Systems Administration ASIST

Topic 1

The System Administrator

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The System Administrator

- What is and what is the need for a System Administrator?
- Any system and infrastructure installation needs care both in normal operation and in intervention if and when a problem occurs
- Furthermore, it is reasonable to assume that it is appropriate to adopt strategies that enable data recovery in case of need
- It is the role of the Systems Administrator to plan, implement, verify and act in all aspects of operation and optimization of infrastructure and systems
- Do not forget that, depending on the activity of the organization, it may also be pertinent to configure the systems and infrastructure to optimize some type of traffic

The System Administrator

- In a small organization - at the limit, each individual's computer - the administration function is simpler
  - Although some aspects of administration are sometimes neglected…
- But as the size of the infrastructure and the number of systems increases, more responsibility and work falls on the Systems Administrator, making it sometimes unviable for it to be performed by a single person
- Despite this, there is or should be only one System Administrator
- Why?

The System Administrator

- Because responsibility cannot be shared by multiple individuals!
- It is the role of the System Administrator
  - Plan, implement, configure and maintain the proper functioning of the infrastructure
  - Plan, implement, configure and maintain the applications inherent to the organization's functioning
  - Plan, implement, configure and maintain security requirements (confidentiality, integrity, availability)
  - Be an active part of security policies appropriate for the organization
  - Analyze and select new technologies or trends that may be useful
  - Be attentive and implement adaptation to the legal requirements that must be met

The System Administrator

- In very large organizations, human resources are sometimes more oriented towards infrastructure components, systems and security
- However, there remains a need for a single System Administrator, who oversees and plans all of these resources
  - Especially because the implementation or alteration of an item can affect the overall strategy of the organization or the performance of other items
- It is therefore the System Administrator always the only and exclusive responsible for adapting the functioning and performance of the infrastructure and systems to the requirements of the organization.

The System Administrator

- It also has the added responsibilities of
  - Form and train the team
  - Plan data and application backup and recovery strategy
  - Ensure the intended operation, which implies
    - Select and adopt a damaged equipment repair strategy
    - Solve application problems
  - Define user management criteria
  - Ensure technical support to users
  - Plan and implement the strategy for updating operating systems and applications
- Several of these tasks can be automated, but it is up to you to analyze and define the automation, and, mainly, to validate that they have been successfully completed

The System Administrator

- It is also responsible for
  - Document all aspects of systems and infrastructure
  - Elaborate recovery plans
  - Prepare reports on the constraints that may eventually arise

The System Administrator

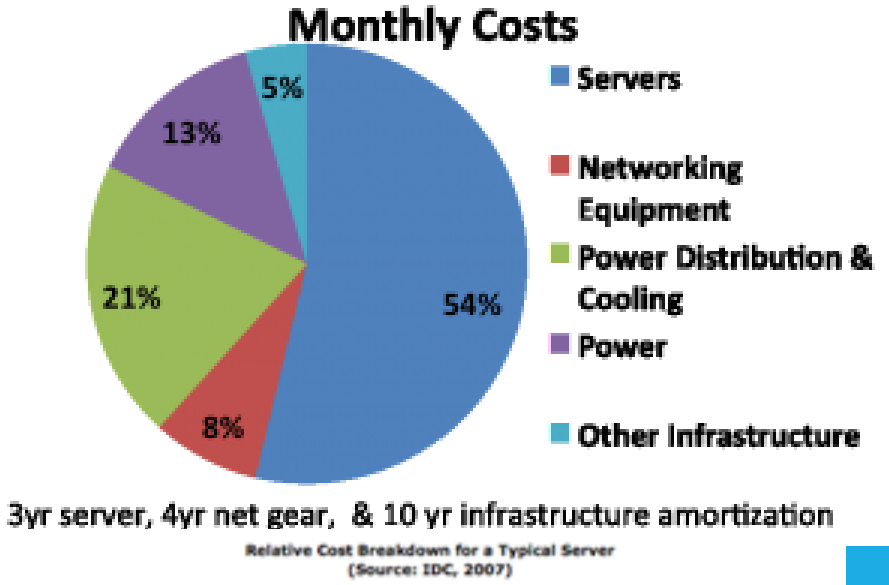
- An alternative for placing systems that ensure the functioning of the technological infrastructure is in a timely manner, each in its own location
- But we have already seen in the structured cabling standards that this should not be the principle to be followed
- The place where systems and equipment from which the infrastructure is developed is usually called the **Data Processing Center** (**CPD**) or **Data Center**

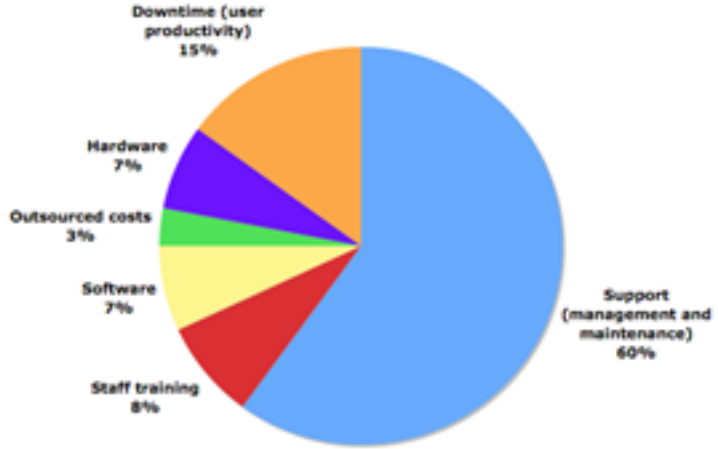
The System Administrator

- The advantages are evident
  - Thus, there is a single place where environmental criteria must be ensured (temperature, humidity, dust, etc.) for better operating conditions of the critical point of the infrastructure
  - It becomes simpler to adopt and use alternative power supplies in the event of failure (UPS, generator set, etc.)
  - Enables the existence of false floor and/or false ceiling for better passage and distribution of wiring
  - Enables the existence and security of cabinets (racks, telecommunications cabinets) appropriate to contain equipment, whatever their type
  - Only place where fire safety is ensured

The System Administrator

- The operational costs of CPD grow rapidly due to the equipment in operation
- The occupied area represents a cost for the organization
- The costs of adopting diverse equipment but essential to the intended requirements increase as more new technologies and brands are adopted, resulting in higher administrative costs

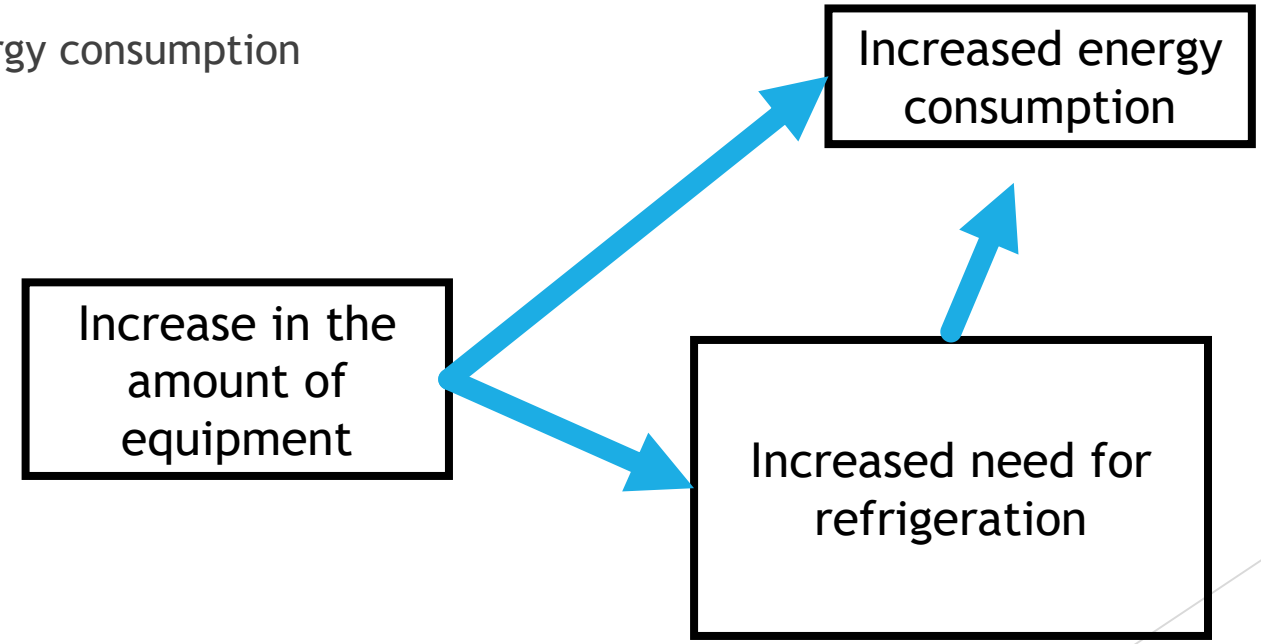




http://cloudscaling.com/blog/cloud-computing/understanding-cloud-datacenter-economies-of-scale/

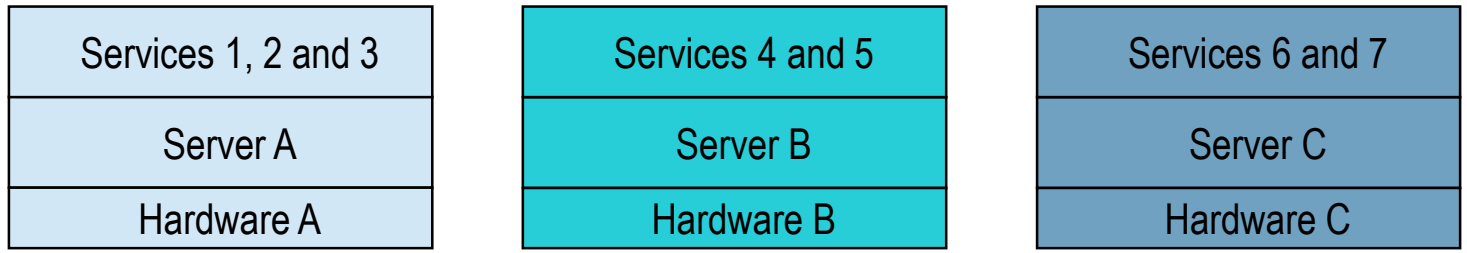
The System Administrator

- The energy costs of a CPD can be summarized in three factors
  - Increase in the amount of equipment
  - Increased need for refrigeration
  - Increased energy consumption



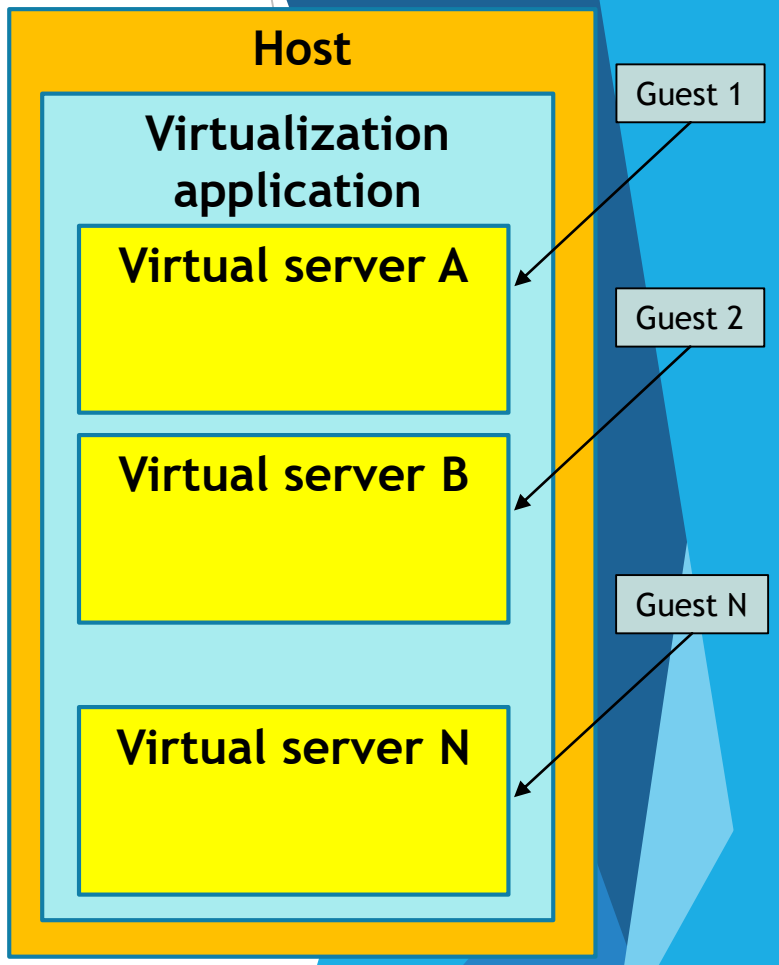
The System Administrator

- Consequently, there is great pressure to reduce operating costs, usually by two factors
  - Energy costs
  - Not adopting a policy of *more equipments to guarantee more services*
- The often usual rule was to install new equipment to ensure a new service (*don't mess around with what works well…*)
- Although the utilization rate of each server is often reduced or even greatly reduced



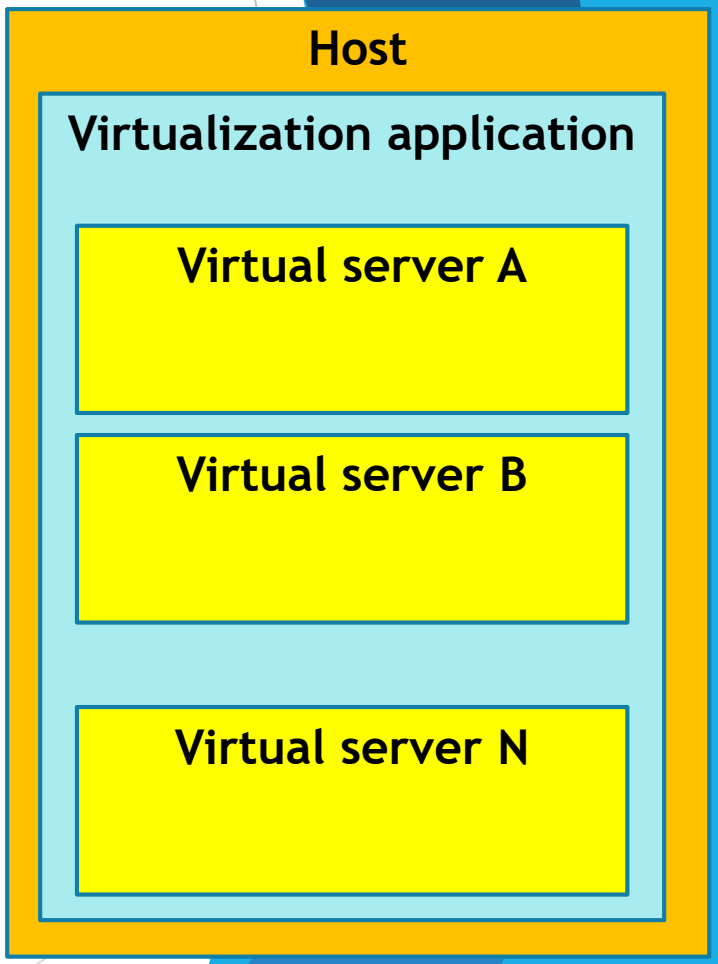
The System Administrator

- Instead of this strategy, a strategy of server virtualization can be resorted
- Thus, there is only at the limit one server (usually - or even necessarily - more powerful) that contains a virtualization host
- In this host virtual servers are configured and installed, called guests
- Virtualization simulates physical equipment with an application
  - Turns *hardware* into *software*



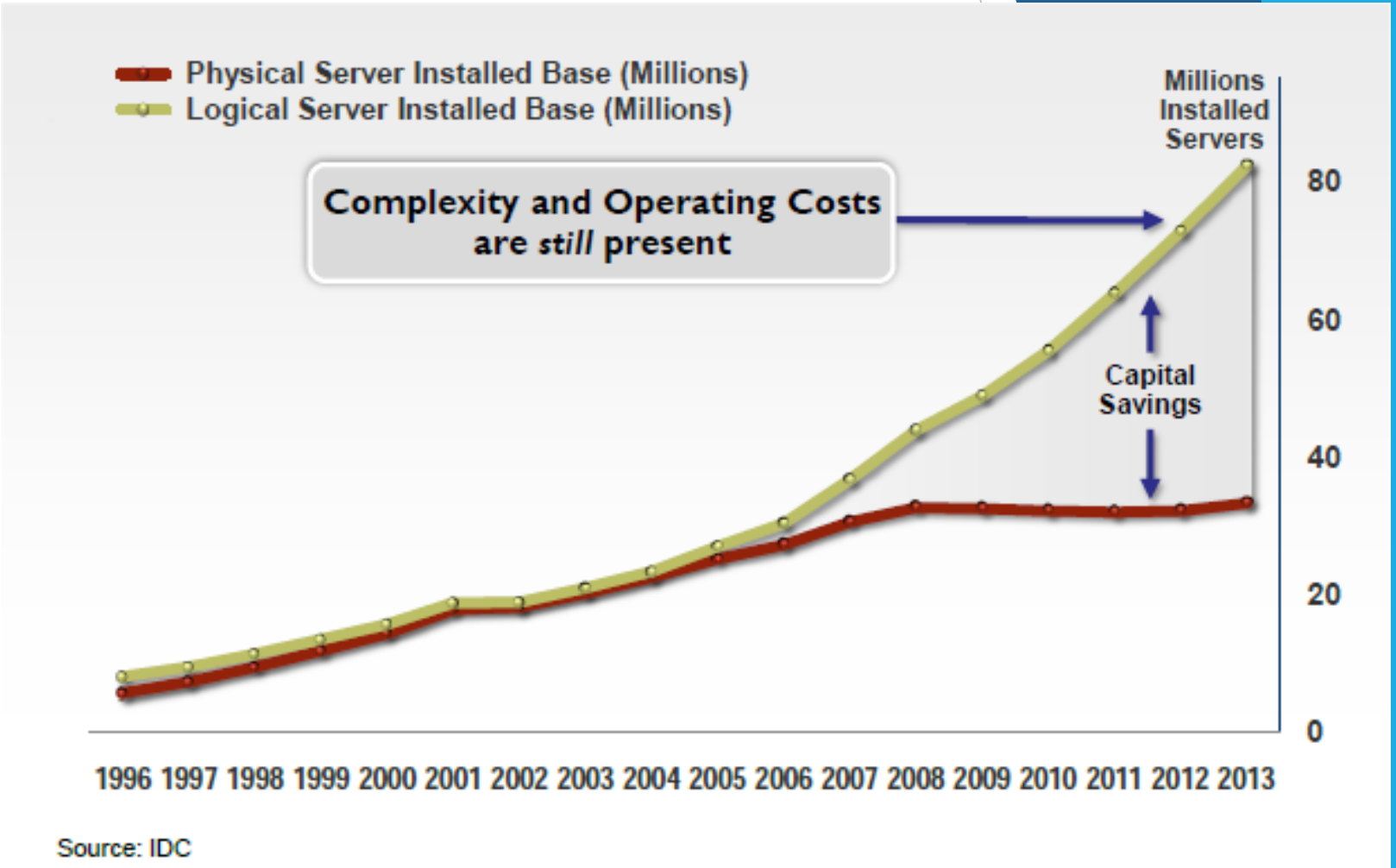
The System Administrator

- Note that each guest needs their operating system and the reservation of features (such as disk, memory, network cards) that use the same physical characteristics as the host
- These characteristics are, however, dynamically distributed
- Guests work completely independently of each other
  - Although virtual infrastructures can be created with network assets that interconnect them
- It should be noted that the virtualization application limits the maximum consumption of resources by each guest, so there may be performance limitations



The System Administrator

- Administrative costs still exist in virtualization, although they do not grow in the same proportion compared to the costs associated with installing physical servers



Source: IDC

The System Administrator

- But since everything is an application that simulates physical equipment, administration is performed exclusively by maintaining and configuring that application
- Operations such as increasing the disk, memory, inserting more processors or colors in the processor, boil down to a configuration
  - Of course, some changes imply subsequent configuration in the guest's operating system
- It also facilitates some aspects such as backup copies, as it can be done simply through an image (*snapshot*)
- Mainly, it greatly facilitates the serial production of guests with the same characteristics because each guest can be copied (*cloned*)

The System Administrator

- The use of server virtualization
  - The physical host server utilization rate increases (hence the need to be more powerful)
  - Reduces the amount of existing physical equipment
  - Simplifies administration tasks
- This way reduces administration and energy costs

The System Administrator

- On the other hand, it also has drawbacks
  - If the host goes down, all guests will also be down
  - If the host is not correctly sized, the performance of the guests can be greatly affected
  - Each guest must have their operating system license which is completely independent from that of the host
  - It is necessary to provide for each guest the disk space and memory necessary for the operation of the operating system (and applications) that will be executed on it
- The solution to the first problem may be host redundancy
  - In addition, the copy or location of a guest, if there is more than one host, can be easily moved from one host to another

The System Administrator

- Among the drawbacks pointed to virtual servers we spoke of the need to have your own operating system
  - Note that this can also be seen as an advantage, as a host, for example, Windows can host guests Windows, Linux, etc.
- However, sometimes the same operating system is desired on all guests
  - Imagine for example an application development company
- In this situation, the use of virtual machines is unreasonable and the use of *containers* is more effective

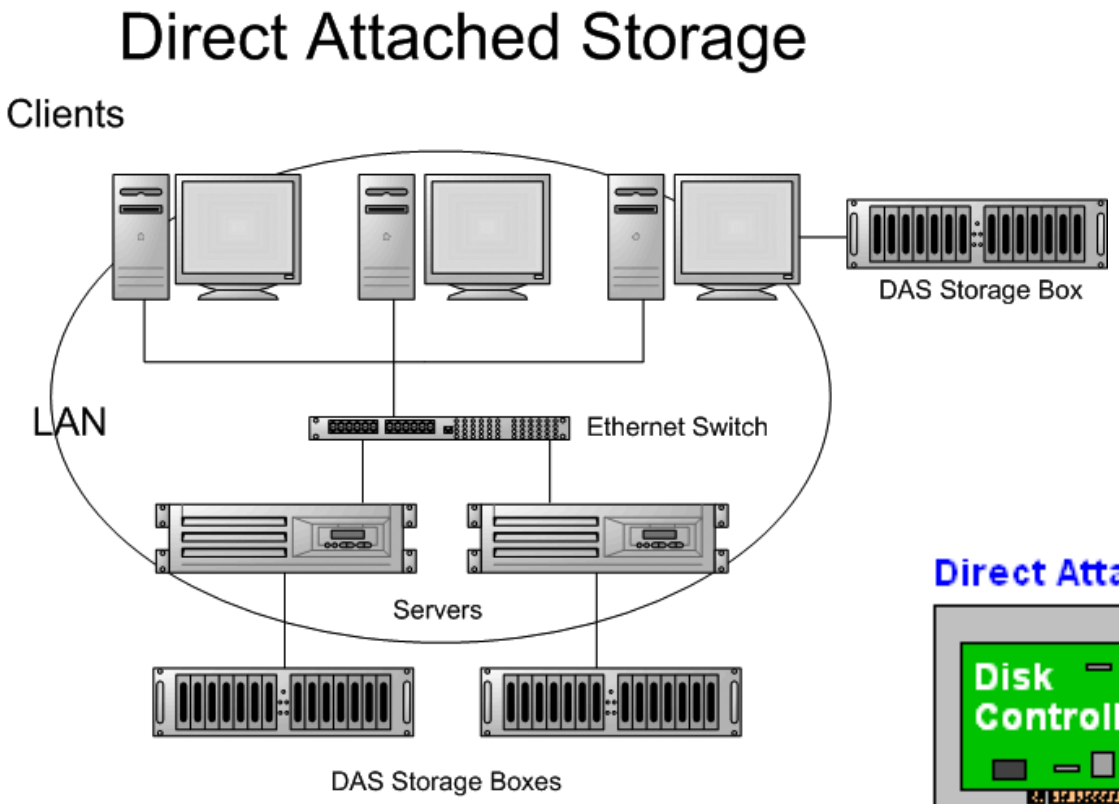
The System Administrator

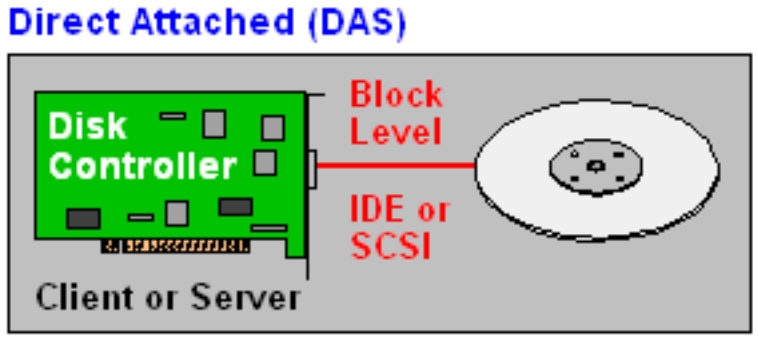
- Containers are also a virtualization of physical equipment, however they share part of the operating system and libraries with the host
- It is therefore not necessary to acquire (and/or install) an operating system on each guest
- Given this way, harnessing the host's capabilities is more effective, enabling more guests - because they require less physical resources
- It has as inconvenience
  - Do not allow different operating systems between host and guests
  - Security problems can occur if one of them, host or guest, is infected with malware
  - It is maintained, of course, that the inoperability of the host causes the inoperability of the guests

The System Administrator

- Another aspect to be planned by the System Administrator is the location of the data
- Typically, each system has its own storage, called ***Direct Attached Storage*** (**DAS**), which will contain the operating system, applications and data
- DAS presents itself to the operating system as a *block device*
- This solution is not very reasonable as it is for the exclusive use of the system to which it is connected
  - Of course, there may be sharing, but using this option will involve other costs
- Adding or removing a storage device involves physical intervention, often with temporary system deactivation
- Data backup operations are performed by the system itself, consuming resources
- Finally, there is no economy of scale in sharing storage

The System Administrator





Source: Computer Desktop Encyclopedia

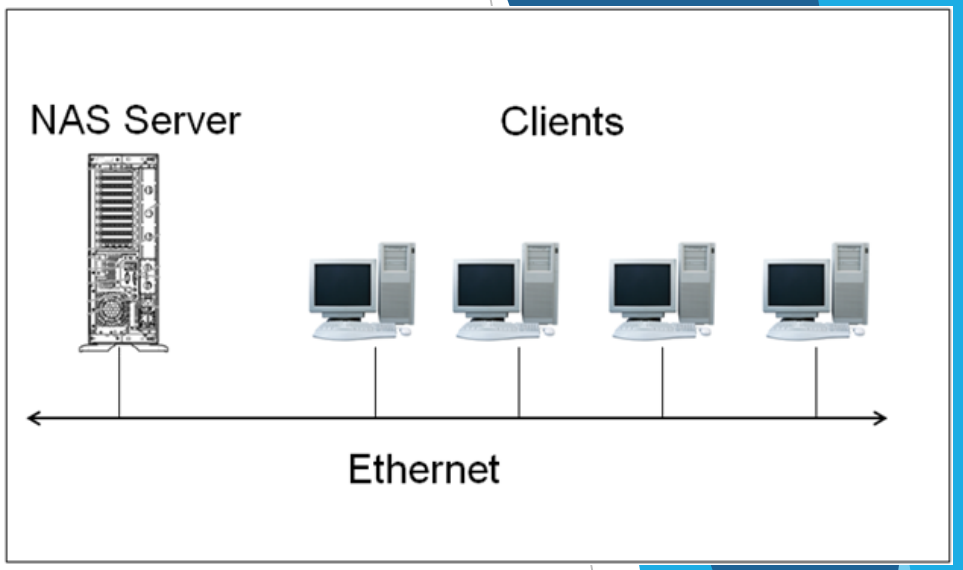
The System Administrator

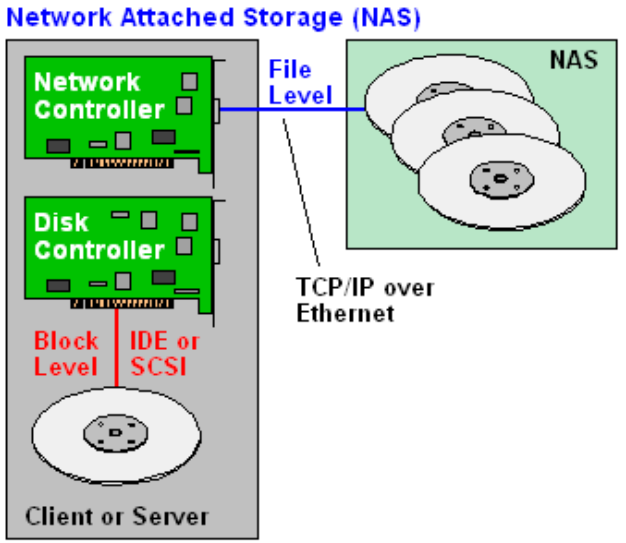
- Alternatively, you can use a ***Network Attached Storage*** (**NAS**)
- This is presented to the operating system as a *file system*
- It has several advantages
  - It is an economical way to provide a large storage space to multiple users and/or systems
  - It's quick to install and configure
  - Usually supports levels of **RAID** (***Redundant Access of Independent Disks***)
  - Allows to set permissions on folders and files
  - Offers high resource utilization

  - *NAS is poor's man SAN*

The System Administrator

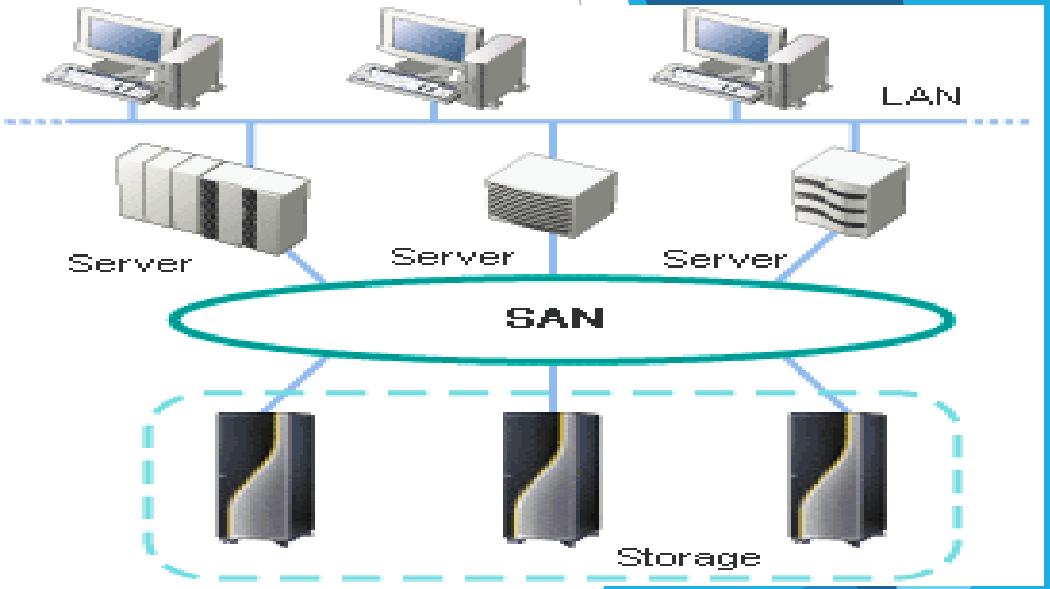
- But it also has drawbacks
  - Occupies network resources (has at least one IP address)
  - Implies increased latency and potential data transfer problems
  - Performance is affected by network availability





The System Administrator

- Another alternative, more expensive but with greater capacity is the ***Storage Area Network*** (**SAN**)
- This is usually a network itself, physically distinct for higher performance
- It must provide high reliability and security
- It can be assembled using a Gigabit Ethernet network infrastructure, but, ideally, it is supported by specific technology called ***Fibre Channel*** (**FC**)
- Also ideally, there should be redundancy of connections on the SAN

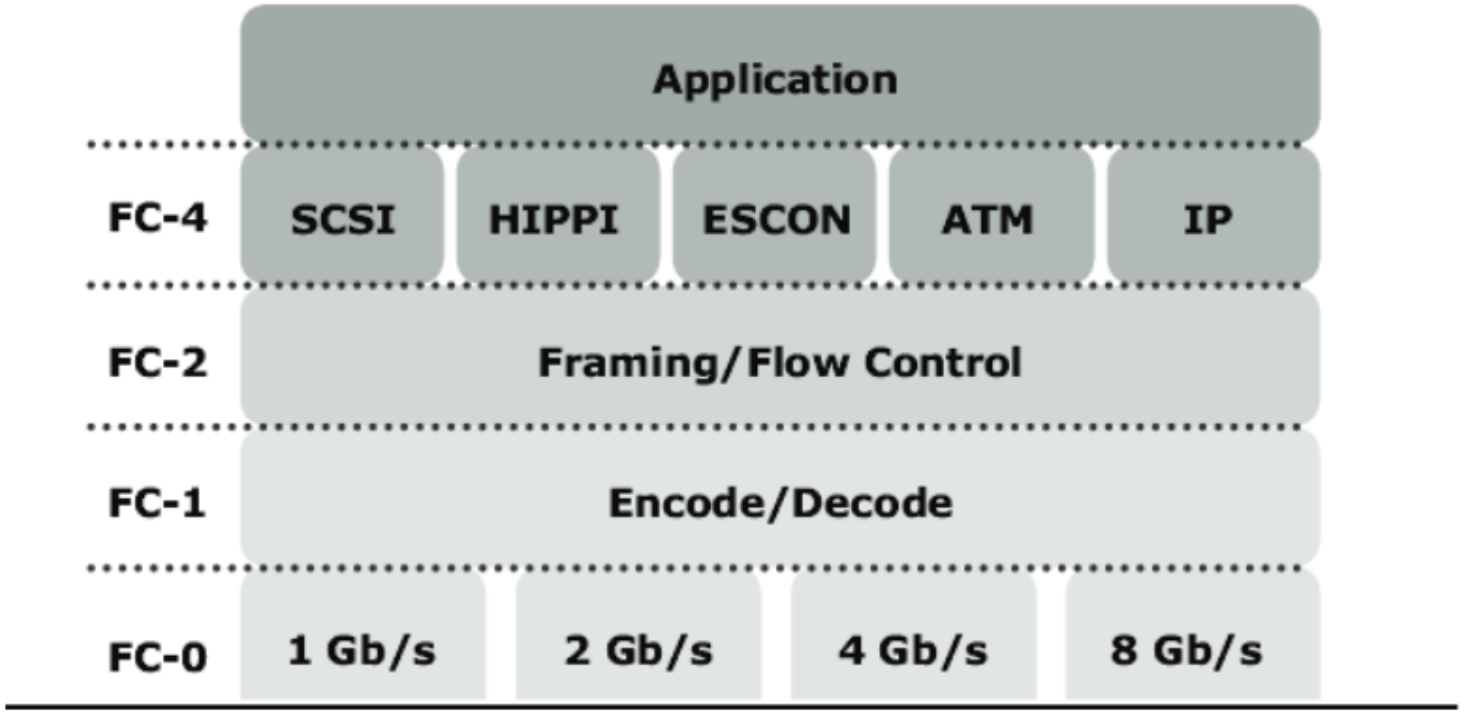


The System Administrator

- There are two protocols and several SAN implementations
  - ***Fibre Channel Protocol*** **(FCP)**
  - ***Fibre Channel over IP*** **(FCIP)**
  - ***Internet Fibre Channel Protocol*** **(iFCP)**
  - ***Fibre Channel over Ethernet*** **(FCoE)**
  - ***Non-Volatile Memory Express over Fibre Channel*** **(FC-NVMe)**
    - It stands out for allowing the interconnection of systems and SSD disks via a high-capacity PCI Express connection
  - ***Internet Small Computer System Interface*** **(iSCSI)**

The System Administrator

- The FC protocol has 4 layers shown in the image
  - In practice there should be 5 but one of the levels (FC-3) has never been implemented



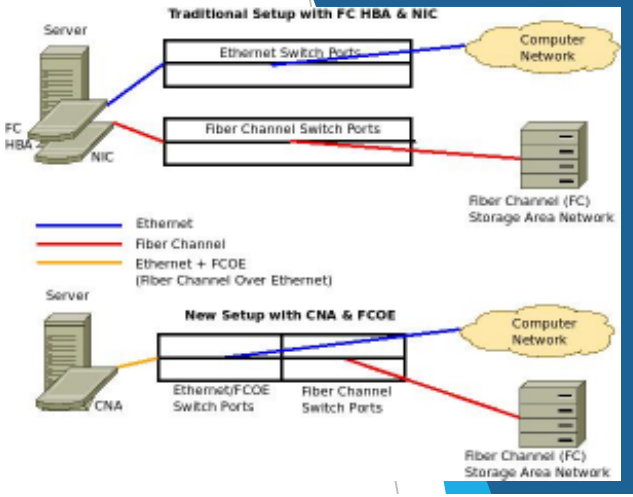
Source: JB Institute of Engineering & Technology

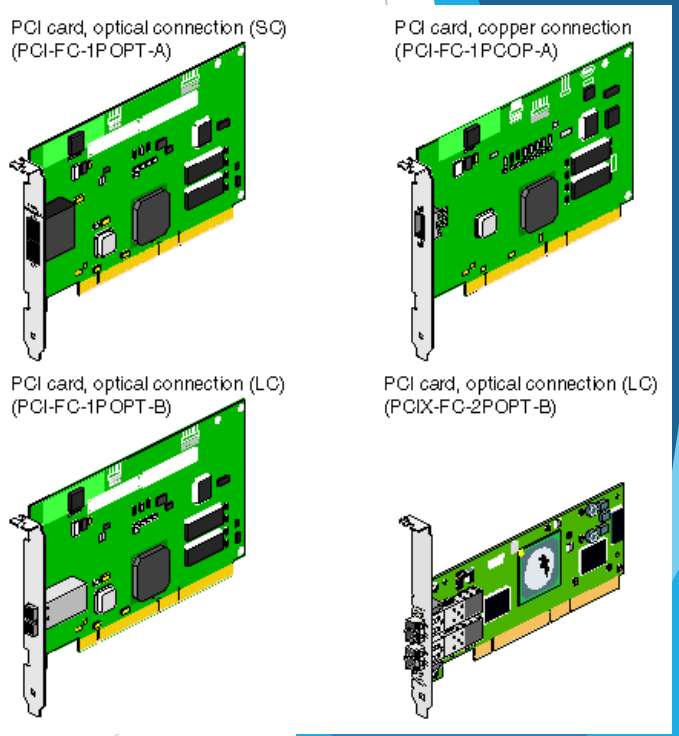
The System Administrator

- FC-4
  - Defines application interfaces and mapping to the lowest levels
  - Some protocols at this level are SCSI, ATM and IP
- FC-2
  - Transport level
  - Contains source and destination addresses, control information, etc.
- FC-1
  - Transmission protocol
  - Includes coding and decoding rules, error control
  - When transmitting, 2 bits are added to each character that are removed at the receiver (for error control)
- FC-0
  - Physical level

The System Administrator

- The use of a SAN with Fiber Channel topology implies the existence of specific equipment for interconnection with the IT infrastructure
- Noteworthy
  - ***Host Bus Adapter*** (**HBA**), board containing the appropriate interface for connecting the system to non-native technology devices
  - ***Converged Network Adapter*** (**CNA**) specific to interconnect an FCoE
    - This card simultaneously contains an HBA interface and a network interface
  - Switch / Gateway FC
- The physical topologies are varied, from the simple connection via an FC switch to the mesh called **Core Edge**





The System Administrator

- There is a huge pressure for greater capacity, reliability and performance of information storage, motivated
  - By technological change
  - Per return on investment requirements
  - By the exponential increase in
    - Devices and data
    - Capacity and need for information processing
    - User requests
- SANs nowadays require to
  - Allow interconnection
  - Be more scalable
  - Be simple to manage

The System Administrator

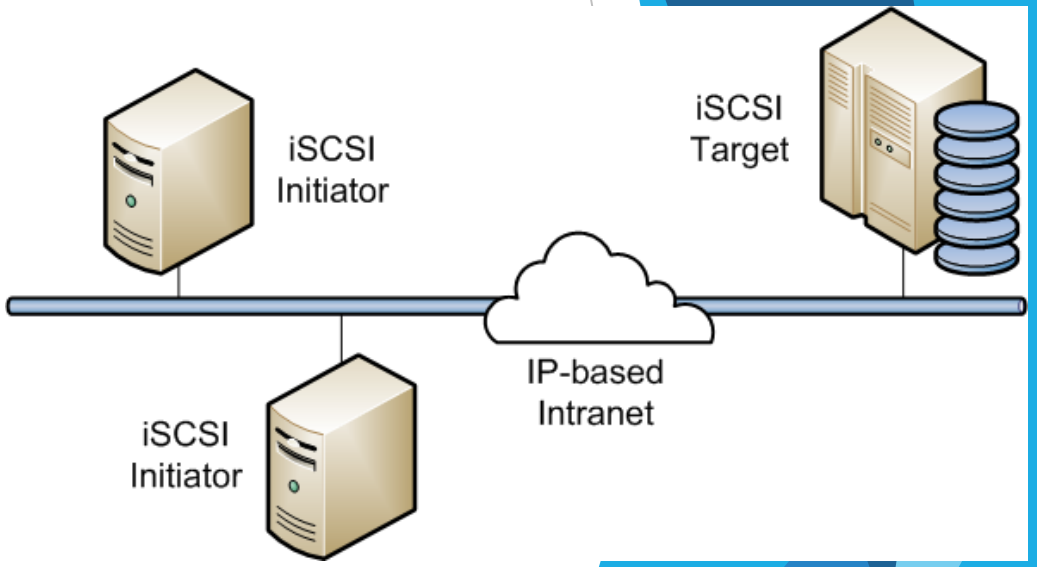
- No wonder the appearance of FCIP and iFCP technologies
- These technologies allow, as opposed to FCoE, the interconnection of remote SANs
- Note that FCIP is implemented at the SAN level while iFCP is implemented at the device level
  - As a result, you cannot directly interconnect a FCIP SAN to an iFCP SAN
- Both are based on and take advantage of TCP / IP

The System Administrator

- It should be noted that FC technology has some constraints, which are gradually being resolved
  - Disk type
  - Protocols
- The first has been resolved with the progressive replacement of HDD disks with newer technologies
- The second has been resolved with NVMe
- FC-NVMe consists of a protocol and architecture that is not limited to SSD disks

The System Administrator

- A more economical alternative is iSCSI
- It is native to modern operating systems
  - So as opposed to other technologies there is no need for specific devices or boards
- Enables remote SAN interconnection
- It is TCP/IP based
- It has *initiator* software (which takes advantage of storage) and *target* software (which makes storage available)
- The *initiator* accesses the *target* as if it were local SCSI disks



Source: Oracle

The System Administrator

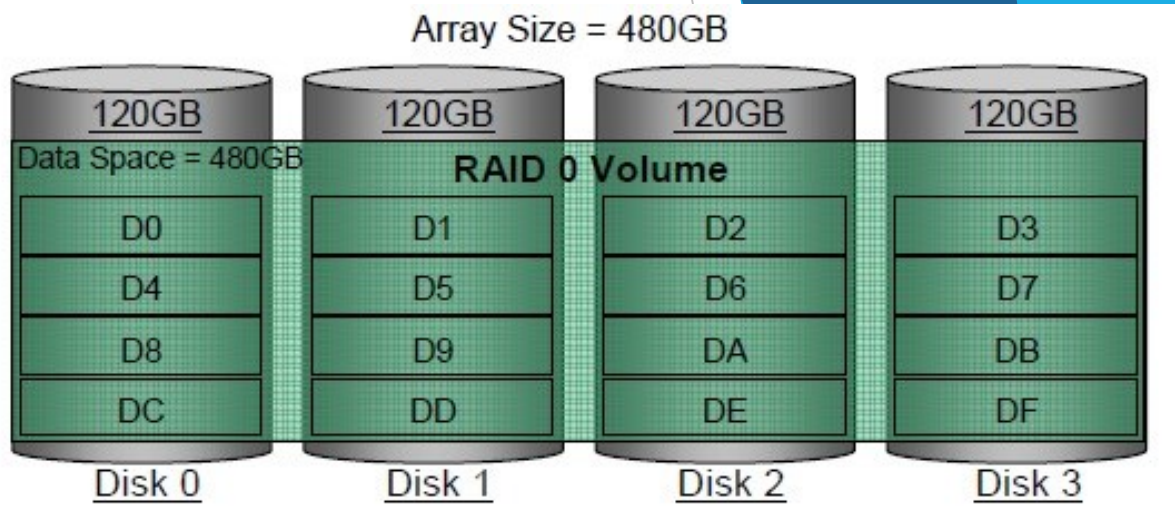
- Whatever the storage system adopted, the System Administrator must always provide for the necessary mechanisms to mitigate or eliminate data
- Any physical equipment can break down, so storage on a single disk can cause problems in the event of a breakdown
- The strategy of regular backup copies (which we will cover in topic 2) is essential but may still not be sufficient for tighter requirements
- In addition, large volumes of data may be too large to be stored on a single disk

The System Administrator

- This need arose for solutions that allow
  - Replicate one disk to another in real time
  - Expanding the capacity of one disk using space from another disk(s)
- This solution is called ***Redundant Array of Independent Disks*** (**RAID**)
- There are several RAID levels with different purposes being identified by number, but we will divide them here using a basic principle
  - Supported directly by the latest operating systems
    - Software RAID
  - Require specific controller
    - Hardware RAID
  - Note that the existence of a specific controller does not prevent RAID types that do not require it!

The System Administrator

- Software RAID
  - **RAID 0** (RAID zero)
    - *Striping*
    - Two or more disks work in a grouped and simultaneous manner, simulating for the operating system a single storage space that corresponds to the sum of the individual disk space
    - Has the advantage of increasing storage space and improving performance
    - It has the inconvenience of losing information if an error occurs in any of the disks involved

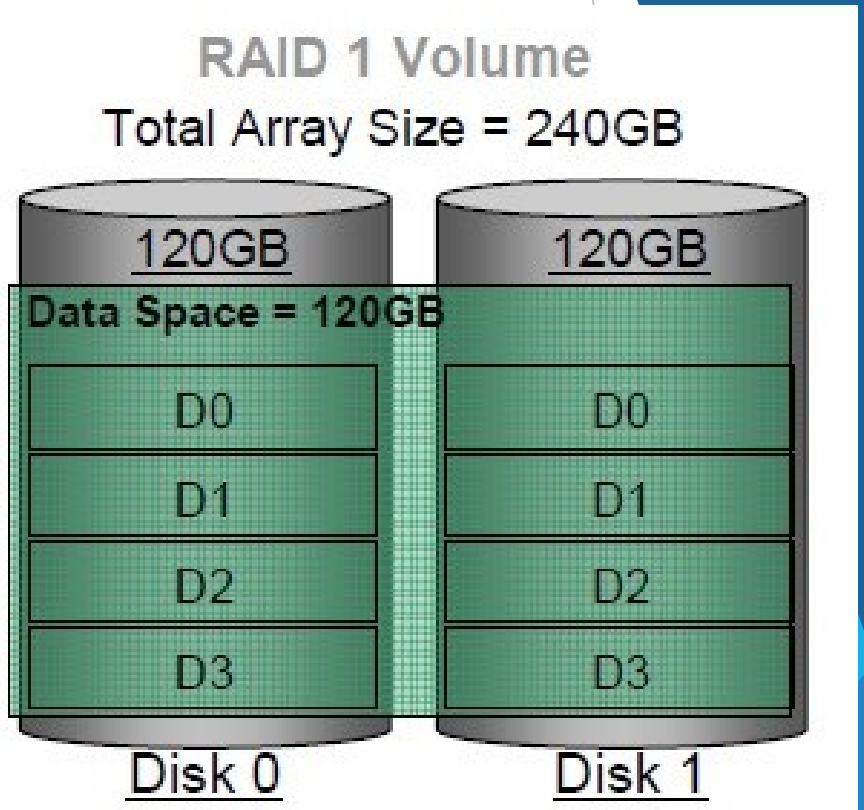


Source: intel.com

Available space = 120 x 4 = 480GB

The System Administrator

- Software RAID
  - **RAID 1**
    - *Mirroring*
    - Two disk units are mirrored, that is, any data written on one is replicated on the other
    - It has the advantage
      - The ability to decrease the likelihood of loss of information, since the data exists on two separate disks
      - Performance is better as data can be read from any disc - but recording is slower
    - It has as inconvenience
      - Shows to the operating system as available the capacity of a single disc
      - The disks must have the same dimension

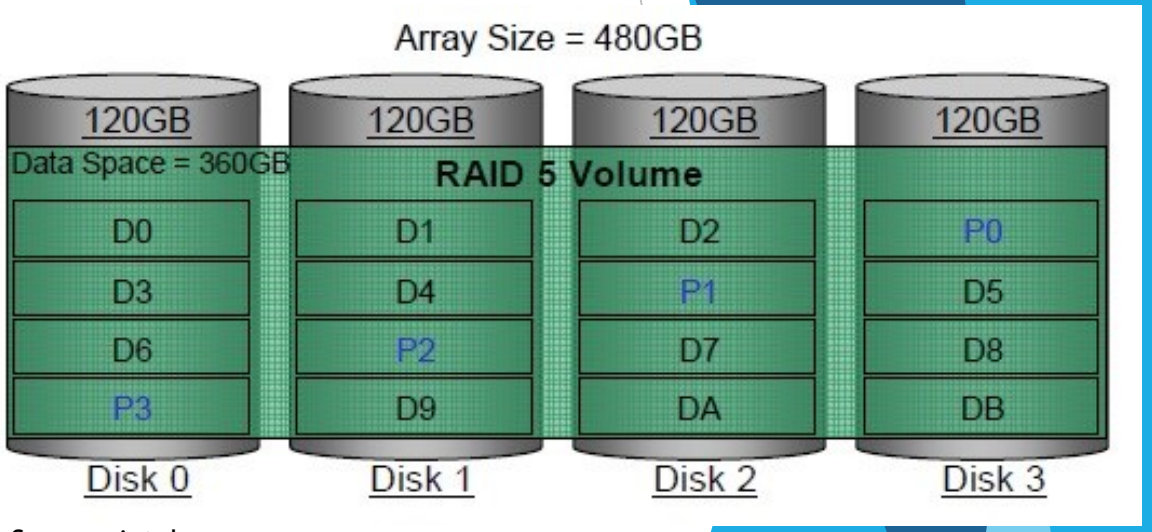


Source: intel.com

Available space = 120GB

The System Administrator

- Software RAID
  - **RAID 5**
    - *Striping with parity*
    - Requires a minimum of 3 (three) discs
    - Data is recorded on two of the discs (Dx) and in the third, parity information is recorded (P*x*)
    - It has the advantage
      - Capacity utilization (75% of the disk is used for data)
      - Performance is better as data can be read from any disc - but recording is slower
      - Allows the recovery of information in case of damage to any disk
      - The maximum capacity of the pool usable by the operating system is the smallest disk size multiplied by the number of disks minus one

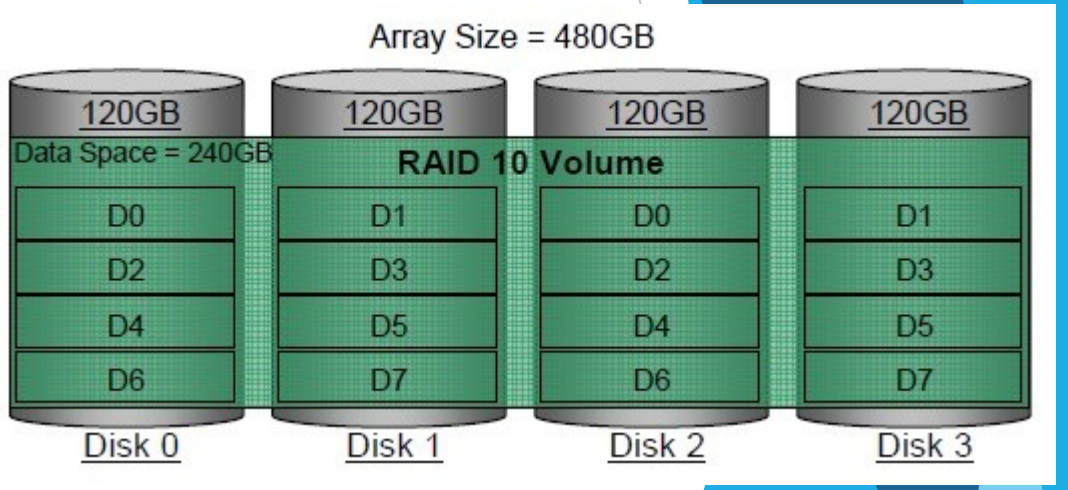


Source: intel.com

Available space = 120 x (4 - 1) = 360GB

The System Administrator

- Software RAID
  - **RAID 10** (RAID 1 + 0)
    - *Striping with mirroring*
    - Two of the discs are extending (striping) each other, and their set is mirrored (mirroring) in the other set
    - It has the advantage
      - Combines the advantages and disadvantages of RAID 0 and RAID 1
      - The maximum capacity of the set usable by the operating system is the associated RAID 0 size



Source: intel.com

Available space = 120 + 120 = 240GB

The System Administrator

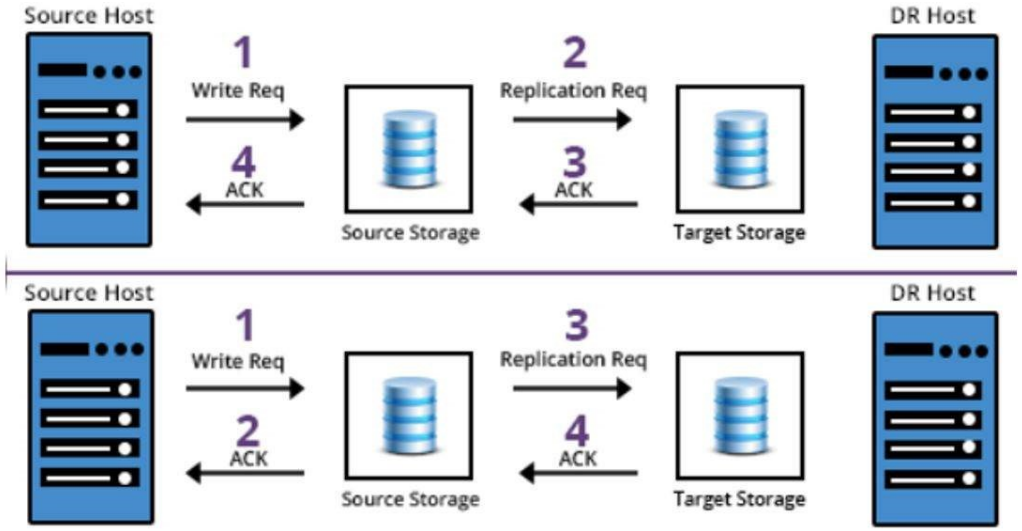
- Hardware RAID
  - **RAID 2**
    - *Striping* bit level
  - **RAID 3**
    - Striping bit level with dedicated parity
  - **RAID 4**
    - Striping block level with dedicated parity
  - **RAID 6**
    - Equivalent to RAID 5
    - It has dual distributed parity
    - Allows information recovery in case of damage up to two of the disks
  - **RAID 50**
    - Requires a minimum of 4 disks
  - **RAID 60**
    - Requires a minimum of disks

The System Administrator

- The use of a SAN is usually referred to as storage virtualization (because it is not physically linked to each system)
- The storage system provides logical disks (***Logical Units*** **LUN**) to servers, in the SAN, taking advantage of the appropriate protocols
- A logical disk can be a physical disk, a part of a physical disk, or even spread across multiple physical disks
- The customer accesses the logical disk in the same way as a local disk, and considers that he has access to all the storage capacity assigned to him

The System Administrator

- With virtualized storage, storage management and maintenance is performed by applications, with no need to stop equipment
- In addition, it also allows the creation of snapshots, cloning, and synchronization (*mirroring*) of the disks
- These operations we will see later that are crucial for disaster recovery



Source: Flackbox

- Synchronous Replication
- Asynchronous Replication