

- ❖ Automatically detect and document source code changes.
- ❖ Create tool-driven test vectors.
- ❖ Run tests on host, compiler, target and simulator.
- ❖ Automatically generate test case documentation including pass/fail and regression analysis reports.

3.3. Test case files and test case management and storage

TBrun stores groups of test cases as strings. User can search sequence and test case by & # 40; TCF) contains all the information needed to run the test case again. TCFs can be packaged and stored with regression reports for regression testing, stored with source files through a Software Configuration Management (SCM) system, or can be used to store requirement-based test data storage, including selected specific values, and requirements management. Can be used as a resource. System input variables are available for additional storage. As an SCM file, administrators can see developers test code directly from their SCM system. TCF can also be rerun in batch mode from the command line to modify the source code and check the module interface and output. For companies engaged in outsourced development management, TCF files are easily distributed and provide a standard template worldwide.

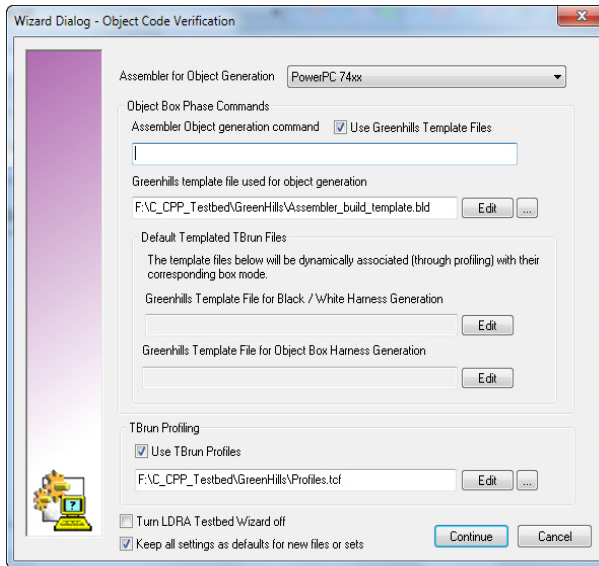


Fig. 3. Object Code Verification wizard

3.4. Assembly Level Coverage/Object Code Verification

TBrun can be used with the LDRA Toolkit Object Code Review feature to provide and apply test cases that ensure complete coverage of code at the assembly level. This feature is commonly used for safety-critical development requirements such as the DO-178B/C to add MC/DC coverage and support operations such as source code to object code mapping. These features enable comprehensive analysis and identification of codes of complex logical conditions.

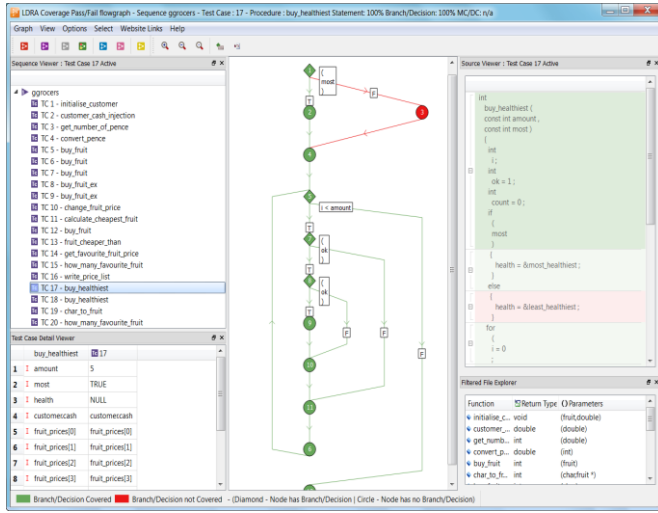


Fig. 4. Test Case flow graph

	Percentage	Success
<ul style="list-style-type: none"> Tenpercentoff.cpp <ul style="list-style-type: none"> Combined Coverage Run: Failed Statement Coverage: 99 Branch/Decision Coverage: 94 Modified Condition / Decision Coverage: 50 main <ul style="list-style-type: none"> Combined Coverage Run: Passed Statement Coverage: 100 Branch/Decision Coverage: 100 Modified Condition / Decision Coverage: 100 TenPercentOff <ul style="list-style-type: none"> Combined Coverage Run: Failed Statement Coverage: 100 Branch/Decision Coverage: 100 Modified Condition / Decision Coverage: 67 		

Fig. 5. Test Coverage view

3.5. Structural Coverage Analysis

TBrun has access to the full range of range indicators available in the LDRA Toolbox. This includes procedural appeals, statements, separations/decisions, and MC/DCs. The user can select an appropriate metric or set of metrics based on security and programmatic limitations. For example, MC/DC coverage is needed to ensure results are not obscured by input conditions, and coverage provides a comprehensive metric for evaluating loops. All of these metrics are available as graphs through TBrun's Flowchart Viewer, Call Graph Viewer, and File View/GUI. Users have direct access to compliance reports that provide overall pass/fail metrics for standards such as DO-178B/C. The line-by-line view shows statements, branches, and controls that have executed and also appear in these reports.

3.6. Software Errors

- There are two types of errors that can be found:
 - Technical errors – These are due to language and programming and can be found by performing static analysis
 - Application errors – These are due to the code not implementing correctly the requirements – These can only be found by performing dynamic analysis on the actual hardware and measuring structure coverage.

3.7. Control flow Analysis

Control Flow Analysis - software correctness through logical control diagrams. Examine your logic flow to identify missing, incomplete, or incorrect requirements. Validate that the flow of control between functions is the correct solution to the problem.

3.8. Data flow Analysis

- Use of data flow diagrams
- Flow balancing
- Compare output data and subsequent input and derived data from each process to ensure data is available when its required
- Confirmation of derived data
- Involves examining derived data within a process for correctness and format
- Compares the data keys used to retrieve data from the in-process data stores to the database index design to ensure that invalid keys are not used and uniqueness properties are consistent.

4. Tool Qualification

- The purpose of the tool qualification process is to gain confidence in the functionality of the tool.
- LDRA's tool qualification packages are tailored per standard and software integrity level.

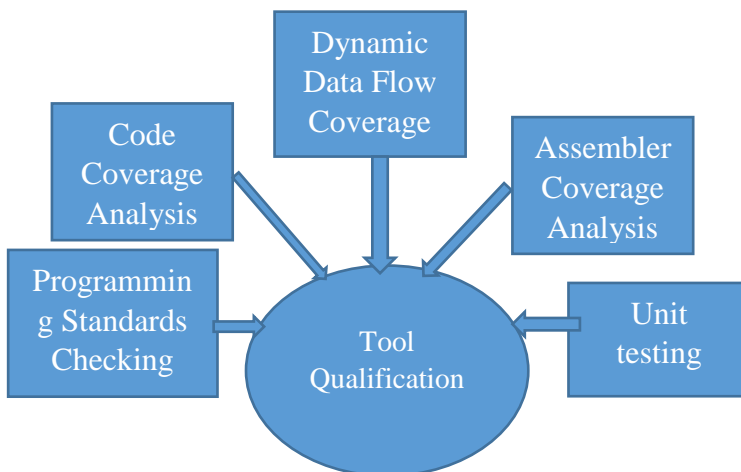


Fig. 6. Tool Qualification flowchart

5. Stepping Up to the DO-178C Certification Challenge

The objectives of the software verification process are defined in the DO-178C standard. As explained, testing approaches are considered at three levels. Standard DO-178C: low level test, software integration test and hardware/software integration test. Low level testing: Low level testing is used to test low level requirements and is usually done with a set of unit tests that isolate a single unit of source code. Vector CAST is used in this testing phase. Software integration testing: Software integration testing verifies the interrelationships of components. This level of testing is performed using Vector CAST to simultaneously test multiple software components under test. To support this type of testing, a complete test framework is automatically generated to map software requirements to specific test cases, ensuring that all requirements are tested. Hardware/Software Integration Testing: Hardware/Software Integration Testing is the process of testing a computer software component (CSC) for high-level functionality in a target hardware environment. The purpose of hardware/software integration testing is to test the behavior of software integration developed on hardware components.

6. LDRA test reviews provide the following coverage metrics

- ❖ Description
- ❖ Decision /Enactment
- ❖ Function/ Procedure call
- ❖ Branch decision coverage
- ❖ Combining branching conditions
- ❖ Modified Condition / Decision Coverage (MC/DC for DO-178B/C Level A)
- ❖ Dynamic data flow

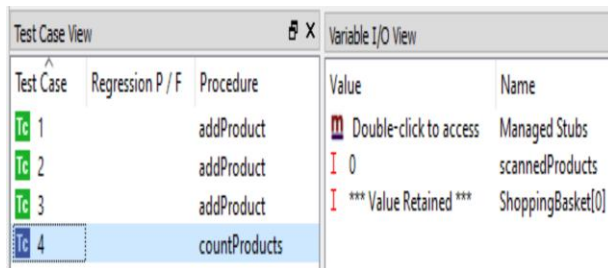
6.1. LDRA Tool Suite Facilitates Design and Customer Collaboration

- Traceability of software changes. It identifies and tracks critical source code changes, enabling project teams to closely monitor the impact of these changes on testing processes and code analysis.
- Detect changes in lifecycle assets such as requirements, design and code to assess impact and optimize regression testing and resolution of suspicious links.
- Unit/module test recognition, validation and regression.

"When we work with multi-billion-dollar aerospace companies that also use LDRA tools, it's much easier to collaborate," "For example, we're working on the design of a toolkit. We centralize data remotely with large avionics and can easily push data to our teams. This is not an unusual way of working, but the more you can collaborate the more you can collaborate., the easier it will be for you to efficiently complete your design and meet certification requirements.

6.2. Unit Testing

Unit test tools are used by developers to test and retrieve the application source code.



Test Case View			Variable I/O View	
Test Case	Regression P / F	Procedure	Value	Name
TC 1		addProduct	Double-click to access	Managed Stubs
TC 2		addProduct	0	scannedProducts
TC 3		addProduct	*** Value Retained ***	ShoppingBasket(0)
TC 4		countProducts		

Fig. 7. Test Case Input / Output view

We should get Coverage as shown:

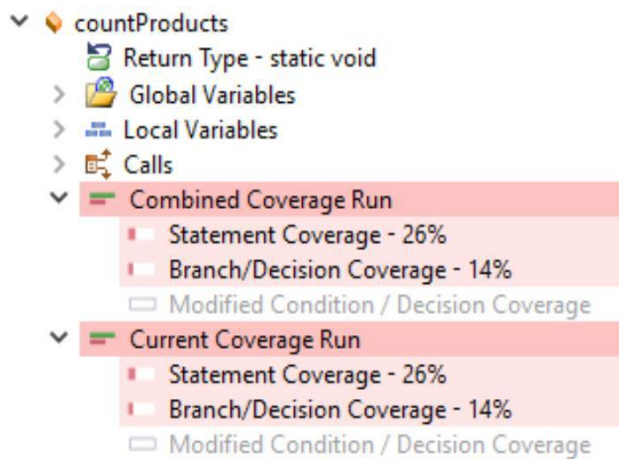


Fig. 8. Test run Coverage

6.3. Flow Graphs

A flowchart is a graphical representation of logic executed with zero or more filters (input parameters) to obtain an output.

"A signal flow graph is a network of nodes (or points) connected by directed edges that represent a set of linear algebraic equations.

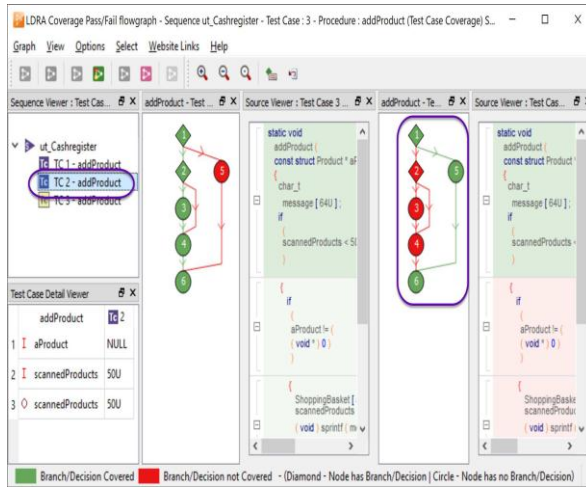


Fig. 9. Code Flow graph

6.4. LDRA testing

The test is not included in the project as there is no resource to any of the equipment. However, to successfully conduct the test, the following things should be considered during the design process.

1. Define the Program
2. Define the Objectives of the Test.
3. Define the requirement of the test (assets, equipment, instruments, data, etc.).
4. Provide test cases to cover most operating conditions.

In the test process, an Exhaustive testing is not practical as the system complicity is beyond the practice of exhaustive attempt. However, the specific exhaustive test may be conducted using all combinations of: data state; data bus state; signal value; pilot input; aircraft response. It is impossible to test, but a series feasible way is developed.

For the hardware life-cycle, an accelerated testing is suggested, as it proves the MTBF for the systems, which did not specify the MTBF from the suppliers. The accelerated test may involve following test methods.

1. Thermal loads, to accelerate the life cycle of semiconductors
2. Chemical loads, to simulate salty, humidity and acid corrosion
3. Electrical loads, from voltages and currents
4. Mechanical loads, including vibrations, shocks and mechanical load cycles

6.5. LDRA rules

LDRA rules is a cost-effective, standalone rule checker that requires no investment in a full toolchain. LDRA rules incorporate next-generation reporting capabilities for code quality metrics, error detection, and avoidance. Users can quickly and easily visualize results in call graphs, flowcharts, and code review reports in an intuitive, easy-to-read format, improving collaboration and communication among all team members in the development team. LDRA rules continues to improve automated code testing and analysis tools for very

complex and safety-critical markets common in industrial sectors such as aerospace, automotive, energy, industrial control, medical, military and transportation. The LDRA Toolkit is a fully integrated solution that enables customers to build quality for their software from requirements through deployment.

7. Verification and Validation

Verification: Inspect and test the product with all expected functionality and performance. Detailed verification must be performed using the list of requirements. A set of tools, e.g. IBM DOORS, IBM LDRA, RTRT can assist in the verification process. **Validation:** Test the product to ensure that it meets the design intent and functions correctly according to the requirements collected during the requirements capture phase. The results of the COTS screening and system security assessment have satisfied the requirements of customers and other system designers. The first print system confirmation is confirmed. However, the detailed system specifications could not be confirmed due to time constraints.

8. Target markets and applications in T2080 into an Avionics Architecture

The T2080 and T2081 processors are intended for mid-range drones or mixed data flight applications. A highly efficient 8-core virtual appliance achieves 1.8 GHz while maintaining a short 7-stage pipeline for better latency response to unpredictable control plane code branches. Advanced virtualization technology facilitates secure data plane partitioning in instrumentation and control applications.

- **Enterprise Equipment:** Ethernet Modular Switches, Service Cards, UTM Devices, Enterprise Storage, Data Center
- **Service Providers:** Core and Edge Routers, Tape Access Broadband, Metro Ethernet, Optical Network
- **Wireless infrastructure:** mobile backhaul, network card, channel card, LTE controller card, WCDMA, GSM, WiMAX
- **Aviation and defense:** Hard or high security routers, avionics networks, control panels, military SBCs
- **Industrial computer:** SBC, industrial automation, test and measurement

9. Conclusion

- ❖ Potential for software errors increases in proportion to software complexity. Best-practice development techniques help to limit them. These include the application of a state-of-the-art coding standard such as MISRA C: 2012, measuring metrics on the code, tracing requirements, and implementing requirements-based testing.

- ❖ The Testing helps to compliance and conformance with standards including DO-178B/C, DO-331, ISO 26262, IEC 61508, IEC 62304, EN 50128, and SAE J3061, ARP 4754A, and Future Airborne Capability Environment (FACETM).
- ❖ In source code Beamer ALM and LDRA's solutions combine to create a powerful tool in the development and test verification of critical software systems. Whether adhering to the V-model process or deploying an Agile, Spiral, Waterfall or Devops software development approach.
- ❖ The standard recommends these practices because experience has shown that they are the most effective ways to achieve high quality, reliable, and robust software. And whether or not a product is critical to safety is certainly a result that benefits all parties involved.

9.1. Summary of Standalone Products

- ❖ Don't have to invest in a complete tool chain. LDRA unit, LDRA rules, and LDRA cover are part of a family of certification technologies emerging from LDRA's 40 years of experience in helping customers achieve certification readiness. These tools support certification objectives at all levels of design assurance:
- ❖ LDRA unit supports automated test generation and management with sophisticated analysis that helps developers to eliminate manual scripting and minimize overall test effort. LDRA unit auto-generates test-case documentation, including pass/ fail and regression analysis reports, and simplifies the viewing of statement coverage, branch coverage, and MC/DC coverage results.
- ❖ LDRA rules offers standards-based rule checking that confirms adherence to company and industry coding standards. With the help of call graphs, flow graphs, and code review reports, the tool clearly demonstrates code quality, fault detection, and security vulnerabilities.
- ❖ LDRA coverage provides a test plan document that demonstrates the completeness of application testing and helps developers achieve the desired level of coverage. This ranges from procedure and function calls to safety-critical MC/DC coverage.

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