In many ad hoc networks such as vehicular networks, links among nodes change constantly and rapidly due to high node speed. Maintaining communication links of an established communication path that extends between source and destination nodes is a significant challenge in mobile ad hoc networks due to movement of the mobile nodes. In particular, such communication links are often broken under a high mobility environment. Communication links can also be broken by obstacles such as buildings in a street environment that block radio signal. In a street environment, obstacles and fast moving nodes result in a very short window of communication between nodes on different streets. Although a new communication route can be established when a break in the communication path occurs, repeatedly reestablishing new routes incurs delay and substantial overhead. To address this limitation, we introduce the Virtual Router abstraction in this dissertation. A virtual router is a dynamically-created logical router that is associated with a particular geographical area. Its routing functionality is provided by the physical nodes (i.e., mobile devices) currently within the geographical region served by the virtual router. These physical nodes take turns in forwarding data packets for the virtual router. In this environment, data packets are transmitted from a source node to a destination node over a series of virtual routers. Since virtual routers do not move, this scheme is much less susceptible to node mobility. There can be two virtual router approaches: Static Virtual Router (SVR) and Dynamic Virtual Router (DVR). In SVR, the virtual routers are predetermined and shared by all communication sessions over time. This scheme requires each mobile node to have a map of the virtual routers, and use a global positioning system (GPS) to determine if the node is within the geographical region of a given router. DVR is different from SVR with the following distinctions: (1) virtual routers are dynamically created for each communication sessions as needed, and deprecated after their use; (2) mobile nodes do not need to have a GPS; and (3) mobile nodes do not need to know whereabouts of the virtual routers.

In this dissertation, we apply Virtual Router approach to address mobility challenges in routing data. We first propose a data routing protocol that uses SVR to overcome the extreme fast topology change in a street environment. We then propose a routing protocol that does not require node locations by adapting a DVR approach. We also explore how the Virtual Router Approach can reduce the overhead associated with initial route or location requests used by many existing routing protocols to find a destination. An initial request for a destination is expensive because all the nodes need to be reached to locate the destination. We propose two broadcast protocols; one in an open terrain environment and the other in a street environment. Both broadcast protocols apply SVR. Our simulation results show show Virtual Router approach can achieve several times better performance than traditional routing and broadcast approach based on physical routers (i.e., relay nodes).
The public is welcome to attend.