EnerG

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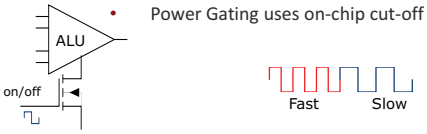
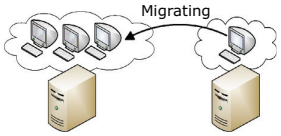
Energy Saving Support of Hardware

- Dynamic adaptation of clock speed and CPU voltage
  - SpeedStep and Demand-Based Switching (Intel)
  - Cool'nQuiet and PowerNow (AMD)
- Unused functional units are switched off
  - ACPI: unused components (e.g. Hard drive, RAM,...) are shut down
  - Power Gating uses on-chip cut-off circuits



Energy Saving Support of Software

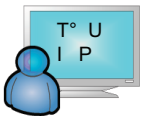
- Virtualization allows energy saving
- Effects of VM live migration
  - Server consolidation
  - Idle servers are shut down
  - More effective use of hardware resources
  - Virtualization reduces real network traffic



Problems Related To Migration

- When migrating VMs network domains change
  - Applications have to cope with migrated services
  - Eventually whole networks have to be virtualized (tunneling techniques)

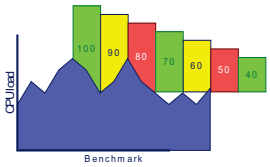
- Requirements for future network protocols
  - Future protocols support virtualization
  - Transparency towards migration



- Monitoring is closely related to migration:
  - Monitor systems must consider virtualization
  - Decisions for migration are based on the correctness of the monitoring data

Optimization Of Energy Consumption

- Modeling energy consumption
  - Collecting empirical data with benchmarks
  - Measuring dynamic and static parameters
- Minimum principle is applied
  - For a fixed output the input is minimized
  - Achieving a defined goal (e.g. QoS) with a minimum of resources



- Energy optimization and migration are based on model dependant decisions
  - Reliability and performance of HW components are described by the models
  - Statistical inference between server load and energy consumption
  - Prediction and tendency how the server load will change in the near future
  - Services are categorized in energy classes
  - Most optimal services are chosen based on the energy requirements

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