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Performance Evaluation of IEEE 802.11 with DSDV, DSR, AODV Routing Protocols in MANETs

Sravya .V[1], Nagaraju. A[2], Pavani. K[3]

Abstract— *A mobile ad hoc network (MANET) is a collection of wireless mobile nodes dynamically forming a network topology without the use of any existing network infrastructure or centralized administration. One of the main procedures for evaluating the performance of MANETs is simulation. In this paper, the comparison is made for the performance of routing protocols i.e. Ad hoc On Demand Distance Vector (AODV), Dynamic Source Routing (DSR) and Destination Sequence Distance Vector (DSDV) over a MAC Layer protocol IEEE 802.11. As per our findings the differences in the protocol mechanics lead to significant performance differentials for these protocols. Always the network protocols were simulated as a function of mobility, but not as a function of network density. In our paper the performance of AODV, DSDV and DSR is evaluated with respect to performance metrics like Packet Delivery Fraction (PDF), Average end-to-end delay, Normalized Routing Load (NRL), and Dropped packets by varying network size. These simulations are carried out using the NS-2 which is the main network simulator.*

Keywords— *AODV, DSDV, DSR, MAC, MANET, NRL, PDF*

I Introduction

A Mobile Ad Hoc Network Is A Collection Of Wireless Mobile Nodes That Dynamically Establishes The Network In The Absence Of Fixed Infrastructure [1]. One Of The Distinctive Features Of MANET Is, Each Node Must Be Able To Act As A Router To Find Out The Optimal Path To Forward A Packet. As Nodes May Be Mobile, Entering And Leaving The Network, The Topology Of The Network Will Change Continuously. Manets Provide An Emerging Technology For Civilian And Military Applications. Since The Medium Of The Communication Is Wireless, Only Limited Bandwidth Is Available. Another Important Constraint Is Energy Due To The Mobility Of The Nodes In Nature. One Of The Important Research Areas In MANET Is Establishing And Maintaining The Ad Hoc Network Through The Use Of Routing Protocols. Though There Are So Many Routing Protocols Available, This Paper Considers DSDV, AODV And DSR For Performance Comparisons Due To Its Familiarity Among All Other Protocols. These Protocols Are Analyzed Based On The Important Metrics Such As Packet Delivery Fraction (PDF), Average End-To-End Delay, Normalized Routing Load (NRL), And Dropped Packets And Is Presented With The Simulation Results Obtained By NS-2 Simulator. The Rest Of The Paper Is Organized As Follows. Section 1 Describes The Brief Introduction Of Dynamic Source Routing (DSR) And Destination Sequenced Distance Vector Routing (DSDV) Protocols. Section 2 Describes The Routing Protocols In Detail. Section 3 Details The Simulation Model And The Key Performance Metrics Respectively. In Section 4 The Simulation Results Are Presented And Analyzed. In Section 5 Conclusions Has Been Summarized And In The Section 6 Future Enhancements Is Given In Brief. And At Last Acknowledgement And References.

II Routing Protocols

A Routing Protocol Specifies How Routers Communicate With Each Other, Disseminating Information That Enables Them To Select Routes Between Any Two Nodes On A Computer Network, The Choice Of The Route Being Done By Routing Algorithms. Each Router Has *A* Prior Knowledge Only Of Networks Attached To It Directly. A Routing Protocol Shares This Information First Among Immediate Neighbours, And Then Throughout The Network.

A. Protocol Classifications

There Are Many Ways To Classify The MANET Routing Protocols, Depending On How The Protocols Handle The Packet To Deliver From Source To Destination. But Routing Protocols Are Broadly Classified Into Three Types Such As Proactive, Reactive And Hybrid Protocols [2].

1) Proactive Protocols: These Types Of Protocols Are Called Table Driven Protocols In Which, The Route To All The Nodes Is Maintained In Routing Table. Packets Are Transferred Over The Predefined Route Specified In The Routing Table. In This Scheme, The Packet Forwarding Is Done Faster But The Routing Overhead Is Greater Because All The Routes Have To Be Defined Before Transferring The Packets. Proactive Protocols Have Lower Latency Because All The Routes Are Maintained At All The Times.
Example Protocols: DSDV,OLSR (Optimized Link State Routing).

2) Reactive Protocols: These Types Of Protocols Are Also Called As On Demand Routing Protocols Where The Routes Are Not Predefined For Routing. A Source Node Calls For The Route Discovery Phase To Determine A New Route Whenever A Transmission Is Needed. This Route Discovery Mechanism Is Based On Flooding Algorithm Which Employs On The Technique That A Node Just Broadcasts The Packet To All Of Its Neighbours And Intermediate Nodes Just Forward That Packet To Their Neighbours. This Is A Repetitive Technique Until It Reaches The Destination. Reactive Techniques Have Smaller Routing Overheads But Higher Latency.
Example Protocols: DSR, AODV

3) Hybrid Protocols: Hybrid Protocols Are The Combinations Of Reactive And Proactive Protocols And Takes Advantages Of These Two Protocols And As A Result, Routes Are Found Quickly In The Routing Zone.
Example Protocol: ZRP (Zone Routing Protocol).

B. Overview Of Routing Protocols
1) Destination-Sequenced Distance-Vector (DSDV) Protocol:
The Table-Driven DSDV Protocol Is A Modified Version Of The Distributed Bellman-Ford (DBF) Algorithm That Was Used Successfully In Many Dynamic Packet Switched Networks [3]. The Bellman-Ford Method Provided A Means Of Calculating The Shortest Paths From Source To Destination Nodes, If The Metrics (Distance-Vectors) To Each Link Are Known. DSDV Uses This Idea, But Overcomes DBF's Tendency To Create Routing Loops By Including A Parameter Called Destination-Sequence Number.
In DSDV, Each Node Is Required To Transmit A Sequence Number, Which Is Periodically Increased By Two And Transmitted Along With Any Other Routing Update Messages To All Neighboring Nodes. On Reception Of These Update Messages, The Neighboring Nodes Use The Following Algorithm To Decide Whether To Ignore The Update Or To Make The Necessary Changes To Its Routing Table[8]:
Step 1: Receive The Update Message
Step 2: Update The Routing Table If Any One Of The Following Condition Satisfies:
I) Sn > Sp
Ii) Sn=Sp , Hop Count Is Less
Otherwise, Ignore The Update Message.
Here, Sn And Sp Are The Sequence Numbers Of New Message And Existing Message Respectively. When A Path Becomes Invalid, Due To Movement Of Nodes, The Node That Detected The Broken Link Is Required To Inform The Source, Which Simply Erases The Old Path And Searches For A New One For Sending Data. The Advantages Are Latency For Route Discovery Is Low And Loop-Free Path Is Guaranteed. The Disadvantage Is The Huge Volume Of Control Messages.

2) Ad Hoc On-Demand Distance Vector Routing (AODV) Protocol: The Ad Hoc On-Demand Distance Vector Routing (AODV) Protocol Is A Reactive Unicast Routing Protocol For Mobile Ad Hoc Networks [4]. As A Reactive Routing Protocol, AODV Only Needs To Maintain The Routing Information About The Active Paths. In AODV, The Routing Information Is Maintained In The Routing Tables At All The Nodes. Every Mobile Node Keeps A Next Hop Routing Table, Which Contains The Destinations To Which It Currently Has A Route. A Routing Table Entry Expires If It Has Not Been Used Or Reactivated For A Pre-Specified Expiration Time.

In AODV, When A Source Node Wants To Send Packets To The Destination But No Route Is Available, It Initiates A Route Discovery Operation. In The Route Discovery Operation, The Source Node Broadcasts Route Request (RREQ) Packets Which Includes Destination Sequence Number. When The Destination Or A Node That Has A Route To The Destination Receives The RREQ, It Checks The Destination Sequence Numbers It Currently Knows And The One Specified In The RREQ. To Guarantee The Freshness Of The Routing Information, A Route Reply (RREP) Packet Is Created And Forwarded Back To The Source Only If The Destination Sequence Number Is Equal To Or Greater Than The One Specified In RREQ.

AODV Uses Only Symmetric Links And A RREP Follows The Reverse Path Of The Respective RREQ. Upon Receiving The RREP Packet, Each Intermediate Node Along The Route Updates Its Next-Hop Table Entries With Respect To The Destination Node. The Redundant RREP Packets Or RREP Packets With Lower Destination Sequence Number Will Be Dropped. The Advantage Of This Protocol Is Low Connection Setup Delay And The Disadvantage Is More Number Of Control Overheads Due To Many Route Reply Messages For Single Route Request.

3) Dynamic Source Routing (DSR) Protocol: The Dynamic Source Routing (DSR) Is A Reactive Unicast Routing Protocol That Utilizes Source Routing Algorithm [5]. In DSR, Each Node Uses Cache Technology To Maintain Route Information Of All The Nodes. There Are Two Major Phases In DSR Such As:

• Route Discovery
• Route Maintenance

When A Source Node Wants To Send A Packet, It First Consults Its Route Cache [6]. If The Required Route Is Available, The Source Node Sends The Packet Along The Path. Otherwise, The Source Node Initiates A Route Discovery Process By Broadcasting Route Request Packets. Receiving A Route Request Packet, A Node Checks Its Route Cache. If The Node Doesn't Have Routing Information For The Requested Destination, It Appends Its Own Address To The Route Record Field Of The Route Request Packet. Then, The Request Packet Is Forwarded To Its Neighbours.

If The Route Request Packet Reaches The Destination Or An Intermediate Node Has Routing Information To The Destination, A Route Reply Packet Is Generated. When The Route Reply Packet Is Generated By The Destination, It Comprises Addresses Of Nodes That Have Been Traversed By The Route Request Packet. Otherwise, The Route Reply Packet Comprises The Addresses Of Nodes The Route Request Packet Has Traversed Concatenated With The Route In The Intermediate Node's Route Cache.

Whenever The Data Link Layer Detects A Link Disconnection, A ROUTE_ERROR Packet Is Sent Backward To The Source In Order To Maintain The Route Information. After Receiving The ROUTE_ERROR Packet, The Source Node Initiates Another Route Discovery Operation. Additionally, All Routes Containing The Broken Link Should Be Removed From The Route Caches Of The Immediate Nodes When The ROUTE_ERROR Packet Is Transmitted To The Source. The Advantage Of This Protocol Is Reduction Of Route Discovery Control Overheads With The Use Of Route Cache And The Disadvantage Is The Increasing Size Of Packet Header With Route Length Due To Source Routing.

III Simulation Environment

B. Simulation Model

Here We Give The Significance For The Evaluation Of Performance Of Ad Hoc Routing Protocol AODV, DSR, DSDV With Varying The Number Of Mobile Nodes. The Network Simulations Have Been Done Using Network Simulator NS-2 [7]. The Network Simulator NS-2 Is Discrete Event Simulation Software For Network Simulations Which Means It Simulates Events Such As Sending, Receiving, Forwarding And Dropping Packets. The Latest Version, Ns-Allinone-2.34, Supports Simulation For Routing Protocols For Ad Hoc Wireless Networks Such As AODV, DSDV, And DSR.We Get The Simulation Results In An Output Trace File And Here, We Analyzed The Experimental Results By Using The Awk Command. The Performance Parameters Are Graphically Visualized In Figure 2. NS-2 Also Offers A Visual Representation Of The Simulated Network By Tracing Nodes Movements And Events In A Network Animator (NAM) File. Simulation Overview Is Represented In Fig1 And Parameters Used For The Simulation Are Listed In The Table1.

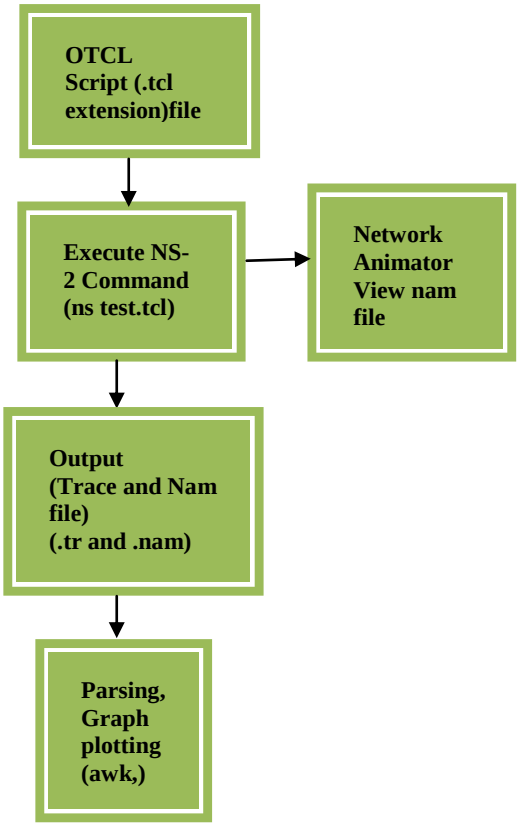

Fig1. Simulation Overview B. Simulation Parameters

Table 1: Simulation Parameters

Simulation Parameters	
Simulator	NS-2.34
Protocols	AODV, DSDV And DSR
Simulation Duration	60 Seconds
Simulation Area	Varying
Number Of Nodes	30, 40,50,60,70
MAC Layer Protocol	IEEE 802.11
Maximum Speed	20 M/S
Traffic Type	CBR (UDP)
Data Payload	512 Bytes/Packet

IV. RESULTS

C. Trace File

Trace Files Are Generated After The Execution Of Tcl Files. Fig 2 Is The Snapshot Of Trace File That Is Generated For Aodv Protocol For 30 Nodes.

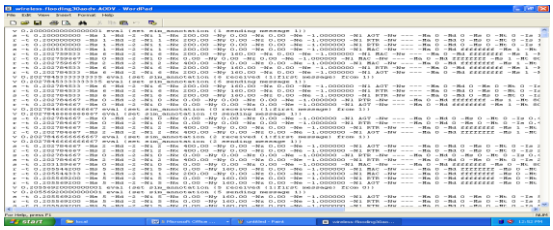

Fig 2.Trace File For Aodv Protocol At Node 30.

D. NAM File

Fig 3 Shows The NAM File Generated For 60 Nodes Using AODV Protocol.

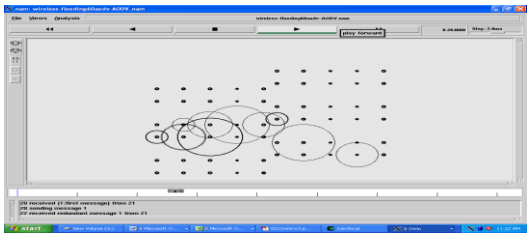

Fig 3. Nam File For AODV Protocol For 60 Nodes

E. AWK Commands

The Metrics Used For Evaluating MANET Performance Are Calculated By Using AWK Commands Bas Shown In The Fig 4.

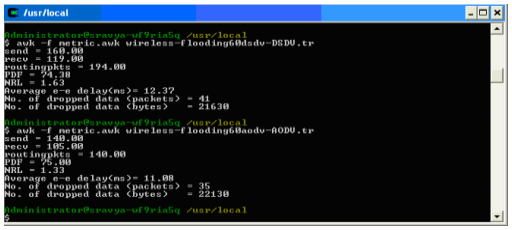

Fig 4: Nam File For AODV Protocol For 60 Nodes

F. Graphs

MANET Performance Is Calculated By Taking Different Metrics. In This Paper We Have Used PDF**,** **A**verage End-To-End Delay, NRL And Number Of Packets Dropped.

*1)**Packet Delivery Ratio:*** PDF Is The Ratio Of The Number Of Data Packets Successfully Delivered To The Destinations To Those Generated By CBR Sources. From Fig5, We Find That When The Number Of Nodes Between 30 And 70; The PDF For AODV Increases, For DSR It Decreases.

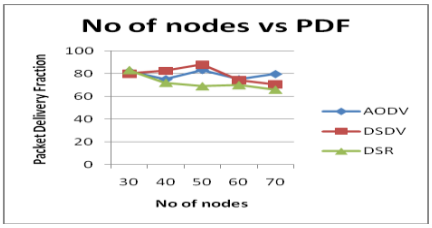

Fig 5. No Of Nodes Vs PDF

*2)**Normalised Routing Load:*** NRL Is The Number Of Routing Packets Transmitted Per Data Packet Delivered At The Destination. It Is Observed From The Fig 6, We Find That When The Number Of Nodes Between 30 And 70; DSR Gives Highest NRL, While DSDV Gives The Lowest NRL. Reason Being That It Is Proactive Routing Protocol.

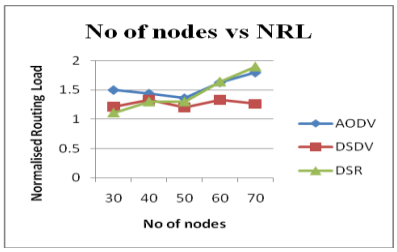

Fig6. No Of Nodes Vs NRL

3)Average End To End Delay: It Is The Average Time From The Beginning Of A Packet Transmission At A Source Node Until Packet Delivery To A Destination. This Includes Delays Caused By Buffering Of Data Packets During Route Discovery, Queuing At The Interface Queue, Retransmission Delays At The MAC, And Propagation And Transfer Times.

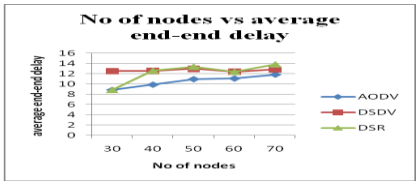

Fig7. No Of Nodes Vs Average End To End Delay

We Observe From The Fig 7 That AODV Has The Shortest End-To-End Delay Than DSDV And DSR. However, DSR Has Highest End-To-End Delay Than AODV And DSDV.

*4)**Number Of Lost Packets:*** It Is The Difference Between The Total Number Of Packets Send By Source And Received By Sink. It Is Observed From The Figure 8 That When The Number Of Nodes Is Varied From 30 To 70, Packet Loss For DSDV Is Highest; While It Is Lowest For DSR. While Packet Loss For AODV Will Increase As The Network Size Increases. Overall, DSR Performs Better In Terms Of Packet Loss As It Has Least Packet Loss Throughout.

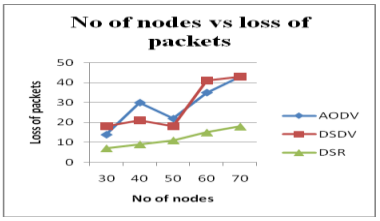

Fig 8: No Of Nodes Vs Loss Of Packets

V. Conclusion

In This Paper, We Have Evaluated The Performance Comparison Of The Routing Protocols DSDV, AODV And DSR With Increasing Number Of Nodes Using NS-2 Simulator. The Performance Metrics Taken Are Average End-To-End Delay, Normalized Routing Load, Packet Delivery Fraction, And Packet Loss. From The Performance Evaluation And Results Obtained, We Conclude That In Between Nodes 30 To 70. DSDV Gives The Lowest NRL While DSR Gives Lowest Packet Loss. And AODV Has The Highest Packet Delivery Fraction And Shortest End-To-End Delay.

Overall, AODV Performs Better Than DSDV And DSR In Terms Of PDF And Shortest End-To-End Delay. DSDV Gives The Lowest NRL, Than AODV And DSR. DSR Performs Better In Terms Of Packet Loss As It Has Least Packet Loss.

VI. Future Enhancement

We Have Analyzed The Performance Evaluation Of The Three Routing Protocols (AODV, DSDV And DSR) In This Project By Considering The Simulation Parameters Packet Delivery Fraction (PDF), Average End-To-End Delay, Normalized Routing Load (NRL), And Loss Of Packets. For The Future Work, We Are Planning To Cover Up Other Routing Protocols And Compare Them By Taking Different Simulation Scenarios. And We Will Try To Simulate These Protocols Using Different Simulation Setups.

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