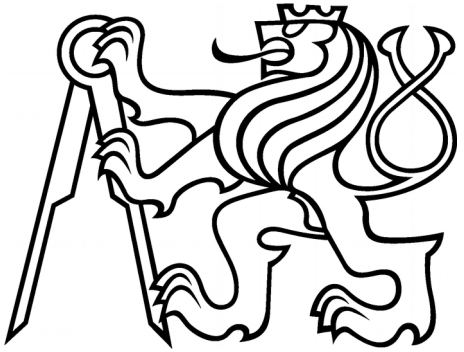

Optimizing resource usage with HTCondor

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NEC2019

1st October 2019

EUROPEAN UNION
European Structural and Investment Funds
Operational Programme Research,
Development and Education

MINISTRY OF EDUCATION, YOUTH AND SPORTS

HTCondor

- Job management system
  - different roles
    - local batch system for scheduling compute-intensive jobs on cluster
    - grid gateway (HTCondor-CE) supporting many local batch system
- High-Throughput Computing (HTC)
  - run as much work as possible on all available resources
  - large amount of computational power over longer period of time
    - huge number of independent jobs or with DAG dependencies
    - vs. HPC with tremendous power of single massively parallel jobs
  - maximize machine utilization
    - don’t leave resources idle
    - optimize time-to-finish not time-to-run
- Operator/user requirements and expectation more complex
  - fair resource distribution, reasonable time to start job, job execution priorities, resource allocations without artificial constraints, …

HTCondor configuration

- HTCondor provides extremely flexible configuration
  - provides tools to enforce local job scheduling policies
  - default / simple configuration usually lack some features
    - job executed to maximize use of available resources
    - missing concept of “queues” known from other batch systems
  - flexible configuration has downsides
    - no single standard way to achieve requested behavior
      - custom attributes (also in submission files, e.g. MaxRuntime, JobFlavor)
      - expression language powerful, but can become complex – hard to read
- Clusters shared between groups with different requirements
  - jobs with non-standard requirements can wait long (infinite) time
    - number of CPUs / GPUs, memory size, disk space, connectivity, …
    - small jobs scheduled to fill idle resources not big enough for big one
      - cluster providing resources for grid jobs have plenty of small jobs
      - special jobs waits till number of small jobs finish at the same time

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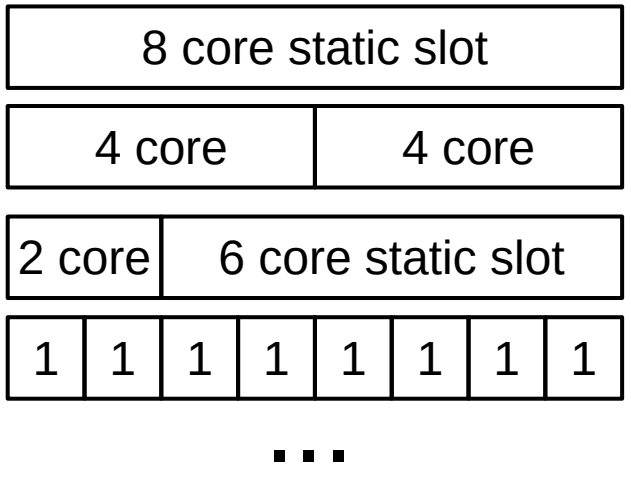

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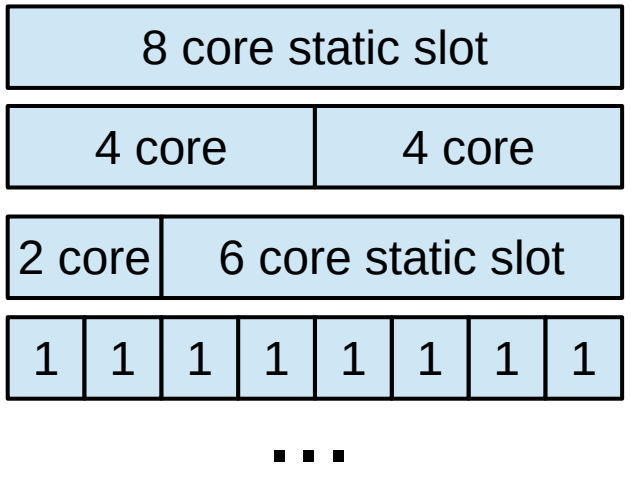

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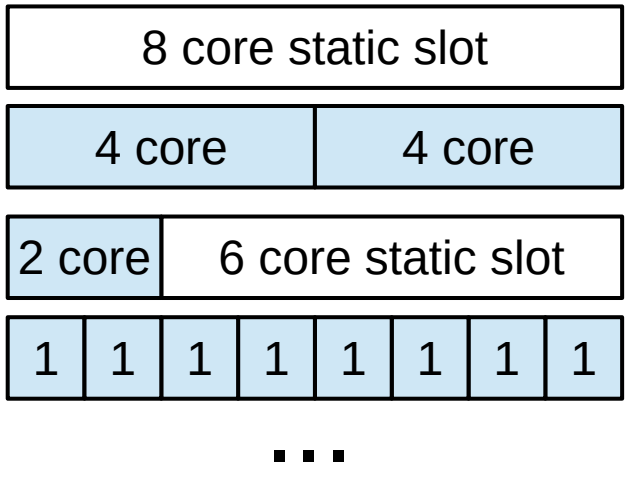

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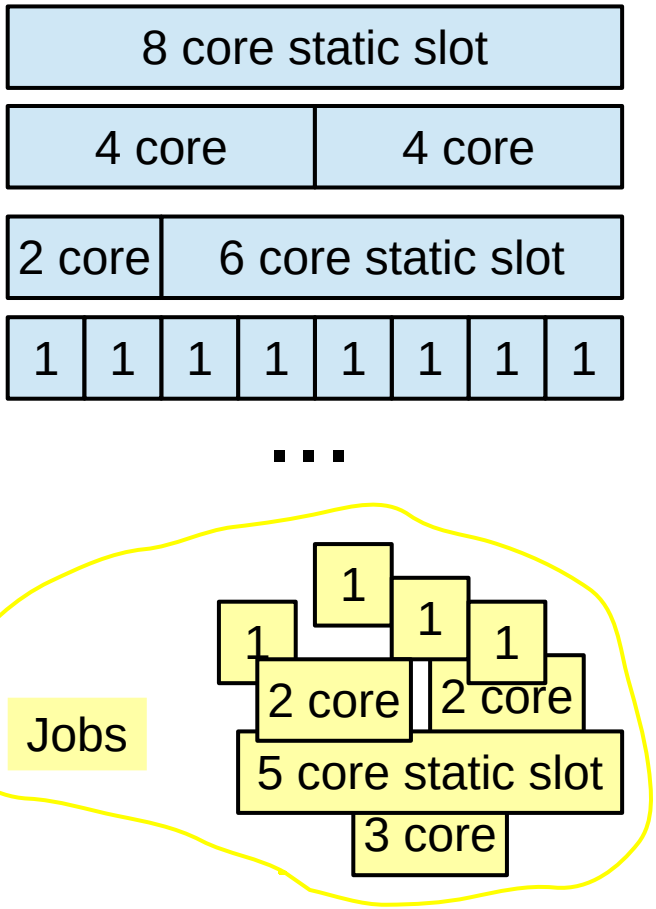

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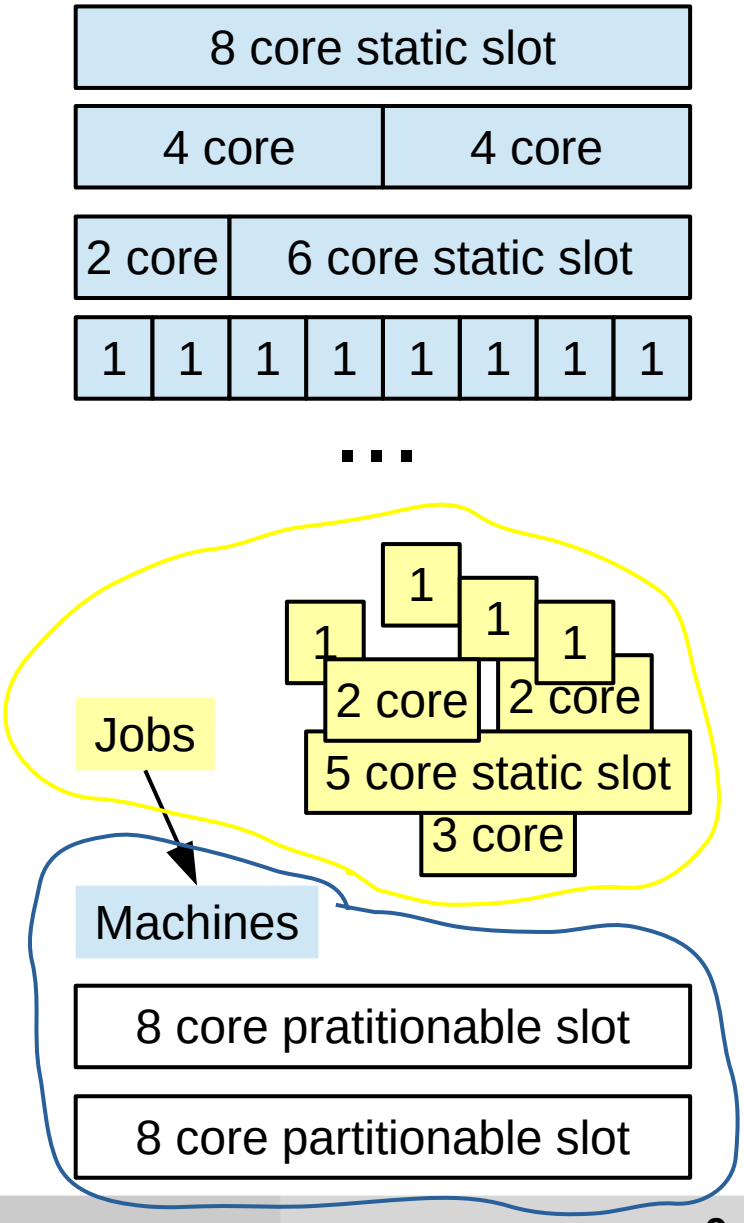

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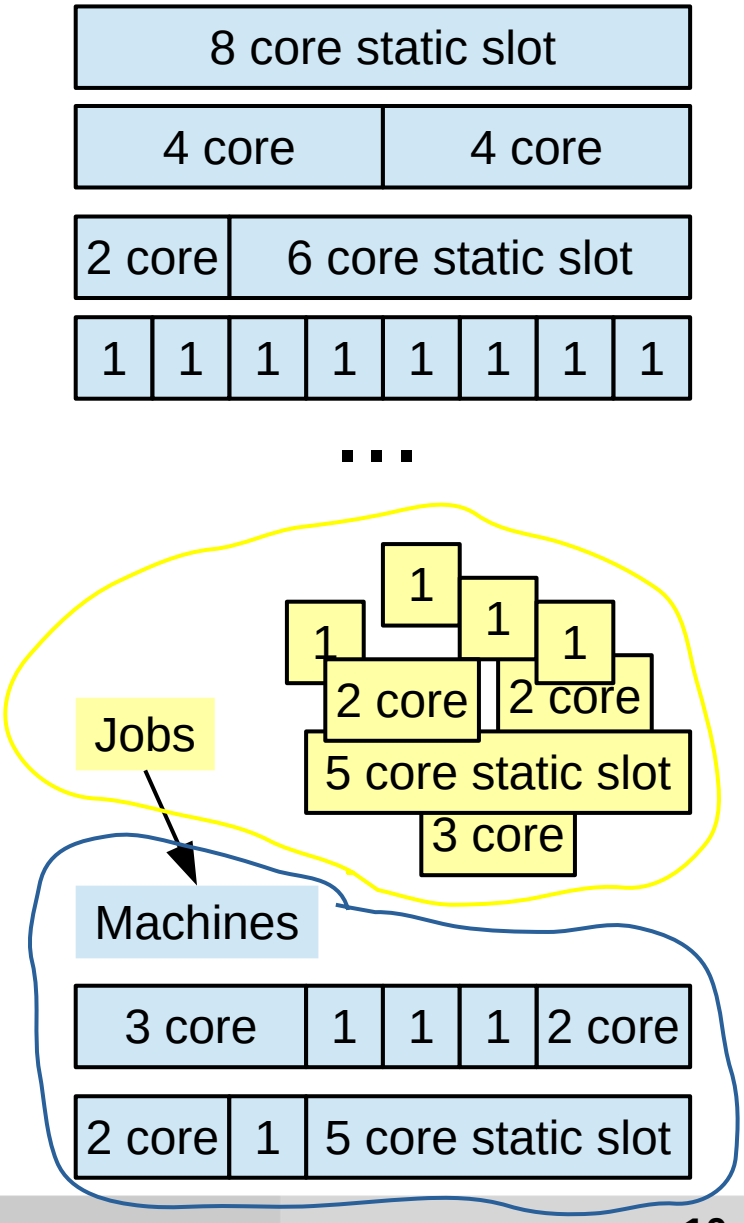

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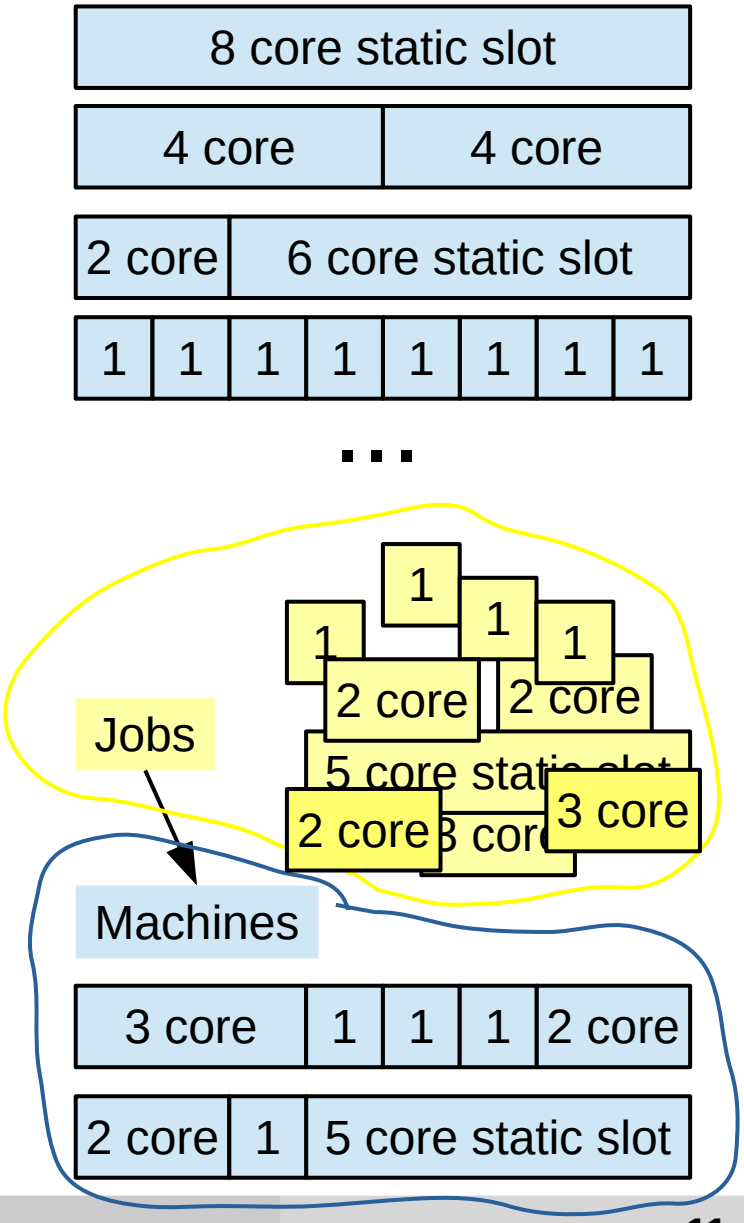

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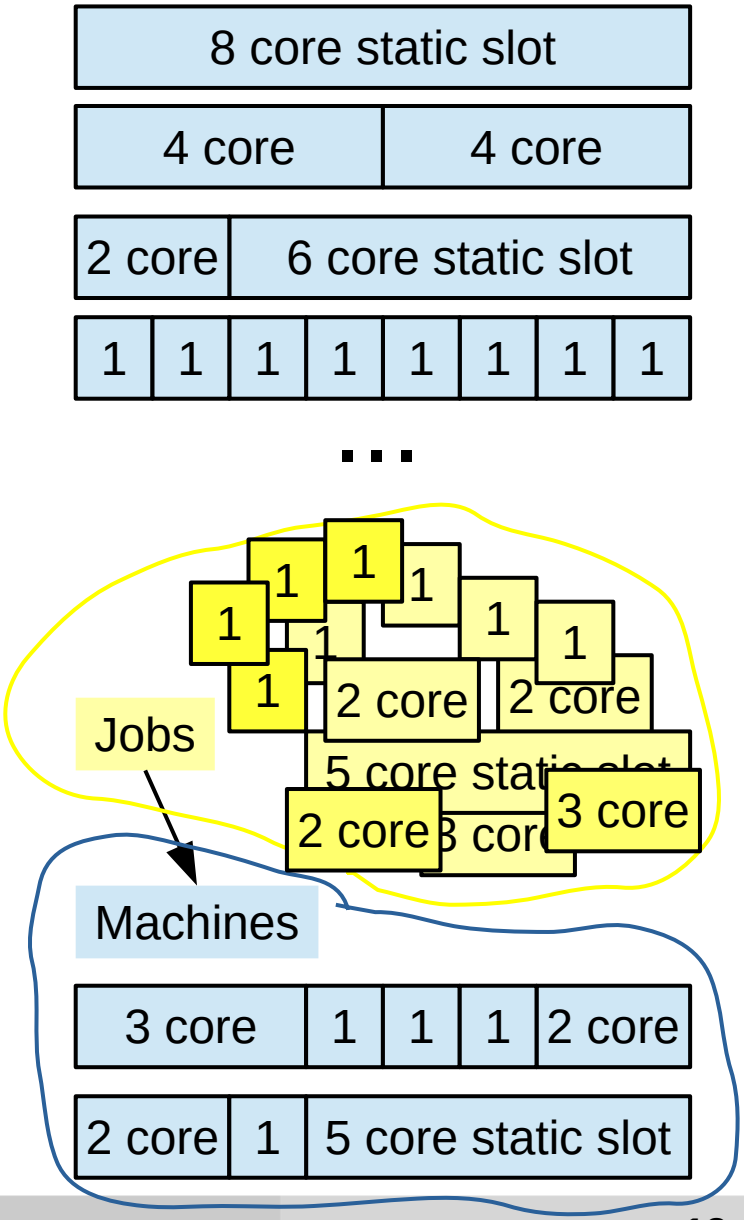

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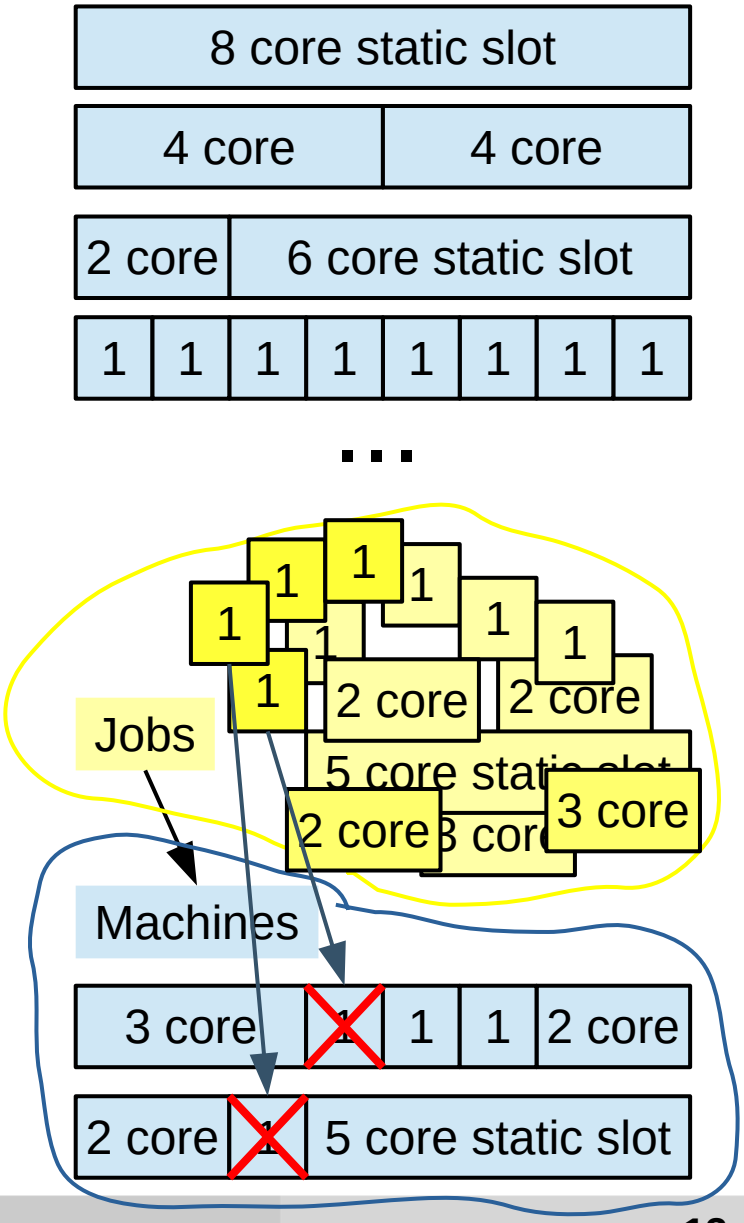

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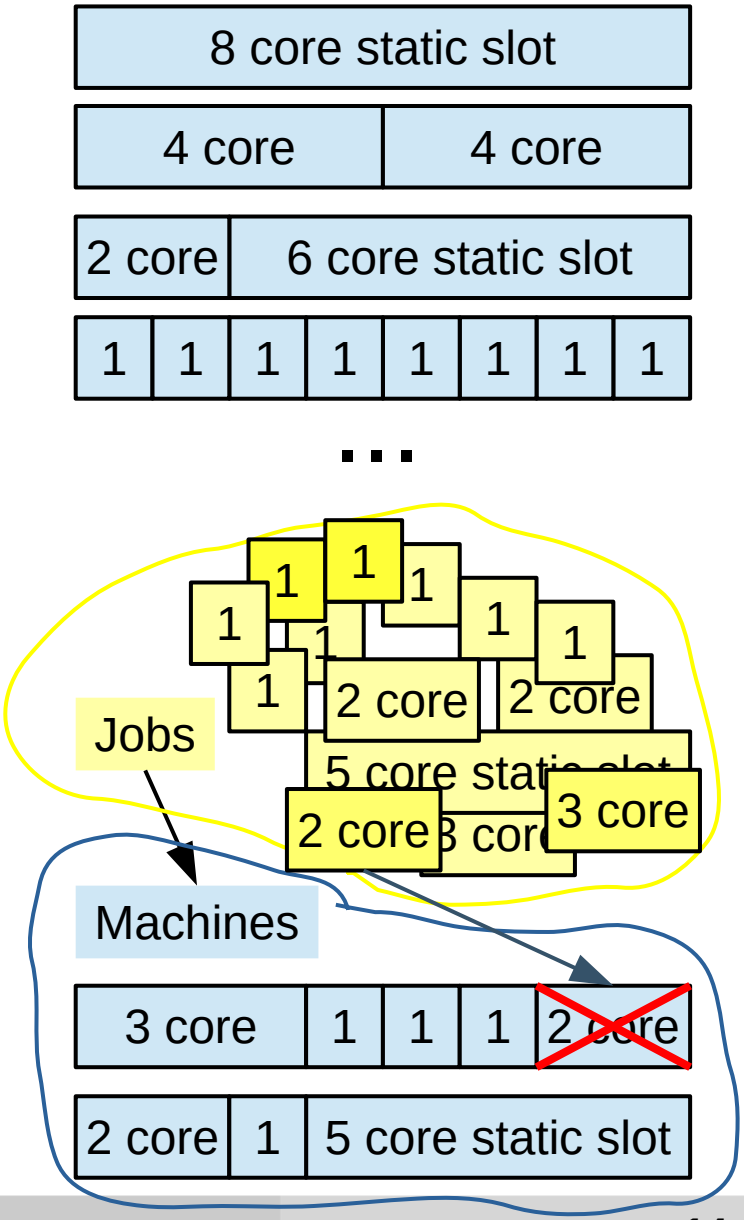

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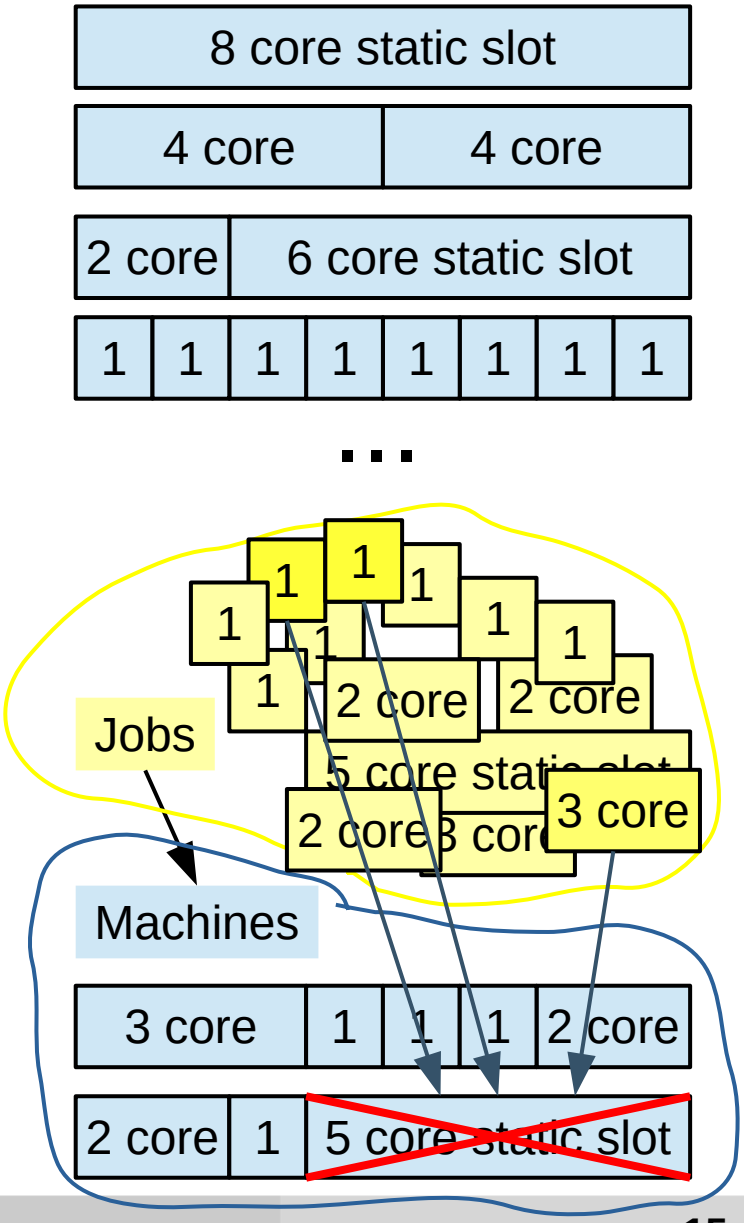

Cluster defragmentation

- Peemptible jobs
  - jobs with lower priority killed by batch system
    - wasted CPU unless job continuously store results (ES, multi-payload)
    - rescheduled to run later once jobs with higher priority completes
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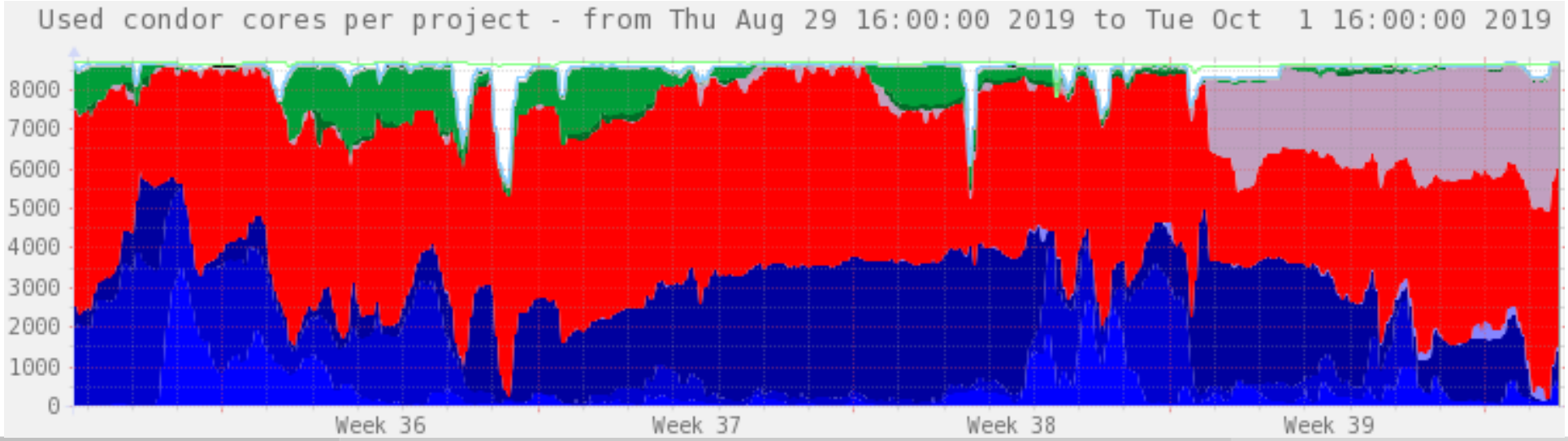
- Defrag daemon
  - HTCondor built-in solution for cluster resource defragmentation
  - select machine passing DEFRAG_REQUIREMENTS (by rank expr.)
    - change machine state to drain (condor_status) – no new jobs
    - wait till DEFRAG_WHOLE_MACHINE_EXPR pass
    - limit number of machines in draining state, max draining per hour, …
  - idle resources waiting for defragmentation
    - no connection to queued job requirements

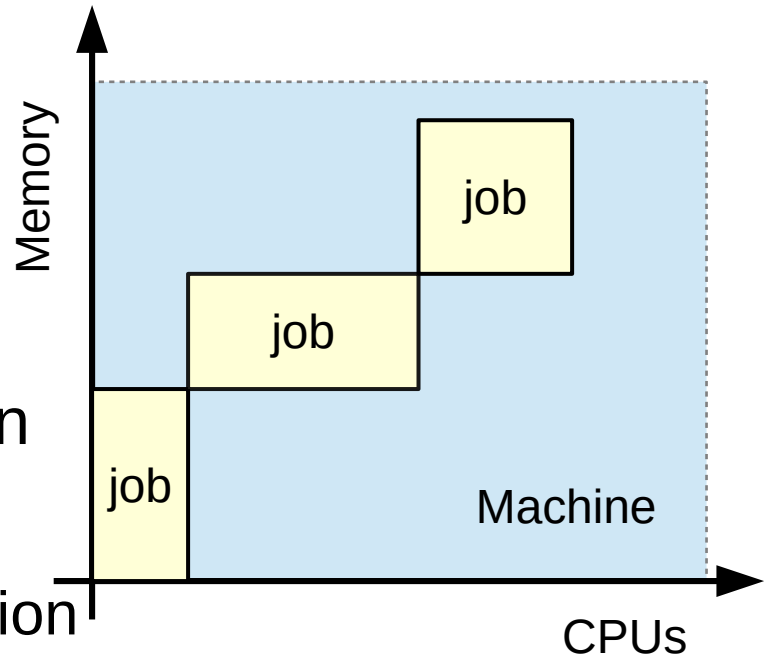
HTCondor defrag

- Doesn’t guarantee drained big slot matched with big job
  - additional configuration necessary not to match with small jobs
    - GROUP_SORT_EXPR – prefer matching multicore jobs first
      - HEP-puppet configuration
      - works quite reliable, but only for one group having multicore jobs
      - one starving muticore fairshare → prevents others to start mcore jobs
    - prevent small jobs to match big slot for few negotiation cycles
- Slow defragmenation vs. number of idle / draining machines
- Not optimal for arbitrary user resource requirements



Optimize resource utilization

- CPU not the only shared resource
  - GPU, memory
  - disk size, disk I/O, network
  - shared storage
- Draining – multidimensional optimization
  - resource requirements of queued jobs
  - monitor condor events for quick adaptation
  - node selection for fastest draining (MaxRuntime, preemption, …)
  - don’t limit users to semi-static resource partition (8 cores / 16GB RAM)
  - more intelligent job placement – group short jobs together
- Concurrency limits
  - could be used to protect (global) shared resource
    from overloading by running jobs (I/O, storage, network)
  - defaults values can be injected by JOB_TRANSFORM



Conclusion

- HTCondor provides means to define flexible job scheduling policies
- Default configuration doesn’t satisfy even simple requirements
- Optimal resource utilization is not an easy task
  - idle resources vs. time-to-start
    - important mainly for local users
  - prevent artificial resource limits
  - dynamic configuration updates necessary
    - HTCondor expression language not optimal for complex policies
- Accounting