Creating easy to use HPC portals with NICE EnginFrame and SLURM

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NICE

Summary

- About NICE
- Introduction to NICE EnginFrame
- Why a SLURM plugin for EnginFrame?
- The SLURM plugin and its current limitations
- Q&A

About NICE

- Company
  - Focus on technical computing since 1996
  - HQ in Italy (offices in USA, GER, UK)
  - Partners all around the world
  - Always profitable and self-funded

- Expertise
  - Industry veterans around Grid & HPC solutions
  - Vertical solutions, Cloud computing, Remote Visualization

- Core business: *Access to Grid / HPC / Cloud solutions*
  - Work, visualize, and collaborate in HPC
  - EnginFrame and DCV product families

NICE Customers and Market Segments

Energy

Anadarko, AECL, Hess, Bayerngas, BHP Billiton, Beicip, British Gas, Centrica, Chevron, Conoco-Phillips, Dong, Dowell, DSC-Libya, ENI/Agip, GazPromNeft, GDF, Logelco, Maersk Oil, Marathon Oil, Nexen, National Oilwell Varco, Novatek, Papuan Oil, PetroChina, Rosneft, Schlumberger, Sinopec, Sonatrach, Statoil, Talisman Energy, TNK-BP, TNNC, TOTAL, WG

Life Sciences and Medical

Baxter, Bayer, Biolab, DEISA project, HHMI, Johnson&Johnson, Novartis, SIB, Partners Healthcare, Pharsight

Others

Accent, Samsung SDI, SensorDynamics, Bank of Italy, Deutsche Bank

Aerospace & Manufacturing

AIRBUS, Air Products and Chemicals, AVIC, Procter&Gamble, SelexGalileo, Goodrich Aerospace, Kimberly Clarke, Magellan Aerospace, NORDAM, Northrop Grumman, Raytheon, Sikorsky, Thales

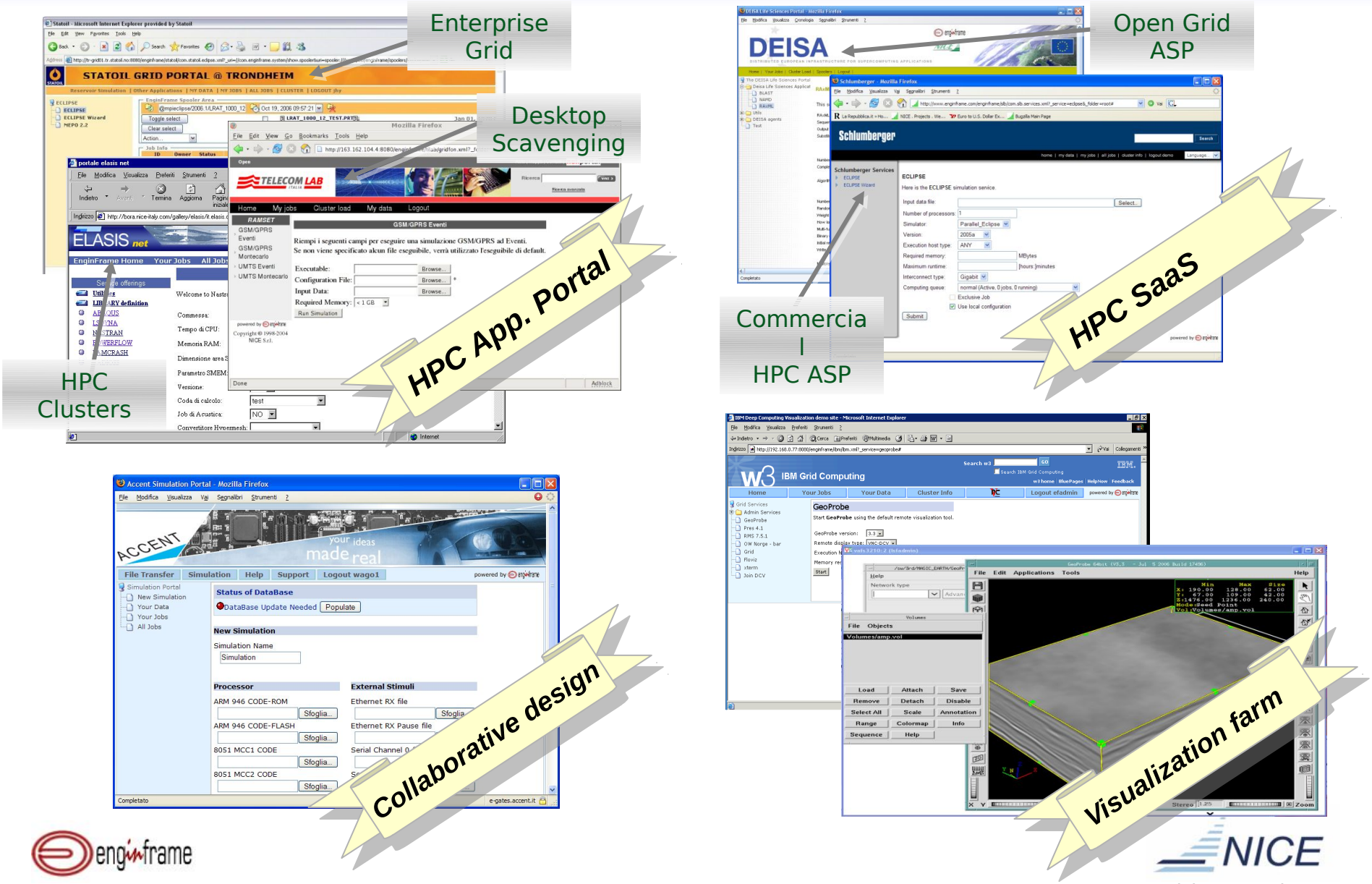
Automotive & Industrial Equipment

3M, ABB, Altran, Audi, ARRK, BMW, Bridgestone, Bosch, Continental, Daimler, Delphi, Dow, Faurecia, Ferrari, Hyundai, JLR, Lear, Magneti Marelli, McLaren, PSA, RedBull, Tata Steel, Toyota, TRW, VW

Research & Education

Beihang U, Birmingham U, Buffalo U, CILEA, Georgia State U, INFN, Harvard U, Liverpool U, Messina U, Huazhong Normal U, TU Ilmenau, Yale U

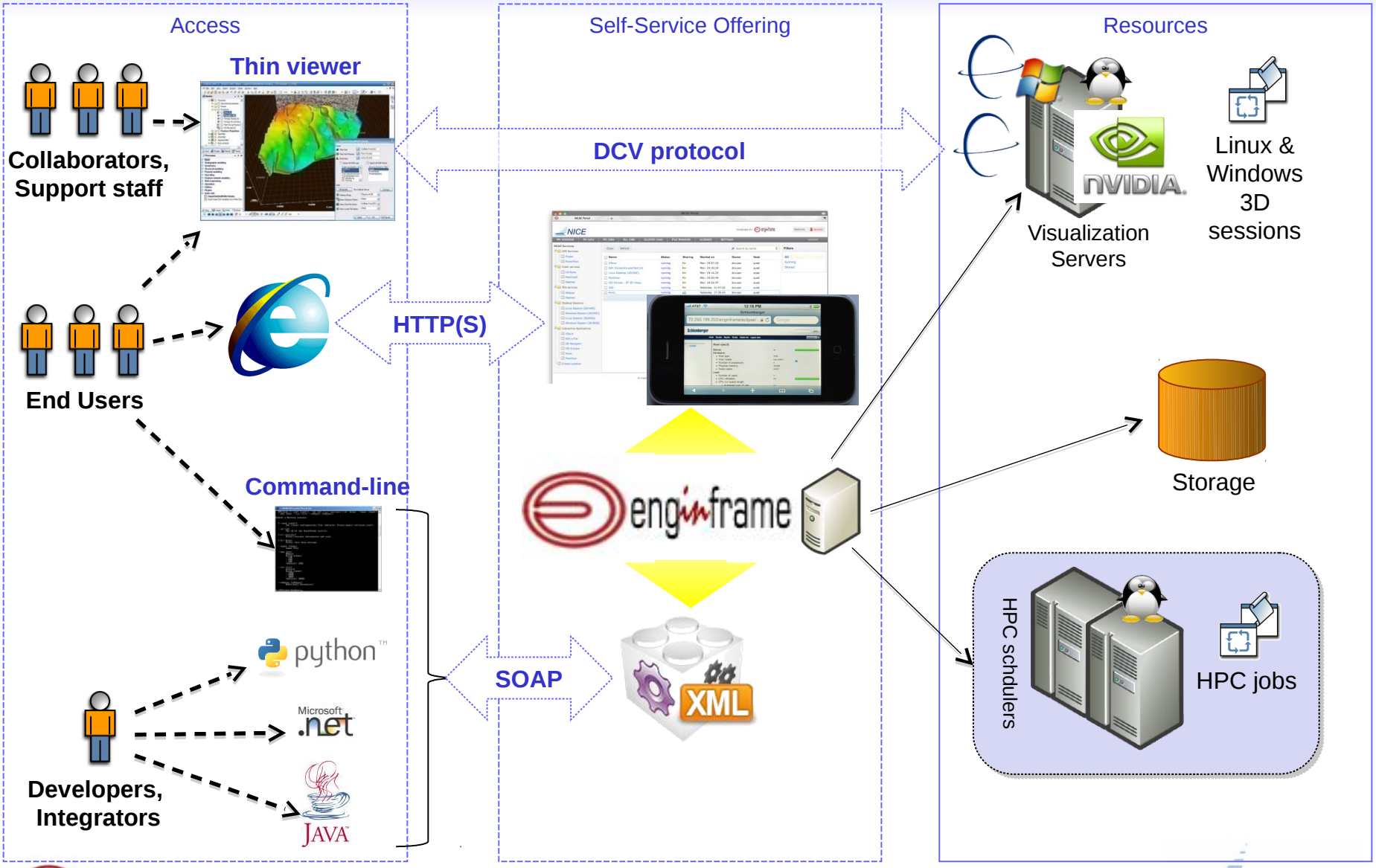
What is NICE EnginFrame?



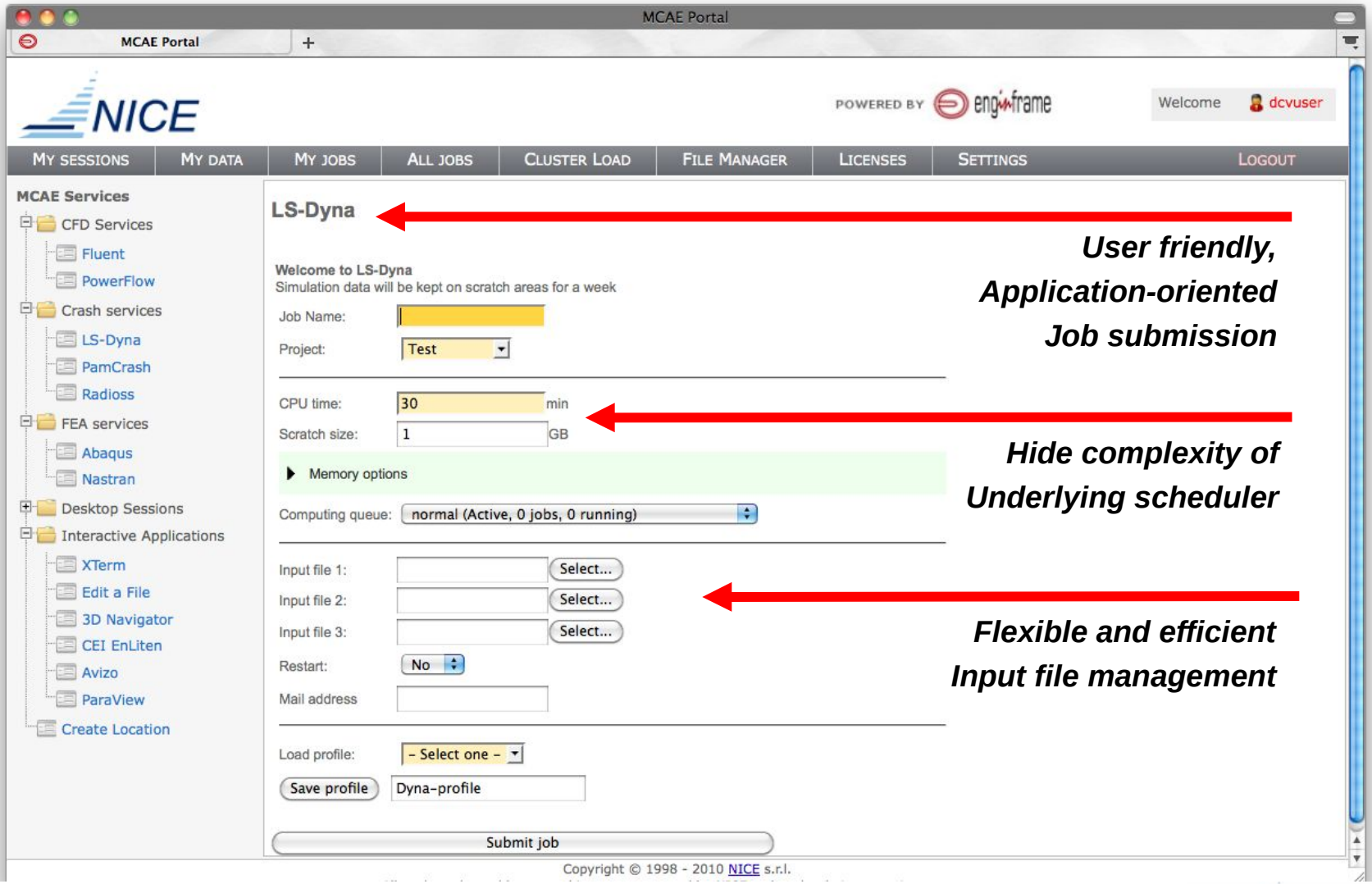
EnginFrame Key Features

- User friendly Web based access to technical computing applications (batch and interactive)
- Flexible service offering for end users
  - Application-oriented HPC job submission and monitoring
  - Access to 2D / 3D remote desktops
- Support all major HPC schedulers: LSF, Grid Engine, PBS, Torque, Moab, OpenLava.... and SLURM
- Multiple remote display protocols support: RealVNC, Tiger/Turbo/TightVNC, NICE DCV, HP RGS, ...
- Data management
- Flexible authentication delegation (NIS, LDAP, AD, Kerberos, …)
- Fine grained authorization system
- Accounting and monitoring of resource usage

Our Architecture



Batch Job / Workflow Submission



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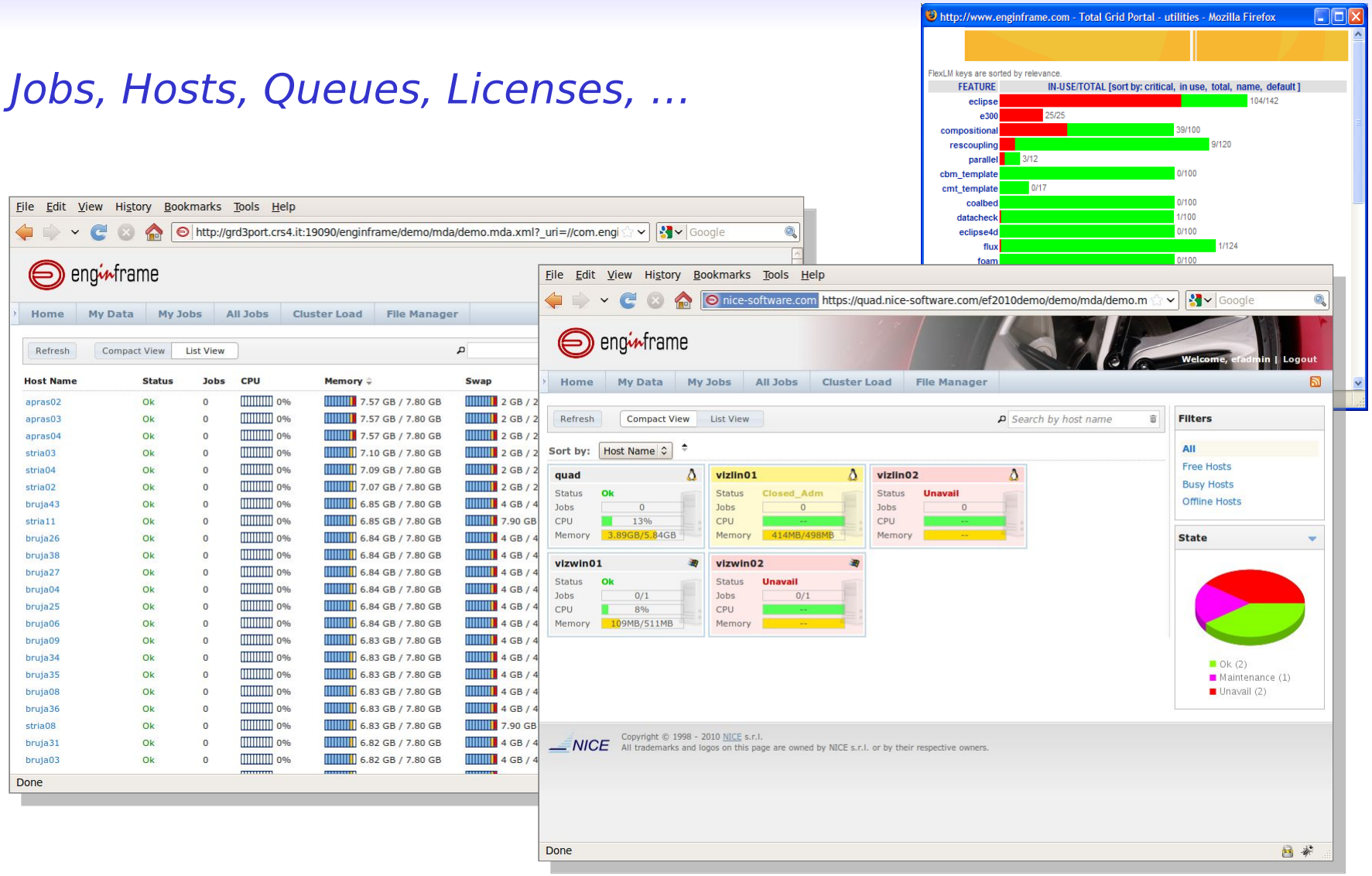
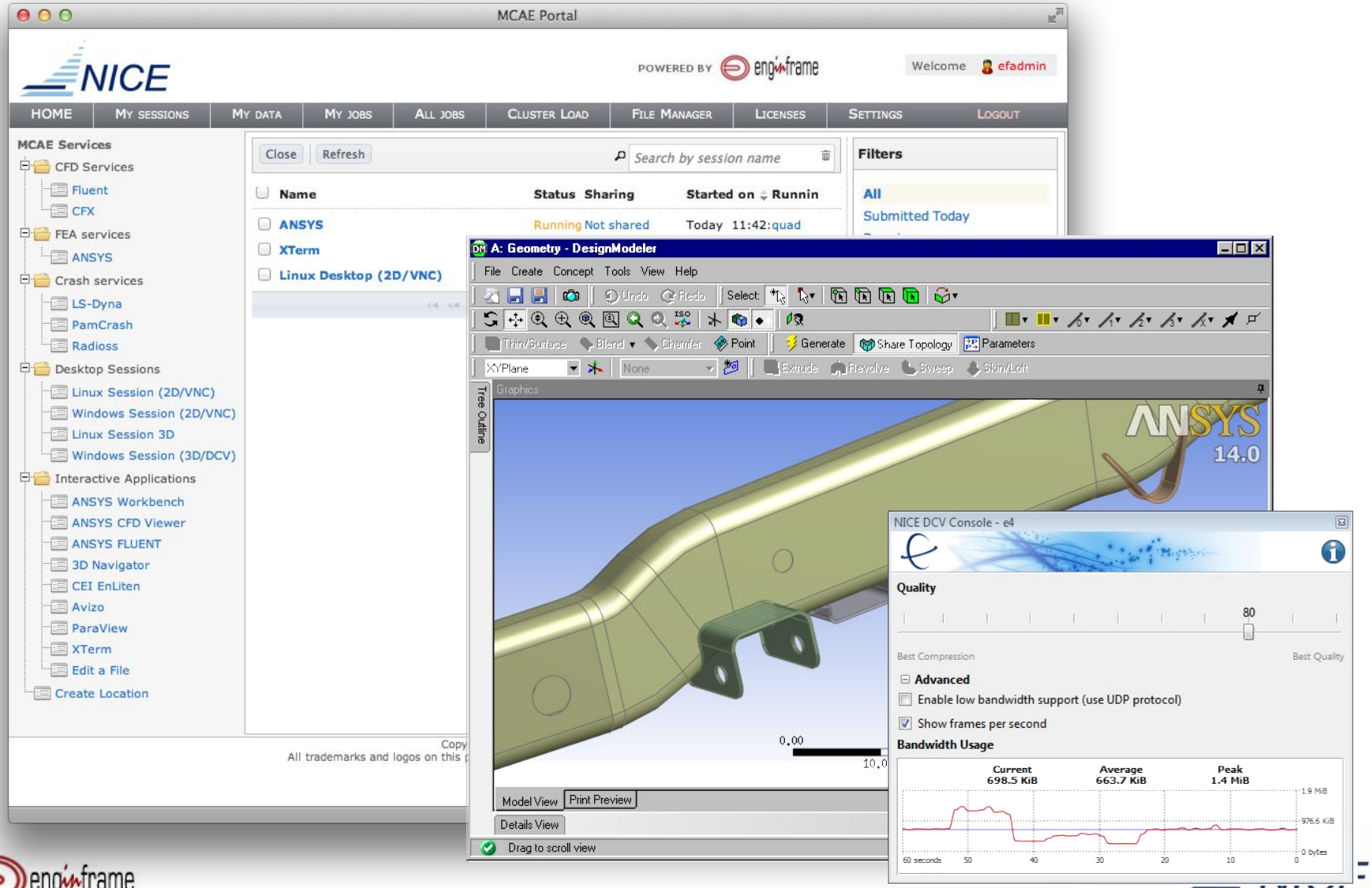
Monitoring

Jobs, Hosts, Queues, Licenses, ...

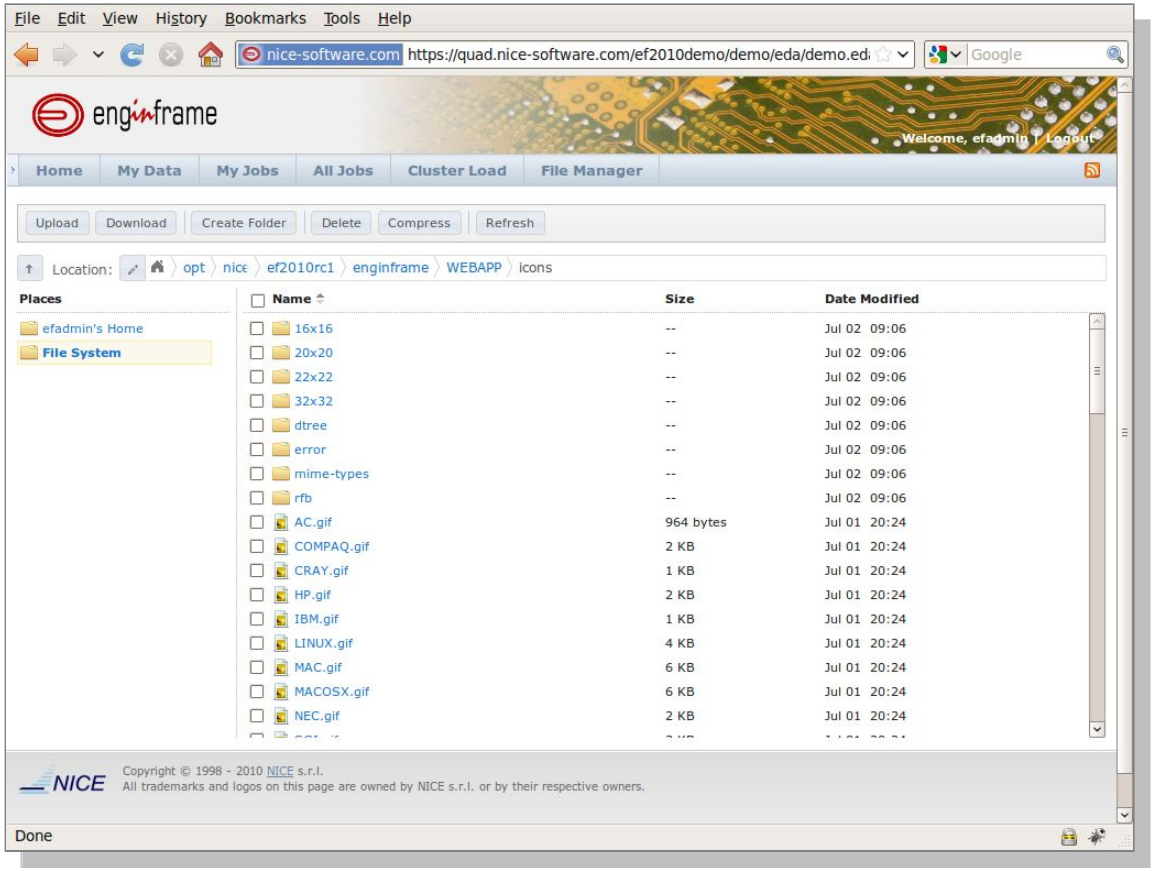


Web-based Interactive Session Management



Data Transfers & File Management

The file manager component allows to seamless navigate and access server-side files from the web browser

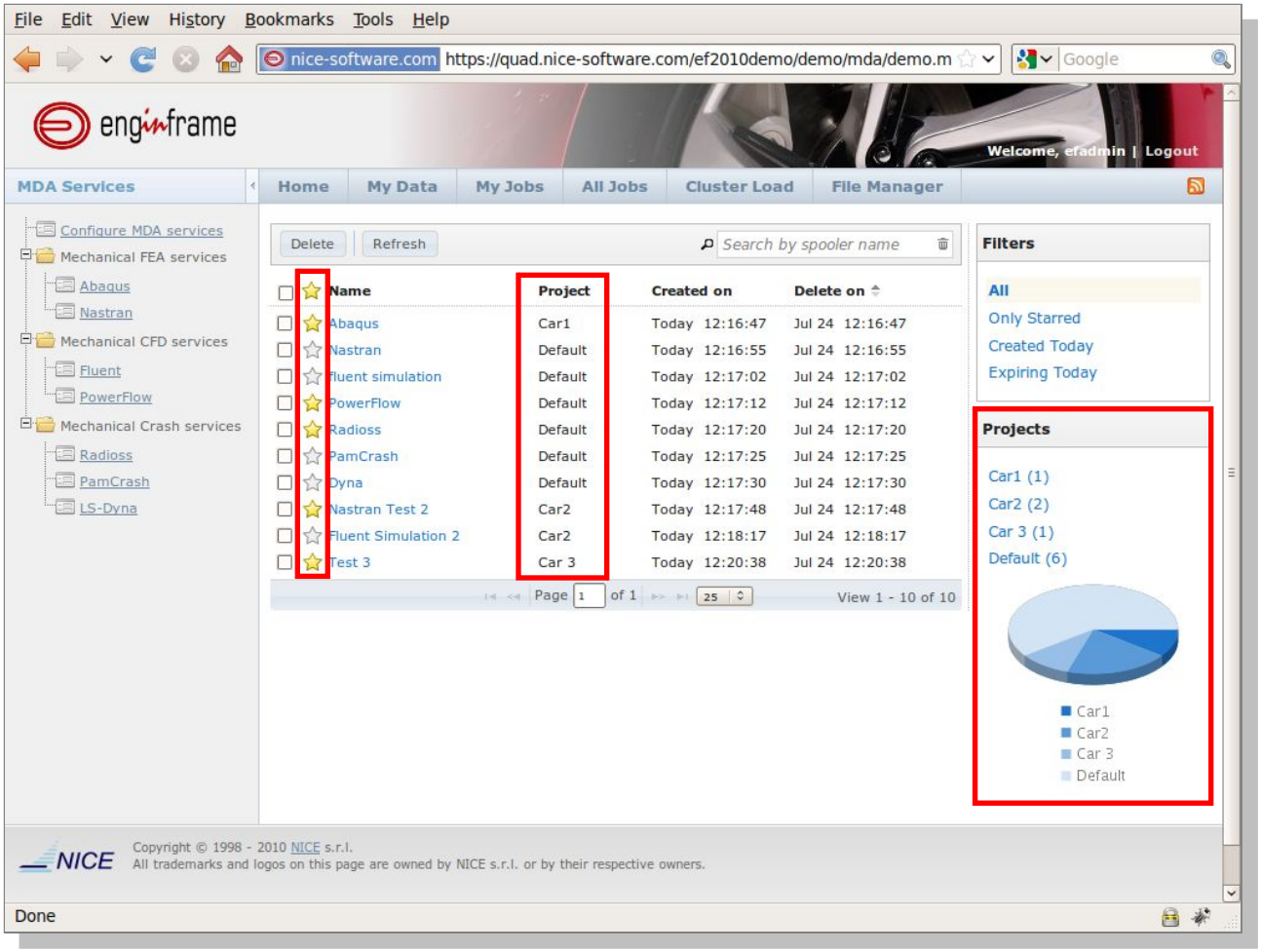


Job Data Management

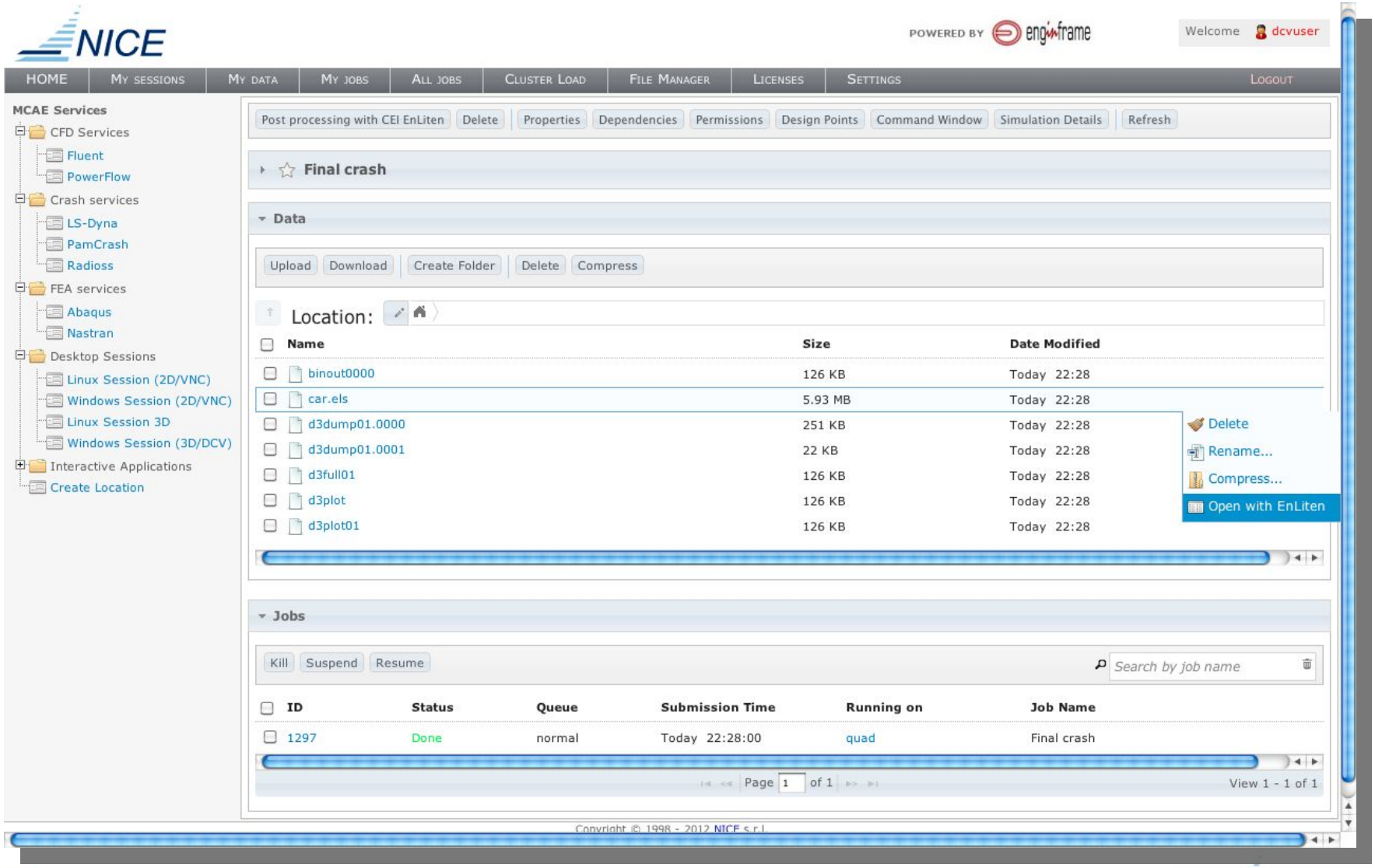
Application data can be organized into projects

Application data can be marked as starred

Metadata can be associated to application data



CAE / HPC Workflow Integration



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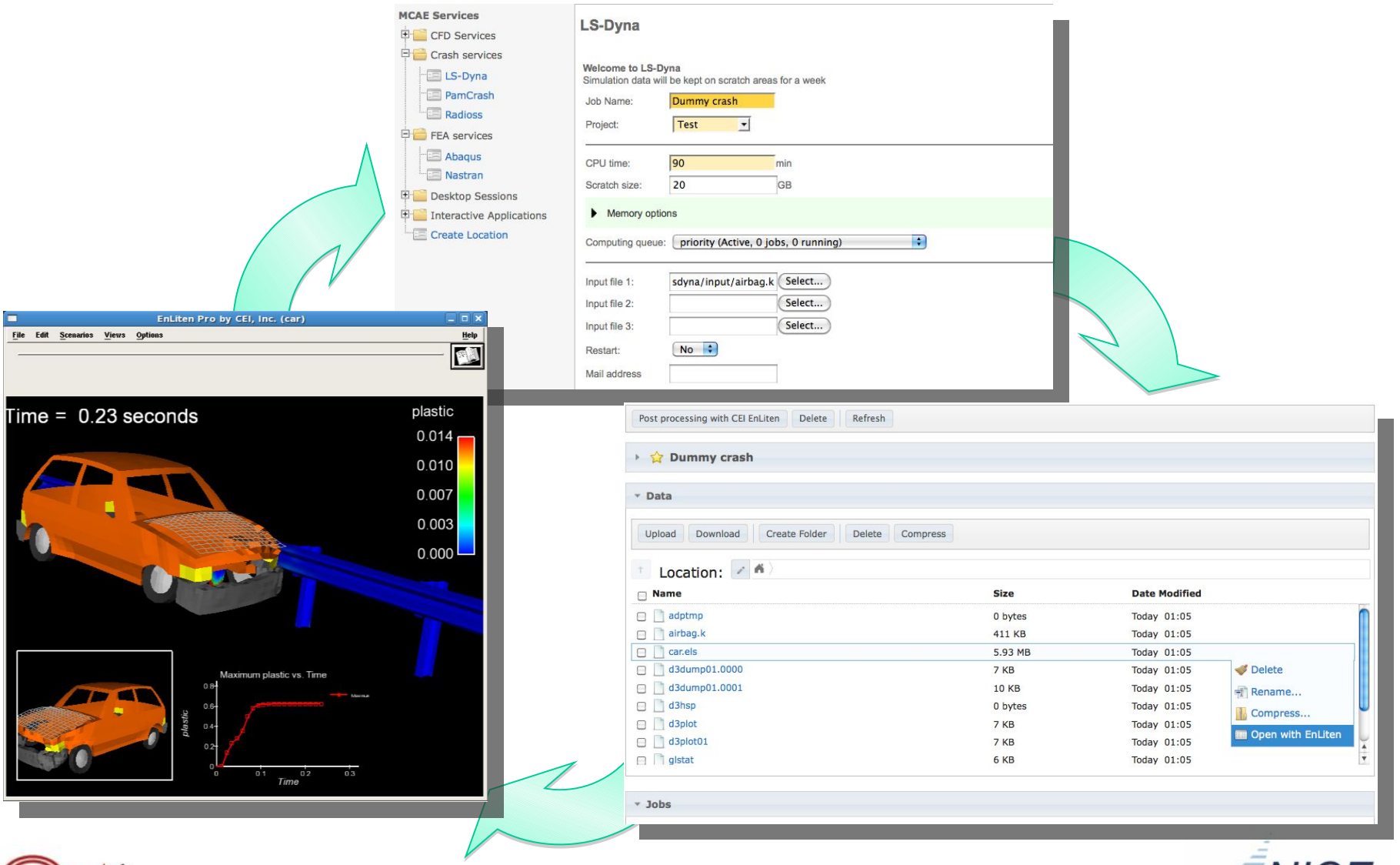
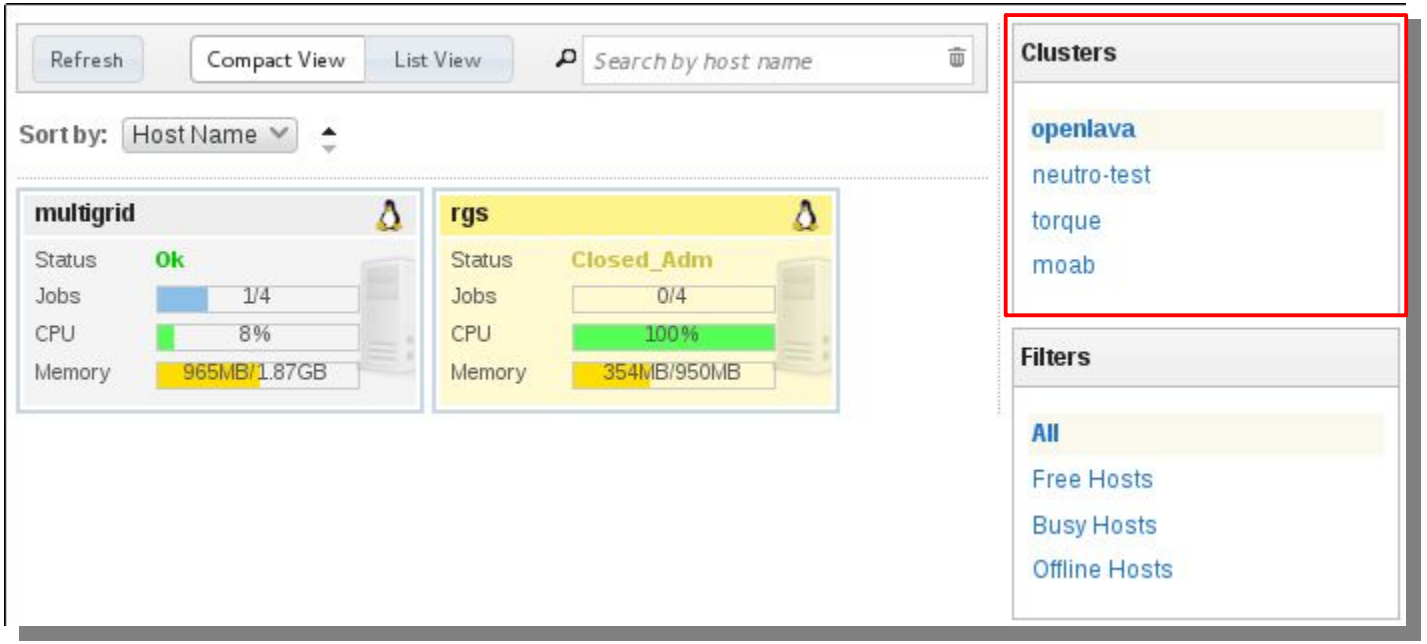
HPC + Visualization Workflows



Multiple Clusters/Schedulers

- Submit/monitor jobs on multiple HPC schedulers through a single EnginFrame instance



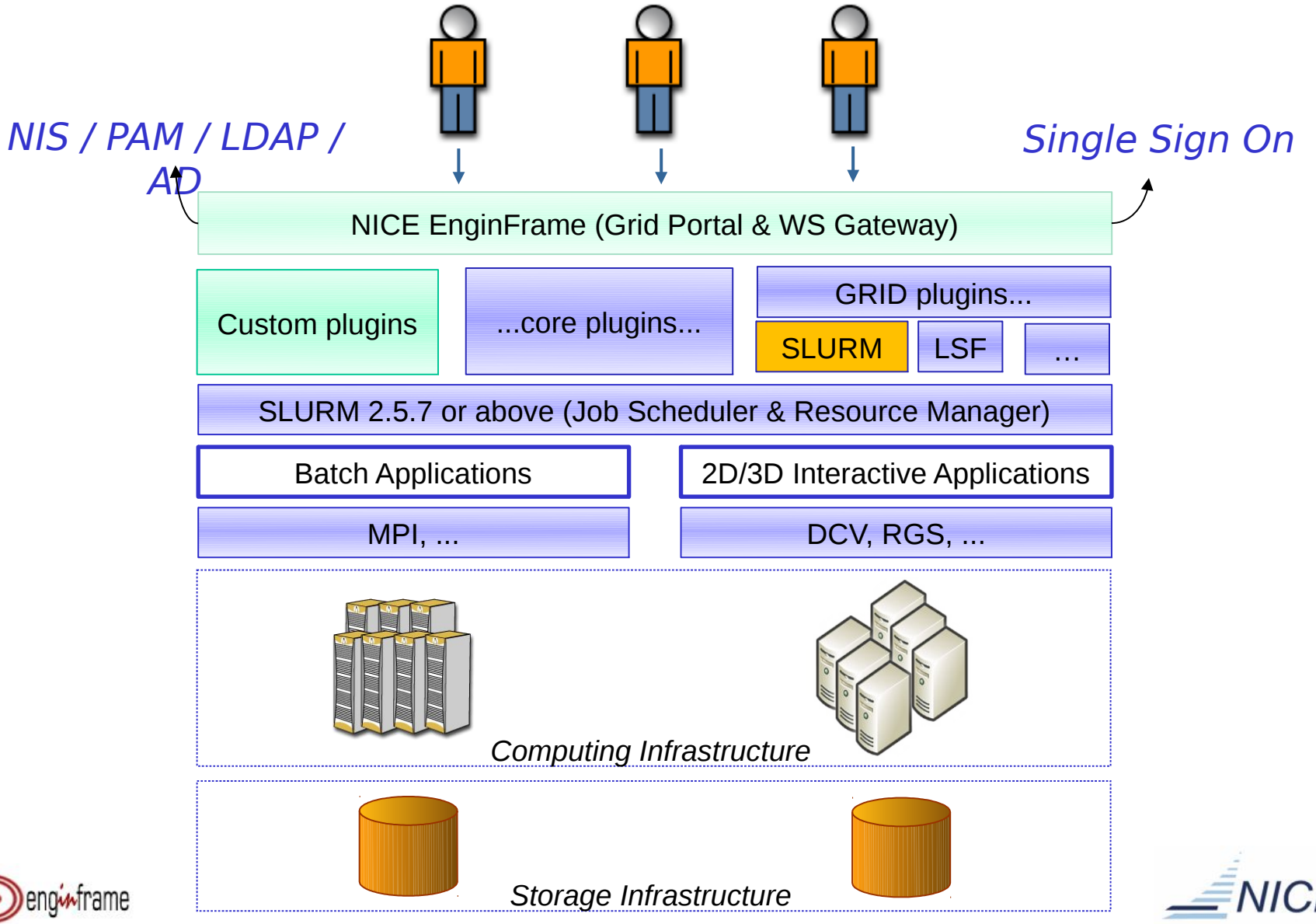
Thanks to the EnginFrame modular architecture, support for new HPC schedulers can be added with no changes to the EnginFrame core.

Why a SLURM plugin for EnginFrame?

- In the last year we observed a growing number of requests related to our capability to support SLURM (both from academy and industry)
- SLURM popularity seems to grow more and more
- There is an active and dedicated community
- We are getting very positive feedbacks about SLURM
- We have internal persons that like to play we new technologies
- We found a customer that got us access to its SLURM cluster and help us for testing activities (many thanks to the guys from Buffalo University)
- We all love David ;)

Development started !

Software Stack



The SLURM Plugin

- The SLURM plugin has been developed as a backend for the EnginFrame GRID plugin
- Interaction with SLURM happens at the command line level:
  - SLURM CLI commands are invoked (**`sbatch`**, **`scontrol`**, ...)
  - The output of the command is parsed and translated into XML documents (GridML)
- Feature parity with all the other major supported schedulers:
  - HPC job submission and monitoring
  - Resource monitoring
  - Submission and managing of interactive sessions

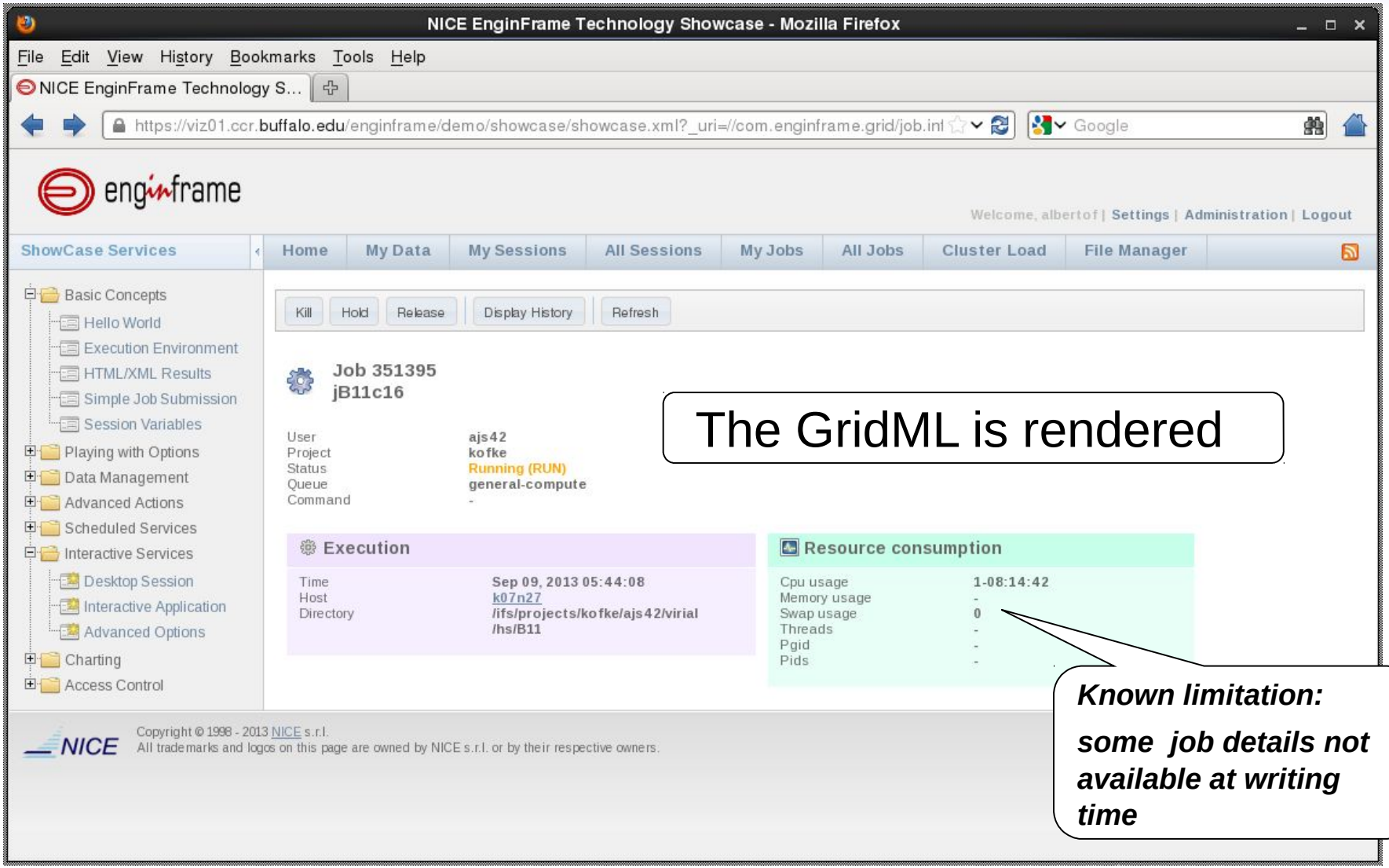
Example: Job Details (scontrol output)

```
$ scontrol show jobs 351395
JobId=351395 Name=jB11c16
   UserId=ajs42(142404) GroupId=kofke(45550)
   Priority=52967 Account=kofke QOS=normal
   JobState=COMPLETED Reason=None Dependency=(null)
   Requeue=0 Restarts=0 BatchFlag=1 ExitCode=0:0
   RunTime=1-08:27:18 TimeLimit=1-16:00:00 TimeMin=N/A
   SubmitTime=2013-09-01T17:40:20 EligibleTime=2013-09-01T17:40:20
   StartTime=2013-09-09T05:44:08 EndTime=2013-09-10T14:11:26
   PreemptTime=None SuspendTime=None SecsPreSuspend=0
   Partition=general-compute AllocNode:Sid=f07n05:62117
   ReqNodeList=(null) ExcNodeList=(null)
   NodeList=k07n27
   BatchHost=k07n27
   NumNodes=1 NumCPUs=16 CPUs/Task=1 ReqS:C:T=*:*:*
   MinCPUsNode=16 MinMemoryCPU=3000M MinTmpDiskNode=0
   Features=(null) Gres=(null) Reservation=(null)
   Shared=OK Contiguous=0 Licenses=(null) Network=(null)
   Command=/ifs/projects/kofke/ajs42/virial/hs/B11/jB11c16
   WorkDir=/ifs/projects/kofke/ajs42/virial/hs/B11
```

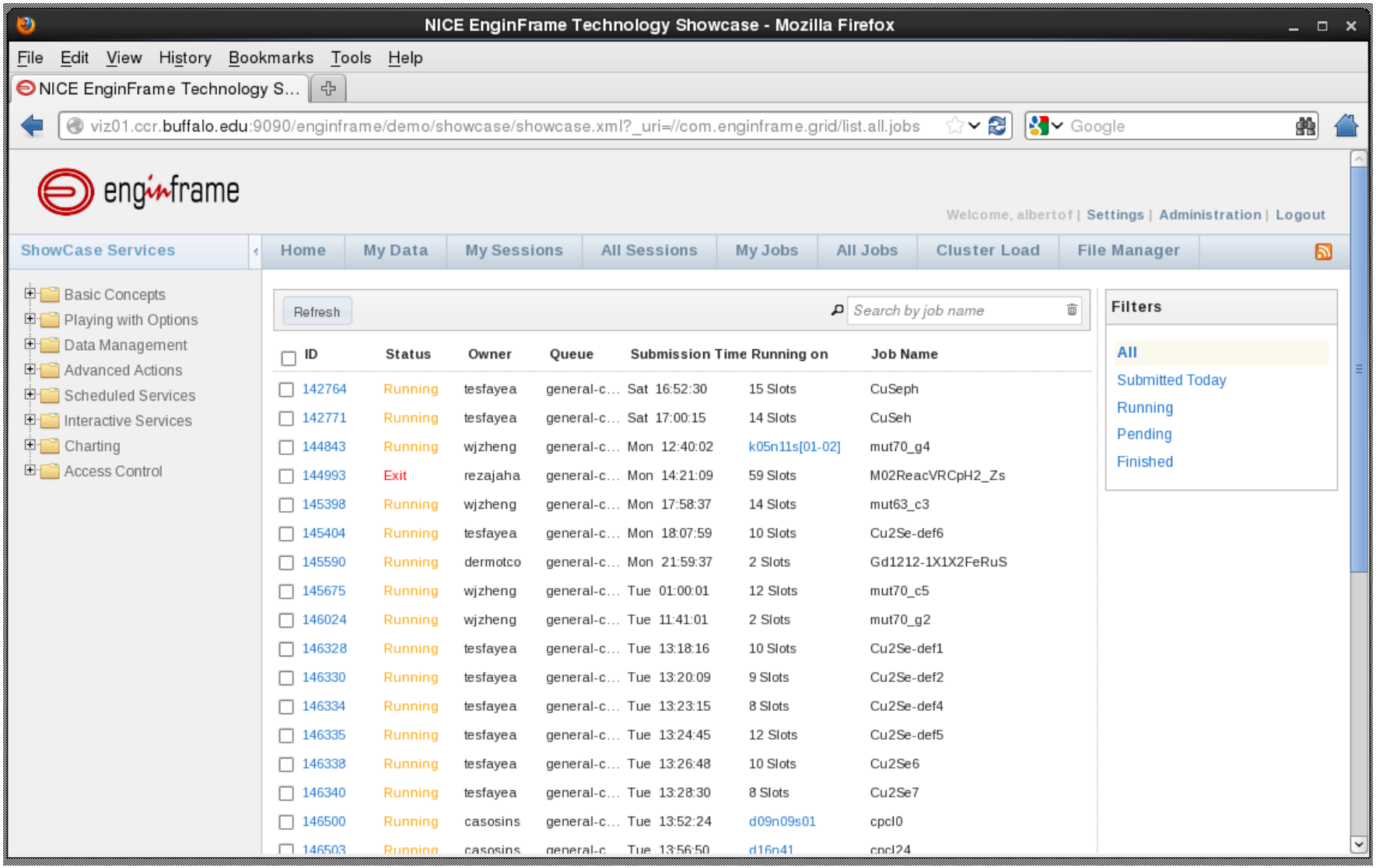
Example: Job Details (GridML)

```
<grid:job-list type="slurm" filtered="true" sorted="true" paginated="true"
filter="" sort-by="" max-results="1" start-index="1" results="1"
total-results="1">
  <grid:job id="351395” type="slurm">
    <grid:name>jB11c16</grid:name>
    <grid:owner>ajs42</grid:owner>
    <grid:account>kofke</grid:account>
    <grid:status ef="Running“ grid="RUNNING">RUN</grid:status>
    <grid:total-cpu-usage>1-08:15:06</grid:total-cpu-usage>
    <grid:submission-time>2013-09-01T17:40:20></grid:submission-time>
    <grid:execution-time>2013-09-09T05:44:08></grid:execution-time>
    <grid:queue>general-compute</grid:queue>
    <grid:execution-host>k07n27</grid:execution-host>
    <grid:parallel max="16" min="16"/>
    <grid:swap-usage>0</grid:swap-usage>
    <grid:execution-directory>/ifs/projects/kofke/ajs42/virial/hs/B11
    </grid:execution-directory>
    <grid:submission-directory>/ifs/projects/kofke/ajs42/virial/hs/B11
    </grid:submission-directory>
  </grid:job>
</grid:job-list>
```

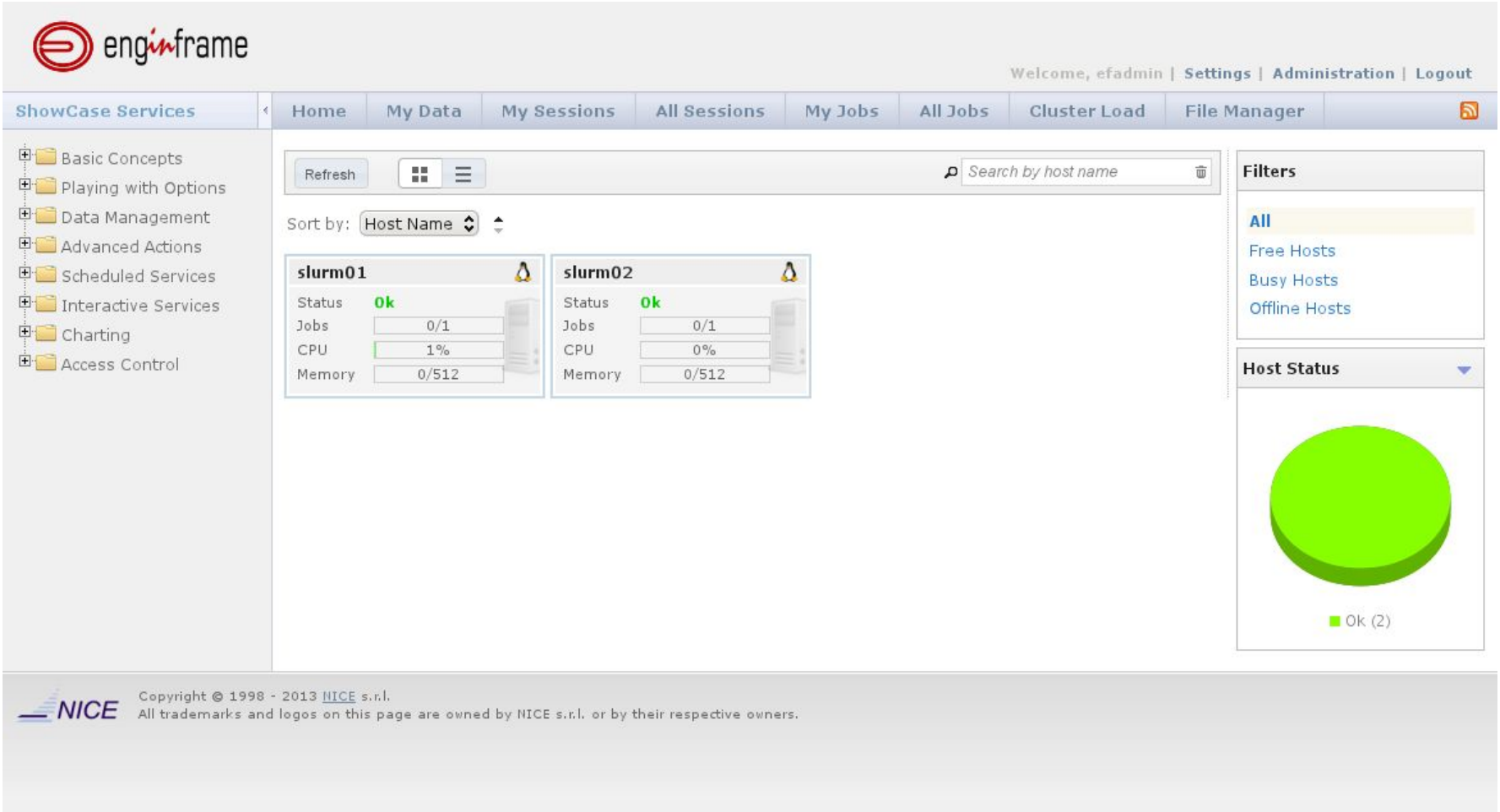
Example: Job Details



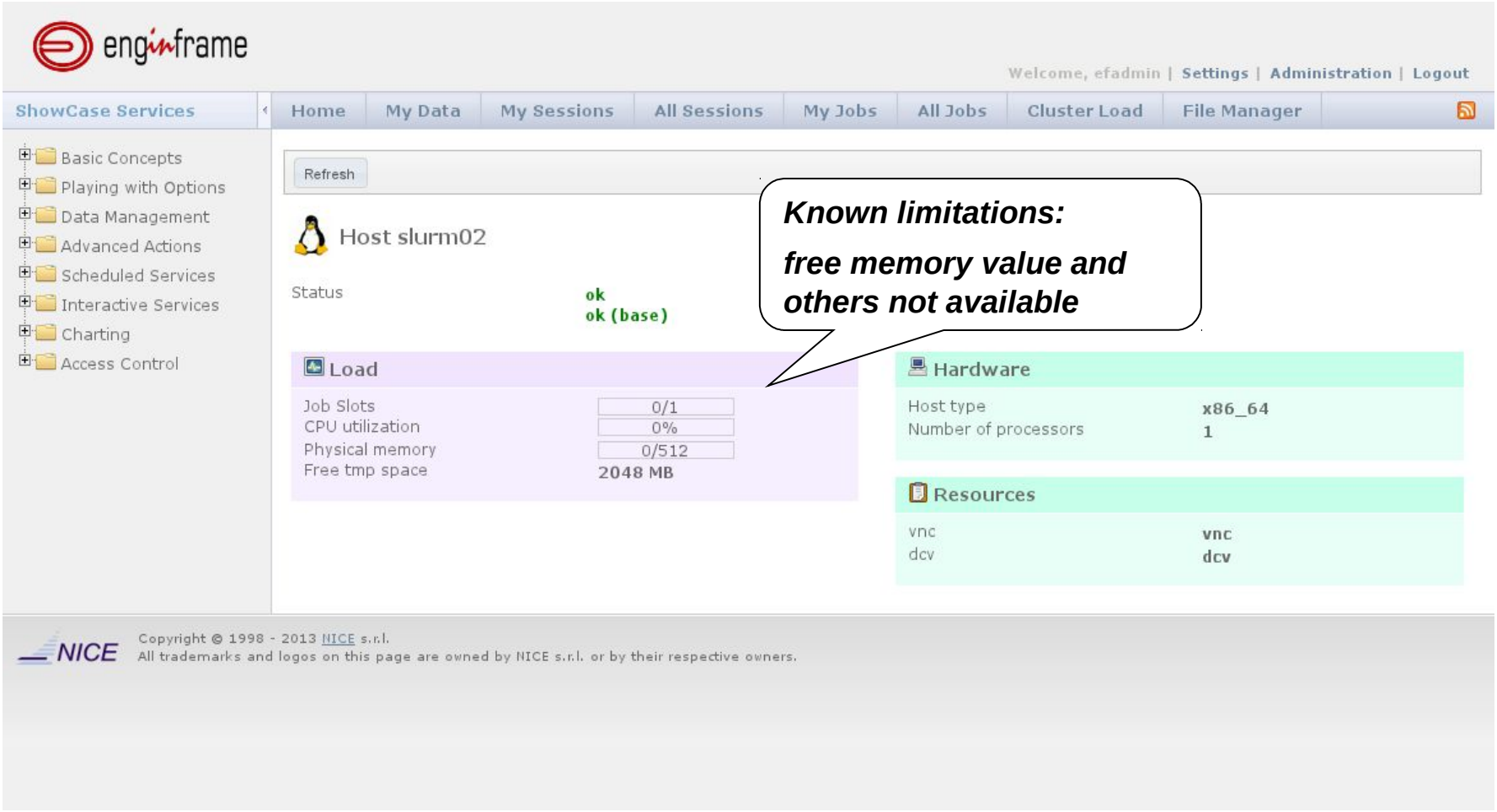
Example: All Jobs



Example: Cluster Load



Example: Host Details



Host Details: Limitations

Comparison of retrievied informations - What is missing

Host lsf706linux

Status	ok ok (base)

Load

Number of users	0
Job Slots	0/1
CPU utilization	15%
CPU run queue length:	
Averaged 15 sec (r15s)	1.6
Averaged one minute (r1m)	0.0
Averaged 15 minutes (r15m)	0.1
Physical memory	792MB/950MB
Swap space	68MB/945MB
Free tmp space	13.97GB
Paging rate	0.2 pages/sec
I/O throughput	56 Kb/sec
Idle time	1035 minutes

Hardware

Host type	X86_64
Host model	Intel_EM64T
Number of processors	1
Swap space	945MB

Host slurm02

Status	busy busy (base)

Load

Job Slots	1/1
CPU utilization	1%
Physical memory	0/512MB
Free tmp space	2048 MB

```
[root@slurm01 ~]# scontrol show node slurm02
NodeName=slurm02 Arch=x86_64 CoresPerSocket=1
   CPUAlloc=1 CPUErr=0 CPUTot=1 CPULoad=0.09
Features=vnc,dcv
   Gres=mem:256
   NodeAddr=slurm02 NodeHostName=slurm02
   OS=Linux RealMemory=512 AllocMem=0 Sockets=1 Boards=1
   State=ALLOCATED ThreadsPerCore=1 TmpDisk=2048 Weight=1
   BootTime=2013-08-01T23:37:11
SlurmdStartTime=2013-08-06T13:24:56
   CurrentWatts=0 LowestJoules=0 ConsumedJoules=0
   ExtSensorsJoules=n/s ExtSensorsWatts=0
```

Hardware

Host type	x86_64
Number of processors	1

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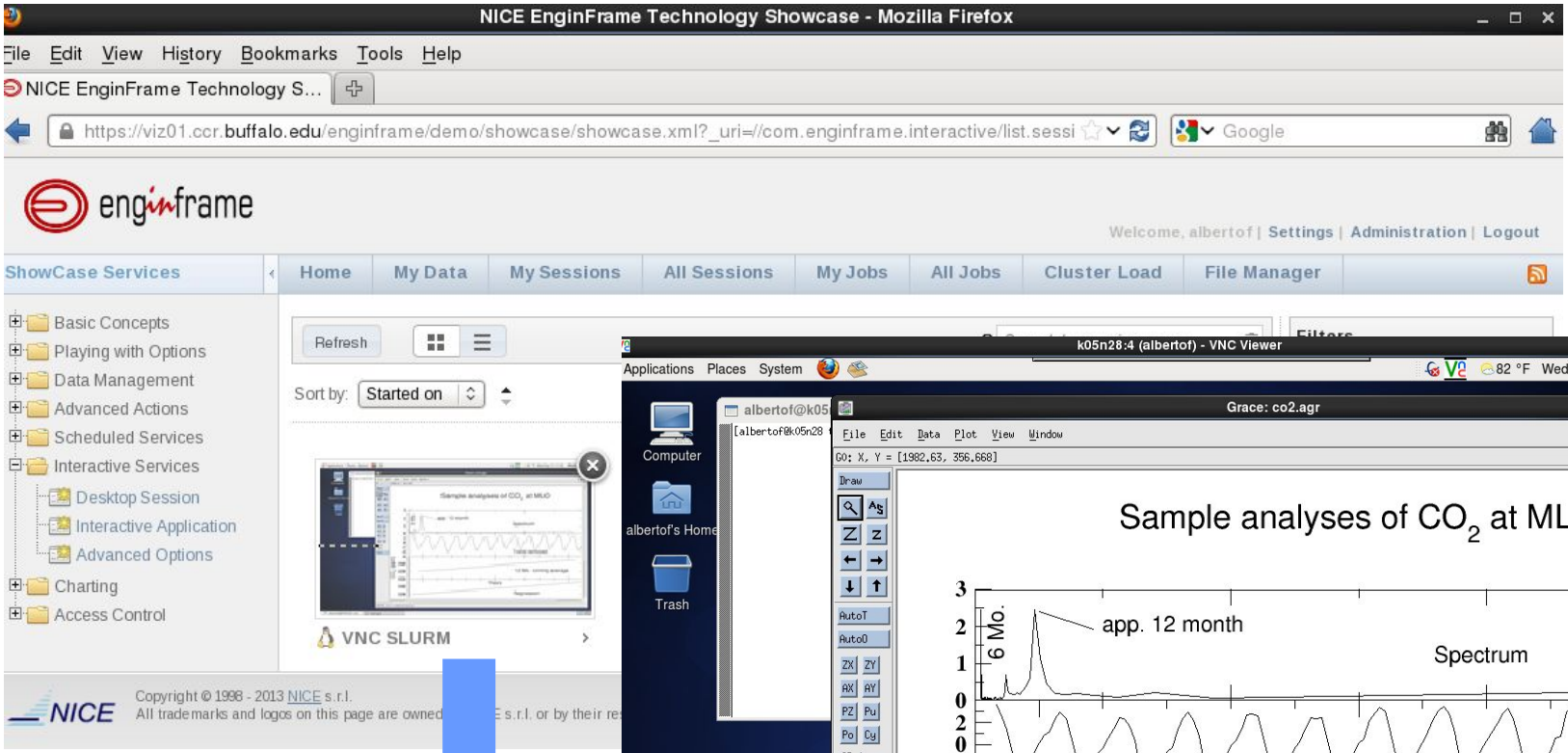
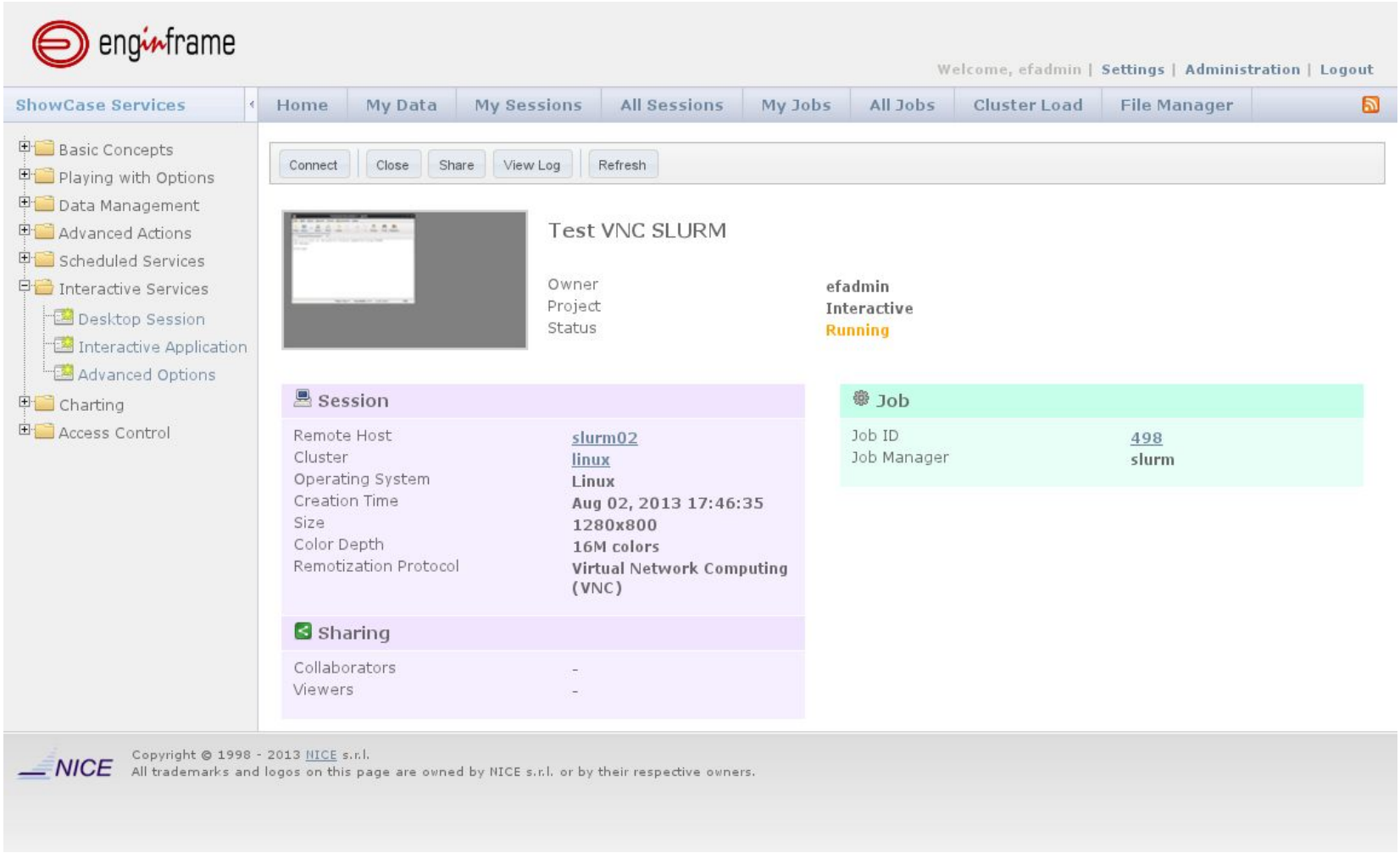
Example: Interactive Sessions



Connect to interactive session on mouse click

Example: Session Details



Conclusions

- NICE EnginFrame can now be used to create easy to use technical computing / HPC portals for your SLURM-based computing infrastructure
- SLURM 2.5.7 or higher version is required
- Future work:
  - How to retrieve the missing informations for hosts and jobs is under evaluation
  - MPI support to be tested in deep
  - Support for previous SLURM version under evaluation

Thanks to Doris Sajdak, Martins Innus and the other great guys @ Buffalo University for their active collaboration during the testing activities of the SLURM Plugin