OS-IoT Overview

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Introduction

- ATIS OS-IoT (Open Source – Internet of Things) is an open source platform to support the oneM2M IoT standard
- OS-IoT has a unique focus in the oneM2M software ecosystem which is to support lightweight client applications that can be deployed on constrained devices
- Using OS-IoT simplifies the development of oneM2M applications
- OS-IoT allows developers to focus on differentiating and value-added features, not just protocol issues
The global oneM2M standard provides a common middleware layer for open, secure and interoperable IoT applications.

IoT value realized from oneM2M includes:
- Scaling and manageability of large deployments
- Security and information access control
- Interoperable platform across multiple vendors and verticals
- Aggregation of data from multiple silos

oneM2M is foreseen as having significant potential value in a number of industrial and consumer applications such as Smart Cities, eHealth, Smart Grid.

As a founding Partner of oneM2M, ATIS recognized that Open Source implementations of the standards would complement oneM2M specifications, drive adoption, and enhance commercial value.
oneM2M and Lightweight Clients

• Analysis by ATIS members and an industry survey highlighted a support need for lightweight clients. Example constraints:
  – Constrained compute resources: limited CPU power, limited memory
  – Limited electrical power: e.g. battery powered devices designed for multi-year operation

• Lightweight clients are required for many IoT applications, e.g.:
  – smart metering, smart city/transport, and wearables

• OS-IoT offers portable, lightweight, open source oneM2M client framework to support the adoption of oneM2M in lightweight clients.
OS-IoT Core Concept: Client Library and Demo Applications

- OS-IoT library provides application-independent support of oneM2M client functions for signalling to the server.
- Demo applications show operation of library and act as a template for third-parties to develop their own work.
- OS-IoT provides an open resource-oriented API between applications and library.
- Library and application are compliant to oneM2M standards and pre-integrated with open oneM2M servers.

Enabling application developers to quickly build oneM2M support.
OS-IoT Participation

• Open to both ATIS members and non-members
• Project leader:
  – Farrokh Khatibi (Qualcomm)
• A range of companies from different parts of the ecosystem have participated during the lifecycle of the work.
OS-IoT Projects

**OS-IoT C++ Library for Linux**
- oneM2M support on light/medium platforms.
- Rich set of client resource types.

**OS-IoT C Library for BG96/ThreadX**
- oneM2M support directly on the cellular IoT module for very lightweight data collection applications.

**OS-IoT OCF to oneM2M Bridge for Linux**
- Using the C++ library to seamlessly integrate Open Connectivity Foundation (OCF) and oneM2M
OS-IoT C++ Library for Linux
OS-IoT Support for Key oneM2M Application Building Blocks

- Discovery: To Find Data
- Cloud & Home Cloud Data Storage
- Subscribe/Notify To Trigger Device Actions
- Cloud & Home Cloud Data Retrieval
- Security and Policy Management
OS-IoT Architectural Overview

- Custom IoT Application
  - Resource Oriented API
    - Parsing, Serialization and Protocols
      - JSON
      - XML
      - HTTP/HTTPS

- Operating System
- HW Platform

- oneM2M Client Device

- oneM2M Infrastructure

  - Interoperability tested with
    - Mobius
    - open mtc
    - IoTDM

- Library
  - oneM2M Infrastructure
    - oneM2M
    - Mobius
    - open mtc
    - IoTDM

- Operating System
- HW Platform
OS-IoT C++ Library - Supported Platforms

- OS-IoT library supports a wide range of Linux based platforms
  - Could also be ported to other operating systems
- Tested platforms:
  - '96boards' DragonBoard 410c (Qualcomm Snapdragon, ARM Cortex A53 CPU)
  - Raspberry Pi Zero and other family members (32 bit ARM)
  - PC x64
- Tested OSs:
  - Ubuntu version 14, 16 and 18
  - Linaro for the 96Boards open platform
  - Raspbian for Raspberry Pi
Initial Release – September 2017

• Core set of oneM2M Application Entity (AE) features:
  – CRUD operations for main oneM2M resources
  – Subscribe/Notify

• Live demo of OS-IoT example applications:
  – oneM2M standards compliant smart lighting application
  – Interworking between oneM2M and commercial ZigBee Light Link system
  – Platform portability between X64 and ARM

Demonstrated the concept of an open, interoperable oneM2M client library.
Expanded Capabilities and Applications

• Feature additions:
  – oneM2M standards compliant HTTPS protocol security to support access to public cloud oneM2M Common Service Entities (CSEs)
  – Home Appliance Information Model (HAIM) support for standard appliance resource types
  – Subscribe/notify efficiency improvements
  – Resource discovery

• Event participation:
  – oneM2M developers event in Japan
  – oneM2M interop. event, Washington DC

Continuous improvement to broaden application and enhance robustness and usability.
oneM2M Interop Event, July 2018

• In total 122 interop test cases based on oneM2M specification TS-0013 (Interop Testing) were run with four different oneM2M servers:
  – Eclipse OM2M
  – Interdigital Chordant
  – KETI Ocean
  – Fraunhofer OpenMTC

• All tests for supported functionality passed at the event
  – A few areas were found where the servers needed small modifications to comply with oneM2M specifications

• Additional informal testing beyond the scope of standard oneM2M tests also took place:
  – Home Appliance Information Model
  – Certificate-based oneM2M security
OS-IoT C++ Library Demo Applications

**Command-Line Application**

- Supports commands to exercise OS-IoT library
- Package includes test scripts for oneM2M standard functional tests and extended test cases

**Smart Lighting Demo**

- Runs OS-IoT on a lighting controller (switch) and simulated lamp
- Interoperates with open-source oneM2M servers

**Cloud Based Data Collection Demo**

- Data collection device running OS-IoT transmits data over WiFi or Cellular
- Hosted web application uses OS-IoT to pull data from oneM2M server
- Supports public oneM2M cloud servers
OS-IoT C Library for BG96/ThreadX
OS-IoT On Embedded Cellular Modules (BG96/ThreadX)

- Highly efficient C implementation
- Optimized functionality for data collection devices
- Optimized use of hardware for reduced Bill of Materials (BoM)
- Support for Power Saving Mode (PSM) to optimize power needs
- Security and Policy Management
OS-IoT Leverages Open Cellular IoT Modules

Conventional Closed Cellular Module Client Architecture

- Cellular IoT Module
  - Real-Time OS (RTOS)
  - e.g. AT Commands/PPP over Virtual Serial
- Application CPU
  - Custom IoT Application
  - OS-IoT Library
  - Application OS
- Peripheral interface
  - e.g. I2C, GPIO, ADC

Sensor and Actuator Hardware

Cost-optimized, Open Cellular Module Client Architecture

- Cellular IoT Module
  - Custom IoT Application
  - OS-IoT Library
  - Real-Time OS (RTOS)

Sensor and Actuator Hardware

Peripheral interface
- e.g. I2C, GPIO, ADC

Lower cost from eliminating application CPU from Bill of Materials (BoM).

Lower power consumption from eliminating hardware and integrating application with cellular module power saving mode.

Smaller devices by reducing part count.
OS-IoT on Embedded Cellular Modules - Platform

- Integrated cellular IoT modems with accessible application SDKs and support for NB-IoT and LTE-Cat M1 are now available.
- OS-IoT C Library adapted from C++ version
  - Evolves and simplifies API for user in C, but retains same concepts
- Test platform is Quectel BG96 module based on the Qualcomm 9206 chipset
- Build files for ThreadX Version 3 Dynamic Application Module (DAM) to run directly on BG96
- Uses Native APIs on module for HTTP and HTTPS
- Tested on GSM and NB-IoT. Testing planned for LTE CAT M1
OS-IoT on Embedded Cellular Modules - Features

- Target application space is data reporting applications. For example:
  - Environmental monitors
  - Smart meters
  - Health trackers
  - Package tracking
- Support for core oneM2M resource types needed for data reporting applications
- Includes support for HTTPS security and onboarding of security credentials
- Demo application showing periodic collection of data and reporting
- Compatible with cellular power saving mode (PSM) features
- BG96 used for development, but portable to other modules with similar capabilities
OS-IoT OCF to oneM2M Bridge for Linux
OS-IoT Support for Home Appliance Information Model (HAIM)

• oneM2M has adopted the Home Appliance Information Model (HAIM) as a standard for semantic representations of home appliances
• HAIM modelling is compatible with other IoT standards – e.g. OCF
• HAIM separates appliance information from the protocol used to transmit that information
  • Support of HAIM will allow clients using OS-IoT to seamlessly integrate with other HAIM appliances and appliance controllers (e.g., apps)
  • Using HAIM also allows OS-IoT to be used in interworking bridges that connect different appliance-centric IoT standards
• The OS-IoT Linux library supports HAIM device resource types
  – Interop tested with oneM2M CSEs that also have HAIM support
Open Connectivity Foundation (OCF) Interworking

• OCF is a standard for proximal IoT interoperability at the appliance level, including a suite of Smart Home applications.
  – OCF/ATIS agreement to collaborate in developing a demo of seamless interoperability

• OS-IoT has developed a demo of a Bridge or “Interworking Proxy Entity (IPE)” that maps OCF devices in to the oneM2M HAIM ecosystem
  – Bridge was demonstrated at OCF Technical Face to Face meeting
  – OCF responded to this work by advancing their standard on OCF/oneM2M interworking to an earlier release and enabling this kind of asymmetric bridge
OCF/oneM2M Bridge Network Architecture

Simulated OCF device from OCF deviceBuilder application

OCF/oneM2M Bride

- OCF Client
- IoTivity C++ Library
- C++ IPE App
- oneM2M AE
- OS IoT Library

Discover OCF devices and create corresponding oneM2M resources.

Process oneM2M state-change notifications and map to OCF states.

- OCF lightdevice
- oneM2M AE
- Mca
- oneM2M CSE
- Mca
- oneM2M Controller AE
- Eclipse OpenM2M

e.g. Eclipse OM2M
Summary

- OS-IoT is the targeted platform to support oneM2M on a variety of lightweight clients
- Using OS-IoT can simplify the development of IoT devices and improve interoperability within the oneM2M ecosystem
- Choice of libraries for different requirements:
  - C++ library with richer feature set for more capable platforms
  - C library with focussed feature set for tightly constrained platforms and embedded cellular IoT modules
- Packages include demo applications to give practical examples of how to use library
- Open source means adaptable, portable and expandable to meet different applications

www.os-iot.org

- Source code
- Test suites
- Example applications
- Documentation

ATIS Open Source – Internet of Things (OS-IoT) is an open source software library that simplifies the development of IoT devices that connect to an open, interoperable ecosystem.

Many IoT solutions are built as vertical silos which inhibits duplication of development effort and multiple, incompatible solutions that perform similar functions like data collection and access control. The global oneM2M standard defines a common, interoperable platform for IoT systems which provides application developers with building blocks that fulfill the core tasks of data collection, management and distribution needed by IoT solutions.
OS-IoT Key Features

Open Source
OS-IoT is Open Source for community and commercial application.

oneM2M v2 Compliant
OS-IoT supports oneM2M version 2 compliant Application Entity (AE) capabilities.

Platform Independent
OS-IoT provides a high degree of platform independence and potential to support constrained devices.

Simple API
OS-IoT provides a simple, resource-oriented API to interact with oneM2M ecosystems.

Interoperable
OS-IoT is interoperable with oneM2M ecosystem components including OM2M, IoTDM and oneMPOWER.