

Connecting Mobile Things to Global Sensor Network Middleware using System-generated Wrappers

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Outline

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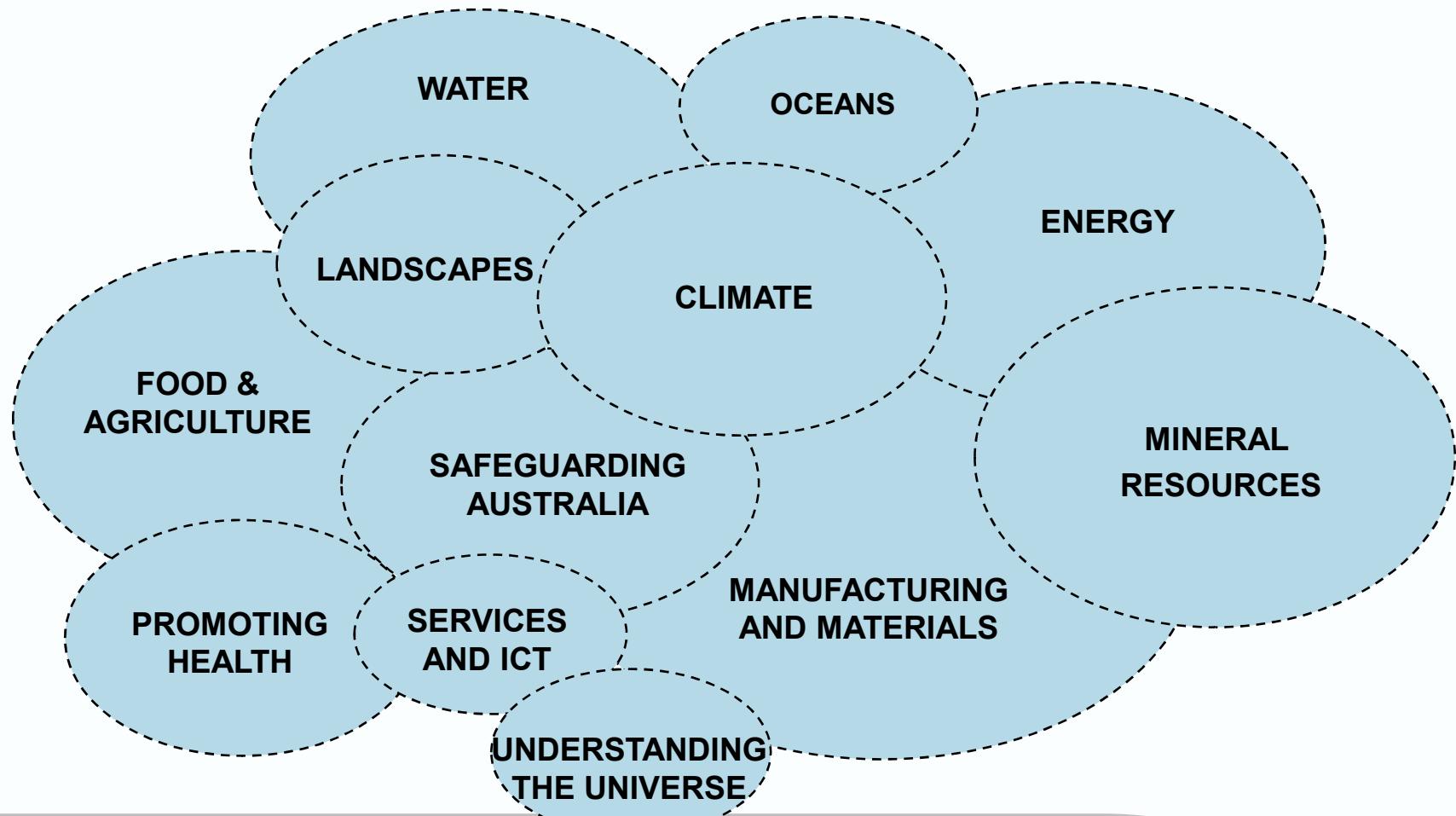
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Future
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Internet of Things (IoT)

A dynamic global network infrastructure with self configuring capabilities

based on standard & interoperable communication protocols

where physical & virtual “things” have identities, physical attributes,

are seamlessly integrated into the information network.

virtual personalities, use intelligent interfaces, and

Introduction

- ❑ Origin of IoT in 1998
- ❑ “The IoT allows people and things to be connected Anytime, Anyplace, with Anything and Anyone, ideally using Any network and Any service”
- ❑ Global market for sensors was around \$56.3 billion in 2010, around \$62.8 billion in 2011. It is expected to increase up to \$91.5 billion by 2016.
- ❑ Compound annual growth rate of 7.8%.
- ❑ Increasing trend of developing middleware solutions in order to connect sensors and actuators to the Internet.(E.g: GSN, Hourglass, HiFi, IrisNet, EdgeServers)
- ❑ These middleware solutions support fast and simple deployment of sensor networks.

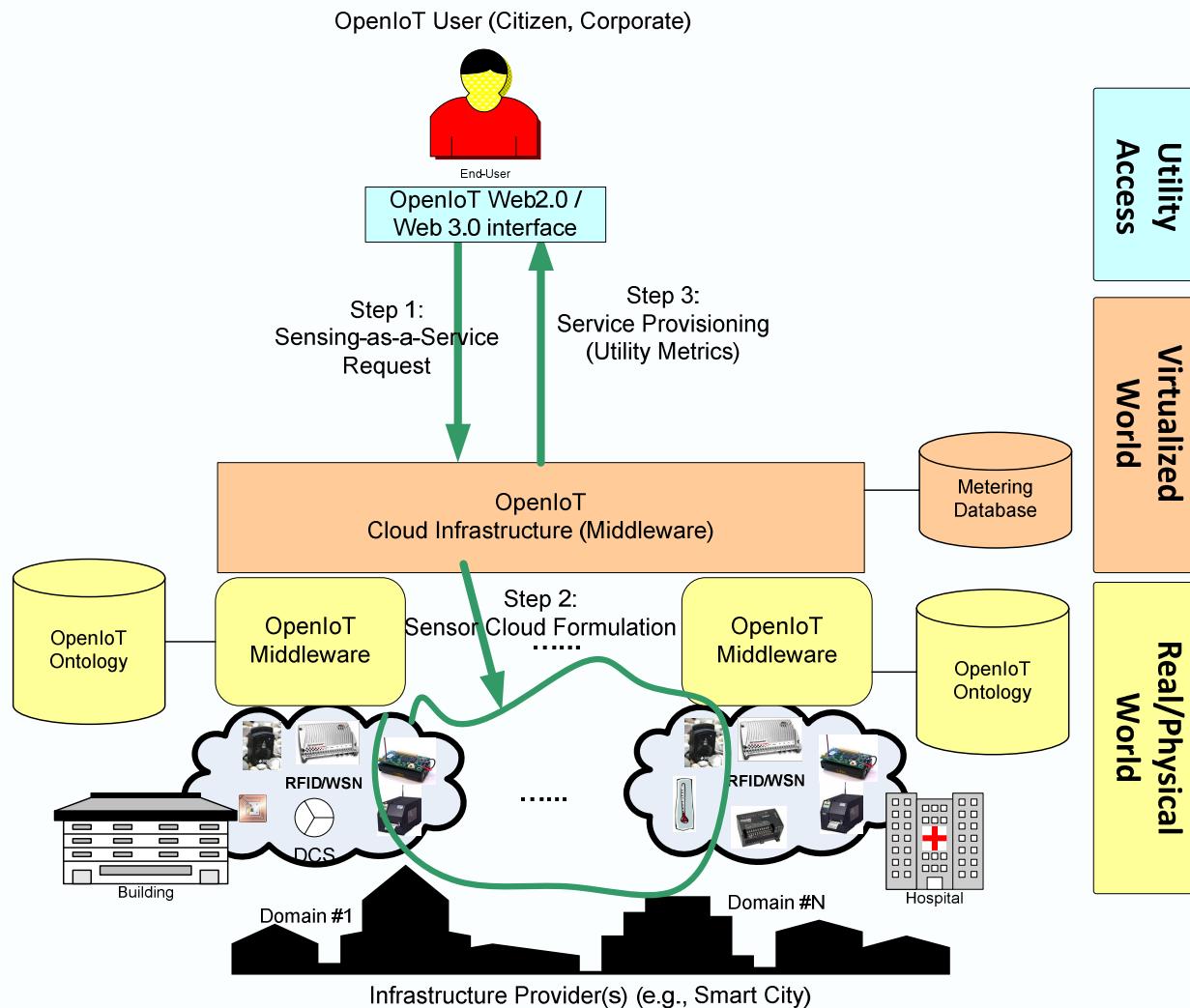


Sensor Networks and IoT

- ❑ Sensor networks are the major enabler of the IoT
- ❑ A sensor network comprises one or more sensor nodes which communicate between each other using wired and wireless means.
- ❑ Applications of IoT and Sensor Networks
- ❑ Mobile phones as mobile sensors
- ❑ Sensor network deployment has been considered as a difficult task in early days due to the heterogeneity of sensors.
- ❑ Global Sensor Network (GSN) is a middleware solution that enables zero-configuration deployment.

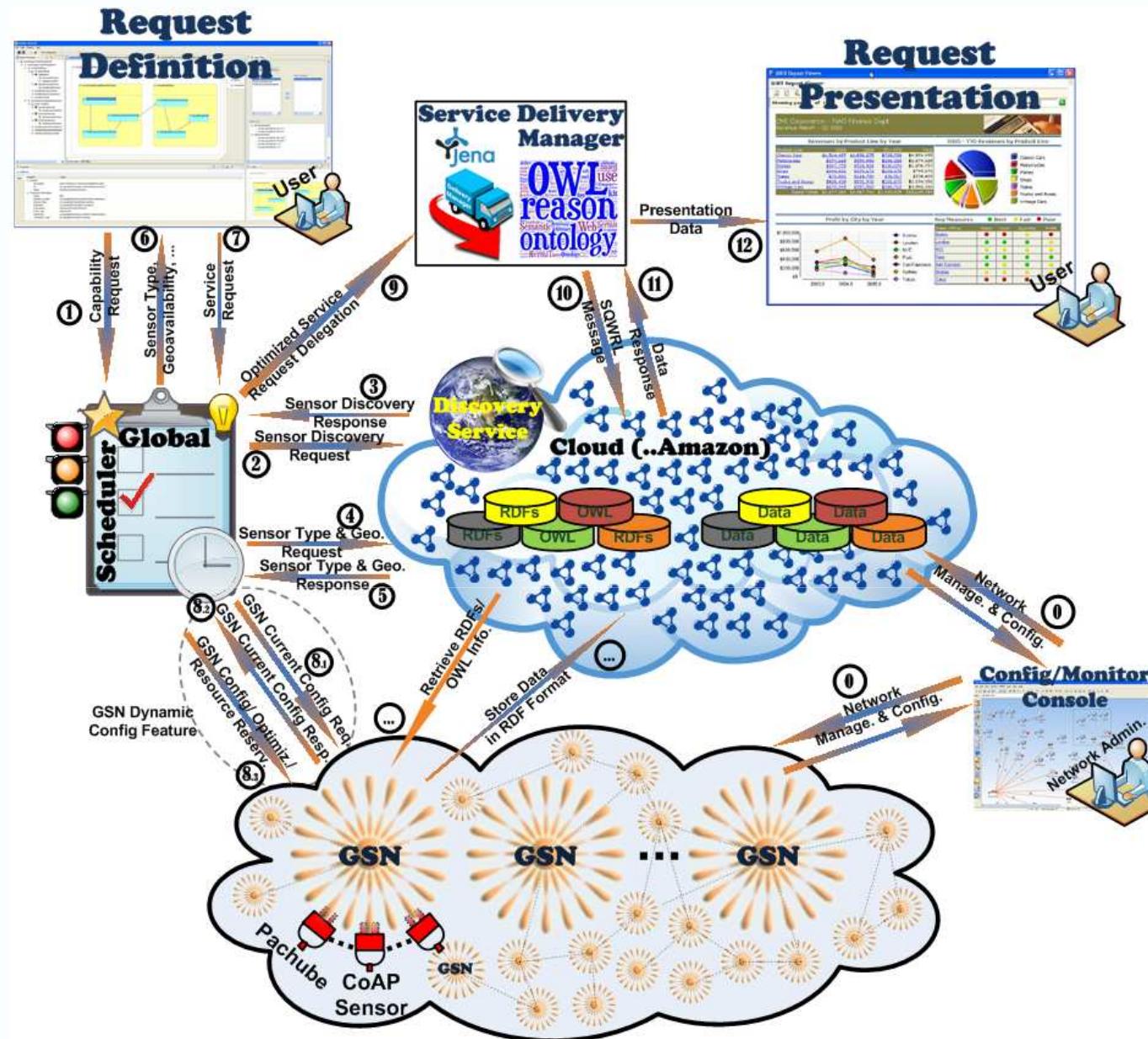


OpenIoT Service Request



OpenIoT High Level Architecture

(Simple Example with dynamic GSN config)



OpenIoT experimental test-bed

For the High Resolution Plant Phenomics Centre's Phenonet project

- Measure environmental and plant physiology parameters in the field
- Improve the quality and scale of data available to plant breeders from grain trial plantings

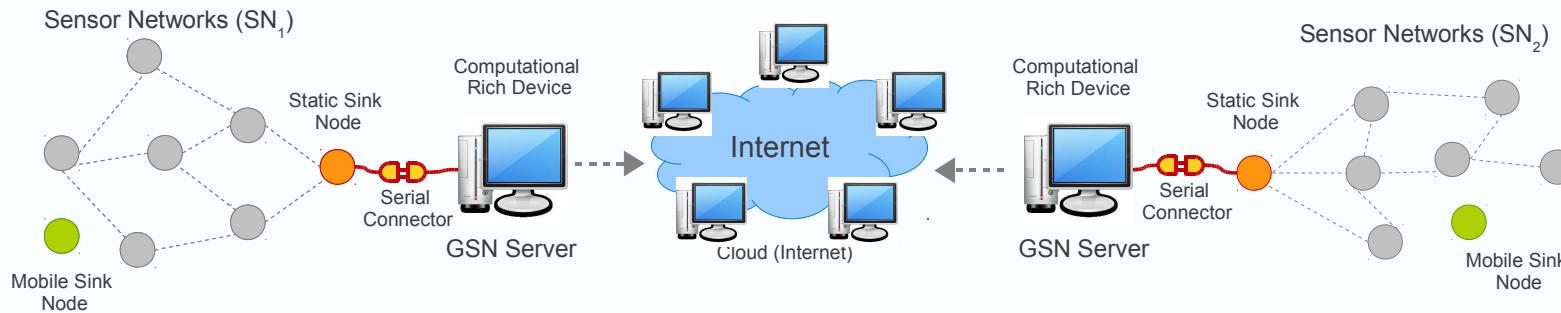
Technical challenges

- Design and programming of sensor network
- Testbed for declarative programming of sensor networks
- Fast browser-based data display & analysis using reusable components
- See <http://phenonet.com>



Global Sensor Networks

- A platform aimed at providing flexible middleware to address the challenges of sensor data acquisition, integration and distributed query processing
- It is used widely in over ten EU/Swiss funded research projects
- We use GSN as the sensor network middleware to exemplify our proposed solution.
- More information: <https://sourceforge.net/apps/trac/gsn/>



The Challenge

- Connectivity and configurability
- Sensors come with APIs that provide software interfaces to retrieve sensor data to the middleware solutions or applications
- If we want to retrieve sensor readings, we need to access the sensor hardware through these provided third party libraries.
- Different middleware solutions use different mechanisms to retrieve data from sensors.(e.g: wrappers, gateways, handlers, proxies, mediators, etc.)
- GSN has wrappers
- Two Problems:
 - **First problem** is that these wrappers need to be developed manually by the programmers. Each sensor has to have a matching wrapper attached to GSN middleware such as;
SunSPOT sensor → SunSPOTWrapper. (Time, Cost, Effort)
 - **Second problem** is lack of code sharing



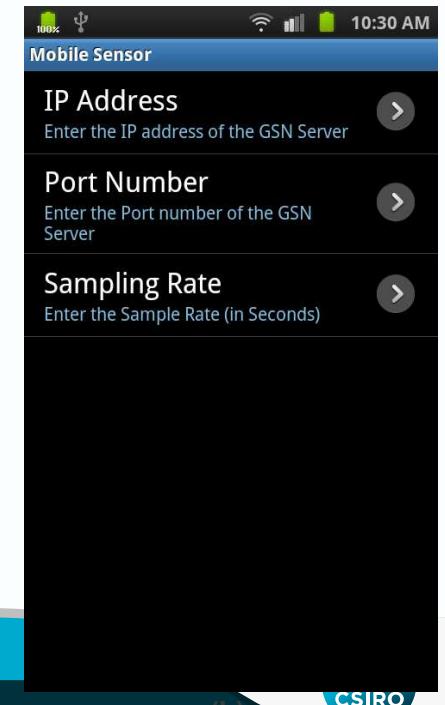
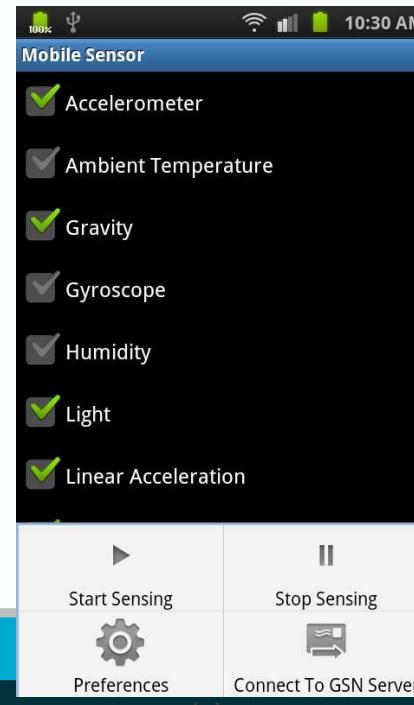
Evaluation of Existing Approach

Common Steps in Connecting Sensors to an IoT Middleware:

Acquire Manufacturers' APIs

1. Acquire System Configuration Details
2. Initiate the Data Structures
3. Initiate the Communication between IoT Middleware and Sensor Device
4. Data Communication
5. Close the Communication and Release the Resources

- Our experiment of developing wrappers manually for Android mobile phones.
- Android Wrapper is around 400 line of code and the Android application is around 800 line of code.
- It could take a few days for a developer to develop and debug a single wrapper for a specific sensor including the time that would take to familiarise with the specific sensor platform.



(a)

(b)

CSIRO

ASCM4GSN as a solution

- We propose Automated Sensor Configuration Model For Global Sensor Network (ASCM4GSN) architecture to address these issues.
- Automating Wrapper generation process and share the already developed wrappers through cloud repository.

Major Components:

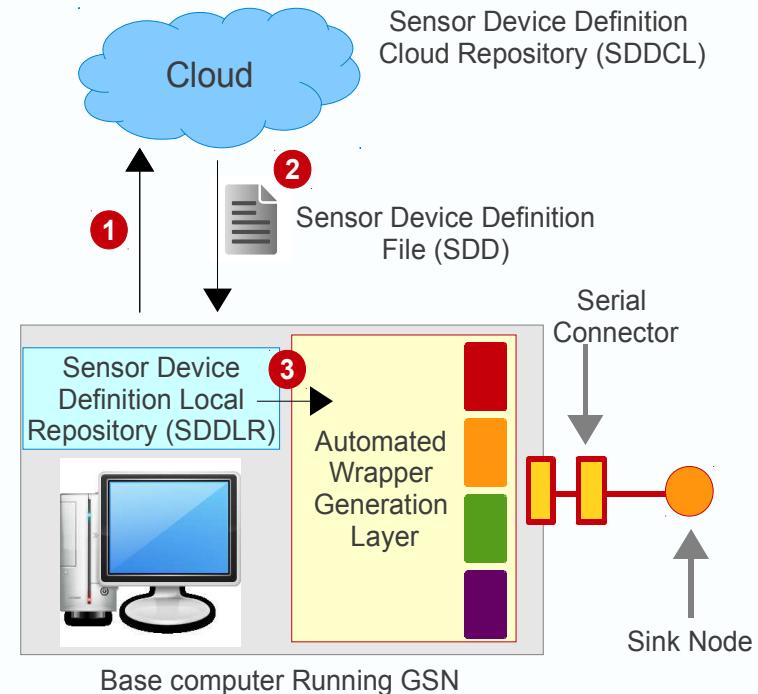
Sensor Device Definition (SDD) File

Sensor Device Definition Local Repository (SDDLRL)

Sensor Device Definition Cloud Repository (SDDCR)

Automated Wrapper Generation Layer (ASCM4GSN

Tool)

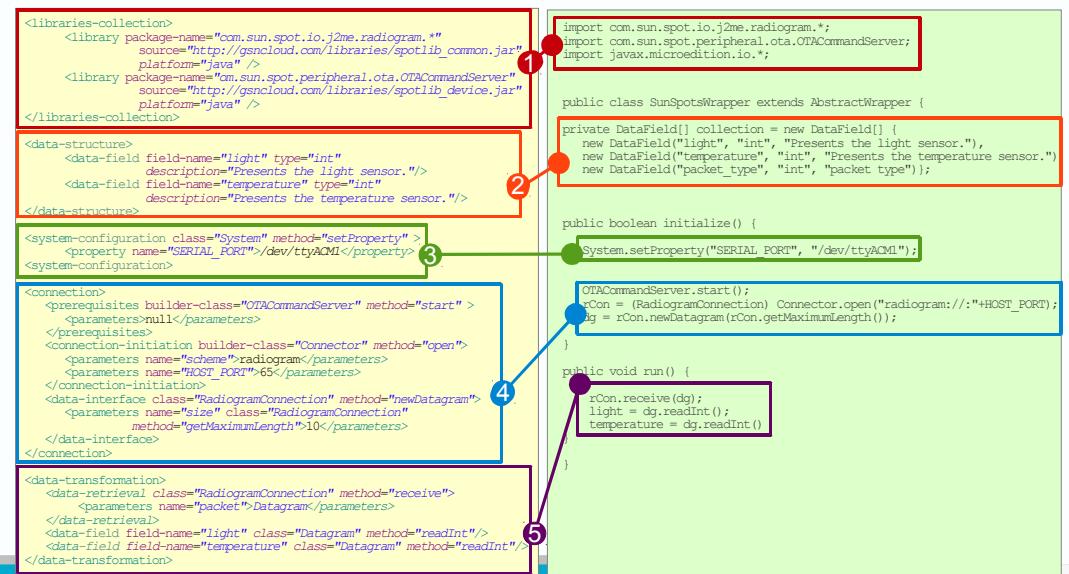


ASCM4GSN as a solution

Common Steps in Connecting Sensors to an IoT Middleware:

1. Acquire Manufacturers' APIs
2. Acquire System Configuration Details
3. Initiate the Data Structures
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- We defined the above steps in XML file called Sensor Device Definition (SDD) file
- The information attached to this files were used to develop the wrapper automatically.



Sensor Device Definition File

System-generated SunSPOT Wrapper



How Automation Works

```
<libraries-collection>
  <library package-name="com.sun.spot.io.j2me.radiogram.">
    source="http://gsncloud.com/libraries/spotlib_common.jar"
    platform="java"/>
  <library package-name="com.sun.spot.peripheral.ota.OTACommandServer">
    source="http://gsncloud.com/libraries/spotlib_device.jar"
    platform="java"/>
</libraries-collection>
```

```
<data-structure>
  <data-field field-name="light" type="int"
    description="Presents the light sensor."/>
  <data-field field-name="temperature" type="int"
    description="Presents the temperature sensor."/>
</data-structure>
```

```
<system-configuration class="System" method="setProperty">
  <property name="SERIAL_PORT">/dev/ttyACM1</property>
</system-configuration>
```

```
<connection>
  <perequisites builder-class="OTACommandServer" method="start">
    <parameters>null</parameters>
  </perequisites>
  <connection-initiation builder-class="Connector" method="open">
    <parameters name="scheme">radiogram</parameters>
    <parameters name="HOST_PORT">65</parameters>
  </connection-initiation>
  <data-interface class="RadiogramConnection" method="newDatagram">
    <parameters name="size" class="RadiogramConnection"
      method="getMaximumLength">10</parameters>
  </data-interface>
</connection>
```

```
<data-retrieval class="RadiogramConnection" method="receive">
  <parameters name="packet">Datagram</parameters>
</data-retrieval>
<data-field field-name="light" class="Datagram" method="readInt"/>
<data-field field-name="temperature" class="Datagram" method="readInt"/>
</data-transformation>
```

Sensor Device Definition(SDD)
File for a Specific Sensor
(e.g: SunSPOT Sensor)

```
package gsn.wrappers;
import gsn.beans.DataField;
import gsn.beans.StreamElement;
public class XXXXXXXXXXXX extends AbstractWrapper {
  private DataField[] collection = new DataField[] {.....};
```

```
  public boolean initialize() {
    setName("TestWrapperMockObject-Thread" + (++threadCounter));
    System.setProperty(".....");
    return true;
  }
  public void run() {
  }
  public DataField[] getOutputFormat() {
    return outputFormat;
  }
  public boolean publishStreamElement(StreamElement se) {
    return postStreamElement(se);
  }
  public void dispose() {
    threadCounter--;
  }
  public String getWrapperName() {
    return "TestWrapperMock";
  }
}
```

Wrapper Template for
Global Sensor Network
Middleware

```
package gsn.wrappers;
import gsn.beans.DataField;
import gsn.beans.StreamElement;
import com.sun.spot.io.j2me.radiogram.*;
import com.sun.spot.peripheral.ota.OTACommandServer;
import javax.microedition.io.*;
public class SunSpotsWrapper extends AbstractWrapper {
  private DataField[] collection = new DataField[] {
    new DataField("light", "int", "Presents the light sensor."),
    new DataField("temperature", "int", "Presents temperature sensor"),
    new DataField("packet_type", "int", "packet type")};
  public boolean initialize() {
    System.setProperty("SERIAL_PORT", "/dev/ttyACM0");
    OTACommandServer.start();
    rCon = (RadiogramConnection)
      Connector.open("radiogram://:"+HOST_PORT);
    dg = rCon.newDatagram(rCon.getMaximumLength());
  }
  public void run() {
    rCon.receive(dg);
    light = dg.readInt();
    temperature = dg.readInt();
  }
  public DataField[] getOutputFormat() {
    return outputFormat;
  }
  public boolean publishStreamElement(StreamElement se) {
    return postStreamElement(se);
  }
  public void dispose() {
    threadCounter--;
  }
  public String getWrapperName() {
    return "SunSPOTWrapper";
  }
}
```

System Generated Wrapper
(e.g: SunSPOTWrapper)



Related Work

- IEEE 1451 standards and SensorML
- Californium (Cf) CoAP framework
- Web Services Gateways
- InterX
- Hydra
- uMiddle



Conclusion and Future Work

- ❑ We have demonstrated that automating the process of developing sensor drivers/wrappers will improve efficiency and productivity.
- ❑ Our future work aims at efficient and effective automation of connecting things to IoT middleware as well as incorporating generated extended functionality
- ❑ We will combine context capturing and semantic data technologies with processing of sensor data inside the wrapper itself.
- ❑ Reasoner on top of ASCM4GSN to include context discovery, semantic enrichment while generating wrappers



Thank you !

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Data Management

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