Cooperative Secondary Authorization Recycling

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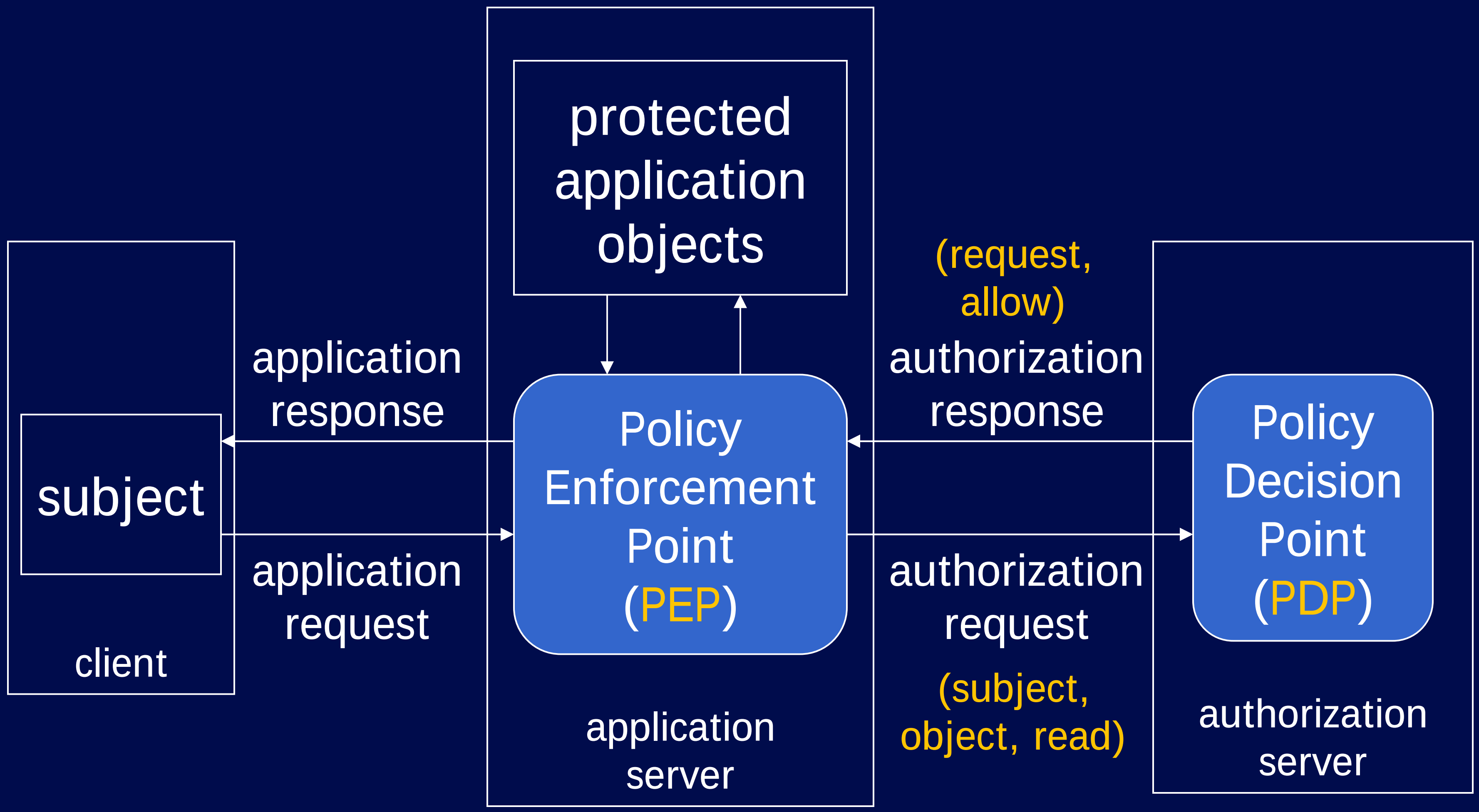
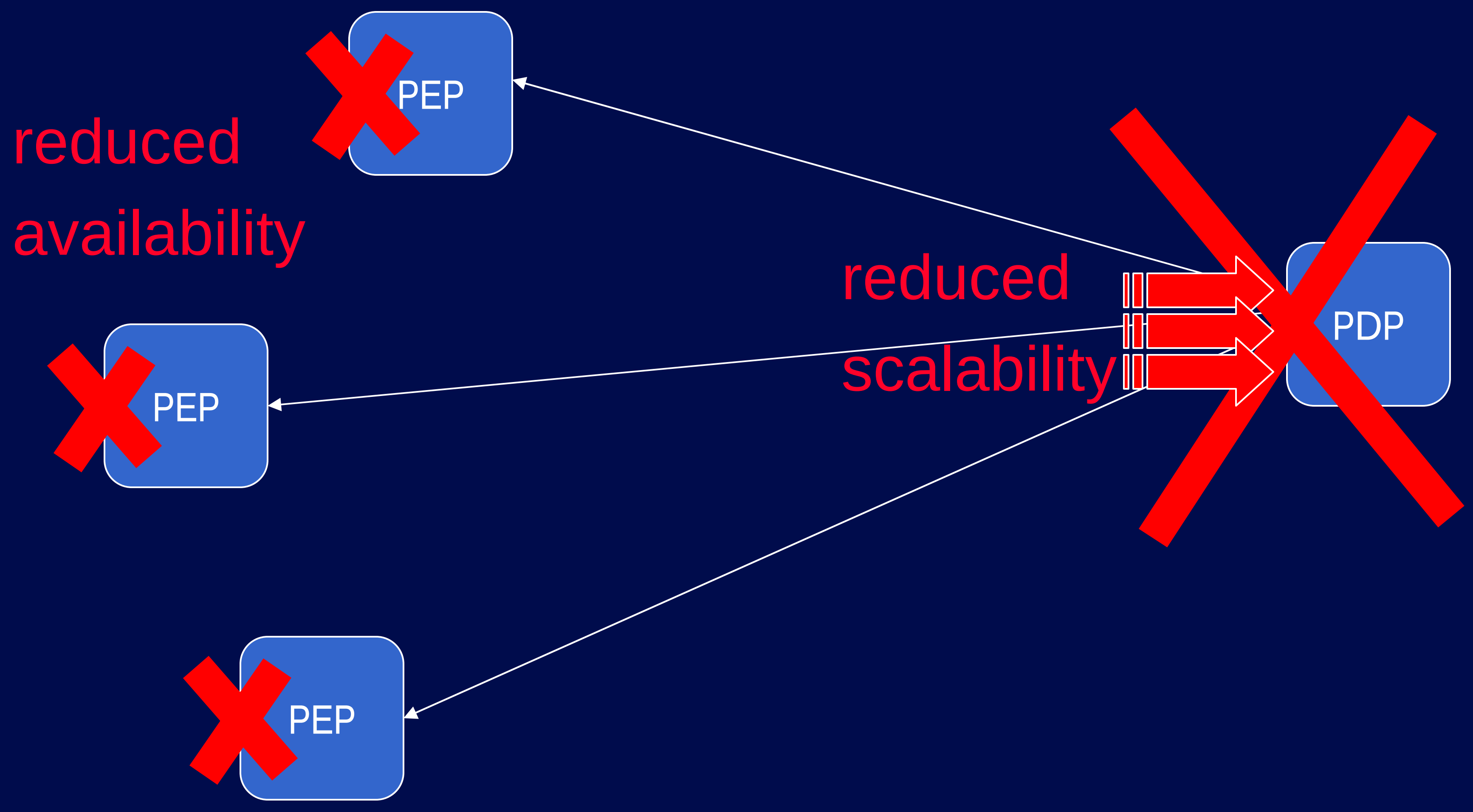
Typical Authorization Architecture

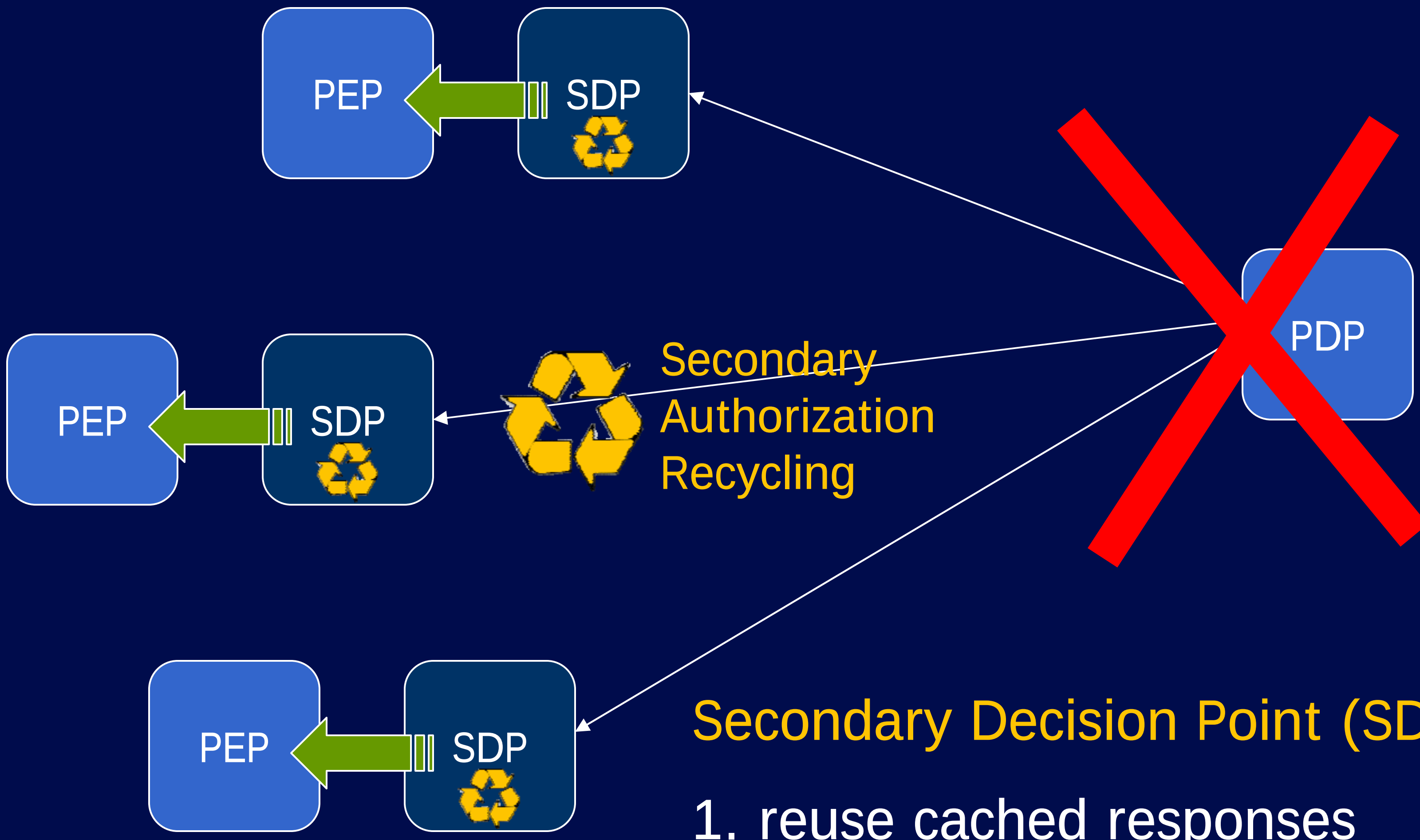


Also known as request-response paradigm
e.g. IBM Access Manager, EJB, XACML

Motivation Problems



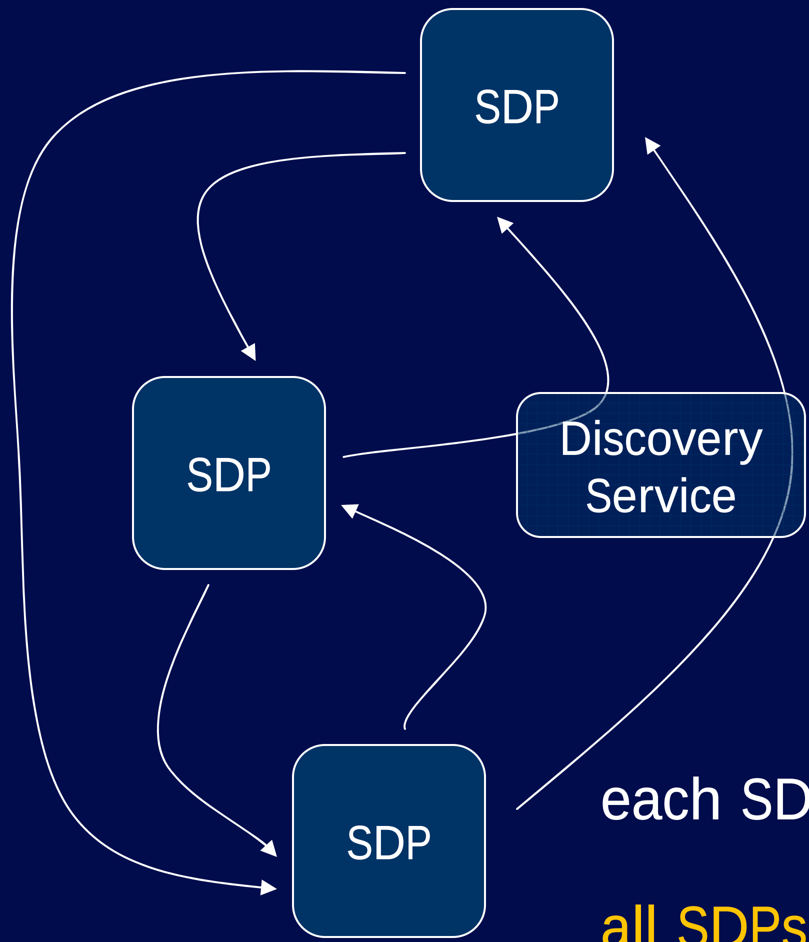
Secondary and Approximate Authorization Model (SAAM)



Secondary Decision Point (SDP)

1. reuse cached responses
2. infer approximate responses

Cooperative Secondary Authorization Recycling

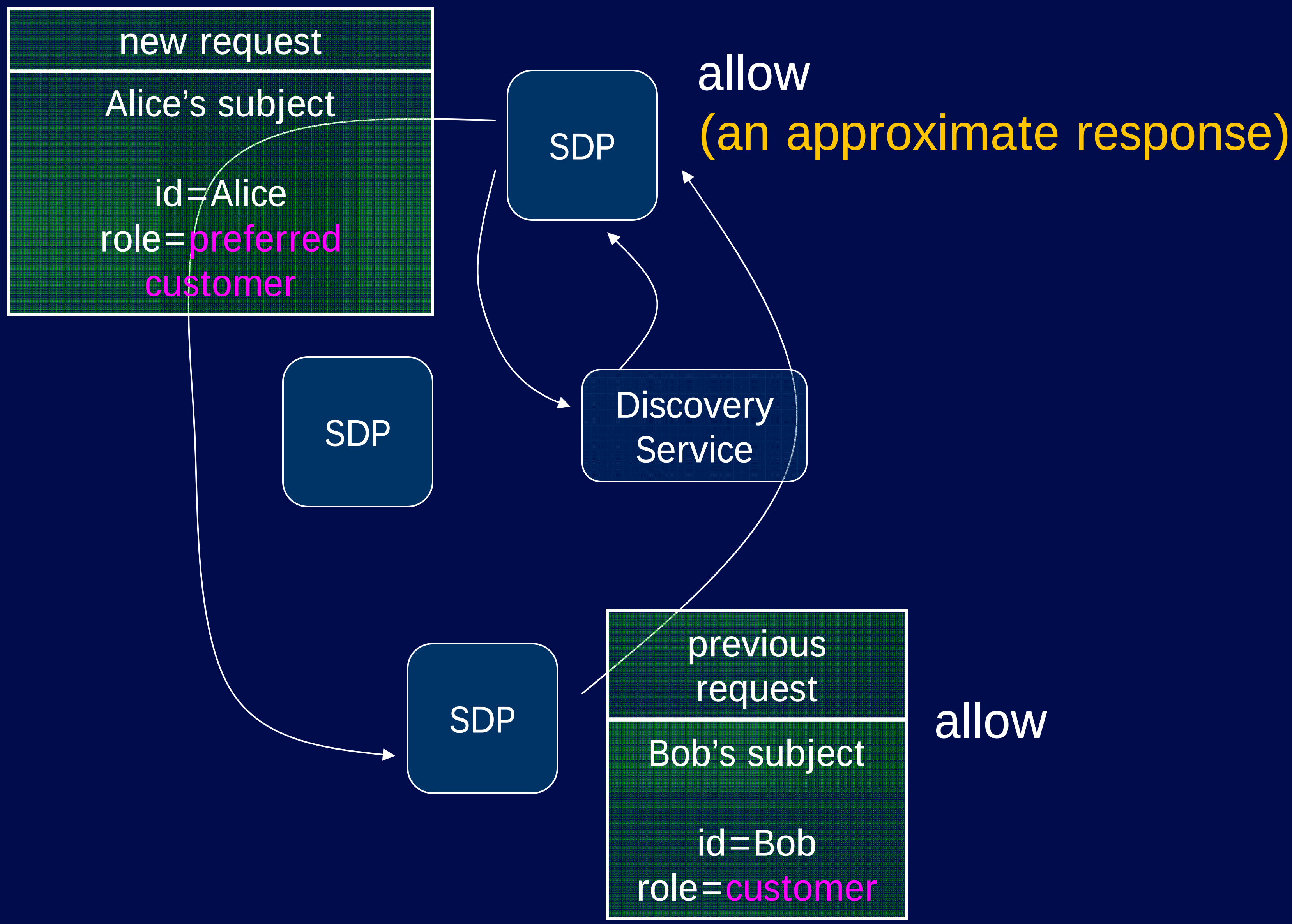


each SDP serves only its own PEP!

⇓

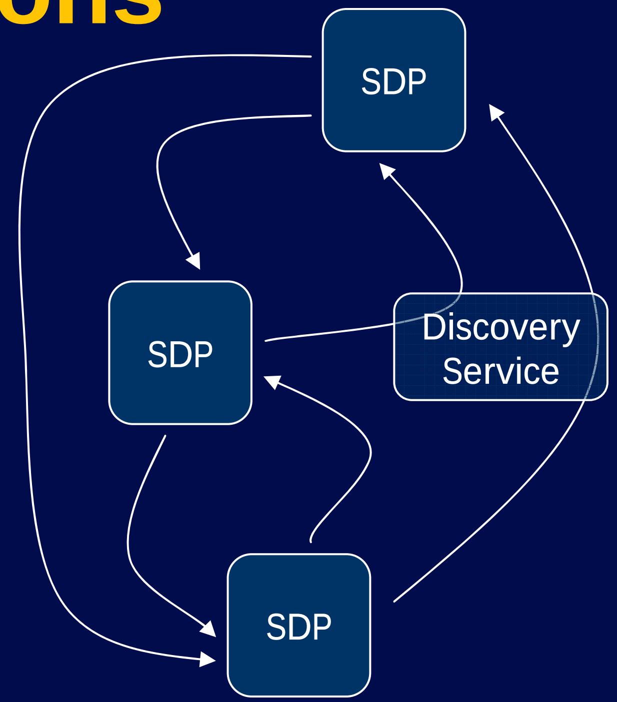
all SDPs cooperate to serve all PEPs

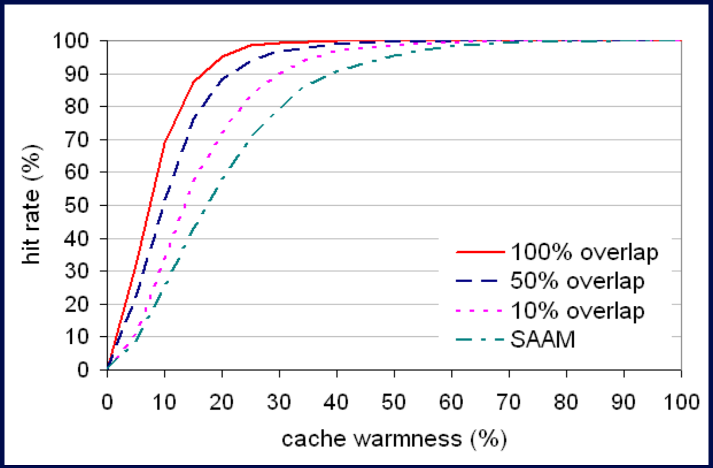
A Simplified Example



Contributions

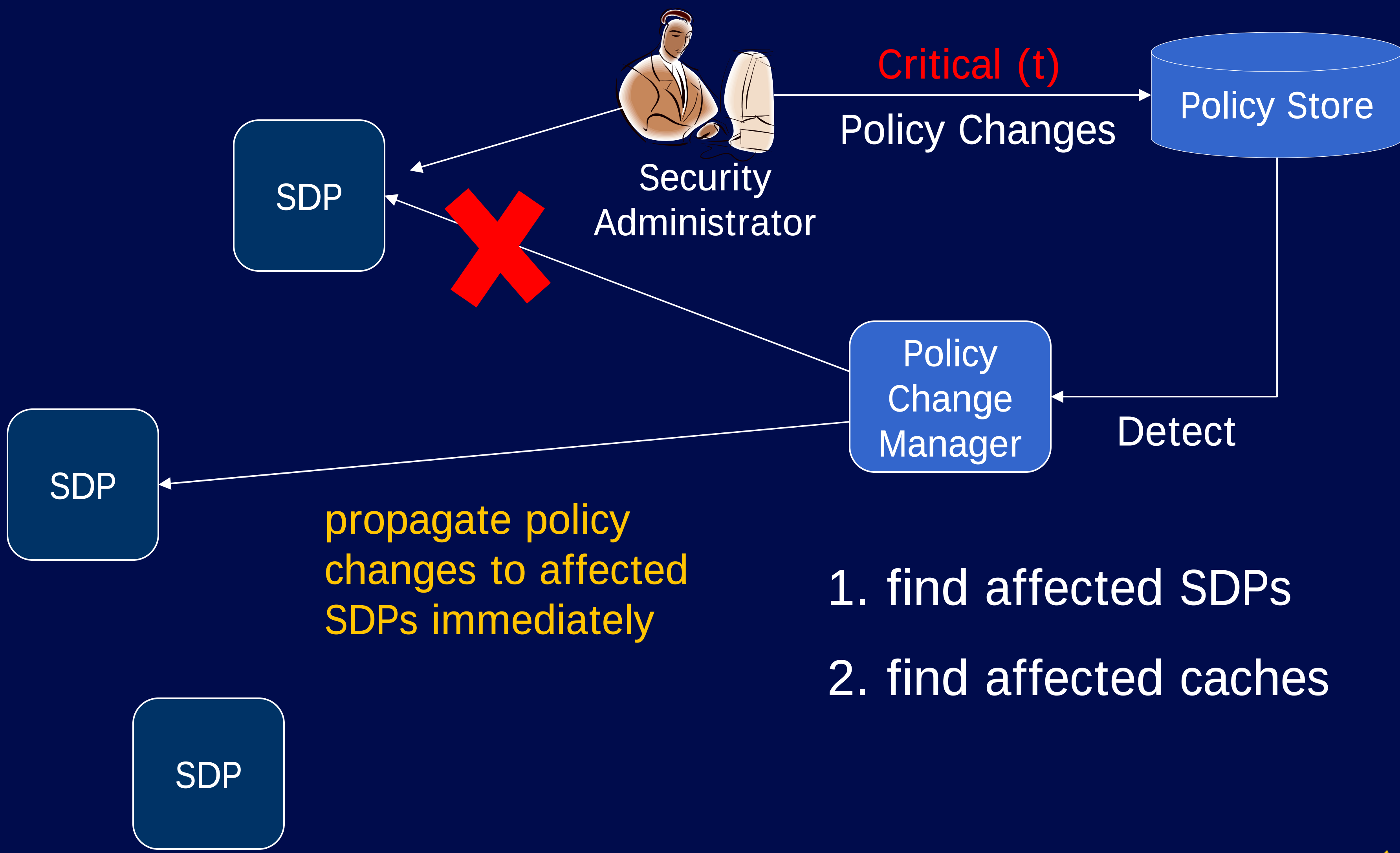
- Proposed
  - the concept of cooperative secondary authorization recycling
  - system architecture & detailed design
- Evaluated
  - availability
  - performance





Key Design Features

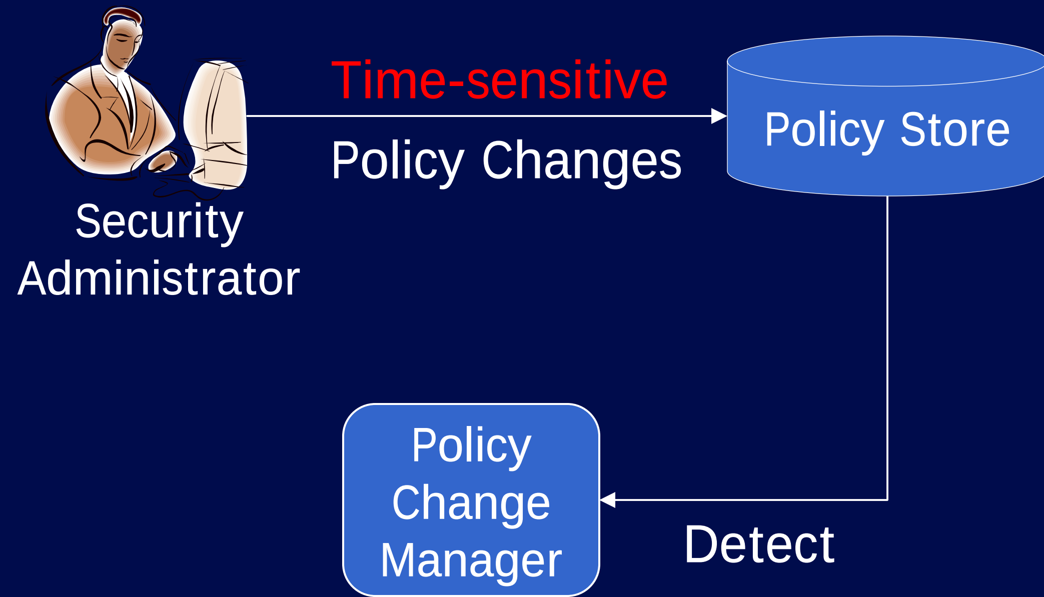
Consistency: Support Critical Policy Changes

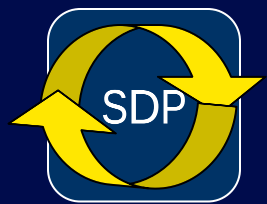


propagate policy changes to affected SDPs immediately

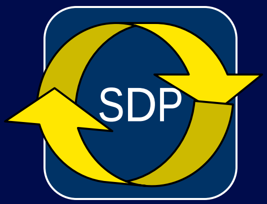
1. find affected SDPs
2. find affected caches

Consistency: Support Time-sensitive Policy Changes





A TTL approach:
delete expired
responses periodically



Support Untrusted Remote SDPs

PEP — Trusts → SDP — Trusts → PDP

Trusted by all SDPs

Does NOT Trust

Malicious SDP

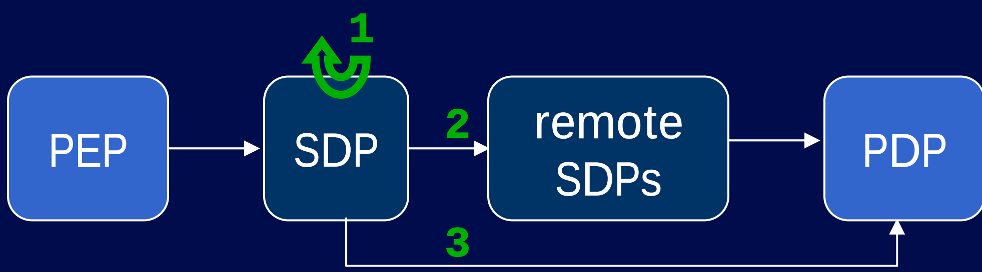
Verify responses made by remote SDPs

1. verify the authenticity and integrity

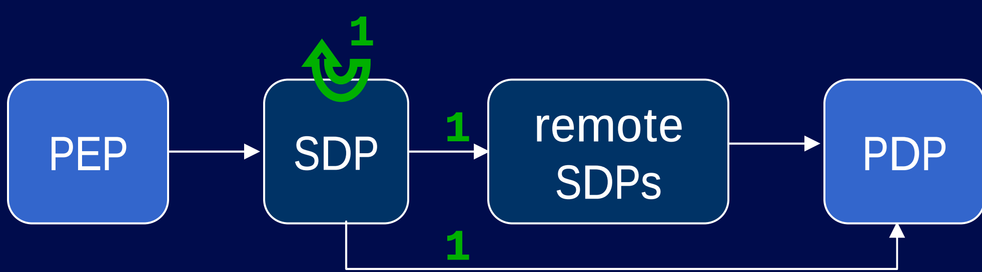
2. verify the correctness of inference

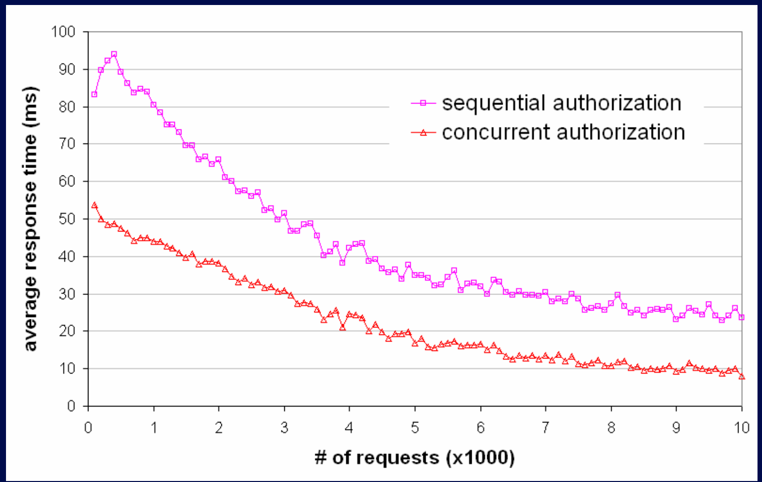
Configurability

- Three decision points
  - local SDP & remote SDPs & the PDP
- To reduce network traffic & PDP's load
  - sequential authorization



- To reduce the response time
  - concurrent authorization



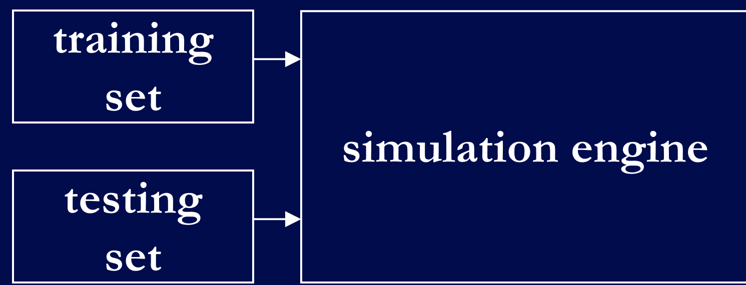


Evaluation Results

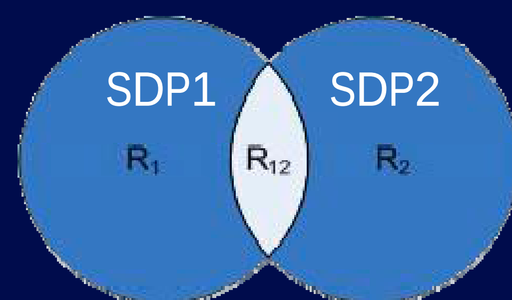
via simulation & prototype implementation

Simulation-based Evaluation

- Metrics
  - cache hit rate
- Methodology

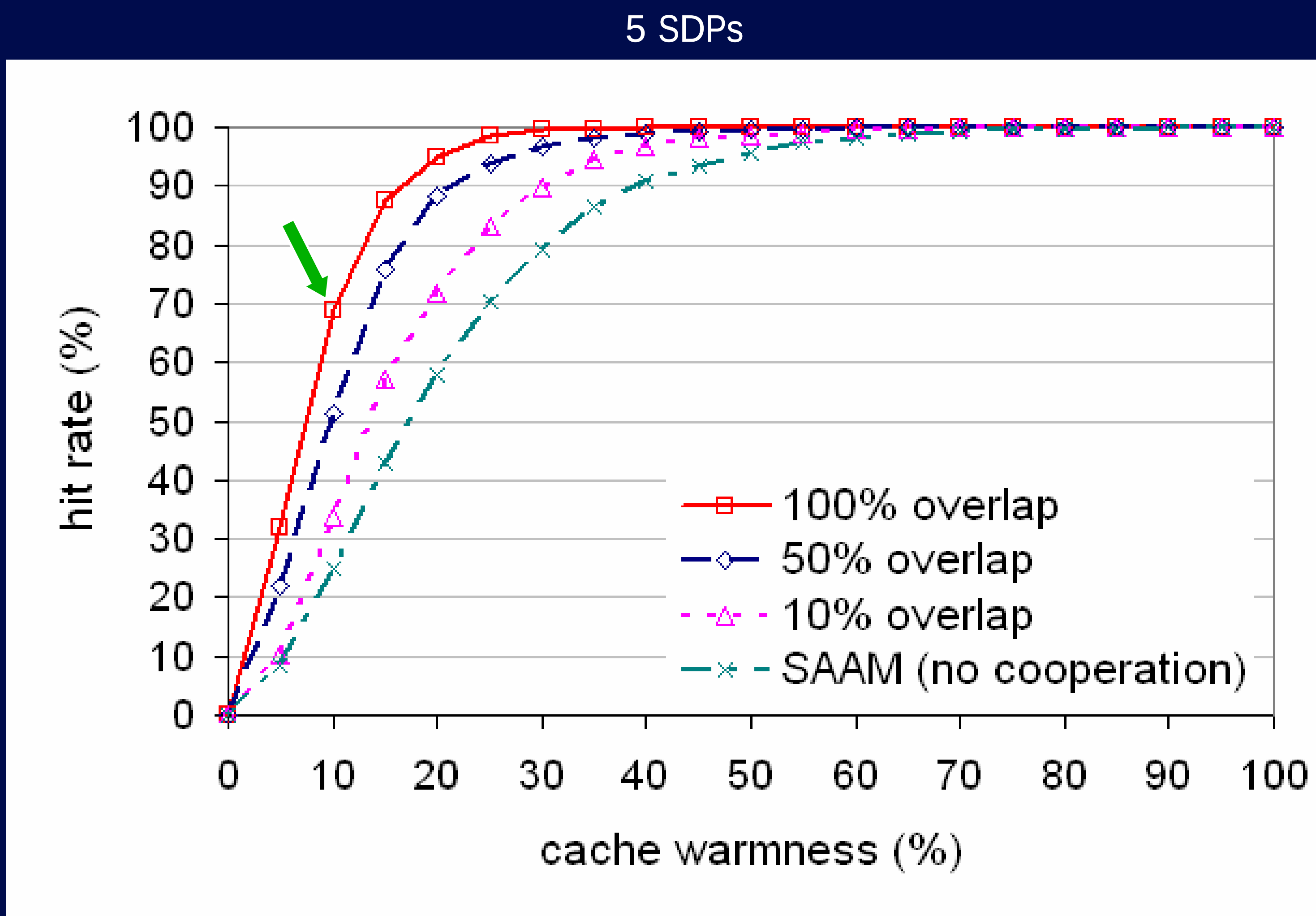


- Affecting factors
  - cache warmness $= \dfrac{|\text{cached requests without replacement}|}{|\text{total possible requests}|}$
  - number of cooperating SDPs
  - overlap rate $O_{12} = \dfrac{|R_{12}|}{|R_1|}$



R – resource space

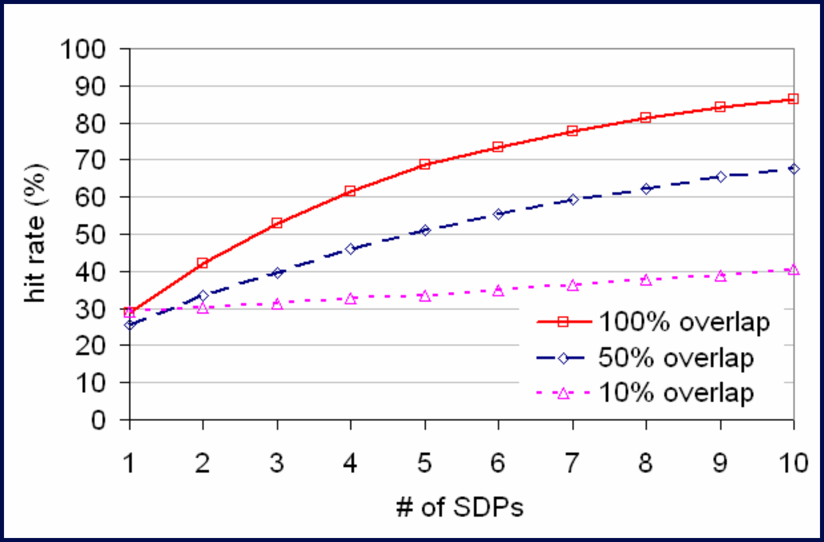
Hit Rate Dependence on Cache Warmness



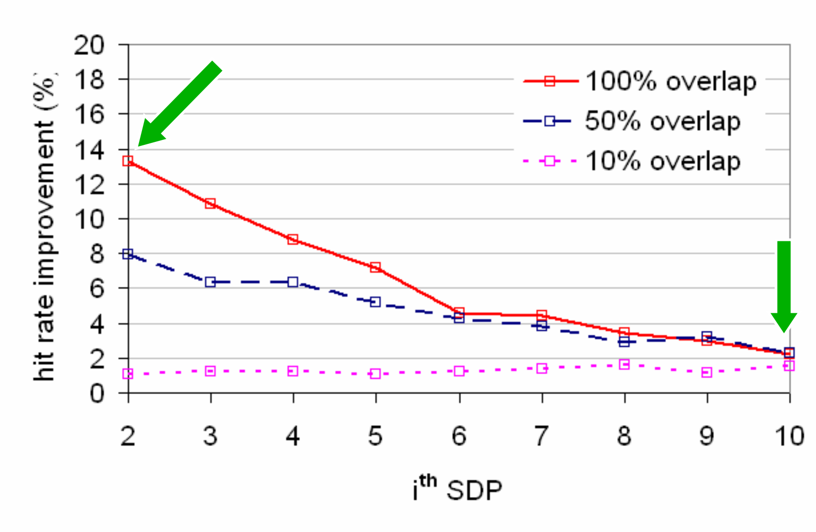
High hit rate is achieved even when cache warmness is low

Hit Rate Dependence on Number of SDPs

10% cache warmness at each SDP



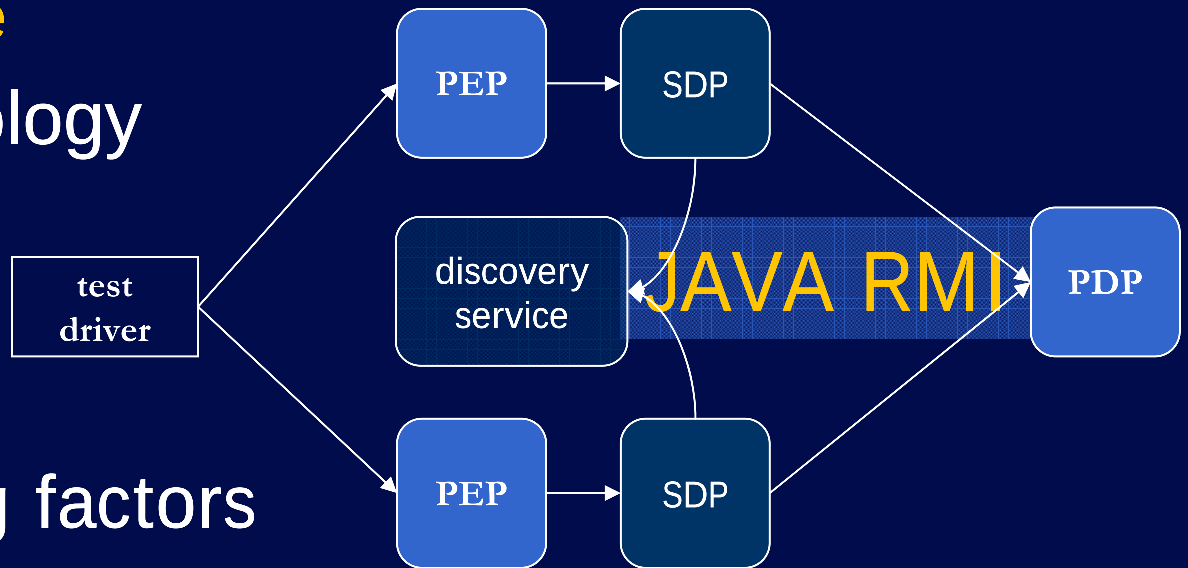
Increasing the number of cooperating SDPs leads to higher hit rates



Additional SDPs provide diminishing returns

Prototype-based Evaluation

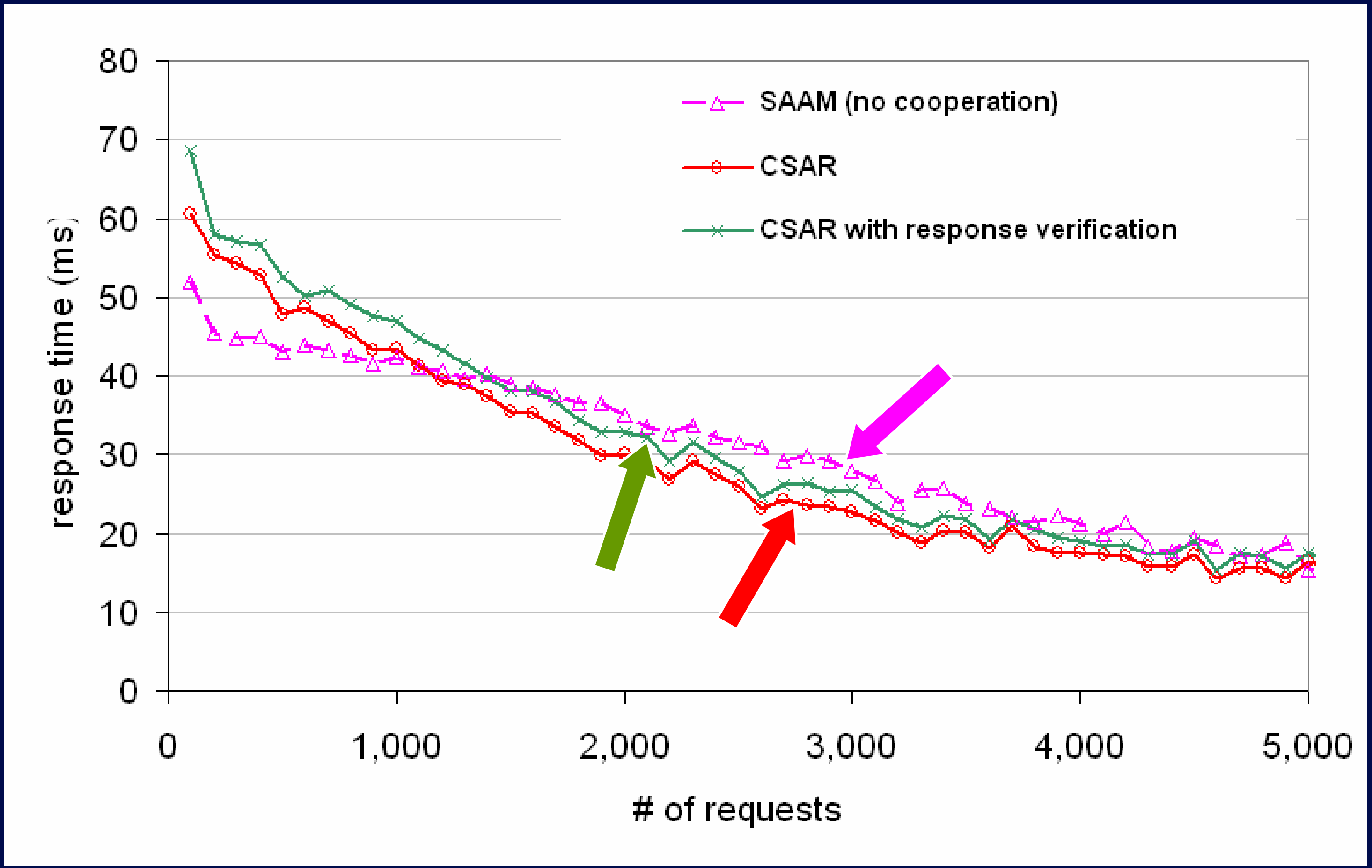
- Metrics
  - average client-perceived response time
  - hit rate
- Methodology



- Affecting factors
  - number of requests
  - response verification
  - frequency of policy change

Response Time Dependence on Number of Requests

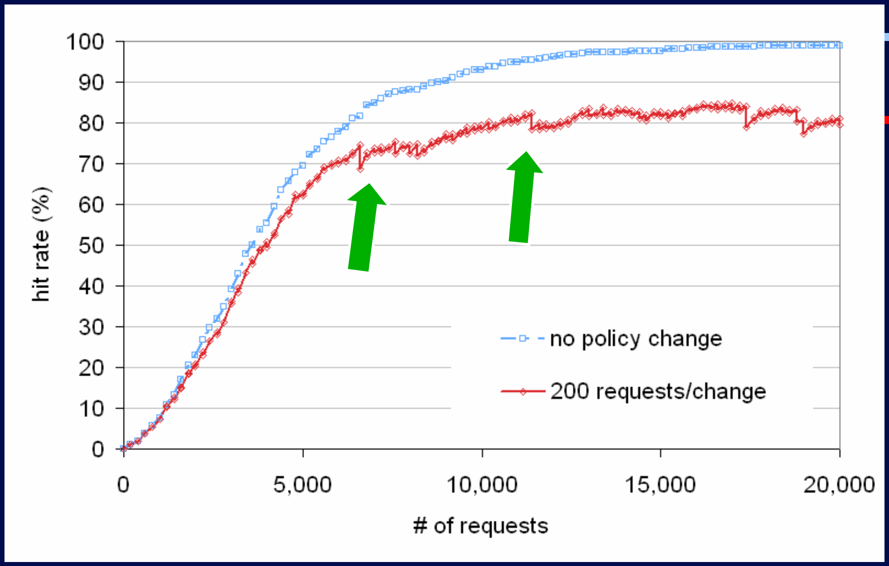
4 SDPs (CSAR), 100% overlap, 40ms RTT between PDP and each SDP



1. Cooperation can contribute to reduced response time
2. The impact of response verification is small

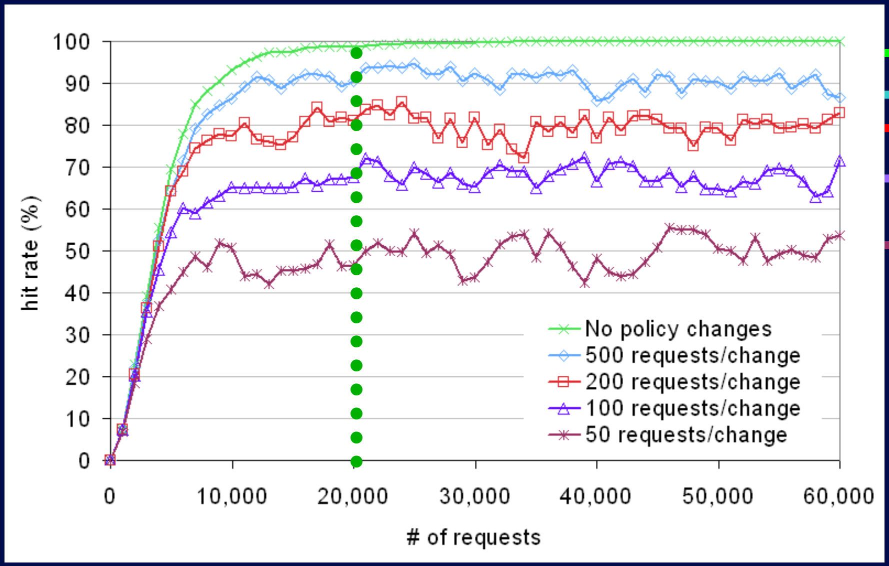
How will regular policy changes affect hit rate?

1 SDP



2. Cumulative effect of policy changes is significant

1. Hit-rate drop caused by each policy change is small

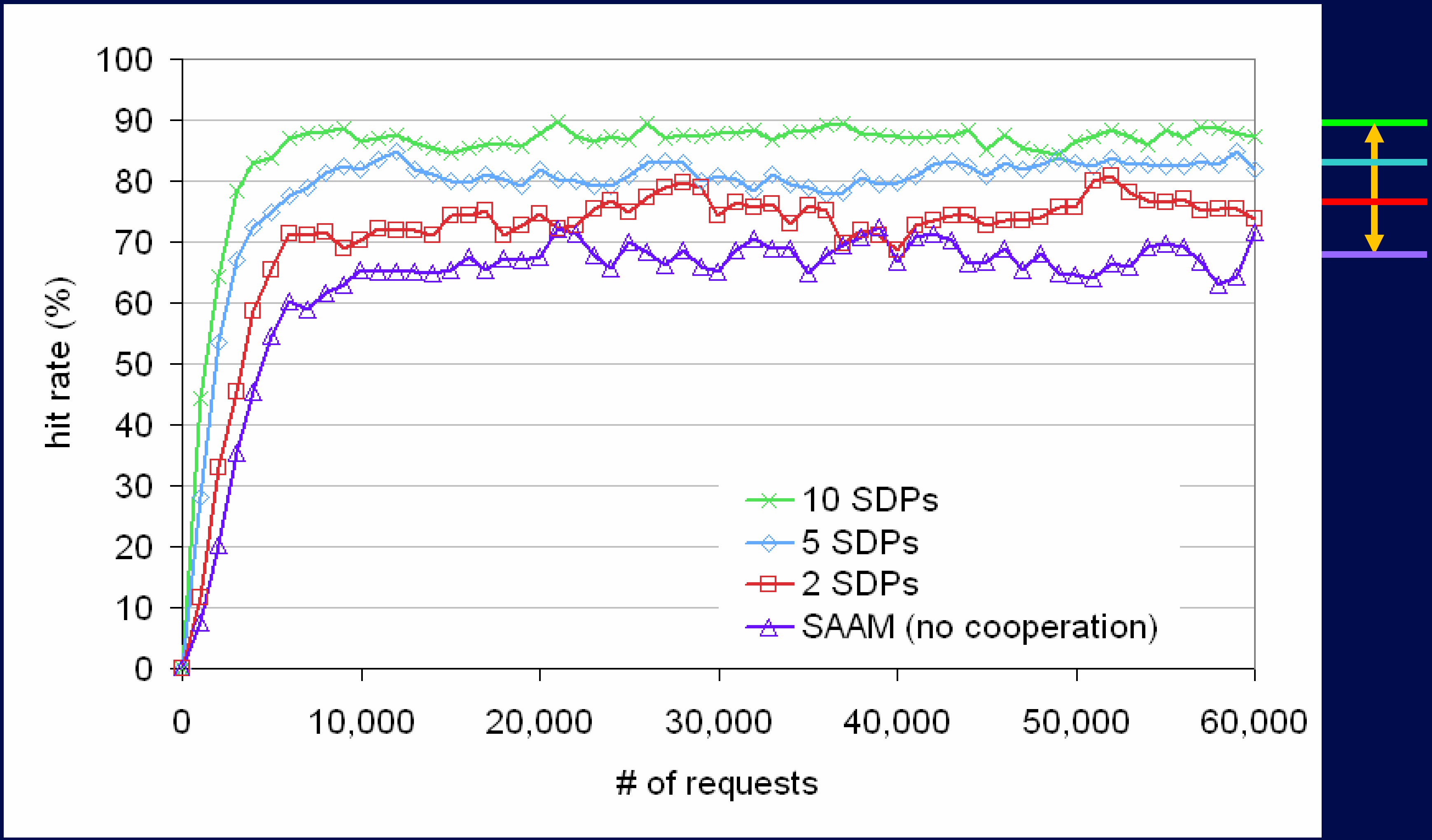


2. More frequent policy changes lead to lower hit rates

1. The hit rates stabilize after the knee

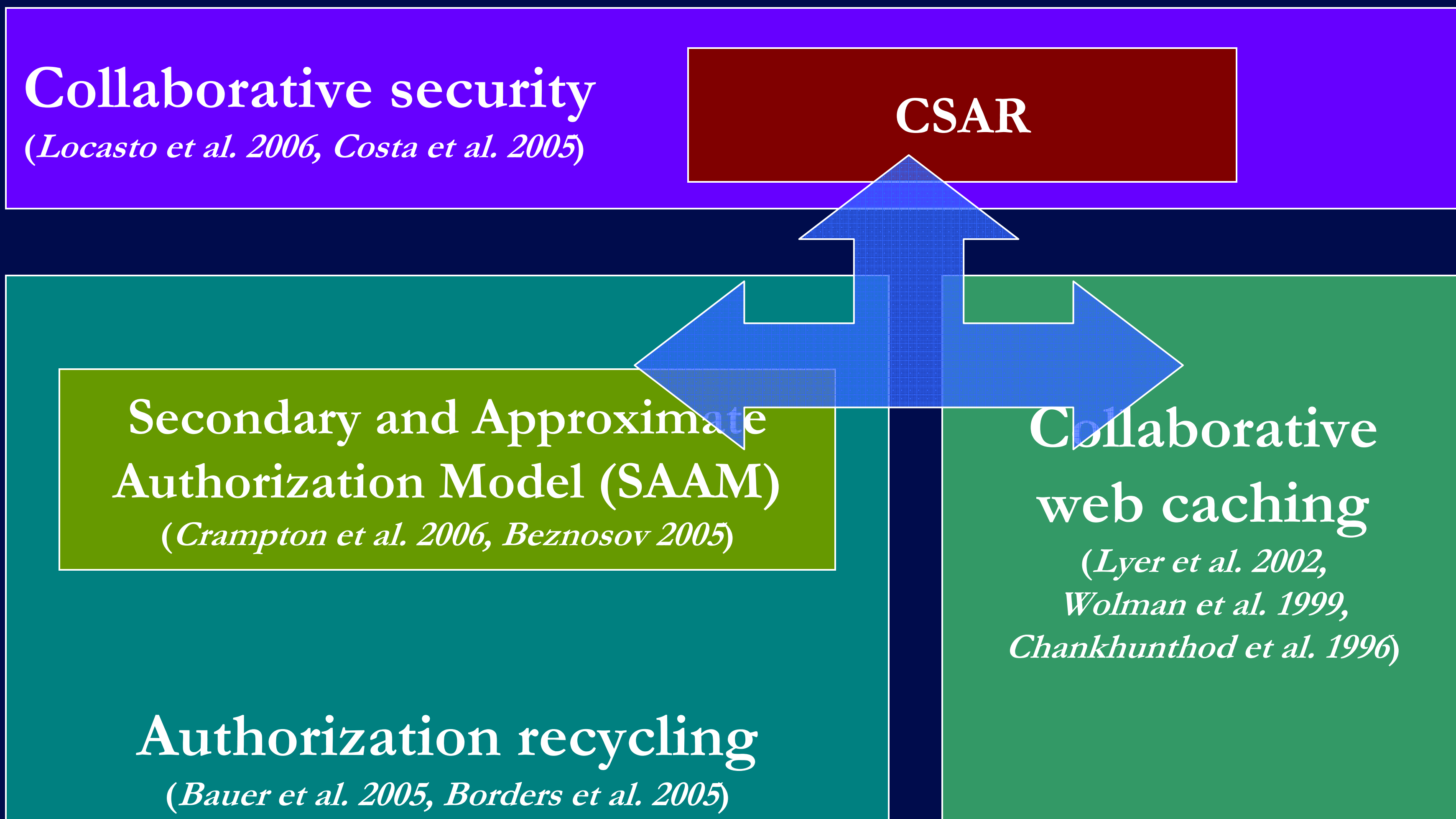
How does cooperation help?

100% overlap, policy changes at 100 requests/change

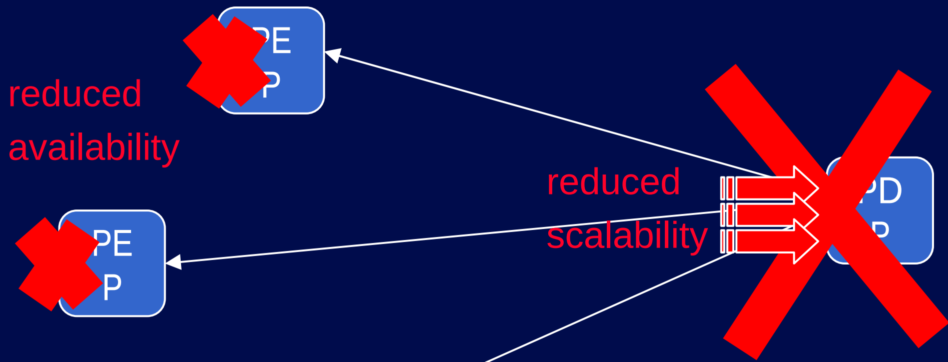


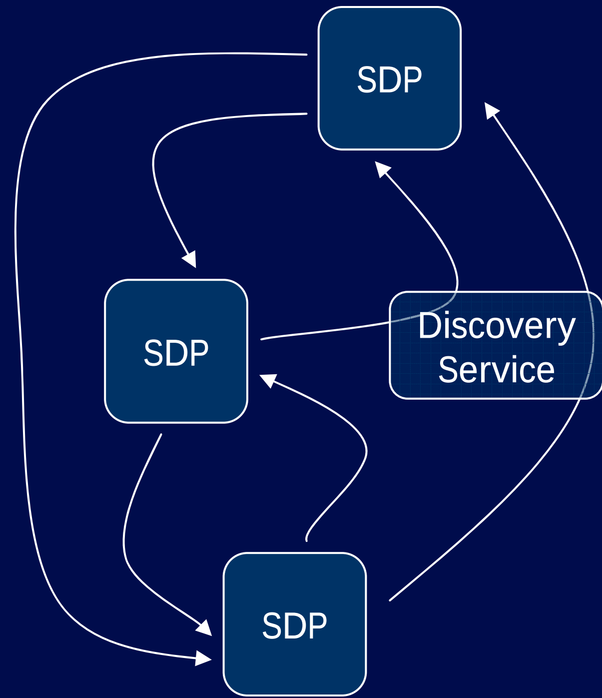
Cooperation improves hit rates when policy changes

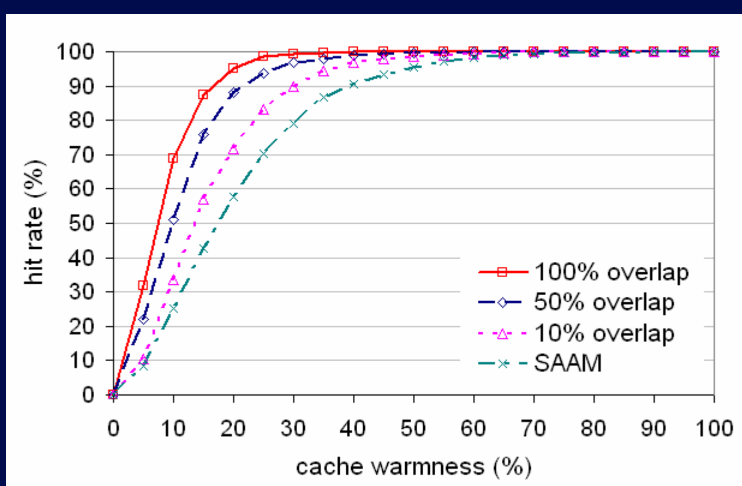
Related Work

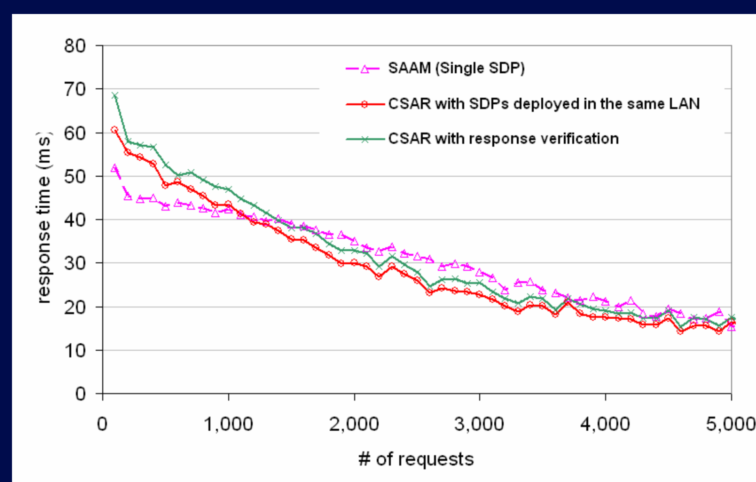


Summary


reduced
availability
reduced
scalability


SDP
SDP
Discovery
Service
SDP


hit rate (%)
cache warmness (%)
100% overlap
50% overlap
10% overlap
SAAM


response time (ms)
# of requests
SAAM (Single SDP)
CSAR with SDPs deployed in the same LAN
CSAR with response verification

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