Potential Based Routing for ICN

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Background

• Route-by-name
  - Awareness, in-network caching.

2000

- Height: 381mm
- Width: 381mm
- Depth: 435mm
- Weight: 15.8kg
- Price: £1500
- CPU: 500MHz
- RAM: 128MB
- Display: 1024 x 768
- Storage: 30GB

2010

- Height: 115.2mm
- Width: 58.6mm
- Depth: 9.3mm
- Weight: 0.14kg
- Price: £599
- CPU: 1GHz
- RAM: 512MB
- Display: 960 x 640
- Storage: 32GB
• A large scale distributed caching architecture.
  - All elements have caching capacities.
  - En-route caching: caching while passing over it.

• Implications
  - Distributed copies of contents in caches.
  - Volatile behavior of copies in caches.
Question?

• How to intelligently locate a content which is distributed not only in repository but also in caches?
Design goals

- **Availability**  All identical contents contribute to the selection (routing) process of a content.

- **Diversity**  It provide abundant decision process for routing. A user request for a content not only based on proximity but also the qualities of the content or network condition.

- **Adaptability**  For dynamic environment where contents are placed on or removed from caches at without much disturbance to the network.

- **Robustness**  Against a single failure based on a fully distributed mechanism.
Potential Based Routing (PBR)

Close but poor quality
Far but good quality

Close and good quality but congested
How does it work?

- Blue dot line
  => Potential field from $n_{p1}$
- Black dot-dashed line
  => Potential field from $n_{p2}$
- Red solid line
  => Potential field that are linearly summed from both potential values.

$$\psi(n) = \sum_{j=1}^{N} \frac{-Q_j}{\text{dist}(n, n_j)^{\delta}}$$
e.g., potential fields.

- e.g. Name resolution system
- e.g. Self-scaling
- e.g. One routing entry.
Who has used the idea of potential field?

Over the past decade, a family of field or potential based approaches have been used in various network applications.

<table>
<thead>
<tr>
<th>Application</th>
<th>Title - Publisher.</th>
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<tbody>
<tr>
<td>Data aggregation</td>
<td>“Effective Data Aggregation Supported by dynamic routing in wireless sensor networks,” – ICC 2010</td>
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<tr>
<td>Content routing in ICN</td>
<td>“Potential Based Routing for highly available ICN” – AWFIT 2011</td>
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</tbody>
</table>
CATT layer structure

APIs

CATT

- CATT Transport Layer (Flow Control, Re-Tx of REQ)
- CATT routing Layer (PBR, Caching)

CATT Abstract Interface

- CATT Abstract Layer (CATL)

Socket Interface

- TCP
- UDP
- IP

Raw Socket Interface

- MAC
- PHY

Pub/Sub app

- Segmentation & de-segmentation
- Flow control
- Retransmission of REQ-MSG
- PBR
- Caching
Implementation design

Routing Module Thread

CATT Thread

Routing Module

Notifications

Interface

Control Layer

CATTID

Cache

Forwarding

HELLO-MSG

ADV-MSG

CATL

TCP/IP, UDP

REQ-MSG

RES-MSG
Evaluation.

- Event driven network simulator.
- Power law topology (N=1000, E=2000).
  - AS level topology is known to be a power law topology.
- A content is located on a randomly chosen node.
  - The node floods ADV-MSGs within a limited area.
    - m: the area where ADV-MSGs are arrived.
- Random walk where potential field is not defined.
Evaluation 1: PBR (Single content)
Evaluation 2: PBR (Multiple contents)
Some issues

• Control overhead.
  - How much control overhead is required to maintain the potential field?
    - Soft state vs Hard state

• Scalability
  - A hybrid approach, e.g., breadcrumbs.
    - Self scaling approach (selective advertising).
  - BloomFilter distribution.
    - Need a mechanism as fallback.
Control overhead issue

<table>
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<tr>
<th>Soft state (SS)</th>
<th>Hard state (HS)</th>
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<tr>
<td>• Using expiration time of ADV-MSG.</td>
<td>• Nodes detect a failure and send ADV-MSG to redefine the potential field.</td>
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<tr>
<td>• Potential values are removed automatically when ADV-MSG is expired.</td>
<td></td>
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<tr>
<td>• High signaling overhead.</td>
<td>• Low control overhead.</td>
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<td>• Robustness, shorter convergence time.</td>
<td>• Great consistency.</td>
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<td>• Unreliable network connection.</td>
<td>• Reliable network connection.</td>
</tr>
<tr>
<td>• Best effort periodic state installation/refresh</td>
<td>• Require additional mechanism to remove orphan state.</td>
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