An Information Management and Retrieval Method Considering Geographical Location on Ubiquitous Environment

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Background
• Development of Wireless Technology & Positioning Devices
  – cars, PDAs, mobile phones…
  – easily connect to the Internet
  – get the actual position
• Demand for location related service
  – weather information (mobile phone)
  – traffic information (car navigation)

Goal
• collect data with geographical location
• share location-related data with each devices
• we can use location-related information of any place.
  – more detailed traffic and weather information
  • new geographical services
  • traffic and environmental problem

Requirements
• Scalability
  – manage a large number of devices
• Region search
  – weather and traffic information is deeply related with geographical position
• Fast Search
  – location-related information is easily affected by TIME (and location)

Architecture

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DEMO

1. Put(x, y) Get(x, y) Put(keyID) Put(keyID, IP) data Get(KeyID)
2. Z-ordering — this layer creates ID “region search”
3. skip-list — this layer provides lookup service “scalability” “fast search”

Application
2D ⇔ 1D Mapping
Lookup Service
Algorithm

- Optimize “Z-ordering”, “Skip-list” for P2P

Simulation environment

- CPU: Pentium4 2.4GHz
- Memory: 1GB
- Programming language: Java 2 SDK ver1.4.2-05
- OS: WindowsXP-SP2
- Number of nodes: 10 → 2560
- ID-space: $2^{14}$ (4096 x 4096)
- Transfer method: Random work

Application Example

1. Create weather information
2. See the atmospheric temperature
3. Region search
4. Supports any size of region search

Routing Cost

- Linear search: $O(N)$
- Proposed System: $O(\log N)$

Messaging Cost

- Linear search: $O(N)$
- Proposed System: $O(\log N)$

Robustness

- Recover overlay network 100%
Related-work

- DHT-based P2P network
  - Chord, SkipNet, Tapestry, Pastory
  - routing cost: $O(\log N)$
  - hashed ID is NOT match Geographical Info
    - so much queries are generated
- Geographical-based P2P network
  - CAN, LL-net
  - routing cost: $O(\sqrt{N})$
  - complex area management
    - There are some kind of special nodes (Super nodes, etc.)

Summary

- Scalability
  - message cost: $O(\log N)$
- Region search
  - can search any size of square (few queries)
- Fast search
  - routing cost: $O(\log N)$
- Other features
  - robustness
- Feature work
  - improve road-balance, support poor devices, etc...