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Introduction

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Cooperative Networking is an important topic in emerging network technologies characterized by relatively high degrees of autonomy and self-dependent behaviour. Cooperative networking deals with how the different hosts in a resource-constrained communication network cooperate with each other to improve the overall network performance. Different issues are involved in cooperative networking – identifying the bottleneck resource, identifying the peers that when selected would improve the resource utilization, identifying the servers that are loaded and that should be avoided for downloading content at a certain time instant, security issues and so on. The topics that this book covers span these issues.

The issue of cooperation is not new. Successful instances of cooperation exist in biological, chemical, economic, social and telecommunication networks. Instances of cooperation in nature have motivated development of models of cooperation in telecommunication networks. In any telecommunication network, cooperation is important in different degrees to improve the network performance. However, there has been an increased interest in cooperation in the recent years with the growing attention to peer-to-peer networks, and ad-hoc and sensor networks, in which the network throughput largely depends on the degree of cooperation amongst the different nodes. As these technologies are viewed to be very promising for the future, it is expected that cooperative networking will remain an essential subject of interest. Short summaries of the rest of the chapters in this book are provided below. We should emphasize that these summaries provide simplified abstraction of concepts that are described in detail in the later chapters of this book. The summaries in some instances have text, terms, expressions or ideas that are borrowed from the respective chapters.

In Chapter 2, the fundamental issues with cooperation in communication networking are investigated. Today's cooperative networking is one of the leading topics of research around the world. It has huge contributions not only in academic areas such as biology, sociology and economy, but it also has direct applications in communications, robotics and military science. The chapter elaborately discusses the interaction of this field with distributed processing where heterogeneous nodes promise significant enhancement in the capability of the system as well as performance and potentiality. Cooperative communication gives an alternative method to make an advantage of existing network infrastructure by means of spatial diversity. The conviction of user operation

consists of the concept of relay channel. The two issues of cooperative quality-of-service (CQoS) and cooperative data caching play a vital role in enhancing the network output, ability and utility.

Chapter 3 discusses the issue of cooperative diversity. Cooperative diversity has revealed an aspiring technique in modern wireless communication systems. According to the authors, the prime concept behind cooperative diversity is that the existing nodes between the pairs of ingress-egress nodes can transmit the signal from the ingress nodes to obtain multiple copies of the same signal at the egress node. This leads to excellent signal quality and amend coverage and acute capacity. Moreover, the authors have represented the main aspects of cooperative diversity including relaying techniques, combining methods and other cooperation schemes (other than cooperative diversity). Efficient algorithms and protocols are necessary to make it easier to accomplish cooperative diversity in order to be able to yield the advantage of cooperative diversity in resource constrained networks.

Chapter 4 reviews the issue of cooperation in Wireless Ad-Hoc Sensor Networks (WAdSN). Commonly, WAdSN are characterized by very small sized nodes having limited radio frequency range, low resources and autonomy. They communicate with one another by transmitting data over multi-hop pathways. However, in this case, collaboration is limited to a certain barter of information. The chapter introduces the new approach taking the network as a whole. It represents cooperation in WAdSN as a collaborative action where network nodes are implicated. Time synchronization, calibration and localization have been emphasized as issues requiring efficient mechanisms of cooperation. Time synchronization is required in wireless sensor networks for the sake of saving of limited energy resident in the nodes. Another issue where cooperation is important is localization, because location information is not only required for monitoring a given area, but can also be exploited to trace a mobile vehicle and animal, or to monitor elderly and disabled people in residencies. In this approach, while a node provides a measure with location information, data fusion techniques can reduce traffic and energy consumption.

Chapter 5 studies cooperation in autonomous vehicular networks. Since chronological advancement of wireless technologies are taking place regularly in all respects, autonomous vehicular networks have become like a new network technology comprising of vehicle-to-infrastructure and vehicle-to-vehicle communication. Cooperation in vehicular networks is categorized into two types: implicit and explicit. Implicit cooperation solicitudes the proficiency of MAC layer protocols for multi-hop communication and for adroit mechanism allowing trusted communication between different vehicles. The behaviours of the drivers focus on explicit communication, and allow the vehicles without having a specific need for a service access to participate in the communication to assist other vehicles that need relay nodes to allow them to access services. It is believed that cooperative techniques can be helpful to amend the enforcement of vehicular networks. Their application ranges from road safety to amusement and commercial.

Chapter 6 investigates the issue of cooperative overlay networking for streaming media content. Currently, media streaming has been recognized as having widespread applications in the networked world. Recently, peer-to-peer content delivery has emanated as one of the inspiring techniques to enable its large-scale deployment. The authors investigate various solutions propounded for peer-to-peer media streaming. The chapter divides the solutions into two categories: tree-based and mesh-based approaches. It states that these two may endure inefficiencies either due to the vulnerability caused by dynamic end-hosts or the efficiency-latency tradeoff. The chapter puts forward a cooperative mesh-tree design, named as *mTreebone*, which clouts both tree and mesh structures. Using simulation analysis and PlanetLab experiments, the authors show that cooperative hybrid solution exhibits superior performance.

Chapter 7 studies the issues of cooperation in Delay Tolerant Network (DTN) based architectures. The DTN architecture consolidates a store-carry-and-forward paradigm by overlaying a protocol layer, called bundle layer, that provides internetworking on heterogeneous networks (regions) operating on different transmission media. DTN is usually exploited in an environment

categorized by sparse connectivity, frequent network partitioning, intermittent connectivity, long propagation delays, asymmetric data rates, and high error rates. DTN can be deployed in different kinds of challenged and resource constrained network environments including interplanetary networks, underwater networks, wildlife tracking networks, remote area networks, social networks, military networks, vehicular networks, among others. In this chapter, the authors present a recapitulation of the delay-tolerant networking epitome, including innovative network architecture for vehicular communications, called vehicular delay-tolerant network (VDTN). The chapter also sketches the recent advances related to cooperation on delay tolerant networks. The chapter also highlighted the importance of the nodes' cooperation to revive the delivery ratio, thereby improving the performance of VDTN networks.

The rapid increase in wireless technologies has led to the opening of fast technological areas that have a great impact on our lives. One of the important requirements in wireless technology is cooperation; it improves the network connectivity and also enhances the quality of service of the network. The ambient network architecture includes both scalability and flexibility and it has also the capability of firming up the connection between two networks. Chapter 8 presents the key aspects followed by ambient networks needed to interact with the heterogeneous access networks based upon the cooperation between two functionalities having relevance to 'Generic Link Layer (GLL)' and 'Multi Radio Resource Management (MRMM).' GLL is essential, as it can make comparison among different radio access technologies. On the contrary, MRMM is based on a decision-based scheme. After having gathered information from different sources, the most suitable path for communication is chosen. Additionally, the chapter introduces two ideas that would function in the ensuing wireless communication technologies.

Chapter 9 presents the issue of cooperation in intrusion detection networks. In today's era of advanced technology, we are mostly dependent on Internet-based applications such as email, web-browsing, social networks, remote connections, and online messaging. Concurrently, network intrusions and consequent loss of privacy and security are becoming serious issues for the Internet community. The intrusions are unwanted traffic or computer activities that are generally vicious and troublesome. As stated by the authors, this leads to Denial of Service (DoS), ID theft, spam and phishing. Malicious pieces of code are used to succeed in attack goals. This chapter surveyed the cooperation schemes in Intrusion Detection Network. The authors have first classified network intrusions and IDSs according to their behaviour and the techniques they use. Some of the open challenges and future directions in cooperative intrusion detection networks are also discussed.

Chapter 10 reviews the issue of utilizing cooperative diversity in link layer over wireless fading channels. In this chapter, the authors discuss a link level retransmission scheme, named as Node Cooperative Stop and Wait (NCSW). The scheme exploits the inherent cooperative diversity belonging to a multi-user communication system, thereby improving upon the traditional stop-and-wait retransmission. The chapter explains how in conventional retransmission schemes the neighbour nodes remain virtually non-existent to the ongoing transmission between a sender and receiver nodes, whereas in the NCSW scheme, some of the neighbour nodes which may have enough resources may want to cooperate and assist the sender node in retransmission.

Chapter 11 presents a novel concept of cooperative network optimization that is based on inter-layer and inter-node communication. With this concept, protocols from the TCP/IP can be extended to fine tune their configuration parameter values continuously based on the past performance. As stated by the authors, compared to non-cooperative approaches, the results manifest that cooperation between layers of a protocol stack can bring major improvements in data transfer performance. The authors present an analysis of cooperative inter-node and inter-layer networking issues and their respective solutions.

Chapter 12 presents the topic of cooperative network coding (CNC). CNC is a fairly recent methodology which came into existence as a combination of concepts from both network coding

and cooperative communications. It has become popular in the last decade or so with the popularity of the future Internet and wireless communications. The authors discuss how the issue of cooperation helps in increasing capacity and minimizing the effect of blackout and how network coding enables more efficient use of the network resources. In addition, this chapter discusses the fundamental issues and definitions underlying the concept of network coding. A summary of currently used cooperative relaying strategies, and different issues of performance is also given.

Chapter 13 reviews the different issues surrounding cooperative caching for chip multiprocessors. In data access patterns, caches are deliberately used to help minimize network activities and storage access latencies. The chapter explores the concept and effectuation of cooperative caching for modern CMPs (i.e., today's multi-core and tomorrow's many-core processors). Cooperative caching helps in supporting various cache sharing behaviours using different techniques relating to cooperative capacity sharing and throttling capabilities.

Finally, Chapter 14 presents a taxonomy and survey of market-oriented resource management and scheduling. Market-oriented computing is currently inevitable for both industry and academia. Grid computing is one of the most important concepts which supports market-oriented computing. Since the last decade, many researchers have investigated issues related to resource management and scheduling in utility grids, but still a lot of work needs to be done. Moreover, the chapter provides a comprehensive taxonomy summarizing the important works on this aspect. A survey of market-oriented resource management systems has been presented as well.

1.1 Major Features of the Book

Below are some important features of this book, which, we believe, would make it a valuable resource for our readers:

- This book is designed, in structure and content, with the aim of making it useful at all learning levels.
- The chapters of this book are authored by prominent academicians/researchers, and practitioners, with solid experience in the subject matter.
- The chapters' authors of the book are distributed across a large number of countries and institutions of worldwide reputation. This gives this book an international flavour.
- The chapter authors have attempted to provide a comprehensive bibliography, which should greatly help the readers interested in exploring the topics in greater detail.
- Throughout the chapters of this book, most of the groundwork research topics of cooperative networking have been covered from both theoretical and practical viewpoints. This makes the book particularly useful for industry practitioners working directly with the practical aspects behind enabling the technologies in the field.
- To make the book useful for pedagogical purpose, all chapters of the book are accompanied by a corresponding set of presentation viewgraphs. The viewgraphs can be obtained as a supplementary resource by contacting the publisher, John Wiley & Sons Ltd, UK.

1.2 Target Audience

The book is written by primarily targeting the student community. This includes the students of both undergraduate and graduate levels – as well as students having an intermediate level of knowledge of the topics, and those having extensive knowledge about many of the topics. To keep up this goal, we have tried to design the overall structure and content of the book in such a manner that makes it useful at all learning levels. The secondary audience for this book is the research community, in academia or in the industry. Finally, we have also taken

into consideration the needs of those readers, typically from the industry, who wish to gain an insight into the practical significance of the topics, expecting to discover how the spectrum of knowledge and the ideas are relevant for real-life applications of cooperative networking.

1.3 Supplementary Resources

As previously mentioned, this book comes with sets of viewgraphs for each chapter, which can be used for classroom instruction by instructors who adopt the book as a textbook. Instructors are requested to contact the publisher for access to these supplementary resources.

1.4 Acknowledgements

We are extremely thankful to the authors of the chapters of this book, who have worked very hard to bring this unique resource forward to help students, researchers and community practitioners. We feel it is in context to mention that as the individual chapters of this book are written by different authors, the responsibility of the contents of each of the chapters lies with the concerned authors of each chapter.

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