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C2MON

A highly scalable monitoring platform
for Big Data and IoT scenarios

Matthias Bräger & Brice Copy

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A lot of systems to control

Controls Computers

Electricity

Cryogenics

Magnets

85'000 Devices > 2 Million I/O Endpoints

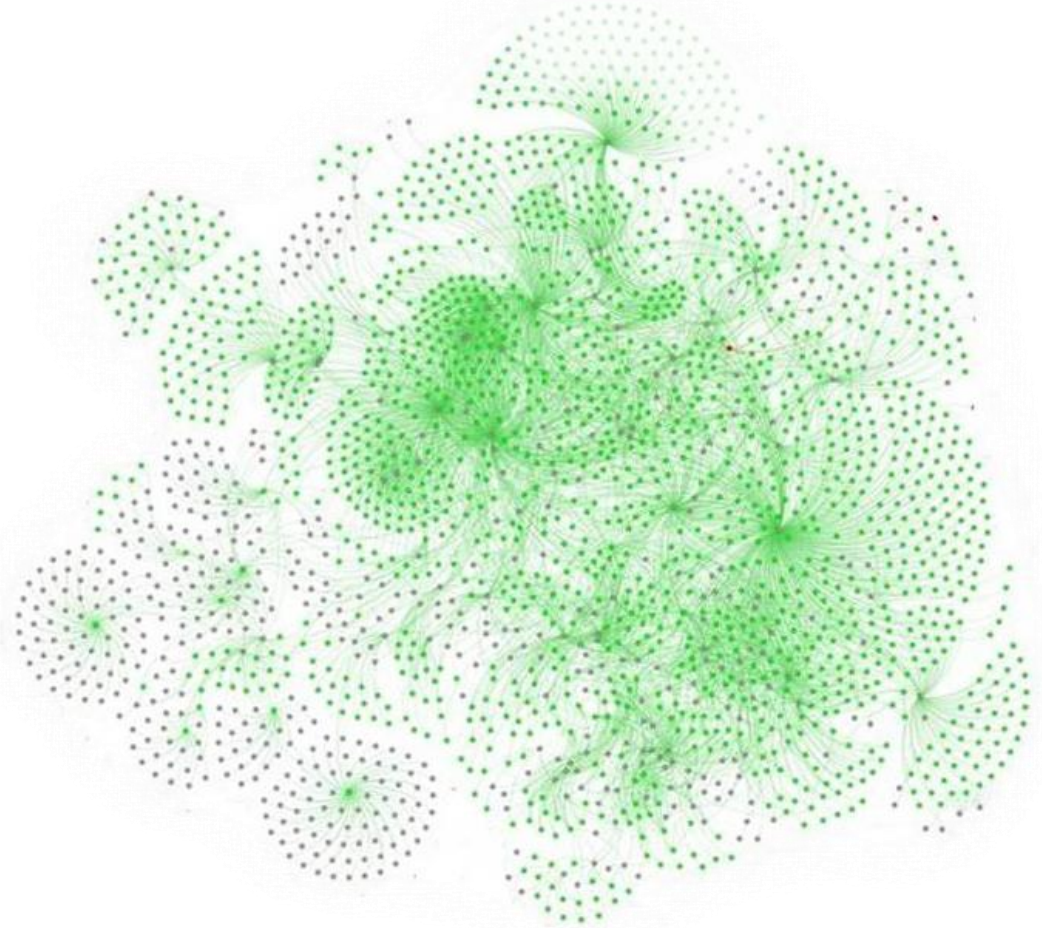*Much more* *when including subsystems!*

Safety

Cooling

Ventilation

Vacuum

Main systems controlled from one central point: The CERN Control Centre

A complex controls infrastructure...

- Each **dot** is a process
- Each **line** is a network connections

The configuration hell

- Many different types of data sources and protocols
- Complex data structure
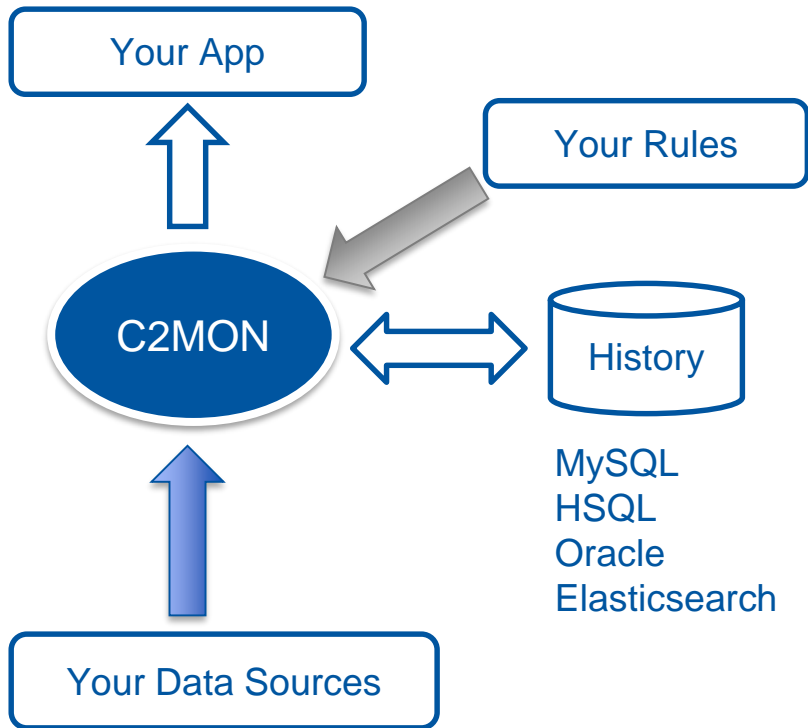- Different data rates
- Data lifecycle management

How to subscribe to my data?

C2MON – a best-of-breed open-source data architecture

C2MON – Features

Your App

Your Rules

C2MON

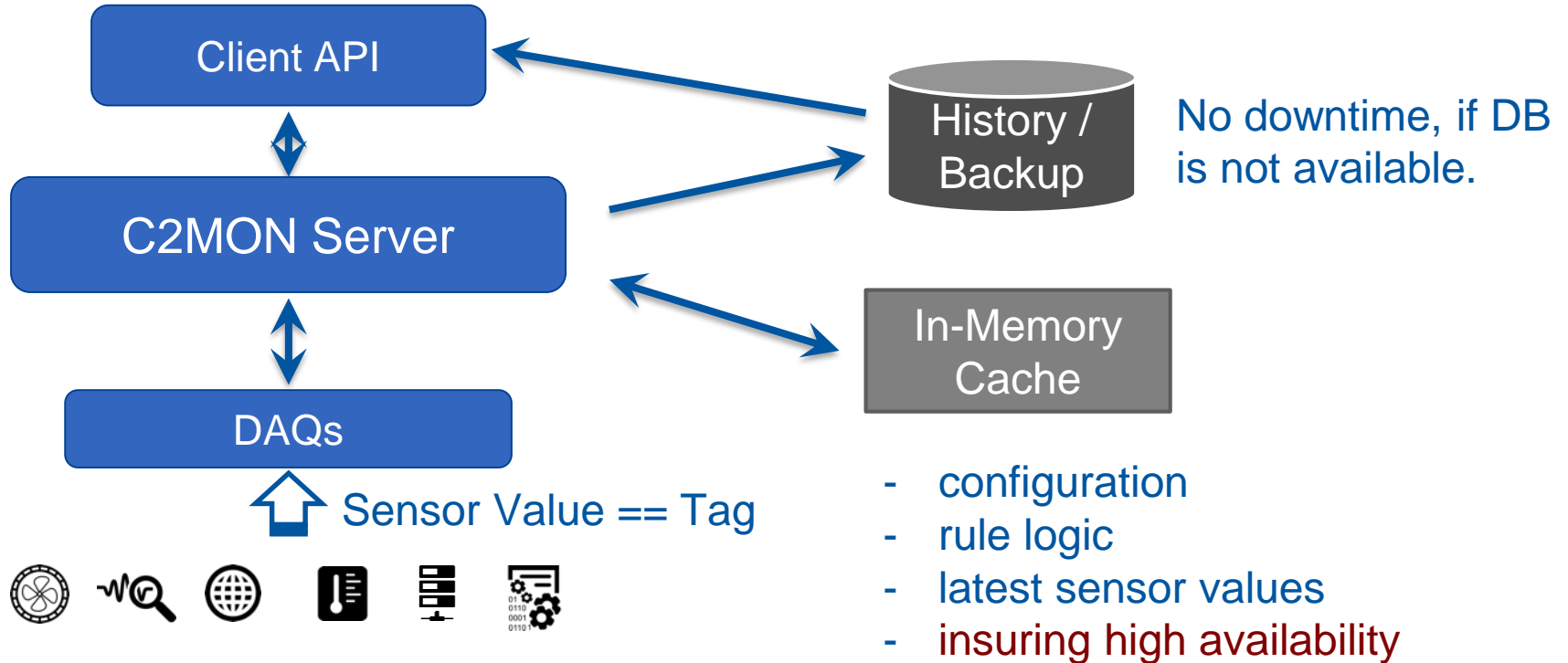History

MySQL
HSQL
Oracle
Elasticsearch

Your Data Sources

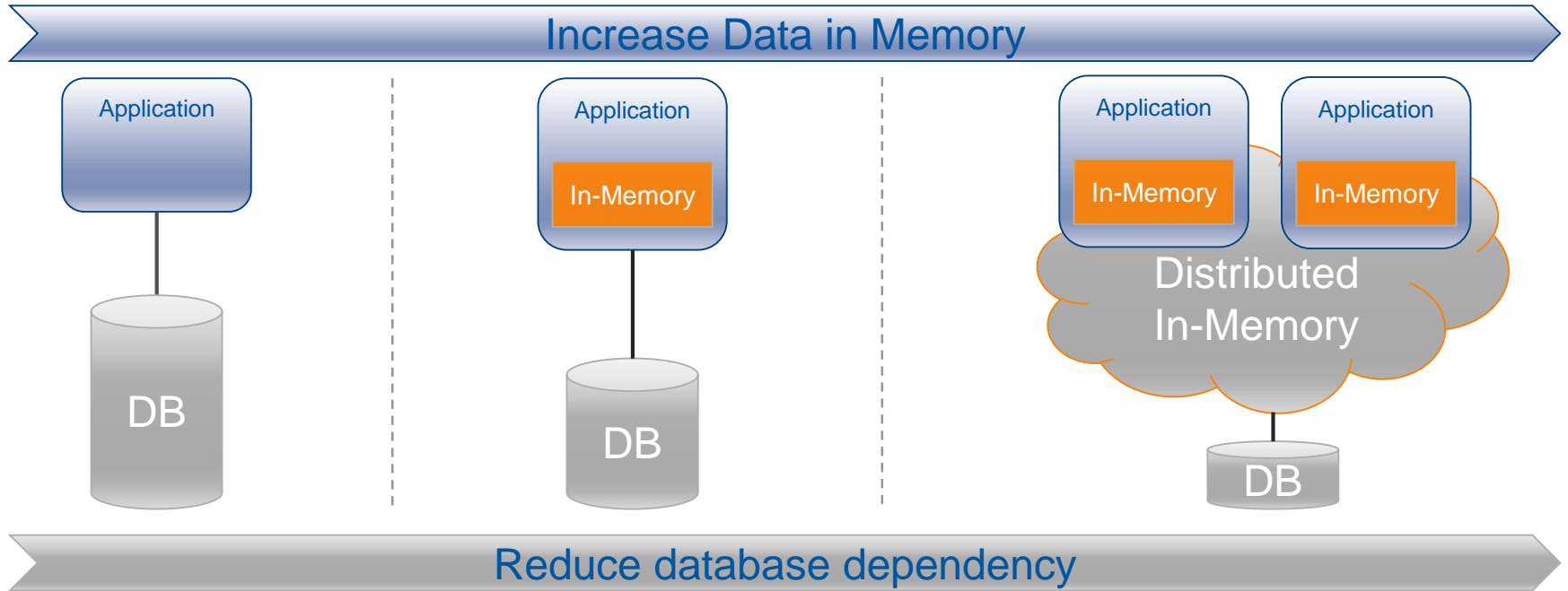C2MON handles the following aspects :
- Ensures the data keeps coming
- Add new data sources on the fly
- Regulates the information flow
- Caches latest values
- Makes sure no message gets lost

C2MON is open-source(LGPLv3) supported by CERN!
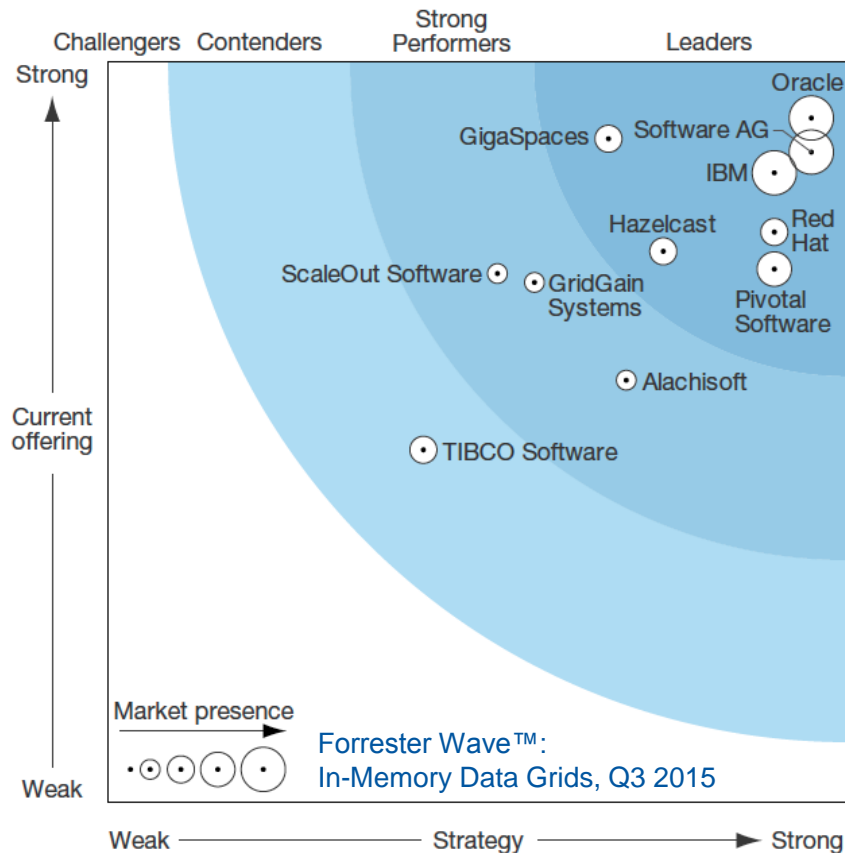
Transactional Architecture

Client API

C2MON Server

DAQs

Sensor Value == Tag

History / Backup

No downtime, if DB is not available.

In-Memory Cache

- configuration
- rule logic
- latest sensor values
- insuring high availability

In-Memory approach:
Scale with data and processing needs

Increase Data in Memory

Application

Application

In-Memory

Application

In-Memory

Application

In-Memory

Distributed
In-Memory

DB

DB

DB

Reduce database dependency

In-Memory Data Grid solutions

Forrester Wave™:
In-Memory Data Grids, Q3 2015

Basic configuration structure
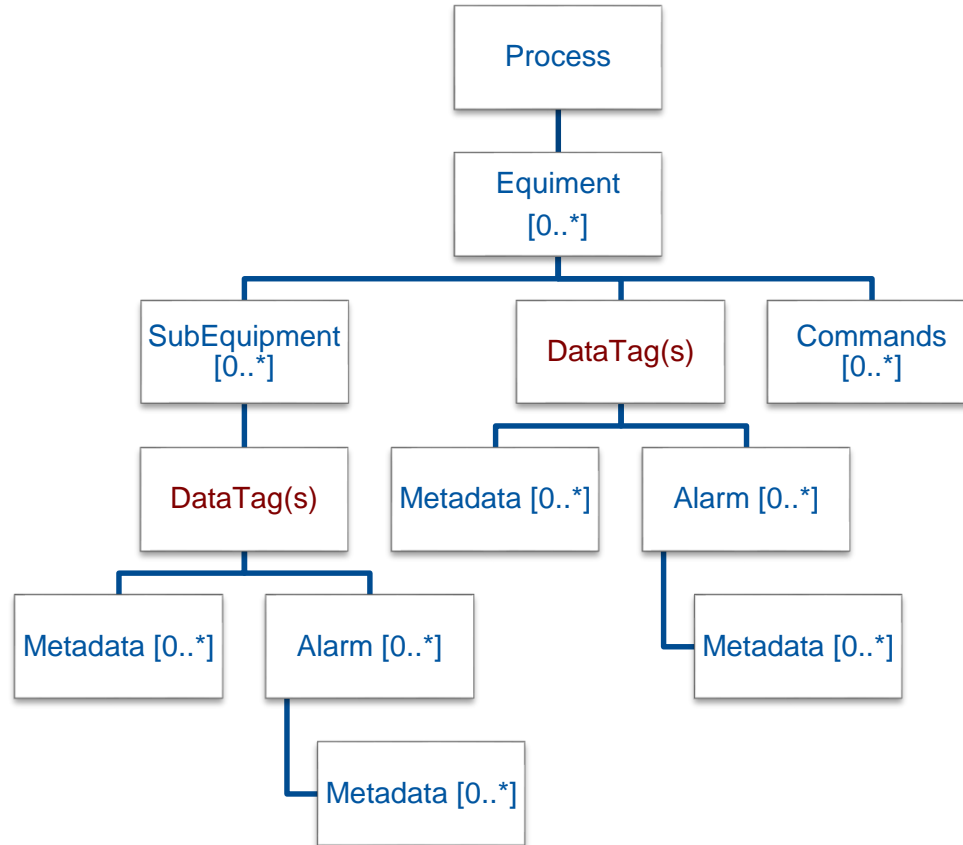
The Tag family

- Id
- **Name**
- Value
- Quality
- Timestamp

ControlTag

Tag

DataTag

RuleTag
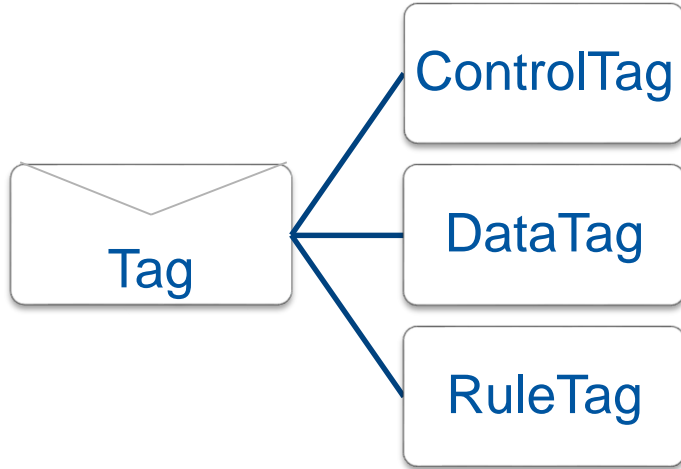
- Internally used for Process and Equipment surveillance

- Used for data acquisition *

- (#123 + #234) > 2 [ERROR], true [OK]

* Support of primitive arrays and arbitrary Objects

Acquisition layer

DAQ Process takes care of:

- Equipment/Service monitoring
- Data acquisition for configured Tags
- Raw data validation & filtering
- Sending data to server tier
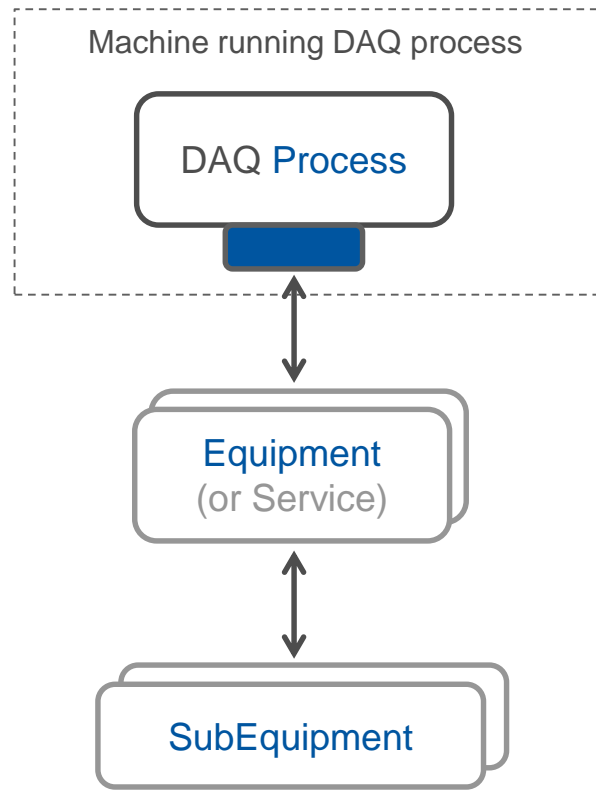
Raw data validation & filtering on DAQ layer

Dynamic Filtering
- Dynamic Time dead-band filtering for Protecting against data bursts

Static Filtering
- Static time dead-band filtering
- Value redundancy
- Value dead-band filtering

Data Validation
- Value in defined range?
- Correct value data type?
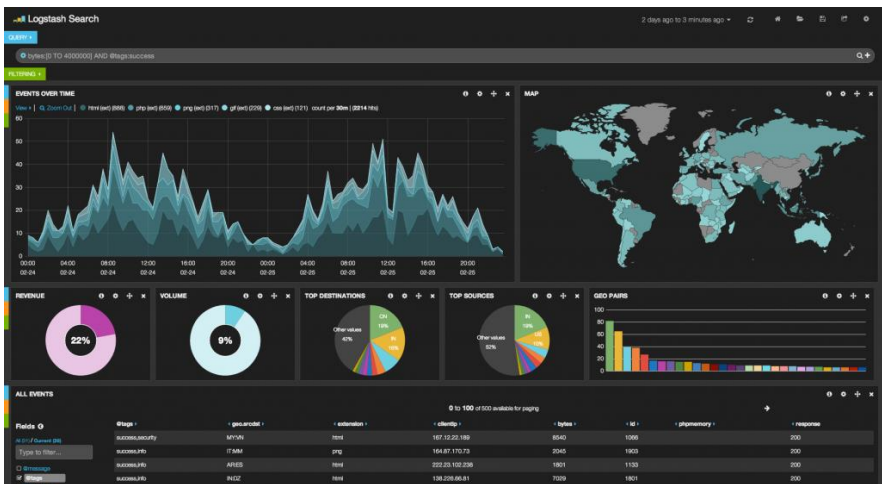- Source timestamp in the future?
- Outdated information?

Configurable by Tag

myMod

C2MON Server — Business

DAQ API — Acquisition Filtering Validation

myDAQ
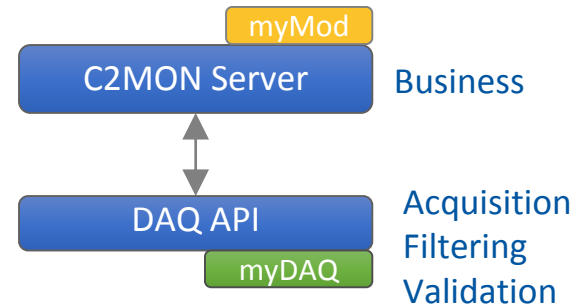
Using ![elasticsearch logo] as timeseries data storage

elasticsearch

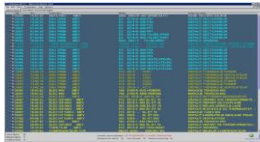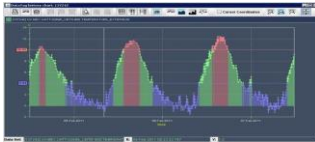← **C2MON** →

kibana

Grafana

C2MON at CERN

▪ CERN uses C2MON since January 2012 as backbone for the **Technical Infrastructure Monitoring (TIM)** service :

- Electrical Network alarm monitoring

- Technical Infrastructure surveillance (fire alarms, access doors …)

- Computing Center cooling and ventilation monitoring

- Radiation zones monitoring

TIM Service

Client Tier

Alarm Console   Data Analysis   TIM Viewer   Web Apps

> 91k data sensors
> 60k alarms

TIM Server
C2MON

> 1200 commands
> 1300 rules

Data Acquisition & Filtering
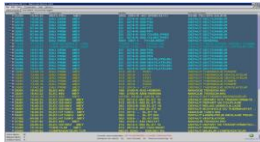

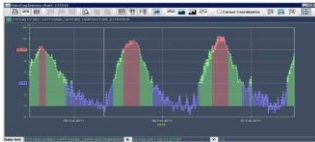Cooling   Safety Systems   Electricity   Access   Network and Hardware Controls   Cryogenics

TIM Service

Client Tier

Alarm Console **Data Analysis** **TIM Viewer** **Web Apps**

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> 60k alarms

TIM Server
C2MON

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Data Acquisition & Filtering

~ 400 million raw values per day → Filtering → **~3 million updates**

Real-world C2MON use cases

▪Geneva-based **Securaxis** is researching road traffic monitoring.

▪ **Bologna University students** implemented a Fruit and Vegetable RFID-based tracking system for one of the top 3 Italian grocer logistics company.

▪**Tanzanian students** implemented a medical field-device for data collection using C2MON as a data back-end.
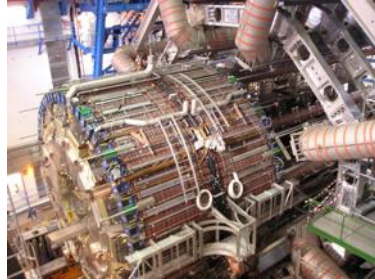
Questions?
Thank you for your attention!