Comparative Study of DYMO and Bellman Ad hoc Routing Protocol for various Battery models in MANET using Qualnet

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Abstract

It is a challenge area in the field of ad hoc networks to support prioritized routing for time sensitive applications, such as multimedia communications, IP telephony and interactive games. However the existing protocols did not consider the special battery discharging behavior of wireless devices. The limited power supply on wireless devices becomes the bottleneck for prioritized routing in ad hoc networks. Wireless devices powered by battery generally waste a huge amount of energy if we do not carefully schedule and budget their discharging. In this paper we compare DYMO and Bellman protocols for battery models DURACELL AA (MX 1500), PANASONIC AA, PANASONIC AAA, duracell MN 2400, DURACELL MX2400 standard using Qualnet as a Simulation tool. Hence performance of the protocols with various battery models counts and helps to make a right selection.

Keywords: MANET, QUALNET, DYMO, BELLMAN

1. Introduction

"Wireless networking is a technology that enables two or more computers to communicate using standard network protocols, but without network cabling" [9]. And now there exist network protocols that are developed just for the purpose of Wireless networks. We can categorize wireless network in primarily following two categories.

Network with existing infrastructure is a network which consists of a wireless access point or earlier wireless hardware support for each node to connect to networks. Here nodes do not participate in any kind of transit services. They communicate to access points to send & receive packets from other nodes. In this kind of network different access point can follow different wireless protocol like 802.11 b or 802.11g and still can communicate with each other. There exist several wireless products based on this kind of technology.

Ad hoc network is a network where there is no existence of wireless infrastructure for networking, Instead each node communicates with each other using their sole transmitter-receiver only. In this kind of network each and every node does participate voluntarily in transit packet that flow to and from different nodes. Each node do follow same routing algorithm to route different packets. Thus this kind of network have limited homogenous feature. There are not many wireless products that follow this proposed technology.

2. Types of routing protocols

2.1.1 Proactive routing protocol

Proactive routing protocols maintain information continuously. Typically, a node has a table containing information on how to reach every other node and the algorithm tries to keep this table up-to-date. Changes in network topology are propagated throughput the network

2.1.2 Reactive (on demand) routing protocols

On demand protocols use two different operations to Route discovery and Route maintenance operation. In this routing information is acquired on-demand. This is the route discovery operation. Route maintenance is the process of responding to change in topology that happen after a route has initially been created.

2.1.3 Hybrid routing protocols

Hybrid routing protocols are a new generation of protocol, which are both are Proactive and Reactive in nature. Most hybrid protocols proposed to date are zone based, which means that the network is partitioned or seen as a number of zones by each node. Normally, Hybrid routing protocols for MANETs exploit hierarchical network architectures.

2.2. The protocols studied here are

2.2.1 DYMO

The Dynamic MANET On-demand (DYMO) routing protocol enables reactive, multihop unicast routing between participating DYMO routers. The basic operations of the DYMO protocol are route discovery and route maintenance. During route discovery, the originator's DYMO router initiates dissemination of a Route Request (RREQ) throughout the network to find a route to the target's DYMO router. During this hop-by-hop dissemination process, each intermediate DYMO router records a route to the originator. When the target's DYMO router receives the RREQ, it responds with a Route Reply (RREP) sent hop-by-hop toward the originator. Each intermediate DYMO router that receives the RREP creates a route to the target, and then the RREP is unicast hop-by-hop toward the originator. When the originator's DYMO router receives the RREP, routes have then been established between the originating DYMO router and the target DYMO router in both directions. Route maintenance consists of two operations. In order to preserve routes in use, DYMO routers extend route lifetimes upon successfully forwarding a packet. In order to react to changes in the network topology, DYMO routers monitor links over which traffic is flowing. When a data packet is received for forwarding and a route for the destination is not known or the route is broken, then the DYMO router of source of the packet is notified. A Route Error (RERR) is sent toward the packet source to indicate the current route to a particular destination is invalid or missing. When the source's DYMO router receives the RERR, it deletes the route. If the source's DYMO router later receives a packet for forwarding to the same destination, it will need to perform route discovery again for that destination. DYMO uses sequence numbers to ensure loop freedom. Sequence numbers enable DYMO routers to determine the order of DYMO route discovery messages, there by avoiding use of stale routing information. (C. Perkins, 2008)

<u>Advantages and disadvantages</u>

The DYMO protocol draft expressively provides for the coupling of MANET with the Internet, which makes an evaluation of communications connections between mobile nodes and static infrastructure especially attractive. Particularly at higher node densities, which commonly occurred in micro-jams, the routing and transport protocol behavior led to drastic increase in network load. When the network becomes congested and new connection could not be established, simple retry mechanism only furthered congestion.

2.2.2 Bellman

The algorithm known as Bellman-Ford was originally developed by Bellman [Bel58] and by Ford and Fulkerson [FF62]. It is typically described in pseudo code. [4]

Bellman-Ford is used for single source shortest path along with Dijkstra Algorithm. It is a Dynamic Programming based algorithm and it work for negative weight edges. Also distributed variant of the Bellman–Ford algorithm is used in distance-vector routing protocols. The Bellman- Ford distance-vector routing algorithm is used by routers on inter networks to exchange routing information about the current status of the network and how to route packets to their destinations. The algorithm basically merges routing information provided by different routers into lookup tables. It is well defined and used on a number of popular networks. It also provides reasonable performance on small-to medium sized networks, but on larger networks the algorithm is slow at calculating updates to the network topology. In some cases, looping occurs, in which a packet goes through the same node more than once. In general, most

DVR (distance-vector routing) algorithms are not suitable for larger networks that have thousands of nodes, or if the network configuration changes often. In the latter case, the routing algorithm must be able to dynamically update the routing tables quickly to accommodate changes [5]. It is used as an algorithm by distance vector routing protocols such as RIP, BGP, ISO, IDRP, NOVELL IPX. Routers that use this algorithm will maintain the distance tables, which tell the distances and shortest path to sending packets to each node in the network[6]. This protocols and algorithms currently use in the IPv4 Internet. If that protocol is used in those system of networks which have several hundreds of networks and if there is any loop formed then Bellman-ford take much time to resolve that loop so this protocol is not suitable for larger networks.

3. BATTERY MODELS

The zinc/potassium hydroxide/manganese dioxide cells, commonly called alkaline [5] or alkalinemanganese dioxide cells, have a higher energy output than zinc-carbon (Leclanche) cells. Other significant advantages are longer shelf life, better leakage resistance, and superior low temperature performance. In comparison to the zinc-carbon cell, the alkaline cell delivers up to ten times the ampere-hour capacity at high and continuous drain conditions, with its performance at low temperatures also being superior to other conventional aqueous electrolyte primary cells. Its more effective, secure seal provides excellent resistance to leakage and corrosion. The use of an alkaline electrolyte, electrolytic ally prepared manganese dioxide, and a more reactive zinc powder contributes to a higher initial cost than zinccarbon cells. However, due to the longer service life, the alkaline cell is actually more cost-effective based upon cost-per-hour usage, particularly with high drains and continuous discharge. The high-grade, energy-rich materials composing the anode and cathode, in conjunction with the more conductive alkaline electrolyte, produce more energy than could be stored in standard zinc carbon cell sizes In comparison to the zinc-carbon cell, the alkaline cell [6] delivers up to ten times the ampere-hour capacity at high and continuous drain conditions, with its performance at low temperatures also being superior to other conventional aqueous electrolyte primary cells. Its more effective, secure seal provides excellent resistance to leakage and corrosion. The product information and test data included in this section represent Duracell's newest alkaline battery products. The usage of alkaline electrolyte, electrolytically developed manganese dioxide, and greater reactive zinc powder distributed to a higher initial price than zinc-carbon cells. However, the alkaline cell is really more cost effective depends upon cost-per-hour (CPH) usage, especially with high drains and uninterrupted discharge and referable to the longer service life. The high- rate, energy-rich substantial composing the cathode and anode, in colligation with the more conductive alkaline electrolyte, yield more energy than could be storage in zinc carbon cell sizes. The comparability between the zinc-carbon cell and alkaline cell delivers more than ten times the ampere-hour capacity at high and uninterrupted drain precondition, and its performance at low temperatures as well being super ordinate to other formal aqueous electrolyte primary cells. Its more efficient, secure seal allows excellent resistance to corrosion and leakage. The product test data and information are including in this division symbolizes Duracell's most newfangled alkaline battery products.

3.1 DURACELL AA (MX 1500)

Nominal Voltage	1.5 V
Operating Voltage	1.6 - 0.75V
Impedance:	81 m-ohm @ 1kHz
Typical Weight:	24 gm (0.8 oz.)
Typical Volume:	8.4 cm^3 (0.5 in.3)
Storage Temperature Range	-20^{o}C to 35^{o}C
Operating Temperature Range	-20oC to 54oC
Terminals:	Flat
ANSI	15A
IEC	LR6

3.2 PANASONIC AA

Nominal Voltage	1.5 V
Operating Voltage	1.6 - 0.75V
Impedance:	136 m-ohm @ 1kHz
Typical Weight:	0.80gm (23.0oz.)
Typical Volume:	3.8 cm^3 (0.2 in.3)
Storage Temperature Range	-20^{o}C to 35^{o}C
Operating Temperature Range	-20oC to 54oC
Terminals:	Flat
ANSI	24A
IEC	LR03

3.3. PANASONIC AAA

Nominal Voltage	1.5V
Operating Voltage	1.6 - 0.75V
Impedance:	136 m-ohm @ 1kHz
Typical Weight:	11.0 grams (0.38 oz.)
Typical Volume:	3.8cm^3(0.2 in.3)
Storage Temperature Range	-20^{o}C to 35^{o}C
Operating Temperature Range	-20°C to 54°C (-4°F to 130°F)
Terminals:	Cap and base
ANSI	24A
IEC	LR03

3.4. Duracell MN 2400

Nominal Voltage	1.5V
Operating Voltage	1.6 - 0.75V
Impedance:	250 m-ohm @1kHz
Typical Weight:	11.0 grams (0.39 oz.)
Typical Volume:	3.5cm^3(0.21 in.3)

Storage Temperature Range	-20°C to 35°C
Operating Temperature Range	-20°C to 54°C (-4°F to 130°F)
Terminals:	Flat
ANSI	24A
IEC	LR03

3.5. DURACELL MX2400

Nominal Voltage	1.5V
Operating Voltage	1.6 - 0.75V
Impedance:	114 m-ohm @ 1kHz
Typical Weight:	11 gm (0.4 oz.)
Typical Volume:	3.5 cm 3 (0.2 in.3)
Storage Temperature Range	-20°C to 35°C
Operating Temperature Range	-20°C to 54°C
Terminals:	Flat
ANSI	24A
IEC	LR03

4. Simulation environments:

The adopted methodology for the results of this work (specifically comparative routing analyses) is based on simulations near to the real time packages before any actual implementation. This is accomplished by simulating the scenario with the help of simulation tool Qualnet [6].QualNet is a comprehensive suite of tools for modeling large wired and wireless networks. It uses simulation and emulation to predict the behavior and performance of networks to improve their design, operation and management. QualNet enables users to design new protocol models, Optimize new and existing models, Design large wired and wireless networks using pre-configured or user designed models, Analyze the performance of networks and perform what-if analysis to optimize them. QualNet is the preferable simulator for ease of operation. So, we found QualNet be the best choice to implement our scenarios as we do not need every feature possible.

To evaluate and compare the effectiveness of these routing protocols in a Mobile Ad-Hoc network, we performed extensive simulations in QualNet5.0.2 each simulation is carried out under a constant mobility. The simulation parameters are listed in Table

Table.1. Simulation Parameters

S.No	Parameter	
1	Antenna model	Omnidirectional
2	Terrain Size	1500X1500
3	No of nodes	60
4	Radio Type	802.11b radio
5	Battery Charge Monitoring Interval	30min
6	Data Rate	2mbps
7	Mobility Model	Random way point
8	Pause Time	10sec
9	Speed of vehicle	min-2m/s, max-10m/s
10	Position granularity	1500
11	Battery model	Residual life Estimator

DESIGNING OF SCENARIO

The Qualnet Simulator is used, has a scalable network library and gives accurate and efficient execution [6].The scenario is designed in such a way that it undertakes the real traffic conditions. We have chosen 60 fast moving vehicles in the region of 1500X1500 m2 with the random way point mobility model. There is also well defined path for some of the vehicles. It shows wireless node connectivity of few vehicles using CBR application. The area for simulation is Hilly area with altitude of 1500 meters. Battery model are DURACELL AA (MX 1500), PANASONIC AA, PANASONIC AAA, duracell MN 2400, DURACELL MX2400.The simulation is performed with different node mobility speed and CBR (Constant bit rate) traffic flow. CBR traffic flows with 512 bytes are applied. Simulations is made in different speed utilization with IEEE 802.11 Medium access control (MAC),the data rate 2mbps. The network protocol here applied is Internet Protocol version four (IPv4). By this proposed topology the failure of node can be easily detected and it gives the way for the accuracy in their performance.

PERFORMANCE METRICS

4.1 Throughput

Throughput is defined as; the ratio of the total data reaches a receiver from the sender. The time it takes by the receiver to receive the last message is called as throughput. Throughput is expressed as bytes or bits per sec (byte/sec or bit/sec). Some factors affect the throughput as; if there are many topology changes in the network, unreliable communication between nodes, limited bandwidth available and limited energy. A high throughput is absolute choice in every network.

4.2 Average End to End delay

The average end-to-end delay of data packets is the interval between the data packet generation time and the time when the last bit arrives at the destination [6].

4.3 Packet Delivery Sent
It is the ratio of the number of data packets received by the CBR sink at the final destinations to the number of data packets originated by the “application layer” at the CBR sources.

4.4 Average Jitter
Average Jitter is the variation (difference) of the inter-arrival times between the two successive packets received.

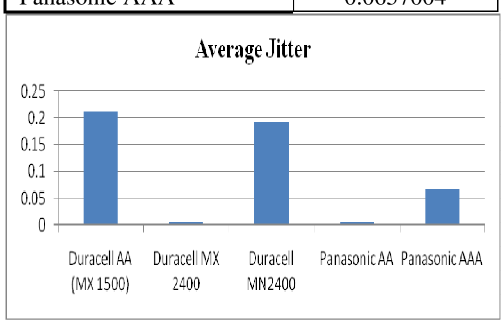
4.5 Throughput (bit/s)
Throughput is the average rate of successful message delivery over a communication channel the throughput is measured in bits per second (bit/s or bps), and rarely in packets per second or packets per time slot.

5. Results

DYMO
A lower average jitter and average end to end delay are obtained for the two battery models Duracell MX 2400 & Panasonic AA so these two are best for DYMO as far as average jitter or average end to end delay is concerned but for overall comparison we have to analyze the performance metrics also. The total number of bytes and packets received are higher in Duracell MN 2400 as compared to other also throughput is obtained high for Duracell MN 2400. So with several compromises we can say it will be better to use Duracell MN 2400 for DYMO.

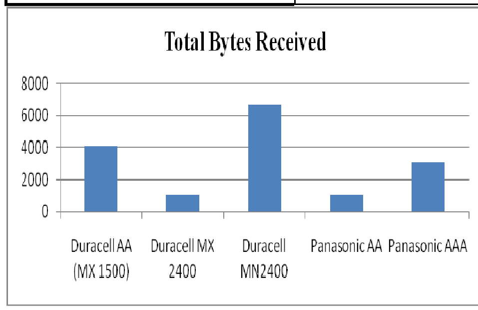
Average Jitter

Battery models	Value
Duracell AA (MX 1500)	0.211189
Duracell MX 2400	0.0052307
Duracell MN2400	0.192161
Panasonic AA	0.0052307
Panasonic AAA	0.0657004



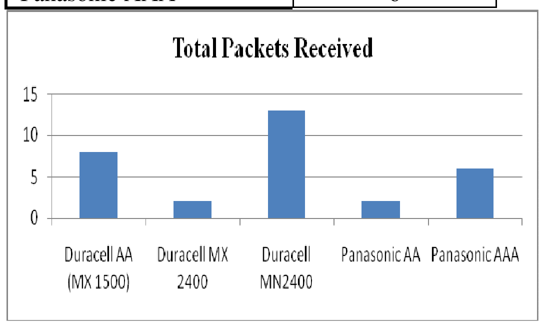
Total Bytes Received

Battery models	Value
Duracell AA (MX 1500)	4096
Duracell MX 2400	1024
Duracell MN2400	6656
Panasonic AA	1024
Panasonic AAA	3072



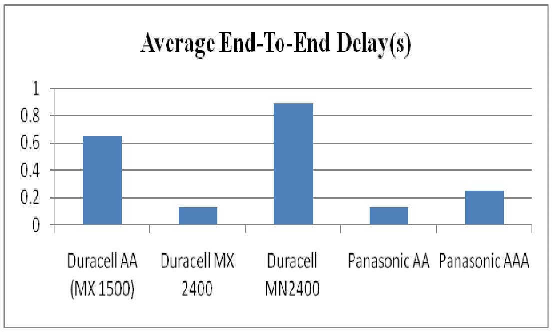
Total Packets Received

Battery models	Value
Duracell AA (MX 1500)	8
Duracell MX 2400	2
Duracell MN2400	13
Panasonic AA	2
Panasonic AAA	6



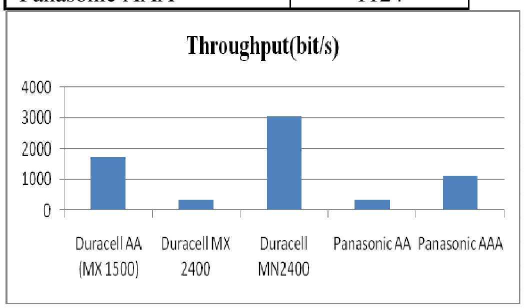
Average End-To-End Delay(s)

Battery models	Value
Duracell AA (MX 1500)	0.648543
Duracell MX 2400	0.126981
Duracell MN2400	0.884246
Panasonic AA	0.126981
Panasonic AAA	0.25601



Throughput(bit/s)

Battery models	Value
Duracell AA (MX 1500)	1765
Duracell MX 2400	357
Duracell MN2400	3061
Panasonic AA	357
Panasonic AAA	1124

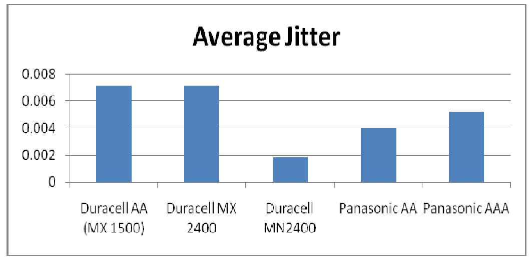


BELLMAN

For BELLMAN routing protocol Duracell MN 2400 has minimum average jitter among all and Panasonic AA has the highest number of received packets and bytes as per the observations made by us. Average end to end delay is zero for Panasonic AA & less for Duracell MN 2400 and throughput is higher for Panasonic AA battery model. When all results are compiled for BELLMAN routing protocol Panasonic AA battery model comes with a better result.

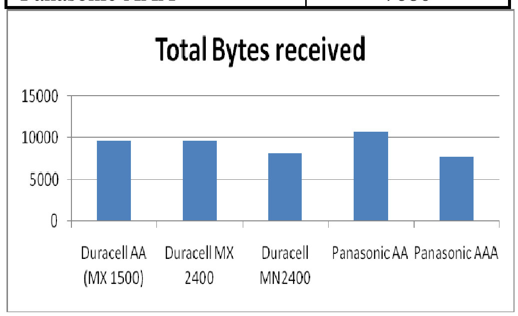
Average Jitter

Battery Model	Value
Duracell AA (MX 1500)	0.0071354
Duracell MX 2400	0.0071354
Duracell MN2400	0.00185138
Panasonic AA	0.00399254
Panasonic AAA	0.00522522



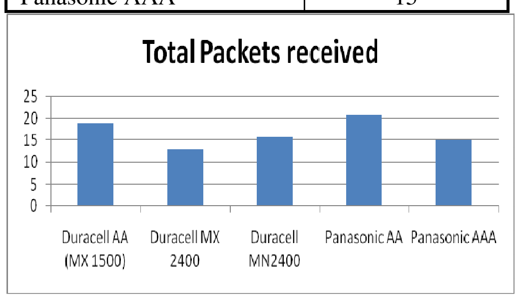
Total Bytes received

Battery Model	Value
Duracell AA (MX 1500)	9728
Duracell MX 2400	9728
Duracell MN2400	8192
Panasonic AA	10752
Panasonic AAA	7680



Total Packets received

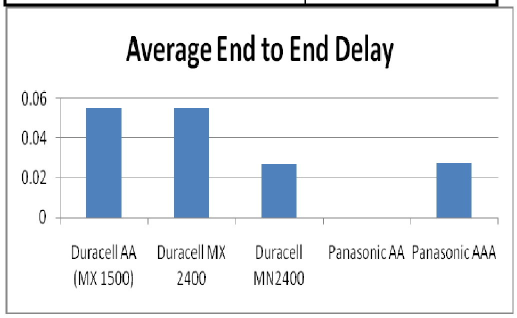
Battery Model	Value
Duracell AA (MX 1500)	19
Duracell MX 2400	13
Duracell MN2400	16
Panasonic AA	21
Panasonic AAA	15



Average End to End Delay

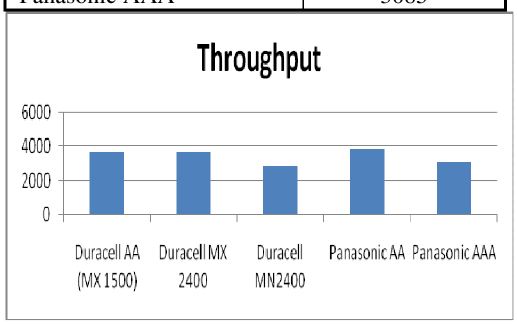
Battery Model	Value
Duracell AA (MX 1500)	0.0552528
Duracell MX 2400	0.0552528
Duracell MN2400	0.0268469
Panasonic AA	0

Panasonic AAA	0.0272528



Throughput

Battery Model	Value
Duracell AA (MX 1500)	3699
Duracell MX 2400	3699
Duracell MN2400	2848
Panasonic AA	3906
Panasonic AAA	3085



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References

[1] S. Khan, A. Amir Pirzada, M. Portmann, *"Performance Comparison of Reactive Routing Protocols for Hybrid Wireless Mesh Networks*" The 2nd International Conference on Wireless Broadband and Ultra Wideband Communications (Aus Wireless 2007) 0-7695- 2842-2/07 $25.00 © 2007

[2] B. Singh, Er. R. Chawla, Er. S. Kaur, *"Performance quantification of Wireless Sensor Networks by implementing Zone Routing Protocol"* International Journal of Computers & Technology Volume 2 No. 3, June, 2012

[3] A. Sreelatha, Dr. A. VinayaBabu, K. Madhukar, S. Nagaprasad, D. Marlene Grace Verghese, V. Mallaiah, A.Pratima, *"Mobile Wireless Enhanced Routing Protocol in Adhoc Networks"* A. Sreelatha et. al. / (IJCSE) International Journal on Computer Science and Engineering Vol. 02, No.07, 2010, 2398-2401

[4] M. M. Nagar, S. Pathak, *"Power Control MAC Protocol with Increased Throughput for MANETs"* International Journal of Engineering Research & Technology (IJERT) Vol. 1 Issue 5, July – 2012 ISSN: 2278-0181

[5] R. K. Singh, A. Asthana *"Evaluation of Proactive, Reactive and Hybrid Ad hoc Routing Protocol for Panasonic AAA Battery model In VANET using Qualnet"* VSRD-IJCSIT, Vol. 1 (8), 2011, 601-607

[6] M. Sharma, G. Singh *"Evaluation of Proactive, Reactive and Hybrid Ad hoc Routing Protocol for various Battery models in VANET using Qualnet"* International Journal of Smart Sensors and Ad Hoc Networks (IJSSAN) ISSN No. 2248-9738 (Print) Volume 1, Issue-2, 2011

[7] D. Yadav, G. S. Mishra, *"Performance Evaluation Of Proactive Routing Protocol For Ad-Hoc Networks"* IRACST - International Journal of Computer Science and Information Technology & Security (IJCSITS), ISSN: 2249-9555 Vol. 2, No.3, June 2012