MANAGEMENT OF INFORMATION SYSTEMS

BME VIK TMIT

SOFTWARE ENGINEERING, BSC

MANAGEMENT OF INFORMATION SYSTEMS

4. SERVERS, DESKTOPS

PART I

SERVERS

ELEMENTS OF THE INFRASTRUCTURE

- User terminals
  - Desktop Computer
  - Personal Computer (laptop)
  - PDA, smartphone, etc.
- Server
- Network (operational and maintenance)
- Storage

- The user terminals, the servers, and their network are complex, computer systems, constituting several units: Information systems

TYPICAL PRODUCT FAMILIES

- Most typically a computer vendor has 3 different product families:
  - home,
  - business,
  - server

HOME PRODUCT FAMILY

- Characteristics of a home product family:
  - absolute cheapest starting price
  - expensive upgrades, accessories
  - characteristics are given in general terms
    - e.g.: video resolution rather than video card type
  - suppliers are changed frequently, so the are not „two same"
  - flexible „gaming features": joystick, high performance graphic, audio

BUSINESS PRODUCT FAMILY

- Characteristics of a business product family:
  - Minimizing the whole „life-cost" (more expensive start price, but longer lifetime)
  - Less frequent changes:
    - Changes are expensive for companies:
      - to store spare parts to a lot of (sub)types
      - to train the support/sales personal

Server Product Family

- Characteristics of a server product family:
  - Different architecture (to have „longer life": lot of free capacity, easy-to-upgrade, easy-to-expand)
  - Minimal cost comparing to performance
  - Easy to maintain, upgrade; robust, minimal maintenance time
  - Location of connections, controllers, buttons:
    - Front and rear, but not at the sides
    - Rackmount
  - Reliability is the key design option

HARDWARE CHARACTERISTICS OF SERVERS

- More internal space for (future) extensions:
  - for cards, CPU-s, drives, etc.
- Larger CPU performance: more CPUs or one very fast and powerful CPU (but frequently I/O bound!)
- High performance I/O: typically servers perform much more I/O activities than the clients (prop. to # of clients)
  - Fast I/O subsystem,
  - Fast internal buses,
  - Fast network interfaces,
  - RAID technology
- More upgrade options
  - designed for growth – easy to add/replace CPU, memory...
- Rack mountable design
  - No side-access needs (connectors only at front and rear)

SERVERS - DEFINITION

- ***Server:*** in computer science & information systems terminology a server is a (typically heavy duty) computer or software that provides access to

  - stored or provided ***data*** for other devices,

  - ***hardware resources*** (e.g. printer, back-up storages, processors)

  - different ***services***

SERVER APPLIANCES

- A Server Appliance is a device that is suitable for one, dedicated service
- E.g.:
  - File server
  - Web-server
  - (E-)mail server
  - DNS server

CLASSIFICATION OF SERVERS

- According to functionality, e.g.
  - Web-servers,
  - FTP-servers,
  - Database-servers
- According to the served area, e.g.
  - Internet servers,
  - Intranet servers;
- According to power, capacity

SERVERS

SERVER RACKS

- Rackmount servers
  - RU (rack unit) or U
    - 1.75 inch high
    - 19 (or 23) inch wide
      - Full-rack (Full-wide) / Half-rack (Half-wide) servers
  - Servers typically 2U or 4U
    - For virtualization larger performance required -> larger space
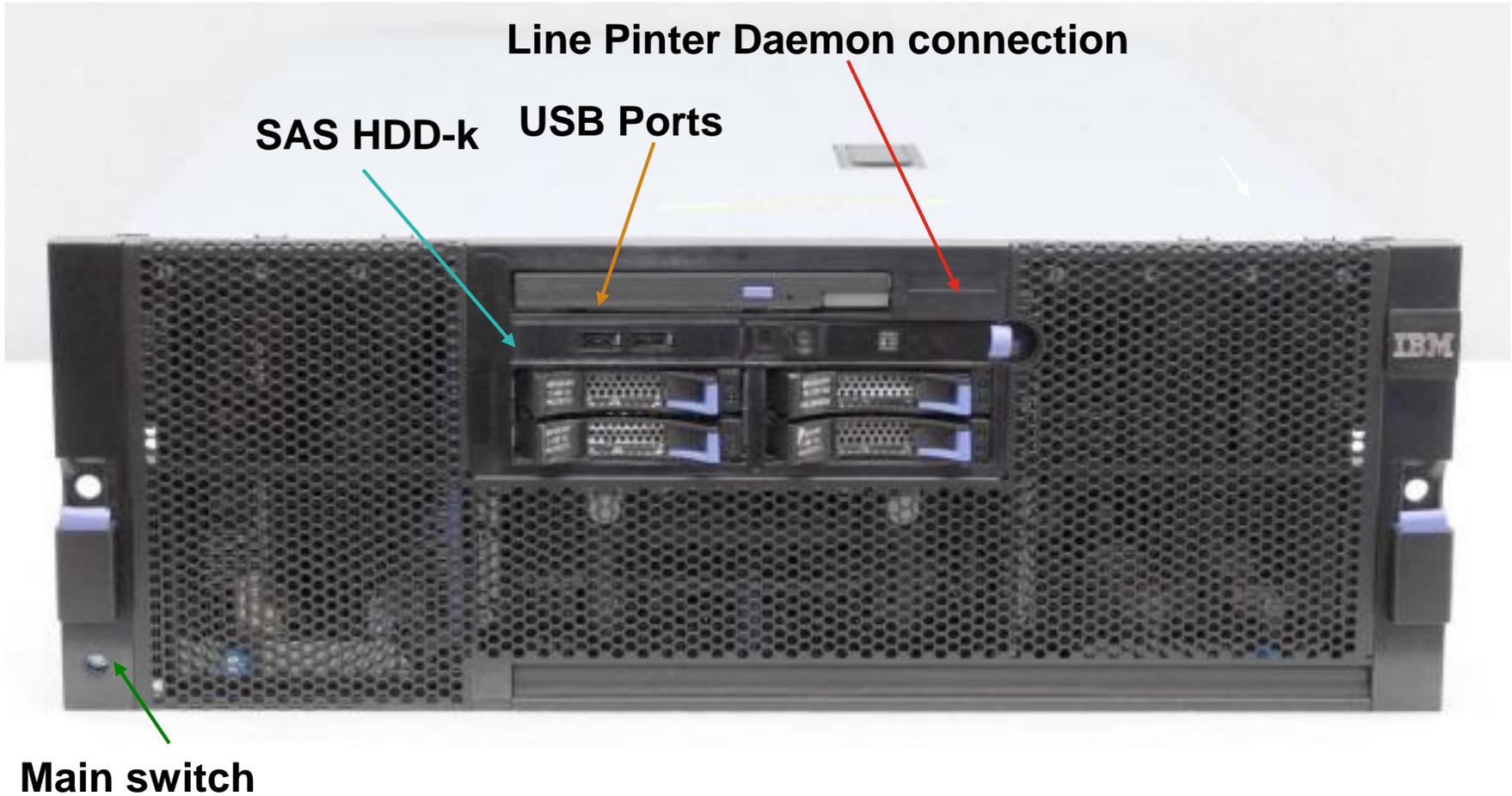
1U, 2U, 4U Servers

Server rack front

Server rack rear

User terminal
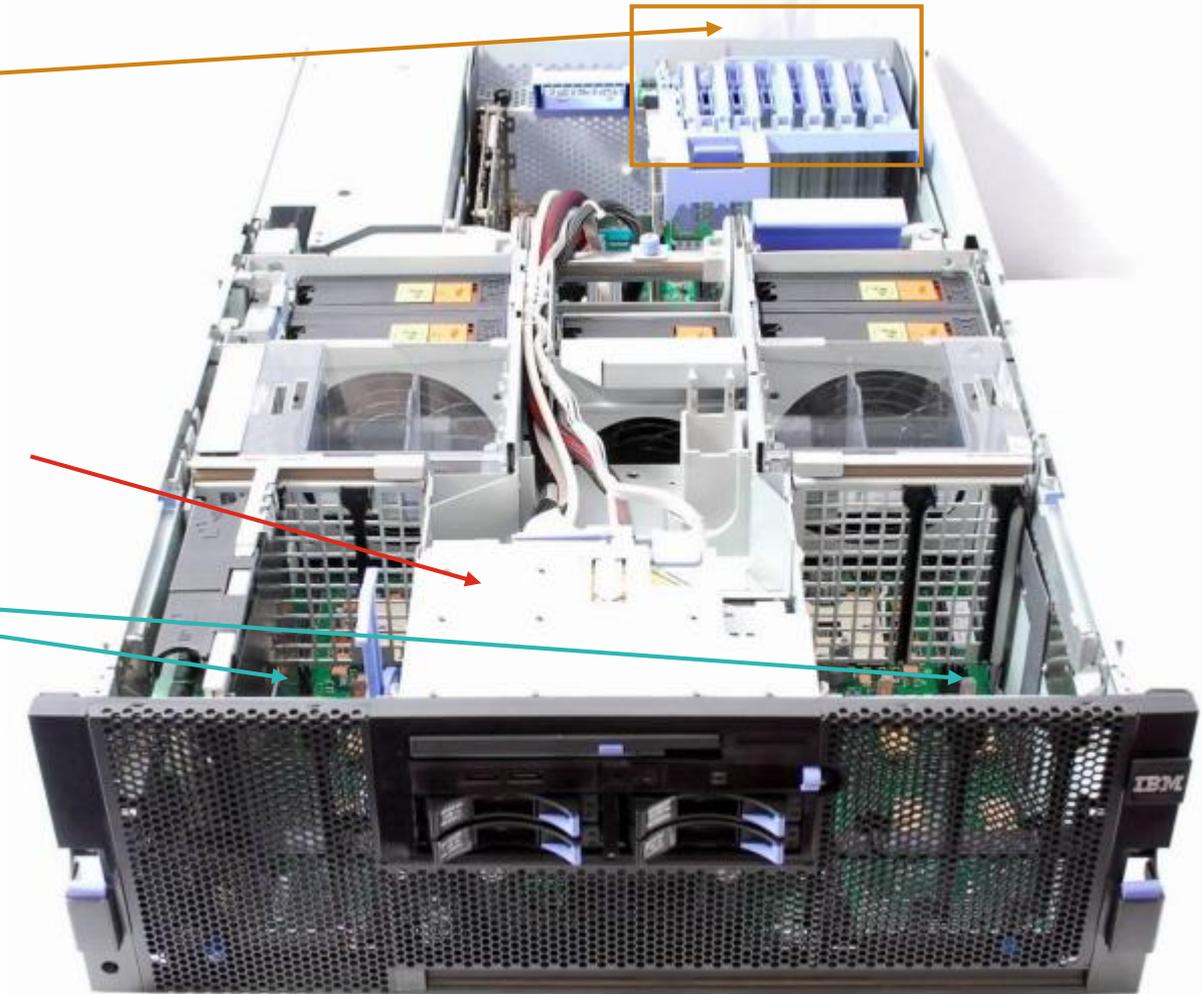
FRONT PANEL

Line Pinter Daemon connection

SAS HDD-k   **USB Ports**

Main switch

INTERNAL VIEW

PCI Slots

Media HDD slot

CPU Board

CENTERFOLD
MEDIA HDD SLOT

Media HDD slot
• **4 - 2.5" HS SAS HDD**
• **Front panel USB slots**

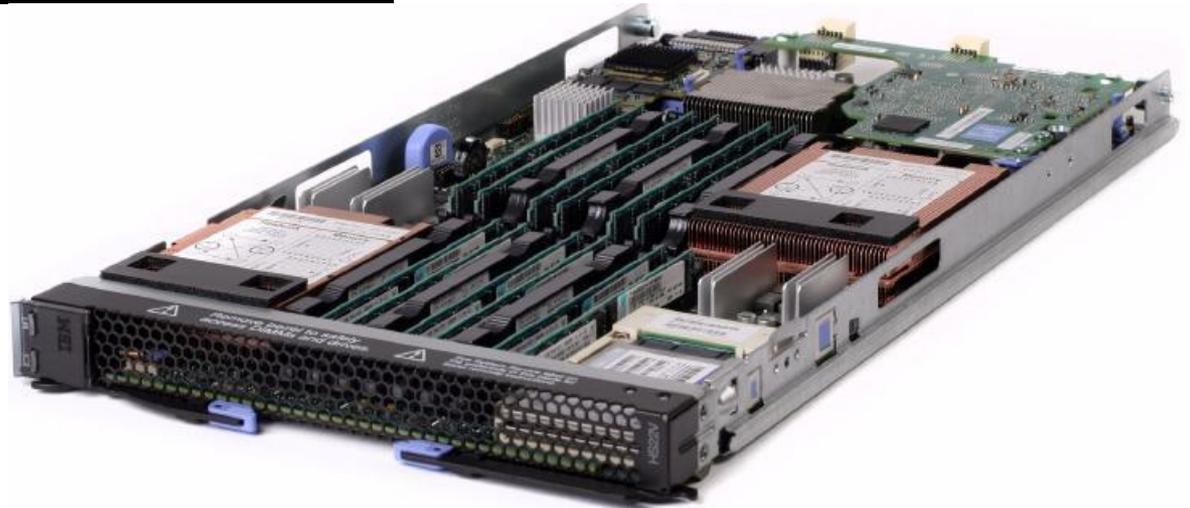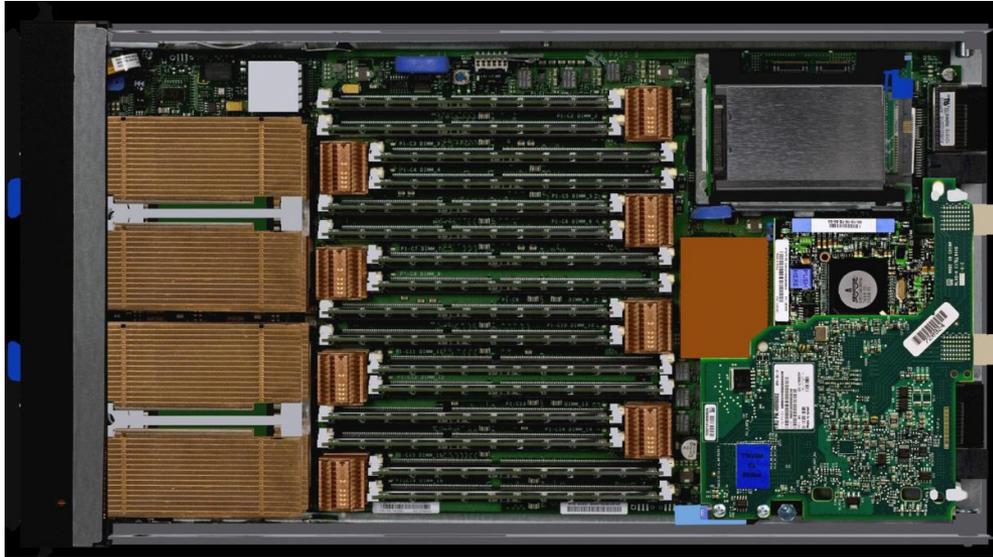**Fans**

CPU card
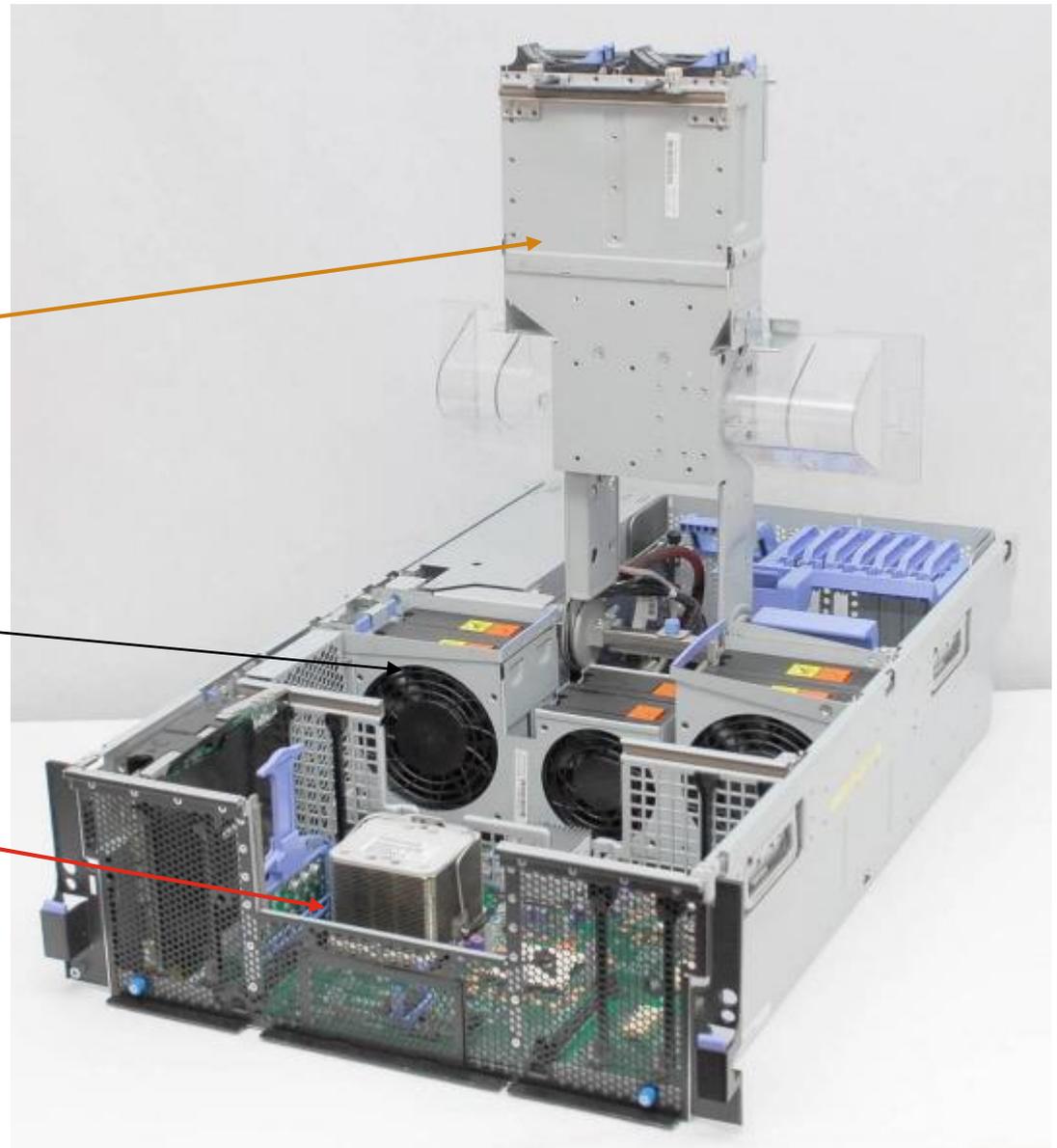
MEMORY CARD
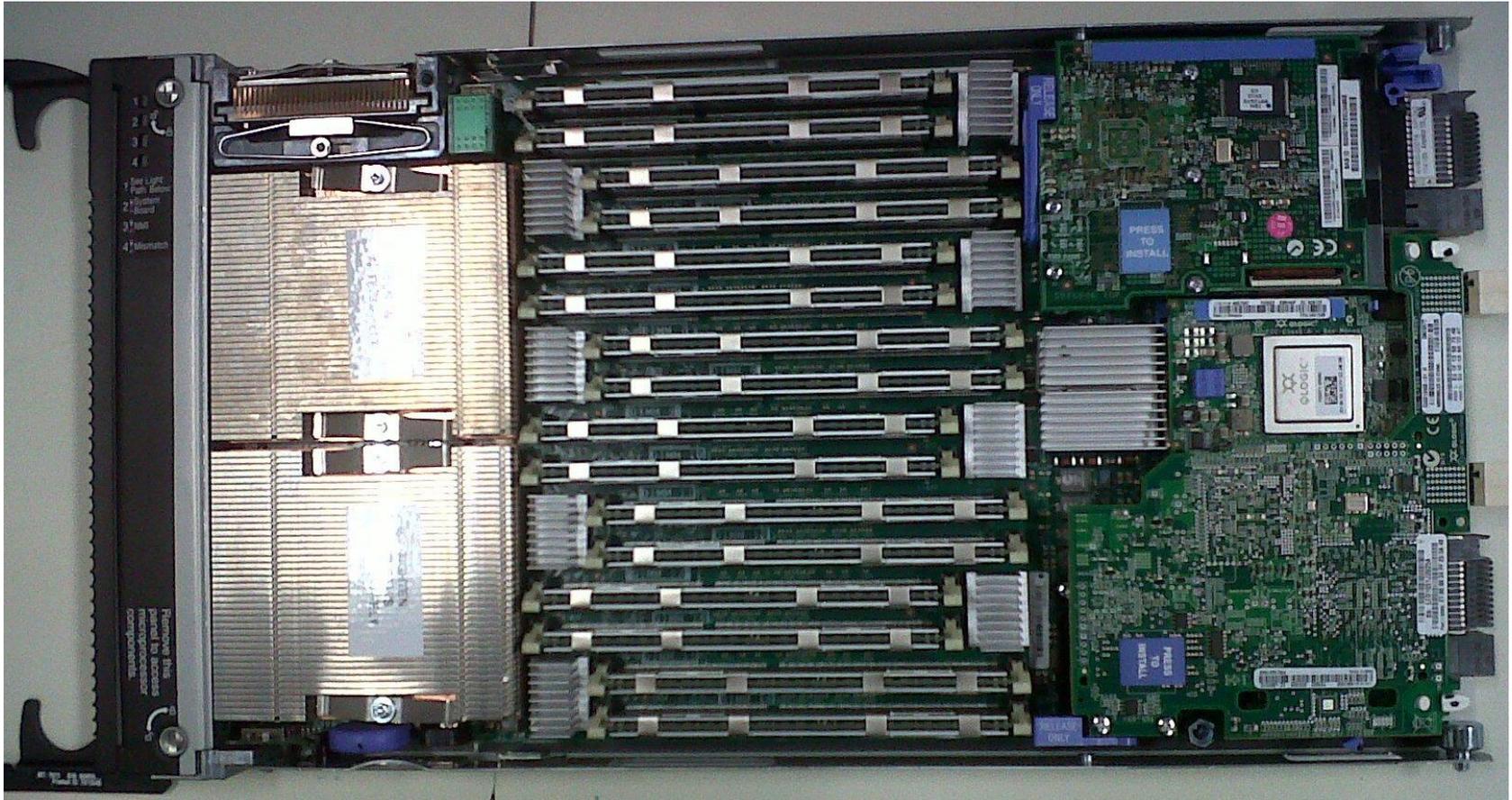
BLADE SERVERS

- Stripped-down computer
- Optimized for minimal energy consumption
- Utilize the space in a data center as efficiently as possible
  - Server density can be ~6 times higher
- How can it be achieved?
  - Only the core components
    - CPU, memory, integrated NW controller
    - Optionally Fiber Channel Host Bus Adaptor (HBA)
  - Rest --???

BLADE SERVERS

BLADE SERVER

BLADE CHASSIS

- Blade server cannot be used on its own
  - -> blade chassis
- Consolidation of
  - Power supply
    - But: multiple power cords (high power requirements)
  - Cooling
  - Disks (in blades no or even just a few -> SAN)
    - Bootable from SAN (Storage Area Network – dedicated network for fast data access – see later)
  - Network connectivity
  - User interface ports
    - Keyboard, video, mouse, DVD

BLADE SERVER CHASSIS – FRONT

BLADE SERVER CHASSIS – REAR
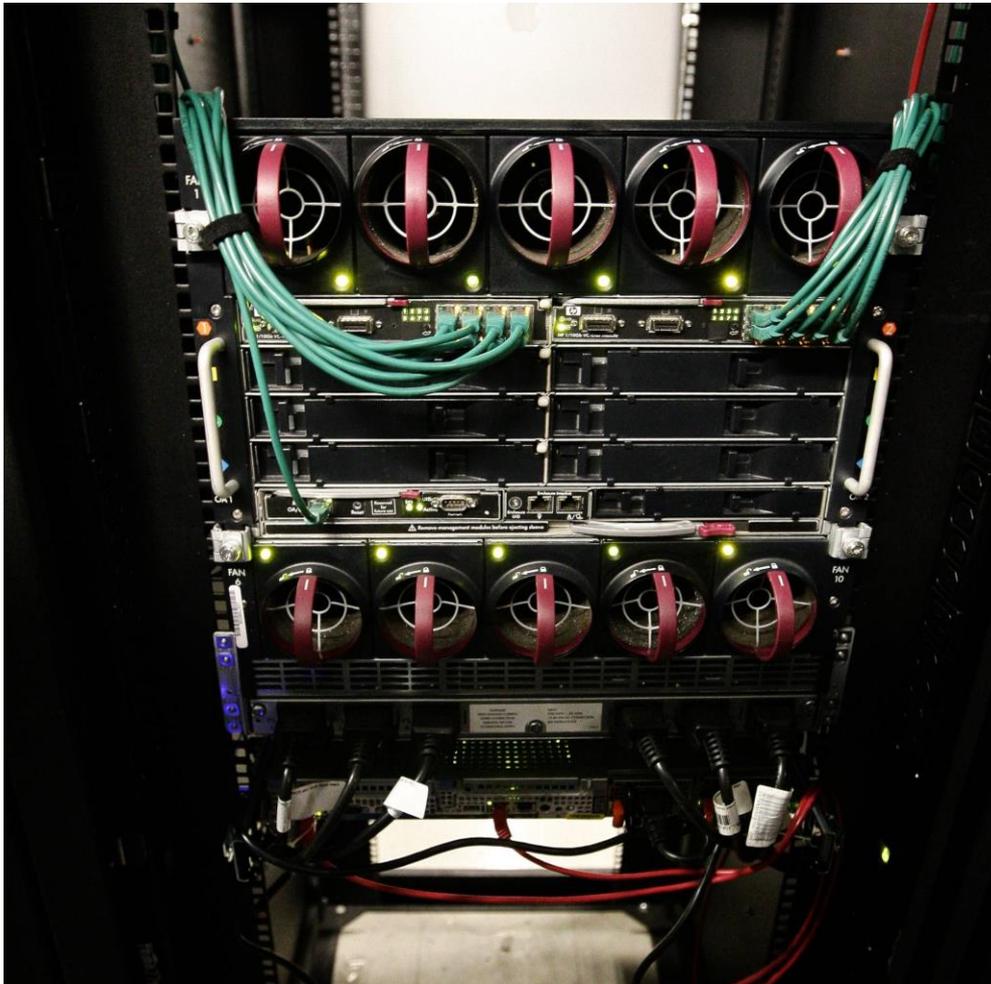
BLADE SERVER CHASSIS – EMPTY

BLADE SERVER CHASSIS – MIDPLANE

- Redundant interconnections among blades

- Switch

- Media IF

- Management (load sharing)

- Redundant power distribution

BLADE SERVER

Half-wide and full-wide blades

BLADE SERVER – TERMINOLOGY

- Server blade
  - One server
- Blade server
  - Synonym of Server blade
  - Chassis with server blades
    - Blade (Server) System

BLADE SERVERS

- Why to use them?
  - Smaller space (~ 1/6 – 1/10)
    - Smaller room
    - Fewer racks
    - Shorter cables (up to 85% reduction)
  - Smaller power consumption (25-50%)
    - -> Reduced cooling costs
    - But…
  - Large computation power
  - High processor/core density

BLADE SERVERS

- But…
  - Disadvantages
    - A blade server is cheaper, but the chassis is expensive
    - It is worth if it is full (14-16 or more)
      - Not good for small companies
      - Not well scalable
    - Chassis is not standardized
      - Only one company
      - Or even only one type (!)

BLADE SERVERS

– Cooling
  - Though less power (heat), but power/heat *density* is high
  - More efficient, special cooling system
  - Traditional case:
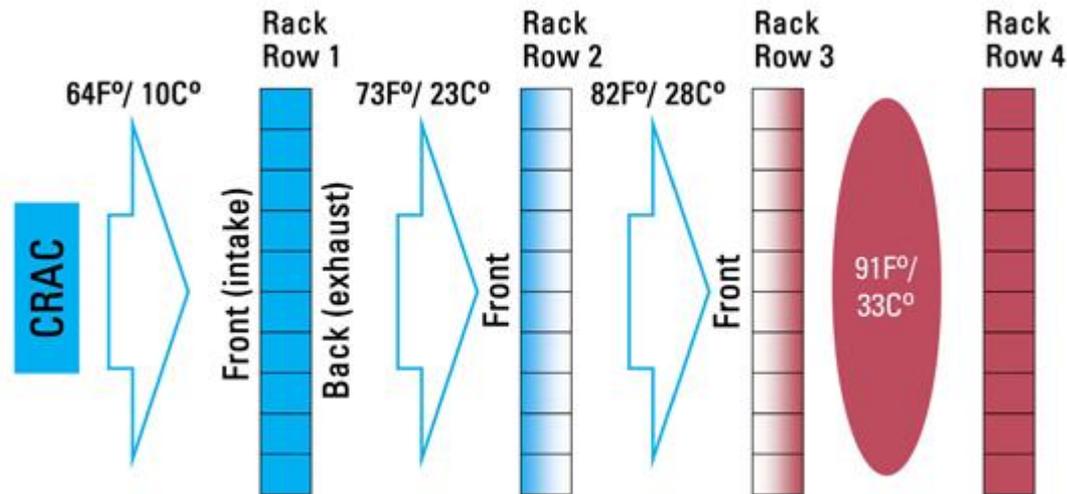
HOT ROW / COLD ROW LAYOUT

- Fronts of the server(rack)s face each other
- Raising the floor ~50cm
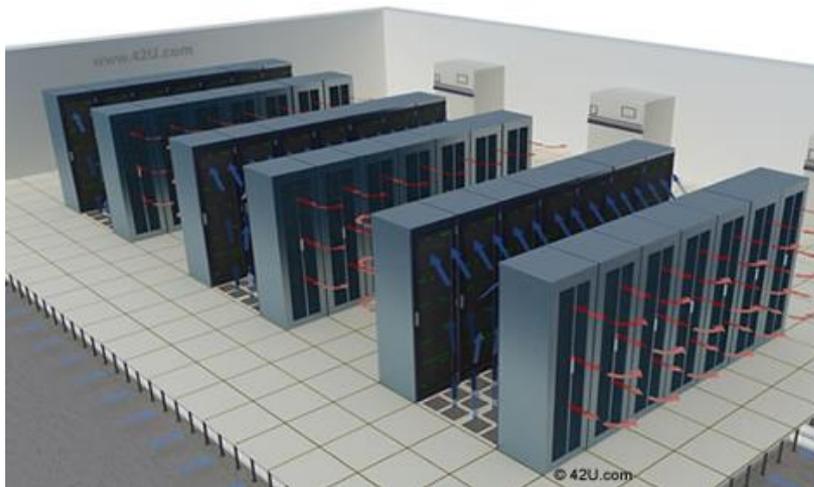
HOT ROW / COLD ROW LAYOUT

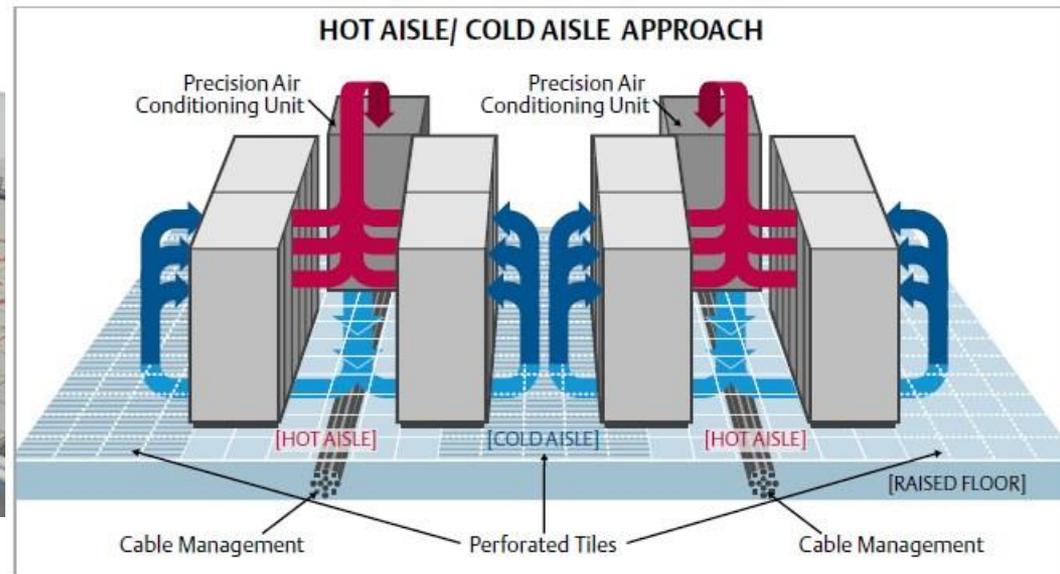# BLADE SERVERS

– Memory
- Smaller than in 'regular' servers, but in nowaday's models acceptable
- But not extendable, because of lack of space

– Disks
- Typically no or very limited disk space
  - 1-2 disks
  - Mainly for the operating system, not to store (large amount of) data
- Disk/Storage modules in chassis
  - Consumes (lot of) space
  - Often it is still not enough
  - SAN – Fibre Channel cards
  - Typically do not support hot-swappable disks
- When is it a big problem???

ADVANTAGES

- More computation power on less space

- Management
  - Failover/load balancing
    - designed for this
  - Self-diagnosis – replace

- Easy set-up
  - Power, network, cabling – already in chassis
    - You do not have to connect each server separately to power, net (Ethernet, SAN, management NW), display, keyboard, mouse

  - Just plug-in into the chassis

DISADVANTAGES

- ## Special climate control
- ## Costs
  - ### Server + chassis
    - Not well scalable
  - ### Special initial configuration, special training, special administration
  - ### Not compatible, vendor-specific solutions
    - Vendor lock
- ## Devaluation
  - ### Cannot be upgraded
  - ### Not standardised, new server not compatible with old chassis

What can they be used for?

- Tasks for high computing but less storage requirements
  - E-mail, web servers
  - SSL encrypting of Web communication
  - Infrastructure applications such as DNS
  - Streaming audio and video content
  - Database control
  - Virtualization, virtual machines – memory!!!
  - Distributed computing
  - Server clusters
    - See later in Data Centers chapter

HOMOGENEOUS / HETEROGENEOUS SYSTEMS

- Servers can be
  - Homogeneous (from same vendor/from same type, family)
  - Heterogeneous (from different vendors/from different product families).

- Advantages of homogeneous systems:
  - Easier education
  - Easier maintenance
  - Easier repairing (one set of spares)

- Advantages of heterogeneous systems :
  - Most appropriate equipment can be chosen for all tasks
  - Can not stuck when something happens (bankrupt) to the vendor
    - Competition between vendors result in smaller price

RELIABILITY OF SERVERS

- More users depend on them – reliability is the key
- Minimal repairing time
  - Different architecture – „longer life"
  - Free capacity
  - Duplications
- Maintenance agreement
- Disk back-up
- Location in a safe place (data center)

Location of Servers

- ## Must be protected against
  - Damage by disaster
  - Electromagnetic influence
  - Damage by human

- ## Must be located in a safe place
  - UPS – Uninterruptible Power Supply
    - Diesel generator / Batteries
  - HVAC - heating, ventilating and air conditioning
  - Fire protection
  - Physical protection (physical harm, unauthorized access)

- Data centers -> see later in details

UNINTERRUPTIBLE POWER SUPPLY (UPS)

- Fire alarm sensor

FIRE-EXTINGUISHER

Fire-safe door
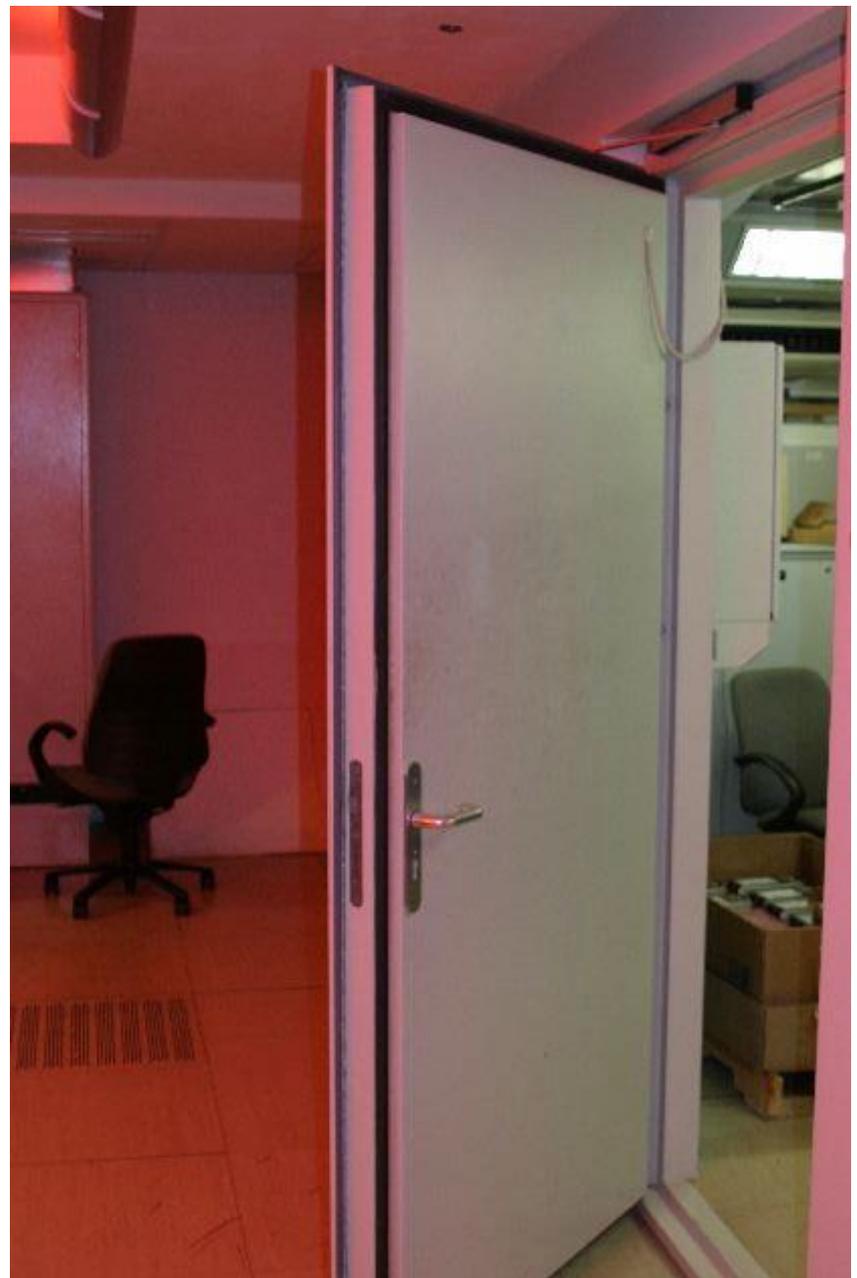
Air Conditioning is essential ☺

- How large part of the energy do you think is used for useful CPU calculations?

POWER SUPPLY OF A TYPICAL DATA CENTER

Data Centre

IT Load

55% **45%**

Batteries, power supply, air conditioning

Data source: *Creating Energy-Efficient Data Centres, , U.S. Department of Energy , Data Centre Facilities and Engineering Conference , May 18, 2007*

POWER SUPPLY OF A TYPICAL DATA CENTER

Data Centre

Server hardware

IT Load

Processor

55% **45%**

70% **30%**

Batteries, power supply, air conditioning

Power, Memory, Fans, HDD . . .

POWER SUPPLY OF A TYPICAL DATA CENTER

Data Centre

IT Load

55% **45%**
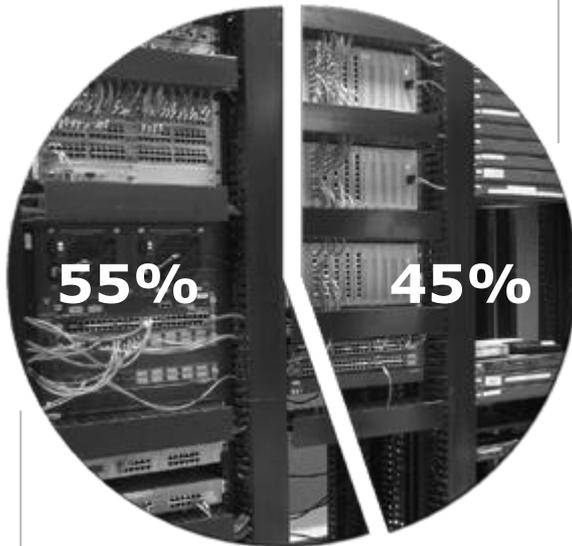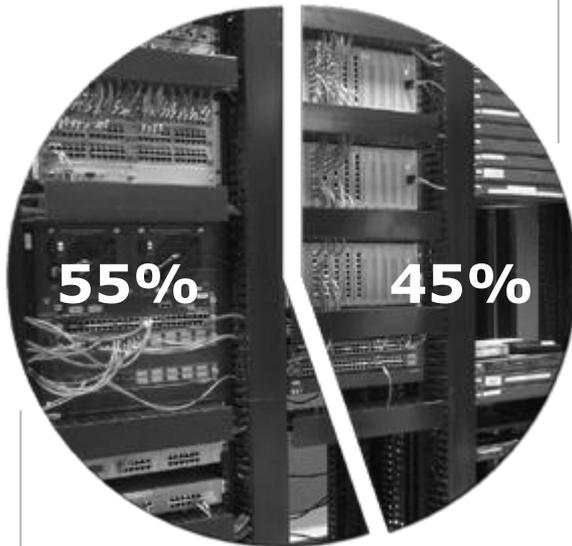
Batteries, power supply, air conditioning

Server hardware

Processor

70% **30%**
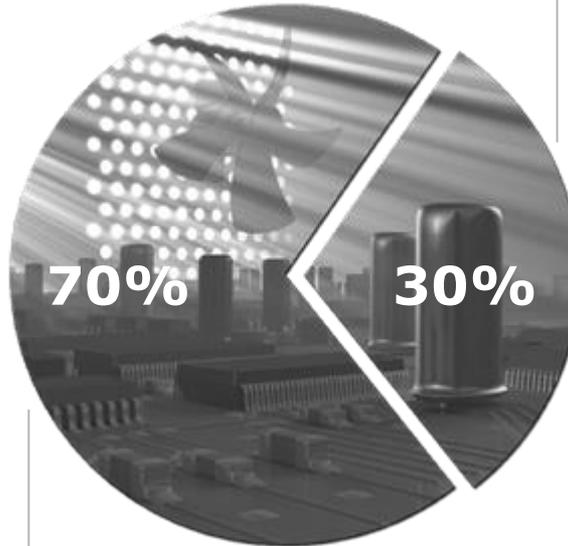
Power, Memory, Fans, HDD . . .

Server loads

Active

80% **20%**
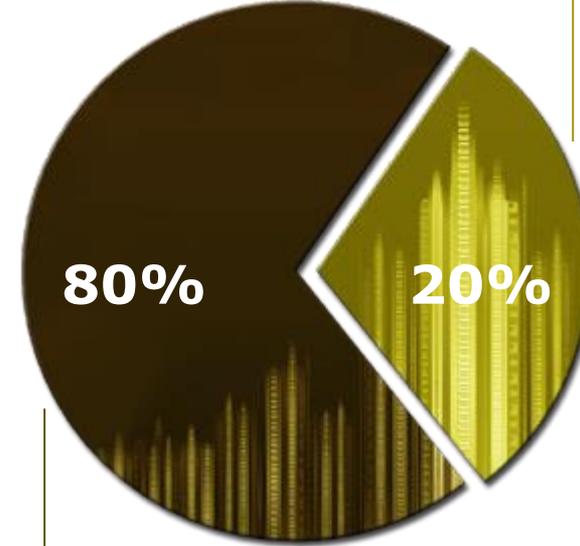
Passive

REAL VIEW OF THE POWER CONSUMPTION OF A DATA CENTER

Data Centre

HVAC, UPS 55%

IT power 45%

Servers - hardware

AC/DC losses; 25%

Fans; 9%

DC/DC losses; 10%

Processor 30%

Standby; 2%

Drives; 6%

PCI; 3%

Planar; 4%

Memory; 11%

Server load

Typical Utilization	
Mainframe	80 – 90%
Unix	10 – 20%
Wintel	5 – 12%

Resource utilisation 20% = 2,7% of total

idle 80%

< 5%
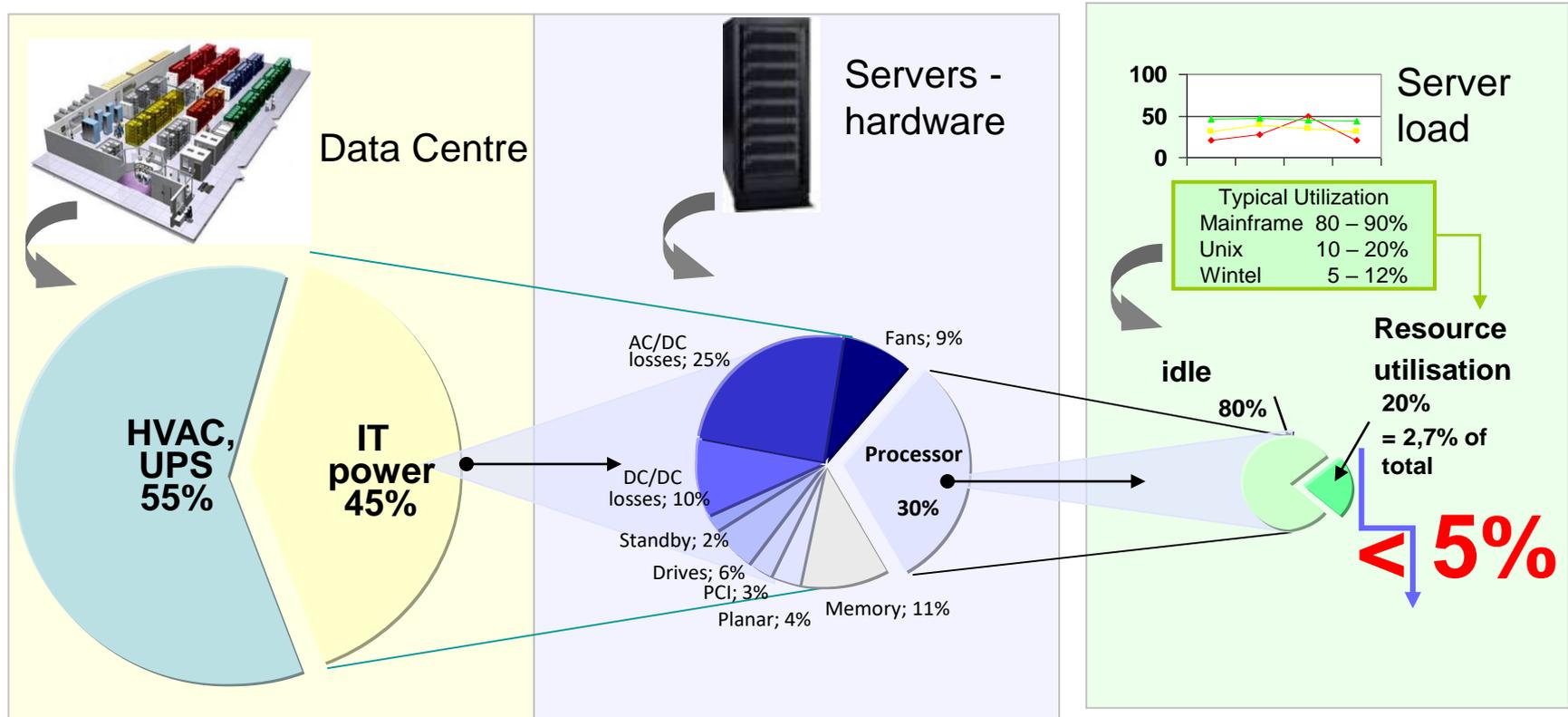
27 W Data Centre — X1,7 — 16 W equiv IT power — x3 — 5 W equiv processor — x5 — +1 W equiv. used resource

DATA CENTERS

- Own site
- Server hotels
- Server service
- Outsourcing
  - Advantages
    - More economic, specific competence
  - Disadvantage
    - Vulnerability
- Later in details

FINAL LOCATION OF SERVERS

- Recommendable to locate the servers into final place *before* operating system, etc. is installed
- To the contrary :
  - machine remains in a labor for a certain period, where no UPS, HVAC, not safe – this itself may cause outage in service,
  - no protection, if the machine is in the lab, additional programs can be installed on them (even by unauthorized persons)
  - while it is moved to its final place FOR SURE out-of-service!

DATA BACK-UP

- Data stored on servers are backed up
  - In case of failure to restore the data (to a not too old state)
  - Archivation
- Later on discussed in full details

OPERATING SYSTEMS

- The operating systems of the servers and desktops can be
  - Different
    - E.g.: in a case of a web-server the operating system of the server and the client may be different, only the communication protocol must be the same
  - Same (exactly, or same operating system with different settings)
    - UNIX CPU server

SPECIAL ADMINISTRATIVE NETWORK

- Servers need to be maintained remotely – later in details
- Advisable to maintain a special, administrative network for back-ups and monitoring
- Back-ups require to carry very high amount of data over the network – highly reduce the bandwidth for users
- The special, administrative network: simpler, more fault-tolerant elements
- Unaffected by the outages of the „regular" network
  - Monitoring system less likely product false errors when there is a network problem
  - A tool for the system administrators to reach the machines during such outages

REMOTE ADMINISTRATION ACCESS

- In old days: Separate keyboard + monitor to every server

- Now: console server

- Advantage:

  - Save space

  - All the administration tasks can be done remotely

  - Not in the air-conditioned/protected data center

- Remotely controlled power supplies

REDUNDANCY

- Redundancy of components
  - Disk storage redundancy (RAID) - later
  - Redundant power supply
- Hot-swap/Cold-swap components

FULL AND N+1 REDUNDANCY

- Full redundancy: two complete sets of hardware and some kind of „fail-over" is configured
  - One system works – other idle till failure
    - Switch over: manual or automatic
      - Cold-swap
      - Hot-swap
  - Load sharing – both systems work with half of the total load, but both have enough capacity to cope with the whole load
- n+1 redundancy: one of any particular component can fail, yet the system is still functional
- In case of n>2: n+1 redundancy is cheaper than full
- Often not the whole system is n+1 redundant, only the main parts

HOT-SWAP COMPONENTS

- Normally: parts can be removed and replaced only when the system is powered off
  - Cold-swap
- Hot-swap: ability to substitute a failed component while the system is running
  - but often the replacement can be delayed till the next scheduled maintenance period
  - risk of double failure

HOT-SWAP PROBLEMS

- Which parts are hot-swappable?

  – Some network devices have hot-swappable IF cards, but the CPU is not

- How and how long is service interrupted during the switch over?

- How long can the system operate – or only with degraded capacity?

  – e.g.: hot-swapped disk, while data content re-building on the new

- The device is hot-swappable, but replacement (or system upgrade) requires reset

- So hot-swap parts do not eliminate the outages, they just reduce the (risk/duration of) outage

EXAMPLES FOR REDUNDANCY

- ## Reliability
  - – Disks
  - – Redundant power supply
  - – Redundant cooling
  - – All I/O connections redundant
  - – Doubled switching modules
  - – Redundant buses, disk connectors
  - – Doubled management modules
- ## Availability
  - – Management system monitors the components
  - – Predictive Failure Analysis
  - – Error logs

REDUNDANT POWER SUPPLY

- Power Supply: apart from HDDs the next most failure-prone component

- Does not simply mean that 2 such devices
  - Means that the system can be operational if one power supply is not functioning (n+1 redundancy)

- Each power supply should have more separate power cords
  - Loose connection
  - Relocation is possible
  - Reliability: each cord from different power supply

SERVER FRONT

Service label

SAS disks
(with RAID)

USB
CD/DVD RW

For service cards

Battery Backup Units

SERVER REAR

Optional Hot-swap Power Supplies

Hot-swap Power Supplies

AMM (Advanced Management Module)

Fans

Ethernet and Other I/O
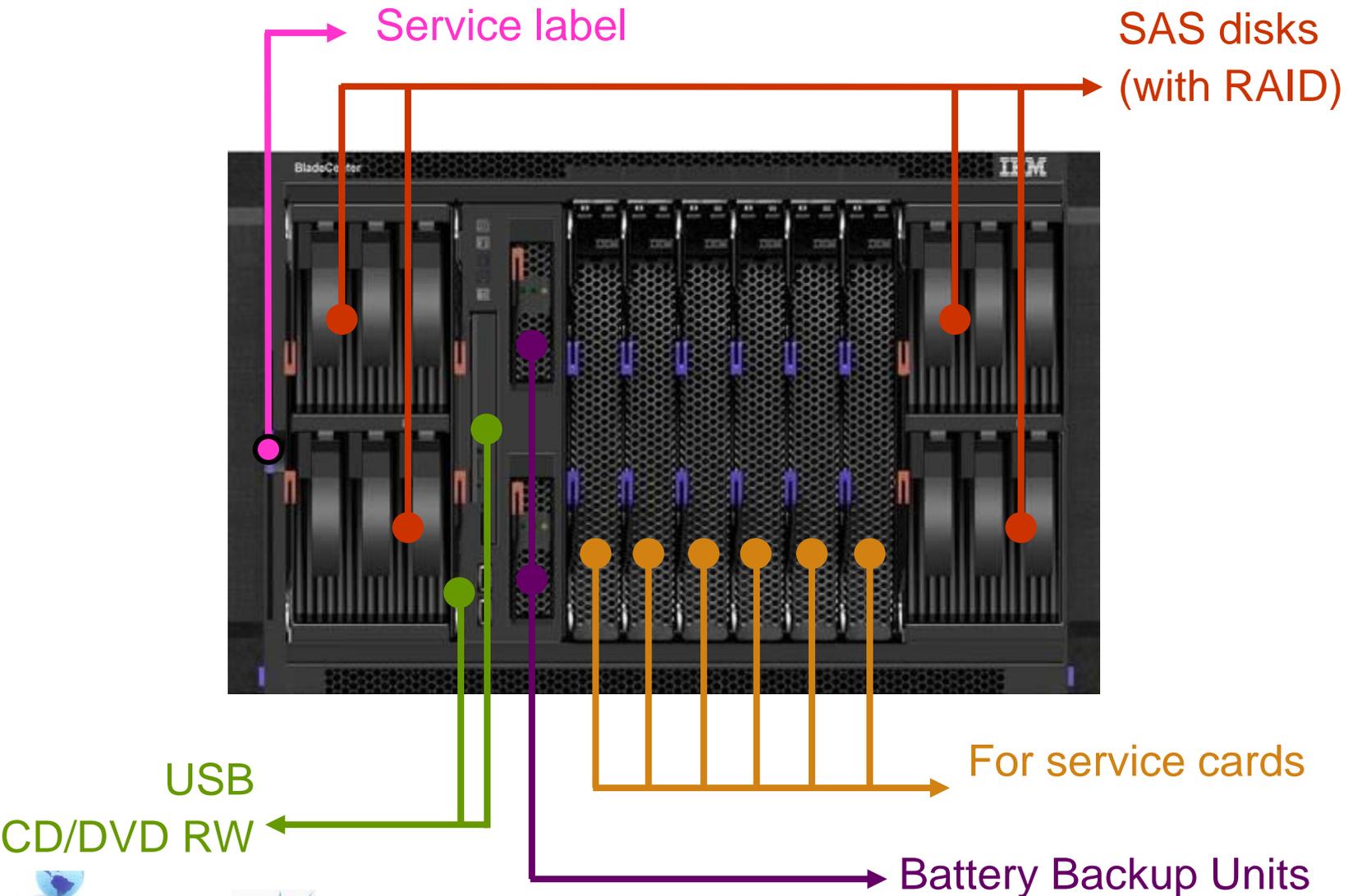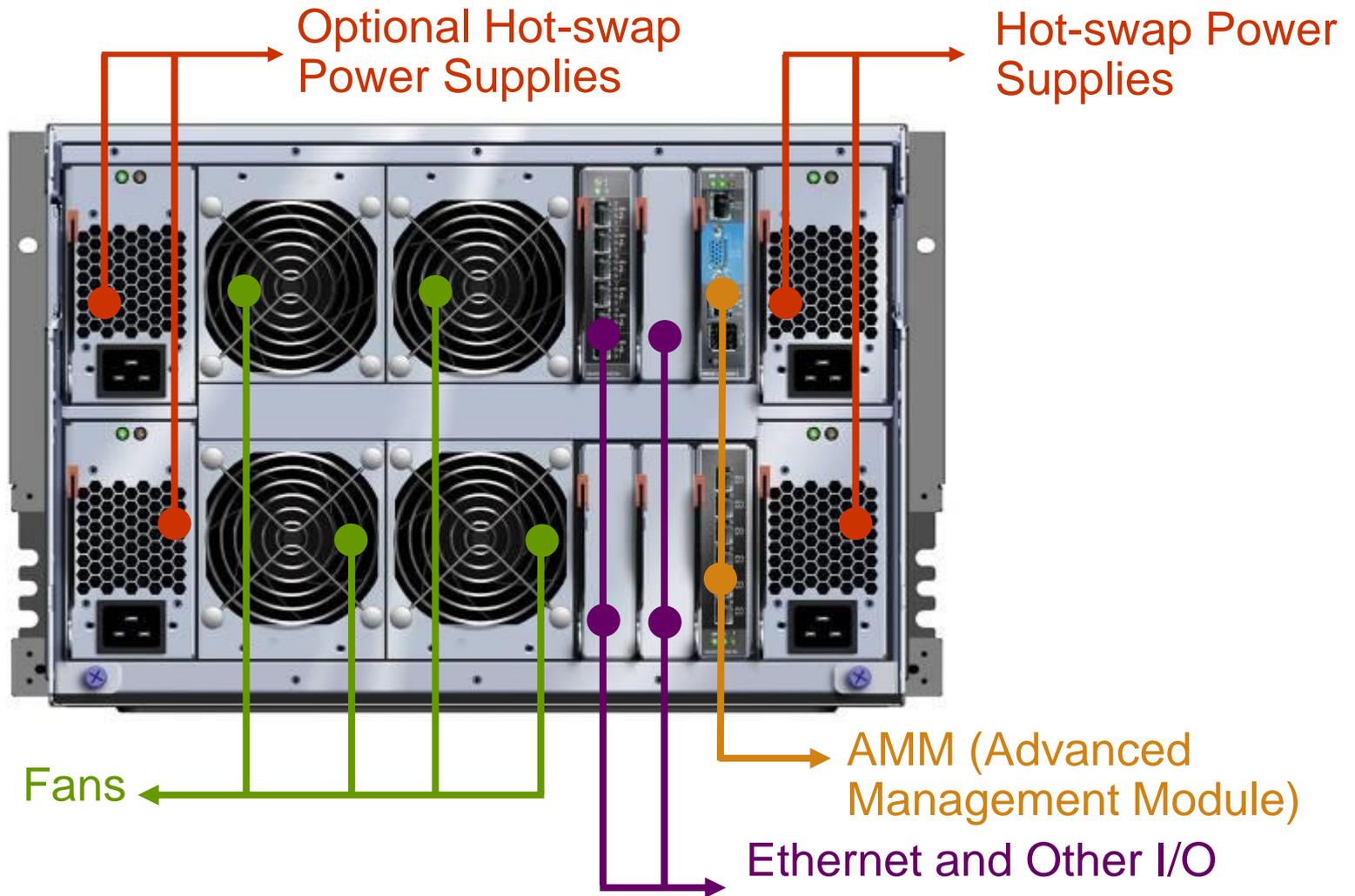
MAINTENANCE CONTRACTS

- When purchasing a server, must also be considered how maintenance will be handled

- Vendors tend to have a variety of maintenance contract options
  - 4 hours,
  - 12 hours,
  - 1 day response contract,
  - Only provision of spare parts
    - replaced when spare parts get used

MAINTENANCE CONTRACTS - EXAMPLES

- Low/medium critical host: 1-2 day response time or no special contract at all
- Large groups of similar hosts: typically spare kits and the repairs can be done by local staff
- Controlled model selection: Goal to have just two different models
- Critical host: too expensive to have fully stocked spare kits. Stock only spares for parts that commonly fail (disk, power supply – interchangeable typically) + same day response maintenance contract
- Large variety of models from same vendor:
  - Very large number of hosts: on-site technician
  - Medium size: spares kits on the spot + technician nearby
  - Direct access to spare kits on an emergency basis
- Highly critical host: on-site technician + duplicate machine ready to be swapped into place (typically as expensive as a redundant server, but better option for non-technical companies)

STOCKING SPARES – SERVICE CONTRACT

- Trade off between stocking spares (1) – service contract (2)
  - (1) Too expensive for a small site
  - (2) Typically includes diagnostic services even if over the phone
- Sometimes the easiest way to diagnose – swap in spare parts until the problem goes away. But its local management (training technicians, stocking spares) can be complicated, if
  - Small, medium site companies
  - Non-technical companies
  - Wide variety of models used

Conclude a Maintenance Contract

- Sometimes it is discovered that a critical host is not on the service contract at a critical time

- To prevent a host being missed from a maintenance contract:
  - Good inventory program
  - Have the person responsible for purchasing machines to be the person responsible for maintenance contracts
  - Maintenance contracts also for the (~ 1 year) warranty period with „zero charge"

PART II

PERSONAL TERMINALS

HOME PROCESSING

DESKTOPS

- Desktop
  - Definition, characteristics
- Desktop Management
  - Tasks of Desktop Management

DESKTOPS / PERSONAL COMPUTERS

- Desktop
- Personal Computer (PC)
- Newer solutions
  - Dockers (for laptop)
  - Personal Digital Assistants (PDA)
  - Smartphone
- ***Personal terminals***, Personal machines

PDA

First PDA (AT&T EO440) 1993

SMARTPHONE

TABLET

OVERVIEW

```
Preparation
    │
    ▼
BIOS settings
    │
    ▼
Preparation for
installation
    │
    ▼
Partitioning,
formatting ──────────┐
                     │
                     ▼
            Copying installation
            files
                     │
                     ▼
            Installation
                     │
                     ▼
            Windows
            settings
                     │
                     ▼
            Installation of
            drivers,
            applications
```
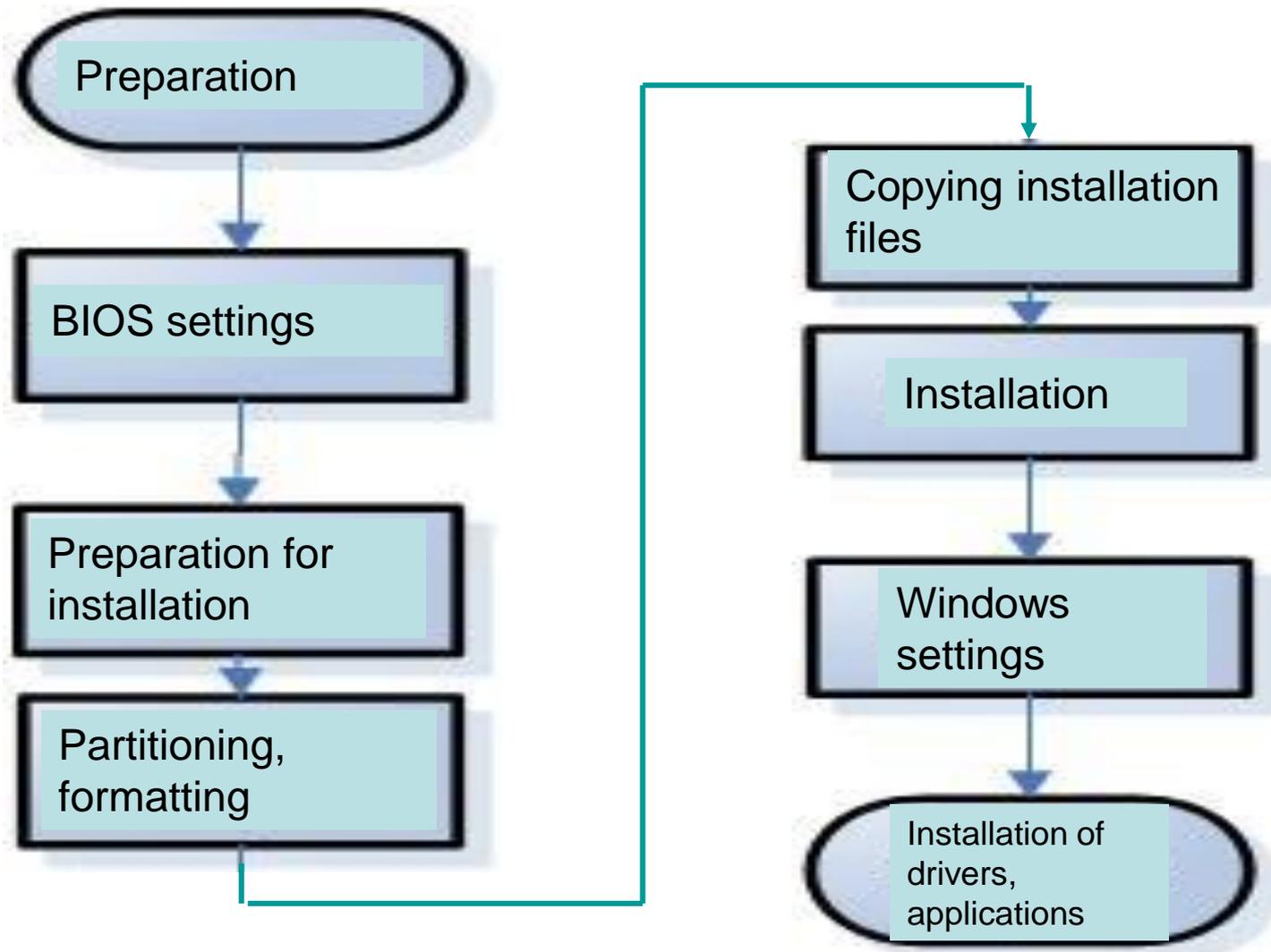
INSTALLATION

- Regional and language options

- Type in the user name/enterprise name

- Product identification key

- Computer name

- Administrator password

- Date, time, time zone

- Network settings

- Workgroup

- Display resolution detection

INSTALLATION OF DRIVERS, PROGRAMS

1. To be able to use the hardware: drivers must be installed
   - Provided by the manufacturers of the functional units
   - Most important: voice, video, network cards
2. For protection:
   - Anti-virus
   - Anti-spyware
   - Firewall

- **What is a firewall?**
  - In computer technology: Hardware and/or software protection against unauthorized electronic access to a networked computer system

INSTALLATION OF DRIVERS, PROGRAMS

✓ After installing anti-virus, anti-spyware and firewall:

1. Internet connection may be established
2. Upgrade the protection software and operating system
3. Network settings
   - IP address
   - Subnet mask
   - Gateway
   - DNS Server address, etc.
4. Install user programs

INSTALLATION OF DESKTOPS IN AN ENTERPRISE ENVIRONMENT

- Imagine the previous process on several hundred machines...
  - Slow
  - Boring
  - Error prone
- On the top of all that:
  - Different user groups
  - Different programs
  - Different **user profiles**
- Automation needed…

DESKTOPS – OPERATION SYSTEMS

- Mainly: Pre-installed operation system
  - Problem: cannot be known *exactly* what is installed, and the machines are different
    - Typically machines are purchased continuously, not all at a time
    - Machine must be replaced promptly
    - Purchase if the organisation expands/re-organized

- Result: non-homogenous desktop and operation system set – source of errors!

- Not sure, if we can reach a homogenous desktop set if *we* install the machines

MANAGEMENT - AUTOMATION

- Advisable to automate not only the installation process, but also the management
  - Attach to network
    - IP address, protocols, rights
  - Access to services
    - printing, e-mailing, Internet access, etc.
  - Other tasks
    - Mailbox management;
    - virus, spam, spyware protection;
   - access to remote storage, database

TASKS OF DESKTOP MANAGEMENT

- The management of the desktops covers several issues:
  - installation and upgrade of the operation systems and applications,
  - their back-up and archivation,
  - develop and maintain a universal user interface that is used all around the company,
  - inventory of machines
- Requirement:
  - Do it with as small human interaction as it can be
  - Automation as much as possible
    - more economical
    - reduces the harms caused by human's fault
- This whole process is called as ***Desktop Management***

LIFE CYCLE OF A PC, TYPICAL ACTIVITIES TO MANAGE
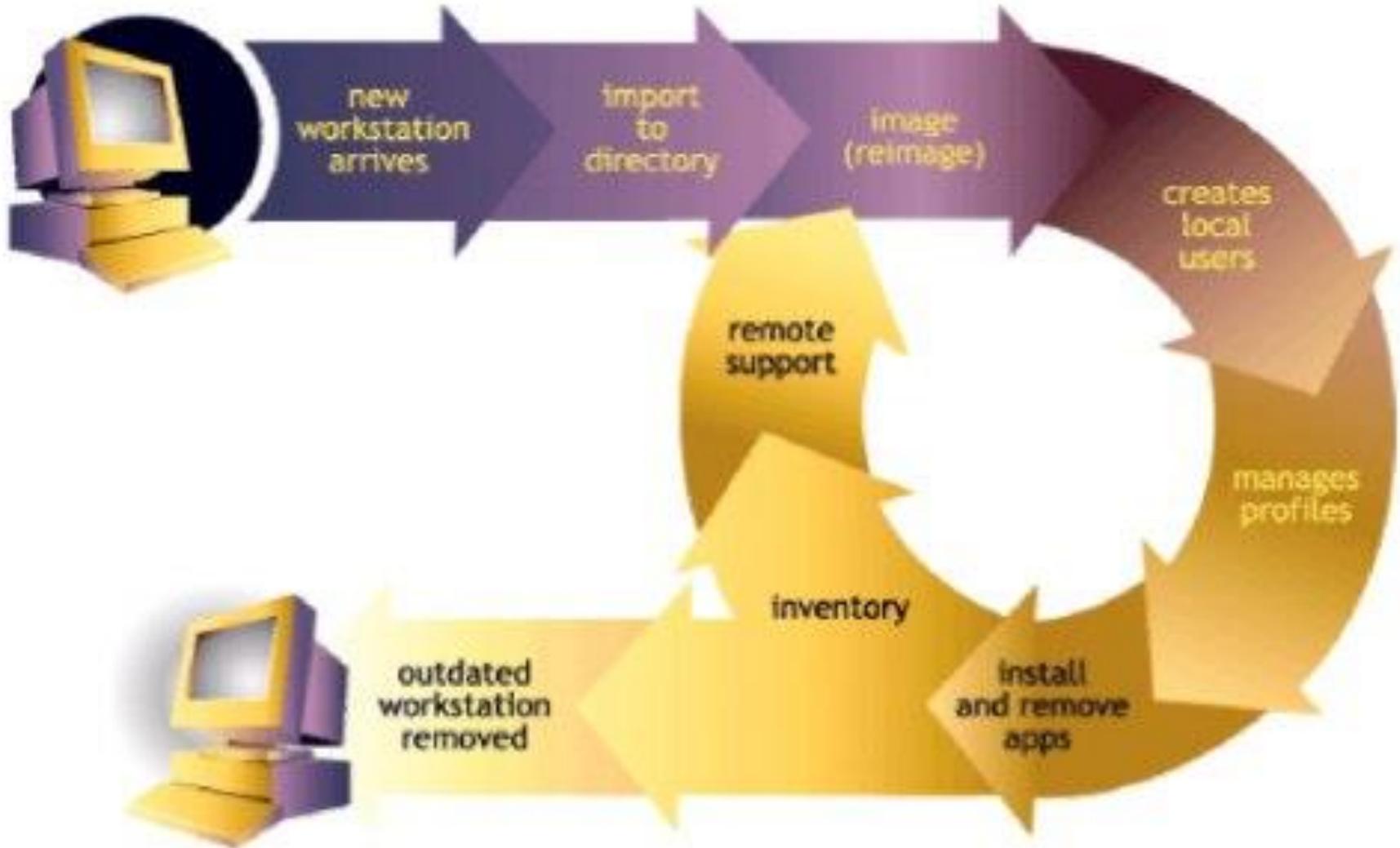
DESKTOP MANAGEMENT SERVICES

- Creating a system image, automatic installation
- Personalized software installation, automatic application supervision, measurement of software usage (statistics)
- Policy-based desktop supervision
- Remote supervision
- Full hardware and software inventory

DESKTOP MANAGEMENT SERVICES

- ***Creating a system image, automatic installation***
- Personalized software installation, automatic application supervision, measurement of software usage (statistics)
- Policy-based desktop supervision
- Remote supervision
- Full hardware and software inventory

CREATING A SYSTEM IMAGE, & AUTOMATIC INSTALLATION

- Installation of new operating systems and applications on every/selected (connected or stand-by) computers of the company
  - from image-file
    - only for exactly same HW/SW configuration
  - distribution of sample installation
    - installation process is executed on all machines
    - when HW different and/or parametrized SW settings needed
- Assignments between „Application-objects" and desktops
  - Upgrades only in one place („Application-object") and the users can see the new version immediately

CREATING A SYSTEM IMAGE, & AUTOMATIC INSTALLATION

- „Wake On LAN"-functionality
  - Switched off machines that are connected to network can be switched on by a network command
- Automatic distribution of applications
  - to several users at same time
  - in a personalized form
  - condition-based (e.g. if there is enough space)
  - system image distribution before (re)starting the computer
  - automatized online application distribution function
    - during installation desktop can be used
  - Layered Agents
    - From a central site to one computer in all other sites
    - From these local central machines to all other local desktops

DESKTOP MANAGEMENT SERVICES

- Creating a system image, automatic installation
- ***Personalized software installation, automatic application supervision, measurement of software usage (statistics)***
- Policy-based desktop supervision
- Remote supervision
- Full hardware and software inventory

PERSONALIZED SOFTWARE INSTALLATION

- Tasks of personalized software installation:
  - Which applications can be accessed by a user
  - Look-out of the desktop (background, screensaver, etc.)
  - Who can have an access to the PC and with which rights
  - Which printers can be used
  - Where to turn to in case of a problem

APPLICATION SUPERVISION FUNCTIONS

- System images stored in a central database
  - (Automatically) Self correcting applications
    - Unintentionally deleted, damaged files,
    - Default/original settings can be restored
- Desktop assignment functions
  - Who from where can have an access to which application
- Application removing function

MEASUREMENT OF SOFTWARE USAGE

- Software measurement functions
  - E.g.: Distributed applications
    - if # of licenses reached – new user cannot start it
- Reports on
  - distribution
  - usage

  of applications

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POLICY-BASED DESKTOP SUPERVISION

- Policies
  - determine of the (access) rights of users/user groups on company level
    - what can be configured
    - what can be downloaded, installed
    - which SW applications can be executed
    - desktop settings
    - which network resources can be used
  - rights assigned to persons not to machines
  - stored in a central database
    - in case of modification, automatically distributed to all concerned machines

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REMOTE SUPERVISION

- Faults can be prevented, fixed
  - users are not bothered with technical questions
  - pressing „help request" – e-mail to SA (system administer) with the description of the error
- Remotely controllable machines
  - if entitled
- SA can control the system from anywhere (via Internet)

FUNCTIONS OF REMOTE SUPERVISION

- Remote file transfer, program execution, diagnostics
- Locking/unlocking of mouse/keyboard during remote control
- Switch off display remotely
  - not to see specific remote control operations
- A „Wake on LAN" – a switched-off desktop can be switched on if it is connected to LAN
- Access rights can be assigned
  - by users, by groups, by departments, by sites, by desktops – according to policies
  - Restrictions even for SAs

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Full hardware and software inventory

- Hardware inventory
- Software inventory
    - list of the „built-in" SW
    - program items/settings can be added
- Data stored in a database
- Predefined / „Own" reports
    - upgrades
    - expiration of licenses
    - paths of programs (needed to automatically remove applications)