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 lose 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

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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
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