MONITORING LOGISTICS OPERATIONS OF THE FOREST BASED SUPPLY CHAIN IN (NEAR) REAL-TIME UTILIZING HARMONIZATION APPROACHES: a Case Study from Austria

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Motivation

- Market penetration of Sensors is increasing

„obvious“ sensors

... but also

i.e. citizens as sensors (Goodchild 2007)
Motivation

• Market penetration of Sensors is increasing
• Number of proprietary systems and data models handling sensor data

Open Issues:
• Sharing data between those proprietary systems?
• Monitoring the status of the forest supply chain in real-time?

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Due to the high number of different available proprietary systems, data models and sensor data transmission techniques it seems difficult to integrate each part of the FSC in one “system”.

In order to integrate different proprietary systems, we need to think about standardization strategies in order to integrate sensor data right from the start.

As the FSC deals with agents that are moving in space and time, any standardization approach needs to take spatial and temporal dimension into account.

Integrating sensors involves semantic understanding of the sensors (Bröring et al. 2011a, Bröring et al. 2011b, Janowicz et al. 2010, Kuhn 2009, Kuhn et al. 2014)
Sensor Data & Spatial-temporal Domain - a Standardization Issue?

Approach for integrating real-time sensor data:


- Sensor Observation Service (SOS)
- Sensor Model Language (SensorML)
- Observations and Measurements (ISO 19156)
- ...

http://www.opengeospatial.org/domain/swe

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Sensor Data & Spatial-temporal Domain - a Standardization Issue?

IEEE 1451 Applications

- TEDS/NCAP/STWS

SWE Applications

- Stored Vector Feature Data
- Stored Sensor Data

Sensor Web Enablement services (and “cloud” resources)

- IEEE 1451
- Legacy custom/proprietary
- SWE “direct”

Any sensor system

McKee (2011)
Integration of Sensor Data in MBC
Model-based Control Overview

Forest supply chain represented as flow diagram:

- tanks = material at different planning and processing stages
- in/out = material flow resulting from processes or disturbances

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Integration of Sensor Data in MBC
Model-based Control Overview

- Harvesting: Standing timber in the forest
- Forwarding: Timber in the forest
- Transportation: Wood piled on roadside
- Austria: Wood reception at the mill
- Germany/Switzerland: Push-system based on mill demand
Integration of Sensor Data in MBC

Data (Sensors) -> Planning

Recognize Deviation (now+future) -> Suggest or Act within a given threshold, Alarm out of a given threshold

Setpoints, constraints -> Controller

Instructions for operations -> Supervising (with anticipation)

Models

Automation, Replan

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In order to collect real-time data of Wood Trucks we need the following data:

- Position
- Truck engine status of the truck (velocity, RPM, weight ..)
- additional attributive data
- Data collection employing the Sensor Web and standardized OGC Sensor Observation Services (SOS):
  - Collection of (any) measurement data in a standardized way
  - Storage of sensor data in a harmonized data-structure to:
    - Query sensor data
    - Parallel sensor requests
    - Providing of data in a standardized way (WFS, WMS)
(Near) Real-Time Sensor Data Collection

FOCUS platform solution for the pilot case

FOCUS planning
• Time-oriented planning control

FOCUS control
• On-going monitoring

FOCUS dashboard (mobile)
• Location-independant monitoring platform

FOCUS core

FOCUS sensor
• iFOS, CANbus
• polterluchs
• TimeControl

backoffice

operations arena

FOCUS data base
(Near) Real-Time Sensor Data Collection
Collecting truck position and engine status information

- Collecting truck position and engine-status in near real-time
  - Combines vehicle sensor measurements with vehicle location & time using the GNSS of a mobile device
  - Transmit combined measurements in a standardized way to be used by the FOCUS architecture over IP (local app-caching supports temporary offline status)
  - Interoperability support - OGC SOS Transactional Standard 2.0

- Vehicle sensor data collection:
  - Starting Point: Collect sensor data via OBDII/CANbus via Bluetooth (ELM327)
  - WWH-OBD (ISO 27145) standard
    - New heavy-duty vehicles must conform to the requirements of the Euro-VI emissions standard starting in 2014. Thus, vehicle manufacturers are obligated to implement a WWH-OBD capable diagnostic system
  - Sensors of the mobile device and derived indicators
(Near) Real-Time Sensor Data Collection
Mobile Phone App :: Collecting Data

- Screenshots of the Android App
  - Connect to OBDII/WWH-OBD
  - Use internal sensors of the mobile phone
  - Send the collected data via IP to the OGC SOS Server live (or stores the data if no Internet connection is available and sends data as bulk message)
(Near) Real-Time Sensor Data Collection
Mobile Phone App :: Collecting Data

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(Near) Real-Time Sensor Data Collection
OGC SOS Service 2.0 – with defined semantics

- The SOS has defined semantics for describing, storing and querying spatio-temporal measurements

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feature of interest (FOI)</td>
<td>The FOI represents the geobject who is subject to the measured values and is measured by sensors. The FOI is usually the means of locating (geocoding) the measuring points, i.e. the geobject has coordinates (for example latitude, longitude and altitude). It depends very much on the project and must be chosen depending on the task at hand.</td>
</tr>
<tr>
<td>Observation</td>
<td>An observation (result) for the property (Phenomenon) of an object under observation (FOI). The value itself is generated by a sensor or by procedures (procedure). Furthermore, the phenomenon was detected at a particular time (sampling time) and generated the value at a particular time (Result Time). Often these two time values are consistent, so in practice the sampling time is used as the time of observation.</td>
</tr>
<tr>
<td>Offering</td>
<td>An offering is a logical grouping of observations that are related to each other, which are jointly offered by a service.</td>
</tr>
<tr>
<td>Phenomenon</td>
<td>A phenomenon (physical quantity) of a geobject. Examples are air temperature, wind velocity, pollutant concentration of the atmosphere, reflected radiation in certain frequency band, etcetera.</td>
</tr>
<tr>
<td>Procedure</td>
<td>A procedure produces the measured value of an observation. This can be done by reading a sensor, or a numerical simulation process.</td>
</tr>
<tr>
<td>in situ</td>
<td><em>in situ</em> is the Latin term for &quot;on the spot.&quot;</td>
</tr>
</tbody>
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(Near) Real-Time Sensor Data Collection

OGC SOS Service 2.0 – with defined semantics

- The SOS has defined semantics for describing, storing and querying spatio-temporal measurements
- SOS uses XML encoding for transmitting and retrieval of sensor data
(Near) Real-Time Sensor Data Collection
Visualization with a GIS

- Geographic Information Systems (GIS) are tools to visualize, manipulate and manage spatio-temporal data – either web-based or desktop-based.
- OGC Sensor Observation Services can be seamlessly integrated in GIS (desktop and web-based GIS via standardized services)
Summary & Future Work

- **Monitoring** of the FSC actors in **near real-time** with a **sensor cloud** in the course of the **FOCUS FP7 research project** *(Advances in Forestry Control and Automation Systems in Europe)*
  - Due to the high number of different sensor and system vendors, a **multitude of proprietary formats/systems** is available – which can hardly be linked in real time.
- **Open Geospatial Consortium** (and ISO) provides **open standards** to describe and transmit sensor measurements (with respect to **spatial and temporal domain**) including open-source reference implementations
  > **OGC Sensor Web Enablement Initiative**

- To connect with **vehicle sensors**, standards (OBDII and WWH-OBD) are used which are amended with spatial and temporal data.

- Vehicle data can be visualized with **Geographical Information Systems** – desktop or web-based – both by **utilizing standards** (OGC SOS, OGC WMS, …).
Resources