Interactive Visual Exploration of Graphs and Networks

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with the help of:

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Overview

- Networks and graphs
- Interactive network visualization on a Multi-Touch Table
- Interactive control over a programmable computer network using the UvA Multi-Touch Table
About us

- **Scientific Visualization and Virtual Reality group**
  - Part of the Section Computational Science at UvA in close collaboration with SARA
- Research theme: interactive visual exploration (the human-in-the-loop)
  - Visualization software solutions and architectures
  - Interactive graphics devices
- Application areas: computational science
Networks and graphs

• Simple idea: vertices (or nodes) define entities, edges describe relations between pairs of entities
Networks and graphs

- Simple idea: *vertices* (or *nodes*) define entities, *edges* describe relations between pairs of entities

- Networks abstract the details from a problem by only describing the most important topological features
Networks and graphs

- Simple idea: *vertices* (or *nodes*) define entities, *edges* describe relations between pairs of entities

- Networks abstract the details from a problem by only describing the most important topological features

- Networks are everywhere
  - Economics
  - Disease transmission
  - Terrorist networks
  - People and friendships
  - Computers and communication lines
  - Chemicals and reactions
  - Scientific papers and citations
  - ...
Interactive Network Visualization on a Multi-Touch Table

- **Twilight**
  - Interactive visualization of large networks
    *Laurence Muller*

- **Karadok**
  - Network visualization using multi-level motifs
    *Fajran Iman Rusadi*

- **Interactive networks**
  - Monitoring and control of a programmable computer network
    *Rudolf Strijkers, Laurence Muller, Mihai Cristea*
The UvA Multi-Touch Table

Multitouch workstations support:

- Direct-touch interaction
- Multifinger interaction
- Bimanual interaction
- Collaborative interaction

Design and construction
Laurence Muller, Paul Melis, Edwin Steffens, Edward Berbee and Robert Belleman.

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SNE, SCS, Gigaport, NEMO Science Center and NCF.
Twilight

- **Features (a.o.):**
  - Supports large networks
  - Static and force layout algorithms (2D/3D), smooth transitions between layouts
  - GraphML input format
  - Interaction methods to manipulate layout: node/edge customization (size, color, texture)
  - Network introspection and statistics: path finding (shortest path), connectivity distribution
  - Fast! Encourages exploration through responsive interaction
Karadok

- **Features (a.o.):**
  - Supports large networks
  - Static layout algorithms (2D), smooth transitions between layouts
  - Cluster / motif detection and representation with icons
  - Interaction methods to manipulate layout
  - Network introspection and statistics: query mechanism
  - Fast! Encourages exploration through responsive interaction

Interactive Control over a Programmable Computer Network using a Multi-touch Surface

Rudolf Strijkers\textsuperscript{1,2}, Laurence Muller\textsuperscript{1}, Mihai Cristea\textsuperscript{1}, Robert Belleman\textsuperscript{1}, Cees de Laat\textsuperscript{1}, Peter Sloot\textsuperscript{1}, Robert Meijer\textsuperscript{1,2}

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\textsuperscript{2}TNO Information and Communication Technology
Overview

- What are programmable networks?
- When are programmable networks useful?
- Interactive control over a programmable network
- Demonstration shown at this venue
Programmable Networks

Protocol

Applications

Virtualization

Network
Programmable Networks

Applications

Sockets

Routing

Applications

Proxies

Middleware
When are Programmable Networks useful?

- When precise control of network resources matter
  - Real-time experiments using Grids (e-VLBI)
    (on-demand network resources)

- Application-specific network demands that can change over time
  - Distributed applications where network performance outweighs CPU performance in scalability issues

- Networks that need to adapt to environmental changes
  - Sensor Networks
  - Resilient and self-healing networks
Basic Issue in Programmable Networks

- Other than in IP networks, there is not a single end-to-end service, but rather a collection of software objects.

- How do you program and coordinate such a network?
  - Configuration and setup files
  - Domain specific programming languages

- We explore a dedicated human-network interface
  - Gestures translate to manipulations in individual network elements
  - Real-time, direct monitoring in the form of visualization of network state
  - Enable multiple persons to manage or monitor the network simultaneously
User Programmable Virtualized Networks

UPVN:
- Architectural framework to model network behavior as part of the application domain
- Applications use proxies (Network Components) to program a network service
- Network cannot know the behavior in advance
- Allow uploading of Application Components

Packets are tagged with identifiers (e.g. string, URL) to bind application behavior to a network service.
Interactive control over programmable networks

- We have developed an experimental platform that combines fine-grained control and monitoring into one system.

- Three different interaction levels:
  - Network topology overview & monitoring
  - Routing (creating streams)
  - Local stream manipulation (node level)

- Network state is visualized by monitoring ACs.
- UPVN takes care of translating gestures into manipulations of individual network elements.
- The human is the optimizer.
Interactive networks

- Creating streams
  - Point-to-point
  - Point-to-point with loops
  - Multicast

- Node types
  - Producer
  - Router
  - Consumer
Implementation

1. Low level functions (ARP discovery, traffic processing)
2. Adapters to middleware services or low-level control loops
3. Asynchronous p2p messaging infrastructure

- Controller is merely a known peer that other peers connect to
- Contains functions that span over multiple peers
  - two-phase commit
  - connection monitoring

Other visualization, analysis or manipulation tools
“Interactive networks” demonstration

- Video streaming (HD content) from Amsterdam, NL to Austin (TX), USA. (:SC08)
- Using the multi-touch device as an input and visualization device to control a Linux computer cluster
- Real-time stream manipulation in a token based network
- The Linux nodes are running *streamline* (kernel module)
- Streamline allows packet manipulation on the detected token
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Or just type “Robert Belleman” in Google and hit “I feel lucky”.