Establishing Coding Requirements for Non-Safety Critical C++ Systems

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October 25, 2016

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DM-0004094
Problem Statement and Focus

Writing secure C++ code is hard, existing coding standards are insufficient

MISRA C++:2008 and JSF++ (2005) focus on safety-critical systems; outdated
  • CERT rules focus on modern concerns: C++11 and C++14.
    - Concurrency, lambdas, and other modern, high-impact C++ features
C++ Core Guidelines (2015) are modern, but subset the language; e.g.,
  - ES.75: Avoid do statements
  - I.11: Never transfer ownership by a raw pointer (T*)
  • CERT rules do not subset the C++ language
    - Encourages adoption within legacy code bases as well as new

Enforceability of the rules is desirable.
  • Demonstrate implementing checkers to help strengthen and enforce rules
Do not replicate rules from the CERT C Coding Standard
Our Results: Checkers

Contributed 15 new checkers to the Clang open source compiler (the C/C++ frontend to the LLVM compiler infrastructure)

Clang community has shown significant interest in CERT's contributions
• Community members are making their own contributions based on our rules
• Demonstrated a desire to make it easier to enable all checks for CERT rules

Clang is used by 10s of millions of programmers to write 100s of millions of apps that are used by billions of users
• Primary compiler for MacOS, iOS, FreeBSD
• Supported by Microsoft Visual Studio, Linux
Our Results: Rules

1. Declarations and Initialization (DCL)
2. Expressions (EXP)
3. Integers (INT)
4. Containers (CTR)
5. Characters and Strings (STR)
6. Memory Management (MEM)
7. Input Output (FIO)
8. Exceptions and Error Handling (ERR)
9. Object Oriented Programming (OOP)
10. Concurrency (CON)
11. Miscellaneous (MSC)

All rules were heavily modified
Our Results: Rule Organization

DCL22-CPP. Functions declared with [[noreturn]] must return void

As described in MSC55-CPP. Do not return from a function declared [[noreturn]], functions declared with the [[noreturn]] attribute must not return on any code path. If a function declared with the [[noreturn]] attribute has a non-void return value, it implies that the function returns a value to the caller even though it would result in undefined behavior. Therefore, functions declared with [[noreturn]] must also be declared as returning void.
Noncompliant Code Example

In this noncompliant code example, the function declared with [[noreturn]] claims to return an int:

```c++
#include <cstdlib>

[[noreturn]] int f() {
  std::exit(0);
  return 0;
}
```

This example does not violate MSC55-CPP. Do not return from a function declared [[noreturn]] because std::exit() is declared [[noreturn]], so the return 0; statement can never be executed.

Compliant Solution

Because the function is declared [[noreturn]], and no code paths in the function allow for a return in order to comply with MSC55-CPP. Do not return from a function declared [[noreturn]], the compliant solution declares the function as returning void and elides the explicit return statement:

```c++
#include <cstdlib>

[[noreturn]] void f() {
  std::exit(0);
}
```
Risk Assessment

A function declared with a non-void return type and declared with the [[noret]] attribute is confusing to consumers of the function because the two declarations are conflicting. In turn, it can result in misuse of the API by the consumer or can indicate an implementation bug by the producer.

<table>
<thead>
<tr>
<th>Rule</th>
<th>Severity</th>
<th>Likelihood</th>
<th>Remediation Cost</th>
<th>Priority</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCL22-CPP</td>
<td>Low</td>
<td>Unlikely</td>
<td>Low</td>
<td>P3</td>
<td>L3</td>
</tr>
</tbody>
</table>

Automated Detection

<table>
<thead>
<tr>
<th>Tool</th>
<th>Version</th>
<th>Checker</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clang</td>
<td>3.9</td>
<td>-Winvalid-noret</td>
<td></td>
</tr>
</tbody>
</table>
Related Vulnerabilities

Search for vulnerabilities resulting from the violation of this rule on the CERT website.

Related Guidelines

| SEI CERT C++ Coding Standard | MSC54-CPP. Value-returning functions must return a value from all exit paths MSC55-CPP. Do not return from a function declared [[noreturn]] |

Bibliography

Our Process

- ISO WG21 (C++ Standards Committee)
- ISO C++14 Standard
- C++ Books
- MITRE CVEs
- CERT Vulnerability Database
THE END