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A State-of-the-Art Literature Survey on Energy / Power Constraint Quality of Service Enabled Routing for Wireless Sensor Communication Networks

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***Abstract*—** Wireless Sensor Communication Networks became more popular from the 21st Century and it gets attracted by more over all the fields including medical, education and defence etc. Even very difficult and complex tasks become very simple, by its various applications and advancements of today. Improving the flexibility, Scalability and the efficiency of the Wireless Sensor Networks draw the attention of the researchers to explore more on it, especially on Energy Saving Mechanisms with Quality of Service. Energy has an important impact in Wireless Sensor Communication Networks, because it makes the environment green, at the same it also creates more challenges that to be solved. This paper reviews the existing researches based on Energy / Power Constraint Quality of Service enabled Routing for Wireless Sensor Communication Networks.

***Keywords*—** *Wireless Sensor Communication Networks, Routing protocols, Energy aware, Quality of Service*

I. INTRODUCTION

Wireless Sensor Communication Networks is composed of a number of wireless sensor nodes which form a sensor field and a sink [1]. The sensor node consists of four components: a sensing unit, a process unit, a radio unit or communication unit, and a power unit these units fit into a smaller unit, which includes one or more microcontrollers, CPUs, Flash memory, RF transceiver and batteries or solar cells. This is shown in Fig. 1.

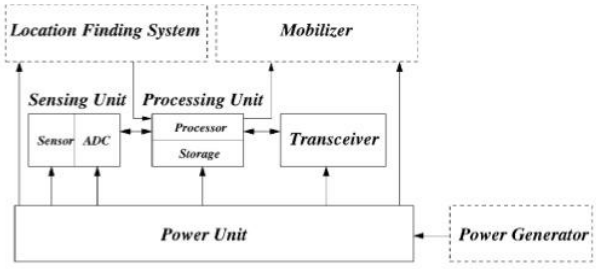

Fig. 1. The components of a sensor node.

- ***Sensing Unit:*** It consists of two operations. Sensor senses the analog signals and then converts them into digital signals. These digital signals are transfer to the processing unit.
- ***Processing Unit:*** It is main portion of the sensor node, associates with a small memory unit.
- ***Communication Unit:*** It consists of transceivers connected with Omni-directional antenna which allows communication in all directions [4]. The maximum energy is consumed for data transmission.
- ***Power Supply unit:*** The sensor node can get the power from the energy storage devices or by energy scavenging [4]. The former technique employs a variety of tiny batteries made up of thin films of vanadium oxide and molybdenum oxide [5].

These networks are built together a large amount of data in a large spatial region, providing users with information in different points of a region [2]. These networks technologies have been adopted by Military operations, Traffic Management, Healthcare, Agriculture, Industrial and Commercial Applications. The Wireless Sensor Communication Networks replaces the Cellular networks and Ad-hoc networks because both networks use mobile devices, low power circuits and these devices are rechargeable. WSCNs are known for its Fault tolerance, Scalability, Cost.

- **Fault tolerance**: In WSCNs, hundreds, and in the extreme, hundreds of thousands of sensors are deployed in a large geographical area. In some cases dropped from airplanes, or deployed using artillery shells. Requiring that every node must work in order for the network to operate is impossible to achieve. The network must have a high level of fault tolerance in order to be of any practical value [3]
- **Scalability:** WSCNs have various protocols to deal with situation when some nodes power supplies are completely exhausted.
- **Cost:** Even though WSCNs consists of large number of nodes cost becomes less.

The WSCNs have number of issues, but the Energy Conservation occupies the major portion, because it increases the life time for sensor nodes. The Energy can be saved in WSCNs by applying different mechanisms at different level.

II. Literature Review

In [6] Mohammad Reza Mazaheri et al, says that the hierarchical networks, nodes are separated to play different roles such as Cluster Heads (CH) and cluster members. Each CH collects data from the cluster members within its cluster, aggregates the data and then transmits the data to the sink. Each algorithm that was used for packet routing in quality of service (QoS) based applications should be able to establish a tradeoffs between end to end delay parameter and energy consumption. Hence, enabling QoS applications in sensor networks requires energy and QoS awareness in different layers of the protocol stack. They proposed a QoS based and Energy aware Multi-path Hierarchical Routing Algorithm in wireless sensor networks namely QEMH tried to satisfy the QoS requirements with the minimum energy via hierarchical methods. The proposed routing protocol includes two phase. In first phase, performs cluster heads election based on two parameters: node residual energy and node distance to sink. In second phase, accomplishes routes discovery using multiple criteria such as residual energy, remaining buffer size, signal-to-noise ratio and distance to sink. When each node detect an event can send data to the CH as single hop and CH to the sink along the paths. The Authors were used a weighted traffic allocation strategy to distribute the traffic amongst the available paths to improve the end to end delay and throughput. By this strategy, the CH distributes the traffic between the paths according to the end to end delay of each path. The end to end delay of each path is obtained during the paths discovery phase. QEMH maximizes the network lifetime as load balancing that causes energy consume uniformly throughout the network. They evaluated and compared the performance of proposed routing protocol with the MCMP and EAP protocols and the Simulation results were shown that their proposed protocol is more efficient than those protocols in providing QoS requirements and minimizing energy consumption.

In [7] Dionisis Kandris et al, presented PEMuR, a novel dual scheme for efficient video communication, which aims at both energy saving and high QoS attainment. PEMuR proposed the combined use of an energy aware hierarchical routing protocol with an intelligent video packet scheduling algorithm. The adopted routing protocol enables the selection of the most energy efficient routing paths, manages the network load according to the energy residues of the nodes and prevents useless data transmissions through the proposed use of an energy threshold. And the proposed packet scheduling algorithm enables the reduction of the video transmission rate with the minimum possible increase of distortion. They make use of an analytical distortion prediction model that can accurately predict the resulted video distortion due to any error pattern. The authors were designed the algorithm to cope with limited available channel bandwidth by selectively dropping less significant packets prior to their transmission and proved the effectiveness of the proposed algorithm.

In [8] Ademola P. Abidoye et al, proposed a Novel Clustering Algorithm for Energy Efficiency. ANCAEE achieves good performance in terms of minimizing energy consumption during data transmission and energy consumptions were distributed uniformly among all nodes. The authors were used a new method of clusters formation and election of cluster heads. The proposed algorithm ensured that a node transmits its data to the cluster head with a single hop transmission and cluster heads forward their data to the base station with multi-hop transmissions. Simulation results were shown that the new approach consumes less energy and effectively extends network utilization.

In [9] Giuseppe Campobello et al, proposed a packet-splitting algorithm based on the Chinese Remainder Theorem (CRT) and was characterized by a simple modular division between integers. They presented an analytical model for estimating the energy efficiency, with several practical issues such as the effect of unreliable channels and topology changes. They proved that the proposed algorithm was outperformed the traditional approaches in terms of power saving, simplicity, and fair distribution of energy consumption among all nodes in the network.

In [10] R. Prema and R. Rangarajan, proposed the Power Aware Routing Protocol (PARP), which attains application-specified communication delays at low energy cost by dynamically adapting transmission power and routing decisions. Extensive simulation results prove that the proposed PARP attains better QoS and reduced power consumption

In [11] Berta Carballido Villaverde et al, proposed InRout route selection algorithm, where local information was shared among neighbouring nodes to enable efficient, distributed route selection while satisfying industrial application requirements and considering sensor node resource limitations. Route selection was described as a multi-armed bandit task and uses Q-learning techniques to obtain the best available solution with low overhead. The performance were done with existing approaches demonstrated and proved that the benefits of the InRout algorithm, was satisfies typical quality of service requirements for industrial monitoring applications while considering sensor node resources.

In [12] Hafiz Bilal Khalil and Syed Jawad Hussain Zaidi, proposed the most nearest and the most used routing algorithm (MNMU-RA) for ad-hoc and WSNs to the

energy conservation. They found the best location of MNMU node for energy harvesting by MNMU-RA algorithm. Their method involves the least number of nodes in transmission of data and set large number of nodes to sleep in idle mode. Based on simulation result they shows the significant improvement in energy saving and enhance the life of the network.

In [13] Engin Zeydan et al, proposed an adaptive and distributed routing algorithm for correlated data gathering and exploit the data correlation between nodes using a game theoretic framework. The routes were chosen to minimize the total energy expended by the network using best response dynamics to local data. The cost function that was used for the proposed routing algorithm takes into account energy, interference and in-network data aggregation. The iterative algorithm was shown to converge in a finite number of steps. The authors were proved that multi-hop data aggregation can significantly reduce the total energy consumption in the network by Simulation results.

In [14] Hoda Taheri et al, proposed an energy-aware distributed dynamic clustering protocol (ECPF) which applies three techniques: (1) non-probabilistic cluster head (CH) elections, (2) fuzzy logic, and (3) on demand clustering. A non-probabilistic CH election was implemented by introducing a delay inversely proportional to the residual energy of each node. Hence, tentative CHs are selected based on their remaining energy. The fuzzy logic was employed to evaluate the fitness (cost) of a node in order to choose a final CH from the set of neighboring tentative CHs. They proved that their approaches were performed better than the well known protocols (LEACH, HEED, and CHEF) in terms of extending network lifetime and saving energy.

In [15] Yaling Tao et al, proposed a flow-balanced routing (FBR) protocol for multi-hop clustered wireless sensor networks, which attempts to achieve both power efficiency and coverage preservation. FBR consists of four algorithms, one each for network clustering, multi-hop backbone construction, flow-balanced transmission, and rerouting. The proposed clustering algorithm groups several sensors into one cluster on the basis of overlapping degrees of sensors. The backbone construction algorithm constructs a novel multi-level backbone by using the cluster heads and the sink. And the flow-balanced routing algorithm assigns the transferred data over multiple paths from the sensors to the sink in order to equalize the power consumption of sensors. Finally, the rerouting algorithm reconstructs the network topology only in a place where a head drops out from the backbone due to the head running out of its energy. The network lifetime and the coverage lifetime were used to evaluate the performance of FBR protocol. Their simulation results were shown that the FBR yields both much longer lifetime and better coverage preservation than previous protocols.

In [16] Wei Li et al, proposed a heuristic-based three-phase algorithm (TPTS) for allocating tasks to multiple clusters in hierarchical WSNs that aims at finding a scheduling scheme that minimizes the overall energy consumption and balances the workload of the system while meeting the application's deadline. The performance of the proposed algorithm and the effect of several parameters on its behaviour were evaluated by simulations, with promising results. The experimental result shows that the time and energy were minimized by TPTS.

In [17] Mourad Hadjila et al, defined that the Clustering routing protocols have been developed in order to reduce the network traffic toward the sink and therefore prolong the network lifetime. An alternative of clustering is to build chains instead of clusters. Hence they proposed a routing protocol based on constructing multiple chains in the direction of the sink. The first node of each chain sends data to the closest node in the same chain. This latter collects, aggregates and transmits data to the next closest node. This process repeats until reaching the last node, which aggregates and transmits data directly to the sink. Inseated of forming multiple chains , they introduced the construction of a main chain, which includes leader node of each chain, initially all main chain nodes have the same amount of power, the nearest node to the sink aggregates data from others then transmits it to the sink. In the next transmission, main chain node having the higher residual energy performs the task. The authors compared both the approaches by network simulation and proved that the improvement approach consumes less energy and effectively extends the network lifetime.

In [18] Shalli Rani et al, proposed an EEICCP (Energy efficient inter cluster coordination) protocol, which evenly distributes the energy load among the sensor nodes and use the multi hop approach for the CHs. The analytical model of new protocol was projected and the algorithm was implemented in MATLAB. The results were shown that the EEICCP has the remarkable improvement over already existing LEACH and HCR protocols in terms of reliability and stability.

In [19] Benazir Fateh and Manimaran Govindarasu has proposed devise scheduling algorithms to minimize energy consumption in Real-time Wireless Sensor Networks (WSNs) by leveraging the energy-delay trade off. Spatial and temporal correlation exhibited by WSNs can be exploited to reduce energy consumption. They proposed determination of the data correlation at each node by way of local computation along with avoiding transmission of significantly similar data which lead to unused time slots at runtime (dynamic slack) that can be traded off for energy savings. Their approach uses techniques namely Dynamic Voltage Scaling (DVS) and Dynamic Modulation Scaling (DMS), which utilize the slack generated dynamically to reduce energy consumption in a real-time environment. They proposed heuristics with varying

complexities for efficient slack management. The authors evaluated the performance of these heuristics by simulating diverse network conditions while incorporating different overheads. Simulation results showed that their proposed heuristics can achieve energy savings up to 40% more than the baseline algorithms employing DVS and DMS.

III. Findings

This paper analyzed the research evolution performed by various authors on the topic of Energy Efficiency / Power Constraint mechanisms and QoS of Wireless Sensor Communication Networks. Different protocols and their approaches are categorised in Fig.2.

Protocol	ref	Approaches	Energy Constraint	QoS
QEMH	6	Multi –hop Hierarchical routing	Yes	Yes
PEMuR	7	Hierarchical routing Video Packet Scheduling	Yes	Yes
ANCAEE	8	Cluster formation and Election of Cluster Heads	Yes	No
CRT based Packet splitting	9	Chinese Remainder Theorem	Yes	No
PARP	10	Dynamic Adaptive Transmission of the Power	Yes	Yes
InRout	11	Q – Learning Techniques	Yes	Yes
MNMU-RA	12	Most Nearest and Most Used nodes	Yes	No
Adaptive and Distributed Routing	13	Game theory	Yes	No
ECPF	14	Fuzzy Logic	Yes	No
FBR	15	Flow Balanced Transmission	Yes	No
TPTS	16	Hierarchical Clustering and Scheduling	Yes	No
Chain-Based Routing Protocol	17	Multiple Chains and Main Chain	Yes	No
EEICCP	18	Multi hop- CHs	Yes	No
Device Scheduling algorithm	19	Dynamic Voltage Scaling (DVS) Dynamic Modulation Scaling (DMS),	Yes	No

Fig.2. Classification of Protocols in WSNs.

Around eleven papers have been extensively reviewed and several finding has been made. Many of the research on the specified problem were done using Hierarchical Crusting methodologies. Some of the researches were conducted using Game Theory techniques. Very few papers approached the specified research using Fuzzy Logic methods. Hence, soft computing techniques and security algorithms was majorly not performed.

IV. Conclusion

In this paper we have presented the taxonomy of energy constraint quality of service enabled routing for wireless sensor communication networks. We have classified the various new invented protocols and methods, according to their approaches, energy constraint and Qos. This taxonomy should help researchers focus on underlying methods, limitations of the existing protocols, schemes and open research issues needed to enhance the Energy Saving and QoS of WSCNs. This paper densely reviewed research manuscripts on the topic of energy / power constraint quality of service enabled routing for wireless sensor communication networks.

References

[1] Vivek Katiyar, Narottam Chand, Naveen Chauhan (2010) , “Recent Advancement and Future trends in Wireless Sensor Networks”, International Journal of Applied Engineering Researh, Vol. 1, No 3, Pp. 330-342.

[2] Suraiya Tarannum (2010), “Energy Conservation Challenges in Wireless Sensor Networks : A Comprehensive Study”, Wir eless Sensor Netwok,Pp.483-491.

[3] H. Baltes et al., (1998) “ Micromachined Thermally Based CMOS Microsensors”, Proceeding of IEEE, Vol. 86, No. 8, Pp, 1660-1678.

[4] Hamid Barati, Ali Movaghar, Ali Barati, and Arsah azizi mazreach (2008), “ A Review of Coverage and Routing for Wireless Sensor Networks”, World Academy of Science, Engineering and Technology, Vol No 37, Pp. 298- 302.

[5] G. Hoblos, M. Staroswiecki, and A.Aitouche (2000), “Optimal Design of Fault Tolerant Sensor Networks” , The IEEE International Conference on Control Applications, Pp.467-472.

[6] Mohammad Reza Mazaheri, Behzad Homayounfar, Sayyed Majid Mazinani, "QoS Based and Energy Aware Multi-Path Hierarchical Routing Algorithm in WSNs", "Wireless Sensor Networks, Vol. 2, No.4, pp.31-39, February 2012.

[7] Dionisis Kandris, Michail Tsagkaropoulos, Ilias Politis, Anthony Tzes, Stavros Kotsopoulos,"Energy efficient and perceived QoS aware video routing over Wireless Multimedia Sensor Networks" Ad Hoc Networks, Vol.9, No.4, pp. 591-607,June 2011.

[8] Ademola P. Abidoye, Nureni A. Azeez, Ademola O. Adesina, Kehinde K. Agbele, "ANCAEE: A Novel Clustering Algorithm for Energy Efficiency in Wireless

Sensor Networks", Wireless Sensor Networks, Vol.9, No.3, pp.307-3012, September 2011.

[9] Giuseppe Campobello,Alessandro Leonardi ,Sergio Palazzo ,"Improving energy saving and reliability in wireless sensor networks using a simple CRT-based packet-forwarding solution", IEEE/ACM Transactions on Networking,Vol.20, No. 1, pp. 191-205, February 2012

[10] R. Prema, R. Rangarajan, "Power Aware Routing Protocol (PARP) for Wireless Sensor Networks",Wireless Sensor Network,Vol.5, No.4, pp.133-137, May 2012.

[11] Berta Carballido Villaverde, Susan Rea, Dirk Pesch, "InRout – A QoS aware route selection algorithm for industrial wireless sensor networks",Ad Hoc Networks, Vol.10, No.3, pp. 458-478, May 2012,

[12] Hafiz Bilal Khalil, Syed Jawad Hussain Zaidi, "MNMU-RA: Most Nearest Most Used Routing Algorithm for Greening the Wireless Sensor Networks",Wireless Sensor Network, Vol.6, No.4, pp.162-166,June 2012.

[13] Engin Zeydan, Didem Kivanc, Cristina Comaniciu, Ufuk Tureli,"Energy-efficient routing for correlated data in wireless sensor networks",Ad Hoc Networks, Vol.10, No.6, pp. 962-975,August 2012.

[14] Hoda Taheri, Peyman Neamatollahi, Ossama Mohamed Younis, Shahrzad Naghibzadeh, Mohammad Hossein Yaghmaee,"An energy-aware distributed clustering protocol in wireless sensor networks using fuzzy logic", Ad Hoc Networks, Vol.10,No.7, pp. 1469-1481,September 2012.

[15]Yaling Tao, Yongbing Zhang, Yusheng Ji, "Flow-balanced routing for multi-hop clustered wireless sensor networks"Ad Hoc Networks, Vol.11, No.1, pp. 541-554,January 2013.

[16] Wei Li , Flávia C. Delicato, Albert Y. Zomaya ,"Adaptive energy-efficient scheduling for hierarchical wireless sensor networks", ACM Transactions on Sensor Networks,Vol. 9, No.3, pp. 35, May 2013.

[17] Mourad Hadjila, Hervé Guyennet, Mohammed Feham, "A Chain-Based Routing Protocol to Maximize the Lifetime of Wireless Sensor Networks", Wireless Sensor Networks, Vol.5, No. 5, pp.116-120, May 2013.

[18] Shalli Rani, Jyoteesh Malhotra, Rajneesh Talwar, "EEICCP—Energy Efficient Protocol for Wireless Sensor Networks", Wireless Sensor Networks, Vol.7, No. 5, pp.127-136, July 2013.

[19] Benazir Fateh, Manimaran Govindarasu, "Energy minimization by exploiting data redundancy in real-time wireless sensor networks", Ad Hoc Networks, Vol.11, No.6, pp.1715-1731, August 2013.

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