On a Cooperation of Broadcast Scheduling and Base Station Caching in the Hybrid Wireless Broadcast Environment

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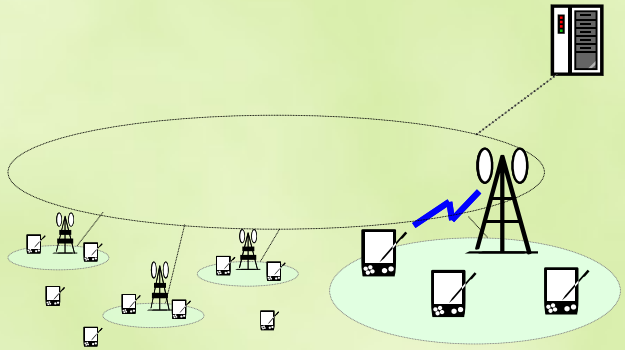
Outline

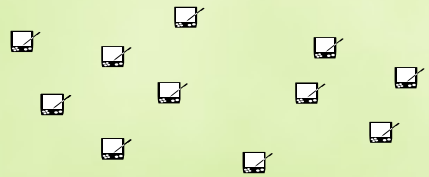
- Background
  - Hybrid Wireless Broadcast (HWB) model
- Efficient control of HWB system
  - Consider heterogeneous and homogeneous access
  - Cooperate broadcast scheduling and base station caching
- Experimental results
- Conclusion

Background

- Wireless information service
  - Hotspot service
  - 3G, 4G service

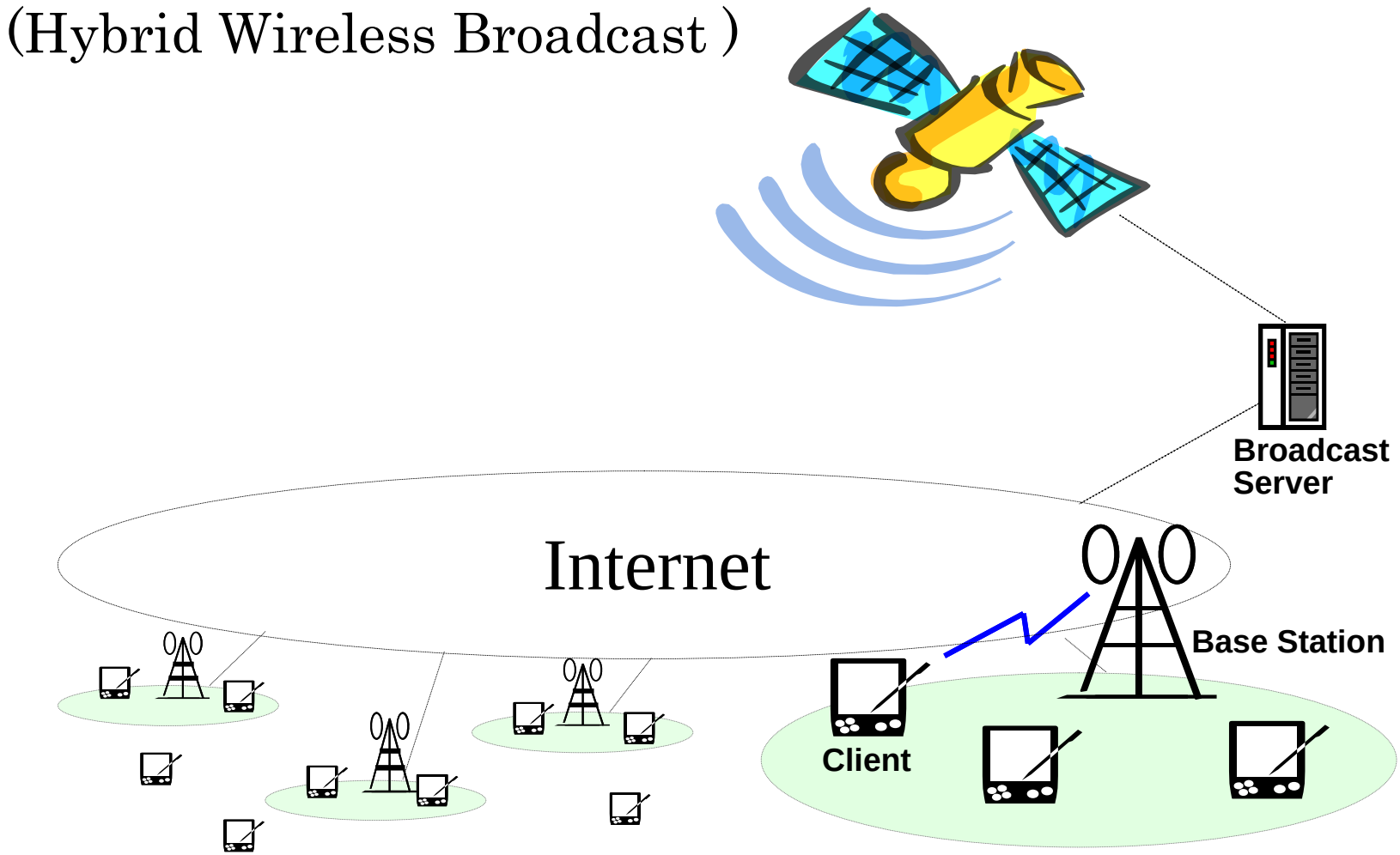


- Data broadcasting
  - Satellite data broadcast
  - Terrestrial data broadcast

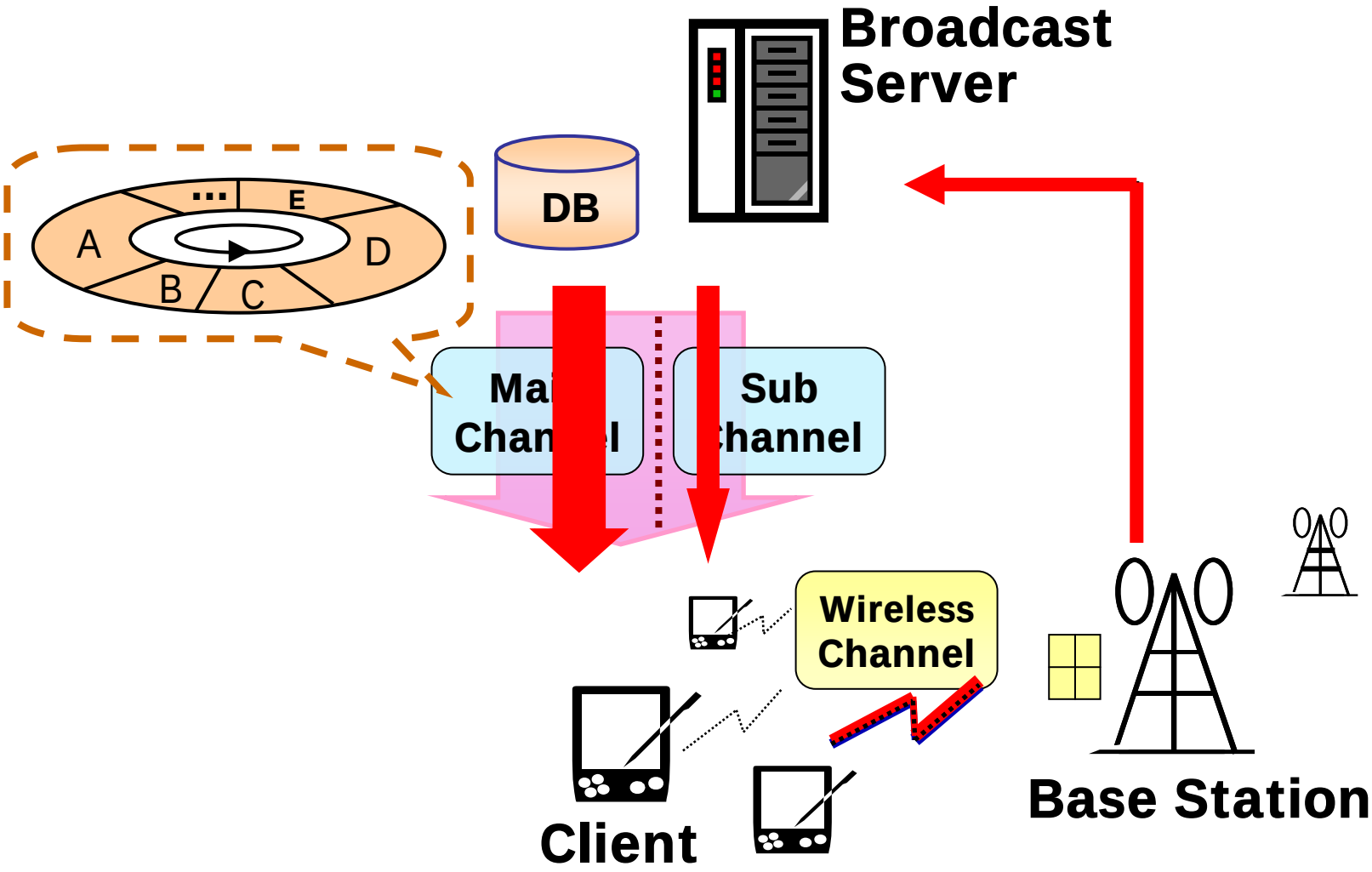


- Hybrid data delivery
  - Combination &. management

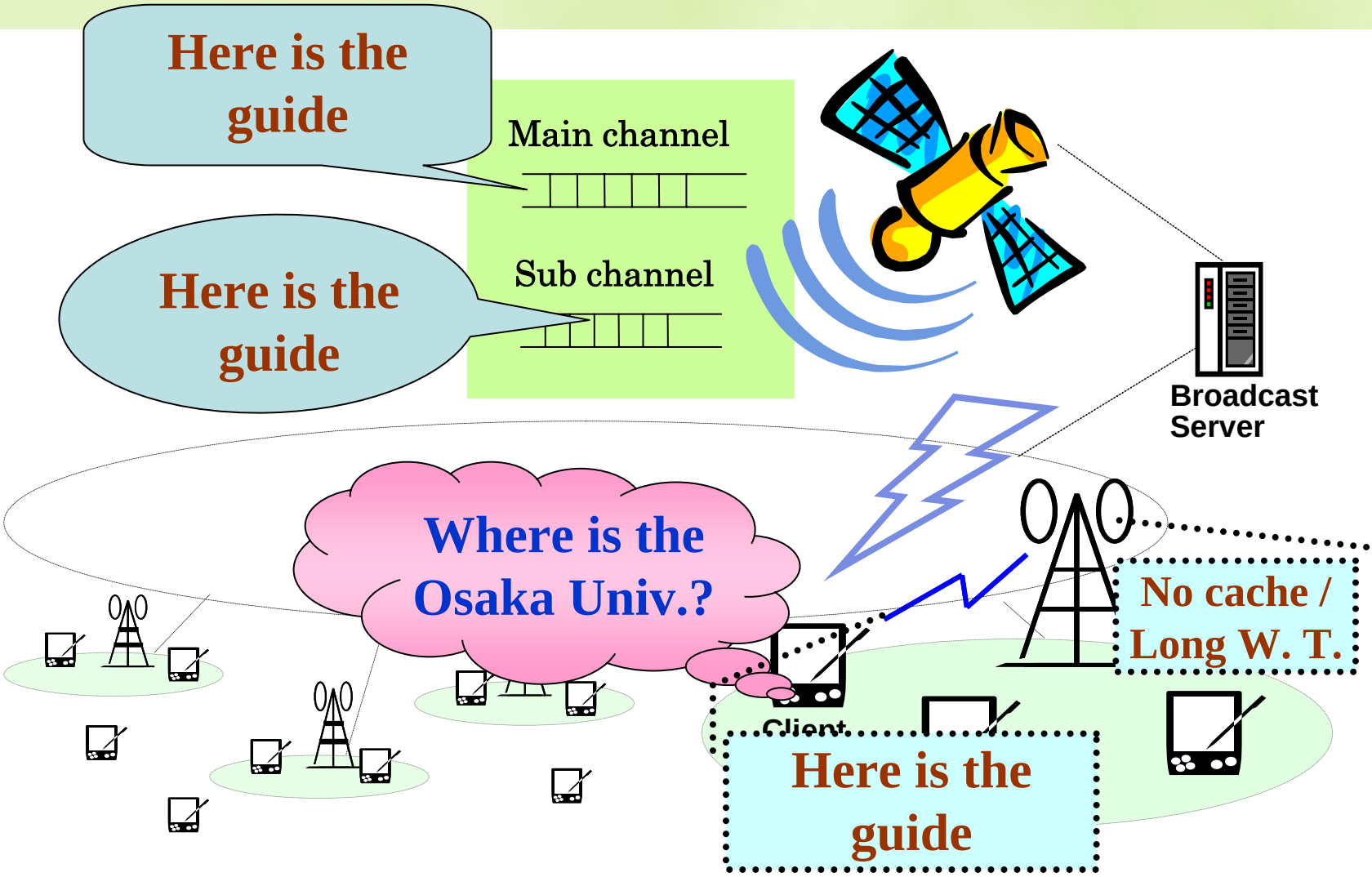
HWB Model [Cai'05] (1/2)



HWB Model [Cai'05] (2/2)



Application Example



Complementary Features（1/2）

Channel	Dissemination	Data Mode	Service Range	Band-width
Main Channel	Push-based broadcast Periodically	Schedule	Global	High
Sub Channel	Pull-based broadcast Non-periodically	On-demand	Global	Middle
Wireless Channel of BS	Pull-based point-to-point wireless communication	On-demand	Local	Low

Complementary Features（2/2）

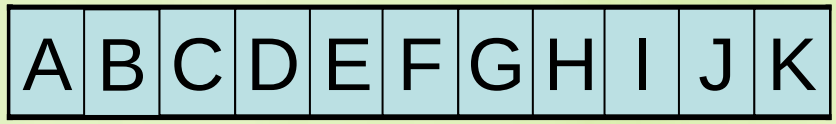
Channel	Merit	Demerit
Main Channel	◆Response not affected by the query load	◆Access latency depends on the volume of broadcast
Sub Channel	◆Meet requirements of global clients ◆On-demand response can be shared	◆Access latency increase with the number of different queries
Wireless Channel of BS	◆Meet requirements of local clients ◆Provide efficient local information	◆On-demand response cannot be shared

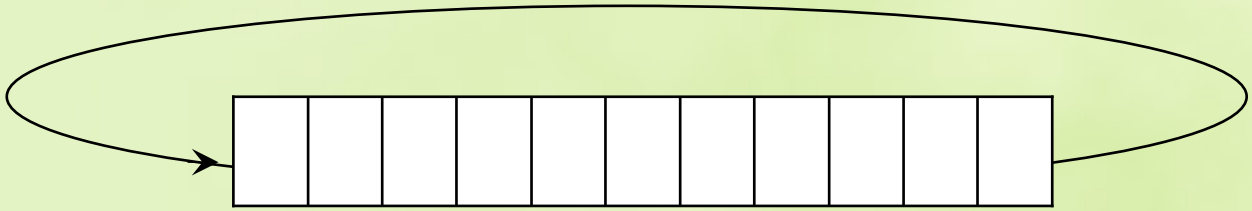
Control of HWB System

- Broadcast scheduling
  - Flat broadcast
  - Multi-Disks (MD) broadcast
- Caching of base station
  - Probability-based caching
  - PIX caching

Related techniques (1/5)

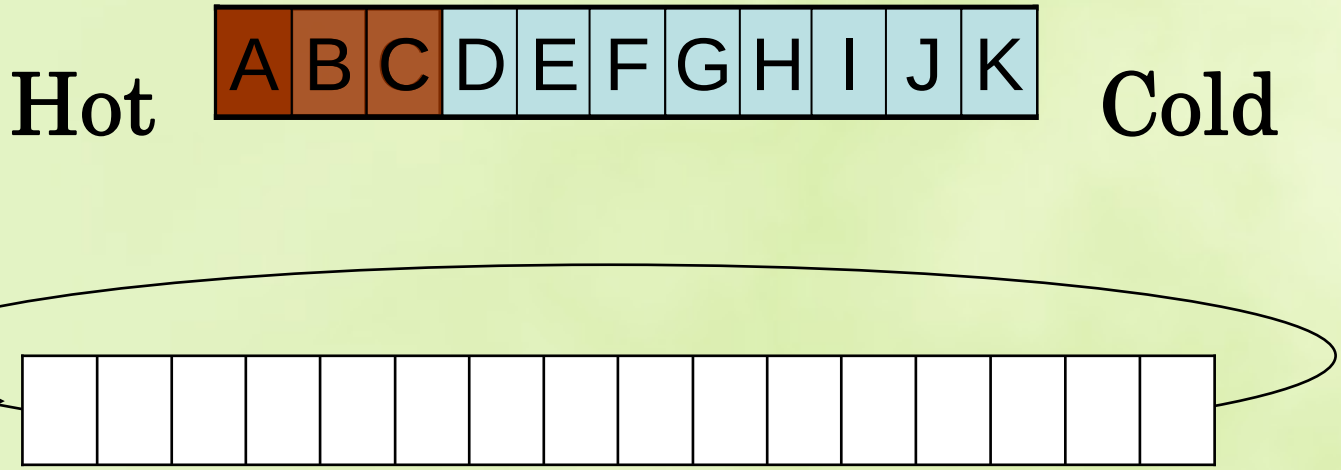
- Broadcast scheduling
  - Flat broadcast
  - Multi-Disks (MD) broadcast





Related techniques (2/5)

- Broadcast scheduling
  - Flat broadcast
  - Multi-Disks (MD) broadcast

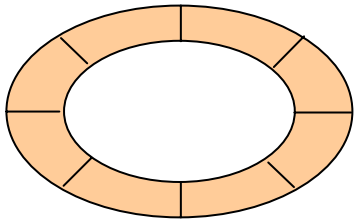


Related techniques (3/5)

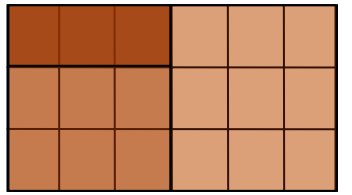
- Broadcast scheduling
  - Flat broadcast
  - Multi-Disks (MD) broadcast
- Caching
  - Probability-based caching
  - PIX caching

Related techniques (4/5)

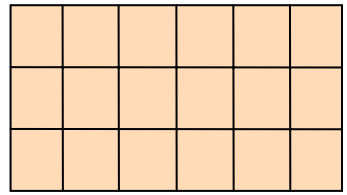
Broadcast Disks



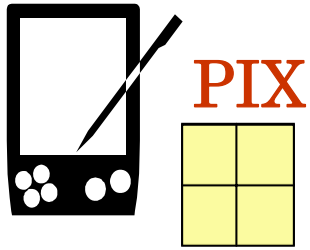
Schedule



all

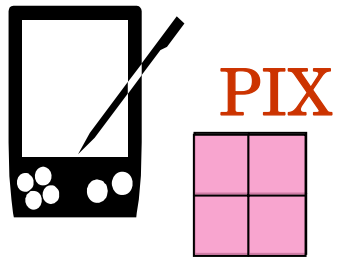


Database

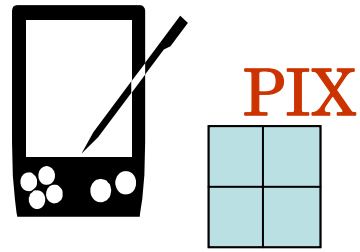


PIX

Client Cache



PIX



PIX

PIX=Access Probability / Broadcast Frequency

Related techniques (5/5)

- Cooperation of broadcast scheduling and cache management
  - Push-based broadcasting
  - Cache at client side
  - **Extended consideration**
    - Hybrid broadcasting environments?
    - Heterogeneous and homogeneous access?

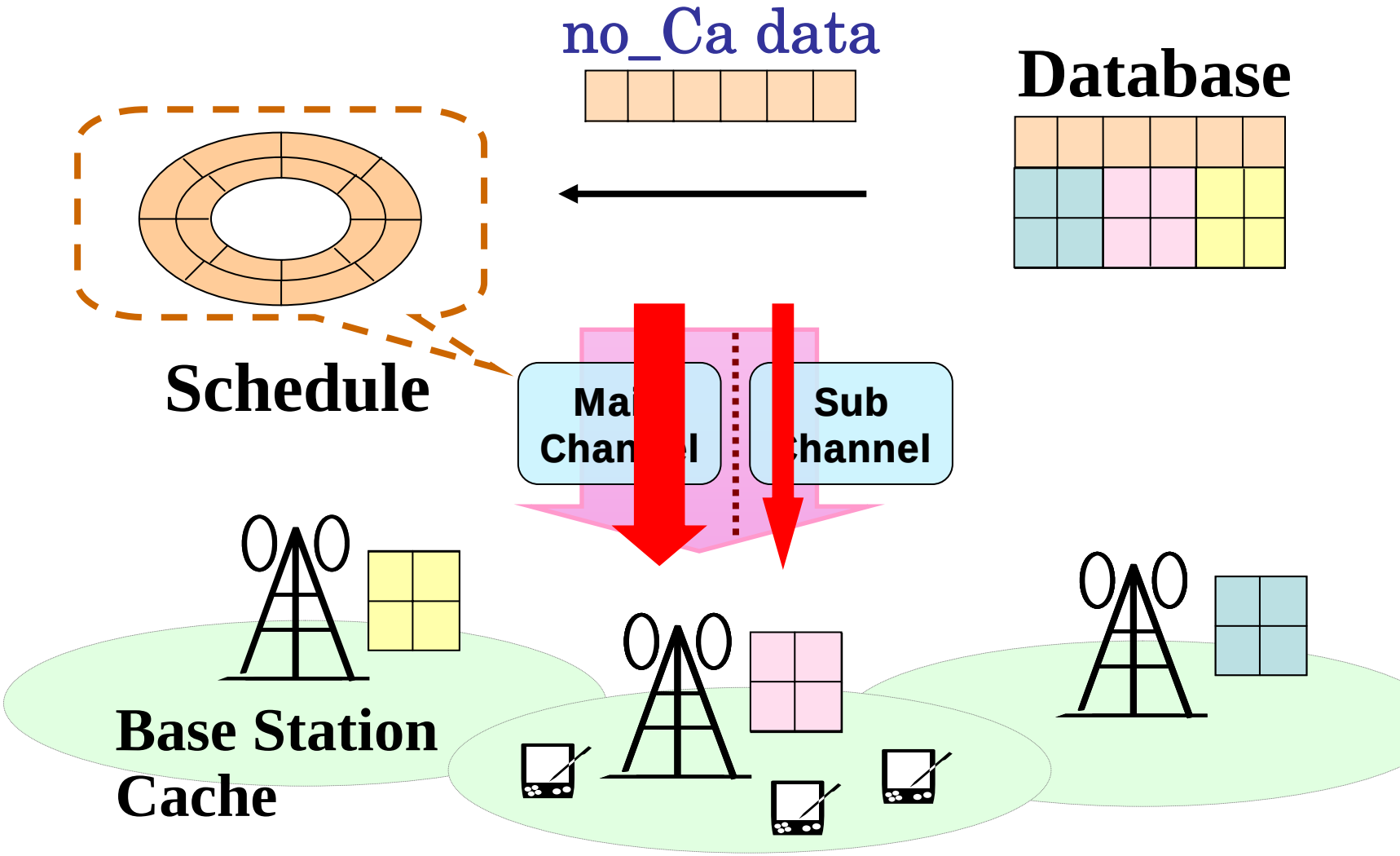
Research Purpose

- Efficient control of HWB system
  - Cooperate base station caching with broadcast scheduling
    - Take account of heterogeneous and homogeneous access of clients
    - Take advantage of the HWB data dissemination

Cooperative Control in HWB (1/3)

- Cooperation in the HWB environment
  - Base station cache
    - Consider homogeneous access of local clients
    - Increase cache hits
  - Broadcast of main channel
    - Consider heterogeneous access in different regions
    - Shorten broadcast cycle (no_Ca scheduling)
  - On demand sub channel
    - Pull the items disappeared in the main channel and without the required cache-resident

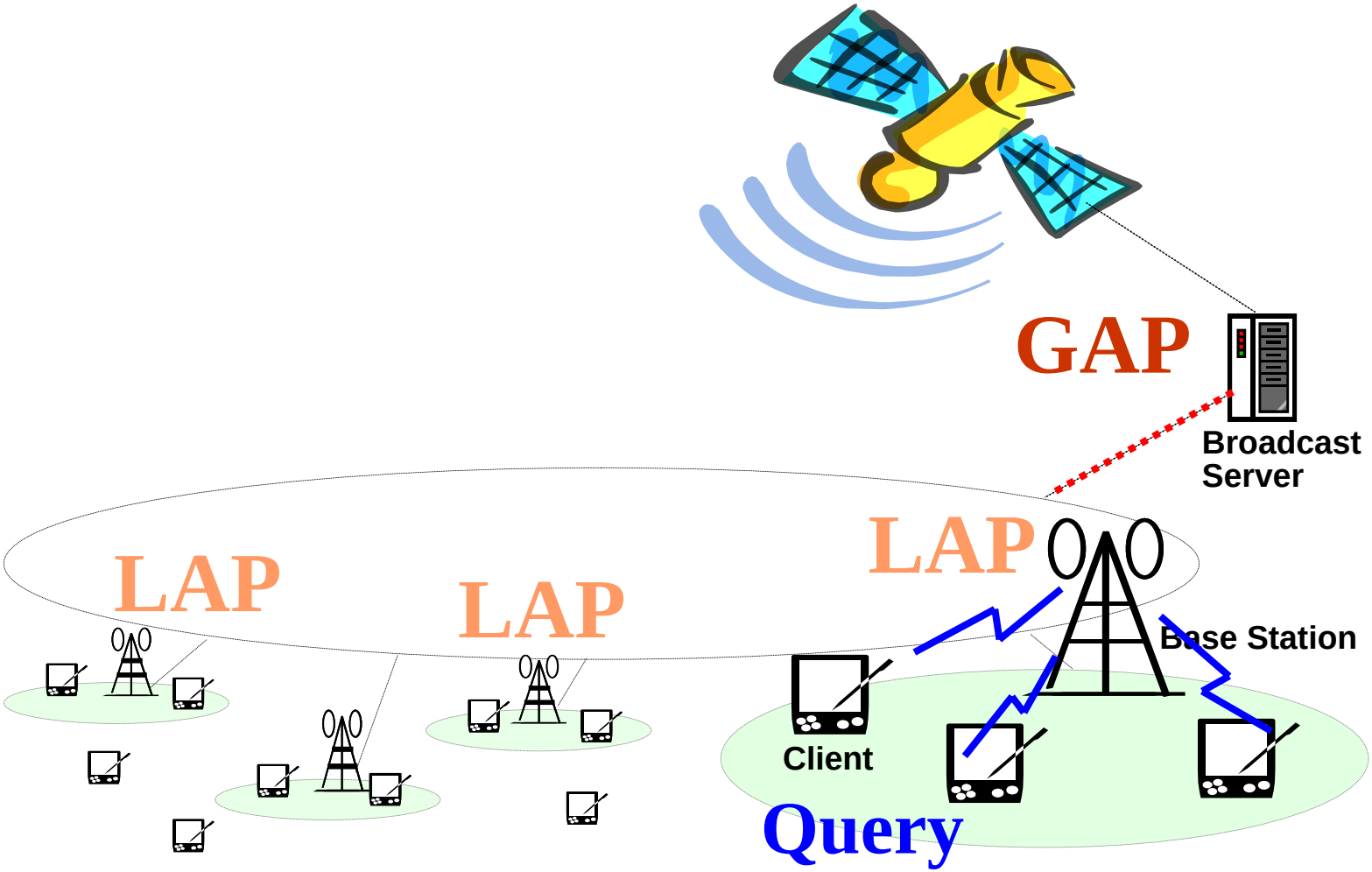
Cooperative Control in HWB (2/3)



Cooperative Control in HWB (3/3)

- Two-phase access probability
  - Local Access Probability (LAP)
    - For each base station
  - Global Access Probability (GAP)
    - For the broadcast server

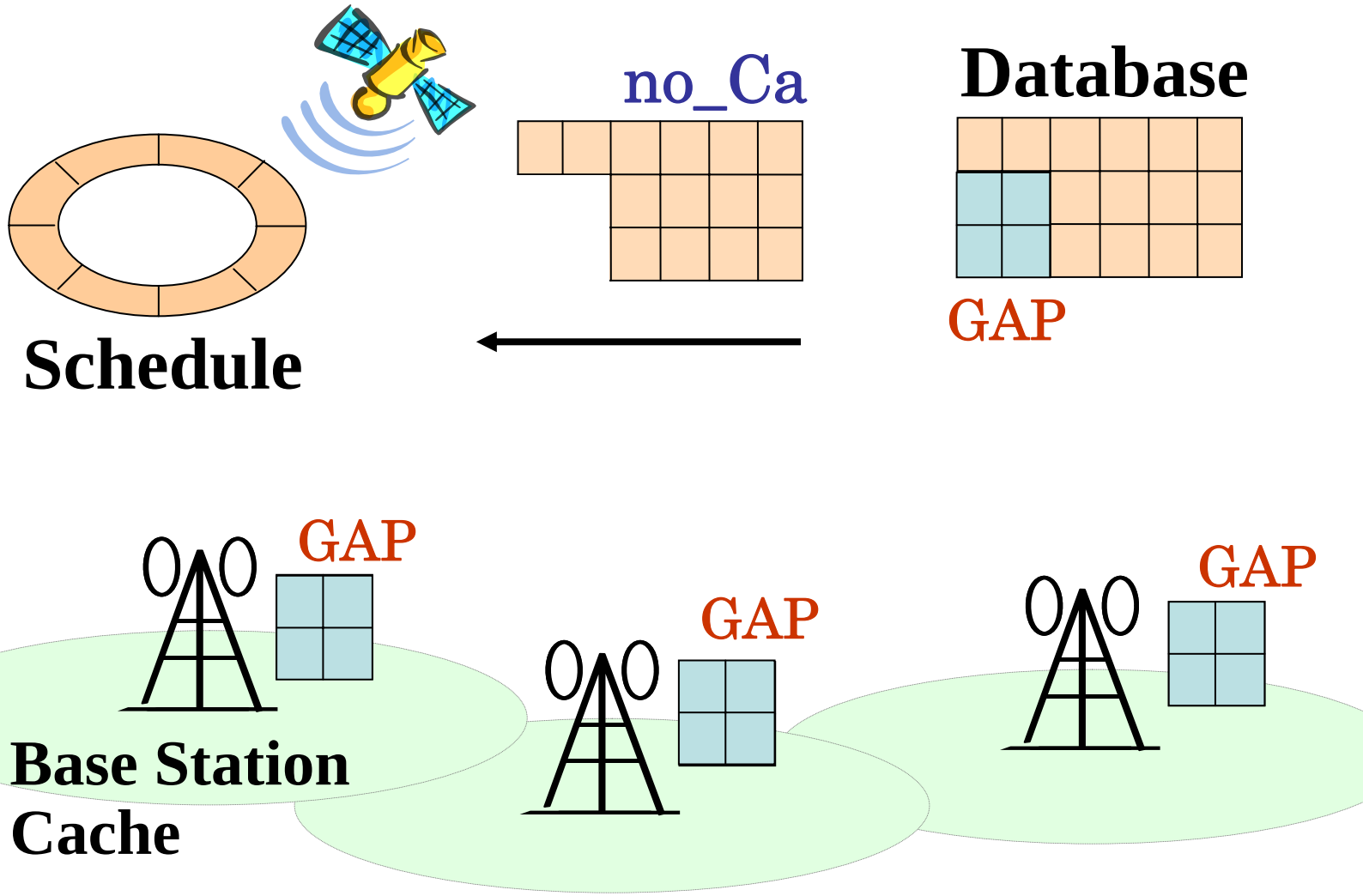
Access Probability



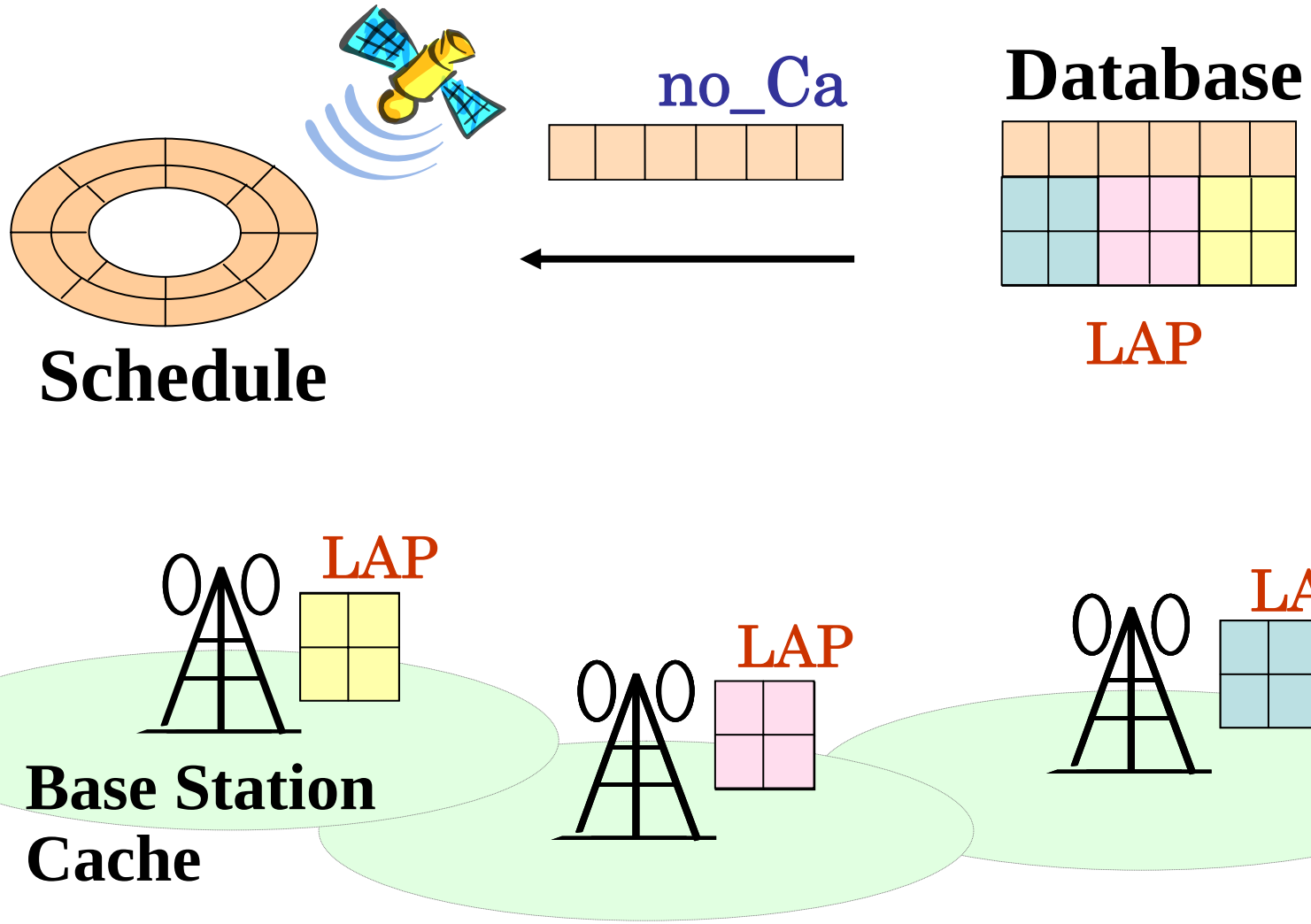
Cooperation Strategy

Scheduling / Caching	no_Ca	all
GAP	GAP-no_Ca	GAP-all
LAP	LAP-no_Ca	LAP-all
PIX	PIX-no_Ca	PIX-all

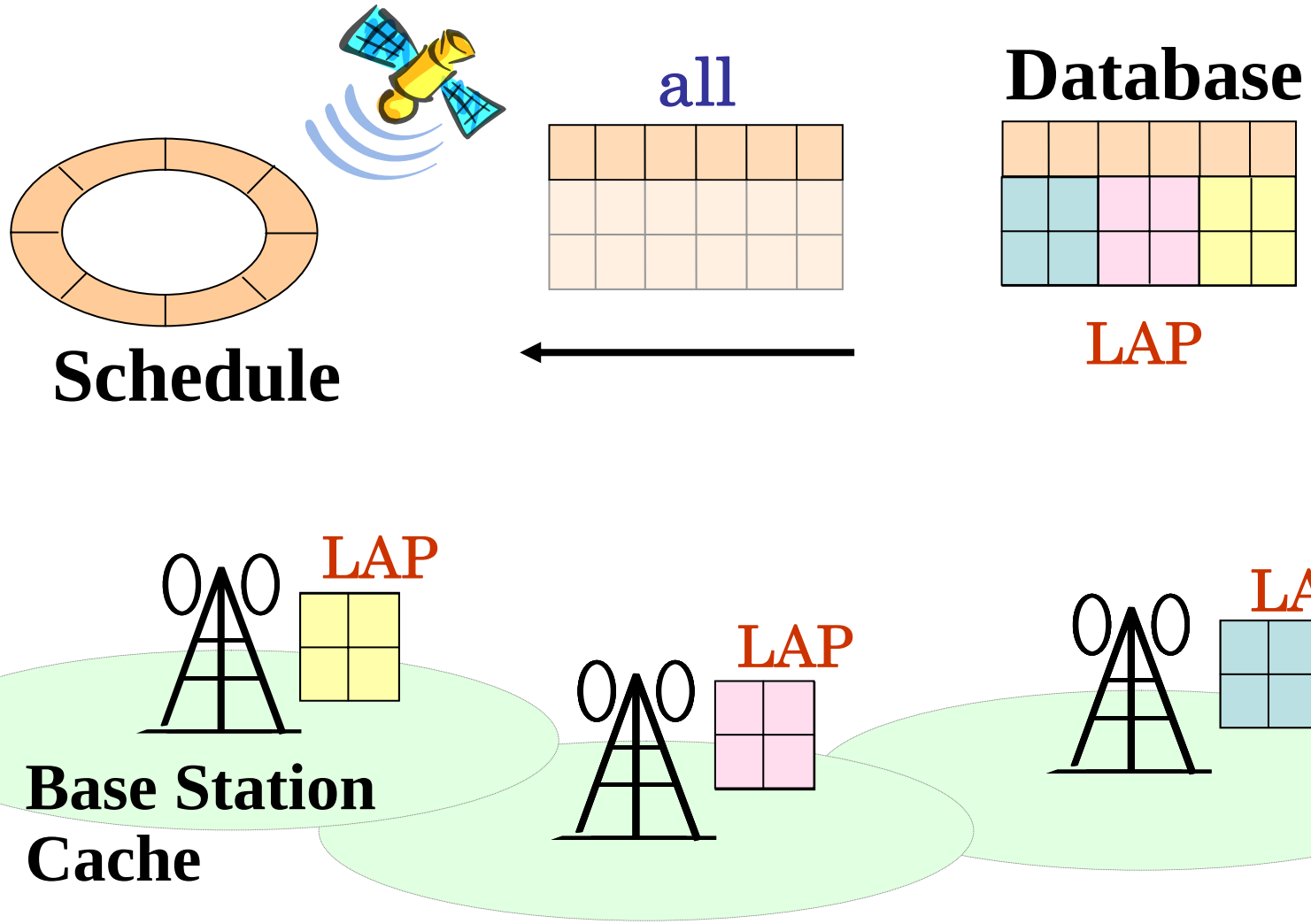
GAP - no_Ca



LAP - no_Ca



LAP - all

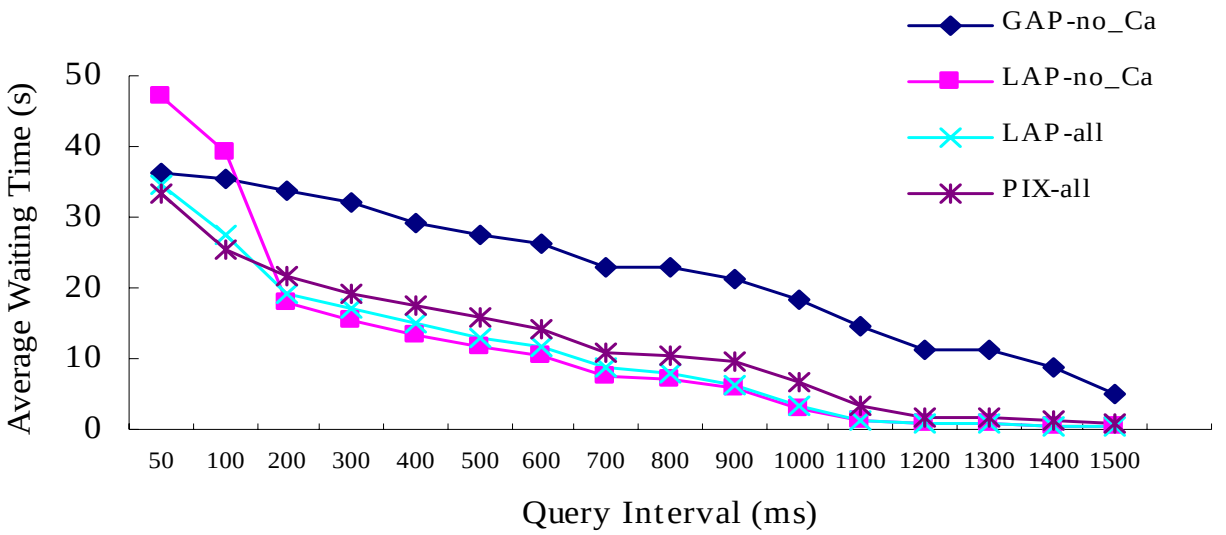


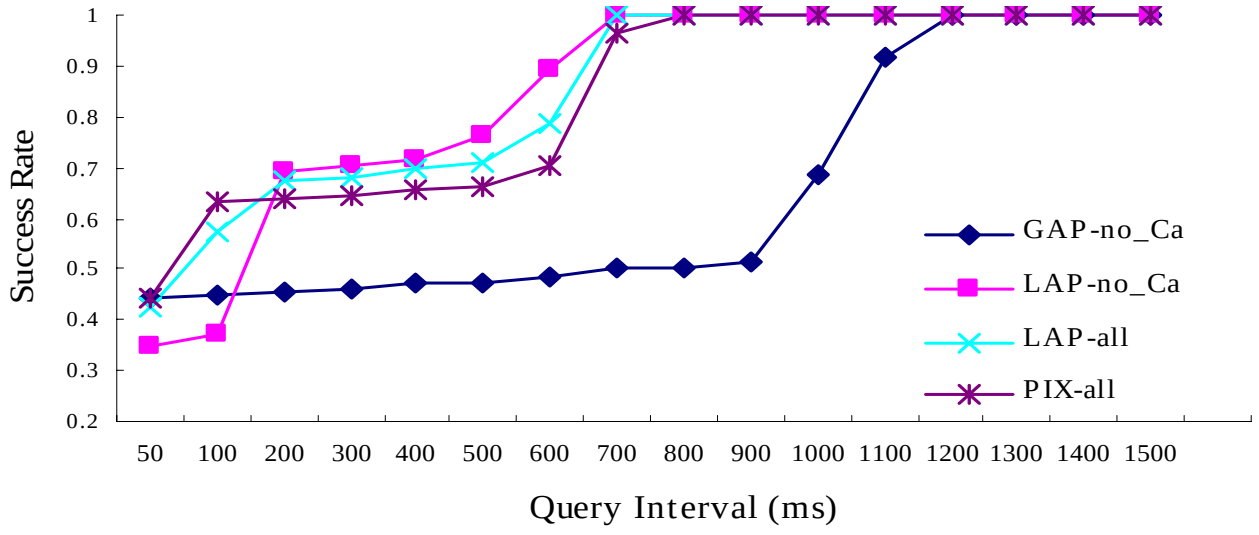
Simulation Environment

Parameters	Values
Database Size [Data Items]	10,000
Data Item Size [KB]	100
Number of Base Station (BS)	10
Cache Size of BS [Data Items]	200
Main Channel Bandwidth [Mbps]	100
Sub Channel Bandwidth [Mbps]	10
Wireless Channel Bandwidth [Mbps]	5
Number of Disks	3
Broadcast Frequency of $Disk_{1, 2, 3}$	4, 2, 1
Size of $Disk_{1, 2, 3}$ [Data Items]	500, 1000, uncertain

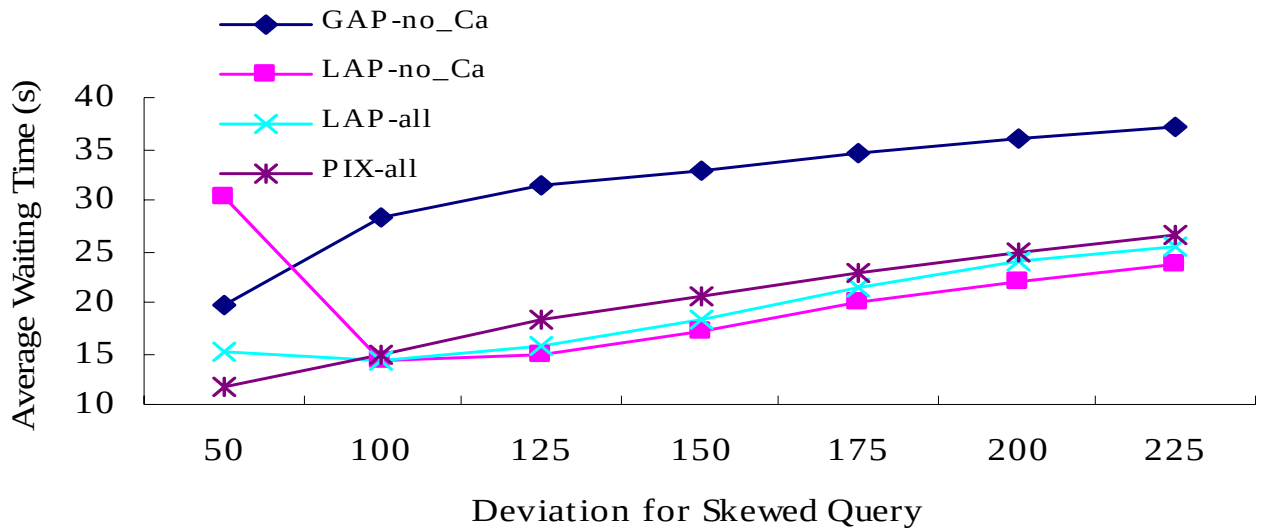
- **Average waiting time**
- **Success rate**

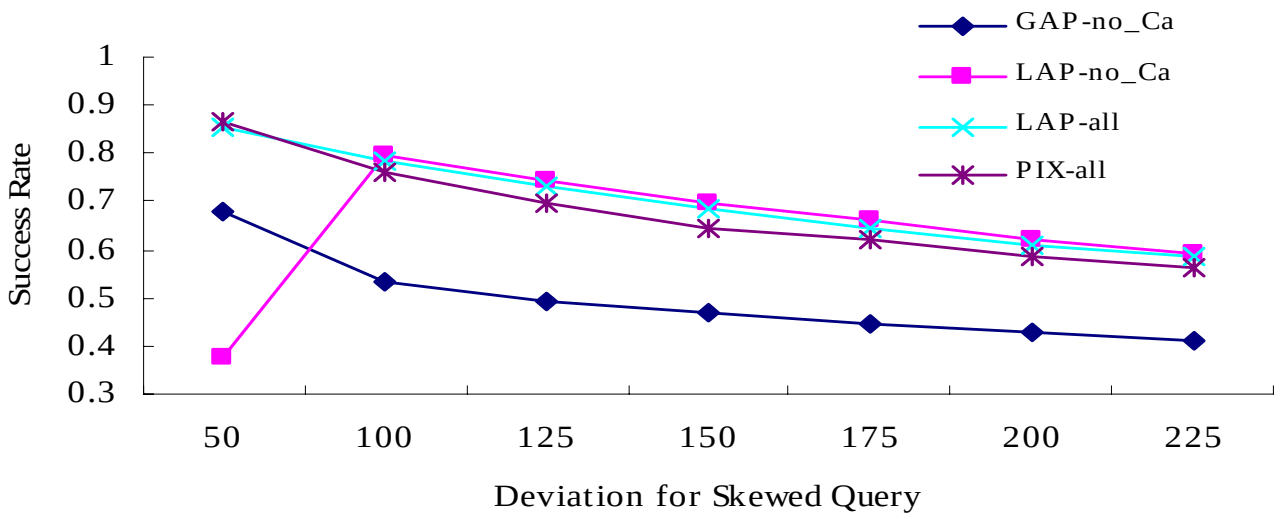
Impact of Query Frequency





Impact of Query Deviation





Summary of Evaluation

- LAP-no_Ca outperforms the others under ordinary condition
  - Shorten average waiting time
  - Heighten success rate
- Advantage
  - Effective use of the HWB data dissemination
  - Efficient cooperation of base station caching and broadcast scheduling
- Further improvement
  - Under a dynamic complicated circumstance

Conclusion

- An efficient integrated control of the HWB system
  - Cooperation of broadcast scheduling and base station caching
- A set of simulation studies
  - Performance confirmation
- Future work
  - Dynamic control of the HWB system

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Thank you for your attention!