

Agent Substitution Mechanism for Dataflow Networks: Case Study and Implementation in Smart-M3

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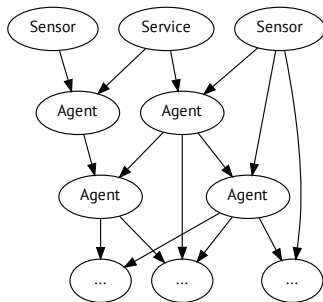


Dataflow Network Model

- IoT can be seen as a large set of interconnected elements
- The basis is the data coming from smart devices and sensors

Dataflow network

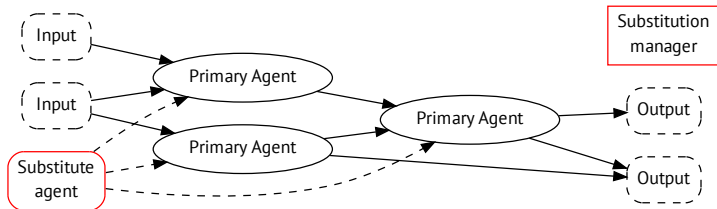
- Multi-step information refinement
- Well-suited for sensor data processing



Agent Substitution Mechanism

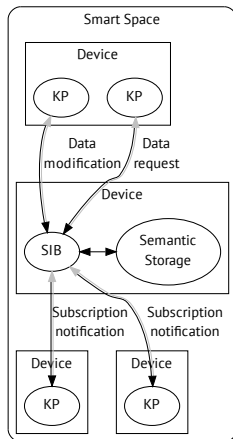
- Many units of IoT are mobile devices
 - have a limited power supply
 - use unreliable wireless channels
- Processing unit may become unavailable for a period of time therefore
 - break existing data flows
 - lose accumulated context information

Agent substitution idea

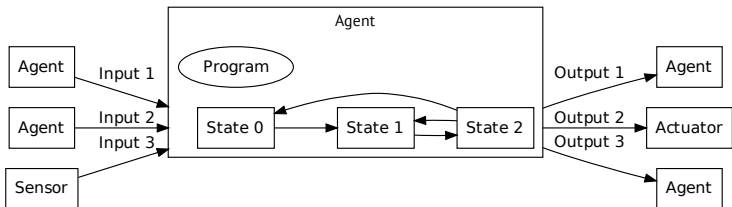


Smart-M3 Platform

- Middleware for multi-agent intelligent services
- Core elements:
 - Semantic Information Broker (SIB)
 - Knowledge Processor (KP)
- SIB manages data storage and provides access to it
- KP query and modify data



Dataflow Network Agent Implementation



- Dataflow agents are stereotypical entities
- Dataflow agents are KPs conforming to certain rules
- Input channels are subscriptions
- Output channels are modified triples
- Internal state is a set of "private" triples



Substitution Mechanism Operations

From the substitution mechanism side the substitution process is event-driven

- Registration/unregistration of the agent
- Agent connection failure/Explicit substitution request
- Substitute agent activation
- Primary agent return
- Substitute agent deactivation

Substitution mechanism must:

- efficiently manage agent context transfer
- detect agent disconnection as fast as possible



Operation Level of Substitution Mechanism

- Need to add new operations: agent substitution, registration and disconnection
- Information exchange alternatives:

	Low level	High level
Implies	Modification of SSAP	Usage of triple-based exchange
Benefit	Allows to execute several operations per one transaction	Allows to use platform as ready data exchange middleware



Handler Implementation Alternatives

- Substitution mechanism needs to monitor agents state
- The agent state is represented in triple format

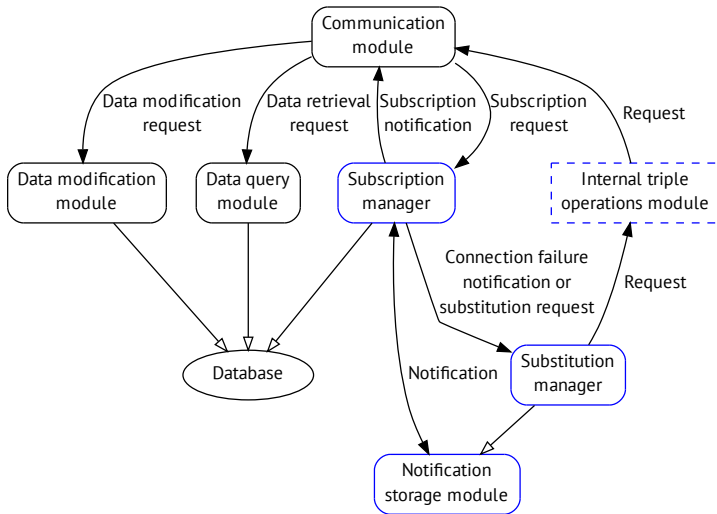
**One handler per one triple
template for all agents**

**Several handlers for each of
agents**

Difference: amount of running handlers



Modified SIB Structure

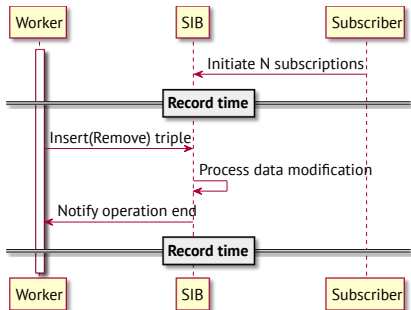


Core SIB Operations Testing

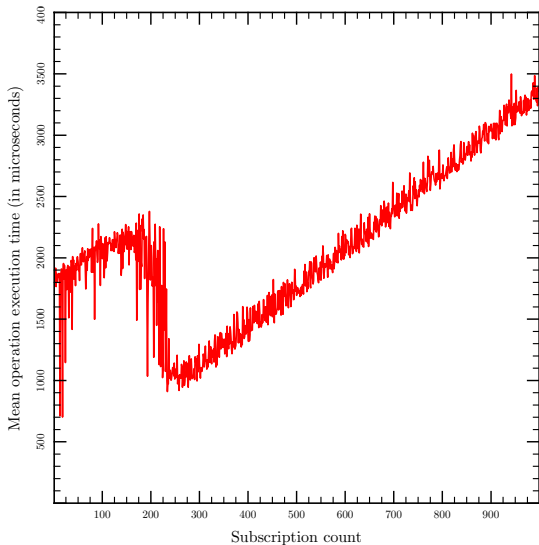
Experiment goal: estimate the mean time of core operations execution

Perform 1000 following test cycles, where N is the current cycle number

- Setup N subscriptions to the smart space
- Insert and remove random triples 50 times (triples do not trigger subscriptions)



Core Operations Testing Result

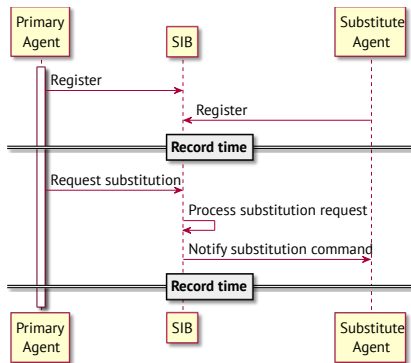


Substitution Performance Testing

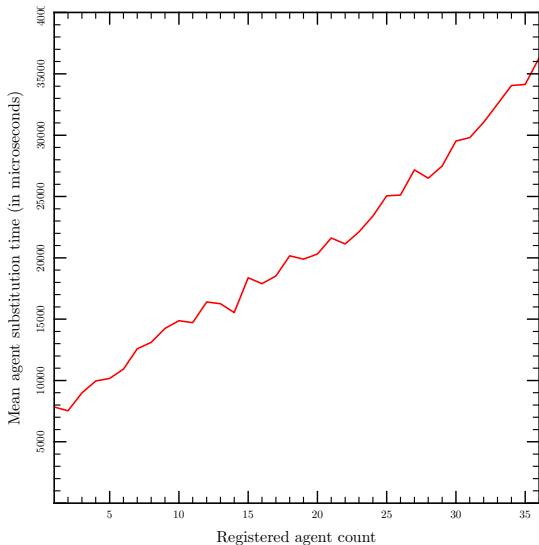
Experiment goal: estimate the mean time of substitution operation execution

Perform 35 following test cycles, where N is the current cycle number

- Register N primary agents and N substitute agents
- Perform sequential substitution request for primary agents



Substitution Performance Testing Results

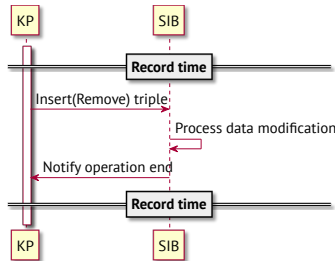


Impact of Substitution on SIB Operations

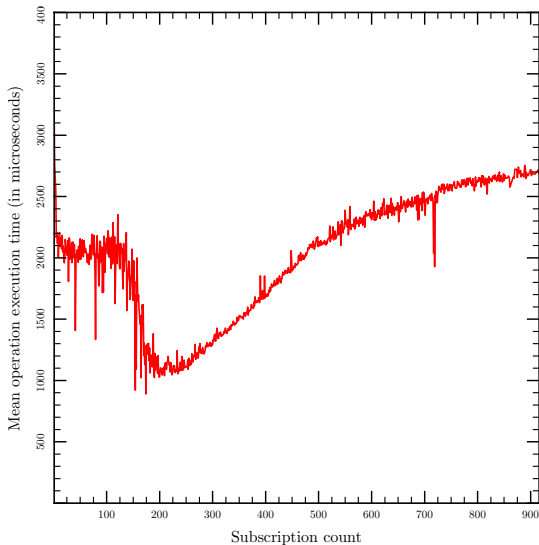
Experiment goal: estimate the mean time of core operations execution during substitution operation execution

Perform 100 following test cycles, where N is the current cycle number

- Register 10 primary agents and 10 substitute agents
- Initiate N subscriptions to the smart space
- Simultaneously:
 - Insert and remove 50 random triples
 - Begin substitution for primary agents



Impact of Substitution on SIB Operations

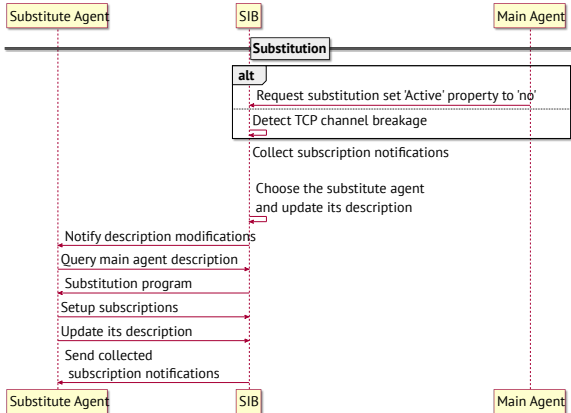
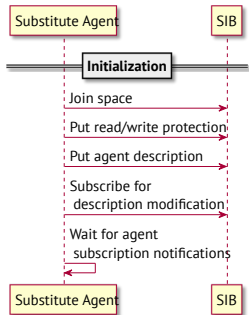


Conclusion and Future Work

- Substitution mechanism
 - Implemented as a SIB module
 - Uses triple-based communication
 - Uses limited set of subscriptions to operate
- Performance considerations
 - Modifications did not worsen core operations
 - Substitution time is small, but should be improved
- Future work
 - Improve current implementation and release new SIB
 - Provide library for easy use of substitution mechanism
 - Test substitution mechanism on service prototypes



Substitute Agent Operation



Main Agent Operation

