



# OS-IoT Overview

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ATIS

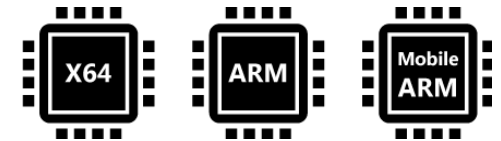
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*Advancing ICT Industry Transformation*

# 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



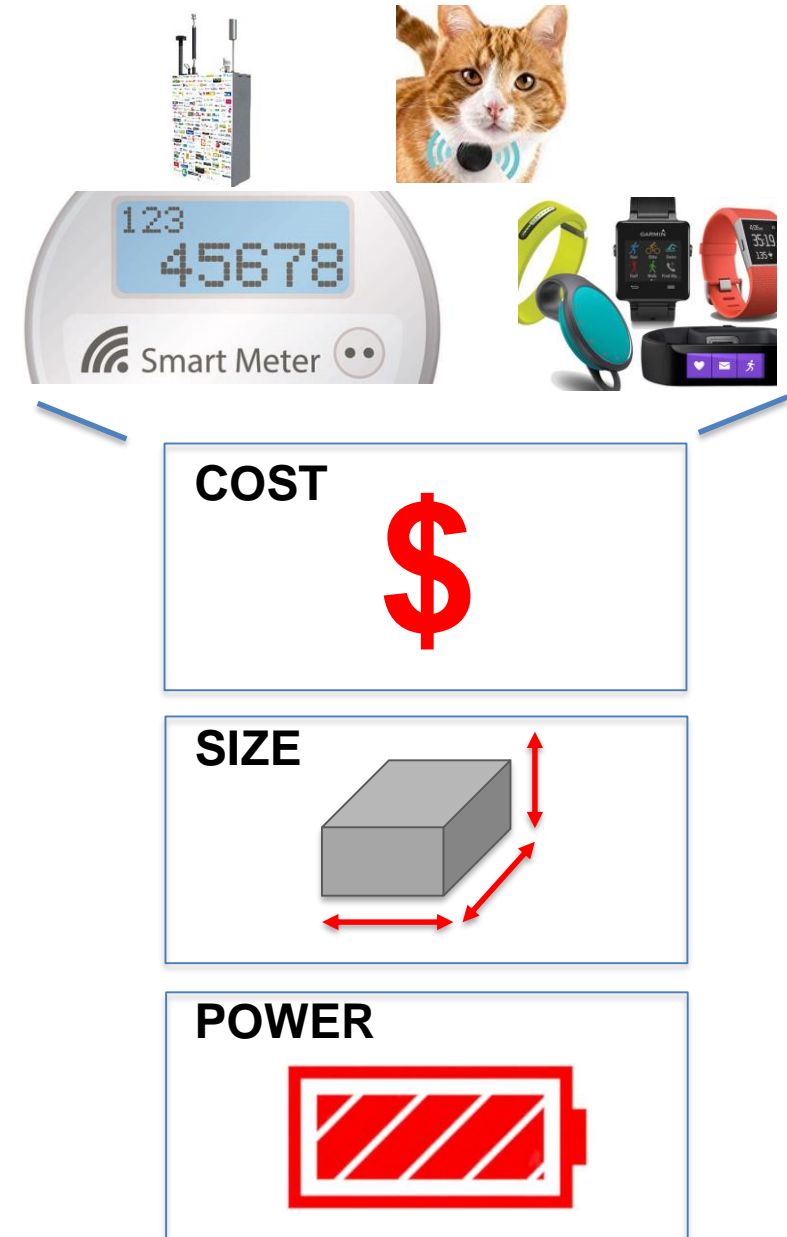
# oneM2M standard and the IoT Ecosystem



- 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

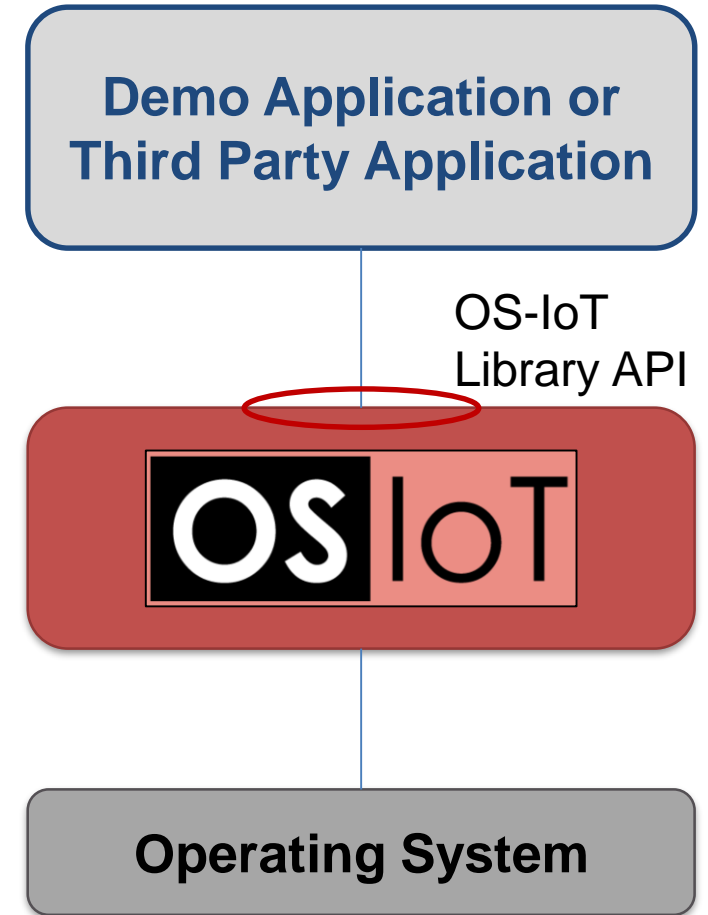
- Analysis by ATIS members and an industry survey highlighted a support need for lightweight clients. Example constraints:
  - Constrained compute resources: limited CPU power, limited memory
  - Limited electrical power: e.g. battery powered devices designed for multi-year operation
- Lightweight clients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

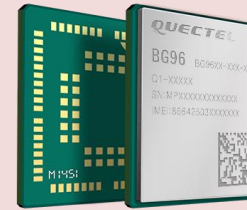
# OS-IoT Projects

## 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 Upper Tester



Framework for automatic conformance testing  
of oneM2M AEs.

## OS-IoT OCF to oneM2M Bridge for Linux



# OS-IoT C++ Library for Linux



# OS-IoT Support for Key oneM2M Application Building Blocks

*Discovery*  
*To Find Data*

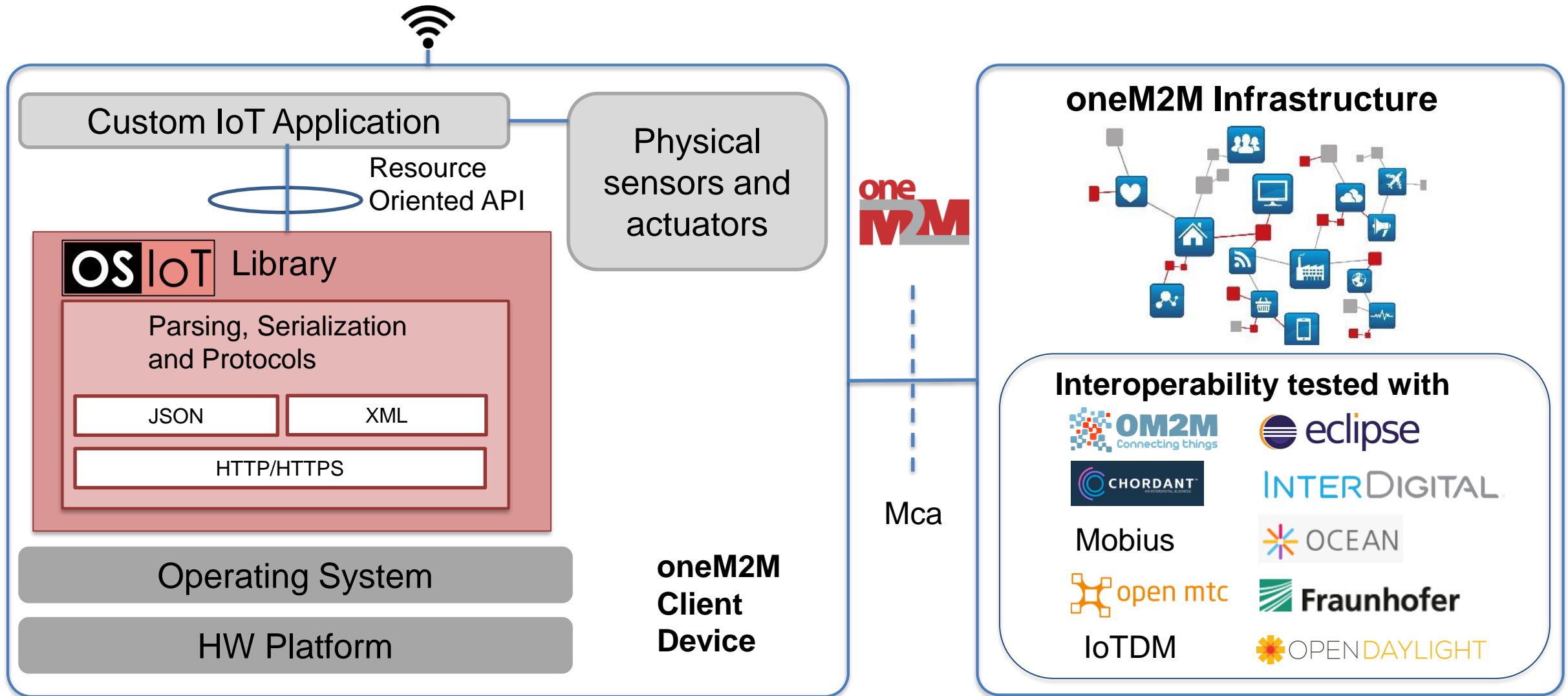
Cloud & Home  
Cloud Data  
Storage

Subscribe/Notify  
To Trigger Device  
Actions

Cloud & Home  
Cloud Data  
Retrieval

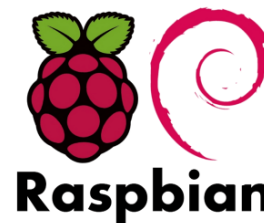
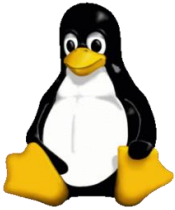
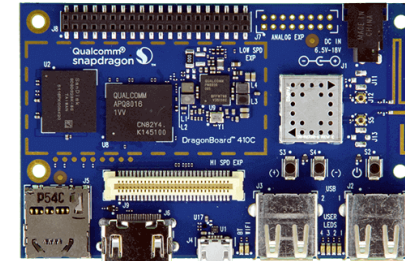
Security and  
Policy  
Management

# OS-IoT Architectural Overview



# OS-IoT C++ Library - Supported Platforms

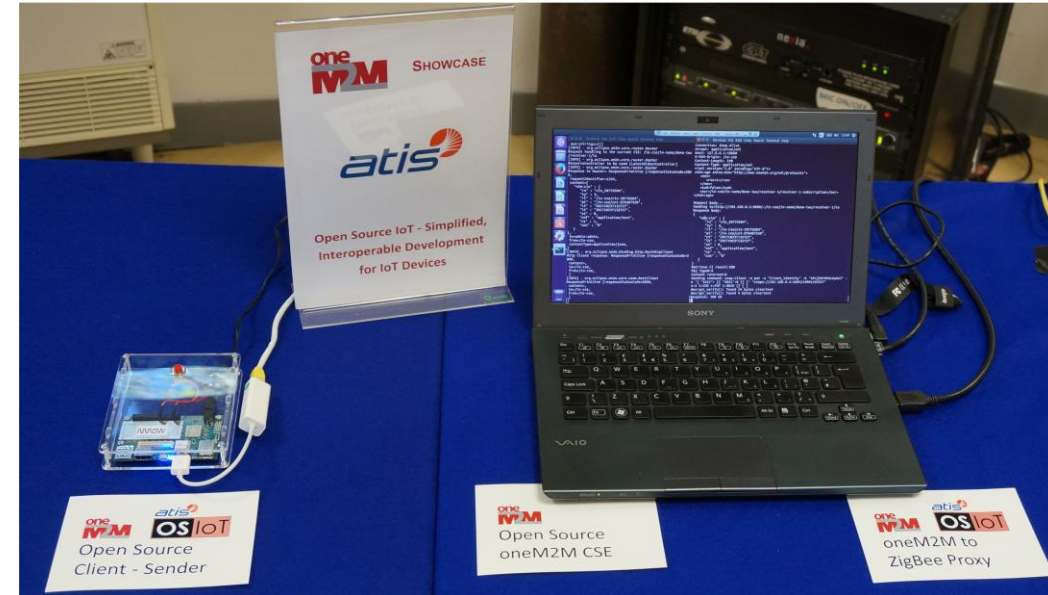
- OS-IoT library supports a wide range of Linux based platforms
  - Could also be ported to other operating systems
- Tested platforms:
  - '96boards' DragonBoard 410c (Qualcomm Snapdragon, ARM Cortex A53 CPU)
  - Raspberry Pi Zero and other family members (32 bit ARM)
  - PC x64
- Tested OSs:
  - Ubuntu 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

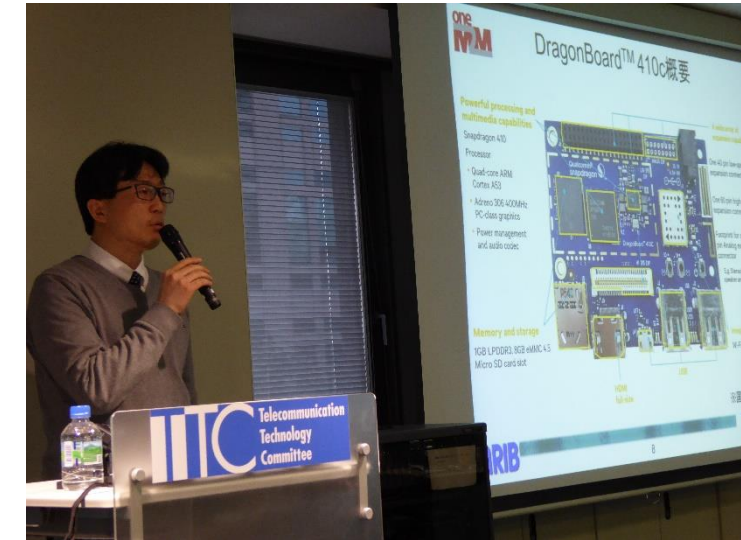
Demonstrated the concept of an open, interoperable oneM2M client library.



# 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.



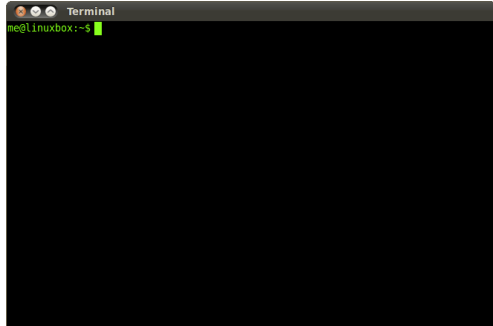
# oneM2M Interop Event, July 2018

- 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



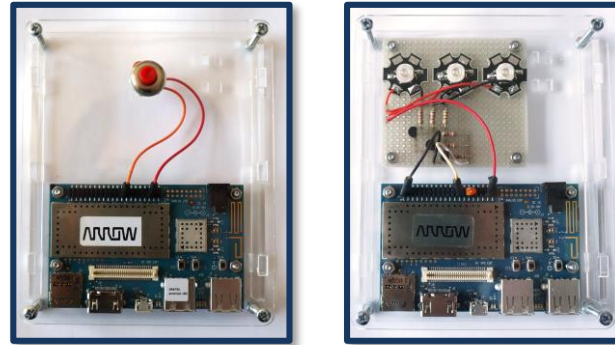
# OS-IoT C++ Library Demo Applications

## Command-Line Application



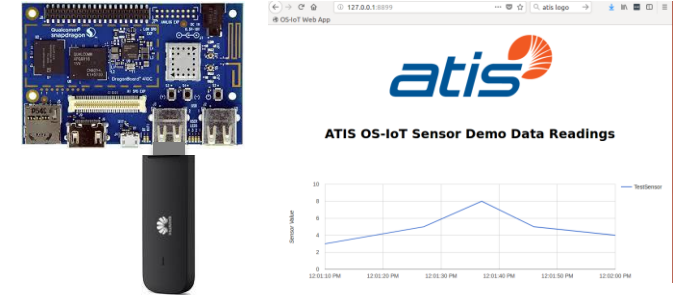
- Supports commands to exercise OS-IoT library
- Package includes test scripts for oneM2M standard functional tests and extended test cases

## 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

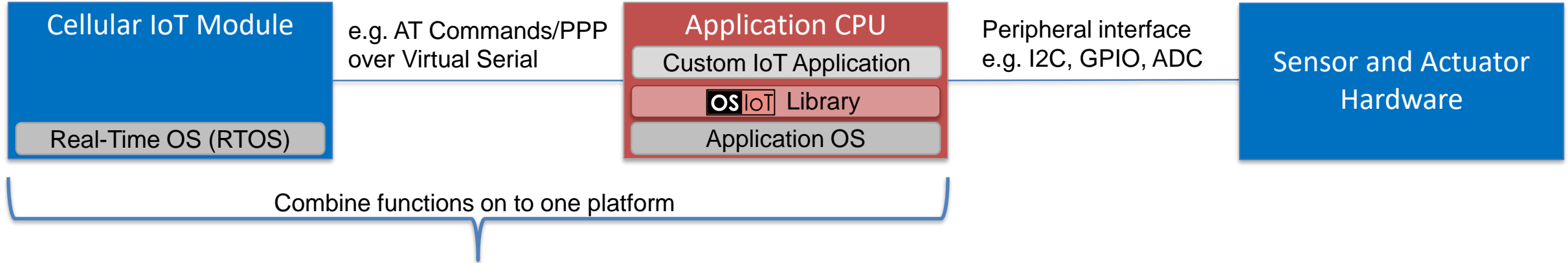
Optimized use of  
hardware for  
reduced Bill of  
Materials (BoM)

*Support for Power  
Saving Mode  
(PSM) to optimize  
power needs*

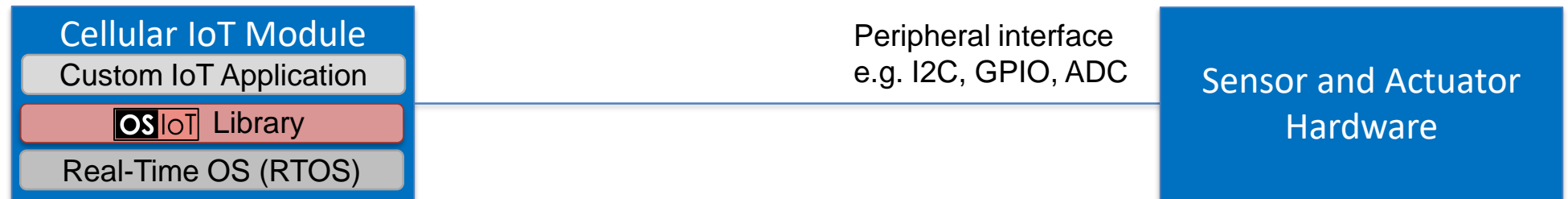
Security and Policy  
Management

# OS-IoT Leverages Open Cellular IoT Modules

## Conventional Closed Cellular Module Client Architecture



## Cost-optimized, Open Cellular Module Client Architecture



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

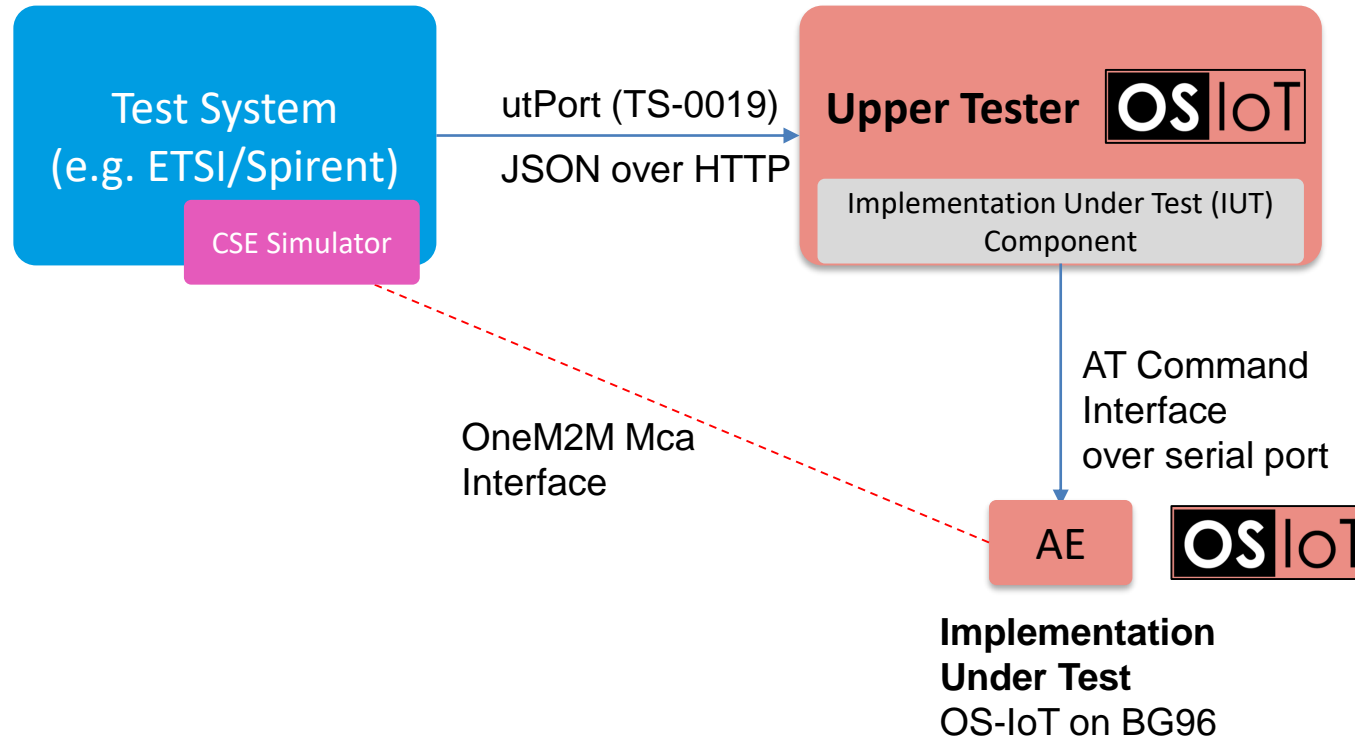
- Target application space is data reporting applications. For example:
  - Environmental monitors
  - Smart meters
  - Health trackers
  - Package tracking
- Support for core oneM2M resource types needed for data reporting applications
- Includes support for HTTPS security and onboarding of security 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 Upper Tester

# Upper Tester Context

- oneM2M is seeking to develop the certification of oneM2M devices (AEs)
- oneM2M work includes:
  - Defining the testing framework and message structures
  - Defining AE certifications profiles
- The target audience is AE developers who will benefit from open-source support (code, libraries, tools) to make their AEs testable, a precursor to certification.

# OS-IoT Testing Framework



# Testing Profile and Options

- A common interface based on AT Commands has been implemented in the BG96 library and Upper Tester
- The Upper Tester supports Profile #3 from oneM2M TS-0025

**Table 5.4.3-1: Fundamental feature set for ADN profile 3**

Function	Feature Set	Feature	Remark
GEN	AE/GEN/00001	At least one	Support one of the format of resource identification
	AE/GEN/00002	AE/GEN/00002/00001	Support Create request targeting one resource
REG	AE/REG/00002	AE/REG/00002/00001	Create <AE> with mandatory attributes
DMR	AE/DMR/00001	AE/DMR/00001/00001	Create <container> with no attribute set
	AE/DMR/00002	AE/DMR/00002/00001	Create <contentInstance> with mandatory attributes



# OS-IoT OCF to oneM2M Bridge for Linux

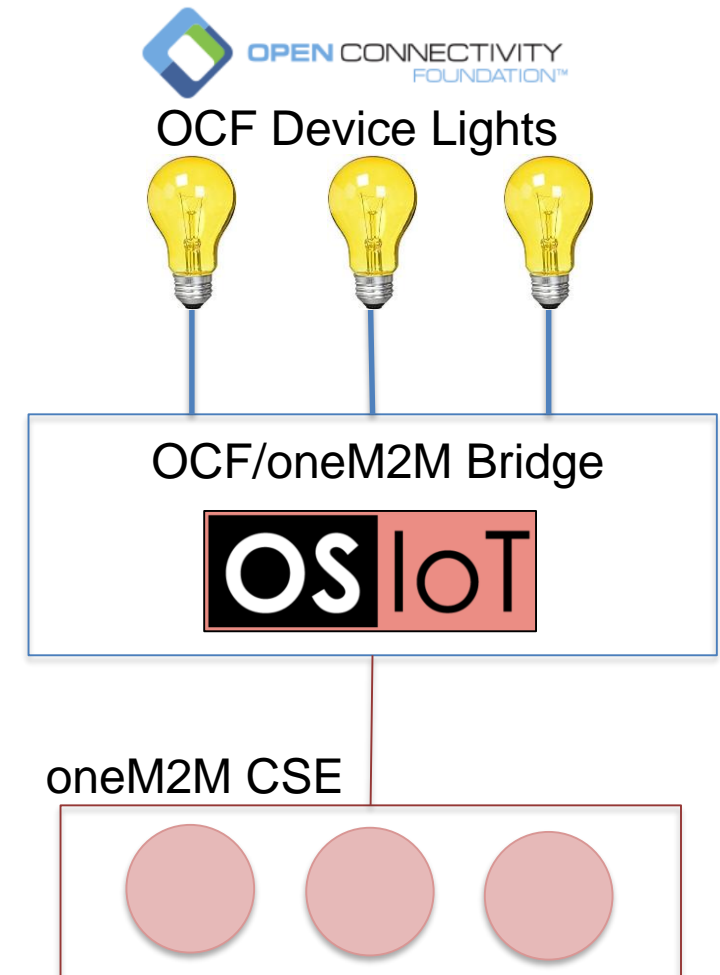
# OS-IoT Support for Home Appliance Information Model (HAIM)

- 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

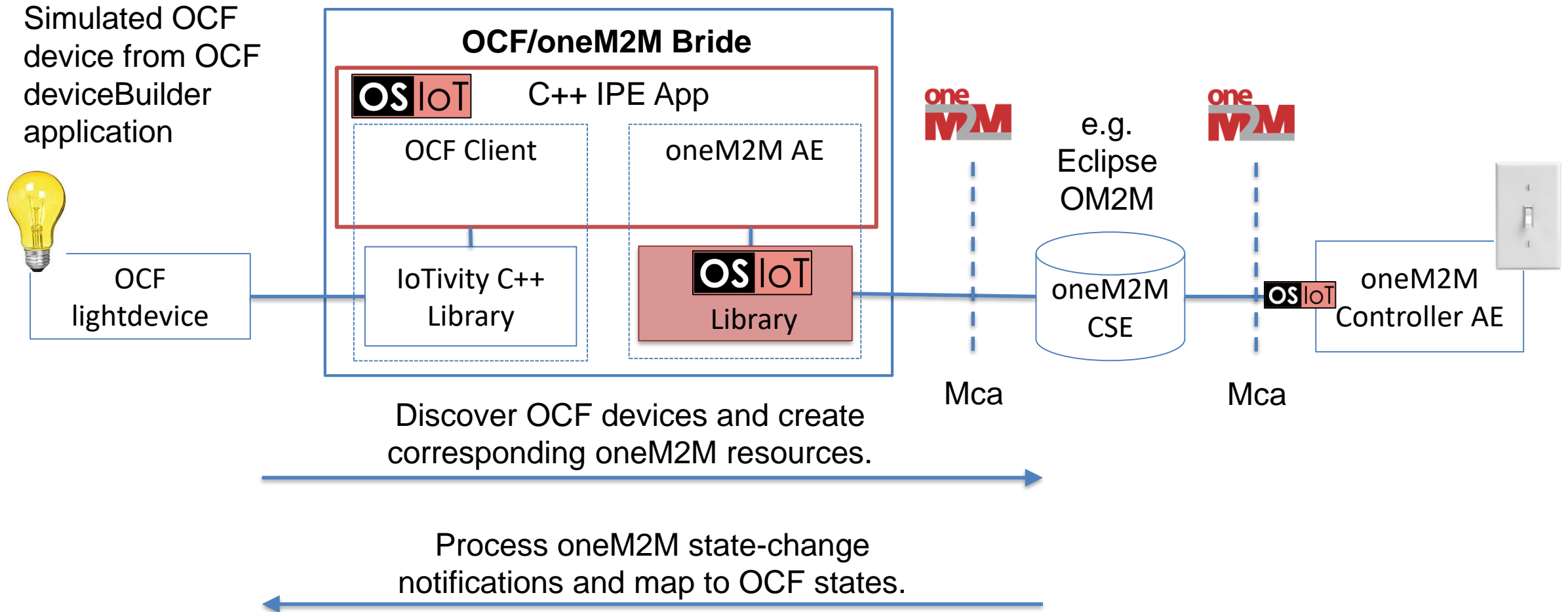


# Open Connectivity Foundation (OCF) Interworking

- 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

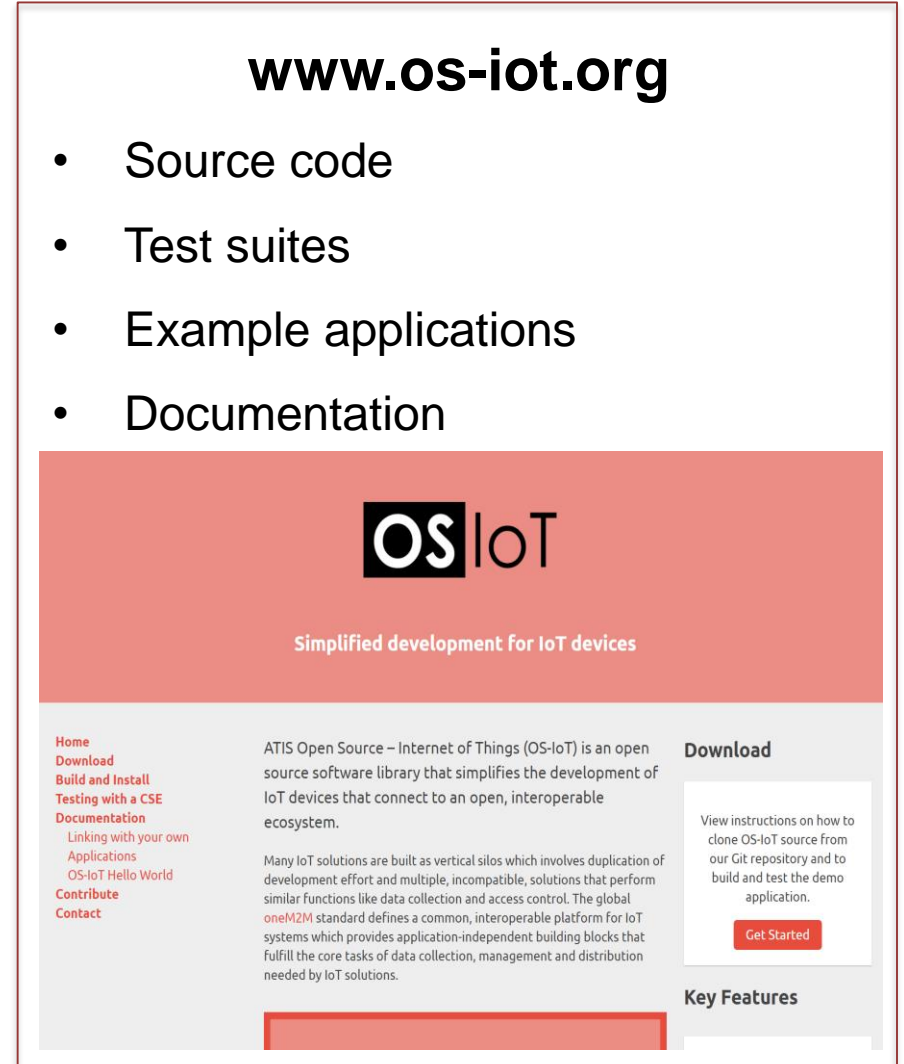


# OCF/oneM2M Bridge Network Architecture



# 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



The screenshot shows the homepage of the OS-IoT website. At the top, the URL **www.os-iot.org** is displayed. Below it is a navigation menu with four items: Source code, Test suites, Example applications, and Documentation. The main header features the **OS IoT** logo and the tagline "Simplified development for IoT devices". The page is divided into three columns. The left column contains a vertical list of links: Home, Download, Build and Install, Testing with a CSE, Documentation, Linking with your own Applications, OS-IoT Hello World, Contribute, and Contact. The middle column contains introductory text about ATIS Open Source – Internet of Things (OS-IoT) as an open source software library, and a paragraph explaining the oneM2M standard. The right column has a "Download" section with instructions on how to clone the source and a "Get Started" button, and a "Key Features" section below it.

# OS-IoT Key Features



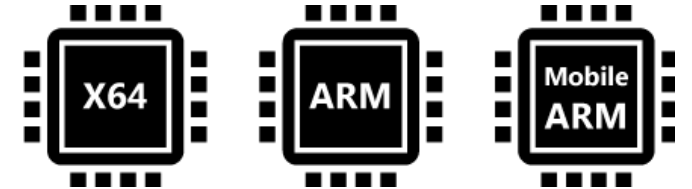
## Open Source

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



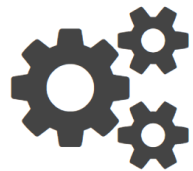
## oneM2M v2 Compliant

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.