微服务监控告警Prometheus

架构和实践

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研发总监/资深架构师

第 1 部分

课程概述

课程大纲

01 课程概述

02 监控模式分类

03 BusDevOps和度量驱动开发(MDD)

04 Prometheus简介

05 Prometheus架构设计

06 Prometheus基本概念

07 Prometheus起步查询实验(Lab01)

08 Prometheus+Grafana展示实验(Lab02)

09 Prometheus+Alertmanager告警实验(Lab03)

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15 开源分布式监控平台ZMon简介

16 微服务监控体系总结

17 参考资源和后续课程预览

课程概述和亮点

1. 波波的微服务基础架构体系的**第7个**模块
2. **测量驱动开发(MDD)**理念介绍
3. **时间序列和Metrics监控**原理
4. CNCF监控组件**Prometheus深度剖析**
5. Prometheus+Grafana**案例和实验**
6. Prometheus监控**最佳实践**
7. **主流开源时序数据库**比较
8. 分布式监控平台**ZMon**简介

杨波的微服务基础架构体系2018

01 微服务OAuth2授权认证中心架构和实践

02 微服务配置中心Apollo架构和实践

03 微服务网关Zuul架构和实践

04 微服务调用链监控CAT架构和实践

05 微服务容错限流Hystrix/Turbine架构和实践

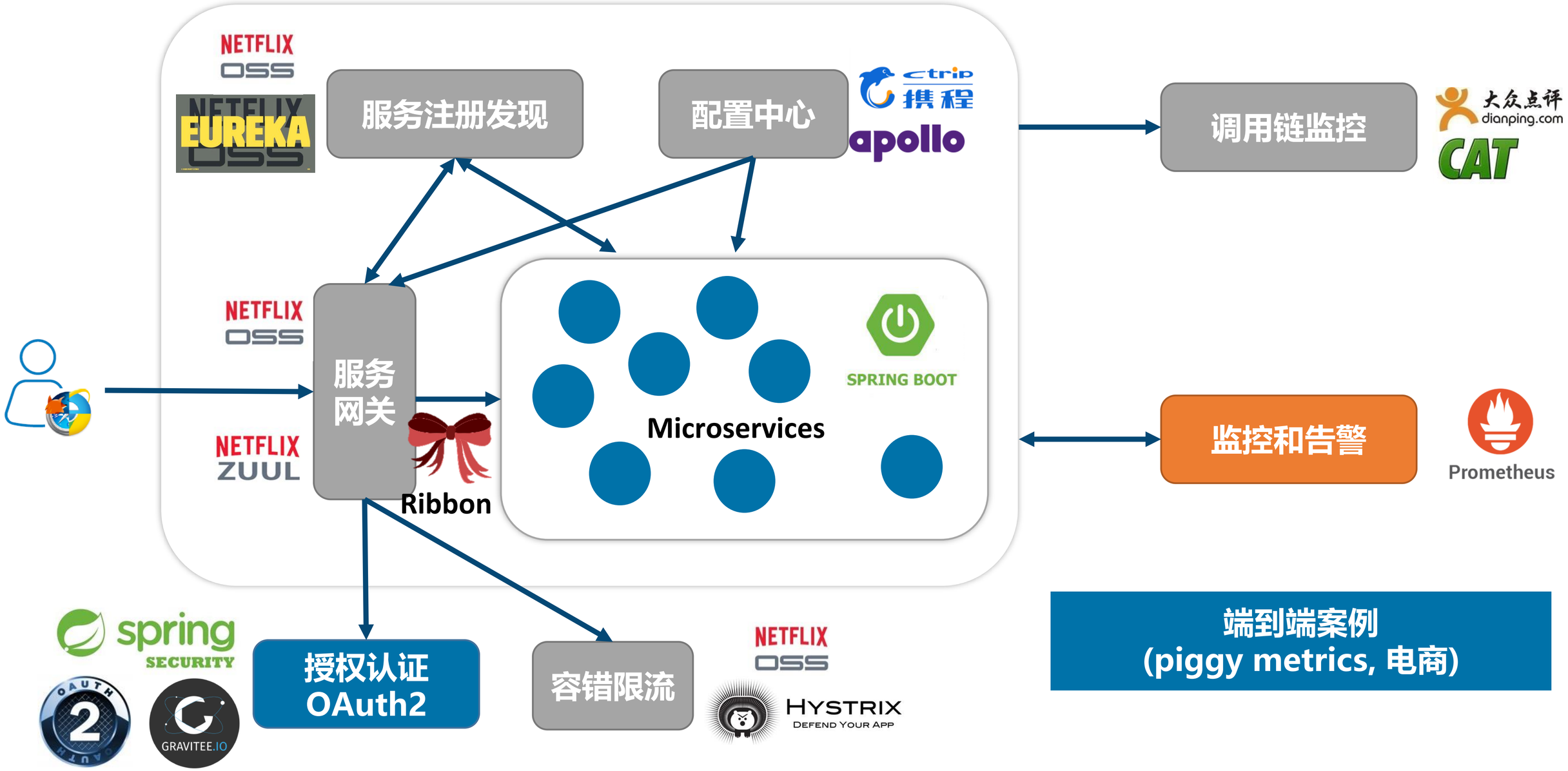
06 微服务注册发现Eureka/Ribbon架构和实践

07 微服务监控告警Prometheus架构和实践

08 开源OAuth2服务器Gravitee AM架构和实践

09 微服务架构综合案例分析

架构和技术栈预览

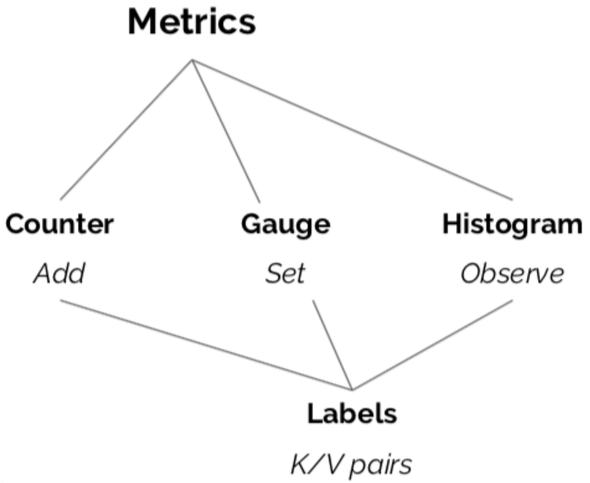

NETFLIX OSS
NETFLIX EUREKA OSS
服务注册发现
配置中心
ctrip 携程
apollo
调用链监控
大众点评 dianping.com
CAT
NETFLIX OSS
服务网关
NETFLIX ZUUL
Ribbon
Microservices
SPRING BOOT
监控和告警
Prometheus
spring SECURITY
OAUTH 2
GRAVITEE.IO
授权认证 OAuth2
容错限流
NETFLIX OSS
HYSTRIX
DEFEND YOUR APP
端到端案例
(piggy metrics, 电商)

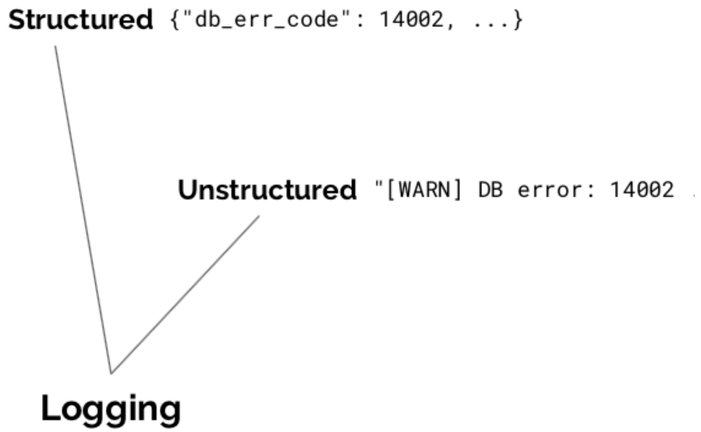
第 2 部分

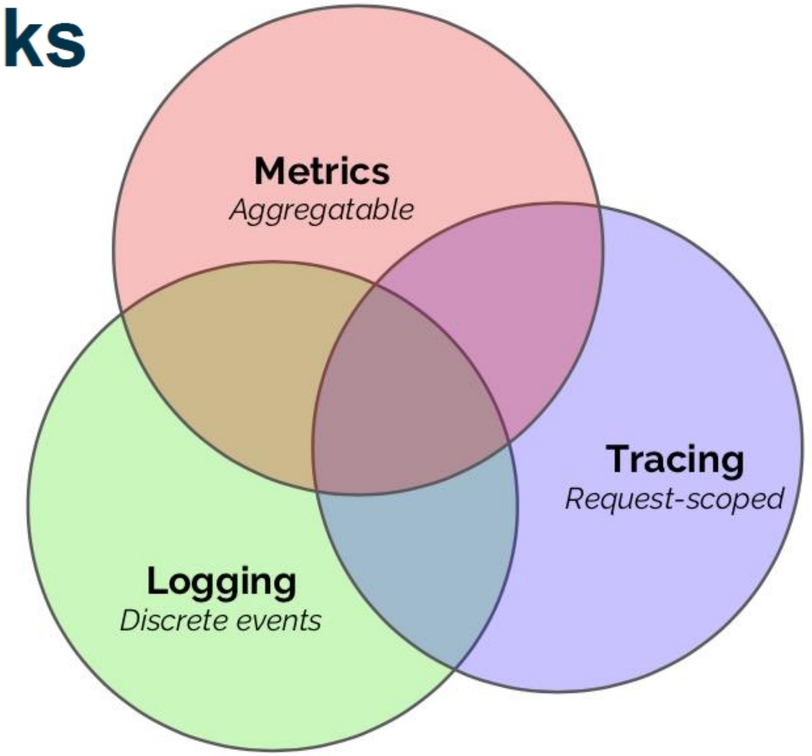
监控模式分类

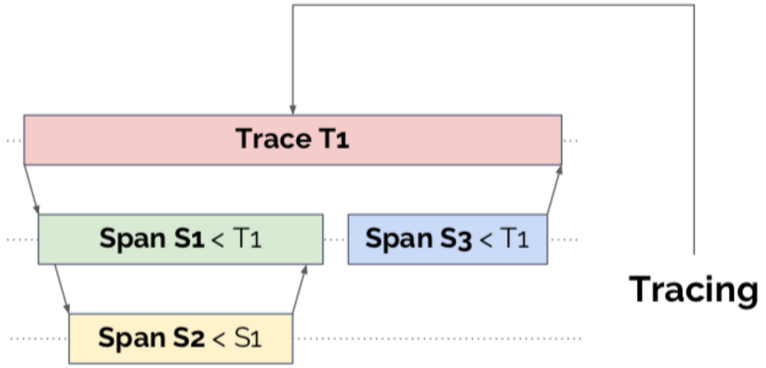
四种主要监控方式

Healthchecks







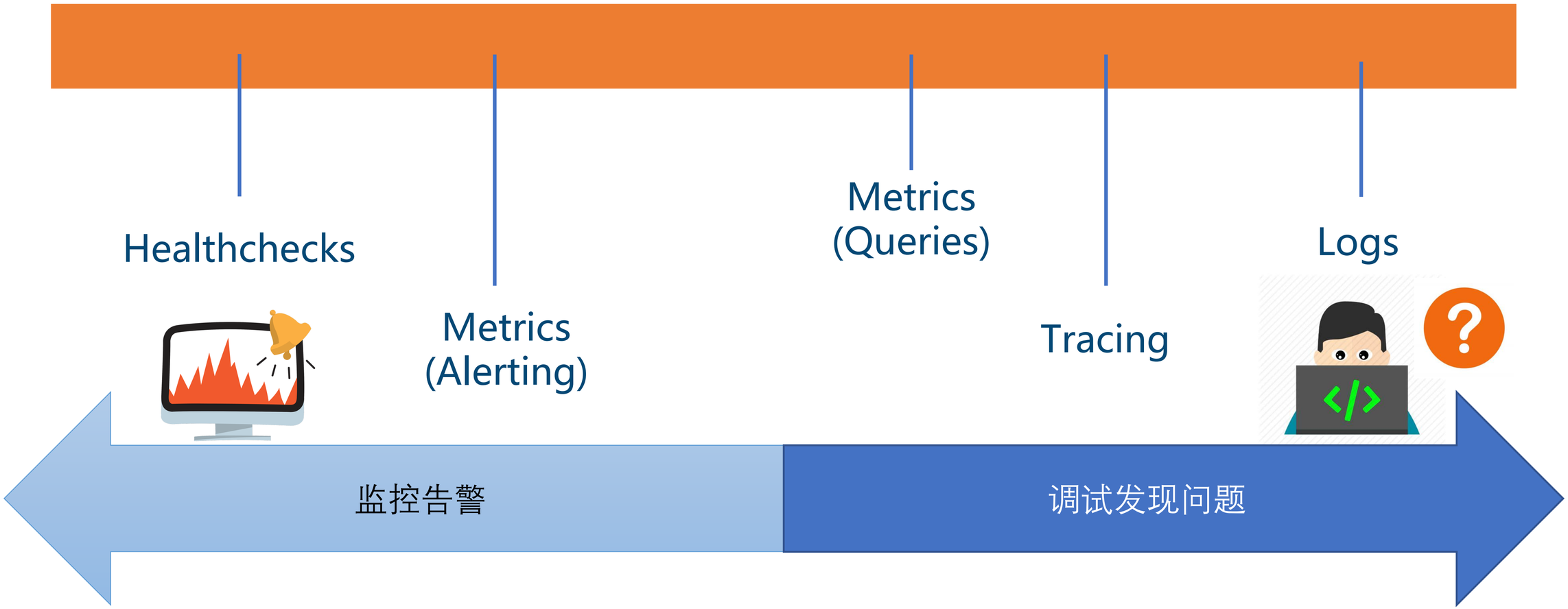


比较

	Metrics	Logging	Tracing
CapEx	Medium	Low	High
OpEx	Low	High	Medium
Reaction	High	Medium	Low
Investigation	Low	Medium	High

https://peter.bourgon.org/go-for-industrial-programming/

适用场景


Healthchecks
Metrics
(Alerting)
Metrics
(Queries)
Tracing
Logs
监控告警
调试发现问题

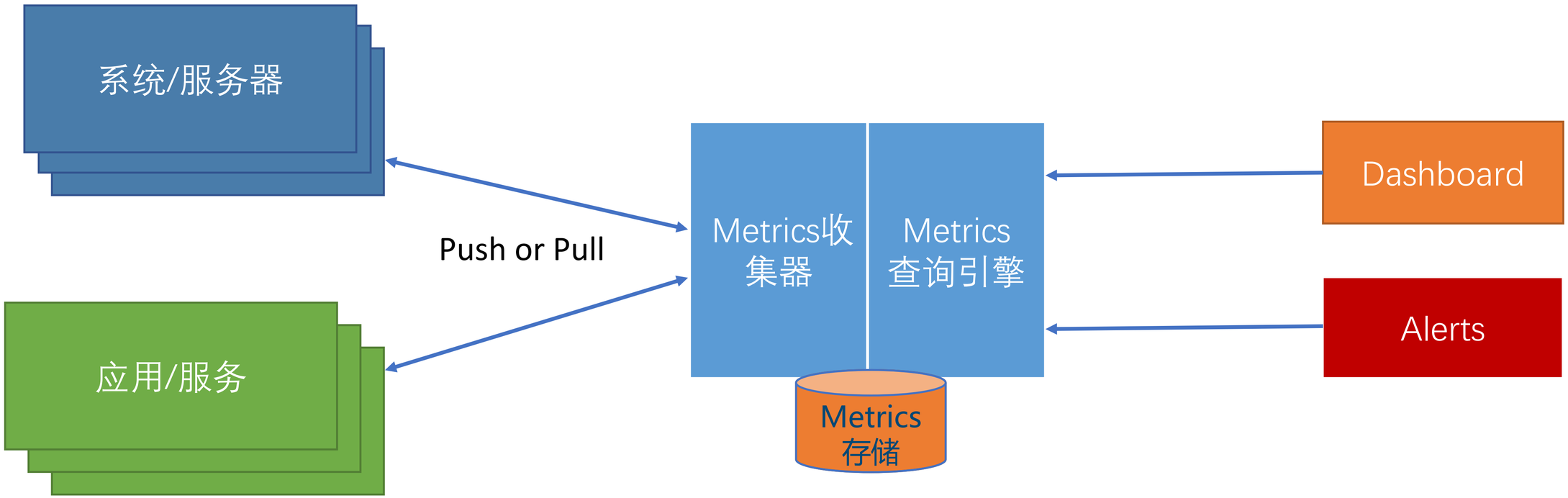
Metrics监控分层

CPU使用率

出错率

客户转化率

Metrics监控架构模式



Prometheus监控Metrics

系统/服务器

/metrics

应用/服务

/metrics

Pull

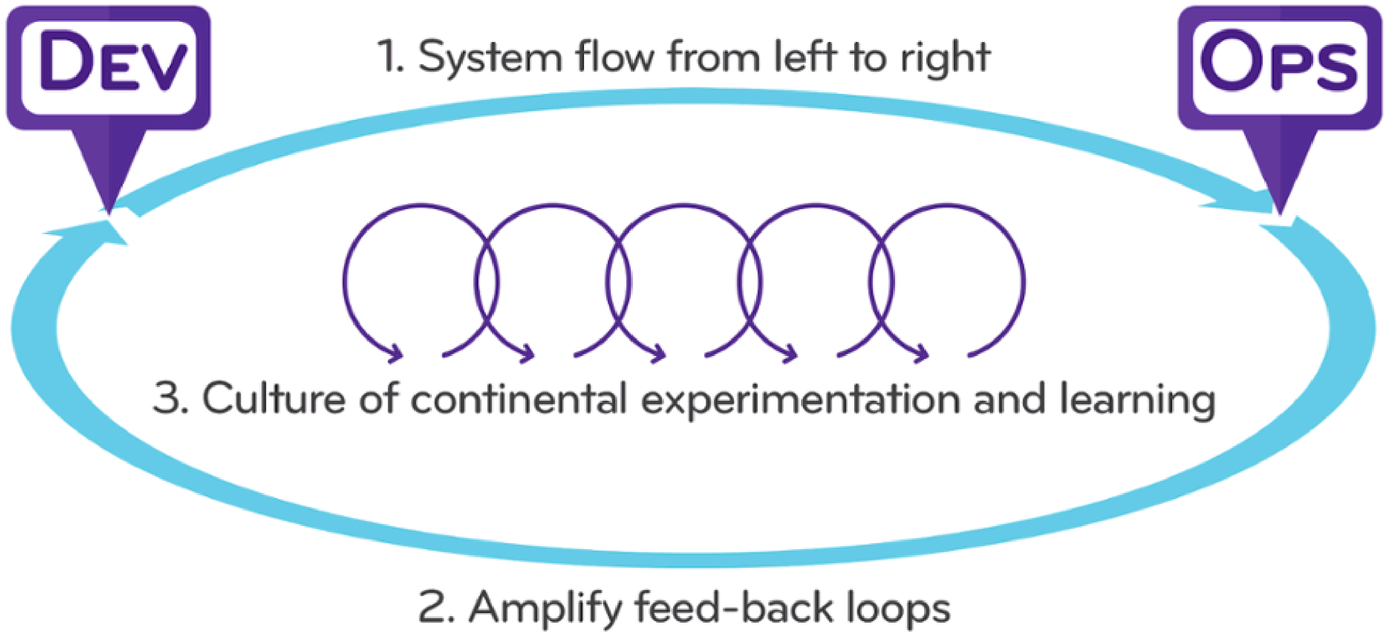
Prometheus

Grafana

第 3 部分

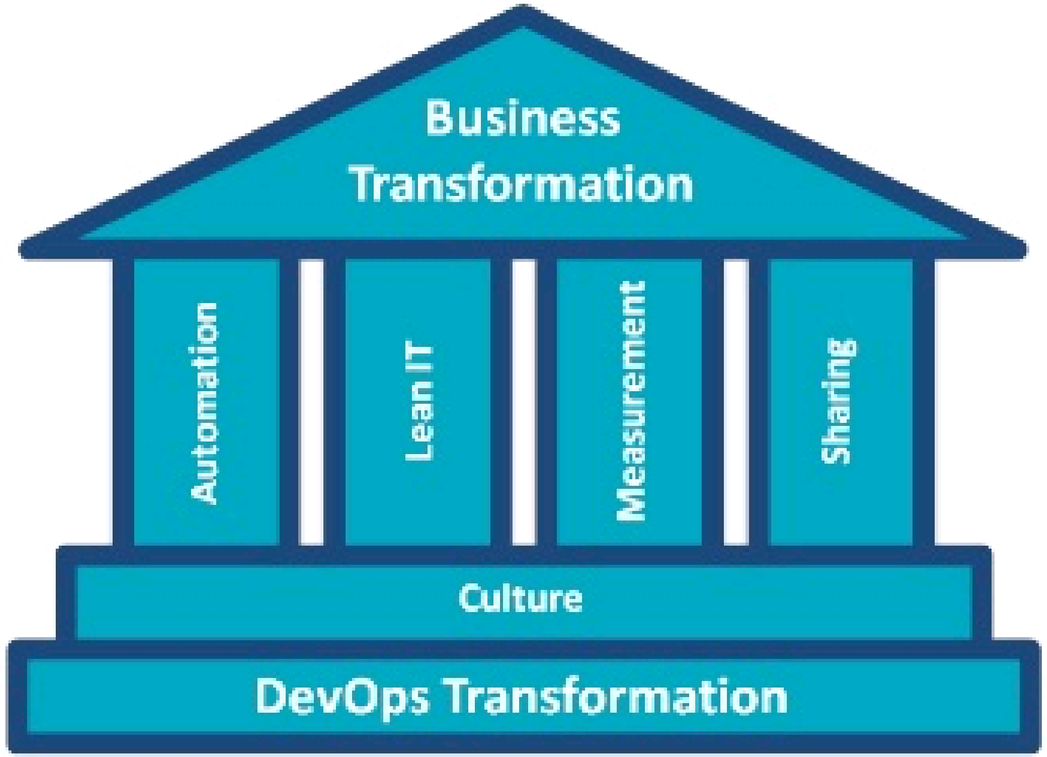
BusDevOps和测量驱动开发MDD

DevOps核心原理：Three Ways



DevOps~CALMS模型

- **C**ulture
- **A**utomation
- **L**ean
- **M**easurement
- **S**haring

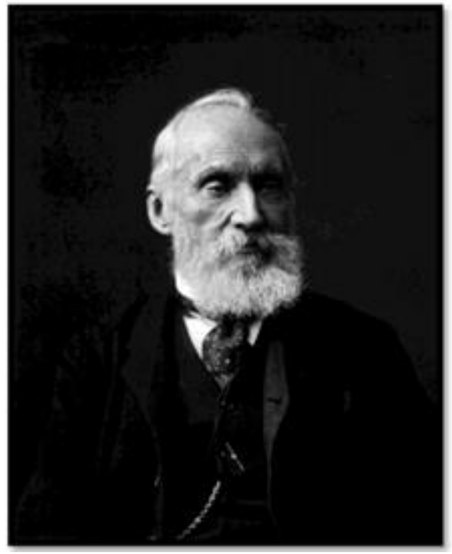


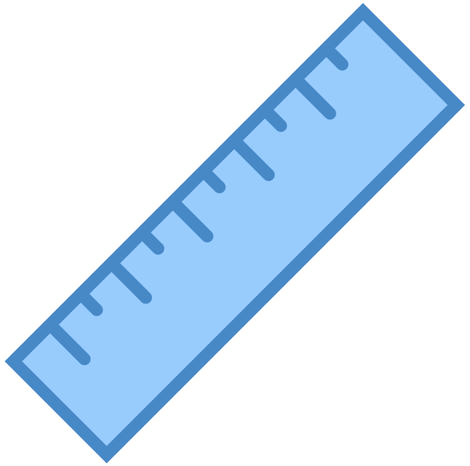
DevOpsGuys

DevOps理念：要提升必先测量

“If you can’t measure it, you can’t improve it.”

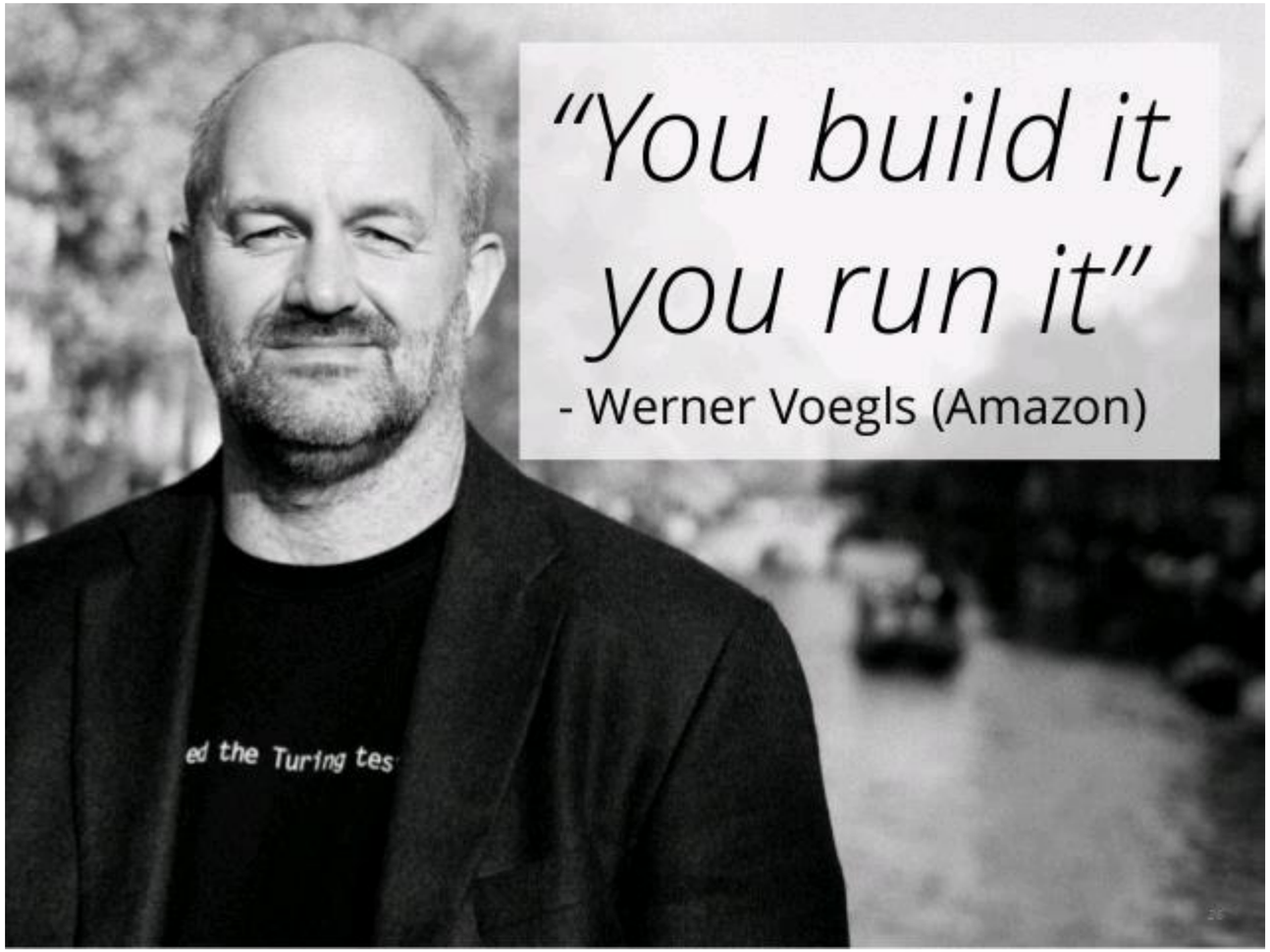
Lord Kelvin





给开发人员一把测量反馈“尺”

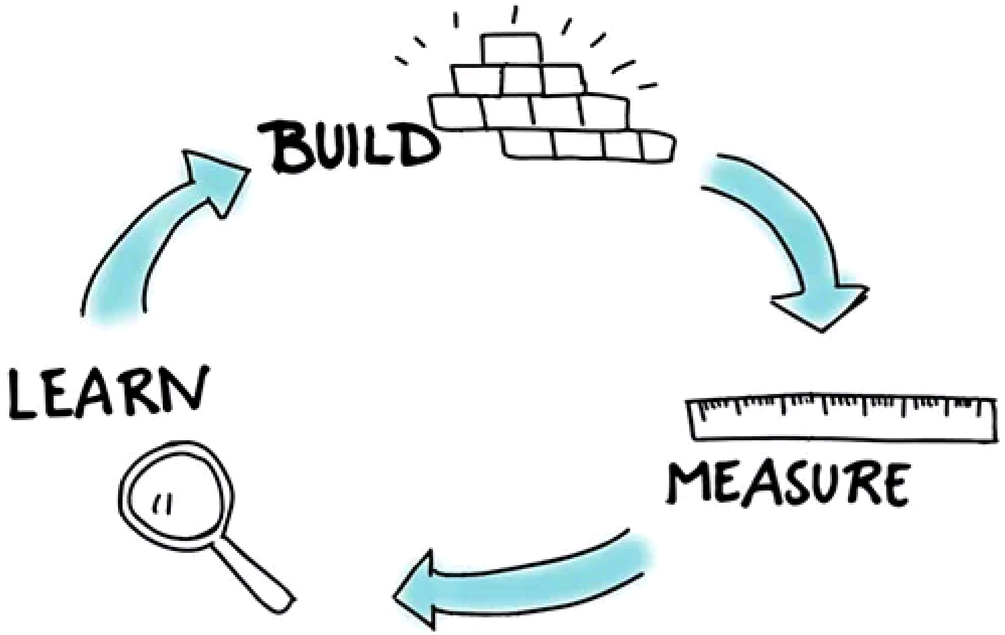
DevOps实践：研发自助监控

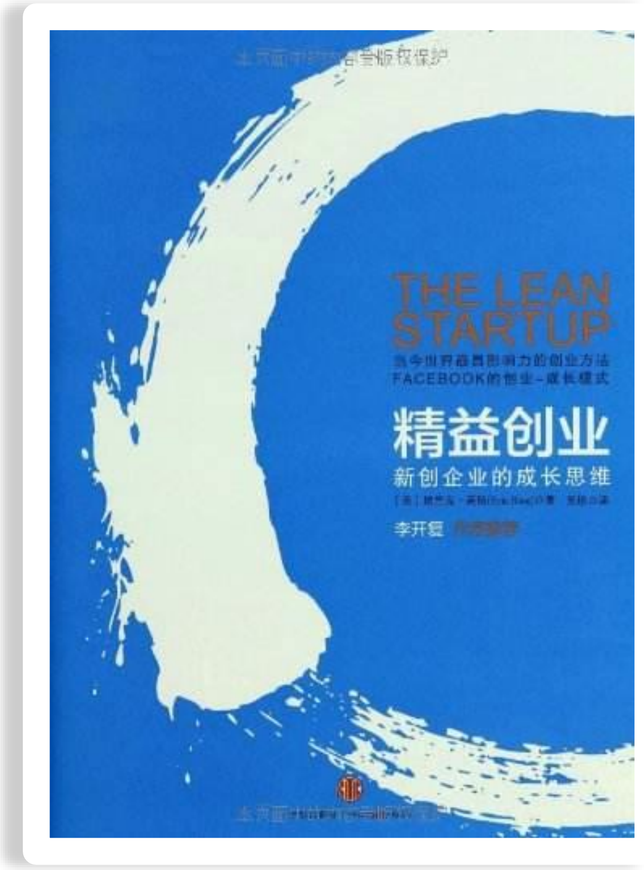


You build it, you run it,
you monitor it.

– 架构师杨波

精益创业反馈环





现状

月度和年度报表

财务报表

Google Analytics

?

测试覆盖报表

CI持续集成报表

性能测试报表

CPU, Mem, IO, Disk

Zabbix/Ganglia /Nagios

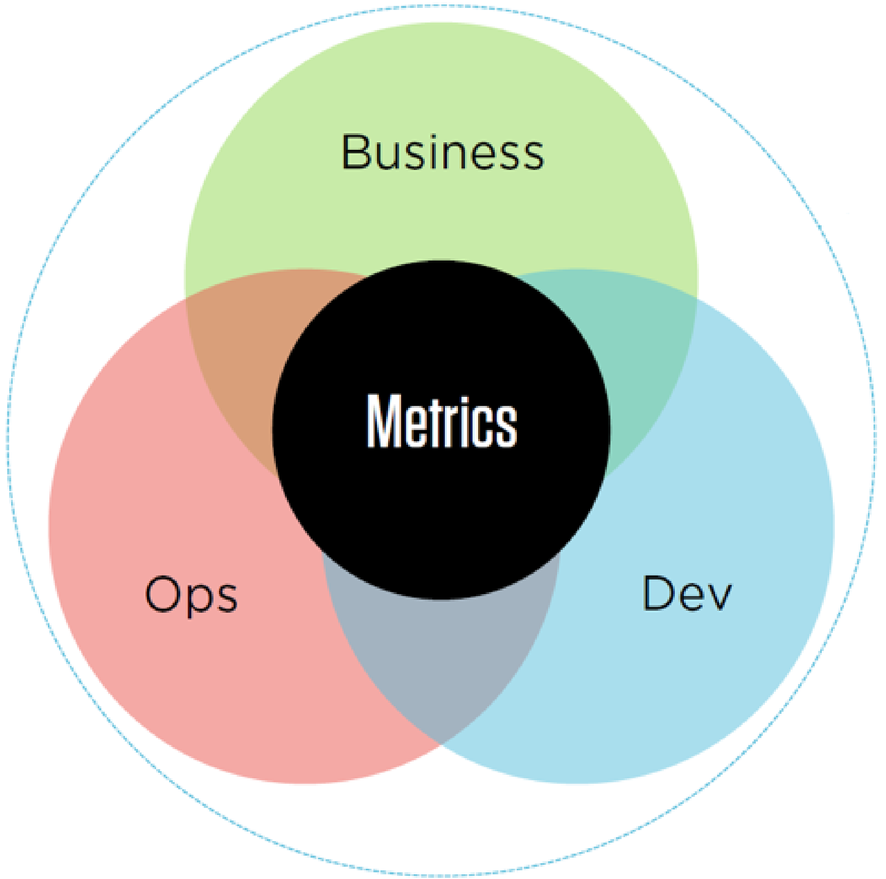
问题

- 运维人员只专注系统监控(日志，负载度量)，没有应用监控能力和上下文
- 开发人员只管实现功能，没有DevOps和度量意识
- 应用监控空白，对应用状态无感知，主要靠蒙
- 业务对关键应用指标无感知，很多功能开发了也无人用

Metrics Driven Development(MDD)

- *"... is a practice where metrics are used to drive the entire application development"*

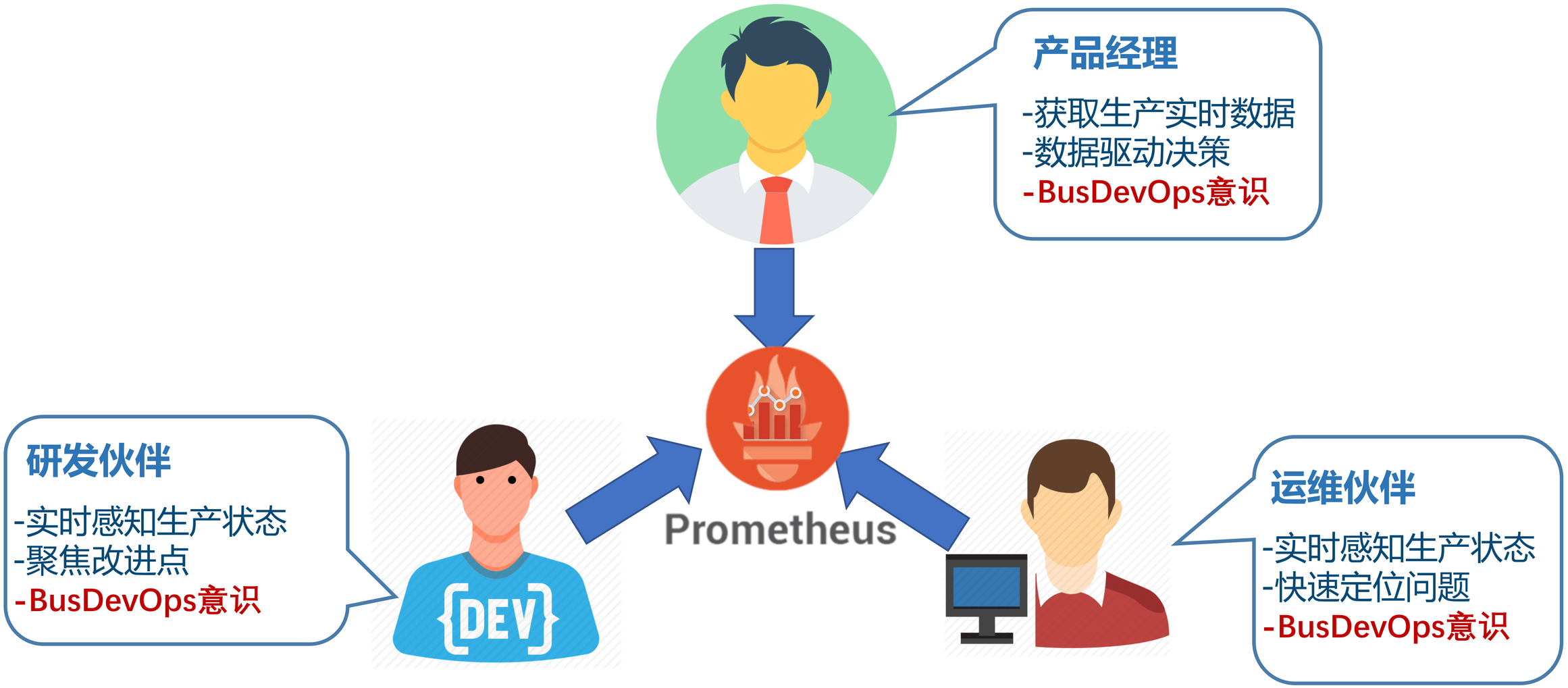
- **是一种实践，主张整个应用开发由度量指标驱动**
  - InfoQ/2012
  - https://www.infoq.com/articles/metrics-driven-development



MDD核心原理

- **开发功能前先定义度量指标(Bus/Dev/Ops)**
  - Define metrics before development
- **开发人员自助埋点**
  - Instrumentation-as-Code
- **真实性的唯一来源**
  - Single Source of Truth
- **关键指标的共同视角**
  - Shared view of key metrics
- **使用度量进行决策**
  - Use metrics when making decisions
- **开发持续维护指标**
  - Maintain and follow metrics

MDD好处


产品经理
-获取生产实时数据
-数据驱动决策
-BusDevOps意识
Prometheus
研发伙伴
-实时感知生产状态
-聚焦改进点
-BusDevOps意识
{DEV}
运维伙伴
-实时感知生产状态
-快速定位问题
-BusDevOps意识

第 4 部分

Prometheus简介

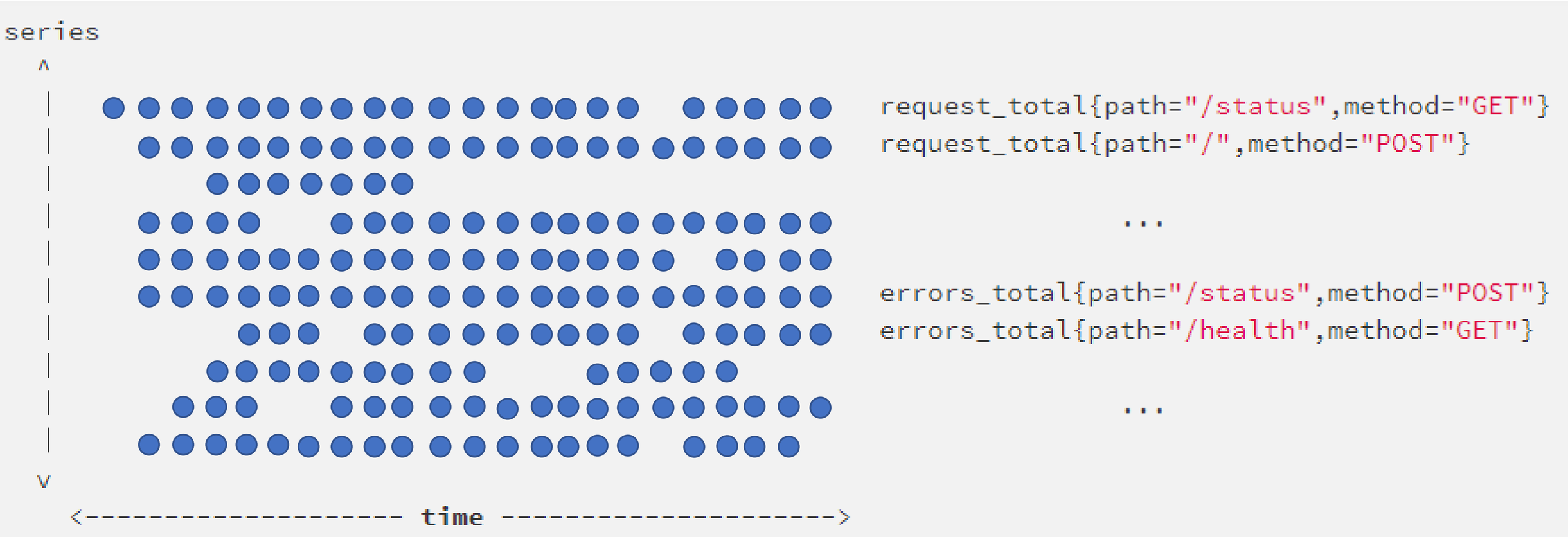
什么是Prometheus

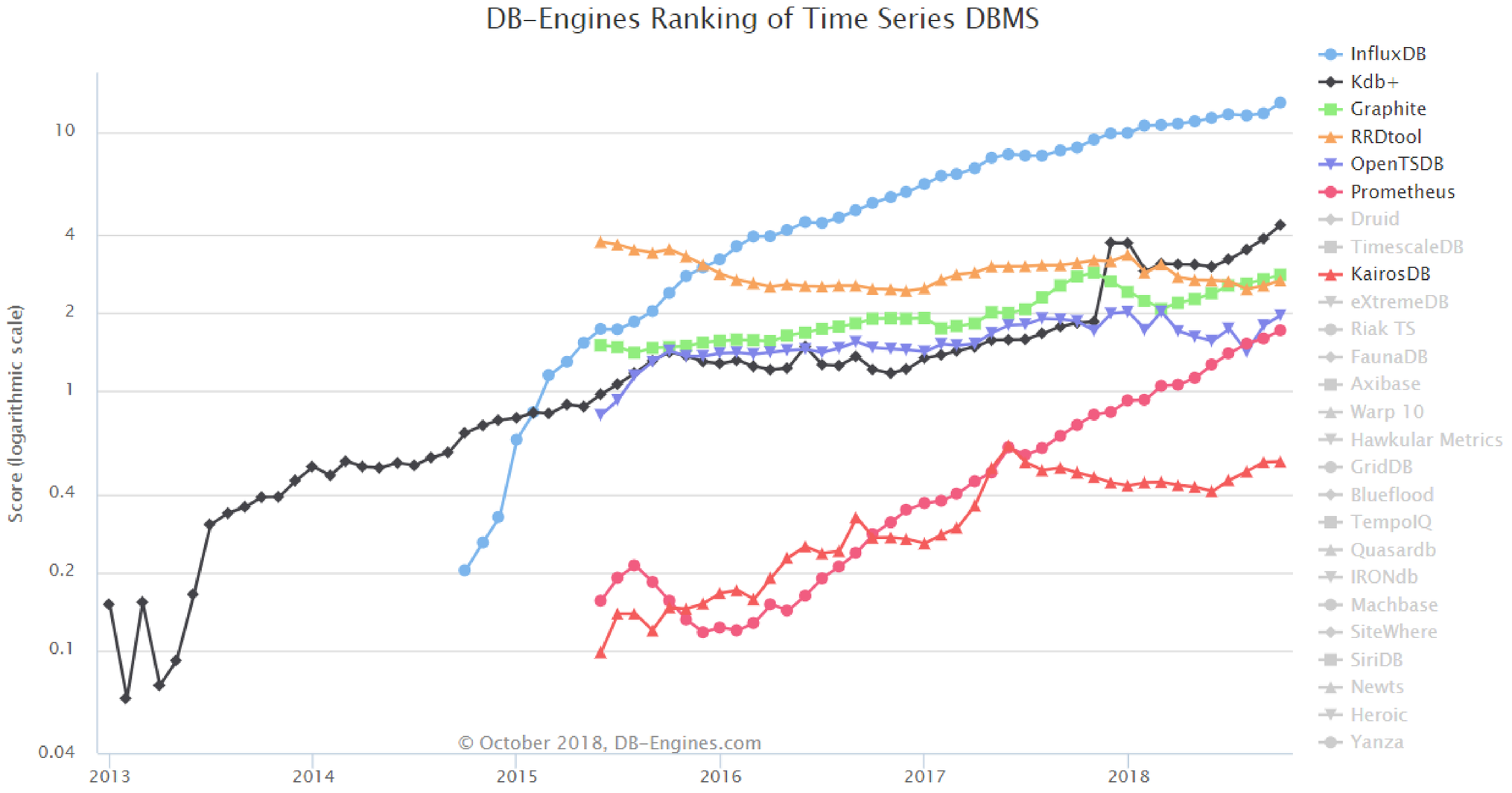
- 开源**监控工具**
- **时间序列数据库**TSDB，golang实现
- **Soundcloud**研发，源于谷歌**borgmon**
- **多维度**(标签)，**拉模式**(Pull-based)
- **白盒&黑盒**监控都支持，**DevOps**友好
- **Metrics & Alert**，不是 loggging/tracing
- **社区生态丰富**(多语言，各种exporters)
- **单机性能**
  - 消费百万级时间序列
  - 上千个targets

https://prometheus.io/

时间序列(Time Series)

(t0, v0), (t1, v1), (t2, v2), ……



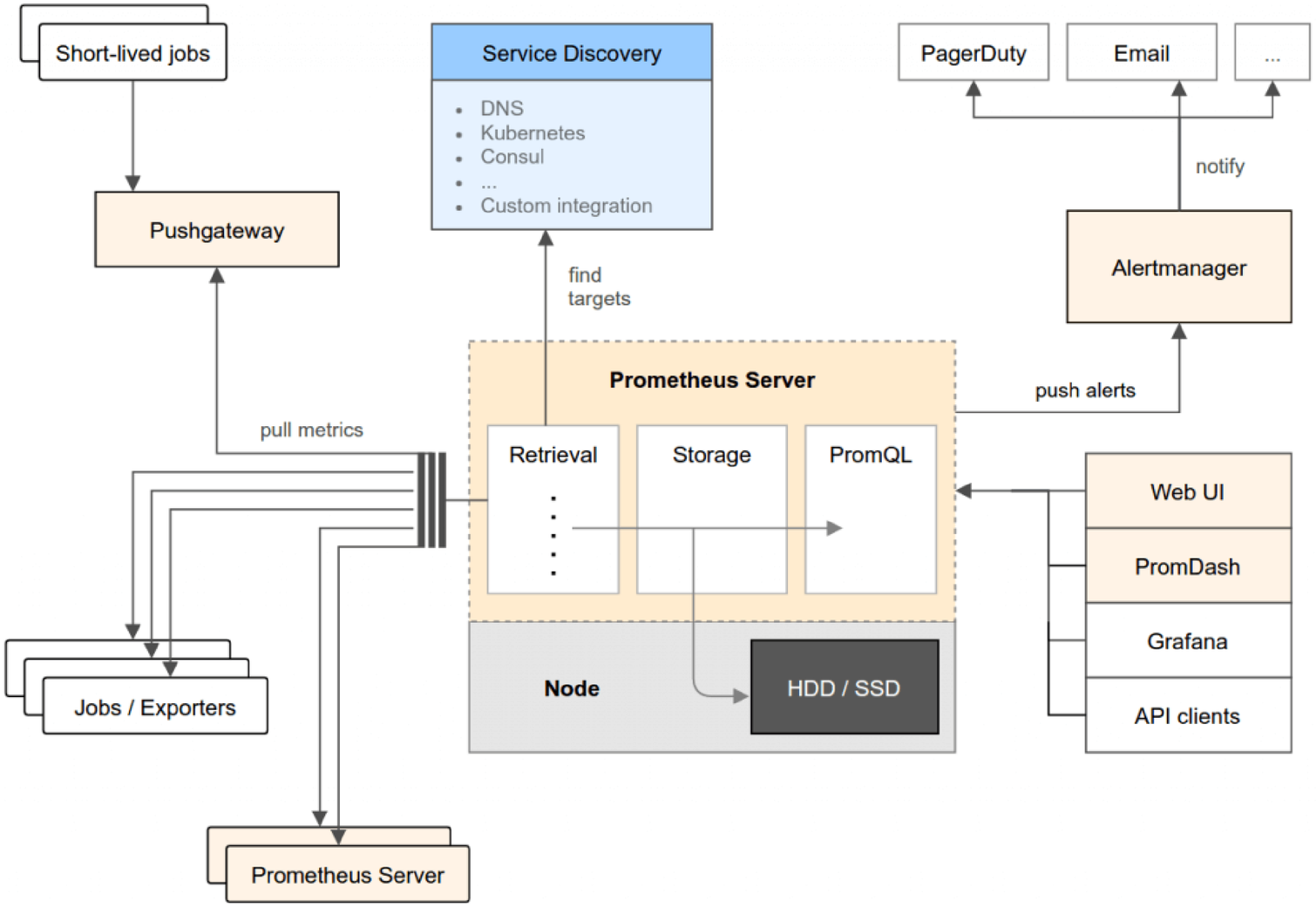


https://db-engines.com/en/ranking_trend/time+series+dbms

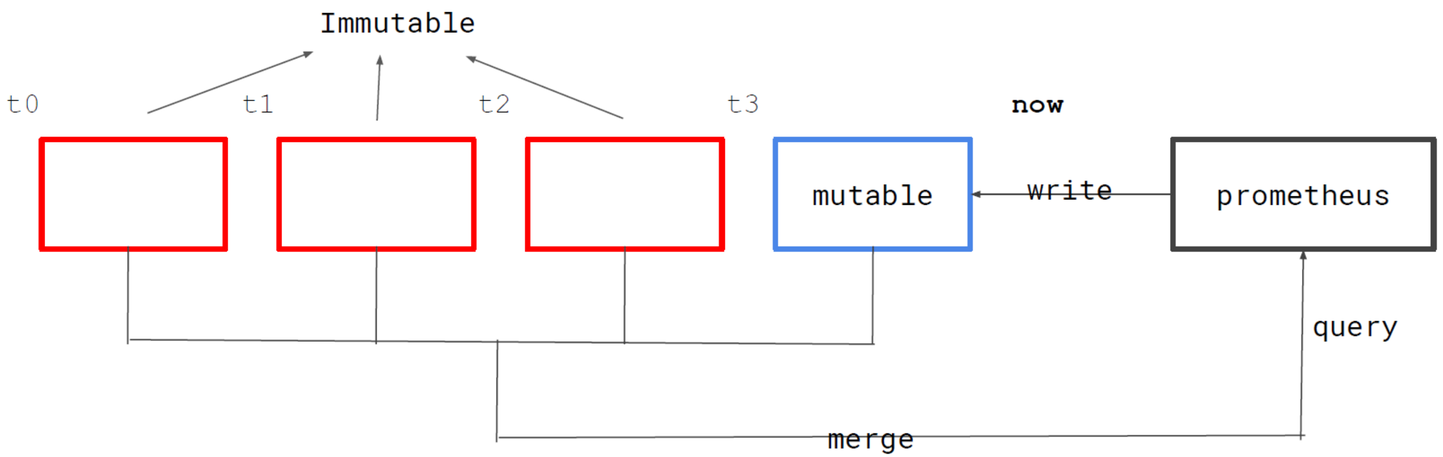
第5部分

Prometheus架构设计

Prometheus架构设计



Prometheus 2.0存储设计




```
→  prom-prom tree data
data
├── 01BW78CHMFQ1NZ7YD7M2PSYDVW
│   ├── chunks
│   │   └── 000001
│   ├── index
│   ├── meta.json
│   └── tombstones
├── 01BW78CJVV9YKEFCWKJPAQ0M4X
│   ├── chunks
│   │   └── 000001
│   ├── index
│   ├── meta.json
│   └── tombstones
├── 01BW7F88WFZD9BQZKRCRHRM90Y
│   ├── chunks
│   │   └── 000001
│   ├── index
│   ├── meta.json
│   └── tombstones
├── lock
└── wal
    ├── 000001
    └── 000003

7 directories, 15 files
```

https://coreos.com/blog/prometheus-2.0-storage-layer-optimization

第 6 部分

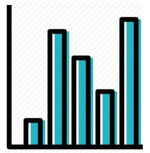
Prometheus基本概念

Metrics种类

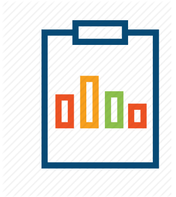
- **Counter(计数器)**
  - 始终增加
  - http请求数，下单数

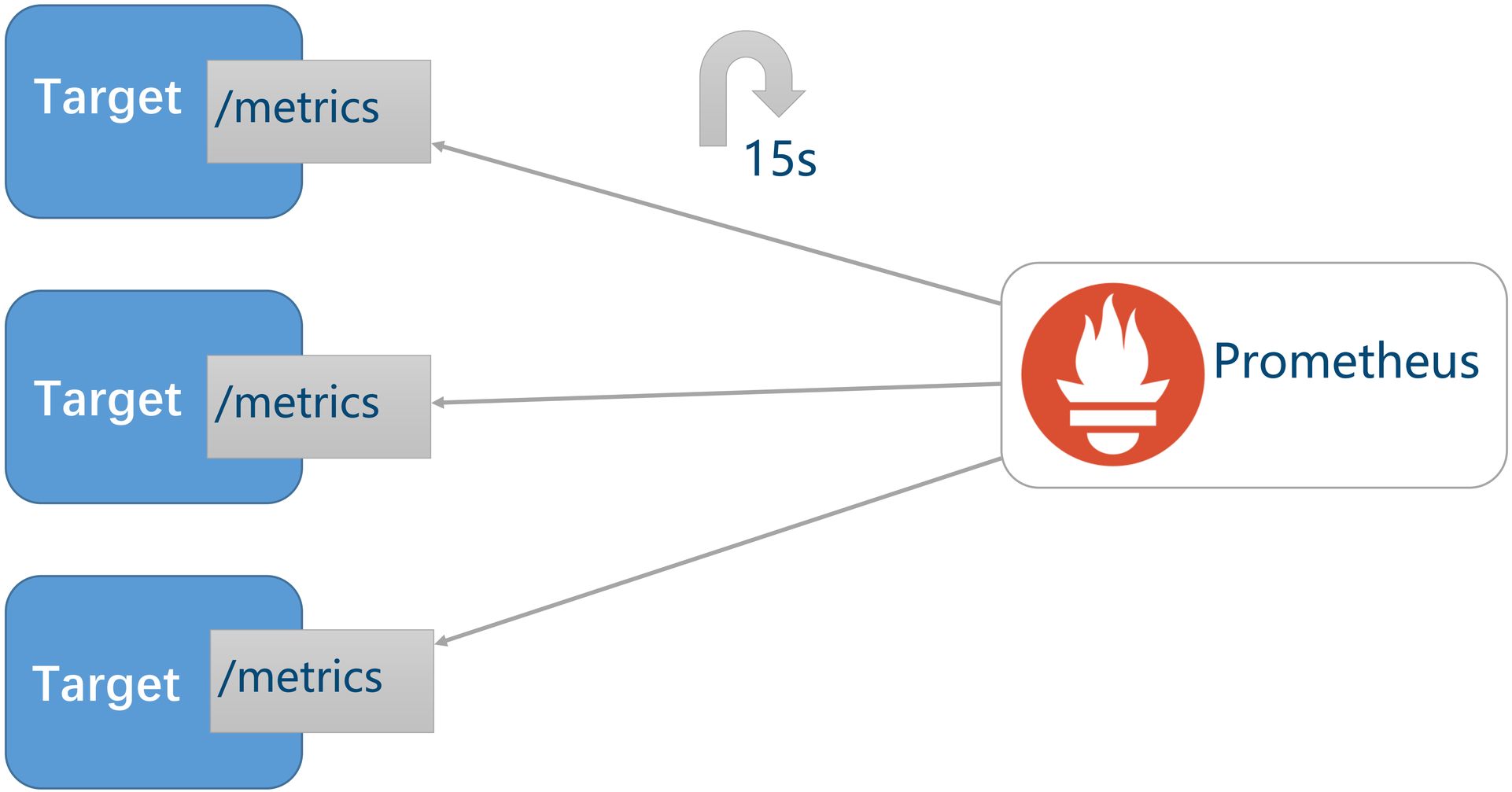
- **Gauge(测量仪)**
  - 当前值的一次快照(snapshot)测量，可增可减
  - 磁盘使用率，当前同时在线用户数

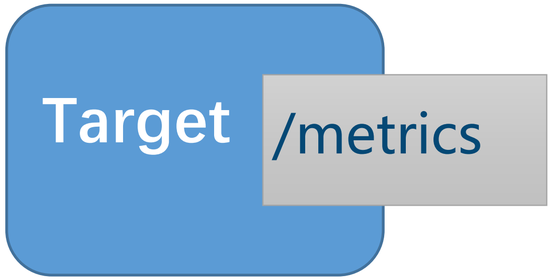
- **Histogram(直方图)**
  - 通过分桶(bucket)方式统计样本分布



- **Summary(汇总)**
  - 根据样本统计出百分位
  - 客户端计算




Target
/metrics
Target
/metrics
Target
/metrics
15s
Prometheus



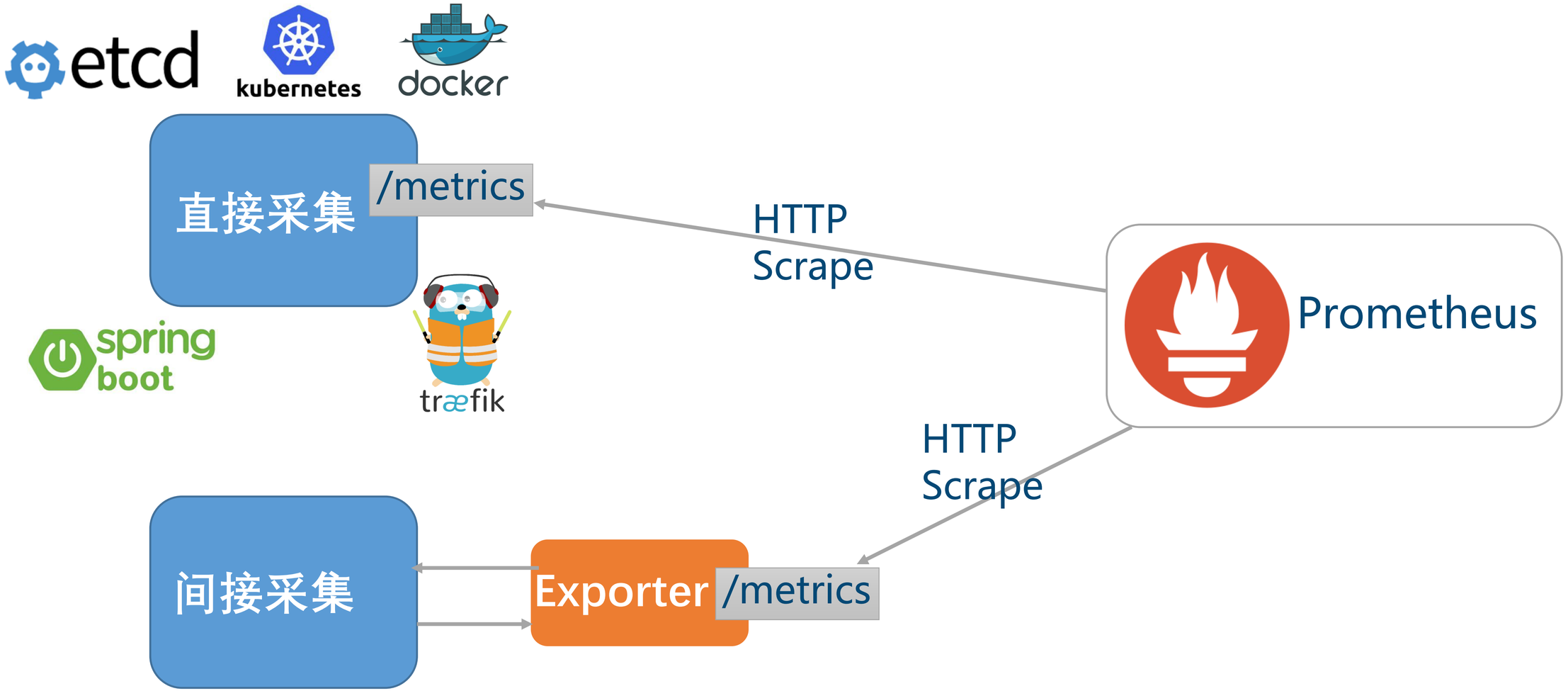

```
# HELP http_requests_total Total number of HTTP requests made.
# TYPE http_requests_total counter

http_requests_total{code="200", path="/status"} 8
```

Metric Name

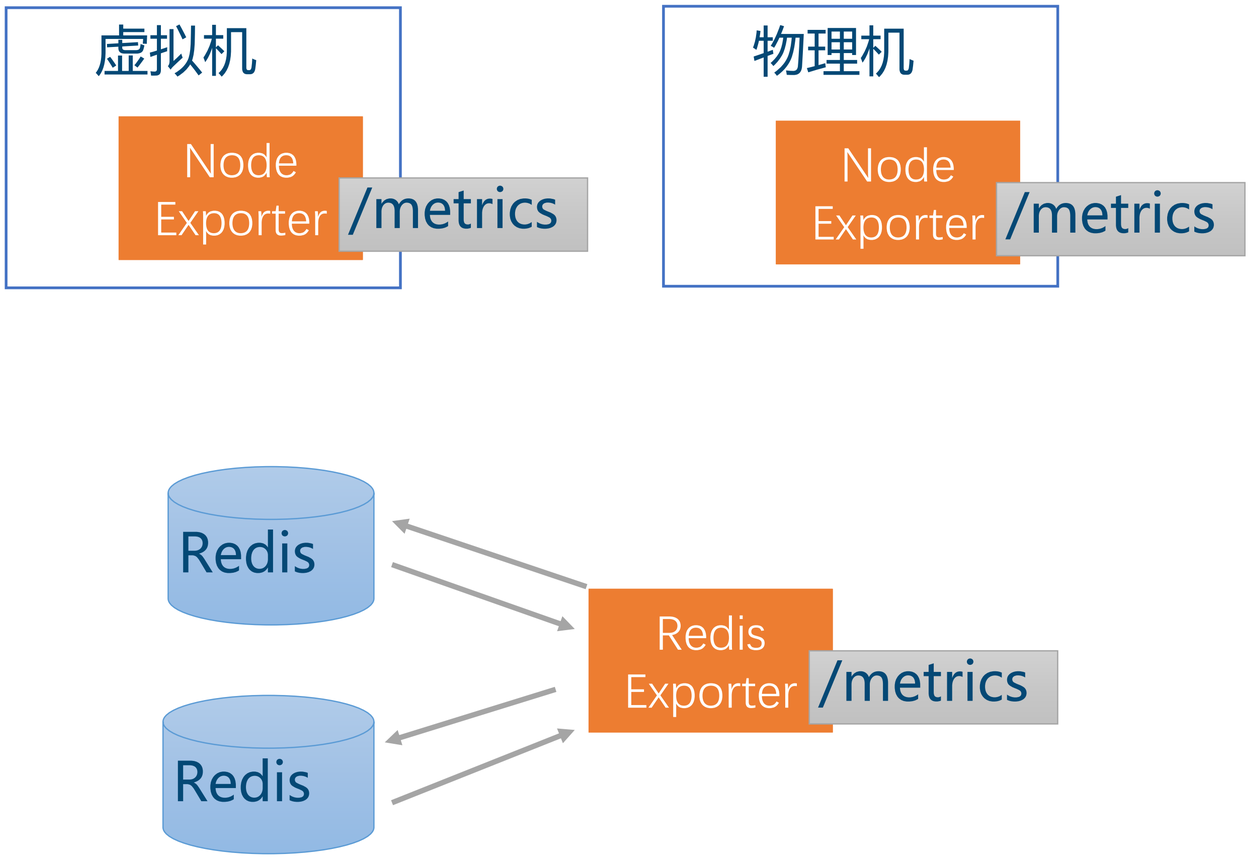
Label

Value

Scrape metric

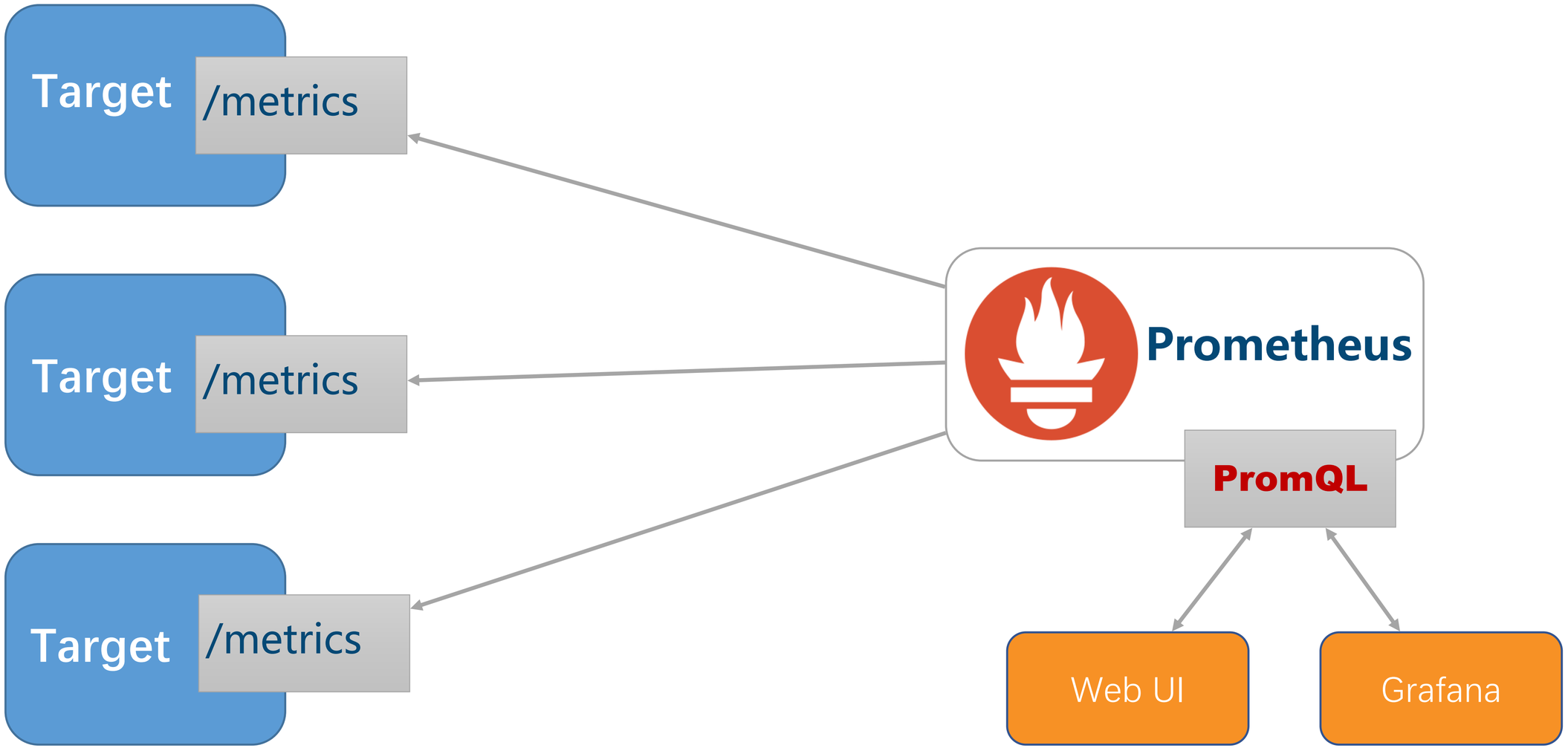


Exporters



- **OS – Node Exporter**
  - Linux, Windows
- **Database**
  - Mysql, Postgres, CouchDB…
- **Messaging**
  - Kafka, RabbitMQ, NATS…
- **Logging**
  - ElasticSearch, Fluentd, Telegraf…
- **Key-Value**
  - Redis, Memcached…
- **WebServer**
  - Apache, Nginx…
- **Proxy**
  - Haproxy, Varnish…
- **DNS**
  - BIND, PowerDNS, Unbound
- **BlackBox**

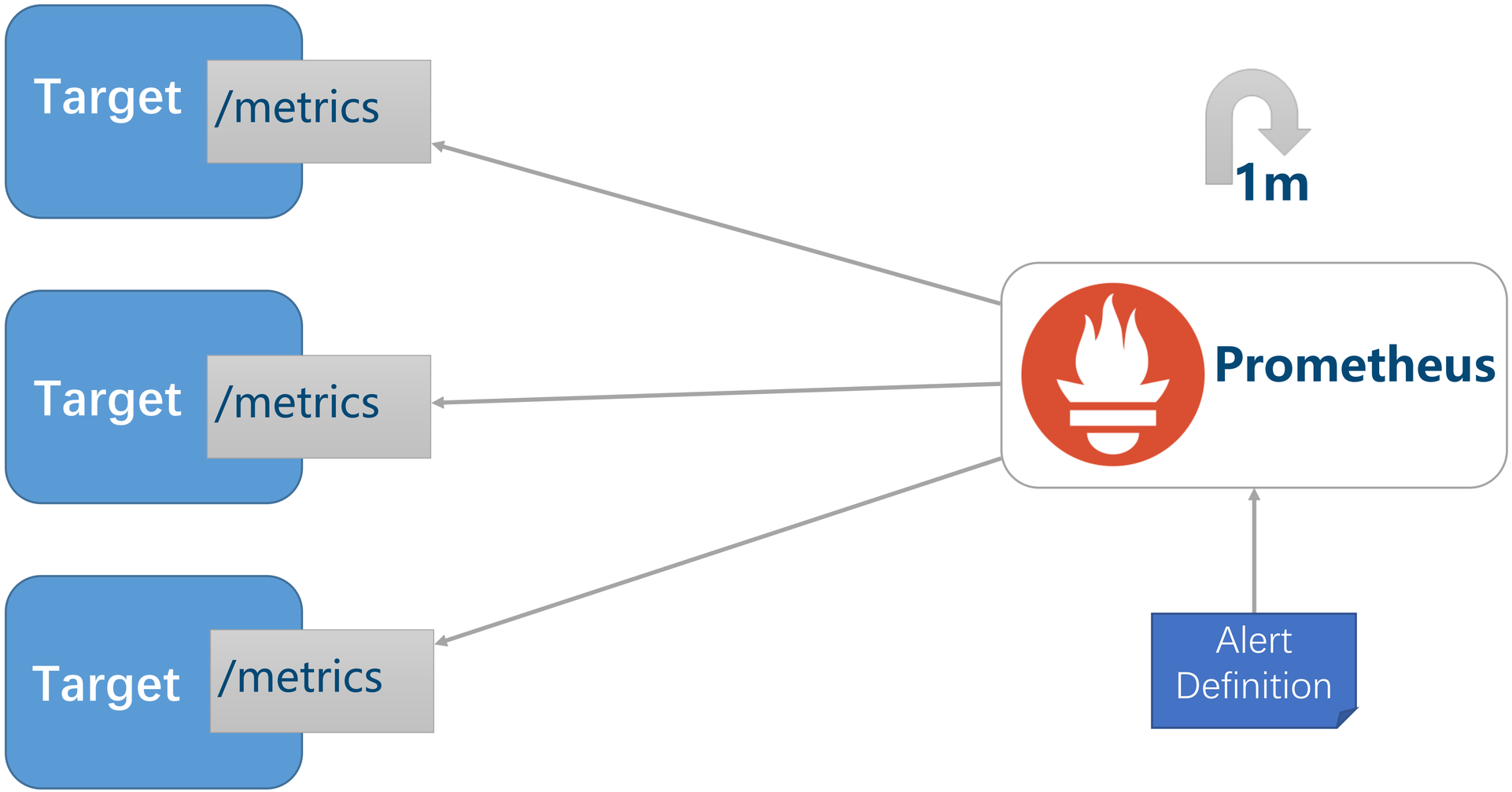
https://prometheus.io/docs/instrumenting/exporters/


Target
/metrics
Target
/metrics
Target
/metrics
Prometheus
PromQL
Web UI
Grafana

HTTP错误百分比

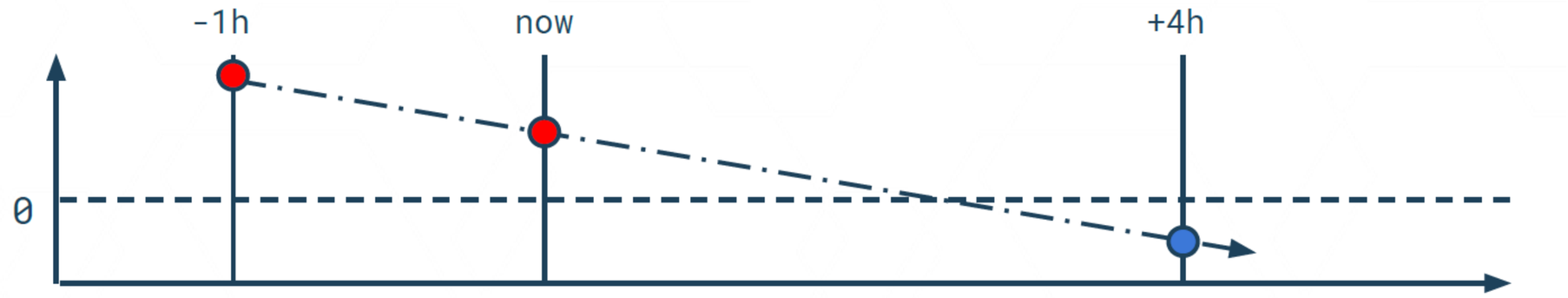
```
sum(rate(http_requests_total{status="500"}[5m])) by (path) /
sum(rate(http_requests_total[5m])) by (path)
```

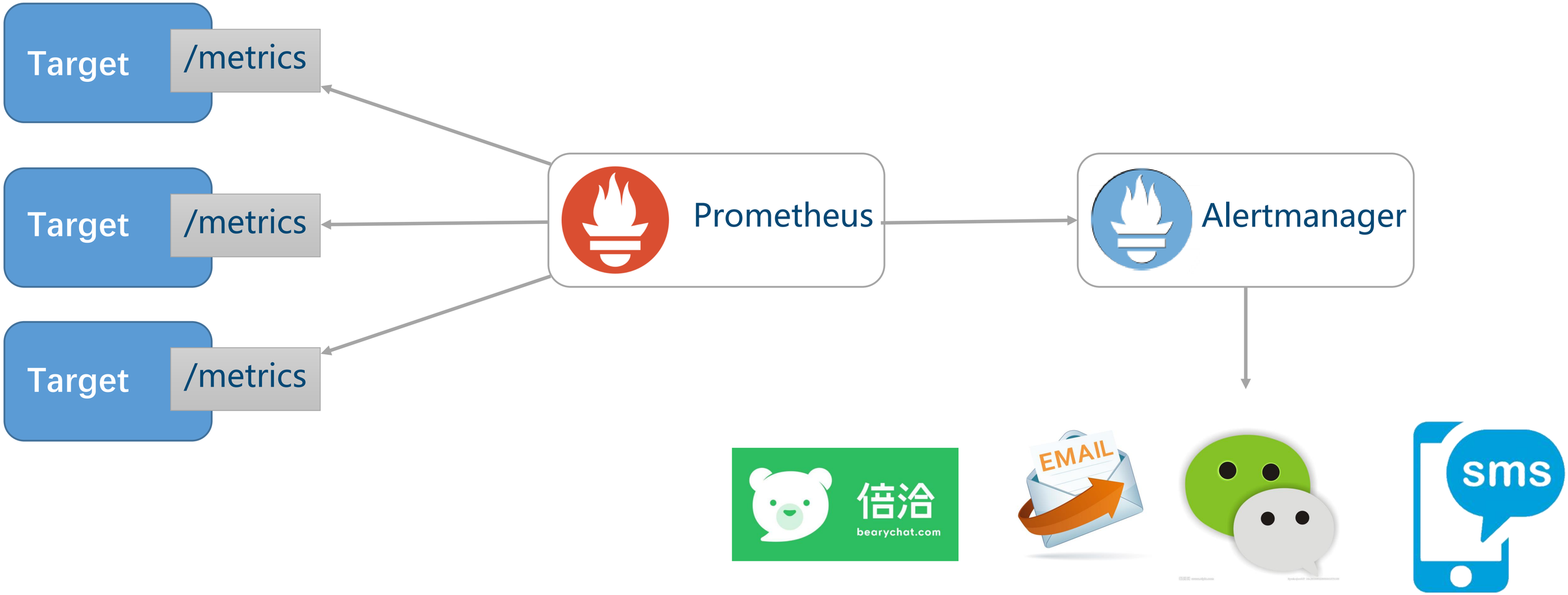
{path=“/status”}	0.0039
{path=“/”}	0.0011
{path=“/api/v1/topics/:topic”}	0.087
{path=“/api/v1/topics}	0.0342

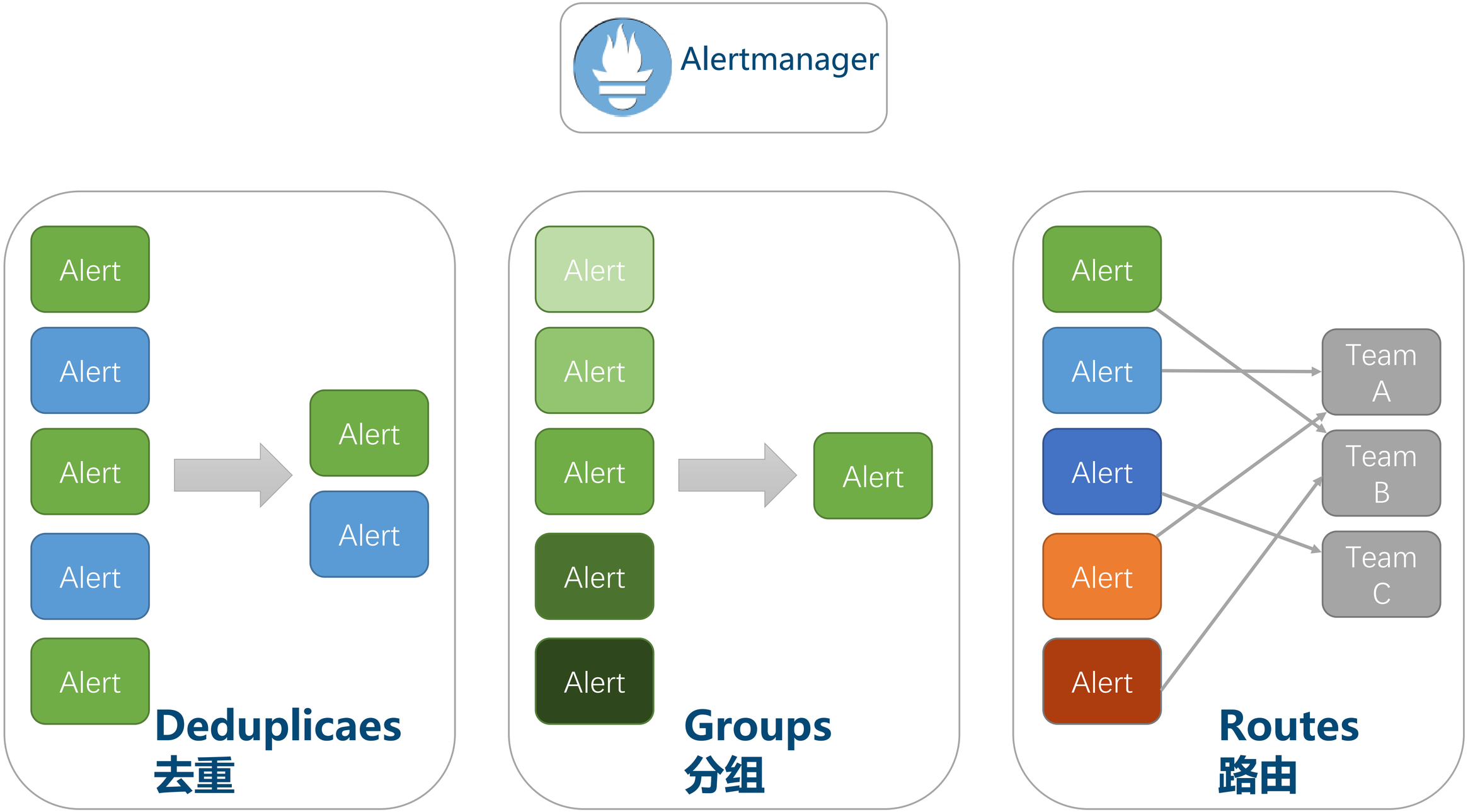

Target
/metrics
Target
/metrics
Target
/metrics
1m
Prometheus
Alert
Definition

4小时内磁盘是否会满?

```
ALERT DiskWillFullIn4Hours
    IF predict_linear(node_filesystem_free[1h], 4*3600) < 0
```

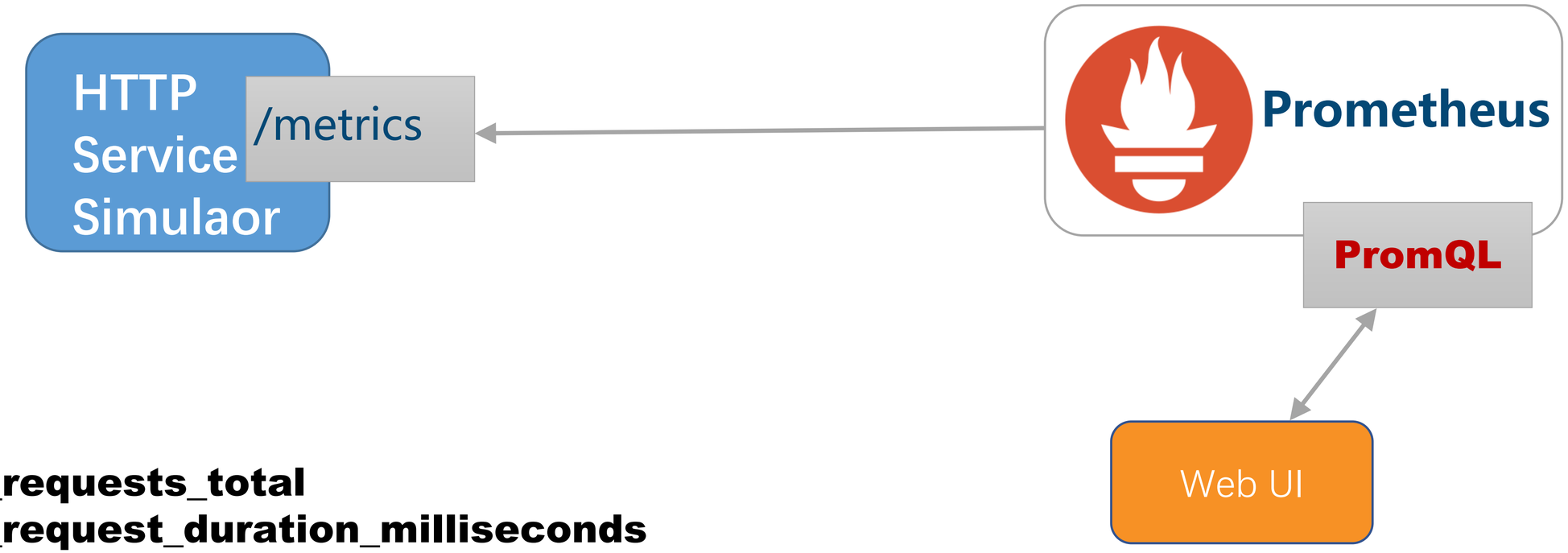



Target
/metrics
Target
/metrics
Target
/metrics
Prometheus
Alertmanager
倍洽
bearychat.com
EMAIL
sms


Alertmanager
Alert
Alert
Alert
Alert
Alert
Alert
Alert
Deduplicaes
去重
Alert
Alert
Alert
Alert
Alert
Alert
Groups
分组
Alert
Alert
Alert
Alert
Alert
Team A
Team B
Team C
Routes
路由

第 7 部分

Prometheus起步查询实验(Lab01)



http_requests_total
http_request_duration_milliseconds

思考练习

- **Request Rate**
  - 求http-simulator的总体请求率(1分钟滚动窗口)
  - 求每分钟多少是错误请求
  - 求对/users端点的错误请求率
- **Latency distribution**
  - 求延迟中位数
  - 求错误请求的90百分位延迟，按端点分组
  - 对/users端点的请求延迟，是否满足3个9都在400ms以内的SLO?

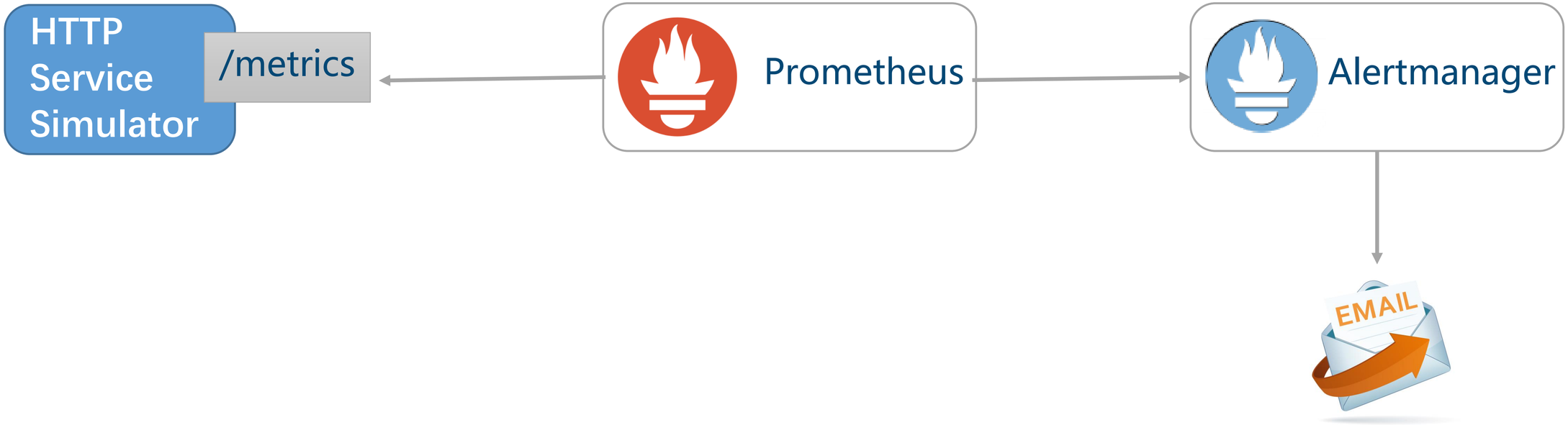
第 8 部分

Prometheus+Grafana展示实验（Lab02）


HTTP
Service
Simulaor
/metrics
Prometheus
PromQL
Web UI
Grafana

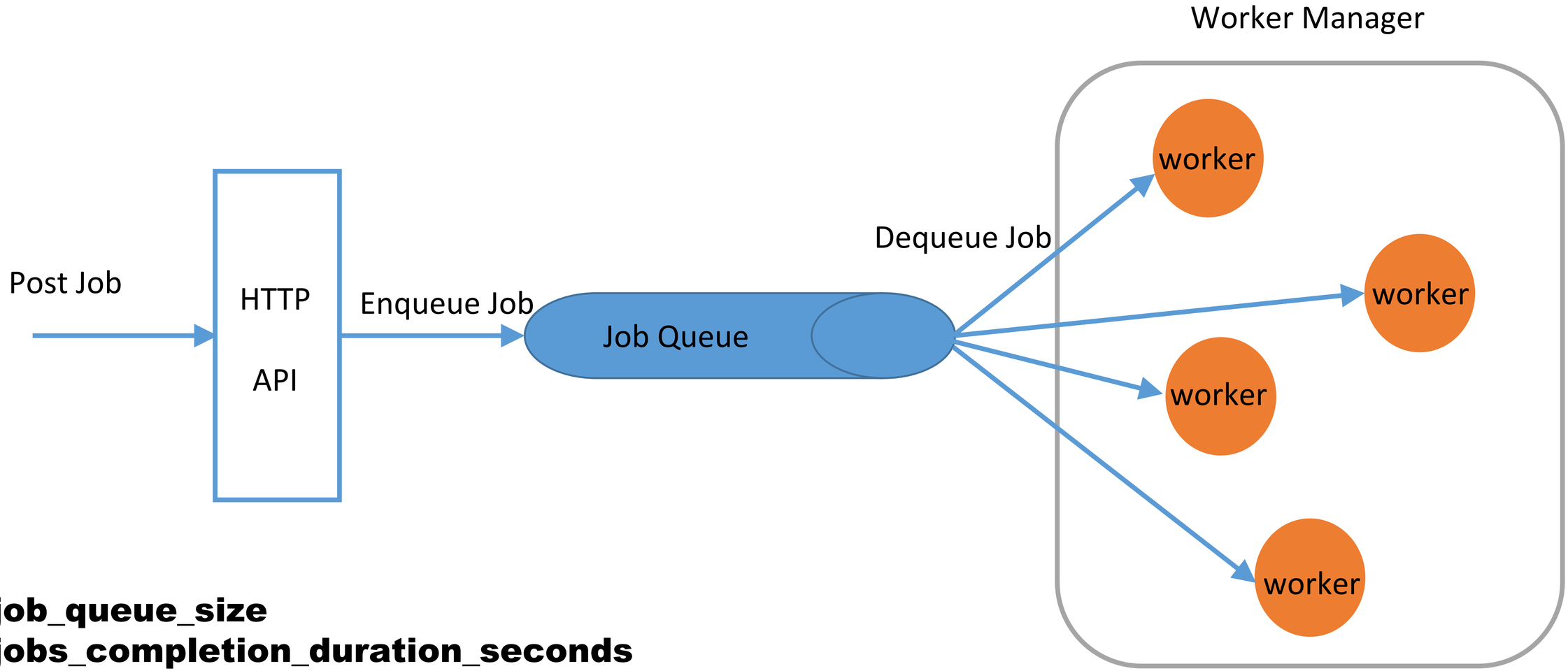
第 9 部分

Prometheus+Alertmanager告警实验（Lab03）


HTTP
Service
Simulator
/metrics
Prometheus
Alertmanager
EMAIL

第10部分

Java应用埋点和监控实验（Lab04）



job_queue_size
jobs_completion_duration_seconds

思考练习

- **其它埋点**
  - 完成的job总数
  - 当前的活跃job数
  - 当前的活跃worker数
  - 当前的空闲worker数

第11部分

NodeExporter系统监控实验（Lab05）

第12部分

Spring Boot Actuator监控实验（Lab06）

第13部分

Prometheus监控最佳实践

四个黄金指标(Google)

- **延迟**：**服务请求所需耗时**
  - 例如HTTP请求平均延迟
- **流量/吞吐**：**衡量服务容量需求**
  - 例如每秒处理HTTP请求数
- **错误**：**衡量错误发生的情况**
  - 例如HTTP 500错误数
- **饱和度**：**衡量资源使用情况**
  - 例如CPU/内存/磁盘使用量

三类系统的监控

Online Serving System	Offline Serving System	Batch Jobs

• **RED方法**
  • Requests
  • Errors
  • Duration
• **Cache**
  • 命中率
	• **USE方法**
	  • Utilization
	  • Saturation
	  • Errors
	• **线程池类似**
		• **Pushgateway**
		• **指标**
		  • Job运行时长
		  • 每阶段时长
		  • 失败/成功数

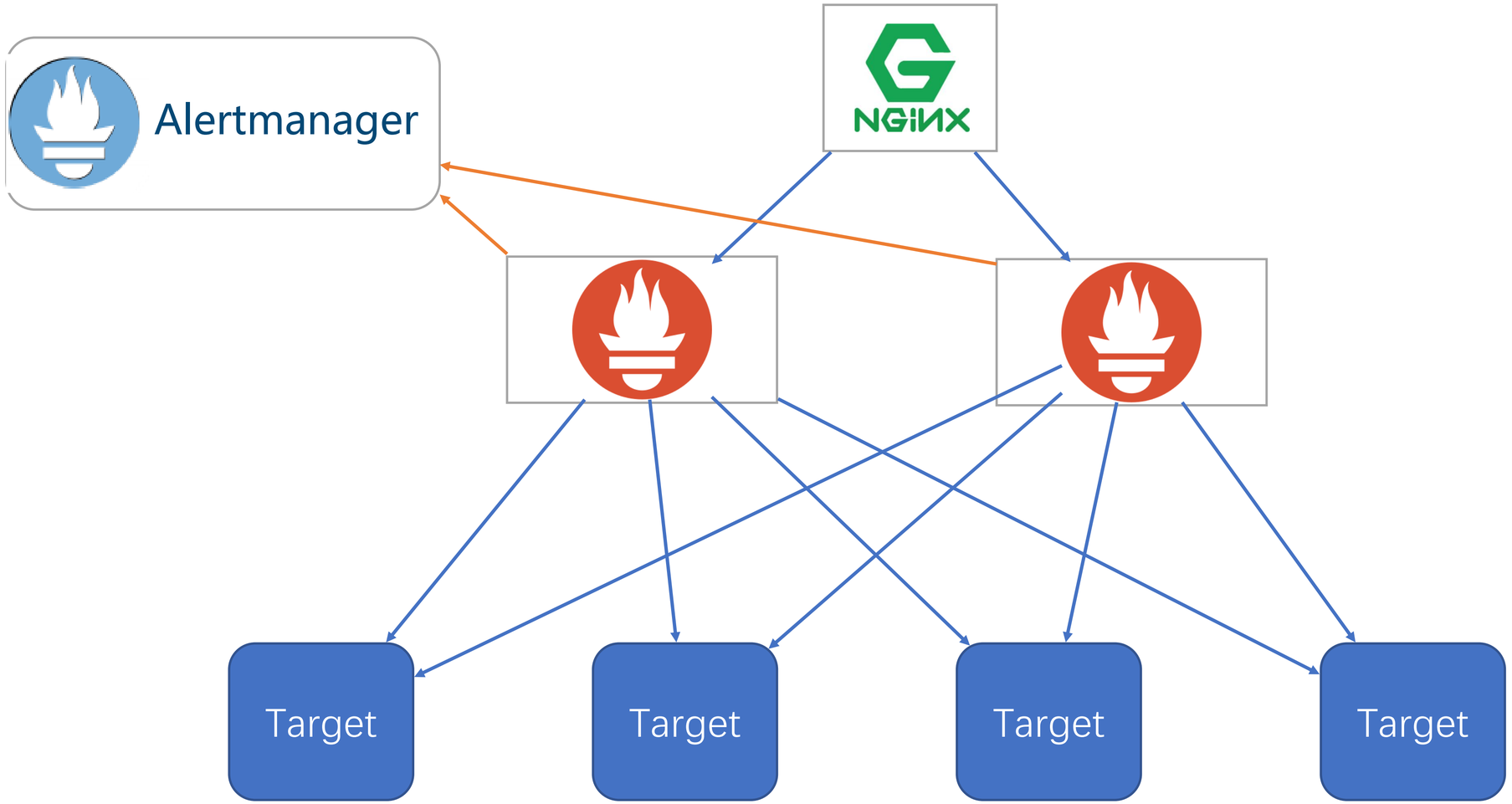
Metrics命名

- **一般建议：library_name_unit_suffix**
- **snake_case**
- **Suffix后缀**
  - _total -> counter
  - _counter, _sum -> summary
  - _bucket -> histogram
- **Unit**
  - 无前缀基本单位
  - seconds, bytes, ratios
- **Name&Library**
  - 直接表意
- **Name vs Label**
  - appName, instanceId/Ip

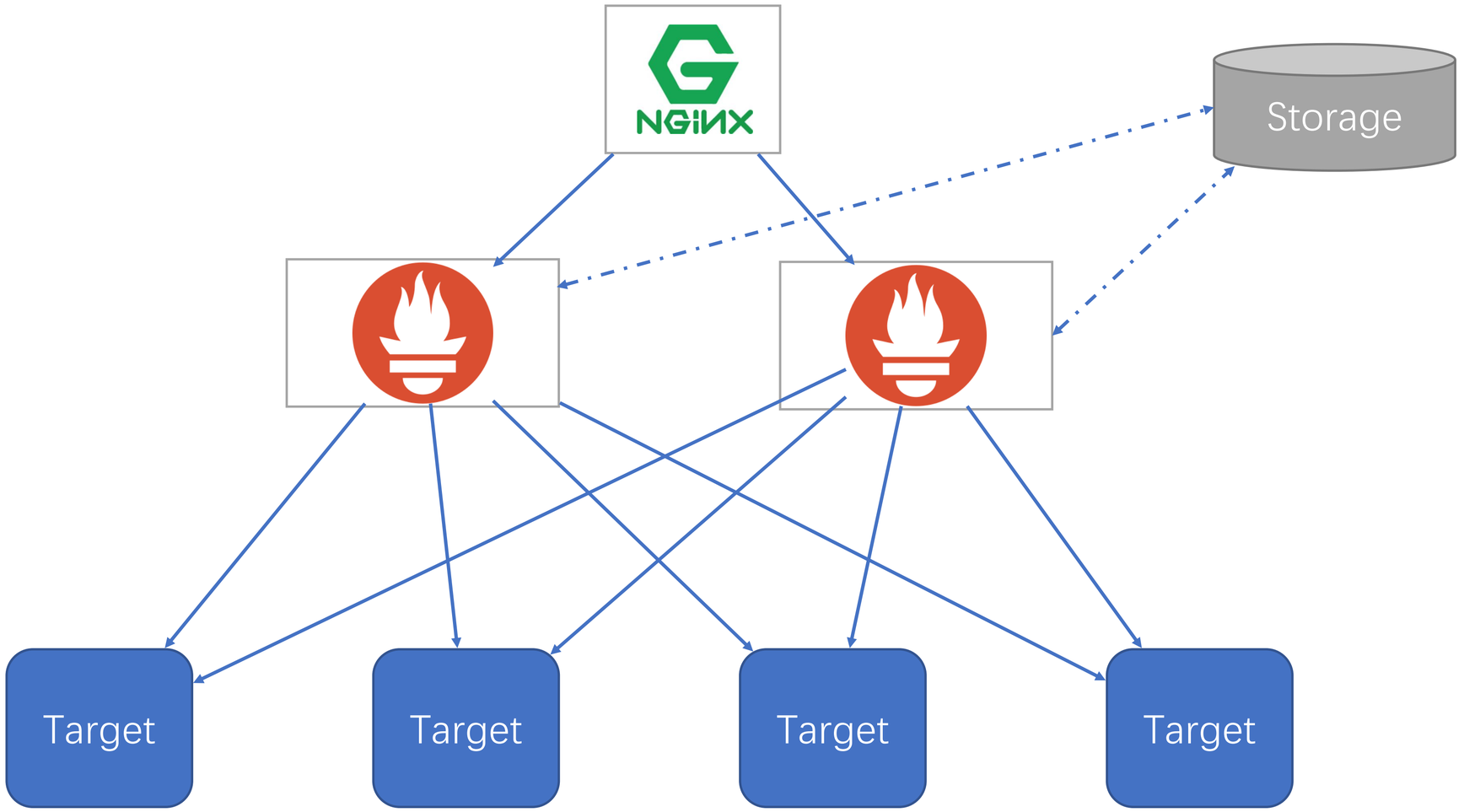
Cardinality(基数)

- **Label的可能取值**
- **新增一个Label值=新增一个时间序列**
- **经验值：单实例Cardinality <= 10个**
- **不适合做Label**
  - Email地址
  - 用户名
  - IP地址
  - HTTP Path
- **关注10个最大的metrics**
- **高Cardinality场景用Log系统**

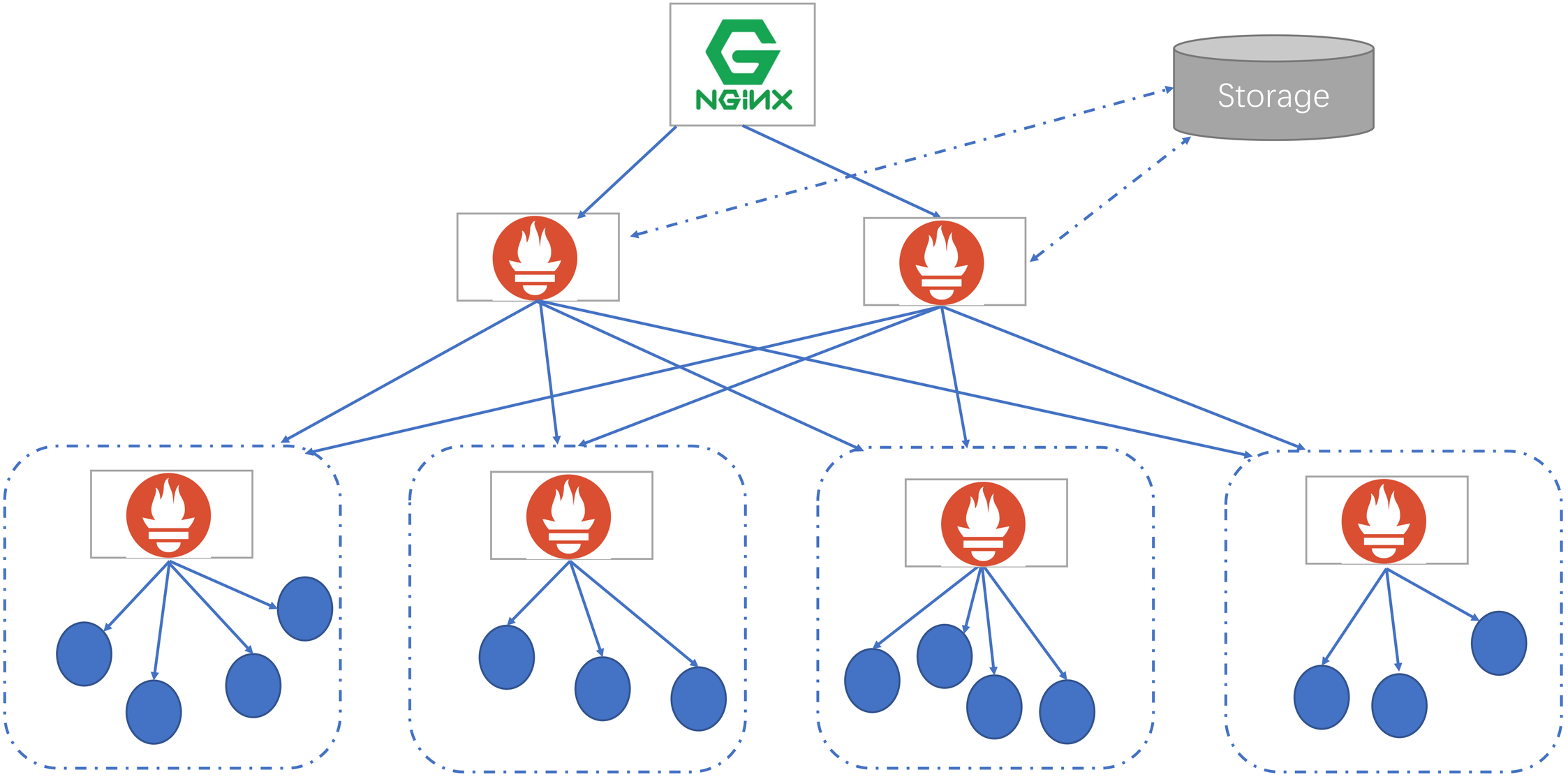
简单HA



基本HA+远程存储



基本HA+远程存储+联邦集群



第14部分

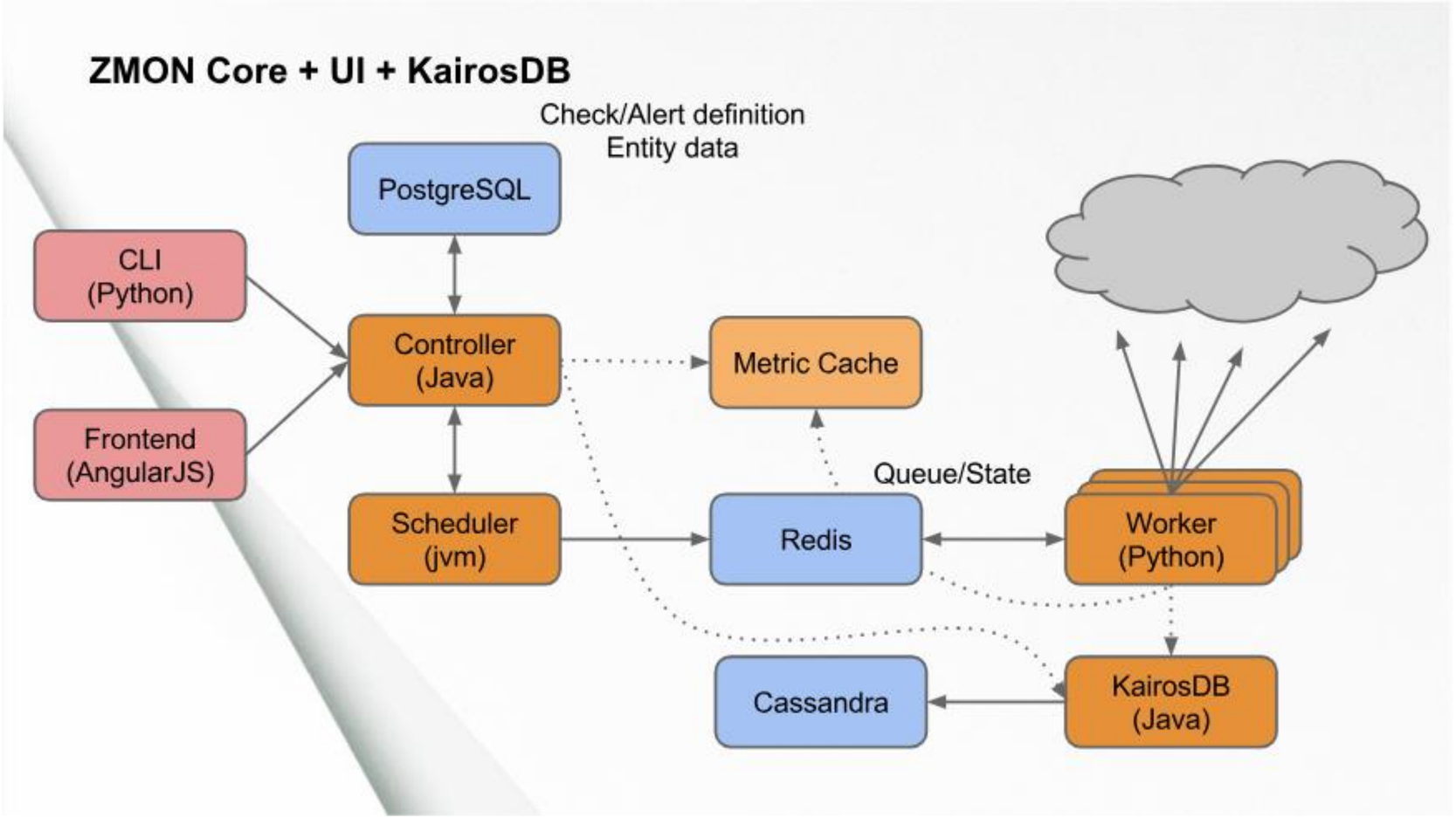
主流开源时序数据库比较

	OpenTSDB	KariosDB	Promethes	InfluxDB
开源时间	2010	2013	2012	2013
类型	时序数据库	时序数据库	时序数据库	**分析数据库**
分布式	**支持**	**支持**	Federation	商业
存储	Hbase	**Cassandra**	定制	定制
采集模式	Push	Push	**Pull**	Push
Grafana集成	支持	支持	支持	支持
计算函数	良好	一般	丰富	丰富
告警模块	无	无（ZMon）	**有**	**有**
查询语言	HTTP API	HTTP API	**PromQA**	**InfluxQL**
Web UI	支持	支持	支持	支持
维度支持	Tag	Tag	**Label**	Tag+Field
预聚合	Roll-up	Roll-up	Recording Rule	Continous Query
实现语言	Java	Java	Golang	Golang
github活跃度	~3.2k	~1.3k	**~19.6k**	~14.6k
商业支持	无	无	无	有
适用	中大规模	中大规模	中小规模	中小规模

第15部分

开源分布式监控平台ZMon简介

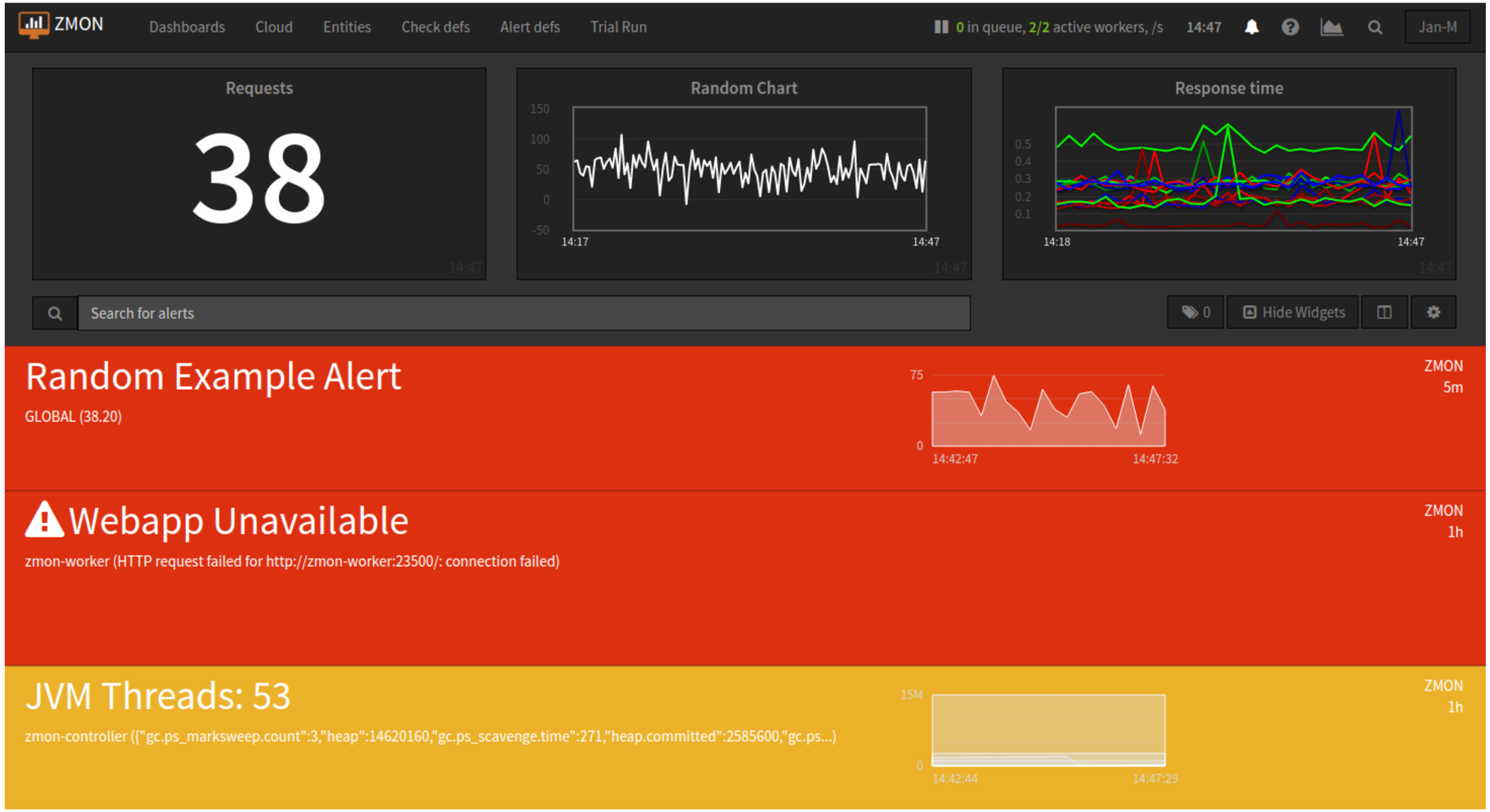
ZMon架构



- Zalando开源
- 分布式监控告警系统
- 拉模式(Check)
- Python定义Check/Alert
- DevOps团队自治监控
- 基于KairosDB

https://opensource.zalando.com/zmon/

ZMon告警大盘


ZMON
Dashboards
Cloud
Entities
Check defs
Alert defs
Trial Run
0 in queue, 2/2 active workers, /s
14:47
Jan-M
Requests
38
Random Chart
150
100
50
0
-50
14:17
14:47
Response time
0.5
0.4
0.3
0.2
0.1
14:18
14:47
Search for alerts
0
Hide Widgets
Random Example Alert
GLOBAL (38.20)
75
0
14:42:47
14:47:32
ZMON
5m
Webapp Unavailable
zmon-worker (HTTP request failed for http://zmon-worker:23500/: connection failed)
ZMON
1h
JVM Threads: 53
zmon-controller ({"gc.ps_marksweep.count":3,"heap":14620160,"gc.ps_scavenge.time":271,"heap.committed":2585600,"gc.ps...)
15M
0
14:42:44
14:47:29
ZMON
1h

Python表达式

ID: 5, Status: , Team: ZMON

Alert: Webapp Unavailable

Edit Clone Inherit Delete History ▶ Trial Run ▶ Evaluate Cleanup Comments (0)

Description	One of the ZMON Demo web applications is not available
Condition	`value not in [200, 400, 404]`
Responsible Team	ZMON

Details

Check Name, ID, History	Webapp HTTP Status, ID: 7, History
Check Team	ZMON
Check Command	`# see https://zmon.readthedocs.org/en/latest/user/check-commands.html#http` `http('/', timeout=5).code()`
Check Interval	1m
Check Entities	type = demowebapp
Parameters	(no parameters)
Entities Filter	(no entities)
Excluded Entities Filter	(no excluded entities)
Notifications	(no notifications defined)
Time Period	(no time periods defined)
Tags	

Alerts/Checks | Downtimes (0) | History | Children (0)

Alerts (1) | In downtime (0) | OK (4)

Filter entities

Name	Last run	Active since	Value	Captures
zmon-scheduler	18.11.16 14:49 (2s ago)		404	{}
zmon-kairosdb	18.11.16 14:49 (2s ago)		200	{}
zmon-eventlog-service	18.11.16 14:49 (2s ago)		400	{}
zmon-controller	18.11.16 14:49 (2s ago)		200	{}
zmon-worker	18.11.16 14:49 (2s ago)	18.11.16 12:51 (1h ago)	HTTP request failed for http://zmon-worker:23500/: connection fa...	{}

Alert状态和历史

type:demowebapp

ID	Type	Alerts
zmon-controller	demowebapp	OK 5d OK
zmon-eventlog-service	demowebapp	OK
zmon-kairosdb	demowebapp	OK
zmon-scheduler	demowebapp	10h OK OK
zmon-worker	demowebapp	5d

Alert调试

Trial Run

Trial Run allows the end user to test check commands and alert conditions before using them on the system.

Details

Stop

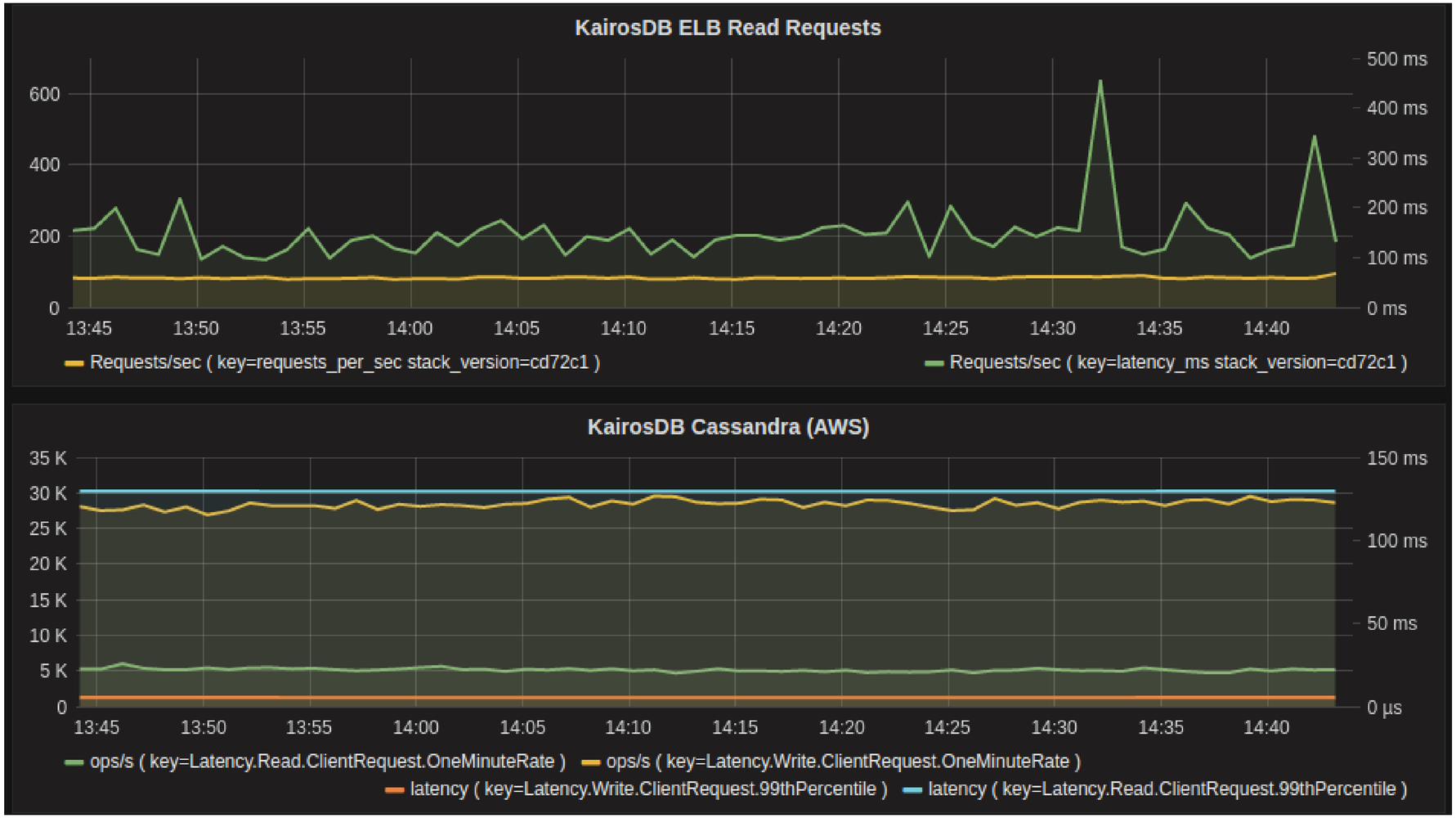
Alerts

Alerts (12) OK (51)

Filter entities

Name	Timestamp	Last run	Value	Captures
asa[team-service]	27.07.15 15:57 (1m ago)	233ms	{"eu-central-1":"[Errno 111] Connection refused","eu-west-1":"[Errno -2] Name or se…	{"problems":["eu-central-1","eu-west-1"]}
bi[team-service]	27.07.15 15:57 (1m ago)	186ms	{"eu-central-1":"[Errno -2] Name or service not known","eu-west-1":"OK"}	{"problems":["eu-central-1"]}
cd[team-service]	27.07.15 15:57 (1m ago)	21ms	{"eu-central-1":"OK","eu-west-1":"[Errno -2] Name or service not known"}	{"problems":["eu-west-1"]}
core[team-service]	27.07.15 15:57 (1m ago)	749ms	{"eu-central-1":"[Errno -2] Name or service not known","eu-west-1":"[Errno -2] Nam…	{"problems":["eu-central-1","eu-west-1"]}

Grafana集成


KairosDB ELB Read Requests
600
400
200
0
500 ms
400 ms
300 ms
200 ms
100 ms
0 ms
13:45
13:50
13:55
14:00
14:05
14:10
14:15
14:20
14:25
14:30
14:35
14:40
Requests/sec (key=requests_per_sec stack_version=cd72c1)
Requests/sec (key=latency_ms stack_version=cd72c1)
KairosDB Cassandra (AWS)
35 K
30 K
25 K
20 K
15 K
10 K
5 K
0
150 ms
100 ms
50 ms
0 µs
13:45
13:50
13:55
14:00
14:05
14:10
14:15
14:20
14:25
14:30
14:35
14:40
ops/s (key=Latency.Read.ClientRequest.OneMinuteRate)
ops/s (key=Latency.Write.ClientRequest.OneMinuteRate)
latency (key=Latency.Write.ClientRequest.99thPercentile)
latency (key=Latency.Read.ClientRequest.99thPercentile)

参考

- **源码**
  - https://github.com/zalando-zmon
- **Check commands reference**
  - https://docs.zmon.io/en/latest/user/check-commands.html
- **Alert Functions reference**
  - https://docs.zmon.io/en/latest/user/alert-ref/alert_reference_functions.html
- **Notifications reference**
  - https://docs.zmon.io/en/latest/user/notifications.html

第16部分

微服务监控体系总结

四层轻量监控体系

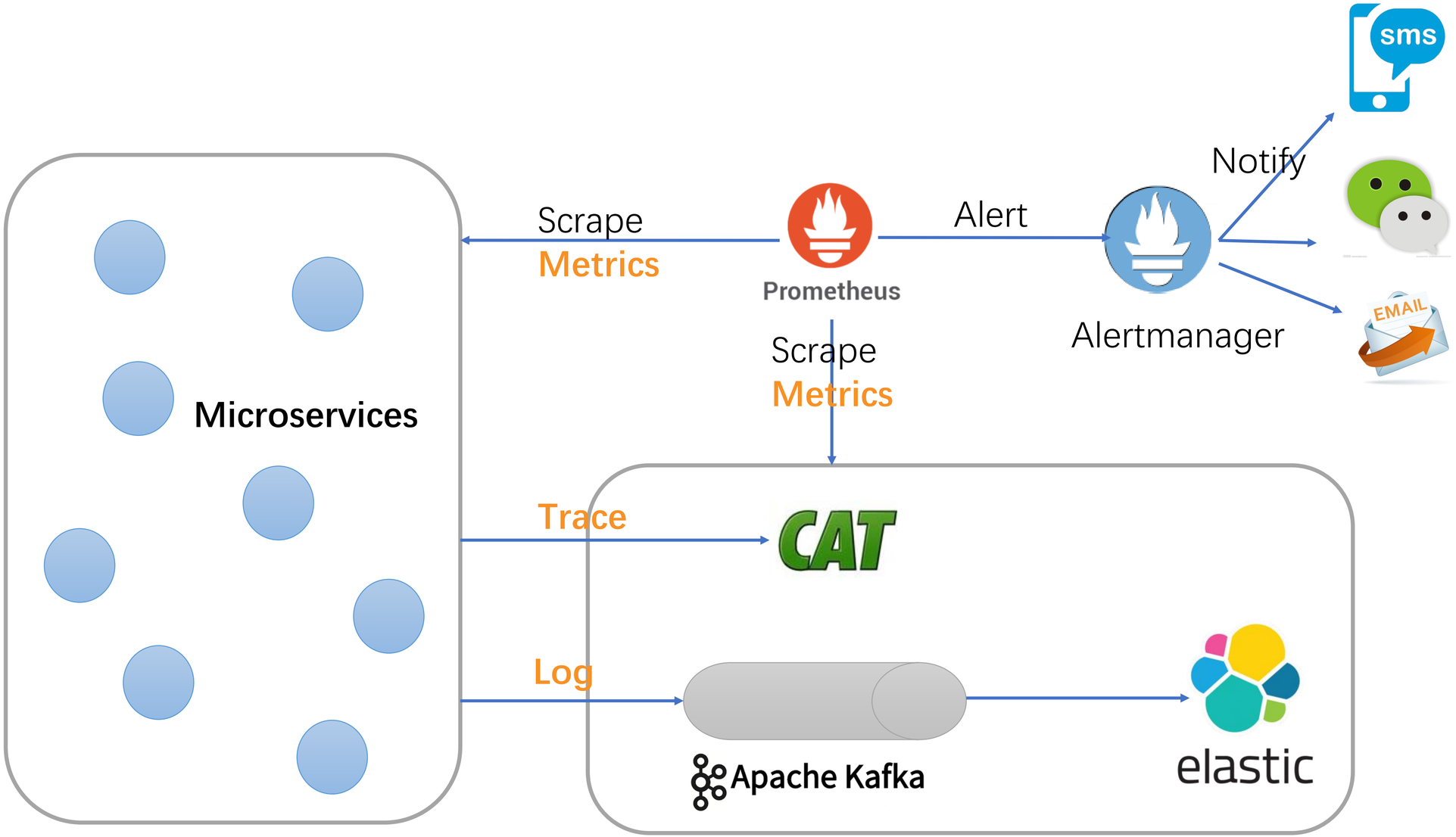
端用户体验监控

业务层监控

应用层监控

系统层监控

参考架构


sms
Notify
Scrape
Metrics
Prometheus
Alert
Alertmanager
EMAIL
Scrape
Metrics
Microservices
Trace
CAT
Log
Apache Kafka
elastic

第17部分

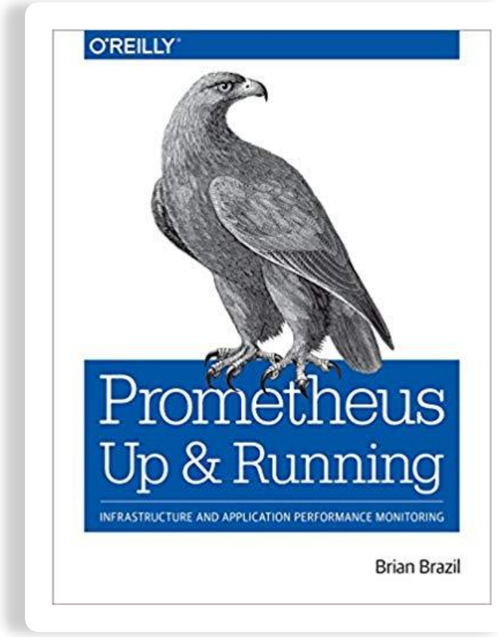
参考资源和后续课程预览

参考文档

- **Metrics Driven Development**
  - https://www.infoq.com/articles/metrics-driven-development
- **Go for Industrial Programming**
  - https://peter.bourgon.org/go-for-industrial-programming
- **Prometheus官网**
  - https://prometheus.io
- **Prometheus入门与实践**
  - https://www.ibm.com/developerworks/cn/cloud/library/cl-lo-prometheus-getting-started-and-practice/index.html
- **全面学习Prometheus（郑云龙）**
  - http://dockone.io/article/5716

参考书籍

- **Prometheus Book(ebook)（郑云龙)**
  - https://github.com/yunlzheng/prometheus-book
- **Prometheus Up & Running(英文版)**



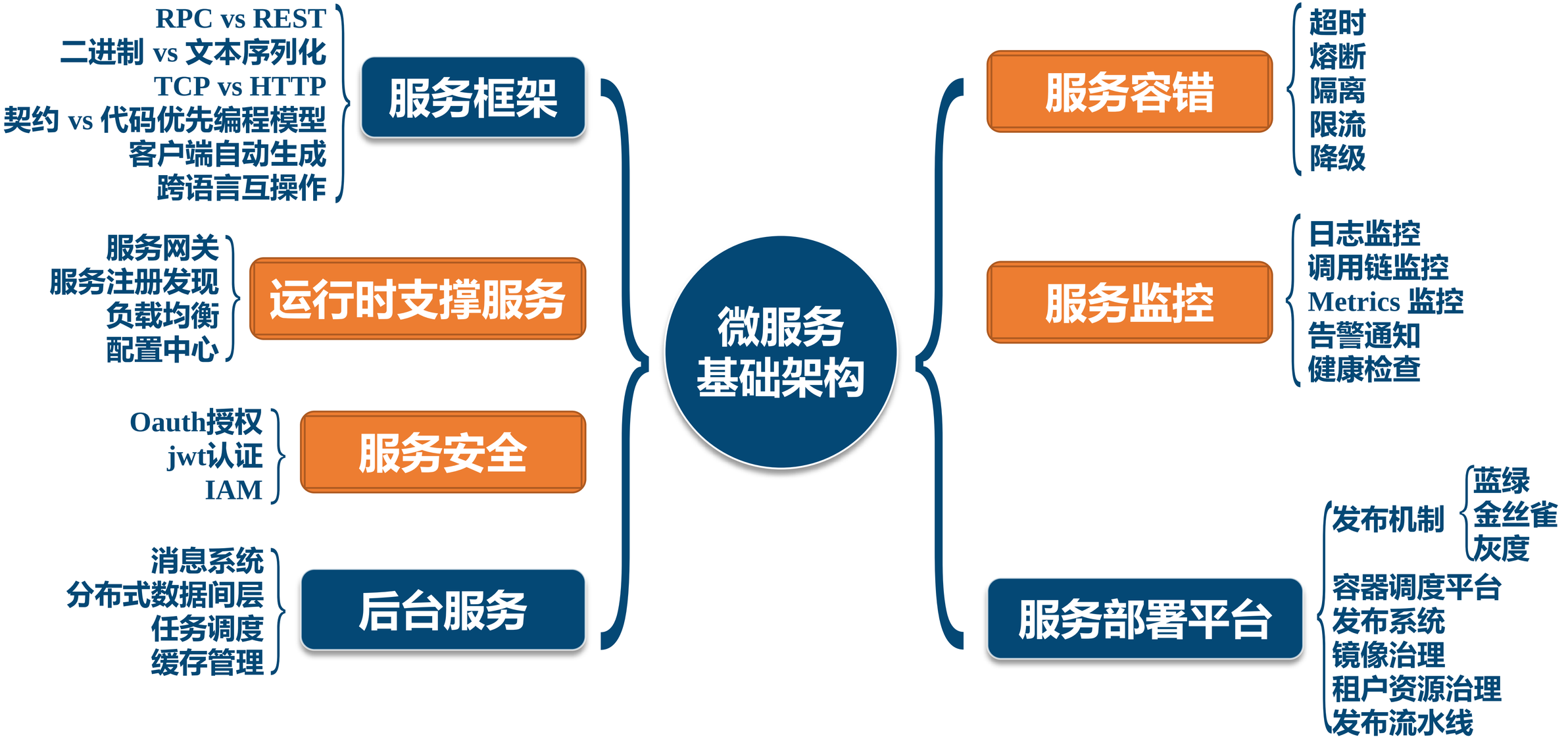
扩展方案

- **高可用和长期存储方案**
  - https://github.com/improbable-eng/thanos
- **长期存储方案**
  - https://github.com/m3db/m3
- **配置管理**
  - https://github.com/line/promgen

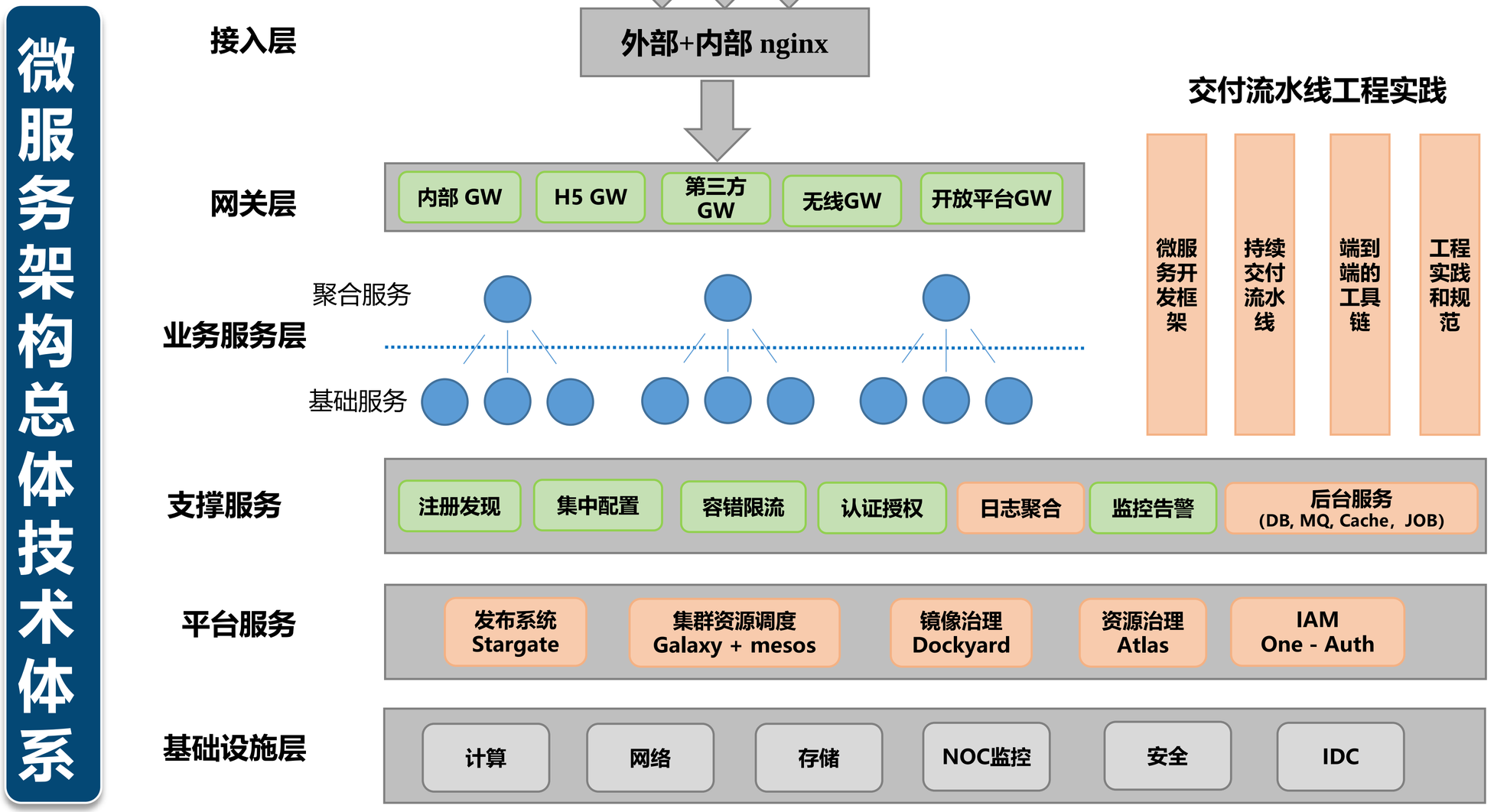
其它开源时序数据库产品

- **OpenTSDB**
  - http://opentsdb.net/
- **KairosDB**
  - https://kairosdb.github.io/
- **InfluxDB**
  - https://www.influxdata.com/
- **Graphite**
  - https://graphiteapp.org/

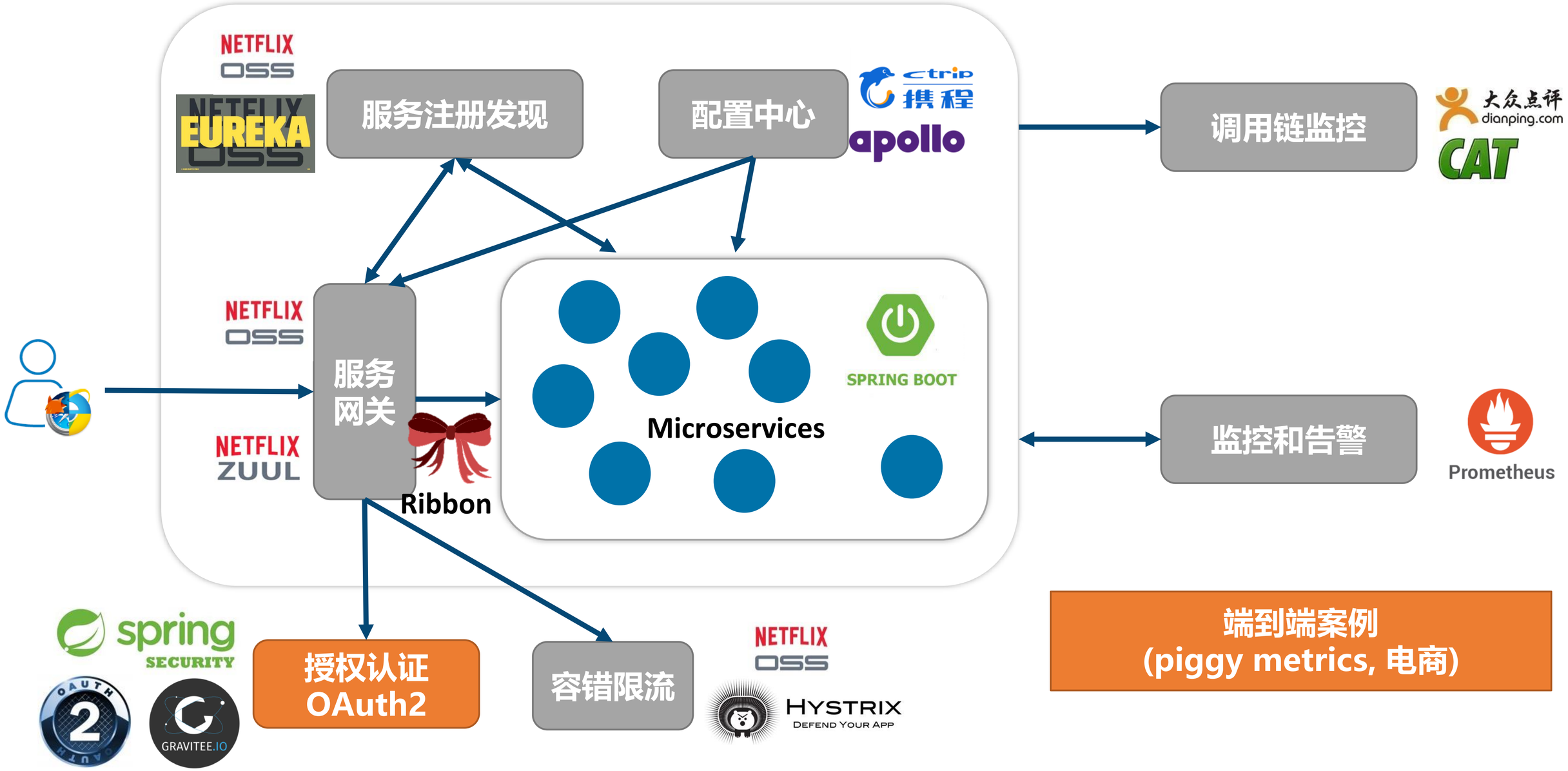
后续课程预览~2018课程模块



后续课程预览~技术体系


微服务架构总体技术体系
接入层
外部+内部 nginx
网关层
内部 GW
H5 GW
第三方 GW
无线GW
开放平台GW
业务服务层
聚合服务
基础服务
支撑服务
注册发现
集中配置
容错限流
认证授权
日志聚合
监控告警
后台服务 (DB, MQ, Cache，JOB)
平台服务
发布系统 Stargate
集群资源调度 Galaxy + mesos
镜像治理 Dockyard
资源治理 Atlas
IAM One - Auth
基础设施层
计算
网络
存储
NOC监控
安全
IDC
交付流水线工程实践
微服务开发框架
持续交付流水线
端到端的工具链
工程实践和规范

架构和技术栈预览


NETFLIX OSS
NETFLIX EUREKA OSS
服务注册发现
配置中心
ctrip 携程
apollo
调用链监控
大众点评 dianping.com
CAT
NETFLIX OSS
服务网关
NETFLIX ZUUL
Ribbon
Microservices
SPRING BOOT
监控和告警
Prometheus
spring SECURITY
OAUTH 2
GRAVITEE.IO
授权认证 OAuth2
容错限流
NETFLIX OSS
HYSTRIX
DEFEND YOUR APP
端到端案例
(piggy metrics, 电商)