Towards GeoS3Web-based Virtual Environmental Observatories

Yong Liu
National Center for Supercomputing Applications (NCSA)
University of Illinois at Urbana-Champaign

The convergence of GeoWeb, Social Web, Sensor Web and Semantic Web (GeoS3Web) provides tremendous opportunities to revolutionize how environmental observatories will be used for research, education and decision making. One key barrier to the sensor -driven revolution is the difficulty faced by individual researchers when attempting to use sensor data from multiple sources (including participatory citizen sensing). It is necessary to consider virtualization of sensors and sensor networks (i.e., virtual sensors) so that existing deployments of sensor networks and their measurements can be easily repurposed and shared in new ways. Furthermore, the concept of virtual sensors can be extended to Data-Information-Knowledge (DIK) three layers, resulting in an interoperable and standards-based virtual sensor framework. Another emergent need is the capability to provide feedback control based on the “virtual” sensing data and coupled with physics-based models to do dynamic calibration and adaptive change of sensor behaviors. Semantics plays increasing roles as the scale of the sense network exponentially grows (e.g., imagining everyone on the planet carries a mobile phone which has several environmental sensors attached). This leads to on-demand semantically annotated data streams to be discovered and integrated and newly derived provenance-aware virtual sensor streams to be re-used for the task-specific analysis and decision making.

We have developed a virtual sensor system [1][2] that can create virtual sensors that are derived from one or multiple sensor data through spatial, temporal and thematic transformations and can then be republished as live new virtual sensor streams for internet-scale data sharing with real-time provenance information generated across the entire system layers (including Web user interactions, workflows, and standalone system daemons) and Virtual Globe-based visualization. Current environmental observatory testbed projects that are using the system include urban flooding control and agricultural & ecosystem research. Future work will incorporate citizen sensing data, multiple models-based virtual sensor transformation and control.