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Scalable and Multimedia Compatible Dynamic Routing Protocol for MANET

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Abstract

Objectives: This paper concentrates on exchanging the multimedia content through MANET nodes in a reliable and scalable manner. **Methods/Statistical Analysis:** Recently Wireless Mobile Adhoc Networks become reliable, Internet Independent and low-cost solution for communication and data exchange in personal digital computers. As on MANETs are used only for vocal communication and text message sending purpose. Due to the wide usage of multimedia content like images, videos and audio files is a need to upgrade the MANETs for multimedia support. To achieve this, a hybrid routing protocol for multimedia data exchange is introduced, it is named as "Scalable and Multimedia compatible Dynamic Routing Protocol (SMDR) for MANETS". **Findings:** After implementation of the proposed protocol the several things from results are obtained. It conducted the experiments with SMDR protocol and compared the results with popular ad-hoc protocols like AODV and OLSR. This protocol resolves the issues of multimedia content exchange over MANET nodes under various circumstances. In perspective of speed, scalability and efficiency SMDR protocol recorded the best results over AODV and OLSR. From the experimental analysis and result is noticed that, the protocol is very suitable for mobile ad-hoc networks to transfer multimedia content. **Application/Improvements:** In future, we are trying to extend this paper to elaborate this protocol to support multimedia content in a distinct way at each multimedia type level. This future work process increases the scalability in multimedia transfer content and also improves the accuracy in a reliable manner.

Keywords: Ad-Hoc routing, Data Clustering, Data Transfer, MANETs, Multimedia Content, Routing

1. Introduction

Today smart computing devices become an integral part of human life and people reliance on them to accomplish their routines. At the beginning these devices are low-configured and restricted only for limited activities. With the inventions from Nano Technology the size of hardware components become too small with high values. This improvement empowered the smart devices capability and enhanced the compatibility with many real-life applications. The smart devices (Smart Mobiles, Watches, digital Sensors and other PDA's) for online games, video conferencing, Remote Accessing, Image and video sharing through networks etc.

Mobile Ad-Hoc networks[1,2] become an active research area since last two decades in wireless communication. People are interested to utilize the MANET based applications. Currently this technology is widely used in disaster management, remote sensing, battle fields and pervasive computing etc. MANETs supports the end to end connectivity among devices without any fixed infrastructure support. Today smart computing devices are insisted with wireless network technology to support un-guided remote connectivity. Figure 1 shows the basic model of MANET technology engaged in transferring multimedia related video content to network nodes.

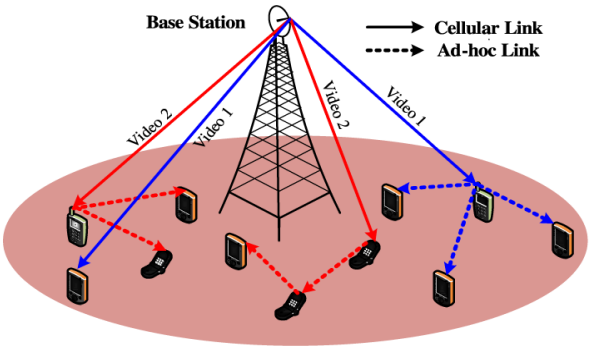

Figure 1. Multimedia content sharing model with MANETs.

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As smart devices are enriched with configuration (RAM, SD card, CPU etc) and interlinked camera systems, they started exchanging the multimedia information over wireless networks. Due to the big data size, multimedia content transfer over wireless networks become a challenging issue in MANETs. As all nodes (smart devices) of MANET is not having same configuration, big data transfer through low-configuration devices cause to record very less date transfer rates.

- While transferring a simple text message and multimedia message over an intermediate node causes latency in sending text messages, due to lack of priority in transferring the messages.
- Bandwidth and throughput mismatching leads to network delays in multimedia content transfer.
- Dynamic routing[8] and switching technologies are required to improve the scalability in transfer multimedia content and to reduce the delay.
- Smart acknowledgement procedure should be implemented to assure the data transfers.
- Finally, all the above problems should be addressed by integrating their solutions as a data transfer protocol.

To address the issue of MANET, transferring the huge amount of data, it introduced a novel protocol called Scalable and Multimedia compatible Dynamic Routing Protocol (SMDR) for MANETS". This protocol is equipped with all possible solutions to do work with multimedia content transfer over MANETs. The below Section 3 explains each problem elaborately and the solutions also from SMDR protocol. We conducted the experiments by implementing the SMDR protocol with 40 plus smart mobile nodes with various configurations and compared the results against today popular ad-hoc protocols like AODV[3,4], OLSR[5,7]. Experimental results shown that, SMDR recorded high scalability and reliability while transferring the multimedia content over ad-hoc networks.

The remaining paper has been arranged as: Section 2 discuss about the other MANET protocols like AODV, OLSR and DLEP. Section 3 represents the flow and implementation about SMDR protocol in detailed manner. Section 4 shows the result comparison of SMDR against the other competitive protocols. Section 5 concludes the paper with achieved improvements and future work of the paper to guide next level enhancement.

In this section, it describe about the existing popular protocols in MANET and their information in a brief manner. We have selected here the OLST and AODV protocols, which are most widely using in current MANET applications. This section provides a basic overview about the respective protocols to understand.

OLSR: Optimized Link State Protocol (OLSR)[5] is a proactive routing protocol, the data transfer routes and node load information is available in very less time at each node level. This is a scalable version of Link State Routing protocol. Multipoint Relays[7] and Topology control techniques were used in this protocol to make this as optimal protocol. As this is a topological based protocol, the frequent changes in topological values cause to management overhead at MANET nodes level. Multipoint Relays (MR) is a new technique to mitigate the overhead at each node level. Apart from reducing the management overhead, this MR technique helps in reducing the broadcasting operation overhead in MANETs.

OLSR protocol sends two kinds of control messages in general are Hello messages for neighbor identification and Topology Control[5] (TC) messages. Hello messages are used for finding the information about the link status and the host's neighbors. Neighbor selection process can be initiated by sending the hello messages through MPR to the active nodes of the network. These hello messages are sent by single hop to all nodes, whereas the control messages (TC) are sent by broadcasting feature.

Advantages of OLSR:

- OLSR is a decentralized management system for administration of routing.
- Multipoint Relays (MR) is a new technique, used in OLSR to mitigate the overhead at nodes.
- High end Node Mobility supported by Topology Control techniques.

Disadvantages of OLSR:

- High utilization of bandwidth, due to the management of topology information at regular interval.
- High storage configured devices are required for topology information management.

AODV: Ad hoc On-Demand Distance Vector (AODV)[3] routing protocol is an on-demand route finding and creating reactive protocol. In ad-hoc routing of AODV, the routing table is maintained at each node level to specify the destination. Along with the participating nodes of route, the neighbor nodes also notified and maintained at each node level. In case of any reason the route breaks all neighbor nodes will be notified with the same information. RREQ messaging system is used to find the new routes by using the unique destination node

sequence numbers. The old information at nodes will be updated based on certain interval timings (by default two seconds). The same route information at nodes is used to send the acknowledgement back to the source node.

Route breaks are managed effectively by maintaining the Route Error messages and by invalidating the route entry from routing table. Under the critical circumstances of broadcasting the unicasting procedure will be used to assured data transfer in AODV. In case of link breaks the repairing procedure also available in this protocol by resending the RREP messages and TTL of IP header[4].

Advantages of AODV:

- It's a decentralized routing process like OLSR.
- On Demand route discovery and repair.
- RREQ and RREP messages are used for routing and network management.
- It's a loop free protocol to mitigate the common infinity problem in multicasting.

Disadvantages of AODV:

- Intolerant for network node high mobility.
- Unable to manage huge amount of nodes.
- Retransmission procedure is very slow in poor connectivity.

2. Scalable and Multimedia Compatible Dynamic Routing Protocol (SMDR)

In this section, it discuss about our proposed SMDR protocol and its implementation with detailed explanation.

SMDR protocol is a compatible protocol for transferring both simple (text and voice messages) and complex data (multimedia content). Although this protocol concentrates in transferring multimedia content, it also cares about simple data transfers. Due to this advantage it can use SMDR protocol from general MANET applications to high end data transfer applications. This is widely required in many applications like military applications, battle field, video conference, multimedia sharing, live telecast etc. These applications are relied in internet for data transfer, which is not always reliable and in-consistent. If any failure happens in internet connectivity causes to the failure of the whole process. Henceforth my research concentrates in developing an efficient MANET protocol to support the comprehensive needs of wireless mobile nodes.

3. Implementation of SMDR

In SMDR protocol, initially mobile nodes are scattered in a region randomly as shown in Figure 2. At each node level node ID, Type, Max Data Transfer Speed, signal strength and processor speed value will be maintained. After this the neighbor node selection will be initiated at each node level and hops will be designed. Once the neighbor node selection completed each hop would be considered as a virtual cluster, which contains a group of mobile nodes. With the help of wireless coverage strength the physical region will be divided into several virtual clusters. At each cluster level, one cluster leader will be elected as specified in RSGM with slight modifications[6]. In this protocol, cluster leader selection will be done based on the configuration the node is having, when compared to the other nodes of cluster. The reason behind this is to avoid the management overhead at leader node. High configured leader node can manage its own activities while acting as a gateway in network data transfer. This mechanism helps in evading the delay in multimedia content transfer over MANET nodes.

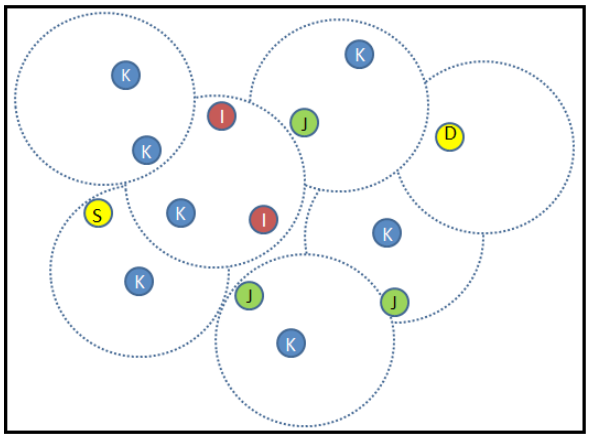


Figure 2. Multi-hop MANET region with scattered nodes of various types.

At a higher layer level all leader nodes of virtual cluster are maintained. These nodes are having the information about each member node along with their health indicator. This health indicator is a new concept proposed in this protocol to check the willingness of a node in participating data transfer. The node health indicator is integers with possible values are 1, 0 or -1. Positive one value indicates the node is ready to participate in data transfer, zero value specifies that the node is having some

difficulties in participating multimedia content transfer and the value -1 indicates that the node is overloaded or causes to delay in data transfer. The health indicator value of a node is decided based on its max transfer speed, signal strength with neighbors, Processor speed and the current network load.

In RSGM, routing is implemented based on distance vectors[10] and respective GPS[9] values. At the end of these values calculation of the nearest neighbors will be selected to create the data transfer path. In SMDR the same procedure is used only for simple data transfer as shown in Figure 3. This image shows the network region is scattered with N number of nodes and each node is marked by its category value like I, J and K. This classification done by cluster leader at each cluster level, by finding the average data transfer speed, processer speed and signal strength values. These values are utilized as threshold values in classification of network nodes. The nodes with category I value are very low configured devices than threshold values. The nodes marked with J category are having bit higher, equal, or bit lower configuration than threshold. Similarly the nodes of K category is having very higher configuration than the threshold value. For example if it wants to transfer the simple text data from S -> D the routing should never care about the node categories and creates the path as shortest path. In these nodes very nearest active neighbor nodes will be selected for routing and for simple text data transfer.

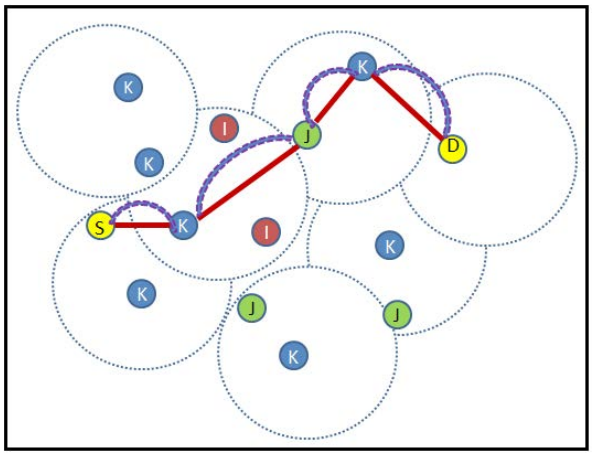


Figure 3. General routing in SMDR for simple text data transfer from S -> D.

In multimedia content transfer through mobile nodes, the general routing procedure cause to latency and delay in transferring the data. For example, if the multimedia content transfer initiated from S -> D, than the routing will be created as shown in Figure 4. In this routing procedure, at each node level SMDR verifies the nearest neighbor with K category to establish the route. The strong and scalable path will be created with all possible nodes of K category. While routing if the node with category K is not available than the next level node with category J will be selected for path creation in SMDR protocol. Apart from this the node health indicator also considered while routing between nodes with the help neighbor nodes. The priority based data transfer through the route nodes like, if a text message and video data both are transferring through a route node, that the text message transfer will be having high priority than video data. This priority based transfer helps SMDR to overcome the complete bandwidth consumption problem while transferring the simple data and multimedia data in parallel.

Due to the dynamic switching power of SMDR the network routes will be rearranged dynamically to support node mobility, error detection, packet losing, security enhancement etc. Instead of the rerouting the whole paths while transfer; SMDR follows the on-demand relative path adjustment or partial path rerouting techniques. By using the data transfer paths information, the same paths would be selected (reverse tree) for returning the acknowledgement from time to time to assure the secured data transfer. Our proposed SMDR protocol addressed the problems in multimedia content transfer with MANET.

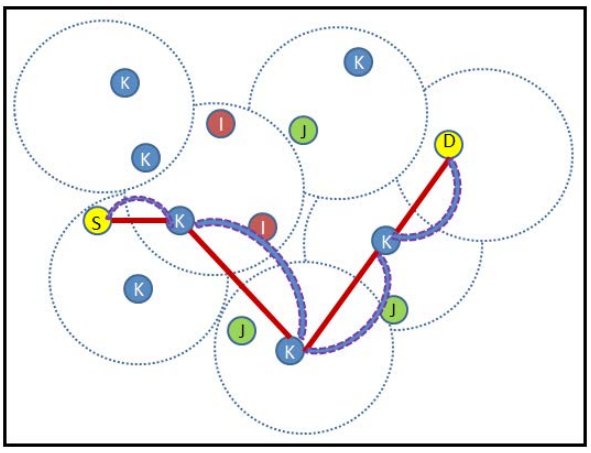


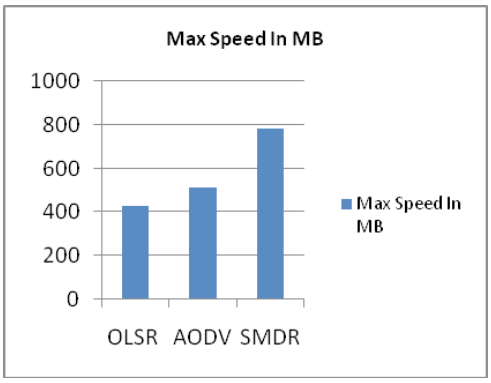
Figure 4. Re-Routing in SMDR for multimedia content transfer from S -> D.

4. Experiments

This section discusses about the experimental setup, execution and results of SMDR in detailed manner.

To implement the proposed protocol with mobile nodes, we have selected 40 plus mobiles of students with various configurations. It implemented a java based android application to install and mimic the behavior of SMDR protocol. This app has been installed in all mobile devices (Andriod OS) to support experiments. An external computer also participated in this operation to track and log each mobile activity and to control the network operations like virtual cluster creation and leader selection etc. All devices with students are deployed in various locations of my college and they are moving from one location to another frequently.

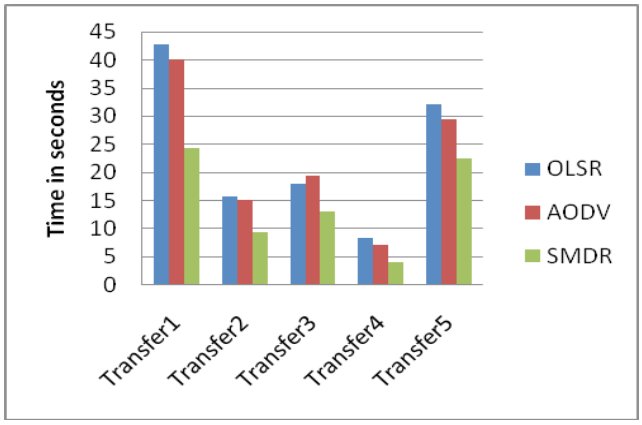
Soon after the node deployment it started the data transfer in different combinations to different target points. We send the text messages, vocal messages, video files and image zips as individual and in all possible combinations. While executing the experiments it recorded the result values at each level of the SMDR experiments and they are compared against the popular ad-hoc protocols AODV and OLSR as shown in graphs.



Graph 1. Max recorded data transfer speed comparison.

Among the 40 plus mobile devices it initiated more than 180 transfers in two hours' time period. By the time it recorded each transfer related max speed value and the graph is displaying the same. From these results it is clear that SMDR protocol recorded max speed while transferring the multimedia content compared to other protocols.

Similarly it also recorded the time consumption value at each transaction level with the three different protocols. Due to space limitation it has mentioned only five transactions in graph structure as shown in Graph 2. In comparison of scalability, SMDR recorded very high scalability due to the very less time taken for data transfer compared to other popular protocols like OLSR and AODV.



Graph 2. Time consumption over data transfer comparison chart.

Experimental results shown that, SMDR recorded high scalability and reliability while transferring the multimedia content over ad-hoc networks.

5. Conclusion

A Scalable and Multimedia compatible Dynamic Routing Protocol to support big data transfers though MANETs. This protocol is exclusively designed to support both normal data transfers and multimedia content. This protocol addressed the several problems in routing and transfers of multimedia content through ad-hoc networks. Node health indicator based transferring and connectivity has been implemented to avoid the latency and time consumption problems in data transferring. Node categorization has been implemented to construct maximum possible high speed path and also to support delay tolerance. Dynamic routing and reverse tree path based acknowledgements are used to avoid the management overhead at network node level. It conducted the experiments by implementing the SMDR protocol with 40 plus smart mobile nodes with various configurations and compared the results with popular ad-hoc protocols like AODV and OLSR.

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