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MULTI PATH ROUTING ALGORITHM USED FOR WIRELESS SENSOR NETWORK

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Abstract - Wireless sensor network WSNs consists of densely deployed sensor nodes, which have limited computational capabilities, power supply and computational bandwidth. These small, smart and inexpensive sensing and computing devices open new vista for scientists and engineers to observe and monitor physical phenomenon. Many works have been done through routing protocols that allow the sensor to distribute the data efficiently with limited energy supply. In this thesis, we propose a ovel routing algorithm to disseminate information via multiple path in static and energy constrained WSNs. The algorithm consists of distributed multipath search protocol and a load balancing algorithm. The multipath search protocol discovers multiple node disjoint path that connect a pair of sink and source node. The load balancing algorithm helps the sink node to allocate traffic over multiple paths found based on their cost which depends on the energy level and the hop distances of nodes along each path. We consider it as a key to improve the energy Efficiency in our protocol. The result is based on the use of ns2 simulator show that our algorithm can prolong the network life time by 9% to 18% and reduce the node energy consumption by a maximum of 34% over comparable schemes, including the energy aware routing, the directed diffusion, and the direct transmission. And these mechanism result in a significant improvement of Throughput, energy consumption and packet delivery ratio.

Keywords-WSNs, Load balancing algorithm, Energy efficiency, Network life time, Throughput

1. INTRODUCTION

1.1 Wireless Sensor Networks

Wireless sensor network WSNs consists of densely deployed sensor nodes, which have limited computational capabilities, power supply and computational bandwidth. These small, smart and inexpensive sensing and computing devices open new vista for scientists and engineers to observe and monitor physical phenomenon. The potential applications of sensor networks widely span both civilian and military domains. For military applications, wireless sensor networks can be used for surveillances in battle field. For civil applications, the sensor network can be used to monitor light, temperature, humidity, and other environmental factors that affect the habitat of endangered spices. Other applications of wireless sensor networks can be found. There are still many logical hurdles to overcome before wireless sensor networks can be widely deployed. The individual sensor nodes are resource constrained. They have limited battery resources processing capabilities and communication bandwidth. The ability to conserve power will determine their life time. An energy efficient and sensible routine protocol plays an essential role to facilitate data dissemination from the source node to the sink. The scalability assures that the size of sensor networks will not impact their functionality, as the number of nodes in the network varies from several hundreds to thousands. It also helps nodes to adapt various topological and geographical conditions, since nodes are deployed randomly. The energy efficiency on the other hand, alone sensor network stops long their life time, as sensor nodes can only carry limited energy supply. In summary, their characteristics of wireless sensor networks requirements and unique networking techniques to address these challenges. Depending on the networks structure adopted, the network routing protocols for wireless sensor networks can be classified in to flat network routing, hierarchal network routing, and location based routing.

1.2 Characteristics of Wireless Sensor Networks

a) Power consumption constraints for node using batteries or energy harvesting.
b) Ability to cope with node failures.
c) Scalability to large scale deployment.
d) Mobility of nodes.
e) Ability to withstand harsh environmental conditions.

1.3 Operating System of Wireless Sensor networks

Operating system of wireless sensor network nodes is typically less complex than general purpose operating system. They more strongly resemble embedded system, for two reasons. First, Wireless sensor networks are typically deployed with a particular application in mind, rather than as general platform.Second,a need of low cost and low power leads most wireless sensor nodes to have low power microcontrollers ensuring the mechanism such as virtual memory are either unnecessary or too expensive to implement. Operating systems also may track energy consumption. For this, both hardware- and software-based approaches have been developed. Quanto uses a hardware-based energy meter coupled with a software-based power state and activity tracking system for TinyOS.The total time and energy measurements are dissected and attributed to hardware peripherals or logical activities. Based on the cumulative energy information in the energy capsules, a power profile can be determined. The operating system must make the underlying network protocols possible to implement efficiently. We call
This communication architecture of the operating system and it performs memory allocation and management for message buffers, manages neighbor and address table, and provide an interface for application.

Operating systems for sensor networks share some characteristics with real-time operating systems for embedded systems. Like sensor network nodes, embedded systems also often have severe resource constraints. But unlike embedded systems, sensor network nodes must interact both with the physical world and with each other: sensor networks are highly communication intensive systems. This communication intensity adds additional challenges are in terms of resource management and operating system structure.

2. PROJECT DESCRIPTION

2.1 Definition & System Model

Wireless sensor nodes are distributed randomly in a field. Each sensor nodes carries a radio transmitter which has a fixed transmission range of R.We assume that the network is connect and dense. That is given an arbitarary pair of nodes, data can be sent from one node to another in a multi-hop manner. There exist multiple paths between a pair of nodes. We further assume each sensor node is stationary and contain an internal battery to support its sensing and communication activities. This battery can neither be replaced nor recharged. Furthermore, the transmitted power of the node is fixed for both the data transmission and reception. At any time, a sensor node m,m_1,2 ,…. M is able to acquire the residual energy level em, residual of its battery.

We define a path, which consists of K<M as a group of nodes that relay the data generated from the source node x to the sink node y.since we assume that the network is dense, it is possible to have multiple route between the source node x to the sink node y.In this case,it is possible to use multiple path routing instead of single path routing. We assume that the multiple paths are used disjoint.That is, the path A, which consists of k nodes, and the path B which consists of L nodes are two groups mutually exclusive except for the source node x and the sink node y.We define a link as an abstract representation of a radio connection established between two neighboring sensor nodes. A path A with K nodes therefore contains (K-1) links. Let N denote the neighbor set of node a, the sensor node a will choose the next hop by following the criteria defined below:

$$\textbf{Next hop} = \arg\min \{(1-e_b, \textbf{residual}/e_{b,}\ \textbf{init})\ [\beta\ [1-(\Delta d + 1)/d_{ay}])\}$$

Where d_{ay} - distance in hop between node a and sink node y
d_{by} - distance in hop between node b and sink node y
d - distance between d_{ay} and d_{by}
$e_{b,}$init - initial energy level of node b
$e_{b,}$residual - residual energy level of node b
β - weight factor, β > 1.

2.2 Protocol and Algorithm Used

2.2.1 Multi path search and Routing Protocol:

To discover alternative nodes disjoint path that connect the sink and the source node, we propose multipath search protocol which is distributed and scalable. In order to maintain the high energy efficiency and allow data transfer delay, the path selection is based on the evaluation of the node residual energy level and its neighbor distance to the destinations. The multipath\ routing protocol helps relaying data packet from source to sink over the newly discovered paths. It also allows a sink node to monitor the path condition in order to make the adjustment of traffic distribution in real time.

2.2.2 Load Balancing Algorithm:

We in introduce the term "Path cost" to reflect the cost of transmitting data with a unit rate through the path. It is obtained from an empirical measurement of the path, such as the residual and initial energy level of nodes along the path and their hop distance to the destination. The load balanced algorithm is applied at the sink node to distribute the traffic over the multiple path based on their "Path cost". The algorithm solves the optimize problem of traffic allocation to extend the network lifetime and main reasonable packet delay.

3. EXISTING SYSTEM

Most of the conventional routing schemes use a single path for data transmission between the sink and source nodes. A single node failure on the path will force the search of an alternate path, which is costly in terms of network resources. The existing multipath protocols still use only one primary path for data transmission and consider other alternative paths as backups. The energy saving is made by eliminating the route discovery when the primary path fails. The overall energy efficiency is not improved significantly compared with conventional single path routing protocols. We used different topologies and traffic patterns in our simulations and compared with other routing protocols, such as the energy-aware routing, the directed diffusion, and the directed transmission. EAR makes use of different paths and tends to balance the load by optimizing the residual energy. Hence, the system lifetime will be more than that obtained by using conventional routing protocols. The average node energy level in fixed intervals after the data transmission starts for three topology settings, with a data rate of 2 packets per second. We notice that the network size has an impact on the node energy level. The average node energy level decreases with larger network. .The shortest path algorithms are still used but with other carefully designed power-aware cost metrics instead of the simple hop count metric. We observe that in practical ad hoc network deployment there are some nodes that are powered by a source that is not critically limited in energy. DEAR that actively redirects the packets to the powered nodes for power-saving operations. MAC protocol is not optimal and better protocols will be investigated in the future. However, for low bit rate applications, the penalty of using this MAC protocol may not be severe.

3.1 Drawback of existing system

a) The single path routing is that it stresses a particular path and has a negative impact on the network lifetime.
b) The overall energy efficiency is not improved significantly in single path routing protocol compared to other conventional protocol.
c) Energy is wasted by collision, overhearing, control packet overhead, idle listening and reemitting.
d) Energy aware routing provide saving but it does not guarantee the better performance.
e) The most of single path and energy aware routing protocol does not increase or provide the better network life time.

4. PROPOSED SYSTEM

We proposed in this thesis a novel multipath routing scheme with objectives of increasing the energy efficiency and extending the network lifetime. Our scheme consists of a multipath search protocol and a load balancing algorithm. The multipath search protocol is distributed, which discovers node-disjoint paths that connect the sink and the source node. The major difference between our protocol and the conventional multipath routing protocols is that the data traffic is handled through multiple paths simultaneously, instead of using single optimal path. This allows us to take full advantage of the energy spent on the search of node-disjoint multipath. It also helps to avoid stressing one particular route and the premature partition of the network. The traffic rate at each route is allocated by the sink node via the load balancing algorithm, which performs the optimization based on the path conditions. In the following sections, we will conclude our work with our contributions and provide suggestions for future work.

4.1 Advantages

a) The energy efficiency has improved by using multi path routing protocol compared to single path routing protocol.
b) Multipath search routing protocol and load balancing algorithm provide better performance and better network lifetime.

5. CONCLUSION

We begin our thesis with an investigation on previous work done for routing and data dissemination schemes in mobile ad-hoc and wireless sensor networks. We have demonstrated that:

- Most of the conventional routing schemes use a single path for data transmission between the sink and source nodes. A single node failure on the path will force the search of an alternate path, which is costly in terms of network resources. Another drawback of the single path routing is that it stresses a particular path and has a negative impact on the network lifetime.

• The multipath routing is able to improve the reliability of the wireless sensor net-works, as alternate paths are made available in the initial phase. However, the majority of the existing multipath protocols still use only one primary path for data transmission and consider other alternative paths as backups. The energy saving is made by eliminating the route discovery when the primary path fails. The overall energy efficiency is not improved significantly compared with conventional single path routing protocols. We have proposed our multipath routing scheme to overcome the drawbacks found in the existing multipath protocols. The major achievements of our work are as follows:

• We propose a distributed multipath routing protocol, which searches multiple node disjoint paths. We introduce the "path cost" to reflect the cost of transmitting data with a unit rate through a path. It is updated constantly to allow the sink node to monitor and adjust the traffic distribution accordingly.

• The load balancing algorithm allocates the traffic rate to each path. It has the objective to extend the network lifetime and improve the energy efficiency by optimizing the load balance ratio.

We have evaluated the performance of our multipath routing protocol with the ns-2 simulator. We used different topologies and traffic patterns in our simulations and compared with other routing protocols, such as the energy aware routing, the directed diffusion, and the directed transmission. We demonstrated that our proposed protocol had a higher network lifetime with an average increase of 9% to 18% than the energy-aware routing. We also noticed that the multipath routing had better node energy consumption when the network size increases.

6. FUTURE WORK

In this thesis, we proposed a multipath routing protocol for wireless sensor networks. Further research work is required to enhance the performance of the protocol. They include:

• ***Data Aggregation:*** *Our multipath routing protocol does not include data aggregation. The future enhancement on data aggregation will make the protocol to be data centric and application aware. It will also allow further energy savings if the source nodes are close to each other and transmit the information collected for the same stimulus. The readings come from different source nodes will also be refined by data aggregation to make the data arrived at the sink node to be more accurate.*

• ***Mobility Support:*** *The multipath routing protocol we proposed applies for static sensor nodes. It will be useful to enhance the protocol to support nodes with limited mobility, as they are able to better adapt to the environment. A location update mechanism is required to allow each node to be aware of its own and its neighbors' positions constantly. It is a challenge to balance between the node energy consumption and the additional Maintenance efforts that keep the node coordinate updated.*

• ***Cross-Layer Optimization:*** *The communication between wireless sensor nodes is influenced heavily by the physical medium, as the quality of radio channels varies over time. By interacting our multipath with the IEEE 802.11 MAC layer, which provides various information about the state of radio connections, the path selection and Maintenance will be more accurate. The protocol can select route with better channel quality and avoid using path with unstable conditions. The load balancing algorithm will also be able to take the channel conditions into consideration, in order to further increase energy efficiency and network lifetime.*

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