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A COMPARATIVE STUDY OF AD HOC NETWORKS

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ABSTRACT

With significant technological breakthroughs in wireless communications and the rise of portable computing devices, academics have shifted their focus to enhancing the functionality of networks and, in particular, assuring speedy access to information regardless of time or location. Wireless networks relied only on meticulously designed and scaled facilities and a hierarchical command structure. With the massive proliferation of wireless applications and incredibly personal and local networks, the need for autonomy, independence, flexibility, and cost reduction has become evident. An ad-hoc network is a set of nodes that self-configure to build a network without the need for existing infrastructure or backbone. It allows the network to be constructed quickly and easily. Ad hoc networks use mobile nodes to facilitate communication in areas outside the wireless transmission range. Multiple classifications of ad hoc networks, including Mobile Ad hoc Network (MANET), Vehicular Ad hoc Network (VANET), Flying Ad hoc Network (FANET), Underwater Ad hoc Network (UANET), and Visible Light Ad hoc Network (VLANET). Each category is distinct from the others. This paper uses a comparative study method that compares various kinds of ad hoc networks from multiple sources. For each form of an ad-hoc network, this study examines its unique traits, current uses, and some of the obstacles it has experienced.

KEYWORDS: *ad hoc, wireless, communication, network*

1 INTRODUCTION

In the previous several decades, wireless networks have played a critical role in communication and represented a revolutionary paradigm change, allowing people and equipment to communicate in real-time across vast space and time. Smart homes, sensor networks, telemedicine, and automated roads are all supported by this technology. The military, emergency services, and law enforcement agencies were initial adopters of wireless technology. (Matin, 2012)

Ad-Hoc is a decentralized wireless network. The network is ad hoc since it does not depend on established infrastructure, such as routers or access points in wired or managed wireless networks (Kahlon, 2012).

2 TYPES OF AD HOC NETWORKS

2.1 Mobile Ad hoc Networks (MANET)

A mobile ad hoc network is a wirelessly linked network of mobile nodes that acts as both a router and an end system for other nodes in the network. Because the nodes are movable, the network architecture may change rapidly and unpredictably over time (R. Kumar, 2018).

Fig.1 shows the architecture of a mobile ad hoc network (Ceballos et al., 2021).

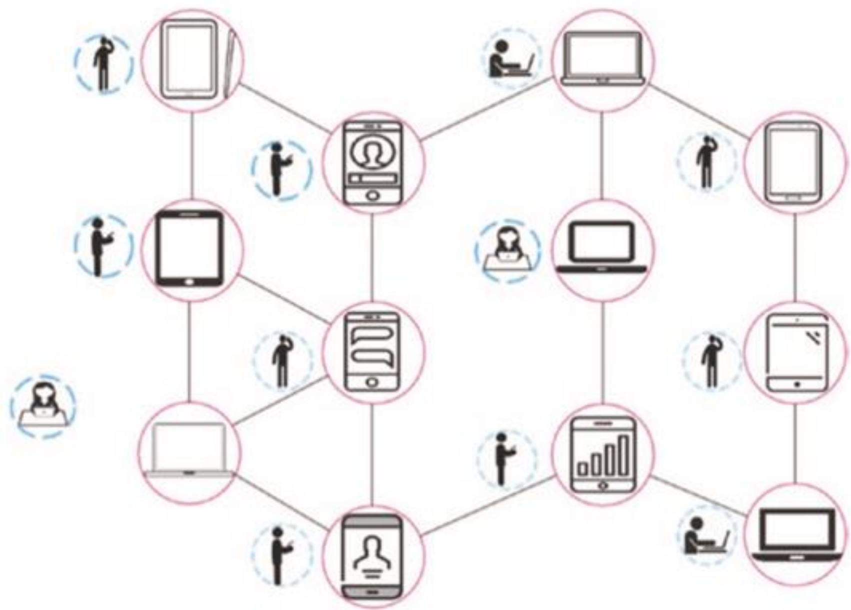

Figure 1: Mobile Ad hoc Network Architecture

Characteristics of MANET, according to (S. Kumar & Kumar, 2015), is:

Distributed operation: when distributing data effectively, the MANET nodes must be able to communicate and collaborate.

2.2 Vehicular Ad hoc Networks (VANET)

VANET is a wireless network that is self-contained and self-organizing. The objective of the VANET design is to provide constant communication between vehicles with Onboard Units (OBU). VANET is a mobile ad hoc network in which the primary node is a vehicle (Verma & Rauthan, 2017). Vanet's mode of communication are, V2V (Vehicle to Vehicle), V2I (Vehicle to Infrastructure), V2P (Vehicle to Pedestrian) and Hybrid architecture (Bhanu, 2021; Sewalkar & Seitz, 2019)

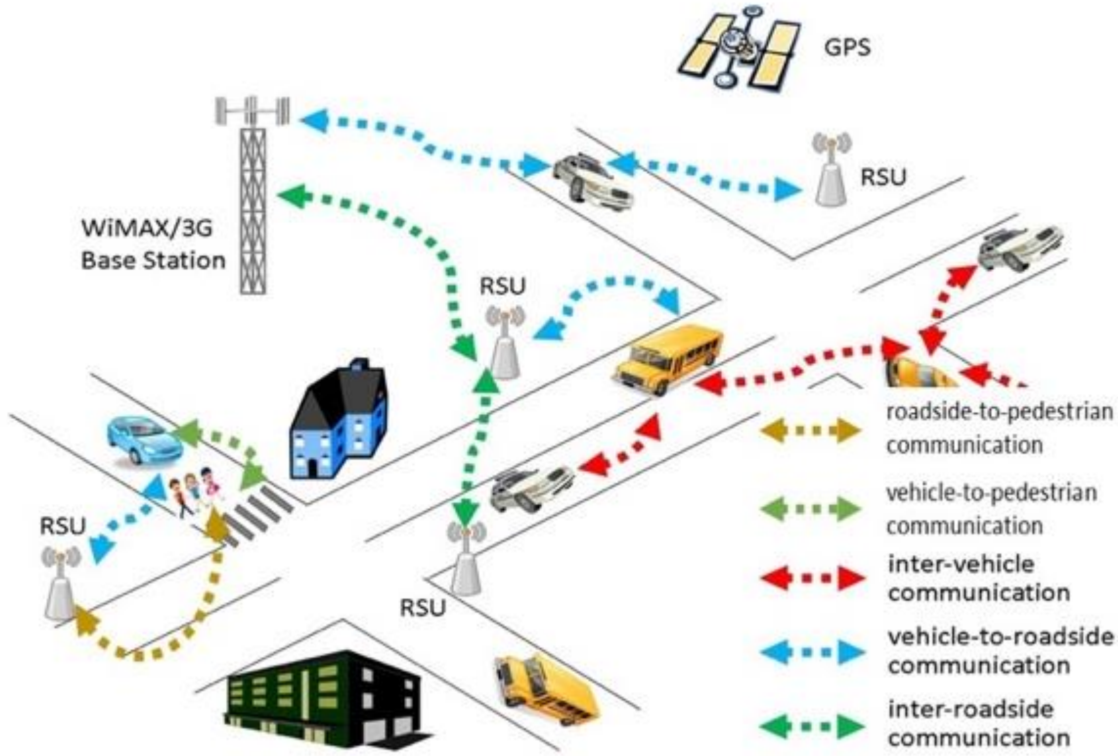

Figure 2: Vehicular Ad hoc Network Communication Infrastructure (Mehta et al., 2022)

VANET's Characteristics:

Rapid change topology: The vehicle's movement and speed might vary extremely fast, affecting the vehicle's location. VANET's topology is very dynamic and unexpected.

2.3 Flying Ad hoc Networks (FANET)

FANET is a component of MANET that allows communication between drones known as UAVs (Unmanned Aerial Vehicles), outfitted with cameras, sensors, and communication systems. Nodes in the FANET interact while flying, transferring signals and data to one another without the need for human involvement or physical touch between nodes, as shown in Fig. 3 (Maakar et al., 2019) (Hassan et al., 2022).

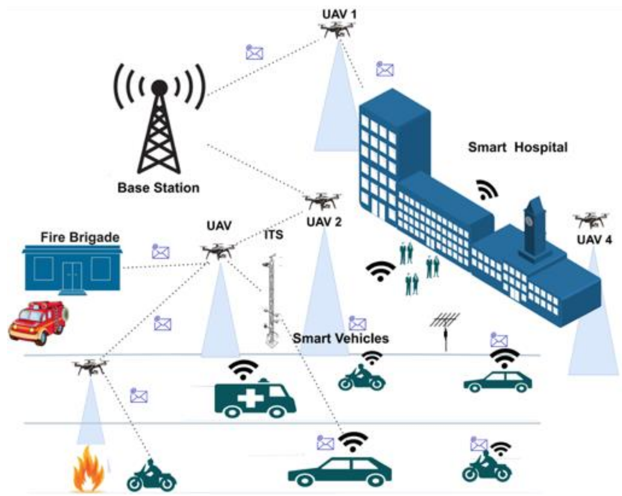

Figure 3: Flying Ad hoc Network Communication System

FANET Characteristics:

Intelligence: Drones will play a significant part in future transportation platforms and other flying missions. However, they will also offer various features such as data recording, extra analysis, and cooperation (Maakar et al., 2019).

2.4 Underwater Ad hoc Networks (UANET)

In the field of computer networks, the Underwater ad hoc network (UNET) and underwater sensor network (UWSN) provide new paradigms for exploring the pristine underwater environment (Kong et al., 2005). Fig. 4 shows an example of underwater acoustic communication (Rahman et al., 2012).

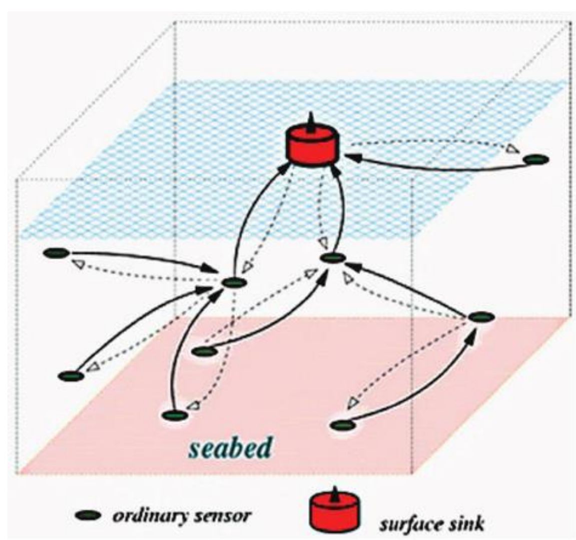

Figure 4: Underwater Acoustic Communication

UANET Characteristics:

Huge propagation latency: This underwater channel's signal propagation speed is just 1.5×10^3 m/sec, which is five times slower than the radio communication signal propagation speed of roughly 3×10^8 m/sec (Kong et al., 2005)

2.5 Visible Light Ad hoc Networks (VLANET)

Visible Light Communication is a subset of telecommunications technology that transmits data using the visible electromagnetic spectrum. Light Emitting Diodes (LEDs) often use this technique to send and transmit data concurrently (Georlette et al., 2020). The scheme of VLANET is shown in Fig. 5 (Georlette et al., 2020).

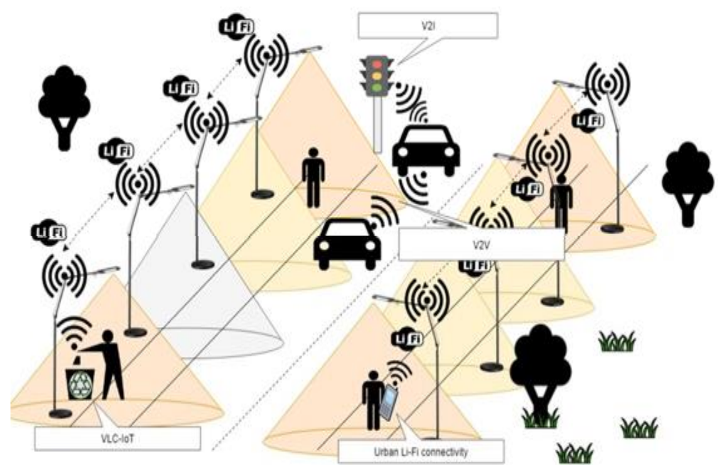

Figure 5: The Scheme of Visible Light Ad hoc Network

VLANET Characteristics:

a. Security: Compared to radio frequency communication, the spatial confinement of light in VLANET makes communication more secure since intruders or trackers may be immediately spotted.

2.6 Ad hoc Routing Protocol

The primary goal of this routing protocol is to increase throughput while reducing packet loss, energy consumption, and overhead. (Boukerche et al., 2011). There are nine categories in the routing protocol, which are as follows (Boukerche et al., 2011):

a. Hybrid (ZRP, FSR, LANMAR, DDR, LRHR)
b. Location-aware (LAR, DREAM, GPSR, DRM, ALARM)
c. Source-initiated (DSR, AODV, TORA, AQOR, LLR)
d. Multipath (CHAMP, AOMDV, SMR, NTBR, TMRP)
e. Table-driven (DSDV, OLSR, CGSR, WRP, GSR)
f. Power-aware (DEAR, LPAR, PARP, MEHDSR, EDSR)
g. Multicast (DCM, ADMR, QMRPCAH, PPMA, AQM)
h. Hierarchical (HSR, CEDAR, HMRP, H-LANMAR, H-OLSR)
i. Geographical Multicast (DGR, ZGMR, EGMP, GEM, GMR)

3 RECENT WORKS AND APPLICATION

3.1 Vehicular Ad hoc Networks (VANET) Environment

Intrusion Detection System based deep learning systems are offered and compared for efficacy and efficiency (Aboelfottoh & Azer, 2022).

3.2 Flying Ad hoc Networks (FANET) Environment

In (Hassan et al., 2022), The Fisheye State Routing (FSR) protocol was presented to utilize communication between several UAVs in a network with dynamic topology and a 3x3 Manhattan grid mobility model.

3.3 Underwater Ad hoc Networks (UANET) Environment

The article in (Choudhary & Goyal, 2021) encourages the researcher to provide a foundation for creating new sophisticated communication systems for efficient underwater communication.

3.4 Visible Light Ad hoc Networks (VLANET) Environment

(Jurado-Verdu et al., 2022) introduces Barcolits, an active LED tag that utilizes rolling-shutter cameras to manifest virtual barcodes in photos. The barcodes created have essential qualities. In contrast to physically printed barcodes, their pixel size does not alter with camera distance.

4 CHALLENGES IN AD HOC NETWORKS

4.1 Vehicular Ad hoc Networks (VANET)

There are several obstacles in the VANET ecosystem, for example (Mahi et al., 2022):

a. Security and Privacy: It is critical to keep an eye on network security, particularly in a diversified setting where many individuals, devices, and service providers share data, increasing the risk of a security breach.
b. Network Intelligence: Vehicles will be outfitted with a multitude of sensors in the future, particularly in the VANET environment, and the edge cloud will store and analyze data before transmitting it to servers or other devices. As a result, we need an intelligent network architecture to accommodate this demand.

4.2 Flying Ad hoc Networks (FANET)

a. Energy: Energy is one of the primary flaws of UAVs. Communication between UAV devices requires more power than between VANET devices. This consumption is also dependent on the size and kind of the UAV.

b. Connectivity: Connectivity is a significant concern, particularly inside the FANET network. Each node may create a FANET network if linked directly or indirectly to other nodes. Connectivity gives comprehensive network information, including protocols and algorithms. Unfortunately, UAVs have a limited communication range, making it impossible to link all UAV equipment. (Li et al., 2022)

4.3 Underwater Ad hoc Networks (UANET)

a. Method of communication: The communication technology used on the UANET network is considerably distinct from other forms of ad hoc networks, which typically employ radio frequency transmissions. Acoustic signals are utilized to establish communication between nodes on UANET (Choudhary & Goyal, 2021).
b. Routing protocols: Routing protocols are currently being developed in two categories: proactive protocols and reactive protocols. When the topology changes due to a node's continual mobility, proactive protocols generate signals to establish a communication channel. When the nodes are submerged, the problem is multiplied. It is best to adopt the reactive topology to construct an efficient communication channel since it is more suited for a more dynamic environment (Chauhan et al., 2021).

4.4 Visible Light Ad hoc Networks (VLANET)

a. Uplink issue: In most circumstances, the LED light transmits data to a receiver, but in other instances, it is necessary to transfer data back to the original transmitter (S et al., 2021).
b. Flickering: Flickering is the most fundamental obstacle that demands particular consideration. Light-emitting diode (LED) devices are anticipated to have an on and off function, and these two functions must operate in tandem to provide illumination and communication (Agarwal et al., 2022).

5 CONCLUSION

Technology may assist individuals in carrying out everyday duties in any sector, regardless of whether the activity affects them or many others. Moreover, today, technology is extensively employed and has permeated even the most fundamental aspects of human existence, ranging from personal communication tools to public transit, aviation technology, intelligent gadgets, and undersea research.

This article discusses various kinds of ad hoc networks, including their distinctions from one another, the applications they are best suited for, and the difficulties they provide. It is anticipated that some of the issues discussed in this study will constitute material for subsequent research, particularly research on several types of ad hoc networks. These concerns provide an opportunity for fresh thinking about addressing the issues inherent to each distinct kind of ad hoc network.

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