The proposed work discusses the design of a novel mobile dynamic reflective context aware middleware for heterogeneous mobile environments addressing the issues of interoperability and cross layering. The work is compared with the existing message oriented middleware for adhoc networks with the CAR (Context Aware Routing) protocol for message delivery. In addition, quantitively the memory footprint of the components and modules inserted in the middleware architecture was studied and it was found that the proposed middleware incurred minimum overhead than the existing context aware architecture. Middleware is software that lies between the hardware and the operating system. Middleware for mobile devices must overcome two heterogeneity issues to provide interoperability in the mobile environment (1) Heterogeneity of service discovery protocols and (2) Heterogeneity of routing protocols between services, which typically arise from the heterogeneity in the devices.

The proposed middleware that is designed at the middleware layer between the transport and routing layer provides varying seamless services to multiple users across heterogeneous networks. Reflective middleware is flexible, and can adapt to the mobile environments including providing interoperability among network device. The interoperability of service discovery and routing protocol occurs in the middleware spontaneously. Interoperability is a feature wherein heterogeneous platforms having different components and functionalities are brought together. Service discovery protocol provides substratum for heterogeneous smart spaces and the interoperability brings all these smart spaces together. In our work, some of the spaces are considered mobile, some are adhoc and others are sensors enabled, offering varying services to the user. The proposed architecture delivers service to the user with minimum time and low overhead with the property of cross layering embedded in the architecture. It
is the cross layer that makes routing protocol interoperable with the service discovery protocol. The nodes in the smart space form clusters. There could be any number of clusters in each of the smart spaces. The services of similar type are grouped together and offered to the user. The user can choose the best service, or based on the utility factor (predicted value) the sensor node itself provides the best matching service to the user. Ant colony algorithm with honey bee optimization in clustering is applied to obtain optimization while routing. Clustering increases the search efficiency by making it simpler and less time consuming.

The property of context awareness, cross layering, interoperability of service discovery and routing protocols enhanced the performance of proposed middleware and proved efficient in terms of both quantitative and qualitative aspects. Digital signature schemes are used to authenticate the user and only valid users are allowed to access the services of the smart space.