Researchers have been studying wireless networks for a number of years and have developed fairly sophisticated protocols using clustering, multi-hop routing, and direct communication approaches. We are developing communication protocols for sensor networks, which differ from traditional wireless networks in both the function that these networks serve and the fact that each node has a very limited energy supply, requiring energy-efficient DSP algorithms, and network protocols to maximize system lifetime. In a sensor network, it is not the individual nodes’ data that is important, but the combined knowledge that reliably describes the environment the nodes are sensing. Therefore, the end-user only needs a function of the data, rather than all the individual data. By exploiting this sensor-specific function, we can ensure energy-efficiency in our algorithms and protocols.

We have developed a framework for minimizing the energy dissipation of wireless protocols using energy models for computation and communication, optimization algorithms, application-specific communication optimizations, and joint optimization across different layers of the communication protocol stack. Using this framework, we created the LEACH (Low-Energy Adaptive Clustering Hierarchy) communication protocol, an adaptive clustering approach that includes localized coordination and control, rotating cluster-heads and associated clusters, and local data fusion and classification.

The cluster-heads in LEACH function as local control centers to coordinate communication within the cluster and perform local data processing. By rotating the cluster-head position, the energy load is equally distributed among all the nodes in the network; this reduces individual node failure by ensuring that there are no overly utilized nodes. LEACH also uses local data processing within each cluster to greatly reduce the amount of data that must be transmitted long distances to the base station, saving considerable amounts of energy. LEACH achieves cross-stack optimization by combining application-level knowledge of the goal of the sensor network into the routing protocol, which allows for local processing to compress data in an intelligent manner. Simulations show that LEACH can achieve an order of magnitude reduction in energy dissipation compared with conventional approaches. LEACH is being incorporated in the µAMPS system.