HORIZON 2020

The EU Framework Programme for Research and Innovation

PRESTOCLOUD

„Proactive Cloud Resources Management at the Edge for efficient Real-time Big Data Processing“

Harald Schöning

June 28, 2017

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SOFTWARE AG
…TO STAND OUT IN THE DIGITAL WORLD

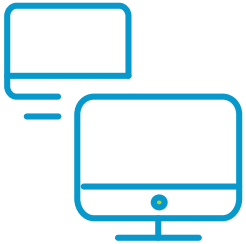
More than

70%

of the

GLOBAL 1000

companies are customers of Software AG



2+

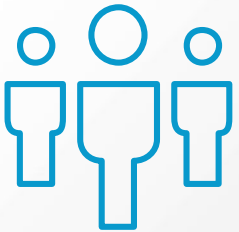
MILLION

Developers

2.5+

MILLION

Users



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The Digital Business Platform
CAPABILITIES

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DBP | A&N

DIGITAL BUSINESS PLATFORM

BUSINESS & IT TRANSFORMATION

- Business Strategy and Planning
- Collaboration
- Design and Analysis
- Risk and Compliance Management
- Audit Management
- Portfolio Management
- Enterprise Architecture

ANALYTICS & DECISIONS	Business Dashboards Process Discovery Process Monitoring	Pattern Detection Visual Analytics Predictive Analytics	Event Processing
PROCESS	Process Automation Application Development Case Management	Mobile Enablement Task Management Rules Management	Process Orchestration
INTEGRATION	Application Integration B2B Integration Master Data Management	Cloud Service Integration IoT Integration Mobile Integration	Services Governance API Gateway API Portal
IN-MEMORY DATA	In-Memory Data Management Universal Messaging	Search & Compute Continuous Query	

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WHAT IS SOFTWARE AG'S *BIG DATA STREAMING ANALYTICS PLATFORM*?

FORRESTER®

"Software that can filter, aggregate, enrich and analyze a high throughput of data from multiple disparate live data sources and in any data format to identify simple and complex patterns to visualize business in real-time, detect urgent situations, and automate immediate actions."

Forrester Research, July 2014

Software AG Big Data Streaming Analytics

… is more than just Apama CEP

… it is a software platform that combines Apama, Universal Messaging, Terracotta BigMemory & Presto and it integrates with the webMethods Suite and AgileApps

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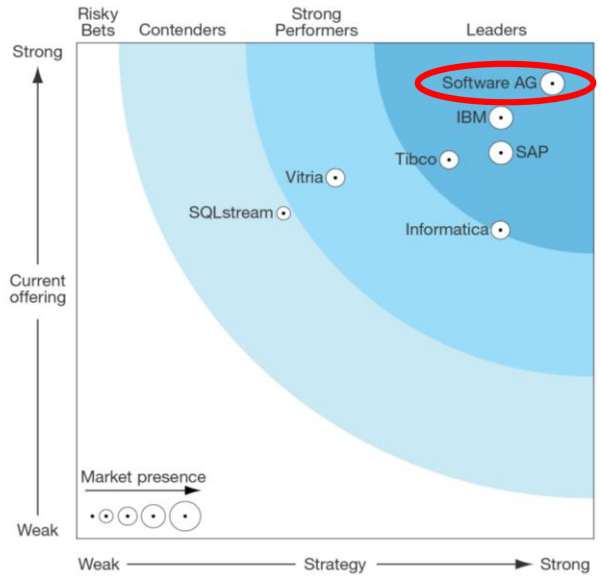
HIGHLY RECOGNIZED
THE Platform for Big Data Streaming Analytics



Source: The Forrester Wave™: Big Data Streaming Analytics Platforms, Q3 2014, Forrester Research, Inc., July 17, 2014

Sell-Side Technology waterstechnology Awards 2014

Best Sell-Side Complex-Event Processing (CEP) Technology
Winner
Software AG (Apama)

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SOFTWARE AG AND IOT

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DÜRR

STRATEGISCHE
IOT-PARTNERS

Software AG Acquires Cumulocity Extending its Internet of Things Technology Leadership

Cumulocity
Connect to Innovate

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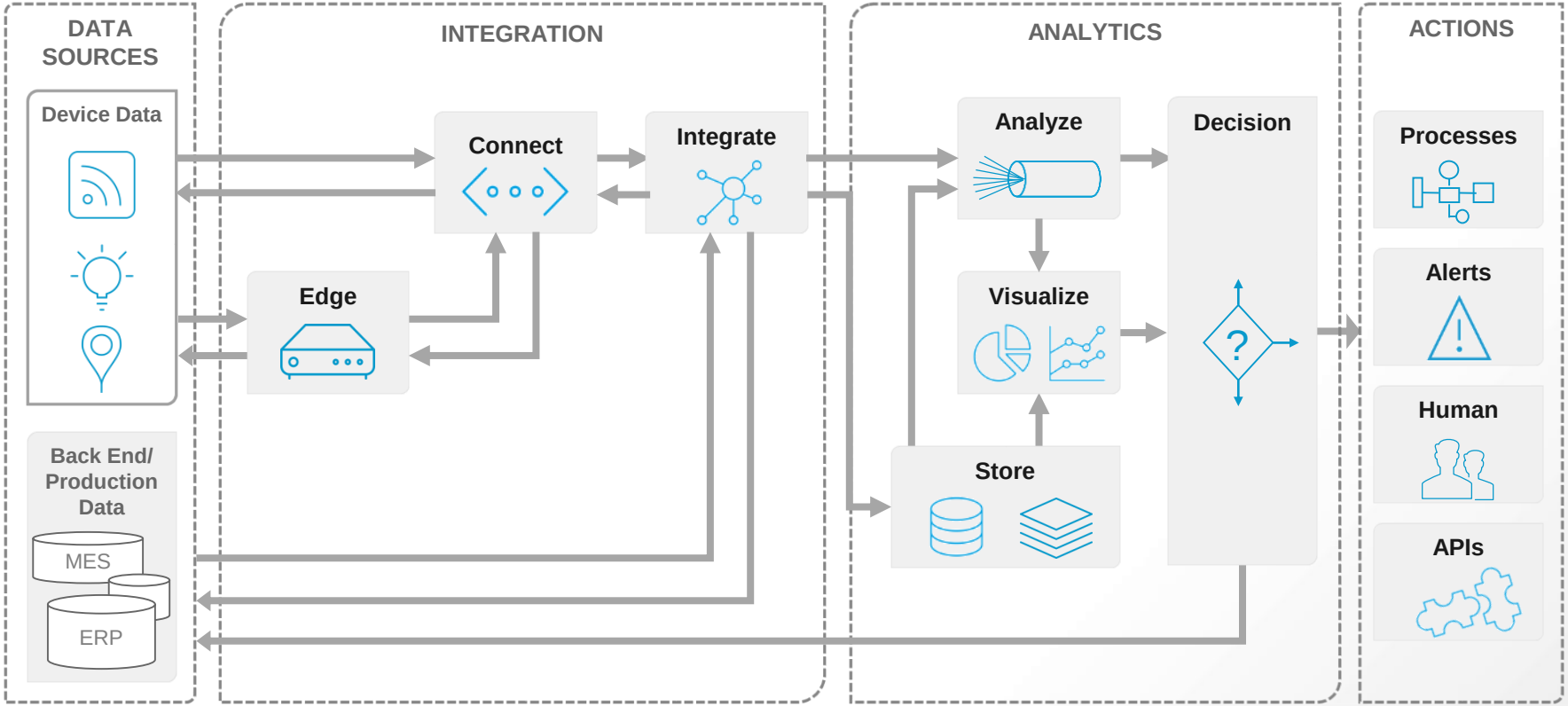
STRATEGIC
INNOVATION PARTNERSHIP

SOFTWARE AG & DATA ANALYTICS
HIGH-LEVEL IOT DATA FLOW CONCEPT



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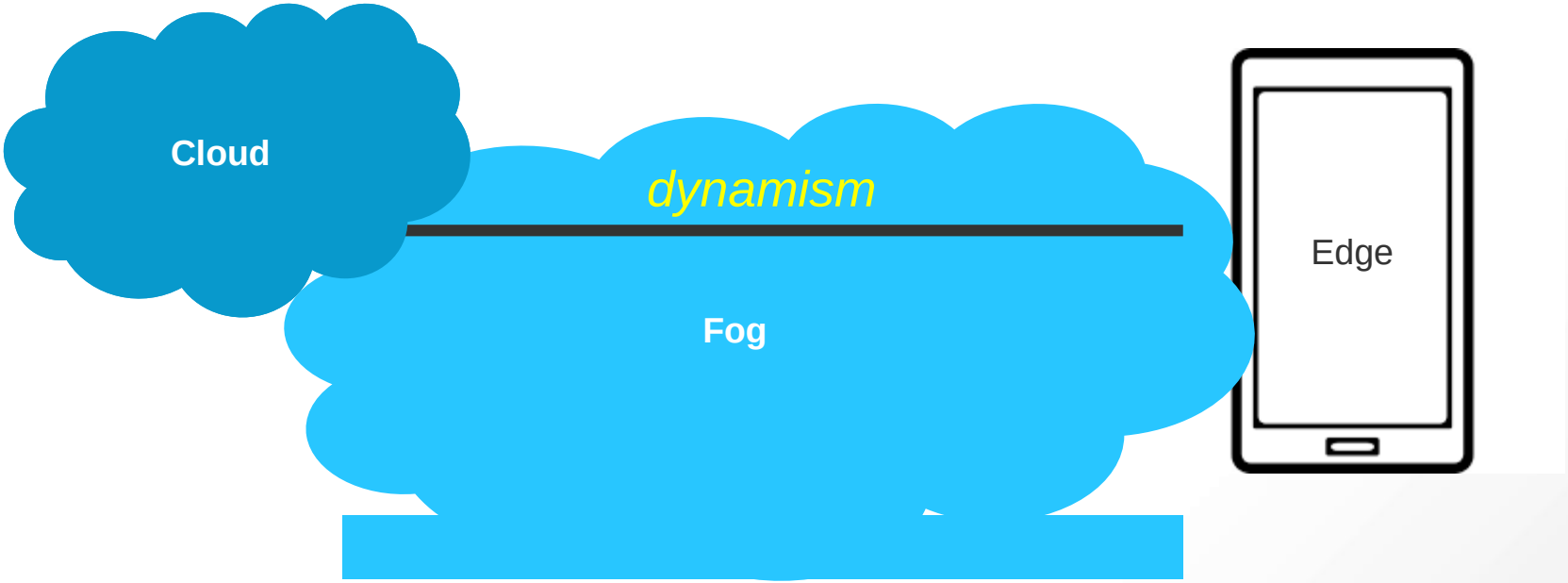
PRESTOCLOUD – CHALLENGE



PRESTOCLOUD - CHALLENGE

Change is inherent in Big Data

in all 3„Vs“ of Big Data -

volume, velocity

Changes can happen

→ in the in

→ ice,

d of changes in data streams

the processing node status.)

Dynamic orchestration of distributed processing nodes to manage sudden changes

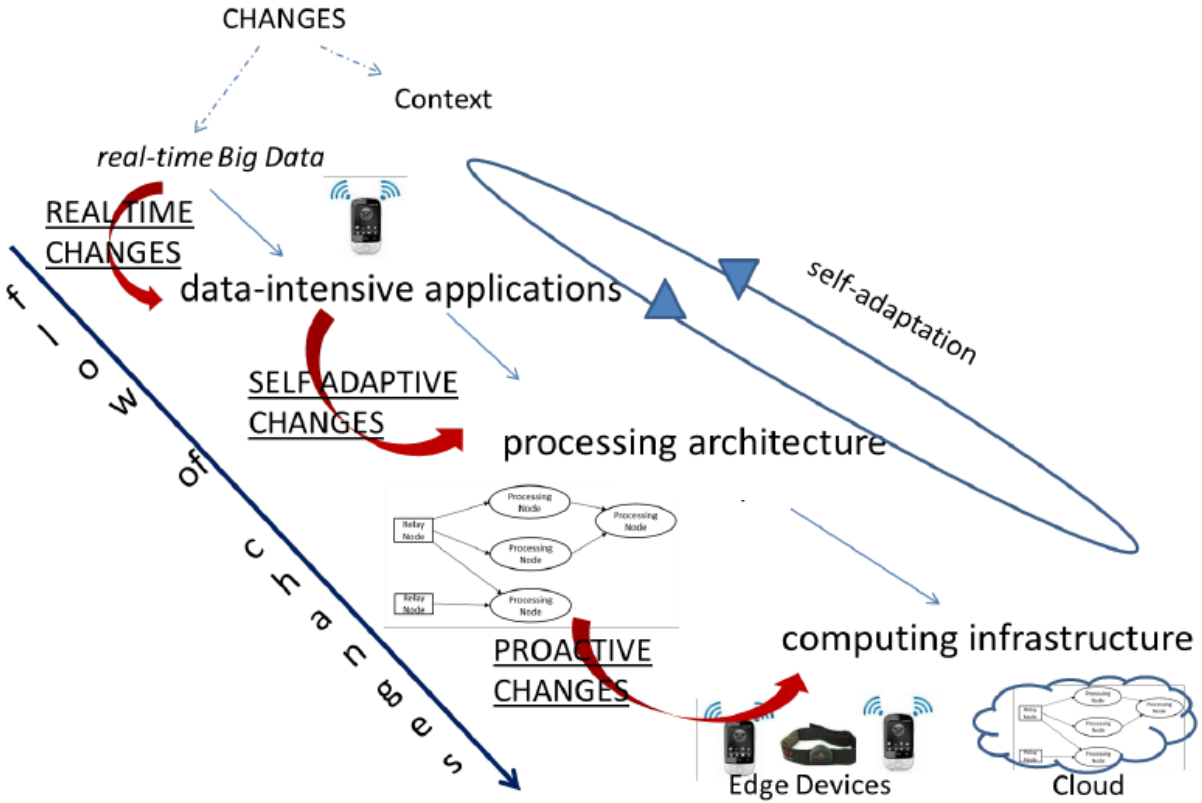
PRESTOCLOUD - VISION

A dynamic, distributed **architecture** for proactive cloud resources management,
reaching the extreme edge of the network
for efficient real-time big data processing.

We target:
Big Data solution providers who utilise cloud & edge resources

- for their client solutions and seek to **optimize resource utilisation** and
- seek for personalized innovative services, an improved **Quality of Service**

VISION OF CHANGE…



PRESTOCLOUD – MEDIA & JOURNALISM USE CASE

A media prosumer platform
offering personalized and flexible consumption of real-time stories by combining freelance reporting, traditional broadcasting and social media streams.

PRESTOCLOUD – MEDIA USE CASE (1/2)

A live media platform offering personalized and flexible consumption of real-time stories by combining freelance reporting, traditional broadcasting and social media streams.

Service includes contribution, distribution, and management of the service on the cloud.

PRESTOCLOUD – MEDIA USE CASE (2/2)

The contribution part is global from any location in the world,
→ used by either professional broadcasters with LiveU dedicated devices,
→ used by prosumers and consumers using their mobile phones.

A clear need for cloud resources optimization in a dynamic manner.

PRESTOCLOUD – SURVEILLANCE USE CASE

A security and surveillance solution combines data streams from cameras and pre-processing results from groups of unmanned aerial vehicles.

PRESTOCLOUD – SURVEILLANCE USE CASE (1/3)

Surveillance System Overview

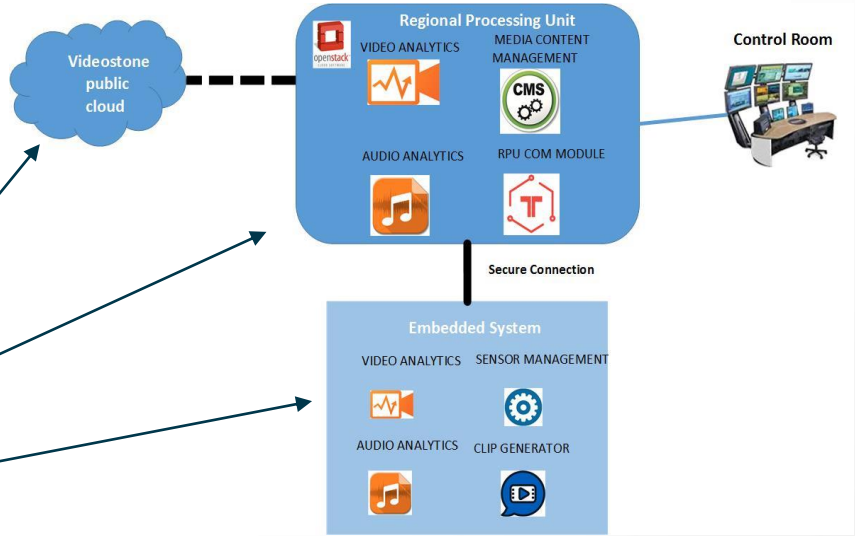
Testbed: wide area video surveillance system including static cameras and UAV-based cameras

Application areas: gather video streams from the cameras, store, and provide security threat notifications in the following cases:

- perimeter protection violation
- trespassing of security areas
- gunshots

Layered Structure:

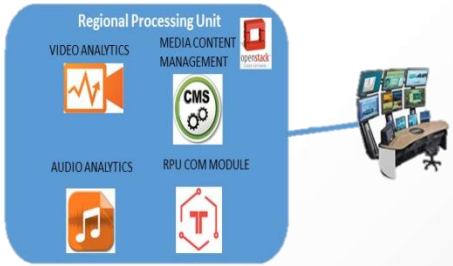
- cloud processing if required based on current workload
- edge processing based on Regional Processing Units (RPUs) forming clusters of embedded systems
- fog computing with camera-built embedded systems



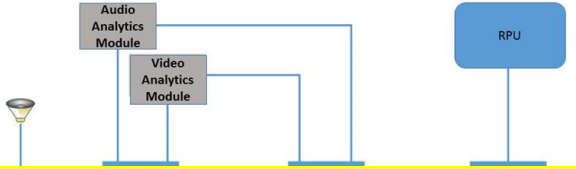
PRESTOCLOUD – SURVEILLANCE USE CASE (2/3)

Regional Processing Unit

- **Video Analytics:** module to run more complex video analytics
- **Audio Analytics:** module to run more complex audio analytics
- **Versatile Media Content Management System**: ADITESS solution for the efficient storage, management archiving, processing and logging of multimedia/heterogeneous content through a modular architecture.
- **RPU Communicator (RCOM):**
  - will be designed to receive the Clips from the Embedded Systems,
  de-encapsulate, forward the contained Clip Object to VMCMS
  - will handle VPN connections directly between the RPU and the Ess
  or from any intermediate equipment
  (aggregation of ESs at the edge e.g. building).



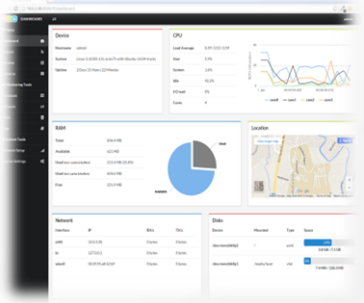
PRESTOCLOUD – SURVEILLANCE USE CASE (3/3)



Embedded System

- **ESM**: Embedded System Manager
  - controls and coordinates the other ES modu
  - handles the communication between the ES
- **ESCOM**: Embedded System Communicator
  - uploads Clips to the RPU
  - initiates VPN connection
- **CG**: Clip Generator
  - encapsulates Clip Data, Clip metadata (Clip Object) an
  - ES Analytics Results in one Clip
- **SM**: Sensors Manager
  - acquires sensors' data and feeds them to the Analytics
  - clips them by exploiting one of the available encoding schemes
  - supports real time streaming

- Video transcoding;
- Audio analytics;
- Security-related events detection



PRESTOCLOUD – LOGISTICS USE CASE

- smart sampling of data
- semantic enrichment of sensor data
- social context identification,
- unsupervised anomaly detection

A vehicle / fleet management via real-time information and alerts – based on data streams from GPS, on-board diagnostics, tire sensors and others.

PRESTOCLOUD – PLATFORM FUNCTIONS

- **processing on the edge**,
  including cloud computing infrastructure and edge resources

- **orchestration of distributed processing nodes**,
  cope with sudden changes in Big Data

- **self-adaptation**
  to real-time changes, sense and cope with dynamics in volume, velocity, variety

- **proactivity**
  regarding the anticipation of need for changes in the processing infrastructure

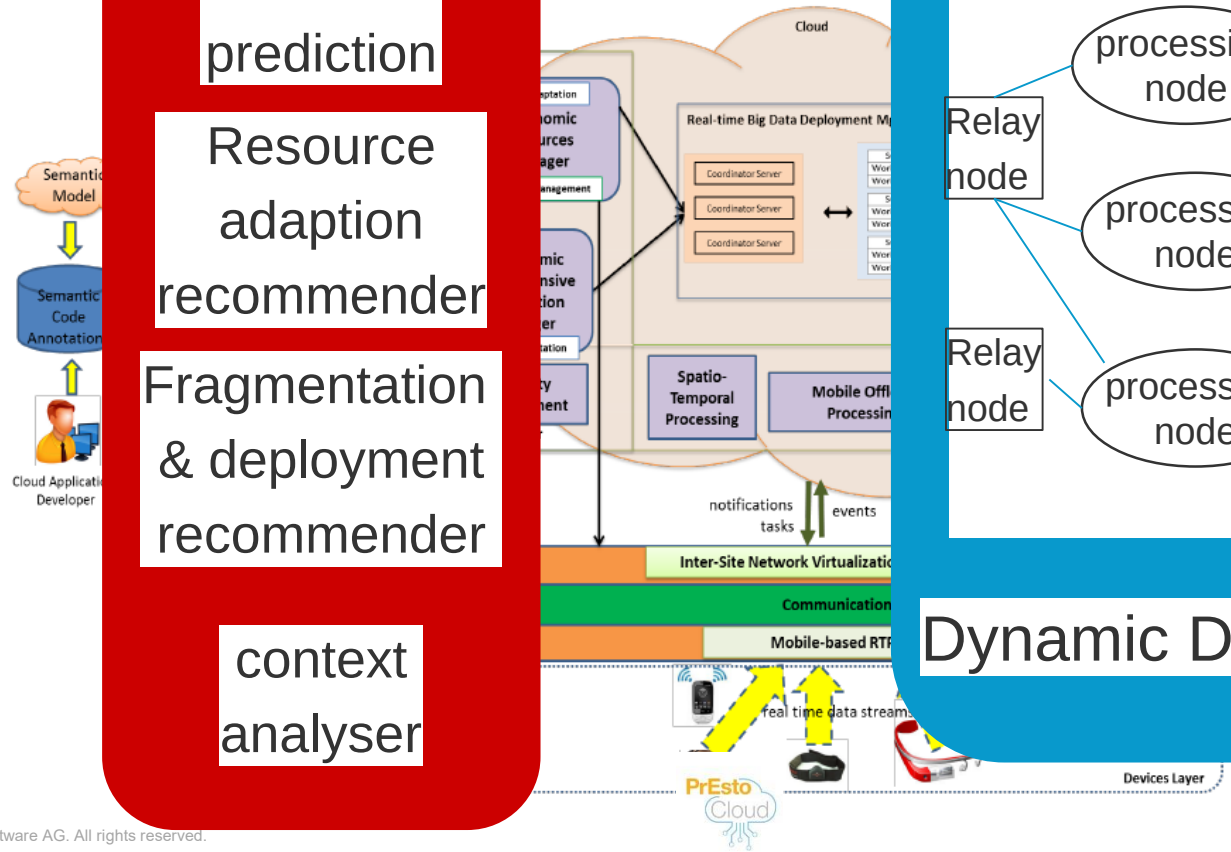
ARCHITECTURE

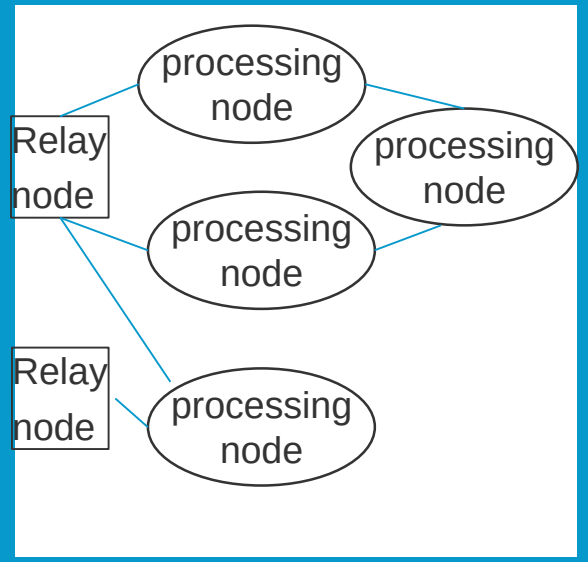
Workload prediction

Resource adaption recommender

Fragmentation & deployment recommender

context analyser





Dynamic Deployment

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PRESTOCLOUD – TECHNICAL OBJECTIVES

- ❑ network virtualization
- ❑ dynamic monitoring in real-time processing architectures for Big Data
- ❑ situation-aware and context-driven adaptation recommender systems
- ❑ real-time mobile stream processing
- ❑ pro-active cloud computing

PRESTOCLOUD – TECHNICAL OBJECTIVES (1/5)

Network virtualization

- intersite network virtualization and security management
  - SDN techniques for heterogeneous cloud infrastructures
- **combine hardware and software network resources** into a single administrative unit, including multi-cloud environments from by different cloud providers
- focus on **usage control and access control** technologies on different operational layers

Going beyond state-of-the-art

- deploy a virtualized OpenvSwitch infrastructure to build a set of virtual networks
- reinforced security at network level
- formulate firewalls and access detection rules
- control the SDN (software-defined network) controllers via a virtual network orchestrator
- obtain statistics about network usage and provide meaningful input to the resource manager

PRESTOCLOUD – TECHNICAL OBJECTIVES (2/5)

Dynamic monitoring in real-time Big Data processing architectures

- multi-layer cloud resource management and monitoring
- **monitor communication scenarios** between different IaaS cloud resource providers, mobile phones, embedded devices and generally resources at the edge
- coordinate and **orchestrate distributed resources**

Going beyond state-of-the-art

detection of anomalous situations on the fly (not predefined anomalies):

- ❖ monitor the real-time processing architecture
- ❖ combine predictive capabilities with the ability to recommend cloud resource adaptations
- ❖ support the meta-modelling of the adaptation process
- ❖ develop a new semantic-based model for distributed real-time processing architectures
- ❖ enable real-time changes of the processing pipeline

PRESTOCLOUD – TECHNICAL OBJECTIVES (3/5)

Situation-aware and context-driven adaptation recommender systems – adaptive scheduling of tasks between cloud and IoT devices

distribution management

- allow for the **definition of distribution constraints** for proper behavior of data-intensive cloud applications (examples: response time, security constraints, …)
- constraints to be expressed during design-time, further refinement by extensions when instantiating an application, verified in real-time together with **recommendations on new distributed opportunities**

Going beyond state-of-the-art

combine predictive capabilities with the ability to recommend cloud resource adaptations:

- ❖ develop a big data situation metamodel that can model situations relevant to cloud and edge resources topology, status and generic capabilites
- ❖ propose algorithms for devising proactive adaptation actions

PRESTOCLOUD – TECHNICAL OBJECTIVES (4/5)

Real-time mobile stream processing

adaptive scheduling of IoT big data processing tasks between devices and the cloud:

- **recommendations for the scheduling mechanisms** to be given depending on the context and the situation
- **scheduling system support** by a mobile context analyzer, a situation detection mechanism, a resource adaptation recommender and a data-intensive application recommender

Going beyond state-of-the-art

use conventional big data analytics and integrate promising concepts of edge computing:

- ❖ investigate the concept of bandwidth and medium utilization and decide on edge, cloud or hybrid computing
- ❖ investigate on acceleration concepts for a local analysis
- ❖ global analytics control local analytics and business rules

PRESTOCLOUD – TECHNICAL OBJECTIVES (5/5)

Pro-active cloud computing

pro-active cloud adaptation:

- realization of the **integrated platform that adapts** the mapping of the real-time processing network on the cloud / edge according **to the dynamics** of the workload
- workload **dynamics** are seen as variations of the data size or heterogeneity of the resources and will be **recognized by a situation detection mechanism and a workload predictor**

Going beyond state-of-the-art

autonomous cloud management platform („proactive cloud automation“) that

- ❖ provides a workflow catalogue system for provisioning and deployment workflows,
- ❖ using a scalable scheduler,
- ❖ the ability to connect to a variety of cloud providers

PREVIOUS WORK BY SOFTWARE AG: CEP RECOMMENDER

- Input: A large Apama (EPL) query from central development
- Output: A set of smaller queries performing the same task
- Deploy the smaller queries in a network of Apama correlators (CEP engines)
- Use event rates and CPU capacities for optimal placement of the queries in the network

→ http://heads-project.eu/

CEP RECOMMENDER – EXAMPLE

```
from guardHr in all GuardHeartRateEvent() within 10.00
   join guardLoc in all GuardLocationEvent() within 10.00
   on
     guardHr.id equals guardLoc.id
   where
     guardHr.heartRate < 30
   select
     AlarmEvent(guardHr.id, guardLoc.location): alarm {
          route alarm;
     }
```


CEP RECOMMENDER – EXAMPLE

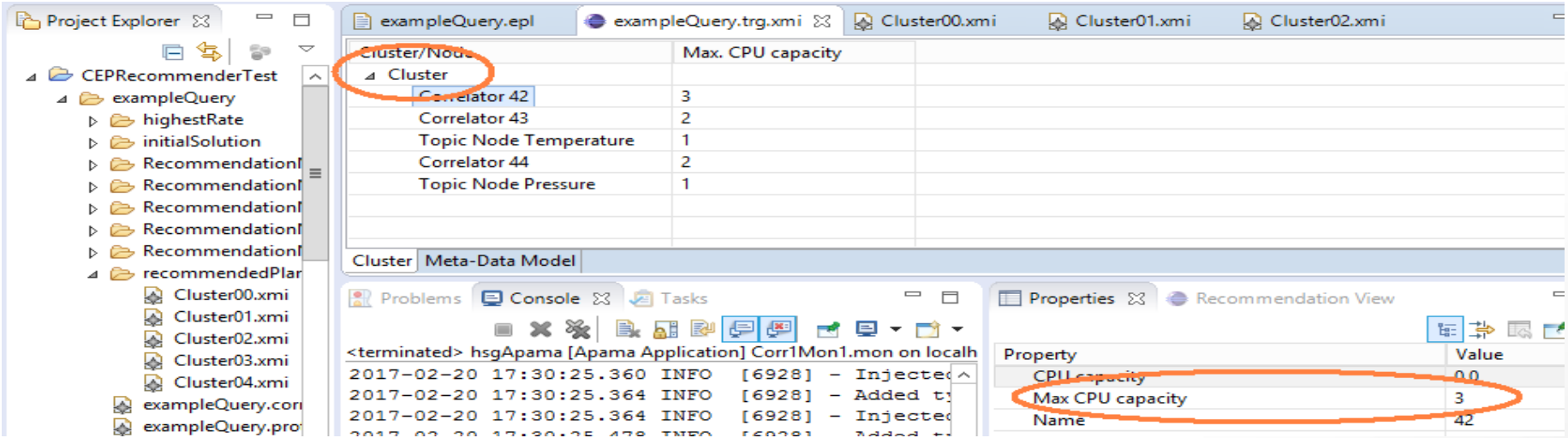
- Part 1 – CEP Engine 1

```
stream<GuardHeartRateEvent> heartRateEvents :=
      from guardHr in all GuardHeartRateEvent()
      within 10.00
      where guardHr.heartRate < 30
      select guardHr;
```

- Part 2 – CEP Engine 2

```
from guardHr in all heartRateEvents within 10.00
join guardLoc in all GuardLocationEvent() within 10.00
      on guardHr.id equals guardLoc.id
      select AlarmEvent(guardHr.id, guardLoc.location):
      alarm {
            route alarm;
        }
```


CEP RECOMMENDER IN HEADS IDE



PRESTOCLOUD – DATA PROTECTION & ETHICS

how we work…

Topic	Relevant
Human beings	yes
Personal data	yes
Non-EU countries involved	yes
Human cells or tissues	no
Animals	no
Human embryos & foetuses	no

Comply with:

- ✓ Directive 95/46/EC (Protection of personal data)
- ✓ General data protection regulation (GDPR) coming into effect 2018
- ✓ Opinion 23/05/2000 of European Group on Ethics in Science and New Technologies:
  - ICT (Protection of privacy and protection against personal intrusion)
  - Ethics of responsibility (Right to information security)
  - Article 15 (Freedom of expression and research and data protection)
- ✓ Charter of Fundamental Rights of the European Union

Project security measures for data collection, storage and protection:

- ✓ private cloud based implementation
- ✓ isolated infrastructure located in an EU member state
- ✓ strictly restricted to the project needs
- ✓ officially notify partner country Data Protection Authorities about project scope and objectives
- ✓ follow latest ISO/IEC, ENISA, CSA and ISACA standards and guidelines

PRESTOCLOUD – USE CASE PARTNERS

CVS Mobile, Slovenia: Logistics use case

→ increased customer satisaction by improved Quality of Experience
→ operational efficiency

Aditess, Cyprus: Surveillance use case

→ improve Quality of Experience
→ improve Quality of Service

LiveU / Amram Technologies, Israel: Media use case

→ strengthen leadership position in live broadcasting from anywhere and anytime
→ development of new services engaging the mass consumer market

PRESTOCLOUD – RESEARCH & TECHNOLOGY

Research

Institute of Communication and Computer Systems, Greece

Centre National de la Recherche Scientifique, France

Jozef Stefan Institute, Slovenia

Technology providers

ActiveEon, France

Ubitech, Greece

Nissatech, Serbia

PRESTOCLOUD – PROJECT COORDINATION

Software AG, Germany

Global player with software solution in

- → Big Data,
- → data management,
- → streaming analytics,
- → visualization.

The PrEstoCloud research project is funded
by the Horizon 2020 Framework Programme of the European Union
Project start: January 2017 - Project end: December 2019.

THANK YOU!