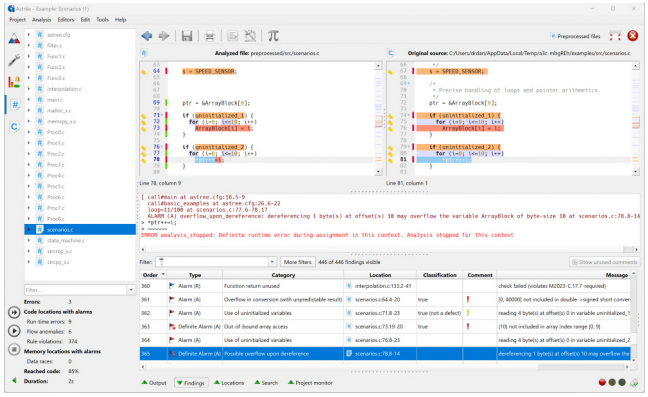
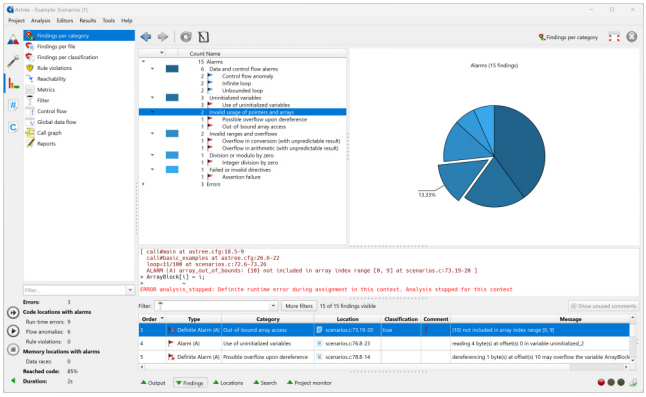
Astrée

Finding all Runtime Errors and Data Races in C/C++ Programs

Astrée is a sound static analyzer designed to **prove the absence of runtime errors and data races** in software programs written in C/C++. Astrée is **parameterizable** and can be **specialized** to the program under analysis – key features to enable **high analysis precision**.





Runtime errors and data races can provoke erroneous program behavior and may even cause the software to crash. They belong to the most dangerous **safety defects** and **cybersecurity vulnerabilities**. Static analysis based on Abstract Interpretation can be used to **prove the absence** of runtime errors and data races. Minimizing the number of false alarms enables an **efficient verification process**.

Examples for Errors detected by Astrée:

- Out-of-bound array accesses
- Erroneous pointer manipulations and dereferencing (NULL, uninitialized, dangling, misaligned, … pointers)
- Divisions by zero and arithmetic overflows
- Read accesses to uninitialized variables
- Pure virtual function calls, invalid `this` pointers
- Memory leaks
- Data races, inconsistent locking, and deadlocks

Additional Features:

- Identify unreachable code
- Detect non-terminating loops
- Find SPECTRE vulnerabilities
- Prove functional properties by static assertions
- User-configurable taint analysis
- Compute inter- and intra-thread control flow graph
- Generate inter- and intra-thread data flow reports
- Software component dependence analysis

Astrée Use Cases:

- **Runtime error analysis** to detect safety and cybersecurity defects at **software component and integration level**
- Report violations of **coding guidelines** to prevent potential safety and security risks
- Demonstrate **freedom of interference** between software components at source code level
- **Signal flow analysis** to prove independence of output signals from input signals
- Contribute to **functional verification** and verify software contracts
- Verify **data and control flow**, enable **data and control coupling** analysis

Benefits:

- Satisfy verification objectives of **functional safety**: DO-178C, ISO 26262, IEC 61508…
- Satisfy verification objectives of **cybersecurity**: ISO 21434, ISO/IEC 15408, …
- Demonstrate compliance to **coding guidelines**: MISRA C/C++, CERT C/C++, CWE, …
- Demonstrate **memory safety** at source code level
- **No missed defects**
- **Minimal false positives**
- Full **CI/CD** support
- Automatic **tool qualification**

Astrée is developed and distributed by AbsInt, under license from the CNRS/ENS. It has been successfully used on safety-critical and security-relevant software from various industry sectors, including aerospace, automotive, medical products, and nuclear energy.

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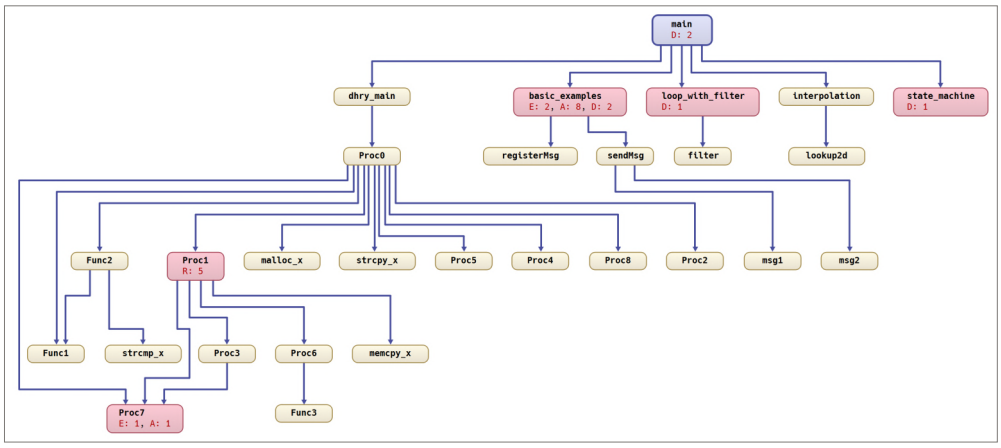

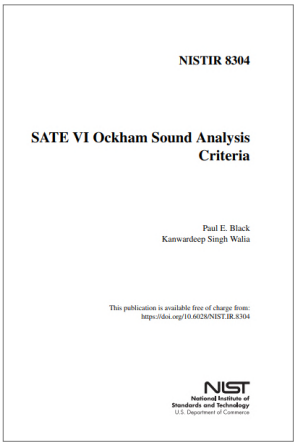
NISTIR 8304

SATE VI Ockham Sound Analysis Criteria

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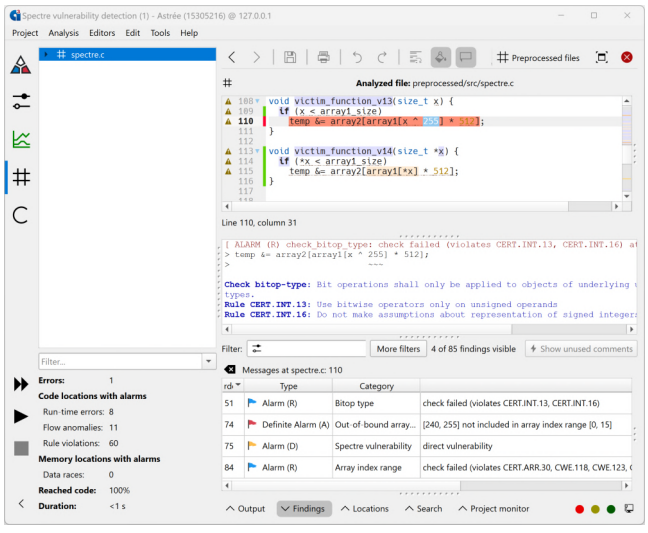
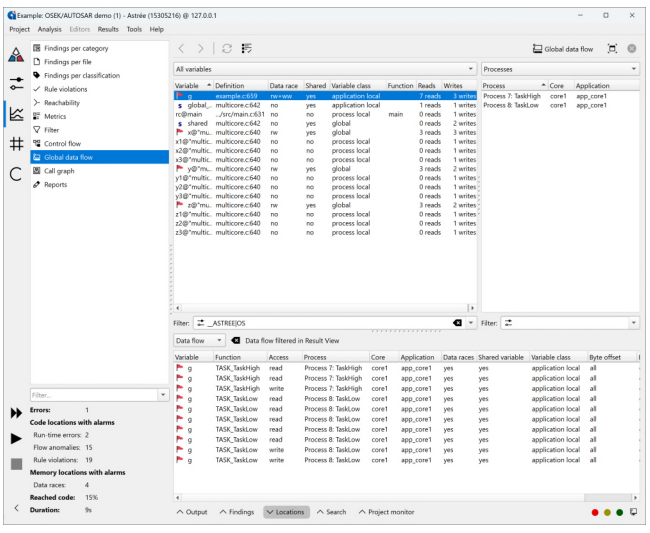
This publication is available free of charge from:
https://doi.org/10.6028/NIST.IR.8304

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

Key Features of Astrée:

- Astrée is **sound**:
  - If the analysis does not detect any runtime errors and data races, their absence has been proven.
  - All possible targets of data and function pointers are taken into account.
  - All possible thread interleavings are considered.
  - Control and data coverage is 100%.
- Astrée is **precise**: Its state-of-the-art analysis engine enables very low false alarm rates.
- **Zero alarm goal**: False alarms can be safely eliminated by tuning the precision to the software under analysis.
- Astrée is **scalable**: Projects with more than 10 million lines of code have successfully been analyzed.
- Astrée features a **sound taint analysis**, capable of demonstrating **freedom of interference.**
- Astrée can be seamlessly integrated in **CI/CD** and **DevOps** environments.
- Astrée is **cloud-ready**: Network connections between Astrée servers and clients are **TLS**-encrypted.
- External user authentication via **OAuth 2.0** / **OIDC** is supported.
- OS-aware analysis of **ARINC 653**, **OSEK**, and **AUTOSAR** projects.
- Automatic setup of AUTOSAR integration analyses from **arxml** files.
- Interactive **visualizations** of call graph, signal flow paths, and C++ class graphs.
- Intuitive **source code navigation** and powerful **interactive result exploration**.
- Supported **coding guidelines** include MISRA C:2004, MISRA C:2012, MISRA C:2023, MISRA C++:2008, MISRA C++:2023, Adaptive AUTOSAR C++ Coding Guidelines, Common Weakness Enumeration CWE, SEI CERT C/C++ Coding Standard, ISO/IEC 17961:2012 C Secure.
- Astrée's Qualification Support Kit enables automatic **tool qualification** up to the highest criticality levels, according to DO-178C, ISO 26262, IEC 61508, and other safety norms.
- **Plugins** for dSPACE TargetLink, Jenkins, Eclipse, µVision are available.
- Astrée satisfies the NIST SATE VI Ockham Sound Analysis Criteria with **market-leading** score.





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