Application and Practice of Apache Flink® In iQIYI

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职位：资深工程师

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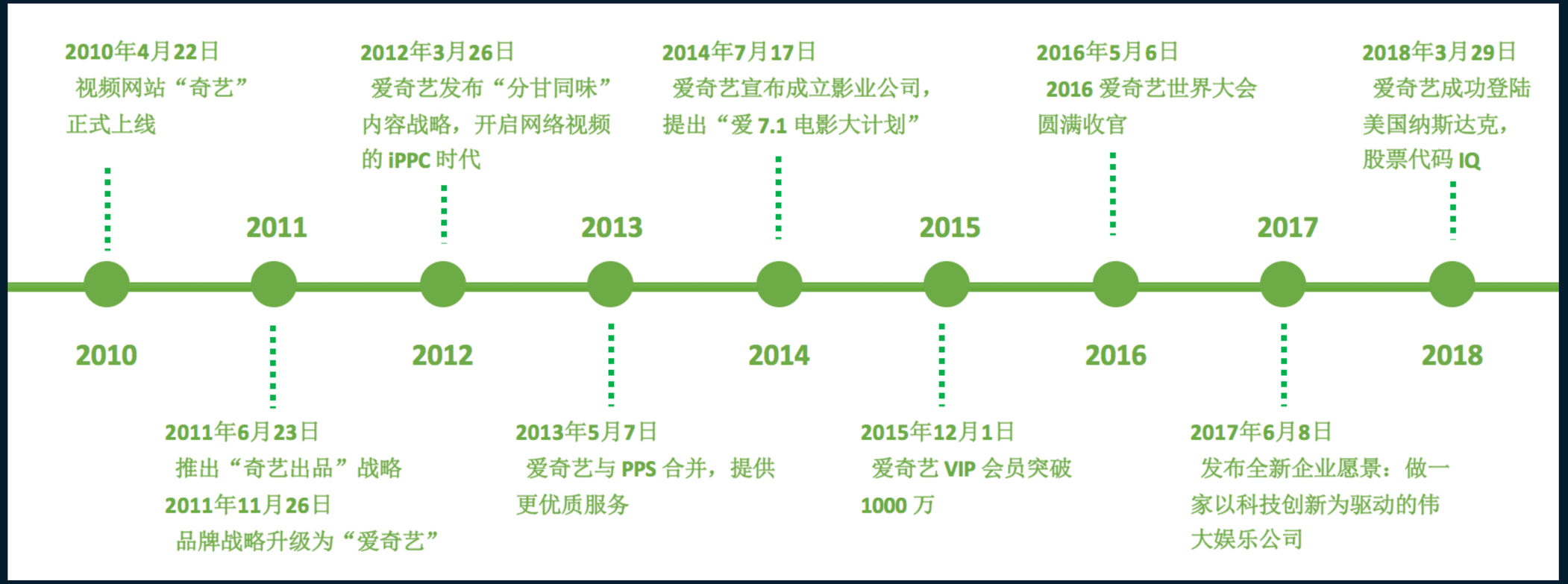
Introduction to iQIYI



Introduction to iQIYI

行业数据领跑 位于行业领先地位

我们拥有规模庞大且高度活跃的用户基础

5.65亿人

月活跃用户数

在线视频领域**No.1**

移动端

数据来源：QuestMobile，2018年8月

59.08亿小时

在线视频领域 **No.1**

全网 **No.3**

爱奇艺月度总有效时长稳居**中国APP榜第三名**

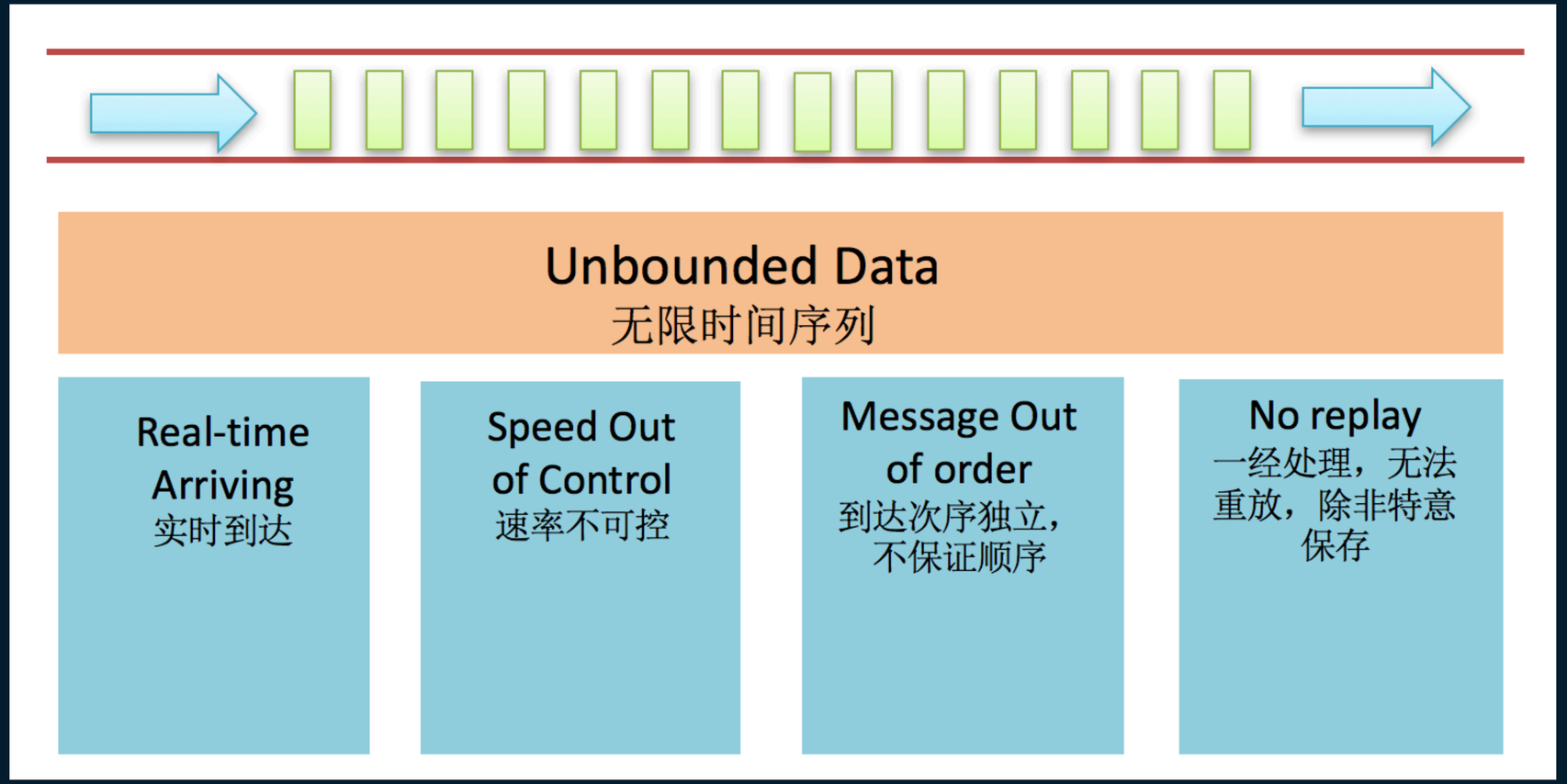
Agenda

- Challenges and evolution
- Flink use cases @iQIYI
- Platform built for Flink
- Improvements on Flink
- Future Work

- 实时计算的挑战与演化
- 爱奇艺怎么使用Flink
- Flink平台化
- 对Flink的改进
- 未来工作

Challenges and evolution

What’s RTC (Real-time computing) ?
实时计算是什么？



Challenges and evolution

Problems 问题

- Out of order 数据乱序
- Out of date 数据延时
- Event time vs Processing time 事件时间 vs 处理时间

Challenges 挑战

- Correctness 正确性
- Fault Tolerant 容错
- Performance 性能
- Latency 延迟
- Throughput 吞吐量
- Scalability 扩展性

Peak events per second: 11 Million/s

峰值事件数：1100万/s

Challenges and evolution

RTC evolution @ iQIYI

- 2013：Storm，3 clusters
- 2015：Spark streaming on YARN
- 2016：Developed platform for Spark streaming
- 2017：Flink standalone & Flink on YARN
- 2018：Flink co-locate with Kafka, developed Streaming SQL and real-time analysis platform

爱奇艺实时计算里程碑

- 2013：小规模使用Storm，3个独立集群
- 2015：引入Spark Streaming，部署在YARN
- 2016：Spark Streaming平台化，大规模使用
- 2017：引入Flink，部署在独立集群和YARN
- 2018：Flink与Kafka混合部署，构建Streaming SQL与实时分析平台

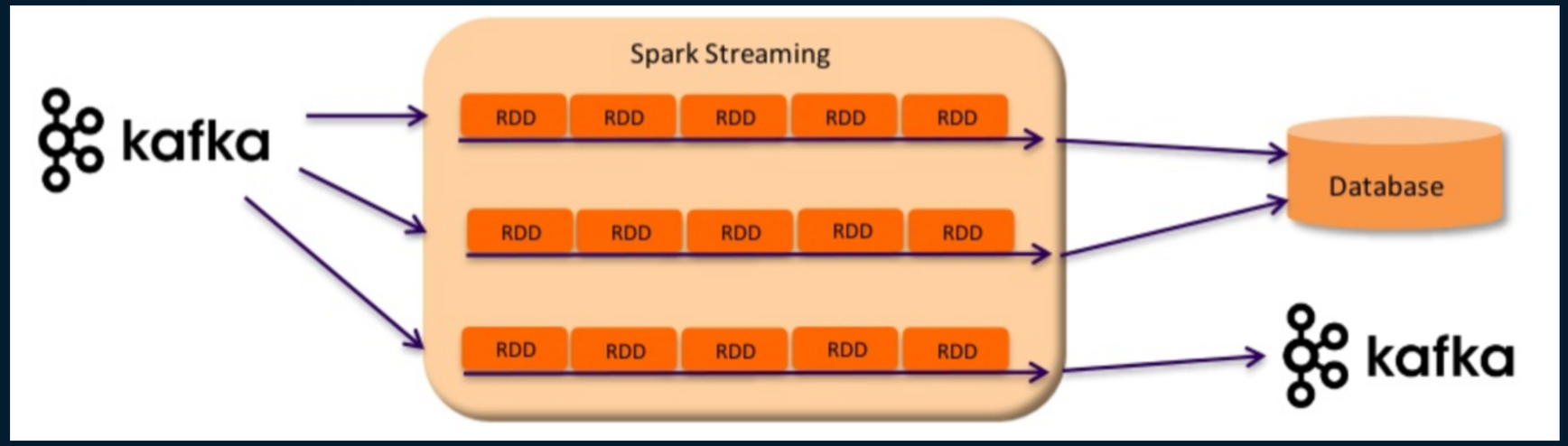
Challenges and evolution

Spark Streaming

- Micro-batch 微批次
- APIs: DStream API, SQL

Problems 问题

- Hard to build REAL real-time, etc.
- event time、late data 很难构建“实时”计算



Challenges and evolution

Flink - Dataflow Model (What Where When How)

- Layered APIs: DataStream API, process function, SQL
- Guaranteed correctness: exactly once, event-time, late data handing
- Performance: low latency (ms)
- Scales: scale-out architecture, incremental checkpointing

- 分层API：DataStream API, Process Function, SQL
- 正确性保证：Exactly once, 事件时间，延时数据处理
- 性能：低延时 (ms)
- 伸缩性：Scale-out架构，增量checkpoint

Challenges and evolution

FLINK FORWARD

Flink vs Spark Streaming

Framework 计算框架	Flink	Spark Streaming
Streaming Model 流计算模型	Native stream processing 原生流处理	Micro batch 微批处理
Latency 延迟	ms 毫秒	s 秒
Throughput 吞吐量	High 高	High 高
Study curve 学习曲线	Middle 中等	Low 低
Fault-tolerant 容错性	Incremental checkpointing 增量checkpoint	RDD checkpoint
Event Time 事件时间	Support 原生支持	Partial 业务逻辑实现
Late Data 延时数据处理	Support 原生支持	Partial 业务逻辑实现

Flink use cases @iQIYI

- Real-time ETL with massive data 海量数据实时ETL
- Real-time fraud detection 实时风控
- Distributed system tracing 分布式调用链分析

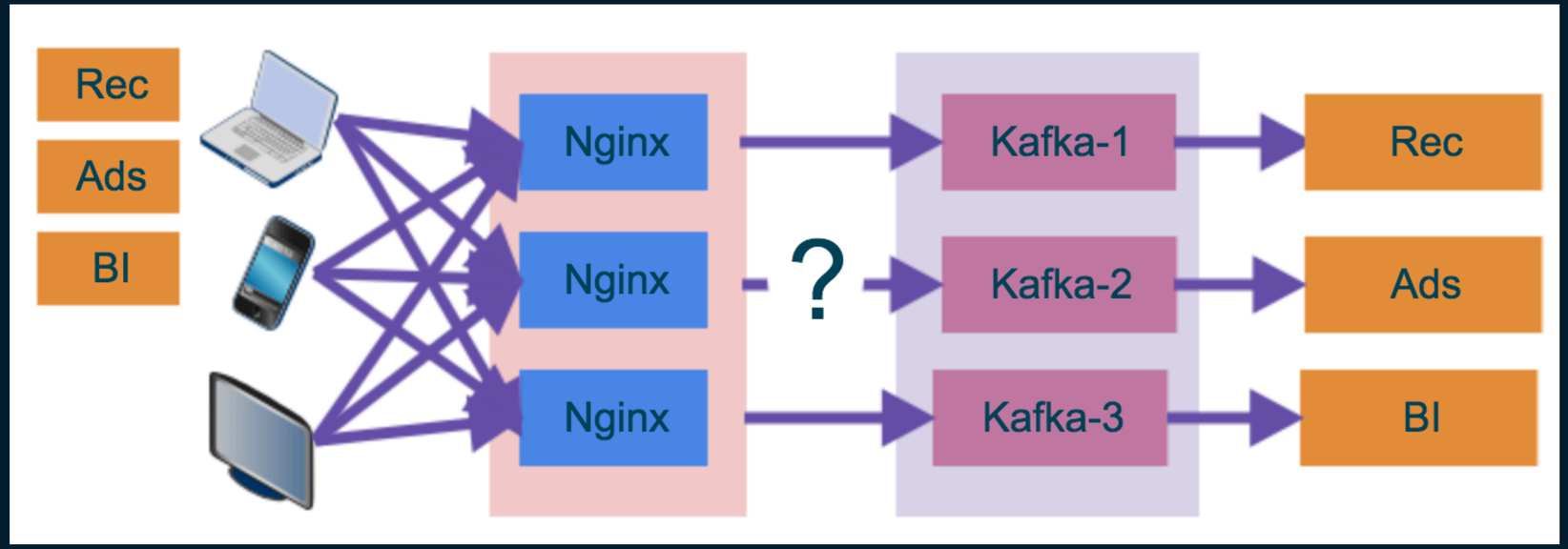
Real-time ETL with massive data

Problem:

- Aggregated event logs in Nginx（Peak: 11 Million/s)
- Sort by category, write to multiple Kafka clusters

问题:

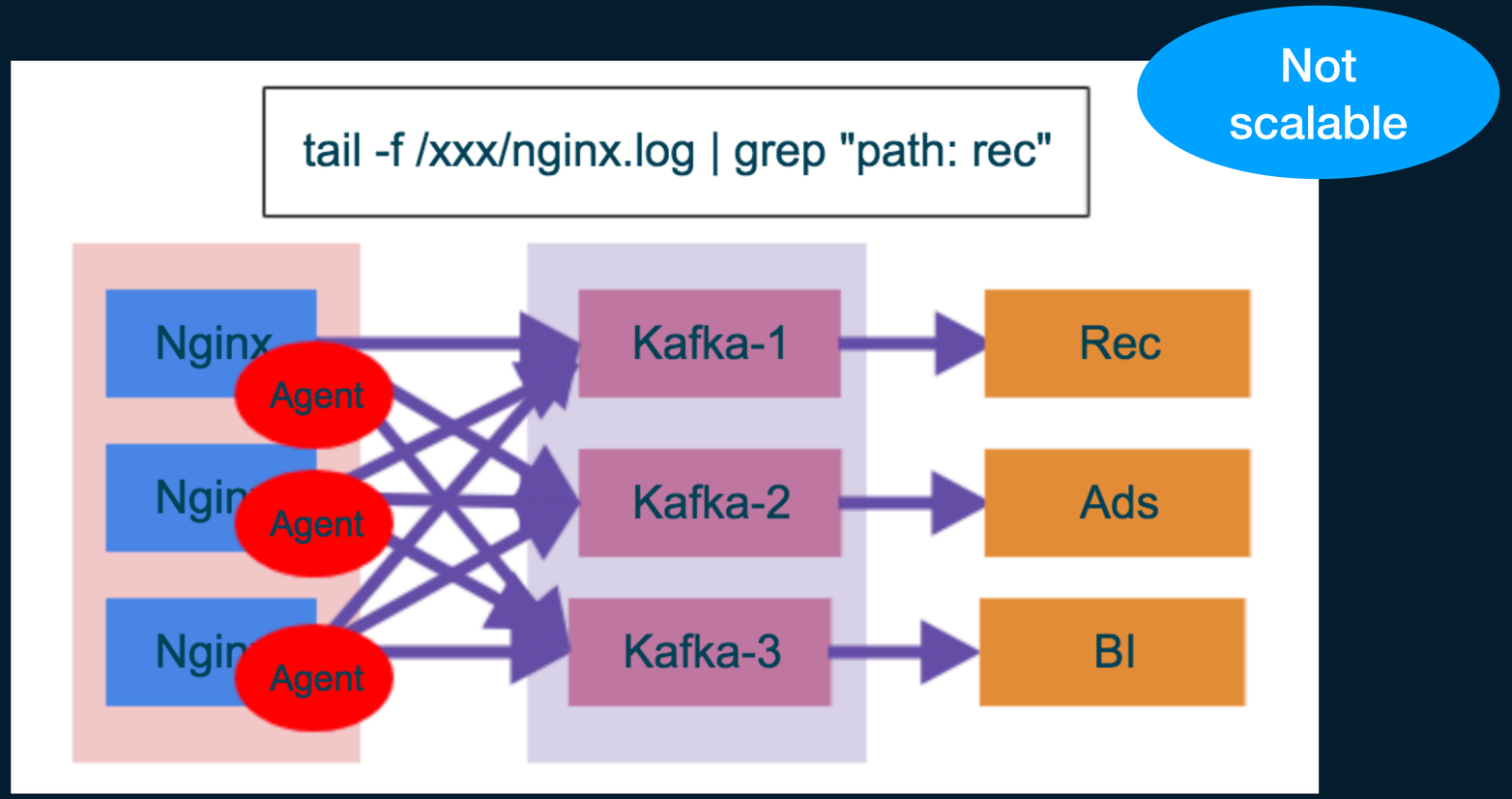
- 将Nginx上聚合日志（峰值流量：1100万/s）根据业务线拆分到多个Kafka集群



Real-time ETL with massive data

Option 1: Use tail command

选项1：使用tail命令



Real-time ETL with massive data

Option 2: ETL

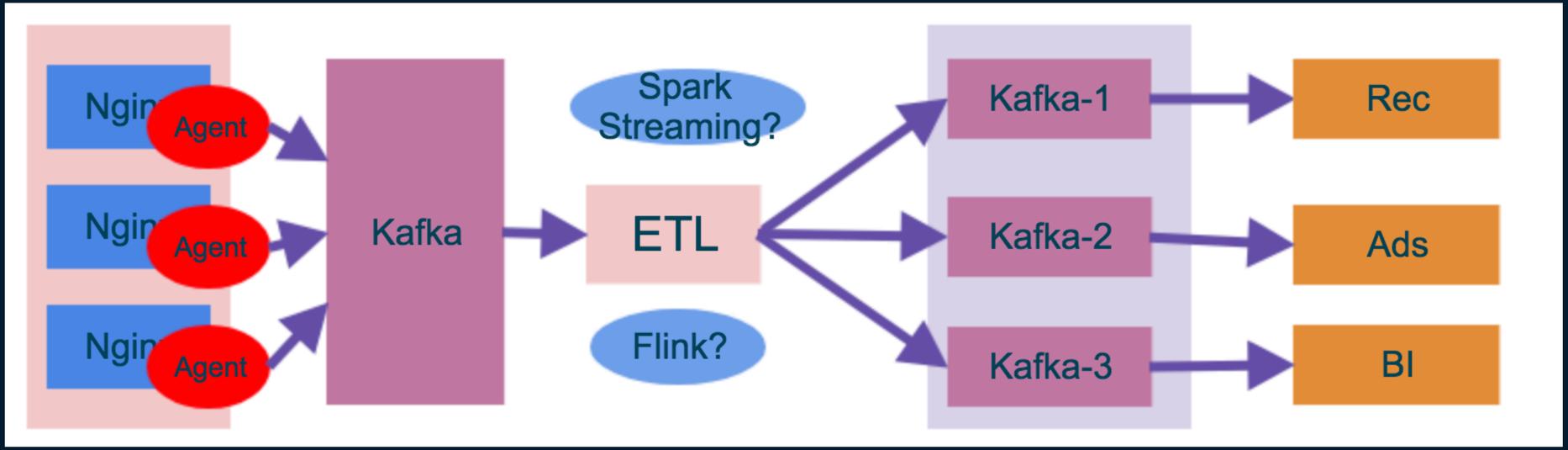
Requirements：

- High Throughout (11 Million/s)
- Low latency (<1s)

选项2：ETL拆分

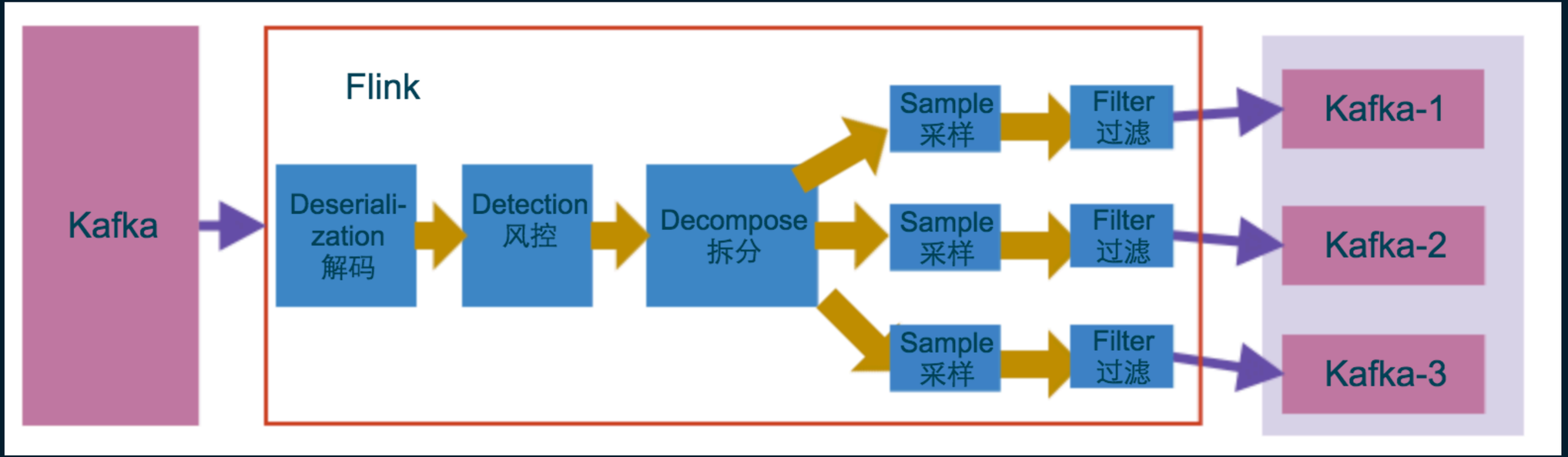
需求：

- 高吞吐（千万QPS）
- 低延时（< 1s）



Real-time ETL with massive data

Flink ETLs



Real-time ETL with massive data

IP Blacklist Filtering

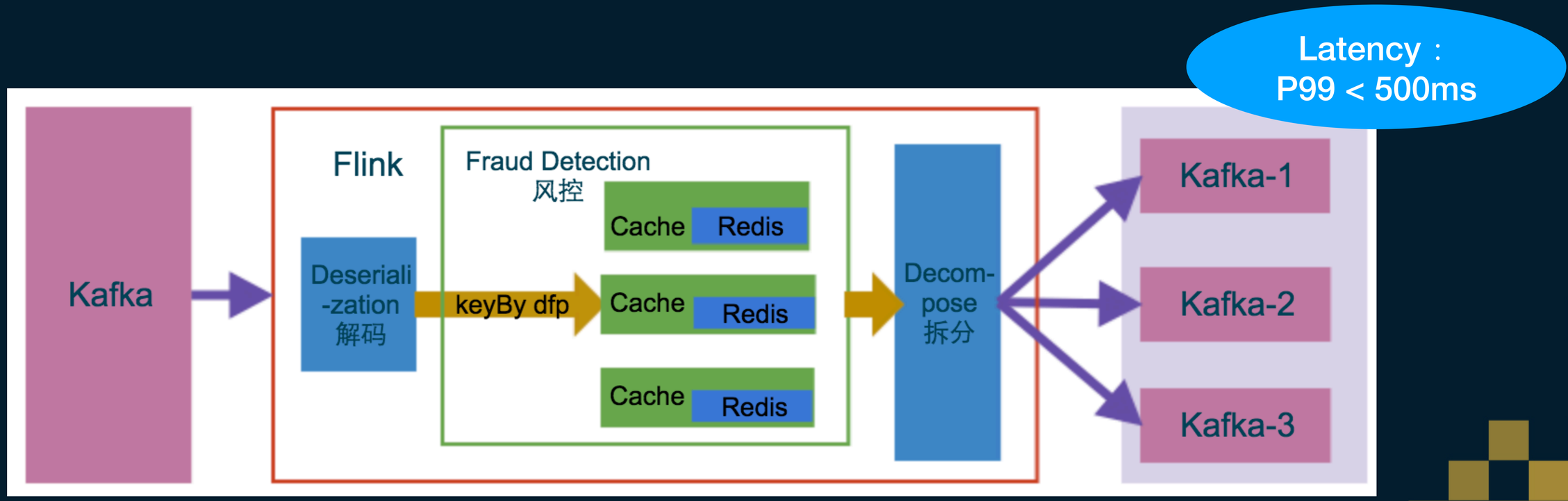
Tuning：

- KeyBy DeviceId
- Local LRU Cache + Redis (4k/s)

IP 黑名单过滤

优化：

- 通过设备ID keyBy，避免处理倾斜
- 缓存优化：Local LRU Cache + Redis（4k/s）



Real-time ETL with massive data

Resource Tuning 资源优化

Flink

- 200+ machines 200+机器
- CPU-bound CPU密集型
- CPU usage: 55% CPU利用率55%

Kafka

- 100+ machines 100+机器
- IO-bound & disk-bound IO吞吐大，磁盘存储多
- IO Throughput: 8W IO吞吐8w
- CPU usage: 15% CPU利用率15%

Mixed: Flink & Kafka 混合部署

- 200+ machines 200+机器
- CPU usage: 70% CPU利用率70%

Real-time fraud detection

Fraud detection–collision attack

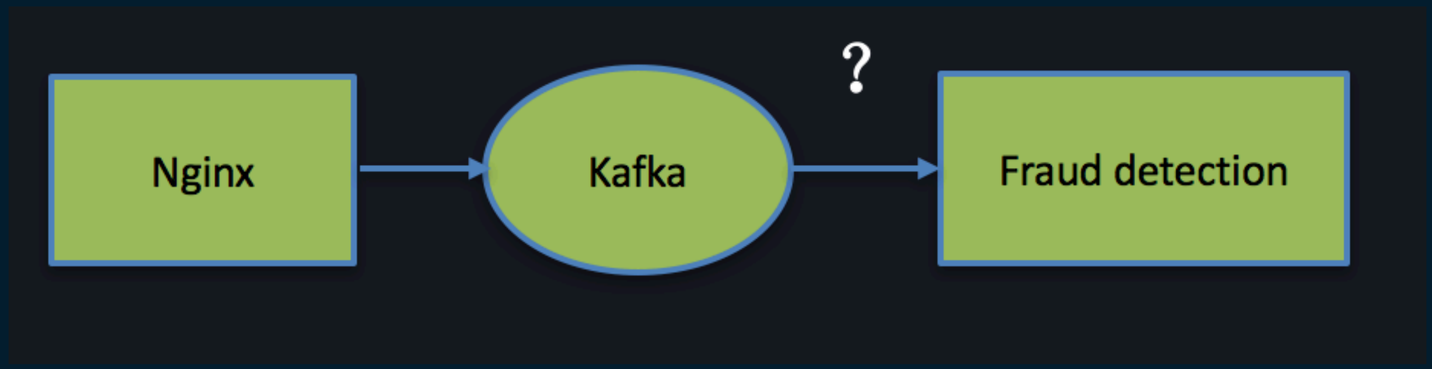
Requirements：

- Detect anomalies
- Post Analysis: Generate IP & Device ID blacklist

风控检测 – 机器撞库盗号攻击

需求：

- 事中过滤：超高频异常检测
- 事后分析：生成IP和设备ID的黑名单



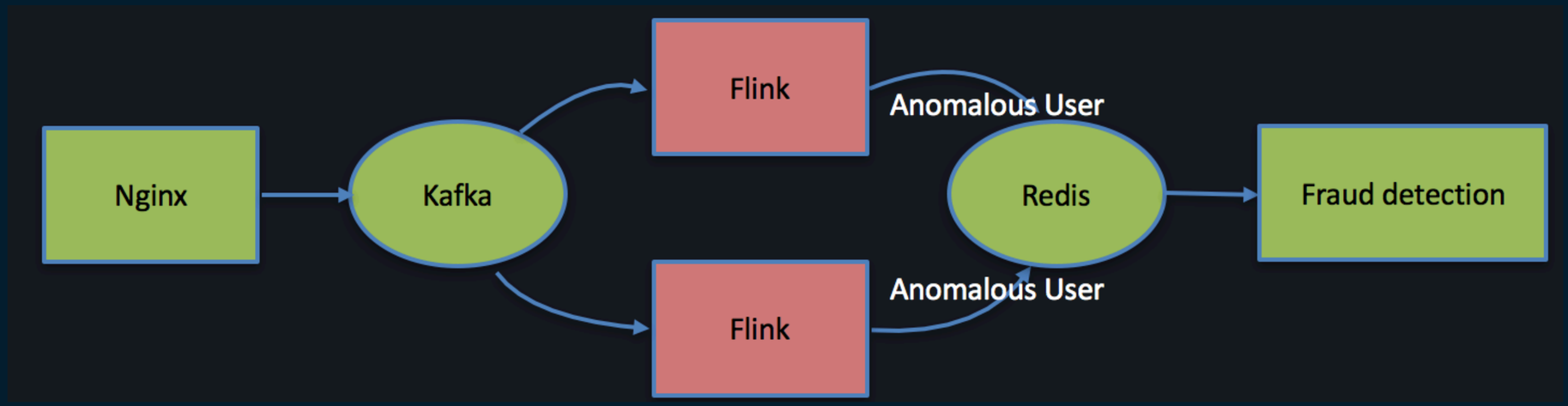
Real-time fraud detection

CEP:

- Recently registered user
- Perform specific actions in short time

复杂事件处理：

- 刚注册的用户
- 短时间内进行一些特定的业务操作



High-frequency anomaly detection:

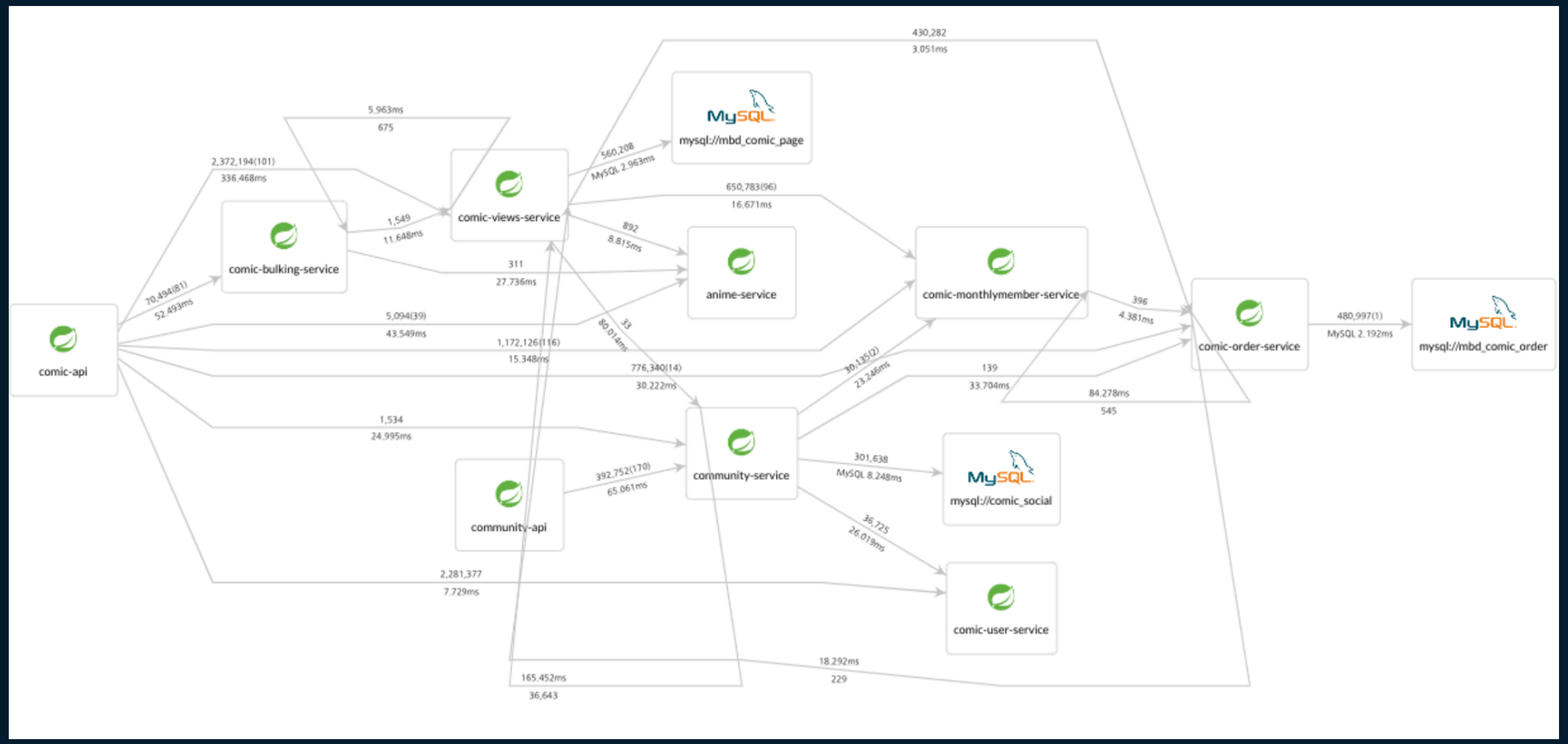
- Count # of requests by one user every second
- Above threshold -> anomalous user

超高频异常检测：

- 对同一个用户在1秒内的请求进行计数
- 超过某个阈值标记为黑产

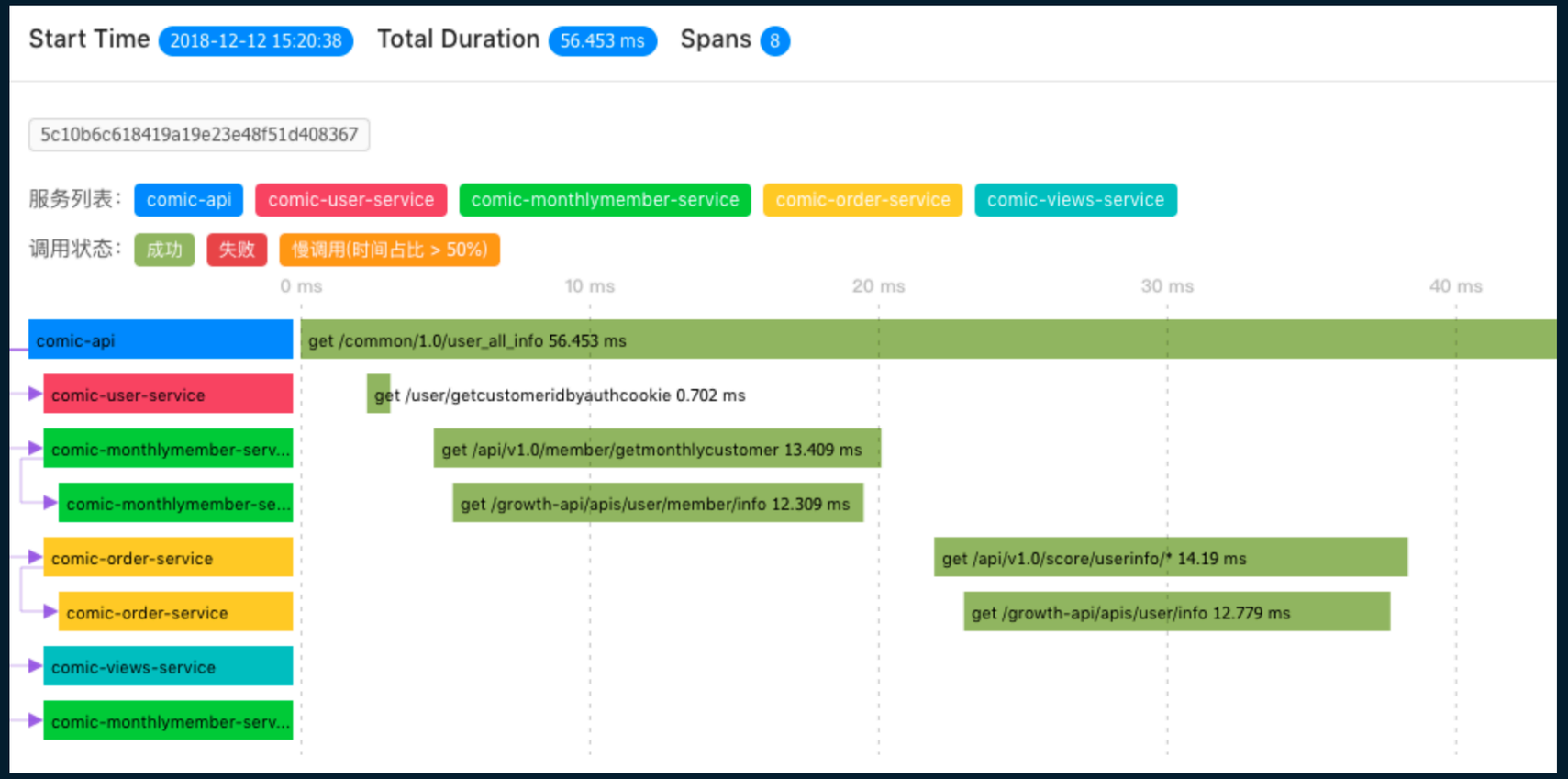
Distributed system tracing

Average duration on tracing topology 整个拓扑的各调用平均耗时



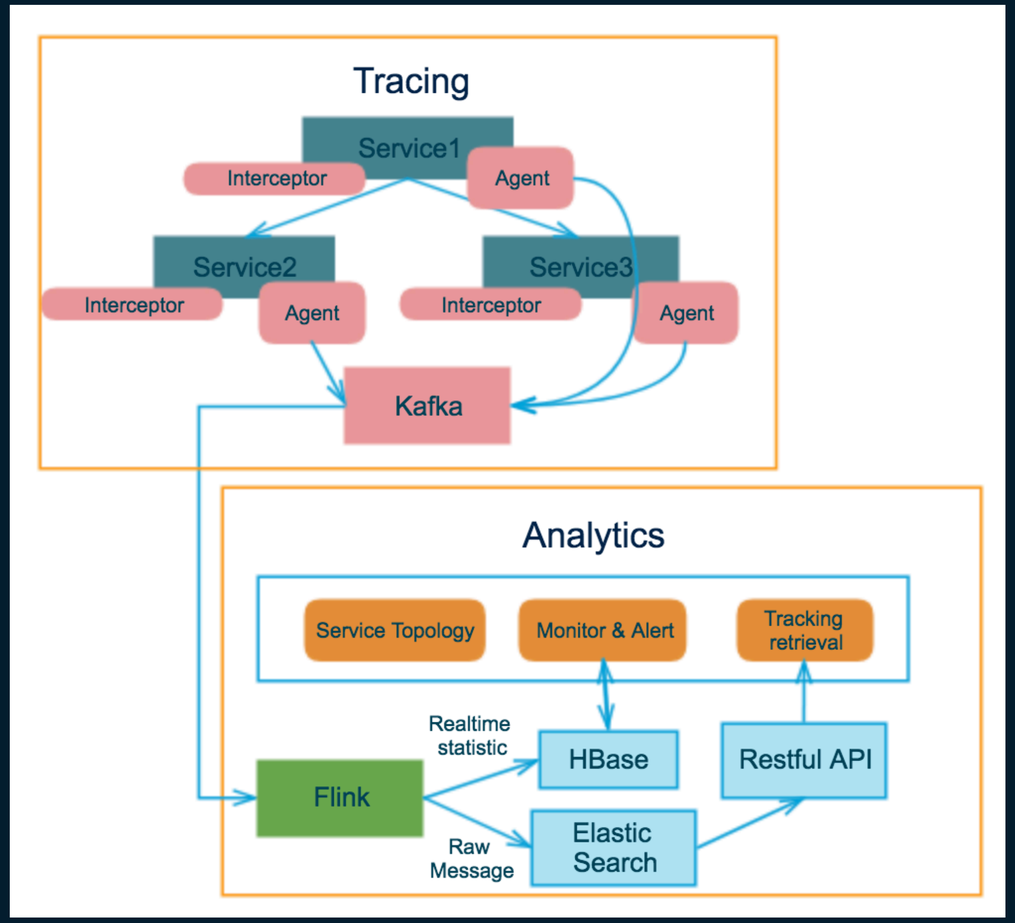
Distributed system tracing

Path and duration of a single call 单次调用的路径和耗时



Distributed system tracing

Architecture 架构



Distributed system tracing

Multiple window aggregations:

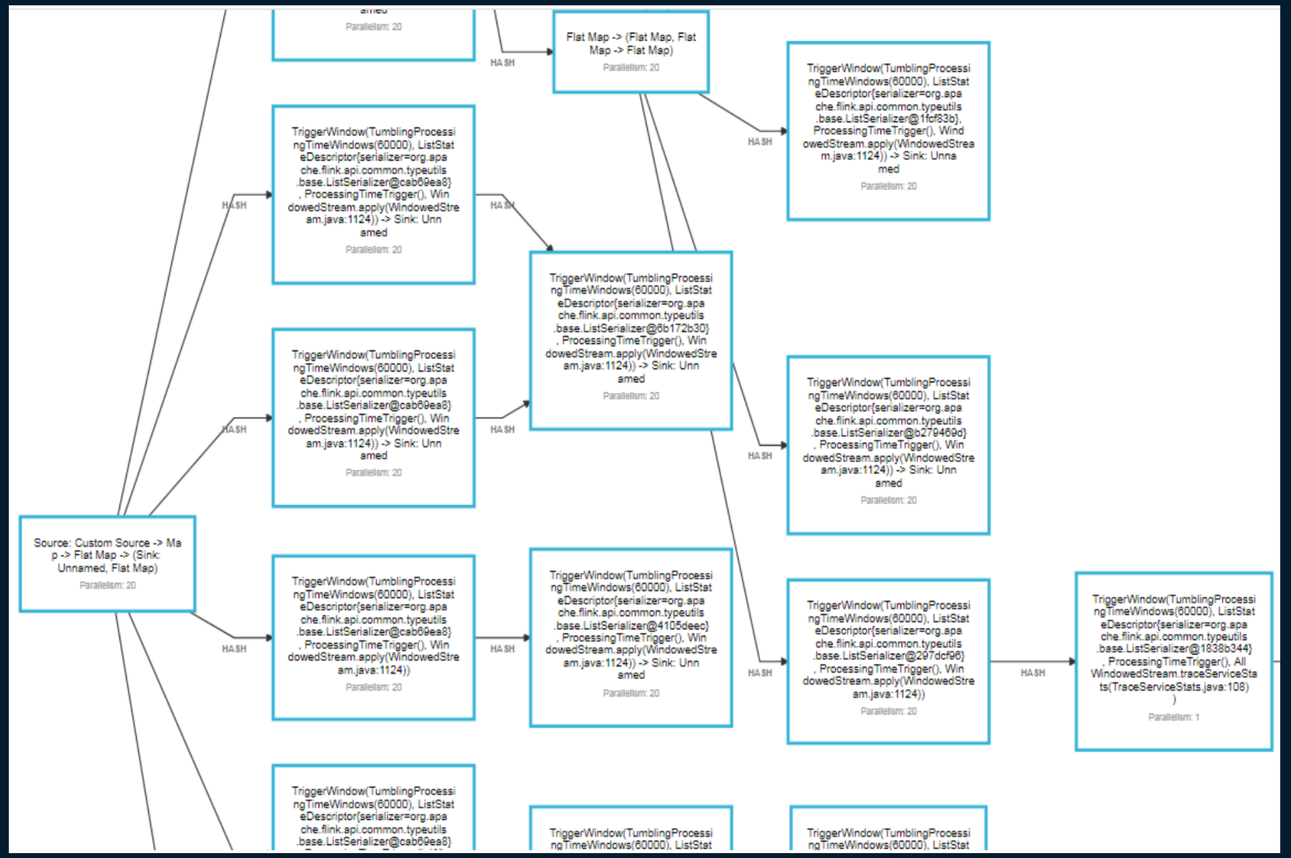
- Level 1: build tracing topology of apps
- Level 2: calculate average call duration aggregated by different windows

多窗口聚合:

- 第一级：构建App调用拓扑
- 第二级：按窗口计算平均耗时统计

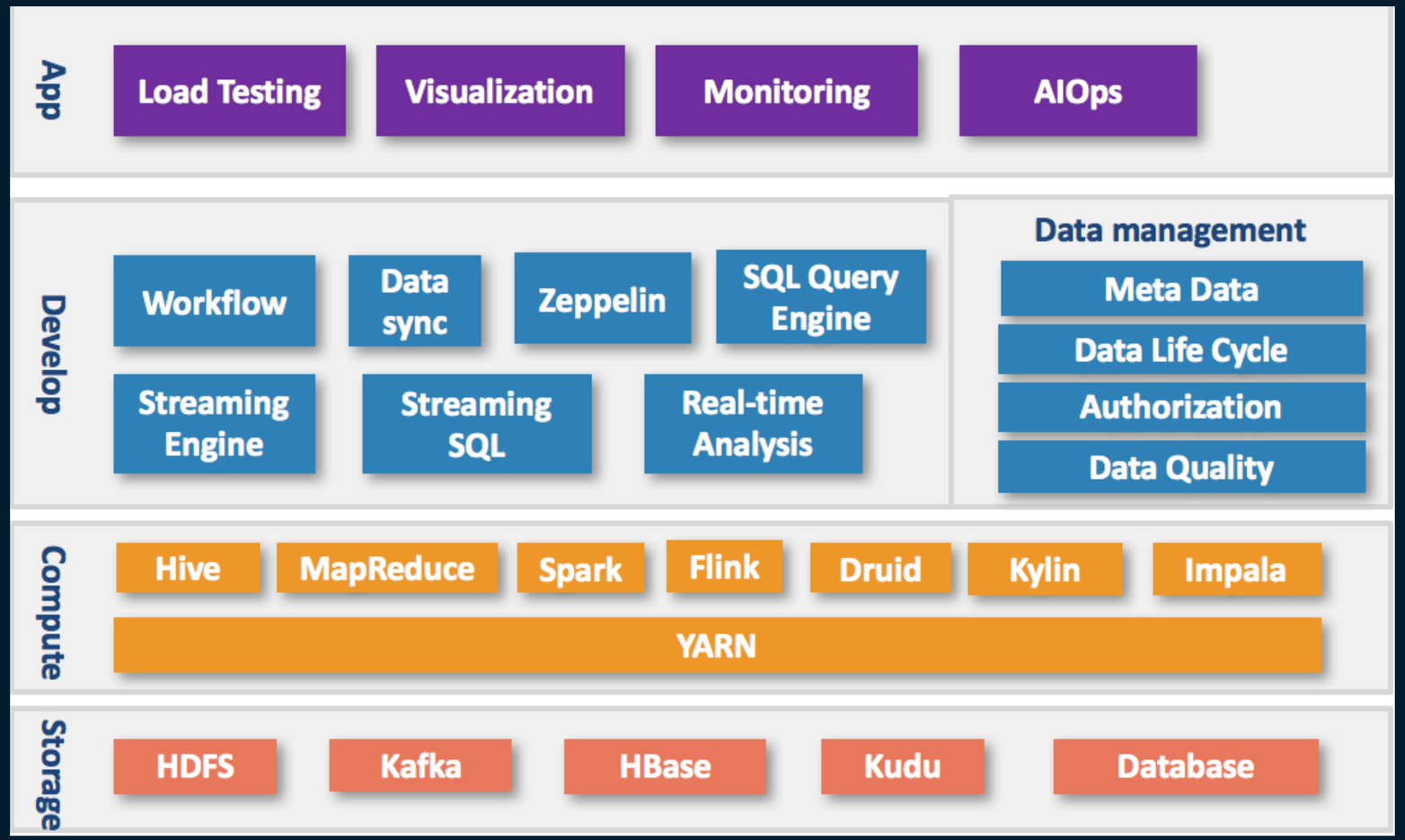
Distributed system tracing

Multiple window triggers 多窗口触发



Platform built for Flink

Overview 概览



Scale

- YARN MapReduce/Spark/Flink

  30+ clusters，6000+ machines

- Streaming Apps：

  Spark Streaming：2000+

  Flink：300+

- YARN MapReduce/Spark/Flink

  30+集群数，6000+机器

- 流任务：

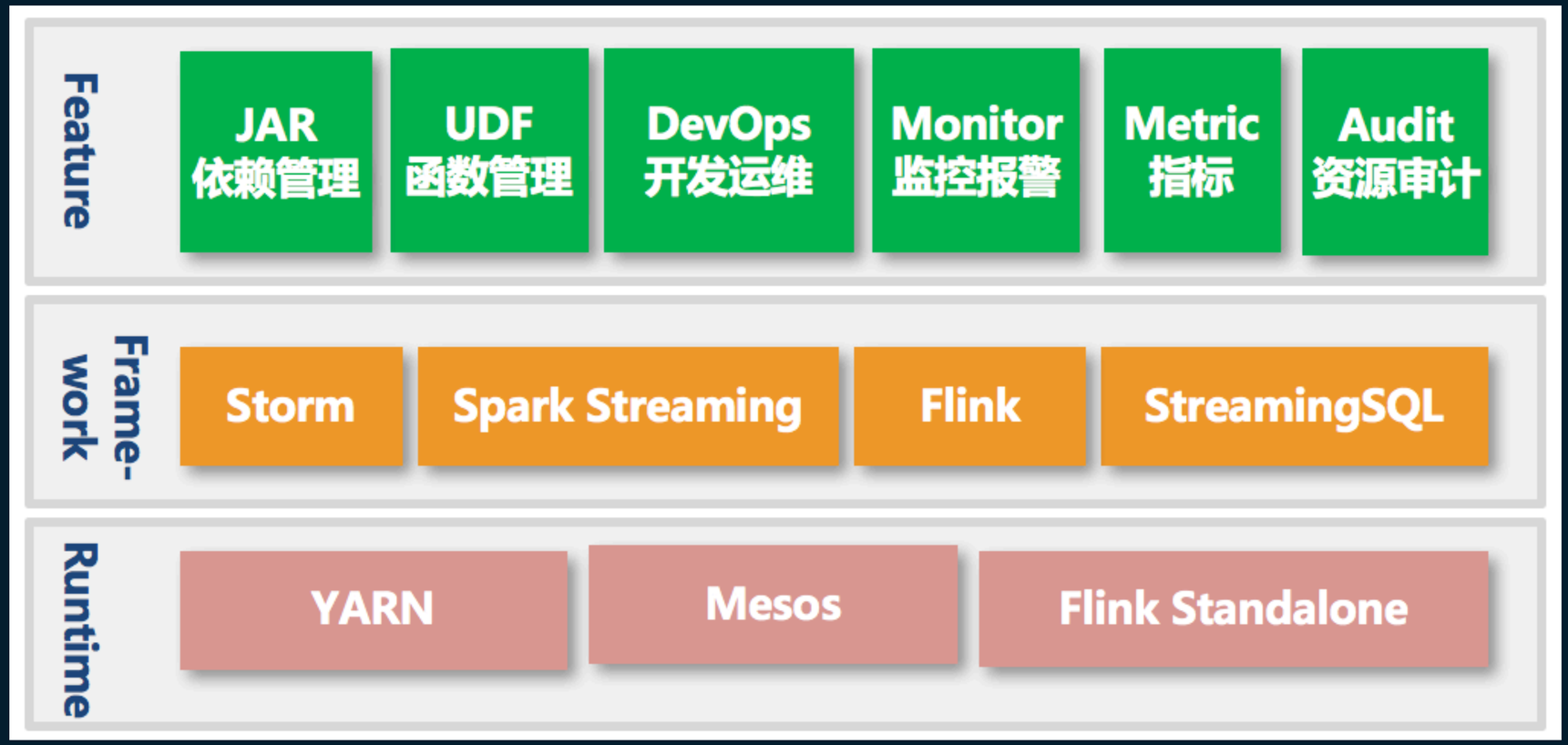
  Spark Streaming：2000+

  Flink：300+

Streaming Platform

FLINK FORWARD

Overview 概览

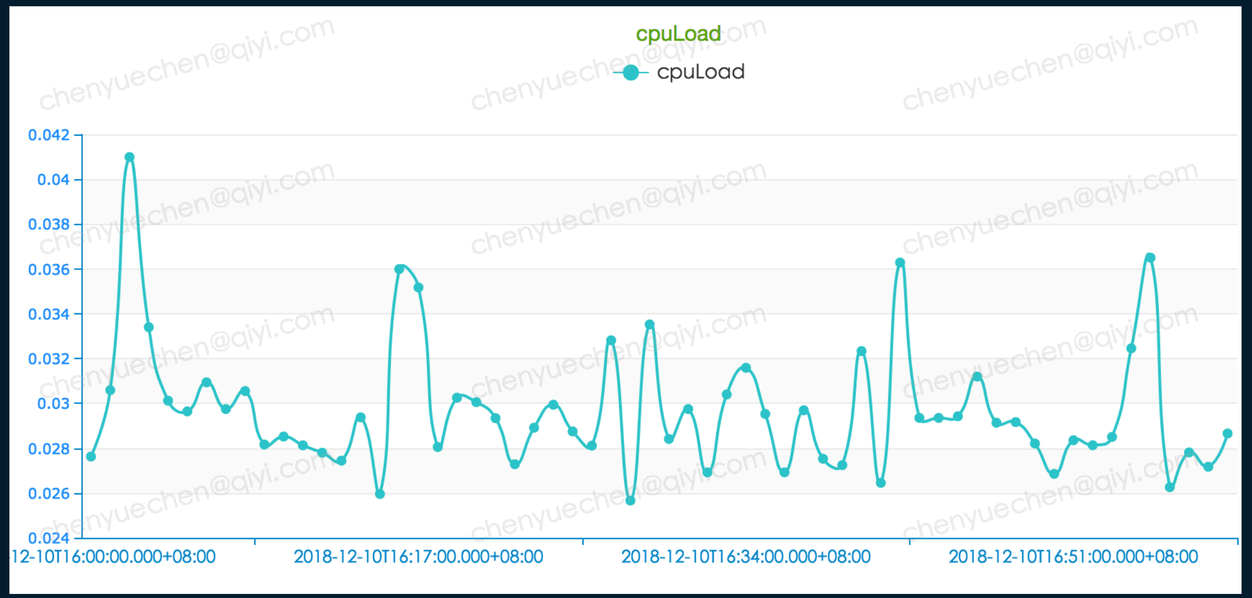


Streaming Platform

Streaming IDE 流任务IDE

Streaming Platform

Monitoring 指标监控



StreamingSQL

Define DDL & DML

- Streaming Table： MQ Access, Decoding
- Dimension Table：Static Table joining with streaming table
- Temporary Table：Intermediate Result
- Result Table：Output
- UDF

Data Sink：Kafka, MySQL, Kudu, ES, Druid, HBase

DDL & DML 定义

- 流表：定义MQ访问方式，解码方式
- 维度表：定义静态表，用于与流表Join
- 临时表：定义中间结果
- 结果表：定义输出数据源信息
- 用户自定义函数

输出源支持：Kafka, MySQL, Kudu, ES, Druid, HBase

StreamingSQL

FLINK FORWARD

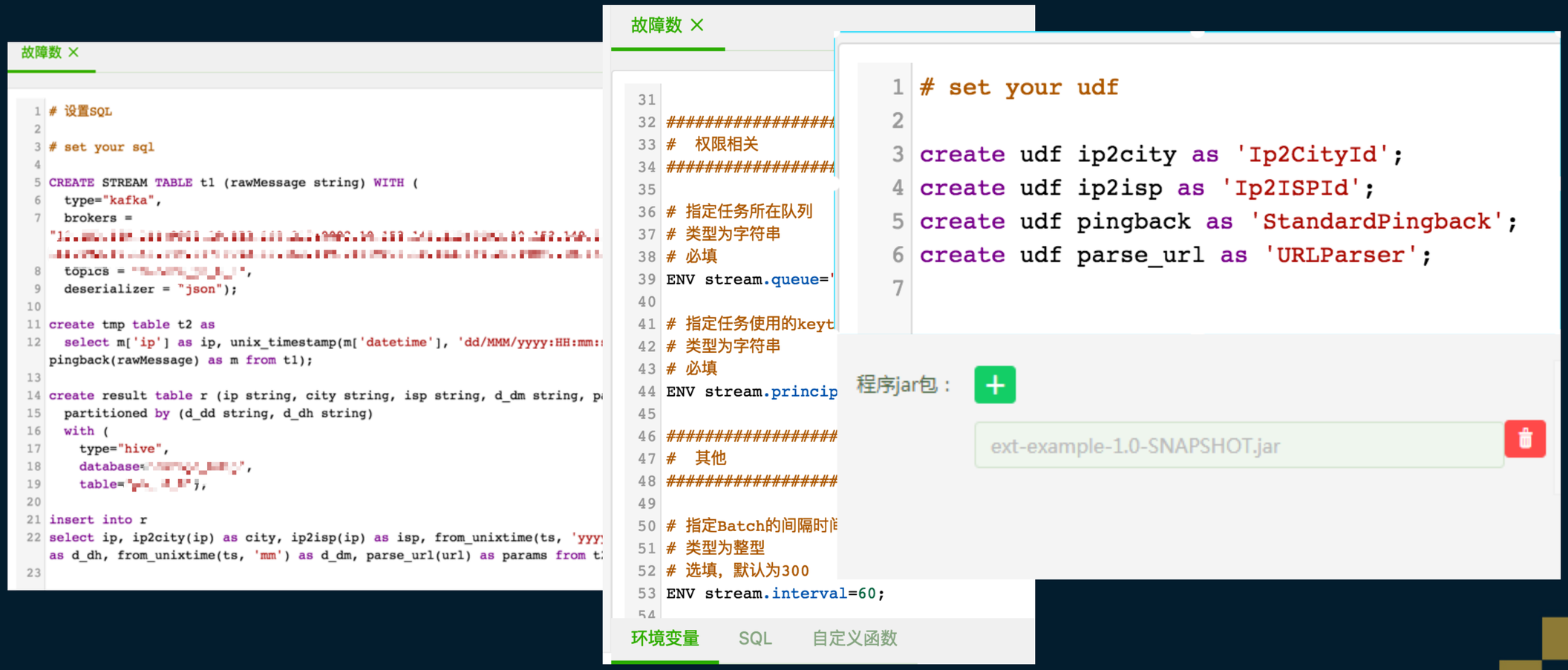
Case 示例

```
CREATE STREAM TABLE t1
(`timestamp` long) WITH (
  type="kafka",
  brokers = "xxxxxxxxxx",
  topics = "xxxxxxxx",
  deserializer = "json");

CREATE TMP TABLE t2 AS
SELECT floor(`timestamp` / 1000) AS
`timestamp` FROM t1;
```

```
CREATE RESULT TABLE r (`timestamp`
timestamp, min_time timestamp, p99
timestamp,
  p50 timestamp, avg_time timestamp,
max_time timestamp) WITH
(type="console");

INSERT INTO r
SELECT
  current_timestamp() AS `timestamp`,
  min(`timestamp`) AS min_time,
  percentile(`timestamp`, 0.01) AS p99,
  percentile(`timestamp`, 0.5) AS p50,
  avg(`timestamp`) AS avg_time,
  max(`timestamp`) AS max_time
FROM t2;
```

StreamingSQL

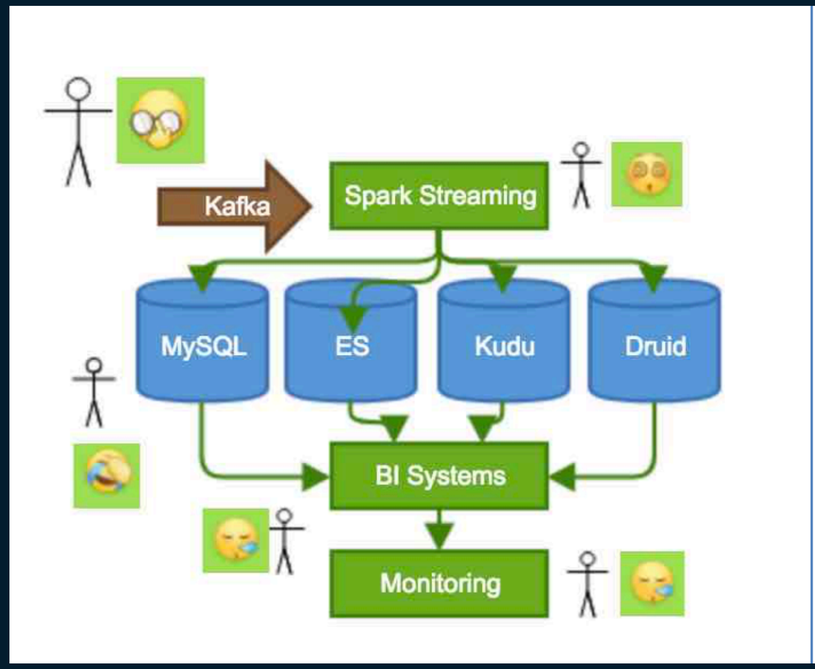
Web IDE

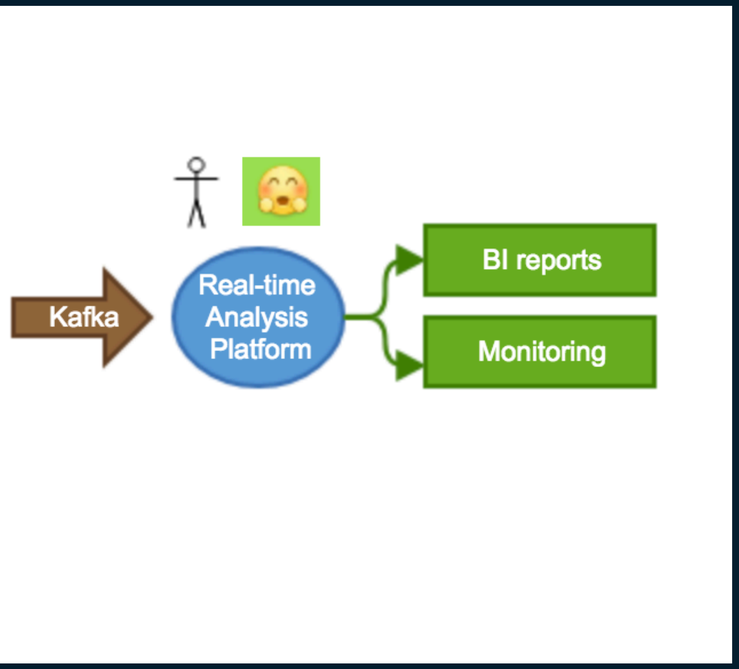


Real-time Analysis Platform

- User-guided configuration
- Compute & Storage invisibility
- Low latency
- Sub-second query response time

- 全向导配置
- 计算存储透明
- 低延时
- 亚秒级查询

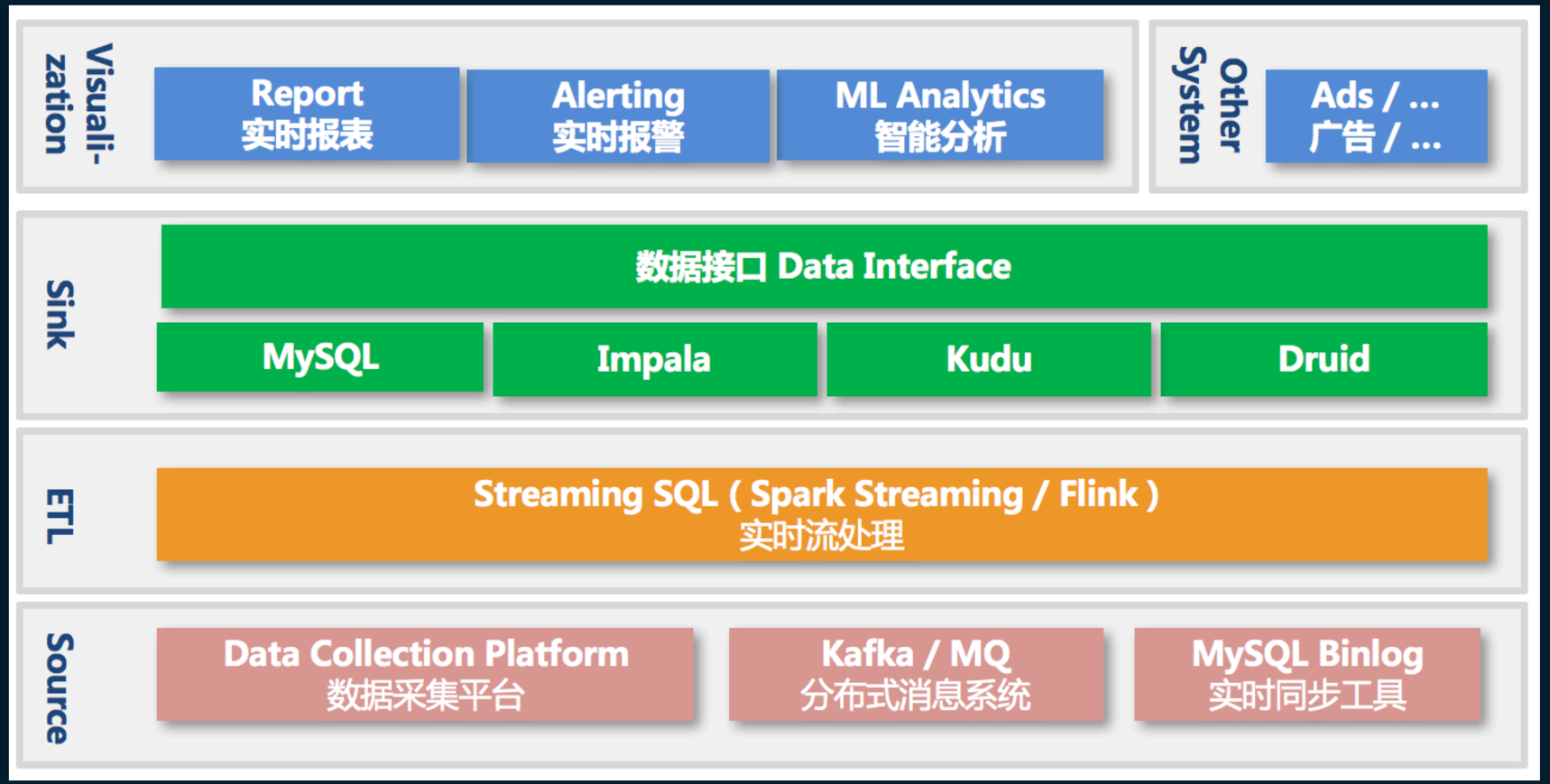




Real-time Analysis Platform

FLINK FORWARD

Architecture 架构

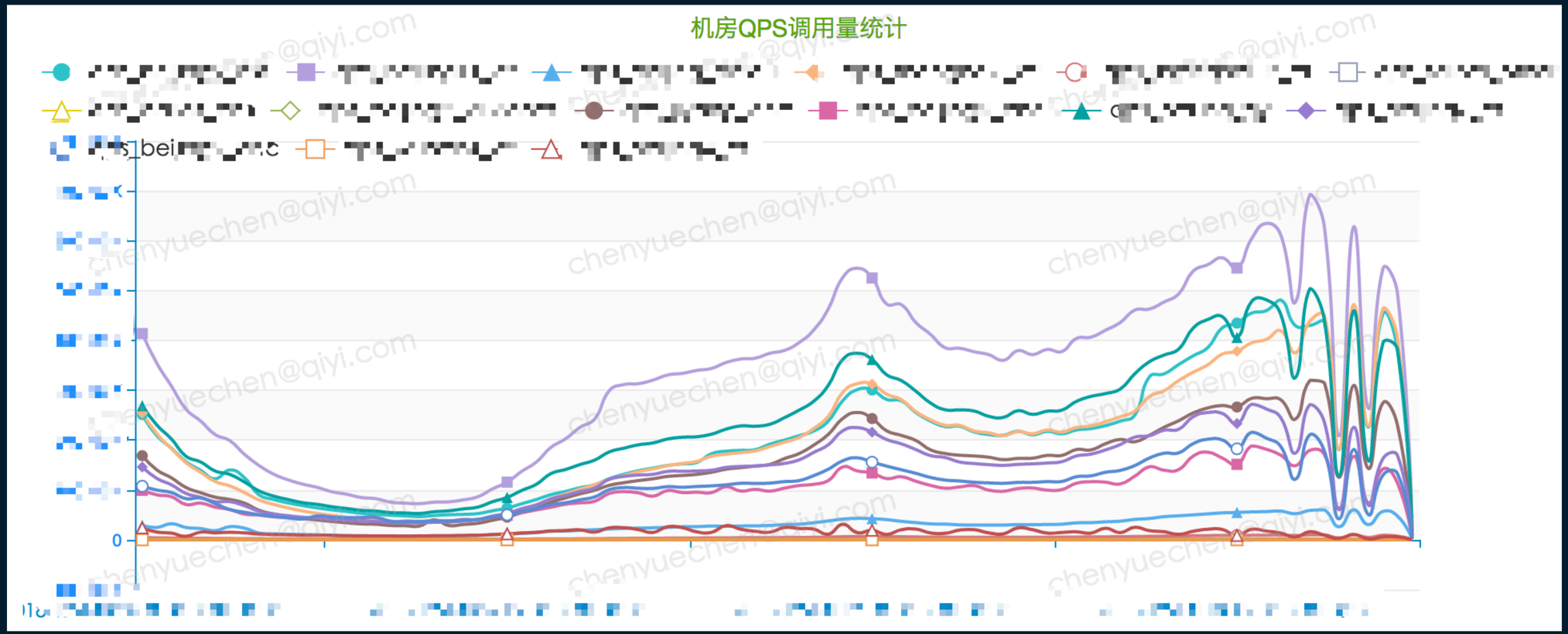


Real-time Analysis Platform

User-guided configuration 用户向导配置

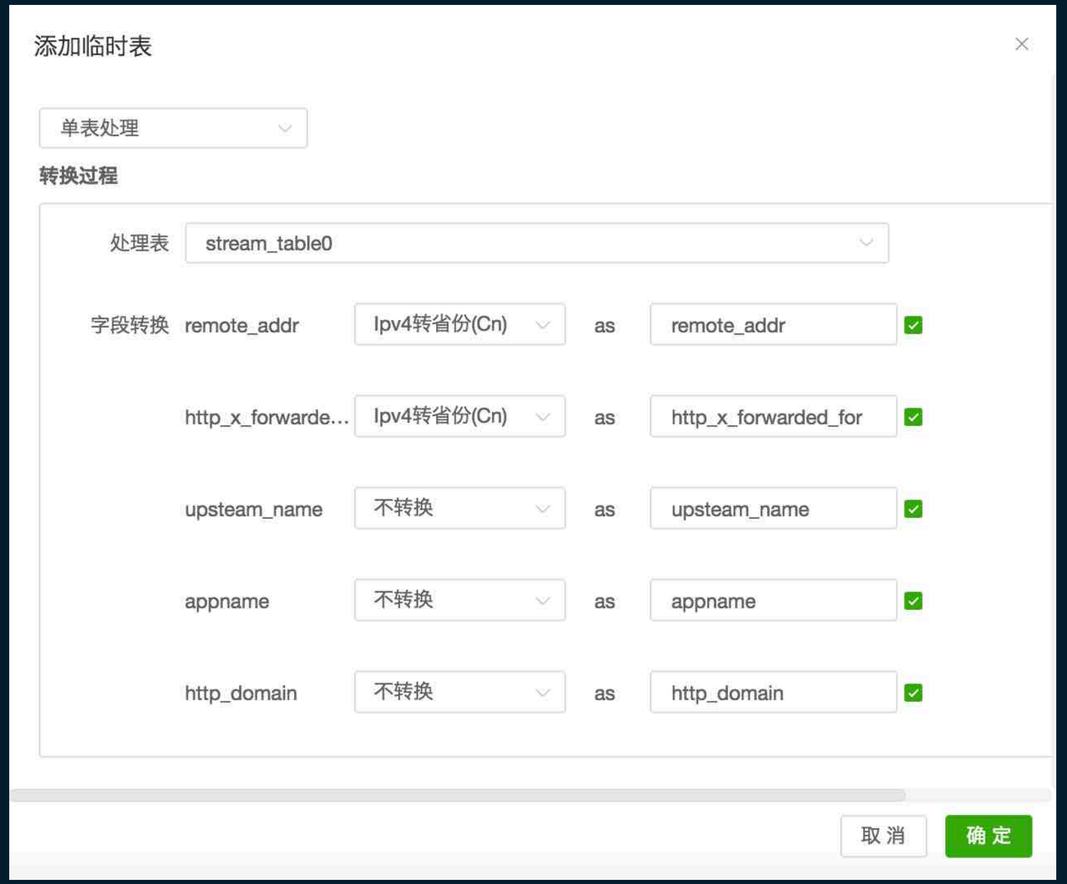
Real-time Analysis Platform

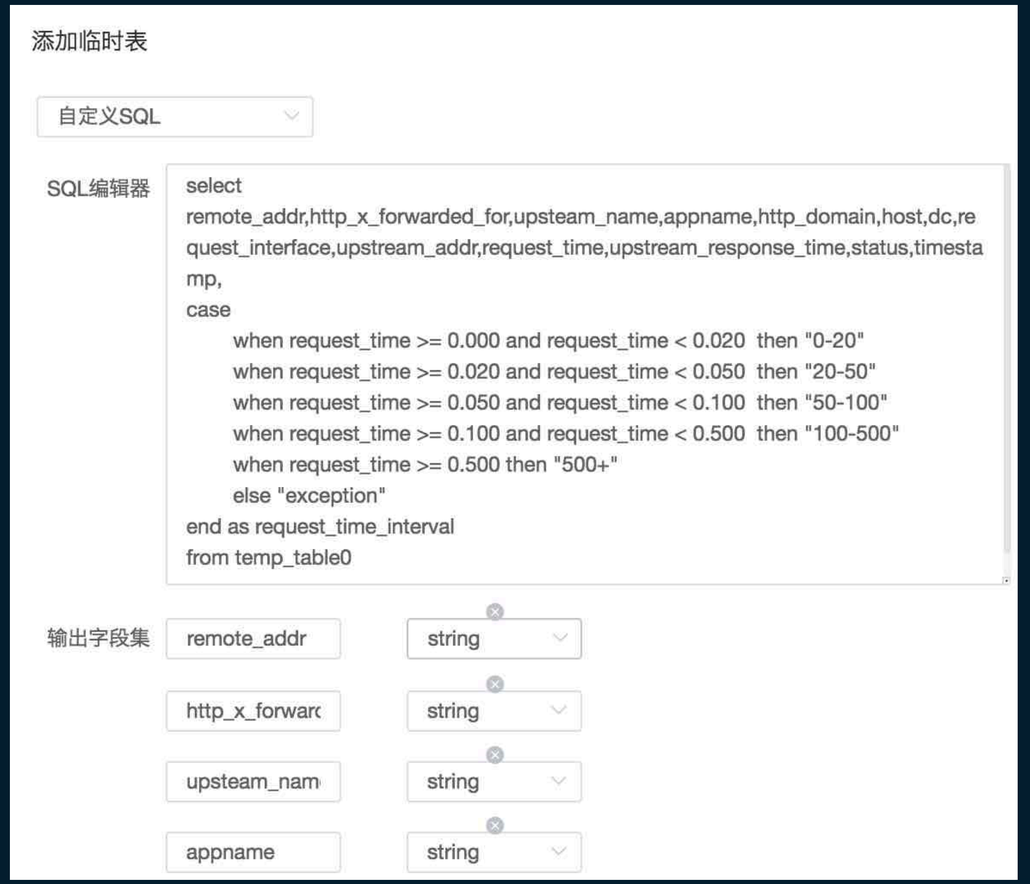
Reports 报表



Real-time Analysis Platform

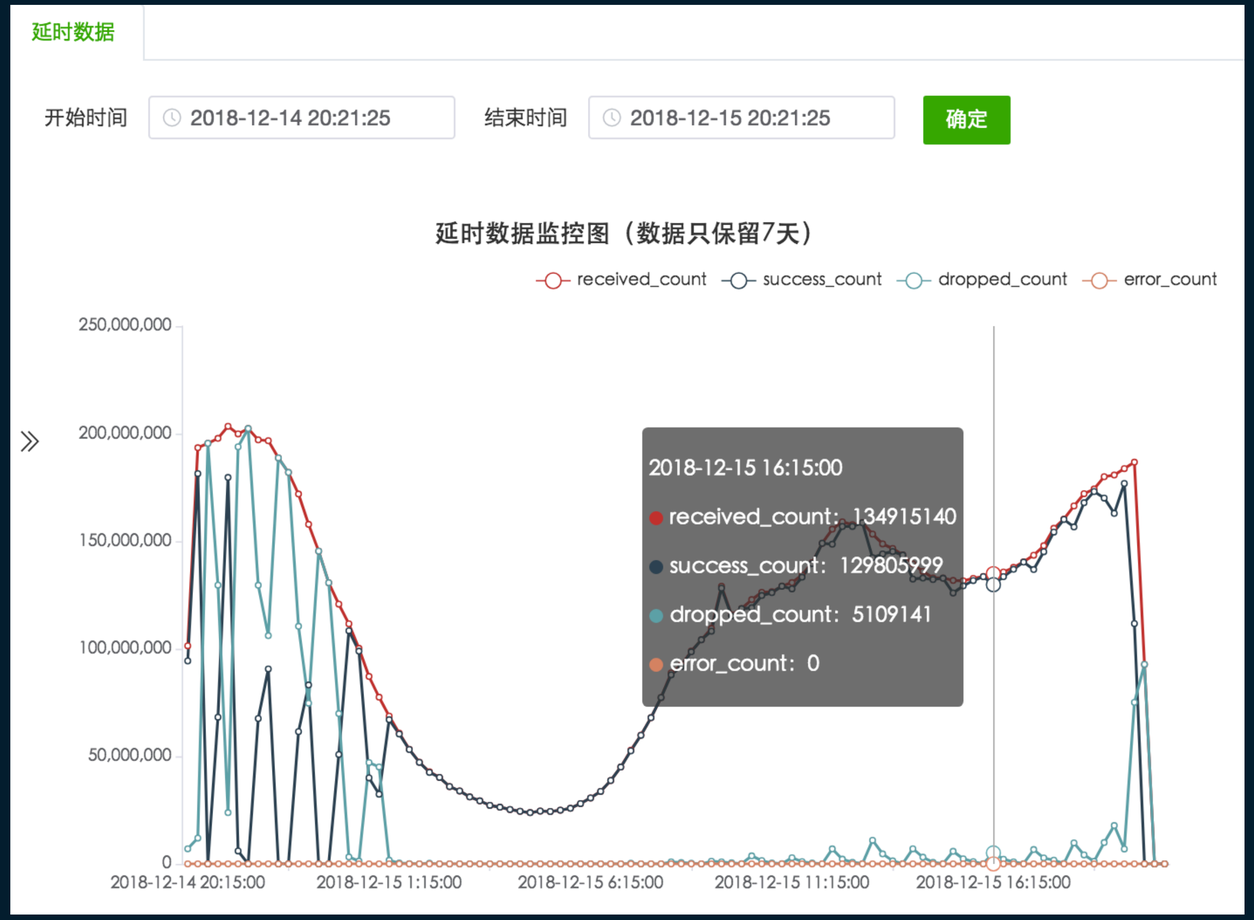
Data processing 数据处理配置





Real-time Analysis Platform

Data quality monitor 数据质量监控



Improvements on Flink

Improvement - Resuming from latest checkpoint gracefully
改进 – 优雅恢复checkpoint

Problem（问题）：

- Savepoint path required for resuming the job from externalized checkpoints

  从checkpoint恢复需指定savepoint路径，无法通过用户代码控制

- Command：flink run -s :savepointPath [:runArgs]

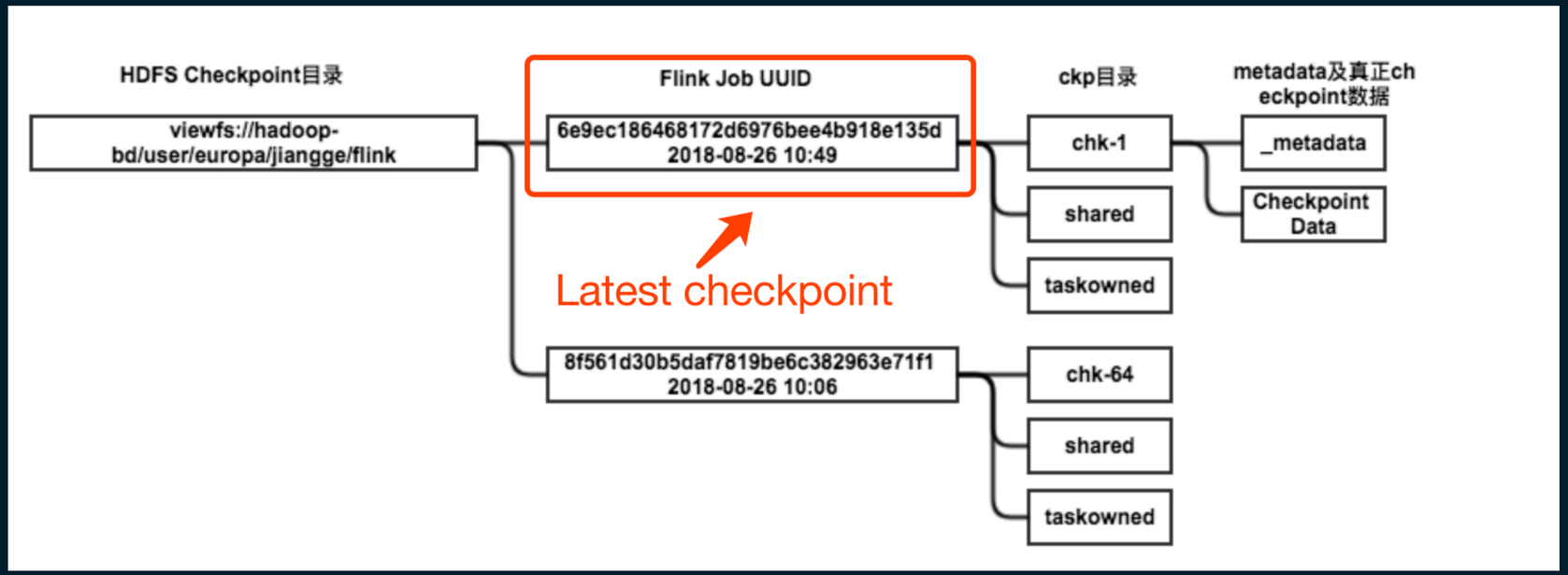
Spark Streaming: Resuming from codes

```
  val ssc = StreamingContext.getOrCreate(checkpointDirectory, () => {
    createStreamingContext(checkpointDirectory, uri, user, password, subject, seconds)
  })

  ssc.start()
  ssc.awaitTermination()
}

def createStreamingContext(checkpointDirectory: String, uri: String, user: String, password: String, subject: String,
                           seconds: Int) : StreamingContext = {
  val sparkConf = new SparkConf()
  sparkConf.setAppName("AmqReader")
  sparkConf.setIfMissing("spark.streaming.receiver.maxRate", "100")
  sparkConf.setIfMissing("spark.master", "local[4]")

  // 如果需要保证数据不丢，必须在设置Checkpoint的同时设置WAL
  sparkConf.setIfMissing("spark.streaming.receiver.writeAheadLog.enable", "true")
```

Improvements on Flink

Improvement - Resuming from latest checkpoint gracefully
改进 – 优雅恢复checkpoint

Command：flink run –s [:runArgs]



Improvements on Flink

Improvement – Kafka Broker HA
改进 - Kafka Broker HA

Problem 问题：

Job failed when one Kafka broker shutdown

一台Kafka Broker宕机后任务会失败

Improvement 改进：

- Handle socketTimeOutException
- Make retry times configurable

处理socketTimeOutException, 支持重试次数配置

```
try {
     fetchResponse = consumer.fetch(fetchRequest);
    }
    catch (Throwable cce) {
     //noinspection ConstantConditions
     if (cce instanceof ClosedChannelException) {
      LOG.warn("Fetch failed because of ClosedChannelException.");
      LOG.debug("Full exception", cce);

      // we don't know if the broker is overloaded or unavailable.
      // retry a few times, then return ALL partitions for new leader
      if (++reconnects >= reconnectLimit) {
       LOG.warn("Unable to reach broker after {} retries. Returning al
       for (KafkaTopicPartitionState<TopicAndPartition> fp: this.parti
        unassignedPartitions.add(fp);
       }
       this.partitions.clear();
       continue; // jump to top of loop: will close thread or subscrib
      }
      try {
       consumer.close();
      } catch (Throwable t) {
```

Future Work

- StreamingSQL on Flink
- Flink Resource Audit
- Exactly once on Flink 1.7 & Kafka 2.0
- Flink batch

- StreamingSQL集成Flink SQL
- Flink资源审计
- Flink 1.7 & Kafka 2.0上的Exactly once
- Flink 批处理模式


THANKS