

# Linux Kernel Debugging

Leverage proven tools and advanced techniques to effectively debug Linux kernels and kernel modules



# The Linux Kernel Debugging Computer Science

**M Mosston**



## **The Linux Kernel Debugging Computer Science:**

**Linux Kernel Debugging** Kaiwan N. Billimoria, 2022-08-05 Effectively debug kernel modules device drivers and the kernel itself by gaining a solid understanding of powerful open source tools and advanced kernel debugging techniques Key Features Fully understand how to use a variety of kernel and module debugging tools and techniques using examples Learn to expertly interpret a kernel Oops and identify underlying defects s Use easy to look up tables and clear explanations of kernel level defects to make this complex topic easy Book DescriptionThe Linux kernel is at the very core of arguably the world s best production quality OS Debugging it though can be a complex endeavor Linux Kernel Debugging is a comprehensive guide to learning all about advanced kernel debugging This book covers many areas in depth such as instrumentation based debugging techniques printk and the dynamic debug framework and shows you how to use Kprobes Memory related bugs tend to be a nightmare two chapters are packed with tools and techniques devoted to debugging them When the kernel gifts you an Oops how exactly do you interpret it to be able to debug the underlying issue We ve got you covered Concurrency tends to be an inherently complex topic so a chapter on lock debugging will help you to learn precisely what data races are including using KCSAN to detect them Some thorny issues both debug and performance wise require detailed kernel level tracing you ll learn to wield the impressive power of Ftrace and its frontends You ll also discover how to handle kernel lockups hangs and the dreaded kernel panic as well as leverage the venerable GDB tool within the kernel KGDB along with much more By the end of this book you will have at your disposal a wide range of powerful kernel debugging tools and techniques along with a keen sense of when to use which What you will learn Explore instrumentation based printk along with the powerful dynamic debug framework Use static and dynamic Kprobes to trap into kernel module functions Catch kernel memory defects with KASAN UBSAN SLUB debug and kmemleak Interpret an Oops in depth and precisely identify it s source location Understand data races and use KCSAN to catch evasive concurrency defects Leverage Ftrace and trace cmd to trace the kernel flow in great detail Write a custom kernel panic handler and detect kernel lockups and hangs Use KGDB to single step and debug kernel module source code Who this book is for This book is for Linux kernel developers module driver authors and testers interested in debugging and enhancing their Linux systems at the level of the kernel System administrators who want to understand and debug the internal infrastructure of their Linux kernels will also find this book useful A good grasp on C programming and the Linux command line is necessary Some experience with kernel module development will help you follow along *Linux Kernel Development* Robert Love, 2010-06-22 Linux Kernel Development details the design and implementation of the Linux kernel presenting the content in a manner that is beneficial to those writing and developing kernel code as well as to programmers seeking to better understand the operating system and become more efficient and productive in their coding The book details the major subsystems and features of the Linux kernel including its design implementation and interfaces It covers the Linux kernel with both a practical and theoretical eye

which should appeal to readers with a variety of interests and needs The author a core kernel developer shares valuable knowledge and experience on the 2.6 Linux kernel Specific topics covered include process management scheduling time management and timers the system call interface memory addressing memory management the page cache the VFS kernel synchronization portability concerns and debugging techniques This book covers the most interesting features of the Linux 2.6 kernel including the CFS scheduler preemptive kernel block I/O layer and I/O schedulers The third edition of Linux Kernel Development includes new and updated material throughout the book An all new chapter on kernel data structures Details on interrupt handlers and bottom halves Extended coverage of virtual memory and memory allocation Tips on debugging the Linux kernel In depth coverage of kernel synchronization and locking Useful insight into submitting kernel patches and working with the Linux kernel community

**Memory Dump Analysis Anthology** Dmitry Vostokov, 2008-04 This revised cross referenced and thematically organized volume of selected DumpAnalysis.org blog posts targets software engineers developing and maintaining products on Windows platforms technical support and escalation engineers

**The Linux Kernel Primer** Claudia Salzberg Rodriguez, Claudia Salzberg, Gordon Fischer, Steven Smolski, 2006 Offers a comprehensive view of the underpinnings of the Linux kernel on the Intel x86 and the Power PC

*Linux Kernel Programming Part 2 - Character Device Drivers and Kernel Synchronization* Kaiwan N Billimoria, 2021-03-19 Discover how to write high quality character driver code interface with userspace work with chip memory and gain an in depth understanding of working with hardware interrupts and kernel synchronization Key Features Delve into hardware interrupt handling threaded IRQs tasklets softirqs and understand which to use when Explore powerful techniques to perform user kernel interfacing peripheral I/O and use kernel mechanisms Work with key kernel synchronization primitives to solve kernel concurrency issues Book Description Linux Kernel Programming Part 2 Character Device Drivers and Kernel Synchronization is an ideal companion guide to the Linux Kernel Programming book This book provides a comprehensive introduction for those new to Linux device driver development and will have you up and running with writing misc class character device driver code on the 5.4 LTS Linux kernel in next to no time You'll begin by learning how to write a simple and complete misc class character driver before interfacing your driver with user mode processes via procfs sysfs debugfs netlink sockets and ioctl You'll then find out how to work with hardware I/O memory The book covers working with hardware interrupts in depth and helps you understand interrupt request IRQ allocation threaded IRQ handlers tasklets and softirqs You'll also explore the practical usage of useful kernel mechanisms setting up delays timers kernel threads and workqueues Finally you'll discover how to deal with the complexity of kernel synchronization with locking technologies mutexes spinlocks and atomic refcount operators including more advanced topics such as cache effects a primer on lock free techniques deadlock avoidance with lockdep and kernel lock debugging techniques By the end of this Linux kernel book you'll have learned the fundamentals of writing Linux character device driver code for real world projects and products What you will learn Get to grips with the basics of the

modern Linux Device Model LDM Write a simple yet complete misc class character device driver Perform user kernel interfacing using popular methods Understand and handle hardware interrupts confidently Perform I O on peripheral hardware chip memory Explore kernel APIs to work with delays timers kthreads and workqueues Understand kernel concurrency issues Work with key kernel synchronization primitives and discover how to detect and avoid deadlock Who this book is for An understanding of the topics covered in the Linux Kernel Programming book is highly recommended to make the most of this book This book is for Linux programmers beginning to find their way with device driver development Linux device driver developers looking to overcome frequent and common kernel driver development issues as well as perform common driver tasks such as user kernel interfaces performing peripheral I O handling hardware interrupts and dealing with concurrency will benefit from this book A basic understanding of Linux kernel internals and common APIs kernel module development and C programming is required

*The Proceedings of the Thirtieth SIGCSE Technical Symposium on Computer Science Education* Daniel T. Joyce, 1999 [The Proceedings of the Thirtieth SIGCSE Technical Symposium on Computer Science Education](#) Jane Prey, SIGCSE99: The 30th ACM SIGCSE Technical Symposium, 1999 [Computerworld](#), 2005-07-18 For more than 40 years Computerworld has been the leading source of technology news and information for IT influencers worldwide Computerworld's award winning Web site Computerworld.com twice monthly publication focused conference series and custom research form the hub of the world's largest global IT media network

**Computer Sciences Technical Report**, 2004 [Information Security](#) Colin Boyd, Wenbo Mao, 2003-12-12 The 2003 Information Security Conference was the sixth in a series that started with the Information Security Workshop in 1997 A distinct feature of this series is the wide coverage of topics with the aim of encouraging interaction between researchers in different aspects of information security This trend continued in the program of this year's conference There were 133 paper submissions to ISC 2003 From these submissions the 31 papers in these proceedings were selected by the program committee covering a wide range of technical areas These papers are supplemented by two invited papers

at third invited talk was presented at the conference but is not represented by a written paper We would like to extend our sincere thanks to all the authors that submitted papers to ISC 2003 and we hope that those whose papers were declined will be able to find an alternative forum for their work We are also very grateful to the three eminent invited speakers at the conference Paul van Oorschot Carleton University Canada Ueli Maurer ETH Zurich Switzerland and Andy Clark Inforenz Limited UK We were fortunate to have an energetic team of experts who took on the task of the program committee Their names may be found overleaf and we thank them warmly for their considerable efforts This team was helped by an even larger number of individuals who reviewed papers in their particular areas of expertise A list of these names is also provided which we hope is complete

**Linux System Programming** Robert Love, 2007-11-15 This book is about writing software that makes the most effective use of the system you're running on code that interfaces directly with the kernel and core system libraries including

the shell text editor compiler debugger core utilities and system daemons The majority of both Unix and Linux code is still written at the system level and Linux System Programming focuses on everything above the kernel where applications such as Apache bash cp vim Emacs gcc gdb glibc ls mv and X exist Written primarily for engineers looking to program better at the low level this book is an ideal teaching tool for any programmer Even with the trend toward high level development either through web software such as PHP or managed code C someone still has to write the PHP interpreter and the C virtual machine Linux System Programming gives you an understanding of core internals that makes for better code no matter where it appears in the stack Debugging high level code often requires you to understand the system calls and kernel behavior of your operating system too Key topics include An overview of Linux the kernel the C library and the C compiler Reading from and writing to files along with other basic file I O operations including how the Linux kernel implements and manages file I O Buffer size management including the Standard I O library Advanced I O interfaces memory mappings and optimization techniques The family of system calls for basic process management Advanced process management including real time processes File and directories creating moving copying deleting and managing them Memory management interfaces for allocating memory managing the memory you have and optimizing your memory access Signals and their role on a Unix system plus basic and advanced signal interfaces Time sleeping and clock management starting with the basics and continuing through POSIX clocks and high resolution timers With Linux System Programming you will be able to take an in depth look at Linux from both a theoretical and an applied perspective as you cover a wide range of programming topics

*Algorithms and Architectures for Parallel Processing* Ting Hu,Feng Wang,Hongwei Li,Qian Wang,2018-12-29 This book constitutes the workshop proceedings of the 18th International Conference on Algorithms and Architectures for Parallel Processing ICA3PP 2018 held in Guangzhou China in November 2018 The 24 full papers presented were carefully selected and reviewed from numerous submissions to the two following workshops ICA3PP 2018 Workshop on Intelligent Algorithms for Large scale Complex Optimization Problems ICA3PP 2018 Workshop on Security and Privacy in Data Processing

*Linux Journal* ,2005-07      **User Mode Linux** Jeff Dike,2006 With User Mode Linux you can create virtual Linux machines within a Linux computer and use them to test and debug applications network services and even kernels This work covers almost everything from getting started through running enterprise class User Mode Linux servers It offers advice on bootup compilation administration and more      **InfoWorld** ,2003-06-02 InfoWorld is targeted to Senior IT professionals Content is segmented into Channels and Topic Centers InfoWorld also celebrates people companies and projects      [Linux Kernel Programming](#) Kaiwan N Billimoria,2021-03-19 Learn how to write high quality kernel module code solve common Linux kernel programming issues and understand the fundamentals of Linux kernel internals Key Features Discover how to write kernel code using the Loadable Kernel Module framework Explore industry grade techniques to perform efficient memory allocation and data synchronization within the kernel Understand the essentials of key internals topics such as

kernel architecture memory management CPU scheduling and kernel synchronization Book DescriptionLinux Kernel Programming is a comprehensive introduction for those new to Linux kernel and module development This easy to follow guide will have you up and running with writing kernel code in next to no time This book uses the latest 5.4 Long Term Support LTS Linux kernel which will be maintained from November 2019 through to December 2025 By working with the 5.4 LTS kernel throughout the book you can be confident that your knowledge will continue to be valid for years to come You'll start the journey by learning how to build the kernel from the source Next you'll write your first kernel module using the powerful Loadable Kernel Module LKM framework The following chapters will cover key kernel internals topics including Linux kernel architecture memory management and CPU scheduling During the course of this book you'll delve into the fairly complex topic of concurrency within the kernel understand the issues it can cause and learn how they can be addressed with various locking technologies mutexes spinlocks atomic and refcount operators You'll also benefit from more advanced material on cache effects a primer on lock free techniques within the kernel deadlock avoidance with lockdep and kernel lock debugging techniques By the end of this kernel book you'll have a detailed understanding of the fundamentals of writing Linux kernel module code for real world projects and products What you will learn Write high quality modular kernel code LKM framework for 5.x kernels Configure and build a kernel from source Explore the Linux kernel architecture Get to grips with key internals regarding memory management within the kernel Understand and work with various dynamic kernel memory alloc/dealloc APIs Discover key internals aspects regarding CPU scheduling within the kernel Gain an understanding of kernel concurrency issues Find out how to work with key kernel synchronization primitives Who this book is for This book is for Linux programmers beginning to find their way with Linux kernel development If you're a Linux kernel and driver developer looking to overcome frequent and common kernel development issues or understand kernel internals you'll find plenty of useful information You'll need a solid foundation of Linux CLI and C programming before you can jump in

**Professional Linux Programming** Jon Masters,Richard Blum,2007-02-26 This book is broken into four primary sections addressing key topics that Linux programmers need to master Linux nuts and bolts the Linux kernel the Linux desktop and Linux for the Web Effective examples help get readers up to speed with building software on a Linux based system while using the tools and utilities that contribute to streamlining the software development process Discusses using emulation and virtualization technologies for kernel development and application testing Includes useful insights aimed at helping readers understand how their applications code fits in with the rest of the software stack Examines cross compilation dynamic device insertion and removal key Linux projects such as Project Utopia and the internationalization capabilities present in the GNOME desktop **Linux NFS and Automounter Administration** Erez Zadok,2001 The Craig Hunt Linux Library provides the advanced information that Linux professionals and systems administrators need to keep their Linux servers up and running at maximum efficiency Developed by noted Linux and TCP/IP guru Craig Hunt and written by acknowledged

Linux experts these books dig deeper into each of the eight key Linux topics Samba Apache DHCP NFS and Automounter Sendmail DNS security and system administration than any other book on the market Erez Zadok creator of the latest release of Automounter Daemon Amd pens this comprehensive look inside the most popular Linux Unix distributed file system Learn how to install and configure Amd and NFS for optimum speed and reliability This addition to the popular Craig Hunt Linux Library gives you an in depth look at troubleshooting NFS access problems server side and client security plus using the Automounter query tool Amq

**Open-source as an Alternative to Commercial Software** Sean Coleman, 2009

**A Guide to Kernel Exploitation** Enrico Perla, Massimiliano Oldani, 2010-10-28 A Guide to Kernel Exploitation Attacking the Core discusses the theoretical techniques and approaches needed to develop reliable and effective kernel level exploits and applies them to different operating systems namely UNIX derivatives Mac OS X and Windows Concepts and tactics are presented categorically so that even when a specifically detailed vulnerability has been patched the foundational information provided will help hackers in writing a newer better attack or help pen testers auditors and the like develop a more concrete design and defensive structure The book is organized into four parts Part I introduces the kernel and sets out the theoretical basis on which to build the rest of the book Part II focuses on different operating systems and describes exploits for them that target various bug classes Part III on remote kernel exploitation analyzes the effects of the remote scenario and presents new techniques to target remote issues It includes a step by step analysis of the development of a reliable one shot remote exploit for a real vulnerability a bug affecting the SCTP subsystem found in the Linux kernel Finally Part IV wraps up the analysis on kernel exploitation and looks at what the future may hold Covers a range of operating system families UNIX derivatives Mac OS X Windows Details common scenarios such as generic memory corruption stack overflow heap overflow etc issues logical bugs and race conditions Delivers the reader from user land exploitation to the world of kernel land OS exploits attacks with a particular focus on the steps that lead to the creation of successful techniques in order to give to the reader something more than just a set of tricks



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