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A Misdirected Route Avoidance Using Topological Transform Adaptive Relational QOS Routing in Wireless Sensor Network

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Abstract: Wireless Sensor Network (WSN) continues to grow and consequently an effective routing scheme is required when the topological changes occur. Existing Distributed algorithm for Time-bounded Essential Localization (DTEL) over a sensor network minimizes the time taken for the broadcasting of packets. But, investigating the throughput level on the different topological route paths is not focused. Topological changes in the wireless sensor network measure the throughput level using Ternary Content Addressable Memory (TCAM)-based packet classification systems. TCAM based sensor network system improves the throughput level but the topological transformation sometimes lead to the misdirected routing in WSN. To improve the routing scheme on the different topological structure, Topological Transform Adaptive Relational Quality of Service Routing (TTA-RQoSR) scheme is proposed in this study. TTA-RQoSR scheme develops the framework with the three main objectives such as adaptively, avoiding the misdirected route and improving the throughput level. TTA-RQoSR scheme uses the abstained misdirected routing to remove the misdirected route path of packet transfer from the source to the destination. The abstained misdirected routing adjusts the flow relationship exclusively on locally observed paths using the erlang's C formula. erlang's C formula uses the Poisson arrival process with arrival rate to avoid the misdirected route. Secondly, TTA-RQoSR scheme uses the Relational QoS Routing to attain approximately 5% improved throughput level on changing mobility of sensor node and sink node in WSN. Experiment is conducted using the simulation tool on the factors such as throughput level on varying topological structure, avoidance rate of misdirected route and delay time.

Keywords: Relational QoS routing, wireless sensor network, Erlang's C formula, misdirected route path, topological change, abstained misdirected routing

INTRODUCTION

Wireless sensor networks are normally composed of many low-powered sensors nodes with a few relatively robust sink nodes to perform the powerful communication. WSN usually gathers the data by the individual nodes where it is eventually routed to the sink nodes. A rate monitoring simply makes use of the idea to forward packets with user required topological structure. The topological structures of different forms are used in sensor network field. Topological structure in WSN is illustrated in Fig. 1.

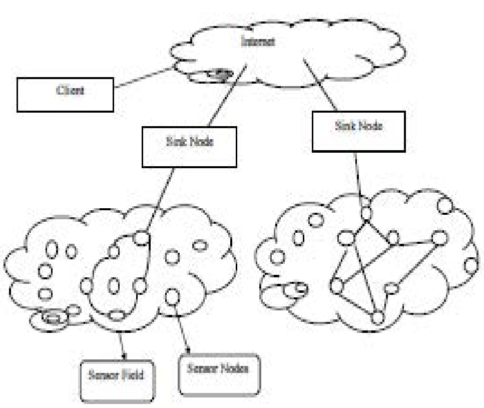

Fig. 1: Topological WSN Structure

Topological routing in WSN is very demanding due to the essential characteristics that distinguish from other wireless networks. Existing joint authentication and Topology Control (JATC) scheme in Guan *et al*. (2012) improve the throughput rate by as a discrete stochastic optimization method. Joint authentication considers spanning over the entire protocol stack for the

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overall wireless network performance measurement. But, not working on the dynamic changing topology.

In internet (Obaidat and Guelzim, 2010), Wi-fi Protected Access (WPA) scheme presents an encryption and decryption process for providing authentication for dynamic changing topology. WPA suffers from a few flaws on using the existing algorithm to interfere with the deployed wireless network. WPA is not suitable for providing quality of services in wireless networks because it does not solve the delay time factor. Localized Quality of Service (QoS) routing protocol make use of an Acknowledgment (ACK) system by Djenouri and Balasingham (2011) to reduce the delay time in sensor network.

Localized QoS factor based on Exponential Weighted Moving Average (EWMA) method consume small memory to transfer the packets from source to destination. The protocol uses multi queuing with priority where higher priority is given for the lager load factor thereby reducing the delay time with minimal memory consumption. A ternary Content Addressable Memory (TCAM)-based packet classification system as demonstrated in (Meiners *et al*., 2011) measures the throughput level. TCAM space for an encoded classifier is three times lesser in space when compared with the re-encoded classifier and its transformers. TCAM based sensor network system improves the throughput level but the topological transformation sometimes leads to failure in routing.

To attain the routing on the topological transformation, Harmony Search and Learning Automata based Topology Control (HSLATC) protocol is described by Yang *et al*. (2012) that determines an appropriate transition radius of the sensor nodes while building the route for packet transmission. In HSLATC, accurate result obtained on selecting the transition radius of sensor nodes but fails to offer the full QoS connectivity on sensor network. Adaptive Location-oriented QoS content delivery as demonstrated by Zhang *et al*. (2012) performs packet movement on mobile sensor nodes. Semi-Markov process is used in the existing work for the movement of packets in sensor network but not developed with energy effective routing protocol.

Optimal selective forward routing as illustrated in (Valles *et al*., 2011) provides the most of the significance approach to save the energy and improve the throughput level. Optimal selective routing approach maximize the sensor to successfully transfer the packet from the sink node to the sensor nodes in the sensor field but eventually misdirection occurs on the large set of sensor nodes.

To correctly direct the route, Energy-Aware Clustering algorithm (EADC) is presented in (Yu *et al*., 2012) to cluster the routes. The EADC uses opposition range clusters of even sizes for routing. The cluster always holds the cluster head with minimal energy consumption but the EADC fails in balancing the load factor. To balance the traffic load in wireless network, Topology Aware Adaptive Routing (TAAR) is presented by Chen *et al*. (2013). TAAR has three routing modes which used on dynamically adjusting the topology status of the routing path, thereby flexibility on small set of wireless network system is improved.

For the large set of wireless network nodes, Position-based Opportunistic Routing (POR) protocol is used for transmission of packets. POR as demonstrated by Zhang *et al*. (2011a) has possessions of geographic routing and transmit the packet in wireless medium. When a data packet is sent out, some of the neighbor nodes eavesdrops the transmission by misdirect the route. The misdirection of route increases the communication overhead and latency time. To reduce the communication overhead, a general random network model is described by Zhang *et al*. (2011b) for enhancing the network performance. A secure communication is carried out with the minimal overhead but not worked on with the very large scale wireless sensor network.

Similarly, to reduce the latency time on geographic routing, Multi-hop Delaunay Triangulation (MDT) method is developed by Nikravan and Jameii (2012) with dynamic topological structure. MDT protocol suite has a packet forwarding protocol for nodes construction and maintains distributed MDT for routing but, MDT method leads to misdirection of routes on the rare scenarios.

First, due to the huge number of sensor nodes, it is not possible to build a scheme for the deployment of a large number of sensor nodes when the overhead of routing maintenance is high. Secondly, large number of sensor nodes also leads to the misdirection of routes in the sensor field. The misdirection leads to the lesser throughput level. Existing Distributed algorithm for Time-bounded Essential Localization (DTEL) as described by Cheng *et al*. (2013) over a sensor network minimizes the time taken for the broadcasting of packets and also integrated the regular payload transmissions. However, investigating the throughput level on the different topological route paths is not focused in DTEL method. DTEL are not broadly developed on social network applications.

In this study, Topological Transform Adaptive Relational Quality of Service Routing (TTA-RQoSR) scheme is developed for enhancing the routing structure without any misdirection. TTA-RQoSR scheme uses the abstained misdirected routing method to remove the misdirected route path of packet transfer from the source to the destination. The routing misdirection is measured using the Erlang's C Formula. Arrived Poisson distribution result is explained briefly and Relational QoS Routing improves the throughput rate in TTA-RQoSR scheme. TTA-RQoSR Scheme plays a vital role in the sensor network structure to avoid the misdirection route and improve the throughput level on packet transferring.

Literature review: The routing along the shortest paths in the sensor field concentrates on reducing the energy consumption. A multi constraint routing using fuzzy logic (Chelliah *et al*., 2012) was developed to improve the performance of WMN and reduces the possibilities of congestion in the network. However, group communication is not focused in wireless mesh networks.

Routing protocols and simulation analysis in Chowdhury *et al*. (2012) uses the GloMoSim-2.03 to find the shortcomings of routing protocols. However, Routing protocols are not effective on solving the data redundancy, energy efficiency. Adaptive routing is also not effective on limiting the memory consumption rate in wireless sensor network structure. Neighbour Aware Multicast Routings Protocol (NAMP) (Pathan *et al*., 2008) is a tree based hybrid multicast routing protocol that enhances the performance of the network with minimum transmission time.

Mobility framework (Ogwu *et al*., 2007) developed for specifying a probabilistic QoS guarantee in mobile ad-hoc network. This model characterizes a mobile user particularly in a large ad hoc network. However, routing is very complex in mobile ad hoc network. Token-Based (TB) robust deadlock-free dynamic reconfiguration protocol (Kadhar, 2014) provides solution for deadlock free reconfiguration protocol and reduced the packet loss.

An adaptive push system as described by Nicopolitidis *et al*. (2010) broadcast the packets in underwater acoustic wireless networks and achieves the low latency broadcasting of packets. But, throughput rate is lesser. To achieve the higher throughput rate in Yuen *et al*. (2009), using the alternate user strategy in the partially overlapping-interests which significantly improved the multiuser diversity of information in infestation network.

MATERIALS AND METHODS

Topological transform adaptive relational QoS routing scheme: The main objective of the proposed routing scheme is to avoid the misdirection routing on varying topological structure in the WSN. The QoS routing is offered to select the effective route path for transferring the packet from the source to destination sensor nodes. The relational QoS routing assume the source routing model with varying network topology information. The information is available in all source nodes for the easy transfer of packets from source to destination. The

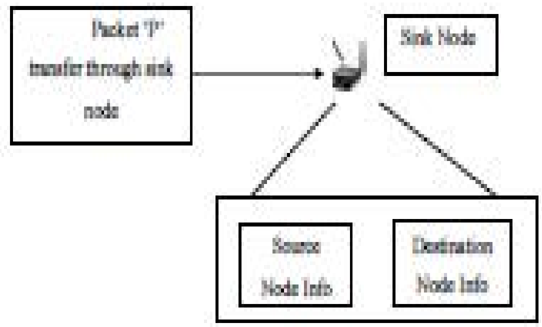

Fig. 2: Packet transferring through sink node

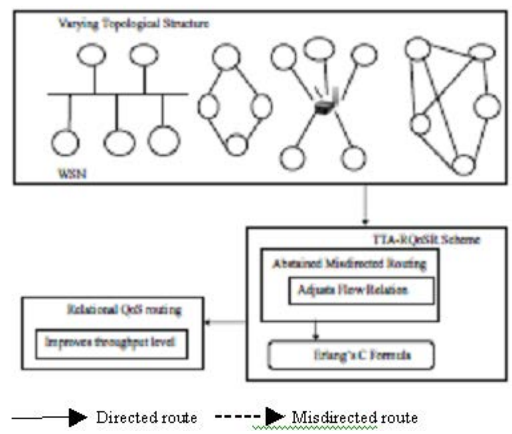

Fig. 3: Architecture diagram of TTA-RQoSR scheme

packet flow is routed along the explicit routed paths in TTA-RQoSR Scheme to improve the throughput level.

TTA-RQoSR Scheme initially identifies the relationship among the route path nodes and recognizes the mutually disjoint routes. The notion of the abstained misdirection routing is introduced to deal with the misdirected route among the different route paths. The avoidance of misdirected route is carried out in the TTA-RQoSR scheme that improves the throughput level.

The packet of varying length is transferred on the wireless sensor route path through the sink node as described in Fig. 2. The network usually transfers the packet through the sink node to the sensor field of varying range. Sink node contains the information about the source and destination route nodes with the intermediate node information. TTA-RQoSR scheme is used to avoid the misdirection route of packets transfer and architecture Diagram of TTA-RQoSR scheme is described in Fig. 3.

As illustrated in Fig. 3, sensor network with sensor nodes consists of the various topological structures. The directed route path for packet transfer varies due to the mobility of sensor nodes within the sensor field. The misdirection of route path leads to the delay on the packet transfer and reduces the throughput level. The misdirected routing avoided through the Abstained Misdirected Routing in TTA-RQoSR scheme. It adjusts the flow relationship on the movable nodes using the Erlang's C formula. Erlang's C formula helps in reducing the delay time using the Poisson arrival process rate. Erlang's C formula finally helps on avoiding the misdirection route path for packet transfer and Relational QoS routing helps in improving the throughput level.

Abstained misdirected routing: Consider a scenario with '500' sensor nodes of topological structure on the sensor network as described in Fig. 2 where the source 's' and a destination 'd' are connected by disjoint paths path 1, path 2, ..., path n in TTA-RQoSR scheme. Each path 'i' has a capacity of $b_i$to transfer the packet from the source in average flow rate. The flow relation is accommodated with b_i flows at any 't'. The QoS state of path is achieved in TTA-RQoSR scheme using the delay time minimization. The delay time is minimized using the erlang's C formula. The packet load capacity in sensor network is computed as:

$$\text{Packet load capacity}\,(c) = \frac{b_i}{l_i b_i} \tag{1}$$

Equation 1 load capacity is illustrated with load l_i of '10' KB with average 'b_i' capacity of '50' KB in sensor network. The packet load capacity 'c' is:

$$c = \frac{3.041409320\times10^{64}}{500}$$
$$c = \frac{3.041409320\times10^{62}}{5}$$
$$c = 60.8281\times10^{60}$$

The packet load capacity is measured on the overall sensor network to compute the packet flow relationship. The average flow relation on the varying topological structure is computed as:

$$\text{Packet flow relation}\,(F_i) = D\,(l_i, b_i) = \frac{c}{\sum_{n=0}^{b_i}\frac{l_i^n}{n}} \tag{2}$$

Equation 2 clearly describes the flow relationship of packets on varying load l_i on the path 'i' in WSN. The 'D' denotes the delay reduced on the varying load l_i and path capacity b_i on transferring of packets form's' to'd' in WSN. The 'n' denotes the number of packet to be transferred from source to destination. The flow relationship is adjusted on the varying topological structure. The flow relationship adjustment is denoted as:

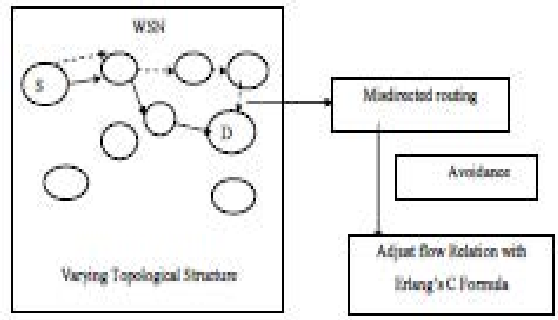

Fig. 4: Abstained misdirected routing procedure

$$\text{Flow relation Adjustment}\,(A_j) = \frac{l_i^{(1)}}{\sum_{j=1}^{n} l_j^{(1)}} \tag{3}$$

$$\text{Flow relation Adjustment}\,(A_n) = \frac{l_i^{(1)}}{\sum_{j=1}^{n} l_j^{(n)}} \tag{4}$$

Equation 3 denotes the first level of adjustment on the packet flow through the varying load capacity path 'i'. The path 'i' is adjusted to the path 'j'. Likewise to the path 'n', (i.e.,) till the misdirection is avoided in the TTA-RQoSR scheme. The misdirection avoidance with minimal delay time is computed using the Erlang's C formula where it improves the throughput level rate. The total load and the path capacity b_i in TTA-RQoSR scheme are computed to avoid the misdirected route path. The abstained misdirected routing is represented through the diagrammatic form in Fig. 4.

Figure 4 clearly describes the procedure of the avoiding the misdirected route path in WSN using the abstained misdirected routing. The objective of the TTA-RQoSR scheme is to find a set of relational routes through which the packet can be transferred. The transferred route path capacity is analyzed and then minimize the overall delay rate by shifting some load from path 'i' to path 'j'. The optimal relationship is analyzed and then the packet flow relationship is adjusted based on the path capacity in TTA-RQoSR scheme.

Erlang's C formula: In the TTA-RQoSR scheme, Erlang's C formula identifies the poisson arrival rate 'λ' and service rate 'μ' with exponential distribution of finite mean time to compute the delay. Erlang's C Formula imagines the stability condition to avoid the misdirection routing on the varying topological structure. The steady state in the Poisson distribution is computed as:

$$\text{Erlang's C formula}\, C(s,d) = \frac{\frac{l_i}{b_i(1-\rho)}}{\sum_{n=1}^{l-1} \frac{d^n}{n} + b_i(1-\rho)} \quad (5)$$

Equation 5 described the formula which avoids the misdirection using the Poisson distribution. The l_i load capacity is determined and then the Poisson distribution 'ρ' is computed. The source node 'n' and destination route path'd' factorial is computed on identifying the misdirection route path in WSN.

Relational QoS routing: Relational quality of service routing in TTA-RQoSR scheme reduces the delay time and improves the throughput level rate. The misdirection is avoided and relational routing precedes the work with sequence of variable length packets in TTA-RQoSR scheme. During each sequence, incoming packet flows are routed along paths selected in the sensor field. A path is selected with frequency determined by prescribed relations. The adjustment on the flow relation avoids the misdirection on the movable sensor nodes and improves the throughput rate.

In TTA-RQoSR scheme, packet flow relationship on the different topological structure from source to destination sensor node is determined. The flow relationship in TTA-RQoSR scheme improved the throughput rate with minimal delay time.

Algorithmic procedure of RQoS routing: Relational QoS routing is developed in proposed TTA-RQoSR scheme for avoiding the misdirection route on the changing mobility of sensor node and sink nodes. The algorithmic procedure of relational QoS routing is described as:

RQoS routing procedure:

Begin
Input: Source sensor node 's', Destination sensor node 'd', load 'i' and capacity range 'b' of sensor node in sensor field
Output: Packet transmit form's' to'd' without any misdirection with higher throughput rate
Step 1: Select the Eligible path 'i' to transfer packet of length 'N'
Step 2: Increment the flow counter from source's' to 's+1'
Step 3: Compute Packet flow relation (F_i) on each topological structure
Step 4: Assign a relationship on QoS routing to avoid misdirection
Step 5: If relationship not matched
Sep 5.1: $\text{Flow Relation Adjustment}(A_j) = \frac{l_i^{(1)}}{\sum_{j=1}^{n} l_j^{(1)}}$

Computed on 'n' adjustment values
Step 6: End If
Step 7: Computed new relation improves the throughput rate on varying topological sensor field.
End

The above algorithmic procedure improves the relationship between the packet flows in sensor field using the packet flow relationship adjustment. TTA-RQoSR scheme also works on the varying load capacity, thereby increasing the throughput rate without any misdirection of packets in sensor field. If the topological system load changes suddenly, the old flow relationship result is terminated and new sequence adjustment carried out to transmit the packet with the higher throughput level.

Experimental evaluation: Topological Transform Adaptive Relational QoS Routing (TTA-RQoSR) scheme performs the experimental evaluation on NS2 simulator. In the simulations, 85 sensor nodes are constructed in sensor network environment. The sensor nodes use the DSDV routing protocol to perform the experiment on the randomly moving objects. In the Random Way Point (RWM) Model, each sensor node moves to an irregularly chosen location. The RWM uses standard number of sensor nodes for scheduling the nodes. The chosen location with an arbitrarily selected speed contains a predefined amount and speed count.

The movement of all nodes generated over a 900×900 m sensor field. The nodes moves at the random speed of 5 m $\sec^{-1}$ and an average pause of 0.01 sec. For simulation, the proposed TTA-RQoSR scheme is compared with existing Distributed algorithm for Time-bounded Essential Localization (DTEL) (Pathan *et al*., 2008) and Ternary Content Addressable Memory (TCAM)-based packet classification systems (Meiners *et al*., 2011). The TTA-RQoSR scheme experiments the research on factors such as throughput level on varying topological structure, avoidance rate of misdirected route, energy consumption on varying sensor node mobility, delay time, communication overhead on varying sensor node density level and false positive rate.

Throughput level is the rate at which the successful packet delivered through the communication channel. The packet delivered over a physical link without any misdirection of route in the network node:

$$\text{Throughput} = \frac{\text{Packet size}}{\text{Transmission speed}}$$

Throughput level takes the packet of Kilo Byte size for the experimental research. Transmission time is about '5' m $\sec^{-1}$. Avoidance of misdirection in the wireless network structure is defined as the avoidance rate and measured in terms of percentage (%). Avoidance rate on the different Route path (R) are measured in terms of Joules (J). The amount of energy used on transmitting the packets is defined as the energy consumption rate:

$$\text{Energy consumption} = \text{Nodemobiltyrate} \times \text{Simulation time}$$

The node mobility rate in sensor network is measured in terms of bits per second. Simulation time gets doubled as the mobility rate increases. The higher mobility rate, then the energy consumption is also getting increased. Delay time in the wireless network structure denotes the amount of time get elapsed for transmitting the packet from one sensor node 'N' to another in the sensor field. Assume a packet transfer carried on 10 sensor nodes:

$$\text{Delay time} = (T_1 - T_2) + (T_2 - T_3) + \ldots + (T_9 - T_{10})$$

Where:

T_1 = First sensor node start time
T_2 = Second sensor node
T_{10} = Tenth sensor node

Similarly, sensor node time taken for packet transmission from one place to another is computed. The proportion of time spends on communicating with network structure rather than transmitting the packets is termed as the communication overhead. Communication overhead is measured in terms of percentage. False positive refers to the probability of falsely rejecting the null hypothesis (misdirection) for a particular packet transmission. Packet transmission misdirection is minimized, so the false positive rate is of negligible percentage.

RESULTS AND DISCUSSION

The TTA-RQoSR scheme is compared with the existing Distributed algorithm for Time-bounded Essential Localization (DTEL) (Pathan *et al*., 2008) and Ternary Content Addressable Memory (TCAM)-based packet classification systems (Meiners *et al*., 2011). The below Table 1 values are used for plotting the graph in this section.

Table 1 illustrates the throughput rate based on packet size using TTA-RQoSR scheme and comparison is made with two other existing methods, namely DTEL Method (Pathan *et al*., 2008) and TCAM System (Meiners *et al*., 2011). The increased throughput rate improves the performance of TTA-RQoSR scheme.

Table 1: Tabulation for throughput rate

	Throughput rate (Mbps)		
Packet size (kb)	DTEL method	TCAM system	TTA-RQoSR scheme
1000	190	200	210
2000	390	400	420
3000	550	575	599
4000	785	805	825
5000	935	955	985
6000	1130	1165	1200
7000	1270	1310	1350
8000	1510	1550	1585

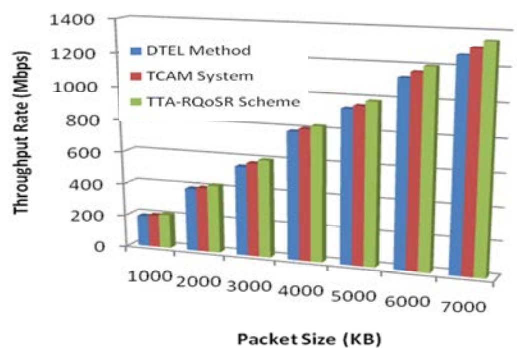

Fig. 5: Measure of throughput rate

Figure 5 shows the measures of throughput rate based on the packet size using TTA-RQoSR scheme, DTEL Method (Pathan *et al*., 2008) and TCAM System (Meiners *et al*., 2011). The packet size is measured in terms of KB. In Fig. 5, the proposed TTA-RQoSR scheme provides higher throughput rate when compared to the DTEL Method (Pathan *et al*., 2008) and TCAM System (Meiners *et al*., 2011). This is because of the application of Erlang's C formula and relational QoS Routing in proposed TTA-RQoSR scheme. Erlang's C formula avoids the misdirection route path for packet transfer and therefore, Relational QoS routing improves the throughput level. TTA-RQoSR scheme improves the throughput level rate by 5-10% when compared with DTEL Method (Pathan *et al*., 2008) thereby selecting the path with a frequency determined relations. In TTA-RQoSR scheme, packet flow relationship on the different topological structure from source to destination sensor node is determined using relational QoS routing, so throughput level improved by 2-5% when compared with the TCAM System (Meiners *et al*., 2011).

Avoidance rate is demonstrated in Fig. 6 where the misdirection is avoided and relational routing precedes the work with sequence of variable length packets. As shown in the figure, the proposed TTA-RQoSR scheme provides higher avoidance rate when compared to the DTEL Method (Pathan *et al*., 2008) and TCAM

Table 2: Tabulation for avoidance rate

Route path count (R)	Avoidance rate of misdirected route (Avoidance %) DTEL	TCAM	TTA-RQoSR
4	49.5	46.5	43.6
8	99	95.1	92.4
12	65.2	62.7	59.1
16	20	19.5	18.4
20	24.8	23.4	22.6
25	42.6	40.5	38.9
30	34.5	33.1	31.9

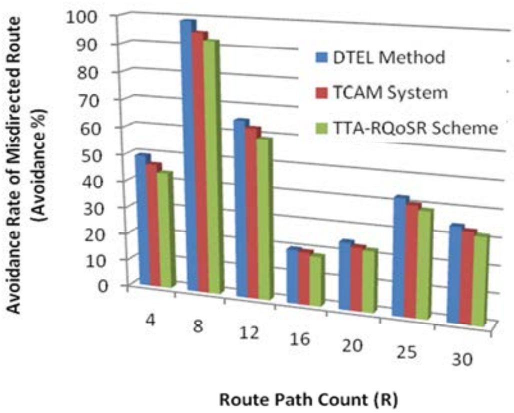

Fig. 6: Measure of avoidance rate

System (Meiners *et al.*, 2011). This is because of the application of erlang's C formula in proposed TTA-RQoSR scheme. Erlang's C Formula uses the Poisson arrival process with arrival rate to avoid the misdirected route, therefore the proposed TTA-RQoSR scheme improved the avoidance rate by 6-11% when compared with the DTEL Method (Pathan *et al.*, 2008). The abstained misdirected routing adjusts the flow relationship entirely on locally observed paths which improves the avoidance rate by 2-6 % when compared with the TCAM System (Meiners *et al.*, 2011) (Table 2).

The results of energy consumption using TTA-RQoSR scheme with two state-of-the-art methods like DTEL Method (Pathan *et al.*, 2008) and TCAM System (Meiners *et al.*, 2011) is shown in Table 3.

Table 3 and Fig. 7 illustrate the energy consumption based on the sensor node mobility range. Energy consumption is reduced in TTA-RQoSR Scheme by identifying the relationship among the route path nodes and recognizes the mutually disjoint routes at the initial stage. The network usually transfers the packet through the sink node to the sensor field of varying range without any delay, so the energy consumption is reduced by 3-8% when compared with DTEL method (Pathan *et al.*, 2008) and 2-5 % when compared with TCAM system (Meiners *et al.*, 2011), respectively.

Table 3: Tabulation for energy consumption

Sensor node mobility (bits/sec)	Energy consumption DTEL method	TCAM system	TTA-RQoSR Scheme
10	215	205	200
20	875	830	800
30	1900	1850	1800
40	3330	3270	3200
50	5160	5300	5000
60	7450	7500	7200
70	10700	10200	9800

Table 4: Tabulation for delay time

No. of Node (N)	Delay time (sec) DTEL method	TCAM system	TTA-RQoSR Scheme
5	42	39	37
10	70	66	62
15	138	122	111
20	156	145	136
25	250	240	231
30	177	166	152
35	225	207	195

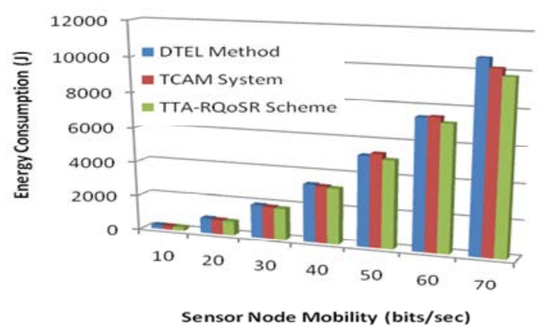

Fig. 7: Measure of Energy Consumption

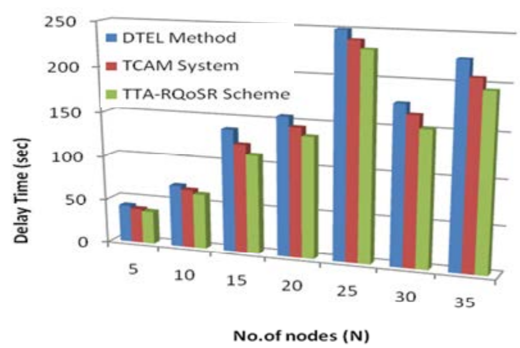

Fig. 8: Measure of delay time

Table 4 demonstrates the delay time based on number of sensor nodes using TTA-RQoSR scheme and comparison is made with two other existing methods, namely DTEL Method (Pathan *et al.*, 2008) and TCAM System (Meiners *et al.*, 2011).

Figure 8 measure the delay based on the node count. From Fig. 8 the proposed TTA-RQoSR scheme

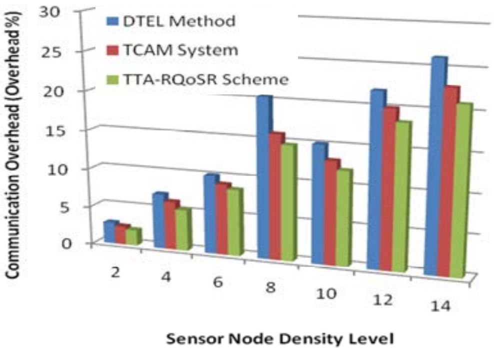

Fig. 9: Measure of communication overhead

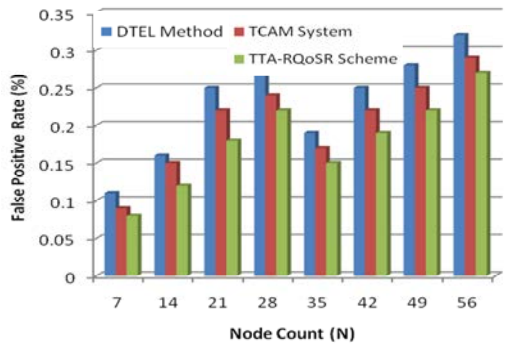

Fig. 10: Measure of false positive rate

Table 5: Tabulation for communication overhead

	Communication Overhead (%)		
Sensor node density level	DTEL method	TCAM system	TTA-RQoSR Scheme
2	2.750	2.350	2.010
4	7.130	6.270	5.320
6	10.12	9.120	8.560
8	20.49	16.00	14.74
10	15.12	13.23	12.12
12	22.01	20.05	18.45
14	26.20	22.85	21.02

Table 6: Tabulation for false positive rate

	False positive rate (%)		
Node count (N)	DTEL method	TCAM system	TTA-RQoSR Scheme
7	0.11	0.09	0.08
14	0.16	0.15	0.12
21	0.25	0.22	0.18
28	0.27	0.24	0.22
35	0.19	0.17	0.15
42	0.25	0.22	0.19
49	0.28	0.25	0.22
56	0.32	0.29	0.27

provides minimum delay time when compared to the DTEL Method (Pathan *et al.*, 2008) and TCAM System (Meiners *et al.*, 2011). This is because of the application of Erlang's C formula in proposed TTA-RQoSR scheme. The Erlang's C formula implementation in TTA-RQoSR Scheme reduces the delay time from 7-19% when compared with DTEL Method (Pathan *et al.*, 2008). Erlang's C formula uses the stability condition to avoid the delay (i.e., elapsed time) on the varying topological structure. The transferred route path capacity is analyzed and then the overall delay rate is minimized by 3-9 % when compared to the TCAM System (Meiners *et al.*, 2011).

Table 5 and Fig. 9 show the communication overhead based on sensor node density level. From the figure it is illustrative that the communication overhead is reduced using the proposed TTA-RQoSR scheme when compared to the two other existing works. Communication overhead is reduced in TTA-RQoSR Scheme by computing the load capacity. Load capacity formula demonstrated in Abstained Misdirected Routing reduces the overhead by 15-28% when compared with the DTEL Method (Pathan *et al.*, 2008). The packet load capacity is measured on the overall sensor network to reduce the overhead by 6-15% when compared with the TCAM System (Meiners *et al.*, 2011).

Table 6 illustrates the false positive rate based on node count using TTA-RQoSR scheme and comparison is made with two other existing methods, namely DTEL Method (Pathan *et al.*, 2008) and TCAM System (Meiners *et al.*, 2011). When false positive rate is reduced, proposed TTA-RQoSR scheme is said to be more efficient.

Figure 10 describes the false positive rate using TTA-RQoSR Scheme and existing method (Pathan *et al.*, 2008; Meiners, 2011). From the figure we can note that the false positive rate is lower using the proposed TTA-RQoSR Scheme when compared to the existing methods DTEL Method (Pathan *et al.*, 2008) and TCAM System (Meiners *et al.*, 2011) respectively. The steady state in the Poisson distribution reduces the false positive rate by 15-28% when compared with the DTEL Method (Pathan *et al.*, 2008) and 6-20% when compared with the TCAM System (Meiners *et al.*, 2011), respectively.

Finally, Topological Transform Adaptive Relational Quality of Service Routing scheme enhances the routing structure with the higher throughput level. Abstained misdirected routing method in TTA-RQoSR scheme remove the misdirected route path for packet transfer from the source to the destination.

CONCLUSION

In this research, a novel method called Topological Transform Adaptive Relational Quality of Service Routing

(TTA-RQoSR) is presented. TTA-RQoSR scheme focused on the QoS metric and achieves the higher throughput rate. At the first step, the design is made on avoiding the misdirection of route over the various topological structures using the abstained misdirected routing method. The routing misdirection is computed based on the packet flow relation measure and adjusted packet flow relation measure. After the measurement in the first step of TTA-RQoSR scheme, Erlang's C formula is used to avoid the misdirected route. At the second step, TTA-RQoSR scheme uses the Relational QoS Routing to attain an improved throughput level on mobility of sensor node and sink node in WSN. Finally, TTA-RQoSR scheme achieves adaptively, avoiding the misdirected route and improving the throughput level. TTA-RQoSR scheme attains the 3.69% higher throughput level and avoidance rate. TTA-RQoSR scheme reduced the communication overhead by 9.71% and also minimizes the delay time, false positive rate and energy consumption.

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