oneM2M Common Architecture for IoT interoperability

Dr. Mahdi Ben Alaya
Founder & CEO, Sensinov
benalaya@sensinov.com
www.sensinov.com

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Biography

- R&D engineer at LAAS-CNRS laboratory in Toulouse, France.
- Ph.D in IoT system interoperability
- Founder and CEO of Sensinov startup.
- Vice Chairman of oneM2M Testing Group.
- Co-founder and technical manager of the open source project Eclipse OM2M.

- IoT tutorials in summer schools and universities worldwide including France, Taiwan, and Korea.
- R&D projects at LAAS-CNRS and Sensinov including ITEA2-USENET, ITEA2-A2NETS, H2020-LSP5-AUTOPILOT, ETSI-OSM, and ETSI-SAREF.
- Authored more than 20 refereed publications in international journals and conferences.
- More than 50 contributions to IoT standards.
The evolution of IoT

- Sent packages are tracked on the web
- Plants action a tap to water themselves.
- Communication Interoperability
- Data Interoperability
- Semantic Reasoning
- Let the things talk to each others
- Take the world online
- Let Things become intelligent
- Monitor and control home appliances.

All monuments are described on the web.

Alarm ring earlier in case of traffic or bad weather.
IoT vs M2M

M2M paradigm
The ability of machines to communicate with other devices without human interventions.

M2M as an industrial environment
- M2M: based on industrial protocols, closed solutions.
- IoT: common usage applications, open solutions for mass.

M2M as a subset of IoT
- IoT: connects general things, animals, peoples.

M2M as the kernel of IoT
- M2M: plumbing of IoT, required connectivity for things.
- IoT: depends on M2M, not possible without it.

Adopted definition
The ability of machines to communicate with other devices without human interventions.
Global Internet device installed Base Forecast

• 33 Billion Internet Devices By 2020: Four Connected Devices For Every Person In World.

Source: Strategy Analytics, October 2014
Adoption of IoT by industry

• Energy and utilities leading closely followed by automotive and retails.

Source: The M2M adoption Barometer 2014, Vodafone
Global IoT Market opportunities

- IoT market opportunity will be reach 4.3 trillion USD by 2024.

Source: Machina Research, 2015
IoT main challenges

- **Vertical Fragmentation**: vendor-specific solutions, no interoperability, semantic gap.
- **Power Management**: Inefficient battery lifecycles, lack of clean energy.
- **Increasing Complexity**: Large number of devices, unmanageable, high costs.
- **Security**: Weakness in M2M devices, privacy, fraud, cyber attacks.
- **Network Misalignment**: Devices behavior differs from humans: collapse of internet infra.

*M2M Communications A Systems Approach - 2012 (book)*
M2M world of connected services
The current marketplace is extremely fragmented, which has increased the R&D cost in each specific domain.

Current IoT silo model is not an efficient way to communicate, it is a barrier to further development.

Many vertical IoT solutions have been designed independently and separately for different applications, which impedes large-scale M2M deployment.
**IoT cross-domain interoperability**

- Highly fragmented market with small vendor-specific applications.
- Reinventing the wheel: Same services developed again and again.
- Each silo contains its own technologies without interop.

- End-to-end platform: common service capabilities layer.
- Interoperability at the level of communications and data.
- Seamless interaction between heterogeneous applications and devices.

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**Diagram:**
- **Building**
  - Existing ICT infra
  - Dedicated devices

- **Energy**
  - Existing ICT infra
  - Dedicated devices

- **Security**
  - Existing ICT infra
  - Dedicated devices

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**Converged ICT infra**
- **Building**
- **Energy**
- **Security**

- **Common service platform**
- **M2M devices**
Standards landscape for IoT

- 143 organizations around the world are involved in M2M standardization according to the Global Standards Collaboration M2MTask Force.
IoT Interoperability potential impact

Interoperability required to capture 40% of total value

< 1% of data currently used, mostly for alarms or real-time control. More can be used for optimization & prediction.

Enable new business models
E.g., remote monitoring enables anything-as-a-service

Transform business processes
Predictive maintenance, better asset utilization, higher productivity

9 Settings
Gave us a cross-sector view of a total potential impact of $3.9 – 11.5 trillion per year in 2025

Home: Chore Automation & Security
$200 – 300 B

Office: Security & Energy
$200 – 700 B

Factories: Operations & Equipment Optimization
$1.2 – 3.7 T

Retail: Automated Checkout
$400 B – 1.2 T

Worksites: Operations Optimization / Health & Safety
$200 – 900 B

Outside: Logistics & Navigation
$600 – 900 B

Cities: Public Health & Transportation
$900 B – 1.7 T

Vehicles: Autonomous Vehicles & Condition-Based Maintenance
$200 – 700 B

Source: McKinsey Global Institute
IoT high level architecture

http://www.etsi.org/technologies-clusters/technologies/m2m
Standards for Wide Area Networks (3GPP, fixed NW, WiMax...):

**Target:** protect networks against negative effects of M2M traffic (many devices, non-human traffic ...)

Standards for Wide Area Networks

http://www.etsi.org/technologies-clusters/technologies/m2m
Standards for Local Area Networks (ZigBee, Bluetooth, PLC, etc.)

**Target:** foster use of LAN technology by supporting diverse ecosystem of service providers and device manufacturers.
Standards for vertical industries applications

**Target:** enable interoperable, cost-efficient solutions.
Standards for M2M Service capabilities:

**Target:** end-to-end enablement across servers, gateways, and devices.
Standardized service interfaces.
oneM2M: The Partnership Project
Over 200 member organizations in oneM2M
oneM2M organization and Structure
oneM2M certification

- oneM2M Certification Program was officially launched at Feb. 9, 2017.
- TTA (Korea) is authorized as the first regional oneM2M CB (Certification Body).
- A Global CB (e.g. GCF) to be setup in 2018.
- See oneM2M certified products at: www.oneM2Mcert.com

www.oneM2Mcert.com
oneM2M liaisons
Purpose, Work & Deliverables

**Purpose**
To specify and promote an
**M2M Common Service Layer**

**Work**
Six physical 1-week meetings per year
About 5 conference calls per week between the meetings
200+ documents produced and discussed at each meeting

**Deliverables**
**Technical Reports and Technical Specifications**

3800 docs in 2013  4200 docs in 2014
Use Cases & Requirements

Energy
Enterprise
Healthcare
Public Services

Residential
Other
Transportation
Industry

REQUIREMENTS
TS-0002

TECHNICAL REPORTS
TECHNICAL SPECS
oneM2M high level architecture

Entities: AE (Application Entity), CSE (Common Services Entity) and NSE (Network Services Entity)

Reference Point: One or more interfaces - Mca, Mcn, Mcc and Mcc’
oneM2M functional architecture

ADN-AE

MN-AE

MN-CSE

MN-NSE

ASN-AE

ASN-CSE

ASN-NSE

IN-AE

IN-CSE

IN-NSE

Other MN Node

Other IN Node

ADN Node

Non oneM2M Nodes

ASN Node

MN Node

MN-AE

REG

SUB

SEC

DMR

GMG

CMDH

ASM

LOC

RF

IN

IN-SE

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MN-SE

OTHER MN NODE

OTHER IN NODE

ADN NODE

NON ONE M2M NODES

ASN NODE

MN NODE

MN-AE

REG

SUB

SEC

DMR

GMG

CMDH

ASM

LOC

RF

REGISTRATION (REG)

APPLICATION AND SERVICE LAYER MGMT (ASM)

GROUP MGMT (GMG)

LOCATION (LOC)

COMMUNICATION MGMT & DELIVERY HANDLING (CMDH)

DATA MGMT AND REPOSITORY (DMR)

SUBSCRIPTION AND NOTIFICATION (SUB)

SECURITY (SEC)

ROUTING FUNCTION (RF)

IN-CSE

IN-NSE

IN-AE
OneM2M resource structure

OneM2M Resource structure

Resource type representation
oneM2M resource types

- Cse BASE
- Access Control Policy
- Remote CSE
- Application Entity
- Container
- Content Instance
- Group
- Subscription
- Polling Channel
- Node
- Mgmt Object
- ...

oneM2M resource types include:
- Cse BASE
- Access Control Policy
- Remote CSE
- Application Entity
- Container
- Content Instance
- Group
- Subscription
- Polling Channel
- Node
- Mgmt Object
- ...
oneM2M resource tree example

Resource Type
- CseBase
- Application Entity
- Container
- Content Instance

CseBase
Application Entity
Container
Content Instance

Smart Meter (ADN)
Gateway (MN-CSE)
Server/Cloud (IN-CSE)
End user (DA)
Interworking with non oneM2M devices

- The Interworking Proxy Entity (IPE) abstracts and maps the non-oneM2M data model to the oneM2M resources.
- Bidirectional communication between the oneM2M system and a specific technology (Monitor and Control).
- Seamless interaction between applications and devices using the oneM2M Restful API.
oneM2M addressing mode

**Unstructured address** *(flat, short)*
- **CSE-Relative**
  http://127.0.0.1:8080/container-id
- **SP-Relative**
  http://127.0.0.1:8080/~/cse-id/container-id
- **Absolute**
  http://127.0.0.1:8080/_/sp-id/cse-id/container-id

**Structured address** *(hierarchical, long)*
- **CSE-Relative**
  http://127.0.0.1:8080/cse-name/ae-name/container-name
- **SP-Relative**
  http://127.0.0.1:8080/~/cse-id/cse-name/ae-name/container-name
- **Absolute**
  http://127.0.0.1:8080/_/sp-id/cse-id/cse-name/ae-name/container-name
Accessing resources in oneM2M (Blocking)
Accessing resources in oneM2M (Non blocking Synchronous)

Non blocking synchronous requests
Accessing resources in oneM2M (Non blocking asynchronous)

Non blocking asynchronous requests
App-ID vs AE-ID

- App-ID uniquely defines the application running in the oneM2M environment
- AE-ID uniquely defines the INSTANCE of the application running in the oneM2M environment
App-ID Registry to avoid App-ID collision

- App-ID registry: uniquely identifying applications is necessary in an interconnected world
Access to App-ID Registry

Welcome to the oneM2M App-ID Registry Portal
This is the official portal for registering oneM2M App-IDs. For more information on this, please visit oneM2M web site. At this portal, you will be able to register App-IDs for your oneM2M applications, and deploy them in oneM2M compliant networks.

https://appid.iconectiv.com
Summary of release 2 & 3 features

**Industrial Domain Enablement**
- Time series data management
- Atomic Transactions
- Action Triggering
- Optimized Group Operations

**Management**
- M2M Application & Field Domain Component Configuration

**Semantics**
- Semantic Description/Annotation
- Semantic Querying
- Semantic Mashups
- oneM2M Base Ontology

**Security**
- Dynamic Authorization
- End to End Security
- Enrollment & Authentication APIs
- Distributed Authorization
- Decentralized Authentication
- Interoperable Privacy Profiles
- Secure Environment Abstraction

**Home Domain Enablement**
- Home Appliance Information Models & SDT
- Mapping to existing standards (OCF, ECHONET, GoTAPl...)

**Smart City & Automotive Enablement**
- Service Continuity
- Cross resource subscriptions

**Market Adoption**
- Developer Guides
- oneM2M Conformance Test
- Feature Catalogues
- Product Profiles

oneM2M as generic interworking framework
- 3GPP SCEF
- OMA LWM2M
- DDS
- OPC-UA
- Modbus
- AllJoyn/OCF
- OSGi
- W3C WoT

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oneM2M implementations

Open source

OM2M

Connecting things

OCEAN

Oasis

atís

OS-IoT

Commercial & Demo (Non exhaustive)

Huawei

LG

KE-TI

InterDigital

C-DOT

Fraunhofer

NTT

Qualcomm

sensinov
oneM2M scenarios

• **Scenario 1** - Nodes mutual authentication and applications registration
• **Scenario 2** - Retrieve data from smart meter
• **Scenario 3** - Get notified when new metering data is created
• **Scenario 4** - Get notified when new smart a meter is registered
• **Scenario 5** - Store smart meter data remotely using announcement
Scenario 1
Nodes mutual authentication and applications registration
Scenario 1

Initial state

ASN-AE

mca

CseBase-SmartMeter

ASN-CSE

mcc

Smart Meter Device

CseBase-MeteringServer

IN-AE

mca

IN-CSE

Smart Metering Server
Scenario 1

Step 1- AE-PowerProcessing Registers to the Metering Server IN-CSE
Scenario 1

Step 2 - The Smart Meter ASN-CSE registers to the Metering Server IN-CSE
Step 3- The Smart Meter ASN-CSE Creates locally RemoteCSE-MeteringServer resource
Scenario 1

Step 4 - AE-SmartMeter registers to the Smart Meter ASN-CSE
Scenario 2
Retrieve data from smart meter
Scenario 2

AE-SmartMeter

ASN-AE

IN-AE

mca

CseBase-SmartMeter

RemoteCSE-MeteringServer

AE-SmartMeter

ASN-CSE

mcc

Smart Meter Device

CseBase-MeteringServer

RemoteCSE-SmartMeter

AE-PowerProcessing

IN-CSE

Smart Metering Server

AE-PowerProcessing

Initial state
Scenario 2

Step 1 - AE-SmartMeter Creates Container-Power sub-resource
Scenario 2

Step 2- AE-SmartMeter creates ContentInstance-Power sub-resource
Scenario 2

Step 3- AE-PowerProcessing retrieves the ContentInstance-Power resource
Scenario 3
Get notified when new metering data is created
Scenario 3

Initial state
Scenario 3

Step 1 - AE-PowerProcessing subscribes to Container-Power of AE-SmartMeter
Step 2 - AE-SmartMeter creates ContentInstance-Power. AE-PowerProcessing is notified.
Scenario 4
Get notified when new smart a meter is registered
Scenario 4

Initial state
Scenario 4

Step 1 - AE-PowerProcessing creates Subscription-devices resource to get notified of new meters.
Step 2 - The Smart Meter registers to the Metering Server. AE-PowerProcessing is notified.
Scenario 4

Step 3 - The Smart Meter ASN-CSE Creates locally RemoteCSE-SmartMeter resource
Scenario 5
Store smart meter data remotely using announcement
Scenario 5

In-CSE

ASN-CSE

CseBase-SmartMeter

RemoteCSE-MeteringServer

Smart Meter Device

IN-AE

ASN-AE

AE-PowerProcessing

mca

mca

mcc

CseBase-MeteringServer

AE-PowerProcessing

Subscription-remoteCSE

RemoteCSE-SmartMeter

Smart Metering Server

Initial state
Scenario 5

Step 1 - AE-SmartMeter registers to the Smart Meter ASN-CSE with announcement.
Step 2 - AE-SmartMeter remotely creates Container-Power on AE-SmartMeter-Announced
Scenario 5

Step 3 - AE-SmartMeter creates remotely ContentInstance-Power
Scenario 5

Step 4 - AE-PowerProcessing retrieves the ContentInstance-Power resource directly from IN-CSE.
Thank you for your Attention

benalaya@sensinov.com
www.sensinov.com