SAREF4IMNA

SAREF for the Industry and Manufacturing domain | Mike de Roode

TNO innovation for life

ABOUT TNO

- TNO Data Science – Connected Business
- Smart Industry (The Netherlands)
  - Smart Connected Supplier Network (SCSN)
  - International Data Space (IDS)
- Smart Applications REFerence ontology (SAREF)

SAREF

- In 2013 the European Commission launched a standardization initiative (SMART 2013/0077 study) in collaboration with ETSI TC SmartM2M
- Goal: create a commonly agreed language (interoperable concepts) for the smart appliances domain
- Study conducted by TNO from January 2014 to March 2015

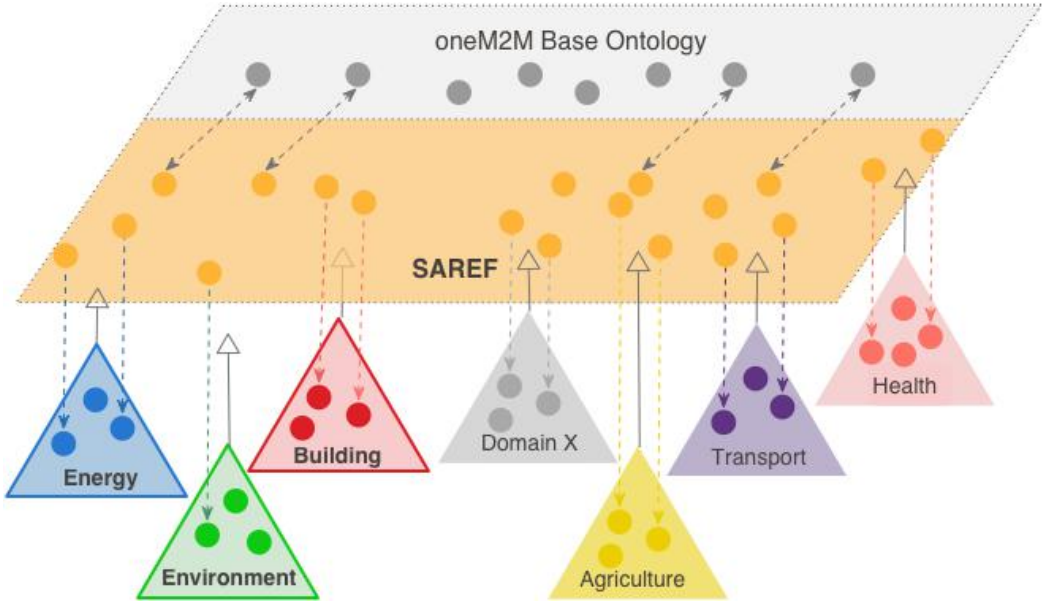
SAREF

- Motivation: more and more home appliances are smart appliances
  - Highly intelligent and networked devices
  - Complete energy consuming, producing and managing systems
- Need for open and standardised interfaces among networked devices (often from different vendors)
- Need to abstract from specific details of individual standards and create an abstraction layer based on a commonly agreed semantics
- Need for high level model - a **reference ontology** - that defines recurring concepts in the smart appliances domain without having to know specifics of the various standards
- The **Smart Appliances REFerence ontology (SAREF)** as “interoperability language”

SAREF

- A multitude of specific domains such as:
  - Smart Cities
  - Smart Building
  - Smart AgriFood
  - **Smart Industry & Manufacturing**
  - Automotive
  - Energy

- Scope: High-level ontology for sharing IIoT data generated during production process
  - Zero-defect manufacturing
  - Smart product lifecycle

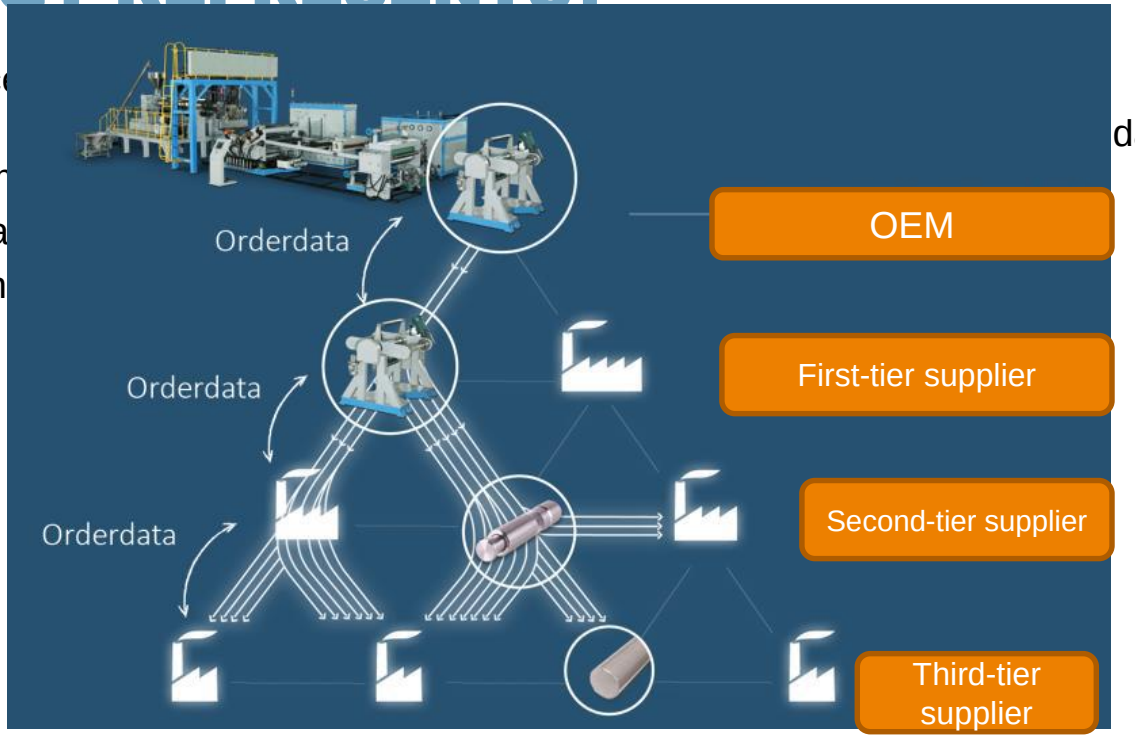


8. RELATIONS

- The production of items (i.e. goods) can be described using SAREF4IMNA
- An Item **isCreatedIn** an ItemBatch
- The Items can **consistOf**:
  - Items and ItemBatches (i.e. subassemblies)
  - MaterialBatch (i.e. raw material)
- Items **belongTo** an ItemCategory which **isProducedBy** certain ProductionEquipment
- Item, ItemBatch, and MaterialBatch can be a **FeatureOfInterest** for Measurements of ProductionEquipment

9. WHAT IS THE KNOWLEDGE YOUR SPECIFIC ONTOLOGY REPRESENTS?

- Knowledge nec
- The ontology is data) between different equipm
  - Material tra
  - Material an
  - Production



10. RELATIONS BETWEEN DIFFERENT GRANULARITY VIEWS ON THE SAME OBJECT?

- An Item **consistsOf** other Items, ItemBatches (i.e. subassemblies) and MaterialBatch (i.e. raw material)
  - These are all continuum concepts

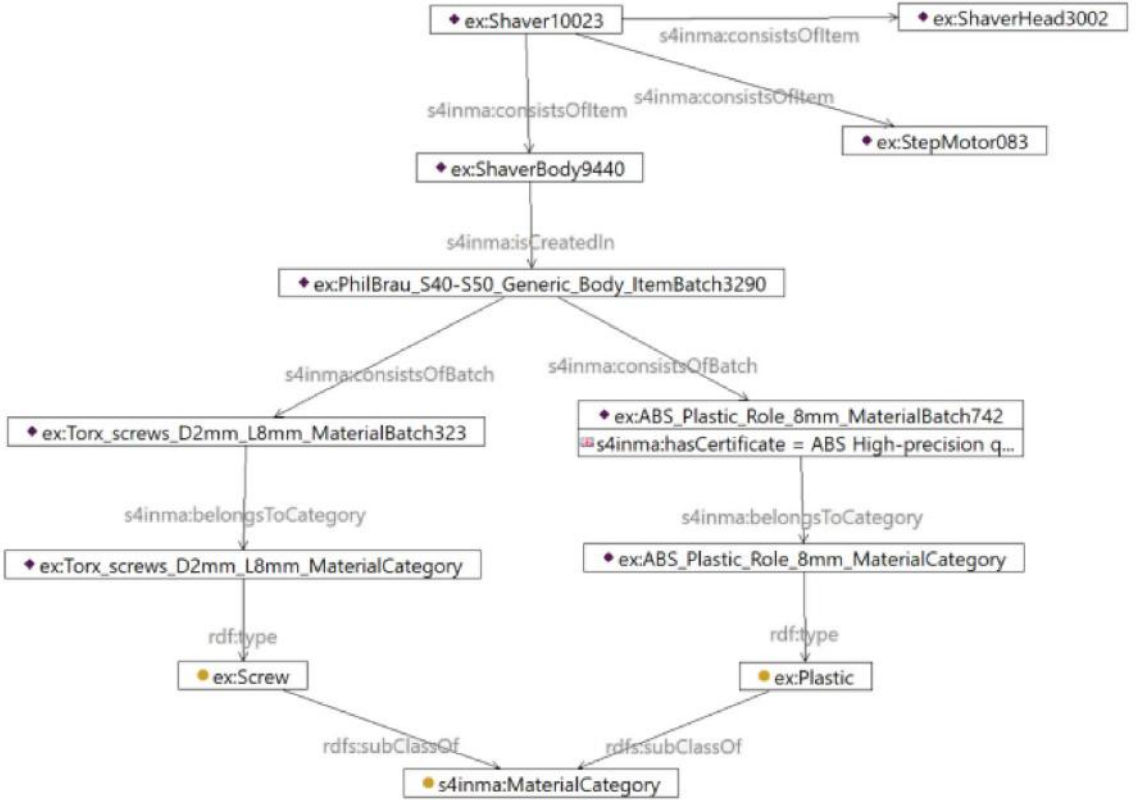
- Items and raw material can in its turn can also be decomposed recursively.

11. HOW I
MATERIA

- *MaterialCategory*
- *MaterialBatch* de
  used in the produ
- An Item(Batch) a
  MaterialCategory

d can be

belongs to a



12. WHAT TYPE OF PROCESSES DO YOU ADDRESS?

- SAREF4IMNA focusses on the usage of IIoT data measured during the **production process** and **quality assurance** of manufactured items.
  - Measurement reports -> *ActualMeasurement/ExpectedMeasurement*
  - Material Certificates -> *Certificates* under *MaterialBatch*
  - Item tracing -> *consistsOfBatch/consistsOfItem* relation

- Relation with *Smart Connected Supplier Network* communication standard which focusses on the procurement of goods (e.g. ordering, product specification, logistical handling, invoicing, sharing of measurement reports…)

13. HOW DOES YOUR ONTOLOGY REPRESENT MANUFACTURING?

- The *Measurement* concept captures data output from manufacturing steps.
- *Item, ItemBatch, Material,* and *MaterialBatch* capture the raw materials used for producing a good, which enables traceability in the supply chain.
- *ProductionEquipment* represents a machinery which contributes in the production process of a good

- The complete manufacturing process is not modelled in SAREF4IMNA.

14. CIRCULAR CONNECTION BETWEEN PHYSICAL PROPERTIES, MATERIALS MODELS

- Material properties, i.e. real properties, are attached to a MaterialBatch
- MaterialBatches are used in the production of Item(Batches)
- During/after the production of Items, measurements, i.e. measured properties, can be made which are related to Item(Batch)
- The measurements can be compared to the expected material models, i.e. simulated properties (digitial twin).

15. WHAT IS THE REPRESENTATION LANGUAGE AND IMPLEMENTATION (LOGICS)?

- OWL2
- Protege and Topbraid composer

- Is used as basis for extending the Smart Connected Supplier Network (SCSN) standard with production process information.
- Data is exchanged in the supply chain via the International Data Space.

SOURCES

- SAREF4INMA: a SAREF extension for the Industry and Manufacturing domain, Mike de Roode, Alba Fernández-Izquierdo, Laura Daniele, María Poveda-Villalón and Raúl García-Castro, Semantic Web of Things for Industry 4.0 special issue [Under Review]
- SAREF: Created in close interaction with the industry: the smart appliances reference (SAREF) ontology, in: International Workshop Formal Ontologies Meet Industries, L. Daniele, F. den Hartog and J. Roes Springer, 2015
- SAREF in EC's 'Rolling Plan for Information Communication and Technology standardization', 2017

THANK YOU FOR YOUR ATTENTION

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