論文の内容の要旨

Adaptive Communication Protocols for Wireless Sensor Networks
(無線センサーネットワークにおける適応的コミュニケーションプロトコル)

氏名　　阿部　玲

Wireless sensor networks are known to have properties that make it challenging to design communication protocols. They typically consist of small-scale sensing devices in massive numbers, each limited in hardware capabilities and battery life. Once deployed, such sensor nodes form a dense ad hoc mesh topology through which they communicate the data they have extracted from the physical environment. Recent trends indicate that future sensor networks are anticipated to become widely established general networking infrastructures that allow open and ubiquitous access to sensory information by diverse applications. In this thesis we explore novel networking protocols aimed at providing scalable and efficient communication in such a scenario. We particularly focus on making two concrete types of communication protocols applicable by having them adapt to temporally and spatially local networking conditions such as regionally varying node densities or changing redundancy qualities of data traffic traversing the network nodes.

First, we propose a protocol on the routing layer that dynamically coordinates stateless geographic forwarding and traditional topology-based route discovery. While the former generally constitutes a scalable and efficient data delivery method, it suffers in its performance from local minima in the spatial network topology and from inaccurate node coordinates. To make geographic routing feasible in large-scale sensor meshes nonetheless, we bridge such conditions by constructing and maintaining a limited number of topology-based routes in a spatial extent necessary to uphold the geographic forwarding functionality. That way we keep the overhead of maintaining routing state localized and the overall routing process scalable, while preserving the efficient nature of the paths selected.

In our second contribution, we propose a protocol for identifying and suppressing redundant data transfers on the network link level. These occur when transmissions carry partially identical data such as repeating sensor readings or address fields. Faced with stringent memory limitations at each sensor node, we resort to probabilistically tracking the most frequently reoccurring data fragments in the traffic stream passing every network link. We make the node at the receiving end of a link selectively cache the thereby identified data contents, so that it becomes able to reference and reconstruct the repeating data locally for subsequent transmissions. As a result we succeed in preventing unnecessary communication traffic throughout the network that would otherwise waste valuable transmission energy.