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A Review on MANET and WSN

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Abstract: *A mobile ad-hoc network (MANET) is a self-configurable network where nodes are connected by wireless links, can move freely and thus the topology of the network changes constantly[1].*

Sensor network have various nodes distributed randomly in a particular area to monitor physical and environmental conditions[4]. Mobile Ad hoc Networks (MANETs) as well as Wireless Sensor Networks (WSNs) suffer from various challenges like low bandwidth, overhead and velocity of nodes. This research contribution is the characterization study between MANETs and WSNs environment with respect to various routing protocols. MANETs and WSNs are auto configurable networks of nodes connected by wireless links, where resources are scarce, and where traditional protocols and networking algorithms are inadequate[1][2]. In this paper we review about the design issues of both type of networks,routing protocols and comparative analysis between these two type of network.

Key word: *MANET, WSN, Routing protocol*

Section I. Introduction:

Mobile Ad-hoc Network (MANET) is an autonomous collection of mobile users that communicate over relatively bandwidth constraint wireless networks. Topology changes rapidly and unpredictably because nodes are mobile.fig 1.

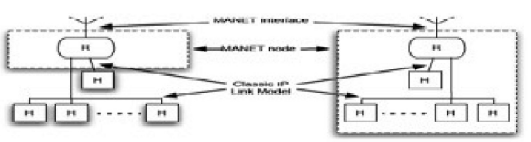

Fig 1: MANET

A sensor network [1][4] is a network of many tiny disposable low power devices, called nodes, which are spatially distributed in order to perform an application-oriented global task. These nodes form a network by communicating with each other either directly or through other nodes. One or more nodes among them will serve as sink(s) that are capable of communicating with the user either directly or through the existing wired networks.[2].

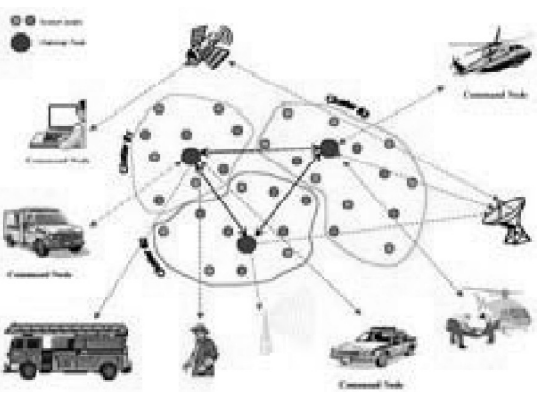

Fig 2 WSN

Section ii gives the characteristics, Design issues, applications of MANET and section iii describes the characteristics, Design issues, Applications of WSN. Section iv discuss the protocol stack for MANET and WSN, Section V gives overview about the similarities and dissimilarities between two type of network and last section conclude about the paper.

Section II. MANET

MANET is a collection of independent mobile nodes which communicate with each other through radio waves. If no direct link exists between the source and the sink then multi-hop routing is used i.e. packets are forwarded using various techniques. They can be setup anywhere without the use of infrastructure.[1]

2.1 Features of MANET

Some salient features of MANETs are as follows:

- Rapidly deployable, self-configuring
- Wireless links
- Multihop communication (basically nodes communicating to fixed infrastructure)
- specific purpose
- Autonomous
- No access point required
- Nodes act both as host and router
- Dynamic network topology.
- Autonomous, no infrastructure required.
- May be set up anywhere.
- Limited security.
- Energy constraints.

2.2 Application:

- Rescue operation
- Military
- Home networks
- Conferencing
- Law enforcement and Security operation.

2.3 Design issues for MANET

- **Energy-constrained operation**: Nodes are battery operated in MANETs. Thus energy conservation is of utmost importance.[2]
- **Limited physical security:** MANETs are more prone to physical security threats like - eavesdropping, spoofing, denial-of service etc.[3]
- Bandwidth-constrained, variable capacity links Wireless links will continue to have significantly lower capacity than their hardwired counterparts. In addition, the realized throughput of wireless communications—after accounting for the effects of multiple access, fading, noise, and interference conditions etc. is often much less than a radio's maximum transmission rate.

Section III. WSN

Wireless sensor networks is composed of large number of nodes that have capabilities to sense their surroundings, perform computations and communicate wirelessly to their neighbor nodes and base station.WSNs are power efficiency, flexibility, robustness, security, time synchronization, size and cost.[4][5]

3.1 Characteristics of WSN

- Power consumption constraints for nodes using batteries or energy harvesting.
- Ability to cope with node failures (resilience)
- Mobility of nodes.
- Heterogeneity of nodes.
- Scalability to large scale of deployment.
- Ability to withstand harsh environmental conditions.
- Ease of use.

3.2 Design Issues

1 Energy Consumption

Sensor nodes are equipped with battery that is used as their energy source. The sensor network can be deployed in hazardous condition so it becomes difficult recharging or changing batteries. The energy consumption depends upon major operations of the sensor nodes which are sensing, data processing, communication. The large amount of energy is consumed during communication.[6]

2 Localization

Sensor localization is a fundamental and critical issue for network operations and management. The sensor nodes are deployed in ad-hoc manner so they do not have any information about their position. The problem of determining the physical location of the sensors after they have been deployed is called localization. This problem can be solved by beacon nodes, GPS, proximity based localization. [7]

3 Coverage

It says how well an area of interest is controlled as traced by the sensor. These Sensor nodes use coverage algorithm to sense data and send them to sink using routing algorithm. For the good coverage, sensor nodes must be selected in such a manner so that whole network should be covered.[6]

4 Clocks

Clock synchronization is a critical service in WSN. The goal of time synchronization is to provide a common timescale for local clocks of nodes in sensor networks. Clocks ought to be synchronized in some applications such as tracking and monitoring. [4,8]

5 Computation

The amount of data proceeds by every node is called computation. The major problem in computation is that it should minimize the use of resources. If the lifetime of base station is more critical then data processing can be completed at every node before sending data to base station. In case when we have few resources at every node then entire computation must be done at sink.

6 Production Cost

As we know, large numbers of nodes are deployed in the sensor networks, so if the cost of a single node will be very high then we can assume the overall cost of the network will also be very high. Eventually, the cost of every sensor node has to be kept low. So cost of each sensor node in the network is a challenging issue.

7 Hardware Design

While designing any hardware of sensor network, it must be energy-efficient. Hardware such as power control, micro-controller, and communication unit should be design in such a way that it consumes less energy.

8 Quality of Service

QOS means data should be delivered within time period. There are some real time sensor applications that are based on time i.e. if data should not be delivered on time to the receiver from the moment it is sensed; data will become useless. There is various quality of service issues in sensor networks such as network topology may change continually and the available state information for routing is constitutionally imprecise.[4,5,7]

3.4 Application of WSN:

- WSNs are applicable for environmental data collection
- security monitoring
- sensor node tracking.
- Targeting

Section IV : Protocol stack for MANET And WSN

4.1 Protocols for MANET

A routing protocol is used to transmit a packet to a destination via number of nodes and numerous routing protocols have been proposed for such kind of ad- hoc networks. Basically, routing protocols can be broadly classified into three types as:[13,14]

Proactive protocols In networks utilizing a proactive routing protocol, every node maintain one or more tables representing the entire topology of the network. These tables are updated regularly in order to maintain up-to-date routing information from each node to every other node. To maintain up-to-date routing information, topology information needs to be exchanged between the nodes on a regular basis which in turn leads to relatively high overhead on the network. The advantage is that routes will always be available on request.[14]

AODV (Ad-hoc On Demand Distance Vector)

AODV is reactive or on demand routing protocol, uses bi-directional links, uses route discovery cycle for route finding and provides unicast and multicast communication. AODV enables dynamic, selfstarting, multi-hop routing between mobile nodes wishing to establish and maintain an ad-hoc network. It allows for the construction of routes to specific destinations does not require that nodes keep these routes when they are not in active communication

Reactive protocols Unlike proactive routing protocols, reactive routing protocols do not make the nodes initiate a route discovery process until a route is required. This leads to higher latency than with proactive protocols, but lower overhead. [12,13,14]

DSR (Dynamic Source Routing Protocol)

DSR is also reactive or on demand routing protocol, no periodic activity, utilizes source routing and supports unidirectional links. It includes source routes in packet headers. DSR is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad-hoc networks of mobile nodes. DSR allows network to be completely selforganizing, self-configuring, without the need for any existing network infrastructure and administration. It manages Route Discovery and Route Maintenance mechanisms. DSR is specially designed for MANETs and to work well in high mobility. DSR operates entirely on demand, with no period activity of any kind required at any level within the network.[16]

Hybrid routing protocols every node acts reactively in the region close to its proximity and proactively outside of that region, or zone. It was proposed to reduce the control overhead of proactive

routing protocols and also decrease the latency caused by route discovery in reactive routing protocols. Hybrid routing protocols are ZRP (Zone routing protocol) and TORA (Temporarily Ordered Routing Algorithm).[13,14]

ZRP (Zone Routing Protocol)

ZRP combines advantages of table driven and on demand driving protocol. According to the application it selects the method. It uses table driven method to communicate in node's local neighbourhood, which is known as Zone of that node and uses on demand method when node had to communicate outside its zone. ZRP divides surrounding in different zones with different radius, which overlap each other.[15]

4.2 Protocols for WSN:

Routing protocols designed for WSNs are more datacentric or geocentric. In data-centric routing, the sink sends queries to certain regions and waits for data from the sensors located in the selected regions. Since data is being requested through queries, attribute based naming is necessary to specify the properties of data. Here data is usually transmitted from every sensor node within the deployment region with significant redundancy. In location aware routing nodes know where they are in a geographical region. Location information can be used to improve the performance of routing and to provide new types of services.In QoS based routing protocols data delivery ratio, latency and energy consumption are mainly considered. To get a good QoS (Quality of Service),the rooting protocols must posses more data delivery ratio, less latency and less energy consumption.[4,5]

We can classify the protocols whether they are operating on a flat topology or on a hierarchical topology. In Flat routing protocols all nodes in the network are treated equally.[7] When node needs to send data, it may find a route consisting of several hops to the sink. A hierarchical routing protocol is a natural approach to take for heterogeneous networks where some of the nodes are more powerful than the other ones. The hierarchy does not always depend on the power of nodes. In Hierarchical (Clustering) protocols different nodes are grouped to form clusters and data from nodes belonging to a single cluster can be combined (aggregated).The clustering protocols have several advantages like scalable, energy efficient in finding routes and easy to manage.[9,11]

- **SPIN** (Sensor Protocols for Information via Negotiation): SPIN is data centric routing protocol sends data to sensor nodes only if they are interested. The SPIN protocols are resource aware and resource adaptive. The sensors running the SPIN protocols are able to compute the energy consumption required to compute, send, and receive data over the network. Thus, they can make informed decisions for efficient use of their own resources. The SPIN protocols are based on two key mechanisms namely *negotiation* and *resource adaptation.* SPIN enables the sensors to negotiate with each other before any data dissemination can occur in order to avoid injecting non-useful and redundant information in the network. [4]
- **LEACH** (Low Energy Adaptive Clustering Hierarchy): forms clusters to minimize energy dissipation. It is the first and most popular energyefficient hierarchical clustering algorithm for WSNs that was proposed for reducing power consumption. In LEACH, the clustering task is rotated among the nodes, based on duration. Direct communication is used by each cluster head (CH) to forward the data to thebase station (BS). It uses clusters to prolong the life of the wireless sensor network. LEACH is based on an *aggregation* (or *fusion)* technique that combines or aggregates the original data into a smaller size of data that carry only meaningful information to all individual sensors.[6]

Location based routing:

- **GEAR** [9] (Geographic and Energy Aware Routing): It uses energy aware and geographicallyinformed neighbor selection heuristics to route a packet towards the destination region. The key idea is to restrict the number of interests in directed diffusion by only considering a certain region rather than sending the interests to

the whole network. By doing this, GEAR can conserve more energy than directed diffusion.[7]

- **GEM [10]:** It makes use of a virtual polar coordinate system to align with the actual network topology. The nodes in the network form a ringed tree whose root is a convergence node. Each node is denoted with the number of hops to the root of the tree and a virtual angle range, and the node to- node routing is denoted with a ringed tree.[9][10]

Section V

5.1 MANET Vs WSN:[4,5,7,11]

Even though sensor networks are a special type of ad hoc networks, the protocols designed for ad hoc networks cannot be used as it is for sensor networks due to the following reasons:

1) The number of nodes in sensor networks is very large and has to scale to several orders of magnitude more than the ad hoc networks and thus require different and more scalable solutions.
2) The data rate is expected to be very low in WSN and is of statistical in nature. But mobile ad hoc network (MANET) is designed to carry rich multimedia data and is mainly deployed for distributed computing.[12]
3) A sensor network is usually deployed by a single owner but MANET is usually run by several unrelated entities.
4) Sensor networks are data centric i.e. the queries in sensor network are addressed to nodes which have data satisfying some conditions and unique addressing is not possible as they do not have global identifiers. But MANET is node centric, with queries addressed to particular nodes specified by their unique addresses.[11]
5) Sensor nodes are usually deployed once in their life time and those nodes are generally stationary except a few mobile nodes, while nodes in MANET move in an ad hoc manner.
6) Like MANET sensor nodes are also designed for self configuration, but the difference in traffic and energy consumption require separate solutions. In comparison to ad hoc networks, sensor nodes have limited power supply and recharge of power is impractical considering the large number of nodes and the environment in which they are deployed. Therefore energy consumption in WSN is an important metric to be considered.
7) Sensor networks are application specific. One can't have a solution that fits for all the problems.
8) Simplicity is the rule in the WSN. Since sensor nodes are small and there is restriction on energy consumption; the communicating and computing software in the nodes should be of less size and computation efficient than the traditional software used for the same purpose.

5.2 Similarities

1) Probably the main reason why WSNs immediately resemble an ad hoc network is because both are distributed wireless networks (i.e., there is not a significant network infrastructure in place).
2) The routing between two nodes may involve the use of intermediate relay nodes (also known as multihop routing).[6]
3) it is also the fact that both ad hoc and sensor nodes are usually battery powered and therefore there is a big concern on minimizing power consumption.[11]
4) Both networks use a wireless channel placed in an unlicensed spectrum that is prone to interference by other radio technologies operating in the same frequency. Finally, self-management is necessary because of the distributed nature of both networks.[8]
5) Wireless ad hoc networks were developed in the early 70´s with the US military as the main customer. Three decades later when commercial applications based on ad hoc technology are finally emerging, [9]

Section VI

Conclusion: Both the type of ad-hoc Networks hold a lot of promise in applications where gathering sensing information in remote locations is required. It is an evolving field, which offers scope for a lot of research. Moreover, unlike MANETS, sensor networks are designed, in general, for specific applications. Hence, designing efficient routing protocols for sensor networks that suits sensor networks serving various applications is important. In this paper, we overviewed the challenges and promising system concepts in MANETs and WSNs.

We discussed various types and routing in MANET and WSN. They have many similarities and many differences.

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