

# THE CERT® C CODING STANDARD

*92 Rules for Developing Safe,  
Reliable, and Secure Systems*

SECOND EDITION

ROBERT C. SEACORD

# The Cert C Secure Coding Standard Robert C Seacord

**George Kostopoulos**



## **The Cert C Secure Coding Standard Robert C Seacord:**

*The CERT C Secure Coding Standard* Robert C. Seacord, 2008-10-14 I m an enthusiastic supporter of the CERT Secure Coding Initiative Programmers have lots of sources of advice on correctness clarity maintainability performance and even safety Advice on how specific language features affect security has been missing The CERT C Secure Coding Standard fills this need Randy Meyers Chairman of ANSI C For years we have relied upon the CERT CC to publish advisories documenting an endless stream of security problems Now CERT has embodied the advice of leading technical experts to give programmers and managers the practical guidance needed to avoid those problems in new applications and to help secure legacy systems Well done Dr Thomas Plum founder of Plum Hall Inc Connectivity has sharply increased the need for secure hacker safe applications By combining this CERT standard with other safety guidelines customers gain all round protection and approach the goal of zero defect software Chris Tapp Field Applications Engineer LDRA Ltd I ve found this standard to be an indispensable collection of expert information on exactly how modern software systems fail in practice It is the perfect place to start for establishing internal secure coding guidelines You won t find this information elsewhere and when it comes to software security what you don t know is often exactly what hurts you John McDonald coauthor of The Art of Software Security Assessment Software security has major implications for the operations and assets of organizations as well as for the welfare of individuals To create secure software developers must know where the dangers lie Secure programming in C can be more difficult than even many experienced programmers believe This book is an essential desktop reference documenting the first official release of The CERT C Secure Coding Standard The standard itemizes those coding errors that are the root causes of software vulnerabilities in C and prioritizes them by severity likelihood of exploitation and remediation costs Each guideline provides examples of insecure code as well as secure alternative implementations If uniformly applied these guidelines will eliminate the critical coding errors that lead to buffer overflows format string vulnerabilities integer overflow and other common software vulnerabilities

**The CERT® C Coding Standard, Second Edition** Robert C. Seacord, 2014-04-25 At Cisco we have adopted the CERT C Coding Standard as the internal secure coding standard for all C developers It is a core component of our secure development lifecycle The coding standard described in this book breaks down complex software security topics into easy to follow rules with excellent real world examples It is an essential reference for any developer who wishes to write secure and resilient software in C and C Edward D Paradise vice president engineering threat response intelligence and development Cisco Systems Secure programming in C can be more difficult than even many experienced programmers realize To help programmers write more secure code The CERT C Coding Standard Second Edition fully documents the second official release of the CERT standard for secure coding in C The rules laid forth in this new edition will help ensure that programmers code fully complies with the new C11 standard it also addresses earlier versions including C99 The new standard itemizes those coding errors that are the root causes of current software

vulnerabilities in C prioritizing them by severity likelihood of exploitation and remediation costs Each of the text s 98 guidelines includes examples of insecure code as well as secure C11 conforming alternative implementations If uniformly applied these guidelines will eliminate critical coding errors that lead to buffer overflows format string vulnerabilities integer overflow and other common vulnerabilities This book reflects numerous experts contributions to the open development and review of the rules and recommendations that comprise this standard Coverage includes Preprocessor Declarations and Initialization Expressions Integers Floating Point Arrays Characters and Strings Memory Management Input Output Environment Signals Error Handling Concurrency Miscellaneous Issues      **The CERT C Coding Standard** Robert C. Seacord,2014 This book is an essential desktop reference for the CERT C coding standard The CERT C Coding Standard is an indispensable collection of expert information The standard itemizes those coding errors that are the root causes of software vulnerabilities in C and prioritizes them by severity likelihood of exploitation and remediation costs Each guideline provides examples of insecure code as well as secure alternative implementations If uniformly applied these guidelines will eliminate the critical coding errors that lead to buffer overflows format string vulnerabilities integer overflow and other common software vulnerabilities      *CERT C Secure Coding Standard* Robert Seacord C.,2008      [The CERT Oracle Secure Coding Standard for Java](#) Fred Long,2012 In the Java world security is not viewed as an add on a feature It is a pervasive way of thinking Those who forget to think in a secure mindset end up in trouble But just because the facilities are there doesn t mean that security is assured automatically A set of standard practices has evolved over the years The Secure R Coding R Standard for Java TM is a compendium of these practices These are not theoretical research papers or product marketing blurbs This is all serious mission critical battle tested enterprise scale stuff James A Gosling Father of the Java Programming Language An essential element of secure coding in the Java programming language is a well documented and enforceable coding standard Coding standards encourage programmers to follow a uniform set of rules determined by the requirements of the project and organization rather than by the programmer s familiarity or preference Once established these standards can be used as a metric to evaluate source code using manual or automated processes The CERT R Oracle R Secure Coding Standard for Java TM provides rules designed to eliminate insecure coding practices that can lead to exploitable vulnerabilities Application of the standard s guidelines will lead to higher quality systems robust systems that are more resistant to attack Such guidelines are required for the wide range of products coded in Java for devices such as PCs game players mobile phones home appliances and automotive electronics After a high level introduction to Java application security seventeen consistently organized chapters detail specific rules for key areas of Java development For each area the authors present noncompliant examples and corresponding compliant solutions show how to assess risk and offer references for further information Each rule is prioritized based on the severity of consequences likelihood of introducing exploitable vulnerabilities and cost of remediation The standard provides secure coding rules for the Java SE 6 Platform including the

Java programming language and libraries and also addresses new features of the Java SE 7 Platform It describes language behaviors left to the discretion of JVM and compiler implementers guides developers in the proper use of Java s APIs and security architecture and considers security concerns pertaining to standard extension APIs from the javax package hierarchy The standard covers security issues applicable to these libraries lang util Collections Concurrency Utilities Logging Management Reflection Regular Expressions Zip I O JMX JNI Math Serialization and JAXP

*Effective C* Robert C. Seacord,2020-08-11 A detailed introduction to the C programming language for experienced programmers The world runs on code written in the C programming language yet most schools begin the curriculum with Python or Java *Effective C* bridges this gap and brings C into the modern era covering the modern C17 Standard as well as potential C2x features With the aid of this instant classic you ll soon be writing professional portable and secure C programs to power robust systems and solve real world problems Robert C Seacord introduces C and the C Standard Library while addressing best practices common errors and open debates in the C community Developed together with other C Standards committee experts *Effective C* will teach you how to debug test and analyze C programs You ll benefit from Seacord s concise explanations of C language constructs and behaviors and from his 40 years of coding experience You ll learn How to identify and handle undefined behavior in a C program The range and representations of integers and floating point values How dynamic memory allocation works and how to use nonstandard functions How to use character encodings and types How to perform I O with terminals and filesystems using C Standard streams and POSIX file descriptors How to understand the C compiler s translation phases and the role of the preprocessor How to test debug and analyze C programs *Effective C* will teach you how to write professional secure and portable C code that will stand the test of time and help strengthen the foundation of the computing world

Secure Coding in C and C++ Robert C. Seacord,2013-03-23 Learn the Root Causes of Software Vulnerabilities and How to Avoid Them Commonly exploited software vulnerabilities are usually caused by avoidable software defects Having analyzed tens of thousands of vulnerability reports since 1988 CERT has determined that a relatively small number of root causes account for most of the vulnerabilities *Secure Coding in C and C++ Second Edition* identifies and explains these root causes and shows the steps that can be taken to prevent exploitation Moreover this book encourages programmers to adopt security best practices and to develop a security mindset that can help protect software from tomorrow s attacks not just today s Drawing on the CERT s reports and conclusions Robert C Seacord systematically identifies the program errors most likely to lead to security breaches shows how they can be exploited reviews the potential consequences and presents secure alternatives Coverage includes technical detail on how to Improve the overall security of any C or C++ application Thwart buffer overflows stack smashing and return oriented programming attacks that exploit insecure string manipulation logic Avoid vulnerabilities and security flaws resulting from the incorrect use of dynamic memory management functions Eliminate integer related problems resulting from signed integer overflows unsigned integer wrapping and truncation errors Perform

secure I/O avoiding file system vulnerabilities Correctly use formatted output functions without introducing format string vulnerabilities Avoid race conditions and other exploitable vulnerabilities while developing concurrent code The second edition features Updates for C11 and C 11 Significant revisions to chapters on strings dynamic memory management and integer security A new chapter on concurrency Access to the online secure coding course offered through Carnegie Mellon's Open Learning Initiative OLI Secure Coding in C and C Second Edition presents hundreds of examples of secure code insecure code and exploits implemented for Windows and Linux If you're responsible for creating secure C or C++ software or for keeping it safe no other book offers you this much detailed expert assistance

*Professional Cocoa Application Security* Graham J. Lee, 2010-05-13 The first comprehensive security resource for Mac and iPhone developers The Mac platform is legendary for security but consequently Apple developers have little appropriate security information available to help them assure that their applications are equally secure This Wrox guide provides the first comprehensive go-to resource for Apple developers on the available frameworks and features that support secure application development While Macs are noted for security developers still need to design applications for the Mac and the iPhone with security in mind this guide offers the first comprehensive reference to Apple's application security frameworks and features Shows developers how to consider security throughout the lifecycle of a Cocoa application including how Mac and iPhone security features work and how to leverage them Describes how to design implement and deploy secure Mac and iPhone software covering how user configurations affect application security the keychain feature how to maximize filesystem security how to write secure code and much more Professional Cocoa Application Security arms Apple developers with essential information to help them create Mac and iPhone applications as secure as the operating system they run on

*Effective C* Robert C. Seacord, 2020-08-04 A detailed introduction to the C programming language for experienced programmers The world runs on code written in the C programming language yet most schools begin the curriculum with Python or Java Effective C bridges this gap and brings C into the modern era covering the modern C17 Standard as well as potential C2x features With the aid of this instant classic you'll soon be writing professional portable and secure C programs to power robust systems and solve real-world problems Robert C. Seacord introduces C and the C Standard Library while addressing best practices common errors and open debates in the C community Developed together with other C Standards committee experts Effective C will teach you how to debug test and analyze C programs You'll benefit from Seacord's concise explanations of C language constructs and behaviors and from his 40 years of coding experience You'll learn How to identify and handle undefined behavior in a C program The range and representations of integers and floating point values How dynamic memory allocation works and how to use nonstandard functions How to use character encodings and types How to perform I/O with terminals and filesystems using C Standard streams and POSIX file descriptors How to understand the C compiler's translation phases and the role of the preprocessor How to test debug and analyze C programs Effective C will teach you how to write

professional secure and portable C code that will stand the test of time and help strengthen the foundation of the computing world *Effective C, 2nd Edition* Robert C. Seacord, 2024-10-29 *Effective C* 2nd edition is an introduction to essential C language programming that will soon have you writing programs solving problems and building working systems The latest release of the C programming language C23 enhances the safety security and usability of the language This second edition of *Effective C* has been thoroughly updated to cover C23 offering a modern introduction to C that will teach you best practices for writing professional effective and secure programs that solve real world problems *Effective C* is a true product of the C community Robert C Seacord a long standing member of the C standards committee with over 40 years of programming experience developed the book in collaboration with other C experts such as Clang's lead maintainer Aaron Ballman and C project editor Jean Heyd Meneide Thanks to the efforts of this expert group you'll learn how to Develop professional C code that is fast robust and secure Use objects functions and types effectively Safely and correctly use integers and floating point types Manage dynamic memory allocation Use strings and character types efficiently Perform I/O operations using C standard streams and POSIX file descriptors Make effective use of C's preprocessor Debug test and analyze C programs The world runs on code written in C *Effective C* will show you how to get the most out of the language and build robust programs that stand the test of time New to this edition This edition has been extensively rewritten to align with modern C23 programming practices and leverage the latest C23 features Updated to cover C23 *Technical Debt in Practice* Neil Ernst, Rick Kazman, Julien Delange, 2021-08-17 The practical implications of technical debt for the entire software lifecycle with examples and case studies Technical debt in software is incurred when developers take shortcuts and make ill advised technical decisions in the initial phases of a project only to be confronted with the need for costly and labor intensive workarounds later This book offers advice on how to avoid technical debt how to locate its sources and how to remove it It focuses on the practical implications of technical debt for the entire software life cycle with examples and case studies from companies that range from Boeing to Twitter Technical debt is normal it is part of most iterative development processes But if debt is ignored over time it may become unmanageably complex requiring developers to spend all of their effort fixing bugs with no time to add new features and after all new features are what customers really value The authors explain how to monitor technical debt how to measure it and how and when to pay it down Broadening the conventional definition of technical debt they cover requirements debt implementation debt testing debt architecture debt documentation debt deployment debt and social debt They intersperse technical discussions with Voice of the Practitioner sidebars that detail real world experiences with a variety of technical debt issues **Java Coding Guidelines** Fred Long, Dhruv Mohindra, Robert C. Seacord, Dean F. Sutherland, David Svoboda, 2013-08-23 A must read for all Java developers Every developer has a responsibility to author code that is free of significant security vulnerabilities This book provides realistic guidance to help Java developers implement desired functionality with security reliability and maintainability goals in mind

Mary Ann Davidson Chief Security Officer Oracle Corporation Organizations worldwide rely on Java code to perform mission critical tasks and therefore that code must be reliable robust fast maintainable and secure Java™ Coding Guidelines brings together expert guidelines recommendations and code examples to help you meet these demands Written by the same team that brought you The CERT Oracle Secure Coding Standard for Java™ this guide extends that previous work s expert security advice to address many additional quality attributes You ll find 75 guidelines each presented consistently and intuitively For each guideline conformance requirements are specified for most noncompliant code examples and compliant solutions are also offered The authors explain when to apply each guideline and provide references to even more detailed information Reflecting pioneering research on Java security Java™ Coding Guidelines offers updated techniques for protecting against both deliberate attacks and other unexpected events You ll find best practices for improving code reliability and clarity and a full chapter exposing common misunderstandings that lead to suboptimal code With a Foreword by James A Gosling Father of the Java Programming Language     **Introduction to the Team Software Process(sm)** Watts S. Humphrey,1999-08-24 Watts Humphrey is the visionary behind the Capability Maturity Model CMM R and the Personal Software Process PSP sm The CMM contains a framework for software process improvement at the organizational level The PSP builds the self discipline needed for individual programmers to work efficiently and effectively The author s new Team Software Process TSP sm details methods to guide the formation of software development teams to motivate their work and to enhance their productivity This book describes an introductory version of TSP ideal for smaller projects but also useful for learning basic techniques and procedures that apply to other development projects Methods presented include how to establish roles how to conceive design and plan a project how to track and report on progress The book walks readers through a complete development cycle illustrating how best to use the talents at hand how to formulate well defined goals how to coordinate activities for maximum progress how to promote effective communication how to alleviate many of the conflicts that undermine teamwork Team members should not have to expend valuable time and energy reinventing ways to organize and run their team By following a proven process the team will more quickly be able to focus on the successful completion of the project itself To help a team course apply these methods the book provides two project exercises with prescribed development goals and team roles     Secure and Resilient Software Development Mark S. Merkow,Lakshmikanth Raghavan,2010-06-16 Although many software books highlight open problems in secure software development few provide easily actionable ground level solutions Breaking the mold Secure and Resilient Software Development teaches you how to apply best practices and standards for consistent and secure software development It details specific quality software developmen     Safety and Security of Cyber-Physical Systems Frank J. Furrer,2022-07-20 Cyber physical systems CPSs consist of software controlled computing devices communicating with each other and interacting with the physical world through sensors and actuators Because most of the functionality of a CPS is implemented



in software the software is of crucial importance for the safety and security of the CPS This book presents principle based engineering for the development and operation of dependable software The knowledge in this book addresses organizations that want to strengthen their methodologies to build safe and secure software for mission critical cyber physical systems The book Presents a successful strategy for the management of vulnerabilities threats and failures in mission critical cyber physical systems Offers deep practical insight into principle based software development 62 principles are introduced and cataloged into five categories Business Provides direct guidance on architecting and operating dependable cyber physical systems for software managers and architects

C++11 for Programmers Paul Deitel,Harvey M. Deitel,2013-03-21 In C 11 for Programmers the Deitels bring their proven Live Code approach to teaching today s powerful new version of the C language Like all Deitel Developer titles they teach the best way possible via hundreds of complete example C programs with thousands of lines of downloadable C source code Unlike other C 11 books this guide teaches robust best practice coding practices that fully support the CERT Coordination Center s authoritative secure coding standards To help you write programs that are even more secure the Deitels also introduce C 11 s new non deterministic random number generation capabilities Using all these techniques you can write industrial strength C 11 code that stands up to attacks from viruses worms and other forms of malware Ideal for anyone who s worked with at least one programming language before C 11 for Programmers utilizes a proven early objects approach emphasizing program clarity software reuse and component oriented software construction In addition to the core language it will help you take advantage of the newest standard libraries and the newest language extensions Coverage includes many new C 11 features including smart pointers regular expressions shared\_ptr and weak\_ptr and more This book contains 240 complete C 11 programs more than 15 000 lines of downloadable code All code has been thoroughly tested on three popular industrial strength C 11 compilers GNU C 4 7 Microsoft Visual C 2012 and Apple LLVM in Xcode 4 5

*Alice and Bob Learn Secure Coding* Tanya Janca,2025-01-10 Unlock the power of secure coding with this straightforward and approachable guide Discover a game changing resource that caters to developers of all levels with Alice and Bob Learn Secure Coding With a refreshing approach the book offers analogies stories of the characters Alice and Bob real life examples technical explanations and diagrams to break down intricate security concepts into digestible insights that you can apply right away Explore secure coding in popular languages like Python Java JavaScript and more while gaining expertise in safeguarding frameworks such as Angular Net and React Uncover the secrets to combatting vulnerabilities by securing your code from the ground up Topics include Secure coding in Python Java Javascript C C SQL C PHP and more Security for popular frameworks including Angular Express React Net and Spring Security Best Practices for APIs Mobile Web Sockets Serverless IOT and Service Mesh Major vulnerability categories how they happen the risks and how to avoid them The Secure System Development Life Cycle in depth Threat modeling testing and code review The agnostic fundamentals of creating secure code that apply to any language or framework Alice and Bob

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**Java SE8 for Programmers** Paul J. Deitel,Harvey Deitel,2014-03-29 The professional programmer's Deitel guide to Java SE 7 and SE 8 Java 8 development with the powerful Java platform Written for programmers with a background in high level language programming this book applies the Deitel signature live code approach to teaching programming and explores the Java language and Java APIs in depth The book presents concepts in the context of fully tested programs complete with syntax shading code highlighting line by line code walkthroughs and program outputs The book features hundreds of complete Java programs with thousands of lines of proven Java code and hundreds of tips that will help you build robust applications Start with an introduction to Java using an early classes and objects approach then rapidly move on to more advanced topics including GUI graphics exception handling lambdas streams functional interfaces object serialization concurrency generics generic collections JDBC and more You'll enjoy the Deitels classic treatment of object oriented programming and the object oriented design ATM case study including a complete Java implementation When you're finished you'll have everything you need to build industrial strength object oriented Java SE 7 and SE 8 Java 8 applications Practical Example Rich Coverage of Java SE 7 and SE 8 Java 8 Lambdas Streams Functional Interfaces with Default and Static Methods Classes Objects Encapsulation Inheritance Polymorphism Interfaces Swing and JavaFX GUIs Graphics Integrated Exception Handling Files Streams Object Serialization Multithreading and Concurrency for Optimal Multi Core Performance Generics and Generic Collections Database JDBC SQL and JavaDB Using the Debugger and the API Docs Industrial Strength Object Oriented Design ATM Case Study and more Visit [www.deitel.com](http://www.deitel.com) Download code examples For information on Deitel's Dive Into Series programming training courses delivered at organizations worldwide visit [www.deitel.com/training](http://www.deitel.com/training) or write to [deitel@deitel.com](mailto:deitel@deitel.com) Join the Deitel social networking communities on Facebook at [facebook.com/DeitelFan](https://facebook.com/DeitelFan) Twitter [deitel](https://twitter.com/deitel) Google at [google.com/DeitelFan](https://google.com/DeitelFan) LinkedIn at [bit.ly/DeitelLinkedIn](https://bit.ly/DeitelLinkedIn) YouTube at [youtube.com/user/DeitelTV](https://youtube.com/user/DeitelTV) Subscribe to the Deitel Buzz Online e-mail newsletter at [www.deitel.com/newsletter/subscribe.html](http://www.deitel.com/newsletter/subscribe.html)

**C for Programmers with an Introduction to C11** Paul Deitel,Harvey Deitel,2013-04-19 The professional programmer's Deitel guide to procedural programming in C through 130 working code examples Written for programmers with a background in high level language programming this book applies the Deitel signature live code approach to teaching the C language and the C Standard Library The book presents the concepts in the context of fully tested programs complete with syntax shading code highlighting code walkthroughs and

program outputs The book features approximately 5 000 lines of proven C code and hundreds of savvy tips that will help you build robust applications Start with an introduction to C then rapidly move on to more advanced topics including building custom data structures the Standard Library select features of the new C11 standard such as multithreading to help you write high performance applications for today s multicore systems and secure C programming sections that show you how to write software that is more robust and less vulnerable You ll enjoy the Deitels classic treatment of procedural programming When you re finished you ll have everything you need to start building industrial strength C applications Practical example rich coverage of C programming fundamentals Compiling and debugging with GNU gcc and gdb and Visual C Key new C11 standard features Type generic expressions anonymous structures and unions memory alignment enhanced Unicode support `_Static_assert` `quick_exit` and `at_quick_exit` `_Noreturn` function specifier C11 headers C11 multithreading for enhanced performance on today s multicore systems Secure C Programming sections Data structures searching and sorting Order of evaluation issues preprocessor Designated initializers compound literals `bool` type complex numbers variable length arrays restricted pointers type generic math inline functions and more Visit [www.deitel.com](http://www.deitel.com) For information on Deitel s Dive Into Series programming training courses delivered at organizations worldwide visit [www.deitel.com/training](http://www.deitel.com/training) or write to [deitel@deitel.com](mailto:deitel@deitel.com) Download code examples To receive updates for this book subscribe to the free DEITEL BUZZ ONLINE e mail newsletter at [www.deitel.com/newsletter/subscribe.html](http://www.deitel.com/newsletter/subscribe.html) Join the Deitel social networking communities on Facebook at [facebook.com/DeitelFan](https://www.facebook.com/DeitelFan) Twitter [deitel](https://twitter.com/deitel) LinkedIn at [bit.ly/DeitelLinkedIn](https://bit.ly/DeitelLinkedIn) and Google+ at [gplus to Deitel](https://plus.google.com/+Deitel)

*Cyberspace and Cybersecurity* George Kostopoulos, 2012-07-26 Based on related courses and research on the cyber environment in Europe the United States and Asia *Cyberspace and Cybersecurity* supplies complete coverage of cyberspace and cybersecurity It not only emphasizes technologies but also pays close attention to human factors and organizational perspectives Detailing guidelines for quantifying and me

## Unveiling the Power of Verbal Art: An Emotional Sojourn through **The Cert C Secure Coding Standard Robert C Seacord**

In some sort of inundated with screens and the cacophony of immediate communication, the profound power and emotional resonance of verbal beauty often fade into obscurity, eclipsed by the regular barrage of sound and distractions. Yet, set within the lyrical pages of **The Cert C Secure Coding Standard Robert C Seacord**, a interesting perform of fictional elegance that impulses with raw feelings, lies an unforgettable trip waiting to be embarked upon. Written by way of a virtuoso wordsmith, this interesting opus courses readers on an emotional odyssey, delicately revealing the latent potential and profound influence embedded within the intricate internet of language. Within the heart-wrenching expanse of the evocative examination, we can embark upon an introspective exploration of the book is central styles, dissect their charming writing type, and immerse ourselves in the indelible effect it leaves upon the depths of readers souls.

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