The M3 nomenclature to describe and interpret sensors, measurements, units and domains in an interoperable way to ease reasoning

We propose to use common terms to describe sensors, measurements, actuators and domains. Of course, we should improve it all together. This work synthetizes all concepts found in existing ontologies or projects related to Internet of Things (IoT) and are implemented in the M3 ontology to unify sensor measures/ IoT data. This step is essential to define interoperable/unified rules to interpret sensor measures. The M3 nomenclature defines a unified data model for the Internet of Things and is an extension of the W3C SSN ontology.

|  |  |
| --- | --- |
| Creator | Amelie Gyrard |
| Last Updated | June 4, 2015  Check actuators and RFID with M3 ontology |
| Status | Work in progress |
| Caption | * Rows in green, compliant with: * M3 ontology * Linked Open Rules * IoT application template * Rows in white or red (to finish) |
| * Definitions | * Correctness means that are no incompatibility with other rules. * Completeness means that all sensor values are covered by an high level information. |
| * Links | * M3 Web site: <http://www.sensormeasurement.appspot.com/> * NS\_M3 = [http://sensormeasurement.appspot.com/m3#](http://sensormeasurement.appspot.com/m3) * SenML language: <http://www.ietf.org/archive/id/draft-jennings-senml-10.txt> * LOV4IoT: * <http://www.sensormeasurement.appspot.com/?p=ontologies> |

# Sensor and measurement interpretation

E.g., precipitation and rainfall sensor have the same meaning and represents the same sensor, we should explicitly describe this information in machine to machine communications to ensure interoperability in each layer of the OneM2M architecture.

## Healthcare

**Table 1. Healthcare domain: sensors, measurements and units**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **M3 or SenML domain** | **M3 or SenML sensor/ measurement name** | **Description, other names (synonyms)** | **M3 or SenML Unit** | **M3 rules** |
| Health | BodyThermometer/  BodyTemperature | Body thermometer | DegreeCelcius | Completude OK (3 rules [Obaid 2013] + 3 rules [Jara 2009]), Correctness OK |
| Health | HeartBeatSensor/  HeartBeat | Pulse sensor, pulse oxymeter, pulse-ox, heart beat, heart rate, pulse rate, cardiac frequency, breath rate | BeatPerMinute | Correctness ok (2 rules [5 rules Tanatong 2011] & [Hristoskova 2014]) + **Completude No (>300 nothing)** |
| Health | PulseOxymeter/  SPO2 | Pulse oxymeter, spO2, blood oxygen saturation sensor, pulse and oxygen in blood sensor | Percent | Correctness OK (1 rule [Hristoskova 2014]) + **Completude NO** |
| Health | CholesterolSensor/  Cholesterol | cholesterol | MmolPerLiter | Correctness OK (1 rule [Bravo 2009-2013]) + **Completude NO** |
| Health | Glucometer/  BloodGlucose | Glucometer, glucose sensor, blood glucose meter, blood sugar level | GramPerLiter | Completude OK (3 rules [Guermah 2014]), Correctness OK |
| Health | BloodPressureSensor/  BloodPressure | blood pressure meter, sphygmomamometer, MAP (Mean arterial pressure), CVP (central venous pressure) | mmHg | 0 rule |
| Health | SkinConductanceSensor/  SkinConductance | skin conductance, galvanic skin response sensor, GSR, sweating | ? | 0 rule |
| Health | WeightSensor/  Weight | Weight sensor, body weight, weight scale | Kilo, Pound | 0 rule |
| Health | Pedometer/  NumberStep |  |  |  |

## Weather

**Table 2. Weather domain: sensors, measurements and units**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **M3 or SenML domain** | **M3 or SenML sensor/ measurement name** | **Description, other names (synonyms)** | **M3 or SenML Unit** | **M3 rules** |
| Weather | HumiditySensor/  Humidity | Hygrometer, humidity sensor, moisture sensor, soil moisture probes | Percent | Correctness OK (Conflict resolved with [Kofler 2011] and [Rodriguez 2014]) +  Completude OK (5 rules [Staroch 2013]) |
| Weather | WindDirectionSensor/  WindDirection | Wind direction | DegreeAngle | Completude OK (5 rules [Staroch 2013]  ) + Correctness OK |
| Weather | SunPositionDirectionSensor/  SunPosition | sun position direction to detect east, west, south, north | DegreeAngle | Completude OK (5 rules [Staroch 2013]  ) + Correctness OK |
| Weather | AtmosphericPressureSensor/  AtmosphericPressure | Atmospheric pressure sensor, Barometer, barometric pressure sensor | Pascal | Completude OK (5 rules [Staroch 2013]) + Correctness OK (even with [Kofler 2011] ) |
| Weather | CloudCoverSensor/  CloudCover | Cloud cover sensor | Okta | Completude OK (5 rules [Staroch 2013]) +Correctness OK (even with [Kofler 2011] ) |
| Weather | SunPositionElevationSensor/  SunElevation | sun position elevation to detect (twilight, day, night, etc.) | DegreeAngle | 8 rules [Staroch 2013]  **Completude NO + Correctness NO** |
| Weather | SolarRadiationSensor/  SolarRadiation | Solar radiation sensor, par (photo synthetically active radiation) sensor, sun light, solar sensors, sun’s radiation intensity | WattPerMeterSquare | Completude OK (5 rules [Staroch 2013]) **+** Correctness OK (even with [Kofler 2011] ) |
| Weather | VisibilitySensor/  Visibility | Visibility sensor to detect fog | Miles, Meter |  |
| Weather | Thermometer, AirThermometer/  Temperature | Thermometer, temperature sensor, thermistor | DegreeCelsius | Integrate [Kofler 2011] 15 rules  See LOV4IoT [Staroch 2013] (6 home temperature rules) |
| 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 | [Kofler 2011] 16 rules  See LOV4IoT [Staroch 2013] 5  overlapping |
| Weather | WindChillSensor/  WindChill | Wind chill |  |  |

## Smart home

**Table 3. Smart home domain: sensors, measurements and units**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **M3 or SenML domain** | **M3 or SenML sensor/ measurement name** | **Description, other names (synonyms)** | **M3 or SenML Unit** | **M3 rules** |
| BuildingAutomation | SoundSensor/  Sound | Noise, sound, microphone, audio sensor | dB | Correctness OK (3 rules [Rodriguez 2014] ) +  **Completude NO** (Between 30 and 110, overlapping with Vasileios] |
| Weather | Thermometer/  Temperature | Thermometer, temperature sensor, thermistor | DegreeCelsius | [Kofler 2011] 15 rules (only 9 implemented)  See LOV4IoT [Staroch 2013] (6 home temperature rules)  Rodriguez 3 rules  Overlapping  overlapping with Vasileios  Yus |
| BuildingAutomation | LightSensor/  Luminosity | Light, luminosity, illuminance, lighting, illumination | lux | Pb with Vasileios |
| BuildingAutomation | Presence | Presence sensor, motion sensor, occupancy detector, pyroelectric IR occupancy, intrusion detector/ trespassing, infrared sensor, motion sensor, motion detector, motion sensor, proximity, passive infrared (PIR) | ? | 2 rules combined with light  See LOV4IoT  [Jacquet 2013] |
| BuildingAutomation | PowerConsumption |  | Watts |  |
| Weather | HumiditySensor/  Humidity | Hygrometer, humidity sensor, moisture sensor, soil moisture probes | Percent | 5 rules See LOV4IoT [Staroch 2013]  completude ok  Correctness : Overlapping with kofler, Rodriguez  More rules staroch |
| BuildingAutomation | gyroscope | Gyroscope attached to objects (e.g., mop) to detect if they are used | rad/s | No too complicated need machine learning to detect activities |
| BuildingAutomation | pressure | Pressure for beds, sofa, couch to detect (lying, sitting), bed occupancy |  |  |
| BuildingAutomation | Accelerometer/  Motion | Accelerometer | m/s² |  |
| BuildingAutomation | magnetic field | Magnetometer, magnetic sensor attached to cupboards to detect if they are opened or closed |  |  |
| BuildingAutomation | Camera | Video sensor |  |  |
| BuildingAutomation | SmokeDetector |  |  | Percent |
| BuildingAutomation | GasDetector |  |  |  |

## Transportation

**Table 4. Transportation domain: sensors, measurements and units**

|  |  |  |  |
| --- | --- | --- | --- |
| **M3 or SenML domain** | **M3 or SenML sensor/ measurement name** | **Description, other names** | **M3 or SenML Unit** |
| Transportation | battery | Battery charge level |  |
| Transportation | motorTemperature |  |  |
| Transportation | RoadSurfaceThermometer/  RoadTemperature |  |  |
| Transportation | SpeedSensor/  Speed | Speed sensor, speedometer, velocity sensor (car) |  |
| Transportation | NumberVehicleSensor/ NumberVehicle |  |  |
| 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 |  |  |

1. Agriculture

**Table 5. Agriculture domain: sensors, measurements and units**

|  |  |  |  |
| --- | --- | --- | --- |
| **M3 or SenML domain** | **M3 or SenML sensor/ name** | **Description, other names (synonyms)** | **M3 or SenML 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 |  |
| Agriculture | Luminosity | LightIntensity |  |
| Agriculture | PHSensor/  PH |  |  |

## Emotion

**Table 6. Emotion domain: sensors, measurements and units**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **M3 or SenML domain** | **M3 or SenML sensor name** | **M3 or SenML measurement name** | **Description, other names (synonyms)** | **M3 or SenML Unit** |
| Emotion | SkinConductanceSensor | SkinConductanceSensor | skin conductance, galvanic skin response sensor, GSR, sweating |  |

## Energy

**Table 6. Emotion domain: sensors, measurements and units**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **M3 or SenML domain** | **M3 or SenML sensor name** | **M3 or SenML measurement name** | **Description, other names (synonyms)** | **M3 or SenML Unit** |
| Energy | EnergyMeter/ Energy | Energy | Electricity meter, electric meter, energy meter | KiloWattHour |

## Environment

**Table 7. Air quality domain: sensors, measurements and units**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **M3 or SenML domain** | **M3 or SenML sensor/ measurement name** | **Description, other names (synonyms)** | **M3 or SenML Unit** | **M3 rules** |
| Environment | AirPollutantSensor/  AirPollution | Air pollutant sensor | EAQI | 5 rules Completude + Correctness  Kofler + See LOV4IoT [Staroch 2013] |
| 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 |  |  |

## Generic

**Table 8. Generic domain: sensors, measurements and units**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **M3 or SenML domain** | **M3 or SenML sensor name** | **M3 or SenML measurement name** | **Description, other names (synonyms)** | **M3 or SenML Unit** |
| 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 |  |

# M3 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.

For instance, Fire is a subclass of Environment.

FOI when duplication with measurement type,

FOI for feature of Interest

**Table 9. Domain names**

|  |  |
| --- | --- |
| **M3 or SenML Domain name** | **Description, other names (synonyms)** |
| BuildingAutomation (subclass: 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 (subclass: 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 |
| EnergyFOI | 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 |

# Actuators

If SenML value = 0 it means the actuator is not used

If SenML value = 1 it means the actuator is used

**Table 10. Actuator names**

|  |  |  |
| --- | --- | --- |
| **M3 or SenML domain** | **M3 or SenML Actuator name** | **Description, other names (synonyms)** |
| Transport | FogLamp | Fog lamp |
| Transport | Brake |  |
| Transport | ABS | Abs, anti-lock braking system |
| Transport | ESP | Electronic stability program |
| Transport | 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 |

**Table 11. 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 |  |

# Others 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

**Table 12. measurement names**

|  |  |
| --- | --- |
| **M3 or SenML measurement name** | **Description, other names (synonyms)** |
| lon | longitude |
| lat | latitude |
| Others measurements are the same than those referenced for sensors |  |