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A Survey on QoS Provision Techniques in Wireless Sensor Network

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Abstract: The latest features developed in Wireless communications have provided maximum opportunities to enable new applications and to develop low-cost wireless sensor network. This low cost sensor networks might be used for several communication networks such as industrial monitoring, military applications, temperature measurement, event detection system and many more like these. And a huge effort of the researchers has resolved different techniques, algorithms, Protocols and models for different applications in different areas. This paper is a review of QoS Provision Techniques, Protocols and Standards in Wireless sensor networks and to discuss the new and different kind of applications in wireless sensor network. The existing protocols, models and techniques are classified and compared. Furthermore, we study trade-off among end-to- end delay, reliability and energy consumption in Wireless Sensor Network as well as open issues and challenges for future research work are also discussed in detail.

Key words: Wireless sensor Networks · Quality of Services (QoS) · End-to-End Delay · Energy Consumption · Reliability

INTRODUCTION

Wireless Sensor Networks can be defined as a group of devices connected with each other, known as sensor nodes, which can sense the environment and transfer the data collected from the observed field over wireless links [1]. All these information then forwarded, through multiple hops, to a sink node also called the main Gateway [2] that can be used locally or can be further transferred to other connected networks (Internet) and the nodes can be fixed or movable. Wireless Sensor Network is kind of network which contain a large number of nodes, connected with each other, communication and transmitting data to the main Gateway sensor node [3]. These sensors are spread in the specific area to monitor or control the physical or environmental conditions like measuring temperature, sound or pressure and many more and to transfer all these information the Gateway through interconnected sensor nodes.

The use of Wireless sensor network was inspired in the military environment such as monitoring of the battlefield [4]. These modern networks are bi-directional and also enable control of sensor activity. Now-a-days we see that wireless senor networks (WSNs) are used in many other important applications such as air pollution monitoring, air quality monitoring, forest fire detection, industrial applications and so on.

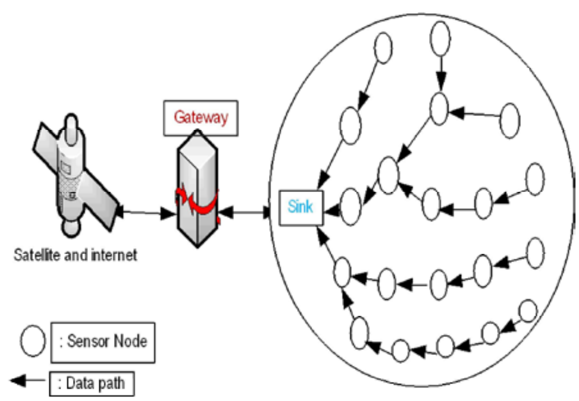

Fig. 1: Example of Typical Multi-hop Wireless Sensor Network

Wireless sensor network (WSNs) is a standard of IEEE 802.15.4 services. This network consists of sensor nodes and number of nodes can change from few to many where every sensor node is connected one sensor node or nodes which sense the surrounding environment and

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Fig. 2: WSN Architecture

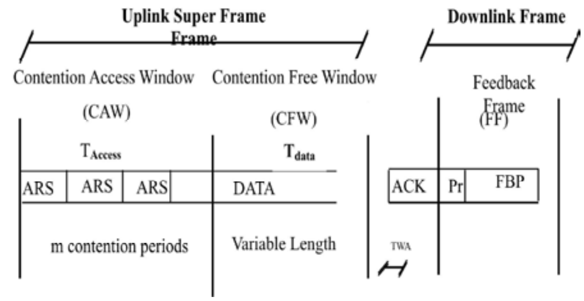

Fig. 3: WSN Frame structure

send the data to a main location. The cost of these sensor nodes depend upon the quality of every sensor node which can be from few to a hundred of dollars. A sensor node has several components that are an electronic circuit for communicating with sensor, called micro controller, a transceiver with an internally or externally fixed radio antenna, an energy source (battery) or a fixed form of energy gathering device. A sensor can found in different size. The topology of WSNs cans either a fixed topology or random topology. WSNs are used for the purpose of the monitoring and industrial processing.

Architecture of Wireless Sensor Network: Wireless sensor network can be grouped in the following parts

- To access the network from the mobile stations from the end user or users.
- To sense the surrounding environment and transfer the data to the main gateway through the network.

Wireless Sensor Network frame structure consists of an uplink super frame and another frame downlink, from the communicating perceptions of sensor nodes. The first framer that is uplink super frame has a Contention Access Window (CAW), with fixed length TACCESS, which is additionally divided into m contention periods. And Access Request Sequences (ARS) are sent within these contention periods to get a position for transferring data into the Contention Free Window (CFW) of TDATA of variable length. In order to detect the channel access for a central sensor the needed minimum signals are ARS.

The second frame is the frame downlink which starts in the worst case after Taw that responds to the maximum time to wait for the response or ACK frame to arrive after a transmitted data frame. Acknowledge (ACK) and the feedbacks (FBP) follow the Taw, the latter proceeded by a preamble (Pr). The FBP comprises some subfields, to indicate the non-transmitting sensors as the length of the super frame, when the next FBP packet will be sent. Pr has the function of enabling power management between FF and CAW for the non-transmitting sensors. In order to allow the MAC Layer to process the received data from Physical layer an Internal Frame Space (IFS) is added at the end of the downlink.

Cross Layer Design For QoS: QoS provision in WSNs is depended on not merely on the accessibility of limited resources but even on the transitory rate of such restricted resources. Since nodes in WSN are static or restricted in motion, the transitory resources can origin connection failures and disconnect routes, that results an unnecessary partition of the network. The restricted and transitory resources must adopt the Mission applications. Therefore, the allotted QoS to an application be determined by the Network's "quality" which is the function of the accessibility and constancy of mainly resource dependent on energy [5]. In WSNs QoS Routing is observed as the delivery of the resource parameter levels in order to espouse different data sensed from the sensors, to network's "quality", while transferring the data packets through intermediary handing out nodes to sinks. [6] A cross-layer model for QoS is a single-layer problem and brings separate layers in to subsets in the OSI stack, as shown in Figure 3.

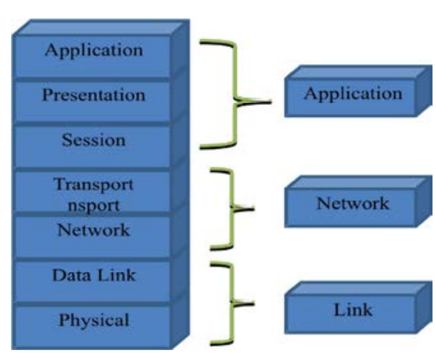

Fig. 4: Cross Layer Model

Background and Related Work: Wireless sensor network has got a very keen interest of the researchers in the last few years in the communication networks [7]. A large number of techniques, models, algorithms and ideas have been proposed by the researchers which have got a good progress. Still it is the area which should be focused more for better enhancement. Wireless Sensor Networks requires guaranteed QoS parameters in all its applications and especially in real time applications. Because a real time application must always be reliable and must have real time communication so all these QoS parameters are very important and always have created problems in Wireless Sensor Network. For a reliable wireless sensor Network it is essential to have the guaranteed QoS requirements such as minimum time delay, high throughput, jitter, latency etc.

Our current work focuses on the IEEE Standard 802.15.4 (WSNs), though a good research work has been done on the QoS parameters in wireless Sensor Network but still it is a critical problem to provide guaranteed solutions in all QoS parameters. These standards do not provide any specific and satisfactory level of techniques to provide the minimum end to end delay with high throughput [8]. The real-time routing problem commonly the delay constrained point to point network is focused.

Quality of Service Requirements in WSNS: WSNs normally have different Quality of Services requirements with the varied traffic Quality of Service (QoS) requirements. In order to deliver dynamic network traffic with different requirements in highly resource constrained sensor networks, QoS providing and service differentiation become mandatory. In order to achieve QoS requirements to support various traffic requirements the system should be ready to look forward to almost any kind of application. The support for various traffic profiles in QoS is of prime importance in the designing of future multiple access schemes. In [9] article the author comes up with a study of an enhanced technique called it a CDS-based backbone formation technique in Wireless Sensor Network and showed that the proposed CDS based approach in this research work has the efficiency to make the backbone of the network in case of more optimizations requirements. The authors suggested the problem of degree constrained extension called OMCDS to model an energy efficient with delay bound backbone formation in WSNs. Authors also suggested an algorithm based on automata learning to construct the backbone of the network by discovering a near optimum solution equivalent to proxy OMCDS problems.

The graph (G) of topology is supposed as G < N, L, E >, where N shows the number of sensors, L denotes the set of links which is L= {(ni,nj) N * N and E presents set of energies related to sensors that is

$$E = \{Eni\ Ani \in N\}\ g, \tag{1}$$

Eni is the residual energy of node Configuration of SLA SLA can be defined as a duple <A(k),$\propto$ (k)>,

Set of learning automata (A (k)) = $\{A_i \circledcirc$ ni N (k)$\}$ and Set of actions (k) = $\{\propto_I \circledcirc$ Ai L(k)$\}$ (2)

As variation occurs in network topology of WSNs, so the parameters, N and L are supposed to be time variable and presented as N(k) and L(k) for every instant k. Learning automation is denoted as Ai that is linked with every sensor node n_i N(k) and $\propto_i$ might be taken by learning automaton $A_i \in A(k)$. Links incident of communication is chosen from every automaton Ai at the node ni corresponding to its activities. That's why; SLA is isomorphic to the graph G. To build action set $\propto_i$, an action (say, $\propto^j_i$) is linked with every communication link (n_i,n_j) L that links node n_i to one of its adjacent nodes n_j.

$$\propto_I (k) = \{\propto^j_i (k) \circledcirc \forall (n_i, n_j) \in L (k)\} \tag{3}$$

Quality of Service Parameters in WSNS: In [10] the author discussed the Quality of Service provision in wireless sensor networks and proposed a Qos-aware MAC protocol for WMSNs, to meet the QoS requirements in heterogeneous traffic environment. The author also proposed Diff-MAC to improve the channel utilization while giving good and fast transmission of the data. They got these result from the simulations compared to the existing protocols. A cross- layer technique can offer more flexible activities at the design stage of the protocols. So, it will be motivating to integrate Diff-MAC with a QoS-aware multi-path routing algorithm to obtain better enhancements.

Table 1: Application classes of QoS Metrics (MAC layer)

QoS metrics	Query driven	Event driven	Cont.	Hybrid
Medium access delay	√	√		√
Collision rate			√	√
Reliability	√	√		√
Energy consumption	√	√	√	√
Interference/concurrency			√	√
Adaptivity	√	√		√

Medium Access Delay: End-to-End delay has been a serious and challenging research issue for the researchers for last few years. The reasons for this delay are the heterogeneous network traffic, changes of network topology, burden on the network and the applications on demand from the users. The complication has enlarged on the basis of various causes, for example the obtainable synthesis of various changed and unusual network channels. To come with the solutions to handle this situation we have to manage the end-to-end delay properly. The complexity of Wireless sensor network increases when providing delivery with less delay for heterogeneous traffic and dynamic changes of network with distinguish demands of QoS in WSNs [11]. In [12] the authors discuss about the traffic protocol QoS Parameters reliability and delay latency in WSNs. Reliability-sensitive traffic should be delivered without loss but may have some delay. Delay-sensitive traffic should be delivered in time but may have some packet loss like Video streaming, Critical-traffic, which has high importance and which requires both reliability and short delay.eg. Safety alarms in vehicular application and physiological parameters of a patient during a surgery.

Here it is shown that sensor nodes can begin the transmission any time as with the TinyOS CSMA/CA protocol, when a packet reaches. Therefore, In (idle layer) components comprises only one form, represented here as Sidle and Furthermore, the Markov chain.The elements are PI, I, tsI and I simply described.

$$P_I = \{0\}\ \alpha_I = \{1\}\ t^s_I = \{1\}\ \lambda_I = \{\lambda^r + 1\} \quad (4)$$

WSNs play a very important role in the industrial environment especially for the monitoring purposes. A higher delay problem occurs time critical applications due to low power mesh networks because for the sleeping nodes will not be able to transmit instantaneous date packets. So for a smaller delay guaranteed applications star Topologies are suitable.[13] [1] the authors proposed an efficient route selection in-route algorithm to promote the use of WSN in industrial monitoring and claim the satisfaction of QoS Requirements with the consideration of sensor nodes limitations. The contributions of in-route Algorithm in terms of QoS requirements are the following. With the demands of QoS the author also suggested the proposed In route algorithm as multi-metric based route selection algorithm using hop count as route selection criteria while considering sensor node's limited resources and for reliable data transmission In-route does not need positioning information so the need for extra often expensive indoor localization system is eliminated. [14] [2] presented M node disjoint paths algorithm in Wireless sensor Network for the minimization of average transmission delay for the active streams whilst producing efficient energy. As it is clear that the streams in few wireless sensor networks can be long-term and expectable, so it is probable to develop schedules for the nodes to be awaken only in the transmission time while keep asleep in other times. They also proposed the joint scheduling to find the schedules for the current flows with minimum average delay. They mentioned in the proposed algorithm that the problem of latency can also be solved under FDMA channel model by construction of a novel delay graph. The proposed algorithm is further extended to deal with dynamic traffic and topology changes in the WSNs [15]. [3] present a derivation of contention window size for optimizing the delay as a function of the number of contending nodes. They presented distinct analysis for the contention delay (CD) and for the energy consumed and have checked it with the simulations. The author proposed a method to estimate the number of nodes contending and to get the optimal performance values in a distributed manner because the wireless sensor nodes as individually do not have this information readily. The proposed method to improve both delay and energy efficiency of the contention-based medium access of this research work has been verified through an event-driven Simulations of WSNs application. They also investigated the end-to-end network performance by using a geographical routing protocol.

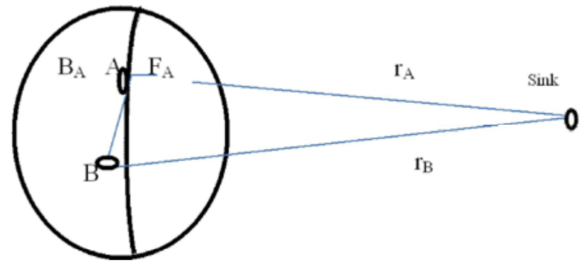

Fig. 5: Feasible region FA and infeasible BA with node A

A class of Mobile Wireless Sensor Networks (WSNs) referred as Delay-tolerant Wireless Sensor Network (DTWSN) which is unlinked maximum of the times and the characteristics of these networks are inherited from rational wireless sensor networks and delay tolerant networks (DTN). The authors proposed a general protocol for Delay tolerant Wireless Sensor Networks based on opportunistic broadcasting delay with the on-off periods

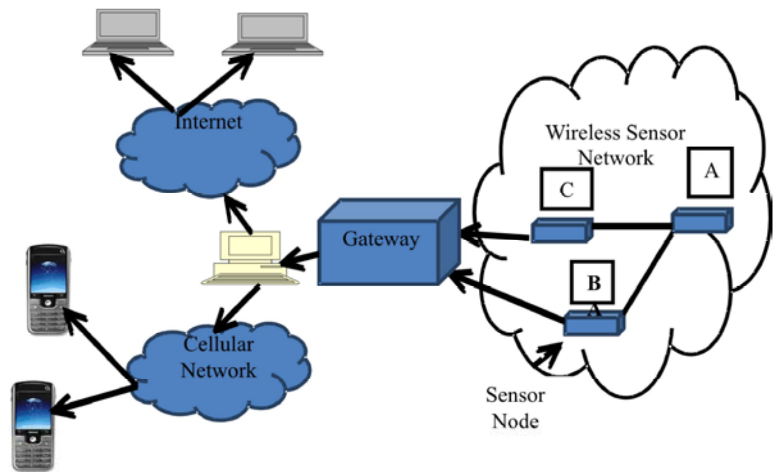

Fig. 6: Deployed Middleware

of radio devices [16]. [4] studied three performance parameters in their work that are the energy for sending queries (querying energy), data transfer energy and absorption time (delay). They also proposed an analytical model to examine the querying energy and an accurate approximation for the transferring energy of data. In their study of work they derived a practical rule of thumb from several parts of the study for an optimal query interval in terms of delay and energy [17]. This research work has focused the minimization of latency of data transmission delivery. Most of the previous research has done on the proposing of delay optimizing routes for the mobile nodes. And leveraging variants of the Traveling Salesman Problem (TSP) has been used for this. But in this paper the authors talk about TSP-based routes that can cause the delay which is arbitrarily poorer than the optimum. The overall perception is that as the sensors data generation rates might vary, certain sensors may be needed visit more recurrently than others. To this point, they supposed a single sink network and develop an algorithm path splitter that "splits" a TSP-based route into numerous loops which intersect at the sink. The proposed algorithms have the objective to minimize the average delay in collecting data using mobile elements in WSNs. Authors also suggested that The improvement in this work is more weighty when sink is nearer to the nodes and the proposed algorithm also improve the existing Hamiltonian result by "splitting" it into numerous loops.

Daemon Process: [18] Presents a three layer architecture for the delay constrained dissemination information in WSNs. The author intended middleware to deploy in three main devices that are the gateway, Base station and the sensor nodes. End-to-end delay, timeliness and confirmation with the help of daemon process which are processed continuously. To examine the system's feasibility an implementation is performed to prove the concept of a real scenario. In the mentioned scenario, the sensors send light intensity data to users in internet or cellular networks, when this data reaches lower than a threshold pre-established. A number of experiments are done in order to achieve the proof of forwarding 400 reports to the consumers through the three protocols which are email, twitter and SMS, email and twitter. Each delay is recorded individually. The authors also performed two separate analyses based on this data that are, the experimental analysis and individual messages analysis. In the earlier analysis they have considered three perceptions that are high, average and percentage of success in end-to-end delay. In this analysis the author understood that the high delay does not go beyond the threshold established. In the later analysis, the authors select 12 arbitrary messages to check the middleware assessments, depended on the end-to-end delay and the approval status listed by every protocol. The middleware is deployed in the following scenario shown in Figure 5.

Cross Layer Framework: [19] Presents QoS parameters the time delay in his work executed by a new cross-layer design framework. And this cross layer concept is dependent on the architecture where several layers can interact with each other and interchange the information to improve the network's quality they also demonstrated that OSI standard layers' conflict can be solved through cross layer design flexible approach.[20][5] Suggested an adaptive technique to guarantee the achievement of end to end delay in multi-chip wireless networks called it an adaptive per hop differentiation (APHD) design. The method proposed is grounded on EDCA scheme proposed in 802.11e draft. The packets data of changed priorities use several MAC Contention parameters sets that interpret into several delays in EDCA. The proposed scheme in this work prolongs the proficiency of EDCA into multi-hop situations by taking end to end delay necessity into account at each intermediary hop.

Following a cross layer technique, APHD is expected to be a circulated and localized scheme. Separate nodes keep track of the channel state self-sufficiently without any exchange of communication overheads. Packets of data transmit end-to-end delay necessity along with other central data in the packet header. At an in-between node, grounded on data packet's end-to-end prerequisite, the delay is accumulative so far and the present status of the node's channel, APHD nicely modifies data packet's priority in order to fulfill the requirements of its end-to-end delay. The results of the scheme proposed has been verified by the Simulation results which state that APHD scheme delivers outstanding delay guarantee while attaining higher network consumption.[21] Proposed a novel cross-layer to make the energy efficient in a WSN application which uses CSMA MAC protocol multichannel non-persistent with modulation adaptively of MQAM at the physical layer. At the MAC layer they achieve the Cross-layer collaborations using bake-off probability with joint and traffic-dependent adaptation and the modulation order at the physical layer.

For the matter to a limitation on the retransmission packet delay the authors conducted the order of the modulation and the joint enhancement of the bake-off probability. Analyzing the objective of QoS parameters and the issues of allocation of optimal energy by using cluster based WSN. The authors develop a scheme supporting QoS for changing traffic situations by managing the rates, generating data at each cluster. Furthermore they also investigate the clear explanations on the matter of distribution energy in WSN at different clusters based on optimum allocation standard of energy. The proposed scheme is beneficial due to flexible nature and stability and the formula of the distribution of energy gained is especially appropriate for the design of sensor nodes deployment in WSNs [22, 23].

[23] Suggested a number of routing protocols and architecture for system to enable intelligent transport systems in which mobile nodes query data from a static WSN. The suitable scenarios for these applications are the moving cars in a hot parking's area, where sensor nodes will be able to sense the place to park the car is free or full in WSN. Mobile Sinks can generally observe the time to time interruptions in connections from the WSN, depends on the distribution of sensor nodes alongside the road. The authors proposed the architecture based on three kinds of sensor nodes that are mobile nodes that query the WSN, vice sinks and sensor nodes. They also presented the two techniques of load balancing that describe energy and delay, in turn, while taking decisions in routing.

Energy Consumption: The most significant element to determine QoS in Wireless Sensor Network is Energy Consumption [24] in order to prolong the lifetime of energy constrained networks the scheduling scheme of sleep-wake is effective but a considerable delay could be resulted as the transferring nodes have to wait for its following hop relay sensor node to wake. [25][7] this work presented another effort to decrease these delays by designing schemes of packets forwarding based on any-cast, where every sensor has an opportunity to forward packet to its adjacent sensor node that awakens amongst numerous candidates sensor nodes. the authors first enhance the any-cast forwarding schemes to reduce the probable delay of the packet delivery, then give a solution to problem of joint control that is to control the application factors of sleep wake scheduling protocol optimally and the any-cast of the proposed scheme protocol to exploit the life of network, to restrict the projected end-to-end packet delay.

[26] A very important application of Wireless sensor Network is the Real time systems communication to achieve collective occurrence monitoring activities in precise timing checks. Here the authors suggest and develop a real time events guaranteed scheme in WSNs called service differentiated real time communication scheme (SDRCS).the proposed scheme SDRCS has the capability of sending packets using cross layer design to combine event based routing functionality with a new ordered MAC Scheme. And because of this design, the proposed scheme's achieves scattered traversal packet speed valuation for traffic flow classification and controlling admission. No additional hardware is needed in proposed scheme SDRCS for the adaptation of power transmission, localization, or transmission of multi-channel. Assessments of the scheme performed display that the scheme proposed considerably enhances the delivery ratio in time and service-differentiation granularity for varied priority stream of traffic in unsynchronized WSNs, compared with existing schemes

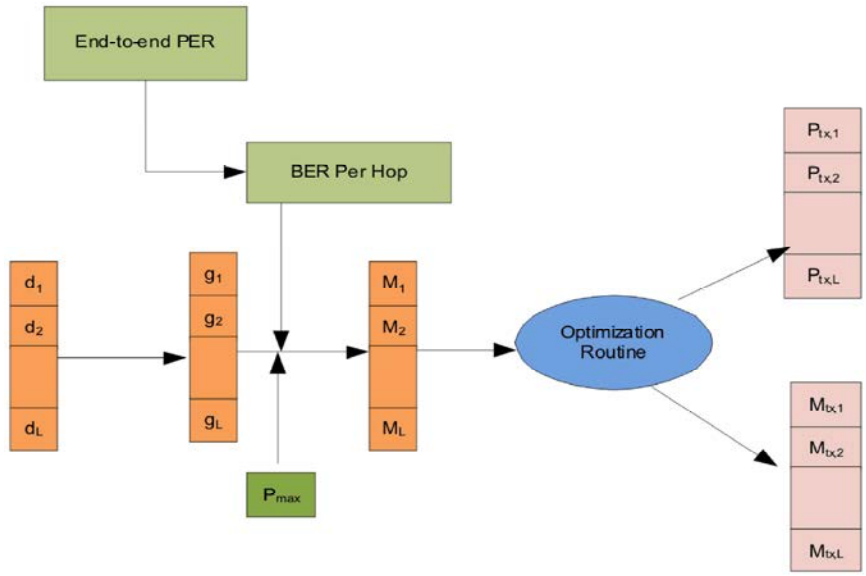

Fig. 7: Routine Optimization

of communication. [27] Proposed a solution approach for E2EDAR problem is to minimize the total (including time of transmission and the free time) energy consumption matter to Qos metric delay, retransmission and data accumulation tree constrictions. The solution suggested is founded on Lagrangean easing for calculating an efficient energy data accumulation tree which takes in account the routing assignment, radius assignment of transmitting, retransmission and the high end-to-end delay limitations. It is also notable that the prices of Lagrangean multipliers are enabling the reflection of the desecration cost for the corresponding relaxed restraints. The use of WSNs in a critical system like fire detection and monitoring in a forest or any other critical system must be very much reliable to receive the information on time and to resolve the issue. In [1] addressed a framework for the utilization of WSNs for the application of monitoring and fire detection in a forest. They propose suggestions for the WSNs architecture, sensor node deployment schemes, communication and clustering protocols in their proposal. The main objective of this framework is the detection of fire risk as quick as possible, taking energy consumption in account of the sensor nodes and considering the surrounding situations that can be the reason to affect the entire necessary events of the network. The authors stated in their research work also stated the whole parts of WSNs life cycle which are dedicated for fire detection and monitoring. The environmental situations of network may change with time and may affect the network performance and operations.

[5] This work has the objective of minimizing the energy consumption to increase the lifetime of the network. For this the authors present a link adaptation scheme using cross layer design for ultra wide base sensor networks (UWB). They also state that for a successful network in WSNs a routing protocol is very important which can ensure the reliability of communication among neighboring sensor nodes and a reliable transmission of data to main location. WSNs are different from the traditional ad hoc networks that they operate with limited power battery.so for such WSN the routing protocols are essential to be considered with a good attention on the energy power.to minimize the consumption of energy in the network they use a consideration jointly of physical layer and MAC Layer and increase network's lifetime. There are several different metrics of QoS in WSNs at the different layers of computational grid. At the computational grid QoS provisions have to be addressed in certain layers to improve QoS perceived by end users. This enhancement of the QoS efficiently is very critical to fulfill the requirements of the users and dynamic forces of the resources. The routine optimization process is shown in the figure 6.

[28] Proposed a policy for the QoS optimization for computational grid.in this work authors have focused QoS optimization using cross layer grid as to decompose the optimization into sub problems and a sub problem decomposed is corresponded by each layer. This work of the authors provides the optimum computational grid

resources set, service composition and users payments in the mentioned policy at application, fabric and collective layer to increase global grid QoS. The mentioned problems are categorized in three sub problems which are composing service, maximizing the satisfaction level of user and grid resource allocation problem, all the above mentioned problems cooperate through the best variables for measurements of grid resources and package request. And to coordinate all these problems, a mechanism of cross-layer QoS feedback is developed to guarantee diverse layer collaborations.

Reliability Estimation: Here the author has used Exponential Weighted Moving Average estimation (EWMA) and has mentioned that it is the best suitable for WSNs compared to other estimation methods such as flip-flop estimator, Kalman filter and Linear regression. Because EWMA has the advantage of being simple and less sources demanding compare to others.it also can react quickly to significant changes, while being stable and less influenced by sporadic, large deviated measurements. But here they have brought a little change to EWMA as the WMEWMA -based link reliability estimation which is appropriate for estimating link latency. The author has also mentioned an algorithm to describe the WMEWMA-based link reliability estimation of the proposed protocol. [29] This work suggests an overall framework of reliability-centric for the reporting of event monitoring in WSANs. The authors stated that reliability depends on not only the precision but also the significance and freshness of the data conveyed in such a real-time application. The proposed scheme follows these urgings and combines the three important components used in the processing of the event data, which are, an algorithm for effectual and fault tolerant occurrence data collection, a delay constrained protocol for transmission of data and an adaptive algorithm for the allocation of actuator for unequally spread event activities. The authors also stated that their protocol approves keen priority scheduling which distinguishes data of non-uniform significance. The proposed protocol is extended more to deal with node and link getting downs by means of an adaptive algorithm. They verified their proposed framework over extensive simulations and achieve the expected results in terms of reliability and reduced delay but they do not consider the dynamic topology changes which can cause the reliability and delay of networks in their work. A cross layer QoS feedback mechanism has been proposed to ensure different layer interactions of the three optimization sub problems: grid resource allocation, service composing and user satisfaction [28].

In [30] the author proposed delay-reliability trade-off in WSANs based on MIMO-Enabled IEEE 802.11 standard, utilizing Enhanced Distributed Channel Access (EDCA) at Medium Access Control (MAC) layer and Maximum Likelihood Spatial Multiplexing at Physical (PHY) Layer is studied. The author also proposed two simple adaptive schemes to minimize packet delay while satisfying the required reliability at noisy factory environment. In this work the authors reducing delay while compromising on reliability which is not satisfying the QoS requirements for WSNs applications. [31, 8] Proposed the Inter DRC scheme to introduce the differentiated delivery paths for a delay constraint and energy efficient reporting based on the traffic characteristics, also proposed the Intra DRC which adapts the slot reservation based on queue status using block designs and schedule. [8, 9] this work imports and defines a problem of topology for limited delay data collection and make it to be integrated programming. Controlling of data Collection is one of the significant operations in WSNs. A number of practical systems need the real time packets transmission, like surveillance systems, event monitoring system, tracking system. The authors proposed an algorithm to control the topology in order to solve this problem. The proposed algorithm may reach for linear networks to O (1) approximation ratio theoretically. And impact of delay is also analyzed on the worst case scenario in planar system.

In [32] they proposed a transmission and novel reliable data aggregation protocol, named RDAT and is based on the concept of functional reputation. The proposed Protocol enhances the reliability of data aggregation and transmission by evaluating each type of sensor node action using a respective functional reputation. Furthermore the proposed protocol RDAT also employs a fault tolerant Reed-Solomon coding scheme based on multi path data transmission algorithm to guarantee the reliable transmission of the date to the base station. The novelty of multi path data transmission algorithm is to select data paths secretly based on routing functional reputation of sensor nodes.

Reliability in a real time WSNs is a very challenging and tough requirement to attain in combination with efficient-energy utilization and responding time checks. Since of the small responding time and crucial reliable data transmission Real time systems are still a discouraging job for WSN. [33] The authors proposed a reliable algorithm design and have the simulation in a self-deployed

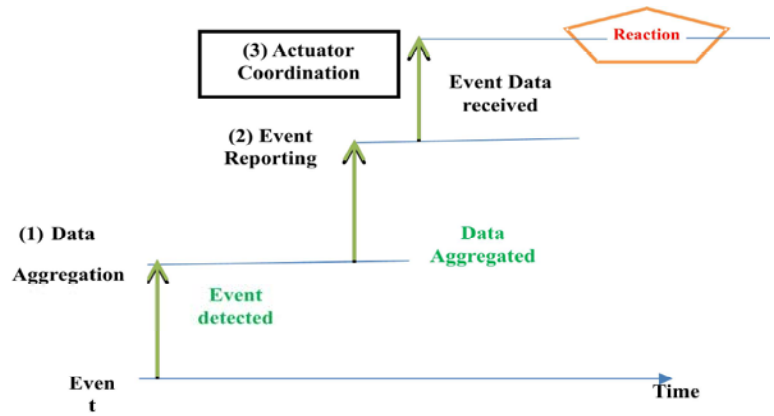

Fig. 8: Aggregation Workflow

simulator that a WSN can add more facilities to the present trains system. They also claim the algorithm to be enhanced with respect to energy depletion and responding time. They proposed that this algorithm can be used in emergency case for a limited responding time as restricted delay on the delivery of packet. The suggested simulator can also define a transmission technique that enhances the responding time and energy utilization for a definite seating plan of a train, while preserving reliability in point to point transmissions. [34][10] the utilization of Wireless sensor nodes are in many different applications, such as monitoring of military operation, natural occurrence and health diagnosis surveillance collection. In all applications all sensor nodes need to sense the secret data, transmit and store the data, where the implementation of an intrusion detection system is required to guarantee sensor node and to keep the quality of service of the node and survivability. The author proposed in his research and suggested the probability model through which he analyzed the best frequency which is based on the code attestation and as a result the reliability of the sensor node is maximized by exploiting the trade-off between the energy consumption and intrusion detection efficiency.

In [29] the authors talk about the reliability that it is strictly related to delay or the freshness of the events and these should be optimized jointly , the main focus of this research work is the reporting of the reliable event from sensors to actuators in a wireless sensor-actuator network (WSAN). Furthermore the authors also suggest exploring the problem of non-uniform importance of the events the process of optimization. More over a general delay and importance-aware event reporting framework are also proposed. This framework is the integrations of three important modules to maximize the reliability: (1) a multi-level data aggregation scheme, that is fault-tolerant with error-prone sensors nodes; (2) a priority-based transmission protocol (PREI), which works for both the importance and delay requirements of the events; A latency-oriented fault-tolerant transmission protocol (LOFT) as an extension to PREI, with the ability to cope with transmission failures; and (3) an actuator allocation algorithm, which can be used to distribute the actuators to match the demands from the sensors. The workflow of the dividing network into grid cells to get clear understanding of data aggregation. Here aggregation of data in same grid cells can control the redundant data, increases the network efficiency and decrease energy depletion for the communications as shown in the Figure 7.

[35] Proposed two cross layer schemes to provide video data reliable delivery called geographic schemes addressing the congestion in the wireless video sensor network (WVSNs). In these two schemes the first one is the Load Balancing Reliable Forwarding (LBRF) in which the concept of local load balancing has been introduced where a sensor can easily determine dynamically the next hop among the alternative nearly connected sensors and providing the progressive improvement towards the sink while considering the balance of the buffer occupancy levels at the delivery time. They suggested that the scheme LBRF uses an enhanced version of SMAC where the structure of packet and the operation of SMAC are amended for the precise observing of the buffer occupancy surroundings of the neighbors. They also proposed a second scheme in their research work Directional Load Balancing Spreading (DLBS) which is used to combine the local and direction-based (spatial) load balancing methods that provide faster and more reliable delivery of video data.

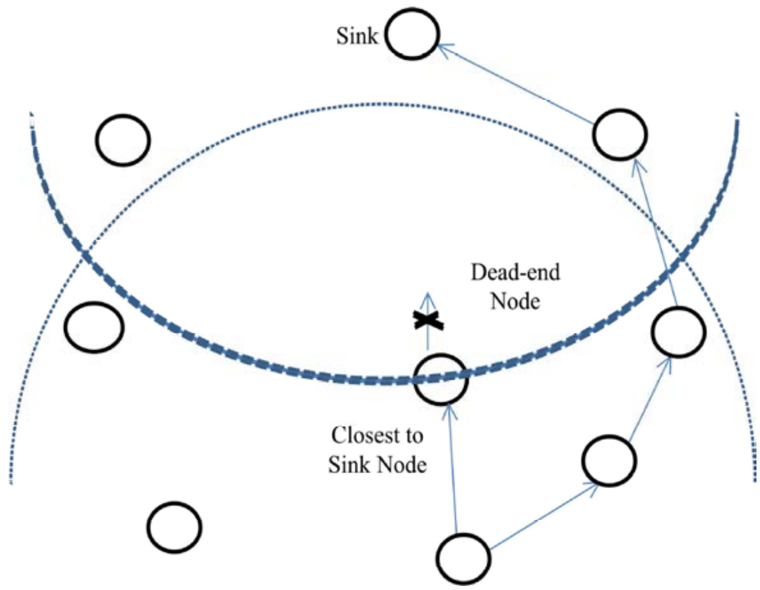

Fig. 9: Problem Dead-end Node

The above proposed schemes in research work have also been compared with two routing geographic schemes. The results show that both LBRF and DLBS provide more reliable video delivery as compared to other schemes, but DLBS is faster and more reliable as compared to LBRF. Furthermore the authors adopt a mechanism dead-end handling for the suggested geographic forwarding schemes, which defines the routing class concept to classify the sensors concerning the forwarding skills and the geographic locations of their neighbors towards the sink. In the proposed technique, every sensor node belongs to a routing class and information of this class is conveyed by piggybacking to every MAC layer packet. And a reserved special class for potentially detached nodes, detected at the timing of each frame delivery by discovering the time of latter packet reception from every neighbor node. The problem of dead-end node is illustrated in Figure 8.

[36] Address the reliability level in between two N hops far away nodes from each other (in a quantitative mode).they have studied their approach with the help of experiments which have been taken through a Simulator named Cooja. The authors proposed a protocol (HERO) which is fault-tolerance, reliable and energy-efficient in WSNs and WSANs. The proposed protocol manages the sensor network nodes in clusters in two stages, the discovery stage and joining stage.in the first stage the sensors have to find the shortest path in order to reach to their cluster heads. And when, these paths have been found by the sensor nodes then the permission has been asked in joining phase to belong to its cluster. The Cluster- heads get benefit of this stage to determine the clue-nodes between cluster-head and their sensor nodes.

They also will let them to estimate where their nodes are placed. Concerning the packet transmission delivery mechanisms, the proposed protocol allows not only sending data two ways (from cluster head to its sensor nodes and vice versa) but it also lets them to identify the anticipated reliability level quantitatively. Additionally, they also defined the notion of "memory path" that permits sensor nodes to store more energy while nodes need an ACK packet at its destination for confirmation of the information arrived correctly. The process of retransmission with ACK (Acknowledgement) or without any ACK has also been discussed. This is the N times retransmission of the same packets in order to get the required reliability, some of the questions can arise here like, N times retransmission is the best or up to N times and which one is better to have less energy depletion when a node A sending more than 7 packets to node B (neighbor node).

$$E(N) = N * (E_t + PR_{ij} * E_r) \quad (5)$$

Where N is the retransmitting number of times sending from i node to the adjacent j node in order to have the required reliability. PRij is the probability of the receiving node j. PRji denotes the probability of receiving node i form the node j. Er denotes as energy consumption at the time of sending and receiving packets. Energy

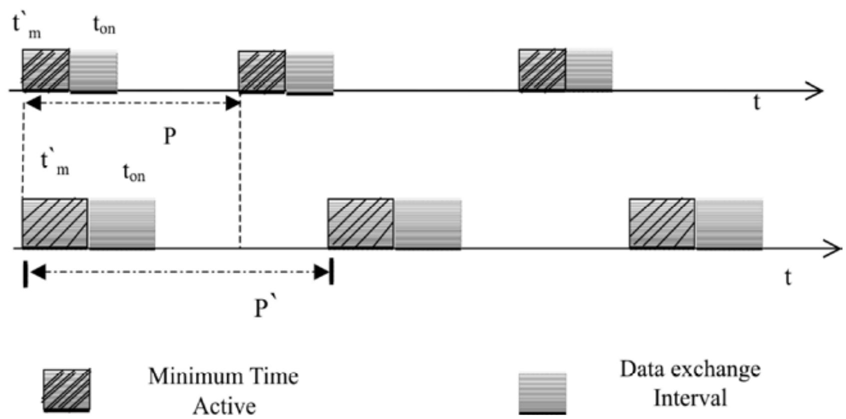

Fig. 10: Minimum time active with task period

consumption in retransmission of the same packet is taken as E(N) and EAck represents the energy consumed of both i and j nodes. In [37] a new algorithm is presented to enhance the QoS in wireless networks by considering the parameters delay and throughput. The authors proposed a new algorithm (packet scheduling algorithm) using a cross layer technique to enhance the quality of service (QoS) in a wireless network. First of all they analyzed the insufficiency of the current packet scheduling algorithms and the demand of packet scheduling for multimedia transmission in wireless networks are analyzed. And then they designed a model of the cost function for packet transmission and the packet scheduling algorithm guaranteeing Qos for high speed downlink packet access which they called QPS. The author also stated the packet delay approach and overall steps to understand the QPS algorithm in detail for wireless channels.

$$T=\frac{1}{N}\sum_{k=1}^{N} t_{k/r_k}$$
$$C=\sum_{k=1}^{N}\max\left\{0, t_{k/r_k}-1\right\} \quad (6)$$

Where tk represents the packet's end to end delay, rk denotes the delay required and Number of packets Sample is denoted by N. so when T approaches to 1 meaning that the packet is sent in the permitted required delay band. The proposed algorithm scheduler is also considered for the QoS parameters together with physical layer channel quality and the delay of data link layer, which explores the cost of each packet, discovers the optimal cost packet, sets it in the front of the queue and sends it. The algorithm proposed in this work can utilize the wireless network resources, guaranteed fairness and temporarily balance the scheduling of the throughput effectively but the response rate of high speed packets can affect the network to understand the real time scheduling.

In [38] this article the presents the issues of maximum latency and low throughput rising from the periodic processes of MAC protocols for WSNs. The authors proposed a low delay energy-efficient and fast mac algorithm which they call FP-Mac Algorithm to come across with design criteria. The algorithm proposed is entirely considered for 802.15.4. It depends on the periodic short communication activities of the sensor comprising WSNs and accomplished by minimizing the activities that a sensor has to execute at the start of each communication period. Furthermore, in order to minimize delay the suggested algorithm defines modifications in sensor nodes.in a real time application the implementation of period adaptation make the application more complex.

Most of time in operating a WSN is spent in the handshaking process and without any communication as the different phases of RTS, CTS and synchronization, confining their capability to absorb the movement variations in a WSN keeping delay, average radio-on time and throughput in proficient stages as shown in figure (name).

Greedy Approach for Reliability: The essential problem of Wireless Sensor Networks is reliability. The communications are radio based and nodes are battery powered which can cause nodes to fail and to be disconnected temporarily or permanently where these individual nodes can have the very important data collected. Fairly, the information gathered by numerous sensor Nodes is usually combined to provide enhanced accuracy and significance. The importance of a reliable sensor networks is not only focused on every single end-to-end delivery but is of an additional common nature, including network-wide significance. In order to improve the problem on the low reliability and limited scope of physical and MAC Layers the Network and higher layers must be considered [39]. And in this research work some of routing approaches like greedy approach which is inherently tolerant to node and the dependence on local information and link failures are also considered. Planarization and Localization algorithms are affected but have elegant degradation characteristics, which support routing and applications graceful. An accurate routing may be prevented by the failure of a single node or link some nodes but there is no compromise for the whole network. In order to maintain the acceptable level for the supported functions the reruns of the Periodic refreshing can help using the proposed technique. Actually the application layer must be given more attention where the data is managed and gathered from the sensors.

The authors also discussed that their focus is on the extremely useful data which is the result of combining several measurements or worth memorizing and gathering. And then these data are sent to gathering point like sink node or can be stored in the network for review later. In [40, 11] the authors propose two significant contributions the First one determines the intrinsic association between transitional and handoffs region. The performance of the handoffs is the best when evaluated its operation in transitional region, as opposite to the operative in a connected region more reliably. They propose in the Second contribution the parameters when tuned finely can decrease the handoff delay in transitional region [41] Presented a routing technique variable-power data-centric routing technique where every source node tunes its power of transmission depended on the distance from this source node to receiver or destination. They investigate to find that how the reliable packet delivery probability and energy linked with reliable delivery of each packet can be affected by the error rate related with a link.

The authors include the scenarios of both fixed and variable power with end-to-end retransmission and hop-by-hop retransmission techniques in their analysis. A WSN needs more reliable and efficient energy protocols to develop and design the data streaming network applications.[2] The main purpose of this work is to design a reliable and energy efficient protocol for streaming data systems in Wireless Sensor Networks. In such applications the data streaming is sensed like pressure, flow of water flow, time to time from several distributed sensor nodes to the sink and transmits them through the IP network to a remote location for executing, storing, processing and demonstration. Reliable packet delivery and the efficient energy are required for the long lifetime and continuous transmission from source nodes to sink. In this research work the authors propose ERTP, Energy efficient Reliable Protocol for the streaming data applications in WSN in which the data sensed by the sensors are transferred from source sensor nodes to the sink (base station).

In this article the authors stated a model for the loss ratio of the packet loss and mean end-to-end latency and overall energy consumption.in order to adjust the modulation and transmit power of each cluster head a distributed online and a centralized offline protocol is designed in integrated framework to assure the static and dynamic QoS necessities in the proposed model. They analyzed and the modulation and transmission schemes and integrated jointly into a single framework in the link layer and in physical layer. And to adjust and transmit and modulation level of the cluster heads adaptively the cluster base protocol is used in the framework [42].

Comparative Study: Here we have come up with a comparative study of the schemes of our systematic literature review and which is a significant part to unify

Table 2: Comparative study of QoS parameters schemes for End to end Delay in WSN.

Scheme	No of Sink	Speed of sink	Sink movement	Network Size	Location Awareness
CDS [9]	Single	Variable & High	N/A	Large	Yes
MP[11]	Single	Fixed & Moderate	Discrete	Small	No
ERF[29]	Multiple	Variable & Moderate	Continuous	Medium	Yes
Inroute [13]	Single	N/A	Continuous	Large	Yes
RL[30]	Single	Variable & High	Discrete	Large	No
DRC[31]	Single	Fixed & slow	N/A	Small	Yes
SDEL and DDEL [8]	Multiple	Fixed & Slow	Continuous	Medium	No
E2EDAR[27]	Single	Variable & Moderate	Discrete	Medium	No
SFA[33]	Single	Fixed & High	Discrete	Large	Yes
LJSR[14]	Multiple	Variable & Moderate	Continuous	Large	No

Table 2: Continue

Scheme	No of Sink	Speed of sink	Sink movement	Network Size	Location Awareness
ENCO[15]	Sinble	Fixed & Moderate	Discrete	Medium	Yes
GAR[16]	Multiple	Variable & Moderate	Discrete	Small	Yes
PSA[17]	Single	Fixed & High	Discrete	Small	Yes
FDF[1]	Single	Fixed & Moderate	Continuous	Large	No
QPS[37]	Single	variable & high	Discrete	Medium	Yes
FP-MAC[38]	Single	Fixed & Moderate	Discrete	Small	No

Table 3: Comparative study of QoS Parameters Schemes for Reliability in WSN

Scheme	No of Sink Nodes	Speed of sink	Sink movement	Network Size	Location Awareness
MAP [12]	Single	Variable & moderate	Discrete	Medium	Yes
ERF [29]	Single	Fixed & high	Continuous	Large	No
In route [13]	Single	Fixed & moderate	Continuous	Large	No
RL [30]	Multiple	Fixed & high	Continuous	Small	No
CLQS [28]	Single	Fixed & Slow	Discrete	Small	No
RDAT [32]	Single	Variable & moderate	Discrete	Large	Yes
PSA [17]	Single	Variable & moderate	Continuous	Medium	Yes
LBRF & DLBS [35]	Multiple	Variable & moderate	Discrete	Medium	Yes
HERO [36]	Multiple	Variable & moderate	Discrete	Small	Yes
QPS [37]	Single	Yes	Continuous	Medium	No
IWTS [42][6]	Multiple	Variable & moderate	Discrete	Large	Yes
MA [18]	Single	Yes	Discrete	Large	No

Table 4: Comparative study of QoS Parameters Schemes for Energy Consumption in WSN

Scheme	No of Sink Nodes	Speed of sink	Sink movement	Network Size	Location Awareness
MAP [12]	Single	Variable & moderate	Discrete	Yes	Yes
SDEL and DDEL [8]	Single	No	Discrete	Yes	No
RDAT[32]	Single	Variable & moderate	Discrete	Yes	Yes
E2EDAR [27]	Single	No	Continuous	Yes	Yes
SFA[33]	Multiple	No	Discrete	Yes	No
LJSR [14]	Multiple	No	Continuous	YEs	Yes
CAID [34]	Single	NO	Continuous	Yes	No
ENCO [15]	Single	No	Discrete	Yes	No
GAR [16]	Multiple	No	Discrete	Yes	Yes
PSA [17]	Single	Variable & moderate	Discrete	Yes	No
LBRF & DLBS [35]	Single	Variable & moderate	Discrete	Yes	Yes
HERO [36]	Single	Yes	Continuous	Yes	Yes
FDF [1]	Multiple	No	Continuous	Yes	Yes
FP-MAC [38]	Single	No	Discrete	Yes	No
IWTS [42][6]	Single	Variable & moderate	Discrete	Yes	Yes

and evaluate these scheme grounded on their main and key objectives. Most of the above mentioned data gathering approaches target to reduce the end to end delay of the network using movable or immovable and multiple or single sinks with their constraints on network to operate which are shown in Table 4. Likewise, in Table 5 we present a comparative study of the methods or schemes that discuss about the network reliability to provide packet delivery on time and successfully. The main purpose of this comparison is to facilitate the researchers and industrials to assist and select the best approach in order to deploy as according to their networks and systems.

Open Issues and Challenges: QoS parameters should be given well concentration and are important to improve in a Wireless Sensor network in order to have an efficient and reliable communication. And especially in a real time and critical system it gets more importance.it is clear to understand that to provide QoS the parameters energy consumption, delay, throughput, routing are tightly associated. In wireless sensor networks, minimizing the medium access delay from sensor nodes to the sink node is a critical issue. Routing layer performance should also

be considered into account [10]. What steps can be taken for the minimizing of medium access delay at the MAC layer of the sensor devices through which the packet latency can be ensured as optimized to meet the end-to-end delay requirements.

The lack of reliability is also an open research issue and has to be given special attention for the betterment of QoS in Wireless Senor Network. CSMA/CA is doing well for this in light traffic mode but in a heavy traffic mode the performance of CSMA/CA degrades quickly and can produce issues in the form of reliability, low throughput and high delays [45][12].

For the reliability assurance MAC layer can also be contributed. In order to fix the issues in time and to identify the packet losses Acknowledgement mechanisms can accordingly be proposed by the researchers. WSNs can get dynamic behavior any time, the sensor nodes can be disconnected from the network or links can be changed in time due to battery depletion, environmental conditions, topological changes and a change can come can occur in the number of nodes which may be increased or decreased to the network, connections between nodes may change with respect to time due to surrounding conditions or changes in topologies. All above issues are the causes that affect the QoS in WSNs. Traffic conditions may change according to the monitored occurrences.

There-fore, in order to control these changes adaptive actions should be taken by MAC protocols as according to the network dynamics [3]. For example, if high-rate, data transmission traffic is dominated in real time system, sensor nodes must continue with a high duty cycles and if low-rate traffic streams in the application most of the sensor nodes could be reserved as passive to conserve energy. Other assumptions can be all these parameters can be accessed from the optimizer for optimizations; practically this can increase the transmission control and yielding overheads. Furthermore, the circulated solutions are not able to accomplish best selection of parameters.

So the tradeoff between optimal parameters and the overheads has to be explored. Another assumption made by optimization proposals is that parameters of the whole network are accessible by the optimizer. In practice, this would increase the control transmission, yielding overheads. On the other hand, distributed solutions cannot achieve optimal parameters selection. Thus, the tradeoff between over- heads and the optimality of the solution needs to be studied and if an interoperable architecture is to be proposed, it must also cope with parameters exchange between sensor nodes.

CONCLUSION

The use of WSNs has got much attraction of researchers in different disciplines. The main and important motivating reason is their extensive coverage of useful applications as sensors are capable of interacting with the surroundings in by achieving fundamental parameters. In this perspective, in this paper we have come with an extensive survey of the solutions relating to the enhancement process of QoS parameters in Wireless sensor Network. Furthermore, the trade-off and energy, delay, reliability have also been highlighted and have come with comparison of previous developed techniques, protocols and algorithms. It is also cleared for the Proposals their own list of issues in the different kinds of WSNs and that each one has to be discussed.

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