Analysis of AODV Protocol in Wireless Scenario

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Abstract--The world of wireless communication is rapidly growing and provide various way of communication such as Ad-hoc network, sensor network etc. Ad-hoc network is a self configured wireless network which consist the number of mobile node and the communication between the nodes are done by without any centralized control. Sensor Network is a technology which has capability to change many of the Information Communication aspects in the upcoming era.This paper analysis the performance of Ad hoc On-Demand Distance Vector routing protocol (AODV) in different wireless Scenario that is Wireless Personal Area Network (WPAN), Local Area Network (WLAN) and Wireless Metropolitan Area Network (WMAN). Zigbee (802.15.4) is a Sensor network, used for WPAN whose network range is very small under in 10-100m and work on star, tree and mesh topology, Wi-Fi (802.11) network for WLAN whose network range is 50-100m and WiMax (802.16) network for WMAN whose network range is 50km and working in two mode –Fixed WiMax and Mobile WiMax .Wi-Fi and WiMax both are Ad-hoc network. This paper presents comparison of the performance of AODV routing protocol under the ZigBee Mesh network, Wi-Fi and Mobile WiMax(WMAN) according to various metrics like throughput, end to end delay, packet error rate, packet delivery ratio and routing overhead with constant Number of nodes.

KEYWORDS:-Ad-hoc Network, Zigbee, Wi-Fi, WiMax, Simulator, Topology

1. INTRODUCTION

In Modern era wireless network play important role in networking and communication field. Wireless technology is rapidly replacing the wired network in maximum field, primarily because it is more efficient and also available in low cost compared to wired network. These networks have become more efficient with the introduction of mobility concept of nodes [1].

There are many variation of wireless networking .i.e. Structured wireless network, Ad-hoc Network, Sensor network etc. Structured wireless network have fixed centralized node (gateway or base station) concerned with routing or switching of data. Ad Hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any centralized administration, in which individual nodes cooperate by forwarding packets to each other to allow nodes to communicate beyond direct wireless transmission range [2].The nodes communicate without an infrastructure,

such as base station, wired access point, supervisors monitoring network performance as a whole etc [2]. A Wireless Sensor Network is a network of many sensor nodes, having wireless channel to communicate with each other. Without any centralized control and predefined communication link, it can transfer signals to the exterior world [3].

Many types of wireless networks exist: Personal Area Network, Local Area Network and Metropolitan Area Network. A PAN is much small in size, such as Home area network, A LAN is small in size as compared to a Metropolitan Area Network [4]. In a LAN there are a limited number of computers in the network. A LAN is mostly used in private organizations. In a MAN there are many computers in the network. It is used in places like a large college campus. In general a MAN consists of many LANs [5]. Routing is always a main issue for any type of wireless network. These paper discuss Zigbee (WPAN), Wi-Fi(WLAN), WiMax(WMAN) and analysis of Ad-hoc on demand Distance vector routing protocol(AODV).In the paper analysis AODV protocol in different network technology, here we use Zigbee terms for Zigbee mesh network and woman for mobile woman.

2. Overview of Zigbee, Wi-Fi and WiMax

2.1 Zigbee

ZigBee is an IEEE 802.15.4Phy/MAC standard. It is a low-cost, low-power, wireless mesh networking use for personal area network. Its network range is 10-100 meters line of sight depending on power output, environment, antenna, and operating frequency band. It is used as a sensor network. To provide the global availability, the ZigBee devices use unlicensed 2.4GHz industrial scientific and medical (ISM) band [7] .The low cost allows the technology to be widely deployed in wireless control and monitoring

applications, the low power-usage allows longer life with smaller batteries, and the mesh networking provides high reliability and larger range. ZigBee has been developed to meet the growing demand for capable wireless networking between numerous low power devices [6].

Zigbee 802.15.4	
Transmission Range (meters)	10 – 100
Battery Life (days)	100 – 1,000
Network Size (# of nodes)	> 65,000
Throughput (kb/s)	20 - 250

Table 1 – General ZigBee Specifications

The IEEE802.15.4 task group is defining the physical layer (PHY) and the media access controller (MAC). Zigbee Alliance defines the network/Security layer security, and application framework profile layers for an IEEE 802.15.4-based system. The PHY work to detect receiver energy, link quality indication and clear channel assessment. Both contention-based and contention-free channel IEEE and 16-bit short addressing, supporting over 65,000 nodes per network.

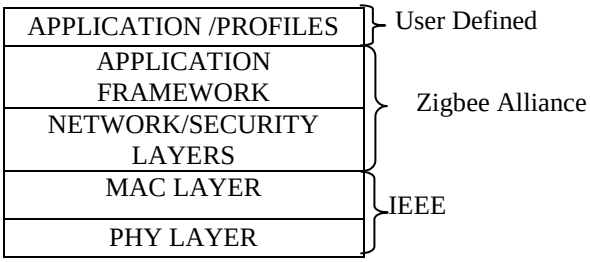

Figure 1- IEEE 802.15.4 Stack

The MAC provides network association and disassociation, has an optional super frame structure with beacons for time synchronization, and a guaranteed time slot (GTS) mechanism for high priority communications. The channel access method is carrier sense multiple access with collision avoidance (CSMA-CA)[8]. The channel access can be obtained in two modes, i.e. non beacon and beacon mode [15]. Zigbee's network layer supports three networking topologies: star, mesh, and cluster tree. Mesh or peer-to-peer, networks enable high levels of reliability and scalability by providing more than one path through the network [8].

The ZigBee network layer supports a "route discovery" facility in which a mesh network can be requested to find the best available route to the destination, when sending a message. Route discovery is initiated when requested by a data transmission request. Zigbee basically use AODV (Ad-hoc on demand distance vector routing) protocol.

Zigbee use three type of node-

Network Coordinator: It requires maximum memory along with computing power and has the ability to maintain the overall network knowledge. Each network has exactly one coordinator.

Full Function Device: It can function as a network coordinator if it is supplied with additional memory and computing power. It supports 802.15.4 functions and features which are supported by the standard. Zigbee Router is FFD. They communicate directly to each other [9].

Reduced Function Device: It have limited function compare to network coordinator and FFD device. This is primarily done

to reduce the cost and complexity. A Zigbee end device is basically a Reduced Function Device (RFD). They communicate to each other through coordinator or router, end device are not participate in routing.

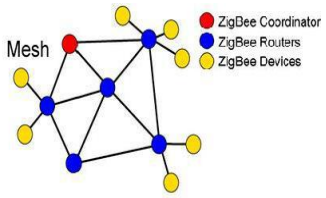

Figure 2- Mesh topology[23]

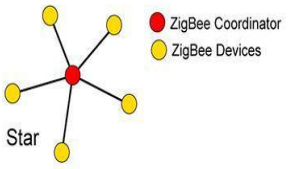

Figure 3- Star topology[23]

2.2 Wi-Fi

Wireless Fidelity (Wi-Fi) is a name given to the IEEE 802.11 standard, which was developed to specify an air interface between a wireless client and a base station. It uses radio waves to provide wireless high-speed Internet and network connection. WiFi/802.11 WLAN standard is limited in most cases to only 100 - 300 feet (30 - 100m)[13]. A WLAN (WiFi) is a data transmission system designed to provide location-independent network access between computing devices by using radio waves rather than a cable infrastructure.

Wi-Fi is meant to be used generically when referring to any type of 802.11 network, whether802.11b, 802.11a, 802.11g etc. The first 802.11b network should move data at up to 11 megabits per second (Mbps).Then came products using 802.11a, followed shortly thereafter by 802.11g, each with maximum speeds of 54Mbpsand throughput of around 25Mbps. WLAN hardware built around 802.11g was quickly embraced by consumers and businesses seeking higher bandwidth.[10]. The next Wi-Fi speed standard, 802.11n, will likely offer a bandwidth of around 108Mbps [10]. And because it will be an industry standard, n-compliant devices will be interoperable. Wi-Fi works with radio frequency (RF) technology, a frequency within the electromagnetic spectrum associated with radio wave propagation. When an RF current is supplied to an antenna, an electromagnetic field is created that then is able to propagate through space.

2.3 WiMAX

WiMAX (Worldwide Interoperability for Microwave Access) is the latest wireless technology to be approved by the IEEE 802.16 working group. It is based on WMAN. WiMAX is used for wireless data transmission covering a range similar to cellular phone towers, with high performance in both distance and throughput [1]. WiMAX networks consist of a central radio Base Station (BS-which is fixed) a number of Subscriber Stations (SSs).

WiMAX can provide broadband wireless access (BWA) up to 30 miles (50 km) for fixed stations, and 3 - 10 miles (5 - 15 km) for mobile stations [13]. It is the latest development and considered as a 4G (Fourth Generation) technology [12].The standard covers both media access control (MAC) and physical (PHY) layers for combined fixed and mobile operation in licensed frequency bands. The

MAC layer is optimized for longer distances because it was designed specifically to tolerate longer delays and delay variations. It is a standard for point-to- multipoint wireless networking. WiMAX system uses Orthogonal Frequency Division Multiplexing (OFDM) in the physical layer. It is based on the adaptive modulation technique in non-line-of–sight (NLOS) environments. Base stations of WiMAX can provide communication without the need of line-of-sight (LOS) connection. WiMAX base station has number of subscribers and also covers large area range.

WiMAX standard have two versions:

1. IEEE 802.16d :- It support fixed applications so it is called as fixed WiMAX.. Fixed WiMAX is very robust against multi-path propagation because it used an air interface based OFDM (Orthogonal Frequency Division Multiplexing) with time division duplexing (TDD) in uplink sub frame and time division multiplexing (TDM) in downlink sub frame[11], in Physical layer. It provides wireless DSL (Digital Subscriber Line/Loop) technology where broadband cables are not available

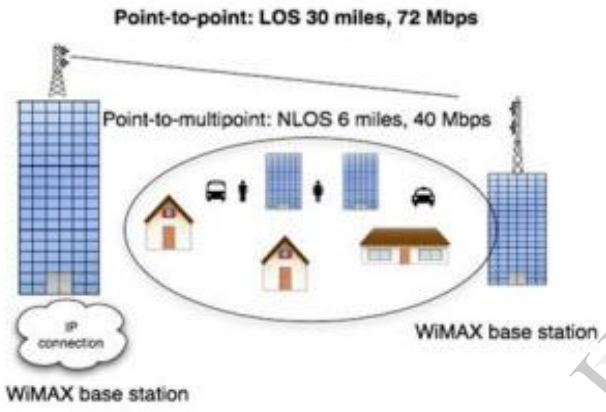

Figure 4- Fixed WiMAX offers cost effective point to point and point to multi-point solutions.[13]

2. IEEE 802.16e:- WiMAX standard 802.16e uses OFDMA (Orthogonal Frequency Division Multiplexing Access) technique with time division multiple access (TDMA). It provides support for nomadic and mobility services so it also known as Mobile WiMAX [12].Here, BS (which is fixed) is connected to public network and can handle multiple sectors simultaneously and SSs are mobile.

Figure 5-Mobile WiMAX allows any telecommunications to go mobile [13].

WiMAX can operate at higher bit rates or over longer distances but not both. Operating at the maximum range of 50 km (31 mile) increases bit error rate and thus results in a much lower bit rate. Conversely, reducing the range (to under 1 km) allows a device to operate at higher bit rates [14].

3. Comparation among Zigbee, Wi-Fi, WiMax

3.1 Difference between Wi-Fi and WiMax

1. WiMAX is a long range system, covering many kilometers that uses licensed or unlicensed spectrum to deliver connection to a network, in most cases the Internet. Wi-Fi uses unlicensed spectrum to provide access to a local network.
2. Wi-Fi runs on the Media Access Control's CSMA/CA protocol, which is connectionless and contention based, whereas WiMAX runs a connection-oriented MAC.
3. Both 802.11 (Wi-Fi) and 802.16 (WiMAX) define Peer-to-Peer (P2P) and ad hoc networks, where an end user communicates to users or servers on another Local Area Network (LAN) using its access point or base station. However, 802.11 supports also direct adhoc or peer to peer networking between end user devices without an access point while 802.16 end user devices must be in range of the base station.
4. WiMAX provides an alternative to DSL and cable modem technologies, providing broadband access for the last mile as it acts as a backbone for Wi-Fi hotspots [16].

3.2 Comparison of Technology Wi-Fi , ZigBee , WiMAX

Technology	WiFi -802.11	ZigBee	WiMAX
Application	Wireless LAN, Internet	Sensor Networks	Metro Area Broadband Internet connectivity
Typical Range	100m	10-100m	50 km
Frequency Range	2.4 GHz	2.4GHz	2-11GHz
Data Rate	108 - 600Mbps	250Kbps	75Mbps
Modulation	DSSS	DSSS	QAM
Network	IP & P2P	Mesh	IP
Network Topology	Infrastructure (Ad-hoc also possible)	Ad-hoc	Infrastructure
Access Protocol	CSMA/CA	CSMA/ CA	Request/ Grant

Table2-comparison of wireless technologies technology Wi-Fi , Zigbee WiMax[10]

4. Overview of AODV Routing Protocol

Adhoc on demand routing protocol is a source-initiated on demand routing protocol. AODV is a combination of both DSR (Dynamic source routing) and DSDV (Destination sequence Distance vector) protocols. It has the basic route-discovery and route-maintenance of DSR and uses the hop-by-hop routing, sequence numbers and beacons of DSDV. The node that wants to know a route to a given destination generates a ROUTE REQUEST. The route request is

forwarded by intermediate nodes that also create a reverse route for itself from the destination. When the request reaches a node with route to destination it generates a ROUTE REPLY containing the number of hops requires to reach destination. All nodes that participate in forwarding this reply to the source node create a forward route to destination. This state created from each node from source to destination is a hop-by-hop state and not the entire route as is done in source routing.

5. Literature Review

In [**17]" Performance of Routing Protocols in WiMAX Networks"** These paper investigated the performance of the Three (AODV, DSDV, DSR) protocols in WiMAX networks and has been seen that the table-driven DSDV protocol has the best performance in terms of the packet delivery fraction parameter which outperforms both DSR and AODV but the delay experienced by DSDV packets are greater than the delay experienced by the on-demand routing protocols.

In[18] **"**AODV **with Source Route Accumulation for improved Routing in WiMAX"** In this propose a new approach of AODV protocol for improving the performance and overcome the problems of delay and overhead up to a large extent as comparison to basic AODV protocols. The protocol, AODV-SRA, incorporates source route path accumulation during the route discovery Process in AODV to attain extra routing information. By Composing this technique, AODV-SRA also scales better than AODV in large networks. AODV-SRA has less delay than AODV under all conditions. The number of routes accumulated in AODV-SRA increases with the number of nodes and connections. This is because the number of routes accumulated during route discovery increases as the number of nodes increase. AODV-PA could also be suitable either if overall routing load or if application oriented metrics such as delay and packet delivery ratio are important for the ad hoc network application.

In [19]" **Performance Tradeoffs among the Reactive, Proactive and Hybrid Protocols in MANET and WSN**", compare the performance of Reactive (AODV), Hybrid protocols (ZRP) and Protocols(OLSR) in terms of Throughput, End to end Delay, Energy consumed in transmit and receive mode. Show the result that for the maximum throughput AODV is the best with IEEE.802.11 as well as IEEE802.15.4,end-to-end delay with IEEE802.11 AODV shows maximum delay and than IEEE802.15.4. Energy consumption for AODV is more with IEEE802.15.4 than IEEE.802.11. ZRP and OLSR consume less transmitting and receiving energy in IEEE 802.15.4 and with IEEE.802.11 ZRP shows maximum then other two.

In [20], **"**Comparative **Performance Analysis of WiMAX IEEE802.16e System in Different Routing Protocols**", In these paper compare the different routing protocol AODV, DSR, TORA, OLSR and GRP is using different mobility scenarios. Simulation has been conducted in OPNET Modeler 14.5 and finds that, GRP and DSR perform better than TORA and OLSR. In case of AODV, it has less routing overhead, but average end to end delay is higher[AODV and OLSR performance is poor.

In [21], "**Simulating AODV and DSDV For Adynamic Wireless Sensor Networks**", Based on IEEE 802.15.4, the ZigBee for the network layer and the application layer. In these paper compare the AODV and DSDV in sensor networks with an assumption that all the node are static using NS-2 simulator and find that DSDV has higher delay and poor performance than that of AODV.

In [22],"**Intelligent Route Discovery for ZigBee Mesh Networks"** make the use of a novel fuzzy logic-based metric to be used in the decision making process of AODV. This metric evaluates important node features during route discovery and their selection, hop by hop, give the best option in order to get energy and delay efficient routes. These experiments provide improved AODV-AODV-FL that provide reduce communication delay, number of packets drops and overhead, improving route efficiency and reducing packet overload.

6. Performance Metrics and Analysis

1. Throughput- It refers to the radio of total number of bits received by the destination and total number of bits sends by source.

2. End to End delay- It refers to time difference between the packet generation time at the source and packet arrival time to the destination**.**

3. Packet delivery ratio-It is a radio between the no of packet received by destination and no of packet send by source.

Metrics	Zigbee (IEEE802.15.4)	Wi-Fi (IEEE802.11b)	WiMax (IEEE802.6e)
Throughput	High (Constant)	High (Constant)	Medium (Varied with load)
End to End Delay Performance	Medium	High	High(varied with time)
Packet Delivery Ratio	High	High	Low

Table-3 Analysis of AODV protocol with Zigbee, Wi-Fi and Mobile WiMax

7. Conclusion

AODV routing protocol is commonly used for these three types of network technology. After the review we conclude that AODV have good and constant throughput after a particular state (load/time) with Wi-Fi (IEEE802.11) and Zigbee (IEEE802.15.4). In Mobile WiMax (IEEE802.16e) AODV have medium throughput which are varying with time and load. Wi-Fi (IEEE802.11) AODV and WiMax (IEEE802.16e) AODV have more end to end delay where as in IEEE802.15.4 AODV have least delay.

In future evaluate the other metric of AODV protocol through network simulator in Zigbee, WiMax and Wi-Fi, and also will include other technologies such as Bluetooth, HyperLan etc and compare the performance of AODV protocol with different no of nodes in all these technologies.

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