Spatial Sensor Web
- Interoperability and Scalability

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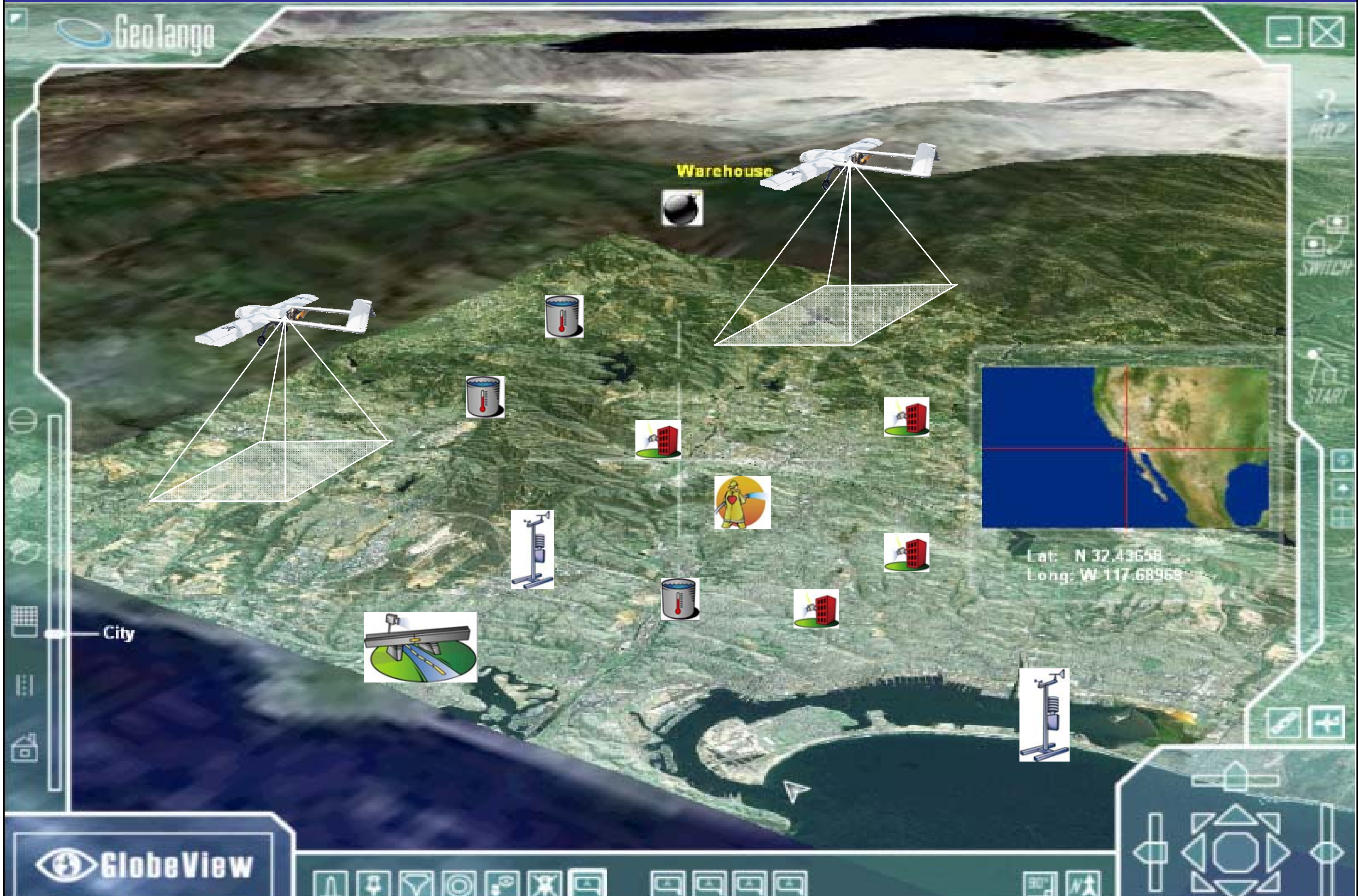
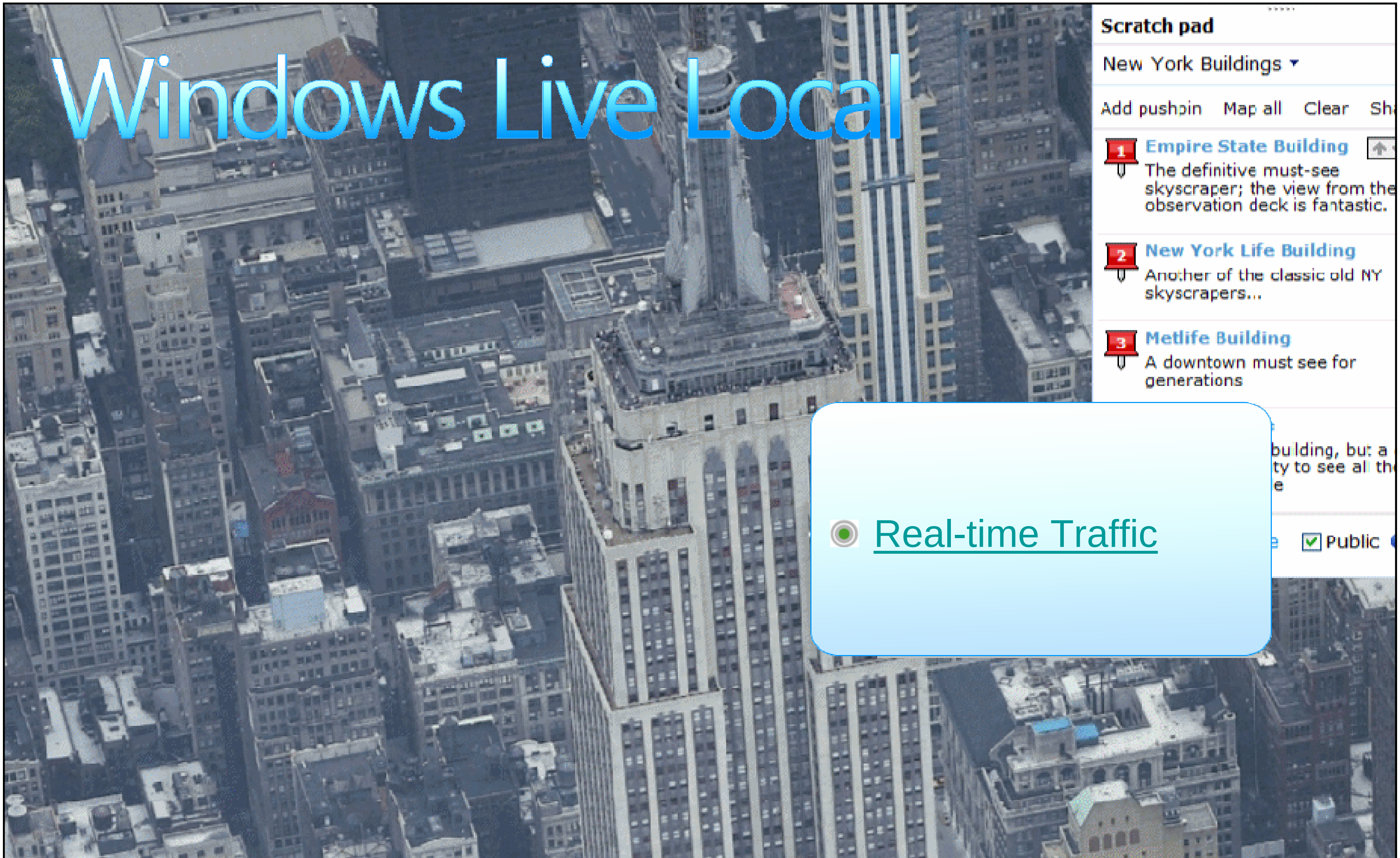
Microsoft Virtual Earth

Build a virtual representation of the Earth for enabling users in the exploration and discovery of information

Spatial Sensor Web: An Electronic Skin of the Virtual Earth



Windows Live Local



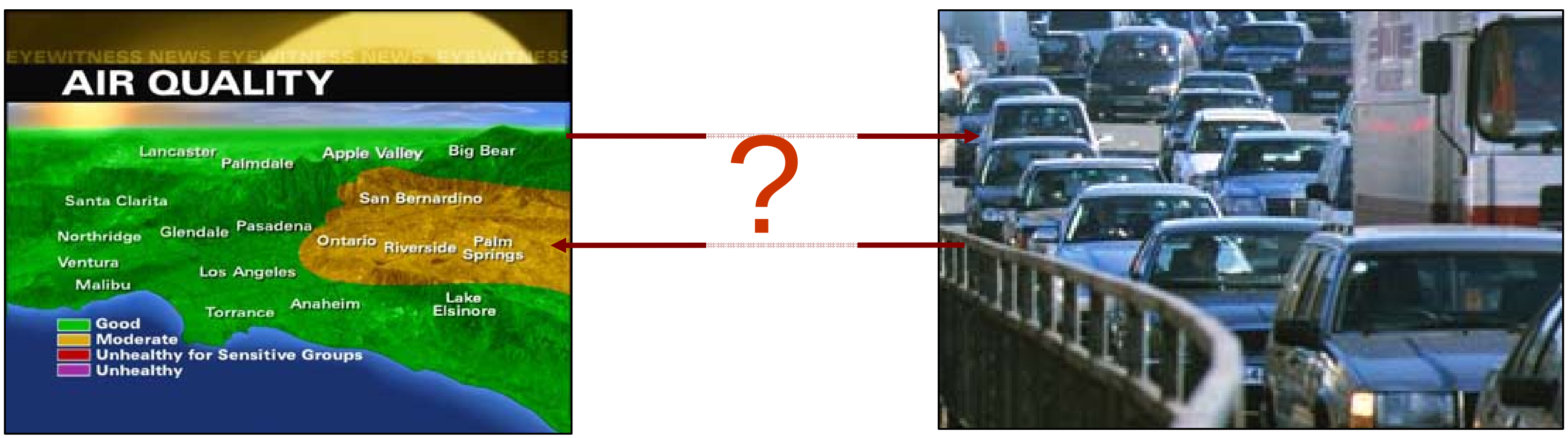
PC WORLD Editor's PICK

PC MAGAZINE EDITORS' CHOICE

Editors' rating Excellent 8.0 out of 10

Sensor Web vs. Sensor Network

- **Q: What is the implication of the traffic flow monitoring to the air quality monitoring?**



Air Quality monitoring sensor network

Traffic monitoring sensor network

Challenges in Spatial Sensor Web

- **Interoperability**
- **Scalability**

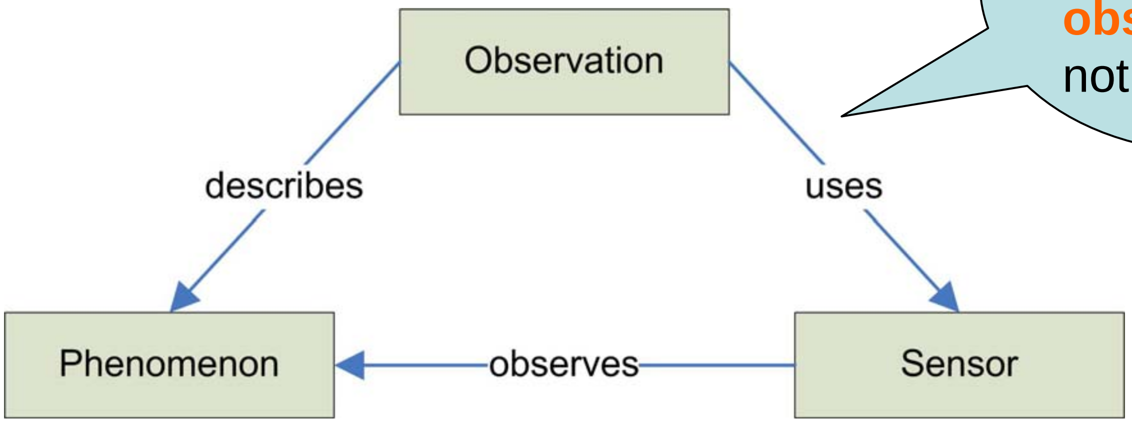
Two Components for Interoperability

- ***information model***
- ***web service interface***

Information Model

- **What is?**
  - The Standard Information Models **describe the entities** involved in the Sensor Web.
- **What are these entities?**
  - **Observation**: An act of observing a phenomenon, with the goal of producing an estimate of the value of the phenomenon.
  - **Sensor**: An entity capable of observing a phenomenon and returning an estimated value of the phenomenon.
  - **Phenomenon**: An event or physical property that can be observed or measured.

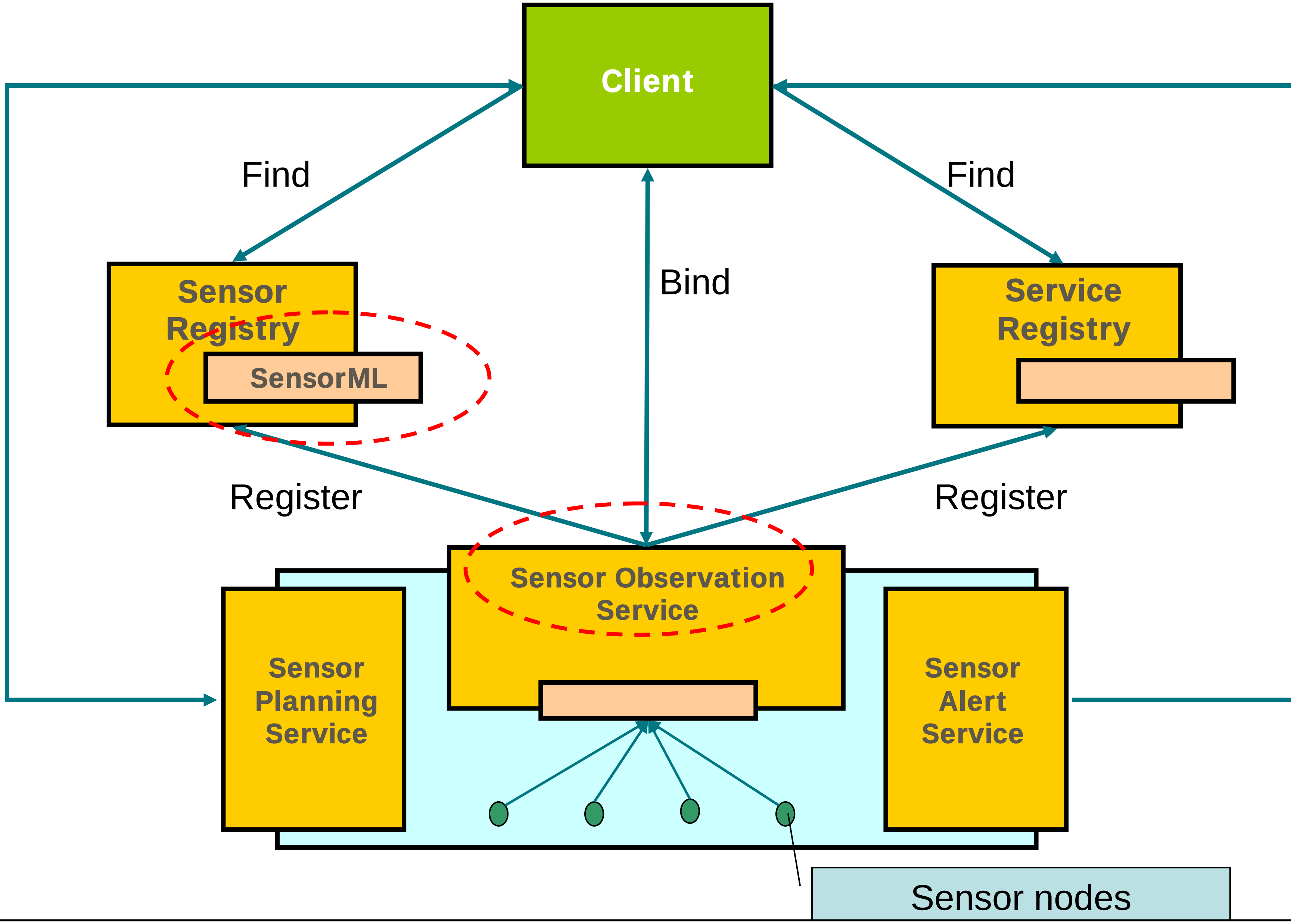
Users are interested in **observations** not **sensors**



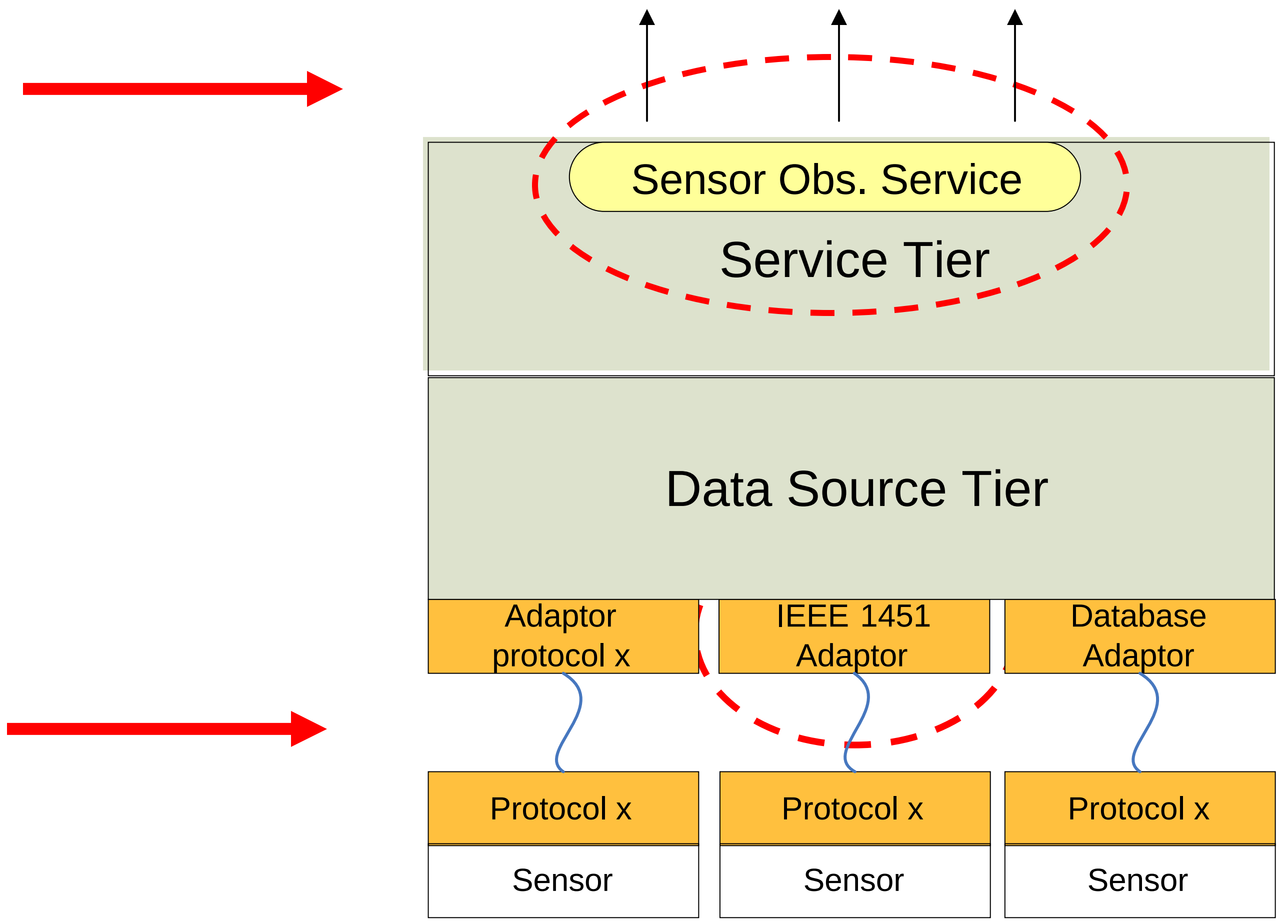
SensorML (OGC):

- Observation characteristics
  - Physical properties measured (e.g. radiometry, temperature, concentration, etc.)
  - Quality characteristics (e.g. accuracy, precision)
  - Response characteristics (e.g. spectral curve, temporal response, etc.)
- Geometry Characteristics
  - Size, shape, spatial weight function (e.g. point spread function) of individual samples
  - Geometric and temporal characteristics of sample collections (e.g. location, array, …)
- Description and Documentation
  - Overall information about the sensor
  - History and reference information supporting the SensorML document

Web Service Interfaces (OCG)



Sensor Observation Services (SOS) Tiered Diagram



Scalability

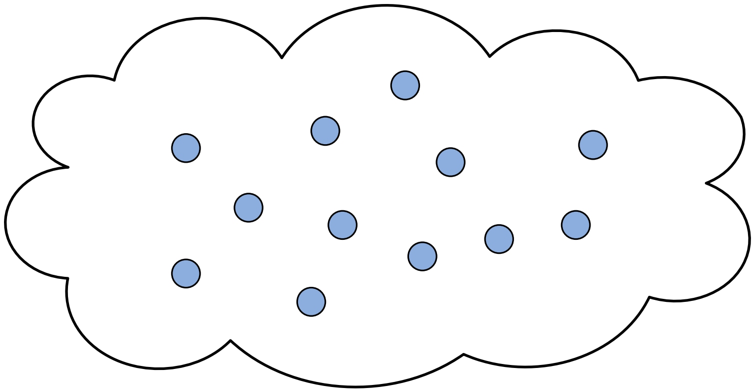
The Scalability Challenge arises in several dimensions

- **Numerical Scalability**
  - Need to large sensors and user populations of potentially millions or billions
  - Need to suppors large amount of simultaneous requests from the users
  - Need to handle very frequent sensor join and arrivals
  - Need to efficiently locate the desired sensors within the user specified geographical area
- **Administrative Scalability**
  - Need to allow different administrative organizations to join the infrastructure while keep their autonomy
- **Heterogeneous Scalability**
  - Need to support a wide range types of sensors, from In-situ sensor networks to remote sensing satellites.

P2P Spatial Access Method (P2P-SAM)

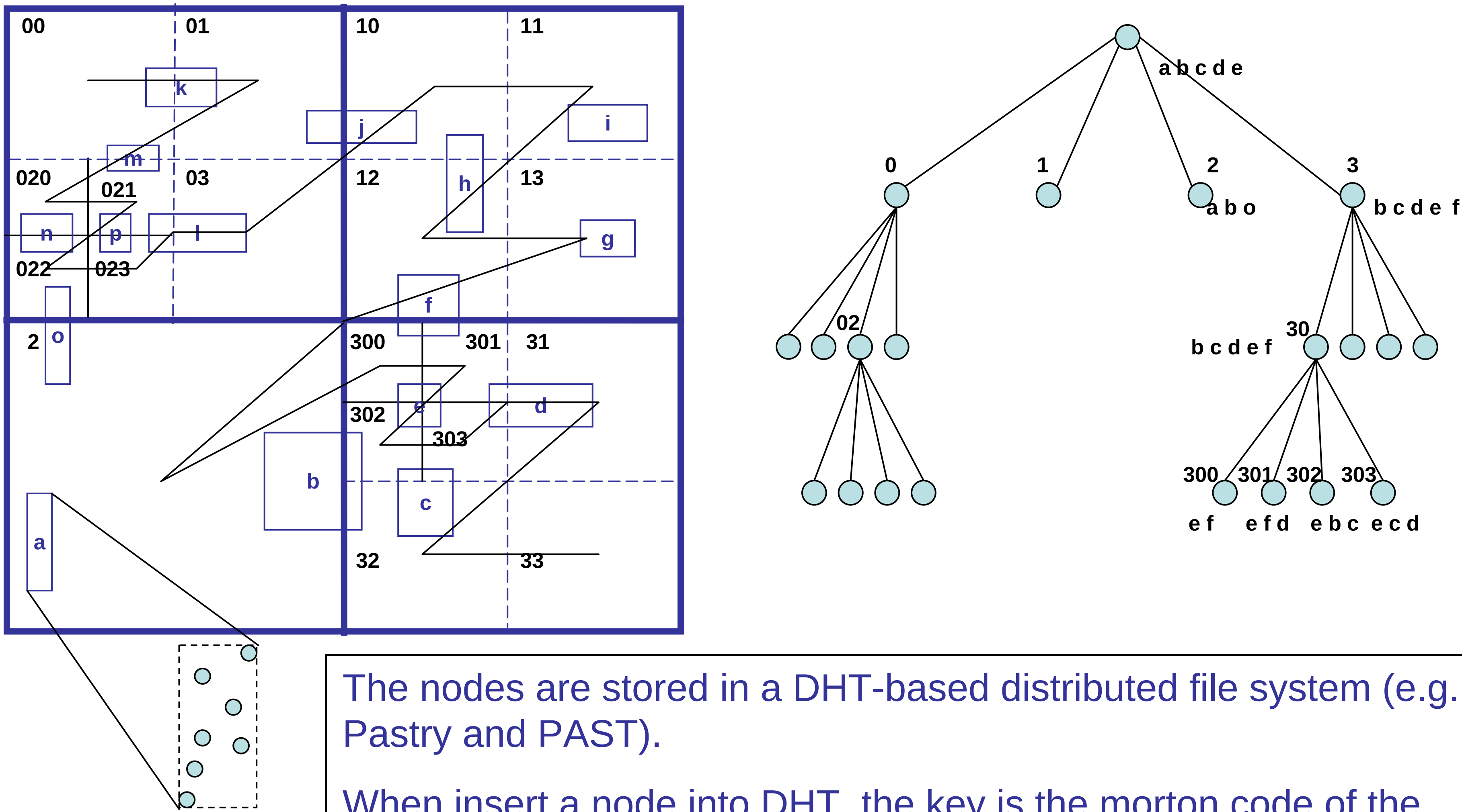
Implement SAM using a Peer-to-Peer network

- **P2P-SAM :**
  - Build and maintain a spatial index (e.g. a linear quad-tree) on a distributed file system implemented using a P2P network (e.g. Pastry and PAST)



1. **SLNs using DHT (Distributed Hash Table) to form a structured P2P network.**
2. **While a SLN join the DHT, it also inserts its bbox into the P2P-SAM index.**

P2P–SAM: Linear Quad-Tree (LQT)



The nodes are stored in a DHT-based distributed file system (e.g. Pastry and PAST).

When insert a node into DHT, the key is the morton code of the quad-tree leaf or quad-tree node (e.g. 303)

The value is a list of the SLNs' bboxes within the quad-tree leaf bbox and the ip-address of the SLNs.

Open Discussions

- **Sensor network vs. sensor web**
- **‘Interoperability’ among organizations**