Spatial Sensor Web
- Interoperability and Scalability

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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

- Real-time Traffic

PC World
Editor's PICK

Editors’ rating
Excellant
8.0 out of 10
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
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
Sensor Observation Services (SOS) Tiered Diagram

Service Tier

Sensor Obs. Service

Data Source Tier

Adaptor (protocol x)
IEEE 1451 Adaptor
Database Adaptor

Protocol x
Sensor
Protocol x
Sensor
Protocol x
Sensor
Scalability

The Scalability Challenge arises in several dimensions

- **Numerical Scalability**
  - Need to large sensors and user populations of potentially millions or billions
  - Need to support 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.
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.
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