



The Significance of Ad-hoc Network Over Traditional Networks: A Review of Latest Evolutions

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Abstract

The idea of an Ad-hoc network is often unaccustomed to end users who have only seen small housing or business networks that use a typical router to send wireless signals to individual computers, the ad hoc network is being used quite a bit in new types of wireless engineering, although until recently it was a rather esoteric idea. For example, the vehicular ad hoc network, includes placing communication devices in cars. Another kind of ad hoc network, a mobile ad hoc network includes mobile devices communicating directly with one another. Both of these are examples of ad hoc networks that use a large collection of individual devices to easily communicate without a kind of top-down or hierarchical communication structure. The point out that for small local area networks, ad hoc networks can be inexpensive to build because they don't need as much hardware. However, others make the point that a large number of devices can be hard to manage without a larger and more concrete infrastructure. Tech leaders are looking at ways to allow more practically network functionality with these peer-to-peer networks.

Keywords: Ad hoc network; Computer network; Mobile ad hoc network; Ad-Hoc wireless networks; Wireless sensor networks.

1. Introduction

An ad hoc network is a network that consists of individual devices communicating with each other directly. The term implies unprompted or impromptu construction because these networks often avoid the gatekeeping hardware or central access point such as a router. Many ad hoc networks are local area networks where computers or other devices are permissible to send data directly to one another rather than going through a centralized access point.

Wireless ad hoc networks are groups of wireless nodes that connect directly over a shared wireless channel. The nodes are prepared with wireless transceiver. They don't want any extra infrastructure, such as base station or wired access point, etc. Therefore, each node doesn't only play the role of an end system, but also acts as a router, that sends packets to wanted nodes [1].

An ad-hoc network is a self-configuring network of wireless links connecting mobile nodes. These nodes may be routers and/or hosts. The mobile nodes connect directly with each other and without the help of access points, and therefore don't have immovable infrastructure. They form random topology, where the routers are free to move randomly and organize themselves as required [2].

Ad hoc networks date back to the Seventies. They were developed by the Defense Forces, to obey with a martial framework. The goal was to quickly deploy a strong, mobile and reactive network, under any circumstances. These networks then proved beneficial in commercial and industrial fields, first help operations and exploration missions. Ad hoc networks, also named peer-to-peer networks, still have a long way to go in order to be completely functional and commercial, as it has some of flaws such as security and routing [2].

The ad hoc are predictable to do assignments, which the infrastructure can't do. Ad hoc networks are mostly used by army, rescue mission team, taxi driver. Their works can't depend on a infrastructure's network. As an explanatory example, imagine firefighters put out dangerous fire in a big forest. They have to communicate each other, but creating a infrastructure or cabling in such area is impossible or too expensive.

2. Most Common Issues and Solutions

2.1. Problem Statement

The core of problems in ad hoc networks are routing and characteristic of wireless communication. In infrastructure's network a node can connect with all nodes in the same cell. In ad hoc a node can communicate only with nodes in its zone. This node can communicate with other nodes, but a routing algorithm is necessary. Unlike wired communication, wireless networks have transmission problem with data transmission such as, likelihood of asymmetrical connections and higher interferences [2].

In ad hoc networks, every node in the network have to be able to take care of routing of the data and this is the domain of ad-hoc routing. As often pointed out, routing is a serious issue for ad hoc networks although it has certainly been addressed widely by the research community. This thesis addresses some issues pertaining to mobile ad hoc networks due to dearth of infrastructure and dynamic topology. The mobility of these nodes imposes issues in terms of mobility management, energy exhaustion, battery life and security. Thus, there is need to optimize these parameters with lowest cost for designing routing protocol [2].

2.2. Objectives

- 1-Describe ad-hoc networking application, advantages, disadvantages and Characteristics.
- 2-Discuss Types of Ad hoc networks
- 3-Describe security goals and routing protocols
- 4-What are the useful applications of mobile for ad-hoc networking?
- 5-What are the requirements for ad-hoc networking?
- 6-What are the challenges of Ad-Hoc Wireless Networks?

2.3. Proposed Method

Many solutions have been proposed to compute the trust level in ad hoc networks. Every solution has its own pros and cons and also designed and developed by keeping particular situation in mind. Thus, it may or may not work in the other condition. Ad hoc networks are based on “trust your neighbor” relationships. Since there is no centralize control, each node is responsible for a secure data communication and as a process of providing secure communication path; each node monitors its neighbors. However, each node has to assure that, it is communicating with a trustworthy neighbor. This article offers a unique way of computing the trust level in the network and reduces the communication overhead by limiting the size of packet containing trust level information.

3. Applications of Ad-hoc Networks

With the augmentation number of lightweight devices as well as development in wireless communication, the ad hoc networking technology is acquisition energy with the growing number of widespread applications. Ad hoc networking can be used anytime, anywhere with limited or no communication infrastructure. The ad hoc network architecture can be used in real time business applications, corporate companies to increase the productivity and profit.

The ad hoc networks can be classified according to their application as Mobile Ad hoc Network (MANET) which is a self-arranging infrastructure less network of mobile devices communicated over wireless link. Vehicular Ad hoc Network (VANET) uses travelling cars as nodes in a network to create a mobile network. Wireless Sensor Network (WSN) involves of autonomous sensors to control the environmental activities. The significance of ad hoc network has been highlighted in many fields which are defined below [3],

Personal area network: A personal area network is a short range, localized network where nodes are usually associated with a given range.

Industry sector: Ad hoc network is widely used for commercial applications. Ad hoc network can also be used in emergency situation such as disaster relief. The rapid development of non-existing infrastructure makes the ad hoc network easily to be used in emergency situation.

Military arena: An ad hoc networking will allow the military battleground to maintain an information network among the soldiers, vehicles and headquarters.

Provincial level: Ad hoc networks can build instant link between multimedia network using notebook computers or palmtop computers to spread and share information among participants for example Conferences.

Bluetooth: Bluetooth can provide short range communication between the nodes such as a mobile phone and laptop.

3.1. Advantages of Ad-hoc Networks

The rapid growth in ad hoc technology is extensively used in portable computing such as laptop, mobile phone used to access the web services, telephone calls when an operator are in travelling. Evolution of self-organizing network decrease the communication cost [4]. The development of 4G technology improves anytime, anywhere, anyhow communication in ad hoc network. Ad hoc network is simple to design and install [5]. The advantages of an ad hoc network include:

- 1-Flexible ad hoc can be temporarily setup at any time, in any place.
- 2-Mobility allows ad hoc networks created on the fly in any situation where there are multiple wireless devices.
- 3-Lower getting-started costs due to decentralized administration.
- 4-Self-configuring nodes are also routers.
- 5-Self-healing through continuous re-configuration.
- 6-Scalability incorporates the addition of more nodes.
- 7-The nodes in ad hoc network need not rely on any hardware and software.
- 8-Separation from central network administration.

3.2. Disadvantages of Ad-hoc Networks

3.2.1. Range

The range in Ad Hoc network is so small comparatively to other wireless networks. The communication range is about 100m which can be prolonged by multihop communication of nodes [2, 6].

3.2.2. Weaker Signal

The signals aren't strong as compared to wireless networks which use a router to function properly [2, 6].

3.2.3. Security

The main disadvantage is security which occurs due to the following reasons [2, 6]

- 1- No boundary
- 2- Scalability
- 3- Absence of accountability in joining and leaving from the network.
- 4- The dynamic topology
- 5- Infrastructure less by nature

3.3. Ad-hoc Networks Characteristics

3.3.1. Mobility

Nodes can be speedily repositioned. We can have individual random mobility, group mobility etc. The mobility model can have fundamentally significant power on the choice of a routing method and can thus influence the performance.

3.3.2. Multi-Hopping

A multi hop network is a network where the paths from source to destination pass over numerous nodes. Ad hoc nets often reveal multiple hops for problem negotiation, spectrum reuse and energy conservation.

3.3.3. Self-Organization

The ad hoc network must unorthodox definition its own configuration parameters including addressing, routing, clustering, identification of position, power control [7].

3.3.4. Energy Conservation

Most ad hoc nodes (for example laptops, PDAs, sensors, etc.) have limited power supply and no capability to generate their own power (e.g., solar panels). Energy efficient protocol design (for example MAC, routing, resource discovery, etc) is critical for longevity of the mission.

3.3.5. Scalability

In some applications (for example large environmental sensor fabrics, battlefield deployments, urban vehicle grids, etc) the ad hoc network can grow up to numerous thousand nodes [7].

3.3.6. Security

The ad hoc networks, however, are even more exposed to attacks than the infrastructure counterpart. Both active and passive attacks are possible. In active attack attacker tries to interrupt processes. Passive attacks are unique in ad-hoc network and can be more dangerous than the active attack. The active attacker is in the end discovered and physically handicapped. The passive attacker is never discovered by the network. It monitors data and control traffic patterns and thus concludes the normal operation. Defense from passive attacks require powerful novel encryption methods coupled with careful network protocol designs [7].

3.3.7. Connection to the Internet

As debated, there is quality in extending the infrastructure wireless networks opportunistically with ad hoc appendices. The incorporation of ad hoc protocols with infrastructure standards is thus becoming a hot issue [7].

4. Types of Ad-hoc Networks

The self-supporting nature of ad hoc networks makes them quite useful in situations such as natural disasters, emergency military operations, or even to just quickly transfer information between two computers at home. However, in spite of such ease of use and scalability, there are physical and performance limitations to an ad hoc network in the practical world. The types of ad hoc networks are as follows:

1- Mobile ad hoc networks: A mobile ad hoc network (MANET) is a self-forming network of mobile devices connected wirelessly.

2- Wireless ad hoc networks: A wireless ad hoc network is a communications network of radio nodes structured in a mesh topology. The clients within the network are usually laptops, mobile phones, and other wireless equipment. The mesh network, with the help of routers and gateways, transmits data to and from the wireless devices. The communication is within the mesh and not to the internet.

3- Wireless sensor networks: A wireless sensor network (WSN) employs sensor based devices to jointly observe physical or environmental settings such as sound, pressure, climatic changes, and so on. Wireless sensor networks are used in a wide range of areas: traffic control, vehicle detection, and greenhouse monitoring.

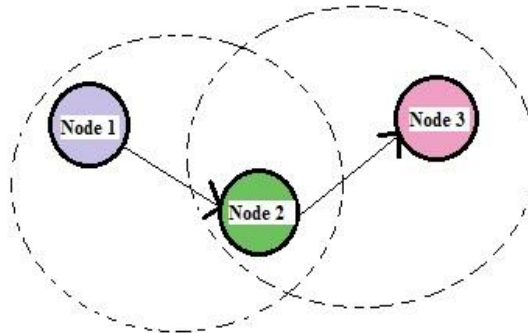
4.1. Mobile Ad-hoc Network

Is a group of independent mobile nodes that can communicate to each other through radio waves? The mobile nodes that are in radio range of each other can directly communicate, however others needs the help of intermediate nodes to route their packets. Each of the node has a wireless interface to communicate with each other. These

networks are completely distributed, and can work at any place without the help of a fixed infrastructure as access points or base stations. Figure 1 shows a simple ad-hoc network with 3 nodes.

Node 1 and node 3 are not within range of each other, however the node 2 can be used to forward packets between node 1 and node 2. Then node 2 will act as a router and these three nodes together form an ad-hoc network [8].

Fig-1. Example of mobile ad-hoc network



4.1.1. MANETs Characteristics

1- Distributed operation: There is no related network for the essential control of the network operations, the control of the network is distributed amongst the nodes. The nodes involved in a MANET must collaborate with each other and communicate among themselves and each node acts as a relay as wanted, to implement specific functions such as routing and security.

2- Multi hop routing: When a node tries to send information to other nodes which is out of its communication range, the packet must be advanced via one or more intermediate nodes.

3- Autonomous terminal: In MANET, every mobile node is an independent node, which might function as both a host and a router.

4- Light-weight terminals: In maximum cases, the nodes at MANET are mobile with fewer CPU ability, low power storage and small memory size.

5- Dynamic topology: Nodes are free to move randomly with different speeds; therefore, the network topology can change arbitrarily and at unpredictable time. The nodes in the MANET dynamically create routing between themselves as they travel around, establishing their own network.

6- Shared Physical Medium: The wireless communication medium is accessible to any entity with the suitable equipment and adequate resources. Therefore, access to the channel cannot be restricted [9].

4.1.2. Advantages of Manet

The advantages of MANET include the following:

- The network can be set up at any place and time.
- They provide access to information and services regardless of geographic position.
- Scalable—accommodates the adding of more nodes.
- Improved Flexibility, and Robust due to decentralize administration.
- Independence from central network administration. Self-configuring network, nodes are also act as routers.
- Less expensive as compared to wired network.

4.1.3. Manets Applications

Some of the typical applications include:

1- Military battlefield: Ad-Hoc networking would allow the military to take benefit of ordinary network technology to keep an information network between the soldiers, vehicles, and military information head quarter.

2- Collaborative work: For some business environments, the need for collaborative computing might be more significant outside office environments than inside and where people do need to have outside meetings to collaborate and exchange information on a given scheme.

3- Local level: Ad-Hoc networks can separately link an immediate and temporary multimedia network using notebook computers to spread and share information between participants at a for example. Conference or schoolroom. Another suitable local level application might be in home networks where devices can communicate directly to exchange information.

4- Personal area network and Bluetooth: A personal area network is a short range, localized network where nodes are usually associated with a given person.

Short-range MANET such as Bluetooth can simplify the communication between different mobile devices such as a mobile phone, and a laptop.

5- Commercial Sector: Ad hoc can be used in emergency/rescue operations for disaster relief efforts, for example in fire, earthquake, or flood. Emergency rescue operations have to take place where non-existing or spoiled communications infrastructure and rapid deployment of a communication network is needed [10].

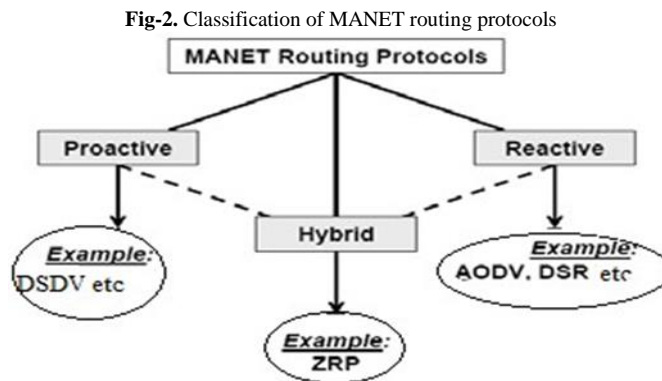
4.1.4. Security Goals

In MANET, all networking functions such as routing and packet forwarding, are completed by nodes themselves in a self-organizing method. For these motives, securing a mobile ad-hoc network is very challenging. The goals to estimate if mobile ad-hoc network is secure or not are as follows:

- 1- Authentication: Authentication is basically guarantee that participants in communication are authenticated and not impressionists. The recourses of network must be accessed by the authenticated nodes.
- 2- Authorization: This possessions assigns different access rights to different kinds of users. For example a network management can be performed by network administrator only.
- 3- Resilience to attacks: It is required to sustain the network functionalities when a part of nodes is compromised or demolished.
- 4- Freshness: It ensures that malicious node does not resend previously captured packets [11].
- 5- Availability: Availability means the assets are accessible to official parties at appropriate times. Availability applies both to data and to services. It guarantees the survivability of network service regardless of denial of service attack.
- 6- Confidentiality: Confidentiality ensures that computer-related possessions are accessed only by official parties. Safety of information which is exchanging over a MANET. It must be protected against any disclosure attack like eavesdropping- unauthorized reading of message.
- 7- Integrity: Integrity means that possessions can be changed only by authorized parties or only in official way [11].

4.1.5. Routing Protocols

Ad-Hoc network routing protocols are commonly divided into three main classes; Proactive, reactive and hybrid protocols as shown in figure 2.



1- Proactive Protocols: Proactive, or table-driven routing protocols. In proactive routing, each node has to keep one or more tables to store routing information, and any changes in network topology need to be reflected by propagating updates throughout the network in order to maintain a consistent network view. Example of such schemes are the conventional routing schemes: Destination sequenced distance vector (DSDV). It minimizes the delay in communication and let nodes to quickly control which nodes are present or reachable in the network.

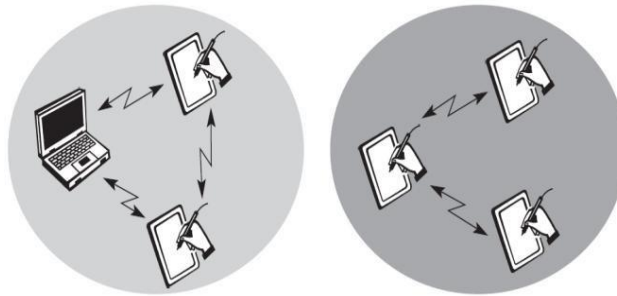
2- Reactive Protocols: Reactive routing is also known as on-demand routing protocol since they do not maintain routing information or routing action at the network nodes if there is no communication. If a node needs to send a packet to another node then this protocol searches for the route in an on-demand method and establishes the connection in order to convey and receive the packet. Examples of reactive routing protocols are the Ad-hoc On-demand Distance Vector routing (AODV) [8] and Dynamic Source Routing (DSR).

3- Hybrid Protocols: They introduces a hybrid model that combines reactive and proactive routing protocols. The Zone Routing Protocol (ZRP) is a hybrid routing protocol that divides the network into zones [12].

4.2. Ad-Hoc Wireless Networks

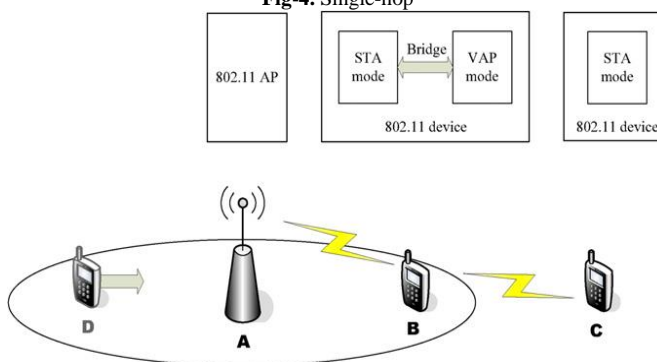
Ad-hoc wireless networks [13] [14] [2], however, do not require any infrastructure to work. Each node is capable of talking directly to other nodes, so access point controlling medium access is not required. Fig 3 shows two ad-hoc networks with three nodes each. Within an ad-hoc network nodes can only communicate, if they can reach each other physically, i.e., if they are present within radio range of each other or if other nodes forward the message. Nodes from the two networks shown in Fig 3 cannot, therefore, communicate with each other if they are not within the same radio range.

Fig-3. Example of two ad-hoc wireless networks



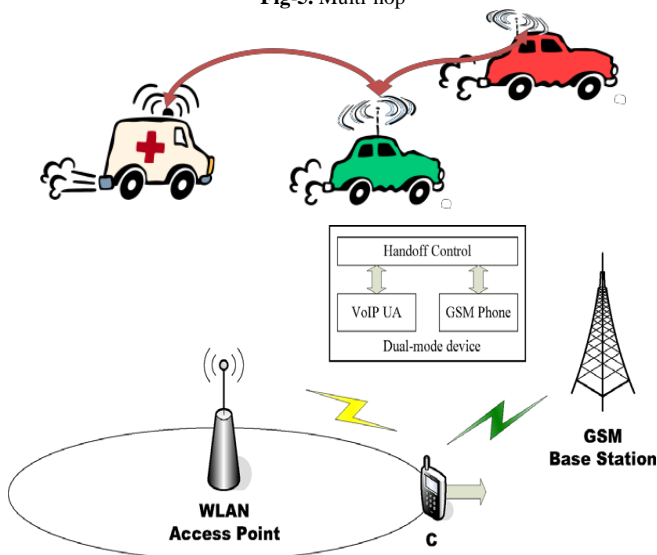
In ad-hoc networks, the complexity of each node is higher because every node has to implement medium access mechanisms and perhaps priority mechanisms, to handle hidden or exposed terminal problems and to provide a certain quality of service respectively. This type of wireless network shows the greatest possible flexibility in quick replacements of infrastructure or communication scenarios. However, might be a selected nodes with the capabilities of forwarding data is present in an ad-hoc networks and most of the nodes have to connect to such that special node first in order to transmit data if the receiver is out of their range. Single-hop [2] (All partners max. one hop apart), For Example: Bluetooth piconets, PDAs in a room, gaming devices.

Fig-4. Single-hop



Multi-hop [2] (Cover larger distances, circumvents obstacles), For Example Bluetooth scatternet, TETRA police network, carto-car networks.

Fig-5. Multi-hop



Out of three WLANs: IEEE 802.11 and HiperLAN2 are usually needs infrastructure, and additionally they support ad-hoc networking. The third WLAN (Bluetooth) is the classical wireless ad-hoc network. Bluetooth focuses on spontaneous ad hoc networks or on the simple connection of two or more devices without the setup of any infrastructure.

4.3. Wireless Sensor Networks (Wsns)

Wireless Sensor Networks (WSNs) have been widely considered as one of the most important technologies for the twenty - first century [15]. Enabled by recent advances in microelectronic mechanical systems (MEMS) and wireless communication technologies, tiny, cheap, and smart sensors deployed in a physical area and networked through wireless links and the Internet provide unprecedented opportunities for a variety of civilian and military

applications, for example, environmental monitoring, battle field surveillance, and industry process control [16]. Distinguished from traditional wireless communication networks, for example, cellular systems and mobile ad hoc networks (MANET), WSNs have unique characteristics, for example, denser level of node deployment, higher unreliability of sensor nodes, and severe energy, computation, and storage constraints [17], which present many new challenges in the development and application of WSNs.

5. Results

There are many more area in ad-hoc networks which persists various issues and challenges in their designing and implementation. These areas are multicast routing in ad-hoc wireless networks, transport layer and security protocols for ad hoc networks, Quality of Service (QoS) in ad-hoc wireless networks. A healthy networks performance need to be measured regularly so that the network may always be at peak performance and available for upgrades. This in turn avoids costs on unexpected crashes or data loss and any other obstacles that maybe faced during the operation of the network. Before a network can be tested, the administrator needs to determine which of the network characteristics are to be tested, thus identifying the network devices that are required for data gathering.

6. Conclusion

In this paper we surveyed the ad-hoc wireless networks mainly from a technical point of view. We also have made an attempt to clarify what an ad hoc network actually is and what issues and challenges are faced by an ad hoc mobile wireless.

Due to dynamic topology, distributed operation and limited bandwidth MANET is more vulnerable to many attacks. In this paper, we discussed the MANET and its characteristics, also challenges, advantages, application and security goal. The network design plays an important role especially when the distribution of the wireless sensors is the point, it has significant impact on the effectiveness of the quality of service of Ad-hoc networks.

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