ABSTRACT

Wireless ad hoc networks have drawn substantial attention from the research community because of their probable applications. However, the fundamental attributes of these networks cause several technology challenges to designers of network protocols starting from the physical layer to the application layer. Due to recurrent topology changes, nodes in the networks get disconnected often and hence data accessibility between the nodes becomes a prime challenge in wireless ad hoc networks.

To improve data accessibility or to ensure data availability in a dynamic network, the preeminent solution is to replicate data items in several nodes. But, conventional replication techniques proposed for fixed networks particularly for distributed systems cannot be applied to wireless ad hoc networks. The reason is that the replication schemes proposed for ad hoc networks must address the additional issues like power constraints, mobility of nodes, link quality of the nodes and real-time necessities which are considered as challenging aspects in ad hoc networks.

The key objective of our thesis is to propose a replication scheme which adapts to the dynamic changes that appear on the network and study how data replication improves the performance of standard types of wireless ad hoc networks such as mobile ad hoc networks (MANET) and wireless sensor networks (WSN). More specifically, the novelty of our work is on selection of stable nodes to replicate data. The proposed scheme differs from existing schemes by selecting appropriate nodes as replication nodes. The node is qualified as a replica holder only if it is close to a number of clients and stable enough to sustain the dynamic changes. The node is said to be stable only if it is immobile with respective to its neighbors for a particular period of time. Hence,
by selecting stable nodes as replica holders frequent migration of data from moving replica holder to new replica nodes is reduced irrespective of the type of the routing protocol used. In addition, the number of messages in inquiring for data is minimal as the servers are close to clients hence making the network energy efficient and apposite for time critical applications. Moreover, the proposed work is well pertinent for large scale networks because the replica nodes selected are evenly distributed to serve more number of clients.

The stable nodes are identified by introducing a mathematical concept known as centrality measures which lies in the scope of graph theory. Though, many typical centrality measures exist in graph theory for network analysis, appropriate centrality measures are indeed required for replicating data for successful information interchange. Hence, we have made an extensive analysis and identified two different centrality measures for MANET and WSN to determine the significance of a node in disseminating data.

An advanced centrality measure known as “subgraph centrality” is applied in the MANET and correspondingly “stability betweenness centrality”, a variant of betweenness centrality is used in wireless sensor networks to decide on stable nodes as replication nodes in a dynamic environment. As far as we know, our proposed work is the first attempt to launch centrality measures to opt for replication nodes to propagate data.

In MANET, the proposed scheme is simulated and performance analysis is made with closely related schemes. The data request and data reply messages are routed with the aid of AODV routing protocol. The results of the proposed model when compared with existing methods prove that the data access delay is minimal, number of hops is nominal as data are replicated closer to clients. In addition, frequent relocation of data is reduced by selecting stable replication points and the number of messages forwarded to access the data is also reduced. Consequently, the network becomes energy efficient and becomes optimal for time critical applications.
The proposed replication scheme in MANET is further practically tested in real wireless ad hoc test bed. The laptops with LINUX platform serve as mobile nodes. The testing took place with moving volunteers in an outdoor environment and OLSRd an extension of the OLSR routing protocol was customized to implement the replication scheme. The empirical results demonstrate that the response time to share the critical files like text file or image file is minimal and query cost is also greatly reduced. The probability of accessing data in one hop is also high because the relocation of data takes place instantly when the existing replica node tries to move out of range from its clients.

Finally, a new replication scheme is put into practice in wireless sensor networks also since it has attained more attraction recently. It is shown that centrality measure is an appropriate measure to select replica nodes or storage nodes in wireless sensor networks. The query and the data are routed with the aid of renowned routing protocol named as collection tree protocol. Experimental results prove that query access delay in accessing the sensed data is minimal, the number of expected transmissions is also reduced, i.e., the number of retransmission of data packets between the source and sink is less which circuitously reduces the energy consumption of nodes. Additionally, the results show that frequent relocation of data is curtailed and the selection of unstable nodes is less possible in the proposed scheme.