Mechanism for Robust Dataflow Operation on Smart Spaces

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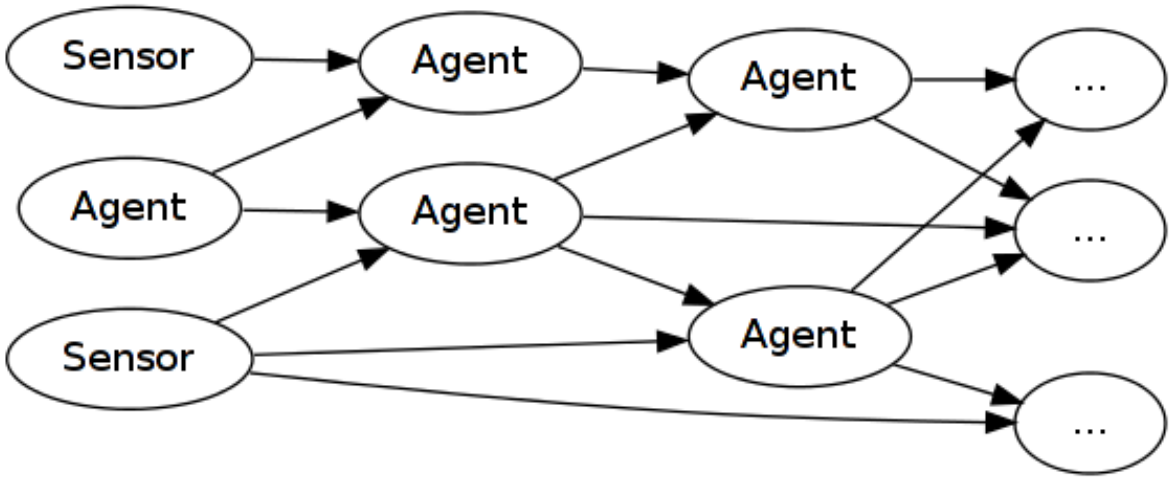
Dataflow Computational Model



Application Areas

- Sensor data refinement
- End-user services

Agent Disconnection Issue

During the operation an agent may loose connection with the dataflow network

Concrete Issues

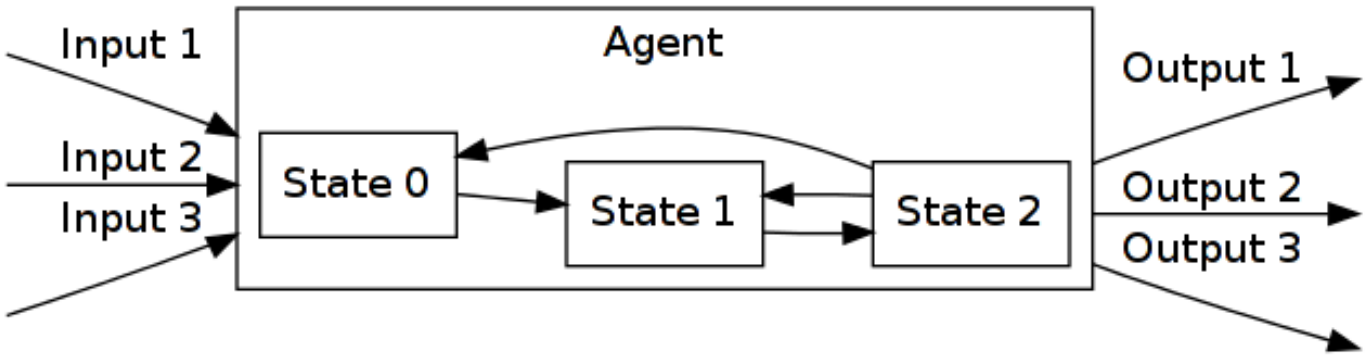
- Data starvation of consumer agents
- The disruption of the information flow

Ways to Overcome Issue

- Consumer agents adaptation
- Agent substitution

Dataflow Model

Agent model



Communication Channel Properties

- Reliable data transmission
- First-In-First-Out

Dataflow Model Implementation

Implementation on Smart-M3 platform

- KP - computational agent
- SIB - communication medium

Agent Operation Constrains

- Input and output channels are predefined and can not be changed during agent operation
- Agent can only use information coming from smart space

Communication Model

Input and Output Channels

- Input channels - subscriptions
- Output channels - write-protected triples

History Problem

SIB does not store history of triple values

- KP should cache
- Use multiple triples for KP communication

KP (Agent) Operational Description

1. Initialization phase
   - Connect to SIB
   - Set up subscriptions on known triple patterns
   - Set up write protection to production triples
2. Operation phase
   - Receive information via subscription
   - Update values of production triples
3. Shutdown phase
   - Remove subscriptions
   - Either set shutdown value or remove triple
   - Remove protection from production triples

Agent Substitution Mechanism

Idea at a Glance

Introduce new type of agents, which are capable to replace the failed agent in network

Execution Context Transfer

- Agent computational state
- Input and output channels (triples)
- Unprocessed information by replaced agent

Platform Implementation Aspects

Node Substitution Mechanism

- Must detect the KP failure as fast as possible
- Provide services to transfer the context

Reasonable to implement it as SIB module

KP Status Storage

- Private information storage inside SIB
- Triples inside the status storage must be updated along with production triples

Agent Initialization Phase

1. Connect to SIB
2. Register as a computational agent (provide fall back program)
    1. Initialize new dataflow agent
    2. Continue operation after a failure

Initialize New Agent

1. Get access to the status storage
2. Resume initialization as the dataflow agent

Initialization & Operation Phases

Continue Operation After Failure

1. Get access to the status storage
2. Set up subscriptions on input triples
3. Notify SIB, that KP is ready to process data

KP Operation Phase

1. Receive information via any subscription
2. Update values in production triples and inside the status storage

Fall Back KP Operation

1. Initialization
    1. Register as a substitute KP
    2. Wait for SIB notification
2. Substitution SIB notification
    1. Receive substitution program
    2. Get access to the status storage
    3. Set up subscription on input triples
    4. Notify SIB, that KP is ready to process data
3. Shutdown SIB notification
    1. Remove subscriptions
    2. Process all gathered data
    3. Notify SIB, that processing is finished

Conclusion and Future Work

- Dataflow computational model for Smart-M3 platform
- Mechanism to robust operation by substitution of failing agent

Future Work

- Implementation and testing of proposed mechanism
- Add support for a wider class of computational agents

SIB Operation Notes

Internal Agent Lists

- Dataflow agents
- Fall back agents

Handling Agent Departure

- When detecting a failure, SIB begins to collect subscription data
- When dataflow KP returns to network, send collected data after corresponding request

Dataflow Agent Registration Request

Parameters

- URI, describing operation of the agent
- Fall back program type
- Fall back program

Return Values

- New node have been registered
- Node must continue operation

Fall Back Agent Registration

SIB Parameters

- Type of program it is able to execute

Internal Parameters

- Initialization SIB message handler
- Shutdown SIB message handler

Notification Messages

Resume Operation

Notify SIB, that current agent is able to process incoming data and place output values

Operation Finished

Notify SIB, that fall back agent has finished data processing