# Use Case 3: Alarm Management

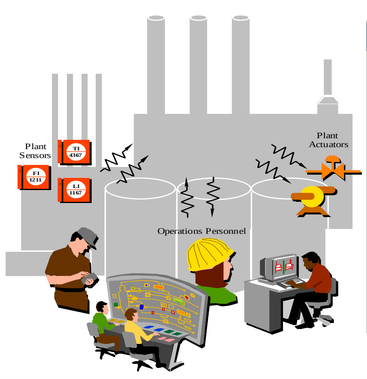
IMC-AESOP

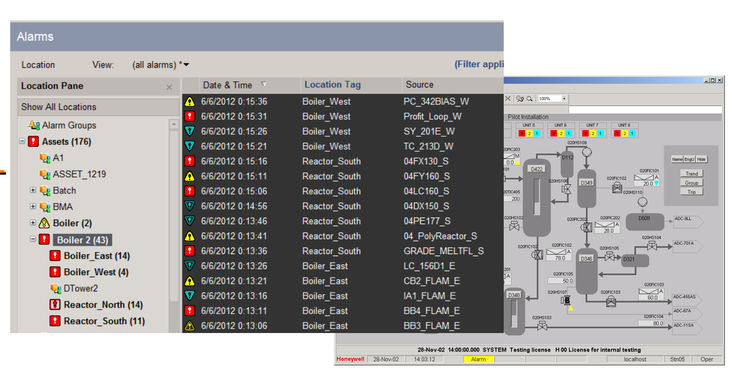
SEVENTH FRAMEWORK PROGRAMME

## Addressing Challenges of Current Control Systems

Current industrial process control and monitoring systems (DCS/SCADA) are becoming increasingly complex and heterogeneous. Interoperability, real-time performance, security, and availability are the key challenges of their architectural design.

This use case demonstrator aims at overcoming these challenges by **exploiting SOA and the CEP technology in the design of the alarm management system**.



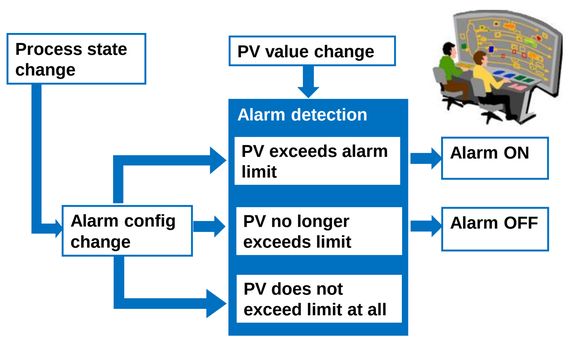

An alarm system configured within a control system aids the operator to handle abnormal process situations. A major challenge of current control systems lies in **flooding the operator with alarms during process upsets** (even is the system is well maintained). Alarm floods are potentially unsafe, since the operator may overlook important alarms or assess the situation wrongly because of stress and information overload.

Alarm floods can be mitigated by the use of **advanced alarm management techniques** (alarm load shedding and state-based alarming).

## State-Based Alarming

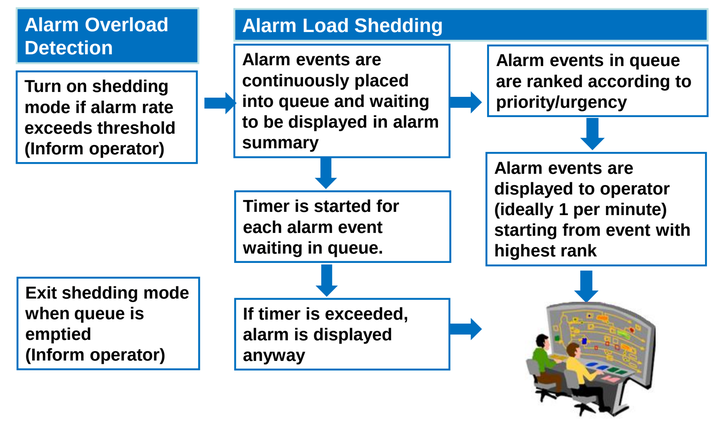
In certain process states, static alarms can be inadvertently triggered due to normal process changes. In such situations, it is advantageous to employ state-based alarming to eliminate such inappropriately triggered alarms.

State-based alarming is based on designing different alarm system configuration for given process states and switching this configuration based on the identified process state (e.g. different feed flow rate).

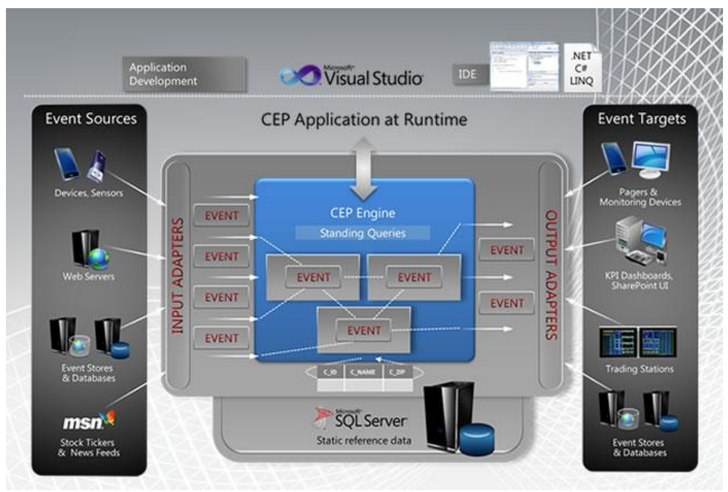



## Alarm Load Shedding

Alarm load shedding helps the operator prioritize his/her actions in alarm floods and **reduces operator overloading**. This method is suitable for abnormal process situations, which have not been handled by alarm system configuration design.

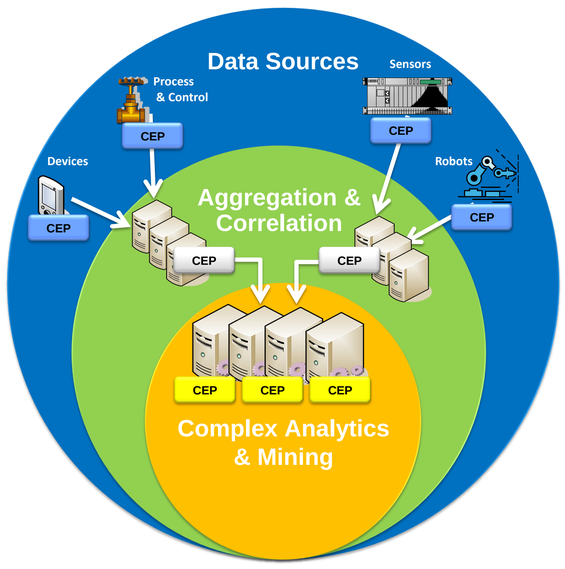



## Complex Event Processing (CEP)




The CEP technology (Microsoft StreamInsight) provides efficient **asynchronous communication** within and across architecture layers and temporal reasoning for large amounts of events.

- **Event:** Defined by Meta Data and Payload
- **Event Stream:** A stream is a possibly infinite sequence of events
- **Operator:** Operation on event streams
- **Query:** Set of Operators
- **Input/Output Adapter:** Import/ Export data into CEP platform




Event processing engines can be deployed at multiple places on different scales

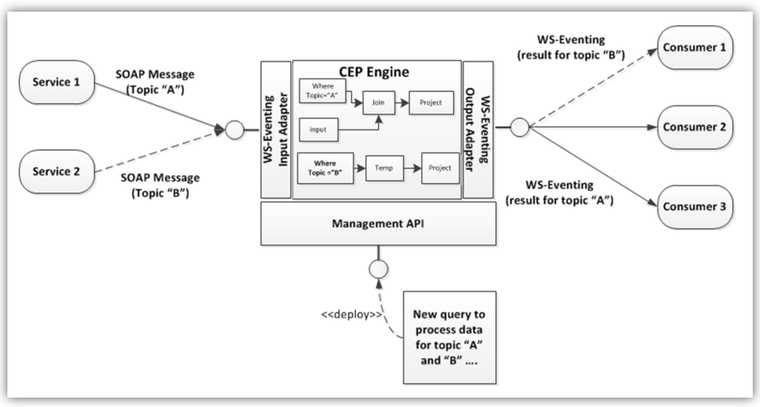
- **At the edge** – close to the data source
- **In the mid-tier –** consolidate related data sources,
- **In the data center** – historical archive, mining, large scale correlation.

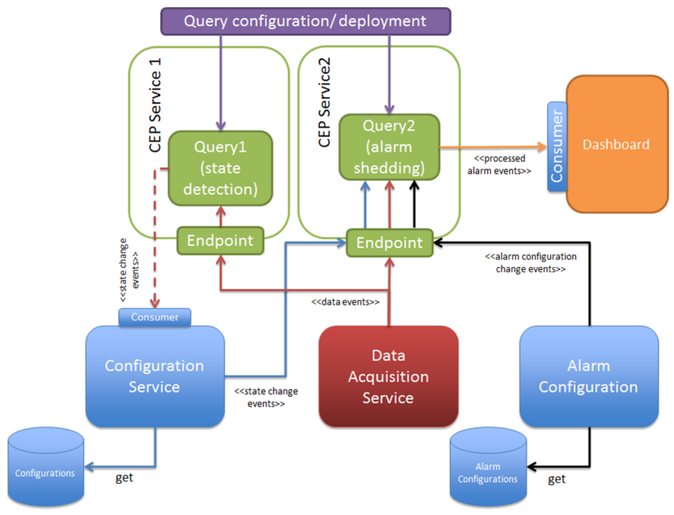
CEP — CEP for lightweight processing and filtering

CEP — CEP for aggregation and correlation of in-flight events

CEP — CEP for complex analytics including historical data

## Solution Architecture



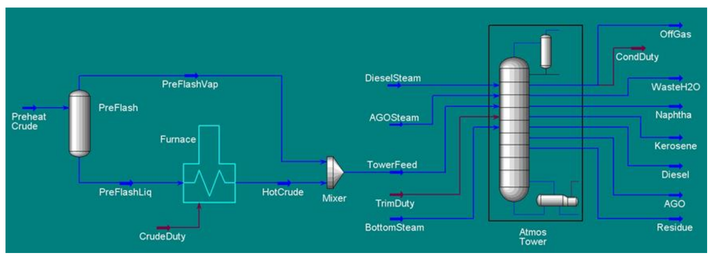




The architecture is based on deploying the CEP engine as a service supporting several protocols and data formats (SOAP, REST/XML, REST/JSON). Multiple instances of the CEP service are configured using different queries for specific purposes, which include:

- **State detection** – based on state definition rules the engine processes incoming data events and raises the state change
- **Alarm shedding (filtering) –** the query compares alarm settings with the process data events while taking into account the current system state by reacting to the state change events

## Simulation

The data used for concept validation are obtained via simulation of abnormal situations in a Crude Distillation Unit (using Honeywell **UniSim Design** simulator).




| Simulated | Process States |
|---|---|
| State 0 | normal state (light crude oil fed into the column at medium flow rate) |
| State 1 | light crude oil, low input flow rate |
| State 2 | light crude oil, high input flow rate |
| State 3 | heavy crude oil, high input flow rate |

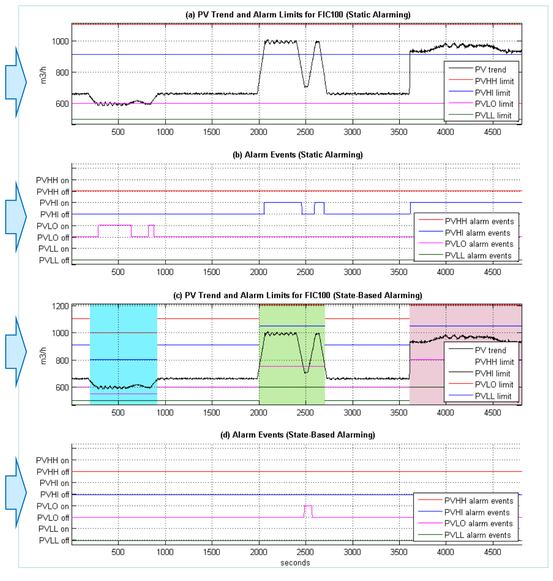
## Results

**Static alarm limits (and a PV trend of the feed flow rate)**

**For static alarm limits, alarm events are generated under normal process conditions**

**State-based alarm limits (the states are displayed by the coloured background)**

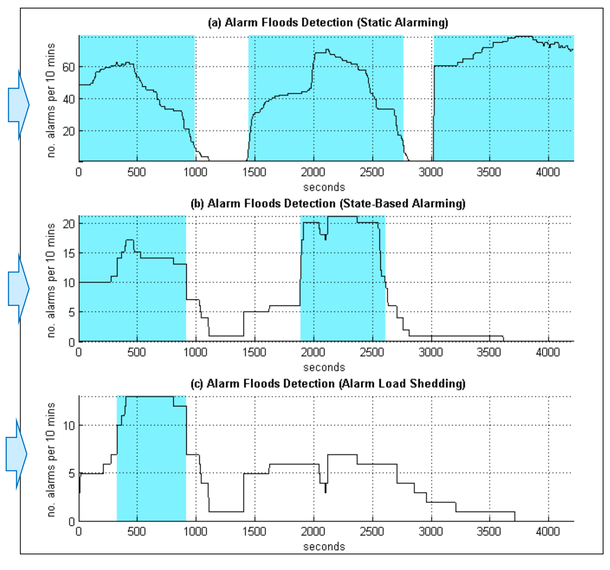
**Alarm count is reduced owing to state-based alarming while relevant process problems needing operator attention are alarmed.**

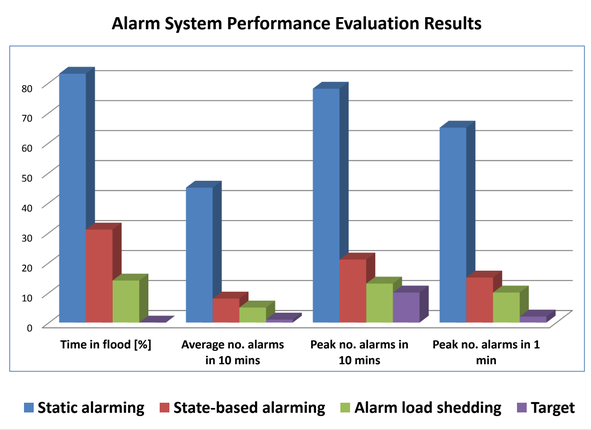



**Alarm flood intervals are detected based on the evaluating the alarm count in 10-minute intervals**

**Alarm count is substantially reduced owing to state-based alarming**

**Alarm count is further reduced and more equally spread by using alarm load shedding**




**Alarm system performance metrics are positively affected by state-based alarming. Alarm load shedding then further improves the results bringing the metrics close to the ideal target values.**

Honeywell

Microsoft Research

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