A case for energy management

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We are used to think about a job as consuming computing resources (CPUs, cores, GPUs), main memory, disk space, and communication bandwidth. This is why when asked about how big is our cluster we answer with FLOPS, bytes and bits per second. We expect jobs submitted to the cluster to tell us how many of these resources it needs and we employ sophisticated resource managers that keep track of the availability of these resources to schedule the jobs that are lined up to be served. Recent changes in the ratio of the cost of computing hardware (purchasing) and the cost of the energy it takes to run this hardware (ownership) make us believe that in the very near future the answer to this question will be “450 KW!”. In other words, building a cluster that can consume a very large amount of energy is not a big deal. What makes you more powerful than others is how much energy you can bring to table.

Adding energy to the list of managed resources means that application developers need to understand and control the energy profile of their software and that facility operators need to understand and control the energy profile of their facility. We argue that making energy a first class citizen in our computing market place requires a comprehensive set of new monitoring and allocation mechanisms. Before we can develop and deploy any energy policies like “given the relative cost of a KW/hour we should reduce the energy consumption at location A to X KW and increase to consumption at location B to Y KW” we need mechanisms that can operate a computing facility effectively at a set level of energy. In other words we need mechanisms that can change and sustain the energy profile of a facility from the current energy level to a different level within a predefined time interval.

For a job to specify energy requirements (or preferences) the developer of the application has to provide an energy profile that associates the parameters of the jobs and/or the properties of the input data to energy consumptions. Given that moving data has a significant impact on energy consumption, understanding the energy profile of a job will be more difficult than counting the processes or estimating memory footprint. Checking for energy violation is also not a simple matter. We also need tools that can help us understand the impact one job can have on the energy consumption of another concurrently running job.

Since its inception in the mid 80’s, the Condor project has been working on allocation mechanisms for hardware as well as software resources. Following our long standing bottom-up approach to technology development, Condor has been offering some basic energy management mechanisms for almost two years. These mechanisms have been deployed in academic and commercial settings and have been proven to be effective. We are very interested in establishing a forum where such energy management mechanisms can be discussed and in building an open source community that will implement and support such mechanisms.