

38
Deseret
Industries
\$ 2.00

SILBERSCHATZ

GALVIN

GAGNE

Operating System Concepts

SEVENTH
EDITION

Operating System Concepts

Seventh Edition

ABRAHAM SILBERSCHATZ

Yale University

PETER BAER GALVIN

Corporate Technologies, Inc.

GREG GAGNE

Westminster College



WILEY

JOHN WILEY & SONS, INC

EXECUTIVE EDITOR	Bill Zobrist
SENIOR PRODUCTION EDITOR	Ken Santor
COVER DESIGNER	Madelyn Lesure
COVER ILLUSTRATION	Susan St. Cyr
TEXT DESIGNER	Judy Allan

This book was set in Palatino by the author using LaTeX and printed and bound by Von Hoffmann, Inc. The cover was printed by Von Hoffmann, Inc.

This book is printed on acid free paper. ∞

Copyright © 2005 John Wiley & Sons, Inc. All rights reserved.

No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, scanning or otherwise, except as permitted under Sections 107 or 108 of the 1976 United States Copyright Act, without either the prior written permission of the Publisher, or authorization through payment of the appropriate per-copy fee to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, (978) 750-8400, fax (978) 646-8600. Requests to the Publisher for permission should be addressed to the Permissions Department, John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, (201) 748-6011, fax (201) 748-6008.

To order books or for customer service please, call 1(800)-CALL-WILEY (225-5945).

ISBN 0-471-69466-5

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

To my children, Lemor, Sivan, and Aaron

Avi Silberschatz

*To my wife, Carla,
and my children, Gwen Owen and Maddie*

Peter Baer Galvin

*In memory of Uncle Sonny,
Robert Jon Heileman 1933 — 2004*

Greg Gagne

... and concepts and algorithms covered in the book are often
... of existing commercial operating systems. Our aim
... these concepts and algorithms in a general setting that is
... particular operating system. We present a large number of
... pertain to the most popular and the most innovative operating
... including Sun Microsystems' Solaris; Linux; Mach; Microsoft MS-DOS,
... Windows 95, Windows 2000, and Windows XP; DEC VMS and TOPS-20; IBM OS/2,
... and Mac OS X.
... in this text, when we refer to Windows XP as an example operating system,
... we are implying both Windows XP and Windows 2000. If a feature exists in
... Windows XP that is not available in Windows 2000, we will state this explicitly.

Preface

Operating systems are an essential part of any computer system. Similarly, a course on operating systems is an essential part of any computer-science education. This field is undergoing rapid change, as computers are now prevalent in virtually every application, from games for children through the most sophisticated planning tools for governments and multinational firms. Yet the fundamental concepts remain fairly clear, and it is on these that we base this book.

We wrote this book as a text for an introductory course in operating systems at the junior or senior undergraduate level or at the first-year graduate level. We hope that practitioners will also find it useful. It provides a clear description of the *concepts* that underlie operating systems. As prerequisites, we assume that the reader is familiar with basic data structures, computer organization, and a high-level language, such as C. The hardware topics required for an understanding of operating systems are included in Chapter 1. For code examples, we use predominantly C, with some Java, but the reader can still understand the algorithms without a thorough knowledge of these languages.

Concepts are presented using intuitive descriptions. Important theoretical results are covered, but formal proofs are omitted. The bibliographical notes contain pointers to research papers in which results were first presented and proved, as well as references to material for further reading. In place of proofs, figures and examples are used to suggest why we should expect the result in question to be true.

The fundamental concepts and algorithms covered in the book are often based on those used in existing commercial operating systems. Our aim is to present these concepts and algorithms in a general setting that is not tied to one particular operating system. We present a large number of examples that pertain to the most popular and the most innovative operating systems, including Sun Microsystems' Solaris; Linux; Mach; Microsoft MS-DOS, Windows NT, Windows 2000, and Windows XP; DEC VMS and TOPS-20; IBM OS/2; and Apple Mac OS X.

In this text, when we refer to Windows XP as an example operating system, we are implying both Windows XP and Windows 2000. If a feature exists in Windows XP that is not available in Windows 2000, we will state this explicitly.

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.