symbIoTe

Towards an IoT Framework for Semantic and Organizational Interoperability

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Overview

- symbIoTe in a nutshell
- Architecture: general overview
- Interoperability aspects
- Semantic and syntactic interoperability
- Implementation status
What is symbIoTe?

- **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
IoT platforms offer **vertical** solutions, closed silos
   – focusing on a single domain, more than 350 platforms on the market

• Absence of cross-domain apps
   – life is **multi-dimensional and partnerships** are sought

• Collocated platforms within smart spaces

• Maintenance of e2e solutions
   – high **market entry** barrier
   – will a single standard/technology/protocol prevail?

• End users
   – vendor lock-in; multiple apps for different devices/spaces
symbIoTe in a Nutshell

- not yet another IoT platform
- a middleware that offers a unified way for
  - exposing of IoT resources to third party applications
  - discovery and secure access to IoT resources
  - sharing/trading of IoT resources
  - flexible integration of smart space infrastructure
Example: Exposing Resources

Temperature sensor “X” at coordinates (... , ...)

Core API
symbIoTe Core Services

IoT Platform A

IoT Platform B

“Room A Temperature” service of room at building “Z”

• How can platforms monetize the value of their resources? ⇒ new revenue streams!
• How can 3rd parties use the offered resources?
Another Example: Actuation

• Universal light switch on your mobile phone
  – switch on/off the lights at home, in the office, in public spaces... wherever you are allowed to do so
  – today we need 3 apps for this, one for each platform
Benefits and Opportunities

Open source software for flexible IoT ecosystems that will allow the co-creation of added value IoT services

Lower market entry costs for SMEs

<table>
<thead>
<tr>
<th>App developers</th>
<th>Infrastructure providers</th>
<th>IoT platform providers</th>
<th>End users</th>
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</thead>
<tbody>
<tr>
<td>• rapid cross-platform application development to create innovative IoT applications</td>
<td>• simplified (re) configurati on of smart environments</td>
<td>• increased user base</td>
<td>• enriched user experience with specialized apps across domains</td>
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<td></td>
<td></td>
<td>• new revenue streams</td>
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<td></td>
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<td>• collaboration (platform federations)</td>
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symbIoTe-enabled Ecosystem

Cross-Domain Apps

Domain-specific Interface

Enablers’ space

Core Interface
symbIoTe Core Services

Cross-Platform Applications

Interworking Interface

IoT Platform Backend

IoT devices, gateways and other resources

Application Domain

Cloud Domain

Smart Space Domain

Smart Device Domain

IoT Devices
Interoperability Aspects

Interoperability aspects:
- technical, syntactic, semantic and organizational/enterprise interoperability

Details on IoT Interoperability

L1
- Resource registry
- Resource search
- Semantic mapping
- Secure access
- Domain enablers
- Resource Trading

L2
- Platform federation
- Resource bartering

L3
- Gateway interworking
- Local interactions

L4
- Device migration
- Device roaming
L1 and L2 components

The diagram shows the components of the symbIoTe system, divided into two categories: symbIoTe core and symbIoTe-compliant platform.

**symbIoTe core**
- Application/Enabler
- Search Engine
- Core Resource Monitor
- Core Resource Access Monitor
- Core Authentication and Authorization Manager
- Core Bartering and Trading
- Statistics, logging, Anomaly Detection
- Registry
- Semantic Manager

**symbIoTe-compliant platform**
- Registration Handler
- Resource Access Proxy
- Monitoring
- Authentication and Authorization Manager
- Federation Manager
- Bartering and Trading Manager
- Optimization Manager
- Trust Manager
Syntactic & Semantic Interoperability (L1)

1. Register devices

2. Search for adequate devices

3. Direct access and usage of devices (as services)

Core Interface

symbIoTe Core Services

Interworking Interface

IoT Platform A

Interworking Interface

IoT Platform B

Core Information Model: stores device metadata

RESTful API based on OData (OASIS standard): access to device data and primitives (for actuation)

Platform-Specific Information Model compliant to the Core Information Model: full definition of devices, their data and primitives
Approach to L1 Interoperability

Syntactic Interoperability

Core Information Model

Meta Information Model

Platform-Specific Information Model A

Platform-Specific Information Model B

mapping between

uses

Resource Access API

Resource Access API

uses

uses

uses

uses

uses

uses

IoT Platform A

IoT Platform B

Native Applications

Native Applications

API Platform A

API Platform B

Internal Information Model A

Internal Information Model B

SPARQL Query Re-Writing

Semantic Interoperability

Interoperability

Approach to L1 Interoperability

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Security Implications

- **symbIoTe**
  - does not interfere with the transfer of resource data
  - enables the secure exchange of authorization tokens
  - establishes trust between platforms
- **light footprint on IoT platforms**
Main security rationale

- Attribute Based Access Control
- Adoption of tokens (JSON Web Tokens)
- Decoupling between Authentication and Authorization
- Attribute mapping function
- Resource tokens provided by platforms

Savio Sciancalepore, Michal Pilc, Svenja Schroder, Giuseppe Bianchi, Gennaro Boggia, Marek Pawlowski, Giuseppe Piro, Marcin Plociennik, and Hannes Weisgrab. **Attribute-Based Access Control scheme in federated IoT platforms.** In *Interoperability and Open-Source Solutions for the Internet of Things (InterOSS-IoT) 2nd International Workshop*, LNCS 10218, April 2017
Technologies and Licenses

symbIoTe is open source: https://github.com/symbiote-h2020

Core Services
- Java
- Spring microservices
- MongoDB
- Eureka
- Zipkin
- RabbitMQ

LGPL-3.0 license

{RESTful} {JSON}(-LD)

L1 Platform Services
- Java
- Spring microservices
- MongoDB
- RabbitMQ

Platform
Sensors, Actuators

BSD-3-Clause

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Components developed in R2

APPLICATIONS

Core Interface

Cloud-Core Interface

Core Services

Admin. Registry Search Engine Semantic Manager Core RAM Core RM Core AAM

Interworking Interface

Registration Handler Monitoring

Platform 1 (Symphony) Sensors, Actuators

RAP P A A M

Platform 2 (OpenIoT) Sensors, Actuators

RAP P A A M

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Thank you!

Questions?

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