Linux Kernel Debugging

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



The Linux Kernel Debugging Computer Science

Nirbhay Chaubey, Satyen Parikh, Kiran Amin

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 defect 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 Linux Kernel Programming THIERRY GAYET, 2025-06-11 DESCRIPTION module development will help you follow along Linus Torvald released the first version of a kernel in 1991 inspired at the time by both proprietary Unix and the Minix system Thirty four years later this system has evolved with stability and robustness making it almost indispensable for the DevSecOps community The Linux kernel forms the robust core of countless systems from embedded devices to vast data centers driving unparalleled power and flexibility This book is your essential guide to deeply understanding this fundamental

component and mastering the art of developing high performance kernel level code This book meticulously details the kernel s history architectural evolution and custom build processes You will master device driver fundamentals distinguishing user from kernel space and understanding the Linux Device Model LDM It explores Linux Security Modules intricate kernel memory management and various vital communication interfaces like I2C SPI SERIAL PCI and RTC The guide concludes with task process management real time concepts and essential kernel debugging and profiling By the end of this book you will be well equipped to confidently develop optimize and debug kernel level code This empowers you to build custom Linux systems craft efficient device drivers and troubleshoot complex issues ready to tackle advanced Linux system programming challenges You will also be able to better understand this system and develop your own drivers or low level developments for it WHAT YOU WILL LEARN GNU Linux kernel history feature evolution and licensing Understand and develop your character and block drivers Develop new file systems Manage your systems by communicating with the USB protocol Debug your drivers your kernel or any other module in the kernel space Understand the layout of the Linux device model Memory management in the kernel as well as via DMA or NUMA Implement Linux Security Modules LSM and Netfilter stack hooks WHO THIS BOOK IS FOR This book is for software engineers looking to understand the Linux kernel s architecture modify it and develop custom modules It also supports project managers team leaders and technical managers seeking a clear view of kernel development and capabilities CISOs and IT managers will benefit from insights into kernel limitations vulnerabilities and security measures such as Linux Security Modules LSMs TABLE OF CONTENTS 1 History of the GNU Linux Kernel 2 Introduction to the Linux Kernel 3 Introduction to Device Drivers 4 Linux Device Model 5 Character Device Drivers 6 Block Drivers and Virtual Filesystem 7 USB Drivers and libusb 8 Network Drivers 9 Linux Security Modules 10 Kernel Memory and DMA 11 Navigating Linux Communication Interfaces 12 Process Management 13 Debugging GNU Linux Kernel and Drivers

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 intervals you ll find plenty of useful information You ll need a solid foundation of Linux CLI and C programming before you can jump in Computer Science for GCSE Student Book George Rouse, Sean O'Byrne, 2016-08-15 Exam Board OCR Level GCSE Subject Computer Science First Teaching September 2016 First Exam June 2018 Build student confidence and ensure successful progress through GCSE Computer Science Our expert authors provide insight and guidance to meet the demands of the new OCR specification with challenging tasks and activities to test the computational skills and knowledge required for success in their exams and advice for successful completion of the non examined assessment Builds students knowledge and confidence through detailed topic coverage and explanation of key terms Develops computational thinking skills with practice exercises and problem solving tasks Ensures progression through GCSE with regular assessment questions that can be developed with supporting Dynamic Learning digital resources Instils a deeper understanding and awareness of computer science and its applications and implications in the wider world <u>Linux Kernel Development</u> 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 Linux Kernel Programming Kaiwan N. Billimoria, 2024-02-29 Gain a solid practical understanding and sufficient theoretical insight into Linux kernel internals while learning to write high quality kernel module code and understanding the complexities of kernel synchronization Purchase of the print or Kindle book includes a free eBook in PDF format Key Features Discover how to write Linux kernel and module code for real world products on the 6 1 LTS kernel Implement industry grade techniques in real world scenarios for fast efficient memory allocation and data synchronization Understand and exploit kernel architecture CPU scheduling and kernel synchronization techniques Book DescriptionThe 2nd Edition of Linux Kernel Programming is an updated comprehensive guide for those new to Linux kernel development Built around the latest 6 1 Long Term Support LTS Linux kernel which is maintained until December 2026 this edition explores its key features and enhancements Additionally with the Civil Infrastructure Project extending support for the 6 1 Super LTS SLTS kernel until August 2033 this book will remain relevant for years to come You ll begin this exciting journey by learning how to build the kernel from source Step by step you will then learn how to write your first kernel module by leveraging the kernel s powerful Loadable Kernel Module LKM framework With this foundation you will delve into key kernel internals topics including Linux kernel architecture memory management and CPU task scheduling You ll finish with understanding the deep issues of concurrency and gain insight into how they can be addressed with various synchronization locking technologies for example mutexes spinlocks atomic refcount operators rw spinlocks and even lock free technologies such as per CPU and RCU By the end of this book you ll build a strong understanding of the fundamentals to writing the Linux kernel and kernel module code that can straight away be used in real world projects and products What you will learn Configure and build the 6 1 LTS kernel from source Write high quality modular kernel code LKM framework for 6 x kernels Explore modern Linux kernel architecture Get to grips with key internals details 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 including cgroups v2 Gain a deeper understanding of kernel concurrency issues Learn how to work with key kernel synchronization primitives Who this book is for This book is for beginner Linux programmers and developers looking to get started with the Linux kernel providing a knowledge base to understand required kernel internal topics and overcome frequent and common development issues A basic understanding of Linux CLI and C programming is assumed Linux Kernel Programming Part 2 - Char 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 FeaturesDelve into hardware interrupt handling threaded IRQs tasklets softirgs and understand which to use when Explore powerful techniques to perform user kernel interfacing peripheral I O and use kernel mechanismsWork with key kernel synchronization primitives to solve kernel concurrency issuesBook Description Linux Kernel Programming Part 2 Char 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 softings 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 learnGet to grips with the basics of the modern Linux Device Model LDM Write a simple yet complete misc class character device driverPerform user kernel interfacing using popular methodsUnderstand and handle hardware interrupts confidentlyPerform I O on peripheral hardware chip memory Explore kernel APIs to work with delays timers kthreads and workgueues Understand kernel concurrency issuesWork with key kernel synchronization primitives and discover how to detect and avoid deadlockWho 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 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 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 Science and Information Engineering David Jin, Sally Lin, 2012-05-11 CSIE2012 is an integrated conference concentrating its focus on Computer Science and Information Engineering In the proceeding you can learn much more knowledge about Computer Science and Information Engineering of researchers from all around the world The main role of the proceeding is to be used as an exchange pillar for researchers who are working in the mentioned fields In order to meet the high quality of Springer AISC series the organization committee has made their efforts to do the following things Firstly poor quality paper has been refused after reviewing course by anonymous referee experts Secondly periodically review meetings have been held around the reviewers about five times for exchanging reviewing suggestions Finally the conference organizers had several preliminary sessions before the conference Through efforts of different people and departments the conference will be successful and fruitful Running Linux Matt Welsh, 2003 Welsh's guide has everything users need to understand install and start using the Linux operating system New topics covered include laptops cameras scanners sound multimedia and more Computer Science & Perl Programming Jon Orwant, 2002-11-04 In its first five years of existence The Perl Journal ran 247 articles by over 120 authors Every serious Perl programmer subscribed to it and every notable Perl guru jumped at the opportunity to write for it TPJ explained critical topics such as regular expressions databases and object oriented programming and demonstrated Perl s utility for fields as diverse as astronomy biology economics AI and games The magazine gave birth to both the Obfuscated Perl Contest and the Perl Poetry contest and remains a proud and timeless achievement of Perl during one of its most exciting periods of development Computer Science and Perl Programming is the first volume of The Best of the Perl Journal compiled and re edited by the original editor and publisher of The Perl Journal Jon Orwant In this series we ve taken the very best and still relevant articles published in TPJ over its 5 years of publication and immortalized them into three volumes This volume has 70 articles devoted to hard core computer science advanced programming techniques and the underlying mechanics of Perl Here's a sample of what you ll find inside Jeffrey Friedl on Understanding Regexes Mark Jason Dominus on optimizing your Perl programs with Memoization Damian Conway on Parsing Tim Meadowcroft on integrating Perl with Microsoft Office Larry Wall on the culture of Perl Written by 41 of the most prominent and prolific members of the closely knit Perl community this anthology does what no other book can giving unique insight into the real life applications and powerful techniques made possible by Perl Other books tell you how to use Perl but this book goes far beyond that it shows you not only how to use Perl but what you could use Perl for This is more than just The Best of the Perl Journal in many ways this is the best of Perl Advances in Computer Science - ASIAN 2006. Secure Software and Related Issues Mitsu Okada, Ichiro Satoh, 2008-01-25 Running to more than 360 pages and complete

with online files and updates this book constitutes the thoroughly refereed post proceedings of the 11th Asian Computing Science Conference ASIAN 2006 held in Tokyo Japan The 17 revised full papers and 8 revised short papers presented together with 1 invited paper were carefully selected during two rounds of reviewing from 115 submissions. The papers cover theory practice applications and experiences related to secure software Computing Science, Communication and **Security** Nirbhay Chaubey, Satyen Parikh, Kiran Amin, 2020-07-18 This book constitutes revised selected papers of the First International Conference on Computing Science Communication and Security COMS2 2020 held in March 2020 Due to the COVID 19 pandemic the conference was held virtually The 26 full papers and 1 short paper were thoroughly reveiwed and selected from 79 submissions Papers are organised according to the topical sections on artificial intelligence and machine learning network communication and security computing science The Linux Programming Interface Michael Kerrisk, 2010-10-01 The Linux Programming Interface TLPI is the definitive guide to the Linux and UNIX programming interface the interface employed by nearly every application that runs on a Linux or UNIX system In this authoritative work Linux programming expert Michael Kerrisk provides detailed descriptions of the system calls and library functions that you need in order to master the craft of system programming and accompanies his explanations with clear complete example programs You ll find descriptions of over 500 system calls and library functions and more than 200 example programs 88 tables and 115 diagrams You ll learn how to Read and write files efficiently Use signals clocks and timers Create processes and execute programs Write secure programs Write multithreaded programs using POSIX threads Build and use shared libraries Perform interprocess communication using pipes message queues shared memory and semaphores Write network applications with the sockets API While The Linux Programming Interface covers a wealth of Linux specific features including epoll inotify and the proc file system its emphasis on UNIX standards POSIX 1 2001 SUSv3 and POSIX 1 2008 SUSv4 makes it equally valuable to programmers working on other UNIX platforms The Linux Programming Interface is the most comprehensive single volume work on the Linux and UNIX programming interface and a book that s destined to become a new classic Recent Advances in Computer Science and Information Engineering Zhihong Qian, Lei Cao, Weilian Su, Tingkai Wang, Huamin Yang, 2012-01-25 CSIE 2011 is an international scientific Congress for distinguished scholars engaged in scientific engineering and technological research dedicated to build a platform for exploring and discussing the future of Computer Science and Information Engineering with existing and potential application scenarios The congress has been held twice in Los Angeles USA for the first and in Changchun China for the second time each of which attracted a large number of researchers from all over the world The congress turns out to develop a spirit of cooperation that leads to new friendship for addressing a wide variety of ongoing problems in this vibrant area of technology and fostering more collaboration over the world The congress CSIE 2011 received 2483 full paper and abstract submissions from 27 countries and regions over the world Through a rigorous peer review process all submissions were refereed based on their quality of content level of

innovation significance originality and legibility 688 papers have been accepted for the international congress proceedings Expert Linux Development: Mastering System Calls, Filesystems, and Inter-Process Communication Adam Jones, 2025-01-09 Expert Linux Development Mastering System Calls Filesystems and Inter Process Communication is an indispensable resource for software developers system administrators and advanced users eager to elevate their understanding of Linux s powerful capabilities This meticulously curated text delves deep into the Linux kernel elucidating the nuances of system calls filesystem management and the intricacies of interprocess communication Each chapter composed with clarity and precision addresses critical topics such as process handling memory management and network programming providing readers with a comprehensive toolkit for optimizing and securing Linux environments Whether it s handling complex synchronization issues debugging sophisticated applications or securing network communications this book offers expert guidance and practical examples to navigate and master the complexities of Linux programming It s designed not just to inform but to transform competent Linux programmers into adept architects of robust efficient and secure software systems Embrace this resource to harness the full potential of Linux and take your programming prowess to remarkable new heights **UGC NET Computer Science Paper II Chapter Wise Notebook | Complete Preparation** Guide EduGorilla Prep Experts, 2022-09-01 Best Selling Book in English Edition for UGC NET Computer Science Paper II Exam with objective type questions as per the latest syllabus given by the NTA Increase your chances of selection by 16X UGC NET Computer Science Paper II Kit comes with well structured Content Chapter wise Practice Tests for your self evaluation Clear exam with good grades using thoroughly Researched Content by experts Running Linux Matthias Kalle Dalheimer, Matt Welsh, 2005-12-22 You may be contemplating your first Linux installation Or you may have been using Linux for years and need to know more about adding a network printer or setting up an FTP server Running Linux now in its fifth edition is the book you ll want on hand in either case Widely recognized in the Linux community as the ultimate getting started and problem solving book it answers the questions and tackles the configuration issues that frequently plaque users but are seldom addressed in other books This fifth edition of Running Linux is greatly expanded reflecting the maturity of the operating system and the teeming wealth of software available for it Hot consumer topics suchas audio and video playback applications groupware functionality and spam filtering are covered along with the basics in configuration and management that always have made the book popular Running Linux covers basic communications such as mail web surfing and instant messaging but also delves into the subtleties of network configuration including dial up ADSL and cable modems in case you need to set up your network manually The book canmake you proficient on office suites and personal productivity applications and also tells you what programming tools are available if you re interested in contributing to these applications Other new topics in the fifth edition include encrypted email and filesystems advanced shell techniques and remote login applications Classic discussions on booting package management kernel recompilation and X configuration have also been

updated The authors of Running Linux have anticipated problem areas selected stable and popular solutions and provided clear instructions to ensure that you ll have a satisfying experience using Linux The discussion is direct and complete enough to guide novice users while still providing the additional information experienced users will need to progress in their mastery of Linux Whether you re using Linux on a home workstation or maintaining a network server Running Linux will provide expert advice just when you need it

Whispering the Techniques of Language: An Mental Journey through The Linux Kernel Debugging Computer Science

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