Internet Visualization

with

Walrus

Graph Visualization Tool

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2009 Spring Simulation Interoperability Workshop (SIW)
Outline

- Internet Measurement
- Hyperbolic Geometry
- Walrus Demo
- Future Work
Internet Measurement

• CAIDA conducts large-scale, ongoing topology measurements
  • monitors distributed around the world perform traceroutes continuously
Internet Measurement

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monitor_1

monitor_2

monitor_3
Internet Measurement

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![Diagram showing network of monitors](image)
Internet Measurement

* skitter infrastructure
  * Jan 1998 to Feb 2008 (decommissioned)
  * 29.5 billion traceroutes; 4.0TB of data
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* Archipelago (Ark) next-generation infrastructure
  * in production since Sep 12, 2007
  * 2.90 billion traceroutes; 1.1TB of data
Ark Monitor Deployment

* 33 monitors in 22 countries

<table>
<thead>
<tr>
<th>Continent</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 North America</td>
<td>19 academic</td>
</tr>
<tr>
<td>2 South America</td>
<td>9 research network</td>
</tr>
<tr>
<td>11 Europe</td>
<td>2 network infrastructure</td>
</tr>
<tr>
<td>1 Africa</td>
<td>1 commercial network</td>
</tr>
<tr>
<td>5 Asia</td>
<td>1 community network</td>
</tr>
<tr>
<td>2 Oceania</td>
<td>1 military research</td>
</tr>
</tbody>
</table>
Ark Datasets

- IPv4 Routed /24 Topology
  - traceroutes to every routed /24 prefix (~7.4 million)
- IPv4 Routed /24 AS Links
  - autonomous system (AS) is approximately an ISP
- IPv6 Topology
  - traceroutes to every routed IPv6 prefix
- DNS Names
  - names of routers and hosts seen in traceroutes
- DNS Query/Response Traffic
Walrus

* interactive tool for visualizing large hierarchical graphs in 3D
  * goal: handle 1 million nodes
* employs fisheye-like spatial distortion techniques
  * permits simultaneous viewing of local detail and global context (that is, Focus+Context)
  * uses 3D hyperbolic geometry to achieve distortion
Walrus

- interactive tool for visualizing large hierarchical graphs in 3D
  - goal: handle 1 million nodes
- employs fisheye-like spatial distortion techniques
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  - uses 3D hyperbolic geometry to achieve distortion
- based on Ph.D research by Tamara Munzner
- written entirely in Java using Java3D
- source code available under GPLv2+
Why Hyperbolic Geometry?

* Euclidean space is *infinite* but *too small*
  * a complete binary tree of height $h$ has $2^h$ leaf nodes
  * but the circumference of a circle only grows linearly on the radius:

$$C = 2\pi r$$
Why Hyperbolic Geometry?

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$$C = 2\pi r$$

* hyperbolic space is bigger
  * the circumference of a circle grows exponentially on the radius:

$$C = 2\pi \sinh r = 2\pi \left( \frac{e^r - e^{-r}}{2} \right) \sim e^r$$
Hyperbolic Visualization

- lay out graph in 3D hyperbolic space
- project 3D hyperbolic space into 3D Euclidean space for visualization
  - Klein model: hyperbolic lines remain straight lines
Hyperbolic Visualization
Walrus Gallery
Walrus Demo

Walrus
Graph Visualization

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Future Work

* get adaptive rendering working again with Java3D
* port Walrus to OpenGL
Thanks!

www.caida.org/tools/visualization/walrus

www.caida.org/projects/ark