PROtEUS++: A Self-managed IoT Workflow Engine with Dynamic Service Discovery

Demo @ ZEUS 2017

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Cyber-physical Systems and Internet of Things

from https://vicci.inf.tu-dresden.de/
CPS/IoT and Workflows

- Automation of daily routines in Smart Home environments (AAL)
- Sensor events, dynamic services, human interactions
Demo: PROtEUS++

- Basic PROtEUS process engine -> Service-based IoT workflow engine
- Semantic Access Layer (SAL) -> Dynamic service selection
- MAPE-K Feedback Service -> Cyber-physical Feedback loop

- Demo processes:
  1) Emergency scenario (Ambient Assisted Living)
  2) Continuous light control (Home Automation)
  3) Distributed processes on service robots (Smart Home)
The Setup
PROtEUS++ [SHS15,SHS16,SHS17]

Process Execution Engine

Semantic Access Layer

PROtEUS

Distribution Manager
Process Manager
Human Task Handler
Local Service Platform
CEP Engine

WebSocket Server
Service Invoker
CEP Adapter

Remote Engine Client
Management Client
Interactive Client

Service
Actuator
Service
Actuator

Sensor
Actuator
Sensor

Feedback Service
Monitor
Analyzer
Planer
Executor
Knowledge Base

Process Goals

https://github.com/IoTUDresden/proteus
The Modelling Tool [SKN+13,SKN+14]

Graphiti - platform/resource/Test/src/diagrams/Scenario.diagram#0 - Eclipse Platform

Diagram showing a process model with various components such as `Process`, `TriggeredEvent`, `HumanTask`, `RESTInvoke`, and `OSGiInvoke`. The diagram includes details such as `name: Process`, `type: HealthMonitoringProcess`, `resource: SmartHome`, and specific properties for `EmergencyCallStep` and `EmergencyWebService`.

14.02.2017 PROTEUS++
Semantic Access Layer (SAL) [HSK+16a, HSK+16b]

- Find services at runtime
- Knowledge base contains
  - IoT devices, Capabilities, Context, IoT Service addresses
  - \( \rightarrow \) DogOnt
- Send SPAQRL queries to SAL
  - Get data from sensors
  - Find actuators/services
  - Invoke services
# PROtEUS Resources

## Robots
- Robot Controls
- Robot Cams

## Persons
- Persons
- Health

## Entertainment
- Kodi

## Home Control
- Tinkerforge
- Homematic
- NFC
- Fingerprint

## Weather
- Berlin Weather
- Dresden Weather

## Dummys
- Hidden
Process 1: Emergency
Process 1: Emergency - Video
CPS Feedback Loop [SHH+16,Sei15]

- **Model**: Goal with Subjectives
  - Context Path (Sensors)
  - Satisfied assertion
  - Compensate assertion
- **Monitor**: data from context path
- **Analyze**: check assertions
- **Plan**: find alternative resource
- **Execute**: execute compensation
- **Knowledge Base**
Feedback Service

https://github.com/IoTUDresden/feedback-service
Process 2: Light Control

- Goal with Objectives
- Context path: path to sensors
- Satisfied assertion: fulfillment of goal
- Compensate assertion: error

MATCH (kitchen) −[:instanceOf]−>(room)
MATCH (light) −[:instanceOf]−>(sensor)
MATCH (light) −[:isIn]−>(kitchen)
RETURN light.value AS lightIntensity

#lightIntensity > 865

#objective . created . isBefore(#now. minusSeconds (5))
• Distributed process execution
• Deploy subprocess on service robot
• Use MAPE-K loop to monitor state of robot
  • Battery levels
  • Liveliness signals
  • Process states
• Redeploy subprocess on other roboter
• PROtEUS++: Workflow Engine for IoT/CPS
• Semantic Access Layer (SAL)
  • Dynamic service discovery (queries to Knowledge Base)
• MAPE-K Feedback Service
  • Correlate execution to physical effects
  • Find alternative resources in case of errors
  -> Self-healing / self-management for workflows

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