ANALYZING THE PERFORMANCE OF ON-DEMAND ROUTING PROTOCOLS BASED ON RAINFALL INTENSITY IN WI-FI NETWORKS

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Abstract: During rainfall the information signal while transmission gets attenuated and the network performance is affected greatly in the regions where frequent rainfall occurs as they are prone to varying climatic conditions. Therefore in order to maintain a reliable communication the implementation of a MANET protocols during rainstorm or similar unfavorable environmental conditions should be paid great attention for the selection of routing protocols. The routing protocol must provide efficient and effective improvement in performance aspects such as total number of packets received, throughput, mean jitter and an end to end delay. This paper undergoes evaluation based study of MANET reactive/on-demand routing protocols namely LANMAR, OSPFV2, ANODR and DYMO in Wi-Fi networks (IEEE802.11n). The behavior of routing protocols is simulated and evaluated using Exata 5.1 network simulator by varying the intensity level of rainfall from light rain (2mm/hr) to cloud burst (100 mm/hr) to predict rainfall efficient routing protocol which can render maximum throughput and minimum delay.

Keywords: Rainfall, LANMAR, OSPFV2(Open Shortest Path First version 2), DYMO(Dynamic MANET On-demand), ANODR(Anonymous On-Demand Routing), WiFi(Wireless-Fidelity), Emulation.

1. INTRODUCTION

Ad hoc wireless networks are self-configuring, infrastructure-less networks with wireless connections [1]. The network topology that is the physical connectivity of the communication network keeps on changing randomly. These ad-hoc networks are capable of high dynamic topology due to the random mobility of the nodes, provides centralized administration as the established environment is absent, bandwidth constraints and resource constraints.

One of the main characteristics mentioned above the mobility of the nodes causes the change in the routing information between networks. In order to provide more convergence of information packets a routing protocol capable of providing an efficient and effective mobility management should be implemented. The routing protocol working under the Wi-Fi (IEEE802.11n) can also provide increased performance in terms such as high reliability, high quality of information reception and low latency in a limited bandwidth.

The regular change in the weather conditions in rainfall prone areas affects the part or a full network in real time environments [2]. Therefore causes isolation in connectivity between the flood prone areas and the network. The protocol chosen should be also capable of not getting affected by rainfall and such similar weather conditions. The places where the precipitations are very high are also need to be implemented with such a protocol which can provide reliable communication to carry out rescue operations as an effective response[3]. Therefore the knowledge regarding the various rainfall intensities and precipitation rate is required in analyzing the impacts caused in protocols.
2. **WI–FI NETWORK (IEEE802.11n)**

The IEEE802.11n standard has fascinating features in the both physical and data link layers [4]. The IEEE802.11 acts a broad opportunity in establishing the real time communications in wireless networks. This standard is proved to be an efficient solution to many of the communication problems like latency, reliability and so on. Particularly the MIMO(Multiple Input Multiple Output) feature which provides operation in the unlicensed frequencies of range 2.4GHz to 5GHz establishing longer distance transmission and increased rate of transmission.

In the physical layer IEEE802.11n has modified the modulation and coding methods which results in 11% of increase in the rate of transmission. The use of orthogonal frequency division multiplexing has increased the yield. In the data link layer it has introduced a quality of service concept through which multiple consecutive frames can be sent without contention back offs thus reducing the overhead. The receiver is also sent an acknowledgement about the multiple data bits in the single frame which also improves the utilization of the channel[5].

3. **RAINFALL INTENSITY**

Rainfall intensity is the total amount of rain falling for a given period of time[6]. The rate of change of rain depth can be an alternate definition. The intensity of the rainfall is expressed in the depth per unit time, in an international system as mm/hr. The instrument which is used to measure the rainfall intensity is rain gauge. In a square meter a millimeter of water is equal to a liter. The rain gauges are of many types such as simple buried pit collectors, tipping bucket gauges and graduated cylinders. The intensity of the rainfall classified based on rate of precipitation is given in Figure.1.

| Rainfall Intensity | Precipitation rate |
|--------------------|--------------------|
| Light rain         | <2.5 mm/hr         |
| Moderate rain      | 2.5-10 mm/hr       |
| Heavy rain         | 10-50 mm/hr        |
| Violent rain       | 50-100 mm/hr       |
| Cloud burst        | >100 mm/hr         |

*Figure.1 Classification of rainfall based on precipitation rate*

In Indian among the wettest cities the top two cities are Cherrapunji and Mawsynram which are situated in the north-eastern parts of the India. For our crucible understanding the statistics of the precipitation rate in these two cities are given in Figure.2 & 3[7]. The variation in statistics shows how they affect the performance metrics of routing protocols.
Figure 2. Statistics of the precipitation rate in Cherrapunji and Mawsynram

In East Khasi Hills, a scenic village named Mawsynram within the district of Meghalaya state is reportedly the wettest place on Earth. It experiences an annual downfall of 11,872 millimetres. The small village has in addition reserved a mention in the Guinness Book of World Records, when it received 26,000 millimetres of downfall at intervals in the year of 1985. It in addition has an extended monsoon season, with average temperature varying in Cherrapunji from 10 degrees to 20 degrees Celsius. In the year of 2010, the state has received 300 mm of downfall[8].

| Year | Cherrapunji Rainfall (mm) | Mawsynram Rainfall (mm) |
|------|---------------------------|-------------------------|
| 2010 | 13,472                    | 14,234                  |
| 2009 | 9,070                     | 12,459                  |
| 2008 | 11,415                    | 12,670                  |
| 2007 | 12,647                    | 13,302                  |
| 2005 | 8,734                     | 8,082                   |
| 2004 | 9,758                     | 10,072                  |
| 2003 | 14,791                    | 14,026                  |
| 2002 | 10,499                    | 11,767                  |
| 2001 | 12,262                    | 11,118                  |

Figure 3 Average precipitation in Cherrapunji and Mawsynram

As per the above mentioned studies in two wet cities, the intensity values were chosen. The goal of the paper is to analyze the performance metrics such as total amount of packets received, mean jitter, end-to-end delay and throughput of the reactive/on-demand routing protocols like LANMAR, ANODR, OSPFv2 and DYMO in Wi-Fi (802.11n) based on above mentioned rainfall intensities.

4. ROUTING PROTOCOLS

A routing protocol configures how routers communicate with one another nodes, distributing data that permits them to pick out routes between any nodes on a network. On internet these routers are capable of performing the "traffic directing"[9]. Knowledge packets are forwarded
through the networks from router to router till they reach their destination nodes. The precise alternative route will be confirmed by the routing algorithm. This information is shared with the routing protocol and it will communicate among immediate neighbors and also to the entire network [10]. Thus the information about the topology of the network is gained by the router. The information about the network topology is not maintained by the on-demand or reactive routing protocols. They obtain path of transmission only when required by establishing the connection as there is no any need in exchange of periodical routing information[11].

LANMAR - Landmark Routing Protocol (LANMAR) builds use of the idea of “landmark” for scalable routing in mobile ad-hoc networks. Landmark idea was first introduced in wired space network. The idea of landmark was borrowed by LANMAR and extended to impromptu network[12]. It will not require a predefined stratified address, however the concept of landmarks to trace the logical subnets during which the users have a typical interest and that they move as a ‘group’ (e.g. Student of same department in an exceedingly college). There will be a “landmark” in every such cluster. For every cluster there will be a predefined space or scope. The routing of packets is barely at intervals the scope. Solely the routing info of every node at intervals the scope is maintained. The route detail on the far side the scope is “summarized” by the various landmarks. Thus, it greatly reduces the routing table size and traffic overhead. It improves the throughput significantly. The landmark failures will be recovered by “landmark” in logical subnets. Nodethat was elective in every subnet. This provides flexibility to LANMAR to cope up with painter. This protocol additionally provides answer for drifters (Nodes outside the wide-angle scope). It runs on the highest of a proactive routing protocol. It needs Fish State Routing protocol (FSR). The route to a landmark is propagated by Distance Vector mechanism[13].

DYMO- DYMO succeeds the Ad hoc On-Demand Distance Vector (AODV) Routing protocol. It is simple to implement and the enhancements can easily be incorporated. The main and salient feature of DYMOs, it can work simultaneously as both table-driven and on-demand routing protocol. The path or routes will be identified only when it is required. To establish a new route a ”Route Request” (RREQ) messages are sent to all the nodes through the MANET. The ordered list of all the nodes, that every RREQ passsthrough is saved in the network, therefore each host after receiving the RREQ message will save the route and inform the traversed path back to the root node. Once RREQ reaches at its destination, a ”Routing Reply” (RREP) can be traversed back to the root node, informing that a route to the destination node has been found. Exchange of data packets will begin once route is established between root and end destination node.

ANODR-(Anonymous on-demand Routing Protocol) it is designed to routing for network-centric anonymous and untraceable routing scheme for wireless ad-hoc networks. The ANODR protocol is based on AODV table-driven protocol. In all other protocols, the data packets are broadcasted to all the nodes and all the routes are open to all the nodes. Therefore, any route can be chosen and pattern of data packets can be identified by observing the communication between the adjacent nodes. The intruder can easily hack the pattern and attack the network and even the data packets can be rerouted to the intruder’s network. It will create a potential threat to the network. In ANODR, the packets are sent in untraceable network and ensures the secure network. The adversaries cannot identify the mobility pattern and signal transmitters, therefore cannot trace the data packets. The ANODR ensures confidentiality by encrypting the data packets.

OSPFv2- IETF link-state protocol for IPv4 networks. The router of OSPFv2 sends a special message known as a salutation packet to get different OSPFv2 neighbor routers. When the invention of
neighbor, the 2 routers begin to match data within the salutation packet to work out whether or not each have compatible configurations. Then the neighbor routers decide to establish contiguousness that is nothing however the routers synchronize their link-state databases to form certain that they need similar OSPFv2 routing data [17]. Adjacent router shares link-state advertisements (LSAs) that embrace data regarding operation, value of the link and the other neighbor data. The routers then flood the LSAs that area unit received to each OSPF-enabled interface so all OSPFv2 routers eventually have identical link-state databases, the network is converged. To create its route table, every routers uses Dijkstra’s Shortest Path 1st formula (SPF). OSPFv2 will be divided into areas that reduces the hardware associate degreed memory necessities for an OSPF-enabled router[18].

5. EVALUATION PARAMETERS

THROUGHPUT—Throughput is defined as the average rate of successful message delivered over a channel in bits/second or data packets/second.

PACKET DELIVERY RATIO—Packet delivery ratio is defined as the ratio between the total amounts of packets sent from the source node to the packets received in the destination node.

END TO END DELAY—End to end delay is the time delay for data packets to reach from source node to the destination node. Delay due to route discovery, queuing, propagation and transfer time are also can be included in delay metrics.

JITTER—Jitter is defined as the variation in packet transit delay from source to destination which is caused due to serialization, contention and queuing on the path through the network, generally this occurs in either slow or heavily congested networks [19].

6. SCENARIO AND SIMULATION SETUP

Totally 60 nodes was used for simulation and all were set to mobile nodes with random mobility. Nodes are connected to cloud through link. CBR is given between two nodes, one will act as a sender and another act as receiver. Totally 100 packets was sent for a simulation time of 101 seconds. In physical layer, 802.11n Radio was used and in MAC layer 802.11e was used. The scenario of with and without rainfall is shown in Figure.4 and Figure.5 respectively. The Figure.6 and Figure.7 shows the 3D and 2D view of routing in Exata 5.1.[20]
Figure 5: Scenario for with rainfall

Figure 6: 3D view of routing

Figure 7: 2D view of routing
7. RESULT AND DISCUSSION

The simulation is carried out under varying rainfall intensity from light rain with 2mm/hr precipitation to heavy cloudburst with 100mm/hr precipitation level. In this paper, the performance of on-demand routing protocols like LANMAR, ANODR, DYMO and OSPFv2 were analyzed for different rainfall intensities using network simulator Exata.

7.1 TOTAL PACKET RECEIVED

The total number of packets sent is 100 for a simulation time of 101 seconds. From the figure.8 it is clear that the ratio of packets delivered is decreased with increase in rainfall intensity. After comparing the results obtained for the above-mentioned protocols it seems that ANODR performs good even at high rainfall intensities.

![Figure 8](image8.png)

Figure 8: Comparison graph of protocols in terms of total packets received

The performance of OSPFv2 is very poor. Thus, for better Packet Delivery Ratio (PDR) it is recommended to use DYMO as the PDR for LANMAR, ANODR, DYMO and OSPFv2 are 64.5%, 71.8%, 90%, 8% respectively. ANODR is also comparatively good.

7.2 AVERAGE JITTER

![Figure 9](image9.png)

Figure 9: Comparison graph of protocols in terms of average jitter
Average Jitter is a parameter which should me minimum for a protocol to ensure the best performance. From the figure.9 it is clear that increase in rainfall intensity increases the Jitter. For OSPFv2 the average jitter is minimum at high rainfall intensity but the packets delivered is very minimum. In case of DYMO the ratio of total packets received and Jitter is higher than all other protocols. Thus, DYMO is considered to be the best among the selected protocols.

7.3 END TO END DELAY

From the results obtained as shown in figure.10, it is obvious that the end to end delay is more for high rainfall intensities. The ratio of packets delivered and delay taken is high for DYMO thus, DYMO can be implemented in heavy rainfall regions to transmit a greater number of packets in short duration.

7.4 THROUGHPUT

It is obvious from the overall result that throughput decreases for increase in rainfall intensities. But in case of DYMO throughput is less deviated compared to other protocols. Figure.11 shows the comparison graph of protocols in terms of throughput.
8. CONCLUSION

Thus as a result of simulation of on-demand routing protocols at different rainfall pattern starting from light rain to heavy cloud burst, the best suited protocol for rainfall prone region can be identified and the same can be used for better communication. The parameters like total packets received, average jitter, End to End delay and throughput are analyzed. From the analysis, it seems that DYMO outperforms well compared to LANMAR, OSPFv2 and ANODR. It is abrupt that OSPFv2’s performance is very poor as the average of total packets received is only 8% which means that out of 100 packets on an average only 8 packets received. Throughput is the key parameter which decides the performance of a protocol. Considering throughput results, LANMAR and OSPFv2 are poor. But DYMO and ANODR perform well. To conclude DYMO outperforms good comparing the others.

REFERENCES

[1]. Hoebeke J, Moerman I., Dhoedt B. and Demeester P., “An Overview of Mobile Ad Hoc Networks: Applications and Challenges”, Published in Journal-Communications Network, Vol. 3, No. 3, Pp. 60-66, 2005.
[2]. Sumathi, K., Kumar, K. S., Sathiyapriya, T., & Gowri, D. K. (2015). An investigation on the impact of weather modelling on various MANET routing protocols. Indian Journal of Science and Technology, 8(15).
[3]. Rangarajan, J., & Baskaran, K. (2015). Evaluating the Impact of Weather Condition on MANET Routing Protocols. International Journal on Electrical Engineering and Informatics, 7(3), 454.
[4]. Skordoulis D, Ni Q, Chen H-H, Stephens AP, Liu C, Jamalipour A (2008) IEEE 802.11n MAC frame aggregation mechanisms for next-generation high throughput WLANs. IEEE Wireless Communication 15(1):40-47.
[5]. IEEE 802.11n-2009- IEEE Standard for Information technology Local and metropolitan area networks Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 5: Enhancements for Higher Throughput, 2009.
[6]. http://www.floodsite.net/juniorfloodsite/html/en/student/thingstoknow/hydrology/rainfallintensity.html
[7]. Sumathi, K., Kumar, K. S., Sathiyapriya, T., & Gowri, D. K. (2015). An investigation on the impact of weather modelling on various MANET routing protocols. Indian Journal of Science and Technology, 8(15)
[8]. All India Rainfall: https://data.gov.in/catalog/all-india-area-weighted-monthly-seasonal-andannual-rainfall-mm
[9]. Shrivastava A., Chander N.,” Overview of Routing Protocols in MANET’s and Enhancements in Reactive Protocols”, 2005, http://cs.lamar.edu/faculty/disrael/COSC5100/Seminar.pdf.
[10]. Rangarajan, J., & Baskaran, K. (2015). Evaluating the Impact of Weather Condition on MANET Routing Protocols. International Journal on Electrical Engineering and Informatics, 7(3), 454.
[11]. Jayakumar G. and Gopinath G., —Ad Hoc Mobile Wireless Networks Routing Protocols- A Review,1 Journal of Computer Science, Vol. 3, No.8, pp. 574-582, 2007.
[12]. Dinesh Singh, Ashish K Maurya, and Anil K Sarje. 2011. Comparative performance analysis of LANMAR, LAR1, DYMO and ZRP routing protocols in MANET using
Random Waypoint Mobility Model in 2011 3rd International Conference on Electronics Computer Technology. 62–66. DOI:http://dx.doi.org/10.1109/ICECTECH.2011.5942051

[13]. G. Pei, M. Gerla and X. Hong, "LANMAR: Landmark Routing for Large Scale Wireless AdHoc Networks with Group Mobility," in Proceedings of IEEE/ACM MobiHOC 2000, Boston, MA, Aug. 2000, pp. 11-18.

[14]. Chakeres, P., & Perkins, C. (2007). C. : Dynamic manet on-demand (dymo) routing. Work in progress. internet-draft, Internet Engineering Task Force (March 2010)

[15]. Aziz S. R. A., Endut N. A., Abdullah S. and Daud M. N. M., —Performance evaluation of AODV, DSR and DYMO routing protocol in MANETi, CSSR 08-09, 14 - 15 March 2009

[16]. Suresh Kumar, R K Rathy and Diwakar Pandey, —Traffic pattern based performance comparison of two reactive routing protocols for ad hoc networks using NS@l, © 2009 IEEE.

[17]. Jabbar, A., Rohrer, J. P., Oberthaler, A., Cetinkaya, E. K., Frost, V., & Sterbenz, J. P. (2009, April). Performance comparison of weather disruption-tolerant cross-layer routing algorithms. In INFOCOM 2009, IEEE (pp. 1143-1151).

[18]. Al-Zaidi, R., Woods, J., Al-Khalidi, M., Alheeti, K. M. A., & McDonald-Maier, K. (2017, May). Next generation marine data networks in an IoT environment. In Fog and Mobile Edge Computing (FMEC), 2017 Second International Conference on (pp. 50-55).

[19]. Balamurugan. E, jagadeesan. A, (2018), —Geographic Routing Resilient To Location Errorsl, International Journal Of Innovations In Scientific And Engineering Research (IJISER),5(3) (pp.2126)

[20]. Saleh, A. I., Abo-Al-Ez, K. M., & Abdullah, A. A. (2017). A Multi-Aware Query Driven (MAQD) routing protocol for mobile wireless sensor networks based on neuro-fuzzy inference. Journal of Network and Computer Applications, 88, 72-98.