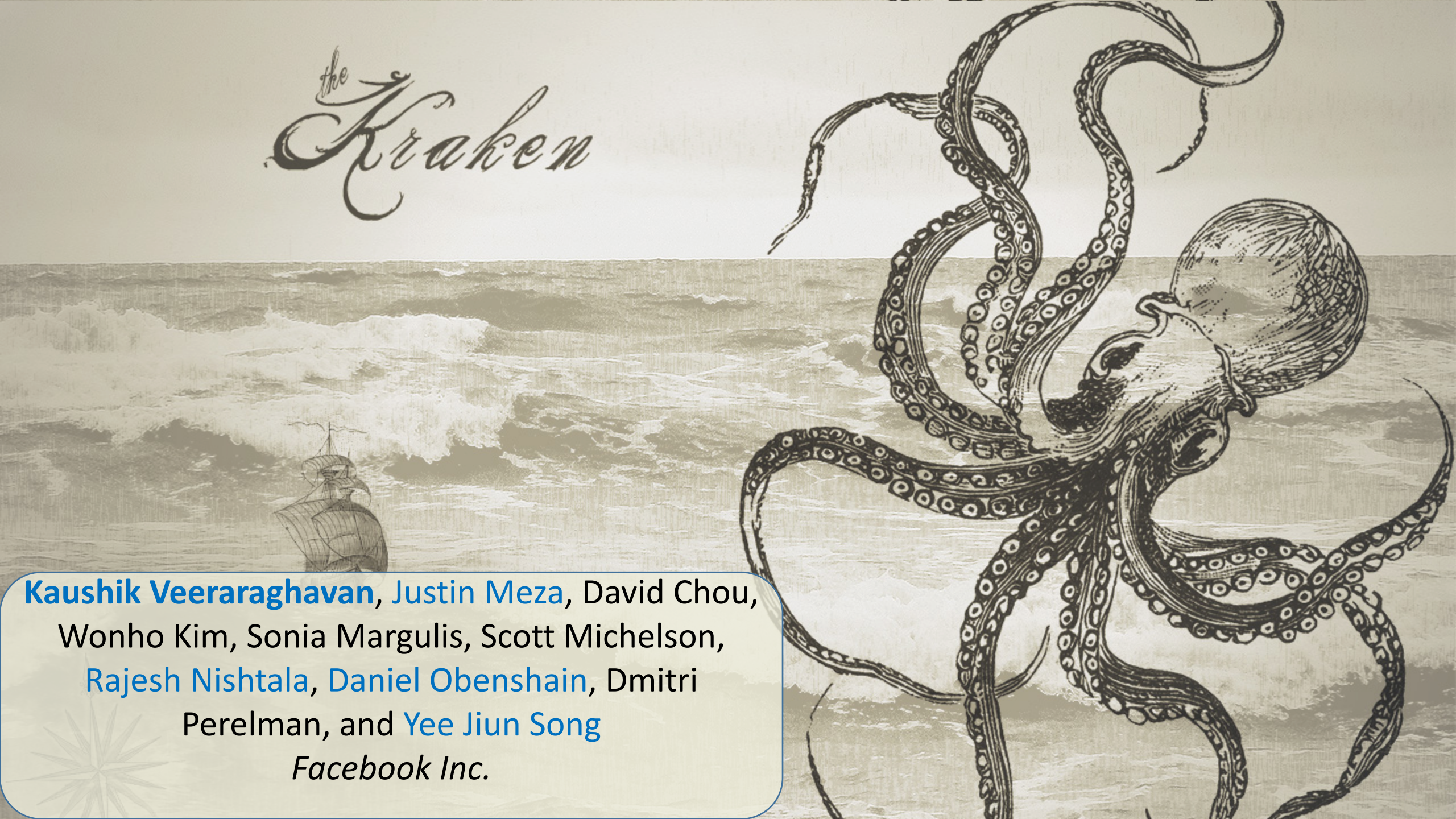
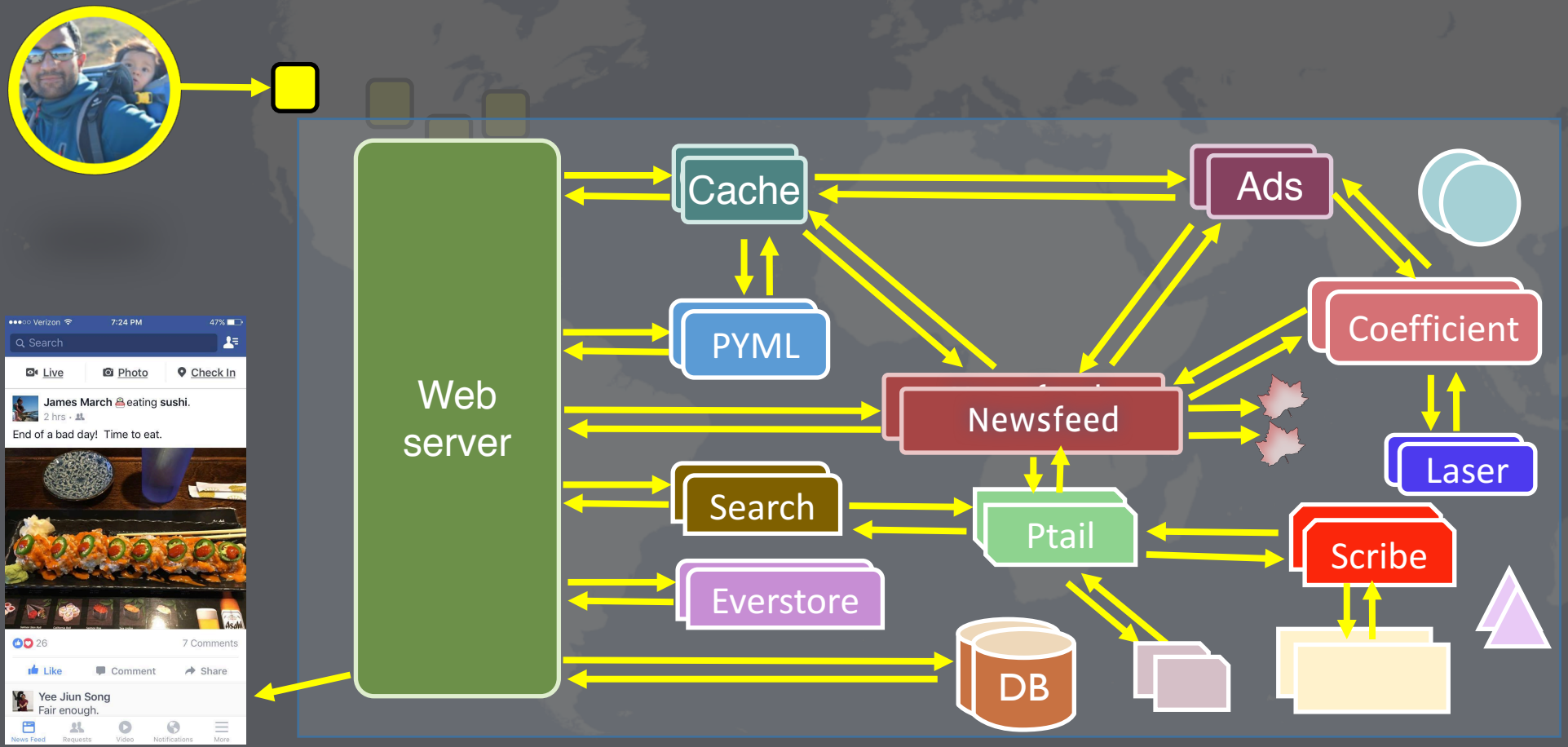


Kaushik Veeraraghavan, Justin Meza, David Chou, Wonho Kim, Sonia Margulis, Scott Michelson, Rajesh Nishtala, Daniel Obenshain, Dmitri Perelman, and Yee Jiun Song

Facebook Inc.

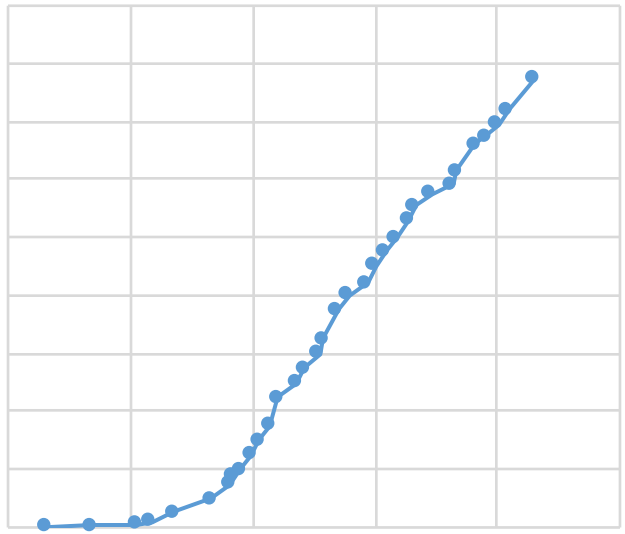
Each user request touches hundreds of systems



The workload is **constantly** evolving

Many products

Growing user base



Rapid software change

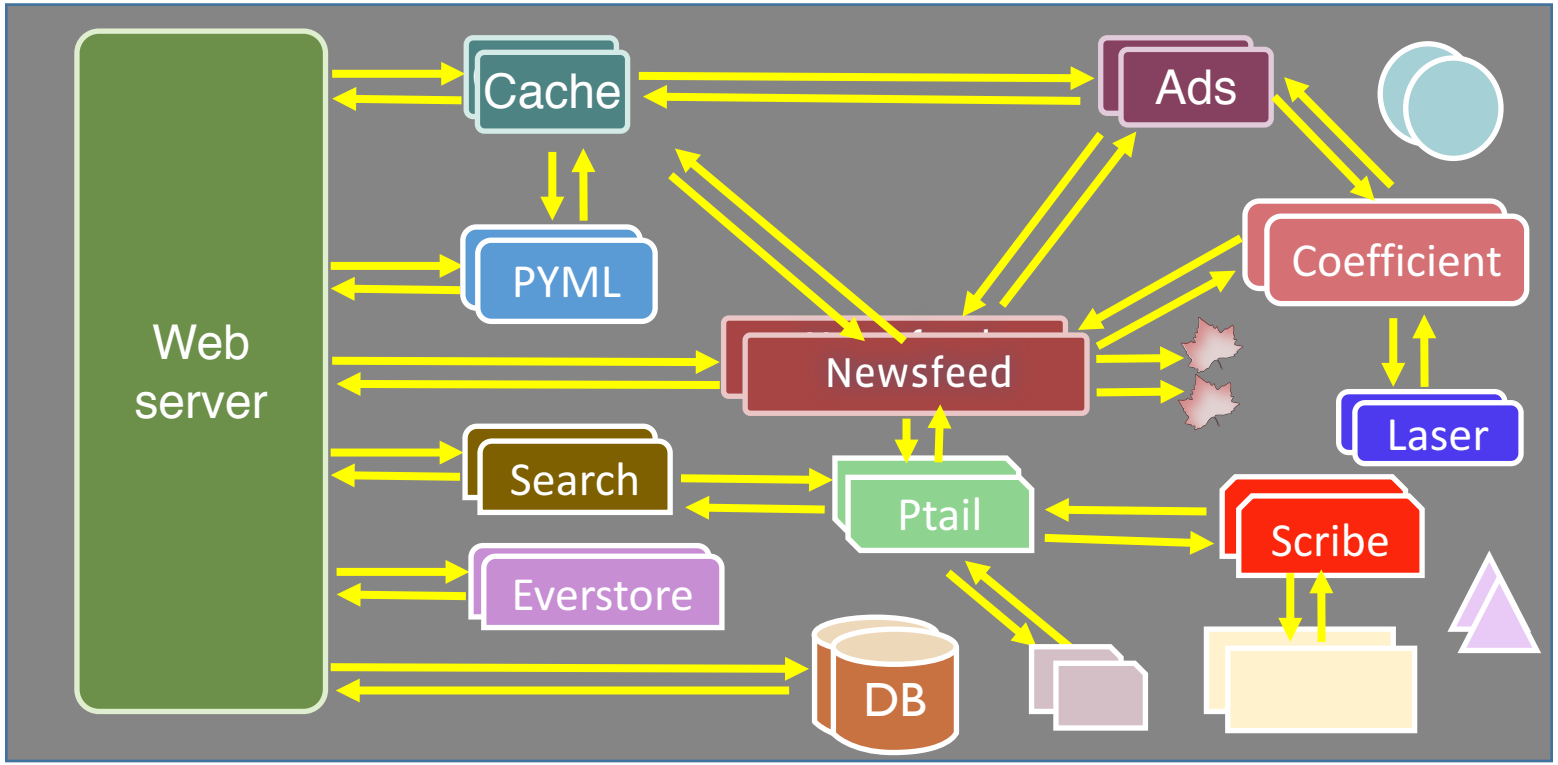
- Facebook: 3 daily releases
- Instagram: cont. release

Goals

- How many machines does each software system need?
- Can we serve peak load?
- Are we operating efficiently?

Common approaches to capacity management

- ✖ **Load modeling**: simulate how system behaves at high load
- ✖ **Load testing**: benchmark using synthetic workloads



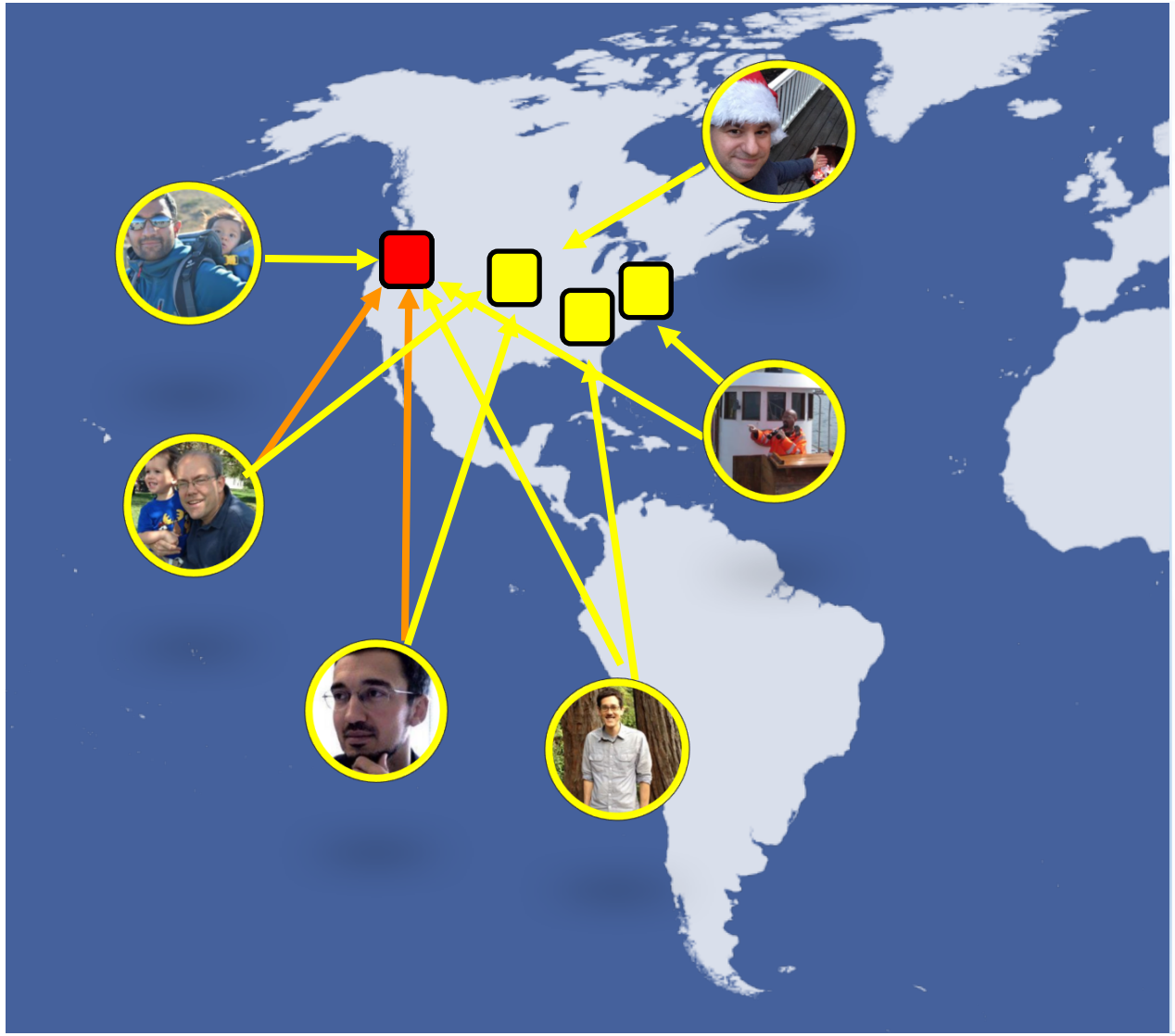
Live user traffic is the most representative workload

- Accurate distribution of reads & writes
- Do not need a custom test setup

Live traffic load tests measure **peak serving capacity**

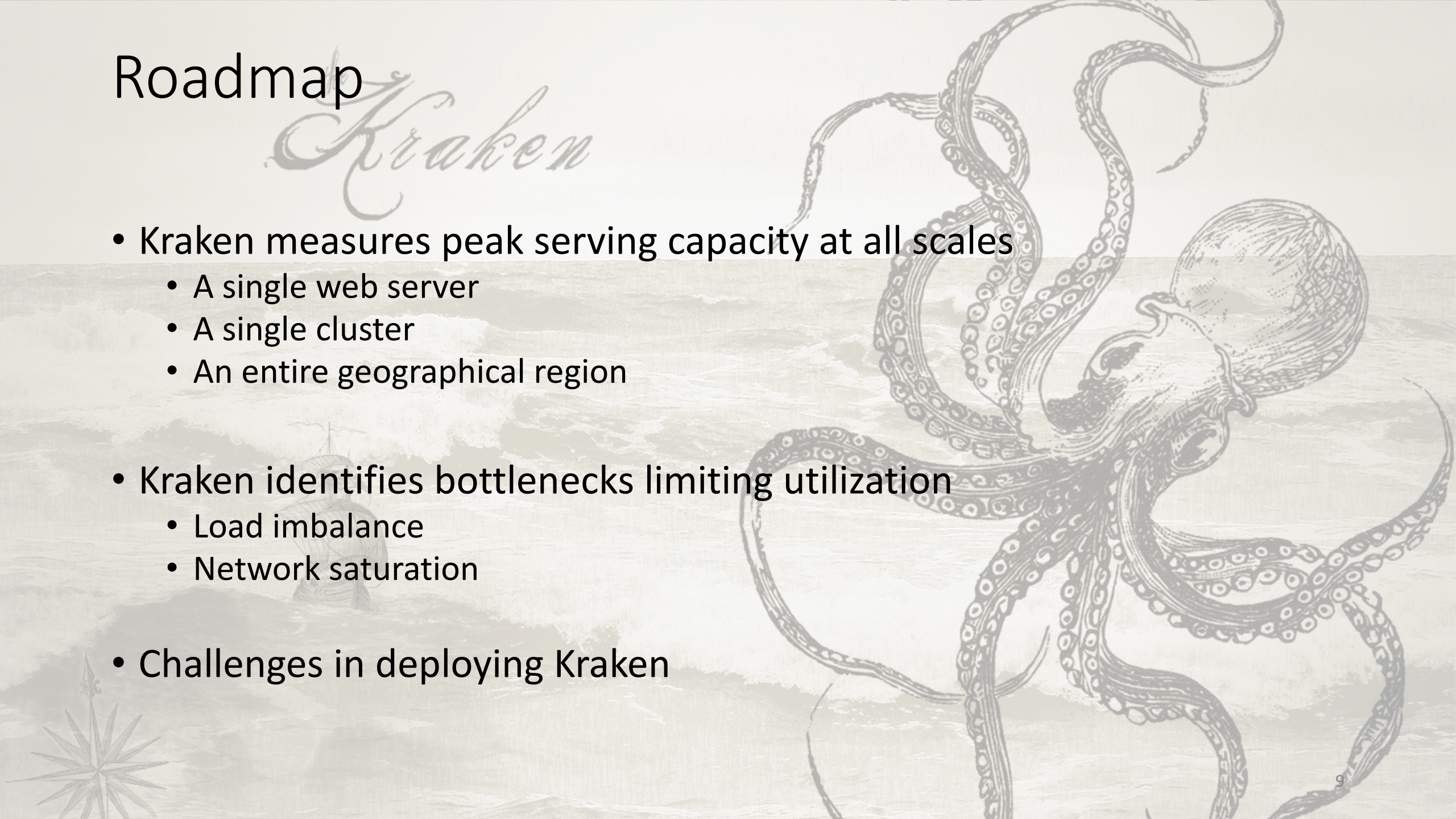
- Direct live user traffic at target

Live traffic load tests measure **peak serving capacity** safely



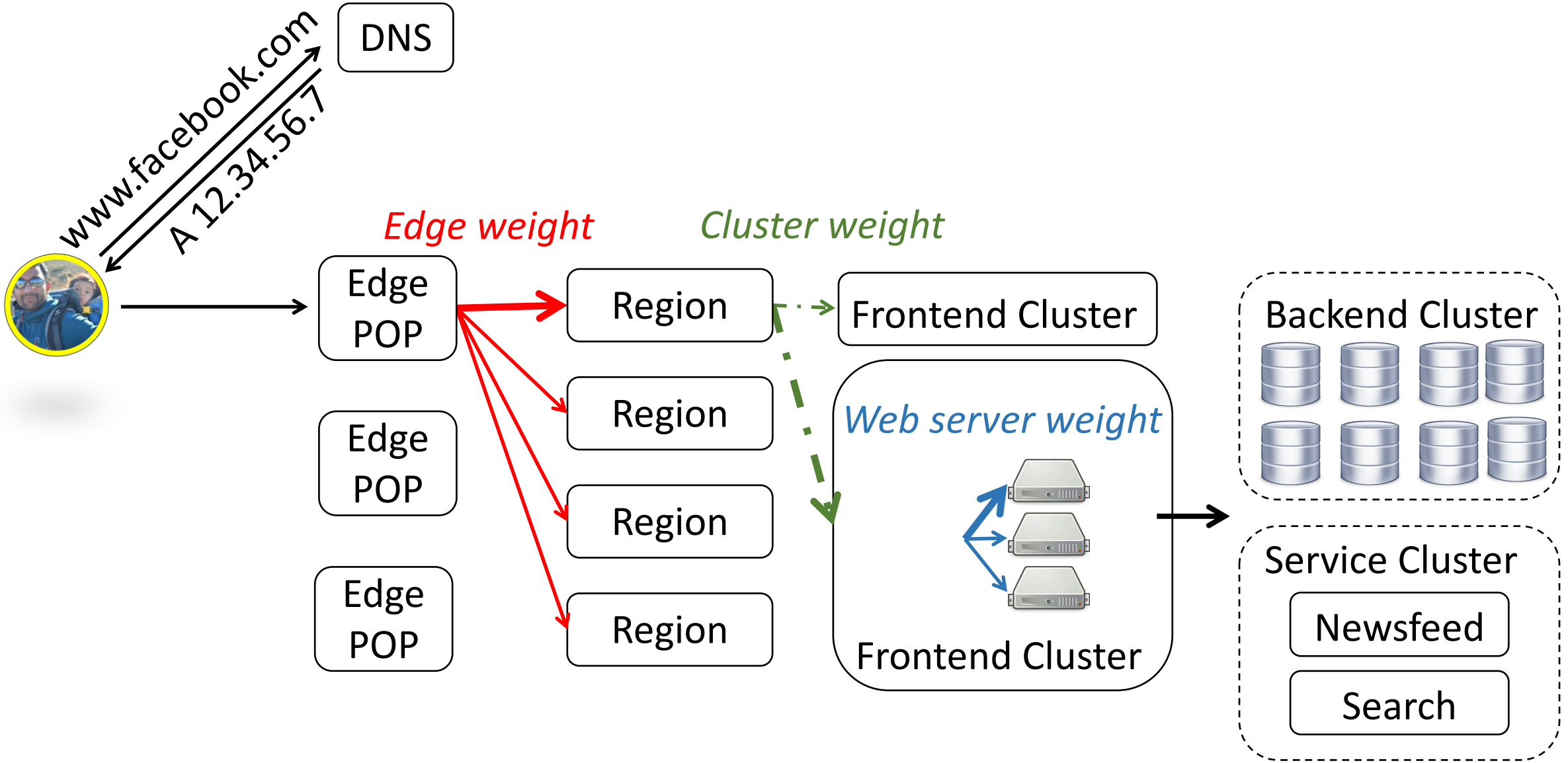
- Monitor health metrics
  - Response latency
  - Server error
- Reset load when thresholds are hit

Roadmap

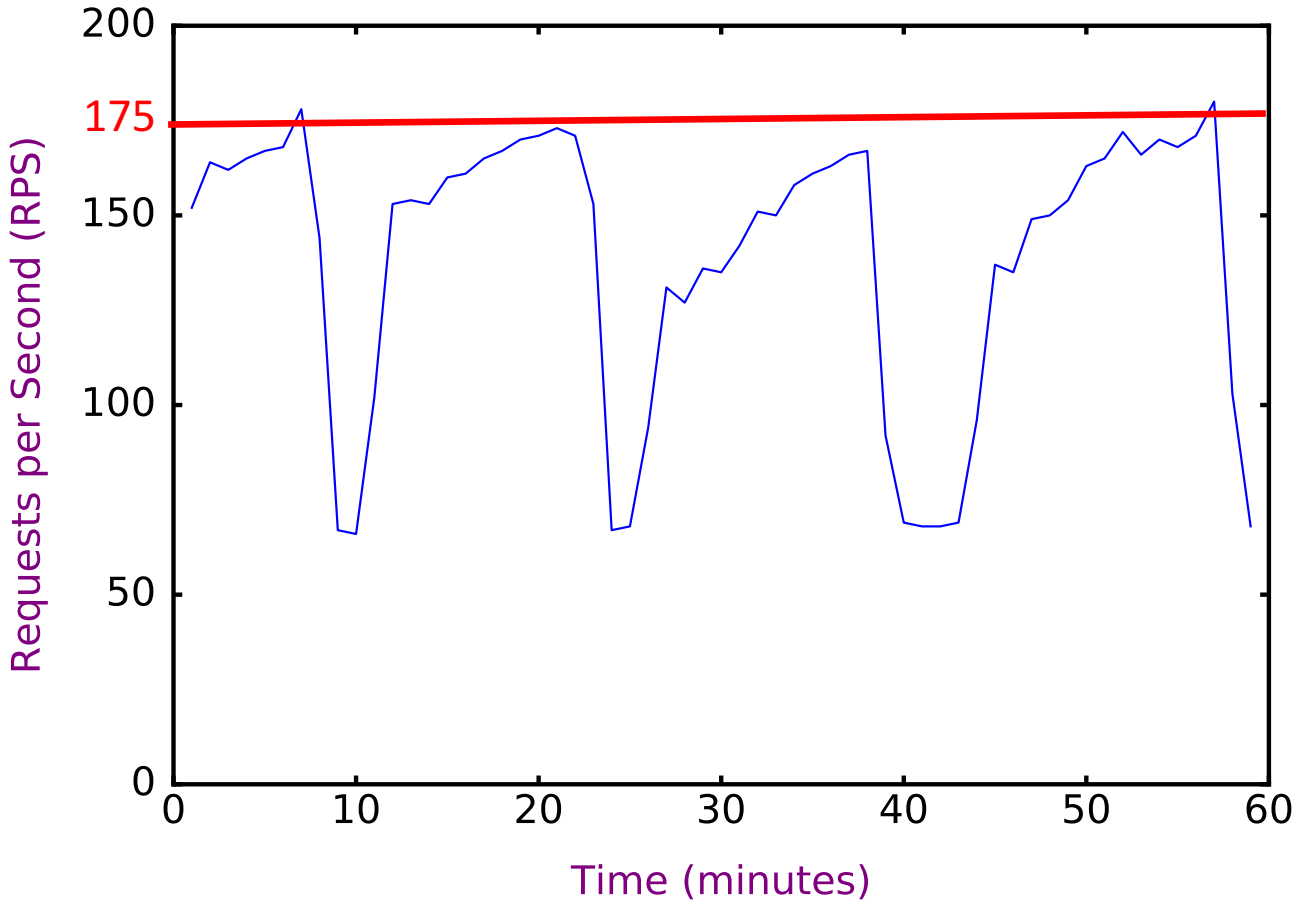


- Kraken measures peak serving capacity at all scales
  - A single web server
  - A single cluster
  - An entire geographical region
- Kraken identifies bottlenecks limiting utilization
  - Load imbalance
  - Network saturation
- Challenges in deploying Kraken

Kraken uses weights to route requests

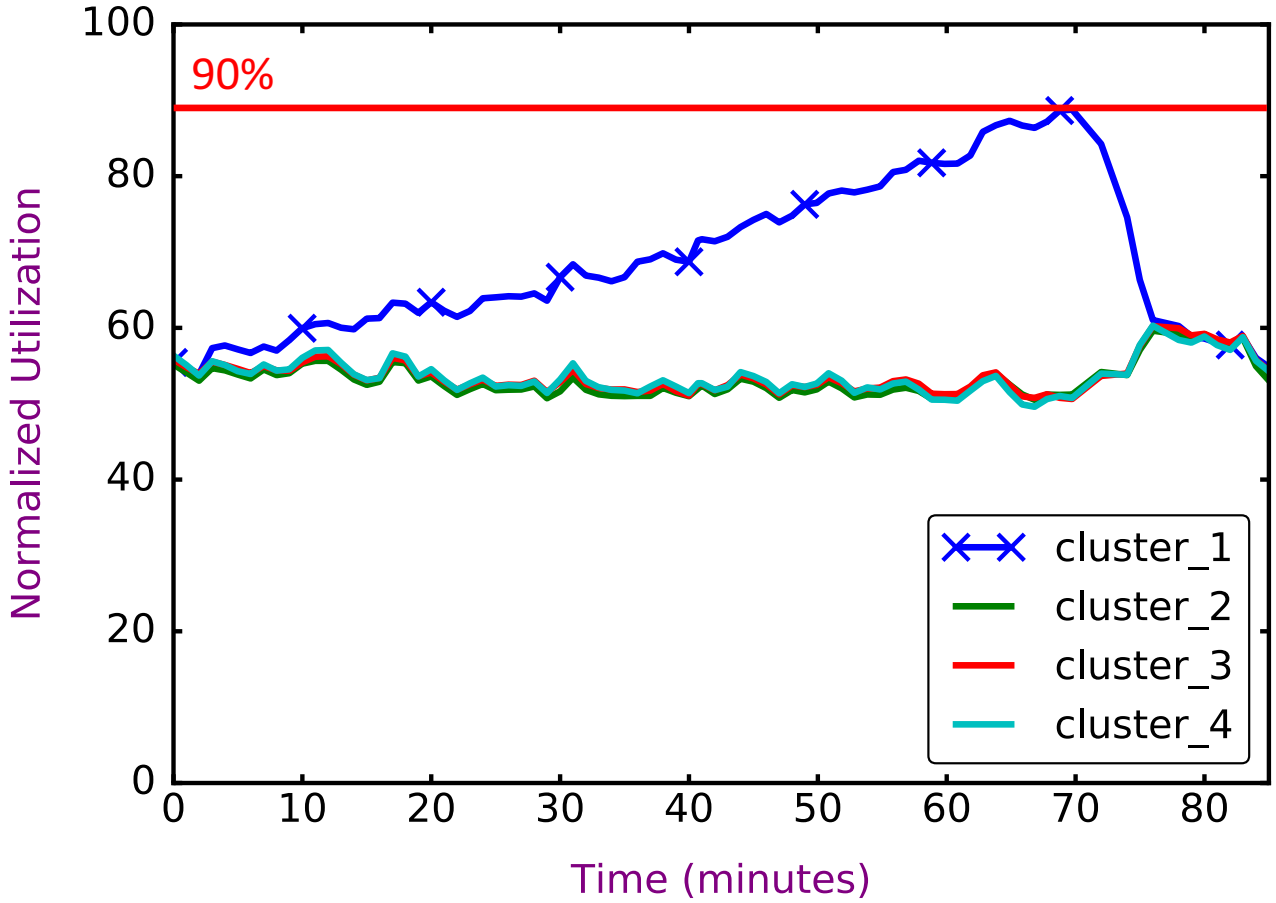


Kraken measures a web server's peak serving capacity



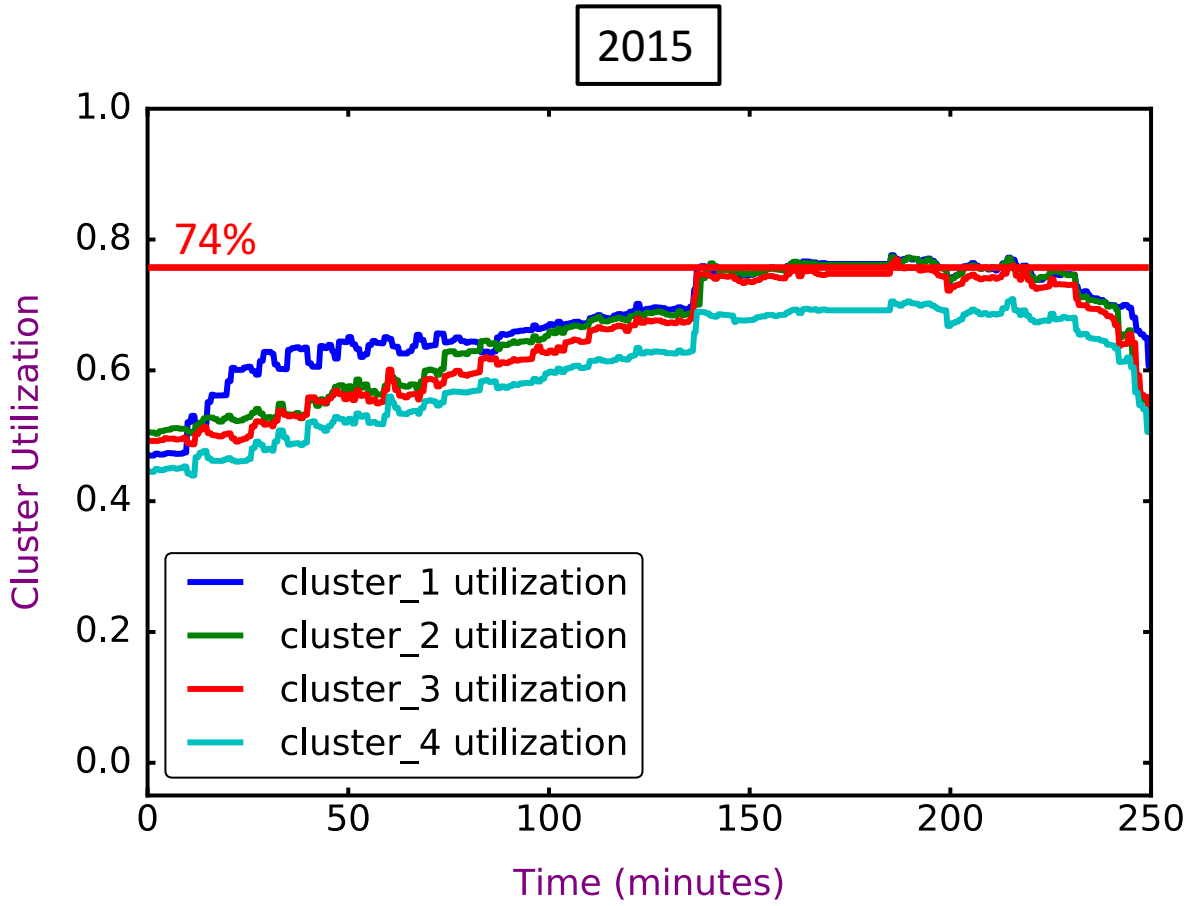
- Peak web server capacity: 175 requests per second (RPS)
- Production target: 90% utilization i.e., 157 RPS

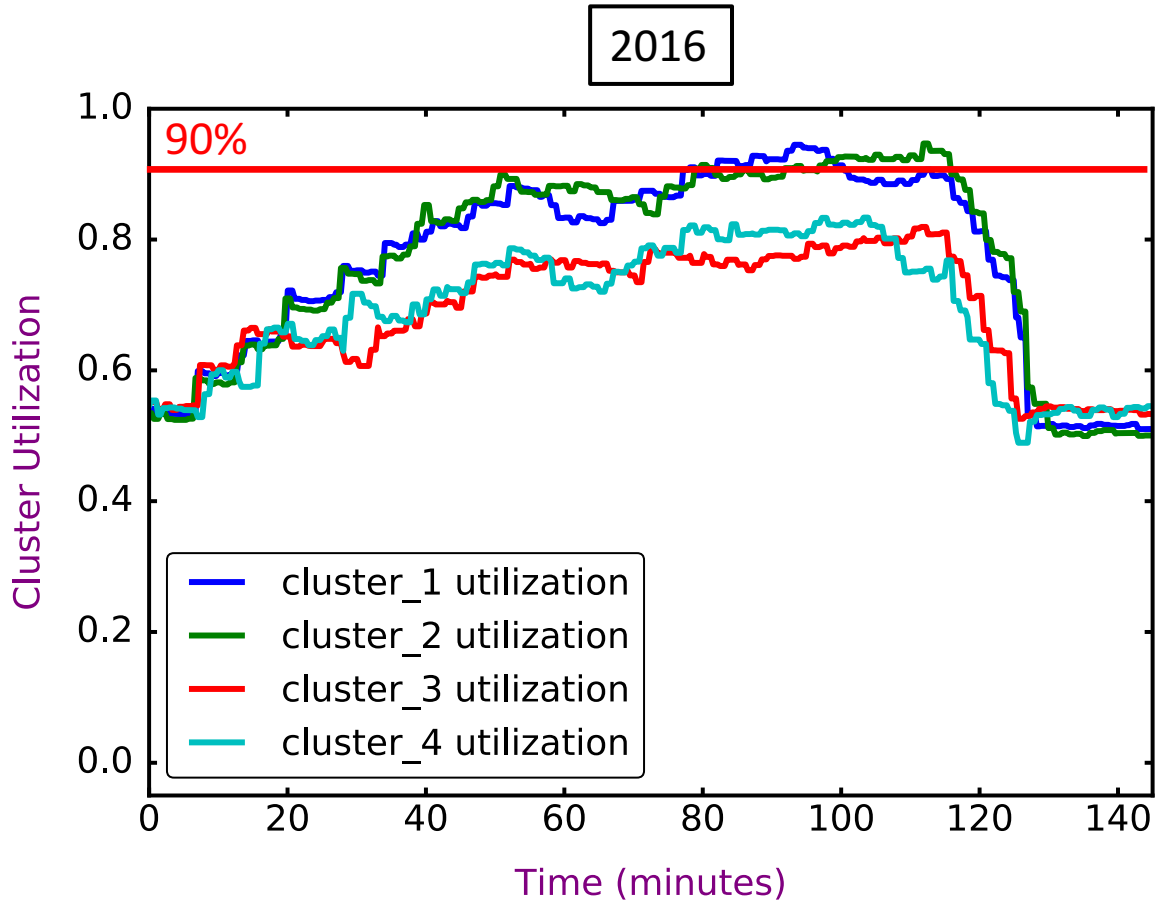
Kraken measures a cluster's peak serving capacity



- Max cluster capacity = (web server capacity) * (num. web servers in cluster)

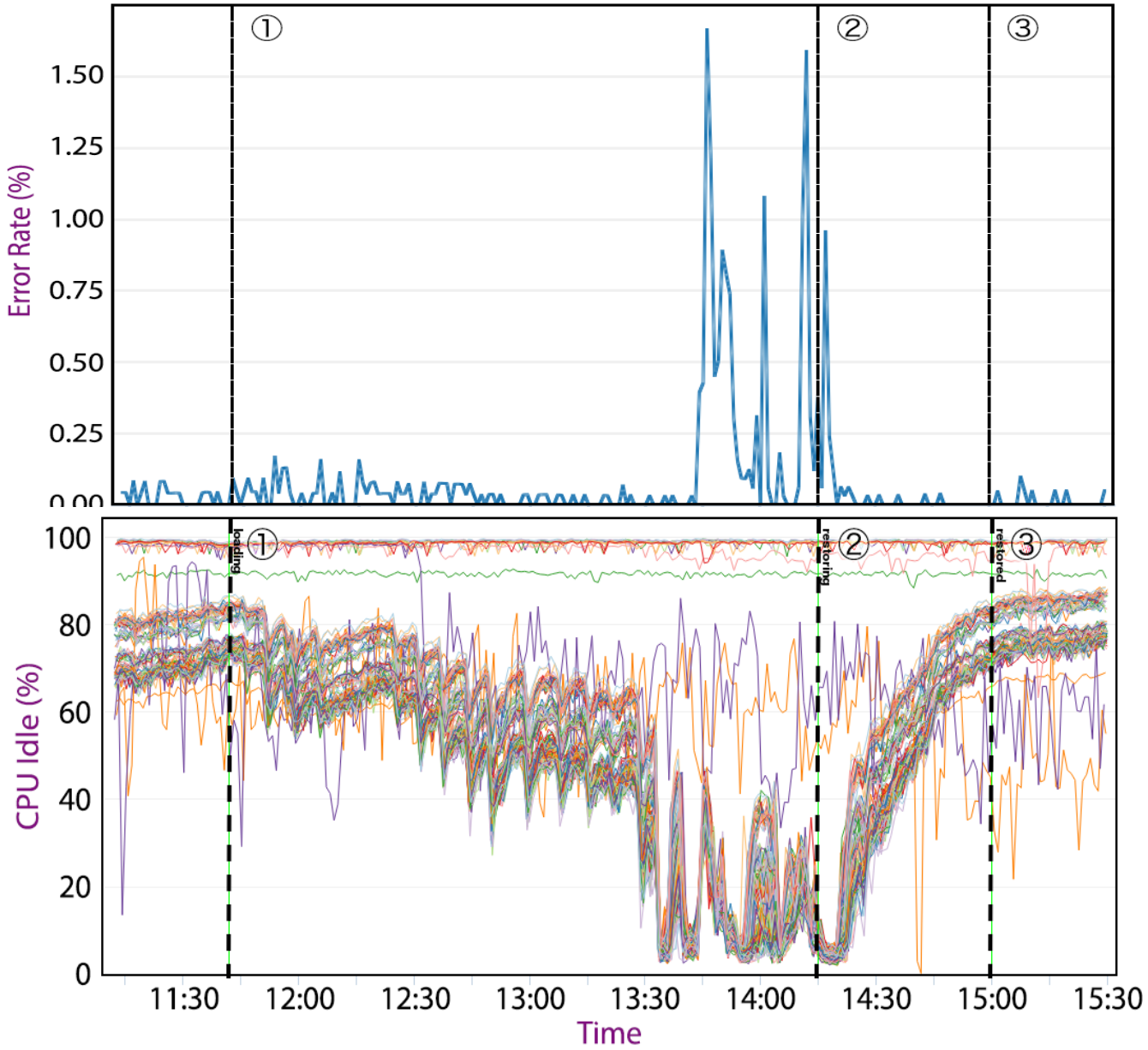
Kraken measures a region's peak serving capacity



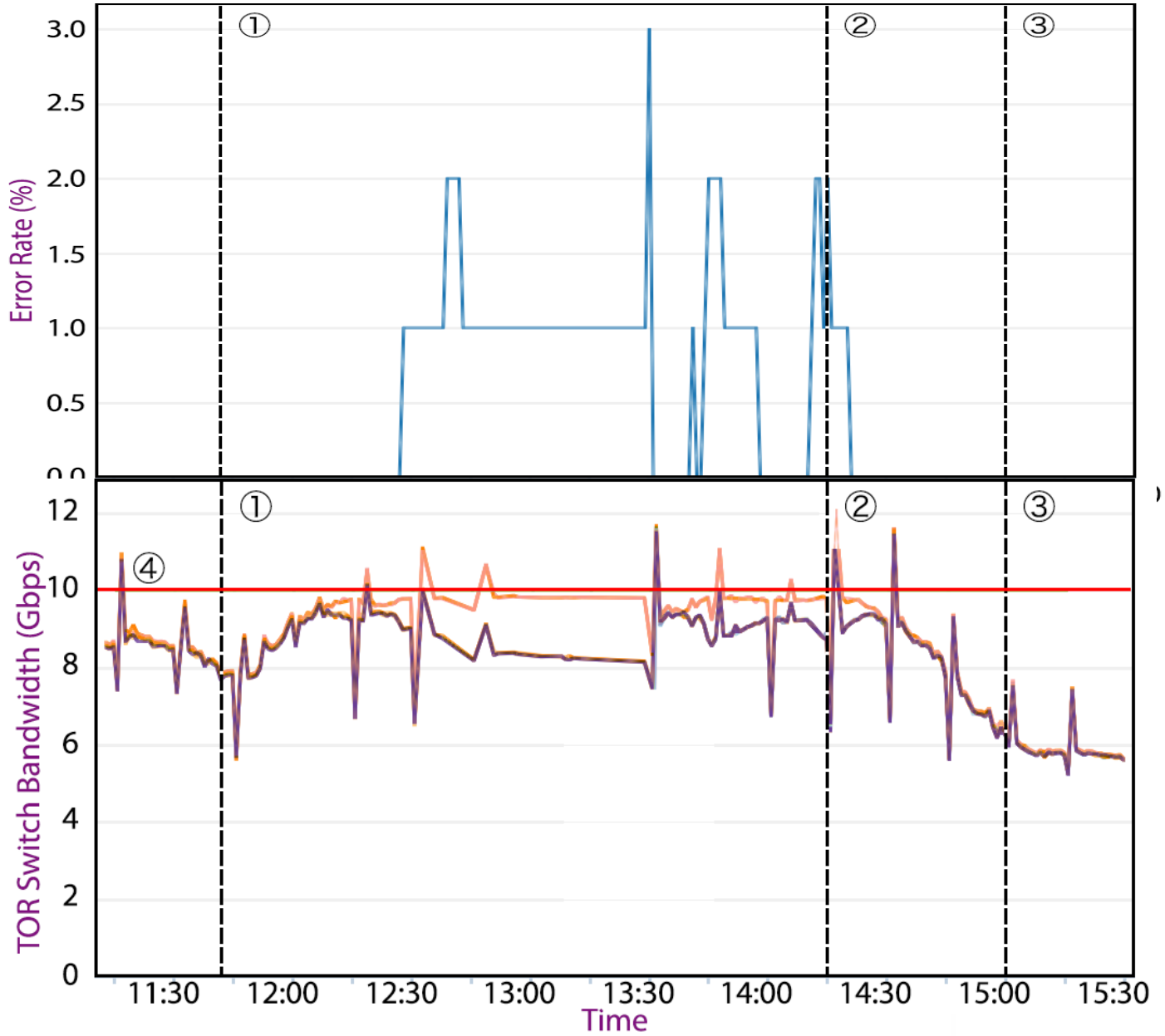


- We now serve 20% more users with the same infrastructure

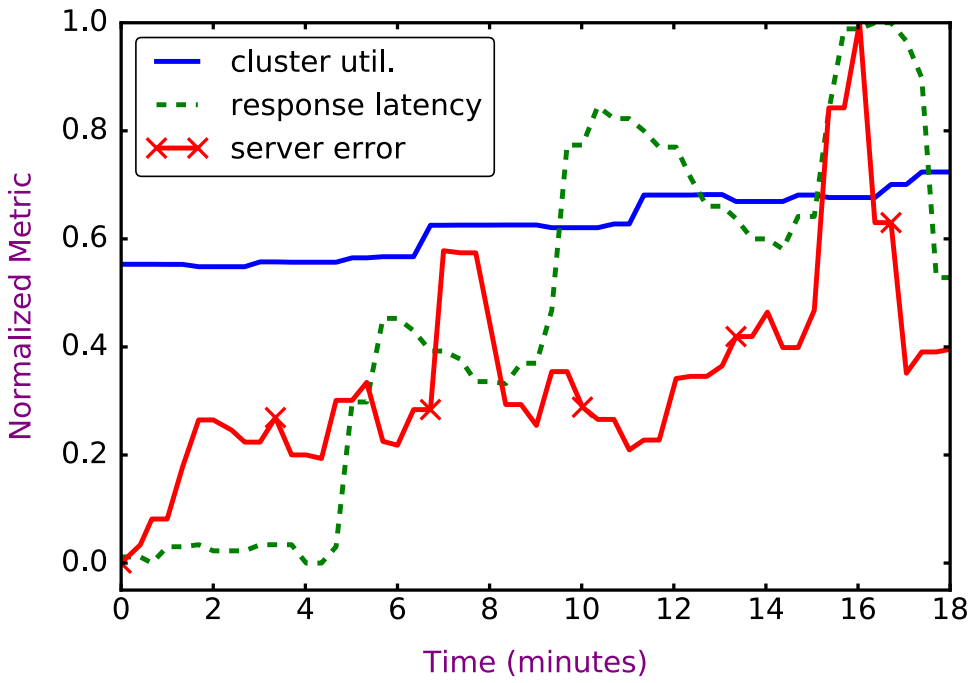
Inefficient load balancing limits utilization

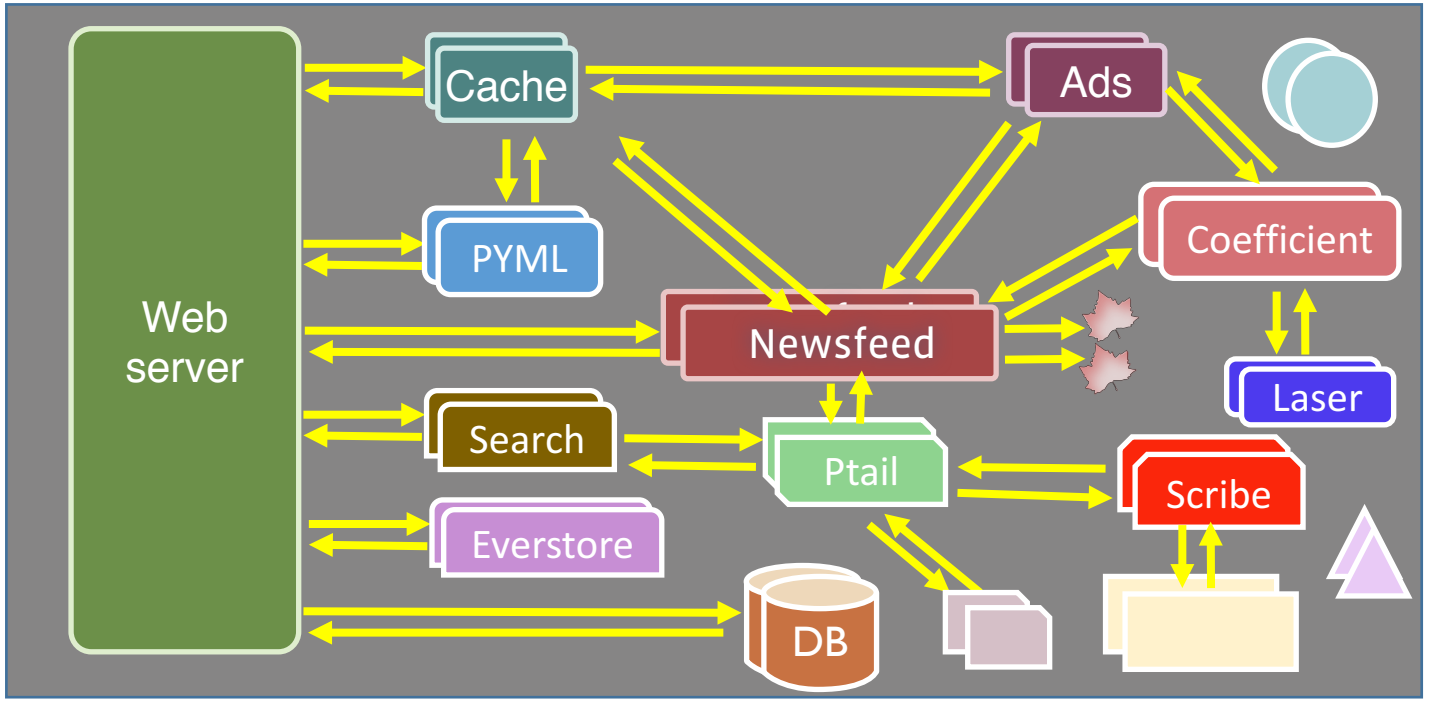


Network saturation limits utilization

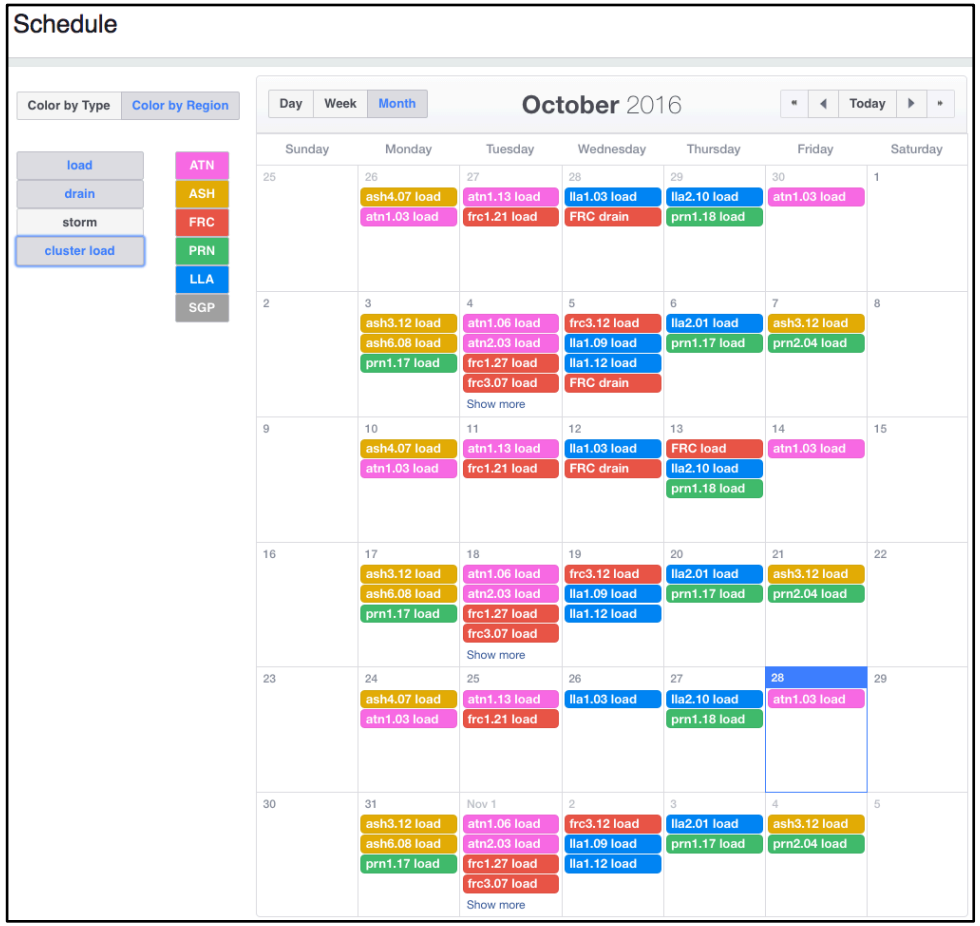


Challenge: non-linear response to traffic shifts





Challenge: how can we foster experimentation?



- Set conservative thresholds
- Communicate widely about tests
- Encourage collaboration
  - Monitoring
  - Failure mitigation strategies

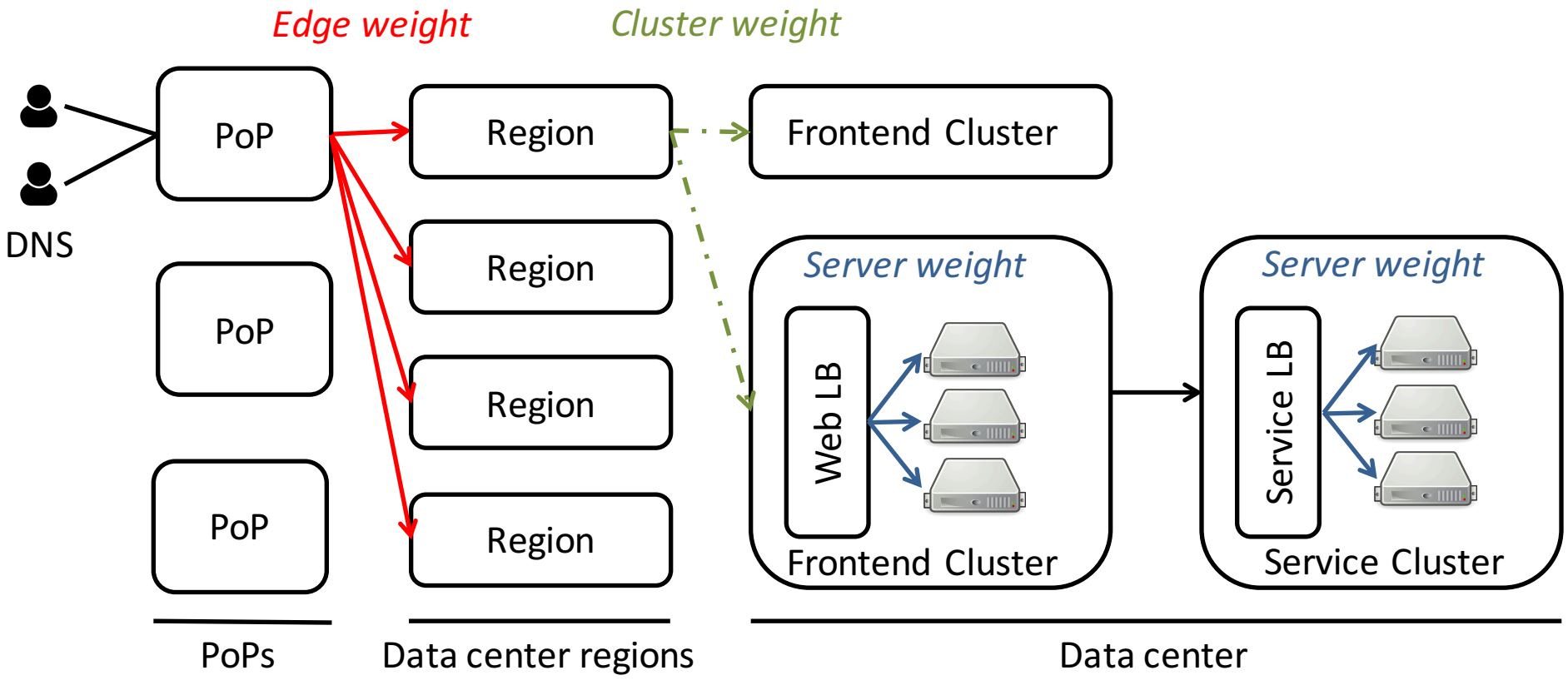
Conclusion

- We've run 50+ regional, 1000+ cluster live traffic load tests in 3 years
- Kraken has helped us identify hundreds of bottlenecks and verify fixes
- We can now serve 20% more users with the same infrastructure

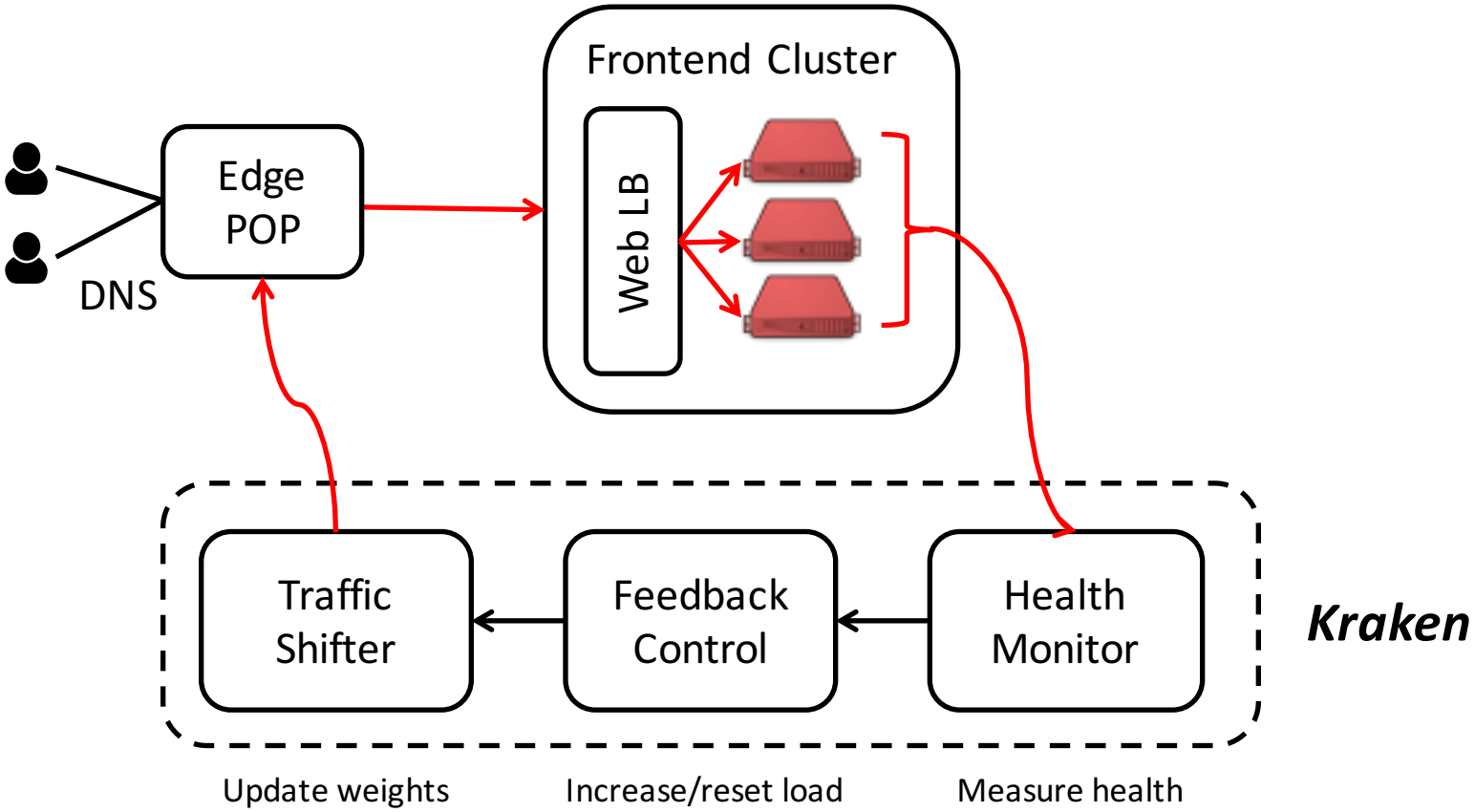
Kraken: assumptions and caveats

- Stateless servers
- Routable requests
- Load impacts downstream systems

Kraken: user traffic management



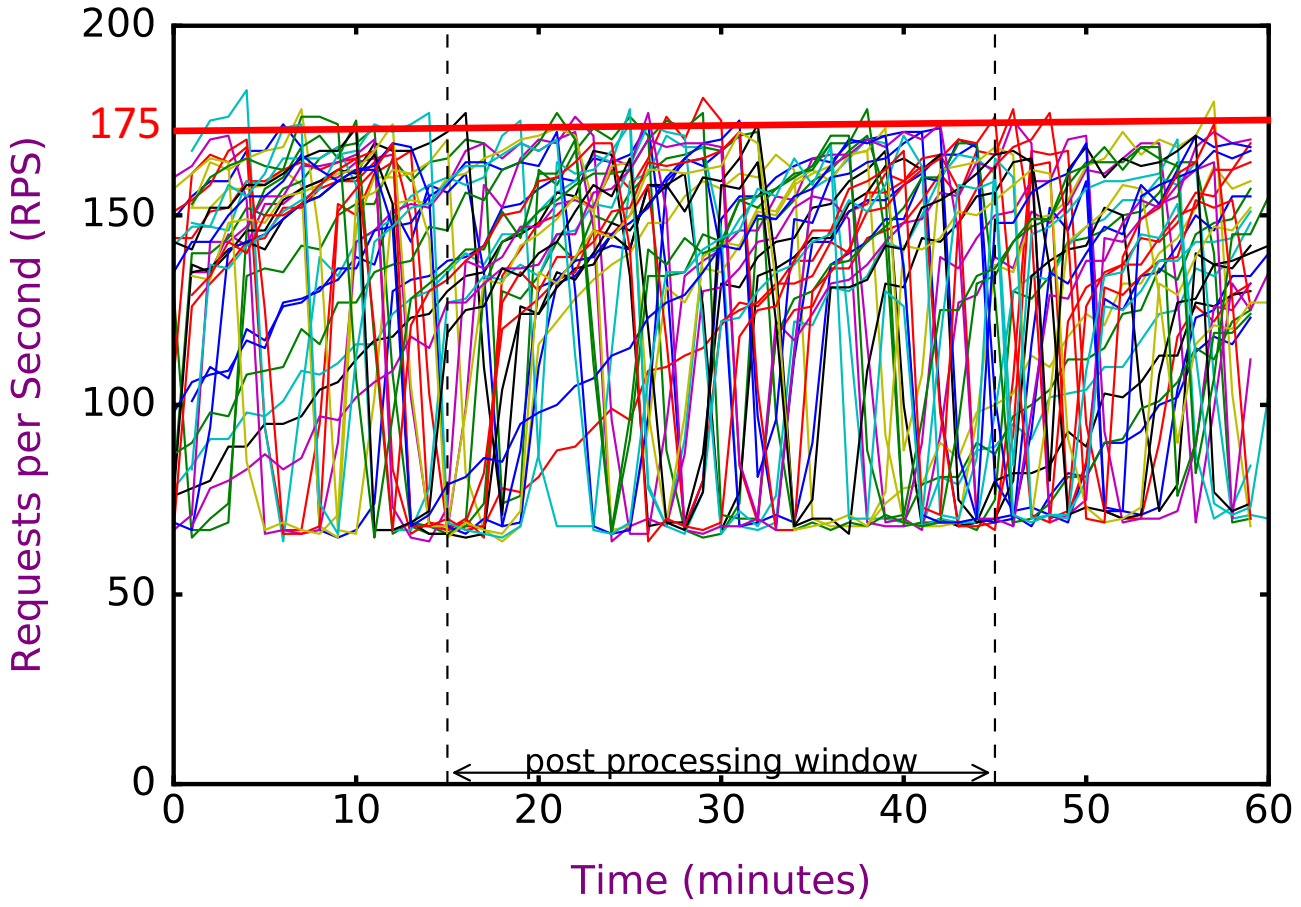
Kraken: live traffic load tests



Health metrics for systems affected by web load

Service type	Metrics
Web servers	CPU utilization, latency, error rate, fraction of operational servers
Aggregator–leaf	CPU utilization, error rate, response quality
Proxygen software L7 load balancer	CPU utilization, latency, connections, retransmit rate, Ethernet utilization, memory capacity utilization
Memcache	Latency, object lease count
TAO	CPU utilization, write suc- cess rate, read latency
Batch processor	Queue length, exception rate
Logging	Error rate
Search	CPU utilization
Service discovery	CPU utilization
Message delivery	CPU utilization

Continuous runs measuring a web server's capacity



Some lessons from a thousand Kraken tests

- Simplicity is key to Kraken's success.
- Identifying the right performance, error rate and latency metrics to track is difficult.
- Cheap solutions, like allocating capacity or fixing misconfiguration, are often more impactful than profile-based tuning or system redesign.