Energy-Aware Processor Management for Virtual Machines

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- Increasing Power  Increasing Density
- Virtualization is currently energy-oblivious
- Some thermal characteristics are indivisible (and thus hard to virtualize)
- Extensible policies require extensible accounting
- Provide unified energy instrumentation framework
- Flexible user-space VM scheduler/accountant
- Temperature is hard to virtualize
- Measure per-VM CPU energy dissipation
- Instrumented at context switches, reported in user-accessible logs
- Gauged by thermal temperature sensors
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- Virtualization introduces two layers of OS-directed resource management
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- VM scheduler pursues coarse-grain, low-frequency scheduling according to energy criteria
- Migration (balancing) and/or preemption of virtual processors
- Enforcement of limits for energy-unaware, defect, or malicious guests
- Energy-aware guest VMs pursue fine-grain, high-frequency migration and/or preemption of threads
- Respect application-level QoS
- Respect global energy criteria through energy-faithful virtualization

- Para-virtual I/O interface enables precise accounting
- Drivers instrument and report energy consumption per VM
- Hypervisor track per-driver CPU energy dissipation
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