

# Preface

The emergence of Web as a ubiquitous media for sharing content and services has led to the rapid growth of the Internet. At the same time, the number of users accessing Web-based content and services are growing exponentially. This has placed a heavy demand on Internet bandwidth and Web systems hosting content and application services. As a result, many Web sites are unable to manage this demand and offer their services in a timely manner.

Content Delivery Networks (CDNs) have emerged to overcome these limitations by offering infrastructure and mechanisms to deliver content and services in a scalable manner, and enhancing users' Web experience. Applications of CDNs can also be found in many communities, such as academic institutions, advertising media and Internet advertisement companies, data centers, Internet Service Providers (ISPs), online music retailers, mobile operators, consumer electronics manufacturers, and other carrier companies. Along with the proliferation, formation, and consolidation of the CDN landscape, new forms of Internet content and services are coming into picture while distribution and management of content is introducing new challenges in this domain. This raises new issues in the architecture, design and implementation of CDNs. The technological trends in this domain need to be explored in order to provide an exclusive research roadmap to the CDN community.

The book, entitled "*Content Delivery Networks*" offers the state-of-the-art CDN concepts, principles, characteristics, applications, platforms, design tips and hints, modeling, simulation, engineering approaches, and recent technological developments. The book builds on academic and industrial research and developments, and case studies that are being carried out at many different institutions around the world. In addition, the book identifies potential research directions and technologies that drive future innovations. We expect the book to serve as a valuable reference for larger audience such as systems architects, practitioners, product developers, researchers, and graduate level students.

**Overview and scope of the book:** This book will enable the readers to understand the basics, to identify the underlying technology, to summarize their knowledge on concepts, ideas, principles and various paradigms which span on broad CDNs areas. Therefore, aspects of CDNs in terms of basics, design process, practice, techniques,

performances, platforms, applications, and experimental results have been presented in a proper order. Fundamental methods, initiatives, significant research results, as well as references for further study have also been provided. Comparison of different design and development approaches are described at the appropriate places so that new researchers as well as advanced practitioners can use the CDNs evaluation as a research roadmap. All the contributions have been reviewed, edited, processed, and placed in the appropriate order to maintain consistency so that any reader irrespective of their level of knowledge and technological skills in CDNs would get the most out of it. The book is organized into three parts, namely, Part I: CDN Fundamentals; Part II: CDN Modeling and Performance; and Part III: Advanced CDN Platforms and Applications. The organization ensures the smooth flow of material as successive chapters build on prior ones. In particular, the topics of the book are the following:

- CDN basics and state of the art
- A taxonomy for categorizing CDN technologies
- Dynamic, scalable and efficient content replication techniques
- Content distribution and management
- Integrated use of replication with caching and its performance
- Request redirection for dynamic content
- Economics-informed modeling of CDNs
- Pricing schemes and CDN business models
- Mathematical modeling for resource allocation and management
- CDN performance
- CDN internetworking scenarios, architecture, and methodology
- Media streaming
- Dynamic CDNs and QoS-based adaptive content delivery
- Mobile dynamic CDNs
- Applications: live and on-demand video services, content delivery for community networks

Part I of the book focuses on the basic ideas, techniques, and current practices in CDNs. In Chap. 1, Pathan et al. provide an introduction to CDNs and their origins, evolution, and the start-of-the-art. This chapter defines CDNs and related terminologies, identifies its uniqueness when compared to related distributed computing paradigms, provides insights for CDNs, and presents authors' visions for future technological evolutions in the CDN domain. As there exist a wide range of studies covering different aspects of CDNs such as content distribution, replication, caching, and Web server placement, in Chap. 2, Pathan and Buyya present a comprehensive taxonomy of CDNs with a broad coverage of applications, features, and implementation techniques. In Chap. 3, Chen highlights on the need of a dynamic, scalable, and efficient replication technique for CDNs. In this context, the author presents algorithms for dynamic and self-organized replica placements respecting client QoS and server capacity constraints. In Chap. 4, Cardellini et al. explore the issues of content delivery through CDNs, with a special focus on the delivery of dynamically generated and personalized content. To analyze and

model simulations of various caching scheme, along with the integrated use of caching and replication, in Chap. 5, Stamos et al. present related design methodology and share implementation experiences, while cover various topics related to Web caching in a CDN simulation framework. In Chap. 6, Ranjan describes request redirection techniques in CDNs and presents a proof-of-the-concept implementation of a technique called WARD to assist the redirection of dynamic content.

Part II of this book focuses on the economic and mathematical modeling of CDNs and their performance. Building on game theory, in Chap. 7, Christin et al. present a cost-based model for agents participating in a CDN overlay and analyze incentives in link establishments in CDNs. In Chap. 8, Hosanagar discusses the economics of content delivery market and provides a model to capture content providers' value from CDN services and uses that to discuss pricing policies. In Chap. 9, Bektaş; and Ouveysi demonstrate how a variety of resource management and allocation problems in CDN domain can be formulated in terms of mathematical models. Sitaraman et al. present global overlay routing supported by Akamai along with its performance and availability benefits in Chap. 10.

Part III, the final part of the book, focuses on advanced CDN platforms and applications with wide appeal. In Chap. 11, Yoshida describes FCAN, a dynamic CDN network to alleviate flash crowds. Fortino et al. presents a CDN-based architecture supporting the collaborative playback service in Chap. 12, by describing the Hierarchical COoperative COntrol Protocol (HCOCOP) which enables the shared media streaming control in collaborative playback sessions. In Chap. 13, Czyrnek et al. address the key aspects of the multimedia CDN design based on the presentation of iTVP, a platform which is built for IP-based delivery of multimedia content on a country-wide scale to a large number of concurrent users. The information dissemination techniques in mobile CDNs, along with related challenges and current status are presented in Chap. 14 by Loulloudes et al. In Chap. 15, Plagemann et al. discuss the infrastructures for community networks based on CDNs. Finally, in the last chapter of the book, Pathan et al. present different models for internetworking between CDNs and identify the challenges in realizing them.

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Prior technical sources are acknowledged citing them at appropriate places in the book. In case of any error we would like to receive feedback so that it could be taken into consideration in the next edition.

We hope that this book will serve as a valuable text for students especially at graduate level and reference for researchers and practitioners working in the CDNs and its emerging consumer applications.

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