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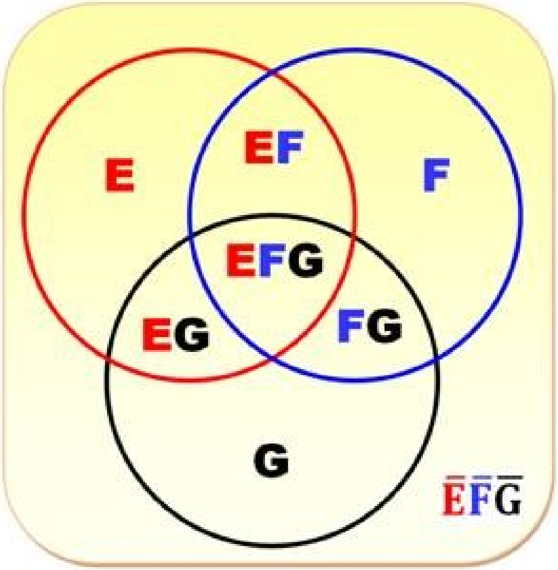
# MCS Plugin
# Multi Category Security



SLURM User Group - September 2016 | A. ROY

# MCS Plugin

## Agenda

Introduction

Implementation

Planned features

# MCS Plugin

## Introduction

# Motivations

- Ensure populations confinement
  - Job confinement: no sharing of nodes for jobs from different populations of users
  - Information confinement: users can only see jobs/nodes of their population
  - A population is associated to a category. The term MCS comes from SELinux: MCS is an enhancement to SELinux, and allows users to label files with categories. A lot of informations can be a category: users, uid, UNIX groups...

# Existing options for job confinement

- Exclusive nodes for sbatch/srun/salloc commands (-x option)
  - No risk for a job to share a node with a user of another population
  - But waste of resources if nodes are not used entirely

- Exclusive nodes per user for sbatch/srun/salloc commands (--exclusive=user)
  - No risk to share a node with another user, but can't share nodes between users of the same population
  - But waste of resources if nodes are not used entirely

# Existing options for information confinement

- Slurm.conf option: privatedata
  - privatedata=jobs
    - Prevents users from viewing jobs or job steps belonging to other users.
  - privatedata=nodes
    - Prevents users from viewing node state information.

# MCS Plugin
## introduction

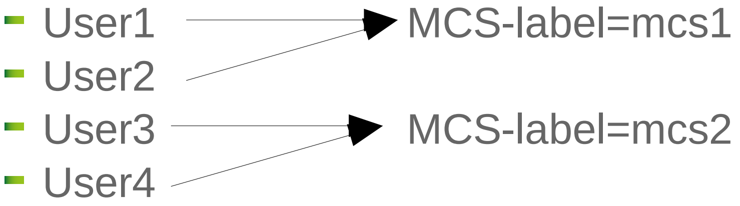
## Goals

- Add a generic/extensible way to include a new logic for confinement.
  - The use of the notion of plugin in slurm was an evidence.
  - With a plugin, possibility to have many levels of logic :
    - 1 to 0 : users have no MCS-label:only one population ; identical to no plugin.
    - 1 to 1 : a user is a population: A plugin for an equivalence between user and population (user name or uid for example). The MCS-label is deducted.
    - N to 1 : a user has an unique MCS-label and a MCS-label has many users. For example: primary group.  The MCS-label is deducted.
    - N to N : a user has a choice between different MCS-label and a MCS-label is associated to many users . There is a set of populations and every user could be in more than one population. Examples: a slurm account, a unix secondary group. This plugin needs an algorithm to choose the MCS-label if none is requested.

# MCS Plugin
## introduction

## Goals

- Overview :
  - 1 to 0
    - Users → MCS-label=N/A  No choice
  - 1 to 1
    - User1 → MCS-label=mcs1
    - User2 → MCS-label=mcs2  No choice
  - 1 to N



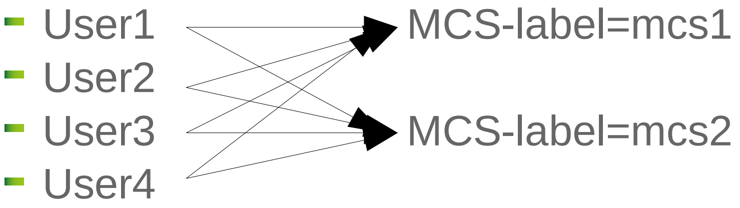
- User1
- User2
- User3
- User4

MCS-label=mcs1

MCS-label=mcs2

No choice

  - N to N



- User1
- User2
- User3
- User4

MCS-label=mcs1

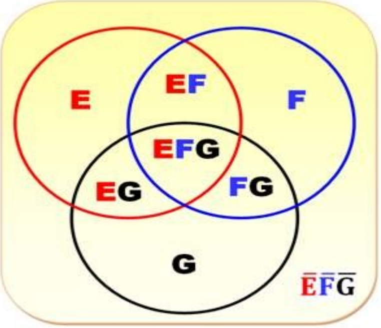
MCS-label=mcs2

Choices...

# MCS Plugin
## introduction

# Our specific goal

- Nodes confinement with unix groups:
  - For a user in groupE and groupF:
    - If --mcs-label is specified, only empty nodes or nodes already tagged with this MCS-label are filtered.
    - If --mcs-label is not specified, only empty nodes or nodes already tagged with the default MCS-label are filtered (default is the first found in the list of possible MCS-labels).
  - For a user in groupE: only empty nodes or nodes already tagged with groupE MCS-label are filtered.
  - ...



# MCS Plugin
## introduction

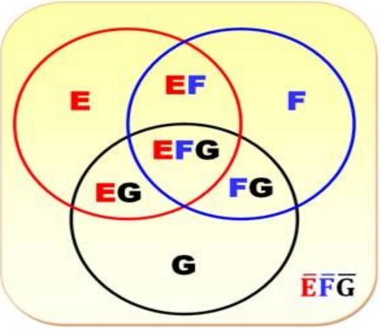
## Our specific goal

- Information confinement : squeue → shows only jobs with authorized MCS-label
  - For a user in groupE and groupF: squeue -O jobid,username,mcslabel

```
JOBID    USER         MCSLABEL
1        user1        groupE
2        user2        groupE
3        user1        groupE
4        user3        groupF
```

  - For a user in groupF: squeue -O jobid,username,mcslabel

```
JOBID    USER         MCSLABEL
4        user3        groupF
```



# MCS Plugin

# Implementation

# MCS Plugin
## Implementation

### Configuration choices

- MCS-label is a category label for jobs and/or nodes
- MCS-label for jobs
  - MCS-label for jobs can be optional or mandatory (slurm.conf option)
  - Users can choose (if possible) their MCS-label for their jobs (in a closed list)
- MCS-label for nodes
  - The selection of nodes can be (or not) filtered on MCS-label depending on slurm.conf options.
- MCS-label of jobs is seen with sview/squeue
- MCS-label of nodes is seen with scontrol show nodes command
- Accordingly with privatedata, jobs and nodes informations can be filtered on the MCS-labels

# New slurm options in slurm.conf

- MCSPlugin
  - 3 implementations mcs/none, mcs/user and mcs/group.
    - mcs/none: Default. No category associated to jobs.
    - mcs/user: Use user name as the category to associate jobs to. This option is equivalent to use --exclusive=user.
    - mcs/group: Use a user group as the category to associate jobs to. The list of available groups is defined in the mcs_plugin_parameters.

# New slurm options in slurm.conf

- MCSParameters is a string of the form: "[ondemand|enforced][,noselect|,select|,ondemandselect][,privatedata]:[mcs_plugin_parameters]"
  - [ondemand|enforced]: set MCS label on jobs on demand (with --msc-label=) or always
  - [,noselect|,select|,ondemandselect]: select nodes with filter on MCS label: never, always or on demand (with --exclusive=mcs)
  - [,privatedata]: accordingly with privatedata option :
    - if privatedata and privatedata=jobs: jobs informations are filtered based on their MCS labels
    - if privatedata and privatedata=nodes: nodes informations are filtered based on their MCS labels

The defaults are ondemand, ondemandselect and no privatedata.

# New slurm options in slurm.conf

- MCSParameters is a string of the form : "[ondemand|enforced][,noselect|,select|,ondemandselect][,privatedata]:[mcs_plugin_parameters]"
  - [mcs_plugin_parameters]: Only mcs/group is currently supporting the mcs_plugin_parameters option. It can be used to specify the list of user groups (separated by |) that can be mapped to MCS labels by the mcs/group plugin.
  - If no specific MCS label is requested (no --mcs-label option), the algorithm search the first group of the user in the groups list of mcs_plugin_parameters. If no valid group is found:
    - If ondemand is set, the job has no MCS-label,
    - If enforced is set, the job is failed.

# New slurm options in slurm.conf

| | Jobs: On demand | Jobs: enforced |
|---|---|---|
| Nodes:<br>No select | MCS-label is optional on jobs (option --mcs-label). No filter on nodes. | MCS-label is mandatory on jobs only. No filter on nodes even if option --exclusive=mcs is set. |
| Nodes:<br>select | MCS-label is optional on jobs (option --mcs-label). Filter on nodes only if MCS-label is set on job. | MCS-label is mandatory on jobs and nodes. Always filter on nodes. |
| Nodes:<br>ondemandselect | MCS-label is optional on jobs (option --mcs-label). Filter on nodes only if options --exclusive=mcs and --mcs-label are set. | MCS-label is mandatory on jobs only. Filter on nodes only if option --exclusive=mcs is set. |

# New slurm options in slurm.conf

- Examples:
  - MCSPlugin=mcs/none

  - MCSPlugin=mcs/user
  - MCSParameters=enforced,select,privatedata

  - MCSPlugin=mcs/user
  - MCSParameters=enforced,noselect

  - MCSPlugin=mcs/group
  - MCSParameters=enforced,select,privatedata:groupA|groupB|groupC

  - MCSPlugin=mcs/group
  - MCSParameters=ondemand,ondemandselect,privatedata:groupA|groupB|groupC

# New options in salloc/sbatch/srun

- --exclusive=mcs
  - User can force the filter with this option (except if noselect mode)
  - With mcs/user and mcs/group

- --mcs-label=groupD
  - User can change default mcs-label
  - Only with mcs/group
  - GroupD must be in the list of user's group and in the list of possible MCS (in parameter mcs_plugin_parameters in slurm.conf)

# New options in salloc/sbatch/srun

- Examples
  - srun -n2 --exclusive=mcs a.out
    - Use default MCS-label,
    - Selection of nodes is filtered on MCS-labels
  - srun -n2 --mcs-label=groupD --exclusive=mcs a.out
    - Use specified valid MCS-label,
    - Selection of nodes is filtered on MCS-labels
  - srun -n2 --mcs-label=groupD  a.out
    - Use specified valid MCS-label,
    - Selection of nodes is not filtered on MCS-labels (if no select).

# New options in salloc/sbatch/srun

- Examples with errors
  - Test to use a specific mcs-label with mcs/none plugin
    srun -n2 --mcs-label=foo  a.out
    - srun: error: --mcs-label=foo can't be used with mcs/none plugin
  - Test to use a bad specific mcs-label with mcs/group plugin
    srun -n2 --mcs-label=foo  a.out
    - srun: error: Failed to create job : invalid mcs-label : foo
  - Test to use default mcs-label with mcs/group plugin and user has no group in the list of possible mcs-labels
    srun -n2 a.out
    - srun: error: Failed to create job : no valid mcs-label found

# New output option in squeue/sview

- Output option mcslabel in squeue

  Example : squeue -O jobid,username,**mcslabel**,nodelist

  ```
  JOBID          USER        MCSLABEL     NODELIST
  1300955         user1        groupA        node[1002-1005]
  1300982         user2        groupB         node[1049,1051,1053]
  1300996         user3        groupB         node[1001,1012-1013]
  ```

- Output option mcslabel in sview

# New output in scontrol show conf

- Example

```
scontrol show conf | grep -i mcs
MCSPlugin                    = mcs/none
MCSParameters                    = (null)
```

# MCS Plugin
## Implementation

## New output in scontrol show nodes

- Example
  scontrol show nodes

```
NodeName=node0 Arch=x86_64 CoresPerSocket=4
   CPUAlloc=0 CPUErr=0 CPUTot=8 CPULoad=0.10
Features=unshare,fs_scratch,fs_store
   Gres=(null)
   NodeAddr=node0 NodeHostName=node0 Version=15.08
   OS=Linux RealMemory=48000 AllocMem=0 FreeMem=43692 Sockets=2 Boards=1
   State=DOWN+DRAIN ThreadsPerCore=1 TmpDisk=0 Weight=1 Owner=N/A
MCS_label=N/A
   BootTime=2016-08-22T15:04:00 SlurmdStartTime=2016-08-22T16:49:13
   CapWatts=n/a
   CurrentWatts=0 LowestJoules=0 ConsumedJoules=0
   ExtSensorsJoules=n/s ExtSensorsWatts=0 ExtSensorsTemp=n/s
   Reason=foo
```

## Availability in Slurm

- First developments in 2015
- In slurm 16.05.0-pre1 version

# MCS Plugin

## Planned features

# MCS Plugin

## Planned features

### MCS-label stored in database

- MCS-label is not stored in the database.
- Should be stored in cluster_job_table table (tinytext type)
- Add a new format option McsLabel in sacct

# Use a hash table for MCS

- Current mcs/group plugin asks the operating system for groups membership of users whenever it is necessary
  - → putting the pressure on the OS groups caching logic,
  - → and thus introducing an heavy load for large systems with a high number of pending and running jobs.

  So:
  - Reusing and/or enhancing the group caching logic of Slurm in the mcs/group plugin is planned to reduce that effect.

# Thank you for your attention

# Questions ?

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# API Functions in MCS plugin

- extern int slurm_mcs_init(void);
- extern int slurm_mcs_fini(void);
- extern int mcs_p_set_mcs_label(struct job_record *job_ptr, char *label);
  - Verify and set or calculate MCS-label for a job.
  - Called by _job_create to get the mcs_label for a job.
- extern int mcs_p_check_mcs_label(uint32_t user_id, char *mcs_label);
  - For squeue/scontrol show nodes in case of option privatedata.
  - Check the compatibility between MCS-label of user and MCS-label of jobs/nodes.

## Internal functions in MCS plugin

- extern int slurm_mcs_reconfig(void);
- extern char *slurm_mcs_get_params_specific(void);
- extern int slurm_mcs_reset_params(void);
- extern int slurm_mcs_get_select(struct job_record *job_ptr);
- extern int slurm_mcs_get_enforced(void);
- extern int slurm_mcs_get_privatedata(void);
- extern char *slurm_mcs_get_params_specific(void);
- extern int mcs_g_set_mcs_label(struct job_record *job_ptr, char *label);
- extern int mcs_g_check_mcs_label(uint32_t user_id, char *mcs_label);