The Good, Bad and Ugly of systemd

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Effective containment of HPC batch workloads on a shared node

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Agenda

• Welcome & Introductions
• What is systemd
• What is the Good
• What is the Bad & Ugly
• Use Cases
• How to protect the Kernel and core processes
systemd

The new system startup and service manager for Linux, replacing the “old” SysV init
Systemd – The Good

- Offers on-demand starting of daemons
- Uses socket and D-Bus activation for starting services
- Supports snapshotting and restoring of the system state
- Maintains mount and automount points
- Systemd daemons make it is easier to supervise and control processes and parallelized job execution.
- keeps track of processes using Linux cgroups
- systemctl offers the systemct1 command and cgroups to make your life easier:
  - systemct1 provides the administrator with more detailed error messages including runtime and start-up errors.
  - cgroups, or "control groups", allow for the grouping of processes into a hierarchy for easier management.
- Process attributes such as function and ownership are much easier to ascertain. For example, under Systemd, sub-processes, once spawned, become 'children' and are organized under the appropriate 'parent' group to show inheritance.
Effective containment of HPC batch workloads on a shared node

Greg Siekas
Enterprise High Performance Computing Service
Containment is required

Needed the ability to enforce resource limits on HPC batch workloads on a shared node

What is driving this?
- Increasing number of cores per node
- Do not want to leave idle resources
- Cannot afford to allow one job to interrupt another

We have deployed a multilevel strategy to enforce resource limits under SLES11
SLES11 login node

User containment on login nodes to enforce shared limit on CPU and Memory resources

Limit users ability to interrupt login node
SLES11 compute node

Hardened enforcement of CPU, Memory, and GPU resources on batch compute nodes

Effective containment allows for sharing of batch compute resources
SLES11 Containment Strategy

Developers and end users can be sneaky or make mistakes

We cannot just place the batch job script inside the control group and hope for the best

We have deployed a 3 level strategy to enforce resource limits on compute nodes
Level 1 – Simple does not work 100%

PBS prologue and epilogue to create and destroy control group with the requested resources

Works great until…
# ssh localhost
A simple way to escape from control group!

Any SSH access from any remote node does not place the process into the control group
Level 2 – PBS_JOBID and SSH

Modification to SSH configuration to send and accept PBS_JOBID environment variable
Pam module for limiting access to node only if user has a valid PBS job running
Profile.d script to use pbs_attach to make process of child of the pbs_mom

Now SSH access isn’t a problem
Level 3 –libcgroup1 and cgrulesengd

Modification to libcgroup1 to use PBS_JOBID in cgrules.conf
  user:1234.pbs  cpuset,devices,memory  1234.pbs/

PBS prologue and epilogue create and destroy rules in cgrules.conf

Handles situation where pbs_attach does not work

We discovered a memory leak in libcgroup1!
Triggered by updating the cgrules.conf and restarting cgrulesengd multiple times (50k+)
Quickly fixed by SUSE
Modifications to libcgroup1

--- libcgroup-0.41.rc1-orig/src/api.c 2017-03-29 12:42:18.001875000 -0700
+++ libcgroup-0.41.rc1/src/api.c 2017-07-19 18:47:06.447814000 -0700
@@ -3905,6 +3905,56 @@
{
}

+int cg_get_pbs_jobid_from_procfs(pid_t pid, char **procname)
+{
+    FILE *f;
+    int ret = ECGFAIL;
+    int c = 0;
+    int len = 0;
+    char path[FILENAME_MAX];
+    char buf[32768];
+
+    sprintf(path, "/proc/%d/environ", pid);
+    f = fopen(path, "re");
+    if (!f)
+        return ECGROUPNOTEXIST;
+
+    while (c != EOF) {
+        c = fgetc(f);
+        if (c != EOF && (c != '\0')) {
+            buf[len] = c;
+            len++;
+        } else {
+            /* Avoid overflowing due to long environment variable settings */
+            continue;
+        }
+    }
+
+    buf[len] = '\0';
+    if (!strcmp(buf, "PBS_JOBID=")) {
+        *procname = strdup(buf + strlen("PBS_JOBID="));
+        if (*procname == NULL) {
+            last_errno = errno;
+            ret = ECGOTHER;
+            break;
+        }
+        ret = 0;
+        break;
+    } else
+        len = 0;
+}

+fclose(f);
+return ret;
+
+*/
+
+int cg_get_pbs_jobid_from_status(pid_t pid, char **procname)
+{
+    FILE *f;
+    int ret = ECGFAIL;
+    int c = 0;
+    int len = 0;
+    char path[FILENAME_MAX];
+    char buf[32768];
+
+    memset(path, '0', sizeof(path));
+    f = fopen(path, "r");
+    if (!f)
+        return ECGROUPNOTEXIST;
+
+    while (c != EOF) {
+        c = fgetc(f);
+        if (c != EOF && (c != '\0')) {
+            buf[len] = c;
+            len++;
+        } else {
+            /* Avoid overflowing due to long environment variable settings */
+            continue;
+        }
+    }
+
+    buf[len] = '\0';
+    if (!strcmp(buf, "PBS_JOBID=")) {
+        *procname = strdup(buf + strlen("PBS_JOBID="));
+        if (*procname == NULL) {
+            last_errno = errno;
+            ret = ECGOTHER;
+            break;
+        }
+        ret = 0;
+        break;
+    } else
+        len = 0;
+}

+return ret;
SLES11 Containment Strategy

All processes are spawned from either PBS or SSH

Uses PBS_JOBID as the key for control group name and rules

We now have a shared multi-node job containment strategy that works!
SLES12 – systemd breaks everything!

With the introduction of SLES12 and systemd we hit a few road blocks...

libcgoup1 is now obsolete and conflicts with systemd!

https://www.suse.com/support/kb/doc/?id=7018741

HELP!

Lots of questions for Craig and SUSE support

Reviewed the SLES12 manuals and information on systemd to find a solution
SLES12 – Simple solution

Simple solution was to modify `/etc/systemd/system.conf`
   JoinControllers=cpu,cpuacct,freezer,cpuset,devices,memory

Collapses the control group directory structure which allows cgrulesengd to work

From the cgrules.conf man page:
   First rule which matches the criteria will be executed

Allows our SLES11 functionality to work on SLES12 without modification
How to deploy in your environment


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