The M3 nomenclature to describe and interpret sensor measurements

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 and are implemented in the M3 ontology to unify rules related to these sensors and later rea son on sensor data.

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Last Update	26 September 2014 Check actuators and RFID with M3 ontology
Status	Ongoing

Caption	• Rows in green, compliant with:
	  ○ M3 ontology
	  ○ Linked Open Rules
	  ○ IoT application template
	• Rows in white or red (to finish)

Definitions	• Correctness: All sensor values are covered by an high level information. • Completude: No incompatibility with other rules
Links	• M3 Web site: http://www.sensormeasurement.appspot.com/ • NS_M3 = http://sensormeasurement.appspot.com/m3# • SenML language: http://www.ietf.org/archive/id/draft-jennings-senml-10.txt

I. 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.

1. 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	6 rules
Health	HeartBeatSensor/ HeartBeat	Pulse sensor, pulse oxymeter, pulse-ox, heart beat, heart rate,	BeatPerMinute	Tanatong [4] (5 rules)

		pulse rate, cardiac frequency		Correctness ok **Completude No** **SlowHeartBeat/ Normal heart rate Hristoskova [2]**
Health	PulseOxymeter/ SPO2	Pulse oxymeter, spO2, blood oxygen saturation sensor, pulse and oxygen in blood sensor	Percent	1 rule
Health	CholesterolSensor/ Cholesterol	cholesterol	MmolPerLiter	1 rule
Health	Glucometer/ BloodGlucose	Glucometer, glucose sensor, blood glucose meter, blood sugar level	GramPerLiter	3 rules Guermah [1]
Health	BloodPressureSensor/ BloodPressure	blood pressure meter, sphygmomamometer, MAP (Mean arterial pressure), CVP (central venous pressure)	mmHg	0 rule [[] [2]
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

2. 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	• 5 rules Staroch [3] • Correctness ok • Completude: Overlapping with kofler, Rodriguez More rules staroch
Weather	WindDirectionSensor/ WindDirection	Wind direction	DegreeAngle	5 rules Completude + Correctness
Weather	SunPositionDirectionSensor/	sun position	DegreeAngle	5 rules Staroch [3]

	SunPosition	direction to detect east, west, south, north		Completude + Correctness
Weather	AtmosphericPressureSensor/ AtmosphericPressure	Atmospheric pressure sensor, Barometer, barometric pressure sensor	Pascal	5 rules Staroch [3] Completude + Correctness
Weather	CloudCoverSensor/ CloudCover	Cloud cover sensor	Okta	• 5 rules Staroch [3] • Correctness: Values between 0 and 9 • Completude: Ok even with kofler
Weather	SunPositionElevationSensor/ SunElevation	sun position elevation to detect (twilight, day, night, etc.)	DegreeAngle	8 rules
Weather	SolarRadiationSensor/ SolarRadiation	Solar radiation sensor, par (photo synthetically active radiation) sensor, sun light, solar sensors, sun's radiation intensity	WattPerMeterSquare	Kofler staroch Kofler incompatiblity Starroch more precise Correctness ok 5 rules
Weather	VisibilitySensor/ Visibility	Visibility sensor to detect fog	Miles, Meter	
Weather	Thermometer, AirThermometer/ Temperature	Thermometer, temperature sensor, thermistor	DegreeCelsius	Kofler 15 rules Staroch (6 home temperature rules)
Weather	LightSensor/ Luminosity	Light, luminosity, illuminance, lighting	Lux	
Weather	PrecipitationSensor/ Precipitation	Precipitation sensor, rainfall sensor, rain fall,	MilimeterPerHour	

		pluviometer, rain, rainfall gauge		
Weather	WindSpeedSensor/ WindSpeed	Wind speed sensor, wind velocity sensor, anemometer	MeterPerSecond	Hofler 16 rules Staroch 5 overlapping

3. 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	Rodriguez 3 rules completude ok correctness no Between 30 and 110 overlapping with Vasileios
Weather	Thermometer/ Temperature	Thermometer, temperature sensor, thermistor	DegreeCelsius	Kofler 15 rules (only 9 implemented) Staroch (6 home temperature rules) Rodriguez 3 rules Overlapping overlapping with Vasileios Yus
BuildingAutomation	LightSensor/ Luminosity	Light, luminosity, illuminance, lighting	lux	Pb with Vasileios
BuildingAutomation	presence	Presence sensor, occupancy detector, pyroelectric IR occupancy, intrusion detector/ trespassing, infrared sensor, motion sensor, motion detector, motion sensor		
Weather	HumiditySensor/ Humidity	Hygrometer, humidity sensor, moisture sensor, soil moisture probes	Percent	• 5 rules Staroch [3] • Correctness ok • Completude: 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)		
BuildingAutomation	acceleration	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		

4. Transport

Table 4. Transport domain: sensors, measurements and units

M3 or SenML domain	M3 or SenML sensor name	M3 or SenML measurement name	Description, other names	M3 or SenML Unit
		speed	Speed sensor, speedometer, velocity sensor (car)	
		tire pressure		
		fuel	Fuel level	
		distance	Distance sensor	
		rpm	Position and/or rotational speed	
		maf	mass air flow sensor	maf

5. Agriculture

Table 5. Agriculture 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
Agriculture	SoilHumiditySensor	SoilHumidity		Percent
Agriculture	AirThermometer	Temperature	Thermometer, temperature sensor, thermistor	°C, K, F

6. 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	

7. Environment

Table 7. Air quality 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	M3 rules
Environment	AirPollutantSensor	AirPollution	Air pollutant sensor	EAQI	5 rules Completude + Correctness Kofler + staroch
		oxygen	oxygen sensor		
		no	Nitrogen oxide sensor		
		CO	Carbon monoxide CO sensor		
		SO2	Sulfure dioxide sensor		
		CO2	Carbon Dioxyde Sensor	Ppm (parts per million)	

8. 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,	lon, lat,

			location sensor	alt
Generic		frequency		Hz
Generic		shake	Shake sensor, vibration	

II. 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.

Table 9. Domain names

M3 or SenML Domain name	**Description, other names (synonyms)**
BuildingAutomation	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	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
Tourism	Tourism
Location	Location, place, GPS coordinates
City	Smart city, city automation, public lighting
RFID	Tracking RIFD goods
Generic	Others

III. 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	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	AirConditioner	Air conditioner, ac
BuildingAutomation	Heating	
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

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	

IV. 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	

V. References

[1] Hatim Guermah, Tarik Fissaa, Hatim Hafiddi, Mahmoud Nassar, and Abdelaziz Kriouile. A semantic approach for service adaptation in context-aware environment. *Procedia Computer Science*, 34:587–592, 2014.

[2] Anna Hristoskova, Vangelis Sakkalis, Giorgos Zacharioudakis, Manolis Tsiknakis, and Filip De Turck. Ontology-driven monitoring of patient's vital signs enabling personalized medical detection and alert. *Sensors*, 14(1):1598–1628, 2014.

[3] Paul Staroch. A weather ontology for predictive control in smart homes. Master's thesis, 2013.

[4] Tanatorn Tanantong, Ekawit Nantajeewarawat, and Surapa Thiemjarus. Towards continuous electrocardiogram monitoring based on rules and ontologies. In *Bioinformatics and Bioengineering (BIBE), 2011 IEEE 11th International Conference on*, pages 327–330. IEEE, 2011.