Hybrid Sensor-Vehicular Networks in the context of next-generation networking

Abstract

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1. INTRODUCTION

Both Wireless Sensor Networks (WSNs) and Vehicular Ad-Hoc Networks (VANETs) are technologies that gained extensive attention in the research community during the last years, and many people agree that those are about to contribute to the networks of tomorrow in a significant way.

Within the talk, we present our work on the novel paradigm of Hybrid Sensor-Vehicular Networks (HSVNs) and their contribution to next-generation network architectures. The idea behind Hybrid Sensor-Vehicular Networks is to deploy sensor nodes within the road environment. For example, it is imaginable that future roads will be equipped with sensor nodes that are able to sense environmental events, such as ice, aquaplaning or structural damages. Those events are gathered locally using a wireless sensor network and are delivered directly to vehicles that pass by. Afterwards, information is spread in a wider area using the VANET. This way, vehicles that are approaching hazardous road sections can be be warned well in advance and drivers can react accordingly.

While HSVNs will provide a significant benefit on their own, we argue that additional Road-Side Units (RSUs) which are connected to backbone networks can increase the reliability of such systems, and furthermore, open up new application domains, such as the collection of WSN data at traffic control centers. This enables e.g. the automatic adjustment of speed limits based on road conditions or provides a detailed road-condition status to road maintenance staff.

2. HSVNS: CONCEPT & PROTOTYPE

As indicated in section 1, within HSVNs a wireless sensor network is used for event detection in the road environment. Figure 1 illustrates this scenario. A slippery ice spot is detected in the WSN, a notification is transmitted over multiple hops to a selected gateway sensor from which the information is delivered to a vehicle. Afterwards, data is disseminated to other vehicles using a multi-hop flooding strategy in the VANET. As the information can even be stored back from the mobile nodes into the WSN, five different ways of information flow can be distinguished:

1. Information flow within the WSN
2. Data transition from WSN to VANET

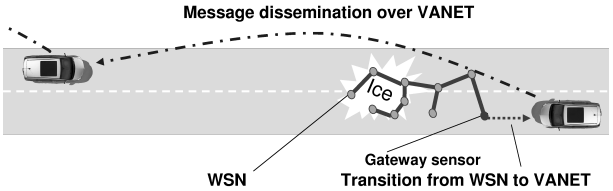

Figure 1: Hybrid Sensor-Vehicular Network

3. VANET dissemination
4. Storage of data into the WSN
5. Data muling

While the first three information distribution mechanisms are required to enable the proposed warning applications, storing event data back into the WSN enables persistence: This way, the delivery of event data originating at a distant location becomes possible even if the VANET has broken down in the meantime. As vehicles move spatially, they are also able to carry information to different locations. This is commonly referred to as data muling.

Up to now, we developed an architecture for the integration of a Wireless Sensor Network and a VANET into a HSVN. A working prototype, using TinyOS 2.0 and Java, has been developed and evaluated in a field test, showing that all five ways of information flow can be actually realized. Furthermore, other experiments we carried out suggest that the direct communication between cars and sensor nodes using 802.15.4 as base technology is feasible. Corresponding results and experiences are going to be presented.