Scientific workflow optimization using systemlogs

Provenance data integration for workflows.

B.A. Blaauwgeers

University of Amsterdam

alexander.blaauwgeers@os3.nl

Research Project 1 Presentation
Supervisor: Zhiming Zhao

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Introduction

These days workflows becoming more complex because of new techniques like **distributed cloud based systems**. There is a need to intergrate the different sources of provenance data generated by workflows.

- Workflow management is there to control the **flow** of information,.
- The service is a **black box** for the Workflow management system.
- Workflow management aims to create an **abstract** of more then one autonomous systems and their functions

Research question

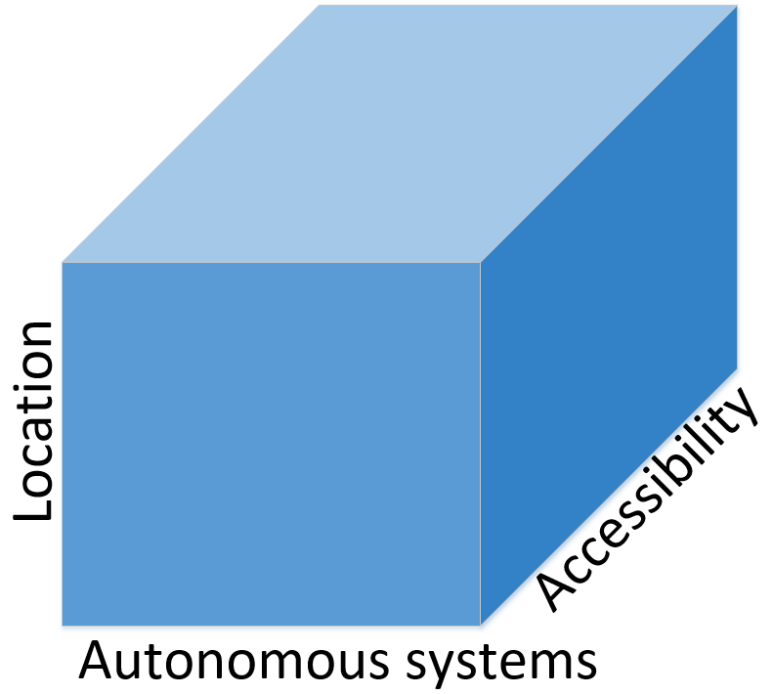
The main question for this research is:

How can different sources of provenance data generated by scientific workflows be integrated to allow analysis?

The research question can be divided into multiple sub-questions:

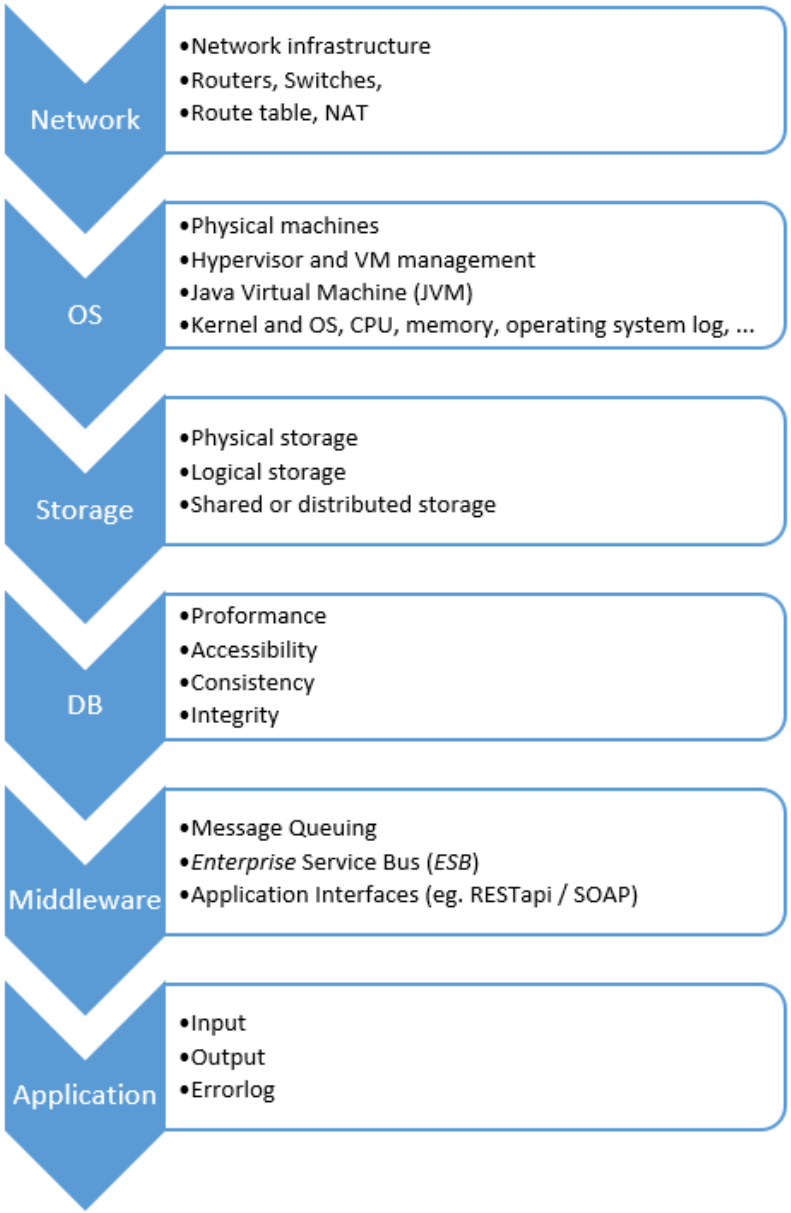
1. What main types of (scientific) workflow exist?
2. What kind of system logs are available according specific use cases?
3. How can the workflow system be integrated with systemlogs?

Theory: Complexity of workflow (1)



- Amount of distributed autonomous systems.
- Accessibility and availability of logs. (Application, Syslog, PROV)
- Geographical and logical location. (Local, Remote, Cloud, ...)

Theory: Chain of logs (2)

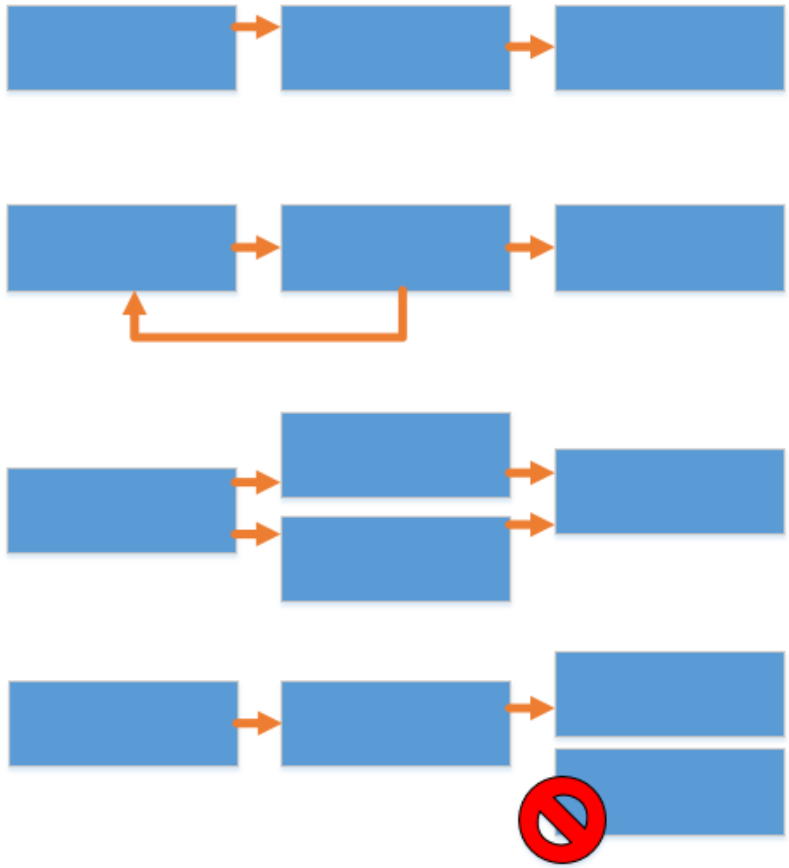


Source: Blaauwgeers B.A., november 2015

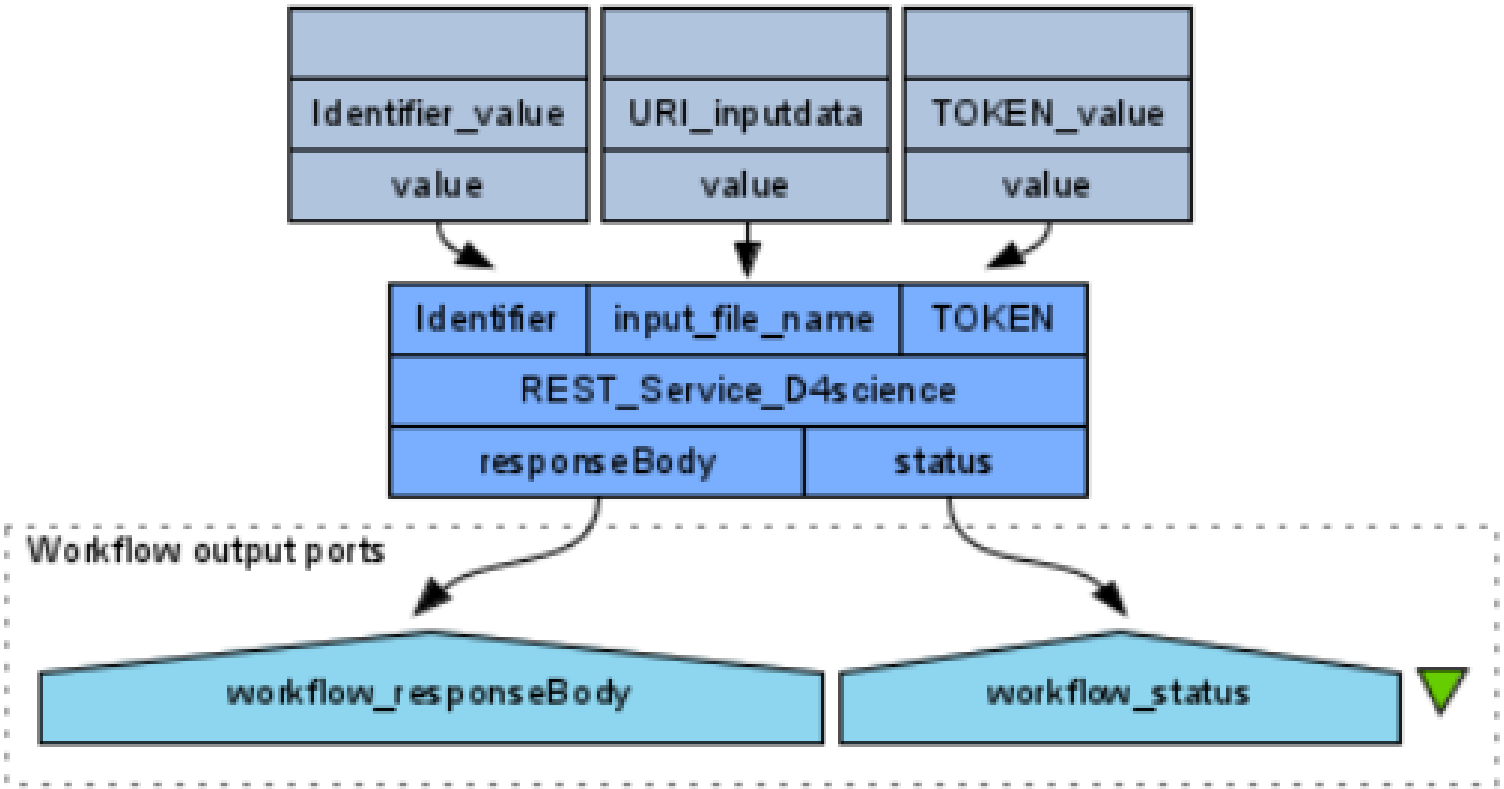
Theory: Types of workflows (3)

There are different time of workflows, eg.

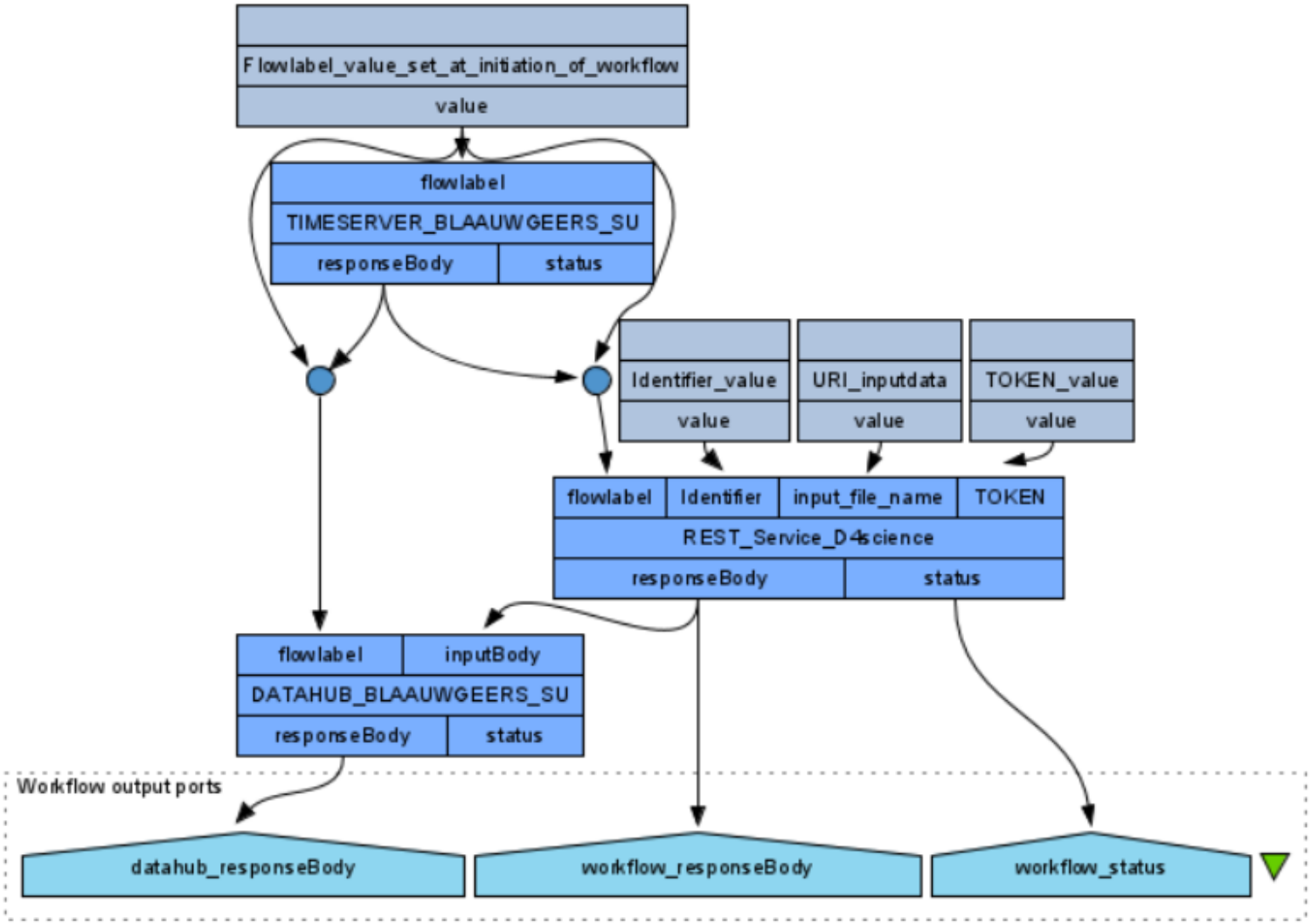
- linear
- recursive
- parallel
- decision based



Workflow: An example of an workflow



Workflow: Workflow with integrator



Experiment: Intergrator Endpoint Example

```php
<?php
require_once("XML2Array.function.php");
#if(!isset($_POST[""])) { header("HTTP/1.1 405 Method Not Allowed"); echo "Error: Post Expected"; exit(); }

$fname["xml"] = "post." . $_GET["flowlabel"] . "." . time() . ".xml";
$fname["log"] = "post." . $_GET["flowlabel"] . "." . time() . ".log";
$fname["data"] = "post." . $_GET["flowlabel"] . "." . time() . ".data";

$fdata = file_get_contents('php://input');
file_put_contents($fname["xml"],$fdata);

#get the file
$flowout = file_get_contents($fname["xml"]);

#Replace the liligal character before parsing to the simple object.
$flowbuffer = str_replace(":", "-", $flowout);

#Convert the xml-string value to an array via a simple xml object.
$flowxml   = simplexml_load_string($flowbuffer);
$flowarray = XML2Array($flowxml);
$flowarray = array($flowxml->getName() => $flowarray);
#grep the wps data.
$flowwps = $flowarray["wps-ExecuteResponse"]["wps-ProcessOutputs"]["wps-Output"]["wps-Data"]["wps-ComplexData"][

#grep the locator of d4s
$flowdfs["data"] = str_replace("http-", "http:", $flowwps[0]["d4science-Data"]); #Log of the computation
$flowdfs["log"] =  str_replace("http-", "http:", $flowwps["d4science-Data"]); #output_file_name

file_put_contents($fname["log"], fopen($flowdfs["log"], 'r'));
file_put_contents($fname["data"], fopen($flowdfs["data"], 'r'));
?>
```

Results: Intergrator log

Inspecting log files on the integrator hub:

```
ablaauwgeers@ipa:/var/log/nginx$ sudo zgrep "rpa" access.log.6.gz | grep java | tail -n 8
145.100.102.66 - - [29/Jun/2018:08:52:10 -0400] "POST /rpa/endpoint.php?flowlabel=0020T HTTP/1.1" 200 259 "-" "Apache-HttpClient/4.0.1 (java 1.5)"
145.100.102.66 - - [29/Jun/2018:08:56:30 -0400] "POST /rpa/endpoint.php?flowlabel=0021T HTTP/1.1" 200 259 "-" "Apache-HttpClient/4.0.1 (java 1.5)"
62.72.193.87 - - [29/Jun/2018:09:03:13 -0400] "GET /rpa/flowlabel.php?flowlabel=0031T.init HTTP/1.1" 200 21 "-" "Apache-HttpClient/4.0.1 (java 1.5)"
62.72.193.87 - - [29/Jun/2018:09:31:37 -0400] "GET /rpa/flowlabel.php?flowlabel=0033T.init HTTP/1.1" 200 21 "-" "Apache-HttpClient/4.0.1 (java 1.5)"
62.72.193.87 - - [29/Jun/2018:09:32:15 -0400] "GET /rpa/flowlabel.php?flowlabel=0034T.init HTTP/1.1" 200 21 "-" "Apache-HttpClient/4.0.1 (java 1.5)"
62.72.193.87 - - [29/Jun/2018:09:32:49 -0400] "GET /rpa/flowlabel.php?flowlabel=0035T.init HTTP/1.1" 200 21 "-" "Apache-HttpClient/4.0.1 (java 1.5)"
145.100.102.66 - - [29/Jun/2018:10:11:14 -0400] "POST /rpa/endpoint.php?flowlabel=0033T HTTP/1.1" 200 259 "-" "Apache-HttpClient/4.0.1 (java 1.5)"
145.100.102.66 - - [29/Jun/2018:10:16:57 -0400] "POST /rpa/endpoint.php?flowlabel=0035T HTTP/1.1" 200 259 "-" "Apache-HttpClient/4.0.1 (java 1.5)"
ablaauwgeers@ipa:/var/log/nginx$
```

```
00] "POST /rpa/endpoint.php?flowlabel=0020T HTTP/1.1" 200
00] "POST /rpa/endpoint.php?flowlabel=0021T HTTP/1.1" 200
 "GET /rpa/flowlabel.php?flowlabel=0031T.init HTTP/1.1"
 "GET /rpa/flowlabel.php?flowlabel=0033T.init HTTP/1.1"
 "GET /rpa/flowlabel.php?flowlabel=0034T.init HTTP/1.1"
 "GET /rpa/flowlabel.php?flowlabel=0035T.init HTTP/1.1"
00] "POST /rpa/endpoint.php?flowlabel=0033T HTTP/1.1" 200
00] "POST /rpa/endpoint.php?flowlabel=0035T HTTP/1.1" 200
```

Results: Intergrator flow data

Inspecting flow files on the integrator hub

```
ablaauwgeers@ipa:/var/www/html/rpa$ ls -la | grep "post.0020T"
-rw-r--r-- 1 www-data     www-data 900278 Jun 29 08:52 post.0020T.1530276728.data
-rw-r--r-- 1 www-data     www-data   4441 Jun 29 08:52 post.0020T.1530276728.log
-rw-r--r-- 1 www-data     www-data   2270 Jun 29 08:52 post.0020T.1530276728.xml
-rw-r--r-- 1 www-data     www-data     10 Jun 29 08:13 post.0020T.init.1530274439.init
ablaauwgeers@ipa:/var/www/html/rpa$
```

Results: Logdata on external application

Logfiles of the example application of the research group[1].

```
ablaauwgeers@desktop-30:~/Downloads/cue_service_logs$ grep "0020T"
localhost_access_log.2018-06-29.txt
10.255.0.2 - - [29/Jun/2018:12:13:25 +0000] "GET /cue/rest/argo/get?
geospatial_lat_min=38.000&geospatial_lat_max=38.200&geospatial_lon_m
in=147.000&geospatial_lon_max=147.100&flowlabel=0020T HTTP/1.1" 200
28172
10.255.0.2 - - [29/Jun/2018:12:13:25 +0000] "GET /cue/rest/argo/get?
geospatial_lat_min=38.000&geospatial_lat_max=38.200&geospatial_lon_m
in=147.000&geospatial_lon_max=147.100&flowlabel=0020T HTTP/1.1" 200
28172
```

[1] With thanks to Spiros Koulouzis

Discussion

- Log data might be influenced by (business-)policies, containerization, time-zones, namespacing, (NAT-) translation.
  - Can be reduced by adding a **flowlabel** and **timestamp** to the requests.
- **Access rights** to the log files are required.
- Some integrator functions might break **when components of the workflow change**.
- Apache Taverna was used as Workflow Manager for the experiment.

Conclusion

- The usage of an **integrator** hub as service is useful during the integration of workflows.
- It is recommended to add a **flowlabel** and **timestamp** to the API calls.
- This integrator **collects and enriches** the log files during the execution.
- The collection of log files can be used to create a **timeline** on which **analysis** can be preformed.
- The **accessibility** of log data is important for completeness of the picture.

Future work

- Should be tested with **different** kind of Workflow **Managers**.
- Improvement on the integration to support **more services**.
- To make the integrator more **resilient to workflow changes**.
- **Distribution strategy** of the integrator and limit the single point of failure.

Questions?

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