Modular Architecture for Heterogeneous Sensor Networks

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Future sensor networks

Wireless sensor networks (WSNs) are no longer used for monitoring only. New and advanced applications are emerging:
- Process and asset monitoring
- Disaster intervention
- Wireless Building Automation
- Many more!

New challenges and requirements are imposed on the design of WSNs. Sensor nodes are no longer homogeneous: additional computing power or functionality will be required in some nodes. Sensor networks are thus evolving into heterogeneous networks.

Physical layer

The physical layer is a separate layer as the properties of this layer largely depend on the design of the hardware.

Middleware

The middleware layer is designed to implement functionality that requires a strong interaction between application and network layer.

Cross layer interface

A shared cross layer database forms a generic interface for the exchange of cross-layer parameters.

Universal Applicable Modular Framework

The framework consists of the following parts:

Cross layer

For advanced cross layer optimization, we propose to merge the MAC and network layer. Functionality is divided in modules that interact with each other.

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Design Challenges

Some new design challenges for modular protocols are:
- Which information to exchange?
- How to exchange the information?
- What about unforeseen interactions?
- Optimization at run-time or at design time?
- Support the possibility of multiple equivalent modules?

Node classification

Depending on their capabilities, more modules are added in the nodes. Thus, heterogeneous networks are supported.

Classes of nodes can be used by defining profiles.

Profiles can be based on:
- The capabilities of the nodes.
- The version of the framework
- Underlying mechanisms

Cross Layer Optimization

Exchange of information between multiple layers strongly enhances the performance of a wireless network.

Examples are QoS, security, transmission power, routing, …

In routing, the next hop can be based on the shortest path, but can also be influenced by the required QoS (reliable link) or energy management (hop with most remaining battery power).

Examples of cross layer interactions

Modular design

In a modular design, functionality is divided in modules.

Advantages

- No duplication of functionality
- More energy-efficient protocols
- Heterogeneity is promoted: modules can be added to a node according to its capabilities;
- Easy adaptation to new conditions: simply replace a module.

Node classification

Lightweight node

Advanced node

Computing node

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