Needed Functional Mapping in agnostic programmable Service Oriented Systems:
(Basic understanding in how to integrate Service management and interaction of IoT)

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1: What is the Functional Mapping?
Functional Mapping describes what to be done when transferring one value into another value with a corresponding meaning [1]. Here is three examples of Functional Mapping:
- Transfer the measurement of unit foot [2] into 0,3048 meters [3].
- The monetary unit 1 Euro becomes 8.22300378 Norwegian kroner.
- the temperature 69.8 Fahrenheit is transferred to 21 degrees Celsius.

In this way you see that other ways for Function Mapping is transmission, conversion or transformation. Everything depends on what Functional Mapping does transfer. Already in the 1300s we know examples of using functions, but first in the end of the 1600s it became common in mathematics [4], 300 years ago.

What does Functional Mapping mean in technical systems? A few obvious examples are related to the temperature measurement. It can happen in milliamps or volts. This provides control data to a heater system that regulates the indoor temperature by help of the measurement value described in degrees Celsius.

Here is indicated several Functional Mappings. Volts or milliamps must first be transferred into a numeric/binary value through an Analog to Digital conversion and then again transferred into the correct degree Celsius scale. Finally the transferred temperature in degree Celsius is compared with wanted temperature(Set point) in the receiving and controlling Service Template. The deviation between wanted and actual temperature is then transferred from a digital deviation value into an analog voltage or amps (Digital to Analog conversion) controlling the level of the Heater. (In general term this is called a Thermostat system). This Thermostat system is illustrated in the following block diagram:
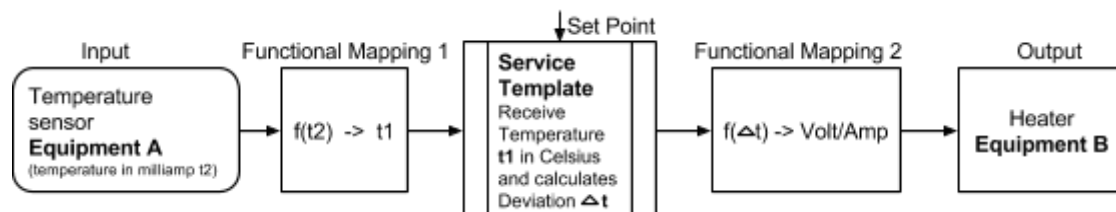

Figure 1: The figure shows the function transfer of temperature at several stages.

The general mathematical expression for Functional Mapping is f: X -> Y
This is shortened to $y = f(x)$, which most have learned in elementary school. For Functional Mapping is used an arrow ->.

An example of a first degree equation f $(x) = 4 - x$ is expressed as x -> 4 - x. Such expression can be very complex and can have many functions and variables that operates dynamically and simultaneously. All this is a standard part of the Set Theory copied from Wikipedia [1]:

> In mathematics, a function is a relation between two distinct objects, so that to each element of the first object (functional argument, independent variable, x value) is assigned to one element in the other object (function value, dependent variable, y-value). An example of such a relationship is f $(x) = X^2$ (read "f of x is equal to x in square") showing the relationship between the input values x and its square.

1. http://en.wikipedia.org/wiki/Function_%28mathematics%29
2. http://en.wikipedia.org/wiki/Foot_%28unit%29
3. http://en.wikipedia.org/wiki/Metre
4. http://en.wikipedia.org/wiki/History_of_the_function_concept#Functions_before_the_17th_century

2: Examples of Functional Mapping in technical systems (Simplified)
Here is a figure that shows how three temperatures can be represented:
- Equipment A - t2 measured in milliamps
- Equipment B - t3 measured in Volt
- Equipment C - t4 measured in a Binary number

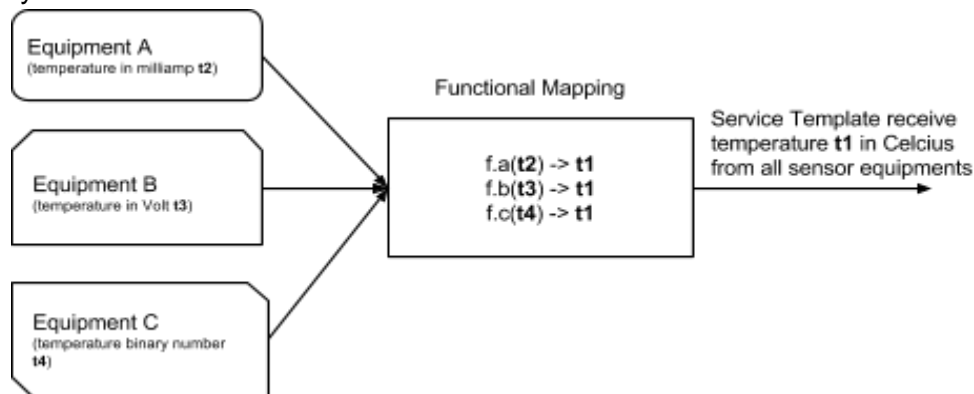All transferred to degrees Celsius through Functional Mapping, which happens quite immediately in the software:

Figure 2: Functional Mapping from three different ways (Equipment A, B and C) of representing a temperature t1 into the scale of degree Celsius.

In the following example we have created three different technical systems measuring temperature, humidity and position. All three systems sends measurement data in three different formats, which causes discrepancies between the 3 values. To bring order to this, you

use the Functional Mapping to transfer measurement data into a common standardized measurement of temperature, humidity and position respectively.

Typical mapping examples of Temperature, Humidity and Position:

Temperature sensor mapping	**mapped to standardized temperature**
Box A (temperature t2 i milliamp)	-> t1 degrees Celsius real number
Box B (temperature t3 i Volt)	-> t1 degrees Celsius real number
Box C (temperature t4 i binary number)	-> t1 degrees Celsius real number

| **Humidity sensor mapping**	**mapped to standardized humidity**
Box X (humidity f2 i milliamp)	-> f1 %Relative Humidity real number
Box Y (humidity f3 i Volt)	-> f1 %Relative Humidity real number
Box Z (humidity f4 binary number)	-> f1 %Relative Humidity real number

Position coordinates mapping	**mapped to standardized position**
Box N (position u,v p2 GPS)	-> x,y 1 latitude and longitude
Box M (position x,y p3 Galileo)	-> x,y 1 latitude and longitude
Box O (position r,s p4 GPRS)	-> x,y 1 latitude and longitude

3: Shared Multivariable Functional Mapping in a Role based Care Technology System
A modern system for information exchange and control, will have to deal with a multitude of different functions transferred. There may be alarm switches (care alarms). It may be fall sensors or temperature sensors that control the heat in a room. In that sense Care Alarms will be a kind of subset to sensors and different alarms.
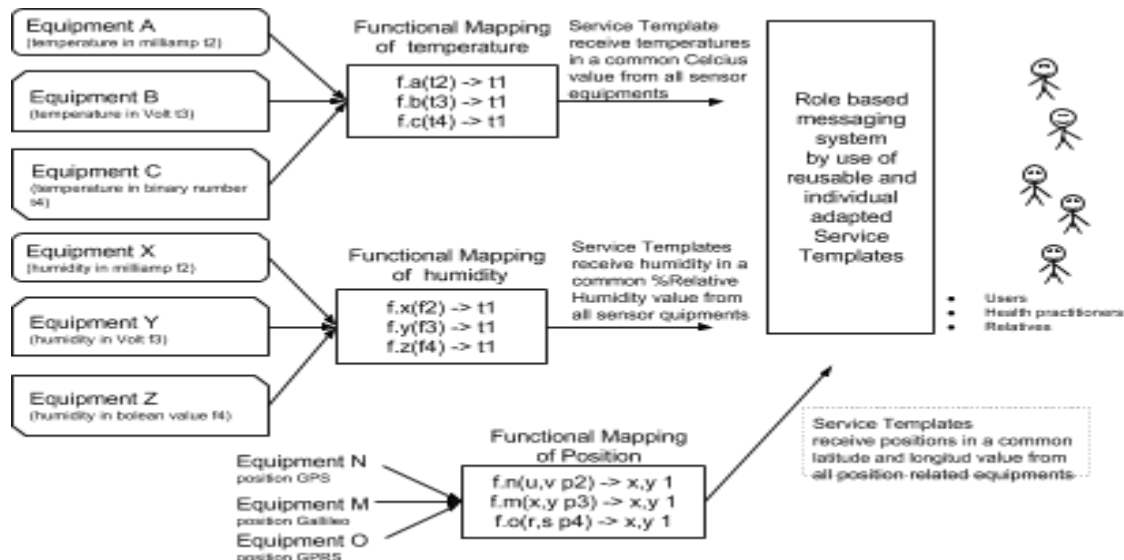
In a well designed care system the functions also will be attached to a specific owner, manually(person) or automatically(programmable process). That means it can be controlled who/what can handle the function, and get access to the data. In this way you can send the function or the information that follows the function to one or several persons who are

authorized to access, but in some cases also handled automatically by a programmable attached process.

It means that we do have a Role based and Shared system that gives access to functions and data for right persons or programmable service process'.

Especially in Health Care sector we are talking about patient data and related functions specially when measurements of the patient health condition are sent and shared among many persons. It can be anything from values such as "heart rate" measured with a mobile phone, or a "blood test" measured at a clinic. It may also be measurements tracing the movement of a patient with dementia. Such data and functions should not be handled by unauthorized persons. Therefore, it must be in place roles for function processing and data, and an authorization to access. This must be part of standardization.

What does this mean? It is the persons that needs care themselves, health practitioners, their family or close associates who should have access to the specific functions and needed information exchange with respect to their privacy and the rules applicable to the patients treatments. Individual needs have to be adapted in accordance to functional disability and requirements. This by help of available technological care functions and solutions.

All this indicate that we are talking about many different functions and related information exchanges between many systems. Putting all this together, you will get complete set of function blocks to be exchanged. In other words a collection of functions and information. All this represent a multivariable Functional Mapping, and it do also carry out conversion to standardized measurement units. Because it also is role based we get an individual adapted Functional Mapping. In such a way we will get an agnostic and individual adapted role based multi variable Functional Mapping in the Healthcare sector. Much of it already standardized in OASIS and through EPR-forum work.

4: Why is Functional Mapping crucial in service oriented standardization?

Why is Functional Mapping important in standardization?
There are many different technologies that are currently used to deliver healthcare services helping people with functional disability and other different requirements (Both legislated public services and private delivered services). It could be simple care alarms or more complete Smart House solutions installed in the living environment for people with dementia or chronic sick persons. Here we do have examples of temperature, humidity or position measurements and controls with related or other sensing alarm conditions as emergency push button alarms, fire alarms, leakage alarms, position alarms, intruder alarms etc etc. As you can see, there is huge collection of different functionality and response services, measurement types etc.

It is not obvious that different vendor delivered systems or equipment use common measurement units or scales. To ensure cooperation and interactions it is needed a top level

standardized service abstraction level dealing with a common "open" understanding of the different information exchange of functions, measurements and controls.
As an example an alarm condition from one system needs to be exchanged to another system in an alarm chain where the alarm still represent an alarm condition. This means that the alarm code get a Functional Mapping in the transfered system to a standard that still represent an alarm condition in the interacting system. But it is important to understand that Functional Mapping is far more complex than this single alarm condition when dealing with multi variable solutions that do interact.

To day usually different equipment do have different ways to measure inputs or control outputs. As an example it is three different ways to measure a person's position on a mobile unit. It may be GPS, GPRS or Galileo. It could also be different ways to measure and control temperature in a room by help of a common heater or heating pump. "Something as simple" as an alarm button connected to a mobile phone do also have many ways to exchange an alarm condition.

The whole is made much more complicated when several solutions do exist side by side as parallel systems. Specially when many vendors of equipment show great creativity in how to lock their customer into their isolated platform systems and technology based products known as "embrace, expand and extinguish" [5]. So there is a political trade side of this issue, and huge values are in play:
5. http://en.wikipedia.org/wiki/Embrace,_extend_and_extinguish

It is not any surprising news that there are different measuring units. More than 200 years ago it was common to change the measuring system each time a new king took over. This represented of course an irritation for those who traded, and happiness for fraudsters. Sellers got significantly more administrative work by acquiring new weights, and convert the weight and size to be sure that the price was right on goods they sold and bought. Such situations also contributed to that someone could "cheat on measure unit." They could cheat with the weights or length measurements. They could swindle with the conversion of a one measurement to another. A little "roundup errors" can provide huge gains. Standardisation of weight, meters and other variables in the 1800s have contributed to more efficient trade. Today the term "cheat on measure unit" is gone out of everyday speech. The independent body, "Justervesenet" in Norway, monitor that measurements units all over Norway are correct, which is a typical public management task.

To avoid small and large measurement and control errors and unwanted system and product locking we need common functional service standardization on top of todays different industry driven technology standards. Measuring and control units must match !
(See attached BUS-technology standards example).
Functional Mapping must be correct. Anything else means "cheat on measurement unit" and introduce much more higher development and integration costs. Without Standardized Functional Mapping and information exchange open up for vendor locking, monopoly pricing and outright fraud. Recent Legal Court cases also proves that it is criminal to withhold needed information in "open" and correct Functional Mapping.

Example: Microsoft was fined 7.2 billion Norwegian kroner of EU because they took too much paid for documentation about how Windows operating system interacts with the world [6]:
6. http://www.digi.no/512242/milliardbot-til-microsoft-for-grov-overprising

The point is it should be possible to substitute equipment from one vendor with another, and retain the desired system functionality so that information can be exchange to other systems with accurate measurements and control outputs. The service functionality and measurement and control units are all standardized and maintained by different standard bodies and organizations both nationally by Standards Norway, and internationally by W3C, ISO,CEN, OASIS etc.

This goes even further. To satisfy business needs and objectives it is possible to combine the functions and measuring units in the business solutions to satisfy customers requirement in a competitive a flexible way. Here the standardized Functional Mapping and processable Service Templates is crucial. Such standardization may also in some cases be in violation with some vendors own interests. Anyway standardized Functional Mapping is today well documented and managed through transparent and open processes. The ongoing important national interaction reforms specially in the healthcare sector require solutions that avoid possible tricks to prevent access to common information and needed transfer of functions, and thus prevent systems to interact. The legislation in public procurement in Norway requires principals that do not use standards and technical specifications that prevent competition [7]. This is followed up in the regulations:
7. http://lovdata.no/dokument/NL/lov/1999-07-16-69#%C2%A75

5: Short summary

As this memorandum highlights we are talking about basic knowledge of Science work over several hundred years. This is coupled with solid routines for standardization over a variety of types of Functional Mapping.

It is also subject to various laws as to determine how measurement units should be understood, developed and standardized. But also that everyone should have access to basic functions and information to preserve free competition. This is because we in a modern democratic society totally depend on high integrity and confidence in that Functional Mapping is done correctly and works as specified.

BUS-technology standards examples:

Examples on Platform based Industrial TECNICAL Standards
Process-Nett: Common & Open Bus-protocolls

- Ethernet:	ISO/IEC/IEEE 8802	Most widely used method of linking computers together in LAN & WLAN
- Firewire:	IEEE 1394	Short distance and high speed serial cable communication with computer equipment
- USB:	ISO/IEC 7816	Short distance and high speed serial cable communication with computer equipment
- Bluetooth:	IEEE 802.15.1	Wireless technology standard for exchanging data over short distances. Mobile personal area network
- Zigbee:	IEEE 802.15.4	A wireless communication protocol for personal data network (WPAN).
- Continua*:	USB+Bluetooth+ZigBee Trade organization	
- CAN:	ISO 11898	Vehicle bus standard designed to allow microcontrollers and devices to communicate with each other within a vehicle without a host computer.
- DALI:	IEC 62386	Technical standards for network-based systems that control lighting in building automation
- KNX:	ISO/IEC 14543	Network communications protocol for intelligent buildings (EIB, EHS, BATIBUS)
- RFID:	ISO 11784	A technology to electronically record the presence of an object using radio signals
- LON:	ANSI/CEA 709	Is a networking platform specifically created to address the needs of control applications in building automation
- SCP/CEBus:	ANSI/CEA-600	A set of electrical standards and communication protocols for electronic devices to transmit commands and data. Home & Building Automation
- BACnet:	ISO 16484(ANSI)	A communications protocol for building automation and control networks
- X10	Industry standard	A protocol for communication among electronic devices used for home automation – Power Line
- MOD bus	Industry standard	A serial communications protocol for use with its programmable logic controllers (PLCs)
- MDB	Industry standard	A computer bus in which all components are connected to the electrical circuit. Vending Machines
- etc		

EPR-eDevice modeling is mirroring fuctionalety from
the Technology level to automated and human service level

Standardization Bodies:
CEN - Comité Européen de Normalisation
ISO - International Organization for Standardization
W3C – Word Wide Web comsortium
OASIS – Organization for the Advancement of Structured Information Standards
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IEC – International Electrotechnical Commission
IEEE - Institute of Electrical and Electronics Engineers
ANSI – American National Standards Institute
CEA – Consumer Electronic Association

*Continua is no standard but use the USB (cable connected),
BlueTooth and ZigBee (Wireless connected) standards