
# A unified user experience for MPI jobs in EMI

Enol Fernández (CSIC)

gLite MPI PT

# Outline

- Parallel Jobs
- EMI middleware stacks approaches
  - How to execute a simple MPI job with 16 process with ARC/gLite/UNICORE?
- Unified Job Execution Experience
  - Submission
  - Execution
- MPI-Start in EMI-1

# Parallel jobs

Submission/Allocation:
- Definition of job characteristics
- Search and select adequate resources
- Allocate (or co-allocate) resources for job

Execution:
- File distribution
- Batch system interaction
- Parallel job runtime implementation details

# Executing an MPI job

- There is no standard way of starting an MPI application
  - No common syntax for mpirun, mpiexec support optional
- The cluster where the MPI job is supposed to run doesn't have a shared file system
  - How to distribute the binary and input files?
  - How to gather the output?
- Different clusters over the Grid are managed by different Local Resource Management Systems (PBS, LSF, SGE,…)
  - Where is the list of machines that the job can use?
  - What is the correct format for this list?
- How to compile MPI program?
  - How can a physicist working on Windows workstation compile his code for/with an Itanium MPI implementation?

# ARC Parallel Job

```
&(jobName="openmpi-gcc64")
(count="16")
(wallTime="10 minutes")
(memory="1024")
(executable="runopenmpi.sh")
(executables="hello-ompi.exe" "runopenmpi.sh")
(inputfiles=("hello-ompi.exe" "runopenmpi.sh"))
(stdout="std.out")
(stderr="std.err")
(gmlog="gmlog")
(runtimeenvironment="ENV/MPI/OPENMPI-1.3/GCC64")
```

```
#!/bin/sh
echo "MPIRUN is $MPIRUN"
echo "NSLOTS is $NSLOTS"
$MPIRUN -np $NSLOTS ./hello-ompi.exe
```

# gLite Parallel Job

```
JobType          = "Normal";
CpuNumber        = 16;
Executable       = "starter.sh";
InputSandbox     = {"starter.sh", "hello-ompi.exe"};
StdOutput        = "std.out";
StdError         = "std.err";
OutputSandbox    = {"std.out","std.err"};
Requirements     =
    Member("MPI-START",
           other.GlueHostApplicationSoftwareRunTimeEnvironment)
 && Member("OPENMPI",
           other.GlueHostApplicationSoftwareRunTimeEnvironment);
```

WholeNode = True;
NodeNumber = 4;
SMPGranularity = 4;

```
#!/bin/sh

# Set environment variables needed
export I2G_MPI_APPLICATION=hello-ompi.exe
export I2G_MPI_TYPE=openmpi

# Execute mpi-start
$I2G_MPI_START
```

# UNICORE Parallel Job

```
{
  Executable: "./hello-ompi.exe",
  Imports: [
    {From: "/myfiles/hello.mpi", To: "hello-ompi.exe" },
  ],
  Resources:{ CPUs: 16, },
  Execution environment: {
    Name: OpenMPI,
    Arguments: { Processes: 4,  },
  },
}
```

```
Resources:{
 CPUsPerNode: 4,
 Nodes: 4,
}
```

No need for user script!

# ARC vs gLite vs UNICORE

| | RTE | MPI-Start | Execution Env. |
|---|---|---|---|
| Deployment | Site | Site / User | Site |
| Invocation | Job Description + user script | Explicit by user | Job Description |
| What the user needs? | write a script for starting the job using some predefined variables | write a script that sets MPI-Start parameters & invoke MPI-Start | Set Execution Environment parameters at job description |
| Pre/Post actions | User script Admin can do pre/post actions. | Hooks | Pre / Post commands |

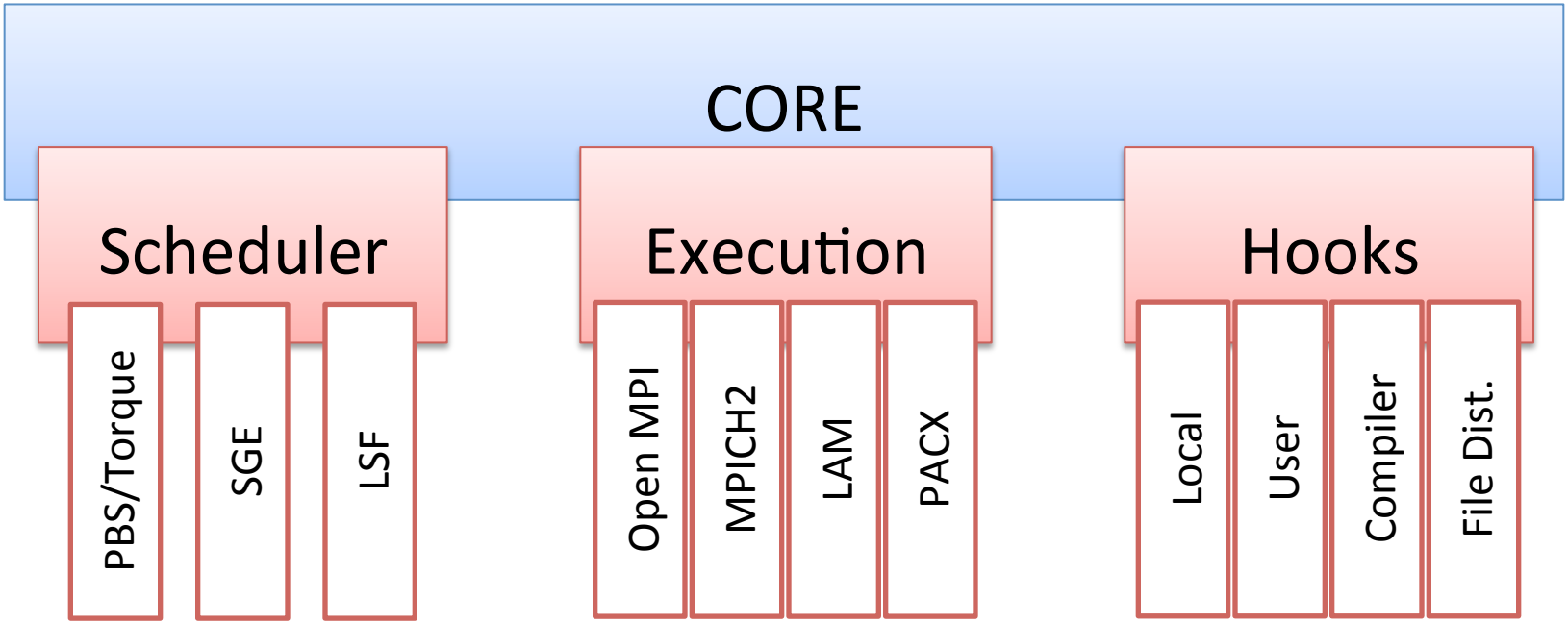
# Unified API for Submission

- EMI-ES (See presentation by Bernd Schuller in this same session)
  - NumberOfSlots:
    - Total number of slots
  - SlotsPerHost (optional):
    - number of slots on each single host.
  - ExclusiveExecution (optional):
    - whether a host should be allocated for exclusive use by the job
  - ProcessPerHost (optional):
    - number of instances of the executable per host.
  - ThreadsPerProcesses (optional):
    - number of threads per process (i.e., per instance of the executable)

# MPI-Start

- Specify a unique interface to the upper layer to run a Parallel (MPI) job
- Allow the support of new MPI implementations without modifications in the Grid middleware
- Portable
- Modular and extensible architecture
- Extensive debugging options

# MPI-Start Architecture



# MPI-Start for users

- Single interface for all parallel jobs:
  - No need to learn a different command line option every time a MPI version changes
  - No need to learn how each scheduler manages the hosts
- Control of process mapping:
  - One process per host
  - N processes per host
  - K total processes
- File distribution
  - No need to worry (much) about shared or not filesystems
- Customizable with hooks
  - Compilation
  - input preparation
  - management of output

# MPI-Start for site admins

- Single interface for all parallel jobs:
  - No need to configure a different Execution Environment / Run Time Environment for each type of job
- Easy to deploy for admins without much experience:
  - Default MPI installations paths for SL5(current target for EMI) installations detected
  - Yaim module for configuration
- Customizable with hooks for sites with specific requirements

# MPI-Start + ARC

```
#!/bin/bash
parallel_env_name="mpi-start"
case "$1" in
0 ) # local LRMS specific settings, no action
        ;;
1 ) # user environment setup
        export I2G_MPI_START=/usr/bin/mpi-start
        export MPI_START_SHARED_HOME=yes
        ;;
2 ) # nothing here
        ;;
* ) # everything else is an error
        return 1
esac
```

# MPI-Start + UNICORE

```
<jsdl-u:ExecutionEnvironment>
  <jsdl-u:Name>mpi-start</jsdl-u:Name>
  <jsdl-u:Description>Run parallel applications</jsdl-u:Description>
  <jsdl-u:ExecutableName>/usr/bin/mpi-start</jsdl-u:ExecutableName>
  <jsdl-u:Argument>
    <jsdl-u:Name>mpi type</jsdl-u:Name>
    <jsdl-u:IncarnatedValue>-t </jsdl-u:IncarnatedValue>
    <jsdl-u:ArgumentMetadata>
      <jsdl-u:Description>MPI implementation to use</jsdl-u:Description>
      <jsdl-u:Type>string</jsdl-u:Type>
    </jsdl-u:ArgumentMetadata>
  </jsdl-u:Argument>
  <jsdl-u:Argument>
    <jsdl-u:Name>Per node</jsdl-u:Name>
    <jsdl-u:IncarnatedValue>-npnode </jsdl-u:IncarnatedValue>
    <jsdl-u:ArgumentMetadata>
       <jsdl-u:Description>Number of processes per node</jsdl-u:Description>
       <jsdl-u:Type>int</jsdl-u:Type>
       <jsdl-u:ValidValue>[1,20]</jsdl-u:ValidValue>
     </jsdl-u:ArgumentMetadata>
  </jsdl-u:Argument>
  …
```

# MPI-Start + UNICORE

```
    <jsdl-u:Argument>
      <jsdl-u:Name>Export Environment Variable</jsdl-u:Name>
      <jsdl-u:IncarnatedValue>-x </jsdl-u:IncarnatedValue>
      <jsdl-u:ArgumentMetadata>
        <jsdl-u:Description>Export an environment variable (e.g., "foo=bar"
exports the environment variable name "foo" and sets its value to "bar" in the
started processes)</jsdl-u:Description>
        <jsdl-u:Type>string</jsdl-u:Type>
      </jsdl-u:ArgumentMetadata>
    </jsdl-u:Argument>
    <jsdl-u:Argument>
       <jsdl-u:Name>MPI-Start Variable</jsdl-u:Name>
       <jsdl-u:IncarnatedValue>-d </jsdl-u:IncarnatedValue>
       <jsdl-u:ArgumentMetadata>
          <jsdl-u:Description>Define a MPI-Start variable (e.g.,
"I2G_MPI_START_VERBOSE=1")</jsdl-u:Description>
          <jsdl-u:Type>string</jsdl-u:Type>
       </jsdl-u:ArgumentMetadata>
    </jsdl-u:Argument>
    <jsdl-u:Argument>
        <jsdl-u:Name>Verbose</jsdl-u:Name>
        <jsdl-u:IncarnatedValue>-v</jsdl-u:IncarnatedValue>
        <jsdl-u:OptionMetadata>
           <jsdl-u:Description>Be verbose</jsdl-u:Description>
        </jsdl-u:OptionMetadata>
    </jsdl-u:Argument>
</jsdl-u:ExecutionEnvironment>
```

# ARC Parallel Job Revisited

```
&(jobName="mpi-start")
(count="16")
(runtimeenvironment="ENV/MPI-START")
(executable="/usr/bin/mpi-start")
(arguments="-t openmpi hello-ompi.exe")
(inputfiles=("hello-ompi.exe"))
(stdout="std.out")
(stderr="std.err")
(gmlog="gmlog")
(wallTime="10 minutes")
(memory="1024")
```

# gLite Parallel Job Revisited

```
JobType          = "Normal";
CpuNumber        = 16;
Executable       = "/usr/bin/mpi-start";
Arguments        = "-t openmpi hello-ompi.exe";
InputSandbox     = {"hello-ompi.exe"}
StdOutput        = "std.out";
StdError         = "std.err";
OutputSandbox    = {"std.out","std.err"};
Requirements     =
    Member("MPI-START",
           other.GlueHostApplicationSoftwareRunTimeEnvironment)
 && Member("OPENMPI",
           other.GlueHostApplicationSoftwareRunTimeEnvironment);
```

# UNICORE Parallel Job Revisited

```
{
  Executable: "./hello-ompi.exe",
  Imports: [
    {From: "/myfiles/hello.mpi", To: "hello-ompi.exe" },
  ],
  Resources:{ CPUs: 16, },
  Execution environment: {
    Name: mpi-start,
    Arguments: { mpi-type: openmpi,  },
  },
}
```

# Hybrid OpenMP + MPI

## ARC

```
(arguments="-t openmpi -d MPI_USE_OMP=1 -pnode -pre myhook.sh -post
myhook.sh myapp")
```

## gLite

```
Arguments="-t openmpi -d MPI_USE_OMP=1 -pnode -pre myhook.sh -post
myhook.sh myapp";
```

## UNICORE

```
Arguments: { mpi-type: openmpi,
             pre: myhook.sh,
             post: myhook.sh,
             Per node: 1,
             MPI-Start Variable: MPI_USE_OMP=1,
            },
```

# Hybrid OpenMP + MPI

```
pre_run_hook() {
  mpicc -fopenmp ${MPI_MPICC_OPTS} -o myapp myapp.c
  if [ ! \$? -eq 0 ]; then
    echo "Error compiling program.  Exiting..."
    return 1
  fi
  return 0
}

# the first paramter is the name of a host
my_copy () {
  scp . $1:$PWD/mydata.*"
}

post_run_hook () {
  if [ "x\$MPI_START_SHARED_FS" = "x0" ] ; then
    echo "gather output from remote hosts"
    mpi_start_foreach_host my_copy
  fi
  tar -czvf output.tgz mydata.*
  return 0
}
```

# MPI-Start in EMI-1

- MPI-Start 1.0.4 released as part of EMI-1
- Includes:
  - Scheduler plugins for (Sun/Oracle/Univa) GE, PBS/Torque, LSF, Slurm & Condor
  - Execution plugins for Open MPI, MPICH, MPICH2, LAM, PACX-MPI
  - Hooks for OpenMP, Marmot, MPI Trace
- Use of command line parameters (instead of environment variables)
- Updated documentation
- Linux FHS compliant


# Thank you

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