Horizontal IoT Application Development using Semantic Web Technologies

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Roadmap

- Introduction
- Challenges
- State-of-the-Art
- Horizontal IoT application development framework
- Conclusion
Introduction

- **IoT is highly interdisciplinary**
  - Application development often requires combining data from multiple domains
Data Cycle in IoT

Data Cycle

Storage, Processing, Analytics

Dissemination

Collection

Communication

Interaction

Generation

Consumption
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Challenges

- Connecting heterogeneous things
- Combine data from different sensors and domains
- Uniform representation, treatment and interpretation of sensor data for cross domain applications
- Uniform application development framework for any smart home scenario
- Deploy across multiple platforms (cloud, home gateway)
- Derive actionable intelligence allowing humans or things to react
- Support resource discovery, automatic management, provisioning while maintaining interoperability
- Preserve privacy through secure mechanisms
Solution: Semantic Web Technologies

- But semantics alone is not sufficient
- Still need components for
  - Resource discovery, provisioning, automatic management of things
  - Deployment platform, support for actuators
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State-of-the-Art

- The reasoning engines and semantic algorithms in a mobile app are largely based on internal sensors.
  - No consideration towards external sensors (deployed in smart home).
  - No dynamic discovery of sensors.

- Current initiatives are largely focused on domain specific scenarios.
  - What about cross-domain (horizontal scenarios)

- Interoperability issue
  - No common catalogue exists for sensors, measurements, units, and domain names.

- Not oriented to a standard

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Machine-to-Machine Measurement Framework

Semantic Reasoning

Horizontal Framework

1) Discovery phase

2) Provisioning phase

3. a) Convert, Reason and Query phase (Data acquisition + knowledge query + reasoning layer)

3. b) Parsing, naming and storing suggestion results

4) Data dissemination phase (Consumer Mobile Phone)

5) Actuation phase

Sensor type + Domain

Infrastructure Node

IoT Application Template Dataset (M3 Framework Cloud)

Actionable Intelligence

GET

Actuation Command

ASN

Sensors, Actuators, Tags
Discovery Phase

Smart Device → M2M Gateway → M2M Devices and Endpoints

- **Discovery**
  - GET request: Discovery
  - Internal query at local storage
  - Retrieve list of M2M Devices, Endpoints and Domain names

- **Configuration**
  - Configuration storage

- **Storage**
  - POST configuration resources
Provisioning Phase

Smart Device

User provisioning

Storage

M3 Framework

searchTemplate

generateTemplate

getSparqlQuery

Sensor + domain

List of cross domain IoT application templates

User chooses an IoT application template

Generate template:
M3 ontologies
M3 datasets
M3 domain rules
M3 rules converter

Query for M3 generic sparql query

M3 generic sparql query
Convert, Reason and Query Phase

Smart device (e.g., phone, tablet)

User interface

M3 Execute SPARQL Query

M3 Reasoner

M3 Converter

Storage

Gateway

M2M device (e.g., sensor)

Get sensor metadata

Sensor data

RDF SenML data

M3 converter rules

M3 RDF SenML data

M3 domain rules

M3 RDF SenML inferred

get M3 SPARQL query

Load M3 ontologies and datasets & M3 RDF SenML inferred

Execute M3 SPARQL query

M3 SPARQL result to parse and display
Data Dissemination Phase

- Based on HTTP GET
  - Consumer mobile phone request for actionable intelligence from Middle Node.

- Based on Push notification
  - Middle node uses Google Cloud Messaging platform to push actionable intelligence into Android powered devices.
  - Apple Push Notification platform is used for iOS powered devices.
Actuation Phase

User selects an actuator
GET: proxy-out URI and destination URI of actuator
Return the proxy-out URI and destination URI
POST new value of actuator
Response: 204, No Content
Push notification with updated value

Request actuator to change value
Response: 204, No Content
Updated value
Push updated value
Deployment and Prototype

- **M3 Framework – Cloud**
  - Developed using Jena Framework
  - Available at - http://sensormeasurement.appspot.com/

- **Cross domain IoT application development framework**
  - Android powered device acting as a home gateway
  - Developed using Android SDK and AndroJena

- **Initial testing performed with**
  - Combining weather and vehicular sensors data
  - Combining eHealth and home automation sensors data
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Conclusion

- In a nutshell,
  - Challenges towards cross domain IoT application development framework in smart home
  - Limitations found in state-of-the-art
  - A semantic based framework for such development
Sometime Soon ...

The Joy of Tech™

by Nitrozac & Snaggy

FATTYPANTS IS KIDDING HIMSELF IF HE THINKS HE’S EATING LESS THAN 2000 CALORIES A DAY!

AT LEAST YOU GET USED! I NEVER DO! ALL HE EATS IS TAKE-OUT!

DID YOU SEE WHAT TIME HE GOT IN LAST NIGHT? SCANDALOUS!

I REFUSE TO PICK UP THIS FRENCH FRY. LAZYBONES CAN DO IT HIMSELF!

HE SPENT A FORTUNE ON US SMARTBULBS AND HE ONLY USES THE "WHITE LIGHT" SETTING! *SIGH*

DUMMY NEEDS TO TEST ME NOW AND THEN, OR AT LEAST CHECK MY APP!

DON’T BOTHER HIM! THE PREVIOUS SMOKE DETECTOR, HE BEAT TO DEATH WITH A BROOM HANDLE!!

HEY GUYS! THE HOUSE SMARTMETER IS TELLING EVERYONE THAT SCAREDY CAT STILL USES A NIGHT LIGHT! HA HA!

What your Internet of Things is saying about you...

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Thank You

Grazie

Thank You

Danke

Thank You

Thank You

Thank You

Thank You

Thank You

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