Monitoring Electrical Power Consumption with Kieker

9th Symposium on Software Performance 2018

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Today’s Industrial Production Environments

Industrial Internet of Things
Monitoring Production Environments
Requirements for a Monitoring Infrastructure

- Server 1
- Printer 1
- Server 2
- Printer 2
- Fan 1

- Computing
- Printing
- Cooling

Monitoring, Integration, Analysis, Visualization
Architectural Requirements

**Horizontal Scalability**  for different-sized production environments and varying loads

**Real-Time Data Processing**  for immediate reactions and continuous evaluation

**Extendability & Flexibility**  for integration of different formats, protocols and metrics
Architecture

Visualization
- <<web browser>> Visualization Frontend
- <<web server>> Visualization Backend

<<microservice>> Record Bridge
- <<application>> Record Bridge Logic

<<microservice>> History
- <<application>> History Logic
- <<database>> Time Series Storage

<<microservice>> Configuration
- <<application>> Configuration Logic
- <<database>> Key-Value Store

<<messaging system>> Asynchronous Event Exchange
Implementation

Record Bridge

TeeTime

History

kafka Streams

cassandra

Configuration

redis

Visualization

NGINX
Defining Record Types

```java
package titan.ccp.models.records

entity ActivePowerRecord {
    string identifier
    long timestamp
    double valueInW // Watts
}
```
Transmitting & Storing Records

Existing Readers & Writers

kafka

Kieker

Cassandra
Hierarchical Model of Consumer for Aggregation

Factory

- Computing
  - Server 1
  - Server 2
  - Power Supply 1
  - Power Supply 2

- Printing
  - Printer 1

- Cooling
  - AC System
  - Fan 1
  - AC 1
  - AC 2
Continuous Aggregation with Kafka Streams

Kafka Topic
records

flatMap
by copying

groupByKey
for repartitioning to internal Kafka topic

aggregate
with history

map
to records

Kafka Topic
aggregated-records
Web-based Visualization
Pilot Deployment

medium-sized enterprise • part of the data center

16 servers • powered by 3 PDUs • over a period of 3 weeks
Conclusions
Infrastructure for monitoring, aggregation & visualization
Scalable & extendable architecture
Implementation of a prototype

Future Work
Further consumption, production & business metrics
Advanced analyses and visualizations
Correlate power consumption with performance
<table>
<thead>
<tr>
<th>Titan Control Center</th>
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<tbody>
<tr>
<td><strong>My Company</strong></td>
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<tr>
<td><strong>Computing Center</strong></td>
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<tr>
<td><strong>Server 1</strong></td>
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<td><strong>Server 2</strong></td>
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<td><strong>Server 3</strong></td>
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<td><strong>IBAK Server</strong></td>
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<tr>
<td><strong>Printing</strong></td>
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<tr>
<td><strong>Printer 1</strong></td>
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<tr>
<td><strong>Printer 2</strong></td>
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<tr>
<td><strong>Cooling</strong></td>
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<tr>
<td><strong>Main Fan</strong></td>
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</tbody>
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Continuous Aggregation Method
Continuous Aggregation with Kafka Streams

1. records
   - forEach
   - flatMap by copying
   - groupByKey
   - internal topic
   - aggregate with history
   - map to record
   - key-value store

2. aggregated-records
   - forEach
   - forEach
   - forEach

3. forEach
   - forEach
   - forEach
   - forEach
   - forEach