TMT-APS Use Case Development

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Date: Oct 31, 2023
Type: Document report

Document Information:

Last published at 6:08 PM on Oct 24, 2023
by Robert Karban (rkarban)

Project Information:

TMT

Last modified at 4:20 PM on Oct 27, 2023
by Robert Karban (rkarban)

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TMT-APS Use Case Development

1 Use Case Development Introduction

This document covers how use cases and activities for Alignment and Phasing System (APS) are developed. Use cases are high level procedures APS uses to perform various telescope alignments and calibrations. In general, use cases are made up of one or more *activities*.

1.1 Purpose

The purpose of developing use cases is to capture high level procedures the Alignment and Phasing System (APS) uses to perform various telescope alignments and calibrations. The use cases verify requirements on the performance of the telescope such as timing, electrical power, and pointing errors. The identified use cases cover a spectrum of interactions with other subsystems of TMT, and to accurately predict the performance of APS.The use cases are developed according to the principles of the Executable Systems Engineering Method (ESEM) which prescribes the functional and physical decomposition of the system into a nested tree of components, and the specification of the behavior of each. The primary model elements that are used to develop TMT use cases are state machines, activities, sequence diagrams, simulation configurations, instance tables, and views. The process for developing use cases consists of extending the behavior of the Procedure Executive and Analysis Software through state machines and activities, specifying a context for automated analysis, specifying the behavior for a particular use case through sequence diagrams, configuring simulation configurations for system execution, exposing instance results to a view, and evaluating simulation results. The TMT use case, Post Segment Exchange Alignment, will provide context on each of these steps below.

Operational scenarios and specific scenarios in which it will be operated. test, nominal, part of it's operational life-cycle.

1.2 Overview

The following list provides an overview of the APS use cases:

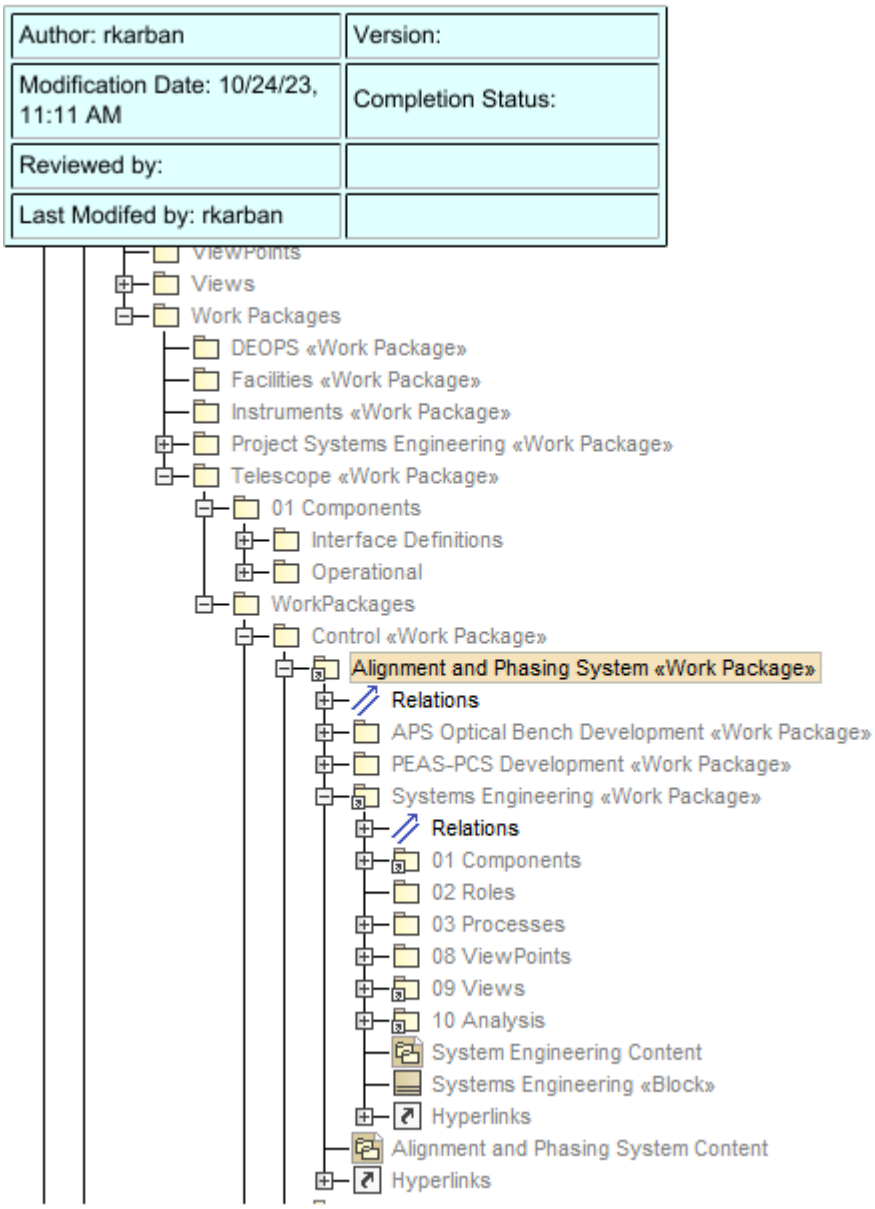
1. Post segment-exchange alignment
2. Maintenance alignment
3. Rigid body M3 alignment
4. Off-axis wavefront measurements
5. Measurement of segment warping harness influence functions
6. APS pre-observing checkout
7. M1CS Sensor Calibration with Post Segment-Exchange Alignment
8. Collection of M2 and M3 gravity calibration data
9. APS pre-observing internal calibrations

For detailed explanations of each use case, see TMT-APS OCDD.

2 Model Organization

The TMT model structure supports different levels of abstraction and deeply nested system hierarchies. All model elements that are required to develop a Use Case will be shown in the context of the Containment Tree.

TMT Model Organization



Navigating to APS

Logical Design Components

Author: rkarban	Version:
Modification Date: 10/24/23, 11:11 AM	Completion Status:
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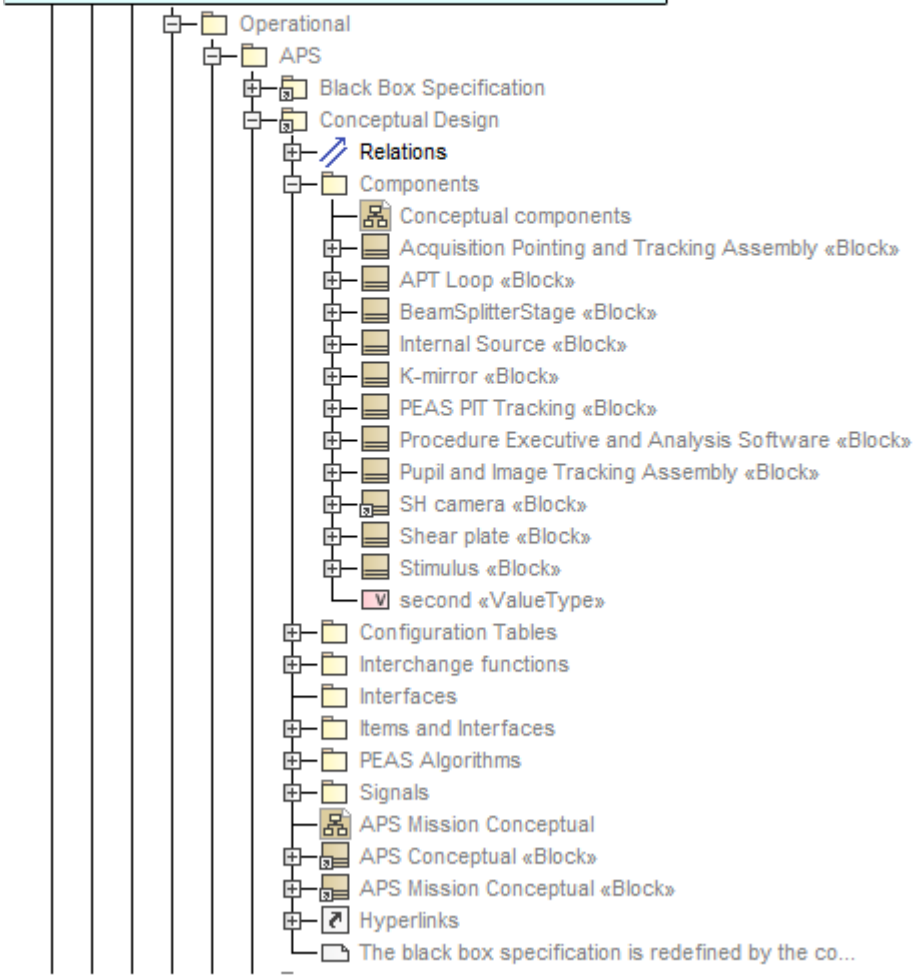
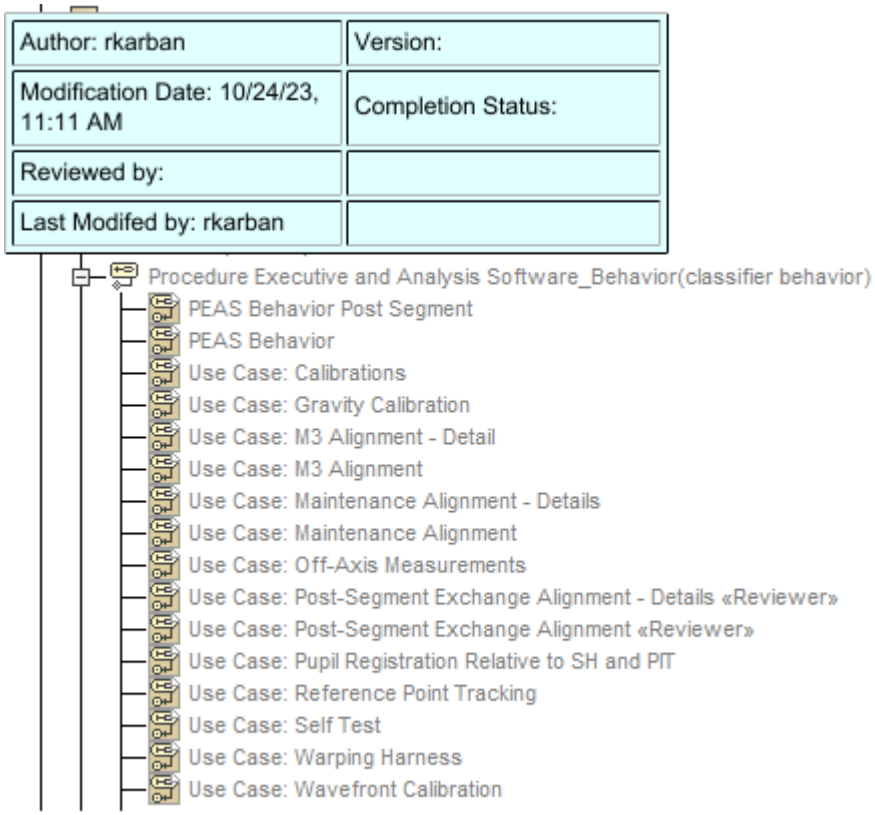
Last Modifed by: rkarban	

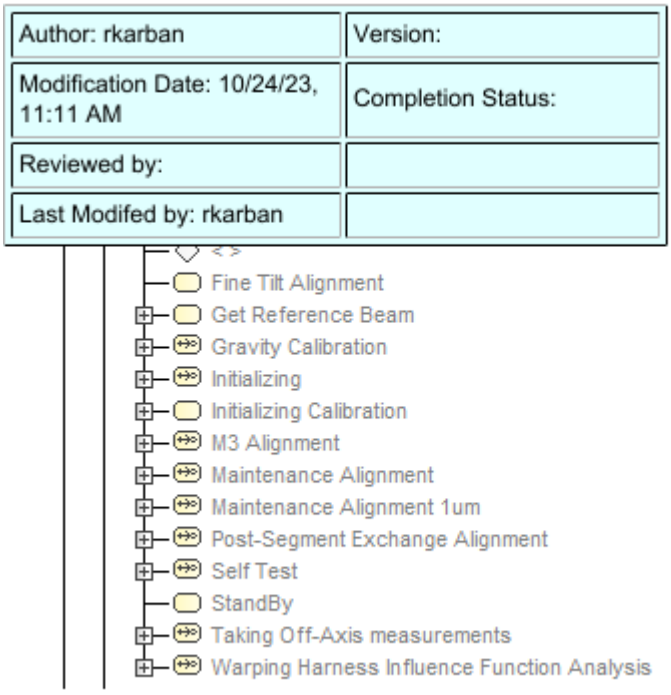


Navigating to PEAS

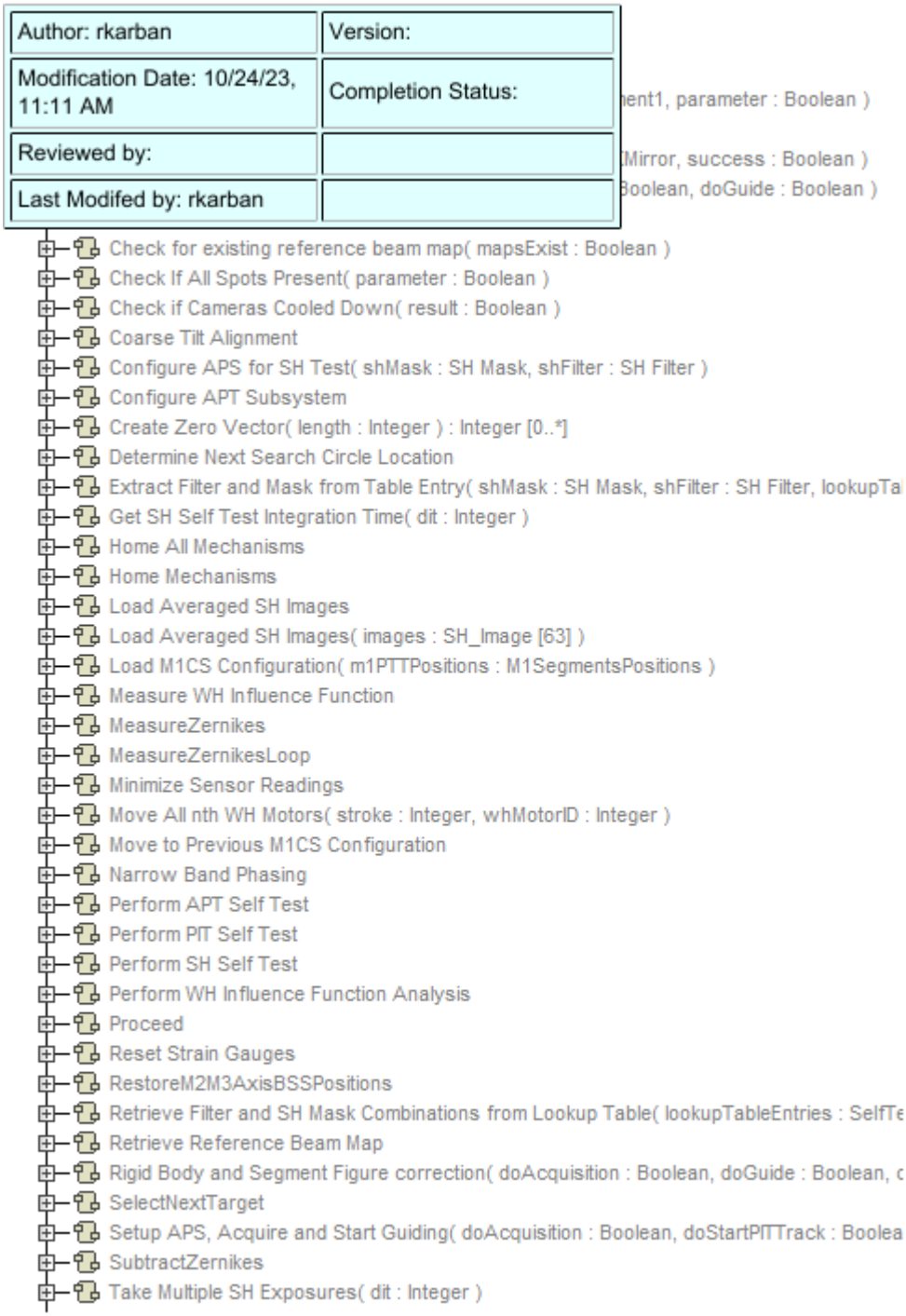
PEAS Use Case Diagrams



PEAS Use Case States



PEAS Activities



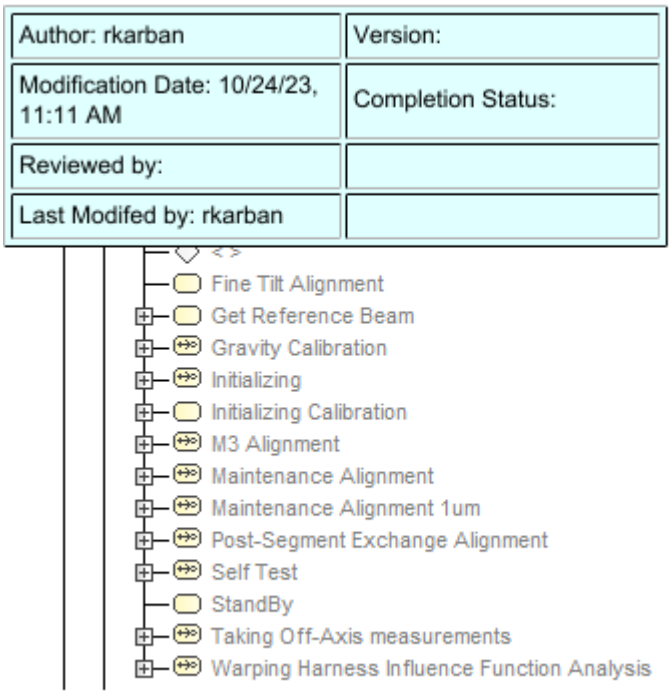
3 Defining Behavior in State Machines and Activites

The behavior of components are distinguished between life-cycle behavior and distinct isolated activities of a component. State machines are used to specify the life-cycle behavior of components. The life-cycle behavior describes the behavior of a component from beginning to end-of-life, and describes the state of a component at any instant in its operational lifetime. State machines a method to specify the various available modes of a system using states, and the conditions for transitioning between them. Activities capture specific tasks that represent only a part of the overall behavior of a component. The flow charts

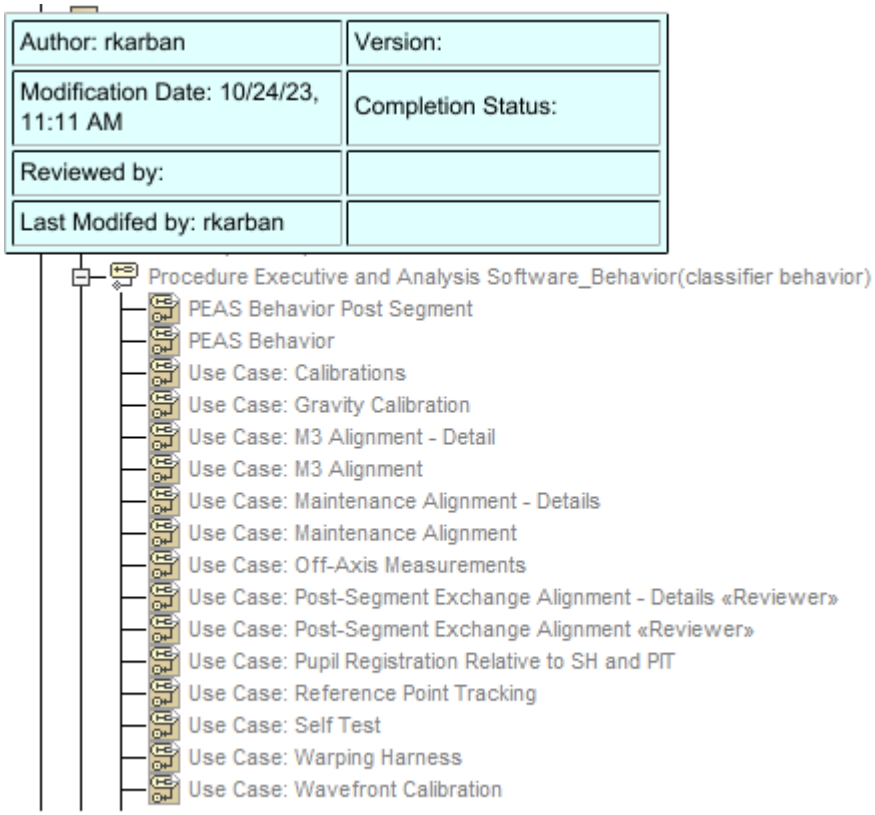
allow for the specification of sequential and parallel behavior, and decision points and synchronization points for an intuitive description of intended behavior.

A use case state machine begins Initializing will the do-activity InitializePEAS. When transitioning to state *StandBy*, a signalEvent of *InitComplete* will occur. An external signal that is specific to the use case (which may be provided by a user) causes a trigger to transition from *StandBy* to the use case specific state. Within this use case specific state, the primary states of the use case are specified. PEAS is specified to only be able to leave the primary use case state if an *Abort* signal is provided (internally or externally), and will return to the state *StandBy*. This can be seen below in the Use Case: Maintenance Alignment diagram.

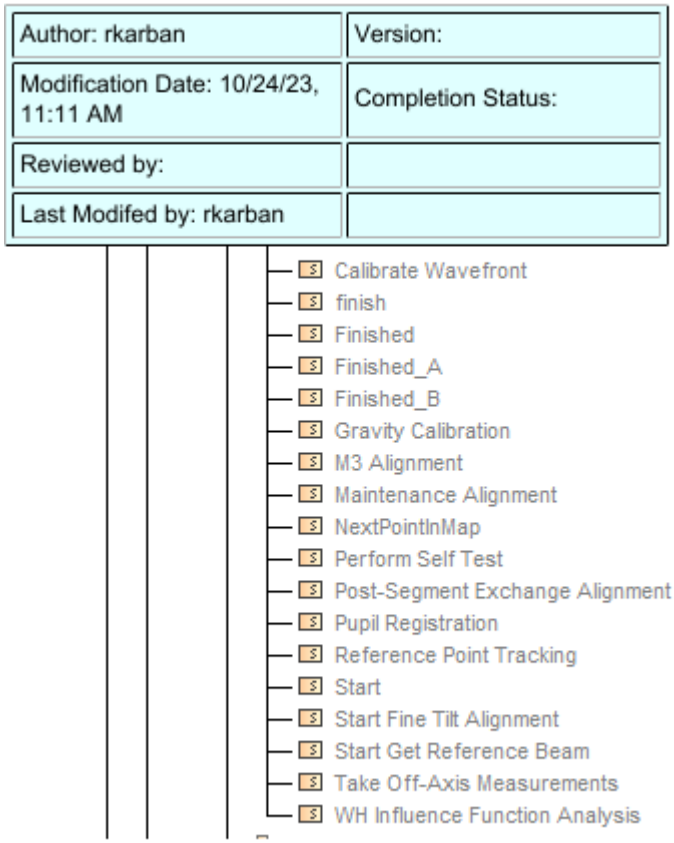
PEAS Use Case States



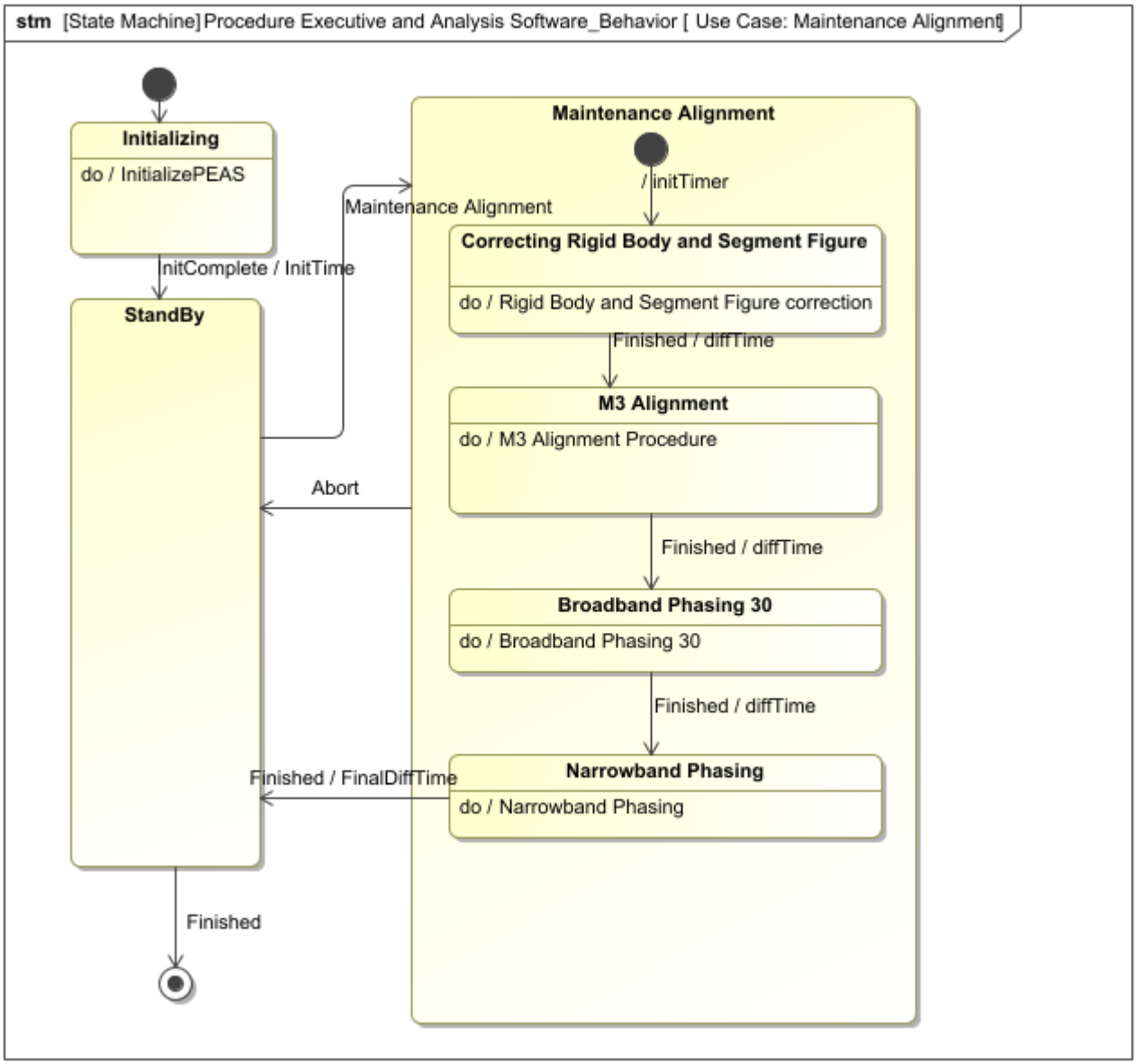
PEAS Use Case Diagrams



Use Case Signals



Use Case: Maintenance Alignment



PEAS Activities

Author: rkarban	Version:
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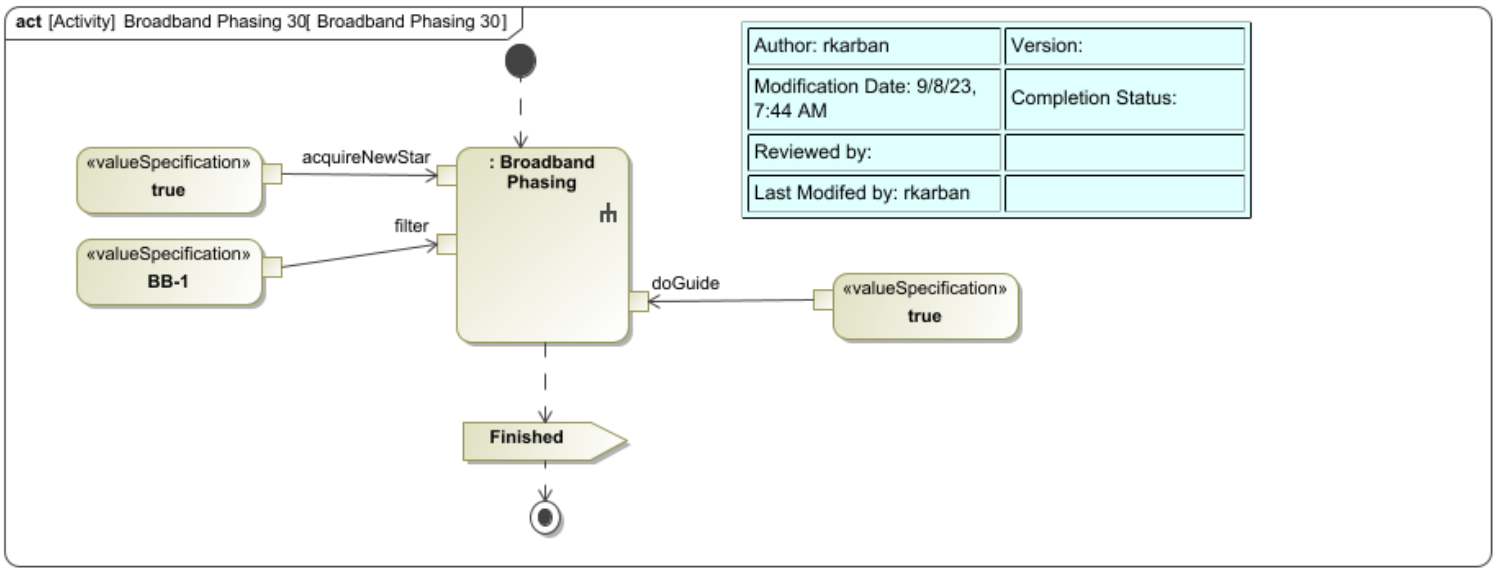
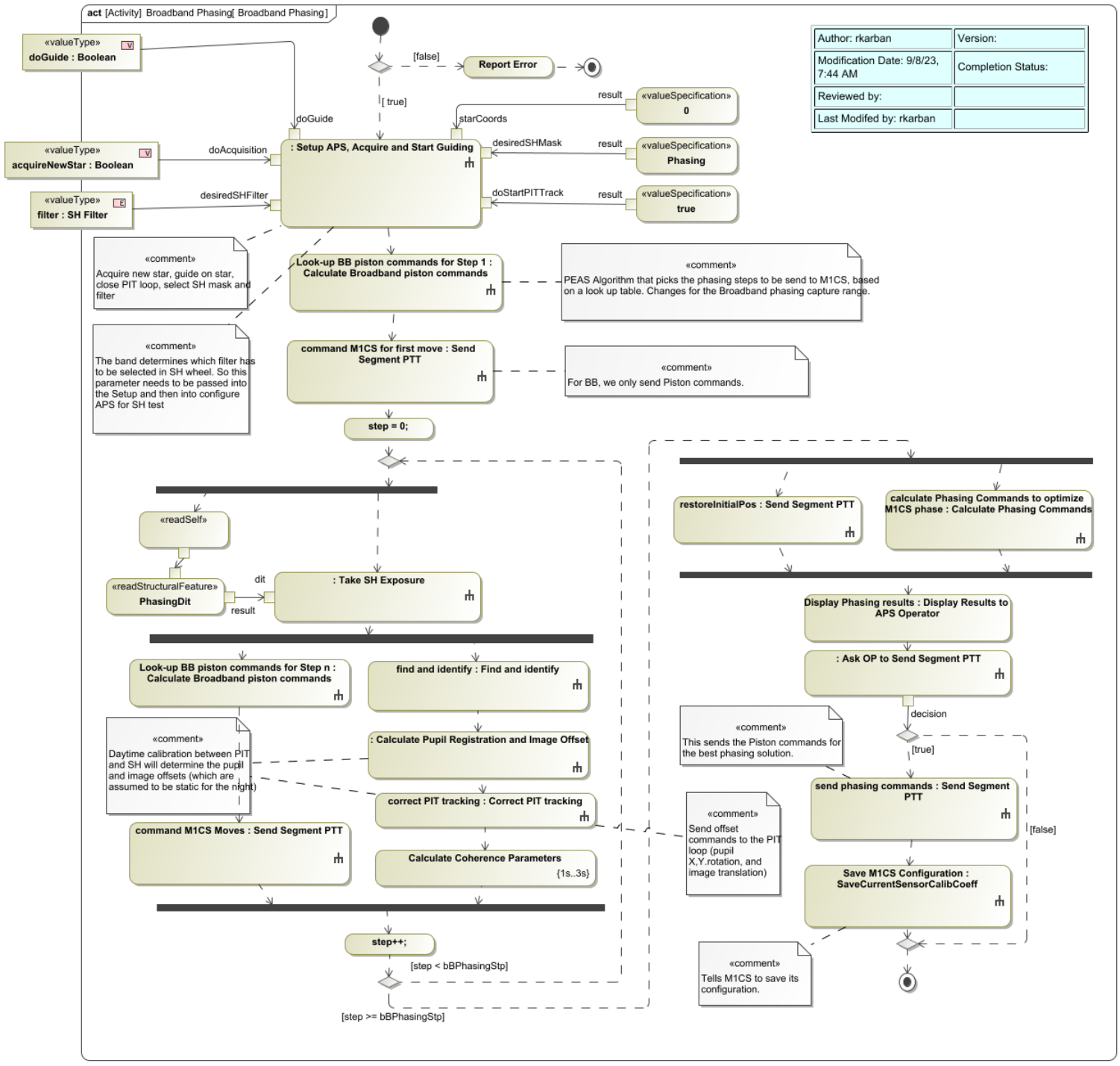
Last Modifed by: rkarban	

- Check for existing reference beam map(mapsExist : Boolean)
- Check If All Spots Present(parameter : Boolean)
- Check if Cameras Cooled Down(result : Boolean)
- Coarse Tilt Alignment
- Configure APS for SH Test(shMask : SH Mask, shFilter : SH Filter)
- Configure APT Subsystem
- Create Zero Vector(length : Integer) : Integer [0..*]
- Determine Next Search Circle Location
- Extract Filter and Mask from Table Entry(shMask : SH Mask, shFilter : SH Filter, lookupTa
- Get SH Self Test Integration Time(dit : Integer)
- Home All Mechanisms
- Home Mechanisms
- Load Averaged SH Images
- Load Averaged SH Images(images : SH_Image [63])
- Load M1CS Configuration(m1PTTPositions : M1SegmentsPositions)
- Measure WH Influence Function
- MeasureZernikes
- MeasureZernikesLoop
- Minimize Sensor Readings
- Move All nth WH Motors(stroke : Integer, whMotorID : Integer)
- Move to Previous M1CS Configuration
- Narrow Band Phasing
- Perform APT Self Test
- Perform PIT Self Test
- Perform SH Self Test
- Perform WH Influence Function Analysis
- Proceed
- Reset Strain Gauges
- RestoreM2M3AxisBSSPositions
- Retrieve Filter and SH Mask Combinations from Lookup Table(lookupTableEntries : SelfTe
- Retrieve Reference Beam Map
- Rigid Body and Segment Figure correction(doAcquisition : Boolean, doGuide : Boolean, c
- SelectNextTarget
- Setup APS, Acquire and Start Guiding(doAcquisition : Boolean, doStartPITTrack : Boolea
- SubtractZernikes
- Take Multiple SH Exposures(dit : Integer)

Broadband Phasing 30



Broadband Phasing



4 Defining Behavior in Sequence Diagrams

The purpose of operational scenarios is to provide a method to model variations and configurations of a system, and allows for analysis to be performed. Operational scenarios for each Use Case are specified and provide a context for duration analysis. Requirements that define a time frame for a behavior can be verified by performing a duration analysis to calculate a time value that is compared to a required value through parametric relations. The Use Case scenarios evaluate whether the performance of the APS meets a specified duration requirement.

Use Case Duration Scenario Blocks

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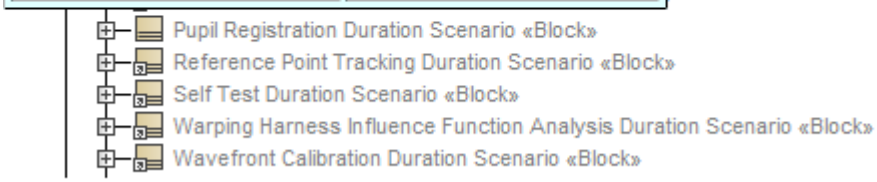
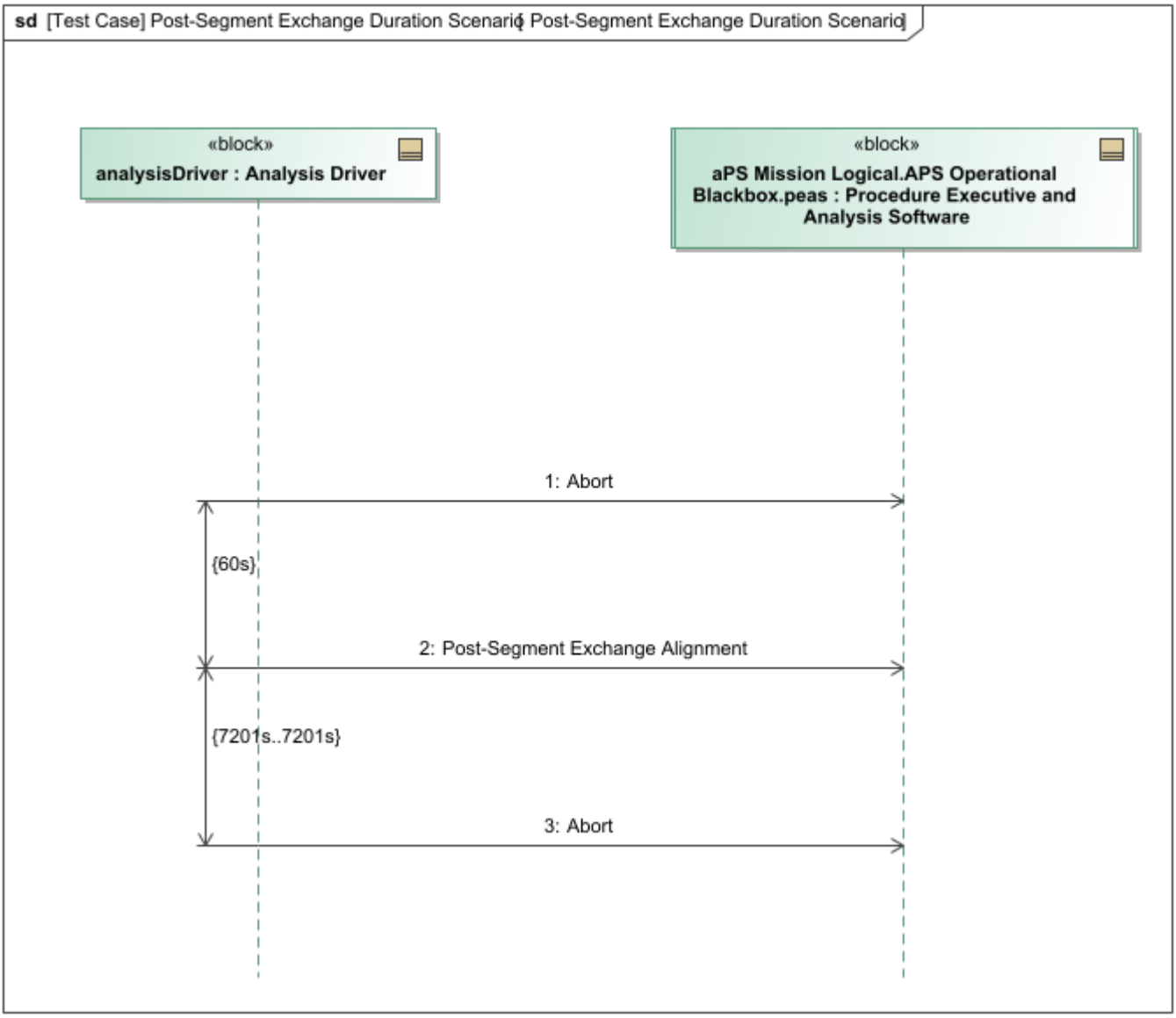


Each corresponding Use Case duration scenario of the PEAS is represented by a SysML block. The naming convention for a Duration Scenario block is Use Case name + "Duration Scenario". The classifier behavior of the duration scenario block is a sequence diagram, and additionally owns a parametric diagram. The Use Case Duration Scenario blocks an be found in the model at the following location TMT::Project::Work Packages::Telescope::WorkPackages::Control::Alignment and Phasing System::Systems Engineering::10 Analysis::Duration Analyses::Automatic Duration Analysis.

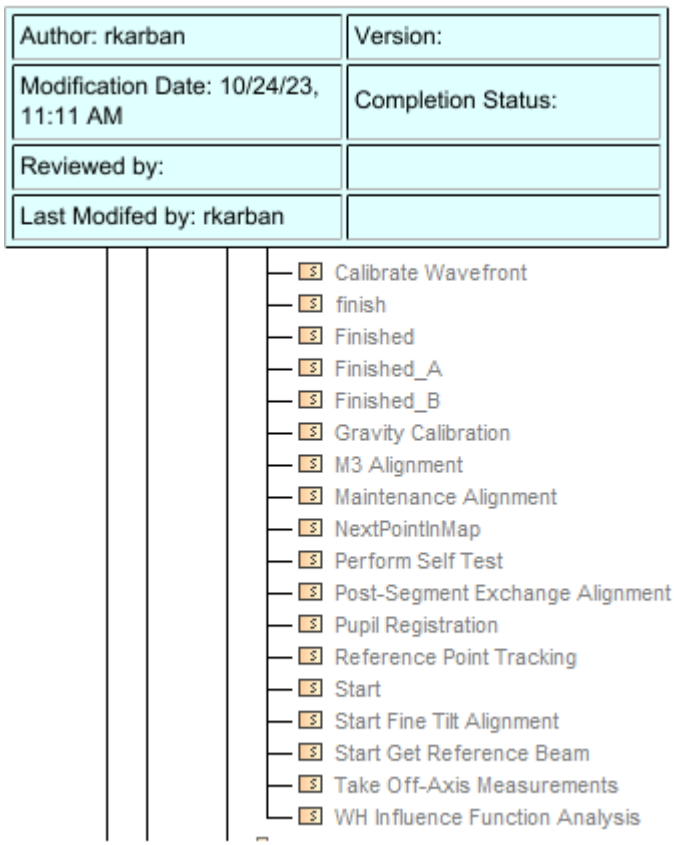
Post-Segment Exchange Duration Scenario



To simulate an operator initiating a particular operational scenario, signals must be injected that trigger appropriate behavior of the various components. Signals are sent from an Analysis Driver (the operator) to the Procedure Executive and Analysis Software. For all interactions of the Use Case Duration Scenarios, the asynch signals that must be sent in the exact order from the Analysis Driver are "Abort ", a Use Case specific signal, and "Abort". Duration constraints are specified between the each signal, and will vary depending on the Use Case.

For example, the Post-Segment Exchange Alignment signal is triggered in the Post-Segment Exchange Duration Scenario as seen above.

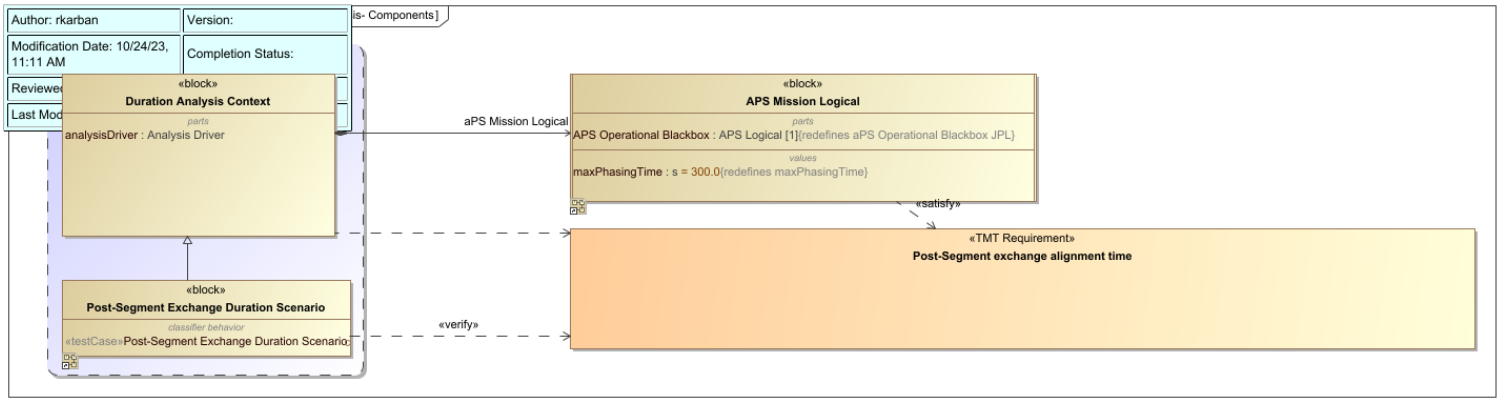
Use Case Signals



5 Requirement Verification

The process for verifying TMT requirements is the following: formalization of requirements, defining an analysis context, connecting system value properties to constraint parameters, evaluating system configurations through analysis, verifying the system requirements, and capturing the verification test results.

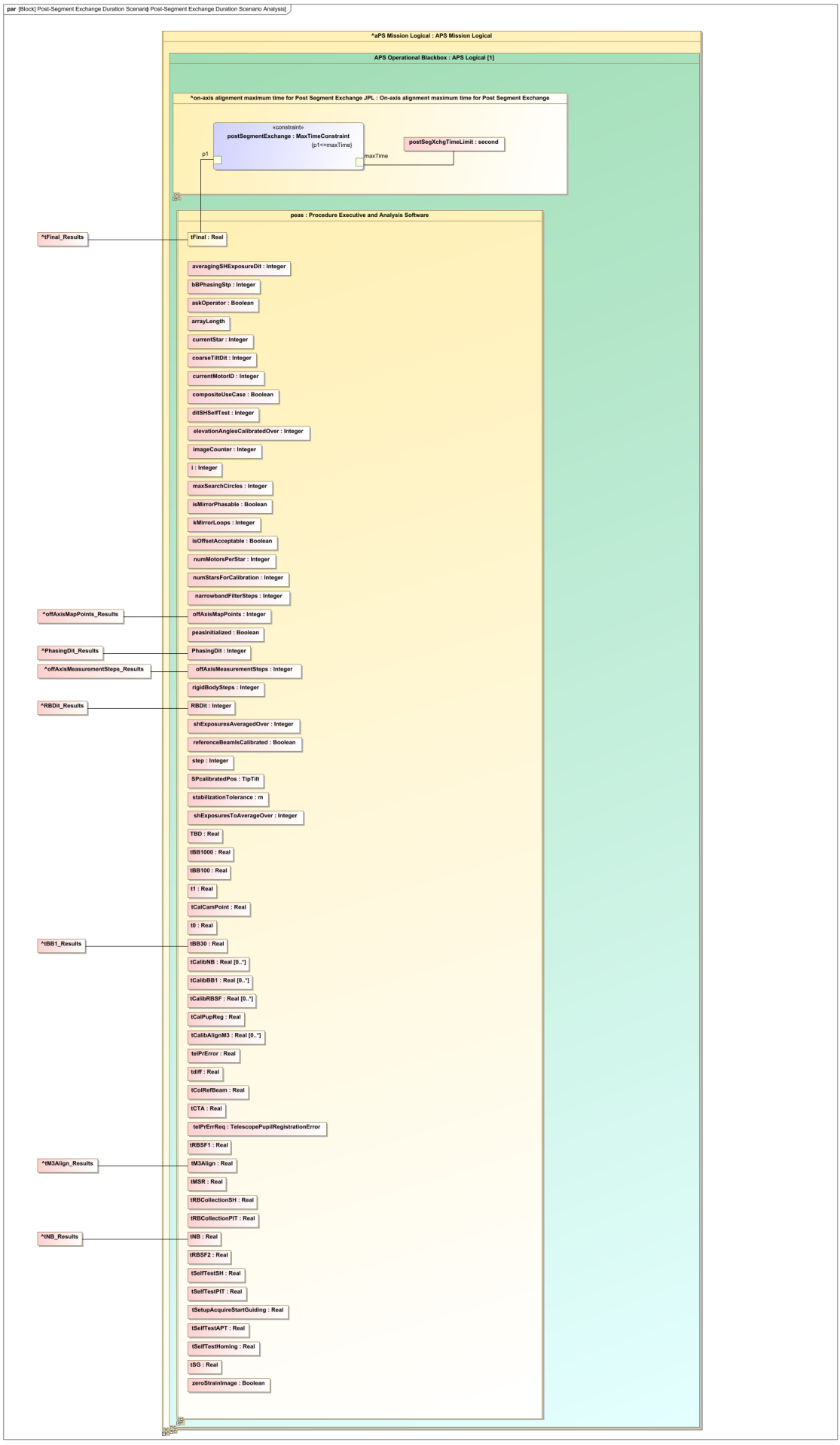
Duration Analysis- Components



All Use Case Duration Scenario blocks that are described in Defining Behavior in Sequence Diagrams specialize the Duration Analysis Context block, and inherit its owned behavior. The Duration Analysis Context owns a part, Analysis Driver, which acts as an operator in the interaction of the Use Case

Duration Scenarios. If a use case should verify a requirement a <<verify>> relation should exist between the Test Case and the Requirement. This is demonstrated in the above diagram. The APS Requirements can be found in the model at the following location: TMT::Project::Work Packages::Project Systems Engineering::01 Components::Operational::TMT Observatory System::Black Box Specification::TMT Requirements imported from DOORS::APS::APS Requirements.

Post-Segment Exchange Duration Scenario Analysis

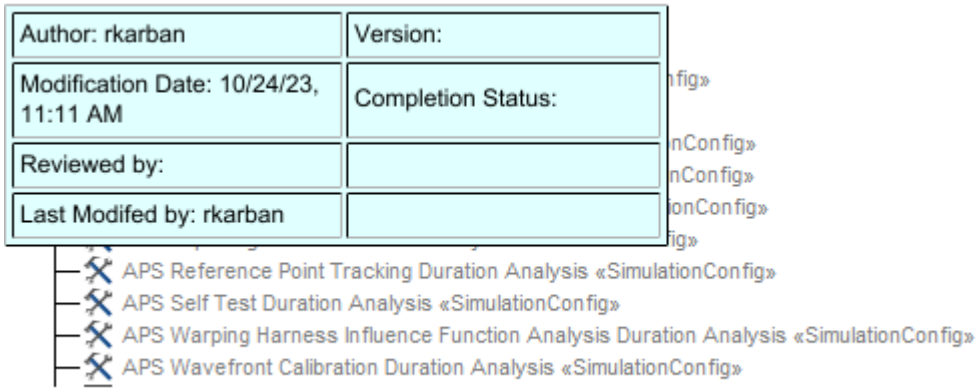


All Use Case Duration Scenarios should own a parametric diagram. The purpose of the Use Case duration scenarios is to determine the final time and overall duration of a particular use case. Therefore, each duration scenario block should own a parametric diagram. Depending on the use case, the tFinal value property of the Procedure Executive and Analysis Software could be constrained to a constraint of the APS Operational Blackbox for requirement verification purposes. All current and future constraints in APS should be found in the model at the following location: TMT::Project::Work Packages::Telescope::WorkPackages::Control::Alignment and Phasing System::Systems Engineering::01 Components::Operational::APS::Black Box Specification::Requirements::10 Formalized Requirements.

6 Simulation Components

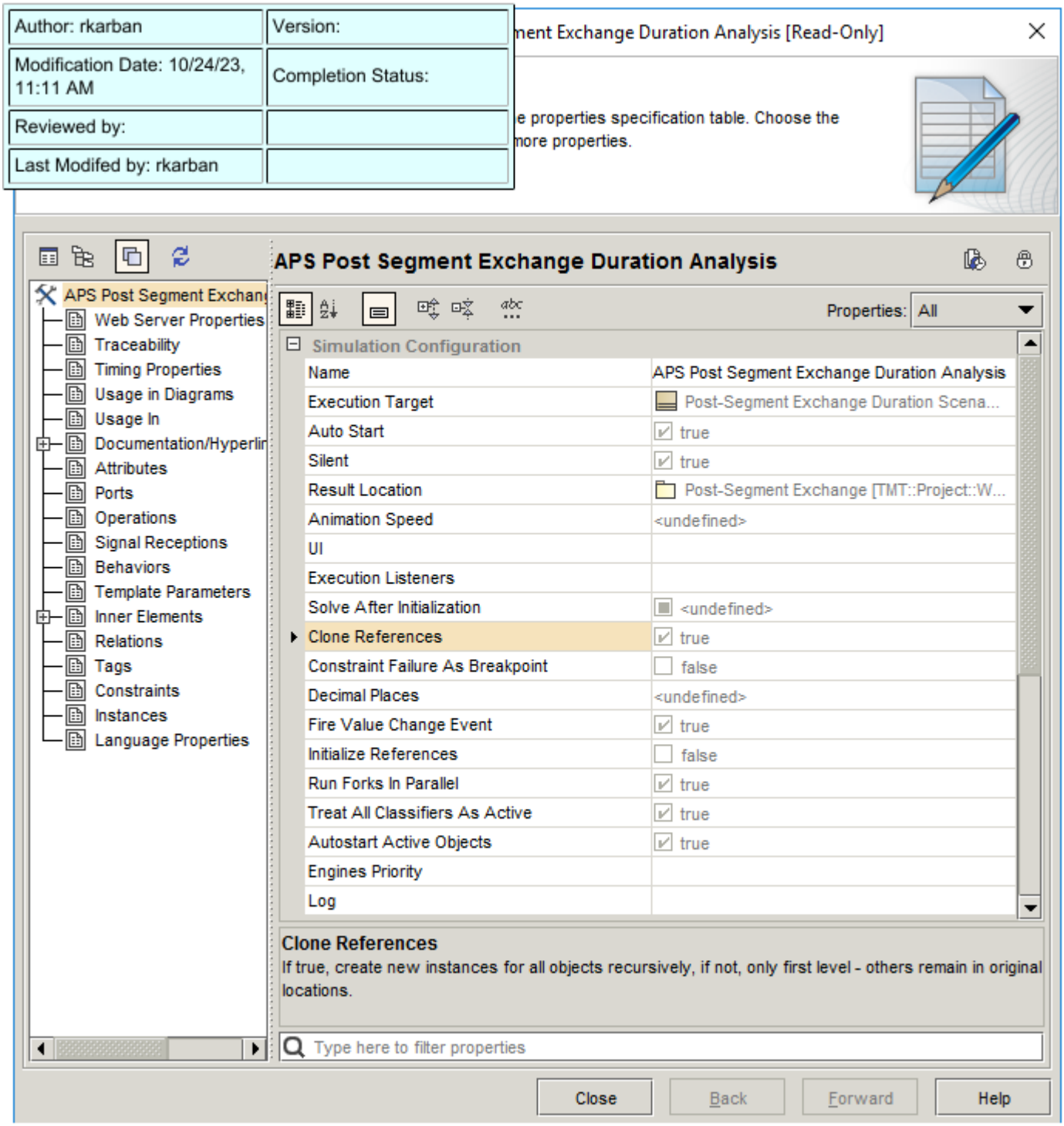
The operational scenario blocks, sequence diagrams, parametric diagrams, and simulation configurations can be found in the model at the following location: TMT::02 JPL::System Model::APS::02 APS Analyses::Duration Analyses::Automatic Duration Analysis.

Use Case Simulation Configurations



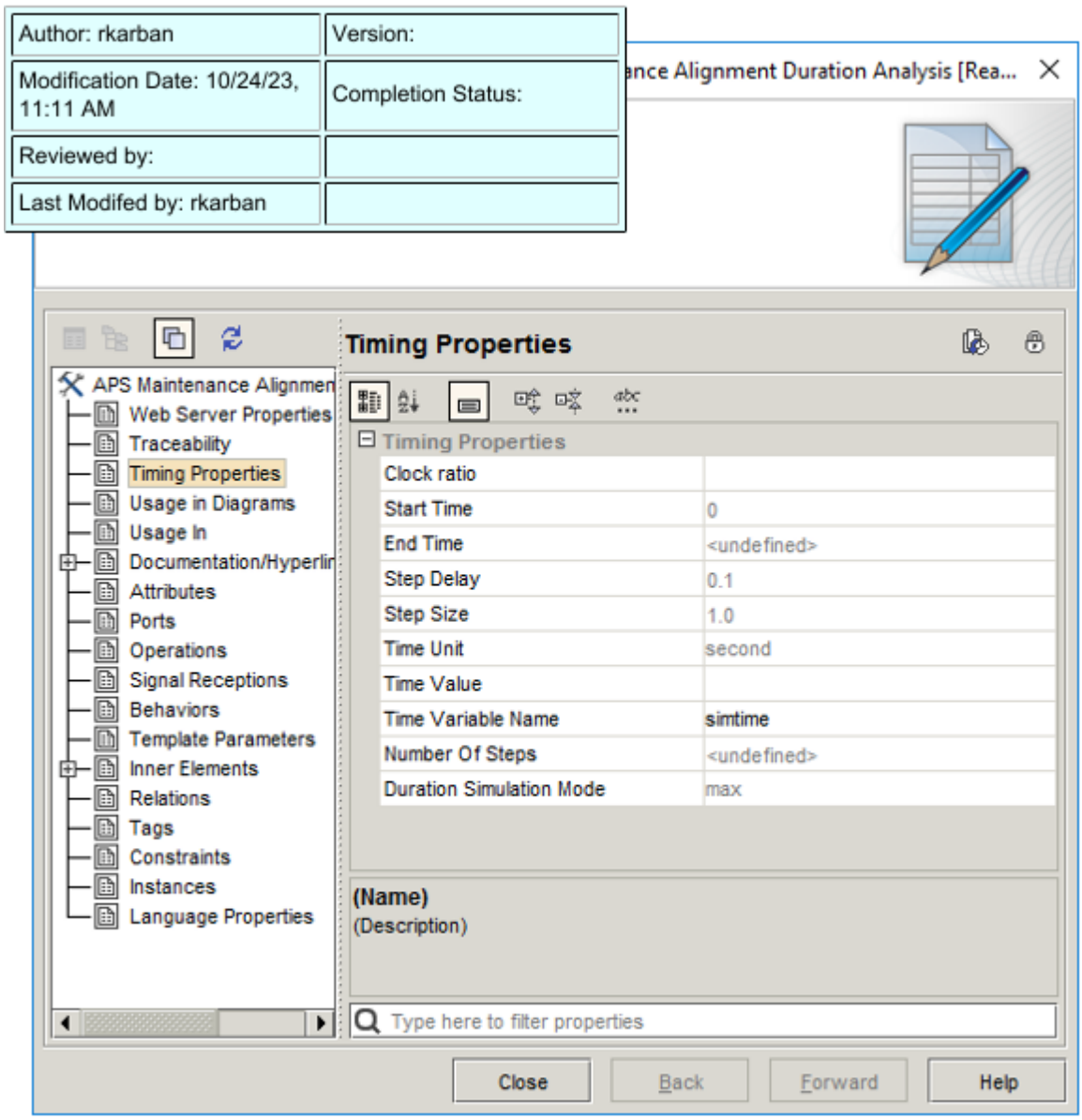
A simulation configuration is created for each Alignment and Phasing System (APS) Use Case. The naming convention for the simulation configurations are "APS" + Use Case name + "Duration Analysis". The execution targets of the simulation configurations are the Use Case Duration Scenario blocks.

Use Case Simulation Configuration Specifications



In the specification of the simulation configuration, it must be decided whether the simulation should run Silent or using animations. The decision to run the simulation with or without animations can affect the values of the value properties. The choice to run with or without animations can be determined by executing a Use Case and evaluating whether the output aligns with the expected values for the Use Case. For example, the Post Segment Exchange Duration Analysis simulation configuration has been specified to run Silent.

Use Case Simulation Configuration Timing Properties



The timing properties of the Use Case simulation configurations must also be specified. The following should be configured in order to complete the simulation configuration set up. The Step Delay property should be specified and the value varies for each Use Case. The Step Delay ranges between .01 to .15. The Step Size property for all simulation configurations should be set to 1.0. The Time Unit property should be specified as "second". For example, the APS Maintenance Alignment Duration Analysis is configured to have a Step Delay of 0.1 and a Step Size of 1.0.

7 Evaluating Results

Through simulation, the conceptual design is automatically evaluated, and verifies whether the system conforms to a requirement. The exposed instance tables display whether the instances have passed or failed a requirement. The values of the resulting instances should be identical or have minimal differences. Therefore, the simulation is run more than once to confirm that the values can be reproduced.

In addition, a manual baseline estimation should be available for comparison to ensure there are no model, simulation, or tooling errors.

Analysis Results

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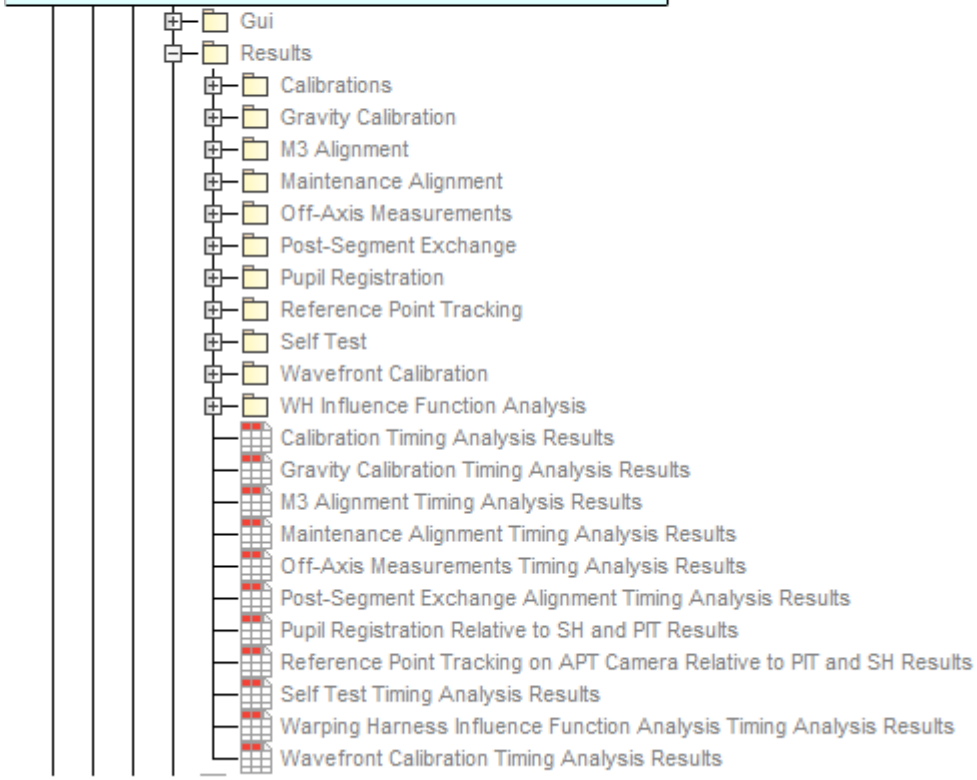
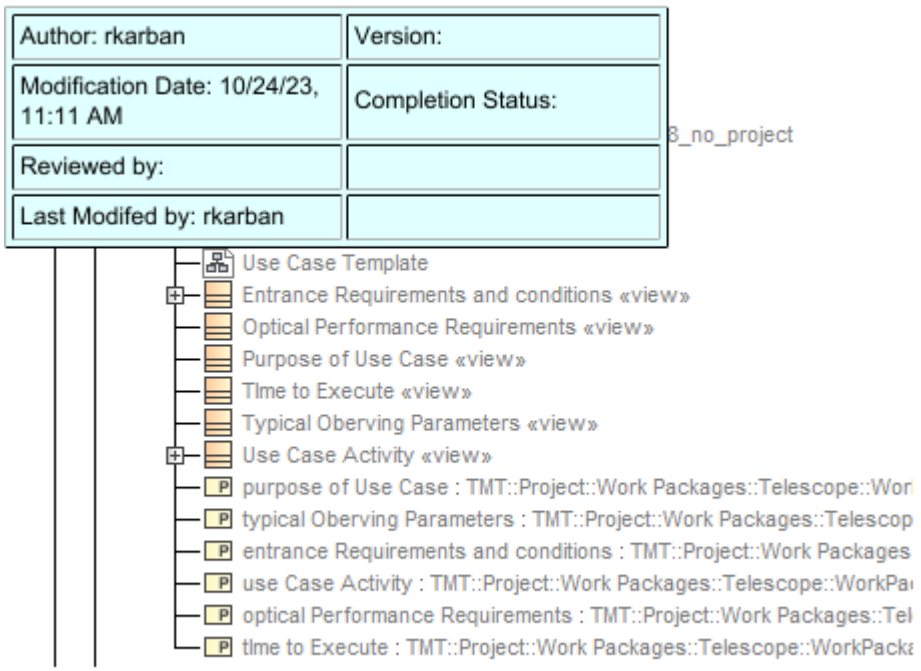


8 Document Generation

The model development kit (MDK) is utilized to sync the TMT model with the model management system (MMS) and implement the DocGen language, which allows for document generation using the view and viewpoint concept. The standard view structure for a TMT use case is composed of the following views: Purpose of use case, Typical observing parameters, Entrance requirements and conditions, Use Case activity, Optical Performance Requirements, and Time to Execute. In MagicDraw, views are created using a template, and expose diagrams containing simulation results and key activities. The documentation of the Use Case is done within ViewEditor.

Use Case Template



The Use Case Template can be found in the model at the following location:TMT::Project::Work Packages::Telescope::WorkPackages::Control::Alignment and Phasing System::Systems Engineering::09 Views::TMT-APS-SE::TMT-APS Use Cases::Templates::Use Case Template

9 Overview of Components

In conclusion all the components that should be created include:

A BDD that displays all components of a PEAS Use Case should be created in the model at the following location: TMT::02 JPL::System Model::APS::02 APS Analyses::Duration Analyses.

This should include the Duration Scenario, Duration Analysis Context, APS Mission Conceptual, the Use Case parametric diagram (if needed), the appropriate TMT Requirement (if needed), the Use Case instance table, and the Use Case simulation configuration. Refer to the below diagram as an example.

An example template workflow is provided for reference at this location: TMT::02 JPL::System Model::APS::02 APS Analyses::Duration Analyses::Automatic Duration Analysis::Template.

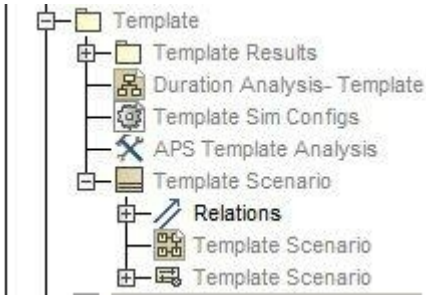
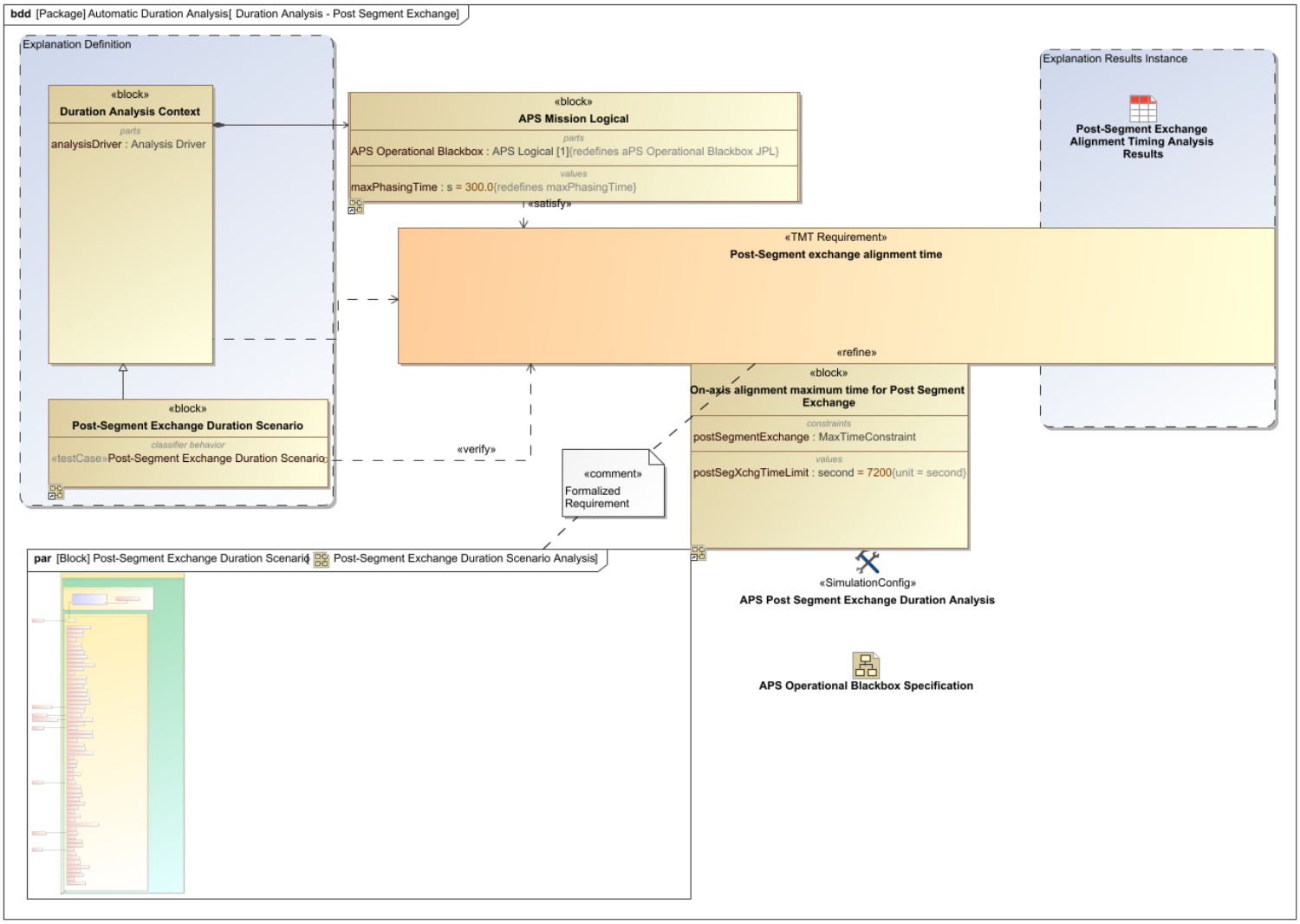


Fig. 1 Template Workflow

Duration Analysis - Post Segment Exchange



The duration performance of the Logical design is analyzed w/r/t to the black box specification.