

A Virtualized Energy-Efficient Office Environment

e-Energy 2010

13. April, Passau, Germany

Andreas Berl and Hermann de Meer



Office Hosts are often turned on – without being physically accessed

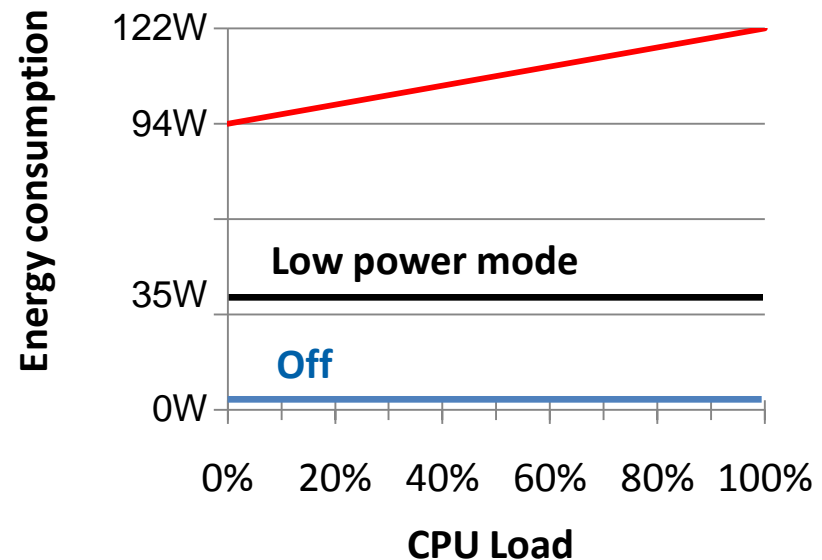
- “Forgot to turn off”
- Overnight jobs (Backups, security-updates, downloads)
- Remote access from home or the customers office (e.g., RDP)
 - Working environment (Cursor at the same place as before)
 - Applications (mail, office, specific work applications)
 - Data on host or network (documents, addresses)



- Webber et. al (investigated 16 office sites in the USA)
 - 64% of office hosts were running during nights
 - Only 4% of office hosts had switched to a low power mode

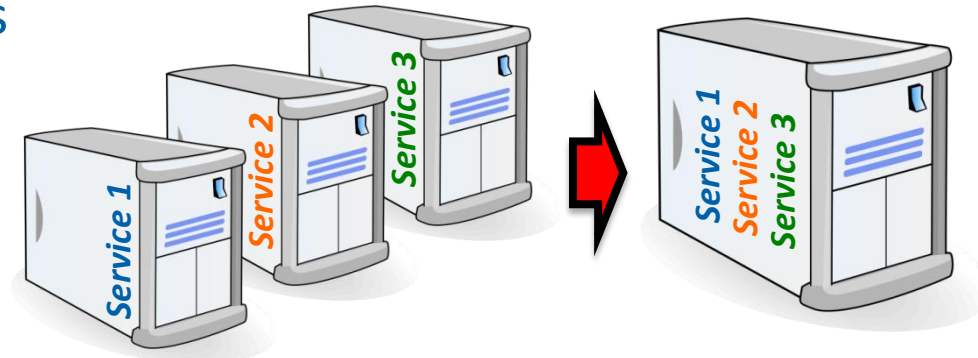
Office hosts typically consume a considerable amount of energy

- When they are idle
- When they are underutilized
 - Word processing, mail writing



Exploiting saving potentials in office environments

1. Prevent idle hosts from consuming energy
(Power management solutions, e.g., FaronicsCore, KBOX)
 - Hibernating idle hosts
 - Switching them on again (e.g., for remote usage)
2. Reduce energy consumption of underutilized hosts
 - Consolidation of services as done in data centres



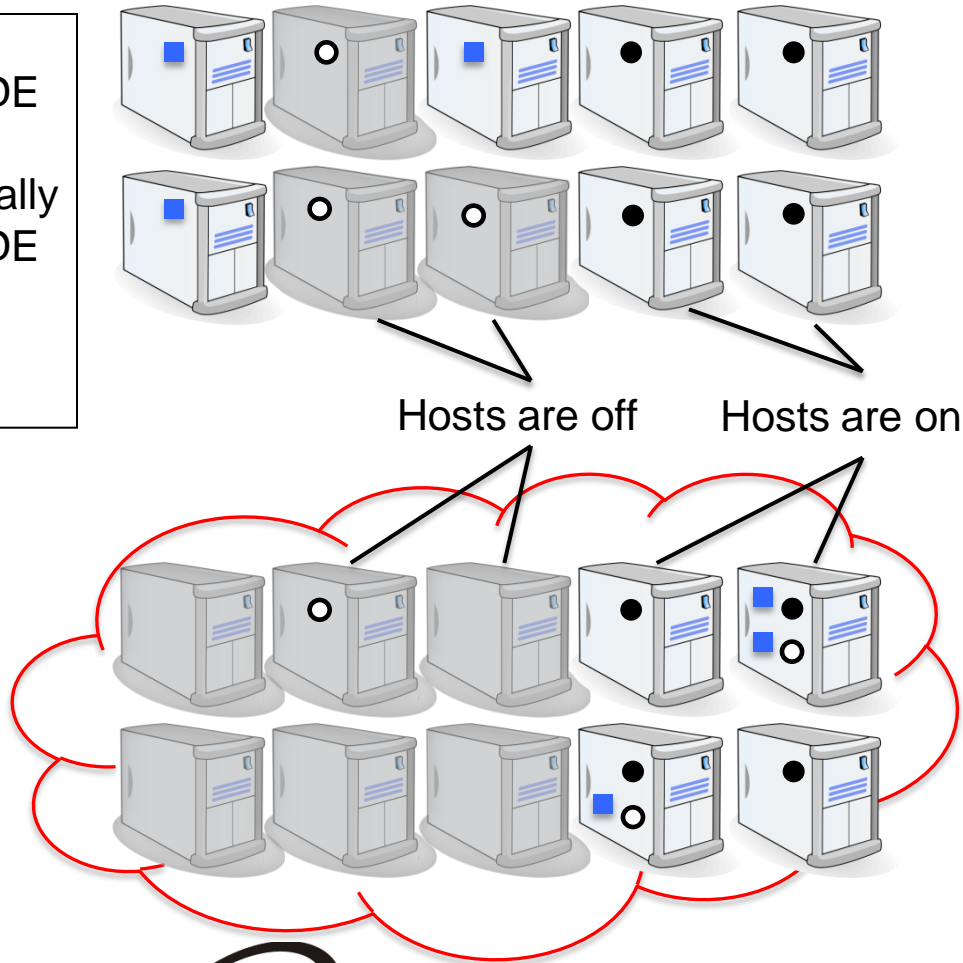
- **What** kind of service can be consolidated in offices?
 - The user's **Personal Desktop Environment (PDE)**
 - Operating system
 - Applications
 - Personal data
 - Personal configuration

- **When** can a PDE be migrated?
 - Running and not being used locally
 - Jobs without user interaction
 - Remote usage
 - Low power mode doesn't work



A Managed Office Environment

- Locally used PDE
- Non-locally used PDE
- Paused PDE



- Unmanaged office environment
 - PDE is bound to host (PDE on → host on)
- Managed office environment
 - PDE becomes partly independent from host

- Autonomic management of hosts and PDEs **without** interrupting the daily work of users
 - The mapping of PDEs to hosts needs to be
 1. Valid
 - Each user finds its PDE located as required
 - No host is overloaded with PDEs
 2. Host optimal
 - The mapping utilizes the least possible number of hosts
 3. Migration minimal
 - Migrations are costly (energy and quality-of-service)



- **System virtualization** similar to data centres
 - + Provides execution environment for PDEs
 - + Hypervisor is able to suspend/resume/migrate PDEs
 - Office environment is not a data centre
 - No high performance network/servers
 - Users interact with hosts
 - PDEs have to be migrated completely (OS, memory, and user data)

- **Peer-to-peer overlays** similar to file sharing networks
 - + Addressing and mediation of idle resources and PDEs
 - + Management of hosts and PDEs

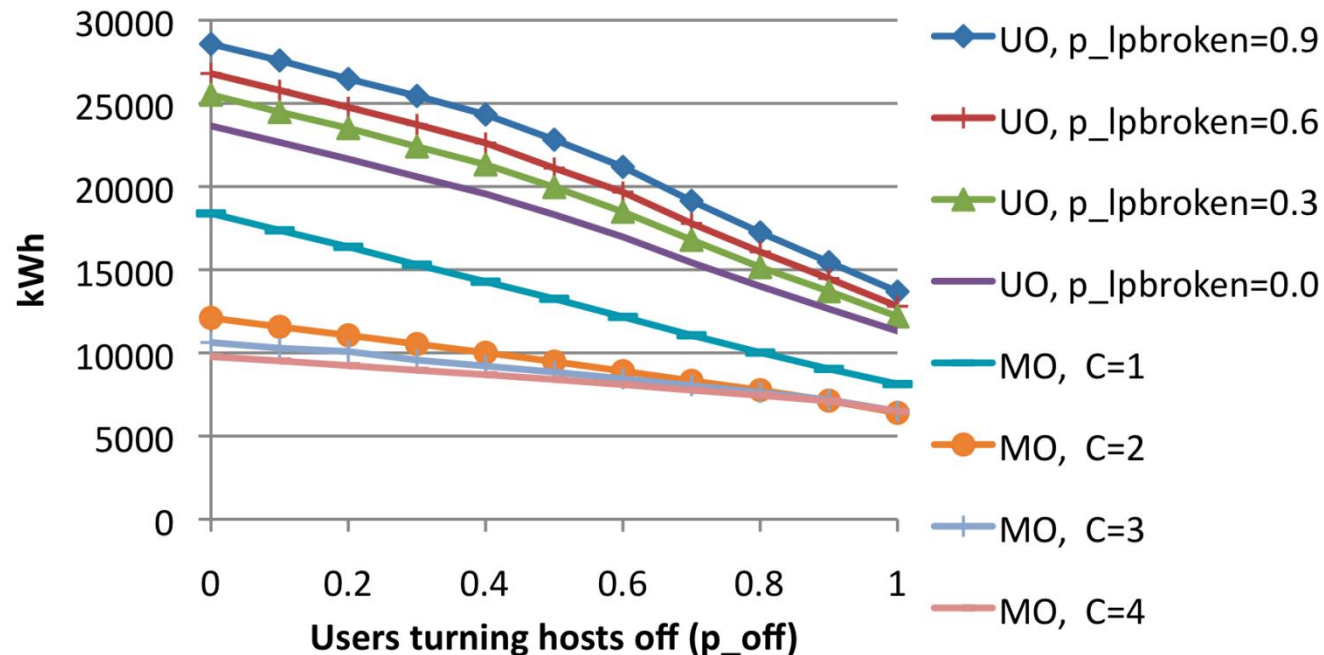


- Office energy consumption model (discrete event simulation)
 - Unmanaged office vs. managed office (identical user behavior)
 - 200 users (and hosts), 12 months
 - Days, nights, weekdays, weekends (no holidays or vacation)
 - Energy consumption of hosts only is evaluated
 - Network (Fast Ethernet) overhead not considered yet
 - Host consumption: On=72W, off=2W, low power mode=36W
 - No peer-to-peer network but server based solution
 - A simple heuristic is used to manage the office environment
 - Two dimensional optimization problem
 - Highly dynamic system



- Office energy consumption with a mean of 25% remote users
 - C=1 represents a pure management solution without consolidation
 - C=2 consolidates 2 PDEs on a single host

- PDE is moved/
hibernated
after being
idle/unused for
45 minutes



- Available technologies can be adapted to virtualize offices
 - System virtualization
 - Peer-to-peer overlay
- Significant energy savings possible
 - With minor interference with day to day work of users
 - Scales with small office environments
- Open issues and next steps
 - Modeling the office's energy consumption in more detail
 - Modeling and evaluation of the peer-to-peer overlay
 - Resilience and security issues
 - E.g., dying hosts or access to copies of PDEs

