ENERGY-AWARE TRUSTABLE MULTI-HOP ROUTING (ETMR) PROTOCOL TO SUPPORT HIGH AMOUNT OF DATA TRANSFERS IN AD-HOC NETWORKS

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ABSTRACT

Today Smart Mobile Devices (PDA’s) are playing a vital role in connectivity and information exchange among the people. Advanced hardware components of PDA are supporting the high amount of Data Transfers to satisfy the user needs. These improvements are allowing the smart mobile users to transfer the videos, images, sounds and other multimedia content through wireless ad-hoc networks. Unstable network routing causes to, redesign the routing frequently till completion of the initiated data transfer. Network Life Time is an essential characteristic while initiating the high amount of data transfer among the mobile nodes. There are several wireless routing protocols have been introduced in this area for energy efficiency, reliable routing and scalable Data Transfers. All these protocols are suffering from network rerouting problem due to the life time uncertainty of network. In this paper, we proposed a novel mobile ad-hoc network routing protocol as Energy-Aware Trustable Multi-hop Routing (ETMR) Protocol to overcome the problems in transmission of high amount of data through ad-hoc networks. The main aim of this protocol is used to design the energy aware stable routing, by considering the vital statistics of network science are enduring-energy levels, distance, robust connectivity and network life time etc. ETMR calculates the node level lifetime assessment, path level lifetime assessment, Expected life time of network and multi-hop trustworthy route designing to assure the stable networks for high amount of Data Transfers.
Keywords: ETMR, Network Life Time, Energy Awareness, Ad-hoc Networks, Routing, Multi-Hop Connectivity.


1. INTRODUCTION

Personal Digital Assistances (PDA’s) are one of the most considerable and popular devices of 21st century. Innovations on software and hardware fields of PDA made them smart and part of human life. Digital Watches, Smart Phones, Censors, Net Books, Tabs and some other popular devices are belongs to the PDA group. Not only smart in size, features and appearance, they also smart in configuration (low configured devices). Due to this low configuration, the components of PDA device like battery, processor and memory become more precious than others. Lack of processing capabilities and memory capabilities can be manageable without halting the devices. In other words, the over burden on processor may cause to slow down the performance of the device, Memory can be extendable with some auxiliary methodologies on-demand. Battery is an energy grid of PDA device that supplies the required energy for each process of the device, which is neither extendable nor recoverable.

Mobile Ad-hoc Networks are the most frequently used communication channels for data exchange in smart (PDA) devices. Ad-hoc networks technology establishes the connectivity among the nodes on-demand is called as Dynamic Routing. The frequent node movements and node terminations of mobile ad-hoc networks are caused to redesign of routing table for reliable communication. Dynamic routing (Ad-hoc) and frequent route redesigns are considered as the main sources for consuming lot of energy from battery grids and causes to reduce the network life time.

Several network routing protocols [1][2][3] have been introduced in wireless mobile connectivity area and are concentrated on either reliability or energy efficiency. Recently a few protocols [4][5]are introduced in this area to obtain the both features are energy efficiency and reliability. None of the previous protocols are concentrated on durability of network (Network Life Time), which is very important and become most considerable aspect while transferring big files through networks. Today smart devices are frequently transferring the big size (in Mega Bytes) audio-video files, software’s, image files and other multi-media content. Long lasting networks with high life time are required to initiate this high amount of Data Transfers among the nodes. Energy level of a network node is an important measure, which highly effects on network life time as specified. All the nodes of a wireless network with enough battery levels increase the durability of network. Similarly any member node of a network route with low energy level cause to abnormal (sudden) termination of the node, which indirectly initiates the re-routing.

In this paper, we proposed a novel ad-hoc routing protocol is, Energy-Aware Trustable Multi-hop Routing (ETMR) Protocol to overcome the problems in ad-hoc networks. The main aim of this protocol is used to design the energy aware efficient routing, by considering the vital statistics of network science are enduring- energy levels of nodes, distance of nodes, robust connectivity, network life time etc. while designing the route for data transferring in Mobile Ad-hoc networks, ETMR performs
the node level lifetime assessment, path level lifetime assessment, Expected life time of a route and multi-hop trustworthy routes. Experimental simulations and the results comparisons are proven that ETMR is an efficient energy aware routing protocol with adequate lifetime and reduced the routing redesign problem to max possible level by using energy aware assessments.

2. RELATED WORK

In this section, we discuss about the definitions which are being used in this paper and the related work about the energy aware routing and its limitations in detail.

Energy Aware Routing: In energy aware routing, available energy levels of each member node are considered for designing the route between source and destination. Here energy level may have the same priority or specified priority with the other route designing factors like distance, availability, mobility etc. Our proposed energy aware routing protocol ETMR checks the remaining battery level at each node to calculate the durability along with the node transmission power. ETMR assess the node level lifetime assessment, path level lifetime assessment, Expected life time of a route and multi-hop trustworthy routes to implement the stable networks.

Network Life Time: Network Life Time is the amount of network durable time to assure the node connectivity without any power based abnormal terminations. In longer communications (for high amount of Data Transfers) this network life time plays a key role to assure the completion of data transfer. As the mobile devices are always having limited power resources, it is very important to manage the power of these nodes to increase the network durability and to maximize the node participation time.

Node Participation Time: Node Participation Time stands for the amount of time a network node participated from joining to network. For a given network node k with the network joining time j1 and leaving time/current time q1 is used to calculate the Node Participation Time of k as NPTk = (j1 – q1).

Limitations of current Energy aware Routing: Although the previous works concentrated on energy aware routing, there are still some limitations need to be addressed in this area of ad-hoc network routing are:

- Remaining Energy level assessments are not evaluated
- Network Life Time is not guaranteed
- Need of frequent redesign of networks
- Unexpected node terminations from designed routes

3. ENERGY-AWARE TRUSTABLE MULTI-HOP ROUTING (ETMR) PROTOCOL

In this section we discuss about the comprehensive information of the proposed ETMR protocol and its advantages in detail with a basic network modeling.

3.1. Network Modeling

Our proposed protocol describes the network architecture as a graph G with set of nodes |K| as vertices and connections as edges |E|. A connection/link between the two nodes of a graph is represented as an edge \( E_r = \{K_m \rightarrow K_n\} \). To collect the required information at each node level, key-value paired data is maintained along with routing information. Node Id (NID), Group ID (GID), Location information (LN-LT), Energy
Consumption Rate (ECR), available energy (RL), File Size (FW), Nearest Neighbor Set (NNS), Node Life Time (NLT), Network Life Time (NWLT), Estimated Transmission Time (ETT), Network Speed (NS) are the prominent data to implement this protocol.

3.2. Energy-aware Path selection process with ETMR protocol

Once the network setup is completed, Neighbor node identification process starts to maintain the neighbor node information as NNS at each node level. This information updates to protocol management system at each specified interval time to inform the neighbor data. After NNS updated with each node, the route selection process starts between the specified source and destination nodes. To identify the stable routing sake Dijkstra’s shortest path algorithm [8] is used internally with edge weights and node priorities. Here the edge weight means the distance (D) between the two nodes and the node weight means the node life time value (NLT). By co-coordinating these both values the routing is implemented at each node level by considering the other factors like NWLT, ETT and NS. As described in related work the expected NWLT value proportional to ETT is calculated based on network speed (NS) and the distance (D) between the source and destination values. The same procedure is implemented at each node level to find the next neighbor node to design the trustable path to initiates the data transfer. The below figures A and B describes the route selection process in detail.

![Figure A. Trustable path selection process between node A and node G](image)

![Figure B. Trustable path selection process between node A and node G](image)
routing to transfer the 30 MB data (FW) with the possible network speed (NS) is 100 Kbps/Sec. By using the FW and NS the obtained ETT is 5.12 minutes. This ETT value is considered as a threshold value to determine the current node is useful to construct the stable and trusted network or not. After applying the ETMR protocol the identified path between the nodes A and G is Path (A->G) = {A -> B -> D -> F -> G}. This selection process first starts from the source node A and ends with when reaching to node G. At node A level the Nearest Neighbor Set NNS (A) = {B, C}. Among the two neighbors B and C, B is selected in ETMR protocol due to the expected battery life time (NLT) of node B is greater than ETT value 5.12. If we consider the node C, its value 2.9 is less than the ETT value cause to discard the node C from routing. ETMR gives the first priority to the node life time to achieve the expected network life time. Similarly the second priority is given to the distance to build the trustable paths among the nodes.

If we considered the node D the neighbor set NNS (D) = {G, F}. Here the both neighbors G and F are having the adequate energy levels to accomplish the data transfer successfully. Under these circumstances node F is selected by considering the shortest path value. Like this our proposed ETMR protocol not only cares about energy awareness, but also considers the trustworthiness and scalability.

4. SIMULATION RESULTS
In this section we explore the simulations results of our proposed ETMR protocol with the other energy efficient and reliable ad-hoc routing protocols.

We implemented the simulations of our proposed protocol with the widely used java network simulator JNetworkSim [6], which is an open source tool designed by Stanford university. We setup the infrastructure for this simulator with Windows-7 OS, i3 G4 Processor, 4 GB RAM and 500 GB hard disk. To run the simulator and to implement the ETMR protocol, Java is used as a base language with JDK-7 and Eclipse Kepler IDE.

We ran the simulation with 85 nodes with distinct location values and unique ID’s. To implement the simulations the battery energy levels and node locations are assigned randomly to obtain the result accuracy. Source and destination node selection process is performed manually to design the routing between most critical paths to test the reliability of the implemented ETMR protocol. Approximately 20 times we executed the simulations to identify the paths and at each execution the important statistics are monitored and recorded for the comparison.

The obtained and recorded result of our proposed ETMR protocol is compared against AODV [7] and PAMAS. The below graph1 is showing the network life time quality for a given big data file transfer with expected ETT is 6.5 minutes. As we selected the all nodes under ETMR the life time of the network is approximately 8 minutes for the expected time 6.5 minutes. Similarly the other energy aware protocol PAMAS value is limited to max 2 minutes. ETMR achieved the adequate life time by using the proposed assessment techniques and node selection method as explained in above section.
The below given graph 2 is another proof to prove the scalability of ETMR when comparing with others. In this case we observed that ETMR is having the high data transfer rate than other two popular protocols. This is possible for ETMR due to the very less number of routing redesign requirements when compared with others. The stable nodes and trustable paths also cause to choose the confidential networks to improvise the performance.

From the above proofs graph 1 and graph 2 our proposed ETMR protocol is proven as efficient energy aware protocol to support the high amount of Data Transfers with trustable paths and robust connectivity.
5. CONCLUSION
In this paper we introduced Energy-Aware Trustable Multi-hop Routing (ETMR) Protocol to overcome the problems in transmission of high amount of data through ad-hoc networks. This protocol utilizes the node life time to assessment techniques to increase the network life time and to reduce the frequent redesigning of routing. The main aim of this protocol is used to design the energy aware efficient routing, by considering the vital statistics of network science are enduring- energy levels of nodes, distance of nodes, robust connectivity, network life time etc. while designing the route for data transferring in Mobile Ad-hoc networks, ETMR performs the node level lifetime assessment, path level lifetime assessment, Expected life time of a route and multi-hop trustworthy routes. Experimental simulations and the results comparisons are proven that ETMR is an efficient energy aware routing protocol with adequate lifetime to support high amount of Data Transfers in ad-hoc networks.

REFERENCES