

Ontology Summit 2016: Industry

Contributing company: Siemens, who is working with an automobile manufacturer

Background: Siemens is working with an automobile manufacturer that has a conveyor that transports vehicles from station to station. The vehicle is mounted to a platform that moves along a track (shown above) using drive motors on either side of the track. These drive motors must be synchronized for the conveyor to work properly.

Siemens needs a semantic model that will detect/diagnose motor problems by detecting anomalies in motor vibration. Elements for the model come from the physical situation (see Photo, and then Diagram below). The semantic model developed should support the ability to trace the forces, motions, and acceleration through their connectivity. Motor vibration is measured using accelerometers mounted at each motor. The vibration histories will ultimately be available in real time and stored for later analysis. Several possible problems can occur, but to make the problem tractable only one will be considered: (1) a motor stops functioning and only one accelerometer (on the functioning motor) is available.

At present the analysis is performed using testbed values, but ultimately, data transfer will be real time and stored in the cloud, in an Internet of Things application.

Motivation for goal: Presently, people attuned to healthy-sounding motors come to the factory site several times a week just to listen, and detect possible conveyor motor malfunction. The new system will rely on sensor input and reasoning in ontologies to detect malfunction automatically.

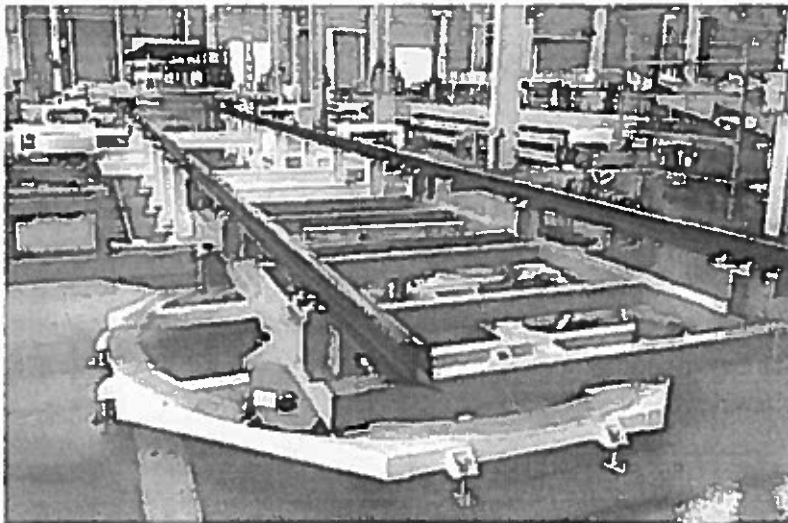


Photo: Testbed for automotive factory, Siemens, April 2016

Problem to solve: The problem is to produce an alignment and mapping among ontologies needed to solve the problem (including SSN and QUDT), so that the ontologies can be updated independently, but the system will be able to employ ontology reasoning.

Components to be represented in the model:

Industrial electric drive motors (2)
Accelerometer sensors (measure acceleration)
Drive wheels (2)
Vehicle platform
Foundation for mounting motors
Platform rails (maybe)

Physics: Low-level behaviors such as motion, connectivity, and force transmission, functionality of machines such as linkages (force transmission) and wheels (mechanical advantage).

Relations: Location
Position
Dimension/Direction
Restraint (as in D.o.F.)
Force

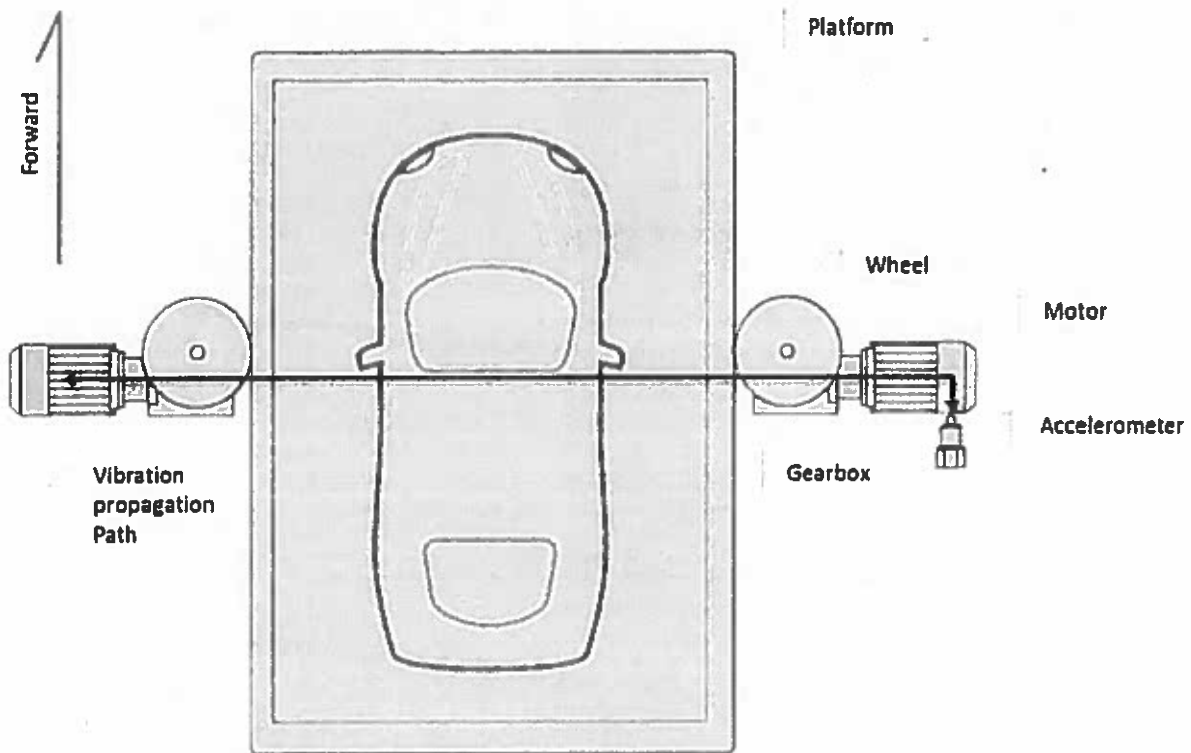
Limitations on method: Use only OWL, SPARQL, SPARQL Endpoints (e.g., REST calls), but limited procedural code. Any interface to demonstrate is acceptable. It would be reasonable/expedient to use SSN for sensors, observations, and operating ranges, QUDT (Quantities, Units Measures and Data Types Ontologies) for quantity kinds, quantity values, and units, and some object model for objects, relations, behaviors, and functions.

What has been done so far:

- ↪ Linked Open Ontology Cloud (Frosterus et al, 2013)
- ↪ *Semantic Cotopy* to compare ontologies at an upper level (Maedche and Staab, 2002)

How the output should look

The output should (1) include the metadata fields needed in the semantic model (2) select those ontologies that cover terminology for those metadata fields (3) be a virtual integration of ontologies that will nevertheless provide reasoning



In the diagram, the platform moving upward is driven by two wheels. It is the motors on both sides of the platform that drive the wheel to propel each conveyor forward. The motor on the right has an accelerometer attached to monitor vibration.

Confidentiality note to Ontology Summit participants: Data and provided models are not sharable outside the problem-solving context.

EVENT data model



Metadata

ID: 4

Sensor: Accelerometer

Sensor input: Vibrations<QUDT>

Unit of input: Volt <QUDT>

Frequency of data gathering <based on device specs.

Battery date last replace<SSN>

Sensing method used (example: capacitive, piezo-electric, etc.)<SSN>

Minimum vibration value: <QUDT>

Maximum vibration value: <QUDT>

Event capture rule: record data velocity

e.g., .3 < x < .8 units

Stimulus: conveyor belt, etc. <SSD>

+ *Event capture rule. Stored on server script to filter the volt data stream for storage in event model at only certain accelerations, where m/sec2 = acceleration*

Data for events (streaming)

ID: 000874 (continuous)

Source ID: 4

SensorOutput: on-going readings (complete accelerometer output)

Description: output if above max or below min

Time start : day/time

Time end: day/time

Acceleration: according to event capture rule

SSN, QUDT are ontologies AND each accelerometer has its own data stream

The Location of each accelerometer, and the association of accelerometer with nearby motor and wheel would be part of the physical model, rather than this data model.

Metadata help you analyze data or the situation; streaming data provide values to solve a problem.

Ontology Summit 2016: Smarter Building Management

NIST Advanced Network Division: Middleware for Application developers and city planners

Motivation for goal: Sensors give feedback about use and proper functioning of different parts of a building. We need to harness this information to:

- Reduce energy costs
- Real-time detection of minor changes in device performance so that staff can respond immediately rather than waiting until extensive repairs are needed
- Compare repair record among units so that purchasing can acquire devices that are the most reliable and efficient
- Reduce risk of failure in mission-critical systems
- Prioritize maintenance actions based on alerts with highest consequences

Problem to solve: Create a data model with ontologies per data field, that will be useful for devices by different manufacturers. This model will enable behind-the-scenes conversations among devices.

Data types:

- Lighting/occupancy sensors
- HVAC
- Loads on electrical outlets
- Elevator functioning
- Meters for use of water, electricity and gas
- Security

What has been done so far:

Ontologies for building automation www.project-haystack.org

OGC Standards in this area:

Sensor Model Language (SensorML)
Sensor Planning Service (SPS)
Sensor Observation Service (SOS)
Observations and Measurements (O&M)

For devices from different vendors: IoT Semantic Smart Gateway Framework (Kostis and Katasonov, 2014)

Service for this application -- Dashboard (below) created to identify sensors and their locations in a building

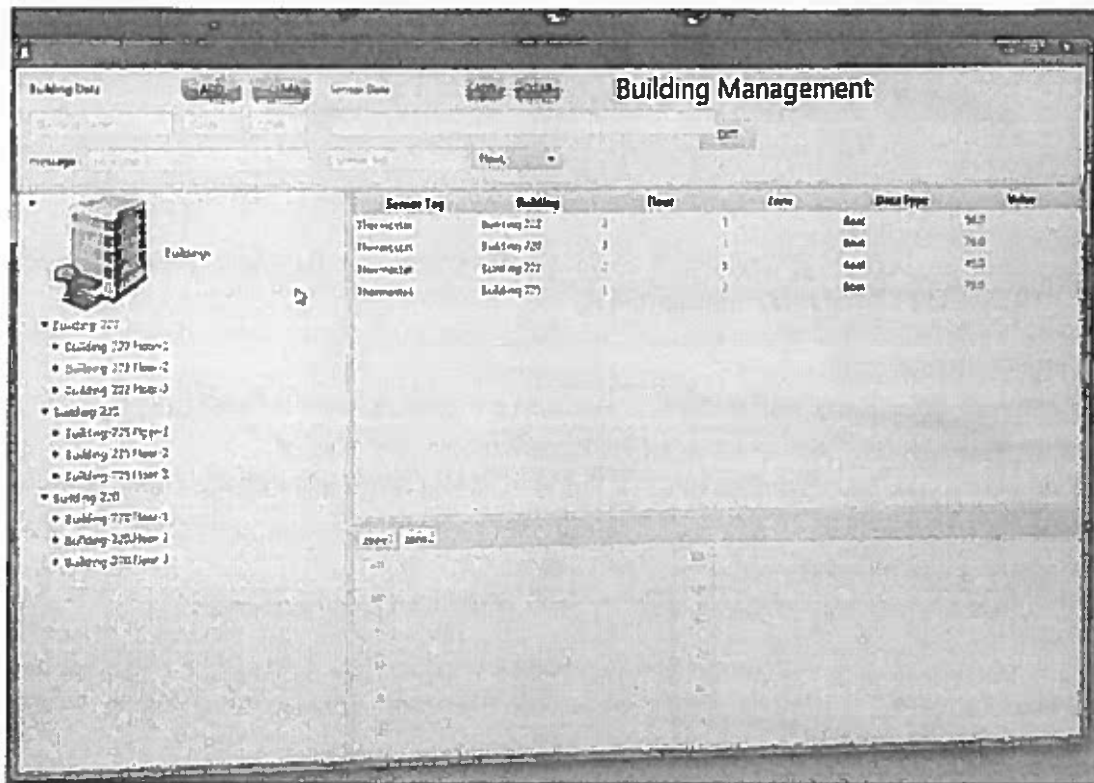


Photo of dashboard: Abdella Battou, May 2016

How the output should look (show example of output with artificial data and format required). For each device type, we need

- event model (see below)
- with parameters recommended for building management applications,
- and with an indication of the correct ontology per field (or per application)

Rules to capture instances (events of interest to the application or service) will be made separately from the data model.

EVENT data model

Metadata

ID:

Sensor:

Sensor/device type input:

Unit of input:

Frequency of data gathering

Sensing method used

Event instance capture rule in words:

Stimulus (for sensor output)

Data for events (streaming)

ID: (auto-generated number)

Source ID: (auto-generated number)

SensorOutput: (on-going readings)

Description of instance:

Time start:

Time end:

Instance data (according to event rule)

+ Code for event instance capture rule. Stored on server. script will filter the data stream for relevant data

Ontology Summit 2016 Challenge Problem: Medical

Contributing: National Institute for Standards and Technology (NIST) project for the Office of the National Coordinator of Standards for Health Information Technology

Motivation for goal: Electronic Health Records (EHR)

Problem to be solved: Map 4 ontologies used by different medical groups (labs, hospitals, clinics and offices) that overlap to improve EHR interoperability. Highly similar and identical terms should be included along with ontology provenance so that each group can continue to use its ontology of choice.

Two questions are asked (1) what is the extent of the overlap? (2) how can the merged terms show provenance?

Data set: (location of data, or sample)

LOINC (lab work) about 71,000 observation terms <https://loinc.org/downloads>

SnoMed CT (clinical diagnosis) about 70,000 diagnoses
<https://www.nlm.nih.gov/research/umls/licensedcontent/snomedctfiles.html>

RxNORM (pharmaceuticals) 1188312 NDC
<https://www.nlm.nih.gov/research/umls/rxnorm/docs/rxnormfiles.html>

ICD 10 (classification of diseases) about 14,440 codes
<http://www.cdc.gov/nchs/icd/icd10cm.htm>

What has been done so far:

- ✎ PROV-O. The W3C provenance ontology
- ✎ Clinical Modelling Initiative: CIMI standards to integrate SnoMed CT and LOINC
http://opencimi.org/policies_cimi
- ✎ Company called SOLOR, Campbell gave talk on this for the Ontology Teleconference on April 7.
SOLOR is proprietary billing software that integrates SNOMED, LOINC, RxNORM
- ✎ Alignment and mapping among ontologies allows each ontology to be updated separately.
- ✎ Linked Open Ontology Cloud.
- ✎ Semantic Cotopy (defines all concepts at an upper level)

How the output should look

1. Use Venn diagram with 1 circle per ontology, to show the extent of the overlap, and number of terms per overlap/group
2. Create table to show provenance of terms which are highly similar or overlap