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Emerging Innovations in Wireless Networks and Broadband Technologies



Naveen Chilamkurti



Emerging Innovations in Wireless Networks and Broadband Technologies

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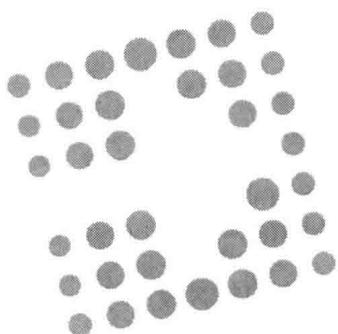
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Preface

In recent years, Long Term Evolution (LTE), now the new 5th Generation telecommunication standard has been well and truly evolved. Due to this new standard, new multiple interconnected communication standard, ranging from wireless metropolitan area networks down to wireless personal networks have been deployed (Chin, Fan, & Haines, 2014). Ad-hoc network are portrayed as the arrangement of remote wireless sensors that make use of wireless multi-hop radio link to relay between the nodes. Wireless Sensor Network (WSN) comprises an extensive number of Ad-hoc networks that are designed to sense the phenomena. As these WSN's are powered by small batteries, low power usage in sensor is required to engage long lifetime by promising low commitment cycle operation and low signal processing. On top of this, sensor localization is a vital and basic issue for network management and operation. Such knowledge of the node location and territory can be used to execute energy capable messages controlling protocols in sensor networks (Alwageed, 2015). At the network layer, we need to find distinctive networks for discovering energy capable protocols to increase the lifetime of the network. Thus requiring multi-path routing protocols that are capable of using multiple short routes, increasing reliability and thus requiring less energy.

WSN is a promising technology with a great potential to transform our world. But dynamic network topologies and harsh environmental conditions may cause sensor node failures and performance degradation. This requires WSN to support adaptive network operations, including signal-processing algorithms, communication and routing protocols to cope with dynamic wireless-channel conditions and varying connectivity (Rawat, Singh, Chaouchi, Bonnin, 2013). In WSN, some sensors can able to equip with cameras and microphones. Such WSNs are capable of storing, processing, and retrieving multimedia data such as video, audio and images. They must cope with various challenges such as high bandwidth demand, high energy consumption, and Quality of Service (QoS), compression and cross-layer design. Given limited energy resources, bandwidth and radio access, keeping QoS at high level is very difficult, but a certain level of QoS must be achieved for reliable content delivery, which is highly challenging.

Bandwidth demanding P2P (Peer-to-Peer) overlay communications strongly require scalable and differentiated provisioning of network resources to enable and deliver demand based contents (Logota, Marques, & Rodriguez, 2013). A major challenge in such systems is to assure a proper synchronization, at the end-user, of the content received and to provide best-effort services such as Internet traffic. But, with Unknown peers and unpredictable network behaviors and other factors that threaten stability in P2P systems and the content delivery may not be guaranteed.

Video distribution over the Internet has been growing every year. Although today there exist many approaches for P2P live streaming over IP networks, P2P Video on Demand (VoD) service provisioning is essentially a different problem as it involves streaming of pre encoded content and, as such, it adds the whole content availability dimension to the problem (Muñoz-Gea et al., 2012).

Besides the client-server mode, the use of content delivery network and the Peer-to-Peer approach is also popular (Yang, Zhou, Chen, Fu, & Chiu, 2015). A view-upload decoupled approach is one of the popular choices in distributing video over P2P networks. The major advantage of this approach is that cross group load balancing can more effectively utilize peer's serve capacity and Video-on-demand can be easily achieved.

In Chapter 1, dynamic priority scheduling of critical data in wireless sensor networks is investigated. In Section I of this chapter, a brief background on cognitive radio concepts such primary and secondary users are discussed. Next, a proposed dynamic priority assignment techniques and mobility issues in unlicensed band are presented. With the data changing dynamically and factors such as energy and mobility, which are major constraints, assigning priority to the nodes becomes difficult. In Section 2, related works are thoroughly investigated. In Section III, we shall discuss about the improvements and the modifications to the existing algorithm. The final sections deal with proposed algorithm analysis and implementation, and the chapter concludes with future research directions

Chapter 2 investigates secure node localization in clustered sensor networks with effective key revocation. Sensor nodes in a WSN are typically deployed in unattended, hostile terrains and therefore, are mostly not aware of their location. The WSN applications may require knowing the locations of the node in the network to assist in neighbour discovery, selective information sharing and so on. The approaches include GPS, Beacon Based (BB) and Without Beacon Based (WBB). GPS enabled nodes are too heavyweight to suit WSNs. In BB approach, few nodes aware of their locations serve as beacons to help other nodes in the network localize themselves. In WBB approach, nodes need to localize themselves with the help of their neighbours only. Although, knowledge of nodes' location within network is desirable, exposure of node location information to adversary may lead to undesir-

able consequences, such as ease of planning for a node capture attack, and hence the need of secure localization. The BB approach has been studied extensively under adversarial model and many algorithms based on BB approach have been proposed in literature in order to localize nodes in a secure manner. In contrast, the WBB approach for node localization under adversarial model has not received substantial attention from researchers. In this chapter, static and dynamic key settings for node localization using WBB for node localization under the adversarial model are discussed. A protocol for the pairwise key establishment and key revocation to facilitate secure node localization without using beacon nodes in mobile sensor networks is adopted from pre-existing protocols such as LEAP, aiming at providing resilience against node impersonation attack and thus minimizing the impact of node capture threats. The proposed protocol is compared with related studies for performance gain and security.

Chapter 3 discusses energy efficient congestion control in wireless sensor networks. Firstly, the background of the existing schemes and their challenges with regard to their unique design level constraints because of the limited signal range, processing power, storage capabilities, as well as communication pattern are investigated. As avoiding congestion and provision of reliable communication in these resource constrained systems are challenging tasks at the MAC layer, a novel design of MAC protocol is required that focuses on energy efficiency as well as congestion control. The congestion issue is also aggravated when constraint in energy requirements is coupled with the mobility of nodes. Here, we propose a Time-Sharing Energy Efficient Congestion Control (TSEEC) technique for Mobile Wireless Sensor Networks, which also includes Time Division Multiple Access Protocol (TDMA) and Statistical Time Division Multiple Access Protocol (STDMA) as major constituents. These techniques help in conserving the energy by managing the sleep, wake up and listen states of sensor nodes. The proposed scheme is composed of two main strategies that is dealing with the delay in a network; Load Based Allocation and Time Allocation Leister. The first technique is designed on the basis of STDMA Protocol and uses the sensor node information to dynamically assign the time slots while later technique handles the job of mobility management of sensor nodes. Both techniques further help in conserving the network energy minimizing the network congestion. The Time Allocation Leister technique further comprises of Extricated Time Allocation (ETA), Shift Back Time Allocation (SBTA), and eScaped Time Allocation (STA) sub techniques for managing the joining and leaving of nodes to the cluster and redundant/absence of data for communication. Mobility pattern as part of TSEEC has been introduced to control the movement of mobile sensor nodes making the protocol adaptive to traffic environment and mobility. A simulation and analytical analysis of the proposed mechanism with SMAC has been performed using

NS2 and mathematically by considering energy consumption, and packet delivery ratio as performance evaluation parameters. The proposed system outperforms the existing system. The chapter concludes by suggesting future studies such as finding the neighbouring mobile sensor nodes

Chapter 4 investigates the techniques and analysis of energy efficient image compression and transmission in wireless sensor networks. The chapter discusses the challenges of Image compression and transmission over a wide ranged sensor network with respect to battery, life time constraints. This chapter looks at analysis and compares different image compression and transmission techniques with respect to computational load, memory constraints and transmission speed.

Chapter 5 explores the issue of novel energy aware algorithm to design a multilayer architecture for dense wireless sensor networks. The chapter outlines the importance of energy aware network layer routing functionalities as it is indispensable for improved network performance and increased network lifetime. This chapter reviews the existing research work, and proposes innovative design technique named Extended Multilayer Cluster Designing Algorithm (E-MCDA) for Lifetime Improvement of wireless sensor network. We improved the idea of MCDA with novel algorithms for time slot allocation at network setup phase to make the cluster designing process more energy efficient, energy efficient cluster head selection, and 'Required Node Degree' based cluster member selection for near equal size clusters. The chapter proposes that the work could be extended in the future employing various techniques.

In Chapter 6, cost minimization of sensor placement and routing in wireless sensor networks with regard to placement and routing issues in a random plane are explained. The chapter underlines the importance of sensor placement from the point of view of cost minimization, and node coverage and connectivity. The sensor node's coverage range is proportional to their cost, as high cost sensor nodes have higher coverage ranges. The main goal of this chapter is to minimize the node placement cost with the help of uniform and non-uniform 2D grid planes. A new algorithm for data transformation between strongly connected sensor nodes, based on graph theory has been proposed. It was found to be that k-mean clustering can solve the problem of deploying sensors on random points on plane. Furthermore, modifying the problem to graph theory's strongly connected components ensures the transmission of data from one node to another without interruption. The future research direction has also been suggested.

Chapter 7 explores the application of 802.11p Based VANET for improving road safety and traffic management. In this chapter, the emphasis was given to the contribution of Intelligent Transportation Systems (ITS) based on wireless vehicular towards improving road transport safety and traffic efficiency as well as environmen-

tal conditions and life quality. The standardization at each layer of the networking protocol stacks is also dealt with. The chapter also reviews the overall architecture and the protocol functionality, and presents some use cases on an 802.11p compliant system prototype.

Chapter 8 explores a scheduling scheme for throughput optimization in mobile peer-to-peer networks. It explains that mobile cloud computing (MCC) paradigm includes all the emerging technological advances, mechanisms and schemes for the efficient resource offloading and the energy-efficient provision of services to mobile users. The chapter further explains that the mobile nodes will act as flexible networking points in emerging mobile networking architectures, where several challenges have to be addressed, like the high energy consumption and the data packet transmission failure, under a Mobile Peer-to-Peer (MP2P) approach. Towards addressing such challenges, several factors that contribute to the increased consumption of the energy is investigated. The chapter proposes Traffic-based S-MAC scheme towards increasing the data exchange and minimize the energy consumption, between mobile nodes operating under an Ad-Hoc approach. The performance of the proposed scheduling scheme was thoroughly evaluated, through a number of simulation experiments.

Chapter 9 deals with a P2P home-box overlay for efficient content distribution. It outlines that the overlay networks composed of residential gateways (i.e. home-box) leverage their storage and upload capacity to achieve scalable and cost-efficient content distribution. The chapter details the architecture of the home-box overlay for video on demand services, with the network-aware request redirection and content caching strategy that optimizes the resource usage at both network and client side, for reducing the overall distribution cost. The proposed system is then compared with existing solutions through comprehensive simulations. Finally, the results demonstrating the advantage of network-aware and popularity-based caching strategy, with reduced the overall cost of the VoD services are presented.

Chapter 10 pinpoints how causal and total ordering can be achieved in an opportunistic network. In the recent years, Opportunistic Networks (ONs) have become an important research field as a viable solution for mobile networks. These network resorts towards unordered immutable messages, like photos, videos or music files. By leveraging on existing dissemination algorithms, we investigate if causal order can be efficiently achieved in terms of hit rate and latency. The chapter proposes a Commutative Replicated Data Type algorithm based on Logoot that uses the nature of opportunistic networks to its advantage. Finally, the results of the experiments for the new algorithm by using an opportunistic network emulator, mobility traces and chat traces are presented.

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Arvind Viswanathan, McMaster University, Canada

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In the unlicensed band, the notion of primary user and secondary user (to implement cognitive radio) is not explicit. By dynamic priority assignment we propose to implement cognitive radio in the unlicensed band. In time critical events, the data which is most important, has to be given the time slots. Wireless Sensor nodes in our case are considered to be mobile, and hence make it difficult to prioritize one over another. A node may be out of the reach of the cluster head or base station by the time it is allotted a time slot and hence mobility is a constraint. With the data changing dynamically and factors such as energy and mobility, which are major constraints, assigning priority to the nodes becomes difficult. In this chapter, we have discussed how Wireless Sensor Networks are able to allocate priorities to nodes in the unlicensed band with multiple parameters being posed. We have done simulations on NS-2 and have shown the implementation results.

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Wireless sensor networks are deployed in unattended and hostile environment for many applications such as battlefield surveillance. The WSN applications may require knowing the locations of the node in the network to assist in neighbour discovery, selective information sharing and so on. The trivial approach to node localization is to equip each node with GPS. However, the cost and size of GPS enabled nodes make it impractical for resource-constrained, low cost WSNs. GPS-free node localization has been addressed using two different approaches - Beacon Based (BB) and Without Beacon Based (WBB). In BB approach, few nodes aware of their locations serve as beacons to help other nodes in the network localize themselves. In WBB approach, nodes need to localize themselves with the help of their neighbours only. Although, knowledge of nodes' location within network is desirable, exposure of node location information to adversary may lead to undesirable consequences, such as ease of planning for node capture attack, and hence the need of secure localization. The BB approach has been studied extensively under adversarial model and many algorithms based on BB approach have been proposed in literature in order to localize nodes in a secure manner. In contrast, WBB approach for node localization under adversarial model has not received substantial attention from researchers. In this chapter, we discuss static and dynamic key settings for node localization using WBB for node localization under adversarial model. We consider the Localized Combinatorial Keying (LEAP) and Localized Encryption and Authentication Protocol (LEAP) as the building block and propose a protocol for pair-wise key establishment and key revocation to facilitate secure node localization without using beacon nodes in mobile sensor networks, aiming at providing resilience against node impersonation attack and thus minimizing the impact of node capture threats. We provide a comparison of the improved protocol with other related protocols. We show that the improved protocol provides effective node localization in a secure manner with minimal node capture threats.