CHAPTER 2
LITERATURE OF REVIEW

2.1 INTRODUCTION

Energy is an important factor in mobile ad hoc networks since nodes are deployed in an environment. Routing between nodes can be realized by nodes themselves; they can identify the path and transfer the messages. The nodes must know about the neighborhood nodes, and it may vary frequently, and hence their knowledge must be updated in a frequent manner. If a node updating its knowledge, identifies the path and makes communication between source and destination, battery life gets lost immediately. Always the node should be in awake state to collect information from all other nodes in the network. AODV routing is used in MANETs. A new mechanism of Local Energy-Aware named LEA-AODV (Le 2010) for ad-hoc is proposed in this work, which is based on the classical Ad hoc On-demand Distance Vector (AODV). It is designed to increase the network survivability by maintaining the network connectivity, and to lead to a longer battery life of the terminals. There are three parameters for energy consumption. i. The initial energy ii. Transmission power iii. Reception power

2.2 MOBILITY CONTROL METHOD

A mobility control method that addresses connectivity, link availability and consistency issues is proposed Jie Wu and Fei Dai (2005).
Three sufficient conditions are given: the first one on the connectivity of the physical network to ensure connectivity of the virtual network, the second one on the bound of the range difference to ensure link availability, and the third one on the consistent local views to ensure correct decision made at each node. Two mechanisms, called buffer zone and aggregated local view, are proposed to satisfy the latter two conditions.

2.2.1 Logical Network and Broadcast State

The coverage condition was applied on a static or quasi-static physical network. In a quasi-static physical network, the physical topology stops to change several ‘Hello’ intervals before a broadcast process and stays unchanged until the broadcast process is completed two levels of observation.

The correctness of the coverage condition is based on the assumption that the local view is an accurate and immediate reflection of the physical topology. In MANETs, however, this assumption can be easily invalidated due to the continuous node mobility. In fact, in order to apply the coverage condition on MANETs with potentially outdated local views the concepts of logical network, a dynamic virtual network constructed from all local views, broadcast state, a snapshot of local views during a broadcast process, and two levels of abstraction are introduced, as shown in Figure 2.1.

1. Level-1 abstraction: from physical network (time space view) to logical network (time space view)

2. Level-2 abstraction: from logical network (time space view) to broadcast state (time space view)

A logical network is the collection of all local views, i.e. a super graph containing all the nodes and links in local views.
2.2.2 Simple Flooding

- The algorithm for Simple Flooding starts with a source node broadcasting a packet to all neighbors
- Each of those neighbors in turn rebroadcasts the packet exactly one time
- This continues until all reachable network nodes have received the packet

Figure 2.1 The mapping from the logical network and broadcast state to the physical network
2.2.3 Probability-Based Flooding

- Each of those neighbors in turn may rebroadcast the packet exactly one time with respect to some random condition.
- This continues until all reachable network nodes have received the packet.
- When the probability is 100%, this scheme is identical to Flooding.

2.2.4 Coverage Condition-Based Flooding Algorithm

- Each of those neighbors in turn may rebroadcast the packet exactly one time with respect to coverage condition.
- This continues until all reachable network nodes have received the packet.
- The coverage condition of a node is calculated based on the number of periodic hello packets received from the neighboring nodes.

2.2.5 Randomly Controlled, Coverage Condition-Based Flooding Algorithm

- Each of those neighbors in turn may rebroadcast the packet exactly one time with respect to coverage condition and a random probability.
- This continues until all reachable network nodes have received the packet.

The coverage condition of a node is calculated based on the number of periodic hello packets received from the neighboring nodes. Packet loss
can be avoided by the connection between two nodes which should be stable. Link stability and energy saving are the important factors.

LAER (Link –stAbility and Energy Aware Routing) protocol is used to reduce power consumption and maintain link stability. This algorithm applies the following three metrics for path selection (1) The estimated total energy to transmit and process a data packet (2) The residual energy (3) The path stability.

In broadcasting, a broadcast storm problem will occur. To avoid redundant packets, network coding approach has been introduced: intermediate nodes are mixing information from different flows before forwarding it. Co-operative communication, which utilizes neighboring nodes to relay the overheard information, has been employed as effective technique to deal with the channel fading and to improve the network performances.

Routing between nodes is created by a set of nodes, i.e. named as connected dominating set. This protocol selects a subset of network nodes named Maximum Weighted Minimum Connected Dominating set (MWMCDS) based on weight, which consists of link stability, mobility and energy to maintain node stability, stable connected dominating set method can be recognized.

A connected dominating set (CDS) node consumes more energy and the energy depletes more quickly than non-dominating nodes. A distributed algorithm for energy efficient stable MPR based CDS construction is needed to extend the lifetime of ad hoc wireless networks by considering energy and velocity of nodes.
Figure 2.2 Flooding Algorithm

A node receives a valid broadcast message from its neighbor

Find coverage condition at the node using the local neighbor node information and traffic condition

Coverage condition results in non-forward status?

Yes

Read the message and discard the packet

No

Read the message and forward it

Is it a duplicate message previously sent?

Yes

Discard the message

No
2.3 RELAY SELECTION

Jinhua Zhu & Xin Wang (2011) have proposed MPR (Multi Point Relay) selection procedure can be used to get efficient broadcasting. In this method, nodes should be chosen as the relay node in a periodic manner. Relay nodes are selected in a random manner within the coverage area. A new way of broadcasting technique called Efficient Power Aware Broadcasts (EPAB) is used to provide an optimal path with suitable bandwidth and battery capacity. Throughput can be increased and packet loss can be reduced by using relay selection procedure. When combining relay method and network coding method advantages will be improved, integrating an energy efficient scheme, namely network coding, with clustering and duty cycling may facilitate the design of a new cluster-based data collection scheme. Data rate should be high in order to get good energy efficiency. Coverage area can be assigned for a node in order to reduce flooding of data packets. The efficiency of network should be improved by reducing redundant messages in the network. Tree-based schemes such as minimal connected dominating set (MCDS) are better in reducing resource consumption. In a low mobility environment, probabilistic broadcast approach can be used to avoid storm problem.

2.4 ENERGY EFFICIENT PROTOCOLS

Doina bein & Zheng (2009) a wireless network in which node positions are fixed and a specific source node $r$ in the network, the minimum energy broadcasting problem (MEB) asks each node to adjust its transmission range to create a spanning tree rooted at $r$ with minimum total energy. This problem is NP-complete for both general graphs and Euclidean space graphs. We propose a heuristic algorithm called Greedy Tradeoff (GT) for the MEB problem. Energy efficiency is an important performance measure, and one bit transmission over the network can consume as much energy as running
thousands of instructions. Genetic Algorithm can be used in energy efficient algorithm in order to get low cost security. To obtain security, key management techniques are used. Coding-Based Broadcast techniques (CodeBCast) for energy efficient broadcast method are introduced. Nodes are available in three states, and based upon the state of the node, it will perform the operations and energy consumption can be reduced. Directional antennas are used to avoid the unwanted transmissions. In a particular direction only transmission takes place and avoids the number of transmissions. Shuhui Yang et al. (2005) proposed EBCD (Efficient Broadcasting using Network Coding and Directional antennas) algorithm can be used to avoid the redundant messages. The two algorithms EFNLA (Efficient Forward Node List Selection Algorithm) and REBA (Reliable and Efficient Broadcast Algorithm) are used to identify the forward node list and select the relay node for transmitting the message. Number of retransmissions can be reduced by tree-based and probability-based approaches, centralized and distributed algorithms. The nodes should be in a centralized manner having a head node, and the secondary sets of nodes are connecting number of branches. Each node will have a head node, and so coverage can be increased. But head node exhausts its energy immediately.

Cheng & Heinzelman (2008) have disputed that many routes in ad hoc networks are short lived, triggering frequent route discovery processes, which in turn report for extra control overhead and packet latency. They suggest two schemes which allow the network to choose long lifetime routes (LLR). The optimal LLRs are computed in a centralized manner in g-LLR approach hence called, a global approach. As such information is not usually available to the nodes in a network; benchmark is mostly important. In the d-LLR approach, long lifetime routes are selected in a distributed manner, using only local information. It is shown that the performance of d-LLR is closely equivalent to that of g-LLR. Shankar et al. (2014) has proposed a new scheme
called efficient power routing DSR (EPRDSR) to improve the existing on-demand routing protocols by introducing a power efficient scheme in the whole MANET. In the route discovery, the EPRDSR selects the bandwidth and the power constraints are built into the DSR route discovery mechanism. Hence, it enhances the network lifetime and delays the repair and reconstruction of the route.

Kaur et al. (2016) has described distance efficient power aware routing protocol (D-EPAR) where lesser number of nodes is involved in forwarding the RREQ messages. So in this manner, energy consumed by the nodes also decreases thus increasing lifetime of the network. Bhople & Waghmare (2016) have proposed Efficient Power Aware Routing (EPAR) new power-aware routing protocol that extends the lifetime of nodes in MANET. The protocol selects the route which has the highest power at nodes and will take the lowest power to transmit the packet. While comparing with other power aware routing protocol, the EPAR not only deals with a remaining energy of nodes but also it will take care of power required to travels the packet from the sender to receiver.

2.5 COOPERATIVE COMMUNICATION

Cooperative communication typically refers to a system where users share and coordinate their resources to enhance the information transmission quality. It is a generalization of the relay communication, in which multiple sources also serve as relays for each other.

Mohammed Tarique & Kemal (2009) have proposed Minimum Energy Dynamic Source Routing (MEDSR) and Hierarchical MEDSR (HMEDSR). Their performances were investigated via computer simulations. As compared to the DSR protocol, MEDSR was found to improve energy efficiency and network lifetime, mainly in dense networks. However, with
increasing network size, the energy efficiency drops due to routing overhead and MAC layer packets. A considerable portion of the total energy was dissipated by the overhead packets in these networks. In order to limit this overhead and improve MEDSR, HMEDSR was proposed. The HMEDSR protocol has successfully eliminated the unnecessary overhead packets, and improves considerably the performance of MEDSR. Both the HMEDSR and MEDSR provided an enormous perfection over the DSR for energy efficient procedure in MANET. As overhead of the MEDSR protocol has been auxiliary reduced by using the HMEDSR, even more energy saving could be realized by using the HMEDSR protocol instead of DSR in MANET.

Vijayakumari & Poongkuzhali (2011) a multi-path routing strategy is presented that guaranteed in-order packet delivery (without packet dropping) for on-chip networks. They presented a method to split the application traffic across multiple paths to obtain a network with minimum power consumption. They also integrate support for tolerance against transient and permanent failures in the NOC links in the methodology by utilizing special and temporal redundancy for transporting packets. They integrated reliability constraints in the multi-path design methods to provide a reliable NOC operation with least increase in network traffic. Less efficiency is the disadvantage associated with the project.

### 2.6 TOPOLOGY CONTROL

Zou et al. (2011) has proposed an energy-efficient preserving algorithm which can be incorporated with proactive routing protocol in MANET. Their energy-aware routing has measured and predicted the per-interval energy consumptions using ARIMA time series model. This formulation preserved preference of residual energy and powerfully reduced unbalanced routing caused by differences in initial energy. Nevertheless, considered energy cost not only improves packet delivery ratio, and other
parameters should be considered when node speed gets higher. Additionally, they formulated an energy-related characteristic of power-wise heterogeneous scenarios.

Andy An-Kai Jeng & Rong-Hong Jan (2011) have proposed an energy-efficient maintenance protocol to reduce the beacon power. It is proven that any reconstruction and power change can cover in four and five beacon intervals. They also presented an adaptive configuration rule to configure the parameter for every node based on the node’s mobility and energy levels. Finally, the proposed protocol has efficiently reduced the overall energy consumption and network lifetime. Chen Q and Gursoy M.C. (2010) proposed a routing protocol, which has considered the position and energy of mobile nodes. The proposed routing protocol modified the continuous mobility by reflecting the position and energy of nodes. Thus, it has been proven that the safety of the routes and lifetime of the nodes were increased by constructing the balanced energy consumption considering the residual energy of nodes. It showed improvement compared to the precious protocols by improving the holding time of the route by more than 2.5 times compared to the existing protocols, and reducing the numbers of nodes that spent all the energy by maximum of 54%.

On the other hand, (Ying Zhu et al. 2011) have formulated a new topology control problem: energy-efficient topology control problem with cooperative communication. They proved that this problem was NP-complete and introduced two new topology control algorithms using cooperative communications. Both algorithms can build a cooperative energy spanner in which the energy efficiency of individual paths was guaranteed. In Jieun Yu et al. (2012) have proposed the basic centralized topology control scheme using Cooperative Communication (CC).The proposed scheme was presented with two helper-node selection schemes: the optimal method and the greedy
heuristic method. Initially, the mobile nodes were grouped into clusters due to transmission range. They also applied MST (or DTCC) to each cluster for direct links, and it achieved further power reduction. As CC has been presented, the path loss exponent and SNR were taken into account. The proposed topology control schemes (Coop. Bridges and Coop. Bridges + DTCC) have higher network connectivity performance than the other topology control schemes.

Zehua Wang et al. (2012) have proposed an opportunistic routing scheme for MANET, which was collected of three components: 1) PSR-a proactive source routing protocol, 2) large-scale live update of forwarder list, and 3) small-scale retransmission of missing packets. All of these have clearly utilized the broadcasting nature of wireless channels; furthermore, they achieved via efficient cooperation among participating nodes in the network. Principally, the proposed routing scheme can take different paths to the destination when packets among the same flow are forwarded. Nevertheless, the prospective cooperative communication in multi-hop wireless networks is to be unchecked at higher layers.

Quansheng Guan et al. (2012) have introduced physical layer cooperative communications that comprises topology control to improve the network capacity of MANETs. They have proposed a Capacity-Optimized Co-operative (COCO) topology control method, which considered both upper layer network capacity and physical layer relay selection in CC. They have adopted the two-hop relays and divided the long link into many hops. Simulation results have shown that physical layer cooperative communication techniques have noteworthy impacts on the performance of topology control and network capacity. Their proposed COCO method significantly improved the network capacity in MANETs with cooperative communications.
Richard Yu et al. (2013) have presented the cooperative communications with MANETs to design security and QoS co-design of MANET and also have proposed a game theoretical approach. The proposed method has enabled the source to advantageously select its relay by energetically updating its belief in the maliciousness of relays according to its record of attacks with the consideration of system throughput and system security requirement. This method is limited to utilize the relays, i.e. it can choose only two-hops as relays. Angelos Antonopoulos et al. (2013) has presented a network coding-aided energy efficient protocol for MAC layer, which has coordinated the transmissions among a set of relay nodes which act as helpers in cooperative Automatic Repeat reQuest-based (ARQ-based) wireless networks. The proposed solution has significantly improved the energy efficiency up to 80% without compromising the offered QoS in terms of throughput and delay.

2.7 COOPERATIVE RELAY NETWORK

Yuksel & Erkip (2007) have described a four terminal Gaussian network, composed of a single source-destination pair, a relay and a wire-tapper. Unlike the relay channel with a wire-tapper, it is assumed that the relay assists the wire-tapper, not the destination. The relay’s objective is to decrease the achievable secrecy rates. However, since the destination is also allowed to listen to the relay’s transmission, it also benefits from the relay in terms of achievable rates. Direct transmission, amplify-and-forward (AF), decode-and-forward (DF) and compress-and-forward (CF) relaying schemes are compared in terms of secrecy rates. It is shown that the best relaying strategy depends on the relay’s location. Comparison of relaying protocols and best power allocation schemes, when the relay assists the source-destination communication, does not readily extend to the case when the relay assists the wire-tapper.
Dong et al. (2010) has provided physical (PHY) layer security approaches for wireless communications that can prevent eavesdropping without upper layer data encryption. This paper addresses secure communications of one source-destination pair with the help of multiple cooperating relays in the presence of one or more eavesdroppers. Three cooperative schemes are considered: decode-and-forward (DF), amplify-and-forward (AF), and cooperative jamming (CJ). For these schemes, the relays transmit a weighted version of a re-encoded noise-free message signal (for DF), a received noisy source signal (for AF), or a common jamming signal (for CJ). Novel system designs are proposed, consisting of the determination of relay weights and the allocation of transmit power, that maximize the achievable secrecy rate subject to a transmit power constraint, or, minimize the transmit power subject to a secrecy rate constraint. For DF in the presence of one eavesdropper, closed-form optimal solutions are derived for the relay weights. For other problems, since the optimal relay weights are difficult to obtain, several criteria are considered leading to suboptimal but simple solutions, i.e. the complete nulling of the message signals at all eavesdroppers (for DF and AF), or the complete nulling of jamming signal at the destination (for CJ). Based on the designed relay weights, for DF in the presence of multiple eavesdroppers, and for CJ in the presence of one eavesdropper, the optimal power allocation is obtained in closed-form; in all other cases, the optimal power allocation is obtained via iterative algorithms. Numerical evaluation of the obtained secrecy rate and transmit power results show that the proposed design can significantly improve the performance of secure wireless communications.

2.8 SINGLE AND MULTI RELAY

Zou et al. (2014) paper has explored the physical-layer security in cooperative wireless networks with multiple relays where both amplify-and-
forward (AF) and decode-and-forward (DF) protocols are considered. They propose the AF- and DF-based optimal relay selection (i.e. AF\textsuperscript{b}ORS and DF\textsuperscript{b}ORS) schemes to improve the wireless security against eavesdropping attack. For the purpose of comparison, they examine the traditional AF\textsuperscript{b}ORS and DF\textsuperscript{b}ORS schemes, denoted by T-AF\textsuperscript{b}ORS and TDF\textsuperscript{b}ORS respectively. It also investigates a so-called multiple relay combining (MRC) framework and presents the traditional AF- and DF-based MRC schemes, called T-AF\textsuperscript{b}MRC and TDF\textsuperscript{b}MRC, where multiple relays participate in forwarding the source signal to destination which then combines its received signals from the multiple relays. Numerical results show that for both AF and DF protocols, the intercept probability performance of the proposed optimal relay selection is strictly better than that of the traditional relay selection and multiple relay combining methods.

Zou et al. (2014) has identified and analyzed the tradeoffs between the security and reliability of wireless communications in the presence of eavesdropping attacks. Typically, the reliability of the main link can be improved by increasing the source’s transmit power (or decreasing its data rate) to reduce the outage probability, which unfortunately increases the risk that an eavesdropper succeeds in intercepting the source message through the wiretap link, since the outage probability of the wiretap link also decreases when a higher transmit power (or lower data rate) is used. It characterizes the security-reliability tradeoffs (SRT) of conventional direct transmission from source to destination in the presence of an eavesdropper, where the security and reliability are quantified in terms of the intercept probability by an eavesdropper and the outage probability experienced at the destination respectively. In order to improve the SRT, opportunistic relay selection (ORS) is proposed and the attainable SRT improvement upon increasing the number of relays is quantified.
2.9 SECURED TRANSMISSION

Goel & Negi (2008) has considered the problem of secret communication between two nodes, over a fading wireless medium, in the presence of a passive eavesdropper. The assumption used is that the transmitter and its helpers (amplifying relays) have more antennas than the eavesdropper. The transmitter ensures secrecy of communication by utilizing some of the available power to produce ‘artificial noise’, such that only the eavesdropper’s channel is degraded. Two scenarios are considered, one where the transmitter has multiple transmit antennas, and the other where amplifying relays simulate the effect of multiple antennas. The channel state information (CSI) is assumed to be publicly known, and hence, the secrecy of communication is independent of the secrecy of CSI.

Lakshmanan et al. (2008) has described the scope of the work, namely the environment, metric and the assumptions about the eavesdropper. Then, they have described the need for and use of a ‘physical space security’ approach. Subsequently, they describe how beam forming can be applied as a baseline strategy for securing against eavesdropping. It highlights why such a technique is insufficient by itself and summarizes the motivations for a better physical space security technique.

Li et al. (2012) has presented the legitimate receiver that generates artificial noise (AN) to impair the intruder’s channel. This method is robust because it does not need the feedback of channel state information (CSI) to the transmitter and does not assume that the number of Eve’s antennas should be smaller than that of Bob. Furthermore, it proposes a new concept of outage secrecy region to evaluate the secrecy performance from a geometrical perspective. This should be useful if it needs to know what zone should be protected (or militarized). Analysis and simulation results in practical environments show that the proposed method has a good performance.
Mukherjee et al. (2014) has provided a comprehensive review of the domain of physical layer security in multiuser wireless networks. The essential premise of physical layer security is to enable the exchange of confidential messages over a wireless medium in the presence of unauthorized eavesdroppers, without relying on higher-layer encryption. This can be achieved primarily in two ways: without the need for a secret key by intelligently designing transmit coding strategies, or by exploiting the wireless communication medium to develop secret keys over public channels. The survey begins with an overview of the foundations dating back to the pioneering work of Shannon and Wiener on information-theoretic security. It then describes the evolution of secure transmission strategies from point-to-point channels to multiple-antenna systems, followed by generalizations to multiuser broadcast, multiple-access, interference, and relay networks. Secret-key generation and establishment protocols based on physical layer mechanisms are subsequently covered. Approaches for secrecy based on channel coding design are then examined, along with a description of interdisciplinary approaches based on game theory and stochastic geometry. The associated problem of physical layer message authentication is also briefly introduced. The survey concludes with observations on potential research directions in this area.

2.10 CONCLUSION

Some proposals on mobility control method are presented. Related views on logical network and broadcast state are listed. Various flooding algorithms have been reviewed. Reviews have been made on works related to relay selection, energy efficiency and secure key management. Various relay selection procedures have been reviewed. Due to mobility topology changes may occur and hence works on topology control are also reviewed.