Towards a Benchmark for BPMN Engines
The Impact of TPC Benchmark on DBMS Performance

Source: http://www.tpc.org/tpcc/results/tpcc_results.asp
What is a Workflow?

- Register Reserv.
- Send Doc.
- Confirm Request
What is a Workflow?

1. Bob

- Send Doc.
- Register Reserv.
- Confirm Request
What is a Workflow?

Bob

Send Doc.

Register Reserv.

Reservation Service

Confirm Request
What is a Workflow?

1. Send Doc.
2. Register Reserv.
3. Confirm Request

Bob

Reservation Service

Alice
What is a Workflow?

1. Send Doc.
2. Register Reserv.
3. Confirm Request
4. Confirmation Handler

Reservation Service

Bob

Alice

Bob
What is a Workflow?

Bob

1

Send Doc.

2

Reservation Service

3

Confirm Request

4

Confirmation Handler

Reservation Handler
What is a Workflow Management System (WfMS)?

Applications

Users

Web Service

WfMS

Application Server

Instance Database

DBMS

Towards a Benchmark for BPMN Engines
Workflow Management System’s Main Components

- WES
- Application Server
- Job Executor
- Core Engine
Workflow Management System’s Main Components

Application Server

WES

Process Navigator

Job Executor

Core Engine

Towards a Benchmark for BPMN Engines
Workflow Management System’s Main Components

WES

- Task Dispatcher
- Process Navigator
- Job Executor
- Core Engine

Application Server

Users

Application
Workflow Management System’s Main Components

- **WES**
  - Task Dispatcher
  - Process Navigator
  - Job Executor
  - Core Engine
  - Service Invoker
  - Event Handler

Application Server

- Users
- Application
- Web Service

Application

Towards a Benchmark for BPMN Engines
Workflow Management System’s Main Components

- Task Dispatcher
- Process Navigator
- Job Executor
- Core Engine
- Service Invoker
- Event Handler
- Transaction Manager
- Persistent Manager

Application Server

DBMS

Instance Database

Web Service

Application

Users
Functionality

• Dynamic handling of Workflows
• Integration capabilities

Deployment Infrastructure

• Standalone
• Cluster deployment
• Cloud deployment
• Mobile deployment

System’s Architecture

• Distributed workflow support
• Migrating workflow objects support
• Transactional workflow support

Supported Languages

• BPMN, BPEL, Petri-Nets, …

Workflow Management Systems’ Diversity
Workflow Management Systems’ Diversity

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• Dynamic handling of Workflows
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Workflow Management Systems’ Diversity

EPC XPDL BPEL BPMN PNML BPMN 2.0
Workflow Management Systems’ Diversity

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Timeline:
- EPC: 1992
- XPDL: 1998
- BPEL: 2002
- BPMN: 2004
- PNML: 2008
- BPMN 2.0: 2011
Workflow Management Systems’ Diversity

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- BPMN 2.0: 2011
BPMN 2.0: A Widely Adopted Standard (?)

https://en.wikipedia.org/wiki/List_of_BPMN_2.0_engines

<table>
<thead>
<tr>
<th>Year of the First Version Supporting BPMN 2.0</th>
<th>Number of BPMN 2.0 WfMSs</th>
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<tr>
<td>2009</td>
<td>1</td>
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<tr>
<td>2010</td>
<td>5</td>
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<td>2015</td>
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<td>Grand Total</td>
<td>23</td>
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BETA
BPMN 2.0
Aug 2009

BPMN 2.0
Jan 2011

ISO/IEC 19510
BPMN 2.0.2
Jan 2014
Towards a Benchmark for BPMN Engines
Control Flow

BPMN 2.0
BPMN 2.0

Control Flow

Events

Data Flow

Towards a Benchmark for BPMN Engines
Towards a Benchmark for BPMN Engines

**BPMN 2.0**

**Control Flow**

- A
- B

**Data Flow**

- A → B
- C

**Events**

- Circle
- Note
- Cross
- Clock
- Mail
- List

**Activities**

- A
- B
- C
- D
- E
- F

**Task Types**

- Send Task
- Receive Task
- User Task
- Manual Task
- Business Rule Task
- Service Task
- Script Task

**Execution Behaviour**

- G
- H
- I
“Design and implement the first benchmark to assess and compare the performance of WfMSs that are compliant with Business Process Model and Notation 2.0 standard.”
Why do we Need a Benchmark?

*end-users, vendors, developers*
Why do we Need a Benchmark?
end-users, vendors, developers

1. How to choose the best WfMS in accordance with the company’s technical requirements?

2. How to choose the best WfMS in accordance with the company’s business process models (workflows)?
Why do we Need a Benchmark?

end-users, vendors, developers

1. How to choose the best WfMS in accordance with the company’s technical requirements?

2. How to choose the best WfMS in accordance with the company’s business process models (workflows)?

3. How to evaluate performance improvements during WfMS’s development?

4. How to identify WfMS’s bottlenecks?
Benchmark Elements for BenchFlow

- Workload Mix
- Load Functions
- Test Data
- Test Types
- Metrics KPIs
- Performance Data
- Workload Model

1. Test Types
2. Workload Mix
3. Load Functions
4. Test Data
5. Workload Model
6. Configurations
7. WfMS
8. Derive
9. Metrics KPIs
10. Performance Data

Towards a Benchmark for BPMN Engines
# State of the Art Limitations (BPEL WfMS)

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Röck et al.  
[SEKE ’14]
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State of the Art Limitations (BPEL WfMS)

Röck et al. [SEKE ’14]
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State of the Art Limitations (BPEL WfMS)

Röck et al.  [SEKE ’14]
Towards a Benchmark for BPMN Engines

Benchmarking Requirements

• Relevant
• Representative
• Portable
• Scalable
• Simple
• Repeatable
• Vendor-neutral
• Accessible
• Efficient
• Affordable

References:

• K. Huppler, The art of building a good benchmark, 2009
• S. E. Sim, S. Easterbrook et al., Using benchmarking to advance research: A challenge to software engineering, 2003
Main Challenges in Benchmarking BPMN 2.0 WfMSs
Main Challenges in Benchmarking BPMN 2.0 WfMSs

WORKLOAD MODEL
Main Challenges in Benchmarking BPMN 2.0 WfMSs

Workload Mix

WORKLOAD MODEL
Main Challenges in Benchmarking BPMN 2.0 WfMSs

Workload Mix

Test Data

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Main Challenges in Benchmarking BPMN 2.0 WfMSs

Workload Mix

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Load Functions

WORKLOAD MODEL

BENCHMARK EXECUTION
Main Challenges in Benchmarking BPMN 2.0 WfMSs

Workload Mix

Test Data

Load Functions

WORKLOAD MODEL

WfMS-specific APIs
and BPMN 2.0 Customisations

BENCHMARK EXECUTION
Main Challenges in Benchmarking BPMN 2.0 WfMSs

Workload Mix

20% D → 80% B → C

Test Data

40% B → 60% A

Load Functions

WORKLOAD MODEL

WfMS ↔ Users
WfMS ↔ Web Services
Application ↔ WfMS

WfMS-specific APIs and BPMN 2.0 Customisations

Asynchronous Execution of Workflows

BENCHMARK EXECUTION
Main Challenges in Benchmarking BPMN 2.0 WfMSs

- Workload Mix
- Test Data
- Load Functions

WORKLOAD MODEL

WfMS-specific APIs and BPMN 2.0 Customisations
Asynchronous Execution of Workflows

BENCHMARK EXECUTION
ANALYSES
Main Challenges in Benchmarking BPMN 2.0 WfMSs

**Workload Mix**

- 20%: D
- 80%: A, B, C

**Load Functions**

- Performance Metrics and KPIs

**Test Data**

- Asynchronous Execution of Workflows

**Workload Model**

- WfMS-specific APIs and BPMN 2.0 Customisations

**Benchmark Execution**

- Performance Metrics and KPIs

**Analyses**
Define the Workload Mix

based on real-world BPMN 2.0 process models

**Diagram:**
- **Register Reserv.**
- **Send Doc.**
- **Confirm Request**
Define the Workload Mix
based on real-world BPMN 2.0 process models

MAIN CHALLENGE:
Obtain Real-World BPMN 2.0 Process Models
Define the Workload Mix
based on real-world BPMN 2.0 process models

MAIN CHALLENGE:
Obtain Real-World BPMN 2.0 Process Models
Towards a Benchmark for BPMN Engines

Define the Workload Mix
characterise real-world BPMN 2.0 process models collections

BPMEter:
Web Service and application for static analysis of BPMN 2.0 collections

> 100 METRICS:
Size, Structure, External Interaction, Data Handling, Complexity

http://benchflow.inf.usi.ch/bpmeter
Towards a Benchmark for BPMN Engines

Define the Workload Mix
heterogeneous usage and support of BPMN 2.0

NUMBER OF WfMSs SUPPORTING THE FEATURE

NUMBER OF REAL-WORLD MODELS USING THE FEATURE
Define the Workload Mix
heterogeneous usage and support of BPMN 2.0

Towards a Benchmark for BPMN Engines
Different Types of Benchmarks

core, advanced, full, custom

BPMN 2.0 SUPPORTED ELEMENTS

BPMN 2.0 APPLICATION DOMAIN

CORE  ADVANCED  FULL  CUSTOM
Towards a Benchmark for BPMN Engines

Different Types of Benchmarks

- core, advanced, full, custom

BPMN 2.0 SUPPORTED ELEMENTS

- Core
- Advanced
- Full
- Custom

BPMN 2.0 APPLICATION DOMAIN

YOUR COMPANY
Different Types of Benchmarks

core, advanced, full, custom
Different Types of Benchmarks

core, advanced, full, custom

BPMN 2.0 SUPPORTED ELEMENTS

BPMN 2.0 APPLICATION DOMAIN

YOUR COMPANY SPECIFIC

DOMAIN GENERAL

CORE ADVANCED FULL CUSTOM
Workload Mix Characterisation Overview

Characterisation

Models Collection

Selection Criteria

Characterisation Criteria

Characterise

Benchmark Workflows
Towards a Benchmark for BPMN Engines

Workload Mix Characterisation Overview

Models Collection

Characterisation Criteria

Characterisation

Selection Criteria

Benchmark Workflows

Reoccurring Structures
Towards a Benchmark for BPMN Engines

Workload Mix Characterisation Overview

Models Collection

Characterisation

Selection Criteria

Benchmark Workflows

Characterisation Criteria

Reoccuring Structures

Clusters of Models

Characterise
Define the Workload Mix
*discover reoccurring structural patterns*

REAL-WORLD PROCESSES
Towards a Benchmark for BPMN Engines

Define the Workload Mix
*discover reoccurring structural patterns*

Skouradaki et al. [SOSE '15]

REAL-WORLD PROCESSES

Graph Matching

REOCCURRING STRUCTURES
Towards a Benchmark for BPMN Engines

Define the Workload Mix

discover reoccurring structural patterns

Skouradaki et al. [SOSE ’15]

Graph Matching

User Defined
Selection Criteria

REAL-WORLD PROCESSES

REOCCURRING STRUCTURES
Skouradaki et al. [SOSE '15]

Define the Workload Mix

discover reoccurring structural patterns

REAL-WORLD PROCESSES

REOCCURRING STRUCTURES

WORKLOAD MIX

User Defined
Selection Criteria

Graph Matching

Composition Criteria

50%

50%
Define the Workload Mix

discover clusters of models

REAL-WORLD PROCESSES
Towards a Benchmark for BPMN Engines

Define the Workload Mix

*discover clusters of models*

REAL-WORLD PROCESSES

> 100 METRICS: Size, Structure, External Interaction, Data Handling, Complexity

CLUSTERS OF MODELS

PCA + Clustering
Define the Workload Mix

discover clusters of models

REAL-WORLD PROCESSES

> 100 METRICS: Size, Structure, External Interaction, Data Handling, Complexity

Towards a Benchmark for BPMN Engines
Towards a Benchmark for BPMN Engines

Define the Test Data

different types of test data

- Register Reserv.
- Send Doc.
- Confirm Request
Define the Test Data

different types of test data

Test Data:

Towards a Benchmark for BPMN Engines
Define the Test Data
different types of test data

Test Data:

Towards a Benchmark for BPMN Engines
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Define the Test Data

different types of test data

Test Data:
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Test Data:

Towards a Benchmark for BPMN Engines
Define the Test Data

different types of test data

Test Data:

Towards a Benchmark for BPMN Engines
Define the Load Functions

different types of load functions
Define the Load Functions

different types of load functions

Towards a Benchmark for BPMN Engines
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Towards a Benchmark for BPMN Engines
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Towards a Benchmark for BPMN Engines
Define the Load Functions

different types of load functions
Define the Load Functions

process logs, experts’ opinion

Process Logs
Define the Load Functions

*process logs, experts’ opinion*

- Process Logs
- Send Doc.
- Register Reserv.
- Confirm Request
- Send Doc., Register Reserv., Confirm Request

Towards a Benchmark for BPMN Engines
Define the Load Functions

*process logs, experts’ opinion*

Process Logs

- Send Doc.
- Confirm Request
- Register Reserv.
- Process Logs
Define the Load Functions

process logs, experts’ opinion

Towards a Benchmark for BPMN Engines
Define the Load Functions

process logs, experts’ opinion

Towards a Benchmark for BPMN Engines
Define the Load Functions

*process logs, experts’ opinion*

Towards a Benchmark for BPMN Engines
Define the Load Functions

process logs, experts’ opinion

Process Logs

Send Doc.

Register Reserv.

Confirm Request

Requests Rate

Response Time

Completion Time

Completion Time

P(branch)

40%

60%

Towards a Benchmark for BPMN Engines
Towards a Benchmark for BPMN Engines

Define the Load Functions

*process logs, experts’ opinion*

Experts

Process Logs

40%

P(branch)

Register Reserv.

60%

Send Doc.

Completion Time

Requests Rate

Response Time

Completion Time

Completion Time

Requests Rate

Experts

40%

P(branch)

Register Reserv.

60%

Send Doc.
### Test Types and the Workload Model

#### Performance Test Types
- Load testing
- Stress testing
- Soak testing
- Spike testing
- Scalability testing
- Capacity testing
- Configuration testing
- Isolation testing
- ...

#### Workload Model
Test Types and the Workload Model

Performance Test Types

- Load testing
- Stress testing
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Workload Model

Load Function

Towards a Benchmark for BPMN Engines
Test Types and the Workload Model

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Workload Model

Load Function

Workload Mix

Test Data
Main Challenges in Benchmarking BPMN 2.0 WfMSs

Workload Mix

Test Data

Load Functions

WORKLOAD MODEL

WfMS-specific APIs and BPMN 2.0 Customisations

Asynchronous Execution of Workflows

Performance Metrics and KPIs

BENCHMARK EXECUTION

ANALYSES

Towards a Benchmark for BPMN Engines
Main Challenges in Benchmarking BPMN 2.0 WfMSs

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BENCHMARK EXECUTION

ANALYSES
Towards a Benchmark for BPMN Engines

Enabling the Benchmark Execution and Analyses
*BenchFlow framework*

Test Execution

- Servers
- Containers

- harness
  - Faban Drivers

Analyses

- Performance Metrics
- Performance KPIs

**Spark**

**DATA TRANSFORMERS**

**Analysers**

- Minio
- Instance Database

**Web Service**: Faban + docker

**WfMS**: DBMS

**Instance Database**: kafka
BenchFlow Framework

core requirements & functionalities

System Under Test (SUT)    Performance Benchmark
BenchFlow Framework

*core requirements & functionalities*

**System Under Test (SUT)**
- Automate the SUT deployment
- Simplify the SUT’s deployment configuration

**Performance Benchmark**
System Under Test (SUT)

• Automate the SUT deployment
• Simplify the SUT’s deployment configuration

Performance Benchmark

• Manage the benchmark lifecycle
• Simulate the entities interacting with the WfMS
• Accommodate and automate different kinds of performance tests
• Ensure reliable execution
• Ensure repeatability
BenchFlow Framework

*system under test*

Docker Engine
Towards a Benchmark for BPMN Engines

BenchFlow Framework

system under test

Docker Engine

Containers
BenchFlow Framework

*system under test*

Docker Machine

provides

Docker Engine

Containers
BenchFlow Framework

system under test

Docker Machine

provides

Docker Swarm

Docker Engine

Containers

Towards a Benchmark for BPMN Engines
BenchFlow Framework

system under test

**Docker Machine**

provides

**Docker Engine**

manages

Containers

Servers
BenchFlow Framework

Docker Machine

provides

Docker Engine

manages

Docker Swarm

Containers

Servers

Docker Compose

system under test
BenchFlow Framework
system under test

Docker Machine
- deploys
- provides

Docker Compose
SUT’s Deployment Conf.

Docker Engine
- Containers

Docker Swarm
- Servers

manages
BenchFlow Framework

*performance benchmark*

System Under Test (SUT)

Manages the Benchmark Lifecycle
BenchFlow Framework

*performance benchmark*

Manages the Benchmark Lifecycle

System Under Test (SUT)

*Simulates interacting entities*

Faban Master

Faban Driver Agents
BenchFlow Framework
performance benchmark

Ensures repeatability
• the behaviour of a load driver is described using code
• load drivers can be released

Simulates interacting entities

Manages the Benchmark Lifecycle

Towards a Benchmark for BPMN Engines
BenchFlow Framework

**performance benchmark**

System Under Test (SUT)

**Ensures repeatability**
- the behaviour of a load driver is described using code
- load drivers can be released

→ paired with Docker:
SUT's initial state is frozen in the container

**Simulates interacting entities**

**Manages the Benchmark Lifecycle**
**BenchFlow Framework**

*Performance Benchmark*

Ensures reliable execution
- checks the environment condition
- validates the benchmark execution
- ensures as few interferences as possible on the SUT during measurements

Ensures repeatability
- the behaviour of a load driver is described using code
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Manages the Benchmark Lifecycle
BenchFlow Framework

**performance benchmark**

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→ paired with Docker:
  - SUT's initial state is frozen in the container

**Automates performance tests**

**Simulates interacting entities**

**Manages the Benchmark Lifecycle**

Towards a Benchmark for BPMN Engines
Towards a Benchmark for BPMN Engines

WfMS-specific APIs
software adapters

Test Execution

harness
Faban Drivers

Containers
Servers

Adapters

WfMS

Web Service

DBMS
WfMS-specific APIs

**custom APIs**

**APIs:**
- Load Driver APIs
- Web Service APIs
- User APIs
- Event APIs
WfMS-specific APIs
requirements from the WfMS
Towards a Benchmark for BPMN Engines

WfMS-specific APIs
requirements from the WfMS

Load Driver APIs

Deploy Workflow

Start Workflow

WfMS

CORE

ADVANCED

FULL
Towards a Benchmark for BPMN Engines

WfMS-specific APIs
requirements from the WfMS

Load Driver APIs
- Deploy Workflow
- Start Workflow

User and Web Service APIs
- Create User
- Create Group
- Pending User Tasks
- Claim Task
- Complete Task
- Invoke WS

WfMS

CORE
ADVANCED
FULL
WfMS-specific APIs
requirements from the WfMS

Load Driver APIs
- Deploy Workflow
- Start Workflow

User and Web Service APIs
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- Invoke WS
- Claim Task
- Complete Task

Event APIs
- Pending Event Tasks
- Issue Event

CORE
ADVANCED
FULL
BPMN 2.0 Customisations
models deployment version
BPMN 2.0 Customisations
models deployment version

Deploy Workflow

WfMS

BPMN 2.0 Standard
XML Serialisation

WfMS A
BPMN 2.0
Serialisation

WfMS B
BPMN 2.0
Serialisation
Towards a Benchmark for BPMN Engines

BPMN 2.0 Customisations
models deployment version

Deploy Workflow

WfMS

XML

BPMN 2.0 Standard
XML Serialisation

WfMS A
WfMS B

XML Processor

XML

BPMN 2.0 Serialisation

XML

BPMN 2.0 Serialisation

WfMS A
WfMS B

Towards a Benchmark for BPMN Engines
BPMN 2.0 Customisations
models deployment version
Towards a Benchmark for BPMN Engines

**BPMN 2.0 Customisations**

*models deployment version*

Deploy Workflow

**WfMS**

XML

BPMN 2.0 Standard XML Serialisation

XML Processor

XML

WfMS A

WfMS B

XML BPMN 2.0 Serialisation

XML BPMN 2.0 Serialisation

Customised Test Data Formatting

WfMS A

WfMS B
Asynchronous Execution of Workflows

Overview

Start Workflow
Asynchronous Execution of Workflows

**Overview**

Diagram showing the asynchronous execution of workflows, with nodes labeled A, B, C, and D connected by arrows indicating the flow of data. The execution starts with a Load Driver and ends with an end node. The workflow is directed towards a WfMS component, which interacts with an Application Server and a database. Users interact with a Web Service, and the execution involves an instance database and a DBMS.
Asynchronous Execution of Workflows

monitors
Asynchronous Execution of Workflows

monitors
Asynchronous Execution of Workflows

**monitors**

- Servers
- Containers
- Web Service
- WfMS
- DBMS

**Monitors’ Characteristics:**

- Microservices
- Lightweight (written in Go)
- As less invasive on the SUT as possible
- Expose REST APIs towards the Drivers

**Examples of Monitors:**

- CPU usage
- Database state
Asynchronous Execution of Workflows

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Main Challenges in Benchmarking BPMN 2.0 WfMSs

Workload Mix

Load Functions

Test Data

WORKLOAD MODEL

WfMS-specific APIs and BPMN 2.0 Customisations

Asynchronous Execution of Workflows

Performance Metrics and KPIs

BENCHMARK EXECUTION

ANALYSES

Towards a Benchmark for BPMN Engines
Main Challenges in Benchmarking BPMN 2.0 WfMSs

Workload Mix

Test Data

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BENCHMARK EXECUTION

WORKLOAD MODEL

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Performance Metrics and KPIs

Towards a Benchmark for BPMN Engines
Towards a Benchmark for BPMN Engines

Performance Metrics and KPIs

levels

Load Driver

WfMS

Application Server

Instance Database

DBMS

Users

Web Service
Performance Metrics and KPIs

Metrics and KPIs

• Engine Level
Performance Metrics and KPIs

levels

Metrics and KPIs

- Engine Level
- Process Level
Performance Metrics and KPIs

- Engine Level
- Process Level
- Feature Level
Performance Metrics and KPIs

Levels

Metrics and KPIs

- Engine Level
- Process Level
- Feature Level
- Interactions
Performance Metrics and KPIs
examples and relevant users
Performance Metrics and KPIs
examples and relevant users

ENGINE LEVEL

PROCESS LEVEL

FEATURE LEVEL
**Performance Metrics and KPIs**

*examples and relevant users*

<table>
<thead>
<tr>
<th>ENGINE LEVEL</th>
<th>PROCESS LEVEL</th>
<th>FEATURE LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>Throughput</td>
<td></td>
</tr>
<tr>
<td>Flexibility to Spike</td>
<td>Response Time</td>
<td></td>
</tr>
<tr>
<td>Latency</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Towards a Benchmark for BPMN Engines
Performance Metrics and KPIs
examples and relevant users

ENGINE LEVEL
- Throughput
- Capacity
- Response Time
- Flexibility to Spike
- Latency

PROCESS LEVEL
- CPU Usage
- Duration of Process
- RAM Usage

FEATURE LEVEL
Performance Metrics and KPIs
examples and relevant users

**ENGINE LEVEL**
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- RAM Usage
- Duration of Process

**FEATURE LEVEL**
- Delay of Timer Event
- Duration of Message Event
- Space Used by a Data Input
Performance Metrics and KPIs
examples and relevant users

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END-USERS
- VENDORS
- DEVELOPERS
Performance Metrics and KPIs

*minimal data requirements*

Accessibility of the Data

```
WFMS

LOG

DBMS

LOG
```
Performance Metrics and KPIs

*minimial data requirements*

**Accessibility of the Data**

- WfMS
- DBMS

**Availability of Timing Data**

- Workflow & Construct:
  - Start Time
  - End Time
  - [Duration]
Performance Metrics and KPIs

*minimal data requirements*

---

**Accessibility of the Data**

- WfMS
- DBMS

**Availability of Timing Data**

- Workflow & Construct:
  - Start Time
  - End Time
  - [Duration]

**Availability of Execution State**

State of the workflow execution. E.g., running, completed, error
Performance Metrics and KPIs

*collect data*

- **harness**
- **Servers**
- **Containers**
- **DBMS**
- **WfMS**
- **Web Service**
- **Faban Drivers**
- **Test Execution**
Performance Metrics and KPIs

**collect data**

Towards a Benchmark for BPMN Engines
Performance Metrics and KPIs

**collect data**

**Collectors’ Characteristics:**
- Microservices
- Lightweight (written in Go)
- Two types: online and offline
- Buffer data locally
- Expose REST APIs towards Drivers

**Examples of Collectors:**
- Container’s Stats (e.g., CPU usage)
- Database dump
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Performance Metrics and KPIs

amount of data

REALISTIC DATA

Number of Repetitions

Number of Tests

Amount of Data (GB)

Towards a Benchmark for BPMN Engines
Performance Metrics and KPIs

*Amount of data*

**REALISTIC DATA**

**Number of WfMSs**

**Number of Repetitions**

**Number of Tests**

**Amount of Data (GB)**

Towards a Benchmark for BPMN Engines
Performance Metrics and KPIs

transform data

Towards a Benchmark for BPMN Engines
Performance Metrics and KPIs

Transform data

---

Data Mappers

- custom DB format
- unstructured logs
- ...

DATA TRANSFORMERS
Performance Metrics and KPIs

Transform data

Data Mappers

ETL Process

- custom DB format
- unstructured logs
- ...

DATA TRANSFORMERS

Analyses

Test Execution

Towards a Benchmark for BPMN Engines
Performance Metrics and KPIs

Transform data

Test Execution

Analyses

Spark

Fast and general engine for large-scale data processing

Data Mappers

DATA TRANSFORMERS

Towards a Benchmark for BPMN Engines
Performance Metrics and KPIs

analyse data

Data Mappers

Performance Metrics and KPIs

ANALYSERS

DATA TRANSFORMERS

Instance Database

Towards a Benchmark for BPMN Engines
Highlights

Why do we Need a Benchmark?
- companies, developers

1. How to choose the best WfMS according to the company's technical requirements?

2. How to choose the best WfMS according to company’s business process models (workflows)?

3. How to evaluate performance improvements during WfMS's development?

4. How to identify WfMS's bottlenecks?

Why a Benchmark for WfMSs
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Benchmark’s Main Challenges

Main Challenges in Benchmarking BPMN 2.0 WfMSs
- Load Functions
- Workload Mix
- Test Data

WfMS-specific APIs and BPMN 2.0 Customisations
- Asynchronous Execution of Workflows
- Performance Metrics and KPIs

BENCHMARK EXECUTION

ANALYSES
Towards a Benchmark for BPMN Engines

**Highlights**

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**Benchmark’s Main Challenges**

**BenchFlow Framework**
Future Work

BenchFlow framework

1. Finalise the release of the BenchFlow framework as an open-source project on GitHub and DockerHub;

   🌐 https://github.com/benchflow

   🧸 benchflow
Future Work
BenchFlow framework

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   🌐 https://github.com/benchflow

2. Simplify and automate the execution of common performance tests: load test, spike test, scalability test, …
Future Work

1. Perform the first real-world experiments
Future Work

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Execute Different Test Types

• Stress testing
• Spike testing
• Scalability testing
• Configuration testing
Future Work
experiments

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Use Real-World Workflows

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Use Real-World Workflows

Production-like Configurations
Future Work

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Use Real-World Workflows

Production-like Configurations

Realistic:
- Load Functions
- Test Data
Future Work

2. Increase the number of supported WfMSs

**APIs:**

**CORE:** Load Driver APIs

**ADVANCED:** User and Web Service APIs

**FULL:** Event APIs
Future Work

experiments

2. Increase the number of supported WfMSs

**APIs:**

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**FULL:** Event APIs

**Deployable BPMN 2.0 Models:**

WFMS N

</>

XSLT

XML

WFMS N Serialisation

customised test data formatting
Future Work

experiments

2. Increase the number of supported WfMSs

**APIs:**
- **CORE:** Load Driver APIs
- **ADVANCED:** User and Web Service APIs
- **FULL:** Event APIs

**Data:**
- Accessibility of the data
- Availability of timing data
- Availability of execution state

**Deployable BPMN 2.0 Models:**

```
<xml>
  <!-- XSLT transformation -->
  <!-- Serialisation to XML -->
  <!-- WfMS N Serialisation -->
</xml>
```
Call for Collaboration
WfMSs, process models, process logs

**WfMSs**
- We want to add more and more WfMSs to the benchmark
- Contact us for collaboration, and BenchFlow framework support

**Process Models**
- We want to characterise the Workload Mix using Real-World process models
- Share your executable BPMN 2.0 process models, even anonymised

**Execution Logs**
- We want to characterise the Load Functions using Real-World behaviours
- Share your execution logs, even anonymised
Join Us @ ICWE 2016 in Lugano!

6-9 June 2016, USI Lugano, Switzerland

http://icwe2016.inf.usi.ch

Towards a Benchmark for BPMN Engines
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