INPUT CONTRIBUTION	
Group Name:*	MAS WG
Title:*	A unified language to describe M2M/IoT data Common terms to describe sensor measurements to ease the automatic interpretation by all M2M/IoT devices.
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Abstract:*	This contribution proposes to share lessons learned: - A unified language to describe M2M/IoT data: sensor, measurement, units and domains.
Agenda Item:*	Tbd
Work item(s):	MAS
Document(s) Impacted*	Study of Existing Abstraction & Semantic Capability Enablement Technologies for consideration by oneM2M.
Intended purpose of document:*	☐ Decision ☐ Discussion ☒ Information ☐ Other <specify>
Decision requested or recommendation:*	For the release 2. This is an informative paper proposed by the French Eurecom institute as a guideline to MAS contributors on Semantic web best practices, as it was suggested during MAS#9.3 call. Amélie Gyrard is a new member in oneM2M (via ETSI PT1).
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1. Content

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3. Scope

The present document describes a common description for M2M data. A necessary step to exchange data between M2M/IOT device and mostly to later automatically interpret produce data to make use of it.

We aim to bridge the gap between the Semantic Web and Internet of Things communities.

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5. Definitions, symbols, abbreviations and acronyms

5.1 Definitions

W3C SSN: is a working group for semantic sensor networks and designs a standardized ontology inspired by existing sensor ontologies.

5.2 Symbols

5.3 Acronyms

IoT	Internet of Things
M2M	Machine-to-Machine
W3C	World Wide Web Consortium
W3C SSN	W3C Semantic Sensor Networks
W3C WoT	W3C Web of Things
LOV	Linked Open Vocabularies
SWoT	Semantic Web of Things
SPARQL	SPARQL Protocol and RDF Query Language
RDF	Resource Description Framework
RDFS	Resource Description Framework Schema
OWL	Ontology Web Language
M3	Machine-to-Machine ontology
SSN	Semantic Sensor Networks
WoT	Web of Things

6. Introduction

Existing Internet of Things (IoT) and Semantic Web of Things (SWoT) applications are not interoperable with each other due to heterogeneous sensor data, formats and protocols. One of the most important challenge for the Internet of Things would be to assist developers in designing and developing interoperable IoT applications. The following challenges need to be addressed:

- Interoperable IoT data, schemas and domains
- Interpreting IoT data
- Generating interoperable IoT/SWoT applications.

Our vision is that the OneM2M standard is relevant to provide:

- A unified language to describe common sensor, measurement and domain terms in a uniform way (see section 7). Indeed, there is a need to explicitly describe these information in all layers of the OneM2M architecture to ease interoperability. It will ease the automatic interpretation of produced data by machines.

Such standardizations are relevant for other standardizations such as W3C SSN, W3C Web of things or IERC.

Recently, [16] explained that the next challenging tasks of Semantic Web of Things (see Figure 1 are:

- A common description for sensor data.
- Agreeing on a common catalogue of ontologies to annotate sensor data in a interoperable manner.

Such challenging tasks have been resolved thanks to our proposed Machine-to-Machine Measurement (M3) framework.

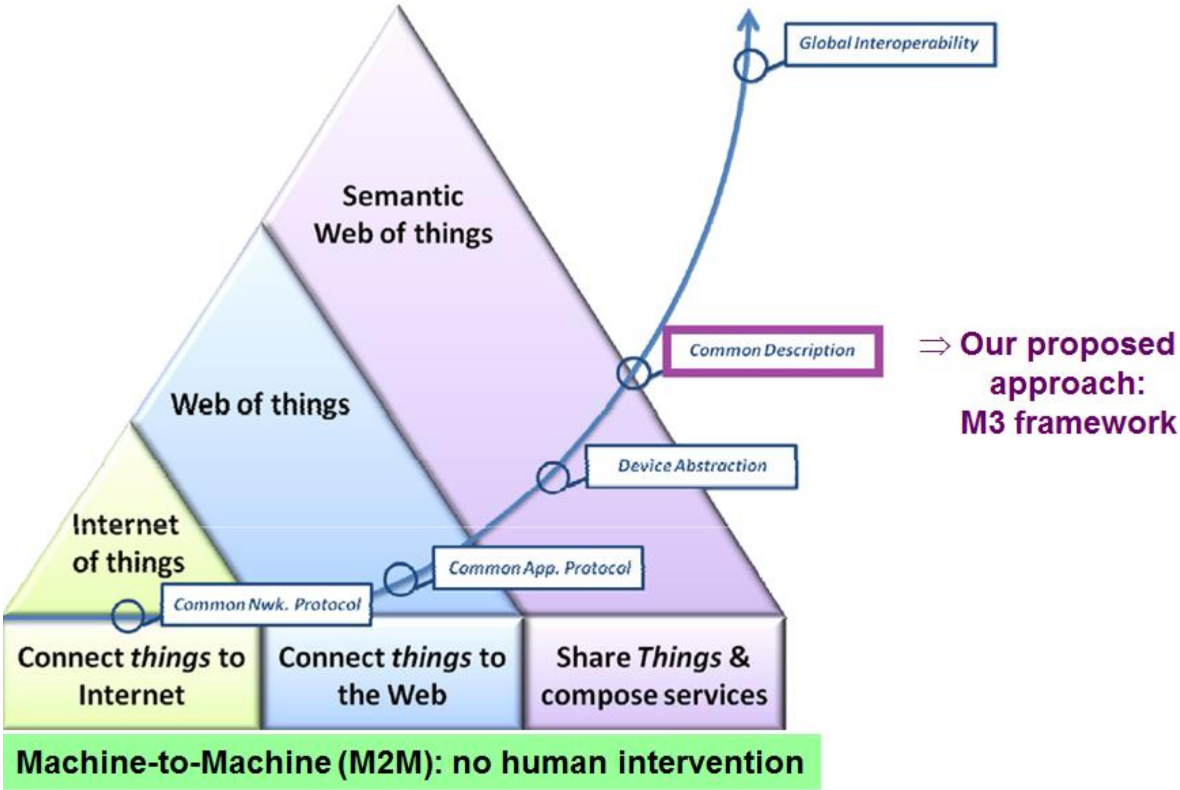

Figure 1. The next challenge is to have common descriptions of sensor data [16]

7. The Machine-to-Machine Measurement (M3) framework

The Machine-to-Machine Measurement (M3) framework assists users in designing interoperable Semantic Web of Things (SWoT) applications. It solves the following challenging tasks:

- Interoperable M2M/IoT data, schemas
- Interoperable domains
- Interpreting M2M/IoT data
- Generating interoperable M2M/SWoT applications.

M3 is composed of the following components as displayed in Figure 2.

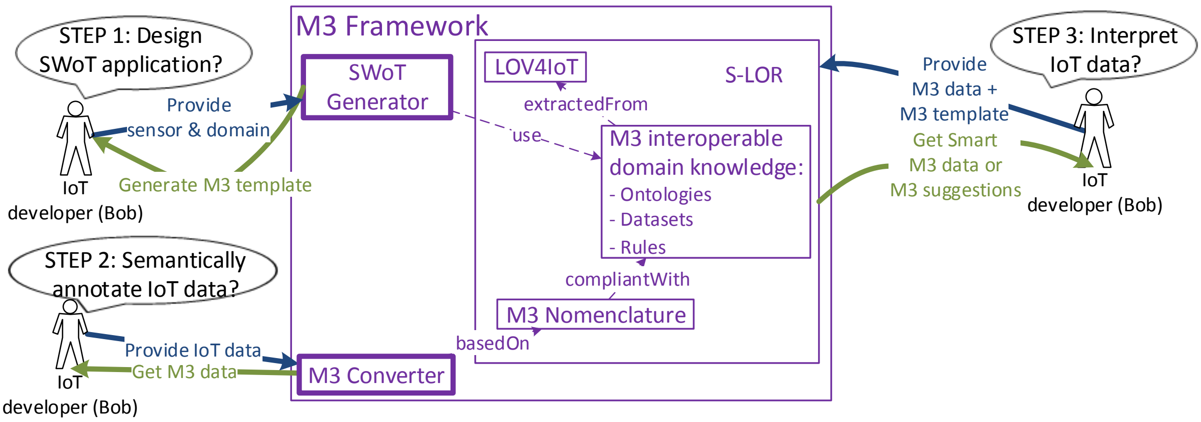

Figure 2. Main components of the M3 framework

The M3 nomenclature[1] and the M3 converter[2] make IoT data interoperable with each other and explicitly add the context. The M3 converter is compatible with the SenML[3] format to describe sensor metadata. As future work, it could handle other formats such as OGC Sensor Web Enablement (SWE) [4]. It generates M3 M2M/IoT data compliant with the M3 domain knowledge.

To interpret M2M/IoT data, LOV4IoT (Linked Open Vocabularies for Internet of Things)[4] has been designed to reuse domain knowledge already designed by domain experts. More than 200 domain knowledge relevant for IoT have been referenced, studied and classified. Stemming from the 'Linked Open Data', the Sensor-based Linked Open Rules (S-LOR)[5] has been designed to share and reuse interoperable rules to easily enrich M2M/IoT data by reusing domain knowledge from LOV4IoT. Due to interoperability issues, the M3 domain knowledge has been rewritten and is composed of interoperable ontologies, datasets and rules to enrich M2M/IoT data and provides inter-domain interoperability to easily build cross-domain IoT applications.

To assists developers in building interoperable IoT/SWoT applications, the SWoT Generator has been conceived[6]. This tool generates a M2M template with all files (M3 ontologies, M3 datasets, M3 rules) needed to interpret and enrich IoT data with domain knowledge to build smarter IoT applications (domain-specific or cross-domain). M3 has been plugged to the sensor discovery conceived by [7]. Finally, M3 has been used by Android-based constrained devices.

8. M3 embedded in oneM2M

M3 could provide the following components to the Common Service Entity (CSE):

- **Application and Service Layer Management**: We propose the generation of M3 M2M application templates in this component, and the execution of generic IoT/M2M applications.
- **Data Management & Repository**:
    - To store M3 domain datasets
    - M3 semantic sensor data inferred or not.
    - M3 ontologies

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[1] http://www.sensormeasurement.appspot.com/?p=m3
[2] http://www.sensormeasurement.appspot.com/?p=senml_converter
[3] http://www.ietf.org/archive/id/draft-jennings-senml-10.txt
[4] http://www.sensormeasurement.appspot.com/?p=ontologies
[5] http://www.sensormeasurement.appspot.com/?p=swot_template
[6] http://www.sensormeasurement.appspot.com/?p=m3api

- M3 rules
- M3 SPARQL queries

- Security for the STAC application to find security mechanisms & attacks specific to technologies.

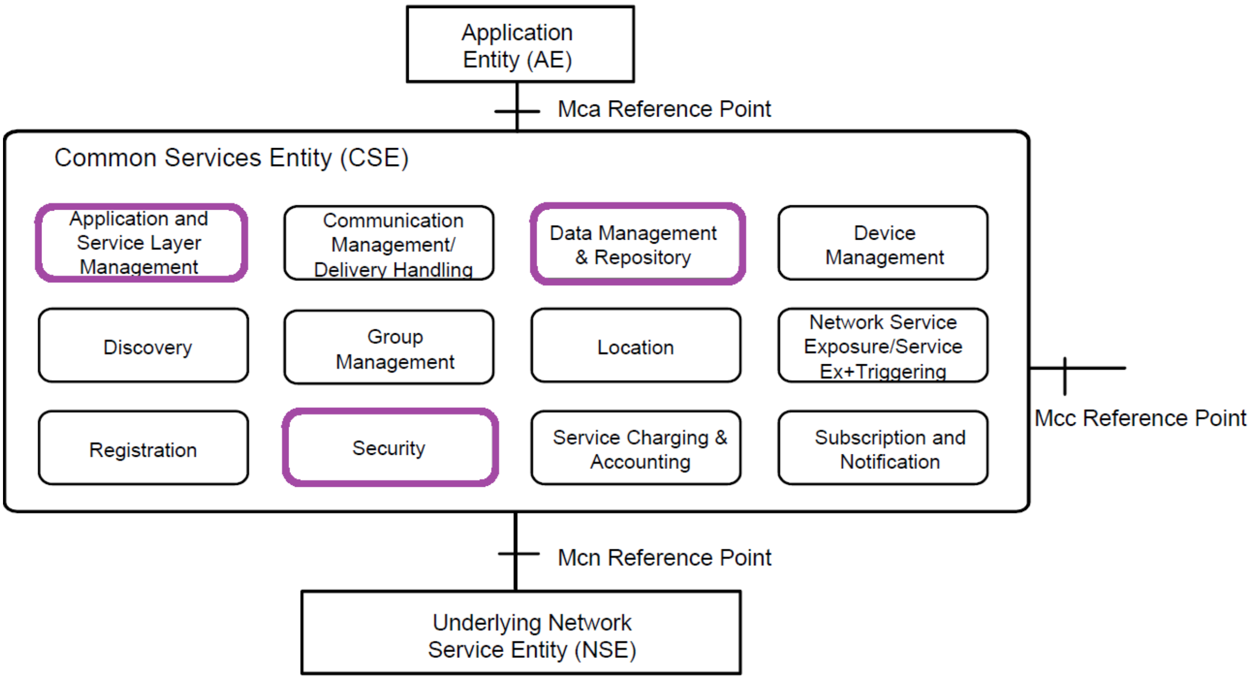

Figure 3. OneM2M Common Service Functions[7] filled by M3

9. Implement a Unified Language as a standardized Ontology

This work has been already done in the Machine-to-Machine Measurement (M3) ontology [15] [14], but still can be improved. This M3 ontology already implements the mentioned unified language. It will be used to semantically annotate M2M/IoT data. This ontology will be an extension of the well-known W3C Semantic Sensor Networks (SSN) ontology [6].

This M3 ontology brings several advantages:

- Describe sensor data in a unified way.
- Provide a basis for reasoning.
- Provide a basis to easily combine domains.
- Provide a basis to assist developers in designing Semantic Web of Things applications, but the semantics will be hidden to the developers.

See Section 13 (Annexe B).

[7] onem2m.org/candidate_release/TS-0001-oneM2M-Functional-Architecture-V-2014-08.pdf

10. Existing Standardizations

10.1 W3C SSN ontology

The **W3C Semantic Sensor Networks (SSN) ontology**[8] [6] is a synthesis of all of existing sensor ontologies.

It defines high-level concepts for representing sensors, their observation and the surrounding environment.

The W3C SSN ontology has several limitations:

- It does not provide common terms to represent subclasses of ssn:Sensor type, measurement type, unit type or domain type (ssn:FeatureOfInterest). This shortcoming hinders machine automation.
- According to the ontology documentation[9], "the W3C SSN ontology does not describe domain concepts, time, locations, etc. these are intended to be included from other ontologies via OWL imports. This leads to interoperability issues between domain ontologies, since domain ontologies relevant for IoT are not standardized.
- In their final report, they explained they "do not provide a basis for reasoning that can ease the development of advanced applications". This fact highlights the need to provide a common description of sensor measurements.
- Future works are to "standardize the SSN ontology to use it in a Linked Sensor Data context" and to "standardize the SSN ontology to bridge the Internet of Things". Adapting the SSN ontology to Internet of Things is exactly the purpose of this thesis.

Currently, W3C and OGC are collaborating to integrate Spatial Data on the Web. The new spatial data on the web working group has been announced in January 2015, including amongst its many tasks, to standardize the SSN ontology[10].

10.2 OneM2M MAS

Swetina et al. explain that industries use proprietary systems that make it difficult to extend applications, integrate new data and interoperate with other solutions [20]. One of the goals of oneM2M, the international standard for M2M, is to: (1) shorten time to market by removing the need to develop common components, and (2) simply development of applications by providing a common set of Application Programming Interface (APIs). The oneM2M architecture comprises of: (1) common services entity (CSE), (2) application entity (AE) that provides application for end-users such as blood sugar monitoring, and (3) common services functions (CSFs) where components can be used in other CSE and applications. For instance, CSF components can be: (1) data management and repository (DMR) that could handle the processing of M2M data, (2) security (SEC) to enable secure establishment of service connections and data privacy. OneM2M is a necessary standard to ensure data interoperability, and efficient development of M2M systems in various domains [19].

The working group 5 (WG5) of oneM2M focus on Abstraction and Semantics [18].

10.3 ETSI M2M

ETSI M2M [17] explains that interpreting and using M2M data from heterogeneous sources is considered essential for creating high-level M2M applications but no do not provide any concrete approaches for this task. Interoperability across different M2M domains and staying independent of vertical markets are essential to build innovative applications.

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[8] http://www.w3.org/2005/Incubator/ssn/XGR-ssn-20110628/
[9] http://www.w3.org/2005/Incubator/ssn/ssnx/ssn\#
[10] http://www.w3.org/2015/01/spatial.html.en

They propose the idea to re-use sensor data across different applications.

10.4 W3C Web of Things

W3C Web of Things[11] underlines the need to use semantics to: (1) ensure interoperability, e.g., as a basis for describing physical units, (2) encourage use of common vocabularies, (3) how should be standardized, and (4) interpreting sensor input.

Such challenging could be overcome with the M3 ontology to ensure interoperable metadata, e.g., describe physical units. Further, the LOV4IoT tool will enable to encourage the use of common vocabularies. Finally, LOV4IoT is a basis to synthetize all ontologies in a same domain to standardize the domain ontologies in smart home, smart energy, smart agriculture, etc. Finally, S-LOR will enable to interpret sensor input.

10.5 Summary: technical gap analysis

We recapitulate in Table 1 the main shortcomings of the current standardizations or working groups such as ETSI M2M [17], oneM2M [18], W3C SSN[12] ontology [6] and W3C Web of Things[13] and how our proposed approach could overcome such limitations.

Table 1. Limitations of current standardizations and working groups

Challenges / Standards	W3C SSN ontology	ETSI M2M	oneM2M	W3C Web of Things	The proposed M3 approach
Interoperable IoT data	No ("Do not provide a basis for reasoning ") They focused on interoperable sensor networks	No	Ongoing (Semantic annotation to enable automated processing of semantic information)	No	Yes M3 ontology
Interpreting IoT data	No ("Do not provide a basis for reasoning ")	Ongoing (Make use of the data)	Ongoing (Semantic annotation to enable automated processing of semantic information)	Ongoing (Interpreting sensor input)	Yes (S-LOR)
Inter-domain interoperability + Reusing domain knowledge	No ("Does not describe domain concepts"). No interoperability among domain ontologies	Ongoing (Stays independent from "vertical markets", application-specific. Re-use of M2M data across	Ongoing (Interoperability between "siloed" applications, data interoperability to heterogeneous M2M applications)	Ongoing (What is needed to encourage use of common vocabularies and how	Yes (M3 nomenclature + M3 interoperable domain knowledge)

[11] http://www.w3.org/2014/02/wot/
[12] http://www.w3.org/2005/Incubator/ssn/XGR-ssn-20110628/
[13] http://www.w3.org/2014/02/wot/

	No (Do not introduce ontologies relevant for IoT)	different applications). (Reuse of data not necessary the domain knowledge)	(Extensible ontologies with new domain concepts)	should these be standardized?)	
Designing interoperable SWoT applications	No	Ongoing Interoperable M2M applications	Ongoing Interoperable M2M applications	No	Yes (LOV4IoT + SLOR + M3 domain knowledge)
Securing IoT	No	Ongoing	Ongoing	Ongoing	Yes (STAC)

11. Existing works

11.1 IERC

IERC (European Research Cluster on Internet of Things)[14] develops a global interoperability framework. They explain that IoT architectures are confined to particular domains. In the IERC book, Chapter 8, Barnaghi et al. define four interoperability issues [2]:

- *Technical interoperability* that concerns heterogeneous software and hardware.
- *Syntactical interoperability* that concerns data formats. This is important to later interpret IoT data and build smartness applications. They underline the need to agree on common vocabularies to describe data.
- *Semantic interoperability* that concerns interpretation of meaning of data exchanged.
- *Organizational interoperability* that concerns heterogeneity of the different infrastructures.

Further, they explicitly indicate the need to assist users by designing tools to build IoT applications. Finally, they addressed security and privacy issues related to IoT data.

The M3 framework addresses the syntactical and semantic interoperability challenges.

11.2 IoT-A

In the context of the IoT-A EU Project, the **Knowledge Acquisition Toolkit (KAT)** toolkit has been developed to interpret sensor data [12] [13]. KAT infers high-level abstractions from sensor data in gateways to reduce the traffic in network communications [11] [12]. KAT is composed of three components: (1) an extension of Symbolic Aggregate Approximation (SAX) algorithm, called SensorSAX, (2) abductive reasoning based on the Parsimonious Covering Theory (PCT), and (3) temporal and spatial reasoning. They use machine learning techniques (k-means clustering and Markov model methods) and then Semantic Web Rule Language (SWRL) rule-based systems to add labels to the abstractions. They propose to use domain-specific background knowledge, more precisely the Linked Data, but they do not clearly explain that it is insufficient for Internet of Things. Ganz et al. employ the abductive model rather than inductive of deductive approach to solve the incompleteness limitation due to missing observation information [13]. Ganz et al. test their work on real sensor data (temperature, light, sound, presence and power consumption). Their gateways support TinyOS, Contiki enabled devices and Oracle SunSpot nodes. They do not propose the idea to combine data from various domains.

[14] http://internet-of-things-research.eu/

Further, they reuse the **Sense2Web** platform. Sense2Web is a Linked Data Platform for Semantic Sensor Networks based on an ontology called SensorData to publish semantic descriptions of sensors [3] [8]. They introduce the need of using rule-based reasoning to deduce high-level abstraction from sensor data. In their recent works [8], they introduce the need to link measured data to domain knowledge through the Linked Data, but they do not provide a method to exploit and link domain ontologies relevant for IoT. They explain that they provide a M2M interface for publishing IoT data and associating it to existing vocabularies on the Web, but they do not explain how they do it. Wang et al. explain that the SSN ontology "does not include modeling aspects for features of interest, units of measurement and domain knowledge that need to be associated with the sensor data to support autonomous data communication, efficient reasoning and decision making" [22] .

11.3 TNO Smart Appliances

TNO designs the Smart Appliances REFerence (SAREF) ontology[15], an unified ontology for smart appliances in the smart home domain [1]. They cover popular sensor and actuators. To the best of our knowledge, we did not find any methods to interpret sensor data based on this ontology.

This is a new ontology in the smart home among the 45 ontologies for smart homes that we referenced in LOV4IoT[16].

12. Annexe A: Real use cases

12.1 Smart grid, Smart meter

We identify several tasks:

- Update the previous tables with this new domain.
- Design and standardize the ontology in this domain
  - See table LOV4IoT, smart agriculture section.
  - Synthetize existing works to design a standardized ontology
- Define goals of the future application: reduce energy?

12.2 Smart agriculture

We identify several tasks:

- Update the previous tables with this new domain.
- Design and standardize the ontology in this domain
  - See table LOV4IoT, smart agriculture section.
  - Synthetize existing works to design a standardized ontology
- Define goals of the future application: horticulture, irrigation, water management, energy.

Concrete applications:

- See Smart Farm project[17] [9] [10] [21]
- Viticulture scenario: Sense-t project[18] [5]

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[15] http://ontology.tno.nl/saref/
[16] http://www.sensormeasurement.appspot.com/?p=ontologies
[17] http://smartfarm-ict.it.csiro.au/
[18] http://www.sense-t.org.au/

13. Annexe B: An unified language to describe M2M data

Devices need to speak the same language to interpret produced M2M data by themselves and combine those from other M2M devices.

13.1 Sensor and measurement names

A first step is to define common terms to describe sensor measurements. For instance, precipitation and rainfall sensor have the same meaning and represents the same sensor, we should explicitly choose one of these terms to ease machine to machine communications to easily automatically interpret M2M data.

See below the proposed unified language to describe M2M data.

13.1.1 Weather

In Table 2, we classify common terms to describe M2M data in the weather domain.

Table 2. Descriptions of M2M data related to the weather domain.

oneM2M domain	oneM2M sensor/ measurement name	Description, other names (synonyms)	oneM2M unit
Weather	HumiditySensor/ Humidity	Hygrometer, humidity sensor, moisture sensor, soil moisture probes	Percent
Weather	WindDirectionSensor/ WindDirection	Wind direction	DegreeAngle
Weather	SunPositionDirectionSensor/ SunPosition	sun position direction to detect east, west, south, north	DegreeAngle
Weather	AtmosphericPressureSensor/ AtmosphericPressure	Atmospheric pressure sensor, Barometer, barometric pressure sensor	Pascal
Weather	CloudCoverSensor/ CloudCover	Cloud cover sensor	Okta
Weather	SunPositionElevationSensor/ SunElevation	sun position elevation to detect (twilight, day, night, etc.)	DegreeAngle
Weather	SolarRadiationSensor/ SolarRadiation	Solar radiation sensor, par (photo synthetically active radiation) sensor, sun light, solar sensors, sun’s radiation intensity	WattPerMeterSquare
Weather	VisibilitySensor/ Visibility	Visibility sensor to detect fog	Miles, Meter
Weather	Thermometer, AirThermometer/ Temperature	Thermometer, temperature sensor, thermistor	DegreeCelsius
Weather	LightSensor/ Luminosity	Light, luminosity, illuminance, lighting	Lux

Weather	PrecipitationSensor/ Precipitation	Precipitation sensor, rainfall sensor, rain fall, pluviometer, rain, rainfall gauge	MilimeterPerHour
Weather	WindSpeedSensor/ WindSpeed	Wind speed sensor, wind velocity sensor, anemometer	MeterPerSecond

13.1.2 Healthcare

In Table 3, we classify common terms to describe M2M data in the healthcare domain.

Table 3. Descriptions of M2M data related to the healthcare domain.

oneM2M domain	oneM2M sensor/ measurement name	Description, other names (synonyms)	oneM2M unit
Health	BodyThermometer/ BodyTemperature	Body thermometer	DegreeCelcius
Health	HeartBeatSensor/ HeartBeat	Pulse sensor, pulse oxymeter, pulse-ox, heart beat, heart rate, pulse rate, cardiac frequency, breath rate	BeatPerMinute
Health	PulseOxymeter/ SPO2	Pulse oxymeter, spO2, blood oxygen saturation sensor, pulse and oxygen in blood sensor	Percent
Health	CholesterolSensor/ Cholesterol	cholesterol	MmolPerLiter
Health	Glucometer/ BloodGlucose	Glucometer, glucose sensor, blood glucose meter, blood sugar level	GramPerLiter
Health	BloodPressureSensor/ BloodPressure	blood pressure meter, sphygmomamometer, MAP (Mean arterial pressure), CVP (central venous pressure)	mmHg
Health	SkinConductanceSensor/ SkinConductance	skin conductance, galvanic skin response sensor, GSR, sweating	?
Health	WeightSensor/ Weight	Weight sensor, body weight, weight scale	Kilo, Pound
Health	Pedometer/ NumberStep		

13.1.3Smart home

In Table 4, we classify common terms to describe M2M data in the smart home domain.

Table 4. Descriptions of M2M data related to the smart home domain.

oneM2M domain	oneM2M sensor/ measurement name	Description, other names (synonyms)	oneM2M unit
BuildingAutomation	SoundSensor/ Sound	Noise, sound, microphone, audio sensor	dB
Weather	Thermometer/ Temperature	Thermometer, temperature sensor, thermistor	DegreeCelsius
BuildingAutomation	LightSensor/ Luminosity	Light, luminosity, illuminance, lighting	lux
BuildingAutomation	Presence	Presence sensor, occupancy detector, motion sensor, pyroelectric IR occupancy, intrusion detector/ trespassing, infrared sensor, motion sensor, motion detector, motion sensor, proximity, passive infrared (PIR)	?
BuildingAutomation	PowerConsumption		Watts
Weather	HumiditySensor/ Humidity	Hygrometer, humidity sensor, moisture sensor, soil moisture probes	Percent
BuildingAutomation	gyroscope	Gyroscope attached to objects (e.g., mop) to detect if they are used	rad/s
BuildingAutomation	pressure	Pressure for beds, sofa, couch to detect (lying, sitting), bed occupancy	
BuildingAutomation	Accelerometer/ Motion	Accelerometer	m/s^2
BuildingAutomation	magnetic field	Magnetometer, magnetic sensor attached to cupboards to detect if they are opened or closed	
BuildingAutomation	Camera	Video sensor	
BuildingAutomation	SmokeDetector		
BuildingAutomation	GasDetector		

13.1.4 Transportation

In Table 5, we classify common terms to describe M2M data in the transportation domain.

Table 5. Descriptions of M2M data related to the transportation domain.

oneM2M domain	oneM2M sensor/ measurement name	Description, other names (synonyms)	oneM2M unit
Transportation	battery	Battery charge level	
Transportation	motorTemperature		

Transportation	RoadSurfaceThermometer/ RoadTemperature		
Transportation	SpeedSensor/ Speed	Speed sensor, speedometer, velocity sensor (car)	
Transportation	tire pressure		
Transportation	fuel	Fuel level	
Transportation	DistanceSensor/ Distance	Distance sensor, safety distance	
Transportation	rpm	Position and/or rotational speed	
Transportation	maf	mass air flow sensor	maf
Transportation	SoundSensor/ Sound		dB
Transportation	AlcoholLevelSensor/ AlcoholLevel		

13.1.5Agriculture

See also those from weather such as solar radiation, humidity, wind speed, luminosity.

Table 6. Descriptions of M2M data related to the agriculture domain.

oneM2M domain	oneM2M sensor/ measurement name	Description, other names (synonyms)	oneM2M unit
Agriculture	SoilHumiditySensor/ SoilHumidity		Percent
Agriculture	LeafWetnessSensor/ LeafWetness		Percent
Agriculture	AirThermometer/ AirTemperature	Thermometer, temperature sensor, thermistor	°C, K, F
Agriculture	SoilThermometer/ SoilTemperature	Thermometer, temperature sensor, thermistor	°C, K, F
Agriculture	Luminosity	LightIntensity	
Agriculture	PHSensor/ PH		

13.1.1Environment

Table 7. Descriptions of M2M data related to the environment domain.

oneM2M domain	oneM2M sensor/ measurement name	Description, other names (synonyms)	oneM2M unit
Environment	AirPollutantSensor/	Air pollutant sensor	EAQI

	AirPollution		
Environment	SaltMeter / Salinity		ppt
Environment	oxygen	oxygen sensor	
Environment	no	Nitrogen oxide sensor	
Environment	CO	Carbon monoxide CO sensor	
Environment	SO2	Sulfure dioxide sensor	
Environment	CO2	Carbon Dioxyde Sensor	Ppm (parts per million)
Environment	pH	pH	

13.2 Generic

Such measurements can be found in numerous domains (see Table 8), we need to explicitly differentiate them.

Table 8. Descriptions of M2M data that can be found in various domains

oneM2M domain	oneM2M sensor/ measurement name	Description, other names (synonyms)	oneM2M unit	oneM2M domain
Generic	HumiditySensor	Humidity	Hygrometer, humidity sensor, moisture sensor, soil moisture probes	Percent
Generic	Thermometer	Temperature	Thermometer, temperature sensor, thermistor	°C
Generic	LightSensor	Luminosity	Light, luminosity, illuminance, lighting	lux
Generic		gps	Global positioning system, gps, location sensor	lon, lat, alt
Generic		frequency		Hz
Generic		shake	Shake sensor, vibration	

13.3 Actuator names

Table 9. Descriptions of actuators in various domains

oneM2M domain	oneM2M sensor/ measurement name	Description, other names (synonyms)
Transportation	FogLamp	Fog lamp
Transportation	Brake	
Transportation	ABS	Abs, anti-lock braking system
Transportation	ESP	Electronic stability program
Transportation	SeatBeltTensionSensor	Seat belt tension sensor

BuildingAutomation	WaterFlow	water flow attached to sinks, showers, flushing
BuildingAutomation, Transportation	AirConditioner	Air conditioner, ac
BuildingAutomation, Transportation	AlarmSystem	
BuildingAutomation	Heating	
BuildingAutomation	Blind	
BuildingAutomation	Ventilation	
BuildingAutomation	Curtain	
BuildingAutomation	Window	
BuildingAutomation	Cupboard	
BuildingAutomation	DishWasher	
BuildingAutomation	WashingMachine	
BuildingAutomation	Drawer	
BuildingAutomation	Door	
BuildingAutomation	Boiler	
BuildingAutomation	CoffeeMachine	Coffee machine, coffee maker
BuildingAutomation	Computer	Computer, pc
BuildingAutomation	Shower	Water actuator
BuildingAutomation	TV	tv, television
BuildingAutomation	Lavatory	
BuildingAutomation	Fridge	Refrigerator, fridge
BuildingAutomation	Freezer	Chiller
BuildingAutomation	Microwave	
BuildingAutomation	Lamp	Dimmable light, lamp

13.4 RFID tags common terms

RFID tags name	Description, other names (synonyms)
RFID_Food	food
RFID_Book	book (isbn)
RFID_CD	cd, music
RFID_DVD	dvd, movie
RFID_Garment	clothes, garments
RFID_BrushTeeth	
RFID_Broom	
RFID_TeaBag	

RFID_Cup	
RFID_Mop	
RFID_Bed	
RFID_Sofa	
RFID_Pan	
pill box	
passport	
luggage	
parking space	
toll	
animal	
payment card	
transit pass	

13.5 Measurement names

E.g., t temp and temperature have the same meaning and represents the temperature measurement.

The same as the one referenced for sensors

Measurement names	Description, other names
lon	longitude
lat	latitude
Others measurements are the same than those referenced for sensors	

13.6 Domains

E.g., Aix means Air en Provence which is a city.

E.g., you use the temperature in the health domain enable the computer to understand that the measurement corresponds to a body temperature.

OneM2M Domain name	Description, other names (synonyms)
BuildingAutomation (subclasses Activity)	Smart home, building automation, or building or room (kitchen, bathroom, living room, dining room)
Health	healthcare
Weather	Weather forecasting, meteorology
Agriculture	Agriculture, smart farm, garden
Environment (subclasses Fire)	Environment (earthquake, flooding, forest fire, air pollution)
Emotion	Affective science, emotion, mood, emotional state; brain wave

Transport	Intelligent transportation systems (ITS), smart car/vehicle, transportation
Energy	Smart grid, smart energy
Tourism	Tourism
Location	Location, place, GPS coordinates
City	Smart city, city automation, public lighting
TrackingGood (subclasses TrackingFood, TrackingCD)	Tracking RIFD goods
Generic	Others