cgroup v2 migration at Google

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Outline

cgroups at Google: what is our history of cgroup usage and why want to migrate to cgroup v2.

Migration: how do we want to approach it?

Interesting use cases: Google use cases which rely on cgroup v1 specific properties.

What do we want to tell you?

- We don’t have specific requests for the kernel community.
- We want to share our approach to the migration and to learn what others think about it.
- We hope that some of the described use cases will be a good starting point for discussion.

cgroups at Google

Past and present

- Used since inception to ensure performance isolation between almost all workloads at Google.
- Used both by system daemons but also delegated to users.

Why cgroup v2?

- Uncertain future of cgroup v1 - ability to upstream new cgroup v1 features or bug fixes is unclear.
- New features are only being implemented in v2.

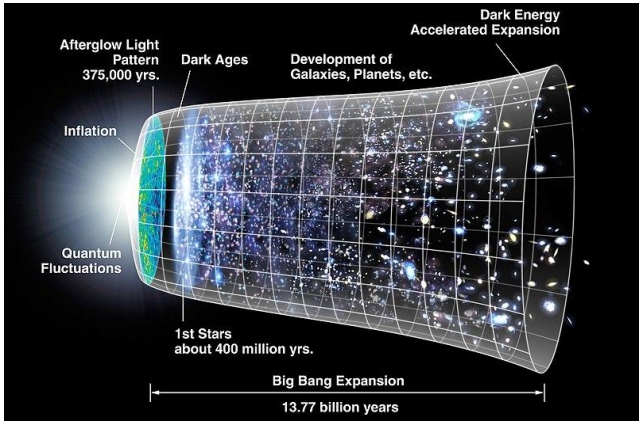
Migration

Challenges

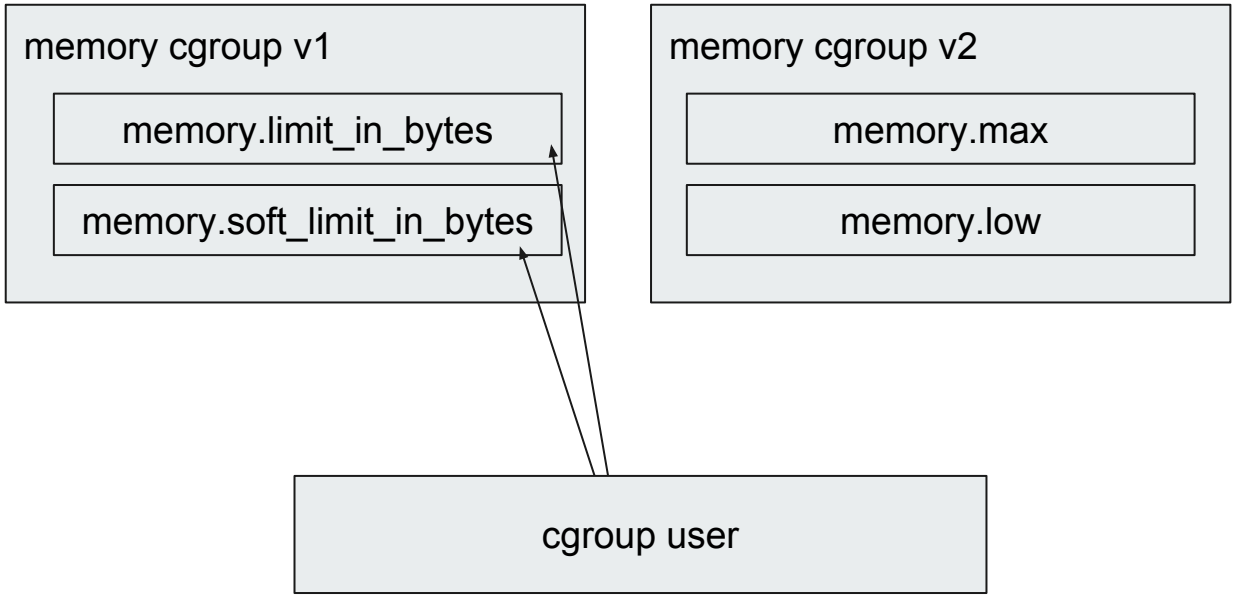
- cgroup v2 restrictions break some of our users.
- Many cgroup v1 features are missing in cgroup v2.
- No way to apply cgroup v2 restrictions incrementally.

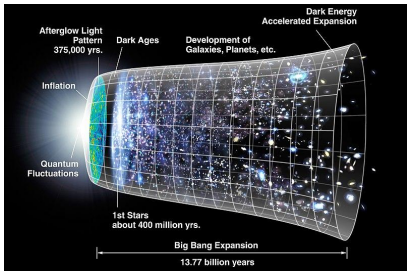
“Big bang” approach: migrating per controller

- A lot of userspace code has to be activated at the same time - “big bang” rollout instead of small steps.
- No way to detect non-conforming users beforehand.



“Big bang” approach: example





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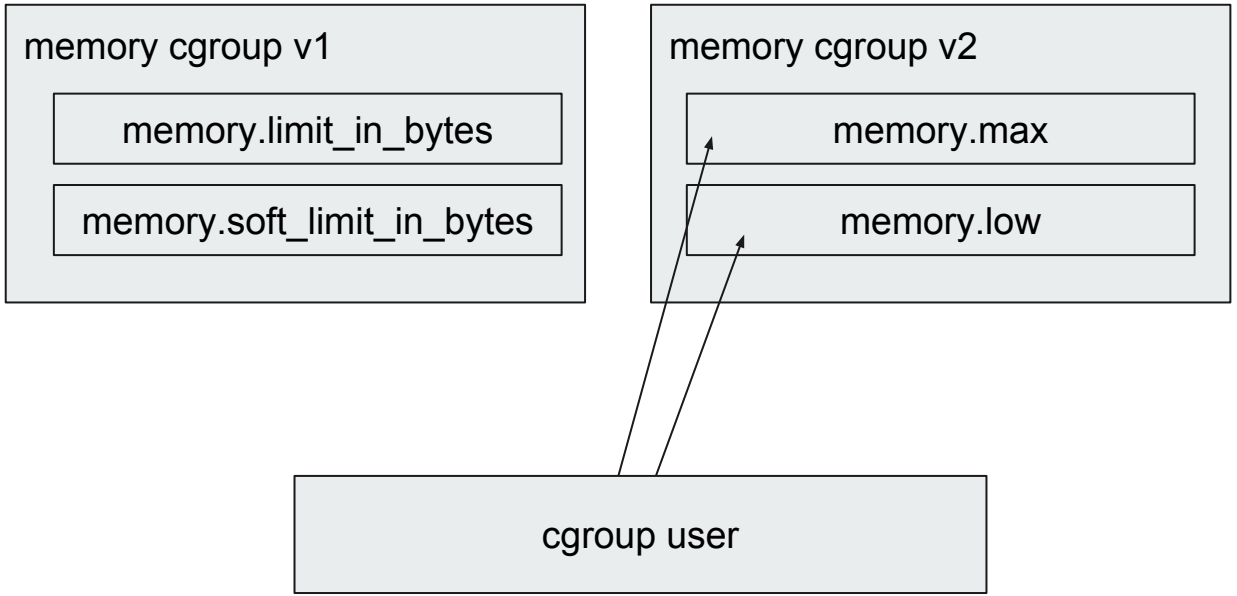
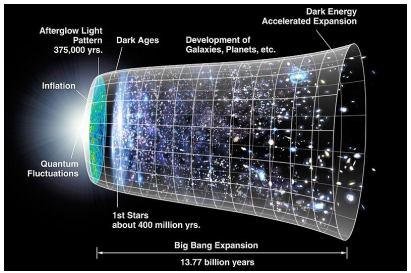
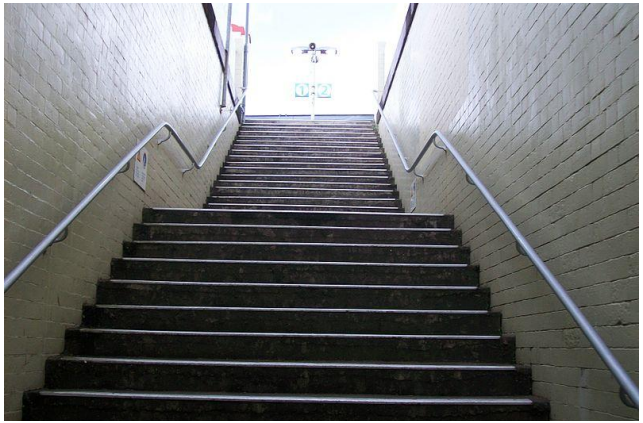


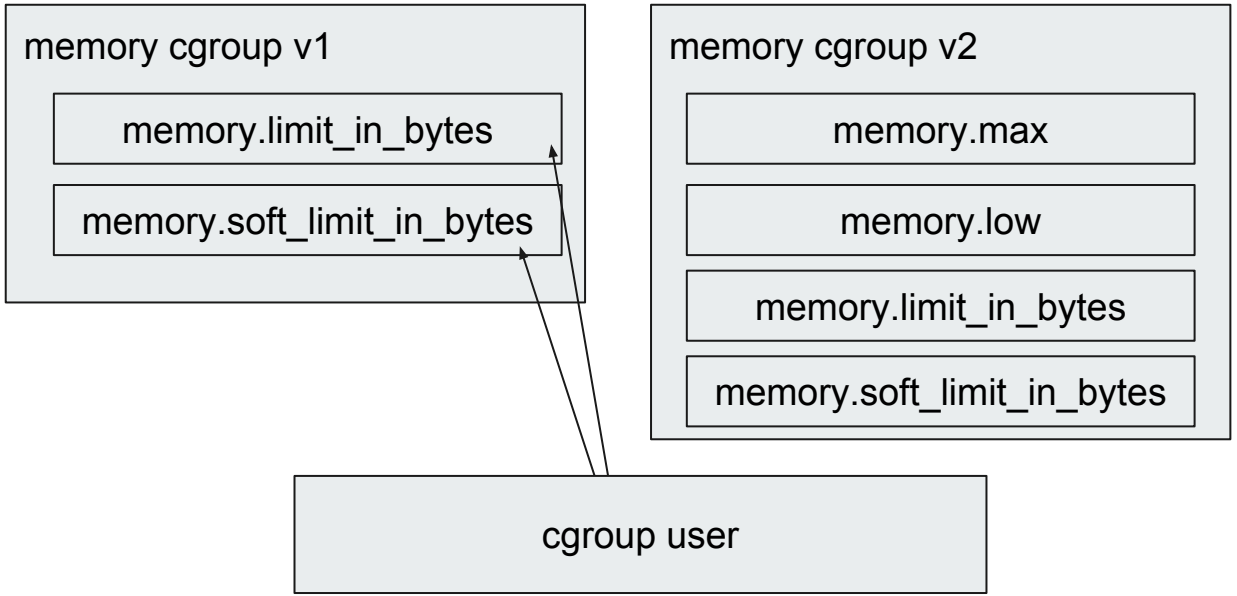


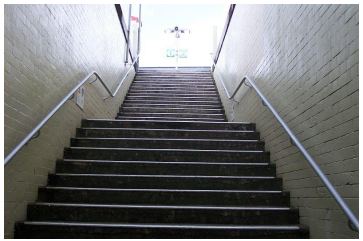
Incremental approach

- Add a way to warn on/enforce cgroup v2 constraints in cgroup v1.
- Initially v1 controller files should be exposed in cgroup v2 too.



Incremental approach: controller files





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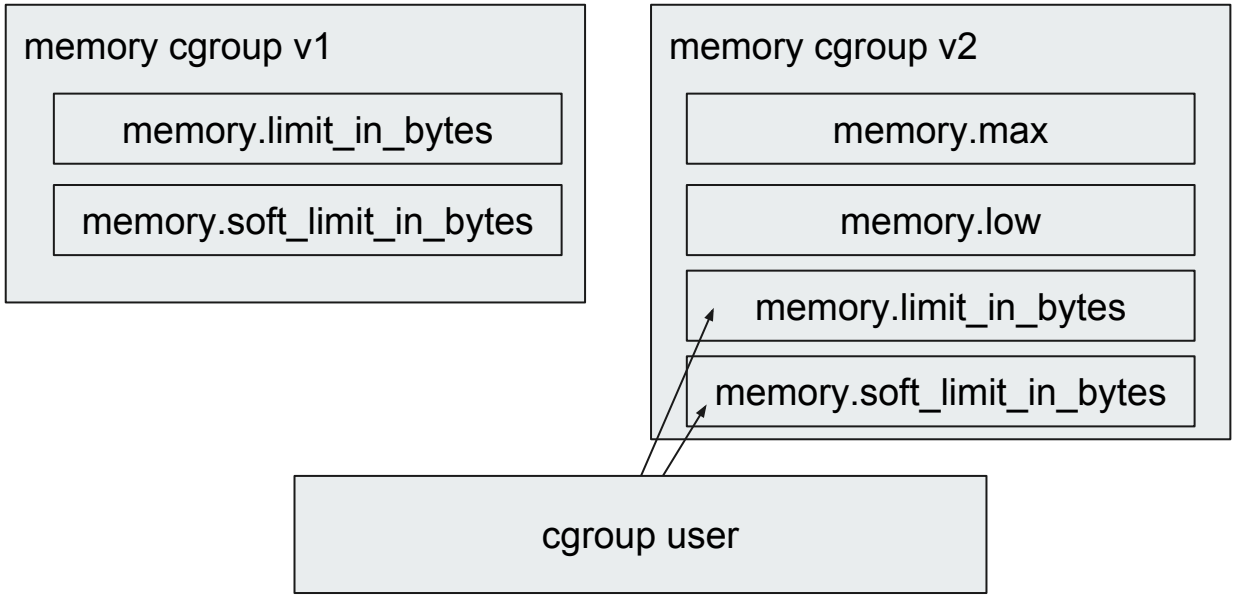

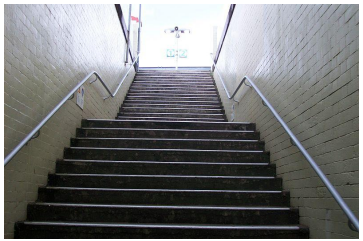

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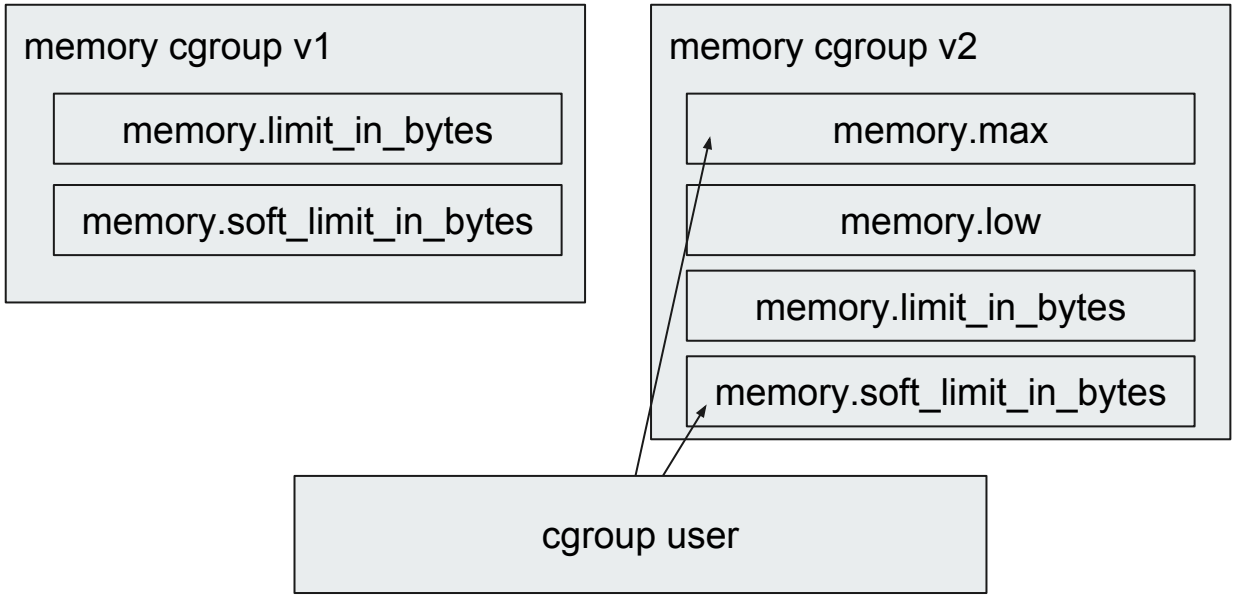

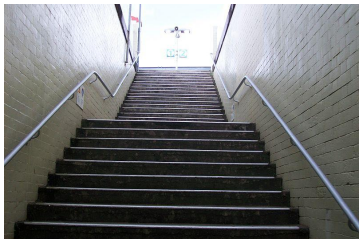

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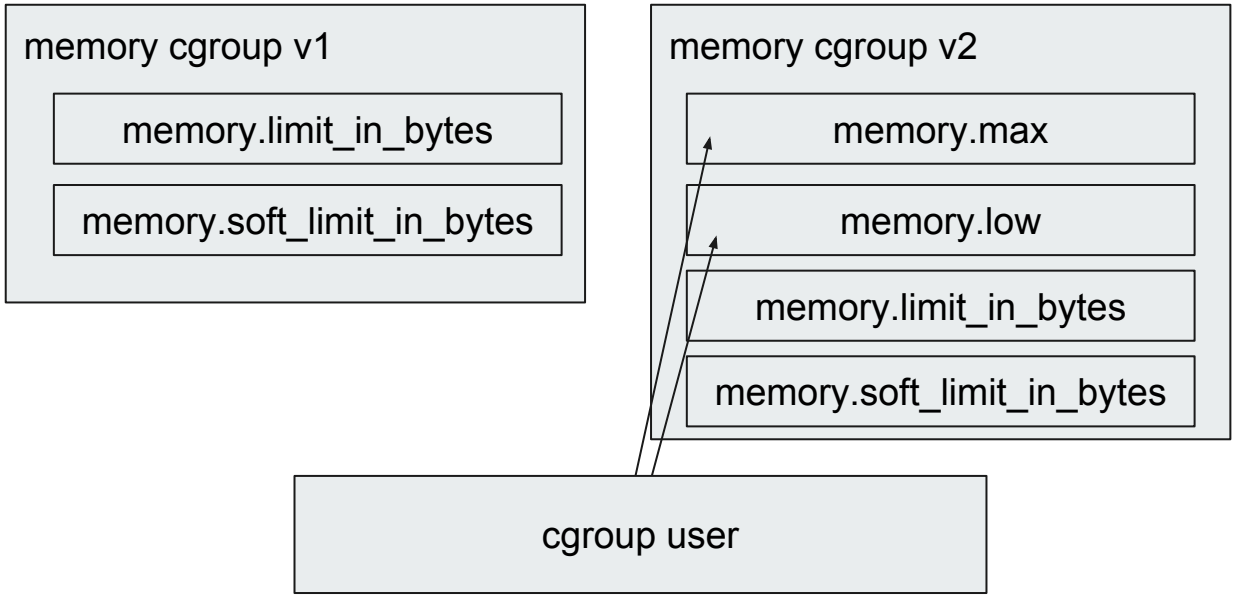
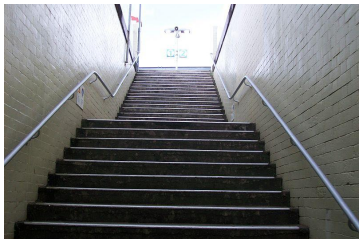
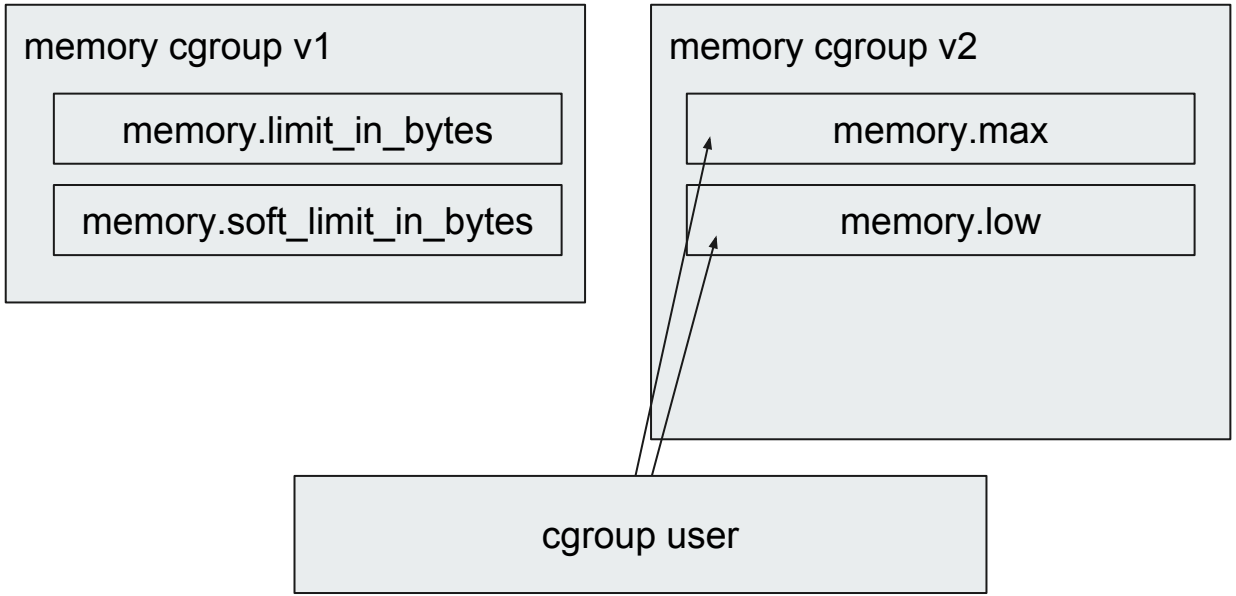
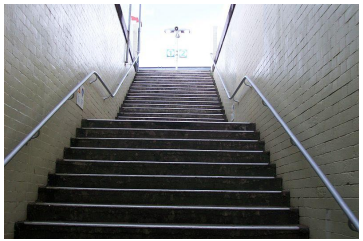




Incremental approach: controller files





Detecting non-conforming users

- Requires kernel support.
- Ultimately no way to tell that the newly activated code will work correctly if we can’t verify it on cgroup v1.

Enforcing cgroup v2 constraints

- Warning and enforcement mode separately for non uniform hierarchy, thread splitting and processes in non-leaf cgroups.
- Expose cgroup.subtree_control and cgroup.type on cgroup v1.

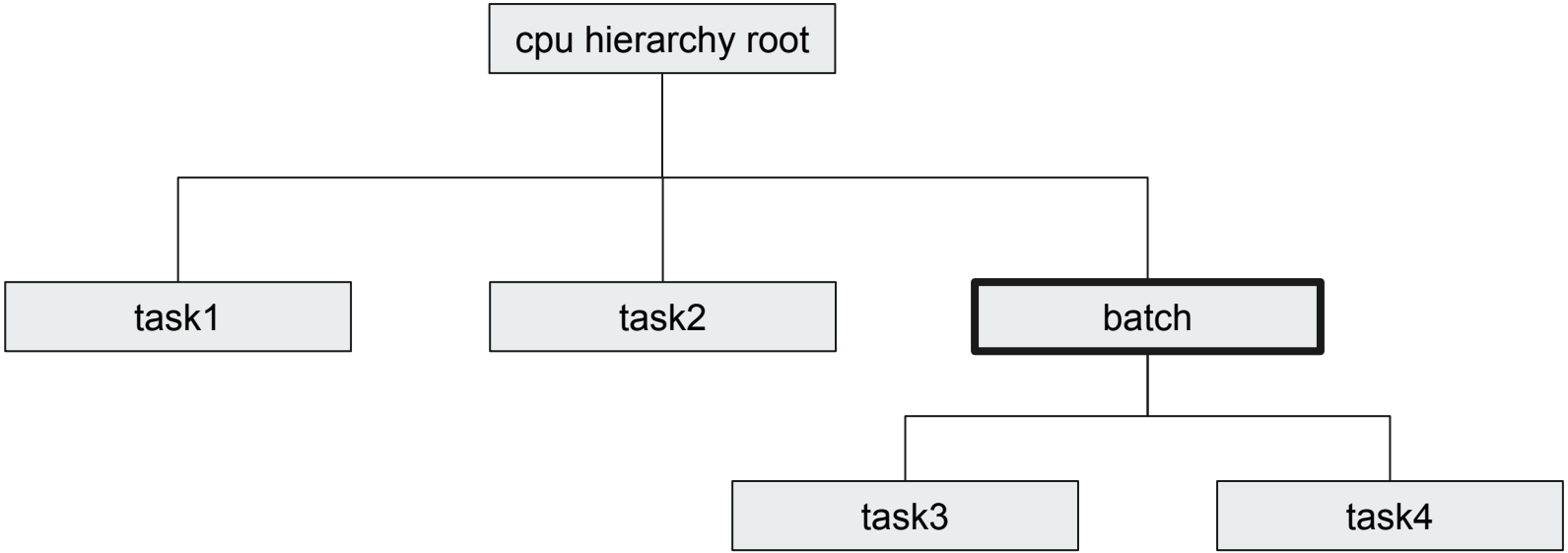
Interesting use cases

Isolating latency tolerant

- Some workloads are very latency sensitive (e.g. serving a user facing query).
- Other workloads care only about overall throughput (batch processing, long running computations).
- Latency is harder to guarantee than throughput.

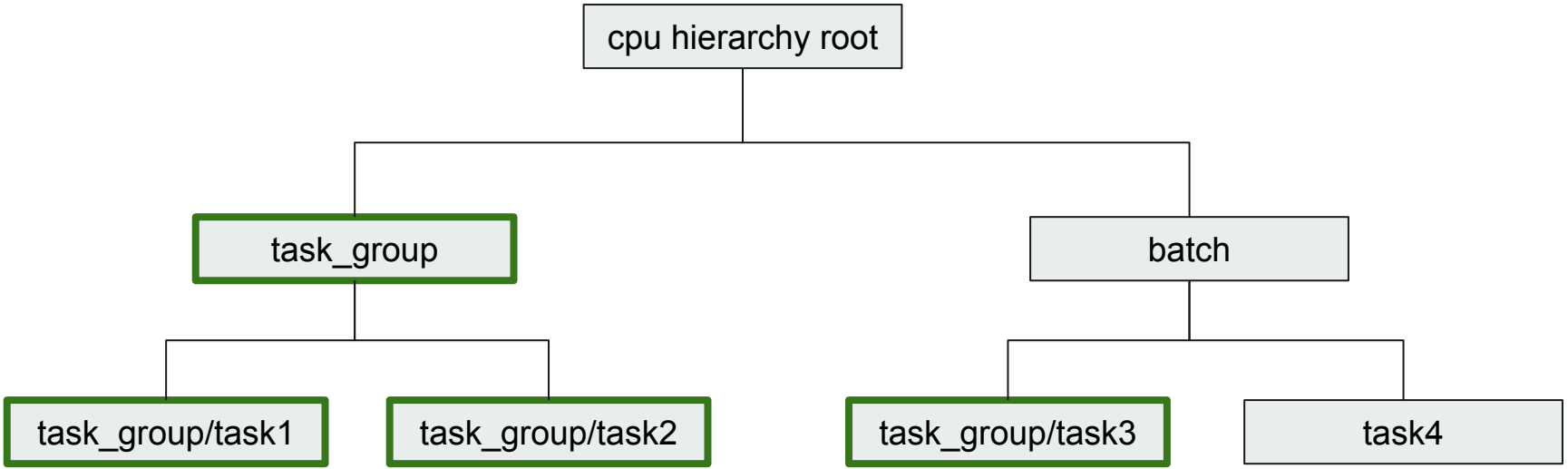
Isolating latency tolerant: CPU priority bands

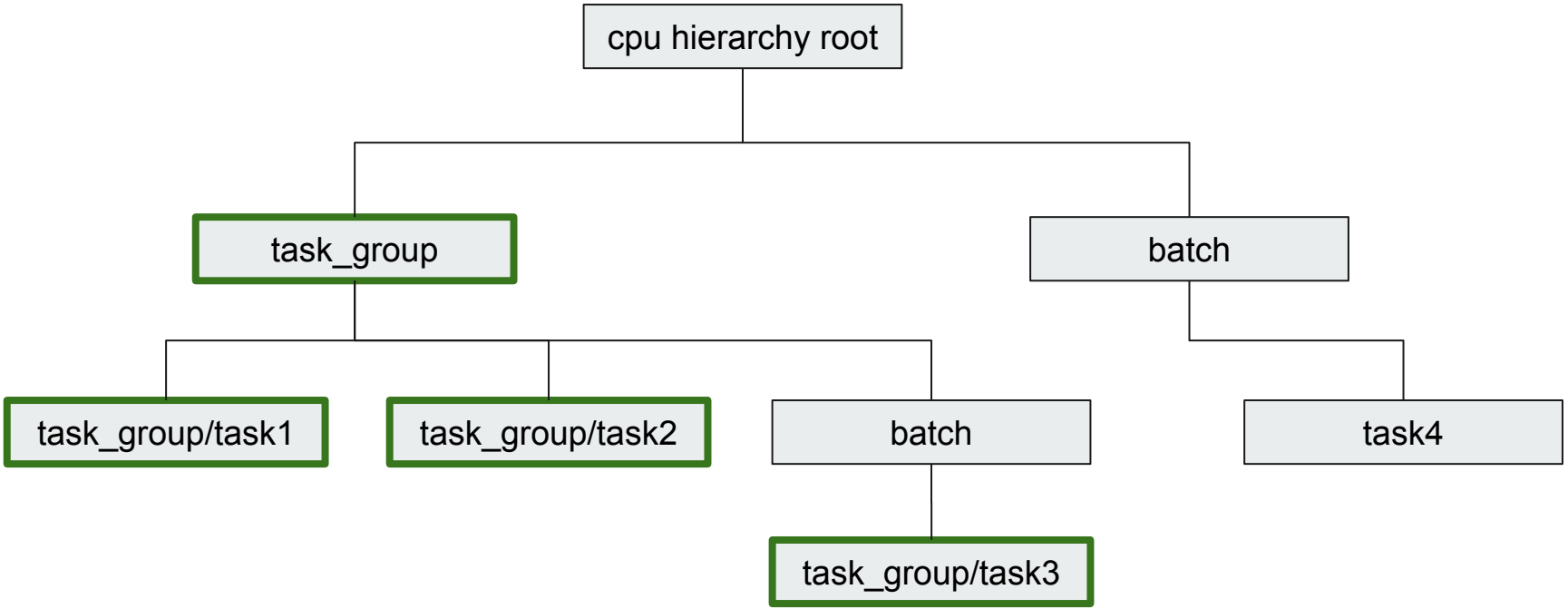
- Top level cgroup “batch” with minimal amount of cpu.shares.
- Ensures that latency tolerant jobs get CPU only if latency sensitive jobs have already been served.


cpu hierarchy root
task1
task2
batch
task3
task4

Isolating latency tolerant: nested

- Situation gets more complicated once we allow nesting.
- The “batch” property can be treated as hierarchical or not.

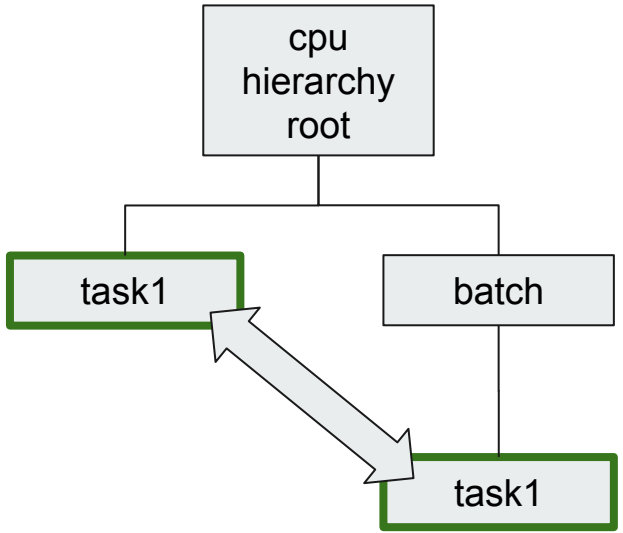

cpu hierarchy root
task_group
batch
task_group/task1
task_group/task2
task_group/task3
task4


cpu hierarchy root
task_group
batch
task_group/task1
task_group/task2
batch
task4
task_group/task3

High/low priority thread splitting

- Create high priority and low priority versions of user cgroup.
- Allow user to move between them.

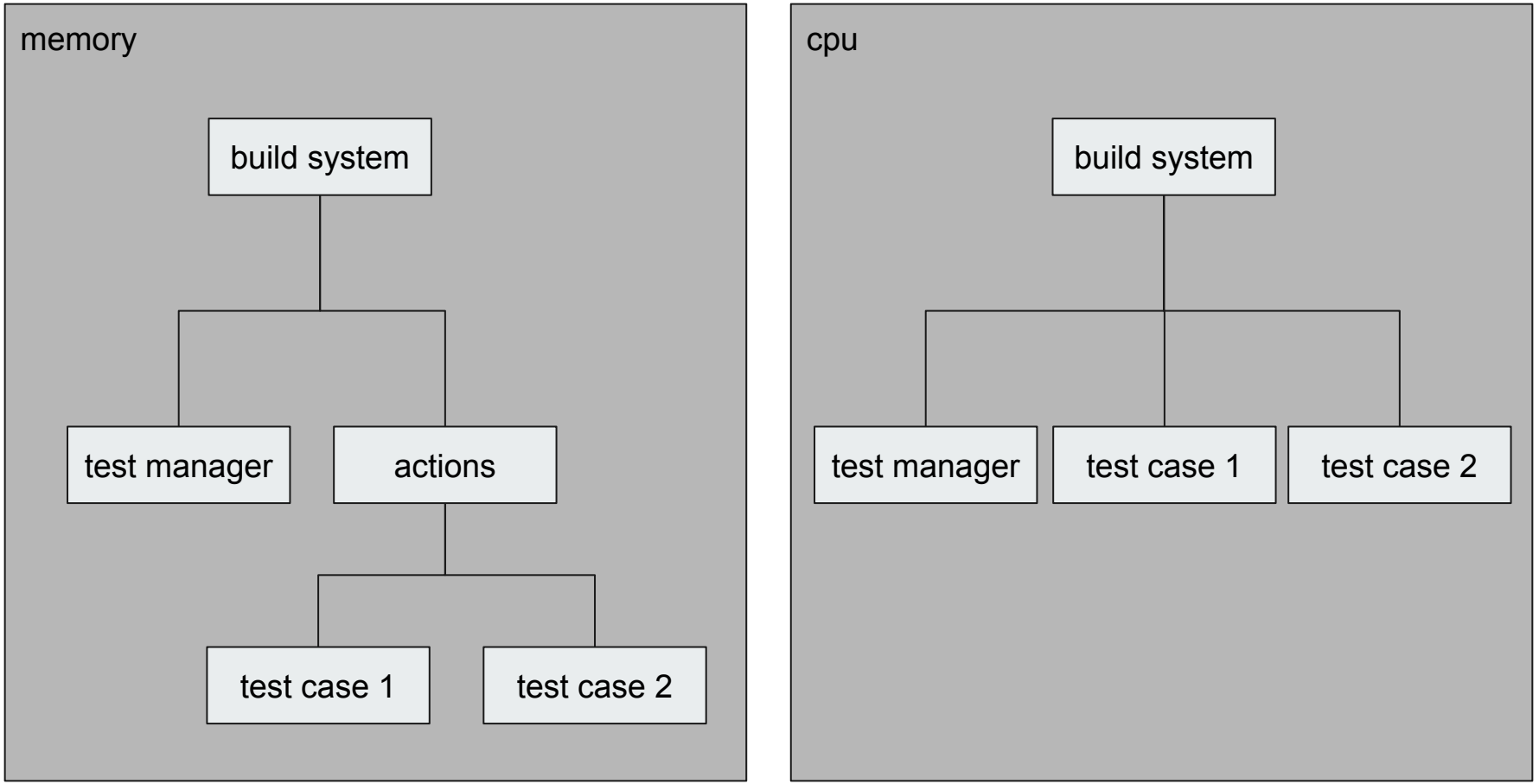
Example use case: server which handles high and low priority queries.



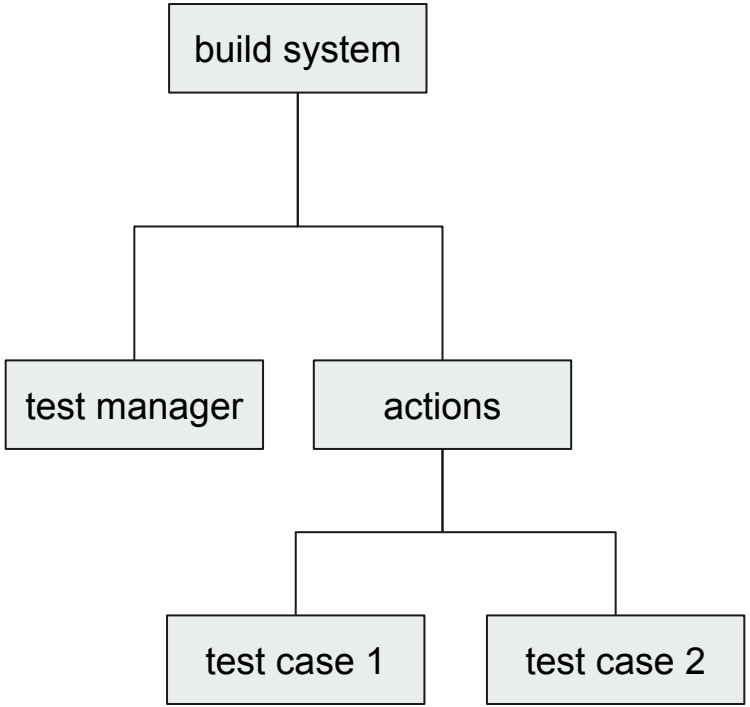
Build system

- Receives test cases to run from users.
- Shared actions memory cgroup which allows test cases to be safely overcommitted on memory.
- CPU competition on an equal level.

cgroup v1

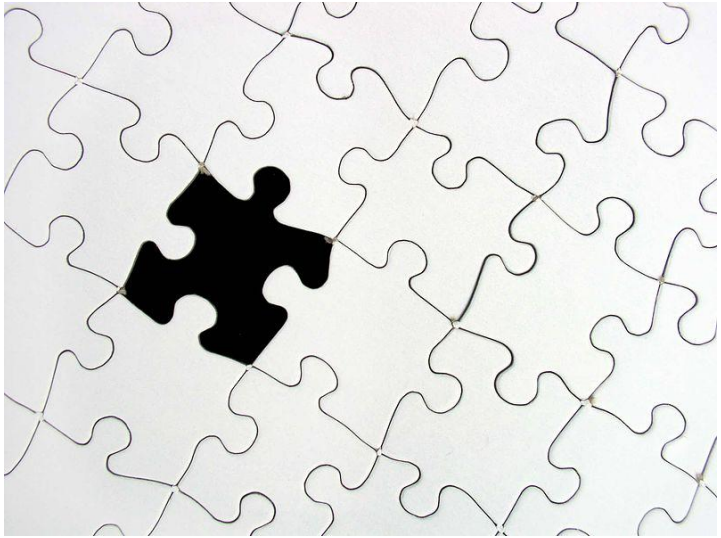

memory
build system
test manager
actions
test case 1
test case 2
cpu
build system
test manager
test case 1
test case 2

cgroup v2?



Missing v1 features: memswap

- We use swap as a tool for overcommitment.
- User limits should not be affected by how much we manage to swap out.



Thanks!

Discussion topics:

- If you are a cgroup v1 user too - how do you want to approach migration?
- Are the split hierarchy use cases something that should be addressed in cgroup v2?
- Are there v1 features that explicitly should not be migrated to cgroup v2?

Image sources

Sources for images in this presentation:

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