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Adaptive Power Transmission and Efficient Energy Scheme of DSR Protocol (APEE-DSR)

Kadry Sayed Mohamed
Computers and Systems Department, Faculty of Engineering, Al Azhar University, Cairo, Egypt.
kelsayed@eces.org.eg

Sayed Abd El Hady Nouh
Computers and Systems Department, Faculty of Engineering, Al Azhar University, Cairo, Egypt.
Sayed.nouh07@gmail.com

Abdelhady M. Naguib
Computers and Systems Department, Faculty of Engineering, Al Azhar University, Cairo, Egypt.
a_naguib@azhar.edu.eg

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Abstract – Mobile ad hoc network, MANET, is a group of several nodes connected in dispersed way to enabling wireless communications. All nodes being moveable and are dynamically connected in a random way. MANETs can be used in many applications such as military battles, WSN, in areas where it is difficult to build wired network. Due to dynamic topology of MANET, restricted battery power, and limited capacity of wireless channels, it becomes design of routing mechanism is one of the master affronts in MANET. MANET routing protocols could be categorized into two classes: table-driven (e.g. DSDV) and on demand routing (e.g. AODV and DSR), many studies prove that reactive routing protocols are outperform proactive protocols. Therefore, this article concerned with performance enhancement of DSR which is the most famous reactive routing protocols. Standard DSR is multi hop in its nature where route selection between any two communicating nodes is only based on minimum hop count as a metric, regardless another metrics such as energy of nodes, traffic load on nodes and power transmission of packets which may have negative effects on performance of the standard DSR. This paper presents new version of standard DSR, called (APEE-DSR), through modification of both route discovery phase and route maintenance phase, in such a way that minimize energy consumption of nodes and realization of balanced traffic load of nodes, in addition to adaptation of transmission power of exchanged data packets among communicating nodes, resulting in prolong life time of nodes, thence increase life time of the routes and relative stability of network. In proposed scheme, route choice depending on two combined metrics: energy of nodes and their traffic load. Moreover, transmission power of packets among nodes through the selected route will be adaptive. Performance assessment and comparison between suggested schema (APEE-DSR) and standard DSR has been carried out utilizing simulation gadget NS2. Simulation results proved that performance of proposed protocol better than original DSR with respect to: successful packet delivery percentage, total delay time, normalized overhead, and nodes energy consumption.

Index Terms – MANET, DSR, APEE-DSR, RREQ, RREP, NEF, REF, ATP.

1. INTRODUCTION

Nowadays mobile ad hoc network (MANET) is one of most important recent wireless networks, where it allows to the modern smart mobile nodes (e.g. mobile phones, laptops etc.) to communicate with each else at anytime and anywhere without needing any type of the centralized management [1]. Due to random mobility of nodes, any node has the ability to enter or depart network at any time, resulting in the network topology changes unpredictably and dynamically [2, 3]. Due to random mobility of nodes, any node has the ability to enter or depart network at any time, resulting in network topology changing unpredictably and dynamically [2, 3]. Due to bounded transmission ambit of wireless channel, if any node wishes to set up communication with anther node located outdoor of its own transmission ambit, it is necessary other intermediary nodes to act as routers to prepare a route in hops style between them. For this reason, each node in MANET should act as host and router in same time.

Due to dynamic topology of MANET, restricted battery power of nodes, and limited capacity of wireless channels. It becomes design of routing mechanism is one of the master problems in MANET. Generally, MANETs routing schemas could be categorized into two sets: proactive routing schemes and reactive routing schemes [4- 7]. In proactive routing manners (e.g. DSDV and OLSR), directing information are interchanged amongst nodes on steady periods and paths are computed constantly among nodes, regardless paths are required or not. And this leads to many consumed network resources, such as energy and bandwidth. In contrary, at reactive routing schemes like AODV and DSR, in lieu of interchanging routing information amongst nodes upon consistent periods, route is created merely while it is needed (i.e. on demand). Hence, reactive routing schemes eschew the routes up-keeping cost that is being not of use and as well not ever launch tremendous control packets. As a result, performance of reactive routing tactics outperform proactive routing methods.

Dynamic source routing algorithm (DSR) is valuable reactive routing schema for purposing of routing [7, 8], it is distributed routing mechanism. Where created routes among nodes take form of multi- hop. DSR is constituted of two fundamental stages: route setup stage and route upkeep stage. In path unearthing phase, two control packages are utilized which are called, Route Request (RREQ) package and Route Reply (RREP) package. For path establishment between two nodes, RREQ is released by source node. On receiving RREQ at destination node, it response through sending RREP to source node to assert route creation. While, in case of route maintenance, Route Error (RERR) package is utilized, for informing source node that current used route during data transmission has been failed.

Although DSR has some advantages like: route is merely created when it is needed, the nodes use route cache information efficiently to minimize collisions of packets and route choice based on minimal hop counts. But while route discovery stage, DSR does not take into consideration nodes' energy, nodes' traffic load and transmission power of packets. Whereas, all of these issues have a side effect on performance of the standard DSR. Therefore, this article aims to improve performance of DSR through amendment of route discovery mechanism, where route choice is based on two merged criteria: energy of nodes, and their traffic load. Moreover, the transmission power of exchanged data packets will be adaptive according to the distance among nodes.

Paper structure is as follows: Part 2 presents the related works while brief description of original DSR routing protocol is stated in Part 3. The suggested protocol is submitted in Part 4. Simulation environment and parameters have been indicated in Part 5. In Part 6, simulation results and discussion have been offered. Finally Part 7 conclusion of the essay.

2. RELATED WORK

M. Sharifdeen and Dhavamaniprakash [9] suggested novel version of DSR, called EEDSR. Where, the route discovery scheme has been modified with aim to minimize energy consumption of nodes, thence prolong life time of network. In the suggested schema, selected route consists of minimum number of intermediate nodes having relatively high energy, resulting in more stabilized route for long time and hence decrease repetitions of route discovery mechanism. Simulation results proved that, in small size network, performance of both DSR and EEDSR is nearly identical with respect to energy consumption and throughput. While in moderate and large size network, EEDSR outperform of DSR from point of view of energy consumption and throughput.

Deepti D. and Rajendra S. K. [10] presented modified DSR algorithm, where path selection is based on node energy consumption as metric, for transmitting and receiving single packet instead of minimum hop counts. The article concluded that, performance of submitted schema outperform original DSR in terms of improving energy efficiency of nodes. Also, the proposed mechanism reduces routing load through shun propagation of RREP packages through multipath in standard DSR.

Uma R. Bhatt, N. Nema et al [11] introduced new schema, called DSRI, to reduce the flooding of RREQ packets, which cause to rebate energy consumption and network congestion. In suggested algorithm, route has been chosen based on three metrics: node's speed, remaining energy and strength of receipted signal. These metrics have been chosen to avoid nodes that having low remaining energy, high mobility and low reception signal strength from participating in route creation, resulting in minimization of RREQ packets flooding, minus network congestion, minimum delay time and efficient bandwidth utilization. Results of simulation proved performance of DSRI outperform standard DSR with respect to throughput, remaining energy of nodes and delay time.

In [12] the authors present a review and categorize the suggested energy conscious routing schemas of MANETs, which minifies either active wasted energy needed to send and receipt packages or inactive consumed energy when mobile node staying in lazy mode however it hearing to channel to any potential communication demands from another nodes.

Shweta S. and Gopal S. [13] proposed new version of DSR, where route maintenance mechanism has been modified to prolong active route life time. The basic idea beyond modification, is to account in advance the time at which active route is about to expire. This will assist to disclose new route before the old route become expired, resulting in saving more time of communication process.

Saurabh A. [14] presents an ideal energy conscious DSR algorithm, called EPAR-DSR, with the aim of prolong network life time, through decreasing nodes' energy consumption. In addition, suggested approach leads to balanced distribution of traffic load among nodes, and precludes from partition of network into small zones.

Krishna D. S. [15] introduced modified version of original DSR, called LS-MDSR. It is an energy- efficient routing algorithm and balanced traffic load sharing, where there is no route becomes heavily loaded or remains idle.

Roy Leung, Jilei Liu, et al [16] present an enhanced version of DSR, named multipath DSR (MP-DSR), with the aim for improving quality of service from point of view of routes

RESEARCH ARTICLE

reliability among communicating nodes with a minimum routing overhead.

Jijesh J. J and Shivashankar [17] projected a modified version of DSR, with goal of reducing energy consumption of nodes and to make routes more stable. Performance assessment and comparative analysis have been performed among the modified DSR, DADV and AODV, where simulation results indicated that proposed modified DSR outperform the aforementioned routing protocols with respect to: consumed energy, maximum throughput and delay time.

P. Parthiban, et al [18] introduced modified route discovery schema of DSR to magnify network life time, where route choice depending on remaining energy of nodes and minimal hop count.

3. DYNAMIC SOURCE ROUTING (DSR)

DSR is entirely a reactive routing protocol. Whereas, it is source routing scheme the exchanged data packets among node contain a tidy list of all addresses of intermediary nodes through which packets should be routed to destination node [5]. In DSR, all nodes enclose a medium storage, called routing cache, to maintain acquired route for any target node in network. DSR schema includes two fundamental phases which are: route creation and route upkeep. During route creation stage, only two control packets are used, named route request (RREQ) package and route reply (RREP) package, for path creation between any two nodes. While, in route maintenance phase merely one control packet, called Route Error (REER) packet, is used.

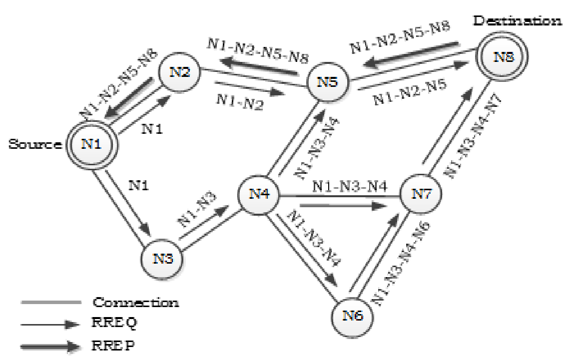

Figure 1 Route Discovery Mechanism of DSR

When source node intends for connecting to destination node, it searches in its routing cache to get a route. If no route is obtained, route creation mechanism is started through broadcasting a RREQ to its neighboring nodes [19]. On receipt RREQ, in case of an intermediary node has a right path for destination node, it sends RREP package containing this route in its header, through reverse path of RREQ packet, to source node [20-22]. Otherwise, it inserts own address into route record field of RREQ header and rebroadcasts RREQ package to its neighboring nodes. This operation is repeated till RREQ package arrives to destination node. Because of rebroadcasting transmissions, RREQ itself may be reach to destination node, through different paths. On receipt 1st RREQ packet, destination node replies by sending RREP package, through rearward path of this RREQ, to source node as illustrated in Figure 1[23-25]. Whereas, the route selection in DSR depends on minimum hop counts [26, 27], so, the identical RREQ packets that later arrive at destination node will be dropped.

In route maintenance phase, each intermediate node along the selected route must ensure that each transmitted data packet have been successfully received by its successor node. On detecting link breakage, intermediary node sends route error (RERR) package to source node through predecessor nodes. In receipt RERR package, source node activates route creation mechanism to setup new route.

4. PORPOSED APEE-DSR

Although DSR is momentous protocol in MANET, it has many shortcomings like:

DSR is not energy efficient routing, as nodes have a limited-power battery, so routing protocols in MANET must be energy efficient. Therefore, modification of DSR is required to be energy efficient.

Route selection using DSR, among communicating nodes, is not energy efficient. Due to DSR chooses the path based on minimum hop count, which may result in poor route selection.

DSR is unaware scheme with respect to traffic load of the nodes during route creation, which might leading to more routes congestion. Thence, resulting in more data packets loss and longer delay time.

In DSR, all exchanged packets are transmitted with maximum power. Resulting in more energy consumed and cause reduction of network life time.

The major aim of proposed APEE-DSR is to remedy the above mentioned shortcomings, by making DSR aware to nodes' energy and their traffic load during route discovery phase. In addition, instead of transmitting route reply/data packets with maximum power, a new simple method is used for making the transmission power of those packets adaptive according to the distance between any two successive nodes along the selected route, resulting in reduction of power consumption of nodes, hence prolong age of selected route as well as increase network life time.

For implementing the suggest APEE-DSR, the following three models were taken into consideration to calculate node's energy factor, node's traffic load factor and adaptive transmission power, for route discovery operation.

RESEARCH ARTICLE

4.1. Energy Model

Whereas, energy efficient routing scheme is main trouble of MANETs. Therefore, the energy factor of nodes has very momentous effect in improvement of route life time and network life time. Node's energy factor (E_f) is calculated according to the following equations:

$$E_f = \frac{E_r}{E_i} \quad (1)$$

$$E_r = E_c - (E_{tx} + E_{rx}) \quad (2)$$

Where

E_r: Remaining energy of node

E_i: Primary energy of node

E_c: Node's current energy

E_{tx}, E_{rx}: Node energy consumption for every transmitted and receipted packet respectively.

4.2. Traffic Load Model

Whereas, the route selection of DSR is multi-hops in its nature. Therefore, the set of intermediate nodes along the selected route should has low traffic load. This is because, high traffic load in nodes resulting more waiting of packets in transmission buffer and hence increase delay time. Also heave loaded nodes cause network congestion. It easy to calculate the Traffic Load factor (TL_f) of node with the following equation:

$$TL_f = \frac{L}{Q} \quad (3)$$

Where

L: Current packets' count in transmitted queue.

Q: Maximum size of transmitted queue.

Energy factor and traffic load factor can be combined into one metric called Node Efficiency Factor (NEF) using the following equation:

$$NEF = \frac{E_f}{TL_f} \quad (4)$$

Where Node Efficiency Factor will be used as a metric during route discovery operation in such a way that to avoid node of low efficiency factor

4.3. Adaptive Transmission Power Model

Whereas, in standard routing protocols of MANET, exchanged control (data) packets among nodes are transmitted with constant transmission power, this may lead to more energy wastage of nodes and increasing the chance of interference. Therefore, an adaptive transmission power model should be designed in such a way that to make transmission power of nodes to be adaptive according to its distance from its successor node, resulting in more saving of node's energy and interference reduction. The adaptive transmission power of node can be compute as the following example.

Suppose that two homogeneous nodes (A, B) are separated by known distance d, each of them has constant transmission power (P_t) and threshold power of received signal (P_{thr}), to detect signal by the receiving circuit. When node A transmits signal to node B. According to two- ray ground reflection paradigm [28], node B can calculate power of received signal (P_r) using the following equation:

$$P_r(d) = \frac{P_t\, G_t\, G_r\, h_t^{\,2}\, h_r^{\,2}}{d^4} \quad (5)$$

Subsequently, when node B transmits signal to node A, instead of it transmits with constant power (P_t), it transmits with adaptive power (AP_t), where

$$AP_t(d) = \frac{1.25P_t}{PRF} \quad < P_t \quad (6)$$

Where, PRF is the reception power factor and it get it by:

$$PRF = \frac{P_r}{P_{thr}} \quad \geq 1 \quad (7)$$

N.B.: In proposed APEE-DSR, it is very important to pay our attention that, both RREP packets and data packets are transmitted with adaptive transmission power (AP_t). While RREQ packets is broadcasted with full constant power (P_t).

By including the aforementioned three models into original DSR, the resulted new version (APEE-DSR) is being able to create a path, between any two communicating nodes, has relatively long- life time and minimum delay time. In addition, realization of minimizing power consumption of nodes resulting in prolong network's life time.

4.4. Operation of Proposed APEE-DSR Scheme

Like standard DSR, the suggested scheme composed of two stages: Route creation stage and Route upkeep stage. To meet our requirements, humble modification has been made in the format of RREQ and RREP packet. Where, two fields have been appended to RREQ packet, first field is used to broadcast present coordinates (x, y) of node and second field to record link efficiency factor (LEF).

While another two fields are added to RREP packet, first field uses for recording recommended adaptive transmission power (AP_t) and second field for recording the path efficiency factor (REF).

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RESEARCH ARTICLE

4.4.1. APEE-DSR Route Creation Process

The suggested route discovery scheme aims to shun routes contain nodes which have low energy and heavily loaded of packets, therefore concept of maximum -minimum of node efficiency factor has been used for route choice. In addition, signal transmission power of both route reply packets (RREPs) and data packets is adapted according to the dimension between each two consecutive nodes via elected path, resulting in reduction of power consumption of nodes.

When source node willing to connect with destination node, it searches in its routing cache to get a route. If there is no route in cache, it commences route creation operation through promulgating RREQ packet, containing source node coordinates (x, y) and field of link efficiency factor (LEF):= 3, to neighbouring nodes. On receipt RREQ, in state of any intermediary node possess a right path for destination node it sends RREP package, containing this route in its header, via reverse path of RREQ packet, to source node. Else, the intermediary node computes its efficiency factor (NEF) and recommended adaptive transmission power (AP_t) utilizing equation 4, 6 respectively, and store AP_t in route cache, and obeys the following procedure:

In case of NEF< LEF, the intermediary node updates LEF field by value of NEF and (x, y) field with its present location and rebroadcasting RREQ package. Otherwise, it updating merely (x, y) field with its present location, and rebroadcasting RREQ package. Rebroadcasting operation is duplicated until RREQ packet arrives to destination node. In this context, we could saying that receipted RREQ package at destination node includes lowest efficiency factor of node via the path between source node and destination node.

Due to repetition of rebroadcasting process, RREQ packet itself may reach destination node via various paths. Therefore, by making destination node waits for time period T for receiving same RREQ packet many times, where for each received RREQ package, destination node calculates its recommended adapted transmission power (AP_t) and store both LEF and AP_t in the reply cache. Then after expiration time T, destination node elects the first two routes having maximum LEF. For each chosen route, destination node sends RREP packet, containing REF:= LEF and APT:= AP_t, to the successor intermediate node toward source node, by transmission power AP_t. On receiving RREP packet, intermediate node store the value of APT field in its reply cache and updates APT field with its recommended AP_t and retransmits RREP packet, with its transmission power AP_t, to its next intermediate node along the route. This process is repeated till RREP packet received by source node.

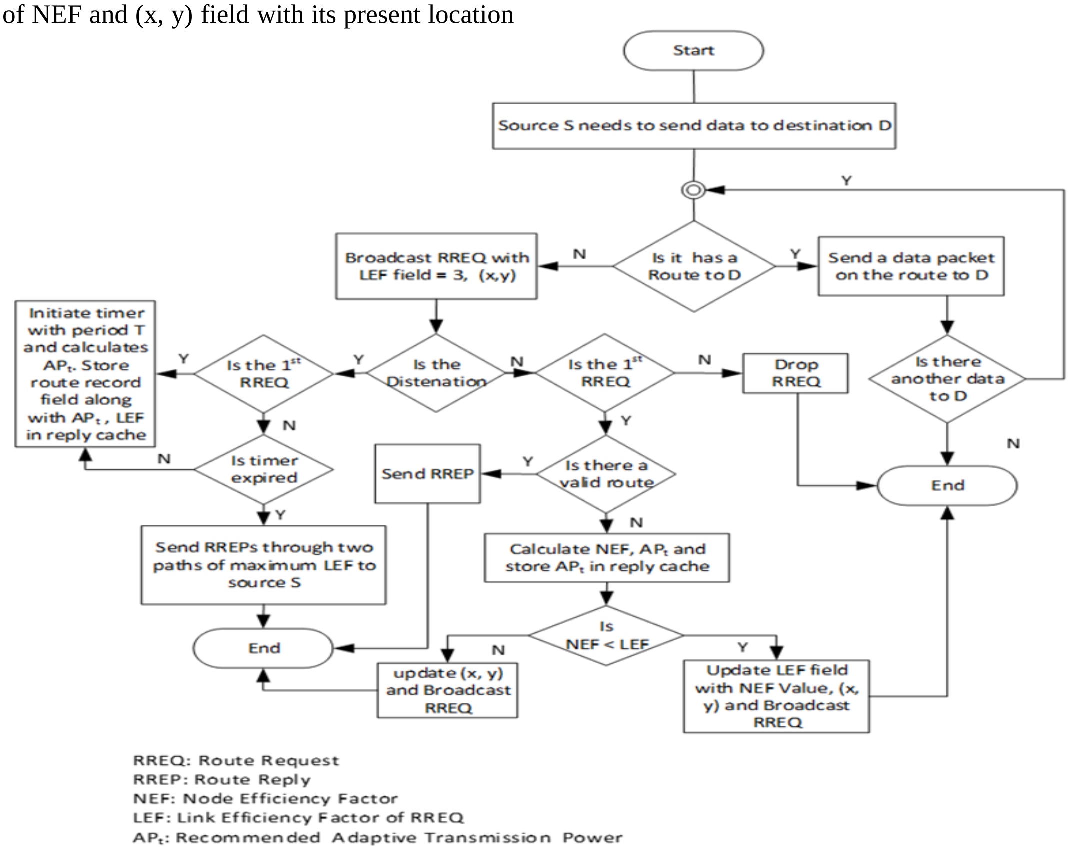

Figure 2 Action of Node on Receiving RREQ Packet

RESEARCH ARTICLE

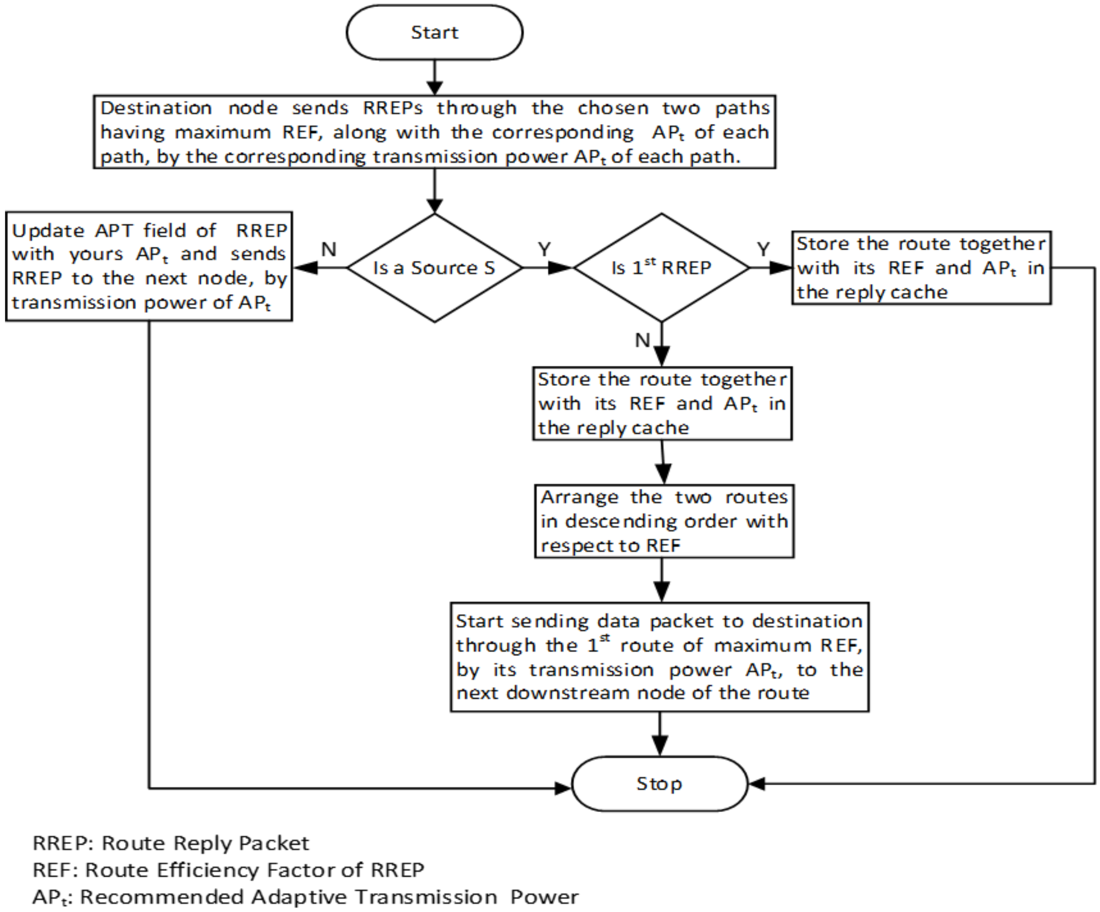

Figure 3 Action of Node on Receiving RREP Packet

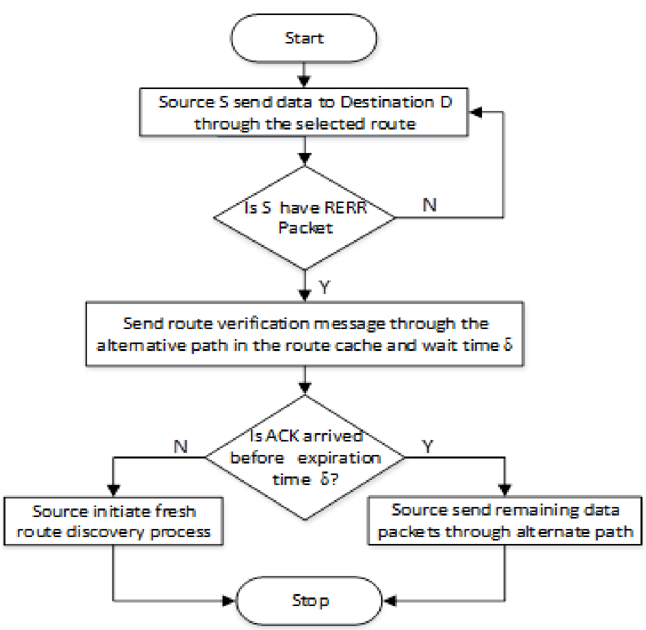

Figure 4 Route Maintenance Mechanism of APEE-DSR

Figures 2, 3 show action of nodes when receiving RREQ and RREP packet respectively. On receiving two RREP packets, source node store them in its reply cache. Hence, starts sending data packet through the route which has highest REF by the recommended transmission power AP_t, to next intermediate node along the route toward destination node. On receiving data packet, intermediated node retransmits data packet by its recommended transmission power AP_t to successor node. The operation is iterated till data package arrives destination node.

4.4.2. APEE-DSR Route Maintenance Process

Route maintenance is a process for keeping the right operation of active route in APEE-DSR protocol. During transmission of data packets, in case of any broken link, pervious node from missed linkage sends Route Error (RERR) packet, by means of hops modality, to source node. During RERR packet trip towards source node, every intermediary node, precedes of missed link, deletes route to any unreachable target node form its routing cache. On reception of RERR package, source node clears the cracked path from routing cache and sends route verification message through the alternative path

RESEARCH ARTICLE

in the reply cache to destination node and waits a time interval δ, as shown in Figure 4. In case of receiving positive acknowledge message from destination node through the alternative route during its waiting time, source node begins transmission of remaining data packages via the alternative route. Otherwise, it initiates fresh route discovery operation.

5. SIMULATION ENVIRONMENT AND PARAMETERS

The simulation is carried out using network's imitator NS2 [29]. It is open- source simulation gadget which operates under unix/linux/windows. NS2 is discrete events system, it is written by C++ and Tcl language. Most various routing protocols of MANET have been built in NS2 (e.g. DSR, AODV DSDV). Performance assessment and comparison between suggested schema APEE-DSR and standard DSR have been executed using simulation gadget NS2. All outcomes of simulation that created in trace file had been computed and analyzed using AWK command. Table 1 contains the parameters that have been used during running of simulator. And the used criterions for assessing performance of APEE-DSR and DSR are: successful packets delivery ratio, end to end delay, normalized routing load and energy consumption of nodes.

Simulation Item	Values
Network simulator	NS2 (ver. 2.34)
No. of nodes	50 - 90 node
Simulation time	500 sec.
Simulation area	400x800 meter
pause time of nodes	0-500 sec.
No. of connection sources	25, 30, 35, 40, 45, 50
Mobility model	Random waypoint model
Routing protocols	DSR, APEE-DSR
Rate of packets	4 packet/sec.
Speed of nodes	5 m/sec. -55 m/sec.
Packet Size	512 bytes
Channel Type	Wireless
MAC Layer	802.11
Traffic Type	CBR
Antenna type	Antenna/Omni Antenna
Radio transmission range	250 m
Radio propagation model	Two ray ground
Interface queue length	50
Initial energy of nodes	20 joule
Transmission energy (E_{tx})	0.6 joule
Reception energy (E_{rx})	0.3 joule

Table 1: Simulation Factors

6. SIMULATION RESULTS AND DISCUSSION

This part is interested with performance assessment and comparison of APEE-DSR and original DSR, under various scenarios by using aforementioned criterions.

6.1. Scenario A

This scenario illustrates impact of pause time changing of nodes on performance of the suggested APEE-DSR and standard DSR from point of view of aforementioned criterions, using the factors of Table 2 and the other factors are mentioned in Table 1.

Simulation Item	Value
No. of nodes	50
Simulation time	500 sec.
Simulation area	800m x 400m
Pause time of nodes	0 - 500 sec.
Speed of nodes	5 m/sec.
No. of connection sources	25

Table 2: Simulation Factors of Scenario A

Figure 5 shows packet delivery fraction (PDF) versus pause time of both APEE-DSR and original DSR. It is lucid that, with increasing pause time (i.e. slow mobility of nodes), PDF for the two protocols increases. This is due to, stability of routes among communicating nodes. On contrast, with decreasing pause time (i.e. high mobility of nodes), PDF of both protocols decreases. This because of, instability of routes which leads to more loss of data packets. It is noted that, average PDF of APEE-DSR (85%) is higher than counterpart of DSR (62%), with percentage of improvement 39%. This is due to, the APEE-DSR scheme during route discovery process avoids routes contain nodes which have low energy, in addition to the modified route maintenance schema that takes into consideration second alternative route to send data packets, in case of failing primary chosen route. All these resulting in more routes stability among communicating nodes.

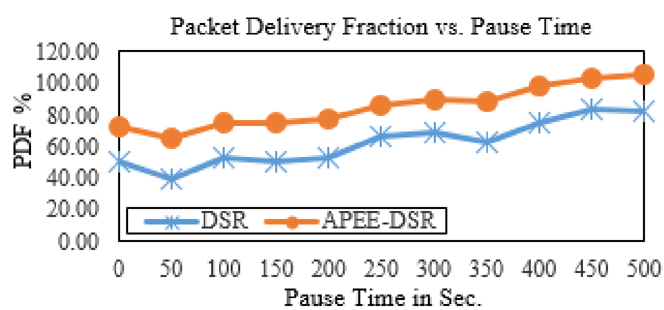

Figure 5 Packet Delivery Fraction versus Pause Time

Figure 6 displays end-to-end delay time against pause time of both APEE-DSR and original DSR. It is noticable that, with increasing pause time of nodes , E2E delay time of both two protocols decreases. This is because, routes stability which leads to minimizing the repetitions of route discovery operation, hence reduction of E2E delay time. It is obvious that, average E2E delay time of APEE-DSR (2.35 sec.) is lower than counterpart of DSR (4.15 sec.), with ratio of

RESEARCH ARTICLE

improvement 44%. This because of, during route creation processe, the APEE-DSR mechanism elects routes contain nodes which have light traffic load, resulting in minimization of time waiting in the transmition buffer. In addition to the modified route maintenance schema that takes into account second alternative route for sending data packets, in state of failing the fundamental chosen route. All these resulting in reduction of end-to-end delay time among communicating nodes.

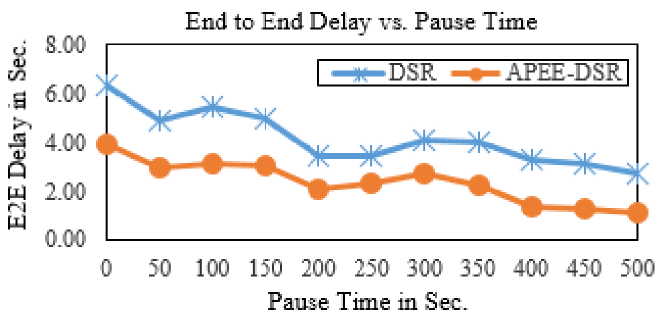

Figure 6 End to End Delay versus Pause Time

Figure 7 illustrates normalized routing load (NRL) against pause time of APEE-DSR and original DSR. It is obvious that, with increasing pause time, NRL for the two protocols decreases. This is because, stability of routes leads to reduction of repeating of route discovery process, hence reduction of control packets. As shown from figure, NRL for APEE-DSR (0.48) is lower by far than its peer of DSR (1.47), with percentage of improvement 67%. This is due to, APEE-DSR submits more stabilized routes comparing with its counterpart of DSR. Resulting in reduction of repeating of route discovery process, thence reduction of normalized routing load.

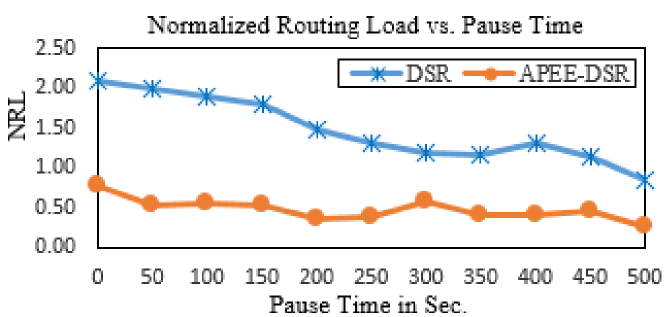

Figure 7 Normalized Routing Load versus Pause Time

Figure 8 presents average energy consumption against pause time of APEE-DSR and original DSR. From figure we note that, with increasing pause time, average energy consumption of both protocols reduces. This is due to, stability of routes resulting in reduction of repeating of route discovery process, hence reduction of control packets which make minimization of energy consumption of nodes. It is lucid that, average energy consumption of APEE-DSR (3226 mj) is lower by far than counterpart of DSR (10944 mj), with percentage of improvement 71%. This is because, APEE-DSR takes into consideration the adaptive transmission power (AP_t) for sending RREP packets and data packets, in addition to traffic load balancing mechanism among nodes.

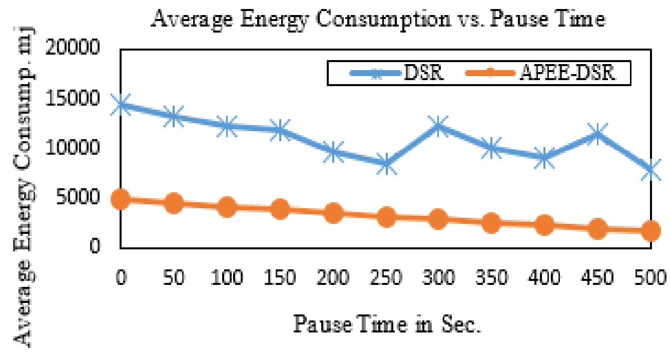

Figure 8 Energy Consumption against Pause Time

6.2. Scenario B

This scenario examines impact of nodes speed on performance of suggested APEE-DSR and standard DSR, utilizing factors of Table 3 and the other factors are indicated in Table 1.

Simulation Items	Value
No. of nodes	50
Simulation time	500 sec.
Simulation area	800m x 400m
Pause time of nodes	0 - 500 sec.
Speed of nodes	5 - 55 m/sec.
No. of connection sources	25

Table 3: Simulation Factors of Scenario B

Figure 9 illustrates packet delivery fraction (PDF) versus nodes' speed of both APEE-DSR and original DSR. It is noticeable that, with increasing nodes' speed (i.e. high mobility of nodes), PDF of both protocols reduces. This because of, when speed of nodes increases, probability of routes failure increases that leads to more data packets loss. Results of simulation show that, average PDF of APEE-DSR (70.56%) is higher than counterpart of DSR (54.33%), with percentage of improvement 30%.

This is due to, the APEE-DSR scheme during route discovery process avoids routes contain nodes which have low energy, in addition to the modified route maintenance mechanism that takes into consideration the second alternative route to send data packets**,** in state of failing the fundamental chosen route. All these resulting in more routes stability among communicating nodes.

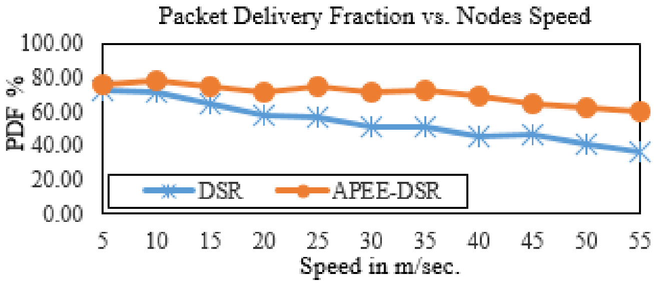

Figure 9 Packet Delivery Fraction against Nodes Speed

Figure 10 displays end-to-end delay time against speed of nodes of APEE-DSR and original DSR. Intuitively, as speed of nodes increases, the delay time for both two protocols increasing. This is due to, routes instability which leading to increasing the frequency of route discovery operation, hence increas of E2E delay time. It noticable that, average E2E delay time of APEE-DSR (3.16 sec.) is lower than counterpart of DSR (7.25 sec.), with improvement ratio 57%. This because of, during route creation process, the APEE-DSR scheme elects routes contain nodes that have light traffic load, resulting in minimization of waiting time in the transmitting buffer. In addition to the modified route maintenance scheme which takes into account the second alternative route to send data packets, in state of failing the fundamental chosen route. All these resulting in increasing of E2E delay time among communicating nodes.

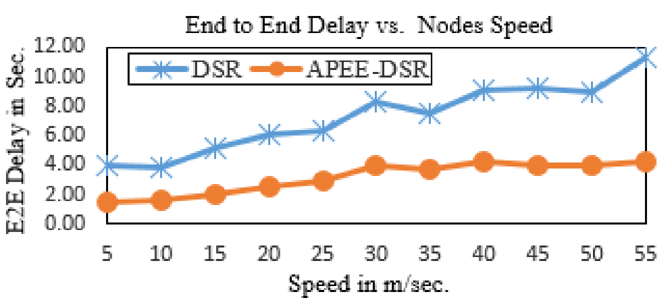

Figure 10 End to End Delay versus Nodes Speed

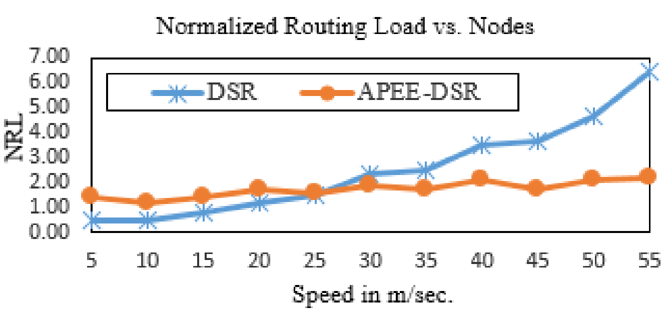

Figure 11 Normalized Routing Load against Nodes Speed

Figure 11 illustrates normalized routing load (NRL) against nodes speed of APEE-DSR and standard DSR. It is lucid that, with increasing nodes' speed, NRL for the two protocols increases. This is because of, instability of routes leads to high probability of repetition of route discovery process, thence increase of normalized overhead. As shown from figure, NRL of APEE-DSR (1.72) is lower than its counterpart of DSR (2.50), with percentage of improvement 31%. This is due to, APEE-DSR submits more stabilized routes comparing with its counterpart of DSR. Resulting in reduction of repetition of route discovery process, thence reduction of normalized routing load.

Figure 12 presents average energy consumption versus speed of nodes of both APEE-DSR and original DSR. From figure we note that, as speed of nodes increases, average energy consumption of both protocols is increased. This is due to, instability of routes leads to increase of repeating of route discovery process, thence increase of control packets which make maximization of energy consumption of nodes. It is lucid that, average energy consumption of APEE-DSR (5113.90 mj) is lower by far than its counterpart of DSR (14808.35 mj), with ratio of improvement 65%. This is because, APEE-DSR takes into consideration the adaptive transmission power (AP_t) for sending RREP packets and data packets, as well as traffic load balancing mechanism among nodes.

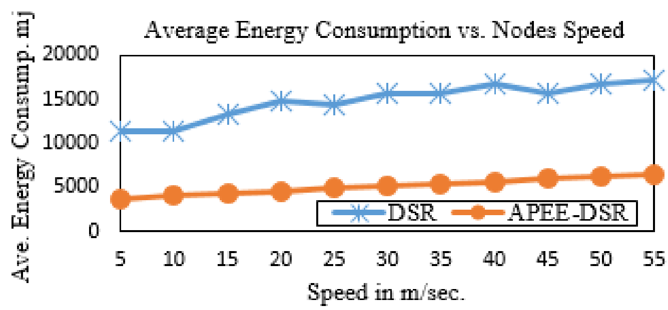

Figure 12 Energy Consumption against Nodes Speed

6.3. Scenario C

This scenario examines impact of number of connection sources on performance of suggested APEE-DSR and standard DSR, utilizing factors of Table 4 and the other factors are indicated in Table 1.

Simulation Items	Value
No. of nodes	50
Simulation time	500 sec.
Simulation area	800m x 400m
Pause time of nodes	15 sec.
Speed of nodes	15 m/sec.
No. of connection sources	25 - 50

Table 4: Simulation Factors of Scenario C

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Figure 13 illustrates Packet delivery fraction (PDF) versus number of connection sources. It is noticeable that, when number of coinciding connection sources increases, PDF for both protocols decreases. This because of, increasing number of synchronized connection sources lead to high probability for transmitted data packets collision, which results in more data packets loss, thence reduction of PDF. It is obvious that, average PDF of APEE-DSR (58.29%) is higher than its counterpart of DSR (44.62%), with percentage of improvement 31%. This is due to, the APEE-DSR scheme presents more routes stabilized among communicating nodes.

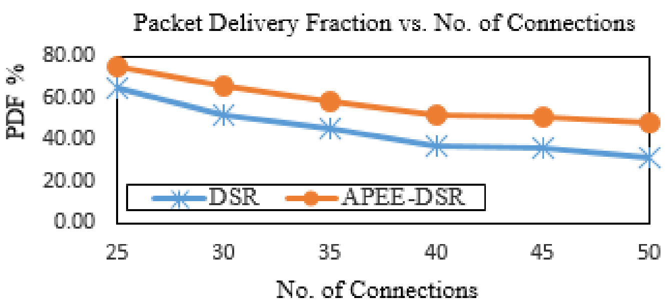

Figure 13 PDF versus No. of Connections

Figure 14 displays end-to-end delay time against number of connection sources of both APEE-DSR and original DSR. Intuitively, as number of connection sources increases, delay time of both two protocols is increase. This is because, increasing connection sources makes network more congested resulting in extra waiting time for data packets in transmission buffer of nodes along the route between source node and destination node. It is noticeable that, average delay time of APEE-DSR (5.20 sec.) is lower than counterpart of DSR (8.18 sec.), with percentage of improvement 36%. This is because, APEE-DSR scheme during route creation operation choses routes contain nodes which have light traffic load, resulting in minimization of waiting time in the transmitting buffer. In addition to the modified route maintenance scheme which takes into account the second alternative route to send data packets, in state of failing the fundamental chosen route. All these resulting in reduction of end-to-end delay time among communicating nodes.

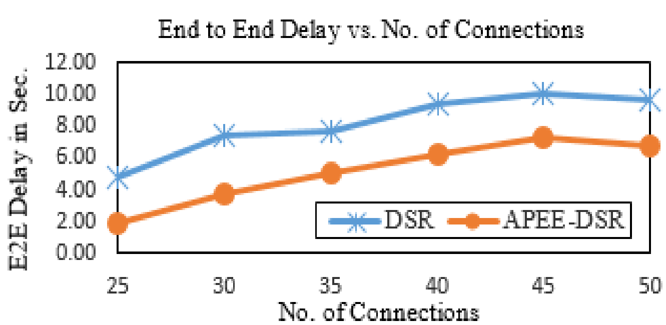

Figure 14 End to End Delay against No. of Connections

Figure 15 demonstrates normalized routing load (NRL) versus number of connection sources of both APEE-DSR and original DSR. Axiomaticly, with increasing connection sources, NRL for the two protocols increases. This is because of, increasing connection sources leads to high probability of repetition of route discovery operation, resulting in more generation of control packets. It is obvious that, normalized routing load of APEE-DSR (1.39) is lower than its counterpart of DSR (1.96), with percentage of improvement 30%. This is due to, APEE-DSR submits more stabilized routes comparing with its counterpart of DSR. Resulting in reduction of repeating of route discovery process, thence reduction the normalized routing load.

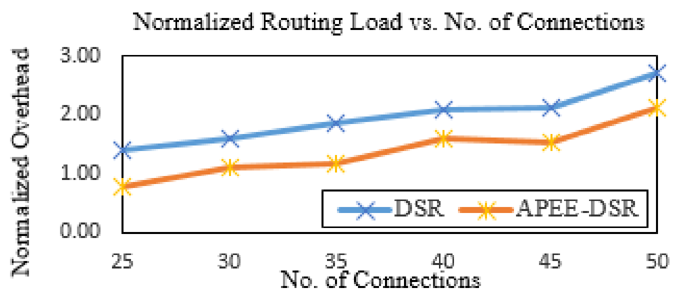

Figure 15 Normalized Routing Load against No. of Connections

Figure 16 presents average energy consumption versus number of connection sources of both APEE-DSR and original DSR. From figure we notice that, with increase connection sources, average energy consumption for the two protocols increases. This is because, increasing connection sources lead to high probability of repetition of route discovery operation, thence increase number of both control packets and data packets resulting in increasing of energy losses of nodes. It is lucid that, average energy consumption of APEE-DSR (4776 mj) is lower by far than its counterpart of DSR (14881 mj), with percentage of improvement 68%. This is because, APEE-DSR takes into consideration the adaptive transmission power (AP_t) for sending RREP packets and data packets, as well as traffic load balancing mechanism among nodes.

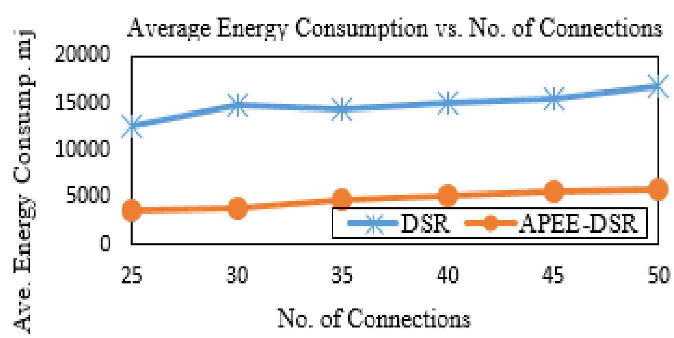

Figure 16 Energy Consumption against No. of Connections

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7. CONCLUSION

This essay submits improved version of standard DSR, called (APEE-DSR), via amendment of both route creation phase and route maintenance phase, in such a way that minimize energy consumption of nodes and balanced traffic load of nodes, in addition to adaptation of transmission power of exchanged data packets among communicating nodes, resulting in prolong life time of nodes, thence increase life time of the routes and relative stability of network. Performance assessment and comparison between suggested scheme (APEE-DSR) and original DSR has been executed utilizing simulator gadget (NS2). Results of simulation proved that performance of the proposed protocol outperform original DSR with respect to: successful packet delivery ratio, end- to-end delay, normalized routing load and energy consumption of nodes.

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Authors

Kadry S. Mohamed received his B.Sc. degree in Systems and Computers Department, Faculty of Engineering, Al-Azhar University in 1990. And M.Sc. degree from Al-Azhar University from 2013. His research areas are: performance analysis and evaluation of computer network, performance analysis and evaluation of computer network and Ad-hoc routing protocols.

RESEARCH ARTICLE

Sayed A. Nouh is the professor of computer networks, Computers and Systems Engineering Department at Al-Azhar University, Cairo, Egypt. He received his B.Sc. degree in communications engineering and M.Sc. degree in computer engineering form Al Azhar University in 1978 and 1982 respectively. He received his Ph.D. degree in computer engineering from AGH University, Cracov, Poland in 1992. From 2006-2010, he has served as the Egyptian Consultant at African Union, Adds Ababa, Ethiopia. From 2012-2015 he has served as the chairman of Computers and Systems Engineering Department at Al Azhar University. He is the chairman of committee of upgrading the professors and associate professors. He is an IEEE member since 1991. He has been involved with research in performance analysis and evaluation of computer networks, Ad-hoc routing protocols, routing and security protocols for wireless sensor networks, Mobile Computing and Wireless Networking, Modeling & Computer Simulation techniques, Data Communications Networks.

Abdelhady M. Naguib received his M.Sc. and Ph.D. in Systems and Computers Engineering from Al-Azhar University in 2008 and 20013 respectively. He is currently an assistant professor at Computers and Systems Department, Faculty of Engineering at Al Azhar University, Cairo, Egypt. His research areas of interest are Sensor Networks, Ad Hoc Networks and Cellular Networks.