



INTEGRATED MASTER SCHEDULE (IMS) - CRITICAL PATH ANALYSIS

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1 Schedule Analysis

1.1 Overview

The OOI IMS has undergone a significant replan per NSF's Corrective Action Plan. The OOI Integrated Master Schedule (IMS) Critical Path Analysis report describes the analysis of the OOI schedule with a focus on the critical path of the program. The analysis used industry standard practices for schedule review and quality to the extent applicable to the OOI Program. Substantial detail has been added to each IO schedule, resulting in greater visibility and management capability.

1.2 Purpose

The IMS Critical Path Analysis Report provides OOI stakeholders the analytical platform from which to review and determine the validity the OOI IMS. This report serves as a technical review and best practice audit of the OOI program schedule. This report is a requirement of the OOI Program Office and a formal submittal to the NSF

1.3 Scope

This report is a review and record of the analysis of the OOI Integrated Master Schedule as constructed by the integration of Implementing Organization component schedules. The report includes a report on and a representation of the following components:

- Schedule Quality Review
- Steelray Analyzer Review
- Critical Path Analysis

1.4 Review Process

1.4.1 Schedule Quality Review

OOI OL Program Management has conducted a preliminary schedule best practice compliance review and analysis in the following four areas. Additional analysis will be conducted to ensure quality in all areas.

- Vertical Traceability (WBS and Milestones)
- Scope
- Level of Detail
- Leads and Lags

1.4.2 Steelray Analyzer Review

Steelray Project Analyzer (SPA) is a Microsoft® Project Add-In which enabled an efficient identification of schedule mechanics problems and a corresponding correction of identified problems. SPA allows the scheduler to create a set of custom scoring criteria or the use of default criteria to score the project file. The Program Office used the Steelray analyzer and generated an OOI IMS SPA score against a set of selected common criteria. The criteria and analysis are detailed in Section 3.

1.4.3 Critical Path

OOI OL Program Management has prepared the Critical Path as a representation of the unrestricted measurement of a forward-to-backward pass through a continuous sequence of schedule activities. The sequence of activities that must be completed on-schedule

for an entire project to be completed on-schedule is commonly known as the Critical Path. The Critical Path is a derived measurement from project/program inception to project/program closure. The Critical Path is represented by the OOI OL Project Management Office through both a Microsoft Project document, as well as through a Program Evaluation and Review Technique (PERT) chart.

Each task on the critical path is called a critical task. If a critical task is delayed, then the entire project will be delayed by the same amount (unless another activity on the critical path can be accelerated). The critical path may change from time to time as activities are completed ahead of or behind schedule. There may be more than one critical path depending on durations and work flow logic.

The critical path of a project is represented in the project schedule as a consecutive sequence or network of activities whose cumulative time requirements determine the minimum total project time. For additional information on both the use and management of OOI Critical Paths and schedules, please refer to the OOI Schedule Management Plan and the OOI Earned Value Management Plan.

2 Schedule Quality Review Findings

2.1 Review Methodology

Each of the following four (4) points of schedule quality review determine if the IMS is reasonable, adheres to OOI scheduling standards and is constructed based on sound scheduling best practices. The schedule quality audit reviews the schedule for issues that undermine the management value of the schedule. The schedule quality review is coupled with a review of the mechanics of the IMS using Steelray Analyzer to form a comprehensive review of the IMS and corresponding critical path. A preliminary review has been performed and additional analysis will be conducted to ensure quality in all areas.

2.2 4 Point IMS Quality Review

1. Vertical Traceability.

- a. Discussion: The OOI WBS is the foundation document of the OOI IMS. A review and analysis of the structure of the WBS was made to determine if the WBS was created correctly and detail tasks roll up to the correct summary levels corresponding to work packages and Control Accounts and to ensure a rational tie from the detail task to the corresponding completion milestone.

Changes to Control Accounts and Work Packages will be furnished in follow-up documentation as required.

- b. Finding: Vertical traceability of WBS Summary to Detail Tasks, and Task(s)-to-Milestones is correct in accordance with OOI SE schedule requirements.
- c. Resolution: Accepted, no action required.

2. Scope

- a. Discussion: Is the entire scope of work covered in the schedule? The review included the contents within the work breakdown structure hierarchy, the linked completion milestones, and the clarity with which the work scope has been included in the schedule.
- b. Finding: The WBS represents the entire MREFC and O&M program scope.
- c. Resolution: Accepted, no action required.

3. Level of detail

- a. Discussion: This subjective check determines if the level of detail in the schedule sufficiently and accurately reflects the work required to complete the corresponding product at the WBS level. The detail check also asks the question as to whether the schedule can be managed with the work represented in the schedule file.
- b. Finding: Significant levels of additional detail have been added to reflect a better understanding of the development lifecycle of the equipment. The number of detailed tasks and milestones increased from approximately 4,200 lines to approximately 32,000.
- c. Resolution: Ninety (90) days prior to the start of MREFC Ocean Leadership will conduct a detailed planning review to evaluate the task level detail of the IMS for the pending contract performance year.

4. Leads & Lags

- a. Discussion: Performs a check of the mechanics of the schedule predecessor and successor links to determine the reasonableness of adding or subtracting overlap time between predecessor relationships. Leads or lags can be used to fix start/finish dates, can lead to negative slack, and ultimate in excess can give false calculations to the critical path.
- b. Finding: There are no significant schedule impacting leads or lags in the IMS. The number of leads and/or lags in the IMS are manageable.
- c. Resolution: Accepted, no action required.

3 Steelray Analyzer® Report

3.1 General – Steelray Analyzer review methodology

The Steelray Analyzer Report is an automated and comprehensive review of the mechanics of the OOI IMS. OOI PMO selected fifteen (15) criteria from the product set against which to score the OOI IMS. These criteria were selected to return the most applicable and realistic set of score results relative to the integrated cost and schedule requirements of the OOI EVM tools, processes, and procedures.

3.2 OOI Steelray Analyzer Criteria

- **Baseline Vertical Schedule Integration Error** - This criterion looks at each summary task and makes sure that the next level tasks all roll up. It compares the baseline start and finish dates of the summary tasks to those of the lower level details tasks. At least one of the lower level detail tasks must have a start date that equals the start of the summary task and that at least one of the lower level detail tasks must have a finish date that equals the end date shown on the summary task. The Summary task start date should always be the earliest date represented and the summary task end date should always be the latest date represented.

Calculation - Each child task is analyzed. All children must start in or after the parent task and must end on or before the parent's baseline.

- **Effort Tasks** – The schedule should be primarily made up of discrete tasks that have work associated with them. Summaries and Milestones are needed for reporting and program tracking but should not be the majority of the line items.

Calculation - Total Effort Tasks / Total Tasks

- **Milestones** – The schedule should be primarily made up of discrete tasks that have work associated with them. Summaries and Milestones are needed for reporting and program tracking but should not be the majority of the line items.

Calculation - Total Milestone Tasks / Total Tasks

- **Missing Predecessors** - All tasks should have a predecessor, with a few exceptions like starting milestones.

Calculation – Task Predecessors is not set – AND – Task Actual Finish is not set – AND – Task Summary is No.

- **Missing Successors** - Almost every task should have a successor, with a few exceptions like the end of project milestone. The question to ask is: 'If the output of the task's effort does not go to anyone else, why are we doing the work?'

Calculation – Task Successors is not set – AND – Task Actual Finish is not set – AND – Task Summary is NO

- **Summary Tasks with Resources** - Summary tasks should not have resources assigned to them. Summary tasks are strictly used as an outlining or rolling up feature and should not drive schedule dates or resource loading.

Calculation – Task Summary is Yes – AND – Task Resources is set – AND – Task Actual Finish is not set. (Total Summary with Resource Tasks / Total Effort Tasks)

- **Summary Tasks with Predecessors** - Summary tasks should not have predecessors or successors. Many scheduling software applications have difficulty calculating dates and critical paths when summary tasks and detail tasks are linked.

Calculation – Task Predecessors is set – AND – Task Summary is Yes.

- **Summary Tasks with Successors** - Summary tasks should not have predecessors or successors. Many scheduling software applications have difficulty calculating dates and critical paths when summary tasks and detail tasks are linked.

Calculation – Task Successors is set – AND – Task Summary is Yes (Total Summary with Successor Tasks / Total Summary Tasks)

- **Tasks with Duration < 5 days** - Task durations should generally be between 5 and 20 working days. Too much detail can make the schedule unreadable, un-maintainable, and ultimately unusable as a management tool. Too little detail can make the schedule little more than window dressing. Sufficient detail must exist to clearly identify all the key deliverables and must contain enough information to know what state the project is in at any given point in time.

Calculation - D5d Task = Task Duration < 5d – AND – Task Milestone is No – AND – Task Summary is No (Total D5d Tasks / Total Effort Tasks)

- **Tasks with Constrained Dates** – Tasks should rarely be artificially tied to dates. Durations and/or Resources combined with schedule logic and work day calendars should determine schedule dates. If a significant number of constrained dates are used, the schedule may not calculate the critical path and near critical paths correctly.

Calculation – Task Summary is No – AND – Task Constraint Type is Not ASAP – AND – Task Actual Finish is not set

- **Tasks with Total Slack < - 20 days** - All schedules should have a reasonably small amount of slack (or float). Large positive or negative slack values may indicate a poorly constructed schedule. Large negative slack indicates a logic error or a program that is no longer on track to meet its commitment dates. Large positive slack may indicate poor or missing logic.

Calculation - TS-20 Task = Task Summary = No – AND – Task Milestone = No – AND – Task Actual Finish is not set – AND – Task Total Slack < -20d (Total TS-20 Tasks / Total Incomplete Tasks)

- **Tasks with Total Slack > 200 days** - All schedules should have a reasonably small amount of slack (or float). Large positive or negative slack values may indicate a poorly constructed schedule. Large negative slack indicates a logic error or a program that is no longer on track to meet its commitment dates. Large positive slack may indicate poor or missing logic.

Calculation - TS200 Task = Task Summary = No – AND – Task Milestone = No – AND – Task Actual Finish is not set – AND – Task Total Slack > 200d (Total TS200 Tasks / Total Incomplete Tasks)

- **Tasks with Total Slack > 30 days** – All schedules should have a reasonably small amount of slack (or float). Large positive or negative slack values may indicate a poorly constructed schedule. Large negative slack indicates a logic error or a program that is no longer on track to meet its commitment dates. Large positive slack may indicate poor or missing logic.

Calculation - TS30 Task = Task Summary = No – AND – Task Milestone = No – AND – Task Actual Finish is not set – AND – Task Total Slack < 30d (Total TS30 Tasks / Total Incomplete Tasks)

- **Tasks without Finish-to-Start Predecessors** - The majority of the task dependencies should be Finish-to-Start. Since most of the tasks represent work that will have a start and an end date resulting in some product or document that is needed by someone else, the work is performed in some sequence most of the time. If the majority of the tasks require parallel linkages the tasks may be at too high a level.

Calculation - Total Non Finish-to-Start Predecessor Tasks / Total Effort Tasks

- **Task with Duration > 20 days** – For our purposes, schedules should examine excessively large durations exceeding 40 days in duration, which challenge planners to closely monitor completion requirements.

Calculation – D40d Task = Task Duration > 40d – AND – Task Summary is NO – AND – Task Milestone is No – AND – Task Actual Finish is not set

3.3 CI Steelray Analyzer Report

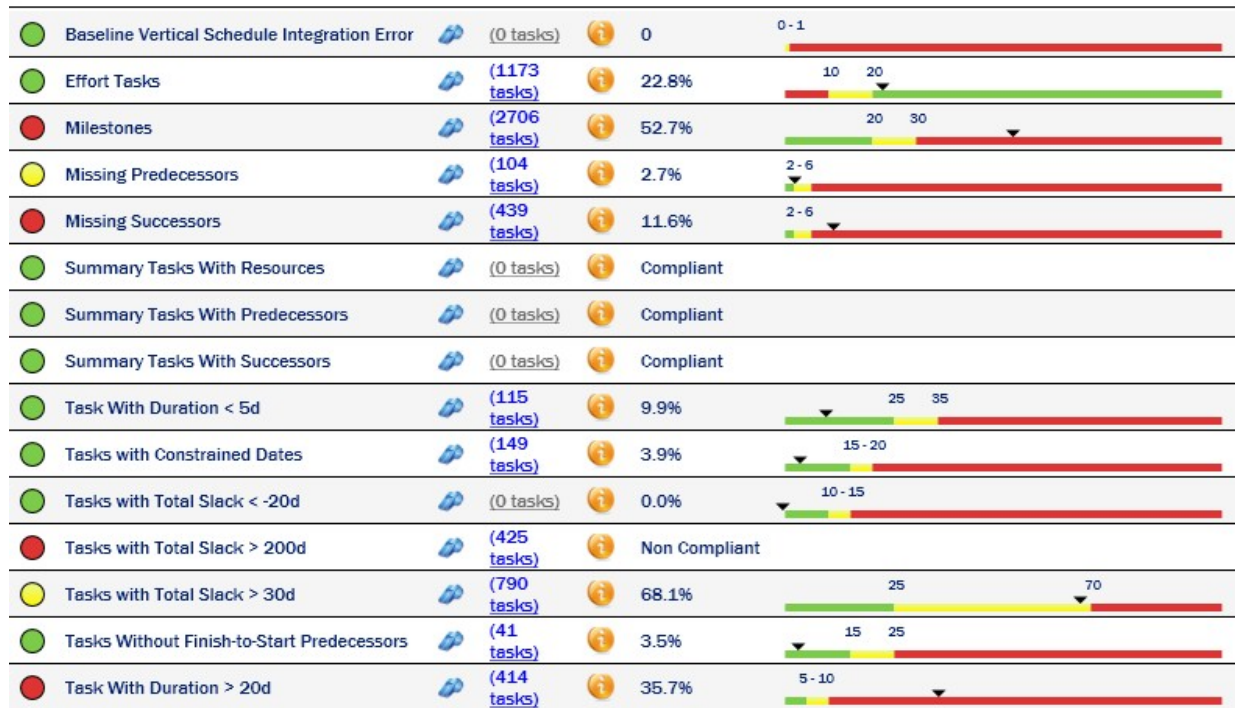


Figure 1. CI Steelray Report

3.4 CI Steelray Analyzer Report Discussion-Findings-Resolution

3.4.1 Baseline Schedule Vertical Integration Error (0 Tasks)

- A. **Discussions:** This criterion looks at each summary task and ensures that next level tasks roll up. It compares the baseline start and finish dates of the summary tasks to those of the lower level details tasks.
- B. **Findings:** The CI schedules are not yet baselined. The Vertical integration error does not appear in the Steelray report. When the CI baseline is set, the CI schedule will be manually reviewed for this criterion.
- C. **Resolution:** This action will be performed on the individual IO schedules at baseline setup.

3.4.2 Effort Tasks (1173 Tasks)

- A. **Discussion:** "Effort Task" is a Steelray tool designation for schedule artifacts more commonly referred to as tasks. The Project Management Institute (PMI) refers to these same artifacts as "activity". Effort Tasks represent the detail work to be accomplished for completion of each succeeding level of the WBS to deliver the corresponding higher level product of the WBS.
- B. **Findings:** The CI Schedule has retained the appropriate level of detail to track and manage its scope.
- C. **Resolution:** No additional action required.

3.4.3 Milestones (2706 Tasks)

- A. **Discussion:** OOI milestones are generally gates, review points and task network completion points.
- B. **Findings:** The large percentage of milestones is due to the deliverables milestones that have been established in the schedule to support the visibility and management of project scope. This has increased the percentage of milestones in the schedule. These milestones correspond to the components planned for each service under each development subsystem for the Integrated Network Observatory development effort.
- C. **Resolution:** No additional action required.

3.4.4 Missing Predecessors (104 Tasks)

- A. **Discussion:** Items with missing predecessors can cause an incorrect critical path calculation. These items are a very small part of the overall schedule (0.4%).
- B. **Findings:** All items with missing predecessors are additional milestones that are in process of predecessor and successor linking.
- C. **Resolution:** The linking effort is ongoing. . Any items not updated will be resolved.

3.4.5 Missing Successors (439 Tasks)

- A. **Discussion:** Items with missing successors can cause an incorrect critical path calculation.
- B. **Findings:** The source of the missing successors is primarily cross project dependencies that are yet to be established and deliverables milestones. There are also a small number of tasks that do not currently have successors.
- C. **Resolution:** The cross project dependencies will be established. Some additional linking for the deliverables milestones and identified tasks remain to be finalized.

3.4.6 Summary Tasks with Resources (0 Tasks) – Compliant

- A. **Discussion:** Resources on the summary tasks can lead to incorrect resource requirements and incorrect budgets.
- B. **Findings:** There are no summary tasks with resources
- C. **Resolution:** No additional action required.

3.4.7 Summary Tasks with Predecessors (0 Tasks) – Compliant

- A. **Discussion:** incorrect placement of Predecessors can lead to incorrect calculation of the critical path.
- B. **Findings:** There are no summary tasks with predecessors
- C. **Resolution:** No additional action required.

3.4.8 Summary Tasks with Successors (0 Tasks) – Compliant

- A. **Discussion:** Incorrect placement of Successors can lead to incorrect calculation of the critical path
- B. **Findings:** There are no summary tasks with successors
- C. **Resolution:** No additional action required

3.4.9 Tasks with Duration < 5 days (115 Tasks)

- A. **Discussion:** Tasks should generally be between 5 and 40 days in duration. A large number of tasks in the less than 5 day duration can be interpreted as a “to do” list.
- B. **Findings:** There are 115 tasks with durations less than 5 days.
- C. **Resolution:** No additional action required.

3.4.10 Tasks with Constrained Dates (149 Tasks)

- A. **Discussion:** Tasks with constrained dates can cause incorrect critical path calculation.
- B. **Findings:** There are 149 tasks with constraints. These tasks represent cross-project dependencies that are yet to be established and are being held in place pending integration with CGSN.
- C. **Resolution:** Cross-project dependencies will be established.

3.4.11 Task with Total Slack < - 20 days (0 Tasks)

- A. **Discussion:** Tasks with negative lag indicate that milestones have been missed and the schedule is late.
- B. **Findings:** There are no tasks with negative lag.
- C. **Resolution:** No action required.

3.4.12 Tasks with Total Slack > 200 days (425 Tasks)

- A. **Discussion:** Task with slack greater than 200 days might be incorrectly linked to the completion milestone.
- B. **Findings:** These consist of cross project dependencies that are yet to be established, level of effort tasks, e.g. Project Management, travel and equipment tasks that span work packages and control accounts, and deliverables milestones.
- C. **Resolution:** The cross project dependencies will be established. Some additional linking for the deliverables milestones remain to be finalized.

3.4.13 Tasks with Total Slack > 30 days (790 Tasks)

- A. **Discussion:** Tasks with slack greater than 30 days might be incorrectly linked to the completion milestone.
- B. **Findings:** There are 790 tasks with slack greater than 30 days. The majority of these tasks are linked to reviews to ensure a solid path.
- C. **Resolution:** No action required. The level of slack is acceptable. Possible delays in integration and testing could impact the installation ship time. Sufficient slack time is desirable (and recommended by the FDR Panel) to assure completion of the OOI on the anticipated date.

3.4.14 Tasks without Finish-to-Start Predecessors (41 Tasks)

- A. **Discussions:** The Finish-to-Start predecessor is the best of the possible predecessor types and is the preferred methodology.
- B. **Findings:** There are 41 tasks that use something other than a FS predecessor, with most of those being Start-to-Start. This indicates parallel efforts starting at the same time.
- C. **Resolution:** There is some parallel effort that will be occurring, especially during the early stages of the CI replan program. These tasks are mostly non-work related tasks, which are mostly LOE tasks.

3.4.15 Tasks with durations > 20 days (414 Tasks)

- A. **Discussion:** Tasks with too long of a duration begin to lose the ability to clearly communicate their progress to a reviewer. However, in this case the schedule will only be updated once per month, so longer task durations may not be hindrances to progress reporting.
- B. **Findings:** The criteria used is > 20d, but the OOI criteria is 40d. The CI schedule contains 209 tasks with durations greater than 40 days. These consist of level of effort tasks, e.g. Project Management, and travel and equipment tasks that span work packages and control accounts.
- C. **Resolution:** No additional action required.

3.5 RSN Steelray Analyzer Report

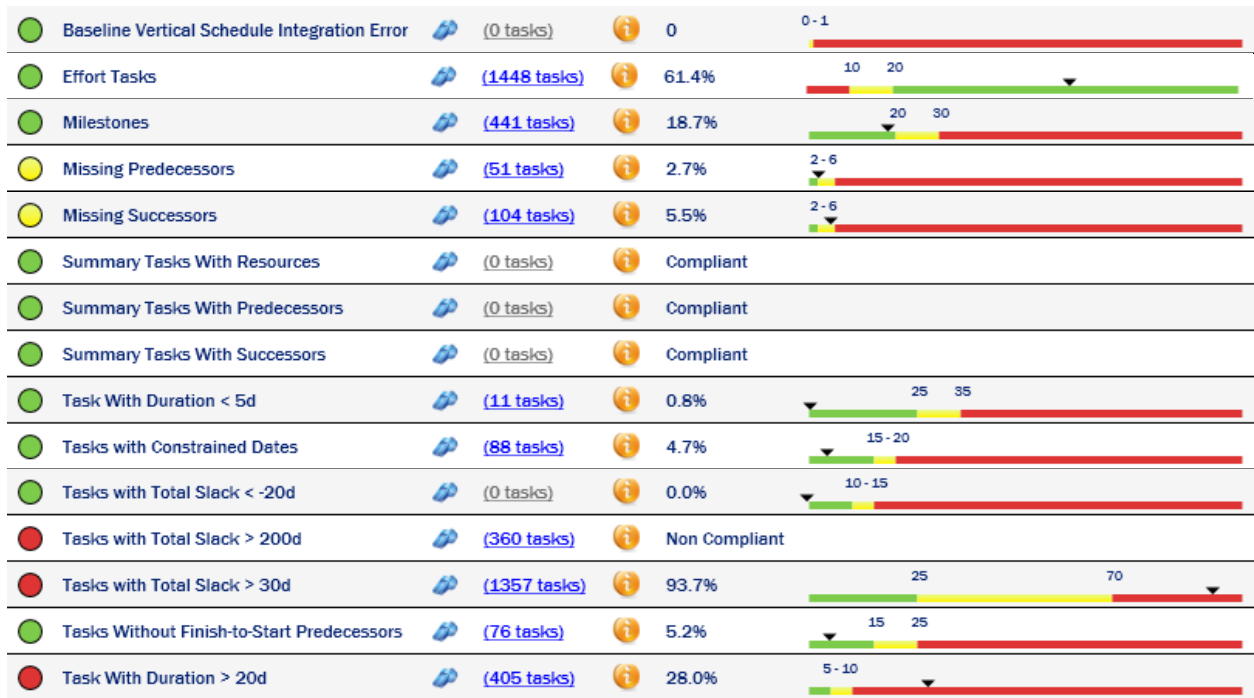


Figure 2. RSN Steelray Report

3.6 RSN Steelray Analyzer Report Discussion-Findings-Resolution

3.6.1 Baseline Schedule Vertical Integration Error (0 Tasks)

- A. **Discussions:** This criterion looks at each summary task and ensures that next level tasks roll up. It compares the baseline start and finish dates of the summary tasks to those of the lower level details tasks.
- B. **Findings:** The RSN schedules are not yet baselined. The Vertical integration error does not appear in the Steelray report. When the RSN baseline is set, the RSN schedule will be manually reviewed for this criterion.
- C. **Resolution:** This action will be performed on the individual IO schedules at baseline setup.

3.6.2 Effort Tasks (1448 Tasks)

- A. **Discussion:** "Effort Task" is a Steelray tool designation for schedule artifacts more commonly referred to as tasks. The Project Management Institute (PMI) refers to these same artifacts as "activity". Effort Tasks represent the detail work to be accomplished for completion of each succeeding level of the WBS to deliver the corresponding higher level product of the WBS.
- B. **Findings:** The RSN SCHEDULE has significantly increased the level of detail, even with the deprecated scope for the design.
- C. **Resolution:** No additional action required.

3.6.3 Milestones (441 Tasks)

- A. **Discussion:** RSN SCHEDULE milestones are generally gates, review points and task network completion points.
- B. **Findings:** The RSN SCHEDULE includes some milestones – zero (0) duration tasks are in place as effort task placeholders, cross-project dependency markers or represent de-scoped work. The milestone saturation point is in the "green" range. Due to the distributed multi-project scope, the RSN schedule includes a large number of completion milestones and the use of cross-project dependencies to show the lifecycle evolution of the equipment as it progresses through construction and deployment.
- C. **Resolution:** Ocean Leadership directed comprehensive rolling-wave planning sessions will affect the placement of effort task placeholder milestones with a corresponding saturation decrease. The Comprehensive rolling-wave planning sessions will further refine the use and placement of detailed "Effort Tasks" with a corresponding saturation decrease in milestones, in each contract performance year.

3.6.4 Missing Predecessors (51 Tasks)

- A. **Discussion:** Items with missing predecessors can cause an incorrect critical path calculation. These items are a very small part of the overall schedule (0.04%).
- B. **Findings:** All items with missing predecessors are additional milestones that are in process of predecessor and successor linking.
- C. **Resolution:** The linking effort is ongoing. . Any items not updated will be resolved.

3.6.5 Missing Successors (104 Tasks)

- A. **Discussion:** Items with missing successors can cause an incorrect critical path calculation.
- B. **Findings:** All items with missing successors are detail level or milestones that are to be defined in subsequent planned efforts and still in process of predecessor and successor linking. These items are a very small part of the overall schedule (0.74%).

- C. **Resolutions:** The linking effort is ongoing. Any items not updated will be resolved.
- 3.6.6 Summary Tasks with Resources (0 Tasks) – Compliant
 - A. **Discussion:** Resources on the summary tasks can lead to incorrect resource requirements and incorrect budgets.
 - B. **Findings:** There are no summary tasks with resources
 - C. **Resolution:** No additional action required.
- 3.6.7 Summary Tasks with Predecessors (0 Tasks) – Compliant
 - A. **Discussion:** incorrect placement of Predecessors can lead to incorrect calculation of the critical path.
 - B. **Findings:** There are no summary tasks with predecessors
 - C. **Resolution:** No additional action required.
- 3.6.8 Summary Tasks with Successors (0 Tasks) – Compliant
 - A. **Discussion:** Incorrect placement of Successors can lead to incorrect calculation of the critical path
 - B. **Findings:** There are no summary tasks with successors
 - C. **Resolution:** No additional action required
- 3.6.9 Tasks with Duration < 5 days (11 Tasks)
 - A. **Discussion:** Tasks should generally be between 5 and 20-30 days in duration. A large number of tasks in the less than 5 day duration can be interpreted as a “to do” list.
 - B. **Findings:** There are 11 tasks with durations less than 5 days.
 - C. **Resolution:** These tasks are RFPs for mooring parts to be integrated.
- 3.6.10 Tasks with Constrained Dates (88 Tasks)
 - A. **Discussion:** Tasks with constrained dates can cause incorrect critical path calculation.
 - B. **Findings:** There are 88 tasks with constraints. These constrained tasks are artifacts of the distributed structure of the program, and are mechanically necessary to process the IMS through the integration and analysis.
 - C. **Resolution:** The comprehensive rolling-wave planning sessions will further refine the use and placement of detailed “Effort Tasks” including the elimination of constrained dates.
- 3.6.11 Task with Total Slack < - 20 days (0 Tasks)
 - A. **Discussion:** Tasks with negative lag indicate that milestones have been missed and the schedule is late.
 - B. **Findings:** There are no tasks with negative lag.
 - C. **Resolution:** No action required.
- 3.6.12 Tasks with Total Slack > 200 days (360 Tasks)
 - A. **Discussion:** Task with slack greater than 200 days might be incorrectly linked to the completion milestone.

- B. **Findings:** There are 360 tasks with slack greater than 200 days. On review, these tasks are initial development and build tasks that are linked from the start of the MREFC program and might have a delay from production before being required for integration and testing. Due to the seasonal nature of the equipment deployment, higher levels of slack will occur in the earlier deployments as they are completed months or even years before the end of the program. It is deemed preferable to allow these long slack periods during the schedule development period rather than restrict the dynamic nature of the scheduling software with hard coded dates.
- C. **Resolutions:** These tasks will continue to be reviewed and RSN will ensure that all new linkages are acceptable.

3.6.13 Tasks with Total Slack > 30 days (1357 Tasks)

- A. **Discussion:** Tasks with slack greater than 30 days might be incorrectly linked to the completion milestone.
- B. **Findings:** There are 1357 tasks with slack greater than 30 days. The majority of these tasks are production and integration testing tasks that are linked to an installation and commissioning task.
- C. **Resolution:** No action required. The level of slack is acceptable. Possible delays in integration and testing could impact the installation ship time. Sufficient slack time is desirable (and recommended by the FDR Panel) to assure completion of the RSN SCHEDULE on the anticipated date.

3.6.14 Tasks without Finish-to-Start Predecessors (76 Tasks)

- A. **Discussions:** The Finish-to-Start predecessor is the best of the possible predecessor types and is the preferred methodology.
- B. **Findings:** There are 76 tasks that use something other than a FS predecessor, with most of those being Start-to-Start. This indicates parallel efforts starting at the same time.
- C. **Resolution:** There is some parallel effort that will be occurring especially during the early stages of the RSN replan program. These tasks are mostly non-work related tasks which are mostly LOE tasks.

3.6.15 Tasks with Duration > 20 days (405 Tasks)

- A. **Discussion:** For the purpose of this schedule, we are examining tasks with a duration of > 40 days. Tasks with too long of a duration begin to lose the ability to clearly communicate their progress to a reviewer. However, in this case the schedule will only be updated once per month, so longer task durations may not be hindrances to progress reporting.
- B. **Findings:** There are 405 tasks with durations longer than 40 days.
- C. **Resolution:** The RSN SCHEDULE program will span over a period in excess of 5 years, not including the pre-MREFC pilot period. The strategy of using tasks in excess of 30 days is permissible by RSN SCHEDULE EV policy and program plans. Additional detail has been added to describe the evolution of the equipment during the construction lifecycle, per the FDR Recommendations. The activity to further define and detail tasks will continue in the Pilot Period and future rolling wave annual plan of work activity.

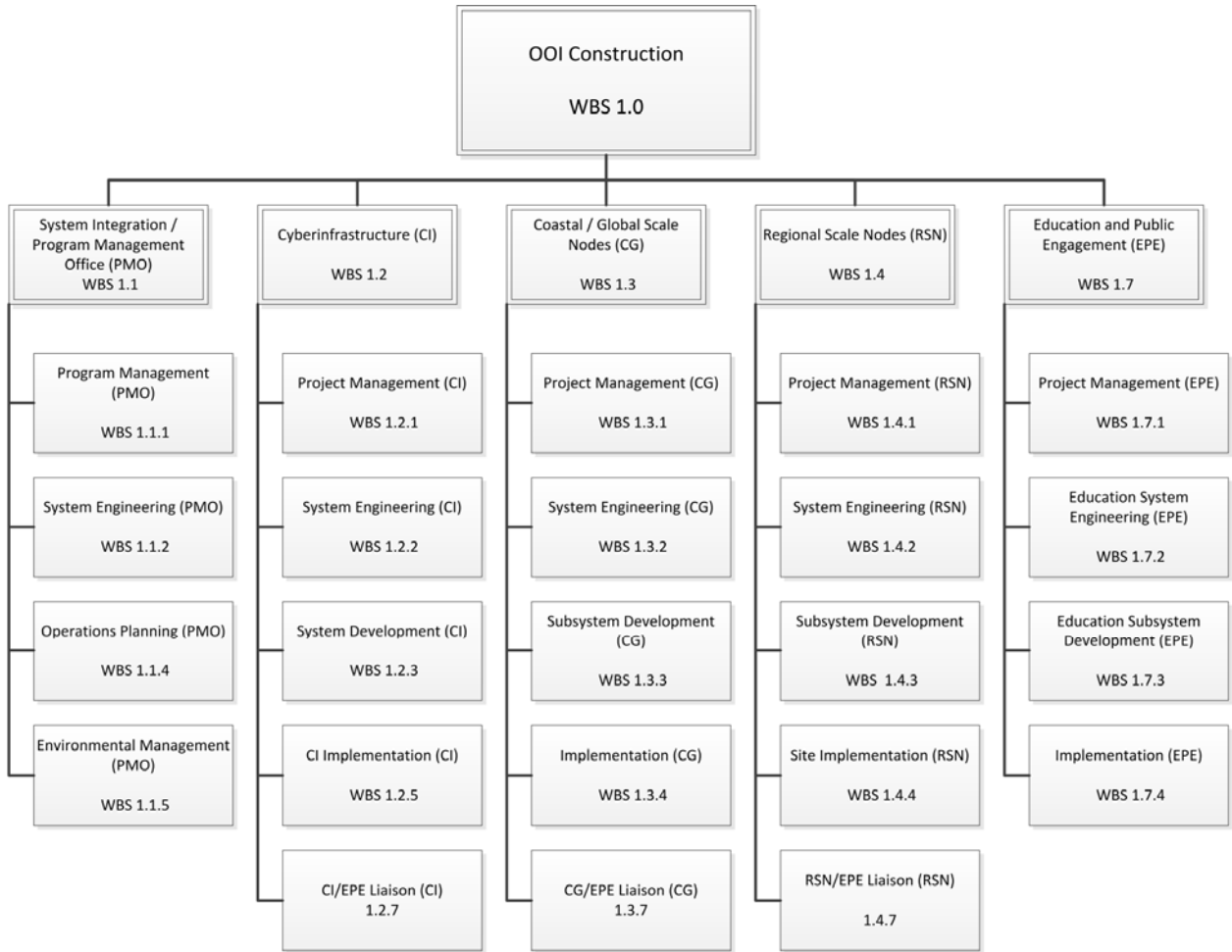


Figure 3. OOI Construction WBS 1.0

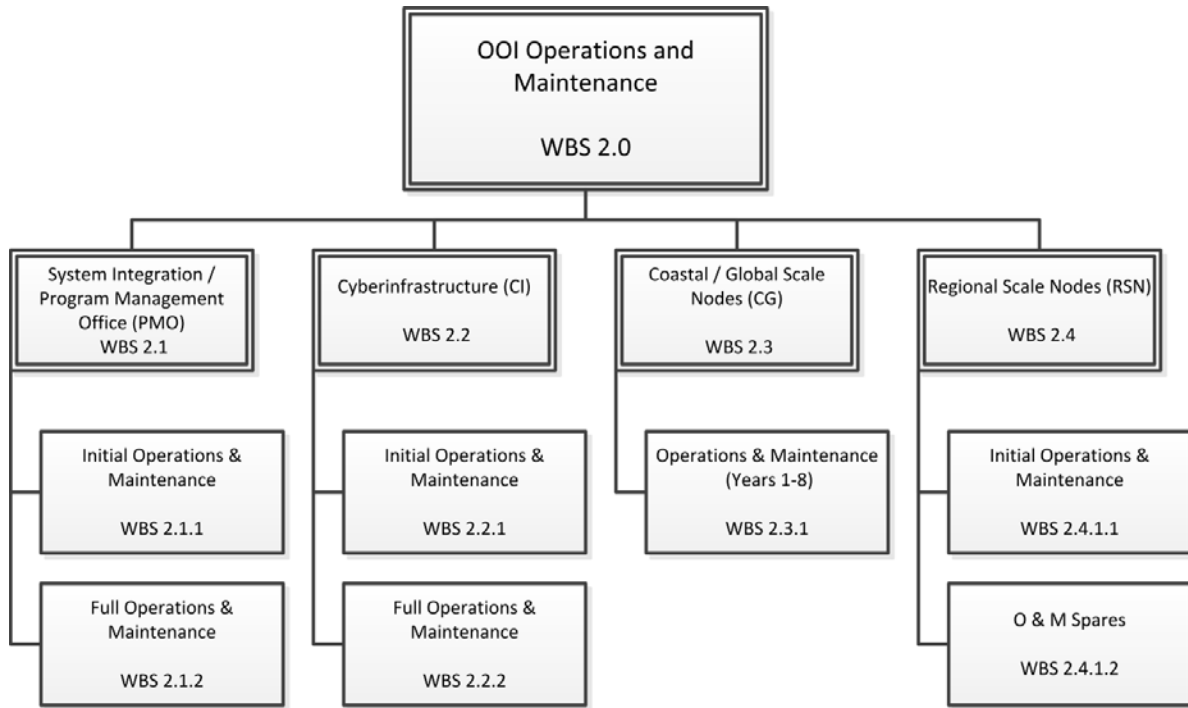


Figure 4. OOI Operations and Maintenance WBS 2.0

3.7 Preparation/Basis for IMS and Preparation of Critical Path

The OOI Master Program WBS (Figure 2 –OOI WBS) is the basis of the OOI IMS against which the Critical Path is determined. Additional information as to the purpose, formation and management of the OOI IMS can be found within the *OOI Schedule Maintenance Plan (SMP)* and the *OOI Earned Value Management Plan (EVM)*. The graphs below represent the activity network of the OOI WBS and IMS. The critical path (critical path: The series of tasks that must be completed on schedule for a project to finish on schedule. Each task on the critical path is a critical task.) is the series of tasks (or even a single task) that dictates the calculated finish date (finish date: The date that a task is scheduled to be completed. This date is based on the task's start date, duration, calendars, predecessor dates, task dependencies, and constraints) of the project. That is, when the last task in the critical path is completed, the project is completed.

3.8 OOI MS Project Critical Path

The OOI MS Project Critical Path is the representation of the OOI critical path extracted for the MS Project 2007 schedule file. This representation is the network of tasks with zero (0) slack as the OOI IMS now exists. With future scheduling enhancements to the detail task structure of the IMS the characteristics of the critical path will in fact adjust to capture and represent the exact nature of the corresponding critical tasks.

3.9 Critical Path Characteristics

3.9.1 Integrated Master Schedule

The primary critical path across IOs flows through the instrument agent development, review, and implementation. At this time, three instruments are on the critical path due to the latency in their availability to begin development of the supporting instrument agents. The three instruments are constructed during Sensor Sets 1 and 3.

3.9.2 Cyberinfrastructure IO Schedule

The CI critical path flows through the integrated observatory network, development of instrument agents, review and transition. In the initial analysis of the critical path, the scheduled completion date of the Integrated observatory network Release 3 has slipped from June 2013 to January 2014. Overall, the CI completion date has slipped from August 2014 to January 2015.

3.9.3 RSN IO Schedule

The primary critical path across RSN flows through the instrument agent development, review, implementation, and commissioning. The completion of the Seafloor Installation (both the Hydrate Ridge and the Axial secondary infrastructure) will occur as scheduled (August 2013). The installation of the Water Column Moorings will complete as scheduled (late August 2014). Final project commissioning is scheduled to complete late January 2015.

3.10 PERT Chart EXPERT – OOI Critical Path

The PERT Chart – OOI Critical Path is another graphic representation of the critical path. This view of the critical path presents the critical path as what is commonly known as a PERT chart (also known as Network Charts, Precedence Diagrams and Logic Diagrams). The PERT chart displays the tasks in a project along with the dependencies between these tasks. Using a PERT chart is an accepted way to define and display the dependency relationships that exist between tasks. Additional information on how OOI uses the PERT Chart is explained in the *OOI Schedule Management Plan*.

Integrated Master Schedule (IMS) - Critical Path Analysis

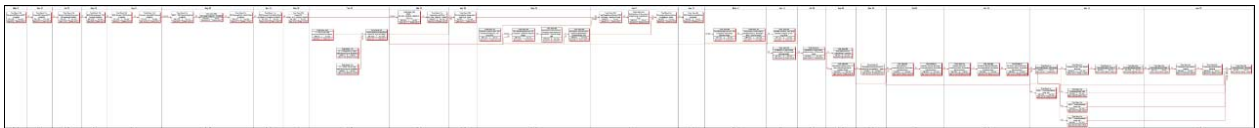
The PERT Chart diagrams below depict the time-phased dependencies of the OOI major tasks. The OOI PMO analyzed the Finish to Start (FS) relationship and dependencies, between the major tasks showing no anomalies or issues.



Critical_Path_CI_Onl
y_2011-04-29_ver_1

Double-click the Icon above to view the embedded PERT Diagram

Figure 5. CI PERT Chart Critical Path



Critical_Path_RSN_Onl
y_2011-04-29_ver_1

Double-click the Icon above to view the embedded PERT Diagram

Figure 6. RSN PERT Chart Critical Path

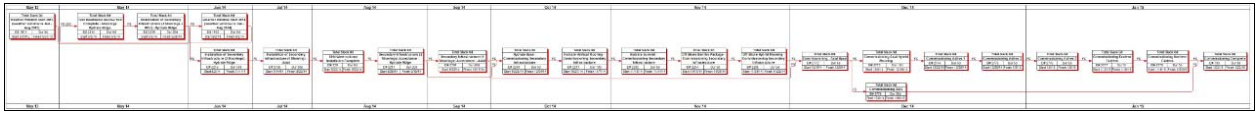


CI and RSN Critical
Path Seafloor Installa

Double-click the Icon above to view the embedded PERT Diagram

Figure 7. CI and RSN Critical Path for Seafloor Installation

Integrated Master Schedule (IMS) - Critical Path Analysis



CI and RSN Critical
Path Commissioning C

Double-click the Icon above to view the embedded PERT Diagram

Figure 8. CI and RSN Critical Path for Commissioning Hydrate Ridge and Axial

Appendix A-1 – CP – IMS Analysis Glossary

- Actual Cost for Work Performed (ACWP) – The costs actually incurred and recorded in accomplishing the work performed within a given time period. (Actual costs include the direct cost plus the related indirect cost such as overhead, G&A, etc. allocated to the activity.)
- Activity - An element of work performed during the course of a project. An activity normally has an expected duration, an expected cost and expected resource requirements. Activities are often subdivided into tasks.
- Baseline Schedule – the original approved plan plus or minus approved scope changes.
- Budgeted Cost for Work Performed (BCWP) (or Earned Value) – The sum of the budgets for completed work packages and completed portions of open work packages, plus the applicable portion of the budgets for level of effort and apportioned effort. This is the value in dollars of the work accomplished.
- Budgeted Cost for Work Scheduled (BCWS) (or Planned Value) – The sum of the budgets for all work packages, planning packages, etc., scheduled to be accomplished (including in-process work packages), plus the amount of level of effort and apportioned effort scheduled to be accomplished within a given time period. This is the value in dollars of planned work.
- Commercial Off The Shelf (COTS) – a term usually used to describe purchased software (as opposed to customized or internally developed software).
- Contracting Officer (CO) – a person with the authority to enter into, administer, and/or terminate contracts and make related determinations and findings Contracting Officer's Technical Representative (COTR) – person responsible to the CO for the contractor's performance on a given contract.
- Cost Performance Index (CPI) - An indicator of the cost efficiency of the work accomplished for the current period(s) or cumulative-to-date as derived by the formula: $CPI = \frac{BCWP}{ACWP}$, i.e., $\frac{\text{Earned Value}}{\text{Actual Cost Incurred}}$.
- Critical Path Analysis - A method that formally identifies tasks which must be completed on time for the whole project to be completed on time. It also identifies which tasks can be delayed for a while if resource needs to be reallocated to catch up on missed tasks.
- Critical Path Scheduling - A scheduling technique whose order and duration of a sequence of task activities directly affect the completion date of a project.
- Critical Path - The sequence of tasks that are tied together with network logic that have the longest overall duration from time now until project completion. Any slippage of the tasks in the critical path will increase the duration.
- Deliverable - A deliverable is any tangible outcome that is produced by the project. All projects create deliverables. These can be documents, plans, computer systems, buildings, aircraft, etc. Internal deliverables are produced as a consequence of executing the project and are usually needed only by the project team. External deliverables are those that are created for clients and stakeholders.
- Free Slack (FS) – The amount of time a task may be delayed without impacting the start of its successor. Guide to the Project Management Body of Knowledge (PMBOK Guide) - a publication authored by the PMI that contains project management guidelines.
- Integrated Master Schedule (IMS) – 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 by lowest level detail schedules.

- Level of Effort (LOE) - Effort of a general or supportive nature that does not produce definite end products.
- Milestone - A milestone is an important event that has no duration. Examples may include; PDR, CDR, and the completion of design activities. Milestones are used in schedules for reporting and measuring performance. A milestone, by definition, has duration of zero and no effort. There is no work associated with a milestone.
- Performance Measurement Baseline (PMB) – 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.
- Planner/Scheduler (P/S) - The person who performs planning and scheduling functions for a project or program. This person may be dedicated solely to this function or may share this function with other functions.
- Program Evaluation and Review Technique (PERT) - It is also called "critical path method". PERT is an event-oriented planning aid, usually computerized used to estimate project duration when there is uncertainty in estimates of duration times for individual activities.
- Planning Packages (PP) - A logical aggregation of work within a control account, normally the far-term effort, that can be identified and budgeted in early baseline
- Project - A specific investment identified in a Program Plan having defined goals, objectives, requirements, life-cycle cost, a beginning, and an end.
- Project Management Institute (PMI) – an international organization comprised of members of the project management community that share a common interest in promoting the development of the project management discipline.
- Resource Leveling – the sequencing of tasks/activities, without violating network logic, for a given resource or resources in a manner that results in a more consistent level of demand for that resource or resources over the life cycle of the project.
- Resource Loading – the act of recording resource requirements for a task/activity or a group of tasks/activities.
- Schedule Logic Network - A schedule format in which the activities and milestones are represented along with the interdependencies between activities. It expresses the logic as to how the work scope will be accomplished. Network schedules are the basis for critical path analysis, a method for identification and assessment of schedule priorities and impacts.
- Schedule Management - the establishment, monitoring, and maintenance of the baseline master schedule and derivative detailed schedules. It is composed of the establishment and operation of the system and includes (1) definition of format, content and control processes, and (2) selection of key progress milestones and indices for measuring program and project performance and indicating problems.
- Statement Of Work (SOW) – a document that contains a narrative description of the work scope for a project or program.
- Schedule Performance Index (SPI) - An indicator of the schedule efficiency at which work has been performed to date. SPI equals BCWP divided by BCWS, i.e., Earned Value divided by Planned (Budgeted) Value.

- Schedule Risk Assessment (SRA) - The process of performing a probabilistic risk assessment on a project schedule. This type of schedule assessment is based on using Monte Carlo simulations that incorporate minimum, maximum, and most likely estimates for task durations.
- Slack (Float) - These two terms, slack and float, are used interchangeably throughout this document and mean the same thing. Both refer to the amount of time that a task or group of tasks may be delayed without impacting the start of a later task or group of tasks. There are two types of slack. Free slack refers to the amount of time a task can slip before impacting the early start date of its immediate successor(s). Total slack refers to the amount of time a task may slip before impacting project completion.
- Task (Activity) - In scheduling terms, a task or activity is the lowest level of detail shown in a schedule. For the purposes of their use in this document, these two terms should be considered synonymous.
- Task/Activity - A discrete effort represented by a single row of data in a schedule.
- Stack Float (SF) - The amount of time a task may be delayed without impacting the end date of a schedule.
- Work Breakdown Structure (WBS) - A product-oriented hierarchical division of the hardware, software, services, and data required to produce the program/project's end product(s), structured according to the way the work will be performed, and reflective of the way in which program/ project costs, schedule, technical and risk data are to be accumulated, summarized, and reported.
- Work Breakdown Structure Dictionary - A document that describes the tasks associated with 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 contract Statement of Work.