Participatory Simulations: Networked-based Design for Systems Learning in Classrooms

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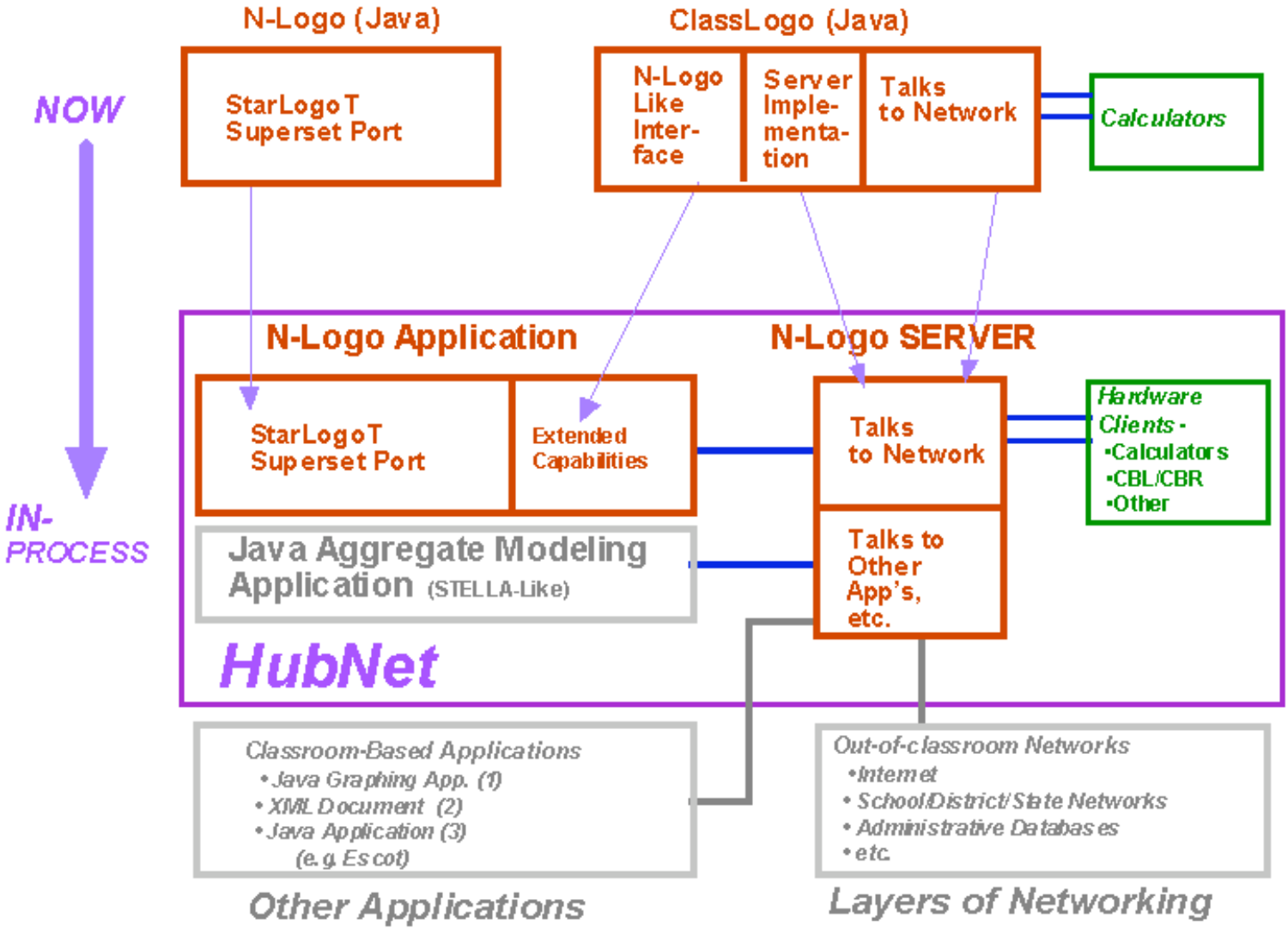
This project introduces a new architecture, HubNet, designed to give students the experience of participating as elements in a simulation of a complex dynamic system. HubNet is an open client-sever architecture, which enables many users at the "Nodes" to control the behavior of individual objects or agents and to view the aggregated results on a central computer known as the Hub. This network of nodes is integrated with a powerful suite of modeling, analysis and display tools that together give both the capacity to "fly' the system in intuitive mode, to reflect on the emergent result of their simulation and, also, to encode their strategies as rules which the system can then run independently. The HubNet architecture is being developed in stages. At present, a workable minimal subset of functionality is implemented. This subset consists of 1) a suite of networked graphing calculators called HubCalc (or ClassNet) developed in concert with our commercial partner, Texas Instruments. 2) a server, which talks to the HubCalc network and 3) an object-based parallel modeling language, N-Logo, which, is an enhanced port of the StarLogoT language that enables users to build object-based models of systems consisting of thousands of distributed elements. We call this subset of HubNet consisting of these three components, ClassLogo. Future versions of HubNet will integrate aggregate modeling languages such as STELLA that will facilitate a dialogue between object-based and aggregate approaches. Many more analysis and display tools will also be integrated (through the ESCOT project as well as internal development) as well as hooks allowing a much wider array of node hardware including arbitrary Internet hosts.



The HubNet systems is being used in several middle and secondary classrooms in Boston, Massachusetts and Austin, Texas.

The problems our society faces are increasingly systemic in character. The perspective of complex systems is rapidly infiltrating all areas of natural and social sciences. Yet, research in mathematics/science education and cognitive science has documented that students have considerable difficulties in making sense of complex systems. Our aim in developing the HubNet system is to be catalytic in advancing an understanding of complex dynamic systems for secondary and post-secondary students. We view the facility with systems thinking as a new form of literacy for *all* students.

There has been a history since the 1960's of the use of participatory simulations for the purpose of advancing systems thinking. However, these efforts have not availed themselves of the powerful networking technologies that enable these activites to be saved, rerun and connected to powerful tools for analysis. The computational tools that have been available.(e.g, STELLA, StarLogoT, Model-It, Agentsheets, Cocoa, SWARM) have not been well linked to participation by students as system elements. There is a need to

connect the methods of student participation with the computational tools of analysis, modeling and simulation. This connection is made by the HubNet architecture.

At the project research sites, middle and high school students are using HubNet to explore a wide variety of emergent activities, simulating such phenomena as the spread of a disease, the flow of traffic in a grid, the distribution of goods in an inventory system, or the emergence of an algebraic function from a set of points. Through analyzing student and teacher use of the HubNet system, we seek to gain a better understanding of how participatory engagement within a simulation can advance student understanding of the unfolding dynamics of systems.