特別研究報告書

IoT 環境における状況依存型サービス連携の実現

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内容梗概

アブストラクト研究の背景と、概要

研究の貢献

1. Web とセンサーを繋ぐ画一化されたプラットフォームが存在しない
2. Web サービスの利用にその都度リクエストを送信しなければならない
3. サービス選択が手動

Realization of situated service composition in IoT environment

Takahiro Watanabe

Abstract

abstract

IoT 環境における状況依存型サービス連携の実現

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第1章　はじめに

はじめに

第2章　関連研究

この章では本研究に利用している各用語についての説明と，課題点について述べる．

2.1　IoT

IoT とは,

2.2　IoS

IoS とは,

2.3　CEP

CEP(Complex Event Processing，または複合イベント処理) とは，刻々と生成されるデータをリアルタイムに処理するための方式である．事前に定義したルールに，リアルタイムにデータを挿入し，そのルールに応じて即座に処理を行う．これまでのビッグデータ分析の方法は，データをデータベースに蓄積し，任意のタイミングで参照し，分析するという手法であったために，情報の処理に時間がかかるという問題点があった．CEP は対象のデータを直近の範囲に絞り，メモリ上に読みこんで処理を行うため処理を高速化でき，”直近の数秒以内に ”などの条件に沿ってデータを処理することが可能となる．本研究では，この CEP をストリーム形式であるセンサーデータに対し応用することを考える．

2.4　サービス連携

サービス連携とは，IoS 基盤に集積された各原子サービスを組み合わせ，ユーザの要求を満たす高い品質 (QoS，または Quality of Service) の複合サービスを構成する技術である．従来，複合サービスを構成するためには，ユーザが自らの要求を満足するような原子サービスを選択する方法が取られていた．また，複合サービスの自動構築を行う方法として，人工知能のプランニング技術を用いてワークフローを自動生成する研究が主流であった．しかし，IoS 環境において

は，同種の原子サービスが複数登録されるために，ワークフローを生成することよりむしろ，ワークフローに当てはめる原子サービスの選択が自動化できる必要がある．

第3章　提案手法

本章では，センサーのサービス化を行うための手法と，センサーから取得したデータによって，複合サービスのサービス選択，サービス実行を自動で行うための手法を提案する．

3.1　センサーのサービス化手法

本節では，センサーのサービス化手法を提案する．現状は，前述した通りセンサーの仕様が画一化されていないために，センサーを利用するシステムを実装する際，センサーの種類によって異なる実装が必要であるという問題点が存在する．この問題点を本提案は解決する．
データ定義を OpenIoT のセンサー定義に基づいて画一化する．OpenIoT のセンサー定義の例は以下である．データの値，取得時間や，温度，湿度，照度といったデータタイプを示す propertyType などが存在する．

センサー定義例

```
//Observation

private String id;
private Date times;
private String sensorId;
private String featureOfInterest="";
private ArrayList<ObservedProperty> readings;
private String metaGraph;
private String dataGraph;



//ObservedProperty

private static final long serialVersionUID = 1L;
private Object value;
private Date times;
private String propertyType;
private String unit;
private String observationId;
```

センサーの開発者は，センサーから値を取得した際に，Observation を作成し，各変数に取得した値を格納するようにサービスを構成する．ユーザはこのサービスの仕様に従ってシステムを実装することで，ユーザからは種々のセンサー間の違いは隠蔽され，画一化されたセンサーサービスとしてデータを利用することができる．例えば，センサーから温度 20 ℃，湿度 50%のデータを取得した際には以下のように Observation を生成する．

```
1 Observation o = new Observation();     //Observationオブジェクトの作成
2 ArrayList<ObservedProperty> readings = new ArrayList<ObservedProperty>();
      //ObservedPropertyのリストの作成
3 ObservedProperty tempProperty = new ObservedProperty();     //
      ObservedPropertyオブジェクトの作成
4 ObservedProperty humdProperty = new ObservedProperty();
5 tempProperty.setPropertyType("http://openiot.eu/ontology/ns/AirTemperature");
```

```
        //propertyTypeの設定
6  humdProperty.setPropertyType("http://openiot.eu/ontology/ns/AtmosphereHumidity"
       );
7  tempProperty.setValue(20);      //valueに値を格納
8  humdProperty.setValue(50);
9  readings.add(tempProperty);       //ObservedPropertyのリストに追加
10 readings.add(humdProperty);
11 o.setReadings(readings);;      //Observationに作成したリストを格納
```

3.2 状況依存型サービス選択手法

本節では，センサーの値によって複合サービス中の原子サービスを選択する手法を提案する．この手法により以下の 2 点の問題点が解決される．

- 複合サービス内の原子サービスの選択
  専門家が作成したセンサーの値によって分岐するルールに従って原子サービスの選択を行うことで，サービス連携においてユーザのサービスに対しての知識や経験を必要とせず質の高いサービス合成が可能となる．
- 複合サービスのリアルタイム実行
  センサーの値をイベントとして CEP エンジンに挿入し，リアルタイムで処理，アクションとして複合サービスへの入力を与えることによって，ユーザがサービスのリクエストを送信することなく，リアルタイムかつ自動的なサービス実行が可能になる．

第 4 章　提案アーキテクチャ

第 5 章　実装

こういうサービスを実装しました. 以下のモジュール

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付録

実装のソースコードを添付する.

A.1 デバイスでセンサーデータを取得し、サーバーへ送信するモジュールのソースコード

A.1.1 MyviewController.java

```
1  package org.langrid.waikiki.sensor;
2
3  import java.net.MalformedURLException;
4  import java.net.URL;
5  import java.util.ArrayList;
6
7  import org.langrid.waikiki.sensor.omron.EnvSensor;
8  import org.langrid.waikiki.sensor.omron.EnvSensorScanner;
9  import org.langrid.waikikiws.service.ObservationReceiverImpl;
10 import org.langrid.waikikiws.service.api.ObservationReceiver;
11 import org.openiot.lsm.beans.Observation;
12 import org.openiot.lsm.beans.ObservedProperty;
13 import org.robovm.apple.coregraphics.CGRect;
14 import org.robovm.apple.foundation.NSBundle;
15 import org.robovm.apple.foundation.NSURL;
16 import org.robovm.apple.uikit.UIColor;
17 import org.robovm.apple.uikit.UIView;
18 import org.robovm.apple.uikit.UIViewController;
19 import org.robovm.apple.webkit.WKScriptMessage;
20 import org.robovm.apple.webkit.WKScriptMessageHandlerAdapter;
21 import org.robovm.apple.webkit.WKUserContentController;
22 import org.robovm.apple.webkit.WKWebView;
23 import org.robovm.apple.webkit.WKWebViewConfiguration;
24
25
26 import jp.go.nict.langrid.client.jsonrpc.JsonRpcClientFactory;
27 import net.arnx.jsonic.JSON;
28
29 public class MyViewController extends UIViewController {
30     public MyViewController() {
31         // Get the view of this view controller.
32         UIView view = getView();
33
34         // Setup background.
35         view.setBackgroundColor(UIColor.white());
36
37         WKUserContentController controller = new WKUserContentController();
38         controller.addScriptMessageHandler(new WKScriptMessageHandlerAdapter()
               {
39             @Override
40             public void didReceiveScriptMessage(WKUserContentController c,
                   WKScriptMessage message) {
```

```
41                  System.out.println("message: " + message.getBody());
42                  if(message.getName().equals("handler")){
43                      if(message.getBody().toString().equals("startScan"))
44                          startScan();
45                      if(message.getBody().toString().equals("stopScan"))
46                          stopScan();
47                  }
48              }
49          }, "handler");
50          WKWebViewConfiguration config = new WKWebViewConfiguration();
51          config.setUserContentController(controller);
52          CGRect frame = view.getFrame();
53          wv = new WKWebView(
54                  new CGRect(frame.getMinX(), frame.getMinY() + 16,
55                          frame.getWidth(), frame.getHeight() - 16),
56                  config);
57          view.addSubview(wv);
58          NSURL bu = NSBundle.getMainBundle().getBundleURL();
59          wv.loadFileURL(new NSURL(bu.toString() + "index.html"), bu);
60
61          try {
62              client = new JsonRpcClientFactory().create(
63                      ObservationReceiver.class,
64  //大学                    new URL("http://10.229.250.104:8080/waikikiws/services/
        ObservationReceiver")
65                      new URL("http://192.168.11.2:8080/waikikiws/services/
                            ObservationReceiver")  //家
66                      );
67          } catch (MalformedURLException e) {
68              e.printStackTrace();
69          }
70      }
71
72      private void startScan(){
73          scanner.startScan(s -> {
74              System.out.println(JSON.encode(s).toString());
75              wv.evaluateJavaScript("found(" + JSON.encode(s) + ");", null);
76              // 送信
77              client.notify(createObservation(s)); //s = {"brightness":-112,....}
78          });
79      }
80
81      private void stopScan(){
82          scanner.stopScan();
83      }
84  //s.get~で要素の値を取り出してObservationを生成
85      private Observation createObservation(EnvSensor s){
86          String TEMPERATURE = "http://openiot.eu/ontology/ns/AirTemperature";
87          String HUMIDITY = "http://openiot.eu/ontology/ns/AtmosphereHumidity";
88
89          Observation o = new Observation();
90          ArrayList<ObservedProperty> readings = new ArrayList<ObservedProperty
                >();
```

```
91          ObservedProperty tempProperty = new ObservedProperty();
92          ObservedProperty humdProperty = new ObservedProperty();
93
94          double temperature = s.getTemperature()/100;
95          double humidity = s.getHumidity()/100;
96
97          tempProperty.setPropertyType(TEMPERATURE);
98          humdProperty.setPropertyType(HUMIDITY);
99          tempProperty.setValue(temperature);
100         humdProperty.setValue(humidity);
101         readings.add(tempProperty);
102         readings.add(humdProperty);
103         o.setReadings(readings);
104         return o;
105     }
106
107     private ObservationReceiver client;
108     private EnvSensorScanner scanner = new EnvSensorScanner();
109     private final WKWebView wv;
110 }
```

A.1.2 WaikikiSensor.java

```
1  package org.langrid.waikiki.sensor;
2
3  import org.robovm.apple.foundation.NSAutoreleasePool;
4  import org.robovm.apple.uikit.UIApplication;
5  import org.robovm.apple.uikit.UIApplicationDelegateAdapter;
6  import org.robovm.apple.uikit.UIApplicationLaunchOptions;
7  import org.robovm.apple.uikit.UIScreen;
8  import org.robovm.apple.uikit.UIWindow;
9
10 public class WaikikiSensor extends UIApplicationDelegateAdapter {
11     private UIWindow window;
12     private MyViewController rootViewController;
13
14     @Override
15     public boolean didFinishLaunching(UIApplication application,
           UIApplicationLaunchOptions launchOptions) {
16         // Set up the view controller.
17         rootViewController = new MyViewController();
18
19         // Create a new window at screen size.
20         window = new UIWindow(UIScreen.getMainScreen().getBounds());
21         // Set the view controller as the root controller for the window.
22         window.setRootViewController(rootViewController);
23         // Make the window visible.
24         window.makeKeyAndVisible();
25
26         return true;
27     }
28
29     public static void main(String[] args) {
```

```
30          try (NSAutoreleasePool pool = new NSAutoreleasePool()) {
31              UIApplication.main(args, null, WaikikiSensor.class);
32          }
33      }
34  }
```

A.2 受信したデータをルールエンジンに挿入し、状況に応じた出力を得るモジュールのソースコード

A.2.1 ObservationReceiverImpl.java

```
 1  package org.langrid.waikikiws.service;
 2
 3  import java.util.ArrayList;
 4
 5  import org.langrid.waikikiws.DroolsManager;
 6  import org.langrid.waikikiws.service.api.ObservationReceiver;
 7  import org.langrid.waikikiws.service.api.ObservationReceiverDebug;
 8  import org.openiot.lsm.beans.Observation;
 9  import org.openiot.lsm.beans.ObservedProperty;
10  import org.langrid.waikikiws.VoiceText;
11  import org.langrid.waikikiws.service.TargetLanguage;
12
13  public class ObservationReceiverImpl
14  implements ObservationReceiver, ObservationReceiverDebug{
15      @Override
16      public void notify(Observation o){
17          System.out.println("------------------");
18          System.out.println(o.getReadings().get(0).getValue());
19          System.out.println("------------------");        //ここまでは通ってる
20          DroolsManager.getSession().insert(o); //
                Observationをルールエンジンへ挿入する
21      }
22  //  String targetlanguage;
23      public static String TEMPERATURE = "http://openiot.eu/ontology/ns/
            AirTemperature";
24      public static String HUMIDITY = "http://openiot.eu/ontology/ns/
            AtmosphereHumidity";
25      @Override
26      public void dummyNotify(double temperature, double humidity,String
            tlanguage) {
27  //      targetlanguage = tlanguage;
28  //      targetlang.setTargetlang(tlanguage);
29          Observation o = new Observation();
30          ArrayList<ObservedProperty> readings = new ArrayList<ObservedProperty
                >();
31          ObservedProperty tempProperty = new ObservedProperty();
32          ObservedProperty humdProperty = new ObservedProperty();
33          tempProperty.setPropertyType(TEMPERATURE);
34          humdProperty.setPropertyType(HUMIDITY);
35          tempProperty.setValue(temperature);
```

```
36          humdProperty.setValue(humidity);
37          readings.add(tempProperty);
38          readings.add(humdProperty);
39          o.setReadings(readings);;
40          DroolsManager.getSession().insert(o);
41          DroolsManager.getSession().insert(new TargetLanguage(tlanguage));
42          // TODO ここに
                temperatureとhumidityからObservationを作ってルールエンジンへ挿入する処理を記述する

43      }
44
45  }
```

A.2.2 Translator.java

```
 1  package org.langrid.waikikiws.service;
 2
 3  import java.io.IOException;
 4  import java.io.InputStream;
 5  import java.io.InputStreamReader;
 6  import java.io.Reader;
 7  import java.net.MalformedURLException;
 8  import java.net.URL;
 9  import java.util.Arrays;
10  import java.util.List;
11  import java.util.Properties;
12
13  import org.langrid.waikikiws.Bindings;
14  import org.langrid.waikikiws.service.api.TranslatorService;
15
16  import jp.go.nict.langrid.client.RequestAttributes;
17  import jp.go.nict.langrid.client.soap.SoapClientFactory;
18  import jp.go.nict.langrid.commons.cs.binding.BindingNode;
19  import jp.go.nict.langrid.service_1_2.AccessLimitExceededException;
20  import jp.go.nict.langrid.service_1_2.InvalidParameterException;
21  import jp.go.nict.langrid.service_1_2.NoAccessPermissionException;
22  import jp.go.nict.langrid.service_1_2.NoValidEndpointsException;
23  import jp.go.nict.langrid.service_1_2.ProcessFailedException;
24  import jp.go.nict.langrid.service_1_2.ServerBusyException;
25  import jp.go.nict.langrid.service_1_2.ServiceNotActiveException;
26  import jp.go.nict.langrid.service_1_2.ServiceNotFoundException;
27  import jp.go.nict.langrid.service_1_2.translation.TranslationService;
28
29  public class Translator implements TranslatorService{
30      public Translator() throws IOException {
31          Properties p = new Properties();
32          try(InputStream is = getClass().getResourceAsStream("/langrid.
                properties");
33                  Reader r = new InputStreamReader(is, "UTF-8")){
34              p.load(r);
35          }
36          this.url = p.getProperty("url");
37          this.userId = p.getProperty("userId");
```

```
38          this.password = p.getProperty("password");
39      }
40      @Override
41      public String translate(String sourceLang, String targetLang, String source
            ) {
42          List<BindingNode> bindings = Arrays.asList(
43                  new BindingNode("MorphologicalAnalysisPL", "Mecab"),
44                  new BindingNode("TranslationPL", "KyotoUJServer")
45                  );
46  //      List<BindingNode> bindings = Bindings.getBindings();
47          try {
48              TranslationService trans = new SoapClientFactory().create(
49                      TranslationService.class,
50                      new URL(url + "
                            TranslationCombinedWithBilingualDictionaryWithLongestMatchSearch
                            "),
51                      userId, password
52                      );
53              for(BindingNode n : bindings){
54                  ((RequestAttributes)trans).getTreeBindings().add(n);
55              }
56              return trans.translate(sourceLang, targetLang, source);
57          } catch (MalformedURLException | AccessLimitExceededException |
                InvalidParameterException | NoAccessPermissionException |
                ProcessFailedException | NoValidEndpointsException |
                ServerBusyException | ServiceNotActiveException |
                ServiceNotFoundException e) {
58              throw new RuntimeException(e);
59          }
60      }
61
62      private String url;
63      private String userId;
64      private String password;
65  }
```

A.2.3 Binding.java

```
1  package org.langrid.waikikiws;
2
3  import java.util.Arrays;
4  import java.util.List;
5
6  import jp.go.nict.langrid.commons.cs.binding.BindingNode;
7
8  public class Bindings {
9      public static List<BindingNode> getBindings() {
10         return bindings;
11     }
12     public static void binding1(){
13         bindings = Arrays.asList(
14                 new BindingNode("MorphologicalAnalysisPL", "Mecab"),
15                 new BindingNode("TranslationPL", "KyotoUJServer")
```

```
16                  );
17          //System.out.println("binding1");
18      }
19      public static void binding2(){
20          bindings = Arrays.asList(
21                  new BindingNode("MorphologicalAnalysisPL", "Mecab"),
22                  new BindingNode("BilingualDictionaryWithLongestMatchSearchPL",
                        "KyotoTourismDictionaryDb"),
23                  new BindingNode("TranslationPL", "KyotoUJServer")
24                  );
25          //System.out.println("binding2");
26      }
27      public static void setBindings(List<BindingNode> bindings) {
28          Bindings.bindings = bindings;
29      }
30      private static List<BindingNode> bindings = Arrays.asList(
31              new BindingNode("MorphologicalAnalysisPL", "Mecab"),
32              new BindingNode("TranslationPL", "KyotoUJServer")
33              );
34  }
```

A.2.4 DroolsManager.java

```
1  package org.langrid.waikikiws;
2
3  import java.io.IOException;
4
5  import org.kie.api.runtime.KieSession;
6
7  public class DroolsManager {
8      public static synchronized KieSession getSession(){
9          if(session == null){
10             try {
11                 session = DroolsUtil.createStreamSessionFromResource("/
                       badminton.drl");
12             } catch (IOException e) {
13                 throw new RuntimeException(e);
14             }
15             Thread t = new Thread(() -> {
16                 session.fireUntilHalt();
17             });
18             t.setDaemon(true);
19             t.start();
20             org.kie.api.runtime.rule.FactHandle.State.class.getName();
21         }
22         return session;
23     }
24
25     private static KieSession session;
26 }
```

A.2.5 DroolsUtil.java

```java
package org.langrid.waikikiws;

import java.io.IOException;
import java.io.InputStream;

import org.kie.api.KieBase;
import org.kie.api.KieBaseConfiguration;
import org.kie.api.KieServices;
import org.kie.api.builder.KieBuilder;
import org.kie.api.builder.KieFileSystem;
import org.kie.api.builder.Message;
import org.kie.api.builder.Results;
import org.kie.api.conf.EventProcessingOption;
import org.kie.api.runtime.KieContainer;
import org.kie.api.runtime.KieSession;

public class DroolsUtil {
    public static KieSession createSessionFromResource(Package pkg, String
        rulePath) throws IOException{
        return createSessionFromResource(
                "/" + pkg.getName().replaceAll("\\.", "/") + "/" + rulePath);
    }

    public static KieSession createSessionFromResource(String rulePath)
    throws IOException{
        KieServices kieServices = KieServices.Factory.get();
        KieFileSystem kfs = kieServices.newKieFileSystem();
        try(InputStream is = DroolsUtil.class.getResourceAsStream(rulePath)){
            // for each DRL file, referenced by a plain old path name:
            kfs.write("src/main/resources" + rulePath,
                    kieServices.getResources().newInputStreamResource(is));
            KieBuilder kieBuilder = kieServices.newKieBuilder( kfs ).buildAll
                ();
            Results results = kieBuilder.getResults();
            if( results.hasMessages( Message.Level.ERROR ) ){
                System.out.println( results.getMessages() );
                throw new RuntimeException("### errors ###" );
            }
            KieContainer kieContainer = kieServices.newKieContainer(
                    kieServices.getRepository().getDefaultReleaseId() );
            KieBase kieBase = kieContainer.getKieBase();
            return kieBase.newKieSession();
        }
    }

    public static KieSession createStreamSessionFromResource(Package pkg,
        String rulePath) throws IOException{
        return createStreamSessionFromResource(
                "/" + pkg.getName().replaceAll("\\.", "/") + "/" + rulePath);
    }
    public static KieSession createStreamSessionFromResource(String rulePath)
    throws IOException{
        KieServices kieServices = KieServices.Factory.get();
```

```
51          KieFileSystem kfs = kieServices.newKieFileSystem();
52          try(InputStream is = DroolsUtil.class.getResourceAsStream(rulePath)){
53              // for each DRL file, referenced by a plain old path name:
54              kfs.write("src/main/resources" + rulePath,
55                      kieServices.getResources().newInputStreamResource(is));
56              KieBuilder kieBuilder = kieServices.newKieBuilder( kfs ).buildAll
                    ();
57              Results results = kieBuilder.getResults();
58              if( results.hasMessages( Message.Level.ERROR ) ){
59                  System.out.println( results.getMessages() );
60                  throw new RuntimeException("### errors ###" );
61              }
62              KieContainer kieContainer = kieServices.newKieContainer(
63                      kieServices.getRepository().getDefaultReleaseId() );
64              KieBaseConfiguration config = KieServices.Factory.get().
                    newKieBaseConfiguration();
65              config.setOption( EventProcessingOption.STREAM );
66              KieBase kieBase = kieContainer.newKieBase(config);
67              return kieBase.newKieSession();
68          }
69      }
70  }
```

A.2.6 TargetLanguage

```
1  package org.langrid.waikikiws.service;
2
3
4  public class TargetLanguage {
5      public TargetLanguage(){
6      }
7
8      public TargetLanguage(String targetlang) {
9          super();
10         this.targetlanguage = targetlang;
11     }
12
13     public String getTargetlang() {
14         return targetlanguage;
15     }
16
17     public void setTargetlang(String targetlang){
18         this.targetlanguage = targetlang;
19     }
20
21     private String targetlanguage;
22
23 }
```

A.2.7 VoiceText.java

```
1  package org.langrid.waikikiws;
2
```

```
3  import java.net.URL;
4  import jp.go.nict.langrid.client.soap.SoapClientFactory;
5  import jp.go.nict.langrid.service_1_2.speech.Speech;
6  import jp.go.nict.langrid.service_1_2.speech.TextToSpeechService;
7  import javax.sound.sampled.*;
8
9
10 import java.io.*;
11
12 public class VoiceText {
13     public void voicetext(String text,String lang) throws Exception {
14
15     // TODO 自動生成されたメソッド・スタブ
16         TextToSpeechService c =
17                 new SoapClientFactory().create(
18                         TextToSpeechService.class,
19                         new URL("http://langrid.org/service_manager/invoker/
                               kyoto1.langrid:VoiceText"),
20                         "ishida.kyoto-u", "tWJaakYm");
21         Speech s = c.speak(lang, text, "woman","audio/x-wav");
22
23         byte[] buf = s.getAudio();
24         ByteArrayInputStream stream = new ByteArrayInputStream(buf);
25         AudioInputStream ais = AudioSystem.getAudioInputStream(stream);
26         byte[] data = new byte [ais.available()];
27         ais.read(data);
28         ais.close();
29         AudioFormat af = ais.getFormat();
30         DataLine.Info info = new DataLine.Info(SourceDataLine.class, af);
31         SourceDataLine line = (SourceDataLine)AudioSystem.getLine(info);
32         line.open();
33         line.start();
34         line.write(buf,0,buf.length);
35         line.drain();
36         line.close();
37     }
38 }
```

A.2.8 TransTextToSpeech.java

```
1  package org.langrid.waikikiws;
2
3  import org.langrid.waikikiws.VoiceText;
4  import org.langrid.waikikiws.service.Translator;
5
6  public class TransTextToSpeech {
7
8      public void transtexttospeech(String text,int i) throws Exception{
9          Translator trans = new Translator();
10         VoiceText tts = new VoiceText();
11         String lang;
12         if (i == 0) {
13             lang = "en";
```

```
14          }
15          else{
16              lang = "zh-CN";
17          }
18          String transtext = trans.translate("ja",lang,text);
19          tts.voicetext(transtext,lang);
20      }
21  }
```

A.2.9 badminton.drl

```
1  import org.openiot.lsm.beans.Observation;
2  import org.openiot.lsm.beans.ObservedProperty;
3  import org.langrid.waikikiws.TransTextToSpeech;
4  import org.langrid.waikikiws.service.TargetLanguage;
5  import java.util.ArrayList;
6
7
8  function void TTTS(String text,int t){
9    TransTextToSpeech ttts = new TransTextToSpeech();
10   ttts.transtexttospeech(text,t);
11 }
12
13 /*
14 rule "test"
15 when
16   $o: Observation()
17   $op1: ObservedProperty(
18     propertyType == "http://ishida.kyoto-u/watanabe/WetBulbGlobTemperature"
19     )
20     from $o.readings
21   $op2: ObservedProperty(
22     propertyType == "http://openiot.eu/ontology/ns/AtmosphereHumidity"
23     )
24     from $o.readings
25   $tl: TargetLanguage(
26 //     targetlanguage == "en"
27     )
28 then
29 //   System.out.println("ok--------");
30 //   System.out.println($tl.getTargetlang());
31 //   TransTextToSpeech ttts = new TransTextToSpeech();
32 //   ttts.transtexttospeech("おはようございます",Integer.parseInt($op2.getValue
       ().toString())$tl.getTargetlang());
33 end
34 */
35
36 rule "WBGTcalc1"
37 when
38   $o: Observation()
39   $op1: ObservedProperty(
40     propertyType == "http://openiot.eu/ontology/ns/AirTemperature"
41     )
```

```
42      from $o.readings
43    $op2: ObservedProperty(
44      value > 80 &&
45      propertyType == "http://openiot.eu/ontology/ns/AtmosphereHumidity"
46      )
47      from $o.readings
48    $t: TargetLanguage()
49  then
50      double tmp = Double.parseDouble($op2.getValue().toString());
51      double hmd = Double.parseDouble($op2.getValue().toString());
52      double WBGT = tmp + (hmd - 80) / 5;
53      Observation o = new Observation();
54      ArrayList<ObservedProperty> readings = new ArrayList<ObservedProperty>();
55      ObservedProperty wbgtProperty = new ObservedProperty();
56      ObservedProperty tlangProperty = new ObservedProperty();
57      wbgtProperty.setPropertyType("http://ishida.kyoto-u/watanabe/
            WetBulbGlobTemperature");
58      tlangProperty.setPropertyType("http://ishida.kyoto-u/watanabe/
            TargetTransLanguage");
59      wbgtProperty.setValue(WBGT);
60      String st =  $t.getTargetlang();
61      if(st.equals("en")){
62          tlangProperty.setValue(0);
63      }else if (st.equals("zh-CN")) {
64          tlangProperty.setValue(1);
65      }
66      readings.add(wbgtProperty);
67      o.setReadings(readings);
68      insert(o);
69  end
70
71  rule "WBGTcalc2"
72  when
73    $o: Observation()
74    $op1: ObservedProperty(
75      propertyType == "http://openiot.eu/ontology/ns/AirTemperature"
76      )
77      from $o.readings
78    $op2: ObservedProperty(
79      value <= 80 &&
80      propertyType == "http://openiot.eu/ontology/ns/AtmosphereHumidity"
81      )
82      from $o.readings
83    $t: TargetLanguage()
84  then
85      double tmp = Double.parseDouble($op2.getValue().toString());
86      double hmd = Double.parseDouble($op2.getValue().toString());
87      double WBGT = tmp - (80 - hmd) / 5;
88      Observation o = new Observation();
89      ArrayList<ObservedProperty> readings = new ArrayList<ObservedProperty>();
90      ObservedProperty wbgtProperty = new ObservedProperty();
91      ObservedProperty tlangProperty = new ObservedProperty();
```

```
92      wbgtProperty.setPropertyType("http://ishida.kyoto-u/watanabe/
            WetBulbGlobTemperature");
93      tlangProperty.setPropertyType("http://ishida.kyoto-u/watanabe/
            TargetTransLanguage");
94      wbgtProperty.setValue(WBGT);
95      String st =  $t.getTargetlang();
96      if(st.equals("en")){
97          tlangProperty.setValue(0);
98      }else if (st.equals("zh-CN")) {
99          tlangProperty.setValue(1);
100     }
101     readings.add(wbgtProperty);
102     readings.add(tlangProperty);
103     o.setReadings(readings);
104     insert(o);
105 end
106
107 /*
108 rule "test2"
109 when
110   $o: Observation()
111   $op1: ObservedProperty(
112     propertyType == "http://ishida.kyoto-u/watanabe/TargetTransLanguage"
113     )
114     from $o.readings
115   $op2: ObservedProperty(
116     value <= 80 &&
117     propertyType == "http://ishida.kyoto-u/watanabe/WetBulbGlobTemperature"
118     )
119     from $o.readings
120 then
121     TTTS("こんばんは",Integer.parseInt($op1.getValue().toString()));
122 end
123 */
124
125 rule "phase5"  //WBGT>=31
126 when
127   $o: Observation()
128   $op1: ObservedProperty(
129     value >= 31 &&
130     propertyType == "http://ishida.kyoto-u/watanabe/WetBulbGlobTemperature"
131     )
132     from $o.readings
133   $op2: ObservedProperty(
134     propertyType == "http://ishida.kyoto-u/watanabe/TargetTransLanguage"
135     )
136     from $o.readings
137 then
138     System.out.println("運動を中止しましょう.");
139     TTTS("運動を中止しましょう.",Integer.parseInt($op2.getValue().toString()));
140 end
141
142 rule "phase4"  //28<=WBGT<31
```

```
143 when
144   $o: Observation()
145   $op1: ObservedProperty(
146     value < 31 && value >= 28 &&
147     propertyType == "http://ishida.kyoto-u/watanabe/WetBulbGlobTemperature"
148     )
149     from $o.readings
150   $op2: ObservedProperty(
151     propertyType == "http://ishida.kyoto-u/watanabe/TargetTransLanguage"
152     )
153     from $o.readings
154 then
155     System.out.println("激しい運動は避け、積極的に休息と水分補給を行いましょう.");
156     TTTS("激しい運動は避け、積極的に休息と水分補給を行いましょう
          .",Integer.parseInt($op2.getValue().toString()));
157 end
158
159 rule "phase3"  //25<=WBGT<28
160 when
161   $o: Observation()
162   $op1: ObservedProperty(
163     value < 28 && value >= 25 &&
164     propertyType == "http://ishida.kyoto-u/watanabe/WetBulbGlobTemperature"
165     )
166     from $o.readings
167   $op2: ObservedProperty(
168     propertyType == "http://ishida.kyoto-u/watanabe/TargetTransLanguage"
169     )
170     from $o.readings
171 then
172     System.out.println("激しい運動を行う際は,30分おきくらいに休息をとりましょう.");
173     TTTS("激しい運動を行う際は,30分おきくらいに休息をとりましょう.",Integer.parseInt
          ($op2.getValue().toString()));
174 end
175
176 rule "phase2"  //21<=WBGT<25
177 when
178   $o: Observation()
179   $op1: ObservedProperty(
180     value < 25 && value >= 21 &&
181     propertyType == "http://ishida.kyoto-u/watanabe/WetBulbGlobTemperature"
182     )
183     from $o.readings
184   $op2: ObservedProperty(
185     propertyType == "http://ishida.kyoto-u/watanabe/TargetTransLanguage"
186     )
187     from $o.readings
188 then
189     System.out.println("水分補給には十分気をつけましょう.");
190     TTTS("水分補給には十分気をつけましょう
          .",Integer.parseInt($op2.getValue().toString()));
191 end
192
```

```
193 rule "phase1"    //WBGT<21
194 when
195   $o: Observation()
196   $op1: ObservedProperty(
197     value < 21 &&
198     propertyType == "http://ishida.kyoto-u/watanabe/WetBulbGlobTemperature"
199     )
200     from $o.readings
201   $op2: ObservedProperty(
202     propertyType == "http://ishida.kyoto-u/watanabe/TargetTransLanguage"
203     )
204     from $o.readings
205 then
206     System.out.println("熱中症の危険は少ないですが,適宜水分補給をしましょう.");
207     TTTS("熱中症の危険は少ないですが,適宜水分補給をしましょう.",Integer.parseInt($op2
          .getValue().toString()));
208 end
209
210 rule "floor"    //湿度で床が滑る
211 when
212   $o: Observation()
213   $h: ObservedProperty(
214     value >= 90 &&
215     propertyType == "http://openiot.eu/ontology/ns/AtmosphereHumidity"
216     )
217     from $o.readings
218   $op2: ObservedProperty(
219     propertyType == "http://ishida.kyoto-u/watanabe/TargetTransLanguage"
220     )
221     from $o.readings
222 then
223     System.out.println("湿度が高く床が滑りやすくなっています.気をつけましょう.");
224     TTTS("湿度が高く床が滑りやすくなっています
          .気をつけましょう.",Integer.parseInt($op2.getValue().toString()));
225 end
226
227 rule "shuttle1"    //1番シャトル
228 when
229   $o: Observation()
230   $op1: ObservedProperty(
231     value >= 33 &&
232     propertyType == "http://ishida.kyoto-u/watanabe/WetBulbGlobTemperature"
233     )
234     from $o.readings
235   $op2: ObservedProperty(
236     propertyType == "http://ishida.kyoto-u/watanabe/TargetTransLanguage"
237     )
238     from $o.readings
239 then
240     System.out.println("1番のシャトルを使いましょう.");
241     TTTS("1番のシャトルを使いましょう.",Integer.parseInt($op2.getValue().
          toString()));
242 end
```

```
243
244 rule "shuttle2"   //2番シャトル
245 when
246   $o: Observation()
247   $op1: ObservedProperty(
248     value < 33 && value >= 27 &&
249     propertyType == "http://ishida.kyoto-u/watanabe/WetBulbGlobTemperature"
250     )
251     from $o.readings
252   $op2: ObservedProperty(
253     propertyType == "http://ishida.kyoto-u/watanabe/TargetTransLanguage"
254     )
255     from $o.readings
256 then
257     System.out.println("2番のシャトルを使いましょう.");
258     TTTS("2番のシャトルを使いましょう.",Integer.parseInt($op2.getValue().
          toString()));
259 end
260
261 rule "shuttle3"   //3番シャトル
262 when
263   $o: Observation()
264   $op1: ObservedProperty(
265     value < 27 && value >= 22 &&
266     propertyType == "http://ishida.kyoto-u/watanabe/WetBulbGlobTemperature"
267     )
268     from $o.readings
269   $op2: ObservedProperty(
270     propertyType == "http://ishida.kyoto-u/watanabe/TargetTransLanguage"
271     )
272     from $o.readings
273 then
274     System.out.println("3番のシャトルを使いましょう.");
275     TTTS("3番のシャトルを使いましょう.",Integer.parseInt($op2.getValue().
          toString()));
276 end
277
278 rule "shuttle4"   //4番シャトル
279 when
280   $o: Observation()
281   $op1: ObservedProperty(
282     value < 22 && value >= 17 &&
283     propertyType == "http://ishida.kyoto-u/watanabe/WetBulbGlobTemperature"
284     )
285     from $o.readings
286   $op2: ObservedProperty(
287     propertyType == "http://ishida.kyoto-u/watanabe/TargetTransLanguage"
288     )
289     from $o.readings
290 then
291     System.out.println("4番のシャトルを使いましょう.");
292     TTTS("4番のシャトルを使いましょう.",Integer.parseInt($op2.getValue().
          toString()));
```

```
293 end
294
295 rule "shuttle5"    //5番シャトル
296 when
297   $o: Observation()
298   $op1: ObservedProperty(
299     value < 17 && value >= 12 &&
300     propertyType == "http://ishida.kyoto-u/watanabe/WetBulbGlobTemperature"
301     )
302     from $o.readings
303   $op2: ObservedProperty(
304     propertyType == "http://ishida.kyoto-u/watanabe/TargetTransLanguage"
305     )
306     from $o.readings
307 then
308     System.out.println("5番のシャトルを使いましょう.");
309     TTTS("5番のシャトルを使いましょう.",Integer.parseInt($op2.getValue().
          toString()));
310 end
311
312 rule "shuttle6"    //6番シャトル
313 when
314   $o: Observation()
315   $op1: ObservedProperty(
316     value < 12 &&
317     propertyType == "http://ishida.kyoto-u/watanabe/WetBulbGlobTemperature"
318     )
319     from $o.readings
320   $op2: ObservedProperty(
321     propertyType == "http://ishida.kyoto-u/watanabe/TargetTransLanguage"
322     )
323     from $o.readings
324 then
325     System.out.println("6番のシャトルを使いましょう.");
326     TTTS("6番のシャトルを使いましょう.",Integer.parseInt($op2.getValue().
          toString()));
327 end
328
329 rule "stringsh"    //温度が高いときのストリング
330 when
331   $o: Observation()
332   $op1: ObservedProperty(
333     value > 25 &&
334     propertyType == "http://ishida.kyoto-u/watanabe/WetBulbGlobTemperature"
335     )
336     from $o.readings
337   $op2: ObservedProperty(
338     propertyType == "http://ishida.kyoto-u/watanabe/TargetTransLanguage"
339     )
340     from $o.readings
341 then
342     System.out.println("適正温度のときより+1ポンドのガットが適切です.");
```

```
343     TTTS("適正温度のときより+1ポンドのガットが適切です.",Integer.parseInt($op2.
            getValue().toString()));
344 end
345
346 rule "stringsn"    //適正温度のときのストリング
347 when
348   $o: Observation()
349   $op1: ObservedProperty(
350     value <= 25 && value >= 15 &&
351     propertyType == "http://ishida.kyoto-u/watanabe/WetBulbGlobTemperature"
352     )
353     from $o.readings
354   $op2: ObservedProperty(
355     propertyType == "http://ishida.kyoto-u/watanabe/TargetTransLanguage"
356     )
357     from $o.readings
358 then
359     System.out.println("適正");
360     TTTS("ガットの適正温度です.",Integer.parseInt($op2.getValue().toString()));
361 end
362
363 rule "stringsl"    //温度が低いときのストリング
364 when
365   $o: Observation()
366   $op1: ObservedProperty(
367     value < 15 &&
368     propertyType == "http://ishida.kyoto-u/watanabe/WetBulbGlobTemperature"
369     )
370     from $o.readings
371   $op2: ObservedProperty(
372     propertyType == "http://ishida.kyoto-u/watanabe/TargetTransLanguage"
373     )
374     from $o.readings
375 then
376     System.out.println("適正温度のときより-1ポンドのガットが適切です.");
377     TTTS("適正温度のときより-1ポンドのガットが適切です.",Integer.parseInt($op2.
            getValue().toString()));
378 end
```

A.3 オムロンのセンサー定義

A.3.1 EnvSensor.java

```
1  package org.langrid.waikiki.sensor.omron;
2
3  public class EnvSensor {
4      public EnvSensor() {
5      }
6      //EnvSensor 11個の変数
7      public EnvSensor(
8              String uuid,
9              int lineNo, int temperature, int humidity, int brightness,
```

```
10              int uvIndex, int pressure, int noise,
11              int discomfortIndex, int heatstrokeIndex, int cellVoltage) {
12          this.uuid = uuid;
13          this.lineNo = lineNo;
14          this.temperature = temperature;
15          this.humidity = humidity;
16          this.brightness = brightness;
17          this.uvIndex = uvIndex;
18          this.pressure = pressure;
19          this.noise = noise;
20          this.discomfortIndex = discomfortIndex;
21          this.heatstrokeIndex = heatstrokeIndex;
22          this.cellVoltage = cellVoltage;
23      }
24  //行番号が1,その他が2バイトずつの19バイト
25      public static EnvSensor create(String uuid, byte[] bytes){
26          if(bytes.length != 19) throw new RuntimeException("The length of bytes
                must be 19");
27          return new EnvSensor(
28                  uuid,
29                  (int)bytes[0],
30                  bytes[1] + (bytes[2] << 8),
31                  bytes[3] + (bytes[4] << 8),
32                  bytes[5] + (bytes[6] << 8),
33                  bytes[7] + (bytes[8] << 8),
34                  bytes[9] + (bytes[10] << 8),
35                  bytes[11] + (bytes[12] << 8),
36                  bytes[13] + (bytes[14] << 8),
37                  bytes[15] + (bytes[16] << 8),
38                  bytes[17] + (bytes[18] << 8));
39      }
40
41      public String getUuid() {
42          return uuid;
43      }
44      public void setUuid(String uuid) {
45          this.uuid = uuid;
46      }
47      public int getLineNo() {
48          return lineNo;
49      }
50      public void setLineNo(int lineNo) {
51          this.lineNo = lineNo;
52      }
53      public int getTemperature() {
54          return temperature;
55      }
56      public void setTemperature(int temperature) {
57          this.temperature = temperature;
58      }
59      public int getHumidity() {
60          return humidity;
61      }
```

```
62      public void setHumidity(int humidity) {
63          this.humidity = humidity;
64      }
65      public int getBrightness() {
66          return brightness;
67      }
68      public void setBrightness(int brightness) {
69          this.brightness = brightness;
70      }
71      public int getUvIndex() {
72          return uvIndex;
73      }
74      public void setUvIndex(int uvIndex) {
75          this.uvIndex = uvIndex;
76      }
77      public int getPressure() {
78          return pressure;
79      }
80      public void setPressure(int pressure) {
81          this.pressure = pressure;
82      }
83      public int getNoise() {
84          return noise;
85      }
86      public void setNoise(int noise) {
87          this.noise = noise;
88      }
89      public int getDiscomfortIndex() {
90          return discomfortIndex;
91      }
92      public void setDiscomfortIndex(int discomfortIndex) {
93          this.discomfortIndex = discomfortIndex;
94      }
95      public int getHeatstrokeIndex() {
96          return heatstrokeIndex;
97      }
98      public void setHeatstrokeIndex(int heatstrokeIndex) {
99          this.heatstrokeIndex = heatstrokeIndex;
100     }
101     public int getCellVoltage() {
102         return cellVoltage;
103     }
104     public void setCellVoltage(int cellVoltage) {
105         this.cellVoltage = cellVoltage;
106     }
107
108     private String uuid;
109     private int lineNo; // ("行番号: " + bytes[0]);
110     private int temperature; // ("温度: " + (bytes[1] + (bytes[2] << 8)));
111     private int humidity; // ("相対湿度: " + (bytes[3] + (bytes[4] << 8)));
112     private int brightness; // ("照度: " + (bytes[5] + (bytes[6] << 8)));
113     private int uvIndex; // ("UVI: " + (bytes[7] + (bytes[8] << 8)));
114     private int pressure; // ("気圧: " + (bytes[9] + (bytes[10] << 8)));
```

```
115     private int noise; // ("騒音: " + (bytes[11] + (bytes[12] << 8)));
116     private int discomfortIndex; // ("不快指数: " + (bytes[13] + (bytes[14] <<
            8)));
117     private int heatstrokeIndex; // ("熱中症危険度: " + (bytes[15] + (bytes[16]
            << 8)));
118     private int cellVoltage; // ("電池電圧: " + (bytes[17] + (bytes[18] <<
            8)));
119 }
```

A.3.2 EnvSensorListener.java

```
1  package org.langrid.waikiki.sensor.omron;
2
3  public interface EnvSensorListener {
4      void onFound(EnvSensor sensor);
5  }
```

A.3.3 EnvSensorScanner.java

```
1  package org.langrid.waikiki.sensor.omron;
2
3  import java.util.LinkedHashSet;
4  import java.util.Set;
5
6  import org.robovm.apple.corebluetooth.CBAdvertisementData;
7  import org.robovm.apple.corebluetooth.CBCentralManager;
8  import org.robovm.apple.corebluetooth.CBCentralManagerDelegateAdapter;
9  import org.robovm.apple.corebluetooth.CBCharacteristic;
10 import org.robovm.apple.corebluetooth.CBPeripheral;
11 import org.robovm.apple.corebluetooth.CBPeripheralDelegateAdapter;
12 import org.robovm.apple.corebluetooth.CBService;
13 import org.robovm.apple.foundation.NSData;
14 import org.robovm.apple.foundation.NSError;
15 import org.robovm.apple.foundation.NSNumber;
16
17 import jp.go.nict.langrid.client.jsonrpc.JsonRpcClientFactory;
18 import jp.go.nict.langrid.repackaged.net.arnx.jsonic.JSON;
19
20 public class EnvSensorScanner {
21     private Set<CBPeripheral> peripherals;
22     private CBCentralManager central;
23     public void startScan(EnvSensorListener listener){
24         this.peripherals = new LinkedHashSet<>();
25         this.central = new CBCentralManager(
26                 new CBCentralManagerDelegateAdapter(){
27                     @Override
28                     public void didUpdateState(CBCentralManager central) {
29                         switch(central.getState().toString()){
30                             case "PoweredOn":
31                                 central.scanForPeripherals(null, null);
32                                 break;
33                         }
34                         super.didUpdateState(central);
```

```
35                  }
36                  @Override
37                  public void didDiscoverPeripheral(CBCentralManager central,
                        CBPeripheral peripheral, CBAdvertisementData
                        advertisementData, NSNumber rssi) {
38                      if(peripherals.contains(peripheral)) return;
39                      peripherals.add(peripheral);
40                      System.out.println(peripheral);
41                      if("EnvSensor-BL01".equals(peripheral.getName())){
42                          central.connectPeripheral(peripheral, null);
43                      }
44                  }
45                  @Override
46                  public void didConnectPeripheral(CBCentralManager central,
                        CBPeripheral peripheral) {
47                      peripheral.setDelegate(new CBPeripheralDelegateAdapter
                            (){
48                          @Override
49                          public void didDiscoverServices(CBPeripheral
                                peripheral, NSError error) {
50                              for(CBService s : peripheral.getServices()){
51                                  if(s.getUUID().toString().equals("0C4C3000
                                        -7700-46F4-AA96-D5E974E32A54")){
52                                      peripheral.discoverCharacteristics(null
                                            , s);
53                                  }
54                              }
55                          }
56                          @Override
57                          public void didDiscoverCharacteristics(CBPeripheral
                                peripheral, CBService service,
58                                  NSError error) {
59                              for(CBCharacteristic c : service.
                                    getCharacteristics()){
60                                  if(c.getUUID().toString().equals("0C4C3001
                                        -7700-46F4-AA96-D5E974E32A54")){
61                                      peripheral.readValue(c);
62                                  }
63                              }
64                          }
65                          @Override
66                          public void didUpdateValue(CBPeripheral peripheral,
                                CBCharacteristic characteristic,
67                                  NSError error) {
68                              NSData data = characteristic.getValue();
69                              listener.onFound(EnvSensor.create(peripheral.
                                    getIdentifier().toString(), data.getBytes
                                    ()));
70                          }
71                      });
72                      peripheral.discoverServices(null);
73                  }
74                  @Override
```

```
75                      public void didFailToConnectPeripheral(CBCentralManager
                            central, CBPeripheral peripheral,
76                              NSError error) {
77                          System.out.println("failed to connected to " +
                                peripheral);
78                      }
79                  }, null
80                  );
81      }
82      public void stopScan(){
83          central.stopScan();
84      }
85  }
```

A.4 OpenIoTのデータ定義

A.4.1 Observation.java

```
1  package org.openiot.lsm.beans;
2  /**
3  *     Copyright (c) 2011-2014, OpenIoT
4  *
5  *     This file is part of OpenIoT.
6  *
7  *     OpenIoT is free software: you can redistribute it and/or modify
8  *     it under the terms of the GNU Lesser General Public License as published
       by
9  *     the Free Software Foundation, version 3 of the License.
10 *
11 *     OpenIoT is distributed in the hope that it will be useful,
12 *     but WITHOUT ANY WARRANTY; without even the implied warranty of
13 *     MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
14 *     GNU Lesser General Public License for more details.
15 *
16 *     You should have received a copy of the GNU Lesser General Public License
17 *     along with OpenIoT.  If not, see <http://www.gnu.org/licenses/>.
18 *
19 *      Contact: OpenIoT mailto: info@openiot.eu
20 */
21 import java.util.ArrayList;
22 import java.util.Date;
23
24 /**
25  *
26  * @author Hoan Nguyen Mau Quoc
27  *
28  */
29 public class Observation implements java.io.Serializable {
30      private String id;
31      private Date times;
32      private String sensorId;
33      private String featureOfInterest="";
```

```
34      private ArrayList<ObservedProperty> readings;
35      private String metaGraph;
36      private String dataGraph;
37
38      public Observation(){
39          id = ""+System.nanoTime();
40          readings = new ArrayList<ObservedProperty>();
41      }
42
43      public String getId() {
44          return id;
45      }
46      public void setId(String id) {
47          this.id = id;
48      }
49      public Date getTimes() {
50          return times;
51      }
52      public void setTimes(Date times) {
53          this.times = times;
54      }
55      public String getSensor() {
56          return sensorId;
57      }
58      public void setSensor(String sensorId) {
59          this.sensorId = sensorId;
60      }
61      public String getFeatureOfInterest() {
62          return featureOfInterest;
63      }
64      public void setFeatureOfInterest(String featureOfInterest) {
65          this.featureOfInterest = featureOfInterest;
66      }
67      public ArrayList<ObservedProperty> getReadings() {
68          return readings;
69      }
70      public void setReadings(ArrayList<ObservedProperty> readings) {
71          this.readings = readings;
72      }
73
74      public void addReading(ObservedProperty reading){
75          readings.add(reading);
76      }
77
78      public void removeReading(ObservedProperty reading){
79          readings.remove(reading);
80      }
81
82      public String getMetaGraph() {
83          return metaGraph;
84      }
85
86      public void setMetaGraph(String metaGraph) {
```

```
87          this.metaGraph = metaGraph;
88      }
89
90      public String getDataGraph() {
91          return dataGraph;
92      }
93
94      public void setDataGraph(String dataGraph) {
95          this.dataGraph = dataGraph;
96      }
97
98  }
```

A.4.2 ObserbatonProperty.java

```
 1  package org.openiot.lsm.beans;
 2  /**
 3  *     Copyright (c) 2011-2014, OpenIoT
 4  *
 5  *     This file is part of OpenIoT.
 6  *
 7  *     OpenIoT is free software: you can redistribute it and/or modify
 8  *     it under the terms of the GNU Lesser General Public License as published
        by
 9  *     the Free Software Foundation, version 3 of the License.
10  *
11  *     OpenIoT is distributed in the hope that it will be useful,
12  *     but WITHOUT ANY WARRANTY; without even the implied warranty of
13  *     MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
14  *     GNU Lesser General Public License for more details.
15  *
16  *     You should have received a copy of the GNU Lesser General Public License
17  *     along with OpenIoT.  If not, see <http://www.gnu.org/licenses/>.
18  *
19  *      Contact: OpenIoT mailto: info@openiot.eu
20  */
21  import java.util.ArrayList;
22  import java.util.Date;
23
24  /**
25   *
26   * @author Hoan Nguyen Mau Quoc
27   *
28   */
29  public class Observation implements java.io.Serializable {
30      private String id;
31      private Date times;
32      private String sensorId;
33      private String featureOfInterest="";
34      private ArrayList<ObservedProperty> readings;
35      private String metaGraph;
36      private String dataGraph;
37
```

```
38      public Observation(){
39          id = ""+System.nanoTime();
40          readings = new ArrayList<ObservedProperty>();
41      }
42
43      public String getId() {
44          return id;
45      }
46      public void setId(String id) {
47          this.id = id;
48      }
49      public Date getTimes() {
50          return times;
51      }
52      public void setTimes(Date times) {
53          this.times = times;
54      }
55      public String getSensor() {
56          return sensorId;
57      }
58      public void setSensor(String sensorId) {
59          this.sensorId = sensorId;
60      }
61      public String getFeatureOfInterest() {
62          return featureOfInterest;
63      }
64      public void setFeatureOfInterest(String featureOfInterest) {
65          this.featureOfInterest = featureOfInterest;
66      }
67      public ArrayList<ObservedProperty> getReadings() {
68          return readings;
69      }
70      public void setReadings(ArrayList<ObservedProperty> readings) {
71          this.readings = readings;
72      }
73
74      public void addReading(ObservedProperty reading){
75          readings.add(reading);
76      }
77
78      public void removeReading(ObservedProperty reading){
79          readings.remove(reading);
80      }
81
82      public String getMetaGraph() {
83          return metaGraph;
84      }
85
86      public void setMetaGraph(String metaGraph) {
87          this.metaGraph = metaGraph;
88      }
89
90      public String getDataGraph() {
```

```
91          return dataGraph;
92      }
93
94      public void setDataGraph(String dataGraph) {
95          this.dataGraph = dataGraph;
96      }
97
98  }
```