ACHIEVING RELIABLE NETWORKING FOR THE GENERIC AUTONOMOUS PLATFORM FOR SENSOR SYSTEMS (GAP4S)

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Networks of wireless integrated sensors are often used to monitor parameters distributed in the environment. These parameters are related to a variety of applications such as security, patient monitoring, chemical and biological hazard detection. Some solutions rely on replaceable batteries with a limited life-time to provide long-term sensor operation. Others envision short transmission range sensors (few meters) that harvest their energy from various environmental sources (e.g., solar, vibrations, acoustic noise). The Generic Autonomous Platform for Sensors (GAP4S) project explores an approach for wireless sensors that is complementary to these and other pre-existing solutions.

In GAP4S, the wireless sensor micro-battery is remotely recharged via a microwave signal. Medium transmission ranges in the tens to hundreds of meters are possible. Within these wireless transmission ranges, a base-station collects data transmitted by the sensors and acts as the access point to a wider (typically wired) communication network, e.g., the Internet. The authorized user can, therefore, remotely connect to, monitor, and manage both the sensor network and the individual sensors. An essential component of GAP4S is its end-to-end

network reliability solution, which ensures the delivery of data generated at the sensor to the interested user across both the wireless and wired segments.

This dissertation investigates ways to achieve reliable networking for GAP4S over both the wireless and the wired segments. A specially designed solution is provided in each segment.

In the wireless segment, error-free transmissions from the sensor node to the base-station is achieved using automatic repeat request (ARQ) protocols at layer 2. Two classes of ARQ protocols are designed and compared. The first is the conventional ARQ, whereby the data frame is retransmitted by the originating sensor until successfully received by the base-station. The second class takes advantage of *cooperative radio communications*, whereby multiple neighboring sensor nodes may combine their efforts during the retransmission process. The ARQ protocols are compared in terms of their saturation throughput, i.e., the maximum data flow that the sensor node can sustain constrained to the available energy amount. In a variety of scenarios — current and future expected circuit energy consumptions — the cooperative ARQ protocols may more than double the saturation throughput when compared to conventional ARQ protocols. Equivalently, it can be said that the energy required to operate the system may be reduced by half.

In the wired segment, fault tolerant networking is achieved by means of protection switching at layer 3. Given the increasingly widespread use of Wavelength Division Multiplexed (WDM) backbone networks, the protection switching scheme is designed to operate in conjunction with WDM. Optical circuits are made reliable by means of a Shared Path Protection (SPP) switching scheme. The SPP scheme is generalized to guarantee Differentiated levels of Reliability (DiR) to the user. In the SPP-DiR combined scheme the desired level of reliability may be guaranteed while minimizing the required network resources, i.e., wavelengths. This feature makes it possible to support more optical connections and users when compared to other existing protection switching schemes.