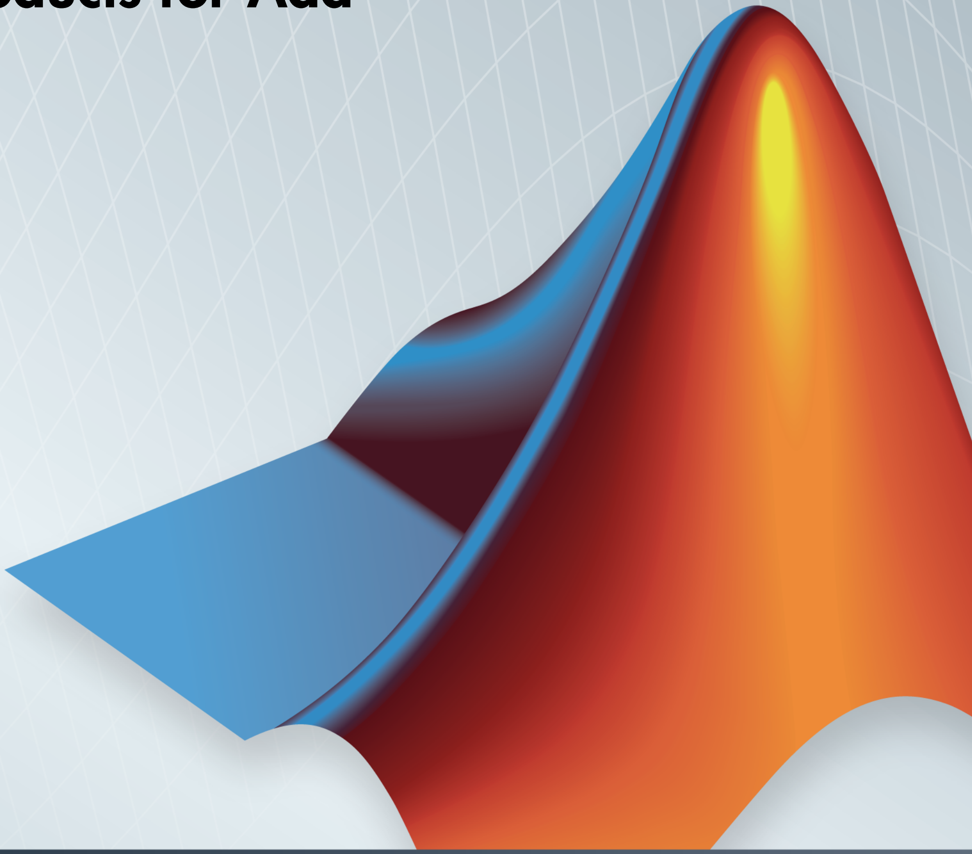
Polyspace® Products for Ada

User's Guide

R2014b



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Polyspace® Products for Ada User's Guide

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Revision History

March 2008	Online Only	Revised for Version 5.1 (Release 2008a)
October 2008	Online Only	Revised for Version 5.2 (Release 2008b)
March 2009	Online Only	Revised for Version 5.3 (Release 2009a)
September 2009	Online Only	Revised for Version 5.4 (Release 2009b)
March 2010	Online Only	Revised for Version 5.5 (Release 2010a)
September 2010	Online Only	Revised for Version 6.0 (Release 2010b)
April 2011	Online Only	Revised for Version 6.1 (Release 2011a)
September 2011	Online Only	Revised for Version 6.2 (Release 2011b)
March 2012	Online Only	Revised for Version 6.3 (Release 2012a)
September 2012	Online Only	Revised for Version 6.4 (Release 2012b)
March 2013	Online Only	Revised for Version 6.5 (Release 2013a)
September 2013	Online Only	Revised for Version 6.6 (Release 2013b)
March 2014	Online Only	Revised for Version 6.7 (Release 2014a)
October 2014	Online Only	Revised for Version 6.8 (Release 2014b)

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Glossary

Introduction to Polyspace Products

Product Description

In this section...
"Polyspace Client for Ada" on page 1-2
"Polyspace Server for Ada" on page 1-2

Polyspace Client for Ada

Prove the absence of run-time errors in source code

Polyspace Client for Ada provides code verification that proves the absence of overflow, divide-by-zero, out-of-bounds array access, and certain other run-time errors in source code using static code analysis that does not require program execution, code instrumentation, or test cases. Polyspace Client for Ada uses formal methods-based abstract interpretation techniques to verify code. You can use it on handwritten code, generated code, or a combination of the two, before compilation and test.

Key Features

- Verification of individual packages and package sets
- Formal method based abstract interpretation
- Display of run-time errors directly in code
- Eclipse™ IDE integration

Polyspace Server for Ada

Perform code verification on computer clusters and publish metrics

Polyspace Server for Ada provides code verification that proves the absence of overflow, divide-by-zero, out-of-bounds array access, and certain other run-time errors in source code. For faster performance, Polyspace Server for Ada lets you schedule verification tasks to run on a computer cluster. Jobs are submitted to the server using Polyspace Client for Ada. You can integrate jobs into automated build processes and set up e-mail notifications. You can view defects and regressions via a Web browser. You then use the client to download and visualize verification results.

Key Features

- Web-based dashboard providing code metrics and quality status

- Automated job scheduling and e-mail notification
- Multi-server job queue manager
- Verification report generation
- Mixed operating system environment support

Overview of Polyspace Verification

Polyspace products verify C, C++, and Ada code by detecting run-time errors before code is compiled and executed. Polyspace verification uses formal methods not only to detect errors, but to prove mathematically that certain classes of run-time errors do not exist.

To verify the source code, you set up verification parameters in a project, run the verification, and review the results. A graphical user interface helps you to efficiently review verification results. The software assigns a color to operations in the source code as follows:

- **Green** – Indicates that an operation is proven to not have certain kinds of error.
- **Red** – Indicates that an operation is proven to have at least one error.
- **Gray** – Indicates unreachable code.
- **Orange** – Indicates that the operation can have an error along some execution paths.

The color-coding helps you to quickly identify errors and find the exact location of an error in the source code. After you fix errors, you can easily run the verification again.

The Value of Polyspace Verification

In this section...

Enhance Software Reliability

Polyspace software enhances the reliability of your Ada applications by proving code correctness and identifying run-time errors. Using advanced verification techniques, Polyspace software performs an exhaustive verification of your source code.

Polyspace software can:

- Prove that your code has certain kinds of errors.
- Prove that your code does not have certain kinds of errors.
- Identify unreachable code.
- Identify code that can have an error along some execution paths.

With this information, you know how much of your code does not contain run-time errors, and you can improve the reliability of your code by fixing the errors.

Decrease Development Time

Polyspace software reduces development time by automating the verification process and helping you to efficiently review verification results. You can use it at any point in the development process, but using it during early coding phases allows you to find errors when it is less costly to fix them.

You use Polyspace software to verify Ada source code before compile time. To verify the source code, you set up verification parameters in a project, run the verification, and review the results. This process takes significantly less time than using manual methods or using tools that require you to modify code or run test cases.

Color-coding helps you to quickly identify errors. You will spend less time debugging because you can see the exact location of an error in the source code. After you fix errors, you can easily run the verification again.

Polyspace verification software helps you to use your time effectively. Because you know the parts of your code that do not have errors, you can focus on the code with proven (red code) or potential errors (orange code).

Reviewing the code that might have errors (orange code) can be time-consuming, but Polyspace software helps you with the review process. You can use filters to focus on certain types of errors or you can allow the software to identify the code that you should review.

Improve the Development Process

Polyspace software makes it easy to share verification parameters and results, allowing the development team to work together to improve product reliability. Once verification parameters have been set up, developers can reuse them for other files in the same application.

Polyspace verification software supports code verification throughout the development process:

- An individual developer can find and fix run-time errors during the initial coding phase.
- Quality assurance can check overall reliability of an application.
- Managers can monitor application reliability by generating reports from the verification results.

How Polyspace Verification Works

Polyspace software uses *static verification* to prove the absence of run-time errors. Static verification derives the dynamic properties of a program without actually executing it. This technique differs significantly from other techniques, such as run-time debugging, in that the verification it provides is not based on a given test case or set of test cases. The dynamic properties obtained in the Polyspace verification are true for all executions of the software.

What is Static Verification

Static verification is a broad term, and is applicable to any tool which derives dynamic properties of a program without actually executing it. However, most static verification tools only verify the complexity of the software, in a search for constructs which may be potentially erroneous. Polyspace verification provides deep-level verification identifying most run-time errors and possible access conflicts on global shared data.

Polyspace verification works by approximating the software under verification, using representative approximations of software operations and data.

For example, consider the following code:

```
for (i=0 ; i<1000 ; ++i)
{    tab[i] = foo(i);
}
```

To check that the variable `i` does not overflow the range of `tab`, a traditional approach would be to enumerate each possible value of `i`. One thousand checks would be required.

Using the static verification approach, the variable `i` is modelled by its domain variation. For instance, the model of `i` is that it belongs to the [0..999] static interval. (Depending on the complexity of the data, convex polyhedrons, integer lattices and more elaborate models are also used for this purpose).

An approximation usually leads to information loss. For instance, the information that `i` is incremented by one every cycle in the loop is lost. However, the important fact is that this information is not required to ensure that a range error will not occur; it is only necessary to prove that the domain variation of `i` is smaller than the range of `tab`. Only one check is required to establish that — and hence the gain in efficiency compared to traditional approaches.

Static code verification has an exact solution. However, this exact solution is not practical, as it would require the enumeration of all possible test cases. As a result, approximation is required for a usable tool.

Exhaustiveness

Nothing is lost in terms of exhaustiveness. The reason is that Polyspace verification works by performing upper approximations. In other words, the computed variation domain of a program variable is a superset of its actual variation domain. The direct consequence is that a runtime error (RTE) item to be checked cannot be missed by Polyspace verification.

Product Components

The Polyspace products for verifying Ada code are:

In this section...

Polyspace Verification Environment

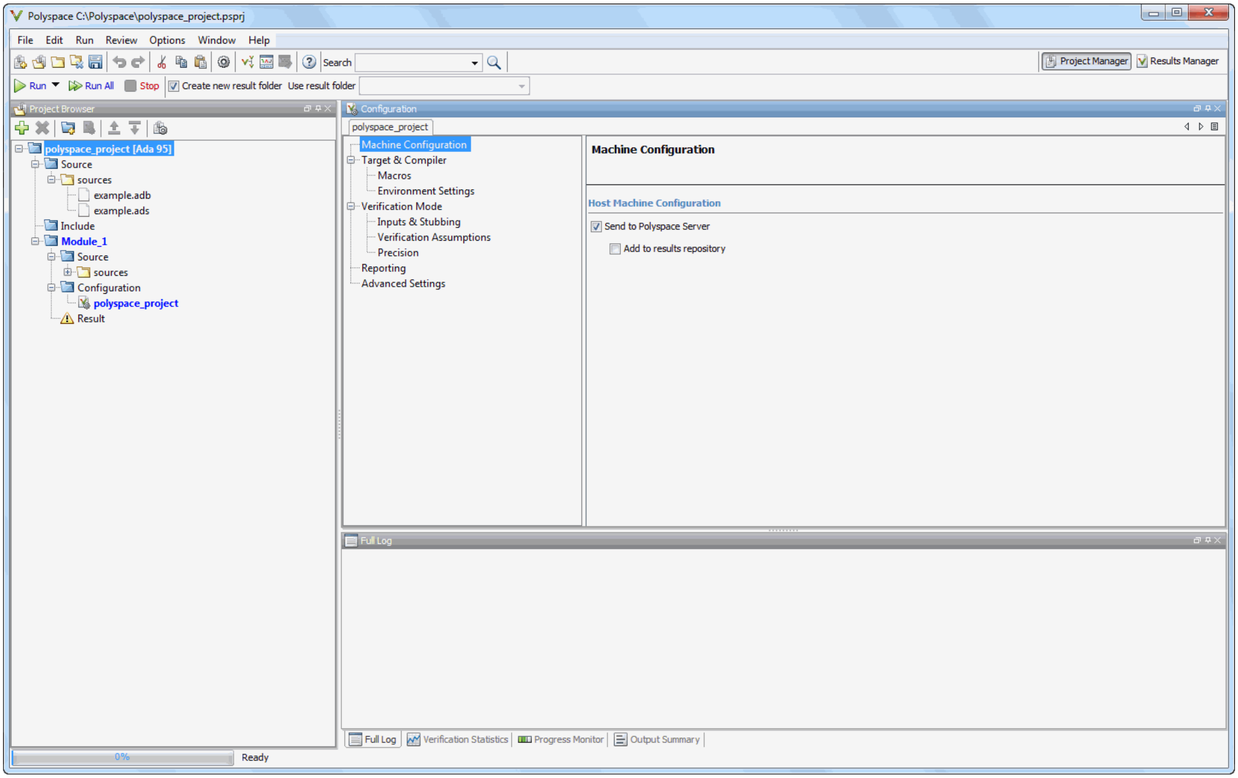
The Polyspace verification environment (PVE) is the graphical user interface of the Polyspace Client for Ada software. You use the Polyspace verification environment to create Polyspace projects, launch verifications, and review verification results.

For Ada verification, you use two perspectives of the Polyspace verification environment:

- "Project Manager Perspective" on page 1-9
- "Results Manager Perspective" on page 1-10

Project Manager Perspective

The Project Manager perspective allows you to create projects, set verification parameters, and start verifications.



☑ Create new result folder

Machine Configuration

Host Machine Configuration

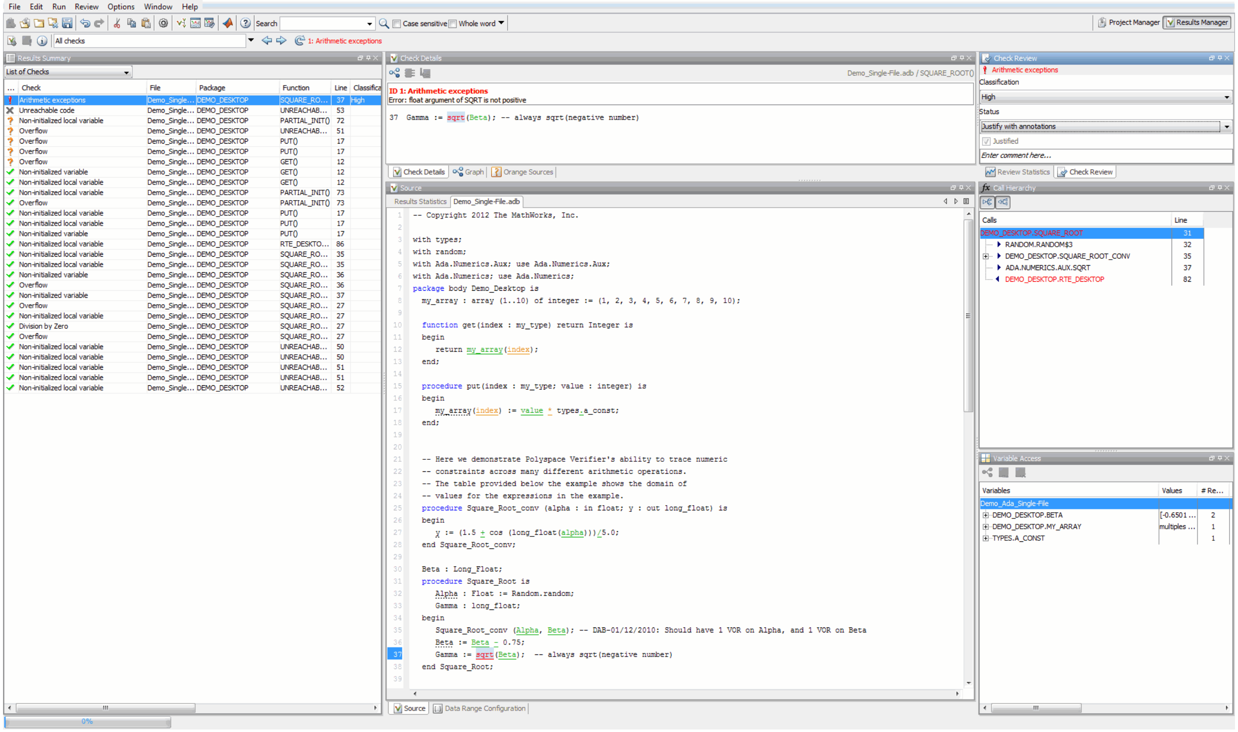
☑ Send to Polyspace Server

□ Add to results repository

For information on using the Project Manager perspective, see “Project Configuration”.

Results Manager Perspective

The Results Manager perspective allows you to review verification results, comment individual checks, and track review progress.



...	Check	File	Package	Function	Line	Classifica
!	Arithmetic exceptions	Demo_Single…	DEMO_DESKTOP	SQUARE_RO…	37	High
✗	Unreachable code	Demo_Single…	DEMO_DESKTOP	UNREACHAB…	53	
?	Non-initialized local variable	Demo_Single…	DEMO_DESKTOP	PARTIAL_INIT()	72	
?	Overflow	Demo_Single…	DEMO_DESKTOP	UNREACHAB…	51	
?	Overflow	Demo_Single…	DEMO_DESKTOP	PUT()	17	
?	Overflow	Demo_Single…	DEMO_DESKTOP	PUT()	17	
?	Overflow	Demo_Single…	DEMO_DESKTOP	GET()	12	
✓	Non-initialized variable	Demo_Single…	DEMO_DESKTOP	GET()	12	
✓	Non-initialized local variable	Demo_Single…	DEMO_DESKTOP	GET()	12	
✓	Non-initialized local variable	Demo_Single…	DEMO_DESKTOP	PARTIAL_INIT()	73	
✓	Overflow	Demo_Single…	DEMO_DESKTOP	PARTIAL_INIT()	73	
✓	Non-initialized local variable	Demo_Single…	DEMO_DESKTOP	PUT()	17	
✓	Non-initialized local variable	Demo_Single…	DEMO_DESKTOP	PUT()	17	
✓	Non-initialized variable	Demo_Single…	DEMO_DESKTOP	PUT()	17	
✓	Non-initialized local variable	Demo_Single…	DEMO_DESKTOP	RTE_DESKTO…	86	
✓	Non-initialized local variable	Demo_Single…	DEMO_DESKTOP	SQUARE_RO…	35	
✓	Non-initialized local variable	Demo_Single…	DEMO_DESKTOP	SQUARE_RO…	35	
✓	Non-initialized variable	Demo_Single…	DEMO_DESKTOP	SQUARE_RO…	36	
✓	Overflow	Demo_Single…	DEMO_DESKTOP	SQUARE_RO…	36	
✓	Non-initialized variable	Demo_Single…	DEMO_DESKTOP	SQUARE_RO…	37	
✓	Overflow	Demo_Single…	DEMO_DESKTOP	SQUARE_RO…	27	
✓	Non-initialized local variable	Demo_Single…	DEMO_DESKTOP	SQUARE_RO…	27	
✓	Division by Zero	Demo_Single…	DEMO_DESKTOP	SQUARE_RO…	27	
✓	Overflow	Demo_Single…	DEMO_DESKTOP	SQUARE_RO…	27	
✓	Non-initialized local variable	Demo_Single…	DEMO_DESKTOP	UNREACHAB…	50	
✓	Non-initialized local variable	Demo_Single…	DEMO_DESKTOP	UNREACHAB…	50	
✓	Non-initialized local variable	Demo_Single…	DEMO_DESKTOP	UNREACHAB…	51	
✓	Non-initialized local variable	Demo_Single…	DEMO_DESKTOP	UNREACHAB…	51	
✓	Non-initialized local variable	Demo_Single…	DEMO_DESKTOP	UNREACHAB…	52	

Demo_Single-File.adb / SQUARE_ROOT()

ID 1: Arithmetic exceptions
Error: float argument of SQRT is not positive

```
37  Gamma := sqrt(Beta); -- always sqrt(negative number)
```

```
-- Copyright 2012 The MathWorks, Inc.

with types;
with random;
with Ada.Numerics.Aux; use Ada.Numerics.Aux;
with Ada.Numerics; use Ada.Numerics;
package body Demo_Desktop is
  my_array : array (1..10) of integer := (1, 2, 3, 4, 5, 6, 7, 8, 9, 10);

  function get(index : my_type) return Integer is
  begin
     return my_array(index);
  end;

  procedure put(index : my_type; value : integer) is
  begin
     my_array(index) := value * types.a_const;
  end;


  -- Here we demonstrate Polyspace Verifier's ability to trace numeric
  -- constraints across many different arithmetic operations.
  -- The table provided below the example shows the domain of
  -- values for the expressions in the example.
  procedure Square_Root_conv (alpha : in float; y : out long_float) is
  begin
     y := (1.5 + cos (long_float(alpha)))/5.0;
  end Square_Root_conv;

  Beta : Long_Float;
  procedure Square_Root is
     Alpha : Float := Random.random;
     Gamma : long_float;
  begin
     Square_Root_conv (Alpha, Beta); -- DAB-01/12/2010: Should have 1 VOR on Alpha, and 1 VOR on Beta
     Beta := Beta - 0.75;
     Gamma := sqrt(Beta);  -- always sqrt(negative number)
  end Square_Root;

```

! Arithmetic exceptions

Classification: High

Status: Justify with annotations

☑ Justified

Enter comment here...

Calls	Line
DEMO_DESKTOP.SQUARE_ROOT	31
RANDOM.RANDOM$3	32
DEMO_DESKTOP.SQUARE_ROOT_CONV	35
ADA.NUMERICS.AUX.SQRT	37
DEMO_DESKTOP.RTE_DESKTOP	82

Variables	Values	# Re…
Demo_Ada_Single-File		
DEMO_DESKTOP.BETA	[-0.6501 …	2
DEMO_DESKTOP.MY_ARRAY	multiples …	1
TYPES.A_CONST		1

For information on using the Results Manager perspective, see "Run-Time Error Review".

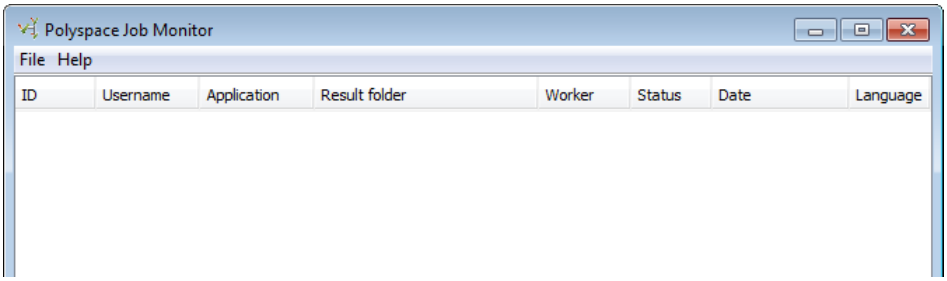
Other Polyspace Components

In addition to the Polyspace verification environment, Polyspace products provide several other components to manage verifications, improve productivity, and track software quality. These components include:

- Polyspace Job Monitor
- Polyspace Metrics Web Interface

Polyspace Job Monitor

The Polyspace Job Monitor is the graphical user interface of the Polyspace Server for Ada software. You use the Polyspace Job Monitor to move jobs within the queue, remove jobs, monitor the progress of individual verifications, and download results.



For information on using the Polyspace Job Monitor, see “Verification Management”.

Polyspace Metrics Web Interface

Polyspace Metrics is a web-based tool for software development managers, quality assurance engineers, and software developers. Polyspace Metrics allows you to evaluate software quality metrics, and monitor changes in code metrics and run-time checks through the lifecycle of a project.

For information on using Polyspace Metrics, see “Quality Metrics”.

Polyspace Documentation

In this section...

About this Guide

This document describes how to use Polyspace software to verify Ada code, and provides detailed procedures for common tasks. It covers both Polyspace Client for Ada and Polyspace Server for Ada products.

This guide is intended for both novice and experienced users.

Note: This document covers both the **Ada83** and **Ada95** languages. References are simply made to **Ada** throughout the document. When the document invokes a `polyspace-ada` command, you may wish to refer to the `polyspace-ada95` command with the same characteristics.

MathWorks Online

For additional information and support, see:

www.mathworks.com/products/polyspace

How to Use Polyspace Software

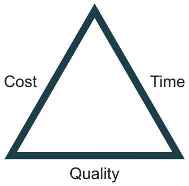
Polyspace Verification and the Software Development Cycle

In this section...

Software Quality and Productivity

The goal of most software development teams is to maximize both quality and productivity. However, when developing software, you must consider the following factors:

- Cost
- Quality
- Time



Changing the requirements for one of these factors can impact the other two.

Generally, the criticality of your application determines the balance between these three variables – your quality model. With classical testing processes, development teams generally try to achieve their quality model by testing the modules in an application until each module meets the required quality level. Unfortunately, this process often ends before quality requirements are met, because the available time or budget has been exhausted.

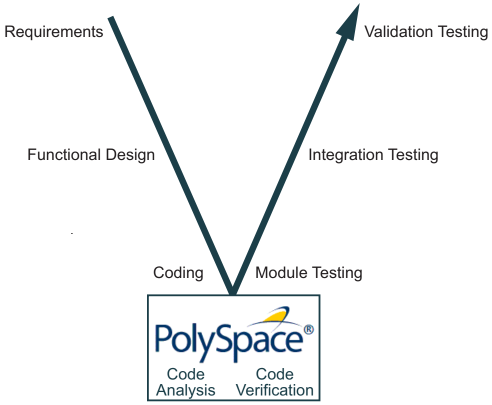
Polyspace verification allows a different process. Polyspace verification can support both productivity improvement and quality improvement at the same time, although you have to reach a balance between these goals.

To achieve maximum quality and productivity, however, you cannot simply perform code verification at the end of the development process. You must integrate verification into your development process, in a way that respects time and cost restrictions.

This chapter describes how to integrate Polyspace verification into your software development cycle. It explains both how to use Polyspace verification in your current development process, and how to change your process to get more out of verification.

Best Practices for Verification Workflow

Polyspace verification can be used throughout the software development cycle. However, to maximize both quality and productivity, the most efficient time to use it is early in the development cycle.



Polyspace Verification in the Development Cycle

Typically, verification is conducted in two stages. First, you verify code as it is written, to check coding rules and quickly identify obvious defects. Once the code is stable, you verify it again before module/unit testing, with more stringent verification and review criteria.

Using verification at this stage of the development cycle improves both quality and productivity, because it allows you to find and manage defects soon after the code is written. This saves time because each developer is familiar with their own code, and can quickly determine why the code contains defects. In addition, defects are cheaper to fix at this stage as they can be addressed before the code is integrated into a larger system.

Implementing a Process for Polyspace Verification

In this section...

Overview of the Polyspace Process

Polyspace verification cannot automatically produce quality code at the end of the development process. However, if you integrate Polyspace verification into your development process, Polyspace verification helps you to measure the quality of your code, identify issues, and ultimately achieve your own quality goals.

To implement Polyspace verification within your development process, you must perform each of the following steps:

1. Define your quality goals.
2. Define a process to match your quality goals.
3. Apply the process to assess the quality of your code.
4. Improve the process.

Defining Quality Goals

Before you can verify whether your code meets your quality goals, you must define those goals. This process involves:

- "Choosing Robustness or Contextual Verification" on page 2-4
- "Defining Software Quality Levels" on page 2-6

Choosing Robustness or Contextual Verification

Before using Polyspace products to verify your code, you must decide what type of software verification you want to perform. There are two approaches to code verification that result in slightly different workflows:

- **Robustness Verification** – Prove software does not generate run-time errors for all verification conditions.
- **Contextual Verification** – Prove software does not generate run-time errors under normal working conditions.

Note: Some verification processes may incorporate both robustness and contextual verification. For example, developers may perform robustness verification on individual files early in the development cycle, while writing the code. Later, the team may perform contextual verification on larger software components.

Robustness Verification

Robustness verification proves that the software does not generate run-time errors under all verification conditions, including "abnormal" conditions for which it was not designed. This can be thought of as "worst case" verification.

By default, Polyspace software assumes you want to perform robustness verification. In a robustness verification, Polyspace software:

- Assumes function inputs are full range
- Initializes global variables to full range
- Automatically stubs missing functions

While this approach ensures that the software works under all verified conditions, it can lead to *orange checks* (unproven code) in your results. You must then manually inspect these orange checks in accordance with your software quality goals.

Contextual Verification

Contextual verification proves that the software works under predefined working conditions. This limits the scope of the verification to specific variable ranges, and verifies the code within these ranges.

When performing contextual verification, you use Polyspace options to reduce the number of orange checks. For example, you can:

- Use Data Range Specifications (DRS) to specify the ranges for your variables, thereby limiting the verification to these cases. For more information, see "Specifying Data Ranges for Variables, Functions, and Procedures (Contextual Verification)".

- Create a detailed main program to model the call sequence, instead of using the default main generator. For more information, see "Verifying an Application Without a Main".
- Provide manual stubs that emulate the behavior of missing functions, instead of using the default automatic stubs. For more information, see "Stubbing".

Defining Software Quality Levels

The software quality level you define determines which Polyspace options you use, and which results you must review.

You define the quality levels for your application, from level QL-1 (lowest) to level QL-4 (highest). Each quality level consists of a set of software quality criteria that represent a certain quality threshold. For example:

Software Quality Levels

Criteria	Software Quality Levels			
	QL1	QL2	QL3	QL4
Document static information	X	X	X	X
Review all red checks	X	X	X	X
Review all gray checks	X	X	X	X
Review first criteria level for orange checks		X	X	X
Review second criteria level for orange checks			X	X
Perform dataflow analysis			X	X
Review third criteria level for orange checks				X

In the example above, the quality criteria include:

- **Static Information** – Includes information about the application architecture, the structure of each module and file. Full verification of your application requires the documentation of static information.
- **Red checks** – Represent errors that occur every time the code is executed.
- **Gray checks** – Represent unreachable code.
- **Orange checks** – Indicate unproven code, meaning a run-time error may occur. .
- **Dataflow analysis** – Identifies errors such as non-initialized variables and variables that are written but not subsequently read. This can include inspection of:

- Application call tree
- Read/write accesses to global variables
- Shared variables and their associated concurrent access protection

Defining a Verification Process to Meet Your Goals

Once you have defined your quality goals, you must define a process that allows you to meet those goals. Defining the process involves actions both within and outside Polyspace software.

These actions include:

- Setting standards for code development, such as coding rules.
- Setting Polyspace Analysis options to match your quality goals. See “Creating a Project”.
- Setting review criteria in the Polyspace Results Manager perspective so that results are reviewed consistently. See “Run-Time Error Review”.

Applying Your Verification Process to Assess Code Quality

Once you have defined a process that meets your quality goals, it is up to your development team to apply it consistently to all software components.

This process includes:

1. Running a Polyspace verification for each software component as it is written.
2. Reviewing verification results consistently. See “Organize Check Review Using Filters and Groups”.
3. Saving review comments for each component, so they are available for future review. See “Import and Export Review Comments”.
4. Performing additional verifications on each component, as defined by your quality goals.

Improving Your Verification Process

Once you review initial verification results, you can assess both the overall quality of your code, and how well the process meets your requirements for software quality, development time, and cost restrictions.

Based on these factors, you may want to take actions to modify your process. These actions may include:

- Reassessing your quality goals.
- Changing your development process to produce code that is easier to verify.
- Changing Polyspace analysis options to improve the precision of the verification.
- Changing Polyspace options to change how verification results are reported.

For more information, see “Orange Check Management”.

Sample Workflows for Polyspace Verification

In this section...

Overview of Verification Workflows

Polyspace verification supports two goals at the same time:

- Reducing the cost of testing and validation
- Improving software quality

You can use Polyspace verification in different ways depending on your development context and quality model. The primary difference being how you exploit verification results.

This section provides sample workflows that show how to use Polyspace verification in a variety of development contexts.

Software Developers – Standard Development Process

User Description

This workflow applies to software developers using a standard development process. Before implementing Polyspace verification, these users fit the following criteria:

- In Ada, unit test tools or coverage tools are not used – functional tests are performed just after coding.
- In C, either coding rules are not used, or rules are not followed consistently.

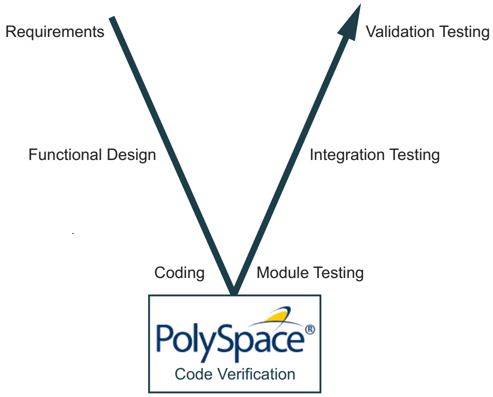
Quality

The main goal of Polyspace verification is to improve productivity while maintaining or improving software quality. Verification helps developers find and fix bugs more quickly than other processes. It also improves software quality by identifying bugs that otherwise might remain in the software.

In this process, the goal is not to completely prove the absence of errors. The goal is to deliver code of equal or better quality than other processes, while optimizing productivity to provide a predictable time frame with minimal delays and costs.

Verification Workflow

This process involves file-by-file verification immediately after coding, and again just before functional testing.



The verification workflow consists of the following steps:

1. The project leader configures a Polyspace project to perform robustness verification, using default Polyspace options.

   Note: This means that verification uses the automatically generated “main” function. This main will call unused procedures and functions with full range parameters.

   ---
2. Each developer performs file-by-file verification as they write code, and reviews verification results.
3. The developer fixes **red** errors and examines **gray** code identified by the verification.
4. Until coding is complete, the developer repeats steps 2 and 3 as required.
5. Once a developer considers a file complete, they perform a final verification.

6 The developer fixes **red** errors, examines **gray** code, and performs a selective orange review.

Note: The goal of the selective orange review is to find as many bugs as possible within a limited period of time.

Using this approach, it is possible that some bugs may remain in unchecked oranges. However, the verification process represents a significant improvement from the previous process.

Costs and Benefits

When using verification to detect bugs:

- **Red and gray checks** — The number of bugs found in red and gray checks varies, but approximately 40% of verifications reveal one or more red errors or bugs in gray code.
- **Orange checks** — The time required to find one bug varies from 5 minutes to 1 hour, and is typically around 30 minutes. This represents an average of two minutes per orange check review, and a total of 20 orange checks per package in Ada and 60 orange checks per file in C.

Disadvantages to this approach:

- **Setup time —** the time required to set up your verification will be higher if you do not use coding rules. You may have to make modifications to the code before starting the verification.

Software Developers – Rigorous Development Process

User Description

This workflow applies to software developers and test engineers working within development groups. These users are often developing software for embedded systems, and typically use coding rules.

These users typically want to find bugs early in the development cycle using a tool that is fast and iterative.

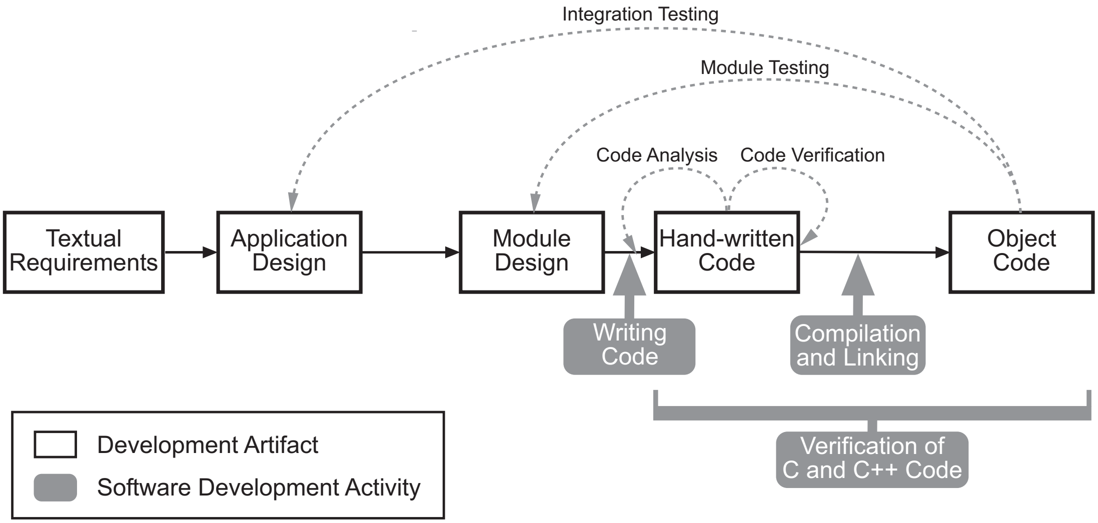
Quality

The goal of Polyspace verification is to improve software quality with equal or increased productivity.

Verification can prove the absence of run-time errors, while helping developers find and fix bugs more quickly than other processes.

Verification Workflow

This process involves both code analysis and code verification during the coding phase, and thorough review of verification results before module testing. It may also involve integration analysis before integration testing.



Workflow for Code Verification

Note: Solid arrows in the figure indicate the progression of software development activities.

The verification workflow consists of the following steps:

1 The project leader configures a Polyspace project to perform contextual verification. This involves:

   - Creates a “main” program to model call sequence, instead of using the automatically generated main.
   - Sets options to check the properties of some output variables. For example, if a variable `y` is returned by a function in the file and should always be returned with a value in the range 1 to 100, then Polyspace can flag instances where that range of values might be breached.

2 The project leader configures the project to check the required coding rules.

3 Each developer performs file-by-file verification as they write code, and reviews both coding rule violations and verification results.

4 The developer fixes coding rule violations, fixes **red** errors, examines **gray** code, and performs a selective orange review.

5 Until coding is complete, the developer repeats steps 2 and 3 as required.

6 Once a developer considers a file complete, they perform a final verification.

7 The developer performs an exhaustive orange review on the remaining orange checks.

Note: The goal of the exhaustive orange review is to examine all orange checks that were not reviewed as part of previous reviews. This is possible when using coding rules because the total number of orange checks is reduced, and the remaining orange checks are likely to reveal problems with the code.

Optionally, an additional verification can be performed during the integration phase. The purpose of this additional verification is to track integration bugs, and review:

- Red and gray integration checks;
- The remaining orange checks with a selective review: *Integration bug tracking*.

Costs and Benefits

With this approach, Polyspace verification typically provides the following benefits:

- 3–5 orange and 3 gray checks per file, yielding an average of 1 bug. Often, 2 of the orange checks represent the same bug, and another represent an anomaly.
- Typically, each file requires two verifications before it can be checked-in to the configuration management system.

- The average verification time is about 15 minutes.

Note: If the development process includes data rules that determine the data flow design, the benefits might be greater. Using data rules reduces the potential of verification finding integration bugs.

If performing the optional verification to find integration bugs, you may see the following results. On a typical 50,000 line project:

- A selective orange review may reveal **one integration bug per hour** of code review.
- Selective orange review takes about 6 hours to complete. This is long enough to review orange checks throughout the whole application and represents a step towards an exhaustive orange check review. Spending more time is unlikely to be efficient.
- An exhaustive orange review takes between 4 and 6 days, assuming that 50,000 lines of code contains approximately 400–800 orange checks.

Quality Engineers – Code Acceptance Criteria

User Description

This workflow applies to quality engineers who work outside of software development groups, and are responsible for independent verification of software quality and adherence to standards.

These users generally receive code late in the development cycle, and may even be verifying code that is written by outside suppliers or other external companies. They are concerned with not just detecting bugs, but measuring quality over time, and developing processes to measure, control, and improve product quality going forward.

Quality

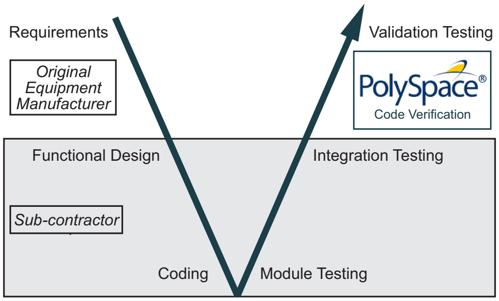
The main goal of Polyspace verification is to control and evaluate the safety of an application.

The criteria used to evaluate code can vary widely depending on the criticality of the application, from absence of red errors only to exhaustive oranges review. Typically, these criteria become increasingly stringent as a project advances from early, to intermediate, and eventually to final delivery.

For more information on defining these criteria, see “Defining Software Quality Levels” on page 2-6.

Verification Workflow

This process usually involves both code analysis and code verification before validation phase, and thorough review of verification results based on defined quality goals.



Note: Verification is often performed multiple times, as multiple versions of the software are delivered.

The verification workflow consists of the following steps:

1. Quality engineering group defines clear quality goals for the code to be written, including specific quality levels for each version of the code to be delivered (first, intermediate, or final delivery) For more information, see "Defining Quality Goals" on page 2-4.
2. Development group writes code according to established standards.
3. Development group delivers software to the quality engineering group.
4. The project leader configures the Polyspace project to meet the defined quality goals, as described in "Defining a Verification Process to Meet Your Goals" on page 2-7.
5. Quality engineers perform verification on the code.
6. Quality engineers review **red** errors, **gray** code, and the number of orange checks defined in the process.

   Note: The number of orange checks reviewed often depends on the version of software being tested (first, intermediate, or final delivery). This can be defined by quality level (see "Defining Software Quality Levels" on page 2-6).

7. Quality engineers create reports documenting the results of the verification, and communicate those results to the supplier.
8. Quality engineers repeat steps 5–7 for each version of the code delivered.

Costs and Benefits

The benefits of code verification at this stage are the same as with other verification processes, but the cost of fixing faults is higher, because verification takes place late in the development cycle.

It is possible to perform an exhaustive orange review at this stage, but the cost of doing so can be high. If you want to review all orange checks at this phase, it is important to use development and verification processes that minimize the number of orange checks. This includes:

- Developing code using strict coding and data rules.
- Providing accurate manual stubs for unresolved function calls.
- Using DRS to provide accurate data ranges for input variables.

Taking these steps will minimize the number of orange checks reported by the verification, and make it likely that remaining orange checks represent true issues with the software.

Project Managers — Integrating Polyspace Verification with Configuration Management Tools

User Description

This workflow applies to project managers responsible for establishing check-in criteria for code at different development stages.

Quality

The goal of Polyspace verification is to test that code meets established quality criteria before being checked in at each development stage.

Verification Workflow

The verification workflow consists of the following steps:

1. Project manager defines quality goals, including individual quality levels for each stage of the development cycle.
2. Project leader configures a Polyspace project to meet quality goals.
3. Developers run verification at the following stages:

   - **Daily check-in** — On the files currently under development. Compilation must complete without the permissive option.
   - **Pre-unit test check-in** — On the files currently under development.
   - **Pre-integration test check-in** — On the whole project, ensuring that compilation can complete without the permissive option. This stage differs from daily check-in because link errors are highlighted.
   - **Pre-build for integration test check-in** — On the whole project, with multitasking aspects accounted for as required.
   - **Pre-peer review check-in** — On the whole project, with multitasking aspects accounted for as required.
4. Developers review verification results for each check-in activity to confirm that the code meets the required quality level. For example, the transition criterion could be: “No bug found within 20 minutes of selective orange review”

Setting Up a Verification Project

What is a Project Template?

A **Project Template** is a predefined set of analysis options for a specific compilation environment. When creating a new project, you have the option to:

- Use an existing template to automatically set analysis options for your compiler.

  Polyspace software provides predefined templates for common compilers such as `Aonix`, `Rational`, and `Greenhills`. For additional templates, see Polyspace Compiler Templates .
- Set analysis options manually. You can save your options to a custom template and reuse them later. For more information, see “Save Analysis Options as Project Template”.

Create New Project

This example shows how to create a new project in Polyspace. Before you create a project, you must know:

- Location of source files
- Location of include files
- Location where verification results will be stored

For the three locations, you will find it convenient to create three subfolders under a common project folder. For instance, under the folder `polyspace_project`, you can create three subfolders `sources`,`includes` and `results`.

1. Select **File** > **New Project...**.
2. In the Project – Properties dialog box, enter the following information:

   - **Project name**
   - **Location**: Folder where you will store the project file with extension `.psprj`. You can use this file to open an existing project.

     The software assigns a default location to your project. You can change this default on the **Project and Results Folder** tab in the Polyspace Preferences dialog box.
   - **Project language**

   If you want to use a template, select the **Use template** check box. Then, click **Next**.
3. Select the template for your compiler. If your compiler does not appear in the list of predefined templates, select **Baseline**. You can then start with a generic template. Click **Next**.
4. Add source files and include folders to your project.

   - Navigate to the location where you stored your source files. Select the source files for your project. Click **Add Source Files**.
   - The software automatically adds the standard include files to your project. To use custom include files, navigate to the folder containing your include files. Click **Add Include Folders**.
5. Click **Finish**.

   The new project opens in the **Project Browser**.

6 Save the project. Select **File** > **Save** or enter **Ctrl+S**.

Related Examples

- "Add Source Files and Include Folders"

More About

- "What Is a Project?"

Add Source Files and Include Folders

This example shows how to add source files and include folders to an existing project.

Add Sources and Includes

1. In the **Project Browser**, right-click your project or the **Source** or **Include** folder in your project.
2. Select **Add Source**.
3. Add source files to your project.
   - Navigate to the location where you stored your source files. Select each source file. Click **Add Source Files**.
   - To add all files in a folder and its subfolders, select the option **Add recursively**. Select the folder. Click **Add Source Files**.
   - To add all files in a folder but not in its subfolders, clear the option **Add recursively**. Select the first file in the folder. Press the **Shift** key while selecting the last file. Click **Add Source Files**.
   - To add certain files in a folder, press the **Ctrl** key while selecting the files. Click **Add Source Files**.
4. Add include folders to your project. The software adds standard include files to your project. However, you must explicitly add folders containing your custom include files.
   - Navigate to the folder containing your include files. Select the folder and click **Add Include Folders**.
   - If you do not want to add subfolders of the folder, clear **Add recursively**. Select the folder and click **Add Include Folders**.
5. Click **Finish**.
6. Before running a verification, you must copy the source files to a module.

   a. Select the source files that you want to copy. To select multiple files together, press the **Ctrl** key while selecting the files.

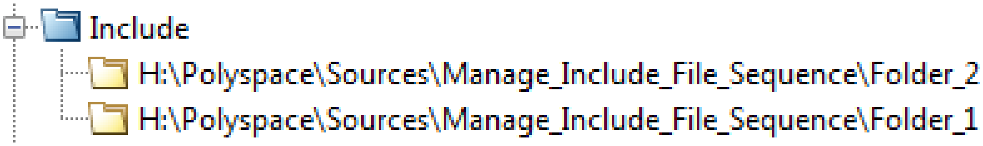
   b. Right-click your selection.

   c. Select **Copy to** > **Module_*n***. *n* is the module number.

Manage Include File Sequence

You can change the order of include folders to manage the sequence in which include files are compiled. When multiple include files by the same name exist in different folders, it is convenient to change the order of include folders instead of reorganizing the contents of your folders. For a particular include file name, the software includes the file in the first include folder under ***`Project_Name`*** > **Include**.

In the following figure, `Folder_1` and `Folder_2` contain the same include file `include.h`. If your source code includes this header file, during compilation, `Folder_2/include.h` is included in preference to `Folder_1/include.h`.



Include

H:\Polyspace\Sources\Manage_Include_File_Sequence\Folder_2

H:\Polyspace\Sources\Manage_Include_File_Sequence\Folder_1

To change the order of include folders:

1. In the **Project Browser**, expand the **Include** folder.
2. Select the include folder that you want to move.
3. To move the folder, click either ⇧ or ⇩ on the Project Browser toolbar.

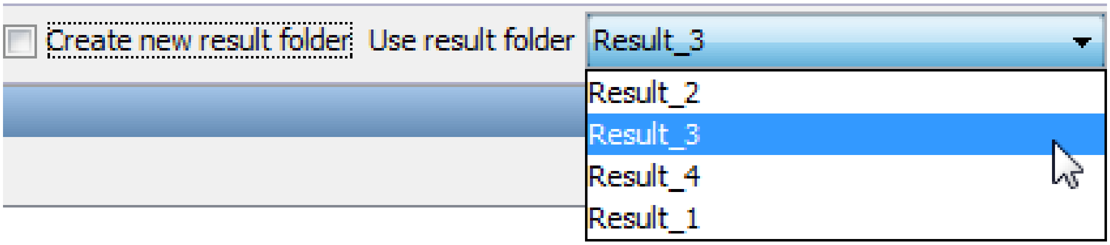
Related Examples

- “Specify Results Folder”
- “Create New Project”

Specify Results Folder

This example shows how to specify a folder for storing results. By default, the software creates a new results folder for each analysis. However, you can choose to overwrite an existing results folder before starting an analysis. For example, you might want to overwrite a results folder if you stopped an analysis before completion and want to restart it.

- To create a new folder, in the Project Manager toolbar, select the **Create new result folder** box.
  - By default, the new folder is created in *`Project_folder`* / *`Module_name`*. *`Project_folder`* is the project location you specified when creating a new project.
  - You can also create a parent folder for storing your results. Select **Tools** > **Preferences** and enter the parent folder location on the **Project and Results Folder** tab. If you enter a parent folder location, any new result folder will be created under this parent folder.
- To overwrite an existing folder that is open in the **Project Browser**, clear the **Create new result folder** box. In the **Overwrite result folder** drop-down list, select the folder that you want to use.



□ Create new result folder

Use result folder Result_3

- To overwrite an existing folder not open in the **Project Browser**, right-click the **Result** node. Select **Choose a Result folder**. Select the folder where you want your results stored.
- To specify a results folder from the command line, use the `-results-dir` option, followed by the full path to the folder inside `"   "`.

When you start the verification, the software saves the results in the specified folder.

More About

- “Results Folder Location and Name”

Results Folder Location and Name

By default, the software saves verification results in `Module_(#)` subfolders within the project folder. However, through the Polyspace Preferences dialog box, you can define a parent folder for your results.

1. Select **Tools** > **Preferences**.
2. On the **Project and Results Folder** tab, select **Create new result folder**.
3. In the **Parent results folder location** field, specify the location that you want.
4. If you require a subfolder, select the **Add a subfolder using the project name** check box. This subfolder takes the name of the project.
5. If required, specify additional formatting options for the folder name . The options allow you to incorporate the following information into the name of the results folder:

   - **Result folder prefix** — A string that you define. Default is `Result`.
   - **Project variable** — Project, module, and configuration.
   - **Date format** — Date of verification
   - **Time format** — Time of verification
   - **Counter** — Count value that automatically increments by one with each verification

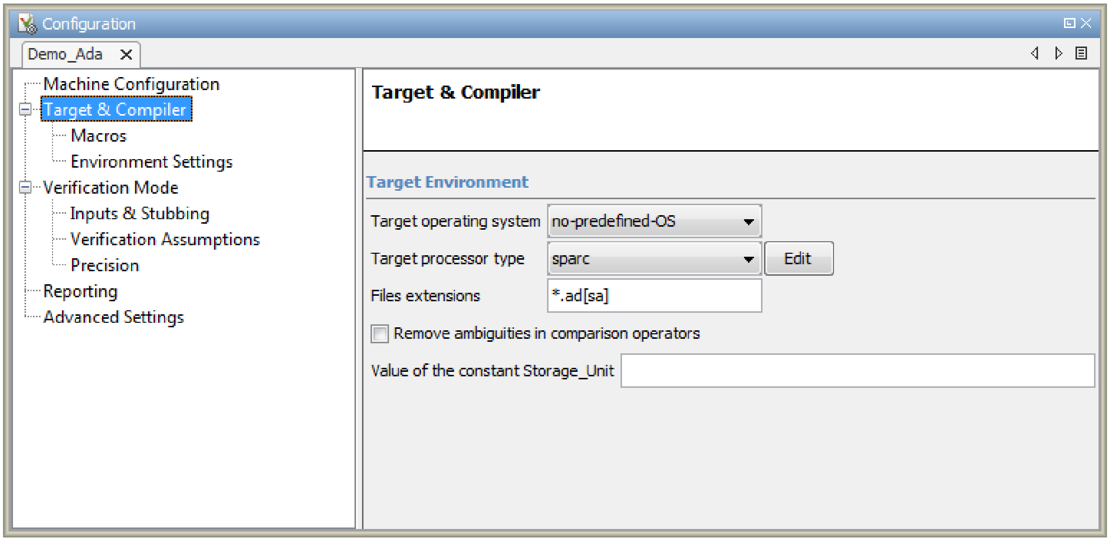
For each verification, the software now creates a new results folder *`ResultFolderPrefix_ProjectVariable_DateFormat_TimeFormat_Counter`*.

Note: If you do not specify a parent results folder, the software uses the active module folder as the parent folder.

Specify Analysis Options

You can either retain the default analysis options used by the software or change them to your requirements. To specify analysis options:

- In the Polyspace Project Manager perspective, use the **Configuration** pane.



Target & Compiler

Target Environment

Target operating system: no-predefined-OS

Target processor type: sparc

Files extensions: *.ad[sa]

☐ Remove ambiguities in comparison operators

Value of the constant Storage_Unit

For instance:

  - To specify the target processor, select **Target & Compiler** in the **Configuration** tree view. Select your processor from the **Target processor type** drop-down list.
  - To specify verification precision, select **Verification Mode** > **Precision**. Select a number from the **Precision level** drop-down list.

- At the command-line, append analysis options to the `polyspace-ada` command. For instance:

  - To specify the target processor, use the `-target` option. For instance, to specify the `m68k` processor, use the command:

    ```
    polyspace-ada -target m68k
    ```

  - To specify verification precision, use the `-O` option. For instance, to set precision level to 2, use the command:

```
polyspace-ada -O2
```

Related Examples

- “Save Analysis Options as Project Template”

More About

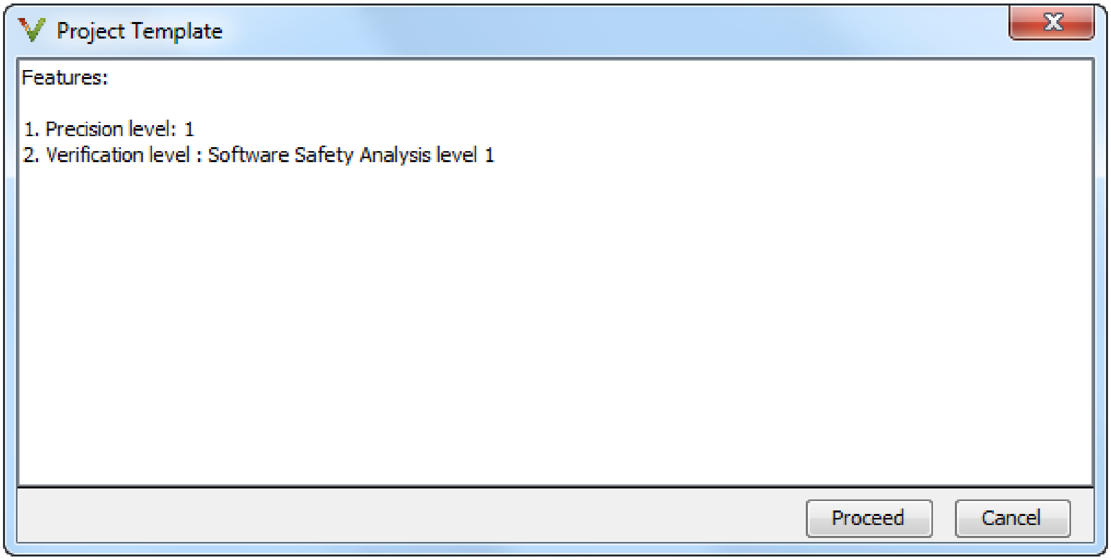
- “Analysis Options”

Save Analysis Options as Project Template

This example shows how to save your analysis options for use in other projects. Once you have configured analysis options for a project, you can save the configuration as a **Project Template**. You can use this saved configuration to automatically set up analysis options for other projects.

- To create a **Project Template** from an open project:

  1. Right-click the configuration that you want to use, and then select **Save As Template**.
  2. Enter a description for the template, then click **Proceed**. Save your Template file.

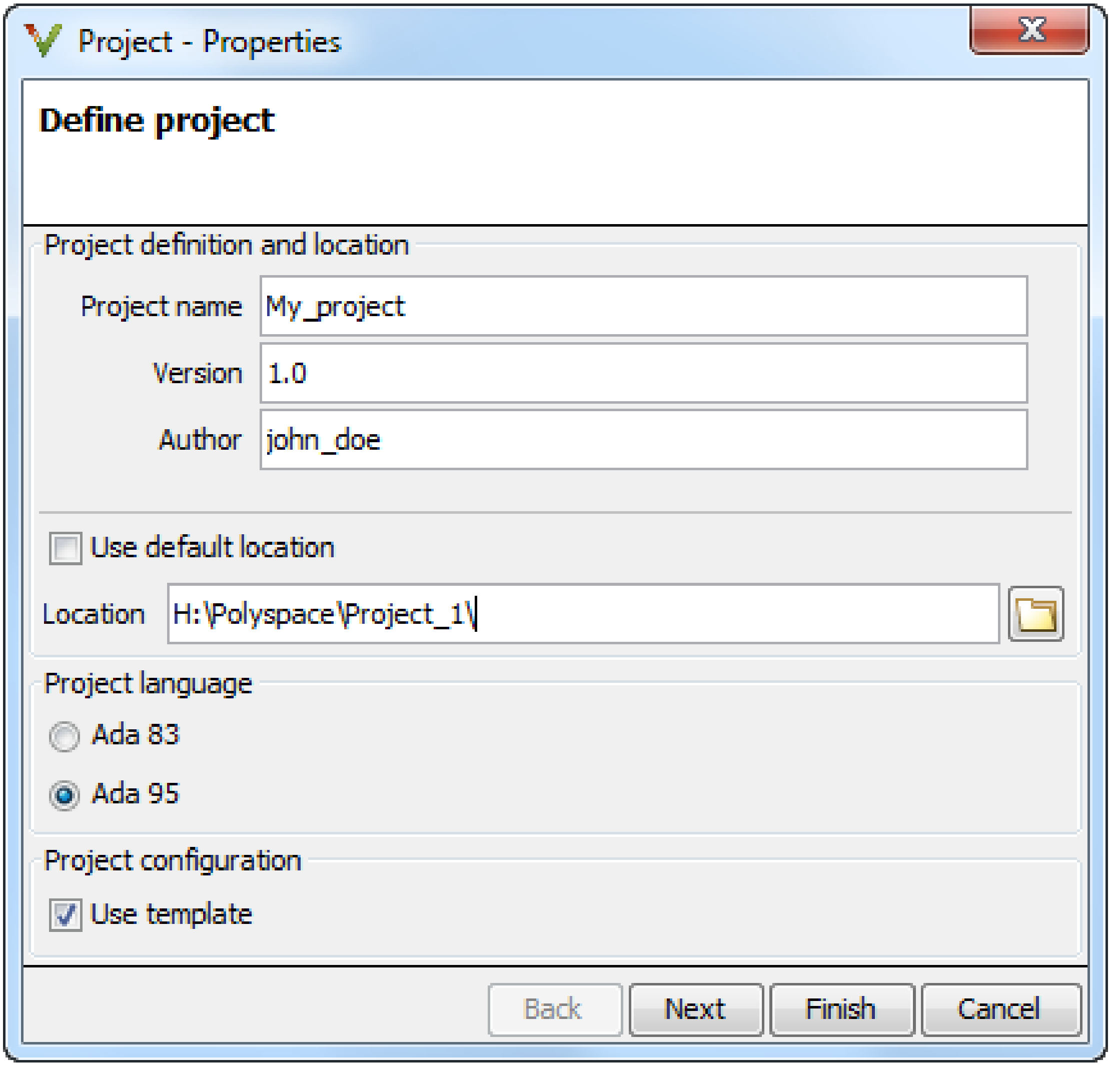


Features:

1. Precision level: 1
2. Verification level : Software Safety Analysis level 1

- When you create a new project, to use a saved template:

  1. Under **Project configuration**, check the **Use template** box. Click **Next**.



Project - Properties

Define project

Project definition and location

Project name: My_project

Version: 1.0

Author: john_doe

□ Use default location

Location: H:\Polyspace\Project_1\

Project language

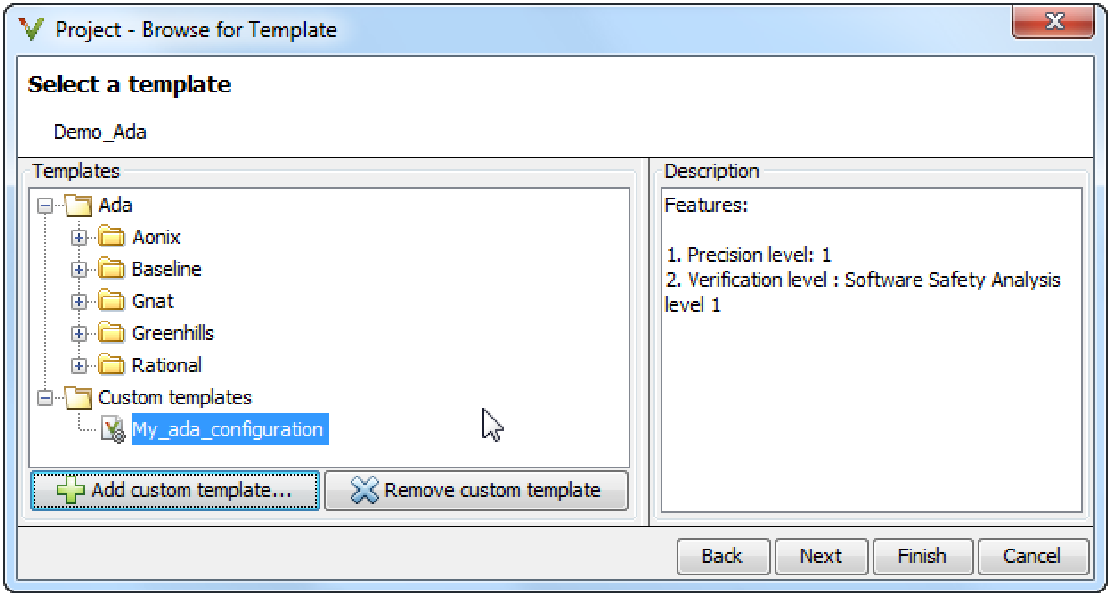
○ Ada 83

● Ada 95

Project configuration

☑ Use template

2 Select Add custom template.... Navigate to the template that you saved earlier, and then click **Open**. The new template appears in the **Custom templates** folder on the **Templates** browser. Select the template for use.



Features:

1. Precision level: 1
2. Verification level : Software Safety Analysis level 1

Related Examples

- “Specify Analysis Options”

More About

- “Analysis Options”

Specify External Text Editor

This example shows how to change the default text editor for opening source files from the Polyspace interface. By default, if you open your source file from the user interface, it opens on a **Code Editor** tab. If you prefer editing your source files in an external editor, you can change this default behavior.

1 Select **Tools** > **Preferences**.

2 On the Polyspace Preferences dialog box, select the **Editors** tab.

3 From the **Text editor** drop-down list, select **External**.

4 In the **Text editor** field, specify the path to your text editor. For example:

   ```
   C:\Program Files\Windows NT\Accessories\wordpad.exe
   ```

5 To make sure that your source code opens at the correct line and column in your text editor, specify command-line arguments for the editor using Polyspace macros, `$FILE`, `$LINE` and `$COLUMN`. Once you specify the arguments, when you right-click a check on the **Results Summary** pane and select **Open Source File**, your source code opens at the location of the check.

   Polyspace has already specified the command-line arguments for the following editors:

   - `Emacs`
   - `Notepad++` — Windows® only
   - `UltraEdit`
   - `VisualStudio`
   - `WordPad` — Windows only
   - `gVim`

   If you are using one of these editors, select it from the **Arguments** drop-down list. If you are using another text editor, select `Custom` from the drop-down list, and enter the command-line options in the field provided.

6 To revert back to the built-in editor, on the **Editors** tab, from the **Text editor** drop-down list, select **Built In**.

For console-based text editors, you must create a terminal. For example, to specify `vi`:

1 In the **Text Editor** field, enter `/usr/bin/xterm`.

2. From the **Arguments** drop-down list, select `Custom`.
3. In the field to the right, enter `-e /usr/bin/vi $FILE`.

Change Default Font Size

This example shows how to change the default font size in the Polyspace user interface.

1 Select **Tools** > **Preferences**.

2 On the **Miscellaneous** tab:

- To increase the font size of labels on the user interface, select a value for **GUI font size**.

  For example, to increase the default size by 1 point, select `+1`.

- To increase the font size of the code on the **Source** pane and the **Code Editor** pane, select a value for **Source code font size**.

3 Click **OK**.

When you restart Polyspace, you see the increased font size.

Creating a Project

In this section...

What Is a Project?

In Polyspace software, a project is a named set of parameters for verification of your software project's source files. A project includes:

- Source files
- Include folders
- One or more configurations, specifying a set of analysis options
- One or more modules, each of which include:
  - Source (specific versions of source files used in the verification)
  - Configuration (specific set of analysis options used for the verification)
  - Verification results

You create and modify a project using the Project Manager perspective.

Create Multiple Modules

This example shows how to create multiple modules in a Polyspace project. With each of these modules, you can analyze a specific set of source files using a specific set of analysis options. When you create a module, the software creates a project configuration with default option values. You can modify these values. In addition, you can create multiple configurations in each module, allowing you to change analysis options each time you run an analysis.

1. In the **Project Browser**, select your project.
2. On the **Project Browser** toolbar, click .

   You see a second module, `Module_2`, in the **Project Browser** tree.

3 In the project **Source** folder, right-click the files that you want to add to the module. From the context menu, select **Copy to** > **Module_2**.

   The software displays these files in the **Source** folder of `Module_2`.

   If you have twenty or more modules in your project, when you select **Copy to**, the Select Modules dialog box opens. From the module list, choose the required modules. Then click **Select**.

Note: You can also drag source files from a project into the Source folder of a module.

Create Multiple Analysis Option Configurations

This example shows how to create and use multiple configurations in your Polyspace project. Each of these configurations specifies a specific set of analysis options. Using multiple configurations allows you to analyze a set of source files multiple times using different analysis options for each run.

1 In the **Project Browser**, select a module.

2 Right-click the **Configuration** folder in the module. From the context menu, select **Create New Configuration**.

   - On the **Project Browser**, the software displays a new configuration *`project_name`*`_1`. To rename the configuration, double-click it.
   - On the **Configuration** pane, the new configuration appears as an additional tab.

3 On the **Configuration** pane, specify the analysis options for the new configuration.

4 To use this new configuration for the verification, right-click the configuration. Select **Set as Default**.

   The default configuration appears blue. When you run a new verification, it uses the default configuration.

5 To see the configuration you used for a certain result, right-click the result on the **Project Browser**. Select **Open Configuration**.

   If you are viewing the results in the Results Manager, to see the configuration you used, select **Window** > **Show/Hide View** > **Settings**.

6 To copy a configuration to another module, right-click the configuration. Select **Copy Configuration to** > ***`Module_name`***.

Specifying Options to Match Your Quality Goals

While creating your project, you must configure analysis options to match your quality goals.

This includes:

In this section...

Quality Goals Overview

While creating your project, you must configure analysis options to match your quality goals.

This includes choosing contextual verification options, coding rules, and options to set the strictness of the verification.

Note: For information on defining the quality goals for your project, see "Defining Quality Goals".

Choosing Contextual Verification Options

Polyspace software performs robustness verification by default. If you want to perform contextual verification, there are several options you can use to provide context for data ranges, function call sequence, and stubbing.

For more information on robustness and contextual verification, see "Defining Quality Goals".

Note: If you are aware of run-time errors in your code but still want to run a verification, you can annotate your code so that these known errors are highlighted in the Results Manager perspective. For more information, see "Highlighting Known Run-Time Errors".

1 On the **Configuration** pane, select **Verification Mode**. Select **Verify module**.

2 On the **Configuration** pane, select **Inputs & Stubbing**. In the **Variable/function range setup** field, specify a data range specification (DRS) file.

3 Control stubbing behavior with the following options:

   - **No automatic stubbing** — If you select this option, the software does not automatically stub functions. The software lists the functions to be stubbed and stops the verification.
   - **Initialization of uninitialized global variables** — Specify how uninitialized global variables are initialized.

For more information on these options, see “Analysis Options”.

Choosing Strict or Permissive Verification Options

Polyspace software provides options that allow you to customize the strictness of the verification. You should set these options to match the quality goals for your application.

Note: If you are aware of run-time errors in your code but still want to run a verification, you can annotate your code so that these known errors are highlighted in the Results Manager perspective. For more information, see “Highlighting Known Run-Time Errors”.

For strict verification, on the **Configuration** pane, select **Inputs & Stubbing**. Select the **No automatic stubbing** check box.

For permissive verification:

1 On the **Configuration** pane, select **Inputs & Stubbing**. Clear the **No automatic stubbing** check box.

2 Select **Verification Assumptions**. Select the **Continue with non-initialized in/out parameters** check box.

For more information on these options, see “Analysis Options”.

Setting Up Project to Generate Metrics

In this section...

About Polyspace Metrics

Polyspace Metrics is a Web-based tool for software development managers, quality assurance engineers, and software developers. In software projects, this tool enables you to do the following :

- Evaluate software quality metrics
- Monitor the variation of code metrics and run-time checks over the lifecycle of a project
- View defect numbers, run-time reliability of the software, review progress, and the status of the code with respect to software quality objectives

For information on using Polyspace Metrics, see "Quality Metrics".

Enabling Polyspace Metrics

1 On the **Configuration** pane, select **Machine Configuration**.

2 Select the **Send to Polyspace Server** check box.

3 Select the **Add to results repository** check box.

The software generates Polyspace Metrics for the next verification.

Specifying Automatic Verification

You can configure verifications to start automatically and periodically, for example, at a specific time every night. At the end of each verification, the software stores results in the repository and updates the project metrics. You can also configure the software to send you an email at the end of the verification.

For more information, see "Specifying Automatic Verification".

Emulating Your Run-Time Environment

Setting Up a Target

In this section...

Target & Compiler Overview

Many applications run on specific target CPUs and operating systems. The type of CPU determines many data characteristics, such as data sizes and addressing. These factors can influence whether errors (such as overflows) occur.

Some run-time errors are dependent on the target CPU and operating system. Therefore, before running a verification, you must specify the type of CPU and operating system for the target environment.

Specifying Target & Compiler Parameters

To specify the target environment and compiler behavior for your application, in the Project Manager perspective, on the **Configuration** pane, select **Target & Compiler**.

For example, to specify the target environment for your application:

1. For **Target operating system**, select the operating system on which your application is designed to run.
2. For **Target processor type**, select the processor on which your application is designed to run.

   For detailed specifications of each predefined target processor, see "Predefined Target Processor Specifications" on page 4-2.

Predefined Target Processor Specifications

Polyspace software supports many processors. To specify a predefined processor:

1 On the **Configuration** pane, select **Target & Compiler**.

2 For **Target processor type**, select your processor.

3 If your processor is not specified in the drop-down list, use the following table to select a processor that shares the same characteristics as your processor.

Target	sparc	m68k ColdFire	1750a	powerpc 32bit	powerpc 64bit	I386
Character	8	8	16	8	8	8
short_integer	16	16	16	16	16	16
Integer	32	32	16	32	32	32
long_integer	32	32	32	32	64	32
long_long_integer	64	64	64	64	64	64
short_float	32	32	32	32	32	32
Float	32	32	32	32	32	32
long_float	64	64	48	64	64	64
long_long_float	64	64	48	64	64	64

In the following list, the largest default alignment of basic types within record/array for various targets is given:

- `powerpc32bits` — 64.
- `powerpc64bits` — 64.
- `i386` — 32.

4 To identify target processor characteristics, compile and run the following program. If none of the characteristics described in the preceding table match, contact MathWorks® technical support for advice.

```
with TEXT_IO;
procedure TEMP is
type T_
Ptr is access integer;
Ptr  :T_Ptr;
begin
TEXT_IO.PUT_LINE ( Integer'Image (Character'Size) );
TEXT_IO.PUT_LINE ( Integer'Image (Short_Integer'Size) );
TEXT_IO.PUT_LINE ( Integer'Image (Integer'Size));
TEXT_IO.PUT_LINE ( Integer'Image (Long_Integer'Size) );
-- TEXT _IO.PUT_LINE ( Integer'Image( Long_Long_Integer'Size) );
TEXT_IO.PUT_LINE ( Integer'Image (Float'Size) );
```

```
--  TEXT _IO.PUT_LINE ( Integer'Image(D_Float'Size) );
TEXT_IO.PUT_LINE ( Integer'Image (Long_Float'Size));
TEXT_IO.PUT_LINE ( Integer'Image (Long_Long_Float'Size) );
TEXT_IO.PUT_LINE( Integer'Image (T_Ptr'Size) );
end TEMP;
```

Verifying an Application Without a Main

In this section...

Main Generator Overview

When your application is a function library (API) or a single module, you must provide a main that calls each uncalled procedure within the code because of the execution model used by Polyspace. You can either manually provide a main, or use Polyspace to generate a main automatically.

When you run a verification on Polyspace Client for Ada software, the main is generated. When you run a verification on Polyspace Server for Ada software, you can choose to generate a main automatically.

Automatically Generating a Main

You can choose to automatically generate a main by selecting the **Verify module** (-main-generator) option. The `-main-generator` option automatically creates a procedure that calls every uncalled procedure within the code.

With Polyspace Client for Ada software, the software, by default, automatically generates a main. You can choose to manually generate a main using the `-main` option:

1. On the **Configuration** pane, select **Verification Mode**.
2. Select **Verify whole application**.
3. In the **Main entry point** field, the package that defines the main, for example, `INIT.MAIN`.

With Polyspace Server for Ada, the software sets the `-main` option by default. You can choose to automatically generate a main using the `-main-generator` option.

1. On the **Configuration** pane, select **Verification Mode**.
2. Select **Verify module**.

For more information on the main generator, see “Verify module”.

Manually Generating a Main

You might prefer to manually generate a main because it allows you to provide a more accurate model of the calling sequence to be generated.

To manually define the main:

1. Identify the API functions and extract their declaration.
2. Create a main containing declarations of a volatile variable for each type that is listed in the function prototypes.
3. Create a loop with a volatile end condition.
4. Inside this loop, create a switch block with a volatile condition.
5. For each API function, create a case branch that calls the function using the volatile variable parameters that you created.

The following code shows the five steps:

```
-- Step 1: API function declarations
function func1(x in integer) return integer;
procedure func2(x in out float, y in integer);

-- Step 2: Create main with declarations of volatile variables
procedure main is
 a,b,c,d: integer;
 e,f: float;
pragma volatile (a);
pragma volatile (e);
begin

  --Step 3: Create loop
  loop
    f:=e;
    c:=a;
    d:=a;
    -- Steps 4 and 5
    if (a = 1) then b:= func1(c); end if;
    if (a = 1) then func2(e,d); end if;
  end loop
end main;
```

How Polyspace Verifies Generic Packages

Consider the following code, which instantiates a generic package.

```
with Ada.Numerics.Generic_Elementary_Functions;

Package Body Test is
   Pi : Constant := 3.141592;
   Buf_Length : constant  := 500;
   type Buffer_type is array(1 .. Buf_Length) of Float;
   Tab   : Buffer_type;

   -- Create instance of generic package
   package Trig is new Ada.Numerics.Generic_Elementary_Functions(float);

Procedure Main is
begin
  for i in Tab'First .. Tab'Last loop
    Tab(i) := float(1.0 - Trig.cos(2.0 * Pi * float(i - 1) / 1000.0));
  end loop;
end Main;

end Test;
```

Polyspace can only analyze packages that are explicitly instantiated. In the code, `Trig` represents a new instantiation of the generic package `Ada.Numerics.Generic_Elementary_Functions(float)`. If you specify the **Verify module** (`-main-generator`) option, Polyspace verifies the functions called by your code. In this case, Polyspace verifies only the function `cos` from the new package.

Specifying Data Ranges for Variables, Functions, and Procedures (Contextual Verification)

In this section...

Overview of Data Range Specifications (DRS)

By default, Polyspace software performs *robustness verification*, proving that the software does not generate run-time errors for all verification conditions. Robustness verification assumes that the data inputs are set to their full range. Therefore, most operations on these inputs could produce an overflow.

The Polyspace Data Range Specifications (DRS) feature allows you to perform *contextual verification*, proving that the software works under normal working conditions. Using DRS, you set constraints on data ranges, and verify the code within these ranges. This process can substantially reduce the number of orange checks in the verification results.

You can use DRS to set constraints on:

- Global variables
- Stubbed functions and procedures
- Function call input values

Specifying Data Ranges Using Text Files

To use the DRS feature, you must specify a file that constrains the range of values for global variables, values returned by stubbed functions, `out` or `in/out` parameters of stubbed procedures, or input parameters of user subprograms called by the main generator during verification. See "DRS Text File Format" on page 4-9.

To configure a verification that applies the data range specifications in this text file:

1 In Project Manager perspective, on the **Configuration** pane, select **Inputs & Stubbing**.

2 To the right of the **Variable/function range setup** row, click 📁. The Load a DRS file dialog box opens.

3 Use this dialog box to navigate to the folder that contains your DRS text file.

4 In the **File name** field, specify your DRS file.

5 Click **Open**. You see the file path in the **Variable/function range setup** field.

6 Select **File** > **Save** to save your project settings, including the DRS text file location.

DRS Text File Format

The DRS file contains a list of variables, functions, and parameter names together with associated data ranges. During verification, the point at which the range is applied, for example, to a variable, is controlled by the mode keyword: `reinit`, `init`, or `permanent`.

Each line of the DRS file must have the following format:

`var_func_param min_val max_val` `<reinit|init|permanent>`

- *`var_func_param`* — A variable name, the name of a function that returns a value, or a subprogram parameter name.
- *`min_val`*, *`max_val`* — Constants that specify minimum and maximum range values. Data type of these values can be character, enumerator, integer, or float. The integer or float values may be binary, octal, decimal, or hexadecimal.
- `reinit` — Sets global variables to the specified range at the entry point for each subprogram called by the main generator, or the entry point for the user-defined main subprogram.
- `init` — Initializes subprogram input parameters to a specified range when the subprogram is called by the main generator.
- `permanent` — Sets the return, `out`, or `in/out` parameters to the specified range of a stubbed subprogram each time the subprogram is called.

Tips for Creating DRS Text Files

- You can replace *`min_val`* and *`max_val`* by the words “`min`” or “`max`”. In this case, the software uses the corresponding minimum and maximum value for the declared data subtype (true even for an enumeration type that has enumerated values `min` and `max`). For example, with a SPARC® processor, the minimum value for the integer data type is -2^31 and the maximum value is 2^31-1.

- You can use tab, comma, space, or semicolon as column separators.
- You can apply data range specification to variables and subprograms declared within a package specification or body, or subprograms outside a package. For subprograms outside a package, use the subprogram name as package name.
- You cannot apply data range specification to:
  - Local subprograms or task entries
  - Constant qualified variables, record discriminants, variables of access type, or variables defined in a protected type or task type

Example DRS Text File

The following lines:

```
P.x 2#0001#E2 100 reinit # x is (re)initialized between [4;100]
P.y min max reinit   # y is initialized with the full range.
P.s1.c 'a' max reinit  # s1.x is initialized between ['a';Character'Last]
P.bar -1.0 1.0 permanent # stubbed function bar returns [-1.0;1.0]
P.bar1.outp -1.0 1.0 permanent   # stubbed procedure bar1's parameter
                                 # outp returns [-1.0;1.0]
P.proc.i -1.0 1.0 init  # main generator calls the user
           # procedure proc with the parameter
           # i initialized to [-1.0;1.0]
dummy_f.dummy_f -10 10 permanent # stubbed free function dummy_f
              # returns [-10;10].
```

are data range specifications for a scenario where:

- `x` and `y` are two global variables declared in the package `P`
- `s1` is a variable of record type that has a character type component `c`
- `bar` is the name of a stubbed function
- `bar1` is a stubbed procedure with `outp` as `out` parameter
- `proc` is a procedure defined with a parameter named `i`
- `dummy_f` is a function declared without a parent package

DRS Warning Messages

Polyspace produces a DRS warning message in the verification log file in the following situations.

- When a data range constraint is applied:

  ```
  Warning:  <symbol> has a range specified by DRS
  ```

`in [<min> .. <max>] (<mode>).`

- If the DRS file contains a syntax error, Polyspace produces one of the following types of messages:
  - `<DRS_file>, line <line#>: Warning: data range specification with incorrect min that is greater than max`
  - `<DRS_file>, line <line#>: Warning: data range specification with incorrect min or max type. <[Integer|Float|Enum]> value is expected`
  - `<DRS_file>, line <line#>: Warning: data range specification with incorrect mode`
  - `<DRS_file>, line <line#>: Warning: data range specification with incorrect [max|min] value`
  - `<DRS_file>, line <line#>: Warning: data range specification with [min|min] out of range of ada type`
- If the DRS file contains an unsupported data range specification, Polyspace produces one of the following types of messages:
  - `<DRS_file>, line <line#>: Warning: data range specification with unsupported object type | DRS cannot be applied to constant variable, record discriminant or variant, access type, protected type, task entry and local subprogram`
  - `<DRS_file>, line <line#>: Warning: data range specification with unsupported variable scope | Variable must be defined within a package specification or body`

Performing Efficient Module Testing with DRS

DRS allows you to perform efficient static testing of modules. To do so, you add design level information, which is missing in the source code.

A module can be seen as a black box that has the following characteristics:

- Input preconditions of call are designed for subprograms to be tested
- Input global data is consumed when testing subprograms
- Output data is produced by missing (stubbed) subprograms

Using the DRS feature, you can define:

- The nominal range for input arguments as preconditions of subprogram calls
- The generic range for input global variables at the start point of each subprogram test
- The generic range for return parameters of stubbed functions, and out or in/out parameters of procedures

These definitions then allow Polyspace software to perform a single static verification task, answering questions about robustness and reliability.

In this context, you assign DRS keywords according to the type of data (input argument of call, input global data, stubbed subprogram output).

Type of Data	DRS Mode	Effect on Results	Why?	Oranges	Selectivity
Input argument of call	`init`	**Reduces** the number of orange checks (compared to a standard Polyspace verification)	Input arguments that were full range are set to a smaller and realistic range.	↓	↑
Input global data	`reinit`	**Reduces** the number of orange checks (compared to a standard Polyspace verification)	Input data that was full range is set to a smaller and realistic range.	↑	↑
Stubbed subprogram output	`permanent`	**Reduces** the number of orange checks (compared to a standard Polyspace verification)	Output data, produced by a missing subprogram, that was full range is set to a smaller and realistic range.	↑	↓

Reducing Orange Checks with DRS

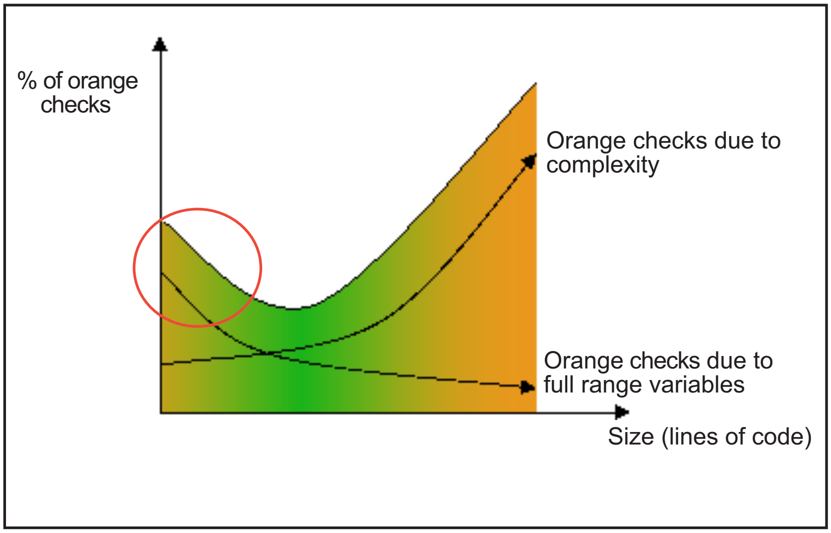
When performing robustness (worst case) verification, data inputs are set to their full range. Therefore, every operation on these inputs, even a simple “`one_input + 10`” can produce an overflow, as the range of `one_input` varies between the minimum value and the maximum value of the type.

If you use DRS to restrict the range of “`one-input`” to the real functional constraints found in a specification, design document, or models, you can reduce the number of orange checks reported on the variable. For example, if you specify that “`one-input`” can vary between `0` and `10`, Polyspace software recognizes that:

- `one_input + 100` does not overflow
- the results of this operation are between `100` and `110`

This process eliminates the local overflow orange and results in more accuracy in the data. This accuracy is then propagated throughout the rest of the code.

The red circle indicates the orange checks that are removed by using DRS.



Removing orange checks caused by full-range (worst-case) data can significantly reduce the total number of orange checks, especially in the verification of small files or modules. However, the orange checks caused by code complexity does not change on applying DRS.

Using Pragma Assert to Set Data Ranges

You can use the construct `'pragma assert'` within your code to inform Polyspace of constraints imposed by the environment in which the software will run. A “`pragma assert`” function is:

```
pragma assert(<integer expression>);
```

If *`<integer expression>`* evaluates to zero, then the program is assumed to be terminated, therefore there is a “real” run-time error. This condition is why Polyspace produces checks for the assertions.. The behavior matches the one exhibited during execution, because **execution paths for unsatisfied conditions are truncated** (red and then gray). Thus it can be assumed that a verification performed downstream of the assert uses value ranges which satisfy the assert conditions.

You can use the construct `'pragma assert'` in a procedure to inform Polyspace of constraints in the environment in which the software will be embedded. You can use user assertions to describe the physical properties of the environment, such as:

- The maximum and minimum speed limit (a car does not go faster than 200 miles per hour or slower than 0 miles per hour),
- The maximum duration of software exploitation (five years for a satellite and one hour for its launcher)

Example

```
procedure main is
  counter: integer;
  -- counter is not initialized
  random: integer;
  pragma volatile (random);
begin
  counter:= random;
  -- counter~ [-2^31, 2^31-1]
  pragma assert (counter < 1000);
  pragma assert (counter > 100);
end;

end main;
```

Both assertions are orange because the conditions may or may not be fulfilled. From then on, counter ~ [101, 999] because execution paths that do not meet the conditions are halted.

Supported Ada Pragmas

Polyspace software provides verification support for many standard Ada or GNAT compiler pragmas.

Pragma	How Polyspace Software Processes Pragma
`Import`, `Import_Function`, and `Import_Procedure`	Stubs function or procedure
`Interface` and `Interface_Name`	Stubs function or procedure
`Inspection_Point`	Provides information about possible values for the variable. May display a range.
`Volatile`	Variable becomes full-range
`Volatile_Components`	If you specify `Polyspace for Ada95`, you get the same results as with the pragma `Volatile`. However, in this case, the pragma applies to arrays.
`Assert`	Produces a user assertion check, `ASRT`. See “User Assertion: ASRT”.
`Restrictions`	Ignored for standard Ada or GNAT compiler restrictions. Other restriction pragmas produce a warning.
`Ada_83` and `Ada_95`	Polyspace option `-lang` overwrites this pragma (option set by default when you use `polyspace-ada` or `polyspace-ada95`).

`Pure`	Applies requirement that package has cross-dependencies only with other `Pure` packages. If requirement is not met, generates compilation errors.
	You can remove requirement by inserting pragma `Not_Elaborated` within package body. For example:
	`package System is`
	`pragma Pure;`
	`pragma Not_Elaborated;`
	`...`

Pragma	How Polyspace Software Processes Pragma
	`end System;`
`Prelaborate`, `Elaborate` `Elaborate_All`, and `Elaborate_Body`	Provides order of elaboration and verification of packages by Polyspace
`Storage_Unit`	Polyspace option `-storage_unit` overwrites this pragma

Note: If your code contains an unsupported pragma, Polyspace ignores the pragma and continues the verification. At the end of the compilation phase, Polyspace displays a message:

```
The following pragmas have been ignored...
```

How Polyspace Evaluates Function and Procedure Parameters

Polyspace applies *by-copy* semantics and a left-to-right evaluation order for parameter passing. You can use Polyspace to verify your Ada code provided your compiler implements:

- Left-to-right evaluation for subprogram parameters. Consider the following code.

  ```
  with ada.integer_text_io;
      use  ada.integer_text_io;
      procedure test1 is
         x,y,z,r : integer;

        function f (x : integer) return integer
        is
         begin
          z := 0;
          return  x + 1;
        end f;
      begin
        x := 10;
        y := 20;
        z := 10;
        R := y / Z + F(x);
        pragma assert(R = 13); -- green ASRT
        put(R);
      end;
  ```

  In this example, Polyspace verification implements left-to-right evaluation and generates a green ASRT check.

- By-copy semantics for subprogram parameters. Consider the following code.

  ```
  procedure Test2
  is

   type Rec is
    record
     F,G: Integer;
    end record;

    R: Rec;
    Result : Integer;

    procedure Multiply (X, Y : in Rec; Z : out Rec)

    is
     begin
      z := (0,0);
      Z.F := X.F * Y.F;
      Z.G := X.G * Y.G;
     end Multiply;

  begin
  ```

```
   R := (10,10);
   Result := 100;
   Multiply (R,R,R);
   Result := Result/R.F;
   pragma assert (Result = 1); -- green ASRT
  end Test2;
```

In this example, Polyspace verification implements by-copy semantics and generates a green ASRT check.

The green checks generated indicate that the code conforms to the Ada standard, which states that *The execution of a program is erroneous if its effect depends on which mechanism is selected by the implementation*. See Formal Parameter Modes.

Preparing Source Code for Verification

Stubbing

In this section...

Stubbing Overview

A function stub is a small piece of code that emulates the behavior of a missing function. Stubbing is useful because it allows you to verify code before all functions have been fully developed.

Manual vs. Automatic Stubbing

The approach you take to stubbing can have a significant influence on the speed and precision of your verification.

There are two types of stubs in Polyspace verification:

- **Automatic stubs** – When you attempt to verify code that calls an unknown function, the software automatically creates a stub function based on the function's prototype (the function declaration). Automatic stubs generally do not provide insight into the behavior of the function.
- **Manual stubs** – You create these stub functions to emulate the behavior of the missing functions, and manually include them in the verification with the rest of the source code.

Only advanced users should consider manual stubbing. Polyspace can automatically stub every missing function or procedure, leading to an efficient verification with a low loss in precision. However, in some cases you may want to manually stub functions instead. For example, when:

- Automatic stubbing does not provide an adequate representation of the code it represents— both in regards to missing functions and assembly instructions.
- The entire code is to be provided, which may be the case when verifying a large piece of code. When the verification stops, it means the code is not complete.

- You want to improve the selectivity and speed of the verification.
- You want to gain precision by restricting return values generated by automatic stubs.
- You need to deal with a function that writes to global variables.

Deciding which Stub Functions to Provide

Stubs do not need to model the details of the functions or procedures involved. They only need to represent how the function interacts with the remainder of the code.

Consider *procedure_to_stub*. If it represents:

- a timing constraint, such as a timer set/reset, a task activation, a delay or a counter of ticks between two precise locations in the code, you can stub it to an empty action `begin null; end;`. Polyspace does not need a concept of timing because the software takes into account possible scheduling and interleaving of concurrent execution. You do not have to stub functions that set or reset a timer. Simply declare the variable representing time as volatile.
- an I/O access, such as to a hardware port, a sensor, read/write of a file, read of an EEPROM, write to a volatile variable:

  - You do not have to stub a write access. If you want to do so, you can stub it through an empty action `begin null; end;`.
  - You can stub read accesses using procedures that read volatile variables.
- a write to a global variable, consider which procedures or function write to it and why: do not stub the concerned *procedure_to_stub* if:

  - this variable is volatile;
  - this variable is a task list. Such lists are accounted for by default because tasks declared with the `-task` option are automatically started.

  write a procedure_to_stub by hand if this variable is a regular variable read by other procedures or functions.
- a read from a global variable: if you want Polyspace to detect that it is a shared variable, you need to stub a read access as well. This is easy to achieve by copying the value into a local variable.

Generally speaking, follow the data flow and remember that:

- Polyspace only uses the Ada code which is provided.

- For multitasking code, Polyspace does not need to be informed of timing constraints through explicit time specification inside the code.

Example

This example shows a header for a missing function (which might occur if, for example, the code is an incomplete subset or a project). The missing function copies the value of the src parameter to dest, so there would be a division by zero (RTE) at run time.

```
procedure a_missing_function
   (dest: in out integer,
   src  : in integer);
procedure test is
  a: integer;
  b: integer;
begin
  a: = 1;
  b: = 0;
  a_missing_function(a,b);
  b:= 1 / a;
  -- "/" with the default stubbing
end;
```

Due to the reliance on the software's default stub, the division is shown with an orange warning because a is assumed to be anywhere in the full permissible integer range (including 0).

If the function was commented out, then the division would be green.

A red division could only be achieved with a manual stub.

This example shows what might happen if the effects of assembly code are ignored.

```
procedure test is
begin
  a:= 1;
  b:= 0;
  -- b:= a
  pragma asm ("move: a,b")
  b:= 1 /a;
end;
```

Due to the reliance on the software's default stub, the assembly code is ignored and the division " /" is green. The red division "/" could only be achieved with a manual stub.

Summary

Stub manually: to gain precision by restricting return values generated by automatic stubs; to deal with a function which writes to global variables.

Stub automatically if you are sure that a run-time error will not be introduced by automatic stubbing; to minimize preparation time.

Automatic Stubbing

Some functions might not be included in the set of Ada source files because the functions are:

- External.
- Written in another programming language, for example, C.
- Part of the system libraries.

By default, Polyspace automatically stubs these functions. For information about how Polyspace automatically stubs functions, see “No automatic stubbing”.

Preparing Code for Variables

In this section...

Float Rounding

Polyspace handles float rounding by following the ANSI/IEEE 754-1985 standard. Using the `-ignore-float-rounding` option, Polyspace computes exact values of floats. Some paths will be reachable or not for Polyspace while they are not (or are) depending of the compiler and target. So it can potentially give approximate results: green should be unproven. Using the option allows to first have a look on remaining unproven check OVFL.

The Following example shows the result of using this option:

```
package float_rounding is
 procedure main;
end float_rounding;
package body float_rounding is
 procedure main is
  x : float := float'last;
  random : boolean;
  pragma import(C,random);
 begin
  if random then
   x := x + 5.0 - float'last;
   -- with -ignore-float-rounding : overflow red on + 5.0
   -- without -ignore-float-rounding : overflow orange and x is
very close to zero
  else
   x := x - 5.0 - float'last;
   -- with -ignore-float-rounding : x is now equal to 5.0
   -- without -ignore-float-rounding : x is very close to zero
  end if;
 end;
```

```
end float_rounding;
```

Expansion of Sizes

The `-array-expansion-size` option forces Polyspace to verify each cell of global variable arrays having length less or equal to number as a separate variable.

Example

```
Package body Test is
 Glob_Array_3 : array(1..3) of Integer := (1,2,3);
 Glob_Array_8 : array(1..8) of Integer := (1,2,3,4,5,6,7,8);
 procedure Main is
  begin
   pragma Assert (Glob_Array_3(3) = 3);
   pragma Assert (Glob_Array_8(3) = 3);
  end Main;
end Test;
```

The `-variable-to-expand` option is used to specify aggregate variables (record, etc.) that will be split into independent variables for the purpose of verification. This option has an impact on the Global Data Dictionary results:

- Each variable specified in this option will have its fields verified separately;
- The data dictionary will distinguish fields accessed by different tasks.

The depth of the variable to expand is controlled by the `-variable-to-expand`.

Note: Expansion options have an impact on the duration of a verification.

Volatile Variables

Problem

A volatile variable can be defined as a variable which does not respect the "RAM axiom".

This axiom is:

"If I write a value V in the variable X and if I read X's value before another writing to X occurs, I will get V."

Explanation

As the value of a volatile variable is "unknown", it can take any value (that can be) represented by the type of the variable and can change even between 2 successive memory accesses.

A volatile variable is viewed as a "permanent random" by Polyspace because the value can change within its whole range between one read access and the next.

```
function test return integer is
  random: Integer;
  pragma volatile (random);
  y: Integer;   -- random ~ [-2^31, 2^31-1] ,
         -- although random is not initialized
begin
  y:= 1 /random;  -- division and init orange
         -- because random
~  [-2^31, 2^31-1]
  random:= 100;
  y:= 1 /random;  -- division and init orange
         -- because random~ [-2^31,2^31-1]
  return random;  -- random ~ [-2^31, 2^31-1]
end;
```

Shared Variables

Abstract

My shared variables appear in orange in the variable dictionary.

Explanation

Polyspace Server for Ada does not make prior assumptions about the execution sequence of tasks. Specifically, shared variables are considered as unprotected.

Solution

You can use the following mechanisms to protect your variables.

- Critical section and mutual exclusion (explicit protection mechanisms);
- Access pattern (implicit protection);
- Rendezvous.

Critical Sections

These are the most common protection mechanism in applications and they are simple to use in Polyspace Server for Ada:

- if one task makes a call to a particular critical section, other tasks specified by the label `-critical-section-begin` will be blocked until the originating task calls the `-critical-section-end` function;
- this doesn't mean the code between two critical sections is atomic;
- It is a binary semaphore: you only have one token per label (in the example below CS1). Unlike many implementations of semaphores, it is not a decrementing counter that can keep track of a number of attempted accesses.

Also refer to "Atomicity" on page 5-22

package my_tasking

```
 procedure proc1;
 procedure proc2;
 procedure my_main;
 X: INTEGER;
 Y: INTEGER;
end my_tasking;
```

package body my_tasking

```
 with pkutil; use pkutil;
package body my_tasking is
 procedure proc1 is
 begin
  begin_cs;
   X := 12; -- X is protected
   Y := 100;
  end_cs;
 end;
 procedure proc2 is
 begin
  begin_cs;
   X := 11; -- X is protected
  end_cs;
  Y := 101; -- Y is not protected
 end;
 procedure my_main is
 begin
```

```
  X := 0;
  Y := 0;
 end
end my_tasking;
```

package pkutil

```
 procedure begin_cs;
 procedure end_cs;
end pkutil;
```

package body pkutil

```
 procedure Begin_CS is
 begin
  null;
 end Begin_CS;
 procedure End_CS is
 begin
  null;
 end end_cs;
end pkutil;
```

Launching command

```
polyspace-ada \
-main my_tasking.my_main \
-entry-points my_tasking.proc1,my_tasking.proc2 \
-critical-section-begin "pkutil.begin_cs:CS1" \
-critical-section-end "pkutil.end_cs:CS1"
```

Mutual Exclusion

Mutual exclusion between tasks or interrupts can be implemented while preparing Polyspace Server for Ada for launch setting.

Suppose there are entry-points which do not overlap with each other, and that variables are shared by nature.

If entry-points are mutually exclusive, i.e. if they do not overlap in time, you may want Polyspace Server for Ada to take this into account. Consider the following example.

These entry-points cannot overlap:

- t1 and t3
- t2, t3 and t4

These entry-points can overlap:

- t1 and t2
- t1 and t4

Before launching Server, the names of mutually exclusive entry-points are placed on a single line

```
polyspace-ada -temporal-exclusion-file myExclusions.txt -entry-points t1,t2,t3,t4
```

The myExclusions.txt is also required in the current folder. This will contain:

```
t1 t3

t2 t3 t4
```

Rendezvous

Polyspace Server for Ada takes the specified rendezvous into account. When the rendezvous are explicitly specified in the code, the software overrides other synchronization mechanisms specified through the `-entry-points` option.

package_first_task

```
package first_task is
 task task_1 is
  entry INIT;
  entry ORDER (X: out Integer);
 end task_1;
end first_task;
package body first_task is
 task body task_1 is
 begin
  accept INIT;
  -- do things
  accept ORDER (X: out Integer)
  do
   -- do things
   -- call functions
   X:= 12;
  end; -- end accept
  -- return to main execution
 end task_1;
end first_task;
```

other tasks

```
with first_task; use first_task;
package other_tasks is
 task task_2 is
 end task_2;
 procedure main;
end other_tasks;
package body other_tasks is
 task body task_2 is
  X: INTEGER;
 begin
  task_1.init;
  task_1.Order(X);
 end task_2;
 procedure main is
 begin;
  null;
 end;
end other_tasks;
```

The use of explicit tasks makes it unnecessary to use the `—entry-points` option in your launching script.

```
polyspace-ada -main other_task.main
```

Semaphores

Although it is possible to implement in ada, it is not possible to take into account a semaphore system call in Polyspace Server for Ada. Nevertheless, Critical sections may be used to model the behavior.

Preparing Multitasking Code

In this section...

Polyspace Software Assumptions

These are the rules followed by Polyspace. It is strongly recommended that the preceding sections should be read and understood before applying the rules described below. Some rules are mandatory; others facilitate improved selectivity.

The following describes the default behavior of Polyspace. If the code to be verified does not conform to these assumptions, then some minor modifications to the code or to the Polyspace run-time parameters will be required.

- The main procedure must terminate in order for entry-points (or tasks) to start.
- All tasks or entry-points start after the execution of the main has completed. They start simultaneously, without predefined assumptions regarding the sequence, priority and preemption.

If an entry-point is seen as dead code, it can be assumed that the main contains (a) red error(s) and therefore does not terminate. Polyspace does not assume any:

- "Atomicity"
- Timing constraints.

Scheduling Model

In the Polyspace model, the main procedure is executed first before other tasks are started. After it has finished, the task entry points are assumed to start concurrently in an interleaved manner. This is an accurate upper approximation model for most concurrent RTOS.

Tasks and main loops need to simply declare as entry points. It only concerns task not defined using keyword of the Ada language.

Example

```
procedure body back_ground_task is
begin
 loop -- infinite loop
-- background task body
-- operations
-- function call
my_original_package.my_procedure;
 end loop
end back_ground_task
```

Launching Command

```
polyspace-ada -entry-points
package.other_task,package.back_ground_task
```

If the tasks are already infinite loops, simply declare them as mentioned above.

Limitation

- A main procedure using the `-main` option is required.
- **The tasks declared in `-entry-points` may not take parameters and may not have return values:**procedure MyTask is end MyTask;

  If it is not the case, it is mandatory to encapsulate with a new procedure. In this case, the real task will be called inside.
- The main procedure cannot be called in a defined or declared task.

Modelling Synchronous Tasks

Problem

My application has the following behavior:

- Once every 10 ms: void tsk_10ms(void);

- Once every 30 ms: ...
- Once every 50 ms

My tasks do not interrupt each other. My tasks do not contain infinite loops.

```
procedure tsk_10ms;
begin do_things_and_exit();
 -- it's important it returns control
end;
```

Explanation

If each task was declared to Polyspace by using the option

```
polyspace-ada -entry-points pack_name.tsk_10ms, pack_name.tsk_30ms,
pack_name.tsk_50ms
```

then the results **would** be valid. However, because more scenarios than those encountered at execution time are modelled, there may be unnecessarily more warnings — the results are less precise.

In order to address this, Polyspace Server for Ada needs to be informed that the tasks are purely sequential. This can be achieved by writing a function to call each of the tasks in the right sequence, and then declaring this new function as a single task entry point.

Solution 1

Write a function that calls the cyclic tasks in the right order: this is an **exact sequencer**. This sequencer is then identified to the software as a single task.

This sequencer will be a single Polyspace task entry point. This solution:

- is more precise,
- but you need to know the exact sequence of events.

```
procedure body one_sequential_Ada_function is
begin
 loop
  tsk_10ms;
  tsk_10ms;
  tsk_10ms;
  tsk_30ms;
  tsk_10ms;
  tsk_10ms;
  tsk_50ms;
 end_loop
end one_sequential_Ada_function;

polyspace-ada -entry-points pack_name.one_sequential_Ada_function
```

Solution 2

Make an **upper approximation sequencer**, which takes into account every possible scheduling. This solution:

- is less precise,
- but is quick to code, especially for complicated scheduling.

```
procedure body upper_approx_Ada_function is
 random : integer;
 pragma volatile (random);
begin
 loop
  if (random = 1) than tsk_10ms; end if;
  if (random = 1) than tsk_30ms; end if;
  if (random = 1) than tsk_50ms; end if;
 end_loop
end upper_approx_Ada_function;

polyspace-ada -entry-points pack_name.upper_approx_Ada_function
```

Note: If this is the only task, then it can be added at the end of the main.

Interruptions and Asynchronous Events/Tasks

Problem

Interrupt service routines appear gray (dead code) in the Results Manager perspective.

Explanation

The gray code indicates that this code is not executed and is not taken into account, so the interruptions are ignored by Polyspace Server for Ada.

The execution model is such that the main is executed initially. Only if the main terminates and returns control (i.e. if it is not an infinite loop) will the task entry points be started.

My interrupts it1 and it2 cannot preempt each other

You can group interruptions in a single function and declare that function as a task entry point if the following conditions are fulfilled:

- The functions `it1` and `it2` cannot interrupt each other.
- Each interrupt can be raised several times in a row.
- The functions do not contain infinite loops.

```
procedure it_1;
procedure it_2;

task body all_interruptions_and_events is
random: boolean;
pragma volatile (random);
begin
 loop
  if (random) then it_1; end if;
  if (random) then it_2; end if;
 end_loop
end all_interruptions_and_events;

polyspace-ada -entry-points package.all_interruptions_and_events
```

My interruptions can preempt each other

If two interruption can be interrupted, then:

- encapsulate each of them in a loop;
- declare each loop as a task entry point.

```
package body original_file is
 procedure it_1 is begin ... end;
 procedure it_2 is begin ... end;
 procedure one_task is begin ... end;
end;

package body new_poly is
procedure polys_it_1 is begin loop it_1; end loop; end;
procedure polys_it_2 is begin loop it_2; end loop; end;
procedure polys_one_task is begin loop one_task; end loop; end;

polyspace-ada -entry-points new_poly. polys_it_1,new_poly. polys_it_2,
new_poly.polys_one_task
```

Are Interruptions Maskable or Preemptive by Default?

Problem

In my main task I use a critical section but I still have unprotected shared data. My application contains interrupts. Why is my variable verified as unprotected?

Explanation

Polyspace Server for Ada does not distinguish between interrupt service routines and tasks. If you specify an interrupt to be an `-entry-point`, it will have the same priority level as other procedures that are also declared as tasks via the `-entry-point` option. Therefore, as Polyspace Server for Ada makes an **upper approximation of scheduling and interleaving**. This upper approximation **includes the possibility that the ISR can be interrupted by other tasks**. There are more paths modelled than can happen during execution.

Solution

Embed your interrupt in a specific procedure that uses the same critical section as the one you use in your main task. Then, each time this function is called, the task will enter a critical section which will be equivalent to a nonmaskable interruption.

Original Packages

```
package my_real_package is
 procedure my_main_task;
 procedure my_real_it;
 shared_X: INTEGER:= 0;
end my_real_package;

package body my_real_package is
 procedure my_main_task is
 begin
  mask_it;
  shared_x:= 12;
  unmask_it;
 end my_main_task;

 procedure my_real_it is
 begin
  shared_x:= 100;
 end my_real_it;
end my_real_package;
```

Extra Packages

An extra package that is required to embed the task with body my_real_package;

```
package extra_additional_pack is
 procedure polyspace_real_it;
end extra_additional_package;

package body extra_additional_pack is
 procedure polyspace_real_it is
 begin
  mask_it;
  my_real_package.my_real_it;
  unmask_it;
 end;
end extra_additional_package;
```

Command Line to Open Polyspace Results Manager Perspective

```
polyspace-ada \
-entry-point my_real_package.my_main_task,extra_additional_pack\
polyspace_real_it
\
-main your_package.your_main
```

Mailboxes

Problem

My application has several tasks:

- some that post messages in a mailbox;
- others that read these messages asynchronously.

This communication mechanism is possible because the OS libraries provide send and receive procedures. I do not have the source files because these procedures are part of the OS libraries.

Explanation

By default, Polyspace Server for Ada will automatically stub these send/receive procedures. Such a stub will exhibit the following behavior:

- for send(char *buffer, int length): the content of the buffer will only be written when the procedure is called;
- for receive(char *buffer, int *length): each element of the buffer will contain the full range of values for the corresponding data type.

Solution

You can provide similar mechanisms with different levels of precision.

Mechanism	Description
Let **Polyspace Server for Ada stub automatically**	• Quick and easy to code • **Imprecise** because between a mailbox sender and receiver are not directly connected. It means that even if the sender is only submitting data within a small range, the full data range for the type(s) will be used for the receiver data.
Provide a **real mailbox** mechanism	• Can be very costly (time consuming) to implement • Can introduce errors in the stubs • Is too much effort compared with the solution below • Precise, but does not provide a much better precision than the upper approximation
Provide an **upper approximation of the mailbox**	in which each new read to the mailbox reads **one** of the recently posted messages, but not necessarily the last one. • Quick and easy to code • Gives precise results • See detailed implementation below

package mailboxes

```
type BIG_ARRAY is
 array (1..100)of INTEGER;
type MESSAGE is
record
```

```
  length: INTEGER;
  content: BIG_ARRAY;
 end MESSAGE;
 MAILBOX : MESSAGE;
 procedure send
  (X: in MAILBOX);
 procedure receive
  (X: out MAILBOX);
end mailboxes;
```

package body mailboxes

```
procedure send (X: in MESSAGE) is
 random : boolean;
 pragma Volatile_(random);
begin
 if (random) then
  MAILBOX:= X;
 end if;
  -- a potential write
  -- to the mailbox
end;
```

procedure receive

```
(X: out MESSAGE) is
begin
 X:= MAILBOX;
end;
```

task body task_1

```
 msg : MESSAGE;
begin
 for i in 1 .. 100 loop
  msg.content(i):= i;
 end loop;
 msg.length : = 100;
 send(msg);
end task_1;
task body task_2 is
 msg : MESSAGE;
begin
 receive(msg);
 if (msg.length = 100) ...
```

```
end;
```

Provided that each of these tasks is included in a package.

```
polyspace-ada -main a_package.a_procedure
```

Atomicity

Definitions

- *Atomic* — In computer programming, atomic describes a unitary action or object that is essentially indivisible, unchangeable, whole, and irreducible
- *Atomicity* — In a transaction involving two or more discrete pieces of information, either all the pieces are committed or none are.

Instructional Decomposition

In general terms, Polyspace Server for Ada does not take into account either CPU instruction decomposition or timing considerations.

It is assumed by Polyspace that instructions are not atomic except in the case of read and write instructions. Polyspace Server for Ada makes an **upper approximation of scheduling and interleaving**. Because of this approximation, the software models more paths than could happen during execution.

Consider a 16 bit target that can manipulate a 32 bit type (an int, for example). In this case, the CPU needs at least two cycles to write to an integer.

Suppose that x is an integer in a multitasking system, with an initial value of 0x0000. Now suppose 0xFF55 is written it. If the operation was not atomic it could be interrupted by another instruction in the middle of the write operation.

- Task 1: Writes 0xFF55 to x.
- Task 2: Interrupts task 1. Depending on the timing, the value of x could be 0xFF00, 0x0055 or 0xFF55.

Polyspace Server for Ada considers write/read instructions atomic, so **task 2 can only read 0xFF55**, even if X is not protected (refer to “Shared Variables” on page 5-8).

Critical Sections

In terms of critical sections, Polyspace Server for Ada does not model the concept of atomicity. A critical section implies that once the function associated with `-critical-`

`section-begin` has been called, other functions making use of the same label will be blocked. Functions not using the label can continue to run.

Polyspace Server for Ada verification of run-time errors supposes that a conflict does not occur when writing the shared variables. Hence even if a shared variable is not protected, the run-time error verification is complete and correct.

More information is available in “Critical Sections” on page 5-9.

Priorities

Polyspace does not consider priorities of tasks during verification. In addition, Polyspace does not assume that priorities can protect shared variables.

Though you cannot implement different task priorities, the verification effectively takes all priorities into account because it assumes that:

- All task entry points that you specify on the **Configuration** pane start at the same time.
- They can interrupt each other in any order, regardless of the sequence of instructions.

For instance, if you have two tasks `t1` and `t2` and `t1` has higher priority than `t2`, use `polyspace-ada -entry-points t1,t2`. Polyspace asumes that:

- `t1` can interrupt `t2` at arbitrary intervals, thus modelling the behavior at execution time.
- `t2` can also interrupt `t1` at arbitrary intervals. This behavior does not occur at execution time unless priority inversion takes place. Polyspace Server for Ada makes an upper approximation of scheduling and interruptions. Because of this approximation, the software models more paths than possible during actual execution.

Highlighting Known Run-Time Errors

In this section...

Annotate Code for Known Run-Time Errors

You can place comments in your code that inform Polyspace software of known run-time errors. Through the use of these comments, you can:

- Highlight run-time errors:
  - Identified in previous verifications.
  - That are not significant.
- Categorize previously reviewed run-time errors.

Therefore, during your analysis of verification results, you can disregard these known errors and focus on new errors.

Annotate your code before running a verification:

1. Open your source file using a text editor.
2. Locate the code that produces a run-time error.
3. Insert the required comment.

```
if (Random.random) then
-- polyspace<RTE: NTC: Low: No action planned > A known run-time error

 Square_Root;
end if;
```

See also "Syntax for Run-Time Errors" on page 5-25.

Note: Instead of typing the full syntax of the annotation, you can copy an annotation template from the Results Manager perspective, paste it into your source code, and modify the template to comment the check. To copy the annotation template, right-click a check in the **Source** pane and select **Add Pre-Justification to Clipboard**.

4. Save your file.

5 Start the verification. The software produces a warning if your comments do not conform to the prescribed syntax, and they do not appear in the Results Manager perspective.

When the verification is complete, open the Results Manager perspective. You see run-time errors in the **Results Summary** view.

In the **Classification**, **Status** and **Comment** columns, the information that you provide within your code comments is now visible. In addition, in the **Justified** column , the check box is selected.

Syntax for Run-Time Errors

To apply comments to a single line of code, use the following syntax:

```
-- polyspace<RTE: RunTimeError1[,RunTimeError2[,…]] :
[Classification] : [Status] > [Additional text]
```

where

- Square brackets *[ ]* indicates optional information.
- *RunTimeError1, RunTimeError2, …* are formal Polyspace checks, for example, COR, OVFL, and NIV. You can also specify ALL, which covers every check.
- *Classification*, for example, High and Low, allows you to categorize the severity of the run-time error with a predefined classification. To see the complete list of predefined classifications, in the PolyspacePreferences dialog box, click the **Review statuses** tab.
- *Status* allows you to categorize the run-time error with a either a predefined status or a status that you define in the Polyspace Preferences dialog box, through the **Review statuses** tab.
- *Additional text* appears in the **Comment** column of the **Results Summary** view of the Results Manager perspective. Use this text to provide information about the run-time errors.

The following is an example of a comment:

```
-- polyspace<RTE: NTC: Low: No action planned > Known issue
```

The software applies the comments, in a case-insensitive way, to the first non-commented line of Ada code that follows the annotation.

Note: Instead of typing the full syntax of the annotation, you can copy an annotation template from the Results Manager perspective, paste it into your source code, and modify the template to comment the check. To copy the annotation template, right-click a check in the **Source** pane and select **Add Pre-Justification to Clipboard**.

To apply comments to a section of code, use the following syntax:

```
-- polyspace:begin<RTE: RunTimeError1[,RunTimeError2[,…]] :
[Classification] : [Status] > [Additional text]

... Code section ...

-- polyspace:end<RTE: RunTimeError1[,RunTimeError2[,…]] :
[Classification] : [Status]  >  [Additional text]
```

Running a Verification

Types of Verification

You can run a verification on a server or a client.

Use...	For...
Server	• Shorter verification time • Large files (more than 800 lines of code including comments)
Client	• When the server is busy • Small files **Note:** Verification on a client takes more time. You might not be able to use your client computer when a verification is running on it.

Running Verifications on Polyspace Server

In this section...

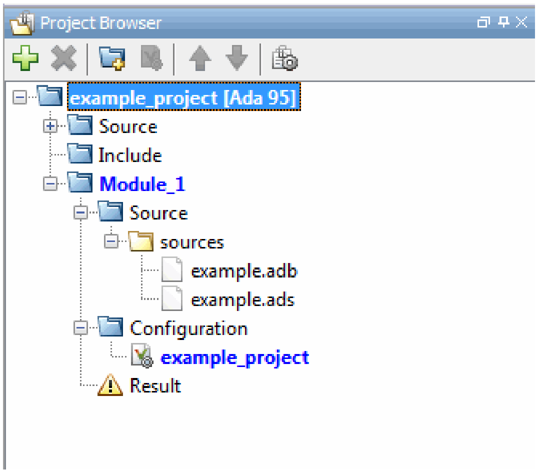
Specifying Source Files to Verify

Each Polyspace project can contain multiple modules. Each of these modules can verify a specific set of source files using a specific set of analysis options. Therefore, before you launch a verification, you must specify which files in your project that you want to verify.

To copy a source file to a module:

1. Open the project containing the file you want to verify.
2. In the **Project Browser** Source tree, right-click the source file that you want to verify.
3. From the context menu, select **Copy to** > **Module_#.**

   You see the source file in the Source tree of the module.



If you have twenty or more modules in your project, when you select **Copy to**, the Select Modules dialog box opens. From the module list, choose the required modules. Then click **Select**.

Note: You can also drag source files from a project into the Source folder of a module.

Specifying Results Folder

Each Module in the Project Browser can contain multiple result folders. This allows you to save results from multiple verifications of the same source files, either to compare results using different analysis options, or to track verification results over time as your source files are revised.

By default, Polyspace software creates a new result folder for each verification. However, if you want to reuse an existing result folder, you can select that folder before launching verification. For example, you may want to reuse a result folder if you stopped a verification before it completed, and are restarting the same verification.

Caution If you specify an existing result folder, the results in that folder are deleted when you start a new verification.

To specify the result folder for a verification:

1 In the Project Browser select the module you want to verify.
2 On the Project Manager toolbar, clear the **Create new result folder** check box.
3 In the **Overwrite result folder** drop-down menu, select the folder you want to use.

   When you run a verification, the software saves verification results in the selected result folder.

Specifying Analysis Options Configuration

Each **Module** in the **Project Browser** can contain multiple configurations, each containing a specific set of analysis options. This allows you to verify the same source files multiple times using different analysis options for each verification.

If you have created multiple configurations, you must choose which configuration to use before launching a verification.

To specify the configuration to use for a verification:

1 In the **Project Browser**, select the module you want to run.
2 In the **Configuration** folder of the module, right click the configuration you want to use.
3 Select **Set as Default**.

   When you run a verification, the software uses the specified analysis options configuration.

Starting Server Verification

Most verification jobs run on the Polyspace server. Running verifications on a server reduces verification time.

To start a verification that runs on a server:

1 In the Project Manager perspective, from the **Project Browser** pane, select the module you want to verify.
2 On the **Configuration** pane, select the **Machine Configuration** node.
3 Select **Send to Polyspace Server**.

4 On the Project Manager toolbar, click the **Run** button .

The verification starts. For information on the verification process, see "What Happens When You Run Verification" on page 6-6.

Note: If you see the message `Verification process failed`, click **OK** and go to "Verification Process Failed Errors".

What Happens When You Run Verification

The verification has three main phases:

1. Checking syntax and semantics (the compile phase). Because Polyspace software is independent of a particular Ada compiler, it ensures that your code is portable, maintainable, and complies with ANSI® standards.
2. Generating a main if the verification does not find a main and you selected the **Verify module** option. For more information, see ""Generate a main"".
3. Analyzing the code for run-time errors and generating color-coded diagnostics.

The compile phase of the verification runs on the client. When the compile phase is complete:

- You see the message `queued on server` at the bottom of the Project Manager perspective. This message indicates that the part of the verification that takes place on the client is complete. The rest of the verification runs on the server.
- A message in the **Output Summary** view gives you the identification number (Analysis ID) for the verification.

Running Verification Unit-by-Unit

When you run a server verification, you can create a separate verification job for each source file in the project. Each file is compiled and verified individually. Verification results can then be viewed for the entire project, or for individual units.

To run a unit-by-unit verification:

1. On the **Configuration** pane, select the **Verification Mode** node.

2. Select **Verify files independently**. The option **Common source files** is now visible.
3. You can create a list of common files to include with each unit verification:

   a. Click ✚. The software creates a new row.
   b. In the new row, enter the full path to a common file. For example, `C:\Polyspace\polyspace_project\includes\include.h`.

   Repeat steps `a` and `b` until you have created your list of common files. These files are compiled once, and then linked to each unit before verification.
4. Save your project.
5. On the Project Manager toolbar, click **Run**.

   Each file in the project is compiled and verified individually as part of a verification group for the project.

Verify All Modules in Project

You can have many modules within a project, each module containing a set of source files and an active configuration.

To verify all modules in a project:

1. In the Project Manager perspective, on the **Project Browser**, select the project for which you want to run verifications.
2. Select **Run** > **Run All Modules**.

   The software verifies each module as an individual job.

Manage Verification Jobs Using Polyspace Job Monitor

You manage server verifications using the Polyspace Job Monitor. The Polyspace Job Monitor allows you to move jobs within the queue, remove jobs, monitor the progress of individual verifications, and download results.

To manage verification jobs on the Polyspace Server:

1. On the Polyspace toolbar, select **Tools** > **Open Job Monitor**.

The Polyspace Job Monitor opens.

2 Right-click a job in the queue to open the context menu for that verification.

3 Select the required option from the context menu.

Monitor Progress of Verification

Monitor Progress Using Project Manager

You can monitor the progress of your verification by viewing the **Output Summary** and **Full Log** tabs at the bottom of the Project Manager perspective.

The **Output Summary** tab highlights the current phase in blue and displays the amount of time and completion percentage for that phase.

The logs report additional information about the progress of the verification. To view a log, click the button for that log. The information appears in the log display area at the bottom of the Project Manager window. Follow the next steps to view the logs:

1. Select the **Output Summary** tab to display compile phase messages and errors. You can search the log by entering search terms in the **Search** field and clicking the left arrow to search backward or the right arrow to search forward.
2. Select the **Dashboard** tab to display statistics, such as analysis options, stubbed functions, and the verification checks performed.
3. Select the **Full Log** tab to display messages, errors, and statistics for the various phases of the verification.

Note: You can search the logs. In the **Search** field, enter a search term and click the left arrow to search backward or the right arrow to search forward.

Monitor Progress Using Job Monitor

You can monitor the progress of a verification using the Polyspace Job Monitor.

To monitor a verification:

1. Select **Tools** > **Open Job Monitor**.

   The Polyspace Job Monitor opens.

2 Place the cursor anywhere in the row containing your job.

3 Right-click, and select **Follow Progress** from the context menu.

Note: This option does not apply to unit-by-unit verification groups, only the individual jobs within a group.

The **Output Summary** opens.

This tab displays information about the progress of the verification. To view a log, click the tab for that log. The information appears in the log display area at the bottom of the Project Manager perspective. Follow the next steps to view the logs:

- Click the **Output Summary** tab to display compile phase messages and errors. You can search the log by entering search terms in the **Search in the log** box and clicking the left arrows to search backward or the right arrows to search forward.
- Click the **Dashboard** tab to display statistics, such as analysis options, stubbed functions, and the verification checks performed.
- Click the **Full Log** tab to display messages, errors, and statistics for the various phases of the verification.

Note: You can search the logs. In the **Search in the log** box, enter a search term and click the left arrows to search backward or the right arrows to search forward.

4 Select **File** > **Quit** to close the progress window.

5 Wait for the verification to finish.

When the verification is complete, the status in the Polyspace Job Monitor changes from `running` to `completed`.

View Log File on Server

You can view the log file of a server verification using the Polyspace Job Monitor.

To view a log file on the server:

1 Select **Tools** > **Open Job Monitor**.

The Polyspace Job Monitor opens.

2 Right-click the job you want to monitor, and select **View log file**.

A window opens displaying the last one-hundred lines of the verification.

3 Click **Close** to close the window.

Stop Verification

You can stop a verification running on the server before it completes using the Polyspace Job Monitor. If you stop the verification, results will be incomplete, and if you start another verification, the verification starts over from the beginning.

To stop a server verification:

1 Select **Tools** > **Open Job Monitor**.

The Polyspace Job Monitor opens.

2 Right-click the job you want to monitor, and select one of the following options:

- **Stop** — Stops a unit-by-unit verification job without removing it. The status of the job changes from “running” to “aborted”. The jobs in the unit-by-unit verification group remain in the queue, and other jobs in the group will continue to run.
- **Stop and download results** — Stops the verification job immediately and downloads preliminary results. The status of the verification changes from “running” to “aborted”. The verification remains in the queue.
- **Stop and remove from queue** — Stops the verification immediately and removes it from the queue. If the job is part of a unit-by-unit verification group, the entire verification is removed, not just the individual job.

Remove Jobs from Server Queue

If your job is in the server queue, but has not yet started running, you can remove it from the queue using the Polyspace Job Monitor.

Note: If the job has started running, you must stop the verification before you can remove the job (see “Stop Verification” on page 6-10). Once you have aborted a verification, you can remove it from the queue.

To remove a job from the server queue:

1 Select **Tools** > **Open Job Monitor**.

   The Polyspace Job Monitor opens.

2 Right-click the job you want to remove, and select **Remove from queue**.

   The job is removed from the queue.

Change Order of Jobs in Server Queue

You can change the priority of verification jobs in the server queue to determine the order in which the jobs run.

To move a job within the server queue:

1 Select **Tools** > **Open Job Monitor**.

   The Polyspace Job Monitor opens.

2 Right-click the job you want to remove, and select **Move down in queue**.

   The job is moved down in the queue.

Note: You can move unit-by-unit verification groups in the queue, as well as individual jobs within a single unit-by-unit verification group. However, you cannot move individual unit-by-unit verification jobs outside of the group.

Purge Server Queue

You can purge the server queue of all jobs, or completed and aborted jobs using the using the Polyspace Job Monitor.

Note: You must have the Job Monitor password to purge the server queue.

To purge the server queue:

1 Select **Tools** > **Open Job Monitor**.

The Polyspace Job Monitor opens.

2 Select **Operations** > **Purge queue**. The Purge queue dialog box opens.

3 Select one of the following options:

- **Purge completed and aborted analysis** — Removes completed and aborted jobs from the server queue.
- **Purge the entire queue** — Removes all jobs from the server queue.

Note: For unit-by-unit verification jobs, the jobs are not removed until the entire group has been verified.

4 Enter the Job Monitor **Password**.

5 Click **OK**.

The server queue is purged.

Change Job Monitor Password

The Job Monitor has an administrator password to control access to advanced operations such as purging the server queue. You can set this password through the Job Monitor.

Note: The default password is `admin`.

To set the Job Monitor password:

1 Select **Tools** > **Open Job Monitor**.

The Polyspace Job Monitor opens.

2 Select **Operations** > **Change Administrator Password**.

The Change Administrator Password dialog box opens.

3 Enter your old and new passwords. Then click **OK**.

The password is changed.

Note: Passwords are limited to 8 characters.

Share Server Verifications Between Users

Security of Jobs in Server Queue

For security reasons, verification jobs in the server queue are owned by the user who sent the verification from a specific account. Each verification has a unique encryption key, that is stored in a text file on the client system.

When you manage jobs in the server queue (for example, download, kill, and remove), the Job Monitor checks the public keys stored in this file to authenticate that the job belongs to you.

If the key does not exist, an error message appears: "`key for verification <ID> not found`".

`analysis-keys.txt` File

The public part of the security key is stored in a file named `analysis-keys.txt` which is associated to a user account. This file is located in `%APPDATA%\Polyspace`:

- **UNIX®** — "`/home/<username>/.Polyspace`"
- **Windows** — "`C:\Users\<username>\AppData\Roaming\Polyspace`"

The format of this ASCII file is as follows (tab-separated):

`<id of launching> <server name of IP address> <public key>`

where *`<public key>`* is a value in the range `[0..F]`

The fields in the file are tab-separated.

The file cannot contain blank lines.

Example:

```
1   m120  27CB36A9D656F0C3F84F959304ACF81BF229827C58BE1A15C8123786
2   m120  2860F820320CDD8317C51E4455E3D1A48DCE576F5C66BEEF391A9962
8   m120  2D51FF34D7B319121D221272585C7E79501FBCC8973CF287F6C12FCA
```

Sharing Verifications Between Accounts

To share a server verification with another user, you must provide the public key.

To share a verification with another user:

1. Find the line in your `analysis-keys.txt` file containing the *<ID>* for the job you want to share.
2. Add this line to the `analysis-keys.txt` file of the person who wants to share the file.

   The second user can then download or manage the verification.

Magic Key to Share Verifications

A magic key allows you to share verifications without copying individual keys. This allows you to use the same key for verifications launched from a single user account.

The format for a magic key is as follows:

```
0  <Server id>  <your hexadecimal value>
```

When you add this key to your `analysis-keys.txt` file, verification jobs you submit to the server queue use this key instead of a random one. Users who have this key in their `analysis-keys.txt` file can then download or manage your verification jobs.

Note: This only works for verification jobs launched after you place the magic key in the file. If the verification was launched before the key was added, the normal key associated to the ID is used.

If `analysis-keys.txt` File is Lost or Corrupted

If your `analysis-keys.txt` file is corrupted or lost (removed by mistake) you cannot download your verification results. To access your verification results you must use administrator mode.

Note: You must have the Job Monitor password to use Administrator Mode.

To use administrator mode:

1. Select **Tools** > **Open Job Monitor**.

   The Polyspace Job Monitor opens.

2. Select **Operations** > **Enter Administrator Mode**.
3. Enter the Job Monitor **Password**.
4. Click **OK**.

   You can now manage verification jobs in the server queue, including downloading results.

Running Verifications on Polyspace Client

In this section...

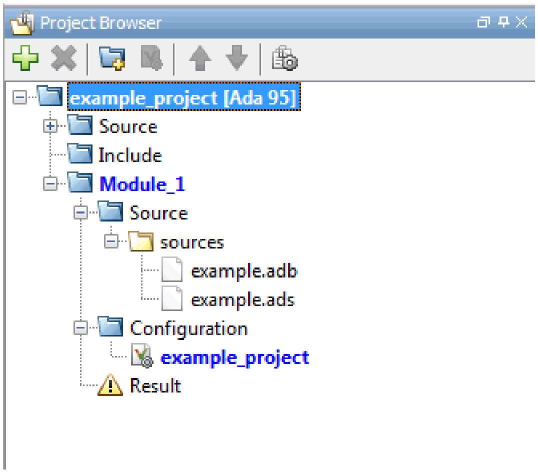
Specifying Source Files to Verify

Each Polyspace project can contain multiple modules. Each of these modules can verify a specific set of source files using a specific set of analysis options. Therefore, before you launch a verification, you must specify which files in your project that you want to verify.

To copy a source file to a module:

1. Open the project containing the file you want to verify.
2. In the **Project Browser** Source tree, select the source file that you want to verify.
3. Right-click the file. From the context menu, select **Copy to** > **Module_#.**

   The selected source file appears in the Source tree of the module.



Note: You can also drag source files from a project into the Source folder of a module.

Starting Verification on Client

For shorter verification time, run verifications on a server. If the server is busy or you want to verify a small file, you can run a verification on a client.

Note: Because a verification on a client can process only a limited number of variable assignments and function calls, the source code should not have more than 800 lines of code.

If you start a verification of Ada code containing more than 2,000 assignments and calls, the verification stops and you see an error message.

To start a verification that runs on a client:

1. In the Project Manager perspective, from the **Project Browser** view, select the module you want to verify.
2. On the **Configuration** pane, select the **Machine Configuration** node.
3. Clear the **Send to Polyspace Server** check box.
4. On the Project Manager toolbar, click ▷ Run.

   The **Output Summary** view becomes active, allowing you to monitor the progress of the verification.

   Note: If you see the message `Verification process failed`, click **OK** and go to "Verification Process Failed Errors".

What Happens When You Run Verification

The verification has three main phases:

1. Checking syntax and semantics (the compile phase). Because Polyspace software is independent of a particular Ada compiler, it ensures that your code is portable, maintainable, and complies with ANSI standards.

2 Generating a main if the verification does not find a main and you selected the **Verify module** option. For more information, see "Verify module".

3 Analyzing the code for run-time errors and generating color-coded diagnostics.

Monitoring the Progress of the Verification

You can monitor the progress of the verification by viewing the tabs at the bottom of the Project Manager perspective.

These tabs report information about the progress of the verification:

- Select the **Output Summary** tab to view verification progress and display compilation messages and errors.
- Select the **Dashboard** tab to display statistics, such as analysis options, stubbed functions, and the verification checks performed.
- Select the **Full Log** tab to display messages, errors, and statistics for the various phases of the verification.

Note: You can search the **Output Summary** and **Full Log**. Select the corresponding tab, and in the **Search** field, enter a search term. Click the left arrow to search backward or the right arrow to search forward.

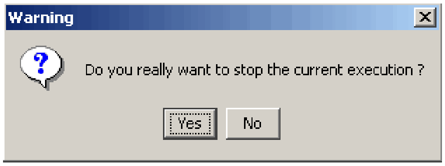
Stopping a Client Verification

You can stop the verification before it is complete. If you stop the verification, results are incomplete. If you start another verification, the verification starts from the beginning.

To stop a verification:

1 On the Project Manager toolbar, click the **Stop** button.

A warning dialog box appears.



Warning

Do you really want to stop the current execution ?

2 Click **Yes**. The verification stops.

Note: Closing the Polyspace verification environment window does *not* stop the verification. To resume display of the verification progress, start the Polyspace software and open the project.

Running Verifications from Command Line

In this section...

Starting Batch Verifications

A set of commands allow you to run batch verifications.

These commands begin with the following prefixes:

- **Server verification** — `Polyspace_Install/polyspace/bin/polyspace-remote-ada95`
- **Client verification** — `Polyspace_Install/polyspace/bin/polyspace-remote-desktop-ada95`

For example, `polyspace-remote-desktop-ada95 -server [<hostname>:[<port>] | auto]` connects the client to the specified server. This connection allows you to run verifications remotely on the server.

These commands are equivalent to commands with the prefix `PolyspaceInstall/polyspace/bin/polyspace-`.

Managing Batch Verifications

A set of commands allow you to manage verification jobs in the server queue. These commands begin with the prefix `Polyspace_Install/polyspace/bin/psqueue-`:

- `psqueue-download <id> <results dir>` — download an identified verification into a results folder. When downloading a unit-by-unit verification group, the unit results are downloaded and a summary of the download status for each unit is displayed.
  - `[-f]` force download (without interactivity)
  - `-admin -p <password>` allows administrator to download results.
  - `[-server <name>[:port]]` selects a specific Job Monitor.
  - `[-v|version]` gives release number.

- `psqueue-kill` *`<id>`* — kill an identified verification. For unit-by-unit verification groups, you can stop the entire group, or individual jobs within the group. Stopping an individual job does not kill the entire group.
- `psqueue-purge all|ended` — remove completed verifications from the queue. For unit-by-unit verification jobs, the jobs are not removed until the entire group has been verified.
- `psqueue-dump` — gives the list of verifications in the queue associated with the default Job Monitor. Unit-by-unit verification groups are shown using a tree structure.
- `psqueue-move-down` *`<id>`* — move down an identified verification in the Queue. Individual jobs can be moved within a unit-by-unit verification group, but not outside of the group.
- `psqueue-remove` *`<id>`* — remove an identified verification in the queue. You cannot remove a single job that is part of a unit-by-unit verification group, you can only remove the entire group.
- `psqueue-get-qm-server` — give the name of the default Job Monitor.
- `psqueue-progress` *`<id>`*`:` give progression of the currently identified and running verification. This command does not apply to unit-by-unit verification groups, only the individual jobs within a group.
  - `[-open-launcher]` display the log in the Project Manager perspective.
  - `[-full]` give full log file.
  - `psqueue-set-password` *`<password> <new password>`* — change administrator password.
- `psqueue-check-config` — check the configuration of Job Monitor.
  - `[-check-licenses]` check for licenses only.
- `psqueue-upgrade` — Allow to upgrade a client side. See “Software Installation”.
  - `[-list-versions]` give the list of available release to upgrade.
  - `[-install-version` *`<version number>`* `[-install-dir` *`<folder>`*`]] [-silent]` allow to install an upgrade in a given folder and in silent.

Note: *`Polyspace_Install`*`/polyspace/bin/psqueue-` *`<command>`* `-h` provides information about available options for each command.

Troubleshooting Verification

Verification Process Failed Errors

In this section...

Verification Failed Messages

If you see a message stating that `Verification process failed`, Polyspace software did not perform the verification. The following sections present some possible reasons for a failed verification.

Hardware Does Not Meet Requirements

If your computer does not have the minimal hardware requirements, you see a warning during verification, but the verification continues. For information about hardware requirements for the Polyspace products, see:

www.mathworks.com/products/polyspaceclientada/requirements.html

To avoid this issue, upgrade your computer to meet the minimal requirements.

Location of Included Files Not Specified

If you see the following message, either the included files are missing or you did not specify the location of included files:

```
example.adb, line 12 (column 14): Error: "runtime_error (spec)" depends
on "types (spec)"
```

For information on how to specify the location of include files, see "Project Creation".

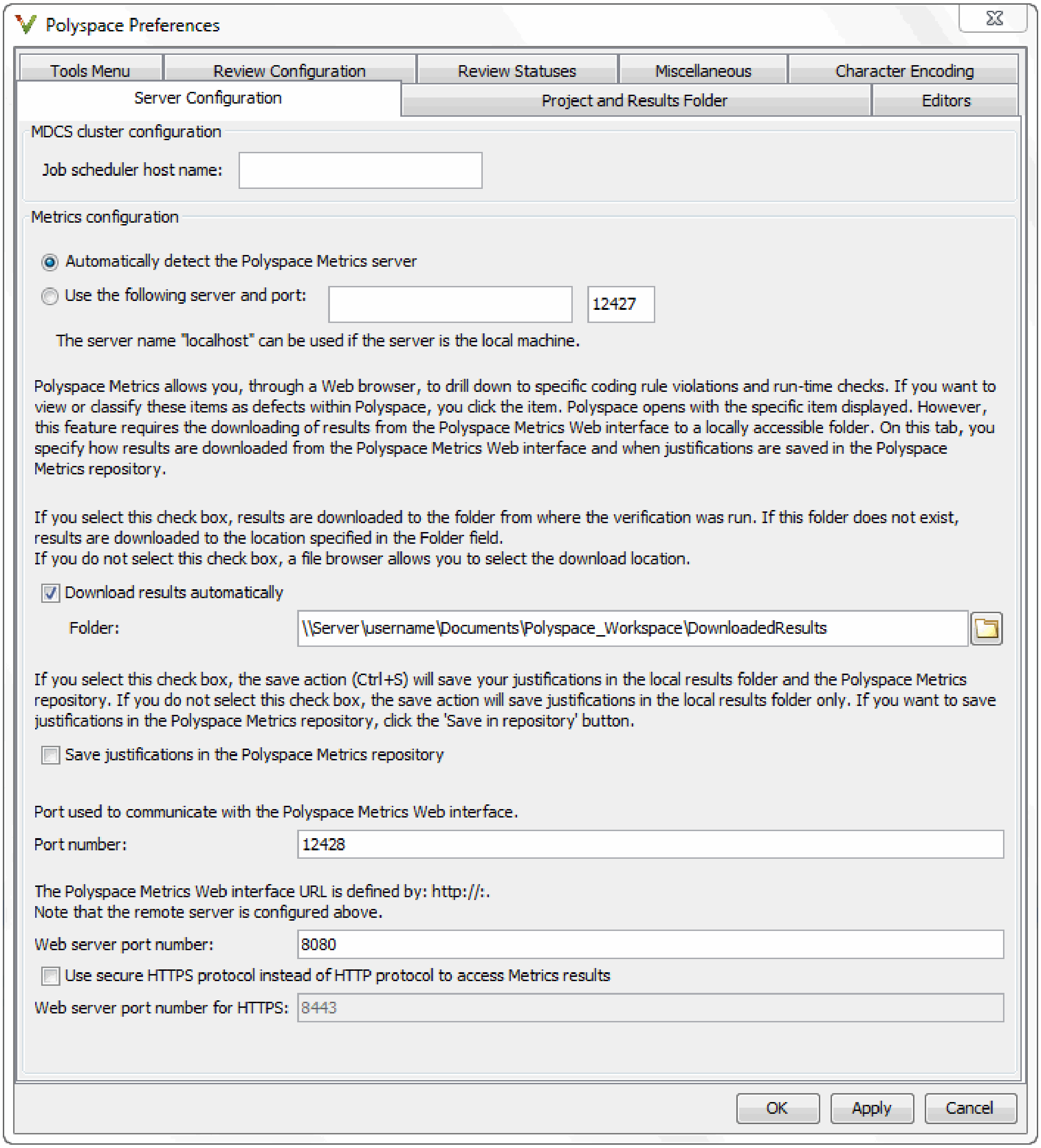
Polyspace Software Cannot Find the Server

If the Polyspace software cannot find the server, you see the following message in the log:

```
Error: Unknown host :
```

To find the server information:

1. Select **Tools** > **Preferences**.
2. Select the **Server configuration** tab.



MDCS cluster configuration

Job scheduler host name:

Metrics configuration

● Automatically detect the Polyspace Metrics server

○ Use the following server and port: 12427

The server name "localhost" can be used if the server is the local machine.

Polyspace Metrics allows you, through a Web browser, to drill down to specific coding rule violations and run-time checks. If you want to view or classify these items as defects within Polyspace, you click the item. Polyspace opens with the specific item displayed. However, this feature requires the downloading of results from the Polyspace Metrics Web interface to a locally accessible folder. On this tab, you specify how results are downloaded from the Polyspace Metrics Web interface and when justifications are saved in the Polyspace Metrics repository.

If you select this check box, results are downloaded to the folder from where the verification was run. If this folder does not exist, results are downloaded to the location specified in the Folder field.
If you do not select this check box, a file browser allows you to select the download location.

☑ Download results automatically

Folder: \\Server\username\Documents\Polyspace_Workspace\DownloadedResults

If you select this check box, the save action (Ctrl+S) will save your justifications in the local results folder and the Polyspace Metrics repository. If you do not select this check box, the save action will save justifications in the local results folder only. If you want to save justifications in the Polyspace Metrics repository, click the 'Save in repository' button.

☐ Save justifications in the Polyspace Metrics repository

Port used to communicate with the Polyspace Metrics Web interface.

Port number: 12428

The Polyspace Metrics Web interface URL is defined by: http://:.
Note that the remote server is configured above.

Web server port number: 8080

☐ Use secure HTTPS protocol instead of HTTP protocol to access Metrics results

Web server port number for HTTPS: 8443

How you handle this error depends on the selected remote configuration option.

Remote Configuration Option	Solution
Automatically detect the remote server	Specify the server by selecting **Use the following server and port** and providing the server name and port.
Use the following server and port	Check the server name and port number.

For information about setting up a server, see the *Polyspace Installation Guide*.

Limit on Assignments and Function Calls

If you start a client verification for a large file, the verification can stop with an error message stating that the number of assignments and function calls is too large. For example:

```
*** License error: number of assignments and function calls is too large
*** for the desktop mode (15462 v.s 2000).
*** Aborting.

-------------------------------------------------------------------
---                                                             ---
---  Verifier has encountered an internal error.                ---
---  Please contact your technical support.                     ---
---                                                             ---
-------------------------------------------------------------------

Failure at: Dec 21, 2009 18:21:42
User time for polyspace-desktop-ada95: 1773real, 1097.1u + 101s (6.1gc)
Exiting because of previous error

***
*** End of Polyspace Verifier analysis
***
```

The Polyspace Client for Ada software can verify only Ada code with up to 2,000 assignments and calls.

To verify code containing more than 2,000 assignments and calls, run a server verification using Polyspace Server for Ada.

Compilation Errors

Compilation Error Overview

You can use Polyspace software instead of your compiler to make syntactical, semantic, and other static checks. The standard compliance-checking stage takes about the same amount of time as a compiler. If you use Polyspace software early in development, you see objective, automatic, and early control of development work. This control allows you to avoid errors prior to checking code into a configuration management system.

Some compile errors can arise because of implementation-related differences between your environment and Polyspace software.

Configuring a Text Editor

Before you can open source files, you must configure a text editor. For more information, see "Specify External Text Editor".

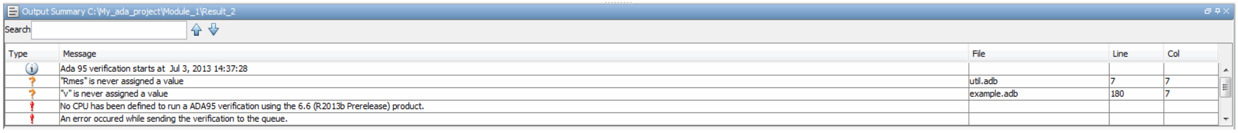
Examining the Compile Log

The compile log displays compile-phase messages and errors. You can search the log by entering search terms in the **Search** box.

To examine errors in the Compile log:

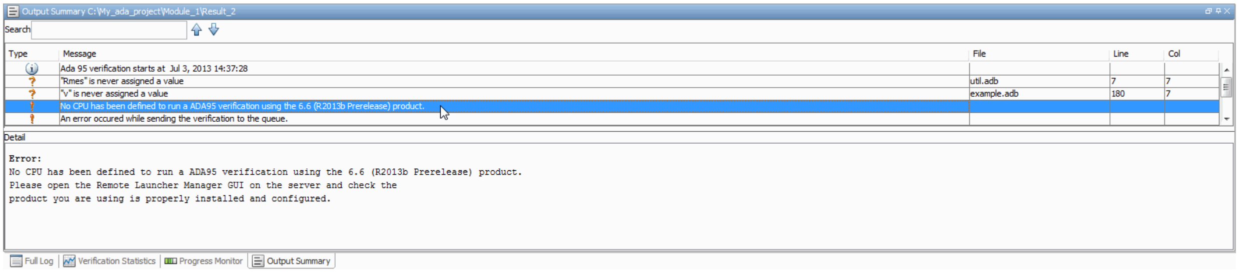
1 In the log area of the Project Manager perspective, click **Compile**.

A list of compile-phase messages appear in the log part of the window.



Type	Message	File	Line	Col
ⓘ	Ada 95 verification starts at Jul 3, 2013 14:37:28			
?	"Rmes" is never assigned a value	util.adb	7	7
?	"v" is never assigned a value	example.adb	180	7
!	No CPU has been defined to run a ADA95 verification using the 6.6 (R2013b Prerelease) product.			
!	An error occured while sending the verification to the queue.			

2 Click a message to see message details, as well as the full path of the file containing the error.



Output Summary C:\My_ada_project\Module_1\Result_2

Search

Type	Message	File	Line	Col
ⓘ	Ada 95 verification starts at Jul 3, 2013 14:37:28			
?	"Rmes" is never assigned a value	util.adb	7	7
?	"v" is never assigned a value	example.adb	180	7
!	No CPU has been defined to run a ADA95 verification using the 6.6 (R2013b Prerelease) product.			
!	An error occured while sending the verification to the queue.			

Detail

```
Error:
No CPU has been defined to run a ADA95 verification using the 6.6 (R2013b Prerelease) product.
Please open the Remote Launcher Manager GUI on the server and check the
product you are using is properly installed and configured.
```

3 To open the source file referenced by a message, right-click the row for the message. From the context menu, select **Open Source File**.

The file opens in your text editor.

4 Fix the error and run the verification again.

Common Compile Errors

- “Missing specification for unit” on page 7-8
- “Calendar not found” on page 7-8
- “Not a predefined library unit” on page 7-8
- “representation clause appears too late” on page 7-9
- “Package system and standard include” on page 7-9
- “Unsigned type” on page 7-10
- “Function not declared in package” on page 7-10
- “preelaborated unit” on page 7-10
- “actual must be a definite subtype” on page 7-11
- “'ref attribute” on page 7-12
- “Cannot load s-dec.ads (unit not found)” on page 7-12
- “Green Hills standard include” on page 7-13
- “Package Analysis Limitation” on page 7-13
- “Ambiguous Bounds in Discrete Range” on page 7-14

Missing specification for unit

Problem

You must supply complete specifications associated with a package body verification to the Polyspace software. If you do not, you might encounter the following error message:

```
Verifying _pst_main

Verifying my_package

-> Verifier found an error
in ./My_Package.adb, line 2 (column 14):
Missing specification for unit "My_Package"
```

Solution/Workaround

Include the specifications of the package body in the list of supplied sources.

Explanation

When you supply a package body as the source, and the package body specification as one of the specifications in one of the `-ada-include-dir` folders, the Polyspace software reports this error.

Calendar not found

Problem

The compiler did not find the package calendar.

Solution/Workaround

In the `sources` folder, create a file with:

```
With ada.calendar;
package calendar renames ada.calendar
```

Explanation

For some compilers, the package calendar is on the top level. For the GNAT compiler, the calendar is a child of Ada.

Not a predefined library unit

Problem

You see the error message:

```
"machine_code" is not a predefined library unit
```

Solution/Workaround

In the `sources` folder, create a file with the following lines:

```
with System.Machine_Code;
package Machine_Code renames System.Machine_Code;
```

Explanation

Depending on the compiler that you are using, the subpackage of the package system can have a different name.

representation clause appears too late

Problem

The compilation phase stops and displays the warning:

```
representation clause appears too late
```

Solution/Workaround

Change:

```
type the_type is new Integer range 0 .. 10;
var : the_type;
for the_type'size use 16; -- Error : representation clause appears too late
```

to:

```
type the_type is new Integer range 0 .. 10;
for the_type'size use 16;
```

Explanation

If you use a type between its declaration clause and the representation clause, the Polyspace software displays this warning.

Package system and standard include

Problem

The standard include files are dependent on the compiler. You may see the following error message:

```
-> Verifier found an error in f1.ada, line 253 (column 29): "Offset" not
   declared(1) in "System"
-> Verifier found an error in f2.ada, line 758 (column 43): expected type
   "System.OFFSET"
```

Solution/Workaround

Copy the `system.ads` file from *<product_dir>*`\adainclude` into your `sources` folder and insert the line:

```
type OFFSET is range -2**31 .. 2**31-1;
```

Explanation

This type definition is specific to the AONIX/Alsys Ada compiler.

Unsigned type

Problem

Some code uses unsigned types. The Polyspace compiler does not support unsigned types.

Solution/Workaround

Define unsigned types as follows:

```
type unsigned_integer is mod 4294967296;
type unsigned_short_integer is mod 65536;
type unsigned_tiny_integer is mod 256;
```

Function not declared in package

Problem

The package `operations` does not declare the function `New_ATCB`. The package `System.Tasking.Initialization` declares that function.

Solution/Workaround

Copy the file `s-taprop.ads` from *<product-dir>*`/adainclude/` into the `sources` folder. Into the `s-taprop.ads` file, insert the following line:

```
function New_ATCB (Self_ID : integer) return Task_ID;
```

Explanation

Add missing specifications to the package.

preelaborated unit

Problem

This package has a `pragma preelaborate` construct.

Solution/Workaround

Comment out the `pragma preelaborate` construct.

actual must be a definite subtype

Problem

The compile error message is:

```
actual for "SOURCE" must be a definite subtype
```

If the formal subtype is definite, the actual subtype must also be definite. This error is a valid compilation error in Ada 95 but is not valid in Ada 83. For more information, see the Ada 95 standard (12.5.1-6) and Ada 95 annotated (12.5.1-28.a).

The following example can be extended to other generic declarations. This example is based on the `unchecked_conversion` generic function.

The example code is:

```
generic
   type SOURCE is limited private;
   type TARGET is limited private;

function UNCHECKED_CONVERSION (S : SOURCE) return TARGET;


with UNCHECKED_CONVERSION;
package Test is
        type INDEX is new INTEGER;
   type DATA_INDEX is new INTEGER;

   type UNCONSTRAINED_DATA_TYPE is array
     (INDEX range <>) of INTEGER;

   subtype CONSTRAINED_DATA_TYPE is
     UNCONSTRAINED_DATA_TYPE (INDEX range INDEX'First..Index'LAST);

     function TO_DATA is new UNCHECKED_CONVERSION
       (SOURCE => UNCONSTRAINED_DATA_TYPE,
        TARGET => INTEGER);

     procedure Main;

end Test;
```

Solution/Workaround

Change the lines:

```
type SOURCE is limited private;
   type TARGET is limited private;
```

to:

```
type SOURCE (<>) is limited private;
type TARGET (<>) is limited private;
```

to match the Polyspace definitions.

Explanation

The Polyspace provides its own version of `Unchecked_Conversion` and its own definition of the `SOURCE` and the `TARGET`.

'ref attribute

Problem

The use of the `'ref` attribute is not standard. The Polyspace software does not support that attribute.

Two examples that cause a compile error are:

```
system.address'ref (16#FFFF_FFFF#)
```

```
a_var'ref
```

Solution/Workaround

In the preceding examples, use the following code instead:

```
system.address (16#FFFF_FFFF#)
```

```
var’address
```

Explanation

This attribute is dependent on the compiler.

Cannot load s-dec.ads (unit not found)

Problem

When compiling VMS Ada code, you may see the following error message:

```
cannot load s-dec.ads (unit not found)
```

Solution/Workaround

Comment out every line that uses the `AST_entry` or `Type_class` attribute.

Explanation

The `AST_entry` and `Type_class` attributes are specific to VMS Ada.

Green Hills standard include

Problem

When analyzing a Green Hills® application, you may see compile errors due to:

- The compatibility between the Polyspace and Green Hills include files
- A limitation the Polyspace Verifier encounters when compiling a Green Hills include file

Solution/Workaround

The Polyspace software now provides a specific option for the Green Hills Ada compiler. For more information, see "Target operating system".

Explanation

The `$POLYSACE_ADA/adainclude/greenhills` folder contains the Green Hills compiler include files.

Package Analysis Limitation

Problem

Suppose you have a types package that defines a task to a pointer type. Other packages include this type package using the `with` clause. When you use that pointer type in the package, you cannot analyze that package.

Solution/Workaround

1. Copy package specifications that have unsupported construction from the `includes` folder to the `include-modified` folder.
2. In these files, comment out every unsupported construction.
3. Use the `-ada-include-dir` option to incorporate the modified files in the analysis.

   For example:

```
polyspace-ada95 \
-ada-include-dir $HERE/includes \
-ada-include-dir $HERE/includes-modified \
-extensions-for-spec-files "*.a??"
```

Note: If a package is defined in two different folders, the file compiled and analyzed by Polyspace is the last one specified.

Explanation

By taking these steps, you do not have to modify the original files. You must maintain copies of the original files in the `includes-modified` folder. These types of include files do not change very often.

Use this workaround for an Ada compiler standard include file.

Ambiguous Bounds in Discrete Range

Problem

The type `System.address` must be declared `private` in the package `System` (file `system.ads`). Otherwise, your verification might fail with the following error:

```
Verifying _pst_main
Verifying mypackage
mypackage.ada, line xx (column yy): Error: ambiguous bounds in discrete range
Warning: Failed compilation of mypackage
```

Solution/Workaround

Rerun the verification with the following options:

```
-OS-target gnat -D PST_GNAT_SYSTEM_ADDRESS_TYPE_IS_PRIVATE
```

Reducing Verification Time

In this section...

Verification Time Considerations

In relation to the verification time, consider the following factors:

- Size of the code
- Number of global variables
- Nesting depth of the variables (the more nested the variables are, the longer the verification takes)
- Depth of the application call tree
- "Intrinsic complexity" of the code, particularly the arithmetic manipulation

Polyspace software provides graphical and textual output to indicate how the verification is progressing.

Displaying Verification Status Information

For *client* verifications, monitor the progress of your verification using the **Output Summary** and **Dashboard** tabs in the Project Manager. For more information, see "Monitoring the Progress of the Verification".

For *server* verifications, use the Polyspace Job Monitor to follow the progress of your verification. For more information, see "Monitor Progress of Verification".

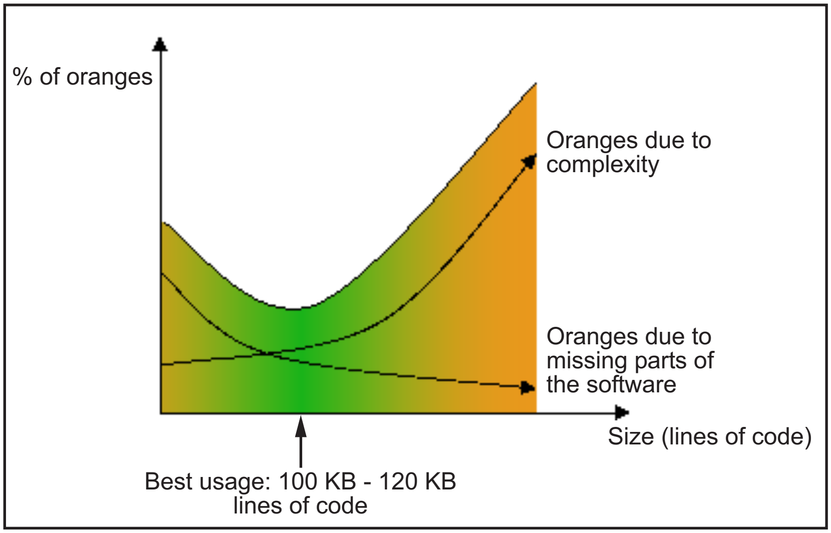
The progress bar highlights each completed phase and displays the amount of time for that phase. You can estimate the remaining verification time by extrapolating from this data, and considering the number of files and passes remaining.

Ideal Application Size

There is a compromise between the time and resources required to verify an application, and the resulting selectivity. The larger the project size, the broader the approximations made by Polyspace. These approximations enable Polyspace to extend the range of project sizes that it can manage and to solve incomputable problems. You must balance the benefits from verifying the whole of a large application against the resulting loss of precision.

Begin with package by package verifications. The maximum recommended application size is 100,000 lines of code.

Subdividing an application prior to verification typically has a beneficial impact on selectivity—that is, more red, green, and gray checks, fewer orange warnings, and therefore more efficient bug detection.



A compromise between selectivity and size

Optimum Size

Polyspace software verifies numerous applications with greater than 100,000 lines of code. However, as project sizes become very large, the Polyspace Server:

- Makes broader approximations, producing more orange checks.
- Can take much more time to verify the application.

Before you use another form of testing, use the Polyspace software early on in the development process.

When a small module (file, piece of code, package) is verified using Polyspace, focus on the red and gray checks. **Orange** unproven checks at this stage are very useful, because most of them deal with robustness of the application. The checks change to red, gray, or green as the project progresses and more and more modules are integrated.

During the integration process, the code might become so large (100,000 lines of code or more) that the verification of the whole project is not achievable within a reasonable amount of time. You have several options:

- Keep using Polyspace only upstream in the process.
- Verify subsets of the code.
- Use the `-unit-by-unit` option, as described in "Subdivide According to Files" on page 7-22.

Selecting a Subset of Code

If a project is subdivided into logical sections by considering data flow, the total verification time is shorter than for the project considered in one pass. (See also "Volatile Variables" and "Automatic Stubbing".)

In such an application, consider the following:

- Function entry points — Refer to the Polyspace execution model because the function entry points are started concurrently, without assumptions regarding sequence or priority. They represent the beginning of your call tree.
- Data entry points — Examine the lines in the code where data is acquired as "data entry points"

Consider the following examples.

Example 1

```
Procedure complete_treatment_based_on_x(input : integer) is
begin
```

```
 thousand of line of computation...
end
```

Example 2

```
procedure main is
begin
 x:= read_sensor();
 y:= complete_treatment_based_on_x(x);
end
```

Example 3

```
REGISTER_1: integer;
for REGISTER_1 use at 16#1234abcd#;
procedure main is
begin
 x:= REGISTER_1;
 y:= complete_treatment_based_on_x(x);
end
```

In each example, the `x` variable is a data entry point, and `y` is the consequence of a data entry point. `y` may be formatted data, due to a very complex manipulation of `x`.

Because `x` is volatile, `y` contains all possible formatted data. You can completely remove the procedure `complete_treatment_based_on_x` and let automatic stubbing work. It then assigns a full range of data to `y` directly.

```
-- removed body of complete_treatment_based_on_x
procedure main is
begin
x:= ... -- what ever;
y:= complete_treatment_based_on_x(x); -- now stubbed!
end
```

Results

- (–) A slight loss of precision on `y`. Polyspace considers all possible values for `y`, including the formatted values present at the first verification.
- (+) A huge investigation of the code is not required to isolate a meaningful subset.
- (+) Functional modules are not lost.
- (+) The results are still valid, because you do not have to remove a thread that uses shared data.

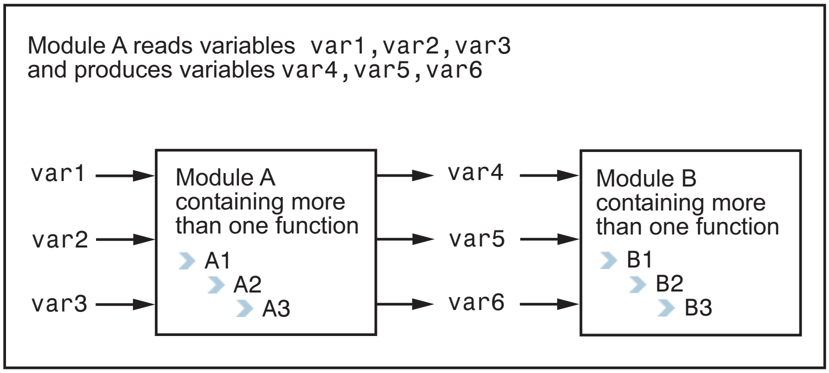
- (+) The complexity of the code is considerably reduced.
- (+) A high precision level (for example, `O2`) can be maintained.

Examples of Removable Components

- **Error management modules**. Contain a large array of structures that are accessed through an API, but return only a Boolean value. By removing the API code and retaining the prototype, the automatically generated stub is assumed to return a value in the range `[-2^31, 2^31-1]`, which includes `1` and `0`. The procedure is considered to return the full range of possible results
- **Buffer management for mailboxes coming from missing code**. Suppose an application reads a huge buffer of 1024 char, and then uses it to populate three small arrays of data, using a very complicated algorithm before passing it to the main module. If the buffer is excluded from the verification and the arrays are initialized with random values instead, the verification of the remaining code is unaffected.

Subdivide According to Data Flow

Consider the following example.


Module A reads variables var1,var2,var3
and produces variables var4,var5,var6
var1
var2
var3
Module A containing more than one function
A1
A2
A3
var4
var5
var6
Module B containing more than one function
B1
B2
B3

In this application, `var1`, `var2`, and `var3` can vary between the following ranges.

`var1`	Between 0 and 10
`var2`	Between 1 and 100
`var3`	Between -10 and 10

Specification of Module A:

Module A consists of an algorithm that interpolates between var1 and var2. That algorithm uses var3 as an exponential factor. When var1 is equal to 0, the result in var4 is also equal to 0.

As a result, var4, var5, and var6 are produced with the following specifications.

Ranges	var4 var5 var6	Between -60 and 110 Between 0 and 12 Between 0 and 100
Properties	A set of properties between variables	For example: • If var2 is equal to 0, then var4 > var5 > 5. • If var3 is greater than 4, then var4 < var5 < 12

Subdivision in accordance with data flow allows modules A and B to be verified separately:

- A uses var1, var2, and var3, initialized respectively to [0;10], [1;100] and [#10;10].
- B uses var4, var5, and var6, initialized respectively to [-60;110], [0;12], and [#10;10].

Results:

- (–) A slight loss of precision on the B module verification, because now the combinations for var4, var5, and var6 are restricted by the A module verification.
- For instance, if the B module included the test:

  ```
  If var2 is equal to 0, then var4 > var5 > 5
  ```

  then the dead code on subsequent else clauses are undetected.
- (+) An in-depth investigation of the code is not required to isolate a meaningful subset.
- (+) The results remain valid, because you do not have to remove a thread that changes shared data.
- (+) The complexity of the code is reduced by a significant factor.

- (+) The maximum precision level can be retained.

Examples of removable components:

- Error management modules. A function `has_an_error_already_occurred` might return `TRUE` or `FALSE`. Such a module may contain a big array of structures that are accessed through an API. The removal of the API code with the retention of the prototype results in the Polyspace verification producing a stub which returns `[-2^31, 2^31-1]`, including 1 and 0. Therefore, the procedure `has_an_error_already_occurred` returns the full range of possible answers, as the code does at execution time.
- Buffer management for mailboxes coming from missing code. Suppose a large buffer of 1024 char is read, and the data is then collated into three small arrays of data using a complicated algorithm. This data is then given to a main module for processing. For the Polyspace Server verification, the buffer can be removed and the three arrays initialized with random values.
- Display modules.

Subdivide According to Real-Time Characteristics

Another way to split an application is to isolate files that contain only a subset of tasks and to verify each subset separately.

If a verification is initiated using only a few tasks, Polyspace Server loses information regarding the interaction between variables.

Suppose an application involves tasks `T1` and `T2`, and a variable `x`.

If `T1` modifies `x`, and `T2` is scheduled to read `x` at a particular moment, subsequent operations in `T2` are impacted by the values of `x`.

As an example, consider that `T1` can write either 10 or 12 into `x` and that `T2` can both write 15 into `x` and read the value of `x`. There are two ways to achieve a sound standalone verification of `T2`:

- `x` can be declared as volatile to take into account all possible executions. Otherwise, `x` takes only its initial value or `x` remains constant, and `T2` verification is a subset of possible execution paths. You might have precise results, but for only one *scenario* among possible states for the variable `x`.
- `x` can be initialized to the whole possible range `[10;15]`, and then the `T2` entry point called.

Subdivide According to Files

Extract a subset of files and perform a verification, in one of three ways:

- Use entry points.
- Create a `main` that calls randomly those functions that are not called by other functions within this subset of code.
- Relaunch your verification using the `-unit-by-unit` option. (For more information, see "Verify files independently".)

When you want to find red errors and bugs in gray code, this method can produce good results.

Benefits of Methods

You might want to split the code:

- To reduce the verification time for a particular precision mode.
- To reduce the number of oranges (for details, see the following sections).

The problems that subdivision may create are:

- Orange checks from a lack of information regarding the relationship between modules, tasks, or variables.
- Orange checks from using too wide a range of values for stubbed functions.

When the Application is Incomplete

When the code consists of a small subset of a larger project, a lot of procedures are automatically stubbed. Automatic stubbing is done according to the specification or prototype of the missing functions. Therefore Polyspace assumes that all possible values for the parameter type can be returned.

Consider two 32-bit integers `a` and `b`, which are initialized with their full range due to missing functions. Here, `a*b` causes an overflow, because `a` and `b` can be equal to 2^31. The number of incidences of these "data set issue" orange checks can be reduced by precise stubbing.

Now consider a procedure `f` that modifies its input parameters `a` and `b`, both of which are passed by reference. Suppose that `a` might be modified to a value between 0 and 10, and b might be modified to a value between -10 and 10. In an automatically stubbed function, the combination a = 10 and b = 10 is possible, even though it might not be possible with the real function. This approach can introduce orange checks in a code snippet such as `1/ (a*b - 100)`, where the division would be orange.

- Even where precise stubbing is used, verifying a small part of an application might introduce extra orange checks. However, the net result from reducing the complexity is to reduce the total number of orange checks.
- When using the default stubbing, the increase in the number of orange checks is more pronounced.

Application Code Size

Polyspace can make approximations when computing the possible values of variables in your code. Such an approximation uses a superset of the actual possible values.

For example, in a relatively small application, the Polyspace Server might retain detailed information about the data at a particular point in the code. For example, the variable VAR can take the values `{ -2 ; 1 ; 2 ; 10 ; 15 ; 16 ; 17 ; 25 }`. If VAR is used to as a divisor, the division is green (because 0 is not a possible value).

If the program being verified is large, the Polyspace Server simplifies the internal data representation using a less precise approximation, such as `[-2 ; 2] U {10} U [15 ; 17] U {25}` . Here, the same division appears as an orange check.

If the complexity of the internal data becomes even greater later on in the verification, the Polyspace Server might further simplify the VAR range to `[-2 ; 25]`.

When the size of the program becomes large, this phenomenon leads to the increase of the number of orange warnings.

Note: The amount of simplification applied to the data representations also depends on the required precision level (O0, O2). The Polyspace Server adjusts the level of simplification, for example:

- `-O0` — Shorter computation time
- `-O1` — Fewer orange warnings
- `-O2` — Default and high-precision results
- `-O3` — Fewer orange warnings and longer computation time

Obtaining Configuration Information

Use the `polyspace-ver` command to quickly gather information about your system configuration. You require this information when entering support requests.

Configuration information includes:

- Hardware configuration
- Operating system
- Polyspace licenses
- Specific version numbers for Polyspace products
- Installed Bug Report patches

To obtain configuration information, use the following command:

```
Polyspace_Install/polyspace/bin/polyspace-ver
```

Note: You can obtain the same configuration information by selecting **Help** > **About** in the Polyspace verification environment.

Storage of Temporary Files

If you specify the option `-tmp-dir-in-results-dir`, Polyspace does not use the standard `/tmp` or `C:\Temp` folder to store temporary files. Instead, Polyspace uses a subfolder of the results folder. If the results folder is mounted on a network drive, this action can increase verification time. Use this option only when the temporary folder partition is not large enough and you need to troubleshoot.

You can specify `-tmp-dir-in-results-dir` through a line command or the **Configuration** > **Advanced Settings** > **Extra Settings** field.

Disk Defragmentation and Antivirus Software

If a disk defragmentation tool or antivirus software runs on the machine on which your client or server verification is running, the verification might fail, generating an error message like the following:

```
Some stats on aliases use:
  Number of alias writes:      22968
  Number of must-alias writes: 3090
  Number of alias reads:       0
  Number of invisibles:        949
Stats about alias writes:
  biggest sets of alias writes: foo1:a (733), foo2:x (728), foo1:b (728)
  procedures that write the biggest sets of aliases: foo1 (2679), foo2 (2266), foo3 (12
**** C to intermediate language translation - 17 (P_PT) took 44real, 44u + 0s (1.4gc)
exception SysErr(OS.SysErr(name="Directory not empty", syserror=notempty)) raised.
unhandled exception: SysErr: No such file or directory [noent]


--------------------------------------------------------------------------
---                                                                    ---
---  Verifier has encountered an internal error.      ---
---  Please contact your technical support.          ---
---                                                                    ---
---------------------------------------------------------------------------
```

On your machine, you must do the following:

- Stop the disk defragmentation tool.
- Deactivate the antivirus software, or configure exception rules for the antivirus software that allow Polyspace to run without failure.

Out-of-Memory Errors During Report Generation

During generation of very large reports, the software might produce errors that indicate insufficient memory. For example:

```
....
Exporting views...
Initializing...
Polyspace Report Generator
Generating Report
 .....
    Converting report
Opening log file:  C:\Users\auser\AppData\Local\Temp\java.log.7512
Document conversion failed
.....
Java exception occurred:
java.lang.OutOfMemoryError: Java heap space
```

To increase the Java® heap size, modify the `-Mx` option in the *`Polyspace_Install`*`\polyspace\bin\`*`architecture`*`\java.opts` file. By default, the heap size is set to 512 MB. For 32-bit machines, you can increase the size to 1 GB. For 64-bit machines, you can specify a higher value, for example, 2 GB.

Reviewing Verification Results

Before You Review Polyspace Results

In this section...

Overview: Understanding Polyspace Results

Polyspace software presents verification results as colored entries in the source code. There are four main colors in the results:

- **Red** – Indicates code proven to contain an error
- **Gray** – Indicates unreachable code (dead code).
- **Orange** – Indicates unproven code (code might have a run-time error).
- **Green** – Indicates code proven not to have a run-time error

When reviewing verification results, remember these rules:

- An instruction is verified only if no run-time error is proven to occur in the previous instruction.
- The verification assumes that each run-time error causes a "core dump". The corresponding instruction is considered to have stopped, even if the actual run-time execution of the code might not stop. With orange checks, only the green parts propagate through to subsequent checks.
- Focus on the message produced by the verification, and do not jump to false conclusions. You must understand the color of a check step by step, until you find the root cause of the issue.
- Determine the cause by examining the actual code. Do not focus on what the code is supposed to do.

Color Sequence of Checks

Consider each line of the procedure `red`, which shows what happens after a **red** check.

```
procedure red is
```

```
X: integer;
begin
X:= 1 / X;
X:= X + 1;
end;
```

When Polyspace divides by `X`, `X` is not initialized. Therefore, the software generates a **red** NIV check for the non-initialized variable `X`. Execution paths following this statement are stopped. Checks are not generated for the statement `X:= X + 1;`

Now consider the procedure `propagate`, which shows how **green** checks propagate out of **orange** checks.

```
function read_an_input return integer;
procedure propagate is
X: Integer;
Y: array (0..99) of Integer;;
begin
X:= read_an_input;
Y(X):= 0;
Y(X):= 0;
end main;
```

For the `propagate` procedure:

- `X` is assigned the value of `read_an_input`. After this assignment, `X = [-2^31, 2^31-1]`.
- At the first array access, an "out of bounds" error is possible because `X` can be equal to, for example, -3 as well as 3.
- The conditions leading to a run-time error are truncated. They are not considered further in the verification. On the following line, the executions for which `X = [-2^31, -1]` and `[100, 2^31-1]` are stopped.
- At the next instruction, `X = [0, 99]`.
- At the second array access, the check is green because `X = [0, 99]`.

Summary

Green checks can propagate out of orange checks.

Note: Through manual stubbing and by using `assert`, you can use value propagation to restrict input values for data.

See "Using Pragma Assert to Set Data Ranges".

Understanding Polyspace Code Analysis

Polyspace software numbers checks to correspond to the code execution order.

Consider the instruction `x := x + 1;` .

The verification first checks for a potential NIV (Non Initialized Variable) for x, and then checks the potential overflow (OVFL). This action mimics the actual execution sequence.

Understanding these sequences can help you to understand the message presented by the verification and the implications for the code.

Consider an orange NIV on `x` in the test:

```
if ( x > 101)
```

You might conclude that the verification does not keep track of the value of x. However, consider the context in which the check is made:

```
function Read_An_Input return integer;
procedure Main is
 X: Integer;
begin
 if (Read_An_input) then
  X := 100;
 end if;
 if (X > 101) then -- [orange on NIV : non initialised variable]
  X : = X + 1; -- gray code
 end if;
end Main;
```

Explanation

When you click the check in the Results Manager perspective, you see the category of the check. Here, the category is NIV. However, Polyspace might verify subsequent lines of code, and continue the verification as if initialization has taken place.

The analysis of this result might be that if X has been initialized, the only possible value for X is { 100 }, which is not greater than 101, so the rest of the code is gray.

Summary

- **FALSE**: `if "( x > 101)"` means: Polyspace does not know anything.
- **TRUE**: `if "( x > 101)"` means: Polyspace does not know if X has been initialized.

The Code Explanation

Verification results depend entirely on the code that you are verifying. When interpreting the results, do not consider:

- Physical actions from the environment in which the code operates.
- Configuration options that are not part of the verification.

Consider the following example, paying particular attention to the dead (gray) code following the "if" statement:

```
function Read_An_Input return integer;
procedure Main is
X: Integer;
Y: array (0..99) of Integer;
begin
X := Read_An_input;
Y(X) := 0; -- [array index may be without its bounds] [x is
initialized]
Y(X-1):= (1 / X) + X ; [array index is within its bounds]
if (X = 0) then
Y(X) := 1; -- this line is unreachable
end if;
end Main;
```

You can see that:

- The line containing the access to the `Y` array is unreachable.
- The line is unreachable only if the test for `x = 0` is always false.
- You can conclude that the test is false because the input data is not equal to 0. However, `Read_An_Input` can represent a value in the full integer range, so this is not the correct explanation.

Instead, consider the execution path leading to the gray code:

- The orange check on the array access (y[x]) truncates execution paths leading to a run-time error, meaning that subsequent lines deal with only x = [0, 99].
- The orange check on the division also truncates execution paths that lead to a run-time error, so instances where x = 0 are also stopped. Therefore, for the code execution path after the orange division sign, `x = [1; 99]`.
- x is not equal to 0 at this line. The array access is green (y (x – 1).

Summary

In this example, the statements are located in the same procedure. However, by using the call tree, you can follow the same process even if an orange check results at the end of a long call sequence. Follow the "called by" call tree, and concentrate on explaining the issues by reference to the code alone.

Opening Verification Results

In this section...

Downloading Results from Server to Client

When you run a verification on a Polyspace server, the Polyspace software automatically downloads the results to the client system that launched the verification. In addition, the results are stored on the Polyspace server. You can then download the results from the server to other client systems.

Note: If you download results before the verification is complete, you get partial results and the verification continues.

To download verification results to your client system:

1 Select **Tools** > **Open Job Monitor**.

The Polyspace Job Monitor opens.

2 Right-click the job that you want to view. From the context menu, select **Download Results** .

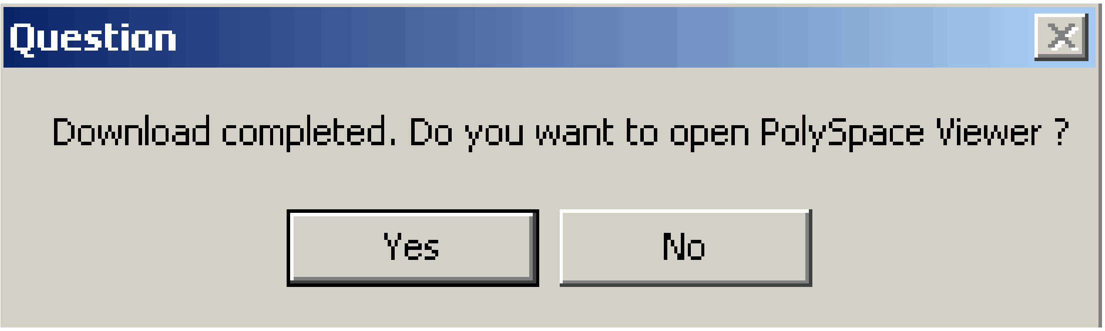
Note: After downloading your results, remove the job from the queue. From the context menu, select **Download Results And Remove From Queue**.

The Save dialog box opens.

3 Select the folder into which you want to download results.

4 Click **OK** to download the results and close the dialog box.

When the download is complete, the following dialog box opens.



Download completed. Do you want to open PolySpace Viewer ?

5 Click **Yes** to open the results.

Once you download results, they remain on the client, and you can review them later using the Polyspace verification environment.

Downloading Server Results Using the Command Line

You can download verification results at the command line using the `psqueue-download` command.

To download your results, enter the following command:

```
<PolyspaceCommonDir>/RemoteLauncher/bin/psqueue-download <id>
<results dir>
```

The verification `<id>` is downloaded into the results folder `<results dir>`.

Note: If you download results before the verification is complete, you get partial results and the verification continues.

Once you download results, they remain on the client, and you can review them later using the Polyspace Results Manager perspective.

The `psqueue-download` command has the following options:

- `[-f]` force download (without interactivity)
- `-admin -p <password>` allows administrator to download results.
- `[-server <name>[:port]]` selects a specific Queue Manager.
- `[-v|version]` gives the release number.

Note: When downloading a unit-by-unit verification group, all the unit results are downloaded and a summary of the download status for each unit is displayed.

For more information on managing verification jobs from the command line, see "Managing Batch Verifications".

Downloading Results from Unit-by-Unit Verifications

If you run a unit-by-unit verification, each source file is sent to the Polyspace Server individually. The Job Monitor displays a job for the full verification group, as well as jobs for each unit (using a tree structure).

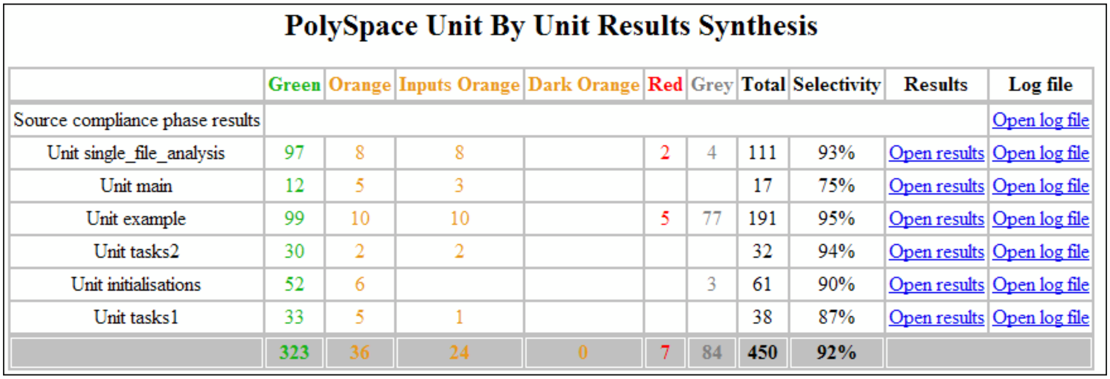
You can download and view verification results for the entire project or for individual units.

To download the results from unit-by-unit verifications:

- To download results for an individual unit, right-click the job for that unit, then select **Download Results**.

  The individual results are downloaded and can be viewed just like other verification results.
- To download results for a verification group, right-click the group job, and then select **Download Results.**

  The results for all unit verifications are downloaded, as well as an HTML summary of results for the entire verification group.



PolySpace Unit By Unit Results Synthesis

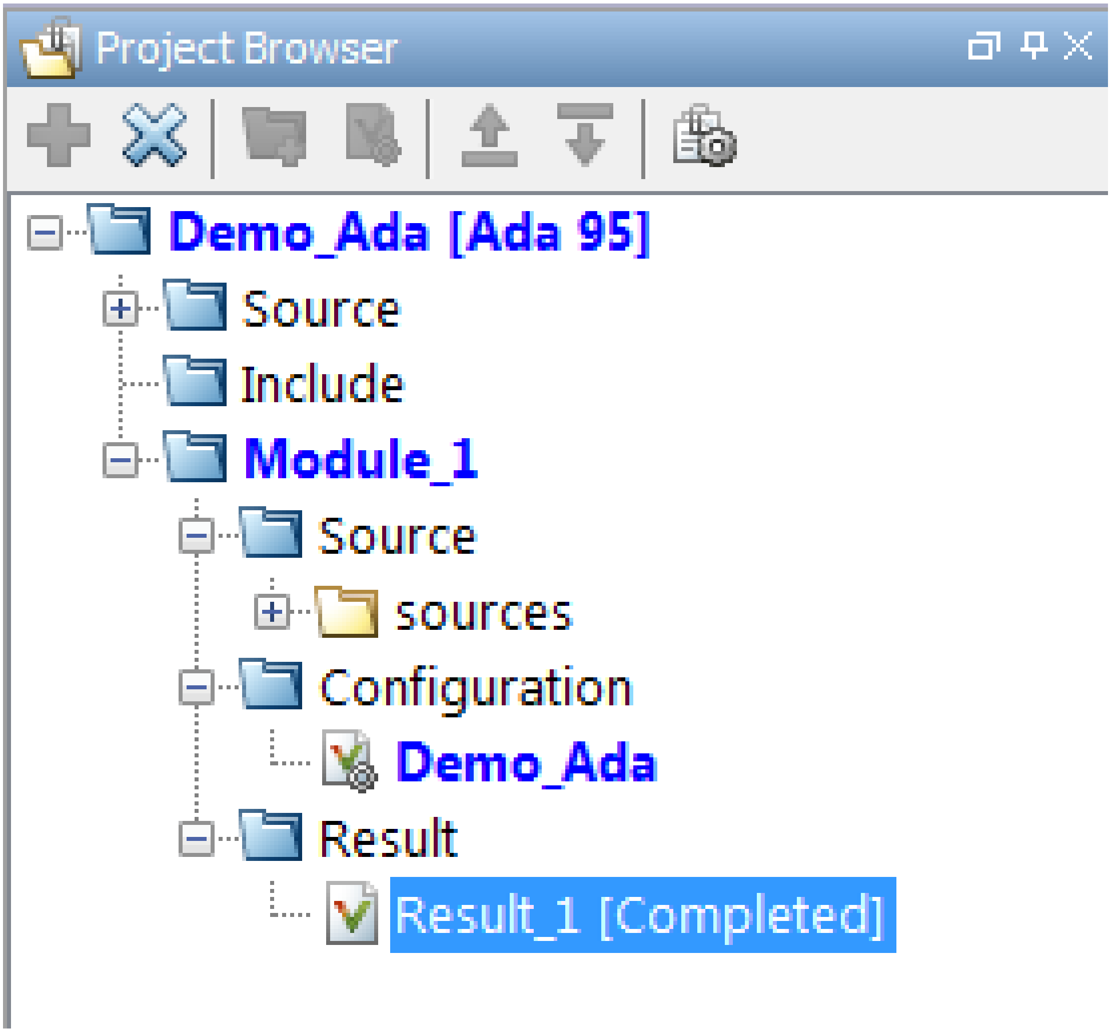
	Green	Orange	Inputs Orange	Dark Orange	Red	Grey	Total	Selectivity	Results	Log file
Source compliance phase results										Open log file
Unit single_file_analysis	97	8	8		2	4	111	93%	Open results	Open log file
Unit main	12	5	3				17	75%	Open results	Open log file
Unit example	99	10	10		5	77	191	95%	Open results	Open log file
Unit tasks2	30	2	2				32	94%	Open results	Open log file
Unit initialisations	52	6				3	61	90%	Open results	Open log file
Unit tasks1	33	5	1				38	87%	Open results	Open log file
	323	36	24	0	7	84	450	92%		

Opening Verification Results from Project Manager Perspective

You can open verification results directly from the **Project Browser** in the Project Manager perspective. Because each Polyspace project can contain multiple verifications, the **Project Browser** allows you to quickly identify and open the results that you want to review.

To open verification results from the Project Manager:

1. Open the project containing the results that you want to review.
2. In the **Project Browser** tree, navigate to the results that you want to review.



3 Double-click the results file.

The results open in the Results Manager perspective.

Opening Verification Results from Results Manager Perspective

Use the Results Manager perspective to review verification results. If you know the location of the results file that you want to review, you can open the file directly from the Results Manager perspective.

Note: You can also browse and open results from the **Project Browser** in the Project Manager perspective.

To open verification results from the Results Manager perspective:

1 Select **File** > **Open Result**

  The Open results dialog box opens.

2 Select the results file that you want to view.

3 Click **Open**.

  The results open in the Results Manager perspective.

Search Results in Results Manager

This example shows how to search for occurrences of a variable or function name in the Results Manager perspective. Search for the variable or function name in the following situations:

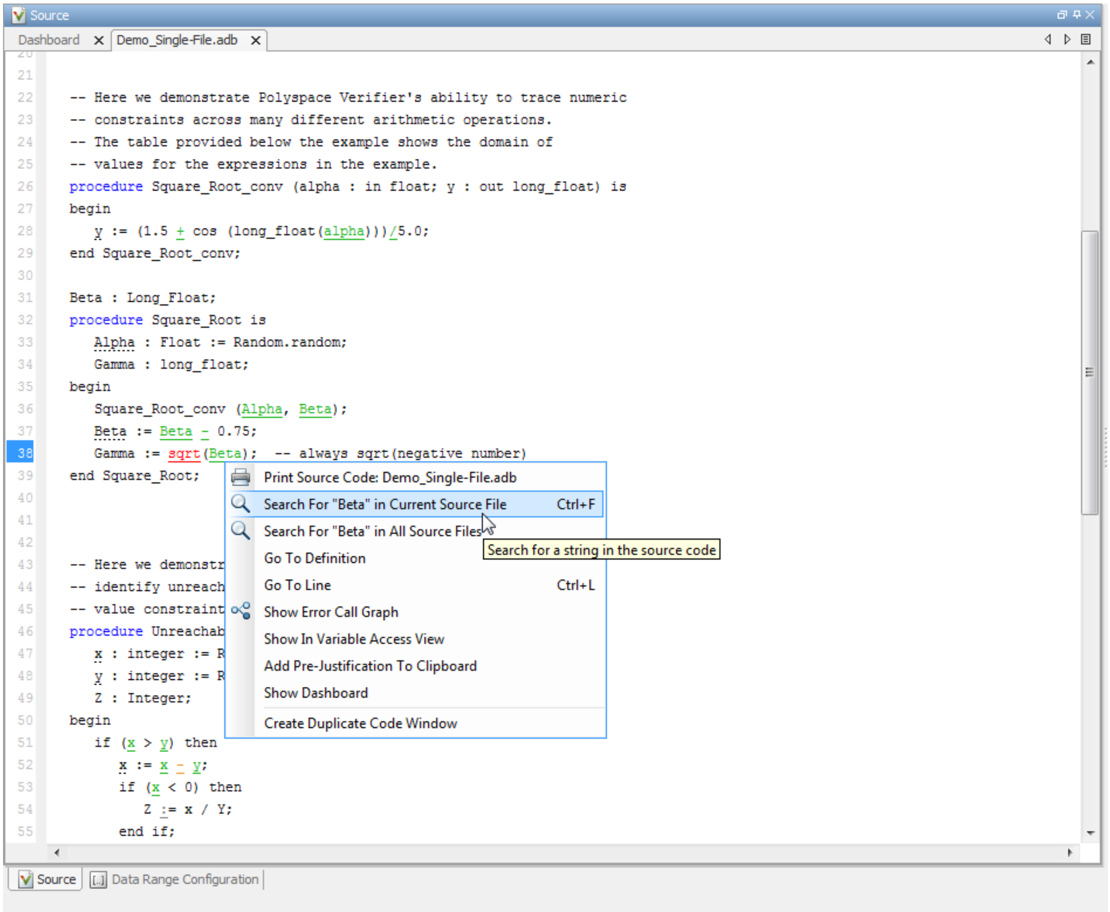
- A read/write operation on a variable causes a check. However, the check might be related to an instruction prior to this read/write operation.

  Selecting a check in the **Results Summary** pane displays the read/write operation only. On the **Source** pane, you can look in the source code for prior instructions containing the variable name. Instead, searching for the occurrences is an easier way to find and quickly navigate to them.

  For instance, consider the check, `Out of bounds array index`. Though an access operation on the array causes the check, it is useful to quickly navigate to the array declaration.
- A function call causes a check. However, the check might be related to an instruction in the function definition. Therefore, it is useful to quickly navigate to the function definition.

Search Variable Name

1 Enter the variable name in the Search box in the Results Manager perspective toolbar. Alternatively, on the **Source** pane, right-click the variable name and select **Search “*`variable_name`*” In All Source Files**.

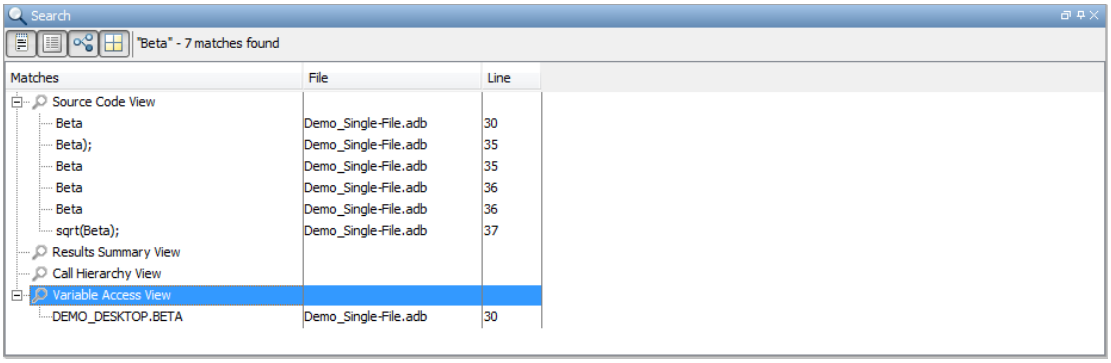

Source
Dashboard
Demo_Single-File.adb
Print Source Code: Demo_Single-File.adb
Search For "Beta" in Current Source File Ctrl+F
Search For "Beta" in All Source Files
Search for a string in the source code
Go To Definition
Go To Line Ctrl+L
Show Error Call Graph
Show In Variable Access View
Add Pre-Justification To Clipboard
Show Dashboard
Create Duplicate Code Window
Source
Data Range Configuration

```
-- Here we demonstrate Polyspace Verifier's ability to trace numeric
-- constraints across many different arithmetic operations.
-- The table provided below the example shows the domain of
-- values for the expressions in the example.
procedure Square_Root_conv (alpha : in float; y : out long_float) is
begin
   y := (1.5 + cos (long_float(alpha)))/5.0;
end Square_Root_conv;

Beta : Long_Float;
procedure Square_Root is
   Alpha : Float := Random.random;
   Gamma : long_float;
begin
   Square_Root_conv (Alpha, Beta);
   Beta := Beta - 0.75;
   Gamma := sqrt(Beta);  -- always sqrt(negative number)
end Square_Root;



-- Here we demonstr
-- identify unreach
-- value constraint
procedure Unreachab
   x : integer := R
   y : integer := R
   Z : Integer;
begin
   if (x > y) then
      x := x - y;
      if (x < 0) then
         Z := x / Y;
      end if;
```

The **Search** tab displays occurrences of the variable name under four categories.

2 To see occurrences of the variable name in the source code, expand the node **Source Code View**.

This node lists each occurrence of the variable name along with the file name and the line number. Use the file name and line number to navigate to the source code line where the variable appears.



"Beta" - 7 matches found

Matches	File	Line
Source Code View		
Beta	Demo_Single-File.adb	30
Beta);	Demo_Single-File.adb	35
Beta	Demo_Single-File.adb	35
Beta	Demo_Single-File.adb	36
Beta	Demo_Single-File.adb	36
sqrt(Beta);	Demo_Single-File.adb	37
Results Summary View		
Call Hierarchy View		
Variable Access View		
DEMO_DESKTOP.BETA	Demo_Single-File.adb	30

3 To navigate to a particular occurrence of the variable name in the source code, use the up and down arrow keys.

The **Source** pane displays the corresponding line of code.

4 If the variable is a global variable, to navigate to its declaration quickly, expand the node **Variable Access View**. Select the only search result under this node.

Search Procedure Name

1 Enter the procedure name in the Search box in the Results Manager perspective toolbar. Alternatively, on the **Source** pane, right-click the procedure name and select **Search "*`procedure_name`*" In All Source Files**.

The **Search** tab displays occurrences of the procedure name under four categories.

2 To see occurrences of the procedure name in the source code, expand the node **Source Code View**.

This node lists each occurrence of the procedure name along with the file name and the line number.

3 To navigate to a particular occurrence of the procedure name in the source code, use the up and down arrow keys.

The **Source** pane displays the corresponding line of code.

4 To navigate to the procedure definition quickly:

a On the **Results Summary** pane, select `Checks by File/Function` from the drop-down list.

The **Results Summary** pane displays the source file names in alphabetical order. Under each file name, the pane displays the procedure names in alphabetical order.

b Select the name of the procedure.

The **Source** pane displays the procedure definition.

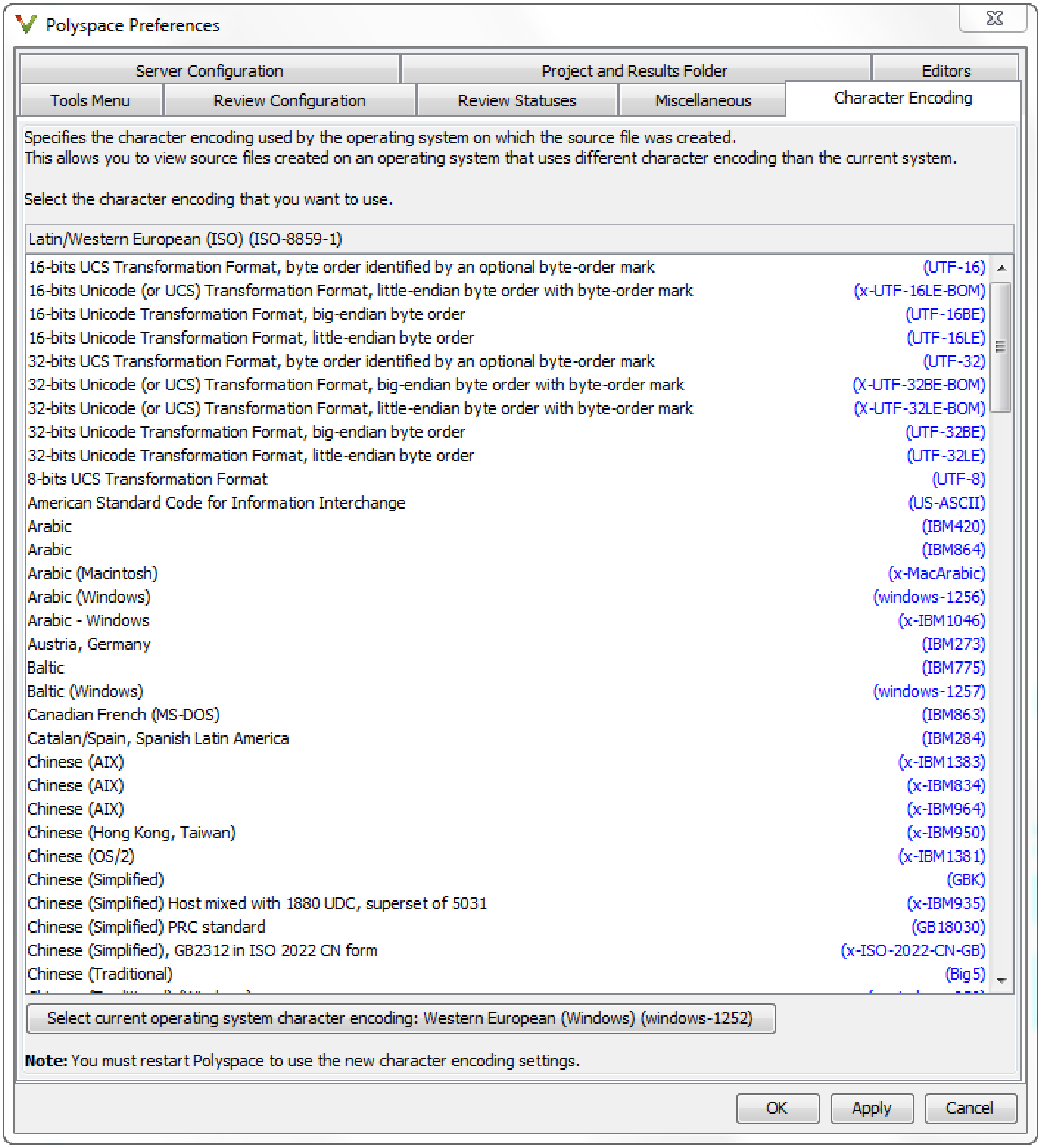
Set Character Encoding Preferences

If the source files that you want to verify are created on an operating system that uses different character encoding than your current system (for example, when viewing files containing Japanese characters), you receive an error message when you view the source file or run certain macros.

The **Character encoding** option allows you to view source files created on an operating system that uses different character encoding than your current system.

To set the character encoding for a source file:

1. Select **Tools** > **Preferences**.
2. In the Polyspace Preferences dialog box, select the **Character encoding** tab.



Specifies the character encoding used by the operating system on which the source file was created.
This allows you to view source files created on an operating system that uses different character encoding than the current system.

Select the character encoding that you want to use.

Latin/Western European (ISO) (ISO-8859-1)

16-bits UCS Transformation Format, byte order identified by an optional byte-order mark	(UTF-16)
16-bits Unicode (or UCS) Transformation Format, little-endian byte order with byte-order mark	(x-UTF-16LE-BOM)
16-bits Unicode Transformation Format, big-endian byte order	(UTF-16BE)
16-bits Unicode Transformation Format, little-endian byte order	(UTF-16LE)
32-bits UCS Transformation Format, byte order identified by an optional byte-order mark	(UTF-32)
32-bits Unicode (or UCS) Transformation Format, big-endian byte order with byte-order mark	(X-UTF-32BE-BOM)
32-bits Unicode (or UCS) Transformation Format, little-endian byte order with byte-order mark	(X-UTF-32LE-BOM)
32-bits Unicode Transformation Format, big-endian byte order	(UTF-32BE)
32-bits Unicode Transformation Format, little-endian byte order	(UTF-32LE)
8-bits UCS Transformation Format	(UTF-8)
American Standard Code for Information Interchange	(US-ASCII)
Arabic	(IBM420)
Arabic	(IBM864)
Arabic (Macintosh)	(x-MacArabic)
Arabic (Windows)	(windows-1256)
Arabic - Windows	(x-IBM1046)
Austria, Germany	(IBM273)
Baltic	(IBM775)
Baltic (Windows)	(windows-1257)
Canadian French (MS-DOS)	(IBM863)
Catalan/Spain, Spanish Latin America	(IBM284)
Chinese (AIX)	(x-IBM1383)
Chinese (AIX)	(x-IBM834)
Chinese (AIX)	(x-IBM964)
Chinese (Hong Kong, Taiwan)	(x-IBM950)
Chinese (OS/2)	(x-IBM1381)
Chinese (Simplified)	(GBK)
Chinese (Simplified) Host mixed with 1880 UDC, superset of 5031	(x-IBM935)
Chinese (Simplified) PRC standard	(GB18030)
Chinese (Simplified), GB2312 in ISO 2022 CN form	(x-ISO-2022-CN-GB)
Chinese (Traditional)	(Big5)

Select current operating system character encoding: Western European (Windows) (windows-1252)

Note: You must restart Polyspace to use the new character encoding settings.

3. Select the character encoding used by the operating system on which the source file was created.
4. Click **OK**.
5. Close and restart the Polyspace verification environment to use the new character encoding settings.

Review Checks Progressively

This example shows how to review checks progressively using the Results Manager perspective.

Review Results

1. Select the first check on the **Results Summary** pane.
   - The **Source** pane displays the source code for this check.
   - The **Check Details** pane displays information about this check.
2. Review the check. For more information, see “Assign Review Status to Result”.
3. Click the forward arrow ⇨ to go to the next check in the set. Review this check.
4. Continue to click the forward arrow until you have reviewed through all of the checks.

Track Review Progress

1. To see what percentage of checks you have reviewed, broken down by color and type:
   a. On the **Results Summary** pane, select **Group by** > **Family**.
   b. For each color and type, view the entries in the **Justified** column.
2. To see what percentage of checks you have reviewed, broken down by file and function:
   a. On the **Results Summary** pane, select **Group by** > **File**.
   b. For each file and function, view the entries in the **Justified** column.

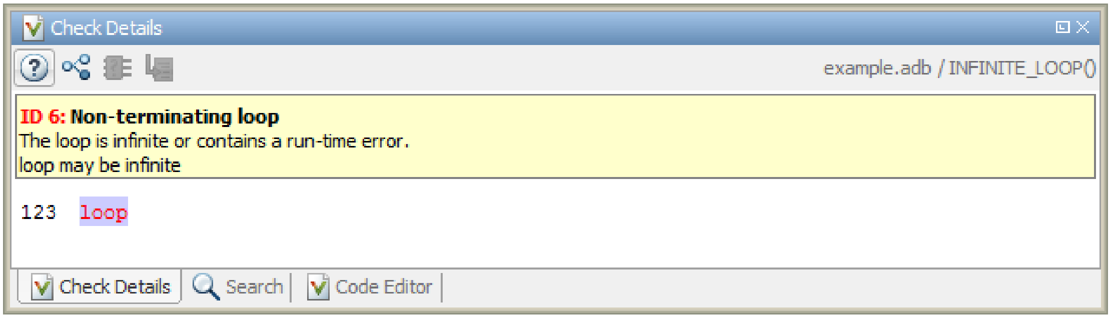
Assign Review Status to Result

This example shows how to review and comment checks using the Results Manager perspective. When reviewing checks, you can assign a status to checks, and enter comments to describe the results of your review. These actions help you to track the progress of your review and avoid reviewing the same check twice.

Review Individual Check

1 On the **Results Summary** pane, select the check that you want to review.

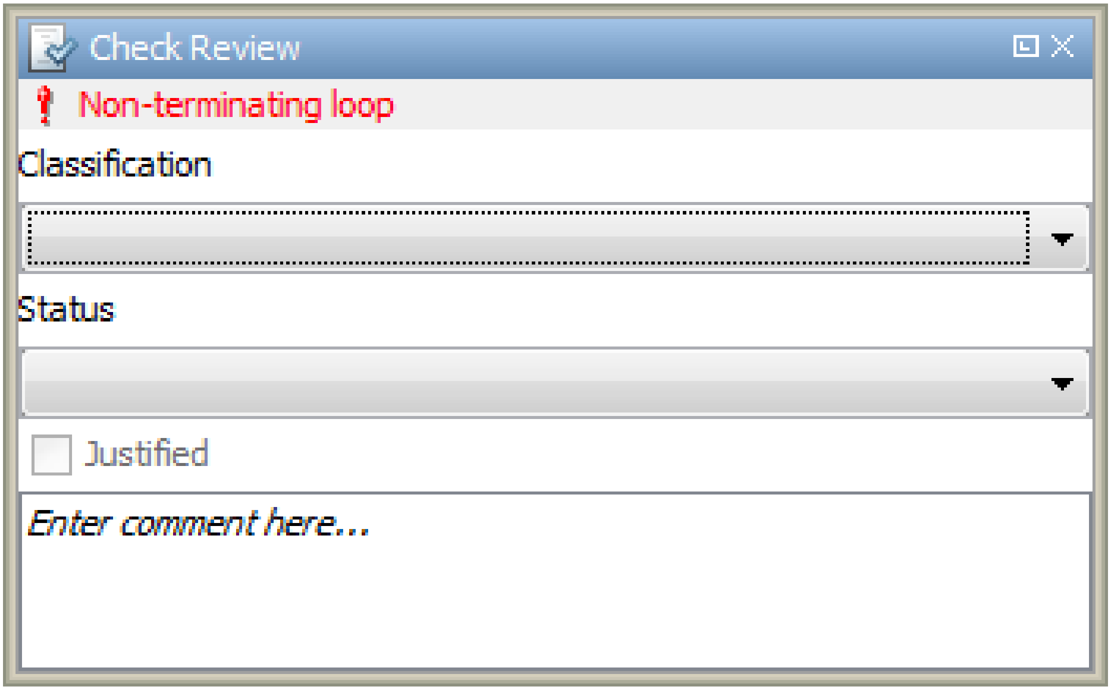
The **Check Details** pane displays information about the current check.



ID 6: Non-terminating loop
The loop is infinite or contains a run-time error.
loop may be infinite

```
123  loop
```

The **Check Review** pane displays fields where you can enter review information.



Check Review

Non-terminating loop

Classification

Status

□ Justified

Enter comment here...

2 Select a **Classification** to describe the severity of the issue:

- `Unset`
- `High`
- `Medium`
- `Low`
- `Not a defect`

3 Select a **Status** to describe how you intend to address the issue:

- `Fix`
- `Improve`
- `Investigate`
- `Justify with annotations`
- `No action planned`

- `Other`
- `Restart with different options`
- `Undecided`

4 To justify the check, select one of the **Status** options, `Justify with annotations` or `No action planned`.

To view the percentage of checks justified per file and function:

a On the **Results Summary** pane, select **Group by** > **File**.

b View the entries on the **Justified** column.

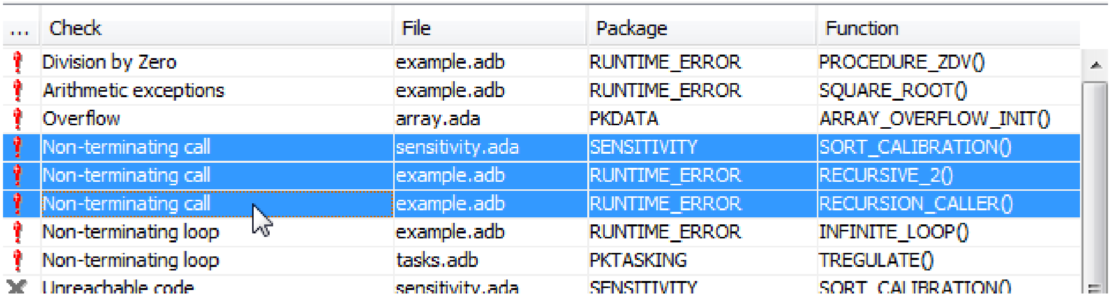
5 In the **Comment** field, enter remarks, for example, defect or justification information.

Note: You can also enter the review information through the **Classification**, **Status**, and **Comment** fields on the **Results Summary** pane.

Review Group of Checks

1 On the **Results Summary** pane, select a group of checks using one of the following methods:

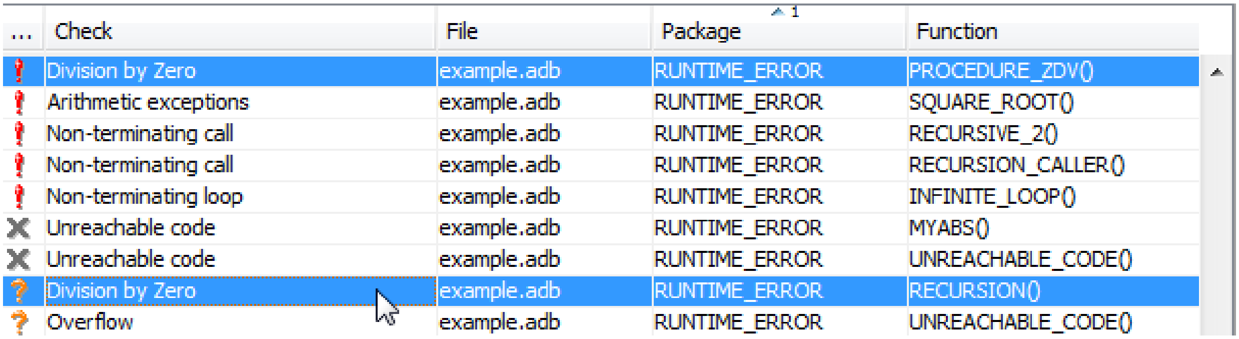
- For contiguous checks, left-click the first check. Then **Shift**-left click the last check.



...	Check	File	Package	Function
!	Division by Zero	example.adb	RUNTIME_ERROR	PROCEDURE_ZDV()
!	Arithmetic exceptions	example.adb	RUNTIME_ERROR	SQUARE_ROOT()
!	Overflow	array.ada	PKDATA	ARRAY_OVERFLOW_INIT()
!	Non-terminating call	sensitivity.ada	SENSITIVITY	SORT_CALIBRATION()
!	Non-terminating call	example.adb	RUNTIME_ERROR	RECURSIVE_2()
!	Non-terminating call	example.adb	RUNTIME_ERROR	RECURSION_CALLER()
!	Non-terminating loop	example.adb	RUNTIME_ERROR	INFINITE_LOOP()
!	Non-terminating loop	tasks.adb	PKTASKING	TREGULATE()
✗	Unreachable code	sensitivity.ada	SENSITIVITY	SORT_CALIBRATION()

To group together checks belonging to a certain category, click the **Check** column header on the **Results Summary** pane.

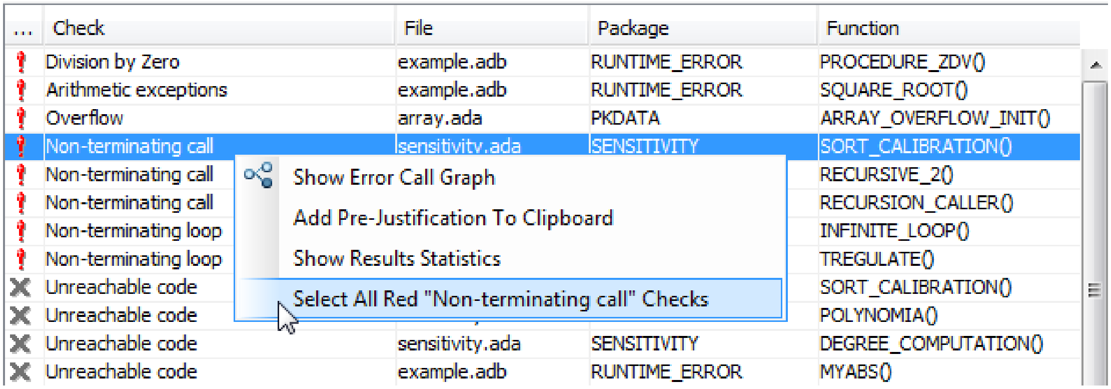
- For non-contiguous checks, **Ctrl**-left click each check.



...	Check	File	Package	Function
!	Division by Zero	example.adb	RUNTIME_ERROR	PROCEDURE_ZDV()
!	Arithmetic exceptions	example.adb	RUNTIME_ERROR	SQUARE_ROOT()
!	Non-terminating call	example.adb	RUNTIME_ERROR	RECURSIVE_2()
!	Non-terminating call	example.adb	RUNTIME_ERROR	RECURSION_CALLER()
!	Non-terminating loop	example.adb	RUNTIME_ERROR	INFINITE_LOOP()
✕	Unreachable code	example.adb	RUNTIME_ERROR	MYABS()
✕	Unreachable code	example.adb	RUNTIME_ERROR	UNREACHABLE_CODE()
?	Division by Zero	example.adb	RUNTIME_ERROR	RECURSION()
?	Overflow	example.adb	RUNTIME_ERROR	UNREACHABLE_CODE()

- For checks of a similar color and category, right-click one check. From the context menu, select **Select All *`Color Type`*Checks**

  For instance, select **Select All Red "Non-terminating call" Checks**.



...	Check	File	Package	Function
!	Division by Zero	example.adb	RUNTIME_ERROR	PROCEDURE_ZDV()
!	Arithmetic exceptions	example.adb	RUNTIME_ERROR	SQUARE_ROOT()
!	Overflow	array.ada	PKDATA	ARRAY_OVERFLOW_INIT()
!	Non-terminating call	sensitivity.ada	SENSITIVITY	SORT_CALIBRATION()
!	Non-terminating call			RECURSIVE_2()
!	Non-terminating call			RECURSION_CALLER()
!	Non-terminating loop			INFINITE_LOOP()
!	Non-terminating loop			TREGULATE()
✕	Unreachable code			SORT_CALIBRATION()
✕	Unreachable code			POLYNOMIA()
✕	Unreachable code	sensitivity.ada	SENSITIVITY	DEGREE_COMPUTATION()
✕	Unreachable code	example.adb	RUNTIME_ERROR	MYABS()

Show Error Call Graph
Add Pre-Justification To Clipboard
Show Results Statistics
Select All Red "Non-terminating call" Checks

2 On the **Check Review** tab, enter the required information. The software applies this information to the selected checks.

Save Review Comments

After you have reviewed your results, save your comments with the verification results. Saving your comments makes them available the next time that you open the results file, allowing you to avoid reviewing the same check twice.

To save your review comments, select **File** > **Save**. Your comments are saved with the verification results.

Track Review Progress

1. To see what percentage of checks you have reviewed, broken down by color and type:

   a. On the **Results Summary** pane, select **Group by** > **Family**.

   b. For each color and type, view the entries in the **Justified** column.

2. To see what percentage of checks you have reviewed, broken down by file and function:

   a. On the **Results Summary** pane, select **Group by** > **File**.

   b. For each file and function, view the entries in the **Justified** column.

Organize Check Review Using Filters and Groups

This example shows how to filter and group checks on the **Results Summary** pane. To organize your review of checks, use filters and groups when you want to:

- Review certain categories of checks in preference to others. For instance, you first want to address only the `Non-terminating loop` checks.
- Not address the full set of coding rule violations detected by the coding rules checker.
- Not review checks you have already justified.

  Typically, in your second or later rounds of review, you would have some checks already justified.
- Review only those checks that you have already assigned a certain status. For instance, you want to review only those checks to which you have assigned the status, `Investigate`.
- Review all checks in the body of a particular file or function. Because of continuity of code, reviewing these checks together can help you organize your review process.

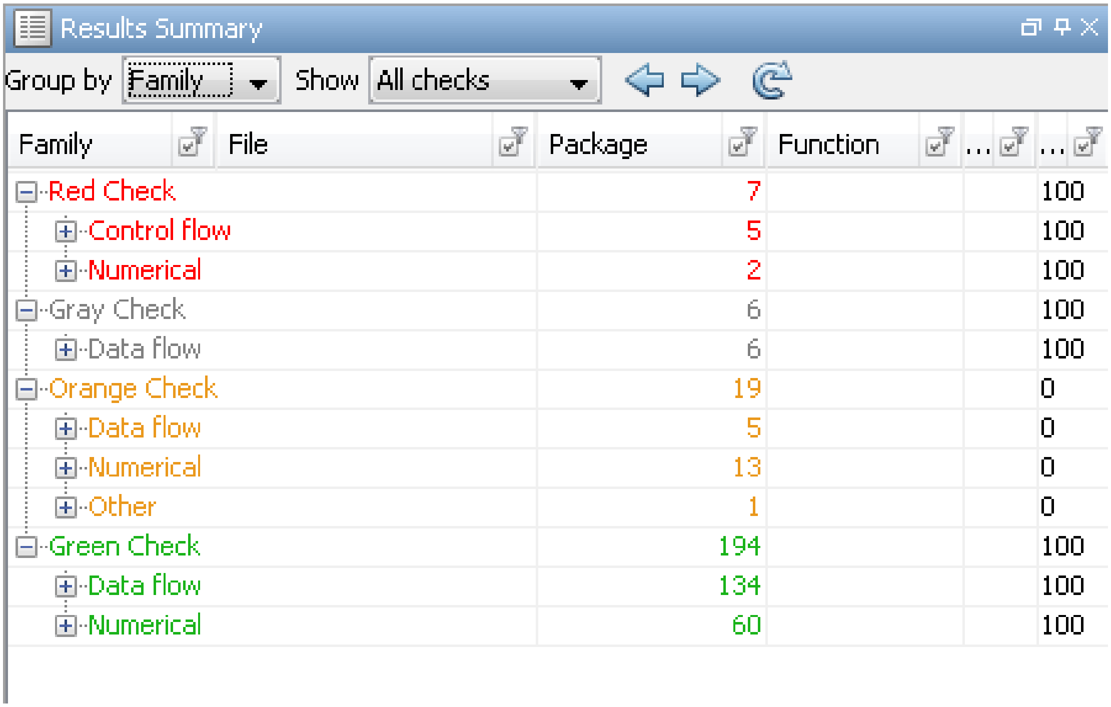
  You can also review the checks in one file alone if you have written the code for that file only and not the entire set of source files used for verification.
- Not review the checks in automatically generated functions.

Review Checks in a Given Category

To review only the `Non-terminating loop` checks:

1. Open the results file, with extension, `.rte`.
2. On the **Results Summary** pane, select **Group by** > **Family**.

   The checks are grouped by type of check.



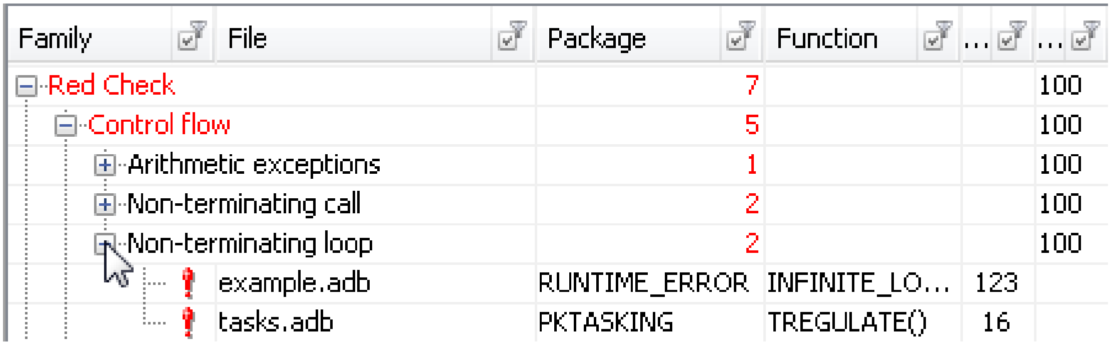
Results Summary

Group by Family Show All checks

Family	File	Package	Function	...	...
⊟ Red Check		7			100
⊞ Control flow		5			100
⊞ Numerical		2			100
⊟ Gray Check		6			100
⊞ Data flow		6			100
⊟ Orange Check		19			0
⊞ Data flow		5			0
⊞ Numerical		13			0
⊞ Other		1			0
⊟ Green Check		194			100
⊞ Data flow		134			100
⊞ Numerical		60			100

3 Under the category **Red Check**, expand the subcategory **Control flow**.

You see the subcategory **Non-terminating loop**.

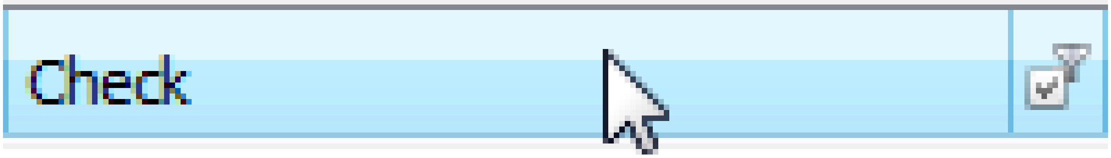


Family	File	Package	Function	...	...
⊟ Red Check		7			100
⊟ Control flow		5			100
⊞ Arithmetic exceptions		1			100
⊞ Non-terminating call		2			100
⊟ Non-terminating loop		2			100
	example.adb	RUNTIME_ERROR	INFINITE_LO...	123	
	tasks.adb	PKTASKING	TREGULATE()	16	

Expand **Non-terminating loop** to view all red checks of this type.

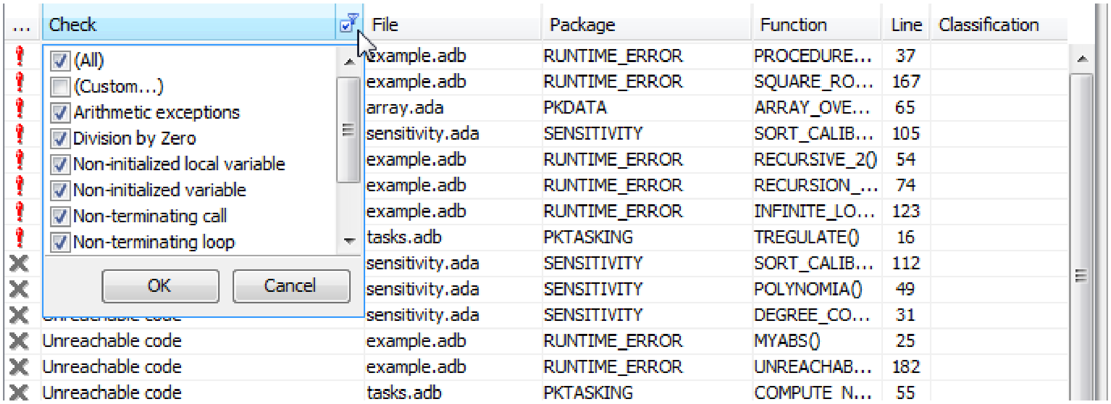
To see further information about a check, select it. The information appears on the **Check Details** pane.

4. To view only the orange checks resulting from this error, repeat step 3 for the subcategory **Control flow** under the category **Orange Check**.
5. To view only the checks resulting from the error, `Non-terminating loop`, on the **Results Summary** pane, from the drop-down list, select `List of Checks`.
6. Place your cursor on the **Check** column head.



7. Click the filter icon.

A context menu lists the filter options available.



...	Check	File	Package	Function	Line	Classification
!		example.adb	RUNTIME_ERROR	PROCEDURE...	37	
!		example.adb	RUNTIME_ERROR	SQUARE_RO...	167	
!		array.ada	PKDATA	ARRAY_OVE...	65	
!		sensitivity.ada	SENSITIVITY	SORT_CALIB...	105	
!		example.adb	RUNTIME_ERROR	RECURSIVE_2()	54	
!		example.adb	RUNTIME_ERROR	RECURSION_...	74	
!		example.adb	RUNTIME_ERROR	INFINITE_LO...	123	
!		tasks.adb	PKTASKING	TREGULATE()	16	
✕		sensitivity.ada	SENSITIVITY	SORT_CALIB...	112	
✕		sensitivity.ada	SENSITIVITY	POLYNOMIA()	49	
✕		sensitivity.ada	SENSITIVITY	DEGREE_CO...	31	
✕	Unreachable code	example.adb	RUNTIME_ERROR	MYABS()	25	
✕	Unreachable code	example.adb	RUNTIME_ERROR	UNREACHAB...	182	
✕	Unreachable code	tasks.adb	PKTASKING	COMPUTE_N...	55	

8. Clear the **All** check box.
9. Scroll down to the **Non-terminating loop** check box and select it. Click **OK**.

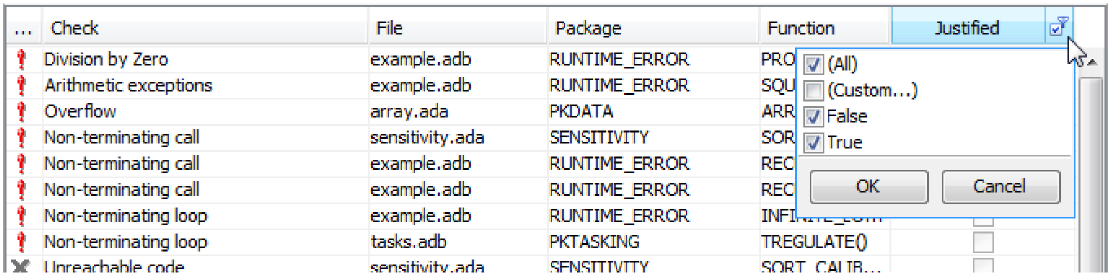
The **Results Summary** pane displays only the checks resulting from the `Non-terminating loop` error.

Review Checks Not Justified

To review only the checks that you have not justified:

1. Open the results file, with extension, `.rte`.
2. On the **Results Summary** pane, place your cursor on the **Justified** column head.
3. Click the filter icon.

   A context menu lists the filter options available.



...	Check	File	Package	Function	Justified
!	Division by Zero	example.adb	RUNTIME_ERROR	PRO	
!	Arithmetic exceptions	example.adb	RUNTIME_ERROR	SQU	
!	Overflow	array.ada	PKDATA	ARR	
!	Non-terminating call	sensitivity.ada	SENSITIVITY	SOR	
!	Non-terminating call	example.adb	RUNTIME_ERROR	REC	
!	Non-terminating call	example.adb	RUNTIME_ERROR	REC	
!	Non-terminating loop	example.adb	RUNTIME_ERROR	INFI	☐
!	Non-terminating loop	tasks.adb	PKTASKING	TREGULATE()	☐
✗	Unreachable code	sensitivity.ada	SENSITIVITY	SORT_CALIB...	☐

4. Clear the **True** check box. Click **OK**.

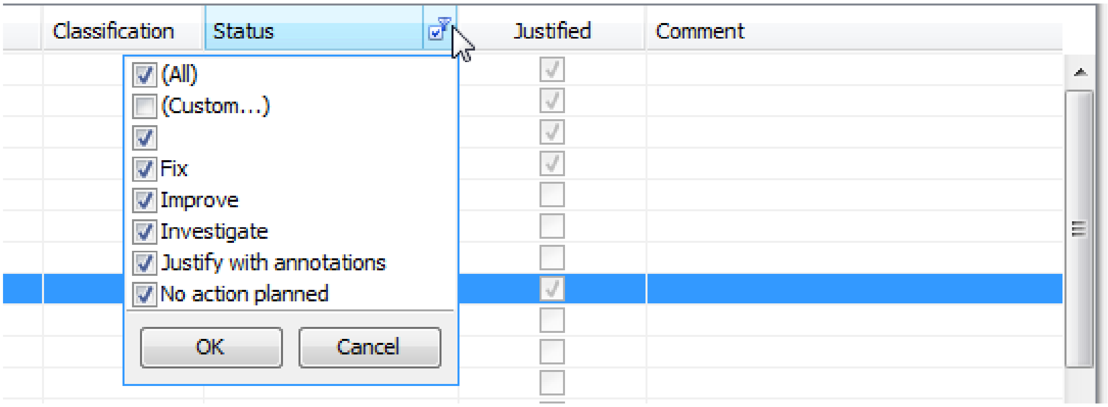
   The **Results Summary** pane displays only the checks that you have not justified.

Review Checks with Given Status

To review only the checks with `Investigate` status:

1. Open the results file, with extension, `.rte`.
2. On the **Results Summary** pane, place your cursor on the **Status** column head.
3. Click the filter icon.

   A context menu lists the filter options available.



4 Clear the **All** check box.

5 Select the **Investigate** check box. Click **OK**.

The **Results Summary** pane displays only the checks with the `Investigate` status.

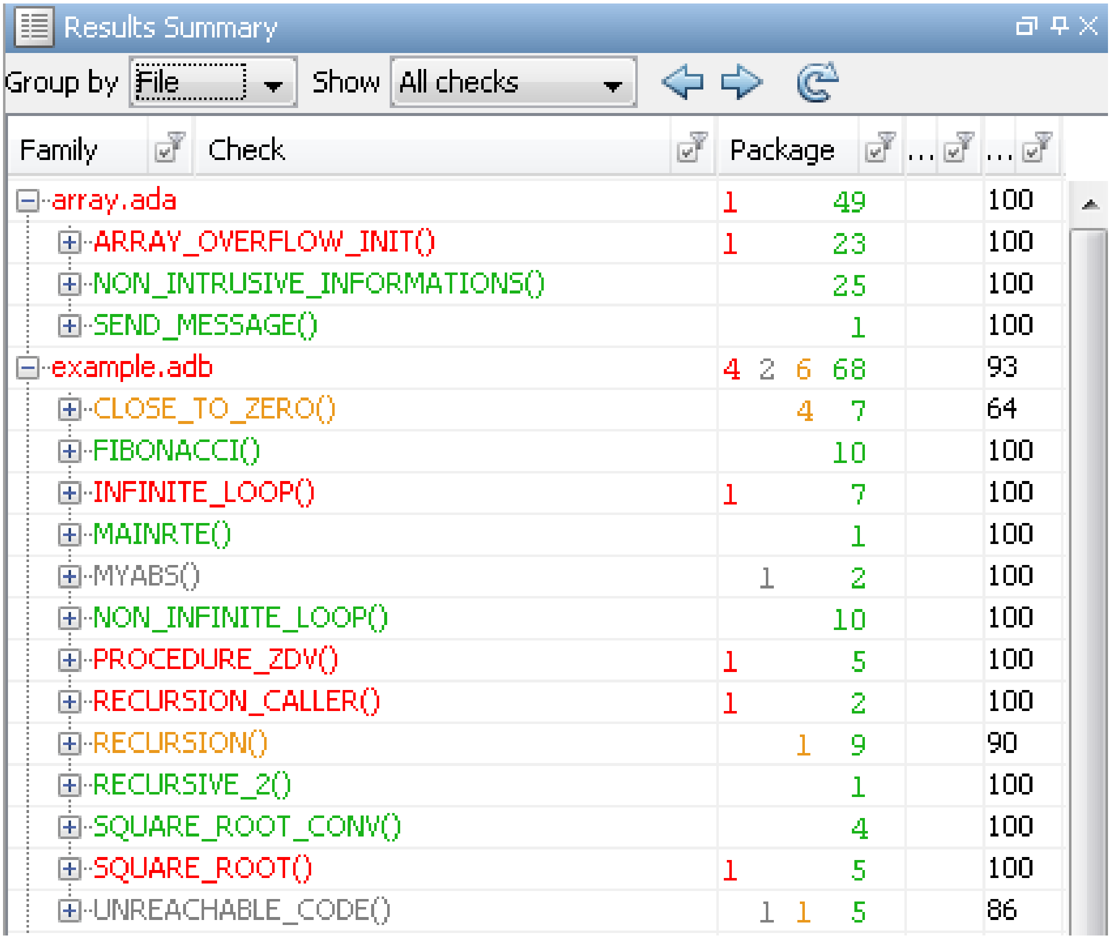
Review All Checks in a File

To review the checks in the file, `tasks.adb`:

1 On the **Results Summary** pane, select **Group by** > **File**.

The checks displayed are grouped by files. The file names are sorted alphabetically. Within each file name, the checks are grouped by functions, sorted alphabetically. Each file or function is colored by the most severe check that occurs. The severity decreases in this order:

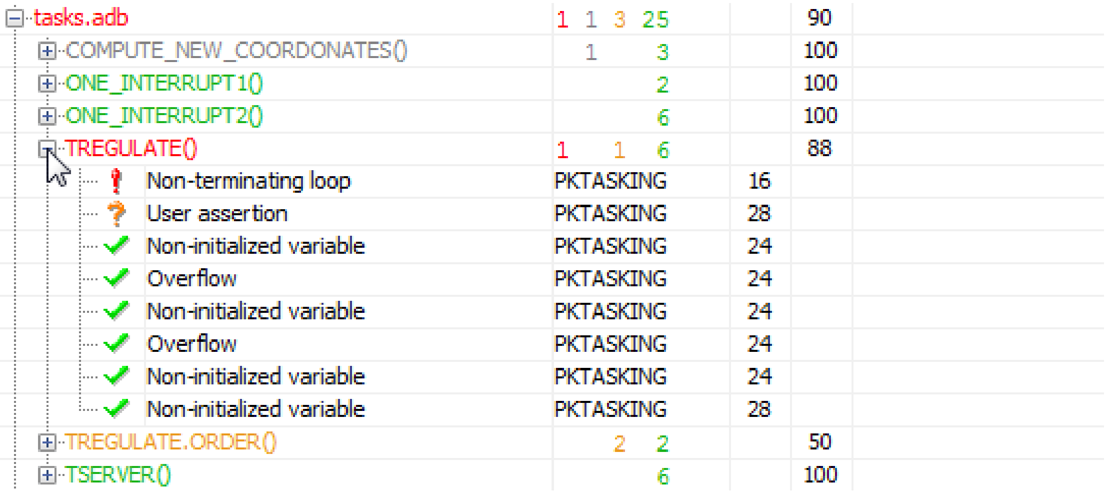
- Red
- Gray
- Orange
- Green



Group by File Show All checks

Family	Check	Package				...	...
array.ada		1			49		100
	ARRAY_OVERFLOW_INIT()	1			23		100
	NON_INTRUSIVE_INFORMATIONS()				25		100
	SEND_MESSAGE()				1		100
example.adb		4	2	6	68		93
	CLOSE_TO_ZERO()			4	7		64
	FIBONACCI()				10		100
	INFINITE_LOOP()	1			7		100
	MAINRTE()				1		100
	MYABS()		1		2		100
	NON_INFINITE_LOOP()				10		100
	PROCEDURE_ZDV()	1			5		100
	RECURSION_CALLER()	1			2		100
	RECURSION()			1	9		90
	RECURSIVE_2()				1		100
	SQUARE_ROOT_CONV()				4		100
	SQUARE_ROOT()	1			5		100
	UNREACHABLE_CODE()		1	1	5		86

2 To view the checks in `tasks.adb`, expand a procedure name under the category, **tasks.adb**.



⊟ tasks.adb	1 1 3 25		90
⊞ COMPUTE_NEW_COORDONATES()	1 3		100
⊞ ONE_INTERRUPT1()	2		100
⊞ ONE_INTERRUPT2()	6		100
⊟ TREGULATE()	1 1 6		88
! Non-terminating loop	PKTASKING	16	
? User assertion	PKTASKING	28	
✓ Non-initialized variable	PKTASKING	24	
✓ Overflow	PKTASKING	24	
✓ Non-initialized variable	PKTASKING	24	
✓ Overflow	PKTASKING	24	
✓ Non-initialized variable	PKTASKING	24	
✓ Non-initialized variable	PKTASKING	28	
⊞ TREGULATE.ORDER()	2 2		50
⊞ TSERVER()	6		100

To view further information on a check, select the check. The information on the check appears on the **Check Details** pane.

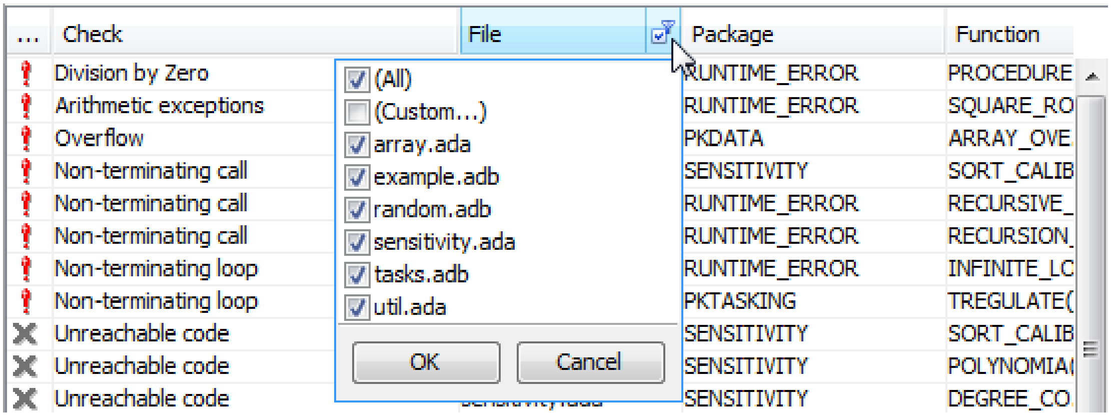
3 To view only the checks in `tasks.adb`, on the **Results Summary** pane, select **Group by** > **None**.

The **Results Summary** pane displays the checks without grouping them.

4 Place your cursor on the **File** column head.

5 Click the filter icon.

A context menu lists the filter options available.



...	Check	File	Package	Function
!	Division by Zero		RUNTIME_ERROR	PROCEDURE
!	Arithmetic exceptions		RUNTIME_ERROR	SQUARE_RO
!	Overflow		PKDATA	ARRAY_OVE
!	Non-terminating call		SENSITIVITY	SORT_CALIB
!	Non-terminating call		RUNTIME_ERROR	RECURSIVE_
!	Non-terminating call		RUNTIME_ERROR	RECURSION_
!	Non-terminating loop		RUNTIME_ERROR	INFINITE_LC
!	Non-terminating loop		PKTASKING	TREGULATE(
✗	Unreachable code		SENSITIVITY	SORT_CALIB
✗	Unreachable code		SENSITIVITY	POLYNOMIA(
✗	Unreachable code		SENSITIVITY	DEGREE_CO

☑ (All)
□ (Custom...)
☑ array.ada
☑ example.adb
☑ random.adb
☑ sensitivity.ada
☑ tasks.adb
☑ util.ada

6 Clear the **All** check box.

7 Select the **tasks.adb** check box. Click **OK**.

The **Results Summary** pane displays only the checks in `tasks.adb`.

Tip If you apply a filter on a column on the **Results Summary** pane, the column header displays the number of check boxes selected in the filter menu. Use this information to keep track of filters that you have applied.

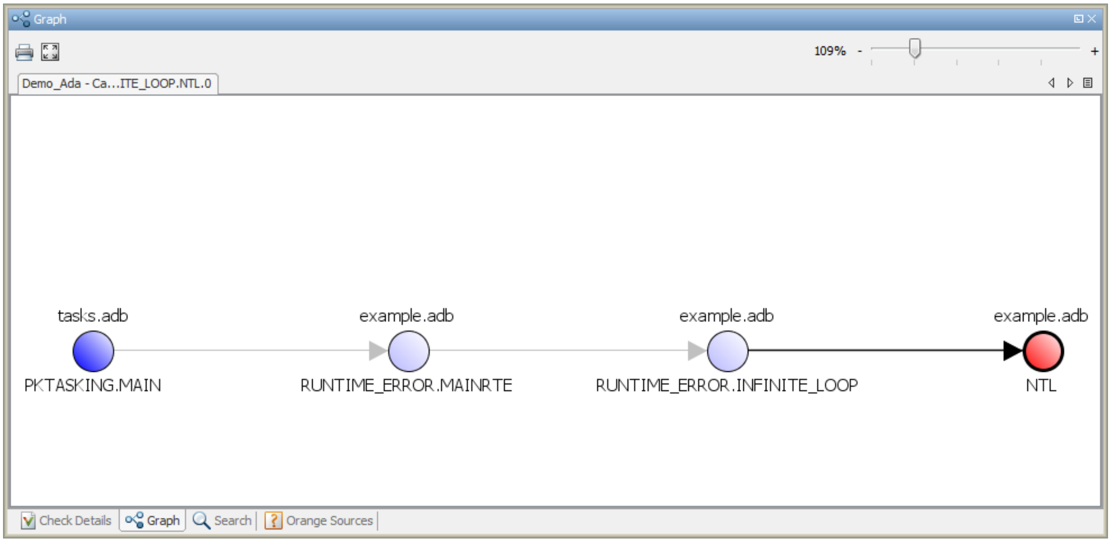
View Call Sequence for Checks

This example shows how to display the call sequence that leads to the code line associated with a check.

1 On the **Results Summary** pane, select the check that you want to review.

2 On the **Check Details** pane, click the Show error call graph button, .

A **Graph** tab appears, displaying the call graph.



The call graph displays the call sequence leading to the code associated with the check. Each node on the graph, except for the terminal node, represents a procedure. The procedure name is below the node. The name of the file containing the procedure is above the node.

3 Select a node to navigate to the function definition in the source code.

The **Source** pane displays the function definition.

4 Select the terminal node to navigate back to the code line associated with the check.

View Call Tree for Procedures

In this section...
"View Callers and Callees of a Procedure" on page 8-35
"Navigate Call Tree" on page 8-37

The call tree (or call graph) shows the calling relationship between procedures (and tasks) in a program. From the call tree, for each procedure or task, `foo`, you can see its:

- Callers: Procedures and tasks calling `foo`.
- Callees: Procedures and tasks called by `foo`.

Sometimes, an error in a procedure might be related to an instruction in its callers or callees. Therefore, to review errors quickly, it is useful to:

- View the callers and callees of a procedure without navigating in the source code.
- Navigate quickly between a procedure, and its callers and callees.
- Verify dataflow for certification purposes.

You can perform these tasks from the **Call Hierarchy Pane** in the Results Manager perspective.

For a complete description of the **Call Hierarchy** pane, see "Call Hierarchy" on page 8-53.

Note: If you do not see the **Call Hierarchy** pane in the Results Manager perspective, select **Window** > **Show/Hide View** > **Call Hierarchy**.

View Callers and Callees of a Procedure

You can view the callers and callees of a procedure from the **Call Hierarchy** pane.

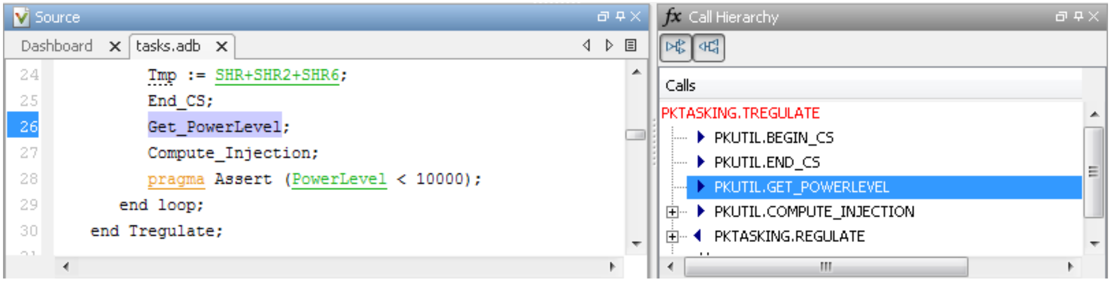
1 On the **Results Summary** pane or the **Source** pane, select a check. The function containing the check appears on the **Call Hierarchy** pane.

2 Select the procedure name.

   In the **Source** pane, the current line shows the beginning of the procedure definition.

3 Select a callee name. These are listed below the procedure name and marked by ▶ (procedures) or ||▶ (tasks).

On the **Source** pane, the current line shows where the callee is called.

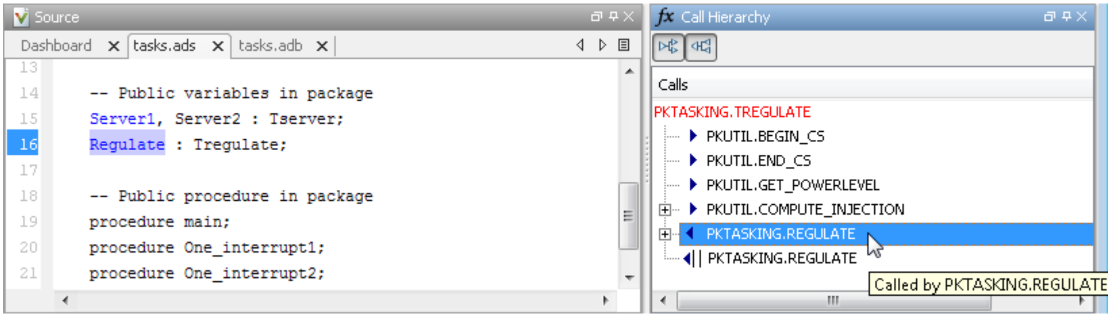


```
            Imp := SHR+SHR2+SHR6;
            End_CS;
            Get_PowerLevel;
            Compute_Injection;
            pragma Assert (PowerLevel < 10000);
        end loop;
    end Tregulate;
```

PKTASKING.TREGULATE
- ▶ PKUTIL.BEGIN_CS
- ▶ PKUTIL.END_CS
- ▶ PKUTIL.GET_POWERLEVEL
- ⊞ ▶ PKUTIL.COMPUTE_INJECTION
- ⊞ ◀ PKTASKING.REGULATE

4 Select a caller name. These are listed below the function name and marked by ◀ (functions) or ◀|| (tasks).

In the **Source** pane, the current line shows where the caller calls the function.



```
    -- Public variables in package
    Server1, Server2 : Tserver;
    Regulate : Tregulate;

    -- Public procedure in package
    procedure main;
    procedure One_interrupt1;
    procedure One_interrupt2;
```

PKTASKING.TREGULATE
- ▶ PKUTIL.BEGIN_CS
- ▶ PKUTIL.END_CS
- ▶ PKUTIL.GET_POWERLEVEL
- ⊞ ▶ PKUTIL.COMPUTE_INJECTION
- ⊞ ◀ PKTASKING.REGULATE
- ◀|| PKTASKING.REGULATE

Called by PKTASKING.REGULATE

5 View all branches of a callee by progressively clicking ⊞ next to the callee name.

6 View all branches ending with the caller by progressively clicking ⊞ next to the caller name.

Tip Instead of progressively viewing the branches by clicking ⊞, you can expand all caller/callee names at once. Right-click anywhere in the **Call Hierarchy** pane. From the context menu, select **Expand All Nodes**. Likewise, you can collapse all caller/

callee names by right-clicking anywhere in the **Call Hierarchy** pane and selecting **Collapse All Nodes**.

Navigate Call Tree

To navigate between a procedure and its callers and callees in the source code:

1. Select a check on the **Results Summary** pane. The **Call Hierarchy** pane shows the procedure.
2. To navigate to a callee in the source code, double-click the callee name. These names are listed below the procedure name and marked by ▸ (procedures) or ||▸ (tasks). Alternatively, right-click the callee name and from the context menu, select **Go To Definition**.

   The **Call Hierarchy** pane now shows the callee. In the **Source** pane, the current line shows the beginning of the callee procedure definition.
3. To navigate to a caller, double-click the caller name. These names are listed below the procedure name and marked by ◂ (procedures) or ◂|| (tasks). Alternatively, right-click the caller name and from the context menu, select **Go To Definition**.

   The **Call Hierarchy** pane now shows the caller. On the **Source** pane, the current line shows the beginning of the caller procedure definition.

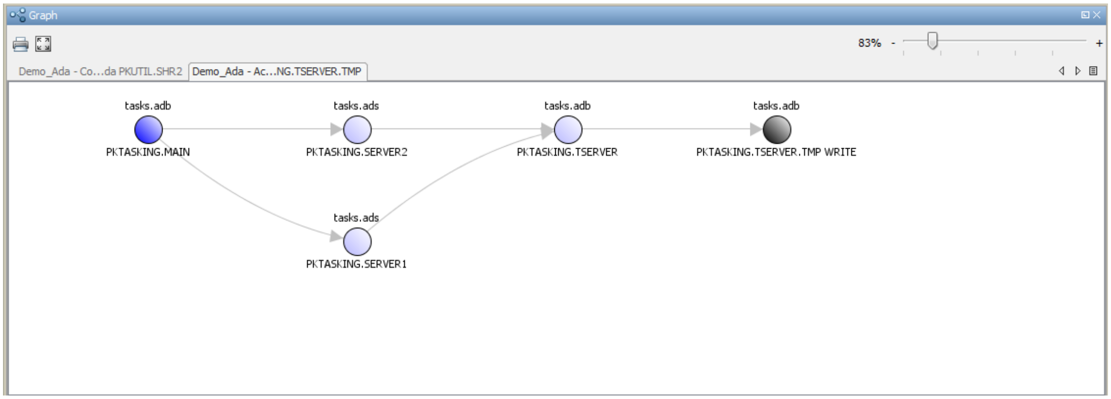
View Access Graph for Global Variables

This example shows how to display the access sequence for a global variable that is read or written in the code.

1 On the **Variable Access** pane, select the variable that you want to view.

2 On the **Variable Access** pane toolbar, click the Show Access Graph button .

A window displays the access graph.



The access graph displays the read and write accesses for the variable. Each node represents a function.

3 On the graph, click a node to navigate to the corresponding procedure on the **Source** pane. The **Call Hierarchy** pane displays the call tree of the procedure.

Customize Review Status

This example shows how to customize the statuses you assign on the **Check Review** pane.

Define Custom Status

1 Select **Tools** > **Preferences**.

2 Select the **Review Statuses** tab.

3 Enter your new status in the **Add a new status** field and click **Add**.

   The new status appears in the **User Statuses** list.

4 Click **OK** to save your changes and close the dialog box.

When reviewing checks, you can select the new status from the **Status** drop-down list on the:

- **Check Review** pane.
- **Results Summary** pane.

Add Justification to Existing Status

By default, a check is automatically justified if you assign the status, `Justify with annotations` or `No action planned`. However, you can change this default setting so that a check is justified when you assign one of the other existing statuses.

To add justification to existing status `Improve`:

1 Select **Tools** > **Preferences**.

2 Select the **Review Statuses** tab. For the `Improve` status, select the check box in the **Justify** column. Click **OK**.

   If you assign the `Improve` status to a check on the **Check Review** or **Results Summary** pane, the check gets automatically justified.

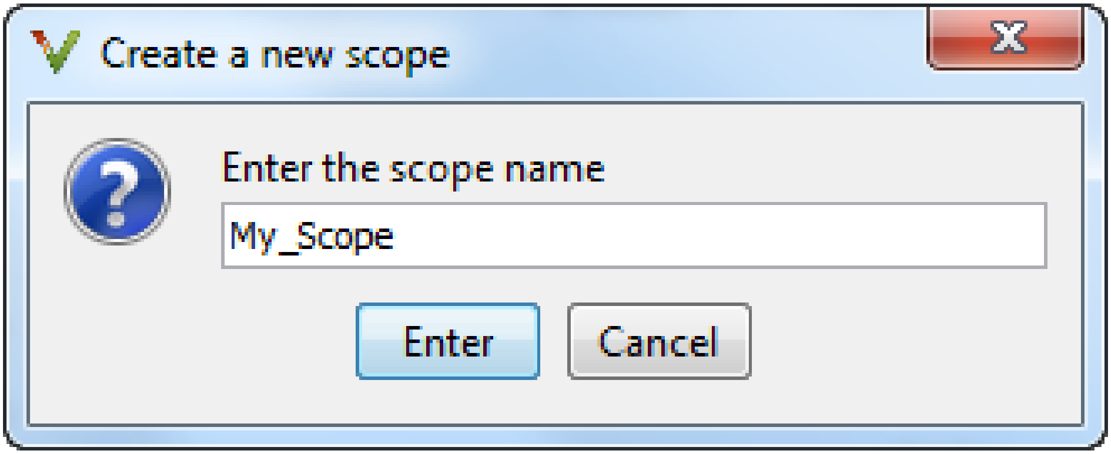
Organize Check Review Using Review Scopes

This example shows how to define and use a custom review methodology to specify the number and type of checks displayed on the **Results Summary** pane. Define a custom methodology to:

- Prioritize the checks that you review.
- Set standards that the developers of this software must meet.

Define a Custom Scope

1. In the Polyspace user interface, select **Tools** > **Preferences**.
2. In the Polyspace Preferences dialog box, select the **Review Scope** tab.
3. From the drop-down list on this tab, select `Add a scope...`.
4. Enter a name for your scope in the Create a new scope dialog box. For this example, enter the name, `My_Scope`. Then, click **Enter**.



Create a new scope

Enter the scope name

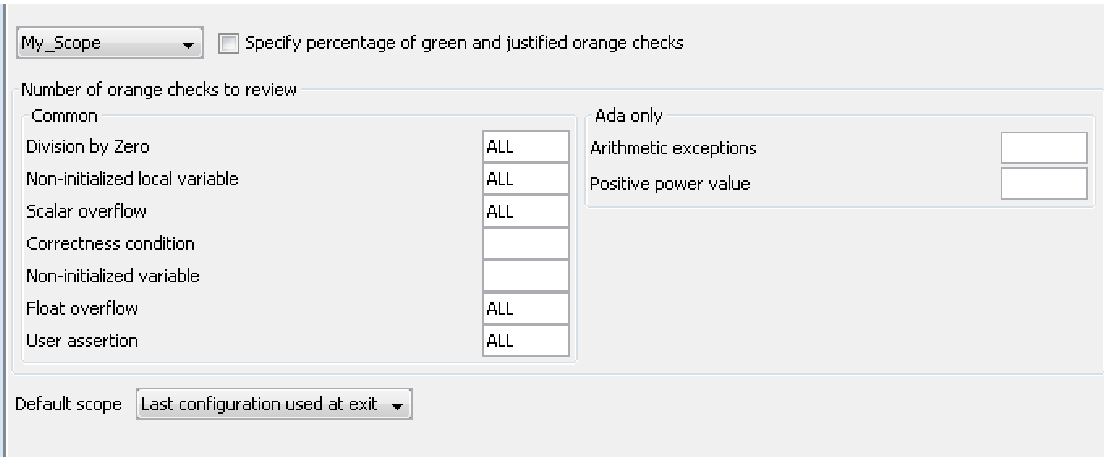
My_Scope

5. If you want to specify orange checks by percentage instead of number, select **Specify percentage of green and justified orange checks**.

   The percentage is calculated by:

   ```
   (green checks + justified orange checks) x 100/(green checks + total orange checks)
   ```

6. Enter the total number of checks (or percentage of checks) to display for each type of check for your methodology. If you want to review all orange checks of a certain type, enter `ALL`.



My_Scope ▾ □ Specify percentage of green and justified orange checks

Number of orange checks to review

Common

Division by Zero	ALL
Non-initialized local variable	ALL
Scalar overflow	ALL
Correctness condition	
Non-initialized variable	
Float overflow	ALL
User assertion	ALL

Ada only

Arithmetic exceptions	
Positive power value	

Default scope: Last configuration used at exit ▾

In this example, ALL was entered for ZDV indicating that all **Division by Zero** orange checks must be displayed when you choose **Show** > **My_Scope** on the **Results Summary** pane.

Click **OK** to save the scope and close the dialog box.

Use Your Custom Scope

1 Open your verification results.

2 On the **Results Summary** pane, select **Show** > **My_Scope**.

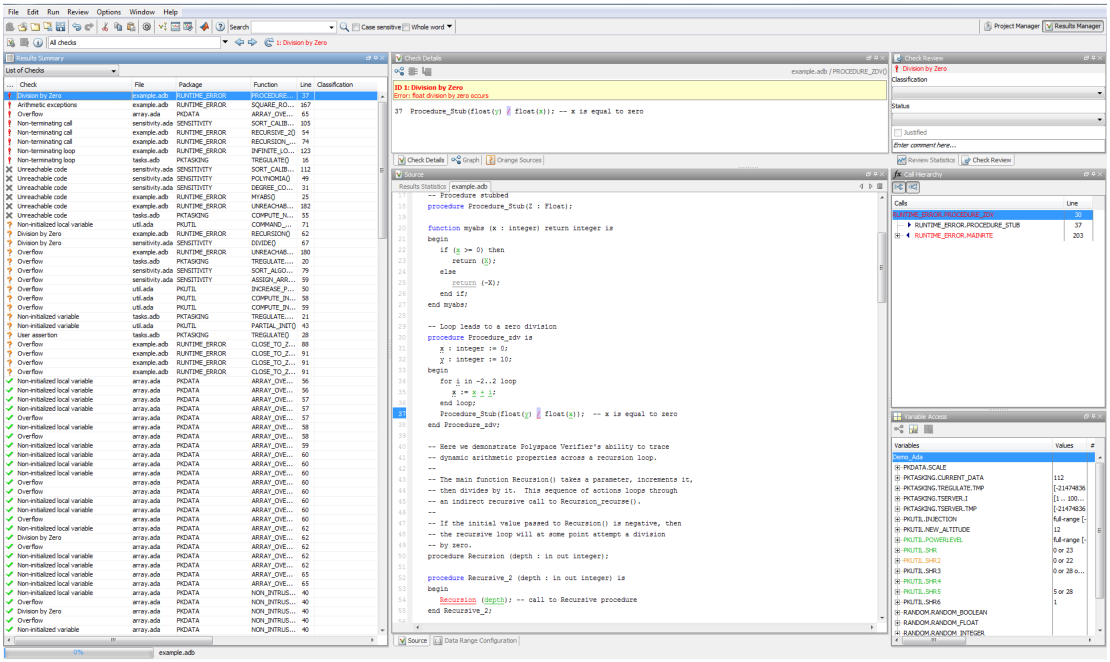
The **Results Summary** pane displays orange checks according to the definition specified for **My_Scope**. For instance, it displays all **Division by Zero** orange checks.

Exploring the Results Manager Perspective

In this section...

Overview

The Results Manager perspective looks like this.



...	Check	File	Package	Function	Line	Classification
!	Division by Zero	example.adb	RUNTIME_ERROR	PROCEDURE...	37	
!	Arithmetic exceptions	example.adb	RUNTIME_ERROR	SQUARE_RO...	167	
!	Overflow	array.ada	PKDATA	ARRAY_OVE...	65	
!	Non-terminating call	sensitivity.ada	SENSITIVITY	SORT_CALIB...	105	
!	Non-terminating call	example.adb	RUNTIME_ERROR	RECURSIVE_2()	54	
!	Non-terminating call	example.adb	RUNTIME_ERROR	RECURSION_...	74	
!	Non-terminating loop	example.adb	RUNTIME_ERROR	INFINITE_LO...	123	
!	Non-terminating loop	tasks.adb	PKTASKING	TREGULATE()	16	
✗	Unreachable code	sensitivity.ada	SENSITIVITY	SORT_CALIB...	112	
✗	Unreachable code	sensitivity.ada	SENSITIVITY	POLYNOMIA()	49	
✗	Unreachable code	sensitivity.ada	SENSITIVITY	DEGREE_CO...	31	
✗	Unreachable code	example.adb	RUNTIME_ERROR	MYABS()	25	
✗	Unreachable code	example.adb	RUNTIME_ERROR	UNREACHAB...	182	
✗	Unreachable code	tasks.adb	PKTASKING	COMPUTE_N...	55	
?	Non-initialized local variable	util.ada	PKUTIL	COMMAND_...	71	
?	Division by Zero	example.adb	RUNTIME_ERROR	RECURSION()	62	
?	Division by Zero	sensitivity.ada	SENSITIVITY	DIVIDE()	67	
?	Overflow	example.adb	RUNTIME_ERROR	UNREACHAB...	180	
?	Overflow	tasks.adb	PKTASKING	TREGULATE....	20	
?	Overflow	sensitivity.ada	SENSITIVITY	SORT_ALGO...	79	
?	Overflow	sensitivity.ada	SENSITIVITY	ASSIGN_ARR...	59	
?	Overflow	util.ada	PKUTIL	INCREASE_P...	50	
?	Overflow	util.ada	PKUTIL	COMPUTE_IN...	58	
?	Overflow	util.ada	PKUTIL	COMPUTE_IN...	59	
?	Non-initialized variable	tasks.adb	PKTASKING	TREGULATE....	21	
?	Non-initialized variable	util.ada	PKUTIL	PARTIAL_INIT()	43	
?	User assertion	tasks.adb	PKTASKING	TREGULATE()	28	
?	Overflow	example.adb	RUNTIME_ERROR	CLOSE_TO_Z...	88	
?	Overflow	example.adb	RUNTIME_ERROR	CLOSE_TO_Z...	91	
?	Overflow	example.adb	RUNTIME_ERROR	CLOSE_TO_Z...	91	
?	Overflow	example.adb	RUNTIME_ERROR	CLOSE_TO_Z...	91	
✓	Non-initialized local variable	array.ada	PKDATA	ARRAY_OVE...	56	
✓	Non-initialized local variable	array.ada	PKDATA	ARRAY_OVE...	56	
✓	Non-initialized local variable	array.ada	PKDATA	ARRAY_OVE...	57	
✓	Non-initialized local variable	array.ada	PKDATA	ARRAY_OVE...	57	
✓	Overflow	array.ada	PKDATA	ARRAY_OVE...	57	
✓	Non-initialized local variable	array.ada	PKDATA	ARRAY_OVE...	58	
✓	Overflow	array.ada	PKDATA	ARRAY_OVE...	58	
✓	Non-initialized local variable	array.ada	PKDATA	ARRAY_OVE...	59	
✓	Non-initialized local variable	array.ada	PKDATA	ARRAY_OVE...	60	
✓	Non-initialized local variable	array.ada	PKDATA	ARRAY_OVE...	60	
✓	Non-initialized local variable	array.ada	PKDATA	ARRAY_OVE...	60	
✓	Overflow	array.ada	PKDATA	ARRAY_OVE...	60	
✓	Overflow	array.ada	PKDATA	ARRAY_OVE...	60	
✓	Non-initialized local variable	array.ada	PKDATA	ARRAY_OVE...	60	
✓	Non-initialized local variable	array.ada	PKDATA	ARRAY_OVE...	60	
✓	Overflow	array.ada	PKDATA	ARRAY_OVE...	60	
✓	Non-initialized local variable	array.ada	PKDATA	ARRAY_OVE...	62	
✓	Division by Zero	array.ada	PKDATA	ARRAY_OVE...	62	
✓	Overflow	array.ada	PKDATA	ARRAY_OVE...	62	
✓	Non-initialized local variable	array.ada	PKDATA	ARRAY_OVE...	62	
✓	Non-initialized local variable	array.ada	PKDATA	ARRAY_OVE...	62	
✓	Non-initialized local variable	array.ada	PKDATA	ARRAY_OVE...	65	
✓	Non-initialized local variable	array.ada	PKDATA	ARRAY_OVE...	65	
✓	Non-initialized local variable	array.ada	PKDATA	NON_INTRUS...	40	
✓	Overflow	array.ada	PKDATA	NON_INTRUS...	40	
✓	Division by Zero	array.ada	PKDATA	NON_INTRUS...	40	
✓	Overflow	array.ada	PKDATA	NON_INTRUS...	40	
✓	Non-initialized variable	array.ada	PKDATA	NON_INTRUS...	40	

example.adb / PROCEDURE_ZDV()

ID 1: Division by Zero
Error: float division by zero occurs

```
37  Procedure_Stub(float(y) / float(x)); -- x is equal to zero
```

```
   -- Procedure stubbed
   procedure Procedure_Stub(Z : Float);

   function myabs (x : integer) return integer is
   begin
      if (x >= 0) then
         return (X);
      else
         return (-X);
      end if;
   end myabs;

   -- Loop leads to a zero division
   procedure Procedure_zdv is
      x : integer := 0;
      y : integer := 10;
   begin
      for i in -2..2 loop
         x := x + i;
      end loop;
      Procedure_Stub(float(y) / float(x));  -- x is equal to zero
   end Procedure_zdv;

   -- Here we demonstrate Polyspace Verifier's ability to trace
   -- dynamic arithmetic properties across a recursion loop.
   --
   -- The main function Recursion() takes a parameter, increments it,
   -- then divides by it.  This sequence of actions loops through
   -- an indirect recursive call to Recursion_recurse().
   --
   -- If the initial value passed to Recursion() is negative, then
   -- the recursive loop will at some point attempt a division
   -- by zero.
   procedure Recursion (depth : in out integer);

   procedure Recursive_2 (depth : in out integer) is
   begin
      Recursion (depth); -- call to Recursive procedure
   end Recursive_2;
```

Check Review: ! Division by Zero

Classification:

Status:

□ Justified

Enter comment here...

Calls	Line
RUNTIME_ERROR.PROCEDURE_ZDV	30
▶ RUNTIME_ERROR.PROCEDURE_STUB	37
◀ RUNTIME_ERROR.MAINRTE	203

Variables	Values	#
Demo_Ada		
PKDATA.SCALE		
PKTASKING.CURRENT_DATA	112	
PKTASKING.TREGULATE.TMP	[-21474836	
PKTASKING.TSERVER.I	[1 .. 100...	
PKTASKING.TSERVER.TMP	[-21474836	
PKUTIL.INJECTION	full-range [-	
PKUTIL.NEW_ALTITUDE	12	
PKUTIL.POWERLEVEL	full-range [-	
PKUTIL.SHR	0 or 23	
PKUTIL.SHR2	0 or 22	
PKUTIL.SHR3	0 or 28 o...	
PKUTIL.SHR4		
PKUTIL.SHR5	5 or 28	
PKUTIL.SHR6	1	
RANDOM.RANDOM_BOOLEAN		
RANDOM.RANDOM_FLOAT		
RANDOM.RANDOM_INTEGER		

The Results Manager perspective has the following sections below the toolbar:

This pane or view ...	Displays ...
Results Summary	List of checks (diagnostics) for each file and function in the project
Results Statistics	• Graphical view of code coverage and check distribution • Top five orange checks (likely errors in unproven code) and purple checks (coding rule violations)
Source	Source code for a selected check in the **Results Summary** view
Check Details	Details about the selected check
Check Review	Review information about selected check
Variable Access	Information about global variables declared in the source code
Call Hierarchy	Tree structure of function calls

You can resize or hide any of these sections.

Results Summary

The **Results Summary** pane lists all checks along with their attributes. To organize your check review, from the **Group by** list on this pane, select one of the following options:

- **None**: Lists all checks without grouping them. The checks are sorted in the following order:

  1. **Red**: Indicates code that is proven to contain an error. The check indicates that the code will fail every time it is executed.
  2. **Gray** — Indicates unreachable code.
  3. **Orange** — Indicates unproven code that might contain an error.
  4. **Green** — Indicates code that is proven to not contain an error.

- **Family**: Lists checks grouped by color. Within each color, the checks are grouped by category. For more information on the checks covered by a category, see the check reference pages.

- **File**: Lists checks grouped by file. Within each file, the checks are grouped by procedure.
- **Package**: Lists checks grouped by package. Within each package, the checks are grouped by procedure.

For each check, the **Results Summary** pane contains the check attributes, listed in columns:

Attribute	Description
Family	Group to which the check belongs. For instance, if you choose the grouping `Checks by File/Function`, this column contains the name of the file and function containing the check.
ID	Unique identification number of the check. In the default view on the **Results Summary** pane, the checks appear sorted by this number.
Type	Check color
Category	Category of the check. For more information on the checks covered by a category, see the check reference pages.
Check	Description of the error
Information	For run-time errors, this attribute indicates whether the check is related to path or bounded input values. For coding rule violations, this attribute indicates whether the rule is `Required`.
File	File containing the instruction where the check occurs
Package	Package containing the instruction where the check occurs
Function	Function containing the instruction where the check occurs.
Line	Line number of the instruction where the check occurs.

Attribute	Description
Col	Column number of the instruction where the check occurs. The column number is the number of characters from the beginning of the line.
%	Percentage of checks that are not orange. This column is most useful when you choose the grouping `Checks by File/Function`. The entry in this column against a file or function indicates the percentage of checks in the file or function that are not orange.
Classification	Level of severity you have assigned to the check. The possible levels are: • `Unset` • `High` • `Medium` • `Low` • `Not a defect`
Status	Review status you have assigned to the check. The possible statuses are: • `Fix` • `Improve` • `Investigate` • `Justify with annotations` • `No action planned` • `Other` • `Restart with different options`
Justified	Check boxes showing whether you have justified the checks
Comments	Comments you have entered about the check

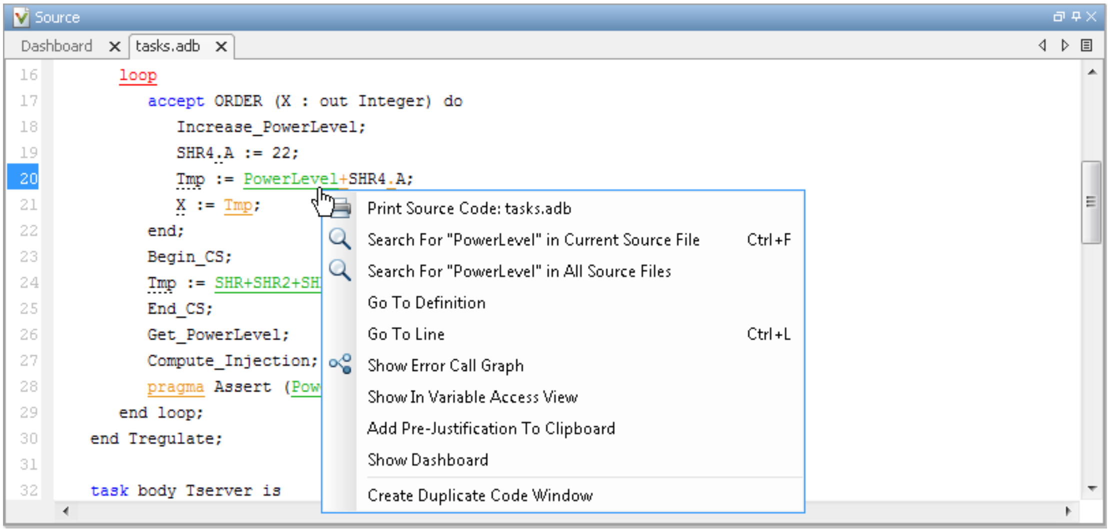
To show or hide a column, right-click anywhere on the column title. From the context menu, select or clear the title of the column that you want to show or hide.

Using this pane, you can:

- Navigate through checks. For more information, see “Assign Review Status to Result”.
- Organize your check review using column filters. For more information, see “Organize Check Review Using Filters and Groups”.

Source

The **Source** pane shows the source code with colored checks highlighted.


Source
Dashboard
tasks.adb
Print Source Code: tasks.adb
Search For "PowerLevel" in Current Source File Ctrl+F
Search For "PowerLevel" in All Source Files
Go To Definition
Go To Line Ctrl+L
Show Error Call Graph
Show In Variable Access View
Add Pre-Justification To Clipboard
Show Dashboard
Create Duplicate Code Window

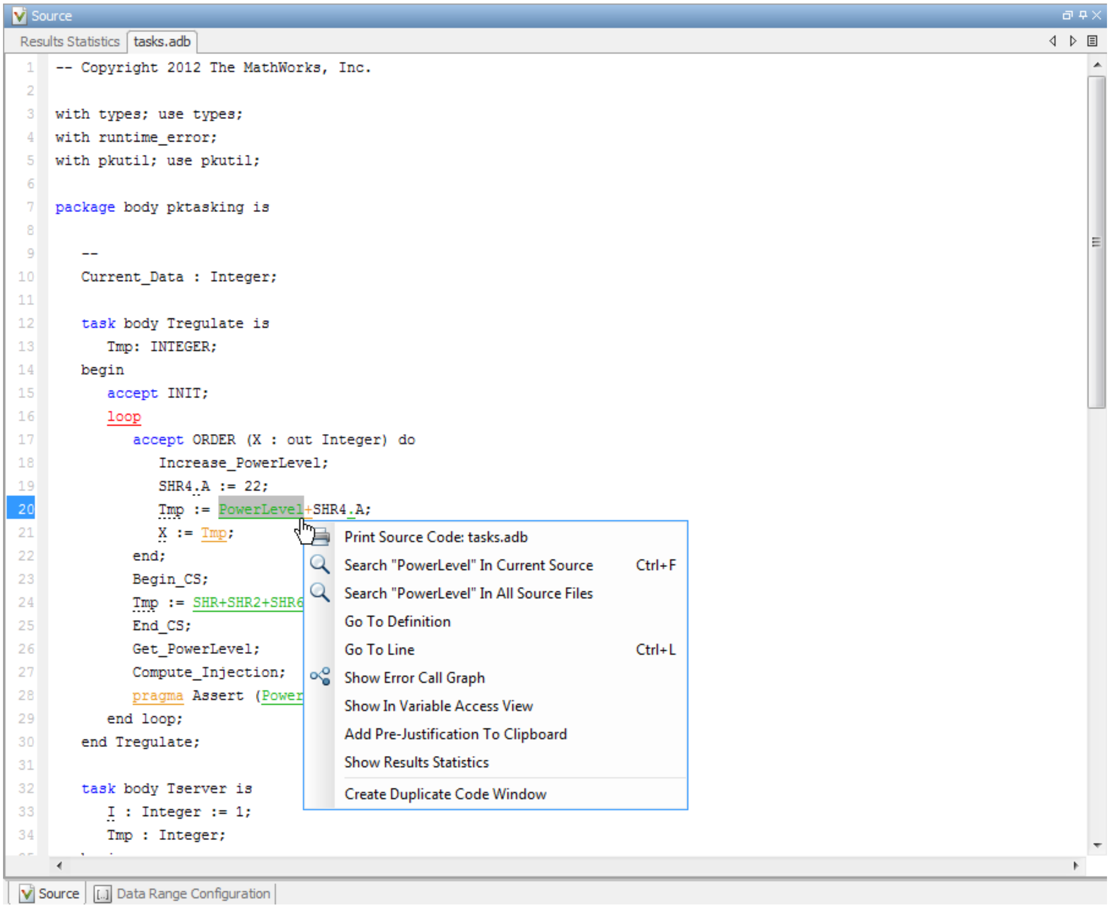
```
      loop
         accept ORDER (X : out Integer) do
            Increase_PowerLevel;
            SHR4.A := 22;
            Tmp := PowerLevel+SHR4.A;
            X := Tmp;
         end;
         Begin_CS;
         Tmp := SHR+SHR2+SH
         End_CS;
         Get_PowerLevel;
         Compute_Injection;
         pragma Assert (Pow
      end loop;
   end Tregulate;

   task body Tserver is
```

Tooltips

Placing your cursor over a check displays a tooltip that provides range information for variables, operands, function parameters, and return values. For more information on tooltips, see “Using Range Information in Results Manager Perspective”.

Examine Source Code

In the **Source** pane, if you right-click a text string, the context menu provides options to examine your code. For example, right-click the variable `PowerLevel`:


Source
Results Statistics
tasks.adb
Print Source Code: tasks.adb
Search "PowerLevel" In Current Source Ctrl+F
Search "PowerLevel" In All Source Files
Go To Definition
Go To Line Ctrl+L
Show Error Call Graph
Show In Variable Access View
Add Pre-Justification To Clipboard
Show Results Statistics
Create Duplicate Code Window
Source
Data Range Configuration

```
-- Copyright 2012 The MathWorks, Inc.

with types; use types;
with runtime_error;
with pkutil; use pkutil;

package body pktasking is

   --
   Current_Data : Integer;

   task body Tregulate is
      Tmp: INTEGER;
   begin
      accept INIT;
      loop
         accept ORDER (X : out Integer) do
            Increase_PowerLevel;
            SHR4.A := 22;
            Tmp := PowerLevel+SHR4.A;
            X := Tmp;
         end;
         Begin_CS;
         Tmp := SHR+SHR2+SHR6
         End_CS;
         Get_PowerLevel;
         Compute_Injection;
         pragma Assert (Power
      end loop;
   end Tregulate;

   task body Tserver is
      I : Integer := 1;
      Tmp : Integer;
```

Use the following options to examine and navigate through your code:

- **Search "PowerLevel" in Current Source** — List occurrences of the string within the current source file in the **Search** pane.
- **Search "PowerLevel" in All Source Files** — List all occurrences of the string in source files. The results appear on the **Search** pane.

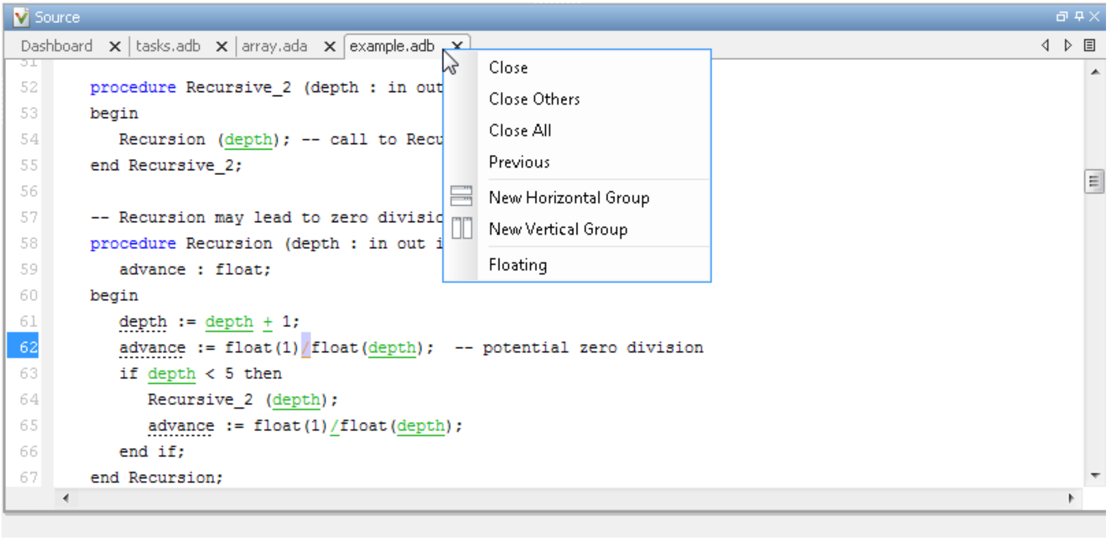
  Go To Definition — Go to the line of code that contains the definition of `PowerLevel`. The software supports this feature for global and local variables, functions and types.

- **Go To Line** — Open the Go To Line dialog box. If you specify a line number and click **Enter**, the software displays the specified line of code.
- **Expand All Macros** or **Collapse All Macros** — Display or hide the content of macros in current source file.

Manage Multiple Files in Source Pane

You can view multiple source files in the **Source** pane.

On the **Source** pane toolbar, right-click a tab title to manage source files.



```
procedure Recursive_2 (depth : in out
begin
   Recursion (depth); -- call to Recu
end Recursive_2;

-- Recursion may lead to zero divisio
procedure Recursion (depth : in out i
   advance : float;
begin
   depth := depth + 1;
   advance := float(1)/float(depth);  -- potential zero division
   if depth < 5 then
      Recursive_2 (depth);
      advance := float(1)/float(depth);
   end if;
end Recursion;
```

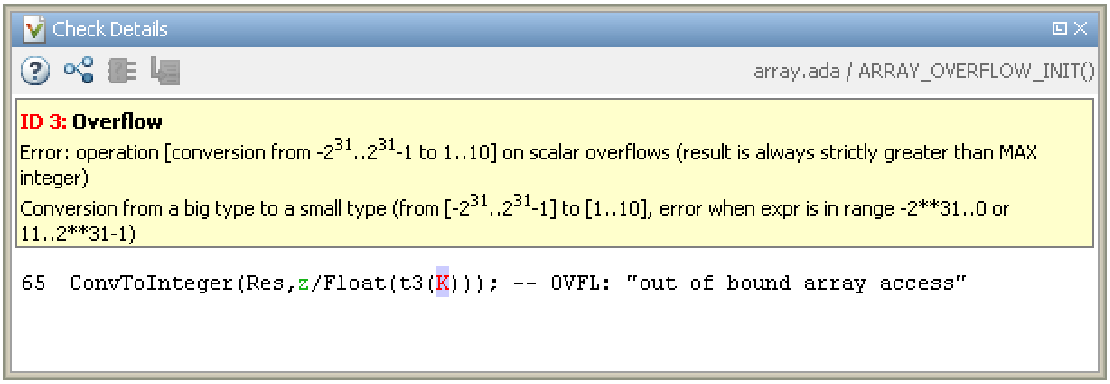
From the **Source** pane context menu, you can:

- **Close** – Close the currently selected source file.
- **Close Others** – Close all source files except the currently selected file.
- **Close All** – Close all source files.
- **Next** – Display the next view.
- **Previous** – Display the previous view.
- **New Horizontal Group** – Split the Source window horizontally to display the selected source file below another file.
- **New Vertical Group** – Split the Source window vertically to display the selected source file side-by-side with another file.

- **Floating** – Display the current source file in a new window, outside the Source pane.

Check Details

On the **Results Summary** pane, if you click a check, you see additional information on the **Check Details** pane.



ID 3: Overflow

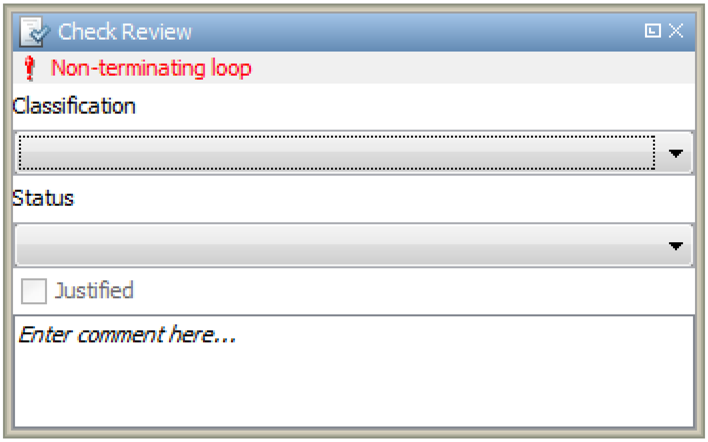
Error: operation [conversion from $-2^{31}..2^{31}-1$ to 1..10] on scalar overflows (result is always strictly greater than MAX integer)

Conversion from a big type to a small type (from $[-2^{31}..2^{31}-1]$ to [1..10], error when expr is in range -2**31..0 or 11..2**31-1)

```
ConvToInteger(Res,z/Float(t3(K))); -- OVFL: "out of bound array access"
```

Check Review

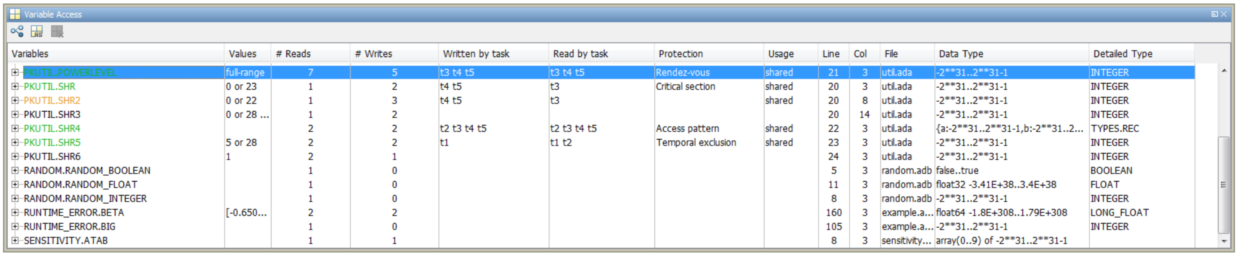
When reviewing checks, use the **Check Review** tab to assign a **Classification** and **Status** to each check. You can also enter comments to describe the results of your review. This action helps you track the progress of your review and avoid reviewing the same check twice.



For more information, see “Assign Review Status to Result”.

Variable Access

The **Variable Access** pane displays global variables. For each global variable, the pane lists functions and tasks performing read/write operation on the variables, along with their attributes, such as values, read/write operations and shared usage.



Variables	Values	# Reads	# Writes	Written by task	Read by task	Protection	Usage	Line	Col	File	Data Type	Detailed Type
PKUTIL.POWERLEVEL	full-range	7	5	t3 t4 t5	t3 t4 t5	Rendez-vous	shared	21	3	util.ada	-2**31..2**31-1	INTEGER
PKUTIL.SHR	0 or 23	1	2	t4 t5	t3	Critical section	shared	20	3	util.ada	-2**31..2**31-1	INTEGER
PKUTIL.SHR2	0 or 22	1	3	t4 t5	t3		shared	20	8	util.ada	-2**31..2**31-1	INTEGER
PKUTIL.SHR3	0 or 28 ...	1	2					20	14	util.ada	-2**31..2**31-1	INTEGER
PKUTIL.SHR4		2	2	t2 t3 t4 t5	t2 t3 t4 t5	Access pattern	shared	22	3	util.ada	{a:-2**31..2**31-1,b:-2**31..2...	TYPES.REC
PKUTIL.SHR5	5 or 28	2	2	t1	t1 t2	Temporal exclusion	shared	23	3	util.ada	-2**31..2**31-1	INTEGER
PKUTIL.SHR6	1	2	1					24	3	util.ada	-2**31..2**31-1	INTEGER
RANDOM.RANDOM_BOOLEAN		1	0					5	3	random.adb	false..true	BOOLEAN
RANDOM.RANDOM_FLOAT		1	0					11	3	random.adb	float32 -3.41E+38..3.4E+38	FLOAT
RANDOM.RANDOM_INTEGER		1	0					8	3	random.adb	-2**31..2**31-1	INTEGER
RUNTIME_ERROR.BETA	[-0.650...	2	2					160	3	example.a...	float64 -1.8E+308..1.79E+308	LONG_FLOAT
RUNTIME_ERROR.BIG		1	0					105	3	example.a...	-2**31..2**31-1	INTEGER
SENSITIVITY.ATAB		1	1					8	3	sensitivity...	array(0..9) of -2**31..2**31-1	

For each variable and each read/write access, the **Variable Access** pane contains the relevant attributes. For the variables, the various attributes are listed in this table.

Attribute	Description
Variables	Name of Variable, *`Package_Name.Variable_Name`* *`Package_Name`*: Name of package where variable is declared
Values	Value (or range of values) of variable
# Reads	Number of times the variable is read
# Writes	Number of times the variable is written
Written by task	Name of tasks writing on variable using aliases, `t1,t2,t3` **Tip** To see the full names for aliases, right-click anywhere on the **Variable Access** pane and select **Show Legend**.
Read by task	

Attribute	Description
	Name of tasks reading variable using aliases, `t1,t2,t3`
Protection	Whether shared variable is protected from concurrent access (Filled only when `Usage` column has entry, `Shared`) The possible entries in this column are: • `Critical Section`: If variable is accessed in critical section of code • `Temporal Exclusion`: If variable is accessed in mutually exclusive tasks For more details on these entries, see "Shared Variables".
Usage	`Shared`, if variable is shared between tasks; otherwise, blank
Line	Line number of variable declaration
Col	Column number (number of characters from beginning of line) of variable declaration
File	Source file containing variable declaration
Data Type	• If the variable has a scalar data type, this column states the values allowed for the type. • If the variable is an array or a record, this column states the values allowed for the data types of its components.
Detailed Type	Data type of variable, if the variable has a scalar data type.

Double-click a variable name to view read/write access operations on the variable. The arrowhead symbols ▸ and ◂ in the **Variable Access** pane indicate functions performing read and write access respectively on the global variable. Likewise, tasks performing read and write access are indicated by the symbols ||▸ and ◂|| respectively.

For access operations on the variables, the various attributes described in the pane are listed in this table.

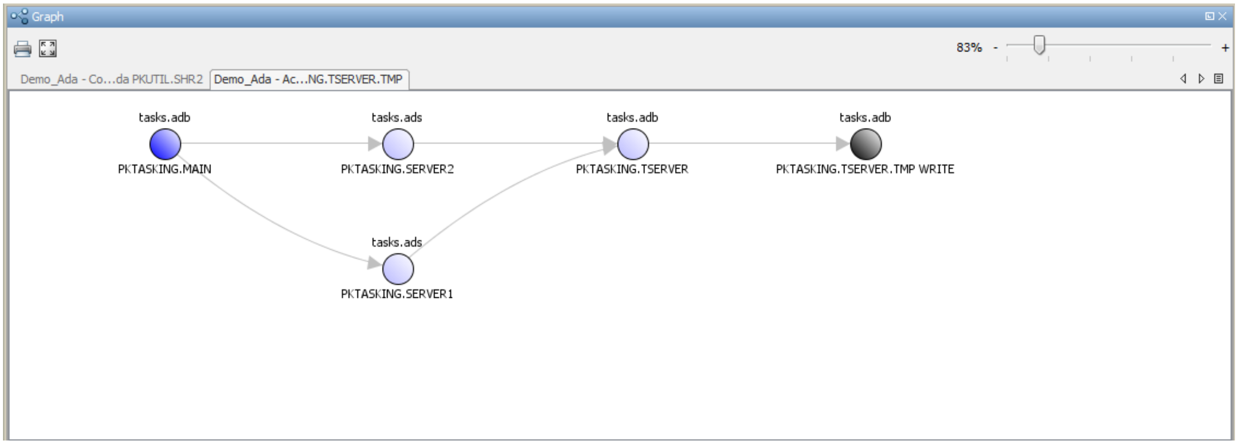
Attribute	Description
Variables	Names of procedure (or task) performing read/ write access on the variable, *`Package_Name. Procedure_Name`* *`Package_Name`*: Name of package containing procedure (or task) definition
Values	Value or range of values of variable in the procedure or task performing read/write access
Written by task	*Only for tasks*: Name of task performing write access on variable
Read by task	*Only for tasks*: Name of task performing read access on variable
Line	Line number where procedure or task accesses variable
Col	Column number where procedure or task accesses variable
File	Source file containing access operation on variable

You can also perform the following actions from the **Variable Access** pane.

• View Access Graph

View the access operations on a global variable in graphical format using the **Variable Access** pane. Select the global variable and click . For more information, see “View Access Graph for Global Variables”.

Here is an example of an access graph:



- ## Show/Hide Non-Shared Variables

  Customize the **Variable Access** pane to show only the shared variables. On the Variable Access pane toolbar, click the Non-Shared Variables button NS to show or hide non-shared variables.

- ## Hide Access in Unreachable Code

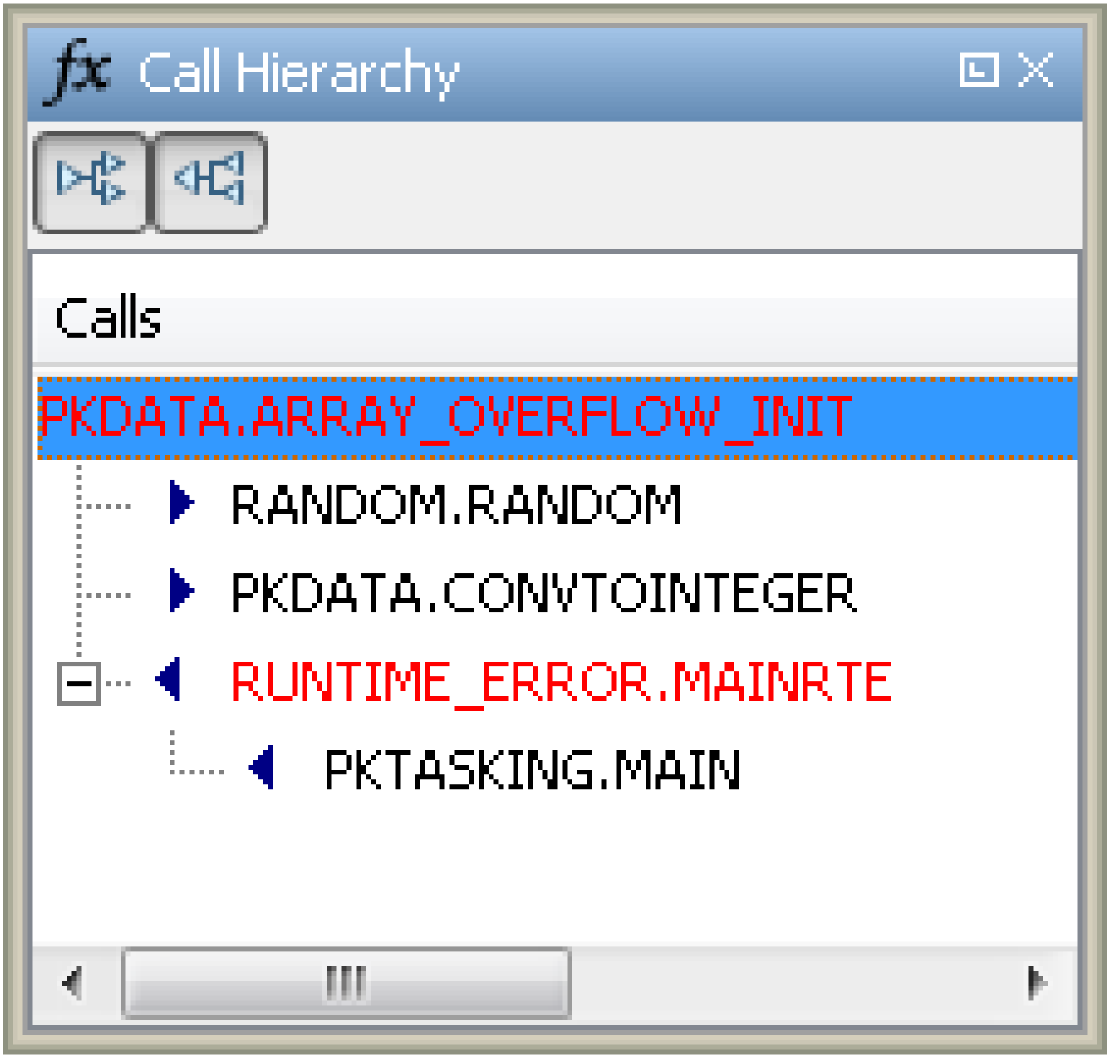
  Hide read/write access occurring in dead code by clicking the filter button ⊠.

Call Hierarchy

The **Call Hierarchy** pane displays the call tree of procedures in the source code.

For each procedure,`foo`, the **Call Hierarchy** pane lists the procedures and tasks that call `foo` (callers) and those called by `foo` (callees). The callers are indicated by ◀ (procedures), or ◀|| (tasks). The callees are indicated by ▶ (procedures) or ||▶ (tasks).

In the following example, the **Call Hierarchy** pane displays the procedure, `SORT_CALIBRATION`, in the package, `SENSITIVITY`. It also displays the callers and the callees of `SORT_CALIBRATION`.



PKDATA.ARRAY_OVERFLOW_INIT
RANDOM.RANDOM
PKDATA.CONVTOINTEGER
RUNTIME_ERROR.MAINRTE
PKTASKING.MAIN

Depending on the name, the corresponding line number in the **Call Hierarchy** pane refers to a different line in the source code:

- For a procedure name, the line number refers to the beginning of the procedure definition. In the preceding example, the definition of `SENSITIVITY.SORT_CALIBRATION` begins on line 97.

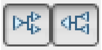
- For a callee name, the number refers to the line where the callee is called. In the preceding example, callee, `SENSITIVITY.POLYNOMIA`, is called by `SENSITIVITY.SORT_CALIBRATION` on line 108.
- For a caller name, the number refers to the line where the caller calls the procedure. In the preceding example, caller, `RUNTIME_ERROR.MAINRTE`, calls `SENSITIVITY.SORT_CALIBRATION` on line 222.

Tip Select a caller or callee name to navigate to the procedure call in the source code.

You can perform the following actions from the **Call Hierarchy** pane:

- ## Show/Hide Callers and Callees

  Customize the view to display callers only or callees only. Show or hide callers and callees by clicking this button

- ## Go to Caller/Callee Definition

  Go directly to the definition of a caller or callee in the source code. Right-click the name of the caller or callee and select **Go To Definition**. .

Import and Export Review Comments

In this section...

Reusing Review Comments

After you have reviewed verification results, you can reuse your review comments for subsequent verifications. By reusing your review comments, you can:

- Avoid reviewing the same check twice.
- Compare verification results over time.

You can directly import review comments from another set of results into the current results. However, it is possible that your review comments do not apply to a subsequent verification because:

- You have changed your source code so that the check is no longer present.
- You have changed your source code so that the check color has changed.
- You have already entered different review comments for the same check.

Importing Review Comments from Previous Verifications

- "Import Comments from Previous Verifications" on page 8-56
- "Automatically Import Comments from Last Verification" on page 8-57

Import Comments from Previous Verifications

1. Open your verification results in the Results Manager perspective.
2. Select **Tools** > **Import Comments**.
3. Navigate to the folder containing your previous results.
4. Select the results file with extension `.rte` and then click **Open**.

The review comments from the previous results are imported into the current results, and the Import checks and comments report opens. For more information, see "View Checks and Comments Report".

Automatically Import Comments from Last Verification

1. Select **Tools** > **Preferences**, which opens the Polyspace Preferences dialog box.
2. Select the **Project and Results Folder** tab.
3. Under **Import Comments**, select **Automatically import comments from last verification**.
4. Click **OK**.

   After you set this preference, for every run, the software imports review comments from the last run.

View Checks and Comments Report

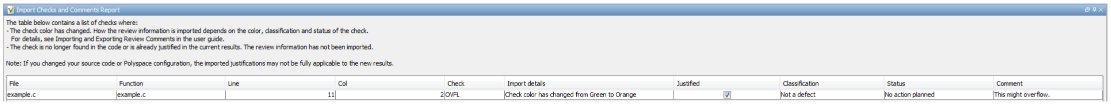
After you have reviewed verification results, you can reuse your review comments for subsequent verifications. However, it is possible that your review comments do not apply to a subsequent verification because:

- You have changed your source code so that the check is no longer present.
- You have changed your source code so that the check color has changed.
- You have already entered different review comments for the same check.

The Import Checks and Comments Report highlights differences between two verification results. When you import comments from a previous verification, you can see this report. If you have closed the report after an import, to review the report again:

1. Select **Window** > **Show/Hide View** > **Import Comments Report**.

   The Import Checks and Comments Report opens, highlighting differences in the two results.

   Import Checks and Comments Report

   The table below contains a list of checks where:
   - The check color has changed. How the review information is imported depends on the color, classification and status of the check.
     For details, see Importing and Exporting Review Comments in the user guide.
   - The check is no longer found in the code or is already justified in the current results. The review information has not been imported.

   Note: If you changed your source code or Polyspace configuration, the imported justifications may not be fully applicable to the new results.

File	Function	Line	Col	Check	Import details	Justified	Classification	Status	Comment
example.c	example.c	11	2	OVFL	Check color has changed from Green to Orange	☑	Not a defect	No action planned	This might overflow.

2. Review the differences between the two results.

- If the check color changes, Polyspace populates the **Comment** field but not the fields **Classification**, **Status** or **Justified**.
- If a check no longer appears in the code, Polyspace highlights only the change in the Import Checks and Comments Report. It does not import review comments from the previous result.
- If you have already entered different review comments for the same check, Polyspace highlights only the change in the Import Checks and Comments Report. It does not import review comments from the previous result.

Generate Report from User Interface

This example shows how to generate a report from your verification results. Using a customizable template, the report presents your results in a concise manner for managerial review or other purposes. To generate a verification report, do one of the following:

- Specify certain analysis options so that the software automatically generates a report after verification.
- Generate a verification report manually from your results.

Specify Report Generation Before Verification

1. In the Project Manager perspective, open your project.
2. On the **Configuration** pane, specify report generation options.

   a. Select the **Reporting** node.

   b. Select **Generate report**.

   c. Select a **Report template** and **Output format**.

      The template determines the information to be placed in the report along with how it is presented.
3. Run verification and open your results.
4. Select **Reporting** > **Open Report**
5. Navigate to the `Polyspace-Doc` subfolder in your results folder.

   You can see the generated report in this subfolder.
6. Select the report and click **OK** to open them.

Generate Report After Verification

1. In the Results Manager perspective, open your verification results.
2. Select **Reporting** > **Run Report**.

   The Run Report dialog box opens.
3. In the **Select Reports** section, select the report templates you want to use. For example, you can select **Developer** and **Quality**.
4. Select the **Output folder** in which to save the reports.

5 Select the **Output format** for the reports.

6 Click **Run Report**.

The software creates the specified reports and opens them.

Generate Report from Command Line

You can also run the Report Generator, with options, from the command line. For example:

```
Polyspace_Install\polyspace\bin\report-generator -template path -
format type -results-dir folder_paths
```

For information about the available options, see the following sections.

-template *path*

Specify the *path* to a valid Report Generator template file. For example:

```
Polyspace_Install\polyspace\toolbox\psrptgen\templates\Developer.rpt
```

Other supplied templates are `CodingRules.rpt`, `Developer_WithGreenChecks.rpt`, `DeveloperReview.rpt`, and `Quality.rpt`.

-format *type*

Specify the format *type* of the report. Use `HTML`, `PDF`, `RTF`, `WORD`, or `XML`. The default is `RTF`.

-help or -h

Displays help information.

-noview

The software does not open the report at the end of the generation process.

Note: If you use a Linux® system and want to run the Report Generator from the command line with the `-format RTF` option, you must also specify the `-noview` option.

-output-name *filename*

Specify the *filename* for the report generated.

-results-dir *`folder_paths`*

Specify the paths to the folders that contain your verification results.

You can generate a single report for multiple verifications by specifying *`folder_paths`* as follows:

```
"folder1, folder2, folder3,..., folderN"
```

`folder1, folder2, ...` are the file paths to the folders that contain the results of your verifications (normal or unit-by-unit). For example:

```
"C:\Results1,C:\Recent\results,C:\Old"
```

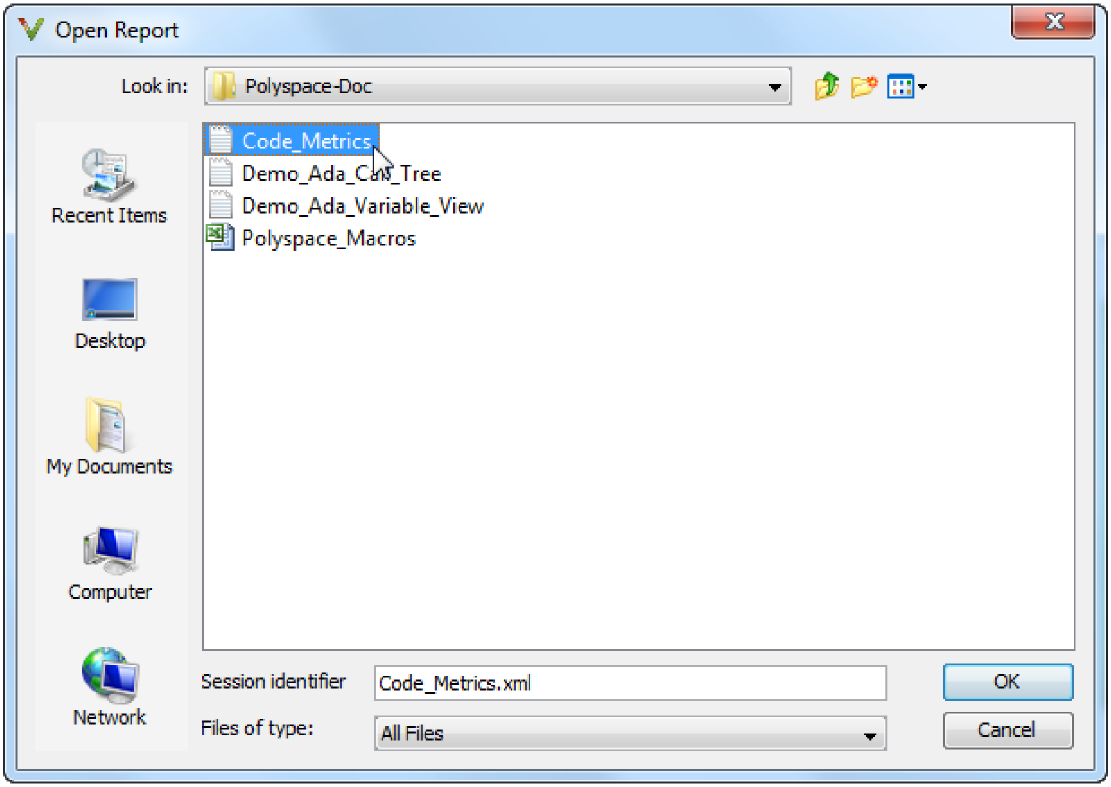
If you do not specify a folder path, the software uses verification results from the current folder.

Open Report

This example shows how to open a verification report. Before you open the report, you must have a generated report. For more information, see “Generate Report from User Interface”.

1. Open your verification results.
2. Select **Reporting** > **Open Report**, which opens the Open Report dialog box.
3. Navigate to the folder that contains your report.

   Unless you specify an output folder explicitly during report generation, the generated report appears in the `Polyspace-Doc` subfolder in your results folder.
4. Select the report and click **OK**.



Look in: Polyspace-Doc

Session identifier: Code_Metrics.xml

Files of type: All Files

Customize Report Templates

This example shows how to customize the templates that you use for report generation. To customize the templates, you must have MATLAB® Report Generator™ software installed on your system.

In this section...

Create Custom Template

If you have MATLAB Report Generator software on your system:

1 Open the Report Explorer from the MATLAB command prompt:

```
report
```

2 Select **File** > **Open** to open the template that you want to customize.

3 Navigate to `*Matlab_Install*/polyspace/toolbox/psrptgen/templates` where *`Matlab_Install`* is the MATLAB installation folder. Use the `matlabroot` command to find the folder location.

4 Modify the template using the options on the **Report Options** pane.

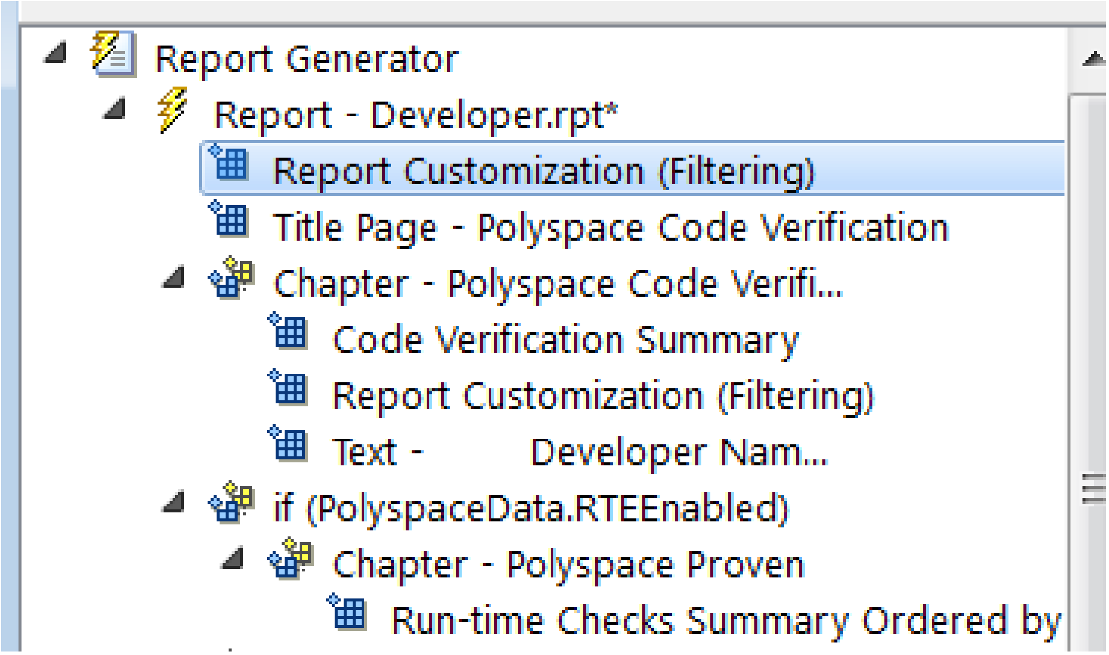
5 Save the modified template as a `.rpt` file.

Apply Global Filters in Template

1 In the Report Explorer, open the template that you want to customize. For instance, **Developer.rpt**.

2 On the **Name** pane, under the **Polyspace** node, select **Report Customization (Filtering)**.

3 Drag this component above the **Title Page** component that is located under the **Report-Developer.rpt** node.



- Report Generator
  - Report - Developer.rpt*
    - Report Customization (Filtering)
    - Title Page - Polyspace Code Verification
    - Chapter - Polyspace Code Verifi...
      - Code Verification Summary
      - Report Customization (Filtering)
      - Text - Developer Nam...
    - if (PolyspaceData.RTEEnabled)
      - Chapter - Polyspace Proven
        - Run-time Checks Summary Ordered by

4 On the **Report Customization (Filtering)** pane in the right side of the Report Explorer, specify your filters. For example:

- To include **Division by zero** checks, under **Advanced filters**, in the **Check types to include** field, enter `ZDV`.
- To exclude **Division by zero** checks, under **Advanced filters**, in the **Check types to include** field, enter the regular expression `^(?!ZDV).*`.
- To include the file `main.c`, under **Advanced filters**, in the **Files to include** field, enter `main.c`.
- To exclude the file `main.c`, under **Advanced filters**, in the **Files to include** field, enter the regular expression `^(?!main.c).*`.

In each text box, specify one filter per line.

For more information, see:

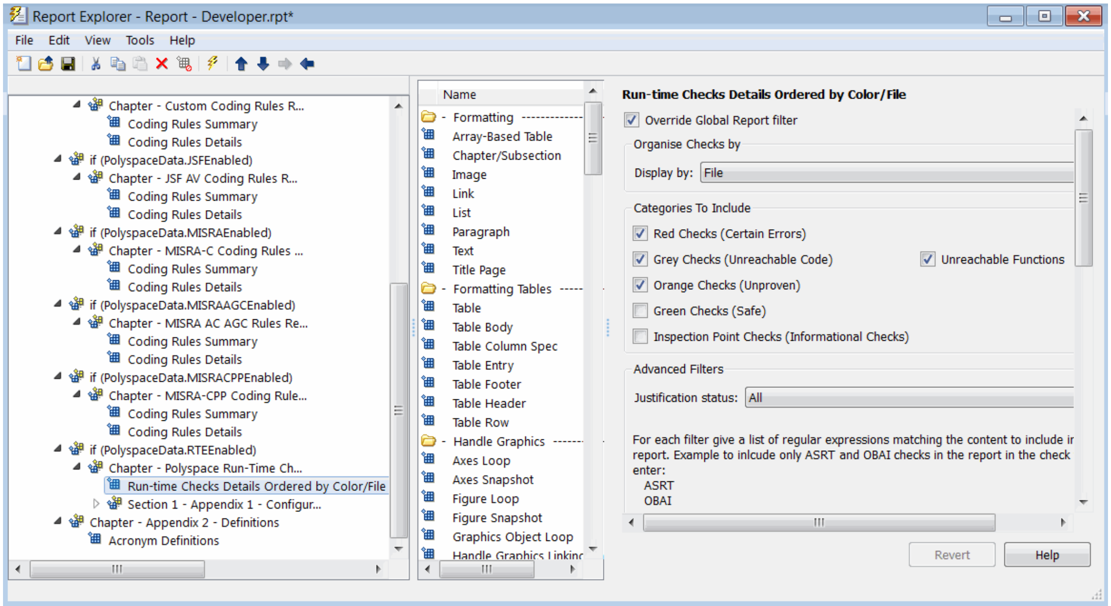
- Check acronyms in "Run-Time Check Reference"

- “Regular Expressions”

Override Global Filters

You can override some of the global filters using the **Run-time Check Details Ordered by Color/File** component. For example, you can have a report chapter that contains NIV checks even though NIV checks are excluded by the global filters.

1 Select the **Run-time Check Details Ordered by Color/File** component.



Run-time Checks Details Ordered by Color/File

☑ Override Global Report filter

Organise Checks by

Display by: File

Categories To Include

☑ Red Checks (Certain Errors)

☑ Grey Checks (Unreachable Code) ☑ Unreachable Functions

☑ Orange Checks (Unproven)

□ Green Checks (Safe)

□ Inspection Point Checks (Informational Checks)

Advanced Filters

Justification status: All

For each filter give a list of regular expressions matching the content to include ir report. Example to inlcude only ASRT and OBAI checks in the report in the check enter:
ASRT
OBAI

2 On the right of the dialog box, select the **Override Global Report filter** check box.

3 Specify your filters for this component. For example, in the **Check types to include** field, enter NIV.

4 Save the template.

For more information on the components available for customizing report, see “Code Verification” in the Simulink® Report Generator documentation.

Use Custom Template

1. Open your results in the Polyspace Code Prover™ Results Manager.
2. Select **Reporting** > **Run Report**.
3. Click **Browse**.
4. Navigate to the location where you saved your template `.rpt` file.
5. Select the file and click **OK**. Under **Select Reports**, you see your template.
6. Select the template and click **Run Report**.

Using Polyspace Results

In this section...

Review Run-Time Errors: Fix Red Errors

The run-time errors highlighted by Polyspace verification are determined by reference to the language standard, and are sometimes implementation dependant — that is, they may be acceptable for a particular compiler but unacceptable according to the language standard.

Consider an overflow on a type restricted from -128 to 127. The computation of 127+1 cannot be 128, but depending on the environment a "wrap around" might be performed with a resulting value of -128.

This result is mathematically incorrect. If the value represents the altitude of a plane, this result could be disastrous.

By default, Polyspace verification does not make assumptions about the way a variable is used. A deviation from the recommendations of the language standard is treated as a red error, and must therefore be corrected.

Polyspace verification identifies two kinds of red checks

- Red errors which are compiler-dependant in a specific way. A Polyspace option might be used to allow particular compiler specific behavior. In other situations, the code must be corrected. An example of a Polyspace option to permit compiler specific behavior is the option to force “IN/OUT” ADA function parameters to be initialized. Examples in C include options to deal with constant overflows, shift operation on negative values, etc.

- You must fix other red errors because they represent real bugs.

Most of the bugs that you find are easy to rectify once they are identified. Polyspace verification identifies bugs regardless of their consequence or the ease with which they can be corrected.

Using Range Information in Results Manager Perspective

Viewing Range Information

On the **Source** pane, you can see range information associated with variables. Place your cursor over a variable. A tooltip displays the range information, if it is available. The software displays tooltips only for variables with a scalar, enumeration, or float data type.

The displayed range information represents a superset of dynamic values, which the software computes using static methods.

Note: Computing range information for read operations may take a long time. You can reduce verification time by limiting the amount of range information displayed in verification results. See“-less-range-information”.

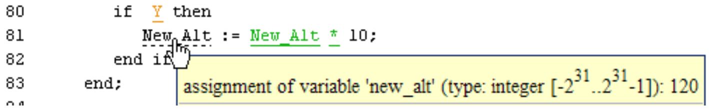
If you click a check, the software provides information about the check on the **Check Details** pane.

Interpreting Range Information

To display range information of variables, the software uses the following syntax:

```
variable_name (type: data_type [data_type_range]) :
[min1 .. max1] or [min2 .. max2] or [min3 .. max3] or exact_value
```

In the following example:

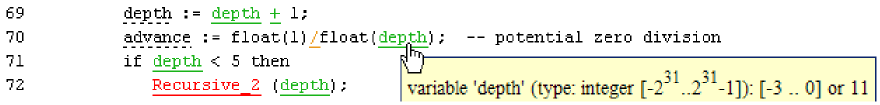


```
      if  Y then
         New_Alt := New_Alt * 10;
      end if;
   end;
```

assignment of variable 'new_alt' (type: integer $[-2^{31}..2^{31}-1]$): 120

the tooltip indicates that the variable New_Alt is a 32-bit integer with the value 120. The range of the data type is -2^{31} to $2^{31} - 1$.

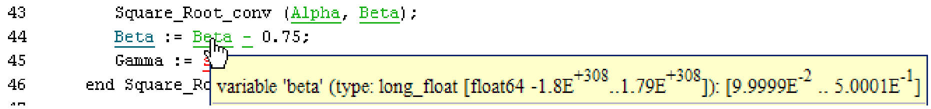
In the next example, the 32-bit integer depth lies either between –3 and 0 or is equal to 11.



```
      depth := depth + 1;
      advance := float(1)/float(depth);  -- potential zero division
      if depth < 5 then
         Recursive_2 (depth);
```

variable 'depth' (type: integer [-2^{31} .. 2^{31}-1]): [-3 .. 0] or 11

With the next case:

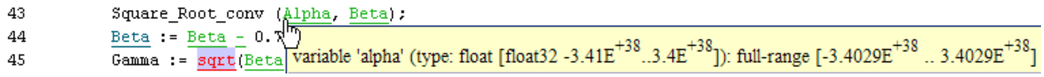


```
      Square_Root_conv (Alpha, Beta);
      Beta := Beta - 0.75;
      Gamma := S
   end Square_Ro
```

variable 'beta' (type: long_float [float64 -1.8E^{+308} ..1.79E^{+308}]): [9.9999E^{-2} .. 5.0001E^{-1}]

the tooltip indicates that the variable Beta is a 64-bit float that lies between 9.9999E-2 and 5.0001E-1. The range of the data type is –1.8E+308 to 1.79E+308.

The tooltip can also reveal whether the variable occupies the full range:



```
      Square_Root_conv (Alpha, Beta);
      Beta := Beta - 0.7
      Gamma := sqrt(Beta
```

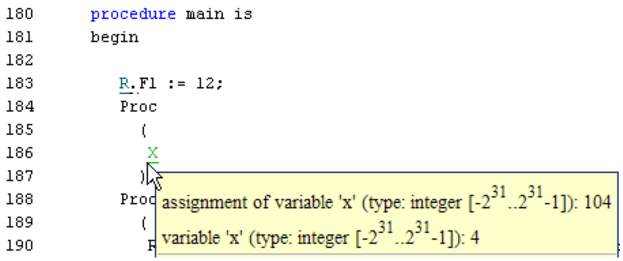
variable 'alpha' (type: float [float32 -3.41E^{+38} ..3.4E^{+38}]): full-range [-3.4029E^{+38} .. 3.4029E^{+38}]

The message shows that the value of the variable Alpha is a 32-bit float that occupies the full range of the data type, –3.4029E+38 to 3.4029E+38.

Consider a procedure with an in out parameter:

```
procedure proc(X : in out Integer) is
begin
   X :=
   X
   +
   100;
end;
```

The procedure is called with a parameter X:



```
procedure main is
begin

   R.F1 := 12;
   Proc
     (
      X
     )
   Proc
     (
      F
```

assignment of variable 'x' (type: integer $[-2^{31}..2^{31}-1]$): 104

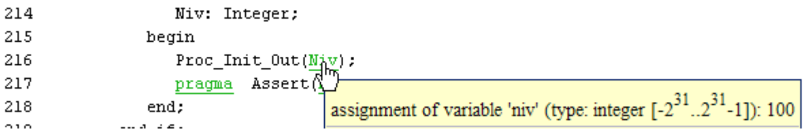
variable 'x' (type: integer $[-2^{31}..2^{31}-1]$): 4

The first line of the tooltip provides information about the `out` value of `X`, a 32-bit integer with the value 104. The second line gives information about the `in` value of `X`, a 32-bit integer with the value 4.

If a procedure has only an `out` parameter, for example:

```
procedure Proc_Init_Out(X : out Integer) is
begin
   X := 100;
   null;
end;
```

the tooltip is a single line with information about the `out` parameter:



```
        Niv: Integer;
     begin
        Proc_Init_Out(Niv);
        pragma  Assert(
     end;
```

assignment of variable 'niv' (type: integer $[-2^{31}..2^{31}-1]$): 100

Why Review Dead Code Checks

- “Functional Bugs in Gray Code” on page 8-71
- “Structural Coverage” on page 8-72

Functional Bugs in Gray Code

Polyspace verification finds different types of dead code. Common examples include:

- Defensive code
- Dead code due to a particular configuration.
- Libraries which are not used to their full extent in a particular context.
- Dead code resulting from bugs in the source code.

The causes of dead code listed in the following examples are taken from critical applications of embedded software by Polyspace verification.

- A lack of parenthesis and operand priorities in the testing clause can change the meaning significantly.
- Consider a line of code such as

  ```
  IF NOT a AND b OR c AND d
  ```

  Now consider how misplaced parentheses might influence how that line behaves

  ```
  IF NOT (a AND b OR c AND d)
  ```

  ```
  IF (NOT (a) AND b) OR (c AND d))
  ```

  ```
  IF NOT (a AND (b OR c) AND d)
  ```
- The test of variable inside an unreachable branch of a conditional statement.
- An unreachable “else” clause where the wrong variable is tested in the “if” statement.
- A variable that is supposed to be local to the file but instead is local to the function.
- Wrong variable prototyping leading to a comparison which is always false.

The consequences of dead code and the effort to deal with it is unpredictable. From a one-week effort of functional testing on target, trying to build a scenario going into that branch, and wondering why the functional behavior is altered to a three-minute code review discovering the bug.

Polyspace does not measure the impact of dead code.

The tool provides a list of dead code. A short code review enables you to place each entry from that list into one of the five categories. Doing so identifies known dead code and uncovers real bugs.

The Polyspace experience is that at least 30% of gray code reveals real bugs.

Structural Coverage

Polyspace software performs upper approximations of possible executions. Therefore, even if a line of code is shown in green, there remains a possibility that it is a dead portion of code. Because Polyspace verification made an upper approximation, it could not conclude that the code was dead. Instead it concludes that a run-time error could not be found.

Polyspace verification finds around 80% of dead code that the developer would find by doing structural coverage.

Polyspace verification is intended to be a productivity aid in dead code detection. It detects dead code which might take days of effort to find by other means.

Reviewing Orange: Automatic Methodology

During a verification, Polyspace can automatically highlight orange checks associated with code that might not be robust.

The automatic methodology separates the following orange NIVL and OVFL checks from other orange checks:

- All NIVL scalar local orange checks. These checks do not concern floats, records (and components), and arrays.
- All OVFL scalar orange checks within subtypes: conversion of a subtype into a smaller subtype.

You must address these checks first. Polyspace is very precise with these checks. These checks indicate issues of robustness.

Example

```
Package body Test is
 ATab : array(0..9) of Integer := (Others => 0);
 function Assign_array(X : integer) return Integer is
   Y : Integer;
  begin
   y := ATab(X - 12);     -- Warning OVFL on operator “-“ given by
                          -- the Automatic methodology
   return y;
  end Assign_Array;

  function read_bus_status return boolean; -- function stubbed
  procedure partial_init( New_Alt : in out Integer ) is
    Y : boolean;
   begin
    if read_bus_status then
     New_Alt := 12;
     Y := True;
    else
     New_Alt := 120;
    end if;
    if Y then     -- Warning NIVL on “Y” given by
                   -- the automatic methodology
     New_Alt := New_Alt * 10;
```

```
24    end if;
25   end partial_init;
26 end Test;
```

In this example, the automatic methodology filters all orange checks except:

- OVFL at line 6. The associated message is:

  ```
  Unproven : operation [-] on scalar may overflow
  (on MIN or MAX bounds of integer [from -2^63 .. 2^63-1 to 0..9])
  ```

  Line 6 is an example of a conversion within a smaller subtype.

- NIVL at line 21. The associated message is:

  ```
  Warning : local variable may be non-initialized
  variable 'y' (type: boolean [false..true]): 1
  ```

  Line 21 is an example where there is a robustness issue if the right branch is not executed.

Reviewing Orange Checks

Orange checks indicate *unproven code*. The code cannot be proved to either have or not have a run-time error.

The number of orange checks that you review is determined by several factors, including:

- The stage of the development process
- Your quality goals

There are also actions you can take to reduce the number of orange checks in your results.

For more information, see “Orange Check Management”.

Integration Bug Tracking

By default, integration bug tracking can be achieved by applying the selective orange methodology to integrated code. Each error category is more likely to reveal integration bugs, depending on the chosen coding rules for the project.

For instance, consider a function that receives two unbounded integers. The presence of an overflow can be checked only at integration phase, because at unit phase the first mathematical operation reveals an orange check.

Consider the following cases:

- When integration bug tracking is performed in isolation, a selective orange review highlights most integration bugs. In this case, a Polyspace verification has been performed integrating tasks.
- When integration bug tracking is performed together with an exhaustive orange review at unit phase, a Polyspace verification has been performed on one or more files.

With the second case, as an exhaustive orange review has been performed file by file, only checks that have turned from green to another color at integration phase are worth assessing.

For instance, if a function takes a structure as an input parameter, the standard hypothesis made at unit level is that the structure is well initialized. The verification displays a green NIV check at the first read access to a field. But this hypothesis might not be true at integration time, where the check can turn orange if the field is not initialized.

This type of orange checks reveals integration bugs.

Finding Bugs in Unprotected Shared Data

Based on the list of entry points in a multitask application, Polyspace verification identifies a list of shared data and provides several pieces of information about each entry:

- The data type
- A list of reading and writing accesses to the data through functions and entry points
- The type of protection against concurrent access

A shared data item is a global data item that is read from or written to by two or more tasks. It is unprotected from concurrent accesses when one task can access it while another task is in the process of doing so. The following is a possible scenario:

- As there is conflict with a particular variable, a bug exists and protection is required.

If this is not a possible scenario, then one of the following explanations might apply:

- The compilation environment guarantees an atomic read or write access for variables of a type that is less than one or two bytes in size. Therefore, the integrity of the variables' content is maintained even if there are conflicts associated with these variables.

- The variable is protected by a critical section or a mutual temporal exclusion. You may want to include this information in the Polyspace project configuration parameters and rerun the verification.

It is also worth checking whether variables that are supposed to be constant are modified . Use the variables dictionary.

Dataflow Verification

Data flow verification is often performed within certification processes — typically in the avionic, aerospace, or transport markets.

This activity makes heavy use of two features of Polyspace results, which are available after the Control and Data Flow verification phase.

- Call tree computation
- Dictionary containing read and write access operations on global variables. (This dictionary can also be used to build a database listing for each procedure, for its parameters, and for its variables.)

Polyspace software can help you to build these results by extracting information from both the call tree and the dictionary.

Checks on Procedure Calls with Default Parameters

Some checks may be located on procedure calls. They correspond to default values assigned to parameters of a procedure.

Example

```
package DCHECK is
 type Pixel is
  record
   X : Integer;
   Y : Integer;
  end record;
 procedure MAIN;

 NError : Integer;
  procedure Failure (Val : Integer := Nerror);
```

```
11   procedure MessageFailure (str : String := "");
12  end DCHECK;
13
14  package body DCHECK is
15   type TwentyFloat is array (Integer range 1.. 20) of Float;
16
17   procedure AddPixelValue(Vpixel : Pixel) is
18   begin
19    if (Vpixel.X < 3) then
20     Failure; -- NIV Verified: Variable is initialized
(Nerror)
21     MessageFailure; --COR Verified: Value is in range (string)
22    end if;
23   end AddPixelValue;
24
25   procedure MAIN is
26    B : Twentyfloat;
27    Vpixel : Pixel;
28   begin
29    NError := 12;
30    Vpixel.X := 1;
31    AddPixelValue(Vpixel);
32    NError := -1;
33    for I in 2 .. Twentyfloat'Last loop
34     if ((I mod 2) = 0) then
35      B(I) := 0.0;
36      if (I mod 2) /= 0 then
37       Failure; -- NIV Unreachable: Variable is not
initialized
38       MessageFailure; -- COR Unreachable: Value is not in range
39      end if;
40     end if;
41    end loop;
42    MessageFailure("end of Main");
43   end MAIN;
44  end DCHECK;
```

Explanation

In the previous example, at line 20 and 37, checks on the procedure called `Failure` represent the check NIV made on the default parameter `N` error (a global parameter).

COR checks at line 21 and 38 on `MessageFailure` represent verification made by Polyspace on the default assignment of a null string value on the input parameter.

Note: Checks remain on the procedure definition except for the following basic types and values:

- A numerical value (example: 1, 1.4)
- A string (example: “end of main”)

- A character (example: A)
- A variable (example: Nerror).

_INIT_PROC Procedures

In the Polyspace Results Manager perspective, you might find nodes _INIT_PROC $ in the “Procedural entities” view. As your compiler, Polyspace generates a function _INIT_PROC for each record where initialization occurs. When a package defines many records, each _INIT_PROC is differentiated by $I (I in 1.n).

Example

```
package test is
 procedure main;
end test;

package body test is

 subtype range_0_3 is integer range 0..3;
 Vg : Integer := 1;
 Pragma Volatile( Vg );

  function random return integer;
  type my_rec1 is
   record
    a : integer := 2 + random; -- Unproven OVFL coming from _INIT_PROC procedure (initialization of V1)
    b : float := 0.2;
   end record;
  V1 : my_rec1;
  V2 : my_rec1 := (10, 10.10);

  procedure main is
   Function Random return Boolean;
  begin
   null;
  end;
 end test;
```

In the previous example, an unproven OVFL on the field a of record `my_rec1` has been detected when initializing the global variable `V1`. It initializes record of global variable

V1 at line 17. A random procedure could return any integer and lead to an overflow by adding to 2. The check is located in the _INIT_PROC node in the **Results Summary** view.

Pointers to Explicit Tasks

If a task type is used through a pointer, then Polyspace automatically adds two instances of this task type to the Polyspace execution model of your application. Task pointer objects that are used in your application are represented by these two instances. Polyspace uses these instances to simulate tasks associated with the execution of your application.

Consider the following example.

```
package Test is
   task type Ressource_T is
      entry Get (X : out integer);
      entry Set (X : in integer);
   end Ressource_T;
   type Ressource_Ptr_T is access Ressource_T;
   Ressource_Ptr : Ressource_Ptr_T;
   V : Integer := 0;
   function Alloc_Ressource return Ressource_Ptr_T;
   procedure Test_Ressource;
private
end Test;

package body Test is
   task body Ressource_T is
      Random : Boolean;
      pragma Volatile (Random);
   begin
      while Random loop
         select
            accept Get (X : out Integer) do
               X := V + 2;
            end Get;
         or
            accept Set(X : in Integer) do
               V := X - 2;
            end Set;
         end select;
      end loop;
   end Ressource_T;

   function Alloc_Ressource return Ressource_Ptr_T is
   begin
      return new Ressource_T;
   end Alloc_Ressource;

   procedure Test_Ressource is
```

```
     X : Integer;
     Tp : Ressource_Ptr_T;
   begin
      Tp := Alloc_Ressource;
      Tp.Get(X);
   end Test_Ressource;
end Test;
```

At the end of verification, in the **Results Summary** view, you see two instances of the task type `Ressource_T`, that is, `PST_Ressource_T_1` and `PST_Ressource_T_2`.

Managing Orange Checks

What Is an Orange Check?

Orange checks indicate *unproven code*, which means the software cannot prove that the code:

- Produces a run-time error
- Does not produce a run-time error

Polyspace verification attempts to prove the absence or existence of run-time errors. Therefore, the software considers all code unproven before a verification. During a verification, the software attempts to prove that the code is:

- Without run-time errors (green)
- Certain to fail (red)
- Unreachable (gray)

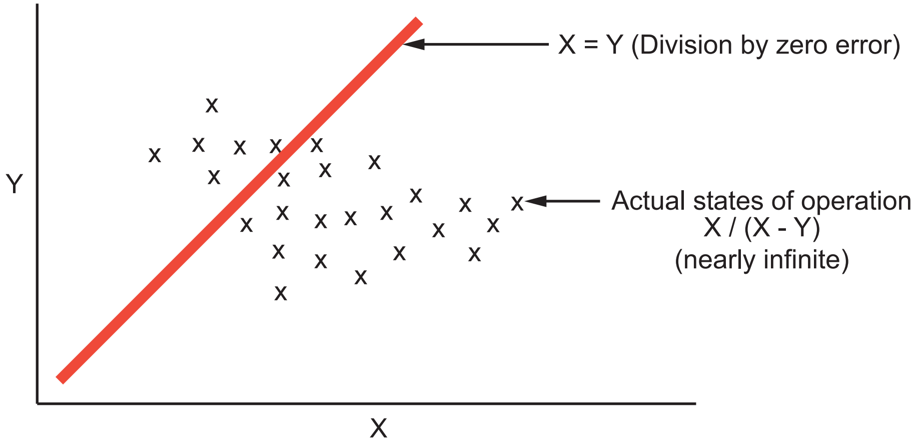
Code that is not assigned one of these categories (colors) stays unproven (orange).

Code often remains unproven in situations where some paths fail while others succeed. For example, consider the following instruction:

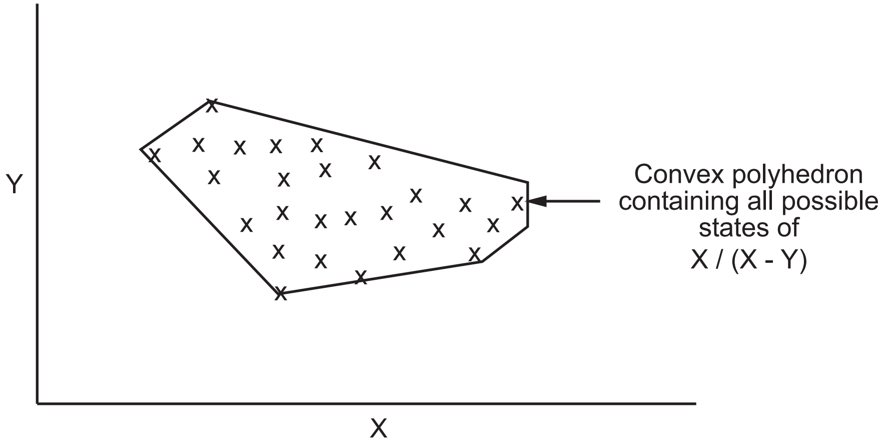
```
X = 1 / (X - Y);
```

Does a division-by-zero error occur?

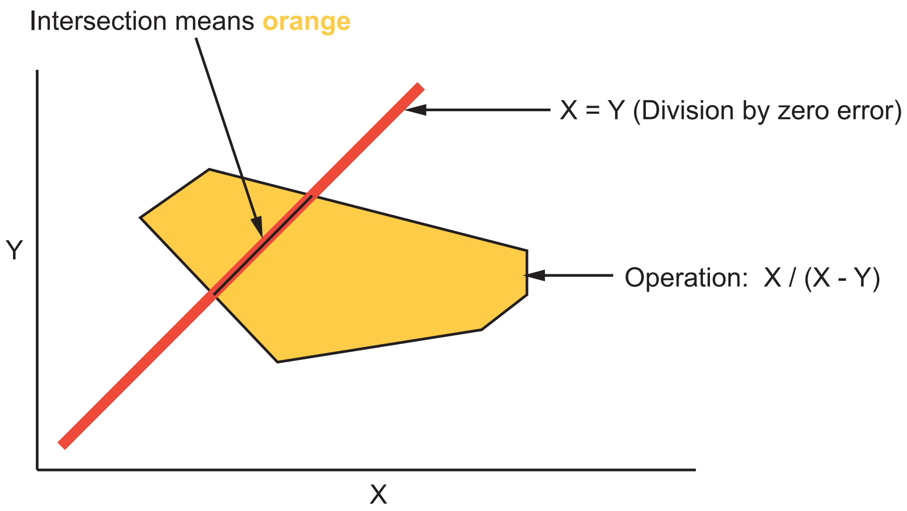
The answer depends on the values of *X* and *Y* . However, there are an almost infinite number of possible values. Creating test cases for all possible values is not practical.



Because it is not possible to test every value for each variable, the target computer and programming language provide limits on the possible values of the variables. Polyspace verification uses these limits to compute a *cloud of points* (upper-bounded convex polyhedron) that contains all possible states for the variables.

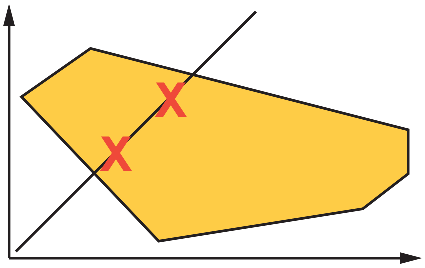


Polyspace verification then compares the data set represented by this polyhedron to the error zone. If the two data sets intersect, the check is orange.

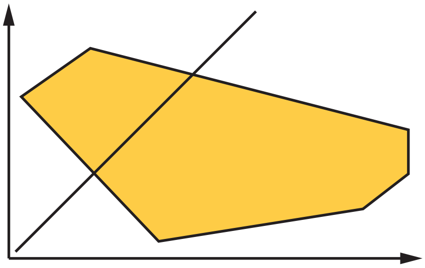


Graphical Representation of an Orange Check

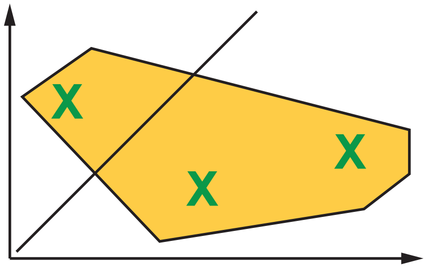
A true orange check represents a situation where some paths fail while others succeed. However, because the data set in the verification is an approximation of actual values, an orange check may actually represent a check of another color.



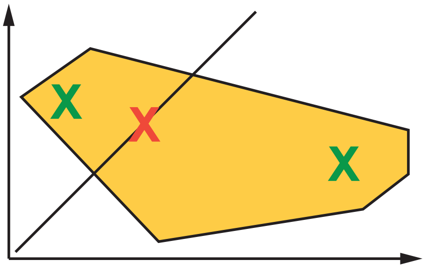
Red approximated by orange



Gray approximated by orange



Green approximated by orange



Any other situation (true orange)

Polyspace reports an orange check when the two data sets intersect, regardless of the actual values. Therefore, you may find orange checks that represent bugs, while other orange checks represent code that does not have run-time errors.

You can resolve some of these orange checks by increasing the precision of your verification, or by adding execution context, but often you must review the results to determine the source of an orange check.

Sources of Orange Checks

Orange checks can be separated into two categories:

In this section…

Orange Checks from Code

Potential Bug

An orange check can reveal code which will fail under some circumstances. These types of orange checks often represent real bugs.

For example, consider a function `Recursion()`:

- `Recursion()` takes a parameter, increments it, then divides by it.
- This sequence of actions loops through an indirect recursive call to `Recursion_recurse()`.

If the initial value passed to `Recursion()` is negative, then the recursive loop will at some point attempt a division by zero. Therefore, the division operation causes an orange `Division by Zero`.

Data Set Issue

An orange check can result from a theoretical set of data that cannot actually occur.

Polyspace verification uses an *upper approximation* of the data set, meaning that it considers many combinations of input data rather than a particular combination. Therefore, an orange check may result from a combination of input values that is not possible at execution time.

For example, consider three variables *X*, *Y*, and *Z*:

- Each of these variables is defined as being between 1 and 1,000.
- The code computes `X*Y*Z` on a 16-bit data type.
- The result can potentially overflow, so it causes an orange OVFL.

When developing the code, you might know that the three variables cannot take the value 1,000 at the same time, but this information is not available to the verification. Therefore, the multiplication is orange.

When an orange check is caused by a data set issue, you can usually identify the cause quickly. After identifying a data set issue, you might want to comment the code to flag the warning, or modify the code to take the constraints into account.

Orange Checks from Verification Limitations

Inconclusive Verification

An orange check can be caused by situations in which the verification is unable to conclude whether a problem exists.

In some code, it is impossible to conclude whether an error exists without additional information.

For example, consider a variable *X*, and two concurrent tasks `T1` and `T2`.

- *X* is initialized to `0`.
- `T1` assigns the value `12` to *X*.
- `T2` divides a local variable by *X*.
- A division by zero error is possible because `T1` can be started before or after `T2`, so the division causes an orange ZDV.

Unless you define the call sequence, the verification cannot determine if an error will occur.

Most inconclusive orange checks take some time to investigate. An inconclusive orange check often results from complex code structure. Sometimes, such situations take an hour or more to understand. Depending on the criticality of the function and the required speed of execution, you may might want to rewrite the code to remove risk of failure.

Basic Imprecision

An orange check can be caused by imprecise approximation of the data set used for verification.

For example, consider a variable *X*:

- Before the function call, *X* is defined as having the following values: `-5`, `-3`, `8`, or a value in the range `[10...20]`.
  `0` has been excluded from the set of possible values for *X*.
- However, due to optimization at low precision levels (`-O0`), the verification approximates *X* in the range `[-5...20]`, instead of the previous set of values.
- Therefore, calling the function `x = 1/x` causes an orange ZDV.

Polyspace verification is unable to prove the absence of a run-time error in this case.

In cases of basic imprecision, you might be able to resolve orange checks by increasing the precision level. If increasing the precision level does not resolve the orange check, verification cannot help directly. You must review the code to determine the problem.

For more information, see “Verification Approximations”.

Do I Have Too Many Orange Checks?

If the goal of code verification is to prove the absence of run-time errors, you might be concerned by the number of orange checks in your results.

However, the presence of multiple orange checks need not be a cause for concern. The minimum number that you want depends on several factors:

- **Development Stage** – When verifying the first version of a software component, focus exclusively on resolving red checks. As development progresses, start considering the orange checks more and more.
- **Application Requirements** – Sometimes, to write provable code, you can compromise with properties such as code size, speed, and portability. Depending on the requirements of your application, you might optimize one or more of these properties at the expense of more orange checks.
- **Quality Goals** – Using Polyspace software, you can meet your quality goals. Therefore, before you verify code, you must define quality goals for your application. These goals should be based on the criticality of the application, as well as time and cost constraints. Based on your quality goals, you can choose to retain a specific minimum number of orange checks in your application.

It is these factors that ultimately determine how many orange checks are acceptable in your results, and what you must do with the orange checks that remain.

Therefore, it is essential to understand how to manage the remaining orange checks. For more information, see “Manage Orange Checks” on page 9-10.

Manage Orange Checks

Polyspace verification by itself cannot produce quality code at the end of the development process. Verification helps you measure the quality of your code, identify issues, and achieve your quality goals. To do this, you must effectively integrate Polyspace verification into your development process.

To manage orange checks effectively, perform each of the following steps:

1. Define your quality goals.
2. Set Polyspace analysis options to match your quality goals.
3. Define a process to reduce orange checks. See “Overview: Reducing Orange Checks” on page 9-11.
4. Apply the process to work with remaining orange checks.

Overview: Reducing Orange Checks

Actions that reduce orange checks and improve the quality of your code:

- “Apply Coding Guidelines” on page 9-12.

Actions that reduce orange checks through increased verification precision:

- “Improve Verification Precision” on page 9-13
- “Stub Parts of the Code Manually” on page 9-14.
- “Specify Multitasking Behavior” on page 9-19.

Each of these actions have trade-offs, either in development time, verification time, or the risk of errors. Therefore, before taking an action, it is important to define your quality goals.

Your quality goals determine how many orange checks are acceptable, what actions you should take to reduce orange checks, and what you should do with the remaining orange checks.

Apply Coding Guidelines

The number of orange checks per file depends on the coding style used in the project.

The following coding guidelines improve Polyspace precision and selectivity in Ada code verification:

- Use constrained types. Use subtype and not standard type.
- Do not use "use at" clause.
- Minimize the use of big and complex types (record of record, array of record, etc.).
- Minimize the use of volatile variables.
- Minimize the use of assembler code.
- Do not mix assembly code and Ada. Gather assembly code in a procedure or function which can be automatically stubbed.

Improve Verification Precision

Improving the precision of a verification can reduce the number of orange checks in your results.

There are a number of Polyspace options that can improve the precision of the verification. The compromise for this improved precision is increased verification time.

The following sections describe how to improve the precision of your verification:

In this section...

Set the Analysis Precision Level

The precision level specifies the mathematical algorithm used to compute the cloud of points (polyhedron) containing many possible states for the variables. Changing the precision level does not improve the quality of your code. However, orange checks caused by low precision can become green when verified with higher precision. The default precision level is 2. To set the precision level:

1. In the Project Manager perspective, on the **Configuration** pane, select **Precision**.
2. From the **Precision Level** drop-down list, select `0`, `1`, `2`, or `3`.

For more information, see “Precision level”.

Set Software Safety Analysis Level

The verification level specifies how many times the abstract interpretation algorithm passes through your code. Each pass results in a deeper level of propagation of calling and called context. The deeper the verification goes, the more precise it is. By default, verification proceeds to `Software Safety Analysis Level 4`. To set the verification level:

1. In the Project Manager perspective, on the **Configuration** pane, select **Precision**.
2. From the **Verification level** drop-down list, select the level that you want.

For more information, see “Verification level”.

Stub Parts of the Code Manually

Manually stubbing parts of your code can reduce the number of orange checks in your results. Manual stubbing does not improve the quality of your code, but only changes the results.

Stubs do not need to model the details of the functions or procedures involved. They only need to represent how the code interacts with the remainder of the system.

If a function is supposed to return an integer, the default automatic stubbing will stub it on the assumption that it can take a value from the full range of an integer.

The following sections describe how to reduce orange checks using manual stubbing:

In this section...
"Manual vs. Automatic Stubbing" on page 9-14
"Emulating Function Behavior with Manual Stubs" on page 9-15
"Reducing Orange Checks with Empty Stubs" on page 9-16
"Applying Constraints to Variables Using Stubs" on page 9-17

Manual vs. Automatic Stubbing

There are two types of stubs in Polyspace verification:

- **Automatic stubs** – The software automatically creates stubs for unknown functions based on the function prototype (the function declaration). Automatic stubs do not provide insight into the behavior of the function, but are very conservative, ensuring that the function does not cause a run-time error.
- **Manual stubs** – You create these stub functions to emulate the behavior of the missing functions, and manually include them in the verification with the rest of the source code. Manual stubs can better emulate missing functions, or they can be empty.

By default, Polyspace software automatically stubs functions. However, because automatic stubs are conservative, they can lead to more orange checks in your results.

Stubbing Example

```
procedure a_missing_function
(dest: in out integer,
src : in integer);
procedure test is
a: integer;
b: integer;
begin
a: = 1;
b: = 0;
a_missing_function(a,b);
b:= 1/a;
end;
```

Due to automatic stubbing, the verification assumes that *a* can be have take a value from the full range of integers, including 0. This assumption produces an orange check on the division.

If you provide an empty manual stub for the function, the division is green. This action reduces the number of orange checks in the result, but does not improve the quality of the code itself. The function could still potentially cause an error.

You can also provide a detailed manual stub that emulates the behavior of the function.

Emulating Function Behavior with Manual Stubs

You can improve both the speed and selectivity of your verification by providing manual stubs that emulate the behavior of missing functions. The trade-off is time spent writing the stubs.

Manual stubs do not need to model the details of the functions or procedures involved. They only need to represent how the code interacts with the remainder of the system.

Example

This example shows a header for a missing function (which may occur when the verified code is an incomplete subset of a project).

```
procedure a_missing_function
  (dest: in out integer,
  src  : in integer);
```

Applying fine-level modeling of constraints in primitives and outside functions at the application periphery propagates more precision throughout the application, which results in a higher selectivity rate (more proven colors, i.e. more red+ green + gray). For this function, you could add a simple body:

```
procedure a_missing_function
  (dest: in out integer,
  src : in integer)
begin
  dest := src;
end;
```

In this case, instead of considering the full range for the `dest` parameter, Polyspace considers the relation between input parameter `src` and the output parameter, propagating more precision throughout the application.

Reducing Orange Checks with Empty Stubs

Providing empty manual stubs can reduce the number of orange checks in your results.

For example, consider the following code:

```
package automatic_vs_manual_stub is

     procedure write_or_not1(x : in out Integer);
     procedure write_or_not2(x : in out Integer);
     procedure green;
     procedure orange;

end;

package body automatic_vs_manual_stub is

     procedure write_or_not2(x : in out Integer) is
     begin
           null;
     end;


     procedure orange is
           x : Integer;
           y : Integer;
     begin
           x := 12;
           y := 1;
           write_or_not1(x);
           y := y/x;   -- Orange ZDV due to automatic stub
     end;
     procedure green is
           x : Integer;
           y : Integer;
     begin
           x := 12;
           y := 1;
           write_or_not2(x);
           y := y/x;    -- Green due to empty stub
     end;

end;
```

The code for the two functions is identical, but the automatic stub produces an orange check, while the empty stub produces a green.

While the empty stub reduces the number of orange checks in your results, you must take additional steps to ensure that the actual function does not result in a run-time error.

Applying Constraints to Variables Using Stubs

Another way to increase the selectivity is to indicate to the Polyspace software that some variables may lie within smaller functional ranges instead of the full range of the considered type.

This smaller function range primarily concerns two items from the language:

- Parameters passed to functions.
- Variables' content, mostly globals, which might change from one execution to another. Typically, these might include things like calibration data or mission specific data. These variables might be read directly within the code, or read through an API of functions.

Reduce the cloud of points

If a function is supposed to return an integer, the default automatic stubbing stubs it on the assumption that it can potentially take a value from the full range of an integer.

Polyspace models data ranges throughout the code it verifies. It produces more precise, informative results provided that the data it considers from the “outside world” is representative of the data that can be expected when the code is implemented. There is a certain number of mechanisms available to model such a data range within the code itself, and there are three possible approaches.

with volatile and assert	**with assert and without volatile**	**without assert, without volatile, without "if"**

`function stub return INTEGER is`
`tmp: INTEGER;`
`random: INTEGER;`
`pragma volatile (random);`
`begin`
`tmp:= random;`
`pragma assert (tmp>=1);`
`pragma assert (tmp<=10);`
`return tmp;`
`end;`
	`function random return INTEGER;`
	`pragma Interface (C, random);`
	`function stub return INTEGER is`
	`tmp: INTEGER;`
	`begin`
	`tmp:= random;`
	`pragma assert (tmp>=1);`
	`pragma assert (tmp<=10);`
	`return tmp;`
	`end;`
		`function random return INTEGER;`
		`pragma Interface (C, random);`
		`function stub return INTEGER is`
		`tmp: INTEGER;`
		`begin`
		`tmp:= random;`
		`while (tmp<1 or tmp>10)`
		`loop`
		`tmp:=random;`
		`end loop;`
		`return tmp;`
		`end;`

The three approaches are equivalent (except, perhaps, that the assertions in the first two usually generate orange checks).

Specify Multitasking Behavior

The asynchronous characteristics of your application can have a direct impact on the number of orange checks. Properly describing characteristics such as implicit task declarations, mutual exclusion, and critical sections can reduce the number of orange checks in your results.

For example, consider a variable `X`, and two concurrent tasks `T1` and `T2`.

- `X` is initialized to `0`.
- `T1` assigns the value `T2` to `X`.
- `T2` divides a local variable by `X`.
- A division by zero error is possible because `T1` can be started before or after `T2`, so the division causes an orange `Division by Zero` error.

The verification cannot determine if an error will occur without knowing the call sequence. Modeling the task differently could turn this orange check green or red.

For more information, see “Preparing Multitasking Code”.

Overview: Reviewing Orange Checks

After you define a process that matches your quality goals, you end up with a certain number of orange checks for your quality model.

At this point, the goal is not to eliminate orange checks, but to work efficiently with them.

To work efficiently with orange checks:

- "Organize Orange Check Review" on page 9-21
- "Import and Export Review Comments"

Organize Orange Check Review

This example shows how to organize your review of orange checks.

1 On the **Results Summary** pane, select **Show** > **Critical Checks**.

  This action retains only red, gray and critical orange checks.

2 Before reviewing orange checks, review red and gray checks.

3 Identify the cause of each orange check. On the **Results Summary** pane, assign a **Classification** and **Status** to the check. Add additional comments if necessary.

4 After you have reviewed critical orange checks, on the **Results Summary** pane, select **Show** > **All checks**.

  Depending on the quality level that you want, you can choose whether to review the noncritical orange checks or not.

Software Quality with Polyspace Metrics

Software Quality with Polyspace Metrics

Polyspace Metrics is a Web-based tool for software development managers, quality assurance engineers, and software developers, to do the following in software projects:

- Evaluate software quality metrics
- Monitor the variation of code metrics and run-time checks through the lifecycle of a project
- View defect numbers, run-time reliability of the software, review progress, and the status of the code with respect to software quality objectives.

If you are a development manager or a quality assurance engineer, through a Web browser, you can:

- View software quality information about your project. See “View Polyspace Metrics Project Index” on page 10-9.
- Observe trends over time, by project or module. See “Review Overall Progress” on page 10-15.
- Compare metrics of one project version with those of another. See “Compare Project Versions” on page 10-20.

If you have the Polyspace product installed on your computer, you can drill down to run-time checks in the Polyspace verification environment. This feature allows you to review run-time checks and, if required, classify these checks as defects. In addition, if you think that run-time checks can be justified, you can mark them as justified and enter relevant comments. See “Review Run-Time Checks” on page 10-21.

If you are a software developer, Polyspace Metrics allows you to focus on the latest version of the project that you are working on. You can use the view filters and drill-down functionality to go to code defects, which you can then fix. See “Fix Defects” on page 10-23.

Polyspace calculates metrics that are used to determine whether your code fulfills predefined software quality objectives. You can redefine these software quality objectives. See “Customizing Software Quality Objectives” on page 10-25.

Setting Up Verification to Generate Metrics

You can run, either manually or automatically, verifications that generate metrics. In each case, the Polyspace product uses a metrics computation engine to evaluate metrics for your code, and stores these metrics in a results repository.

Before you run a verification manually, in the Project Manager perspective:

1. On the **Configuration** pane, select **Machine Configuration**.
2. Select the **Send to Polyspace Server** check box.
3. Select the **Add to results repository** check box.

To set up scheduled, automatic verification runs, see "Specifying Automatic Verification" on page 10-3.

The software saves generated metrics in the following XML file:

`Results_Folder``/Polyspace-Doc/Code_Metrics.xml`

Specifying Automatic Verification

You can configure verifications to start automatically and periodically, for example, at a specific time every night. At the end of each verification, the software stores results in the repository and updates the project metrics. You can also configure the software to send you an email at the end of the verification. This email will contain:

- Links to results
- An attached log file if the verification produces compilation errors
- A summary of new findings, for example, new potential and actual run-time errors

To configure automatic verification, you must create an XML file `Projects.psproj` that has the following elements:

```
<?xml version="1.0" encoding="UTF-8" ?>
<!-- Polyspace Metrics Automatic Verification Project File -->
<Configuration>
  <Project>
    <Options>
    </Options>
    <LaunchingPeriod>
    </LaunchingPeriod>
    <Commands>
    </Commands>
    <Users>
      <User>
      </User>
    </Users>
  </Project>
  <SmtpConfiguration>
  </SmtpConfiguration>
</Configuration>
```

Configure the verification by providing data for the elements (and their attributes) within `Configuration`. See “Element and Attribute Data for Projects.psproj” on page 10-4.

After creating `Projects.psproj`, place the file in the following folder on the Polyspace Queue Manager server:

```
/var/Polyspace/results-repository
```

Note: If the flag `process_automation` in your configuration file `polyspace.conf` is set to `yes`, then, when you start your Polyspace Queue Manager server, Polyspace generates two template files in the results repository folder:

- `ProcessAutomationWindowsTemplate.psproj` for Windows
- `ProcessAutomationLinuxTemplate.psproj` for Linux

Use the relevant template to create your `Projects.psproj` file.

For more information about the configuration file `polyspace.conf`, see “Manual Configuration of the Polyspace Server”.

Element and Attribute Data for Projects.psproj

Project

Specify three attributes:

- `name` — Your project name.
- `language` — ADA or ADA95.

- `verificationKind` — Mode, which is either `INTEGRATION` or `UNIT-BY-UNIT`.

For example,

```
<Project name="Demo_Ada" language="Ada" verificationKind="INTEGRATION">
```

The Project element also contains the following elements:

- "Options" on page 10-5
- "LaunchingPeriod" on page 10-5
- "Commands" on page 10-6
- "Users" on page 10-7

Options

Specify a list of Polyspace options required for your verification, with the exception of –`unit-by-unit`, `–results-dir`, `–prog` and `–verif-version`. If these four options are present, they are ignored.

The following is an example.

```
<Options>
  -O2
  -to pass2
  -target sparc
  -temporal-exclusions-file sources/temporal_exclusions.txt
  -entry-points tregulate,proc1,proc2,server1,server2
  -critical-section-begin Begin_CS:CS1
  -critical-section-end End_CS:CS1
</Options>
```

LaunchingPeriod

For the starting time of the verification, specify five attributes:

- `hour`. Integer in the range 0–23.
- `minute`. Integer in the range 0–59.
- `month`. Integer in the range 1–12.
- `day`. Integer in the range 1–31.
- `weekDay`. Integer in the range 1–7, where 1 specifies Monday.

Use `*` to specify all values in range, for example, `month="*"` specifies a verification every month.

Use `-` to specify a range, for example, `weekDay="1-5"` specifies Monday to Friday.

You can also specify a list for each attribute. For example, `day="1,15"` specifies the first and the fifteenth day of the month.

Default: If you do not specify attribute data for `LaunchingPeriod`, then a verification is started each week day at midnight.

The following is an example.

```
<LaunchingPeriod hour="12" minute="20" month="*" weekDay="1-5">
```

Commands

You can provide a list of optional commands. There must be only one command per line, and these commands must be executable on the computer that starts the verification.

- `GetSource`. A command to retrieve source files from the configuration management system, or the file system of the user. Executed in a temporary folder on the client computer, which is also used to store results from the compilation phase of the verification. This temporary folder is removed after the verification is spooled to the Polyspace server.

  For example:

  ```
  <GetSource>
    cvs co –r 1.4.6.4 myProject
    mkdir sources
    cp –fvr myProject/*.adb sources
  </GetSource>
  ```

  You can also use:

  ```
  <GetSource>
    find /……/myProject –name “*.adb” | tee sources_list.txt
  </GetSource>
  ```
  and add `-sources-list-file` *`sources_list`*`.txt` to the `options` list.

- `GetVersion`. A command to retrieve the version identifier of your project. Polyspace uses the version identifier as a parameter for `-verif-version`.

  For example:

  ```
  <GetVersion>
    cd /…../myProject ; cvs status Makefile 2>/dev/null | grep 'Sticky Tag:'
    | sed 's/Sticky Tag://'  | awk '{print $1"-"$3}'| sed 's/).*$//'
  </GetVersion>
  ```

Users

A list of users, where each user is defined using the element “User” on page 10-7.

User

Define a user using three elements:

- `FirstName`. First name of user.
- `LastName`. Last name of user.
- `Mail`. Use the attributes `resultsMail` and `compilationFailureMail` to specify conditions for sending an email at the end of verification. Specify the email address in the element.
  - `resultsMail`. You can use one of the following values:
    - `ALWAYS`. Default. Email sent at the end of each automatic verification (even if the verification does not produce new run-time checks).
    - `NEW-CERTAIN-FINDINGS`. Email sent only if verification produces new red, gray, NTC, or NTL checks.
    - `NEW-POTENTIAL-FINDINGS`. Email sent only if verification produces new orange check.
    - `ALL-NEW-FINDINGS`. Email sent if verification produces a new run-time check.
  - `compilationFailureMail`. Either Yes (default) or No. If Yes, email sent when automatic verification fails because of a compilation failure.

  The following is an example of `Mail`.

```
<Mail resultsMail="NEW-POTENTIAL-FINDINGS"
compilationFailureMail="yes">
 user_id@yourcompany.com
</Mail>
```

SmtpConfiguration

This element is mandatory for sending email, and you must specify the following attributes:

- `server`. Your Simple Mail Transport Protocol (SMTP) server.
- `port`. SMTP server port. Optional, default is 25.

For example:

```
<SmtpConfiguration server="smtp.yourcompany.com" port="25">
```

Example of Projects.psproj

The following is an example of `Projects.psproj`:

```
<?xml version="1.0" encoding="UTF-8" ?>
<!-- Polyspace Metrics Automatic Verification Project File -->
<Configuration>
<Project name="Demo_Ada" language="ADA" verificationKind="INTEGRATION">
  <Options>
    -O2
    -to pass2
    -target sparc
    -temporal-exclusions-file sources/temporal_exclusions.txt
    -entry-points tregulate,proc1,proc2,server1,server2
    -critical-section-begin Begin_CS:CS1
    -critical-section-end End_CS:CS1
  </Options>
  <LaunchingPeriod hour="12" minute="20" month="*" weekDay="1-5">
  </LaunchingPeriod>
  <Commands>
    <GetSource>
      /bin/cp -vr /yourcompany/home/auser/tempfolder/Demo_Ada_Studio/sources/ .
    </GetSource>
    <GetVersion>
    </GetVersion>
  </Commands>
  <Users>
    <User>
      <FirstName>Polyspace</FirstName>
      <LastName>User</LastName>
      <Mail resultsMail="ALWAYS"
            compilationFailureMail="yes">userid@yourcompany.com
      </Mail>
    </User>
  </Users>
</Project>
<SmtpConfiguration server="smtp.yourcompany.com" port="25">
</SmtpConfiguration>
</Configuration>
```

Accessing Polyspace Metrics

In this section...

View Polyspace Metrics Project Index

1. In the address bar of your Web browser, enter the following URL:

   `protocol:// ServerName: PortNumber`

   - `protocol` is either `http` (default) or `https`.
   - `ServerName` is the name or IP address of the server that is your Polyspace Queue Manager.
   - `PortNumber` is the Web server port number (default 8080)

   To use HTTPS, you must set up the configuration file and the **Metrics configuration** preferences. For more information, see “Configure Web Server for HTTPS”.

2. Select the **Projects** tab.

You can save the project index page as a bookmark for future use. You can also save as bookmarks Polyspace Metrics pages that you subsequently navigate to.

To refresh the page, click Refresh.

At the top of each column, use the filters to shorten the list of displayed projects. For example:

- In the **Project** filter, if you enter `demo_`, the browser displays a list of projects with names that begin with `demo_`.
- From the drop-down list for the **Language** filter, if you select `Ada`, the browser displays only Ada projects.

If a new verification has been carried out for a project since your last visit to the project index page, then the icon appears before the name of the project.

If you place your cursor anywhere on a project row, in a box on the left of the window, you see the following project information:

- **Language** — For example, `Ada`, `C`, `C++`.
- **Mode** — Either `Integration` or `Unit by Unit`.
- **Last Run Name** — Identifier for last verification performed.
- **Number of Runs** — Number of verifications performed in project.

In a project row, click anywhere to go to the **Summary** view for that project.

Organize Polyspace Metrics Projects

The Polyspace Metrics project index allows you to display projects as categories, a useful feature when you have a large number of projects to manage. You can:

- Create multiple-level project categories.
- Move projects between categories by dragging and dropping projects.
- Rename and remove categories. When you remove a category, the software does not delete the projects within the category but moves the projects back to the parent or root level.

To create a root-level project category:

1. On the Polyspace Metrics project index, right-click a project.
2. From the context menu, select **Create Project Category**. The Add To Category dialog box opens.
3. In **Enter the name of the project category** field, enter the required name, for example, `MyNewCategory`. Then click **OK**.
4. To add projects to this new category, drag and drop the required projects into this category.

To create a subroot-level category:

1. Right-click a project category.

2 From the context menu, select **Create Project Category**. The Add To Category dialog box opens.

3 In **Enter the name of the project category** field, enter the required name, for example, `SubCategory1`. If you decide that you do not want a subroot category, but want a new root category instead, select the **Create a root project category** check box. Then click **OK**.

4 To add projects to this new category, drag and drop the required projects into this category.

To rename a project category:

1 Right-click the project category.

2 From the context menu, select **Rename Project Category**. The category name becomes editable.

3 Enter the new name for your category. Press **Return**.

4 A message dialog box opens requesting confirmation. Click **OK**. The software updates the category name.

To remove a project category:

1 Right-click the project category.

2 From the context menu, select **Delete Project Category**. If the project category is a:

- Root-level project category, the software moves all projects in the category to the root level and removes the project category and associated subroot categories.
- Subroot-level category, the software moves all projects within the subroot category to the parent level and removes the subroot category.

Note: The software does not delete projects when removing project categories.

You can move projects back to the root level from project categories without removing the project categories:

1 From within project categories, select the projects that you want to move to the root level.

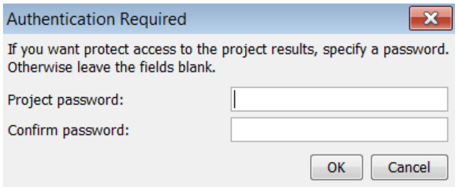
2 Right-click the selected projects. From the context menu, select **Move to Root**. The software moves the projects back to the root level.

Protect Access to Project Metrics

You can restrict access to the metrics for a project by specifying a password:

- When you run a verification with Polyspace Metrics enabled or upload results to Polyspace Metrics:

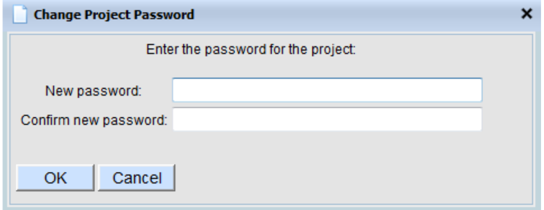
  1. The Authentication Required dialog box opens.

  
  Authentication Required
  If you want protect access to the project results, specify a password.
  Otherwise leave the fields blank.
  Project password:
  Confirm password:
  OK
  Cancel

  2. In the **Project password** and **Confirm password** fields, enter your password.
  3. Click **OK**.

- After the creation of a project:

  1. From the Polyspace Metrics project index, right-click the project.
  2. From the context menu, select **Change/Set Password**. The Change Project Password dialog box opens.

  3. In the **New password** and **Confirm new password** fields, enter your password.
  4. Click **OK**. The software displays the password-restricted icon 🔒 next to the project.

From the command line, you can use the `-password` option. For example:

```
polyspace-results-repository.exe -prog psdemo_model_link_sl -password my_passwd
```

Note: The password for a Polyspace Metrics project is encrypted. The Web data transfer is not encrypted. The password feature minimizes unintentional data corruption, but it does not provide data security. However, data transfers between the Polyspace Client and Polyspace Server are encrypted. To use a secure Web data transfer with HTTPS, see "Configure Web Server for HTTPS".

After you enter your password, the project pages are accessible for a session that lasts 30 minutes. Access is available for this period of time, even if you close your Web browser.

If you return to the Polyspace Metrics project index, the session ends. If you click Refresh during a session, the project pages are accessible for another 30 minutes.

Monitor Verification Progress

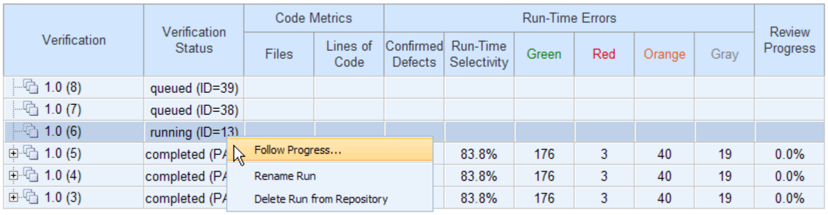
In the **Summary > Verification Status** column, Polyspace Metrics provides status information for each verification in the project. The status can be `queued`, `running`, or `completed`.

If the verification mode is `Unit By Unit`, the software provides status information in each unit row. If the verification mode is `Integration`, the software provides status information in the parent row only.

If the verification status is `running` (and you have installed the Polyspace product on your computer), you can monitor progress of the verification with the Polyspace Job Monitor.

To open the Progress Monitor of the Polyspace Job Monitor:

1 In the **Summary > Verification Status** column, right-click the parent or unit cell with the status `running`.



Verification	Verification Status	Code Metrics		Run-Time Errors						Review Progress
		Files	Lines of Code	Confirmed Defects	Run-Time Selectivity	Green	Red	Orange	Gray	
1.0 (8)	queued (ID=39)									
1.0 (7)	queued (ID=38)									
1.0 (6)	running (ID=13)									
1.0 (5)	completed (PA				83.8%	176	3	40	19	0.0%
1.0 (4)	completed (PA				83.8%	176	3	40	19	0.0%
1.0 (3)	completed (PA				83.8%	176	3	40	19	0.0%

2 From the context menu, select **Follow Progress**.

   The **Output Summary** tab opens in the Polyspace verification environment.

For more information, see “Monitor Progress Using Job Monitor”.

Web Browser Support

Polyspace Metrics supports the following Web browsers:

- Internet Explorer® 7.0, or later
- Firefox® version 3.6, or later
- Google® Chrome version 12.0, or later

To use Polyspace Metrics, you must install on your computer Java, version 1.4 or later.

For the Firefox Web browser, you must manually install the required Java plug-in. For example, if your computer uses the Linux operating system:

1. Create a Firefox folder for plug-ins:

   ```
   mkdir ~/.mozilla/plugins
   ```

2. Go to this folder:

   ```
   cd ~/.mozilla/plugins
   ```

3. Create a symbolic link to the Java plug-in, which is available in the Java Runtime Environment folder of your Polyspace installation:

   ```
   ln -s Polyspace_Install/jre/lib/amd64/libnpjp2.so
   ```

What You Can Do with Polyspace Metrics

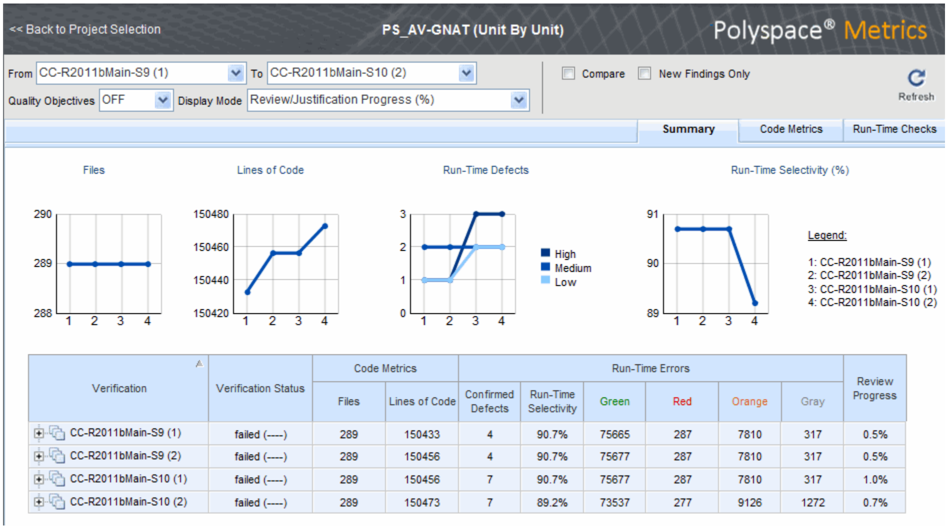
In this section...

Review Overall Progress

For a development manager or quality assurance engineer, the Polyspace Metrics **Summary** view provides useful high-level information, including quality trends, over the course of a project.

To obtain the **Summary** view for a project:

1. Open the Polyspace Metrics project index. See "View Polyspace Metrics Project Index" on page 10-9.
2. Click anywhere in the row that contains your project. You see the **Summary** view.



From CC-R2011bMain-S9 (1) To CC-R2011bMain-S10 (2) □ Compare □ New Findings Only

Quality Objectives OFF Display Mode Review/Justification Progress (%)

Verification	Verification Status	Code Metrics		Run-Time Errors						Review Progress
		Files	Lines of Code	Confirmed Defects	Run-Time Selectivity	Green	Red	Orange	Gray	
CC-R2011bMain-S9 (1)	failed (----)	289	150433	4	90.7%	75665	287	7810	317	0.5%
CC-R2011bMain-S9 (2)	failed (----)	289	150456	4	90.7%	75677	287	7810	317	0.5%
CC-R2011bMain-S10 (1)	failed (----)	289	150456	7	90.7%	75677	287	7810	317	1.0%
CC-R2011bMain-S10 (2)	failed (----)	289	150473	7	89.2%	73537	277	9126	1272	0.7%

At the top of the **Summary** view, use the **From** and **To** filters to specify the project versions that you want to examine. By default, the **From** and **To** fields specify the earliest and latest project versions respectively.

In addition, by default, the **Quality Objectives** filter is `OFF`, and the **Display Mode** is `Review/Justification Progress (%)`.

Below the filters, you see:

- Plots that reveal how the number of verified files, lines of code, defects, and run-time selectivity vary over the different versions of your project
- A table containing summary information about your project versions

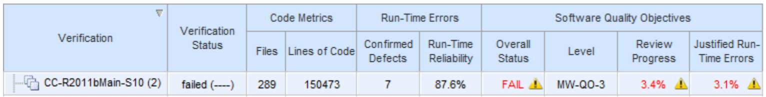
  If you have projects with two or more file modules in the Polyspace verification environment, by default, Polyspace Metrics displays verification results using the same module structure. However, Polyspace Metrics also allows you to create or delete file modules. See “Creating File Module and Specifying Quality Level” on page 10-19.

With the default filter settings, you can monitor progress in terms of run-time checks that quality assurance engineers or developers have reviewed.

You can also monitor progress in terms of software quality objectives. You may, for example, want to find out whether the latest version fulfills quality objectives.

To display software quality information, from the **Quality Objectives** drop-down list, select `ON` .

Under **Software Quality Objectives**, look at **Review Progress** for the latest version (`CC-R2011bMain-S10 (2)`), which, in this example, indicates that the review of verification results is incomplete (3.4 % reviewed). You also see that the Overall Status is `FAIL`. This status indicates that, although the review is incomplete, the project code fails to meet software quality objectives for the quality level `MW-QO-3`. With this information, you may conclude that you cannot release version `CC-R2011bMain-S10 (2)` to your customers.



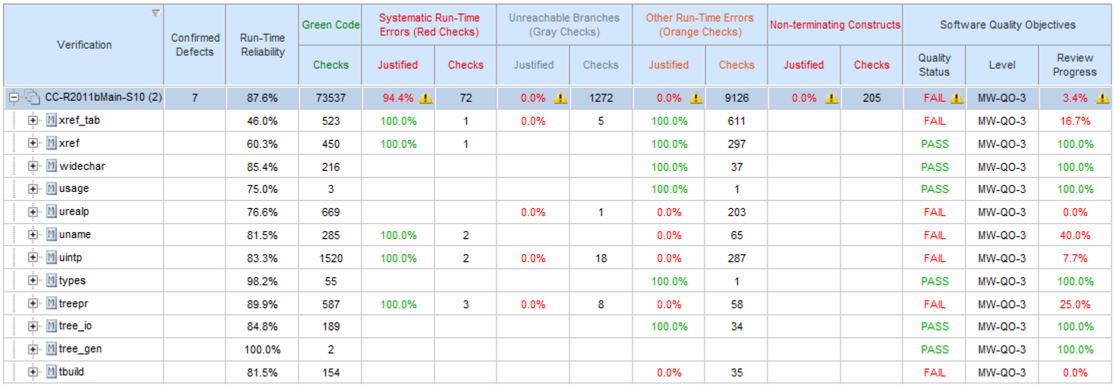
Verification	Verification Status	Code Metrics		Run-Time Errors		Software Quality Objectives			
		Files	Lines of Code	Confirmed Defects	Run-Time Reliability	Overall Status	Level	Review Progress	Justified Run-Time Errors
CC-R2011bMain-S10 (2)	failed (----)	289	150473	7	87.6%	FAIL ⚠	MW-QO-3	3.4% ⚠	3.1% ⚠

When Polyspace Metrics adds the results for a new project version to the repository, Polyspace Metrics also imports comments from the previous version. For this reason, you rarely see the review progress metric at 0% after verification of the first project version.

Note: You may want to find out whether your code fulfills software quality objectives at another quality level, for example, `MW-QO-1`. **Under Software Quality Objectives**, in the **Level** cell, select `MW-QO-1` from the drop-down list.

There are seven quality levels, which are based on predefined software quality objectives. You can customize these software quality objectives and modify the way quality is evaluated. See "Customizing Software Quality Objectives" on page 10-25.

To investigate further, under **Run-Time Errors**, in the **Run-Time Reliability** cell, you click the link `87.6%`. This action takes you to the **Run-Time Checks** view, where you see an expanded view of check information for each file in the project.

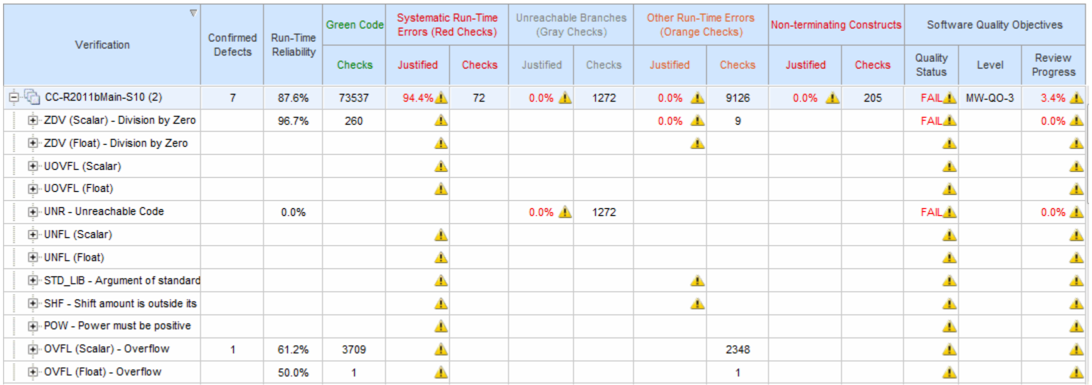


Verification	Confirmed Defects	Run-Time Reliability	Green Code	Systematic Run-Time Errors (Red Checks)		Unreachable Branches (Gray Checks)		Other Run-Time Errors (Orange Checks)		Non-terminating Constructs		Software Quality Objectives		
			Checks	Justified	Checks	Justified	Checks	Justified	Checks	Justified	Checks	Quality Status	Level	Review Progress
CC-R2011bMain-S10 (2)	7	87.6%	73537	94.4% ⚠	72	0.0% ⚠	1272	0.0% ⚠	9126	0.0% ⚠	205	FAIL ⚠	MW-QO-3	3.4% ⚠
xref_tab		46.0%	523	100.0%	1	0.0%	5	100.0%	611			FAIL	MW-QO-3	16.7%
xref		60.3%	450	100.0%	1			100.0%	297			PASS	MW-QO-3	100.0%
widechar		85.4%	216					100.0%	37			PASS	MW-QO-3	100.0%
usage		75.0%	3					100.0%	1			PASS	MW-QO-3	100.0%
urealp		76.6%	669			0.0%	1	0.0%	203			FAIL	MW-QO-3	0.0%
uname		81.5%	285	100.0%	2			0.0%	65			FAIL	MW-QO-3	40.0%
uintp		83.3%	1520	100.0%	2	0.0%	18	0.0%	287			FAIL	MW-QO-3	7.7%
types		98.2%	55					100.0%	1			PASS	MW-QO-3	100.0%
treepr		89.9%	587	100.0%	3	0.0%	8	0.0%	58			FAIL	MW-QO-3	25.0%
tree_io		84.8%	189					100.0%	34			PASS	MW-QO-3	100.0%
tree_gen		100.0%	2									PASS	MW-QO-3	100.0%
tbuild		81.5%	154					0.0%	35			FAIL	MW-QO-3	0.0%

To view a check in the Polyspace verification environment, in the relevant cell, click the numeric value for the check. The Polyspace verification environment opens with the Results Manager perspective displaying verification information for this check.

Note: If you update a check information through the Polyspace verification environment (see "Review Run-Time Checks" on page 10-21), when you return to Polyspace Metrics, click **Refresh** to incorporate this updated information.

If you want to view check information with reference to check type, from the **Group by** drop-down list, select `Run-Time Categories` .



Verification	Confirmed Defects	Run-Time Reliability	Green Code	Systematic Run-Time Errors (Red Checks)		Unreachable Branches (Gray Checks)		Other Run-Time Errors (Orange Checks)		Non-terminating Constructs		Software Quality Objectives		
			Checks	Justified	Checks	Justified	Checks	Justified	Checks	Justified	Checks	Quality Status	Level	Review Progress
CC-R2011bMain-S10 (2)	7	87.6%	73537	94.4% ⚠	72	0.0% ⚠	1272	0.0% ⚠	9126	0.0% ⚠	205	FAIL ⚠	MW-QO-3	3.4% ⚠
ZDV (Scalar) - Division by Zero		96.7%	260	⚠				0.0% ⚠	9			FAIL ⚠		0.0% ⚠
ZDV (Float) - Division by Zero				⚠				⚠				⚠		⚠
UOVFL (Scalar)				⚠								⚠		⚠
UOVFL (Float)				⚠								⚠		⚠
UNR - Unreachable Code		0.0%				0.0% ⚠	1272					FAIL ⚠		0.0% ⚠
UNFL (Scalar)				⚠								⚠		⚠
UNFL (Float)				⚠								⚠		⚠
STD_LIB - Argument of standard				⚠				⚠				⚠		⚠
SHF - Shift amount is outside its				⚠				⚠				⚠		⚠
POW - Power must be positive				⚠								⚠		⚠
OVFL (Scalar) - Overflow	1	61.2%	3709	⚠					2348			⚠		⚠
OVFL (Float) - Overflow		50.0%	1	⚠					1			⚠		⚠

Displaying Metrics for Single Project Version

To display metrics for a single project version:

1. In the **From** field, from the drop-down list, select the required project version.
2. In the **To** field, from the drop-down list, select the same project version.
3. In **# items** field, enter the maximum number of files for which you want information displayed.

   The software displays:

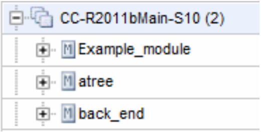
   - Bar charts with file defect information, ordering the files according to the number of defects in each file
   - A table with information about the selected project version

Creating File Module and Specifying Quality Level

You can group files into a module and specify a quality level for the module. The quality level applies to all files within the module. By grouping your files in different modules, you can specify different quality levels for your files.

To create a module of files:

1. Select a tab, for example, **Summary**.
2. In the **Verification** column, expand the node corresponding to the verification that you are interested. You see the verified files.
3. Select the files that you want to place in a module.
4. Right-click the selected files, and, from the context menu, select **Add To Module**. The Add to Module dialog box opens.
5. In the text field, enter the name for your new module, for example, `Example_module`. Click **OK**. You see a new node.



To specify a quality level for the module:

1 Select the row containing the module.

2 Under **Software Quality Objectives**, click the **Level** cell.

3 From the drop-down list, select the quality level for your module.

To remove files from a module:

1 Expand the node corresponding to the module.

2 Select the files that you want to remove from the module.

3 Right-click your selection, and from the context menu, select **Remove From Module**. The software removes the files from the module. If you remove all files from the module, the software also removes the module from the tree.

Note: You can drag and drop files into and out of folders. For example, you can select `back_end` and drag it to `Example_module`.

Compare Project Versions

You can compare metrics of two versions of a project.

1 In the **From** drop-down list, select one version of your project.

2 In the **To** drop-down list, select a newer version of your project.

3 Select the **Compare** check box.

In each view, for example, **Summary** and **Run-Time Checks**, you see metric differences and tooltip messages that indicate whether the newer version is an improvement over the older version.

Review New Findings

You can specify a project version and focus on the differences between the verification results of your specified version and the previous verification. For example, consider a project with versions `1.0`, `1.1`, `1.2`, `2.0`, and `2.1`.

1 In the **To** field, specify a version of your project, for example, `2.0`.

2 Select the **New Findings Only** check box. In the **From** field, you see `1.2` in dimmed lettering, which is the previous verification. The charts and tables now show the changes in results with respect to the previous verification.

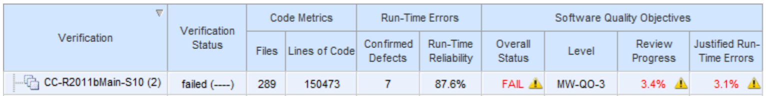
To manage the content of the bar charts, in the **# items** field, enter the maximum number of files for which you want information displayed. The software displays file defect information, ordering the files according to the number of defects in each file.

Review Run-Time Checks

If you have installed Polyspace on your computer, you can use Polyspace Metrics to review and add information about run-time checks produced by a verification.

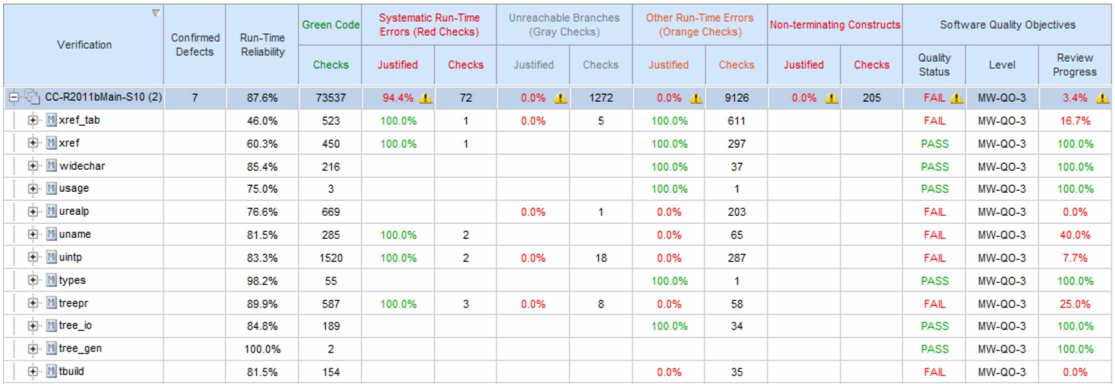
You may use the **Review Progress** metric in the **Summary** view to decide when your team of developers should start work on the next version of the software. For example, you may wait until the review is complete (**Review Progress** cell displays 100%), before informing your development team.

Consider an example, where you see the following in the **Summary** view.



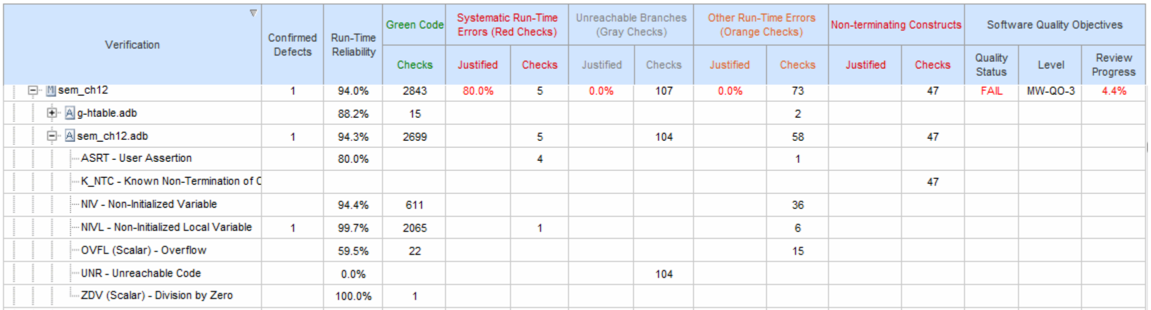
Verification	Verification Status	Code Metrics		Run-Time Errors		Software Quality Objectives			
		Files	Lines of Code	Confirmed Defects	Run-Time Reliability	Overall Status	Level	Review Progress	Justified Run-Time Errors
CC-R2011bMain-S10 (2)	failed (----)	289	150473	7	87.6%	FAIL ⚠	MW-QO-3	3.4% ⚠	3.1% ⚠

Under **Run-Time Errors**, click a cell value. This action takes you to the **Run-Time Checks** view.



Verification	Confirmed Defects	Run-Time Reliability	Green Code	Systematic Run-Time Errors (Red Checks)		Unreachable Branches (Gray Checks)		Other Run-Time Errors (Orange Checks)		Non-terminating Constructs		Software Quality Objectives		
			Checks	Justified	Checks	Justified	Checks	Justified	Checks	Justified	Checks	Quality Status	Level	Review Progress
CC-R2011bMain-S10 (2)	7	87.6%	73537	94.4% ⚠	72	0.0% ⚠	1272	0.0% ⚠	9126	0.0% ⚠	205	FAIL ⚠	MW-QO-3	3.4% ⚠
xref_tab		46.0%	523	100.0%	1	0.0%	5	100.0%	611			FAIL	MW-QO-3	16.7%
xref		60.3%	450	100.0%	1			100.0%	297			PASS	MW-QO-3	100.0%
widechar		85.4%	216					100.0%	37			PASS	MW-QO-3	100.0%
usage		75.0%	3					100.0%	1			PASS	MW-QO-3	100.0%
urealp		76.6%	669			0.0%	1	0.0%	203			FAIL	MW-QO-3	0.0%
uname		81.5%	285	100.0%	2			0.0%	65			FAIL	MW-QO-3	40.0%
uintp		83.3%	1520	100.0%	2	0.0%	18	0.0%	287			FAIL	MW-QO-3	7.7%
types		98.2%	55					100.0%	1			PASS	MW-QO-3	100.0%
treepr		89.9%	587	100.0%	3	0.0%	8	0.0%	58			FAIL	MW-QO-3	25.0%
tree_io		84.8%	189					100.0%	34			PASS	MW-QO-3	100.0%
tree_gen		100.0%	2									PASS	MW-QO-3	100.0%
tbuild		81.5%	154					0.0%	35			FAIL	MW-QO-3	0.0%

The **Review Progress** column reveals the progress level for each file. Expand`sem_ch12`.



Verification	Confirmed Defects	Run-Time Reliability	Green Code	Systematic Run-Time Errors (Red Checks)		Unreachable Branches (Gray Checks)		Other Run-Time Errors (Orange Checks)		Non-terminating Constructs		Software Quality Objectives		
			Checks	Justified	Checks	Justified	Checks	Justified	Checks	Justified	Checks	Quality Status	Level	Review Progress
sem_ch12	1	94.0%	2843	80.0%	5	0.0%	107	0.0%	73		47	FAIL	MW-QO-3	4.4%
g-htable.adb		88.2%	15						2					
sem_ch12.adb	1	94.3%	2699		5		104		58		47			
ASRT - User Assertion		80.0%			4				1					
K_NTC - Known Non-Termination of C											47			
NIV - Non-Initialized Variable		94.4%	611						36					
NIVL - Non-Initialized Local Variable	1	99.7%	2065		1				6					
OVFL (Scalar) - Overflow		59.5%	22						15					
UNR - Unreachable Code		0.0%					104							
ZDV (Scalar) - Division by Zero		100.0%	1											

In the row containing the NIVL (Non-Initialized Local Variable) check, click the value in the red **Checks** cell. This action opens the Polyspace verification environment with the Results Manager perspective. You see the NIVL check on the **Results Summary** tab.

To view details in the **Check Details** pane, double-click the NIVL check.

On the **Check Review** tab, using the drop-down list for the **Classification** field, you can classify the check as a defect (`High`, `Medium`, or `Low`) or specify that the check is `Not a defect`.

Using the drop-down list for the **Status** field, you can assign a status for the check, for example, `Fix` or `Investigate`. When you assign a status, the software considers the check to be *reviewed*.

If you think that the presence of the check in your code can be justified, select the check box **Justified**. In the **Comment** field, enter remarks that justify this check.

Save the review. See "Saving Review Comments and Justifications" on page 10-23.

Note: Classifying a run-time check as a defect or assigning a status for an unreviewed check in the Polyspace verification environment increases the corresponding metric values (**Confirmed Defects** and **Review Progress**) in the **Summary** and **Run-Time Checks** views of Polyspace Metrics.

Specifying Download Folder for Polyspace Metrics

When you click a coding rule violation or run-time check, Polyspace downloads result files from the Polyspace Metrics web interface to a local folder. You can specify this folder as follows:

1 Select **Options** > **Preferences** > **Server configuration**.
2 If you want to download result files to the folder from which the verification is launched, select the check box **Download results automatically**.
3 If this launch folder does not exist, specify another path in the **Folder** field.

If you do not specify a folder using step 2 or 3, when you click a violation or check, the software opens a file browser. Use this browser to specify the download location.

Saving Review Comments and Justifications

By default, when you save your project (**Ctrl+S**), the software saves your comments and justifications to a local folder. See “Specifying Download Folder for Polyspace Metrics” on page 10-22.

If you want to save your comments and justifications to a local folder *and* the Polyspace Metrics repository, on the Results Manager toolbar, select **Metrics** > **Save comments to Metrics**.

This default behavior allows you to upload your review comments and justifications only when you are satisfied that your review is, for example, correct and complete.

If you want the software to save your comments and justifications to the local folder *and* the Polyspace Metrics repository whenever you save your project (**Ctrl+S**):

1 Select **Tools** > **Preferences** > **Server configuration**.
2 Select the check box **Save justifications in the Polyspace Metrics repository**.

Note: In Polyspace Metrics, click Refresh to view updated information.

Fix Defects

If you are a software developer, you can begin to fix defects in code when, for example:

- In the **Summary** view, **Review Progress** shows 100%
- Your quality assurance engineer informs you

You can use Polyspace Metrics to access defects that you must fix.

Within the **Summary** view, under **Run-Time Errors**, click a cell value. This action takes you to the **Run-Time Checks** view.

You want to fix defects that are classified as defects. In the **Confirmed Defects** column, click a non-zero cell value. Polyspace Code Prover opens with the checks visible in **Results Summary** tab.

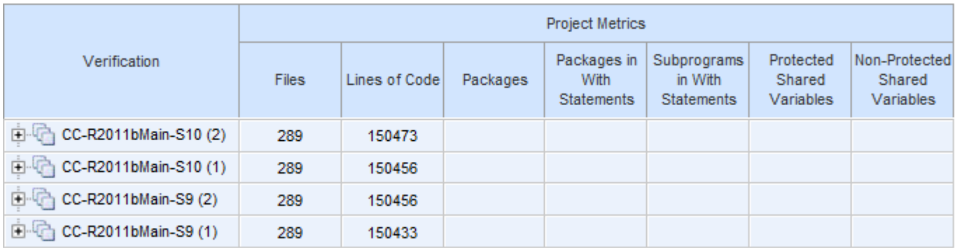
Double-click the row containing a check. In the **Check Details** pane, you see information about this check. You can now go to the source code and fix the defect.

Review Code Metrics

Polyspace Metrics generates metrics about your Ada code. These metrics provide the number of:

- Files
- Lines of code
- Packages
- Packages that appear in `with` statements
- Subprograms that appear in `with` statements
- Protected shared variables
- Unprotected shared variables

To review code metrics for your project, in the **Summary** view, click a value in a **Code Metrics** cell. The **Code Metrics** view opens.



Verification	Project Metrics						
	Files	Lines of Code	Packages	Packages in With Statements	Subprograms in With Statements	Protected Shared Variables	Non-Protected Shared Variables
⊞ CC-R2011bMain-S10 (2)	289	150473					
⊞ CC-R2011bMain-S10 (1)	289	150456					
⊞ CC-R2011bMain-S9 (2)	289	150456					
⊞ CC-R2011bMain-S9 (1)	289	150433					

Customizing Software Quality Objectives

In this section...

About Customizing Software Quality Objectives

When you run your first verification to produce metrics, Polyspace software uses *predefined* software quality objectives (SQO) to evaluate quality. In addition, when you use Polyspace Metrics for the first time, Polyspace creates the following XML file that contains definitions of these software quality objectives:

```
RemoteDataFolder/Custom-SQO-Definitions.xml
```

`RemoteDataFolder` is the folder where Polyspace stores data generated by remote verifications. See “Modify Polyspace Server Configuration” in the *Polyspace Installation Guide*.

If you want to customize SQOs and modify the way quality is evaluated, you must change `Custom-SQO-Definitions.xml`. This XML file has the following form:

```
<?xml version="1.0" encoding="utf-8"?>
<MetricsDefinitions>
  SQO Level 2
  SQO Level 3
  SQO Level 4
  SQO Level 5
  SQO Level 6
  SQO Exhaustive
  Run-Time Checks Set 1
  Run-Time Checks Set 2
  Run-Time Checks Set 3
  Status Acronym 1
  Status Acronym 2
</MetricsDefinitions>
```

The following topics provide information about `MetricsDefinitions` elements and how SQO levels are calculated. Use this information when you modify or create elements.

SQO Level 2

The default `SQO Level 2` element is:

```
<SQO ID="SQO-2" ParentID="SQO-1">
  <Num_Unjustified_Red>0</Num_Unjustified_Red>
  <Num_Unjustified_NT_Constructs>0</Num_Unjustified_NT_Constructs>
</SQO>
```

To fulfill requirements of SQO Level 2, the code must meet the requirements of SQO Level 1 **and** the following:

- Number of unjustified red checks `Num_Unjustified_Red` must not be greater than the threshold (default is zero)
- Number of unjustified NTC and NTL checks `Num_Unjustified_NT_Constructs` must not be greater than the threshold (default is zero)

SQO Level 3

The default `SQO Level 3` element is:

```
<SQO ID="SQO-3" ParentID="SQO-2">
  <Num_Unjustified_UNR>0</Num_Unjustified_UNR>
</SQO>
```

To fulfill requirements of SQO Level 3, the code must meet the requirements of SQO Level 2 **and** the number of unjustified UNR checks must not exceed the threshold (default is zero).

SQO Level 4

The default `SQO Level 4` element is:

```
<SQO ID="SQO-4" ParentID="SQO-3">
  <Percentage_Proven_Or_Justified>
   Runtime_Checks_Set_1
  </Percentage_Proven_Or_Justified>
</SQO>
```

To fulfill requirements of SQO Level 4, the code must meet the requirements of SQO Level 3 **and** the following ratio as a percentage

```
(green checks + justified orange checks) / (green checks + all orange checks)
```

must not be less than the thresholds specified by "Run-Time Checks Set 1" on page 10-28.

SQO Level 5

The default `SQO Level 5` element is:

```
<SQO ID="SQO-5" ParentID="SQO-4">
  <Percentage_Proven_Or_Justified>
   Runtime_Checks_Set_2
  </Percentage_Proven_Or_Justified>
</SQO>
```

To fulfill requirements of SQO Level 5, the code must meet the requirements of SQO Level 4 **and** the percentage of green and justified checks must not be less than the thresholds specified by "Run-Time Checks Set 2" on page 10-28.

SQO Level 6

The default `SQO Level 6` element is:

```
<SQO ID="SQO-6" ParentID="SQO-5">
  <Percentage_Proven_Or_Justified>
   Runtime_Checks_Set_3
  </Percentage_Proven_Or_Justified>
</SQO>
```

To fulfill requirements of SQO Level 6, the code must meet the requirements of SQO Level 5 **and** the percentage of green and justified checks must not be less than the thresholds specified by "Run-Time Checks Set 3" on page 10-29.

SQO Exhaustive

The default `Exhaustive` element is:

```
<SQO ID="Exhaustive" ParentID="SQO-1">
  <Num_Unjustified_Red>0</Num_Unjustified_Red>
  <Num_Unjustified_NT_Constructs>0</Num_Unjustified_NT_Constructs>
  <Num_Unjustified_UNR>0</Num_Unjustified_UNR>
  <Percentage_Proven_Or_Justified>100</Percentage_Proven_Or_Justified>
</SQO>
```

Run-Time Checks Set 1

The Run-Time Checks Set 1 is composed of `Check` elements with data that specify thresholds. The `Name` and `Type` attribute in each `Check` element defines a run-time check, while the element data specifies a threshold in percentage. The default structure of Run-Time Checks Set 1 is:

```
<RuntimeChecksSet ID="Runtime_Checks_Set_1">
      <Check Name="OBAI">80</Check>
      <Check Name="ZDV" Type="Scalar">80</Check>
      <Check Name="ZDV" Type="Float">80</Check>
      <Check Name="NIVL">80</Check>
      <Check Name="NIV">60</Check>
      <Check Name="IRV">80</Check>
      <Check Name="FRIV">80</Check>
      <Check Name="FRV">80</Check>
      <Check Name="OVFL" Type="Scalar">60</Check>
      <Check Name="OVFL" Type="Float">60</Check>
      <Check Name="IDP">60</Check>
      <Check Name="NIP">60</Check>
      <Check Name="POW">80</Check>
      <Check Name="SHF">80</Check>
      <Check Name="COR">60</Check>
      <Check Name="NNR">50</Check>
      <Check Name="EXCP">50</Check>
      <Check Name="EXC">50</Check>
      <Check Name="NNT">50</Check>
      <Check Name="CPP">50</Check>
      <Check Name="OOP">50</Check>
      <Check Name="ASRT">60</Check>
</RuntimeChecksSet>
```

When you use Run-Time Checks Set 1 in evaluating code quality, the software calculates the following ratio as a percentage for each run-time check in the set:

```
(green checks + justified orange checks)/(green checks + all orange checks)
```

If the percentage values do not exceed the thresholds in the set, the code meets the quality level.

To modify the default set, you can change the check threshold values.

Run-Time Checks Set 2

This set is similar to “Run-Time Checks Set 1” on page 10-28, but has more stringent threshold values.

```
 <RuntimeChecksSet ID="Runtime_Checks_Set_2">
      <Check Name="OBAI">90</Check>
      <Check Name="ZDV" Type="Scalar">90</Check>
      <Check Name="ZDV" Type="Float">90</Check>
      <Check Name="NIVL">90</Check>
      <Check Name="NIV">70</Check>
      <Check Name="IRV">90</Check>
      <Check Name="FRIV">90</Check>
      <Check Name="FRV">90</Check>
      <Check Name="OVFL" Type="Scalar">80</Check>
      <Check Name="OVFL" Type="Float">80</Check>
      <Check Name="IDP">70</Check>
      <Check Name="NIP">70</Check>
      <Check Name="POW">90</Check>
      <Check Name="SHF">90</Check>
      <Check Name="COR">80</Check>
      <Check Name="NNR">70</Check>
      <Check Name="EXCP">70</Check>
      <Check Name="EXC">70</Check>
      <Check Name="NNT">70</Check>
      <Check Name="CPP">70</Check>
      <Check Name="OOP">70</Check>
      <Check Name="ASRT">80</Check>
</RuntimeChecksSet>
```

Run-Time Checks Set 3

This set is similar to “Run-Time Checks Set 1” on page 10-28, but has more stringent threshold values.

```
<RuntimeChecksSet ID="Runtime_Checks_Set_3">
      <Check Name="OBAI">100</Check>
      <Check Name="ZDV" Type="Scalar">100</Check>
      <Check Name="ZDV" Type="Float">100</Check>
      <Check Name="NIVL">100</Check>
      <Check Name="NIV">80</Check>
      <Check Name="IRV">100</Check>
      <Check Name="FRIV">100</Check>
      <Check Name="FRV">100</Check>
      <Check Name="OVFL" Type="Scalar">100</Check>
      <Check Name="OVFL" Type="Float">100</Check>
      <Check Name="IDP">80</Check>
      <Check Name="NIP">80</Check>
      <Check Name="POW">100</Check>
      <Check Name="SHF">100</Check>
      <Check Name="COR">100</Check>
      <Check Name="NNR">90</Check>
      <Check Name="EXCP">90</Check>
      <Check Name="EXC">90</Check>
      <Check Name="NNT">90</Check>
      <Check Name="CPP">90</Check>
      <Check Name="OOP">90</Check>
      <Check Name="ASRT">100</Check>
```

```
</RuntimeChecksSet>
```

Status Acronyms

When you click a link, `StatusAcronym` elements are passed to the Polyspace verification environment. This feature allows you to define, through your Polyspace server, additional items for the drop-down list of the **Status** field in **Check Review**. See “Review Run-Time Checks” on page 10-21.

Polyspace Metrics provides the following default elements:

```
<StatusAcronym Justified="yes" Name="Justify with code/model annotations"/>
<StatusAcronym Justified="yes" Name="No action planned"/>
```

The **Name** attribute specifies the name that appears on the **Status** field drop-down list. If you specify the `Justify` attribute to `yes`, then when you select the item, for example, `No action planned`, the software automatically selects the **Justified** check box. If you do not specify the `Justify` attribute, then the **Justified** check box is not selected automatically.

You can remove the default elements and create new `StatusAcronym` elements, which are available to all users of your Polyspace server.

Tips for Administering Results Repository

In this section...

Through the Polyspace Metrics Web Interface

You can rename or delete projects and verifications.

Project Renaming

To rename a project:

1. In your Polyspace Metrics project index, right-click the row with the project that you want to rename.
2. From the context menu, select **Rename Project**.
3. In the **Project** field, enter the new name.

Project Deletion

To delete a project:

1. In your Polyspace Metrics project index, right-click the row with the project that you want to delete.
2. From the context menu, select **Delete Project from Repository**.

Verification Renaming

To rename a verification:

1. Select the **Summary** view for your project.
2. In the **Verification** column, right-click the verification that you want to rename.
3. From the context menu, select **Rename Run**.
4. In the **Project** field, edit the text to rename the verification.

Verification Deletion

To delete a verification:

1. Select the **Summary** view for your project.
2. In the **Verification** column, right-click the verification that you want to delete.
3. From the context menu, select **Delete Run from Repository**.

Through the Command Line

You can run the following batch command with various options.

```
Polyspace_Install/polyspace/bin/polyspace-results-repository[.exe]
```

- To rename a project or version, use the following options:

  ```
  [-f] [-server hostname] -rename [-prog old_prog -new-prog new_prog]
  [-verif-version old_version -new-verif-version new_version]
  ```

  - *hostname* — Polyspace server. `localhost` if you run the command directly on the server. Can be omitted if, in the Polyspace Preferences dialog box, on the **Server configuration** tab, you have specified a server name. See “Modify Polyspace Client Configuration”.
  - *old_prog* — Current project name
  - *new_prog* — New project name
  - *old_version* — Old version name
  - *new_version* — New version name
  - `-f` — Specifies that a confirmation is not requested
- To delete a project or version, use the following options:

  ```
  [-f] [–server hostname] -delete -prog prog [-verif-version version]
  [-unit-by-unit|-integration]
  ```

  - *hostname* — Polyspace server. `localhost` if you run the command directly on the server. Can be omitted if, in the Polyspace Preferences dialog box, on the **Server configuration** tab, you have specified a server name. See “Modify Polyspace Client Configuration”.
  - *prog* — Project name
  - *version* — Version name. If omitted, all versions are deleted

  - `unit-by-unit|-integration` — Delete only unit-by-unit or integration verifications
  - `-f` — Specifies that a confirmation is not requested
- To get *information* about other commands, for example, retrieve a list of projects or versions, and download and upload results, use the `-h` option.

Renaming and Deletion Examples

To change the name of the project `psdemo_model_link_sl` to `Track_Quality`:

```
polyspace-results-repository.exe -prog psdemo_model_link_sl
-new-prog Track_Quality -rename
```

To delete the fifth verification run with version `1.0` of the project `Track_Quality`:

```
polyspace-results-repository.exe -prog Track_Quality -verif-version 1.0
-run-number 5 -delete
```

To rename verification `1.2` as `1.0`:

```
polyspace-results-repository.exe -prog Track_Quality -verif-version 1.2
-new-verif-version 1.0 -rename
```

To rename the fourth verification run with version `1.0` as version `0.4`:

```
polyspace-results-repository.exe -prog Track_Quality -verif-version 1.0
-run-number 4 -new-verif-version 0.4 -rename
```

Backup of Results Repository

To preserve your Polyspace Metrics data, create a backup copy of the results repository *`Polyspace_RLDatas`*`/results-repository` — *`Polyspace_RLDatas`* is the path to the folder where Polyspace stores data generated by remote verifications. See “Configure the Polyspace Server”.

For example, on a Linux system, do the following:

1. `$cd` *`Polyspace_RLDatas`*
2. `$zip -r` *`Path_to_backup_folder`*`/results-repository.zip results-repository`

If you want to restore data from the backup copy:

1. `$cd` *`Polyspace_RLDatas`*

2
```
$unzip Path_to_backup_folder/results-repository.zip
```

Verifying Code in the Eclipse IDE

Install Polyspace Plug-In for Eclipse IDE

You can install the Polyspace plug-in only if you have already set up the Eclipse Integrated Development Environment (IDE). For information about downloading and installing the Eclipse IDE, go to www.eclipse.org.

In addition to the Eclipse IDE, you must have:

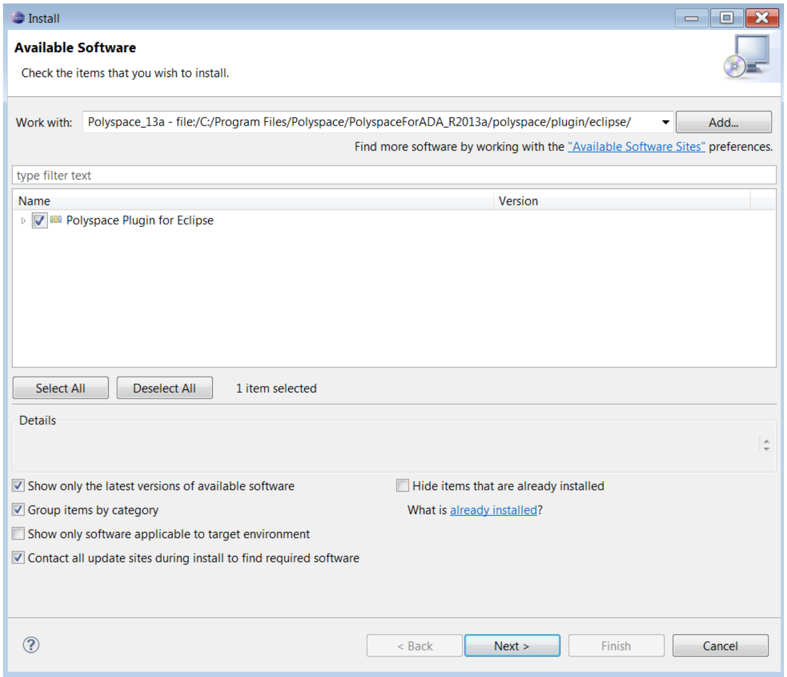
- The GNATbench 2.5.1 plug-in. For more information, go to www.adacore.com.
- A GNAT compiler, a free compiler for Ada95 that is integrated into the GCC compiler system. For more information, go to www.gnu.org/software/gnat/.

Note: On a Windows system, the GNATbench plug-in supports only the 32-bit version of the Eclipse IDE. Therefore, on a 64-bit Windows machine, you must install the 32-bit version of the Polyspace product. From a DOS command window, run the following command:

```
DVD\Installer32bits\Windows\Disk1\InstData\VM\Polyspace.exe
```

To install the Polyspace plug-in:

1. From the Eclipse editor, select **Help** > **Install New Software**. The Install wizard opens, displaying the Available Software page.
2. Click **Add**, which opens the Add Repository dialog box.
3. In the **Name** field, specify a name for your Polyspace site, for example, `Polyspace_13a`.
4. Click **Local**, which opens the Browse for Folder dialog box.
5. Navigate to the `*Polyspace_Install*\polyspace\plugin\eclipse` folder. Then click **OK**.
6. Click **OK**, which closes the Add Repository dialog box.
7. On the Available Software page, select `Polyspace Plugin for Eclipse`.



Available Software

Check the items that you wish to install.

Work with: Polyspace_13a - file:/C:/Program Files/Polyspace/PolyspaceForADA_R2013a/polyspace/plugin/eclipse/

Find more software by working with the "Available Software Sites" preferences.

type filter text

Name	Version
☑ Polyspace Plugin for Eclipse	

1 item selected

Details

☑ Show only the latest versions of available software

☑ Group items by category

☐ Show only software applicable to target environment

☑ Contact all update sites during install to find required software

☐ Hide items that are already installed

What is already installed?

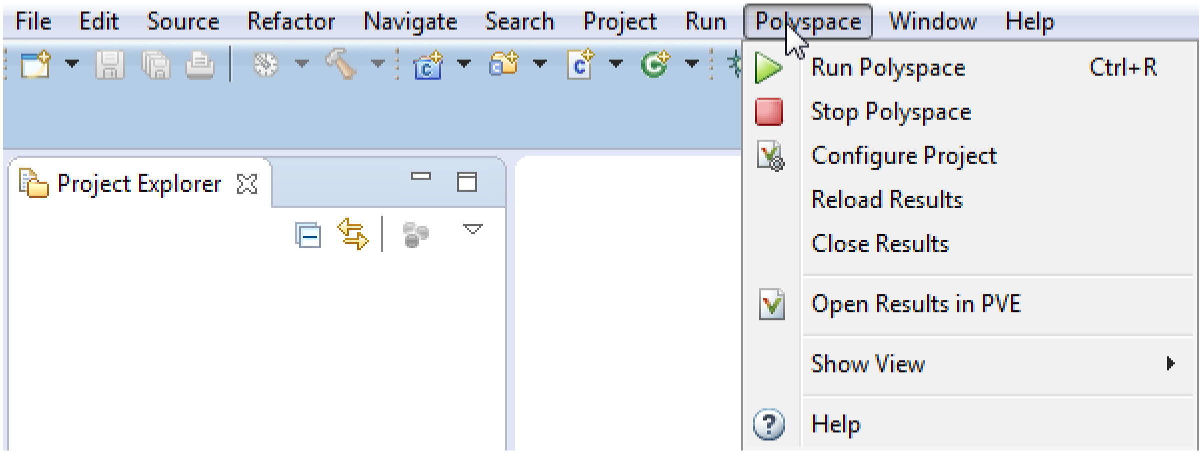
8 Click **Next**.

9 On the Install Details page, click **Next**.

10 On the Review Licenses page, review and accept the licence agreement. Then click **Finish**.

Once you install the Polyspace plug-in, in the Eclipse editor, you have access to:

- A **Polyspace** menu
- A **Polyspace Run** view


File
Edit
Source
Refactor
Navigate
Search
Project
Run
Polyspace
Window
Help
Project Explorer
Run Polyspace Ctrl+R
Stop Polyspace
Configure Project
Reload Results
Close Results
Open Results in PVE
Show View
Help

Run Polyspace Verification in Eclipse

In this section...

Workflow for Code Verification in Eclipse

You can use Polyspace software to verify Ada code that you develop within the Eclipse Integrated Development Environment (IDE).

The workflow is:

- Use the editor to create an Eclipse project and develop code within your project.
- Set up the Polyspace verification by configuring analysis options and settings.
- Start the verification and monitor the process.
- Review the verification results.

Before you verify code, install the Polyspace plug-in for Eclipse IDE. See “Polyspace Plug-In Requirements” and “Install Polyspace Plug-In for Eclipse IDE” on page 11-2.

Create Eclipse Project

Creating New Project

If your source files do not belong to an Eclipse project, then create a project using the Polyspace editor:

1 Select **File** > **New** > **Project** to open the New Project dialog box.

2 Under **Wizards**, select **Ada** > **Ada Managed Project**.

Note: The software supports only `Ada Managed Project` and `Ada Standard Project`. If you use the Eclipse template `General Project` for Ada source files, you may encounter problems.

3 Click **Next** to start the New Ada Project wizard.

4 On the Create an Ada Project page, specify the name and location of the Ada project.

Either:

a Select the **Use default location** check box.

b In the **Project name** field, enter a name, for example, `Demo_Ada`.

Or:

a Clear the **Use default location** check box.

b Click **Browse**, and select a folder, for example, `C:\Test\Source_ada`.

c In the **Project name** field, enter a name, for example, `Demo_Ada`.

Click **Next**.

5 On the Select Ada Toolchain and Build Type page, specify the default build configuration for your project:

a In the **Configuration Name** field, specify the library name, for example, `lib`.

b In the **Toolchain Type** field, from the drop-down list, select `GNAT for Windows` (or `GNAT Linux x86`).

c In the **Build Type** field, from the drop-down list, select either `Executable` or `Static Library`.

d Under **Toolchain Path**, select **Use Installed Toolchain**.

6 Click **Manage** to open the Preferences dialog box.

7 Click **Add** to start the Install a new Ada toolchain wizard.

8 On the New Ada toolchain page, specify:

a In the **Type** field, from the drop-down list, select `GNAT for Windows` (or `GNAT Linux x86`).

b In the **Name** field, your toolchain, for example, `GNAT GPL`.

c. In the **Path** field, the path to your Ada installation folder, for example, `C:\GNAT\2009`.

   Click **Next**.

9. On the Select source directories page, select the folder that contains the Ada include files, and click **Finish**.
10. Click **OK** to close the Preferences dialog box.
11. On the Select Ada Toolchain and Build Type page, under **Initial Setting Values**, select **Use Default Settings**.
12. If you want to specify options for the Ada build on the Select Build Options page, click **Next**. Otherwise, click **Finish**.

    You have created an Polyspace project.

Add Source Files

To add Ada source files to a project:

1. In the **Ada Navigator** view, right-click the project, for example, `Demo_Ada`.
2. Select **Import** to start the Import wizard.
3. On the Select page, select **General** > **File System**, and click **Next**.
4. On the File system page:

   a. In the **From directory** field, specify your source folder.

   b. In the folder or file view, select the check boxes for the folder or files that you want to import.

   c. In the **Into folder** field, specify the project, for example, `Demo_Ada`.

   d. Under **Options**, select **Create selected folders** only.

   e. Click **Finish**.

For information on developing code within Eclipse IDE, go to www.eclipse.org.

Configure Polyspace Verification

To configure your verification:

1. In **Project Explorer**, select the project or files that you want to verify.

2. Select **Polyspace** > **Configure Project** to open the **Configuration** pane in the Polyspace verification environment.
3. Select your options for the verification process.
4. Select **File** > **Save** to save your options.

For more information, see “Analysis Options”.

Start Verification

To start a Polyspace verification from the Eclipse editor:

1. Select the file, files, or class that you want to verify.
2. Either right-click and select **Run Polyspace**, or select **Polyspace** > **Run Polyspace**.

   You can see the progress of the verification in the **Polyspace Run** view. If you see an error or warning during the compilation phase, double-click it to go to the corresponding location in the source code. Once the verification is over, the results are displayed on the **Results Summary** tab.
3. To stop a verification, select **Polyspace** > **Stop Polyspace**. Alternatively you can use the 🟥 button in the **Polyspace Run** view.

Review Results

You can examine results of the verification either in Eclipse or the Polyspace verification environment.

- **Eclipse**:

  After you run a verification in Eclipse, your results open automatically on the **Results Summary** tab. Select a check to see detailed information on the **Check Details** tab. If you close Eclipse or run Polyspace on another Eclipse project, your results are closed. To reopen your results in Eclipse, select **Polyspace** > **Reload Results**.
- **Polyspace environment**:

  The results in Eclipse are overwritten every time a new verification is performed. However, Polyspace automatically imports **Status**, **Classification** and **Comment** information to the new verification. If you want to save your earlier results:

1 Select **Polyspace** > **Open Results in PVE** to open your results in the Polyspace environment.

2 Upload your results to Metrics by selecting **Metrics** > **Upload to Metrics**

Glossary

Atomic

In computer programming, the adjective *atomic* describes a unitary action or object that is essentially indivisible, unchangeable, whole, and irreducible.

Batch mode

Execution of Polyspace from the command line rather than through the Project Manager perspective.

Category

One of four types of orange check: *potential bug, inconclusive check, data set issue* and *basic imprecision.*

Certain error

See ”red check.”

Check

A test performed by Polyspace during a verification and subsequently colored red, orange, green or gray in the Run-Time Checks perspective.

Code Verification

The Polyspace process through which code is tested to reveal definite and potential runtime errors and a set of results is generated for review.

Dead Code

Code which is inaccessible at execution time due to the logic of the software executed prior to it.

Development Process

The process used within a company to progress through the software development lifecycle.

Green check

Code has been proven to be free of runtime errors.

Gray check

Unreachable code; dead code.

Imprecision

Approximations are made during a Polyspace verification, so data values possible at execution time are represented by supersets including those values.

Orange check

A warning that represents a possible error which may be revealed upon further investigation.

Polyspace Approach

The manner of use of Polyspace to achieve a particular goal, with reference to a collection of techniques and guiding principles.

Precision

A verification which includes few inconclusive orange checks is said to be precise

Progress text

Output from Polyspace during verification that indicates what proportion of the verification has been completed. Could be considered to be a “textual progress bar”.

Red check

Code has been proven to contain definite runtime errors (every execution will result in an error).

Review

Inspection of the results produced by a Polyspace verification.

Scaling option

Option applied when an application submitted to Polyspace Server proves to be bigger or more complex than is practical.

Selectivity

The ratio (green checks + gray checks + red checks) / (total amount of checks)

Unreachable code

Dead code.

Verification

The Polyspace process through which code is tested to reveal definite and potential runtime errors and a set of results is generated for review.