

The M3 Architecture for Smart Spaces

Overview of Semantic Information Broker Implementations

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Outline

- ① Smart-M3 Overview
- ② Smart-M3 SIBs
 - The Piglet-based SIB
 - RedSIB
 - The OSGi SIB
 - pySIB
 - CuteSIB
 - Suspended projects
- ③ Evaluation
- ④ Summarizing...
- ⑤ Conclusion

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- 1 **Smart-M3 Overview**
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Smart-M3

Smart-M3 is an open source **interoperability platform** implementing the M3 paradigm (**multi-device, multi-vendor, multi-domain**).

Originally framed in:

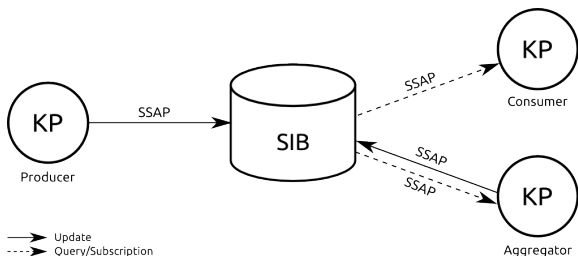
- **ARTEMIS** JU European funded SOFIA (Smart Objects For Intelligent Applications) project;
- Finnish nationally funded **DIEM** (Device Interoperability Ecosystem) program.

Formerly developed by Nokia, it is now maintained by **FRUCT Association, SOFIA Community** and the **ARCES department** of the University of Bologna.

Smart-M3

The M3 architecture relies on three main components:

- **SIB** (*Semantic Information Broker*)
- **KPs** (*Knowledge Processors*)
- **SSAP** (*Smart Space Access Protocol*)



Smart-M3

The SIB is a SPARQL endpoint built on top of an RDF triple-store. This publish-subscribe broker allows to:

- update the knowledge base (using SPARQL, RDF/XML or a triple-pattern based formalism, i.e. RDF-M3)
- query the knowledge base (through SPARQL or RDF-M3)
- subscribe to user-defined subgraphs (through SPARQL or RDF-M3)

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The Piglet-based SIB

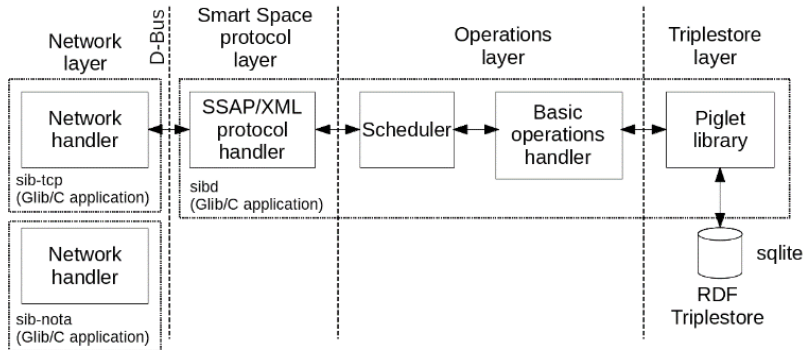
Where Developed by Nokia Research Center

When Project started in 2009

Why To formalize the concept of space-based information sharing

What It is the first official implementation of a Smart-M3 Semantic Information Broker

Piglet-based SIB Architecture



RedSIB

Where Developed by the University of Bologna

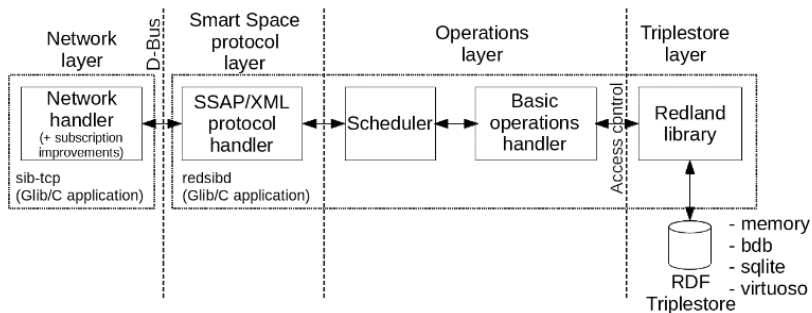
When Project started in 2012

Why It is an evolution of the old Piglet-based SIB born to avoid some criticalities and improve performance

What It provides:

- support for Virtuoso triple store and for volatile storage based on BDB
- prototype of access control mechanism
- optimized subscription engine

RedSIB Architecture



The OSGi SIB

Where Developed by the University of Bologna and Eurotech

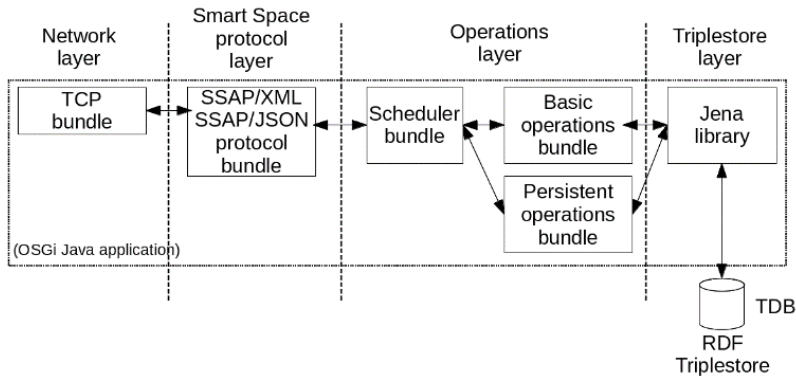
When Project started in 2010

Why To provide a portable SIB for industrial domains

What A modular architecture based on OSGi bundles that:

- provides reliable query engine
- introduces the new Persistent Update (PU) primitive
- opened the way to the development of an Android SIB

The OSGi SIB Architecture



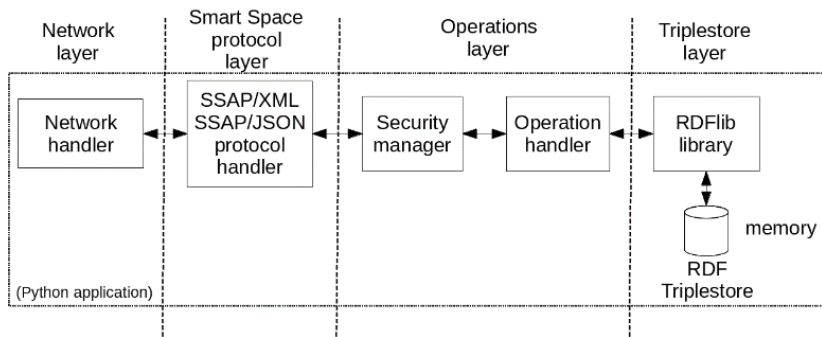
Where Developed by the University of Bologna

When Project started in late 2015

Why To provide a portable and lightweight SIB, with a modular and easy structure suitable for didactics

What Lightweight Python implementation supporting an experimental JSON-encoded SSAP

pySIB Architecture



CuteSIB

Where Developed by the Petrozavodsk State University (PetrSU)

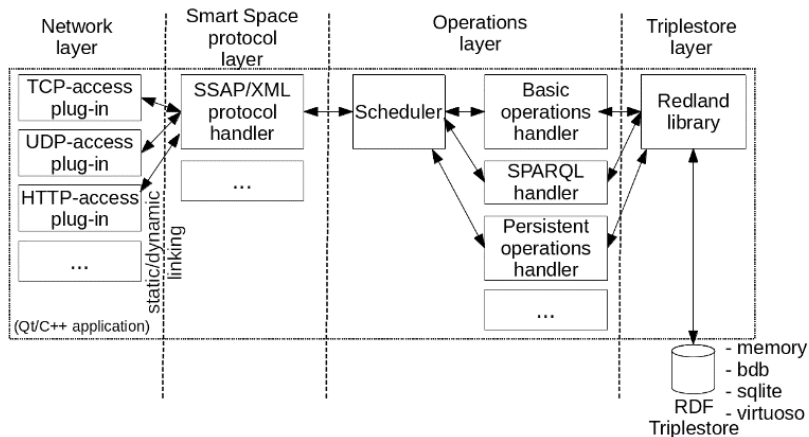
When Project started in 2015

Why To provide a renewed C implementation of the SIB

What A fork of RedSIB that:

- is based on QT framework
- replaces the D-BUS
- has a modular structure
- is portable and extensible

CuteSIB Architecture



RIBS

Where Developed at the VTT Technical Research Center of Finland

When During the SOFIA project (2008-2012)

Why To provide a secure architecture oriented at low-resources devices

What RIBS was a SIB addressing two of the main problems of IoT: providing security and supporting low-resources nodes. Due to a not open source license it failed to build a community of users and developers, so the project was suspended.

The ADK SIB

Where Developed by Indra & Tecnia

When During the SOFIA Project (2008-2012)

Why It was designed to have a powerful suite for ontology based code generation and model based application development

What ADK was developed using the OSGi framework and provided a SIB integrated in the Eclipse Development Environment.

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Evaluation

The following performance tests have been performed on the available SIBs:

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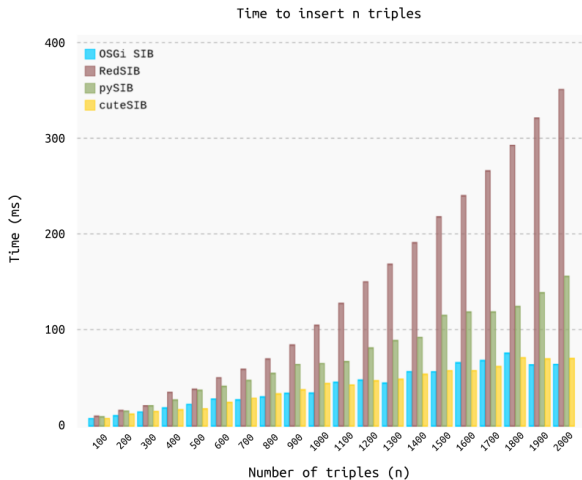
- The update mechanism
 - i.e. the time needed to put data into the SIB
- The query mechanism
 - i.e. the time needed to retrieve data from a SIB

Evaluation

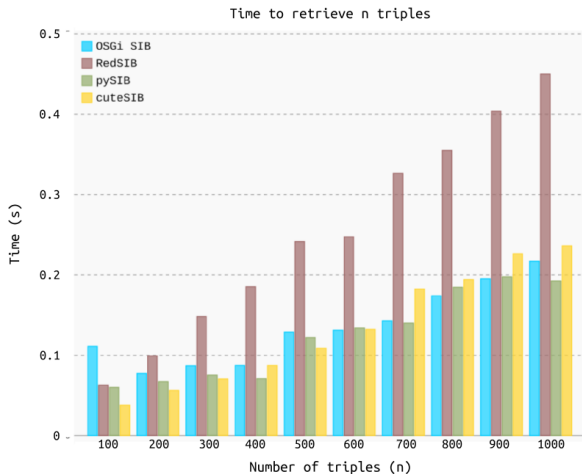
The following performance tests have been performed on the available SIBs:

- The update mechanism
 - i.e. the time needed to put data into the SIB
- The query mechanism
 - i.e. the time needed to retrieve data from a SIB
- The subscription mechanism
 - i.e. the time needed to receive a notification

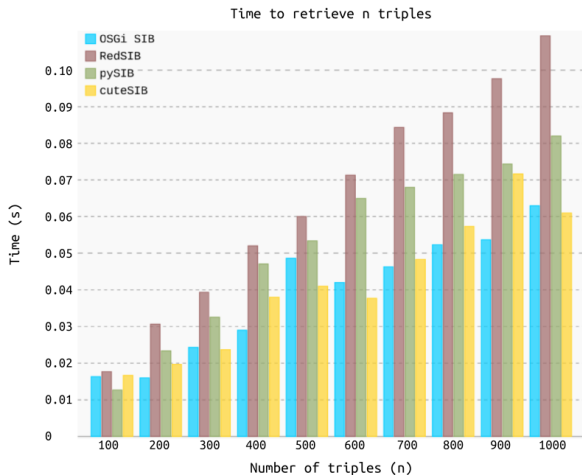
Evaluation of the Update mechanism



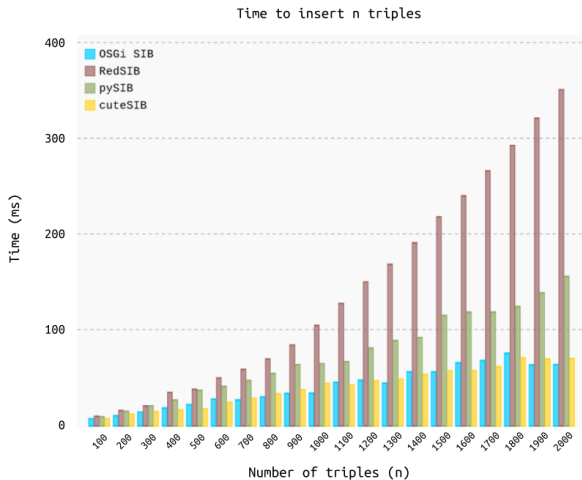
Evaluation of the Query engine (with RDF-M3)



Evaluation of the Query engine (with SPARQL)



Evaluation of the Subscription engine



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Summarizing. . .

SIB	Developer	Language	Active
ADK SIB		Java	No
CuteSIB	PetrSU	C	Yes
OSGi SIB	ARCES	Java	Yes
Piglet-based SIB	NOKIA	C	No
pySIB	ARCES	Python	Yes
RedSIB	ARCES	C	Yes
RIBS	VTT	C	No

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Conclusion

Smart-M3 provides a promising technology for smart spaces. We reviewed the Smart-M3 platform by focusing on the main SIB implementations.

The evaluation of the currently available SIBs highlights good performance of CuteSIB and pySIB. On the other hand a weak point is represented by the SPARQL engine that looks less reliable than the one provided by the OSGi SIB.