Objective of the document

This document describes the implementation work done by the CWIN and MAS. As CWIN is prototyping a demonstrator, the document also indicates the integration aspects of micro, power and possibly personal node with the demonstrator. At the end, the document describes possible extension of the current state of the prototype with some of the SPD aspects (this is may need further discussions).

Relevance

The report announces contributions to the various tasks of WP6, especially T6.1 Multi-Technology System Integration and T6.4 Multi-technology Demonstration. Within T6.1 the main focus was on the integration of nano-, micro- and personal nodes into the railway prototype, while the contribution in T6.4 focusses on bringing the prototype into the real life scenario of both the electrical motorbike for the Telenor Innovation Fair and the Measurement Vehicle Roger of the Norwegian Rail Administration (JBV).

The work answers the T6.1 task challenges: *"This task aims at integrating components and prototypes developed in WP3, WP4 and WP5 and at providing validation & verification based on the requirements and scenario specified in WP2"*. In this phase the major focus was on integration of the various nodes. Prototypical demonstration of SPD functionalities is foreseen for the final demonstration.

For T6.4, which addresses *"pilot demonstrator will be developed to validate the proposed architecture in an industrial relevant application scenario: monitoring of freight trains"*, the work focussed on the demonstration in the real industry.

Highlights

The platform developed through pSHIELD received attention from ESIS, working on new transport scenarios for electric-based transportation. The possibility of monitoring an electrical motorbike, and publish the information through the public Telecom platform of Telenor. The motorbike became a part of Telenor's Innovation Fair at the HQ at Fornebu, which was inaugurated by the Norwegian Minister of Economy, Trond Giske, and Telenor's CEO Frederick Baksaas.

Figure 1: Opening of the Telenor Innovation Fair

Figure 2: Marius Bakken from Telenor Objects explaining the electrical motorbike with pSHIELD powered sensors

An initial implementation of the platform at the Norwegian Rail Administration was performed in April 2011. The goal was to get the platform ready for live monitoring while the measurement locomotive is out on the track. However, the initial platform did not satisfy the requirements of the measurement vehicle. The requirement of "autonomous operation" required a redesign of communication protocols for the sensors, which caused a substantial rework and a delay of four months.

The second experience from the initial live-demonstration was the request for an additional implementation of “location”. As the locomotive is well protected, GPS positioning is almost impossible. This asked for a second redesign, the implementation of a mobile phone as additional source for location.
Both redesigns were performed in spring/summer 2011 and are available for the September review.

Figure 3: The measurement locomotive "Roger" as a live demonstrators of pSHIELD

Detailed descriptions

The aim of the prototype implementation from the Norwegian associate is to securely integrate on-train installed sensors with the Telenor Shepherd Platform. The prototype follows the ETSI TS 102.690 specifications. The implementation contains the micro node and power node. Instead of reinventing the wheel from scratch, we utilize the available sensor and embedded hardware for this prototype implementation.

Micro Node – Sun SPOT Sensor Platform

The implementation uses the Sun SPOT sensor platform as micro node. Sun SPOT is a useful platform for developing and prototyping application for sensor network and embedded system. Sun SPOT is suitable for application areas such as robotics, surveillance and tracking. The main units are Sunspot devices with embedded sensors and base station. Each Sunspot has a so-called eSPOT with battery, while the base station is not equipped with battery and must be powered from the host computer via an USB cable. The Sunspot does not need to run any operating system, it needs only JVM that runs on bare metal, and executes directly out of ash memory.

Stack-boards composed of specific sensors and actuators such as accelerometers, light sensor and temperature sensor. The platform consists of the following integrated sensors:

- Temperature Sensor: Chip-type is ADT7411 sensor that measures temperature with ADC. ADC is integrated into eDemo, and can measure temperatures between -40℃ to +125℃.
- Accelerometer sensor: 3-axis accelerometer of the type LIS3L02AQ, designed by ST Micro Systems and is in eDemo Board. This sensor can measure the x-axis, y-axis and z-axis in the direction up and down with the value either ±2G or ±6G. When the Sunspot is at rest, it measures x = y = 0 and z = 1G.
- Light sensor is of the type TPS851, designed by Toshiba. The sensor can measure the voltage between 0.1V (dark) - 4.3V (light), and converts the voltage to the brightness of Luminance (lx) 3.

SUN SPOT JVM
Squawk is open source and has been written in the Java programming language. It is a virtual machine, and is a highly portable Java VM. Figure 3 below shows the architecture of Squawk. The advantage of Squawk is that it can run on bare metal instead of being run on top of the operating system. This means that applications can be isolated and be treated as application objects. This

allows multiple applications running on the same virtual machine. Squawk also supports CLDC 1.1 that facilitates connectivity to mobile phones.

Personal Node – VIA Embedded Board

The VIA EPIA N700 is a compact, low heat, power-efficient Nano-ITX board, ideal for compact industrial PCs and embedded automation devices. The board is integrated with the VIA VX800 media system processor, an all-in-one chipset solution that provides an extensive feature set while using less real state, helps to make the VIA EPIA N700 a superb choice for compact systems.

It is based on Nano-ITX form factor (12cm x 12cm. VGA, USB, COM, Compact Flash (CF) and Gigabit network ports are provided on the board to help reduce system foot-print size and eradicate cluttered cabling for improved air-flow and enhanced stability in always-on systems. The VIA VX800 offers an integrated DirectX9 graphics core and excellent hardware accelerated video playback for MPEG-2, WMV9, VC1 video formats. An on-board VGA port is provided along with support for DVI and a multi-configuration 24-bit, dual channel LVDS transmitter, enabling display connection to embedded panels.

The VIA EPIA N700 is equipped with a power-efficient 1.5GHz VIA C7, supports up to 2GB of DDR2 system memory and includes two onboard S-ATA connectors, USB 2.0, COM and Gigabit LAN ports. Expansion includes a Mini-PCI slot with an IDE port, additional COM and USB ports and PS/2 support available through pin-headers. The VIA EPIA N700 offers total system stability at extreme temperatures ranging from -20°C to 70°C, an ideal solution for our Norwegian rail use case to meet the extreme weather condition of Norway. The implementation uses Ubuntu Linux Kernel 2.6.32-24-generic and Java runtime environment (JRE) 1.6 for development.

Implementation Details

Integration with Telenor Shepherd® Platform

Telenor, Norway have introduced a platform (named as Shepherd®) for interoperability and integration that supports communication between connected devices (nano and micro nodes) and makes them accessible from anywhere at anytime. The Shepherd® is a platform for Connected Objects (COs) [32]. This means that any the pluggable component can be connected, and be integrated in Shepherd® platform as a Connected object (CO). Figure 4 depicts the overview of Shepherd® platform.

The platform offers number of service including:

- Service Management for monitoring, device configuration, SLAs, and supporting.
- Service Enabler has a specific API that allows further access to other modules.
- Message Engine handles and secures the process of message flow, including capturing, processing, routing and storage of data in an environment.
- Notification services that inform about the status of devices and applications.
- Device library consists of interfaces for tools and services recognition.

Connectivity with Shepherd® Platform

Shepherd® offers two methods for establishing connection. This includes:

1. HTTP Connection API - This mechanism establishes a direct connection to the Shepherd by using the HTTPS protocol. With this method, it requires the development of the HTTP API of the object. Shepherd accepts both methods POST and GET. When the connection is established, the Shepherd sends a response code back to that object as a confirmation

of success or failure of reception. To be able to connect to the Shepherd, the "device object" is identified with an Application ID and an Object ID.

2. Connected Objects Operating System (COOS) - is an open source and has been written in Java. When using the COOS instance, the applications can connect to Shepherd in a secure, reliable and stable manner. In particular, it is important in this respect that eavesdropping by third parties is not possible when using COOS. Reliable in the sense that it is an M2M network, and communication between objects with COOS instance and the Shepherd will not be interrupted or delayed more than necessary. Thereby, ensuring a stable environment for the users and the applications. It requires therefore, developing an application using COOS, so this can apply to device so it can communicate with the Shepherd. From a programming perspective, "Connected Objects Operating System (COOS) is an application distributed in a container so that it can enable data exchange between the object and the Shepherd. In COOS concept, every component that is integrated, and can be pluggable is called "Connected Object (CO). This means that a COOS instance can have multiple Connected Object, and each COOS instance carries its own distinctive character. The Figure 5 below illustrates the relationship between COOS instance and CO.

A two-way communication between Sun SPOT sensors and its base station is implemented, and also two-way communication between the embedded Linux system and the Shepherd Platform.

A Host application has been developed, that performs broadcasts every fifteen seconds. While, the spot application will detect the broadcasts every thirty seconds. But, it does not transmit the values to the base station after one minute has passed since the last envoy. When the values arrive, these will also be stored in cache. At the same time, the Host application sends out a request to Shepherd for receiving the values. The connection is opened until the application has received confirmation from the Shepherd of receipt. However, the values to be sent to Shepherd, only happens in every five minutes. The SPOT application is also designed to detect spot's battery level prior it using the wireless communication. If spot battery is either lower than -32 or greater than 32, then the MIDlet will be destroyed, terminated and a notification will be send to the concerned actors.

Possible extensions with SPD aspects

While the first phase of the project had, for the Norwegian Partners, the focus on integration into the third party an open platform of Telenor Objects. This integration has only limited considerations on security, privacy and dependability (SPD). However the communication with the Telenor Shepherd platform is secured using HTTPS protocol. The following scenarios can illustrate how the above implementation can be extended with the SPD aspects. The first two scenarios address the security aspect and the third scenario deals with the dependability situation.

Scenario 1: Only valid node can be connected to the system. In this regard, we may use mobile phone as personal node and can only be integrated with the system if it is authenticated by the system. This will avoid getting communication and data from a fake node.

Scenario 2: Communication to ‘new sensor’ is only allowed if it is taking place at a pre-defined location. In this regard we assume that the location is a restricted place and only authorised user can access the premise. The system will get the location information from GPS sensor and if the location is same as the ‘pre-defined‘ location, the system can communicate with the ‘new sensor’ installed on-board. Scenarios 2 can further secure the new sensor integration on top of scenario 1.

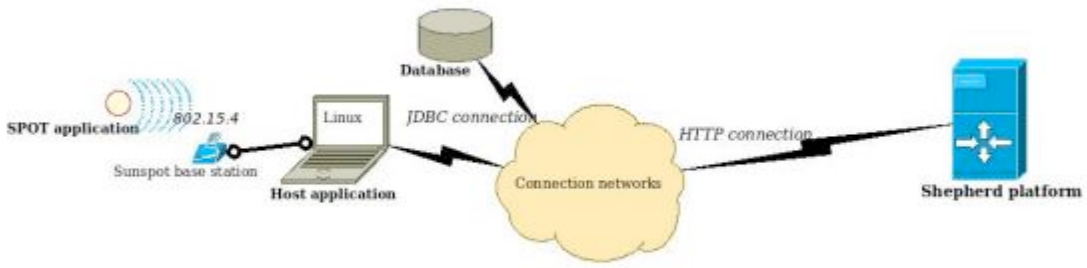

Figure 4: Outline of implemented railway demonstrator

Scenario 3: As GPS reception is typically very poor inside the measurement vehicle, we needed to address location through a combined approach of two independent sensor. We extended the set-up with a mobile phone, which allows us position based on three methods: GPS, network and WLAN coverage. Taking into consideration the time-stamp of the equipment will open for a “dependable” positioning solution through a composition of sensor data from the embedded linux platform and the mobile phone.

The realization of the scenarios is subject to further discussion.