Resource Management with CGroups

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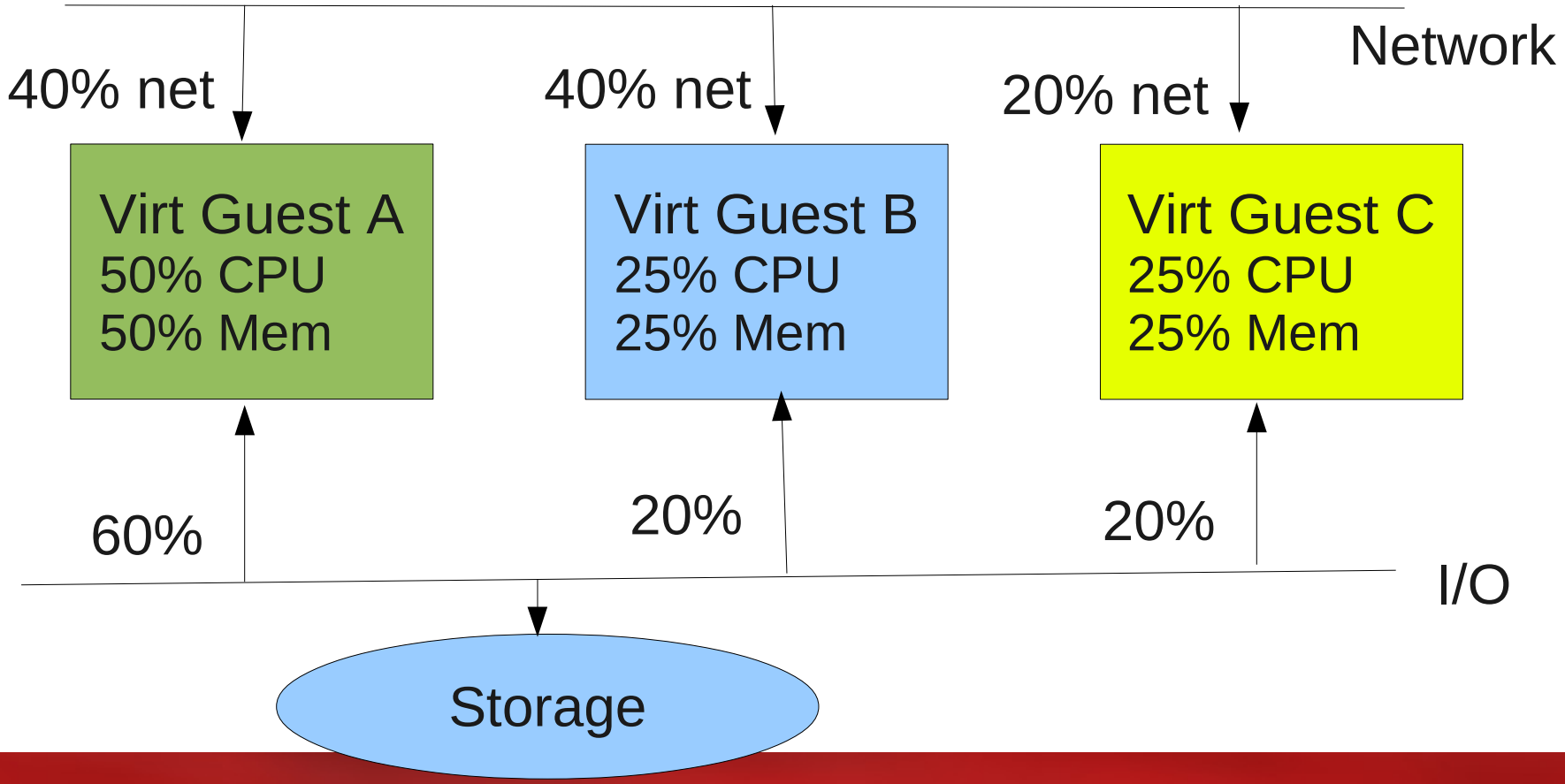
Overview

- Control Group (cgroup)
  - Meet application SLAs by reducing resource contention and increasing predictability in performance. Resource controllers include:
    - CPU/CPUSET
    - Memory
    - Network
    - I/O

Kernel Resource Management

- **Illustrative cgroup use cases**
  - Database workload dedicated 90%, background backup utility 10%
  - Virtualization hosting provider – allows QoS (quality of service guarantees based on pricepoint)



Kernel resource management

- **Cgroup – Control group**
  - A control group provides a generic framework where several “resource controllers” can plug in and manage different resources of the system such as process scheduling, memory allocation, network traffic, or IO bandwidth.
    - Can be tracked to monitor system resource usage
    - Sysadmin can use tools to allow or deny these groups access to resources
- **Memory resource controller**
  - Isolates the memory behavior of a group of tasks – cgroup – from the rest of the system (including paging). It can be used to:
    - Isolate an application or a group of applications
    - Create a cgroup with limited amount of memory
- **Cgroup scheduler**
  - CFS – Hierarchical proportional fair scheduler (SCHED_OTHER)
  - Static priority scheduler with constant bandwidth limits (SCHED_FIFO)

Kernel resource management (continued)

- **I/O controller**
  - Designate portion of I/O bandwidth (based on controller queue depth)
- **Network controller**
  - Define classes & queues between generic network layer and NIC. Tagging packets with class identifier with different priorities, placing outbound packets in different queues for traffic shaping.
- **libcgroup**
  - Cgroup creation, deletion, move and configuration management.
  - Rules based automatic task placement, PAM module, daemon, uid/gid based rules
- **Illustrative cgroup use cases**
  - Database workload dedicated 90%, background backup utility 10%
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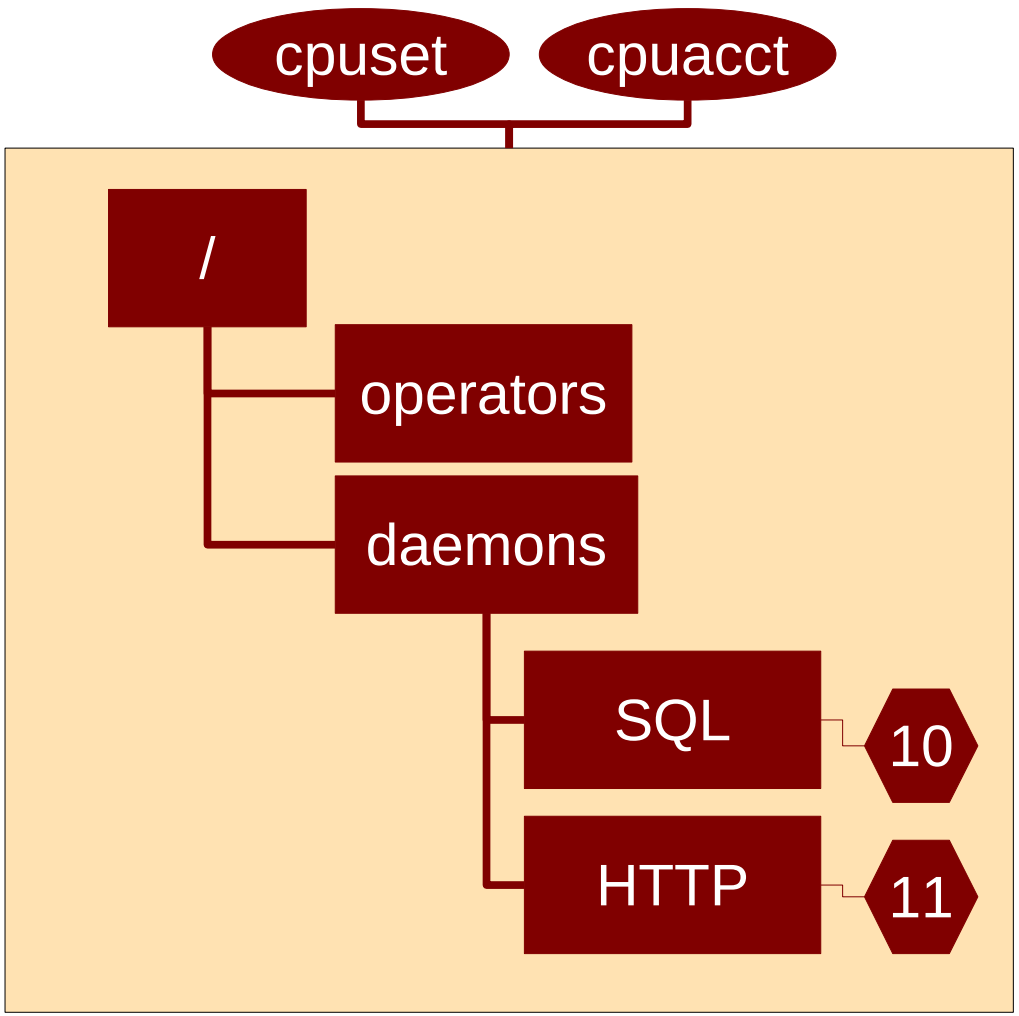
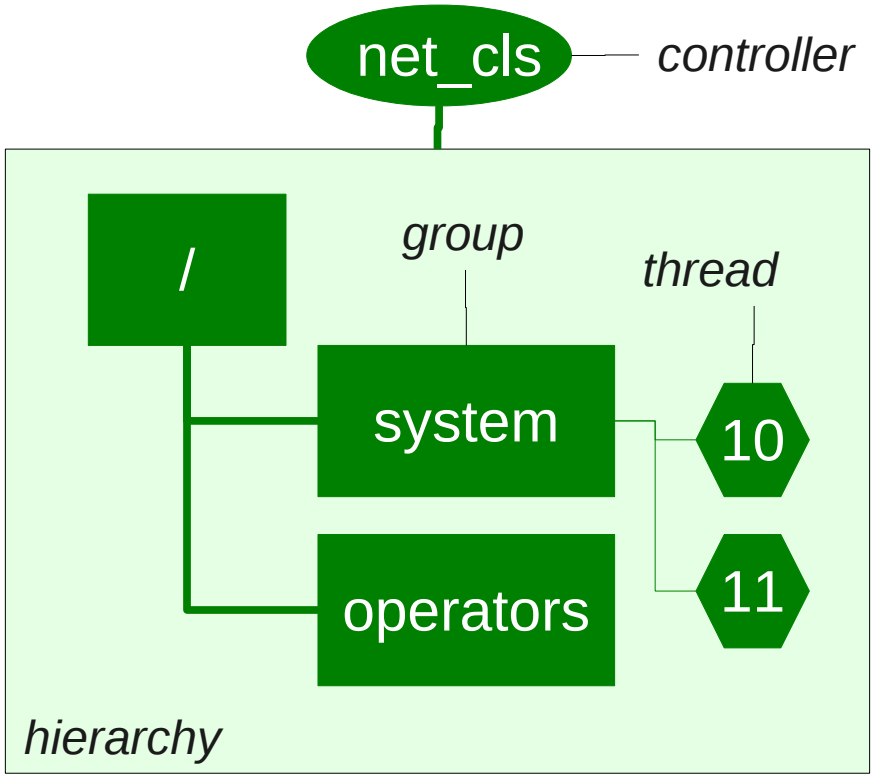
CGroup Controllers

- **memory**: Memory controller
  - Allows for setting limits on RAM and swap usage and querying cumulative usage of all processes in the group
- **cpuset**: CPU set controller
  - Binding of processes within a group to a set of CPUs and controlling migration between CPus
- **cpuacct**: CPU accounting controller
  - Information about CPU usage for a group of processes
- **cpu**: CPU schedular controller
  - Controlling the priorization of processes in the group. Think of it as a more advanced nice level
- **devices**: Devices controller
  - Access control lists on character and block devices

Hierarchy example





Subsystems - memory

- Limit memory usage of **processes** in a group
- Parameters (see memory.txt):

  `memory.limit_in_bytes` – maximum allowed memory usage by tasks in the group.

  `memory.max_usage_in_bytes` – maximum of used memory.

  `memory.stat` – current memory statistics (RSS, swap, ...)
- Examples:
  - HTTP can take only 30% of memory.

Subsystems - cpuacct

- Computes CPU cycles, burned by members of the group.
- Parameters:

  `cpuacct.usage` – nr. of cycles.

  `cpuacct.usage_percpu` – nr. of cycles per CPU.
- Example:
  - Members of 'daemons' used 10^7 cpu cycles.
  - Out of that, only $2x10^6$ cpu cycles were exhausted by SQL.

Subsystems - cpu

- Set scheduler priority.
- Parameters:

  `cpu.shares` – priority of threads in this group, relative to other groups.
- Example:
  - SQL can take 2x more CPU cycles than HTTP.

Using CGroups

- Install cgroups support
  - yum install libcgroup
  - apt-get install cgroup-bin libcgroup1
- Setup a basic /etc/cgconfig.conf

```
mount {
    cpuset  = /cgroup/cpuset;
    cpu = /cgroup/cpu;
    cpuacct= /cgroup/cpuacct;
    memory  = /cgroup/memory;
}
```

- Start the cgroups daemon
  - service cgconfig start

Command Line Tools

- cgexec
  - Start new process in specified group(s).
- cgclassify
  - Move process to specified group(s).
- cgcreate / cgdelete
  - Create and remove cgroups manually
- cgset
  - Modify defined cgroup

Apache Example

- Edit /etc/cgconfig.conf

```
group http {
    memory {
        memory.limit_in_bytes = 1024M;
    }
}
```

- Next add this to the /etc/sysconfig/httpd.conf:

```
CGROUP_DAEMON="memory:/http"
```

- Then start cgconfig service and httpd

CGroups and Virtual Machines

- Allows to control libvirtd and any other process in the cgroup “virt”
  - Examples are memory ceiling / capping
  - Restrict which CPUs libvirt can utilise
- Add these rules to /etc/cgconfig.conf

```
group virt {
    memory {
        memory.limit_in_bytes = 3.5G;
    }
    cpuset {
        cpuset.cpus = 1-3;
    }
}
```

- Modify /etc/sysconfig/libvirtd and add

```
CGROUP_DAEMON="memory:/virt”
```


cgred

- Daemon, distributes processes to groups according to their user and group id
- Configured by **`/etc/cgrules.conf`**:

```
john            cpu         operators
@operator       cpu         operators
apache          cpu         daemons/http
maria           devices     staff
maria:ftp       devices     staff/ftp
```


References

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  - http://docs.redhat.com/docs/en-US/Red_Hat_Enterprise_Linux/6/html/Resource_Management_Guide
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