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Monitoring Testbed Experiments with MonEx

Abdulqawi Saif\textsuperscript{1,2} Alexandre Merlin\textsuperscript{1} Lucas Nussbaum\textsuperscript{1} Ye-Qiong Song\textsuperscript{1}

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\textsuperscript{2}Qwant Entreprise, Épinal, France

April 04, 2018
1\textsuperscript{st} Grid’5000-FIT School - Sophia Antipolis, France
Context

**Computer system experiments**

- Diversity of environments
- Variety of contexts
- Many kinds of outputs
Computer system experiments

- Diversity of environments
- Variety of contexts
- Many kinds of outputs

Experiments’ data is often collected via:

- Ad-hoc solutions (e.g. combining multiple scripts)
- Manual actions (e.g. manipulating some missed values)
- Portability and reproducibility aware-less methods
Context

**Computer system experiments**
- Diversity of environments
- Variety of contexts
- Many kinds of outputs

Experiments’ data is often collected via:
- Ad-hoc solutions *(e.g. combining multiple scripts)*
- Manual actions *(e.g. manipulating some missed values)*
- Portability and reproducibility aware-less methods

How to overcome these challenges?
Context

**Our aim: having an Experiment Monitoring Framework**
- Monitoring?, Yes!, but from experimenters perspective
- Easily collection of experiments’ data
- Reducing experimenters effort during experimentation e.g. facilitating analysis by drawing figures
- Permit to repeat experiment analysis and comparisons

**Open questions:**
- What should be targeted by EMFs?
- What needed to build an EMF?
- Do we need to build EMFs from scratch?
Our aim: having an Experiment Monitoring Framework

- Monitoring?, Yes!, but from experimenters perspective
- Easily collection of experiments’ data
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  e.g. facilitating analysis by drawing figures
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Open questions:

- What should be targeted by EMFs?
- What needed to build an EMF?
- Do we need to build EMFs from scratch?
- EMF requirements
- EMF requirements Vs related work
- MonEx EMF design
- Use case experiments of MonEx
- Grid’5000 and MonEx
- Conclusions
EMF requirements

**Motivation experiment**

- Target: torrent completion
- 100 peers & one seeder
- Dynamic growth of network → adding a peer after $n$ sec
- Emulated bandwidth of peers
EMF requirements

Motivation experiment

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Experiment Monitoring Framework (EMF) requirements

- Experiment-focused
- Independent of experiments
- Independent of testbed services and man. frameworks
- Scalable
- Low impact
- Controllable by users
- Real-time monitoring
- Publishable figures
- Archival of experiments data
### EMF requirements vs related works

<table>
<thead>
<tr>
<th>Infrastructure monitoring tools e.g. Munin</th>
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EMF requirements vs related works

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**EMF requirements vs related works**

**Vendetta** → code modification is necessary  
**OML** → def. of measurement points, compilation with OML code,

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EMF requirements vs related works

Vendetta $\rightarrow$ also a management tool

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EMF requirements vs related works

Inf. mon. → typical for 5-10 m measurements
Vendetta → no info. about the measurement frequency

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**EMF requirements vs related works**

**Inf. mon.** → some with heavy nature (threads, ...)
**Vendetta** → parsing events in-place

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EMF requirements vs related works

Testbed-provided services → specific infrastructure

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EMF requirements vs related works

Inf. mon. & Testbed-provided services → only by infrastructure operators

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## EMF requirements vs related works

Inf. mon. & Testbed-provided services → RRDtool

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Experiments running on a testbed

Collects data

Push or Pull

MonEx EMF (Monitoring Experiments)

MonEx: Experiment Monitoring Framework

Data collectors

Prometheus

OR

InfluxDB

Get Exp_A

Start or end Exp_A

Draw Exp_B

An experimenter

MonEx figures creator

Grafana

(Real-time visualization)

MonEx

Experiment-focused
Independent of experiments
Independent of testbeds services
Scalability
Low impact
Easy deployment
Controllable
Real-time monitoring
Producing publication-quality figures
Archival of data
Monitoring Testbed Experiments with MonEx

MonEx EMF (Monitoring Experiments)

Experiments running on a testbed

MonEx: Experiment Monitoring Framework

- Data collectors
  - Prometheus
  - InfluxDB

Start or end Exp_A
Get Exp_A
Draw Exp_B

An experimenter

MonEx server

MonEx: Experiment Monitoring Framework

MonEx figures creator

Experiments running on a testbed

- Experiment-focused
- Independent of experiments
- Independent of testbeds services
- Scalability
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- Easy deployment
- Controllable
- Real-time monitoring
- Producing publication-quality figures
- Archival of data

Prometheus
- Up-to 1 sec as a polling interval 😊
- A lot of data exporters
  e.g. node spec, specific app.
- Fixed-interval polling 😞

InfluxDB
- Suitable for pushing data 😊
- Variated interval measurements 😊
MonEx EMF (Monitoring Experiments)

Experiments running on a testbed

Collects data
Push or Pull

MonEx server
MonEx: Experiment Monitoring Framework
MonEx figures creator

Exp_A

Exp_B

Prometheus
metrics
OR

InfluxDB
metrics

Grafana
(Real-time visualization)

Start or end Exp_A
Get Exp_A
Draw Exp_B

An experimenter

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MonEx EMF (Monitoring Experiments)

- Create figures that respect publication aspects e.g. X-Y figures, Y-figures, multiple Y-figures, stack figures, . . .
MonEx EMF (Monitoring Experiments)

- Handle experiments by name
- Specify experiment time boundaries
- Allow interacting with experiments metrics

MonEx: Experiment Monitoring Framework

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MonEx EMF (Monitoring Experiments)

Experiments running on a testbed

MonEx: Experiment Monitoring Framework

Data collectors

- Prometheus
  - metrics
- InfluxDB
  - metrics

MonEx server

MonEx figures creator

Grafana
(Real-time visualization)

Start or end Exp_A
Get Exp_A
Draw Exp_B

An experimenter

Experiments running on a testbed

Collects data

Push or Pull

MonEx

- Experiment-focused
- Independent of experiments
- Independent of testbeds services
- Scalability
- Low impact
- Easy deployment
- Controllable
- Real-time monitoring
- Producing publication-quality figures
- Archival of data
**MonEx EMF (Monitoring Experiments)**

Experiments running on a testbed

![Diagram](image)

**MonEx: Experiment Monitoring Framework**

- Data collectors
  - Prometheus
  - InfluxDB

- MonEx server
- MonEx figures creator
- Grafana
  - *(Real-time visualization)*

- Start or end Exp_A
- Get Exp_A
- Draw Exp_B

**An experimenter**

<table>
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<td>1. Make a <strong>usual experiment deployment</strong></td>
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<tr>
<td>2. Communicate data with MonEx</td>
</tr>
<tr>
<td>→ <strong>Expose it for Prom. or push it into InfluxDB</strong></td>
</tr>
<tr>
<td>→ <strong>Use or write your own exporters</strong></td>
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**MonEx**

- Experiment-focused
- Independent of experiments
- Independent of testbeds services
- Scalability
- Low impact
- Easy deployment
- Controllable
- Real-time monitoring
- Producing publication-quality figures
- Archival of data
Use case experiments

Three different experiments
- Highlighting MonEx ability to cover EMF requirements
- Performed on the Grid’5000 testbed

First Experiment: many-nodes Bittorrent Download
- One seeder & 100 peers
- Transmission as torrent client
- Distem for emulating slow peers (30KB/s)
- Dedicated VLAN for monitoring traffic
- Prometheus as a MonEx data collector
- We use our own exporter\(^1\) (tens LOC)

First Experiment: workflow

Monitoring Testbed Experiments with MonEx
First Experiment: workflow

Make a usual deployment and install MonEx
First Experiment: workflow

```
curl -X POST MonEx_IP:5000/exp/Exp_A
```
First Experiment: workflow

Bittorrent experiment

Pull monitoring

MonEx: Experiment Monitoring Framework

Data collectors

Prometheus
metrics

MonEx server

MonEx figures creator

Grafana (Real-time visualization)

Run experiments' workload
Use case experiments

First Experiment: workflow

```
curl -X PUT MonEx_IP:5000/exp/Exp_A
```
First Experiment: workflow

Bittorrent experiment

MonEx: Experiment Monitoring Framework

Data collectors

Prometheus

MonEx server

MonEx figures creator

Grafana
(Real-time visualization)

Pull monitoring

Draw main metric of Exp_A

An experimenter

Torrent completion of a 500MBytes file over time on a 30 kBytes/s network

```
./monex-draw -S M_IP:5000 -exp "Exp_A" -metric "completion" -type "duration" -t "Torrent ..." -y "Completion (%)
-x "Time (sec)" -n
```
Second Experiment: metrics diversity

- Metrics: HDD Util & power of a *MongoDB* cluster
- Three-shard nodes & 80 GB of total data
- *Prometheus* as a data collector & *Grafana* for visualization
- Two default node-exporters of *Prometheus*
  - node-exporter → nodes spec.
  - SNMP-exporter → PDUs data

Disk utilization (%)

<table>
<thead>
<tr>
<th>Time (sec)</th>
<th>node1</th>
<th>node2</th>
<th>node3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30</td>
<td>40</td>
<td>50</td>
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<tr>
<td>200</td>
<td>20</td>
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<td>400</td>
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<tr>
<td>600</td>
<td>0</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

Power usage (W)

<table>
<thead>
<tr>
<th>Time (sec)</th>
<th>Disk utilization (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>120</td>
</tr>
<tr>
<td>200</td>
<td>130</td>
</tr>
<tr>
<td>400</td>
<td>140</td>
</tr>
<tr>
<td>600</td>
<td>150</td>
</tr>
</tbody>
</table>
Third Experiment: time-dependent & heavy-measurement

- Metric: file offsets vs sequences of I/O requests
- High-frequency measurement (thousands of I/O) → pushing data to InfluxDB
- Generate I/O traces using an eBPF tool
- Fio benchmark generates rand. read workload

Third Experiment: results

- Get data
  curl -X GET 127.1:5000/exp/accessPattern -H "Content-Type: application/json" -d '{"measurement":"ebpf","server":"influx","database":"monex","type":"sample"}' > d.csv
- Draw-it!
  ./monex-draw -F d.csv -x "I/O request (sample)" -y "Offset (bytes)" -p -r "random"
MonEx leverages several features of Grid’5000:

- Monitoring traffic on separate LAN or another NIC
  - Targeting scalable experiments
    e.g. torrent experiment
- Up-to-date docs and rich API
  e.g. We automated the power experiment thanks to a Grid’5000 wiki page
- Co-operating easily with outside environment
  e.g. placing MonEx outside the testbed
- Deploying customized images with root privileges
  e.g. with built-in node-exporters
Conclusions:

- We defined the minimal requirements of EMFs
- Absence of related work with full coverage of requirements
- We designed MonEx EMF on top of Prometheus and InfluxDB monitoring systems
  - Usable on various experimentations’ context
  - Efficient for analysis repetition and metrics comparisons
  - First step to unifying experiments’ data collection methods
  - Towards experiments portability and reproducibility

Future prospects:

- MonEx maturity?
- Monitoring experiments on federated testbeds

Any Questions?
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