Simulation-Optimization for Threat Management in Urban Water Systems

Abstract

This application incorporates dynamic water use data, in real-time, into a simulation-optimization process for contamination threat management in drinking water distribution systems. The nature of this work is highly compute-intensive and requires multi-level parallel processing via computer clusters and high-performance computing architectures such as SURAgrid. The optimization component uses evolutionary computation based algorithms and the simulation component uses EPANET, a water distribution simulation code originally released by USEPA. Simulation-Optimization with EPANET is part of a multi-disciplinary, three-year NSF-funded DDDAS (Dynamic Data-Driven Application Systems) research project to develop a cyber-infrastructure system that will both adapt to and control changing needs in data, models, computer resources and management choices facilitated by a dynamic workflow design.

Project Partners

North Carolina State University
University of Chicago
University of Cincinnati
University of South Carolina

Application Project Team

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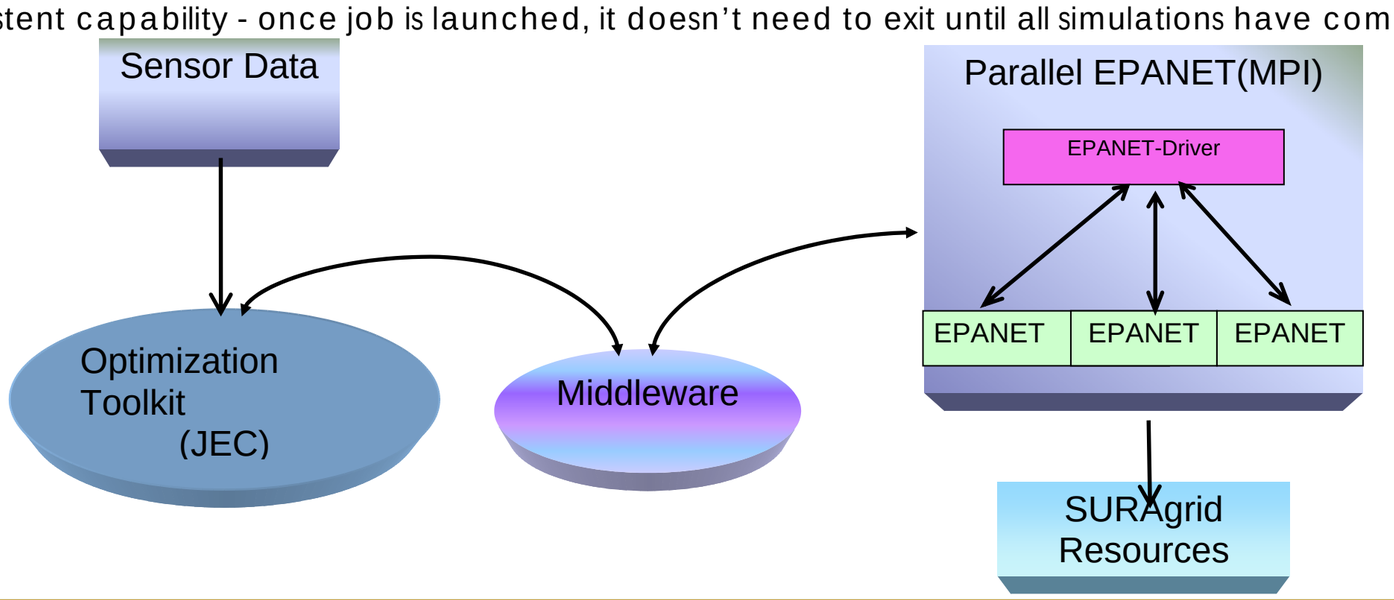
Overall Architecture of Simulation-Optimization

Optimization component -JEC (Java Evolutionary Computation toolkit) - the client side that drives the simulation component by calling the middleware interface

Simulation component - an MPI C wrapper written around EPANET. This component:

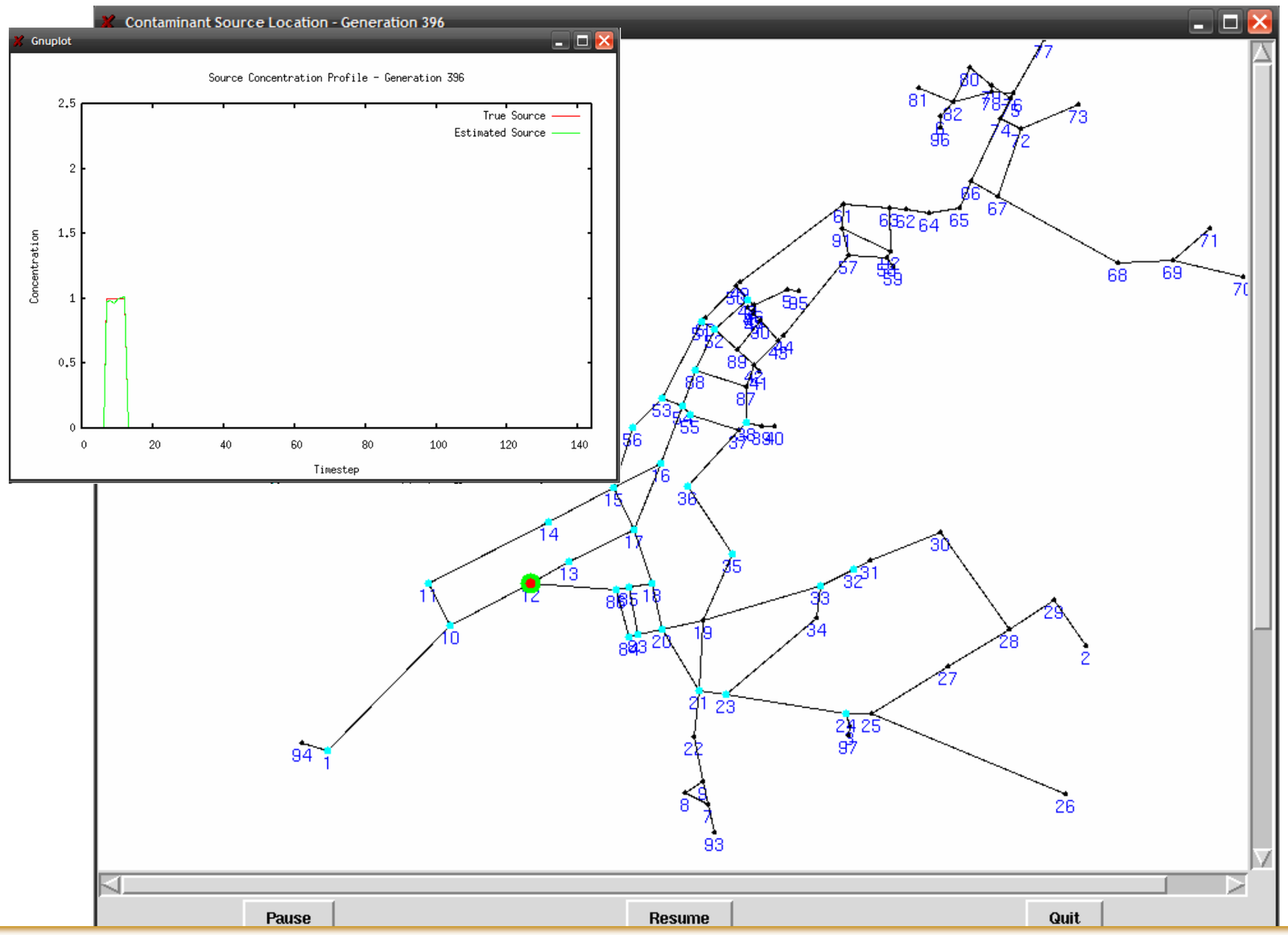
- bundles multiple simulations & performs simultaneous execution on a single cluster via MPI-based parallelism
- does not duplicate I/O and parts of simulations common to all simulation instances
- has persistent capability - once job is launched, it doesn't need to exit until all simulations have completed



Using SURAgrid to Ramp-Up for TeraGrid

One of the research needs being met through SURAgrid is that of providing a proving ground for researchers to ready their applications for porting to the national scientific cyberinfrastructure. The Simulation-Optimization for Threat Management in Urban Water Systems project is a prime example of this. Citing specific benefits of system heterogeneity and low overhead to participate, NCSU researchers are uncovering and addressing potential programming and workflow issues within their application on SURAgrid prior to using their allocations on the TeraGrid. SURAgrid anticipates expanding its role as an "on-ramp" to effective use of the TeraGrid and similar environments, helping to realize the full potential of grid-to-grid integration in the process. For more information about this and other uses of SURAgrid, contact Mary Fran Yafchak, maryfran@sura.org.

Graphical Monitoring Interface - As simulation progresses, output files are moved back to client workstation; a python/TK real-time visualization tool developed by NCSU enables visualization of algorithm progress on water distribution network. The visualization tool creates PNGs of various stages of output.



Application Driven Design for a Large-Scale, Multi-Purpose Grid Infrastructure

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