

# Cloud Computing

# Course plan

Learning session 5

Pricing

Monitoring and Observability

# Pricing

Sometimes you pay not for what you use, but for what you forgot to turn off

There is no Garbage Collection

# Pricing

- Snowflake pricing
- Pay-as-you-go vs pre-paid vs spot instances
- Storage pricing
- Traffic pricing
- Cost analysis
- Calculator

# Pricing

The pricing story could be entirely different for different resources in the same cloud

# Pricing

Pay-as-you-go (on-demand) – pay according to consumption

# Pricing

Consumption could be calculated:

- Memory/cpu/disk
- Seconds/minutes/hours
- Custom units

# Pricing

Pre-paid (reserved) – pay in advance

Sometimes can reduce price by >50%



# Pricing

Spot instance – propose your price for resource

# Pricing

## Spot instances

- Cloud unused capacity
- Best suitable for batch or non-critical workloads
- You cannot know when resources will be available and when cloud takes them away
- Sometimes can reduce prices by 80%

# Pricing

In the cloud, **network traffic** could be expensive

- Try not to cross a single data-center boundary
- Network traffic between data-centers is (often) billed
- Internet traffic is (often) billed

# Pricing

## Storage pricing

Cross-zone availability or backups could be included into cloud-managed service

You will pay for it if you implement the same functionality using basic Compute/Storage/Network primitives

# Pricing

Regularly use cost analysis tools and **set alerts on crossing your budget**

# Pricing

To estimate spending use Calculator:

- [Azure](#)
- [AWS](#)
- [GCP](#)

# Pricing

## Demo

# Pricing

## Tips

- Shut-down unused resources (automation is your friend)
- Consider changing resource size (often it's easy-peasy, but could be only one direction - up)
- Reserved and spot instances to the rescue
- Autoscaling
- Regularly review your architecture (new services and features may arise)
- Set budget and ALERTS



# Pricing

All the rules apply even if you do ...

# Pricing

All the rules apply even if you do ...

...[a small pet-project](#)

The image is a screenshot of a tweet from Kyle Barron (@kylebarron2). The tweet text reads: "Time to shut down my old personal projects... Someone abused/scraped one of my map tiling APIs in June, sending the service 200 million API requests and me an \$850 AWS bill 🤯😭 1/9". Below the text is a screenshot of a mobile phone screen showing the AWS console. The status bar at the top of the phone screen shows the time 4:34, LTE signal, and a battery icon. The browser address bar shows "console.aws.amazon.com". The AWS console header includes the AWS logo, a "Services" dropdown, and search, home, and notification icons. The main content area shows a section titled "Amazon Web Services, Inc. - Service Charges" with a total of "\$851.45". Below this, it lists "Invoice 790286689 - AWS" for the period "2021-07-03" with a charge of "\$851.45". The service is described as "Usage charge for this statement period".

**Kyle Barron**  
@kylebarron2

Time to shut down my old personal projects...

Someone abused/scraped one of my map tiling APIs in June, sending the service 200 million API requests and me an \$850 AWS bill 🤯😭 1/9

4:34 LTE

console.aws.amazon.com

aws Services 🔍 🏠 🔔 More ▼

▼ Amazon Web Services, Inc. - Service Charges	\$851.45
Invoice 790286689 - AWS	2021-07-03
Service: Usage charge for this statement period	\$851.45

# Pricing

All the rules apply even if you do ...

...[a big non-profit](#)

[\[ua\] translation](#)

## How I Got Pwned by My Cloud Costs



24 JANUARY 2022

I have been, and still remain, a massive proponent of "the cloud". I built [Have I Been Pwned](#) (HIBP) as a cloud-first service that took advantage of modern cloud paradigms such as Azure Table Storage to massively drive down costs at crazy levels of performance I never could have achieved before. I wrote many blog posts about [doing big things for small dollars](#) and did talks all over the world about the great success I'd had with these approaches. One such talk was [How I Pwned My Cloud Costs](#) so it seems apt that today, I write about the exact opposite: how my cloud costs pwned me.

It all started with my monthly Azure bill for December which was way over what it would normally be. It only took a moment to find the problem:

Purchases Charge Start Date - Charge End Date	Charges/ Credits (AUD)	GST	Tax Amount (AUD)	Total (including Tax) (AUD)
Networking 01/12/2021-31/12/2021	4,557.13	10.00%	455.72	5,012.85

# Pricing

p.s.

Often engineering team salary is >>> cloud bill

Self-managed service price also includes engineering time

# Course plan

Learning session 5

Pricing

Monitoring and Observability

# Monitoring and Observability

**"A DISTRIBUTED SYSTEM IS  
ONE IN WHICH THE FAILURE  
OF A COMPUTER YOU DID NOT  
EVEN KNOW EXISTED CAN  
RENDER YOUR OWN  
COMPUTER UNUSABLE"**

Leslie Lamport

# Monitoring and Observability

- What is Monitoring and Observability
- Logs
- Metrics (and SLI/SLO/SLA)
- Traces
- Audit
- Alerts
- Available solutions

# Monitoring and Observability

Any system eventually starts misbehaving



# Monitoring and Observability

When system misbehaves on *my-machine* – I can debug it

# Monitoring and Observability

When system misbehaves in-production – I can ...

# Monitoring and Observability

**Logging** – process for collecting, storing, retrieving, processing and visualizing log records/events.

```
STATUS | monitor | 2012/11/11 00:51:23 | --> Monitor Started as Daemon
STATUS | monitor | 2012/11/11 00:51:23 | Launching a Service...
INFO   | buserver | 2012/11/11 00:51:24 |
INFO   | buserver | 2012/11/11 00:52:09 | Nov 11, 2012 12:52:09 AM org.apache.catalina.startup.Embedded start
INFO   | buserver | 2012/11/11 00:52:09 | INFO: Starting tomcat server
INFO   | buserver | 2012/11/11 00:52:09 | Nov 11, 2012 12:52:09 AM org.apache.catalina.core.StandardEngine start
INFO   | buserver | 2012/11/11 00:52:09 | INFO: Starting Servlet Engine: Apache Tomcat/6.0.35
INFO   | buserver | 2012/11/11 00:52:09 | Nov 11, 2012 12:52:09 AM org.apache.catalina.startup.DigesterFactory register
INFO   | buserver | 2012/11/11 00:52:09 | WARNING: Could not get url for /javax/servlet/jsp/resources/web-jsptaglibrary_
2_1.xsd
INFO   | buserver | 2012/11/11 00:52:10 | Nov 11, 2012 12:52:10 AM org.apache.catalina.startup.DigesterFactory register
INFO   | buserver | 2012/11/11 00:52:10 | WARNING: Could not get url for /javax/servlet/jsp/resources/web-jsptaglibrary_
2_1.xsd
INFO   | buserver | 2012/11/11 00:52:12 | Nov 11, 2012 12:52:12 AM org.apache.catalina.startup.ContextConfig defaultWebC
onfig
INFO   | buserver | 2012/11/11 00:52:12 | INFO: No default web.xml
INFO   | buserver | 2012/11/11 00:52:13 | Nov 11, 2012 12:52:13 AM org.apache.catalina.core.ApplicationContext log
INFO   | buserver | 2012/11/11 00:52:13 | INFO: Initializing Spring root WebApplicationContext
INFO   | buserver | 2012/11/11 00:52:14 | Nov 11, 2012 12:52:14 AM org.zkoss.zk.ui.http.WebManager <init>:114
INFO   | buserver | 2012/11/11 00:52:14 | INFO: Starting ZK 5.0.10 EE (build: 2012010610)
INFO   | buserver | 2012/11/11 00:52:14 | Nov 11, 2012 12:52:14 AM org.zkoss.zk.ui.sys.ConfigParser parseConfigXml:160
INFO   | buserver | 2012/11/11 00:52:14 | INFO: Loading system default
INFO   | buserver | 2012/11/11 00:52:15 | Nov 11, 2012 12:52:15 AM org.zkoss.zk.ui.sys.ConfigParser parse:276
INFO   | buserver | 2012/11/11 00:52:15 | INFO: Running in the Standalone WEB-INF folder
```

# Monitoring and Observability

**Monitoring** – process for collecting, storing, retrieving, processing and visualizing state data

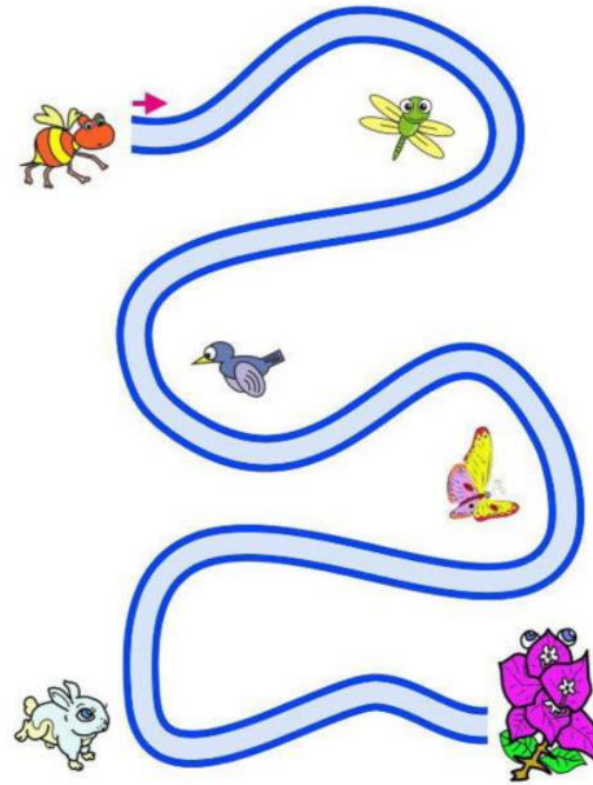


<https://grafana.com/>

# Monitoring and Observability

**Tracing** – represents the entire path of a request: which services (or methods) it crosses, how long each step takes

Use your crayon to draw a line along the path to the flower.



# Monitoring and Observability

**Observability** – a measure of how well internal states of a system can be inferred from knowledge of its external outputs

“Observability is about being able to ask arbitrary questions about your environment **without having to know ahead of time what you wanted to ask**” © [Honeycomb](#)

If you want to look fancy, you can write **o11y** instead of Observability (or squeeze it into a tweet limit)

# Monitoring and Observability: Logging

Logs – events written to a file or storage (almost always time-stamped)

# Monitoring and Observability: Logging

Plain-text (unstructured) log: just a string

```
"2010-01-01 12:34:56.0000 Info: Hello, world"
```



# Monitoring and Observability: Logging

## Plain-text log **pros**

"2010-01-01 12:34:56.0000 Info: Hello, world"

- + easy to read by humans
- + easy to implement
- + cheap to store

# Monitoring and Observability: Logging

Plain-text log **cons**

"2010-01-01 12:34:56.0000 Info: Hello, world"

- limited filtering capabilities
- limited analysis options

# Monitoring and Observability: Logging

Structured logs: all log events follow a defined structure.

*time*  
"2010-01-01 12:34:56.0000"  
*level*  
Info  
*message*  
Hello, world"

```
{  
  "time": "2010-01-01 12:34:56.0000",  
  "level": "Info",  
  "message": "hello, world",  
  "user": "test-user",  
  "env": "prod",  
  "hostname": "vm-0001"  
}
```

# Monitoring and Observability: Logging

The most popular format for structured logs is json

*Big* companies often prefer binary encoding, for example, protobuf or avro

# Monitoring and Observability: Logging

Structured logs **pros:**

- + unlimited filtering capabilities
- + unlimited analysis options
- + (could) enforce format
- + (could be) small messages

```
{  
  "time": "2010-01-01 12:34:56.0000",  
  "level": "Info",  
  "message": "hello, world",  
  "user": "test-user",  
  "env": "prod",  
  "hostname": "vm-0001"  
}
```

# Monitoring and Observability: Logging

## Structured logs **cons**:

- hardly readable by humans
- harder to implement
- could be expensive to store
- requires infrastructure to process, aggregate, ingest, index

```
{  
  "time": "2010-01-01 12:34:56.0000",  
  "level": "Info",  
  "message": "hello, world",  
  "user": "test-user",  
  "env": "prod",  
  "hostname": "vm-0001"  
}
```

# Monitoring and Observability: Logging

Demo

# Monitoring and Observability: Metrics

Metrics – numerical representation of data



# Monitoring and Observability: Metrics

Popular metric types:

- Counter/Gauge – a number, which goes up or down
- Histogram – samples observations into buckets

# Monitoring and Observability: Metrics

Often metrics are stored in *Time-Series Database (TSDB)*: software optimized to store ordered by time data-points

But could be also stored as structured records in any other storage type

# Monitoring and Observability: Metrics

Often time-series record is identified by name + unique set of **dimensions** *<name>{<label\_name>=<label value>, ...}*:

- `api_http_requests_total{method="POST", handler="/messages"}`
- `api_http_requests_total{method="GET", handler="/messages"}`

# Monitoring and Observability: Metrics

Each unique label generates a new time-series, thus:

- Save one more measurement into **existing time-series** – *cheap*
- Save one more measurement into **new time-series** – *expensive*

# Monitoring and Observability: Metrics

- Querying *the same* time-series– *cheap*
- Querying *multiple* time-series – *expensive*

# Monitoring and Observability: Metrics

**High-cardinality label** – label that could have a lot of unique values

When you use TSDB, better not to use high-cardinality labels

# Monitoring and Observability: Metrics

## Good label:

- HTTP Verb and Status Code
- VM id

## Bad label:

- UserId
- RequestId

# Monitoring and Observability: Metrics

Service-Level Objective (**SLO**) – target availability: how long system can be unavailable.

Service-Level Agreement (**SLA**) – SLO promised to others (users)

Service-Level Indicator (**SLI**) – units of SLO

[sli, sla, slo by Google](#)



# Monitoring and Observability: Metrics

## Compute AWS Service Level Objective

*AWS will use commercially reasonable efforts to make the Included Services each available for each AWS region with a Monthly Uptime Percentage of at least 99.99%*

# Monitoring and Observability: Metrics

## Compute AWS Service Level Agreement

### Monthly Uptime Percentage

### Service Credit Percentage

Less than 99.99% but equal to or greater than 99.0%

10%

Less than 99.0% but equal to or greater than 95.0%

30%

Less than 95.0%

100%

# Monitoring and Observability: Metrics

## Compute AWS Service Level Indicator

*“Monthly Uptime Percentage” is calculated by subtracting from 100% the **percentage of minutes** during the month in which ... [service] was **in the state of Unavailability***

*“Unavailable” and “Unavailability” mean ... for Single EC2 Instances, when your Single EC2 Instance **has no external connectivity**.*

# Monitoring and Observability: Metrics

## Uptime calculator

← → ↻ 🔒 https://uptime.is

### Uptime and downtime with 99.9 % SLA


[ [simple](#) / [flexible](#) / [reverse](#) / [@uptisbot](#) 🤖 ]

**Agreed SLA level:**  % (enter SLA level and hit the <enter> key)

SLA level of 99.9 % uptime/availability results in the following periods of allowed downtime/unavailability:

- **Daily:** 1m 26s
- **Weekly:** 10m 4s
- **Monthly:** 43m 49s
- **Quarterly:** 2h 11m 29s
- **Yearly:** 8h 45m 56s

Direct link to page with these results: [uptime.is/99.9](https://uptime.is/99.9) (or [uptime.is/three-nines](https://uptime.is/three-nines))



# Monitoring and Observability: Metrics

p.s.

Internal and External SLO often are different

# Monitoring and Observability: Metrics

Demo

# Monitoring and Observability: Traces

Finding logs and metrics associated with the same action/request could be tricky in a distributed system.

# Monitoring and Observability: Traces

Tracing is an attempt to address this problem.

Trace represents the entire journey of a request/action as it moves through all the nodes/modules of a distributed system.



# Monitoring and Observability: Traces

OpenTelemetry proposes vendor-neutral specification for trace model

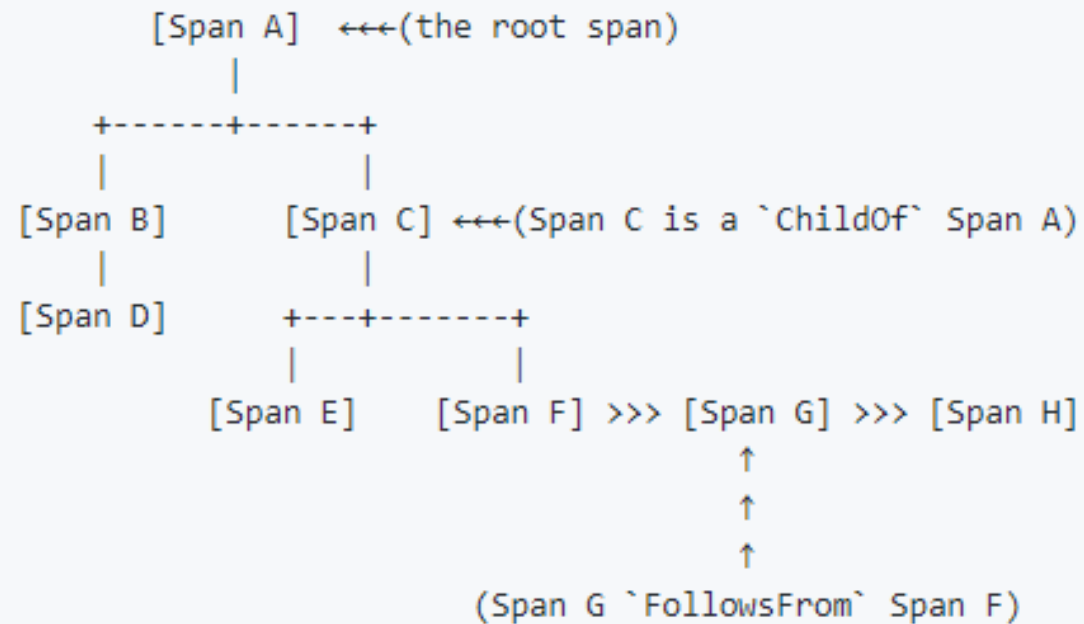
# Monitoring and Observability: Traces

OpenTelemetry introduces data model:

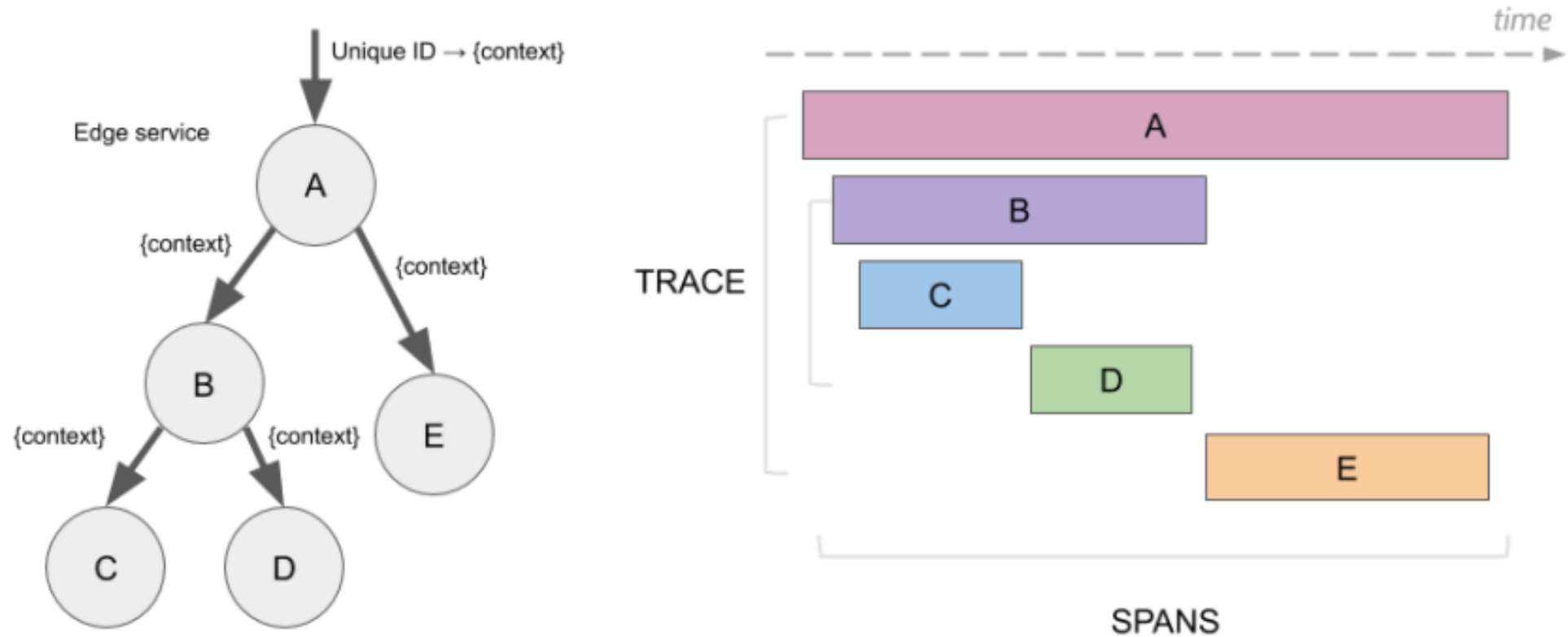
- *Trace* is directed acyclic graph (DAG)
- Each edge of this graph is named *Span*
- *Spans* could have two relation types: *ChildOf* and *FollowsFrom*
- *Spans* can have associated *Timestamp*, *Attributes*, *Links*, *Context*

# Monitoring and Observability: Traces

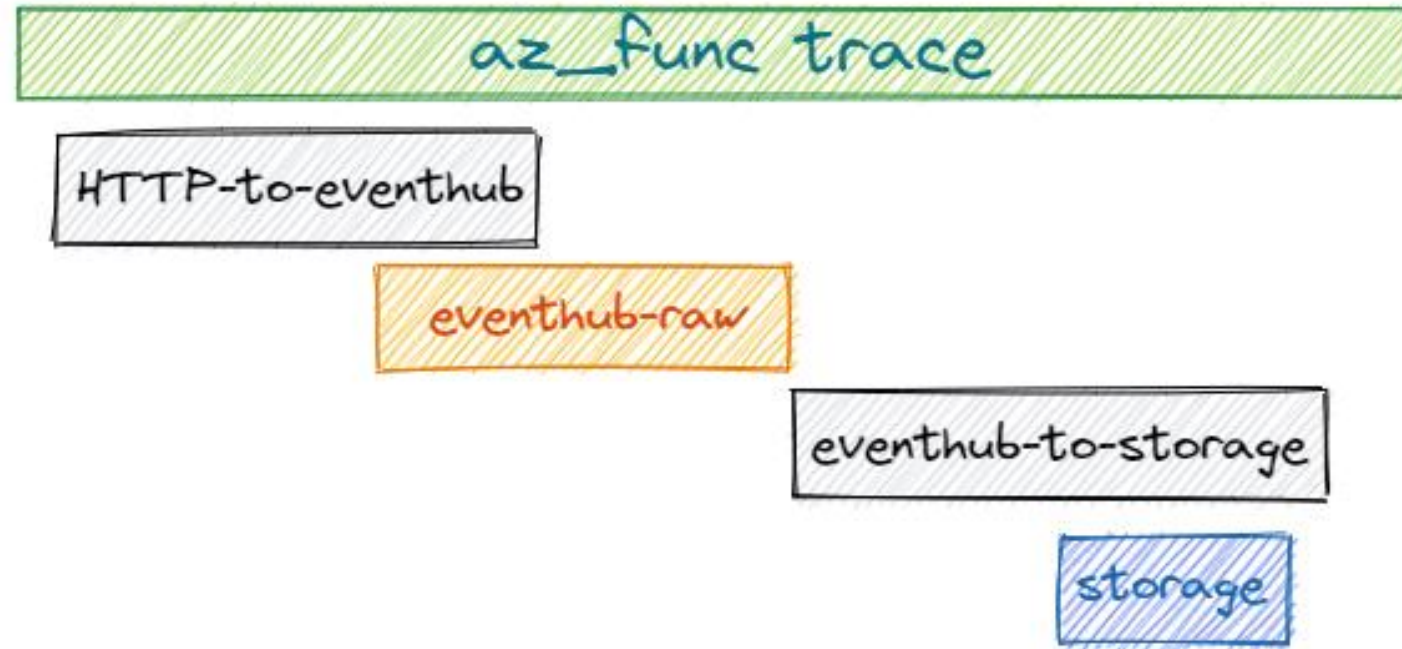
Causal relationships between Spans in a single Trace



# Monitoring and Observability: Traces



# Monitoring and Observability: Traces



# Monitoring and Observability: Traces

To build a trace:

- Propagate *trace-id* with each request
- Write events with attached *trace-id*
- Aggregate events from all the services into a single storage
- Group all events from the storage that have the same *trace-id*

# Monitoring and Observability: Traces

Demo

# Monitoring and Observability: Alerts

Alert – action based on a criteria



# Monitoring and Observability: Alerts

Alert could be based on

- Logs
- Metrics
- Billing

# Monitoring and Observability: Alerts

Alert, often, is a notification: a message sent to a communication channel

# Monitoring and Observability: Alerts

But instead of sending a message you can make a request or invoke an API

# Monitoring and Observability: Alerts

With alerts you can:

- post a warning to messenger (for example, Slack or email)
- make a phone call or send SMS
- invoke a Lambda function

# Monitoring and Observability: Alerts

## Demo

- Billing alert
- Metric alert
- Logs alert

# Monitoring and Observability

All-in-one solutions:

- [Azure Monitor](#); [Amazon CloudWatch](#); [Google Stackdriver](#)
- Datadog, Splunk, Elastic, New Relic, Dynatrace, Honeycomb

Metrics-only: Prometheus, Graphite, Victoria-Metrics

Traces-only: Jaeger, Zipkin

Logs-only: Elasticsearch (ELK), Grafana Loki

...and many-many-many others

# Monitoring and Observability: Audit

Audit log – records/events answering the question: “***who did what and when?***”

# Monitoring and Observability: Audit

Some audit logs are enabled by default

Some – you must enable explicitly and route to a long-term storage



# Monitoring and Observability: Audit

Audit log is crucial in terms of Security

# Monitoring and Observability: Audit

Demo

# Additional resources

- (articles + java samples) Terse logback: [github](#) and [webpage](#)
- (article) [SRE fundamentals: SLIs, SLAs and SLOs](#)
- (article) [Distributed Tracing](#)

# Additional resources

(course summary 😊) [Serverless to speed-up observability servers](#)