pps
Platform
for Industrial
Cooperation
FI MU

lasaris
Lab of Software
Architectures and
Information Systems
FI MU

# Complex Event Processing in Building Management Systems — a Prototype

**Adam Kučera, Faculty of Informatics, Masaryk University**

## Introduction

Complex Event Processing (CEP) is set of tools and techniques allowing us to handle events from large systems in real time. CEP in commonly used in network security, algorithmic stock-trading, fraud detection or business process monitoring for correlating, aggregating and analyzing various events.

Modern ("intelligent") buildings are often equipped with BMS – network of interconnected devices that ensures integrated building operation, control and monitoring. Building operators and maintenance staff are easily overwhelmed by large amounts of data and events produced by the BMS. In this way BMS are similar to other fields where CEP is successfully used (network monitoring, credit card fraud detection, algorithmic stock trading etc.).

## The goals

Aim of this research is to adapt existing CEP framework (Microsoft StreamInsight) to work with data from intelligent buildings and provide building operators with the easily understandable outputs that help to optimize building operation and detect various types of faults that occurs in a building. The CEP framework was extended to be able to work with specific features of building management data (location, source device, measured/controlled quantity). A prototype of the system was implemented and tested in real operation environment.

## Test environment — BMS at Masaryk University

- Integrates monitoring and control of University Campus in Brno—Bohunice (first phase of construction ended in 2007) and other university buildings in Brno.
- Uses BACnet as common communication protocol
- Over **700 native BACnet devices** by approximately 10 vendors
- Integrated systems/technologies: HVAC (Heating, Ventilation and Air-conditioning), Fire alarms, Security system, Access control system, CCTV, Power systems, UPS monitoring, university information system (controlling door locks according to lecture room timetables)

## Selecting, filtering, joining, aggregating data

Using building management data semantics, we are able to perform selections, filtering and computations (average, summa, maximum, minimum) over the data from the BMS. The system uses time windows for performing continuous computations of the data characteristics. We can utilize hierarchy of passport databases and use masks to gather related data into separate groups.
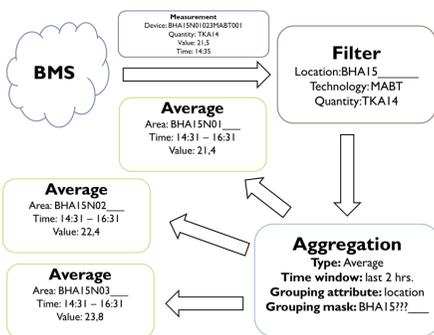


## System architecture overview
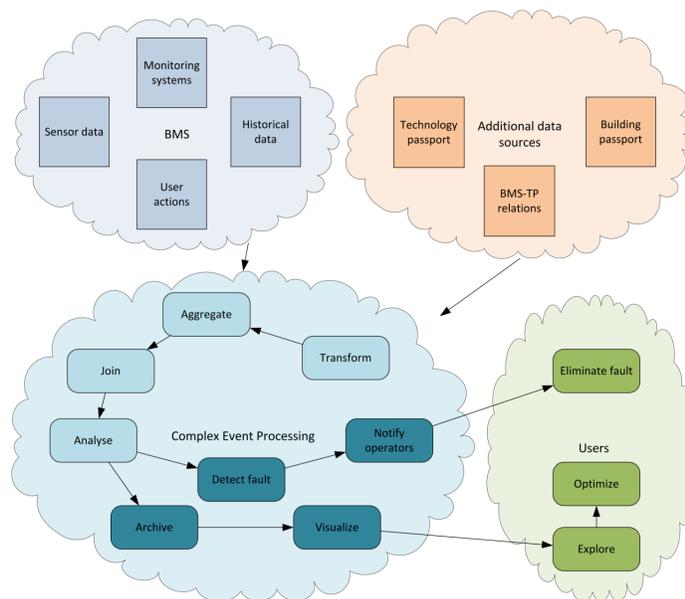


## Building and technology passport

Passports are spatial databases containing information about facilities and devices that university uses. Each item in the databases is identified with unique code with hierarchic structure.

Example of full device code in technology passport with included location:

building passport: BHA01N01001a
site, building, floor, room

technology passport: MABT001
system, subsystem, device, index
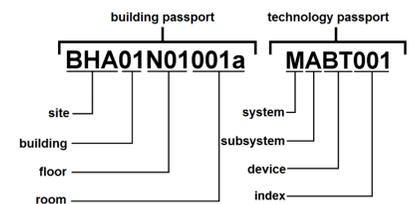
## Building management data semantics

Joining data from BMS and from passport allows as to add „machine-readable" information about semantics (meaning) of data points (i.e. inputs, outputs, control variables) in BMS. In addition to the information from technology passport we add information about measured quantity (temperature, pressure, humidity, actual current, voltage...) of each data point.

| Attribute | Value | Meaning |
|---|---|---|
| Data point | 102.AV145 | ID of data point in BMS |
| Location | BHA12P01005 | Room 005 in the basement of building 12 at university cam- |
| Device | BAPK | Energy meter |
| Quantity | ESS0 | Electricity consumption |

## System prototype — Data analysis and visualization

System runs continuous user-defined queries that transform input data from BMS using various methods (selection, filtering, joining, aggregation, grouping). Results of the computations performed by the system can by further analyzed automatically (e.g. Detecting fault on particular device) or stored for later visualization that can be examined by users.
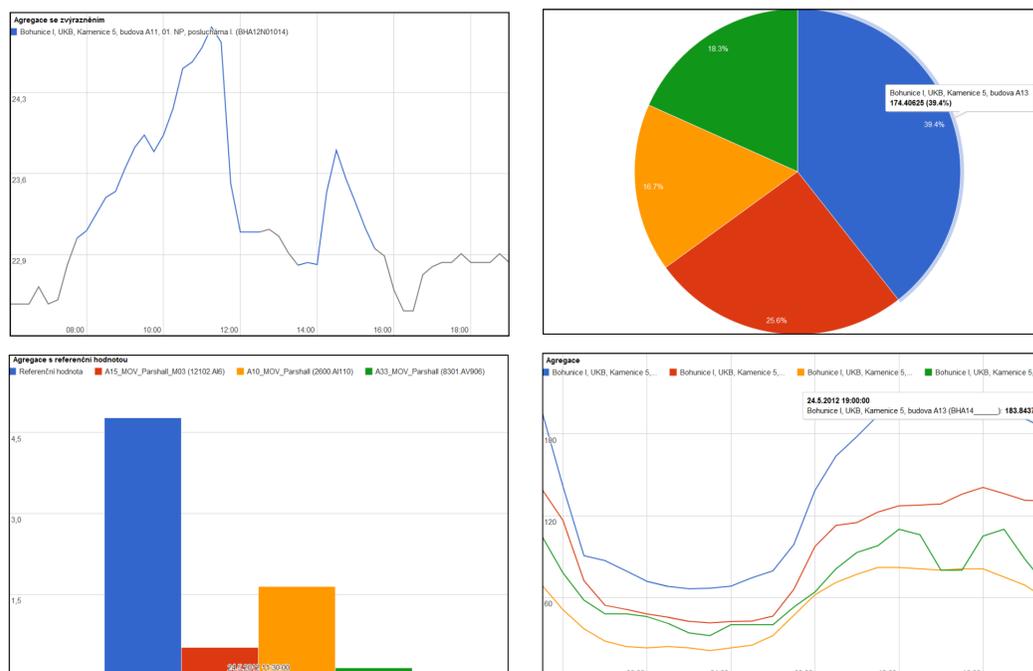


## References

D. Luckham, "The Power of Events", Addison-Wesley, 2002.

H. Merz, T. Hansemann and C. Hübner, "Building automation", Springer, 2009.

O. Etzion and P. Niblett, "Event Processing in Action", Manning Publications, 2010.

A. Kučera, "Complex Event Processing in Building Management Systems", Master thesis, Masaryk University, Faculty of Informatics, 2012.

esf european social fund in the czech republic

EUROPEAN UNION

MINISTRY OF EDUCATION, YOUTH AND SPORTS

OP Education for Competitivness

UNIVERSITAS MASARYKIANA BRUNENSIS

INVESTMENTS IN EDUCATION DEVELOPMENT