Consistency-Driven Data Quality Management of Networked Sensor Systems

With more and more real deployments of wireless sensor network applications, we envision that their success is nonetheless determined by whether the sensor networks can provide a high-quality stream of data over a long period. In this paper, we propose a consistency-driven data quality management framework called Orchis that integrates the quality of data into an energy efficient sensor system design. Orchis consists of four components, data consistency models, adaptive data sampling and process protocols, consistency-driven cross-layer protocols and flexible APIs to manage the data quality, to support the goals of high quality and energy efficiency. We first formally defined a consistency model, which not only includes temporal consistency and numerical consistency, but also considers the application-specific requirements of data and data dynamics in the sensing field Next, we propose an adaptive lazy energy efficient data collection protocol, which adapts the data sampling rate to the data dynamics in the sensing field and keeps lazy when the data consistency is maintained. Finally, we conduct a comprehensive evaluation to the proposed protocol based on both a TOSSIM-based simulation and a real prototype implementation using MICA2 motes. The results from both simulation and prototype show that our protocol reduces the number of delivered messages, improves the quality of collected data, and in turn extends the lifetime of the whole network. Our analysis also implies that a tradeoff should be carefully set between data consistency requirements and energy saving based on the specific requirements of different applications.