symbIoTe

Platform interoperability from the Smart Space to the Cloud

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The symbIoTe Approach

- **symbiosis of smart objects across IoT environments**
- **interoperability and mediation framework**
- **aims at the collaboration of vertical IoT platforms towards the creation of cross-domain applications**
symbIoTe features

- core Services: a semantic IoT search engine
- platforms can define and use their own information model which extends the symbIoTe Core Information Model
- uniform access to virtualized platform resources: RESTful OData-like interface on the platform side
- platform federations: platform-to-platform interaction
- bartering and trading of resources between platforms
- dynamic adoption of new devices in smart spaces
- interaction of devices collocated in smart spaces
- resource migration and roaming of IoT devices
Layered Approach for Interoperability

Level 1 (L1)

Level 2 (L2)

Level 3 (L3)

Level 4 (L4)

Application Domain
Cloud Domain
Smart Space Domain
Smart Device Domain

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Architecture

IN-AE

IN-CSE

MN

ASN/ADN

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symbIoTe’s L1/L2 in oneM2M

L1

Platform A IN
IN-AE
IN-CSE

Platform B IN
IN-AE
IN-CSE

symbIoTe Core (registry, search, AAM, ...)

L2

Platform A IN
IN-AE
IN-CSE

Platform B IN
IN-AE
IN-CSE

symbIoTe Core (registry, search, AAM, federation, ...)

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Information models

• Core, Best practice and Platform Information Models address sensing, actuation and services

• strongly inspired by the Semantic Sensor Network (SSN) ontology, borrowing the concepts of Device, Sensor, Property, FeatureOfInterest, Observation.

• many similarities with Sensor, Observation, Sample and Actuator (SOSA)

• usage of OData inspired by OGC SensorThings API

• looking at vocabularies from schema.org

• similar to oneM2M Base Ontology
Core Information Model

- Service
- Resource
- Location
- Device
- Actuator
- Capability
- Effect
- Property
- Feature of Interest
- Sensor
- Mobile Sensor
- Stationary Sensor
- Observation
- Time:Instant
- Time:Interval
- UnitOfMeasurement
- RDF Schema (rdfs): http://www.w3.org/2000/01/rdf-schema#
- Resource Description Format (rdf): http://www.w3.org/1999/02/22-rdf-syntax-ns#
- Web Ontology Language (owl): http://www.w3.org/2002/07/owl#
- XML Schema Definition (xsd): http://www.w3.org/2001/XMLSchema#
symbIoTe’s Approach to Interoperability

Syntactic Interoperability

Interworking Interface

Interworking Interface

Platform-Specific Information Model A

Platform-Specific Information Model B

Core Information Model

Meta Information Model

Mapping between

SPARQL Query Re-Writing

Semantic Interoperability

Native Applications

API Platform A

Internal Information Model A

IoT Platform A

Native Applications

API Platform B

Internal Information Model B

IoT Platform B
Platform Federations

Core Services

- SLAs
- Bartering & Trading rules
- Trust Management

Federated Platform 1

- Platform A
  - Resources

- Platform B
  - Resources

- Platform C
  - Resources

Federated Platform 2

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Local vs. cloud-based architectures

- **Fully local platform**
  - Remote user to Cloud front-end
  - Cloud front-end to Local Smart Space
  - Local Smart Space to IoT Platform “A”
  - IoT Platform “A” to Platform devices
  - Platform devices to Local user

- **Hybrid cloud/local platform**
  - Remote user to Cloud front-end
  - Cloud front-end to IoT Platform “B”
  - IoT Platform “B” to Platform devices
  - Platform devices to Local user

- **Fully cloud platform**
  - Remote user to Cloud front-end
  - Cloud front-end to IoT Platform “C”
  - IoT Platform “C” to Lightweight gateway
  - Lightweight gateway to Platform devices
  - Platform devices to Local user

- **Platform devices**
  - IoT Platform “A”
  - IoT Platform “B”
  - IoT Platform “C”

- **Local user**
  - Local to Platform devices

- **Cloud front-end**
  - Remote to Cloud
  - Cloud to Local Smart Space

- **Local Smart Space**
  - Remote to Local Smart Space
  - Local Smart Space to Remote

- **Fully local platform**
  - IoT Platform “A”
  - Local Smart Space

- **Hybrid cloud/local platform**
  - IoT Platform “B”
  - Local Smart Space

- **Fully cloud platform**
  - IoT Platform “C”
  - Lightweight gateway

- **Remote user**
  - Remote user to Cloud front-end

- **Cloud**
  - Remote user to Cloud

- **Platform devices**
  - IoT Platform “A”
  - IoT Platform “B”
  - IoT Platform “C”

- **Local user**
  - Local to Platform devices
symbIoTe Smart Spaces and Devices

• In a **Smart Space** one or more IoT platforms provide **coordinated services**
  – related to a physical space (home, building, vessel)
  – or even a broader area (campus, city)

• Inter-platform resource exchange

• A **Smart Device** can **directly interact** with a SSP
  – any mobile device running a proper symbIoTe app
  – any third party device with an appropriate wrapper
Main features of symbIoTe L3/L4

- IoT platform interoperability at the SSP level (platform transparency)
- Inclusive architecture for third party devices
- Dynamic discovery and automatic configuration of resources
- Baseline operation even when the cloud components are not reachable
- Support for nomadic devices
Local platform interoperability

- **Resource registration**
- **Semantic mapping**

Platform A
- **Platform A end-point**
- **Platform resources**
- **symbIoTe Agent**

Platform B
- **Platform B end-point**
- **Platform resources**

**symbIoTe SSP middleware**
- **Platform A plug-in**
- **Platform B plug-in**

**Innkeeper (SSP registry)**

**symbIoTe Agent**

**Smart Space**

**SSP RAP**

**OData + CIM/BIM**

- **Dimmer**
- **RGB Dimmer**
- **Lighting Service**
- **CIM / BIM**
- **Light**
- **Light**
- **Light+Curve**
Inclusive architecture

Cloud

- L1 app
- Local IoT platform

Smart Space

- Local IoT app
- Local IoT platform

symbIoTe Cloud components

- Core Registry
- Core RAP
- ...

symbIoTe components

symbIoTe SSP middleware

Third party IoT appliance

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Interoperable foreign objects

Cloud

symbIoTe Cloud components

Core Registry

Core RAP

Netatmo interworking

Registration Handler

RAP

Netatmo Cloud components

Netatmo core

Virtual SDEV

Smart Space

Platform controller

symbIoTe Agent

Netatmo station

Native app

Local platform

symbIoTe SSP middleware

L1 app

Core

SSP

RAP

Gateway

Netatmo interworking

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Key Achievements until M18

- Core search and interoperability demonstrated
- Several platforms already extended for compatibility
- An innovative interoperability vision, where multiple IoT platforms provide coordinated services in the cloud as well as in the smart space
- Seamless local and remote resource access
- A flexible Smart Device inclusive approach
Thank you!

Questions?

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