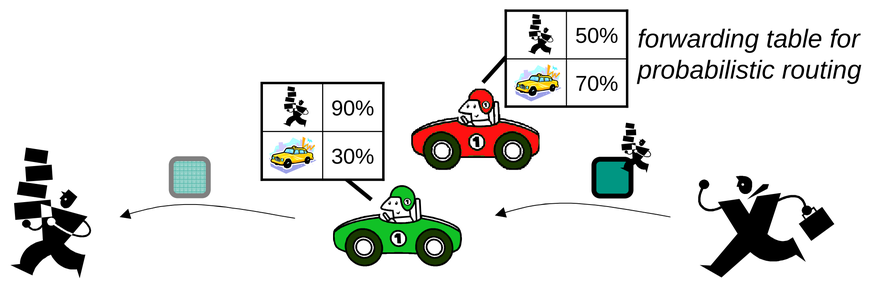
Institute of Telematics, Prof. Martina Zitterbart
Karlsruhe Institute of Technology (KIT), Germany
Christoph P. Mayer – christoph.mayer@kit.edu
ACM CoNEXT'09 PhD Student Workshop

Bloom Filters and Overlays for Routing in Pocket Switched Networks

Motivation

Pocket Switched Networks (PSN)

- **opportunistic networking** in intermittently connected human networks
- **store-and-forward communication**



Problems and solution approach

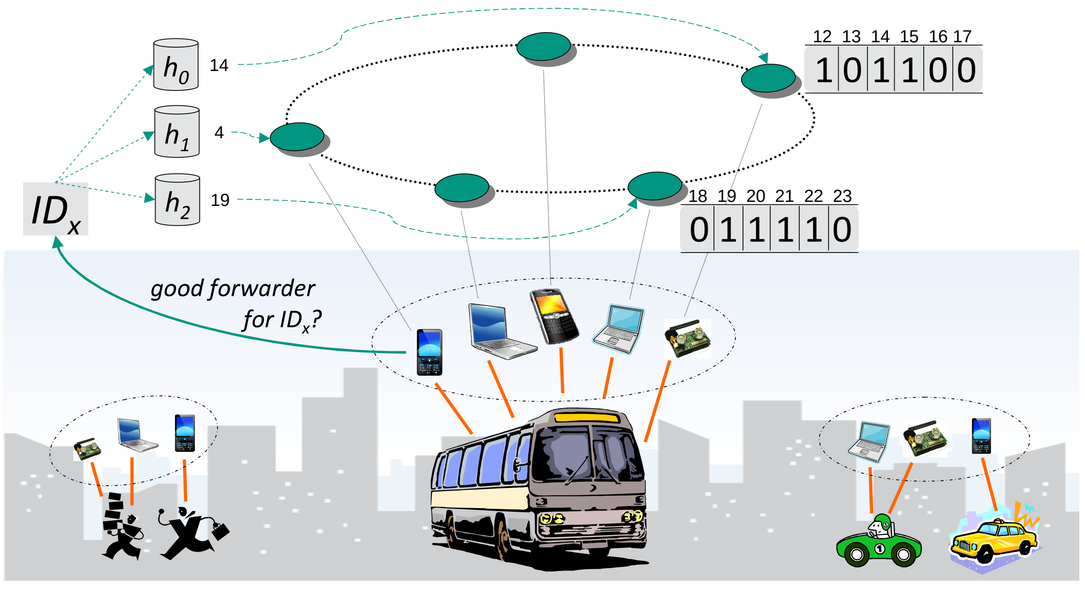
1. **large forwarding tables** in probabilistic routing → Bloom Filter extensions
2. **non-scalable handling of dense PSN** situations (e.g. bus, train, place) → overlay with DHT approach

2 Overlay-supported Forwarding

Scalable forwarding in dense PSNs

- **current schemes are not scalable,** need to check every device to find best forwarder

- **Overlays for distributed Bloom Filters**
  - Bloom Filters split and distributed in DHT
  - each device manages specific range of bits of all collaborating devices



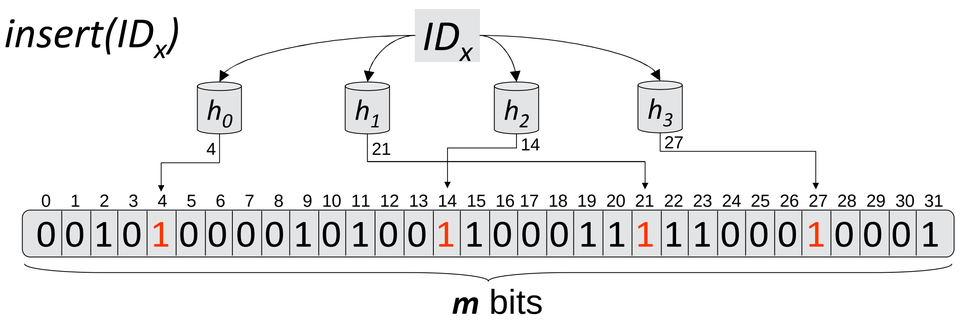
- **Scalable query DHT:** is good forwarder within collaborating devices?
  1. compute required *k* bits $h_i(ID_x)$ locally
  2. test DHT for specific bits in parallel

→ ***Scalable forwarding selection in dense PSNs with large number of devices***

1 Bloom Filter Extensions

Bloom Filter: space-efficient element storage

- lookup functionality, no false negatives, tunable false positives
- ***m*** bits, ***k*** hash functions $h_i(x): ID_x \mapsto [0,m-1]$
  - *insert*(ID_x)

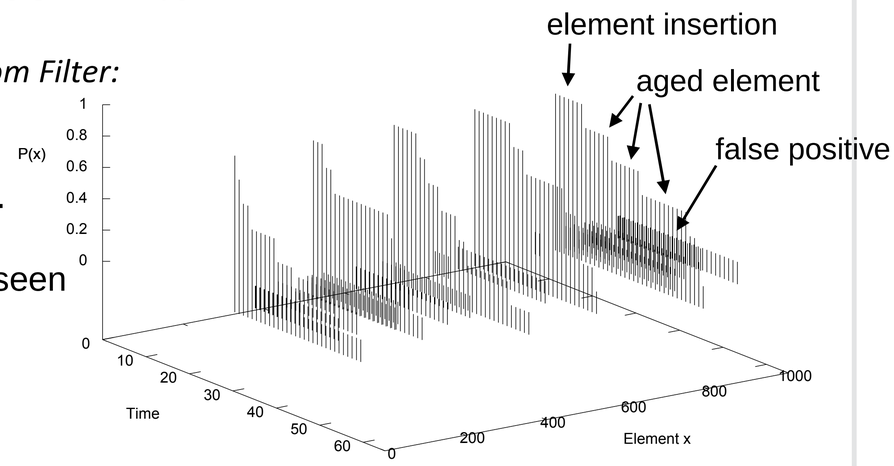


  - *lookup*(ID_x) $\mapsto$ *true* if all *k* bits are set

- **Extension – Fuzzy Bloom Filter**
  - use ***j*** hash functions out of ***k*** available, with $j/k \sim p$, granularity of *p* depends on *k*
  - false positive rate has different semantics, new error rate is induced

- **Extension – Aging Fuzzy Bloom Filters**
  - aging element probabilities over time
  - deletion of random bits ages all elements in the Bloom Filter

Aging Fuzzy Bloom Filter: Five elements inserted and aged over time. False positives arising can be seen



→ ***Space-efficient storage of forwarding tables for probabilistic forwarding***

Conclusion and Outlook

Fuzzy Bloom Filters allow for

- **space-efficient probabilistic forwarding**

and in combination with overlays and DHTs

- **scalable forwarding** in dense PSNs

Next steps

- formal analysis of Bloom Filter extensions
- simulative evaluation of overlay scheme
- implementation using the ariba library *www.ariba-underlay.org*