

SUMMER STUDENT - PROJECT REPORT



Contribution to the new Database on demand Web application

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1 Introduction

1.1 Context

Particle physics is built entirely around statistical tests, as a consequence of the probabilistic very essence of quantum physics and strong experimental uncertainties in this sector. We need therefore to ensure the persistence of measurements long after the collisions take place in order to be able to establish tangible physical results. This is why databases are critical entities in particle physics experiments.

The multiplication of activities at CERN, the strong trend towards clouding of research and development tools and the decentralisation of computing units have pushed CERN's dedicated department - the IT-DB department which welcomed me as a Summer Student - to set up a unified web interface allowing database users to carry out ordinary tasks without systematically having to go through the administrator staff.

This interface was developed under the ZK framework which is no longer one of the most popular Web technologies. Currently, it is the node.js eco-system and the front-end MVC frameworks Angular, React and Vue.

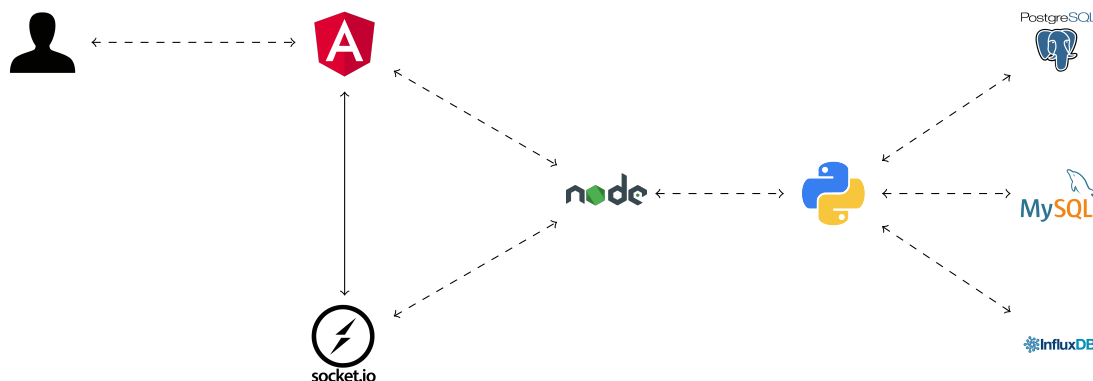
That is why it was decided to completely redesign this Web interface in order to make it more modern, more ergonomic and more modular. My work at CERN is part of this process, and in this document I will only mention the features that I have entirely developed or on which I intervened.

1.2 Terminology

- *Instance*: implied "database instance", an autonomous storage entity set up for the needs of a particular activity at CERN.
- *Log*: text data provided by an instance, whose content may largely vary.
- *Job*: action performed on an instance asynchronously.
- *Snapshot*: save of the past state of an instance, in order to be able to restore it in case of major problem.
- *Backup*: creation of a snapshot.

1.3 Architecture & technologies

The following scheme constitutes a summary of the architecture on which the new database on demand system is built:





We can distinguish three parts:

- The *database management* part, where an agnostic Python REST API and Rundeck services form the very back-end. Logs (defined above) are stored in an ElasticSearch database.
- The *node.js* part (using Express framework), formed of an HTTPS proxy, handling authentication and permissions, giving access to ElasticSearch, and making use of socket.io (a package dedicated to real-time communication between client and server).
- The *front-end* - or client side - on which I worked the most (but not exclusively) using Angular and Angular Material to provide an elegant and ergonomic interface to the user.

1.4 The asynchronous paradigm

The new dominant “way of thinking” - which has a lot of virtues - in the web developpment landscape is the *asynchronous paradigm*, in which client and server can exchange requests and responses in a completely symmetric way and without blocking behaviours. Socket.io is the technology used here to establish this bi-directionnal communication channel (websocket), used in a parcimounious way (in the sense that the server, although it queries the database frequently, only sends relevant changes to the user).

However, it also brings new concepts such as *Promises* or *Observables* which need to be understood in order to write quality asynchronous code.

In the next four sections I will describe in detail the different features I have implemented, first a part of the authentication & permissions to access the website, then the Dashboard page, the Instance page and finally the API.

2 Authentication & permissions

Access to a particular instance is restricted to its owner and to administrators. Authentication is done through the OAuth CERN service, then the persistence of session is guaranteed by a JSON Web Token, signed by the server and transmitted to the user using HTTPS protocol.

Once the identity of the user is clearly established, the node proxy implements a validation system:

```
1 function routesValidate(req,auth) {
2   switch(req.url.split('?')[0].split('/')[1]) {
3     case('instance') :
4       // If user is admin, or owns the instance and is not doing a POST or DELETE
4         request on anything else than 'attribute/backup'
5       return auth.admin || (req.url.split('?')[0].split('/')[2]==undefined || auth.
          instances.includes(req.url.split('?')[0].split('/')[2])) && (req.method!='
          POST' && req.method!='DELETE' || req.url.split('?')[0].split('/')[3]=='
          attribute' && req.url.split('?')[0].split('/')[4]!='backup');
6     break;
7     case('rundeck') :
8       // If user is admin, or owns the instance
9       return auth.admin || auth.instances.includes(req.url.split('?')[0].split('/')
          [4]);
10    break;
11    // Additionnal routes access restriction come here
12    default:
13      return true;
14  }
15 }
```

3 Dashboard page

The *Dashboard* is the first page of interest the user will access once he will be logged on.

3.1 Instances overview

Instances Overview							
Filter							
ID ↑	State	Name	Owner	Egroup	Project	Type	Category
358	Running	mys01	icoteril	dbondemand-admin	DBOD	MYSQL	TEST
378	Running	rdeck_p	cdelort	dbondemand-admin	DBOD	MYSQL	PROD
484	Running	moninf	icoteril	dbondemand-admin	DB On Demand	InfluxDB	PROD
512	Running	postgd1	aromerom	dbondemand-admin	DB On Demand	PG	TEST
821	Awaiting approval	pgpool01	isotirop	dbondemand-admin	dbod	PG	REF
883	Running	myd1	icoteril	dbondemand-admin	DB On Demand	MYSQL	REF
1458	Running	influxd2	dcollado	dbondemand-admin	DBOD	InfluxDB	REF
1459	Maintenance	influxd3	dcollado	dbondemand-admin	DBOD	InfluxDB	REF
2999	Running	ts_eval	estefanc	dbondemand-admin	DBOD	InfluxDB	REF
3040	Awaiting approval	ts_eval2	estefanc	dbondemand-admin	DBOD	PG	REF
Items per page: 10 11 - 20 of 20 < >							

This table provides efficient access to instances, implementing a filtering, paging and sorting system.

3.2 Jobs overview

Jobs Overview

« « 1 2 3 4 5 6 7 8 9 10 ... 75 » » Filters Items per page

Finished	May 14, 2018, 12:14:28 PM	May 14, 2018, 12:15:35 PM	BACKUP requested by icoteril	▼
Finished	Jul 25, 2018, 12:14:28 PM	Jul 25, 2018, 12:15:39 PM	BACKUP requested by icoteril	▼
Finished	May 18, 2018, 12:14:28 PM	May 18, 2018, 12:15:16 PM	BACKUP requested by icoteril	▼
Finished	May 20, 2018, 11:39:01 PM	May 20, 2018, 11:39:27 PM	BACKUP_LOGS_TO_TAPE requested by icoteril	▼
Finished	Apr 29, 2018, 3:30:00 PM	Apr 29, 2018, 3:31:12 PM	BACKUP requested by icoteril	▼
Finished	Jun 28, 2018, 11:39:01 PM	Jun 28, 2018, 11:39:27 PM	BACKUP_LOGS_TO_TAPE requested by icoteril	▼
Finished	May 17, 2018, 12:14:28 PM	May 17, 2018, 12:15:22 PM	BACKUP requested by icoteril	▼
Finished	May 17, 2018, 10:10:00 AM	May 17, 2018, 10:11:12 AM	BACKUP requested by dcollado	▼
Finished	Jun 21, 2018, 11:39:02 PM	Jun 21, 2018, 11:39:29 PM	BACKUP_LOGS_TO_TAPE requested by icoteril	▼
Finished	May 26, 2018, 11:39:01 PM	May 26, 2018, 11:39:31 PM	BACKUP_LOGS_TO_TAPE requested by icoteril	▼

This table displays in real time the jobs of the instances concerning you (or of all instances for the administrators), allowing a fast and global monitoring of the evolution of the actions in progress.

4 Instance page

The main page I worked on is the one you access after a click on an instance in the table mentioned above. It is dedicated to the management of the instance, providing most of the common tools allowing the user to monitor his instance efficiently and change its settings.

4.1 One instance's state & parameters

RUNNING

 **pinocho**
IT-DB Ignacio Cotterillo Coz

Owner icoteril	Egroup dbondemand-admin	Project DBOD2	Description MySQL puppet test
Creation date 2014-08-26T00:00:00	Expiry date 2018-09-28T00:00:00	Type MYSQL	Version 1.0.1
Category REF	☒ Notifications		

An instance can be in one of the five following states:

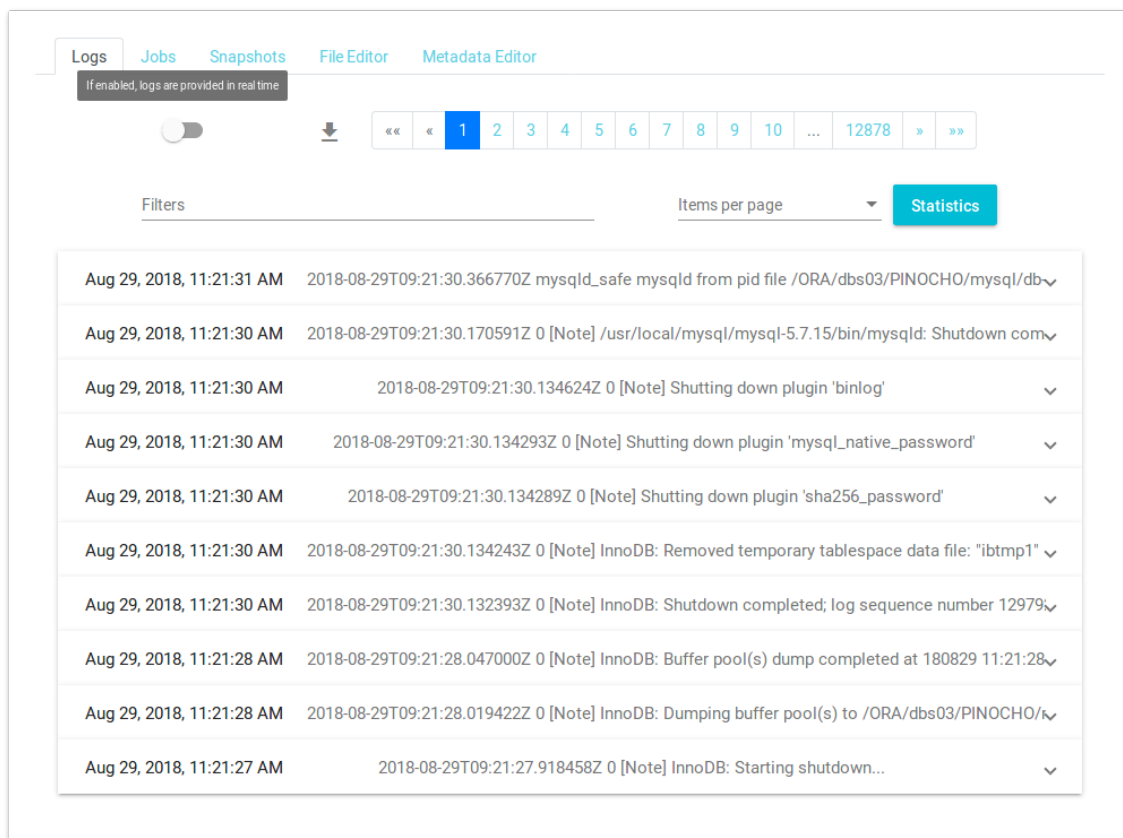
- Running
- Stopped
- Awaiting Approval
- Busy
- Maintenance



A click on the button indicating the status of the instance opens a menu allowing to launch the "Start" and "Stop" jobs.

Below are several editable fields, some of which are grayed out depending on the permissions you are granted.

4.2 Logs tab



The screenshot shows the 'Logs' tab in the DBOD web application. The interface includes a navigation bar with tabs for 'Logs', 'Jobs', 'Snapshots', 'File Editor', and 'Metadata Editor'. Below the navigation bar, there is a toggle switch for 'If enabled, logs are provided in real time'. A pagination bar shows the current page is 1 out of 12878. Below the pagination bar, there is a 'Filters' section and an 'Items per page' dropdown menu. A 'Statistics' button is also present. The main content area displays a list of log entries with columns for the timestamp, the log message, and a dropdown arrow for more details.

Timestamp	Log Message	Action
Aug 29, 2018, 11:21:31 AM	2018-08-29T09:21:30.366770Z mysqld_safe mysqld from pid file /ORA/dbs03/PINOCHO/mysql/db~	▼
Aug 29, 2018, 11:21:30 AM	2018-08-29T09:21:30.170591Z 0 [Note] /usr/local/mysql/mysql-5.7.15/bin/mysqld: Shutdown com~	▼
Aug 29, 2018, 11:21:30 AM	2018-08-29T09:21:30.134624Z 0 [Note] Shutting down plugin 'binlog'	▼
Aug 29, 2018, 11:21:30 AM	2018-08-29T09:21:30.134293Z 0 [Note] Shutting down plugin 'mysql_native_password'	▼
Aug 29, 2018, 11:21:30 AM	2018-08-29T09:21:30.134289Z 0 [Note] Shutting down plugin 'sha256_password'	▼
Aug 29, 2018, 11:21:30 AM	2018-08-29T09:21:30.134243Z 0 [Note] InnoDB: Removed temporary tablespace data file: "ibtmp1"	▼
Aug 29, 2018, 11:21:30 AM	2018-08-29T09:21:30.132393Z 0 [Note] InnoDB: Shutdown completed; log sequence number 12979~	▼
Aug 29, 2018, 11:21:28 AM	2018-08-29T09:21:28.047000Z 0 [Note] InnoDB: Buffer pool(s) dump completed at 180829 11:21:28~	▼
Aug 29, 2018, 11:21:28 AM	2018-08-29T09:21:28.019422Z 0 [Note] InnoDB: Dumping buffer pool(s) to /ORA/dbs03/PINOCHO/~	▼
Aug 29, 2018, 11:21:27 AM	2018-08-29T09:21:27.918458Z 0 [Note] InnoDB: Starting shutdown...	▼

A button enables or disables the supply of logs in real time. A paging and filtering system is set up to facilitate their exploitation. Clicking on a Log title displays the complete JSON containing the log details.

Aug 29, 2018, 11:21:30 AM
2018-08-29T09:21:30.134293Z 0 [Note] Shutting down plugin 'mysql_native_password'

```

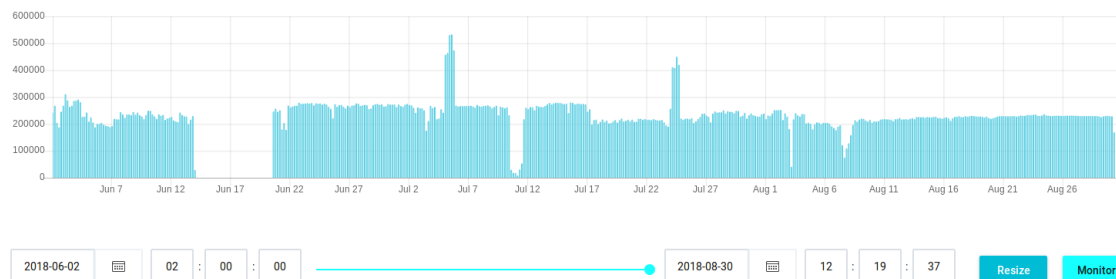
{
  "message": "2018-08-29T09:21:30.134293Z 0 [Note] Shutting down plugin 'mysql_native_password'",
  "type": "mylog",
  "host": {
    "name": "db-gc505.cern.ch"
  },
  "logstash_start_filter_timestamp": "1535534492491",
  "@timestamp": "2018-08-29T09:21:30.134Z",
  "@version": "1",
  "msg_timestamp": "2018-08-29T09:21:30.134293Z",
  "log_source": "instances",
  "mysql": {
    "error": {
      "level": "Note",
      "message": "Shutting down plugin 'mysql_native_password'",
      "thread_id": "0"
    }
  },
  "source": "/ORA/dbs03/PINOCHO/mysql/db-gc505.cern.ch.err",
  "timestamp_processed_in_logstash": "2018-08-29T09:21:31.371Z",
  "index": "itdb_dbod-mylog-2018.08.29",
  "beat": {
    "name": "db-gc505.cern.ch",
    "version": "6.4.0",
    "hostname": "db-gc505.cern.ch"
  },
  "offset": 123891,
  "tags": [
    "beats_input_codec_plain_applied",
    "matched"
  ],
  "logstash_source": "dbod-logstash-c01.cern.ch",
  "instance": "pinocho"
}

```

The filtering system is based on the Elasticsearch Query Strings, and thus allows the main logical connectors such as negation (!), conjunction (AND) and disjunction (OR). Restrict a search to a single field, like *@field:keyword* is supported too.

It is also possible to download the log files.

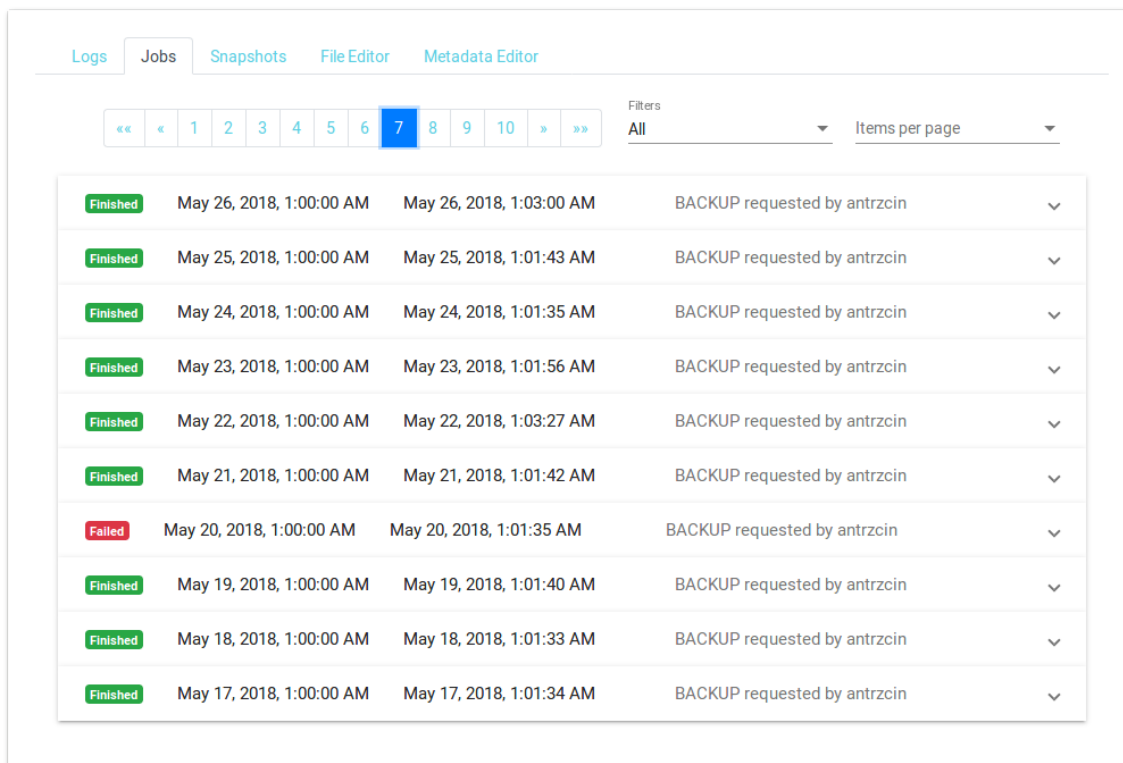
Clicking on the statistics button displays the following panel:



This histogram is dedicated to the visualization of the instance activity. It is possible to choose the start and end date of this histogram, in order to focus on a particular time slot. The "Resize" button selects the time window framing all the instance logs. A slider is used to adjust the histogram resolution.

Finally, the "Monitor" button can be used to activate real-time new histogram data (refreshed every ten seconds), the end date being then associated with the present moment. This is the best way to visualize the activity on a database so that you can react quickly in case of problem.

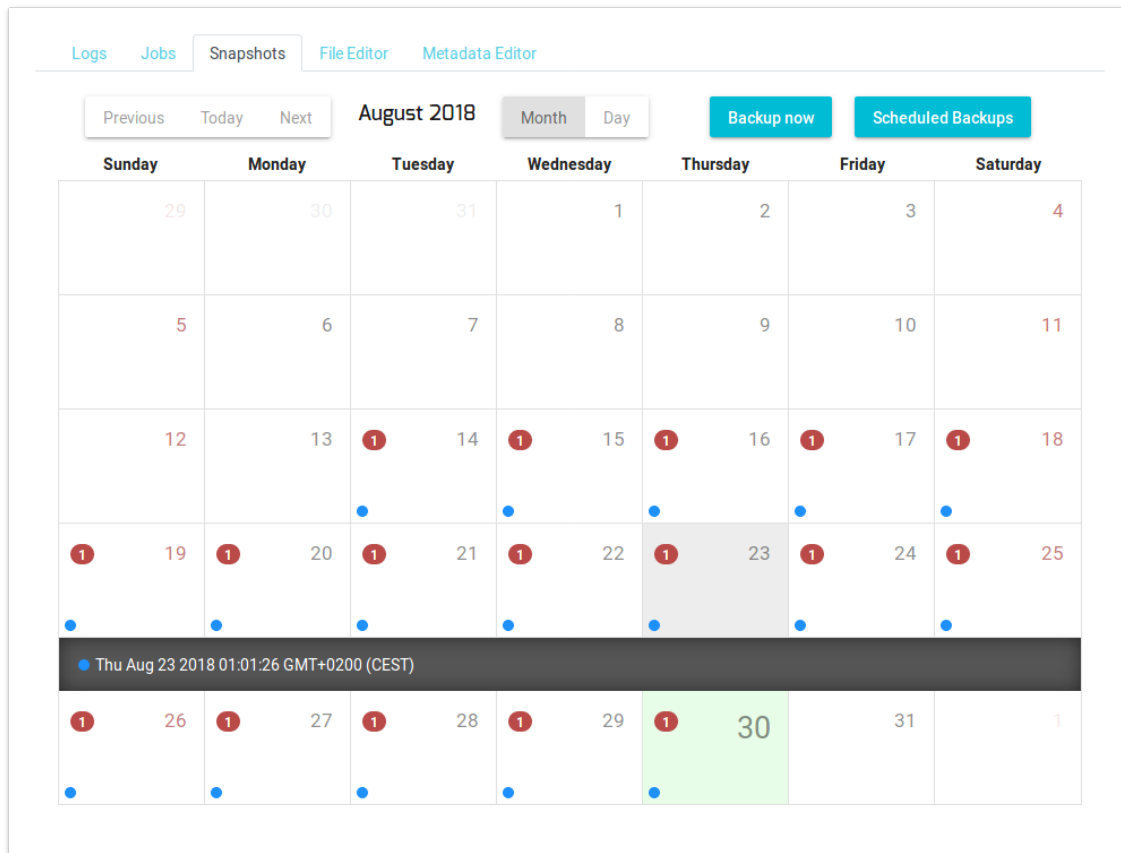
4.3 Jobs tab



Status	Start Time	End Time	Description	Action
Finished	May 26, 2018, 1:00:00 AM	May 26, 2018, 1:03:00 AM	BACKUP requested by antrzcine	▼
Finished	May 25, 2018, 1:00:00 AM	May 25, 2018, 1:01:43 AM	BACKUP requested by antrzcine	▼
Finished	May 24, 2018, 1:00:00 AM	May 24, 2018, 1:01:35 AM	BACKUP requested by antrzcine	▼
Finished	May 23, 2018, 1:00:00 AM	May 23, 2018, 1:01:56 AM	BACKUP requested by antrzcine	▼
Finished	May 22, 2018, 1:00:00 AM	May 22, 2018, 1:03:27 AM	BACKUP requested by antrzcine	▼
Finished	May 21, 2018, 1:00:00 AM	May 21, 2018, 1:01:42 AM	BACKUP requested by antrzcine	▼
Failed	May 20, 2018, 1:00:00 AM	May 20, 2018, 1:01:35 AM	BACKUP requested by antrzcine	▼
Finished	May 19, 2018, 1:00:00 AM	May 19, 2018, 1:01:40 AM	BACKUP requested by antrzcine	▼
Finished	May 18, 2018, 1:00:00 AM	May 18, 2018, 1:01:33 AM	BACKUP requested by antrzcine	▼
Finished	May 17, 2018, 1:00:00 AM	May 17, 2018, 1:01:34 AM	BACKUP requested by antrzcine	▼

This tab plays the same role as the previous tab, but for the jobs ran in the corresponding instance.

4.4 Snapshots tab



This tab displays an interactive calendar containing all snapshots performed. Two viewing modes are possible, by month and by day. By clicking on a snapshot, you are asked whether you would like to recover it. A "Backup Now" button is used to create a backup, and "Scheduled Backup" to set the time of day at which scheduled backups are performed (or to disable them).

Snapshot settings

You can rename the snapshot :

Wed Aug 15 2018 16:21:49 GMT+0200...

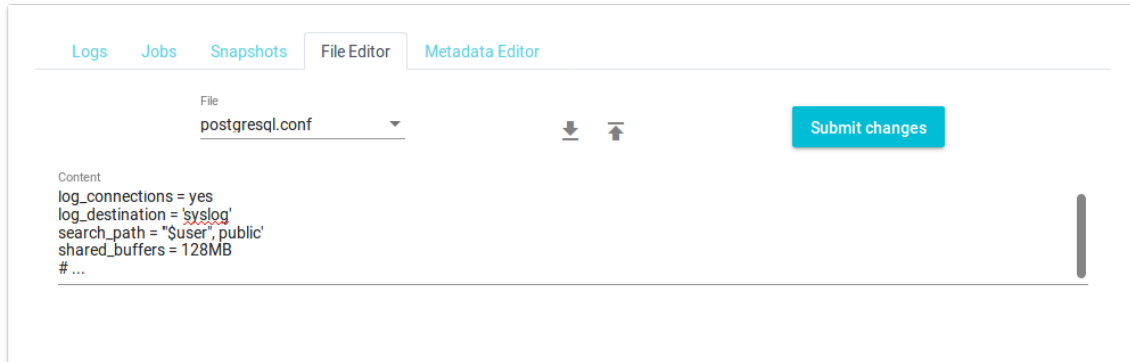
Or recover it :

Backup scheduling

Here are the parameters of your backup shedule. Backup at :

:

4.5 File Editor tab



This tab allows you to access the different configuration files of the instance, edit them online, download them and upload new ones.

5 API

A secure API is provided to users who want to control their instances without using the website. In order to do so they need to connect using HTTPS to `/auth` and log-on in the unified CERN panel to get the JSON Web Token containing their session information.

This token can be used by anybody, so users should be careful and always use HTTPS in order to avoid man-in-the-middle attacks!

The following table contains all the information needed to use this API. To use it, simply provide the JSON Web Token in a field called `jwt-session` in the Header of every request:

Name	Path	Type	Parameters
Authentication	<code>/auth</code>	GET	
List instances	<code>/instance</code>	GET	
Get instance parameters	<code>/instance/instance-name</code>	GET	
Modify instance parameter	<code>/instance/instance-id</code>	PUT	{parameter-name : value}
Modify instance attribute	<code>/instance/instance-id/attribute/attribute-name</code>	PUT	value
Activate scheduled backups	<code>/instance/instance-id/attribute/backup</code>	POST	cron code
Modify scheduled backups	<code>/instance/instance-id/attribute/backup</code>	PUT	cron code
Disable scheduled backups	<code>/instance/instance-id/attribute/backup</code>	DELETE	
Backup now	<code>/rundeck/job/backup/instance-name</code>	POST	
Recover	<code>/rundeck/job/recover/instance-name</code>	POST	
Start instance	<code>/rundeck/job/start/instance-name</code>	POST	
Stop instance	<code>/rundeck/job/stop/instance-name</code>	POST	
Get snapshots	<code>/rundeck/job/get-snapshots/instance-name</code>	POST	
List config files	<code>/rundeck/job/list-config-files/instance-name</code>	POST	
List log files	<code>/rundeck/job/list-log-files/instance-name</code>	POST	
Serve file	<code>/rundeck/job/serve-file/instance-name</code>	POST	{filepath: value}
Get file served	<code>dbod-instance-name.cern.ch:55005</code>	GET	

6 Conclusion

In addition to the Summer Student program as a whole, which was an extremely enriching experience that enabled me to specify my professional project, this move to the IT-DB department was an opportunity for me to acquire skills that I would not have sought on my own. In particular, knowledge of session systems, protocols securing client-server communications and standard libraries of graphic components. I now feel able to “develop full-stack” common Web applications using modern tools.



Nowadays, there is the package *NW.js* which allows to transform in an almost instantaneous way such Web application into Desktop one. As an engineer with an orientation to scientific calculus and at a time when the trend is to mutualized tools, it is an interesting skill to know how to create versatile, modular and user-friendly interfaces.

In addition, I think that one of the most interesting aspects I have had the opportunity to discover during this project at CERN relates to the management techniques employed there, that is totally different from to what I have seen so far. Things are organized in such a way that I've almost never been short of work, the absence of pressure exerted by the hierarchy is very beneficial to maintain motivation.

Finally, I would like to thank my supervisor Charles Delort for trusting my skills during the recruitment - not being a computer science student, he took me on the basis of uncertified skills - and his monitoring. Thanks to Ignacio Coterillo as well to lead this project with a master hand, and the Summer Student Team for their great kindness.