Polyspace® Products for Ada

User's Guide

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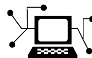

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Polyspace® Products for Ada User's Guide

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Introduction to Polyspace Products

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Polyspace Products for Ada

Polyspace Client for Ada

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.

Polyspace Server for Ada

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.

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. Results are color-coded:

- **Green** – Indicates code that never has an error.
- **Red** – Indicates code that always has an error.
- **Gray** – Indicates unreachable code.
- **Orange** – Indicates unproven code (code that might have an error).

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

Polyspace verification can help you to:

- “Ensure Software Reliability” on page 1-3
- “Decrease Development Time” on page 1-4
- “Improve the Development Process” on page 1-4

Ensure Software Reliability

Polyspace software ensures 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.

Because Polyspace software verifies all possible executions of your code, it can identify code that:

- Never has an error
- Always has an error
- Is unreachable
- Might have an error

With this information, you can be confident that you know how much of your code is run-time error free, 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.

Using Polyspace verification software helps you to use your time effectively. Because you know which parts of your code are error-free, you can focus on the code that has definite errors or might have errors.

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 dangerous. Polyspace verification provides deep-level verification identifying almost all runtime errors and possible access conflicts on global shared data.

Polyspace verification works by approximating the software under verification, using safe and 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' never overflows the range of 'tab' a traditional approach would be to enumerate each possible value of 'i'. One thousand checks would be needed.

Using the static verification approach, the variable 'i' is modelled by its variation domain. 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 elaborated models are also used for this purpose).

Any approximation leads by definition 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 no range error will occur; it is only necessary to prove that the variation domain 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 but it is generally not practical, as it would in general require the enumeration of all possible test cases. As a result, approximation is required if a usable tool is to result.

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 any program variable is always a superset of its actual variation domain. The direct consequence is that no runtime error (RTE) item to be checked can be missed by Polyspace verification.

Product Components

The Polyspace products for verifying Ada code are:

- "Polyspace Verification Environment" on page 1-6
- "Other Polyspace Components" on page 1-9

Polyspace Verification Environment

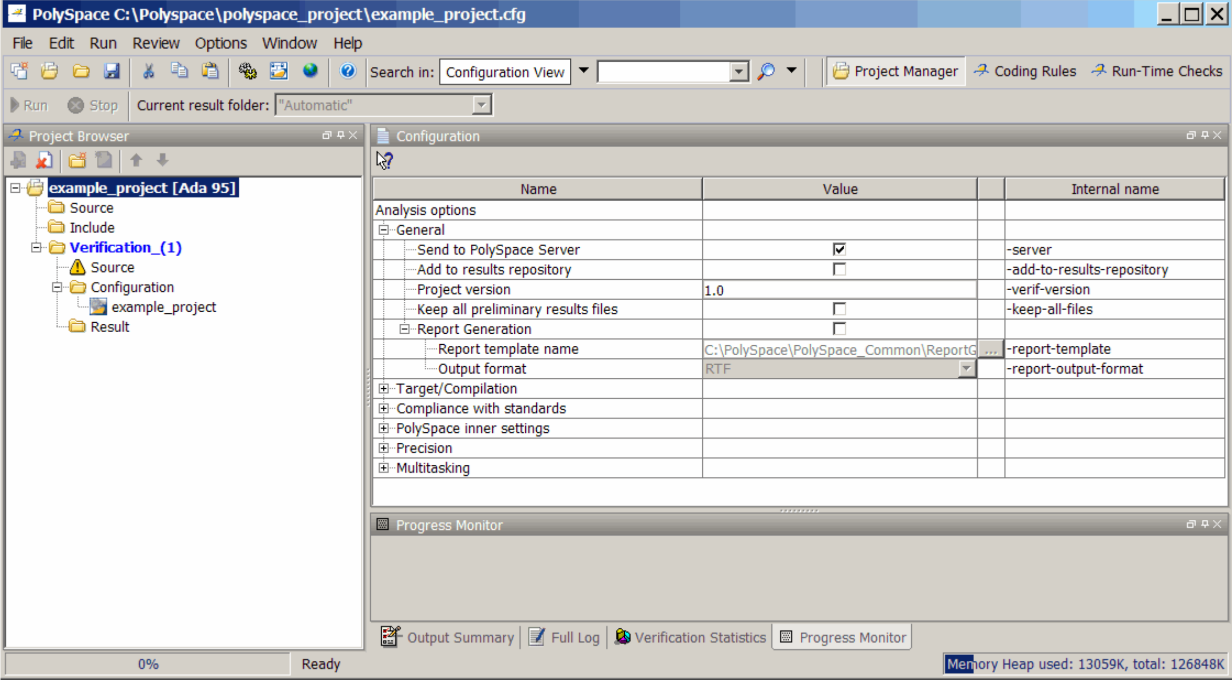
The Polyspace verification environment (PVE) is the graphical user interface of the Polyspace Client for Ada software. You use the Polyspace verification

environment to create Polyspace projects, launch verifications, and review verification results.

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

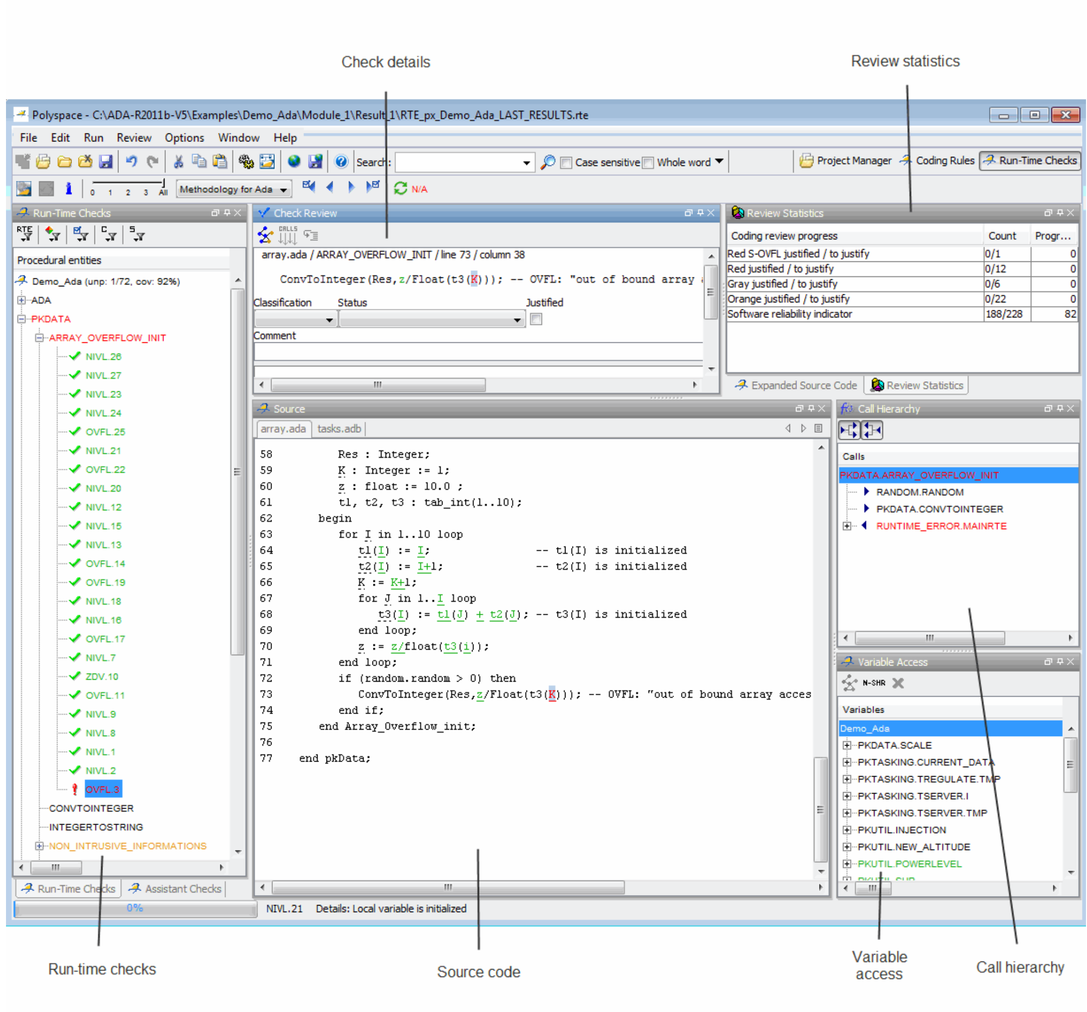
- "Project Manager Perspective" on page 1-7
- "Run-Time Checks Perspective" on page 1-8

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



For information on using the Project Manager perspective, see Chapter 3, "Setting Up a Verification Project".

Run-Time Checks Perspective. The Run-Time Checks perspective allows you to review verification results, comment individual checks, and track review progress.



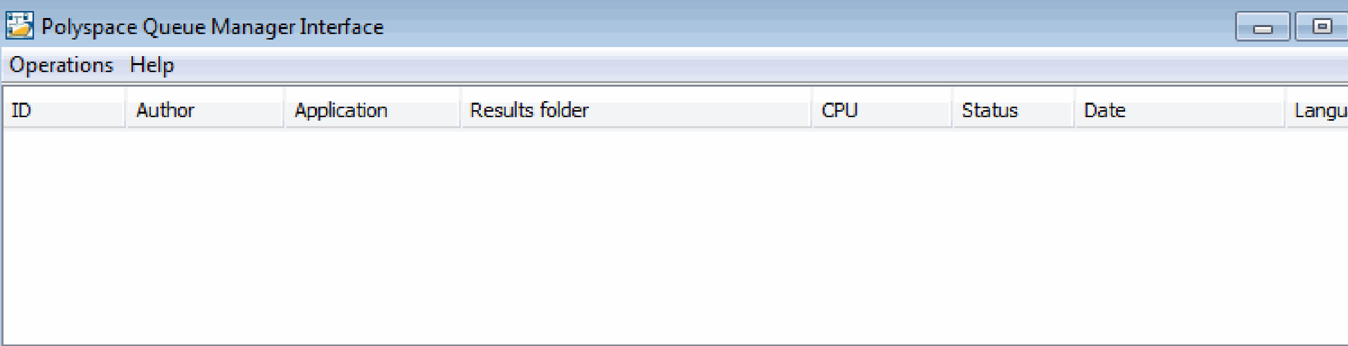
For information on using the Run-Time Checks perspective, see Chapter 8, “Reviewing Verification Results”.

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 Queue Manager Interface (Spooler)
- Polyspace in One Click
- Polyspace Metrics Web Interface

Polyspace Queue Manager Interface (Polyspace Spooler). The Polyspace Queue Manager (also called the Polyspace Spooler) is the graphical user interface of the Polyspace Server for Ada software. You use the Polyspace Queue Manager Interface to move jobs within the queue, remove jobs, monitor the progress of individual verifications, and download results.



For information on using the Polyspace Queue Manager Interface, see Chapter 6, “Running a Verification”.

Polyspace in One Click. Polyspace in One Click is a convenient way to verify multiple files using the same set of options.

After creating a project with the options that you want, you can use Polyspace in One Click to designate that project as the *active project*, and then send source files to Polyspace software for verification with a single mouse click.

For information on using Polyspace in One Click, see Chapter 10, “Day to Day Use”.

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 Chapter 11, "Software Quality with Polyspace Metrics".

Installing Polyspace Products

For information on installing and licensing Polyspace products, refer to the *Polyspace Installation Guide*.

Related Products

- "Polyspace Products for Verifying C and C++ Code" on page 1-10
- "Polyspace Products for Linking to Models" on page 1-10

Polyspace Products for Verifying C and C++ Code

For information about Polyspace products that verify C and C++ code, see the following:

`http://www.mathworks.com/products/polyspaceclientc/`

`http://www.mathworks.com/products/polyspaceserverc/`

Polyspace Products for Linking to Models

For information about Polyspace products that link to models, see the following:

`http://www.mathworks.com/products/polyspacemodelsl/`

`http://www.mathworks.com/products/polyspaceumlrh/`

Polyspace Documentation

In this section...

"About this Guide" on page 1-11

"Related Documentation" on page 1-11

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.

Related Documentation

In addition to this guide, the following related documents are shipped with the software:

- ***Polyspace Products for Ada Getting Started Guide*** – Provides a basic workflow and step-by-step procedures for verifying Ada code using Polyspace software, to help you quickly learn how to use the software.
- ***Polyspace Products for Ada Reference Guide*** – Provides detailed descriptions of all Polyspace options, as well as all checks reported in the Polyspace results.
- ***Polyspace Installation Guide*** – Describes how to install and license Polyspace products.
- ***Polyspace Release Notes*** – Describes new features, bug fixes, and upgrade issues.

You can access these guides from the **Help** menu, or by or clicking the Help icon in the Polyspace window.

To access the online documentation for Polyspace products, go to:

`www.mathworks.com/help/toolbox/polyspace/polyspace_product_page.html`

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" on page 2-2
- "Implementing a Process for Polyspace Verification" on page 2-4
- "Sample Workflows for Polyspace Verification" on page 2-11

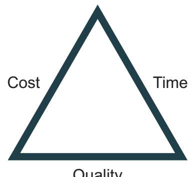
Polyspace Verification and the Software Development Cycle

In this section...

"Software Quality and Productivity" on page 2-2
"Best Practices for Verification Workflow" on page 2-3

Software Quality and Productivity

The goal of most software development teams is to maximize both quality and productivity. However, when developing software, there are always three related variables: cost, quality, and time.



Changing the requirements for one of these variables always impacts 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 all modules in an application until each meets the required quality level. Unfortunately, this process often ends before quality objectives are met, because the available time or budget has been exhausted.

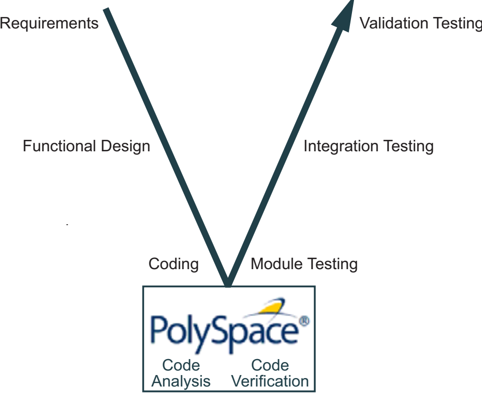
Polyspace verification allows a different process. Polyspace verification can support both productivity improvement and quality improvement at the same time, although there is always a balance between these goals.

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 any 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 code cannot be proven safe. In addition, defects are cheaper to fix at this stage, since 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" on page 2-4
"Defining Quality Objectives" on page 2-5
"Defining a Verification Process to Meet Your Objectives" on page 2-9
"Applying Your Verification Process to Assess Code Quality" on page 2-10
"Improving Your Verification Process" on page 2-10

Overview of the Polyspace Process

Polyspace verification cannot magically produce quality code at the end of the development process. Verification is a tool that helps you measure the quality of your code, identify issues, and ultimately achieve your own quality goals. To do this, however, you must integrate Polyspace verification into your development process.

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

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

Defining Quality Objectives

Before you can verify whether your code meets your quality goals, you must define those goals. Therefore, the first step in implementing a verification process is to define your quality objectives.

This process involves:

- "Choosing Robustness or Contextual Verification" on page 2-5
- "Choosing Strict or Permissive Verification Objectives" on page 2-6
- "Defining Software Quality Levels" on page 2-7

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 works under all conditions.
- **Contextual Verification** – Prove software works 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 works under all 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 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 objectives.

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)” on page 4-9.
- 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” on page 4-6.
- Provide manual stubs that emulate the behavior of missing functions, instead of using the default automatic stubs. For more information, see “Stubbing” on page 5-2.

Choosing Strict or Permissive Verification Objectives

While defining the quality objectives for your application, you should determine which of these options you want to use.

Options that make verification more strict include:

- **`-strict`**

Options that make verification more permissive include:

- **`-permissive`**

For more information on these options, see "Option Descriptions" in the *Polyspace Products for Ada Reference*.

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 appropriate 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

You define the quality criteria appropriate for your application. In the example above, the quality criteria include:

- **Static Information** – Includes information about the application architecture, the structure of each module, and all files. This information must be documented to ensure that your application is fully verified.
- **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. Polyspace software allows you to define three criteria levels for reviewing orange checks in the Polyspace . For more information, see “Reviewing Results Systematically”.
- **Dataflow analysis** – Identifies errors such as non-initialized variables and variables that are written but never 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 Objectives

Once you have defined your quality objectives, you must define a process that allows you to meet those objectives. 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 objectives. See "Creating a Project" on page 3-2.
- Setting review criteria in the Polyspace Run-Time Checks perspective to ensure results are reviewed consistently. See Chapter 8, "Reviewing Verification Results".

Applying Your Verification Process to Assess Code Quality

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

This process includes:

1. Launching Polyspace verification on each software component as it is written. See "Using Polyspace In One Click" on page 10-3.

2. Reviewing verification results consistently. See "Reviewing Results Systematically" on page 8-28.

3. Saving review comments for each component, so they are available for future review. See "Importing Review Comments from Previous Verifications".

4. Performing additional verifications on each component, as defined by your quality objectives.

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 objectives.
- 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 Chapter 9, "Managing Orange Checks".

Sample Workflows for Polyspace Verification

In this section...

"Overview of Verification Workflows" on page 2-11
"Software Developers – Standard Development Process" on page 2-12
"Software Developers – Rigorous Development Process" on page 2-15
"Quality Engineers – Code Acceptance Criteria" on page 2-19
"Quality Engineers – Certification/Qualification" on page 2-22
"Model-Based Design Users — Verifying Generated Code" on page 2-23
"Project Managers — Integrating Polyspace Verification with Configuration Management Tools" on page 2-27

Overview of Verification Workflows

Polyspace verification supports two objectives 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, no unit test tools or coverage tools are used – functional tests are performed just after coding.
- In C, either no coding rules are used, or rules are not followed consistently.

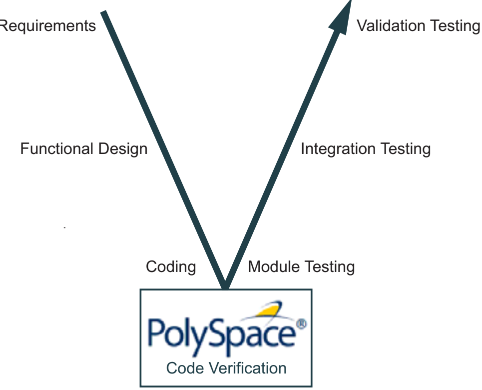
Quality Objectives

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 that other processes, while optimizing productivity to ensure 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 all 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 all **red** errors and examines **gray** code identified by the verification.
4. The developer repeats steps 2 and 3 as needed, while completing the code.
5. Once a developer considers a file complete, they perform a final verification.
6. The developer fixes any **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 needed to set up your verification will be higher if you do not use coding rules. You may need to make modifications to the code before launching 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.

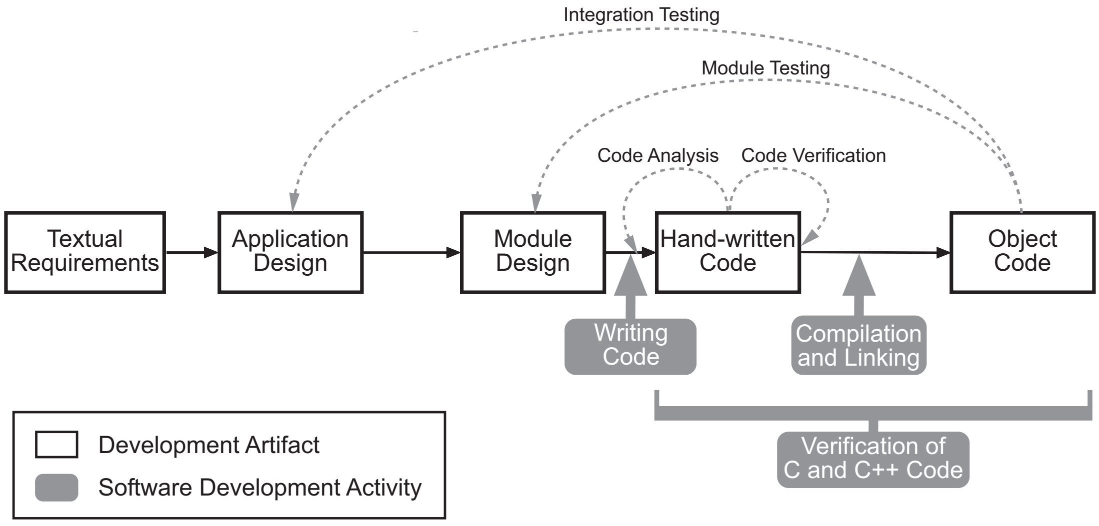
Quality Objectives

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

Verification can prove the absence of runtime errors, while helping developers find and fix any 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 appropriate 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 any coding rule violations, fixes all **red** errors, examines **gray** code, and performs a selective orange review.
5. The developer repeats steps 2 and 3 as needed, while completing the code.
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. This represents a step towards an exhaustive orange check review. However, spending more time is unlikely to be efficient, and will not guarantee that no bugs remain.
- 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 Objectives

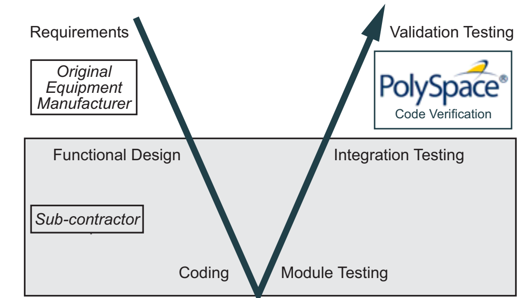
The main goal of Polyspace verification is to control and evaluate the safety of an application.

The criteria used to evaluate code can vary widely depending on the criticality of the application, from no red errors 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 2-7.

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 objectives.



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 objectives 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 Objectives" on page 2-5.

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 objectives, as described in "Defining a Verification Process to Meet Your Objectives" on page 2-9.

5. Quality engineers perform verification on the code.

6. Quality engineers review all **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 2-7).

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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 correcting 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 all unresolved function calls.
- Using DRS to provide accurate data ranges for all input variables.

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

Quality Engineers – Certification/Qualification

User Description

This workflow applies to quality engineers who work with applications requiring outside quality certification, such as IEC 61508 certification or DO-178B qualification.

These users must perform a set of activities to meet certification requirements.

For more information on using Polyspace products within an IEC 61508 certification environment, see the *IEC Certification Kit: Verification of C and C++ Code Using Polyspace Products*.

For more information on using Polyspace products within an DO-178B qualification environment, see the *DO Qualification Kit: Polyspace Client/Server for C/C++ Tool Qualification Plan*.

Model-Based Design Users — Verifying Generated Code

User Description

This workflow applies to users who have adopted model-based design to generate code for embedded application software.

These users generally use Polyspace software in combination with several other MathWorks® products, including Simulink®, Embedded Coder™, and Simulink® Design Verifier™. In many cases, these customers combine application components that are hand-written code with those created using generated code.

Quality Objectives

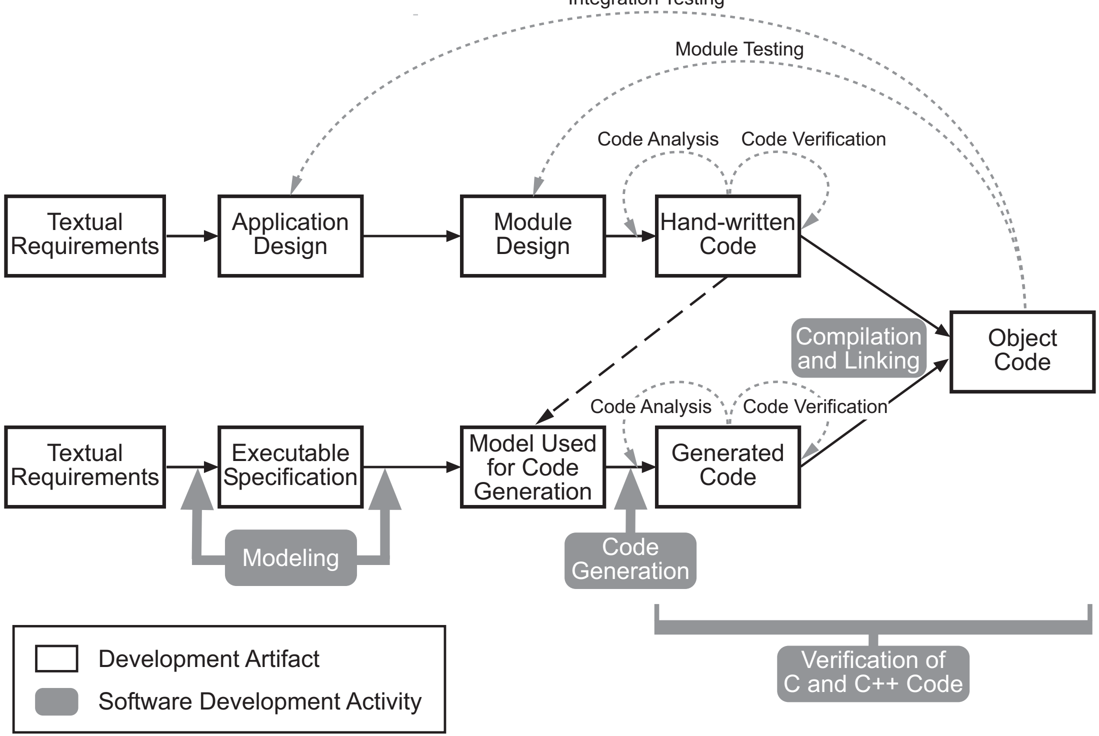
The goal of Polyspace verification is to improve the quality of the software by identifying implementation issues in the code, and ensuring the code is both semantically and logically correct.

Polyspace verification allows you to find run time errors:

- In handwritten portions within the generated code
- In the model used for production code generation
- In the integration of handwritten and generated code

Verification Workflow

The workflow is different for hand-written code, generated code, and mixed code. Polyspace products can perform code verification as part of any of these workflows. The following figure shows a suggested verification workflow for hand-written and mixed code.



Workflow for Verification of Generated and Mixed Code

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 meet defined quality objectives.

2. Developers write hand-coded sections of the application.

3. Developers perform **Polyspace verification** on any hand-coded sections within the generated code, and review verification results according to the established quality objectives.

4. Developers create Simulink model based on requirements.

5. Developers validate model to ensure it is logically correct (using tools such as Simulink Model Advisor, and the Simulink® Verification and Validation™ and Simulink Design Verifier products).

6. Developers generate code from the model.

7. Developers perform **Polyspace verification** on the entire software component, including both hand-written and generated code.

8. Developers review verification results according to the established quality objectives.

Note The Polyspace Model Link™ SL product allows you to quickly track any issues identified by the verification back to the appropriate block in the Simulink model.

Costs and Benefits

Polyspace verification can identify errors in textual designs or executable models that are not identified by other methods. The following table shows how errors in textual designs or executable models can appear in the resulting code.

Examples of Common Run-Time Errors

Type of Error	Design or Model Errors	Code Errors
Arithmetic errors	• Incorrect Scaling • Unknown calibrations • Untested data ranges	• Overflows/Underflows • Division by zero • Square root of negative numbers
Memory corruption	• Incorrect array specification in state machines • Incorrect legacy code (look-up tables)	• Out of bound array indexes • Pointer arithmetic
Data truncation	• Unexpected data flow	• Overflows/Underflows • Wrap-around
Logic errors	• Unreachable states • Incorrect Transitions	• Non initialized data • Dead code

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 Objectives

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 objectives, including individual quality levels for each stage of the development cycle.

2. Project leader configures a Polyspace project to meet quality objectives.

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 all multitasking aspects accounted for as appropriate.
   - **Pre-peer review check-in** — On the whole project, with all multitasking aspects accounted for as appropriate.

4. Developers review verification results for each check-in activity to ensure the code meets the appropriate quality level. For example, the transition criterion could be: “No bug found within 20 minutes of selective orange review”

3

Setting Up a Verification Project

- "Creating a Project" on page 3-2
- "Specifying Options to Match Your Quality Objectives" on page 3-13
- "Setting Up Project to Generate Metrics" on page 3-16

Creating a Project

In this section...

"What Is a Project?" on page 3-2

"Project Folders" on page 3-3

"Opening Polyspace Verification Environment" on page 3-3

"Creating New Projects" on page 3-5

"Opening Existing Projects" on page 3-7

"Specifying Source Files" on page 3-8

"Specifying Include Folders" on page 3-9

"Changing Project Location" on page 3-9

"Specifying Analysis Options" on page 3-10

"Configuring Text and XML Editors" on page 3-11

"Saving the Project" on page 3-12

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.

Project Folders

Before you begin verifying your code with Polyspace software, you must know the location of your Ada source package and any other specifications upon which it may depend either directly or indirectly. You must also know where you want to store the verification results.

To simplify the location of your files, you may want to create a project folder, and then in that folder, create separate folders for the source files, include files, and results. For example:

`polyspace_project/`

- `sources`
- `includes`
- `results`

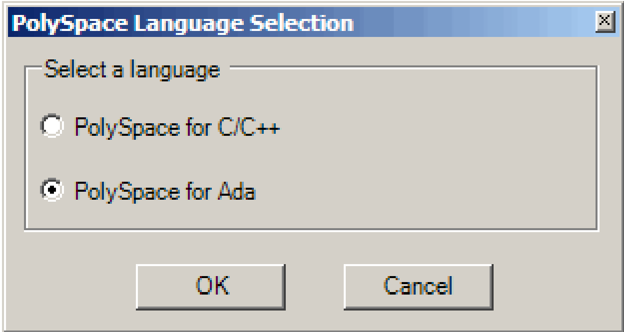
Opening Polyspace Verification Environment

Use the Polyspace verification environment to create projects, start verifications, and review verification results.

To open the Polyspace verification environment:

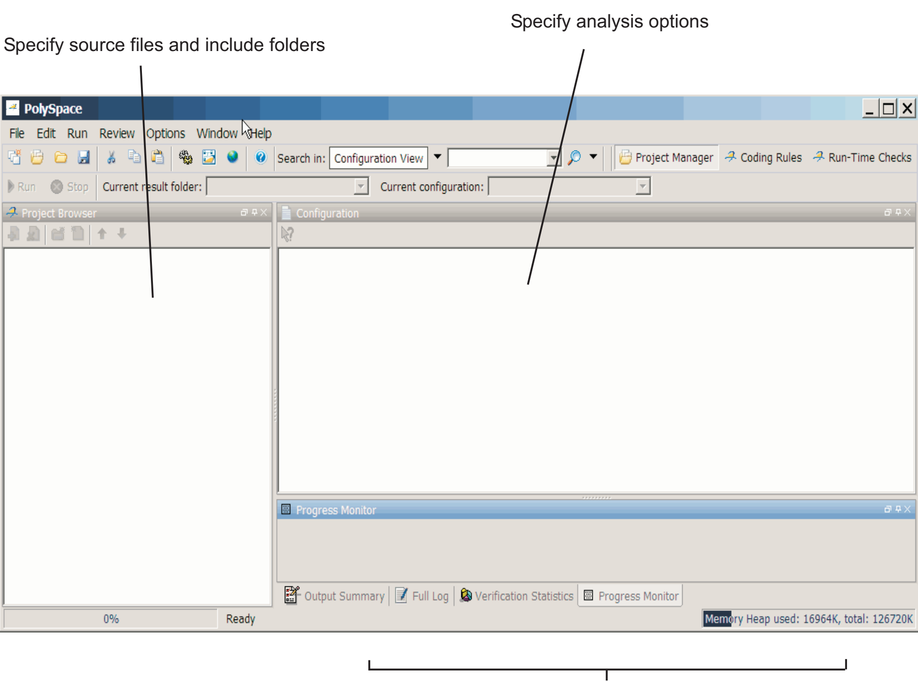
1. Double-click the Polyspace icon.

2. If you have both Polyspace for C/C++ and Polyspace for Ada products on your system, the **Polyspace Language Selection** dialog box opens.



Select **Polyspace for Ada**, and click **OK**.

The Polyspace verification environment opens:



By default, the Polyspace Verification Environment displays the Project Manager perspective. The Project Manager perspective has three main sections.

Use this section...	For...
Project Browser (upper-left)	Specifying: • Source files • Include folders • Results folder
Configuration (upper-right)	Specifying analysis options
Output (lower-right)	Monitoring the progress of a verification, and viewing status, log messages, and general verification statistics.

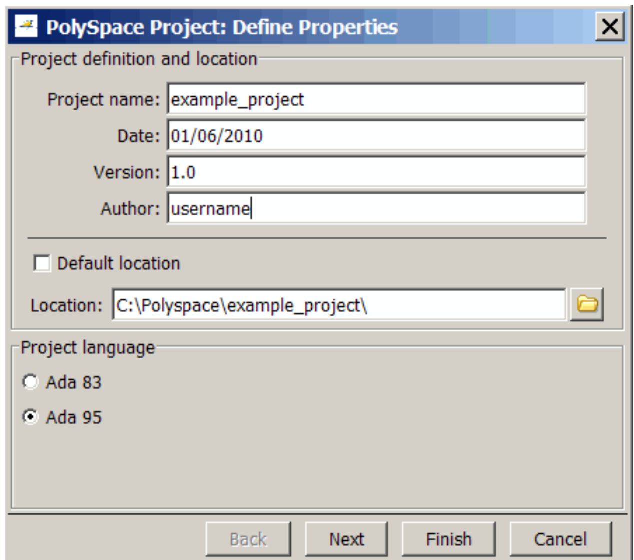
You can resize or hide any of these sections.

Creating New Projects

To create a new project:

1 Select **File > New Project**.

The Polyspace Project: Define Properties dialog box appears:

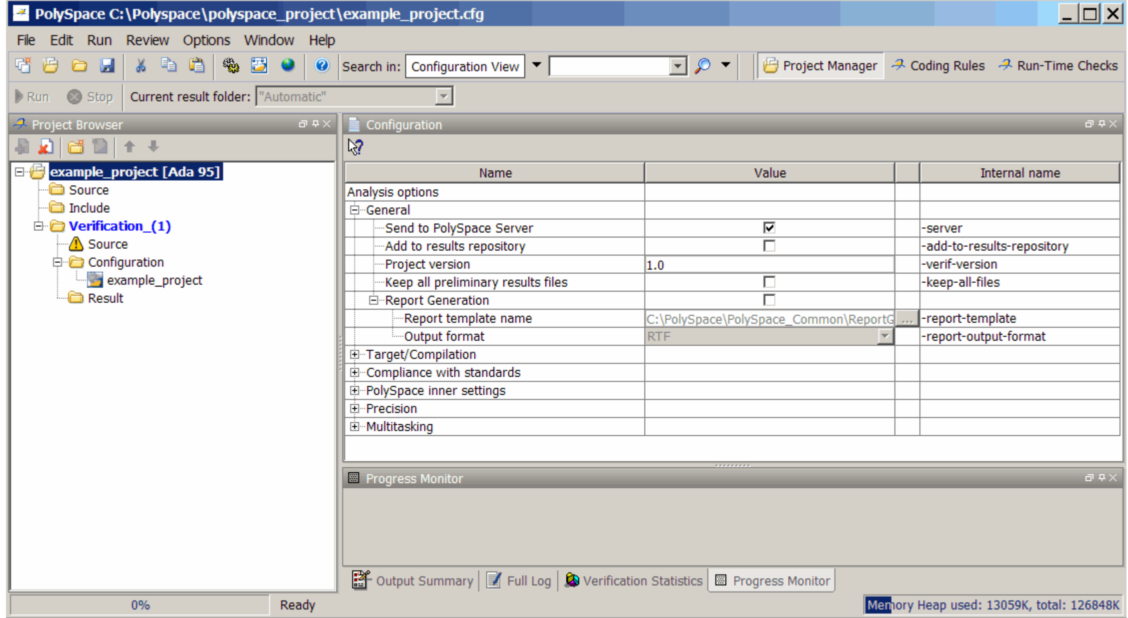


2 In the **Project name** field, enter a name for your project.

3 If you want to specify a location for your project, clear the **Default location** check box, and enter a **Location** for your project.

4 In the Project language section, select either **Ada 83** or **Ada 95**.

5 Click **Finish**. The Polyspace verification environment opens. See also



Opening Existing Projects

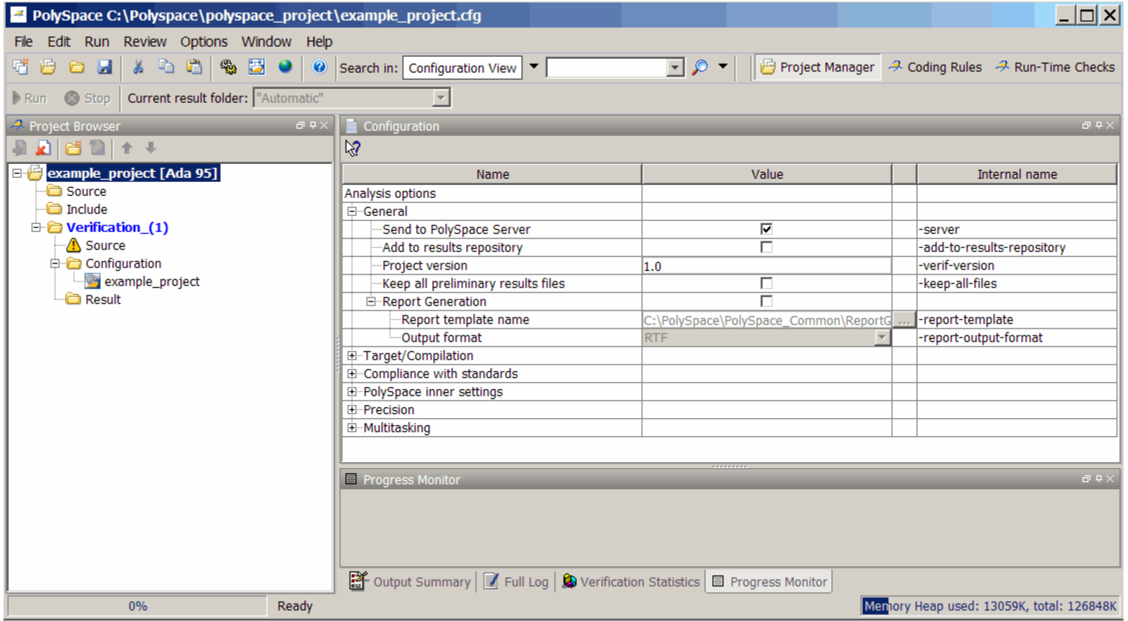
To open an existing project:

1. Select **File > Open Project**.

   The **Please select a file** dialog box opens.

2. Select the project you want to open, and click **OK**.

   The selected project opens in the Project Manager perspective.



Specifying Source Files

To specify the source files for your project:

1 In **Project Browser**, select the **Source** folder.

2 Click the **Add source** icon The Polyspace Project: Add Source Files and Include Folders dialog box opens.

3 In the **Look in** field, navigate to the folder containing your source files.

4 Select the source files you want to include in the project, then click **Add Source**.

   The source files appear in the Source tree for your project.

5 Click **Finish** to apply the changes and close the dialog box. The source files you selected appear in the Project Browser.

Specifying Include Folders

To specify the include folders for the project:

1. In **Project Browser**, select the **Include** folder.

2. Click the **Add source** icon .

   The Polyspace Project: Add Source Files and Include Folders dialog box opens.

3. In the **Look in** field, navigate to the folder containing your Include files.

4. Select the Include folders you want to include in the project, and click **Add Include**. The Include folders appear in the Include tree for your project.

5. Click **Finish** to apply the changes and close the dialog box. The Include folders you selected appear in **Project Browser**.

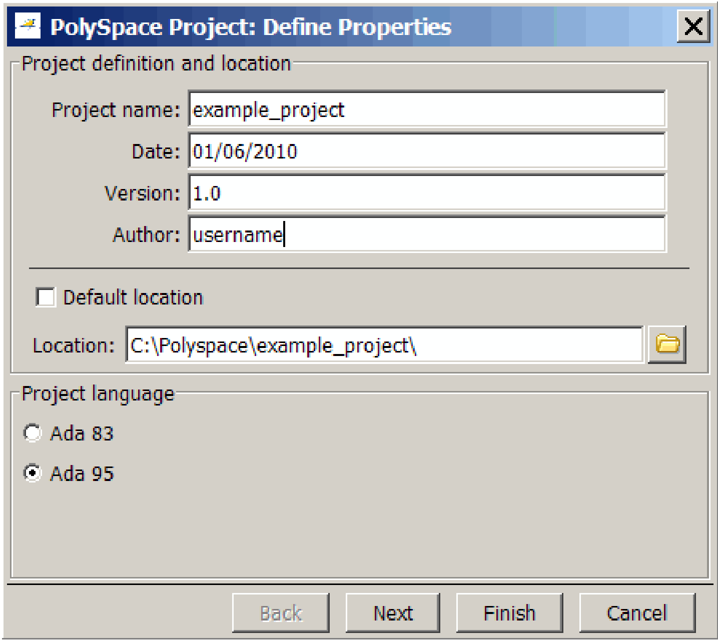
Changing Project Location

Polyspace software saves verification results in `Module_(#)` subfolders within the project folder. To change the location of your results, you must change the project location.

To change the location of an existing project:

1. In **Project Browser**, right-click the project name and select Project Properties.

   The Polyspace Project – Properties dialog box opens:



2 Clear the **Default location** check box.

3 Enter the new **Location** for your project.

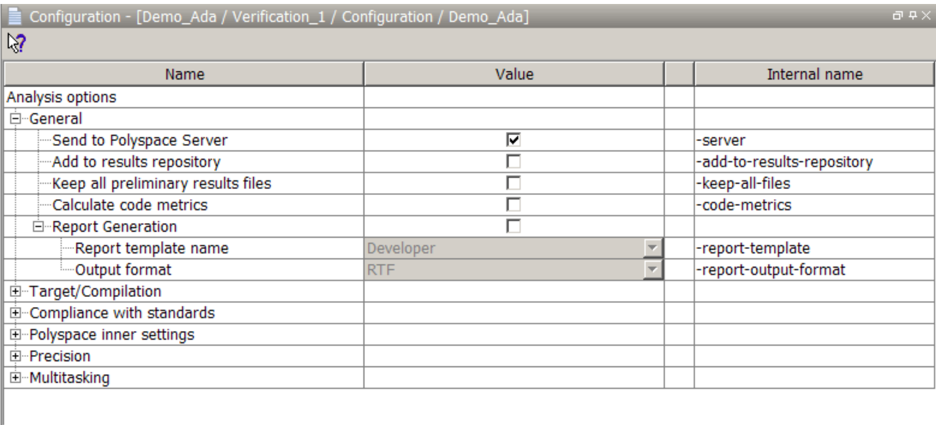
4 Click **Finish**.

Specifying Analysis Options

The analysis options in the **Configuration** view of the Project Manager perspective include parameters that Polyspace software uses during the verification process.

To specify, for example, general parameters for your project:

1 Expand **General** to display the **General** options.



2 Specify the appropriate general parameters for your project.

For detailed information about specific analysis options, see "Option Descriptions" in the *Polyspace Products for Ada Reference*.

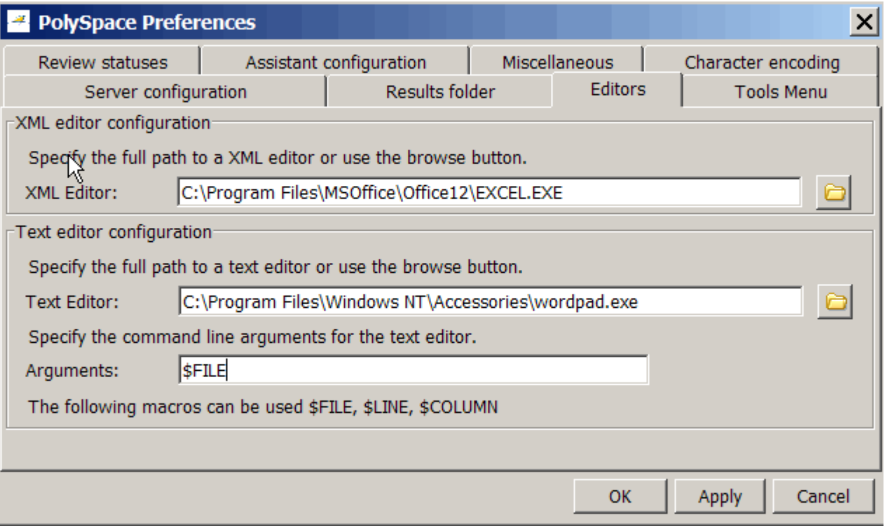
Configuring Text and XML Editors

Before you run a verification, you should configure preferences for your text and XML editors to enable viewing of source files and reports from the Polyspace verification environment.

To configure your text and .XML editors:

1 Select **Options > Preferences**. The Polyspace Preferences dialog box opens.

2 Select the **Editors** tab.



3. Specify an XML editor to use to view reports. For example:

   ```
   C:\Program Files\MSOffice\Office12\EXCEL.EXE
   ```

4. Specify a Text editor to use to view source files from the Project Manager logs. For example:

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

5. Specify command line arguments for the text editor. For example:

   ```
   $FILE
   ```

6. Click **OK**.

Saving the Project

To save the project, select **File > Save**.

Polyspace software saves your project using the Project name and Location you specified when creating the project.

Specifying Options to Match Your Quality Objectives

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

This includes:

In this section...
"Quality Objectives Overview" on page 3-13
"Choosing Contextual Verification Options" on page 3-13
"Choosing Strict or Permissive Verification Options" on page 3-15

Quality Objectives Overview

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

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

Note For information on defining the quality objectives for your project, see "Defining Quality Objectives" on page 2-5.

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.

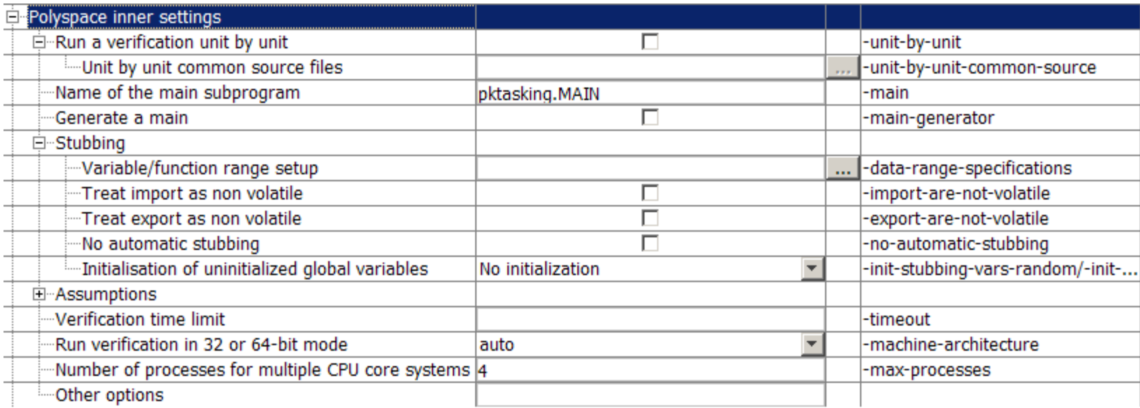
For more information on robustness and contextual verification, see "Choosing Robustness or Contextual Verification" on page 2-5.

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 Run-Time Checks perspective. For more information, see “Highlighting Known Run-Time Errors” on page 5-29.

To specify contextual verification for your project:

1. In the **Configuration** view of the Project Manager perspective, expand **Polyspace inner settings**.

2. Expand the **Generate a main** and **Stubbing** options.



3. To control main generation behavior, specify the following options:

   - **Generate a main (`-main-generator`)** – Specifies whether the software automatically generates a main.

4. To set ranges on variables, use **Variable/function range setup (`-data-range-specifications`)**:

5. To control stubbing behavior, use the following options:

   - **No automatic stubbing (`-no-automatic-stubbing`)** – Specifies that the software will not automatically stub functions. The software list the functions to be stubbed and stops the verification.

- **Initialization of uninitialized global variables (`-init-stubbing-vars-random`)** – Specifies how uninitialized global variables are initialized.

For more information on these options, see "Option Descriptions" in the *Polyspace Products for Ada Reference*.

Choosing Strict or Permissive Verification Options

Polyspace software provides several options that allow you to customize the strictness of the verification. You should set these options to match the quality objectives 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 Run-Time Checks perspective. For more information, see "Highlighting Known Run-Time Errors" on page 5-29.

To specify the strictness of your verification:

1. In the **Configuration** view of the Project Manager perspective, expand **Compliance with standards**.

2. From the Analysis Mode drop-down menu, select **Strict** or **Permissive**.

Name	Value		Internal name
Analysis options			
⊞ General			
⊞ Target/Compilation			
⊟ Compliance with standards			
Value of the constant Storage_Unit			-storage-unit
Remove comparison operators ambiguities	☐		-base-type-directly-visible
Analysis Mode	Permis...		-strict/-permissive
⊞ PolySpace inner settings	Strict		
⊞ Precision	Customize		
⊞ Multitasking	Permissive		

For more information on these options, see "Option Descriptions" in the *Polyspace Products for Ada Reference*.

Setting Up Project to Generate Metrics

In this section...

"About Polyspace Metrics" on page 3-16

"Enabling Polyspace Metrics" on page 3-16

"Specifying Automatic Verification" on page 3-17

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, coding rule violations, 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 Chapter 11, "Software Quality with Polyspace Metrics".

Enabling Polyspace Metrics

Before you can use Polyspace Metrics, you must run a Polyspace verification with the `-code-metrics` option enabled. This option enables a metrics computation engine that evaluates metrics for your code, and stores these metrics in a results repository.

To enable code metrics:

1. In the Analysis Options window, expand the **General** menu.
2. Select the **Add to results repository** check box.
3. Select the **Calculate code metrics** check box.

Polyspace Metrics are generated 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" on page 11-3.

4

Emulating Your Run-Time Environment

- "Setting Up a Target" on page 4-2
- "Verifying an Application Without a Main" on page 4-6
- "Specifying Data Ranges for Variables, Functions, and Procedures (Contextual Verification)" on page 4-9
- "Using Pragma Assert to Set Data Ranges" on page 4-17
- "Supported Ada Pragmas" on page 4-19

Setting Up a Target

In this section...
"Target/Compiler Overview" on page 4-2
"Specifying Target/Compilation Parameters" on page 4-2
"Predefined Target Processor Specifications" on page 4-3

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 affect whether errors (such as overflows) occur.

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

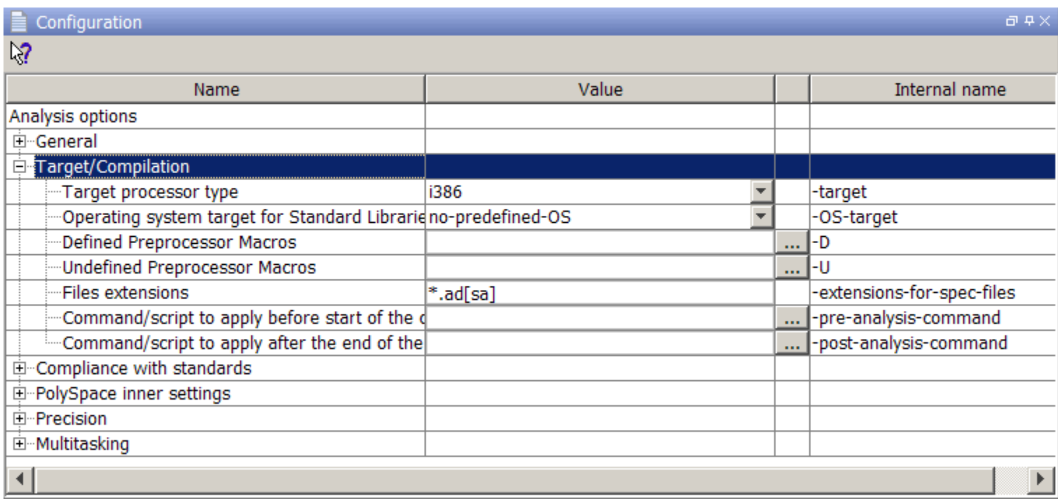
For detailed information on each Target/Compilation option, see "Target and Compiler Options" in the *Polyspace Products for Ada Reference*.

Specifying Target/Compilation Parameters

In the Project Manager perspective, on the **Configuration** pane, the Target/Compilation options allow you to specify the target processor and operating system for your application.

To specify target parameters for your project:

1. Under **Analysis options**, expand **Target/Compilation**.



2 Select the **Target processor type** for your application.

3 Specify the **Operating system target** for your application.

For detailed information on each Target/Compilation option, see "Target and Compiler Options" in the *Polyspace Products for Ada Reference*.

Predefined Target Processor Specifications

Polyspace software supports many processors, as listed in the following table. To specify one of the predefined processors, select it from the **Target processor type** drop-down list.

If the processor for a target environment is not explicitly listed in the following table, you can safely specify a processor which shares the same listed characteristics as your processor.

Target	sparc	m68k ColdFire	1750a	powerpc 32bits	powerpc 64bits	I386
Character	8	8	16	8	8	8
short_integer	16	16	16	16	16	16

Target	sparc	m68k ColdFire	1750a	powerpc 32bits	powerpc 64bits	I386
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

- Target powerpc32bits: The largest default alignment of basic types within record/array is 64.
- Target powerpc64bits: The largest default alignment of basic types within record/array is 64.
- Target i386: The largest default alignment of basic types within record/array is 32.

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" on page 4-6
"Automatically Generating a Main" on page 4-6
"Manually Generating a Main" on page 4-7
"Example" on page 4-7

Main Generator Overview

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

When you run a verification on Polyspace Client for Ada software, the main is always 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 **Generate a main** (`-main-generator`) option. The `-main-generator` option automatically creates a procedure which calls every non-called procedure within the code.

- **Polyspace Client for Ada software** – By default, the software automatically generates a main. You can choose to manually generate a main using the `-main` option:
  1. On the **Configuration** pane, Under **Polyspace inner settings**, clear the **Generate a main** check box.
  2. In the **Value** cell for **Name of the main subprogram**, specify your file that defines the main, for example, `INIT.MAIN`.
- **Polyspace Server for Ada software** – The `-main` option is set by default. You can choose to automatically generate a main using the `-main-generator` option. On the **Configuration** pane, under **Polyspace**

inner settings, select the **Generate a main** (`-main-generator`) check box.

For more information on the main generator, see "Generate a main" in the *Polyspace Products for Ada Reference*.

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.

There are five steps 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.

Example

```
The API spec are:
function func1(x in integer) return integer;
procedure func2(x in out float, y in integer);
The main you'll have to create is the following :
procedure main is
 a,b,c,d: integer;
 e,f: float;
pragma volatile (a);
pragma volatile (e);
-- We need an integer and float variable as a function parameter
begin
 loop
f := e;
c:=a;
```

```
d:=a;
  if (a = 1) then b:= func1(c); end if;
  if (a = 1) then func2(e,d); end if;
 end loop
end main;
```

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

In this section...

"Overview of Data Range Specifications (DRS)" on page 4-9
"Specifying Data Ranges Using Text Files" on page 4-9
"Performing Efficient Module Testing with DRS" on page 4-14
"Reducing Orange Checks with DRS" on page 4-15

Overview of Data Range Specifications (DRS)

By default, Polyspace software performs *robustness verification*, proving that the software works under all conditions. Robustness verification assumes that all data inputs are set to their full range. Therefore, nearly any operation 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

Note Data ranges are applied during verification level 2 (`pass2`).

Specifying Data Ranges Using Text Files

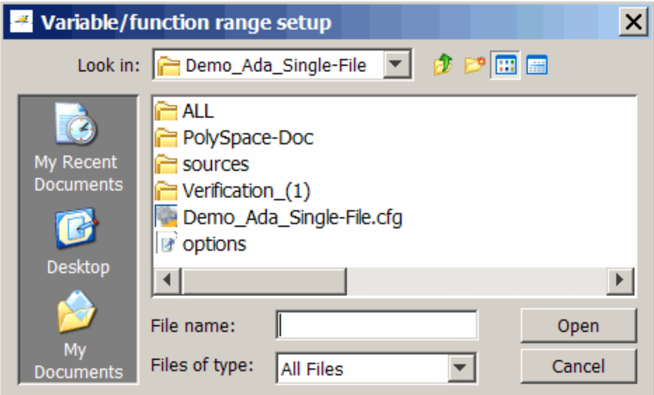
To use the DRS feature, you must specify a file that constrains the range of values for global variables, values returned by stubbed functions, `out`

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 4-11.

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

1. In Project Manager, using Project Browser, select your project.
2. On the **Configuration** pane, under **Analysis options** , select **Polyspace inner settings > Stubbing**.
3. In the **Variable range setup** row, select the browse button ... .

   The Variable/function range setup configuration dialog box opens.



4. Use this dialog box to navigate to the folder that contains your DRS text file.
5. In the file view, either select your DRS text file, or enter its name in **File name**.
6. Click **Open**. The file path appears in the **Value** cell.
7. 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 with no 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 there is a syntax error in the DRS file. 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 there is an unsupported data range specification in the DRS file. 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

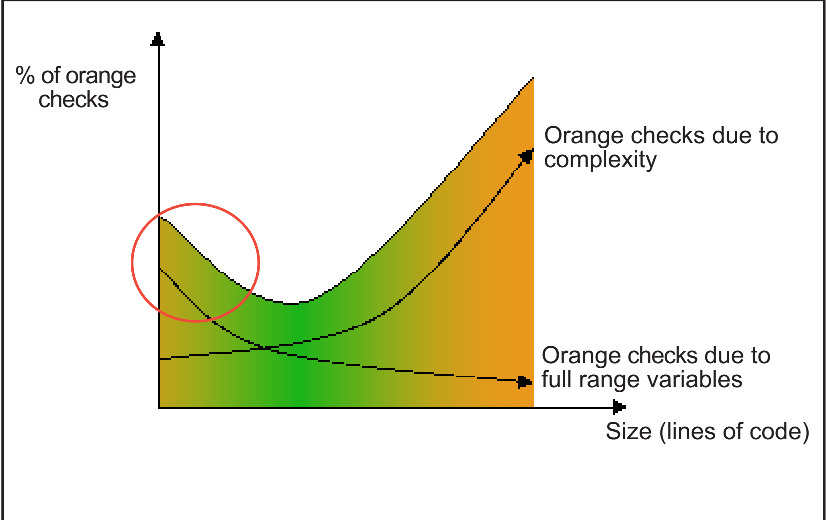
When performing robustness (worst case) verification, data inputs are always set to their full range. Therefore, every operation on these inputs, even a simple "`one_input + 10`" can produce an overflow, as the range of `one_input` varies between the minimum value and the maximum value of the type.

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` never overflows
- the results of this operation are always 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 number of orange checks caused by code complexity is not affected by 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 **all execution paths for unsatisfied conditions are truncated** (red and then gray). Thus it can be assumed that any 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 never goes 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 any 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. If you specify `Polyspace for Ada83`, there is no effect.
`Assert`	Produces a user assertion check, `ASRT`. See "User Assertion: ASRT" in the *Polyspace Products for Ada Reference Guide*.
`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`).

Pragma	How Polyspace Software Processes Pragma

`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;`
	
	`...`
	`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 a supported pragma in your code contains unknown or invalid parameters and syntax, Polyspace ignores the pragma and continues the verification. However, Polyspace displays a warning.

Preparing Source Code for Verification

- "Stubbing" on page 5-2
- "Preparing Code for Variables" on page 5-7
- "Preparing Multitasking Code" on page 5-15
- "Highlighting Known Run-Time Errors" on page 5-29

Stubbing

In this section...
“Stubbing Overview” on page 5-2
“Manual vs. Automatic Stubbing” on page 5-2
“Automatic Stubbing” on page 5-5

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 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 the effect that the code might have on the remainder of the system.

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, then you can stub it to an empty action (begin null; end;). Polyspace has no timing constraints and already takes into account all possible scheduling and interleaving and enhances all timing constraints: there is no need to stub functions that set or reset a timer. Simply declare the variable representing time as volatile.
- an I/O access: to a hardware port, a sensor, read/write of a file, read of an eeprom, write to a volatile variable, then: there is no need to stub a write access or simply stub a write access to an empty action (see above), stub read accesses as "I read all possible values (volatile)".
- a write to a global variable, you may need to 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 all 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 cares about the Ada code which is provided.
- Polyspace does not need to be informed of timing constraints because all possible sequencing is taken into account.

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 in the knowledge that no runtime error will be ever introduced by automatic stubbing; to minimize preparation time.

Automatic Stubbing

Problem

What is the default behavior for missing functions?

Explanation

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

- they are external,
- they are written in C, or any other language than Ada,
- they are part of the system libraries.

Polyspace relies on and trusts their specifications when stubbing them.

Solution

Add the `-automatic-stubbing` option to your launching script and Polyspace will stub missing code as follows:

- for an **in** parameter, nothing happens;
- for an **out** (or **in out**) parameter, the variable will be given the full range of its type;
- for a **return** parameter, it will be the full range of its type.

A procedure with this specification:

```
procedure a_missing_function (a: in out type_1,  b: in integer);
```

will be stubbed like so:

```
a_missing_function (var_1, var_2)
```

That is - the "var_1" variable will be overwritten with the full range of type_1.

Preparing Code for Variables

In this section...
"Float Rounding" on page 5-7
"Expansion of Sizes" on page 5-8
"Volatile Variables" on page 5-8
"Shared Variables" on page 5-10

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 board effect of such 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 any other 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.

Note Even if the volatile characteristic of a variable is also commonly used by programmers to avoid compiler optimization, it has no consequence for Polyspace.

```
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

All of my shared variables appear in orange in the variable dictionary.

Explanation

When you launch Polyspace Server for Ada without any option all tasks are examined at the same level, making no assumptions about priorities, sequence order, or timing. In this context, shared variables will always be 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, all other tasks will be blocked on the "critical-section-begin" function call 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 5-26

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 \
 -automatic-stubbing \
 -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 never overlap 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

All Ada rendezvous are taken into account without any input from the user. This is the only way to synchronize tasks. Polyspace Server for Ada does not handle atomicity, so other task synchronization mechanisms (including the use of critical sections) are not recognized by Polyspace Server for Ada.

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
```

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;
```

<table>
<tr><th>package_first_task</th><th>other tasks</th></tr>
<tr><td><pre>
   X:= 12;
  end; -- end accept
  -- return to main execution
 end task_1;
end first_task;
</pre></td><td><pre>
  null;
 end;
end other_tasks;
</pre></td></tr>
</table>

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" on page 5-15

"Scheduling Model" on page 5-16

"Modelling Synchronous Tasks" on page 5-17

"Interruptions and Asynchronous Events/Tasks" on page 5-19

"Are Interruptions Maskable or Preemptive by Default?" on page 5-21

"Mailboxes" on page 5-22

"Atomicity" on page 5-26

"Priorities" on page 5-27

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 all start simultaneously, without any 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 assumes:

- no atomicity,
- no timing constraints.

Scheduling Model

A problem can occur when some code is verified and the results suggest that all background tasks are dead code. In the same way, the problem could the same (gray code) if several tasks (infinite loops) are defined and run concurrently in an RTOS.

In the Polyspace model, the main procedure is executed first before any other task is started. After it has finished, all task entry points are assumed to start concurrently, meaning they can interrupt each other at any time. 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 is always needed using `-main` option.
- **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 never interrupt each other. My tasks are not infinite loops - they always return control to the calling context.

```
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 - but there may be more warnings than necessary (that is, the results are less precise) because more scenarios than could actually happen at execution time are modelled.

In order to address this, Polyspace Server for Ada needs to be informed that the tasks are purely sequential - that is, that they are functions to be called in a deterministic order. This can be achieved by writing a function to call each

of the tasks in the correct 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 in gray (dead code) in the Run-Time Checks perspective.

Explanation

The gray code indicates that this code is not executed and is not taken into account, so all interruptions and tasks 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, with all potential starting sequences being modeled.

My interrupts it1 and it2 cannot preempt each other

If these 3 following conditions are fulfilled:

- the it1 and it2 functions can never interrupt each other;
- each interrupt can be raised several times, at any time;
- they are returning functions, and not infinite loops.

Then you can group non preemptive interruptions in a single function and declare that function as a task entry point.

```
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 any other procedures that are also declared as tasks via the -entry-point option. Therefore, as Polyspace Server for Ada makes an **upper approximation of all scheduling and all interleaving,** it **includes the possibility that the ISR might be interrupted by any other task**. There are more paths modelled than can happen during execution, but this has no adverse effect on the results obtained;

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 necessary 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 Run-Time Checks 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 appropriate to that 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 there is no direct connection between a mailbox sender and receiver. It means that even if the sender is only submitting data within a small range, the full data range appropriate for the type(s) will be 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

Mechanism	Description
	• 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 of 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 never atomic except in the case of read and write instructions. Polyspace Server for Ada makes an **upper approximation of all scheduling and all interleaving**. There are more paths modelled than could happen during execution, but given that **all possible paths are always verified,** this has no adverse effect on the results obtained.

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 any of 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 5-10).

Critical Sections

In terms of critical sections, Polyspace Server for Ada does not model the concept of atomicity. A critical section only guarantees that once the function associated with -critical-section-begin has been called, any other function making use of the same label will be blocked. All other functions can still continue to run, even if somewhere else in another task a critical section has been started.

Polyspace Server for Ada verification of Run-time Errors (RTEs) supposes that there was no conflict when writing the shared variables. Hence even if a shared variable is not protected, the RTE verification is complete and correct.

More information is available in “Critical Sections” on page 5-10.

Priorities

Priorities are not taken into account by Polyspace as such. However, the timing implications of software execution are not relevant to the verification performed by Polyspace Server for Ada, which is usually the primary reason for implementing software task prioritization. In addition, priority inversion issues can mean that it would be dangerous to assume that priorities can protect shared variables. For that reason, Polyspace makes no such assumption.

In practice, while there is no facility to specify differing task priorities, all priorities **are** taken into account because of the default behavior of Polyspace Server for Ada assumes that:

- all task entry points (as defined with the option `-entry-points`) start potentially at the same time;
- they can interrupt each other in any order, no matter the sequence of instructions - and so all possible interruptions will be accounted for, in addition to some which can never occur in practice.

If you have two tasks t1 and t2 in which t1 has higher priority than t2, simply use `polyspace-ada -entry-points t1,t2` in the usual way.

- t1 will be able to interrupt t2 at any stage of t2, which models the behavior at execution time;

- t2 will be able to interrupt t1 at any stage of t1, which models a behavior which (ignoring priority inversion) would never take place during execution. Polyspace Server for Ada has made an **upper approximation of all scheduling and all interleaving**. There are more paths modelled than could happen during execution, but this has no adverse effect on the results obtained.

Highlighting Known Run-Time Errors

In this section...

"Annotating Code to Indicate Known Run-Time Errors" on page 5-29

"Syntax for Run-Time Errors" on page 5-30

Annotating Code to Indicate 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 5-30.

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

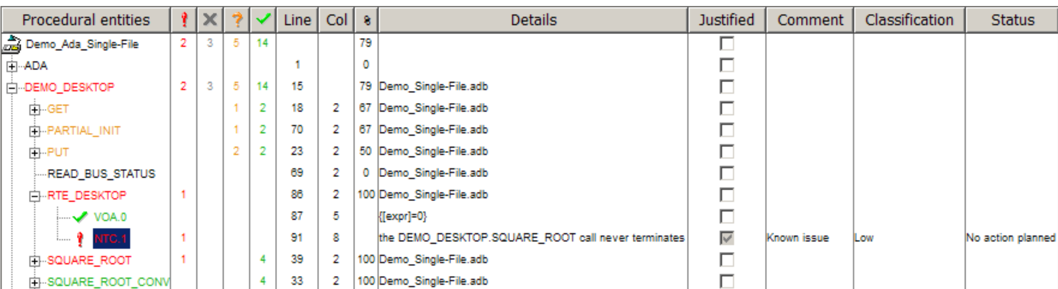
---

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 Run-Time Checks perspective.

When the verification is complete, open the Run-Time Checks perspective. You see run-time errors in the procedural entities 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.



Procedural entities	!	X	?	✓	Line	Col		Details	Justified	Comment	Classification	Status
Demo_Ada_Single-File	2	3	5	14			79					
ADA					1		0					
DEMO_DESKTOP	2	3	5	14	15		79	Demo_Single-File.adb				
GET			1	2	18	2	67	Demo_Single-File.adb				
PARTIAL_INIT			1	2	70	2	67	Demo_Single-File.adb				
PUT			2	2	23	2	50	Demo_Single-File.adb				
READ_BUS_STATUS					69	2	0	Demo_Single-File.adb				
RTE_DESKTOP	1				86	2	100	Demo_Single-File.adb				
VOA.0					87	5		{[expr]=0}				
NTC.1	1				91	8		the DEMO_DESKTOP.SQUARE_ROOT call never terminates		Known issue	Low	No action planned
SQUARE_ROOT	1			4	39	2	100	Demo_Single-File.adb				
SQUARE_ROOT_CONV				4	33	2	100	Demo_Single-File.adb				

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 Polyspace Preferences 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 procedural entities view of the Run-Time Checks 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 Run-Time Checks perspective, paste it into your source code, and modify the template to comment the check. To copy the annotation template, right-click any 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” on page 6-2
- “Running Verifications on Polyspace Server” on page 6-3
- “Running Verifications on Polyspace Client” on page 6-22
- “Running Verifications from Command Line” on page 6-27

Types of Verification

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

Use...	For...
Server	• Best performance • 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" on page 6-3
"Starting Server Verification" on page 6-4
"What Happens When You Run Verification" on page 6-5
"Running Verification Unit-by-Unit" on page 6-6
"Run All Verifications in Project" on page 6-7
"Managing Verification Jobs Using Polyspace Queue Manager" on page 6-8
"Monitoring Progress of Server Verification" on page 6-9
"Viewing Verification Log File on Server" on page 6-12
"Stopping Server Verification Before It Completes" on page 6-13
"Removing Verification Jobs from Server Before They Run" on page 6-14
"Changing Order of Verification Jobs in Server Queue" on page 6-15
"Purging Server Queue" on page 6-16
"Changing Queue Manager Password" on page 6-18
"Sharing Server Verifications Between Users" on page 6-18

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.

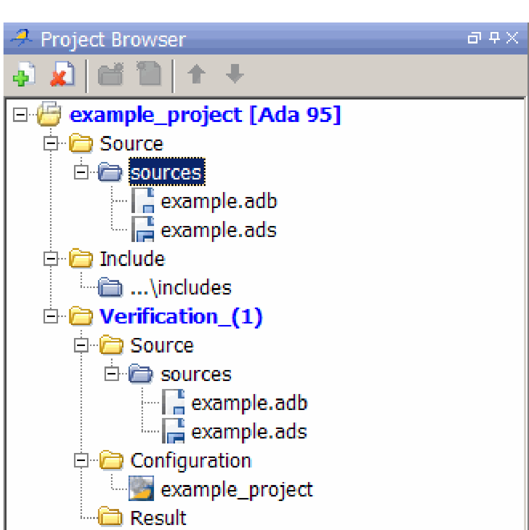
To copy a source file to a module:

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 Source File to > Module_(#).**

The 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 Server Verification

Most verification jobs run on the Polyspace server. Running verifications on a server provides optimal performance.

To start a verification that runs on a server:

1. In the **Project Browser**, specify the source files you want to include in the verification. For more information, see "Specifying Source Files to Verify" on page 6-3.

2. Under **Analysis options > General**, select the **Send to Polyspace Server** check box.

Name	Value		Internal name
Analysis options			
General			
Send to PolySpace Server	☑		-server
Add to results repository	☐		-add-to-results-repository

3 Click the **Run** button Run on the Project Manager toolbar.

The verification starts. For information on the verification process, see "What Happens When You Run Verification" on page 6-5.

Note If you see the message `Verification process failed`, click **OK** and go to "Verification Process Failed Errors" on page 7-2.

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 any 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 **Generate a main** option. For more information about generating a main, see "Generate a main" in "Option Descriptions" of the *Polyspace Products for Ada Reference*.

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 launching a server verification, you can create a separate verification jobs for each source file in the project. Each file is compiled, sent to the Polyspace Server, and verified individually. Verification results can then be viewed for the entire project, or for individual units.

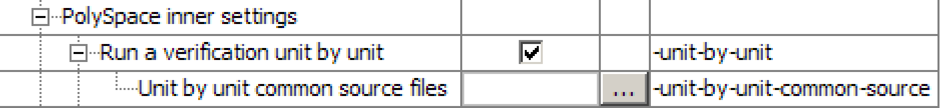
To run a unit-by-unit verification:

1. In the Project Manager perspective, under **Configuration > Analysis options > General**, select the **Send to Polyspace Server** check box.

Name	Value		Internal name
Analysis options			
⊟ General			
Send to PolySpace Server	☑		-server
Add to results repository	☐		-add-to-results-repository

2. Under **Analysis options**, expand **Polyspace inner settings**.

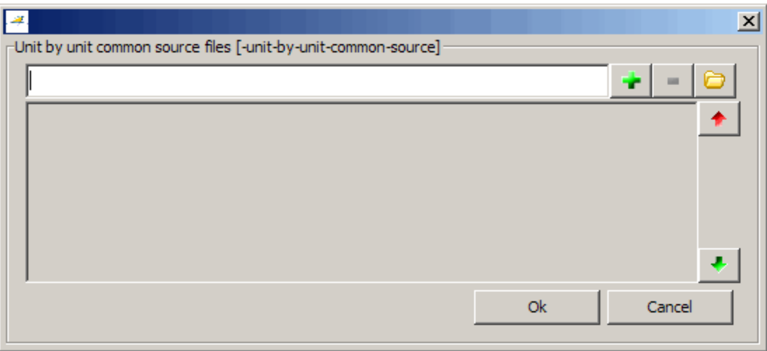
3. Select the **Run a verification unit by unit** check box.



4. Expand the **Run a verification unit by unit** node.

5. Click the button to the right of the **Unit by unit common source** option.

   The following dialog box opens.



6 Click the folder icon.

   The **Select a file to include** dialog box appears.

7 Select the common files to include with each unit verification.

   These files are compiled once, and then linked to each unit before verification. Functions not included in this list are stubbed.

8 Click **Ok**.

9 Click **Start**.

   Each file in the project is compiled, sent to the Polyspace Server, and verified individually as part of a verification group for the project.

Run All Verifications in Project

You can have many verifications within a project, each verification associated with an active configuration. You can run all verifications in your project using the batch run option.

To run all verifications in a project:

1 In the Project Browser, select the project for which you want to run verfications.

2 Click the **Batch Run** button Batch Run on the Project Manager toolbar.

Each verification is run as an individual job.

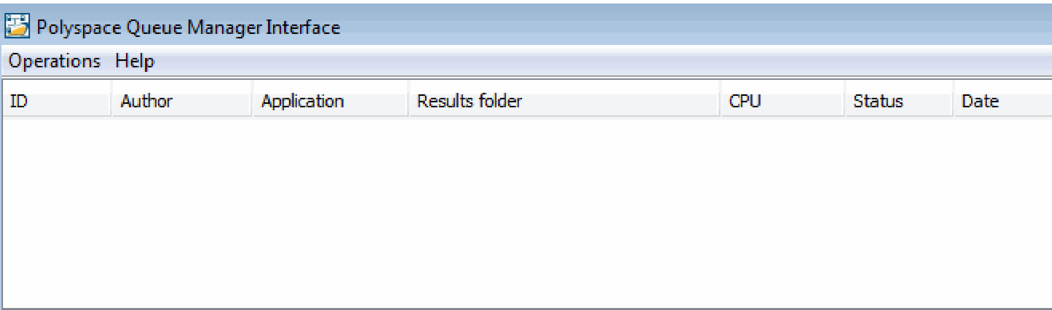
Managing Verification Jobs Using Polyspace Queue Manager

You manage all server verifications using the Polyspace Queue Manager (also called the Polyspace Spooler). The Polyspace Queue Manager allows you to move jobs within the queue, remove jobs, monitor the progress of individual verifications, and download results.

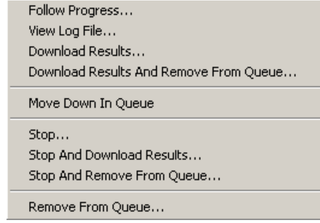
To manage verification jobs on the Polyspace Server:

1 Double-click the **Polyspace Spooler** icon:

The Polyspace Queue Manager Interface opens.



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



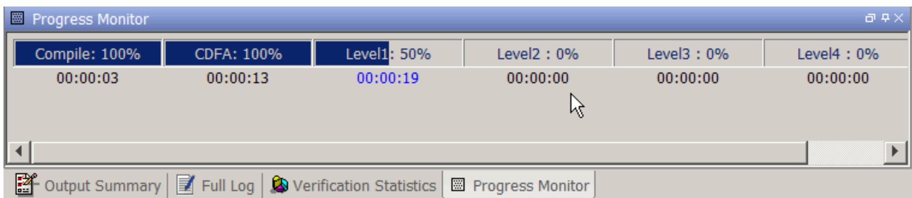
3 Select the appropriate option from the context menu.

Tip You can also open the Polyspace Queue Manager Interface from the Polyspace verification environment toolbar. Click the Polyspace Queue Manager icon .

Monitoring Progress of Server Verification

Monitoring Progress Using Project Manager

You can monitor the progress of your verification by viewing the progress monitor and logs at the bottom of the Project Manager perspective.



The progress monitor 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 **Verification Statistics** tab to display statistics, such as analysis options, stubbed functions, and the verification checks performed.

3 Click the **Refresh** button to update the display as the verification progresses.

4 Select the **Full Log** tab to display messages, errors, and statistics for all 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.

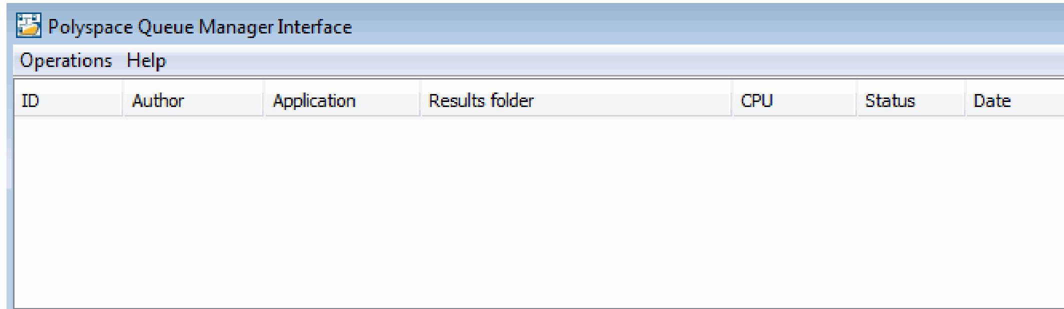
Monitoring Progress Using Queue Manager

You can monitor the progress of a verification using the Polyspace Queue Manager (also called the Spooler).

To monitor a verification:

1 Double-click the **Polyspace Spooler** icon.

The Polyspace Queue Manager Interface opens.



Tip You can also open the Polyspace Queue Manager Interface from the Run-Time Checks perspective toolbar. Click the Polyspace Queue Manager icon .

---

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 **Progress Monitor** opens.

You can monitor the progress of the verification by watching the progress bar and viewing the logs at the bottom of the window. The progress monitor 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 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 **Verification Statistics** tab to display statistics, such as analysis options, stubbed functions, and the verification checks performed.
- Click the **Refresh** button to update the display as the verification progresses.
- Click the **Full Log** tab to display messages, errors, and statistics for all 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 Queue Manager Interface changes from `running` to `completed`.

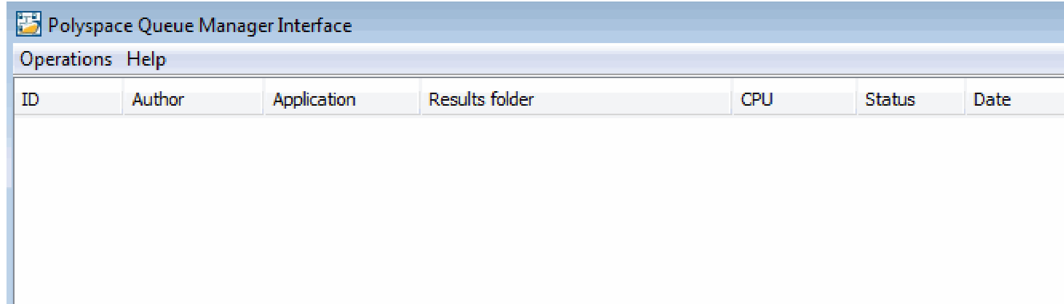
Viewing Verification Log File on Server

You can view the log file of a server verification using the Polyspace Queue Manager.

To view a log file on the server:

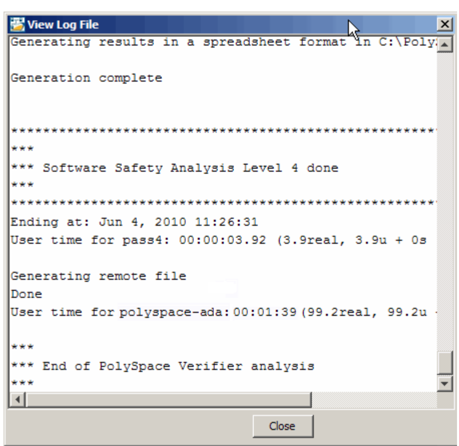
1 Double-click the **Polyspace Spooler** icon:

The Polyspace Queue Manager Interface 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.

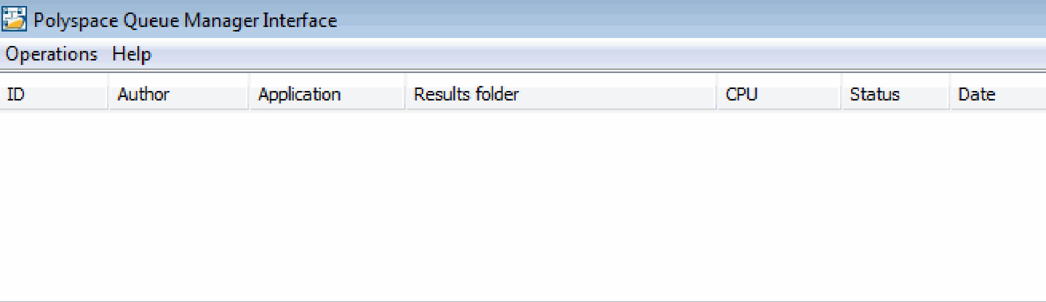
Stopping Server Verification Before It Completes

You can stop a verification running on the server before it completes using the Polyspace Queue Manager. 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 Double-click the **Polyspace Spooler** icon.

The Polyspace Queue Manager Interface 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”. All 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 any 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.

Removing Verification Jobs from Server Before They Run

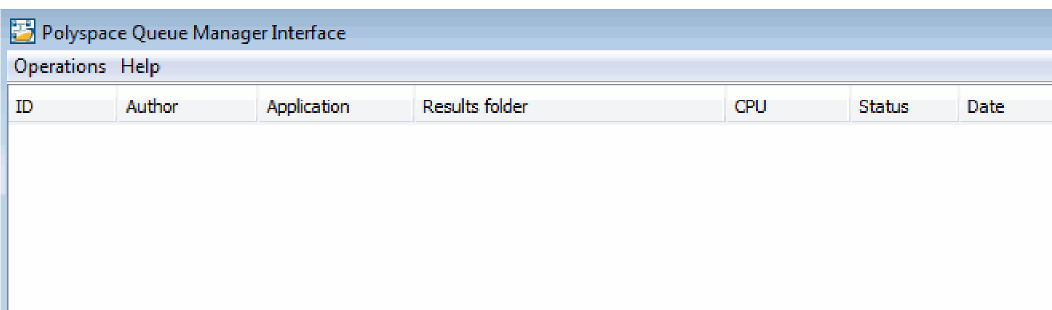
If your job is in the server queue, but has not yet started running, you can remove it from the queue using the Polyspace Queue Manager.

Note If the job has started running, you must stop the verification before you can remove the job (see “Stopping Server Verification Before It Completes” on page 6-13). Once you have aborted a verification, you can remove it from the queue.

To remove a job from the server queue:

1 Double-click the **Polyspace Spooler** icon.

The Polyspace Queue Manager Interface opens.



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

The job is removed from the queue.

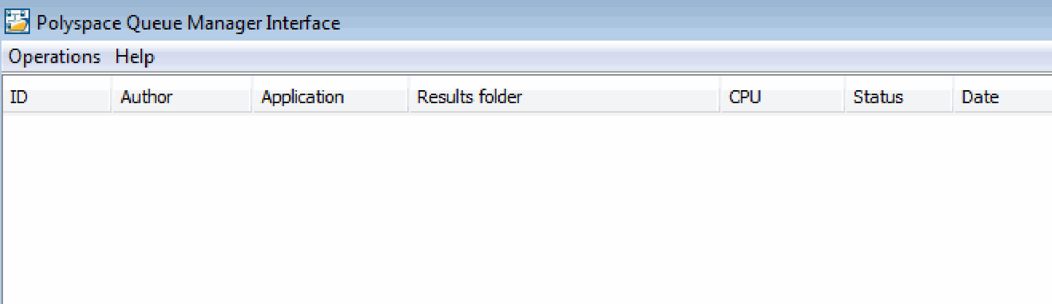
Changing Order of Verification Jobs in Server Queue

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 Double-click the **Polyspace Spooler** icon.

The Polyspace Queue Manager Interface opens.



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

   The job is moved down in the queue.

3. Repeat this process to reorder the jobs as necessary.

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 can not move individual unit-by-unit verification jobs outside of the group.

Purging Server Queue

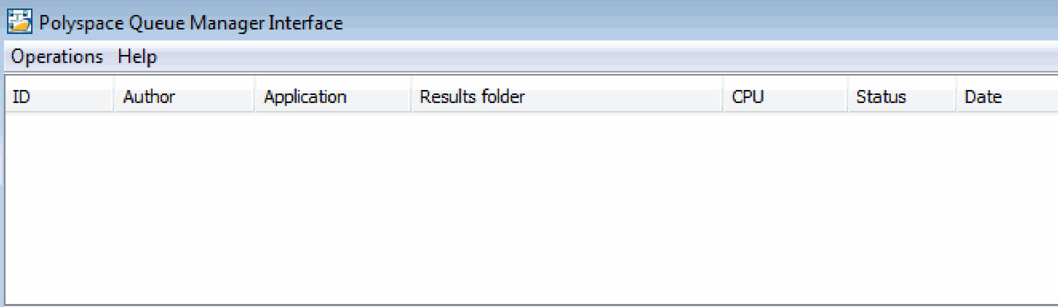
You can purge the server queue of all jobs, or completed and aborted jobs using the using the Polyspace Queue Manager.

Note You must have the queue manager password to purge the server queue.

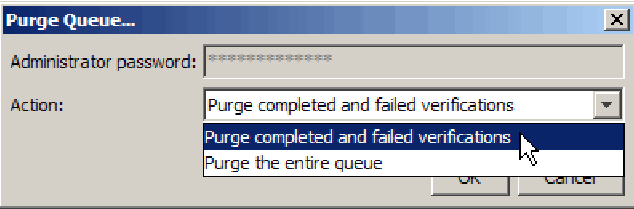
To purge the server queue:

1. Double-click the **Polyspace Spooler** icon.

   The Polyspace Queue Manager Interface 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 all 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, no jobs are removed until the entire group has been verified.

---

4 Enter the Queue Manager **Password**.

5 Click **OK**.

The server queue is purged.

Changing Queue Manager Password

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

Note The default password is `admin`.

To set the Queue Manager password:

1. Double-click the **Polyspace Spooler** icon.

   The Polyspace Queue Manager Interface 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.

Sharing Server Verifications Between Users

Security of Jobs in Server Queue

For security reasons, all 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 Queue Manager 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 all 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, all verification jobs you submit to the server queue use this key instead of a random one. All 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

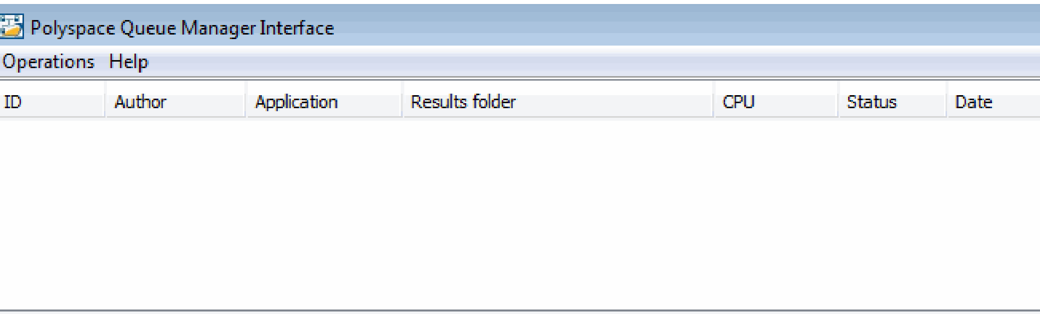
If your `analysis-keys.txt` file is corrupted or lost (removed by mistake) you cannot download your verification results. To access your verification results you must use administrator mode.

Note You must have the queue manager password to use Administrator Mode.

To use administrator mode:

1 Double-click the **Polyspace Spooler** icon.

The Polyspace Queue Manager Interface opens.



2. Select **Operations > Enter Administrator Mode**.

3. Enter the Queue Manager **Password**.

4. Click **OK**.

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

Running Verifications on Polyspace Client

In this section...

"Specifying Source Files to Verify" on page 6-22

"Starting Verification on Client" on page 6-23

"What Happens When You Run Verification" on page 6-24

"Monitoring the Progress of the Verification" on page 6-24

"Stopping Client Verification Before It Completes" on page 6-25

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.

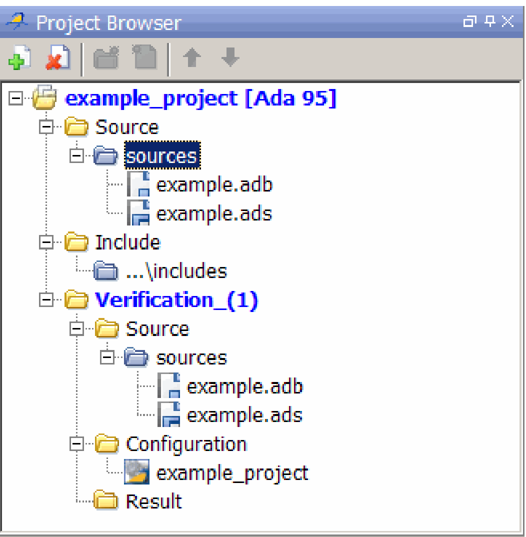
To copy a source file to a module:

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 Source File 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 the best performance, 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 have no more than 800 lines of code.

If you launch a verification on Ada code containing more than 2,000 assignments and calls, the verification will stop and you will receive an error message.

To start a verification that runs on a client:

1. In the **Project Browser**, specify the source files you want to include in the verification. For more information, see "Specifying Source Files to Verify" on page 6-22

2. In the **Configuration** view, under **Analysis options > General**, clear the **Send to Polyspace Server** check box.

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

   The **Output Summary** and **Progress Monitor** views become 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" on page 7-2.

What Happens When You Run Verification

The verification has three main phases:

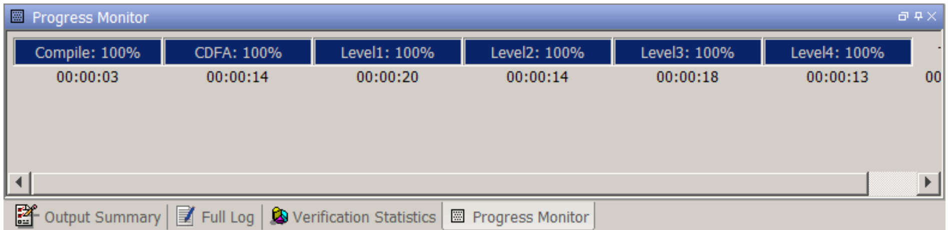
1. Checking syntax and semantics (the compile phase). Because Polyspace software is independent of any particular Ada compiler, it ensures that your code is portable, maintainable, and complies with ANSI standards.

2. Generating a main if the verification does not find a main and you selected the **Generate a Main** option. For more information, see "Generate a main" in the *Polyspace Products for Ada Reference*.

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 progress monitor and logs at the bottom of the Project Manager perspective.



The progress bar 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. Click the **Output Summary** tab to display compile phase messages and errors. You can search the log by entering search terms in the **Search** box and clicking the left arrow to search backward or the right arrow to search forward.

2. Click the **Verification Statistics** tab to display statistics, such as analysis options, stubbed functions, and the verification checks performed.

3. Click the **Refresh** button to update the display as the verification progresses.

4. Click the **Full Log** tab to display messages, errors, and statistics for all phases of the verification.

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

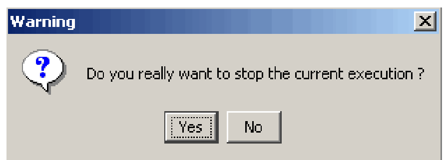
Stopping Client Verification Before It Completes

You can stop the verification before it completes. 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 verification:

1. Click the **Stop** button on the Project Manager toolbar.

   A warning dialog box appears.

2. Click **Yes**.

   The verification stops and the message `Verification process stopped` appears.

3. Click **OK** to close the **Message** dialog box.

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...
"Launching Verifications in Batch" on page 6-27
"Managing Verifications in Batch" on page 6-27

Launching Verifications in Batch

A set of commands allow you to launch a verification in batch.

All these commands begin with the following prefixes:

- **Server verification** — `<PolyspaceInstallDir>/Verifier/bin/polyspace-remote-ada95`
- **Client verification** —`polyspace-remote-desktop-ada95`

These commands are equivalent to commands with a prefix `<PolyspaceInstallDir>/bin/polyspace-`.

For example, `polyspace-remote-desktop-ada95 -server [<hostname>:[<port>] | auto]` allows you to send a Ada desktop verification remotely.

Note If your Polyspace server is running on Windows, the batch commands are in the `/wbin/` folder. For example, `<PolyspaceInstallDir>/Verifier/wbin/polyspace-remote-ada95.exe`

Managing Verifications in Batch

In batch, a set of commands allow you to manage verification jobs in the server queue.

On UNIX platforms, all these commands begin with the prefix `<PolyspaceCommonDir>/RemoteLauncher/bin/psqueue-`.

On Windows platforms, these commands begin with the prefix `<PolyspaceCommonDir>/RemoteLauncher/wbin/psqueue-`:

- `psqueue-download <id> <results dir>` — download an identified verification into a results folder. 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.
  - `[-f]` force download (without interactivity)
  - `-admin -p <password>` allows administrator to download results.
  - `[-server <name>[:port]]` selects a specific Queue Manager.
  - `[-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 all completed verifications from the queue. For unit-by-unit verification jobs, no jobs are removed until the entire group has been verified.
- `psqueue-dump` — gives the list of all verifications in the queue associated with the default Queue Manager. 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 Queue Manager.
- `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 Queue Manager.
  - [-check-licenses] check for licenses only.
- psqueue-upgrade — Allow to upgrade a client side (see the *Polyspace Installation Guide* in the *Polyspace_Common*/Docs folder).
  - [-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 <*PolyspaceCommonDir*>/bin/psqueue-<*command*> -h provides information about all available options for each command.

7

Troubleshooting Verification

- "Verification Process Failed Errors" on page 7-2
- "Compilation Errors" on page 7-6
- "Reducing Verification Time" on page 7-16
- "Obtaining Configuration Information" on page 7-27

Verification Process Failed Errors

In this section...

"Verification Failed Messages" on page 7-2
"Hardware Does Not Meet Requirements" on page 7-2
"You Did Not Specify the Location of Included Files" on page 7-2
"Polyspace Software Cannot Find the Server" on page 7-3
"Limit on Assignments and Function Calls" on page 7-4

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 seeing this warning in the future, upgrade your computer to meet the minimal requirements.

You Did Not Specify the Location of Included Files

If you see a message in the log such as the following, 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 "Creating a New Project" in *Polyspace Products for Ada Getting Started Guide*.

Polyspace Software Cannot Find the Server

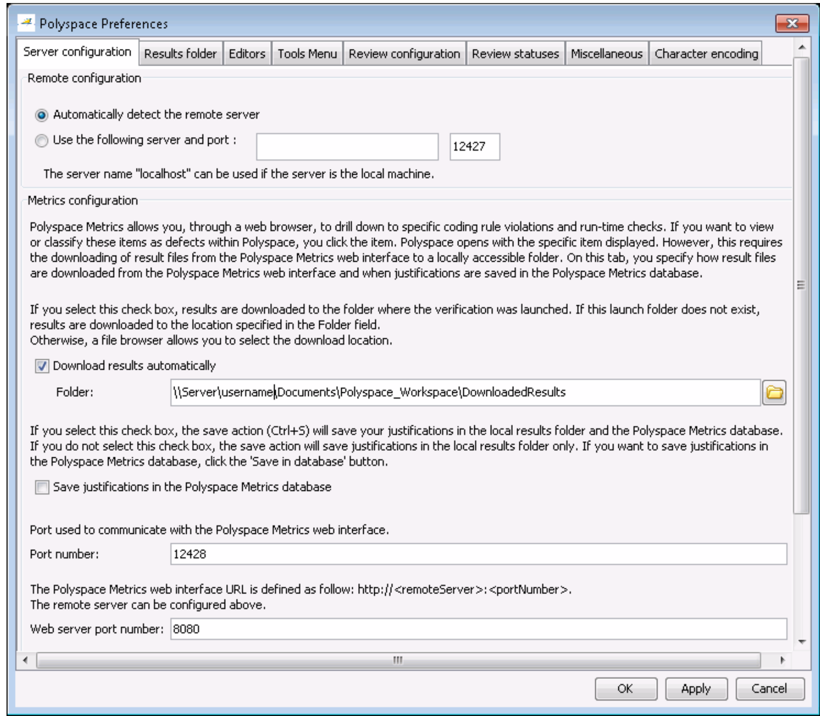
If the Polyspace software cannot find the server, you see the following message in the log:

```
Error:  Unknown host :
```

To find the server information in the preferences:

1. Select **Options > Preferences**.

2. Select the **Server configuration** tab.



How you deal with 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	Confirm the server name and port number are accurate.

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

Limit on Assignments and Function Calls

If you launch a client verification on a large file, the verification may stop and you may receive an error message 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, launch your verification on the Polyspace Server for Ada.

Compilation Errors

In this section...

"Compilation Error Overview" on page 7-6

"Configuring a Text Editor" on page 7-6

"Examining the Compile Log" on page 7-6

"Common Compile Errors" on page 7-8

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-defined differences between it own environment and the Polyspace software.

Configuring a Text Editor

Before you can open source files, you must configure a text editor. For more information, see "Configuring Text and XML Editors" on page 3-11.

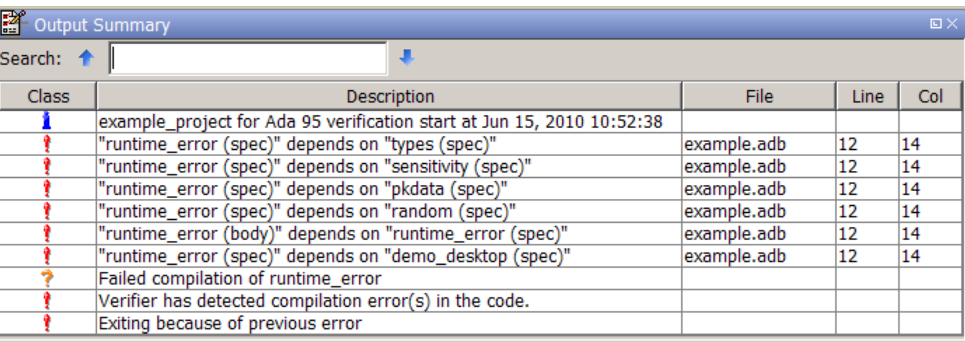
Examining the Compile Log

The compile log displays compile phase messages and errors. You can search the log by entering search terms in the **Search** box. Click the left arrow to search backward or the right arrow to search forward.

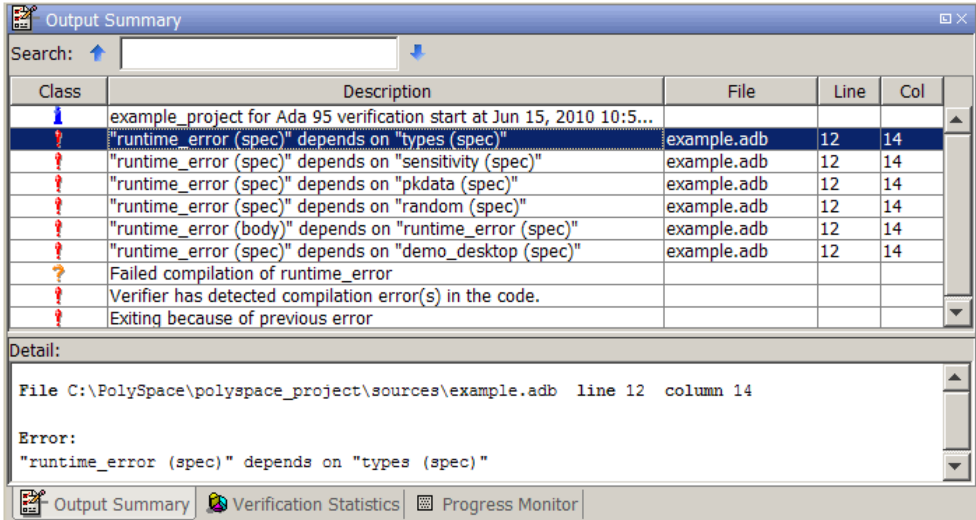
To examine errors in the Compile log:

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.



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



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

The file opens in your text editor.

4 Correct the error and run the verification again.

Common Compile Errors

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

Missing specification for unit Error

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 Error

Problem. The compiler could 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 Error

Problem. You see the error message:

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

Solution/Workaround. In `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 Error

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; -- Error : representation clause appears too late var : the_type
```

Explanation. If you use the `type` keyword between the declaration clause and the representation clause, the Polyspace software displays this warning. The representation clause must apply either all the time or only after the representation clause.

Package system and standard include Error

Problem. The standard include files are compiler dependant. 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 Error

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 Error

Problem. The package operations does not declare the function New_ATCB, but 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 any missing specifications to the package.

preelaborated unit Error

Problem. This package has a pragma preelaborate construct.

Solution/Workaround. Comment out the pragma preelaborate construct.

actual must be a definite subtype Error

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 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 may 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 Error

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 compiler dependent.

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

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

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

Solution/Workaround. Comment 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 Error

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

- The compatibility between the Polyspace and Green Hills includes

- A limitation the Polyspace Verifier encounters when compiling a Green Hills include

Solution/Workaround. The Polyspace software now provides a specific option for the Green Hills Ada compiler. For more information, see "Operating system target for Standard Libraries compatibility".

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. Take these steps:

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

If a package is defined in two different folders, the file compiled and analyzed by the Polyspace Verifier is the last one in the list to be compiled and analyzed.

For example:

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

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 includes do not change very often.

Use this workaround for any Ada compiler standard include.

Reducing Verification Time

In this section...

"Factors Affecting Verification Time" on page 7-16
"Displaying Verification Status Information" on page 7-16
"An Ideal Application Size" on page 7-17
"Optimum Size" on page 7-18
"Selecting a Subset of Code" on page 7-19
"Benefits of These Methods" on page 7-24

Factors Affecting Verification Time

The following factors affect the duration of a verification:

- 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

Because many factors impact verification time, there is no precise formula for calculating verification duration. Instead, 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 **Progress Monitor** and **Verification Statistics** tabs in the Project Manager. For more information, see "Monitoring the Progress of the Verification" on page 6-24.

For *server* verifications, use the Polyspace Queue Manager to follow the progress of your verification. For more information, see "Monitoring Progress of Server Verification" on page 6-9.

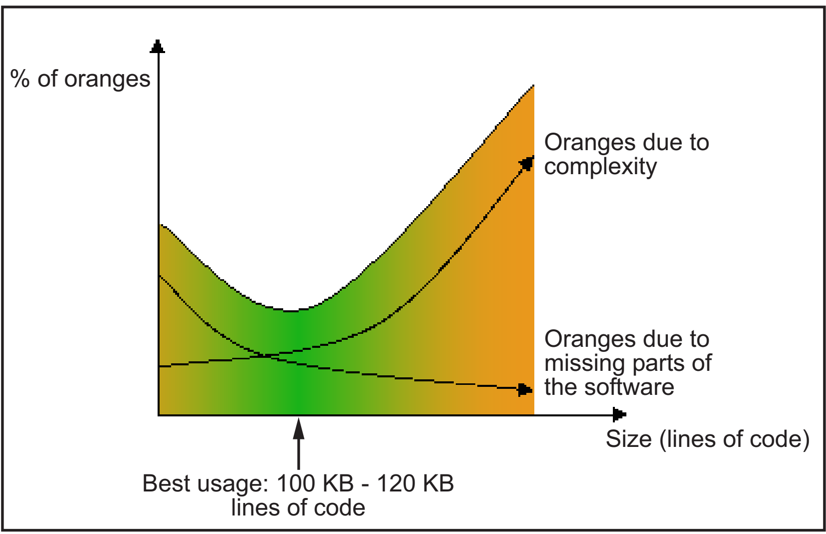
The progress bar highlights each completed phase and displays the amount of time for that phase. You can estimate the remaining verification time by extrapolating from this data, and considering the number of files and passes remaining.

An 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 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. Sometimes the duration of a verification may not be reasonable.

Experience suggests that 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 one hundred thousand lines of code. However, as project sizes become very large, the Polyspace Server:

- Makes broader approximations, producing more oranges
- Can take much more time to verify the application

Before you use any other 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. They 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. Then 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 7-24.

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” on page 5-8 and “Automatic Stubbing” on page 5-5.)

In such an application, consider the following:

- Function entry points — Refer to the Polyspace execution model because they are started concurrently, without any assumption 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

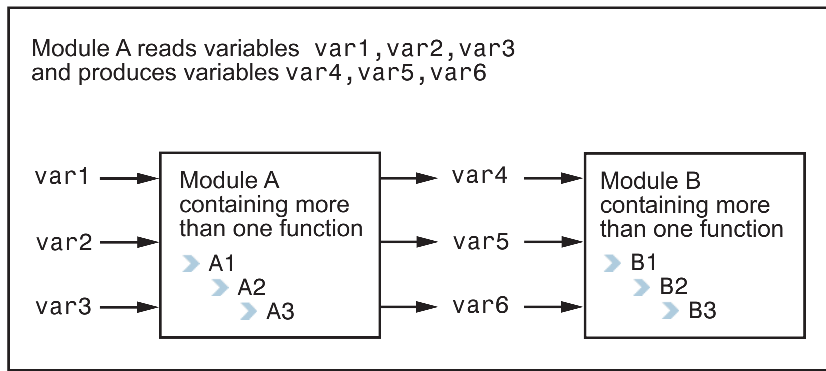
- (–) A slight loss of precision on y. Polyspace considers all possible values for y, including the formatted values present at the first verification.
- (+) A huge investigation of the code is not necessary to isolate a meaningful subset. Any application can be split logically in this way.
- (+) No functional modules are lost.
- (+) The results are still correct, because there is no need to remove any thread affecting (change) shared data.
- (+) The complexity of the code is considerably reduced.
- (+) A high precision level (say 02) 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 all 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 the same.

Subdivide According to Data Flow

Consider the following example.



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 all combinations for `var4`, `var5`, and `var6` are:
  - All of the possible combinations.
  - Combinations 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 any subsequent `else` clause is undetected.

- (+) An in-depth investigation of the code is not necessary to isolate a meaningful subset. A logical split is possible for any application, in accordance with the logic of the data.
- (+) The results remain valid, because there is no need 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]`. This includes 1 and 0 (yes and no). The procedure `has_an_error_already_occurred` therefore returns all 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 treatment. 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, the 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 could 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 it includes only one *scenario* among all possible states for the variable x.
- x can be initialized to the whole possible range [10;15], and then the T2 entry point called. If x is calibration data, this is accurate.

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 all functions that are not called by any other function within this subset of code.
- Relaunch your verification using the -unit-by-unit option. (For more information, see "Run a verification unit by unit".)

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

Benefits of These 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, and 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 any value between 0 and 10, and `b` might be modified to any 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 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 effect 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.

Effects of Application Code Size

The Polyspace Server can make approximations when computing the possible values of the variables at any point in the program. Such an approximation always 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 divide, 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

The `polyspace-ver` command allows you to quickly gather information on your system configuration. Use this information when entering support requests.

Configuration information includes:

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

To obtain your configuration information, enter the following command, depending on your operating system:

- **UNIX/Linux** — `<PolyspaceInstallDir>/Verifier/bin/polyspace-ver`
- **Windows** — `<PolyspaceInstallDir>\Verifier\wbin\polyspace-ver.exe`

C:\WINNT\system32\cmd.exe

```
C:\PolySpace\PolySpaceForADA_R2010a\Verifier\wbin>polyspace-ver
------------------------------------------------------------------
Machine Hardware Configuration:

* Number of CPUs   : 2
* CPU frequency    : 2.327GHz
* CPU type         : i686
* Memory           : 1.97GB
* Swap             : 5.82GB
* /tmp free space  : 21.36GB


------------------------------------------------------------------
Machine Software Configuration:

Windows XP (Service Pack 3)


------------------------------------------------------------------
PolySpace Licenses:

PolySpace_Client_C_CPP:
        License Number: DEMO
        Expiration date: 5-apr-2010

PolySpace_Client_ADA:
        License Number: DEMO
        Expiration date: 5-apr-2010

PolySpace_Server_C_CPP:
        License Number: DEMO
        Expiration date: 5-apr-2010

PolySpace_Server_ADA:
        License Number: DEMO
        Expiration date: 5-apr-2010

PolySpace_Model_Link_SL:
        License Number: DEMO
        Expiration date: 5-apr-2010

PolySpace_Model_Link_TL:
        License Number: DEMO
        Expiration date: 5-apr-2010

PolySpace_UML_Link_RH:
        License Number: DEMO
        Expiration date: 5-apr-2010

------------------------------------------------------------------
PolySpace Versions:

PolySpace Version R2010a
* Kernel                    ADA-5.5.0.3
* Viewer                    IHME-R2010a-V10
* Launcher                  IHML-R2010a-V10
* Remote Launcher           RL-R2010a-V9
* PolySpace In One Click    POC-R2010a-V8

Remote Launcher configuration
* Compatibility version 3_41_2

Server :
runstroms.dhcp.mathworks.com


------------------------------------------------------------------

C:\PolySpace\PolySpaceForADA_R2010a\Verifier\wbin>
```

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

8

Reviewing Verification Results

- "Before You Review Polyspace Results" on page 8-2
- "Opening Verification Results" on page 8-8
- "Reviewing Results Systematically" on page 8-28
- "Reviewing All Checks" on page 8-40
- "Tracking Review Progress" on page 8-48
- "Importing and Exporting Review Comments" on page 8-54
- "Generating Reports of Verification Results" on page 8-58
- "Using Polyspace Results" on page 8-68

Before You Review Polyspace Results

In this section...

"Overview: Understanding Polyspace Results" on page 8-2

"Why Gray Follows Red and Green Follows Orange" on page 8-3

"The Message and What It Means" on page 8-4

"The Code Explanation" on page 8-5

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 that always has an error (errors occur every time the code is executed).
- **Gray** – Indicates unreachable code (dead code).
- **Orange** – Indicates unproven code (code might have a runtime error).
- **Green** – Indicates code that never has a runtime error (safe code).

When you analyze these colors, remember these rules:

- An instruction is verified only if no runtime error was detected in the previous instruction.
- The verification assumes that each runtime 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. This means that red checks are always followed by gray checks, and orange checks only propagate the green parts through to subsequent checks.
- Focus on the message given 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 problem.
- Determine the cause by examining the actual code. Do not focus on what the code is supposed to do.

Why Gray Follows Red and Green Follows Orange

This section explains why gray checks follow **red** checks, and how **green** checks are propagated out of **orange** ones.

In the example below, consider why:

- the gray checks follow the **red** in the red function.
- there are **green** checks relating to the array.

```
procedure red is
X: integer;
begin
X:= 1 / X;
X:= X + 1;
end;
```

```
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; -- [array index within bounds]
Y(X):= 0;
end main;
```

Consider each line of code for the red function:

- When Polyspace divides by X, X has not been initialized. Therefore the corresponding check (Non Initialized Variable) on X is red;
- As a result all possible execution paths are stopped, because they all produce an RTE.

The propagate function:

- 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 since X can be equal to (say) -3 as well as 3;
- All conditions leading to an RTE are assumed to have been truncated - they are no longer considered in the verification. So on the following line, the executions for which X ~ [-2^31, -1] and [100, 2^31-1] are stopped;
- Consequently at the next instructions X ~ [0, 99];

- Hence at the second array access, the check is green because X ~ [0, 99].

Summary

Green checks can be propagated out of orange checks.

Note When doing 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" on page 4-17.

The Message and What It Means

Polyspace software numbers checks to correspond to the code execution order.

Consider the instruction `x := x + 1;`

In each case, Polyspace first checks for a potential NIV (Non Initialized Variable) for x, then checks the potential OVFL (overflow). An awareness of such sequences will help to understand the message which Polyspace is presenting before going on to assess what that means for the code.

In the example below, the orange NIV on X in the test:

```
if ( x > 101)
```

does not mean Polyspace does not know the value of X, which might be the conclusion of a hasty analysis.

So - what does it mean?

```
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 Run-Time Checks perspective, you see the category of the check. Here, the category is NIV (Non Initialized Variable). However, Polyspace may well verify subsequent lines of code, and continue with an understanding of the possible values as if initialization has taken place.

The correct 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. Hence we can conclude that Polyspace did know the values.

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 first rules of reviewing results are: focus on the message given by Polyspace and do not focus on a speedy interpretation.

The Code Explanation

Verification results depend entirely on the code that you are verifying. When interpreting the results, do not consider:

- Any physical action from the environment in which the code operates.
- Any configuration that is not part of the verification.
- Any reason other than the code itself.

The only thing that the verification considers is the Ada code submitted to it.

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.
- Therefore, the test to assess whether `x = 0` is always false.
- **The initial conclusion is that "the test is always false."** You might conclude that this results from input data that is not equal to 0. However, `Read_An_Input` can be any 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 any execution path leading to a run-time error, meaning that subsequent lines deal with only x = [0, 99].
- The orange check on the division also truncates all execution paths that lead to a run-time error, so all instances where x = 0 are also stopped. Therefore, for the code execution path after the orange division sign, `x = [1; 99]`.
- x is never equal to 0 **at this line**. The array access is green (y (x – 1).

Summary

In this example, all the results are located in the same procedure. However, by using the call tree, you can follow the same process even if an orange check

results from a procedure 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" on page 8-8

"Downloading Server Results Using Command Line" on page 8-9

"Downloading Results from Unit-by-Unit Verifications" on page 8-10

"Opening Verification Results from Project Manager Perspective" on page 8-11

"Opening Verification Results from Run-Time Checks Perspective" on page 8-12

"Exploring Run-Time Checks Perspective" on page 8-13

"Selecting Review Level" on page 8-24

"Searching Results in Run-Time Checks Perspective" on page 8-25

"Setting Character Encoding Preferences" on page 8-26

Downloading Results from Server to Client

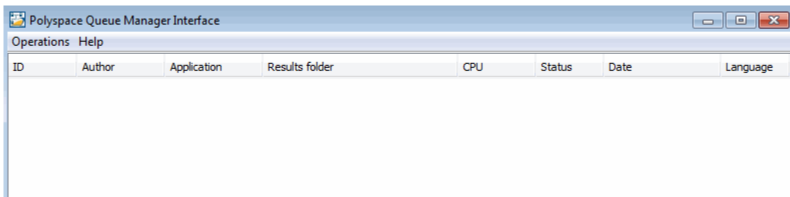
When you run a verification on a Polyspace server, the Polyspace software automatically downloads the results to the client system that launched the verification. In addition, the results are stored on the Polyspace server. You can then download the results from the server to other client systems.

Note If you download results before the verification completes, you get partial results and the verification continues.

To download verification results to your client system:

1 Double-click the **Polyspace Spooler** icon.

The Polyspace Queue Manager Interface opens.



2 Right-click the job you want to view. From the context menu, select **Download Results** from the context menu.

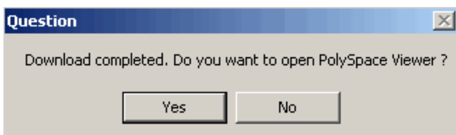
Note To remove the job from the queue after downloading your results, from the context menu, select **Download Results And Remove From Queue**.

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.



5 Click **Yes** to open the results.

Once you download results, they remain on the client, and you can review them at any time using the Polyspace verification environment.

Downloading Server Results Using Command Line

You can download verification results from 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 at any time using the Polyspace Run-Time Checks perspective.

The `psqueue-download` ccmmand 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 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 Verifications in Batch” on page 6-27.

Downloading Results from Unit-by-Unit Verifications

If you run a unit-by-unit verification, each source file in sent to Polyspace Server individually. The queue manager 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 as any other verification results.

- To download results for a verification group, right-click the group job, 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%		

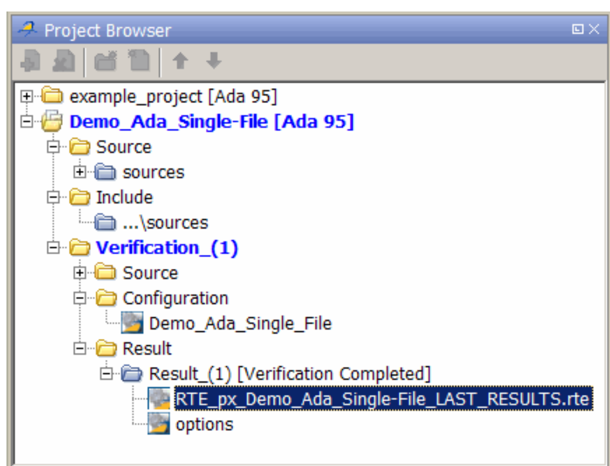
Opening Verification Results from Project Manager Perspective

You can open verification results directly from the Project Browser in the Project Manager perspective. Since each Polyspace project can contain multiple verifications, the Project Browser allows you to quickly identify and open the results you want to review.

To open verification results from the Project Manager:

1. Open the project containing the results 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 Run-Time Checks perspective.

Opening Verification Results from Run-Time Checks Perspective

Use the Run-Time Checks perspective to review verification results. If you know the location of the results file you want to review, you can open the file directly from the Run-Time Checks perspective.

Note You can also browse and open results from the Project Browser in the Project Manager perspective.

To open verification results from the Run-Time Checks perspective:

1 Select the **Run Time Checks** button Run-Time Checks in the Polyspace verification environment toolbar.

2 Select **File > Open Result**

The Please select a file dialog box opens.

3. Select the results file that you want to view.

4. Click **Open**.

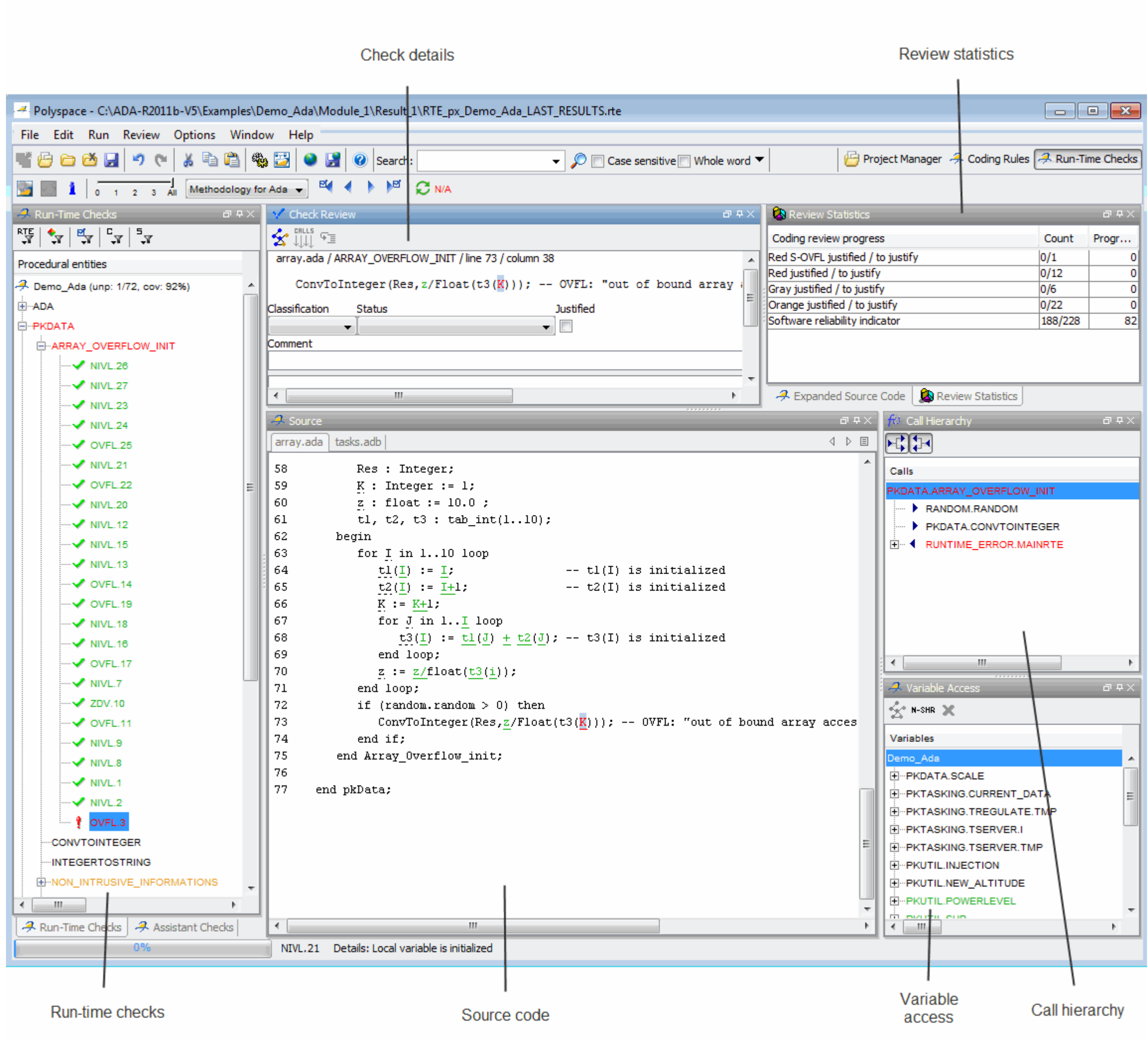
   The results open in the Run-Time Checks perspective.

Exploring Run-Time Checks Perspective

- "Overview" on page 8-13
- "Run-Time Checks Pane" on page 8-15
- "Source Pane" on page 8-18
- "Check Review Pane" on page 8-20
- "Review Statistics Pane" on page 8-21
- "Variable Access Pane" on page 8-22
- "Call Hierarchy Pane" on page 8-24

Overview

The Run-Time Checks perspective looks like this.



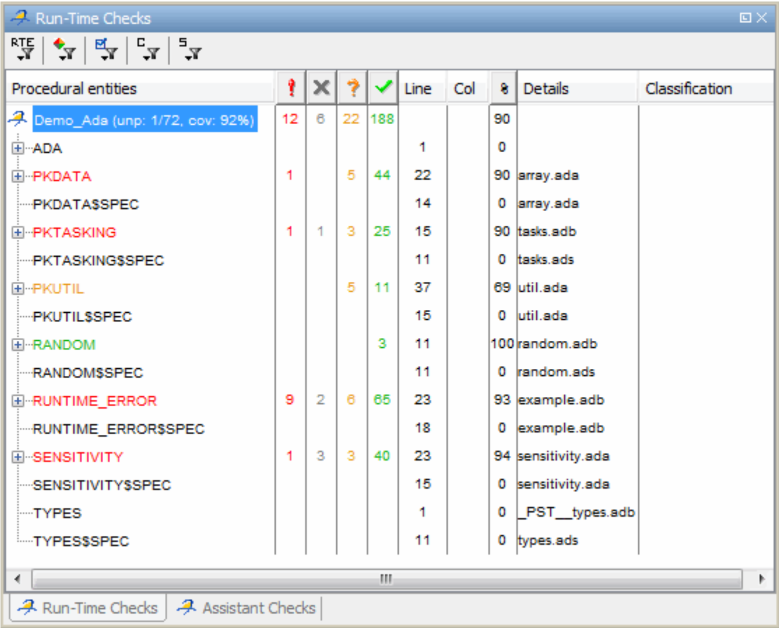
The Run-Time Checks perspective has six sections below the toolbar. Each section provides a different view of the results. The following table describes these views.

This Pane...	Displays...
Run-Time Checks (Procedural entities view)	List of the checks (diagnostics) for each file and function in the project
Source (Source code view)	Source code for a selected check in the procedural entities view
Review Statistics (Coding review progress view)	Statistics about the review progress for checks with the same type and category as the selected check
Check Review (Selected check view)	Details about the selected check
Variable Access (Variables view)	Information about global variables declared in the source code
Call Hierarchy (Call tree view)	Tree structure of function calls

You can resize or hide any of these sections.

Run-Time Checks Pane

The Run-Time Checks pane displays a table with information about the diagnostics for each file in the project. The Run-Time Checks pane is also called the **Procedural entities** view.



In this view, the first column contains the procedural entity (package or function).

Polyspace software assigns each package the color of the most severe error found in the package. For example, the package `RUNTIME_ERROR` is red because it contains at least one run-time error. There are entities that are black, which indicates that the entities contain specifications used by the verification.

The following table describes some of the other columns in the **Procedural entities** view.

Column Heading	Indicates
	Number of red checks (operations where an error always occurs)
	Number of gray checks (unreachable code)

Column Heading	Indicates
?	Number of orange checks (warnings for operations where an error might occur)
✓	Number of green checks (operations where an error never occurs)
%	Selectivity of the verification (percentage of checks that are not orange) This is an indication of the level of proof.

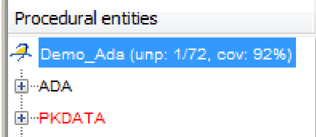
To specify the columns displayed by the **Procedural entities** view, right-click the **Procedural entities** column heading, and select the columns that you want to display.

Tip If you see three dots in place of a heading, ..., resize the column until you see the heading. Resize the procedural entities view to see additional columns.

Code Coverage Metrics.

The software displays two metrics for the project in the **Procedural entities** view:

- `unp` — Number of unreachable procedures (functions) as a fraction of the total number of procedures (functions)
- `cov` — Percentage of elementary operations in executable procedures (functions) covered by verification



These metrics provide:

- A measure of the code coverage achieved by the Polyspace verification.

- Indicators about the validity of your Polyspace configuration. For example, a large `unp` value and a low `cov` value may indicate an early red check or missing function call.

Source Pane

The **Source** pane or source code view shows the source code with colored checks highlighted.

Source

array.ada

```
61         t1, t2, t3 : tab_int(1..10);
62      begin
63         for I in 1..10 loop
64            t1(I) := I;                -- t1(I) is initialized
65            t2(I) := I+1;              -- t2(I) is initialized
66            K := K+1;
67            for J in 1..I loop
68               t3(I) := t1(J) + t2(J); -- t3(I) is initialized
69            end loop;
70            z := z/float(t3(i));
71         end loop;
72         if (random.random > 0) then
73            ConvToInteger(Res,z/Float(t3(K))); -- OVFL: "out of bound array access"
74         end if;
75      end Array_Overflow_init;
76
77   end pkData;
```

Variable 'k' (integer range -2**31..2**31-1): 11

Press 'F2' for focus

Tooltips. Placing your cursor over a variable displays a tooltip with range information about the variable. See "Using Range Information in Run-Time Checks Perspective" on page 8-69.

Examining Source Code. In the Source pane, if you right-click a text string, the context menu provides options that help you to examine your code. For example, right-click the procedure `Compute_New_Coordonates`:

Source

sensitivity.ada | array.ada | tasks.adb | util.ada | tasks.ads

```
73      begin
74         SHR4.B := 22;
75         SHR3 := SHR3 + 1 + SHR4.B + SHR5;
76      end One_interrupt2;
77
78      procedure main is
79      begin
80         PowerLevel := -10000;
81         runtime_error.mainRTE;
82         Compute_New_Coo
83      end main;
84
85   end pktasking;
86
```

Print View - Source code tasks.adb
Search "Compute_New_Coordonates" in current source Ctrl+F
Goto Line Ctrl+L
Open Declaration
Add Pre-Justification to Clipboard
Create Duplicate Code Window

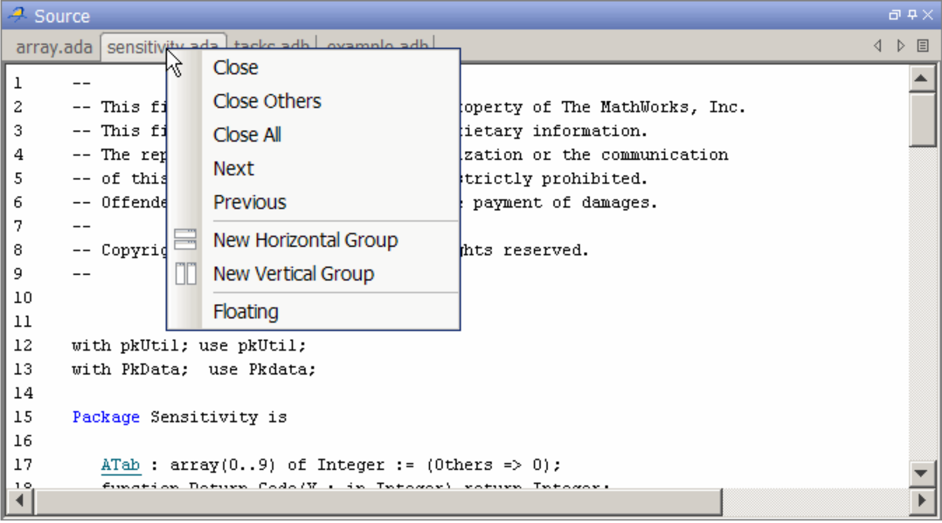
Use the following options to examine and navigate through your code:

- **Search “Compute_New_Coordonates” in current source code** — List all occurrences of the string in the Search pane.
- **Goto Line** — Open the Goto Line dialog box. If you specify a line number and click **Enter**, the software displays the specified line of code.
- **Open declaration** — If the selected text is a global variable, function, or procedure, display the line of code that contains the declaration.

Additional Information on checks. When you click a check, the software provides information about the check in the Check Review pane.

Managing Multiple Files in Source Pane. You can view multiple source files in the Source pane. By default, the files are displayed as tabs.

In the Source pane toolbar, right-click any tab to manage source files.

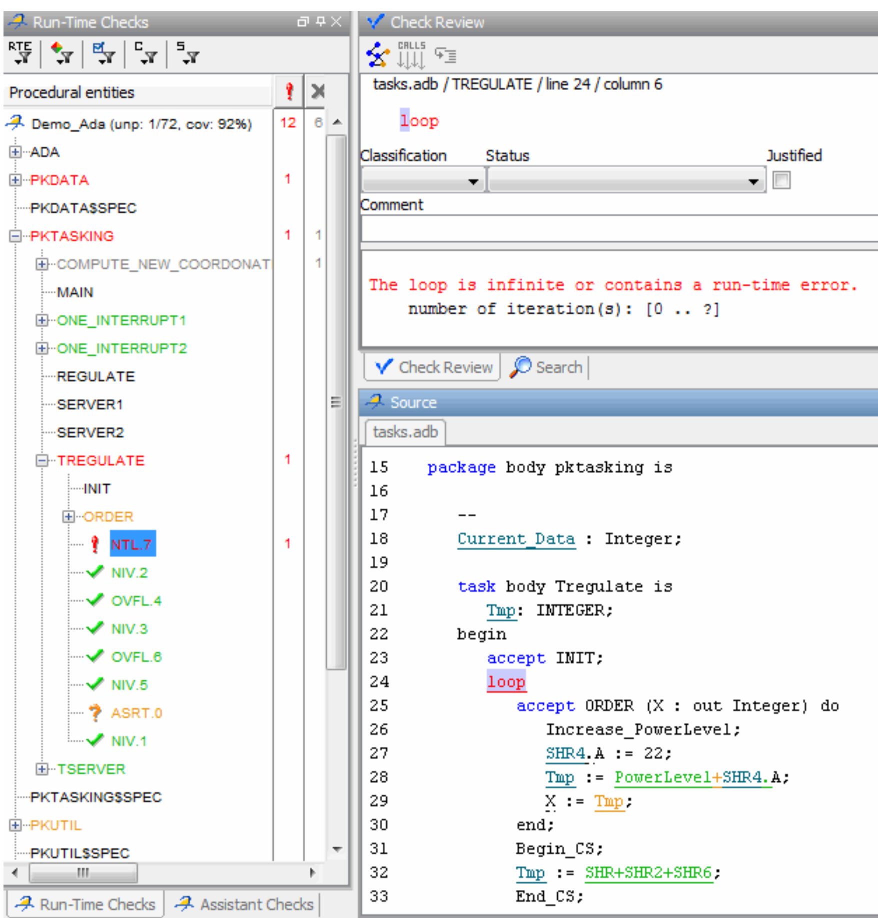


From the Source pane context menu, you can:

- **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 tab.
- **Previous** – Display the previous tab.
- **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 Review Pane

In the procedural entities view, if you click a check, you see additional information in the Check Review pane.

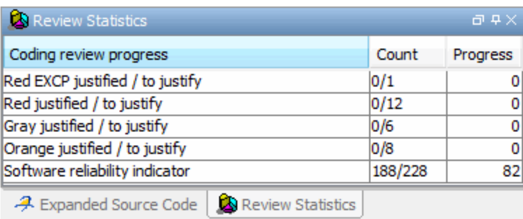


You can use the Check Review pane, for example, to classify a check and mark the check as **Justified**. This action helps you track the progress of your review and avoid reviewing the same check twice.

For more information, see “Reviewing and Commenting Checks” on page 8-48.

Review Statistics Pane

The **Review Statistics** pane allows you to keep track of the checks that you have reviewed.



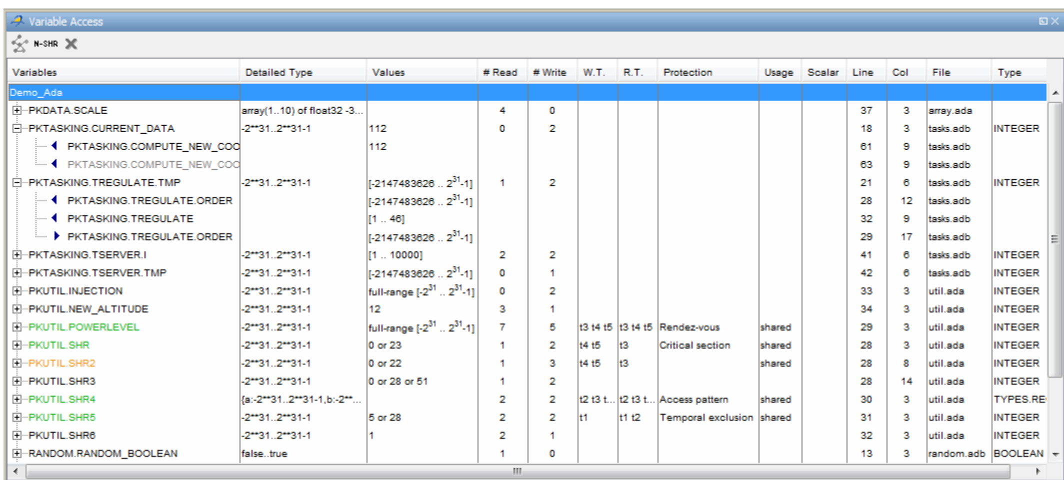
Coding review progress	Count	Progress
Red EXCP justified / to justify	0/1	0
Red justified / to justify	0/12	0
Gray justified / to justify	0/6	0
Orange justified / to justify	0/8	0
Software reliability indicator	188/228	82

The **Count** column displays a ratio and the **Progress** column displays the equivalent percentage. The first row displays the ratio of justified checks to the total number of checks that have the same color and category as the current check. In this example, the first row displays the ratio of justified red NTL checks to total red NTL errors in the project.

The second, third, and fourth rows display the ratio of justified Expert Mode checks to total checks for red, gray, and orange checks respectively. The fifth row displays the ratio of the number of green checks to the total number of checks, providing an indicator of the software reliability.

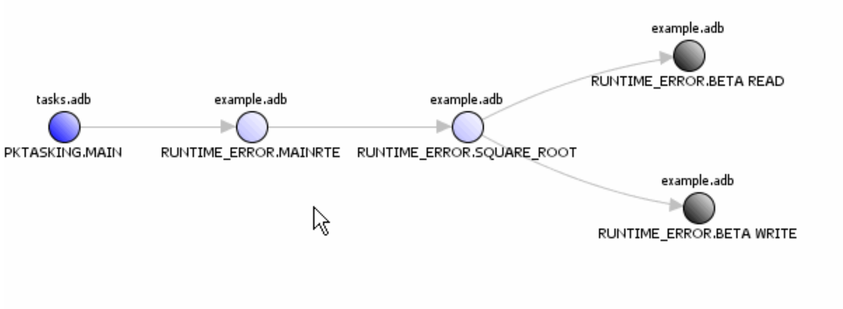
Variable Access Pane

The Variable Access pane, or variables view, displays global variables and locations in the source code where the global variables are read or written to. The pane provides information about the variables and associated fields. For example, number of read/write access operations, data type, and value range. For global variables that are integers (signed and unsigned), the software provides range information for both the individual read/write access operations within a file and the union of these operations.



Variables	Detailed Type	Values	# Read	# Write	W.T.	R.T.	Protection	Usage	Scalar	Line	Col	File	Type
Demo_Ada													
PKDATA.SCALE	array(1..10) of float32 -3...		4	0						37	3	array.ada	
PKTASKING.CURRENT_DATA	-2**31..2**31-1	112	0	2						18	3	tasks.adb	INTEGER
PKTASKING.COMPUTE_NEW_COO		112								61	9	tasks.adb	
PKTASKING.COMPUTE_NEW_COO										63	9	tasks.adb	
PKTASKING.TREGULATE.TMP	-2**31..2**31-1	[-2147483626 .. 2^{31}-1]	1	2						21	6	tasks.adb	INTEGER
PKTASKING.TREGULATE.ORDER		[-2147483626 .. 2^{31}-1]								28	12	tasks.adb	
PKTASKING.TREGULATE		[1 .. 46]								32	9	tasks.adb	
PKTASKING.TREGULATE.ORDER		[-2147483626 .. 2^{31}-1]								29	17	tasks.adb	
PKTASKING.TSERVER.I	-2**31..2**31-1	[1 .. 10000]	2	2						41	6	tasks.adb	INTEGER
PKTASKING.TSERVER.TMP	-2**31..2**31-1	[-2147483626 .. 2^{31}-1]	0	1						42	6	tasks.adb	INTEGER
PKUTIL.INJECTION	-2**31..2**31-1	full-range [-2^{31} .. 2^{31}-1]	0	2						33	3	util.ada	INTEGER
PKUTIL.NEW_ALTITUDE	-2**31..2**31-1	12	3	1						34	3	util.ada	INTEGER
PKUTIL.POWERLEVEL	-2**31..2**31-1	full-range [-2^{31} .. 2^{31}-1]	7	5	t3 t4 t5	t3 t4 t5	Rendez-vous	shared		29	3	util.ada	INTEGER
PKUTIL.SHR	-2**31..2**31-1	0 or 23	1	2	t4 t5	t3	Critical section	shared		28	3	util.ada	INTEGER
PKUTIL.SHR2	-2**31..2**31-1	0 or 22	1	3	t4 t5	t3		shared		28	8	util.ada	INTEGER
PKUTIL.SHR3	-2**31..2**31-1	0 or 28 or 51	1	2						28	14	util.ada	INTEGER
PKUTIL.SHR4	{a:-2**31..2**31-1,b:-2**...		2	2	t2 t3 t...	t2 t3 t...	Access pattern	shared		30	3	util.ada	TYPES.RE
PKUTIL.SHR5	-2**31..2**31-1	5 or 28	2	2	t1	t1 t2	Temporal exclusion	shared		31	3	util.ada	INTEGER
PKUTIL.SHR6	-2**31..2**31-1	1	2	1						32	3	util.ada	INTEGER
RANDOM.RANDOM_BOOLEAN	false..true		1	0						13	3	random.adb	BOOLEAN

Concurrent Access Graph. Click the Show Access Graph button in the **Variable Access** toolbar to display a graph of read and write access for the selected variable.



For more information, see "Displaying the Access Graph for Variables" on page 8-42.

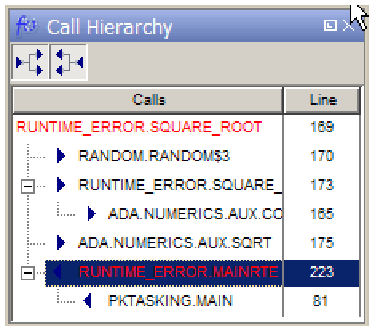
Non Shared Variables. Click the Non-Shared Variables button N-SHR in the **Variable Access** toolbar to show or hide non-shared variables.

Read and Write Access in Dead Code. If a read or write access operation on a global variable lies within dead code, then Polyspace colors the operation gray in the **Variable Access** pane. When you examine verification results, you can hide these operations by clicking the filter button .

Legend Information. To display the legend for a variable, right-click the variable and select **Show legend**.

Call Hierarchy Pane

The Call Hierarchy pane displays the call tree of functions in the source code. You can easily navigate up and down this call tree. The Call Hierarchy pane is also called the Call Tree view.



Callers and Callees. Click the buttons in the **Call Hierarchy** toolbar to show or hide callers and callees.

Function Definitions. To go directly to the definition of a function, right-click the function call and select **Go to definition**.

Selecting Review Level

Use the slider on the Run-Time Checks toolbar to specify the review level.

You can review results from five different levels:

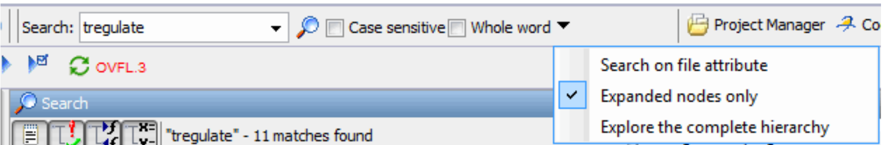
- 0 — Display red and gray checks (default). You can also display orange checks that are potential run-time errors. On the **Polyspace Preferences > Review Configuration** tab, specify the type of potential run-time errors that you are interested in. See "Reviewing Checks at Level 0" on page 8-29.
- 1, 2, and 3 — Display red, gray, and green checks. In addition, display orange checks according to values specified on the **Polyspace Preferences > Review Configuration** tab. You can use either a predefined or custom methodology to specify the number of orange checks per category. See "Reviewing Checks at Levels 1, 2, and 3" on page 8-30.
- All — Display all checks.

The default setting is 1.

Searching Results in Run-Time Checks Perspective

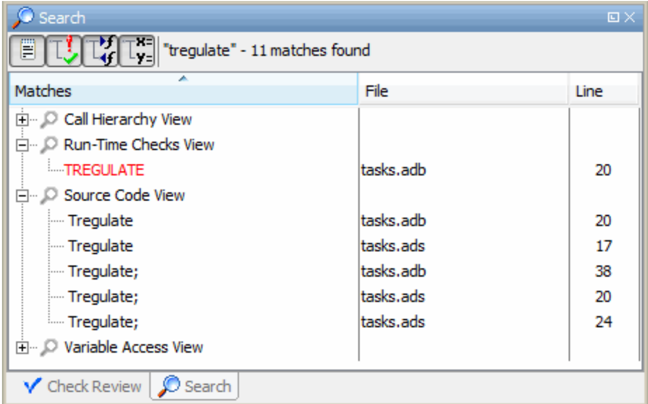
You can search your results and source code using the Search feature in the Run-Time Checks Perspective toolbar.

The Search toolbar allows you to quickly enter search terms, specify search options, and set the scope for your search.



You can limit the scope of your search to only file content, only expanded nodes, or you can search the complete hierarchy.

When you perform a search, your search results are reported in the Search pane.



Search results are organized by location:

- Source Code View
- Run-Time Checks View
- Call Hierarchy View
- Variable Access View

You can use the four filter buttons in the Search pane toolbar to hide results from any of these locations.

Setting Character Encoding Preferences

If the source files you want to verify were created on an operating system that uses different character encoding than your current system (for example, when viewing files containing Japanese characters), you will receive an error message when you view the source file or run certain macros.

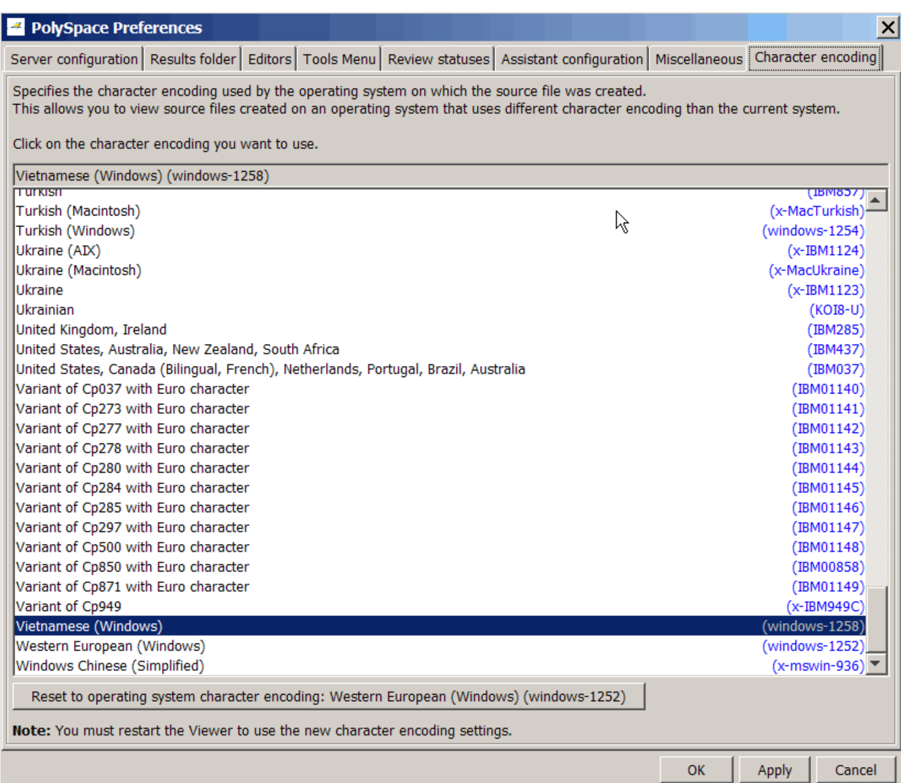
The **Character encoding** option allows you to view source files created on an operating system that uses different character encoding than your current system.

To set the character encoding for a source file:

1 In the Run-Time Checks perspective, select **Options > Preferences**.

The **Polyspace Preferences** dialog box opens.

2 Select the **Character encoding** tab.



3 Select the character encoding used by the operating system on which the source file was created.

4 Click **OK**.

5 Close and reopen the Polyspace verification environment to use the new character encoding settings.

Reviewing Results Systematically

In this section...
"What are Review Levels?" on page 8-28 "Reviewing Checks at Level 0" on page 8-29 "Reviewing Checks at Levels 1, 2, and 3" on page 8-30 "Reviewing Checks Progressively" on page 8-35 "Saving Review Comments" on page 8-38

What are Review Levels?

To facilitate your review of verification results, Polyspace allows you to control the type and number of orange checks displayed in the **Procedural entities** and **Source** views of the Run-Time Checks perspective. There are five levels at which you can review your results:

- 0 — The software displays red and gray checks. In addition, you can configure the software to displays orange checks that are potential run-time errors. Through the **Polyspace Preferences > Review Configuration** tab, specify the categories of potential run-time errors that you want the software to display. By default, the software does not display any orange checks at this level. See "Reviewing Checks at Level 0" on page 8-29.

  This level is suitable for the review of fresh code.

- 1, 2, and 3 — The software displays red, gray, and green checks. In addition, the software displays orange checks according to values specified on the **Polyspace Preferences > Review Configuration**. You can use either a predefined methodology or a custom methodology to specify the number of orange checks per check category. See "Viewing Methodology Requirements for Levels 1, 2, and 3" on page 8-32 and "Defining a Custom Methodology for Levels 1, 2, and 3" on page 8-34.

  For a predefined methodology, these levels are suitable for reviews at the following stages of the development process.

Level	Development Stage
1	Fresh code
2	Unit tested code
3	Code Review

- All — In addition to red, gray, and green checks, the software displays *all* orange checks. Use this level when you want to carry out an exhaustive review of your verification results.

The toolbar in the Run-Time Checks perspective provides controls specific to review levels.

The controls include:

- A slider for selecting the review level. By default, the Run-Times Checks perspective opens at level 1.
- A menu for selecting the review methodology for levels 1, 2, and 3.
- Arrows for navigating through checks.

Reviewing Checks at Level 0

At this level, in addition to red and gray checks, you can focus on orange checks that Polyspace identifies as potential run-time errors. These potential run-time errors fall into three categories:

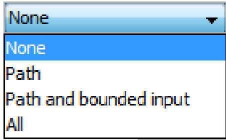
- `Path` – The software identifies orange checks that are path-related issues, which are not dependent on input values.
- `Path and bounded input` – In addition to orange checks that are path-related issues, the software identifies orange checks that are related to bounded input values.
- `All` – In addition to path-related and bounded input orange checks, the software identifies orange checks that are related to unbounded input values.

To specify the potential run-time error category for level 0:

1 In the Polyspace verification environment, select **Options > Preferences**. The Polyspace Preferences dialog box opens.

2 Select the **Review configuration** tab.

3 From the **Level** drop-down list, select your category.



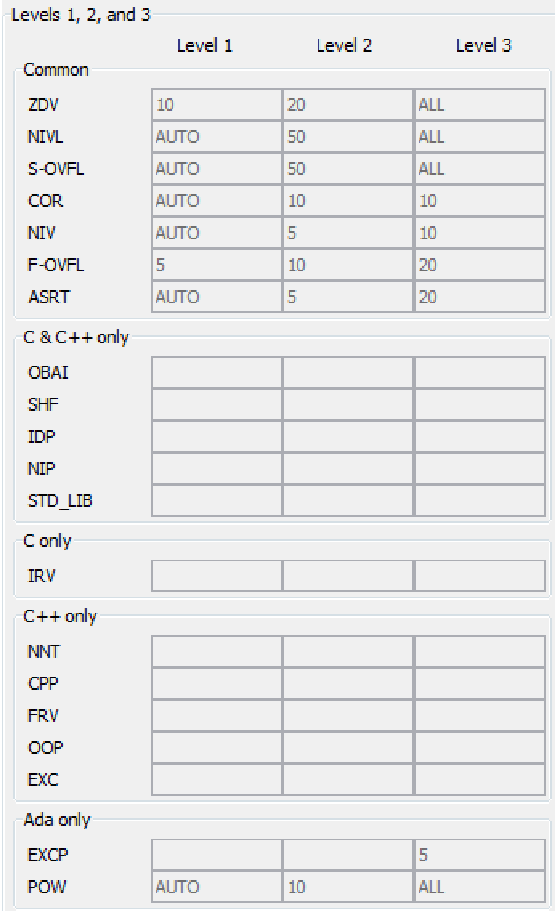
The default is `None`, that is, the software displays only red and gray checks.

4 Click **OK** to save your options and close the Polyspace Preferences dialog box.

To select review level 0, in the Run-Time Checks toolbar, move the Review Level slider to **0**.

Reviewing Checks at Levels 1, 2, and 3

In addition to red, gray, and green checks, the software displays orange checks according to values specified on the **Review Configuration** tab in the Polyspace Preferences dialog box.



Levels 1, 2, and 3

	Level 1	Level 2	Level 3
Common			
ZDV	10	20	ALL
NIVL	AUTO	50	ALL
S-OVFL	AUTO	50	ALL
COR	AUTO	10	10
NIV	AUTO	5	10
F-OVFL	5	10	20
ASRT	AUTO	5	20
C & C++ only			
OBAI			
SHF			
IDP			
NIP			
STD_LIB			
C only			
IRV			
C++ only			
NNT			
CPP			
FRV			
OOP			
EXC			
Ada only			
EXCP			5
POW	AUTO	10	ALL

You can use either a predefined methodology or a custom methodology to specify the number of orange checks per check category. See "Defining a Custom Methodology for Levels 1, 2, and 3" on page 8-34.

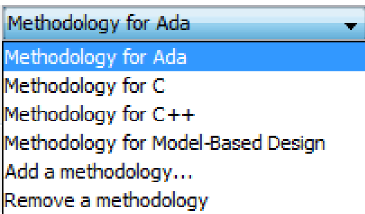
Each predefined methodology has three levels, with increasing review requirements. As the level increases, you review more checks.

To select, for example, a predefined methodology and level:

1 From the Run-Time Checks perspective, select **Options > Preferences**. The Polyspace Preferences dialog box opens.

2 Select the **Review configuration** tab.

3 From the **Methodology** drop-down list, select `Methodology for Ada`.



4 Use the Review Level slider to select the appropriate level.

Viewing Methodology Requirements for Levels 1, 2, and 3

A methodology specifies the orange checks that you review, and you can view the requirements of the methodology through the Polyspace Preferences dialog box.

Note You cannot change the parameters specified in predefined methodologies, for example, `Methodology for C`, but you can create your own custom methodologies. See "Defining a Custom Methodology for Levels 1, 2, and 3" on page 8-34.

To examine the configuration for `Methodology for Ada`:

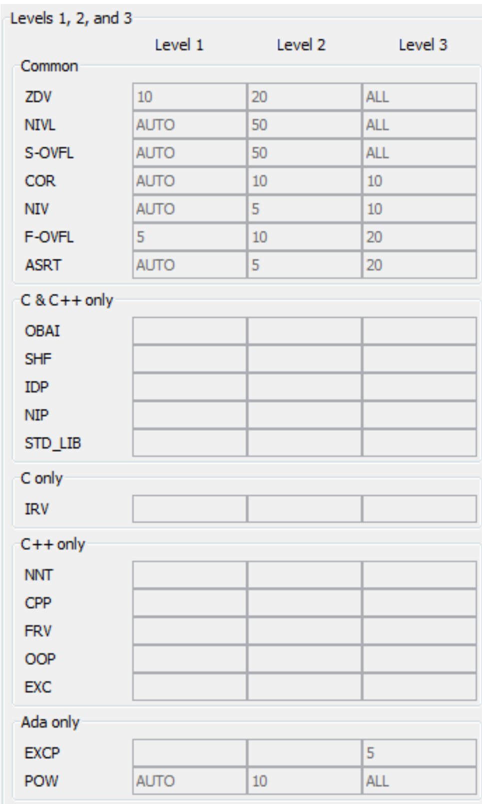
1 In the Polyspace verification environment, select **Options > Preferences**.

The Polyspace Preferences dialog box opens.

2 Select the **Review configuration** tab.

3 From the **Methodology** drop-down list, select `Methodology for C`.

In the section **Levels 1, 2, and 3**, a table shows the number of orange checks that you review for a given level and check category.



Levels 1, 2, and 3

	Level 1	Level 2	Level 3
Common			
ZDV	10	20	ALL
NIVL	AUTO	50	ALL
S-OVFL	AUTO	50	ALL
COR	AUTO	10	10
NIV	AUTO	5	10
F-OVFL	5	10	20
ASRT	AUTO	5	20
C & C++ only			
OBAI			
SHF			
IDP			
NIP			
STD_LIB			
C only			
IRV			
C++ only			
NNT			
CPP			
FRV			
OOP			
EXC			
Ada only			
EXCP			5
POW	AUTO	10	ALL

For example, the table specifies that you review ten orange ZDV checks when you select level 1. The number of checks increases as you move from level 1 to level 3, reflecting the changing review requirements as you move through the development process.

4 Click **OK** to close the dialog box.

Defining a Custom Methodology for Levels 1, 2, and 3

A methodology specifies the orange checks that you review. For review levels 1, 2, and 3, you cannot change the predefined methodologies, for example, `Methodology for C`, but you can define your own methodology.

With custom methodologies, you can specify either a specific number of orange checks to review, or a minimum percentage of orange checks that must be reviewed. This percentage is given by:

```
(green checks + reviewed orange checks) x 100/(green checks + total orange checks)
```

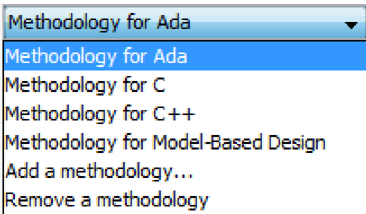
To define a custom methodology:

1. In the Polyspace verification environment, select **Options > Preferences**.

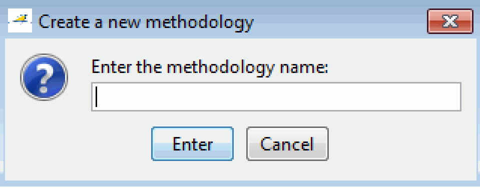
   The **Polyspace Preferences** dialog box opens.

2. Select the **Review configuration** tab.

3. From the **Methodology** drop-down list, select `Add a methodology`.



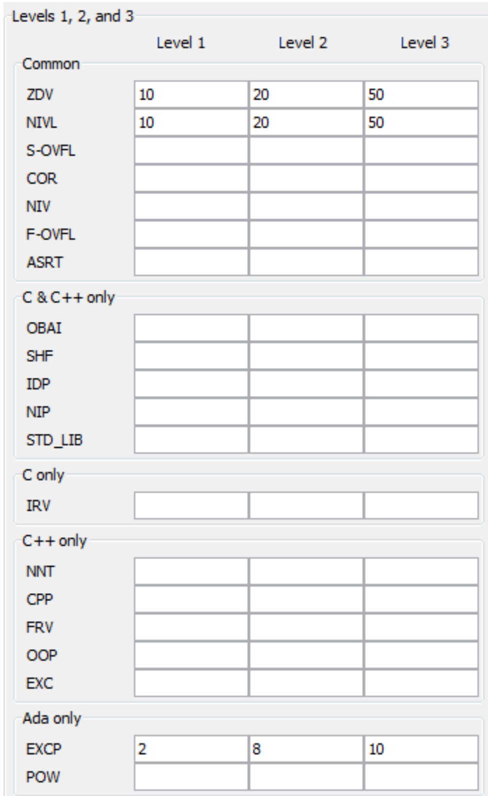
   The Create a new methodology dialog box opens.



4. Enter a name for the new methodology, for example, `my_methodology`. Then click **Enter**.

5 If you want to review orange checks by percentage, select the **Specify percentage of green and justified orange checks** check box.

6 Enter the total number of checks (or percentage of checks) to review for each type of check at levels 1, 2, and 3.



7 Click **OK** to save the methodology and close the dialog box.

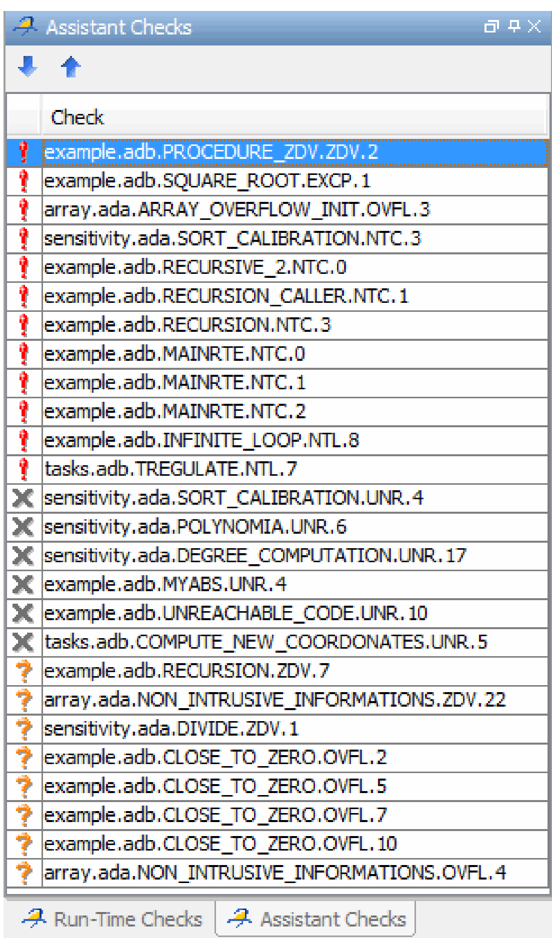
Reviewing Checks Progressively

On the Run-Time Checks perspective toolbar, use the forward arrow or back arrow to move to the next or previous unjustified check. The software takes you through checks in the following order:

- All red checks
- All gray checks (the first check in each unreachable function). If you want to skip gray checks when using the forward or back arrows, on the **Polyspace Preferences > Review Configuration** tab, select **Skip gray checks review**.
- Orange checks — the number of orange checks is determined by the methodology and review level that you select

To review checks:

1. Select the **Assistant Checks** tab.



2 Click the forward arrow to go to the first check in the set:

- The Source pane displays the source code for this check.
- The Check Review pane displays information about this check.

Note You can also display the call sequence for a check. See "Displaying the Calling Sequence" on page 8-42.

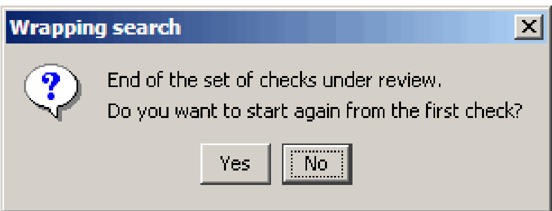
---

3 Review the current check.

After you review a check, you can classify the check and enter comments to describe the results of your review. You can also mark the check as Justified to help track your review progress. For more information, see "Tracking Review Progress" on page 8-48.

4 Continue to click the forward arrow until you have gone through all of the checks.

After the last check, a dialog box opens asking if you want to start again from the first check.



5 Click **No**.

Note If you want to navigate through justified checks, use the justified check forward arrow and back arrow .

Saving Review Comments

After you have reviewed your results, you can save your comments with the verification results. Saving your comments makes them available the next time 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.

Note Saving review comments also allows you to import those comments into subsequent verifications of the same module, allowing you to avoid reviewing the same check twice.

Reviewing All Checks

In this section...
"Selecting a Check to Review" on page 8-40
"Displaying the Calling Sequence" on page 8-42
"Displaying the Access Graph for Variables" on page 8-42
"Filtering Checks" on page 8-43
"Saving Review Comments" on page 8-46

Selecting a Check to Review

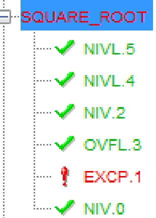
To display all checks, on the Run-Time Checks perspective toolbar, move the Review Level slider to **All**:

To review a check in expert mode:

1. In the procedural entities section of the **Run-Time Checks** pane, expand any file containing checks.

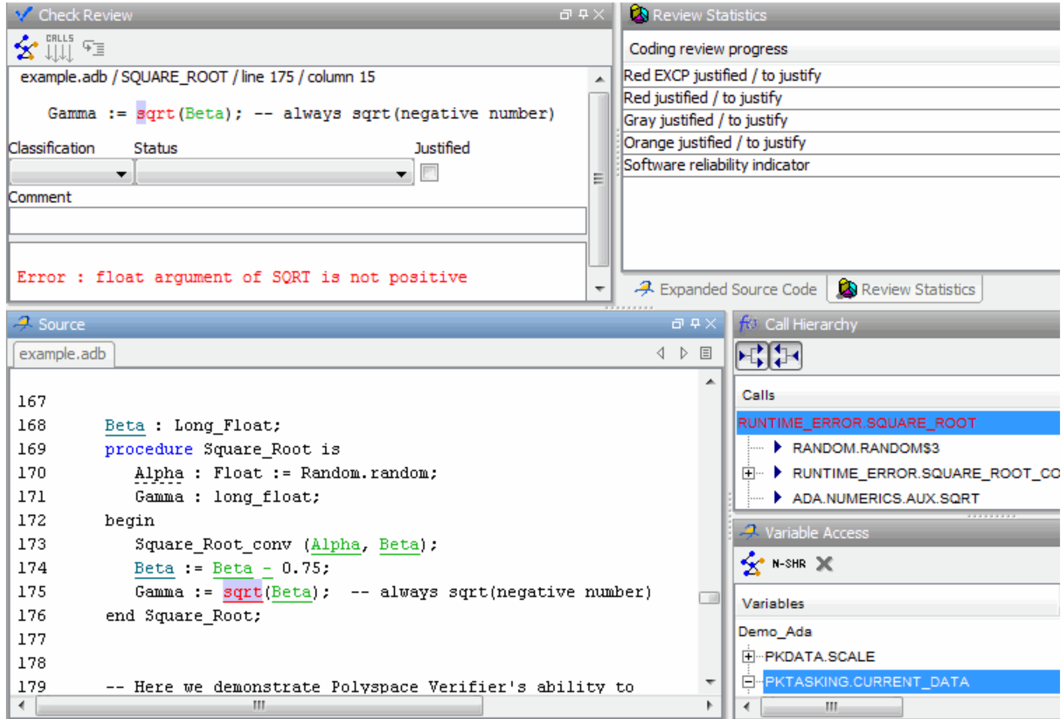
2. Expand the procedure containing the check that you want to review.

   You see a color-coded list of the checks:

   In the list of checks, each item has an acronym that identifies the type of check and a number. For example, in `EXCP.1`, EXCP stands for Arithmetic Exception. For more information, see "Check Descriptions" in the *Polyspace Products for Ada Reference*.

3. Click the red `EXCP.1`. You see the section of source code where this error occurs and details about the check.



The **Source** pane displays the section of source code where this error occurs. If you place your cursor over a colored check (for example, a variable), you see range information in a tooltip or at the bottom of the window. See "Using Range Information in Run-Time Checks Perspective" on page 8-69.

4 In **Check Review**, you can:

- Classify the run-time check as a defect. Select a category from the **Classification** drop-down list, for example, `High`.
- Assign a status, for example, `Fix`. This action indicates to Polyspace that you have reviewed the check
- Justify the check. For example, if you classified the check as `Not a defect`, you could select the **Justified** check box to indicate that the check is justified.

- Enter remarks in the **Comment** field, for example, defect or justification information.

Displaying the Calling Sequence

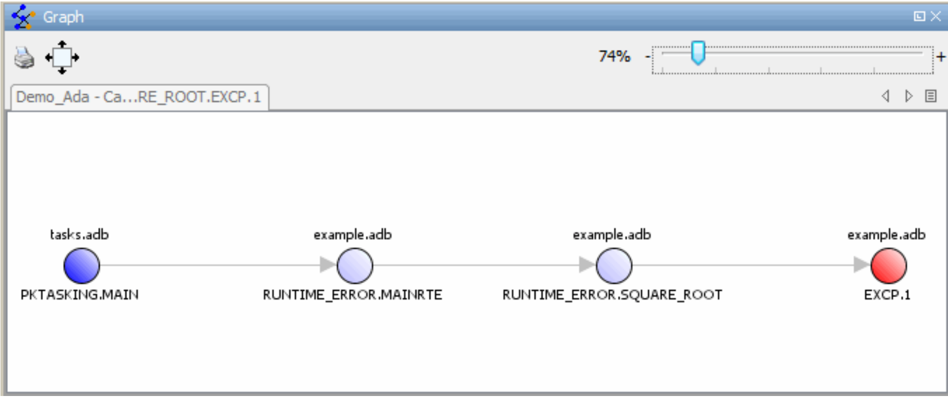
You can display the calling sequence that leads to the code associated with a check. To see the calling sequence for a check:

1. Expand the package containing the check you want to review.

2. Click the check you want to review.

3. In the Check Review toolbar, click the call graph button.

   A window displays the call graph.

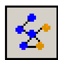
   The call graph displays the code associated with the check.

Displaying the Access Graph for Variables

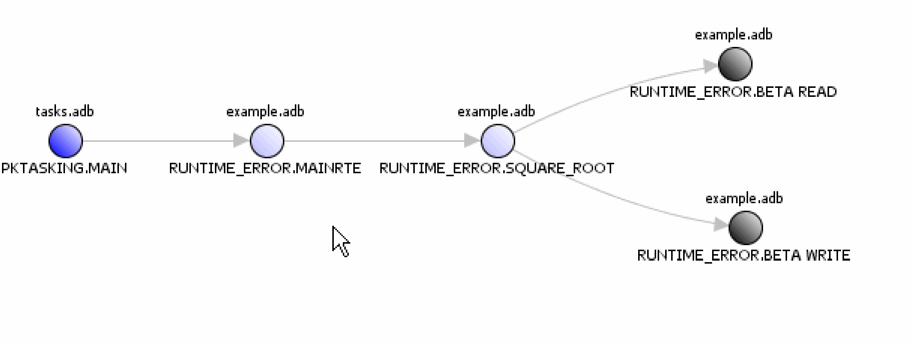
You can display the access sequence for any variable that is read or written in the code.

To see the access graph:

1 In **Variable Access**, select the variable you want to view.

2 In the toolbar, click the call graph button. 

A window displays the access graph, which displays the read and write access for the variable.



3 Click any object in the graph to navigate to that function in the procedural entities view and source code view.

Filtering Checks

You can filter the checks that you see in the Run-Time Checks perspective so that you can focus on certain checks. Polyspace software allows you to filter your results in several ways. You can filter by:

- Check category (ZDV, IDP, NIP, etc.)
- Color of check (gray, orange, green)
- Justified or unjustified
- Classification
- Status

To filter checks, select one of the filter buttons in the Run-Time checks toolbar.

Tip The tooltip for a filter button tells you what filter the button is for.

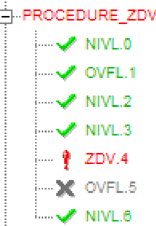
Example: Filtering NIVL Checks

You can use an RTE filter to hide a given check category, such as NIVL. When a filter is enabled, you do not see that check category.

To filter NIVL checks in `PROCEDURE_ZDV`:

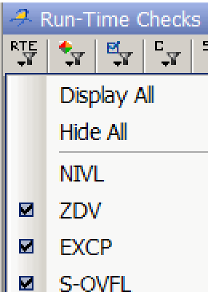
1 Expand `PROCEDURE_ZDV`.

   `PROCEDURE_ZDV` has eight checks: six are green, one is gray, and one is red.

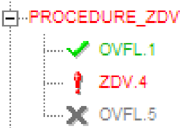


2 Click the **RTE filter** icon .

3 Clear the **NIVL** check box.



The software hides the NIVL check for PROCEDURE_ZDV.



4 Select the NIVL option to redisplay the NIVL check.

Note When you filter a check category, red checks of that category are not hidden. For example, if you filter ZDV checks, you still see ZDV.4 under PROCEDURE_ZDV.

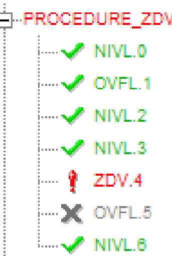
Example: Filtering Green Checks

You can use a color filter to hide checks of a certain color.

To filter green checks:

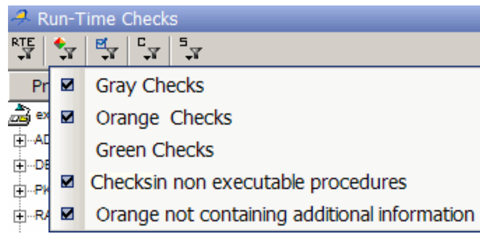
1 Expand PROCEDURE_ZDV.

PROCEDURE_ZDV has seven checks: five are green, one is gray, and one is red.

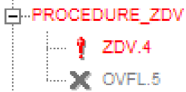


2 Click the **Color filter** icon .

3 Clear **Green Checks**.



The software hides the green checks.



Saving Review Comments

After you have reviewed your results, you can save your comments with the verification results. Saving your comments makes them available the next time 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.

Note Saving review comments also allows you to import those comments into subsequent verifications of the same module, allowing you to avoid reviewing the same check twice.

Tracking Review Progress

In this section...

"Checking Progress of Coding Review" on page 8-48

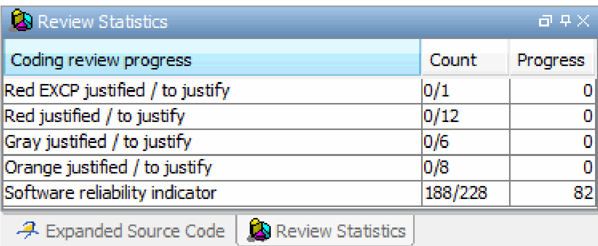
"Reviewing and Commenting Checks" on page 8-48

"Defining Custom Status" on page 8-50

"Tracking Justified Checks in Procedural Entities View" on page 8-52

Checking Progress of Coding Review

The **Review Statistics** pane allows you to keep track of the checks that you have reviewed.



Coding review progress	Count	Progress
Red EXCP justified / to justify	0/1	0
Red justified / to justify	0/12	0
Gray justified / to justify	0/6	0
Orange justified / to justify	0/8	0
Software reliability indicator	188/228	82

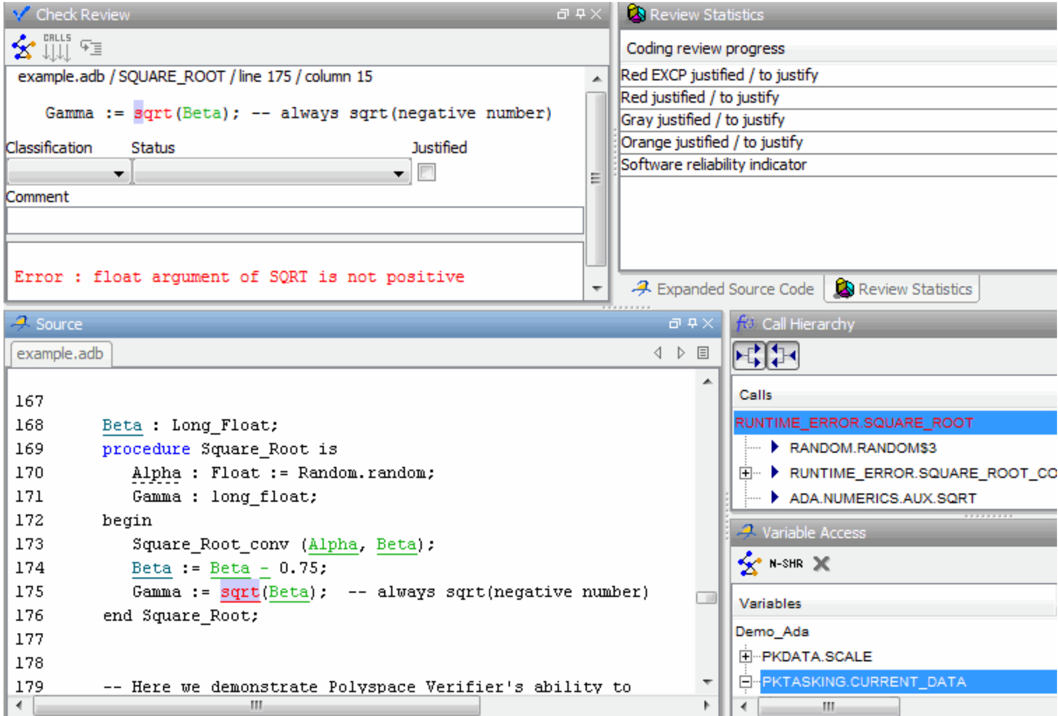
The **Count** column displays a ratio and the **Progress** column displays the equivalent percentage. The first row displays the ratio of reviewed checks to the total number of checks that have the same color and category as the current check. In this example, it displays the ratio of reviewed red EXCP checks to total red EXCP errors in the project.

The second, third, and fourth rows displays the ratio of reviewed checks to total checks for red, gray, and orange checks respectively. The fifth row displays the ratio of the number of green checks to the total number of checks, providing an indicator of the reliability of the software.

Reviewing and Commenting Checks

To review and comment a check:

1 In the procedural entities view, select the check you want to review. You see the section of source code where this error occurs, and details about the check.



2 After you review the check, in **Check Review**, you can do the following:

a To describe the severity of the issue, from the **Classification** drop-down list, select one of the following:

- `High`
- `Medium`
- `Low`
- `Not a defect`

b To describe how you intend to address the issue, from the **Status** drop-down list, select one of the following:

- `Fix`
- `Improve`
- `Investigate`
- `Justify with annotations`
- `No Action Planned`
- `Other`
- `Restart with different options`
- `Undecided`

Note You can also define your own statuses. See "Defining Custom Status" on page 8-50.

---

3. Justify the check. For example, if you classified the check as `Not a defect`, you could select the **Justified** check box to indicate that the check is justified.

   The software updates the ratios of errors justified to total errors in the **Review Statistics** pane of the Run-Time Checks perspective window.

4. Enter remarks in the **Comment** field, for example, defect or justification information.

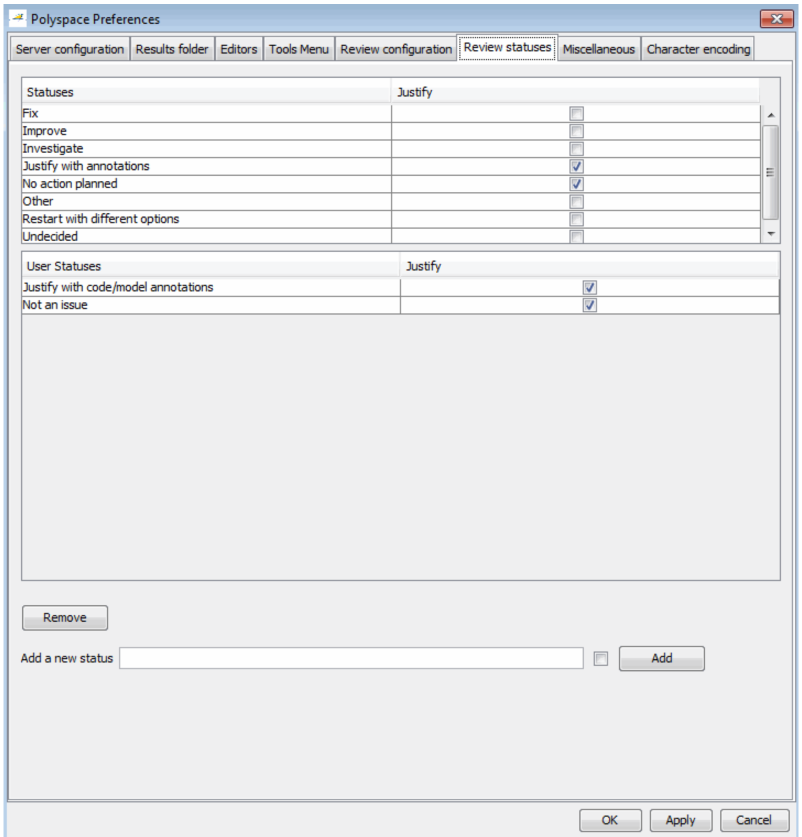
Defining Custom Status

In addition to the predefined statuses for reviewing checks, you can define your own statuses. Once you define a status, you can select it from the **Status** drop-down list in the selected check view.

To define custom statuses:

1. Select **Options > Preferences**.

2. Select the **Review Statuses** tab.



3 Enter your new status at the bottom of the dialog box. Then click **Add**.

The new status appears in the **User Statuses** list.

4 Click **OK** to save your changes and close the dialog box.

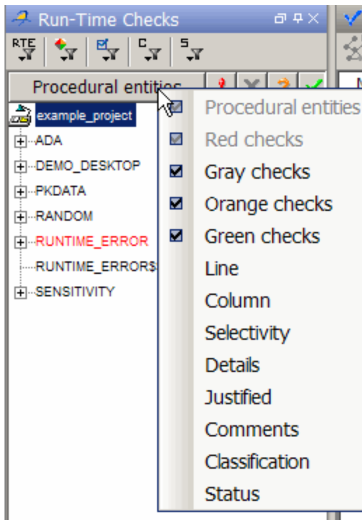
When reviewing checks, you can select the new status from the **Status** menu in the selected check view. See "Reviewing and Commenting Checks" on page 8-48

Tracking Justified Checks in Procedural Entities View

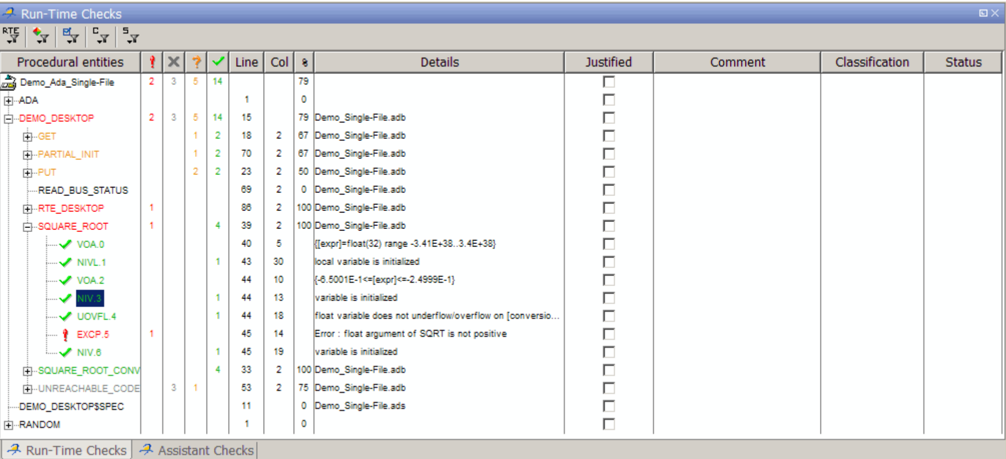
You can use the **Run-Time Checks** pane to display checks you have justified together with other check information.

To display the Justified column:

1. Place the cursor over **Procedural entities** and right-click.



2. From the context menu, select `Justified`. If you want to display other columns, select the corresponding items from the drop-down list, for example `Comments`, `Classification`, and `Status`.



Tip If you do not see the Justified column, resize the procedural entities view to display the column.

You can select the **Justified** check box to mark a check as justified. Selecting this check box also automatically selects the check box for that check in the **Check Review** pane.

Importing and Exporting Review Comments

In this section...

"Reusing Review Comments" on page 8-54

"Importing Review Comments from Previous Verifications" on page 8-55

"Exporting Review Comments to Spreadsheet" on page 8-56

"Viewing Checks and Comments Report" on page 8-56

Reusing Review Comments

After you have reviewed verification results on a module, you can reuse your review comments with subsequent verifications of the same module. This allows you to avoid reviewing the same check twice, or to compare results over time.

The Run-Time Checks perspective allows you to either:

- Import review comments from another set of results into the current results.
- Export review comments from the current results to a spreadsheet.

You can also generate a report that compares the source code and verification results from two verifications, and highlights differences in the results.

Note If the code has changed since the previous verification, the imported comments may not be applicable to your current results. For example, the justification for an orange check may no longer be relevant to the current code. Open the Import/Export Report to see changes that affect your review comments.

Importing Review Comments from Previous Verifications

If you have previously reviewed verification results for a module and saved your comments, you can import those comments into the current verification, allowing you to avoid reviewing the same check twice.

Caution The comments you import replace any existing comments in the current results.

To import review comments from a previous verification:

1. Open your most recent verification results in the Run-Time Checks perspective.
2. Select **Review > Import > Import Comments**.
3. Navigate to the folder containing your previous results.
4. Select the results (.RTE) file, 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 "Viewing Checks and Comments Report" on page 8-56.

Once you import checks and comments, the **go to next check** icon in assistant mode will skip any reviewed checks, allowing you to review only checks that you have not reviewed previously. If you want to view reviewed checks, click the **go to next reviewed check** icon.

Note If the code has changed since the previous verification, the imported comments may not be applicable to your current results. For example, the justification for an orange check may no longer be relevant to the current code.

Exporting Review Comments to Spreadsheet

After you have reviewed verification results, you can export your review comments to .CSV format, for use with the PolyspaceMacro spreadsheet.

To export review comments to spreadsheet format:

1. Select **Review > Export in Spreadsheet Format**.
2. Navigate to the folder in which you want to save the comments file.
3. Select **Export**.

   The review comments from the current results are exported into .CSV format.

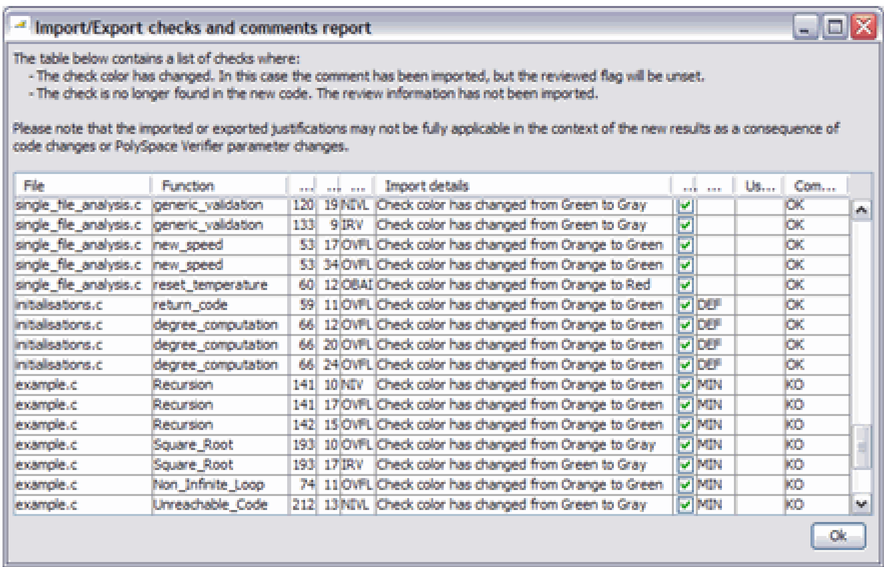
Viewing Checks and Comments Report

Importing review comments from a previous verification can be extremely useful, since it allows you to avoid reviewing checks twice, and to compare verification results over time.

However, if your code has changed since the previous verification, or if you have upgraded to a new version of the software, the imported comments may not be applicable to your current results. For example, the color of a check may have changed, or the justification for an orange check may no longer be relevant to the current code.

The Import/Export checks and comments report allows you to compare the source code and verification results from a previous verification to the current verification, and highlights differences in the results.

To view the Import/Export checks and comments report, select **Review > Import > Open Import Report**. The Import/Export checks and comments report opens, highlighting differences in the two results, such as unmatched lines and changes to the color of checks.



If the color of a check changes, the previous review comments are imported, but the check is not marked as reviewed.

If a check no longer appears in the code, the report highlights the change, but the software does not import any comments on the check.

Generating Reports of Verification Results

In this section...

"Polyspace Report Generator Overview" on page 8-58
"Generating Verification Reports" on page 8-59
"Running the Report Generator from the Command Line" on page 8-61
"Automatically Generating Verification Reports" on page 8-62
"Customizing Verification Reports" on page 8-63
"Generating Excel Reports" on page 8-64

Polyspace Report Generator Overview

The Polyspace Report Generator allows you to generate reports about your verification results, using predefined report templates.

The Polyspace Report Generator provides the following report templates:

- **Coding Rules Report** — Provides information about compliance with Coding Rules, as well as Polyspace configuration settings used for the verification.
- **Developer Report** — Provides information useful to developers, including summary results, detailed lists of red, orange, and gray checks, and Polyspace configuration settings for the verification. Detailed results are sorted by type of check (Proven Run-Time Violations, Proven Unreachable Code Branches, Unreachable Functions, and Unproven Run-Time Checks).
- **Developer Review Report** – Provides the same information as the Developer Report, but reviewed results are sorted by review acronym (NOW, NXT, ROB, DEF, MIN, OTH) and untagged checks are sorted by file location.
- **Developer with Green Checks Report** — Provides the same content as the Developer Report, but also includes a detailed list of green checks.
- **Quality Report** — Provides information useful to quality engineers, including summary results, statistics about the code, graphs showing

distributions of checks per file, and Polyspace configuration settings for the verification.

- **Software Quality Objectives Report** — Provides comprehensive information on software quality objectives (SQO), including code metrics, code verification (run-time checks), and the configuration settings for the verification. The code metrics section provides the same information as the **Code Metrics** view of the Polyspace Metrics web interface.

Using the Polyspace Report Generator, you can generate verification reports in the following formats:

- HTML
- PDF
- RTF
- Microsoft® Word
- XML

Note Microsoft Word format is not available on UNIX platforms. Use the RTF format instead.

Generating Verification Reports

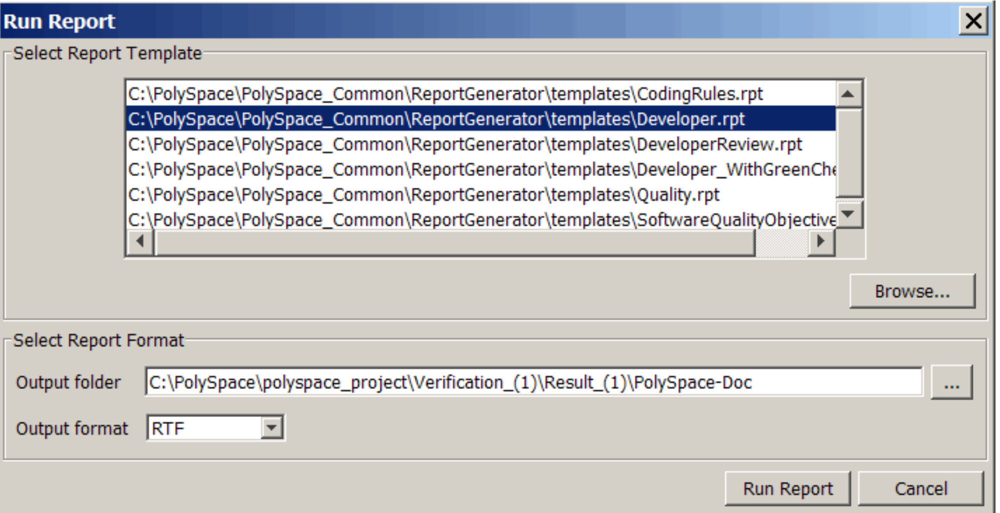
You can generate reports for any verification results using the Polyspace Report Generator.

To generate a verification report:

1. In the Run-Time Checks perspective, open your verification results.

2. Select **Run > Run Report > Run Report**.

   The Run Report dialog box opens.



3 Under **Select Report Template**, select the type of report that you want to run.

4 If your results are part of a unit-by-unit verification, you can generate a report for the current unit results, or for the entire project. Select **Generate a single report including all unit results** to combine all unit results in the report.

5 Select the Output folder in which to save the report.

6 Select the Output format for the report.

7 Click **Run Report**.

   The software creates the specified report.

Note If you generate an RTF format report on a Linux system, the software does not open the report at the end of the generation process.

Running the Report Generator from the Command Line

You can also run the Report Generator, with options, from the command line, for example:

```
C:\>\Polyspace\Polyspace_Common\ReportGenerator\wbin\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,

```
C:\Polyspace\Polyspace_Common\ReportGenerator\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, then 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"
```

where *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.

Automatically Generating Verification Reports

You can specify that Polyspace software automatically generate reports for each verification using an option in the Project Manager perspective.

Note You cannot generate reports of software quality objectives automatically.

To automatically generate reports for each verification:

1. In the Project Manager perspective, open your project.
2. In the Configuration pane, expand the **Analysis options > General** node.
3. Select **Report Generation**.
4. Select the **Report template name**.
5. Select the **Output format** for the report.
6. Save your project.

Customizing Verification Reports

If you have MATLAB® Report Generator™ software installed on your system, you can customize the Polyspace report templates or create your own reports. You can then generate these custom reports using the Polyspace Report Generator.

Before you can customize Polyspace reports, you must configure the MATLAB Report Generator software to access the following folders:

- **Custom components** – *Polyspace_Common*/ReportGenerator/components
- **Report templates** – *Polyspace_Common*/ReportGenerator/templates

To customize a Polyspace report:

1. Open MATLAB.
2. Add the Polyspace reports custom components folder to the MATLAB search path, using the following command:

   ```
   addpath(`Polyspace_Common/ReportGenerator/components')
   ```

3. Set the current folder in MATLAB to the Polyspace reports template folder, using the following command:

   ```
   cd('Polyspace_Common/ReportGenerator/templates')
   ```

4. Start the Report Editor GUI using the following command:

   ```
   report
   ```

For more information on using the MATLAB Report Generator software, refer to the *MATLAB Report Generator User's Guide*.

Note To access custom reports in the Polyspace Report Generator, you must save the report template in:*Polyspace_Common*/ReportGenerator/templates.

Generating Excel Reports

You can also generate Microsoft Excel® reports of verification results.

Note Excel reports do not use the Polyspace Report Generator.

To generate an Excel report of your verification results:

1. In your results folder, navigate to the `Polyspace-Doc` folder. For example:`polypace_project\results\Polyspace-Doc`.

   The folder should have the following files:

   ```
   Example_Project_Call_Tree.txt
   Example_Project_RTE_View.txt
   Example_Project_Variable_View.txt
   Example_Project-NON-SCALAR-TABLE-APPENDIX.ps
   Polyspace_Macros.xls
   ```

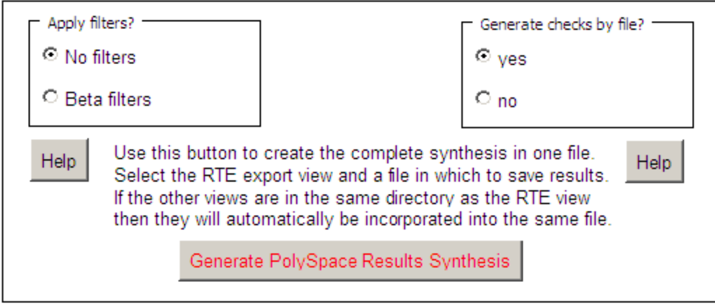
   The first three files correspond to the call tree, RTE, and variable views in the Polyspace Run-Time Checks Perspective window.

2. Open the macros file `Polyspace_Macros.xls`.

   A security warning dialog box opens.

3. Click **Enable Macros**.

   A spreadsheet opens. The top part of the spreadsheet looks like the following figure:



4 Specify the report options you want, then click **Generate Polyspace Results Synthesis**.

The synthesis report combines the RTE, call tree, and variables views into one report.

The **Where is the Polyspace RTE View text file** dialog box appears.

5 In **Look in**, navigate to the `Polyspace-Doc` folder in your results folder. For example:`polypace_project\results\Polyspace-Doc`.

6 Select *`Project`*`_RTE_View.txt`.

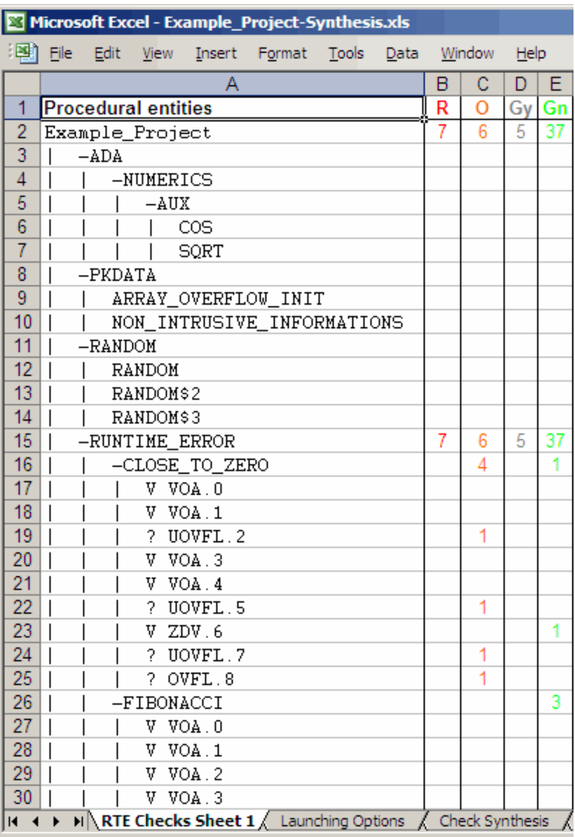
7 Click **Open** to close the dialog box.

The **Where should I save the analysis file?** dialog box opens.

8 Keep the default file name and file type.

9 Click **Save** to close the dialog box and start the report generation.

Microsoft Excel opens with the spreadsheet that you generated. This spreadsheet has several worksheets:



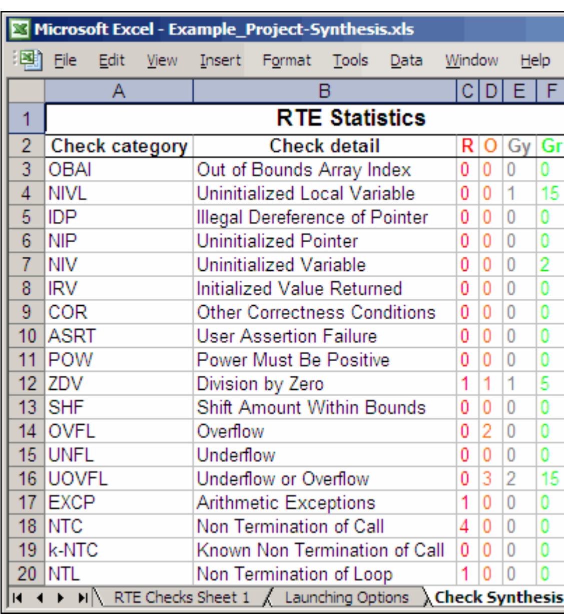
Microsoft Excel - Example_Project-Synthesis.xls

File Edit View Insert Format Tools Data Window Help

	A	B	C	D	E
1	Procedural entities	R	O	Gy	Gn
2	Example_Project	7	6	5	37
3	| -ADA				
4	| | -NUMERICS				
5	| | | -AUX				
6	| | | | COS				
7	| | | | SQRT				
8	| -PKDATA				
9	| | ARRAY_OVERFLOW_INIT				
10	| | NON_INTRUSIVE_INFORMATIONS				
11	| -RANDOM				
12	| | RANDOM				
13	| | RANDOM$2				
14	| | RANDOM$3				
15	| -RUNTIME_ERROR	7	6	5	37
16	| | -CLOSE_TO_ZERO		4		1
17	| | | V VOA.0				
18	| | | V VOA.1				
19	| | | ? UOVFL.2		1		
20	| | | V VOA.3				
21	| | | V VOA.4				
22	| | | ? UOVFL.5		1		
23	| | | V ZDV.6				1
24	| | | ? UOVFL.7		1		
25	| | | ? OVFL.8		1		
26	| | -FIBONACCI				3
27	| | | V VOA.0				
28	| | | V VOA.1				
29	| | | V VOA.2				
30	| | | V VOA.3				

RTE Checks Sheet 1 / Launching Options / Check Synthesis

10 Select the **Check Synthesis** tab to view the worksheet showing statistics by check category.



Microsoft Excel - Example_Project-Synthesis.xls

File Edit View Insert Format Tools Data Window Help

	A	B	C	D	E	F
1	RTE Statistics					
2	Check category	Check detail	R	O	Gy	Gr
3	OBAI	Out of Bounds Array Index	0	0	0	0
4	NIVL	Uninitialized Local Variable	0	0	1	15
5	IDP	Illegal Dereference of Pointer	0	0	0	0
6	NIP	Uninitialized Pointer	0	0	0	0
7	NIV	Uninitialized Variable	0	0	0	2
8	IRV	Initialized Value Returned	0	0	0	0
9	COR	Other Correctness Conditions	0	0	0	0
10	ASRT	User Assertion Failure	0	0	0	0
11	POW	Power Must Be Positive	0	0	0	0
12	ZDV	Division by Zero	1	1	1	5
13	SHF	Shift Amount Within Bounds	0	0	0	0
14	OVFL	Overflow	0	2	0	0
15	UNFL	Underflow	0	0	0	0
16	UOVFL	Underflow or Overflow	0	3	2	15
17	EXCP	Arithmetic Exceptions	1	0	0	0
18	NTC	Non Termination of Call	4	0	0	0
19	k-NTC	Known Non Termination of Call	0	0	0	0
20	NTL	Non Termination of Loop	1	0	0	0

RTE Checks Sheet 1 / Launching Options / Check Synthesis

Using Polyspace Results

In this section...

"Review Run-Time Errors: Fix Red Errors" on page 8-68
"Using Range Information in Run-Time Checks Perspective" on page 8-69
"Why Review Dead Code Checks" on page 8-72
"Reviewing Orange: Automatic Methodology" on page 8-74
"Reviewing Orange Checks" on page 8-75
"Integration Bug Tracking" on page 8-76
"How to Find Bugs in Unprotected Shared Data" on page 8-76
"Dataflow Verification" on page 8-77
"Potential Side Effect of a Red Error" on page 8-78
"Checks on Procedure Calls with Default Parameters" on page 8-79
"_INIT_PROC Procedures" on page 8-81
"Pointers to Explicit Tasks" on page 8-82

Review Run-Time Errors: Fix Red Errors

All 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 of course mathematically incorrect. If the value represents the altitude of a plane, this could result in a disaster.

By default, Polyspace verification doesn't make assumptions about the way a variable is used. Any 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. On some occasions a Polyspace option may be used to allow particular compiler specific behavior, and on others the code must be corrected in order to comply. An example of a Polyspace option to permit compiler specific behavior would be 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.
- All other red errors must be fixed. They are bugs.

Most of the bugs you'll find are easy to correct once they are identified. Polyspace verification identifies bugs regardless of their consequence, or of the ease with which they can be corrected.

Using Range Information in Run-Time Checks Perspective

Viewing Range Information

Within 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" in the *Polyspace Products for Ada Reference*.

If you click a check, the software provides information about the check in the Check Review pane.

Interpreting Range Information

The software uses the following syntax to display range information of variables:

```
variable_name (type: data_type [data_type_range]) :
[min1 .. max1] or [min2 .. max2] or [min3 .. max3] or exact_value
```

In the following example:

```
80        if  Y then
81           New_Alt := New_Alt * 10;
82        end if
83     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.

```
69        depth := depth + 1;
70        advance := float(1)/float(depth);  -- potential zero division
71        if depth < 5 then
72           Recursive_2 (depth);   variable 'depth' (type: integer [-2^31..2^31-1]): [-3 .. 0] or 11
```

With the next case:

```
43        Square_Root_conv (Alpha, Beta);
44        Beta := Beta - 0.75;
45        Gamma := S
46     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:

```
43        Square_Root_conv (Alpha, Beta);
44        Beta := Beta - 0.7
45        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:

```
127  procedure proc(X : in out Integer) is
128  begin
129     X :=
130     X
131     +
132     100;
133  end;
```

The procedure is called with a parameter `X`:

```
180     procedure main is
181     begin
182
183        R.F1 := 12;
184        Proc
185          (
186           X
187          );
188        Proc
189          (
190           R
```

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:

```
148  procedure Proc_Init_Out(X : out Integer) is
149  begin
150     X := 100;
151     null;
152  end;
```

the tooltip is a single line with information about the `out` parameter:

```
214             Niv: Integer;
215           begin
216             Proc_Init_Out(Niv);
217             pragma  Assert(
218           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 8-72
- “Structural Coverage” on page 8-73

Functional Bugs in Gray Code

Polyspace verification finds different types of dead code. Common examples include:

- Defensive code which is never reached
- 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 examples below 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 a branch where the conditions are never met;

- 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 (say)

As is the case for red errors, the consequence of dead code and the effort needed to deal with it is unpredictable. It can vary

- From 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 3 minutes code review discovering the bug.

Again, as for red errors, Polyspace doesn’t measure the impact of dead code.

The tool provides a list of dead code. A short code review will enable you to place each entry from that list into one of the five categories from the beginning of this chapter. Doing will identify known dead code and uncover real bugs.

Polyspace experience is that at least 30% of gray code reveals real bugs.

Structural Coverage

Polyspace software always performs upper approximations of all 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, but it could conclude that no runtime error could be found.

Polyspace verification will find around 80% of dead code that the developer would find by doing structural coverage.

Polyspace verification is intended to be used as a productivity aid in dead code detection. It detects dead code which might take days of effort to find by any other means.

Reviewing Orange: Automatic Methodology

During a verification, Polyspace can automatically highlight orange checks associated with code that may 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 in a smaller subtype.

You must address these checks first. Polyspace is very precise with these checks. These checks indicate issues of robustness.

Example

```
1 Package body Test is
2  ATab : array(0..9) of Integer := (Others => 0);
3  function Assign_array(X : integer) return Integer is
4    Y : Integer;
5   begin
6    y := ATab(X - 12);  -- Warning OVFL on operator  -  given by
7                          -- the Automatic methodology
8    return y;
9   end Assign_Array;
10
11  function read_bus_status return boolean; -- function stubbed
12  procedure partial_init( New_Alt : in out Integer ) is
13    Y : boolean;
14   begin
15    if read_bus_status then
16     New_Alt := 12;
17     Y := True;
18    else
19     New_Alt := 120;
20    end if;
21    if Y then  -- Warning NIVL on  Y  given by
22                 -- the automatic methodology
```

```
23     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. There is no neighbouring code that ensures robustness.

- 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*. This means that the code can neither be proven safe, nor can it be proven to contain a runtime error.

The number of orange checks you review is determined by several factors, including:

- The stage of the development process
- Your quality objectives

There are also actions you can take to reduce the number of orange checks in your results.

For information on managing orange checks in your results, see Chapter 9, “Managing Orange Checks”.

Integration Bug Tracking

By default, integration bug tracking can be achieved by applying the selective orange methodology to integrated code. Each error category will be more likely to reveal integration bugs, depending on the chosen coding rules for the project.

For instance, consider a function receives two unbounded integers. The presence of an overflow can only be checked at integration phase, since at unit phase the first mathematical operation will reveal an orange check.

Consider these two circumstances:

- When integration bug tracking is performed in isolation, a selective orange review will highlight 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.

In this second case, an exhaustive orange review will already have been performed file by file. Therefore, at integration phase **only checks that have turned from green to another color** 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. This will consequentially display a green NIV check at the first read access to a field. But this might not be true at integration time, where this check can turn orange if any context does not initialize these fields.

These orange checks will reveal integration bugs.

How to Find Bugs in Unprotected Shared Data

Based on the list of entry points in a multi-task 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 any implemented 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 whilst another task is in the process of doing so. All the possible situations are considered below.

- If there is a possible scenario which would lead to such conflict for a particular variable, then a bug exists and protection is required.
- If there are no such scenarios, then one of the following explanations may apply:
  - The compilation environment guarantees an atomic read/write access on variable of type less than 1, 2 bytes, and therefore all conflicts concerning a particular variable type still guarantee the integrity of the variables content. But beware when porting the code!
  - The variable is protected by a critical section or a mutual temporal exclusion. You may wish to include this information in the Polyspace launching parameters and reverify.

It is also worth checking whether variables are modified which are supposed to be constant. 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 any time after the Control and Data Flow verification phase.

- Call tree computation
- Dictionary containing read/write access to global variables. (This 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.

Potential Side Effect of a Red Error

This section explains why when a red error has been found the verification continues but some cautions need to be taken. Consider this piece of code:

```
7  package body Main is
8   procedure Main is
9    X: array (1..5) of Integer;
10    Tmp: Integer;
11    Zero: Integer:= 0;
12   begin
13    X:= (1,2,3,4,5);
14    if (X(4) > X(5))
15    then
16     Tmp:= 1 / Zero;
17    end if;
18   end;
19
20  end;
```

Polyspace verification works by propagating data sets representing ranges of possible values throughout the call tree, and throughout the functions in that call tree. Sometimes, Polyspace internally subdivides the functions for verification, and the propagation of the data ranges need several iterations (or integration levels) to complete. You can observe that effect by examining the color of the checks upon completion of each of those levels.

- The verification detects gray code which exists due to a terminal RTE which is not be flagged in red until a subsequent integration level.
- The verification flags an NTC in red with the content in gray. This red NTC is the result of an imprecision; it should be gray.

Suppose that an NTC is hard to understand at given integration level (level 4):

- If other red checks exist at level 4, fix them and restart the verification

- Otherwise, look back through the results from each previous level to see whether other red errors can be located. If so, fix them and restart the verification

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

```
1  package DCHECK is
2   type Pixel is
3    record
4     X : Integer;
5     Y : Integer;
6    end record;
7   procedure MAIN;
8
9   NError : Integer;
10   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 calls Failure represent the check NIV made on the default parameter N error (a global parameter).

In the same way, 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 Not all the checks have been moved to procedure calls. 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 Run-Time Checks perspective, it could be possible to 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

```
1  package test is
2   procedure main;
3  end test;
4
5  package body test is
6
7   subtype range_0_3 is integer range 0..3;
8   Vg : Integer := 1;
9   Pragma Volatile( Vg );
10
11   function random return integer;
12   type my_rec1 is
13    record
14     a : integer := 2 + random; -- Unproven OVFL coming from
_INIT_PROC procedure (initialization of V1)
15     b : float := 0.2;
16    end record;
17   V1 : my_rec1;
18   V2 : my_rec1 := (10, 10.10);
19
20   procedure main is
21    Function Random return Boolean;
22   begin
23    null;
24   end;
25  end test;
```

Explanation

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. Indeed, random procedure could return any value in the integer type and so, leads to an overflow by adding to 2. Check is located in the _INIT_PROC node into "Procedural entities" view.

Pointers to Explicit Tasks

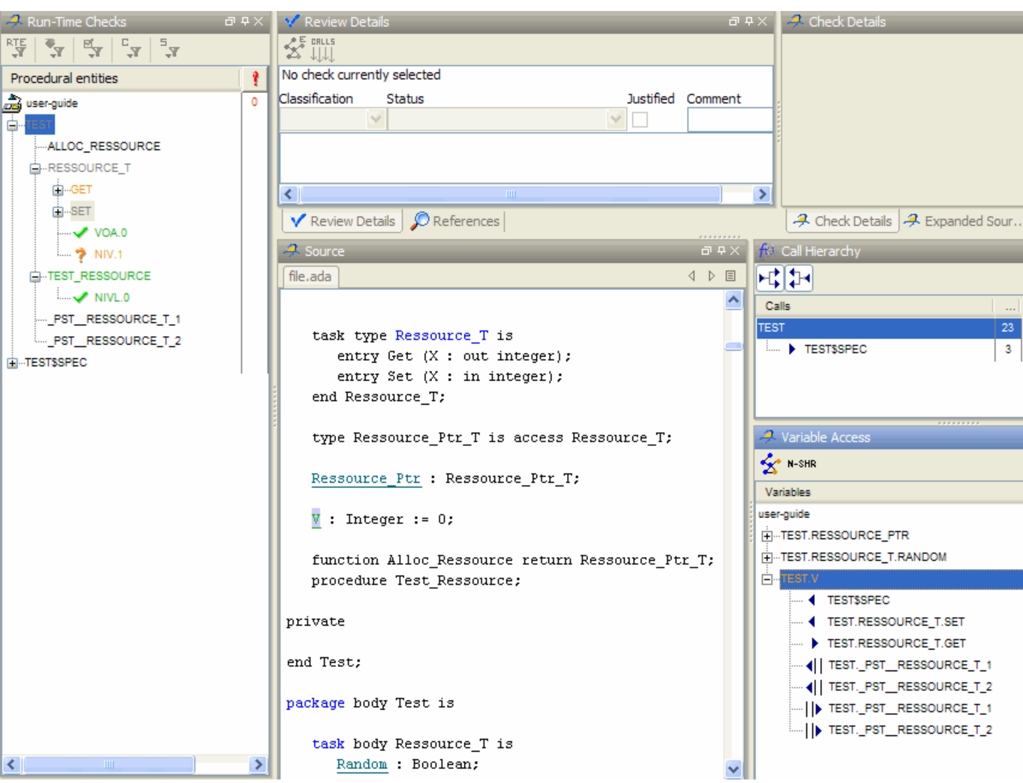
If a task type is used through a pointer, then Polyspace automatically adds two instances of this task type to the Polyspace execution model of your application. All task pointer objects that are used in your application are represented by these two instances. Polyspace uses these instances to simulate all 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 procedural entities view, you see two instances of the task type `Ressource_T`, that is, `PST_Ressource_T_1` and `PST_Ressource_T_2`.


Run-Time Checks
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TEST
ALLOC_RESSOURCE
RESSOURCE_T
GET
SET
VOA.0
NIV.1
TEST_RESSOURCE
NIVL.0
_PST__RESSOURCE_T_1
_PST__RESSOURCE_T_2
TEST$SPEC
Review Details
No check currently selected
Classification
Status
Justified
Comment
References
Check Details
Expanded Sour...
Source
file.ada
task type Ressource_T is
entry Get (X : out integer);
entry Set (X : in integer);
end Ressource_T;
type Ressource_Ptr_T is access Ressource_T;
Ressource_Ptr : Ressource_Ptr_T;
V : Integer := 0;
function Alloc_Ressource return Ressource_Ptr_T;
procedure Test_Ressource;
private
end Test;
package body Test is
task body Ressource_T is
Random : Boolean;
Call Hierarchy
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23
TEST$SPEC
3
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TEST.RESSOURCE_PTR
TEST.RESSOURCE_T.RANDOM
TEST.V
TEST$SPEC
TEST.RESSOURCE_T.SET
TEST.RESSOURCE_T.GET
TEST._PST__RESSOURCE_T_1
TEST._PST__RESSOURCE_T_2
TEST._PST__RESSOURCE_T_1
TEST._PST__RESSOURCE_T_2

Managing Orange Checks

- “Understanding Orange Checks” on page 9-2
- “Too Many Orange Checks?” on page 9-9
- “Reducing Orange Checks in Your Results” on page 9-11
- “Reviewing Orange Checks” on page 9-23

Understanding Orange Checks

In this section...
"What is an Orange Check?" on page 9-2
"Sources of Orange Checks" on page 9-6

What is an Orange Check?

Orange checks indicate *unproven code*. This means that the code can neither be proven safe, nor can it be proven to contain a runtime error.

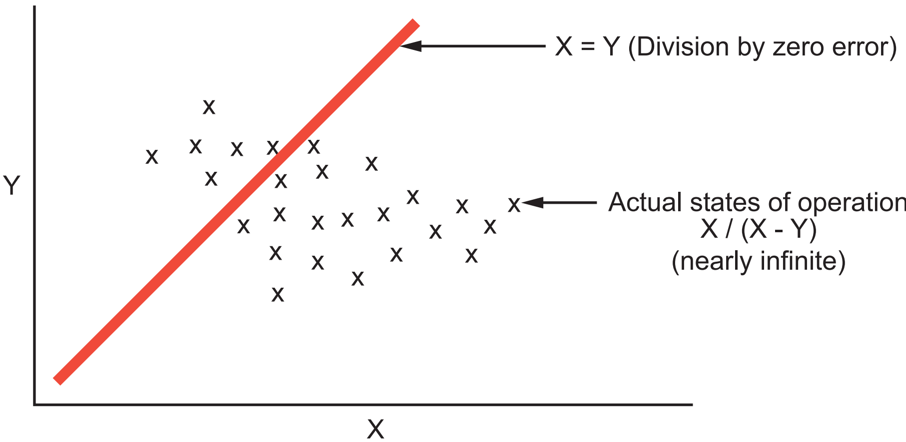
Polyspace verification does not try to find bugs, it attempts to prove the absence or existence of run time errors. Therefore, all code starts out as unproven prior to verification. The verification then attempts to prove that the code is either correct (green), is certain to fail (red), or is unreachable (gray). Any remaining code stays unproven (orange).

Code often remains unproven in situations where some paths fail while others succeed. For example, consider the following instruction:

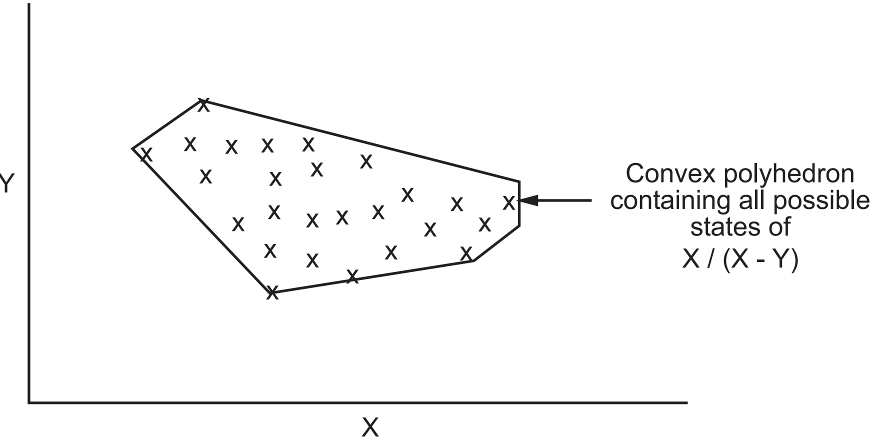
```
X = 1 / (X - Y);
```

Does a division-by-zero error occur?

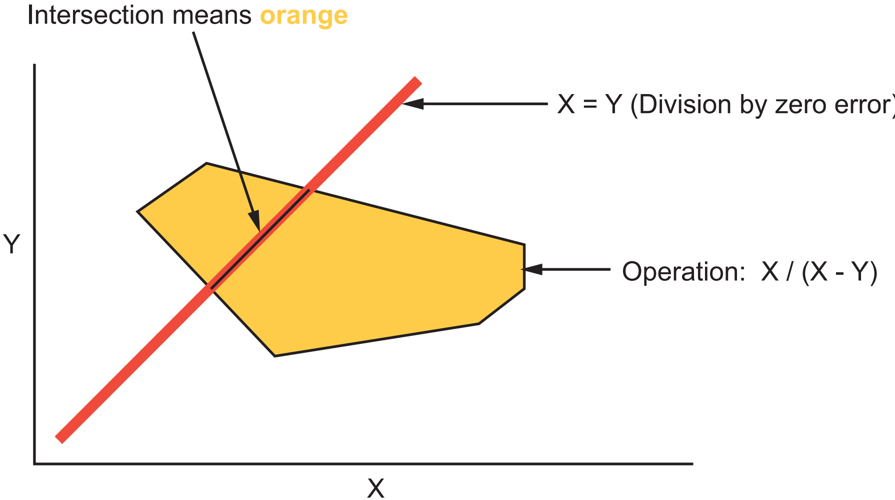
The answer clearly depends on the values of X and Y. However, there are an almost infinite number of possible values. Creating test cases for all possible values is not practical.



Although 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.

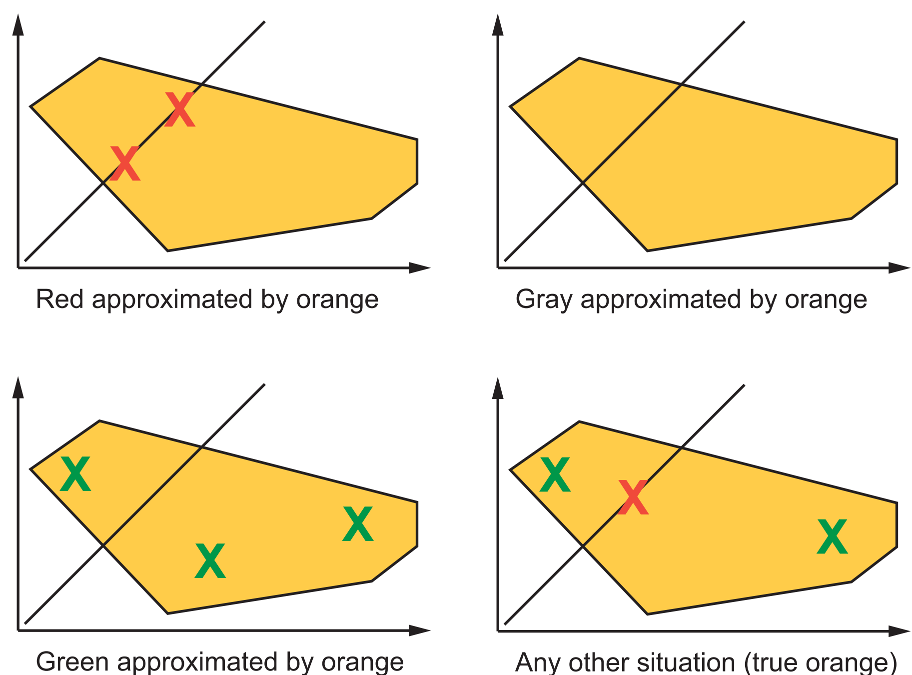


Polyspace verification than compares the data set represented by this polyhedron to the error zone. If the two data sets intersect, the check is orange.



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 used in the verification is an approximation of actual values, an orange check may actually represent a check of any other color, as shown below.



Polyspace reports an orange check any time 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 is safe.

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 caused by any of the following:

- Potential bug
- Inconclusive check
- Data set issue
- Basic imprecision

Bugs can be revealed by any of these categories except for basic imprecision.

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 ZDV.

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.

The verification cannot determine if an error will occur unless you define the call sequence.

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. You may want to recode to ensure there is no risk, depending on the criticality of the function and the required speed of execution.

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 all combinations of input data rather than any 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 may know that the three variables cannot all 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, it is usually possible to identify the cause quickly. After identifying a data set issue, you may want to comment the code to flag the warning, or modify the code to take the constraints into account.

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 any value in range `[10...20]`.
  This means that `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 may be able to resolve orange checks by increasing the precision level. If this does not resolve the orange check, verification cannot help directly. You need to review the code to determine if there is an actual problem.

For more information, see and “Approximations Used During Verification”in the *Polyspace Products for Ada Reference*.

Too Many Orange Checks?

In this section...

"Do I Have Too Many Orange Checks?" on page 9-9

"How to Manage Orange Checks" on page 9-10

Do I Have Too Many Orange Checks?

If the goal of code verification is to prove the absence of run time errors, you may be concerned by the number of orange checks (unproven code) in your results.

In reality, asking "Do I have too many orange checks?" is not the right question. There is not an ideal number of orange checks that applies for all applications, not even zero. Whether you have too many orange checks depends on:

- **Development Stage** – Early in the development cycle, when verifying the first version of a software component, a developer may want to focus exclusively on finding red errors, and not consider orange checks. As development of the same component progresses, however, the developer may want to focus more on orange checks.
- **Application Requirements** – There are actions you can take during coding to produce more provable code. However, writing provable code often involves compromises with code size, code speed, and portability. Depending on the requirements of your application, you may decide to optimize code size, for example, at the expense of more orange checks.
- **Quality Goals** – Polyspace software can help you meet quality goals, but it cannot define those goals for you. 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.

It is these factors that ultimately determine how many orange checks are acceptable in your results, and what you should do with the orange checks that remain.

Thus, a more appropriate question is "How do I manage orange checks?"

This question leads to two main activities:

- Reducing the number of orange checks
- Working with orange checks

How to Manage Orange Checks

Polyspace verification cannot magically produce quality code at the end of the development process. Verification is a tool that helps you measure the quality of your code, identify issues, and ultimately achieve the quality goals you define. To do this, however, you must integrate Polyspace verification into your development process.

Similarly, you cannot successfully manage orange checks simply by using Polyspace options. To manage orange checks effectively, you must take actions while coding, when setting up your verification project, and while reviewing verification results.

To successfully manage orange checks, perform each of the following steps:

1. Define your quality objectives to set overall goals for application quality. See “Defining Quality Objectives” on page 2-5.

2. Set Polyspace analysis options to match your quality objectives. See “Specifying Options to Match Your Quality Objectives” on page 3-13.

3. Define a process to reduce orange checks. See “Reducing Orange Checks in Your Results” on page 9-11.

4. Apply the process to work with remaining orange checks. See “Reviewing Orange Checks” on page 9-23.

Reducing Orange Checks in Your Results

In this section...

"Overview: Reducing Orange Checks" on page 9-11

"Coding Guidelines for Reducing Orange Checks" on page 9-12

"Improving Verification Precision" on page 9-12

"Stubbing Parts of the Code Manually" on page 9-16

"Describing Multitasking Behavior Properly" on page 9-21

Overview: Reducing Orange Checks

There are several actions you can take to reduce the number of orange checks in your results.

However, it is important to understand that while some actions increase the quality of your code, others simply change the number of orange checks reported by the verification, without improving code quality.

Actions that reduce orange checks and improve the quality of your code:

- Apply "Coding Guidelines for Reducing Orange Checks" on page 9-12 — Most efficient way of reducing orange checks. Can also improve quality of code.

Actions that reduce orange checks through increased verification precision:

- **Set precision options** – There are several Polyspace options that can increase the precision of your verification, at the cost of increased verification time.
- **Implement manual stubbing** – Manual stubs that accurately emulate the behavior of missing functions can increase the precision of the verification.
- **Specify multitasking behavior** – Accurately defining call sequences and other multitasking behavior can increase the precision of the verification.

Options that reduce orange checks but do not improve code quality or the precision of the verification:

- **Create empty stubs** – Providing empty stubs for missing functions can reduce the number of orange checks in your results, but does not improve the quality of the code.

Each of these actions have trade-offs, either in development time, verification time, or the risk of errors. Therefore, before taking any of these actions, it is important to define your quality objectives, as described in "Defining Quality Objectives" on page 2-5.

It is your quality objectives that determine how many orange checks are acceptable in your results, what actions you should take to reduce the number of orange checks, and what you should do with any orange checks that remain.

Coding Guidelines for Reducing Orange Checks

The number of **orange checks** per file strongly depends on the coding style used in the project.

Here is a list of coding guidelines that improves 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 all assembly code in a procedure/function which can be automatically stubbed.

Improving Verification Precision

Improving the precision of a verification can reduce the number of orange checks in your results, although it does not affect the quality of the code itself.

There are a number of Polyspace options that affect the precision of the verification. The trade off for this improved precision is increased verification time.

The following sections describe how to improve the precision of your verification:

- "Balancing Precision and Verification Time" on page 9-13
- "Setting the Analysis Precision Level" on page 9-14
- "Setting Software Safety Analysis Level" on page 9-16

Balancing Precision and Verification Time

When performing code verification, you must find the right balance between precision and verification time. Consider the two following extremes:

- If a verification runs in one minute but contains only orange checks, the verification is not useful because each check must be reviewed manually.
- If a verification contains no orange checks (only gray, red, and green), but takes six months to run, the verification is not useful because of the time spent waiting for the results.

Higher precision yields more proven code (red, green, and gray), but takes longer to complete. The goal is therefore to get the most precise results in the time available. Factors that influence this compromise include the time available for verification, the time available to review results, and the stage in the development cycle.

For example, consider the following scenarios:

- **Unit testing –** Before going to lunch, a developer starts a verification. After returning from lunch the developer will review verification results for one hour.
- **Integration testing** – Before going home, a developer starts a verification. The developer will spend the next morning reviewing verification results.
- **Validation testing** – Before leaving the office on Friday evening, a developer starts a verification. The developer will spend the following week reviewing verification results.

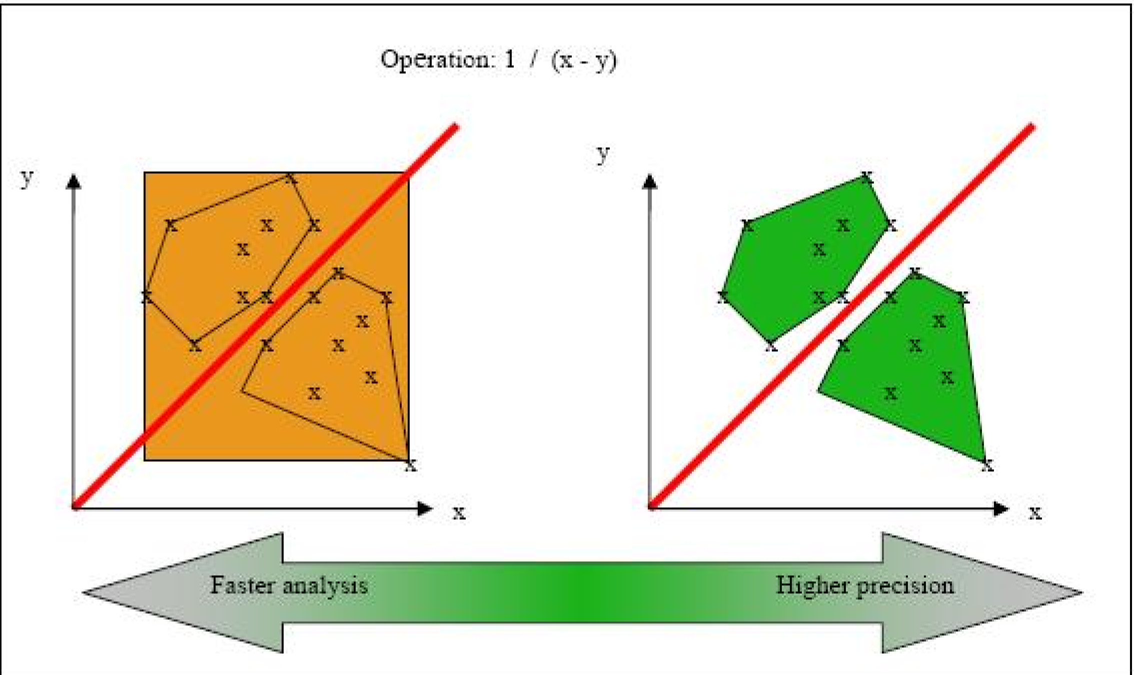
Each of these scenarios require the developer to use Polyspace software in different ways. Generally, the first verification should use the lowest precision mode, while subsequent verifications increase the precision level.

Note It is possible that a verification never ends. In this case, you may need to split the application.

Setting the Analysis Precision Level

The analysis **Precision Level** specifies the mathematical algorithm used to compute the cloud of points (polyhedron) containing all possible states for the variables.

Although changing the precision level does not affect the quality of your code, orange checks caused by low precision become green when verified with higher precision.



Affect of Precision Rate on Orange Checks

To set the precision level:

1 From the Project Manager perspective, in the **> Configuration** view, expand the node **Analysis options > Precision**.

2 From the **Precision Level** drop-down list, select 0, 1, 2, or 3.

For more information, see “Precision Level” in the *Polyspace Products for Ada Reference*.

Note You can select specific precision levels for individual modules in the verification.

Setting Software Safety Analysis Level

The Software Safety Analysis level of your verification specifies how many times the abstract interpretation algorithm passes through your code. The deeper the verification goes, the more precise it is.

There are 5 Software Safety Analysis levels (`pass0` to `pass4`). By default, verification proceeds to `pass4`, although it can go further if required. Each iteration results in a deeper level of propagation of calling and called context.

To set the Software Safety Analysis level:

1. From the Project Manager perspective, in the **Configuration** view, expand the node **Analysis options > Precision**.
2. From the **To end of** drop-down list, select the appropriate level.

For more information, see "To end of"in the *Polyspace Products for Ada Reference*.

Note The Software Safety Analysis level applies to the entire application. You cannot select specific levels for individual modules in the verification.

Stubbing Parts of the Code Manually

Manually stubbing parts of your code can reduce the number of orange checks in your results. However, manual stubbing generally does not improve the quality of your code, it only changes the results.

Stubs do not need to model the details of the functions or procedures involved. They only need to represent the effect that the code might have on 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 potentially take any value from the full type of an integer.

The following sections describe how to reduce orange checks using manual stubbing:

- "Manual vs. Automatic Stubbing" on page 9-17
- "Emulating Function Behavior with Manual Stubs" on page 9-18
- "Reducing Orange Checks with Empty Stubs" on page 9-19
- "Applying Constraints to Variables Using Stubs" on page 9-20

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's 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 any runtime errors.
- **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

The following example shows the effect of automatic stubbing.

```
void main(void)
{
 a=1;
 b=0;
 a_missing_function(&a, b);
 b = 1 / a;
}
```

Due to automatic stubbing, the verification assumes that *a* can be any integer, including `0`. This produces an orange check on the division.

If you provide an empty manual stub for the function, the division would be green. This 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.

However, if you provide a detailed manual stub that accurately emulates the behavior of the function, the division could be any color, including red.

Emulating Function Behavior with Manual Stubs

You can improve both the speed and selectivity of your verification by providing manual stubs that accurately 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 the effect that the code might have on 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 will propagate more precision throughout the application, which will result in a higher selectivity rate (more proven colors, i.e. more red+ green + gray). For this function, you could just add a simple body:

```
procedure a_missing_function
  (dest: in out integer,
  src : in integer)
begin
  dest := src;
end;
```

In this case, it is obvious that instead of considering the full range for the `dest` parameter, Polyspace will consider the relation between input parameter `src` and the output parameter, propagating more precision throughout the application. See the same example in the section of this guide titled “Manual vs. Automatic Stubbing” on page 5-2.

Reducing Orange Checks with Empty Stubs

Providing empty manual stubs can reduce the number of orange checks in your results, but it does not make your code more reliable.

For example, consider the following code:

```
void write_or_not1(int *x);

void write_or_not2(int *x);
 {  //empty manual stub
 }

void orange(void)
 {
  int x = 12;
  int y;

 write_or_not1(&x);
  y = y / x;    //Orange ZDV due to automatic stub
 }

void green(void)
 {
  int x = 12;
  int y;

 write_or_not2(&x);
  y = y / x;   // Green due to empty stub
  }
```

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 the actual function does not result in a runtime error.

Applying Constraints to Variables Using Stubs

Another way to increase the selectivity is to indicate to the Polyspace software that some variables (detailed below) might vary between some functional ranges instead of the full range of the considered type.

This 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 will stub it on the assumption that it can potentially take any value from the full type of an integer.

Given that Polyspace models data ranges throughout the code it verifies, it will obviously produce 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 three possible approaches are presented here.

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;`

There is no particular advantage in using one approach or another (except, perhaps, that the assertions in the first two will usually generate orange checks) – it is largely down to personal preference.

Describing Multitasking Behavior Properly

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 `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.

The verification cannot determine if an error will occur without knowing the call sequence. Modelling the task differently could turn this orange check green or red.

Refer to *"Preparing Multitasking Code"* for information on tasking facilities, including:

- Shared variable protection:
  - Critical sections,
  - Mutual exclusion,
  - Tasks synchronization,
- Tasking:
  - Threads, interruptions,
  - Synchronous/asynchronous events,
  - Real-time OS.

Reviewing Orange Checks

In this section...

"Overview: Reviewing Orange Checks" on page 9-23

"Defining Your Review Methodology" on page 9-23

"Performing Selective Orange Review" on page 9-24

"Importing Review Comments from Previous Verifications" on page 9-27

"Performing an Exhaustive Orange Review" on page 9-28

Overview: Reviewing Orange Checks

After you define a process that matches your quality objectives, you do not have too many orange checks. You have the correct number of orange checks for your quality model.

At this point, the goal is not to eliminate orange checks, it is to work efficiently with them.

Working efficiently with orange checks involves:

- Defining a review methodology to work consistently with orange checks
- Reviewing orange checks efficiently
- Importing comments to avoid duplicating review effort

Defining Your Review Methodology

Before reviewing verification results, you should configure a methodology for your project. The methodology specifies both the type and number of orange checks you need to review at review levels 0, 1, 2, and 3.

As part of the process for defining quality objectives for your project, you should:

- For review level 0, establish the categories of potential run-time errors that must be reviewed before moving to the next level. See "Reviewing Checks at Level 0" on page 8-29.

- For review levels 1, 2, and 3, specify the number of checks per check category using either a predefined or custom methodology. See "Reviewing Checks at Levels 1, 2, and 3" on page 8-30.

Note For information on setting the quality levels for your project, see "Defining Software Quality Levels" on page 2-7.

After you configure a methodology, each developer uses the methodology to review verification results. This approach ensures that all users apply the same standards when reviewing orange checks at each stage of the development cycle.

For more information on defining a methodology, see "Reviewing Results Systematically" on page 8-28.

Performing Selective Orange Review

Once you have defined a methodology for your project, you can perform a *selective orange review*.

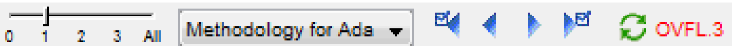
The number and type of orange checks you review is determined by your methodology and the quality level you are trying to achieve. As a project progresses, the quality level (and number of orange checks to review) generally increases.

For example, you may perform a review at level 0 and 1 in the early stages of development, to improve the quality of newly written code. Later, you may perform a level 2 review as part of unit testing.

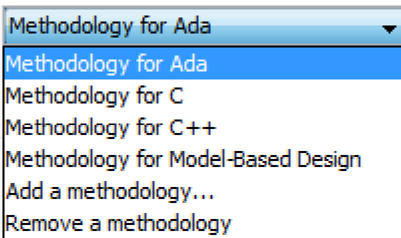
In general, the goal of a selective orange review is to find the maximum number of bugs in a short period of time. Many orange checks take only a few seconds to understand. Therefore, to maximize the number of bugs you can identify, you should focus on those checks you can understand quickly, spending no more than 5 minutes on each check. Leave checks that take longer to understand for later analysis.

To perform a selective orange review, for example, at level 1:

1 On the Run-Time Checks perspective toolbar, move the Review Level slider to **1**.

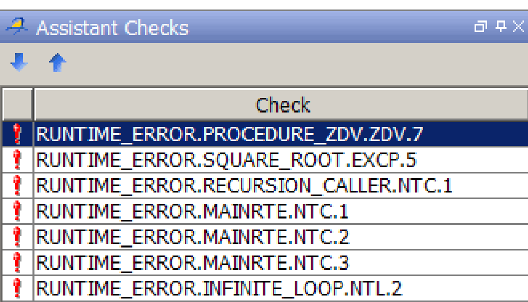


2 Select the methodology for your project from the methodology menu, for example, `Methodology for Ada`.



3 Click the forward arrow to select the first check to review.

The **Assistant Checks** tab shows the current check, and the **Source** pane displays the source code for this check.



4 Perform a quick code review on each orange check, spending no more than 5 minutes on each.

Your goal is to quickly identify whether the orange check is a:

- **potential bug** — Code that will fail in some circumstances.

- **inconclusive check** — A check that requires additional information to resolve, for example, the call sequence.
- **data set issue** — A theoretical set of data that is not encountered in practice.

See "Sources of Orange Checks" on page 9-6 for more information on each of these causes.

Note If an orange check is too complicated to explain quickly, it may be an inconclusive check caused by complex code structure, or the result of basic imprecision (approximation of the data set used for verification). These types of checks often take a substantial amount of time to understand.

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5. If you cannot identify a cause within 5 minutes, move on to the next check.

Note Your goal is to find the maximum number of bugs in a short period of time. Therefore, you want to identify the source of as many orange checks as possible, while leaving more complex situations for future analysis.

---

6. Once you understand the cause of an orange check, in the **Check Review** pane, enter information to document the results of your review. See "Reviewing and Commenting Checks" on page 8-48
7. Click the forward arrow to navigate to the next check, and repeat steps 5 to 6.
8. Continue to click the forward arrow until you have reviewed all of the checks identified on the **Assistant Checks** tab.
9. Select **File > Save** to save your review comments.

Importing Review Comments from Previous Verifications

Once you have reviewed verification results for a module and saved your comments, you can import those comments into subsequent verifications of the same module, allowing you to avoid reviewing the same check twice.

To import review comments from a previous verification:

1. Open your most recent verification results in the Run-Time Checks perspective.
2. Select **Review > Import > Import Comments**.
3. Navigate to the folder containing your previous results.
4. Select the results (.RTE) file. Then click **Open**.

   The review comments from the previous results are imported into the current results, and the Import checks and comments report opens.

Once you import checks and comments, the **go to next check** icon in assistant mode will skip any reviewed checks, allowing you to review only checks that you have not reviewed previously. If you want to view reviewed checks, click the **go to next reviewed check** icon.

Note If the code has changed since the previous verification, the imported comments may not be applicable to your current results. For example, the justification for an orange check may no longer be relevant to the current code. To see the changes that affect your review comments, open the Import/Export Report.

For more information, see "Importing and Exporting Review Comments" on page 8-54.

Performing an Exhaustive Orange Review

Up to 80% of orange checks can be resolved using multiple iterations of the process described in "Performing Selective Orange Review" on page 9-24. However, for extremely critical applications, you may want to resolve all orange checks. Exhaustive orange review is the process for resolving the remaining orange checks.

An exhaustive orange review is generally conducted later in the development process, during the unit testing or integration testing phase. The purpose of an exhaustive orange review is to analyze any orange checks that were not resolved during previous selective orange reviews, to identify potential bugs in those orange checks.

You must balance the time and cost of performing an exhaustive orange review against the potential cost of leaving a bug in the code. Depending on your quality objectives, you may or may not want to perform an exhaustive orange review.

Cost of Exhaustive Orange Review

During an exhaustive orange review, each orange check takes an average of 5 minutes to review. This means that 400 orange checks require about four days of code review, and 3,000 orange checks require about 25 days.

However, if you have already completed several iterations of selective orange review, the remaining orange checks are likely to be more complex than average, increasing the average time required to resolve them.

Exhaustive Orange Review Methodology

Performing an exhaustive orange review involves reviewing each orange check individually. As with selective orange review, your goal is to identify whether the orange check is a:

- **potential bug** – code which will fail under some circumstances.
- **inconclusive check** – a check that requires additional information to resolve, such as the call sequence.
- **data set issue** – a theoretical set of data that cannot actually occur.

- **Basic imprecision** – checks caused by imprecise approximation of the data set used for verification.

Note See "Sources of Orange Checks" on page 9-6 for more information on each of these causes.

Although you must review each check individually, there are some general guidelines to follow.

1. Start your review with the modules that have the highest selectivity in your application.

   If the verification finds only one or two orange checks in a module or function, these checks are probably not caused by either inconclusive verification or basic imprecision. Therefore, it is more likely that these orange checks contain actual bugs. In general, these types of orange checks can also be resolved more quickly.

2. Next, examine files that contain a large percentage of orange checks compared to the rest of the application. These files may highlight design issues.

   Often, when you examine modules containing the most orange checks, those checks will prove inconclusive. If the verification is unable to draw a conclusion, it often means the code is very complex, which can mean low robustness and quality. See "Inconclusive Verification" on page 9-6.

3. For all files you review, spend the first 10 minutes identifying checks that you can quickly categorize (such as potential bugs and data set issues), similar to what you do in a selective orange review.

   Even after performing a selective orange review, a significant number of checks can be resolved quickly. These checks are more likely than average to reflect actual bugs.

4. Spend the next 40 minutes of each hour tracking more complex bugs.

   If an orange check is too complicated to explain quickly, it may be an inconclusive check caused by complex code structure, or the result of basic

imprecision (approximation of the data set used for verification). These types of checks often take a substantial amount of time to understand. See “Sources of Orange Checks” on page 9-6.

5. Depending on the results of your review, correct the code or comment it to identify the source of the orange check.

Inconclusive Verification and Code Complexity

The most interesting type of inconclusive check occurs when verification reveals that the code is too complicated. In these cases, most orange checks in a file are related, and careful analysis identifies a single cause — perhaps a function or a variable modified many times. These situations often focus on functions or variables that have caused problems earlier in the development cycle.

For example, consider a variable *Computed_Speed*.

- *Computed_Speed* is first copied into a signed integer (between -2^31 and 2^31-1).
- *Computed_Speed* is then copied into an unsigned integer (between 0 and 2^31-1).
- *Computed_Speed* is next copied into a signed integer again.
- Finally, *Computed_Speed* is added to another variable.

The verification reports 20 orange overflows (OVFL).

This scenario does not cause a real bug, but the development team may know that this variable caused trouble during development and earlier testing phases. Polyspace verification also identified a problem, suggesting that the code is poorly designed.

Resolving Orange Checks Caused by Basic Imprecision

On rare occasions, a module may contain many orange checks caused by imprecise approximation of the data set used for verification. These checks are usually local to functions, so their impact on the project as a whole is limited.

In cases of basic imprecision, you may be able to resolve orange checks by increasing the precision level. If this does not resolve the orange check, however, verification cannot help directly.

In these cases, Polyspace software can only assist you through the call tree and dictionary. The code needs to be reviewed using alternate means. These alternate means may include:

- Additional unit tests
- Code review with the developer
- Checking an interpolation algorithm in a function
- Checking calibration data

For more information on basic imprecision, see "Basic Imprecision" on page 9-8.

Day to Day Use

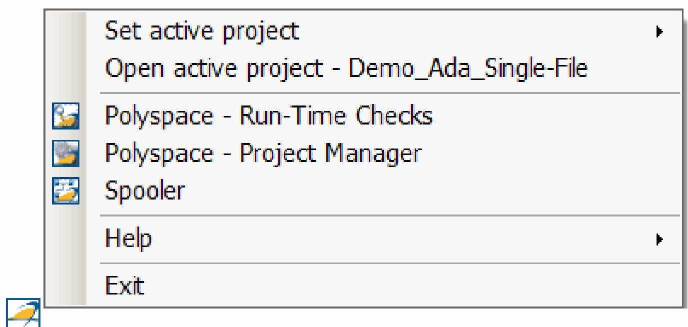
- "Polyspace In One Click Overview" on page 10-2
- "Using Polyspace In One Click" on page 10-3

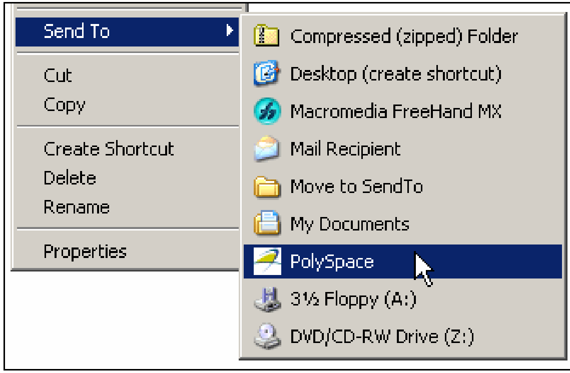
Polyspace In One Click Overview

Most developers verify the same files multiple times (writing new code, unit testing, integration), and usually need to run verifications on multiple project files using the same set of options. In a Microsoft Windows environment, Polyspace In One Click provides a convenient way to streamline your work when verifying several files using the same set of options.

Once you have set up a project file with the options you want, you designate that project as the *active project*, and then send the source files to Polyspace software for verification. You do not have to update the project with source file information.

On a Windows systems, the plug-in provides a Polyspace Toolbar in the Windows Taskbar, and a **Send To** option on the desktop pop-up menu:





Using Polyspace In One Click

In this section...

"Polyspace In One Click Workflow" on page 10-3

"Setting the Active Project" on page 10-3

"Launching Verification" on page 10-5

"Using the Taskbar Icon" on page 10-8

Polyspace In One Click Workflow

Using Polyspace In One Click involves two steps:

1. Setting the active project.

2. Sending files to Polyspace software for verification.

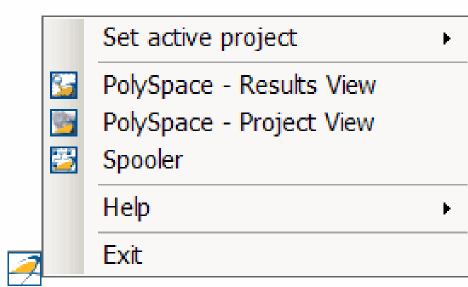
Setting the Active Project

The active project is the project that Polyspace In One Click uses to verify the files that you select. Once you have set an active project, it remains active until you change the active project. Polyspace software uses the analysis options from the project; it does not use the source files or results folder from the project.

To set the active project:

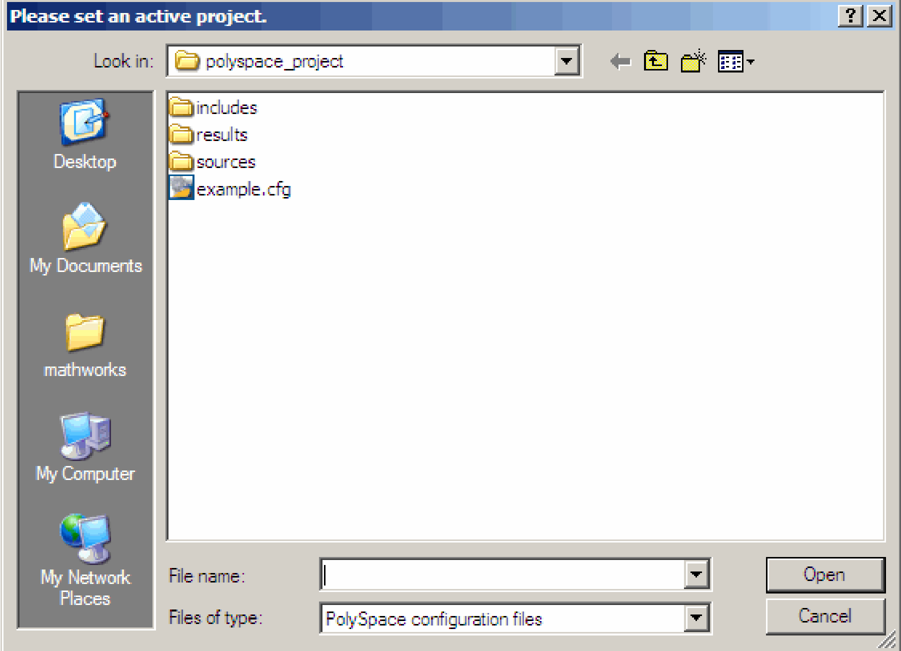
1. In the taskbar area of your Windows desktop, right-click the Polyspace In One Click icon :

   The context menu appears.



2 Select **Set active project > Browse** from the menu.

The **Please set an active project** dialog box opens.



3 Select the project you want to use as the active project.

4 Click **Open** to apply the changes and close the dialog box.

Launching Verification

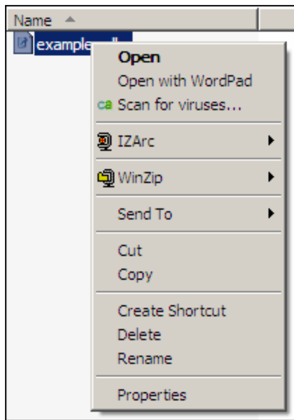
Polyspace in One Click allows you to send multiple files to Polyspace software for verification.

To send a file to Polyspace software for verification:

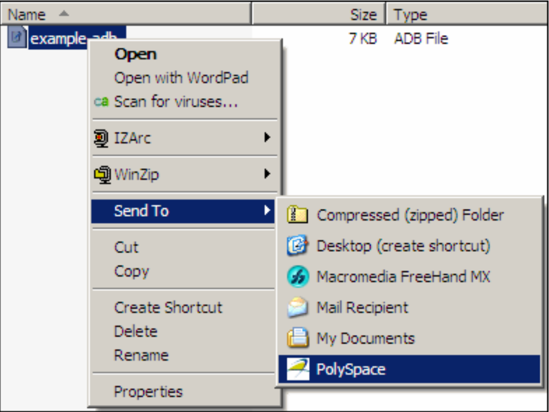
1 Navigate to the folder containing the source files you want to verify.

2 Right-click the file you want to verify.

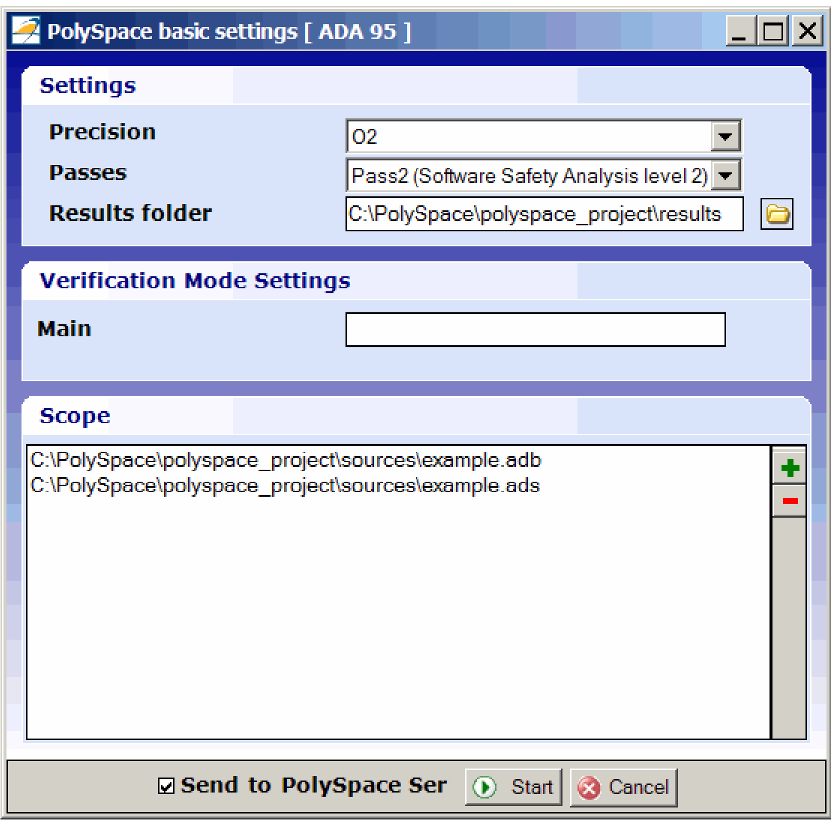
   The context menu appears.



3 Select **Send To > Polyspace**.



The Polyspace basic settings dialog box appears.



Note The options you specify in the Polyspace basic settings dialog box override any options set in the configuration file. These options are also preserved between verifications.

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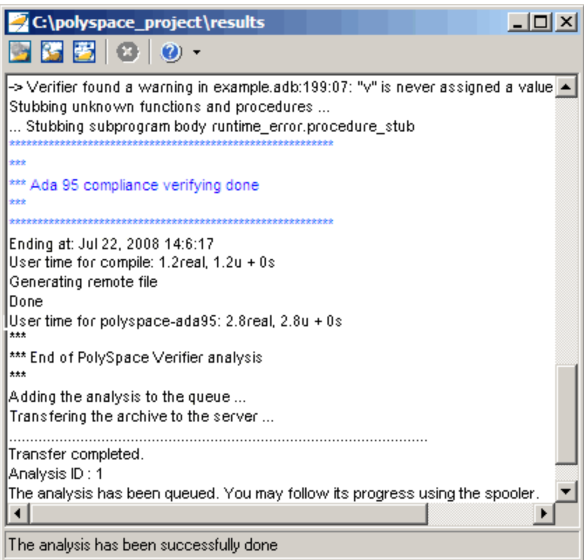
4 Enter the appropriate parameters for your verification.

5 Leave the default values for the other parameters.

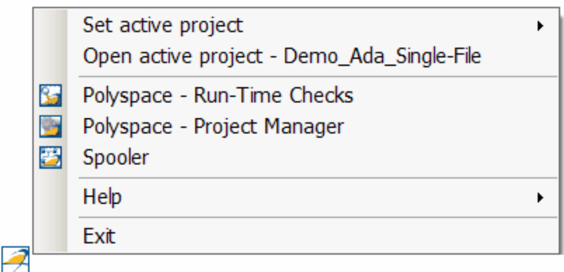
6 Click **Start**.

The verification starts and the verification log appears.



Using the Taskbar Icon

The Polyspace in One Click Taskbar icon allows you to access various software features.



Click the Polyspace Taskbar Icon. Then select one of the following options:

- **Set active project** — Allows you to set the active configuration file. Before you start, you have to choose a Polyspace configuration file which contains the common options. You can choose a template of a previous project and move it to your working folder.

A standard file browser allows you to choose the configuration file. If you have multiple configuration files, you can quickly switch between them using the browse history.

Note No configuration file is selected by default. You can create an empty file with a .cfg extension.

- **Open active project** — Opens the active configuration file. This allows you to update the project using the Polyspace verification environment Project Manager perspective. It allows you to specify all Polyspace common options, including directives of compilation, options, and paths of standard and specific headers. It does not affect the precision of a verification or the results folder.
- **Polyspace - Run-Time Checks** — Opens the Polyspace verification environment, Run-Time Checks perspective. This allows you to review verification results in the standard graphical interface.
- **Polyspace - Project Manager** — Opens the Polyspace verification environment, Project Manager perspective. This allows you to launch a verification using the standard Polyspace graphical interface.
- **Spooler** — Opens the Polyspace Queue Manager Interface. If you selected a server verification in the Polyspace Preferences dialog box, the spooler allows you to follow the status of the verification.

Software Quality with Polyspace Metrics

- “About Polyspace Metrics” on page 11-2
- “Setting Up Verification to Generate Metrics” on page 11-3
- “Accessing Polyspace Metrics” on page 11-10
- “What You Can Do with Polyspace Metrics” on page 11-13
- “Customizing Software Quality Objectives” on page 11-25
- “Tips for Administering Results Repository” on page 11-32

About 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 "Accessing Polyspace Metrics" on page 11-10.
- Observe trends over time, by project or module. See "Review Overall Progress" on page 11-13.
- Compare metrics of one project version with those of another. See "Compare Project Versions" on page 11-18.

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 appropriate comments. See "Review Run-Time Checks" on page 11-19.

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 11-23.

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 11-25.

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 Polyspace verification environment:

1. Select the Project Manager perspective.

2. In **Project Browser**, select the project that you want to verify.

3. In the **Configuration** view, under **Analysis options > General**, select the following check boxes:

   - **Send to Polyspace Server**
   - **Add to results repository**
   - **Calculate code metrics**

   For more information, see "Setting Up a Verification Project" and "Running a Verification".

To set up scheduled, automatic verification runs, see "Specifying Automatic Verification" on page 11-3.

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 there are 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 11-5.

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 appropriate template to create your `Projects.psproj` file.

For more information about the configuration file `polyspace.conf`, see "Manual Configuration of the Polyspace Server" in the *Polyspace Installation Guide*.

Element and Attribute Data for Projects.psproj

Project. Specify three attributes:

- `name`. Project name as it appears in Polyspace Metrics.
- `language`. Ada, or Ada95. Case insensitive.
- `verificationKind`. Mode, which is either Integration or Unit-by-Unit. Case insensitive.

For example,

```
<Project name="Demo_Ada" language="Ada" verificationKind="Integration">
```

The Project element also contains the following elements:

- "Options" on page 11-6
- "LaunchingPeriod" on page 11-6
- "Commands" on page 11-7
- "Users" on page 11-7

Options. Specify a list of all 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`. Any integer in the range 0–23.
- `minute`. Any integer in the range 0–59.
- `month`. Any integer in the range 1–12.
- `day`. Any integer in the range 1–31.
- `weekDay`. Any 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 11-7.

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 any of the following values:
    - `ALWAYS`. Default. Email sent at the end of each automatic verification (even if there are no 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...
"Monitoring Verification Progress" on page 11-11
"Web Browser Support" on page 11-12

To go to the Polyspace Metrics project index, in the address bar of your Web browser, enter the following URL:

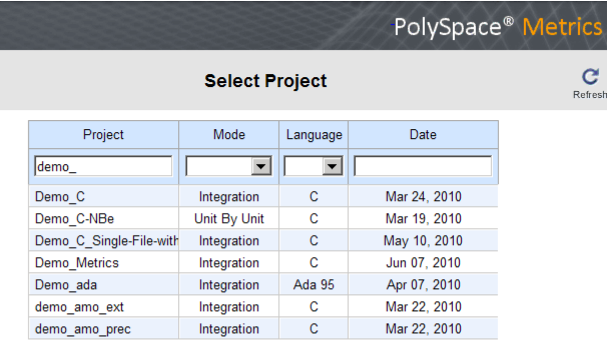
```
http:// ServerName: PortNumber
```

where

- *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)

See also "Configuring Polyspace Software" in the *Polyspace Installation Guide*.

The following graphic is an example of a project index.



You can save the project index page as a bookmark for future use. You can also save as bookmarks any Polyspace Metrics pages that you subsequently navigate to.

To refresh the page at any point, click .

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.

Monitoring Verification Progress

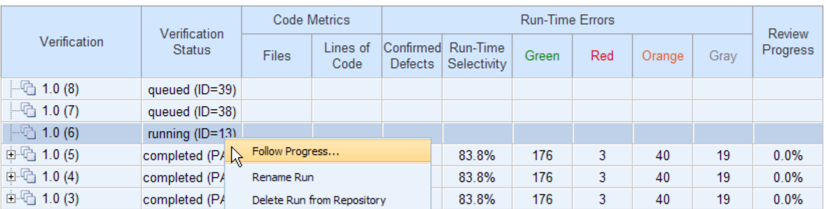
In the **Summary > Verification Status** column, Polyspace Metrics provides status information for each verification in the project. The status can be `queued`, `running`, or `completed`.

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 Queue Manager.

To open the Progress Monitor of the Polyspace Queue Manager:

1 In the **Summary > Verification Status** column, right-click the parent or unit cell with the status `running`.



2 From the context menu, select **Follow Progress**.

The Progress Monitor opens in the Polyspace verification environment.

For more information, see “Monitoring Progress Using Queue Manager” on page 6-10.

Web Browser Support

Polyspace Metrics supports the following Web browsers:

- Internet Explorer® 7, Internet Explorer 6
- Firefox®

Polyspace Metrics is optimized for Internet Explorer 7 and Firefox. Polyspace Metrics has also been tested — but not optimized — for Internet Explorer 6.

Note To use Polyspace Metrics, you must install on your computer Java™, version 1.4 or later.

What You Can Do with Polyspace Metrics

In this section...

"Review Overall Progress" on page 11-13
"Displaying Metrics for Single Project Version" on page 11-17
"Creating a File Module and Specifying Quality Level" on page 11-17
"Compare Project Versions" on page 11-18
"Review New Findings" on page 11-19
"Review Run-Time Checks" on page 11-19
"Fix Defects" on page 11-23
"Review Code Metrics" on page 11-24

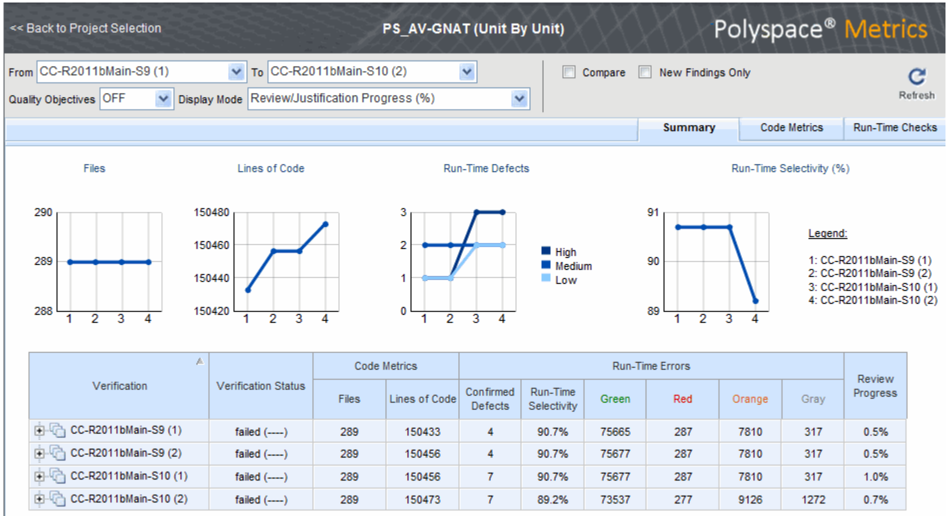
Review Overall Progress

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 "Accessing Polyspace Metrics" on page 11-10.

2. Click anywhere in the row that contains your project. You see the **Summary** view.



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

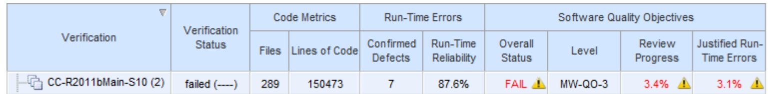
  If you have projects with two or more file modules in the Polyspace verification environment, by default, Polyspace Metrics displays verification results using the same module structure. However, Polyspace Metrics also allows you to create or delete file modules. See “Creating a File Module and Specifying Quality Level” on page 11-17.

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.



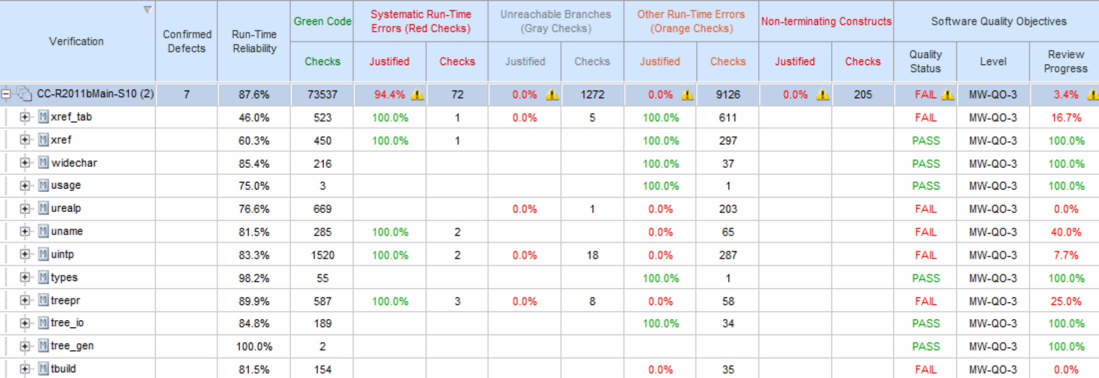
Verification	Verification Status	Code Metrics		Run-Time Errors		Software Quality Objectives			
		Files	Lines of Code	Confirmed Defects	Run-Time Reliability	Overall Status	Level	Review Progress	Justified Run-Time Errors
CC-R2011bMain-S10 (2)	failed (----)	289	150473	7	87.6%	FAIL	MW-QO-3	3.4%	3.1%

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 11-25.

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.

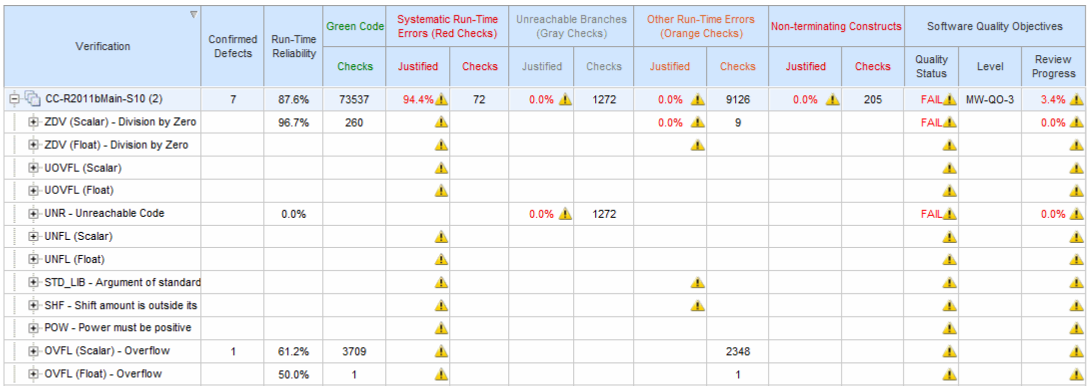


Verification	Confirmed Defects	Run-Time Reliability	Green Code	Systematic Run-Time Errors (Red Checks)		Unreachable Branches (Gray Checks)		Other Run-Time Errors (Orange Checks)		Non-terminating Constructs		Software Quality Objectives		
			Checks	Justified	Checks	Justified	Checks	Justified	Checks	Justified	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 any of these checks in the Polyspace verification environment, in the appropriate cell, click the numeric value for the check. The Polyspace verification environment opens with the Run-Time Check perspective displaying verification information for this check.

Note If you update any check information through the Polyspace verification environment (see "Review Run-Time Checks" on page 11-19), 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 a File Module and Specifying Quality Level

You can group files into a module and specify a quality level for the module, which 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:

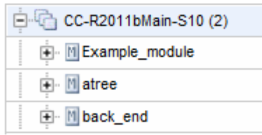
1. Select a tab, for example, **Summary**.

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.

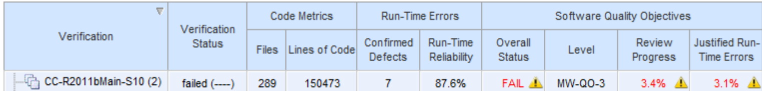
To manage the content of the bar charts, in the **# items** field, enter the maximum number of files for which you want information displayed. The software displays file defect information, ordering the files according to the number of defects in each file.

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.

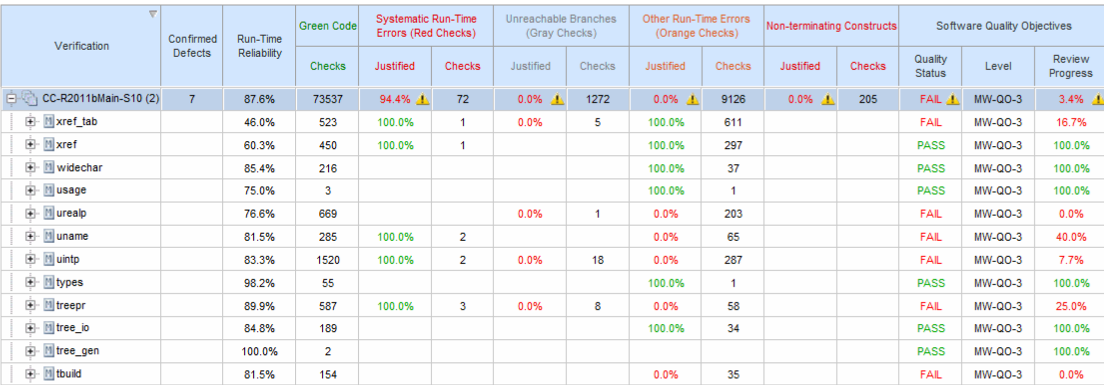
You may use the **Review Progress** metric in the **Summary** view to decide when your team of developers should start work on the next version of the software. For example, you may wait until the review is complete (**Review Progress** cell displays 100%), before informing your development team.

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 any cell value. This action takes you to the **Run-Time Checks** view.

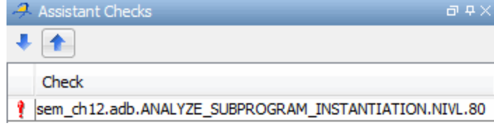


Verification	Confirmed Defects	Run-Time Reliability	Green Code	Systematic Run-Time Errors (Red Checks)		Unreachable Branches (Gray Checks)		Other Run-Time Errors (Orange Checks)		Non-terminating Constructs		Software Quality Objectives		
			Checks	Justified	Checks	Justified	Checks	Justified	Checks	Justified	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%

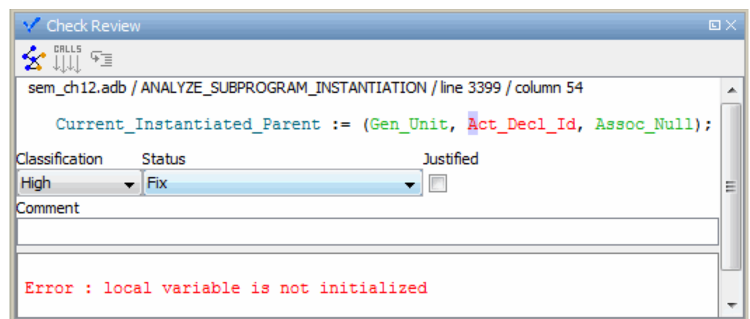
The **Review Progress** column reveals the progress level for each file. Expand`sem_ch12`.

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 Objecti		
			Checks	Justified	Checks	Justified	Checks	Justified	Checks	Justified	Checks	Quality Status	Level	R Pr
sem_ch12	1	94.0%	2843	80.0%	5	0.0%	107	0.0%	73		47	FAIL	MW-QO-3	[illegible]
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 Run-Time Checks perspective. You see the NIVL check in the **Assistant Checks** view.



To view details in **Check Review**, double-click the NIVL check.



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 11-22.

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 11-21.

If you want to save your comments and justifications to a local folder *and* the Polyspace Metrics repository, on the Run-Time Checks toolbar, click the button .

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 **Options > Preferences > Server configuration**.

2 Select the check box **Save justifications in the Polyspace Metrics database**.

Note In Polyspace Metrics, click Refresh to view updated information.

Fix Defects

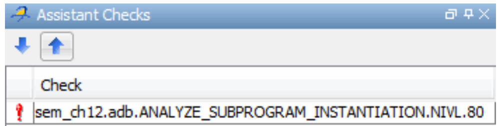
If you are a software developer, you can begin to fix defects in code when, for example:

- In the **Summary** view, **Review Progress** shows 100%
- Your quality assurance engineer informs you

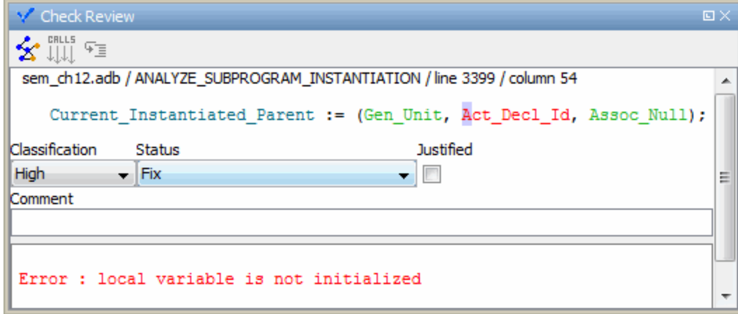
You can use Polyspace Metrics to access defects that you must fix.

Within the **Summary** view, under **Run-Time Errors**, click any 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. The Polyspace verification environment opens with the checks visible in **Assistant Checks**.



Double-click the row containing a check. In **Check Review**, 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 any 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" on page 11-25

"SQO Level 2" on page 11-26

"SQO Level 3" on page 11-26

"SQO Level 4" on page 11-27

"SQO Level 5" on page 11-27

"SQO Level 6" on page 11-27

"SQO Exhaustive" on page 11-28

"Run-Time Checks Set 1" on page 11-28

"Run-Time Checks Set 2" on page 11-29

"Run-Time Checks Set 3" on page 11-30

"Status Acronyms" on page 11-31

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 "Configuring Polyspace Server Software" 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 11-28.

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 11-29.

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 11-30.

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 11-28, 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 11-28, 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 11-19.

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 be `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" on page 11-32

"Through the Command Line" on page 11-33

"Backup of Results Repository" on page 11-35

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.

```
PolyspaceInstallCommon/RemoteLauncher/[w]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 or clicked **Automatically detect the remote server**. MathWorks does not recommend the latter. See "Configuring Polyspace Client Software" in the *Polyspace Installation Guide*.
  - *old_prog* — Current project name
  - *new_prog* — New project name
  - *old_version* — Old version name
  - *new_version* — New version name
  - `-f` — Specifies that no confirmation is 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 or clicked **Automatically detect the remote server**. MathWorks does not recommend the latter. See "Configuring Polyspace Client Software" in the *Polyspace Installation Guide*.
- *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 no confirmation is 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 "Configuring the Polyspace Server Software" in the *Polyspace Installation Guide*.

For example, on a UNIX 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

- "Verifying Code in the Eclipse IDE " on page 12-2
- "Creating an Eclipse Ada Project" on page 12-4
- "Setting Up Polyspace Verification with Eclipse Editor" on page 12-7
- "Launching Verification from Eclipse Editor" on page 12-9
- "Reviewing Verification Results from Eclipse Editor" on page 12-10
- "Using Polyspace Spooler" on page 12-11

Verifying Code in the Eclipse IDE

You can apply Polyspace software verification to 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.

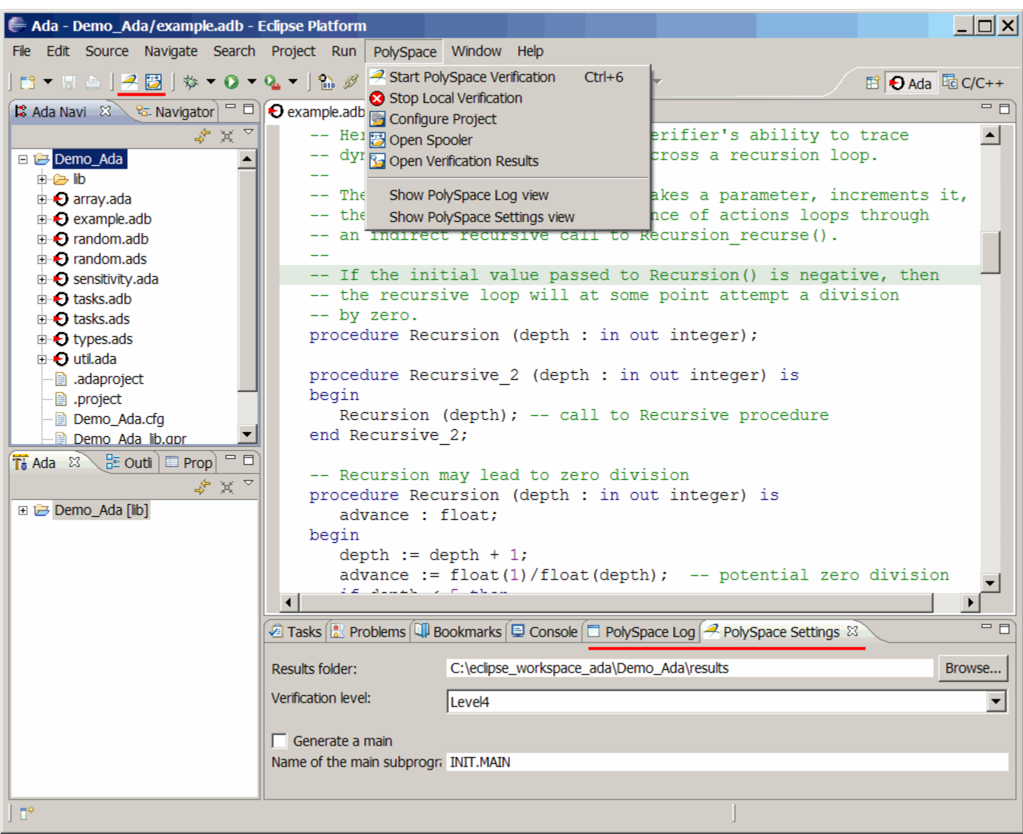
In addition to the Eclipse IDE, you must have:

- The Hibachi Ada plug-in. For information about downloading and installing the Eclipse IDE and Hibachi plug-in, go to www.eclipse.org.
- 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/.

Before you verify code, install the Polyspace plug-in for Eclipse IDE. See “Polyspace Plug-In Requirements” in the *Polyspace Installation Guide*.

Once you install the Polyspace plug-in, in the Eclipse editor, you have access to:

- A **Polyspace** menu
- Toolbar buttons to launch a verification and open thePolyspace spooler
- **Polyspace Log** and **Polyspace Setting** views


Ada - Demo_Ada/example.adb - Eclipse Platform
File Edit Source Navigate Search Project Run PolySpace Window Help
Start PolySpace Verification Ctrl+6
Stop Local Verification
Configure Project
Open Spooler
Open Verification Results
Show PolySpace Log view
Show PolySpace Settings view
Ada
C/C++
Ada Navi
Navigator
Demo_Ada
lib
array.ada
example.adb
random.adb
random.ads
sensitivity.ada
tasks.adb
tasks.ads
types.ads
util.ada
.adaproject
.project
Demo_Ada.cfg
Ada
Outli
Prop
Demo_Ada [lib]
example.adb
-- 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;
-- Recursion may lead to zero division
procedure Recursion (depth : in out integer) is
advance : float;
begin
depth := depth + 1;
advance := float(1)/float(depth); -- potential zero division
Tasks
Problems
Bookmarks
Console
PolySpace Log
PolySpace Settings
Results folder:
C:\eclipse_workspace_ada\Demo_Ada\results
Browse...
Verification level:
Level4
Generate a main
Name of the main subprogr
INIT.MAIN

Creating an Eclipse Ada Project

In this section...

"Creating a New Project" on page 12-4

"Adding Source Files" on page 12-6

Creating a New Project

If your source files do not belong to an Eclipse project, then create a project using the Eclipse 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`. Although Eclipse allows you to create a `General Project` for any type of source file, if you use `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 Eclipse project.

Adding 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.

Setting Up Polyspace Verification with Eclipse Editor

In this section...
"Analysis Options" on page 12-7
"Other Settings" on page 12-7

Analysis Options

You can specify analysis options for your verification using **Configure Project** from the Polyspace drop-down list:

1. Using **Ada Navigator**, select the project or files that you want to verify.
2. Select **Polyspace > Configure Project**, which opens the Polyspace Launcher for Ada95 dialog box.
3. Select your analysis options.
4. Save your options, and close the dialog box.

For information on how to choose your options, see "Option Descriptions" in the *Polyspace Products for Ada Reference Guide*.

Other Settings

In the Polyspace Settings view, specify:

- In the **Results folder** field, the location of your results folder, for example, `C:\eclipse_workspace_ada\Demo_Ada\results`.
- The required **Verification level**, for example, `Level4`.

In the **Polyspace Settings** view, you can also do one of the following:

- Select the **Generate a main** check box to automatically generate a main procedure.
- In the **Name of the main subprogram** field, specify the path to the main procedure that you manually created.

For more information on generating a main procedure either automatically or manually, see “Verifying an Application Without a Main” on page 4-6 in the *Polyspace Products for Ada User Guide*.

Launching Verification from Eclipse Editor

To launch a Polyspace verification from the Eclipse editor:

1 Select the files that you want to verify.

2 Either right-click and select **Start Polyspace Verification**, or select **Polyspace > Start Polyspace Verification**.

In the **Polyspace Log** view, you can follow the progress of the verification. If you see an error or warning, you can double-click it to go to the corresponding location in the source code.

For more information, see "Monitoring the Progress of the Verification" on page 6-24 and Chapter 7, "Troubleshooting Verification" in the *Polyspace Products for Ada User Guide*.

Reviewing Verification Results from Eclipse Editor

Use the Run-Time Checks perspective of the Polyspace verification environment to examine results of the verification:

1. Select **Polyspace > Open Verification Results** to open the Run-Time Checks perspective.

2. Select **File > Open**. The Please select a file dialog box opens.

3. Select the results file that you want to view, and click **Open**. You see the results in the Run-Time Checks perspective.

For information on reviewing and understanding Polyspace verification results, see Chapter 8, "Reviewing Verification Results" in the *Polyspace Products for Ada User Guide*.

Using Polyspace Spooler

Use the Polyspace spooler to manage jobs running on remote servers. To open the spooler, select **Polyspace > Open Spooler** .

For more information, see "Managing Verification Jobs Using Polyspace Queue Manager" on page 6-8 in the *Polyspace Products for Ada User Guide*.

Glossary

Atomic

In computer programming, the adjective *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 of the pieces are committed or none are.

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 under all circumstances 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.

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