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Origin, Growth, Events and Development of Mobile Ad Hoc Networking

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Abstract: ***All technologies need their time to develop. Nevertheless, we are experiencing hug growth of wireless networks. Wireless networks are of two types: infrastructure mode and ad hoc mode. In infrastructure mode, the mobiles stations (MS) are connected to a base station or Access Point (AP). This is similar to a star network where all the mobiles stations are attached to the base station. Through a protocol the base station manages the dialogues between the AP and the MS. In ad hoc mode; there is no access point or infrastructure. A number of mobile stations form a cluster to communicate with each other. Therefore, technically an ad hoc network (MANET) is an autonomous system of mobile stations connected by wireless links to form a network. This paper provide us with the origin, growth, events and development of dynamic field of mobile ad hoc networking to understand not only today's network, but tomorrow's as well.***

Keywords: AP, MS, MANET, ALOA, DoD, PRNET, SCMA, LAN, SURAN, WLAN, MAC

1. Introduction

Recent years have seen a great amount of research in wireless networks, especially ad hoc wireless networks due to their potential application in various situations such as battlefield, emergency relief, and so on [1]. Because of their ease of deployment and their cost, wireless networks are increasingly used by human both in his private life and in his work field. Mobile Ad hoc networks are autonomous systems which comprise a collection of mobile nodes that use wireless transmission for communication [2]. They are:

- Self - organized
- Self - configured
- Self – controlled infrastructure – less network

In Mobile ad hoc networks (MANETS) nodes have the ability to communicate to each other without any plan, design, and constructive model. Hence MANETS do not rely on any fixed infrastructure but communicate in a self-organized way.

This type of network can be set up or deployed anywhere and anytime because it poses very simple infrastructure set up and no or minimal central administration.

Wireless networking or mobile ad hoc network becomes possible trough the evolution of portable computers and wireless connection over mobile telephone network [4]. However the growth of mobile ad hoc networking has grown explosively due to those portable devices. The growth and uses of the global internet are among the most interesting and exciting phenomena in networking. Since it is an emerging wireless communication system, understanding the origin, growth, event and development of mobile ad hoc networking will allow the researchers to understand why this network was created and how it has become one of the wireless communication used today and what make it unique from others communication wireless networks. This paper is organized as follows: Section II presents the origin of mobile ad networking. Section III presents the growth, types of infrastructure wireless network and characteristics of mobile ad hoc network. Section IV elaborates the development of MANET with its challenges. Finally, Section V is the conclusion.

2. The Converging Origin of Ad Hoc Networks

In general, wireless networking refers to the use of infrared or radio frequency signals to share information and resources between devices. To understand why non infrastructure – based mobile ad hoc networks are poised to play an important role in the evolution of future wireless networks, it helps to review its origin path.

- The root of ad hoc networking can be traced back as far as in 1968, when work on the ALOHA network was initiated. The objective of this network was to connect educational facilities in Hawaii [5].
- The idea of mobile ad hoc networks date back to early 1970s. The main Driving force behind ad hoc networks was the need for survival, infrastructure – less and hard – to – detect military applications.
- In 1972 [6], the Department of Defense (DoD) initiated a new program on Packet Radio Networks (PRNET) with the intension to create technologies for the battlefield that do not need a previously deployed infrastructure but are highly survivable even when some of the radios fail or are destroyed. PRNET features a distributed architecture consisting of networks of broadcast radios with minimal central control, and a combination of ALOHA and CSMA channel access protocols used to support the dynamic sharing of the broadcast radio channel. The medium access technology employed was slightly modified version of the ALOHA protocol developed two years earlier in academia to interconnect the computing infrastructure over four Hawaiian Islands with eight transceivers. Thus, the first ad hoc network was already using wireless LAN technology as the underlying MAC and PHY layers [6].
- Lates on, in the early 1980s, the PRNET program was replaced by the Survivable Adaptive Radio Networks (SURAN) to address open issues in PRNET, in the areas

of networking scalability, security, processing capability, and energy management. Technologies to create moderate – cost ad hoc networks outside of the DoD were not present, and since there were very few mobile devices with any computing power, there was no need for commercial deployment either [7, 8].

3. Growth of Ad-Hoc Networking

Mobile ad hoc network has grown explosively. However, There are situations in which user – required infrastructure is not available, cannot be installed, or cannot be installed in time in a given geographic area. Hence, providing the need connectivity and network services in these situations requires a mobile ad hoc network [1].

Mobile ad hoc network consists of devices that are autonomously self – organizing in networks. In ad hoc networks, the devices themselves form the network, and this allows seamless communication, at low cost, in a self – organized fashion and with easy deployment. Hence, mobile ad hoc networking is becoming possible through the evolution of portable computers and wireless connections over a mobile telephone network. Also, the growth and uses of the global internet are among the most interesting and exciting phenomena in mobile ad hoc networking.

The early 1990s saw the renaissance of ad hoc networking research, wherein packet radio networks were renamed ad hoc networks [9, 10]. There was a commercial need for mobile interconnection, leading toward a push for wireless infrastructure based standard as well as a strong lobbying from research organizations to develop technologies that could be used as the basis of ad hoc networking. Due to the major interest from several companies, the Institute of Electrical and Electronics Engineering (IEEE) 802 Group in charge of computer communication established a subcommittee, IEEE802.11, to standardize and unify techniques and technologies to be used for wireless LANs. Since the subcommittee was established involving experts from companies and academia, it was also aware of the need for infrastructure less communication and was working simultaneously to address both infrastructure – based and infrastructure less needs [9].

3.1 Infrastructure and Ad-Hoc networks

Many WLANs of today need an infrastructure network. Infrastructure networks not only provide access to other networks, but also include forwarding functions, medium access control etc. In these infrastructures – based wireless networks, communication typically takes place only between the wireless nodes and the access point (see Figure1), but not directly between the wireless nodes [3].

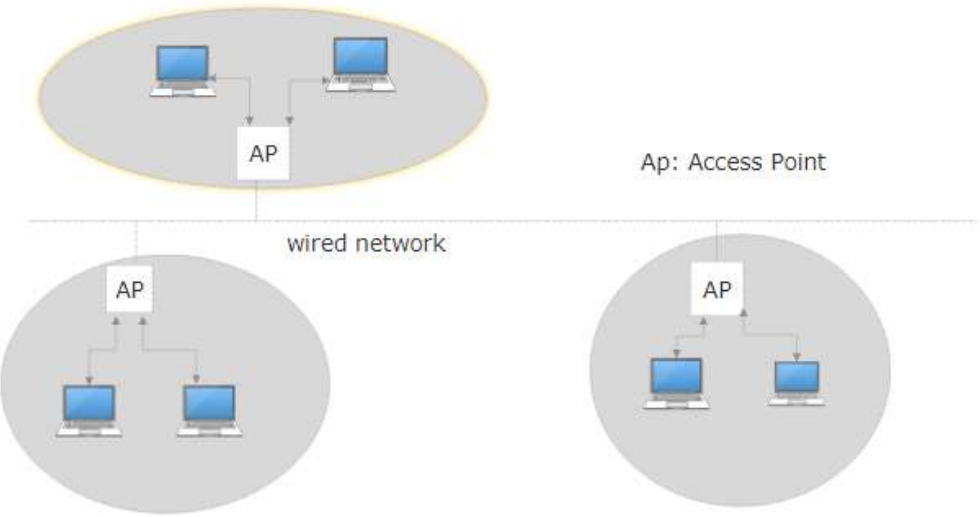

Figure 1: Example of infrastructure-based wireless networks

The access point does not just control medium access, but also acts as a bridge to other wireless or wired networks. **Figure 1** shows three access points with their three wireless networks and a wired network. Several wireless networks may form one logical wireless network, so the access points together with the fixed network in between can connect several wireless networks to form a larger network beyond actual radio coverage.

In contrast, ad hoc networks however do not need any infrastructure to work. Each node can communicate directly with other nodes, so no access point controlling medium access is necessary [3].

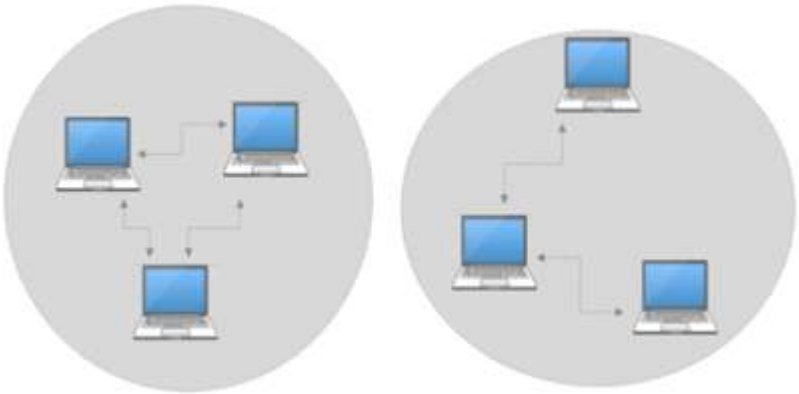

Figure 2: Example of two ad-hoc wireless networks

Figure 2 shows two ad-hoc networks with three nodes each. Nodes within an ad-hoc network can only communicate if they can reach each other physically; if they are within each other's radio range or if other nodes can forward the message. Nodes from the two networks shown in figure 2 cannot, therefore communicate with each other if they are not within the same radio range.

3.2 Characteristics of Mobile ad hoc networks

MANETs inherit common characteristics found in wireless networks in general, and add characteristics specific to ad hoc networking [11]:

- **Wireless**: Nodes communicate wirelessly and share the same media(radio, infrared, etc)
- **Ad-hoc based**: Mobile ad hoc network is a temporary network formed dynamically in an arbitrary manner by a collection of nodes as need arises.
- **Autonomous and infrastructure-less**: MANET does not depend on any established infrastructure or centralized administration. Each node operates in distributed peer-to-peer mode, acts as an independent router, and generates independent data.
- **Multihop routing**: No dedicated routers are necessary; every node acts as a router and forwards each others' packets to enable information sharing between mobile hosts.
- **Mobility:** Each node is free to move about while communicating with other nodes. The topology of such an ad hoc networks is dynamic in nature due to the constant movement of the participating nodes, causing the interconnection patterns among nodes to change continuously.

Ad hoc wireless networks eliminate the constraints of infrastructure and enable devices to create and join networks on the fly – anytime, anywhere – for virtually any application [4].

3.3 Development of Mobile Ad Hoc Networks

An ad hoc network consists of node that may be mobile and have wireless communications capability without the benefit of a mediating infrastructure. The intrinsic flexibility, ease of maintenance, lack of needed infrastructure, autoconfiguration, self-administration capabilities, and significant cost advantages make ad hoc networks a prime candidate for becoming the stalwart technology for personal pervasive communication. The opportunities for and importance of ad hoc networks are being increasingly recognized by both the research and industry community, as evidenced by the flood of research activities, strong industry interest, and almost exponential growth of the wireless LAN and Bluetooth [4].

The field of wireless networking emerges from the integration of personal computing, cellular telephony and the internet. This is due to the increasing inter – actions between communication computing, which are changing information access from "anytime, anywhere" into "all time, everywhere" [3].

3.4 MANET Applications

Because ad hoc networks are flexible networks that can be set up anywhere at any time, without infrastructure, including reconfiguration or administration,, people have come to realize the commercial potential and advantages that mobile ad hoc networking can bring.

Historically, mobile ad hoc networks have been primarily used for tactical network related applications to improve battlefield communications and survivability [7]. Commercial ad hoc network could be used in situations where no infrastructure is available. Example includes rescue operations in remote areas, or when local coverage must be deployed quickly at a remote construction site. Ad hoc networking could also serve as wireless public access in urban areas, providing quick deployment of an extended coverage [12].

A great advantage of mobile wireless system is that they can be formed in a spontaneous and fast way; this is why they are called "ad hoc Networks" [13]. However MANET poses various challenges that need to be addressed

3.5 Technical challenges posed by ad hoc networking

Mobile ad hoc networks pose several technical and research challenges that need to be addressed.

Media Access Control and Optimization

In MANT, use of broadcasting and shared transmission media introduces a nonnegligible probability of packet collations and media contention. In addition, with half-

duplex radio, collision detection is not possible, which severely reduces channel utilization as well as throughput, and brings new challenges to conventional CSMA/CD-based MAC protocol in general. Among the top issues are hidden-terminal and exposed-terminal problems [14].

Ad hoc routing

The highly dynamic nature of mobile ad hoc networks results in frequent changes and un-predictability in network topologies, adding difficulty and complex to routing among the mobile nodes within the network. These added challenges, coupled with critical importance of routing protocols in establishing communication among mobile nodes, make the routing protocols perhaps the most active research within the MANET domain [16].

Network Security

The wireless and mobile ad hoc nature of MANET brings new security challenges to network design. Because nodes in mobile ad hoc network generally communicate with each other via open and shared broadcast wireless channels, they are more vulnerable to security attacks. In addition, their distributed and infrastructure-less nature means that centralized security control is hard to implement and the network has to rely on individual security solutions from each mobile node .Furthermore, as ad hoc networks are often designed for specific environments and may have to operate with full availability even in adverse conditions, security solutions applied in more traditional networks may not be directly suitable [17, 18].

Energy Conservation

Mobile devices rely on batteries for energy. Battery power is finite and represents one of the greater constraints in designing algorithms for mobile devices [19, 20]. It is therefore vital that power utilization be managed efficiently by identifying ways to use less power, preferably with no impact on the applications. Energy conservation is not restricted to a single network layer, but instead requires a coordinated effort from all related layers, including the physical-layer transmission, the operating system, and the applications [21]

Quality of Service and Optimization

In mobile ad hoc networks, the availability of additional bandwidth, link and medium constraints as well as the constant change in network topology, make supporting quality of service more difficult than fixed wireline networks, which only need to deal with static constraints such as bandwidth, memory, or processing power. Due to the lack of sufficiently accurate knowledge of the network states, both instantaneous and predictive, even statistical QoS guarantees may be impossible if the nodes are highly mobile [22].

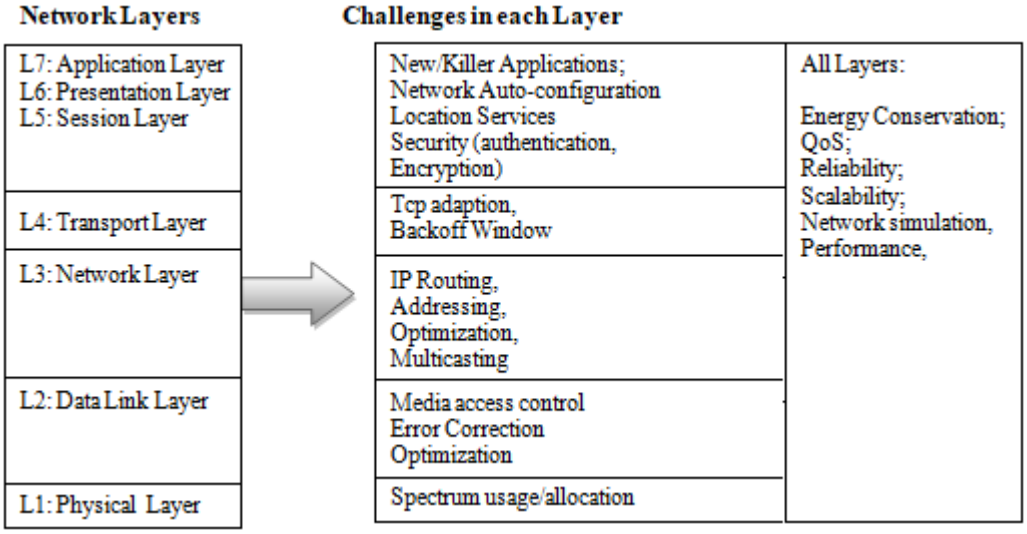

Figure 3: MANET network Layers and research challenges

4. Conclusion

Ad hoc networks are the key in the evolution of wireless networks. Its intrinsic flexibility, ease of maintenance, lack of needed infrastructure, autoconfiguration, self-administration capabilities, and significant cost advantages make it a prime candidate for becoming the stalwart technology for personal pervasive communication. The opportunities for and importance of ad hoc networks are being increasingly recognized by both the research and industry community, as evidenced by flood of research activities, strong industry interest, and almost exponential growth of the wireless LAN and Bluetooth sectors.

Despite the large volume of research activities and recent progress made in the mobile ad hoc networking area both in the research community and industry, there are still many interesting and important research problem to be solved in order to enable the large-scale commercialization of the technology. Future challenges for ad hoc wireless networks include: Routing Protocol optimization, QoS Support, Security, Standardization and interoperability, mobility, and simulation. These issues among the least need to be addressed in order to make mobile ad hoc networks safe and reliable.

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