Introduction to distributed tracing

Exploring the Power of Distributed Tracing with OpenTelemetry on Kubernetes, KubeCon EU 2024

Observability and distributed tracing

- Internal state of our system
- Signals
  - Metrics
  - **Traces (spans)**
  - Logs
  - Profiles
  - ….

Observability and distributed tracing

- Internal state of our system
- Signals
    - Metrics -> [KubeCon NA 2023 Tutorial](#)
    - **Traces (spans)**
    - Logs
    - Profiles
    - ….

OpenTelemetry

```json
{
  "name": "/v1/sys/health",
  "context": {
    "trace_id": "7bba9f33312b3dbb8b2c2c62bb7abe2d",
    "span_id": "086e83747d0e381e"
  },
  "parent_id": "",
  "start_time": "2021-10-22 16:04:01.209458162 +0000 UTC",
  "end_time": "2021-10-22 16:04:01.209514132 +0000 UTC",
  "status_code": "STATUS_CODE_OK",
  "status_message": "",
  "attributes": {
    "net.transport": "IP.TCP",
    "net.peer.ip": "172.17.0.1",
    "net.peer.port": "51820",
    "net.host.ip": "10.177.2.152",
    "net.host.port": "26040",
    "http.method": "GET",
    "http.target": "/v1/sys/health",
    "http.server_name": "mortar-gateway",
    "http.route": "/v1/sys/health",
    "http.user_agent": "Consul Health Check",
    "http.scheme": "http",
    "http.host": "10.177.2.152:26040",
    "http.flavor": "1.1"
  },
  "events": [
    {
      "name": "",
      "message": "OK",
      "timestamp": "2021-10-22 16:04:01.209512872 +0000 UTC"
    }
  ]
}
```

- **Trace**
  - Story of a request through the system
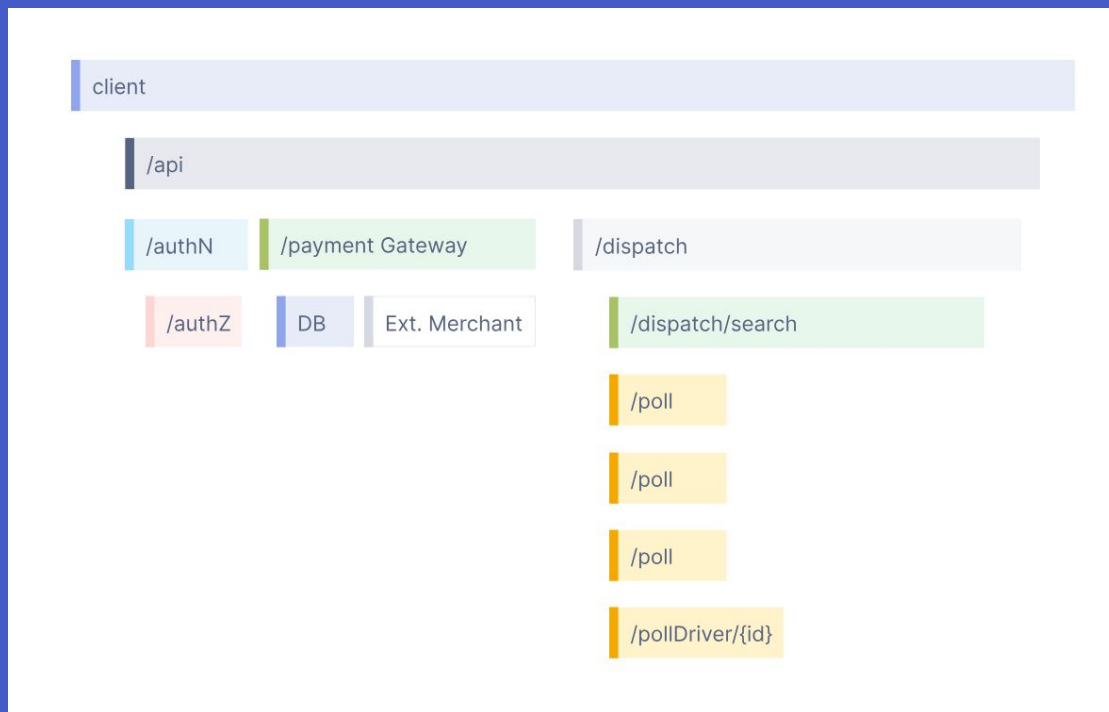- **Span**
  - A basic unit
  - Relates to specific operation
  - Contains:
    - Name & IDs
    - Time-related data
    - Log messages (events)
    - Metadata (attributes)
    - …

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}
```

- **Span context**
  - Trace ID
  - Span ID
  - Trace flags and state
- **Parent ID**
- **(Links)**

Visualizing traces

Taken and adjusted from: https://opentelemetry.io/docs/concepts/observability-primer/

Span relations

```json
{
  "name": "hello",
  "context": {
    "trace_id": "0x5b8aa5a2d2c872e8321cf37308d69df2",
    "span_id": "0x051581bf3cb55c13"
  },
  "parent_id": null,
  ...
}
```

Parent-child

Parent-child

```json
{
  "name": "hello-greetings",
  "context": {
    "trace_id": "0x5b8aa5a2d2c872e8321cf37308d69df2",
    "span_id": "0x5fb397be34d26b51"
  },
  "parent_id": "0x051581bf3cb55c13",
  ...
}
```

Siblings

```json
{
  "name": "hello-salutations",
  "context": {
    "trace_id": "0x5b8aa5a2d2c872e8321cf37308d69df2",
    "span_id": "0x93564f51e1abe1c2"
  },
  "parent_id": "0x051581bf3cb55c13",
  ...
}
```

OpenTelemetry

Taken and adjusted from: https://opentelemetry.io/docs/concepts/signals/traces/#spans

Span relations

Parent-child

```json
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  "name": "hello",
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    "span_id": "0x5fb397be34d26b51"
  },
  "parent_id": "0x051581bf3cb55c13",
  "links": [
    {
      "trace_id": "7bba9f33312b3dbb8b2c2c62bb7abe2d",
      "span_id": "086e83747d0e381e"
    }
  ]
  ...
}
```

Causal
relationship

```json
{
  "name": "how-are-you",
  "context": {
    "trace_id": "7bba9f33312b3dbb8b2c2c62bb7abe2d",
    "span_id": "086e83747d0e381e"
  },
  "parent_id": null,
  ...
}
```

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- **Attributes**
  - Key-value pairs
- **Events**
  - Structured log messages
- **Links**
  - Causal span association
- **Status code and message**
  - Unset / OK / Error
  - Error message
- **Kind**
  - Client / Server / Internal / Producer / Consumer

Context Propagation

- Ensure signal correlation regardless of their generation
- Transmitting context *across* process and network boundaries
  - vs. in-process propagation
- W3C standards for propagation

OpenTelemetry

Context Propagation

- **Trace context**
  - HTTP header to propagate context
  - `traceparent` and `tracestate`

- **Baggage**
  - Propagate custom key-value pairs
  - Associates key-value pairs with requests

```
traceparent: 00-0af7651916cd43dd8448eb211c80319c-00f067aa0ba902b7-01
tracestate: rojo=00f067aa0ba902b7,congo=t61rcWkgMz
```

```
baggage: userId=Am%C3%A9lie,serverNode=DF%2028,isProduction=false
```

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