Open Mobile Alliance
Lightweight Machine-2-Machine (LwM2M)
and related open standards for managing sensor/actuator devices in IoT application scenarios

Francesco Doddo
IoT System Development Manager
Application Scenarios

Smart Home & City

Smart Industry
End-to-End View

Wireless Sensors Nodes
- IP based connectivity
- Motion, Environmental, ToF sensors
- Generic Data Model

Terminal

Cloud
- Application Services
- IoT Devices Management (bootstrap, Firmware Update, Change settings)
- Sensors Data Access
- Actuators Control

Manage Home/City Devices

Sensors Data Collection

Actuators Management

Terminal
Data Access and Management of IoT Devices: Emerging Open Standards

- Data Model: IPSO Smart Objects, LwM2M Objects
- Device Management: OMA Lightweight M2M (LwM2M)
- Connectivity Protocols: CoAP, DTLS, 6LoWPAN
CoAP:
- Makes each IoT device a lightweight server that exposes a REST API
- Similar to HTTP, but designed for low power devices
- Publish/Subscribe support
- Specified in RFC 7252

DTLS:
- Provides communication security by providing confidentiality, integrity and authentication
- Specified in RFC 6347 and builds on TLS 1.2

6LoWPAN:
- Adaptation layer to transport IPv6 over low-power RF links
- Specified by RFC 6282 for 802.15.4
Protocol Stack of an IP Based IoT Device

Application Software
- IPSO, LwM2M Objects, OCF, etc…
- mDNS, DNS-SD, etc…
- LwM2M
- CoAP
- HTTP
- MQTT
- DTLS/TLS
- UDP/TCP
- RPL
- IPV6/IPV4
- 6LoWPAN
- NDv6
- 802.15.4 (G)
- Wi-Fi
- ETH
- MCU

Applications
- Data Models
- API and Services
- Application Protocols
- Transport Layer Security
- Transport Protocols
- Networking Protocols
- Link Layer
- Hardware
OMA Lightweight M2M (LwM2M):
- Management protocol for resource constrained devices (e.g. Sensor hub)
- Features: device bootstrapping (service provisioning, key management), firmware update, remote management (change settings, trigger actuators), fault management, information reporting (notification of sensors values)
- Simple and extensible Data Model
- Version 1.0 ratified in Feb. 2017

LwM2M Interfaces:
1. Bootstrap
2. Registration
3. Device Management & Service Enablement
4. Reporting

LwM2M over UDP Protected by DTLS

IoT Device

LWM2M Client

Objects

IoT Service

LWM2M Server

LWM2M Bootstrap Server
LwM2M Interfaces

**Bootstrap**
- LwM2M Client
- LwM2M Bootstrap Server
- Bootstrap Request
- Write
- Discover
- Delete
- Bootstrap Finish

**Device Management And Service Enablement**
- LwM2M Client
- LwM2M Server
- Read
- Write
- Execute
- Create
- Delete
- Write Attribute
- Discover

**Client Registration**
- LwM2M Client
- LwM2M Server
- Register
- Update
- De-register

**Information Reporting**
- LwM2M Client
- LwM2M Server
- Observe
- Cancel Observ.
- Notification
LwM2M Object Model

Objects/Resources are accessed with simple URIs: 
/{Object ID}/{Object Instance}/{Resource ID}

- Defines the object type
- Instance Number (one or more)
- Defines the Resource type

Reusable resource and object IDs
- Common definitions
- Map to semantic terms (e.g. temperature)
- IDs uniquely defined since they are registered by the Open Mobile Naming Authority (OMNA)

For example, take the case of a weather station device in your home: the access on this device/object/resource can be made at:

/home/weather/3303/0/5700
- a reply from the device will provide a reading of the value from a **Temperature Sensor** (Object ID: 3303), **Instance #0**, **Sensor Value** (Resource ID: 5700)

/home/weather/3304/0/5602
- a reply from the device will provide a reading of the value from a **Humidity Sensor** (Object ID: 3304), **Instance #0**, **Max Measured Value** (Resource ID: 5602)
LwM2M Objects
(defined by OMA)

- The LwM2M v1.0 standard defines 8 objects
- Other organizations (for ex. IPSO Alliance) and vendors can define some objects
- A public repository managed by the OMA contains all the registered objects

<table>
<thead>
<tr>
<th>OMA Defined Object</th>
<th>Object ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LwM2M Security</td>
<td>0</td>
<td>Keying material of a LwM2M client to access a specified LwM2M server</td>
</tr>
<tr>
<td>LwM2M Server</td>
<td>1</td>
<td>Data related to a LwM2M server</td>
</tr>
<tr>
<td>Access Control</td>
<td>2</td>
<td>Used to check whether the LwM2M server has access right for performing an operation</td>
</tr>
<tr>
<td>Device</td>
<td>3</td>
<td>Device related information which can be queried by the server, include device reboot and factory reset functions</td>
</tr>
<tr>
<td>Connectivity Monitoring</td>
<td>4</td>
<td>Monitoring of parameters related to network connectivity</td>
</tr>
<tr>
<td>Firmware</td>
<td>5</td>
<td>Management of firmware to be updated (FOTA)</td>
</tr>
<tr>
<td>Location</td>
<td>6</td>
<td>Information related to device location</td>
</tr>
<tr>
<td>Connectivity Statistics</td>
<td>7</td>
<td>Statistics about connectivity collected by the client</td>
</tr>
</tbody>
</table>
**LwM2M Objects (defined by IPSO Alliance)**

**«IPSO Smart Objects»:**
- Simple Data Model for semantic interoperability across IoT Devices
- Compliant with the LwM2M specification
- 54 standards sensors and actuator Objects already specified and inserted in the OMA public registry

**LwM2M Client Device Example**
(with Temperature, Humidity sensors and LED actuator)

<table>
<thead>
<tr>
<th>IPSO Temperature Sensor Object (Instance: 0)</th>
<th>IPSO Humidity Sensor Object (Instance: 0)</th>
<th>IPSO Light Control Object (Instance: 0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object ID: 3303</td>
<td>Object ID: 3304</td>
<td>Object ID: 3311</td>
</tr>
<tr>
<td>Resource: Max Measured Value (ID: 5602)</td>
<td>Resource: Max Measured Value (ID: 5602)</td>
<td></td>
</tr>
</tbody>
</table>
**Object Info:**

<table>
<thead>
<tr>
<th>Object</th>
<th>Object ID</th>
<th>Object URN</th>
<th>Multiple Instances?</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPSO Temperature</td>
<td>3303</td>
<td>urn:oma:lwmc2m:ext:3303</td>
<td>Yes</td>
<td>Temperature sensor, example units = °C</td>
</tr>
</tbody>
</table>

**Resources:**

<table>
<thead>
<tr>
<th>Resource Name</th>
<th>Resource ID</th>
<th>Access Type</th>
<th>Multiple Instances?</th>
<th>Mandatory</th>
<th>Type</th>
<th>Range or Enumeration</th>
<th>Units</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor Value</td>
<td>5700</td>
<td>R</td>
<td>No</td>
<td>Mandatory</td>
<td>Float</td>
<td></td>
<td></td>
<td>Last or Current Measured Value from the Sensor</td>
</tr>
<tr>
<td>Units</td>
<td>5701</td>
<td>R</td>
<td>No</td>
<td>Optional</td>
<td>String</td>
<td></td>
<td></td>
<td>Measurement Units</td>
</tr>
</tbody>
</table>

**Object Info:**

<table>
<thead>
<tr>
<th>Object</th>
<th>Object ID</th>
<th>Object URN</th>
<th>Multiple Instances?</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPSO Light Control</td>
<td>3311</td>
<td>urn:oma:lwmc2m:ext:3311</td>
<td>Yes</td>
<td>Light control object with on/off and optional dimming and energy monitor</td>
</tr>
</tbody>
</table>

**Resources:**

<table>
<thead>
<tr>
<th>Resource Name</th>
<th>Resource ID</th>
<th>Access Type</th>
<th>Multiple Instances?</th>
<th>Mandatory</th>
<th>Type</th>
<th>Range or Enumeration</th>
<th>Units</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-Off</td>
<td>5850</td>
<td>R, W</td>
<td>No</td>
<td>Mandatory</td>
<td>Boolean</td>
<td></td>
<td></td>
<td>On/off control, 0=OFF, 1=ON</td>
</tr>
<tr>
<td>Dimmer</td>
<td>5851</td>
<td>R, W</td>
<td>No</td>
<td>Optional</td>
<td>Integer</td>
<td>0-100</td>
<td>%</td>
<td>Proportional control,</td>
</tr>
</tbody>
</table>

**Source:** IPSO Alliance

**Definition of an IPSO Object and associated Resources**

Resources are reusable (the same can be used in multiple object definitions)

Allowed Access Type from Server e.g. Read (R), Execute (E)...
### IPSO Smart Object

**XML Version in the OMA registry**

<table>
<thead>
<tr>
<th>URN / Version</th>
<th>ObjectID / xml</th>
<th>LwM2M Editor</th>
<th>Version</th>
<th>Object Name / Specification</th>
<th>Owner</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>urn:oma:lwm2m:ext:3303</td>
<td>3303</td>
<td>3303</td>
<td>-</td>
<td>Temperature Sensor</td>
<td>IPSO Alliance</td>
<td>This IPSO object should be used with a temperature sensor to report a remote temperature measurement. It also provides resources for minimum/maximum measured values and the minimum/maximum range that can be measured by the temperature sensor. An example measurement unit is degree Celsius (°C).</td>
</tr>
</tbody>
</table>


```xml
<Object ObjectType="XMLDefinition">
  <Name>Temperature</Name>
  <Description>This IPSO object should be used with a temperature sensor to report a remote temperature measurement. It also provides resources for minimum/maximum measured values and the minimum/maximum range that can be measured by the temperature sensor. An example measurement unit is degree Celsius (°C).</Description>
  <ObjectID>3303</ObjectID>
  <ObjectURN>urn:oma:lwm2m:ext:3303</ObjectURN>
  <MultipleInstances>Multiple</MultipleInstances>
  <Mandatory>Optional</Mandatory>
  <Resources>
    <Item ID="5780">
      <Name>Sensor Value</Name>
      <Operations>Read</Operations>
      <MultipleInstances>Singles</MultipleInstances>
      <Mandatory>Mandatory</Mandatory>
      <Type>Float</Type>
      <Range>Enumeration</Range>
      <Units>Defined by "Units" resource</Units>
      <Description>Last or Current Measured Value from the Sensor</Description>
    </Item>
    <Item ID="5681">
      <Name>Min Measured Value</Name>
      <Operations>Read</Operations>
      <MultipleInstances>Singles</MultipleInstances>
      <Mandatory>Optional</Mandatory>
      <Type>Float</Type>
    </Item>
    <Item ID="5682">
      <Name>Max Measured Value</Name>
      <Operations>Read</Operations>
      <MultipleInstances>Singles</MultipleInstances>
      <Mandatory>Optional</Mandatory>
      <Type>Float</Type>
    </Item>
  </Resources>
</Object>
```

### XML Definition of the an Object Stored in the OMA Registry

**Example here with Object 3303: Temperature Sensor**

[http://www.openmobilealliance.org/tech/profiles/lwm2m/3303.xml](http://www.openmobilealliance.org/tech/profiles/lwm2m/3303.xml)

**Source:** [http://www.openmobilealliance.org/wp/OMNA/LwM2M/LwM2MRegistry.html](http://www.openmobilealliance.org/wp/OMNA/LwM2M/LwM2MRegistry.html)
Interaction Scenarios Examples

- **Reading a Humidity Sensor Value**
  - Client: `READ /3304/0/5700
  - Server: "75"

- **Rebooting the Device**
  - Client: `EXECUTE /3/0/4
  - Server: SUCCESS

- **Retrieving the Device Battery Level**
  - Client: `READ /3/0/9
  - Server: "46"

- **Switch a Light On**
  - Client: `WRITE /3311/0/5850
  - Server: SUCCESS

- **Receiving Notifications of Temperature Sensor Value Changes**
  - Client: `READ /3303/0/5700
  - Server: "22"
  - Option: OBSERVE
  - "24"

- **Firmware Update**
  - Client: `WRITE /5/0/0
  - Server: ACK MSG #1
  - FW MSG #1
  - WRITE /5/0/0
  - FW MSG #N
  - ACK MSG #N
Benefits for the IoT Scenarios

LwM2M and related standards cover the IoT needs
• Horizontal and extensible open standard
• Proven Web paradigm (“REST”) applied to the IoT
• Single protocol for device and application management
• Based on efficient communication protocols, designed for low power resource constrained devices (e.g. CoAP)
• State of the art security (DTLS)
• Open source implementations for both server and client are available
STM32 ODE

Fast, affordable prototyping & development

Tools & IDEs
- Developer community and support
  - Compatibility with free & commercial Development Environments

Application
- Function Packs
  - Set of function examples for some of the most common application cases

Middleware
- STM32Cube middleware
- STM32Cube Expansion middleware

Hardware Abstraction
- STM32Cube Hardware Abstraction Layer (HAL)
- STM32Cube Expansion HAL

Hardware
- STM32 Nucleo development boards
- STM32 Nucleo expansion boards (X-NUCLEO)

- Cloud Connectivity
- Safety & Security
- Networking
- Sensing

STM32 Nucleo development boards
- Move / Actuate
- Connect
- Translate
- Power

www.st.com/stm32ode
STM32 ODE Function Packs

A set of key building blocks used in most popular application domains

STM32Cube middleware
STM32Cube expansion middleware
STM32Cube Hardware Abstraction Layer
STM32Cube expansion Hardware Abstraction Layer
STM32 Nucleo development boards
STM32 Nucleo expansion boards

Sample applications
Mobile apps

Pre-packaged offer integrating functionality from several expansion boards

Cloud
Wearable
IoT
Smart Things
Home applications
Building automation

Sample applications

STM32Cube middleware
STM32Cube expansion middleware
STM32Cube Hardware Abstraction Layer
STM32Cube expansion Hardware Abstraction Layer
STM32 Nucleo development boards
STM32 Nucleo expansion boards

Mobile apps

Cloud
Wearable
IoT
Smart Things
Home applications
Building automation

Pre-packaged offer integrating functionality from several expansion boards
STM32 ODE Function Pack
FP-SNS-6LPNODE1: 6LoWPAN Node

FP-SNS-6LPNODE1 Function Pack
• This firmware package allows connecting an IoT node with sensors and actuators to a 6LoWPAN network, using sub-1GHz RF communication technology
• Middleware library with Contiki OS and Contiki 6LoWPAN protocol stack 3.x
• Support for mesh networking technology through the standard RPL protocol
• Environmental, Motion MEMS and Time of Flight sensors supported
• Embedded LwM2M Client with IPSO Smart Objects representation of sensors

Latest info available at www.st.com
FP-SNS-6LPNODE1
## STM32 ODE Function Pack
### FP-SNS-6LPNODE1: LwM2M/IPSO Objects

<table>
<thead>
<tr>
<th>Object</th>
<th>ID</th>
<th>Instances</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Device</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>IPSO Digital Input</td>
<td>3200</td>
<td>1</td>
<td>The instance maps the NUCLEO board User button</td>
</tr>
<tr>
<td>IPSO Light Control</td>
<td>3311</td>
<td>2</td>
<td>The instances map the NUCLEO and X-NUCLEO-IDS01A4/5 boards LEDs</td>
</tr>
</tbody>
</table>

**LwM2M/IPSO Objects for STM32 Nucleo Board**

<table>
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<th>ID</th>
<th>Instances</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Device</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>IPSO Digital Input</td>
<td>3200</td>
<td>1</td>
<td>The instance maps the NUCLEO board User button</td>
</tr>
<tr>
<td>IPSO Temperature</td>
<td>3303</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>IPSO Humidity</td>
<td>3304</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>IPSO Light Control</td>
<td>3311</td>
<td>1</td>
<td>The instance maps the NUCLEO board LED</td>
</tr>
<tr>
<td>IPSO Accelerometer</td>
<td>3313</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>IPSO Magnetometer</td>
<td>3314</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>IPSO Barometer</td>
<td>3315</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

**LwM2M/IPSO Objects for Motion & Environmental Sensors**
(X-NUCLEO-IKS01A2 board)

<table>
<thead>
<tr>
<th>Object</th>
<th>ID</th>
<th>Instances</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Device</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>IPSO Digital Input</td>
<td>3200</td>
<td>1</td>
<td>The instance maps the NUCLEO board User button</td>
</tr>
<tr>
<td>IPSO Presence Sensor</td>
<td>3302</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>IPSO Light Control</td>
<td>3311</td>
<td>1</td>
<td>The instance maps the NUCLEO board LED</td>
</tr>
</tbody>
</table>

**LwM2M/IPSO Objects for Proximity and ambient light Sensors**
(X-NUCLEO-6180XA1 board)
STM32 ODE Function Pack
FP-NET-6LPWIFI1: 6LoWPAN-Wi-Fi Bridge

FP-NET-6LPWIFI1 Function Pack

- This firmware package provides application-level functions to bridge 6LoWPAN and Wi-Fi networks
- Middleware library with Contiki OS and Contiki 6LoWPAN protocol stack 3.x
- Support for mesh networking technology by the means of the standard RPL protocol
- Middleware library for Wi-Fi connectivity using the SPWF01SA module

Latest info available at www.st.com

FP-NET-6LPWIFI1
STM32 ODE Solutions
End-to-End Deployment Example
FP-SNS-6LPNODE1 ↔ FP-NET-6LPWIFI1 ↔ LwM2M SERVER
STM32 ODE solutions are interoperable with a public LwM2M Server

- For evaluation purpose, the sensors nodes FP-SNS-6LPNODE1 can be managed by an OMA Lightweight M2M server called “Leshan”
- This public server is available at: http://leshan.eclipse.org
- The server can also be installed on a local machine by the user

WHAT IS ECLIPSE LESHAN?

- Leshan provides libraries that help people develop their own Lightweight M2M server and client
- Eclipse project since 2014
- Modular Java libraries
- Based on Californium CoAP implementation
- Based on Scandium DTLS implementation
- IPSO objects support
- http://www.eclipse.org/leshan/
LwM2M Server Access

LwM2M Server Dashboard (http://leshan.eclipse.org)

Standard Objects implemented on the 6LoWPAN node (running the LwM2M client) accessed by the Leshan LwM2M Server on the Internet

Current temperature and humidity sensor values on the IoT node that are read by the server

LED light control (e.g. ON/OFF) on the node
**Available STM32 ODE Function Packs (1/2)**

<table>
<thead>
<tr>
<th>Function</th>
<th>Application case</th>
<th>STM32 Nucleo Develop. board</th>
<th>X-NUCLEO Expansion board</th>
<th>STM32 ODE Function Pack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local and cloud connectivity</td>
<td>An IoT node with Wi-Fi and sensors, securely connected to Microsoft Azure cloud</td>
<td>NUCLEO-F401RE</td>
<td>X-NUCLEO-IDW01M1 X-NUCLEO-IKS01A2 X-NUCLEO-NFC01A1</td>
<td>FP-CLD-AZURE1</td>
</tr>
<tr>
<td></td>
<td>An IoT node with Wi-Fi, NFC and sensors, securely connected to IBM Bluemix cloud</td>
<td>NUCLEO-F401RE</td>
<td>X-NUCLEO-IDW01M1 X-NUCLEO-IKS01A2 X-NUCLEO-NFC01A1</td>
<td>FP-CLD-WATSON1</td>
</tr>
<tr>
<td></td>
<td>An IoT node with Wi-Fi and sensors, securely connected to Amazon AWS IoT</td>
<td>NUCLEO-F401RE</td>
<td>X-NUCLEO-IDW01M1 X-NUCLEO-IKS01A2</td>
<td>FP-CLD-AWS1</td>
</tr>
<tr>
<td>Sensing</td>
<td>An IoT node with BLE Connectivity, sensors and NFC for simple and secure BLE pairing</td>
<td>NUCLEO-F401RE NUCLEO-L476RG</td>
<td>X-NUCLEO-IDB05A1 X-NUCLEO-IKS01A2 X-NUCLEO-NFC01A1 X-NUCLEO-6180XA1</td>
<td>FP-SNS-FLIGHT1 ST BlueMS</td>
</tr>
<tr>
<td></td>
<td>An IoT node with BLE connectivity and with sensors for temperature, humidity, pressure, motion, and digital microphone</td>
<td>NUCLEO-F401RE NUCLEO-L476RG</td>
<td>X-NUCLEO-IDB05A1 X-NUCLEO-IKS01A2</td>
<td>FP-SNS-ALLMEMS1 ST BlueMS</td>
</tr>
<tr>
<td></td>
<td>An IoT node with BLE Connectivity and with 4 sensors for temperature, humidity, pressure and motion</td>
<td>NUCLEO-F401RE NUCLEO-L476RG NUCLEO-L053R8</td>
<td>X-NUCLEO-IDB05A1 X-NUCLEO-IKS01A2</td>
<td>FP-SNS-MOTENV1 ST BlueMS</td>
</tr>
<tr>
<td>Safe and security</td>
<td>An IoT node with secure BLE network pairing through NFC</td>
<td>NUCLEO-F401RE NUCLEO-L053R8</td>
<td>X-NUCLEO-IDB05A1 X-NUCLEO-NFC01A1</td>
<td>FP-SEC-BLENFC1 ST BlueMS</td>
</tr>
<tr>
<td></td>
<td>An IoT node with secure Wi-Fi network pairing through NFC</td>
<td>NUCLEO-F401RE</td>
<td>X-NUCLEO-IDW01M1 X-NUCLEO-NFC01A1</td>
<td>FP-SEC-WIFINFC1 ST M24SR</td>
</tr>
</tbody>
</table>
Available STM32 ODE Function Packs (2/2)

<table>
<thead>
<tr>
<th>Function</th>
<th>Application case</th>
<th>STM32 Nucleo Develop. board</th>
<th>X-NUCLEO Expansion board</th>
<th>STM32 ODE Function Pack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network infrastructure</td>
<td>A BLE star network connected via Wi-Fi bridge to IBM Bluemix cloud</td>
<td>NUCLEO-F401RE</td>
<td>X-NUCLEO-IDW01M1</td>
<td>FP-NET-BLESTAR1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NUCLEO-L476RG</td>
<td>X-NUCLEO-IDB05A1 (X-NUCLEO-IKS01A2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NUCLEO-L053R8</td>
<td></td>
<td>ST SensNet</td>
</tr>
<tr>
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<td>A bridge to connect 6LoWPAN IoT nodes connected to smartphones via BLE interface</td>
<td>NUCLEO-F401RE</td>
<td>X-NUCLEO-IDS01A4 (X-NUCLEO-IDS01A5)</td>
<td>FP-NET-6LPBLE1</td>
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<td>X-NUCLEO-IDS01A4 (X-NUCLEO-IDS01A5)</td>
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<td>6LowPAN SPIRIT connectivity and bridge to Wi-Fi connectivity</td>
<td>NUCLEO-F401RE</td>
<td>X-NUCLEO-6180XA1 (X-NUCLEO-IKS01A2)</td>
<td>FP-NET-6LPWIFI1</td>
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<td>6LowPAN SPIRIT nodes based on the LwM2M standard</td>
<td>NUCLEO-F401RE</td>
<td>X-NUCLEO-6180XA1 (X-NUCLEO-IKS01A2)</td>
<td>FP-SNS-6LPNODE1</td>
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Questions?