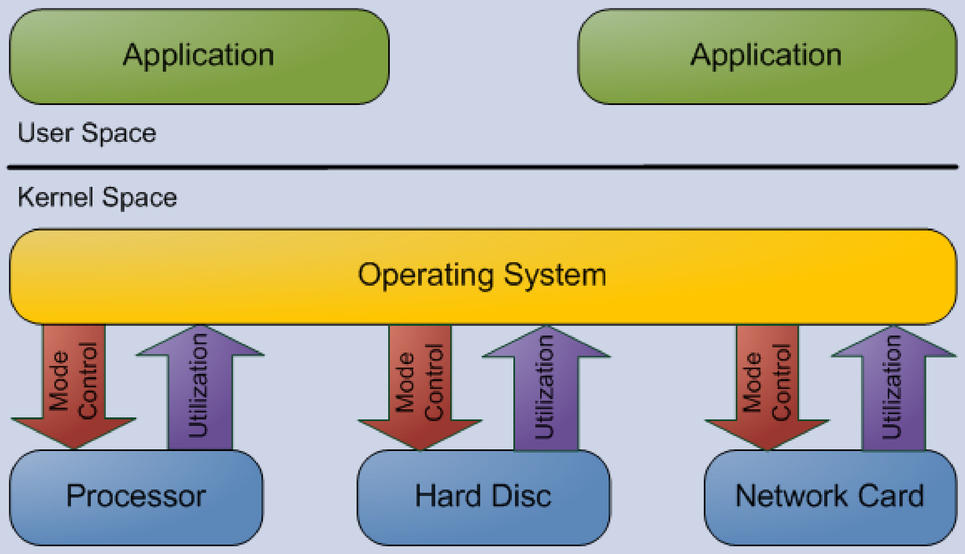
# Energy Efficient Cluster Computing

## Motivation

- Energy costs of HPC systems are of growing importance
- Existing power saving technologies largely unused in HPC
- Intelligent use of existing technologies has the potential to significantly reduce power consumption while retaining performance

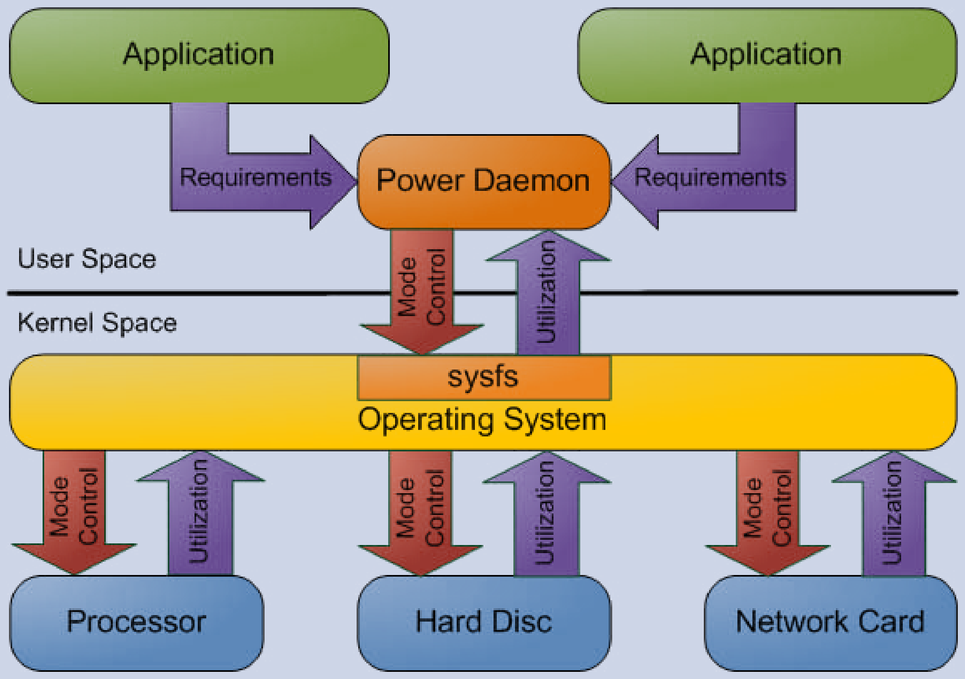
## Current Paradigm in HPC

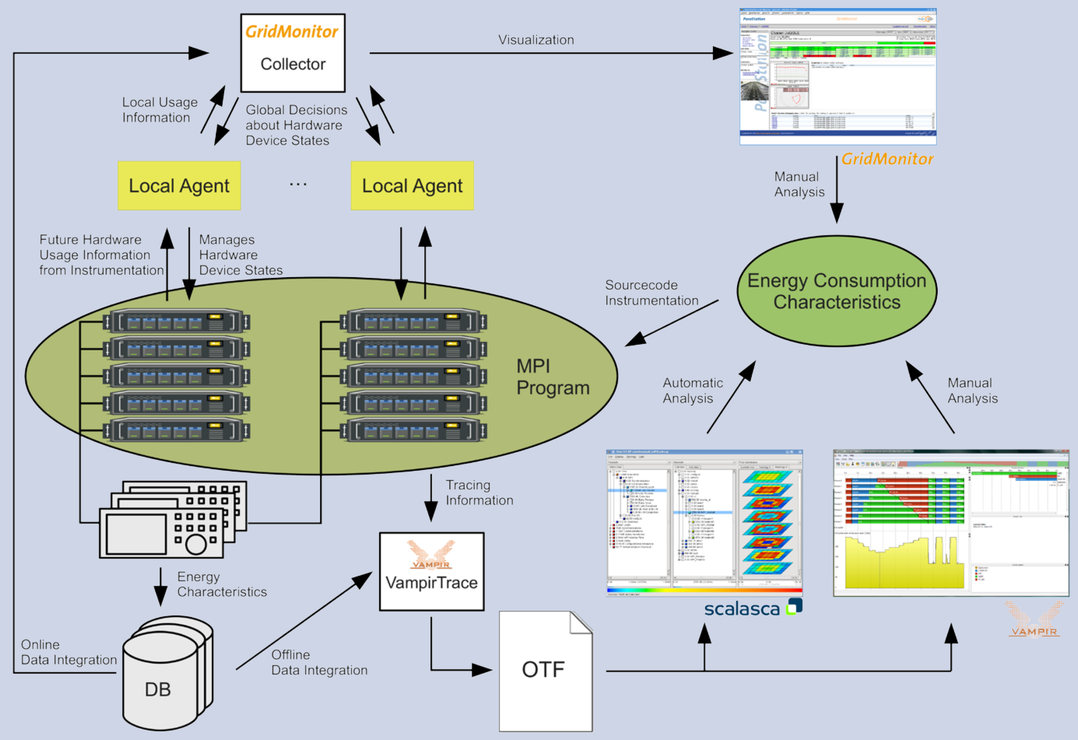
- Systems optimized for performance and reliability
  - Limited use of low power states of devices
- State changes (if any) based on simple heuristics
  - E.g. switch to higher performance level if utilization is above a certain threshold
  - Not tailored to applications' future requirements
  - Applications can not directly influence device modes




## Approach

- Improve energy efficiency of clusters by better utilizing available power saving technology
- Operating system provides interfaces to influence power management
  - E.g. sysfs to control power saving technologies
  - Requires root privileges , thus can not be accessed directly by applications
- Knowledge about future requirements of applications can be used to optimize power management
  - Disable unused components without delay
  - Reactivate components early enough




## Goals

- Record energy-related metrics
- Analyze traces to find most energy efficient configuration
  - Increasing clock rates reduces runtime at best inversely proportional, whereas power consumption of CPUs escalates cubically
  - Most energy efficient clock rate is application specific
- System software to control power management
  - Provide standard interface for applications
  - Instrument applications to use power management
- Energy efficiency benchmark
  - Measure workload-related energy consumption of HPC systems
  - Selectively stress components
  - Synthetic and application benchmarks
  - Evaluate energy saving capabilities of HPC systems

## Partners

Universität Hamburg

Center for Information Services & High Performance Computing

PARTEC CLUSTER COMPETENCE CENTER

JÜLICH FORSCHUNGSZENTRUM

DKRZ DEUTSCHES KLIMARECHENZENTRUM

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