

A Tangible Interface for IP Network Simulation

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ABSTRACT

We present the IP Network Design Workbench which supports collaborative network design and simulation by a group of experts and customers. This system is based on a tangible user interface platform called “Sensetable,” which can wirelessly detect the location and orientation of physical pucks. Using this system, users can directly manipulate network topologies, control parameters of nodes and links using physical pucks on the sensing table, and simultaneously see the simulation results projected onto the table in real-time.

Keywords

tangible user interface, network design, network simulation, computer supported collaborative work

INTRODUCTION

The growing diversity and complexity of information technology services, as well as the ever growing size of networks, has increased the difficulty of many network design tasks. To provide the means for the network designers to strike a balance between cost and performance in IP network design, we first studied the network design task, and then developed a tool to support this collaborative design task. Although there are several computational simulation tools useful for evaluating performance and forecasting the behavior of an IP network [1][2][3], they are limited to use on a conventional PC, and are not suitable for collaborative design. Therefore, we developed our system on the Sensetable to support the following scenario:

IP Network Design Scenario

A customer who has a network system for e-mail, HTTP and Voice over IP (VoIP) requests a network designer to propose a network design plan for a new streaming service. The network designer designs an initial network topology model through computer simulation, paying



Figure 1: IP Network Design Workbench system

attention to maintaining performance. The designer then presents the topology model showing simulation results in real-time before the customer's eyes. Though the customer understands that the model would meet performance requirements, he points out its cost would be expensive and suggests changing the bandwidth of a link. Refining this part of the model and its parameters directly and repeatedly, they finally find the solution to keep the balance between performance and cost that the customer wants.

This scenario was created based on the observation and the analysis of practical network design tasks at NTT Comware. It illustrates that it is important to refine network models, listen to customers' needs, and feed them back into the design quickly. A customer's participation in the network design process is a useful way to ensure their understanding of and agreement with the performance and cost of the network.

GOAL OF IP NETWORK DESIGN WORKBENCH

We have designed and developed an interface for an IP network simulation to support a collaborative design by a group of network experts and their customers. The goal of this system is to make simulation tools more accessible for people who have little network knowledge, so that they too can join the network design process. Using Tangible User Interface (TUI) [4], it became possible to directly control multiple parameters simultaneously. Users can explore the solution collaboratively by sharing multiple controllers. Results of the simulation are available in real-time.

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IMPLEMENTATION

This system is implemented upon the Sensetable [5] system, one of the TUI platforms, which can wirelessly detect physical pucks' locations and orientations. A video projector set on the ceiling projects a network topology onto the surface of the Sensetable. LC tags are attached on the back of the pucks. A puck has either one tag to detect its location; or two tags to detect its rotation in addition to its location. The second type supports a button on its surface so that button-press events are also detectable. The status of the pucks is handled by a computer connected to the Sensetable. Currently, we are using OPNet[6] software as a network simulation engine at back end. Simulation results are projected as an animation. Graphs of statistical data are displayed on a GUI screen of a LCD display next to the Sensetable.

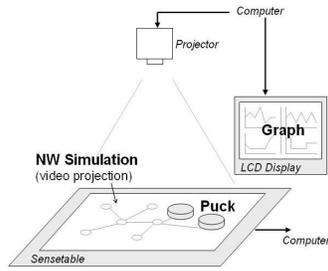


Figure 2. System architecture

INTERFACE DESIGN

By attaching video-projected components to pucks on the table, users can physically manipulate the network configuration.

Network Topology Editing

In the bottom left corner of the table is a graphical menu of the nodes that can be added to the network. When a user puts a puck onto the image of the nodes menu, a detailed menu appears around the puck, providing choices of application type such as HTTP, Streaming, etc. The user selects one of the menus by moving the puck onto the icon. After the image is highlighted, the user can add the item by sliding the puck to the workspace. To add a link between two nodes, the user binds two pucks to each target node and puts them close to each other physically.

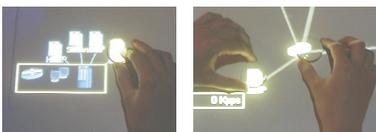


Figure 3.

Actions to add a new node (left) and a link (right)

Parameter Control for Simulation

When the user starts rotating the puck linked with a target node, a property window appears around it. The user can select a value by rotating the puck, and chooses a value by pressing a button on the surface of the puck. For discrete parameters like link bandwidth or router service priority patterns, a predefined list of selectable values appears, and the current value is highlighted. For numerical parameters like the number of client users and the server performance, a scale is displayed around the puck to guide users to increase or decrease the values, with the current value shown to the left. It is possible to change multiple parameters simultaneously during the simulation using multiple pucks and hands.



Figure 4. Parameter setting of a link, a client and a server

Real-time Simulation Result Feedback

We integrated NTT Comware's network design expertise, including their guidelines for performance standards into this system. Also, in order to visualize the cost to performance trade-offs, graph contents and layout were repeatedly improved based on the reviews of experts.

The changes of parameters are reflected in the simulation in real-time, and the results are projected as an animation as follows. The color of each client node changes according to its performance: blue if it satisfies performance requirements, yellow if it is close to standard value, red if it exceeds standard value. The color of a link turns dark gray at 0-30% usage rate, light gray at 31-70% or red at 71-100%. The ratio of each application's traffic is shown as an animation of colored spheres. In addition, values of link usage rate, application response time and running cost are monitored on the graph screen.

CONCLUSION AND FUTURE WORK

IP Network Design Workbench supports collaborative design by customers alongside experts. With intuitive group interfaces, we believe this system makes the task of network design more accessible to those without special network design skills. We plan to evaluate this system on site, and are planning to enhance it to deal with larger network topology designs.

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