DYNAMIC Complex Event Processing

Not Only the Engine Matters!

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Motivation

reactive monitoring of time-critical buisness processes

- **predictions about the near future and recommendations for action**

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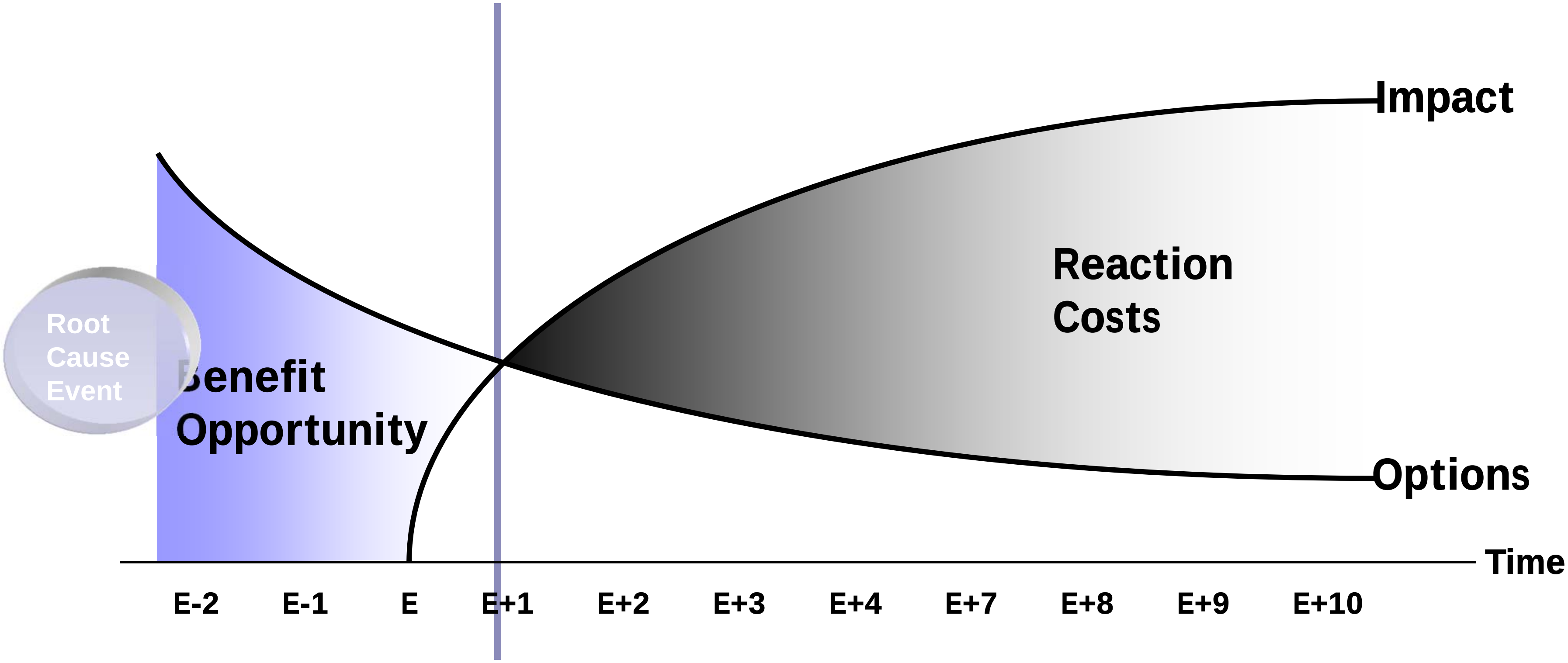
Situations of Interest



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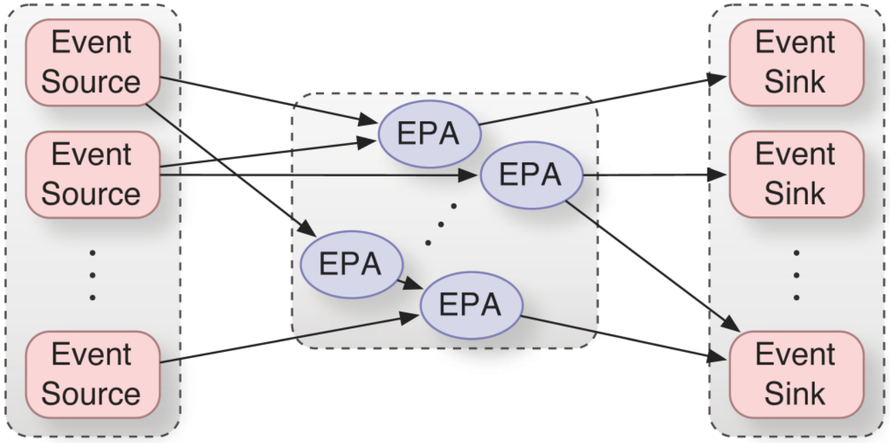
Agenda

- **Motivation**
- **Review of CEP**
- **Dynamic CEP**
  - Requirements
- **Conclusion**

2. Overview of CEP



- **CEP application**
  - □ Registration of event sources
  - □ Definition of EPAs (**E**vent **P**rocessing **A**gents)
  - □ Registration of Event Sinks

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Comparison CEP←→DBMS

- **DBMS**
  - Persistent data
  - Flowing queries
  - …
  - Dynamic
    - Insertions and Updates of data
  - Data independence
  - Data quality
  - Standards

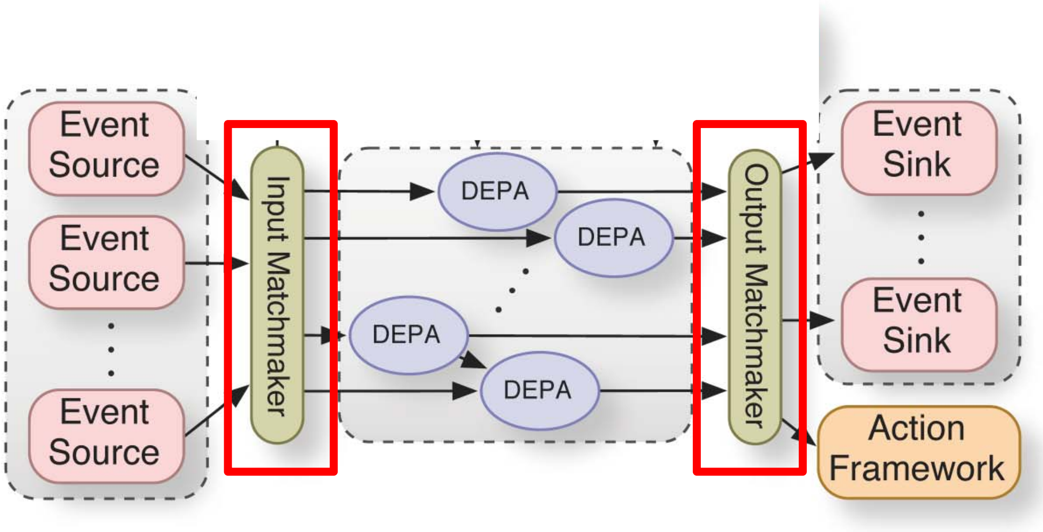
- **CEP**
  - Persistent Queries
  - Flowing Data
  - Temporal Data

?

Static CEP

- **Static Approach**
  - Signature-based EPA
  - Deployment of a fixed system
  - Changes of the system
    - offline
    - purely manual
- **Observation: CEP is highly context-sensitive**
  - Temperature depends on season
  - Network traffic patterns (weekdays – weekend)
- **Fast changes of contexts**

3. Dynamic CEP



- **Key Features**
  - Event/EPA independence
  - Event store
  - Model store
  - Dynamic EPAs

3.1 Event/Query Independence

- **Requirements**
  - □ If new event sources are inserted

    ➔ no modifications of EPA
  - □ If new DEPA are inserted

    ➔ no modifications of event sinks

Matchmakers

- **Basic idea**
  - □ Virtual sensors/DEPA
    - Indirect connections through continuous queries on metadata

      "Return all temperature sensor data 10 km around TU München"
- **Input Matchmaker**
  - □ New sources at runtime without modifications of DEPA
- **Output Matchmaker**
  - □ New DEPA at runtime without modifications of sinks

3.2 Dynamic EPAs

- **Goal**
  - Detection of abnormal behavior in event stream

- **Change of EPAs at runtime**
  - Not only a performance issue
  - Impact on the semantics of queries
    - Day mode → night mode

- **Questions**
  - When should a DEPA be changed?
  - How should a change be performed?

Event Store

- **Persistent management of the history of events.**
- **Append-only database (XXL-AO)**
  - □ Optimized for fast writes
    - 2 Mio/s using a single disk
  - □ Queries
    - Efficient support of temporal predicates
    - If possible also other types of predicates
  - □ Fast garbage collection and compression of outdated events

Model Store

- **Management of models for describing normal behavior**
  - State-based models
    - Average
    - Histograms
  - Process-based models
    - Markov models
- **Patterns of models**
  - Parameters still need to be adapted for a specific context

Model Patterns → Model Instances

- **Derive instances from patters**
  - □ Learning the best parameter setting of these models from the past.
    - ➔ number of parameters should be limited
- **Monitoring the quality of model instances**

Simulations

- **Running of EPA in a sandbox using real data (from the event store)**
- **Benefits**
  - □ Test and debug EPA
  - □ Support of what-if analysis
  - □ Adaption of DEPA
    - Identify points where one DEPA has to be replaced by another one.

Actions

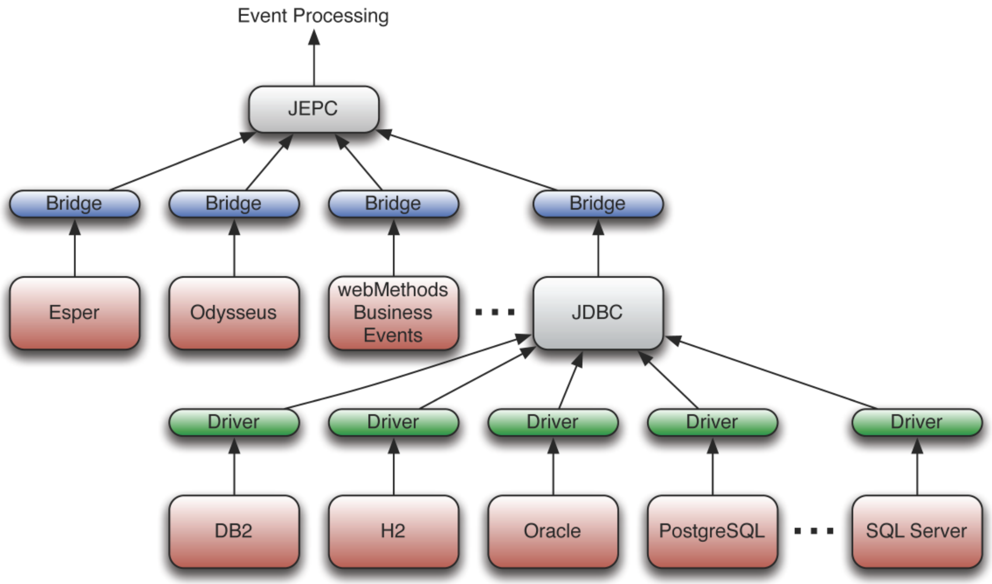
- **Current CEP systems don‘t care about actions**
- **Need actions for reactive CEP**
  - How to prevent detect-react-cycles?
  - Avoid contradictive actions?
  - Provenance
    - Event store
    - Reproducibility of results

Quality of EPA

- **Data quality is a big issue in databases**
- **What about EPA quality in CEP?**
  - □ Set of EPA is the most important asset!
    - ➔ Need research on this important topic
  - □ Prerequisite for semi-automatic generation of queries
    - Ideally: Minimal, but complete set of queries

Standardization

- **Well covered in databases, but the CEP area is still too diverse**
  - □ vendor locking
  - □ no federation of CEP engines
- **Java Event Processing Connectivity**



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Conclusions

- **Dynamic CEP**
  - Substantially more than a CEP-engine
  - Enhancements required in real CEP use-cases
    - Dynamic-enabled CEP
      - EPA independence
      - Quality Management of EPA
        - Event Store
        - Model Store
- **Current use-case for Dynamic CEP**
  - IT security: **A**nomaly management in **C**omputer Systems using **CEP T**echnology

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