JobAgent/JobWrapper function

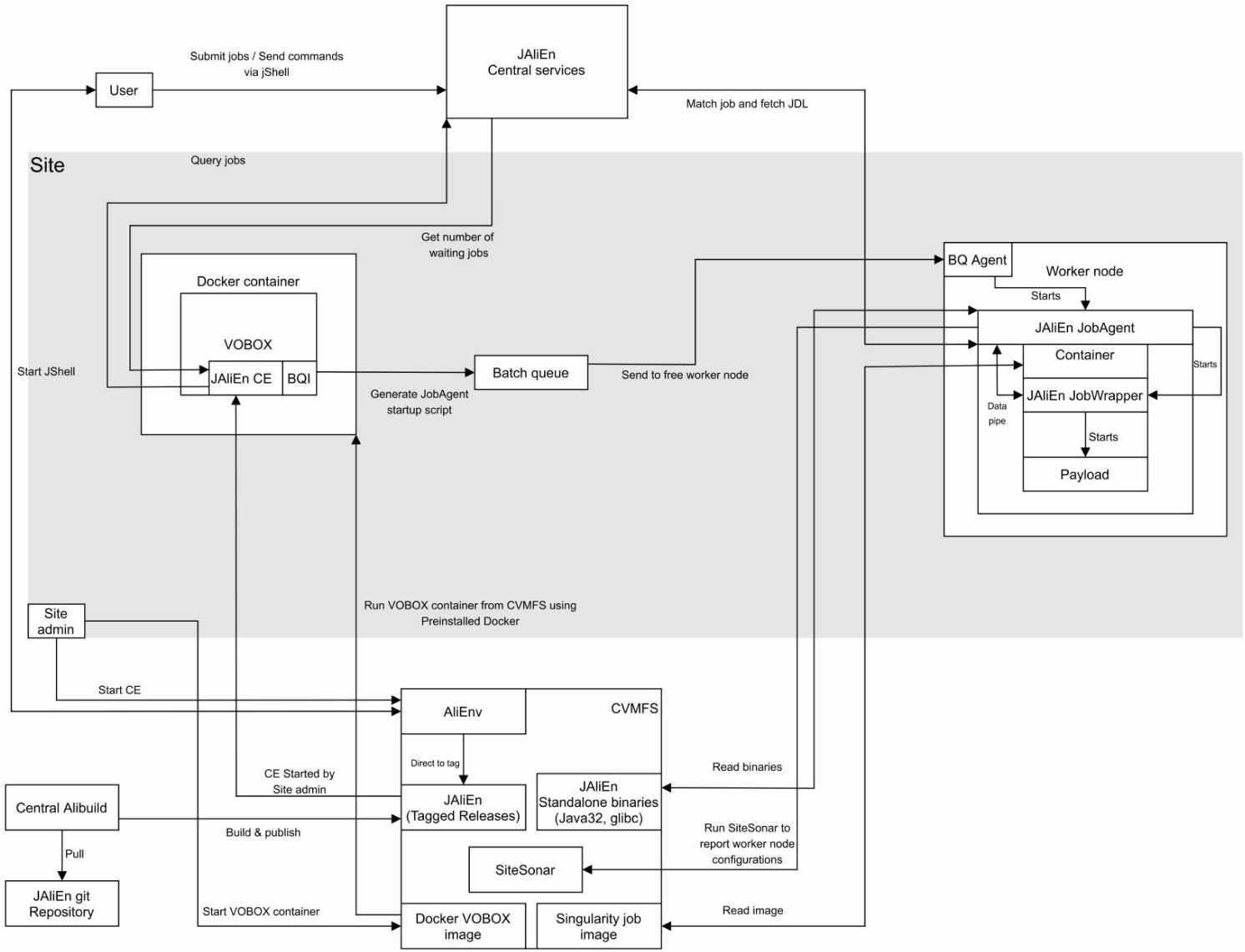
The JAliEn job pilot

Maxim Storetvedt |ALICE Tier-1/Tier-2 Workshop| Budapest, HU | 26/09/2022

Background

- JAliEn features a **redesigned job pilot**
  - Deployed across **all JAliEn sites** (i.e. now nearly all sites)
  - Split into **multiple components** for each task
    - Provides for better isolation
  - Fully **standalone** via CVMFS
    - Environment, dependencies, core libraries: all in CVMFS
    - No other requirements or prior installations needed on worker nodes
  - Integrates **containers**, with all payload wrapped/isolated
    - Also fully standalone: runtime and container images all taken from CVMFS
    - Used automatically and by default on all jobs
    - GPU support
  - Allows better utilising **multicore**

Overview


JAliEn
Central services
Submit jobs / Send commands
via jShell
User
Match job and fetch JDL
Site
Query jobs
Get number of
waiting jobs
Docker container
VOBOX
JAliEn CE
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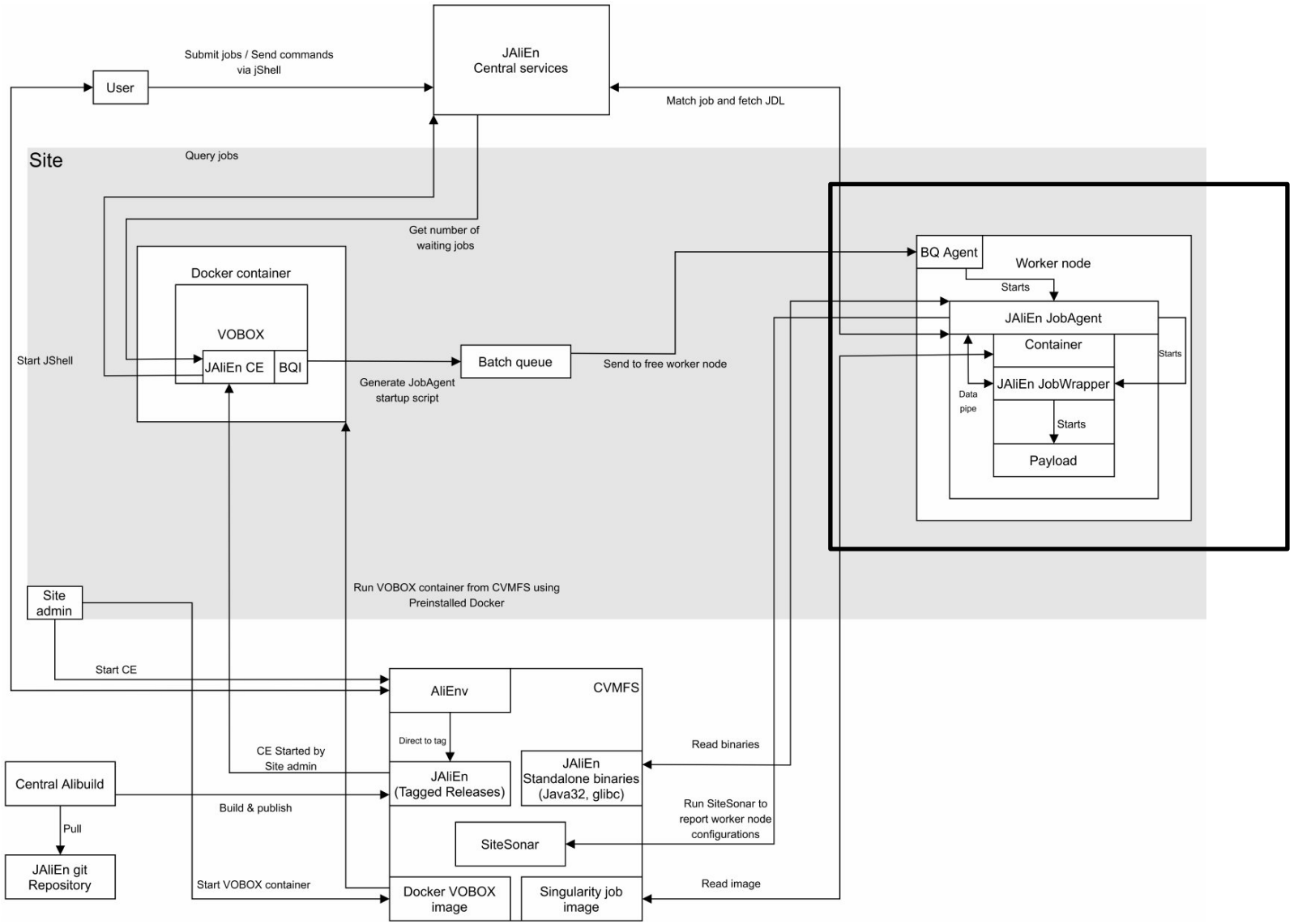
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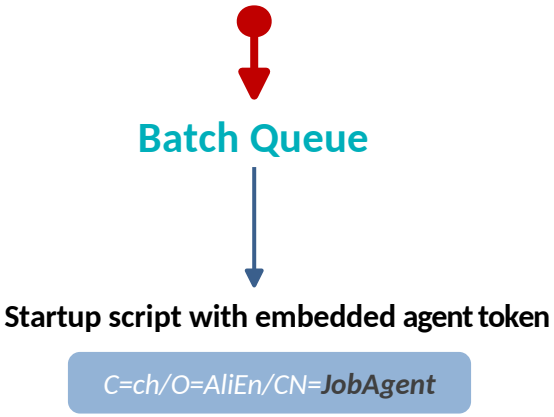
Architecture

Batch Queue

Architecture



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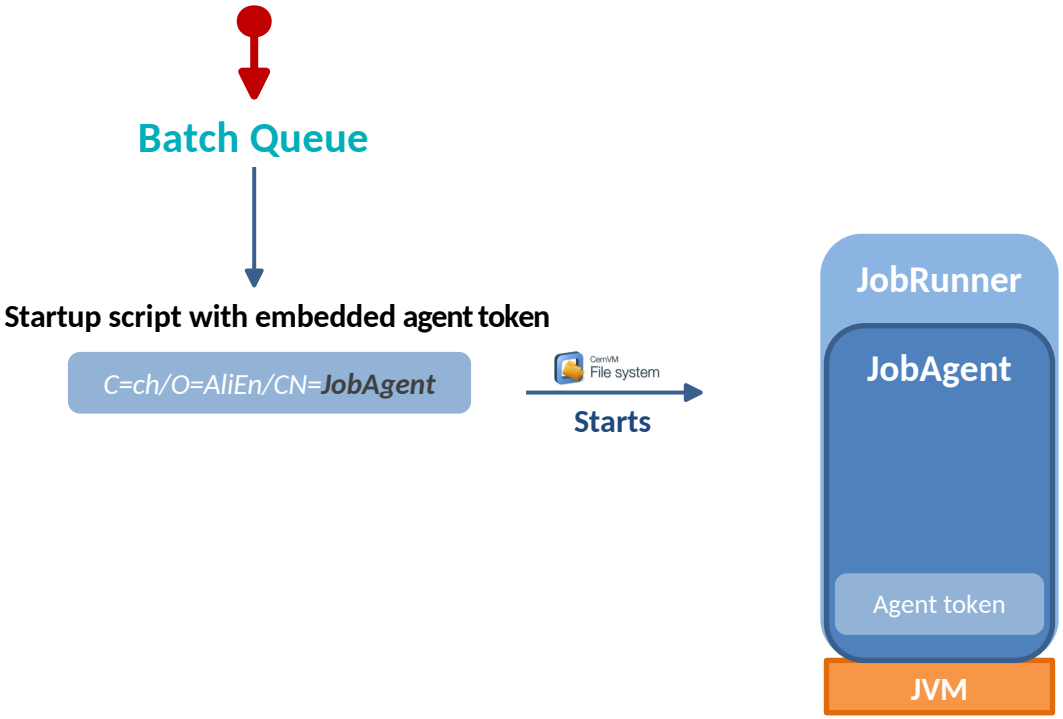

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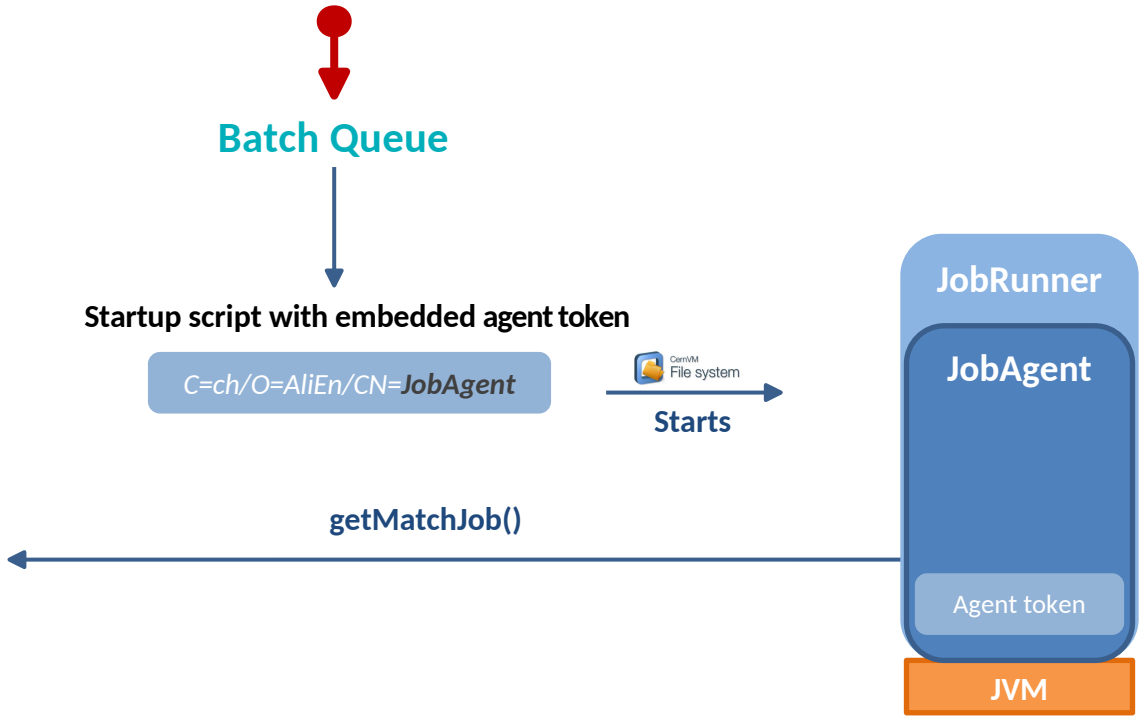

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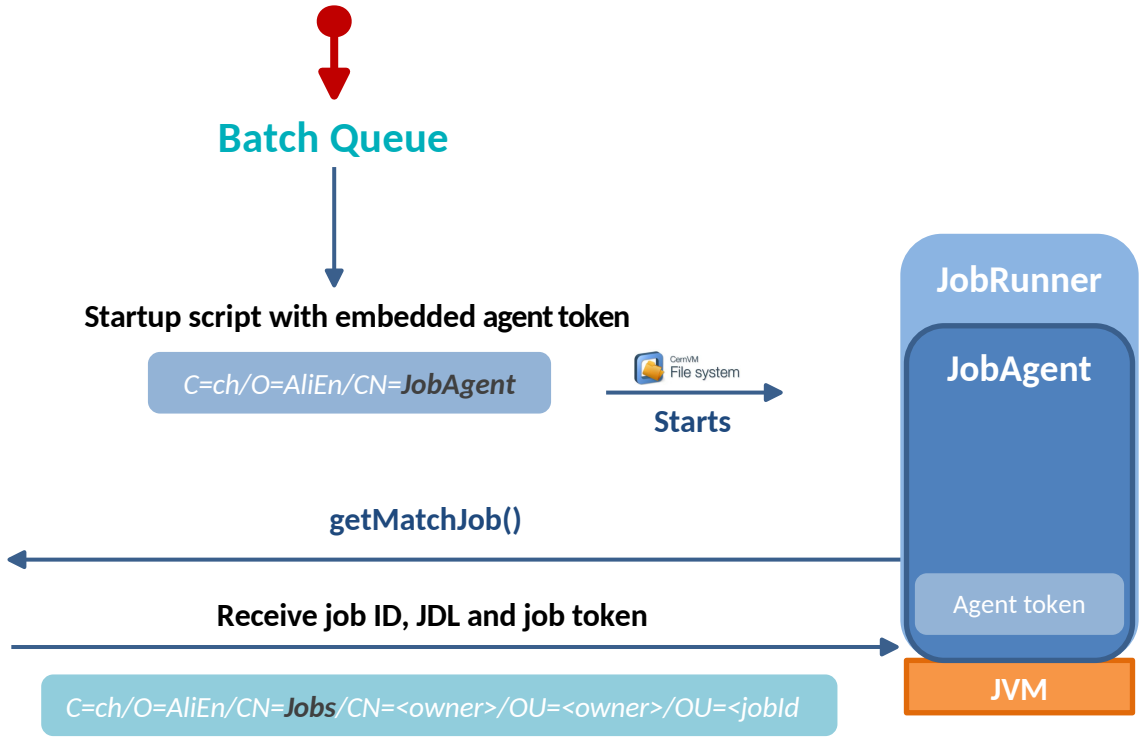

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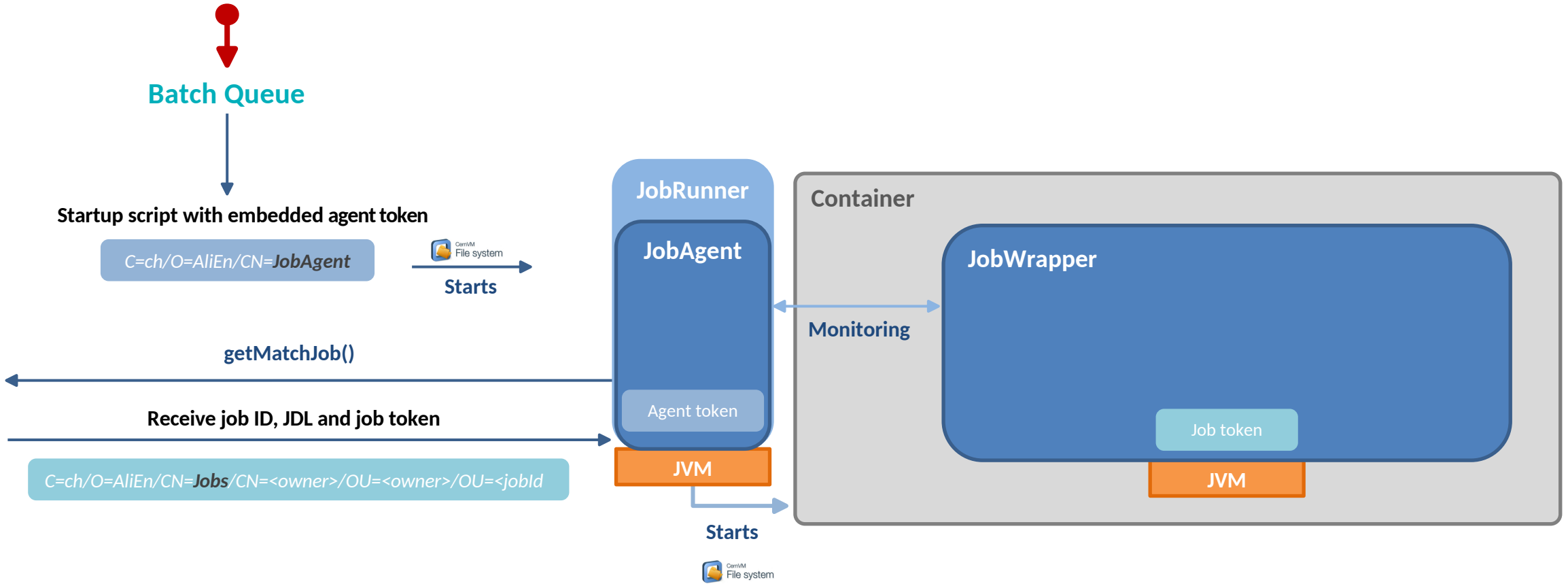

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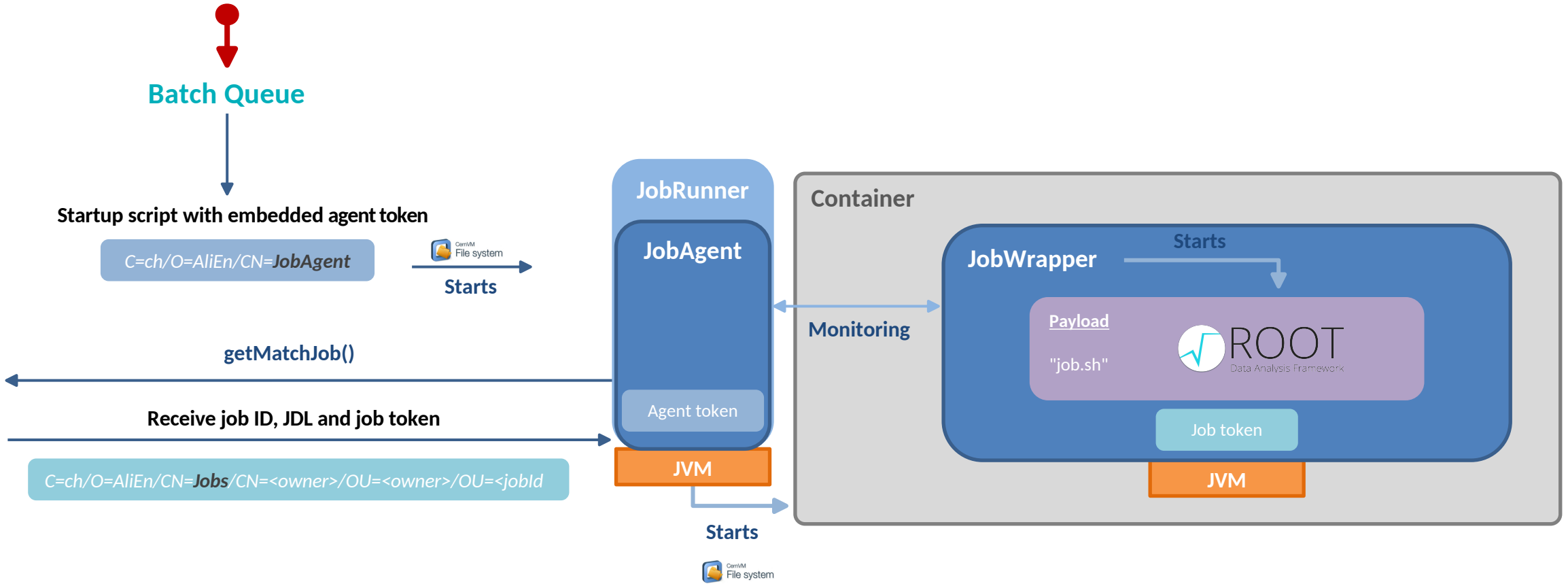

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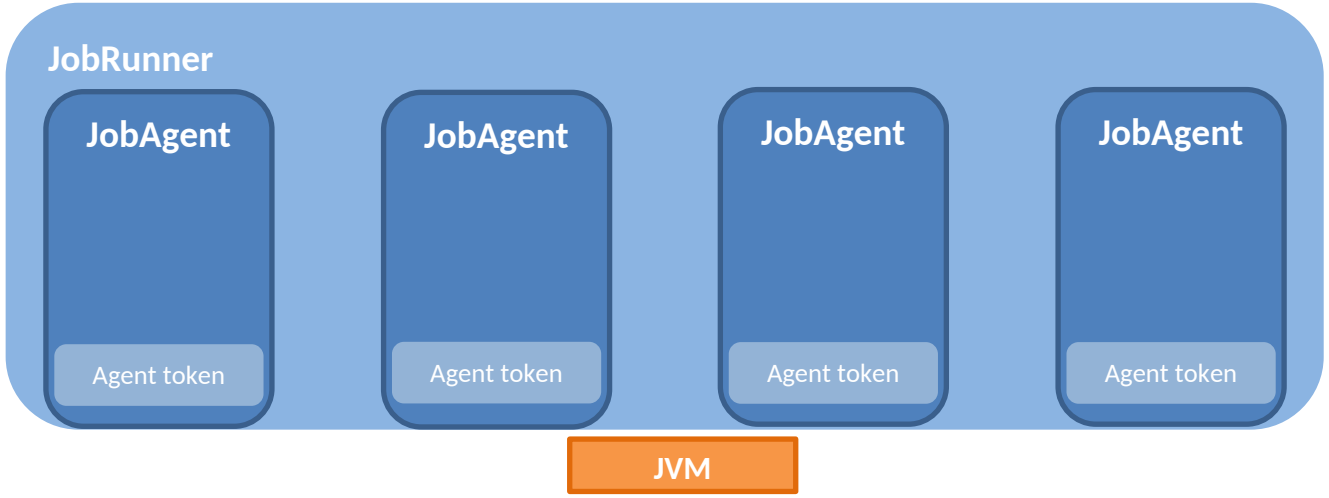

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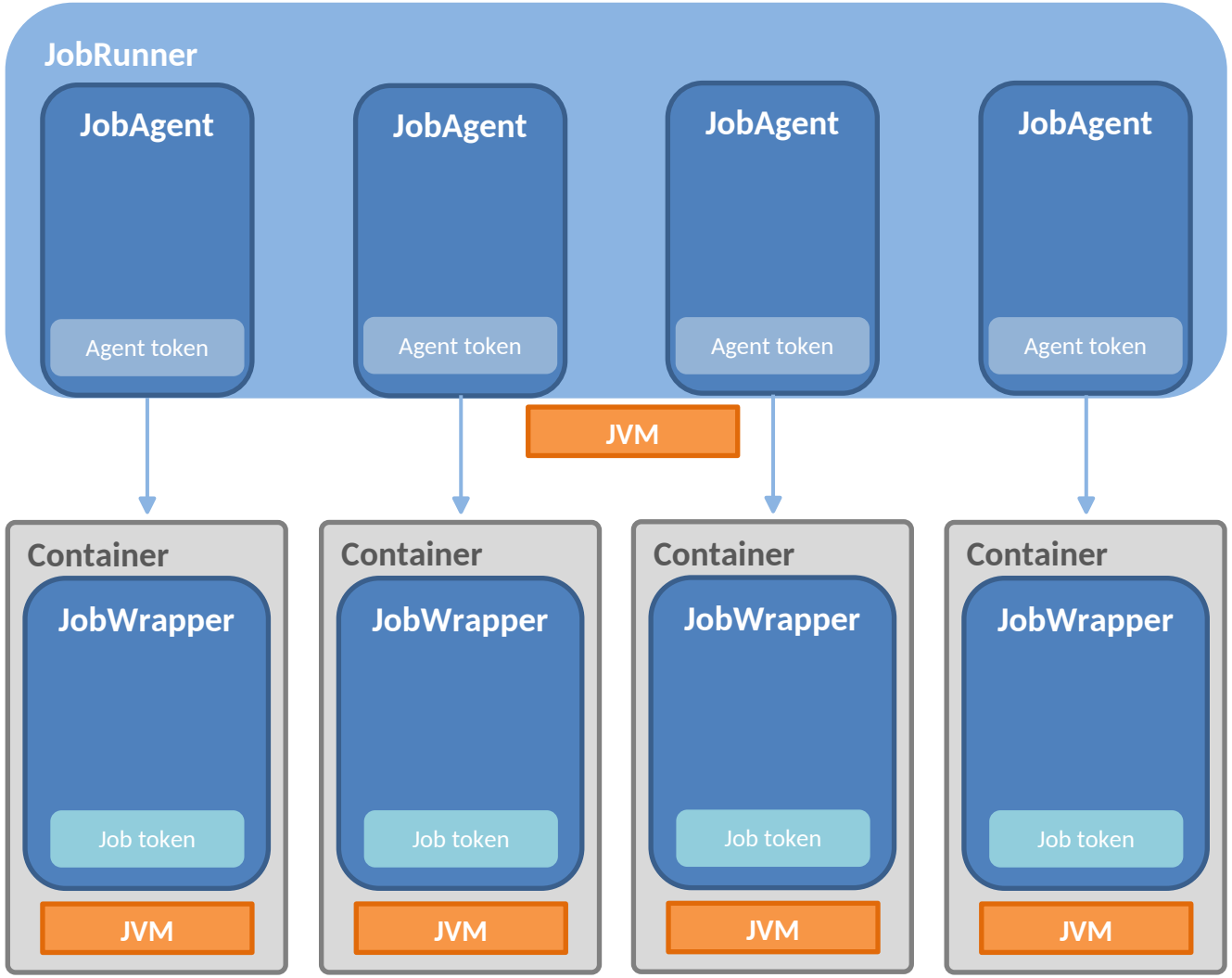

Runner can spawn multiple agents/wrappers when there are free cores

Architecture: key points

- The old AliEn JobAgent is **now two independent components**
  - **JobAgent (JA):** Job matching / monitoring
  - **JobWrapper (JW):** Job execution / file handling
- Each has a token with just enough permissions for their tasks
  - **JA:** Agent token
  - **JW:** Job token
- Additionally, a **JobRunner (JR)** is provided for multicore
- Startup script from BQ calls everything it needs from CVMFS
- **32-bit JVMs** for minimal memory footprint
  - All needed 32-bit libraries bundled in CVMFS
- The JA will automatically **containerise** the JW and its payload
  - Tries multiple runtimes (Apptainer/Singularity/Podman), and uses whichever works on WN
  - All taken from CVMFS, but will fallback to local Singularity (or nothing) if none work
    - Needs *user namespaces* enabled for unprivileged runtimes from CVMFS

Payload container

- By default, **all** jobs are wrapped in a **CentOS 7.9** container
  - JAliEn jobdir mounted to “/workdir”
  - TMPDIR is “/workdir/tmp”, and “/tmp” also points here
- Image as a sandbox directory located in CVMFS at
  - `/cvmfs/alice.cern.ch/containers/fs/singularity/centos7`
- Build recipe available on Gitlab
  - In case of package requests —> add PR
- Two optional images available (can be set in config)
  - **Rocky 8.6**: For newer payloads (no ROOT5) and GPUs[1]
  - **Rocky 9.0:** Testing only (no production use)
- [1]**GPUs are supported** when using *Apptainer* (formerly Singularity)
  - Drivers may require EL8+ for this

Configuration options

The new job pilot (JobAgent/Jobwrapper) can be customised (to some extent)

- Specific version for the pilot can be selected, independent of CE
  - By default, JobAgents will match the CE JAliEn version
- Custom JA executable possible
- Different container images can be selected
  - Custom containers also possible
    - Per site only - **not** per job
- Use of containers can also be completely disabled
- Default configuration directory: **~/.alien/config** on the VO-Box
  - Initial versions used **~/.j/config** —> now changed

Pilot behaviour

- The new JobAgent is *mostly* transparent to the end-users
- However, some, notable differences exist
  - Changed state transitions
    - No more **SAVED**
    - Re-introduction of **ERROR_S**
      - Specified outputfile in JDL not found
  - Always upload a default output for ERROR jobs, if nothing else specified
    - Uploaded, not registered
  - Strict TTL enforcement
    - 1hr grace period for upload provided, but payload always killed immediately
  - Presence of core dumps will abort job
  - Consequences of containerisation
    - Environment
    - Different directory structure (jobdir is *always* **/workdir**)
      - Needed for unprivileged containers

Traces

Trace of subjob 2709881462, masterjob 2709876726

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Sep 23 12:00:39 [state ]: Job 2709881462 inserted from aliendb7.cern.ch (5) [Master Job is 2709876726]
Sep 23 12:40:03 [state ]: Job ASSIGNED to: ALICE::CERN::Yerevan
Sep 23 12:40:03 [trace ]: BatchId GlobalJobId = "ce510.cern.ch#22591372.0#1663929146"
Sep 23 12:40:03 [trace ]: BatchId SubmitterGlobalJobId = "voboxalice3.cern.ch#18989.0#1663929104"
Sep 23 12:40:03 [trace ]: Created workdir: /pool/condor/dir_8027/alien-job-2709881462
Sep 23 12:40:03 [trace ]: Running JAliEn JobAgent/1.5.5-1 on b7s11p8965.cern.ch
Sep 23 12:40:03 [trace ]: Job requested 1 CPU cores to run
Sep 23 12:40:03 [trace ]: Local disk space limit: 10000MB
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Sep 23 12:40:21 [trace ]: The following OS has been detected: "Rocky Linux 8.6 (Green Obsidian)"
Sep 23 12:40:24 [state ]: Job state transition from ASSIGNED to STARTED
Sep 23 12:40:24 [trace ]: Getting InputFile: /alice/cern.ch/user/a/aliprod/LHC22d1/validation.sh to /workdir/validation.sh (5.915 KB)
Sep 23 12:40:25 [trace ]: Getting InputFile: /alice/sim/2020/LHC20e3/OCDB/296380/OCDBrec.root to /workdir/OCDBrec.root (250.1 MB)
Sep 23 12:40:31 [trace ]: Getting InputFile: /alice/cern.ch/user/a/aliprod/bin/aliroot_dpgsim.sh to /workdir/aliroot_dpgsim.sh (1.835 KB)
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Sep 23 12:40:03 [trace]: BatchId GlobalJobId = *"**ce510.cern.ch**#22591372.0#1663929146"*
Sep 23 12:40:03 [trace]: BatchId SubmitterGlobalJobId = *"**voboxalice3.cern.ch**#18989.0#1663929104"*
Sep 23 12:40:03 [trace]: Created workdir: /pool/condor/dir_8027/alien-job-2709881462
Sep 23 12:40:03 [trace]: Running JAliEn JobAgent/1.5.5-1 on **b7s11p8965.cern.ch**
Sep 23 12:40:03 [trace]: Job requested 1 CPU cores to run
Sep 23 12:40:03 [trace]: Local disk space limit: 10000MB
Sep 23 12:40:03 [trace]: Virtual memory limit (JDL): 8192MB
Sep 23 12:40:03 [trace]: Starting JobWrapper ← **Preparing JobWrapper process**
Sep 23 12:40:03 [trace]: Job asks for a TTL of 72000 seconds
Sep 23 12:40:08 [trace]: Support for containers detected. Will use: ApptainerCVMFS
Sep 23 12:40:09 [trace]: JobWrapper started
Sep 23 12:40:17 [procfmt]: FRUNTIME | RUNTIME | CPUUSAGE | MEMUSAGE | CPUTIME | RMEM | VMEM | NOCPUS | CPUFAMILY | CPUMHZ | RESOURCEUSAGE | RMEMMAX | VMEMMAX
Sep 23 12:40:17 [proc]: 00:00:08 8 4.00 0.00 0.32 30.48 30.48 64 6 2339 0.75 30.48 30.48 1000
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Sep 23 12:40:24 [state]: Job state transition from ASSIGNED to STARTED
Sep 23 12:40:24 [trace]: Getting InputFile: /alice/cern.ch/user/a/aliprod/LHC22d1/validation.sh to /workdir/validation.sh (5.915 KB)
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Traces

Trace of subjob 2709881462, masterjob 2709876726

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```

Container runtime is working, and will be used

Traces

Trace of subjob 2709881462, masterjob 2709876726

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```

Detected OS for the payload. Usually the container

Traces

Trace of subjob 2709881462, masterjob 2709876726

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Notice job dir is now "/workdir" (container)

Traces

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Sep 23 14:00:08 [trace ]: JobWrapper has finished execution
Sep 23 14:00:12 [proc ]: 01:19:59 4799 99.89 0.00 4793.64 75.17 75.17 64 6 2339 11212.32 1013.78 1013.78 1000
Sep 23 14:00:12 [trace ]: JobWrapper exit code: 0
Sep 23 14:00:12 [trace ]: Cleaning up after execution...
```

Files are registered as uploaded. Status from central returned

Traces

Trace of subjob 2709881462, masterjob 2709876726

```
Sep 23 12:00:39 [state ]: Job 2709881462 inserted from aliendb7.cern.ch (5) [Master Job is 2709876726]
Sep 23 12:40:03 [state ]: Job ASSIGNED to: ALICE::CERN::Yerevan
Sep 23 12:40:03 [trace ]: BatchId GlobalJobId = "ce510.cern.ch#22591372.0#1663929146"
Sep 23 12:40:03 [trace ]: BatchId SubmitterGlobalJobId = "voboxalice3.cern.ch#18989.0#1663929104"
Sep 23 12:40:03 [trace ]: Created workdir: /pool/condor/dir_8027/alien-job-2709881462
Sep 23 12:40:03 [trace ]: Running JAliEn JobAgent/1.5.5-1 on b7s11p8965.cern.ch
Sep 23 12:40:03 [trace ]: Job requested 1 CPU cores to run
Sep 23 12:40:03 [trace ]: Local disk space limit: 10000MB
Sep 23 12:40:03 [trace ]: Virtual memory limit (JDL): 8192MB
Sep 23 12:40:03 [trace ]: Starting JobWrapper
Sep 23 12:40:03 [trace ]: Job asks for a TTL of 72000 seconds
Sep 23 12:40:08 [trace ]: Support for containers detected. Will use: ApptainerCVMFS
Sep 23 12:40:09 [trace ]: JobWrapper started
Sep 23 12:40:17 [procfmt ]: FRUNTIME | RUNTIME | CPUUSAGE | MEMUSAGE | CPUTIME | RMEM | VMEM | NOCPUS | CPUFAMILY | CPUMHZ | RESOURCEUSAGE | RMEMMAX | VMEMMAX
Sep 23 12:40:17 [proc ]: 00:00:08 8 4.00 0.00 0.32 30.48 30.48 64 6 2339 0.75 30.48 30.48 1000
Sep 23 12:40:21 [trace ]: The following OS has been detected: "Rocky Linux 8.6 (Green Obsidian)"
Sep 23 12:40:24 [state ]: Job state transition from ASSIGNED to STARTED
Sep 23 12:40:24 [trace ]: Getting InputFile: /alice/cern.ch/user/a/aliprod/LHC22d1/validation.sh to /workdir/validation.sh (5.915 KB)
Sep 23 12:40:25 [trace ]: Getting InputFile: /alice/sim/2020/LHC20e3/OCDB/296380/OCDBrec.root to /workdir/OCDBrec.root (250.1 MB)
Sep 23 12:40:31 [trace ]: Getting InputFile: /alice/cern.ch/user/a/aliprod/bin/aliroot_dpgsim.sh to /workdir/aliroot_dpgsim.sh (1.835 KB)
Sep 23 12:40:32 [trace ]: Getting InputFile: /alice/sim/2020/LHC20e3/OCDB/296380/OCDBsim.root to /workdir/OCDBsim.root (250.1 MB)
Sep 23 12:40:38 [trace ]: Starting execution
Sep 23 12:40:38 [state ]: Job state transition from STARTED to RUNNING
Sep 23 12:50:18 [proc ]: 00:10:09 609 89.83 0.30 547.06 961.64 961.64 64 6 2339 1279.57 1012.87 1012.87 1000
Sep 23 13:00:22 [proc ]: 00:20:13 1213 95.91 0.30 1163.44 1007.37 1007.37 64 6 2339 2721.29 1012.87 1012.87 1000
Sep 23 13:10:20 [proc ]: 00:30:12 1812 97.80 0.30 1772.13 976.79 976.79 64 6 2339 4145.01 1012.87 1012.87 1000
Sep 23 13:20:20 [proc ]: 00:40:12 2412 98.82 0.30 2383.61 971.69 971.69 64 6 2339 5575.26 1012.87 1012.87 1000
Sep 23 13:30:20 [proc ]: 00:50:11 3011 99.58 0.30 2998.27 968.82 968.82 64 6 2339 7012.95 1012.87 1012.87 1000
Sep 23 13:40:17 [proc ]: 01:00:09 3609 99.95 0.30 3607.09 957.61 957.61 64 6 2339 8436.98 1012.87 1012.87 1000
Sep 23 13:50:20 [proc ]: 01:10:11 4211 100.27 0.30 4222.43 1003.53 1003.53 64 6 2339 9876.26 1013.78 1013.78 1000
Sep 23 14:00:06 [trace ]: Execution completed. Time spent: real 4767.57, user 449.55, sys 29.63,
Sep 23 14:00:06 [trace ]: Starting validation
Sep 23 14:00:07 [trace ]: Execution completed. Time spent: real 0.74, user 0.08, sys 0.13,
Sep 23 14:00:07 [trace ]: Going to uploadOutputFiles(exitStatus=DONE, outputDir=/alice/sim/2022/LHC22d1_ext/296380/2861)
Sep 23 14:00:07 [state ]: Job state transition from RUNNING to SAVING
Sep 23 14:00:07 [trace ]: Uploading: log_archive.zip to /alice/sim/2022/LHC22d1_ext/296380/2861
Sep 23 14:00:08 [trace ]: /alice/sim/2022/LHC22d1_ext/296380/2861/log_archive.zip: uploaded as requested
Sep 23 14:00:08 [trace ]: Registering: log_archive.zip. Return status: true
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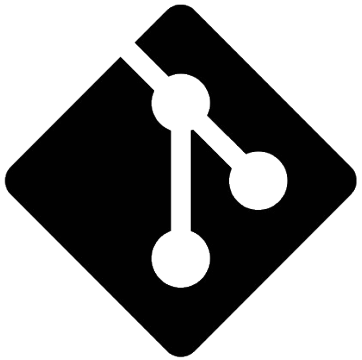
JobWrapper exits after upload. Code nonzero only if JA/JW issue

Recent JobAgent changes

- **1.5.8** and most recent versions
  - JobAgent / JobWrapper refactor
  - Podman support
  - JDK18+ support
  - Better error detection
  - First steps towards SiteSonar integration
  - Removal of old workarounds
  - Better GPU forwarding
  - TTL fix
  - Heartbeat monitor detected fix
  - Abort if corefiles present
- Changelog will now be provided for each tag on **Gitlab**

Upcoming JobAgent changes

- Tuning of edge cases
  - Heartmon will remain for a while longer
- SiteSonar integration
  - Also used for jobmatching
- Retire SingularityCVMFS runtime
  - Fully replaced by Apptainer
  - Local Singularity will remain as fallback
- CPU task isolation
- **Fine-grained resource control per job**
  - Num. CPUs per container
  - CPUtime utilisation / constraints
  - Exposed memory / limits
  - Available swap
  - I/O limits



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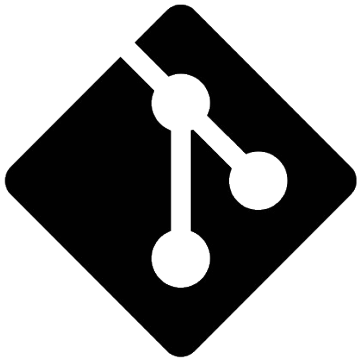

However, requires **Cgroups v2** on host

- Not available on CentOS 7!
  - EL8/EL9+ only
- Also, C7 EOL is not too far off
- Possibly better for multicore
- A first nudge to **update** to EL8/EL9…

Moving to EL8/EL9

- Note: CentOS was **discontinued** and retired by RedHat on 31/12/2021
  - C8 completely abandoned
  - C7 will remain until EOL
- CentOS Stream will remain as upstream build
  - “Beta-channel” for RHEL
  - Halved support window
- CERN entered a licence agreement for allowing the use of RHEL
  - Valid on CERN premises only
- CentOS successor projects (1:1 RHEL rebuilds)
  - **Rocky Linux** – Founded by original CentOS creator
  - **AlmaLinux** – Backed by CloudLinux
- What to use…?

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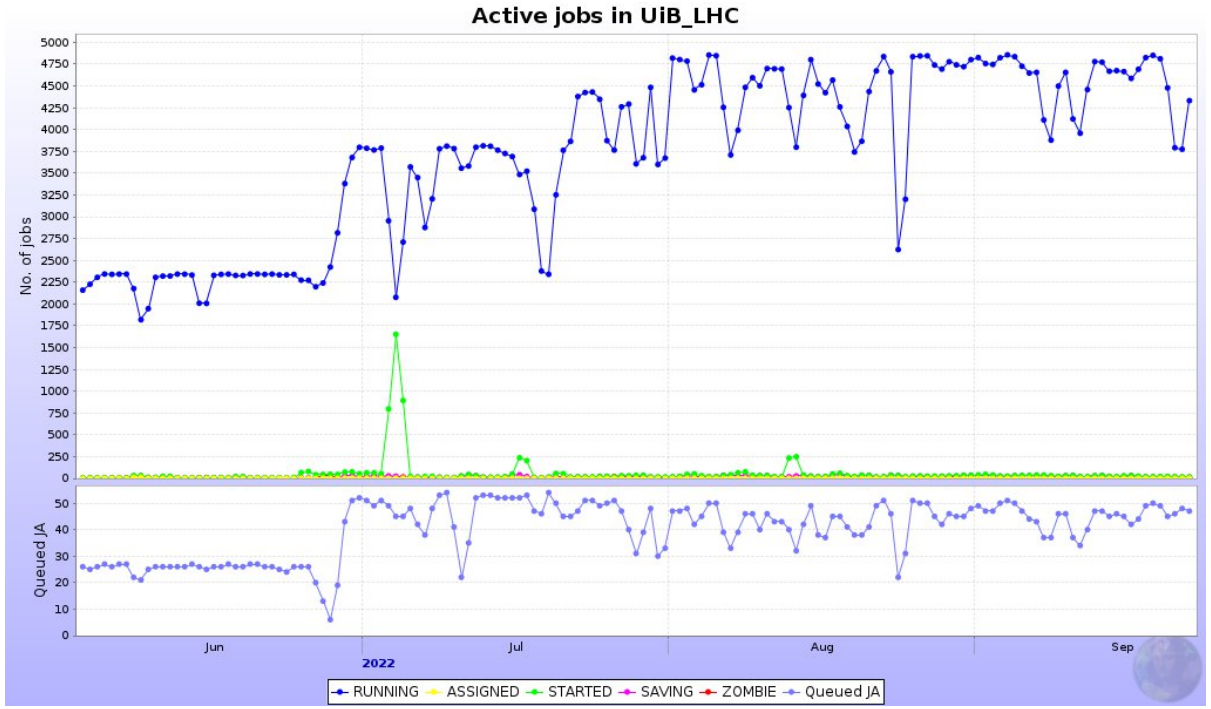
*"GDB recommends **Red Hat Enterprise Linux**, **CentOS Stream** and **Enterprise Linux Clones (ELCs)** should be treated equally*
  – *ELCs defined as 100% functionally equivalent to RHEL such as **Rocky** or **Alma**"*

Moving to EL8/EL9

- JAliEn and the JobAgent/JobWrapper already supports both EL8 and EL9
  - CERN is set to **skip** EL8 and go directly to EL9
  - EL8 to be used if compatibility needs it
- In other words, ideally
  - If RHEL licence available: **RHEL 9**
  - For quicker releases, and OK with shorter EOL window: **CentOS Stream 9**
  - If wanting a 1:1 CentOS replacement: **Rocky Linux 9** or **AlmaLinux 9**
- Warning: Rocky and Alma are the **only** supported ELCs
  - Other rebuilds, even if they are fully 1:1, will not work
    - Packages often rely on distro version strings

Moving to EL8/EL9

- Updated sites already exist
  - Example: **UiB** worker nodes running on AlmaLinux 8 since mid-June 2022



Summary and outlook

- JAliEn features a **redesigned job pilot**
  - Default across **all JAliEn sites**
  - Split into **multiple components** for each task
    - Provides for better isolation
    - Fully standalone via CVMFS
  - Integrates **containers**, with all payload wrapped/isolated
  - Mostly **transparent** to the end-user
- Changes still to come
  - SiteSonar integration
  - Better compatibility
  - Improved **resource control**
    - Will require **EL8/EL9** on site worker nodes

Thank You

[Questions, comments?]

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