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Monitoring Testbed Experiments with *MonEx*

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\(^2\)Qwant Entreprise, Épinal, France

April 04, 2018
1\(^{st}\) *Grid’5000-FIT* School - Sophia Antipolis, France
Context

**Computer system experiments**

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

Computer system experiments

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- 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
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**Computer system experiments**
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**Experiments’ data is often collected via:**
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- Manual actions *(e.g. manipulating some missed values)*
- Portability and reproducibility aware-less methods

How to overcome these challenges?
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?
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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
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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EMF requirements

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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>
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EMF requirements vs related works

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

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EMF requirements vs related works

**Vendetta → 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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Inf. mon. & Testbed-provided services → RRDtool

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MonEx EMF (Monitoring Experiments)

MonEx server
MonEx: Experiment Monitoring Framework
MonEx figures creator

Grafana
(Real-time visualization)

Prometheus

InfluxDB

Data collectors

Start or end Exp_A
Get Exp_A
Draw Exp_B

An experimenter

Experiments running on a testbed

Collects data
Push or Pull

Exp_A
Exp_B

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**MonEx EMF (Monitoring Experiments)**

- 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 😊

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**MonEx EMF** (**Monitoring Experiments**)

#### MonEx: Experiment Monitoring Framework

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- **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)**

MonEx is an open-source tool that provides a monitoring framework for experiments running on a testbed.

- **MonEx** server
- MonEx figures creator
- Grafana (Real-time visualization)
- **Data collectors**
  - Prometheus
  - InfluxDB

**MonEx: Experiment Monitoring Framework**

- Collects data
  - Push or Pull
- **Start or end Exp_A**
- **Get Exp_A**
- **Draw Exp_B**

**Experiments running on a testbed**

**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**

- Handle experiments by name
- Specify experiment time boundaries
- Allow interacting with experiments metrics
MonEx EMF (Monitoring Experiments)

Experiments running on a testbed

MonEx: Experiment Monitoring Framework

- Data collectors
  - Prometheus
  - InfluxDB

OR

- 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

Collected data
Push or Pull

MonEx

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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

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An experimenter

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**Experimenter responsibilities:**

1. Make a **usual experiment deployment**

2. Communicate data with MonEx
   - **Expose it for Prom. or push it into InfluxDB**
   - Use or **write your own exporter(s)**
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

Bittorrent experiment

MonEx: Experiment Monitoring Framework

Data collectors

Prometheus

metrics

MonEx server

MonEx figures creator

Grafana
(Real-time visualization)

An experimenter
First Experiment: workflow

Make a usual deployment and install \textit{MonEx}
First Experiment: workflow

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

Run experiments' workload
First Experiment: workflow

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

Bittorrent experiment

MonEx: Experiment Monitoring Framework

Data collectors

Prometheus

metrics

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
Use case experiments

**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

![Graphs showing disk utilization and power usage over time for node1, node2, and node3](image)

**Monitoring Testbed Experiments with MonEx**
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"
Grid’5000 and MonEx

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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Any Questions?