Query Guidance with Transmission Records for Efficient Content Searching in Unstructured Peer-to-Peer Networks

Takuya Tomimatsu, Shinji Sugawara, Yutaka Ishibashi
Nagoya Institute of Technology
Nagoya, Japan

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Background (1/2)

- Extension of BIA (Broadband Internet Access)
- Development of communication terminals

Huge amount of content items are shared based on Peer-to-Peer (P2P) networks
Several studies improved the search accuracy by using query guidance information.
Searching method

- Breadcrumbs
  Routers cache contents and query guidance information

Content items can be downloaded from the cache

Reduction of the server’s load
Searching method

- Breadcrumbs
  Routers cache contents and query guidance information

Content items can be downloaded from the cache

Reduction of the server’s load
Unstructured P2P

If churn situation

Queries can be sent to drop-out peer.

This study

We need to keep the integrity of the query guidance information to the drop-out peer.
Assumed environment

- Peers joining in or dropping out of the network
- Replica contents deployment (or replacement)
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Proposed method

- After a content's discovery
  - Create TR
    - TR: Transmission Record
    - (Query guidance information)
  - Content requesting
  - Replica placement
  - TR integrity check
  - Update (Delete) TR
After content discovery

If the request peer gets the content from remote supply peer,

and if the content is useful,

- Request peer
  - most downstream peer
- Deploy replica to request peer

Request peer

:TR (Transmission Record: Query guidance information)
After content discovery

If the request peer gets the content from remote supply peer,

and if the content is not useful,

- Supply peer
  ➔ most downstream peer
- Do not deploy replica

:TR (Transmission Record: Query guidance information)
1. Explore content item by flooding
2. Guiding query by TRs
3. If the content item does not exist in the most downstream peer, the query is guided to the most upstream peer (and update TRs).
Replica placement

When a replica of a content item is deleted,

- TRs for replica are corrected.
  If replica is recorded as the most upstream peer,
  the second most upstream peer takes the place of the most upstream peer.

:TR (Transmission Record: Query guidance information)
When a replica of a content item is deleted,

- TRs for the replica is corrected.
  If replica is recorded as the most downstream peer,

peer reverse the direction of TRs.

:TR (Transmission Record: Query guidance information)
TR integrity check

A message of connection confirmation is sent to the downstream peer at the frequency of $P_{\text{update}}$.

If the response is not returned,
TR integrity check

A message of connection confirmation is sent to the downstream peer at the frequency of $P_{update}$.

If the response is not returned,

- delete the TR to the 1 hop downstream peer.
- reverse the direction of each TR in the upstream direction.

:TR (Transmission Records: Query guidance information)
Two measures are used for the evaluation:

- **Network load**
- **Content acquisition success rate**

The content acquisition success rate is calculated as:

\[
\frac{\text{Number of successful content acquisitions}}{\text{Total number of content requests}} \times 100 \, (\%)\]
Methods for comparison

- BC (Breadcrumbs)
  Proposed method without TR integrity check procedure

- Flooding
  Simple flooding method incorporating the owner replica allocation
Simulation conditions

<table>
<thead>
<tr>
<th>Network topology</th>
<th>BA model</th>
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<tbody>
<tr>
<td>Initial number of peers</td>
<td>500</td>
</tr>
<tr>
<td>Total number of peers</td>
<td>700</td>
</tr>
<tr>
<td>Total number of contents</td>
<td>500</td>
</tr>
<tr>
<td>Threshold $R_{th}$</td>
<td>0.3</td>
</tr>
<tr>
<td>Threshold $H_{th}$</td>
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</table>

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<thead>
<tr>
<th>TTL</th>
<th>6</th>
</tr>
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<tbody>
<tr>
<td>Unit times</td>
<td>5000</td>
</tr>
<tr>
<td>Trial times</td>
<td>300</td>
</tr>
</tbody>
</table>

- Request of contents: Poisson distribution ($\lambda_{req} = 0.5$)
- Peers joining in or dropping out of the network: Poisson distribution ($\lambda_p = 0.5$)

Frequency of sending connection confirmation messages:

$$P_{update} = 0 \sim 1.0$$
Arrival rate of peer joining in and dropping out: $\lambda_p = 0.5$
Arrival rate of peer joining in and dropping out: $\lambda_p = 0.5$
Conclusions

- Proposed a method to guide queries efficiently in unstructured P2P networks by using the records’ periodical integrity check mechanism in each relay peer.

- Achieved high content acquisition success rate and suppress the network load by setting appropriate frequency of integrity check for query guidance information.
Future works

- Compare proposed method with a variety of methods like Winny

- Investigate the effectiveness of proposed method in various network environments