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Good backup and recovery strategies are key to the health of any organization. Medium- to very-large-scale systems administrators have to protect large amounts of critical data as well as design backup solutions that are scalable and optimized to meet changing conditions. Pro Data Backup and Recovery will cover some of the more common backup applications, such as Symantec NetBackup/BackupExec, EMC NetWorker, and CommVault, but the main discussion will focus on the implementation of 21st century architectures that allow the backup software to be a "commodity" item. The underlying architecture provides the framework for meeting the requirements of data protection for the organization. This book covers new

developments in data protection as well as the impact of single-instance storage upon backup infrastructures. It discusses the impact of backup and data replication, the often misapplied B2D and D2D strategies, and "tapeless" backup environments. Continuous data protection and remote replication strategies are also addressed as they are integrated within backup strategies—a very important topic today. Learn backup solution design regardless of specific backup software Design realistic recovery solutions Take into account new data protection standards and the impact of data replication Whether you are using NetBackup, CommVault, or some other backup software, Pro Data Backup and Recovery will give you the information you need to keep your data safe and available. Replication Techniques in Distributed Systems organizes and surveys the spectrum of replication protocols and systems that achieve high availability by replicating entities in failure-prone distributed computing environments. The entities discussed in this book vary from passive untyped data objects, to typed and complex objects, to processes and messages. Replication Techniques in Distributed Systems contains definitions and introductory material suitable for a beginner, theoretical foundations and algorithms, an

annotated bibliography of commercial and experimental prototype systems, as well as short guides to recommended further readings in specialized subtopics. This book can be used as recommended or required reading in graduate courses in academia, as well as a handbook for designers and implementors of systems that must deal with replication issues in distributed systems. Two techniques, namely, reverse scaling and series peaking, are proposed to ease the trade-offs in equalizer design. Dual- and triple-loop adaptation schemes are also presented for stand-alone equalizers and a merged equalizer/CDR circuit, respectively. The loops enable adaptation to transmitter swing variations and a range of channel loss profiles. Cybellium Ltd is dedicated to empowering individuals and organizations with the knowledge and skills they need to navigate the ever-evolving computer science landscape securely and learn only the latest information available on any subject in the category of computer science including: - Information Technology (IT) - Cyber Security - Information Security - Big Data - Artificial Intelligence (AI) - Engineering - Robotics - Standards and compliance Our mission is to be at the forefront of computer science education, offering a wide and comprehensive range of

resources, including books, courses, classes and training programs, tailored to meet the diverse needs of any subject in computer science. Visit https://www.cybellium.com for more books. Often considered more of an art than a science, books on clustering have been dominated by learning through example with techniques chosen almost through trial and error. Even the two most popular, and most related, clustering methods-K-Means for partitioning and Ward's method for hierarchical clustering-have lacked the theoretical underpinning req Traditional theory and practice of write-ahead logging and of database recovery focus on three failure classes: transaction failures (typically due to deadlocks) resolved by transaction rollback; system failures (typically power or software faults) resolved by restart with log analysis, "redo," and "undo" phases; and media failures (typically hardware faults) resolved by restore operations that combine multiple types of backups and log replay. The recent addition of single-page failures and single-page recovery has opened new opportunities far beyond the original aim of immediate, lossless repair of single-page wear-out in novel or traditional storage hardware. In the contexts of system and media failures, efficient single-page recovery enables on-demand incremental

"redo" and "undo" as part of system restart or media restore operations. This can give the illusion of practically instantaneous restart and restore: instant restart permits processing new queries and updates seconds after system reboot and instant restore permits resuming queries and updates on empty replacement media as if those were already fully recovered. In the context of node and network failures, instant restart and instant restore combine to enable practically instant failover from a failing database node to one holding merely an out-of-date backup and a log archive, yet without loss of data, updates, or transactional integrity. In addition to these instant recovery techniques, the discussion introduces self-repairing indexes and much faster offline restore operations, which impose no slowdown in backup operations and hardly any slowdown in log archiving operations. The new restore techniques also render differential and incremental backups obsolete, complete backup commands on a database server practically instantly, and even permit taking full up-to-date backups without imposing any load on the database server. Compared to the first version of this book, this second edition adds sections on applications of single-page repair, instant restart, single-pass restore, and instant

restore. Moreover, it adds sections on instant failover among nodes in a cluster, applications of instant failover, recovery for file systems and data files, and the performance of instant restart and instant restore. The second edition of this bestselling title is a perfect blend of theoretical knowledge and practical application. It progresses gradually from basic to advance concepts in database management systems, with numerous solved exercises to make learning easier and interesting. New to this edition are discussions on more commercial database management systems. In this book, Oracle experts Darl Kuhn, Sam Alapati, and Arup Nanda show you the power of Recovery Manager, or RMAN, which is Oracle's backup and recovery tool of choice. Oracle RMAN Recipes helps you take advantage of all that RMAN has to offer. This handy guide demystifies the steps required to protect your business data. It provides ready-made and example-based solutions to common (and some not-so-common) backup and recovery operations. In recent years, Condition Monitoring (CM), which can be performed via several sensor channels, has been recognized as an effective paradigm for failure prevention of operational equipment or processes. However, the complexity caused by

asynchronous data collection with different and/or time-varying sampling/transmission rates has long been a hindrance in the effective use of multichannel data in constructing empirical models. The problem becomes more challenging when sensor readings are incomplete. Traditional sensor data recovery techniques are often prohibited in asynchronous CM environments, not to mention sparse datasets. The proposed Functional Principal Component Analysis (FPCA) methodologies, e.g., nonparametric FPC model and semi-parametric functional regression model, provide new sensor data recovery techniques to improve the reliability and robustness of multichannel CM systems. Based on the FPCA results obtained from historical asynchronous data, the deviation from the smoothing trajectory of each sensor signal can be described by a set of unit-specific model parameters. Furthermore, the relationships among these sensor signals can be identified and used to construct regression models for the correlated signals. For real-time or online implementation, use of these models along with the parameters adjusted by real-time CM data become powerful tools for dealing with asynchronous CM data while recovering lost data when needed. To improve the robustness and predictability in dealing with

asynchronous data, which may be skewed in probability distribution, robust methods were developed based on Functional Data Analysis (FDA) and Local Quantile Regression (LQR) models. Case studies examining turbofan aircraft engines and an experimental two-tank flow-control loop are used to demonstrate the effectiveness and adaptability of the proposed sensor data recovery techniques. The proposed methods may also find a variety of applications in systems of other industries, such as nuclear power plants, wind turbines, railway systems, economic fields, etc., which may face asynchronous sampling and/or missing data collection problems. This comprehensive manual covers three areas in which system administrators must be proficient to successfully recover data: the structure and operating principles of the most popular file systems, automatic data recovery techniques, and manual recovery techniques used in cases of total data destruction. Data recovery from hard drives and optical storage in Windows, BSD, and Linux file systems is described, as are automatic recovery utilities, manual and automatic recovery of deleted files on ext2/ext3 partitions and NTFS partitions, formatted NTFS partitions and deleted UFS/FFS files, RAID data recovery, media restoration with physical damage, and data loss

prevention. "Recovery techniques are an important aspect of database systems. They are essential to ensure that data integrity is maintained after any type of failure occurs. The recovery mechanism must be designed so that the availability and performance of the system are not unacceptably impacted by the recovery algorithms running during normal execution. On the other hand, enough information must be stored so that the database can be restored or transactions backed out in a reasonable amount of time. Concepts, techniques, and problems associated with database recovery will be presented in this thesis. The recovery issues for both centralized and distributed systems will be discussed, along with the tradeoffs of different recovery tools. The database recovery schemes in IMS/VS, DB2 and SDD-1 will be described to show approaches in existing systems."--Abstract. Advances in Digital Forensics VI describes original research results and innovative applications in the discipline of digital forensics. In addition, it highlights some of the major technical and legal issues related to digital evidence and electronic crime investigations. The areas of coverage include: Themes and Issues, Forensic Techniques, Internet Crime Investigations, Live Forensics, Advanced Forensic Techniques,

and Forensic Tools. This book is the sixth volume in the annual series produced by the International Federation for Information Processing (IFIP) Working Group 11.9 on Digital Forensics, an international community of scientists, engineers and practitioners dedicated to advancing the state of the art of research and practice in digital forensics. The book contains a selection of twenty-one edited papers from the Sixth Annual IFIP WG 11.9 International Conference on Digital Forensics, held at the University of Hong Kong, Hong Kong, China, in January 2010. "This book is a must for anyone attempting to examine the iPhone. The level of forensic detail is excellent. If only all guides to forensics were written with this clarity!"-Andrew Sheldon, Director of Evidence Talks, computer forensics experts With iPhone use increasing in business networks, IT and security professionals face a serious challenge: these devices store an enormous amount of information. If your staff conducts business with an iPhone, you need to know how to recover, analyze, and securely destroy sensitive data. iPhone Forensics supplies the knowledge necessary to conduct complete and highly specialized forensic analysis of the iPhone, iPhone 3G, and iPod Touch. This book helps you: Determine what type of data is

stored on the device Break v1.x and v2.x passcode-protected iPhones to gain access to the device Build a custom recovery toolkit for the iPhone Interrupt iPhone 3G's "secure wipe" process Conduct data recovery of a v1.x and v2.x iPhone user disk partition, and preserve and recover the entire raw user disk partition Recover deleted voicemail, images, email, and other personal data, using data carving techniques Recover geotagged metadata from camera photos Discover Google map lookups, typing cache, and other data stored on the live file system Extract contact information from the iPhone's database Use different recovery strategies based on case needs And more. iPhone Forensics includes techniques used by more than 200 law enforcement agencies worldwide, and is a must-have for any corporate compliance and disaster recovery plan. RMAN Recipes for Oracle Database 12c is an example-driven approach to the Oracle database administrator's #1 job responsibility: Be able to recover the database. Of all the things you are responsible for as database administrator, nothing is more important than the data itself. Like it or not, the fearsome responsibility of protecting your organization's most critical data falls squarely upon your shoulders: Lose that data

and your company could fail. Lose that data and you could be out of a job. Oracle's flagship database product fortunately implements a wide-ranging feature set to aid you in the all-important task of safeguarding against data loss. Recovery Manager, or RMAN, is at the heart of that feature set, and is the tool most-often used to initiate database backup and recovery operations. In this book, well-known authors and database experts Darl Kuhn, Sam Alapati, and Arup Nanda have created a set of examples encompassing the gamut of backup and recovery tasks that you might need to perform. Sometimes, especially when the heat is on, a good example is what you need to get started towards a solution. RMAN Recipes for Oracle Database 12c delivers. It'll be the book you reach for when that dreaded call comes in at 3:00am some dreary morning. It'll be the book that lets you sleep at night knowing that no matter what transpires, that you've done your job well and can recover from any outage. RMAN Recipes for Oracle Database 12c gets right to the point with quick and easy-to-read, step-by-step solutions that can help you backup and recover your data with confidence. Recovering deleted information from storage drives is a long-standing problem. Prior research has approached information recovery by developing file-

carving techniques. However, two issues present significant challenges to on-going efforts. 1) Prior knowledge of file types is required to construct file carvers, including file headers and footers, and 2) fragmentation prevents file carvers from achieving successful recovery. More recently, solid state drives or "SSDs" have become more popular. SSDs provide several advantages over traditional mechanical hard drives. They have smaller sizes, are constructed without moving parts, and provide better performance. However, due to problems such as wear leveling and write amplification in SSDs, files are severely fragmented and thus exacerbate the data recovery problem. In addition, SSDs use TRIM and garbage collection schemes to enhance their performance, which can permanently delete data immediately after a delete operation. In this dissertation, I developed a framework for recovering deleted files without knowing the file types and despite significant fragmentation. I developed the Recovery Filesystem by modifying an existing implementation of the exFat filesystem running on top of FUSE. The central idea underlying the Recovery Filesystem is a special identifier embedded in each data block. The identifier monitors each block by mapping the data block to a single file regardless of the

file status, existing or deleted. The block sequence number and creation timestamp are also maintained to facilitate the recovery process. In addition, I developed a garbage collection scheme for SSDs that maximizes data retention without sacrificing SSD performance. The experiments conducted in this dissertation demonstrate that the Recovery Filesystem yields acceptable read/write performance results. In addition, file recovery experiments used to compare the Recovery Filesystem with open source recovery techniques demonstrate that the Recovery Filesystem provides significant advantages in the case of fragmented data. Often considered more as an art than a science, the field of clustering has been dominated by learning through examples and by techniques chosen almost through trial-and-error. Even the most popular clustering methods--K-Means for partitioning the data set and Ward's method for hierarchical clustering--have lacked the theoretical attention that would establish a firm relationship between the two methods and relevant interpretation aids. Rather than the traditional set of ad hoc techniques, Clustering for Data Mining: A Data Recovery Approach presents a theory that not only closes gaps in K-Means and Ward methods, but also extends them into areas of current

interest, such as clustering mixed scale data and incomplete clustering. The author suggests original methods for both cluster finding and cluster description, addresses related topics such as principal component analysis, contingency measures, and data visualization, and includes nearly 60 computational examples covering all stages of clustering, from data pre-processing to cluster validation and results interpretation. This author's unique attention to data recovery methods, theory-based advice, pre- and post-processing issues that are beyond the scope of most texts, and clear, practical instructions for real-world data mining make this book ideally suited for virtually all purposes: for teaching, for self-study, and for professional reference. Often considered more as an art than a science, the field of clustering has been dominated by learning through examples and by techniques chosen almost through trial-and-error. Even the most popular clustering methods--K-Means for partitioning the data set and Ward's method for hierarchical clustering--have lacked the theoretical attention that wou The two-volume Proceedings set CCIS 1675 and 1676 constitutes the refereed proceedings of the Second International Conference, ARTIIS 2022, held in Santiago de Compostela, Spain, during September 12-15, 2022. The 72 papers included

in these proceedings were carefully reviewed and selected from 191 submissions. These papers were categorized into 2 technical tracks, i.e., Sustainability and Ethics, Security, and Privacy. Traditional theory and practice of write-ahead logging and of database recovery techniques revolve around three failure classes: transaction failures resolved by rollback; system failures (typically software faults) resolved by restart with log analysis, "redo," and "undo" phases; and media failures (typically hardware faults) resolved by restore operations that combine multiple types of backups and log replay. The recent addition of single-page failures and single-page recovery has opened new opportunities far beyond its original aim of immediate, lossless repair of single-page wear-out in novel or traditional storage hardware. In the contexts of system and media failures, efficient single-page recovery enables on-demand incremental "redo" and "undo" as part of system restart or media restore operations. This can give the illusion of practically instantaneous restart and restore: instant restart permits processing new queries and updates seconds after system reboot and instant restore permits resuming queries and updates on empty replacement media as if those were already fully recovered. In

addition to these instant recovery techniques, the discussion introduces much faster offline restore operations without slowdown in backup operations and with hardly any slowdown in log archiving operations. The new restore techniques also render differential and incremental backups obsolete, complete backup commands on the database server practically instantly, and even permit taking full backups without imposing any load on the database server. Data loss can be happened either human made cause or system failure. If we know the reasons of data loss, we can reduce our data loss. In this section of this book, I'll introduce you with most common reason of data loss. After reading this book, you will be able to take necessary steps to protect your data from loss & recover it. What You'll Get Inside: Data Loss Reason of Data Loss 1) System Failure Prevention 2) Human Errors 3) Software Corruption 4) Computer viruses and Malware 5) Natural Disasters What is Data Recovery? How Data Recovery Process Work File Data Recovery for Hard Drive How you can determine a Physical Hard Drive Failure When you will have to Recover Hard Drive Recovering Hard Drive Deleted File Recovery [Windows] Formatted Drive Recovery RAW Recovery Recovering Files on Partition is lost File/Data Recovery for unreachable partition

File Recovery in case all the Partitions are lost File Data Recovery for Mac Introduction to MAC Undelete files on MAC Recovering deleted file from Trash Why deleted data is recoverable File recovery in MAC Hard Drive Data Recovery for MAC Lost Partition Recovery in MAC Recovering Data from Lost Partition File Data Recovery for USB What is USB Flash Drive Reason of losing files from USB Flash Drive Recovering File from Formatted USB Drive Recovering Lost Data from Pen Drive Reasons of File/Data Loss on Pen Drive Recovering Pen Drive Data (Using EaseUs Data Recovery Software) File Data Recovery for Memory Card & SD Card Reasons and Solutions of Data Loss File Data Recovery for Android Reason of Data Loss on Android Recovering Lost Data File Data Recovery For iPhone Reason of Data Losing on I-Phone Recovering iPhone Data Process 1 [Restoring data directly from iPhone] Process 2 [Restoring data from iTunes Backup] Process 3 [Restoring data from iCloud Backup] Data Recovery Software's Data Recovery Software for PC 1. Recuva 2. Pandora Recovery 3. Puran File Recovery 4. Glary Undelete 5. SoftPerfect File Recovery 6. EaseUS Data Recovery Wizard 7. Wise Data Recovery 8. Restoration 9. Free Undelete 10. ADRC Data Recovery Tools Data Recovery Software for Android 1. Android Data Recovery 2 Data Recovery for Android 3. iCare

Recovery 4. Data Recovery from Google Store 5. MyJad Android Data Recovery Take a Sneak Peak Inside (page 12): "Mac is the one of the most favorite operating system to users. It is introduced by Apple Inc. From the very beginning of the release Mac has won users mind. The developer of Mac has worked to give maximum protection to their user's data. However, like windows Mac users also face problem of data losing. Reason of data losing is same as data losing on Windows. Now I am going to describe how you can recover files on MAC using a small software called "EaseUs Data Recovery." It allows users to quickly get deleted, damaged or formatted data." This book constitutes the refereed proceedings of the 28th IFIP TC 11 International Information Security and Privacy Conference, SEC 2013, held in Auckland, New Zealand, in July 2013. The 31 revised full papers presented were carefully reviewed and selected from 83 submissions. The papers are organized in topical sections on malware, authentication and authorization, network security/cryptography, software security, policy compliance and obligations, privacy protection, risk analysis and security metrics, social engineering, and security management/forensics. Database Recovery presents an in-depth discussion on all aspects

of database recovery. Firstly, it introduces the topic informally to set the intuitive understanding, and then presents a formal treatment of recovery mechanism. In the past, recovery has been treated merely as a mechanism which is implemented on an ad-hoc basis. This book elevates the recovery from a mechanism to a concept, and presents its essential properties. A book on recovery is incomplete if it does not present how recovery is practiced in commercial systems. This book, therefore, presents a detailed description of recovery mechanisms as implemented on Informix, OpenIngres, Oracle, and Sybase commercial database systems. Database Recovery is suitable as a textbook for a graduate-level course on database recovery, as a secondary text for a graduate-level course on database systems, and as a reference for researchers and practitioners in industry. Abstract: "This thesis presents fast crash recovery: a simple, efficient, and inexpensive method for increasing availability in distributed systems. In fast crash recovery we assume that critical resources will fail, and we do not attempt to mask the failures with redundant hardware or software. Instead, we design the system to recover so quickly that there is little downtime. This approach is intended for environments that can tolerate occasional

failures and cannot afford the cost and overhead of redundant resources. In particular, I focus on fast recovery of distributed state. An example of distributed state is the file caching information maintained by servers in most modern file systems. This information describes the state of file caches on client workstations. After a crash, a server must recover this informationin order to guarantee the consistency of the caches. Unfortunately, distributed state recovery can be slow and complex. The techniques I have developed reduce state recovery from several minutes to under six seconds for a Sprite file server [Ouster88] with 40 clients. This thesis evaluates three distributed state recovery techniques based on their speed, complexity, and performance overhead. In client-driven recovery clients send their state information to the server after a crash. The server uses this information to regenerate its copy of the distributed state. Server-driven recovery is a modification of client-driven recovery that is faster and eliminates cache inconsistencies that can arise during client-driven recovery. The fastest technique is transparent recovery, so-called because client workstations do not communicate with the server during recovery. Instead, the server stores its distributed

state in a protected area of its own main memory called the recovery box. The interface to the recovery box helps detect and prevent corruption of this state information. To achieve fast overallrecovery times, we must also recover other parts of the system quickly. For example, we can eliminate a lengthy file system consistency check by using a log-structured file system that recovers in seconds [Rosenb91]. By combining the improvements described in this thesis, a Sprite file server can reboot in under 30 seconds. This is two orders of magnitude faster than most modern file systems recover. In addition to evaluating distributed state recovery techniques, this thesis presents some overall guidelines for designing distributed systems that will recover quickly from crashes." Traditional theory and practice of write-ahead logging and of database recovery techniques revolve around three failure classes: transaction failures resolved by rollback; system failures (typically software faults) resolved by restart with log analysis, “redo,” and “undo” phases; and media failures (typically hardware faults) resolved by restore operations that combine multiple types of backups and log replay. The recent addition of single-page failures and single-page recovery has opened new opportunities far

beyond its original aim of immediate, lossless repair of single-page wear-out in novel or traditional storage hardware. In the contexts of system and media failures, efficient single-page recovery enables on-demand incremental "redo" and "undo" as part of system restart or media restore operations. This can give the illusion of practically instantaneous restart and restore: instant restart permits processing new queries and updates seconds after system reboot and instant restore permits resuming queries and updates on empty replacement media as if those were already fully recovered. In addition to these instant recovery techniques, the discussion introduces much faster offline restore operations without slowdown in backup operations and with hardly any slowdown in log archiving operations. The new restore techniques also render differential and incremental backups obsolete, complete backup commands on the database server practically instantly, and even permit taking full backups without imposing any load on the database server. Table of Contents: Preface / Acknowledgments / Introduction / Related Prior Work / Single-Page Recovery / Applications of Single-Page Recovery / Instant Restart after a System Failure / Single-Pass Restore / Applications of Single-Pass Restore / Instant Restore after a Media Failure /

Multiple Failures / Conclusions / References / Author Biographies Be guided through the techniques to back up and restore databases and files in SQL Server. Multiple techniques are presented for ensuring the integrity and consistency of database backups, as well as the reliability and manageability of restoring from backups. In today's data-driven world, the most important asset that a company has is its data. Data recovery strategies can be wide ranging; from the practically non-existent backup without verification to a very complex, distributed, and redundant system. An important objective for any database administrator is data loss prevention, and in a catastrophic data loss event, pre-defined data recovery techniques must be employed in order to get the databases back up and running efficiently and quickly. Using a tutorial method of teaching, Beginning Backup and Restore for SQL Server explores the many facets behind the principles of backing up and restoring data from your database, and then shows practical application methods for getting the work done quickly and correctly. This book is an essential guide toward discovering the correct path to protecting the data for your organization. What You'll Learn Be instructed on backup and restore techniques and principles Understand the importance of a

fully implemented backup plan in SQL Server Agent Integrate backup and restore techniques into an existing environment Consider space and time requirements for backup and restore operations Master the principles for common deployment types Who This Book Is For Administrators who need to learn or refresh their knowledge of how to back up and restore SQL Server databases in various scenarios This book constitutes the thoroughly refereed post-proceedings of the Second International Service Availability Symposium, ISAS 2005, held in Berlin, Germany in April 2005. The 15 revised full papers presented together with a keynote talk were carefully selected for inclusion in the book. The papers are organized in topical sections on data and computation availability, specifying, modeling and verifying service availability, high-availability by service-oriented architectures, modeling and composition, and verification and availability assessment. &Quot;SQL Server 7 Backup & Recovery is your one-stop resource for planning, developing, implementing, and managing backup and restore procedures. Learn to execute data protection strategies, implement a backup solution, and handle data recovery before potentially disastrous data loss occurs. You'll get details on the latest methods for increasing

database uptime and improving performance. The case studies included show you how to apply the techniques described in the book in your own environment."--BOOK JACKET. Computer crimes call for forensics specialists---people who know to find and follow the evidence. System Forensics, Investigation, and Response examines the fundamentals of system forensics what forensics is, an overview of computer crime, the challenges of system forensics, and forensics methods. It then addresses the tools, techniques, and methods used to perform computer forensics and investigation, including evidence collection, investigating information-hiding, recovering data, and more. The book closes with an exploration of incident and intrusion response, emerging technologies and future directions of the field, and additional system forensics resources. The Jones & Bartlett Learning Information Systems Security & Assurance Series delivers fundamental IT security principles packed with real world applications and examples for IT Security, Cybersecurity, Information Assurance, and Information Systems, Security programs. Authored by Certified Information Systems Security professionals (CISSPs), and reviewed by leading technical experts in the field, these books are current, forward-thinking resources

that enable readers to solve the cybersecurity challenges of today and tomorrow. This is a guide to optimizing performance of SQL Server written by a Microsoft insider. Traditional theory and practice of write-ahead logging and of database recovery focus on three failure classes: transaction failures (typically due to deadlocks) resolved by transaction rollback; system failures (typically power or software faults) resolved by restart with log analysis, "redo," and "undo" phases; and media failures (typically hardware faults) resolved by restore operations that combine multiple types of backups and log replay. The recent addition of single-page failures and single-page recovery has opened new opportunities far beyond the original aim of immediate, lossless repair of single-page wear-out in novel or traditional storage hardware. In the contexts of system and media failures, efficient single-page recovery enables on-demand incremental "redo" and "undo" as part of system restart or media restore operations. This can give the illusion of practically instantaneous restart and restore: instant restart permits processing new queries and updates seconds after system reboot and instant restore permits resuming queries and updates on empty replacement media as if those were already fully recovered. In the context of node and

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