Simple and Scalable Handoff Prioritization in Wireless Mobile Networks

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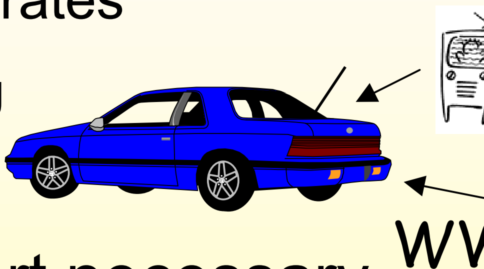
Outline

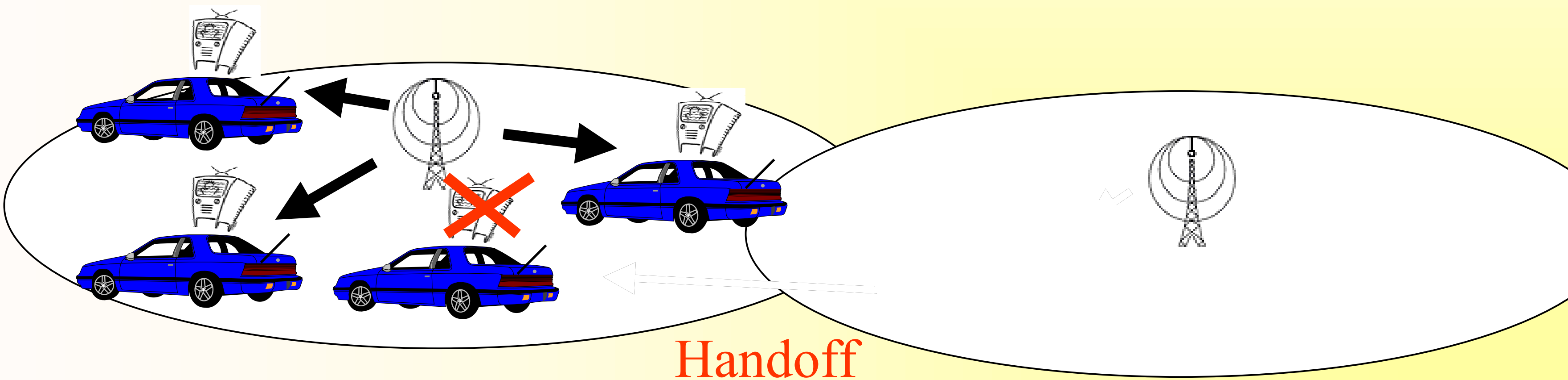
- Motivation: Quality of Service in wireless mobile networks
- Basics on handoff prioritization
- Requirements: Scalability, easy administration,...
- SiS-HoP: Simple and scalable handoff prioritization
- Simulation results

Quality of Service in IP-based Mobile Networks

- Advantages of IP-based wireless mobile networks:
  - + Support for applications with variable bit rates
    - + e.g., WWW browsing, video streaming
  - + Higher resource utilization



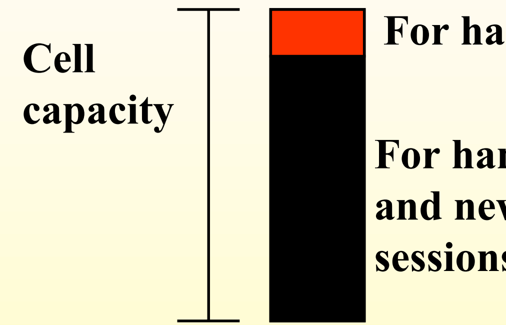
- Problem: Quality of Service (QoS) support necessary
  - Mobile telephony, streaming, games,...



Mobile-specific problem: Handoff drop

Well-known Approach: Handoff Prioritization

- Resource reservation for handoff resource requests
  - Based on mobility prediction



- Early blocking of new session request
  - Admission control

Compromise:
Less handoff drops vs. high resource utilization

- Handoff resource reservation
- Modified admission control

Requirements on Handoff Prioritization

- Robustness: *The* IP paradigma
  - Error tolerance in case of failure of a single system
  - ⇨ Decentralized approach on each base station
- Easy administration:
  - Network configuration already highly complex for provider
- Adaptivity:
  - High performance for different mobility patterns:
    - High / low mobility
    - High / low speed
    - Directional / random mobility
- Scalability: *The* Differentiated Services paradigma
  - ⇨ No per-flow state information/signaling in the network

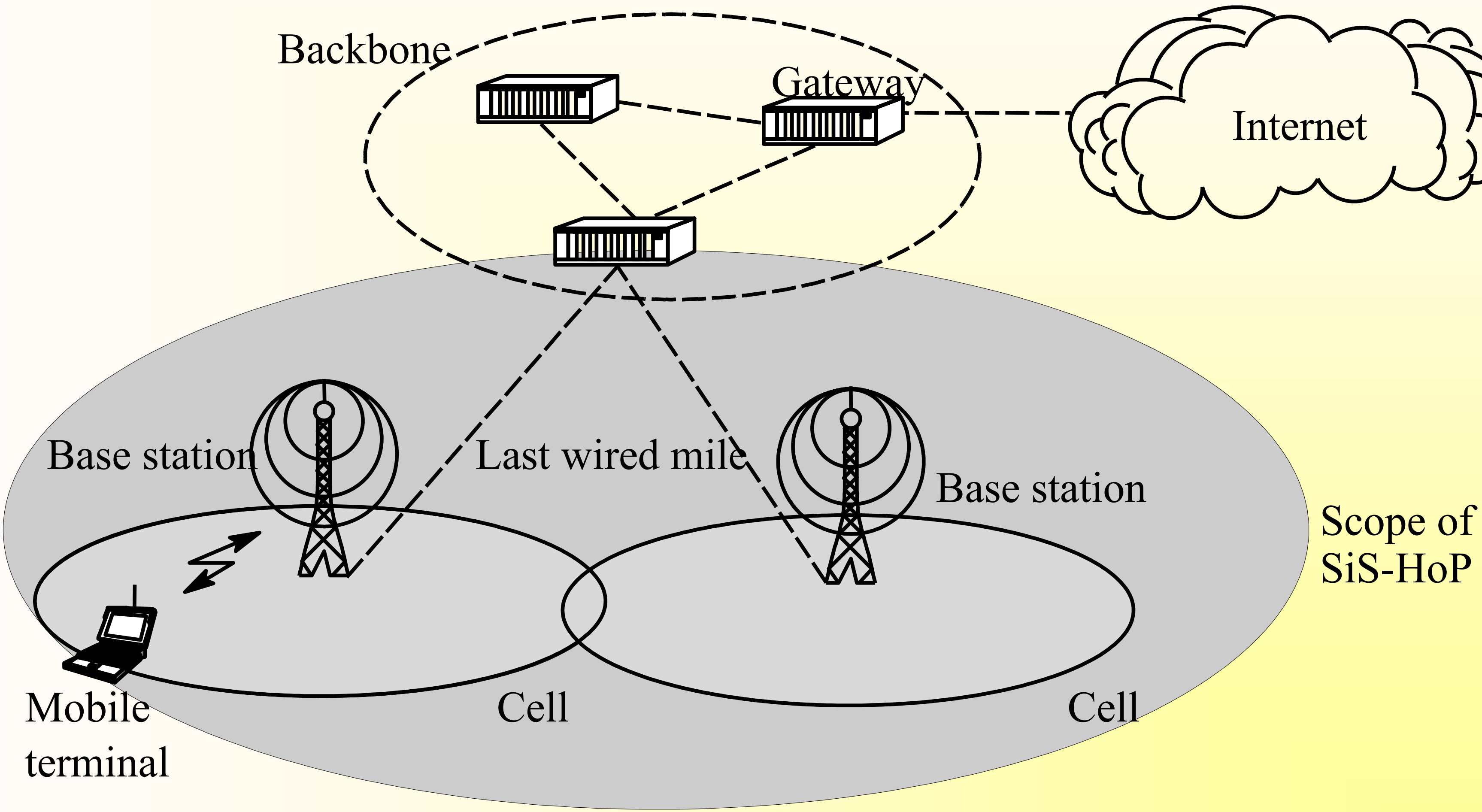
Available Approaches for Handoff Prioritization

- Analysis of > 30 existing approaches
- Problems:
  - Limited to few mobility scenarios (low mobility, large cells)
  - Low scalability because of per-flow state keeping
  - Complex configuration
  - Errors in evaluating the approaches

➩ No approach fulfills requirements sufficiently

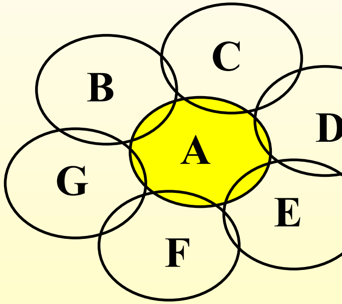
SiS-HoP: Simple and Scalable Handoff Prioritizati

- Focus on the most probable bottleneck links



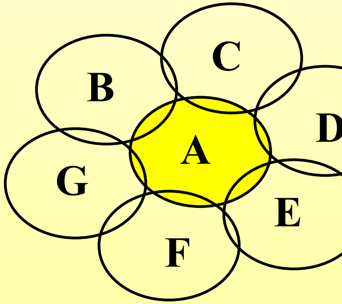
SiS-HoP: Mobility Prediction

- Aggregated prediction per cell
  - Variant 1: Based on destination cell
  - Variant 2: Normalized version of variant 1
- History cache with limited size
  - On each base station
- Example for cell A, variant 1:
  - 5 handoff to B, 3 to C, 1 to D, 3 to E, 0 to F, 5 to G, 3 session terminations:
    - Sum: 20 entries in history cache
  - Handoff probabilities:
    - 25%➜B, 15%➜C, 5%➜D, 15%➜E, 0%➜F, 25%➜G
    - Sum: < 100% because of session terminations



SiS-HoP: Handoff Resource Reservation

- Aggregated resource reservation in neighboring cells
  - Considering the handoff probabilities
  - Considering the current resource utilization
- Signaling between neighboring cells
  - Periodical
- Example (cont.):
  - Handoff probability A→B: 25%
  - ⇨ Cell A reserves 25% of currently utilized resources in cell B

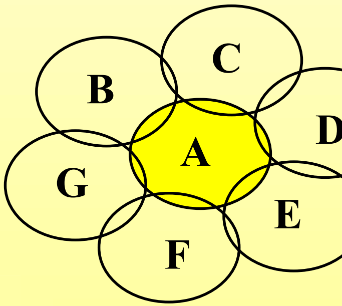


SiS-HoP: Admission Control

- Resource request from new session admitted only:
  - If resource available in local cell
  - If weighted amount of resources available in neighboring cel
  - Weights: handoff probabilities

- Periodical signaling: Resource utilization

- Example (cont.):
  - Admitting new session request only:
    - if requested resources available in cell A
    - if 25% of resource request available in cell B



SiS-HoP: Design Parameter CUR

- SiS-HoP: Conservative Approach
  - + Low handoff drop probability
  - - Low resource utilization because of high handoff reservation

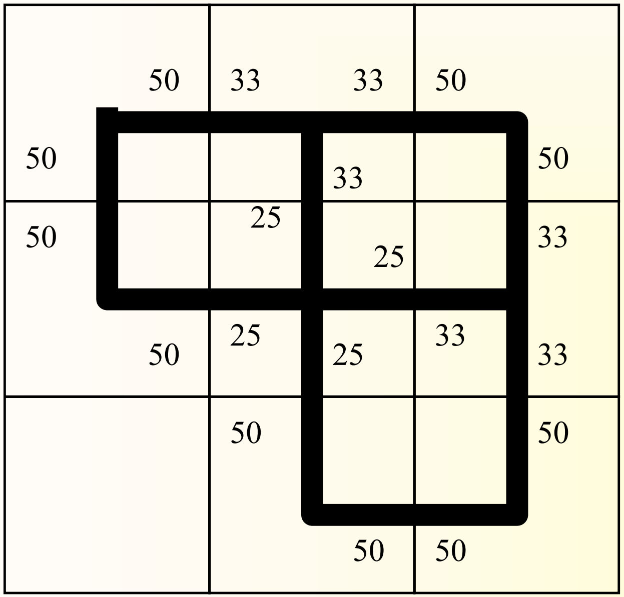
- Improvement: Controlled Under-Reservation (CUR)
  - Reduction of reservation to <CUR>%
  - Similar to reservations in airline reservation systems
  - Assumption: handoff reservation not completed used

⇨ Enhancing resource utilization

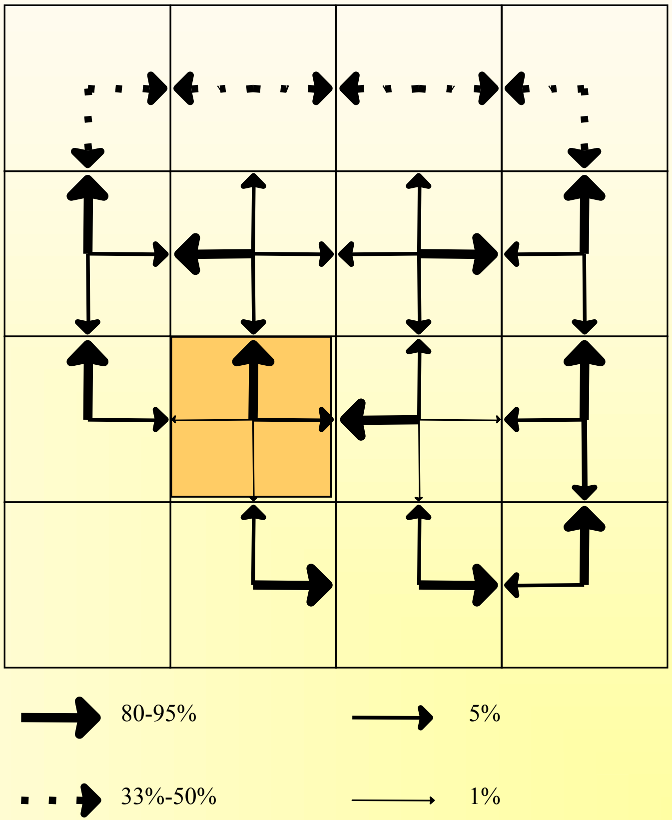
⇨ but: Handoff drop probability may increase!

Simulation SiS-HoP: Scenarios

Random mobility



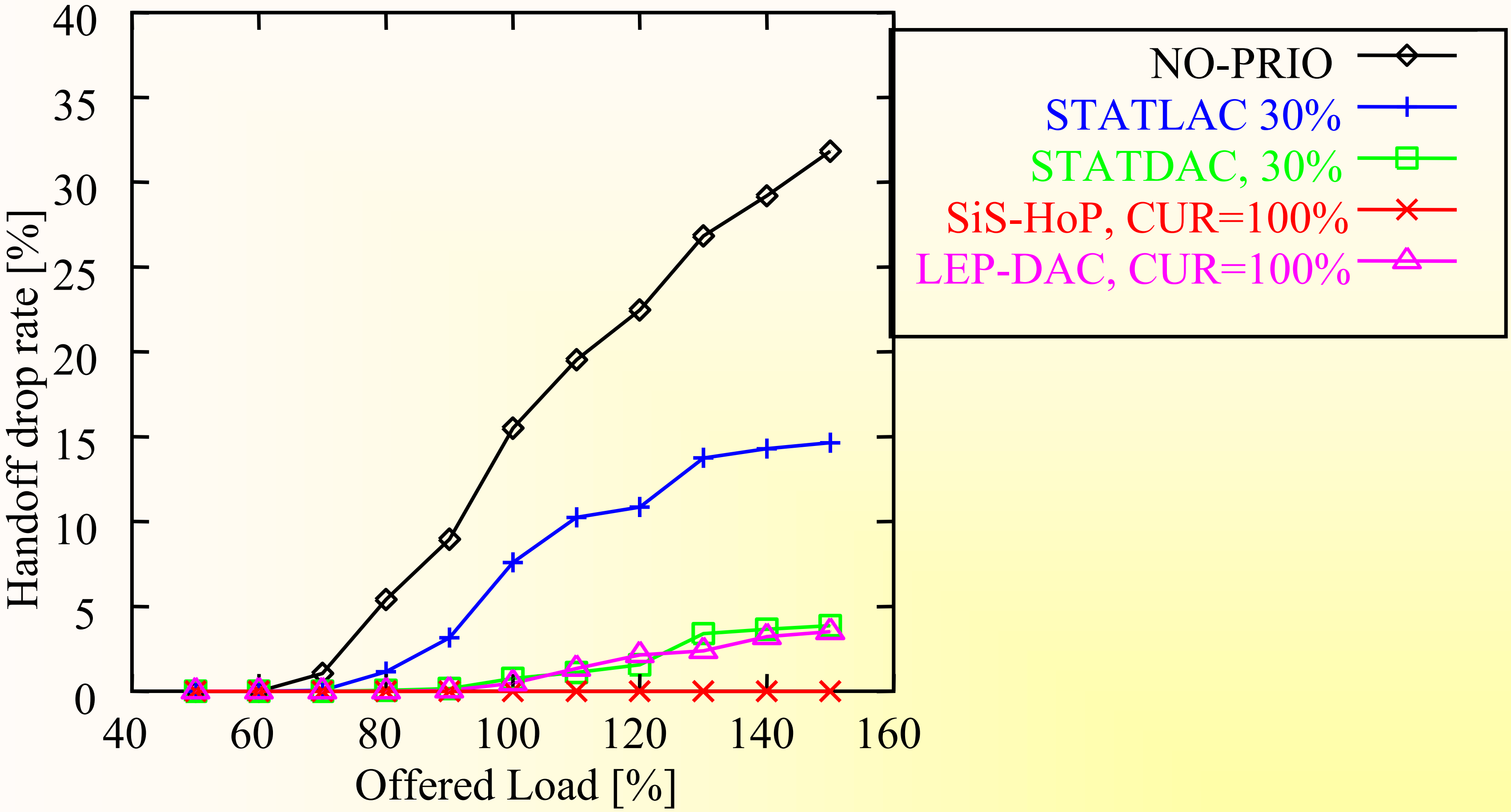
Directional mobility



Overview: Approaches for Comparison

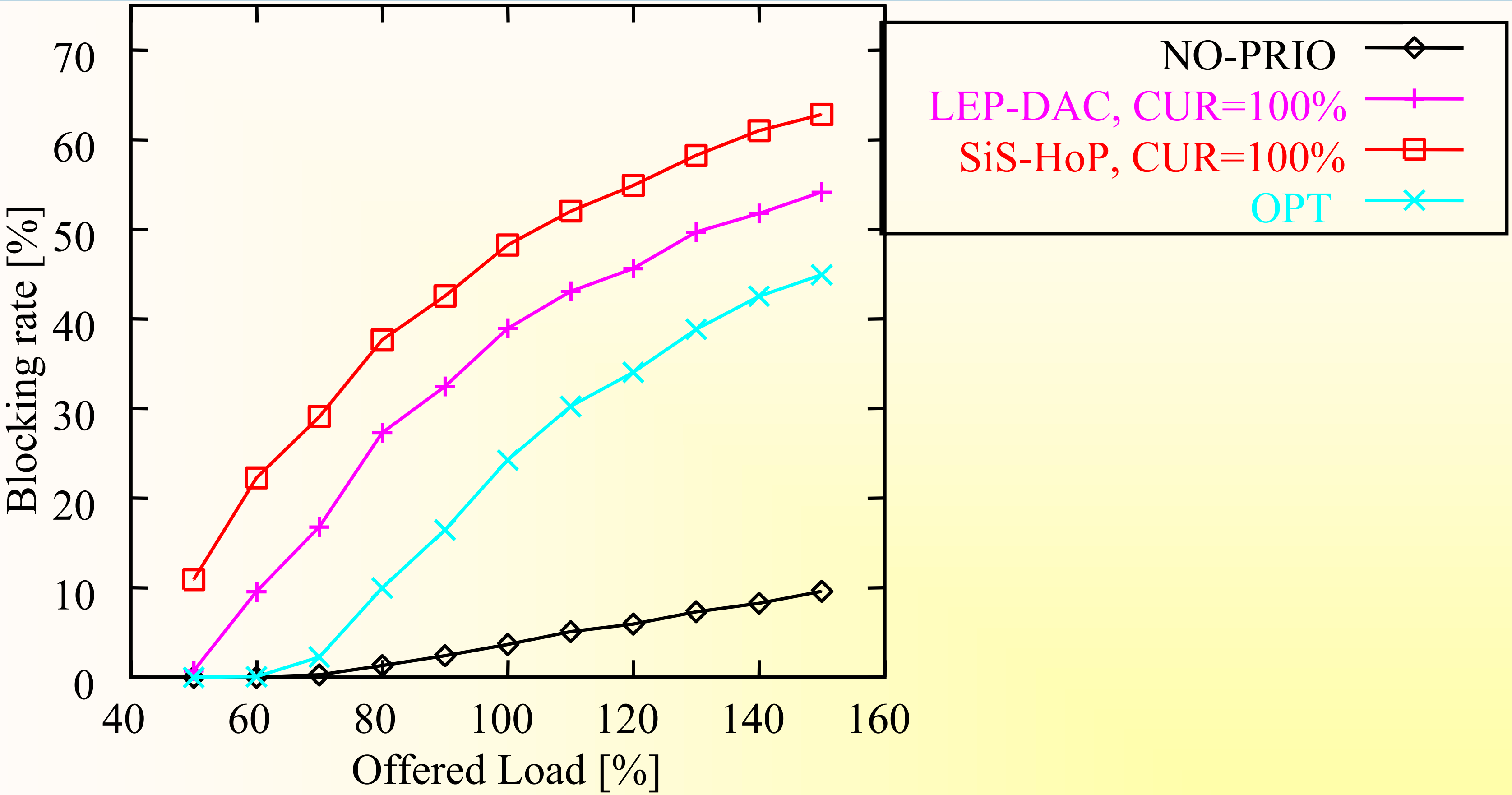
Approach	Handoff resource reservation	Admission control
NOPRIO	none	local
STATLAC	static	local
STATDAC	static	distributed (neighb. cells)
LEPDAC	load-dependent	distributed (neighb. cells)
OPT	optimal	distributed (all cells)

Simulation Results: SiS-HoP: Directional Mobility



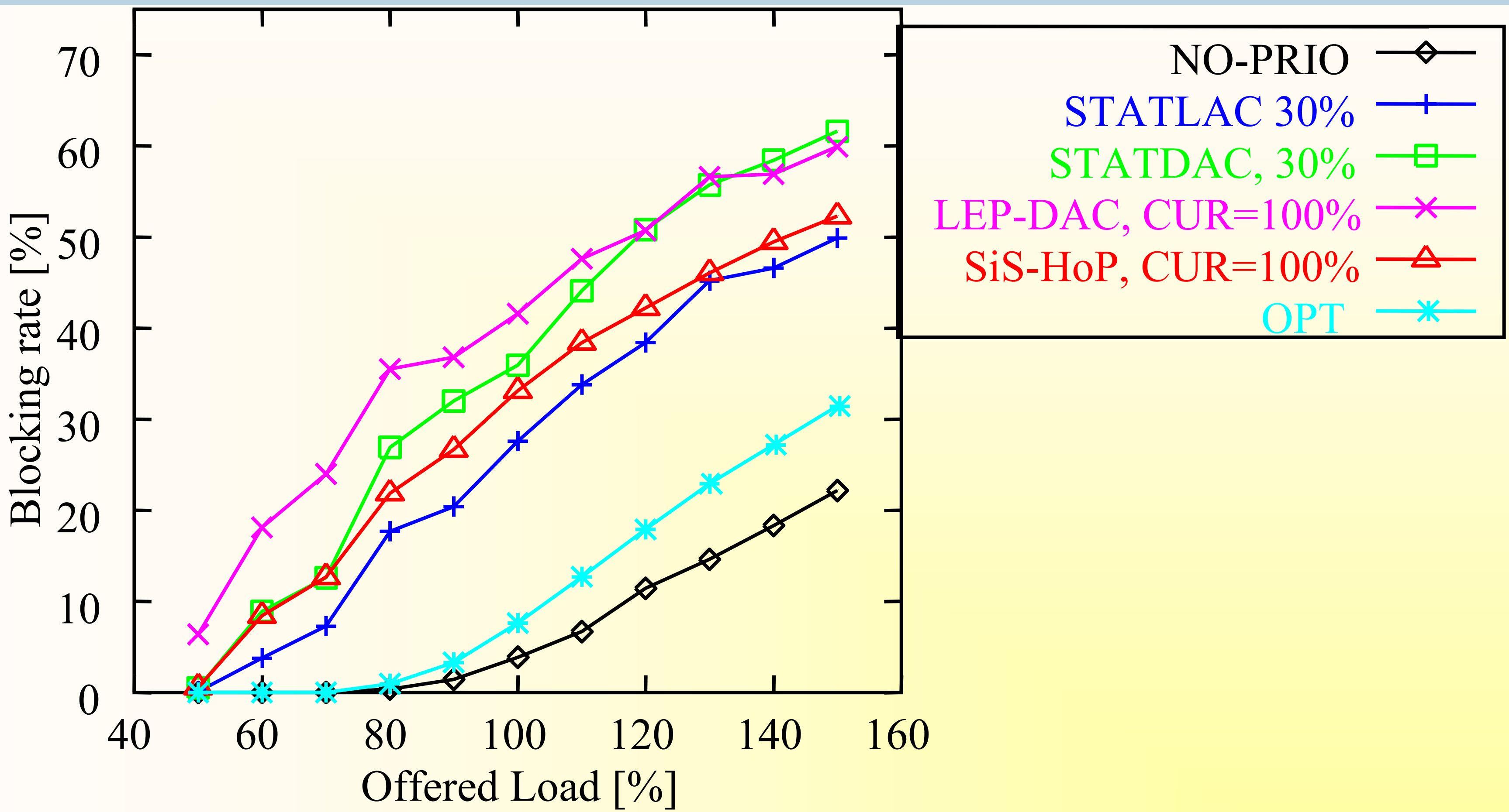
- Example 1: Scenario with highly directional mobility
- Result: No handoff drops in SiS-HoP

Results SiS-HoP: Directional Mobility II



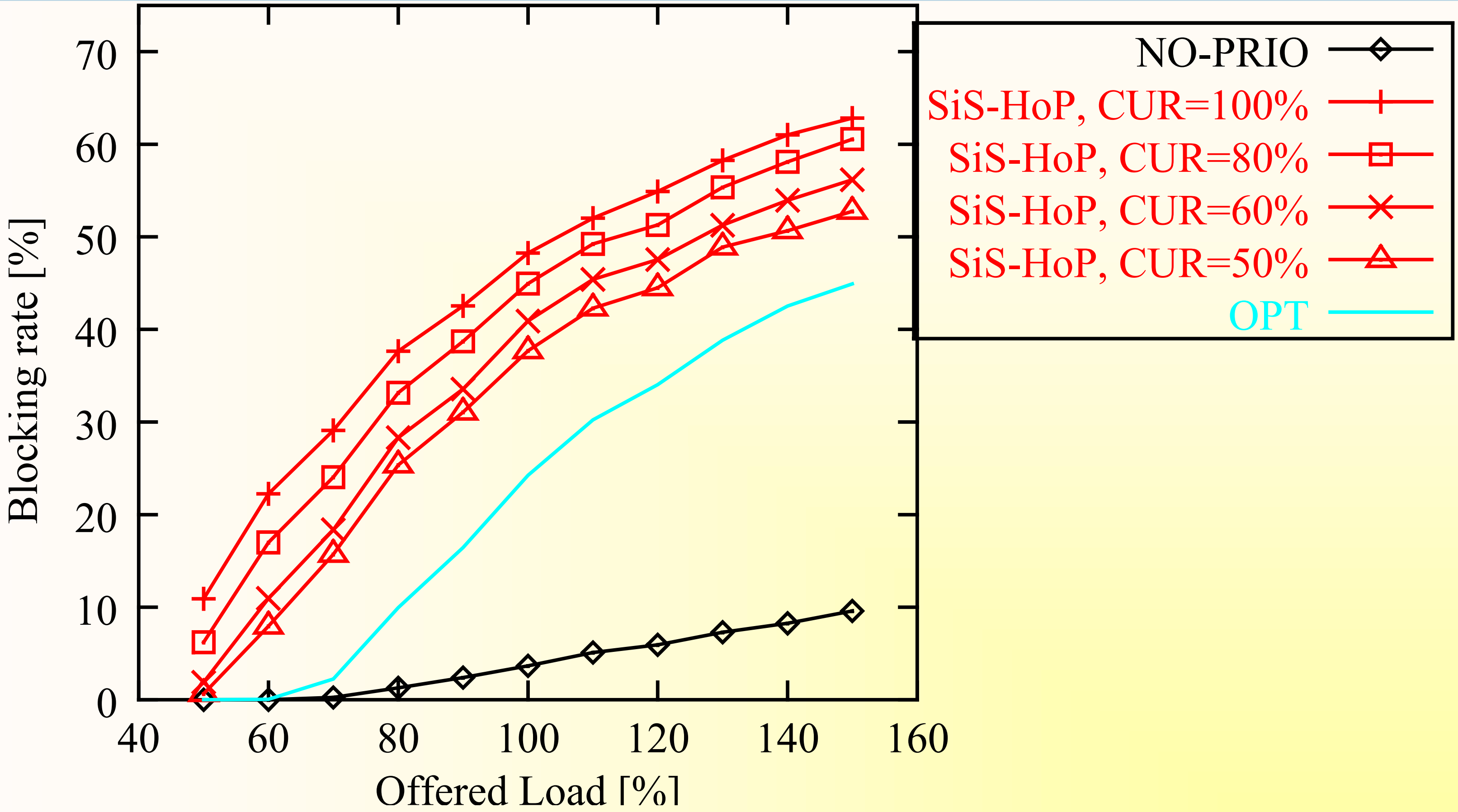
- Drawback: Higher number of new session requests block

Results: Random + Low Mobility



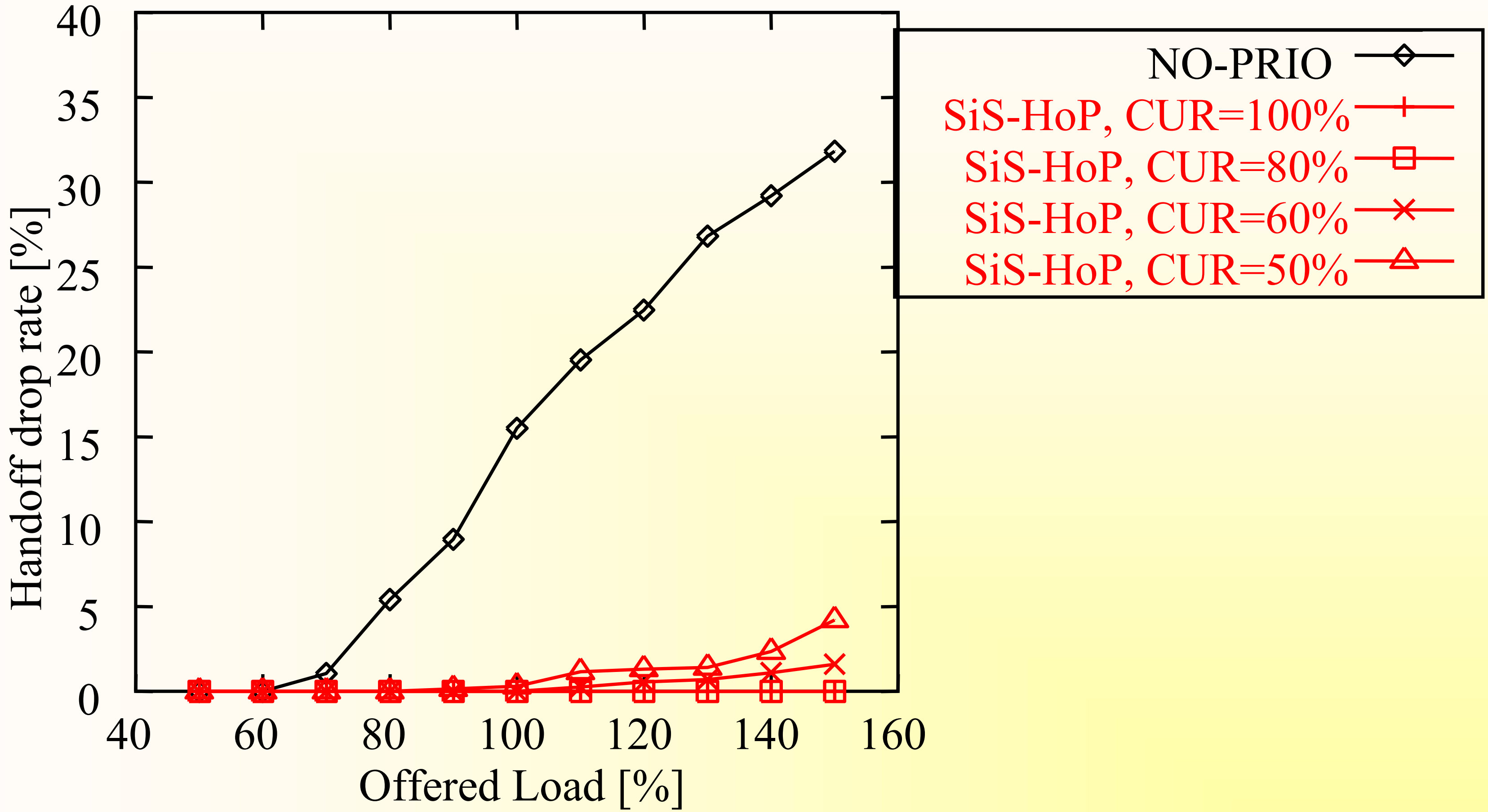
- LEP-DAC + SiS-HoP: No handoff drops
- SiS-HoP: less new session blocks

Results: Easy Administration



- Performance improvement:
  - Less amount of new session blocking

Results: Easy Administration (cont.)



- Drawback: Handoff drop at high loads
- Robustness: Smooth change of the handoff drop rate

SiS-HoP: Conclusions

- All three components
  - robust (no additional per-flow state information)
  - adaptive to different mobility patterns
  - scalable (no additional per-flow state information)
  - simple to configure (cache size, signaling period, CUR)
  - incrementally deployable (bottleneck link)

SiS-HoP: Conclusions (cont.)

- Compared to less complex approaches:
  - Less handoff drops or
  - More new session requests admitted
- But: Resource utilization can be improved
  - Further component of my Ph.D. thesis: MoDiQ service mode

Thank you for your attention!

Questions?