Soroban: Attributing latency in virtualized environments

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Tail latency increases when you virtualize software.

But who's responsible?

of individual requests

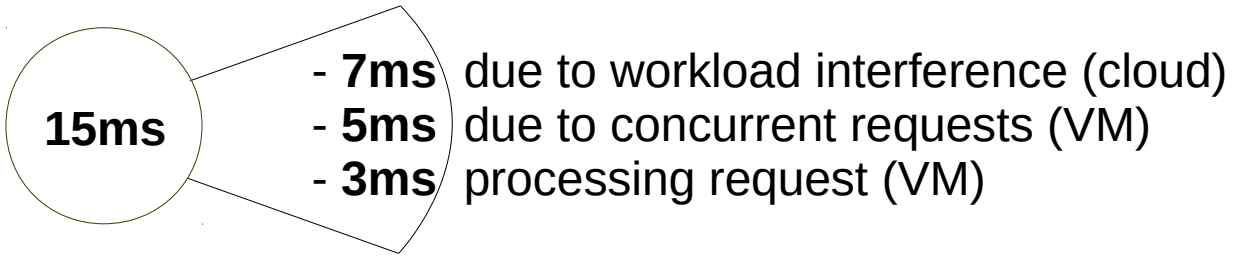
Tail latency increases when you virtualize software.

But who's responsible?

Attribution as a cloud problem

- Typical issues:
  - tail latency
  - perf variability & isolation
  - workload colocation side-effects

- Measurement only tells half of the story



Attribution gives an in-depth view of time spent doing an action

Attribution as a cloud problem

- Typical issues:
  - tail latency
  - perf variability & isolation
  - workload colocation side-effects
- Measurement only tells half of the story

- Precise measuremens
- Context (relating different measurements)
- Inference

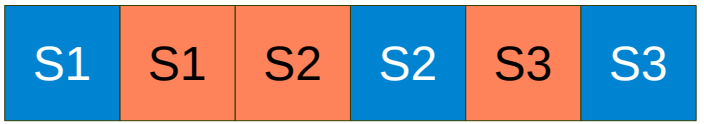
Attribution gives an in-depth view of time spent doing an action

Attribution based on measurement

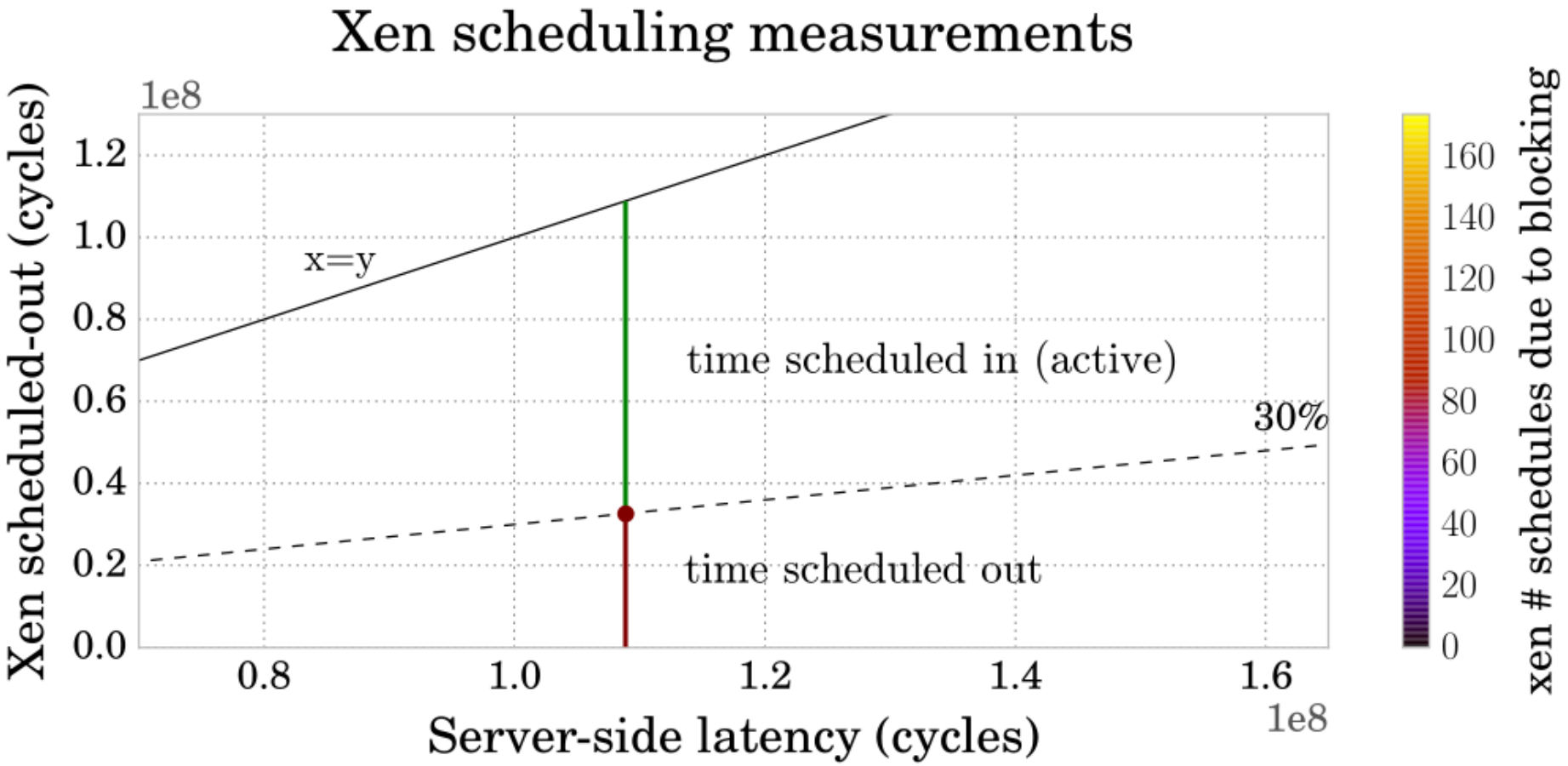
- Setup:
  - Lighttpd (modified with Soroban API),
  - 16 concurrent VMs,
    Low contention (periodic CPU load, low network load)

- **Goal**:
  - determine how much is the concurrent workload slowing down each request

- Start from a simple idea (soroban-enabled measurement):
  - look at the time the lighttpd VM was scheduled out
  - during each request!



Measurement



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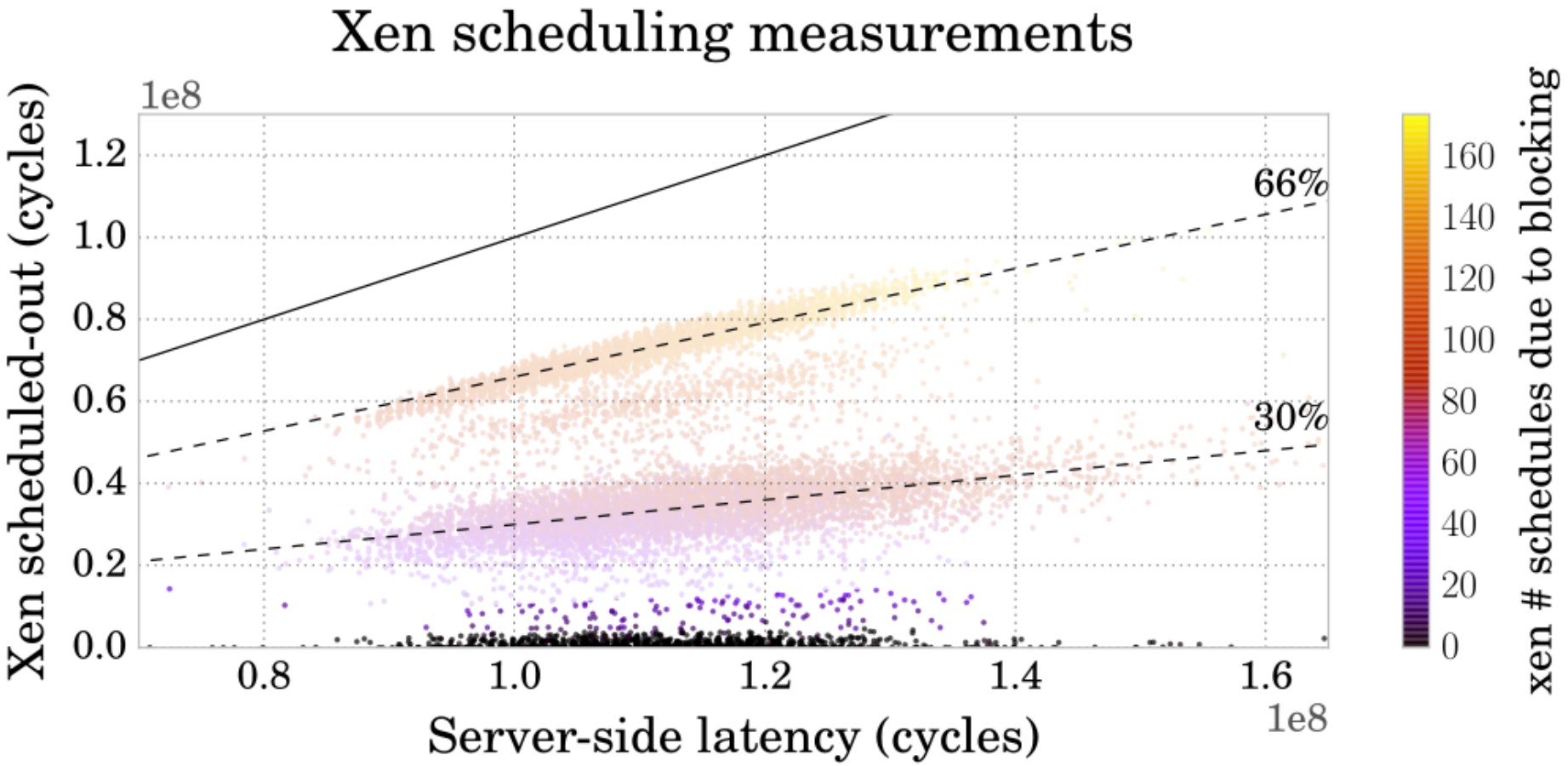

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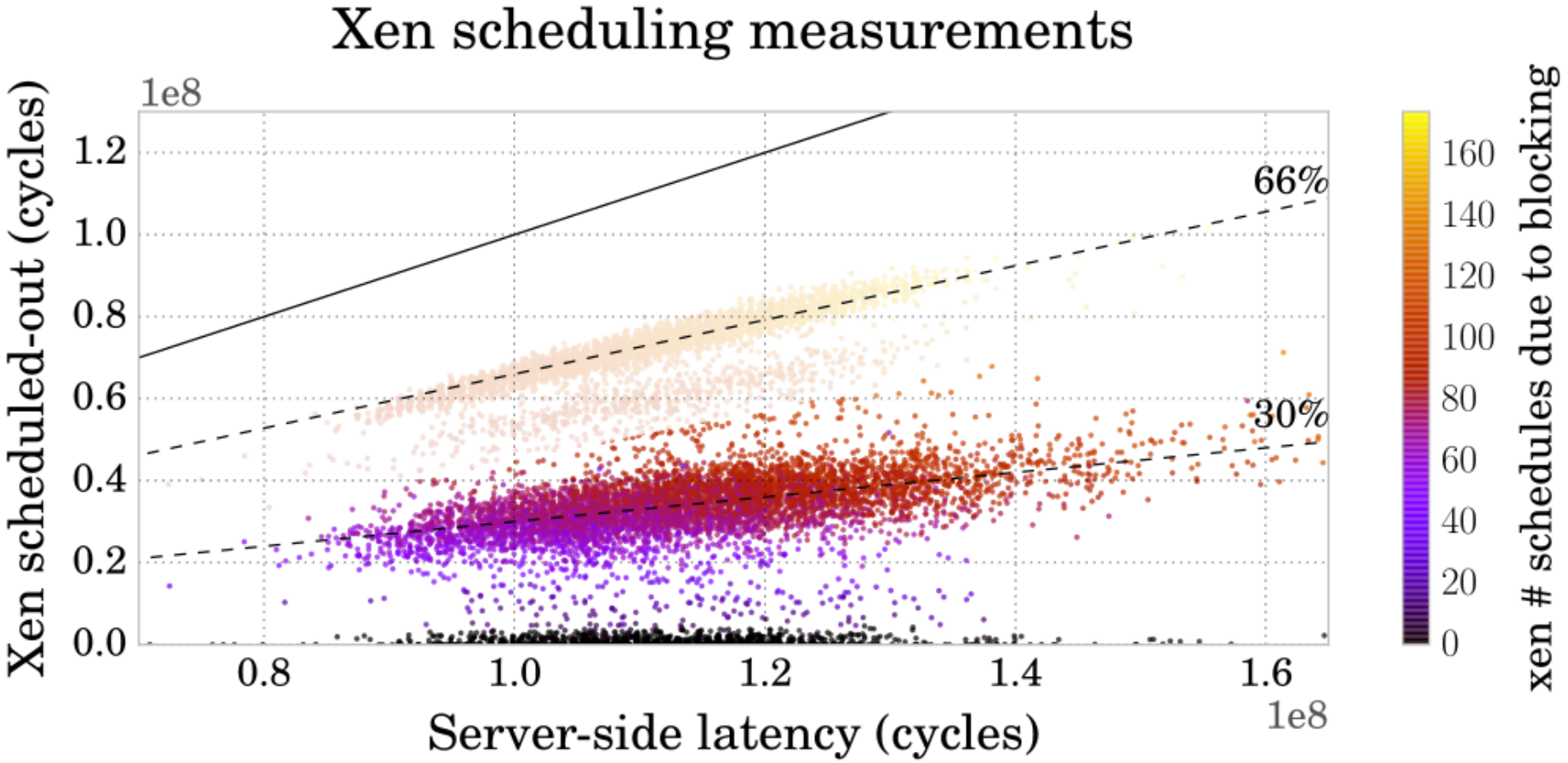

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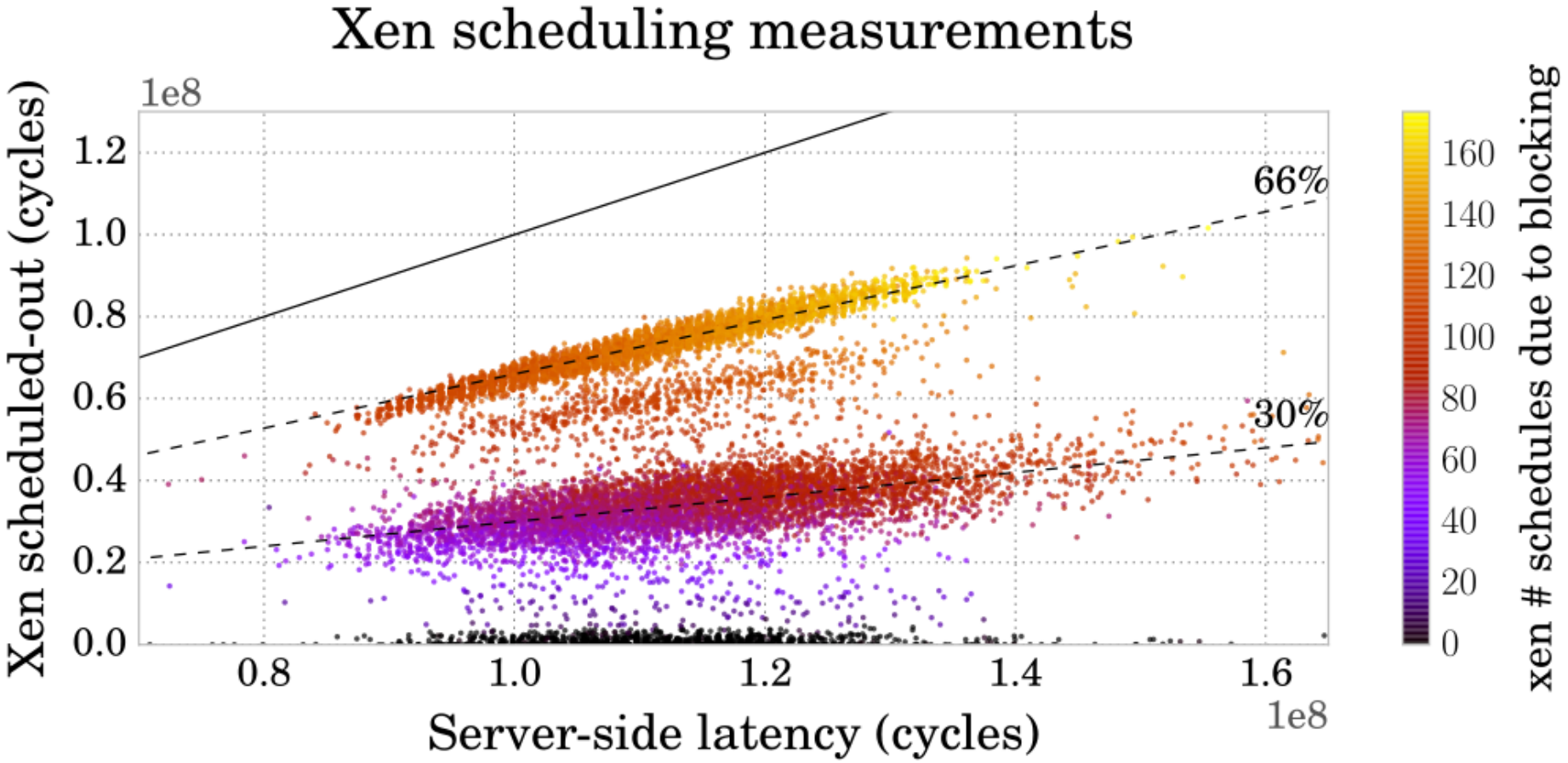

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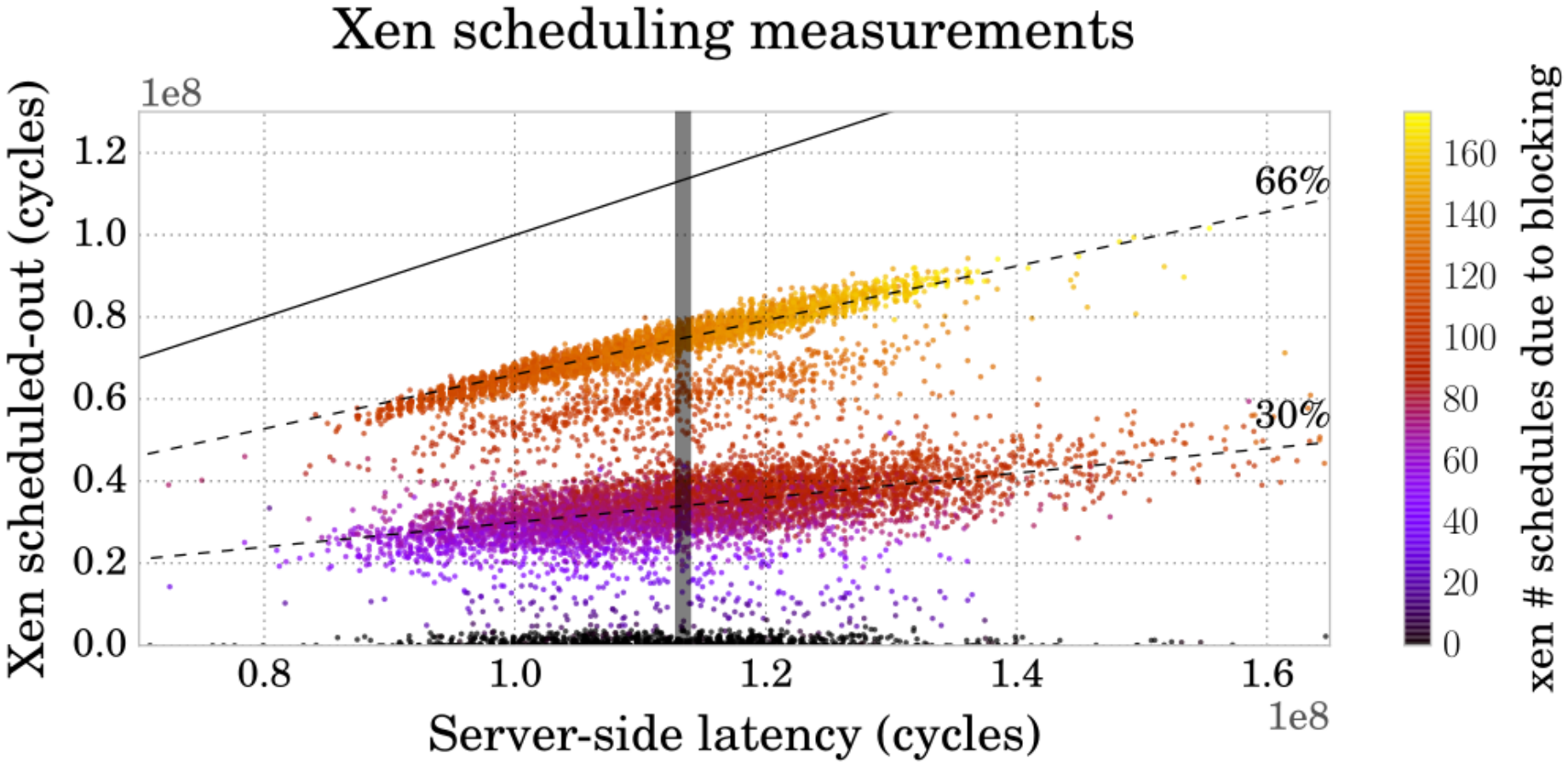
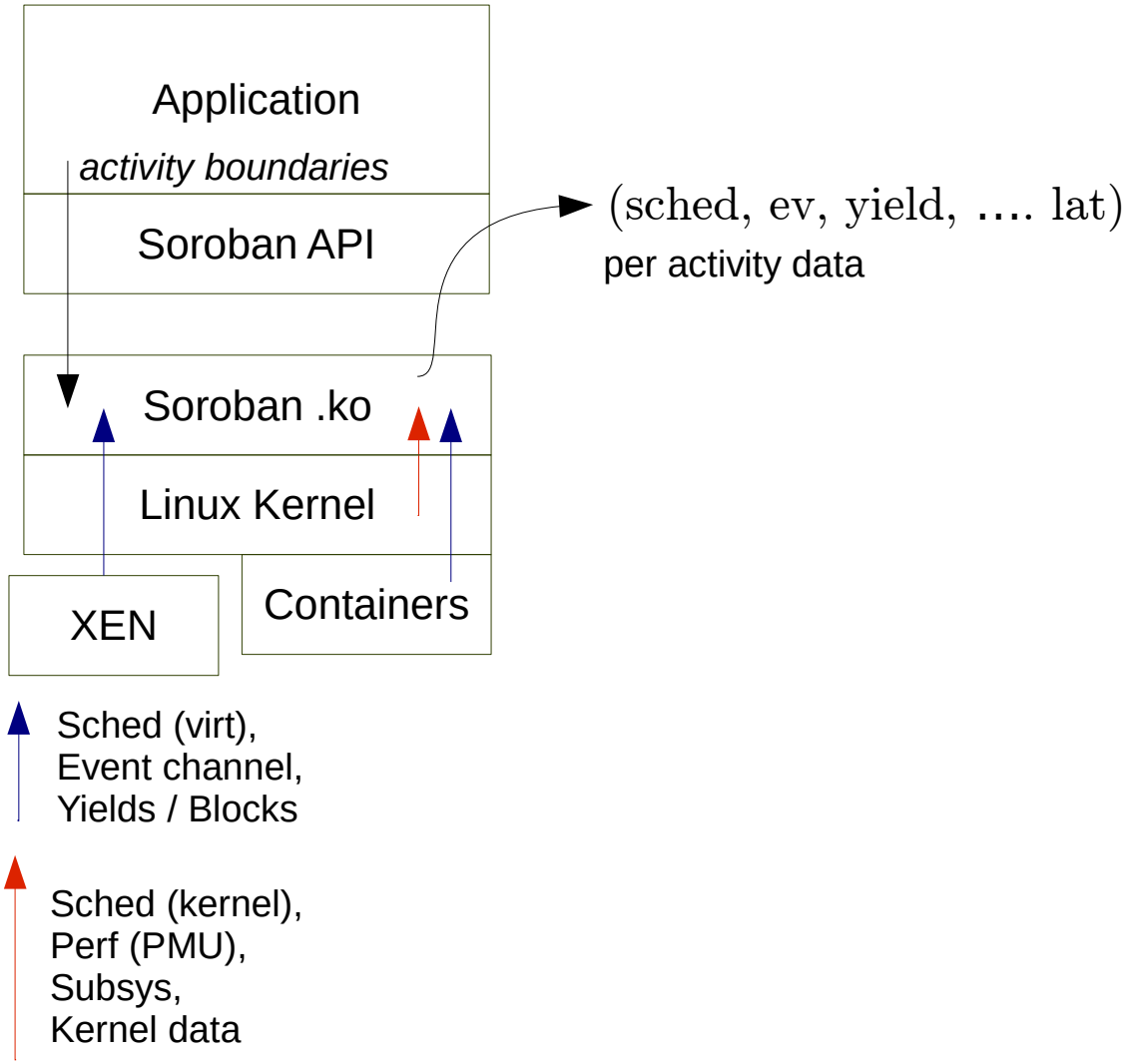


Soroban

- Precise measurement API
  - Activity boundaries
- Kernel module
  - Provides measurement context
  - Aggregation
- Inference
  - Machine learning to determine attribution model

Soroban

Measurement



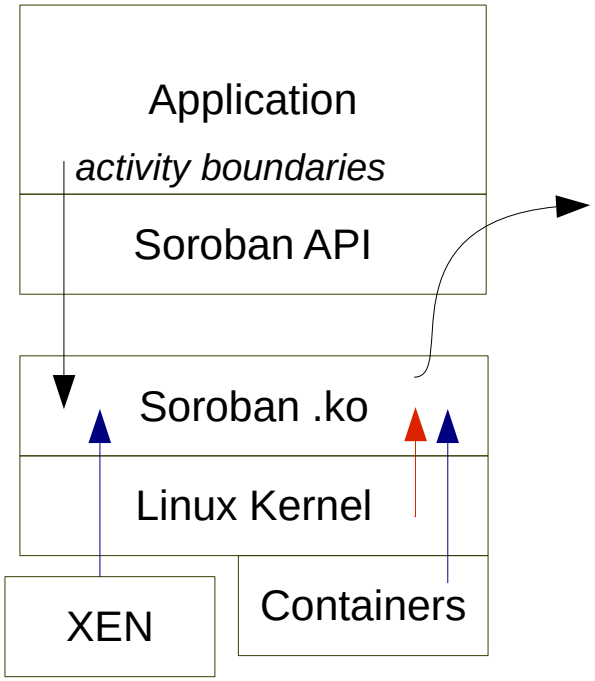
Training

$(\text{sched}, \text{ev}, \text{yield}, \ldots. \text{lat})$

per activity data

Soroban

Measurement



Sched (virt),
Event channel,
Yields / Blocks

Sched (kernel),
Perf (PMU),
Subsys,
Kernel data

Training

Measurements in virtualized environment

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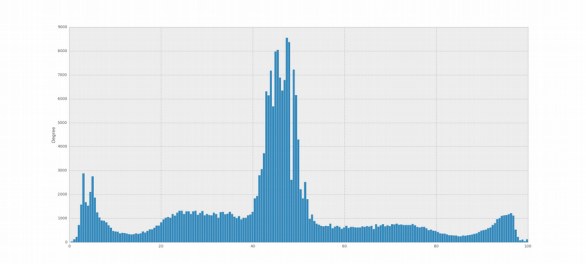
Reference latency profile (bare metal)



Soroban

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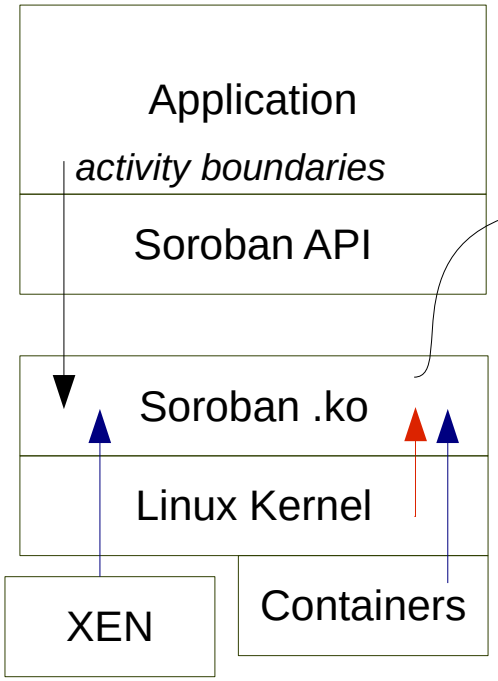

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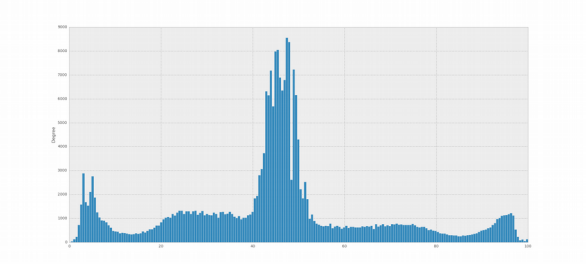
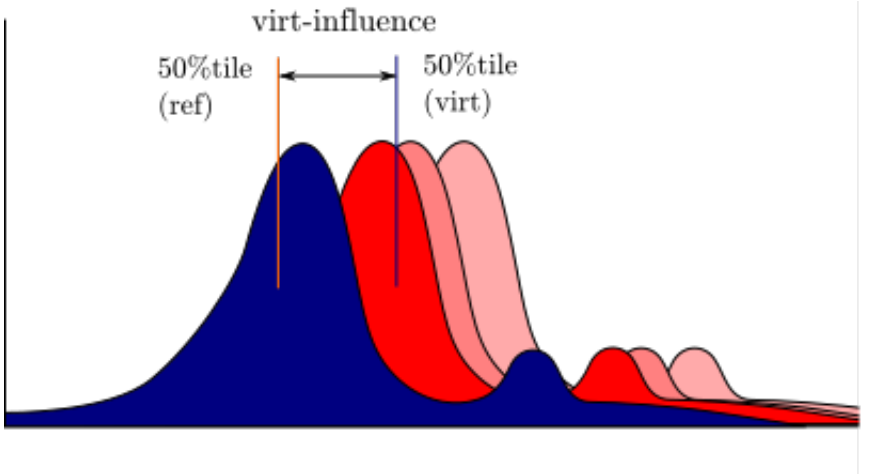


quantile-quantile difference



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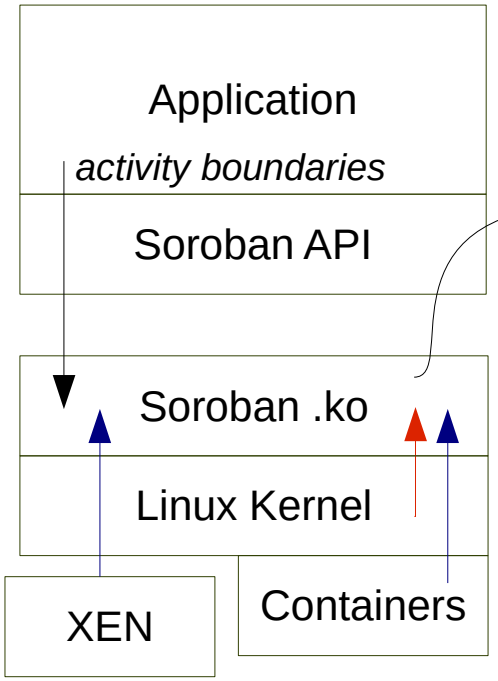

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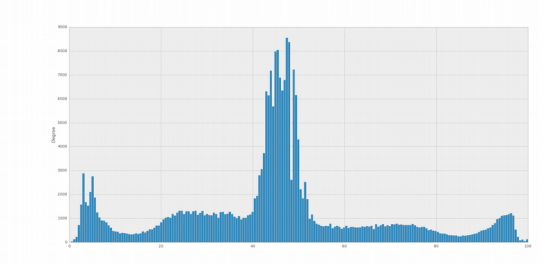
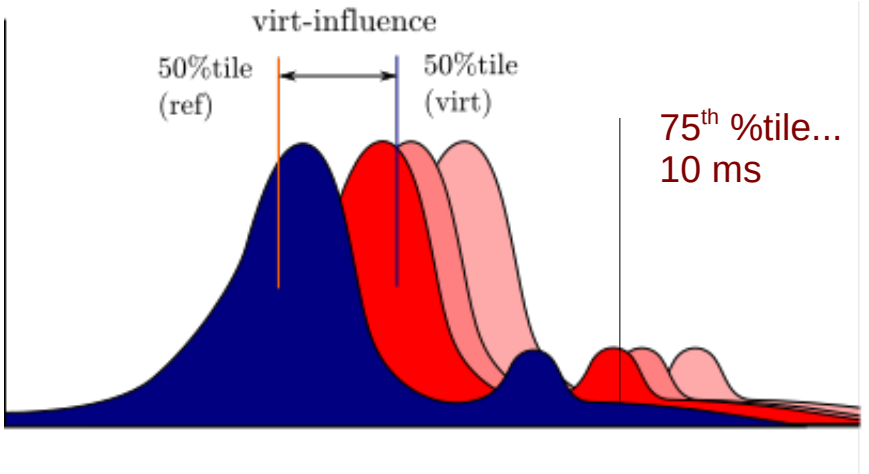


23 ms … 75th %tile

quantile-quantile difference



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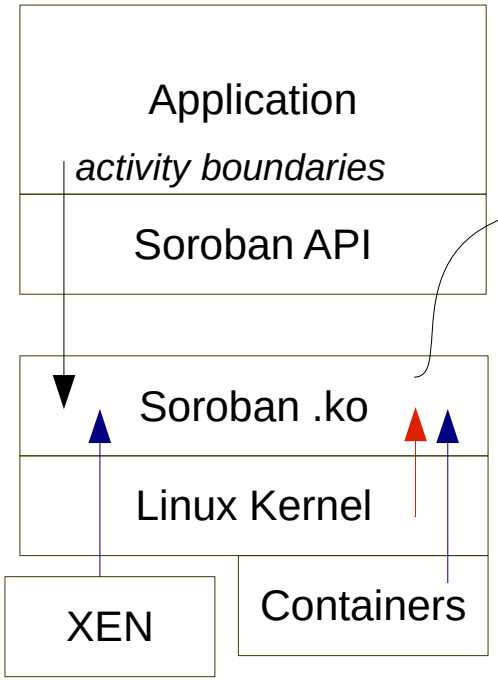

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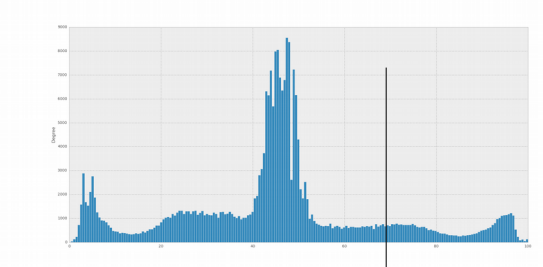


23 ms … 75th %tile

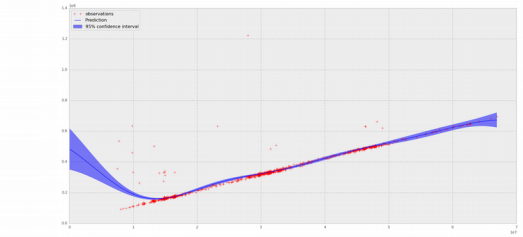
75th %tile...
10 ms

quantile-quantile difference

13 ms

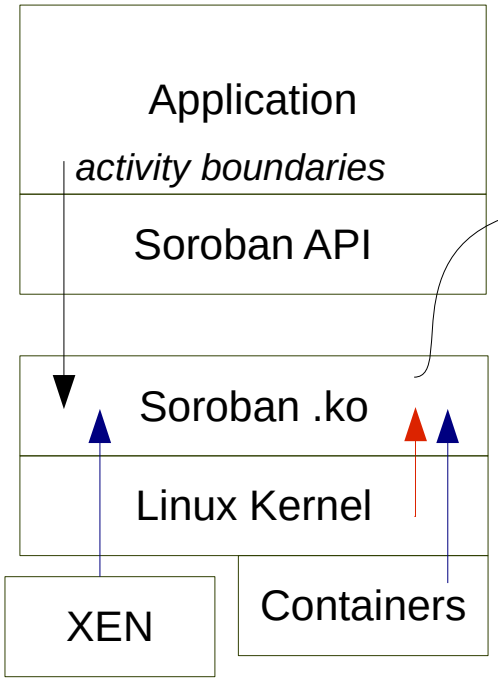
$(\text{sched}, \text{ev}, \text{yield}, \ldots. \text{lat}, \textbf{virt-influence})$

Gaussian Process regression model



Soroban

Measurement



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per activity data

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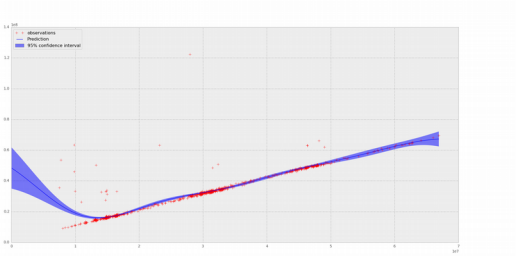
Attribution

Measurements in virtualized environment

Gaussian Process regression model



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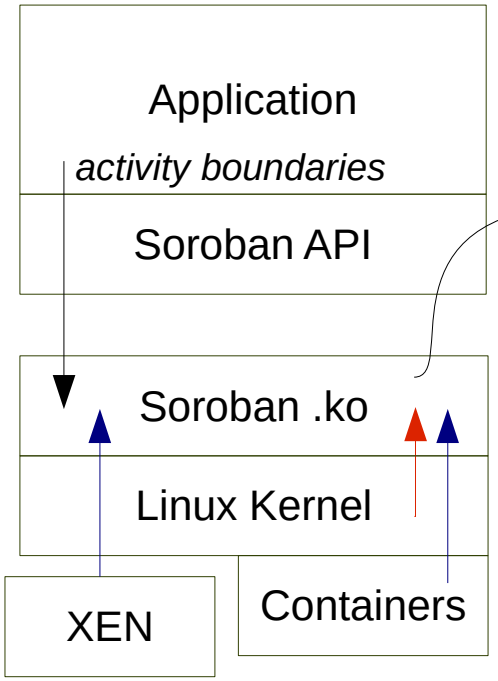
Measurement



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Attribution

Measurements in virtualized environment

(sched, ev, yield, ... lat)

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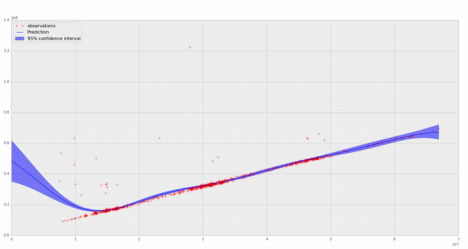


(**virt-influence,** confidence)

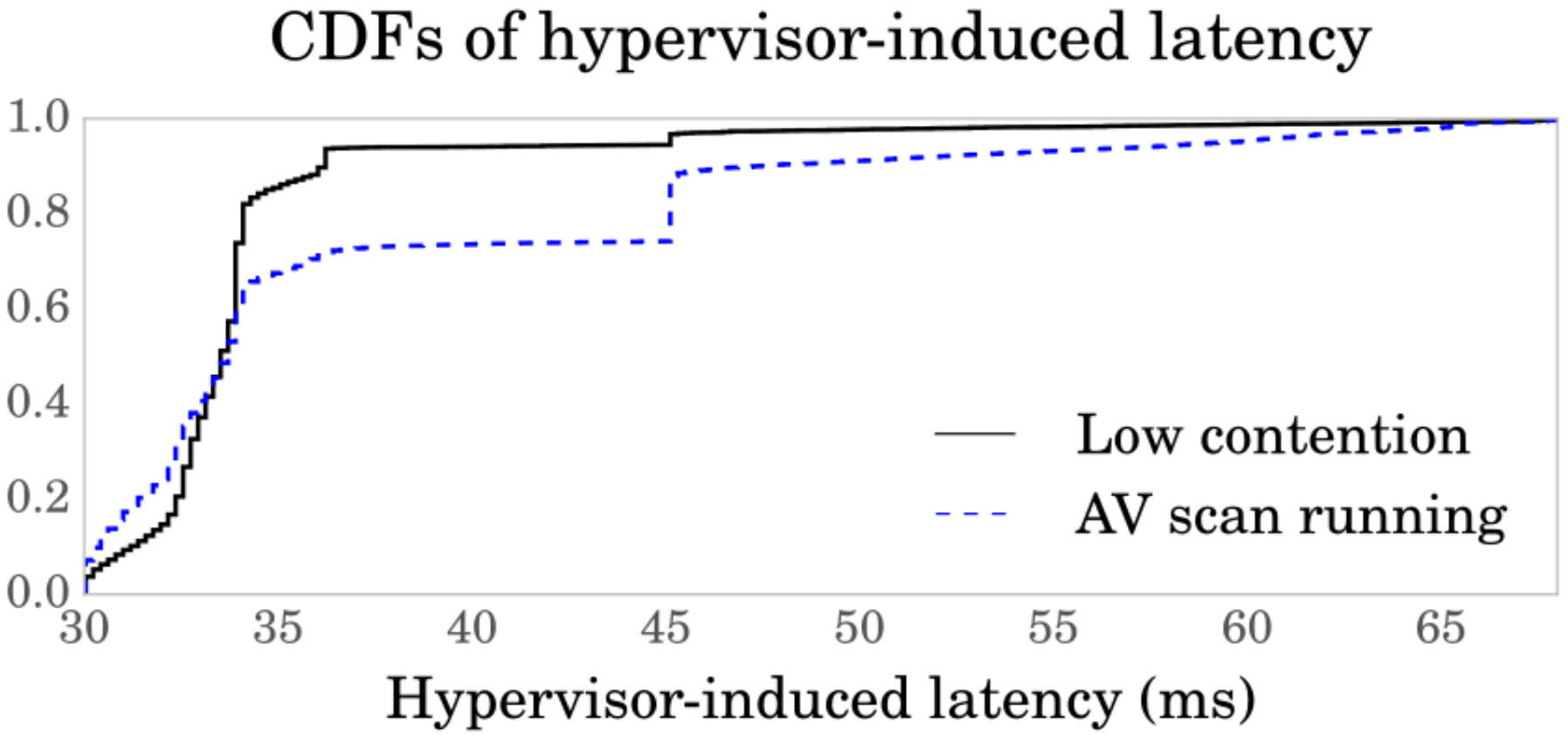
prediction

Hypervisor-induced latency

Containerisation-induced latency

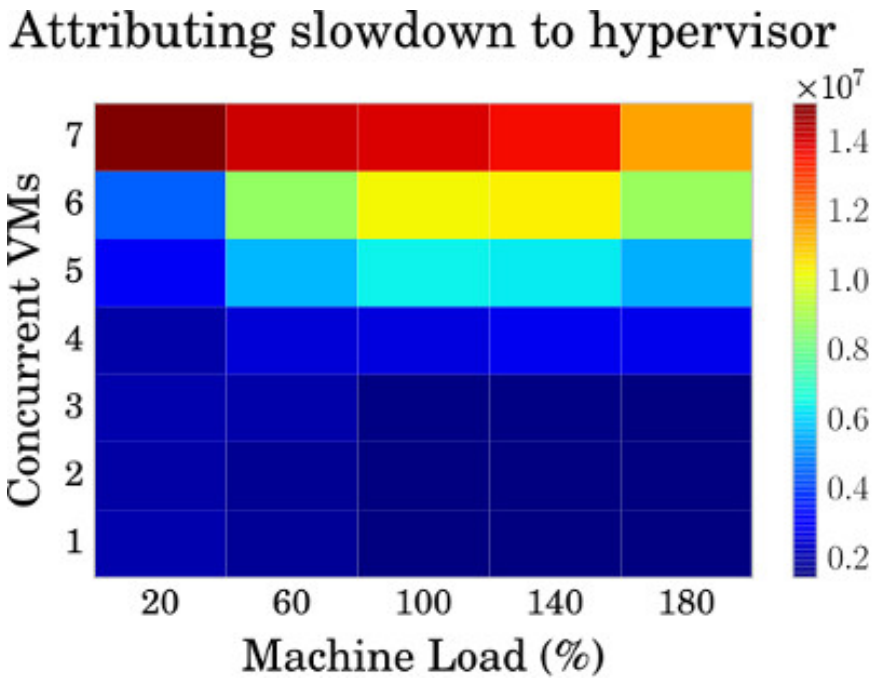
Results

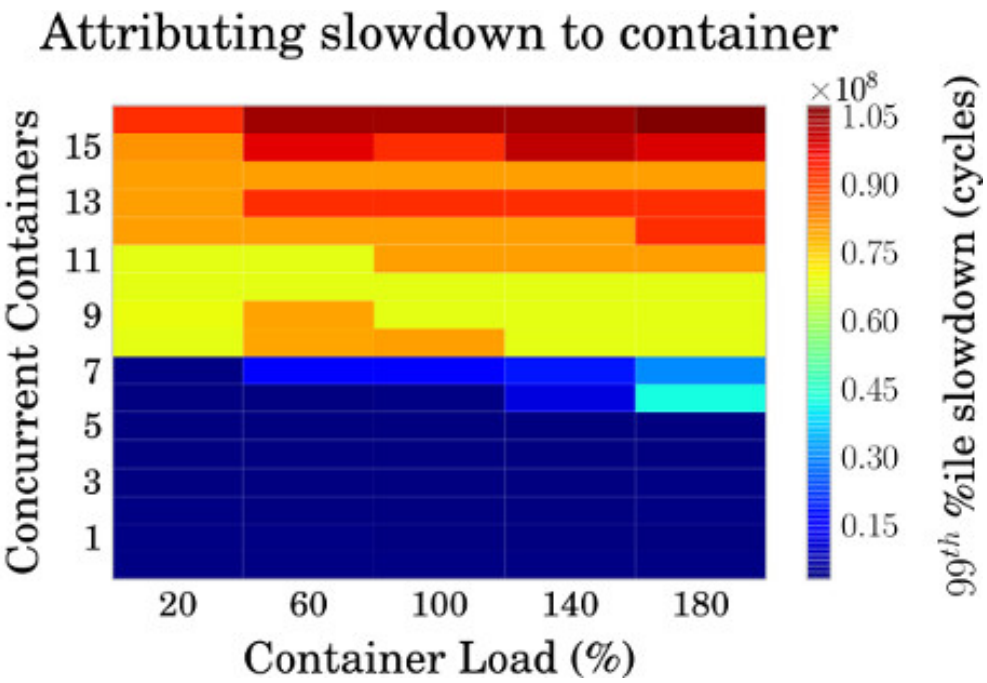
- Anti-Virus Scan performed in DOM0



Results

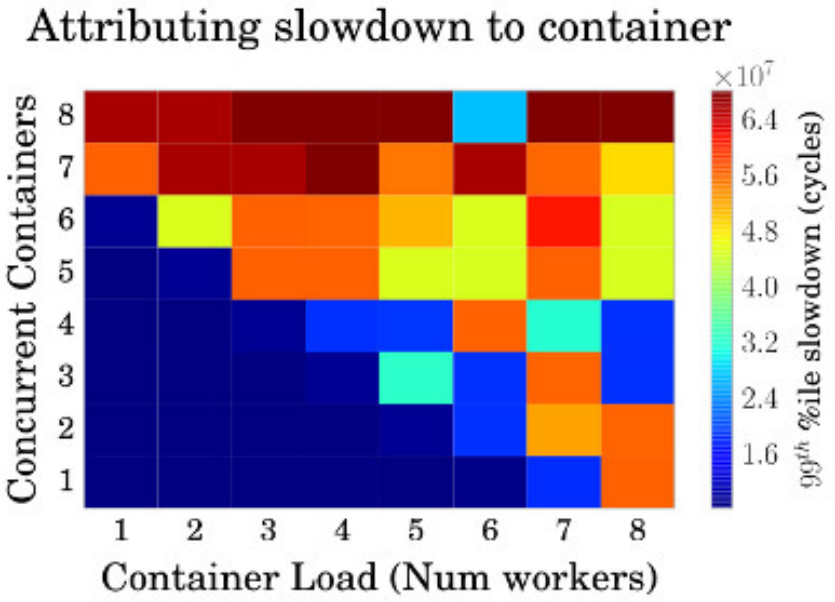
- Systematically varying load and contention





Limitations

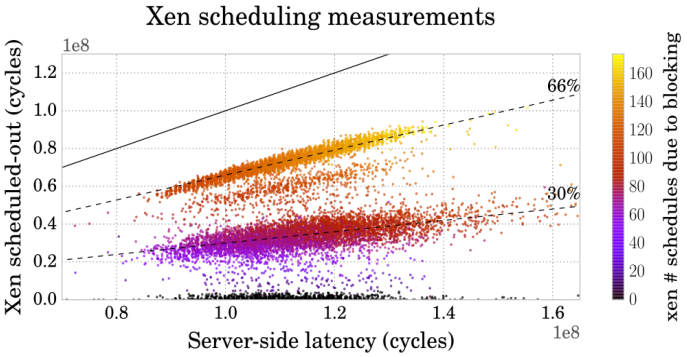
- Needs applications to disclose activity boundaries
- Training phase
- Depends on virtualization isolation properties

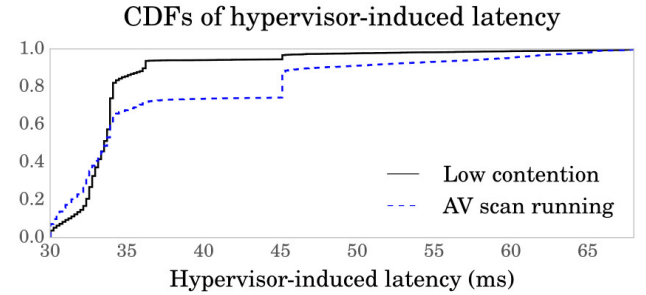


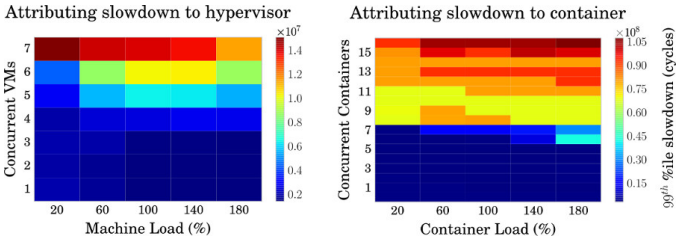
Discussion

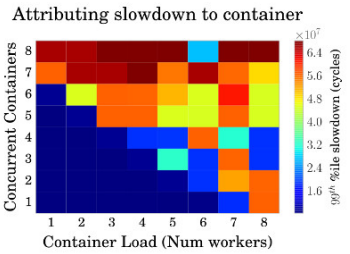
- Moving to multi-hop requests / actions
- Automating app instrumentation

- Cloud provider transparency
- Finer-grained charging?









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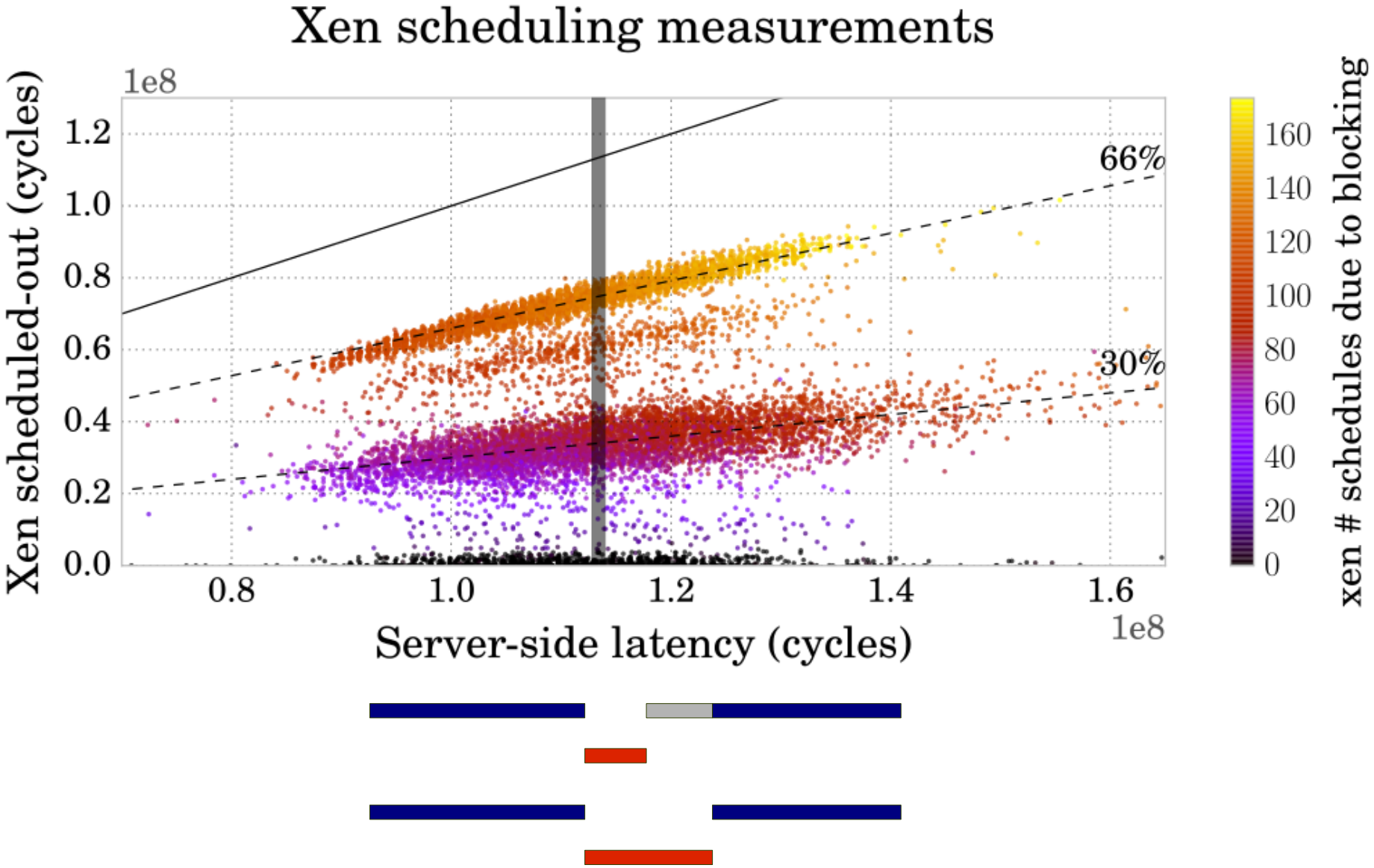
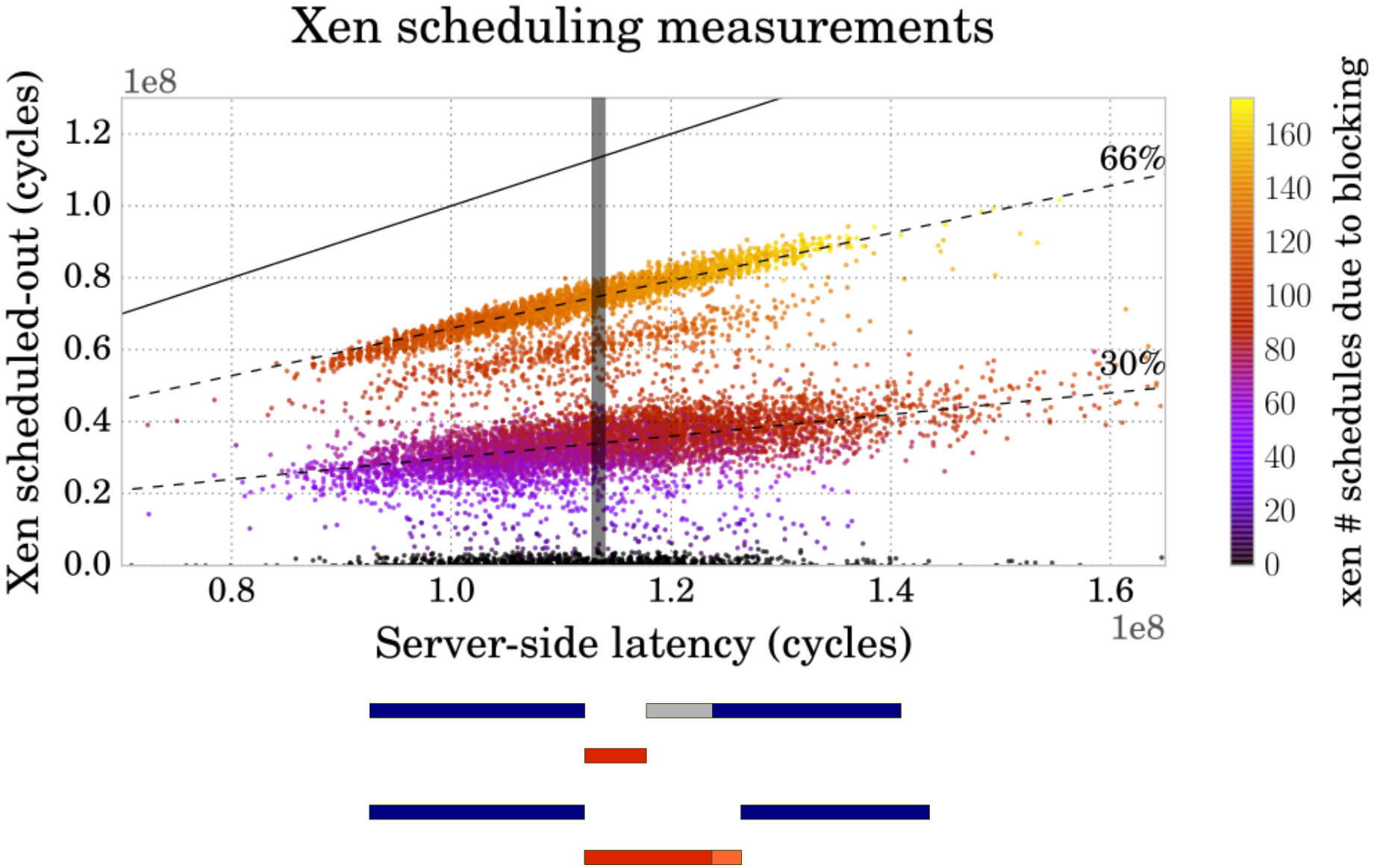
Discussion Slides

Measurement



Measurement