CHAPTER 7

CONCLUSION

In the past few years, the latest advances in the dynamic computing network have enabled the emergence of Wireless sensor networks application in various sectors. WSNs are attracting considerable researchers into this fascinating field that are demanding promising technology for enhancing the energy performance design of the hardware and software. The most constraint of the WSNs is that the power management attributes to the restricted capacity of battery power and computational capability of the resources. The goal of this thesis is to design a power efficient novel, architecture for wireless sensor networks. Several WSNs analysis proposed for the routing applies a conventional layer approach to the planning of protocol. This restricts the modularity in system development style. Moreover, the single layered design style restricts the performance improvement of network communication factors. Thus, overhead strike is incurred by exploiting the standard layer routing design by considering the cross-layer approach. This Chapter 7 is to propose the energy efficient architecture which supports cross-layer design for routing the information. A cross-layer frame design is adopted by integrating the Network layer and MAC layer protocol. The novel methods were tested by the simulations, and empirical study carried out with WSNs, deployed in numerous communication scenarios. Therefore, the design of our cross-layer architecture protocol ought to sufficiently investigated application properties, taking under consideration algorithm generality and adaptability.
7.1 PROPOSED ARCHITECTURE

The primary areas of WSNs analysis study are distributed in hardware and software domain. The software domain includes the development of energy efficient communication protocol by focusing our proposed cross-layer clustered approach. The design of cross-layer protocol architecture explicitly supports cross-layer design is by considering four factors like clustering, localization, routing, and sleeps scheduling.

The first objective for the cross-layer architecture network is to attain flexible and low-power consumption. Increasing power consumption inside a WSN is turning into a core issue. Economical scheduling and budgeting power in sensor networks has become an essential issue in wireless sensor network technique. The proposed architecture constitutes based on an empirical study of Chapter 3, 4, 5 and 6 are ready for integrating into firmware. Simulation shows that improved energy efficient solution is possible with WSNs protocol architecture. From the simulation study analysis the Chapter 7 proposes promising energy efficient protocol architecture. The design model for cross-layer protocol for power economical hybrid routing architecture model is shown in Figure 7.1 can be used in various application where nodes identify their absolute or relative position.

As shown in the Figure 7.1, the architecture comprises of following four models.
First model is cluster building in wireless sensor network, a method of novel adaptive clustering algorithm using DFLCP for the distributed networks permits the sensors to self computation of cluster network decision making. Applying this approach the MAC layer improves the throughput, scalability and power reduction of the nodes.

Second model is range-free Localization using convex optimization of wireless sensor nodes. Applying the range-free localization for the wireless sensor networks in conjunction with radio irregularities in anisotropic networks attenuate the situation errors. This model enable sensors to self localize the network position and communicate within the network. The design integrated cluster head choice with localization to maximize energy
potency of wireless sensor nodes. This protocol improves the throughput performance by improving the MAC layer.

Third model is Hybrid routing to maximize energy potency of wireless sensor nodes. The energy economical routing approach that's proposed for the cluster zone is simple hybrid routing protocol to improve the network performance factors. The design incorporates integrated cluster head choice with localization and Hybrid routing to maximize energy potency of wireless sensor nodes. The protocol improves the network layer performance in conjunction with the MAC protocol and also further improving the MAC.

Fourth model is sleep scheduling to maximize energy saving by turning sensor unit to sleep mode for wireless sensor nodes. The design incorporates integrated cluster head choice with localization, Hybrid routing and sleep scheduling to maximize energy potency of wireless sensor nodes. The sensor optimizes the energy utilization by permitting sensors sleep/awake mode to improves MAC protocol. The contribution to the current scheduling is an energy economical MAC layer sleep scheduling protocol for sensor networks that maintain high throughput similarly as low latency.

Sensor inbuilt with the above four model feature improves the network performance. Finally, the overall model as shown in Figure 7.1 is the new cross-layer localized clustering hybrid routing architecture for wireless sensor node protocol. This will further embed within the firmware for the sensor hardware.

The strategy handles optimization method of power consumption and utilizes the services of clustering, localization, routing and sleep scheduling for cross-layer communication between the protocol stack of MAC layer and Network layer. Thus, analysis challenges maintain cross-layer design distinctive based on the simulation that has carried to support our
cross-layer architecture. The proposed architecture improves the throughput and network performance for a given number of nodes within the cluster. The energy consumption using our proposed model is low for a small network and robust for the large network. Thus, by the proposed architecture the network using the dynamic clustering and self-adaptability of nodes within a cluster render more flexibility, robustness, scalability and longer lifetime in real-time of WSNs. The architecture model that is shown in the Chapter 7 consisting of cross-layer design allows following features:

- The node deployed in the distributed network is self-configure,
- High scalability support of sensor nodes,
- High throughput and improvement in the QoS.
- Enhance the energy efficiency under randomly position node.

Easy to embedded cross-layer localized clustering protocol architecture in the firmware for sensor hardware.

7.2 CONTRIBUTIONS

We have proposed in this thesis a series of a novel approach that fit to the optimum requirements of the design of cross-layer protocol for power management of hybrid scheduling and routing in cluster based wireless sensor networks. Our approach is to propose a frame work to support a cross layered architecture sensor design to enable multi-scale communication. The thesis summarizes the research work discussed from Chapter 3, 4, 5 and 6 resulting in the formation of the architecture model as shown in Chapter 7. We have proposed a cross-layer protocol design that exploits the characteristics of sensor network to improve the scalability, throughputs, power-aware and fault-tolerance requirement of WSNs. To our knowledge no such schemes have satisfied all these areas of requirements under one block of cross-layer
Our thesis presents detailed methods for improving the scalability and network lifetime in an energy efficient WSNs. The empirical analysis of sensor nodes operate in real time scenario in the distributed network is observed. Our model of our thesis in Chapter 3, 4, 5 and 6 gives the relative superior performance capability to the existing models of WSNs.

A number of typical protocol approaches for the wireless sensor network are surveyed and evaluated with various metrics. In this thesis, these metrics are evaluated separately in all four Chapters. All approaches have been evaluated based on an empirical study to overcome the drawbacks, making it suitable for different applications for the wireless sensor networks. Following contributions are made for the thesis towards the development of scalable and energy efficient WSN architecture.

In Chapter 3, we analyze the clustering mechanisms for the distributed network environments for robust collection of information using dual Fuzzy logic. The state-of-art of hierarchical clustering algorithms called DFLCP, use two proposed algorithm to facilitate the Confined level and Universal level of decision making. The architecture for the MAC layer improvement used clustering technique using the Mamdani as fuzzy interference system. Mamdani fuzzy interference system and defuzzification decide the confined and universal level membership function so that various level of distribution parameters can be decide at the optimum energy uniformity of distributed nodes. These algorithms incorporate the centrality factor to consider the validity of localization error as a Fuzzy membership functions.

Simulation experiments show that DFLCP improves the network life performance by 18% to 24 % when compared to most widely used
LEACH protocol. The overall nodes are monitored for the uniform distribution of energy so that life of the network can be improved and increased.

In Chapter 4, we have presented a range-free localization technique. The two computationally efficient and relatively accurate localization models in multi-scale communication applied for the cluster nodes based on (1) Region of Intersection of mobile anchor assisted localization algorithm using region of intersection and (2) Mobile anchor obstacle based convex optimization algorithm principles, are proposed for distributed cluster nodes, range-free, 2 step neighbor WSN localization. An improvement phase incorporates the pseudocode for finding intersection points in the localization process to improve the performance. To diminish the propagation of localization error the pseudocode for localization estimating error is imposed based on convex optimization under various obstacle shapes. The consideration of obstacle based mobile anchor localization applying the convex optimization scheme shows high localization accuracy. Moreover, our proposed is scalable and self-adaptive to the dynamic network using mobile sensor network.

From the simulation study, it is observed that degree of irregularity for interior point algorithm improved to 16%. Also, when applied the radical line method it gives approximately 24% improvement over Centroid algorithm. Study of our proposed algorithm compared to other most widely used algorithm shows that proposed localization algorithms achieve excellent localization accuracy.

In Chapter 5, the energy efficient routing approach is proposed for the cluster zone based routing. First the multipath proactive routing employs for intra-cluster and reactive routing for inter-cluster protocol. Secondly the real time test bed carried out to prove the hybrid routing protocol exhibit good
network performance under mobile node condition.

In Chapter 6, we have presented the sleep scheduling protocol. WSN transceiver with the knowledge based on the threshold value with respect to the neighboring nodes decides which node to function either in sleep or wake mode. We proposed an optimal sleep/awake scheduling algorithm that satisfy the minimum energy consumption based on a threshold value. The contribution to this scheduling is an energy efficient MAC layer sleep scheduling protocol for sensor networks that maintain high throughput, as well as low latency.

By using the dynamic clustering approach with localization, and newly introduced sleep scheduling node extend, the inactivity period for improvement in the network performance. As the demand for the wireless sensor networks application and hardware necessities our cross-layer design considerably improves to attain higher energy potency in MAC and Network layer interaction for WSN. In depth analysis is conducted into the important design aspects of power efficient cross-layer techniques of wireless sensors.

7.3 **FUTURE WORK**

The thesis provided some methods for the cross-layer architecture design of power management in wireless sensor network. In terms of future works, several areas of interest are cross-layer design consideration of clustering with sleep scheduling, sensor localization and hybrid routing to maximize energy efficiency of wireless sensor nodes. There is still scope for the protocol design for WSNs. The protocol developed in this research is for the scenarios where the sensors have to correlate data and nodes that can adapt to the varying traffic scenarios. However, in the WSN application for monitoring changing network topology, the network node likely focus on maximizing long system lifetime, low latency for data transfer and higher
QoS. Therefore, the proposed architecture supports QoS issues in the present modern network.

The future scope demand for high quality data transfer with self-powered systems provides maximum benefit for the end-user. Such energy efficient scalability adds the new parameter design of the present protocol architecture. Also, it is important to develop secure communication for WSNs. Without these security measures, the application of WSNs will be limited. Further, the importance of mobility is sensor network focus on energy constraints. In many applications cluster node moves in various patterns. So a cluster based MAC and Network layer, need to handle the mobility pattern by making self-configuring process for more energy conserving.

Although, our proposal shows good perform when compared to the various effective protocols. We still think there is a chance for improvement of above architecture areas. Nevertheless, a number of research problems is still interesting require further investigation.

In general, the entire scheme that have highlighted shows accuracy with respect to communication range. Such work can be carried out at a low level of connectivity. However, there is still scope for development of accurate scheme. In the Chapter 3 further research study based on a new approach of the clustering optimization for unbalanced node density, number of cluster node selection, and sleep scheduling techniques is possible. In Chapter 4, we could like to address this problem by introducing further enhancement of localization approach that can be made for fast changing node density. In Chapter 5 and 6, we like to introduce new techniques for MAC and Network layer protocol improvement. We expect that the thesis can be enhanced by further improvement in the architecture for wider application.

Further, the scope for research in this thesis, for the improvement
and enhancement of new cross-layer architecture design will enable wireless sensor networks to support the future demand. For the future demand of wireless sensor networks, the present architecture needs to optimize for network performance and hardware sensor nodes. So that future trends of the wireless sensor networks goal can be “anytime” and “anywhere” communication network that minimize the gap between the device and users.