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Research Article

Cross-layer Architecture in Wireless Sensor Network

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Abstract

Abstract-Implementation of Software in wireless sensor networks is a demanding task because of the many challenges like resource constraints computations, energy conservation, data processing and scalability of the protocols, and low quality communication. This paper presents an architecture having cross-layer management with low protocol stack. The purpose of the paper is to make application programming easier and to use available resources with low protocols stack. The use of cross-layer management entity is to the offer a shared data structure with use of some sensor network specific function such as Topology management and power saving. This architecture in this paper supports the needs of wireless sensor networks implementation.

Keywords: *Wireless sensor networks; cross-layer; architecture; protocols*

1. Introduction

In wireless sensor network (WSN) one essential feature is a low power consumption of sensor nodes, that is, small devices equipped with a short range wireless transceiver, a small processor, and advanced sensing functionalities. Another key requirement for WSN is a self-configuring capability, the importance of this increase with the size of the network. In atty bigger network at least some of the nodes must also be capable of multi-hop data transmission despite low memory and computational capacity. There exists many .routing protocols that may function well in ad-hoc networks, but these protocols cannot be adapted directly to wireless sensor networks. The memory and other requirements of these protocols are usually too demanding for tiny ' devices. Most of these algorithms and networking methods must be taken care in more than one layer. It is obvious, therefore, that the interaction between layers cannot be ignored. One solution is that necessary data could be transmitted through service access points (SAP) and processes the tasks in each OSI layer's Layer Management Entity (LME) section. This would, however, increase the computational requirements in a protocol stack. For this reason, it is suggested that some parts of the system responsible for the power saving characteristics and network management could be implemented in a cross-layer module working in parallel with the traditional protocol stack.

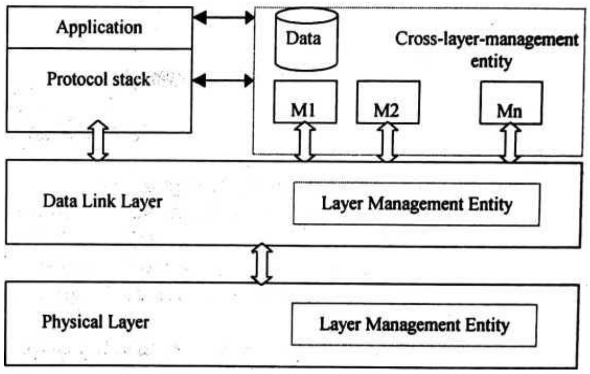
This paper presents a software architecture where cross -layer management entity and low protocol stack has been combined. The architecture is aimed for wireless sensor network nodes with reduced resources.

Cross-layer architecture

a. Introduction

The proposed cross-layer architecture is versatile and an adaptive solution for WSN nodes with limited resources. This architecture combines a low protocol stack and a cross-layer management entity with shared data structures and some special functions.

b. Description of Cross-layer Architecture



Functions J I Primitives Ml,M2...Mn Modules

Fig. 1. Sensor network's cross-layer architecture

Figure 1 shows the principle of cross-layer architecture in a WSN node. Above the data link layer, the architecture branches into two parallel areas. The application and the protocol stack are responsible for the application-specific data transmission and the cross-layer management entity takes care of network management. The cross-layer management entity is further divided into two parts -

Management Entity and Shared Data Structures. The reason why the cross-layer management entity sits on the data link layer is that in practice it uses the services of the data link layer like multiplexing and error-free data transmission offered by the link. The messages are divided so that protocol stack handles all data transfer between applications and the cross-layer entity handles control messages.

The application uses the services provided by the protocol stack and cross-layer management entity. The interface between the cross-layer management entity and the protocol stack/application employs the client/service principle.

c. Tasks Suitable for Cross-layer implementation

• Use of short duty cycles: To extend the lifetime of a battery-powered device into many years, the duty cycle must be very short The task of the cross-layer management entity is on'off type switching, in which lime is allocated to the protocol layer and the application as needed.
• Common data structures: To minimize memory and computational requirements, shared data structures can be used. As an example the neighbor's data can be used for optimal broadcasting power adjustment and routing.
• Topology management and network configuring: Network configuring and multi-hop data transmission using, as little power as possible are the two sides of the same coin. Flooding as a routing algorithm may suffice to some networks, but in some cases more intelligent solutions arc needed for optimal routing, Especially, due to strict power saving requirements, it could be useful to monitor the state of the surrounding network.
• Coding/decoding: Coding/decoding is not dependent on the protocol stack used. Therefore, it can be done in the cross-layer management entity. Algorithms used in coding may include, different compression and encryption algorithms

b. Some Problems with Cross-Layer Architecture The cross-layer architecture makes the implementation of both the protocol stack and the application easier, but there is a risk that it itself might become difficult to maintain if the tasks were not properly defined and die implementation was not modular. As a solution, it is suggested that die cross-layer management entity should be split into smaller modules that arc caster to manage and test.

Sensor node software, when compared with many other ad-hoc type networks, is usually more modest and. as its size indicates, easier to manage,

Conclusions

When implementing a sensor network node it is worthwhile to consider software architectures. In this paper, we have proposed a cross-layer architecture specially designed for embedded software in a sensor network node, which have strict power saving requirements and limited resources.

To be functional, the sensor network architecture must support networks with different topologies, sizes, and other different characteristics. For this reason, it is necessary thal the operation of the sensor node can be adjusted if the need arises. An important future development requirement for sensor nodes is to improve their adaptability.

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