Opportunistic Web Access via WLAN Hotspots

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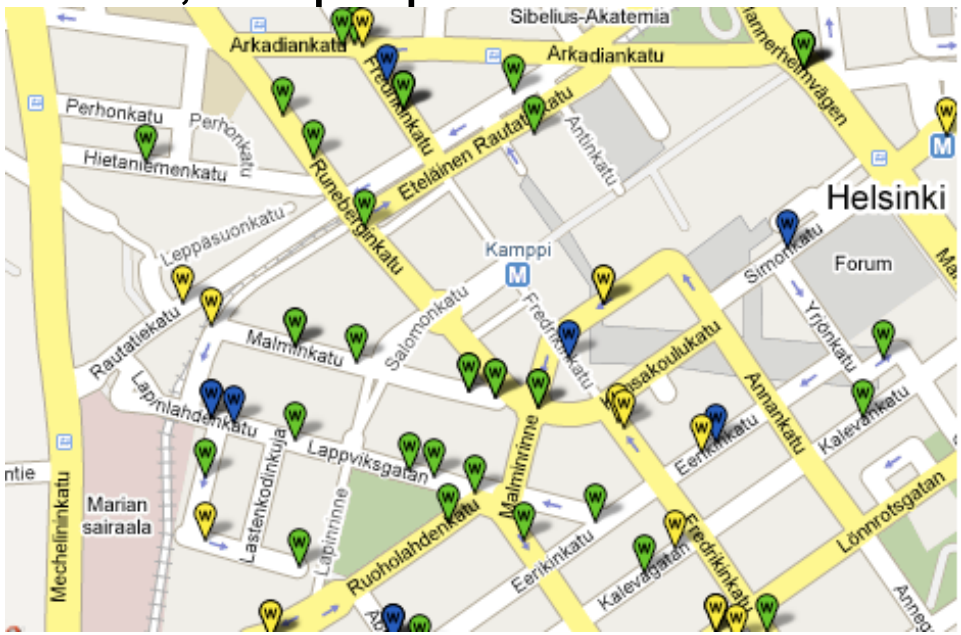
Agenda

- Introduction: Urban Pedestrians and Hotspot Access
- Opportunistic Web Access
- DTN-based Resource Retrieval
- Routing, Urban Mobility, and Geographic Awareness
- Simulation Results
- Practical Implementation
- Conclusions

Intro: Opportunities for Hotspot Access

- Mobile phones more pervasive than cellular connectivity
  - Affordable cellular connectivity in home operator network only
- BUT, there are alternatives; we propose to use:
  - WLAN Hotspots
  - Cooperation
  - DTN based model
    - bundles
    - hop-by-hop

example: Wippies hotspot locations in Helsinki



Mobile Users, Hotspots, the Internet

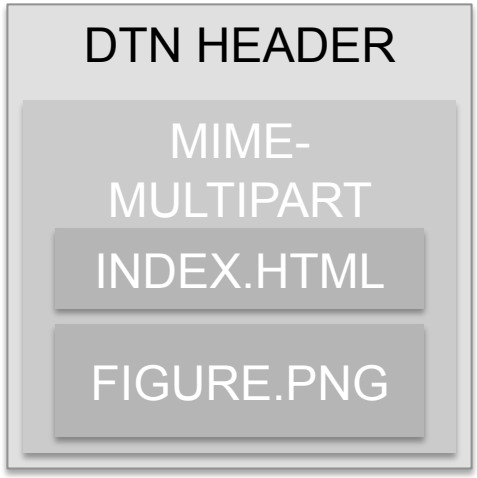
Delay-tolerance, Mobility and Cooperation

- Delay-tolerance, mobility and cooperation overcome:
  - incomplete coverage (eventually nodes move to hotspots)
  - partial access to hotspots (other nodes can relay to hotspots)
- Can benefit also cellular data services
  - helps to offload operations that are not time-critical
  - always possible to fallback to cellular data if available
- Mobile users in an urban setting
  - share a lot: content interests, routes…
  - mobility limits: streets, routes, walking speed
    - node encounters different from random way point model
- Hotspots are stationary and thus add structure

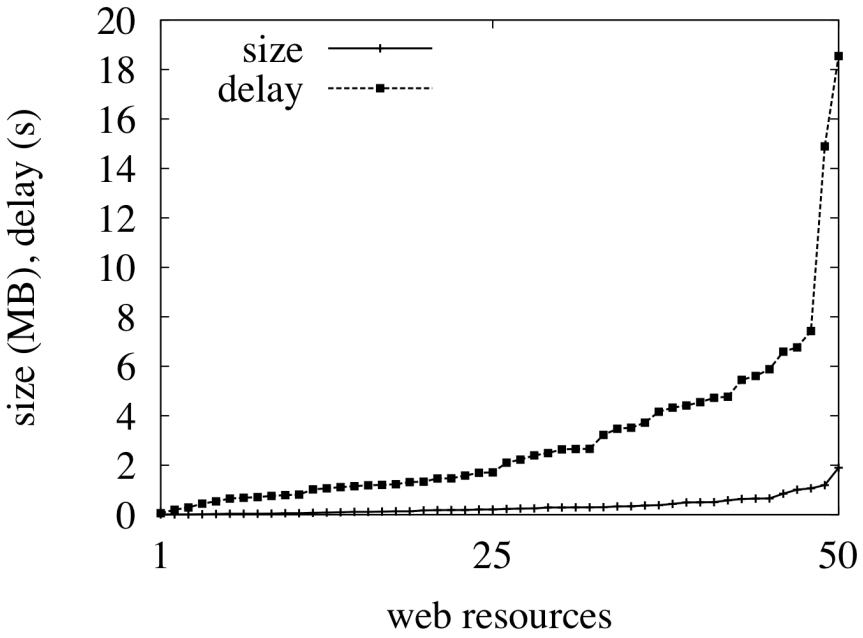
Opportunistic Web Access

- Web access over opportunistic contacts
  - WLAN and Bluetooth contacts are available and fast
  - but, multi-hop paths are not stable (MANET routing fails)
- Web traffic normally uses multiple round-trips
  - but, Web retrieval (i.e., GET-RESP) can be done in a single RTT
- Resources can be bundled in a meaningful manner
  - web page (e.g., index.html + pictures) in single bundle
  - supports caching and cooperation especially well
  - practical implementations exists (MHTML)
    - standard mechanisms available for client and servers
  - illustrated in the next slide

Example: Top 50 Web Pages (Finland)



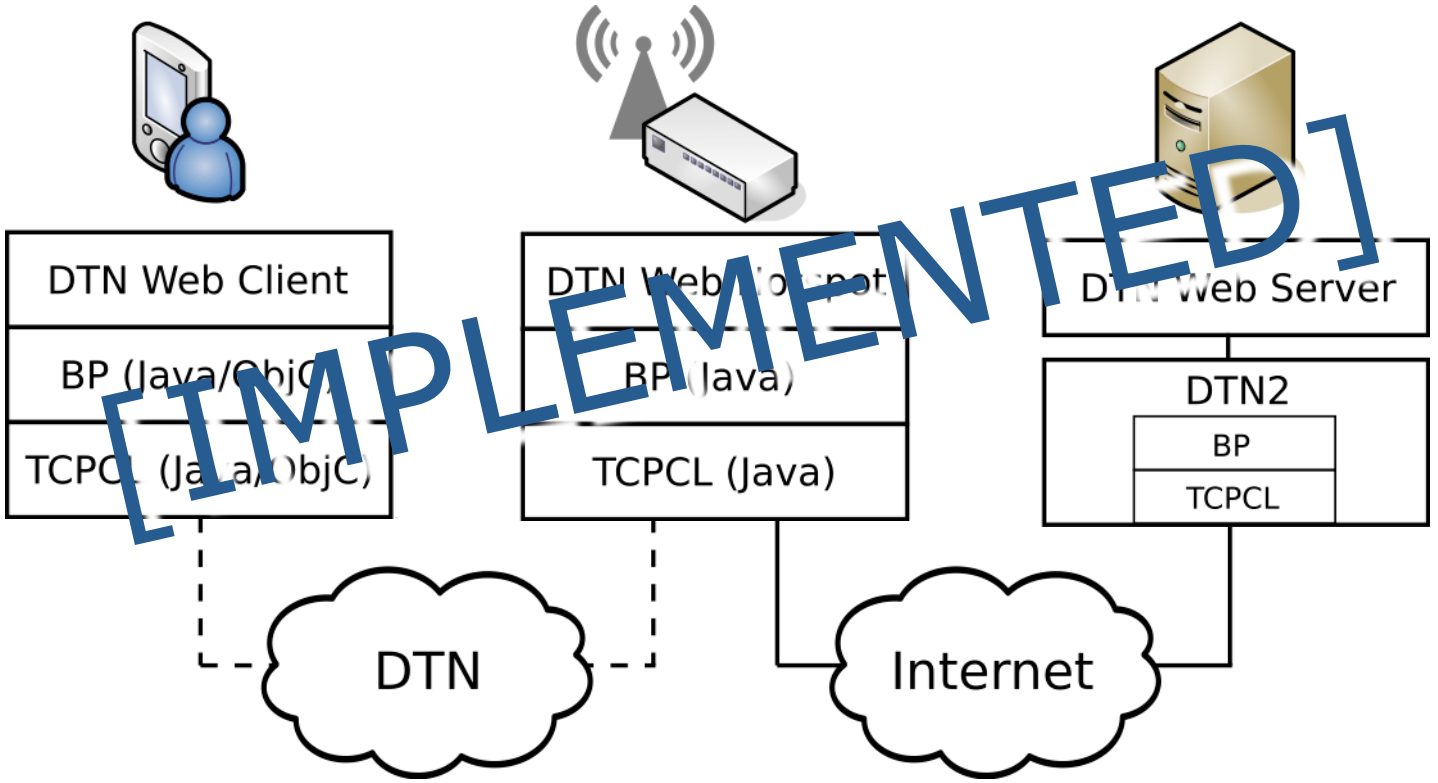
- Average Web site ~300kB
- Average retrieval delay 3s
  - also long delays occur



Routing, Urban Mobility, and Geographic Awareness

- Several routing protocols exists for DTN
  - single-copy, multi-copy, statefull, stateless
- Users on the streets are mobile
  - move according to roads and routes
  - speed fairly predictable
- Hotspots are static
  - thus provide implicit geographic location
  - good candidates for backwards routing
    - slow walking speed keeps nodes close to request location

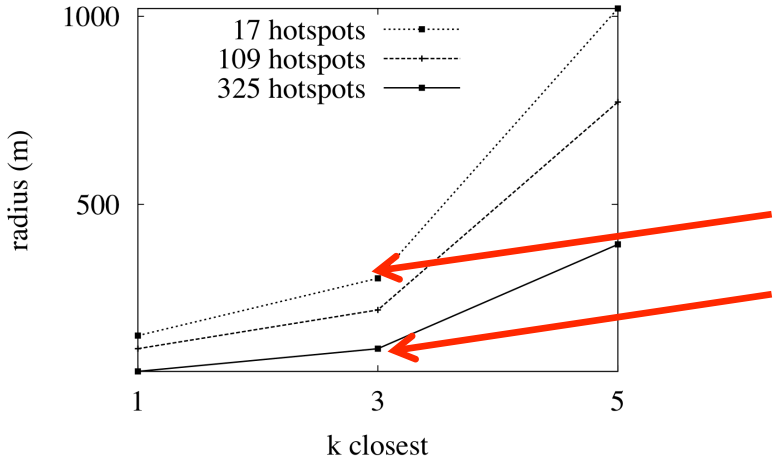
System Architecture for Opportunistic Web Access



[IMPLEMENTED]

Simulations

- ONE simulator for urban mobility and DTN routing
  - modeling 140 urban pedestrians (tourists) in downtown area
  - users retrieving Web resources with shared interests
- WLAN hotspots located at street side
  - locations according to real geographic data (Wippies)



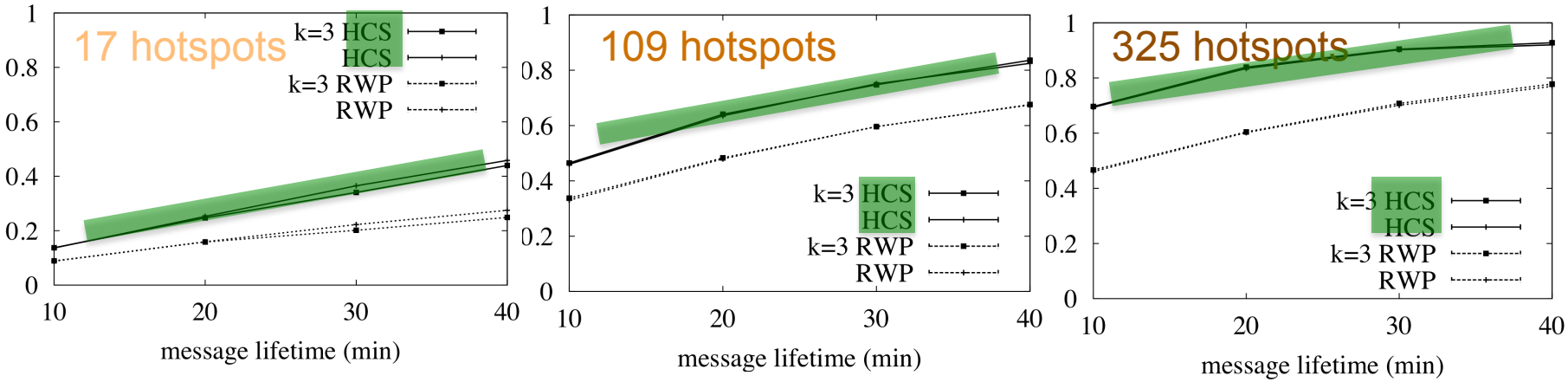
3-closest hotspots within

300 meters (17 hotspots)

110 meters (325 hotspots)

Simulation results (I)

Retrieval performance with spray-and-wait, 1 vs. 3 closest hotspots responding

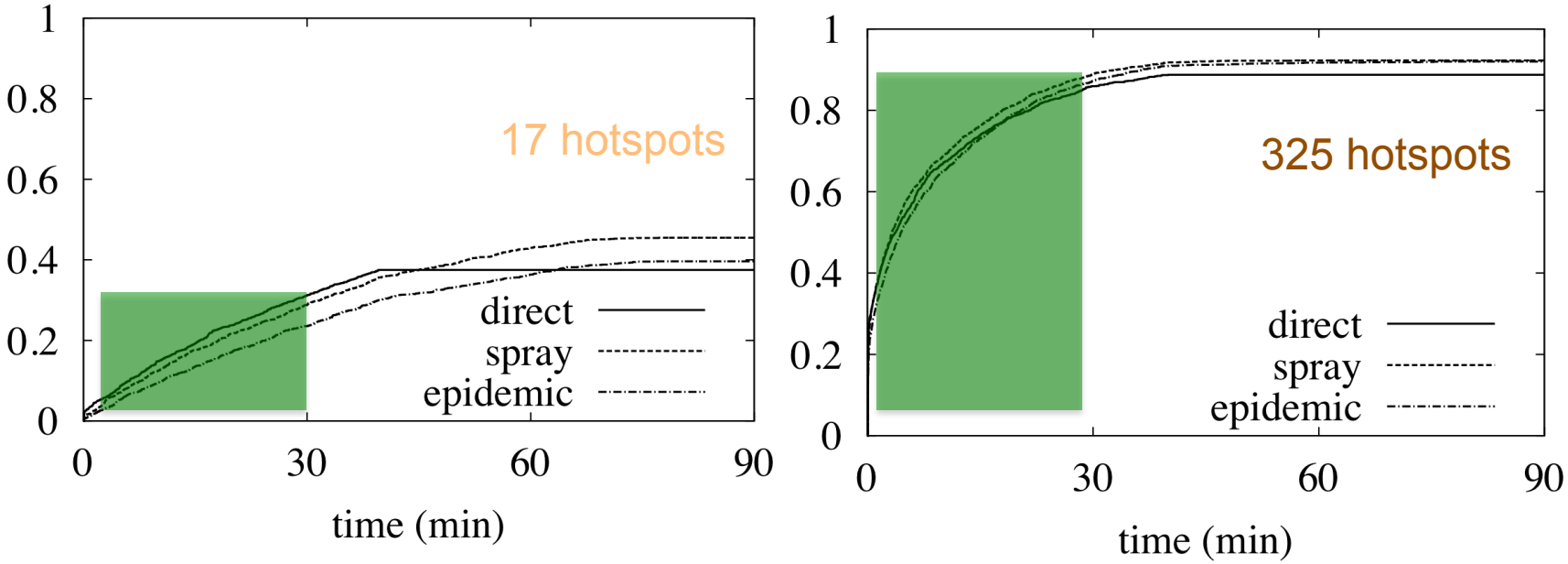


Urban mobility leads to better response rates, than random walks in same area

Closest hotspot good for routing back, spreading further not directly helpful
-> but does benefit indirect access via capable mobile nodes

Simulation Results (II)

Retrieval delay with TTL=40min, 1vs. 3 closest hotspots responding



Majority of responses arrive early

Practical Implementation

- Web browser with delay-tolerance
  - create request bundles, parse responses, display content..
  - implementations: iPhone, Android

Conclusions

- WLAN hotspots appealing for opportunistic web access
  - free Internet while travelling, offloading background tasks
  - can help in areas where other options fail
- Has been implemented and tested to work
  - validation conducted on an emulated testbed
- Gradual deployment possible
- More details in the paper, including
  - indirect access via mobile nodes only
  - caching in gateways and mobile nodes
  - validation set-up and results
  - deployment considerations