Software Controlled Power Management

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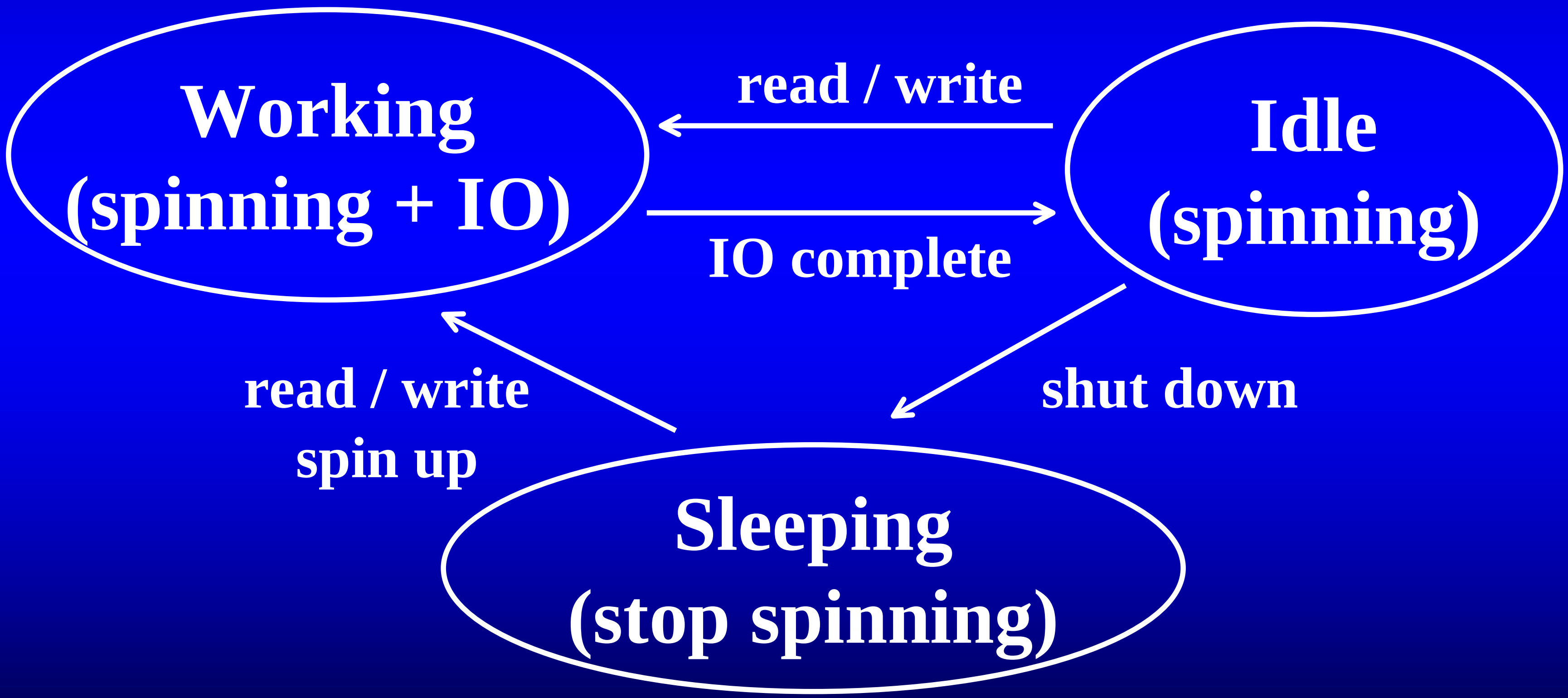
Outline

- Dynamic Power Management (DPM)
- ACPI (Advanced Configuration & Power Interface)
- Software Architecture
- Experimental Result
- Conclusion

Power State Transitions (Hard Disk)



Dynamic Power Management

Shutdown a device when it is not used.

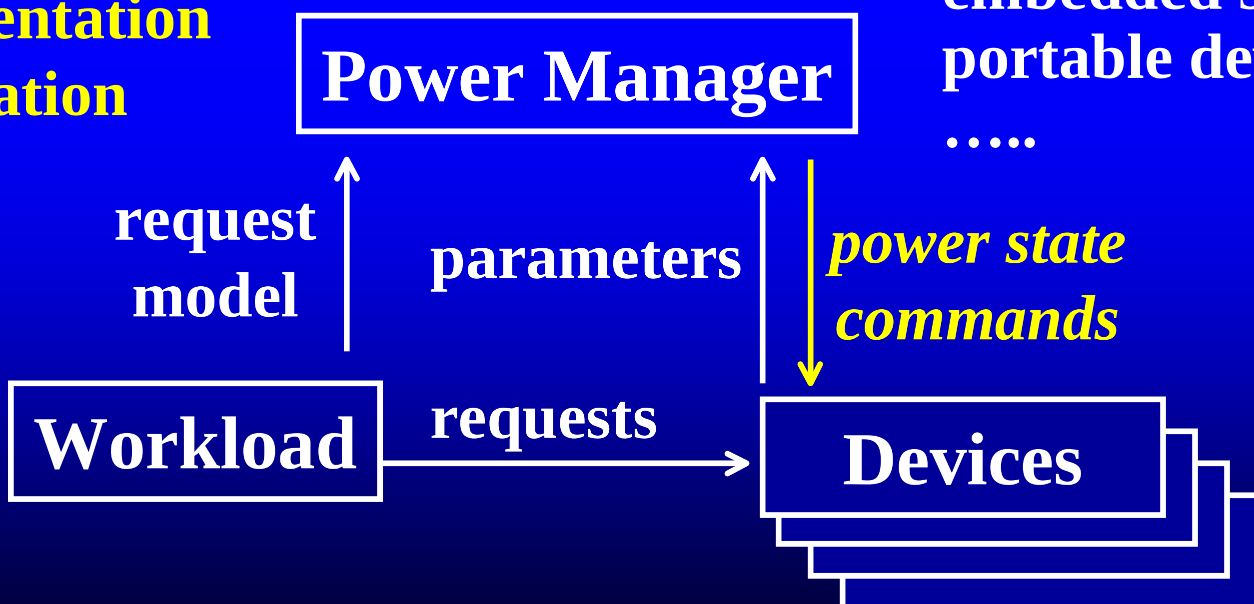
Request and device modeling

Management algorithms

Power and performance tradeoffs

Implementation & evaluation

Applications:
- **computers**
- **embedded systems**
- **portable devices**
- **…..**



DPM is a Co-Design Issue

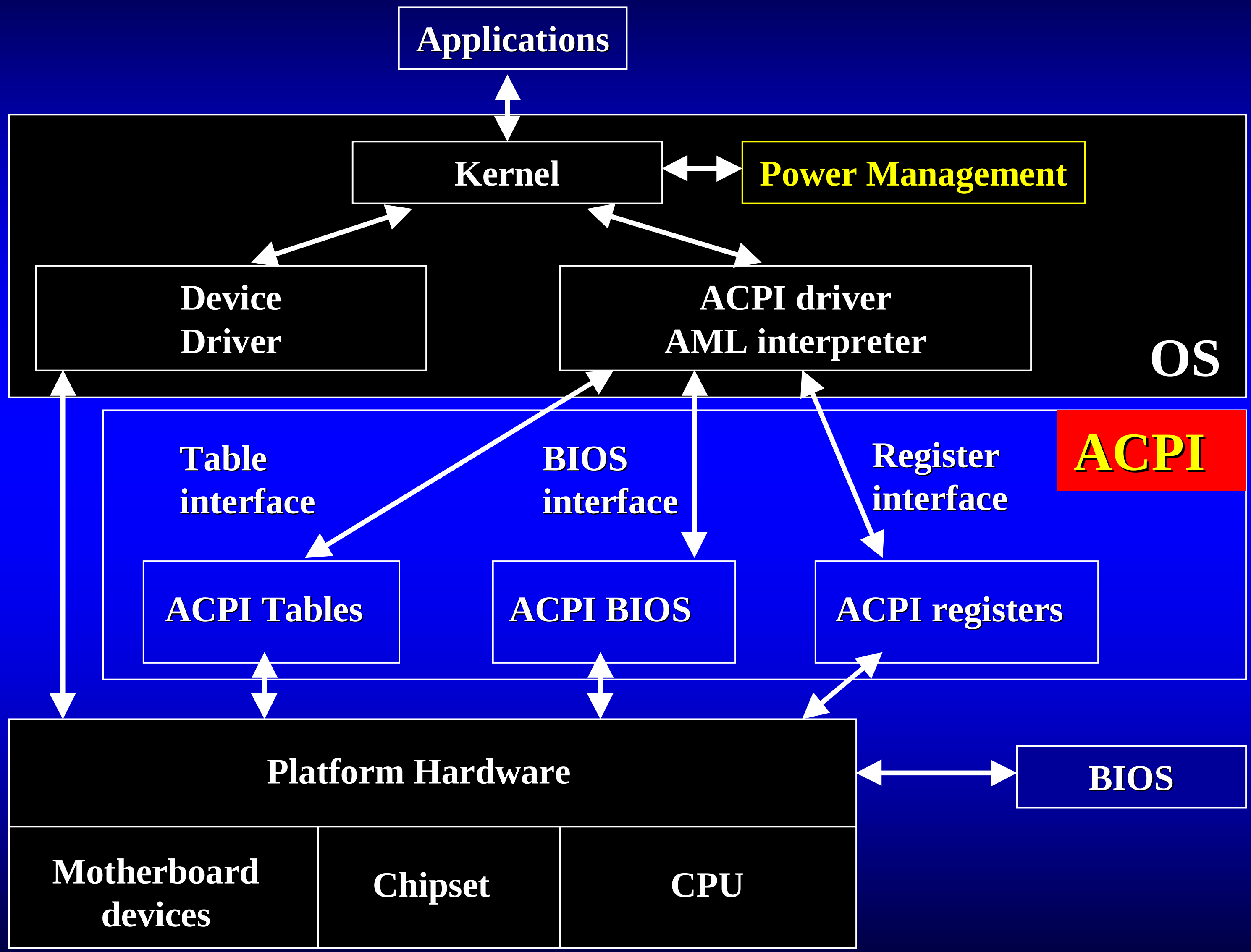
- HW provides multiple power states
  - allowing dynamic power state change
  - providing low state-transition overhead
- SW implements DPM algorithms
  - implementing adaptive, flexible, smart algorithms
  - using higher-level information

Our Goal

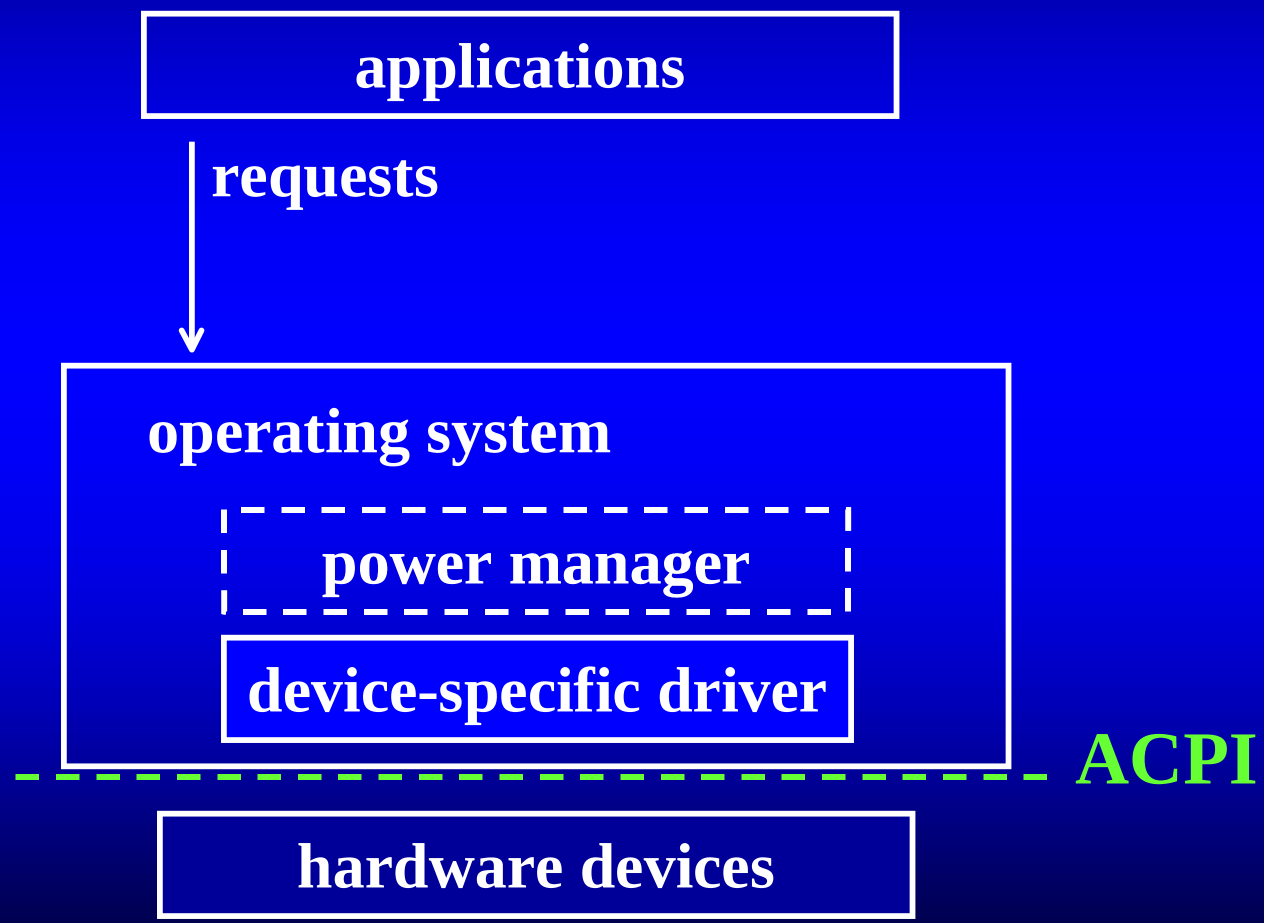
Build a framework to facilitate the design and evaluation of DPM algorithms on realistic workloads.

- **personal computer**
- **commercial OS**
- **real applications**

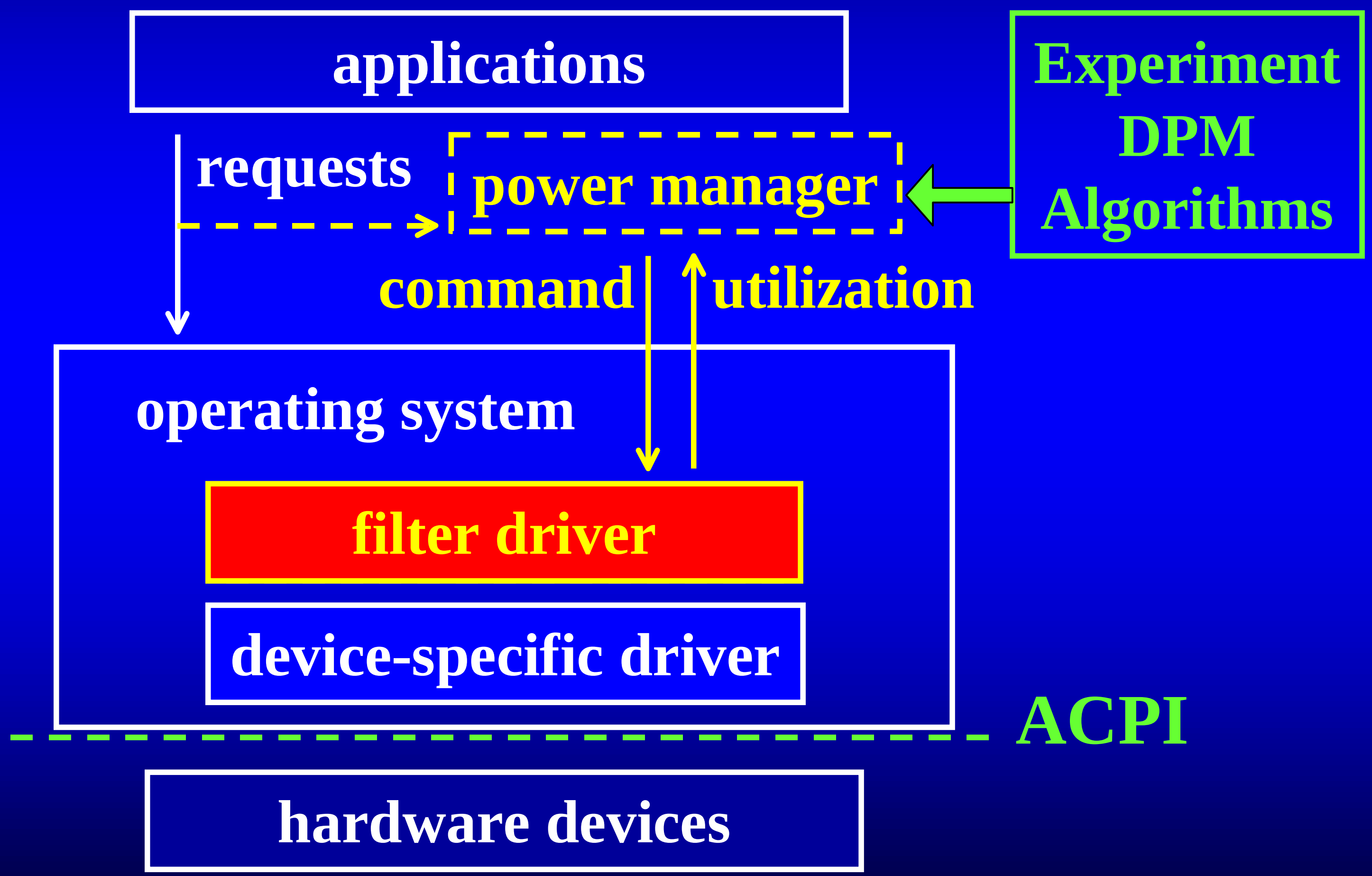
ACPI Architecture



Software Architecture



Our Software Architecture



Advantages

- Separate policy and mechanism
- Facilitate algorithm implementation & evaluation
- Achieve high-precision performance analysis (microsecond)

Programming Interface

Power Manager

`Requests Arrive` ↑ ↓ `SetPowerState`

Filter Driver

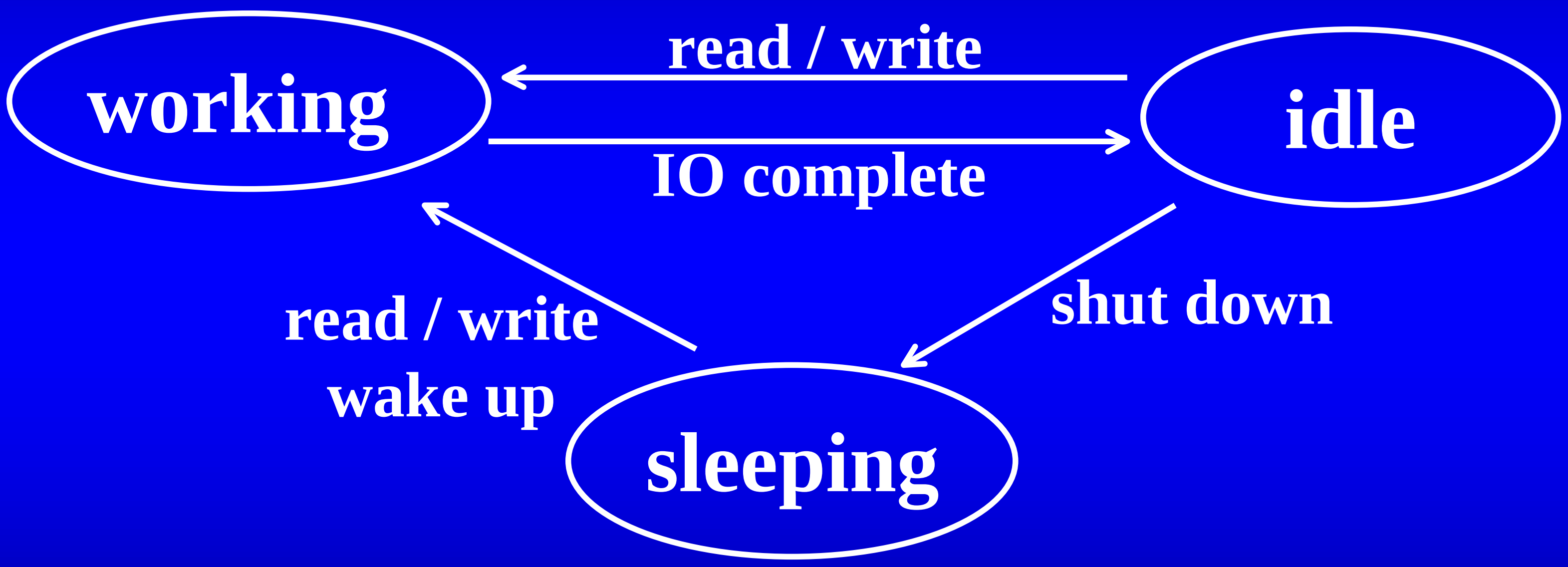
observing IO activities,
power state change….

synchronization
creating power command
timing analysis

Experiment Environment

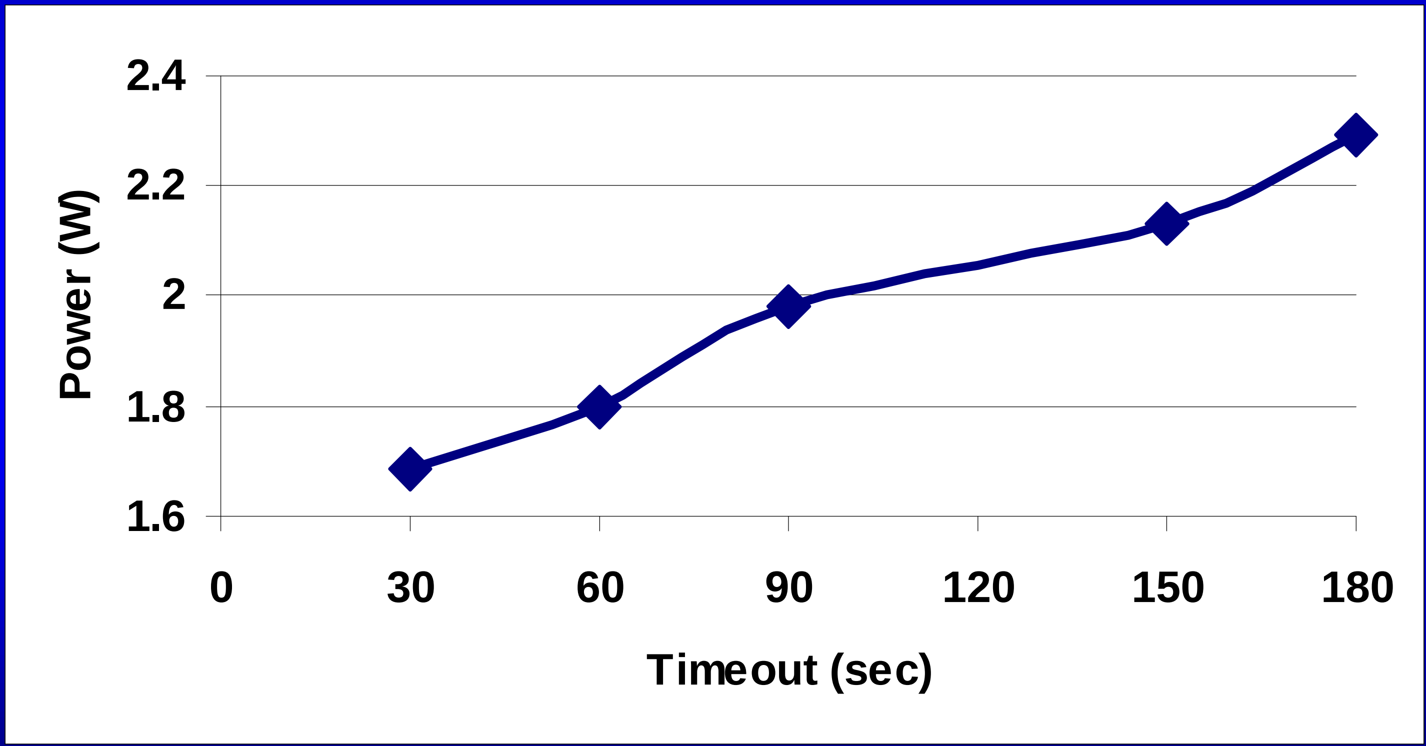
- Intel Pentium II-266 MHz
- Windows NT 5 beta-2
- 256 MB RAM
- IBM Deskstar IDE HDD
  - 3 power states
  - idle power 3.48 W
  - sleeping power 0.75 W
  - 7.2 sec / 52 J to wake up and 0.51 sec to sleep

Hard Disk State Transitions

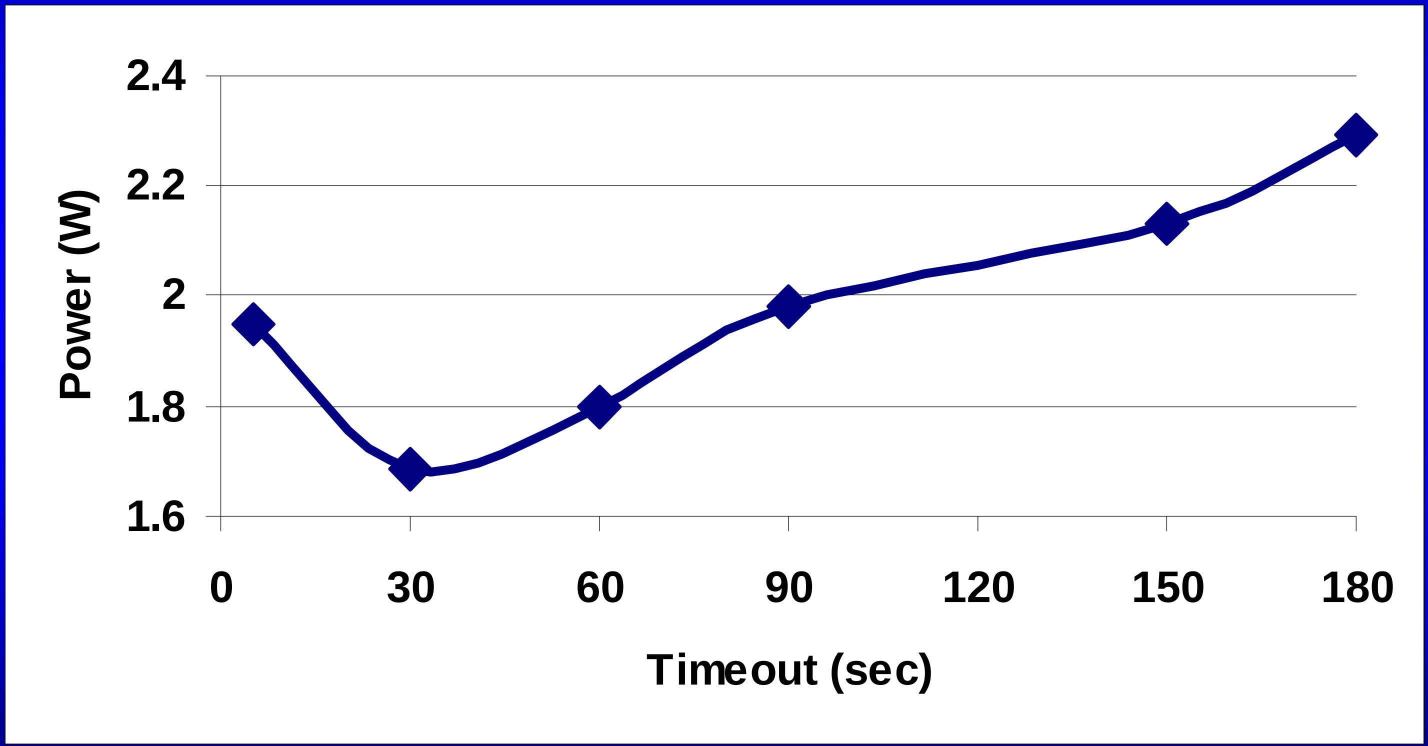


Total Energy = $\text{time}_{\text{sleeping}} \times \text{Power}_{\text{sleeping}} + \text{time}_{\text{idle}} \times \text{Power}_{\text{idle}} + \#\,\text{wakeups} \times \text{Energy}_{\text{wakeup}}$

Power vs. Timeout

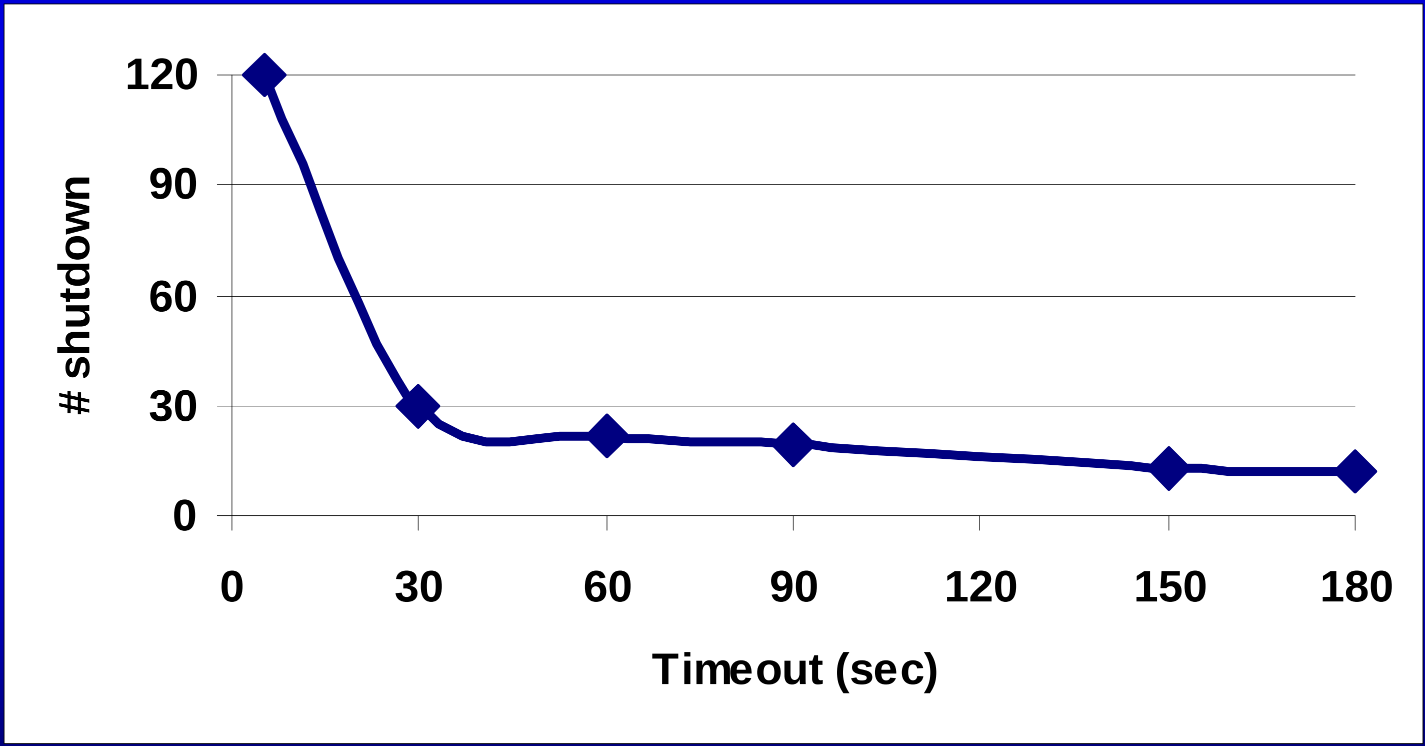


Power vs. Timeout

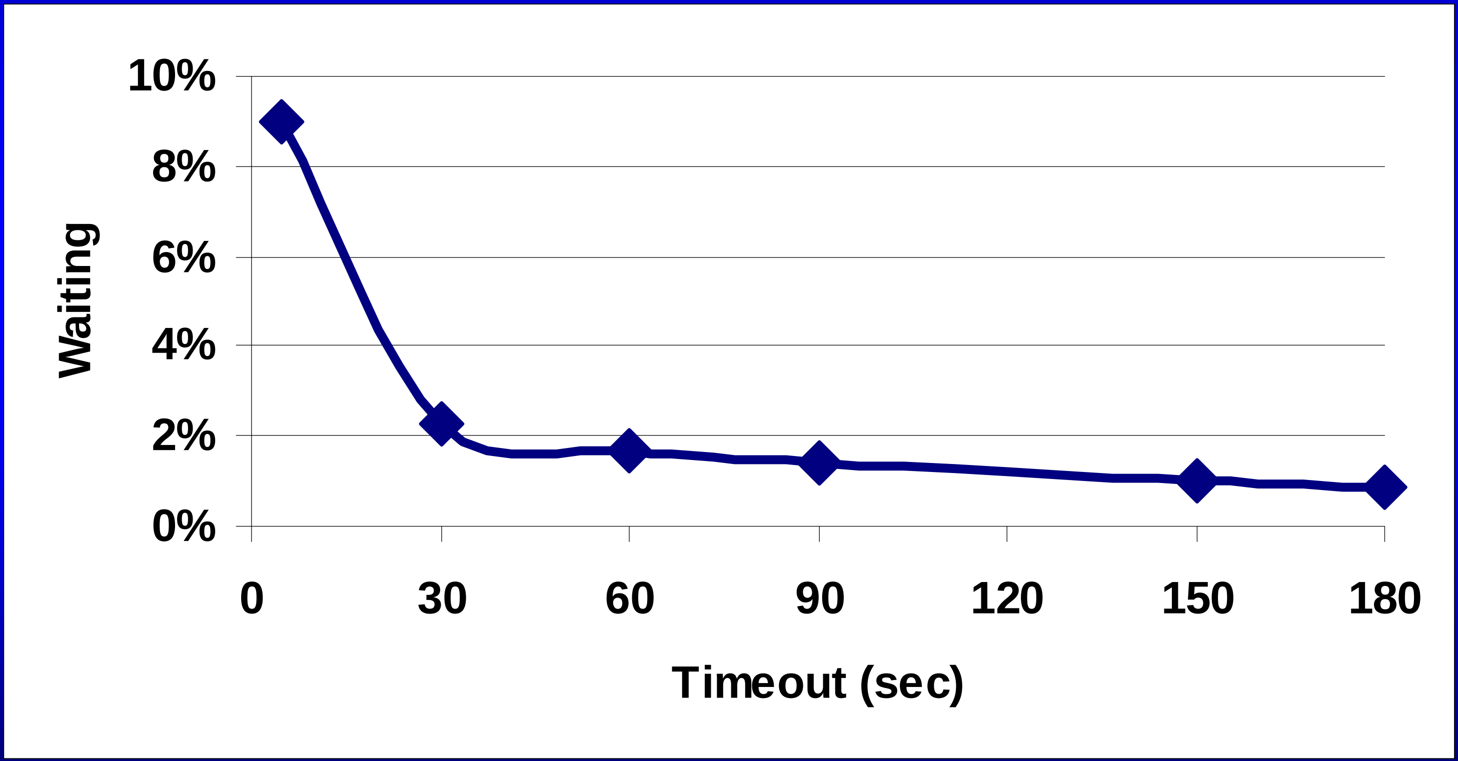


Adaptive timeout [Lu GLSVLSI 99]: 1.60 W

shutdowns



% Waiting for Spinning Up



Conclusion

- DPM is a HW/SW collaborative approach for reducing power.
- We built a software architecture that
  - is portable
  - facilitates DPM algorithm evaluation
  - runs realistic workloads

Acknowledgements

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