12th IBCAST-2015

International Bhurban Conference on Applied Sciences & Technology

13th – 17th January, 2015

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ADVANCED MATERIALS
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WIRELESS COMMUNICATION & RADAR

Organized by
Centres of Excellence in Science & Applied Technologies (CESAT) Islamabad - Pakistan
in Collaboration with
Beihang University (BUAA), Beijing (China), Beijing Institute of Technology (BIT), Beijing (China)
Nanjing University of Aeronautics & Astronautics (NUAA), Nanjing (China)
and Northwestern Polytechnical University (NPU), Xi'an (China)

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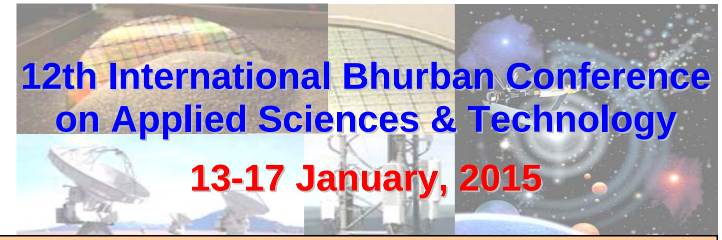
Table of Contents

Technical Program (Tentative)
Wireless Communication & Radar



Day 1: January 13, 2015

9:30-Onwards	**REGISTRATION**	
10:30-12:00	**INAUGURAL CEREMONY**	
12:30-1400	**LUNCH**	
14:00-14:50 Invited Talk # 1	Electromagnetic Diffraction Modeling and Simulation	**Prof. Levent Sevgi** Okan University Istanbul, Turkey
14:50-16:30 **EM & Antenna Session-I**	**WCR-111** U Slot Microstrip Patch Antenna with truncated corners and its Performance Improvement Using EBG Structures	**Adil Zaman Babar** UET, Peshawar
	WCR-123 Tunable Textile Antenna for Wireless Body Area Network	**Ambreen Javed** SEECS, NUST
	WCR-125 Effect of Ground Plane on the Input Impedance of Quadrifilar Helix Antenna	**Muhammad Ahmad** COMSATS, Lahore
	WCR-129 Research on the Radiation Mechanism of Plate End-fire Arrays	**Jia Cao** BIT, China
	WCR-85 A Novel Super Wideband Patch Antenna using Frequency Selective Surface (FSS)	**Aqeel Hussain Naqvi** SEECS, NUST

Day 2: January 14, 2015

10:00-10:50 Invited Talk # 2	An Efficient Approach for Reducing the Complexity of Reconfigurable Antennas	**Dr. ChangYing Wu** NPU, China
10:50-11:10 **EM & Antenna Session-II**	**WCR-154** A Novel Printed RFID Tag Antenna for Specific UHF Bands	**Abdul Quddious** SEECS, NUST
11:10-11:30	**TEA**	
11:30-12:50 **EM & Antenna Session-II**	**WCR-313** Effect of Land Clutter on Burst Height of Radio Proximity Fuze	**Ali Raza** BUAA, China
	WCR-322 Analysis of Tropospheric Radio Refractive Conditions in Karachi, Pakistan	**Naveed Mufti** UET, Peshawar
	WCR-394 Correction of faulty pattern using cuckoo search algorithm and symmetrical element failure technique along with distance adjustment between the antenna array.	**Shafqat Ulla Khan** ISRA University
	WCR-451 On-body textile antenna design & development for body-centric wireless communication systems	**Hamza Nawaz** CESAT, Islamabad
12:50-1400	**LUNCH**	
14:00-14:50 Invited Talk # 3	Research on ISAR Imaging for orbital objects	**Dr. Xiongjun Fu** BIT, China
14:50-16:30 **Communication System Session-I**	**WCR-42** Quality of Service Analysis for Multimedia traffic using DSR, AODV and TORA over Wi-Media Ultra wide band	**Yousaf Bin Zikria** Yeungnan Univ, Korea
	WCR-45 Distributed turbo codes with multiple-relays and multi-receive antennas at the destination for non-line of sight source-destination link with unknown CSI	**Saqib Ejaz** NUAA, China
	WCR-131 Extension of SAFNAQ Algorithm for MC-CDMA Using Channel Allocation	**Muhammad Safdar** Zhejiang Univ, China
	WCR-138 A Cluster Based Cooperative Technique for Spectrum Sensing using Rely Factor	**Tallataf Rasheed** NUST, Islamabad
	WCR-239 AT-SAFNAQ Algorithm for Power Allocation in MC-CDMA System	**Imran Mehmood** QAU, Islamabad

Technical Program (Tentative)
Wireless Communication & Radar

Day 3: January 15, 2015		
10:00-10:50 Invited Talk # 2	Multi-frequency impedance transformers for frequency dependent complex loads	**Dr. Yun Liu** NUAA, China
10:50-11:10 **RF & Microwave**	**WCR-51** Design and Fabrication of a GaN HEMT Based Amplifier for Wideband Applications	**Faheem Akhtar Mughal** CESAT, Islamabad
11:10-11:30	**TEA**	
11:30-12:10 **RF & Microwave**	**WCR-87** GaN based Two-Stage Pulsed Class-C Amplifier for S-band Radar Applications	**Ahsan Kashif** CESAT, Islamabad
	WCR-136 Design and Analysis of Metamaterial based Power Divider/Combiner for Microwave Applications	**Usman Ahmed** COMSATS, Lahore
12:10-12:50 **Radar Algorithms**	**WCR-452** Low-Earth-Orbit Object Detection by space borne netted radar	**Jiayun Chang** BIT, China
	WCR-396 Cognitive Frequency Offset Calculation for Frequency Diverse Array Radar	**Abdul Basit** IIU, Islamabad
12:50-1400	**LUNCH**	
14:00-14:50 Invited Talk # 3	Radar HRRP-ATR based on EMD and NGPSR	**Dr. Wang Cai Yun** NUAA, China
14:50-16:30 **Communication System Session-II**	**WCR-157** Effect of Variation in Filter Length on Adaptive Equalization in Frequency Selective Channels	**Fazal E Asim** IST, Islamabad
	WCR-292 A multi rate CPFSK transmitter	**Muhammad Abid** CASE, Islamabad
	WCR-311 Your Own Moving Cell: A Performance Evaluation	**Syed Tariq Shah** Sungkyunkwan Univ, Korea
	WCR-356 Elimination of Co-Channel Interference under different modulation schemes in Hybrid Terrestrial-Satellite Mobile Communication using Adaptive Beam-Forming technique	**Kamran Ali Shah** BUAA, China
	WCR-432 Fault Tolerance in Dynamic Cluster-Based Wireless Sensor Networks	**Asim Zeb** University Technology Malaysia

*Poster Session	**WCR-360** Optimizing nodes proportion for Intrusion Detection in Uniform and Gaussian distributed Heterogeneous WSN	**Fawad Raza** IQRA Univ, Islamabad
	WCR-393 An Application of Hybrid Nature inspired computational technique to detect faulty element in array antenna	**Shafqat Ulla Khan** ISRA Univ. Islamabad
	WCR-395 Reduction of Four Wave Mixing by Employing Circular Polarizers in DWDM Optical Networks	**Habib Ullah Manzoor** GIK, Pakistan
	WCR-453 Auto-Tuning in LTE networks using joint RRM optimization	**Syed Hassan Raza** CESAT, Islamabad

***Poster Session will be held on Thursday 15th January 2015 (whole day). The mandatory presence of poster presenter is required during the tea break (11:10-11:30)**

For any query contact:
Program Coordinator: Dr. Naveed Ahsan
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Email: wcr@ibcast.org.pk

Quality of Service Analysis for Multimedia traffic using DSR, AODV and TORA over Wi-Media Ultra wide band

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* Department of Information and Communication Engineering, Yeungnam University, South Korea,

** School of Engineering and Computer Science, Victoria University of Wellington, New Zealand

Abstract— **The introduction of new technologies to meet the growing demands of multimedia traffic is on the rise. To cope with this challenge, efficient mechanism is required on all TCP/IP layers. Therefore, this paper studies the performance of routing protocols over Wi-Media ultra-wideband (UWB). The objective of this study is to determine which routing protocol can better meet the quality of service (QoS) for multimedia traffic. The comparison made among three protocols, namely dynamic source routing (DSR), ad hoc on-demand distance vector (AODV), and temporally-ordered routing algorithm (TORA), respectively. The extensive set of simulations has been carried out for video streaming. The metrics used to evaluate the routing protocols are packet loss, throughput, average end-to-end delay, average jitter, and routing overhead. Simulation results and their analysis show that, when there is single source DSR routing protocol perform better QoS for video traffic in terms of higher throughput, the slighter average end-to-end delay, smaller jitter, and less routing overhead. However, in case of multicasting, AODV protocol proves to be the best choice..**

I. INTRODUCTION

Ultra-wideband (UWB) wireless communication is a promising spread-spectrum technology with features of low cost, low power, and high time resolution. UWB has potentially important applications in wireless ad Hoc networks. High data rate and accurate localization at low energy cost can be provided on UWB. The UWB is well suited for multimedia applications simply because , its throughput outdoes the Wi-Fi.Moreover, UWB MAC was designed for high data rate and low power, the efficiency are 80 to 90 percent greater as compared to Wi-Fi. Furthermore, UWB MAC was designed by keeping quality of service (QoS) in mind. Its excess amount of data rate can help maintain the data rate as well [1]. Therefore, to explore high data rates on UWB video streaming can be used as a traffic model over the network. Network layer plays an important role in order to provide the functional and procedural means of transferring variable length data sequences from a source to a destination while maintaining the quality of service (QoS) requested by the transport layer. Significant research activities have been found on routing strategies in the past. We can find a variety of research articles whose focal point is the determination of most advantageous routing path over different types of network such as IEEE 802.11, mobile ad hoc networks (MANET), wireless mesh networks (WMNs), and others.

In [2], the authors evaluated the performance of reactive (i.e. DSR and AODV) and proactive (i.e. OLSR) routing protocols in IEEE 802.11 ad hoc network. The optimized link state routing protocol (OLSR) offers better performances for voice services given that it guaranties lowest delay but on trade of bandwidth. DSR and AODV routing protocols are more tailored for data services such as file transfer.

In [3], on wireless mesh networks (WMNs), the proposed approach takes accurate routing decisions based on a cross-layer fuzzy system that has as input the values of the expected transmission count metric ETX, minimum delay, and queue availability. The queue utility information aims to select routes in WMNs without queue overloaded that reduces packet loss, jitter and delay and increases the system performance.

A bandwidth calculation scheme is proposed in [4] which work independently on the MAC layer. The multimedia multicast sender at the application layer adapts the multimedia multicast transmission sender rate based on the feedback. It shows that the network performance for multicast multimedia transmission over shared and congested wireless networks can be significantly improved using the proposed rate-adaptive admission control QoS scheme.

In [5], a QoS routing protocol of mobile network based on UWB has been introduced. Performance evaluation between the proposed protocol and traditional on-demand protocol has been performed. Simulation results show that in order to satisfy the QoS, given protocol can provide reduced end-to-end delay and lessen the routing load.

The general idea of UWB ad hoc networks is introduced in [6]. A QoS routing scheme is proposed. The scheme makes better use of the UWB technology, which is characterized by very high capacity that can support multimedia services with a wide range of bit rates and QoS requirements. The scheme focuses the source routing protocols, such as DSR, three QoS parameters are used in route discovery; packet transmission delay, packet transmission rate, packet buffer length. In addition, the scheme introduces neighbor detection method. All nodes can distinguish the connectivity of the communication link, which make the multimedia

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transmission, immune from the influence of unused routes. Simulation results demonstrate that the QoS scheme is effective and efficient in the end-to-end QoS provisioning.

In this article, we evaluate the performance of routing protocols for video streaming over UWB by means of various performance metrics such as packet loss, throughput, average end-to-end delay, average jitter, and routing overhead. The basic idea is that among the simulated protocols which one can award the better routing for transmitting multimedia traffic, video in our case over UWB.

The rest of the paper is organized as follows. Section II discusses the routing protocols. In Section III, we present the simulation environment in detail. Section IV provides the simulation modeling and analysis and finally, Section V concludes the paper.

II. Routing Protocols

A. Dynamic Source Routing (DSR)

DSR [6-8] is an ad hoc routing protocol which is based on source-based routing. This protocol is source-initiated and is particularly designed for use in multi-hop wireless ad Hoc networks. This protocol is composed of two parts, i.e. route discovery and route maintenance. Every node maintains a cache to store recently discovered paths. When a node desires to send a packet to a destination node, it first checks its entry in the cache. If it is present, then it uses that path to transmit the packet, and also attach its source address with the packet. The main benefits of the DSR routing protocol [10] is that there is no need to keep the routing table because entire route is contained in the packet header during transmission. The limitation of DSR protocol is that this is not scalable to large networks.

B. Ad Hoc on Demand Distance Vector (AODV)

AODV [10] is on-demand routing protocol. On-demand means the route will only create between the two nodes when they want to communicate. It facilitates, self-starting, multi-hop routing between contributing mobile nodes desiring to launch and keep up an ad Hoc network. The mechanism of the route creation in AODV can be found in [11-13].

The benefits of AODV [14] protocol are that it favors the least congested route instead of the shortest route and it also supports both Unicast and multi-cast packet transmissions even for nodes in constant movement. The limitation of AODV protocol is that it expects/requires that the nodes in the broadcast medium can detect each other broadcasts.

C. Temporally Ordered Routing Algorithm (TORA)

TORA was developed by V. Park and M. Scott Corson. It is highly adaptive, efficient and scalable routing algorithm, which is source-initiated on-demand routing protocol and it finds multiple routes between the source and the destination. The concept of the directed acyclic graph (DAG) is used in TORA [4]. One of the benefits of TORA [6] is that the multiple routes between any source destination pair are supported by this protocol. Therefore, failure or removal of any of the nodes is quickly resolved without source intervention by switching to an alternate route. TORA is also not free from limitations. One of them is that it depends on synchronized clocks among nodes in the ad Hoc network.

III. Simulation Environment

A. Simulation Tools

The tool used for simulation is network simulator 2 (NS-2). The UWB medium access control (MAC) and physical (PHY) standards have been installed on NS-2.29 version.

B. Network Parameters

Parameter values for simulation are given below in Table 1.

TABLE 1. Simulation Parameters

Radio propagation model	Two Ray Ground
Antenna model	Omni Directional Antenna
Physical Terrain-Dimensions	1000 x 1000
Queue type	Drop Tail /PriQueue
Queue length	50 packets
Network interface	805_15
MAC standard	802_15_4
Transport protocol	udp
Routing protocol	DSR, AODV, TORA
Traffic type	MPEG4
Simulation time	100 seconds
No. of nodes	50

C. Traffic Model

We have simulated MPEG4 traffic model for video streaming between sender and destination. The Video traffic has been simulated for high data rates to evaluate routing protocols at high data rates.

D. Performance Metrics

The performance parameters that we have used for comparison are

- Throughput
- Packet lost
- Delay
- Jitter
- Routing Overhead

1. Throughput

   The data which is delivered may be transferred all the way through a specific station over a link is computed typically in bits per second (bps), or in data packets per second or data packets per time period. In this paper throughput is evaluated as

   $$Throughput = \frac{Number\ of\ bytes*8}{Simulation\ Time} \quad (1)$$

2. Number of packet loss

   The number of data packets that are not effectively sent to destination and are calculated as (2)

   $$P_L = P_S - P_R \quad (2)$$

   Where

   $P_L = Number\ of\ Packet\ Loss$

$P_S = Number\ of\ Packets\ Sent$
$P_R = Number\ of\ Packets\ Received$

3. End to End Delay
It is the time of the packet to reach to the destination from the source node.The relation of delay which we used for our results is as follows
$$D_A = T_{RP} - T_{SP} \quad (3)$$
Where
$D_A = Delay$
$T_{RP} = Time\ of\ received\ packet$
$T_{SP} = Time\ of\ Packet\ sent$

4. Routing overhead
In this work, we have taken the number of hops as routing overhead. It is defined as the maximum number of intermediate nodes taken by a packet to reach the destination. As in wireless communication, all nodes have limited power. For this purpose, preference will be given to protocols having least intermediate nodes to reach to the destination.

IV. SIMULATION MODELING AND ANALYSIS

We have conducted an extensive set of simulation and chose four types of scenarios

1. Single Source and Single Destination
2. Single Source and Multiple Destinations
3. Multiple Sources and Single Destination
4. Multiple Sources and Multiple Destinations

A. Single Source and Single Destination

A full WMN [15] is shown in Fig. 1, i.e. every node is connected to every other node in the network. System model contains 50 nodes. There is a single source *S* and single destination *D* in this experiment.

It can be observed in Fig. 2 and Fig. 3 TORA routing protocol shows higher packet loss and low throughput with increasing video rate. However, the packet loss of AODV is higher when we increase the video rate. , Considering the throughput it was initially good and maintained its consistency, on the other hand, as the transmit rate increases throughput decreases as towards 30 Mbps. In case of DSR, for the video sends rate of 5Mbps, it shows the excellent throughput and establishes consistency up to 15Mbps, then from 15Mbps to onwards there is a slight decrease in throughput value as compared

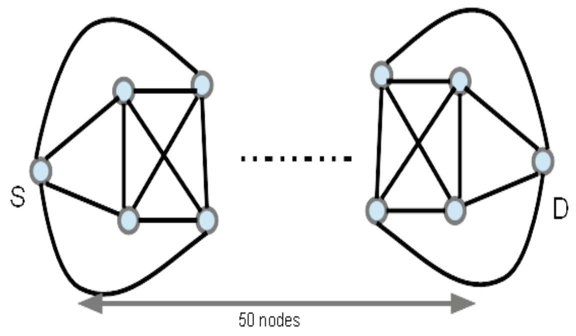

Fig 1. System Model for Scenario 1.

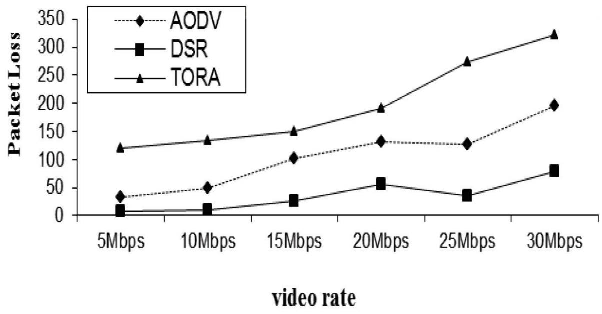

Fig.2. Packet loss Comparison of Scenario 1.

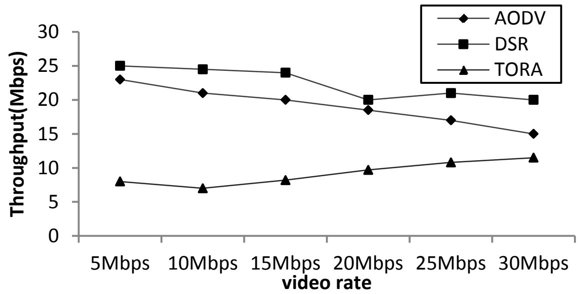

Fig 3. Throughput comparisons for Scenario 1.

to its previous reading. But still throughput performance of DSR is better than other two protocols, even at high data rates of video. Similarly, in case of the packet loss comparison, DSR establishes better performance. For example, at initial values of video send rates, the packet loss is very low, it exhibits excellent performance at the receiver side, and even at higher data rates DSR maintains its low packet loss consistency.

Fig. 4 compares the average end-to-end delay of AODV, DSR and TORA routing protocols. The Fig. 4 shows that the TORA routing protocol exhibits very high end to end delay and it continues to increase as video sends rate increases. In case of AODV protocol, the average end-to-end delay is less when the video rate is from 5Mbps to 15Mbps. However, at the send rate of 20 Mbps there is an increase in average end-to-end delay, in spite of that, as the send rate increases onwards, it slightly decreases and then achieves stability. DSR average delay performance is better as compared to TORA and AODV routing protocol. For instance, at video send rate of 5Mbps to 30 Mbps the average delay is very small; provides satisfactory end to end delay performance as compared to other protocols.

Fig. 5 compares the average jitter of AODV, DSR, and TORA routing protocol. The jitter performance of TORA and AODV routing protocol is not satisfactory. On the other hand, DSR protocol shows excellent performance. DSR jitter value is small at low video rates as well as for high rates. Therefore, in summary, for average jitter comparison, DSR protocol gives the best performance as compared to TORA and AODV routing protocols.

The Table.2 shows the routing overhead of TORA, DSR and AODV routing protocols for video send rate of 5Mbps to 30Mbps.

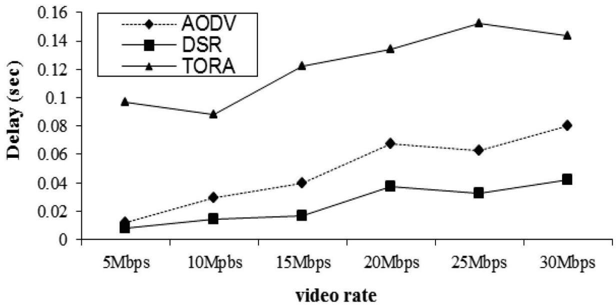

Fig 4. Average Delay Comparison of Scenario 1.

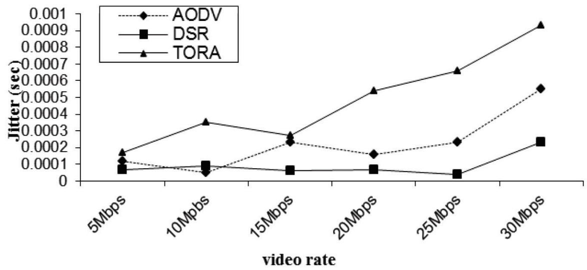

Fig 5. Average Jitter Comparison for Scenario 1.

Considering the DSR, routing overhead, i.e. intermediate nodes between the sender and receiver is 4, and it remains constant up to higher data rate of 30Mbps. In case of AODV and TORA, the routing overhead is initially low, i.e. 3 but as the video sends rate increases to 20Mbps, it reaches to a drastically highly value of 5 and then become constant.

For above simulation scenario, it is noted that DSR has exhibited good performance in term of less packet loss, more throughput, low jitter value consistency and routing overhead with a stabilized value.

B. Single Source and Multiple Destination

In this experiment, the system model consists of a single source and multiple destinations. The system model is depicted in Fig. 6. The simulation results are shown in Fig. 7, Fig. 8 and Table 3 respectively.

In Fig.6, we have a wireless mesh network with single source S and multiple destinations as D1, D2 and D3. There is a multicasting of video streams from the source to destination.

Fig. 7 demonstrates the packet loss performance of three protocols. The TORA exhibits smaller packet loss as compared to DSR and AODV for low data rates. However, with increasing video rate it demonstrates more packet loss. The DSR and AODV have more packet loss for smaller data rate and continue to increase for higher data rates. Fig.8 shows the throughput performance

Table 2. Routing Overhead (No. of hops) in Scenario 1

Video send rate	No. of nodes		
	AODV	DSR	TORA
5Mbps	3	4	3
10Mbps	3	4	4
15Mbps	4	4	5
20Mbps	5	4	5
25Mbps	5	4	5
30Mbps	5	4	5

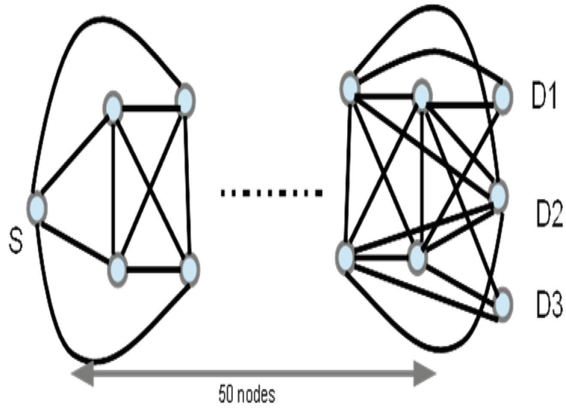

Fig 6. System Model for Scenario 2.

Comparison of three routing protocols; we are considering the case when more than one destination nodes receive data simultaneously. According to simulation analysis, DSR is outstanding in performance, it exhibits highest received rate and there is consistency in its throughput value for both smaller and higher data rates; Comparing TORA, it affords smaller throughput for low data rate but as video sends rate continue to grow, its throughput become more. So for higher data rates TORA achieved better throughput performance. AODV performance is poor among both protocols, for example, at smaller send rate such as 5Mbps to 10Mbps, it shows good received rate, but for higher send rates of 15Mbps to onwards, throughput decreases drastically.

Fig.9 reveals the average end to end delay performance of routing protocols for scenario 2. Considering the graphical results, TORA provides highest delay among other two protocols, as video sends rate increases from 5Mbps to onwards 30Mbps, average delay exhibited by TORA increases. AODV has smaller delay for low data rate such as at 5Mbps to 15Mbps, as the send rate reaches to 20Mbps, delay exhibit by AODV increases. In short DSR gives the best end to end delay performance among other protocols; it provides smaller delay for video input rate of 5Mbps to 30Mbps.

Fig.10 determines the jitter performance of protocols for the above scenario. Both DSR and AODV provide the unpredictable results. For example, an input video rate of 5Mbps, DSR and AODV exhibit smaller jitter and then it drastically increased for video rate of 10Mbps and so on. TORA however, displays some predictable jitter pattern; however, its jitter value increases as send rate increases towards 30Mbps.

Considering the Table 3, at 5Mbps of the input rate routing overhead of all three protocols is same. Moreover, the routing overhead of TORA and AODV become more i.e. 5 and remains constant throughout. Routing overhead exhibited by DSR remains same, i.e. 4 hops from 5Mbps to 30Mbps of video send rate. So in this case DSR has smallest routing overhead as compared to other two protocols and also it remains constant.

If we summarize the analysis, DSR achieved similar results in scenario 1, however for higher video input data rates, TORA also revealed satisfactory performance.

C. Discussion

Let us discuss the reasoning behind the best performance, exhibition of the DSR routing protocol in scenario 1 and scenario 2, it is because of the fact that the DSR protocol doesn't wait for routing tables updating overhead at each intermediate node, as entire address of the destination node is contained in the routing packet header. DSR uses no periodic routing messages (e.g. no router advertisements and no link-level neighbor status messages), thereby reducing network bandwidth overhead,

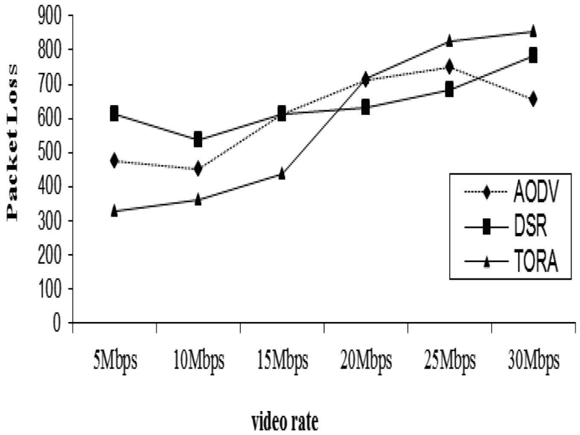

Fig 7. Packet loss comparison for Scenario 2

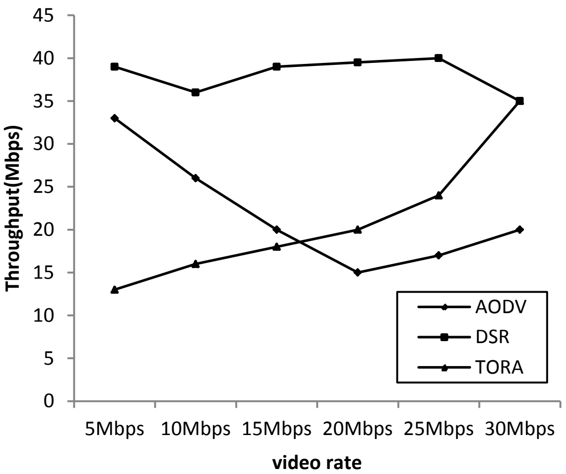

Fig 8. Throughput comparisons for Scenario 2

conserving battery power, and avoiding the propagation of potentially large routing updates throughout the Ad Hoc network [8, 16].Similarly TORA exhibited better performance for higher data rates in second scenario; this is because of the reason that TORA supports multicasting, it establishes multiple routes between the source and destination. Failure or removal of any nodes is quickly resolved without source intervention by switching to an alternate node as multiple nodes are available [16].

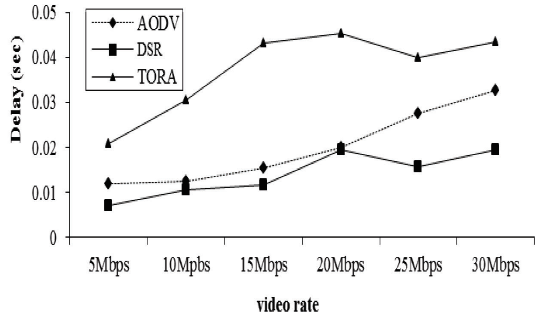

Fig 9. Average Delay comparisons for Scenario 2

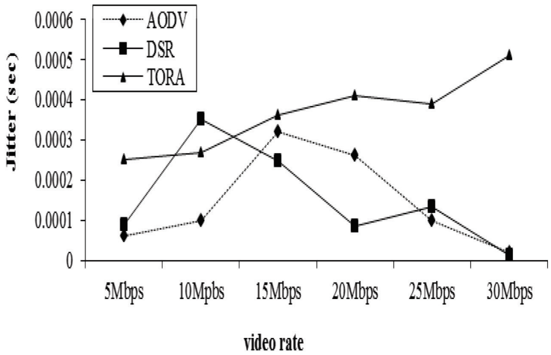

Fig 10. Average Jitter Comparison of Scenario 2

Table 3. Routing Overhead (No.of hops) in Scenario 2

Video send rate	No. of nodes		
	AODV	DSR	TORA
5Mbps	4	4	4
10Mbps	4	4	5
15Mbps	5	4	5
20Mbps	5	4	5
25 Mbps	5	4	5
30Mbps	5	4	5

D. Multiple Sources and Single Destination

Fig.11 represents multiple sources named as S_1 , S_2 and S_3 with single destination D in a wireless mesh network. Multiple video streams from three senders have been transmitted simultaneously. The Receiver has to receive all the three streams from different senders. For this special case, behaviors of network protocols have been analyzed. The Simulation results and their analysis are graphically given below as Fig.12 to Fig. 15 and Table 4. Let us discuss the Fig.12 and Fig.13 for packet loss and throughput comparison. For instance, at 5Mbps AODV has zero packet loss and establishes the 100% throughput, packet loss of DSR is 50% more than AODV and TORA has 200% more packet loss than AODV. Now, if we consider at 20Mbps, AODV packet loss is 40 %, and DSR and TORA have 100% more loss than AODV. Furthermore, as the transmit rate increases, the packet loss of all three protocols increases, but AODV packet loss is comparatively less than TORA and DSR. TORA and DSR have a drastic increase in packet loss as video sends rate increases towards 30Mbps.Similarly AODV throughput performance is better than TORA and DSR for smaller and higher data rates. For example, let us discuss the throughput at 15Mbps, TORA received rate is 10% less than AODV and DSR have 30% less throughput than AODV. Similar the case for a higher data rate of 30Mbps the AODV provides better performance than TORA and DSR.

Fig.14 explains average delay performance of three protocols. AODV has relatively smaller end to end delay than other protocols. End to end delay performance of DSR and TORA is unpredictable, which can be clearly seen in the figure. . In Fig.15, at 5Mbps, TORA shows satisfactory jitter value of 0.0001 seconds. But as the data rate increases from 25Mbps to onwards a drastic increase in the value of jitter is observed, i.e. it reaches to 0.00075 seconds for 30Mbps. So in short TORA provides better jitter performance for smaller video send rates. Now considering the DSR behavior, it provides extremely high jitter value of 0.0007 seconds at the start; but as data rate increased, its jitter value going to decrease and then become stable. In this way DSR exhibits adequate jitter stability for larger data rates.

Let us discuss the AODV work, its jitter performance is better than TORA and DSR, For instance, from 30Mbps to onwards, stability is observed in jitter value. Now considering their jitter behavior in ratios, at 5Mbps of sending rate ratio for TORA: AODV: DSR is 1:4:7, in this case TORA performance is best. But if we watch at 30Mbps, this ratio becomes 7:1:5. In this way we can conclude that for higher data rates we prefer AODV as its jitter performance is adequate.

Now let us consider the routing overhead ratio of protocols AODV: DSR: TORA. For example, at 5Mbps, the ratio is 3: 3: 4. In this way AODV and DSR have less routing overhead than TORA. At 15Mbps this ratio becomes 4:5:4. And at 30Mbps, ratio by considering the table is 4: 4: 4. So in short while considering the routing overhead as a performance metric, there is not much difference in value for all three protocols.

Regarding performance, AODV showed foremost performance in term of fewer packet losses, higher throughput, relatively smaller delay and little jitter value for low and high data rates of video traffic.

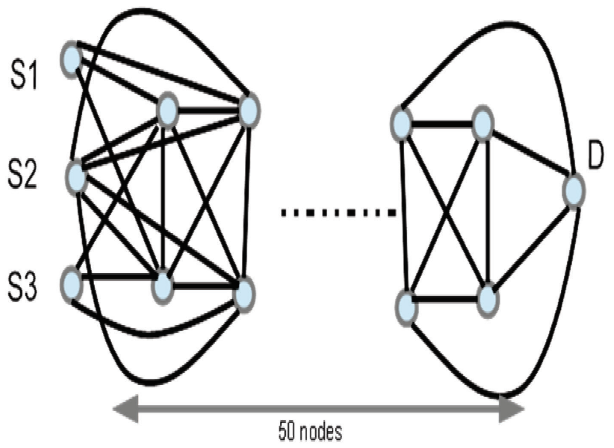

Fig 11. Network Design for Scenario 3

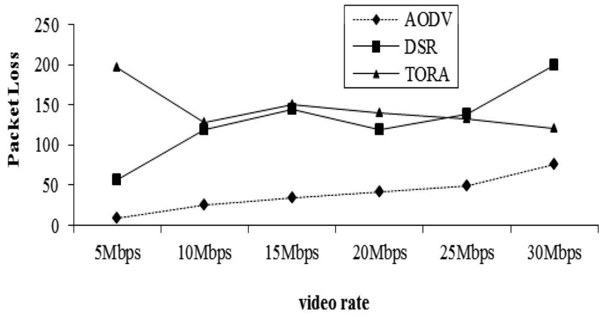

Fig 12. Packet loss comparison for Scenario 3

E. Multiple Sources and Multiple Destinations

This network model testifies multiple senders, S1, S2, S3 and multiple receivers D1, D2, D3 respectively in wireless mesh network. Protocols conduction over the network is graphically explained below.

Fig.17 and Fig.18 demonstrate Packet loss and throughput performance. There is no stability in the performance of DSR and TORA in term of packet loss and throughput.

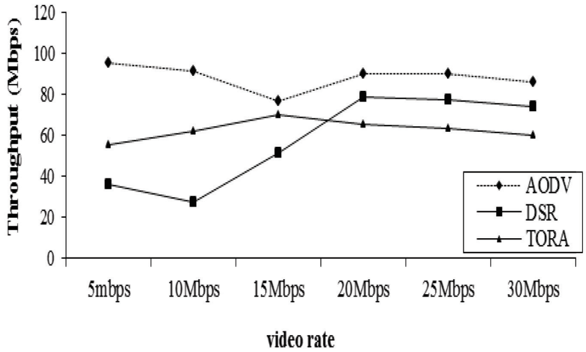

Fig 13. Throughput comparisons for Scenario 3

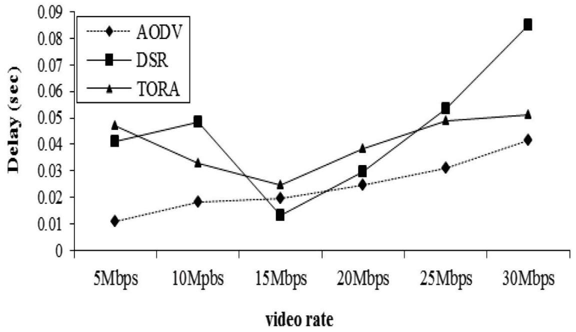

Fig 14. Average Delay Comparison of Scenario 3

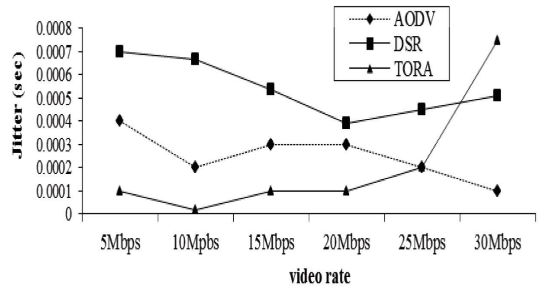

Fig 15. Average Jitter Comparison of Scenario 3

Table 4. Routing Overhead (No. of hops) in Scenario 3

Video send rate	No. of nodes		
	AODV	DSR	TORA
5Mbps	3	3	4
10Mbps	4	5	5
15Mbps	4	5	4
20Mbps	5	4	3
25 Mbps	5	4	4
30Mbps	4	4	4

AODV shows stable performance in this case. From Fig.19 if we analyze the average end to end delay, we found unpredictable results and it is inconclusive.

Jitter performance comparison revealed in Fig.20, AODV demonstrates worthy results, and there is a decrease, then stability in jitter value as video traffic rate increases from 15Mbps to onwards, such as 0.0004 seconds to 0.00022, 0.0002 and so on. TORA and DSR show an unpredictable

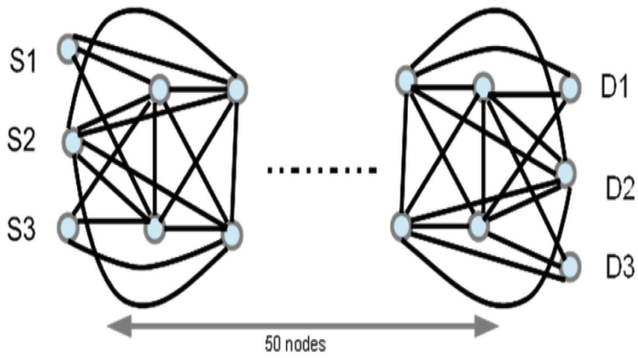

Fig 16.Network Design for Scenario 4

jitter pattern, and there is no stability in the performance. Therefore, in this scenario AODV among other protocol's exhibits best jitter performance.

The Table.5 shows the routing overhead comparison for three protocols. At the start AODV protocol is having less routing overhead, but it increased, as the traffic rate grows. DSR and TORA routing overhead performance is unpredictable, there an increase than decrease in intermediate nodes and then again increase as video send rate grows. So there is no stability. So AODV shows stability in comparison of TORA and DSR.

F. Discussion

Let us talk about results achieved in last two simulations. We found the results achieved are similar to results in the third scenario. AODV come through stable throughput value, exhibited better jitter performance and less routing overhead.

The AODV proved as the finest routing protocol in third and fourth scenario, where multicasting at source and destination has been simulated. This is because of the fact that AODV strongly designed to support the Multicasting for packet transmission, it favors, least congested route instead of shortest route [9]. It does not make use of source routing. Moreover, AODV develops multicast tree [11], any node can join the multi-cast group through multiple hops via non- member nodes, and the need for

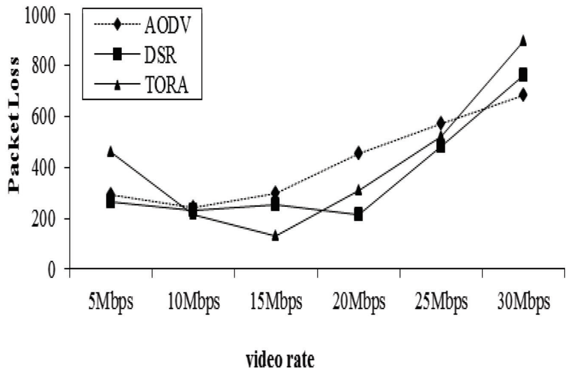

Fig 17. Packet loss comparison for Scenario 4

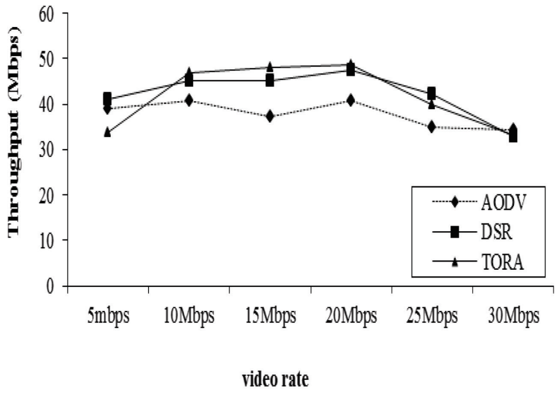

Fig 18. Throughput comparisons for Scenario 4

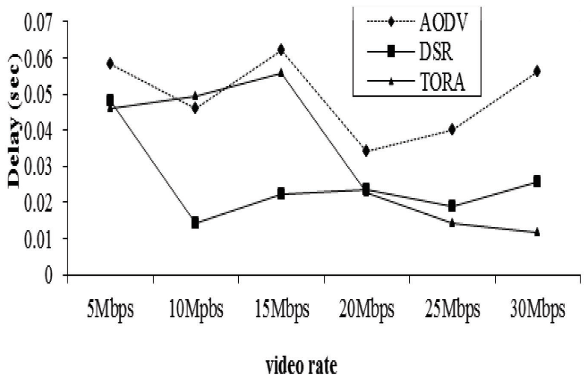

Fig 19. Average Delay Comparison of Scenario 4

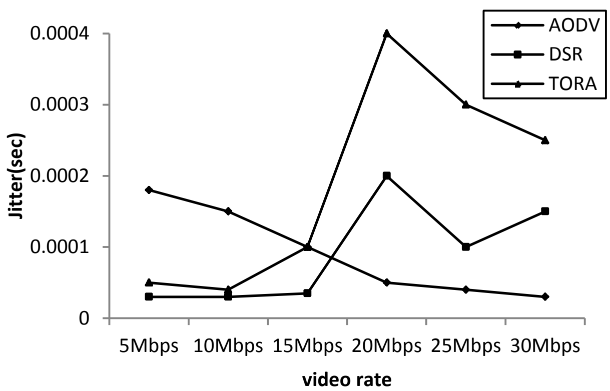

Fig 20. Average Jitter Comparison of Scenario 4

Table 5. Routing Overhead (no. of hops) in Scenario 4

Video send rate	No. of nodes		
	AODV	DSR	TORA
5Mbps	4	6	6
10Mbps	5	5	4
15Mbps	5	5	4
20Mbps	4	4	3
25Mbps	4	5	5
30Mbps	5	4	5

broadcast traffic in such networks is effectively reduced.

V. CONCLUSION

We have emphasized on the performance evaluation of three routing protocols AODV, DSR and TORA; the highlight is to determine which routing protocol can better satisfy the Quality of Service (QoS) for multimedia over Wi-media ultra wide band. For this study, we have simulated four different experimental setups. In all four scenarios we diverse the video traffic rate of 5Mbps to 30Mbps; network consisted of 50 maximum nodes. Matrices used for evaluating the performance are packet loss, throughput, end to end average delay, average jitter and routing overhead.

In first and second investigation cases, i.e. Single source and single destination, and multiple source single destination. DSR out performs the other routing protocols in terms of higher throughput, smaller packet loss, lesser delay and less jitter value in the first scenario. The DSR does not involve routing table updating overhead [4]. However, in the second scenario TORA exhibited better performance for higher data rates; it develops multiple routes between the source and destination. So failure of any node is resolved in a faster way without source intervention [13].

Deliberating the third and fourth simulation setup where multicasting at both the source and destination has been simulated, AODV manifest to be dominant protocol. As mentioned above AODV aimed to care multicasting [8, 11].

Summarizing, AODV proved to be a superlative routing protocol for multi-streams high data video transmission in UWB. TORA also performed well for high video rates.

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