bugSeng Online Professional Training

Effective MISRA C++

A professional training course delivered by BUGSENG on MISRA C++:2023, the latest version of the MISRA C standard, which includes guidelines for safety and security supporting all published versions of the C++ standard.

The course has been designed for the smooth and successful adoption of MISRA C++ into an organization. Lectures, exercises, tests, hands-on sessions and, optionally, a final exam, will significantly strengthen the skills and competences of teams involved in the design, development and verification of critical embedded software systems.

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The C++ programming language is one of the most widely used across industry, even in safety, security and mission critical contexts. Several features of C++ that proved to be crucial for the success of the language in terms of efficiency and portability, are in sharp conflict with both safety and security requirements.

Hence, the development of critical applications requires language subsetting: this is mandated or recommended by all safety- and security-related industrial standards, such as **IEC 61508** (industrial), **ISO 26262** (automotive), **ISO 25119** (tractors and machinery for agriculture and forestry), **CENELEC EN 50128/50657/50716** (railways), **RTCA DO-178B/C** (aerospace) and **FDA's *General Principles of Software Validation***.

The most authoritative language subset for the C++ programming language is MISRA C, currently in its latest edition MISRA C+ +:2023. Formal training of personnel involved in the development and quality assessment of C++ source code is an essential part of the adoption of MISRA C++.

Without a proper understanding of **C++ pitfalls** and of the reasons behind each of the MISRA guidelines, developers often:

- perceive the adoption of the guidelines as a useless burden;
- misunderstand messages output by the tool and do not know what should be done;
- are unable to recognize false positives;
- change the code by trial-and-error in an attempt to silence the tools.

Lack of training always implies significant time losses and even, more often than one might think, a strict decrease in the quality of the code produced.
This training course has proven to be very effective: it has been used both to successfully introduce MISRA C++ to companies with no previous exposure to the subject, and to boost productivity in companies that had already adopted MISRA C++ but without adequate training. In all cases the course resulted in **stronger, more productive teams**.

The course optionally includes hands-on experience with ECLAIR, a state-of-the-art software verification platform available from BUGSENG.

Course Objectives

Upon completion of the course, partecipants will

- understand the C++ language pitfalls, the compilation process, static analysis techinques and tools,
- understand the origin and nature of MISRA C++ and its role in the development of safe and secure software,
- understand all important MISRA C++ guidelines and the unwanted phenomena they are designed to prevent,
- understand the notion of compliance to MISRA C++ and the permitted deviation procedures,
- appreciate and understand the advantages of the adoption of MISRA C++ and other best practices.

In addition, they will be able to

- recognize and avoid dangerous features of the C++ language by adhering to the MISRA C++ language subset, thus minimizing rework and extended testing phases,
- analyze the output of static analyzers and recognize MISRA C++ false positives (and negatives),
- decide on the best remediation for each kind of MISRA C++ violation,
- work effectively on bringing projects into compliance,
- formulate accurate and defensible MISRA compliance reports.

Intended Audience and Teaching Methods

The course is meant for software developers, engineers and architects as well as V&V engineers and project managers.

The content is geared towards people with working understanding of C++; however, no previous knowledge of MISRA C++ is required.

The course, which favors participatory approaches as much possible, is based on the following methodologies: lectures/presentation, discussion, question and answers, demonstrations, practical session, exercises and optional final exam.

Contents and Schedule

The course provides a thorough understanding of MISRA C++ ,debunking common misconceptions that are usually the reason for its ineffective and counterproductive adoption. The course begins with a presentation of the **safety and security pitfalls** that are inherent in C++ programming; the most common and dangerous programming errors (with a particular emphasis on embedded systems programming) are then explained in detail. A selection od MISRA C++ guideliness is presented along with its rationale and the role it plays in achieving safety, testability, maintainability and portability. Most importantly, each rule is presented along with a clear explanation of the right corrective measures (those that do increase overall code quality) and with instructions about why, when and how rule deviations might be necessary or advisable.
The use of tools for the automatic verification of MISRA C++ rules is then introduced, with a particular emphasis on their proper configuration and integration with the development environment.
The course includes the **demonstrative analysis** of portions of real software projects: this gives the opportunity to review and practice all the learned concepts and abilities.

Sessions are set by BUGSENG.
Each session spans **5 half days (20h)**.
Attendees can express preference for 5 half days or 3 half days + 1 full day.
Upon confirmation of instructors' availability, BUGSENG confirms the schedule.

20 hours

DAY 1 Half	DAY 2 Half	DAY 3 Half	DAY 4 Half	DAY 5 Half	5 half days
DAY 1 Half	DAY 2 Half	DAY 3 Half	DAY 4 Full		3 half days + 1 full day

Brief Course outline

- Introduction to the course.
- Quick review of undefined, unspecified and implementation-defined behavior in C++.
- How the compilers may take advantage of undefined behavior.
- Quick review of explicit casts and implicit casts: promotion, usual arithmetic conversions, etc.
- Quick review of enumerated, integer and floating-point types: representation and operations.
- Review of common integer pitfalls: overflow, sign error, extension, truncation, ...
- Review of common floating-point pitfalls: error propagation, comparison, excess precision, ...
- Review of arrays, strings, pointer types and associated programming errors: access outside bounds, null-termination, truncation, off-by-one errors, ...
- The purpose of MISRA C++ and its role in improving code quality.
- The MISRA C ++ essential type system and other preliminary notions.
- The main guidelines of MISRA C++:2023.
- Compliance matrices and deviation procedures: MISRA Compliance:2020.
- Simplifying the deviation procedure with deviation permits.
- Automatic verification of compliance to the MISRA C++ rules: the tools and their proper configuration and use.
- Demonstrative analysis of the MISRA C++ violations in real software projects (possibly provided by customers) along with the correct remediation measures.
- Final exam (optional) and course wrap-up.

CUSTOMIZATION

The course contents can be customized to some extent. For example, in the case of an audience with all attendees from one company, the hands-on part of the course can be based on a project selected by that company

LANGUAGE

The course can be taught in **English** or **Italian**.
The course material is all in English.

THE INSTRUCTORS

The course is taught by **qualified** BUGSENG **instructors**, in collaboration with members of the MISRA C, MISRA C++, MISRA SQM, and C standardization international working groups.

HANDOUTS

Each participant will receive:

- All relevant MISRA documents in PDF format, including a copy of MISRA C++:2023 (**licensed individually** to each participant)
- Course material including examples and exercises for individual study.
- **Certificate** of attendance or achievement.
- One month of email **consultancy** on the course topics.

Online platform provided by BUGSENG

Via Fiorentina 214/C · I-56121 Pisa, Italy

info@bugseng.com · http://bugseng.com