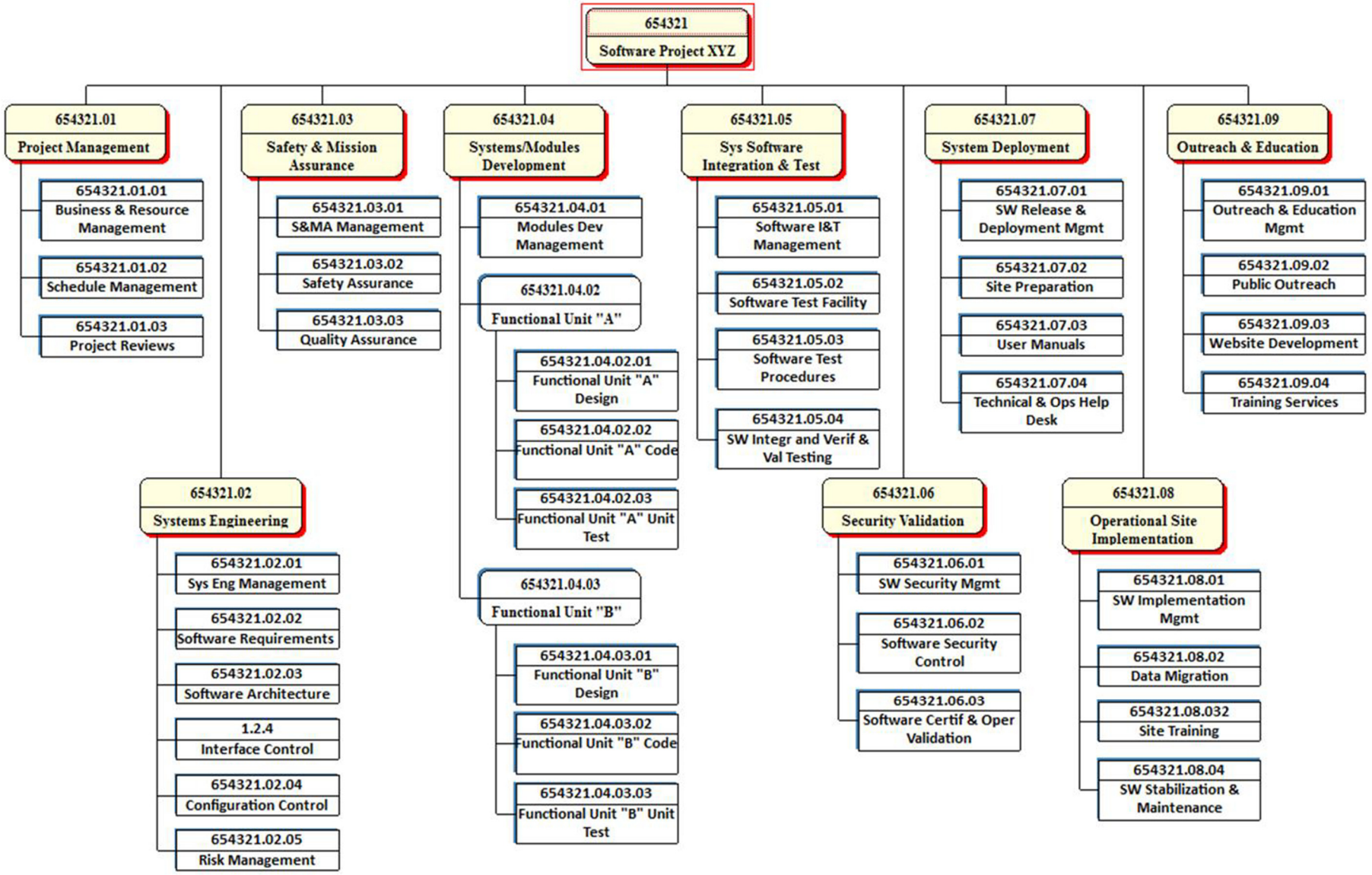

Figure 5: Sample Software WBS Illustration

A WBS dictionary lists and defines the WBS element contents. It is prepared by the project team for the purposes of ensuring that all work scope has been identified and to eliminate duplication and overlap of work assignments. Content ambiguities should be eliminated with clear statements describing the effort to be completed. The level of descriptive detail needed for each element should be commensurate with the element's hierarchical position in the overall WBS structure. The lower the level of a WBS element, the greater the level of descriptive detail needed. The descriptive detail of element content should clearly identify all element interfaces. The dictionary also contains an index (see Figure 6), which lists the WBS elements in indented format to show their hierarchical relationship.

WBS #	WBS Level	WBS Element Title
123456	**1**	**Project XYZ**
123456.01	**2**	**Project Management**
123456.01.01	3	Project Management
123456.01.02	3	Resource & Schedule Management
123456.01.03	3	Configuration Management
123456.01.04	3	Project Reviews
123456.02	**2**	**Systems Engineering**
123456.02.01	3	Sys Engineering Management
123456.02.02	3	Requirements Dev & Verification
123456.02.03	3	System & Mission Analysis
123456.03	**2**	**Safety & Mission Assurance (SMA)**
123456.03.01	3	S&MA Management
123456.03.02	3	Mission Assurance
123456.03.03	3	Systems Safety
123456.04	**2**	**Science**
123456.04.01	3	Science Management
123456.04.02	3	Science Requirements
123456.04.03	3	Science Test Procedures
123456.04.04	3	Science Data Analysis
123456.05	**2**	**Payload**
123456.05.01	3	Payload Management
123456.05.02	3	Payload Electrical Sys
123456.05.03	3	Payload Structures & Mech
123456.05.04	3	Payload Avionics
123456.05.05	3	Payload Thermal Control
123456.05.06	3	Payload Integr &Test
123456.05.07	3	Payload GSE

Figure 6: Example WBS Index

Each element definition should include the following:

1. WBS element title;
2. WBS element code;
3. WBS element content description (including quantities, relevant associated work, and contract end items where applicable);
4. WBS Index;
5. Specification (number and title) associated with the WBS element (if applicable);
6. Date, revision number, revision authorization and approved changes;
7. Budget and reporting number (i.e., charge code); and
8. WBS element performer (NESDIS point of contact, contractor, partner, etc.).

A WBS Dictionary (example in Figure 7) should be a controlled document, and as such, should be maintained as a baseline document with revisions being reviewed and approved according to each project's configuration control requirements for the life of the project.

WBS Dictionary

WBS Element Title:

Develop Prototype Code

WBS Element No:

xxxx

Parent WBS No: xxxx

WBS Level: 6

Parent WBS Title: Develop Prototype

Originator:

Samuel L. Kates

Project:

Project XYZ Software Development

WBS Element Description:

The scope of this element includes the development of all necessary software code required to satisfy the functional requirements established for prototype software. This effort will include the identification of all prototype use-case functions, code development for all identified use-case functions, informal use-case testing, integration of all use-case code, and software preparation for full prototype user testing.

Related Work Excluded:

1) Associated supervision

2) Prototype requirements validation

3) PP&C planning and control effort

WBS Element Performer:

Charge Code:

Revision No: 01c

Figure 7: Example WBS Dictionary

c. Using Development Checklists

Checklists are a useful tool to ensure proper WBS development. A WBS checklist helps ensure that all major factors have been considered. Consider the checklist example in Figure 8.

(1) _____Has the correct level 1 and 2 WBS template been used?

(2) _____Are the WBS elements predominantly product-oriented (Not functional or organizational)

(3) _____Does the overall WBS structure include 100% of the project scope of work? (This should include enabling support and products such as project management.)

(4) _____Does the subdivision of WBS elements reflect accurate, logical, and compatible hierarchy of work scope?

(5) _____Does the WBS Dictionary provide complete and explicit content descriptions?

(6) _____Does the WBS subdivide the project scope of work down to an adequate level of detail to provide for effective resource planning, management insight, and performance measurement?

(7) _____Do the project WBS elements correlate with the following?

a. Functional design criteria
b. Technical scope of work
c. Project Integrated Implementation Plan
d. Project Integrated Master Schedule (IMS)
e. NESDIS internal reporting level requirements

Figure 8: Example WBS Checklist

d. Using WBS Templates

Since the purpose of a WBS is to divide the project into manageable pieces of work for better planning and control, more consistency within the WBS can be achieved by using standard WBS templates. This standardization not only aids in subdividing the work in current projects, but will also make possible the creation of historical data repositories of cost, schedule, and technical information with standard content categories to aid in the planning of future projects. As noted earlier, the top two levels of a project WBS are dictated and controlled by the NESDIS CFO through a standard template.

3.5. Common Development Errors

Developing a properly structured and effective project WBS is a complex process. Increased training in the “best practices” for effective WBS development will help reduce the errors that are commonly found. Examples of common WBS development errors are illustrated below.

a. Using an Unsuitable Former WBS

If a WBS from a prior project is used as a basis for WBS development on a new project or contract, be careful not to perpetuate any mistakes or undesirable features of the earlier WBS.

b. Using Non-Product Elements

WBS elements should be predominantly product-oriented. For example, Design, Engineering, Manufacturing, Phase A, Pipe Fitters, and Direct Labor are not products and typically should not be used for WBS element subdivisions. Design, Engineering, and Manufacturing are functions and/or organizations, and Pipe Fitter is a skill type, Direct Labor is a labor category,

and Phase A is a time frame. None are appropriate as WBS elements. Rework, Retesting, and Refurbishing are additional non-product oriented terms and are not usually recommended for the WBS element hierarchy.

There is a natural tendency for PMs and contractors to ask, “Where am I in that WBS?” They feel more comfortable if they see specific elements that reflect their functional or organizational areas of responsibility. Since projects are often functionally organized, the tendency may be for a project team to approve a functionally or organizationally oriented WBS. This error should be avoided. Figure 9 illustrates typical errors related to non-product-oriented WBSs.

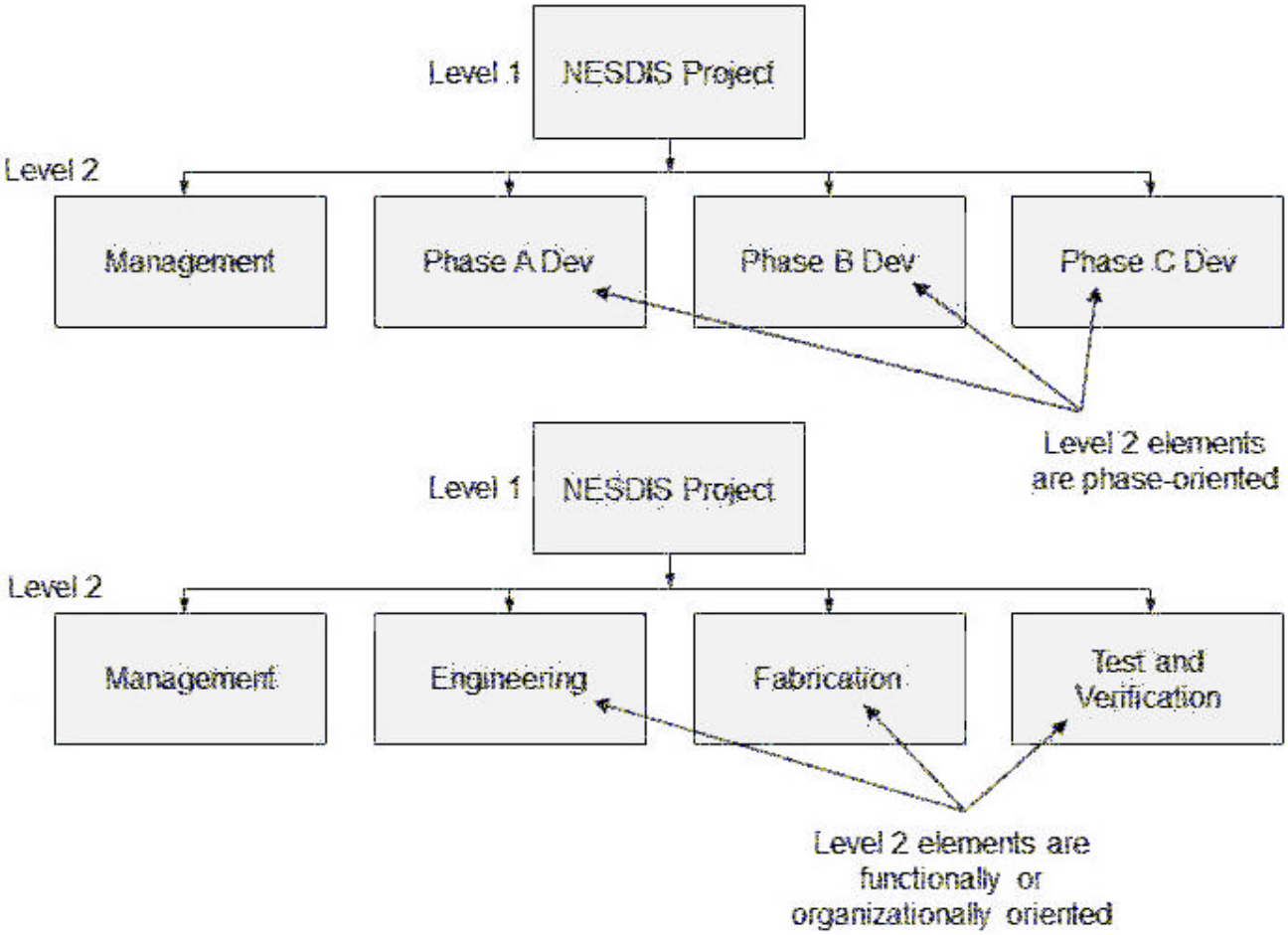

Figure 9: Examples of Unsuitable WBS Breakdowns

c. Correct Element Hierarchy

A common error in WBS development is subdividing the elements in a manner that does not correctly reflect the hierarchy of work structure. This error many times is due to not having the right personnel involved in the WBS development effort due to a lack of understanding of the total work scope, system hardware, and implementation processes. This makes it nearly impossible to correctly build a WBS without the responsible and knowledgeable people involved. Figure 10 illustrates correct and incorrect subdivision of work elements.

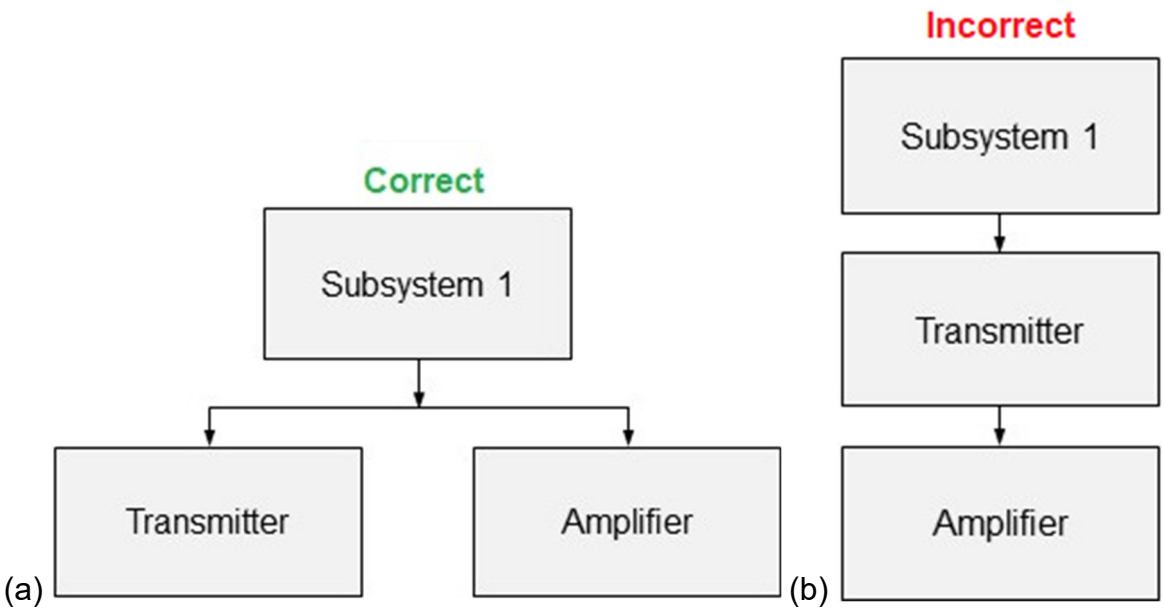

Figure 10: Correct (a) and Incorrect (b) Examples of Element Hierarchy
Amplifier belongs as a co-element under Subsystem 1, not as a sub-element of Transmitter.

4. WBS Uses

The WBS is a project management tool. It provides a framework for specifying the technical aspects of the project by defining the project in terms of hierarchically related, product-oriented elements for the total project scope of work. The WBS also provides the framework for schedule and budget development. As a common framework for cost, schedule, and technical management, the WBS elements serve as logical summary points for insight and assessment of measuring cost and schedule performance. Figure 11 illustrates how the WBS provides a common reference capability in relating cost, schedule, and technical data.

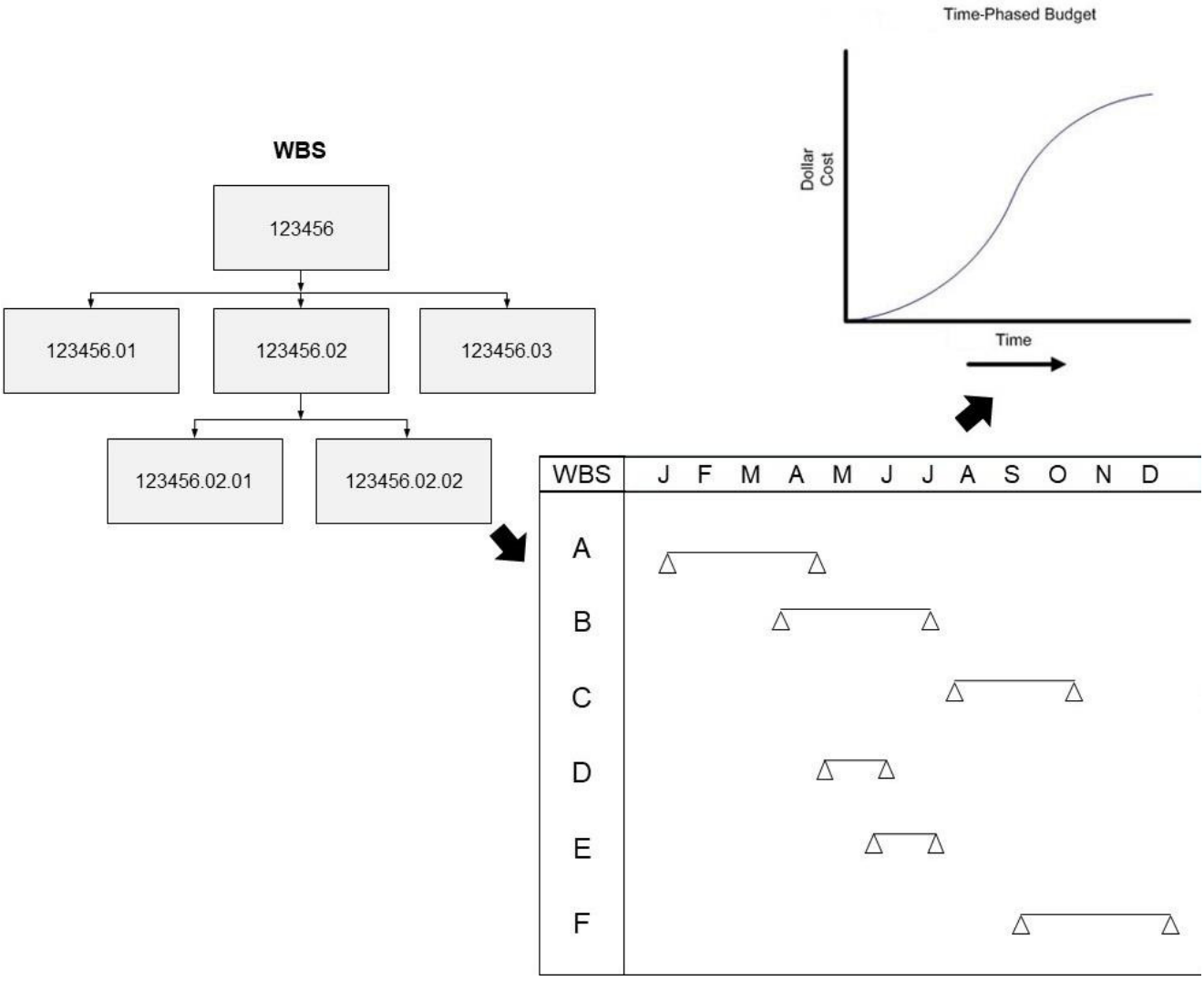

Figure 11: The WBS as a Project Management Tool for Integration

The following paragraphs discuss using the WBS for work identification and assignment, schedule management, cost management, performance management, and risk management.

4.1. Work Identification and Assignment

Personnel performing work are organized to facilitate effective management, whether the organization is designed along project, functional, or matrix lines. To assign specific work responsibility to a specific organization, the WBS and organizational structure should be integrated with each other (i.e., functional responsibility is established for managing specified work to produce defined products). This integration process results in a Responsibility Assignment Matrix (RAM), which is illustrated in Figure 12. This integration can occur at any level of the WBS and at whatever level of responsibility has been assigned to manage the work. While an interface relationship may exist between the organizational structure and the WBS, keep in mind that the organizational structure should not drive how the WBS is structured and subdivided. The WBS hierarchy should be driven totally by the makeup of the work content and its most effective subdivision for management planning, insight, and control.

4.2. Schedule Management

The WBS provides a framework for detailed project planning and schedule development. As WBS elements are established and work content is clearly defined in the WBS Dictionary, it is then possible for the project team to determine the tasks (activities) and events (milestones) required to successfully complete the project objectives and products. Tasks and events are identified for the effort contained in each lowest-level WBS element. These are then included in project schedules and organized in a format that enables management to determine the proper time-phasing of work. This process should be done using a project management scheduling tool that has functional capabilities for task sequencing, slack (float) calculations, task start/finish date generation, critical path determination, constraint identification, and resource loading. Tasks for each of the lowest WBS elements are input into the scheduling tool, along with various types of associated data for each task, such as description, duration, sequencing, responsibility, constraints, resources, and WBS coding. When all task information is input in the scheduling tool for all lowest-level WBS elements, an Integrated Master Schedule (IMS) is produced. Because WBS coding is included in the IMS, task networks (logic networks) and other schedule data can be produced at the lowest detail or summarized to various levels of the WBS structure for project management insight, assessment, and control. Refer to NESDIS-HBK-1224.1, NEDIS Project Cost and Schedule Tracking Handbook, for additional scheduling process guidance.

Project schedules are typically available at detailed, intermediate, and summary levels. The level of schedule detail needed is dictated by the scope and complexity of the project work and the needs of management for schedule visibility and control. Schedule levels and management levels need not coincide with WBS levels. Generally, there is no requirement for separate schedules for each WBS level. However, if the appropriate WBS element numbers are assigned to each lowest-level task and milestone contained in the IMS, then, through data filtering, all schedule items can be extracted and formatted by lowest detail or summarized by any WBS level. The lowest level of each WBS element should have at least one task or activity.

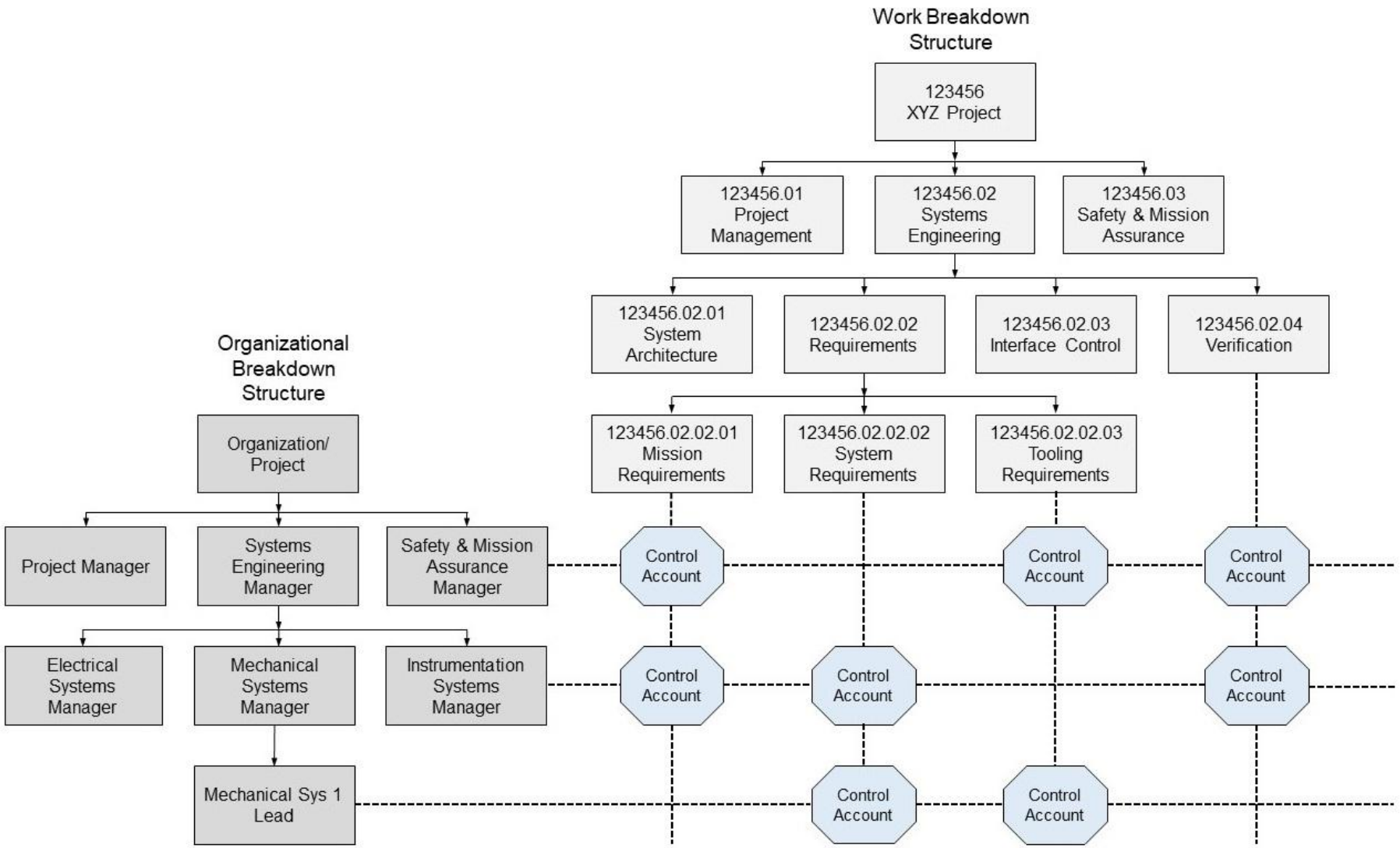

Figure 12: Responsibility Assignment Matrix

Since a product-oriented WBS serves as the framework for schedule development, then resulting project schedules are also product-oriented. This type of schedule allows managers to monitor the schedule baseline for the project's products to ensure that the project objectives are completed on time. Contractors must also submit required schedule reporting, with WBS coding included, to permit NESDIS insight and control at the necessary levels of detail.

4.3. Cost Management

The WBS is a key tool used for assisting project teams in managing cost. By breaking the total product into successively smaller entities, management can more readily verify that all work identified by the WBS and budgeted for (and later charged against) actually contributes to the project objectives. By using an approved project WBS to plan the total scope of work, it serves as the framework for cost estimating, budgeting, accounting, and control of project costs.

The WBS structure and content definition provides a systematic approach to cost estimating that helps ensure that relevant costs are not omitted. A project estimate that is based on the WBS helps NESDIS management to ensure that budget development is credible and complete. When WBS elements and the supporting work are scheduled, a solid basis for time-phased budgets is ready-made. The WBS also provides a common framework for tracking the evolution of estimates (e.g., conceptual estimates, preliminary design estimates, and detailed design estimates). The WBS can also provide a framework for life cycle cost analysis. As periodic project cost estimates are developed, each succeeding estimate is made in an attempt to forecast more accurately the project's total cost.

The standard level-2 elements can be used as categories to accumulate pertinent historical cost data. Such historical data can be used in conjunction with learning curves, regression, and other techniques to estimate the cost requirements for similar elements of new projects. Subsequent cost data collected by NESDIS can be compared to the original estimates to establish their validity, identify trends, and re-estimate future project needs. Contractor and other performing entity data can also be included in this type of historical database if consistent WBS coding is maintained.

4.4. Performance Management

Integrated performance management, also known as EVM, begins with a product-oriented WBS that accurately reflects all project work to be accomplished. As stated above, the WBS provides a framework for organizing all technical, schedule, and budget planning. It should be noted that NESDIS' requirement for the technical and financial WBS to be one and the same will enhance a project team's ability to successfully correlate cost, schedule, and technical planning into a cohesive management baseline. Proper use of the WBS as a common reference for integration of cost, schedule, and technical management accomplishes the performance management objectives of defining and controlling project work.

The integrated performance management process dictates using the same WBS in defining the work scope, scheduling (time-phasing) the work, and establishing budgets that correlate appropriately. Figure 13 depicts in a simple overview how the Performance Measurement Baseline (PMB) is derived from a resource-loaded schedule. This figure shows how the time-

phased accumulation of resources that have been applied to the schedule provide a performance profile that is used for measuring project performance. This baseline is used not only for measuring performance accomplishment but also for deriving trend data for future project cost and schedule projections.

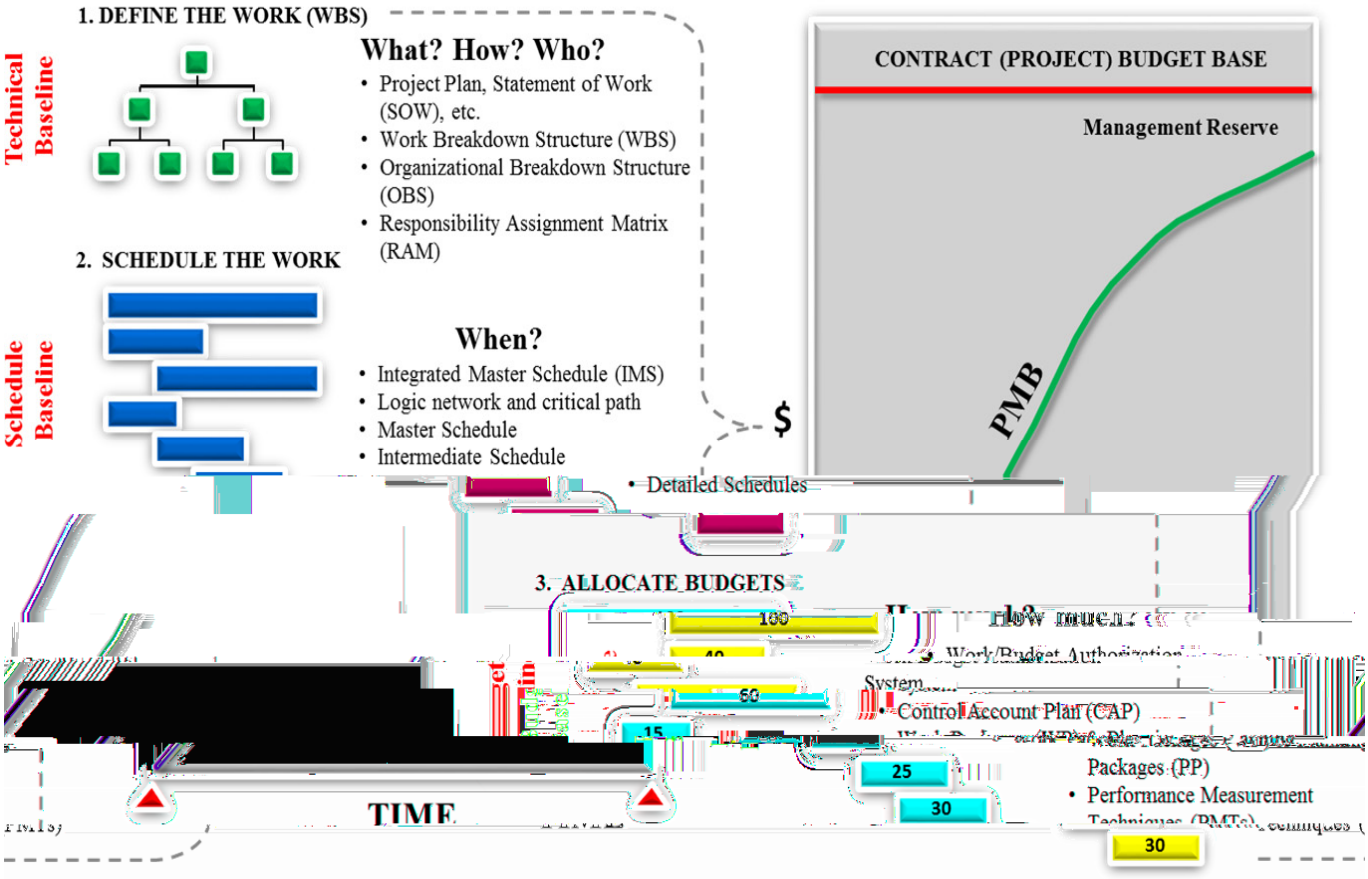

Figure 13: WBS and the Development of the PMB

4.5. Risk Management

Risks represent potential impacts to successful achievement of project goals and objectives. Project risks typically fall into various defined categories such as technical, programmatic (cost, schedule, resources), etc. A risk can also exist in any element of work content and at any time during the project life cycle. Since a WBS serves as the common reference for all project cost, schedule, and technical data, it should also play an important role in managing risks. All risks identified during project implementation should be correlated to effort associated with a WBS element. As risks are logged into the risk management system, the WBS element number will be a key data point for further tracking and mitigation planning. Risk mitigation or the lack thereof will often impact cost and/or schedules for affected WBS elements. Thus, the level of WBS (level 3 and lower) is derived by risk to cost, schedule, or performance to closely monitor the effort. Control of risk impacts is a critical management emphasis and as such will involve on-going mapping to the WBS.

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Appendix A: Glossary

Baseline: An agreed-to set of requirements, designs, budgets, schedules, or documents that will have changes controlled through a formal approval and monitoring process.

Control Account: A documented scope of technical, cost, and schedule objectives within a project corresponding to a WBS element that has a responsible organizational element or individual identified; a final combination of end products components, parts, or materials which is ready for its intended use; or an item of software or documentation that is deliverable to a user or customer. The control account is represented in a Responsibility Assignment Matrix End Item.

End Item: A final combination of end products components, parts, or materials which is ready for its intended use; an item of software or documentation that is deliverable to a user or customer.

Integrated Master Schedule: An integrated schedule developed by logically networking all detailed program/project activities. The highest level schedule is the Master Schedule supported by intermediate-level schedules and lowest-level schedules.

Performance Measurement Baseline: The time-phased budget plan against which performance is measured. It is formed by the budgets assigned to scheduled control account and the applicable indirect budgets. For future effort, not planned to the control account level, the performance measurement baseline also includes budgets assigned to higher level WBS elements and undistributed budgets. It equals the total allocated budget less management reserve.as the intersection of the WBS and the Organizational Breakdown Structure (OBS).

NESDIS Office(s): A term used in the widest sense to include NESDIS Headquarters elements, NESDIS Operations and Acquisitions offices, the Center for Satellite Applications and Research (STAR), and the National Centers for Environmental Information (NCEI).

Process: A set of activities used to convert inputs into desired outputs to generate expected outcomes and satisfy a purpose.

Program: A strategic investment that has defined goals, objectives, architecture, funding levels, and a management structure that supports one or more projects.

Project: A specific investment that has defined goals, objectives, requirements, lifecycle cost, a beginning, and an end. A project yields products or services that directly address NESDIS' strategic needs. In this document, the term 'project' applies in the widest sense to include projects, programs, portfolios, and major initiatives.

Project Plan: A detailed plan which, when formally approved, sets forth the agreement between a program manager and project managers, and defines the guidelines and constraints under which the project will be executed.

Requirement: A statement that identifies a system, product, or process characteristic or constraint. A requirement statement must be clear, correct, feasible to obtain, unambiguous in meaning, and able to be validated at the level of the system structure at which it is stated.

Stakeholder: A group or individual for whose need or mission a requirement or project is created. Also known as the "customer".

Statement of Work: A document containing a narrative description of the total work scope for a project or contract.

Subsystem: A functional entity within a system. The name given for the next level of breakdown under a system.

System: The combination of elements that function together to produce the capability required to meet a need. The elements include all hardware, software, equipment, facilities, personnel, processes, and procedures needed for this purpose.

Work Breakdown Structure: A product-oriented hierarchical division of the hardware, software, services, and other work tasks that organizes, displays, and defines the products to be developed and/or produced and relates the elements of the work to be accomplished to each other and the end product(s). The WBS should be accompanied by a text document referred to as a WBS Dictionary that describes the work content each element of the WBS in detail.

WBS Dictionary: A document that describes the work content of each WBS element, in product-oriented terms, and relates each element to the respective, progressively higher levels of the structure, as well as to the Statement of Work.

WBS Element: Any block or unique entry in a Work Breakdown Structure regardless of level.

WBS Levels: The arrangement or configuration of a WBS, which establishes the hierarchy of projects to programs, systems to projects, subsystems to systems, etc.

Work Package: Detailed jobs, or material items, identified by the implementer for accomplishing work required to complete the project/contract. A work package has the following characteristics:

a. It represents units of work at levels where work is performed.
b. It is clearly distinguished from all other work packages.
c. It is assigned to a single organizational element.
d. It has scheduled start and completion dates and, as applicable, interim milestones, which are representative of physical accomplishment.
e. It has a budget or assigned value expressed in terms of dollars, man-hours, or other measurable units.
f. Its duration is limited to a relatively short span of time or it is subdivided by discrete value milestones to facilitate the objective measurement of work performed or it is level-of-effort.
g. It is integrated with detailed engineering, manufacturing, or other schedules

Appendix B: Acronyms

CA	Control Account
CFO	Chief Financial Officer
CWIP	Construction Work In Progress
EVM	Earned Value Management
FMDS	Financial Management Data System
IMS	Integrated Master Schedule
HBK	Handbook
NCEI	National Centers for Environmental Information
NESDIS	National Environmental Satellite, Data, and Information Service
NOAA	National Oceanic and Atmospheric Administration
OBS	Organizational Breakdown Structure
OCFO	Office of the Chief Financial Officer
OSAAP	Office of Systems Architecture and Advanced Planning
PM	Project Manager
PMB	Performance Measurement Baseline
PP	Planning Package
RAM	Responsibility Assignment Matrix
STAR	Satellite Applications and Research
WBS	Work Breakdown Structure
WP	Work Package

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