Scheduling result and bounds

Processes P1,P2, ... ,Pn on VBSs u1,u2, ... ,un, are schedulable

if $\sum ui \leq 1$

For any action α on a resource (λ,π) we have

upper response time bound
$\lceil load / \lambda \rceil \pi + \pi - 1$

lower response time bound
$\lceil load / \lambda \rceil \pi$

jitter
$\pi - 1$

Programmable temporal isolation

the “speed“ of an action is programmable
(influencing response time and jitter)

smaller π ⇒

+ smaller jitter

+ VBS response time closer to „ideal“ response time

- higher administrative overhead

(more scheduler invocations)

Finding the right λ,π is difficult.

server design problem

Real-world example

```
loop {

  sensor_data = read(sensors);
  actuator_data=compute(sensor_data);
  write(actuator_data);

  log(actuator_data);
  update_internal_state();

} until (done);
```

low latency

less stringent

control-loop period

Real-world example

```
loop {

  sensor_data = read(sensors);
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  log(actuator_data);
  update_internal_state();

} until (done);
```

action 1

action 2

control-loop period

different throughput and latency requirements for different portions of code

Implementation

- constant-time scheduling algorithm
- different queue management plugins

(lists, arrays, matrices, trees)

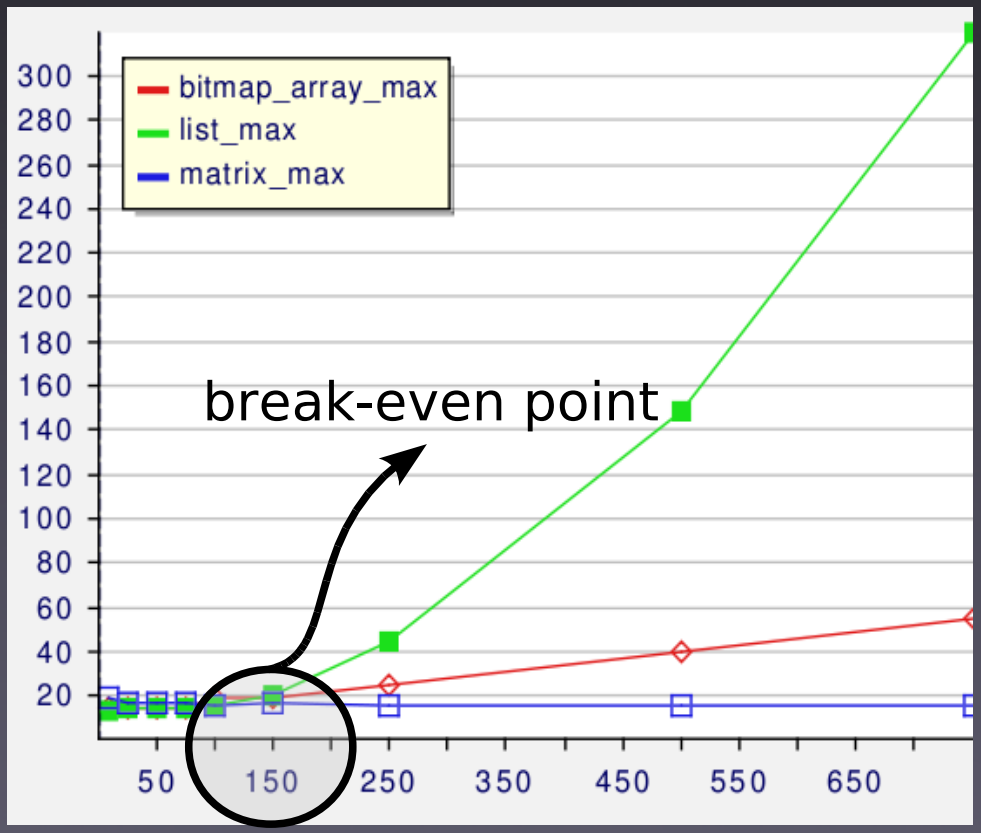
trade off time and space complexity

	list	array	matrix/tree
time	$O(n^2)$	$O(\log(t)+n\log(t))$	$\Theta(t)$
space	$\Theta(n)$	$\Theta(t+n)$	$O(t^2+n)$

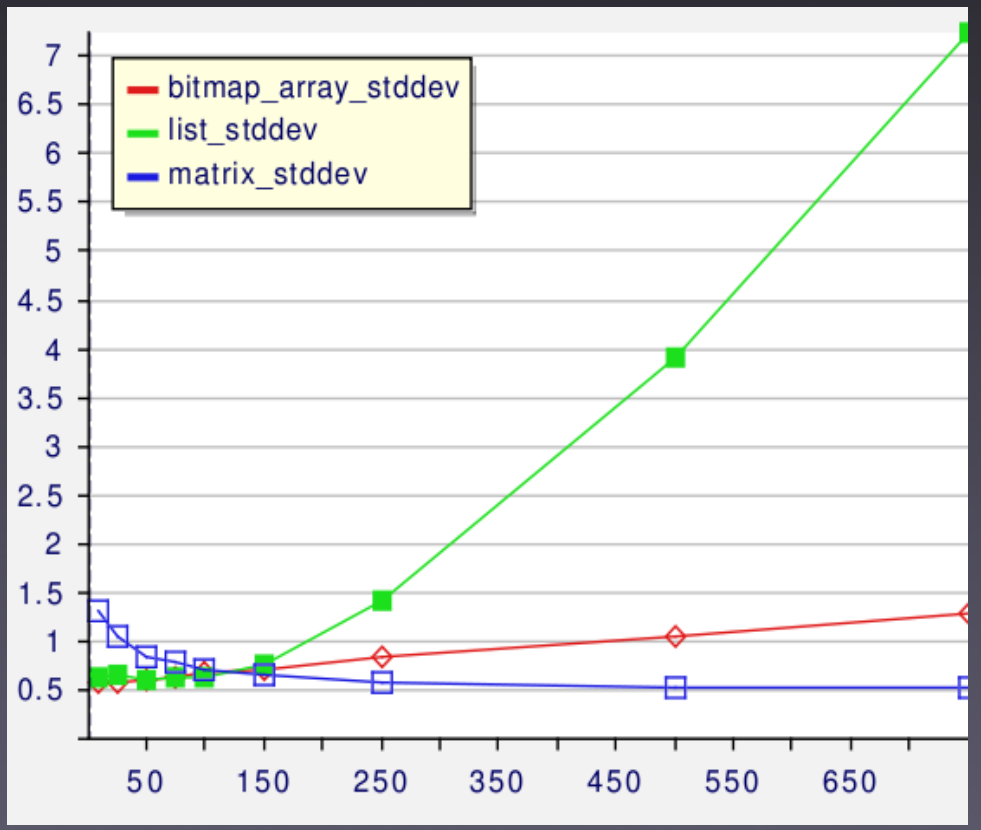
n – number of processes t – number of time instants

Results

scheduler overhead



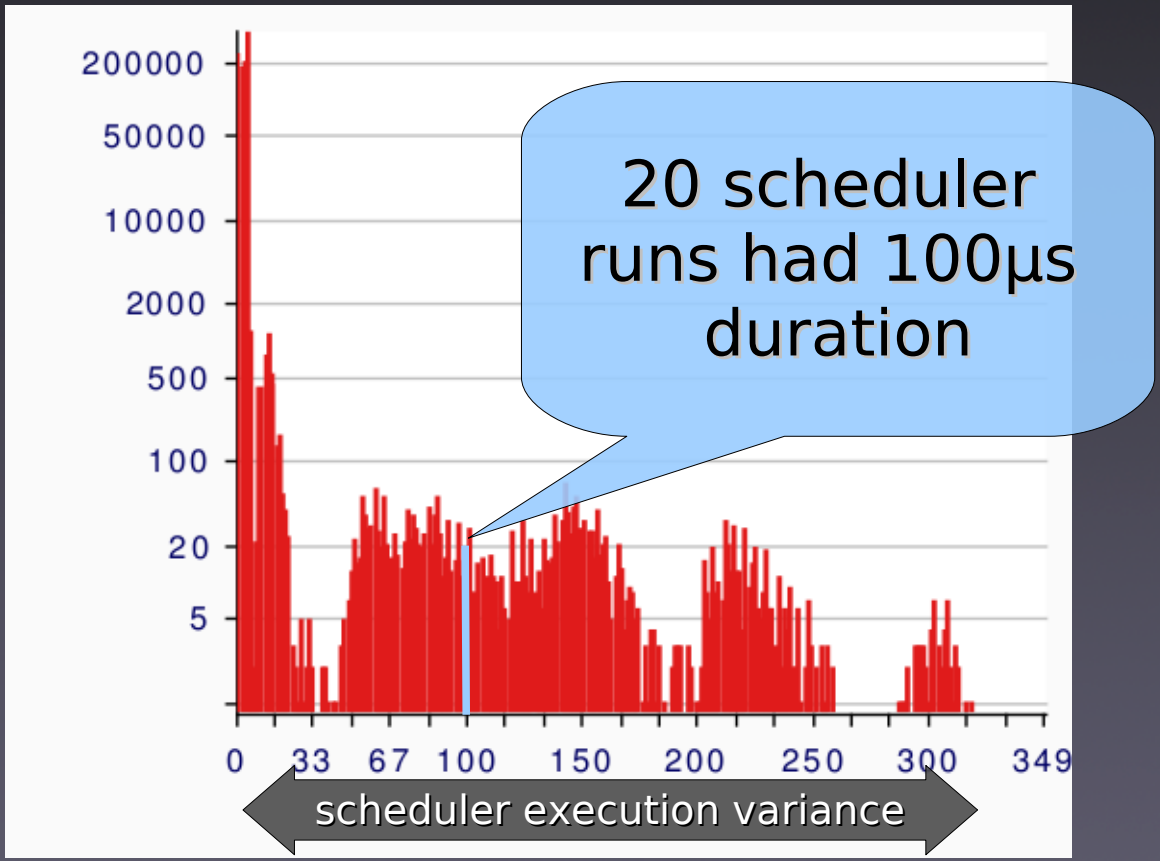
Maximum duration(µs) for increasing number of processes



Standard deviation for increasing number of processes

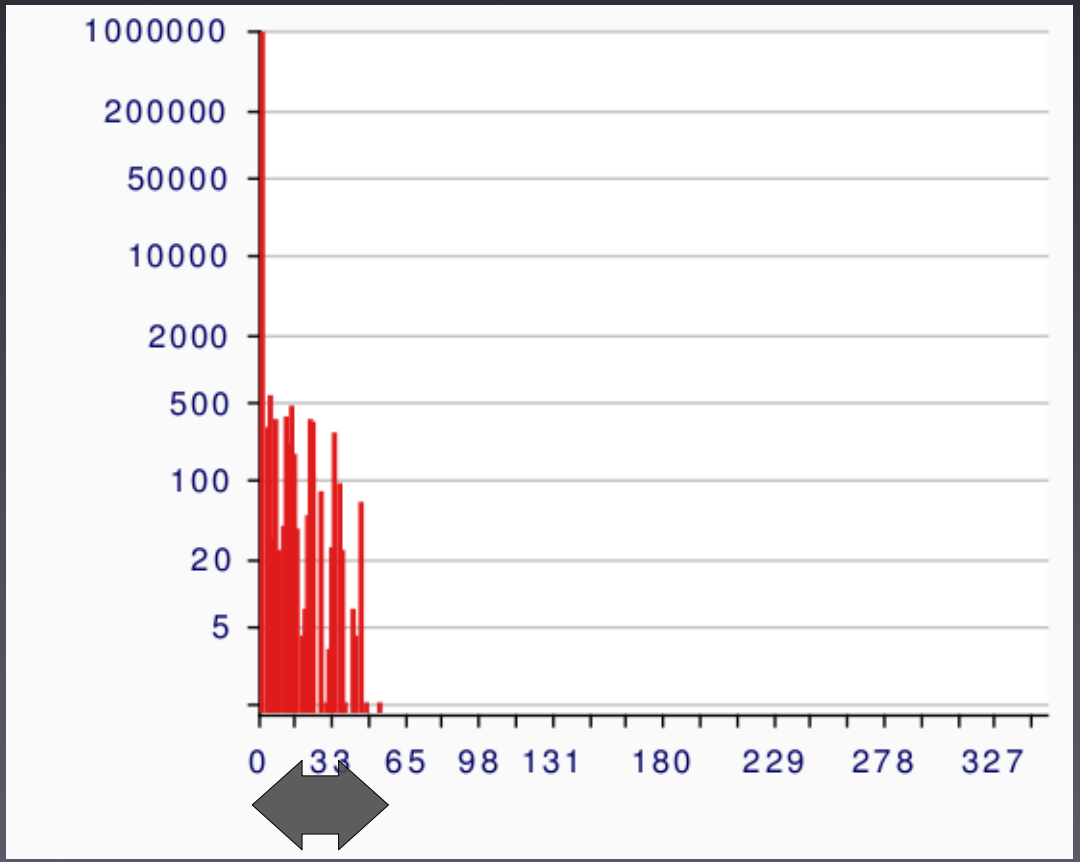
Results

scheduler overhead (list)



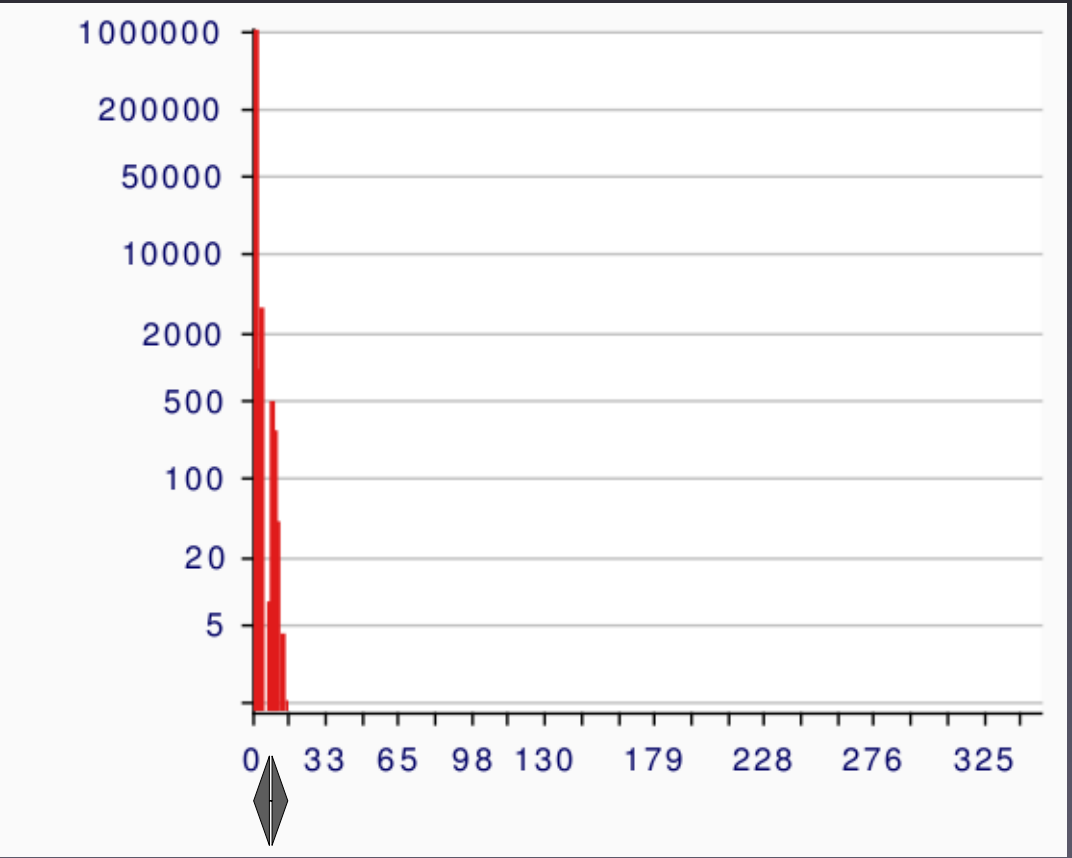
Results

scheduler overhead (array)



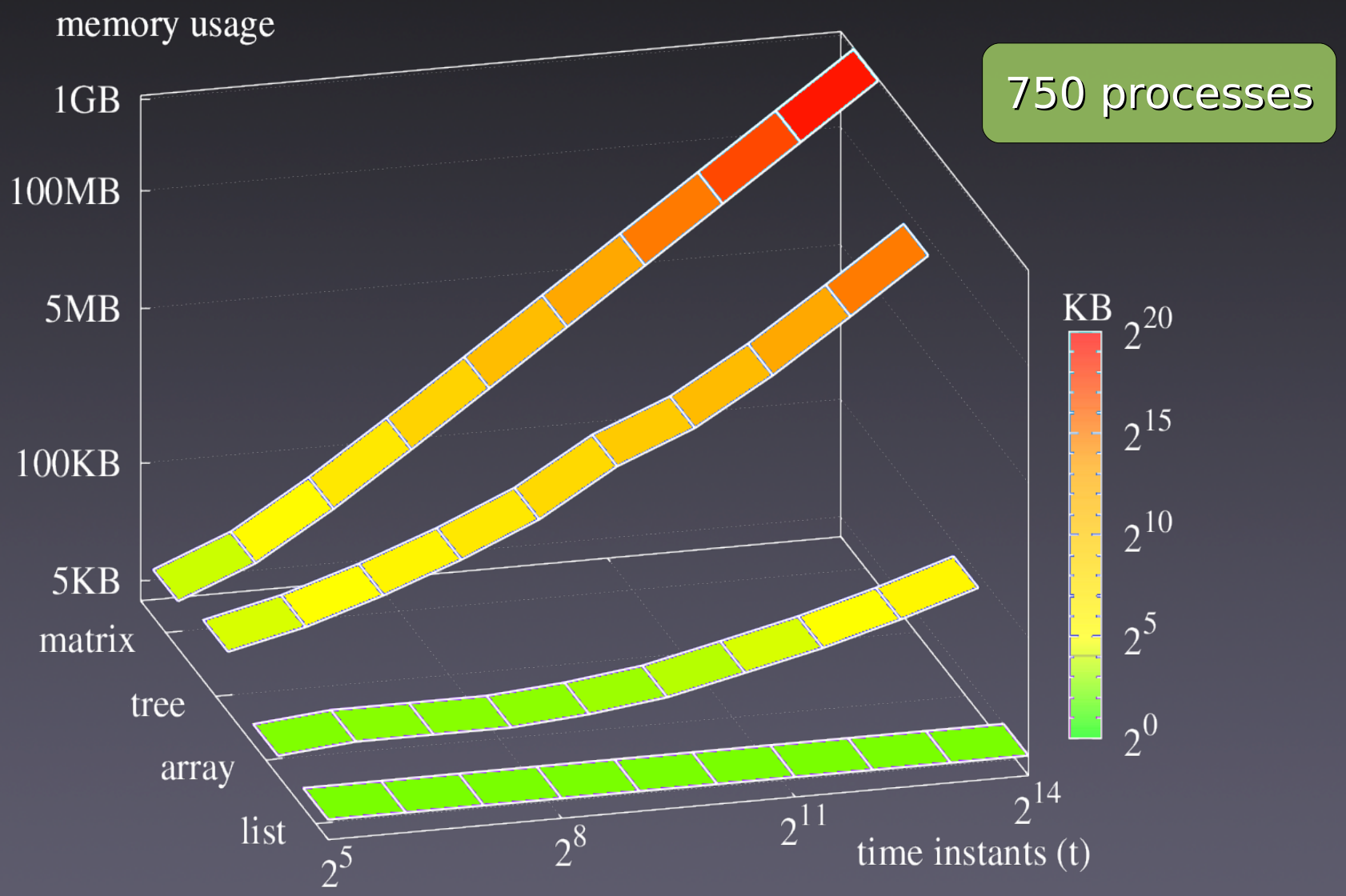
Results

scheduler overhead (matrix)



Results

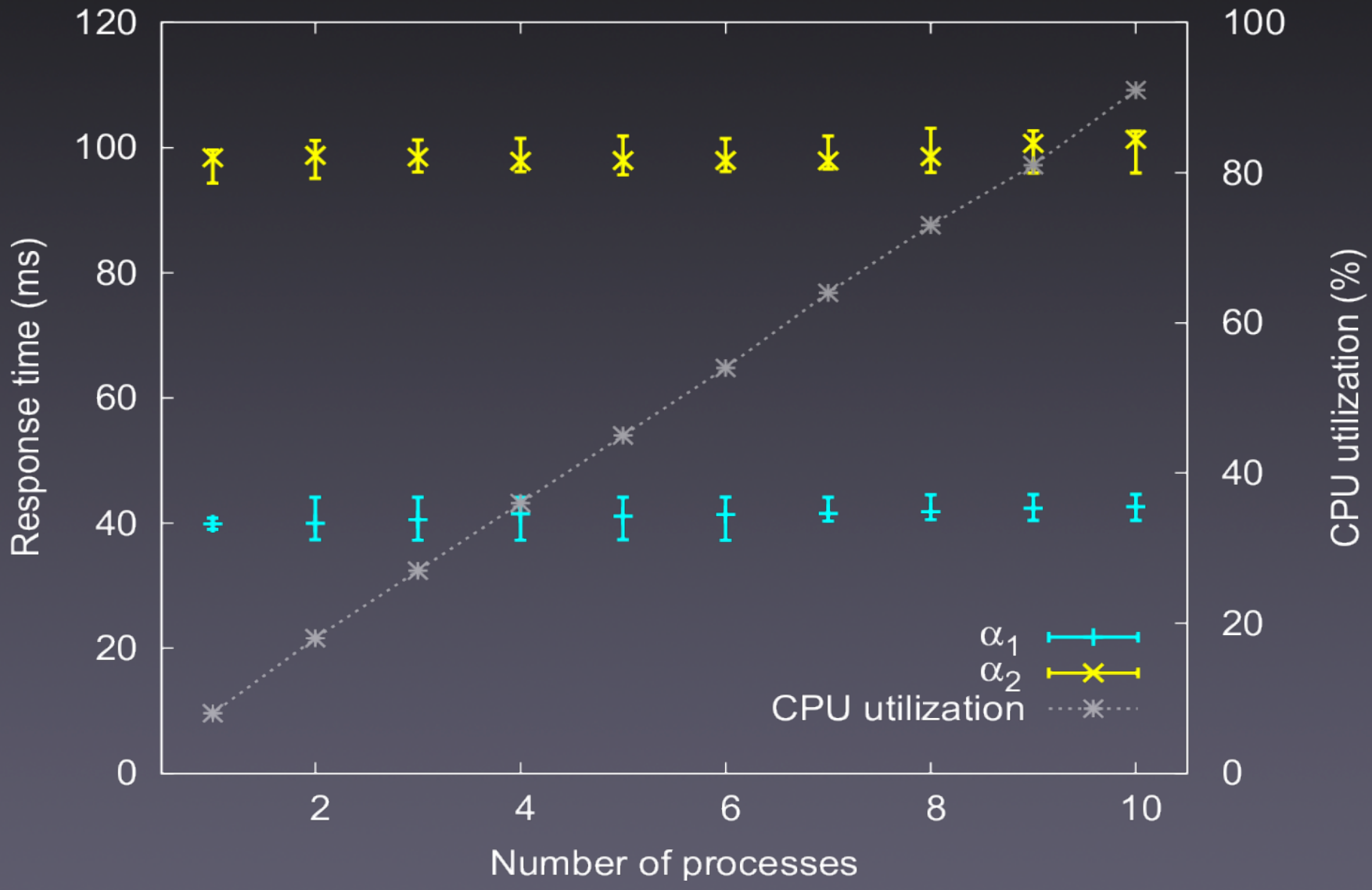
space complexity



750 processes

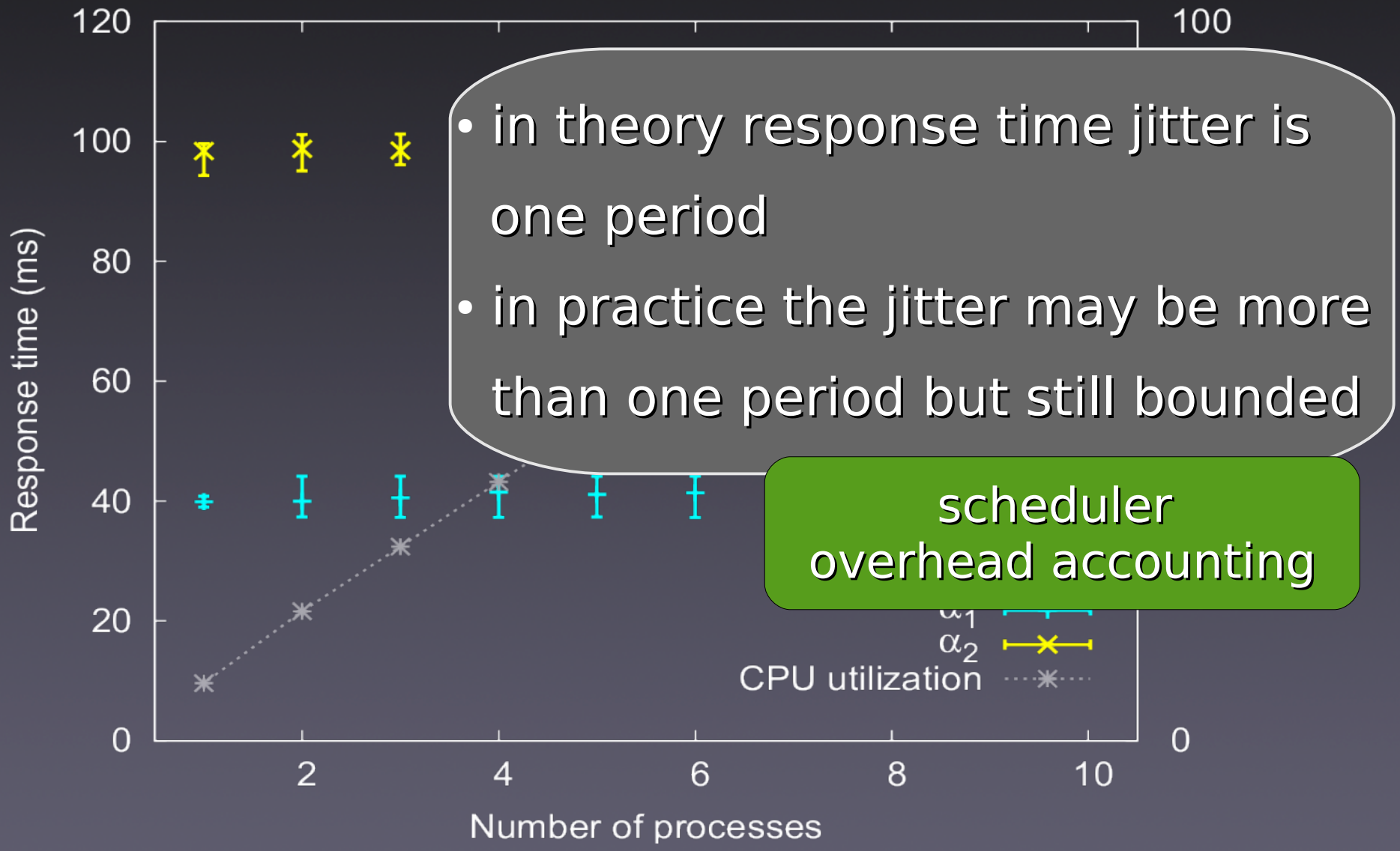
Results

bare-metal experiment



Results

bare-metal experiment



- in theory response time jitter is one period
- in practice the jitter may be more than one period but still bounded

scheduler overhead accounting

Conclusion

VBS scheduling enables:

- temporal isolation
- trading off throughput and latency
- controlling the response-time jitter of individual process actions
- trading off space and time complexity of the scheduling overhead

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Conclusion

VBS scheduling enables:

- temporal isolation
- trading
- controll of individu
- trading off space and time complexity of the scheduling overhead

Thank you!

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