Everything You Wanted to Know About Distributed Tracing.

Strange Loop Conference

September 2019

AJUA

Who Am I

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How to use this talk

- **Please don’t just follow it blindly:** There are often times when you will need to do things differently.
- **Software is all about trade-offs**: Very few decisions are about right and wrong.
- **Try things for yourself**: Why not make Friday afternoons a time to play and experiment?

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Software Evolution.

- Monolith
- On Prem
- Single Language
- Single Stack
- Virtual Machines

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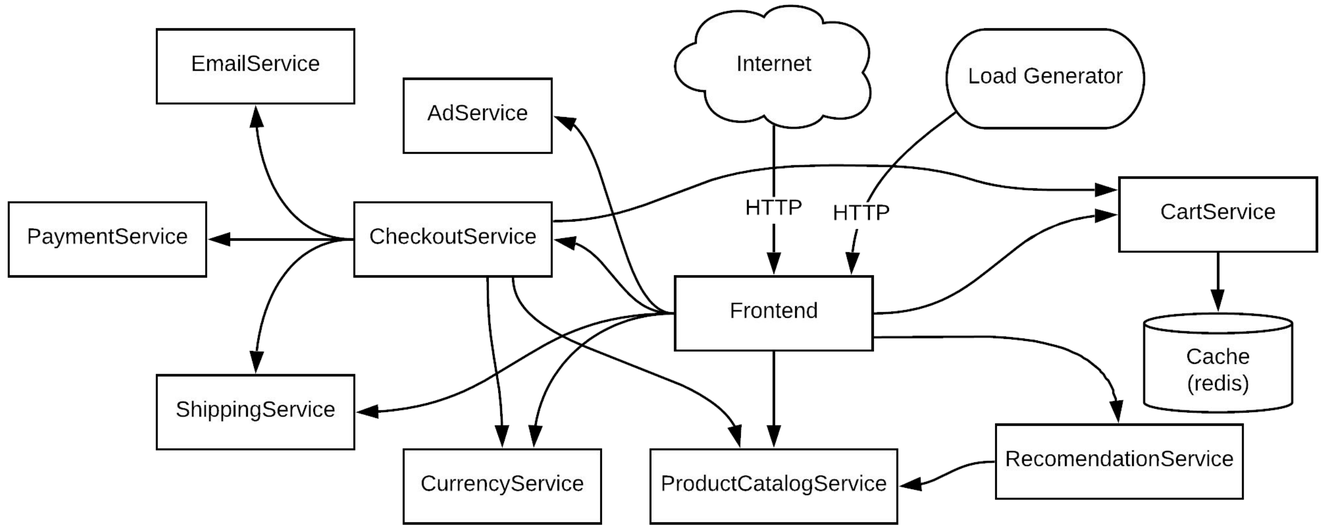
Software Evolution.

- Microservices
- Containers
- Multi Cloud/ Hybrid
- Polyglot
- Containers
- Serverless/ Cloud Functions



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New Architectures/ New Challenges.

- **Observability**
- Deployment / Packaging
- Configuration Management
- Debugging
- Secrets Management

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Meet: Distributed Tracing

“**Distributed Tracing**, also called distributed request tracing, is a method used to profile and monitor applications, especially those built using a microservices architecture. Distributed tracing helps pinpoint where failures occur and what causes poor performance.”

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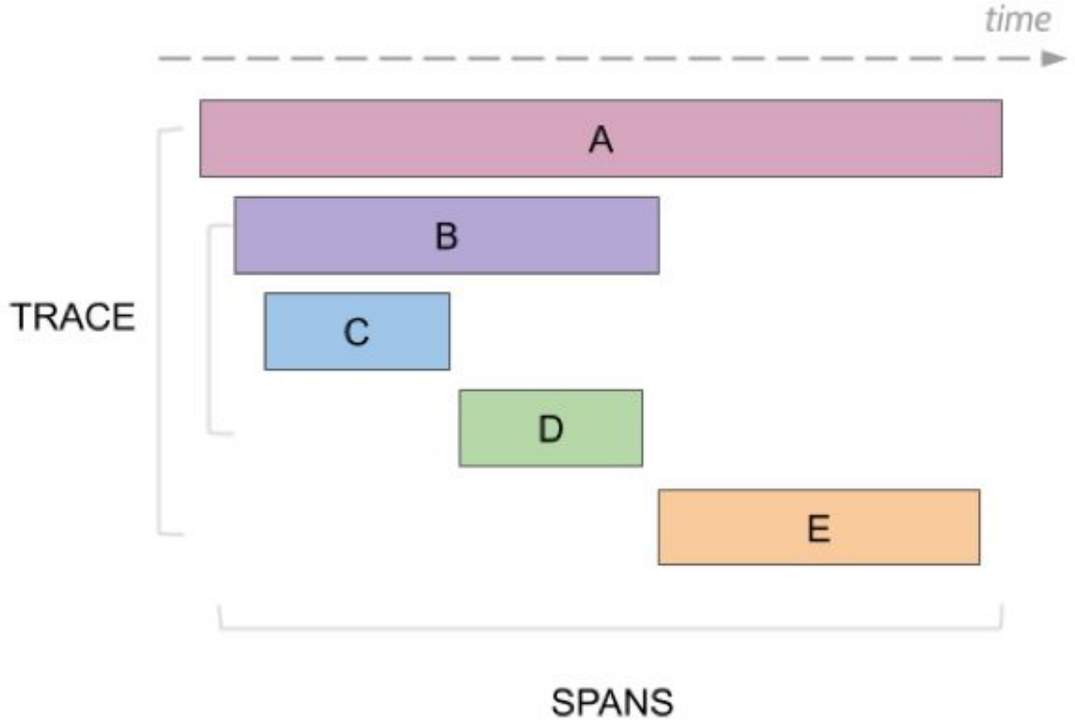
Distributed Tracing - Terminology

Trace - a trace is a tree of spans that follows the course of a request or system from its source to its ultimate destination.

Each **trace** is a narrative that tells the requests story as it travels through the system.



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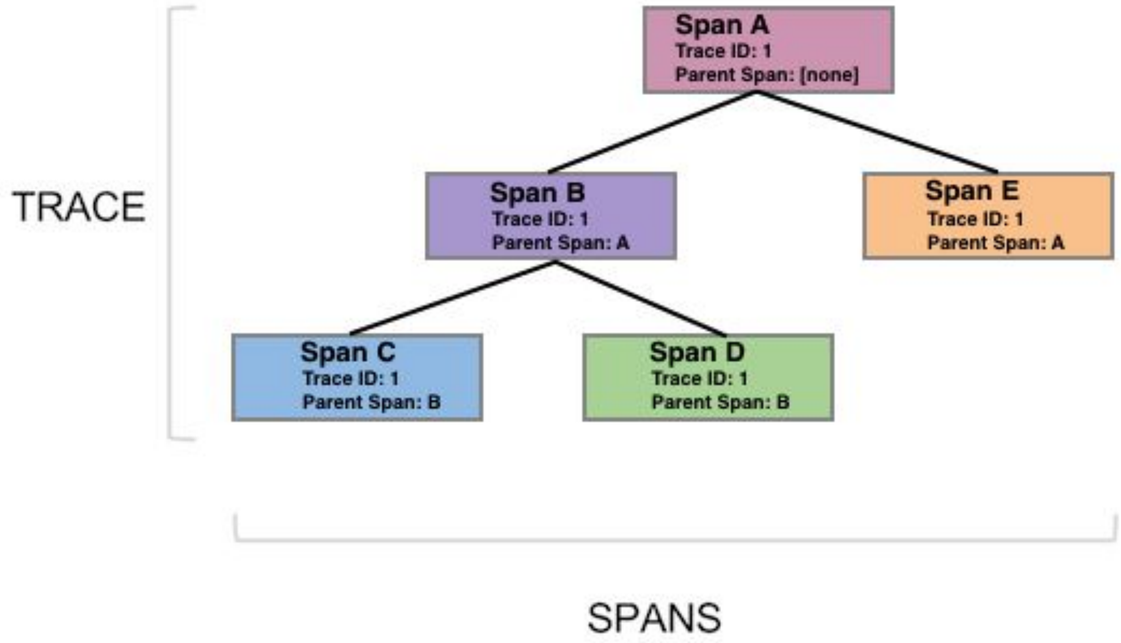
Distributed Tracing - Terminology

Span - are logical units of work in a distributed system. They all have a name, a start time, and a duration.

Each **Span** captures important data points specific to the current process handling the request.



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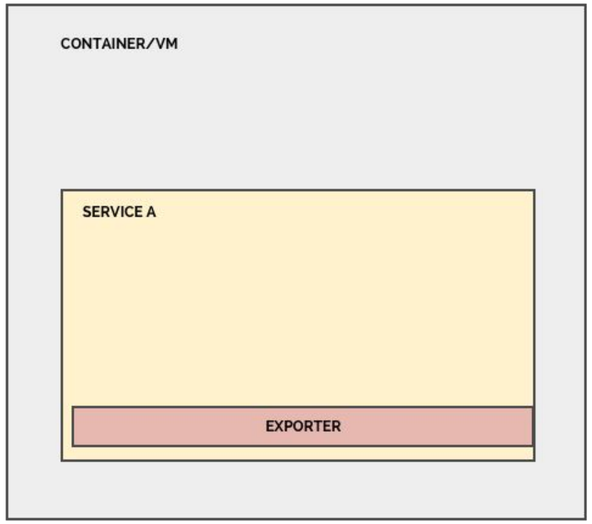
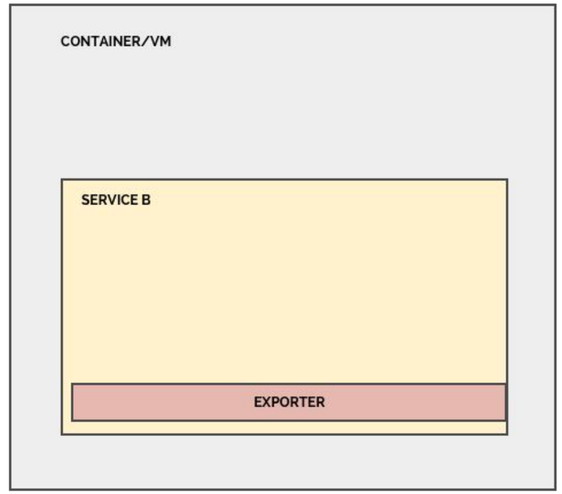
Distributed Tracing - Terminology

Context Propagation:

Incoming Request





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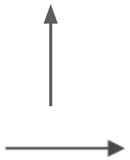
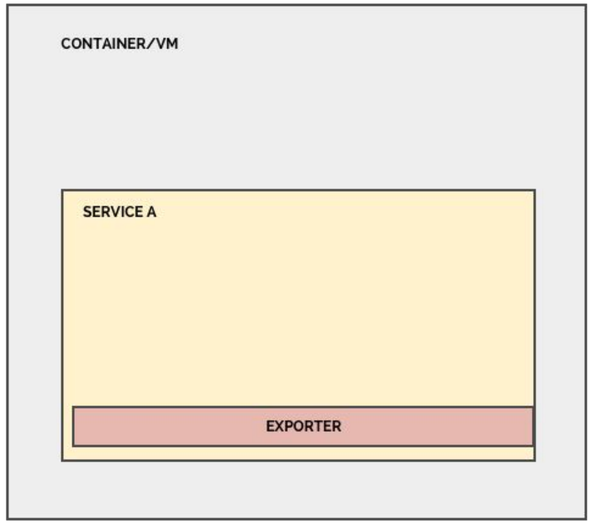
Distributed Tracing - Terminology

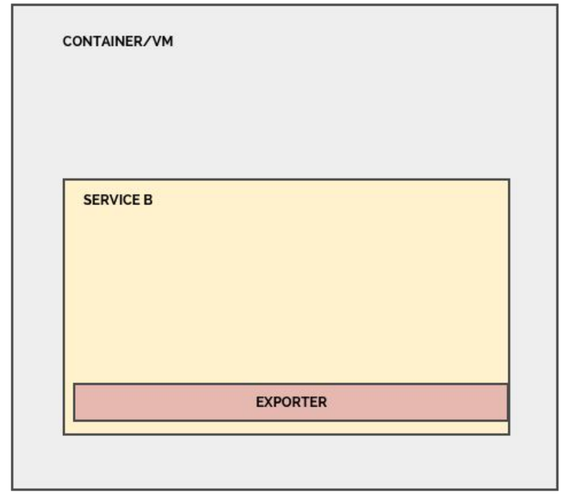
Context Propagation:

trace-id = 123
parent-d = nil
span-id = 1

Incoming Request







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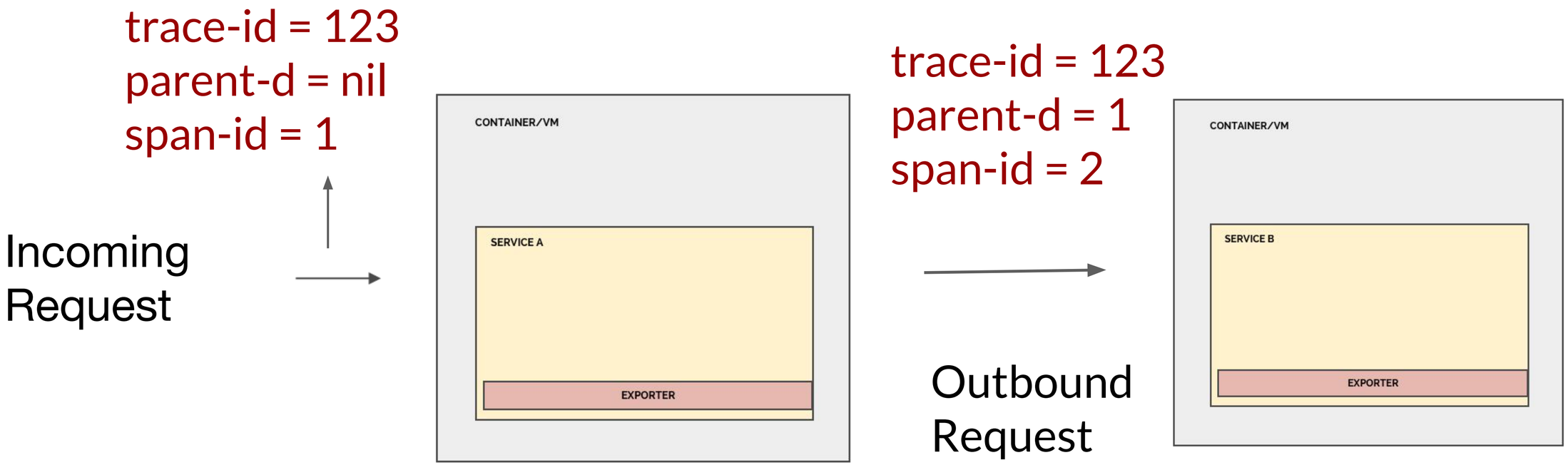
Distributed Tracing - Terminology

Context Propagation:



Distributed Tracing - Terminology

Tags & Logs: both annotate the span with some contextual information.

- Tags typically apply to the whole span, while logs represent some events that happened during the span execution.
- A log always has a timestamp that falls within the span's start-end time interval.
- The tracing system does not explicitly track causality between logged events the way it keeps track of causality relationships between spans, because it can be inferred from the timestamps.

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What questions can tracing help us answer?

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Distributed Tracing:

- What services did a **request pass through**?

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- What occured in **each service** for a given request?

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Distributed Tracing:

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- What occured in **each service** for a given request?
- Where did the **error** happen?
- Where are the **bottlenecks**?
- What is the **critical path** for a request?
- Who should I **page**?

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If tracing is so good why isn’t everyone using it?

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- Not much education or not many publicized case studies on the benefits.
- Vendor Lock in is unacceptable: Instrumentation must be decoupled from vendors .
- Inconsistent APIs: Tracing semantics must not be language dependent.
- Handoff woes: Tracing libs in Project X do not handoff to tracing libs in Project Y.

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Meet OpenTelemetry

OpenTelemetry

Open Telemetry is made up of an integrated set of APIs and libraries as well as a collection mechanism via a agent and collector. These components are used to generate, collect, and describe telemetry about distributed systems.

Problems OpenTelemetry solves:

- Vendor neutrality for tracing, monitoring and logging
- Context Propagation.

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OpenTelemetry (opentelemetry.io) Is:

- **Single set of APIs** for tracing and metrics collection.
- **Standardized Context Propagation**.
- **Exporters** for sending data to backend of choice.
- **Collector** for smart traces & metrics aggregation.
- **Integrations** with popular web, RPC and storage frameworks.

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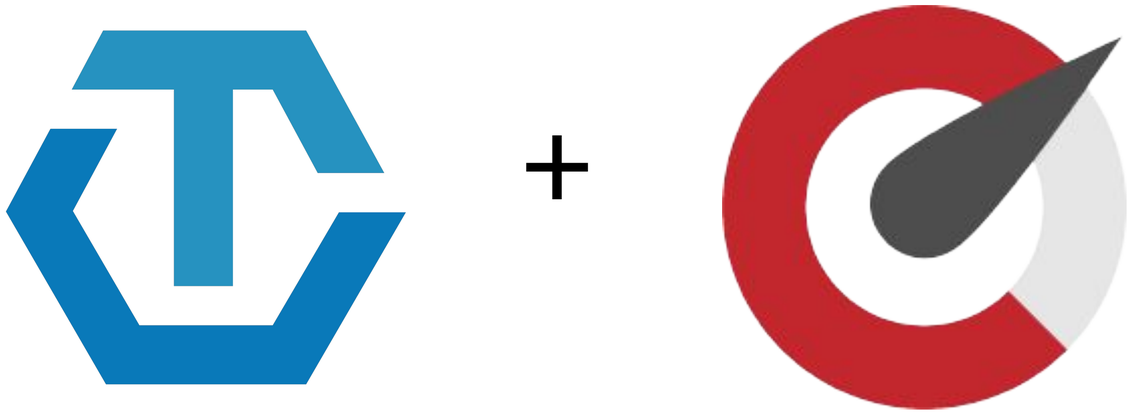
OpenTelemetry (opentelemetry.io) Is:

Next major version of the OpenTracing and OpenCensus projects.

OpenTelemetry Roadmap:



Merging OpenTracing and OpenCensus: Goals and Non-Goals

Ben Sigelman Follow

Mar 29 · 3 min read

Announcement: https://medium.com/opentracing/merging-opentracing-and-opencensus-f0fe9c7ca6f0

Roadmap: https://medium.com/opentracing/a-roadmap-to-convergence-b074e5815289

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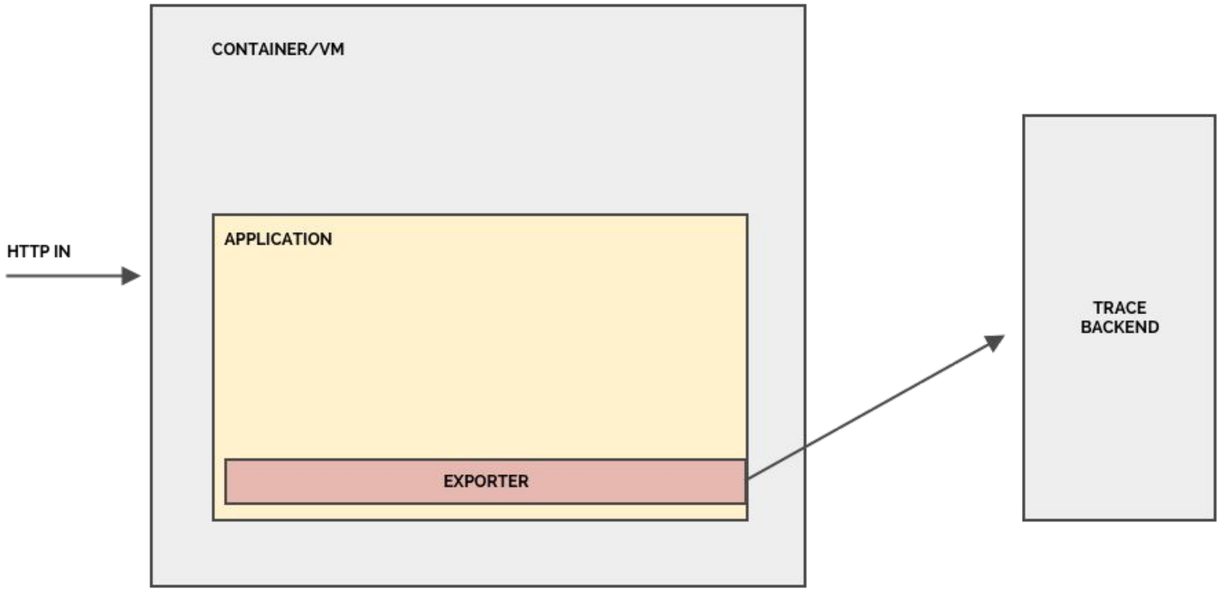
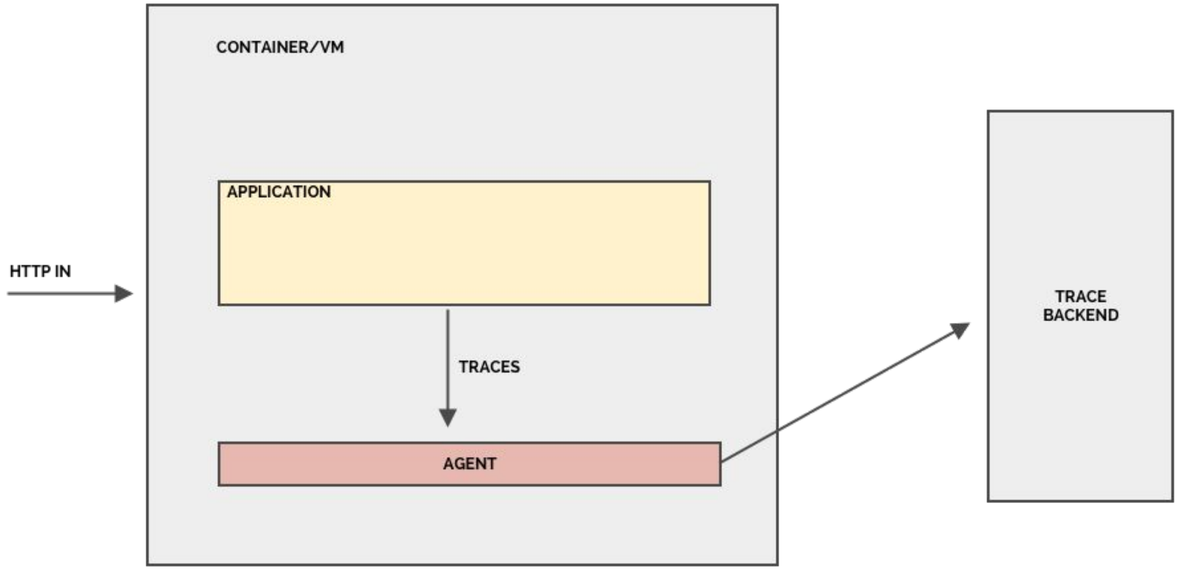
Tracing with OpenTelemetry - The Options

Agentless



Initialize exporter in app code

Using an Agent



Install the agent alongside the app

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OpenTelemetry: How to get Involved

Github: https://github.com/open-telemetry

Gitter: https://gitter.im/open-telemetry

Languages:

- .NET SDK
- GoLang SDK
- Java SDK
- JavaScript SDK
- Python SDK
- Ruby SIG
- Erlang/Elixir SDK

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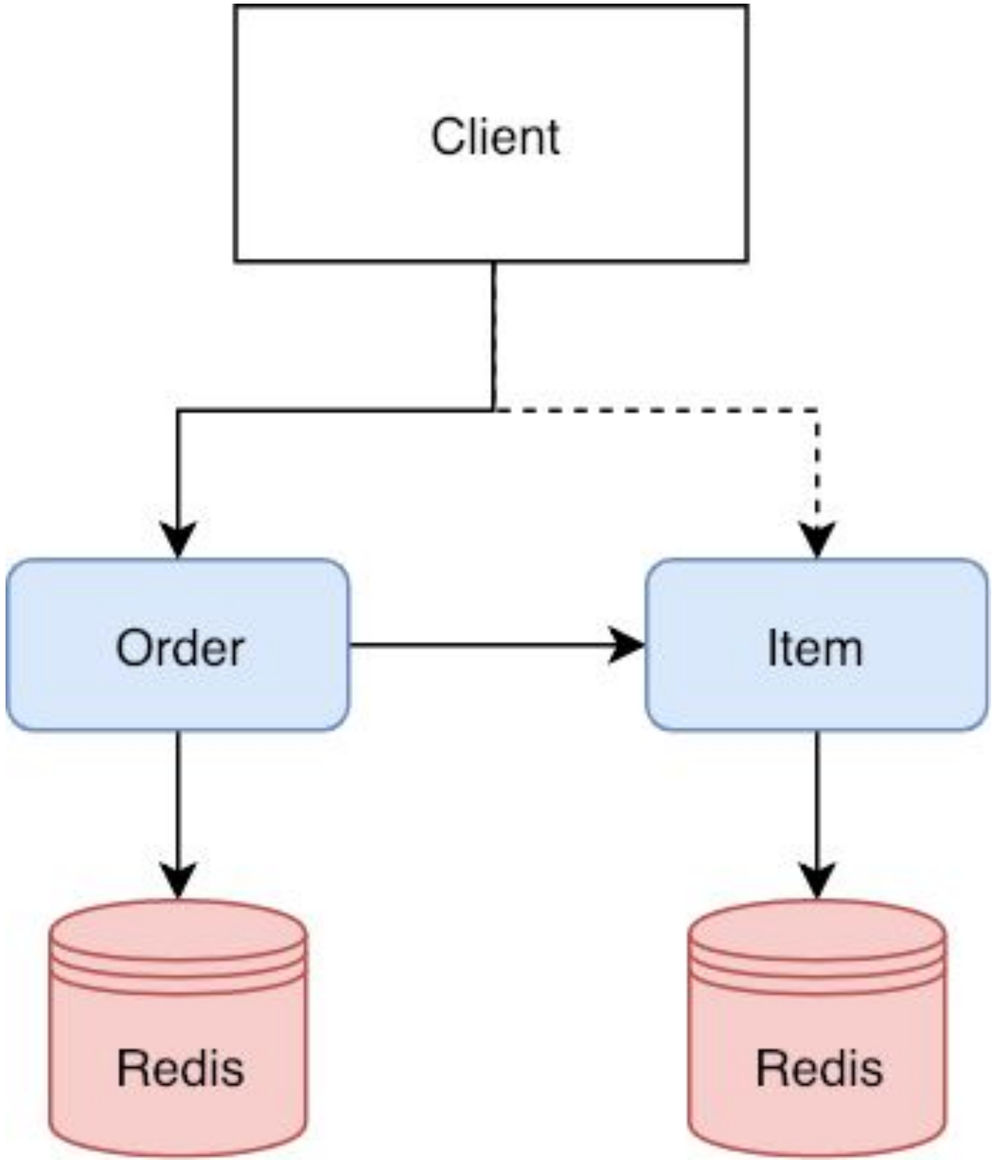
EXAMPLE



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Create a Tracer

```
125     // Creating tracer
126     var tracer ot.Tracer
127     var closer io.Closer
128     tracer, closer, err = util.InitTracer("item", s.logger)
129     if err != nil {
130         s.logger.Warnw("unable to initialize tracer",
131             "error", err,
132         )
133     } else {
134         defer closer.Close()
135         ot.SetGlobalTracer(tracer)
136     }
137
```

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Create a Tracer

```
14
15  // InitTracer returns an instance of Jaeger Tracer that samples 100% of traces and logs all spar
16  func InitTracer(serviceName string, logger *Logger) (ot.Tracer, io.Closer, error) {
17      cfg, err := config.FromEnv()
18      if err != nil {
19          return nil, nil, err
20      }
21
22      cfg.Sampler.Type = "const"
23      cfg.Sampler.Param = 1
24      cfg.Reporter.LogSpans = false
25
26      tracer, closer, err := cfg.New(
27          serviceName,
28          config.Logger(logger),
29          config.Metrics(prometheus.New()),
30      )
31      if err != nil {
32          return nil, nil, err
33      }
34      return tracer, closer, nil
35  }
```

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Tracers

JAEGER

DATADOG

honeycomb.io

ZIPKIN

THE APACHE SOFTWARE FOUNDATION

Skywalking

LIGHTSTEP

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Instrument

```
37  // TracerMiddleware adds a Span to the request Context ready for other handlers to use it.
38  func TracerMiddleware(inner http.Handler, route Route) http.HandlerFunc {
39      return http.HandlerFunc(func(w http.ResponseWriter, r *http.Request) {
40          var ctx context.Context
41          var span ot.Span
42          tracer := ot.GlobalTracer()
43
44          // If possible, extract span context from headers
45          spanCtx, _ := tracer.Extract(ot.HTTPHeaders, ot.HTTPHeadersCarrier(r.Header))
46          if spanCtx == nil {
47              span = tracer.StartSpan("request")
48              defer span.Finish()
49              ctx = ot.ContextWithSpan(r.Context(), span)
50          } else {
51              span = tracer.StartSpan("request", ext.RPCServerOption(spanCtx))
52              defer span.Finish()
53              ctx = ot.ContextWithSpan(r.Context(), span)
54          }
55          for k, v := range r.Header {
56              span.SetTag(fmt.Sprintf("header.%s", k), v)
57          }
58
59          // TODO: capture return code as tag in root trace
60          span.SetTag("method", r.Method)
61          span.SetTag("url", r.URL.Path)
62          span.SetTag("handler", route.Name)
63
64          r = r.WithContext(ctx)
65          inner.ServeHTTP(w, r)
66      })
67  }
```

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Instrument

```
204  // getItem retrieves a single Item by ID from Redis.
205  func (s *Server) getItem() http.HandlerFunc {
206      return func(w http.ResponseWriter, r *http.Request) {
207          span, ctx := ot.StartSpanFromContext(r.Context(), "getItem")
208          defer span.Finish()
209
210          pr := mux.Vars(r)
211          key := pr["id"]
212
213          item, err := s.RedisGetItem(ctx, key)
214          if err != nil {
215              s.logger.Errorw("unable to get key from redis",
216                  "key", key,
217                  "error", err,
218              )
219              s.Respond(ctx, http.StatusInternalServerError, "unable to retreive item", 0, nil, w)
220              return
221          }
222          if item == nil {
223              s.Respond(ctx, http.StatusNotFound, fmt.Sprintf("item with ID %s doesn't exist", key
224              return
225          }
226          s.Respond(ctx, http.StatusOK, "item retrieved", 1, []*Item{item}, w)
227      }
228  }
```

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Introducing Jaeger:

- Open source distributed tracing platform.
- Inspired by Google Dapper and OpenZipkin
- Created by Uber in 2015 and donated to CNCF in 2017.
- Compliant with both OpenTracing and OpenCensus.
- Supports multiple storage options (Cassandra, ElasticSearch, In-Memory)
- Compatible with Apache Kafka for backpressure management.

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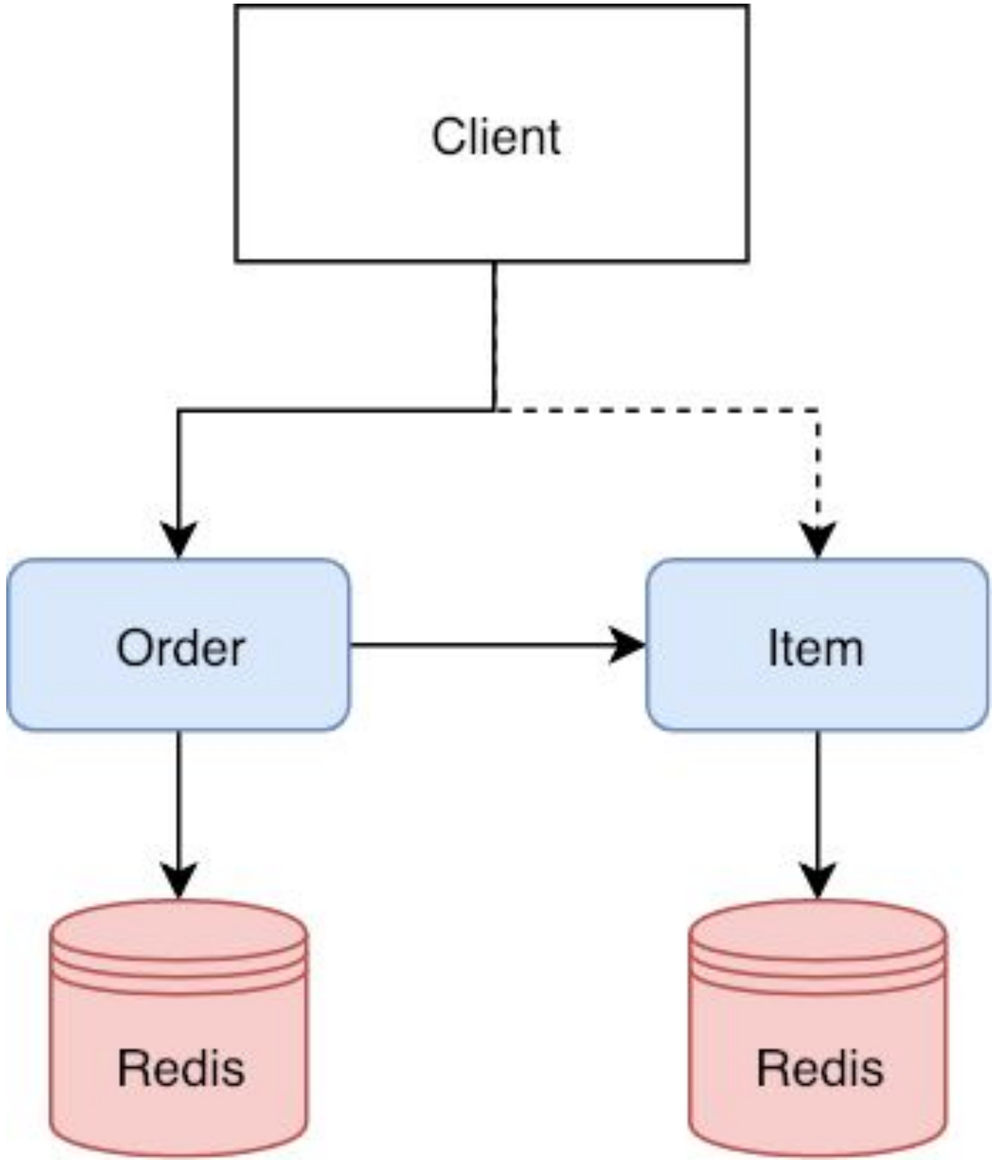
DEMO

obitech/micro-obs



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Conclusion

- Tracing is crucial for understanding complex, microservices applications.
- Distributed tracing provides a base view of the system that can drastically shorten feedback loops and the number of people involved incidents.
- Tracing provides much more context, allowing an on call responder to better understand the system and get further on their own before involving more people.

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Thank You

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