Information Services for Smart Grids

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Motivation: *What do we need?*

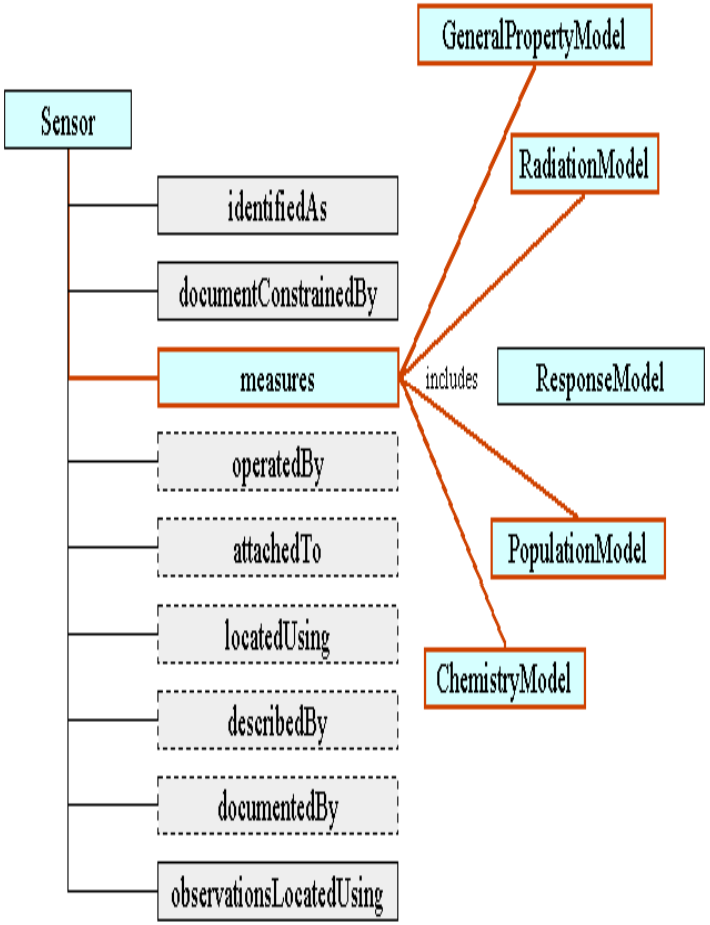
- Making data available timely
  - required for emergency response tasks.
- Better categorization / aggregation of content
  - formulation of custom products and provision of subsetting tools at spatial and temporal levels.
- Interoperability between various formats of data.
- Package products based on
  - meaning and knowledge about the measurements
  - context of the information sources.
- Creation of machine understandable semantic metadata
  - intelligent search engines / agents can automatically process and index the content.

Information Services

- Focused on providing the right information at the right moment to the right decision maker.
- The information services required by grid operators could vary from scenario development to estimates of socio-economic impacts of failures to quantitative statistics, trends and forecasts.
- These services also must be available in a geospatial context and at various temporal scales to support the needs of system operators, planners, and regulatory agencies.
- Characterized by a strong integration of grid data with ancillary data and information.

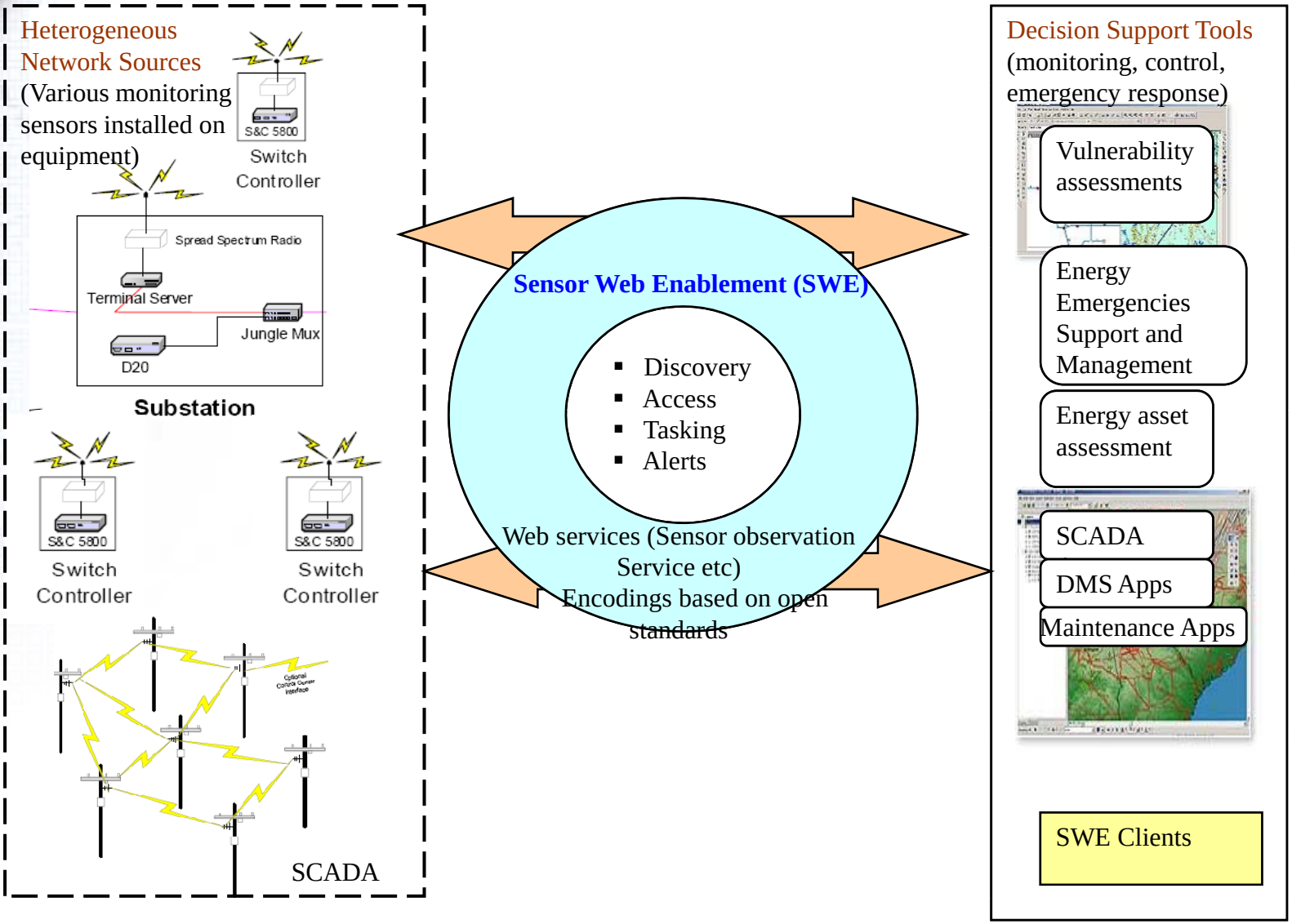
SensorML and Descriptions for Grid Measurement Devices

- The general models and XML encodings for sensors and observation processing.
- Provides a framework within which the geometric, dynamic, and observational characteristics of sensors and sensor systems can be defined.
- Provides a functional model of the sensor system, rather than a detailed description of its hardware



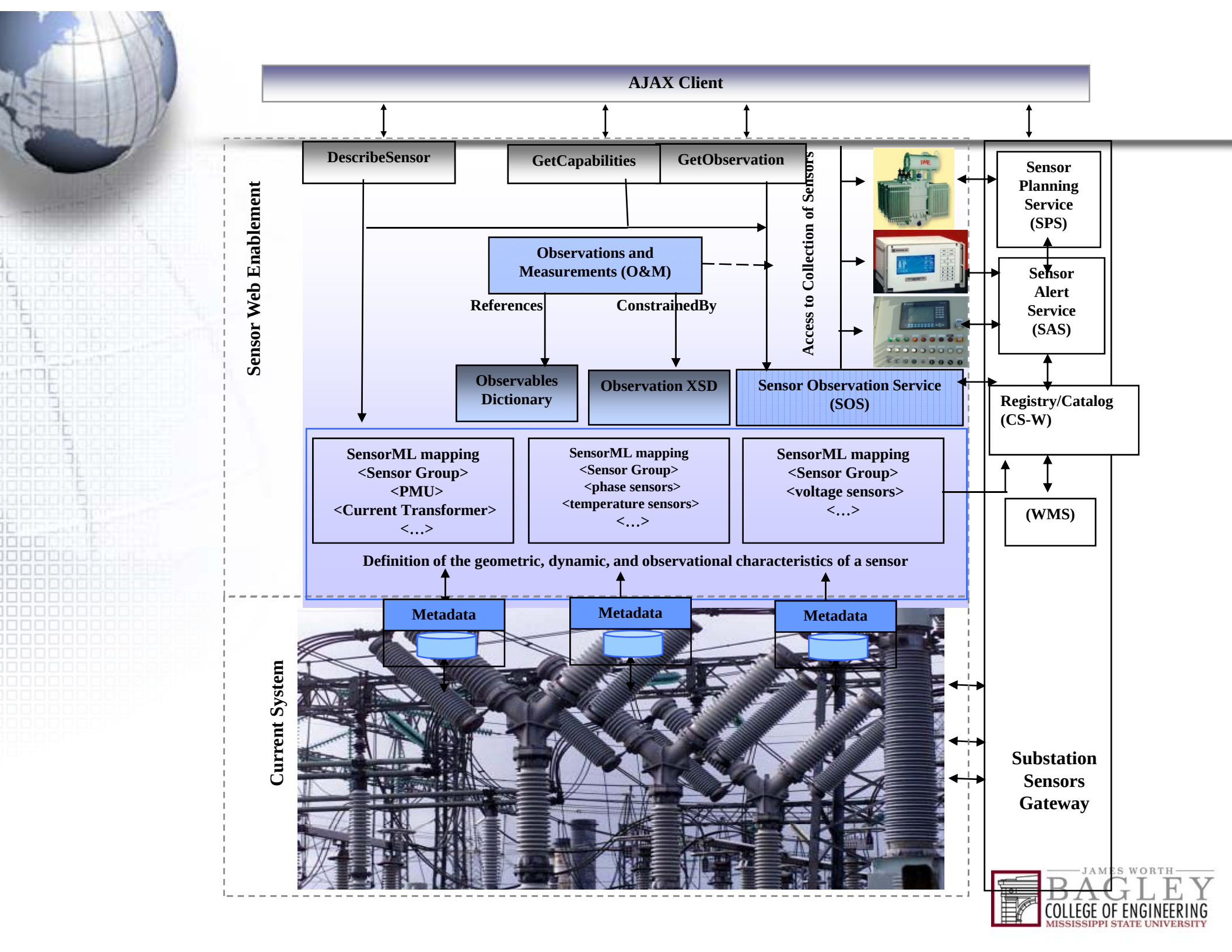
(Botts and Richard, 2006).

Sensor Web Enablement (SWE) of sensors involved in wide area monitoring of electric power grid



Other services of SWE

- Sensor Planning Service (SPS)
- Sensor Observation Service (SOS)
  - A service by which a client can obtain observations from one or more sensors/platforms (can be of mixed sensor/platform types). Clients can also obtain information that describes the associated sensors and platforms.
- Sensor Alert Service (SAS)
  - define how data collection requests are expressed, observations retrieved, and alert or alarm conditions defined.
- Web Notification Service (WNS)
  - A service by which a client may conduct asynchronous dialogues (message interchanges) with one or more other services. This service is useful when many collaborating services are required to satisfy a client request, and/or when significant delays are involved is satisfying the request.


AJAX Client
Sensor Web Enablement
DescribeSensor
GetCapabilities
GetObservation
Observations and Measurements (O&M)
References
ConstrainedBy
Observables Dictionary
Observation XSD
Sensor Observation Service (SOS)
Access to Collection of Sensors
Sensor Planning Service (SPS)
Sensor Alert Service (SAS)
Registry/Catalog (CS-W)
(WMS)
SensorML mapping <Sensor Group> <PMU> <Current Transformer> <…>
SensorML mapping <Sensor Group> <phase sensors> <temperature sensors> <…>
SensorML mapping <Sensor Group> <voltage sensors> <…>
Definition of the geometric, dynamic, and observational characteristics of a sensor
Metadata
Metadata
Metadata
Current System
Substation Sensors Gateway
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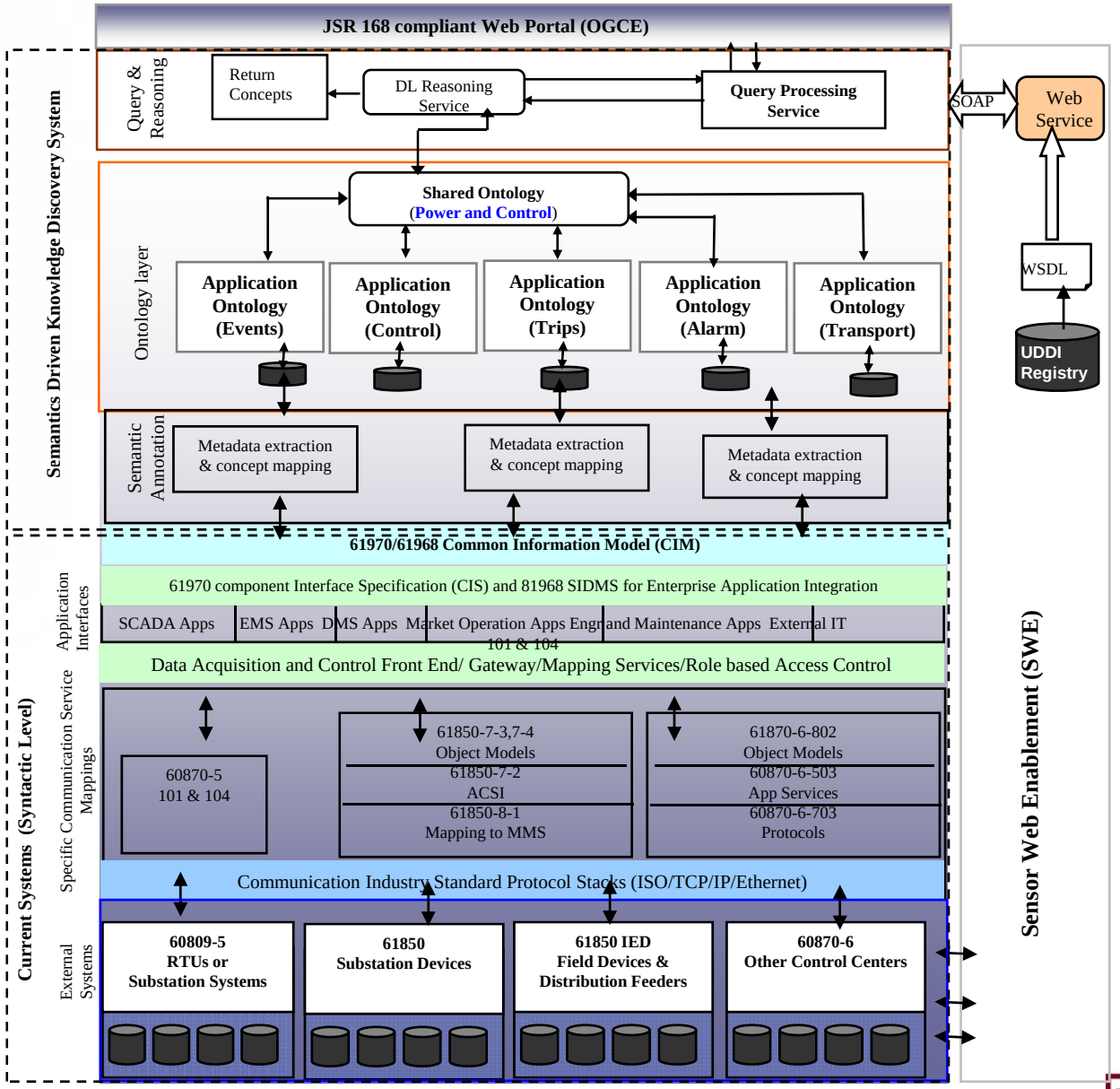
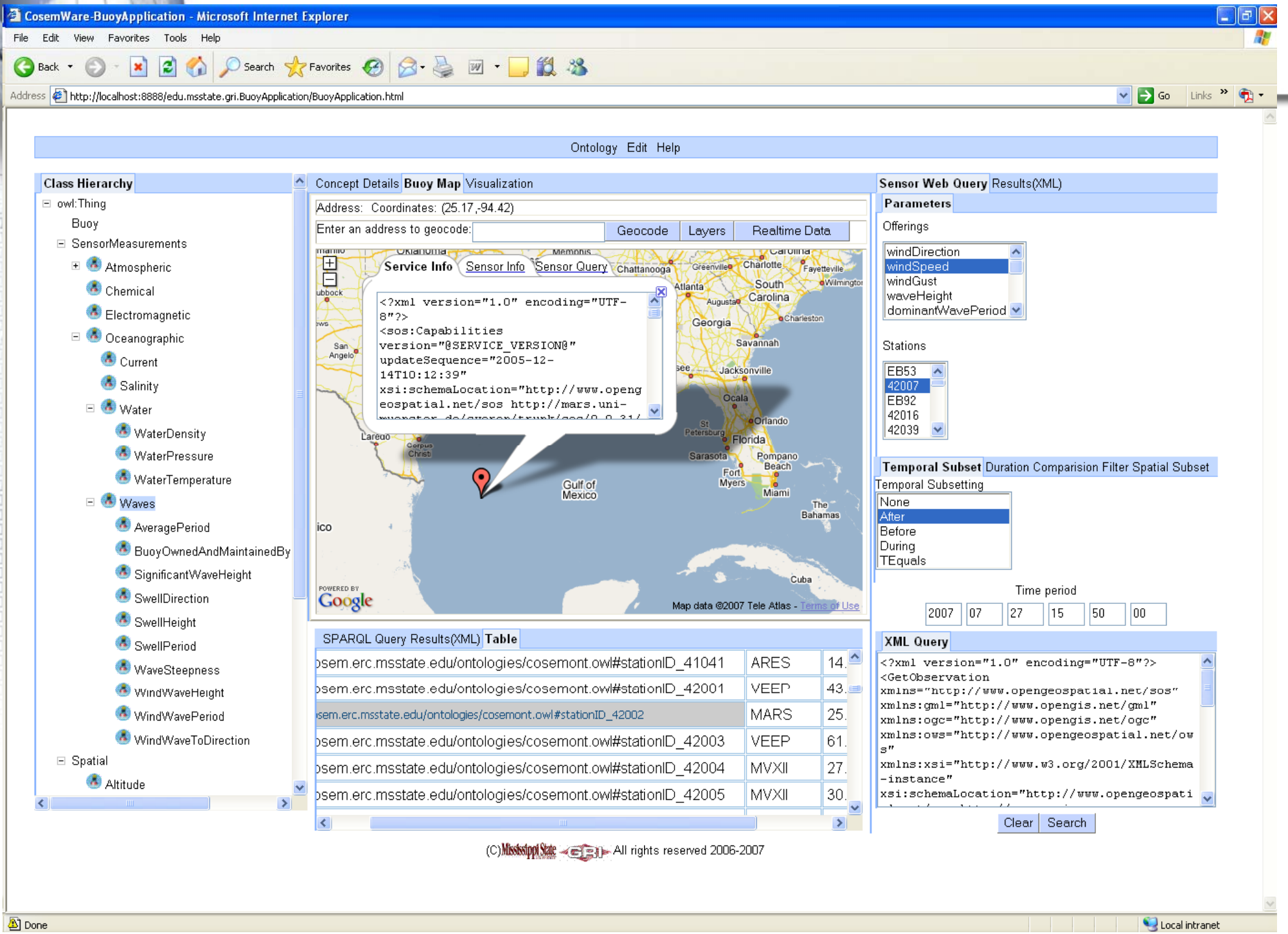
Power Sensor Web Enablement (PSWE)

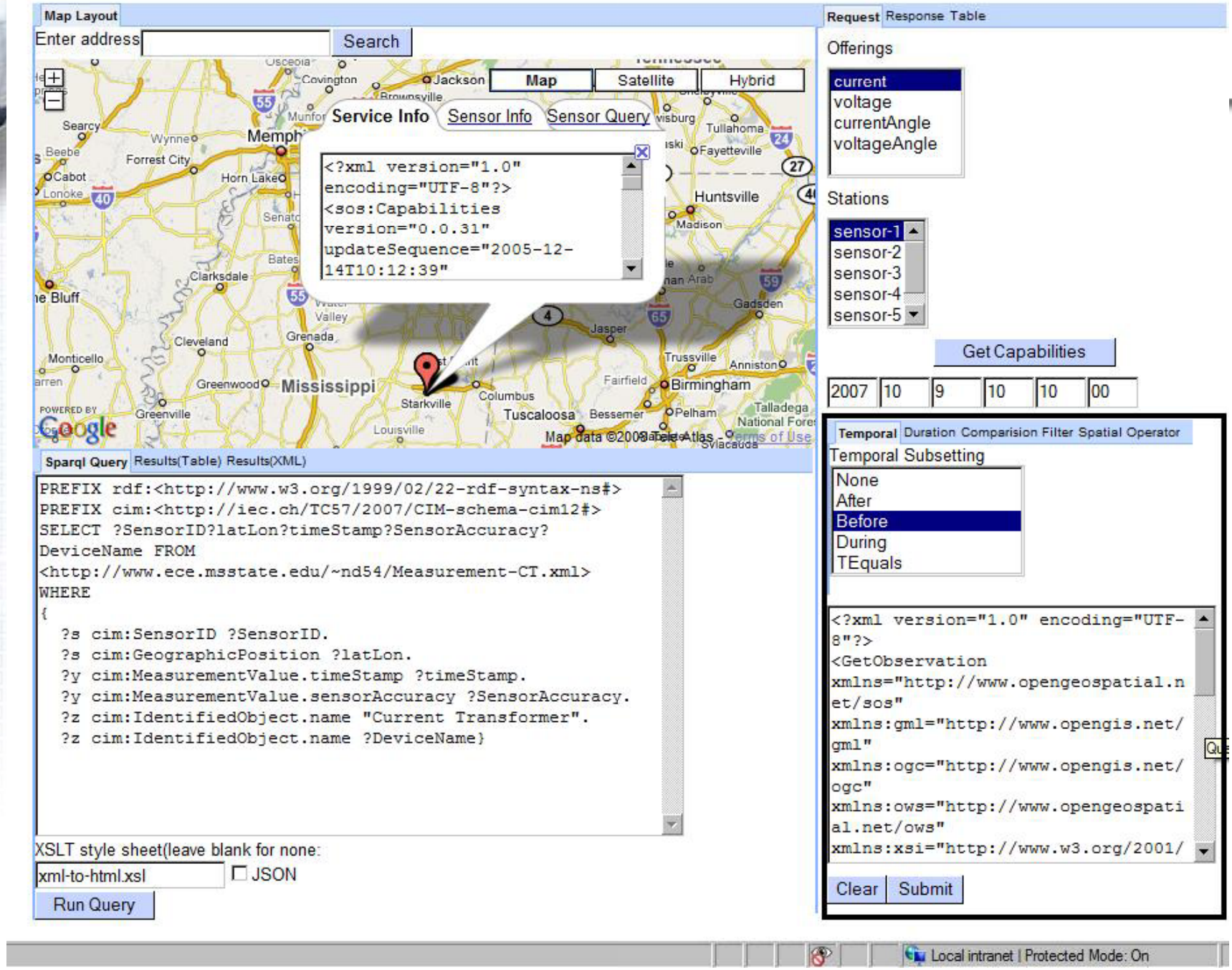
- Can perform as an extensive monitoring and sensing system that provides timely, comprehensive, continuous, and multi-mode observations for the power systems.
- A PSWE component could provide the following potential benefits:
  - Discovery of sensor systems, observations, and observation processes that meet an application or users immediate needs, i.e. acquisition of data from field devices, processing the data in substation, etc.;
  - Determination of a sensor's capabilities and quality of measurements;
  - Access to sensor parameters that automatically allow software to process and geo-locate observations (e.g. remotely issue supervisory control commands as needed to field devices.)
  - Retrieval of real-time or time-series observations and coverages in standard encodings; and
  - Subscription to and publishing of alerts to be issued by sensors or sensor services based upon certain criteria.

Architecture of Power Grid Sensors integration through Semantics enabled middleware.

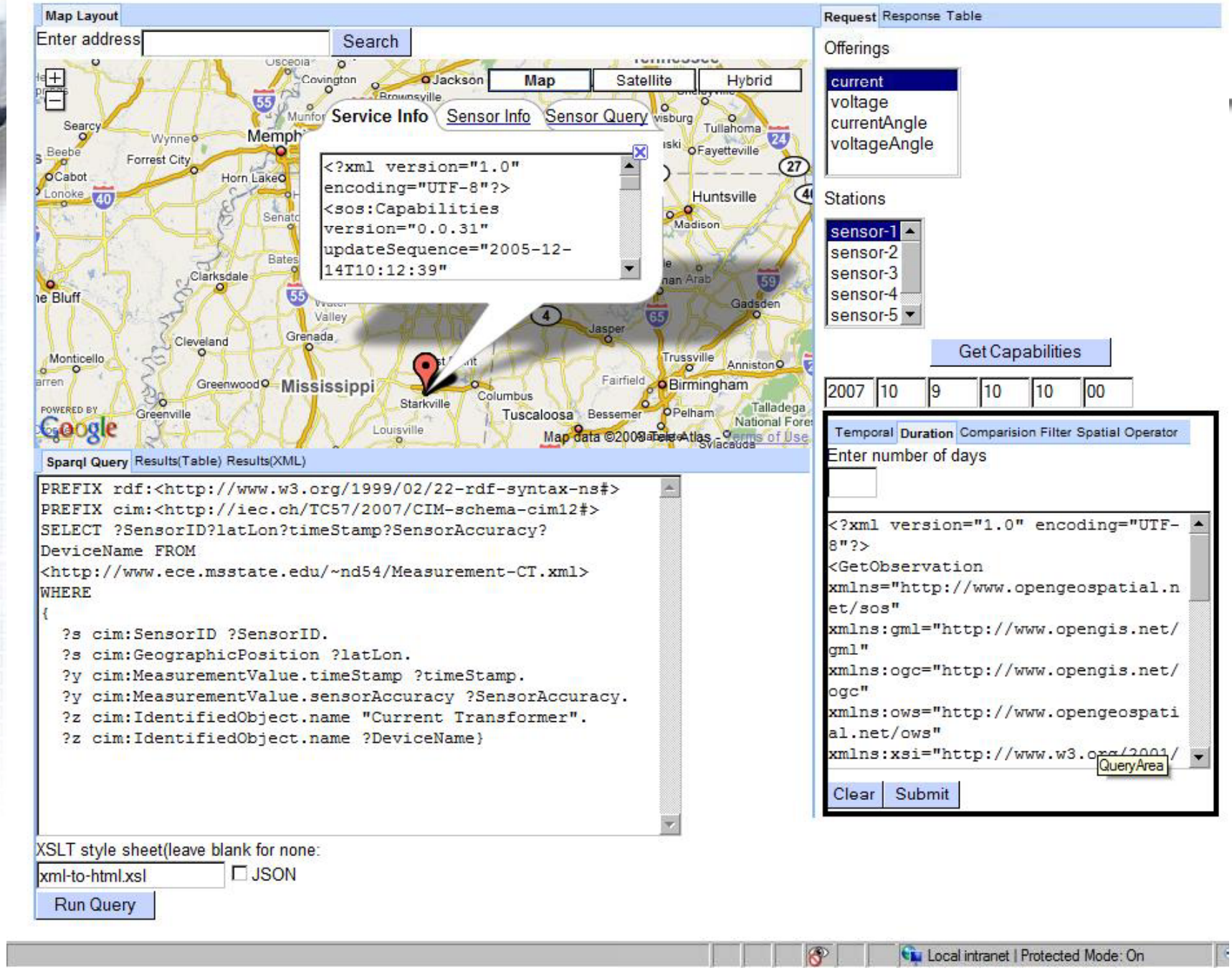


COSEMWare – SWE NOAA Buoys

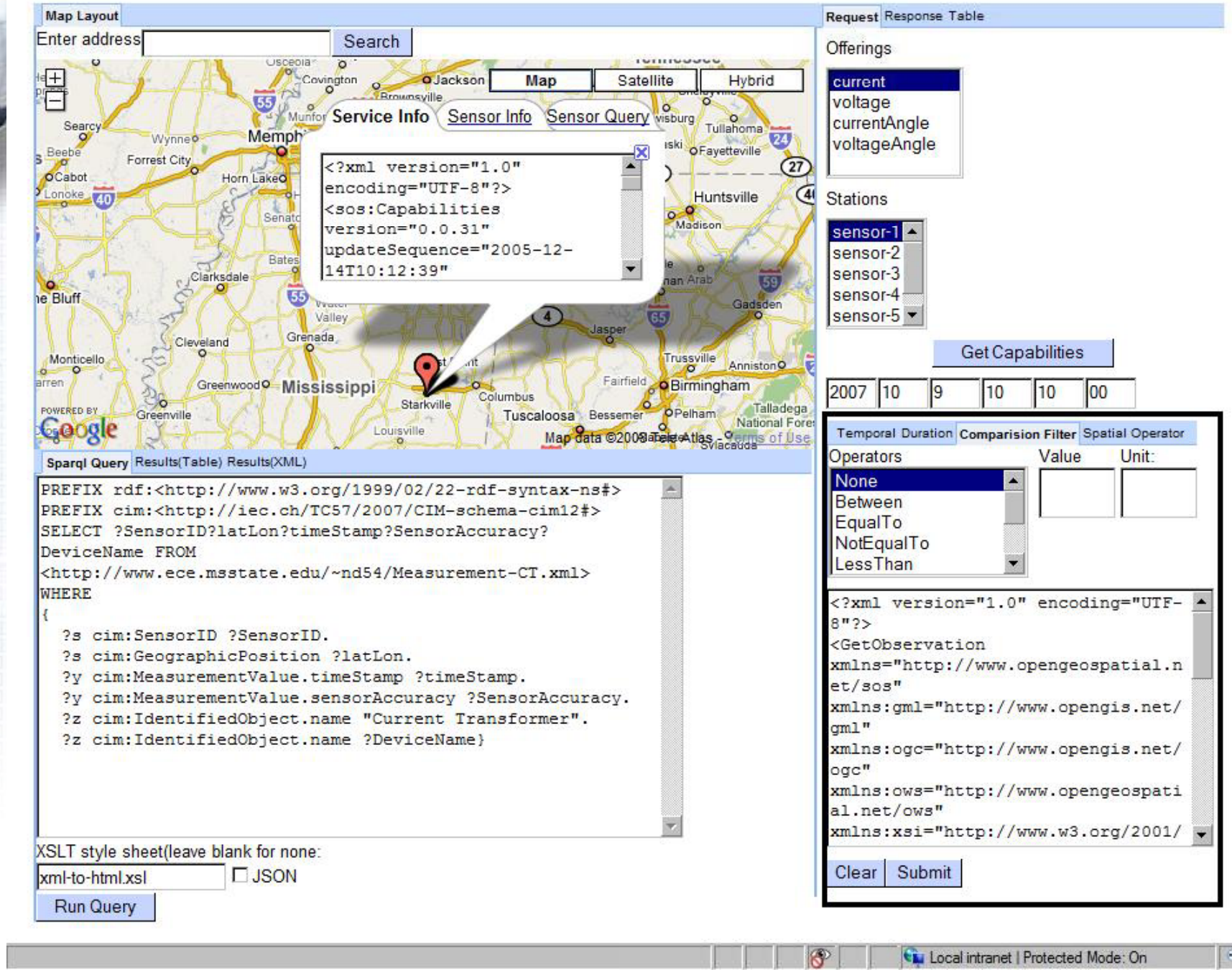




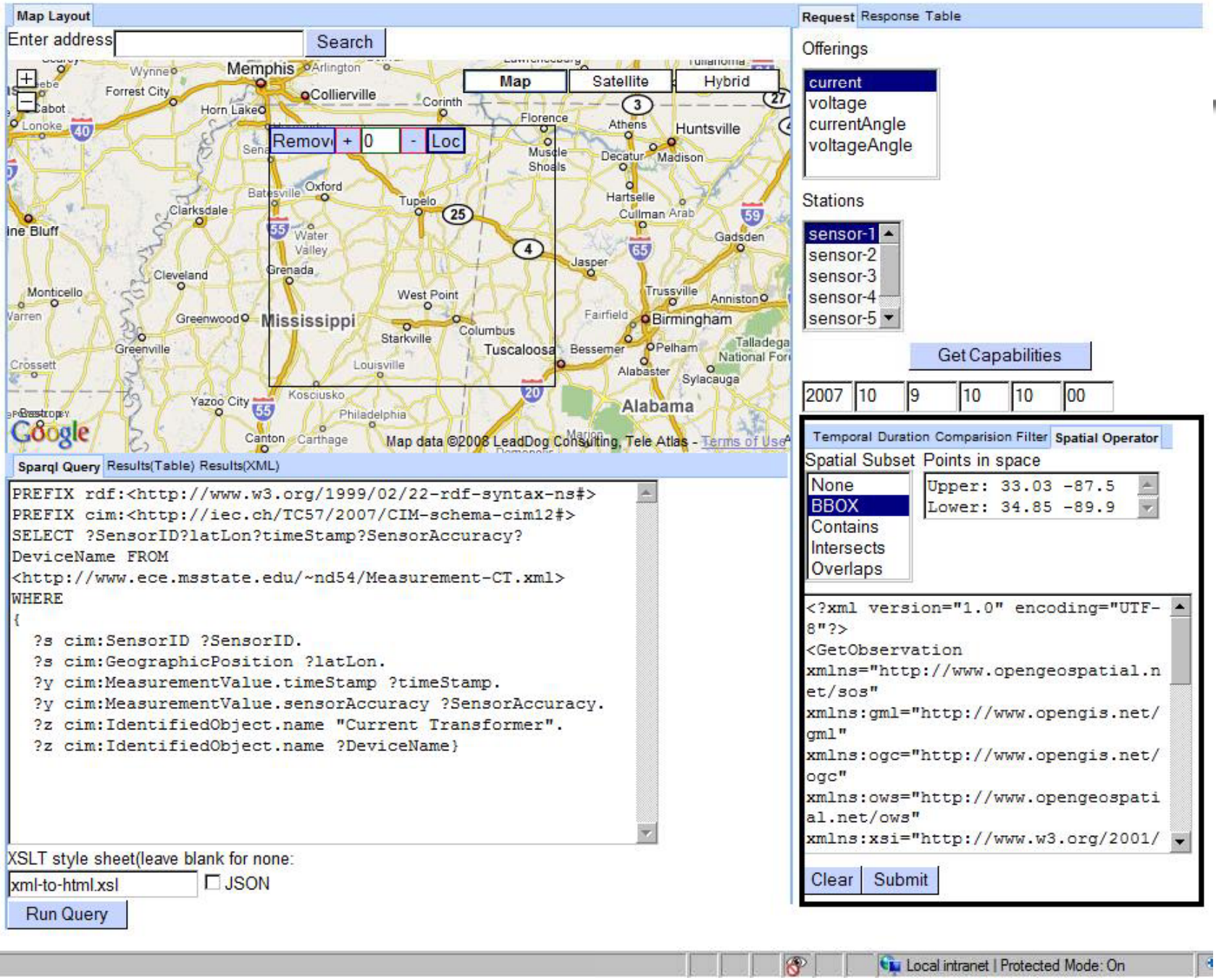
Temporal Operator: The sensor data can be filtered temporally, with the tab highlighted above. When the sensor, offering and temporal filter is selected by the user, the application creates a XML query and sends it to SOS



Duration Operator: The sensor data can be filtered within certain duration of the date and time given, with the tab highlighted above. When the sensor, offering and duration is entered by the user, the application creates a XML query and sends it to SOS.



Comparison Operator: The sensor data can be filtered according to the value of the measured offering, with the tab highlighted above. When the sensor, offering and comparison filter is selected by the user, the application creates a XML query and sends it to SOS.



Spatial Operator: The sensor data can be filtered spatially, with the tab highlighted above. Whenever spatial operator is selected, a box appears on the map, with coordinates of upper left corner and lower right corner of box recorded. The upper left corner coordinates are used if only one coordinate is needed.

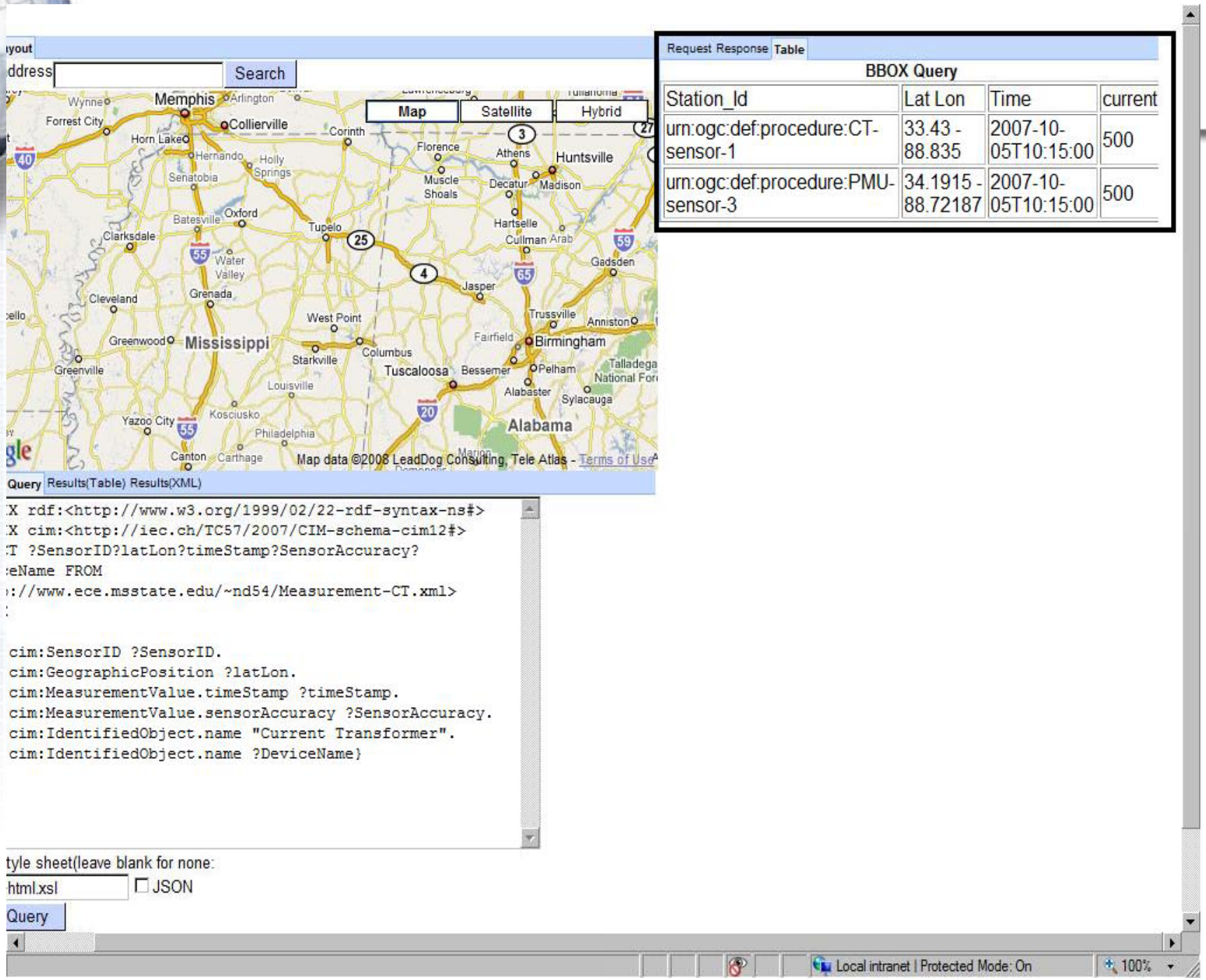
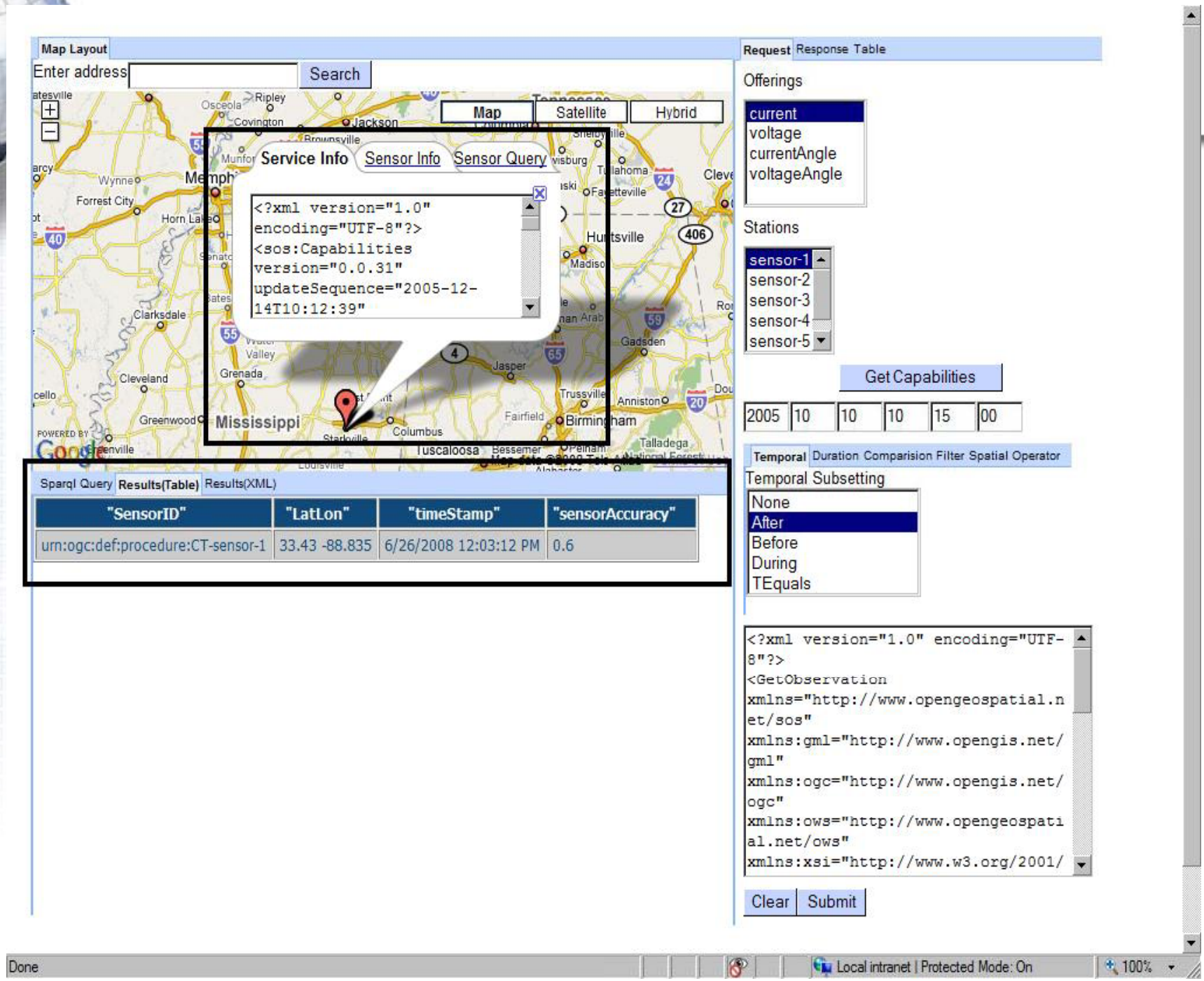
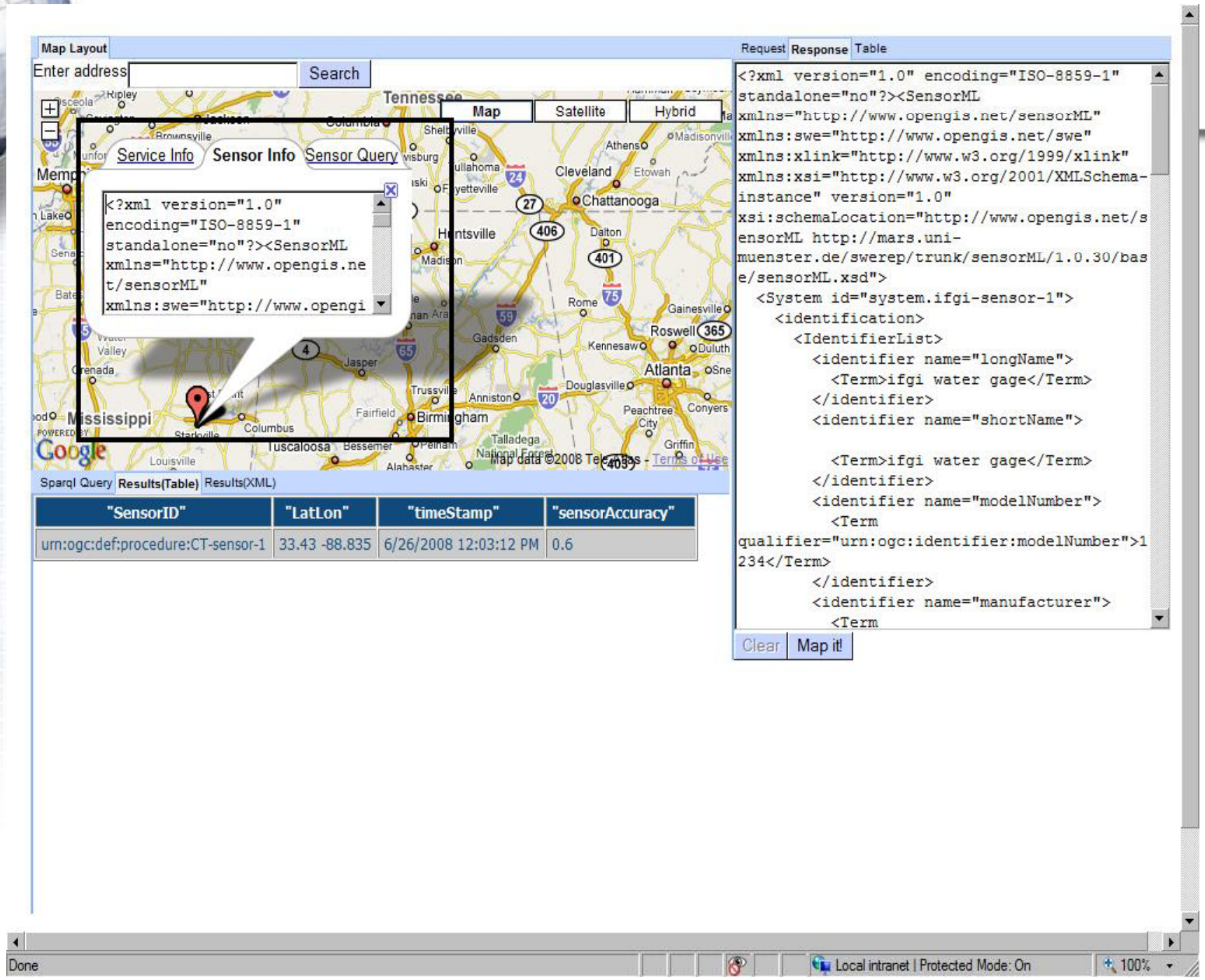


Table Format Result: The response of the SOS is displayed in the tabular format.



GetCapabilities Response: The tabular format of the result of SPARQL query is shown in the highlighted tab. The user has to query for the Geographic position or SensorID in order to enable the marking of the Sensor location in the Map as shown in the figure. When the user clicks on the marker of the sensor, the SensorML and GetCapabilities response are displayed. The GetCapabilites respnse is shown in the figure above



Sensor Discovery Response: As described in the previous slide the SensorML of the sensor selected in the table is shown in the figure above.

Conclusions

- The electric power grid is part of this country's critical infrastructure.
- An architecture has been developed for using a sensor web enablement to provide information services for wide area monitoring and power system protection and control.
- To facilitate these services it will be incumbent upon the power research community to develop tools to facilitate operational data acquisition and handling in interoperable formats and to create information products through a coordinated process chain.
- The successful conversion of power sensor data into actionable intelligence requires the integration of power system expertise in modeling, data management and service delivery to describe the state of the grid and to predict responses to actual and potential change.