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PIAX: A Ubiquitous Service Platform based on Overlay Network Technologies

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Background

• Pervasive/Ubiquitous Computing Environment

- In-door observation
- Observe Real-time environment
- Probe-car network
- Watching School Children
- Environment Measurement
- Home Entertainments
- Network Robots
- Web Services
- Automation Services in the Real-world
- Distribution Systems
- Traffic Controls
- Deliveries
- Community Services
- PANs
- Real-time Environment Measurement
- Probe-car network
- Watching School Children
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- Automation Services in the Real-world
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- Traffic Controls
- Deliveries
- Community Services
- PANs
Interoperability of Pervasive Systems

• Vertical Integration
  – Specialized, Closed System
  – Enormous cost for wide-area coverage
  – Centralized, uniformed

• Horizontal Integration
  – No limit the purpose, Open System
  – Cooperation for wide-area coverage
  – Distributed, diversified
Vertical & Horizontal Integration

- Large-scale Web Services
- Traditional Web
- Mash-up / Web Services
- Peer-to-Peer Loose Syndicate

Vertical

Horizontal
PIAX: P2P Interactive Agent eXtensions

- Java-based platform that integrates:
  - Multiple P2P overlay discovery functions
  - Mobile agent features

Variants ubiquitous applications

- Multi-Overlay
- Discovery Messaging

Flexible Computing by Mobile Agents

Scalable Messaging by P2P Overlay

Navigation
Reputation Sharing
Shopping Assistant
Recommendation
Streaming

http://www.piax.org/

Sensors
Contents
Devices
Users
Profiles
Reputations

NiCT
Software Structure of PIAX

Flexible and loose coupling of different services

Agent library

- File sharing
- Location-dependent contents
- Sensor handling
- RDF DB

Scalable handling of enormous data and nodes

Concealing heterogeneity and complexity
The core overlay network of PIAX is based on Skip Graph that can support range-query.

- Each peer has ONE key in the original Skip Graph, but Multi-key Skip Graph that can handle multiple keys in each peer is proposed and implemented in PIAX.

![Diagram showing Skip Graph with membership vectors and keys.](image)

**Membership vector**

- **Level 0**
  - 000
  - 100
  - 010
  - 001
  - 110
  - 111

**Key**

- 1
- 2
- 3
- 4
- 5
- 6

**Forward query for key range of [1:3] from peer ‘110’**
• Handle a ‘range’ as a key in Skip Graph

• Usage examples:
  – Discover a provider that covers a certain place as a service area
  – Connect and federate intra-resources among the different organizations (e.g., databases, sensor networks)
Geographical Key-value Store

- RKSG’s range-query enables distributed peers to manage location-dependent contents
Summarized Features of PIAX

- **Flexibility**
  - Different kinds of services can be cooperated

- **Scalability**
  - Enormous peers and data can be managed

- **Tolerance**
  - Heterogeneous protocols and devices can be federated

Large-scale intelligent services with heterogeneous devices can be realized over wide-area
Large-scale & Wide-area Data Sharing

1 million peers
100 billion entries

Large-scale Key-value Store
(Each node manages a certain region)

Node discovery by Range-key Skip Graph

Discover peers that manages the required area

Retrieve location-dependent contents form the matched peers

Map area

User Terminal

Weather Sensor Map

User Movement Histories
Ex.2) Recommendation for Shopping Centers

- Distributed Online Services
- Recommendation Know-how, Sales Analysis
- Sensing data
  - Rain Sensor
  - Temp. Sensor
  - Wind Sensor etc.

- User terminal
- Digital signage
- Terminals, Displays

- Direction to the Shopkeepers

- Sales Database
  - Recommendation Algorithms
  - Analytic Algorithms etc.

- Discoveries over Overlay Networks
  - Reduce costs for startup, operation

- Timely, friendly Interface

- Robots/Sensors

- Robots
- Detection Sensors
- RFID Reader
- Camera
- Laser-Range Finder

- Detect position of the products
- Behavior, Position of the Customer

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Ex. 3) Sensor Network Federation

Wide-area and large-scale applications
Facility management  Weather observation
Disaster management
Traffic control

Federation among heterogeneous sensor networks require loosely-coupled framework
Conclusion

• PIAX: A P2P Agent Platform
  – Integrate P2P structured overlay network with mobile agent platform
    • Coupling services flexibility and scalability with concealing heterogeneity and complexity of networks and devices
  – Examples:
    • Large-scale and wide-area data sharing
    • Various resources federation for intelligent services

➢ Please visit http://www.piax.org/en/ for more information.