A Survey on WSN and MANET

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ABSTRACT: Communication technology has become a norm of modern world and is impacting our daily lives. The wireless mode of communication has further eased the need of information sharing and data analysis. The two popular wireless technologies called MANET (Mobile Ad-hoc Network) and WSN (Wireless Sensor Network) are much researched topics. Both are ad-hoc network technologies. This paper does a comparative study of these technologies by analysing their performance based on some parameters like their applications, energy conservation, Cross-layer design, security, deployment and network topology. Finally, we conclude the paper with some insights on the future scope of both technologies.

KEYWORDS: WSN, MANET, Nodes, CLD, deployment, ad-hoc.

I. INTRODUCTION

In past few years, wireless communication has caught the fancy of both masses and researchers alike. Due to technology advancements, the manufacturing cost of wireless devices has reduced substantially. Manufacturers have been working to improve the configuration and features of these devices. It has led to their easy accessibility. The wireless networks use the capability of the wireless devices (e.g. laptop, mobile, sensor devices etc.) to transfer messages from a source node to the destination node. The platform and architecture of any of the nodes need not to be same. To realise the goal of seamless connectivity and information sharing, wireless standards have been developed which allow communication among heterogeneous platforms.

Due to geographical distances, the source and destination may not be connected directly and may have many other nodes between them, called intermediate nodes, to aid in the final data transfer. These nodes will forward the transmission to other nodes en-route till it reaches its addressed node.

This process applies to wireless networks of all types. MANET (Mobile Ad-hoc Network) and WSN (Wireless Sensor Network) are two wireless ad-hoc network technologies. What makes them different is their capability to operate without the support of fixed and established infrastructure. Both MANET and WSN are distributed, autonomous, temporary wireless networks [1]. Both technologies do not require any infrastructure support and nodes can be networked anytime, anywhere. This makes wireless technologies an attractive option for commercial as well as non-commercial communication. The figure below illustrates the functioning of both technologies. In WSN, there always is a device called base station or 'sink', which collects data from other nodes, called sensor nodes, for analysis purposes. On the other side, under MANET, there is one source node, which starts the transmission and sends it to a destination node with the help of some intermediate devices.
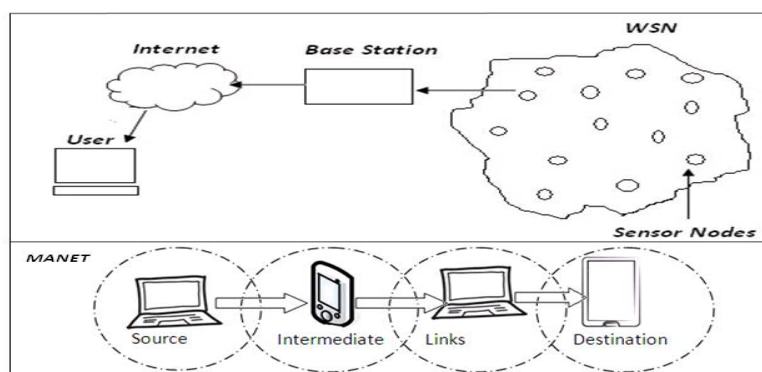

Fig. 1 Working of a WSN and MANET

II. RELATED WORK

Both of the technologies have been previously analysed in an extensive manner by researchers [1], [3]. They have many applications but the design, algorithm and protocols of both MANET and WSN are not interchangeable [3]. Gopinath.S et al. proposed a routing protocol called "On Demand Based Energy Efficient Routing Protocol", which seeks optimum utilisation of battery power for conserving battery life of wireless devices. Both types of networks can utilise the cross-layer design, which can improve overall network performance of wireless devices by sharing the information among layers or by coordinating their working [7]. Security of wireless communication is more important due to their easy access as compared to wired devices. To counter malicious attacks, Zheng Yan has proposed measures like secure routing, threshold cryptography and Key management service in his paper "Security in Ad Hoc Networks." Regarding deployment, WSN devices are deployed in either deterministic or random manner suitable for data collection and sending to a sink device.

In this paper, we have discussed these different aspects for both MANET and WSN to develop an understanding on their key differences as well as similarities.

III. MANET vs. WSN

In this section, we will discuss the common as well as unique features of both technologies. At one glance, the functioning of both will appear as same in many areas. But after studying their applications, differences become visible. Both have been researched as separate technologies owing to their area of applications which are quite different from each other. The table below outlines the points which are discussed in further paragraphs.

Table 1. MANET vs. WSN

MANET	WSN
1. MANETs are close to humans and require direct communication between them (e.g. battlefield communication).	1. The devices are deployed in harsh environmental conditions to collect sensor based data and do not require direct communication between persons (e.g. temperature analysis at different times of a day).
2. MANETs are generally formed for short duration; lasting from a few hours to a few days only. Hence, energy conservation is not very critical issue.	2. A WSN may be in operation for long duration; for many months. Hence, energy conservation is a very important issue here.
3. MANETs allow and use cross-layer design for network efficiency.	3. WSNs also allow and use cross-layer design for network efficiency.
4. MANETs require the additional security methods as compared to wired network.	4. WSNs also require similar security methods. e.g. cryptography, Key Management Techniques etc.
5. Data exchange can happen among multiple nodes. There is no central node; any node can send data to any other node.	5. All nodes in WSN collect data and send data to a central device called "sink". If sink has no direct link, intermediate nodes can be used.
6. MANETs have dynamic topology due to repeated activity of joining/leaving of nodes. The no. of nodes is not very high in a single MANET.	6. WSNs have dynamic topology due to failure of devices due to energy constraints, extreme weather conditions etc. The no. of tiny nodes can be very high in a single WSN

A. APPLICATIONS

Both technologies have a wide range of applications. WSN devices are mainly used for sensing and collecting data from its surroundings. These devices can be deployed at odd places and in harsh environments to collect invaluable data which otherwise would be difficult for humans to do themselves. WSN devices are called sensor nodes because they sense data from their environment and send it to a central device called "sink". The sink collects such data from many sensor nodes. This way, WSNs exhibit many-to-one pattern, while MANETs use one-to-one traffic.

MANETs are mostly used for emergency rescue operations, battlefield communication, or any human interaction (e.g. PAN) with the help of technology. All these areas can be termed as group of mobile devices networked together to exchange data of casual nature as well as data critical to human existence. In this sense, MANETs are close to 'humans', as they are used by human beings [3]. On the other hand, human interaction is not a consideration in sensor networks. WSNs instead focus on interaction with the environment.

B. ENERGY CONSERVATION

One of the biggest challenges in the growth of wireless technologies is their dependency on battery of the device/node. A lot of research has been done in past few years to handle the concerns related to energy efficiency in wireless networks. Many researchers have proposed that efficient utilization of limited battery power of the wireless device for all operations will enhance their lifetime. This applies to processing time, routing methods as well as operation time [4] (the time when the node is actively involved in transmission).

In this section, we will analyze the efforts made for efficient transmission. Transmission time consumes most of the device energy. The energy cost of sending a single bit of information is roughly the same as that needed for processing a thousand operations in a typical sensor node [4]. The battery energy is used more while sending data than receiving. To conserve the device's energy, it is suggested to occasionally switch-off the node components not required as well as the transceiver when it is idle; it is not participating in any transmission. One of the suggested methods is to select next hop (in multi-hop transmission) based on the power-level of the selected node [5].

If we analyze the energy saving needs of a network, WSNs require more saving of energy as their operation time is higher, ranging from a few days to many years. MANETs, however, normally operate at most for a few days only.

C. CROSS-LAYER DESIGN

Since both MANET and WSN are networks, they utilize the services of transmission models such as OSI & TCP/IP. These reference models do not allow direct communication between non-adjacent layers [6]. Cross-layer design (CLD) allows this and stresses on cooperative processing among layers. It improves on network functions by allowing separate layers to share information between them. CLD makes a network highly adaptable. The features of this design can be applied to all layers of the model. Both MANET & WSN have adopted this design to improve network efficiency in terms of security, QoS (Quality of Service), and mobility [7]. CLD has reduced power requirements as compared to traditional reference model design, which is a great favouring factor for both technologies.

D. SECURITY

Wireless networks have higher security requirements than wired networks. Wireless networks are attacked more as compared to wired networked due to easy access of radio signals. For example, any attacker can monitor the traffic flow and can interrupt, intercept, modify or fabricate transmitted packets [8]. To prevent such attacks, implementation of security measures is very critical for both MANET & WSN. Different strategies have been implemented in both types of networks. MANETs require authentication procedure because i) new nodes can join the network any time and ii) nodes often leave the network and re-join later [8]. Authentication steps will ensure that malicious nodes do not become part of the network.

Security solutions must be implemented in cross-layers. Implementing security at separate layers will not help in a robust Intrusion Detection System [7], which is required both in MANET & WSN.

E. DEPLOYMENT

The purpose of MANETs is to connect a sending mobile device to the other device, which are operated by humans directly. On the other hand, devices in WSN work independently from direct involvement of humans. The devices are deployed in different environments to sense data from their surroundings. For example, a device can be deployed near a busy road to study the pattern of traffic in busy hours. The methods to deploy sensor networks can be random (e.g., dropped from an airplane or helicopter) or can be done manually [2]. The communication range and deployment density of MANETs is less as compared to WSNs. A single WSN may have thousands of tiny nodes spread in a large geographical area [10]. These devices communicate with a central device called "sink" to send the data studied by them. Data aggregation technique is used to collect data from multiple nodes placed under multiple clusters. This data is then sent to the sink device. [11]

Both technologies utilize the services of devices en-route to send data to the final node. The "sink" node in WSN is common to all sensor nodes of the network. But in MANETs, there is no such "sink" node; any node can send transmission to any other node with the help of intermediate links.

F. TOPOLOGY

The transfer of the desired communication can be directly between the two devices or with the help of intermediate devices. Means, communication can be using either single-hop or multi-hop method. The type of deployment of devices determines the no. of participants. There are only a few devices for small PAN networks. But there can be thousands of devices in a single wireless network deployed for communication in emergency situations like natural calamities, wars etc. The inter-connection among devices is referred to as network topology.

There are many protocols for efficient routing within a network. Some routing protocols are specific to either MANET or WSN only. For example, three protocols named i) Maximum lifetime energy routing, ii) Maximum lifetime data gathering, and iii) Minimum cost forwarding are used for MANETs. Two protocols named i) SAR (Security Aware Routing) and ii) SPEED [12] are specific to WSNs.

One thing common to both technologies is their dynamic topology. In MANETs, devices keep on leaving or joining the network and contribute to constantly changing network topology. In WSN, the topology changes not due to joining/leaving of the network, but either due to the failure of the device in adverse environment or limited battery life. WSN nodes have severe power, computation, and memory constraints [12]. This fact make them prone to damage and frequent failures.

IV. CONCLUSION

In this paper, we highlighted the points where both MANET and WSN are similar and also where these differ. The purpose of this paper was to analyze the scope of both technologies. MANETs are appropriate for devices with higher processing power, big storage, and which are part of such networks which are short-lived. They have less stringent requirements than WSNs. On the other hand, WSNs can operate even with less storage, less powerful nodes but require longer battery life. They are suitable for applications having severe weather conditions or extreme situation which may be out of place for humans. MANETs are deployed where humans can access their services and interact directly with others. WSNs are required to collect sensor based data, need to interact only with their neighbor node(s) in order to send data to the sink node. Both of these technologies will continue to co-exist and serve the society

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BIOGRAPHY

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