But What About Updates?
Read-Mostly Workloads Scale Well
Update-Heavy Workloads, Not So Much...
But There Are Some Special Cases
But There Are Some Special Cases

- **Split counters (used for decades)**
  - Have a per-CPU/thread counter
  - For updates, each CPU/thread non-atomically updates its own counter
  - For reads, sum all the counter
  - Rely on commutative and associative laws of addition
  - Plus rely on short-term inaccuracy permitted for statistical counters
  - Constant work done for updates, linear scaling, great performance

- **Per-CPU/thread processing (perfect partitioning)**
  - Huge number of examples, including the per-thread/CPU stack
  - But not everything can be perfectly partitioned
Special Case: Stream-Based Applications

- Adrian Sutton of LMAX presented this at linux.conf.au 2013:
  - http://www.youtube.com/watch?v=UvE389P6Er4

- Only two threads permitted to access a given location

- Use fixed-array circular FIFOs to pipe data between data-processing stages (represented by individual threads/CPUs)

- Get nearly uniprocessor performance, especially for heavy-weight processing
Example Stream-Based Application

Input → Initial Processing → FIFO → Fan-out

FIFO → More Processing → FIFO → FIFO

FIFO → Fan-in → FIFO → More Processing

Output
Other Approaches

- Hardware transactional memory
  - You saw Andi Kleen's talk

- More sophisticated uses of associativity and commutativity
  - Research topic, some progress being made
  - And they are using the Linux kernel as a test case!

- Your ideas here!!!
Summary

- We are farther along with read-mostly methods than with update-heavy methods
- But there are some good approaches for update-heavy workloads for some special cases
  - Split counters
  - Stream-based applications
  - Hardware transactional memory
  - Maybe some more
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