Chapter 1
Introduction

The growth of the wireless network was targeted primarily on voice alone. The inclusion of data orientation in wireless network and internet-based packet to the cellular network can trigger another explosion. Various mechanisms are projected and recently deployed to support knowledge traffic over wireless media. A Mobile Ad-hoc Network (MANET) is a network that combines these services. MANET is made of wireless self-configuring mobile nodes that create networks without the need for any infrastructure. The distinguishing features of MANETS are self-organizing, easily deployable, dynamic multi-hop topology. They have the advantage of speedy readying and reconfiguration. It is straightforward to tailor the network to specific applications. They are extremely sturdy owing to their distributed nature and also the lack of single purpose of failure. Owing to these facts, mobile ad-hoc networks are extremely appealing.

The first public wireless data packet was named as ALOHAnet that emerged in 1971. Thereafter, wireless communication networks have ceaselessly matured and their applications have grown. ALOHAnet used ALOHA random access and experimental ultra high frequency for its operation. Wireless LANs have gain popularity both in indoor and outside environments, owing to their ability to completely different traffic demands, network quality, and infrastructure-less nature. Just like the infrastructural networks, ad-hoc networks adopt to random access protocols because the basic IEEE 802.11 DCF protocol can handle multi-access burst traffic with a high peak to average rate. In distinction to wired networks wireless networks are subject to interference that results in completely different style challenges. First, full-duplex communication is sometimes tough in wireless since the signal from native transmission interferes with the transmission from different nodes. A wireless link will either receive or transmit however not each on a similar frequency at a similar time[1]. Two close-by wireless links cannot communicate at a similar time due to interference. Owing to these variations, directly employing the

ISO superimposed protocol stack in wireless is not as triple-crown together wishes. This has lead researchers to rethink the standard class-conscious isolated protocol style philosophy and explore new paradigms wherever every layers get together to optimize performance in terms of throughput, power expenditure, and delay in random access primarily based wireless networks. The goal of this thesis is to use cross-layer interactions with energy efficient routing to optimize various performance metrics.

1.1 Overview of Cross-Layer Ad-hoc Networks

The ad-hoc networks exhibit many promises; however, they can jointly create bound design challenges. The reasons are the result of sub-urbanized control dynamic topology, lack of established infrastructure, and wireless channel characteristics. Particularly these challenges, the assorted network expectations must be met. As a promising resolution for economical networking, the problem of cross-layer design of network protocols with power economical routing has been self-addressed. The existing wired network is implemented in the form of hierarchy of network layers that are freelance and non-cooperating, creating it unable to require the advantage of the layer interactions for information sharing. This approach optimized each layer by itself, whereas cross-layer optimization of the network layers would result into better performances [2].

The rigidness and limitations of information sharing in wired network, leads to poor performance in ad-hoc networks where energy constraints and bandwidth are the standing issues. To satisfy these, a cross-layer protocol design is needed that supports adaptability and also the co-operation of layers. In the cross-layer protocol stack, the link layer will adapt rate, power, and other information to satisfy the current channel and network conditions. The medium access control layer will adapt on the underlying link and interference conditions. The routing protocols are to be designed considering current link status, network condition, and traffic rates. The concept of cross-layer network will increase performance in ad-hoc networks.

1.2 Power Efficient Routing Protocols

The mobile nodes in ad-hoc networks are supercharged by battery and share a dependent relationship wherever every node acts as a router and end host. Energy is exhausted in every node as it will be used in individual processing and forwarding of packets that reduces node lifetime. Energy conservation is thus essential in these networks. In wireless networks, transmit power selection is vital that is recognized within the physical layer and it determines the channel capacity once interference is taken into account. Later on, the researchers realized that transmit power influences varied layers in wireless ad-hoc networks. Power selection is important for the network layer protocols as the aim is to use spatial recycle opportunities within the presence of interference among wireless links. Selecting the transmit power is extremely crucial as it not solely affects the interference resilience of a node but conjointly alters its interference on alternative links. Hence, in principle the power got to hand and glove designated, therefore, as to improve the spatial recycle.

1.3 Motivation behind the Present Work

Different analysis work was dispensed throughout the past, over ad-hoc networks. Thanks to their magnet of being simply deployable and low price. Before the ad-hoc networks, wireless LANs was wide unfold, however, had the limitation of low-mobility information applications. The wired networks are built upon the stratified specifications of the layered architecture. The network layers are independent of each other and isolated from different kind of layers. In ad-hoc networks, there is a requirement for layer interactions for providing energy potency and achieving different performance objectives. Cross-layer networking are thought about jointly during which completely different layers of the network protocol stack inter-communicate the helpful information, therefore, on collectively bring home the beacon the specified vertical improvement goal. Energy conservation has been dispensed in varied levels of the system: application layer, transport layer, network layer, data link layer, and physical layer. At the application level, applications are designed that adapt on the idea of the current energy of the system [3]. At the software level, energy conservation caused by shift systems to associate degree idle or stand-by mode. Energy is preserved at the central processing unit level by reducing the clock speed and voltage level of the central processing unit [4]. At the data link level, schemes that power down the cards once not in use induce savings [5].

Energy is preserved at the routing layer as the routing layer protocols use power metric as an important issue for routing the packets. The problem of energy conservation through cross-layer interaction is of overriding importance and has attracted several analysis efforts. Past analysis has shown the good thing about cross-layer improvement to cut back the energy consumption of wireless devices. Visible of the higher than this, the investigator felt intended to increase the thought of cross-layer improvement to boost the look and performance of wireless ad-hoc networks. Many techniques to boost the energy potency of wireless ad-hoc networks are taken into account of their distinctive characteristics like low transmit power, limited energy offer, vital power consumption and low process ability.

1.4 Scope and Objectives of the Present Work

The analysis focus is on the energy potency of wireless ad-hoc networks through cross-layer improvement. The optimization during this thesis is conducted conjointly at the physical layer, the information link layer, the multiple access layers, the network layer, and therefore the application layer. The most contributions of this thesis are high-lighted as follows;

1. To evaluate the energy potency of a communication link in wireless ad-hoc networks. This metric incorporates the influences of the circuit power consumption of the nodes, the transmit power consumption, packaging overhead, cryptography overhead, and potential re-transmissions.

2. To investigate the energy-optimal relay distance to reduce energy consumption per data bit by perceptive optimum constellation size and packet length.

3. The analysis of the optimum packet length from Step 2, the optimum modulation and power management schemes that minimize the energy consumption per data bit in an exceedingly typical Impulse Radio Ultra Wide-Band (IR-UWB) system over a frequency selective channel.

4. A comprehensive analysis of the energy potency of a clustered wireless ad-hoc network by selecting the best transmit power, choosing the best cluster head and deciding whether or, not to use multi-hop routing among a cluster.

5. A two-layer cross design is proposed, over the medium access layer and the network layer

that is incorporated in the DSR protocol. The access efficiency factor is considered for route selection

6. A three-layer cross design is proposed that spans physical, medium access control and network layer for power conservation based on transmission power control. The DSR protocol with power control capability is proposed.

1.5 Achievements

In a modest way, the following contributions have been made in this thesis work.

1. The power conservation methods in the physical and data link layers are analyzed and techniques are devised to avoid collision by using the IEEE PSM. These layers incorporate power control and channel allotment like modulation/demodulation, coding strategies and these characteristics are represented through a control vector. The progressions in the mobility pattern and environment calculation come about into progressions in the channel and network topology. The different exercises at the diverse network layers are to be tackled the variability of the network to remunerate in an optimal way The transmission rate between the sending and receiving node is represented as a function of topology state and the control vector.

2. In the next stage, the routing and flow control decisions to control multi-hop traffic forwarding are made. The network layer and transport layer queues are assumed to have infinite buffers. Traffic may arrive to the network endogenously or exogenously through the transport layer. A network layer control algorithm makes decisions about routing, scheduling, and resource allocation in reaction to current topology state and queue backlog information.

3. Energy efficient routing models are designed and developed and their performances have been tested on different types of environment. To address the issues of the inevitable trade-off between power management and packet delay for wireless ad-hoc networks, the wireless ad-hoc nodes are assumed to have a finite buffer capacity for buffering the data to be transmitted. Later, a cross-layer function is defined between the application MAC and physical layers of the protocol stack for calculating the optimal rate power combination based on the channel condition. The received signal-to-noise ratio (SNR) value is used as

a channel quality measurement. A constraint is imposed on the maximum power used for transmission and uses of different power levels corresponding to the channel state.

4. Devised performance optimization design challenges in ad-hoc networks by using congestion-aware cross-layer protocol design. The experiments are conducted to assess the performance improvements by simulating different cross-layer implementations for an ad-hoc network.

1.6 Thesis Outline

This thesis work contains six chapters-

Chapter 2 provides background information and literature survey on energy efficiency through cross-layer optimization on wireless ad-hoc networks and introduces the background of the concepts and techniques used in this dissertation

Chapter 3 describes the approaches to reduction in energy dissipation in the physical layer by determining optimal transmission power for modulation to increase network lifetime.

Chapter 4 describes that the nodes in mobile ad-hoc networks have different transmission power, bandwidth, battery life, reliability, and data rate. This variant property of the nodes leads to hidden/exposed terminal problem in the MAC layer and routing problem due to link asymmetry. In this chapter, the focus is to have cross-layer design that spans the network and MAC layer. This concept is incorporated in the Dynamic Source Routing (DSR) by making necessary changes.

In chapter 5, a three-layer cross design is analyzed that spans Physical, Medium Access Control and Network layer, which is an extension of Chapter 4, for power conservation based on transmission power control. The Dynamic Source Routing (DSR) protocol with power control capability is proposed in this chapter.

Chapter 6 is the concluding chapter. This chapter describes the energy saving strategies through cross-layer interaction of network layers. At the end, the scope for future works are mentioned in this chapter.