Hodor

Detecting and Remediating Overload in LinkedIn Microservices

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“Improve service resiliency by reliably detecting overloads and automatically remediating them while minimizing production impact.”

Our Mission

Agenda

- **Hodor Framework Overview**
- Overload Detectors: CPU, GC and ThreadPool
- Overload Remediation: Adaptive load shedder and Request Retries
- Monitoring and Rollout
- A Success story
- Related/Future work

Hodor Framework

Holistic **O**verload **D**etection and **O**verload **R**emediation

- Hodor is designed to detect service overload caused by multiple root causes, and to automatically remediate the problem by dropping just enough traffic

- Hodor has 3 components:
  - Overload Detectors
  - Load Shedder
  - Platform-specific adapter to combine the two

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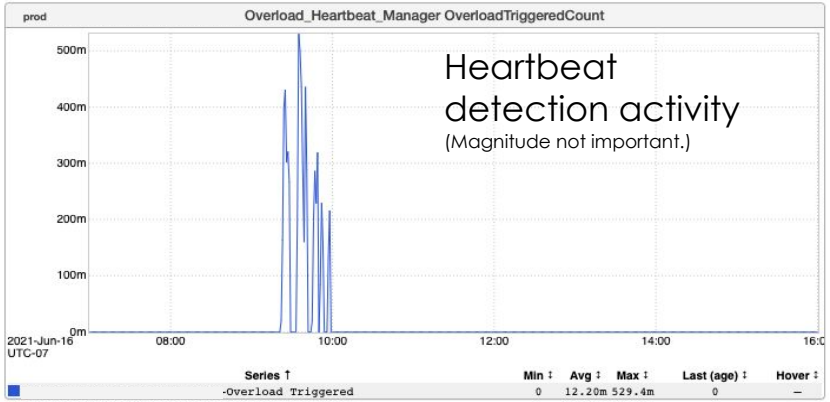
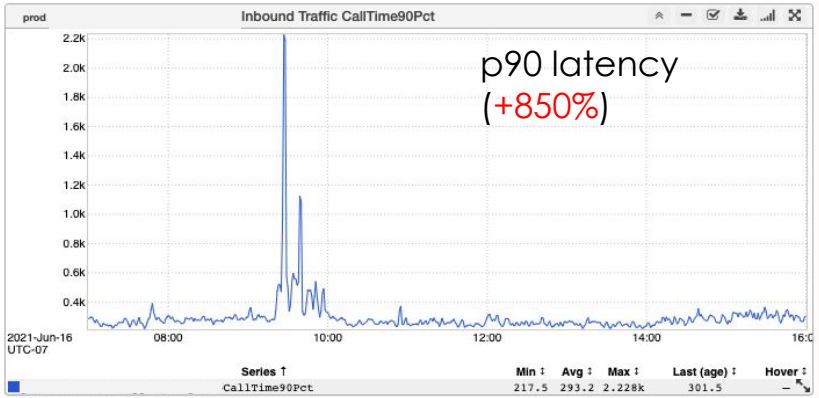
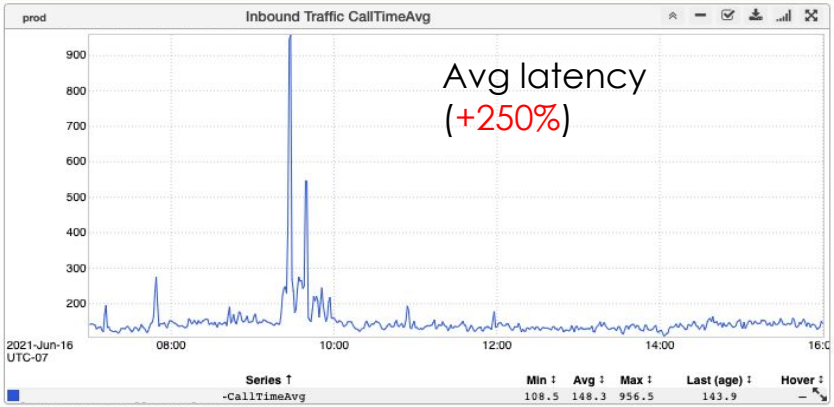
CPU Overload detection - Heartbeat

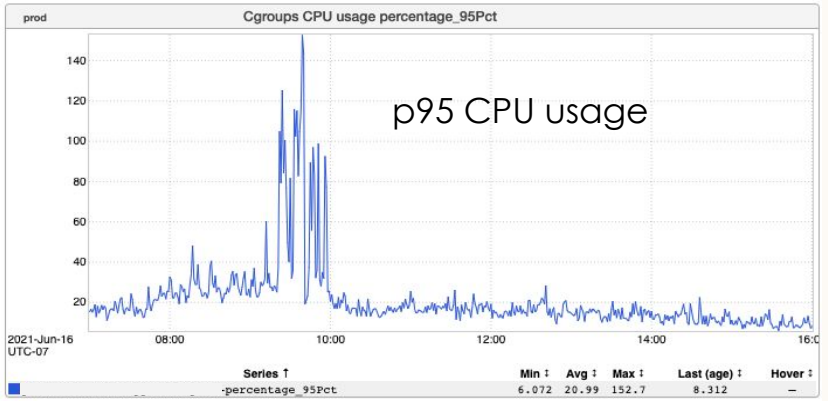
- Objective
  - Early and accurate detection of **CPU bottlenecks**
- Heartbeat algorithm
  - Heartbeat thread: lightweight background thread on a schedule
  - Monitor heartbeat thread wakeups
- Rationale
  - Direct way to measure availability of useful CPU cycles
  - Applicable irrespective of bare-metal, VM, cgroup, cfs quota/shares config etc.

CPU Overload detection case in prod





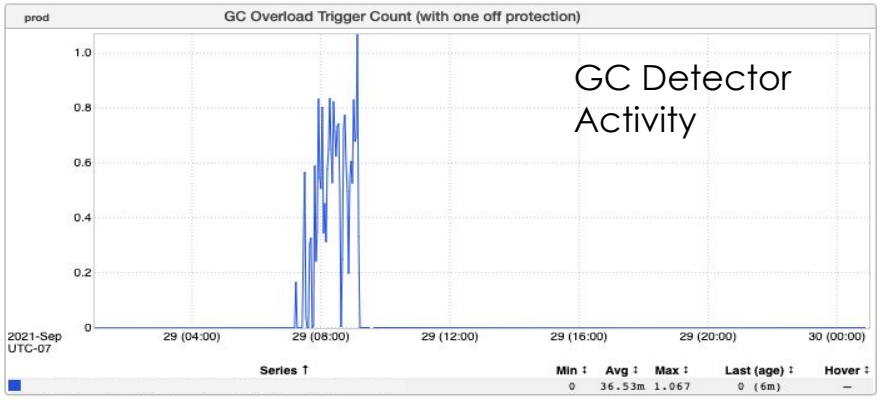




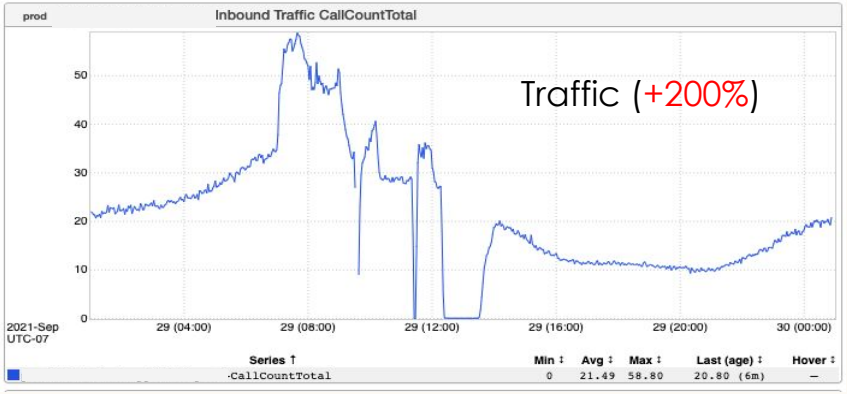
GC Overload detection

- Objective
  - Early and accurate detection of **bottlenecks caused by excessive GC**
- GC Overload Detection algorithm
  - Calculate amortized percentage of time spent in GC over a given time window.
  - The GC Overhead Tiers based on percentage ranges of GC Overhead.
  - If the duration in GC Overhead Tiers exceed the violation period, signal overload
- Rationale
  - A unified signal that catches different types of GC issues.
  - Detect GC overhead before it causes CPU Overload

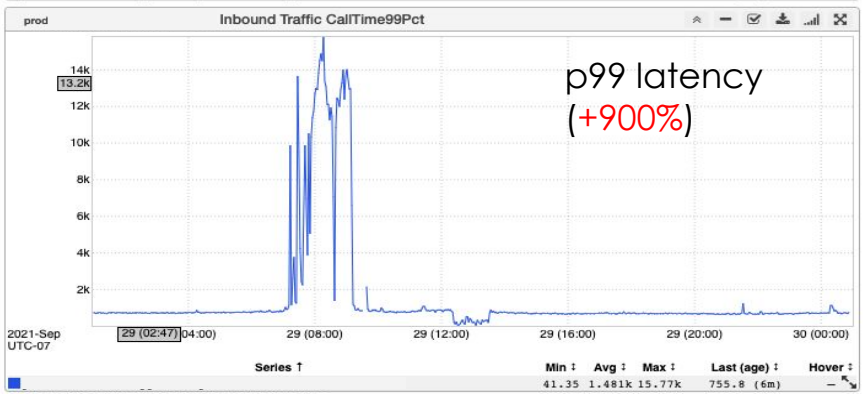
GC Overload detection case in prod



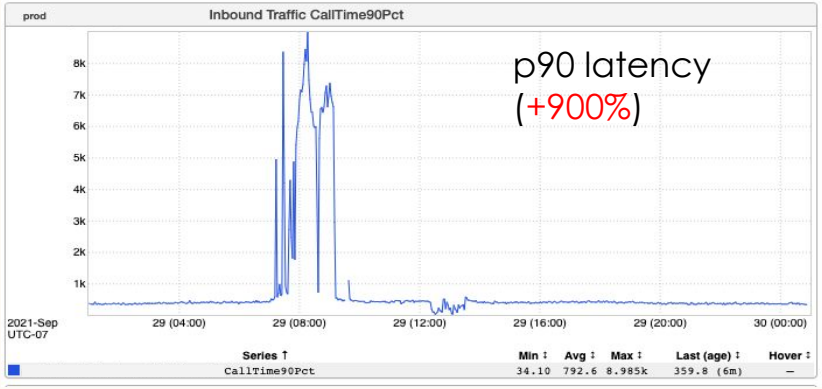
GC Detector Activity



Traffic (+200%)



p99 latency (+900%)

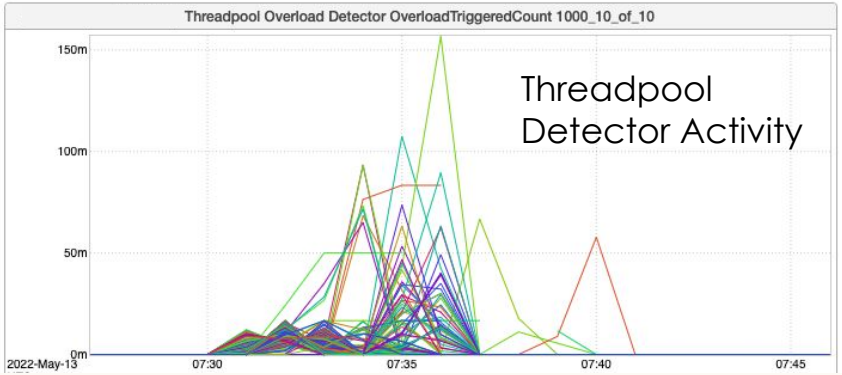


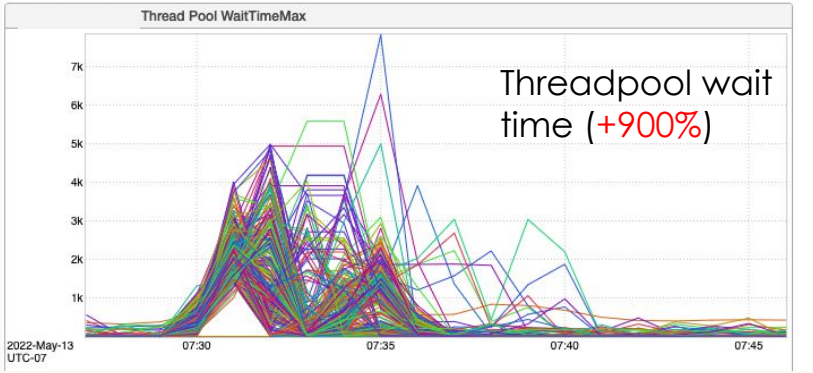
p90 latency (+900%)

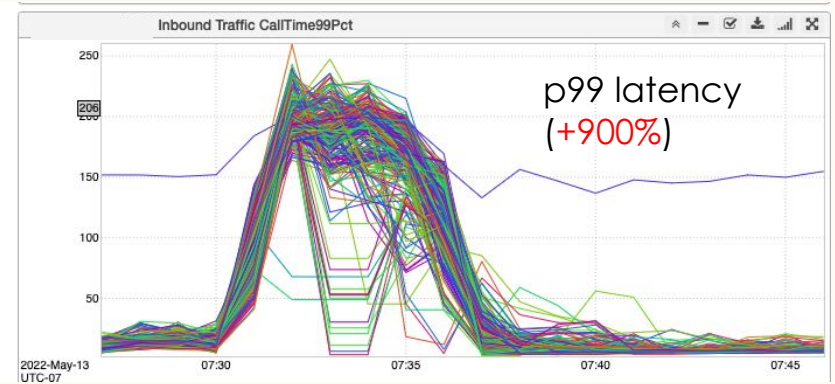
Thread Pool Starvation/Overload detection

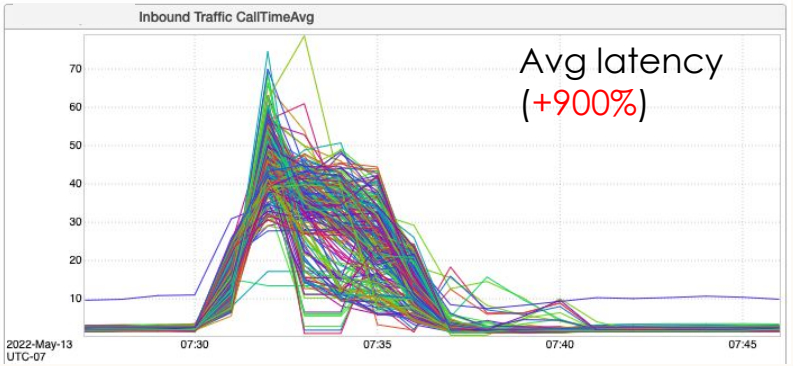
- Objective
  - Early and accurate detection of **Thread Pool Starvation**
- Thread Pool Overload Detection algorithm
  - Monitor ThreadPool Queue wait times
  - If a threshold is consistently breached, flag an Overload
- Rationale
  - HB and GC detect overload of a physical resource. Thread Pool Detector detects overload of a "virtual"/non-tangible resource
  - Helps alleviate backed up downstreams and/or slowed down DBs

Threadpool Overload detection case in prod









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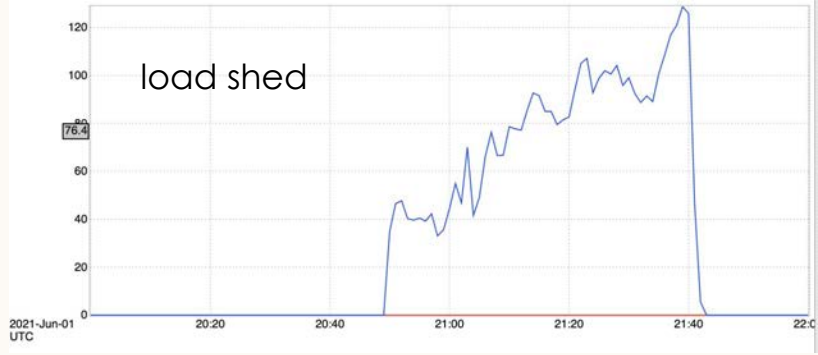
Adaptive Load Shedder

- Listens to signals from the detectors
- Modulates allowed inbound concurrency
  - Shed aggressively and re-ramp conservatively
- Shed requests by returning HTTP 503 which can be idempotently retried
- Percentage based shedder did not work well during experimentation

--- control host: no load-shedding

--- treatment host: with load-shedding



Overload Failure Retry

- Minimize member impact due to load-shedding
  - Automatically retry requests rejected due to overload
  - Fail quickly and retry safely (avoiding retry storms)
    - Client Side Budget
    - Server Side Budget

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Monitoring & Rollout

- When rolling out Hodor we must ensure to not cause unnecessary traffic drops.
- Service analysis and evaluation are a core component of our rollout process.

  - Deploy the overload detectors in monitoring mode to gather data about when they were firing, and if those firings were false positives.

  - Correlate firing data from detectors with performance metrics to determine if there have been any false positives indicating that the service may not be a good candidate for adoption yet.

"Adding overload detectors to our services has surfaced unexpected behavior that owners were generally not familiar with."

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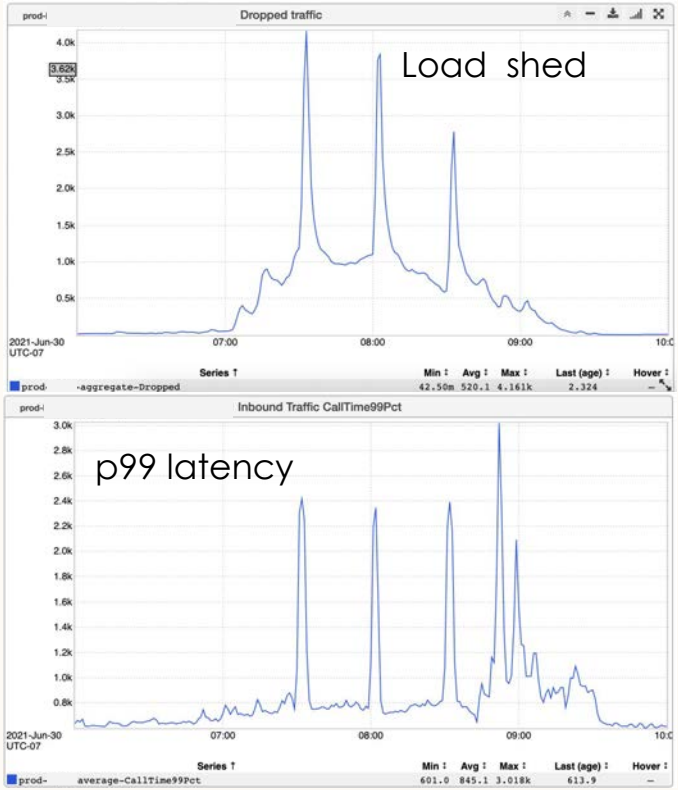
LinkedIn Flagship app incident mitigated

- Traffic shift led to aggressive load-shedding due to Hodor kicking-in
- Previous traffic shifts did not have a similar response
- Loadshedding likely turned a major member impact incident into a minor one; continued to serve 80% traffic
- Led to quicker discovery of the issue



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Related/Future work for Hodor

- Traffic Tiering: Categorize by impact and importance
- New Detectors (Latency based, Eventloop)
- Elastic cluster scaling

Thank you!