

# George Coulouris Distributed Systems Concepts Design 3rd Edition

Explains fault tolerance in clear terms, with concrete examples drawn from real-world settings Highly practical focus aimed at building "mission-critical" networked applications that remain secure

Society is now completely driven by data with many industries relying on data to conduct business or basic functions within the organization. With the efficiencies that big data bring to all institutions, data is continuously being collected and analyzed.

However, data sets may be too complex for traditional data-processing, and therefore, different strategies must evolve to solve the issue. The field of big data works as a valuable tool for many different industries. The Research Anthology on Big Data Analytics, Architectures, and Applications is a complete reference source on big data analytics that offers the latest, innovative architectures and frameworks and explores a variety of applications within various industries. Offering an international perspective, the applications discussed within this anthology feature global representation. Covering topics such as advertising curricula, driven supply chain, and smart cities, this research anthology is ideal for data scientists, data analysts, computer

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engineers, software engineers, technologists, government officials, managers, CEOs, professors, graduate students, researchers, and academicians. *Distributed and Cloud Computing: From Parallel Processing to the Internet of Things* offers complete coverage of modern distributed computing technology including clusters, the grid, service-oriented architecture, massively parallel processors, peer-to-peer networking, and cloud computing. It is the first modern, up-to-date distributed systems textbook; it explains how to create high-performance, scalable, reliable systems, exposing the design principles, architecture, and innovative applications of parallel, distributed, and cloud computing systems. Topics covered by this book include: facilitating management, debugging, migration, and disaster recovery through virtualization; clustered systems for research or ecommerce applications; designing systems as web services; and social networking systems using peer-to-peer computing. The principles of cloud computing are discussed using examples from open-source and commercial applications, along with case studies from the leading distributed computing vendors such as Amazon, Microsoft, and Google. Each chapter includes exercises and further reading, with lecture slides and more available online. This book will be ideal for students taking a distributed systems or distributed computing class, as well as for

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professional system designers and engineers looking for a reference to the latest distributed technologies including cloud, P2P and grid computing. Complete coverage of modern distributed computing technology including clusters, the grid, service-oriented architecture, massively parallel processors, peer-to-peer networking, and cloud computing Includes case studies from the leading distributed computing vendors: Amazon, Microsoft, Google, and more Explains how to use virtualization to facilitate management, debugging, migration, and disaster recovery Designed for undergraduate or graduate students taking a distributed systems course—each chapter includes exercises and further reading, with lecture slides and more available online

- \* Comprehensive introduction to the fundamental results in the mathematical foundations of distributed computing
- \* Accompanied by supporting material, such as lecture notes and solutions for selected exercises
- \* Each chapter ends with bibliographical notes and a set of exercises
- \* Covers the fundamental models, issues and techniques, and features some of the more advanced topics

bull; Learn UNIX essentials with a concentration on communication, concurrency, and multithreading techniques bull; Full of ideas on how to design and implement good software along with unique projects throughout bull; Excellent companion to Stevens'

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## Advanced UNIX System Programming

Each Chapter concludes with a Summary.) 1.

Characterization of Distributed Systems.

Introduction. Examples of Distributed Systems.

Resource Sharing and the Web. Challenges. 2.

System Models. Introduction. Architectural Models.

Fundamental Models. 3. Networking and

Internetworking. Introduction. Types of Network.

Network Principles. Internet Protocols. Network

Case Studies: Ethernet, Wireless LAN and ATM. 4.

Interprocess Communication. Introduction. The APIs

for the Internet Protocols. External Data

Representation and Marshalling. Client-Server

Communication. Group Communication. Case

Study: Interprocess Communication in UNIX. 5.

Distributed Objects and Remote Invocation.

Introduction. Communication between Distributed

Objects. Remote Procedure Calling. Events and

Notifications. Java RMI Case Study. 6. Operating

System Support. Introduction. The Operating System

Layer. Protection. Processes and Threads.

Communication and Invocation. Operating System

Architecture. 7. Security. Introduction. Overview of

Security Techniques. Cryptographic Algorithms.

Digital Signatures. Cryptographic Pragmatics. Case

Studies: Needham-Schroeder, Kerberos, SSL, and

Millicent. 8. Distributed File Servers. Introduction.

File Service Architecture. Sun Network File System.

The Andrew File System. Recent advances. 9.

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Name Services. Introduction. Name Services and the Domain Name System. Directory and Discovery Services. Case study of the Global Name Service. Case study of the X.500 Directory Service. 10. Time and Global States. Introduction. Clocks, Events, and Process States. Synchronizing Physical Clocks. Logical Time and Logical Clocks. Global States. Distributed debugging. 11. Coordination and Agreement. Introduction. Distributed Mutual Exclusion. Elections. Multicast Communication. Consensus and Related Problems. 12. Transactions and

Designing distributed computing systems is a complex process requiring a solid understanding of the design problems and the theoretical and practical aspects of their solutions. This comprehensive textbook covers the fundamental principles and models underlying the theory, algorithms and systems aspects of distributed computing. Broad and detailed coverage of the theory is balanced with practical systems-related issues such as mutual exclusion, deadlock detection, authentication, and failure recovery. Algorithms are carefully selected, lucidly presented, and described without complex proofs. Simple explanations and illustrations are used to elucidate the algorithms. Important emerging topics such as peer-to-peer networks and network security are also considered. With vital algorithms, numerous illustrations, examples and homework

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problems, this textbook is suitable for advanced undergraduate and graduate students of electrical and computer engineering and computer science. Practitioners in data networking and sensor networks will also find this a valuable resource. Additional resources are available online at [www.cambridge.org/9780521876346](http://www.cambridge.org/9780521876346).

For this third edition of *Distributed Systems*, the material has been thoroughly revised and extended, integrating principles and paradigms into nine chapters: 1. Introduction 2. Architectures 3. Processes 4. Communication 5. Naming 6. Coordination 7. Replication 8. Fault tolerance 9. Security A separation has been made between basic material and more specific subjects. The latter have been organized into boxed sections, which may be skipped on first reading. To assist in understanding the more algorithmic parts, example programs in Python have been included. The examples in the book leave out many details for readability, but the complete code is available through the book's Website, hosted at [www.distributed-systems.net](http://www.distributed-systems.net). A personalized digital copy of the book is available for free, as well as a printed version through Amazon.com.

The chapters in this new edition have been revised and updated. New material includes coverage of large-scale applications, fault modelling and fault tolerance, models of system execution, object

orientation and distributed multimedia systems.

Welcome to the proceedings of the 2nd International Symposium on Parallel and Distributed Processing and Applications (ISPA2004) which was held in Hong Kong, China, 13–15 December, 2004. With the advance of computer networks and hardware technology, parallel and distributed processing has become a key technology which plays an important part in determining future research and development activities in many academic and industrial branches. It provides a means to solve computationally intensive problems by improving processing speed. It is also the only - able approach to building highly reliable and inherently distributed applications. ISPA2004 provided a forum for scientists and engineers in academia and industry to exchange and discuss their experiences, new ideas, research results, and applications about all aspects of parallel and distributed computing.

There was a very large number of paper submissions (361) from 26 countries and regions, including not only Asia and the Pacific, but also Europe and North America. All submissions were reviewed by at least three program or technical committee members or external reviewers. It was extremely difficult to select the presentations for the conference because there were so many excellent and interesting submissions. In order to allocate as many papers as possible and keep the high quality of the conference, we finally decided to accept 78

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regular papers and 38 short papers for oral technical presentations. We believe that all of these papers and topics not only provide novel ideas, new results, work in progress and state-of-the-art techniques in this field, but also stimulate the future research activities in the area of parallel and distributed computing with applications.

Java's rich, comprehensive networking interfaces make it an ideal platform for building today's networked, Internet-centered applications, components, and Web services. Now, two Java networking experts demystify Java's complex networking API, giving developers practical insight into the key techniques of network development, and providing extensive code examples that show exactly how it's done. David and Michael Reilly begin by reviewing fundamental Internet architecture and TCP/IP protocol concepts all network programmers need to understand, as well as general Java features and techniques that are especially important in network programming, such as exception handling and input/output. Using practical examples, they show how to write clients and servers using UDP and TCP; how to build multithreaded network applications; and how to utilize HTTP and access the Web using Java. The book includes detailed coverage of server-side application development; distributed computing development with RMI and CORBA; and email-enabling applications with the

powerful JavaMail API. For all beginning to intermediate Java programmers, network programmers who need to learn to work with Java. The 2004 IFIP International Conference on Intelligence in Communication Systems (INTELLCOMM2004), held in Bangkok, Thailand, 23–26 November 2004, was the successor and an expansion of SMARTNET, a series of annual conferences on intelligence in networks held during 1995–2003 under the auspices of IFIP TC6's Working Group 6.7. The Internet and Web provide more connection facilities, hence the man-man, man-machine and machine-machine interactions will increase and communication will have an important role in modern systems. In order to obtain effective and efficient communication, artistic, social and technical issues have to be tackled in a holistic and integrated manner. However, communication techniques, concepts and solutions which have been developed so far treat these issues separately, so that there arises a need for communication researchers and practitioners in different fields (engineering, science and arts) to meet, share their experience and explore all possibilities of developing integrated and advanced solutions which incorporate ideas from such disciplines as communication arts, art design, linguistics, Web technologies, computer system architecture and protocols, computer science and artificial intelligence. INTELLCOMM 2004 was jointly

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sponsored by IFIP WG 6.7: Smart Networks and WG 6.4: Internet Applications Engineering and aimed to provide an international forum which brings academia, researchers, practitioners and service providers together. The discussion areas covered the latest research topics and advanced technological solutions in the area of intelligence in communication systems, ranging from architectures for adaptable networks/services and Semantic Web/Webservices technologies to intelligent service application interface and intelligent human interaction. INTELLCOMM 2004 received 112 paper submissions from 28 countries. From these, 24 were accepted, and are included in this proceedings. There were also 3 papers accepted for poster presentation, published separately.

This second edition of *Distributed Systems, Principles & Paradigms*, covers the principles, advanced concepts, and technologies of distributed systems in detail, including: communication, replication, fault tolerance, and security. Intended for use in a senior/graduate level distributed systems course or by professionals, this text systematically shows how distributed systems are designed and implemented in real systems.

*Distributed Systems: An Algorithmic Approach, Second Edition* provides a balanced and straightforward treatment of the underlying theory and practical applications of distributed computing.

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As in the previous version, the language is kept as unobscured as possible—clarity is given priority over mathematical formalism. This easily digestible text: Features significant updates that mirror the phenomenal growth of distributed systems Explores new topics related to peer-to-peer and social networks Includes fresh exercises, examples, and case studies Supplying a solid understanding of the key principles of distributed computing and their relationship to real-world applications, *Distributed Systems: An Algorithmic Approach, Second Edition* makes both an ideal textbook and a handy professional reference.

The 14th International Symposium on Distributed Computing and Artificial Intelligence 2017 (DCAI 2017) provided a forum for presenting the application of innovative techniques to study and solve complex problems. The exchange of ideas between scientists and technicians from both the academic and industrial sector is essential to advancing the development of systems that can meet the ever-growing demands of today's society. The book brings together past experience, current work and promising future trends in distributed computing, artificial intelligence and their applications to efficiently solve real-world problems. It combines contributions in well-established and evolving areas of research, including the content of the DCAI 17 Special Sessions, which focused on multi-

disciplinary and transversal aspects, such as AI-driven methods for multimodal networks and processes modeling, and secure management towards smart buildings and smart grids. The symposium was jointly organized by the Polytechnic of Porto, the Osaka Institute of Technology and the University of Salamanca. The latest event was held in Porto, Portugal, from 21st to 23rd June 2017. Distributed applications are a necessity in most central application sectors of the contemporary information society, including e-commerce, e-banking, e-learning, e-health, telecommunication and transportation. This results from a tremendous growth of the role that the Internet plays in business, administration and our everyday activities. This trend is going to be even further expanded in the context of advances in broadband wireless communication. New Developments in Distributed Applications and Interoperable Systems focuses on the techniques available or under development with the goal to ease the burden of constructing reliable and maintainable interoperable information systems providing services in the global communicating environment. The topics covered in this book include: Context-aware applications; Integration and interoperability of distributed systems; Software architectures and services for open distributed systems; Management, security and quality of service issues in distributed systems; Software agents and mobility; Internet and

other related problem areas. The book contains the proceedings of the Third International Working Conference on Distributed Applications and Interoperable Systems (DAIS'2001), which was held in September 2001 in Kraków, Poland, and sponsored by the International Federation on Information Processing (IFIP). The conference program presents the state of the art in research concerning distributed and interoperable systems. This is a topical research area where much activity is currently in progress. Interesting new aspects and innovative contributions are still arising regularly. The DAIS series of conferences is one of the main international forums where these important findings are reported.

This book constitutes the refereed proceedings of the 6th IFIP WG 6.1 International Conference on Distributed Applications and Interoperable Systems, DAIS 2006, held in Bologna, Italy, June 2006. The book presents 21 revised regular and 5 revised work-in-progress papers, on architectures, models, technologies and platforms for interoperable, scalable and adaptable systems and cover subjects as methodological aspects, tools and language of building adaptable distributed and interoperable services, and many more.

A detailed introduction to interdisciplinary application area of distributed systems, namely the computer support of individuals trying to solve a problem in cooperation with each other but not necessarily having identical work places or working times. The book is addressed to students of distributed systems, communications, information science and socio-organizational theory, as well as to users and

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developers of systems with group communication and cooperation as top priorities.

Provides a broad and up-to-date account of the principles and practice of distributed system design.

Large and complex software systems, such as Internet applications, depend on distributed applications. Although Java has helped reduce the complexity of distributed systems, developers still have to contend with diverse hardware platforms, remote communication over networks, and system failures. Java in Distributed Systems provides a comprehensive guide for anyone wishing to deepen their knowledge of Java in distributed applications. Beginning with a tutorial guide to distributed programming in the Java environment, it shows you how building blocks from threads to Jini can help you to fulfil Sun's vision, that 'the Network is the Computer'. It then goes on to focus on aspects that are still challenging researchers such as concurrency, distribution, and persistence. Key Features: - One of the few books to focus specifically on Java for building distributed applications - Coverage includes threads & sockets, RMI, CORBA, Voyager, Mobile agents, JDBC, object-oriented databases, Java spaces and Jini - Includes advanced chapters on the cutting edge of Java language development, including the author's own proposed Dejay (Distributed Java), an open-source project that offers a unified approach to concurrency, distribution and persistence

A comprehensive overview of data mining from an algorithmic perspective, integrating related concepts from machine learning and statistics.

Broad and up-to-date coverage of the principles and practice in the fast moving area of Distributed Systems. Distributed Systems provides students of computer science and engineering with the skills they will need to design and maintain software for distributed applications. It will also be

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invaluable to software engineers and systems designers wishing to understand new and future developments in the field. From mobile phones to the Internet, our lives depend increasingly on distributed systems linking computers and other devices together in a seamless and transparent way. The fifth edition of this best-selling text continues to provide a comprehensive source of material on the principles and practice of distributed computer systems and the exciting new developments based on them, using a wealth of modern case studies to illustrate their design and development. The depth of coverage will enable students to evaluate existing distributed systems and design new ones.

This is the eBook of the printed book and may not include any media, website access codes, or print supplements that may come packaged with the bound book. Broad and up-to-date coverage of the principles and practice in the fast moving area of Distributed Systems. Distributed Systems provides students of computer science and engineering with the skills they will need to design and maintain software for distributed applications. It will also be invaluable to software engineers and systems designers wishing to understand new and future developments in the field. From mobile phones to the Internet, our lives depend increasingly on distributed systems linking computers and other devices together in a seamless and transparent way. The fifth edition of this best-selling text continues to provide a comprehensive source of material on the principles and practice of distributed computer systems and the exciting new developments based on them, using a wealth of modern case studies to illustrate their design and development. The depth of coverage will enable readers to evaluate existing distributed systems and design new ones. This timely text/reference describes the development and implementation of large-scale distributed processing systems using open source tools and technologies. Comprehensive in

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scope, the book presents state-of-the-art material on building high performance distributed computing systems, providing practical guidance and best practices as well as describing theoretical software frameworks. Features: describes the fundamentals of building scalable software systems for large-scale data processing in the new paradigm of high performance distributed computing; presents an overview of the Hadoop ecosystem, followed by step-by-step instruction on its installation, programming and execution; Reviews the basics of Spark, including resilient distributed datasets, and examines Hadoop streaming and working with Scalding; Provides detailed case studies on approaches to clustering, data classification and regression analysis; Explains the process of creating a working recommender system using Scalding and Spark.

Technological advancements have extracted a vast amount of useful knowledge and information for applications and services. These developments have evoked intelligent solutions that have been utilized in efforts to secure this data and avoid potential complex problems. Advances in Secure Computing, Internet Services, and Applications presents current research on the applications of computational intelligence in order to focus on the challenge humans face when securing knowledge and data.

This book is a vital reference source for researchers, lecturers, professors, students, and developers, who have interest in secure computing and recent advanced in real life applications.

Distributed Operating Systems will provide engineers, educators, and researchers with an in-

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depth understanding of the full range of distributed operating systems components. Each chapter addresses de-facto standards, popular technologies, and design principles applicable to a wide variety of systems. Complete with chapter summaries, end-of-chapter exercises and bibliographies, Distributed Operating Systems concludes with a set of case studies that provide real-world insights into four distributed operating systems.

This book provides an in-depth study concerning a class of problems in the general area of load sharing and balancing in parallel and distributed systems. The authors present the design and analysis of load distribution strategies for arbitrarily divisible loads in multiprocessor/multicomputer systems subjects to the system constraints in the form of communication delays. In particular, two system architecture-single-level tree or star network, and linear network-are thoroughly analyzed. The text studies two different cases, one of processors with front-ends and the other without. It concentrates on load distribution strategies and performance analysis, and does not cover issues related to implementation of these strategies on a specific system. The book collates research results developed mainly by two groups at the Indian Institute of Science and the State University of New York at Stony Brook. It also covers results by other researchers that have either appeared or are due to

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appear in computer science literature. The book also provides relevant but easily understandable numerical examples and figures to illustrate important concepts. It is the first book in this area and is intended to spur further research enabling these ideas to be applied to a more general class of loads. The new methodology introduced here allows a close examination of issues involving the integration of communication and computation. In fact, what is presented is a new "calculus" for load sharing problems.

A lucid and up-to-date introduction to the fundamentals of distributed computing systems As distributed systems become increasingly available, the need for a fundamental discussion of the subject has grown. Designed for first-year graduate students and advanced undergraduates as well as practicing computer engineers seeking a solid grounding in the subject, this well-organized text covers the fundamental concepts in distributed computing systems such as time, state, simultaneity, order, knowledge, failure, and agreement in distributed systems. Departing from the focus on shared memory and synchronous systems commonly taken by other texts, this is the first useful reference based on an asynchronous model of distributed computing, the most widely used in academia and industry. The emphasis of the book is on developing general mechanisms that can be applied to a variety of

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problems. Its examples-clocks, locks, cameras, sensors, controllers, slicers, and synchronizers-have been carefully chosen so that they are fundamental and yet useful in practical contexts. The text's advantages include: Emphasizes general mechanisms that can be applied to a variety of problems Uses a simple induction-based technique to prove correctness of all algorithms Includes a variety of exercises at the end of each chapter Contains material that has been extensively class tested Gives instructor flexibility in choosing appropriate balance between practice and theory of distributed computing

The new edition of this bestselling title on Distributed Systems has been thoroughly revised throughout to reflect the state of the art in this rapidly developing field. It emphasizes the principles used in the design and construction of distributed computer systems based on networks of workstations and server computers.

In Distributed Algorithms, Nancy Lynch provides a blueprint for designing, implementing, and analyzing distributed algorithms. She directs her book at a wide audience, including students, programmers, system designers, and researchers. Distributed Algorithms contains the most significant algorithms and impossibility results in the area, all in a simple automata-theoretic setting. The algorithms are proved correct, and their complexity is analyzed

according to precisely defined complexity measures. The problems covered include resource allocation, communication, consensus among distributed processes, data consistency, deadlock detection, leader election, global snapshots, and many others. The material is organized according to the system model—first by the timing model and then by the interprocess communication mechanism. The material on system models is isolated in separate chapters for easy reference. The presentation is completely rigorous, yet is intuitive enough for immediate comprehension. This book familiarizes readers with important problems, algorithms, and impossibility results in the area: readers can then recognize the problems when they arise in practice, apply the algorithms to solve them, and use the impossibility results to determine whether problems are unsolvable. The book also provides readers with the basic mathematical tools for designing new algorithms and proving new impossibility results. In addition, it teaches readers how to reason carefully about distributed algorithms—to model them formally, devise precise specifications for their required behavior, prove their correctness, and evaluate their performance with realistic measures.

This book presents the refereed proceedings of the 1998 Ada-Europe International Conference on Reliable Software Technologies, Ada-Europe'98, held in Uppsala, Sweden, in June 1998. The 23

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revised full papers presented together with two invited contributions were carefully selected by the program committee. The papers address all current aspects of the Ada programming language; they are organized in sections on Ada 95 and Java, Ada 95 language and tools, distributed systems, real-time systems, case studies and experiments, software quality, software development, software architectures, and high integrity systems.

Introduction : distributed systems - The model - Communication protocols - Routing algorithms - Deadlock-free packet switching - Wave and traversal algorithms - Election algorithms - Termination detection - Anonymous networks - Snapshots - Sense of direction and orientation - Synchrony in networks - Fault tolerance in distributed systems - Fault tolerance in asynchronous systems - Fault tolerance in synchronous systems - Failure detection - Stabilization.

Distributed Computing is a textbook designed for students of computer science engineering, information technology, and computer applications. The book provides a clear understanding of the computing aspects of distributed systems.

Here is the CORBA book that every C++ software engineer has been waiting for. Advanced CORBA® Programming with C++ provides designers and developers with the tools required to understand CORBA technology at the architectural, design, and

source code levels. This book offers hands-on explanations for building efficient applications, as well as lucid examples that provide practical advice on avoiding costly mistakes. With this book as a guide, programmers will find the support they need to successfully undertake industrial-strength CORBA development projects. The content is systematically arranged and presented so the book may be used as both a tutorial and a reference. The rich example programs in this definitive text show CORBA developers how to write clearer code that is more maintainable, portable, and efficient. The authors' detailed coverage of the IDL-to-C++ mapping moves beyond the mechanics of the APIs to discuss topics such as potential pitfalls and efficiency. An in-depth presentation of the new Portable Object Adapter (POA) explains how to take advantage of its numerous features to create scalable and high-performance servers. In addition, detailed discussion of advanced topics, such as garbage collection and multithreading, provides developers with the knowledge they need to write commercial applications. Other highlights

- In-depth coverage of IDL, including common idioms and design trade-offs
- Complete and detailed explanations of the Life Cycle, Naming, Trading, and Event Services
- Discussion of IIOP and implementation repositories
- Insight into the dynamic aspects of CORBA, such as dynamic typing and the new DynAny interfaces

Advice on selecting appropriate application architectures and designs Detailed, portable, and vendor-independent source code

In the race to compete in today's fast-moving markets, large enterprises are busy adopting new technologies for creating new products, processes, and business models. But one obstacle on the road to digital transformation is placing too much emphasis on technology, and not enough on the types of processes technology enables. What if different lines of business could build their own services and applications—and decision-making was distributed rather than centralized? This report explores the concept of a digital business platform as a way of empowering individual business sectors to act on data in real time. Much innovation in a digital enterprise will increasingly happen at the edge, whether it involves business users (from marketers to data scientists) or IoT devices. To facilitate the process, your core IT team can provide these sectors with the digital tools they need to innovate quickly. This report explores: Key cultural and organizational changes for developing business capabilities through cross-functional product teams A platform for integrating applications, data sources, business partners, clients, mobile apps, social networks, and IoT devices Creating internal API programs for building innovative edge services in low-code or no-code environments Tools including

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Integration Platform as a Service, Application Platform as a Service, and Integration Software as a Service The challenge of integrating microservices and serverless architectures Event-driven architectures for processing and reacting to events in real time You'll also learn about a complete pervasive integration solution as a core component of a digital business platform to serve every audience in your organization.

This new edition represents a significant update of this best-selling textbook for distributed systems. It incorporates and anticipates the major developments in distributed systems technology. All chapters have been thoroughly revised and updated, including emphasis on the Internet, intranets, mobility and middleware. There is increased emphasis on algorithms and discussion of security has been brought forward in the text and integrated with other related technologies. As with previous editions, this book is intended to provide knowledge of the principles and practice of distributed system design. Information is conveyed in sufficient depth to allow readers to evaluate existing systems or design new ones. Case studies illustrate the design concepts for each major topic.

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