

RH: 85 %  
Temp: 18 Celsius

0.23 litre/minute

0.25 litre/minute  
0.27 litre/minute

# OGC SensorThings: IoT Data Interoperability with a GeoWeb approach

Dr. Steve Liang  
Chair, OGC SensorThings API Standard Working Group  
Rapporteur, ITU-T Q12/11 on IoT Test Specifications  
Founder and CEO, SensorUp Inc.  
Associate Professor, University of Calgary

# Agenda

- **Introduction to Open Geospatial Consortium (OGC)**
  - Why Location (almost always) matters?
  - What is IoT interoperability?
- **Introduction to OGC Sensor Web Enablement**
- **Introduction to OGC SensorThings API**
- **SensorThings API Introduction and Benefits**
- **Case Studies**
- **Demo**

# About Dr. Steve Liang

- Associate Professor, Geomatics Engineering, Uni. Calgary
- AITF-Microsoft Industry Chair on Open Sensor Web
- Chair OGC SensorThings API Standard Working Group
- Co-Chair OGC Sensor Web Enablement Domain Working Group
- N.A. Chair, OGC University Domain Working Group
- Rapporteur, ITU-T SG12/11 on Internet of Things Test Specifications
- Founder and CEO, SensorUp Inc, a University of Calgary startup  
(<http://www.sensorup.com>)

# About SensorUp

- **We are a world leader in OGC Sensor Web and IoT**
  - e.g., we developed the very first integrated SWE client back in 2005.
  - Our clients include Lockheed Martin, Natural Resources Canada, Agriculture and Agri-Food Canada, etc.
- **We are leading several international IoT standard development efforts (OGC and ITU-T)**
- **We developed world's first OGC SensorThings API implementation**
- **We are proud member of Eclipse and OGC.**

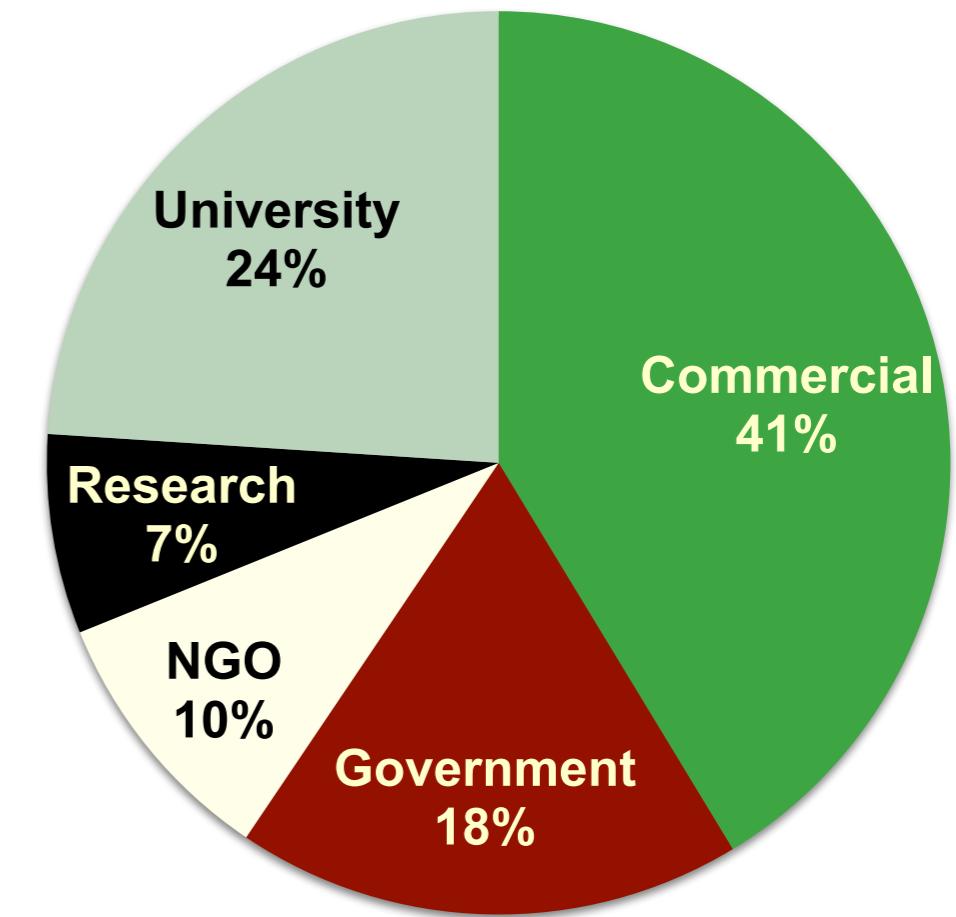


# The Open Geospatial Consortium



Not-for-profit, international voluntary consensus standards organization;  
leading development of geospatial standards

- 20<sup>th</sup> Anniversary celebrated in 2014
- 515+ members
- 40+ standards
- Many profiles, schema and best practices
- Thousands of product implementations
- Broad user community implementation worldwide
- Alliances and collaborative activities with many other organizations
- Every OGC standard at least needs three independent implementations.

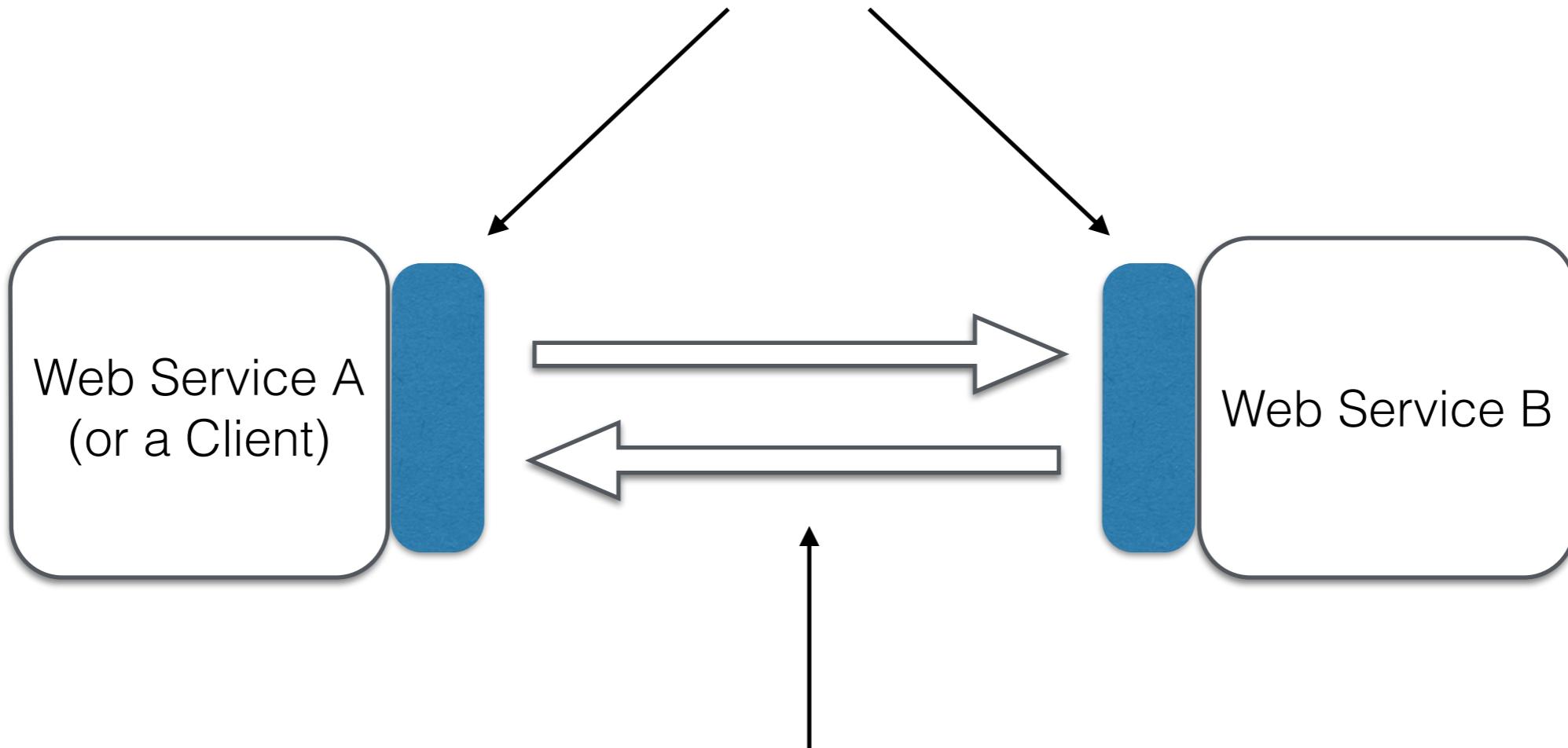


## Some OGC standards become ISO standards

# What are OGC standardizing?



## 2. web service interfaces (also ISO 19119)



In other words, OGC's IoT work can be considered as Web of Things (WoT) as well.

# Why Location (almost always) matters?

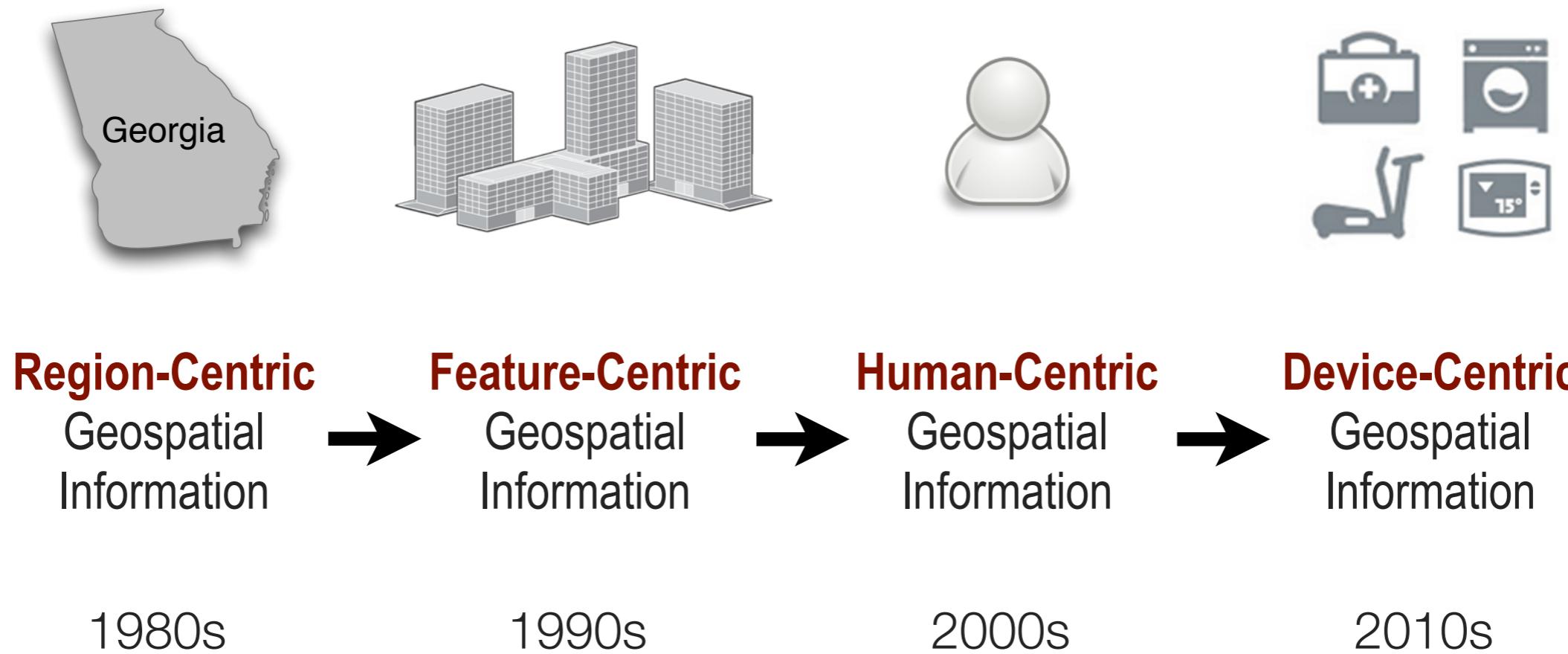


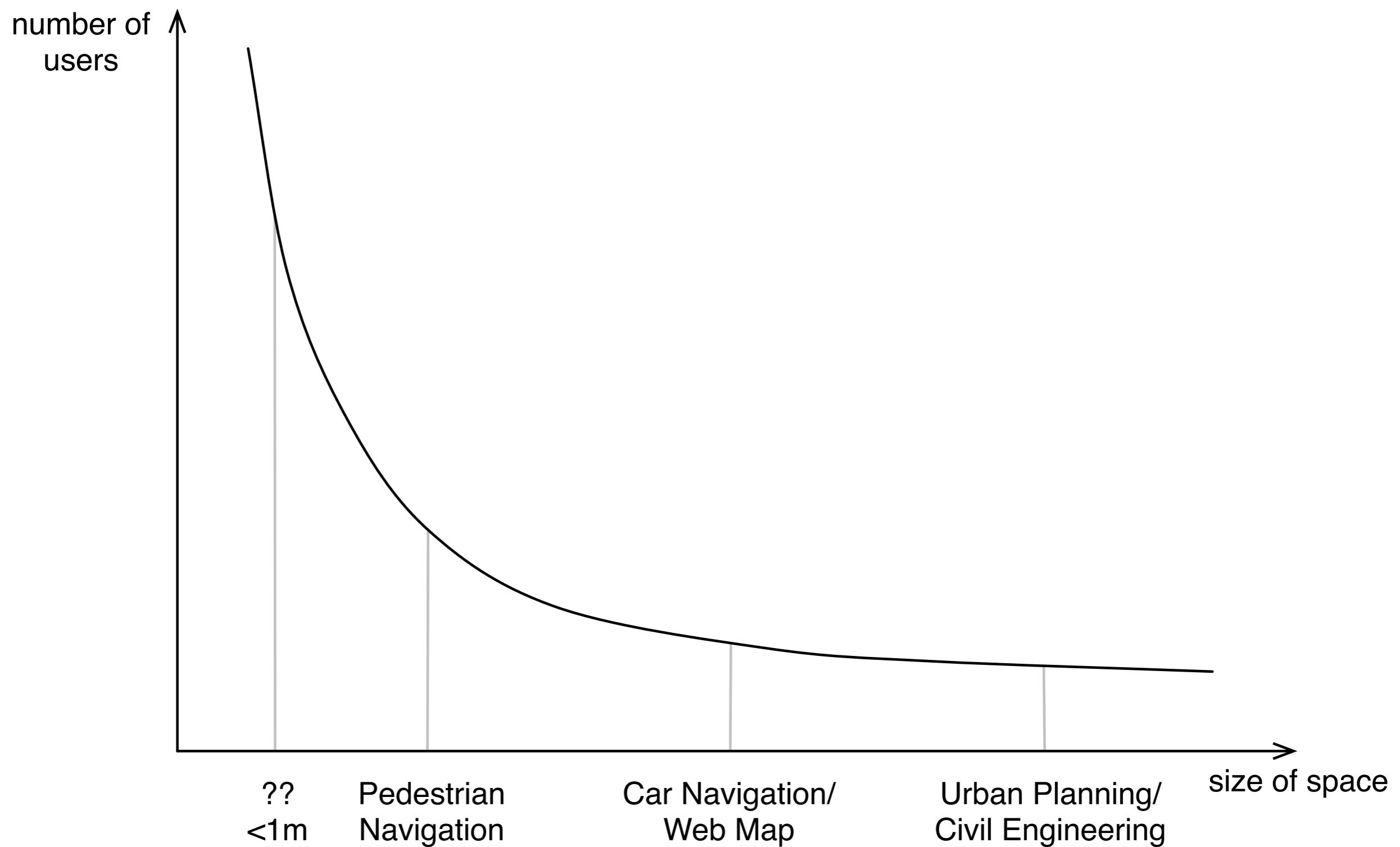
Smoke Detector

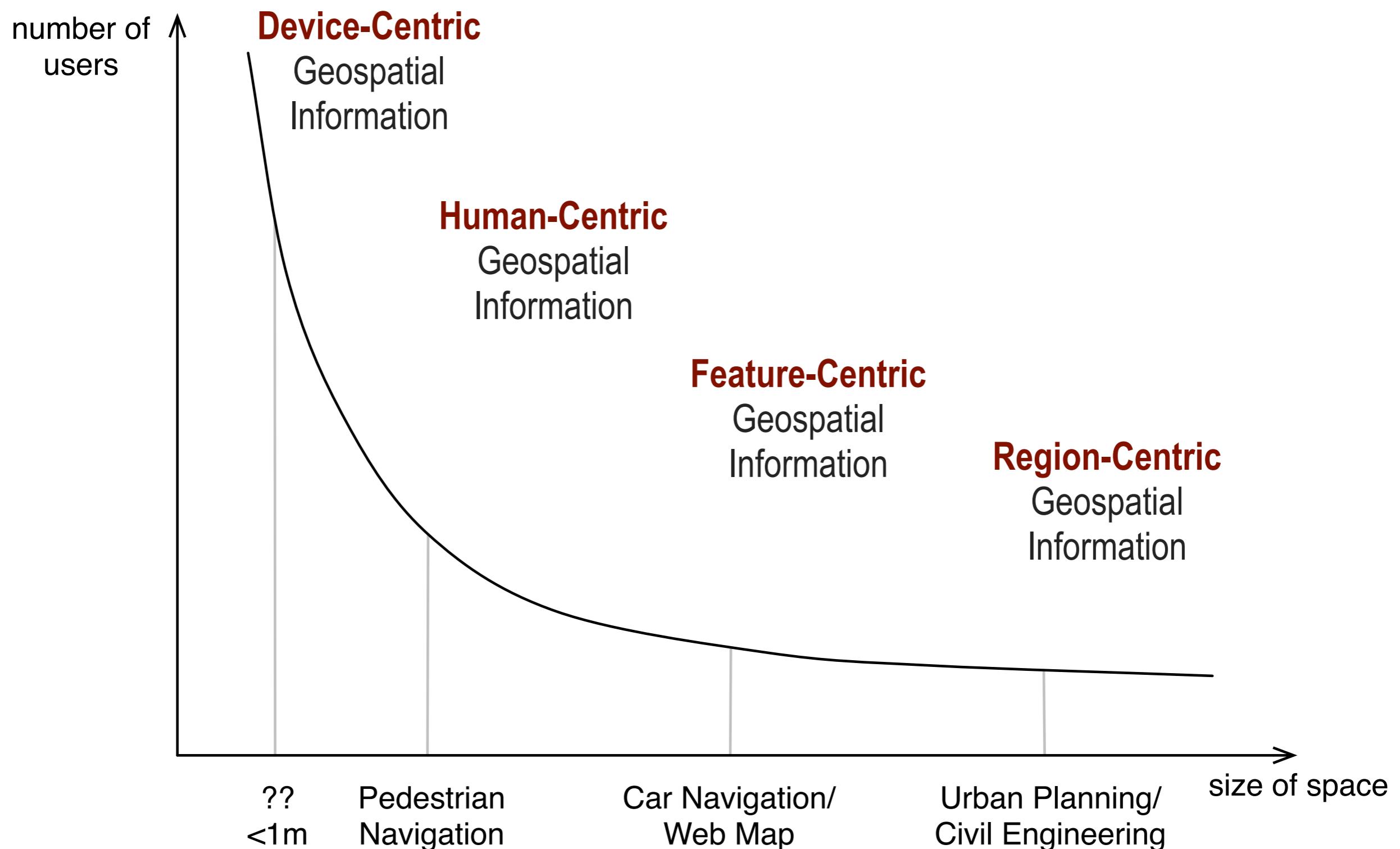


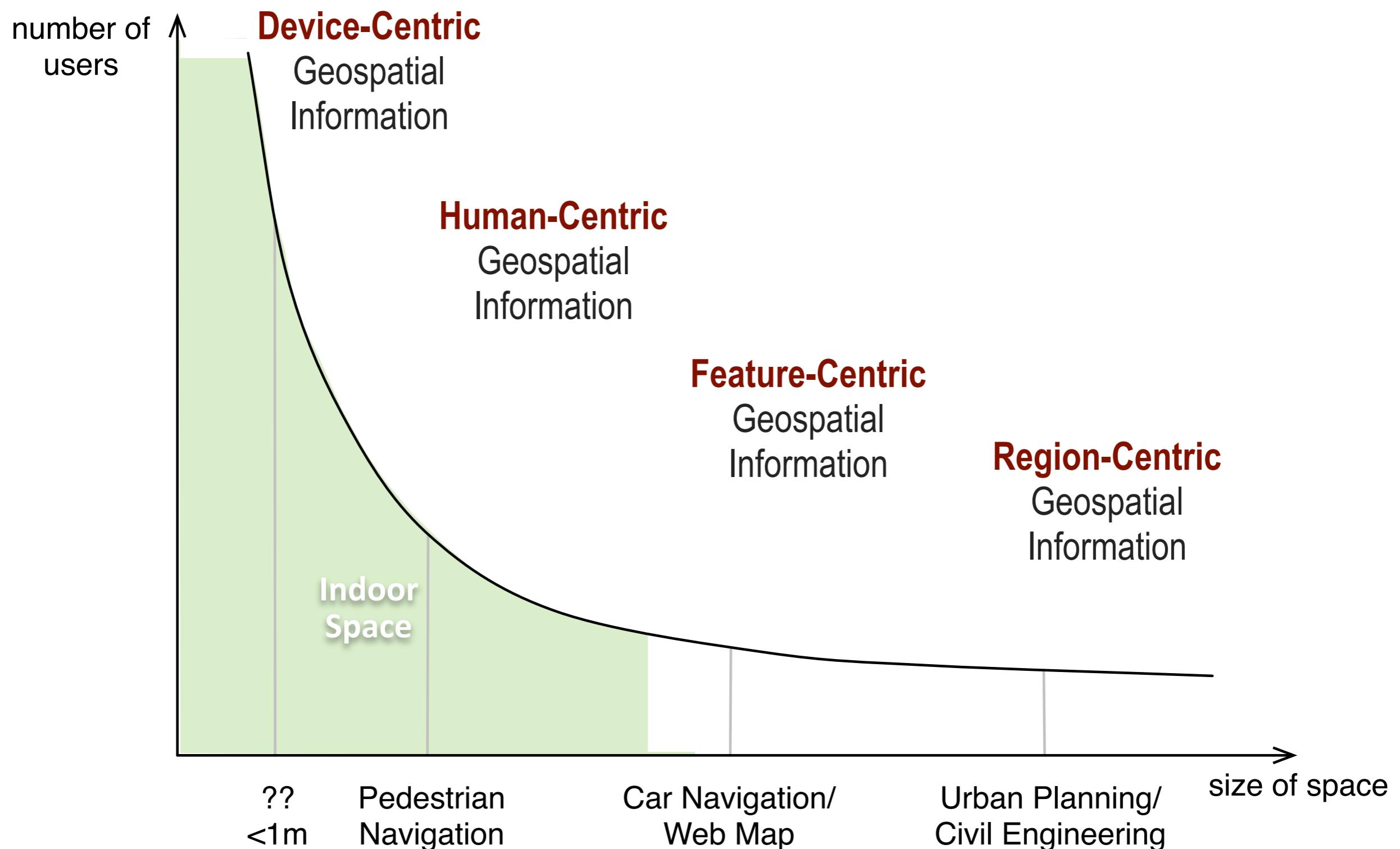
Emergency Evacuation

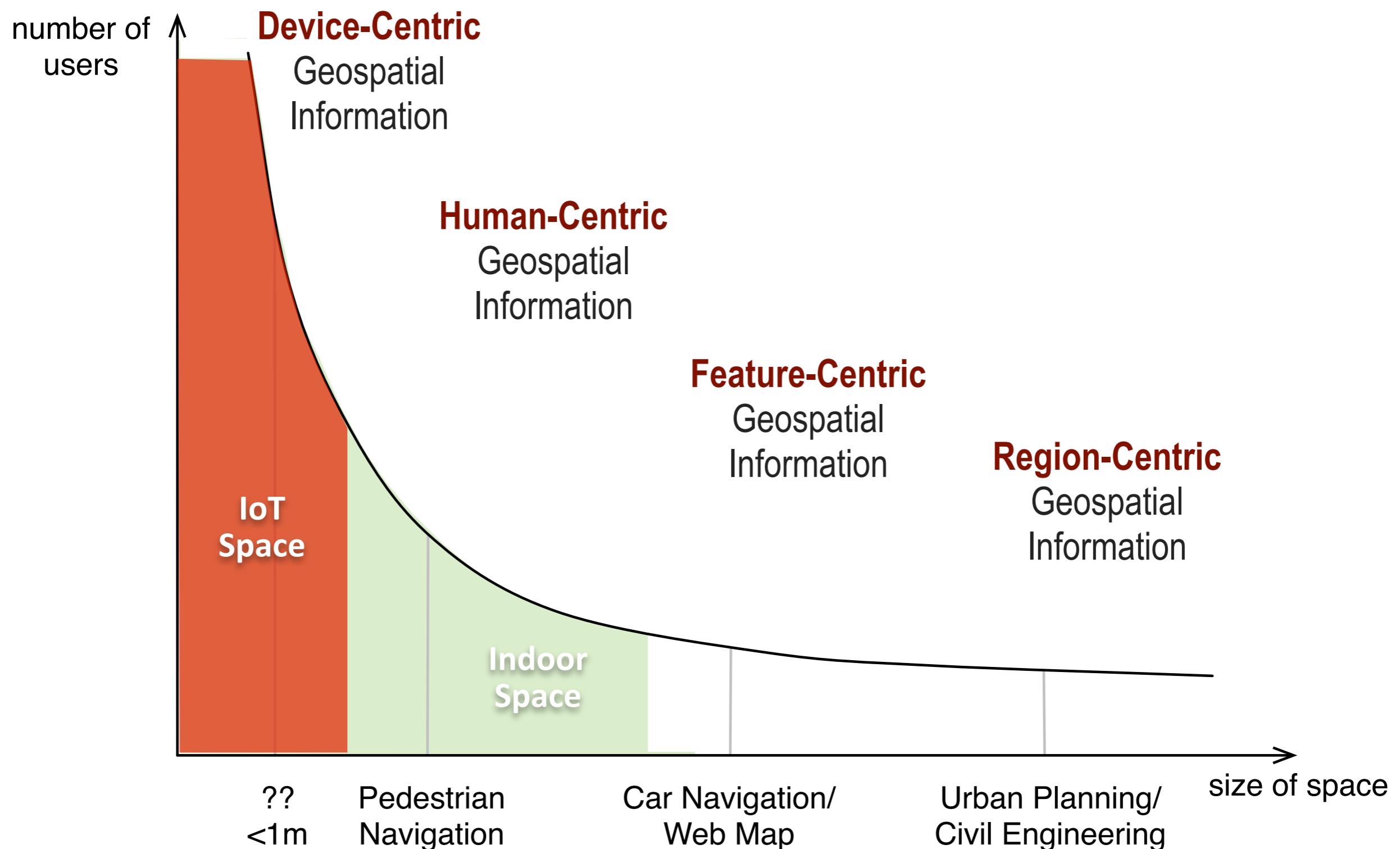
# Location Technology Evolution









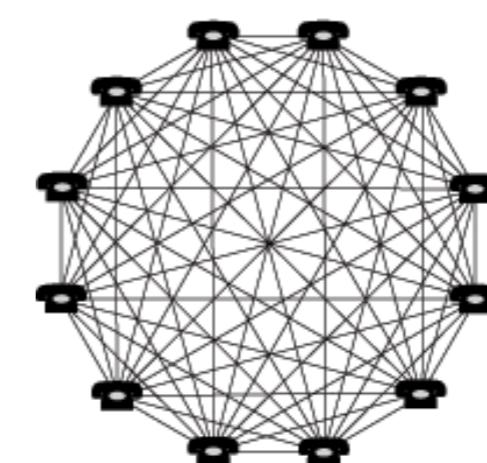
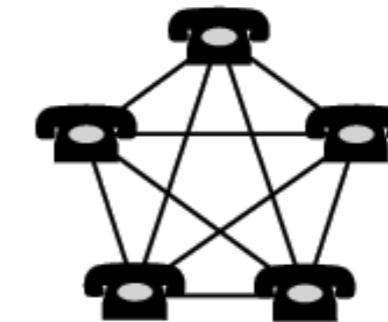


“77% of surveyed IoT experts claimed that **Interoperability** is the biggest challenge currently facing the Internet of Things”

IoT Nexus Report

# Why is IoT interoperability important?

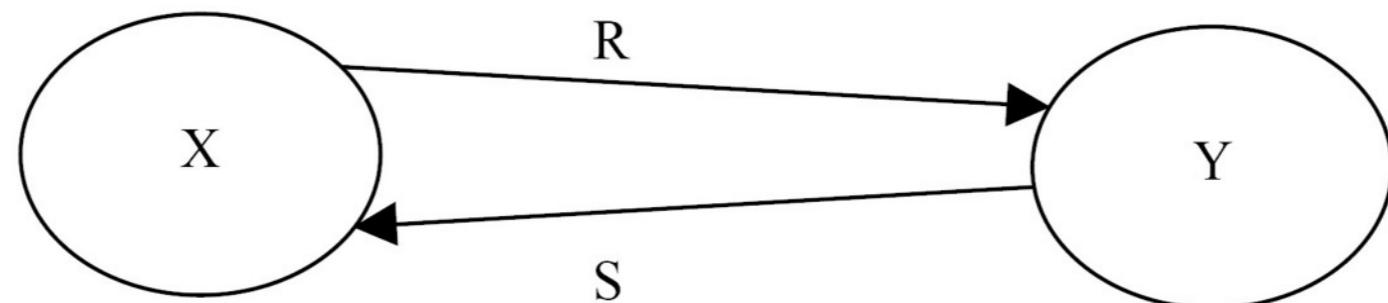
- Future Proof
- No Vendor Lock-in, More Choices!
- Lower Capital expenditure (CAPEX)
- Lower Operating expenditure (OPEX)
- Lower Training Cost
- Innovation in Assembly (create Network Effect)



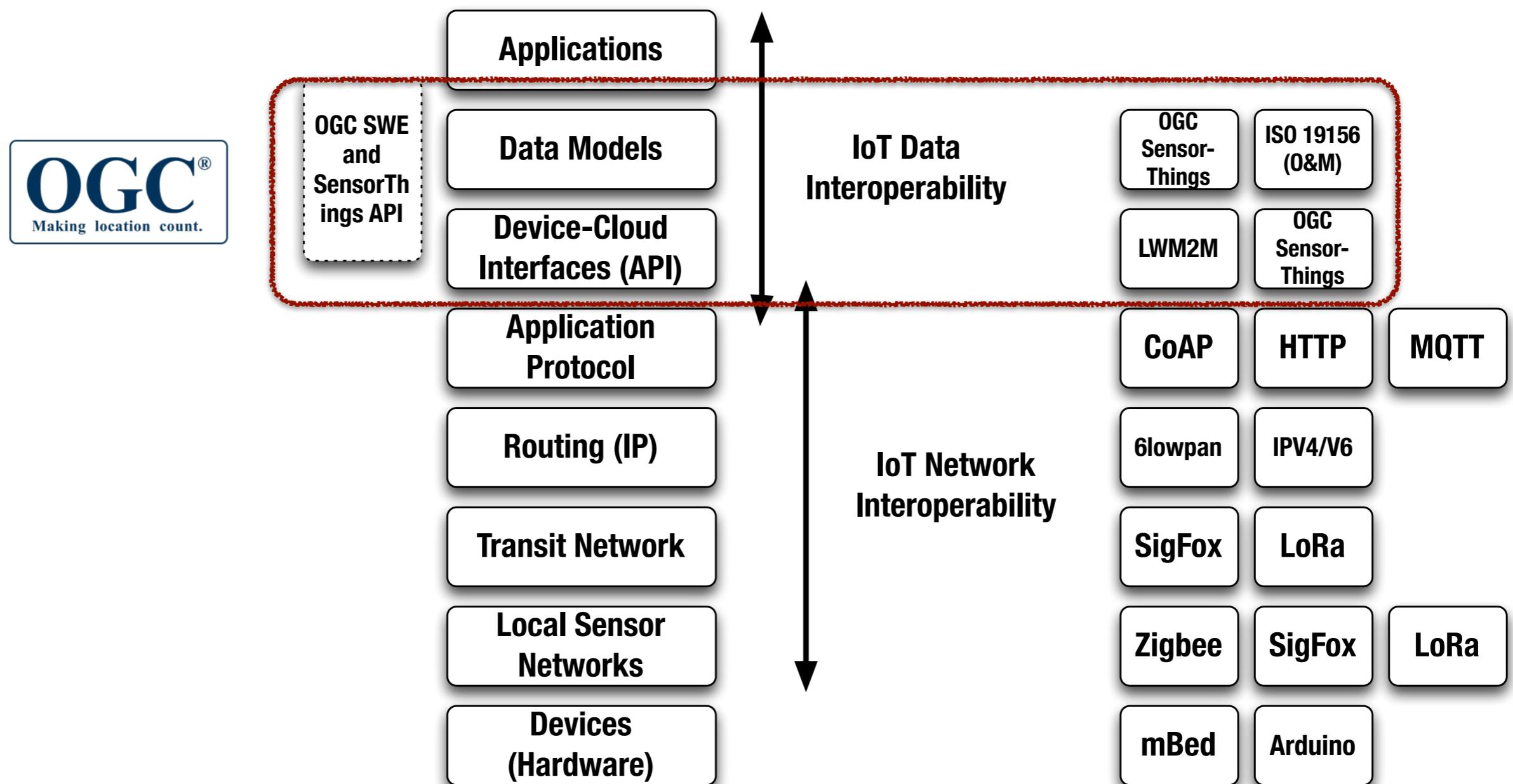
# What is IoT Interoperability?

(IEEE) Interoperability is the ability of two or more (IoT) systems or components to **exchange** information and to **use** the information that has been exchanged.

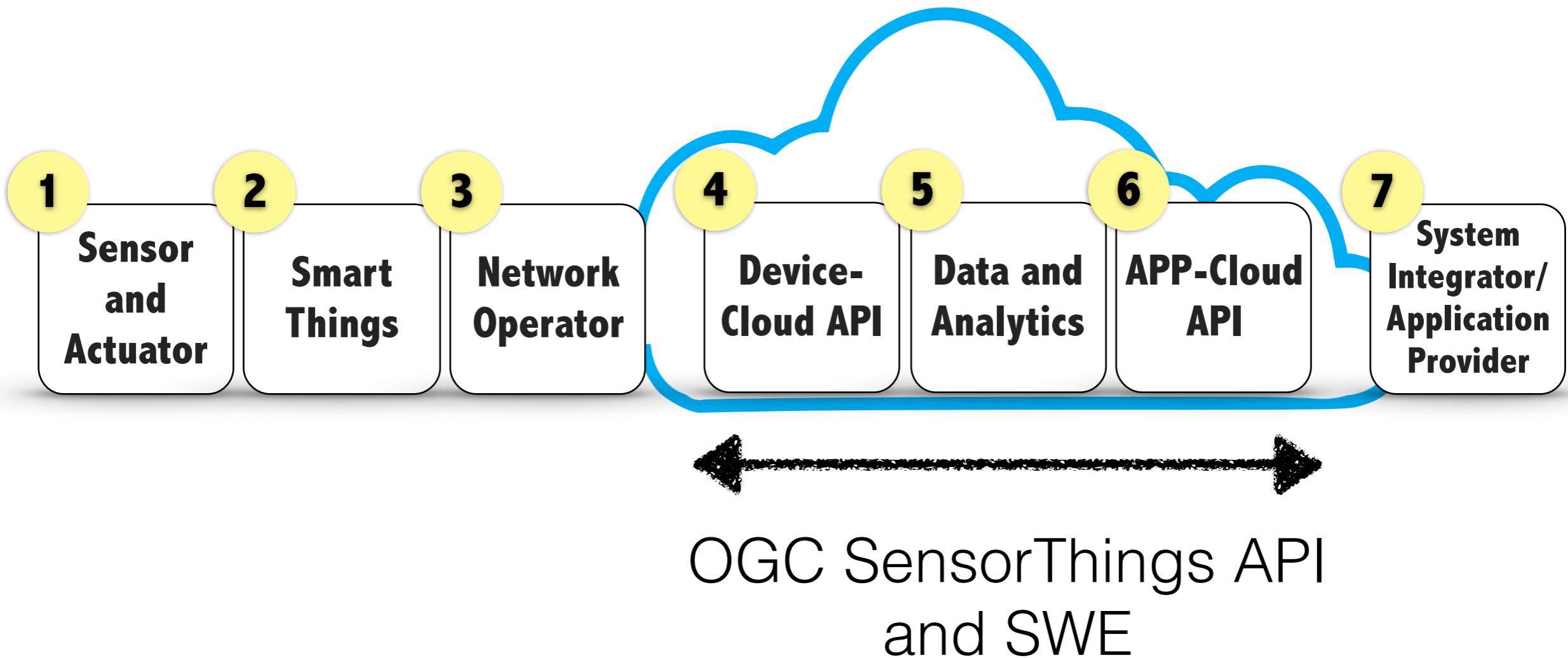
(Brodie, 1993) Two components X and Y can interoperate (are interoperable) if X can send requests R for services to Y, based on a **mutual understanding** of R by X and Y, and if Y can similarly return **mutually understandable** responses S to X.



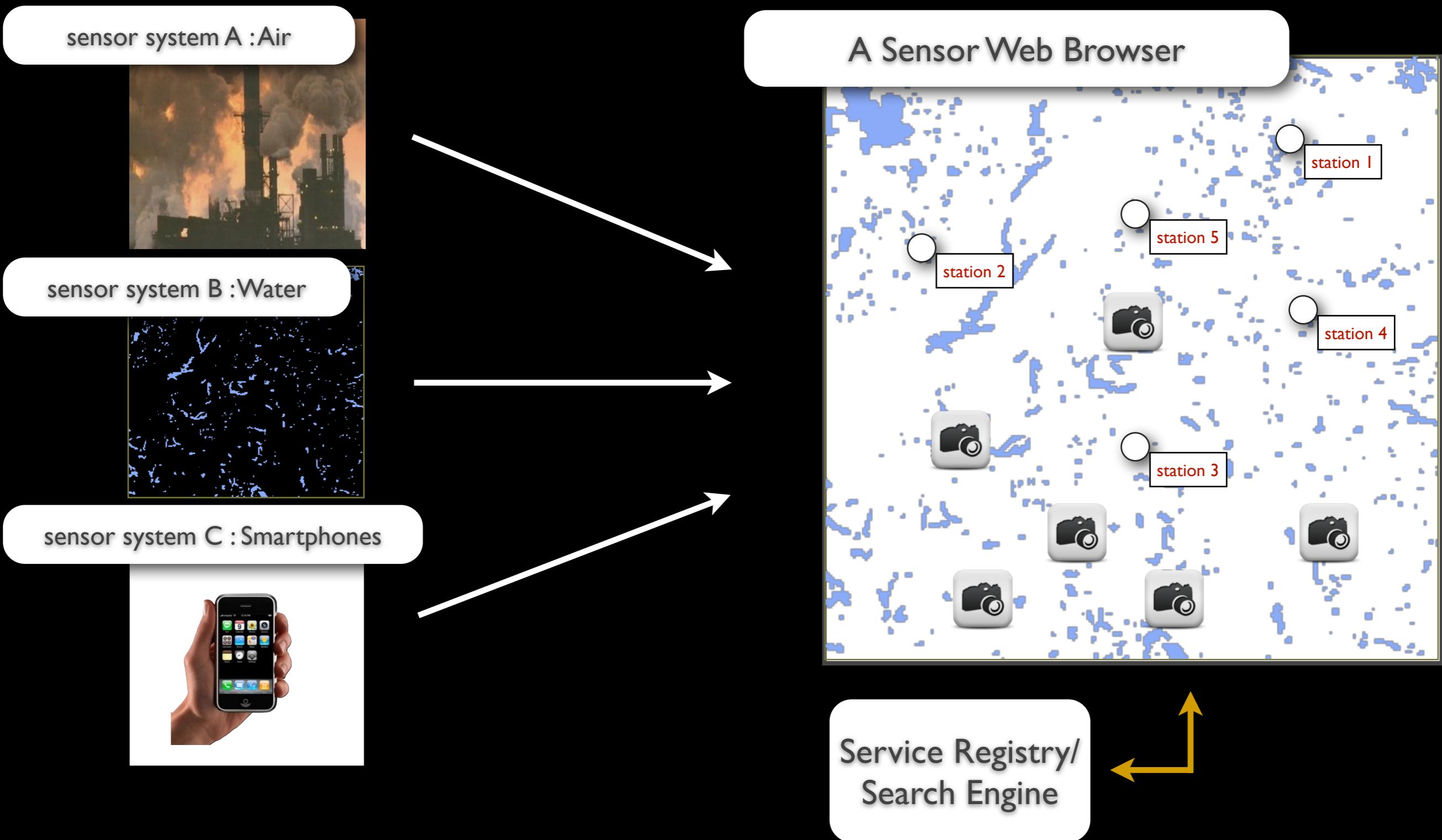
# IoT Interoperability, which layer?



# IoT (WoT) Value Chain

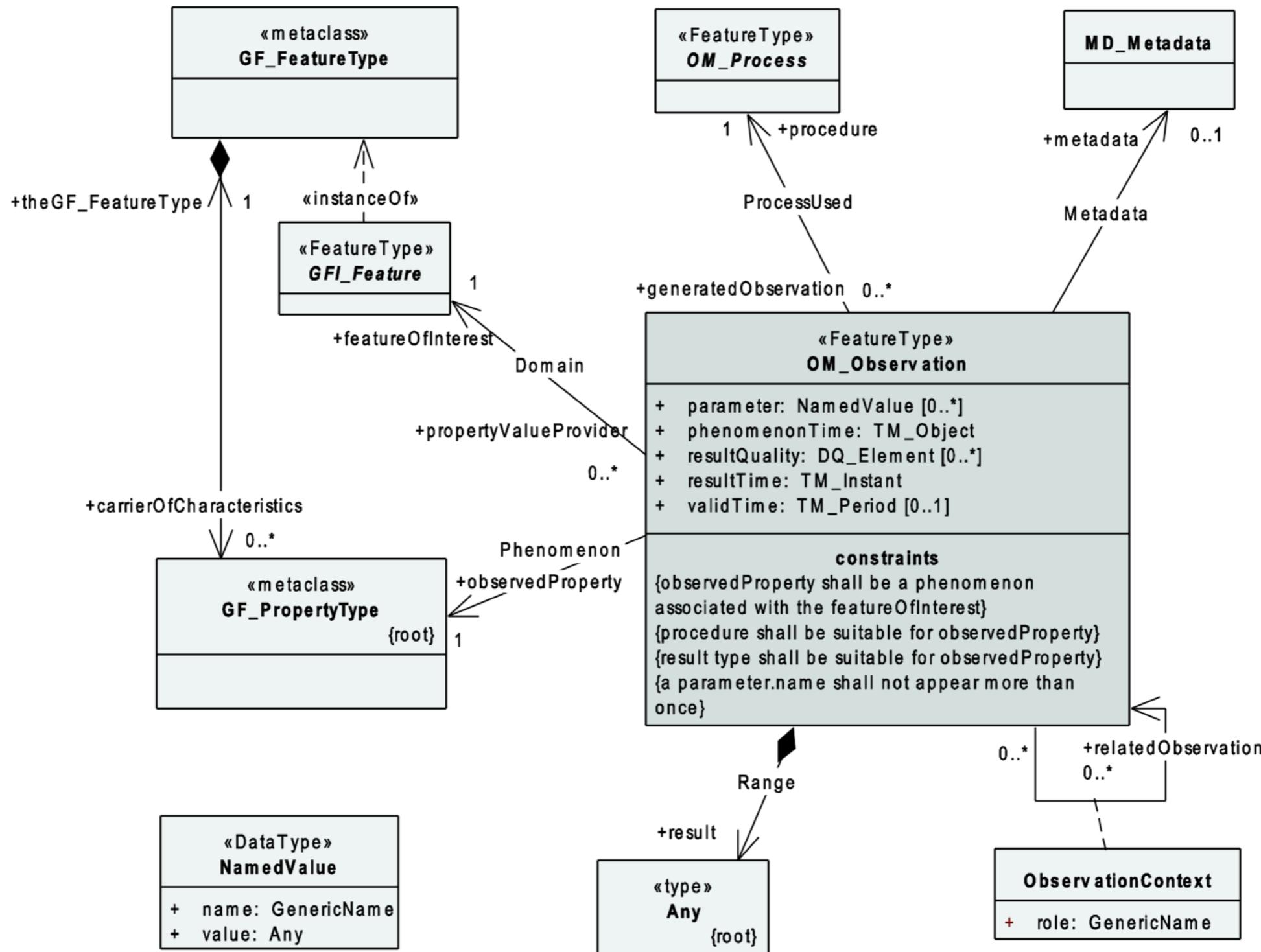


# OGC Vision: an word wide sensor web (OGC Sensor Web Enablement)

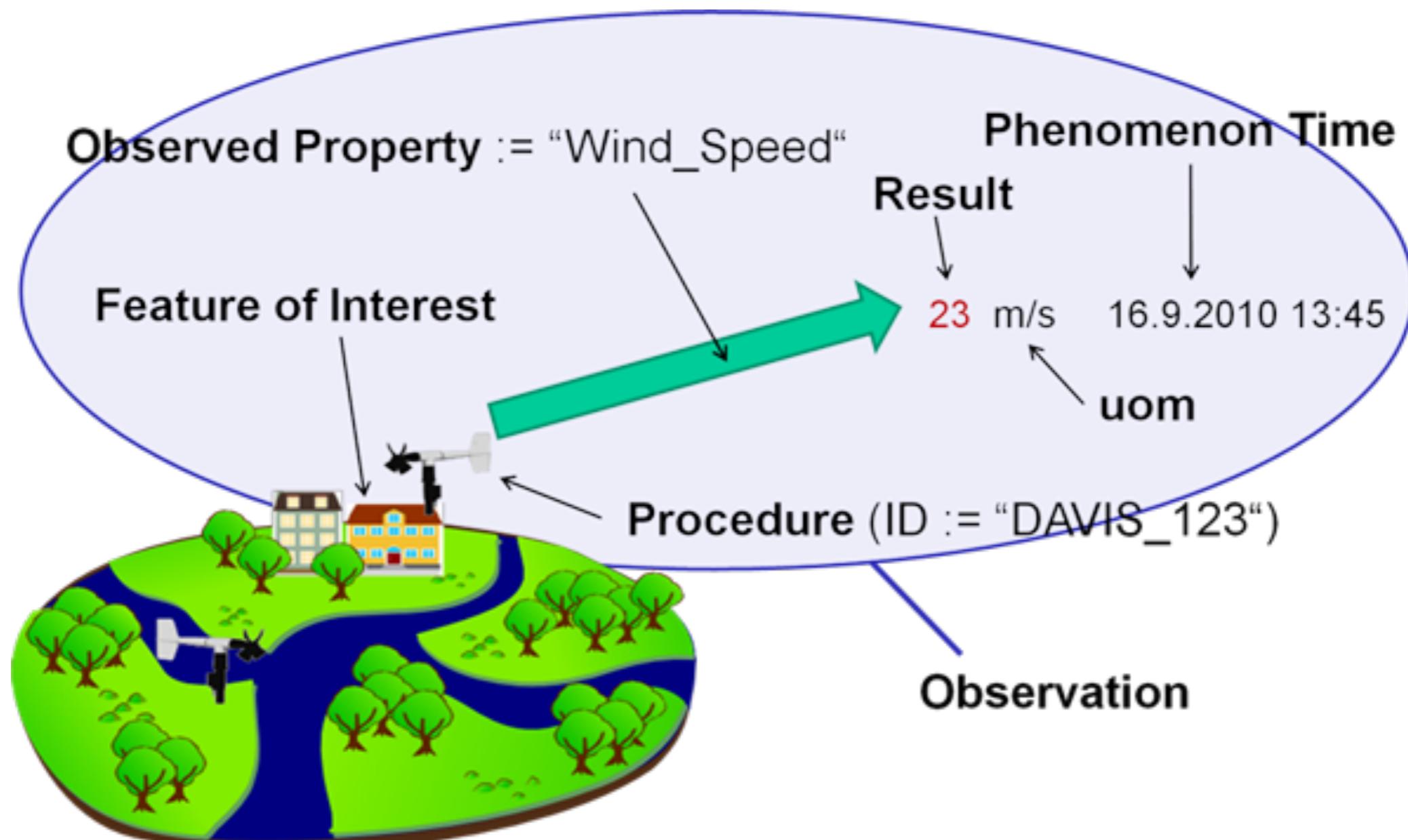


# Observation and Measurement (O&M)

## OGC/ISO 19156:2011



# O&M Concept



# Sensor Web Enablement is a mature standard



Proven Working!!



Natural Resources  
Canada      Ressources naturelles  
Canada

Canada



More details: OGC SWE Implementation Maturity Report

[https://portal.opengeospatial.org/files/?artifact\\_id=53823](https://portal.opengeospatial.org/files/?artifact_id=53823)

bingmap\_browsers : show

dev.geocens.ca/bingmap\_browser

Welcome GeoCENS 

Search | [Browse](#) | Projects | Share Data | Discuss | FAQ | Logout  
[2D Browser](#) | Pivot Browser | 3D Browser

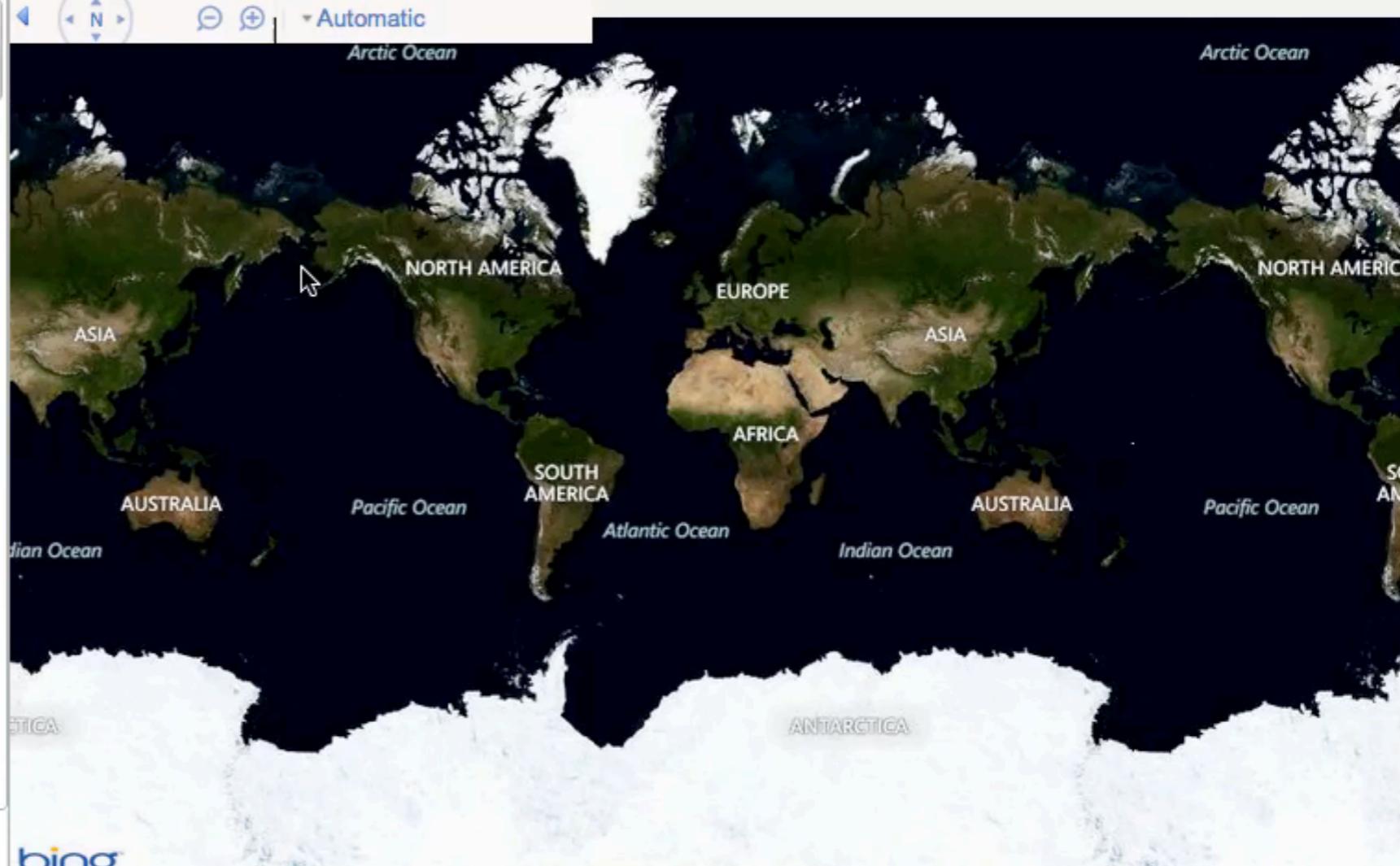
Enter a keyword... 

Enter a place name... 

Sensor Data  SPS  Maps / Remote Sensing  Non-sensor Datasets

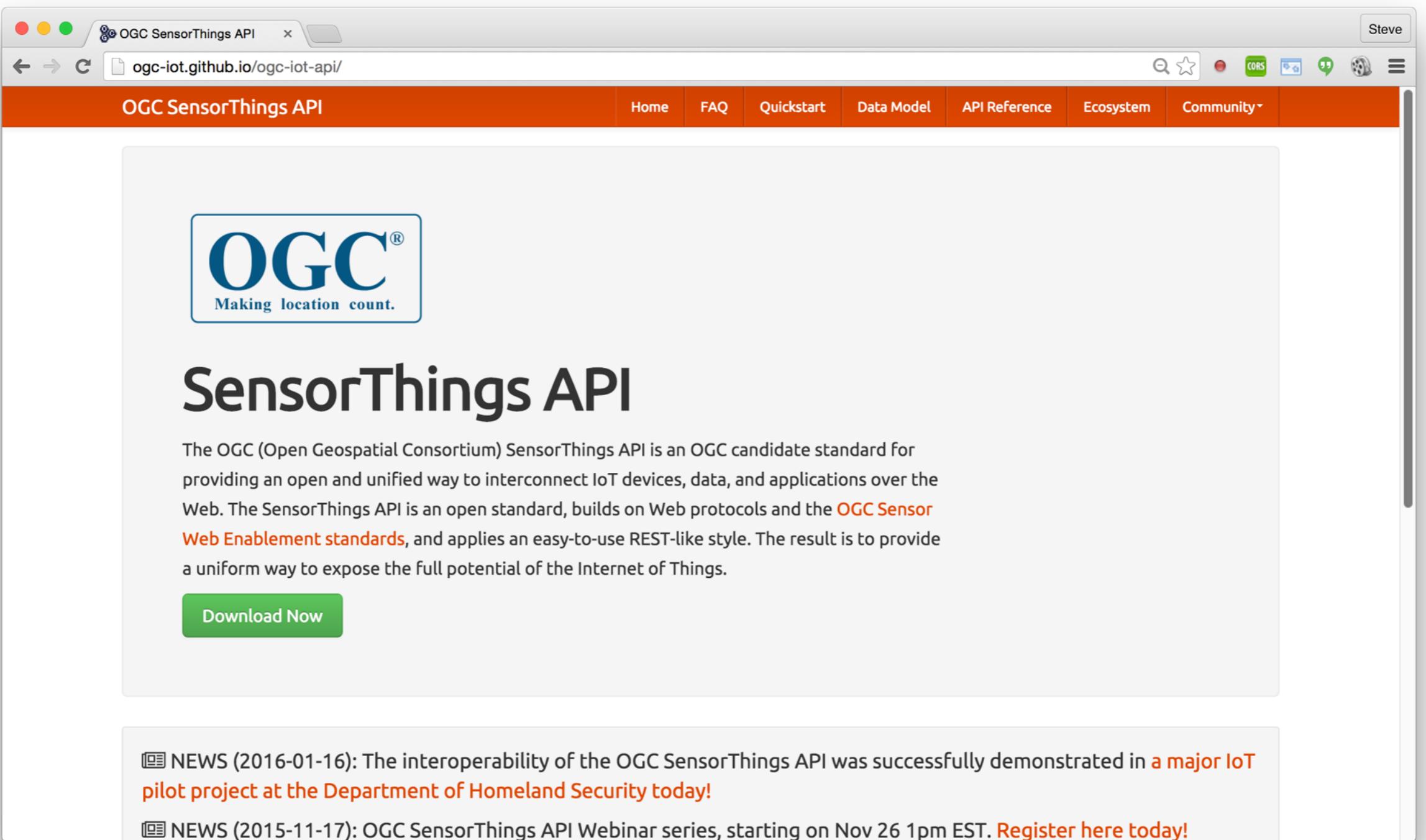
**Active Layers**

  
The map shows the world with several layers visible. Labels include: ASIA, NORTH AMERICA, EUROPE, NORTH AMERICA, ASIA, AFRICA, AUSTRALIA, SOUTH AMERICA, PACIFIC OCEAN, ATLANTIC OCEAN, INDIAN OCEAN, and ANTARCTICA. A cursor is positioned over the North America continent. A compass rose and zoom controls are visible at the top left of the map area.

Save as Project 

GeoCENS, 2009 - 2012 | Icons from [Glyphicons Free](#), licensed under [CC BY 3.0](#).

# OGC SensorThings API



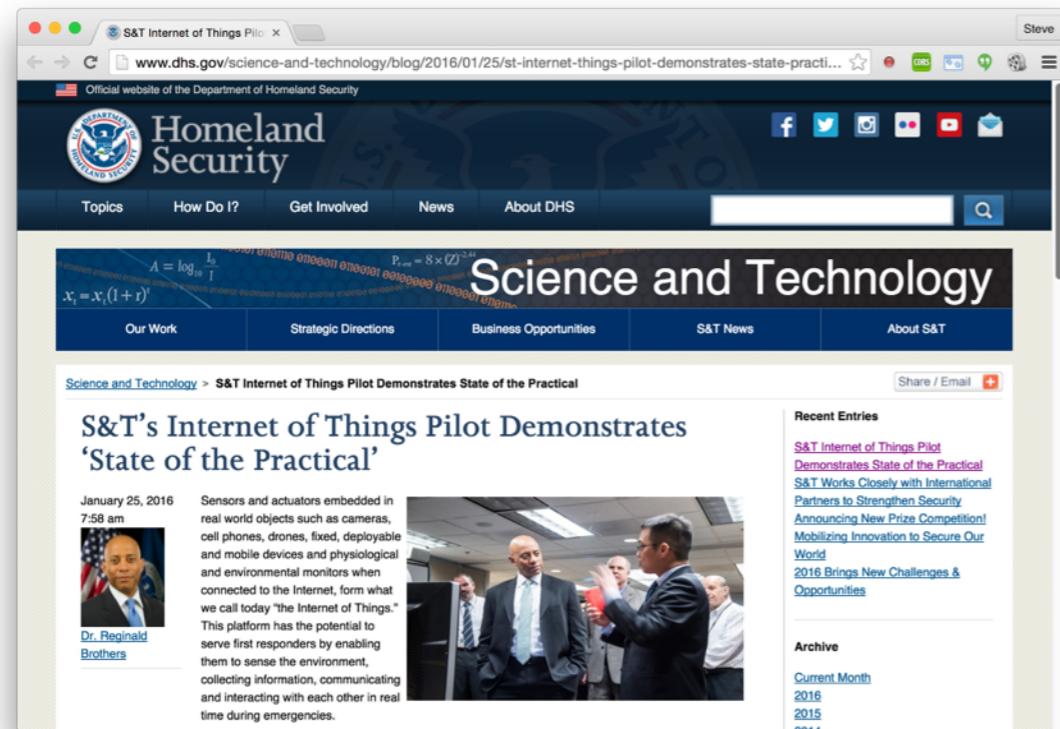
The screenshot shows a web browser displaying the OGC SensorThings API homepage. The browser window has a title bar "OGC SensorThings API" and a URL "ogc-iot.github.io/ogc-iot-api/". The page features a header with the OGC logo and navigation links for Home, FAQ, Quickstart, Data Model, API Reference, Ecosystem, and Community. The main content area is titled "SensorThings API" and describes it as an OGC candidate standard for interconnecting IoT devices. It mentions the OGC Sensor Web Enablement standards and REST-like style. A green "Download Now" button is visible. Below the main content, there are two news items: one about interoperability at the Department of Homeland Security and another about an upcoming webinar series.

The OGC (Open Geospatial Consortium) SensorThings API is an OGC candidate standard for providing an open and unified way to interconnect IoT devices, data, and applications over the Web. The SensorThings API is an open standard, builds on Web protocols and the [OGC Sensor Web Enablement standards](#), and applies an easy-to-use REST-like style. The result is to provide a uniform way to expose the full potential of the Internet of Things.

[Download Now](#)

NEWS (2016-01-16): The interoperability of the OGC SensorThings API was successfully demonstrated in [a major IoT pilot project at the Department of Homeland Security today!](#)

NEWS (2015-11-17): OGC SensorThings API Webinar series, starting on Nov 26 1pm EST. [Register here today!](#)



The screenshot shows a web browser window with the URL [www.dhs.gov/science-and-technology/blog/2016/01/25/st-internet-things-pilot-demonstrates-state-practical](http://www.dhs.gov/science-and-technology/blog/2016/01/25/st-internet-things-pilot-demonstrates-state-practical). The page is titled 'Science and Technology' and features a sub-section 'S&T's Internet of Things Pilot Demonstrates 'State of the Practical''. It includes a photo of Dr. Reginald Brothers, a bio, and a sidebar with recent entries and an archive.



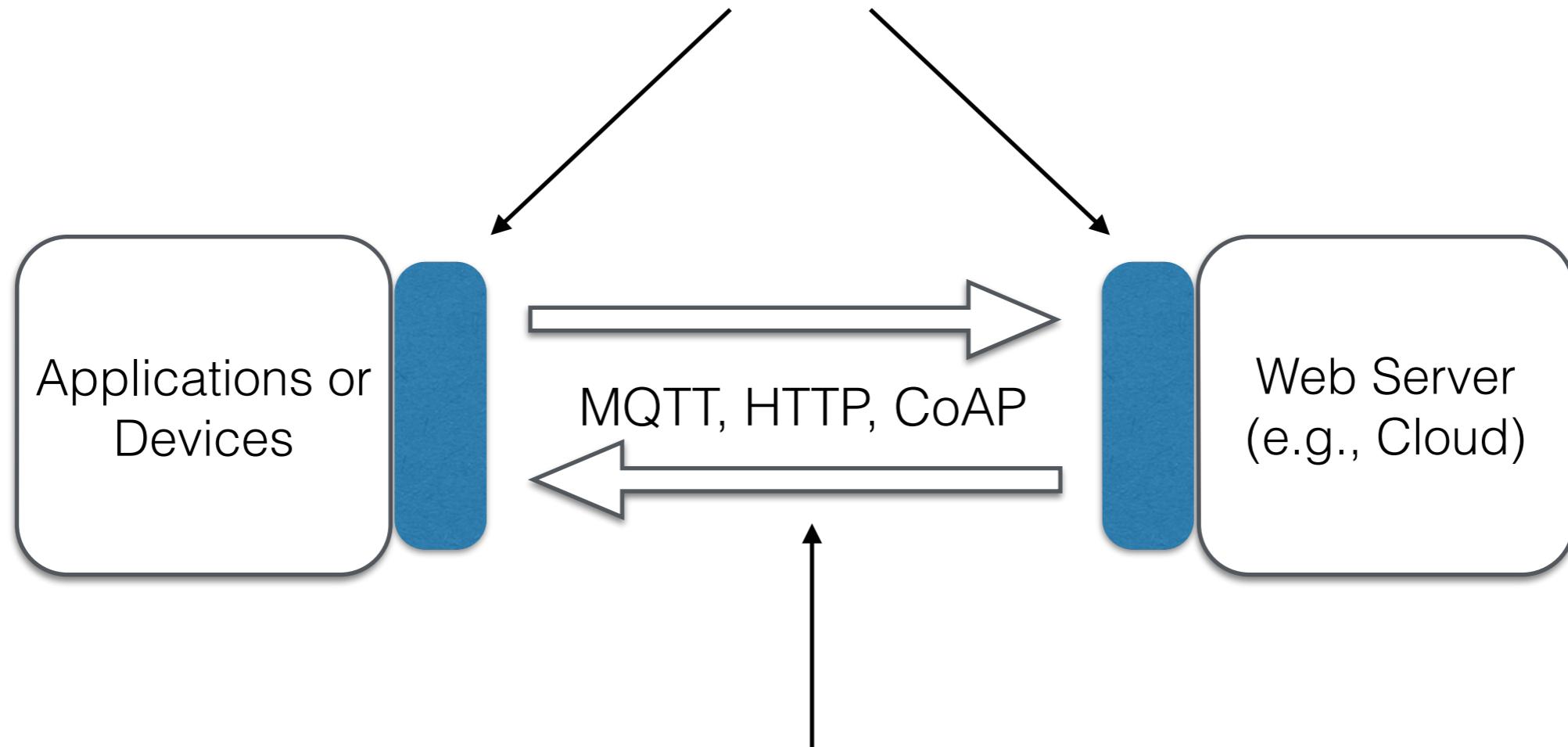
*"I was impressed with the 'state of the practical' where these various industry sensors can be integrated today using open standards (i.e., SensorThings API) that remove the stovepipe limitations of one-off technologies."*

Dr. Reginald Brothers  
Under Secretary for Science and Technology

# What is SensorThings API

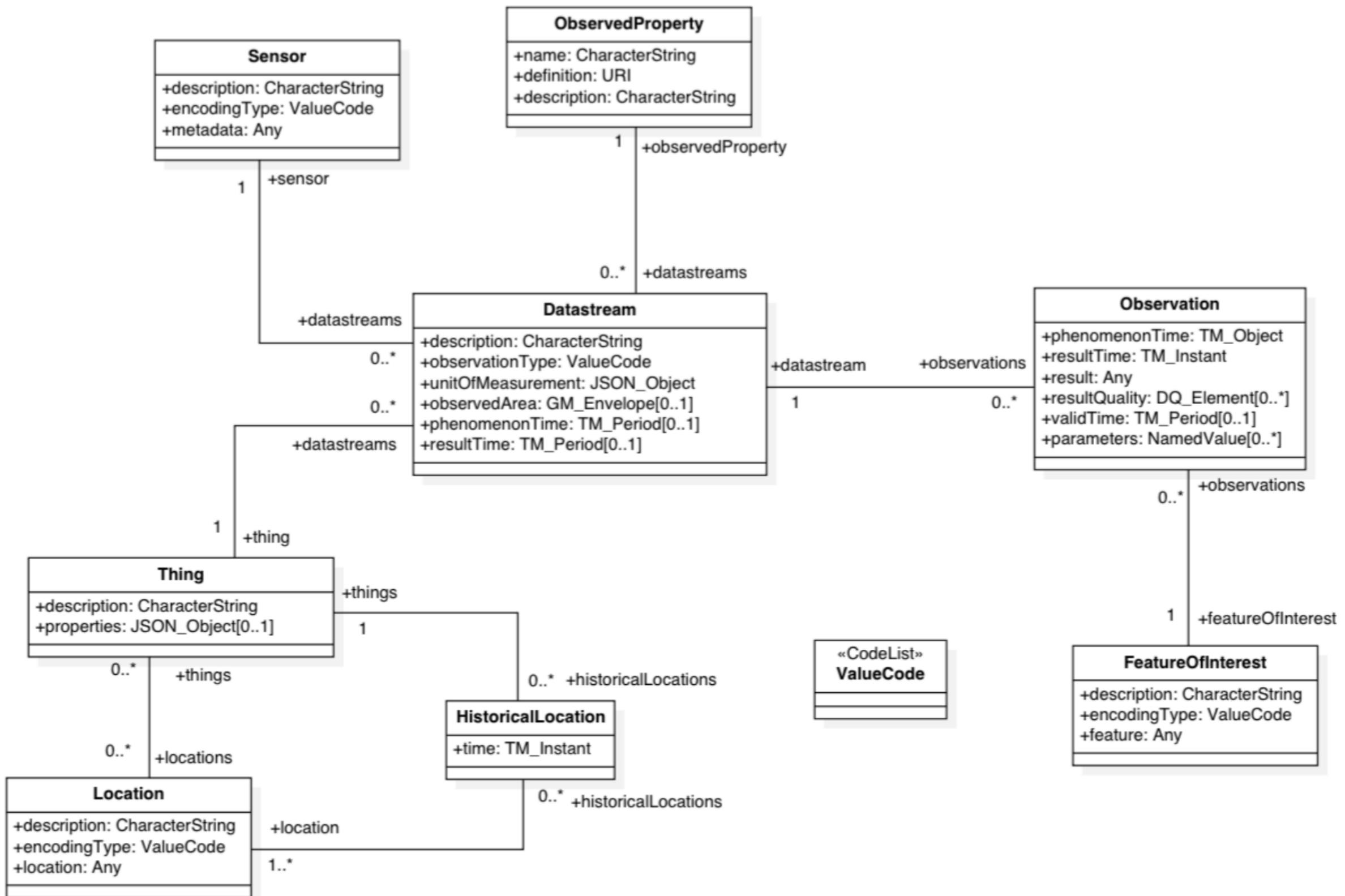
- An Open Geospatial Consortium (OGC) Standard Candidate (approval vote ends in 5 days!!)
- Part of the mature OGC Sensor Web Enablement standards
- Provide the following functions:
  - Sensor Data Management (sensing profile - part I)
  - Sensor Data Analytics (sensing profile - part I)
  - Command and Control (tasking profile - part II)
  - Event Detection and Notification (rules engine profile - part III)

## 2. SensorThings API RESTful Interfaces for accessing sensor data, tasking actuators and detect events



## 1. Standard Data Model based on ISO/OGC Observation and Measurement

# SensorThings API Entities

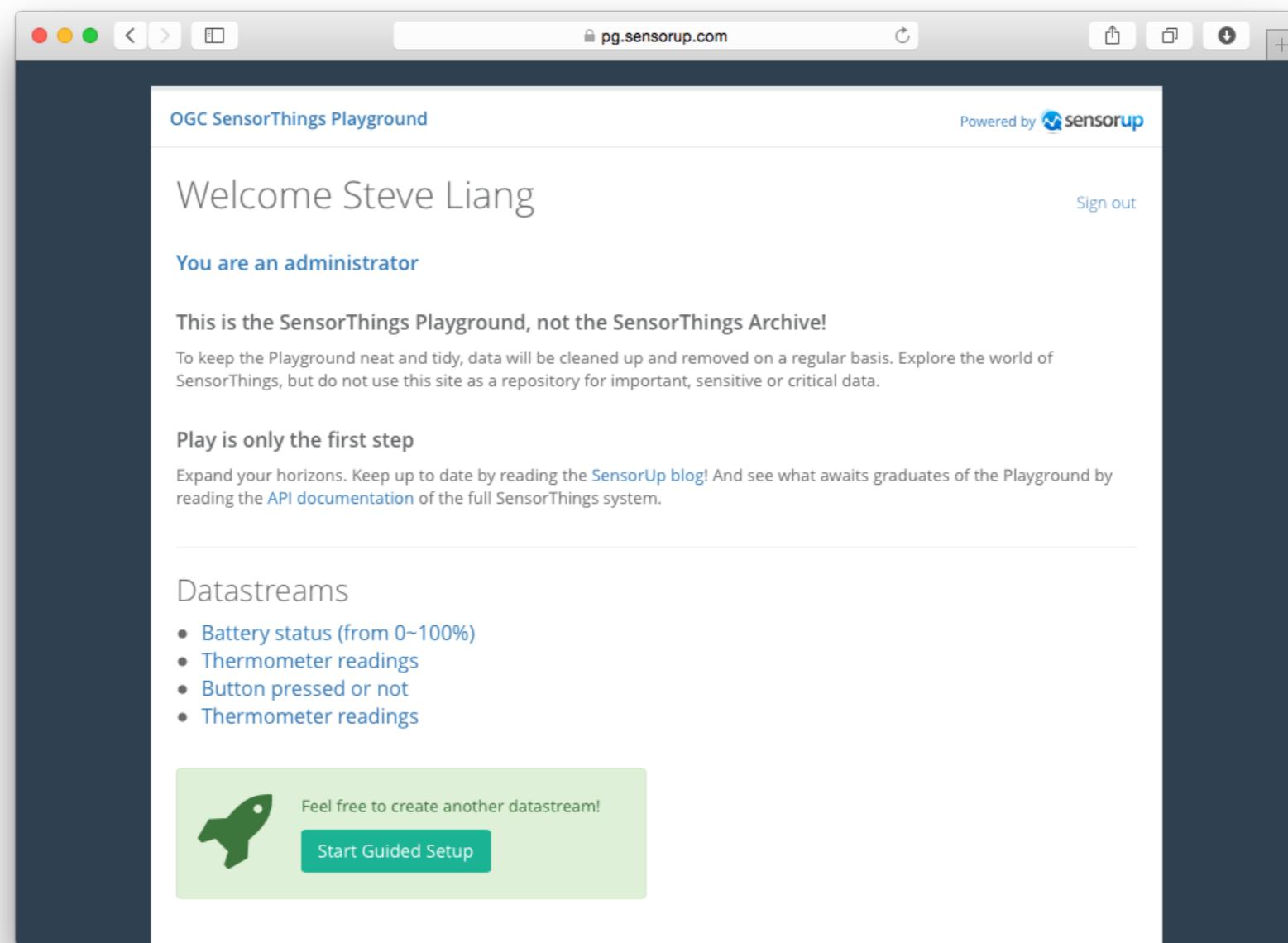


# HTTP Verbs to CRUD

- **POST**
  - create a new entity
- **PATCH**
  - update partial resources
- **DELETE**
  - remove an entity

# DEMO - SensorThings Playground

- <http://pg.sensorup.com>



# Demo and GIST



- <https://gist.github.com/liangsteve/9bbc095c9e417af63a6e>



# Query Options

# Evaluating System Query Options

- **Prior to applying any server-driven paging:**
  - \$filter
  - \$orderby
  - \$skip
  - \$top
- **After applying any server-driven paging:**
  - \$expand
  - \$select (reduce data transmitted)

**Table 8-1. Built-in Filter Operators**

Operator	Description	Example
<b>Logical Operators</b>		
eq	Equal	/ObservedProperties?\$filter=UnitOfMeasurement eq 'Celsius'
ne	Not equal	/FeaturesOfInterest?\$filter=Geometry/type ne 'Polygon'
gt	Greater than	/Observations?\$filter=ResultValue gt 20.0
ge	Greater than or equal	/Observations?\$filter=ResultValue ge 20.0
lt	Less than	/Observations?\$filter=ResultValue lt 100
le	Less than or equal	/Observations?\$filter=ResultValue le 100
and	Logical and	/Observations?\$filter=ResultValue le 3.5 and FeatureOfInterest/ID eq 'FOI_1'
or	Logical or	/Observations?\$filter=ResultValue gt 20 or ResultValue le 3.5
not	Logical negation	/Things?\$filter=not startswith(Description,'test')
<b>Arithmetic Operators</b>		
add	Addition	/Observations?\$filter=ResultValue add 5 gt 10
sub	Subtraction	/Observations?\$filter=ResultValue sub 5 gt 10
mul	Multiplication	/Observations?\$filter=ResultValue mul 2 gt 2000
div	Division	/Observations?\$filter=ResultValue div 2 gt 4
mod	Modulo	/Observations?\$filter=ResultValue mod 2 eq 0
<b>Grouping Operators</b>		
( )	Precedence grouping	/Observations?\$filter=(ResultValue sub 5) gt 10



- **SensorThings API MQTT Extension**

- <http://jsfiddle.net/nrv4wbhf/4/>
- <http://jsfiddle.net/0etm8kvn/4/>



# SensorThings API Maturity

- Adoption vote ends on February 1st 2016
- OGC Compliance Test available
- At least four different server implementations
- Being tested in OGC Incident Management Information Sharing Pilot (sponsored by Department of Homeland Security and IJIS)



# FAQ

- **Is SensorThings API part of the OGC Sensor Web Enablement?**
  - YES.
- **Is SensorThings API compatible with OGC Sensor Observation Services?**
  - YES.
- **Is SensorThings API compatible with Spatial Data Infrastructure (SDIs)?**
  - YES.
- **Can I use my existing GIS to connect to SensorThings API services?**
  - YES. For example, we have an ArcGIS plug-in available.



# Case Study #1

# Incident Management Information Sharing (an OGC Pilot Project)



- Project sponsor:



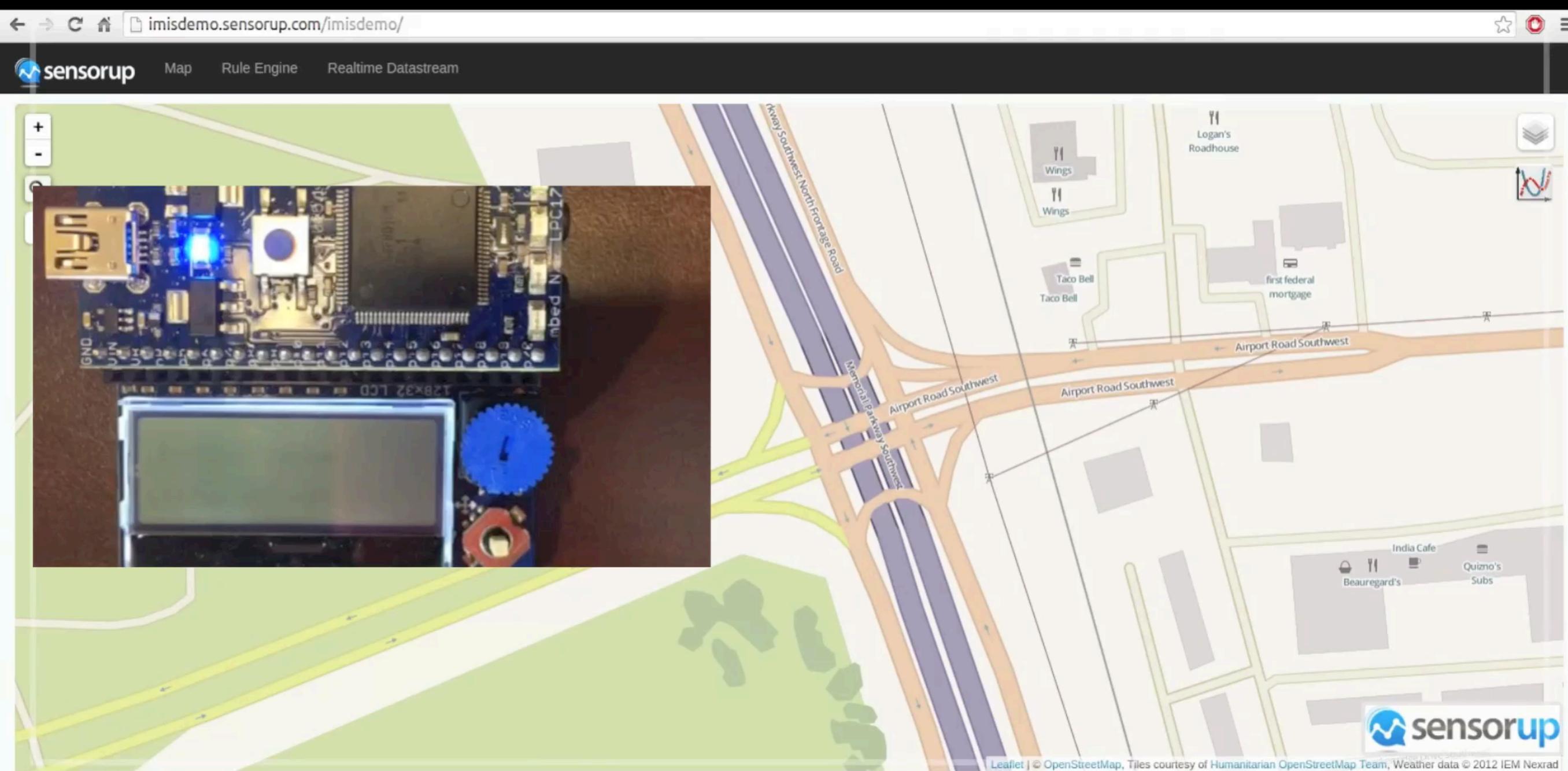
IJIS Institute

# Case Study #1

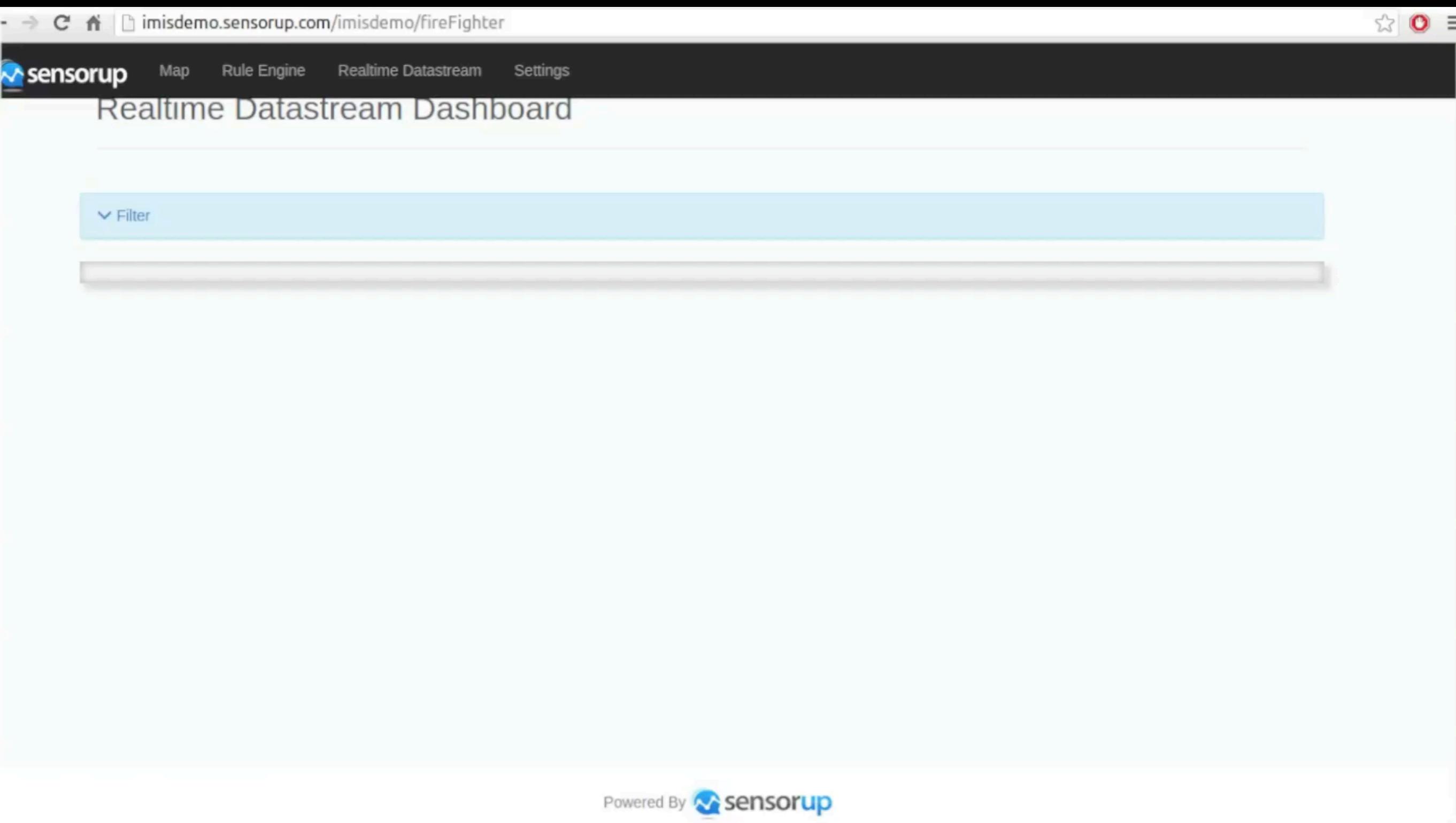


- Opportunities:
  - next generation first responders need to be protected, connected, fully aware.
  - sensors are everywhere, including smart shirts, plug-and-play sensing systems, smart cities infrastructure
  - lacking a Common Operating Picture (COP) for various first responder groups and disaster managers
- Solution and Results:
  - SensorThings API allows various groups accessing heterogeneous IoT-based sensing systems within a coherent platform
  - enable interoperability
  - can reduce implementation and training time and cost significantly in the future

# Sensor registration



# Smart Shirt and Wearable Cam

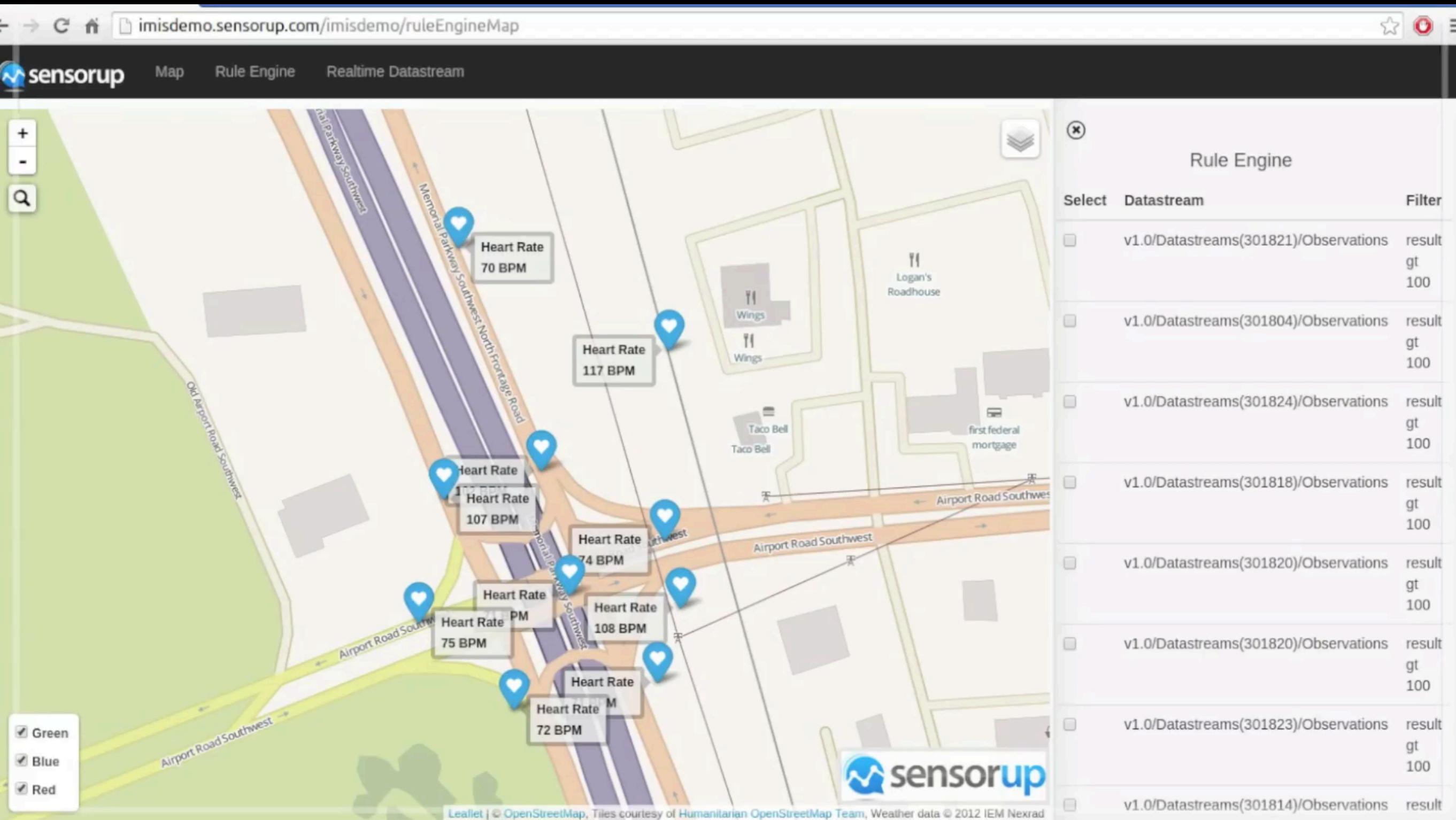


The screenshot shows a web browser window with the URL [imisdemo.sensorup.com/imisdemo/fireFighter](http://imisdemo.sensorup.com/imisdemo/fireFighter). The page title is "Realtime Datastream Dashboard". The header includes the Sensorup logo, Map, Rule Engine, Realtime Datastream, and Settings links. A "Filter" dropdown menu is open. The main content area is currently empty, showing a large, light gray rectangular placeholder.

# Event Notification via MQTT

imisdemo.sensorup.com/imisdemo/ruleEngineMap

**sensorup** Map Rule Engine Realtime Datastream



Rule Engine

Select	Datastream	Filter
<input type="checkbox"/>	v1.0/Datastreams(301821)/Observations	result gt 100
<input type="checkbox"/>	v1.0/Datastreams(301804)/Observations	result gt 100
<input type="checkbox"/>	v1.0/Datastreams(301824)/Observations	result gt 100
<input type="checkbox"/>	v1.0/Datastreams(301818)/Observations	result gt 100
<input type="checkbox"/>	v1.0/Datastreams(301820)/Observations	result gt 100
<input type="checkbox"/>	v1.0/Datastreams(301820)/Observations	result gt 100
<input type="checkbox"/>	v1.0/Datastreams(301823)/Observations	result gt 100
<input type="checkbox"/>	v1.0/Datastreams(301814)/Observations	result gt

Green  
 Blue  
 Red

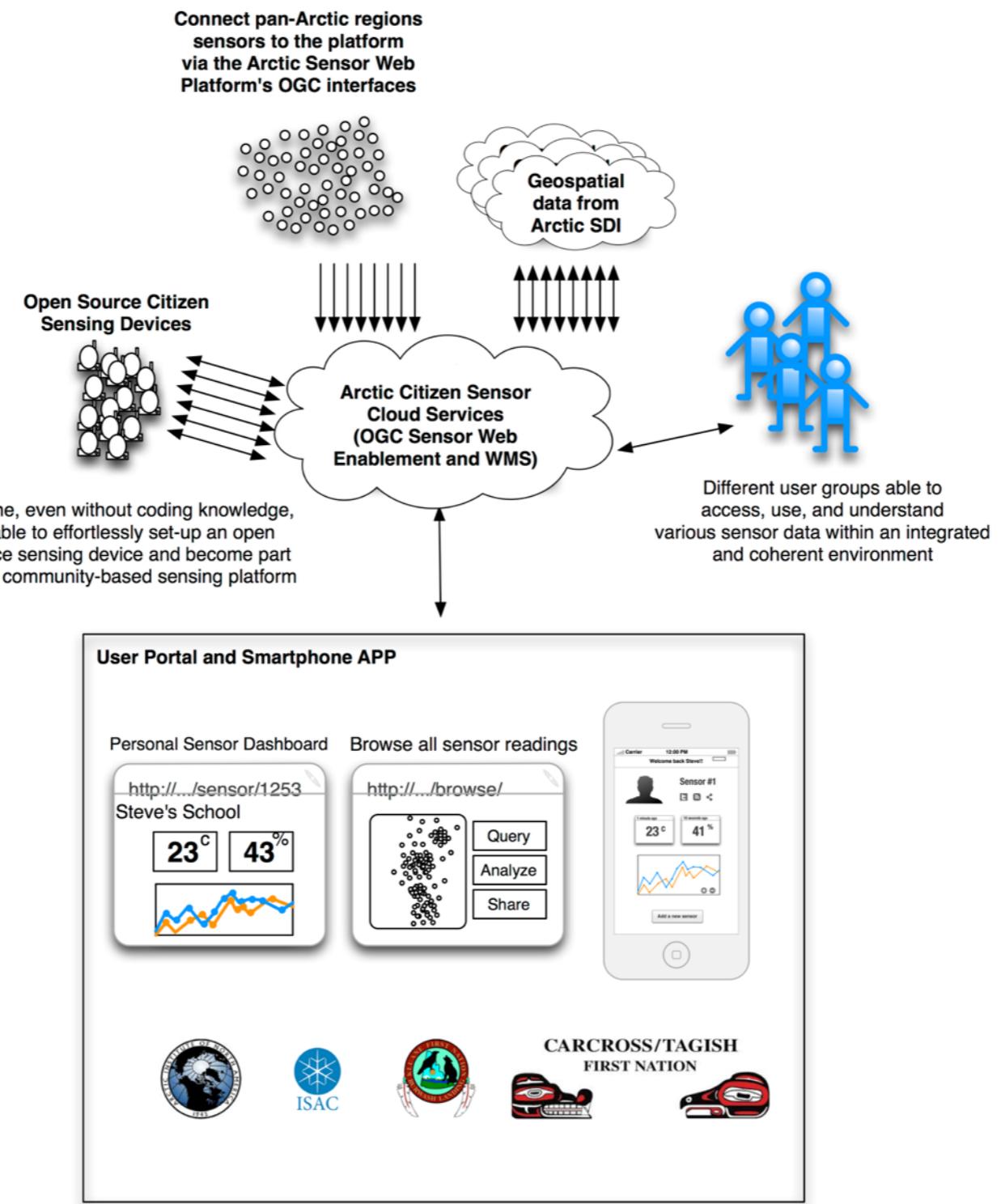
Lealet | OpenStreetMap, Tiles courtesy of Humanitarian OpenStreetMap Team, Weather data © 2012 IEM Nexrad

# SensorThings API Next Step

- SensorThings Part II - Tasking
- SensorThings Part III - Rules Engine
- ISO
- ITU-T



# Arctic Citizen Sensors



# How to learn more?



- **Video tutorials: SensorUp YouTube Channel**



- **Developer Documentations: <http://sensorup.com/docs/>**



- **OGC SensorThings SWG Community Site: <http://ogc-iot.github.io/ogc-iot-api/>**



- **Read our technical blog: <http://sensorup.com>**



- **Attend our bi-weekly webinars: <http://www.sensorup.com/index.php/tag/webinar/>**

# Acknowledgement



# Any Questions?