Hierarchical Cooperative Caching in Mobile Opportunistic Social Networks

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Outline

- Mobile Opportunistic Social Networks
- Cooperative Caching
- Hierarchical Cooperative Caching
- Simulation Results
- Conclusion

Mobile Opportunistic Social Networks

- *Mobile Opportunistic Social Networks* (MOSNs)
  - Opportunistic contacts (Mobile)
  - Intermittent connectivity
  - Instantaneous end-to-end paths may not exist

Challenges

- Short contact duration
- Limited bandwidth

- A small amount of data can be transferred during each contact.
  - Slow development of the battery technology
  - Limited cache space of the mobile devices
- Impossible for message flooding between the mobile devices.

Cooperative Caching

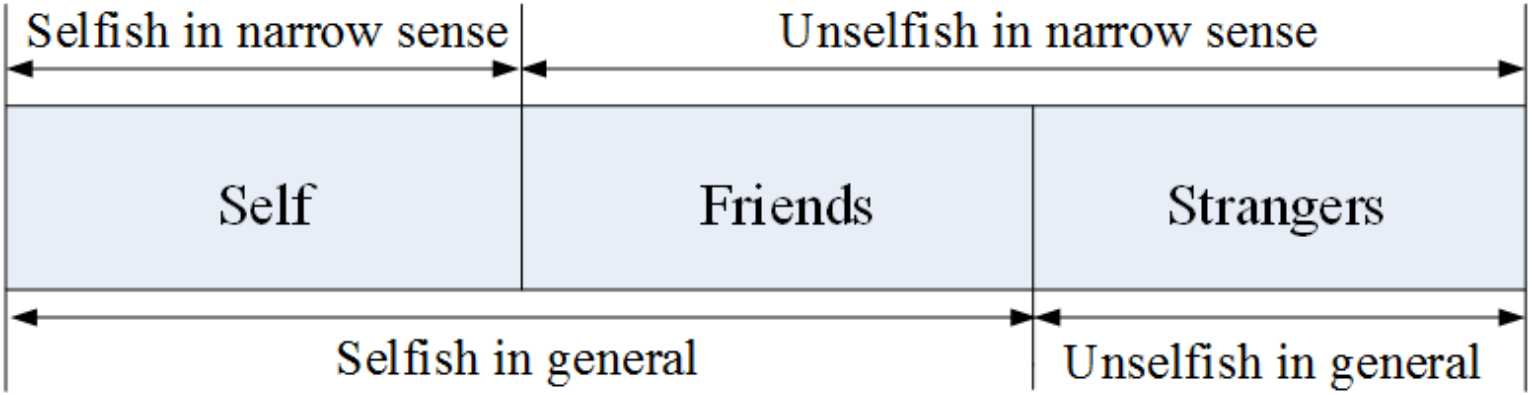
- Mobile users may cache data items in a cooperative way to improve the efficiency of data access.
  - Data sources transfer some data copies to some nodes called ***cache nodes***.
  - Each cache node selects a subset of all the data items to cache, due to its limited storage.
  - Other nodes can access data items from cache nodes instead of data sources.

Motivation

- **The individuals with higher contact frequency may have similar interests [1], which means they have similar high-frequency access data items.**
- **Designing an efficient cooperative caching strategy, by considering the *social relationship* between the mobile users, can improve the performance dramatically.**

[1] J. J. Brown and P. H. Reingen, “Social ties and word-of-mouth referral behavior,” *Journal of Consumer Research*, vol. 14, no. 3, 1987.

Hierarchical Cooperative Caching



Data Item Placement

- In the ***self*** component, each mobile node caches the most frequently accessed data items, so that it can access these data items with the minimum delay.
- In the ***friends*** component, each node will store the most frequently accessed data items from its friends' point of view, so that its friends can access these items from this cached node with short delay.
- In the ***strangers*** component, each mobile node randomly selects data items from the remaining ones to cache.

Cache Replacement

- Dynamically adjustment
- When the buffer is full, after the new data item is received:
  1. If it is the most frequently accessed data item for itself, it will compare the access frequency with the data items in the self component and replace the lowest one.
  2. If this received data item belongs to the friends component, it will replace the data item in its friends component by comparing its access frequency to the friend nodes.
  3. If the data item belongs to the strangers component, it randomly replaces one data item in the strangers component.

Simulation

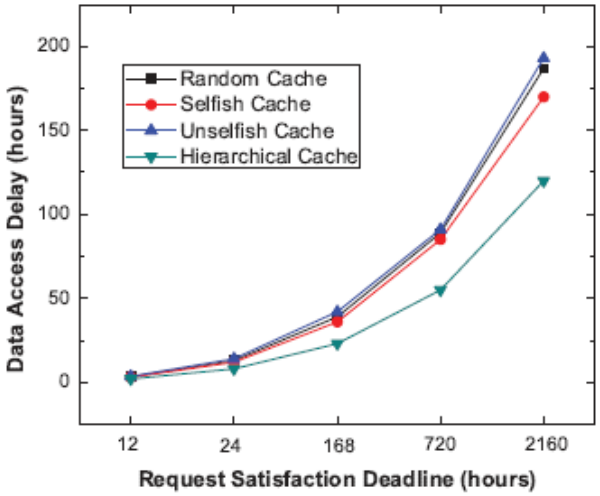
- **Comparison Caching Mechanisms:**
  - **Random Cache**
  - **Selfish Cache**, which is similar as CacheData [2] in mobile ad-hoc networks. The mobile nodes cache the pass-by data items, according to their popularity in its own point of view.
  - **Unselfish Cache**, in which every mobile node only caches the data items for other nodes, according to their knowledge about the data items' request frequency of their encountered nodes.

[2] L. Yin and G. Cao, "Supporting cooperative caching in ad hoc networks," *IEEE Trans. on Mobile Computing*, vol. 5, no. 1, Jan. 2006.

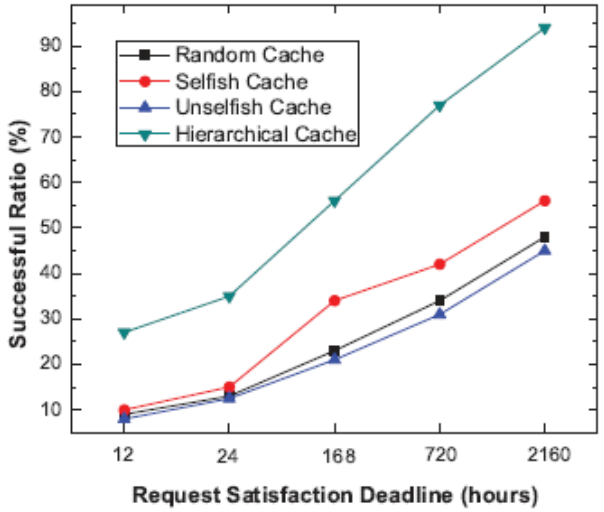
Evaluation Metrics

- ***Data access delay***: the average delay for receiving the request data item.
- ***Successful ratio***: the ratio of queries being satisfied with the requested data item within the deadline.
- ***Overhead***: the average number of data copies being cached in the whole network.

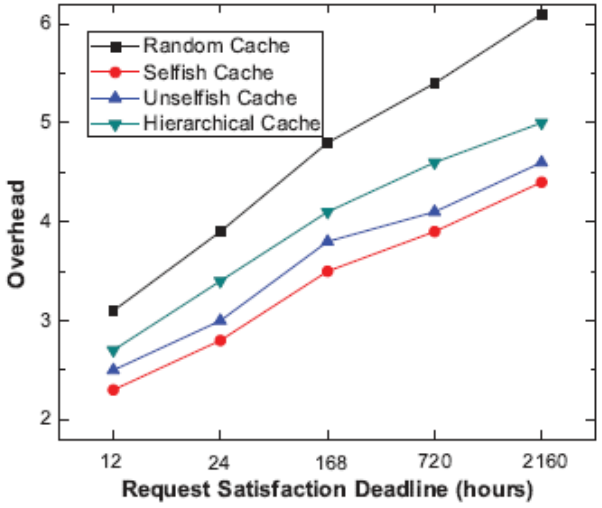
Simulation Results 1



(a) Data access delay



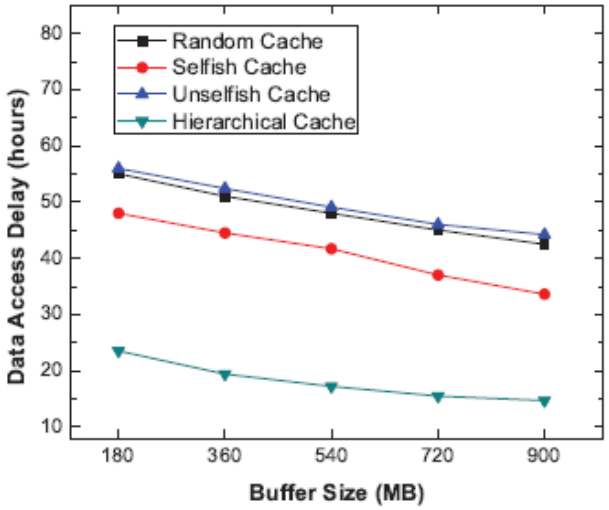
(b) Successful ratio



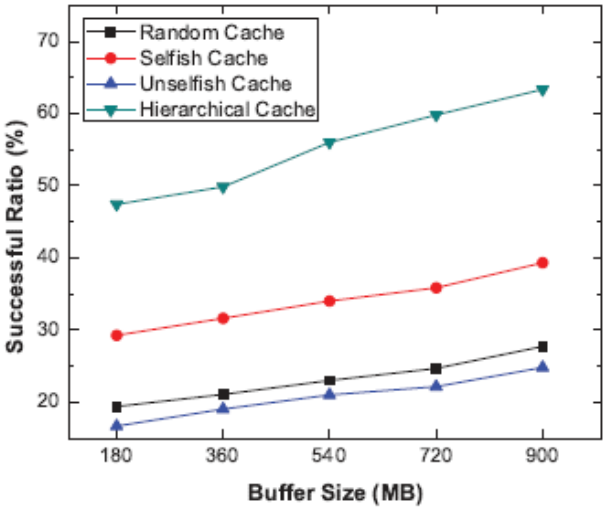
(c) Overhead

Comparison of the performance with different varying data request frequency.

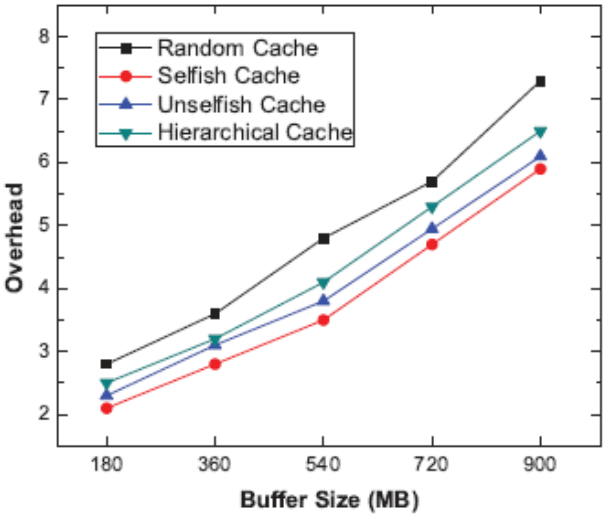
Simulation Results 2



(a) Data access delay



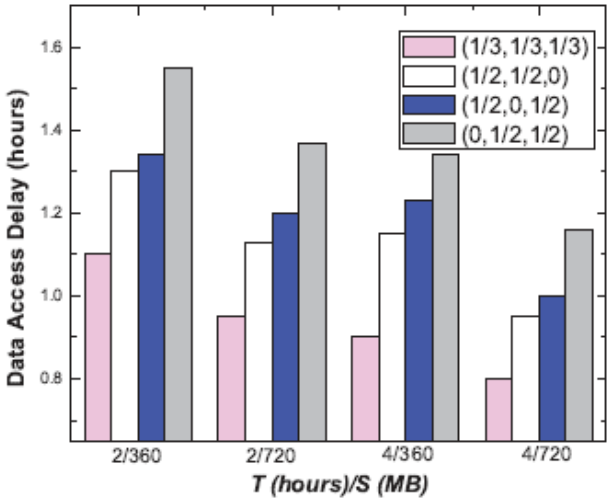
(b) Successful ratio



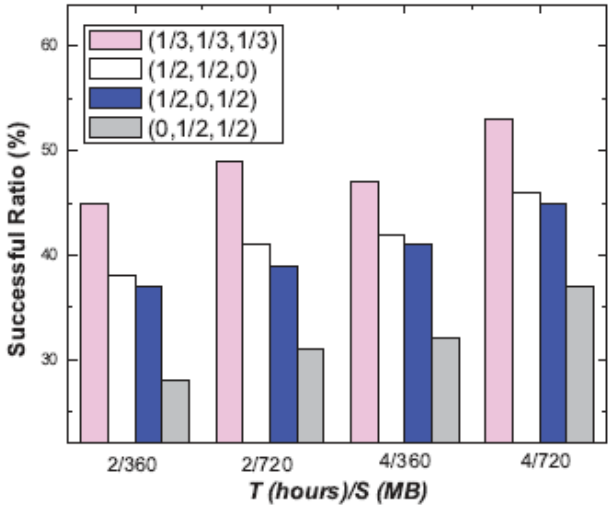
(c) Overhead

Comparison of the performance with different buffer sizes.

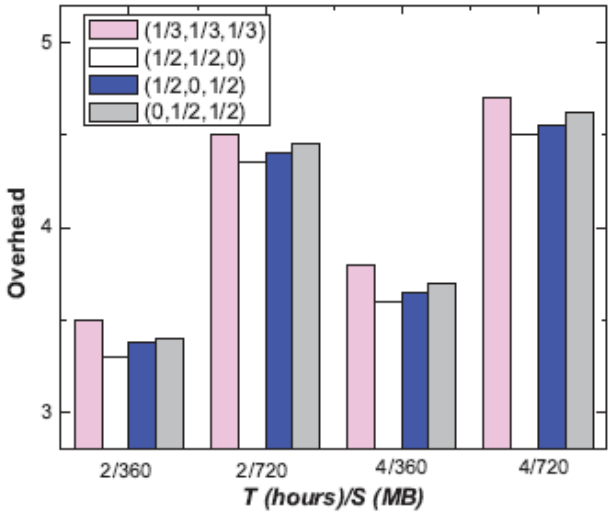
Simulation Results 3



(a) Data access delay



(b) Successful ratio



(c) Overhead

Comparison of the performance with different sizes of each key component.

Conclusion

- Mobile Opportunistic Social Networks
- Cooperative Caching
- Hierarchical Cooperative Caching
  - Self
  - Friends
  - Strangers
- Simulation Results

Thank You