



The Mobile
Hub

Luis Talavera
Advisor:
Markus Endler

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The Mobile Hub: An energy-aware IoT Gateway with data processing capabilities

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Outline

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Figure: Events occur at every second of every day



Main Challenges

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- Discovery and management of devices
- Processing of large data streams
- Power management in mobile devices
- Security and privacy of personal information



Overview

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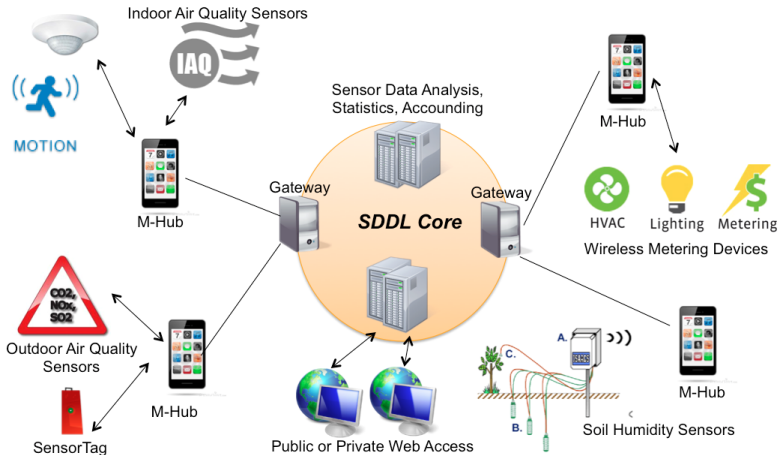
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Moible Hub Concept

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- It is a mobile middleware
- Discovers and connects M-OBJs (Things) to the Internet
- Provides context information
- Detect complex events



Architecture

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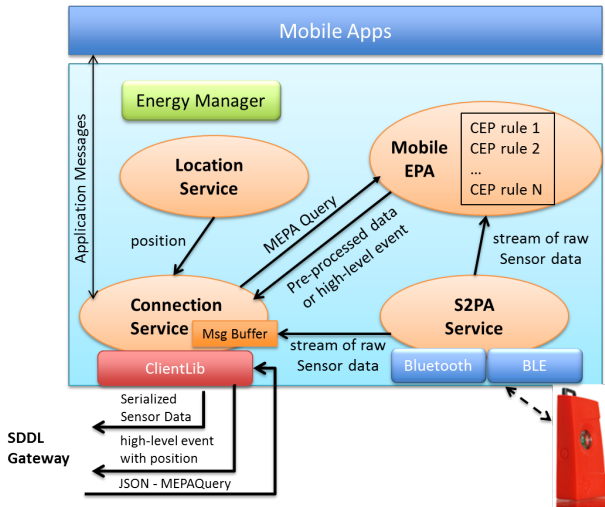
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Short-Range Sensor, Presence and Actuation API

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Maps the main capabilities of each WPAN technology:

- Discovery of, and connection to M-OBJs
- Discovery of services provided by each M-OBJ
- Read and write of service attributes
- Notifications about disconnection of M-OBJs



Interfaces

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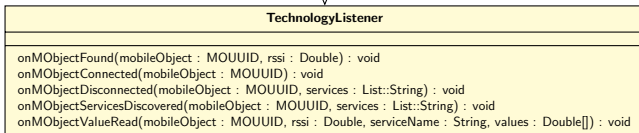
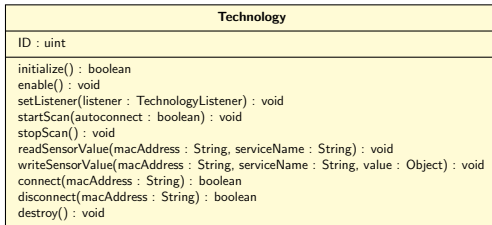


Figure: Main interfaces used by the S2PA Service to communicate with M-OBJs.



Mobile Event Processing Agent

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- Process sensor data streams using CEP
- CEP looks for event patterns (rules) over the stream data
- To define CEP rules it uses a SQL-like language
- Rules can be deployed/remove dynamically



Outgoing Messages

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Samples the current location of the Mobile Hub

Listing 1: LocationData

```
{  
  "tag": "LocationData",  
  "uuid": "b06de58d-6a20-44f9-8cd4-83f074c2edd6",  
  "latitude": -22.98137128,  
  "longitude": -43.23421961,  
  "battery": 50,  
  "charging": false,  
  "timestamp": 1442169467  
}
```



Outgoing Messages

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Information about the M-OBJs (e.g. sensors)

Listing 2: SensorData

```
{  
  "tag": "SensorData", *  
  "uuid": "b06de58d-6a20-44f9-8cd4-83f074c2edd6", *  
  "source": "00000000-0000-0000-0001-bc6a29aecef5", *  
  "action": "found|connected|disconnected|read", *  
  "signal": -48,  
  "sensor_name": "Temperature",  
  "sensor_value": [21.70,23.42],  
  "latitude": -22.98137128,  
  "longitude": -43.23421961,  
  "timestamp": 1442169467 *  
}
```



Complex Events detected by the MEPA Service

Listing 3: EventData

```
{
  "tag": "EventData",
  "uuid": "b06de58d-6a20-44f9-8cd4-83f074c2edd6",
  "label": "AVGTemp",
  "data": {"value": 22.30},
  "latitude": -22.98137128,
  "longitude": -43.23421961,
  "timestamp": 1442169467
}
```



Outgoing Messages

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Errors from the Mobile Hub (e.g. wrong CEP rule syntax) or Replies (e.g. Response from a MEPA Query)

Listing 4: MessageData

```
{  
  "tag": "ErrorData|ReplyData",  
  "uuid": "b06de58d-6a20-44f9-8cd4-83f074c2edd6",  
  "component": "MEPAService|S2PAService",  
  "message": "Action not supported.",  
  "latitude": -22.98137128,  
  "longitude": -43.23421961,  
  "timestamp": 1442169467  
}
```



Incoming Messages

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Can modify the current state of the MEPA Service

Listing 5: MEPAQuery

```
{
  "MEPAQuery": {
    "type": "add|remove|start|stop|clear|get",
    "label": "AVGTemp",
    "object": "rule|event",
    "rule": "SELECT avg(sensorValue[1]) as value FROM
             SensorData(sensorName='Temperature')
             .win:time_batch(10 sec)",
    "target": "local|global"
  }
}
```



Core Server

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```
public class CoreServer implements
    UIDataReaderListener<ApplicationObject> {

    /** SDDL Elements */
    private Object receiveMessageTopic;
    private Object toMobileNodeTopic;
    private static SddlLayer core;

    public static void main( String[] args ) {
        new CoreServer();
    }

    @Override
    public void onNewData( ApplicationObject topicSample ) {

    }
}
```




Core Server

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```
private CoreServer() {  
    // Create a layer and participant  
    core = UniversalDDSLayerFactory.getInstance(  
        SupportedDDSVendors.OpenSplice );  
    core.createParticipant(  
        UniversalDDSLayerFactory.CNET_DOMAIN );  
    // Receive and write topics to domain  
    core.createPublisher();  
    core.createSubscriber();  
    // ClientLib Events  
    receiveMessageTopic = core.createTopic(  
        Message.class,  
        Message.class.getSimpleName() );  
    core.createDataReader(  
        this,  
        receiveMessageTopic );  
    // To ClientLib  
    toMobileNodeTopic = core.createTopic(  
        PrivateMessage.class,  
        PrivateMessage.class.getSimpleName() );  
    core.createDataWriter( toMobileNodeTopic );  
}
```



Core Server: Send Messages

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```
ApplicationMessage appMsg = new ApplicationMessage();  
appMsg.setPayloadType( PayloadSerialization.JSON );  
appMsg.setContentObject( "[" + message + "]" );  
sendUnicastMSG( appMsg, nodeDest );
```

...

```
public static void sendUnicastMSG(  
    ApplicationMessage appMSG, UUID nodeID ) {  
    PrivateMessage privateMSG = new PrivateMessage();  
    privateMSG.setGatewayId(  
        UniversalDDSLayerFactory.BROADCAST_ID );  
    privateMSG.setNodeId( nodeID );  
    privateMSG.setMessage(  
        Serialization.toProtocolMessage( appMSG ) );  
  
    core.writeTopic(  
        PrivateMessage.class.getSimpleName(),  
        privateMSG );  
}
```



Core Server: Receive Messages

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```
@Override
public void onNewData( ApplicationObject topicSample ) {
    msg = (Message) topicSample;
    String content = new String( msg.getContent() );
    ...
    JSONObject object = (JSONObject) parser.parse( content );
    String tag = (String) object.get( "tag" );

    switch( tag ) {
        case "SensorData": ...
        break;
        case "EventData": ...
        break;
        case "ReplyData": ...
        break;
        case "ErrorData": ...
        break;
    }
}
```



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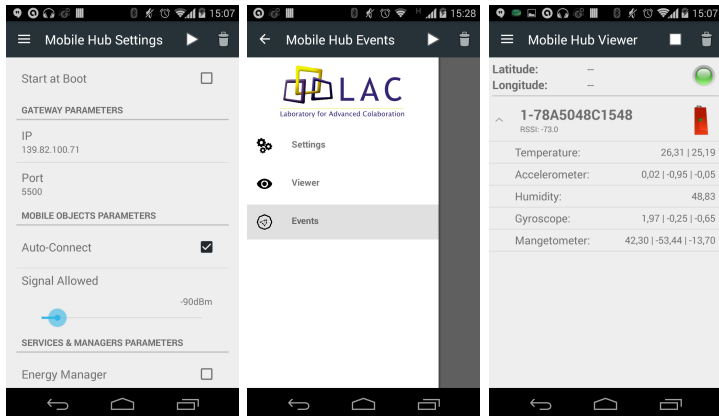


Figure: Screenshots of the M-Hub and its configuration windows



Execution & Resources

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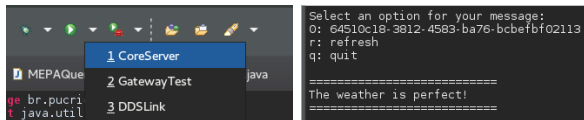
Demo

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- First, create a gateway, it receives the public IP, the port and the DDS product

```
$ gateway 127.0.0.1 5500 OpenSplice
```

- Then, instantiate the processing node,





Execution & Resources

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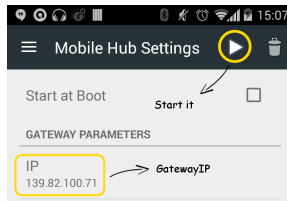
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- And finally, start the Mobile Hub,



- Deploy some rules and connect some M-OBJs
- All the code and other resources can be downloaded from:
<https://bitbucket.org/luistlvr/simpleserver>



CEP Rules Example

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```
[{
  "MEPAQuery": {
    "type": "add",
    "label": "AVGTemp",
    "rule": "SELECT avg(sensorValue[1]) as value FROM
              SensorData(sensorName='Temperature').
              win:time_batch(10 sec)",
    "target": "local"
  }
}, {
  "MEPAQuery": {
    "type": "add",
    "label": "MaxAVG",
    "rule": "SELECT max(value) as average FROM
              AVGTemp.win:length_batch(3)",
    "target": "global"
  }
}]
```



CEP Rules Example

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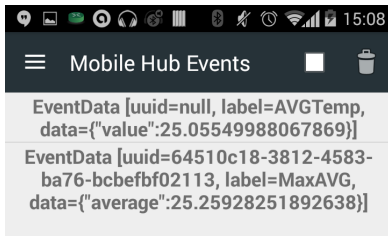
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The two previous events being shown in the event viewer





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Email: luistlvr1989@gmail.com

<http://www.lac.inf.puc-rio.br/dokuwiki/doku.php>

<https://bitbucket.org/luistlvr/simpleserver>