

Network Coordinate System

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Outline

- Background
- Network Coordinate System
- System Design
- Summary
- Future Work

Background

- A class of large-scale globally-distributed network services and applications have emerged.
- Application scenarios
 - Server (peer) selection and path selection
 - measurement
 - time, overhead, cost.....

Background

- Network Coordinate System:
 - Target on distance prediction in large scale applications
 - Fast
 - Accurate
 - Low overhead

Background

- Distance prediction in Internet
- Network Coordinate System
 - Infrastructure based
 - Geometric space based

Network Coordinate System

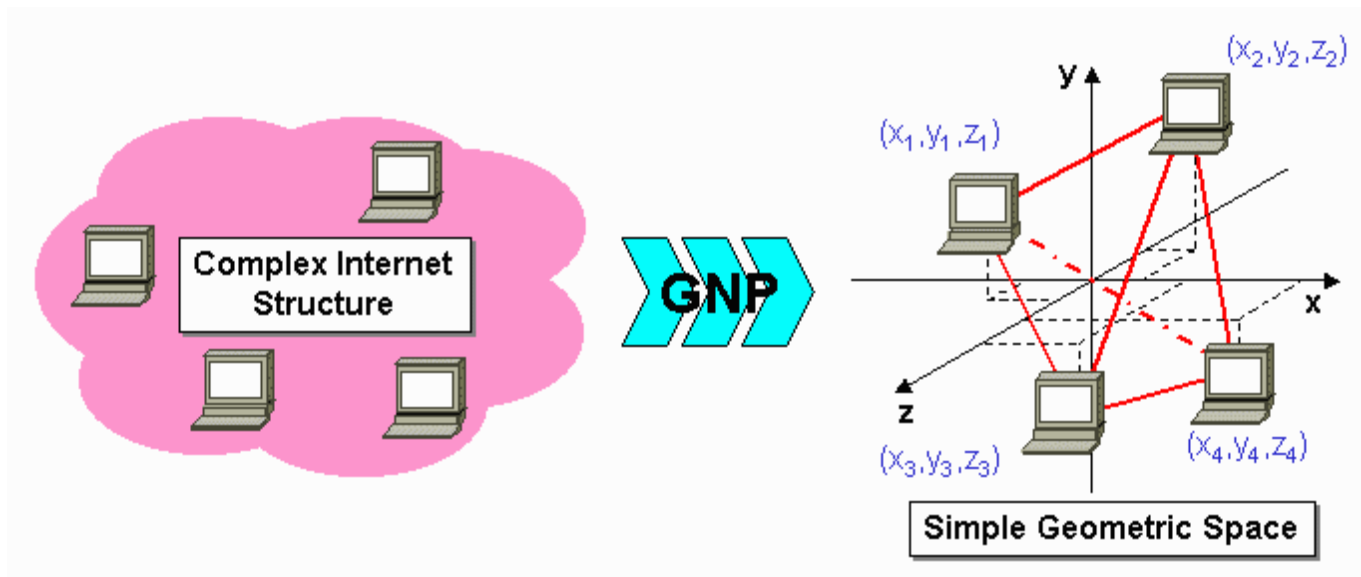
- Geometric space
 - Euclidean space
 - Used in Network Coordinate System
 - Norm

Network Coordinate System

- Requirement for Network Coordinate System
 - Finding a metric space that embeds the Internet with little error
 - Scaling to a large number of hosts
 - Decentralizing the implementation
 - Minimizing probe traffic
 - Adapting to network changes

Network Coordinate System

- Some Examples
 - GNP (Global Network Positioning)



Network Coordinate System

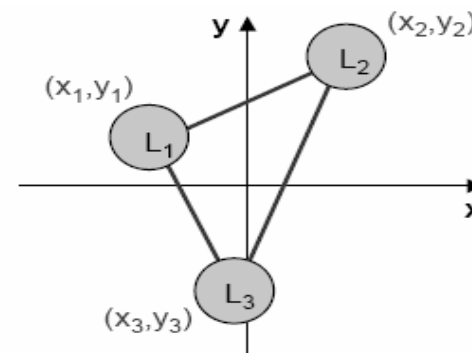
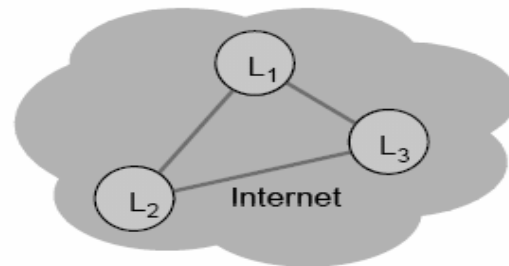
- Some Examples

- GNP

- Landmark based
 - Model the Internet as a geometric space
 - Characterize the position of any host with geometric coordinates
 - Use geometric distance to predict network distance

Network Coordinate System

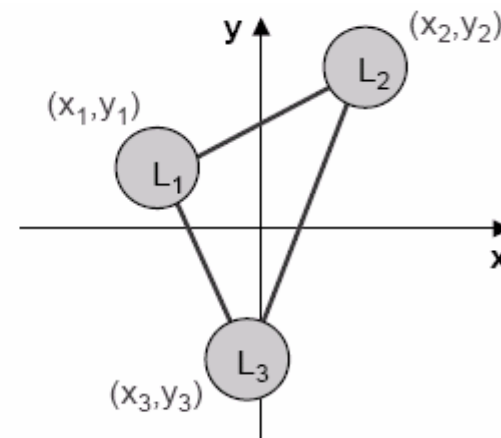
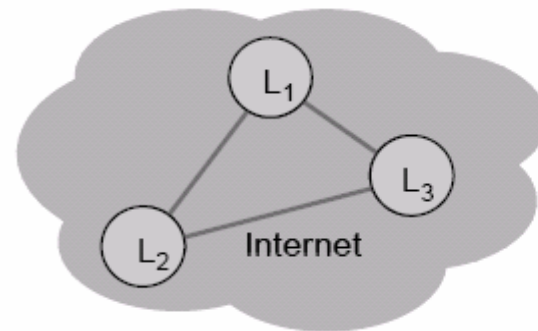
- Some Examples
 - Landmarks in GNP



- Small number of distributed hosts called Landmarks measure inter-Landmark distances
- Compute Landmark coordinates by minimizing the overall discrepancy between measured distances and computed distances
 - Cast as a generic multi-dimensional global minimization problem

Network Coordinate System

- GNP
 - Landmark in GNP

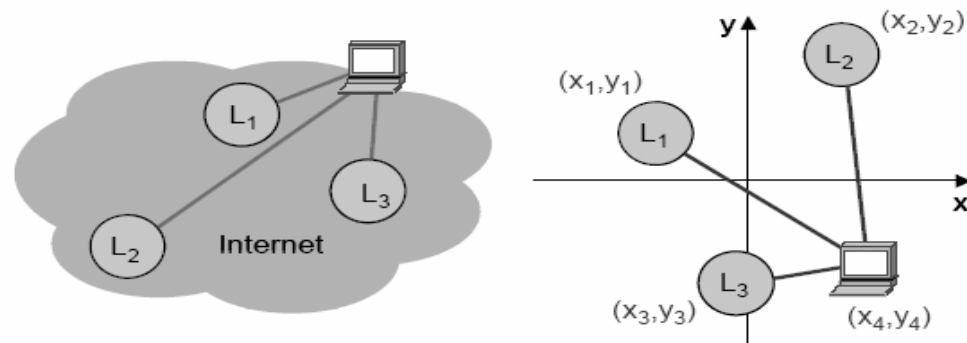


- Minimizing the objective function

$$f_{obj1}(c_{L_1}^S, \dots, c_{L_N}^S) = \sum_{L_i, L_j \in \{L_1, \dots, L_N\} \mid i > j} \mathcal{E}(d_{L_i L_j}, \hat{d}_{L_i L_j}^S)$$

Network Coordinate System

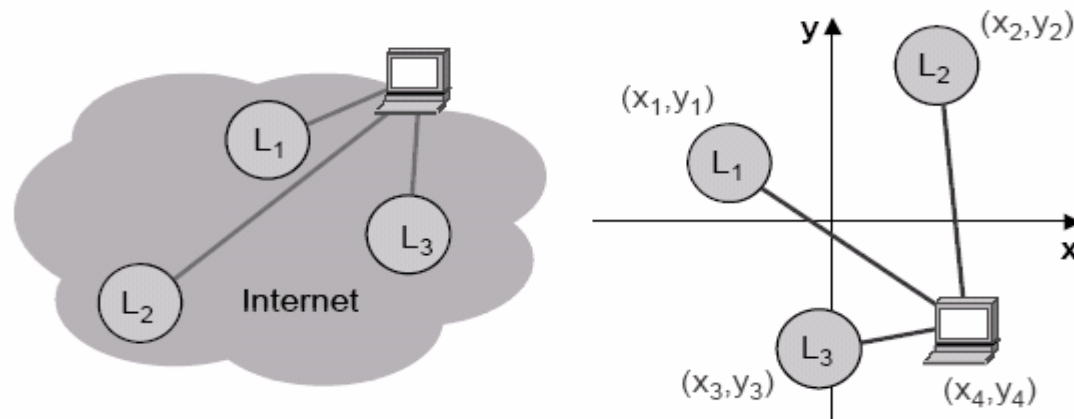
- Some Examples
 - Host in GNP



- Each ordinary host measures its distances to the Landmarks, Landmarks just reflect pings
- Ordinary host computes its own coordinates relative to the Landmarks by minimizing the overall discrepancy between measured distances and computed distances
 - Cast as a generic multi-dimensional global minimization problem

Network Coordinate System

- Some Examples
 - Host in GNP



- Optimizing the objective function

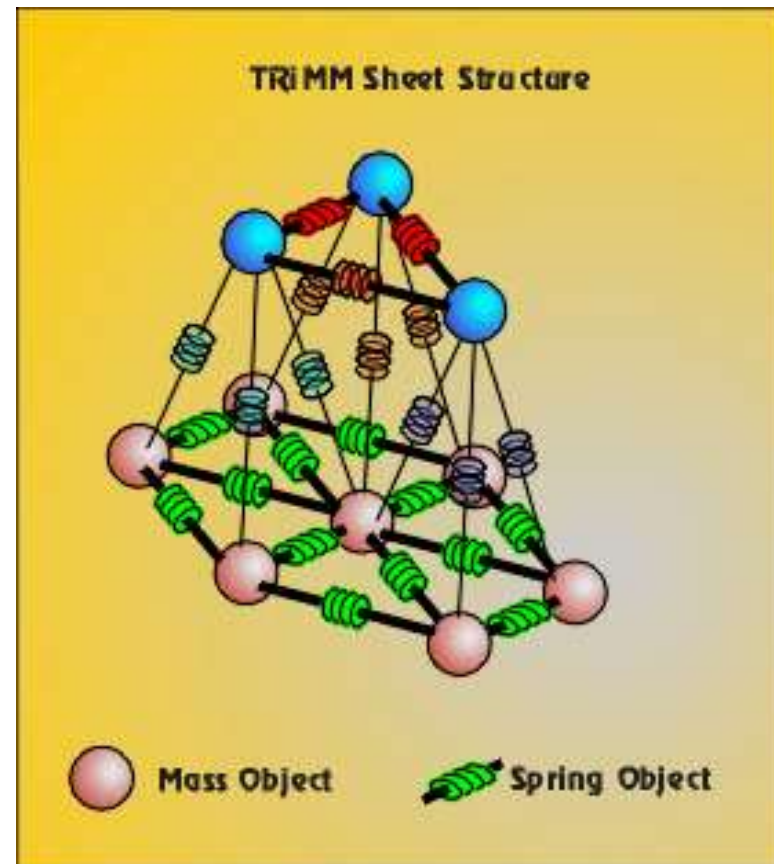
$$f_{obj2}(c_H^S) = \sum_{L_i \in \{L_1, \dots, L_N\}} \mathcal{E}(d_{HL_i}, \hat{d}_{HL_i}^S)$$

Network Coordinate System

- Some Examples

- Vivaldi

- Similar to physical mass-spring system.
 - Nodes - mass object
 - Network Distance – spring

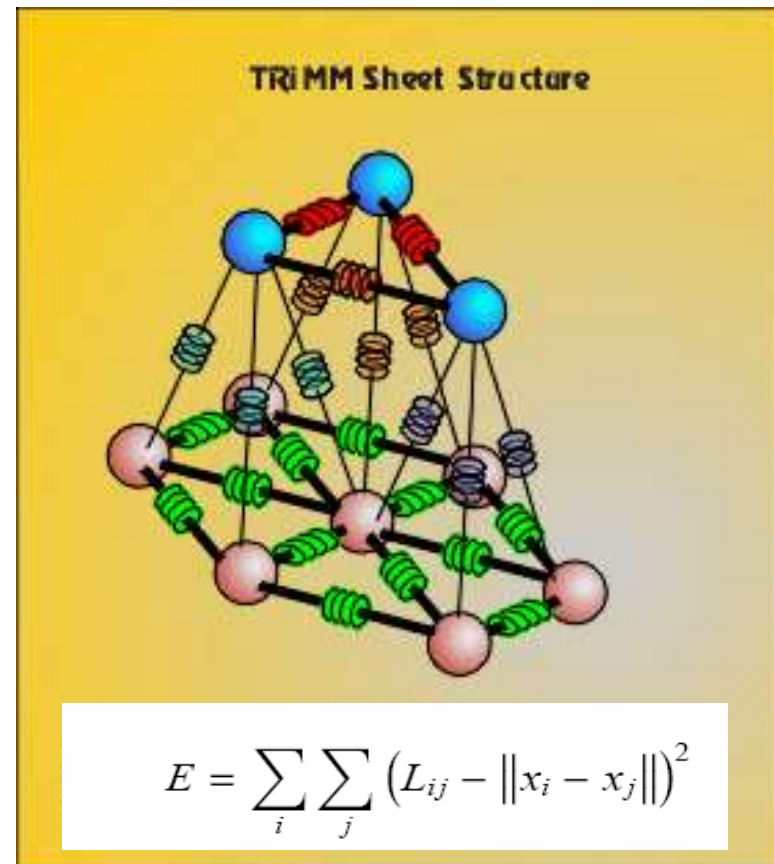


Network Coordinate System

- Some Examples

- Vivaldi

- Minimizing the energy in a spring network is equivalent to minimizing the squared-error.
 - Function the optimization object is minimizing the system potential energy.
 - Square error function:



System Design

- Nodes Classification

- Server

- Register the peers
 - Provide essentially initial configuration parameters to ordinary nodes in the system
 - Manage the overlay network and the peers

- Peer

- Construct the overlay
 - Compute network coordinates
 - Predict network distances
 - Do some measurements
 - ...

System Design

- **Overlay Structure**
 - Mesh-based overlay
 - Unstructured overlay
 - There are some random connections between the peers

System Design

- Experiments

- On PlanetLab Testbed

- (<http://www.planet-lab.org/>)

an open platform for developing, deploying and accessing planetary-scale services



System Design

- Experiments
 - Network Coordinate System
 - Convergence
 - Accuracy
 - Adaptability to network changes
 - Overhead

Summary

- Network Coordinate System can compute coordinates of the nodes in the system.
- Network Coordinate System can predict the distances among the nodes.
- Network Coordinate System is useful for large-scale applications.

Future Work

- Deal with NAT & Firewalls
- Better algorithm for computing network coordinate and better algorithm for predicting network distance
- Network Coordinate System should be used in other network services and applications.

The END

Thank you very much!

The END

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