International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163
Volume 1 Issue 10 (November 2014) www.ijirae.com

A Review on Scalability Issue in Wireless Sensor Networks

Ms. Swati V. Dhage
P.G., Scholar/CSE
B.D.C.E, Sevagram
Maharashtra, India

Prof. A. N. Thakre
Dept. of Computer Science and Engineering
B.D.C.E, Sevagram
Maharashtra, India

Prof. S. W. Mohod
Dept. of Computer Science and Engineering
B.D.C.E, Sevagram
Maharashtra, India

Abstract- The property of scalability for a given system indicates the ability of a system or a subsystem to be modified with changing load on the system. For a sufficiently large complex system, there are several factors that influence the ability of the system to scale. It is necessary to incorporate solutions to these factors (or bottlenecks) in the design for scalability of a given system. The design principles to handle the key factors that influence the scalability of large complex systems are explained further. Protocols can support simple, innovative, and relatively less expensive methodology to guarantee that a large complex system (such as network of sensors) is scalable under varying load conditions. These sensor networks connect large numbers of independent sensor nodes to make measurements of interest over a geographic region. Because of their small physical size and low cost, sensor nodes have a number of constraints in their operation: they have limited processing ability, limited storage on the node itself, and limited power. A sensor network system and protocol design aims to reduce and optimize the power usage of sensor nodes.

Keywords- Wireless Sensor Network, Scalabilty.

I. INTRODUCTION

Vast amount of sensor nodes are deployed in Wireless Sensor Networks which communicate with each other via frequency waves. Those sensor nodes are designed to collect data, monitor and control the physical environment efficiently. Every node consists of a small processor, antenna and a battery. These nodes communicates effectively with other nodes in their communication ranges to gather information.

Sensor network periodically gather data from a remote terrain where each node continually senses the environment and sends back the data to the Base Station (BS) for further analysis, which is usually located considerably far from the target area. Sensor nodes are tightly packed in the sensor networks, there are possibilities for the nearby sensor nodes to overlap sensing ranges.

Wireless sensor networks are composed of thousands of nodes, to consider with this amount of nodes to utilize the environment termed as scalability. A scalable network is a network which grows with increasing network load.

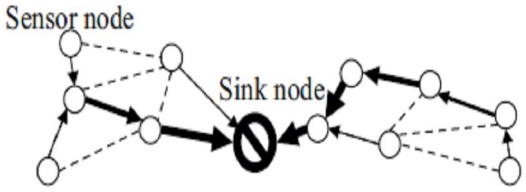

Figure 1: Structure of WSN

The structure of a WSN, as illustrated in figure 1 above, is made up of sensor nodes and a sink node. The sensor nodes collect data from their surroundings and forward them to the sink node. Additionally, since ad-hoc networking is used to compensate the lack of infrastructure support, individual nodes act as routers by assuming the packet forwarding role. The sink node acts the gateway for the WSN, an assembly point from which the user extracts data from the WSN.

Therefore, there is a need for the development of an improved method for scalability issue in the wireless sensor networks that should support network scalability where such network should continue to perform well as the network grows larger or as the workload increases.

In large scale wireless sensor networks, to achieve the network scalability and robustness objectives, one common approach is to group sensor nodes into clusters, forming the hierarchical clustering structure [5]. Each cluster has a leader, referred to as the cluster head (CH). A cluster head may simply collect sensed data in its cluster or perform aggregation or fusion of collected sensed data. In any case, the CH acts as a backbone node to route the sensed data to the sink via the inter-cluster communication.

Cluster head have longer radio ranges than ordinary nodes, so that a direct link between CHs is available, or that clusters are constructed within very limited hops. However, these are not always realistic assumptions since the CH may be a regular sensor node and the sink is often not directly reachable. Cluster-based WSNs have many advantages [5]. Cluster of nodes can be managed more easily, e.g., individual nodes need to store small routing tables, thus improving the network scalability. Finally, communication bandwidth is conserved since redundant exchange of messages among sensor nodes is avoided.

Therefore, in large scale cluster-based WSNs, the inter-cluster multi-hop communication is necessary to cover a large monitoring region. i.e, CHs communicate with each other by using multi-hops communication through the sensor nodes inside

the clusters. So, in this work, we have considered the scalability issue. This is a major issue in sensor network domain, which is considered for the study.

II. LITERATURE SURVEY

John D. Owens [2004] Recent advances in sensor networks have developed routing algorithms and compression and aggregation schemes that allow these networks to use their limited resources, particularly power, most efficiently. As sensor networks mature and sensor nodes become cheaper, deployed sensor networks will feature more nodes. This work examines the scalability behaviour of routing and compression algorithms as the number of nodes in a sensor network increases. They demonstrate the longer lifetimes of clustered routing algorithms as they increase in size, the superior spatial distribution of node deaths in hierarchical clustered and high-compression multihops routing algorithms.

Arash Nasiri Eghbali, et al., [2007] In this work, they propose SLTP, a Scalable Lightweight Time-synchronization Protocol for wireless sensor networks. By using passive clustering and linear regression SLTP can reduce the energy consumption of network nodes and also decrease the overhead of creating and maintaining the clusters. Moreover SLTP uses linear regression to compute the time. Therefore, it can calculate the clock skew and offset between each node and its cluster head in order to estimate the local time of remote nodes in the future or the past. By this they can gain considerable improvements in power consumption, accuracy and scalability in comparison to similar algorithms.

Ameesh Pandya, et al., [2008] Individual nodes will have some combination of sensing, signal processing and communications capability and may self-organize for a variety of cooperative sensing and communication tasks, subject to resource constraints such as energy and bandwidth. They consider the circumstances under which sensor networks can be scalable. The key attribute is a localization of the source destination distribution, achievable through localized processing. They show that very simple strategies, viz., selection of the closest sensor or group of sensors, are sufficient to achieve scalability when distortion is permitted for point sources. When spatial distortion is permitted, networks are also scalable when sensing distributed phenomena.

Prasanna Sridhar, et al., [2009] The property of scalability for a given system indicates the ability of a system or a subsystem to be modified with changing load on the system. For a sufficiently large complex system, there are several factors that influence the ability of the system to scale. It is necessary to incorporate solutions to these factors in the design for scalability of a given system. In this work, they discuss such design principles to handle the key factors that influence the scalability of large complex systems. Specifically, they explain the design and implementation of simple, innovative, and relatively less expensive methodology to guarantee that a large complex system such as network of sensors is scalable under varying load conditions.

J.V. Capella, et al., [2009] The major problem for most of wireless sensor networks applications is the scalabilty. In this work they propose a new architecture called EDETA (Energy-efficient aDaptive hiErarchical and robusT Architecture) optimized to save node's power. This architecture is scalable and suitable for heterogeneous and homogeneous wireless sensor networks, supports single or multiple sinks. The proposed protocol is able to autoconfigure, and it is based on two-levels hierarchical architecture. The lower level is based on cluster organization, while the upper one is formed as a dynamic tree of clusters heads to send the data to the sink.

Xiang Gao, et al., [2009] Wireless sensor networks (WSN) including large quantity of small sensor nodes with low-power energy consumption can effectively extend its life-span. However, the performance of WSN is affected by the environment. In this work, they devise a new multi-hop routing algorithm clustering sensor nodes into groups to minimize the total energy consumption and improve scalability of the WSN. The proposed algorithm optimizes the intensity distribution of the cluster-heads(CHs) when introducing the model of Voronoi-Structure trees.

Lejiang Guo, et al., [2010] This work analyzes the implementation and existing issues in LEACH. Specifically for node energy and the network lifetime, it proposes an energy efficient routing algorithm based on cycle-switching cluster head. It improves node energy efficiency, balances energy consumption of all sensor nodes, enhances reliability of data transmission and postpones network lifetime in comparison to LEACH. Moreover, the protocol increases the balance of energy dissipation, scalability and reliability of WSN.

Long Cheng, et al., [2011] In large-scale sensor networks, grouping sensor nodes into clusters has been considered as an effective way to achieve network scalability and robustness. Broadcasting over cluster heads (CHs) is often necessary for routing protocols to establish routes in cluster-based wireless sensor networks (WSNs), e.g., disseminating data to a mobile sink or flooding data centric queries sent by a sink. However, inter-cluster communication between CHs has not been sufficiently investigated in the existing literature. In this work, they focus on scalable and energy efficient broadcasting over CHs in multi-hop cluster-based WSNs, where a direct link between CHs is not necessarily available. They present a distributed heuristic

protocol, named BOCH, to improve the scalability and energy efficiency of inter-cluster communication when performing the broadcasting service over CHs.

Thanawat Horjaturapittaporn, et al., [2011] Wireless Sensor Networks have the limitations such as energy source, memory size and processing power. Therefore, developing scalable routing protocol is an interested research work in this field. The routing protocols in sensor networks are able to c1assity into three categories data-centric, hierarchical and location based. In this work, they propose a hierarchical routing protocol which is suitable for a medium size of the network at two hundred nodes.

Azlan Awang [2011] In large scale single-sink WSNs, number of hops to reach the sink increases. This causes an issue to the scalability of access and routing protocol for WSNs which is affected by the topological changes and number of nodes in the network. Due to an increasing number of hops, nodes close to the sink deplete their energy quickly. As the network size grows, the length of multihop paths increases and causes the above issues more defiant. Therefore, multiple sinks usage appears as a solution for large scale sensor networks. In this work, they propose to use node's minimum path loss and sinks 1-hop neighbours residual energy for guiding nodes to shuffle data packets among the sinks. Using this mechanism, nodes avoid from sending data packets toward the 1-hop neighbors that are about to deplete their energy and thus, improving the scalability.

Ahmed E.A.A. Abdulla, et al., [2011] Power-aware routing algorithms in Wireless Sensor Networks (WSNs) aim to solve the key issue of prolonging the lifetime of resource-constrained ad-hoc sensor nodes. Contemporary WSN routing algorithm designs have severe limitations on their scalability; that is, large-scale deployments of WSNs result in relatively shorter lifetimes, as compared to small-scale deployments, due to rapid sink node isolation caused by the quick battery exhaustion of nodes that are close to the sink. In this work, they analyze the scalability limitations of conventional routing algorithms and compare them to those of our recently proposed Hybrid Multi-hop routiNg (HYMN).

M. Hadjila1, et al., [2011] A wireless sensor network typically consists of a large number of low-cost sensor devices with limited battery energy deployed in an unattended manner. The common goals of designing a routing algorithm is not only to reduce control packet overhead, maximise throughput and minimise the end-to-end delay, but also take into consideration the energy consumption. Three metrics (power consumption, time of transmission and packet loss rate) are used in order to compare three routing protocols which are AODV, DSDV and LEACH.

Hyung-Sin Kim, et al., [2012] It is of great concern to employ an efficient network joining mechanism to construct a large scale wireless sensor network (WSN). However, when applied to a large scale WSN, it may not provide desirable node connectivity mainly due to the waste of network depth and networking bias. In this work, they consider the design of network joining algorithms that can construct a large scale cluster-tree structured WSN with maximal node connectivity. A new node willing to join as a router selects its parent node among neighbour routers which are closer to the network coordinator than itself, reducing the waste of network depth. The parent node selects isolated nodes first as its child routers, alleviating the networking bias problem.

S.No	Paper title	Author	Year	Description
1	A Multi- Hop Energy Efficient Clustering Algorithm in Routing Protocol for WSNs	Xiang Gao and Yintang Yang	2009	A new multi-hop routing algorithm clustering sensor nodes into groups to minimize the total energy
2	Consumed Energy as a Factor For Cluster Head Selection in WSNs	Desalegn Melese and Huagang Xiong	2010	Focuses on reducing power consumption by considering consumed energy as a factor for cluster head selection
3	A Novel Chain-Cluster Based Routing Protocol for Mobile WSNs	Tian Ying and Ou Yang	2010	1. organizes the mobile node, whose battery can be recharged regularly 2. a simple but efficient cluster head selection criterion
4	An Energy Efficient Cluster Based Node Scheduling Protocol for WSNs	R.Saravanakumar and S.G.Susila	2010	1. fixed clustering based data gathering approach 2. the node scheduling of active and sleep nodes.
5	Optimization of Clustering Probability of LEACH Protocol for Lifetime Maximization of WSNs	Sushant Miglani and Rajoo Pandey	2011	In LEACH,nodes organize themselves into clusters, The CH receives and aggregates information and pass it to BT.

6	Scalable and Energy-Efficient Broadcasting in Multi-hop Cluster-Based WSNs	Long Cheng and Sajal K. Das	2011	1. Focus on scalable and energy efficient broadcasting over CHs 2. achieving good scalability in large scale
7	Scalable Routing Protocol in Wireless Sensor Networks	Thanawat and w. Suntiamornt	2011	1. LEACH, main protocol 2. process and compress data from neighbour nodes
8	A Cluster Based Energy Efficient Reliable Routing Protocol For WSNs	Basavaraj Mathapati and Siddarama Patil	2012	1.Data aggregation is essentially used to gather and aggregate data 2. eliminating redundant data transmission.
9	A Cluster-based Algorithm for Energy-efficient Routing in WSNs	Sushant Miglani and Rajoo Pandey	2012	In LEACH,nodes organize themselves into clusters, The CH receives and aggregates information obtained from sensors in its own cluster it to the BTS. and passes
10	Away Cluster Heads Scheme for Energy Efficient Clustering Protocols in WSNs	N. Javaid, and M. Waseem	2013	increases the efficiency of conventional clustering

III. CONCLUSION

Scalability is one of the important concepts necessary in more effectively implementing and analyzing large, complex, independent, heterogeneous and autonomous systems working cooperatively. When systems interact (and often cooperate and coordinate) with each other to address the defined high level objectives, the performance of the entire combination of such systems could degrade due to optimization, autonomy, etc. Scalability is the key factor which plays an important role in designing the Wireless Sensor Network. The network should always be scalable to adapt to the newly entered node in the network.

REFERENCES

[1] John D. Owens, "On The Scalability of Sensor Network Routing and Compression Algorithms", Technical Report ECE-CE-2004-1, Computer Engineering Research Laboratory, University of California, Davis, 2004.
[2] Arash Nasiri Eghbali, Laleh Roustapoor and Mehdi Dehghan, "Scalable Lightweight Time Synchronization Protocol for Wireless Sensor Network", MSN 2007, LNCS 4864, pp. 536–547, 2007/Springer-Verlag Berlin Heidelberg 2007.
[3] Ameesh Pandya, Huiyu Luo, and Gregory Pottie, "Scalability of Sensor Networks", 2008 IEEE.
[4] Prasanna Sridhar & Asad M. Madni, "Scalability and Performance Issues in Deeply Embedded Sensor Systems", International Journal on smart sensing and intelligent system, VOL. 2, NO. 1, MARCH 2009.
[5] J.V. Capella, A. Bonastre, R. Ors, and S. Climent, "A new energy-efficient, scalable and robust architecture for Wireless Sensor Networks", 2009 IEEE.
[6] Xiang Gao, Cuiqin Duan and Jingjing Sun, Yintang Yang, "A Multi- Hop Energy Efficient Clustering Algorithm in Routing Protocol for Wireless Sensor Networks", 978-1-4244-3693-4/09/2009 IEEE.
[7] Lejiang Guo, Weijiang Wang, Jian Cui, Lan Gao, "A Cluster-based Algorithm for Energy-efficient Routing in Wireless Sensor Networks", 2010 IEEE.
[8] Long Cheng, Sajal K. Das, "Scalable and Energy-Efficient Broadcasting in Multi-hop Cluster-Based Wireless Sensor Networks", IEEE ICC 2011.
[9] Thanawat Horjaturapittaporn, w. Suntiamorntut "Scalable Routing Protocol in Wireless Sensor Networks", 2011 IEEE.
[10] Azlan Awang," Multi-sink Routing using Path loss in Multihop Wireless Sensor Networks", 2011 17th Asia-Pacific Conference on Communications, 2011 IEEE.
[11] Ahmed E.A.A. Abdulla, Hiroki Nishiyama, Nirwan Ansari, "HYMN to Improve the Scalability of Wireless Sensor Networks ", 30th IEEE International Conference on Computer Communications (INFOCOM 2011).
[12] M. Hadjila & M. Feham, "A Comparitive study of the Wireless Sensor networks routing protocols scalability", International Journal of Distributed and Parallel Systems (IJDPS) Vol.2, No.4, July 2011.
[13] Hyung-Sin Kim, Jin-Seok Han and Yong-Hwan Lee, "Scalable Network Joining Mechanism in Wireless Sensor Networks", 2012 IEEE.

