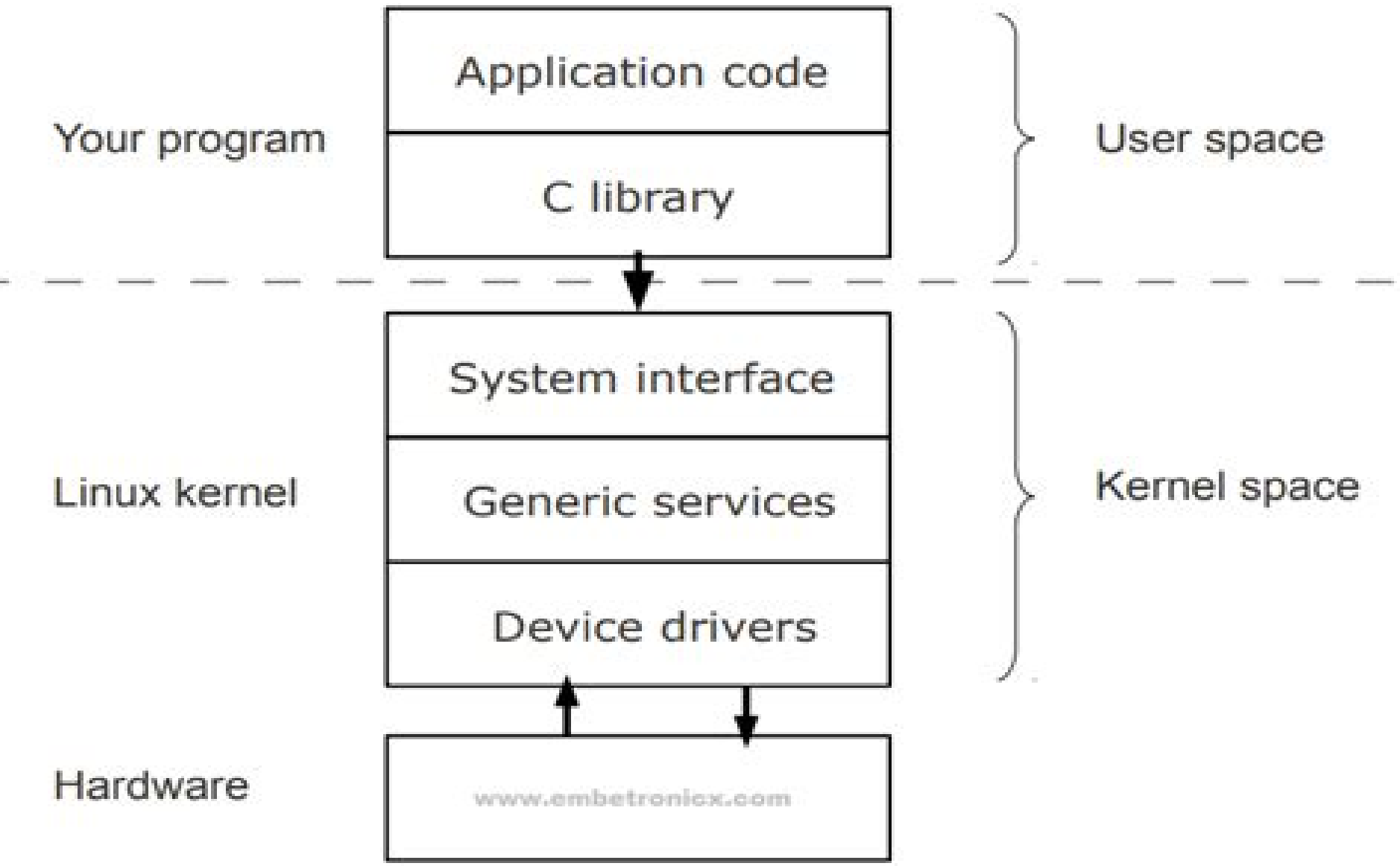
Kernel vs user space



Linux Kernel Module And Device Driver Development

Mahmoud Harmouch

Linux Kernel Module And Device Driver Development:

Linux Kernel Module and Device Driver Development Thomas Zink,2012 *Linux Device Driver Development* John Madieu,2022-04-21 Get up to speed with the most important concepts in driver development and focus on common embedded system requirements such as memory management interrupt management and locking mechanisms Key FeaturesWrite feature rich and customized Linux device drivers for any character SPI and I2C deviceDevelop a deep understanding of locking primitives IRQ management memory management DMA and so onGain practical experience in the embedded side of Linux using GPIO IIO and input subsystemsBook Description Linux is by far the most used kernel on embedded systems Thanks to its subsystems the Linux kernel supports almost all of the application fields in the industrial world This updated second edition of Linux Device Driver Development is a comprehensive introduction to the Linux kernel world and the different subsystems that it is made of and will be useful for embedded developers from any discipline You ll learn how to configure tailor and build the Linux kernel Filled with real world examples the book covers each of the most used subsystems in the embedded domains such as GPIO direct memory access interrupt management and I2C SPI device drivers This book will show you how Linux abstracts each device from a hardware point of view and how a device is bound to its driver s You ll also see how interrupts are propagated in the system as the book covers the interrupt processing mechanisms in depth and describes every kernel structure and API involved This new edition also addresses how not to write device drivers using user space libraries for GPIO clients I2C and SPI drivers By the end of this Linux book you ll be able to write device drivers for most of the embedded devices out there What you will learnDownload configure build and tailor the Linux kernelDescribe the hardware using a device treeWrite feature rich platform drivers and leverage I2C and SPI busesGet the most out of the new concurrency managed workqueue infrastructureUnderstand the Linux kernel timekeeping mechanism and use time related APIsUse the regmap framework to factor the code and make it genericOffload CPU for memory copies using DMAInteract with the real world using GPIO IIO and input subsystemsWho this book is for This Linux OS book is for embedded system and embedded Linux enthusiasts developers who want to get started with Linux kernel development and leverage its subsystems Electronic hackers and hobbyists interested in Linux kernel development as well as anyone looking to interact with the platform using GPIO IIO and input subsystems will also find this book useful *Linux Device Driver Development Cookbook* Rodolfo Giometti,2019-05-31 Over 30 recipes to develop custom drivers for your embedded Linux applications Key Features Use kernel facilities to develop powerful drivers Learn core concepts for developing device drivers using a practical approach Program a custom character device to get access to kernel internals Book DescriptionLinux is a unified kernel that is widely used to develop embedded systems As Linux has turned out to be one of the most popular operating systems worldwide the interest in developing proprietary device drivers has also increased Device drivers play a critical role in how the system performs and ensure that the device works in the manner intended By

exploring several examples on the development of character devices the technique of managing a device tree and how to use other kernel internals such as interrupts kernel timers and wait queue you ll be able to add proper management for custom peripherals to your embedded system You ll begin by installing the Linux kernel and then configuring it Once you have installed the system you will learn to use different kernel features and character drivers You will also cover interrupts in depth and understand how you can manage them Later you will explore the kernel internals required for developing applications As you approach the concluding chapters you will learn to implement advanced character drivers and also discover how to write important Linux device drivers By the end of this book you will be equipped with the skills you need to write a custom character driver and kernel code according to your requirements What you will learn Become familiar with the latest kernel releases 4 19 5 x running on the ESPRESSOBin devkit an ARM 64 bit machine Download configure modify and build kernel sources Add and remove a device driver or a module from the kernel Understand how to implement character drivers to manage different kinds of computer peripherals Get well versed with kernel helper functions and objects that can be used to build kernel applications Gain comprehensive insights into managing custom hardware with Linux from both the kernel and user space Who this book is for This book is for anyone who wants to develop their own Linux device drivers for embedded systems Basic hands on experience with the Linux operating system and embedded concepts is necessary **Linux Kernel Programming Essentials** M.T. Holbrook, Build robust high performance drivers for hardware devices and ensure seamless integration with production Linux systems Linux kernel driver development requires understanding both hardware interfaces and kernel subsystem architecture This comprehensive guide takes you through the complete driver development lifecycle from initial hardware communication to production deployment and maintenance You ll start by understanding kernel module basics and the driver model then progress to building character devices with proper file operations and ioctl interfaces The book covers block device drivers and I O scheduling network device drivers with NAPI integration and USB and PCI device enumeration You ll learn to manage DMA transfers handle cache coherency and implement efficient interrupt handling with deferred work As you advance you ll explore critical topics like kernel synchronization using spinlocks mutexes and RCU along with power management for runtime PM and system suspend resume The book demonstrates debugging with printk ftrace kgdb and performance profiling with perf Security chapters cover input validation capability systems and preventing common vulnerabilities Key Features Develop character block and network device drivers with detailed code examples and architectural explanations Master DMA operations interrupt handling power management and kernel synchronization primitives Deploy drivers to production with DKMS packaging monitoring infrastructure and kernel community patch submission What you will learn Build character block and network device drivers following kernel best practices Implement DMA transfers with proper cache coherency and scatter gather support Handle interrupts efficiently using top half bottom half processing and NAPI Apply kernel synchronization primitives

to prevent race conditions and deadlocks Debug kernel code using ftrace kgdb perf and KASAN memory sanitizers Implement power management with runtime PM and system suspend resume callbacks Package drivers with DKMS and create distribution packages for Debian Ubuntu RHEL Submit patches to the Linux kernel following community coding standards Who this book is for This book is for systems programmers with C programming experience who want to develop Linux kernel drivers Embedded systems engineers working with custom hardware driver developers supporting new devices and performance engineers optimizing I O subsystems will find this guide valuable Familiarity with basic Linux system administration and understanding of computer architecture concepts like memory management and interrupts is expected No prior kernel development experience is required **Easy Linux Device Driver, Second Edition** Mahesh Sambhaji Jadhav,2014-03-13 Easy Linux Device Driver First Step Towards Device Driver Programming Easy Linux Device Driver book is an easy and friendly way of learning device driver programming Book contains all latest programs along with output screen screenshots Highlighting important sections and stepwise approach helps for quick understanding of programming Book contains Linux installation Hello world program up to USB 3 0 Display Driver PCI device driver programming concepts in stepwise approach Program gives best understanding of theoretical and practical fundamentals of Linux device driver Beginners should start learning Linux device driver from this book to become device driver expertise Topics covered Introduction of Linux Advantages of Linux History of Linux Architecture of Linux Definations Ubuntu installation Ubuntu Installation Steps User Interface Difference About KNOPPIX Important links Terminal Soul of Linux Creating Root account Terminal Commands Virtual Editor Commands Linux Kernel Linux Kernel Internals Kernel Space and User space Device Driver Place of Driver in System Device Driver working Characteristics of Device Driver Module Commands Hello World Program pre settings Write Program Printk function Makefile Run program Parameter passing Parameter passing program Parameter Array Process related program Process related program Character Device Driver Major and Minor number API to registers a device Program to show device number Character Driver File Operations File operation program Include h header Functions in module h file Important code snippets Summary of file operations PCI Device Driver Direct Memory Access Module Device Table Code for Basic Device Driver Important code snippets USB Device Driver Fundamentals Architecture of USB device driver USB Device Driver program Structure of USB Device Driver Parts of USB end points Imporent features USB information Driver USB device Driver File Operations Using URB Simple data transfer Program to read and write Important code snippets Gadget Driver Complete USB Device Driver Program Skeleton Driver Program Special USB 3 0 USB 3 0 Port connection Bulk endpoint streaming Stream ID Device Driver Lock Mutual Exclusion Semaphore Spin Lock Display Device Driver Frame buffer concept Framebuffer Data Structure Check and set Parameter Accelerated Method Display Driver summary Memory Allocation Kmalloc Vmalloc Ioremap Interrupt Handling interrupt registration Proc interface Path of interrupt Programming Tips Softirqs Tasklets Work Queues I O Control Introducing ioctl Prototype Stepwise execution of

ioctl Sample Device Driver Complete memory Driver Complete Parallel Port Driver Device Driver Debugging Data Display Debugger Graphical Display Debugger Kernel Graphical Debugger Appendix I Exported Symbols Kobjects Ksets and Subsystems DMA I O *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 softirqs and understand which to use whenExplore 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 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 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 memoryExplore kernel APIs to work with delays timers kthreads and workqueuesUnderstand 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 **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

Jetson Platform Development Guide Richard Johnson,2025-06-09 Jetson Platform Development Guide The Jetson Platform Development Guide is the definitive technical manual for harnessing the full potential of NVIDIA Jetson embedded systems Addressed to engineers developers and system architects this guide navigates the comprehensive range of Jetson modules including Nano TX Xavier and Orin delving deeply into their hardware architectures performance profiles and integration strategies From system on module design and expansion interfaces to advanced carrier board considerations and foundational platform security the book offers thorough insight into creating robust scalable Jetson based solutions Beyond hardware the guide expertly covers the entire software stack from deploying and customizing Linux for Tegra L4T and

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through comprehensive unit testing practices Table of Contents 1 Systems Programming with Rust 2 Basics of Rust 3 Traits and Generics 4 Rust Built In Data Structures 5 Error Handling and Recovery 6 Memory Management and Pointers 7 Managing Concurrency 8 Command Line Programs 9 Working with Devices I O in Rust 10 Iterators and Closures 11 Unit Testing in Rust 12 Network Programming 13 Unsafe Coding in Rust 14 Asynchronous Programming 15 Web Assembly with Rust Index **Proceedings of Ninth International Congress on Information and Communication Technology** Xin-She Yang,Simon Sherratt,Nilanjan Dey,Amit Joshi,2024-08-01 This book gathers selected high quality research papers presented at the Ninth International Congress on Information and Communication Technology held in London on February 19 22 2024 It discusses emerging topics pertaining to information and communication technology ICT for managerial applications e governance e agriculture e education and computing technologies the Internet of Things IoT and e mining Written by respected experts and researchers working on ICT the book offers an asset for young researchers involved in advanced studies The work is presented in ten volumes *Linux Device Drivers* Jonathan Corbet,Alessandro Rubini,Greg Kroah-Hartman,2005-02-07 Device drivers literally drive everything you re interested in disks monitors keyboards modems everything outside the computer chip and memory And writing device drivers is one of the few areas of programming for the Linux operating system that calls for unique Linux specific knowledge For years now programmers have relied on the classic Linux Device Drivers from O Reilly to master this critical subject Now in its third edition this bestselling guide provides all the information you ll need to write drivers for a wide range of devices Over the years the book has helped countless programmers learn how to support computer peripherals under the Linux operating system how to develop and write software for new hardware under Linux the basics of Linux operation even if they are not expecting to write a driver The new edition of Linux Device Drivers is better than ever The book covers all the significant changes to Version 2 6 of the Linux kernel which simplifies many activities and contains subtle new features that can make a driver both more efficient and more flexible Readers will find new chapters on important types of drivers not covered previously such as consoles USB drivers and more Best of all you don t have to be a kernel hacker to understand and enjoy this book All you need is an understanding of the C programming language and some background in Unix system calls And for maximum ease of use the book uses full featured examples that you can compile and run without special hardware Today Linux holds fast as the most rapidly growing segment of the computer market and continues to win over enthusiastic adherents in many application areas With this increasing support Linux is now absolutely mainstream and viewed as a solid platform for embedded systems If you re writing device drivers you ll want this book In fact you ll wonder how drivers are ever written without it **Embedded Linux** Craig Hollabaugh,2002 A guide to using Linux on embedded platforms for interfacing to the real world Embedded Linux is one of the first books available that teaches readers development and implementation of interfacing applications on an Embedded Linux platform **Linux Device Drivers Development** John Madieu,2017-10-20 Develop Linux device

drivers from scratch with hands on guidance focused on embedded systems covering key subsystems like I2C SPI GPIO IRQ and DMA for real world hardware integration using kernel 4 13 Key Features Develop custom drivers for I2C SPI GPIO RTC and input devices using modern Linux kernel APIs Learn memory management IRQ handling DMA and the device tree through hands on examples Explore embedded driver development with platform drivers regmap and IIO frameworks Book DescriptionLinux kernel is a complex portable modular and widely used piece of software running on around 80% of servers and embedded systems in more than half of devices throughout the World Device drivers play a critical role in how well a Linux system performs As Linux has turned out to be one of the most popular operating systems used the interest in developing proprietary device drivers is also increasing steadily This book will initially help you understand the basics of drivers as well as prepare for the long journey through the Linux Kernel This book then covers drivers development based on various Linux subsystems such as memory management PWM RTC IIO IRQ management and so on The book also offers a practical approach on direct memory access and network device drivers By the end of this book you will be comfortable with the concept of device driver development and will be in a position to write any device driver from scratch using the latest kernel version v4 13 at the time of writing this book What you will learn Use kernel facilities to develop powerful drivers Develop drivers for widely used I2C and SPI devices and use the regmap API Write and support devicetree from within your drivers Program advanced drivers for network and frame buffer devices Delve into the Linux irqdomain API and write interrupt controller drivers Enhance your skills with regulator and PWM frameworks Develop measurement system drivers with IIO framework Get the best from memory management and the DMA subsystem Access and manage GPIO subsystems and develop GPIO controller drivers Who this book is for This book is ideal for embedded systems developers engineers and Linux enthusiasts who want to learn how to write device drivers from scratch Whether you re new to kernel development or looking to deepen your understanding of subsystems like I2C SPI and IRQs this book provides practical real world instructions tailored for working with embedded Linux platforms Foundational knowledge of C and basic Linux concepts is recommended Linux Command Line and Shell Scripting Bible Richard Blum,Christine Bresnahan,2011-03-23 The authoritative guide to Linux command line and shell scripting completely updated and revised it s not a guide to Linux as a whole just to scripting The Linux command line allows you to type specific Linux commands directly to the system so that you can easily manipulate files and query system resources thereby permitting you to automate commonly used functions and even schedule those programs to run automatically This new edition is packed with new and revised content reflecting the many changes to new Linux versions including coverage of alternative shells to the default bash shell For this edition the author has teamed up with another Linux expert with their shared expertise they take you beyond the basics of shell scripting and guide you through using shell scripting for higher level applications that are commonly found in Linux environments In addition this edition features a host of real world examples so you can see how the scripts work in

application Reflects changes to new Linux versions and covers alternate shells to the default bash shell Offers new chapters on working with file system commands and software installation commands Includes a plethora of real world examples of advanced shell scripting Shows how to use shell scripts in a graphical desktop environment With Linux Command Line and Shell Scripting Bible you ll learn to manage file systems install software write scripts for graphical desktops work with alternative shells and more *Linux Kernel Programming* Michael Beck,2002 CD ROM contains Linux kernel version 2 4 4 plus sources from other programs and documents from the Linux Documentation Project *Embedded Software for SoC* Ahmed Amine Jerraya,Sungjoo Yoo,Norbert Wehn,Diederik Verkest,2005-12-30 This title covers all software related aspects of SoC design from embedded and application domain specific operating systems to system architecture for future SoC It will give embedded software designers invaluable insights into the constraints imposed by the use of embedded software in an SoC context *Linux Programming Unleashed* Kurt Wall,2001 Complete and comprehensive reference with in depth coverage of the core topics Learn how to program core systems and find out about such topics as interprocess communications user interfaces device drives and X Windows system Written by top Linux programming consultsnts Kurt Wall and Mark Watson and reviewed by Linux Journal writer and freelance developer Michael Hamilton Practical tested examples of how to apply the best programming practices in the Linux environment *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 **Operating System Concepts** Abraham Silberschatz,Peter B. Galvin,Greg Gagne,2018-05-04 The tenth edition of Operating System Concepts has been revised to keep it fresh and up to date with contemporary examples of how operating systems function as well as enhanced interactive elements to improve learning and the student s experience with the material It combines instruction on concepts with real world applications so that students can understand the practical usage of the content End of chapter problems exercises review questions and programming exercises help to further reinforce important concepts New interactive self assessment problems are provided throughout the text to help students monitor their level of understanding and progress A Linux virtual machine including C and Java source code and development tools allows students to complete programming exercises that help them engage further with the material The Enhanced E Text is also available bundled with an abridged print companion and can be ordered by contacting customer service here ISBN 9781119456339 Price 97 95 Canadian Price 111 50

Shortening the Path from Specification to Prototype ,2002

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