**Data Center Technology**

* Grouping IT resources in close proximity with one another, rather than having them geographically dispersed, allows for power sharing, higher efficiency in shared IT resource usage, and improved accessibility for IT personnel.
* These are the advantages that naturally popularized the data center concept.
* Modern data centers exist as specialized IT infrastructure used to house centralized IT resources, such as servers, databases, networking and telecommunication devices, and software systems.

Data centers are typically comprised of the following technologies and components:

**Virtualization**

* Data centers consist of both physical and virtualized IT resources.
* The physical IT resource layer refers to the facility infrastructure that houses computing / networking systems and equipment, together with hardware systems and their operating systems (Figure 5.7).
* The resource abstraction and control of the virtualization layer is comprised of operational and management tools that are often based on virtualization platforms that abstract the physical computing and networking IT resources as virtualized components that are easier to allocate, operate, release, monitor, and control.

Diagram

Description automatically generated

**Remote Operation and Management**

* Most of the operational and administrative tasks of IT resources in data centers are commanded through the network’s remote consoles and management systems.
* Technical personnel are not required to visit the dedicated rooms that house servers, except to perform highly specific tasks, such as equipment handling and cabling or hardware-level installation and maintenance.

**High Availability**

* Since any form of data center outage significantly impacts business continuity for the organizations that use their services, data centers are designed to operate with increasingly higher levels of redundancy to sustain availability.
* Data centers usually have redundant, uninterruptable power supplies, cabling, and environmental control subsystems.

**Facilities**

* Data center facilities are custom-designed with specialized computing, storage, and network equipment.
* These facilities have several functional layout areas, as well as various power supplies, cabling, and environmental control stations that regulate heating, ventilation, air conditioning, fire protection, and other related subsystems.

**Computing Hardware**

Much of the heavy processing in data centers are executed by standardized

commodity servers that have substantial computing power and storage capacity.

Several computing hardware technologies are integrated into these modular

servers, such as:

• rackmount form server design composed of standardized racks with

interconnects for power, network, and internal cooling support for different hardware processing architectures, such as x86- 32bits, x86-64, and power-efficient multi-core CPU architecture that houses hundreds of processing cores in a space as small as a single unit of standardized racks.

• redundant and hot-swappable components, such as hard disks, power

supplies, network interfaces, and storage controller cards

* Computing architectures such as blade server technologies use rack-embedded physical interconnections (blade enclosures), fabrics (switches), and shared power supply units and cooling fans.
* The interconnections enhance intercomponent networking and management while optimizing physical space and power.
* These systems typically support individual server hot-swapping, scaling,

replacement, and maintenance, which benefits the deployment of fault-tolerant systems that are based on computer clusters.

* Contemporary computing hardware platforms generally support industry standard and proprietary operational and management software systems that configure, monitor, and control hardware IT resources from remote management consoles.
* With a properly established management console, a single operator can

oversee hundreds to thousands of physical servers, virtual servers, and other IT resources.

**Storage Hardware**

* Data centers have specialized storage systems that maintain enormous amounts of digital information in order to fulfill considerable storage capacity needs.
* These storage systems are containers housing numerous hard disks that are organized into arrays.

**Storage systems usually involve the following technologies:**

• *Hard Disk Arrays* – These arrays inherently divide and replicate data among multiple physical drives, and increase performance and redundancy by including spare disks. This technology is often implemented using redundant arrays of independent disks (RAID) schemes, which are typically realized through hardware disk array controllers.

• *I/O Caching* – This is generally performed through hard disk array controllers, which enhance disk access times and performance by data caching.

• *Hot-Swappable Hard Disks* – These can be safely removed from arrays without requiring prior powering down.

• *Storage Virtualization* – This is realized through the use of virtualized hard

disks and storage sharing.

• *Fast Data Replication Mechanisms* – These include *snapshotting*, which is

saving a virtual machine’s memory into a hypervisor-readable file for future reloading, and *volume cloning*, which is copying virtual or physical hard disk volumes and partitions.

Networked storage devices usually fall into one of the following categories:

• *Storage Area Network (SAN)* – Physical data storage media are connected

through a dedicated network and provide block-level data storage access using Small Computer System Interface (SCSI).

• *Network-Attached Storage (NAS)* – Hard drive arrays are contained and managed by this dedicated device, which connects through a network and facilitates access to data using Network File System (NFS) or Server Message Block (SMB).

NAS, SAN, and other more advanced storage system options provide fault tolerance in many components through controller redundancy, cooling redundancy, and hard disk arrays that use RAID storage technology.