**Challenge**

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

**Can we trade off costs?**

- Active Process
- Inactive Process
- N = 10, latency values are based on theoretical model.
- No inactive processes
- Latency: 3.0 µs, 100%
- Most number of messages: 50, 100%
- Recursion Multiplying
- Recursive Doubling
- Merged Recursive Multiplying
- 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.**

**Recursive Multiplying**
More Flexible Than Expected

- Martin Ruefenacht
- Mark Bull
- Stephen Booth

**How far can we push the size?**

- 8 Processes
  - No clearly superior schedule to use for message size.
  - Dense schedules perform well up to 4 KB.

- 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.

**Does schedule order matter?**

- Same color = same schedule set

- Degenerate schedules, any order is equivalent.

- Best schedule does not seem to be influenced by ordering.

- Some schedules perform opposite to expected.

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

- Yes, the best schedules are descendingly ordered.