# Dynamic Resource Throttling for Well-Conditioned Internet Servers

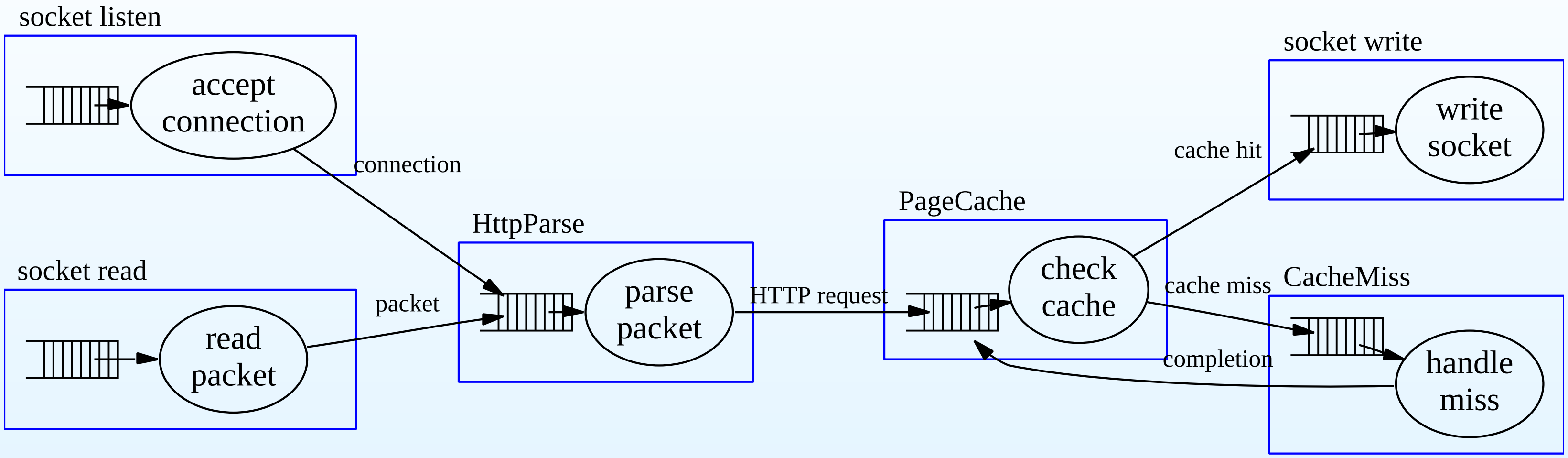
Matt Welsh and David Culler

UC Berkeley Computer Science Division

*mdw@cs.berkeley.edu*

USITS'01, San Francisco, March 27, 2001

# SEDA: The Staged Event-Driven Architecture



## Supports massive concurrency

▷ *Stages are event-driven and use nonblocking I/O*

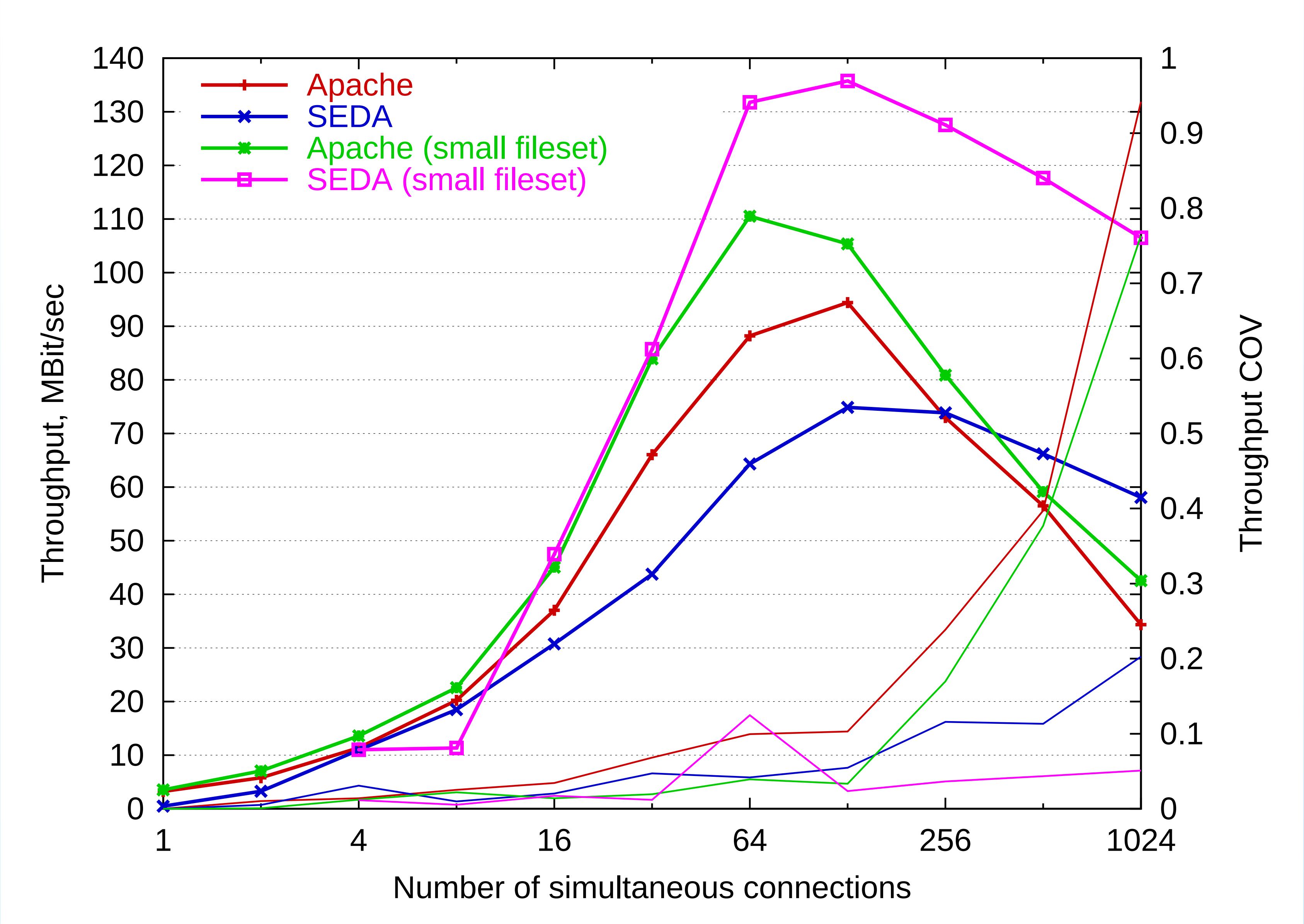
## Enables load conditioning

▷ *Exposure of queues facilitates inspection of request stream*

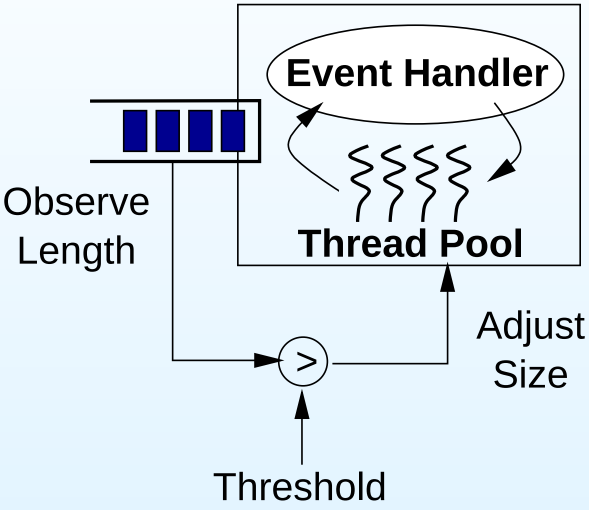
## Simplifies service construction

▷ *Stages embody robust, reusable service components*

# Robust Performance under Heavy Load



# SEDA Stage Controllers

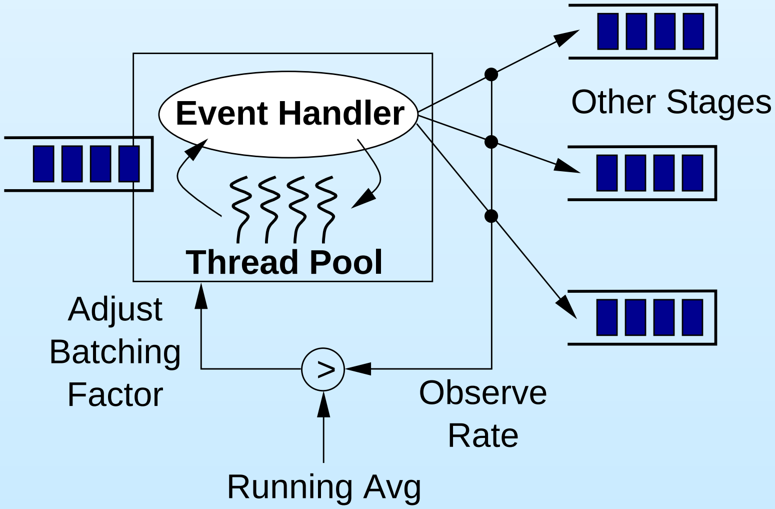


## *Thread pool controller*

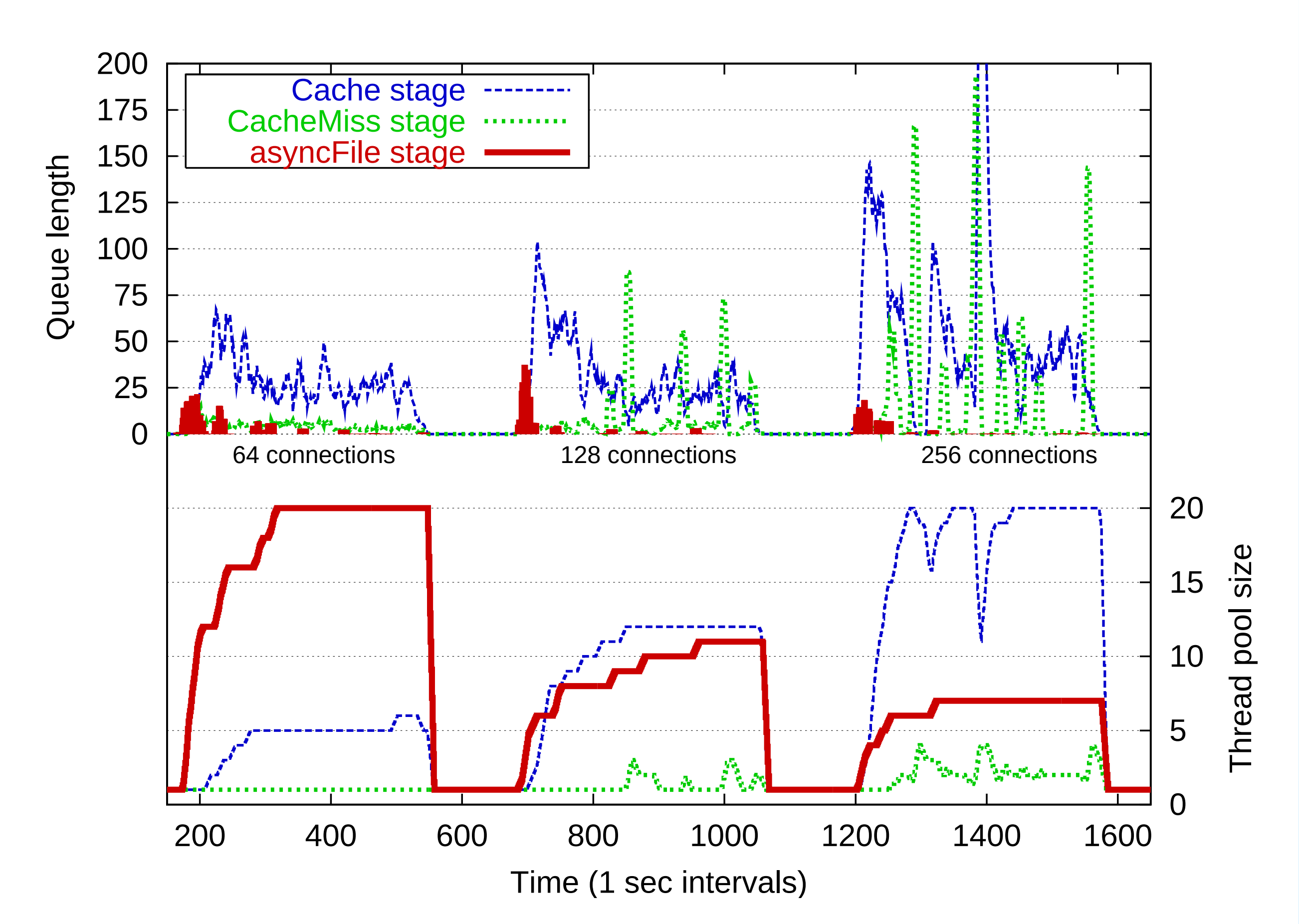
- Adjusts number of threads allocated to each stage
- Observes input queue length
- Adds threads if over threshold
- Idle threads removed from pool

## *Batching controller*

- Adjusts number of events processed by event handler
- Observes output event rate
- Attempts to find smallest batching factor with stable throughput

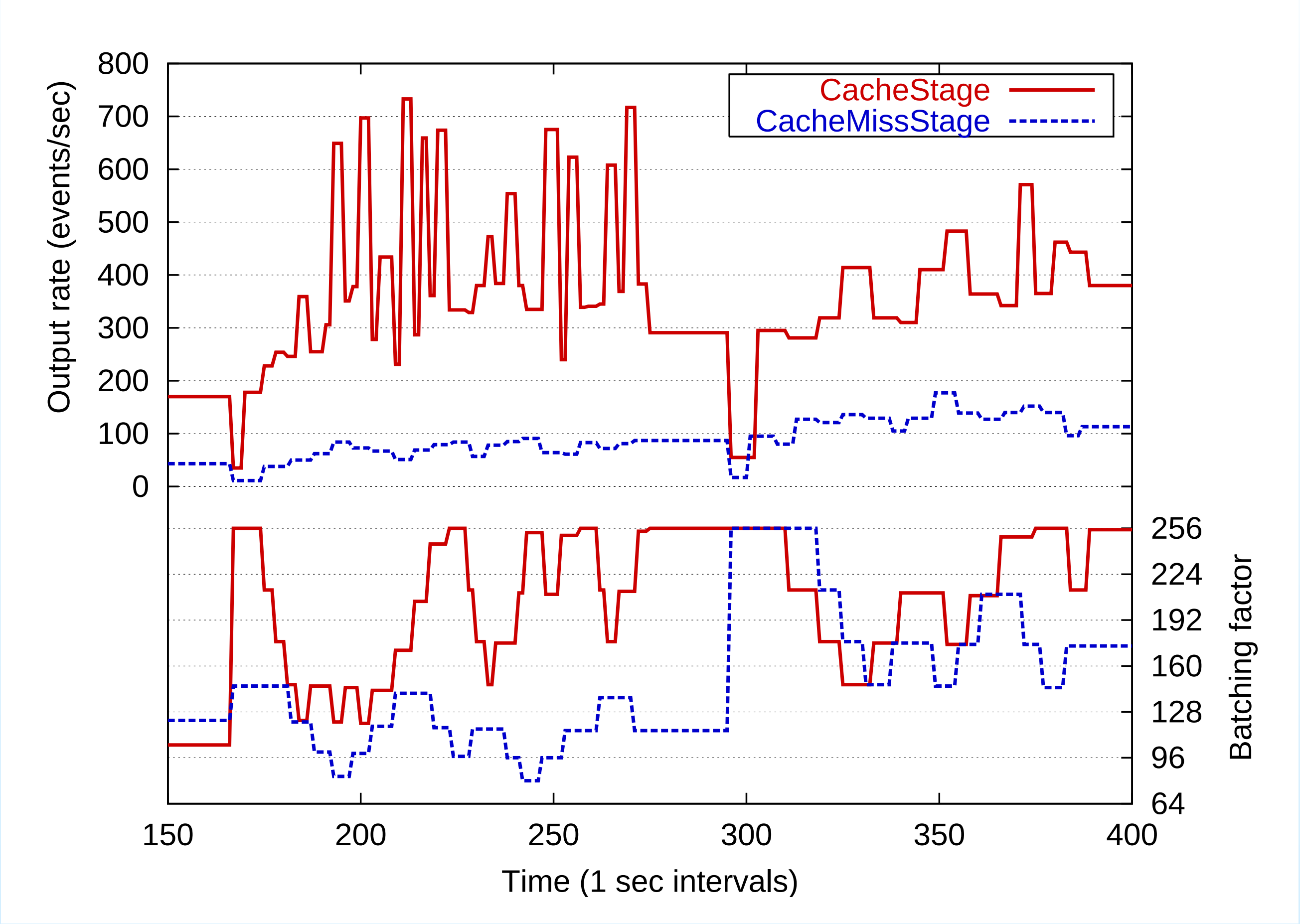


# Thread Pool Controller in Action



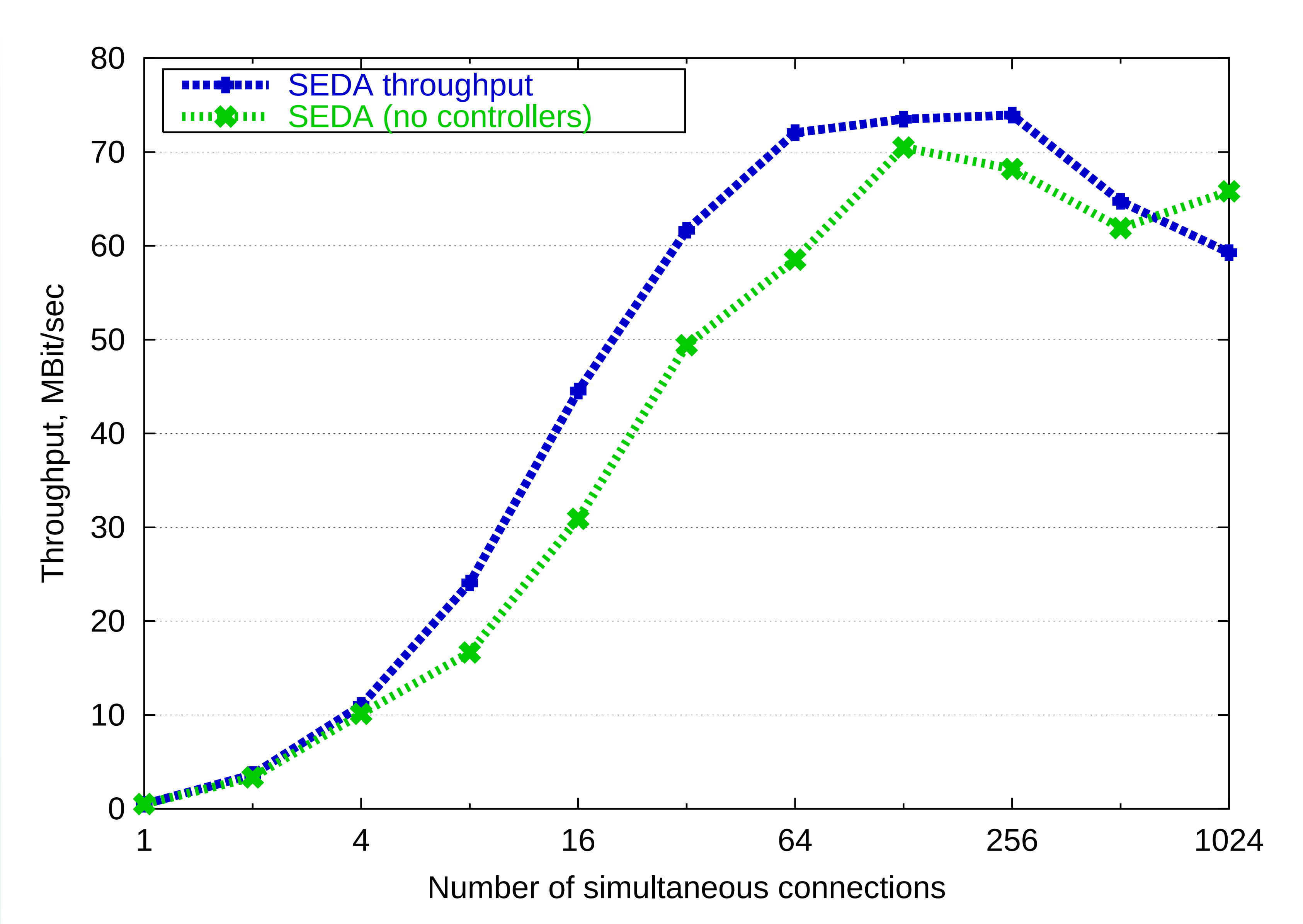
- Fewer threads needed for file I/O over time
  - ▷ *Filesystem buffer cache warming up*

# Batching Controller in Action

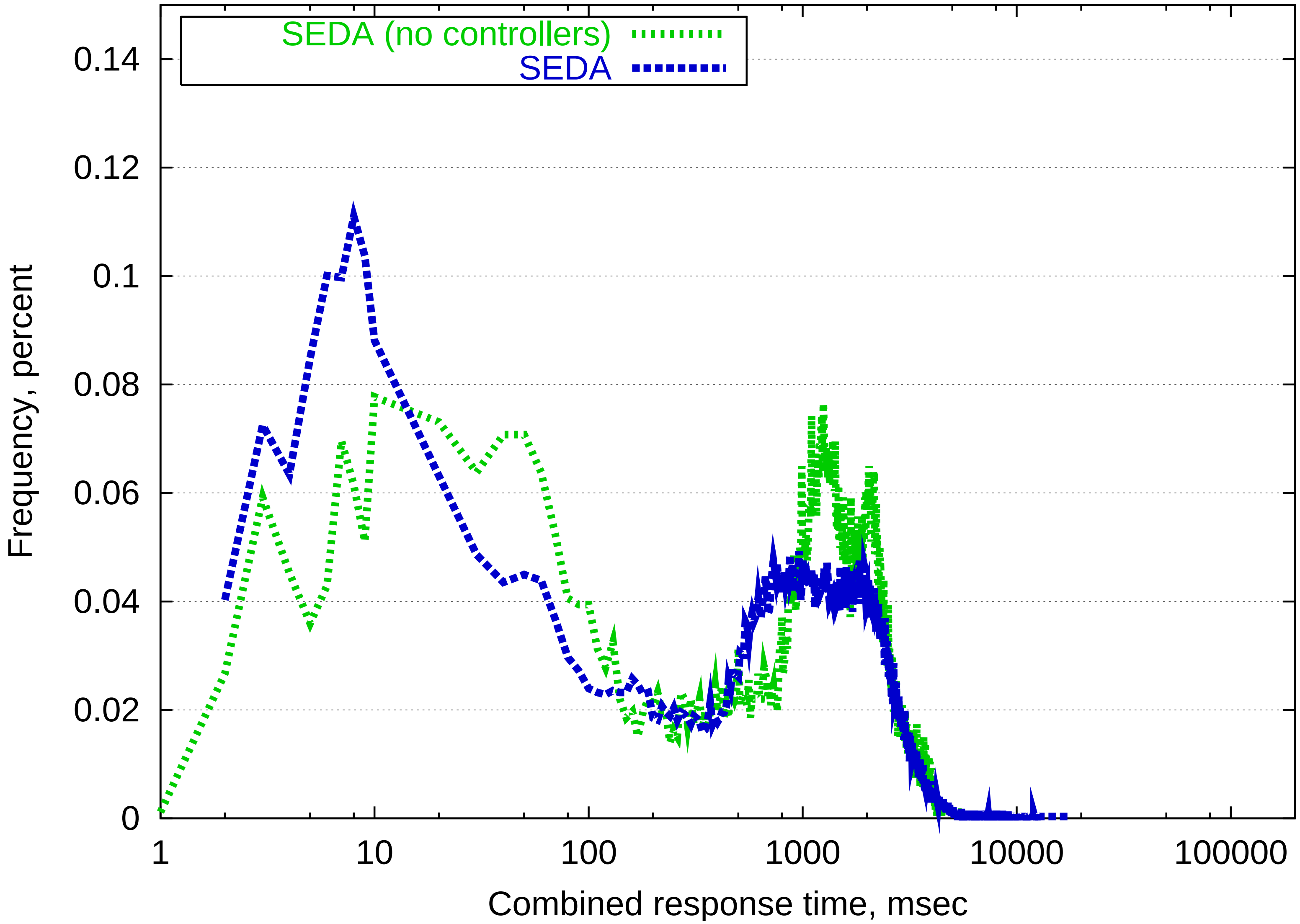


- At light load, maximum batching → high throughput, low inherent response time
  - ▷ *Respond to sudden drop in load by resetting batching factor to max*

# Throughput benefit of controllers



# Response time benefit of controllers



# New Way of Thinking about Software

## Support for massive concurrency requires new design techniques

- SEDA introduces service design as a *network of stages*
- Design for robustness and adaptivity, rather than best case
- Expose request streams to applications for load conditioning

## Resource throttling to keep stages within operating regime

- Adapt behavior at runtime to deal with changing load
- Controllers shield service developers from much of this complexity

## Implications for OS and language design

- SEDA model opens up new questions in service design space
- Bring body of work on control systems to bear on service design
- Many interesting controller algorithms possible

For more information:
`http://www.cs.berkeley.edu/~mdw/proj/seda/`