

A FRAMEWORK AND ONTOLOGY FOR MOBILE SENSOR PLATFORMS IN HOME HEALTH MANAGEMENT

Mark Hennessy, Chris Oentojo, Dr. Steven Ray

Carnegie Mellon University Silicon Valley
Moffett Field, CA, USA

Supported by Grant 60NANB11D144 from the
National Institute of Standards and Technology

**Carnegie Mellon University
Silicon Valley**

PROBLEMS / OPPORTUNITIES

Problems

- Cost
- Complexity

Goals

- Interoperability framework
- Simplifying use of complex medical standards

Approach

- Cloud based reasoning environment



RESEARCH OVERVIEW

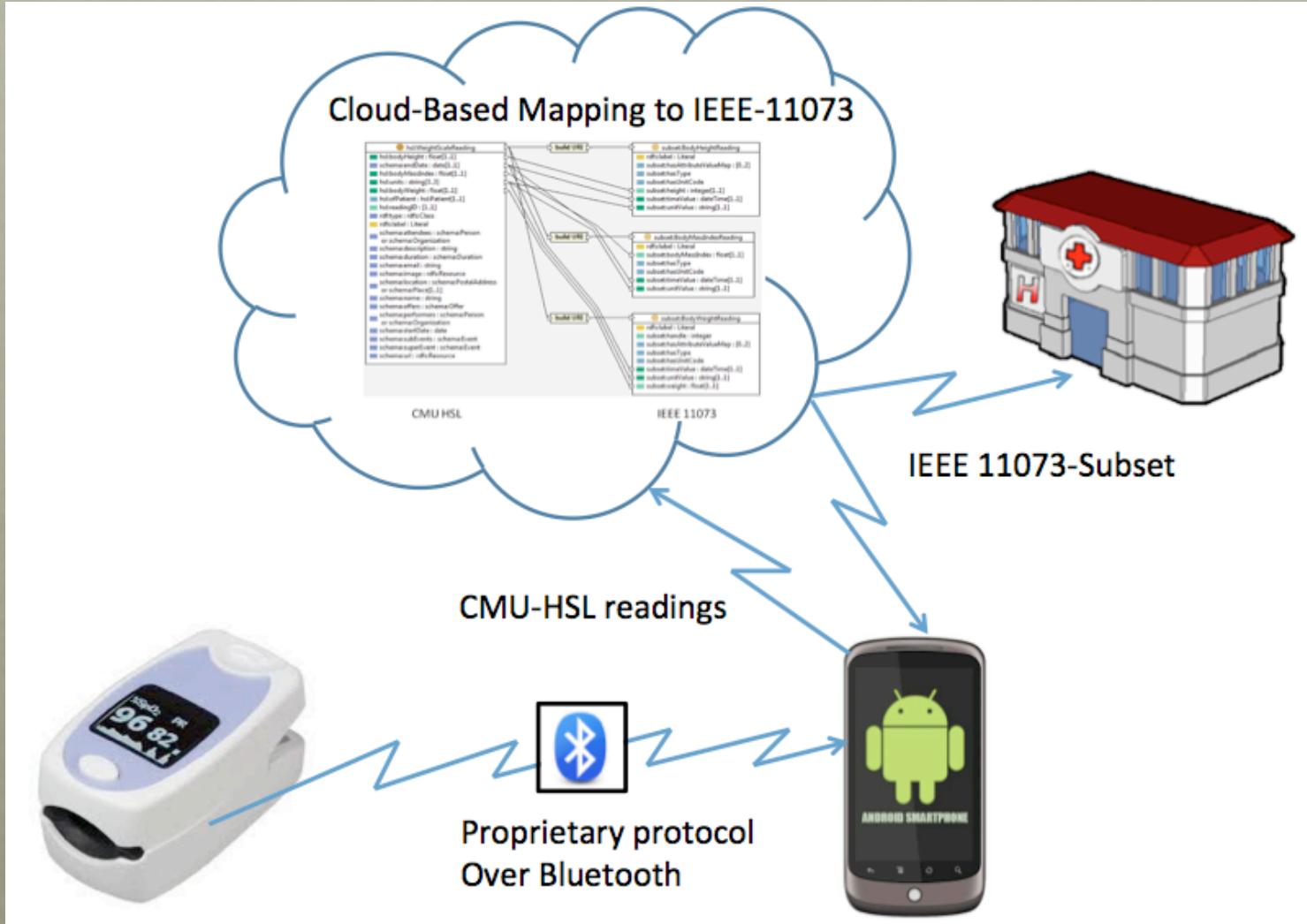


Source: http://www.ercim.eu/publication/Ercim_News/enw60/husemann.html

- Ontologies to map sensor data to medical standards like IEEE 11073
- A cloud-based reasoning and mapping system built with RDF, OWL, SPARQL and SPIN



THE BIG PICTURE



EXISTING STANDARDS

- **Health Level 7 (HL7)** - A global health standard that provides a framework for easy and transparent exchange of electronic health information.
- **IEEE 11073** – Family of standard for medical device information exchange.



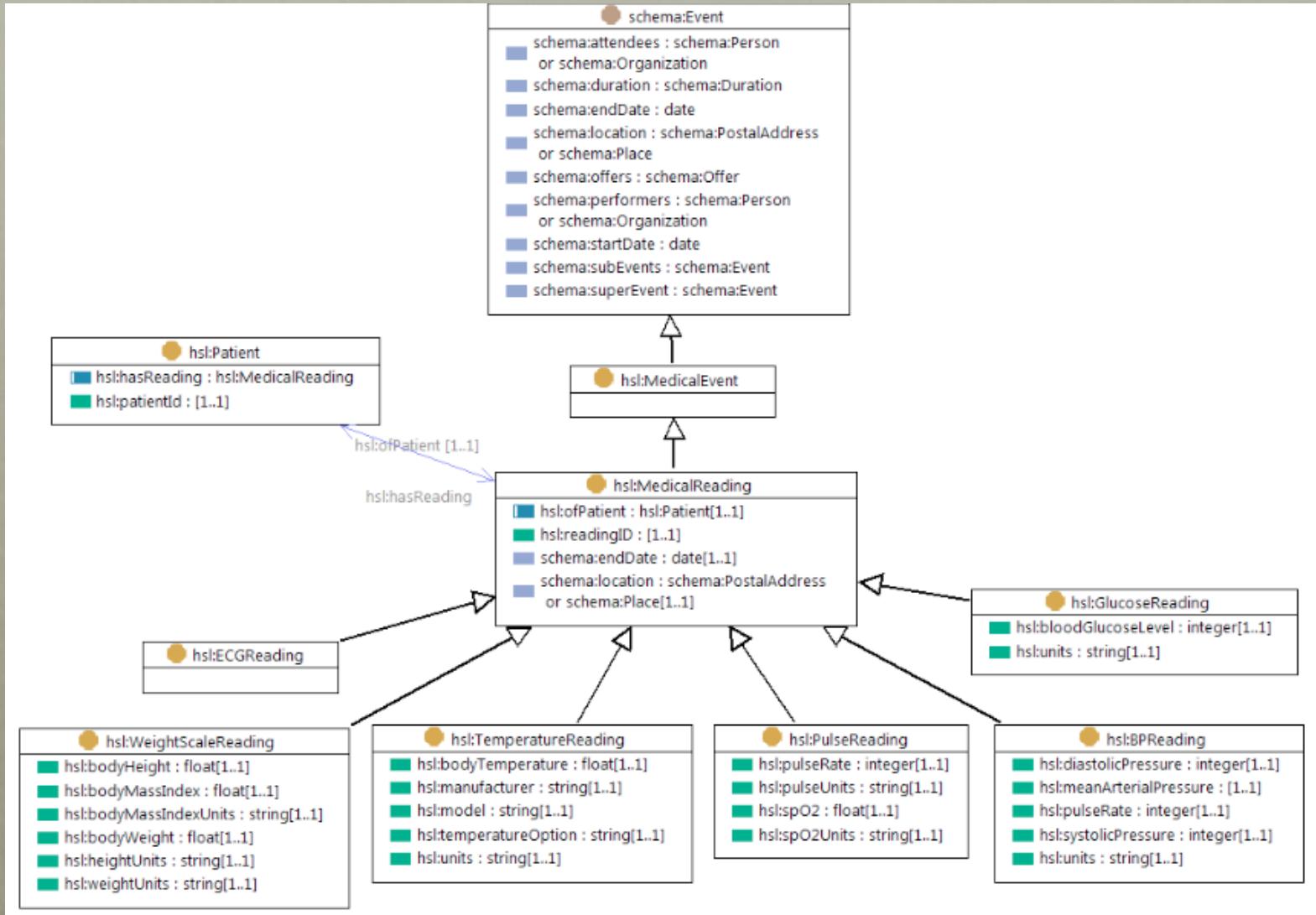
HSL ONTOLOGY

The Healthcare Semantics Lite (HSL) ontology

- Minimum set of data a medical reading
- Represents data for developers and public
- Inherits from Schema.org



HSL ONTOLOGY (PARTIAL)



IEEE 11073 SUBSET ONTOLOGY

Subset of the IEEE 11073 device-specific component standards

	subset:BloodPressureReading
	subset:hasAttributeValueMap : [0..2]
	subset:hasMetricIdList : [0..3]
	subset:hasUnitCode : [1..1]
	subset:diastolicBP : integer[1..1]
	subset:meanArterialPressureBP : integer[1..1]
	subset:metricSpecSmall : string[1..1]
	subset:systolicBP : integer[1..1]
	subset:timeValue : dateTIme[1..1]

Class with mandatory IEEE 11073–10407 mandatory fields

MAPPING HSL TO SUBSET

SPINMap used to define mappings

Example

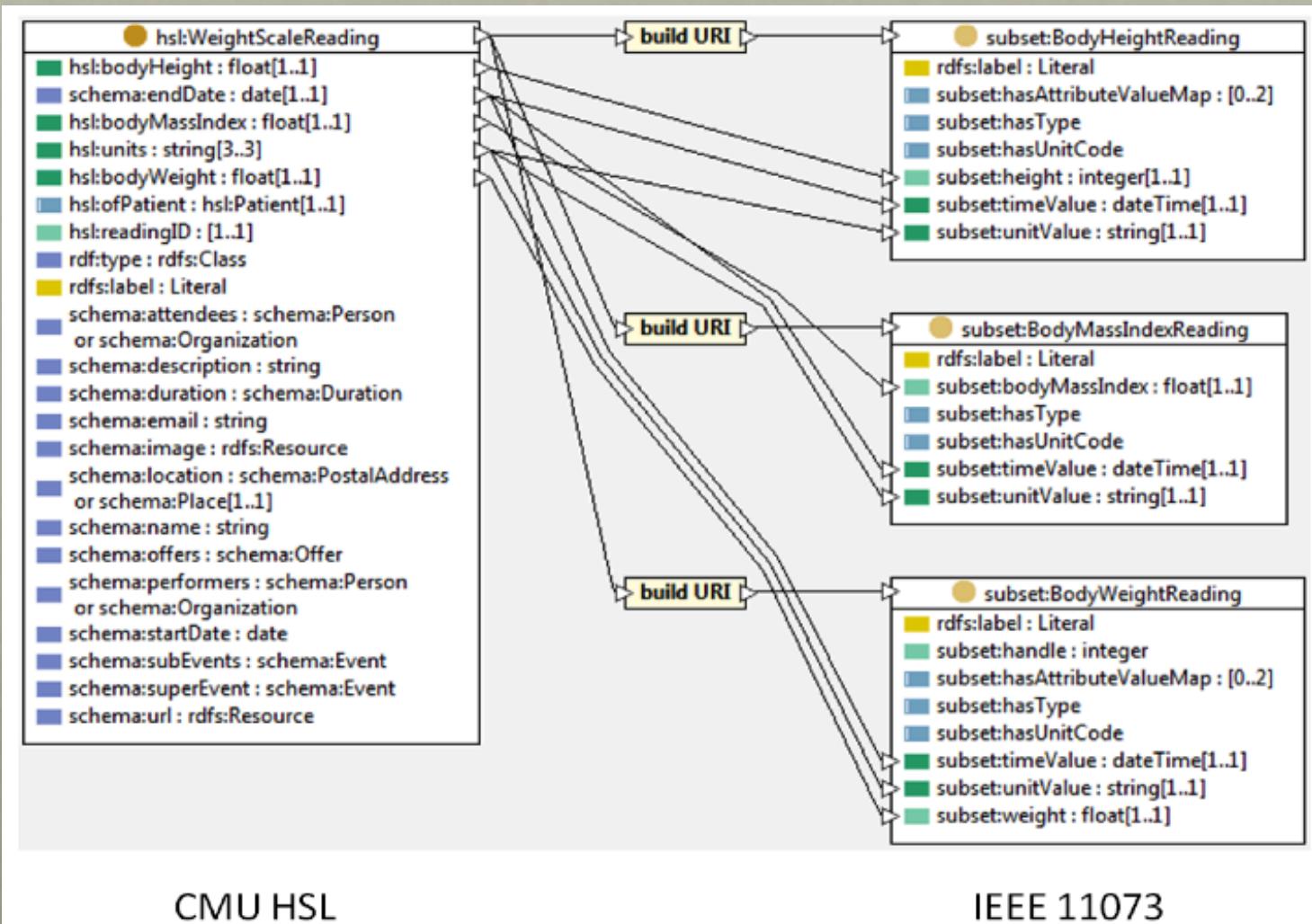
Unit of measure for blood pressure

HSL: “mmhg” → Subset: “MDC_DIM_MMHG”

Other values mapped by default, e.g., manufacturer of the medical sensor.



HSL TO SUBSET DIAGRAM



PROOF OF CONCEPT FRAMEWORK

- RDF
- Cloud-based OWL reasoner
- RESTful Endpoints
- SPARQL queries + SPIN rules
- Consumer context → Hospital context

Technology Stack

SPARQL Query Editor

Amazon Web Server (AWS)

TopBraid Live on AWS

Tomcat

TopBraid Live Platform
RDF/RDFS/OWL, SPARQL, SPARQLMotion

Pulse Reading SPARQL Construct Query

```
CONSTRUCT {  
?newHslPatient a hsl:Patient .  
?newHslPatient hsl:patientId ?patientId .  
?newHslReading a hsl:PulseReading .  
?newHslReading hsl:readingID ?readingId .  
?newHslReading hsl:ofPatient ?newPatient .  
?newHslReading hsl:pulseRate ?pulseRate .  
?newHslReading hsl:spO2 ?spO2 .  
?newHslReading schema:endDate ?timestamp .  
}  
WHERE {  
BIND ("http://cmusv/hsl#" AS ?hslUri) .  
BIND (spif:buildURI(fn:concat(?hslUri, ?patientId)) AS ?newHslPatient) .  
BIND (spif:buildURI(fn:concat(?hslUri, ?readingId)) AS ?newHslReading) .
```

MOBILE APP

- Interacts with medical sensors
 - Bluetooth Support
- Thin client
 - Interacts with cloud-based OWL reasoner
 - Renders JSON/XML data



APP SCREEN FLOW

The diagram illustrates the screen flow of a medical app. It starts with the "Medical Readings" screen, which lists various reading types. A blue arrow points from the "Blood Pressure Reading" item on this screen to the "Blood Pressure Reading" screen. This screen contains fields for Diastolic Pressure (89), Systolic Pressure (110), Mean Arterial Pressure (100), Pulse Rate (76), and Units (mmhg). At the bottom are "Take Reading" and "Submit" buttons. A second blue arrow points from the "Submit" button to the "Reading Results" screen. This screen displays a detailed log of the measurement data, including:

- hasAttributeValueMap
- MeasurementOOA.3.1.1thru3.2.2.5-96
- diastolicBP
- 89
- systolicBP
- 110
- timeValue
- 2013-02-03
- type
- BloodPressureReading
- hasType
- MeasurementHemoA.8.3.4-150
- handle
- 1
- meanArterialPressureBP
- 100
- metricSpecSmall
- mss-avail-stored-data
- hasMetricIdList
- MeasurementECGMSMTSA.7.1.2-1

- Easy to understand for patient and app developers
- IEEE 11073 compliant
- New data inferred

CONCLUSION

The biggest barriers to home healthcare are **cost** and **complexity**.

Smartphones

- Can replace many of the single-purpose medical devices
- Allow for home health monitoring
- Can provide important information to hospitals

Our extensible framework

- Opens world of home healthcare for mobile app developers
- Supports open interoperable information exchange
- Allows for sophisticated reasoning



QUESTIONS?

Contact Info:

Mark Hennessy - mark.hennessy@sv.cmu.edu

Chris Oentojo - christopher.oentojo@sv.cmu.edu

Dr. Steven Ray - steve.ray@sv.cmu.edu

Carnegie Mellon University Silicon Valley

Moffett Field, CA, USA

<http://www.cmu.edu/silicon-valley/>

