UNIK4750 - Measurable Security for the Internet of Things

L7 – Security Semantics

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http://cwi.unik.no/wiki/UNIK4750, #IoTSec, #IoTSecNO

Overview

- Learning outcomes L8
- Recap: technology mapping
- Service requirements
  - Functional Requirements
  - Non-functional requirements
  - Security requirements
- Semantic technologies
  - why Semantics
  - elements of semantics
  - examples
- Security Ontologies
  - traditional view
  - Application-oriented view
- Map Security, Privacy, Dependability
- Conclusions

Expected Learning outcomes

Having followed the lecture, you can

- explain components of the Smart Grid (AMS) System of Systems
- can explain the difference between functional, non-functional and security components
- provide examples of security challenges in IoT

- explain the difference between the web, the semantic web, web services and semantic web services
- explain the core elements of the Semantic Web

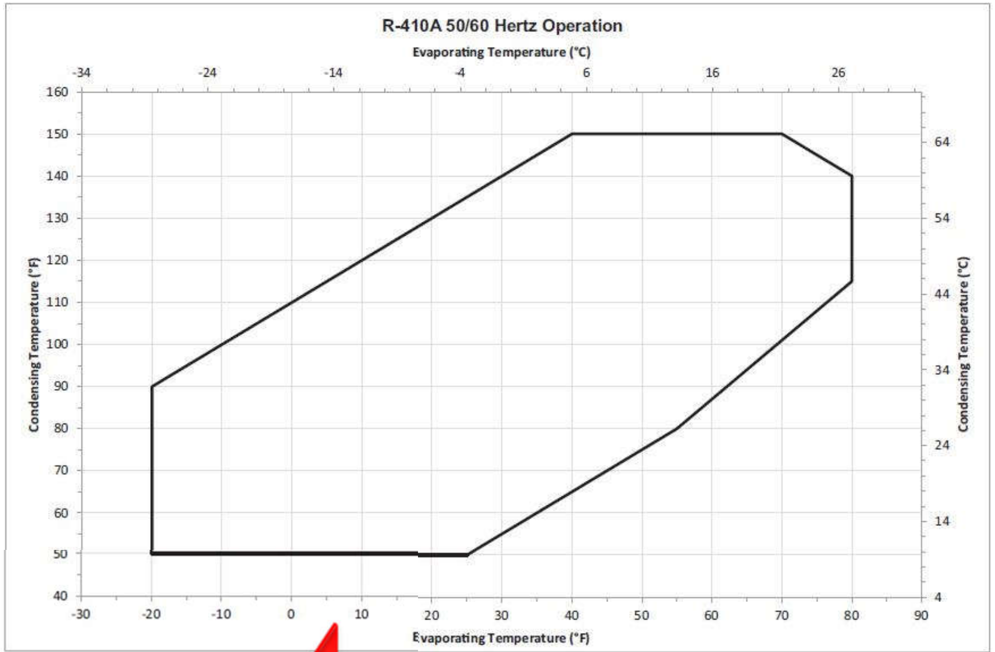
- apply semantics to IoT systems
- provide an example of attribute based access control

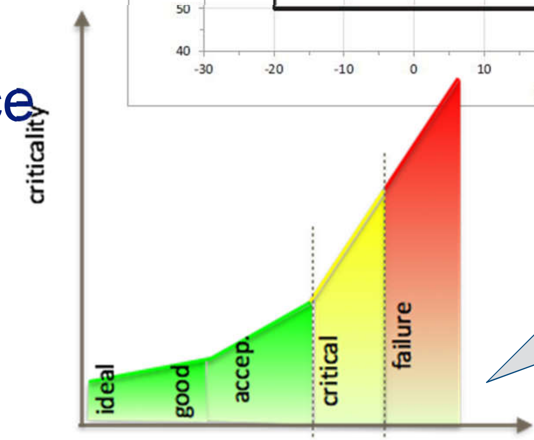
- discuss the shortcomings of the traditional threat-based approach
- list the main elements of the semantic descriptions of s,p,d functionalities
- perform a semantic mapping of s,p,d attributes

Service Requirements
- Functional Requirements
- Non-functional requirements
- Security requirements

Recap:
Conversion and operating envelope

- Operating envelope: the operational parameters where our network can work "well", depends on the technology and on the task
- For traffic estimation we need it in communication QoS
  - Bandwidth, delay, jitter, (redundancy)
- Often can be done with simple arithmetic with a certain confidence level



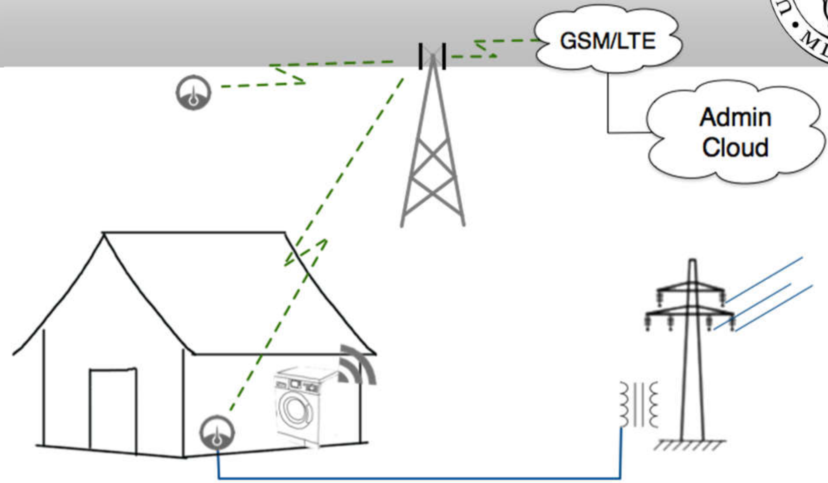


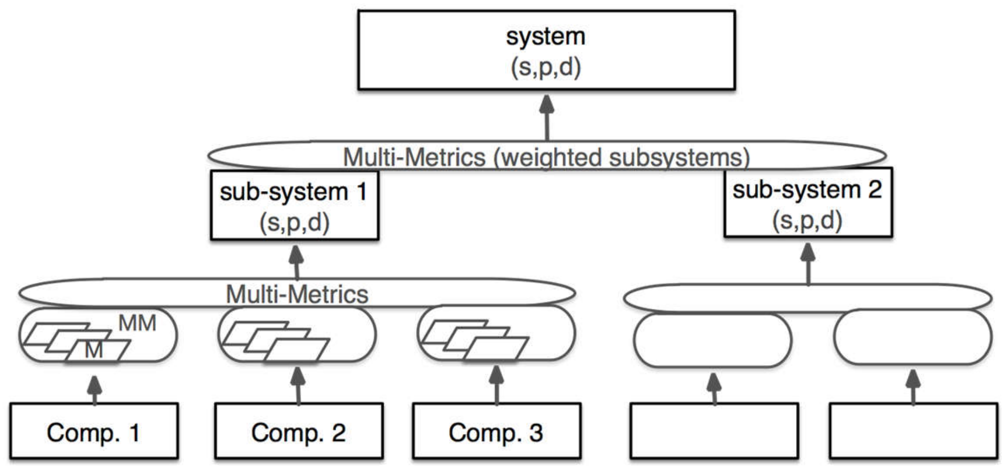
1) How does he Operating Envelope look like applying criticality?
2) How can the criticality be applied for SPD?

Example:

System of Systems

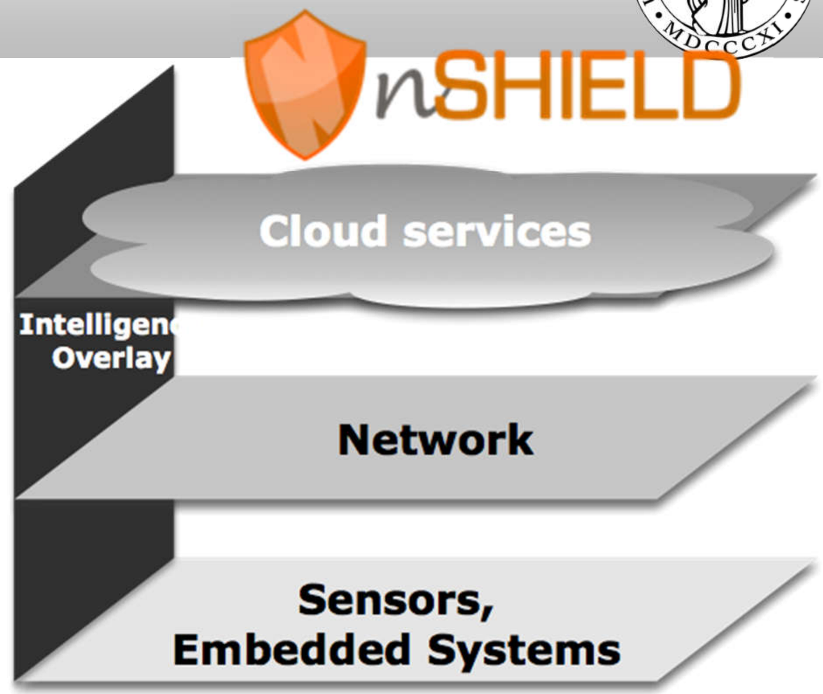
- A system consists of sub-systems
  - Example: Automatic Meter System (AMS) consists of reader (AMR), aggregator, communications, storage, user access
- A sub-system consists of sub-…-system
  - Example: AMR consists of power monitor, processing unit, communication unit
- A sub-....-system consists of components
  - Ex: AMR communication contains of a baseband processing, antenna, wireless link
- Components have parameters
  - Wireless link component: f=868 MHz, output power=?, Encryption=?

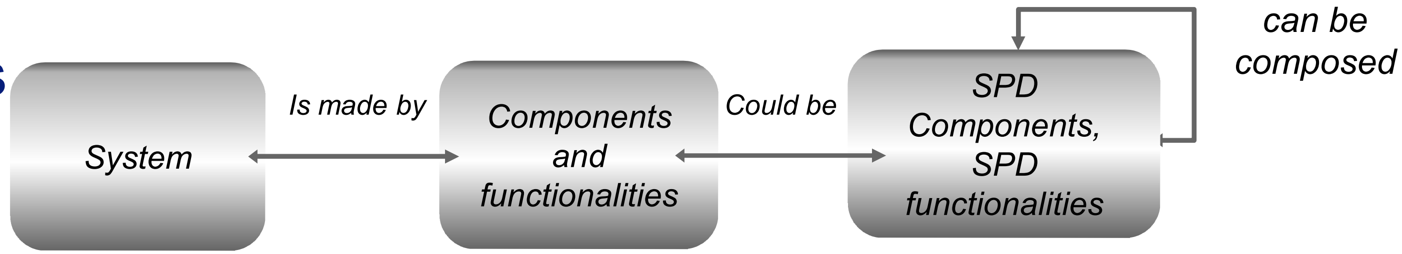




newSHIELD.eu approach

- Security approach by JU Artemis
  - Industry, National and EU supported (JU) activities
  - special focus on sensor systems
- Security, here
  - security (S)
  - privacy (P)
  - dependability (D)
- across the value chain
  - from sensors to services
- measurable security





Examples of
Security challenges in the IoT

- **System**: Intrusion awareness, fault-tolerance, data redundancy and diversity
- **Platform**: Auto start up on power failure, Auto reconfigurable on software failure, Auto synchronization on software failure, End-to-end secure communication, Mal-user detection, Access control for accessing sensor data
- **Middleware**: SPD Audit, Cryptographic Support, Identification and Authentication, Protection of the SPD functionalities, Security Management
- **Hardware**: SPD metrics, Self-recovery from hardware transient faults, Auto-reconfiguration, Data encryption, Provision of security and privacy services, data encryption/decryption
- **Radio**: Threats tolerant transmission
- Periodic risk evaluation is key

System components
classified after objective

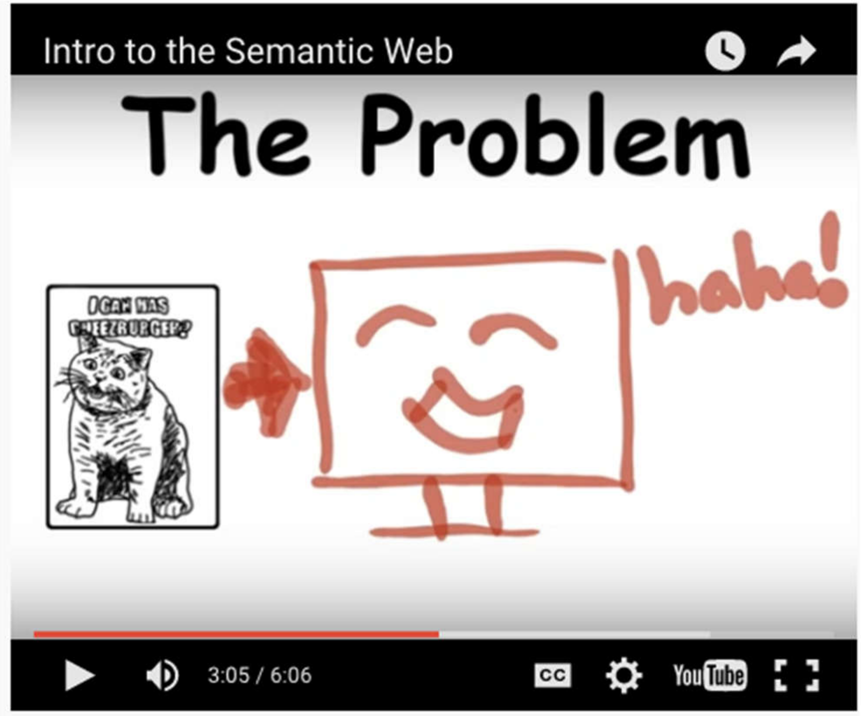
- Functional components
  - input component (sensors, keyboard, mouse,..)
  - output component (alarm, screen, actuator,..)
  - processing component
  - Storing component (data base, files,)
  - Connection (wireless connection, wired connection)

- Security, Privacy, Dependability (SPD) components:
  - Encryption: Encryption algorithm, keys,..
  - Protocols
  - Authentication(mechanism (fingerprint, password, password complexity,.….) .
  - Authorization (privileges, ..)

- Management components (OS, Web server, data server)
- Human component (admin, user, ..).
- Physical component, car being a component in a car factory. (if treated as “sub-system)

Semantic technologies
- why Semantics
- elements of semantics
- Examples

https://www.youtube.com/watch?v=OGg8A2zfWKg



The Semantic Dimension of
the Internet of Things (IoT)

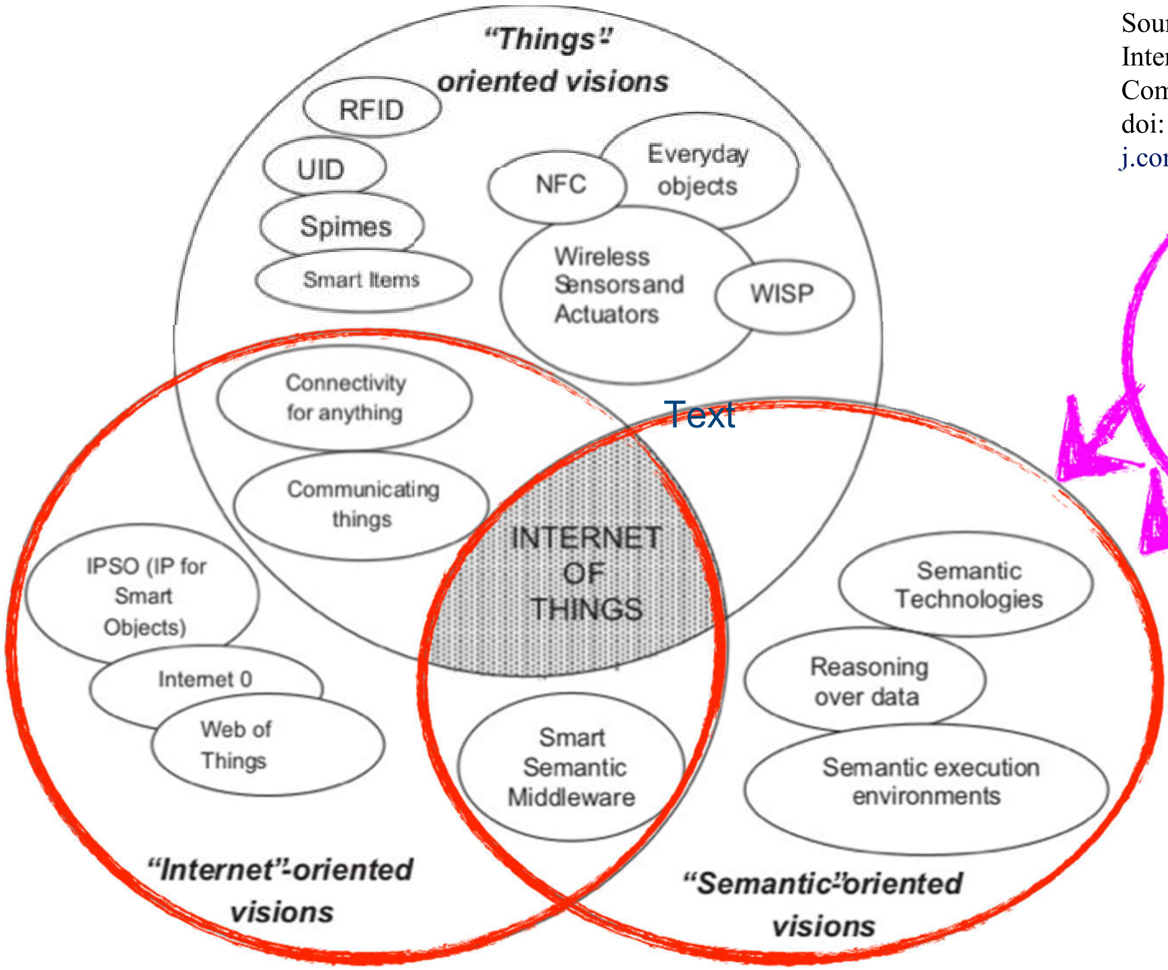
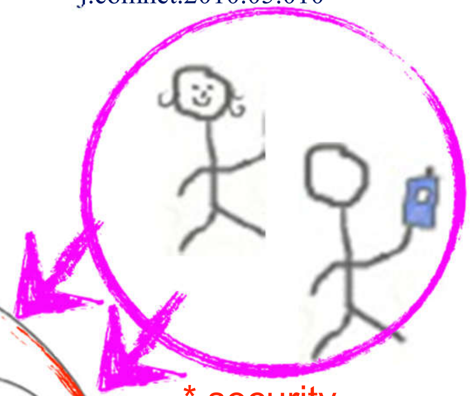


Fig. 1. "Internet of Things" paradigm as a result of the convergence of different visions.

Source: L. Atzori et al., The Internet of Things: A survey, Comput. Netw. (2010), doi:10.1016/j.comnet.2010.05.010

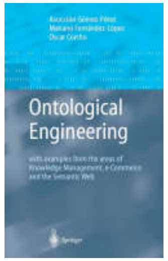


* security
* privacy
* dependability
  - context
  - content
* personalised

Why Semantics?

- Syntax vs. Semantics

Arab



الاسم: الهندسة فعلم التطو ر
المؤلّفون:آسنسيون غومزبرز
السّعر: $74.95
المنتج:الكتاب

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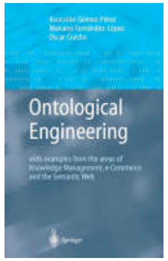
English



Title: Ontological Engineering
Authors: Asunción Gómez-Pérez...
Price: $74.95
Product: Book

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What do the tags mean for the machine?

Source: Juan Miguel Gomez, University Carlos III de Madrid

Why Semantics?

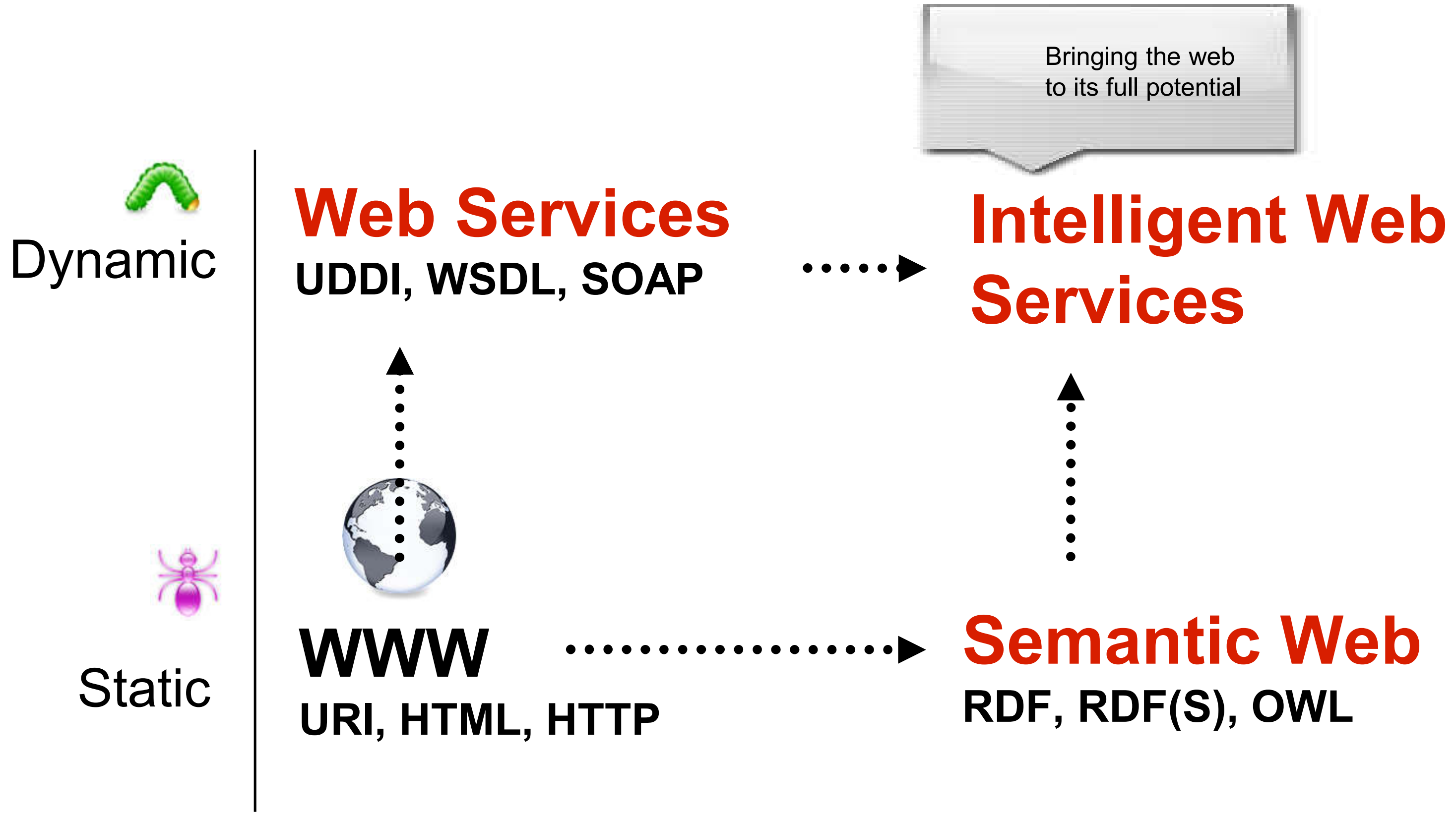
- Conceptual Level

lunch (.no)

lunch (.es)

Source: Juan Miguel Gomez, University Carlos III de Madrid

Semantic Web Services



Source: Juan Miguel Gomez, University Carlos III de Madrid

Requirements for Service Evolution

Web services

- Fixed service set, Static service composition, Low degree of automation
- Fixed Service Level Agreement

Semantic Web Services

- Flexible services, easy new services
- Alternative service provision
- Global, dynamic services

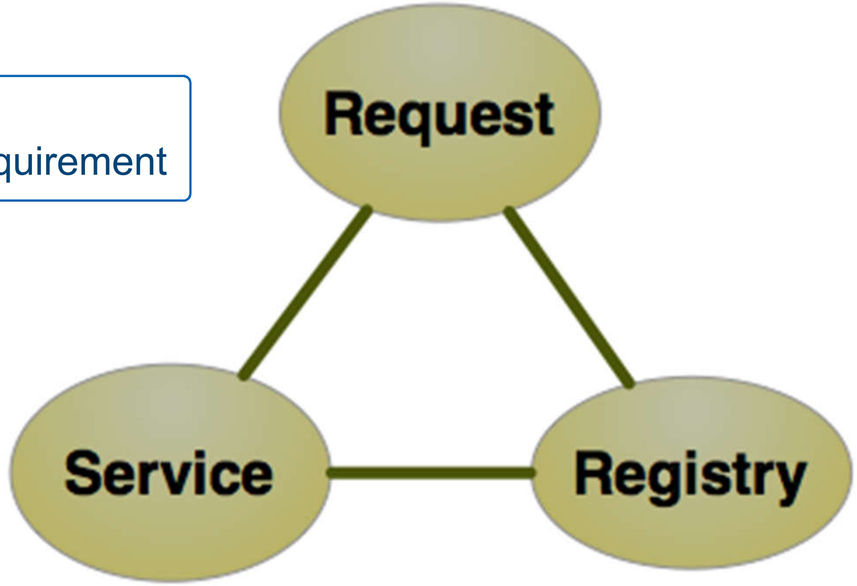
Elements of Web Services

- Service Request
  - want to come to Barcelona University
- Services
  - buy a flight ticket (cheap, direct, …)
  - buy a metro/bus ticket
- Service registry
  - link to ticket ordering at airline webpage
- (Security) - Privacy attribute
  - only use company which does not sell my data

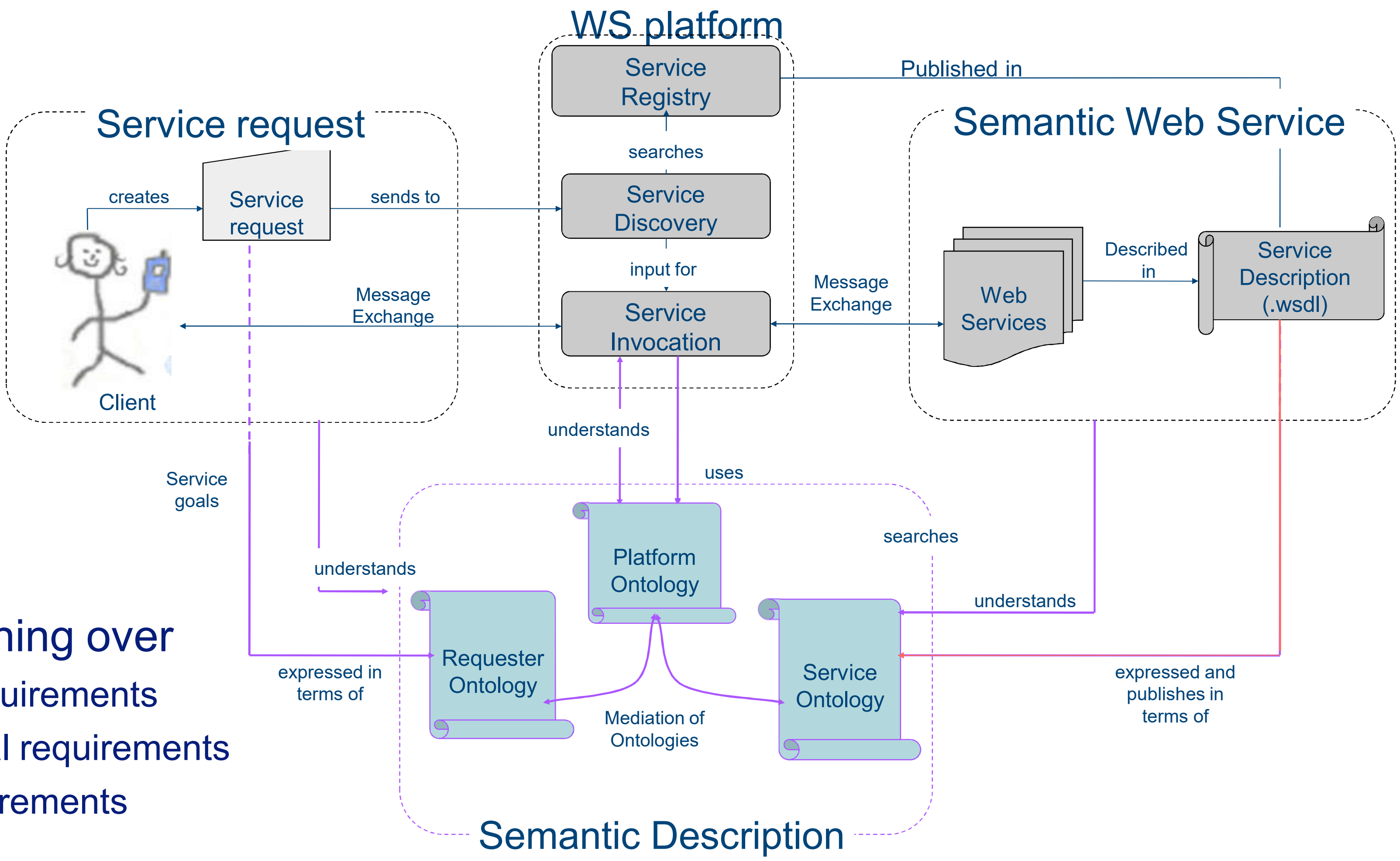
functional requirement

non-functional requirement

s,p,d requirement



Semantic Web Services Architecture

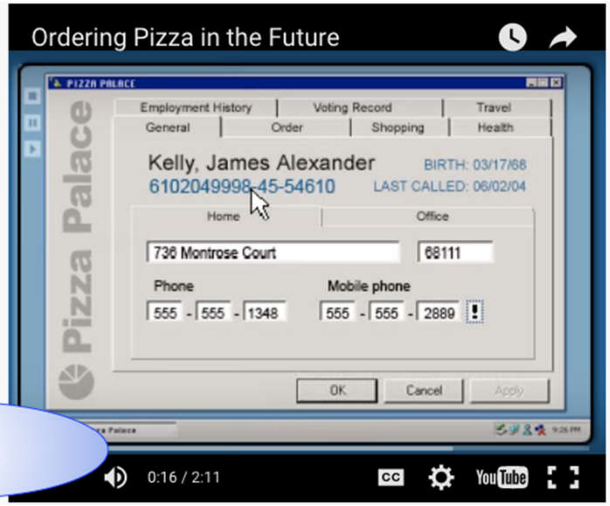


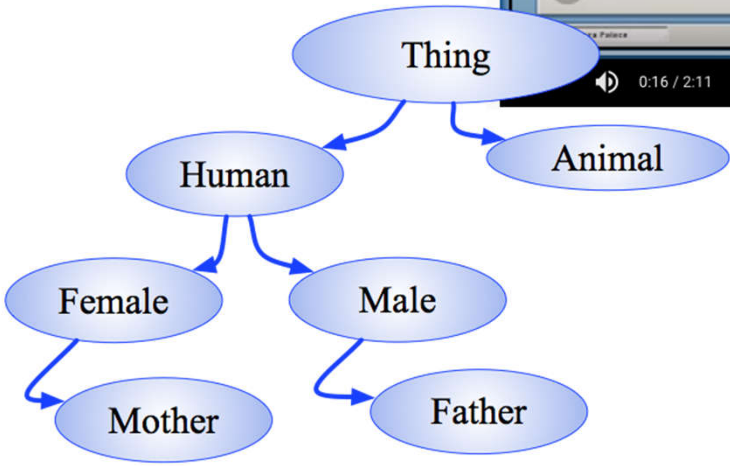
Goal: Reasoning over
- functional requirements
- non-functional requirements
- security requirements

Elements in Semantic Technologies

- Extensible Markup Language (XML) is a markup language that defines a set of rules for encoding documents in a format which is both human-readable and machine-readable.
- RDF - Formal semantics is built upon a W3C XML standard for objects called the Resource Description Framework (RDF)
- OWL - The Web Ontology Language (OWL) is a family of knowledge representation languages for authoring ontologies.
- A semantic reasoner, reasoning engine, rules engine, or simply a reasoner, is a piece of software able to infer logical consequences from a set of asserted facts or axioms.
- Classes (concepts) are abstract groups, sets, or collection of objects (example: human, woman)
- Individuals (instances) are the specific objects, e.g. Josef is a Father
- Attributes (properties) describing objects (individual and classes) in the ontology. Example: Human hasName, Josef has name Josef Noll

[Source: Wikipedia]

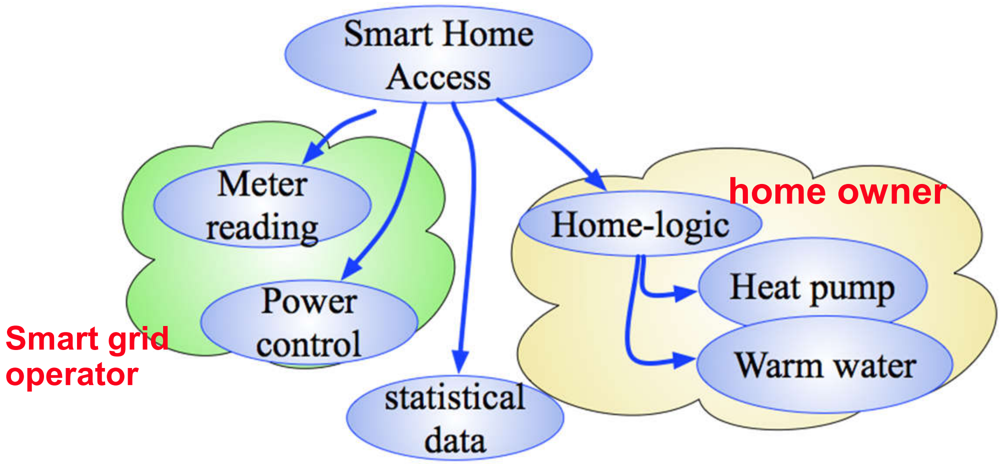




further reading:
http://www.slideshare.net/SergeLinckels/semantic-web-ontologies

Semantic attribute based access control (S-ABAC)

- Access to information
  - who (sensor, person, service)
  - what kind of information
  - from where
- Attribute-based access
  - role (in organisation, home)
  - device, network
  - security tokens
- OWL & SWRL implementation
- Rules inferring security tokens



Attributes: roles, access, device, reputation, behaviour, ...

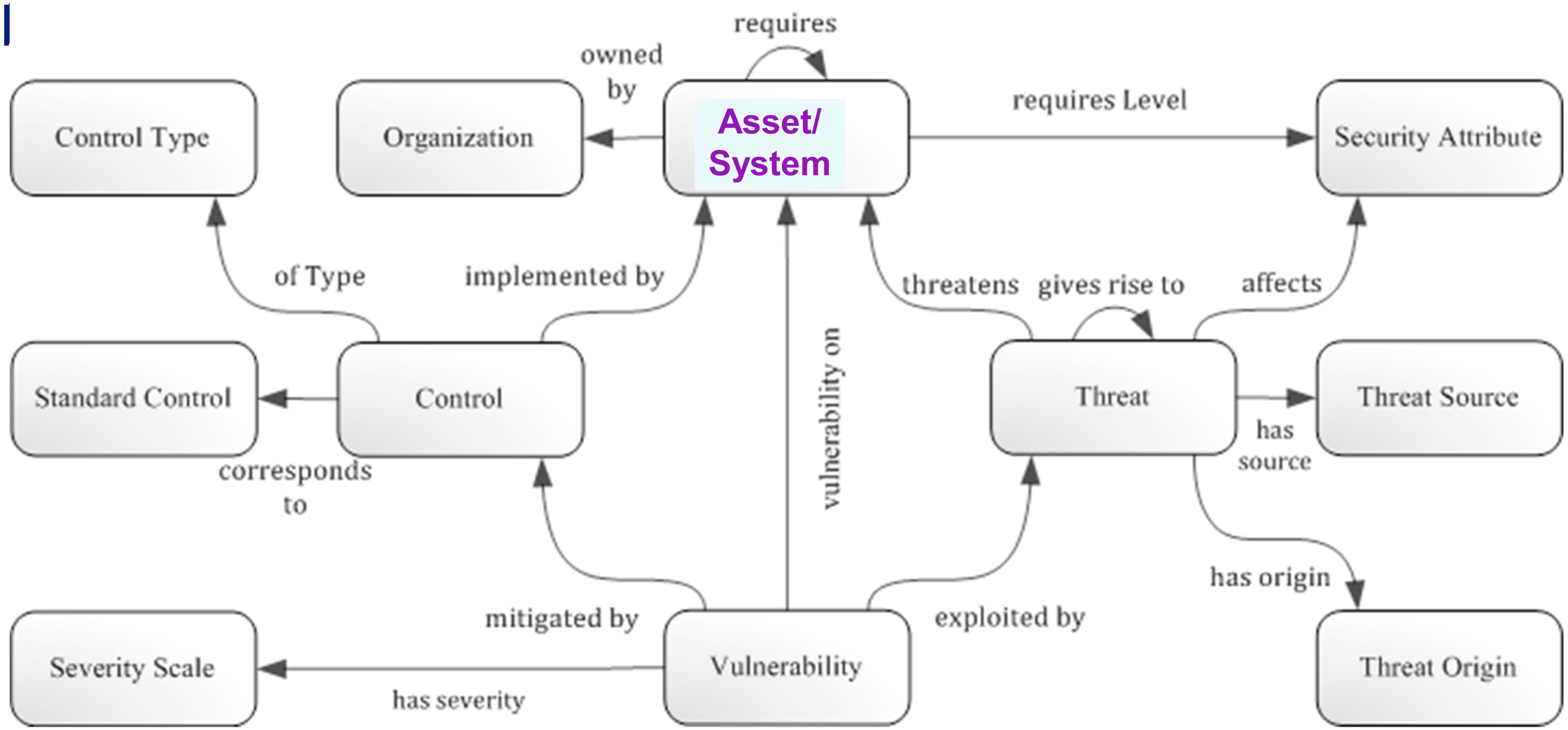
canOwn(?person,?attributes) ∩ withHold(?token,?attributes) ∩ (Person(?person) -> SecurityTokenIssueTo(?token, ?person)

[token]	principal
◆ BasicToken_1	◆ Carol
◆ BasicToken_2	◆ Alice

Security Ontologies
- traditional view
- Application-oriented view

Traditional approach

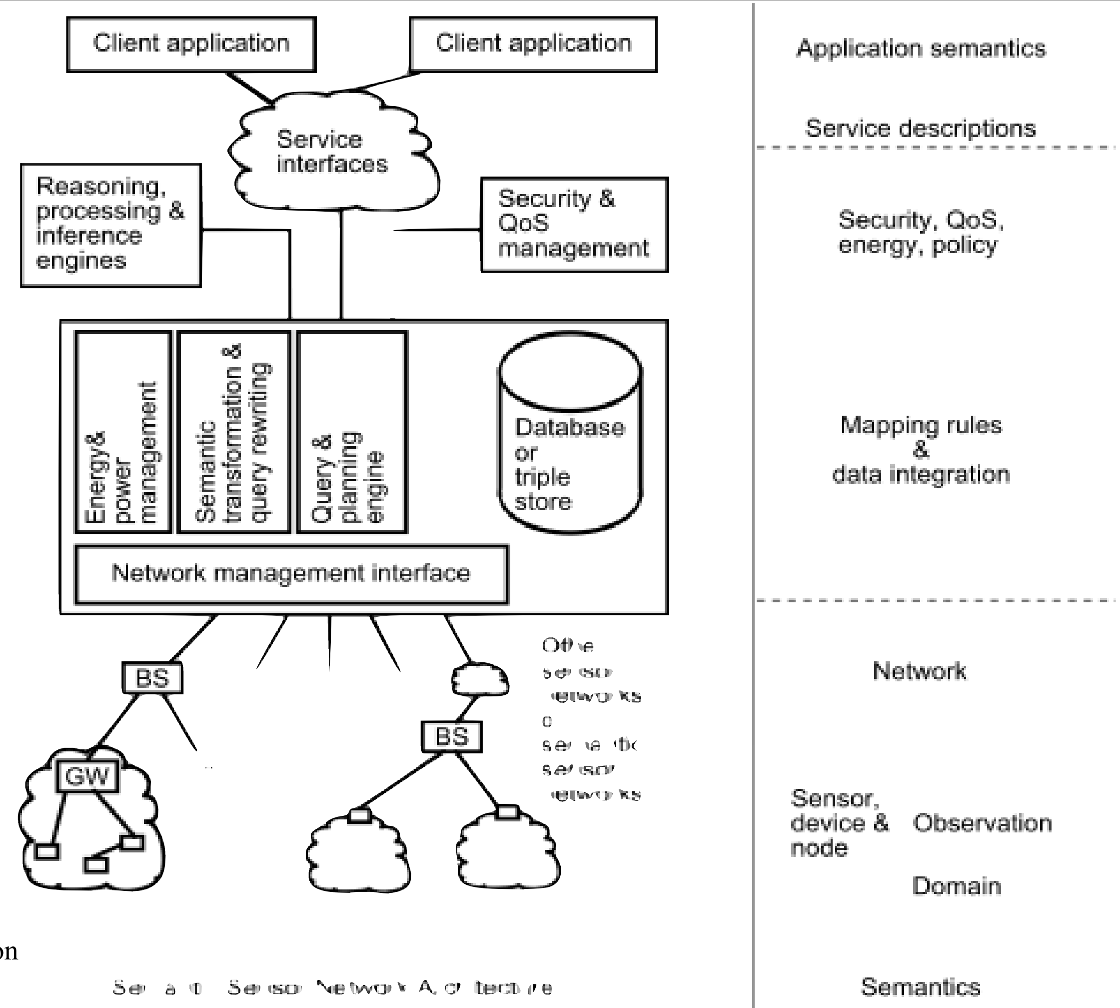
- Combined approach, addressing threat, vulnerability, system impact and control



[source: http://securityontology.sba-research.org/]

Sensor Network Architecture

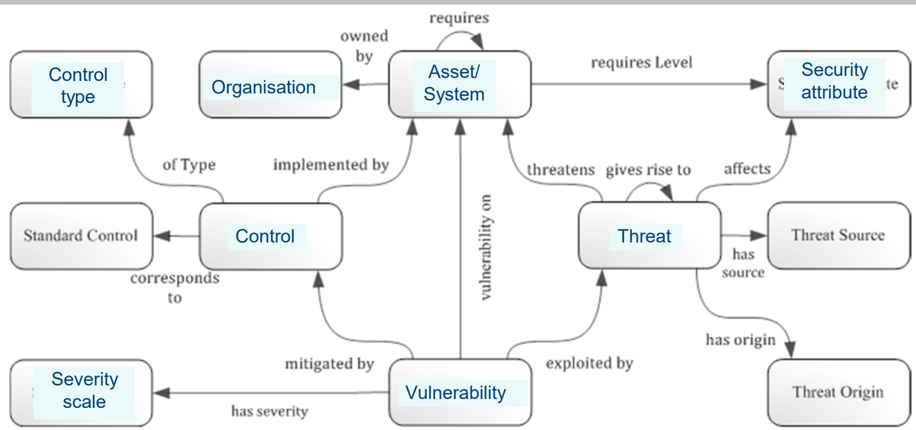
- Semantic dimension
  - Application
  - Services
  - Security, QoS,
  - Policies
  - mapping
- System
  - sensor networks
  - gateway
  - base station



Source: Compton et al., A survey of semantic specification of sensors, 2009

Limitations of the traditional approach

- Scalability
  - Threats
  - System
  - Vulnerability
- System of Systems
  - sensors
  - gateway
  - middleware
  - business processes



Recommendation:

One ontology per aspect:
- security
- system
- threats
...

Applied security

- Security, here
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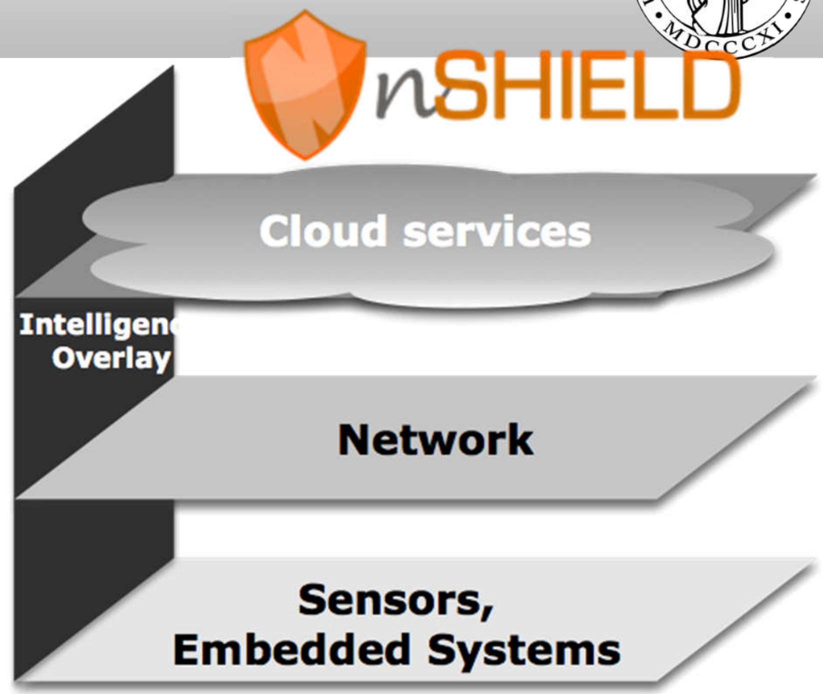
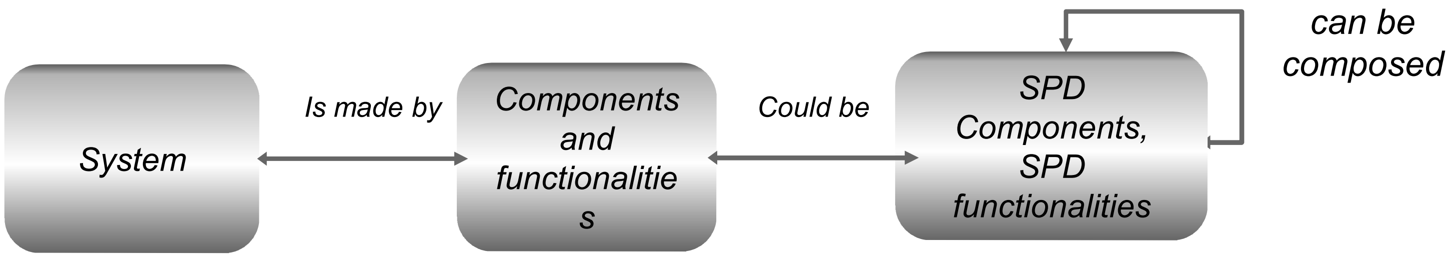
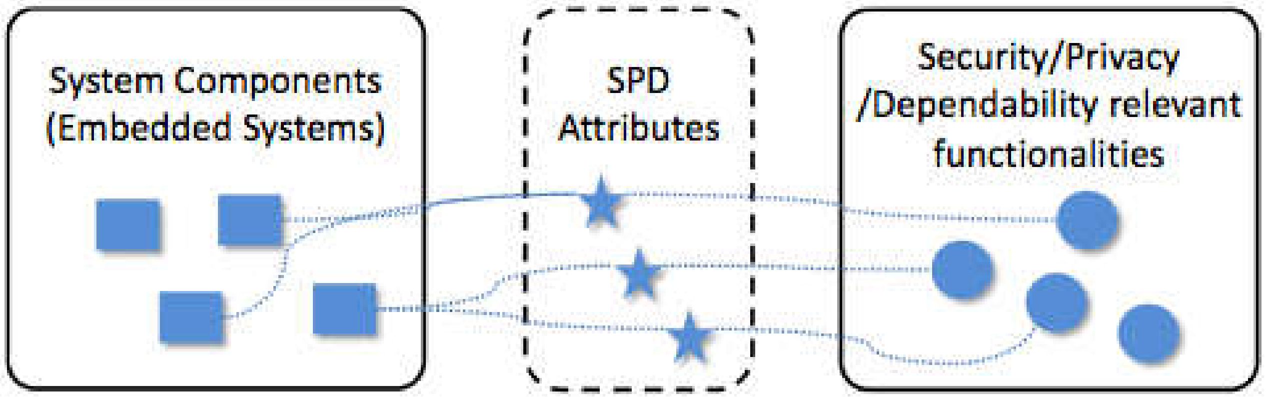
  - privacy (P)
  - dependability (D)
- across the value chain
  - from sensors to services
- measurable security

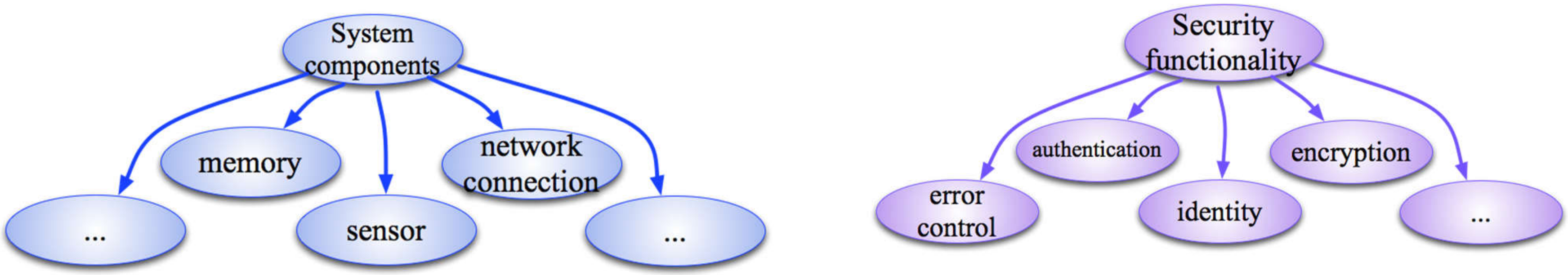




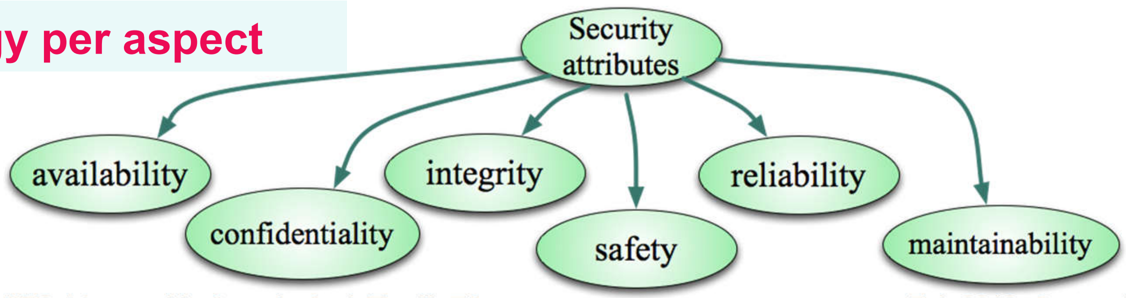
Security description

- Ontologies for system, security attributes, security functionality





Recommendation: One ontology per aspect



L8 - Learning outcomes

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- **Further readings**
- https://plus.google.com/u/0/+MarcelEggum/posts/9kbGFHA972J (about the Semantic Web)
- http://www.slideshare.net/SergeLinckels/semantic-web-ontologies (on Ontologies)