Scope International Journal of Science, Humanities, Management and Technology. ISSN : 2455-068X

Vol.3 Issue 4 (2017) 54 - 58. Submitted 01/11/2017. Published 12/12/2017

CODE- BASED NEIGHBOR DISCOVERY PROTOCOLS IN MOBILE WIRELESS NETWORKS

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Abstract:

Underwater Acoustic Sensor Networks (UASN) consisting of sensor nodes and underwater gateways (routers) have wide variety of applications, which include environmental monitoring, scientific exploration, surveillance etc. Ad hoc nature of these networks in terms of mobility due to water current pose challenges in topology management. Neighbor discovery is an important issue in topology management which is required to auto configure the node addresses, and establish communication links among the nodes to perform routing management. The media access control (MAC) protocol may utilise the neighbor discovery information to decide the accessibility of the media by nodes so as to reduce the delays and increase throughput. Thus, there is a necessity of integrating MAC protocol and neighbor discovery mechanism in UASN. In this paper, we describe the architectural elements of neighbor discovery protocol module implementation in NS3. The implementation models surface and underwater interactions, mobility, and channel conditions required for network level simulation. The module implements two main classes namely, NeighborDiscoveryProtocol and NeighborDiscoveryCache, which enable the protocol interactions. We present the preliminary results from implemented module using NS3.

Keywords: Direction of arrival estimation, neighbor discovery protocol implementation, underwater acoustic networks.

1. INTRODUCTION

Around two-third surface of earth covered by oceans has received considerable interest in the field of underwater acoustic networks from the research community for its potential information. The Ad hoc Underwater Acoustic Sensor Networks (UWASNs) consists of a variable number of sensors and vehicles that are deployed to perform collaborative monitoring tasks over a given area [1]. The potential applications are in field of monitoring oceanic environments for scientific, security, military needs and monitoring the strong influences and impact of climate regulation such as temperature, salinity and wave pressures, nutrient production, oil retrieval and transportation. The development of low cost, low size, light weight sensor nodes and the improvement in the methods of deployment of these devices physically near the objects of interest brings new opportunities for the researchers to collect and analyse the data for human benefit. The environment of underwater poses many challenges in terms of the bandwidth, node mobility, neighbor discovery, error rate, propagation delay, the network operation begins only after each node has discovered its neighbors and established the paths to the other nodes even when the nodes have no knowledge of their neighbor's IDs or locations. The objective of Neighbor discovery protocol is to inform the neighbor's identity and build the routing tables that can be further utilized by the network layer to establish the communication path. Neighbor discovery is the process by which a node in a network determines the total number and identity of other nodes in its vicinity. It is a basic building block of many protocols including localization, routing, and cluster management. Also network layer algorithm and many media access control mechanisms rely on accurate neighbor information. Neighbor discovery is especially important for proper functioning of wireless networks.

The proposed neighbor discovery uses the directional sectored antennas for the transmission and reception of the frames. The best estimate of received signals is computed using the various Direction of Arrival (DOA) algorithms [3] for discovery. The advantage of using the DOA estimation is that the neighbors linked with high link quality are estimated and thus network throughput will be improved. Directional antennas have a number of advantages [4] over omni-directional antennas for ad hoc networking. By focusing energy only in the intended direction, directional antennas significantly increase the potential for spatial reuse. They provide a longer range and/or more stable links due to increased signal strength and reduced multipath components. Increased spatial reuse and longer ranges translate into higher ad hoc network capacity (more simultaneous transmissions and fewer hops), and longer ranges also provide richer connectivity. Further, since the spatial signature of the energy is reduced to a smaller area, chances of eavesdropping are reduced, and with “smart” antennas, steering of nulls allows suppression of unnecessary interference (such as jammers). However, unlike sensors with omnidirectional antenna sensors with directional antenna take longer time to discover their neighbors [5]. This is because although sensors may be within transmission range, the sender/receiver sensor may not necessarily be located within the given sector determined by the beaming antenna of the transmitting sensor.

2. RELATED WORK

Neighbor discovery has been extensively investigated for radio networks, but work in the field of underwater acoustic networks is extremely scarce. In this section, we briefly review the work related to neighbor discovery protocols. Efficient neighbor discovery algorithms in a synchronous network of sensors employing directional antenna with identical transmission authors provide deterministic and randomized algorithms to accomplish neighbor discovery. A decentralized node discovery procedure for an underwater acoustic network is proposed in [8] in which the nodes use random access and transmit at the minimum power level required to reach a particular neighbor. If the neighbors are not reachable with the present power level, the power level will be increased and the process is repeated for node discovery. Power control is implemented in discrete levels and accounts for both the distance-dependent transmission loss and the channel fading. The authors assume that the nodes are deployed over a possibly large area that cannot be spanned in a single hop within the constraints of a finite power budget. The nodes operate in a distributed manner, that is, without a central station of the channel access and a random access environment. The goal is to design a protocol that is efficient in terms of energy consumption as well as the time it takes to complete. A specific neighbor discovery procedure based on polling by a master node in a centralized configuration for an underwater acoustic network is discussed in [9]. The channel access was regulated through code division-multiple access. The exhaustive works have been carried out for node discovery in the terrestrial sensor networks. The work in [6] proposes a Polling based MAC protocol (PMAC) for mobile ad hoc networks. The PMAC exclusively uses directional antennas for transmission and reception of all the frames, the protocol facilitates the discovery of one-hop neighbors. Polling is also used to schedule the transmissions and receptions of information. The transmitter and receiver nodes point their antenna beams towards each other and carry on the communication exclusively in directional mode. A cross-layer approach to integrate neighbor discovery with the MAC protocol stems from the close interaction and dependence between the two functionalities. The authors discuss the inability of exclusively using directional antennas for both the transmission and reception of all MAC layer frames (control or data). A few of the works have been discussed as follows. The usage of directional antenna for the improvement of MAC.

3. PROPOSED SYSTEM

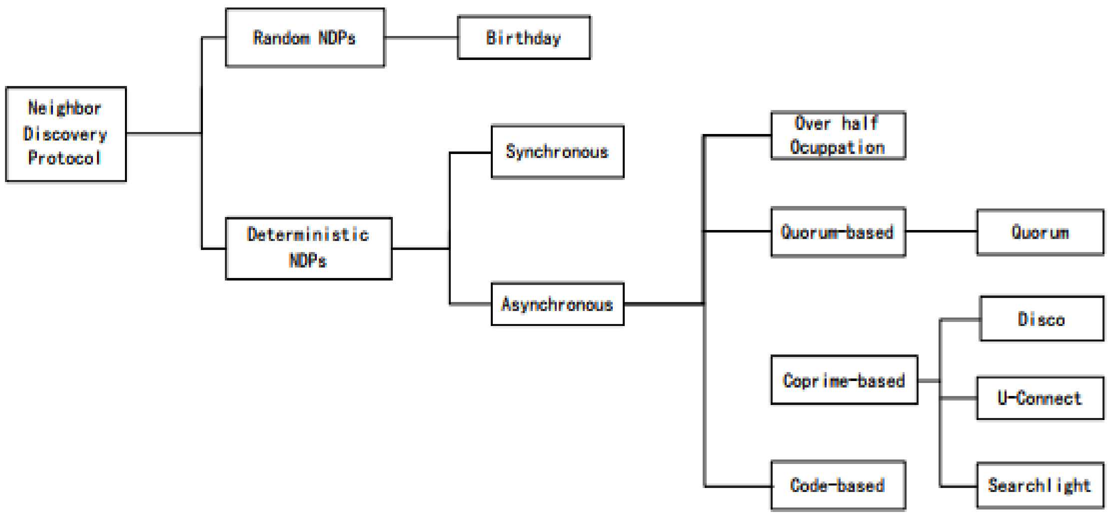

Fig.1.Proposed Analysis

In quorum protocol, time is divided into m2 consecutive slots, arranging as a m×m array. Each node picks one column and one row. This pattern of slot schedule ensures that no matter which row or column is chosen, any two nodes can have at least two time slots overlapped. Quorum-based protocols provide a reasonable bound for the worst-case discovery latency. But compared with random protocols, it performs worse in the average case. Because m is a global variable, the origin quorum protocol can only support symmetric duty cycle operation. Lai et al. gives an improvement for asymmetric duty cycle operation when there are two different schedules in the total network. But only two duty cycle scheme cannot meet the requirement of real environment. Compared with quorum, prime-based schemes can support asymmetric neighbour discovery when they choose different prime pairs. In Disco, node chooses a pair of primes and the sum of their reciprocal equals the target duty cycle. When the counter is a multiple of either prime, the node turns awake. This schedule provides a deterministic discovery latency which is better than Quorum and Birthday protocols in the asymmetric duty cycle case. However, there exists a key problem that we can select primes for symmetric case or primes for asymmetric case, but we cannot select primes that are suitable for both cases. If we choose the same unbalanced pair of primes for the nodes, the worst-case latency will be very large.

Neighbour discovery protocols in low duty cycled wireless sensor networks have four basic requirements. First, distribution. While centralized services can provide much of the support, but it must be limited in the connection between nodes and central server and it will bring big discovery latency and energy consumption. Second, asynchronous. The need to synchronize between nodes, like GPS, may introduce high energy consumption and reduce the lifetime of battery. Third, deterministic. Random methods may lead to random length of discovery latency. In this case, a node may lose the chance to interact with other neighbour nodes. Fourth, symmetric and asymmetric duty cycle. Different nodes may have different tasks and remain with different battery life, so they choose different duty cycles in the discovery process.

4. ANALYSIS

Therefore, nodes must rely on distributed asynchronous neighbour discovery method and each node ought to have independent deterministic active-sleep pattern. After the above analysis, to meet the four requirements is a prerequisite for real applications. Currently, neighbour discovery protocol proposed for WSN is not mature.

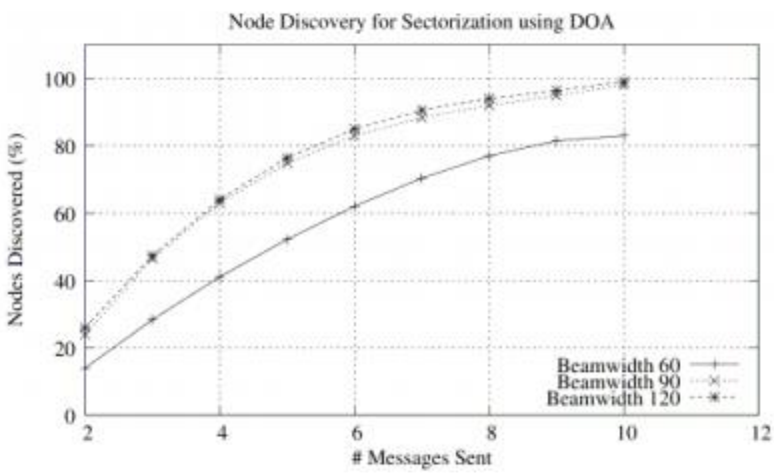

Fig.2.Analysis Output

Though these protocols can achieve good performance in theoretical analysis, they need adjustment in real deployment because of a series of factors, for example, the node density of the deployment region, the size of time slot, whether the node is moving or not. Therefore, that how to build a more robust neighbour discovery protocol in the real environment should get more attention. To study the NDPs together with actual platform has a greater significance. The performance of the neighbor discovery protocol is evaluated using the simulation. The simulations were run with NS3 for underwater networks. The scenario considered for simulation consists of sensor nodes and mobile nodes randomly deployed with the grid boundaries of 500m by 500m with a depth of 1000m. The mobility model chosen was the Random Waypoint mobility model with a vertical speed of 0.2 - 0.4 m/s, the movement duration of 20 seconds and pause time of 5 seconds.

CONCLUSION

The paper presented the implementation design architecture of novel neighbor discovery protocol which utilizes DOA feedback. The design discusses the development of two main classes namely NeighborDiscoveryProtocol and NeighborDiscoveryCache. The protocol operations are also presented describing the functionality of the protocol including discovery procedures, rediscovery procedures (response to failure events and unreachability detection). The NDP module developed for NS3 is used to simulate the process of neighbor discovery in both static and mobile node scenarios. In both scenarios, the node deployments are randomly generated and the network performance results averaged over multiple simulation runs are presented. The results demonstrate a significant performance improvement of DOA-NDP over existing mechanisms.

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