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Fault Tolerant Middleware Multicast Routing In Wireless Sensor Network

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Abstract: Energy consumption, memory and throughput of nodes are crucial factor that constrains the networks life time for Wireless Sensor Networks (WSNs). These are challenges to optimize communication amongst a group of spatially distributed sensor nodes in a WSN (Wireless Sensor Network). There are several traditional approaches to overcome these challenges such as to apply clustering techniques to effectively establish an ordered connection of sensor nodes whilst improving the overall network lifetime. In this paper an improved clustering based multicast approach is proposed that allows any cluster head to be a multicast source with an unlimited number of subscribers, to optimize group communication in WSNs whilst ensuring sensor nodes do not deprecate rapidly in energy levels. Also several clustering approaches are reviewed and multicast versus broadcast communication in WSNs is examined.

Keywords: Wireless Sensor networks, multicast, subscribers, broadcast, clustering

I. INTRODUCTION

Traditional networking involves communications between two end systems. However, important emerging applications like IPTV, remote teaching or videoconference, require simultaneous communication between groups of users.

Multicast protocols can offer several benefits. The use of a set of point-to-point channels to support a virtual multicast environment results in a complex and inefficient process, mainly in wide area networks. When a source needs to transmit a message to *n* receivers using point-to-point channels, it is necessary to transmit the same message *n* times. In the case of IPTV, where the number of receivers is extremely high, this is not only technologically impossible but also the required resources are prohibitive.

Sensor networks offer a powerful combination of distributed sensing, computing and communication. They lend themselves to countless applications and, at the same time, offer numerous challenges due to their peculiarities, primarily the stringent energy constraints to which sensing nodes are typically subjected. Energy efficiency is crucial because of the scale and application environments in which sensors are deployed. The network topology of WSN affects the network connectivity and organization, hence affecting various performance metrics such as communication, network scalability, reliability, data latency, energy efficiency and network life time. Therefore, current research depicts customized domain-specific WSN topologies for efficient utilization of their constrained resources.

The emergence of applications with inherent multicast requirements led to the development of native multicast protocols. In the case of IP networks, multicast support was typically based on the Internet Group Management Protocol (IGMP) [Fenner1997] to announce hosts interested in receiving multicast information, and on Protocol-Independent Multicast – Sparse Mode (PIM-SM) [Estrin1998], Multicast Border Gateway Protocol (MBGP) [Bates2000] and Multicast Source Discovery Protocol (MSDP) [Fenner2003] to route multicast messages between core routers.

With the increasing demand for multicast support, new protocols were proposed. The most promising protocol is the Source-Specific Multicast (SSM) protocol [Bhattacharya2003]. According to this protocol, when a host decides to join a multicast group it is necessary to specify not only the IP multicast address, as usual, but also the source address or a list of source addresses that the node joining the multicast sessions accepts to receive information from. This source identification significantly reduces the routing complexity. However, as shown in [SaSilva2005], SSM has several limitations when applied to mobile environments. Recent advances in wireless communications, electronics and miniaturization supported the development of a new generation of multi functional, low-cost sensor nodes. These new sensor nodes, with control components and communication functionality, are at the base of the development of Wireless Sensor Networks (WSNs).

Wireless Sensor Networks are composed by a set of several nodes which can cooperate in order to perform certain measurements and tasks, and can re-organize themselves in an ad-hoc way. Typically, sensors collect ambient measurements, process them and transmit them to a sink node.

The applicability of WSNs is becoming very high, and although some approaches have already been proposed, it is crucial to evaluate if:

- » multicast can be useful for the next generation Internet, which will integrate WSNs,
- » the current multicast protocols are well prepared for WSN environments.

The wireless networking environment presents imposing challenges to the study of broadcasting and multicasting problems. Developing an algorithm to optimize communication amongst a group of spatially distributed sensor nodes in a WSN (Wireless Sensor Network) has been met with a number challenges due to the characterization of the sensor node device. These challenges include, but are not limited to: energy, memory, and throughput constraints. The traditional approach to overcome these challenges have emphasised the development of low power electronics, efficient modulation, coding, antenna design etc., it has been recognised that networking techniques can also have a strong impact on the energy efficiency of such systems. A variety of networking based approaches to energy efficiency are possible. One of the well-known approaches is to apply clustering techniques to effectively establish an ordered connection of sensor nodes whilst improving the overall network lifetime. The proposed system has an improved clustering based multicast approach that allows any cluster head to be a multicast source with an unlimited number of subscribers, to optimize group communication in WSNs whilst ensuring sensor nodes do not deprecate rapidly in energy levels.

II. Survey of Literature

Olutayo Boyinbode, Han le, et al, focused mostly on distributed clustering approaches they are more suitable for large-scale sensor networks and effective approach to provide better data aggregation and scalability for large WSNs. Clustering is most suitable for large scale wireless sensor networks and a useful topology management approach to reduce the communication overhead and exploit data aggregation in sensor networks. There exists a large number of clustering algorithms and some are reviewed in this paper. We have focused mostly on distributed clustering approaches, because they are more suitable for large-scale sensor networks. However energy consumption during cluster formation and maintenance is still high; the compelling challenges for clustering algorithms are how to schedule concurrent intra-cluster and intercluster transmissions, how to compute the optimal cluster size, and how to determine the optimal frequency for cluster head rotation in order to maximize the network lifetime. But energy consumption during cluster formation and maintenance is still high.

Chengfa Li, Mao Ye, et al a novel energy-efficient clustering mechanism for WSNs. The hot spots problem appears when employing the multihop routing in a clustering approach. They argue that both the rotation of cluster heads and the metric of residual energy are not sufficient to balance the energy consumption across the network. To address the problem, They first introduce an unequal clustering mechanism to balance the energy consumption among cluster heads. Clusters closer to the base station have smaller sizes than those farther away from the base station, thus cluster heads closer to the base station can preserve some energy for the purpose of inter-cluster data forwarding. What’s more, They propose an energy-aware multihop routing protocol for the inter-cluster communication.[6]

J. Sá Silva, T. Camilo et al addressed both the use of IPv6 and the use of multicast in WSNs. Multicast in IP networks is based on the concept of group. An arbitrary set of receivers express their interest in receiving a particular data stream. This group does not have any specific physical or geographical boundaries. Hosts that are interested in receiving packets sent to a particular multicast group must join the group using Internet Group Management Protocol (IGMPv3) [Cain2002] or Multicast Listener Discover (MLDv2) [Vida2003], for IPv4 and IPv6, respectively. These protocols manage the communication between hosts and routers. Each router maintains a list of active members per multicast group in its sub-network. middleware scenarios, each node will have installed only the components that it requires, from a group of components. For instance, it may be necessary to support some security mechanisms in some nodes while other nodes, from the same group, may need mobility support. For these scenarios it will be necessary to group the nodes with the same requirements in the same multicast group. The results clearly show that WSNs can greatly benefit from both. Specifically, multicast leads to reductions in the number of transmitted packets and, consequently, in energy consumption. In fact, WSNs may become the next successful field of multicast deployment, in addition to the emerging field of IPTV.[5]

Krishna Doddapaneni, Enver Ever, et al path-loss is introduced, increasing the transmission power is needed to reduce the amount of packets lost. Path loss is the attenuation in power density of an electromagnetic wave as it propagates. Path loss is consequence of many effects such as free-space loss, refraction, diffraction, reflection, aperture-medium coupling loss, and absorption. Path loss is also affected by other factors such as propagation medium (dry or moist air), the distance between the transmitter and the receiver, and the frequency of the signal. When the effects of path loss are not considered, the evaluation of underlying structure can become optimistic, since the problems associated, retransmissions and the way this phenomena affects the energy consumption are not taken into account. In our approach a path loss model can be specified by the user. This model is used together with the physical environmental model in order to define the path loss between two nodes. In this paper we consider indoor environment and the dependant path loss model. This is one of the most commonly used path loss models that defines the behaviour of signal strength in an indoor area. The path loss behaviour is dependent on the distance between nodes and the attenuation factor added by the objects. This presents a tradeoff between the residual energy and the successful transmission rate when more realistic settings are employed for simulation. But the network life time is not that much improve.[1]

III. Proposed System

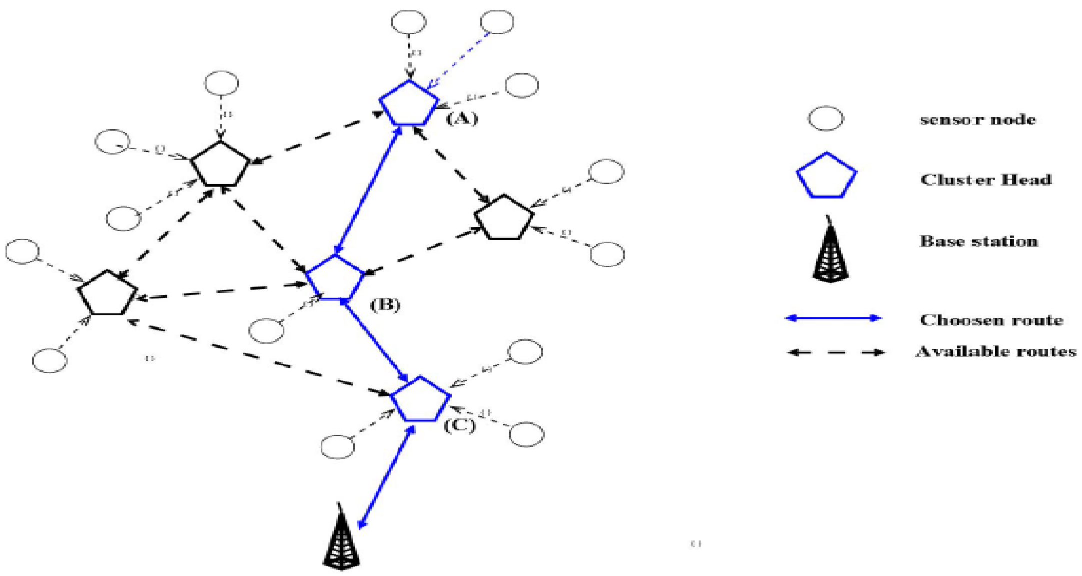

Fig. 1 Extended view of proposed system

1. Interested CH initiates the multicast data transfer, sends a unicast join message to the source CH of the multicast containing the source-group pair (*S*,*G*).

2. Source CH receives a valid join message, responds with a join acknowledgement unicast back to the subscriber.
3. Continues to send the join messages until a join acknowledgement is received or the subscription fails after maximum attempts.
4. Once the CH receives join acknowledgement, it becomes a subscriber to the specified multicast.
5. The multicast source and every CH on the path to the unicast destination of the join acknowledgement stores the address of the next hop towards the destination.
6. These CH's are now subscribers to the multicast (*S*,*G*), and the information is used to forward multicast data packets sent from that (*S*,*G*).

Figure 1 illustrates cluster head "A" joining cluster head Ns multicast. The unicast join acknowledgement messages are indicated by the arrows. Each CH along the path of the join acknowledgement (D, E, and J) updates their local subscription list. For example, cluster head E stores that it must forward multicast packets from N to D. The acknowledgement messages may take different paths (as shown in figure 1). Data flows along the path of the join acknowledgement. Cluster head D then forwards N's multicast packets to cluster head A. If multiple cluster heads subscribe to N's multicast, paths to each subscriber are created using the same process. Only one packet is transferred along paths shared by multiple subscribers. This approach can result in optimal, energy efficient and reliable multi casting but is not scalable as it incurs high communication overhead when the number of nodes in the network is very large.

IV. Conclusion

Here we have proposed an fault tolerant middleware multicast routing in wireless sensor network. The proposed scheme can significantly reduce energy consumption and increase the lifetime of the network compared to the existing schemes. It also allows any CH to be a multicast source with an unlimited number of subscribers, to optimize group communication in WSNs whilst ensuring sensor nodes do not deprecate rapidly in energy levels, hence able to mitigate the hotspot problems in WSN and also to enhance better performance in terms of connectivity, reliable packet delivery, low latency and life time of the network.

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