GEA Farm Technologies

CONDOR as Job Queue Management for Teamcenter 8.x

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The issue

- To support a few automatic document converting and handling mechanism inside Teamcenter a Job Queue Management solution is required, which can perform operations in background processes.
- Such background processes have to be included into Teamcenter EPM workflows.
- Type of background processes:
  - Update of NX CAD UGPART drawing files
  - Converting NX CAD UGPART drawing files into TIFF formats
  - Upload TIFF drawing files into SAP archive
  - Render product representation images for sales tools with UGPHOTO
  - Run numerical solvers for FEA, CFD in the background
  - …

The Job Queue Principle

- To collect multiple process requests into a list of jobs, which should be performed.
- Select a job from the queue and assign it to an execution process / machine.
- Get the output / response from the execution and store it back into the system, which generates the call initially (e.g. Teamcenter)
- Inform the initial system that this specific job is completed
  (e.g. Teamcenter workflow approve – perform sign off)

The Job Queue Software Solutions

- **CRI – Create Image Server**
  This is part of the Teamcenter PLM – Easy package, which was developed and offered by the German subsidiary of UGS / SIEMENS. It was shipped in Germany with the Teamcenter 2005SR1 releases. It is not a part of the Teamcenter core development roadmap. The availability for future release of Teamcenter is undefined.
- **TSTK Translation Solution Toolkit (former ETS)**
  This is the standard tool, shipped with the Teamcenter installation package. It is the core mechanism developed and supported by the Teamcenter development.
- **CONDOR**
  Condor is a development project, managed by the University of Wisconsin (USA). The intent is to provide a reliable system for High Throughput Computing (HTC) on large collections of computing resources.
  http://www.cs.wisc.edu/condor/

Why not using the PLME Create Image Server?

- The development strategy of this is not transparent to the customer base.
- We have utilized this in our Teamcenter 2005 SR1 installation an have made experiences with it.
- The system is limited to 2Tier server based nodes / executors
- The implementation of a new job type (e.g. render video sequences) requires an entire copy of an existing CRI instance.
- The different CRI instances are not linked together. Therefore each pipe has its own CPU consumtion.

Why not using the TSTK standard solution?

- The TSTK requires for each translator type a separate JAVA class programming for the PRE- and POST- actions (e.g. export of files and import of files).
- The JAVA classes have to be integrated into the core Teamcenter installation. This requires multiple system shutdown and start operations during the implementation phase.
- The TSTK dispatcher is not able to negotiate between multiple available nodes to assign specific nodes to the jobs, based on its criteria.

Why using CONDOR?

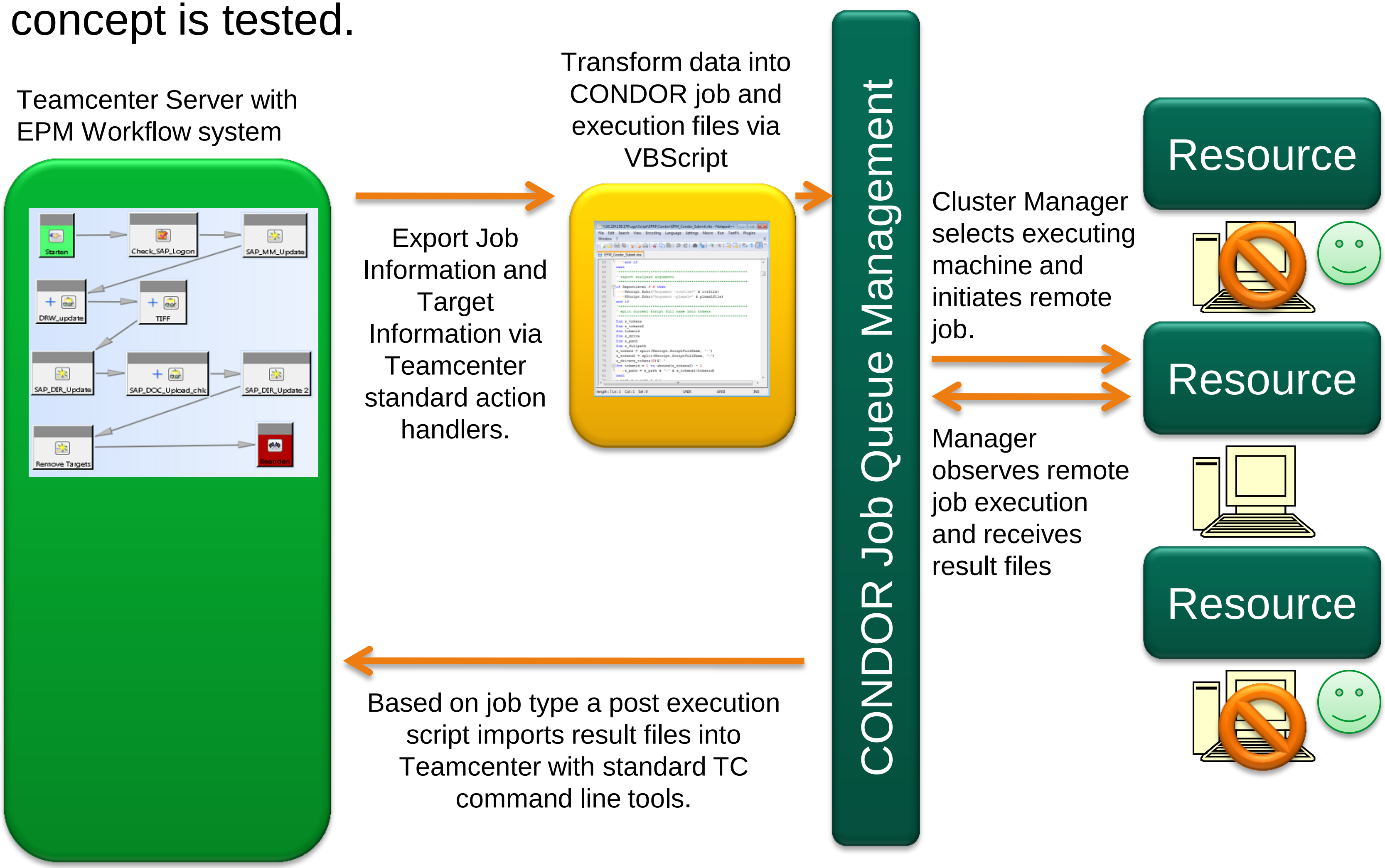
- CONDOR provides the capability to classify the available nodes by customized criteria (e.g. NX node, 4Tier or 2Tier node, Server or Client node, Location of the node, etc.).
- Each CONDOR job can be submitted with individual job requirements (e.g. a special job type has to be performed in every case on a server node while other job types can be performed on 4Tier clients).
- The jobs can be managed within the job queue with various command line tools. (e.g. a specific job type can be set to a higher priority)
- Multiple jobs can by linked together via the CONDOR DAG (Directed Acyclic Graph) mechanism (e.g. A workflow perform sign off job has to be performed on a server node while the previous render job can be preformed on a 4Tier client node)
- The system provides a high flexibility on the job type definition and node definitions (e.g. A job for a drawing update has to be performed on an execution node, which is located near the original file volume).

Disadvantages of CONDOR within Teamcenter

- There is no direct interface between Teamcenter and CONDOR, which can be installed and configured out of the box.
- The interaction between Teamcenter and CONDOR has to be programmed.

The interface concept

- To connect CONDOR with Teamcenter the following interface concept is tested.



Teamcenter Server with EPM Workflow system

Export Job Information and Target Information via Teamcenter standard action handlers.

Transform data into CONDOR job and execution files via VBScript

CONDOR Job Queue Management

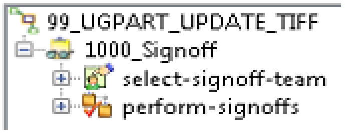
Cluster Manager selects executing machine and initiates remote job.

Manager observes remote job execution and receives result files

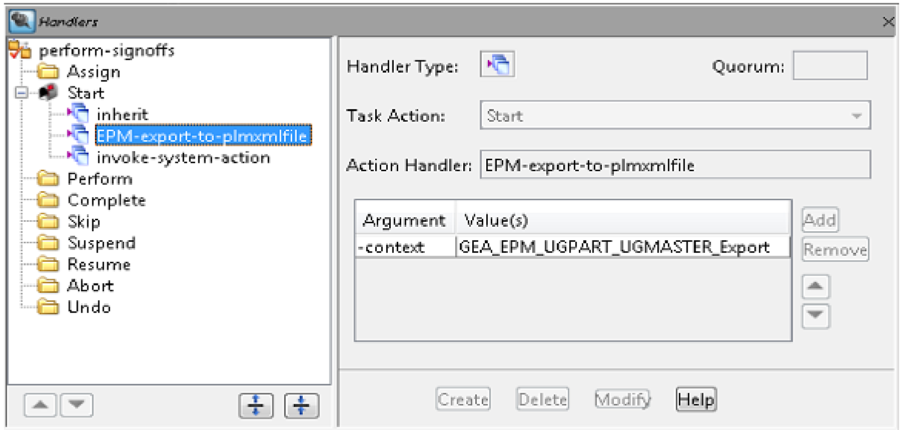
Based on job type a post execution script imports result files into Teamcenter with standard TC command line tools.

1. Export from Teamcenter

- To export data from Teamcenter within a workflow two standard action handlers (EPM-export-to-plmxmlfile & invoke-system-action) are used

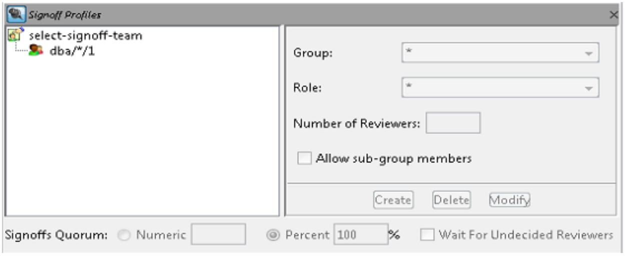


Both action handlers are attached to the perform-signoffs task, which is assigned to the “imageuser” as executing resource

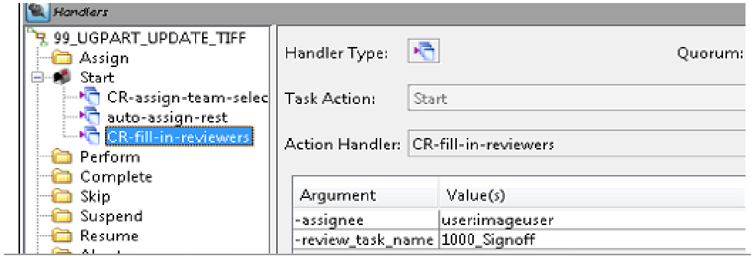


Handler Type:
Quorum:
Task Action: Start
Action Handler: EPM-export-to-plmxmlfile

Argument	Value(s)
-context	GEA_EPM_UGPART_UGMASTER_Export

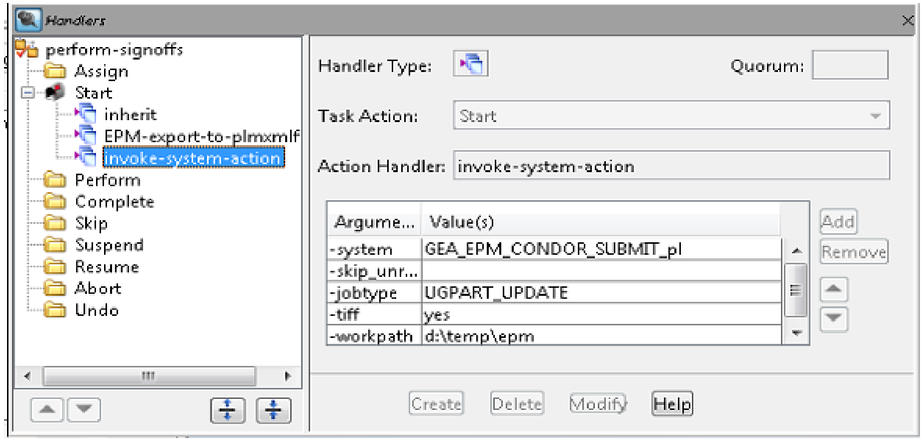


Group: *
Role: *
Number of Reviewers:
□ Allow sub-group members
Signoffs Quorum: ○ Numeric ● Percent 100 % □ Wait For Undecided Reviewers



Handler Type:
Quorum:
Task Action: Start
Action Handler: CR-fill-in-reviewers

Argument	Value(s)
-assignee	user:imageuser
-review_task_name	1000_Signoff

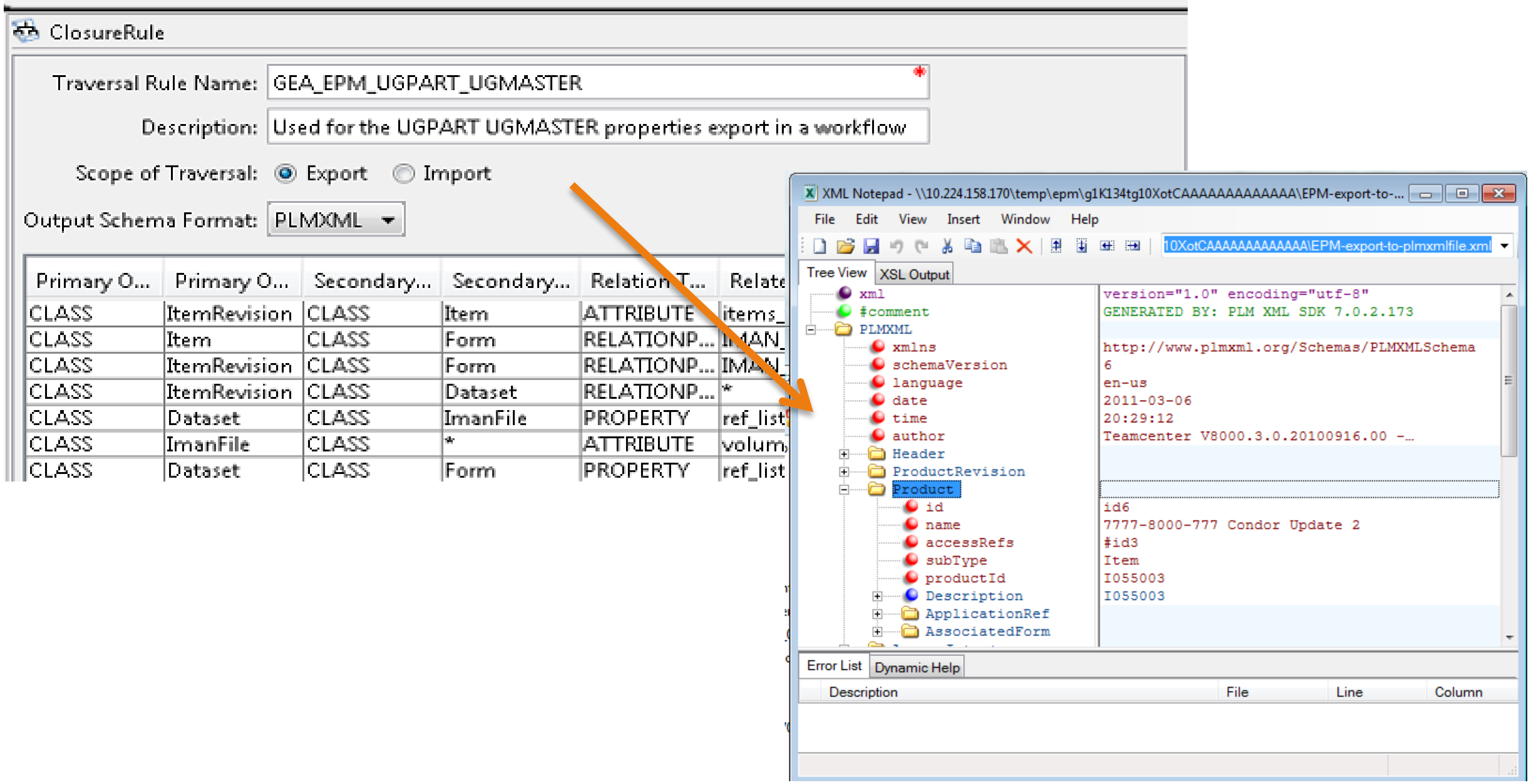


Handler Type:
Quorum:
Task Action: Start
Action Handler: invoke-system-action

Argume...	Value(s)
-system	GEA_EPM_CONDOR_SUBMIT_pl
-skip_unr...	
-jobtype	UGPART_UPDATE
-tiff	yes
-workpath	d:\temp\epm

1. Export from Teamcenter – The target objects

- The EPM-export-to-plmxmlfile handler exports a lot of information for the attached targets as XML file. Which data are exported are defined in a special PLMXML transformation rule



ClosureRule

Traversal Rule Name: GEA_EPM_UGPART_UGMASTER

Description: Used for the UGPART UGMASTER properties export in a workflow

Scope of Traversal: ● Export ○ Import

Output Schema Format: PLMXML

Primary O...	Primary O...	Secondary...	Secondary...	Relation T...	Relate
CLASS	ItemRevision	CLASS	Item	ATTRIBUTE	items_
CLASS	Item	CLASS	Form	RELATIONP...	IMAN_
CLASS	ItemRevision	CLASS	Form	RELATIONP...	IMAN_
CLASS	ItemRevision	CLASS	Dataset	RELATIONP...	*
CLASS	Dataset	CLASS	ImanFile	PROPERTY	ref_list
CLASS	ImanFile	CLASS	*	ATTRIBUTE	volum
CLASS	Dataset	CLASS	Form	PROPERTY	ref_list

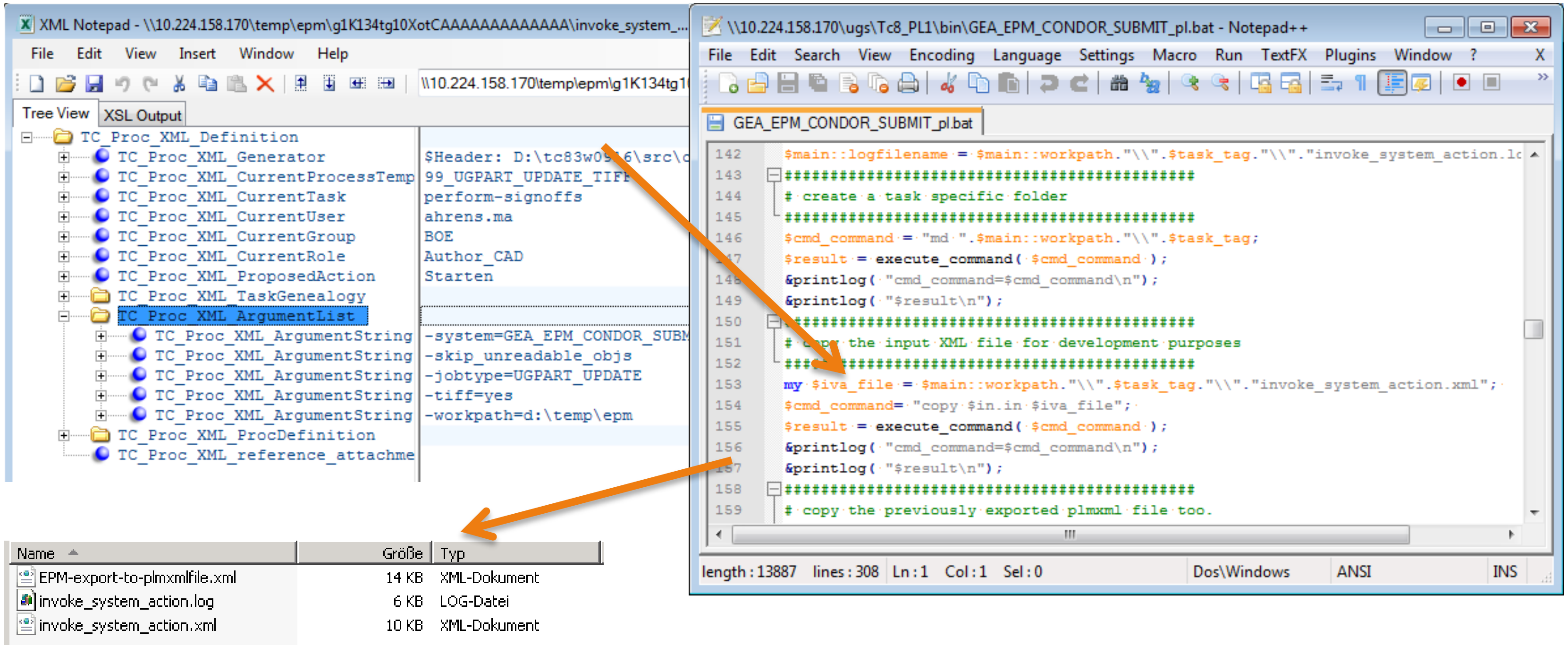
XML Notepad - \\10.224.158.170\temp\epm\g1K134tg10XotCAAAAAAAAAAAAA\EPM-export-to-...

10XotCAAAAAAAAAAAAA\EPM-export-to-plmxmlfile.xml

xml	version="1.0" encoding="utf-8"
#comment	GENERATED BY: PLM XML SDK 7.0.2.173
PLMXML	
xmlns	http://www.plmxml.org/Schemas/PLMXMLSchema
schemaVersion	6
language	en-us
date	2011-03-06
time	20:29:12
author	Teamcenter V8000.3.0.20100916.00 -...
Header	
ProductRevision	
Product	
id	id6
name	7777-8000-777 Condor Update 2
accessRefs	#id3
subType	Item
productId	I055003
Description	I055003
ApplicationRef	
AssociatedForm	

1. Export from Teamcenter – The job objects

- The invoke-system-action handler exports the major information for the job to another XML file. The structure of the XML file content is Teamcenter internal standard, which can be addressed by a PERL script, which is executed automatically as follow up. The customized PERL script creates a unique job folder and copies the two XML file into it an calls the VBScript.



XML Notepad - \\10.224.158.170\temp\epm\g1K134tg10XotCAAAAAAAAAAAAA\invoke_system_...

\\10.224.158.170\temp\epm\g1K134tg1

TC_Proc_XML_Definition	
TC_Proc_XML_Generator	$Header: D:\tc83w0[illegible]6\src\c
TC_Proc_XML_CurrentProcessTemp	99_UGPART_UPDATE_TIFF
TC_Proc_XML_CurrentTask	perform-signoffs
TC_Proc_XML_CurrentUser	ahrens.ma
TC_Proc_XML_CurrentGroup	BOE
TC_Proc_XML_CurrentRole	Author_CAD
TC_Proc_XML_ProposedAction	Starten
TC_Proc_XML_TaskGenealogy	
TC_Proc_XML_ArgumentList	
TC_Proc_XML_ArgumentString	-system=GEA_EPM_CONDOR_SUBM
TC_Proc_XML_ArgumentString	-skip_unreadable_objs
TC_Proc_XML_ArgumentString	-jobtype=UGPART_UPDATE
TC_Proc_XML_ArgumentString	-tiff=yes
TC_Proc_XML_ArgumentString	-workpath=d:\temp\epm
TC_Proc_XML_ProcDefinition	
TC_Proc_XML_reference_attachme	

\\10.224.158.170\ugs\Tc8_PL1\bin\GEA_EPM_CONDOR_SUBMIT_pl.bat - Notepad++

GEA_EPM_CONDOR_SUBMIT_pl.bat

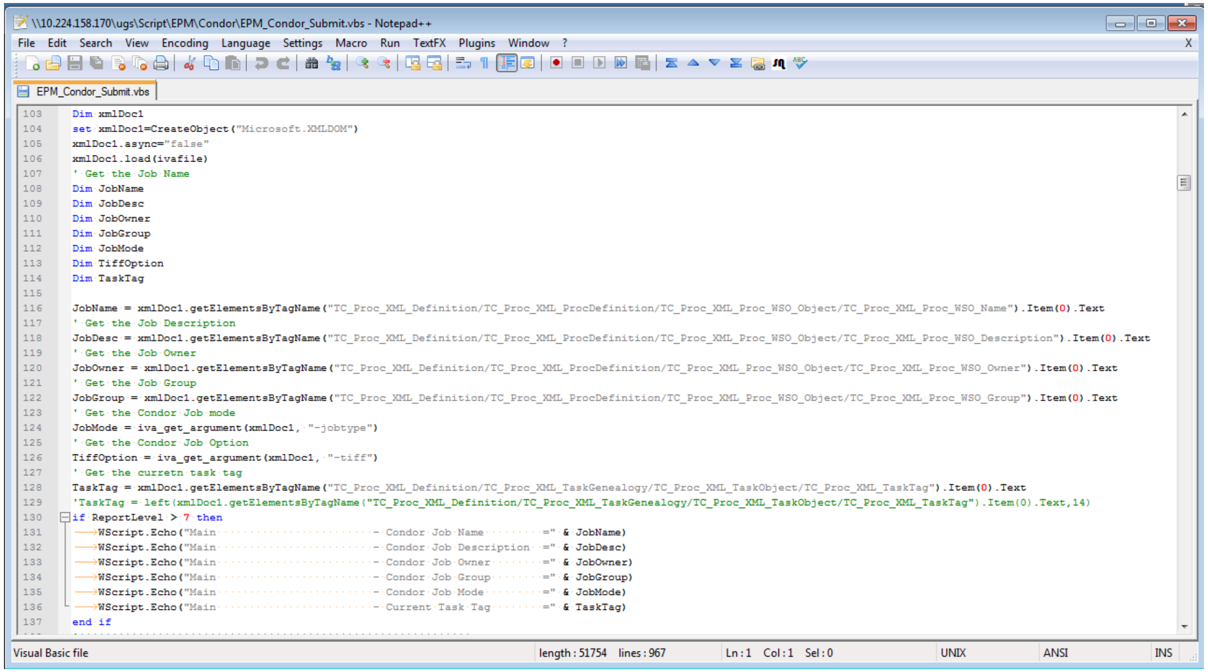
```
$main::logfilename = $main::workpath."\\".$task_tag."\\"."invoke_system_action.lc
###############################################
# create a task specific folder
###############################################
$cmd_command = "md ".$main::workpath."\\".$task_tag;
$result = execute_command( $cmd_command );
&printlog( "cmd_command=$cmd_command\n");
&printlog( "$result\n");
###############################################
# copy the input XML file for development purposes
###############################################
my $iva_file = $main::workpath."\\".$task_tag."\\"."invoke_system_action.xml";
$cmd_command= "copy $in.in $iva_file";
$result = execute_command( $cmd_command );
&printlog( "cmd_command=$cmd_command\n");
&printlog( "$result\n");
###############################################
# copy the previously exported plmxml file too.
```

length : 13887 lines : 308 Ln : 1 Col : 1 Sel : 0 Dos\Windows ANSI INS

Name	Größe	Typ
EPM-export-to-plmxmlfile.xml	14 KB	XML-Dokument
invoke_system_action.log	6 KB	LOG-Datei
invoke_system_action.xml	10 KB	XML-Dokument

2. Transform data for CONDOR job

- The core implementation development is made on the VBScript, which captures information from the two XML files and convert them into CONDOR job descriptions.
- It starts with the invoke-system-action XML file and gets additional, related data from the EPM-export-to-plmxmlfile XML file (e.g. UGPART-ATTR data like page size, etc.)


\\10.224.158.170\ugs\Script\EPM\Condor\EPM_Condor_Submit.vbs - Notepad++
File Edit Search View Encoding Language Settings Macro Run TextFX Plugins Window ?
EPM_Condor_Submit.vbs
Visual Basic file
length : 51754 lines : 967
Ln : 1 Col : 1 Sel : 0
UNIX
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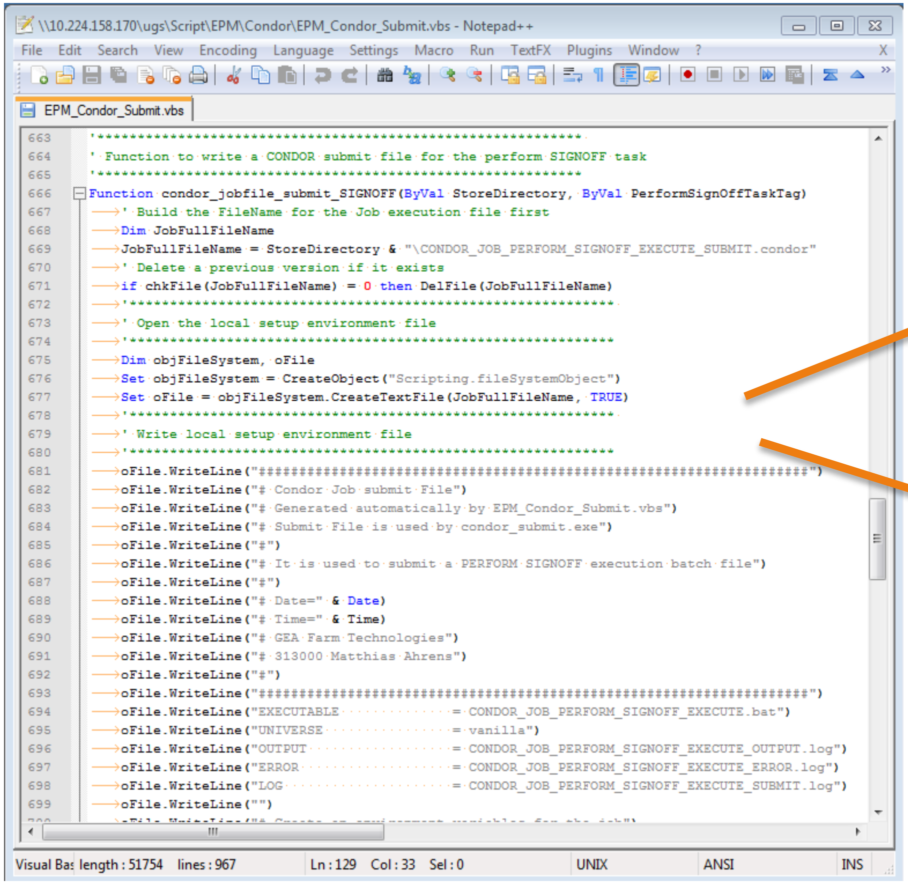
INS

```vbscript
Dim xmlDoc1
set xmlDoc1=CreateObject("Microsoft.XMLDOM")
xmlDoc1.async="false"
xmlDoc1.load(ivafile)
' Get the Job Name
Dim JobName
Dim JobDesc
Dim JobOwner
Dim JobGroup
Dim JobMode
Dim TiffOption
Dim TaskTag

JobName = xmlDoc1.getElementsByTagName("TC_Proc_XML_Definition/TC_Proc_XML_ProcDefinition/TC_Proc_XML_Proc_WSO_Object/TC_Proc_XML_Proc_WSO_Name").Item(0).Text
' Get the Job Description
JobDesc = xmlDoc1.getElementsByTagName("TC_Proc_XML_Definition/TC_Proc_XML_ProcDefinition/TC_Proc_XML_Proc_WSO_Object/TC_Proc_XML_Proc_WSO_Description").Item(0).Text
' Get the Job Owner
JobOwner = xmlDoc1.getElementsByTagName("TC_Proc_XML_Definition/TC_Proc_XML_ProcDefinition/TC_Proc_XML_Proc_WSO_Object/TC_Proc_XML_Proc_WSO_Owner").Item(0).Text
' Get the Job Group
JobGroup = xmlDoc1.getElementsByTagName("TC_Proc_XML_Definition/TC_Proc_XML_ProcDefinition/TC_Proc_XML_Proc_WSO_Object/TC_Proc_XML_Proc_WSO_Group").Item(0).Text
' Get the Condor Job mode
JobMode = iva_get_argument(xmlDoc1, "-jobtype")
' Get the Condor Job Option
TiffOption = iva_get_argument(xmlDoc1, "-tiff")
' Get the curretn task tag
TaskTag = xmlDoc1.getElementsByTagName("TC_Proc_XML_Definition/TC_Proc_XML_TaskGenealogy/TC_Proc_XML_TaskObject/TC_Proc_XML_TaskTag").Item(0).Text
'TaskTag = left(xmlDoc1.getElementsByTagName("TC_Proc_XML_Definition/TC_Proc_XML_TaskGenealogy/TC_Proc_XML_TaskObject/TC_Proc_XML_TaskTag").Item(0).Text,14)
if ReportLevel > 7 then
	WScript.Echo("Main                         - Condor Job Name          =" & JobName)
	WScript.Echo("Main                         - Condor Job Description  =" & JobDesc)
	WScript.Echo("Main                         - Condor Job Owner         =" & JobOwner)
	WScript.Echo("Main                         - Condor Job Group         =" & JobGroup)
	WScript.Echo("Main                         - Condor Job Mode          =" & JobMode)
	WScript.Echo("Main                         - Current Task Tag         =" & TaskTag)
end if
```

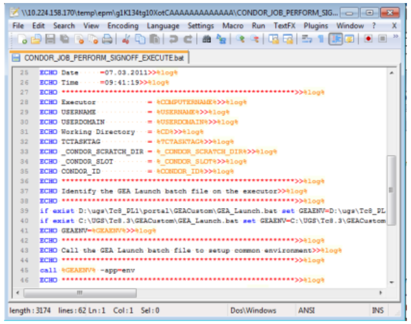
2. Transform data for CONDOR job

- Based on the job type it creates multiple CONDOR specific files. An BATCH file, which should be executed on the node and a CONDOR submit description file.


\\10.224.158.170\ugs\Script\EPM\Condor\EPM_Condor_Submit.vbs - Notepad++
File Edit Search View Encoding Language Settings Macro Run TextFX Plugins Window ?
EPM_Condor_Submit.vbs
Visual Bas length : 51754 lines : 967 Ln : 129 Col : 33 Sel : 0 UNIX ANSI INS

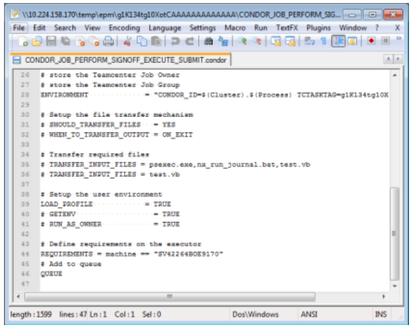
```
'*****************************************************************
' Function to write a CONDOR submit file for the perform SIGNOFF task
'*****************************************************************
Function condor_jobfile_submit_SIGNOFF(ByVal StoreDirectory, ByVal PerformSignOffTaskTag)
    ' Build the FileName for the Job execution file first
    Dim JobFullFileName
    JobFullFileName = StoreDirectory & "\CONDOR_JOB_PERFORM_SIGNOFF_EXECUTE_SUBMIT.condor"
    ' Delete a previous version if it exists
    if chkFile(JobFullFileName) = 0 then DelFile(JobFullFileName)
    '*****************************************************************
    ' Open the local setup environment file
    '*****************************************************************
    Dim objFileSystem, oFile
    Set objFileSystem = CreateObject("Scripting.fileSystemObject")
    Set oFile = objFileSystem.CreateTextFile(JobFullFileName, TRUE)
    '*****************************************************************
    ' Write local setup environment file
    '*****************************************************************
    oFile.WriteLine("##########################################################################")
    oFile.WriteLine("# Condor Job submit File")
    oFile.WriteLine("# Generated automatically by EPM_Condor_Submit.vbs")
    oFile.WriteLine("# Submit File is used by condor_submit.exe")
    oFile.WriteLine("#")
    oFile.WriteLine("# It is used to submit a PERFORM SIGNOFF execution batch file")
    oFile.WriteLine("#")
    oFile.WriteLine("# Date=" & Date)
    oFile.WriteLine("# Time=" & Time)
    oFile.WriteLine("# GEA Farm Technologies")
    oFile.WriteLine("# 313000 Matthias Ahrens")
    oFile.WriteLine("#")
    oFile.WriteLine("##########################################################################")
    oFile.WriteLine("EXECUTABLE              = CONDOR_JOB_PERFORM_SIGNOFF_EXECUTE.bat")
    oFile.WriteLine("UNIVERSE                = vanilla")
    oFile.WriteLine("OUTPUT                  = CONDOR_JOB_PERFORM_SIGNOFF_EXECUTE_OUTPUT.log")
    oFile.WriteLine("ERROR                   = CONDOR_JOB_PERFORM_SIGNOFF_EXECUTE_ERROR.log")
    oFile.WriteLine("LOG                     = CONDOR_JOB_PERFORM_SIGNOFF_EXECUTE_SUBMIT.log")
    oFile.WriteLine("")
    oFile.WriteLine("# Create an environment variables for the job")
```

The .bat execution file


\\10.224.158.170\temp\epm\g1K134tg10XotCAAAAAAAAAAAAA\CONDOR_JOB_PERFORM_SIG...
File Edit Search View Encoding Language Settings Macro Run TextFX Plugins Window ?
CONDOR_JOB_PERFORM_SIGNOFF_EXECUTE.bat
length : 3174 lines : 62 Ln : 1 Col : 1 Sel : 0 Dos\Windows ANSI INS

```
ECHO Date     =07.03.2011>>%log%
ECHO Time     =09:41:19>>%log%
ECHO ****************************************************>>%log%
ECHO Executor            = %COMPUTERNAME%>>%log%
ECHO USERNAME            = %USERNAME%>>%log%
ECHO USERDOMAIN          = %USERDOMAIN%>>%log%
ECHO Working Directory   = %CD%>>%log%
ECHO TCTASKTAG           = %TCTASKTAG%>>%log%
ECHO _CONDOR_SCRATCH_DIR = %_CONDOR_SCRATCH_DIR%>>%log%
ECHO _CONDOR_SLOT        = %_CONDOR_SLOT%>>%log%
ECHO CONDOR_ID           = %CONDOR_ID%>>%log%
ECHO ****************************************************>>%log%
ECHO Identify the GEA Launch batch file on the executor>>%log%
ECHO ****************************************************>>%log%
if exist D:\ugs\Tc8_PL1\portal\GEACustom\GEA_Launch.bat set GEAENV=D:\ugs\Tc8_PL
if exist C:\UGS\Tc8.3\GEACustom\GEA_Launch.bat set GEAENV=C:\UGS\Tc8.3\GEACustom
ECHO GEAENV=%GEAENV%>>%log%
ECHO ****************************************************>>%log%
ECHO Call the GEA Launch batch file to setup common environment>>%log%
ECHO ****************************************************>>%log%
call %GEAENV% -app=env
ECHO ****************************************************>>%log%
```

The .condor Job description file

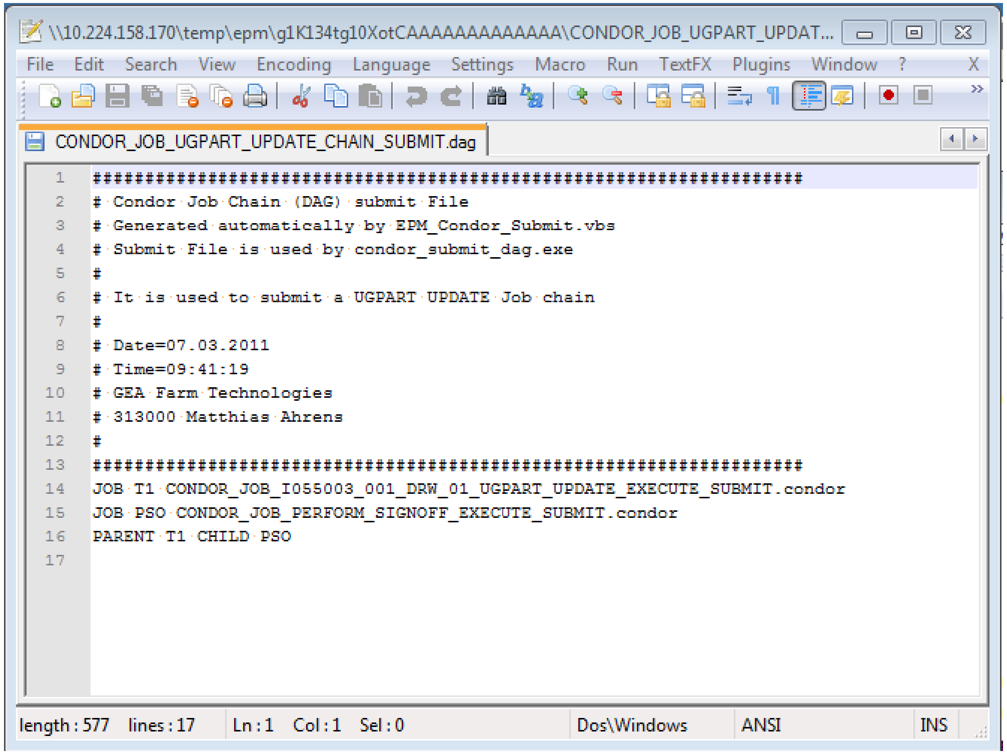

\\10.224.158.170\temp\epm\g1K134tg10XotCAAAAAAAAAAAAA\CONDOR_JOB_PERFORM_SIG...
File Edit Search View Encoding Language Settings Macro Run TextFX Plugins Window ?
CONDOR_JOB_PERFORM_SIGNOFF_EXECUTE_SUBMIT.condor
length : 1599 lines : 47 Ln : 1 Col : 1 Sel : 0 Dos\Windows ANSI INS

```
# store the Teamcenter Job Owner
# store the Teamcenter Job Group
ENVIRONMENT             = "CONDOR_ID=$(Cluster).$(Process) TCTASKTAG=g1K134tg10X

# Setup the file transfer mechanism
# SHOULD_TRANSFER_FILES   = YES
# WHEN_TO_TRANSFER_OUTPUT = ON_EXIT

# Transfer required files
# TRANSFER_INPUT_FILES = psexec.exe,nx_run_journal.bat,test.vb
# TRANSFER_INPUT_FILES = test.vb

# Setup the user environment
LOAD_PROFILE            = TRUE
# GETENV                = TRUE
# RUN_AS_OWNER          = TRUE

# Define requirements on the executor
REQUIREMENTS = machine == "SV42264BOE9170"
# Add to queue
QUEUE

```

2. Transform data for CONDOR job

- If multiple processes are required (e.g. Update on a 4Tier client and follow up perform signoffs confirmation on a 2Tier server) it creates an over DAG job dependency file for CONDOR too.

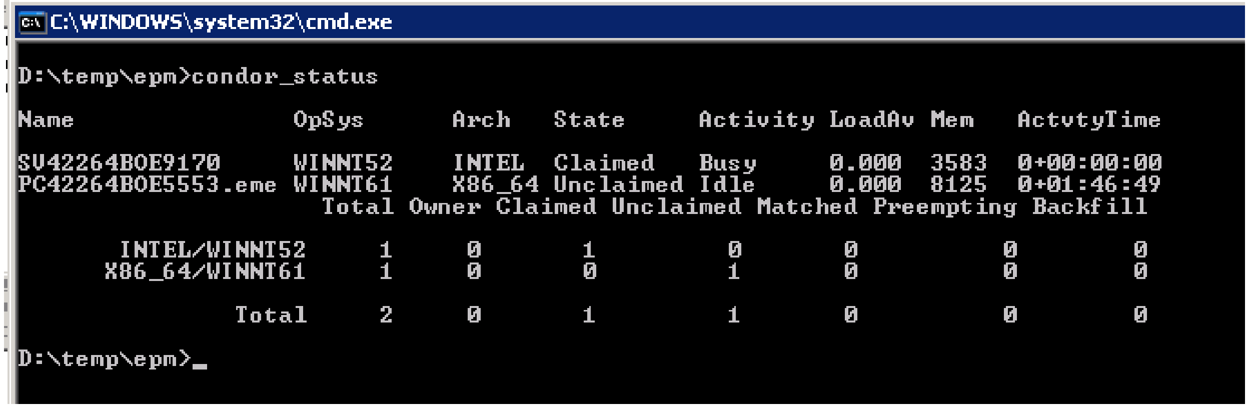
The .dag file, which defines the job dependencies for CONDOR


\\10.224.158.170\temp\epm\g1K134tg10XotCAAAAAAAAAAAAA\CONDOR_JOB_UGPART_UPDAT...
File Edit Search View Encoding Language Settings Macro Run TextFX Plugins Window ? X
CONDOR_JOB_UGPART_UPDATE_CHAIN_SUBMIT.dag
length : 577 lines : 17 Ln : 1 Col : 1 Sel : 0 Dos\Windows ANSI INS

```
####################################################################
# Condor Job Chain (DAG) submit File
# Generated automatically by EPM_Condor_Submit.vbs
# Submit File is used by condor_submit_dag.exe
#
# It is used to submit a UGPART UPDATE Job chain
#
# Date=07.03.2011
# Time=09:41:19
# GEA Farm Technologies
# 313000 Matthias Ahrens
#
####################################################################
JOB T1 CONDOR_JOB_I055003_001_DRW_01_UGPART_UPDATE_EXECUTE_SUBMIT.condor
JOB PSO CONDOR_JOB_PERFORM_SIGNOFF_EXECUTE_SUBMIT.condor
PARENT T1 CHILD PSO

```

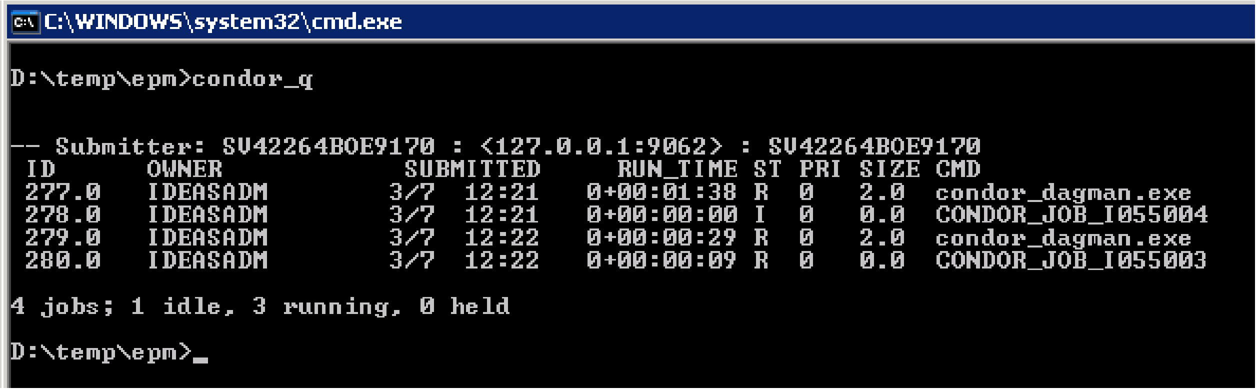
2. CONDOR job submit

- Finally it submits the jobs to the CONDOR queue management system



C:\WINDOWS\system32\cmd.exe

```
D:\temp\epm>condor_status

Name               OpSys       Arch   State     Activity LoadAv Mem   ActvtyTime

SV42264BOE9170     WINNT52     INTEL  Claimed   Busy     0.000  3583  0+00:00:00
PC42264BOE5553.eme WINNT61     X86_64 Unclaimed Idle     0.000  8125  0+01:46:49
                     Total Owner Claimed Unclaimed Matched Preempting Backfill

       INTEL/WINNT52     1     0       1         0       0          0        0
      X86_64/WINNT61     1     0       0         1       0          0        0

               Total     2     0       1         1       0          0        0

D:\temp\epm>_
```

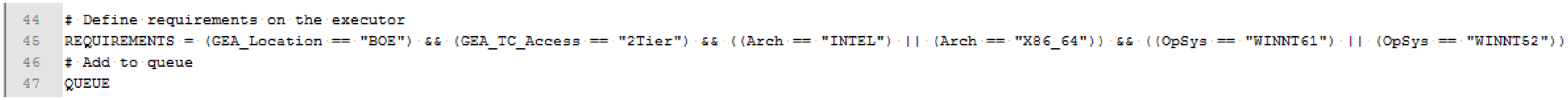


C:\WINDOWS\system32\cmd.exe

```
D:\temp\epm>condor_q


-- Submitter: SV42264BOE9170 : <127.0.0.1:9062> : SV42264BOE9170
 ID      OWNER            SUBMITTED     RUN_TIME ST PRI SIZE CMD
 277.0   IDEASADM        3/7  12:21   0+00:01:38 R  0   2.0  condor_dagman.exe
 278.0   IDEASADM        3/7  12:21   0+00:00:00 I  0   0.0  CONDOR_JOB_I055004
 279.0   IDEASADM        3/7  12:22   0+00:00:29 R  0   2.0  condor_dagman.exe
 280.0   IDEASADM        3/7  12:22   0+00:00:09 R  0   0.0  CONDOR_JOB_I055003

4 jobs; 1 idle, 3 running, 0 held

D:\temp\epm>_
```

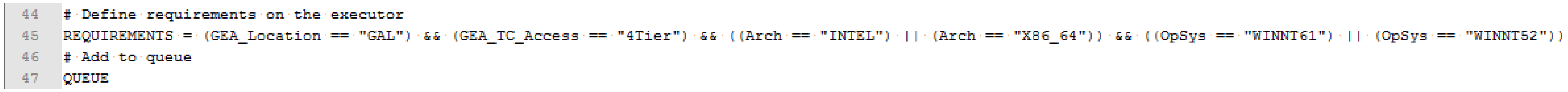
2. CONDOR job submit

- The advantage of CONDOR is that each job can be prepared with a requirement string, which defines the attributes of the needed resources.



```
# Define requirements on the executor
REQUIREMENTS = (GEA_Location == "BOE") && (GEA_TC_Access == "2Tier") && ((Arch == "INTEL") || (Arch == "X86_64")) && ((OpSys == "WINNT61") || (OpSys == "WINNT52"))
# Add to queue
QUEUE
```

or



```
# Define requirements on the executor
REQUIREMENTS = (GEA_Location == "GAL") && (GEA_TC_Access == "4Tier") && ((Arch == "INTEL") || (Arch == "X86_64")) && ((OpSys == "WINNT61") || (OpSys == "WINNT52"))
# Add to queue
QUEUE
```

3. CONDOR Teamcenter interaction back link

- When a job is done by CONDOR a few post – processing actions are required (e.g. import files, approve task)
- For these actions a server based CONDOR job is defined, which uses standard Teamcenter 2Tier command line tools like:
  - Tc_workflow_postprocess.exe => to approve the perform-signoffs task
  - Import_file => to upload the results (e.g. TIFF exports) into Teamcenter
  - TCX-delete-dataset workflow handler => to delete previous versions