Packing, spreading and scheduling latency

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V0.1

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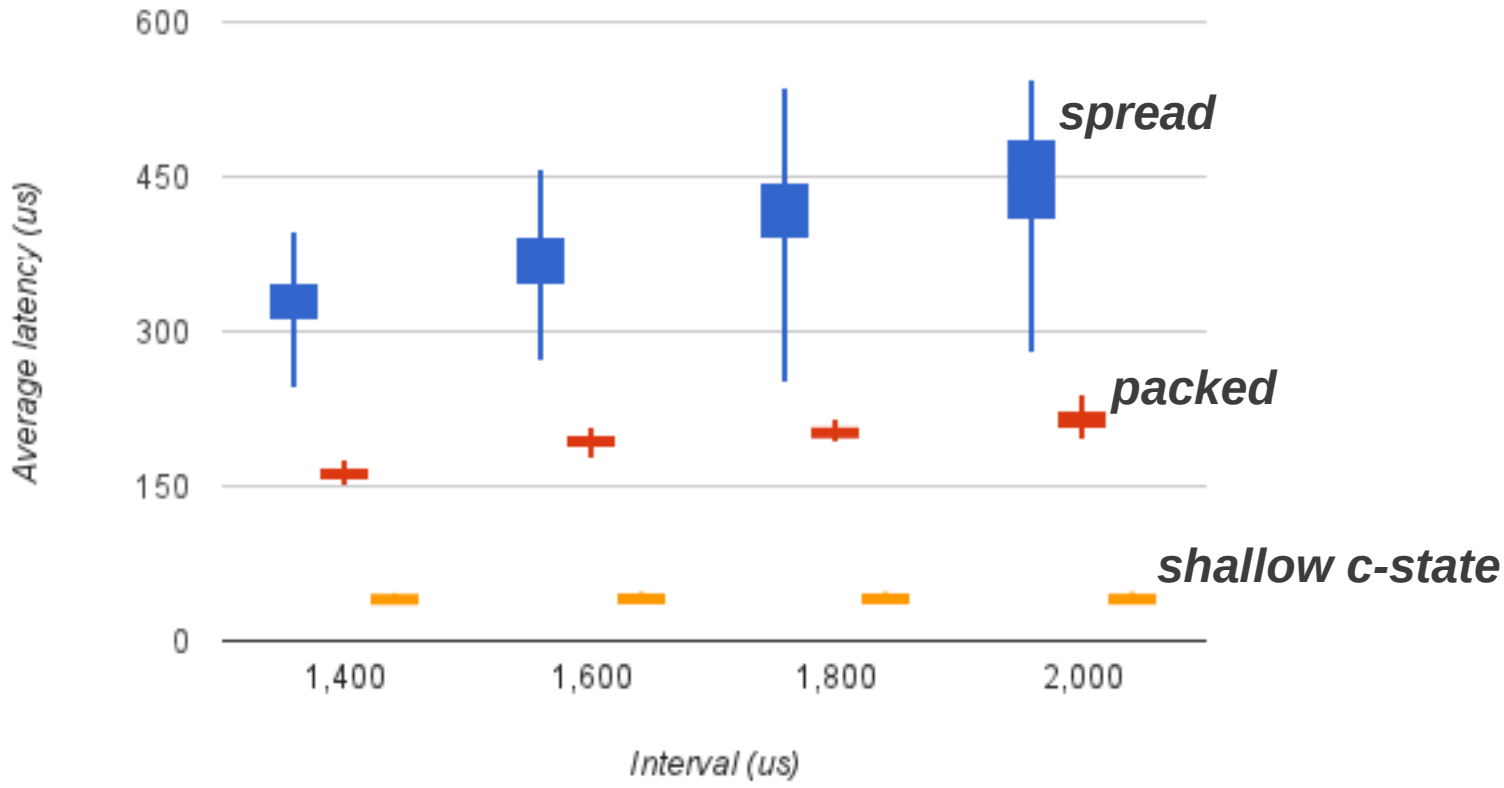
Spreading for performance

- Spreading tasks in the system
  - Default policy of the scheduler
  - Minimize ressources sharing
- Often the best policy
  - Long running tasks
  - Memory / CPU intensive workloads
- But some use cases don't follow the rule
  - Shared ressources are not the critical path
  - Light workload

An example with cyclictest

- Use various intervals in the range [1ms:2ms]
- Use both tasks placement policy
  - Spread tasks on CPUs (default behavior)
  - Pack tasks on 1 CPUs
- Enable/Disable C-state
- 10 runs per configuration
  - Get min/max/avg and stdev of the average latency of each run

Latency results



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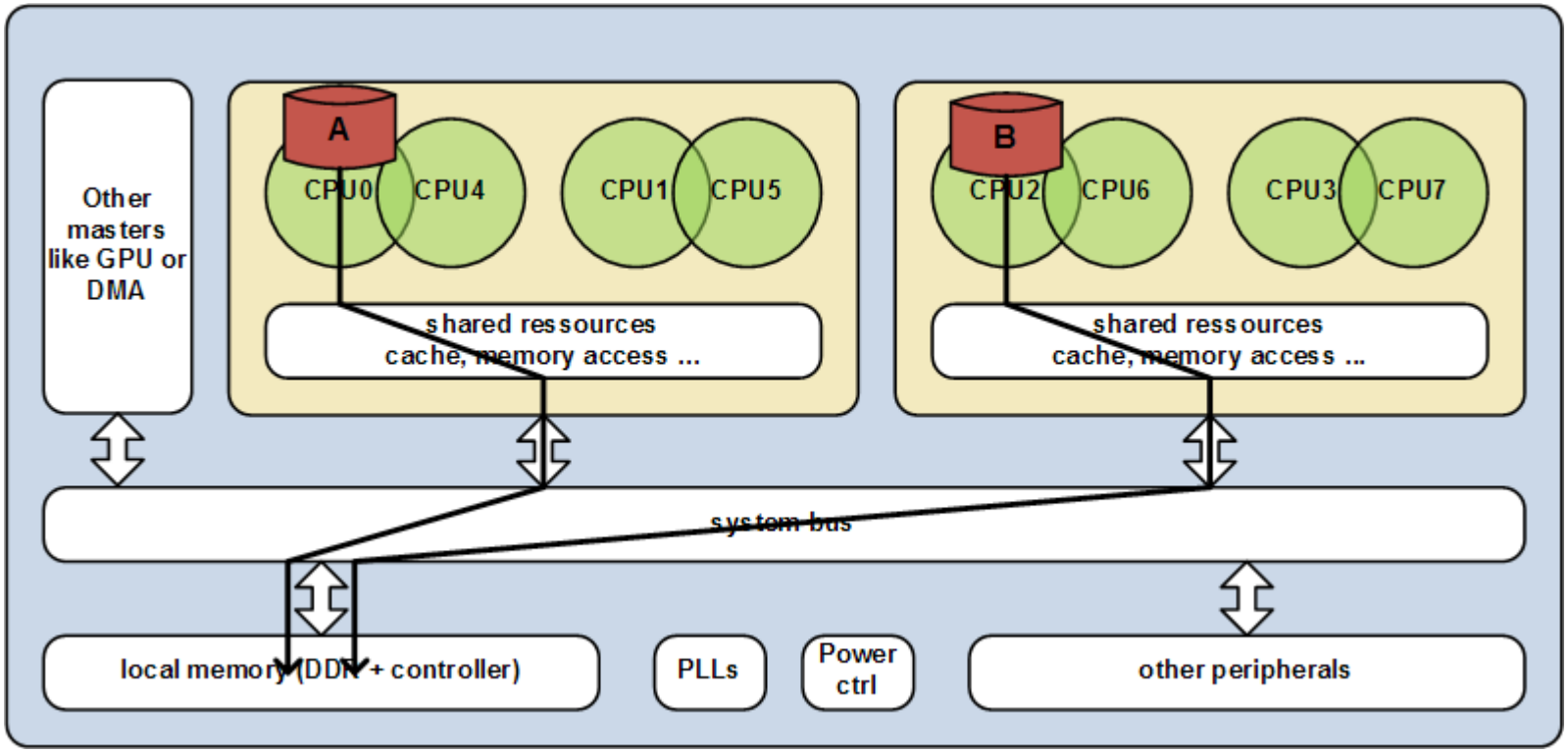
Why such difference ?

Topology of a system

- Have a look at the topology of a typical system



Idle state and wake up latency

- Generally, we can powergate/power down at all level:
  - Each core can be power gated independently
  - The cluster/package with/without the associated PLLs, power domains and regulators.
  - Nearly the complete system when all masters are off

- Wakeup latency increases with powered-down area
  - PLLs state
  - regulators state
  - peripherals state

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Back to our latency results

- Idle statistics for cyclictest -q -t 3 -i 1800-d 100 -e 1000000 -D 5
  - Spread

	% cpu0	avg idle cpu0	# cpu0	% cpu1	avg idle cpu1	# cpu1	% cpu2	avg idle cpu2	# cpu2
C0	55	0.53	5315	0	0.4	73	0	0.4	32
C1	40	1.12	1787	98	2.02	2427	98	1.92	2564

T0 : 2778 cycles

T1 : 2500 cycles

T2 : 2632 cycles

  - Packed

	% cpu0	avg idle cpu0	# cpu0	% cpu1	avg idle cpu1	# cpu1	% cpu2	avg idle cpu2	# cpu2
C0	30	0,36	4125	0		0	0		0
C1	62	1,57	1974	100		0	100		0

How to select the right CPU ?

- Take wake up latency of core into account
  - Select the idle CPU with shortest latency in the LLC
  - Compare runnable_avg of the task with the cost of wake up latency
- weighted_cpuload
  - Used to compare the load of CPUs
  - All idle CPUs have a null load
- Modify the weighted_cpuload of Idle CPUs
  - No more null but reflect the effort to wake it up
- Don't choose the 1st idle CPU
  - Use the weighted_cpuload for selecting an idle CPU

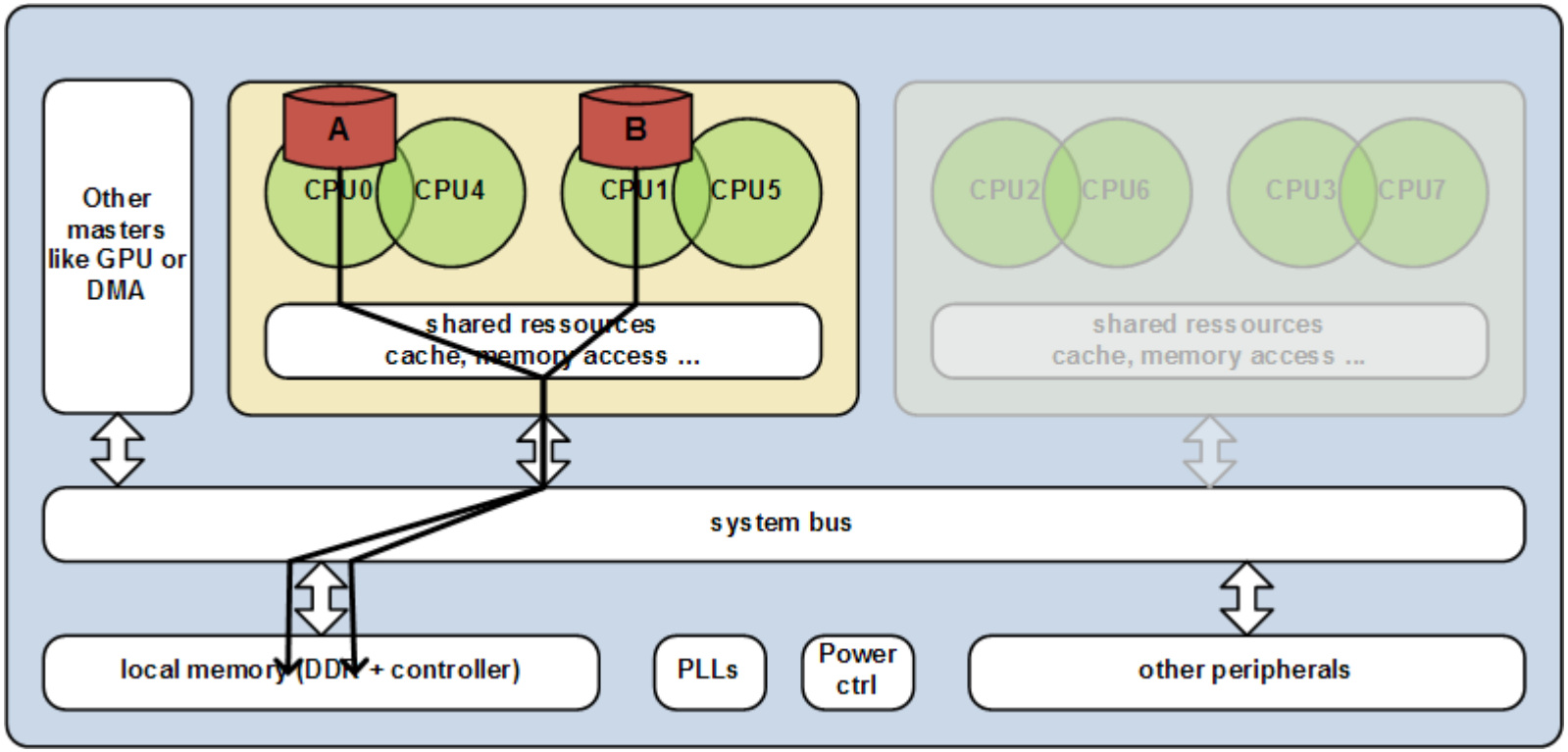
Is it enough ?

Packing tasks for saving power

- Scheduler knows when CPUs share
  - Core capacities
  - Ressources like the cache
- But it doesn't know their power dependency
- Packing makes sense only if there is a gain in
  - Latency as seen previously
  - Power consumption by increasing powered down area

Packing tasks for saving energy

- Optimizing the power down area
  - With minimal increase of the running time



Power CPU topology

- Add a new flag in sched_domain : SD_SHARE_POWERDOMAIN
  - Domain member shares their power down capabilities
- Let architecture describes their topology
  - New function ***arch_sd_local_flags (cpu, flag)***
  - Return per-cpu power dependency in a domain
  - Used during the init of sched_domain's levels
- Use DT to describe power dependency
  - Add a new property for CPU topology description
  - power-gate= <0/1>

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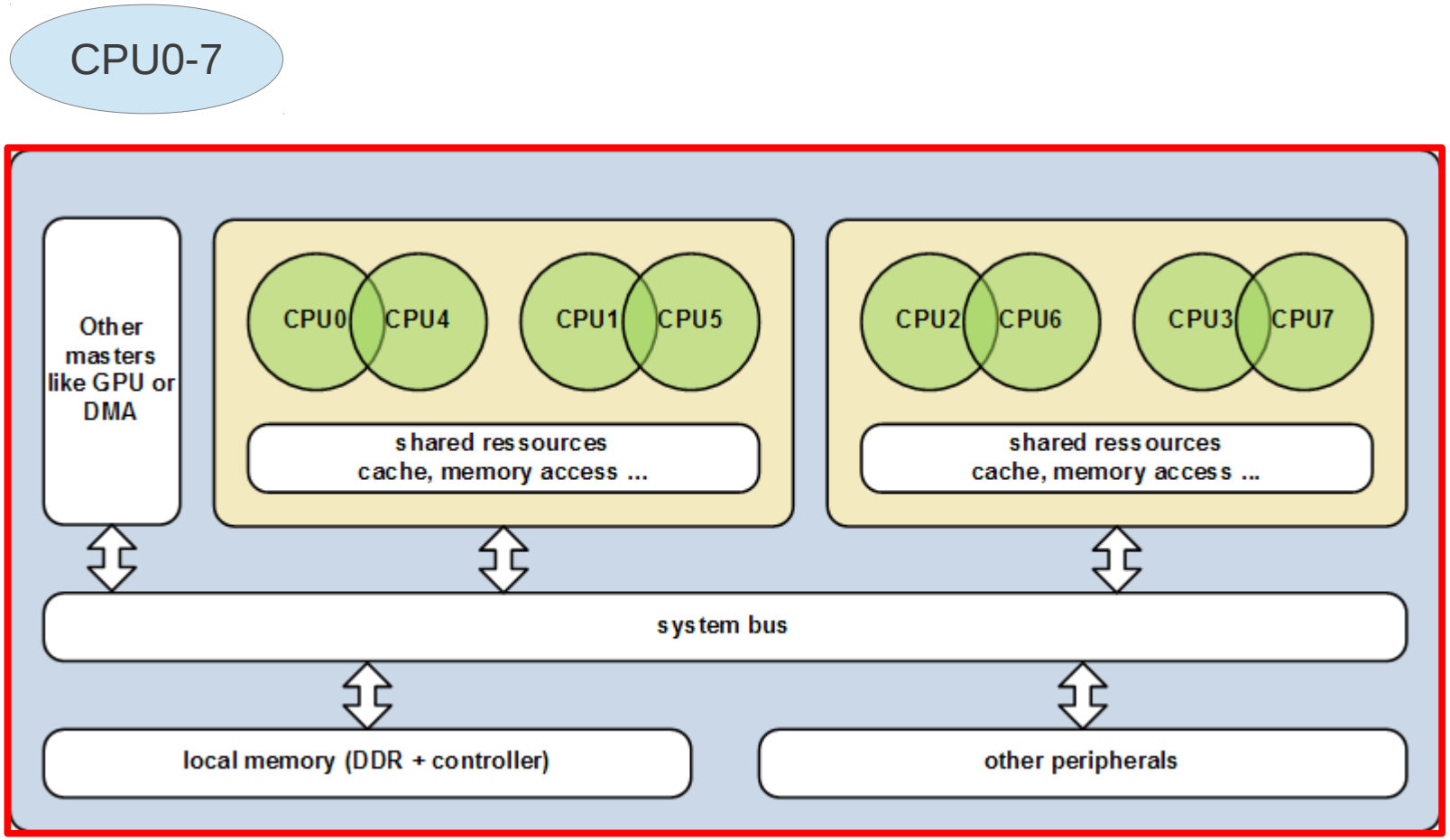
Create a list of packing CPUs

- Pack tasks only if you can power down/gate the forced idle CPUs
  - Use all cores that share their power state
- Use group of CPUs with lowest capacity first
  - Assuming they are the most power efficient
- Use 1st CPU in the mask
  - Default policy in the scheduler

Example of packing policy

- Full sharing of power state (defaut configuration)



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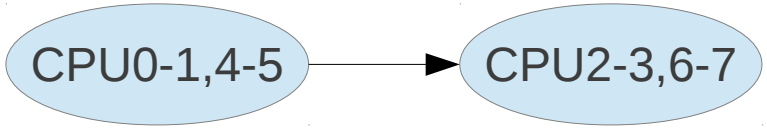
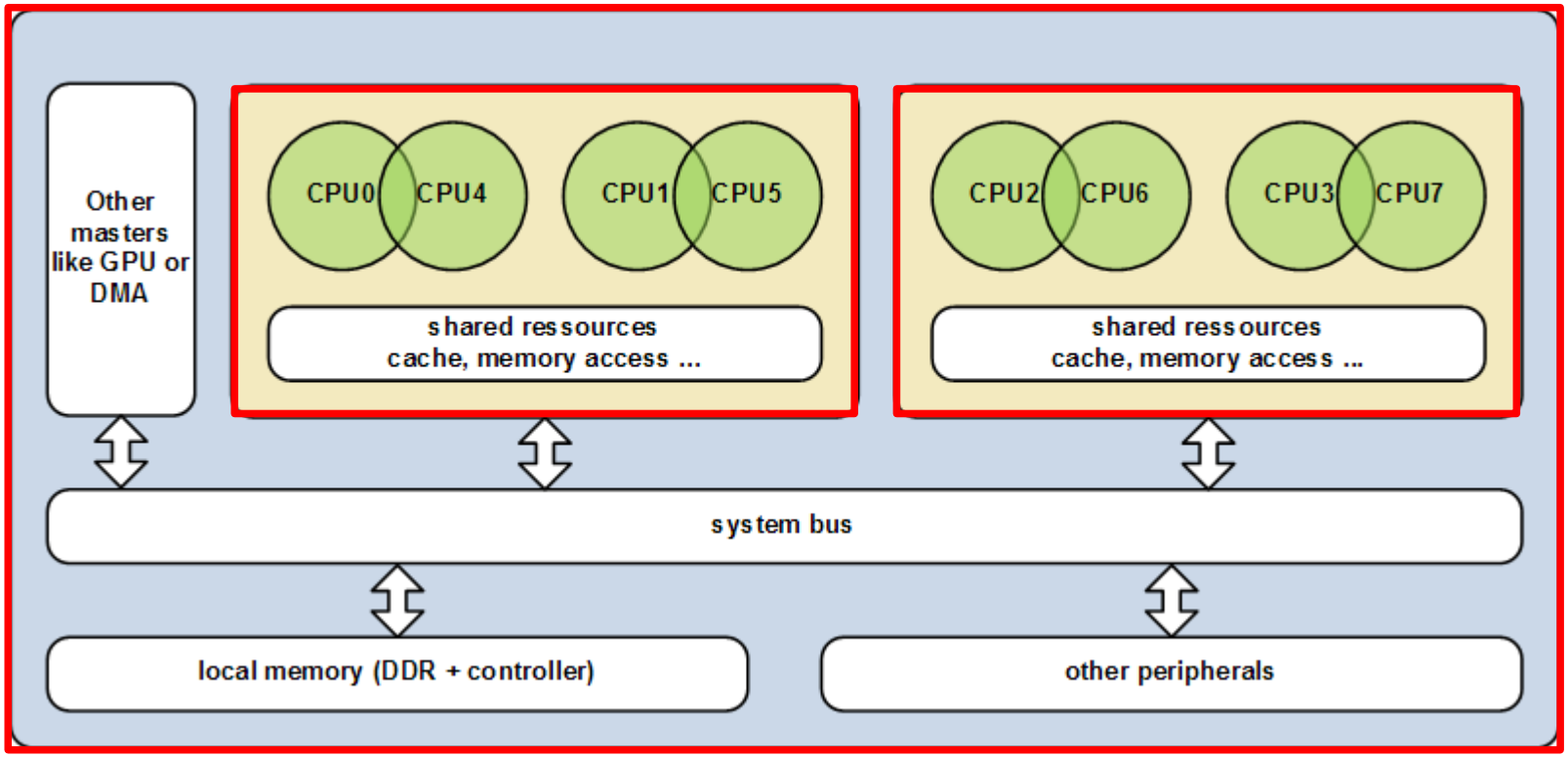
Example of packing policy

- Can power gate cluster independently





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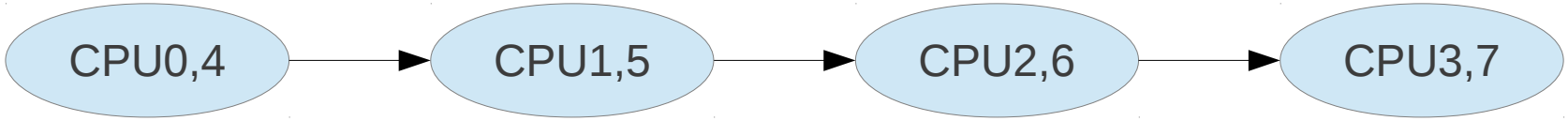
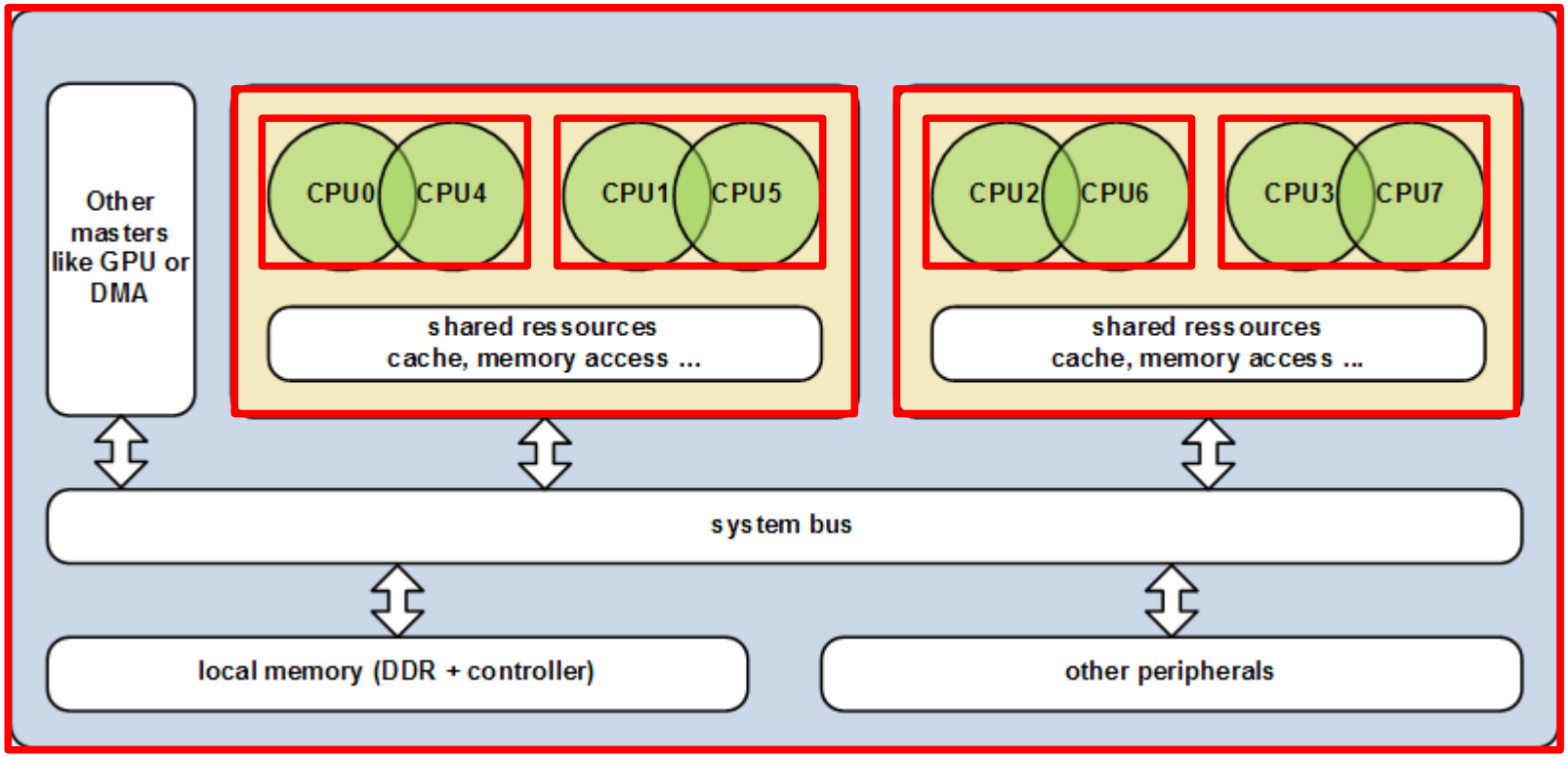
Example of packing policy

- Each core can be power gated independently





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Updating the list

- Periodically evaluate system activity
  - Use runnable_avg_sum/period of CPUs
  - Use CPU's capacity (cpu_power)
  - Sync activity monitoring with load balance
- Deduct how many CPUs needed
  - Use CPUs' capacity (cpu_power)
- Then ensure that a target CPUs is in this list
  - check CPU selection at wake up
  - Define a buddy CPU that will handle the activity of non packing CPU
  - New task can use a CPU out of the list

Is it enough ?

Questions ?

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