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MITIGATE REPLICA NODES IN WIRELESS SENSOR NETWORKS USING ADAPTIVE TRAFFIC DATA CONTROL SCHEME [ATDCS]

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Abstract

With the growing demand in wireless sensor network (WSN), adversary attack on sensor node becomes major issue in current WSN deployment. The replica nodes which are generated by attackers time transmits inappropriate message to the sink in the sensor networks. To reduce the overhead of sensor node transmission on the adversary conditions, first work extends replica detection scheme of probability ratio test with Finite Range Query (FRQ) technique to effectively identify the mobile replica nodes and eliminate the varying query ranges of mobile sensor nodes. But it is necessary to validate the query to improve the detection of mobile replica nodes. So, second work focused on validating the functionality of the query scheme at the time of the operation, thus reducing the risk of untimely failures. Numerous source nodes require accounting data to a sink node, producing the funneling consequence where the traffic load enhances since the distance to the sink node reduces. An implication of the funneling outcome is network jamming where packet lines spread out, since packets appear at nodes faster than what the nodes can broadcast. Distinctive packet traffic in a sensor network exposes distinct models that permit an adversary examining packet traffic to realize the position of a base station. To manage the packet creation rate at the sources and transitional nodes, an adaptive traffic data control scheme is presented in which it controls the data flow rate at the sink based on the original nodes. It improves energy efficiency of the sensor nodes and controls the data traffic rate based on the sequence data packet arrival. An experimental evaluation is conducted to estimate the performance of the proposed adaptive traffic data control scheme in WSN [ATDCS] in terms of delay, traffic control rate, reliability.

Keywords: WSN, replica nodes, Finite range query, query validation, adaptive traffic control scheme

1. Introduction

Wireless sensor networks might be observed as a huge compilation of small sensor nodes that can categorize themselves in an ad-hoc system. It can be accomplished of intellection ecological conditions inside their variety and have sequence activated restricted energy. After the intelligence phase, sensor nodes require to broadcast the information to the sink node or base station, wherever an appliance will practice the data. Nevertheless, a wireless sensor network generally requires communications and sensor nodes must systematize themselves so as to generate method that guide to a sink. Consequently, WSNs achieve multi hop data proliferation so as to communicate data to a fixed sink.

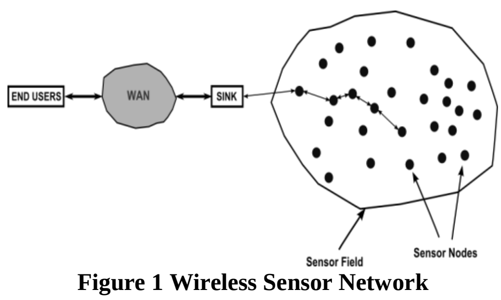

Figure 1 Wireless Sensor Network

The assumption and framework development of Wireless Sensor Networks (WSN) have admirably leading to exploitation of tempting the important examining systems. Nevertheless, the presentation of the systems after the operation, frequently changes drastically from the time of the development practically.

Apart from malevolent intention; there can be further reasons of packet dipping like crashes, buffer spread out, jamming, etc. It is significant to discover solutions that obtain these issues into account, for instance, to thwart fake alarms. Packet loss happens when one or more packets of data roaming diagonally a network not succeed to get to their destination. Packet loss is illustrious as one of the three major error kinds met in digital connections; the other two being fragment error and false packets based owing to noise. Packet loss can be processed by a amount of factors, counting signal deprivation in excess of the network standard owing to multi-path fading, packet dive as of channel jamming, dishonored packets discarded in-transit, defective system hardware, defective network drivers or standard steering routines. In count to this, packet defeat possibility is also exaggerated by Signal to noise ratio and detachment among the source and receiver. The packet failure is examined with regard to number of packet sent.

Transmission organize protocols are a solution allowing knowledge in numerous of today's sensor system requests. Applications for instance of locale supervising, structural strength supervising, and image sensing are greatly rely on overcrowding organization techniques of any communication control protocol. Well considered jamming control approaches permit efficient communication of significant degrees of data from a huge number of nodes beside one or more ways towards the data dealing out centers (generally termed as 'sink' in antenna network expressions). In these high data-rate requests, frequently mass data is produced in count to the continually sensed data. For instance, in structural health supervising, a place of sensors is organized in a social organization for instance a building. Each sensor trials structural atmosphere incessantly and broadcasts the data to the sink at a definite rate. When the sensors sense a significant irregularity, they produce and throw out volumes of data at a much superior rate. With no jamming power, beneath such traffic uniqueness, network disintegrate owing to jamming is predictable.

Congestion also contains harmful things on energy deficiency. As the accessible traffic weight annoyed a definite point of jamming, the number of bits that might be derived with the similar quantity of energy reduces. The network tops up killing energy by broadcasting packets from nodes upstream in the system towards the descend, merely to be crashed.

In this paper we present an adaptive traffic data control scheme to avoid over-utilizing the network in terms of the node packet buffers and wireless channels. The proposed adaptive traffic data control scheme control the data flow rate at the sink based on the original nodes presence in the wireless sensor networks

2. Literature review

Numerous schemes were provided for distributed detection of replica nodes that take advantage of group deployment knowledge to reduce the communication, computation, and storage overheads. It is highly required for replica detection and improved on the replica detection capability of the line-selected scheme [1]. Due to the unattended environment of wireless sensor networks, an opponent can confine and co-operate sensor nodes, construct replicas of them, and then increase a mixture of attacks with this reproduction. These duplicate node assaults are hazardous since they permit the assailant to influence the cooperation of a few nodes to exercise control over much of the network. It suggests a rapid and efficient mobile replica node discovery system using the Sequential Probability Ratio Test(SPRT).

The position examination in a mobile ad-hoc network (MANET) is believed, where every node needs to continue its position information. It extends a stochastic chronological decision structure [2] to evaluate position update resolution trouble. Deployment of a wireless sensor network (WSN) system is a dangerous pace because hypothetical models and hypothesis habitually diverge from genuine ecological uniqueness and presentation at the operation site. A deployment time validation framework SeeDTV comprises of system and measures for WSN status estimation and confirmation.

For wireless sensor network, a control duty based approach is used [3] to manage the duty series during the queue organization to facilitate high performance beneath changeable traffic rates in a liberated localization process [7]. When nodes operate in a duty cycling mode, path routine can be enhanced if the objective action can be calculated and nodes beside the course can be proactively awakened. Probability-based Prediction and Sleep Scheduling protocol (PPSS) used to progress energy effectiveness of positive wake-up. To retrieve the data collection from wireless sensor networks, tree based structural system is being used [4].

An unnecessary packet collision leads to envelope losses and retransmissions, resulting in noteworthy transparency costs and latency. In order to deal with this issue, we initiate a disseminated and scalable scheduling access system for objective detection process [6] that diminishes high data loss in data-intensive sensor networks [5]. For target detection, distributed energy optimization scheme is also being utilized [8] with probability prediction and sleep scheduling algorithm.

A dispersed energy optimization system for object tracking applications proposed where sensor nodes are gathered by the greatest entropy clustering [9]. Energy constraint is an imperative concern in wireless sensor networks. Then, the sensing pasture is spitted for similar sensor deployment optimization. From the work, we have seen that the proposed validation scheme used with query detection process in wireless sensor networks.

Communication protocols are a main technology in today's sensor system applications. A dispersed jamming control algorithm [10] is employed for tree based connections in wireless sensor networks that try to locate to adaptively allocate a fair and well-organized communication rate to each node.

WSN have a broad series of possible applications connected to technical, ecological, built-up, and military monitoring. These are presently little instances of how WSN can be utilized to assemble significant data and assist considerable services in genuine life [11]. To assemble the wireless sensor networks professionally, the author presented an algorithm to build a minimal size wireless sensor networks to cover entirely the size of the grid.

3. Proposed adaptive traffic data control with wireless sensor networks

The proposed work is efficiently designed for controlling the data traffic rate occurred while eliminating the replica nodes in the wireless sensor networks. The architecture diagram of the proposed adaptive traffic data control scheme is shown in Figure 2.The first process is to remove the replica nodes present in the wireless sensor networks. The replica detection scheme of probability ratio test with Finite Range Query (FRQ) is to detect replica node attacks in mobile sensor networks. If nodes are moving around in network, a benevolent mobile node will be treated as a replica because of its incessant change in location.

The second process describes the query validation process in continuation with an existing identification of mobile replica nodes in finite range query scheme. By validating the query in wireless sensor networks, the mobile replica nodes are removed entirely and it reduces the loss of data occurred while make a transaction between the nodes in the network environment.

The third process describes the process of controlling the traffic data in WSN to enhance the data transmission between the sink and the base station. Numerous source nodes require accounting data to a sink node, producing the funneling consequence where the traffic load enhances since the distance to the sink node reduces. To control the packet generation rate at the sinks and intermediary nodes, we present an adaptive traffic data control scheme. The traffic data occurring at the sink is controlled based on the flow of the original nodes presence.

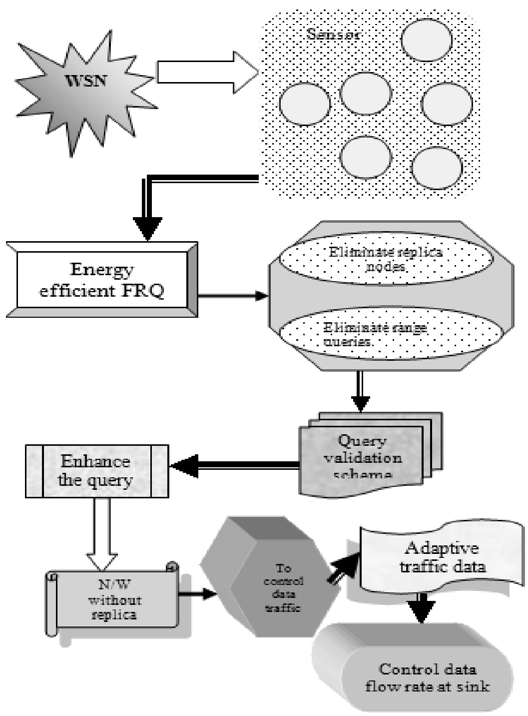

Figure 2 Architecture diagram of the proposed ATDCS

3.1. Eliminating replica nodes in WSN

The Finite Range Query Scheme is used in the previous work made to endeavoring the mobile duplication detection problem whereas we construct an arbitrary pace with two restrictions in such a way that each pace is dogged by the research rapidity of a mobile node. The lesser and higher limits will be configureured to be associated with speeds below and in burden of Vmax, likewise. Every time a mobile sensor node schedules to a new location, each one of its neighbors desires for an obvious state having its position and time information and decides possibility of whether to promote the received state to the base station.

The base station evaluates the speed from all two consecutive states of a mobile node and accomplishes the Energy Efficient Finite Range Query Scheme by permitting for speed as a practical model. Once the base station makes a decision that a mobile node has been replicated, it eliminates the replica nodes from the network

3.2. Validating the range query of nodes in WSN

The validation of query is processed at three stages of communication in wireless sensor network environment. The first stage of query processing is made with the identification of original node in the network environment. Even the finite range queries are used for the removal of mobile replica nodes, there is a great extent of nodes to be extracted or discarded by the attacker. At this sense, it is necessary to validate the query by identifying the node authorized id given by the certified authority. The node identification query is processed depending on node id, key value pairs.

After verifying with the nodes present in the wireless sensor network, the valid nodes are available. The node communication is done based on sending and receiving the query and outcome with the free nodes for passing the message from source to destination. For sending the message, the sending query must contain a valid node id which is given by the authorized entity and the key value pairs for sharing the message with the destination.

Before delivering the message, it is necessary to check the destination node id by the query validation scheme. The query validation scheme openly communicates with every node to authenticate the packet transmission and link feature by inspecting the node id, key value pairs provided by the authorized entity. It establishes the action of every node based on its contribution in the communications. Now the network is designed with the original nodes in the network to process.

3.3. Adaptive data traffic control algorithm

The adaptive traffic data control algorithm can be described by the following steps carried out at each node organize interval. Before describing the algorithm, it is essential to find out the some terms to achieve the data traffic control scheme.

i) Average Output rate of packets (AOR)

Let tout seconds be the time needed to broadcast a packet, considered initiating from the time the packet was sent by the system. Then, we remind that the efficient rate rout packets per second is contrary to the time interval tout seconds

, i.e., . $r_{out} = \frac{1}{t_{out}}$ The value of tout in packet transmission is instance of the average time required to broadcast a packet.

$$AOR = (\alpha_{out}) \bullet T_{out} + (1-\alpha_{out}) * \bar{t}_{out}^{\,i-1} \quad \text{... Eqn 1}$$

Where α_{out} the capacity of the sink and Tout is the present value of the variable tout.

ii) Average Input rate of packets (AIR)

Let tin seconds be the time needed to broadcast a packet, considered initiating from the time the packet was sent by the system. Then, we remind that the efficient rate rin packets per second is contrary to the time interval tin seconds,

i.e., . $r_{in} = \frac{1}{t_{in}}$

The value of tin in packet transmission is instance of the average time required to broadcast a packet.

$$AIR = (\alpha_{in}) \bullet T_{in} + (1-\alpha_{in}) * \bar{t}_{in}^{\,i=1} \quad \text{… eqn 2}$$

Where α_{in} is the capacity of the sink Tin is the present value of the variable tin.

iii) Controlling traffic data efficiency

The efficiency of traffic data controller calculates the vital transmission rate of the traffic (TR) in terms of packets per second. This is computed as [1]:

$$TR = \alpha \times (r_{out} - r_{in}) - \beta \times (\frac{Q}{t_{CI}}) \quad \text{… eqn 3}$$

Where, tCI is the control period of the node, α and β are steady parameters and Q is the constant queue size. Q is measured as the smallest number of packets to be sent in a certain interval.

The value of (rout - rin), can be negative, positive or zero. When (rout - rin) is positive, positive feedback desires to enhance the communication rates of the transmissions. When (rout - rin) is negative, negative feedback is vital to reduce the communication rates. If (rout - rin) is equal to zero, i.e., the input capacity matches the sink capacity.

The below steps describes the entire process of ATDCS. Based on the values obtained from AOR, AIR, TR, the data flow rate at the sink is controlled. The sink would allow the packet data to enter only if the capacity is met with the incoming data packet. Finally, the traffic data rate is controlled in a reliable manner.

In the following process packet P, node N, and time T are the inputs given in the adaptive data traffic control scheme in wireless sensor network. For each packet P and node N it identifies the out time taken to transmit the packet among the nodes N (tout) and the rate of packets to be sent at a second (rout) to compute AOR. For each packet P and node N it also identifies time taken to transmit the packet among the nodes N (tin) and rate of packets to be sent at a second (rin) to compute AIR.

Based on the value of α, it allocates the packet data to the sink. If sink capacity is full, it transmit the packets to the Base station, else it allow the packets to enter the sink.

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Input: Set of packets P, time T, nodes N
Step 1: For each packet P and node N
Step 2:  Identify the out time taken to transmit the
         packet among the nodes N (t_out)
Step 3:  Identify the rate of packets to be sent at a
         second (r_out)
Step 4:    Compute AOR (eqn 1)
Step 5:  Identify in time taken to transmit the packet
         among the nodes N (t_in)
Step 6:  Identify the rate of packets to be sent at a
         second (r_in)
Step 7:    Compute AIR (eqn 2)
Step 8: End for
Step 9: Compute α
Step 10: Based on the value of α (eqn 3)
Step 11: Allocate the packet data to the sink
Step 12: If sink capacity is full,
Step 13: Transmit the packets to the Base station
Step 14: Else
Step 15: Allow the packets to enter
Step 16: End If
Step 17: End
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Figure 3 Process of the proposed ATDCS

4. Experimental evaluation

We simulated the proposed adaptive traffic data control scheme in a wireless sensor network by using the ns-2 network simulator. In the simulations, we set up n nodes consistently at arbitrary surrounded by a 900 × 900 square, with n changeable among 100 and 1000. We determine the mobile sensor node movement patterns. In particular, to exactly estimate the presentation of the system, we use the RWM model in which each node progress to an arbitrarily selected position with an arbitrarily chosen speed among a predefined minimum and maximum speed.

We guess the standard unit disc bidirectional communication representation and we change the message range, so that every node will include roughly 40 neighbors on average. The moving mobile sensor networks stays there for a predefined pause time. After the pause time, it then randomly chooses and moves to another location. This arbitrary progression is constant during the simulation period. All simulations were performed for 1,000 simulation seconds. We fixed a pause time of 25 simulation seconds and a minimum moving speed of 1.2 m/s of each node. Each node uses IEEE 802.11 as the medium access control protocol in which the transmission range is 60 m. To emulate the speed errors caused by the inaccuracy of time synchronization and localization protocols, we modify the measured speeds with maximum speed error rate. The performance of the proposed adaptive traffic data control scheme in WSN is measured in terms of Energy Utilization, Traffic Control Rate, Delay and Reliability.

5. Results and Discussions

In the proposed ATDCS, the finite range query are organized and processed under query validation. The proposed work controlled the data flow rate based on the removal of replica nodes in the wireless sensor networks. The utilization of energy is measured in terms of joules. Compared to the other works (FRQ, DQV-FRQ, SPRT), the proposed ATDCS consumes less energy and process the given queries.

No. of nodes	Traffic control rate (%)			
	Proposed ATDCS	DQV-FRQ	FRQ	Existing SPRT
10	42	35	30	21
20	54	48	42	32
30	63	52	50	40
40	78	66	65	49
50	84	75	70	52

Table 1 No. of nodes vs. traffic control rate

The above table (table 1) describes the traffic data control rate to perform an efficient data packet transmission in the wireless sensor networks

The traffic control rate of the proposed adaptive traffic data control scheme in WSN is compared with the previous works DQV-FRQ (deployment of query validation for finite range query scheme in WSN), FRQ (Finite Range Query) and existing SPRT (Sequential Probability Ratio Test).

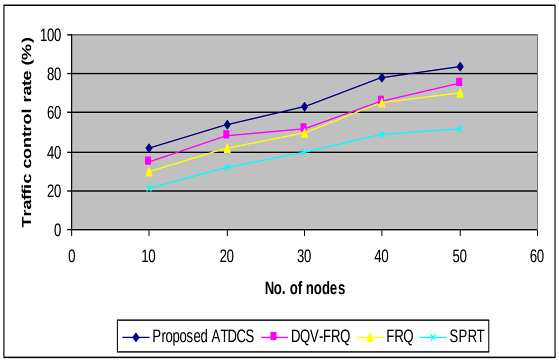

Figure 4 No. of nodes vs. traffic control rate

Figure 4 describes the traffic data control rate to perform an efficient data packet transmission in the wireless sensor networks. In the proposed ATDCS, the traffic data at the sink are efficiently controlled by the adaptive mechanism. The traffic occurring at the sink is controlled based on the capacity of the sink to have the packet data. Once the sink is filled with the data, it allowed all the packet data to the base station. After that, it allows other packet to enter into it. By the way, it controls traffic reliably. Compared to an existing SPRT and other works such as DQV-FRQ, FRQ, the proposed adaptive traffic data control scheme in WSN efficiently controlled the traffic data at the wireless sensor networks.

Node ID	No. of packets received (%)			
	ATDCS	DQV-FRQ	FRQ	SPRT
20	97	88	75	71
40	95	85	77	65
60	94	84	80	62
80	92	89	71	60
100	91	90	74	58
120	94	82	76	63
140	91	81	77	58

Table 2 Tabulation of Node ID versus number of packets received

It brings out the fact that the sink, over a long term, receives an equal number of packets on an average from the nodes. The above table (Table 2) describes the no. of packets received in Adaptive Traffic Data Control Scheme [ATDCS], Deployment of Query Validation Scheme (DQV), Energy Efficient Finite Range Query Scheme (FRQ) for Detecting Mobile Adversary Replica Nodes and Sequential Probability Ratio Test (SPRT) in wireless sensor networks. The number of packets versus node ID result shows that these algorithms have a linear response.

Figure 5 demonstrates the performance of the packets received in an Adaptive Traffic Data Control Scheme [ATDCS] in the wireless sensor network. As the node ID increases, the number of packet rate increases, due to an increase in congestion and the data packets are queued in the node buffers until they get served.

The unrefined data illustrating the effects of node ID on number of packet ratio are shown in Figure. 6.9. Although ATDCS in the wireless sensor network numerous source nodes require accounting data to a sink node, producing the funneling consequence where the traffic load enhances since the distance to the sink node reduces [4]. Distinctive packet traffic in a sensor network exposes distinct models that permit an adversary examining packet traffic to realize the position of a base station.

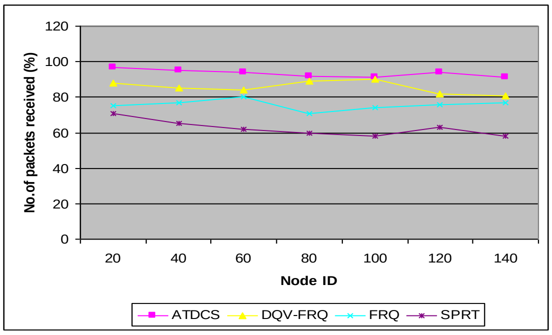

Fig 5 Node ID versus number of packets received

The number of total control packets and the number of route search packets in the network per slot is generated by the scheme.

The below table (Table 3) describes the Control packet per slot in Adaptive Traffic Data Control Scheme [ATDCS], Deployment of Query Validation Scheme (DQV), Energy Efficient Finite Range Query Scheme (FRQ) for Detecting Mobile Adversary Replica Nodes and Sequential Probability Ratio Test (SPRT) in wireless sensor networks.

Fig 6 demonstrates the performance of the control packet rate in an Adaptive Traffic Data Control Scheme [ATDCS] in wireless sensor network. Distinctive packet traffic in a sensor network exposes distinct models that permit an adversary examining packet traffic to realize the position of a base station. To manage the packet creation rate at the sinks and transitional nodes, we present an adaptive traffic data control scheme. The control packet rate consisting of adaptive mechanism leads to process the control flow rate.

No. of Control packet per slot	Percentage			
	ATDCS	DQV -FRQ	FRQ	SPRT
2	45	35	30	25
4	85	75	60	50
6	37	32	25	20
8	60	50	45	40
10	70	66	55	45
12	70	60	55	40

Table 3 Tabulation of No. of Control packet per slot on various Technique

The No. of Control packet per slot results shows that adaptive traffic data control scheme control the packets rate at different intervals in wireless sensor network [5].The raw data illustrating the No. of Control packet per slot are shown in Fig. 6.

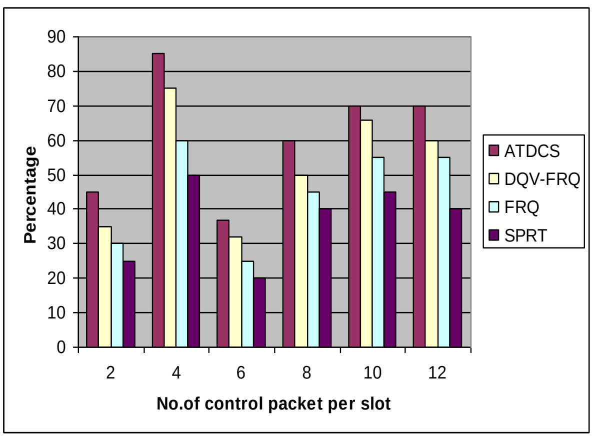

Fig 6 No. of Control packet per slot on various Techniques

The proposed ATDCS efficiently eradicate the replica nodes and validate the query. The performance of the network is measured in terms of how efficient the nodes in the network are involved in communication.

Finally, it is being observed that the proposed adaptive traffic data control scheme in WSN efficiently solved the crisis of data traffic rate raised at the sink. Even numerous source nodes require accounting data to a sink node, the proposed adaptive mechanism controlled based on the sequence of the packet data arrives. Compared to an existing SPRT, the proposed ATDCS efficiently controlled the traffic data rate.

6. Conclusion

The paper has presented an adaptive traffic data control scheme for traffic data control in wireless sensor networks that seeks to consign a fair and efficient rate to every node. The proposed ATDCS needs all node to observe their traffic rate, based on the dissimilarity of which every node chooses to raise or fall of the communication rates of itself and its upstream nodes. The traffic data control is invoked at every node flows transmitting through the gateway node, which we termed as the control period. We performed simulations of the proposed adaptive traffic data control scheme under an arbitrary association attack strategy in which it process the packet transmission range of the network. The results indicate that the proposed data traffic control mechanism can accomplish gradually high good put, is capable to achieve fairness for all nodes in the wireless sensor networks to obtain the finest communication rates rapidly.

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