Dynamic Routing in Telecommunications Networks

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Dynamic routing in telecommunications networks has been a research area actively pursued within academic institutions, telecommunications service providers, and telecommunications equipment manufacturers throughout the world in the past two decades. While numerous papers have been published on dynamic routing, including two feature topics of *IEEE Communications Magazine*, no books were dedicated to this subject until now. Gerald R. Ash, a pioneer of dynamic routing, has been leading the revolution and evolution of routing in the AT&T worldwide intelligent network since the 1970s. While giving a historical view of dynamic networks evolution, this book can serve as an encyclopedia for engineers, researchers, and network managers involved in studies, plans, and operations of dynamic routing networks. This book provides not only practical information and techniques needed to design, develop, test, implement, and manage a dynamic routing network, but also the theoretical materials on the basic concepts of traffic theory and network design. University professors would find it a good textbook for engineering students who would later continue the routing evolution. The author provides technical details of the wide variety of routing methods including variations of fixed hierarchical routing, preplanned dynamic routing, real-time dynamic routing, and dynamic transport routing. The book covers network design and management methods, network impact studies and cost/benefit analysis, network implementation planning, and many examples of the actual performance of dynamic routing networks. Readers will learn to analyze routing models, design dynamic routing networks, and operate and manage a dynamic routing network.

Chapter 1 covers an overview of various network configurations from metropolitan area networks to national and global networks, routing methods of three stages of network routing evolution, and fundamentals of network management and design methods. Mapping, from various dynamic routing schemes proposed and/or implemented in several major networks in the world to the classes of routing methods in Table 1.1, helps to identify real-world examples. Readers can gain a clear picture of dynamic routing from this chapter even without reading the rest of the book.

Chapter 2 discusses fixed hierarchical routing, which is used in most networks in the world. Some background information about switching, trunking, numbering, signaling, billing, and network design traffic engineering is also provided. Routing rules and network design principles and link sizing techniques are described in detail.

Chapters 3 to 6 discuss various preplanned dynamic routing methods and network designs including hierarchical routing networks in Chapter 3, multi-link path routing networks in Chapter 4, progressive routing networks in Chapter 5, and two-link path routing networks in Chapter 6. Each chapter gives details on the routing method, network management and design techniques, and performance based on modeling results. The route-erlang flow optimization model described in detail in Chapter 4 provides a fundamentally new approach for evaluating a wide variety of dynamic routing methods and is applied to analyze routing methods in Chapters 4, 5, and 6. It is also noted that the preplanned two-link sequential path routing method described in Chapter 6 forms the basis for dynamic non-hierarchical routing (DNHR) deployed in the AT&T network in 1984.

Chapters 7 to 10 dig deeper into essential elements of network design. Chapter 7 illustrates the implementation and design of preplanned dynamic two-link path routing using path-erlang flow optimization model on a four-switch network. The step-by-step approach on a small four-switch network helps to explain a complex concept. Chapter 8 analyzes dynamic routing design under random load variations, in which real-time routing methods are combined with preplanned dynamic routing. In-depth analytical and simulation models are also discussed. Chapter 9 discusses dynamic routing design under forecast uncertainty and shows how ongoing network design based on current traffic load leads to reduction in network reserve capacity through more efficient utilization of capacity available in the network. Chapter 10 describes dynamic routing design principles employed in multiservice integrated networks, which include bandwidth allocation strategies, dynamic routing call setup, network management procedures, and integrated network design models.

Chapters 11 to 13 address the implementation and design of real-time state-dependent routing. Chapter 11 describes centralized real-time dynamic routing with the example of trunk status map routing (TSMR), which uses a central status database maintained in real time for derivation of optimum routing tables. Chapter 12 discusses real-time network routing (RTNR) as a representative example of distributed real-time dynamic routing for multiservice integrated networks. Multiple ingress/egress routing and real-time internetwork routing (RINR) are also described in detail. Chapter 13 presents real-time dynamic routing network design methods and illustrates path-erlang flow optimization with various models.

Thus far traffic routing networks, primarily designed for a performance under normal network conditions, have been discussed. If there is a network failure this design may not provide sufficient surviving capacity to meet the required performance levels. Chapters 14 and 15 show that joint consideration of traffic and transport dynamic routing in network design makes the network more robust to overload and failure conditions. The roles of dynamic routing as networks evolve to ATM high-speed packet broadband networks are also discussed. It is shown in Chapter 15 how network performance and efficiency are improved as networks evolve to logically sparce ATM networks, with multilink shortest path routing for integrated voice/data services. The author gives in Chapters 16 to 18 his own experience in business case feasibility study, implementation, network management and design, and performance analysis. These chapters serve as an excellent guide for network planners, network managers, and network designers who can apply the experience to their own applications.

I recommend this book to IEEE Communications Society members for its relevance, and more importantly, for its excellent presentation and comprehensive coverage. It not only describes in detail the routing methods and the associated network design methods during the past two decades of evolution, but also provides all the tools needed to design and implement dynamic routing networks including theoretical models, performance analysis, network management methods, business case analysis, and implementation principles. Readers who simply want to broaden their knowledge or are deeply involved in dynamic routing network design will find that this book fits their needs. It would be further improved if the next edition could include more discussions on the topics of ATM and IP routing, which could well be the next step of public network routing evolution.