Connecting Sensor Network Islands to the Future Internet using the SpoVNet Architecture

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Trends towards the Future Internet are eager to combine the digital network with the physical world [1]. As sensor network islands are becoming more ubiquitous the transparent integration of digital and physical world promises great benefit. We present an exemplary scenario in combining the Future Internet architecture *SpoVNet* [2] with sensor network islands. Our scenario is based on cargo container monitoring and shows how SpoVNet supports deployment of future services and applications in mobile nodes on top of heterogeneous networks. One of SpoVNet's objectives is "to support flexible, adaptive, and spontaneous provisioning of application-oriented and network-oriented services on top of heterogeneous networks" [2]. Using an *Underlay Abstraction* SpoVNet hides issues like connection maintenance, mobility, and heterogeneity from upper services and applications. We exploit the SpoVNet architecture for global deployment of a new *Sensor Network Service* (SNS). Aim of the SNS is to connect the Internet with sensor network islands. The new service is placed inside SpoVNet's service layer and provides means for communicating with sensor network islands, as shown in Figure 1.

Today's cargo tracking systems most often consist of a GPS receiver and a mobile phone unit that transmits GPS coordinates to a central monitoring system operated by the cargo owner, e. g., using GSM. This tracking unit is attached to the actual cargo container and therefore allows tracking of container locations. We now extend this simple tracking system into a system for online monitoring that allows the cargo owner more control over its containers.

First, the GSM unit in current location tracking systems is not limited to the transfer of GPS coordinates. Deploying several sensor nodes—e. g., for temperature and door status—at a container provides more extensive monitoring. Second, to reduce costly GSM communication several containers can use a single GSM unit that is attached to a dedicated container. Communication between sensor nodes and GSM unit now must be performed using wireless communication. Furthermore, self-organization of the sensor network is necessary due to mobility of containers. Third, cost and availability of GSM communication is still problematic and only allows transmission of data at large intervals, e. g., every hour. This granularity may not be sufficient for all applications: Temperature sensitive goods, e. g., may need more continuous monitoring to enable fast intervention in case of cooling failure.

As presented so far the current scenario is not satisfying, mainly for two reasons: (1) No continuous connectivity is available, therefore disallowing online monitoring. (2) Communication is costly, making monitoring expensive. Using the introduced SNS—that allows communication with sensor network islands—we employ a new *Container Monitoring Application* (CNA) on top of SpoVNet (see Figure 1) that uses SNS to access sensor network islands and perform the actual communication for our monitoring application.

Cargo containers remain in different transport domains, e. g., train, airplane, truck, or ship. Additionally, stationary places like lading port, airport, or interstate service area are of interest. All transport domains and stationary places offer different connectivity opportunities for SpoVNet. Through further installation of, e. g., WLAN at lading ports increased connectivity is available at decreased cost. Through the above mentioned SpoVNet Underlay Abstraction best possible continuous connectivity is achieved. Using the introduced SNS service and CNA application in SpoVNet, the GSM communication unit is now exchanged by a SpoVNet node and attached SpoVNet device.

SpoVNet is the enabling technology to allow best possible continuous monitoring for container transports. Continuous monitoring allows more flexibility in case of, e. g., cooling failure: Malfunction of a cooling device can be detected early. Repair can then be planned, new parts acquired and exchanged, e. g., at the next lading port. Furthermore, notification of, or reparation through company-external transport personnel may not always be favored, e. g., if locking of a container door is malfunctioning. In this case online notification of the container owner is preferable who can then arrange reparation through an company-internal mechanic.

We presented an exemplary scenario based on cargo container tracking that shows the benefit of combining the global Internet with sensor network islands.

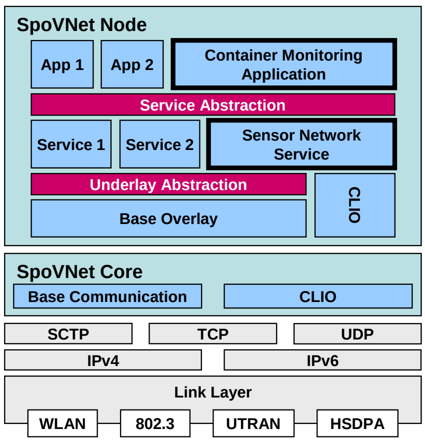

Figure 1: *Sensor Network Service* and *Container Monitoring Application* in the SpoVNet architecture.

References

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[2] SpoVNet Consortium. SpoVNet: An Architecture for Supporting Future Internet Applications. EuroView07, July 2007. http://www.spovnet.de.