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Improved Aodv Routing Protocol with Efficient Qos for Wireless Mesh Network

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ABSTRACT
Wireless Mesh Network (WMN) Is Emerging Concept In Wireless Networks Supporting Broadband An And High Speed Multimedia Services, So Network Must Guaranteed The Quality-Of-Services (Qos). This Paper Proposed, A New Qos-Aware Routing Protocol For Mesh Networks Based On AODV Named Qos- Mesh On-Demand Distance Vector (QMODV). Under The Parameter Delay In Communication And Available Bandwidth Required To Meet The Qos Demands, The Protocols Defines A New Route Metric With Respect To The Load Rate And Hop Count. Depending On This Parameter, QMODV Scheduled The Packets And Select The Optimal Shortest Route. The Proposed Schema Gives Better Performance Of Both Network Throughput And End-To-End Communication Delay.
Keywords – WMN, AODV, Hop Count, Quality-Of-Service

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I. INTRODUCTION

Wireless Communication Has Provides Rapid Service With The Improvement In Cellular And Wireless Local Area Networks. These Two Different Technologies Come Close In The Terms Of Their Needs And With This Cooperation, Numerous Applications Have Become Available.

There Are Currently Two Variations Of Mobile Wireless Networks. As Shown In Figure 1, The First One Is Infrastructured Network Which Has Fixed And Wired Gateways. Base Stations Are The Bridges For These Networks. Typical Applications Of This Type Of Networks Include Office Wireless Local Area Networks (Wlans). And Another Type Is Infrastructureless Networks Also Known As Self-Organized Networks. They Consist Of Mobile Radio Nodes Which Do Not Need Existing Network Infrastructure Or Central System Management. They Are Suitable For Situations That Need An Immediate Infrastructure.

Next Generation Services Will Provide High Data Rates, Overall Flexibility On Sending And Receiving Levels, Lower Equipment Cost And Capacity Of Arriving To All Subscribers. At That Point, To Solve All Of These Problems, A New Concept Called Wireless Mesh Network (WMN) Has Been Proposed. WMN Is A New Technology Area That Will Take A Hand In Next Generation Wireless Mobile Networks [1].

In Wmns, Nodes Are Comprised Of Mesh Routers And Mesh Clients. Each Node Operates Not Only As A Host But Also As A Router, Forwarding Packets On Behalf Of Other Nodes That May Not Be Within Direct Wireless Transmission Range Of Their Destinations. A WMN Is Dynamically Self-Organized And Self-Configured, With The Nodes In The Network Automatically Establishing And Maintaining Mesh Connectivity Among Themselves. This Feature Brings Many Advantages To Wmns Such As Low Up-Front Cost, Easy Network Maintenance, Robustness, And Reliable Service Coverage. Because Of These Reason, Various Multimedia And Real-Time Applications Are Expected To Be Introduced By WMN In The Future. While Implement These Services; Quality-Of-Service (Qos) Of The Network Must Be Garmented.

Figure 1: Infrastructure/Backbone Wmns [10]

AODV Is Most Widely Used Routing Protocol In Wireless Networks Because Of The Advantages Of Rapid Convergence, Small Computation, And Self-Repair Property. One Distinguishing Feature Of AODV Is Its Use Of A Destination Sequence Number For Each Route Entry [21]. The Requesting Nodes Receives The Destination Sequence Number Along With The

Route Information Through It Will Communicate [2]. However, AODV Measures Route Only By The Number Of Hops And The Destination Node Deals With The Routing Request Packet (RREQ) First Arrives. It Isn't A Qos Routing Protocol [3]. Those Characteristics Don't Satisfy The Integrated Requirement Of Some Services Which Demand Dynamic Requirements On Multi-Target Performance (Such As Delay, Bandwidth, Few Congestion And High Qos).

Considering Those Parameter, This Paper Proposed A Methodology For Finding Of Optimal Shortest Path In Wireless Mesh Network. The Proposed Methodology Calculates The Path Depending Upon Load At Every Node. This Results In Congestion Free Routing Path Which Minimized The Communication Delay And Packet Loss.

Section II Represents The Related Work On Qos Based Routing Algorithm In Wireless Mesh Network. Sections III Represents The Proposed Methodology And At The End Section IV Conclude On Study.

II. RELATED WORK

Routing Protocol Is A Protocol That Specifies How Routers Communicate With Each Other, Disseminating Information And Enables Them To Select Routes Between Any Two Nodes On A Computer Network. Many Routing Schemes Have Been Proposed For Wireless Mesh Network Which Provides Different Level For Maintain Quality-Of-Service (Qos).

In Ad-Hoc Network, For Mobile Nodes, Ad-Hoc On Demand Distances Vector Routing Protocol Is Wildly Used [4]. It Offers Quick Adaptation To Dynamic Link Conditions, Low Network Utilization, Low Processing And Memory Overhead And Determines Unicast Routes To Destinations Within The Ad Hoc Network. Before AODV, DSDV Routing Protocol Used For The Communication. It Is Table-Driven Routing Scheme Based On Bellman Ford Algorithm. As DSDV Is Table-Driven Routing Scheme, It Store Predefine Communication Path. DSDV Requires A Regular Update Of Its Routing Tables, Which Takes Some Battery Power And A Small Amount Of Bandwidth Even When The Network Is Idle. Although, DSR Are Similar To AODV, DSR Has Access To A Significantly Greater Amount Of Routing Information Than AODV [6]. Referring To The Table 1 [5][6][7], Average End-To-End Communication Delay And Packet Loss Has Been Increased. Also In Single Request Cycle, DSR Replies On All Requests Reaching From Destination Due To Which Network Overhead Increased, Whereas AODV Replies On Request Which Reach First. Thus, Network Overhead Is Maintained.

But AODV Used As-Is, Can Result In Poor Performance In A Wireless Mesh Network [8]. The Reasons [9] Are As Follows,

1. AODV Lacks Support For High Throughput Routing Metrics.
2. AODV Lacks An Efficient Route Maintenance Technique.
3. AODV Route Discovery Latency Is High.

Based On Mentioned Reasons It Is Necessary To Improve AODV Routing Protocol For Maintaining Qos And Implementation In Wireless Mesh Network.

Surveys Presented In [10] & [11] Focus On Major Contributions Pool Of QOS Routing Solutions For Wireless Mesh Network And Ad-Hoc Network, And Classified Them Based On Their Interaction Between The Networks. Author Discusses Network Architecture Of WMN, What Are The Characteristics Of WMN, How Will Be The Application Scenarios [12], [13], [14] And Critical Factors Influencing Network Performance [15]. At The End Concluded That, Depending On These Entire Factors How Capacity Of WMN Affected In Terms Of Throughput, End-To-End Delay, Limited Capabilities Of Network Integration. Because Of These Influence, There Is A Need Of Secure Qos Aware Routing Protocol Is Important. To Accomplish This Process, Network Management Can Be Functionally Divided Into Five Areas: Fault Management, Configuration Management With Respect To Network Configuration, Security Management With Respect To Data And Node Authentication, Performance Management As Per Routing Of Path And Accounting Management With Respect To Load Management [15].

By Considering The Above Parameters, Ling Liu, Lei Zhu *Et. Al.* Proposed Routing Algorithm By Improving AODV Routing Protocol In WMN Defines A New Route Metric By Estimation Of Available Bandwidth And Select's The Best Route According To It [3]. Authors Modified The AODV By Excluding Some Nodes Before Establishing The Route Which Unfit To The Qos Requirements And Reduce Invalid Transmission Of RREQ. A. Bhorkar *Et. Al.* [17] And K. Choumas *Et. Al.* [16] Provides Concept Of Congestion Diversity To Minimized End-To-End Delay By Using Backpressure (BP), Enhanced-Back Pressure (E-BP) Routing Algorithms Available For Congestion-Aware Routing Algorithms. Author's Modifies The Protocol Stack At The Routing Layer To Take The Congestion In The

TABLE 1: Comparison Of Various Routing Protocol

	AODV	DSDV	DSR	TORA
Packet Loss	Minimum	Mediocrity	Mediocrity	Mediocrity
Packet Delivery Ratio	Peak	Mediocrity	Mediocrity	Mediocrity
End-To-End Delay	Minimum	Mediocrity	Peak	Mediocrity
Routing Overhead	Minimum	Constant	Minimum	Mediocrity
Path Discovery Time	Minimum	Minimum	Mediocrity	Mediocrity
Packet Loss	Minimum	Mediocrity	Mediocrity	Mediocrity
System Throughput	High	Mediocrity	Mediocrity	Mediocrity

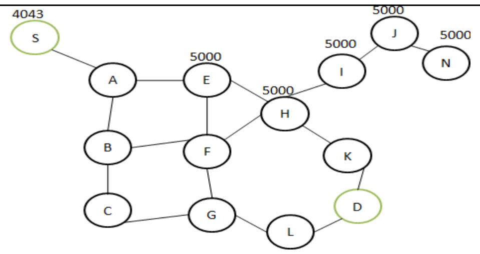


Figure 1: Simulation Scenario

Network Into Account. Thus, They Achieve The Qos In Terms Of Throughput Ratio And End-To-End Communication Delay. Some Systems Use The Concept Of Supergraphs Which Provide A Node Transition And Load Sharing Method To Achieve Qos In Wireless Mesh Network [5][18][19].

Load Distributed Mesh Routing (LDMR) Design For Load Distribution In WSN [20]. LDMR Select Potential Next Hop Nodes Based On A Quadrant And Distance Information. The Potential Next Hop Selection Based On Packet Success Rate And Maximum Velocity Of A Packet. Due To Such Selection, The Throughput Increase.

III. PROPOSED METHODOLOGY

3.1 Path Discovery:

This Section Presents The QMODV Routing Metrics For Wireless Mesh Network. The Intuition Behind The Proposed Scheme Is That If Load Is Calculated At Each Node In Route Path, The Communication Delay And Packet Loss Will Be Decreases And Increase The Packet Delivery Ratio. Here, Load Is Considered As Waiting Packets For Transmission At Each Node.

Following Example Explain How QMODV Routing Works:

Assume, Every Node Transmitting Data At The Rate 100 Packet/Sec And There Is Communication Going On Between Node N And Node E Of Data Size 5000 Packets.

A. Node S Needs To Transmit A Data Of Size 4043 Packets To D.
B. Creates A Route Request (RREQ)
   - Enters D's IP Addr, Seq#, S's IP Addr, Seq#, Hopcount=0
C. Node S Broadcasts RREQ To Neighbors

D. Node A Receives RREQ

- Makes A Reverse Route Entry For S Dest=S, Nexthop=S, Hopcount=1
- It Has No Routes To D, So It Rebroadcasts RREQ

E. Node B And E Receives RREQ

- Makes A Reverse Route Entry For S Dest=S, Nexthop=A, Hopcount=2
- It Has No Routes To D, So It Rebroadcasts RREQ

Process Is Going On Till All Possible Routes To Node D Not Found. When The First Three Shortest Routes Are Found, It Creates The Route Reply And Calculates The Load At Each Node. Here,

- L And K Creates A Route Reply (RREP), Enters D's IP Addr, Seq#, S's IP Addr, Hopcount To D=1, Maintain Session Table For Load Calculated.
- L Unicasts RREP To G, Update The Load Table By Adding The Load Of G And K Unicasts RREP To H, Update The Load Table By Adding The Load Of H.

F. Node S Receives RREP

Process Is Going On Till Route Reach To Node S. After Reaching All Route Reply At Source Node, Depending Upon Load At Each Node, Source Node Calculates The Average Waiting Time And Selects The Optimal Shortest Path For Data Transformation. Here, Node N To Node E Communication Is Going On Of Data Packet Size 5000. So That, The Calculated Waiting Time By First Three Shortest Paths Is:

Table 2: Waiting Time Table Assuming Every Node Transmitting 100 Packets/ Sec

Path	Time
S-A-E-H-K-D	66 Sec
S-A-B-C-G-L-D	41 Sec
S-A-B-F-G-L-D	41sec

- Select Optimal Shortest Path And Makes A Forward Route Entry To D Dest=D, Nexthop =A, Hopcount = 6
- Sends Data Packet On Route To D

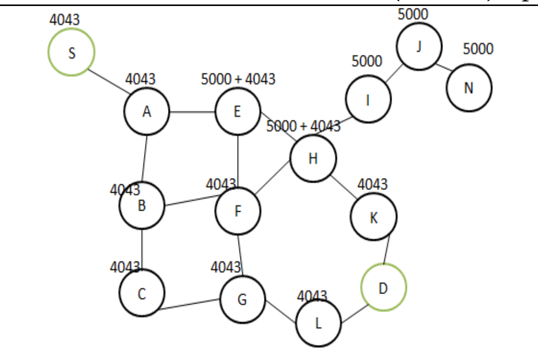


Figure 3: All First Three Route To Node D

1)S-A-E-H-K-D, 2) S-A-B-C-G-L-D AND
3) S-A-B-F-G-L-D

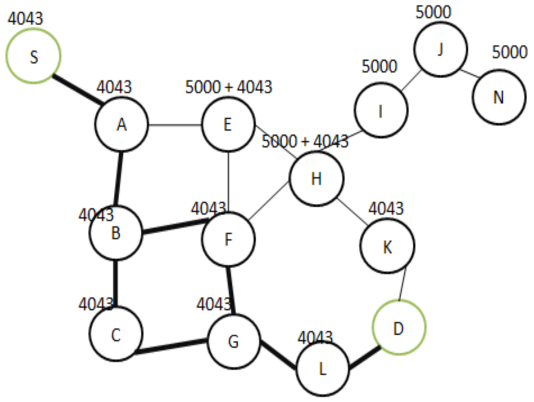


Figure 4: Optimal Shortest Route To Node D

3.2 Packet Loss And Delay:

Usually, Packet Loss Occurs Because Of Conjunction At The Intermediate Node. If, In The Waiting Queue Of Any Transmitting Node Become Full, The Packets Will Dropped. As Per The Scenario, At Node H, Incoming Data Are More Than Transmitting Data. Thus, At Node H Conjunction Occurs, And After Reaching Maximum Capacity Of Data Packet Storage, Packet Will Be Lost. Figure 3 Shows The Waiting Packets At Node H.

At Node H, If Transmitting Channel Is Having 10 Mbps Bandwidth And Storing Capacity 20 Packets Then There Is Approximately 20 Packets Dropped For Both Communications I.E. For Communication Between S To D And N To E If We Select The Path As Per Hop Count.

But, By Selecting Path Depending Upon Time, The Packet Loss And Delay Of Communication Minimized.

1.3 Packet Delivery Ratio:

Packet Delivery Ratio Is Calculated As,

$$\text{Packet Delivery Ratio} = \frac{\text{Packet Resived} * 100}{\text{Packet Sent}}$$

Thus, Overall Performance Analysis Is:

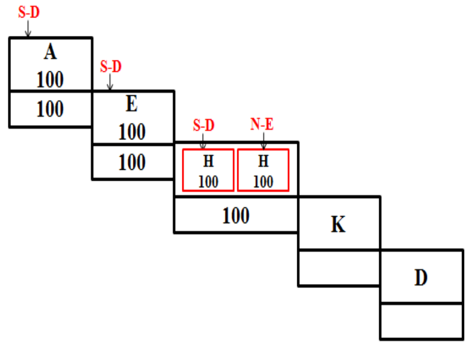


Figure 5: Waiting Packets

Path	Actual Time	Packet Loss	Delay	Total Time	Packet Delivery Ratio
S-A-E-H-K-D	41 Sec	10-12	25 Sec	66 Sec	71-76
S-A-B-C-G-L-D	41 Sec	0	0 Sec	41 Sec	100
S-A-B-F-G-L-D	41 Sec	0	0 Sec	41 Sec	100

Table 3: Routing Path Analysis

IV. SIMULATION AND PERFORMANCE EVOLUTION

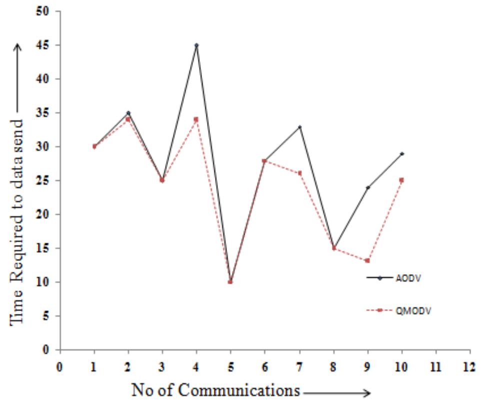
Simulations Were Done By Creating JAVA Simulator In Which No. Of Nodes And Routers Are Given By User. Nodes Are Randomly Connected With Router And Each Other. Table 6 Shows The Connectivity Matrix Of Node And Router Connection. Load On Each Node Also Randomly Given In Between 100-1000 As Shown In Table 5.

For Simulating, Node 2 As A Source Node And Node 16 As Destination Nodes. Here, For Finding The Path, We Calculate The All Path From Source To Destination. Thus, Node 2 Send Request To All Node For Finding Route To Destination. The All Possible Shortest Paths From Node 2 To Node 16 Are:

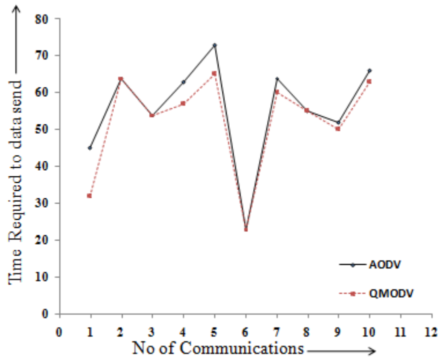
Table 4: Shortest Path Table From Node 2 To Node 16

Path No.	**Route**	**No. Of Hop Count**	**Load (In Packets)**
Path 1	2-4-8-12-16	5	1412
Path2	2-4-8-20-16	5	1299
Path3	2-4-8-10-17-16	6	1155

If, We Used Traditional Routing Protocol, It Selects The Path Which Arrived First With Minimum Hop Count. Therefore, It Selects Path 1 Or Path 2 Which Is Arriving First. But, The Proposed Routing Protocol Select The Path Having Minimum Load And Minimized The Packet Loss.



a. For 20 Nodes



b. For 100 Nodes

c. **Figure 6:** Comparison Between Time Required For Data Send For Every Communication

Figure 6 Shows The Comparison Between Current AODV Routing Protocol And Proposed Routing Protocol Depending Upon Time Required For Competing Communication Between The Numbers Of Communications. The Proposed Routing Protocol Improves The Traditional Routing By 30% To 40%.

V. CONCLUSION

As, Proposed Routing Protocol Calculates The Load At Each Node And Select Congestion Aware Optimal Shortest Path, The End-To-End Communication Delay Will Be Minimized And Packet Delivery Ratio Will Be Increased. Also, Varying Load From Other Nodes Sharing The Same Network Resources Will Be Minimized, Thus Results In Increased System Throughput.

Overall, Proposed Routing Protocol Maintains The Qos Of The Network While Communication And May Provides Better Performance In Wireless Mesh Network. In Future, If We Provide The Security Like Node Authentication, It Will Provide A Secure Routing Protocol For Communication And Data Transformation.

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NODE	Load
NODE1	878
NODE2	478
NODE3	560
NODE4	173
NODE5	994
NODE6	344
NODE7	314
NODE8	358
NODE9	713
NODE10	399
NODE11	947
NODE12	881
NODE13	438
NODE14	905
NODE15	747
NODE16	233
NODE17	225
NODE18	723
NODE19	706
NODE20	768

Table 6: Load Distribution

	R1	R2	R3	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12	N13	N14	N15	N16	N17	N18	N19	N20
R1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R2	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
R3	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
N1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N2	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N3	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N4	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N6	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
N7	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N8	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1	0	0	0	1	1
N9	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	1	0	1
N10	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	1	1	1	0
N11	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	1	1	1	0
N12	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	1	0	0	0	1
N13	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	1	0
N14	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	1	0	1
N15	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	1	1	1
N16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1
N17	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	1	0
N18	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	1	0	0	0	0	0
N19	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0	1	0	1	0	0	1
N20	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	1	1	0	0	1	0

Table 5: Connectivity Matrix

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