BOnSAI: a Smart Building Ontology for Ambient Intelligence

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Outline

Abstract
1. Background
2. Target
3. Related Work
4. BOnSAI
5. BOnSAI Usage
6. Future Work

Abstract

- BOnSAI: a Smart Building Ontology for Ambient Intelligence
- Includes concepts for
  - Functionality (Hardware, Services), Environment, QoS, Users, Context
  - Imports from existing ontologies
- Put in use
  - Smart Building at the International Hellenic University – Smart IHU
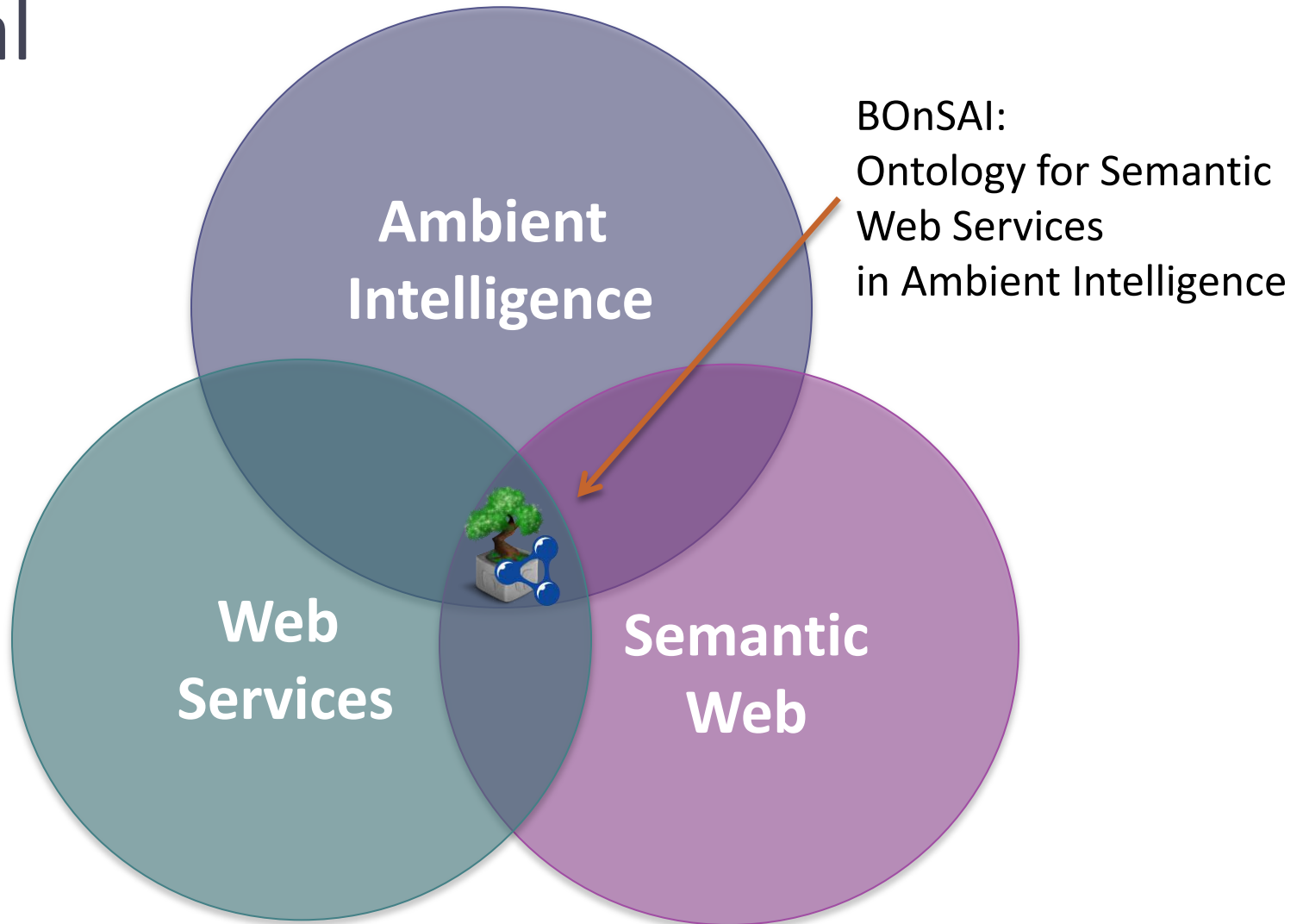 - Semantic Service description for Sensor Network Devices

1 Background

- Ambient Intelligence (AmI)
  - Derives from Ubiquitous, Pervasive Computing
  - Users surrounded by embedded/wearable/portable computing devices
- Web Services (Sensor Web)
  - WSDL standard for syntactic interoperability
  - Widely used in AmI
- Semantic Web Services
  - Various standards
  - OWL-S, WSMO (top-down)
  - SAWSDL, WSMOLite (bottom-up)
  - Confusion, Complexity, lack of universal solutions

2 Goal of BOnSAI

- ➤ To provide a simple yet powerful solution for the convergence of AmI, WS, SW
- ➤ Compatible with top-down descriptions (upper ontologies)
  - ▫ Interoperability with existing approaches
  - ▫ Also to use as a knowledge base of services
- ➤ Can be used for bottom-up descriptions (e.g. SAWSDL)
  - ▫ Lightweight semantic descriptions
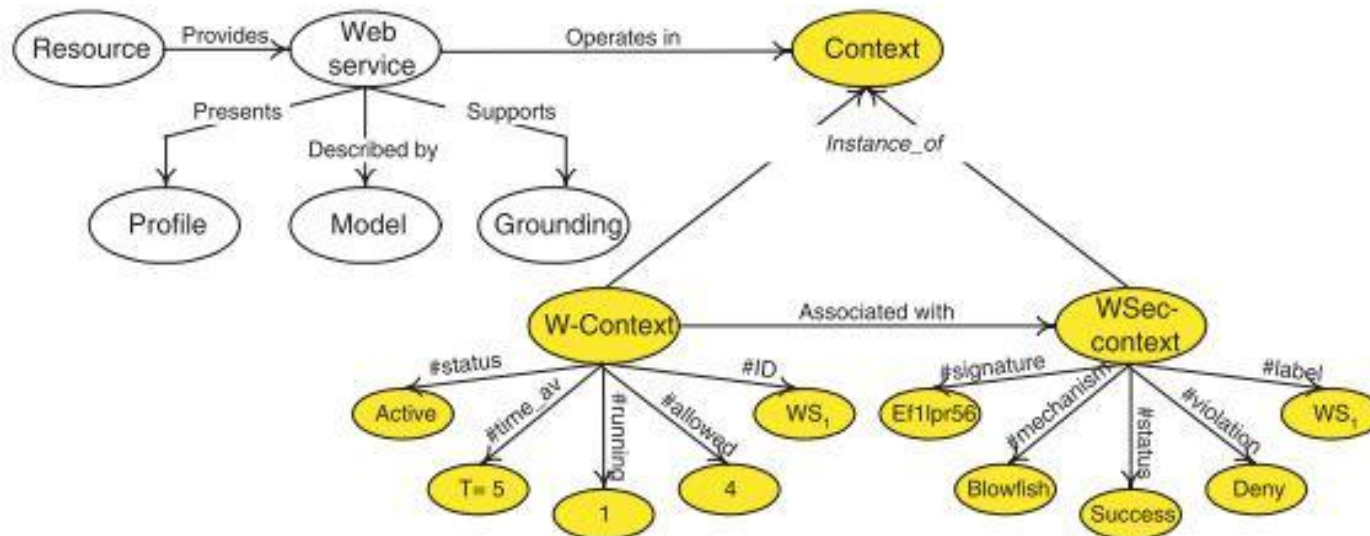 - ▫ Even more universal

2 Goal

Ambient Intelligence

Web Services

Semantic Web

BOnSAI:
Ontology for Semantic Web Services
in Ambient Intelligence

3 Related Work
Context Ontology [1]

1. Maamar et al: Towards an ontology-based approach for specifying and securing Web services(2006)

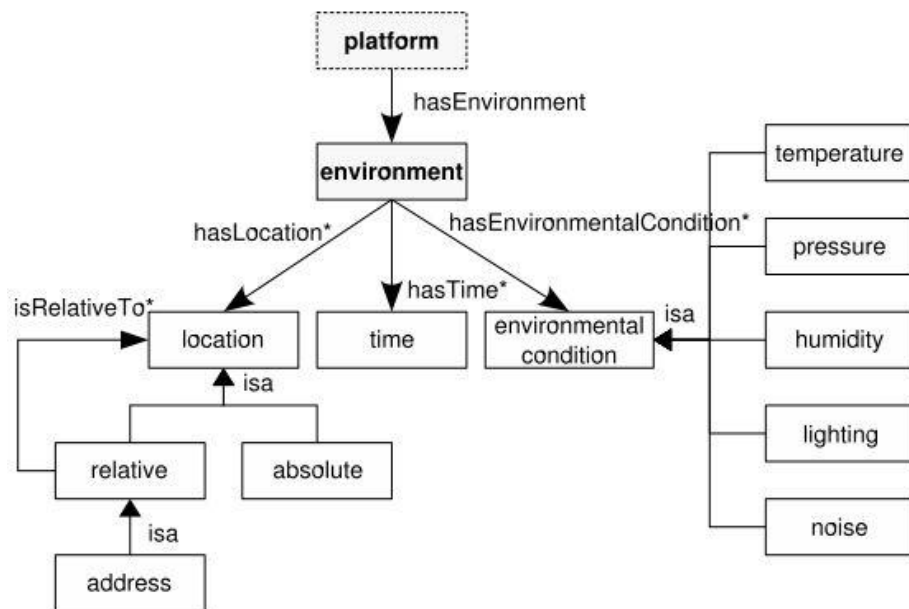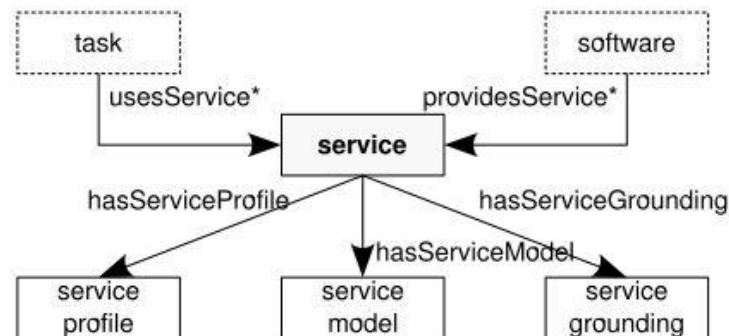✓OWL-S extension
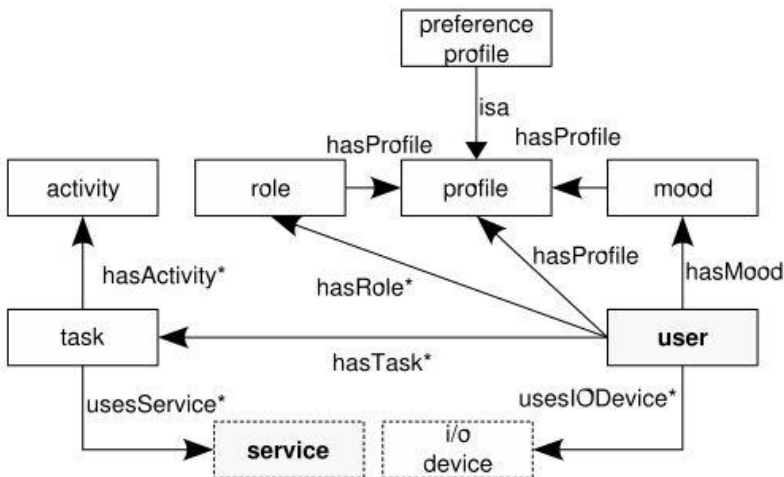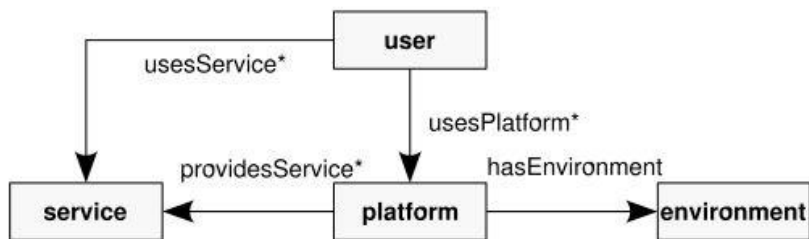
• Quite application specific

3 Related Work CoDAMoS [2]

2. Preuveneers et al. Automated context-driven composition of pervasive services to alleviate non-functional concerns
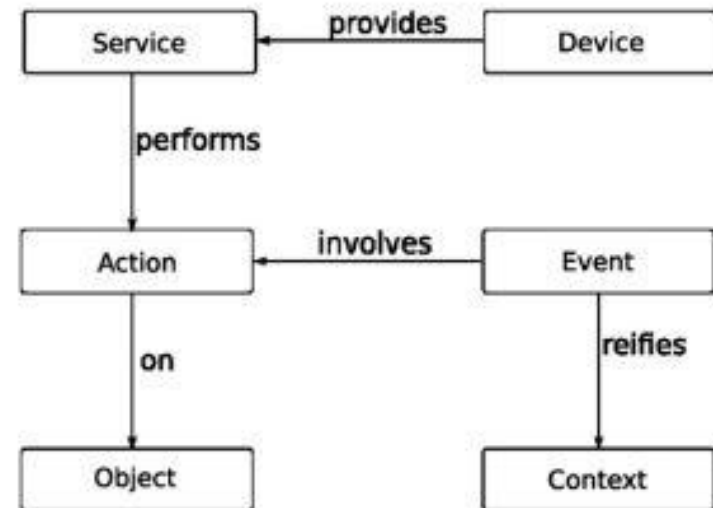
✓ imported in BOnSAI

3 Related Work
OntoAMI [3]

3. Santofimia et al. (2008) An agent-based approach towards automatic service composition in ambient intelligence

- ✓ Quite minimal
- But not general enough:
  - ▫ Device provides Service
  - ▫ Action on Object
    - • BOnSAI is less restrictive
  - ▫ Event reifies Context
    - • Leads to many instances

3 Related Work
# DEHEMS [4]

4. Shah et al: Ontology for Home Energy Management Domain (2011)

✓Energy Savings (FP7)

✓Knowledge Base

- Various Household Appliances
- Consumption measurements
- Energy Classes
- Reasoning on the above

■ Does not model services / sensors

■ Could not be found online

ENVISION Ontology

- Event-based Sensor Service System
- Uses
  - W3C's Semantic Sensor Network ontology
  - SOA4All (WSML, IRIS Reasoner)
- Introduces
  - A Service Ontology (SOS)
  - POSM (Operations, Preconditions, Effects)

4 BOnSAI
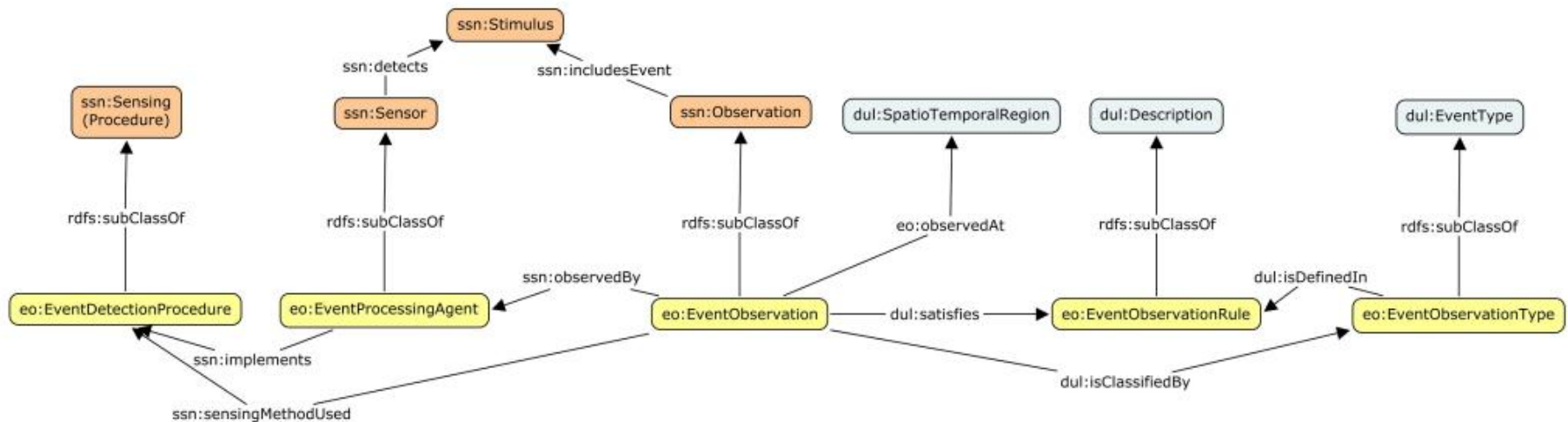
- Online at http://lpis.csd.auth.gr/ontologies/bonsai/
- Hardware (Devices)
  - Device Role
    - Sensor, Actuator, (MultiSensor, SensorActuator)
  - Device Communication protocol
    - Wired, Wireless (PLC, ZigBee, Z-Wave, RF etc.)
- Context
  - Location, Environment Parameters, Time
- Functionality of Services
  - Sensor Parameter readings (Environment and more)
  - Actuator Effects (Actions)

4 BOnSAI

- Service
  - Imports OWL-S (top-down)
  - Service (I)nput – (O)utput – (P)reconditions – (E)ffects
    - SAWSDL (bottom-up)
- QoS
  - Import from CoDAMoS:Resource
    - E.g. CPU speed, …
  - Define Communication Protocols

BOnSAI Class Diagram
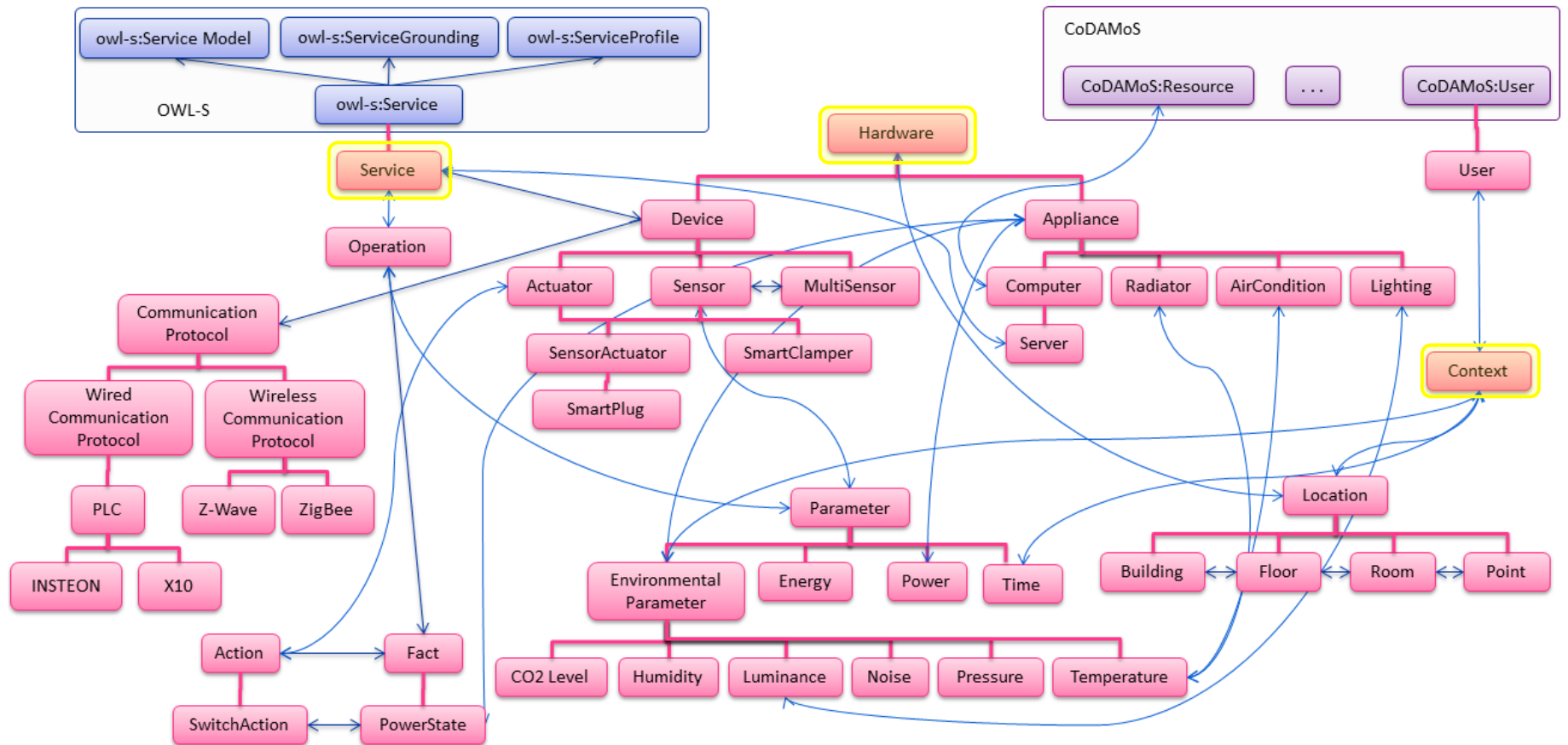
5 BOnSAI Usage
Smart IHU project

- Instantiation on Smart IHU (International Hellenic University) project
  - Smart Building AmI project that targets energy savings, automations and quality of life in a University
- Existing infrastructure
  - Sensors
    - Environmental (Humidity, Temperature, Luminance)
    - Motion detection (Camera, Infrared)
    - Power Consumption (Per Building, Per Appliance)
  - Actuators
    - Plugs (Switch Appliances)
    - IT Equipment management (Wake-On-Lan, Shutdown etc.)
- Devices and functions are exposed by developed Web Services
  - Syntactically described in WSDL

5 BOnSAI Usage (cont'd)
Smart IHU project
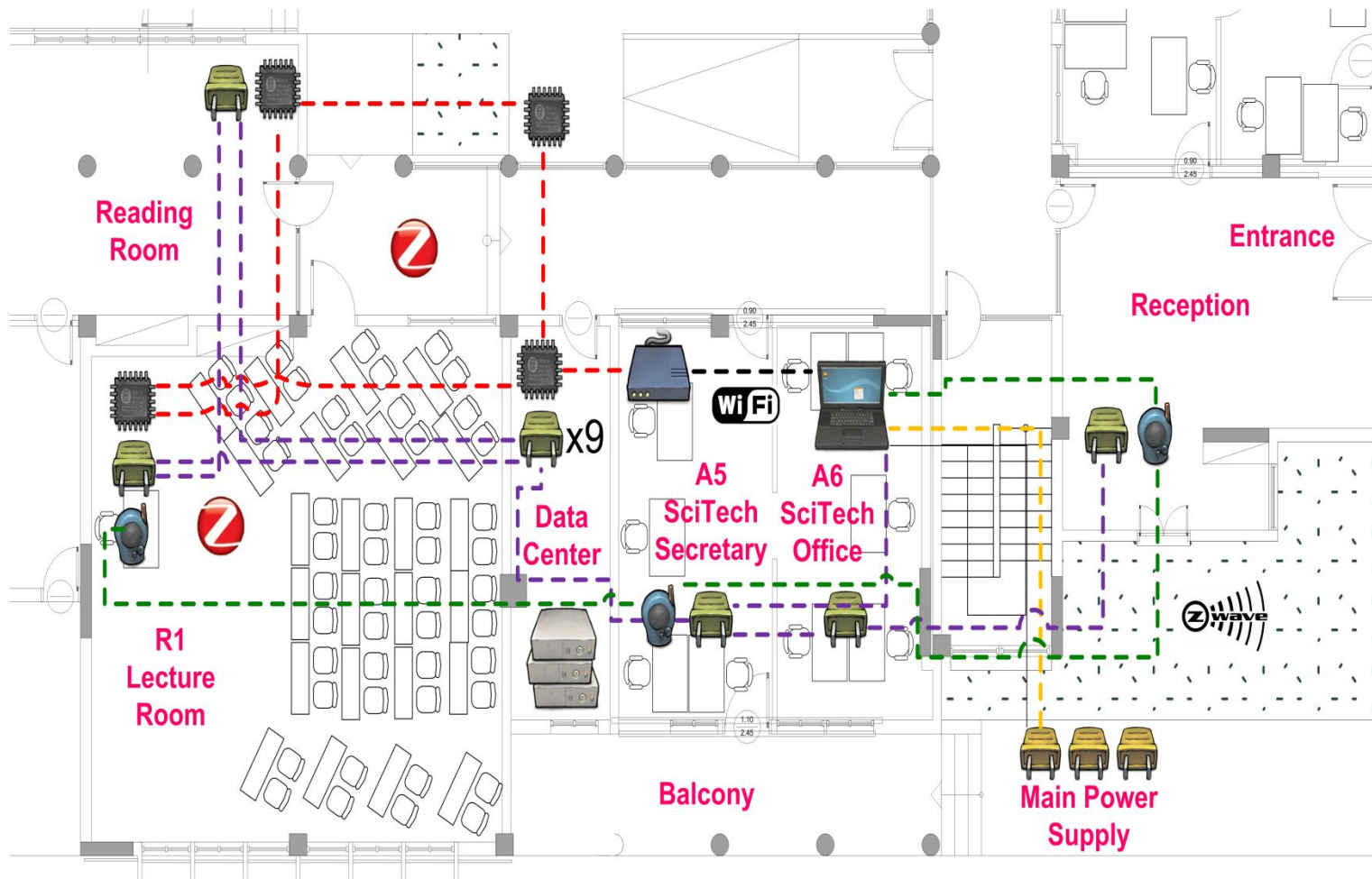
5 BOnSAI Usage (cont'd)
Smart IHU project

1. BOnSAI instances (Specific vendor devices)
- Used as a knowledge base
  - Separate ontology file
  - Adds classes e.g. Smart Plug, Sensor Board
  - Inserts instances for all classes (Communication protocol, Location etc) and for all deployed devices
- Used as Semantic Description of Services
  - Adding Service properties
  - Operations, Preconditions, Effects
  - OWL-S Grounding, Process Model etc.

5 BOnSAI Usage
Smart IHU project

2. Used for WSDL annotation (SAWSDL lightweight descriptions)
   - sawsdl:modelReference
- Usage of lightweight annotations
  - In various applications
  - Currently used in an expert system
    - Knowledge acquisition (e.g. tell conditions from actions)
    - Identify range and source of rule parameters
    - Dynamically adding/removing services
    - Interoperable services
  - In the future will be used for matching, composition, etc.

6 Future Work

- Extensive exploitation of semantic descriptions
  - Semantic Web Service discovery
    - Selection
    - Matching
    - Composition
  - Knowledge Base
  - Expert System
    - Save energy
    - Provide automations

References

1. Maamar Z., Narendra N. C., Subramanian S.: Towards an ontology-based approach for specifying and securing Web services. Information & Software Technology 48(7): 441-455 (2006)
2. Preuveneers D, Berbers Y (2005) Automated context-driven composition of pervasive services to alleviate non-functional concerns. Int J Comput Inf Sci 3(2):19–28
3. Santofimia MJ, Moya F, Villanueva FJ, Villa D, Lopez JC (2008) An agent-based approach towards automatic service composition in ambient intelligence. Artif Intell Rev 29(3–4):265–276
4. Shah N., Chao K., Zlamaniec T., Matei A.: Ontology for Home Energy Management Domain. DICTAP (2) 2011: 337-347