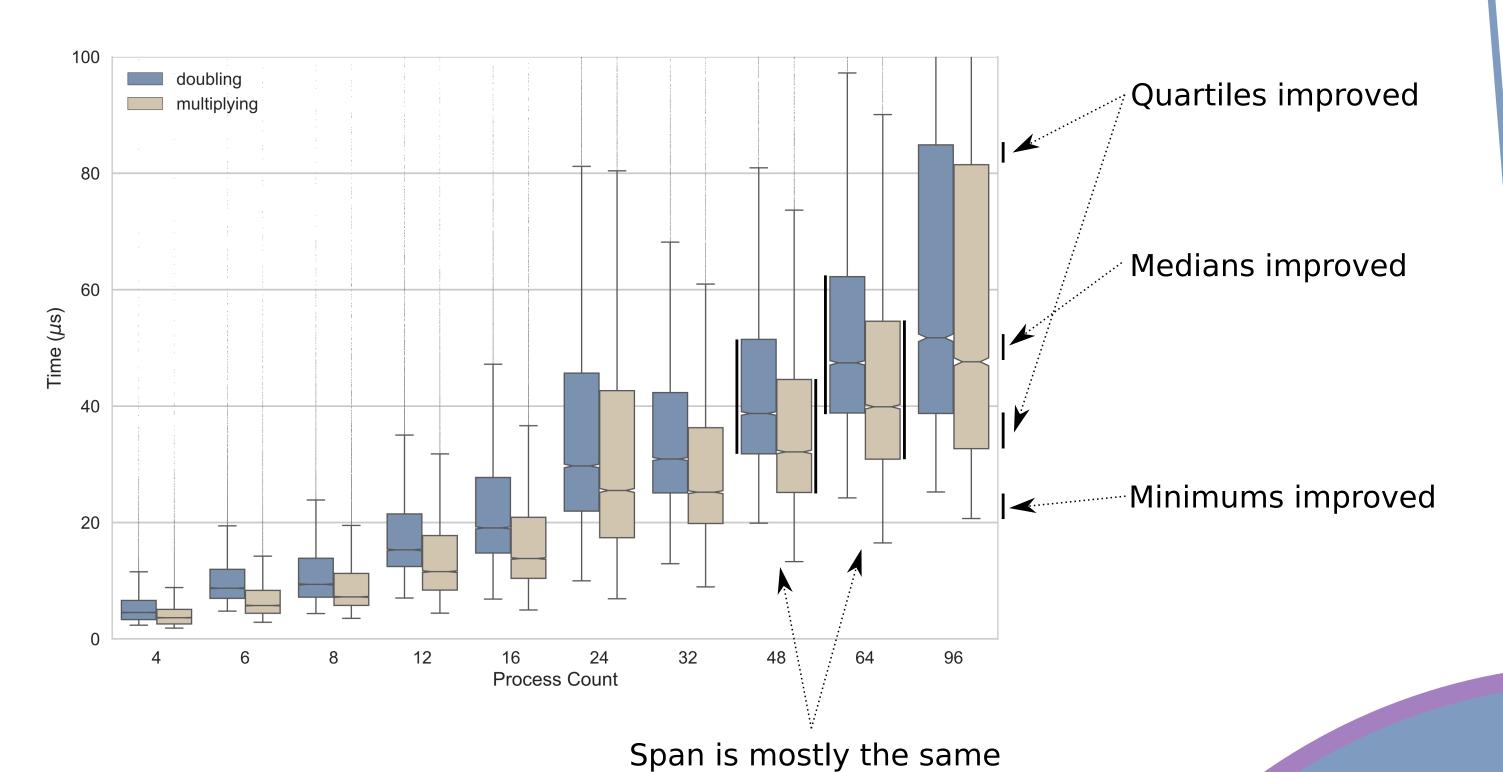
#### Challenge Superset of Recursive Doubling • We have Recursive Multiplying: Each process has 2x 3-way a value to reduce exchanges Communication is done 3x pairwise with multiway exchanges exchanges Yields reduced value on This is the all processes Possible due to message pipelining schedule (a3, a2)

Recursive Multiplying outperforms Recursive Doubling



#### Problems:

- Long tails of the distributions
- Only intended for small message sizes

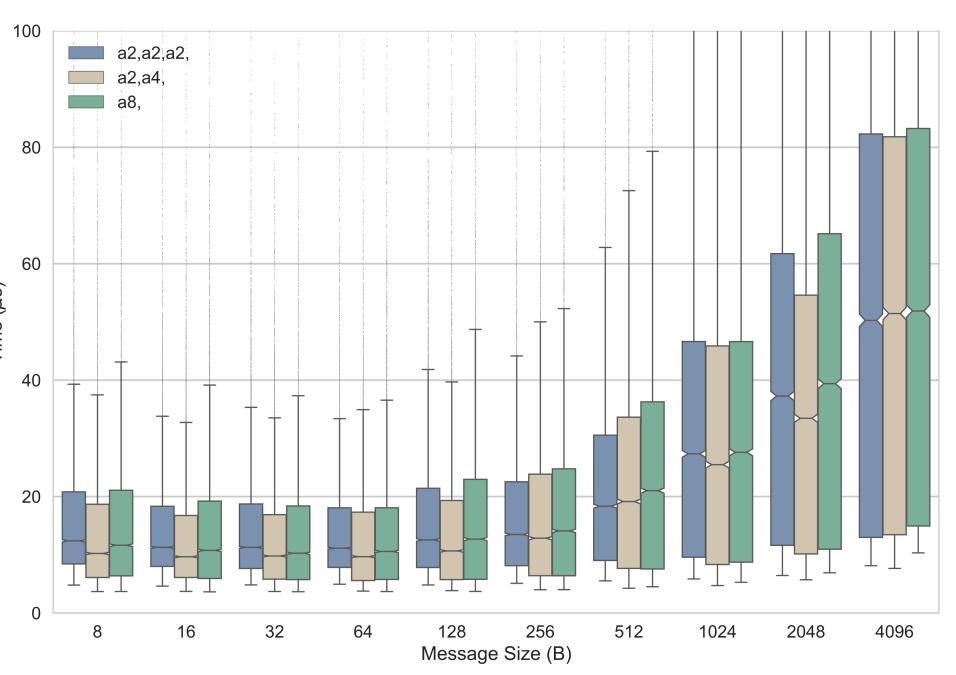
## Recursive Multiplying More Flexible Than Expected

Martin Ruefenacht

Mark Bull

Stephen Booth

How far can we push the size?



a2.a2.a2.a2.a2.a2.

- 8 Processes
- No clearly superior schedule to use for message size.
- well up to 4 kB.

Dense schedules perform

64 Processes

- Divergence between schedules is opposite of expected.
- Recursive Doubling should outperform other schedules due to low bandwidth.

 Suprisingly, as far as Recursive Doubling which is not used above 4KB with better results.

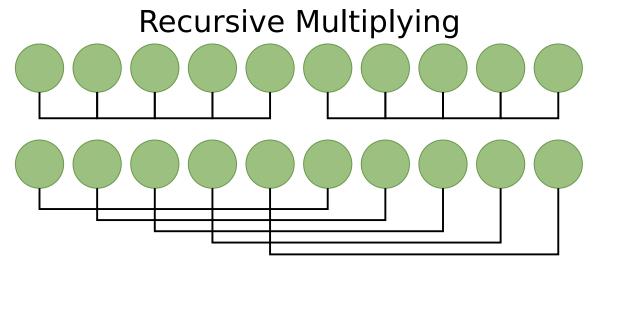
All results shown are from ARCHER, Cray XC30, with the default environment.

# Engineering and Physical Sciences

Can we trade off costs?

Send One-way **Active Process** Send Two-way **Inactive Process** No Receive

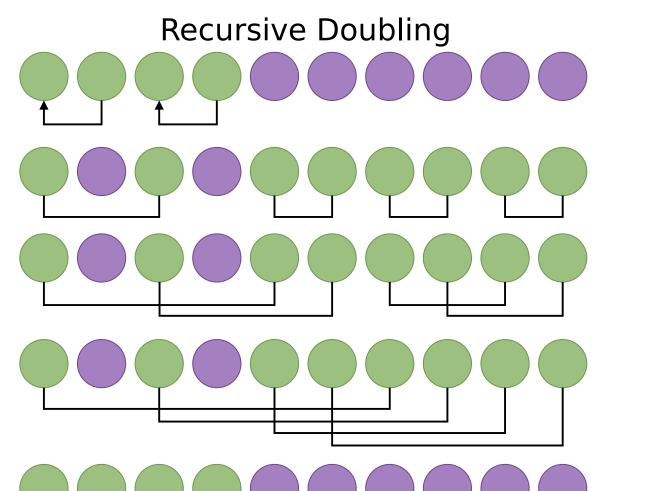
N = 10, latency values are based on theoretical model.



No inactive processes

Latency: 3.0 μs, 100%

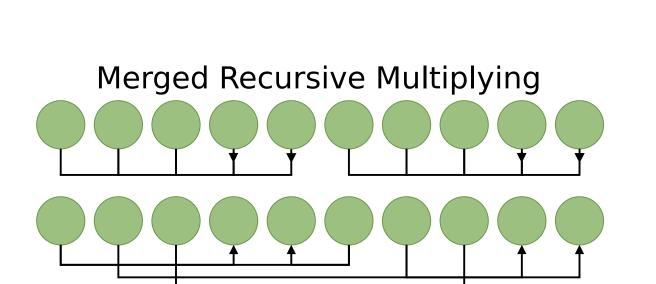
Most number of messages: 50, 100 %



Inactive processes are not contributing

Latency: 6.0 μs, 200 %

Least number of messages: 28, 56 %



No inactive processes

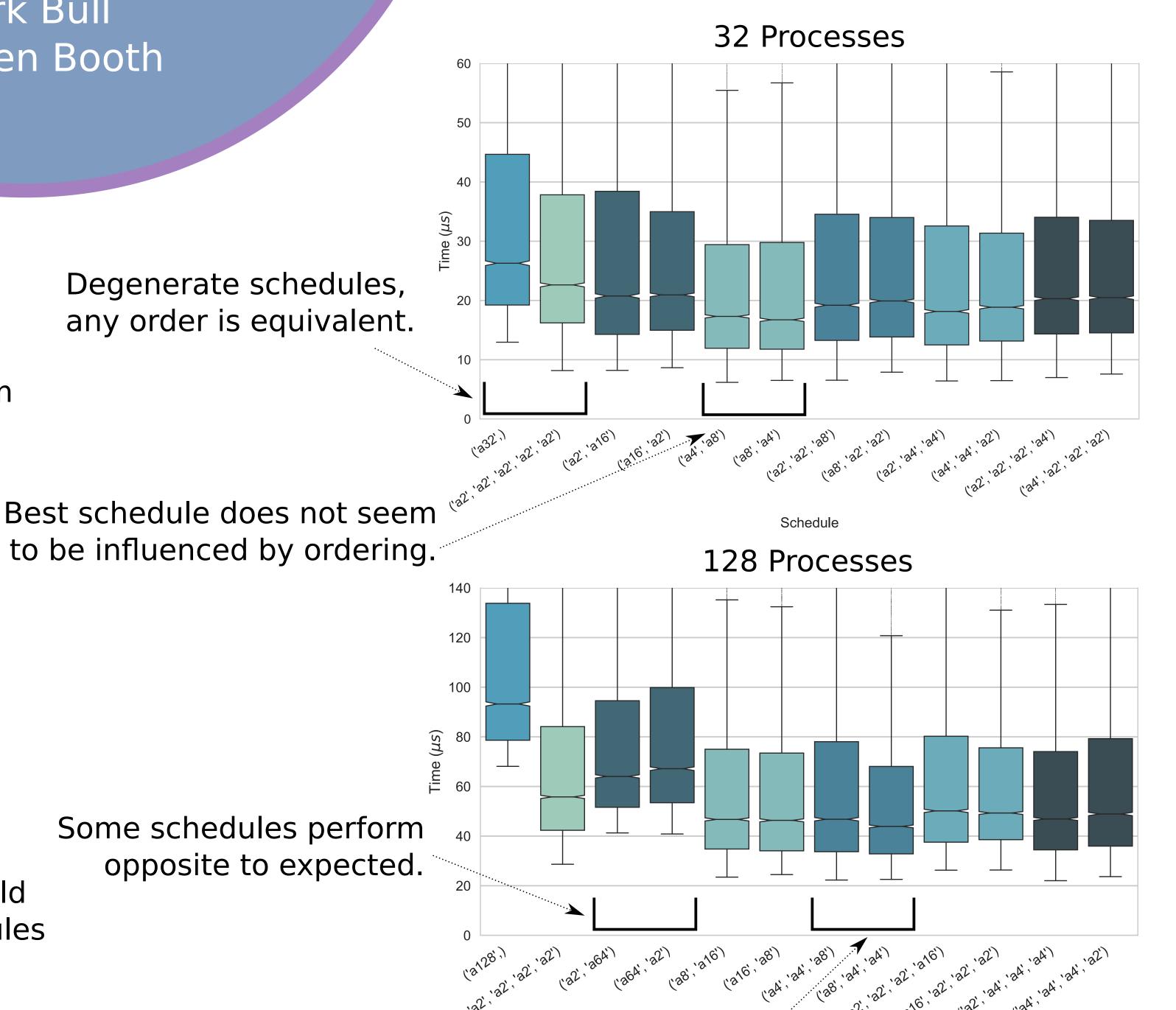
Latency: 3.2 μs, 107 %

Reduced number of messages: 36, 72 %

Yes, we can use different schedules to trade off between latency and message count.

### Does schedule order matter?

Same color = same schedule set



Best schedule 75th quartile improved by 12.7% with specific ordering.

 Yes, the best schedules are descendingly ordered.





