# COMPARATIVE ANALYSIS OF MANET ROUTING PROTOCOLS IN WI-FI NETWORKS USING EXATA 5.1

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***Abstract- Now a days video streaming is an attractive feature to many applications, such as emergency live video transmission, video conferencing and inter-vehicle video conversation. This Paper undergoes an emulation based study of MANET Routing Protocols in WiFi (IEEE 802.11n) networks. In this paper four routing protocols namely AODV, DYMO, LANMAR and OSPFv2 protocol has been compared with change in aggregation mode and change in bandwidth of 802.11n using EXata 5.1 emulator. Various metrics used for performance evaluation are throughput, End to End Delay and Packet Delivery Ratio. This analysis will help to forecast the best routing protocol.***
***General Terms Performance evaluation, WiFi, Routing Protocols***
***Keywords: Wifi, AODV, DYMO, LANMAR, OSPFV2, Emulation***

## I. INTRODUCTION

The IEEE 802.11 wireless LANs (WLANs) represent an interesting opportunity for real time enivornment since, besides the known advantages of wireless networks, they can provide satisfactory performance for a wide range of applications. In particular, the IEEE 802.11n[1][2] standards have proved to be an effective solution to the communication problems typical of real time environment where tight constraints in terms of both timeliness and reliability are often encountered. The IEEE 802.11, actually, is a family of progressively defined standards. In 2009 the IEEE 802.11n amendment was released, providing several improvements to the previous versions. In particular, it supports Multiple Input Multiple Output (MIMO) features, which allow for increased reliability, longer communication distances and higher transmission rates, while maintaining operations in the unlicensed 2.4 GHz and 5 GHz Instrumentation, Scientific and Medical (ISM) bands. Today, IEEE 802.11n[2][3] networks are widely deployed in general purpose home/office/college campus communication systems. Video communication over mobile broadband has demanded network venders to maintain high reliability, quality and low latency in limited bandwidth environment. These performance improvements are typically obtained through how nodes interact with each other to route packets between various nodes in a campus network. Though illustrates the best performance of the protocols. Thus, in this paper, we start from an analysis of the most promising features of IEEE 802.11n and determine which could be useful in a real–time environment context[4]. Then, we present the results of some experimental sessions, which provide useful insights about the proper network configuration for college environments. Network emulation method provides an exact, high quality reproduction of real system behavior so that the emulated system is indistinguishable from the real system. Emulation is a cost-effective method for evaluating new network technologies before actual systems or networks are implemented. Further, emulation can be used to verify performance of net-centric systems and to set realistic expectations of the real system to be deployed. Hence, in this paper an attempt has been made to evaluate the performance of best routing protocol for real video traffic generated by Video LAN (VLC) media player using EXata network emulator considering Packet Delivery Ratio (PDR), Throughput and End to End Delay as performance metrics. The rest of the paper is organized as follows. Section 2 gives a brief overview of WiFi (IEEE 80211n). Section 3 gives a overview of Routing Protocols. Emulation studies and results are given in section 4 and Section 5 concludes the paper.

## II. OVERVIEW OF Wi-Fi (802.11N)

The IEEE 802.11n standard provides new and interesting features at both the physical and data link layers.

1) IEEE 802.11n PHY layer: the introduced enhancements required, basically, a substantial re-design of the whole layer. Modulation and coding schemes (MCS): The set of available modulations has been slightly modified with respect to older versions of the standard, achieving an 11% increase in raw transmission rate, and also the number of subcarriers of the Orthogonal Frequency-Division Multiplexing (OFDM) modulation for 20 MHz channels has been increased from 48 to 52, yielding a further 8% rate improvement. Moreover, IEEE 802.11n makes available 40 MHz transmission channels, in both the 2.4 GHz and the 5 GHz frequency bands, as an alternative to basic 20. MHz ones, roughly allowing to double the transmission rate, reaching 130 Mbit/s. Finally, two other appealing features are worth mentioning, namely the reduction of the guard interval (GI) between two consecutive OFDM symbols from 800 ns to 400 ns (which raises the transmission rate to 150 Mbit/s), and the possibility of replacing classic convolutional codes with the more robust low density parity check (LDPC) ones. IEEE 802.11n MAC layer: the new MAC layer strongly builds on the IEEE 802.11e found at the ones which could actually ions, which introduced the Quality of Service (QoS) concept and defined the possibility for a station to obtain a transmit opportunity (TXOP) period during which it can send multiple consecutive frames avoiding contention and back off procedures. IEEE 802.11n enhances this feature allowing

  

to aggregate more frames into a single data unit to be transmitted during a TXOP, thus reducing the overhead due to interframe spaces and headers. In addition, the Block ACK (BA) mechanism allows the receiver to acknowledge the transmission of multiple data units with a single frame, further improving channel utilization. As a difference from the original IEEE 802.11e procedure, in the new standard the BA is implicitly sent by the receiver in response to an aggregated frame.There are two aggregation options: A-MSDU: The concept of A-MSDU is to allow multiple MSDUs to be sent to the same receiver concatenated in a single MPDU. This supporting function for A-MSDU within 802.11n is mandatory at the receiver[5]. Due to Destination address (DA) and Sender address (SA) in the subframe header must match to same receiver address (RA) and the transmitted address (TA) in the MAC header. A-MSDU cannot be used for broadcast and multicast.

A-MPDU: The concept of A-MPDU aggregation is to join multiple MPDU sub frame with a single leading PHY header. A difference from A-MSDU aggregation is that A-MPDU functions after the MAC header encapsulation process. This method offer higher MAC throughput compare to A-MSDU.

Two-Level Aggregation: A two-level frame aggregation comprises a blend of A-MSDU and A- MPDU over two stages. The basic operation is explained as follows: In the first stage, if any MSDUs that are buffered in the A-MSDU provisional storage area justify the A-MSDU constraints explained in the previous related subsection, these data units can be compacted into a single A-MSDU[6]. If the TIDs are different, all these aberrant frames can move to the second stage where they will be packed together with any A-MSDUs derived from the first stage or other single MSDUs by using A-MPDU aggregation. However, it must be mentioned that given that the maximum MPDU length for an A-MPDU data frame is limited to 4095 bytes, then A-MSDUs or MSDUs with lengths larger than this threshold can not be transmitted. Conjointly, any fragments from an A-MSDU or MSDUs also cannot be included in an A-MPDU. In the following section, we evaluate how this synthesis is more efficient in most of the cases than A-MPDU and A-MSDU aggregation operating alone.

## III. ROUTING PROTOCOLS

AODV

The Ad Hoc On-Demand Distance Vector routing protocol (AODV) is an improvement of the Destination-Sequenced Distance Vector routing protocol (DSDV). It is based on distance vector and also uses the destination sequence numbers to determine the freshness of the routes. It operates on the On-demand fashion. AODV requires hosts to maintain only active routes[7]. The advantage of AODV is that it tries to minimize the number of required broadcasts. It creates the routes on an on-demand basis, as opposed to maintain a complete list of routes for each destination. Therefore, the literature on AODV, classifies it as a pure on demand route acquisition system.

Dymo

The DYnamic MANET On-demand (DYMO) protocol is a reactive routing protocol being developed within IETF's MANET working group[8]. Typically, all reactive routing protocols rely on the quick propagation of route request packets throughout the MANET to find routes between source and destination. While this process typically relies on broadcasting, route reply messages that are returned to the source rely on unicasting. DYMO is basically an improvement over the AODV protocol as for AODV every node records the next hop to send a packet to a specific destination.

LANMAR

LANMAR is an efficient routing protocol in a “flat” ad hoc wireless network[9]. LANMAR assumes that the large scale ad hoc network is grouped into logical subnets in which the members have a commonality of interests and are likely to move as a “group” LANMAR uses the notion of landmarks to keep track of such logical subnets. It uses an approach similar to the landmark hierarchical routing proposed in for wired networks. Each logical group has one node serving as landmark. The route to a landmark is propagated throughout the network using a Distance Vector mechanism. The routing update exchange of LANMAR routing can be explained as follows. Each node periodically exchanges topology information with its immediate neighbours. In each update, the node sends entries within its Fisheye scope. Updates from each source are sequentially numbered. To the update, the source also piggybacks a distance vector of all landmarks. Through this exchange process, the table entries with larger sequence numbers replace the ones with smaller sequence numbers. As a result, each node has detailed topology information about nodes within its Fisheye scope and has a distance and routing vector to all landmarks. LANMAR outperform AODV protocol.

OSPFv2

OSPFv2 is an IETF link-state protocol for IPv4 networks. An OSPFv2 router sends a special message, called a hello packet, out each OSPF-enabled interface to discover other OSPFv2 neighbor routers. Once a neighbor is discovered, the two routers compare information in the Hello packet to determine if the routers have compatible configurations. The neighbor routers try to establish adjacency, which means that the routers synchronize their link-state databases to ensure that they have identical OSPFv2 routing information. Adjacent routers share link-state advertisements (LSAs) that include information about the operational state of each link, the cost of the link, and any other neighbor information. The routers then flood these received LSAs out every OSPF-enabled interface so that all OSPFv2 routers eventually have identical link-state databases. When all OSPFv2 routers have identical link-state databases, the network is converged. Each router then uses Dijkstra’s Shortest Path First (SPF) algorithm to build its route table.

## IV. EMULATION STUDIES AND RESULTS

Emulation studies has been carried out to evaluate the performance of specified routing protocols such as AODV, DYMO, LANMAR and OSPFv2 for real video traffic using EXata 5.1 network emulator. Emulation test bed established consists of an emulation server and four computers interconnected using network router as shown in Figure 1.

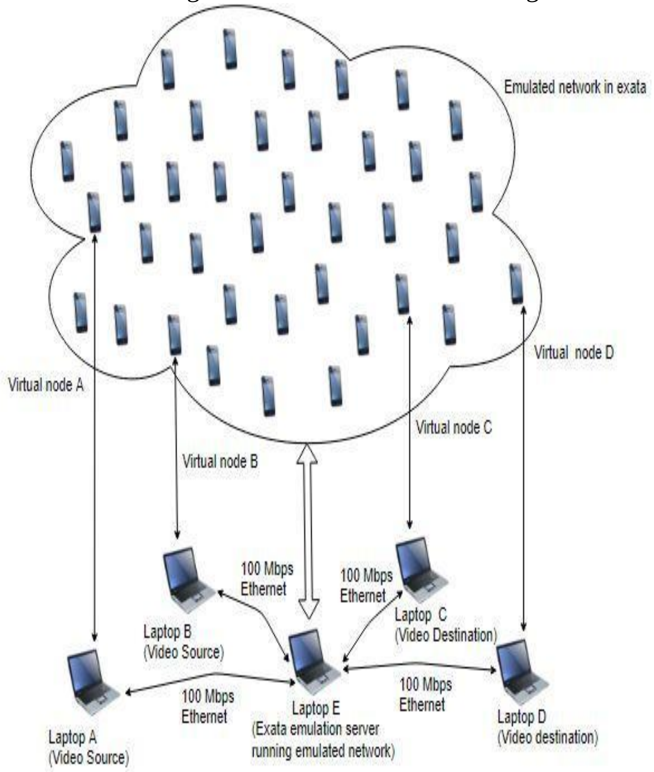


Figure 1: Target scenario setup

The connections between them are established using EXata connection manager[11]. The scenario designed for emulation studies using EXata 5.1 network emulator consists of an one subnet, twelve access point, four routers and remaining nodes are user equipment's as shown in Figure 2, where four user equipment’s are mapped onto four real computers (Figure 1).

Figure 2. Snapshot of the scenario designed for emulation studies

Among these four computers two of them are configured as media servers and the other two as media clients[10]. Each media server transmits mp4v encoded video file using VLC media player to the corresponding client (Figure 1). Packets are captured using Wireshark network protocol analyzer version 1.10.6 at both the media server and client for analysis of performance metrics considered. The emulation parameters considered are listed in Table 1 and Table 2 gives the information of Transmitted video configuration.

| Parameter | Values |
|---|---|
| Emulator | Exata 5.1 |
| Emulation-Time | 235 sec |
| Emulation Area | 1500m x 1500m |
| Propagation-channel-frequency | 2.4GHz |
| Propagation-Model | Statistical |
| Antenna Model | Omni-directional |
| Transport layer Protocol | UDP |
| Network Protocol | IPv4 |
| Physical Layer Model | IEEE 802.11n |
| Mac Protocol | IEEE 802.11e |
| Path-loss model | Two ray |
| Shadowing model | Constant |
| Routing Protocol | AODV, DYMO, LANMAR and OSPFv2 |
| Channel Bandwidth | 20/40 MHz |
| Mobility model | Random way-point |
| Node mobility speed | 10 |
| PHY-Num-Antenna | 2x2 |

Table 1. Emulation parameters

| Parameters | Values |
|---|---|
| Application Software | VLC-2.2.6 |
| Transcoding (active) | H.264+ACC(MP 4) |

  

| | |
|---|---|
| Encapsulation | MPEG-TS |
| Video codec | MPEG-4 |
| Streaming bit rate | Variable (16 to 2048 Kbps) |
| Streaming frame rate | 52 fps |
| Video resolution | 398x224 |

Table 2. Transmitted video configuration

Emulation study is carried out for video codec bit rate of 16 Kbps with AODV routing protocol. Throughput, end to end delay and PDR are calculated by capturing packets at media servers and clients. Emulation studies are repeated for video codec bit rates: 16, 32, 64, 128, 256, 512, 1024 and 2048 Kbps. Emulations studies are repeated with DYMO, LANMAR, and OSPFv2 routing protocols for various video codec bit rates as considered in emulation studies of AODV.

Scenario 1: A-MPDU and Two level aggregation mode without destination mobility.

In this scenario, Emulation has been carried out with change in aggregation mode in mac layer of IEEE 802.11n and performance metrics such as average throughput, average end-to-end delay, and PDR connections are recorded in order to find best routing protocols. Emulation studies are repeated by changing the video codec bit rate of each routing protocols.

Figure 3 shows the average throughput performance of specified routing protocols for different video codec bit rates. It is evident from Figure 3 that the throughput performance of OSPFv2 routing protocol for A-MPDU and two level aggregation mode is similar. It is also observed from Figure 3 that for higher video codec bit rates, throughput performance of OSPFv2 routing protocol is better than AODV, LANMAR and DYMO.

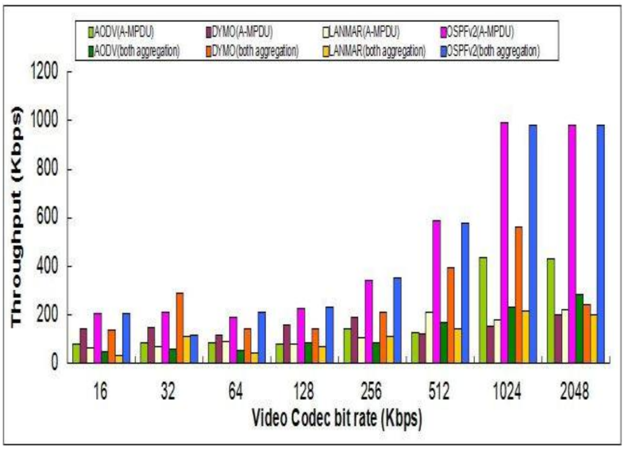


Figure 3:Average Throughput performance for different video codec bit rates

Figure 4 shows the End to End Delay for different video codec bit rates. Here we observed that LANMAR, DYMO, and AODV have high delay in A-MPDU and two level aggregation. So OSPFv2 performs the low delay. Since OSPFv2 has the advantage of large enterprise networks and converges much faster than other routing protocols due to its calculation algorithm.

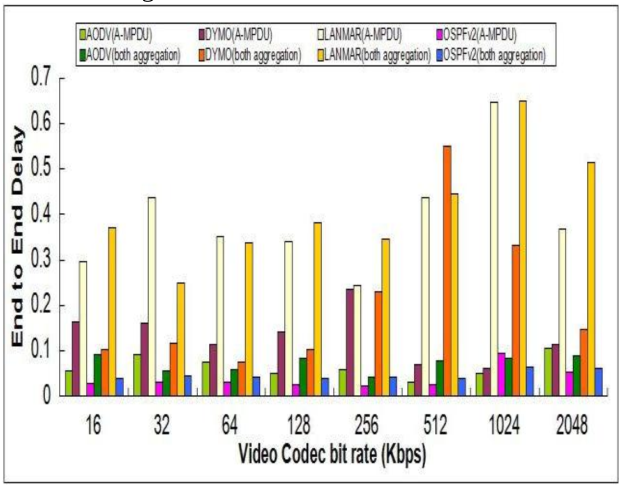


Figure 4: Average End to End Delay performance for different video codec bit rates

Figure 5 and 6 illustrates the PDR for different video codec bit rates at media client 1 and 2 respectively. It is apparent from figure 5 and 6 that PDR for OSPFv2 for the both level aggregation are almost same. From the above analysis we can say that OSPFv2 is the best routing protocol for A-MPDU and Two level aggregation.

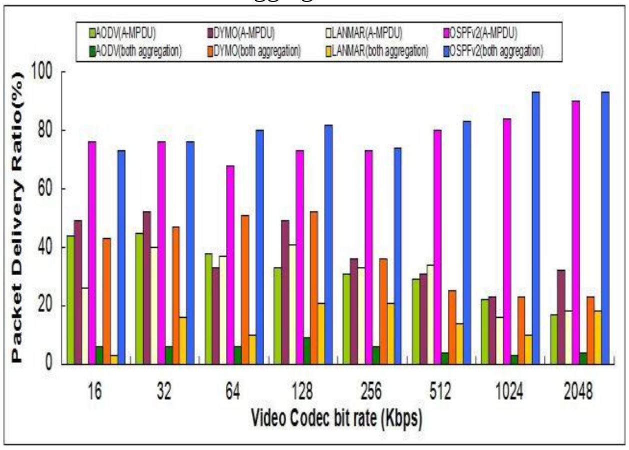


Figure 5: PDR at media client 1 for different video codec bit rates

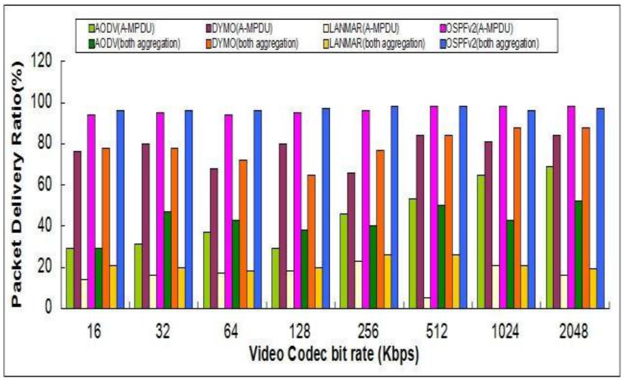


Figure 6: PDR at media client 2 for different video codec bit rates

Scenario 2: Change in Bandwidth of WiFi network to 20MHz and 40 MHz. In this scenario, Emulation has been carried out with change in Bandwidth of WiFi networks in physical layer of IEEE 802.11n and performance metrics such as aggregate throughput, average end-to-end delay, and PDR connections are recorded in order to find best routing protocols. Emulation studies are repeated by changing the video codec bit rate of each routing protocols. Figure 7 shows the average throughput performance of specified routing protocols for different video codec bit rates. It is evident from Figure 7 that the throughput performance of OSPFv2 routing protocol for 20 MHz and 40MHz where 40MHz performs better. It is also observed from Figure 7 that for higher video codec bit rates, throughput performance of OSPFv2 routing protocol is better than AODV, LANMAR and DYMO.

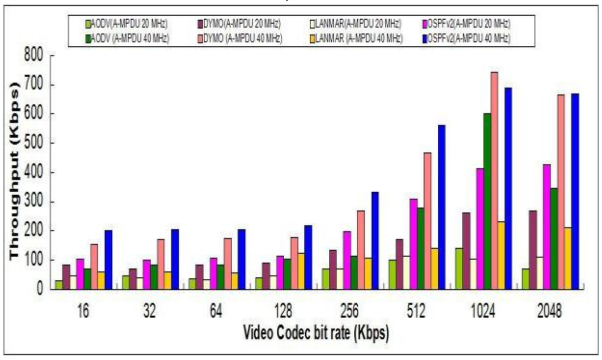


Figure7: Average Throughput performance for different video codec bit rates

Figure 8 shows the End to End Delay for different video codec bit rates. Here we observed that LANMAR, DYMO, and AODV have high delay in 20MHZ. So OSPFv2 performs the low delay in 40 MHz bandwidth. Since OSPFv2 has the advantage of large enterprise networks and converges much faster than other routing protocols due to its calculation algorithm.

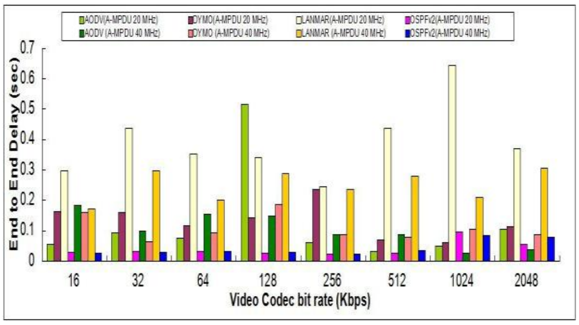


Figure 8: Average End to End Delay performance for different video codec bit rates

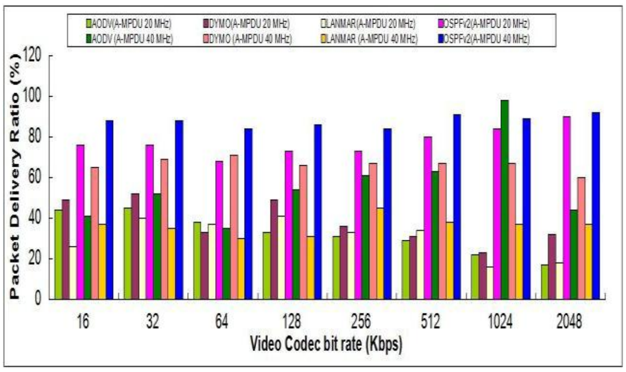


Figure 9: PDR at media client 1 for different video codec bit rates

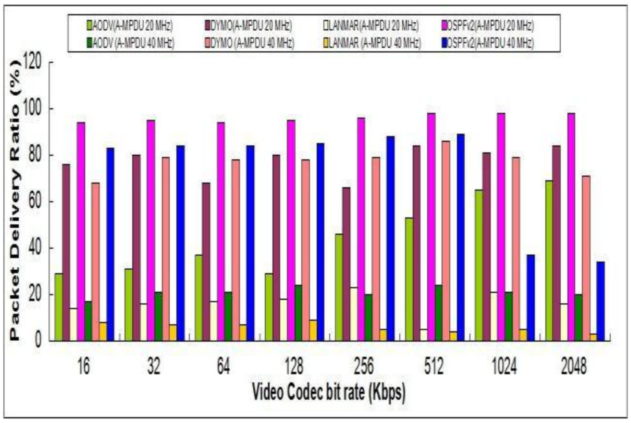


Figure 10: PDR at media client 2 for different video codec bit rates

Figure 9 and 10 illustrates the PDR for different video codec bit rates at media client 1 and 2 respectively. It is apparent from figure 9 and 10 that PDR for OSPFv2 for 40MHz performs better. From the above analysis we can say that OSPFv2 is the best routing protocol for 40MHz bandwidth as well as for 20 MHz.

## V. CONCLUSION

In this paper, we evaluate the performance of real time video streaming using EXata 5.1 network emulator. In order to presents a performance difference of AODV, DYMO, LANMAR and OSPFv2 routing protocols in WiFi (IEEE 802.11n) networks. We measured the throughput, end to end delay and PDR as performance metrics. Our emulation result showed that OSPFv2 shows better performance among all routing protocols. We can conclude that OSPFv2 is the best choice for large networks since it has the fastest convergence and bandwidth efficiently.

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