Advanced Application Management Using Red Hat OpenShift Service Mesh

Observability

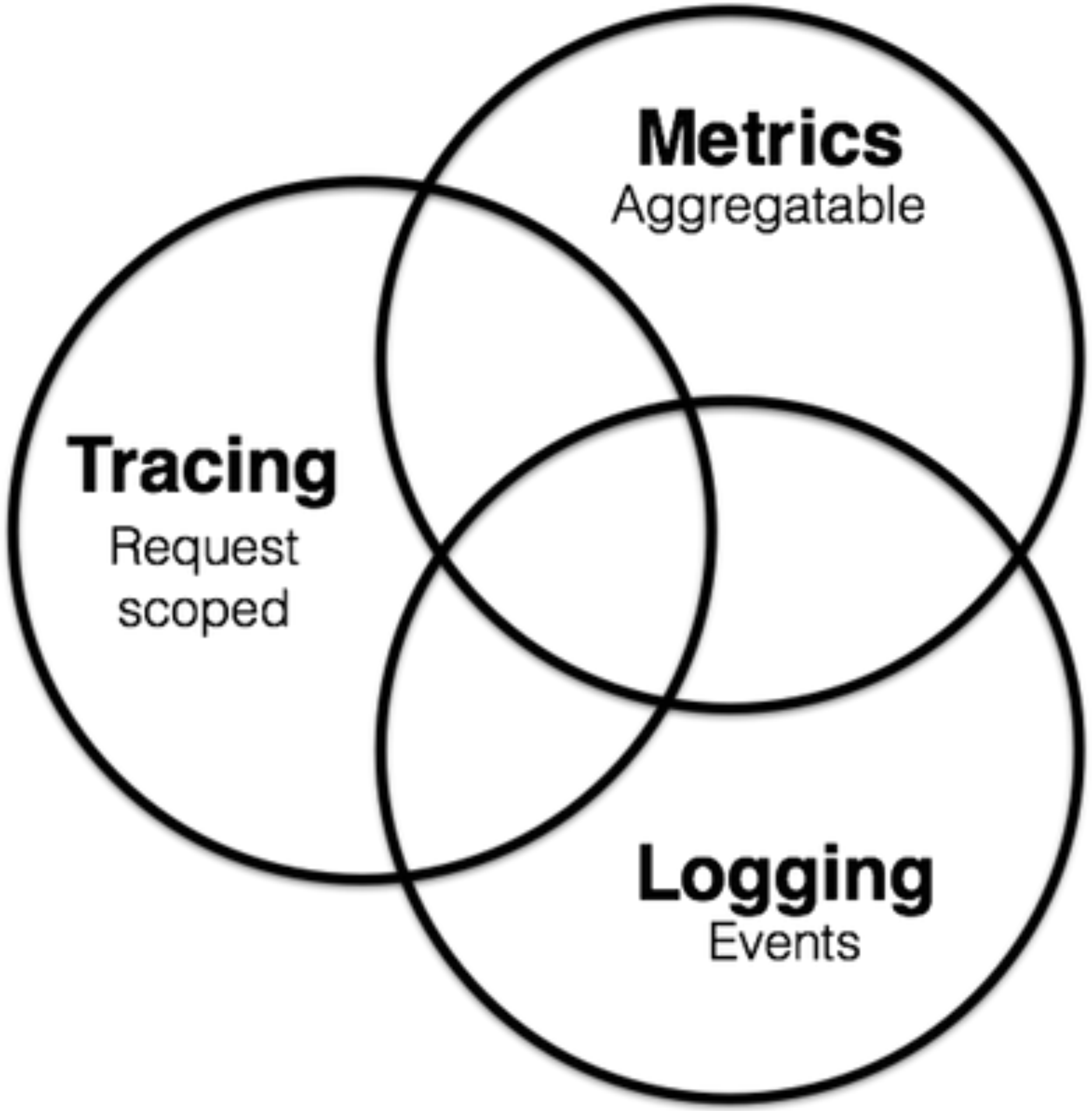
Module Topics

- Observability
- Logging
- Distributed Tracing
- Monitoring
- Visualization

Observability

- Ability to understand how system behaves in production
- System is observable if current state can be understood from outside
- Important characteristic of cloud-native distributed systems, like availability and scalability
- Techniques:
  - Logging
  - Tracing
  - Monitoring
  - Visualization
- Goal: Gain understanding of application services to help understand, operate, maintain, evolve system

Observability



Source: http://peter.bourgon.org/blog/2017/02/21/metrics-tracing-and-logging.html

Logging

- Messages representing events
- Aggregation and correlation:
    - By process: Thread name

```
Thread-1 2018-09-03T15:52:54+02:00 Request started
Thread-2 2018-09-03T15:52:55+02:00 Charging credit card x321
Thread-1 2018-09-03T15:52:55+02:00 Order submitted
Thread-1 2018-09-03T15:52:56+02:00 Charging credit card x123
Thread-1 2018-09-03T15:52:57+02:00 Changing order status
Thread-1 2018-09-03T15:52:58+02:00 Dispatching event to inventory
Thread-1 2018-09-03T15:52:59+02:00 Request finished
```

    - By transaction: Correlation ID

```
abc123 Order     2018-09-03T15:52:58+02:00 Dispatching event to inventory
def456 Order     2018-09-03T15:52:58+02:00 Dispatching event to inventory
abc123 Inventory 2018-09-03T15:52:59+02:00 Received `order-submitted` event
abc123 Inventory 2018-09-03T15:53:00+02:00 Checking inventory status
abc123 Inventory 2018-09-03T15:53:01+02:00 Updating inventory
abc123 Inventory 2018-09-03T15:53:02+02:00 Preparing order manifest
```

Distributed Tracing

- Story of request across services
  - Which services were touched, when, in which order, etc.
- With context information: Routing info, version, tags, etc.
- Not replacement for logging
  - Process/thread-level details
  - Not all traces sampled

Distributed Tracing

Use cases

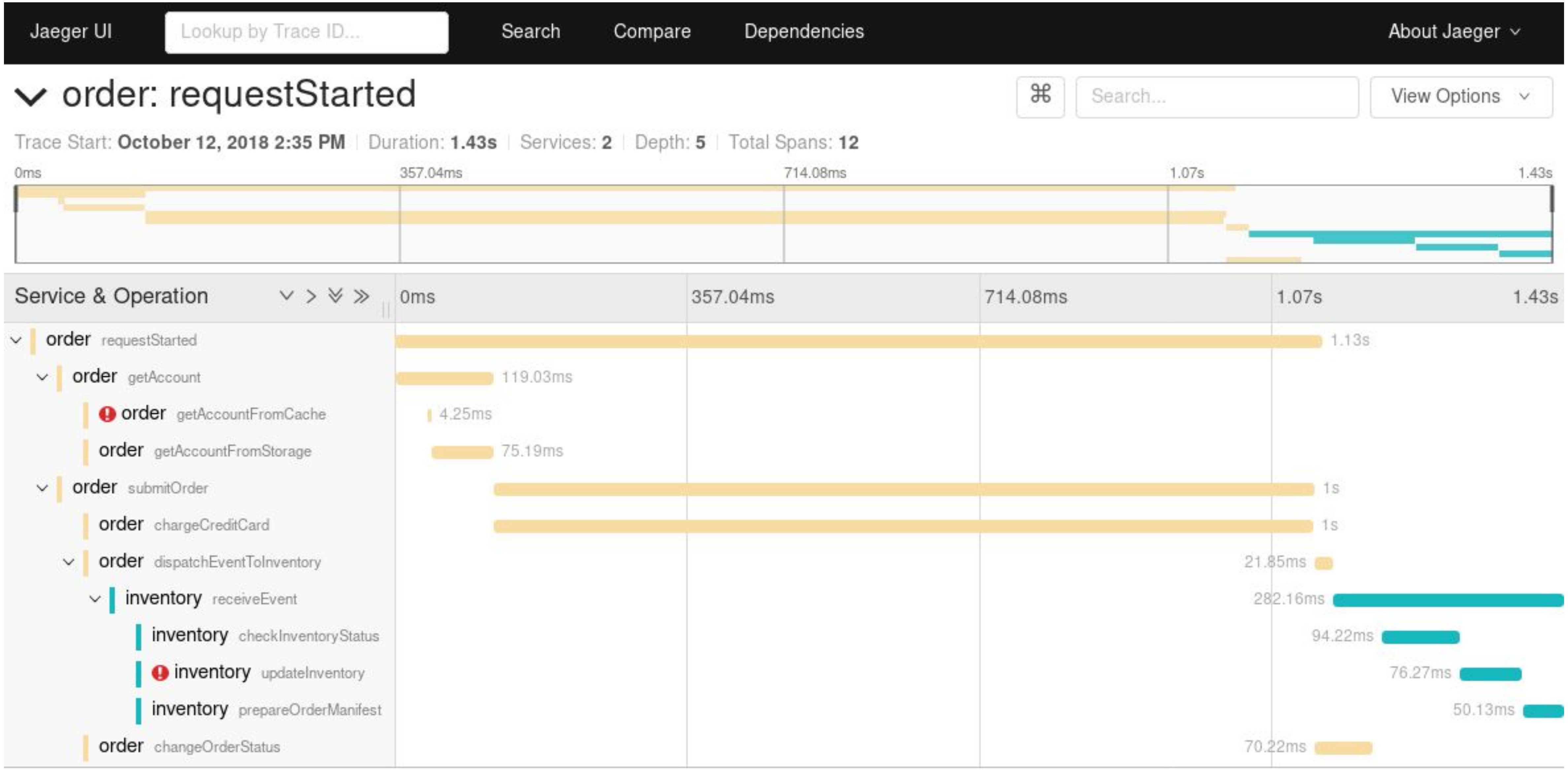
- Root cause analysis
    - Where did first failure happen?
    - Trace contains error code and message
- Performance optimization
    - Is a service behaving badly?
    - Impact of performance optimization
- Service dependency visualization

Distributed Tracing

Concepts

- Measures unit of work
- Data stored in *span*
- References other spans
  - Causality
- Context propagation
  - Similar to correlation identifiers
  - Typically autogenerated
- Additional information: Tags, baggage

Distributed Tracing Visualization



order: requestStarted

Trace Start: **October 12, 2018 2:35 PM** | Duration: **1.43s** | Services: **2** | Depth: **5** | Total Spans: **12**

Service & Operation | 0ms | 357.04ms | 714.08ms | 1.07s | 1.43s

- order requestStarted 1.13s
  - order getAccount 119.03ms
    - order getAccountFromCache 4.25ms
    - order getAccountFromStorage 75.19ms
  - order submitOrder 1s
    - order chargeCreditCard 1s
    - order dispatchEventToInventory 21.85ms
      - inventory receiveEvent 282.16ms
        - inventory checkInventoryStatus 94.22ms
        - inventory updateInventory 76.27ms
        - inventory prepareOrderManifest 50.13ms
    - order changeOrderStatus 70.22ms

Distributed Tracing Visualization

Request Summary

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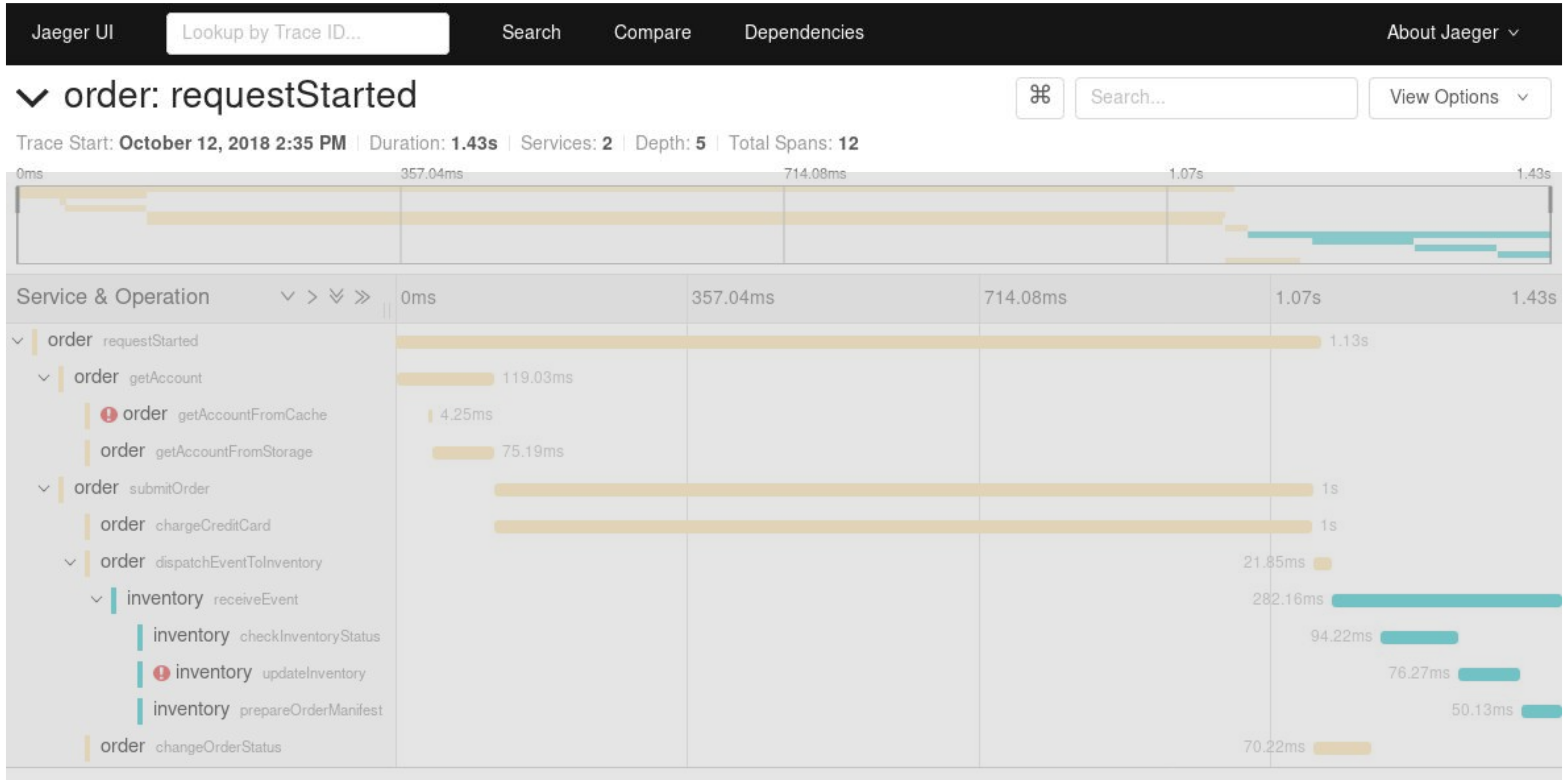

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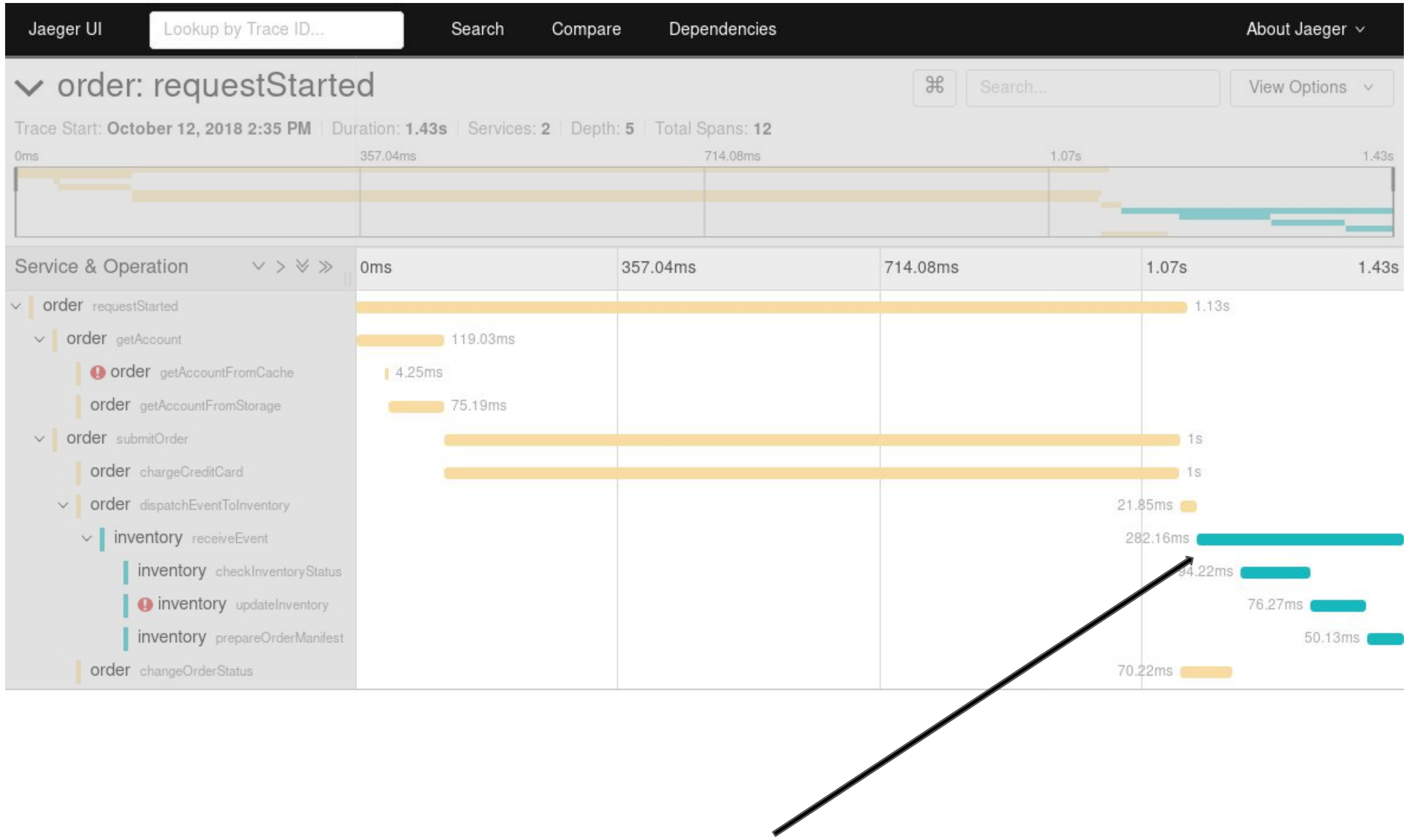
Distributed Tracing Visualization

Process Boundary



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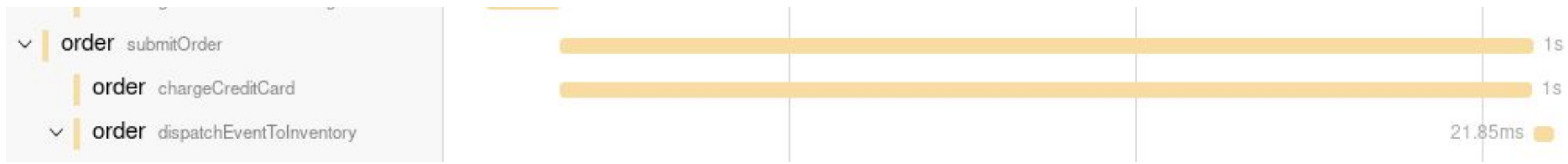
Distributed Tracing Visualization

Performance Bottleneck



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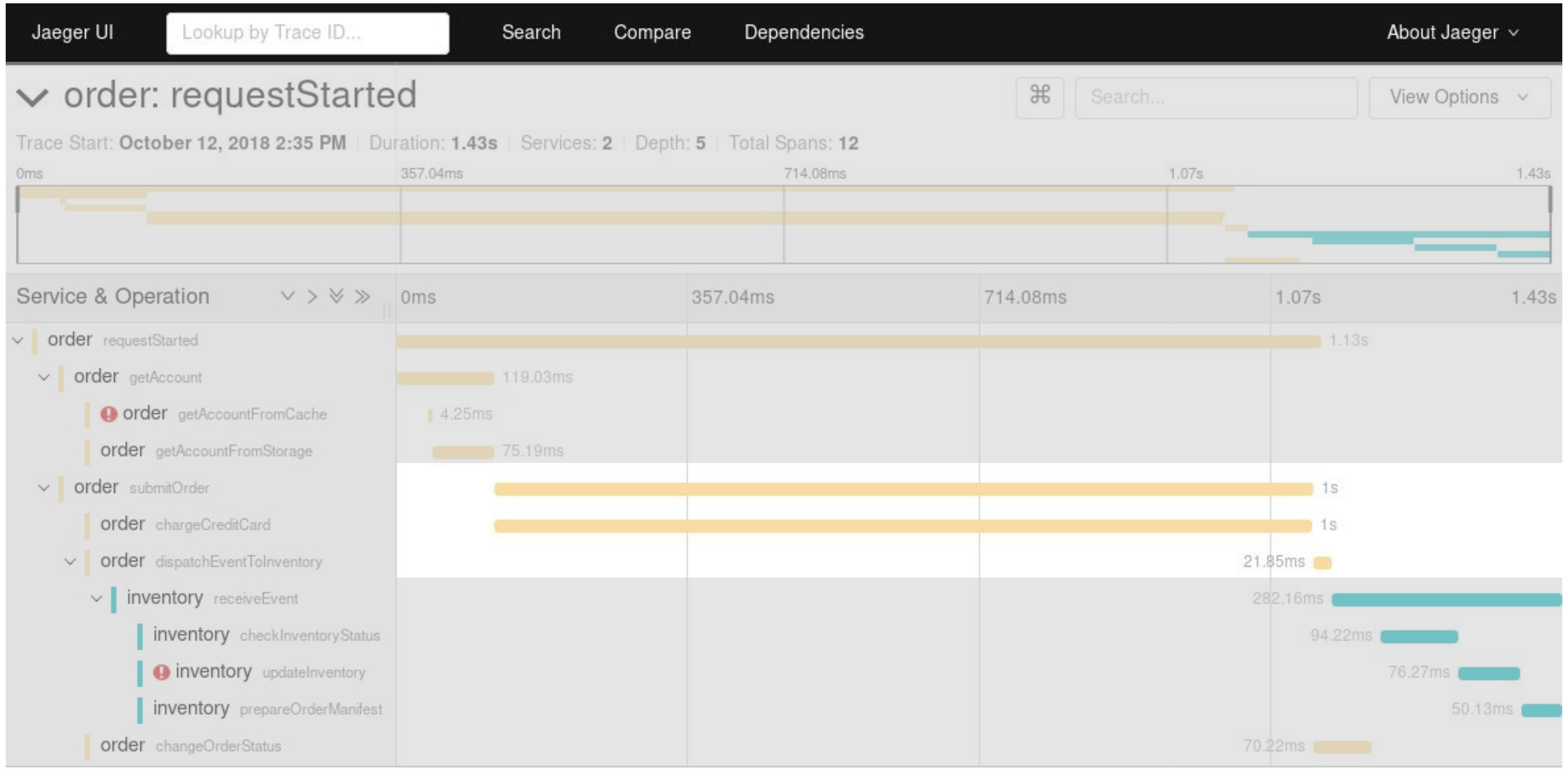

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Code Instrumentation

- Explicit
  - Included in source code
- Implicit
  - Span generation and propagation done automatically
  - Web frameworks, REST libraries, Spring Boot, JMS, etc.
- Span propagation
  - Mechanism depends on protocol
  - HTTP: Span context propagated to upstream services as HTTP headers

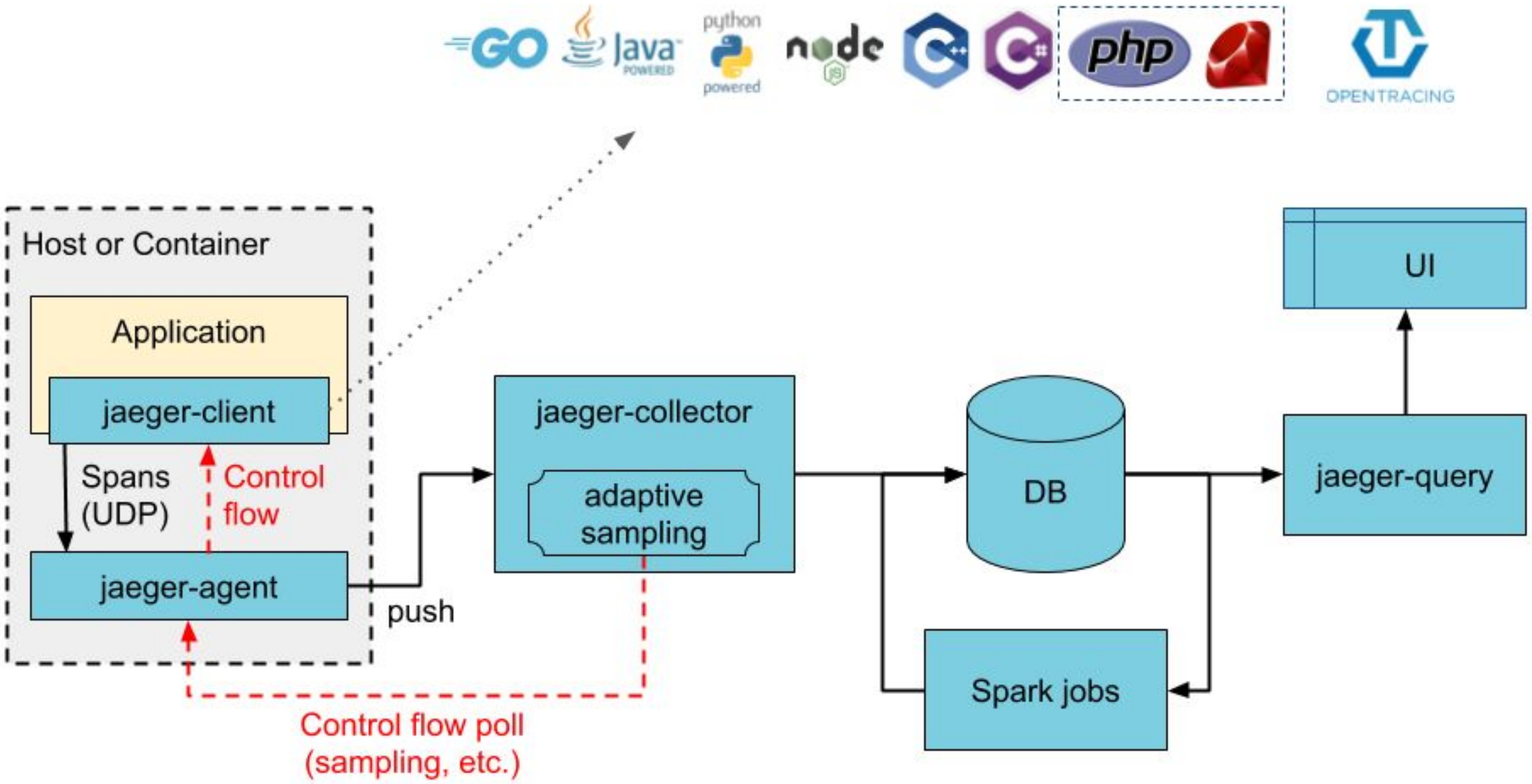
OpenTracing

- Open standard specification for distributed tracing
- Defines semantics: What is a trace, what is a span, etc.
- Instrumentation API
    - Official APIs for Java™, Go, Ruby
    - Can be used with compatible tracers—e.g., Zipkin, Jaeger
- Hosted at Cloud Native Computing Foundation
- Integrations
    - Frameworks, stack, platform
        - JAX-RS, JDBC, JMS, others
        - Spring Boot, MicroProfile, others
    - Infrastructure
        - Istio

Jaeger

- Concrete OpenTracing implementation
  - Native OpenTracing semantics
- Originated at Uber
- Back-end components
  - Agent, Collector, Query, UI
- Production-ready
  - Bare metal, Kubernetes, OpenShift

Jaeger Architecture



Service Mesh and Jaeger

- Jaeger optionally installed as part of OpenShift Service Mesh
  - All-in-one
  - Production Elasticsearch
- Envoy proxy responsible for generating initial trace headers
  - Uses Zipkin format headers.
  - Default sampling rate: 1%
- Envoy proxy sends tracing information directly to tracing back ends
- Application responsible for propagating trace context to upstream services
  - Envoy proxy not compatible with Jaeger agent sidecar
  - Applications must send traces directly to Jaeger collector
- Integration with other tracers (e.g. StackDriver) possible through Envoy WASM modules

Monitoring

- Gathering, processing, storing metric data about system
- Blackbox monitoring
  - Tests externally visible behavior as user sees it
  - HTTP endpoints, ICMP, overall response times
- Whitebox monitoring
  - Based on internal system metrics
  - CPU, memory, JVM, application-specific metrics
- Monitoring data typically stored as time series
- Requirements for monitoring data:
  - Aggregation
  - Mathematical processing and transformation
  - Examples: Averages, histograms

Monitoring Solutions for Cloud Native Apps

- Commercial, closed source
    - AppDynamics
    - New Relic
    - Dynatrace
- Open source
    - Zabbix
    - Heapster
    - Prometheus

Prometheus

- Open source monitoring solution
- Inspired by Google's *Borgmon* monitoring tool
- Graduated project of CNCF
  - Second after Kubernetes
- Inclusive monitoring: Blackbox/whitebox, client libraries
- Time series collection implemented via pull model over HTTP
- Multi-dimensional data model with time series data identified by metric name and key/value pairs
- Powerful query language
  - Multiply, add, aggregate, join, compute quantiles

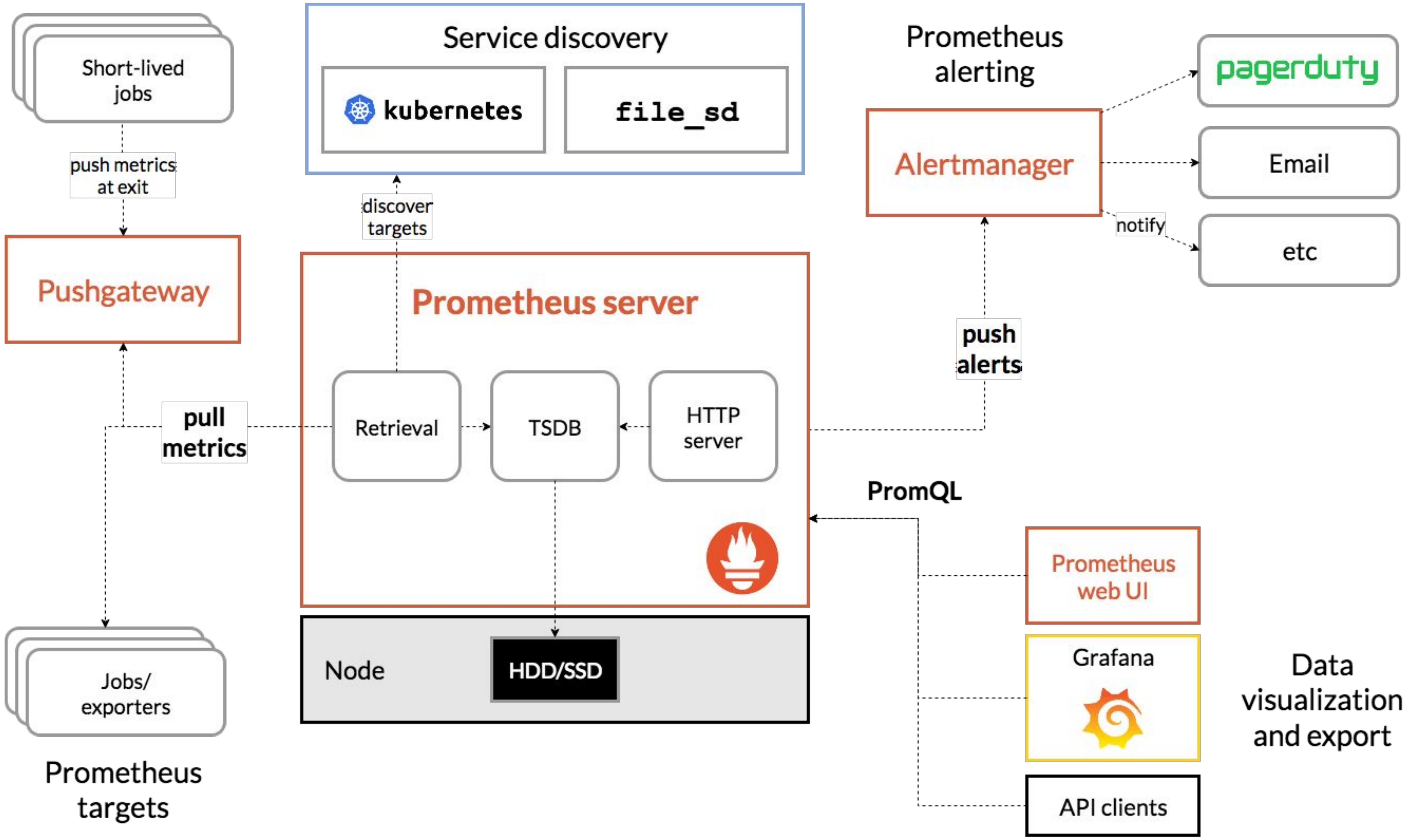
Prometheus

Features

- Open source monitoring solution
- Monitoring targets discovered via service discovery or static configuration
- Kubernetes integration: Service discovery through Kubernetes API
- No reliance on distributed storage: Local on-disk time series database
- Efficient:
  - Minimal datapoint size
  - Single server can handle millions of metrics
- Recording rules to precompute frequently needed or computationally expensive expressions
- Scale out through sharding and federation

Prometheus

Architecture



Service Mesh and Monitoring

- Prometheus and Grafana installed as part of OpenShift Service Mesh
- Prebuilt Grafana dashboards for metrics generated by Envoy proxies and Istio control plane components
- Telemetry V2
  - Integration with Prometheus through Envoy WebAssembly Module (WASM) extension
  - Metrics exposed by Envoy and scraped by Prometheus
- Integration with other monitoring solutions through WASM extensions

Visualization

- Jaeger UI
- Grafana dashboards
- Kiali
  - OpenShift Service Mesh console
  - Visualizes service mesh topology in real time
  - Provides visibility into features like request routing, circuit breakers, request rates, latency, etc.
  - Inline edition of YAML representation of Istio resources, with powerful semantic validation
  - Actions to create, update, delete Istio configuration resources, driven by wizards
  - Custom metrics dashboards
  - Integrated with distributed tracing

Module Summary

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