BOnSAI: a Smart Building Ontology for Ambient Intelligence

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Outline

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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

BOnSAI: Ontology for Semantic Web Services in Ambient Intelligence
3 Related Work

Context Ontology [1]

- OWL-S extension
  - Quite application specific

3 Related Work

CoDAMoS [2]

✓ imported in BOnSAI

2. Preuveneers et al. Automated context-driven composition of pervasive services to alleviate non-functional concerns
3 Related Work

OntoAMI [3]

✓ 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]

✓ 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

- 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)output – (P)reconditions – (E)ffects
    • SAWSDL (bottom-up)

• QoS
  ▸ Import from CoDAMoS:Resource
    • E.g. CPU speed, ...
  ▸ Define Communication Protocols
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


