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A Study on Load Balancing in Wireless Sensor Network

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ABSTRACT

Today's smart environment wireless sensor network play a vital role in sensing data from sensor node deployed in various location. Sensor nodes have an energy constraint due to battery powered. The major issue involve in routing techniques due to energy awareness in WSN to manage traffic efficient load balancing is required for sensor nodes. Software defined network (SDN) is separates the control plane and data plane where SDN controller connected with the switches and manage and control the operation of switches. The SDN controller improves the load balances on the network to manage traffic. In this paper discuss about the various Load balancing with software defined network and utilizes the advantages of SDN controller in wireless sensor network

.Keywords: Software defined network,Wireless sensor network, Load Balancing, Switches.

1.Introduction

Wireless sensor network is collection of sensornodes distributed in various locations. Sensor node is capable of sensing,computation and communication elements in specified environment.There are four fundamental segments in a sensor network: a gathering of distributed sensors; an interconnection of wireless network;centralized clustering; and a centralized information mining. WSNs as a " distributed with centralization of low-power sensor nodes with a small measure of CPU and memory. Sensor networks have been utilized in various End applications, for example, biomedical application, seismic monitoring,habitat monitoring,and fire detection. In this network, nodes are densely populated so that handle the failure of sensor nodes is a challenge (C. S. Raghavendra, K. M. Sivalingam, T.Znati 2004). Topology changes takes place due to low power nodes, computational capabilities and memory are limited (N. Bulusu, S. Jha (2004).

Sensor nodeshave large number of sensors nodes and computation is difficult to identify the nodes. It is challenge in WSN directing nodes for responsiveness and efficiency. This makes tobalance the limited processing and communication capabilities of sensor nodes. In WSN routing a sensor node need ofmeasuring of bandwidth utilization,power consumption and processing of sensor nodes due to balance the routing challenge.Software defined network (SDN) is a software based network management that makes dynamic network configuration to improve the performance in networking (Y.D. Lin, C. C. Wang, Y.J. Lu, Y.C. Lai, and H.-C. Yang2017), SDN-based load balancing is more responsive and effective in managing devices(Ali Akbar Neghabi, Nima Jafari Navimipour, Mehdi Hosseinzadeh, And Ali Rezaee,2018)(Letswamotse, B.B., Malekian, R., Chen, C.Y,2018). SDN distinguishes the network control plane from the data plane to control devices. The administration of network forwarding and packet routing was centralized by the switches in the control plane.SDN controller control all task in network(Babedi Betty Letswamotse, Reza Malekian , Chi-Yuan Chen, Kgotlaetsile Mathews Modieginyane,2018)(Tkachova O, Uzor Chinaobi, Abdulghafoor Raed Yahya, 2016).

NFV is a virtualization function allows routing control functions to run on a virtual machine. Network function virtualization (NFV) not depend on SDN but combined with SDN to forward data packets from one network device to another (Sikandar Ejaz, Zeshan Iqbal, Peer Azmat Shah, Bilal Haider Bukhari, Armughan Ali, and Farhan Aadil ,2019). Open flow protocol is SDN protocol communication with network plane element for the purpose of determining the path of network packets. Open flow protocol identify network traffic based on predefined rule .The SDN controller manages the switches through Open flow protocol.The controller maintain flow table for update the nodes information (B. Han, V. Gopalakrishnan, L. Ji, and S. Lee, 2015) (Mijumbi ,2016).

This paper discusses different Load Balancing schemes in Wireless Sensor environment. The rest of the paper is organized as follows: Section 2 discusses load balancing with Software Defined Network. Section 3 discusses some related work to load balancing algorithms with SDN in wireless Sensor Network. We conclude our study in Section 4.

2. Load balancing with software defined network

Load balancing is important in networking.Load balancing is the method of improving the process efficiency by distributing a collection of tasks through a set of resources (memory, CPU capacities) with balancing work load. Loadbalancing is classified as two algorithms is Static and Dynamic algorithm. Static algorithm does not include the current state of the system for distribution of task. Dynamic algorithm takes the current state of the system for distributing work load (Anish Ghosh , Mrs. T. Manoranjitham 2018).A load balancer based on Software Defined Networks saves time by controlling an entire network of application and web servers. Without having to rely on algorithms specified by conventional network equipment, SDN controller load balancing allows data path control decisions. Load balancing in SDN identifies the optimal route and server for delivering requests as quickly as possible(Kavana H M , Kavya V B , Madhura B, and Neha Kamat,2018).Load balancing is a strategy for distributing workload across several resources in order to prevent any of the controllers from being overloaded. Load balancing targets include increasing throughput, reducing response time, and optimizing traffic. As a result, conventional load balancing methods are not precise, while SDN load balancing methods are more precise and have better efficiency.In Table I shows the difference of SDN with load balance and Traditional load balance.

TableI. Difference of Load Balance with SDN and Traditional Load balance

Traditional Load Balance	**Load Balance with SDN**
Changes in network need to configure Hardware devices,	No need to Configure hardware device,software will be programmed
Hardware is Expensive and inefficient	Software based efficient and inexpensive
Limitation in Quality of service and security	Quality of service and Security is highly accurate
NonProgrammable	SDN balancer are programmable

In SDN associated research, load balancing issue is one of the most important issuesbecause of industry concerns(T.L.Lin, C.H.Kuo, H.Y.Chang, W.K.Chang, andY.Y.Lin ,2016). Furthermore, since load balancing mechanisms are so critical in the SDN, no comprehensive and systematic study has been conducted in this area.Different methods of load balancing exist; these methods may be static, dynamic, or a combination of both. Static load balancing methods have the rule explicitly programmed in the load balancer; but, since user actions cannot be anticipated, static load balancing methods in a network can be inefficient.The dynamic methods are more efficient than the static methods because the load is distributed dynamically according to some pattern programmed in the load balancer(M. Karakus and A. Durresi,2016). The aim of static load balancing method is to reduce the execution time and minimize the contact delays. Round Robin Randomized, Central Manager and Min Min algorithms are the static load balancing algorithms.In dynamic load balancing algorithms, the work load is spread among the processors at runtime. The master assigns new processes to the slaves based on the new information obtained. Token routing, central queuing, and least link algorithms are the most common forms of dynamic load balancing algorithms (Gourav Shrivastava , Praveen Kaushik , R. K. Pateriya,2018).

In centralized network architectures, scalability, consistency, interoperability, and fault tolerance remain a challenge. However, the positive aspect of SDN is that it is centralized but highly flexible and programmable at the same time. The network programmability aspects of SDNs makes unique. Moreover, the SDNs support multiple distributed SDN controllers to be connected to a network serving as backup controllers in the time of a failure. Moreover, multiple controllers allow load sharing when a single controller is overwhelmed with numerous flow requests. Furthermore, multiple controllers can reduce the latency, increase the scalability and fault tolerance, and provide availability in SDN deployment. However, the main problem with this approach is to maintain the consistency among various distributed controllers. The network applications will be treated improperly by the distributed controllers because of inconsistency among the controllers concerning global view of the network states. In addition, multiple controllers create controller resource management problems, including controller state distribution, data sharing, consistency, and long propagation delay among multiple controllers which limits the network convergence time as well as affects the ability of the controller(Ahmed Abdelaziz, Ang Tan Fong, Abdullah Gani, Usman Garba, Suleman Khan, Adnan Akhunzada, Hamid Talebian, Kim-Kwang Raymond Choo,2017).In Large Scale network single controller is not able to control the network, so multicontroller is need to manage large network (Rahmatollah Andishmand, Hossein Mohammdi and Seyedakbar Mostafavi,2020).

3. Load balancing in wsn with software defined network

Load balancing is an efficient approach for balancing workload and extending the lifespan of properties. Local network knowledge is used to implement a load balancing strategy that distributes data traffic through various routes. In general, effective load balancing increases the efficiency of large-scale computer programmes and networks while also preventing overload. The load balancing approach also helps to optimize server-side resource utilization, reduce request processing time, and improve thescalability of the Sensor Network. In Table II show the importance of SDN with WSN to improve load balance in network.

SDN in combination with a wireless sensor network is a powerful combination. Sensor control server is in charge of SDSN. Reprogramming sensor nodes with the code that a user needs to be executed within the network is how a new task or function is deployed. SDSN has a feature to adjust the network configuration for functions, in addition to WSN's wide applicability(Luo T, Tan H.P, Quek T.Q.2012).

Table II. Differentiate WSN with SDN and WSN without SDN

Wireless Sensor Network Without SDN	Wireless Sensor Network With SDN
Control Decision is difficult	SDN Controller control the network
Distributed management make hard to control networks	Multi controller manages the network
In efficient and unpredictable network behavior	Efficient management and Resources Allocation
Security issues	Network scalability increased
Low power, Memory and computational	Low power consumption is maintained

In figure 1 shows SDSNs are classified as three layers to perform the functions. The first layer is Data plane (Physical layer) contains sensor nodes and software defined radio. The Second layer is Control plane (Networking Layer) contain SDN controller to transmit data in network. The Third layer is Application Layer contain application program to perform various task.

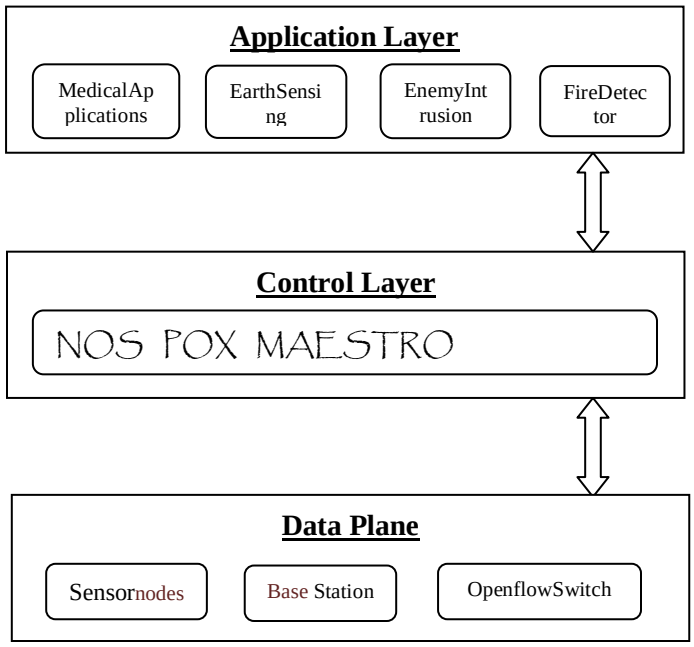

Fig 1.SDN Architecture

A collection of Sensor nodes in data plane is participating in local control not interacts with global controller. Different flow rules are programmed in controllers to improve the route optimization of communication and efficient load balance in WSN. The routing table is maintained by server to balance the transmission. Three different routing strategies are used to route the data transmission. They are proactive, reactive and hybrid(S.Saidaro,RAR Chandrasekhar,2017),(P.Kumar, M.P.Singh and U.S, Triar,2012). To ensure reliable and precise routing tables across all nodes of the network, the proactive approach, also known as table oriented, relies on periodic distribution of routing information. The network's layout can be either flat or hierarchical. Flat constructive routing schemes include the ability to choose the best routes. Wide ad hoc networks need hierarchical routing, which is best suited to fulfill their needs. On demand, reactive routing schemes provide routes to a small range of destinations. Usually, these methods do not preserve global knowledge across all network nodes. To create routes between a source and a destination, they must depend on a complex route scan. This usually entails flooding a path discovery question with responses going in the opposite direction. To achieve consistency and scalability in large networks, hybrid strategies depend on the presence of network structure. The network is grouped into mutually adjacent clusters in these methods, which are dynamically managed as nodes join and exit their assigned clusters. Clustering provides a framework for limiting the complexity of the routing algorithm's response to changes in the network context. Where proactive routing is used within a clusters and reactive routing is used across clusters, a hybrid routing approach may be used. The biggest challenge is to reduce the amount of time it takes to keep the clusters running(Jesus Antonio Puente Fernandez , Luis Javier Garcia Villalba , and Tai-Hoon Kim,2018).

In routing optimize the energy of node is important in WSN.Open flow Technology and SDN play a vital role to achieve on efficient load balancing in WSN network(Thabo Semong, Thabiso Maupong, Stephen Anokye, Gabanthone Boipelo, Seth Sarefo,2020).

Sensor Open Flow Extension SDN-WISE It uses SDN to make policy changes to WSNs made up of various provider sensor nodes easier. In SDN-WISE, multiple controllers (local controllers) and an additional one are included (global controller)(Galluccio, L. Milardo, S. Morabito, G. Palazzo, 2015).

SDEAR network is divided into clusters or zone and each zone is controlled by SDN controller to reduce the energy consumption in the network.It reduces routing requests by determining the best path for energy efficiency(Anuradha Banerjee, D.M. Akbar Hussain,2018).

It is difficult to achieve the criteria of stability and adaptability in traditional WSN load balancing techniques. Elman neural network enables load handling with SDWSN. The SDN controller is in charge of traffic scheduling and path optimization (XinCui, Xiaohong, Yan Ma and Qingke Meng ,2019).

4.Conclusion

Load balancing is a critical task in a Wireless Sensor Network to ensure that sensor nodes are used to their full potential. Static load balancing schemes make simulation and control of the environment easier. Dynamic load balancing algorithms are difficult to simulate, but they work best in an h Wireless Sensor Network environment. The level at which this static and dynamic algorithm is implemented is also important for determining the algorithm's effectiveness. Unlike centralized algorithm, distributed design of algorithm provides better fault tolerance but needs higher degree of replication and on the other hand, hierarchical algorithm divide the load at different levels of hierarchy with upper level nodes requiring for services of lower level nodes in balanced way.As a result, in a distributed dynamic load balancing techniques provide better efficiency. Software defined networks, on the other hand, will improve the efficiency of the Wireless Sensor Network.

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