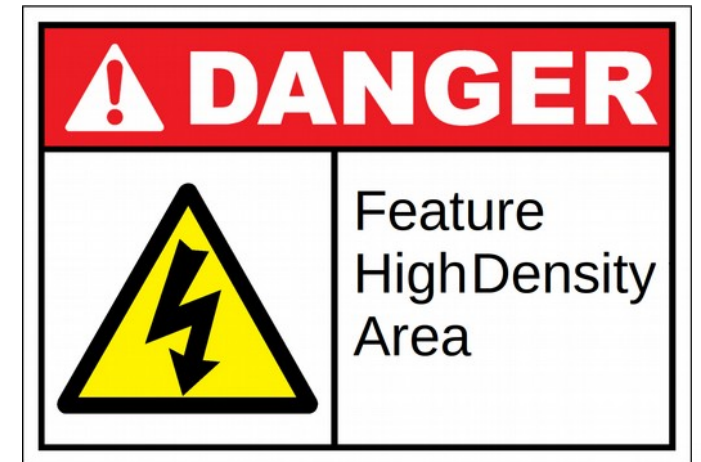# Operating ARC CEs:
sysadmin toolbox and resource usage analysis

Accounting and sysadmin tools in ARC6

ARCCTL: CE under your control

Deployment Automation
- CA Certificates
- VOMS
- Firewall
- Package install

Service Control

manage ARC services based on configuration

Configuration Management
- overview
- validation
- in-line help
- runtime config

Jobs Control
- get info, logs, script
- kill and clean
- ownership
- statistics

arcctl

Accounting, Usage Analysis
- who is using CE
- how they using CE
- how much CPU, memory, disc, network

Worker Node Environment
- features available during job runtime
- environment setup
- containers support

Data Staging
- cache control
- transfers stats

ARC Control Tool
designed to automate ARC CE operations for sysadmins

Andrii Salnikov

ARCCTL Highlights

- **Single entry point** to manage ARC and related subsystems
  - one-stop-shop for sysadmins of ARC6 sites
- **Easy to use** without knowledge of ARC internals
  - quick start for new ARC CE admins
- **Shortcuts** to automate typical CE administrations and management operations
  - effective maintenance and troubleshooting
- **Modular** and **extendable**
- Designed with **bash-completion in mind**
  - Easy to find component, ID, etc
  - Completes names, Job IDs, Certificate DNs, etc
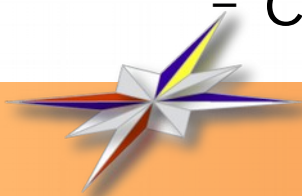
ARCCTL: Deployment and Service Control

- Install ARC CE package*

  - `yum install nordugrid-arc-arex`

- Deploy CA certificates

  - `arcctl deploy igtf-ca classic`

- Fetch VOMS trust chains

  - `arcctl deploy voms-lsc -e atlas`

- Modify `arc.conf`

  - Storage areas and cache

  - Batch system and queues

  - Authorization rules

- Configure firewall

  - `arcctl deploy iptables-config`

- Run it "as-configured"

  - `arcctl service start --as-configured`

*Available from EPEL or NorduGrid repositories

ARCCTL: Analyze the ARC CE setup

- Read full configuration including all defaults
  - `arcctl config dump`

- Find important paths (system dirs and logs)
  - `arcctl config brief`

- Apply config tuning using inline
  or online configuration reference
  - `arcctl config describe`

- Verify configuration syntax
  - `arcctl config verify`

```
[root ~]$ arcctl config brief
ARC Storage Areas:
    Control directory:
        /var/spool/arc/jobstatus
    Session directories:
        /home/grid/arc6.univ/session
    Scratch directory on Worker Node:
        Not configured
    Cache directories:
        /home/grid/arc6.univ/cache
    Additional user-defined RTE directories:
        Not configured
    Accounting a...
        /var/spoo...
ARC Log Files:
    A-REX Service...
        /var/log/...
    A-REX Jobs lo...
        /var/log/...
    A-REX Helpers...
        /var/log/...
    A-REX WS Inte...
        /var/log/...
    A-REX Data St...
        Not confi...
```

defaultttl

Synopsis: `defaultttl = [ttl [ttr]]`

Description: The ttl parameter sets the time in seconds for how long a
job session directory will survive after job execution has finished. If not
specified the default is 1 week. The ttr parameter sets how long
information about a job will be kept after the session directory is
deleted. If not specified, the ttr default is one month.

Default: `604800 2592000`

Example:

`defaultttl=2592000`

```
[root ~]$ arcctl config describe arex defaultttl
## defaultttl = [ttl [ttr]] - The ttl parameter sets the time...
## directory will survive after job execution has finished. If not specified
## the default is 1 week. The ttr parameter sets how long information about a job will be kept
## after the session directory is deleted. If not specified, the ttr default is one month.
## default: 604800 2592000
```

```
        Infosys LDAP/BDII logs:
            /var/log/arc/bdii
```

ARCCTL: Configuring Worker Node Environment

ARC CE has a feature of **dynamic and flexible provisioning** of the **execution environments on the WN** (**RunTimeEnvironment(RTE) concept**).

Various **RTE categories** to advertise and configure:

- **feature** (`ENV/PROXY`)

- **resource** (`ENV/GPU`)

- **software** (`APPS/HEP/ATLAS`)

**Out of the box RTEs
are included!**

- Enable to be requested on-demand
  - `arcctl rte enable ENV/PROXY`

- Configure for all jobs
  - `arcctl rte params-set ENV/SINGULARITY
     SINGULARITY_IMAGE
     default:/srv/containers/centos7.img`
  - `arcctl rte default ENV/SINGULARITY`

ARCCTL: Working with CE Jobs
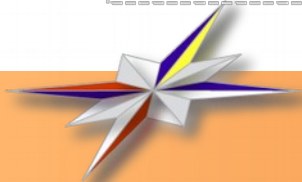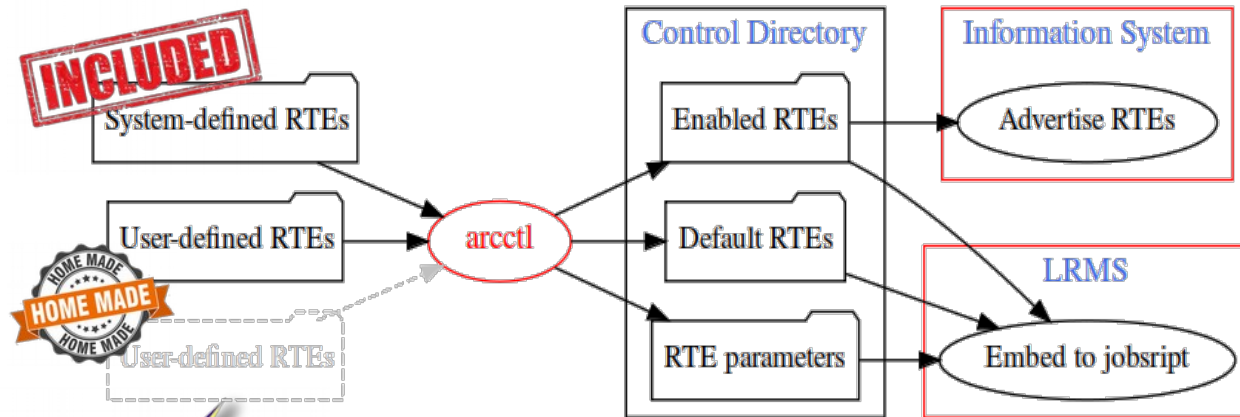
NOTICE
Only subset of command line arguments shown here!

- Check jobs
  - `arcctl job list [-o OWNER]`
  - `arcctl job stats`

- Job details
  - `arcctl job info JOBID`
  - `arcctl job attr JOBID [attr]`

- Job processing logs
  - `arcctl job log JOBID [-s]`

- Job batch script and output
  - `arcctl job script JOBID`
  - `arcctl job std{out|err} JOBID`

- Job control
  - `arcctl kill JOBID`
  - `arcctl cleanall -o OWNER`

```
[root ~]$ arcctl -d INFO job killall -o "/DC=org/DC=ugrid/O=people/O=KNU/
CN=Andrii Salnikov"
[2019-11-14 14:32:54] [Arc.gm-jobs] [INFO] [5927/13526032] Job: 4PLODmbAu
lvnjwO5upha6lOqABFKDmABFKDmENIKDmEBFKDmWik1Mm : Cancel request put
[2019-11-14 14:32:54] [Arc.gm-jobs] [INFO] [5927/13526032] Job: LLCMDmWwB
mvnjwO5upha6lOqABFKDmABFKDmHHJKDmABFKDmb0EFJo : Cancel request put
[2019-11-14 14:32:54] [Arc.gm-jobs] [INFO] [5927/13526032] Job: KJ0NDmZxB
mvnjwO5upha6lOqABFKDmABFKDmENIKDmHBFKDm6uS52n : Cancel request put
[2019-11-14 14:32:54] [Arc.gm-jobs] [INFO] [5927/13526032] Job: JCILDmN7s
mvnjwO5upha6lOqABFKDmABFKDm0lIKDmABFKDmNpLeLm : Cancel request put
```

ARCCTL: Accounting and Usage Analysis

- ## General accounting data queries
  - `arcctl accounting stats`

- ## Per-job resource usage analysis
  - `arcctl accounting job info`

- ## Job life-cycle events
  - `arcctl accounting job events`

- ## Job data transfers detailed history
  - `arcctl accounting job transfers`
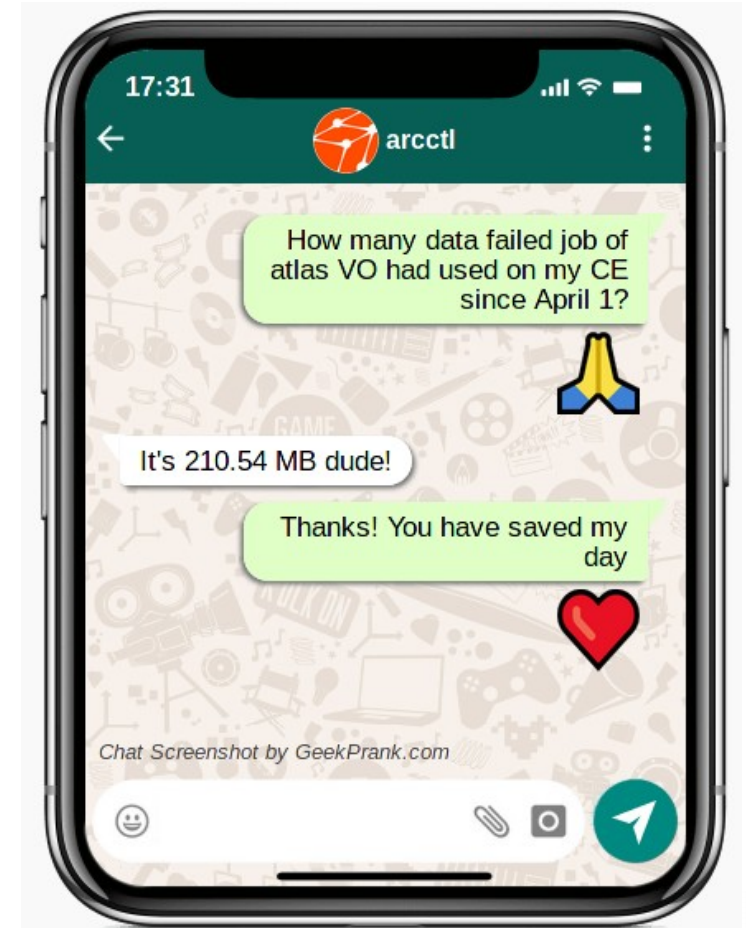
Accounting: keep track on resource usage

- ARC CE accounting subsystem collects data about **per-job resource usage** in the local **SQLite database** for **on-site CE auditing** and **publishing**

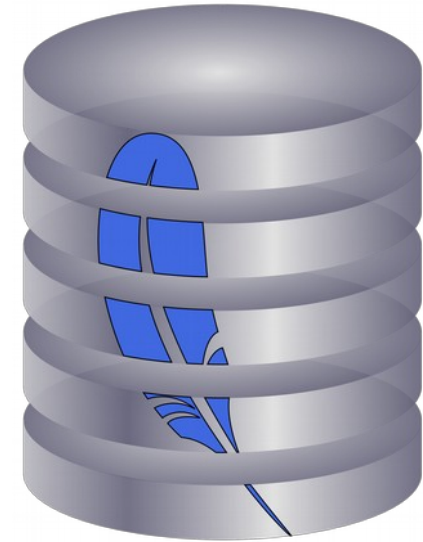- A-REX Accounting Record* **(AAR)** defines data stored about the job
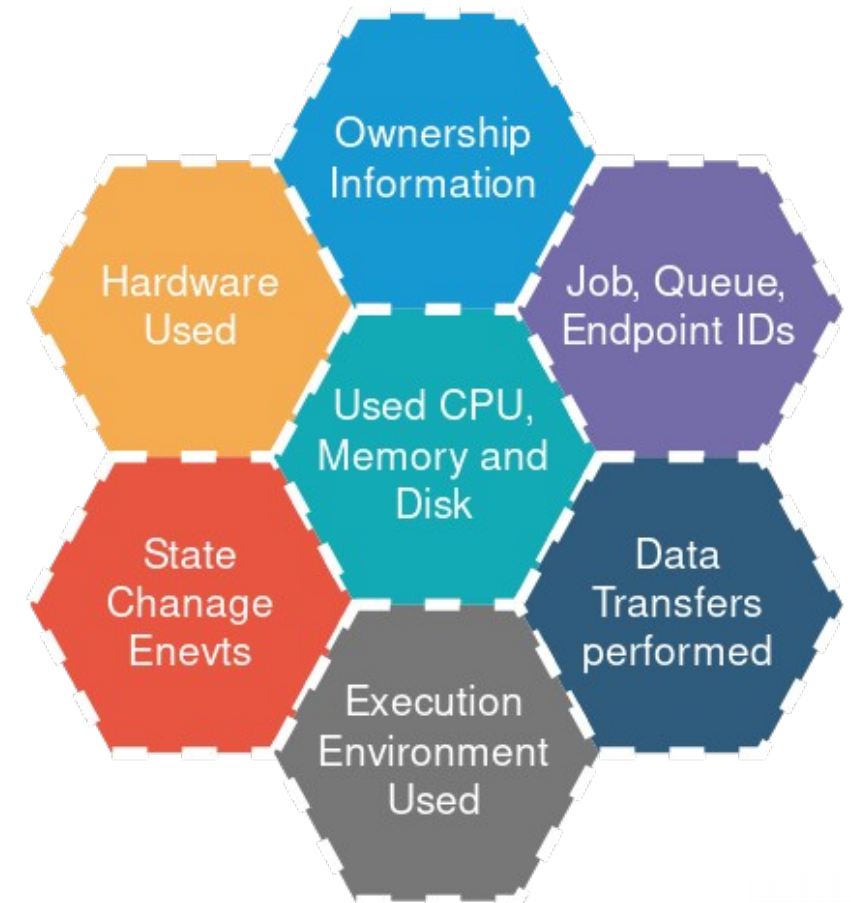
Complete AAR Definition can be found in the documentation.

Accounting highlights: database

- Accounting DB is **integral part** of A-REX (v 6.4) and **always populated**
  - Approx. **10MB** of data per **5000** jobs
  - **SQLite**: no need to deploy additional services
  - Highly scalable

Scalability tested on 10 000 000 jobs database that was recreated from data collected for real jobs usage records archived during 5 year!

# Accounting: collecting and publishing data

- Support for various **resource usage measurement** methods:
  - batch system data
  - GNU Time tool
  - **arc-job-cgroup** tool

- **Job Usage Reporter (JURA)** subsystem for **publishing records** to central accounting services:
  - Multiple simultaneous targets (**SGAS** and **APEL** are supported)
  - **OGF.98 UR**, **EMI CAR 1.2**, **APEL Summary** and **APEL Sync** formats
  - Highly configurable per-target

Accounting: technical details
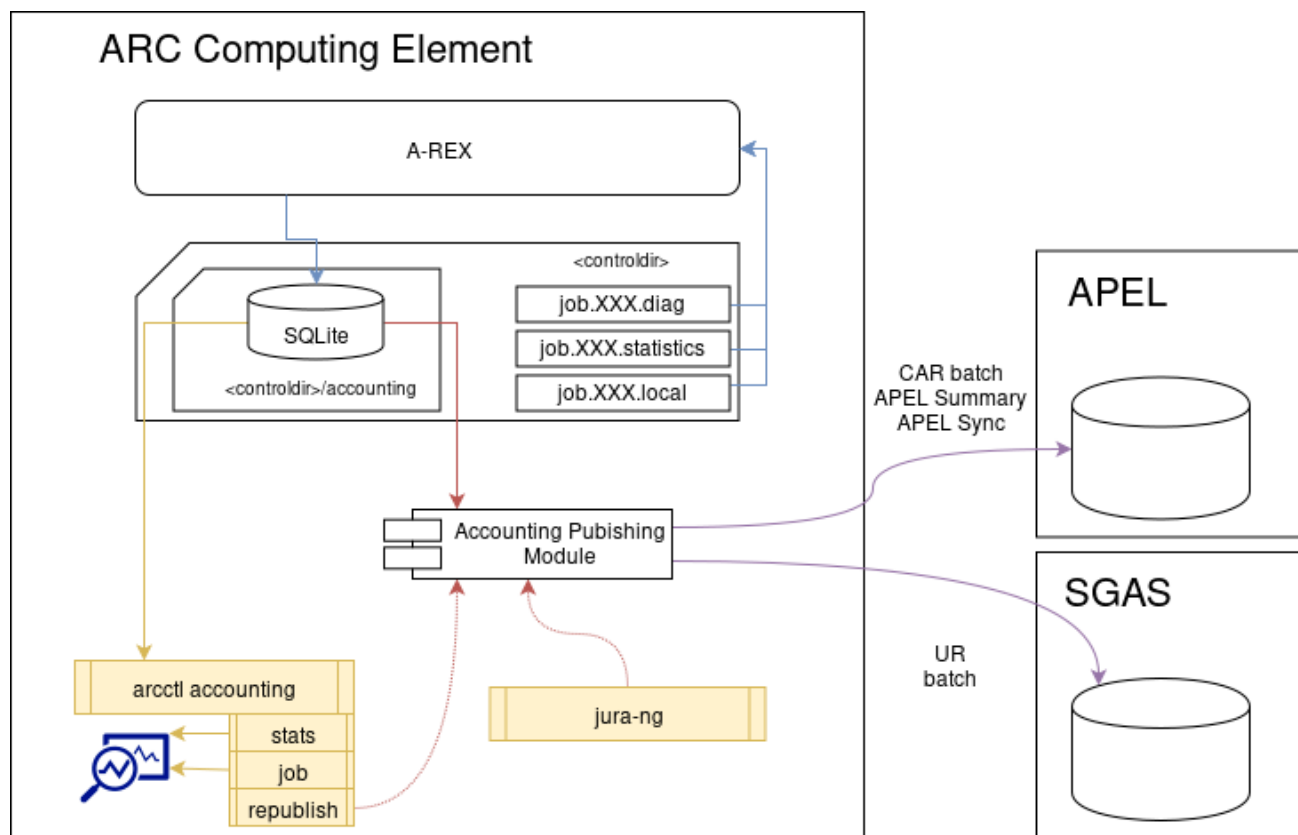
- **Database is a central point** of the accounting
- **Updated by A-REX** on each job state change event
- Source of data for **local analysis**
- Source of data for **publishing**
  - old data can be easily (re)published to newly added target

Local analysis: `arcctl job info`

```
[root ~]# arcctl accounting job info rUyNDmQoRpvnHHSrXqgZnWSqksstOoABFKDm7eKKDmAB
Job rUyNDmQoRpvnHHSrXqgZnWSqksstOoABFKDm7eKKDmAB accounting info:
===============================================================================
Job description:
  Job was submitted at 2019-11-14 10:45:47 via "org.nordugrid.gridftpjob" interface
using "gsiftp://atlas.bluegrass.nsc.liu.se:2811/jobs" endpoint.
  Job owned by "/DC=ch/DC=cern/OU=Organic Units/OU=Users/CN=atlact1/CN=Robot: ATLAS
aCT 1" as a member of "atlas" WLCG VO.
  It was targeted to the "bluegrass" queue with "1906417" LRMS ID.
  Job completed with exit code 0 at 2019-11-14 12:44:14.
  Following job properties are recorded:
    Localuser: atlasuser0000:atlasuser0000
    Lrms: SLURM
    Systemsoftware: CentOS Linux 7 (Core)
    Nodenames: n1535
    Benchmark: HEPSPEC:15.925
    Jobname: user.gfrattar.410470.PhPy8EG_ttbar_FTAG1.pflow.mc16e.1Nov/.4546575012
```

To Be Continued...

Local analysis: `arcctl job info` (continued)

Resource usage:
Execution timeframe: 2019-11-14 10:45:47 - 2019-11-14 12:44:14
Used WallTime: 2296
Used CPUTime: 2358 (including 62 of kernel time)
Used WN Scratch: 21.3M
Max physical memory: 1.3M
Max virtual memory: 1.3M
Used CPUs: 1 on 1 node(s)
Data staged in: 585.2M
Data staged out: 7.1M

Used RunTime Environments:
ENV/PROXY
APPS/HEP/ATLAS-SITE
ENV/RTE

Auth token attributes provided:
VOMS FQAN: /atlas/Role=pilot
VOMS FQAN: /atlas
VOMS FQAN: /atlas/lcg1

[root ~]$ arcctl accounting job info aa4LDmSm3IvnjwO5upha6lOqABFKDmABF KDmxSFKDmPqGKDmf2jwwn -o json
{"RunTimeEnvironments": [], "UserSN": "/DC=EU/DC=EGI/C=HR/O=Robots/O=S RCE/CN=Robot:argo-egi@cro-ngi.hr", "NodeCount": 1, "VOID": 3, "JobEven ts": [["LRMSSTART", "2019-08-17 05:37:04"], ["LRMSEND", "2019-08-17 05 :37:05"], ["ACCEPTED", "2019-08-17 05:37:52"], ["PREPARING", "2019-08- 17 05:37:52"], ["DTRDOWNLOADSTART", "2019-08-17 05:37:52"], ["DTRDOWNL DADEND", "2019-08-17 05:37:52"], ["SUBMIT", "2019-08-17 05:37:53"], [" INLRMS", "2019-08-17 05:37:53"], ["FINISHING", "2019-08-17 05:42:20"], ["DTRUPLOADSTART", "2019-08-17 05:42:20"], ["DTRUPLOADEND", "2019-08- 17 05:42:33"], ["FINISHED", "2019-08-17 05:42:34"]], "UserID": 2, "Job ID": "aa4LDmSm3IvnjwO5upha6lOqABFKDmABFKDmxSFKDmPqGKDmf2jwwn", "Queue" : "grid_rt", "WLCGVO": "ops", "StageOutVolume": 24, "CPUCount": 1, "En dTime": "2019-08-17 02:42:34", "UsedScratch": 746, "UsedVirtMem": 1056 , "DataTransfers": [{"url": "srm://se05.esc.qmul.ac.uk/ops/nagios-argo -mon.egi.cro-ngi.hr/arcce/srm-input", "timestart": "2019-08-17 02:37:5 2", "type": "cache_input", "timeend": "2019-08-17 02:37:52", "size": 5 7}, {"url": "srm://se05.esc.qmul.ac.uk/ops/nagios-argo-mon.egi.cro-ngi .hr/arcce/srm-20190817T0437-arc6.univ.kiev.ua", "timestart": "2019-08- 17 02:42:20", "type": "output", "timeend": "2019-08-17 02:42:33", "siz e": 24}], "Status": "completed", "QueueID": 3, "JobExtraInfo": {"local user": "ops23:ops", "jobname": "org.nordugrid.ARC-CE-SRM-result-ops", "systemsoftware": "CentOS Linux 7 (Core)", "clienthost": "161.53.0.239 :55218", "lrms": "pbs", "nodenames": "s3"}, "AuthTokenAttributes": [[" mainfqan", "/ops"]], "RecordID": 1832, "UsedCPUTime": 0, "EndpointURL" : "https://arc6.univ.kiev.ua:443/arex", "UsedMemory": 1056, "UsedWallt ime": 1, "SubmitTime": "2019-08-17 02:37:52", "StageInVolume": 0, "End pointID": 1, "Interface": "org.ogf.glue.emies.activitycreation", "Used CPUUserTime": 0, "ExitCode": 0, "StatusID": 3, "UsedCPUKernelTime": 0, "LocalJobID": "2817764"}

Want it machine-readable?
Use "`-o json`"!

ARCCTL: analysis of job events and transfers

```
[root ~]# arcctl accounting job events
rUyNDmQoRpvnHHSrXqgZnWSqkstOoABFKDm7eKKDmAB
2019-11-14 11:45:47  ACCEPTED
2019-11-14 11:45:47  PREPARING
2019-11-14 11:45:47  DTRDOWNLOADSTART
2019-11-14 13:02:38  DTRDOWNLOADEND
2019-11-14 13:02:39  SUBMIT
2019-11-14 13:02:52  INLRMS
2019-11-14 13:03:26  LRMSSTART
2019-11-14 13:41:42  LRMSEND
2019-11-14 13:42:50  FINISHING
2019-11-14 13:42:53  DTRUPLOADSTART
2019-11-14 13:44:13  DTRUPLOADEND
2019-11-14 13:44:14  FINISHED
```

```
[root ~]# arcctl accounting job transfers
rUyNDmQoRpvnHHSrXqgZnWSqksstOoABFKDm7eKKDmAB
Data transfers (downloads) performed during A-REX stage-in:
    http://pandaserver.cern.ch:25085/cache/pilot/pilot2.tar.gz
    (from cache):
        Size: 258.4K
        Download timeframe: 2019-11-14 10:45:47 - 2019-11-14
10:45:50
    rucio://rucio-lb-prod.cern.ch/replicas/mc1_13TeV/
    DAOD_FTAG1.19607426._001748.pool.root.1:
        Size: 564.7M
        Download timeframe: 2019-11-14 10:45:48 - 2019-11-14
11:58:51
<output omitted>
Data transfers (uploads) performed during A-REX stage-out:
    srm://srm.ndgf.org:8443/srm/managerv2?SFN=/atlas/disk/
    atlasscratchdisk/rucio/panda/42/82/
    panda.um.user.gfrattar.19770512._001292.output.root:checksumty
    pe=adler32:checksumvalue=75aa3e91:
        Size: 7.1M
        Upload timeframe: 2019-11-14 12:42:53 - 2019-11-14 12:44:13
<output omitted>
```

ARCCTL: Resource usage statistics

```
[root arc-dev]# arcctl accounting stats
A-REX Accounting Statistics:
  Number of Jobs: 238
  Execution timeframe: 2019-07-09 18:42:18 - 2019-07-12 15:16:56
  Total WallTime: 6 days, 1:35:37
  Total CPUTime: 4:19:45 (including 0:00:00 of kernel time)
  Data staged in: 62.1M
  Data staged out: 1.7K
```

```
[root arc-dev]# arcctl accounting stats --filter-state failed --filter-vo atlas \
> --start-from 2019-04-01 -o data-staged-in
220767192
```

```
[root arc-dev]# arcctl accounting stats --filter-extra jobname "test 04" -o jobids
g3AMDmCCP5unf5481mks8bjnABFKDmABFKDmN9IKDmIBFKDmnjU0ym
nEhMDmvqQ5unf5481mks8bjnABFKDmABFKDmN9IKDmZBFKDmtXEYGn
UufLDmmmS5unf5481mks8bjnABFKDmABFKDmmSMKDmNBFKDm9nRnVo
bdoLDmCnS5unf5481mks8bjnABFKDmABFKDmmSMKDmaBFKDmfKldDn
```

```
[root arc-dev]# arcctl accounting stats --filter-queue grid \
> --filter-user /DC\=org/DC\=ugrid/O\=people/O\=KNU/CN\=Andrii\
A-REX Accounting Statistics:
  Number of Jobs: 8
  Execution timeframe: 2019-07-09 18:42:18 - 2019-07-10 17:31:59
  Total WallTime: 0:01:20
  Total CPUTime: 0:00:00 (including
  Data staged in: 61.7M
  Data staged out: 0
```

```
[root arc-dev]# arcctl accounting stats --filter-extra rte ENV/PROXY -o json | jq .
{
  "stageout": 0,
  "rangeend": 1562938441,
  "count": 86,
  "cpukerneltime": 0,
  "users": [
    "/DC=EU/DC=EGI/C=HR/O=Robots/O=SRCE/CN=Robot:argo-egi@cro-ngi.hr",
    "/DC=EU/DC=EGI/C=GR/O=Robots/O=Greek Research and Technology Network/CN=Robot:argo-egi@grnet.gr"
  ],
  "wlcgvos": [
    "ops"
  ],
  "cpuusertime": 0,
  "cputime": 0,
  "rangestart": 1562688395,
  "stagein": 398180,
  "walltime": 172
}
```

WARNING: ARCCTL is highly addictive!

- Once upon a time there was a sysadmin who needed to install CA certificates and VOMS trust chains on a **RUCIO machine.**

- He hesitated a bit to install them manually...

- …but end up **installing A-REX only to get access to ARCCTL!**

- **Therapy:** we'll provide a standalone `arcctl` in the future ARC releases for admins get hooked on it.

Thank you for your kind attention!

Questions?

One Tool to rule them all,
One Tool to find them,
One Tool to bring them all
and in the darkness bind them.