



Fundamentals of Storage and Data Center

Module Number: 01

**Module Name: Introduction to Storage and
Data Centers Information Storage**

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Introduction to Storage and Data Centers Information Storage

AIM

To equip students with fundamentals of storage and overview of data centers.



Objectives of This Module

The Objectives of this module are:

- Basic understanding of data, information and storage.
- To explain the evolution of storage technology.
- Understand the basics of data center.

Outcome

At the end of this module, you are expected to:

- Understand what is data and its types.
- Differentiate between data and information.
- Understand how storage technology evolved over time.
- Understand the lifecycle of information and its management.
- Acquire basic overview of data centers.

Contents

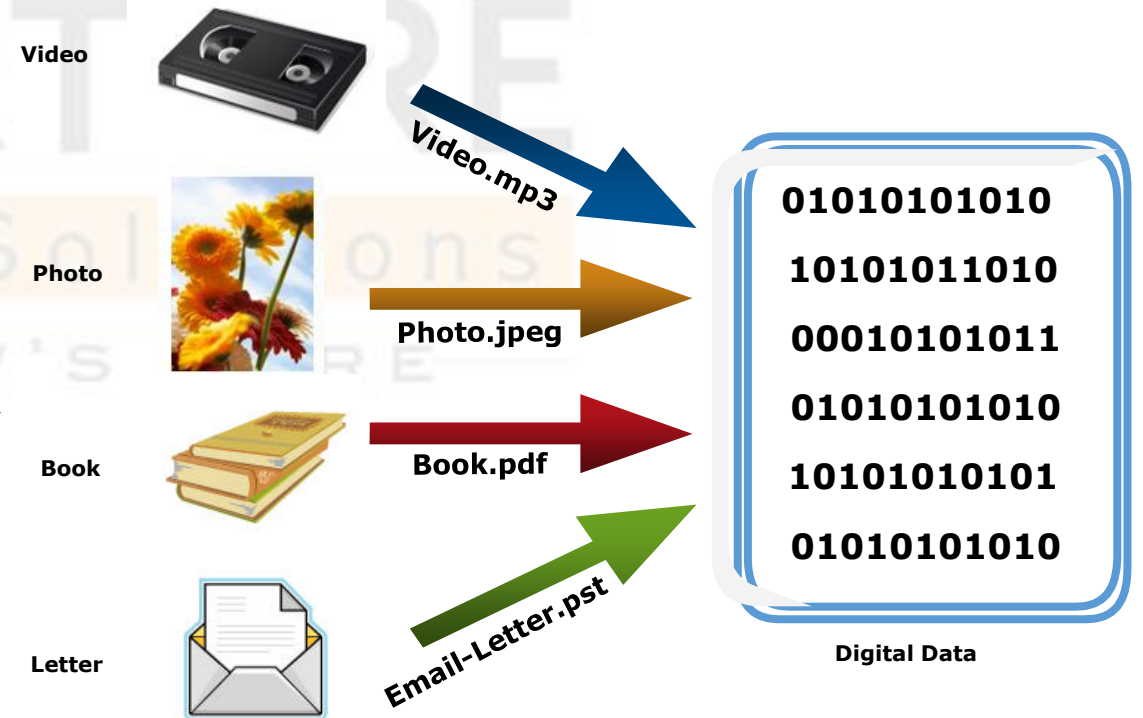
1. Introduction to data and its types
2. Data and Information
3. Information Storage
4. Evolution of Storage Technology
5. Information Lifecycle and ILM
6. Introduction to Data Center
7. Role of Data Center in the Enterprise
8. Role of Data Center in Service Provider Environment
9. Data Center Architecture

Introduction to Storage and Data Centers Information Storage

Do you have any idea about what is data?

“Collection of raw facts from which conclusions may be drawn”

- Most data is being converted into a digital format
 - Driven by user demand
 - Facilitated by
 - Increase in data processing capabilities
 - New and cheaper peripherals
 - Lower cost and increased speed of storage
 - Affordable and faster networks
- Who creates data?
 - Individuals
 - Businesses



How many categories of data are there?

- Data can be categorized into following categories:

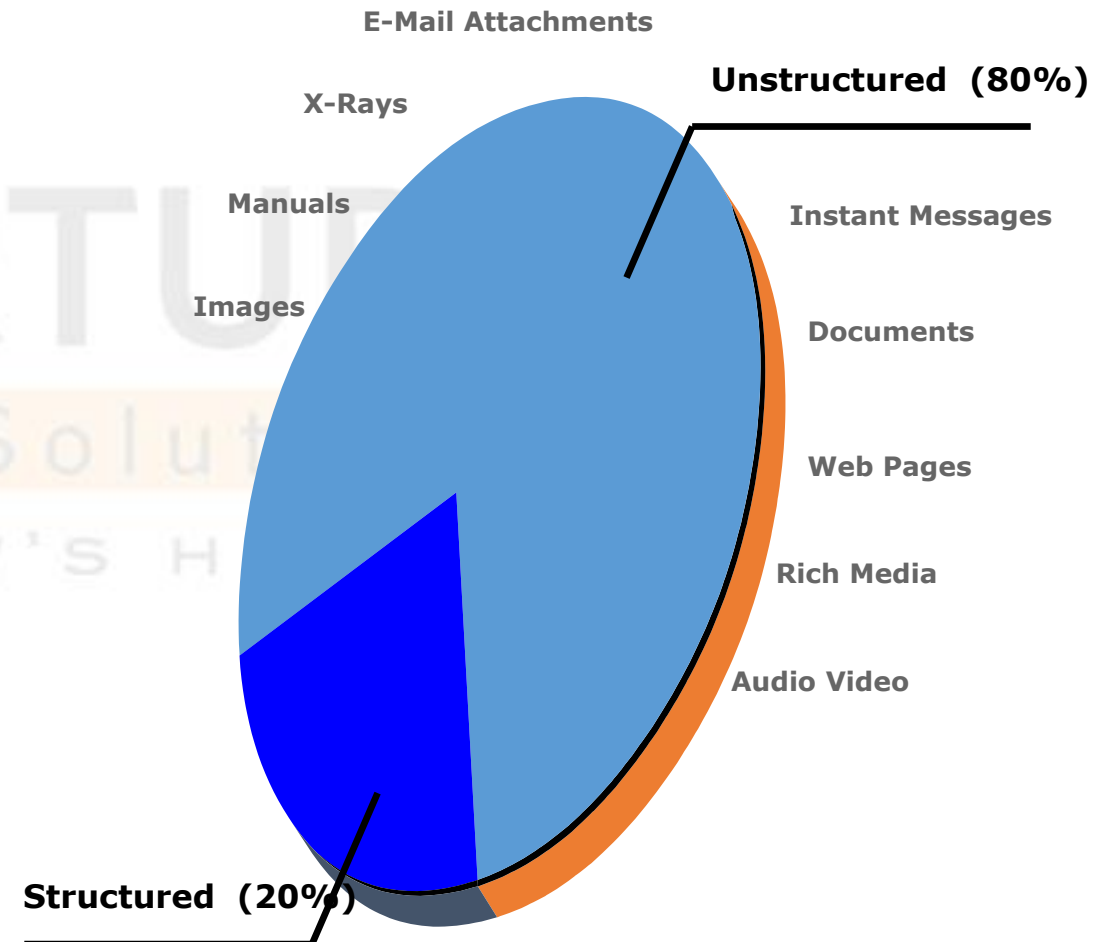
- Structured:

- Data Bases
- Spread Sheets

- Unstructured:

- Instant messages
- Images
- Audio
- Video
- Movies

- Over 80% of enterprise data is unstructured



IP Operation

How data differs from information?

- **Data:** Collection of raw facts from which the required output is extracted.
- **Information:** Intelligence and knowledge derived from data.



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Information Storage



Collects and arranges data



Acts as an Information repository

Examples:



Why Information Storage ?

- **“Digital universe – The Information Explosion”**
 - 21st Century is information era
 - Information is being created at ever increasing rate
 - Information has become critical for success
- We live in an on-command, on-demand world
 - Example: Social networking sites, e-mails, video and photo sharing website, online shopping, search engines etc.
- Information management is a **big** challenge
 - Organization seek to Store Protect Optimize Leverage the information optimally

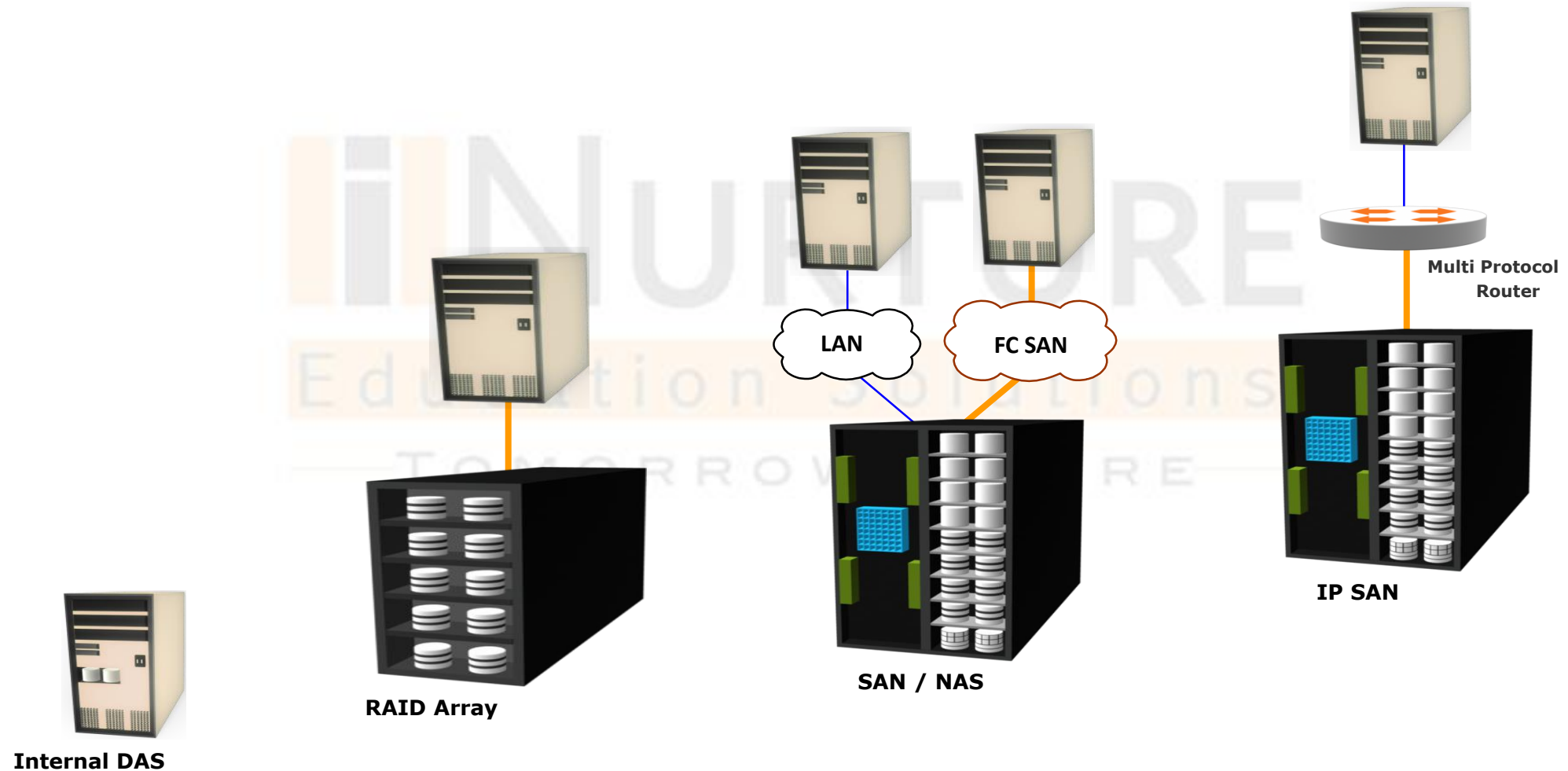


Evolution of Storage Technology

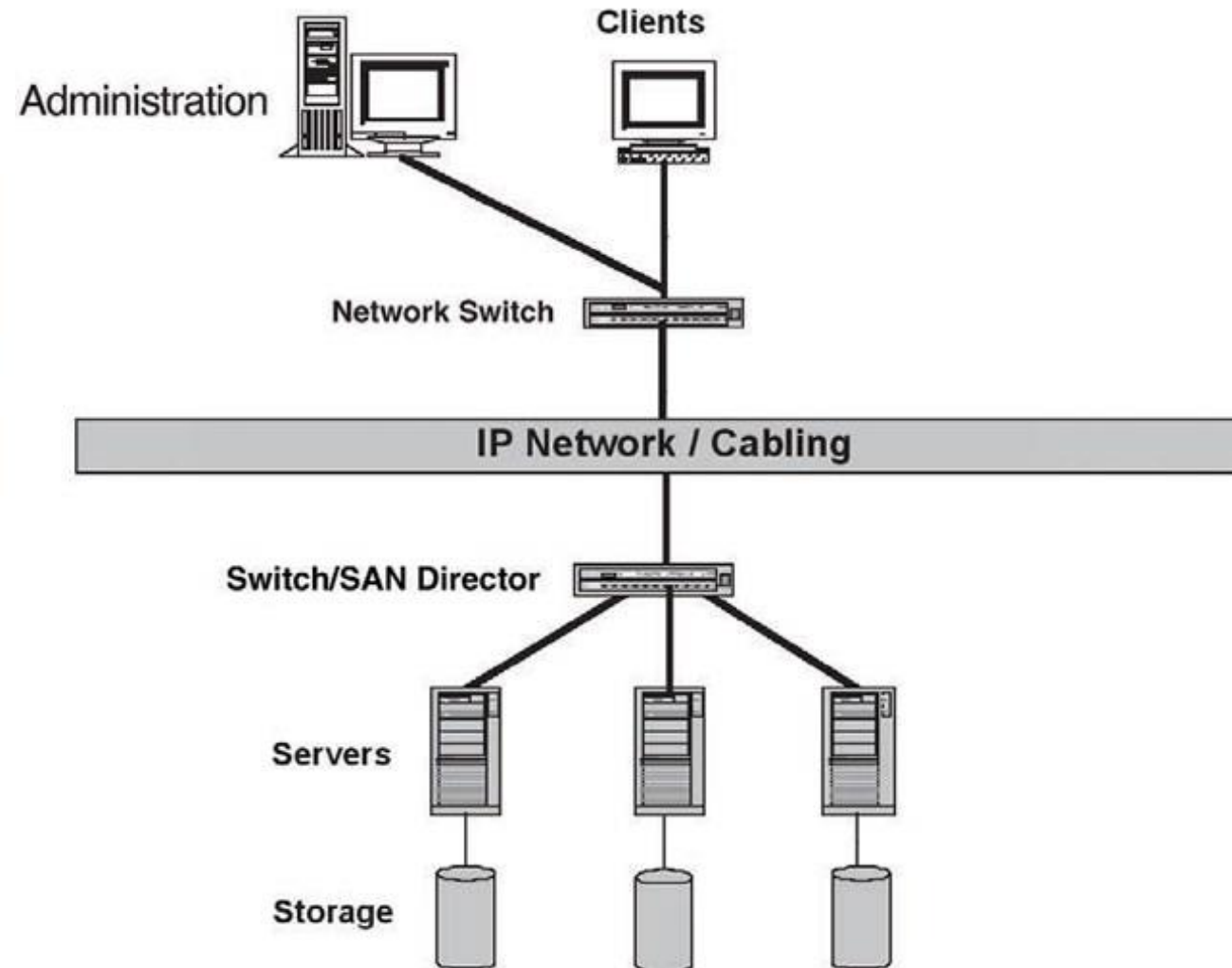
Storage technology has evolved through the following configurations:

- Direct Attached Storage (DAS)
- Redundant Array of Independent Disks (RAID)
- Network Attached Storage (NAS)/Storage Area Network (SAN)
- Internet Protocol SAN (IP-SAN)

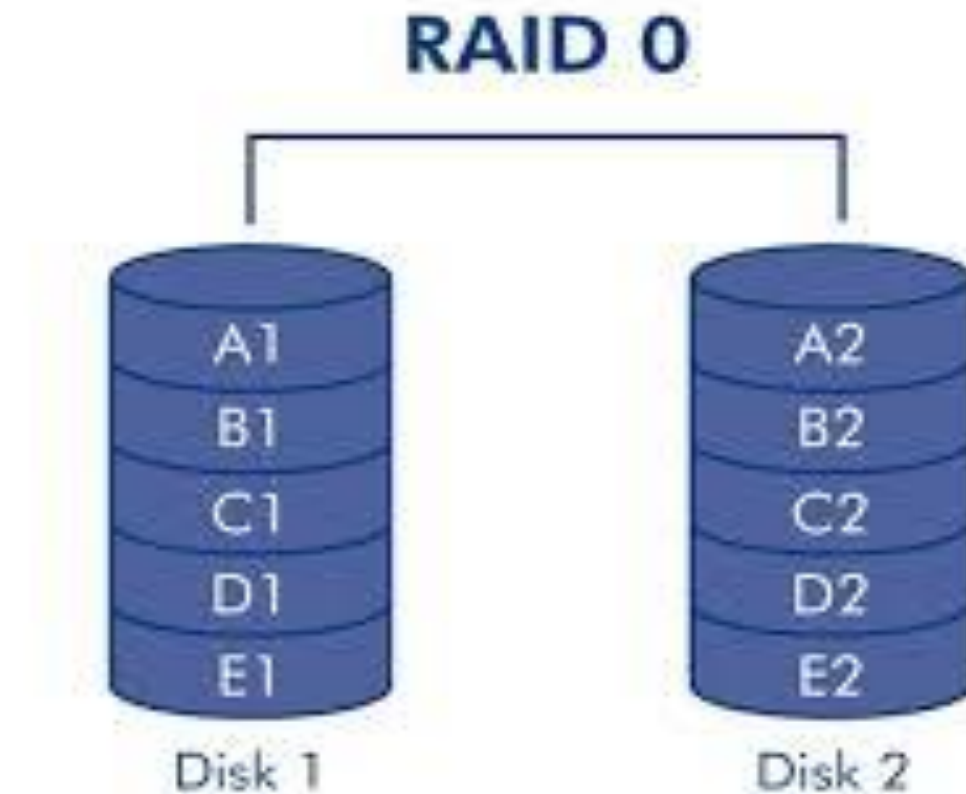
Introduction to Storage and Data Centers Information Storage



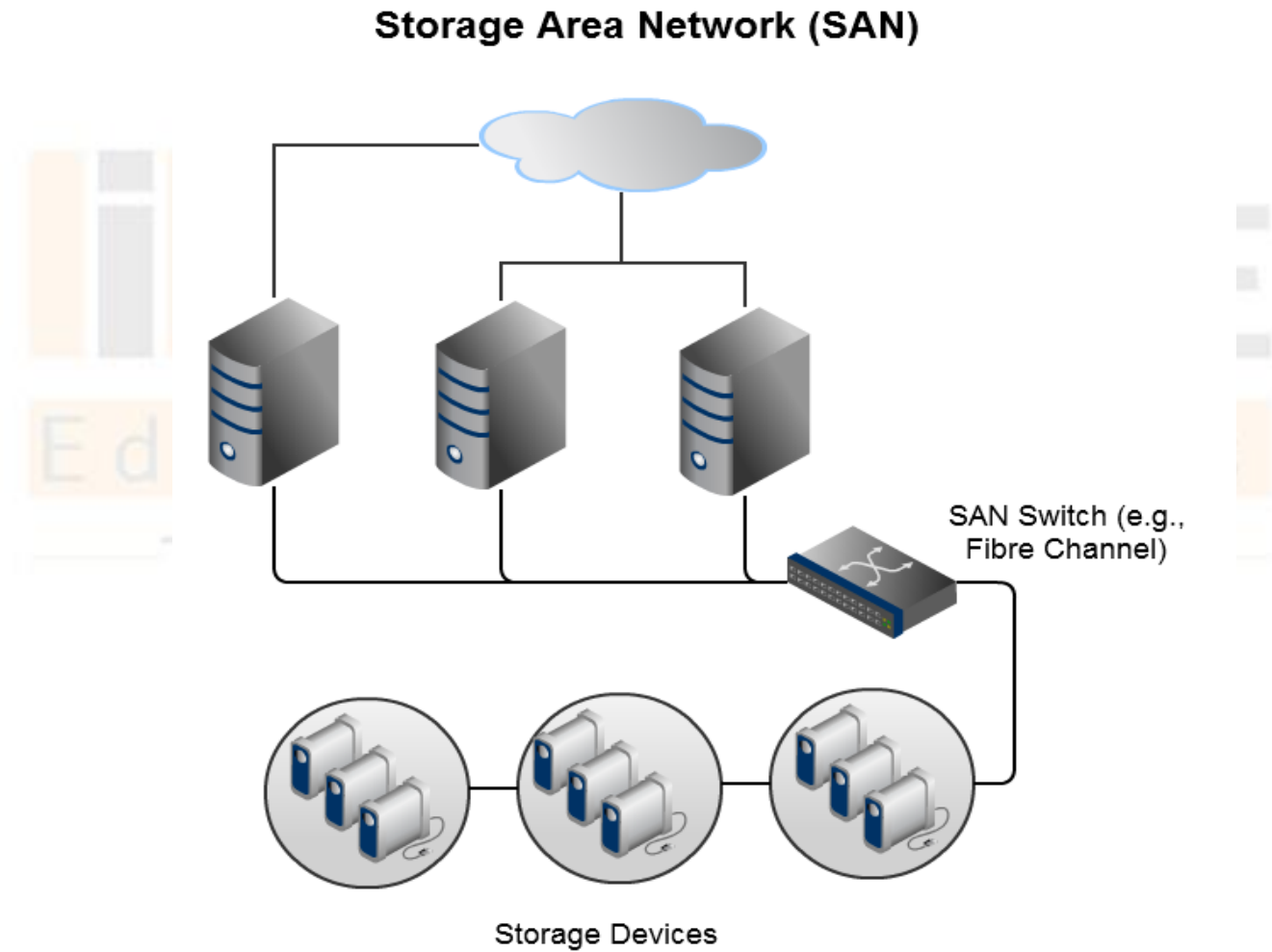
Direct Attached Storage



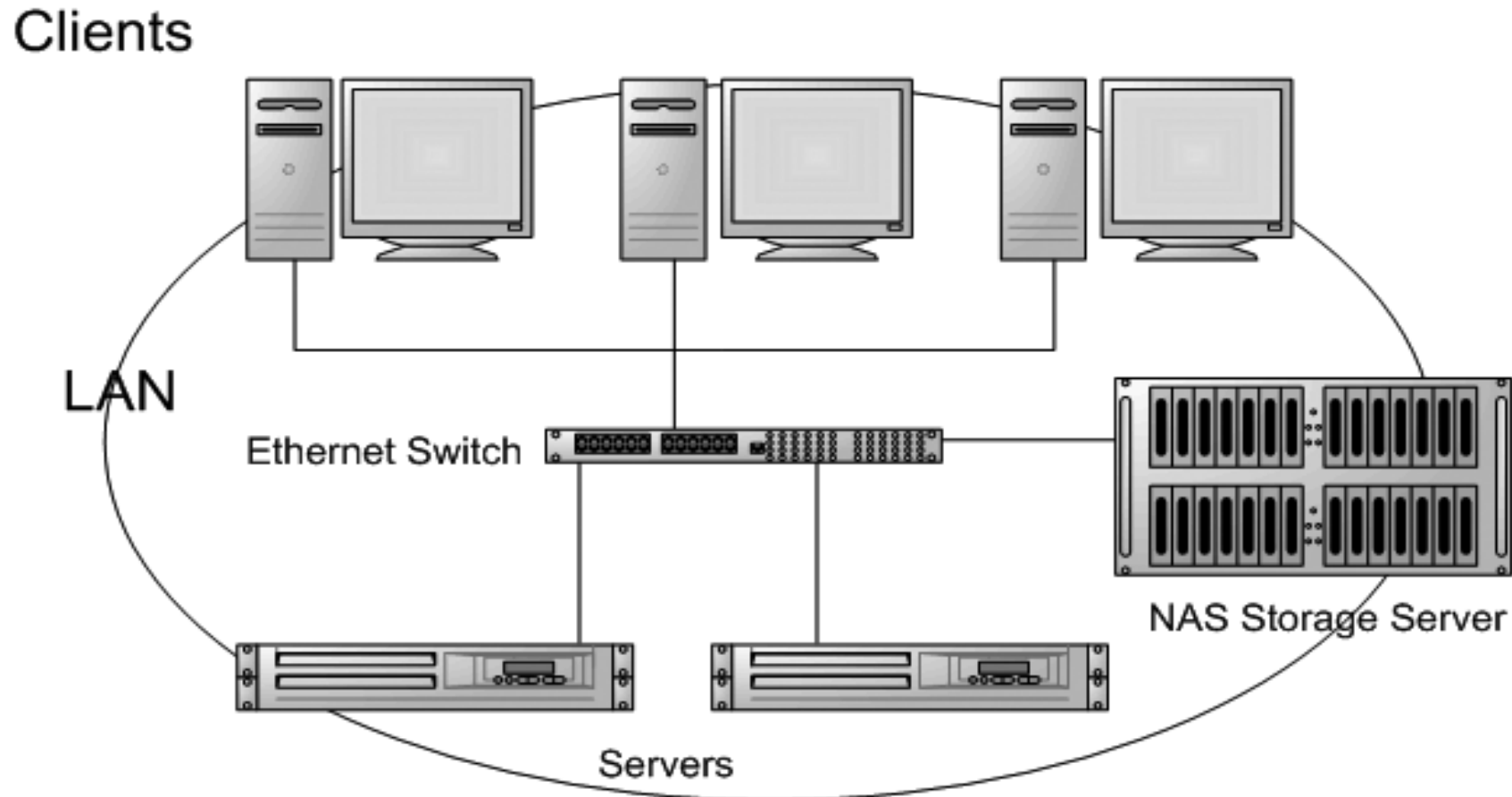
Redundant Array of Independent Disks



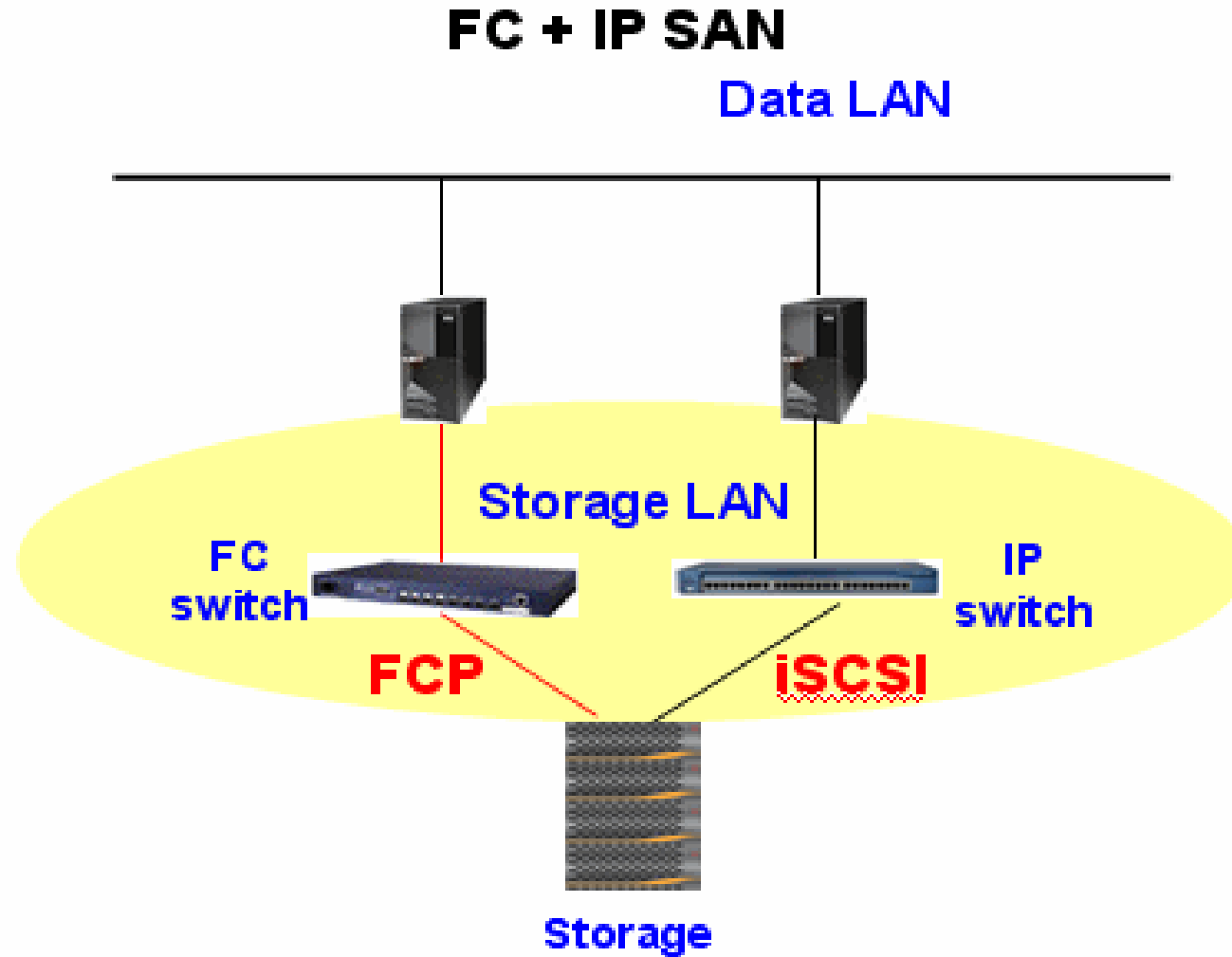
Storage Area Network



Network Attached Storage



IP-SAN



Self Assessment Questions

1. Which of the given options is true about data?

- a) Raw fact
- b) Processed fact
- c) Processed information
- d) None of the Above

Answer: a)

2. Which of these is not an example of unstructured data?

- a) Images
- b) Videos
- c) Audio
- d) Spreadsheet

Answer: d)

Introduction to Storage and Data Centers Information Storage

Document Links

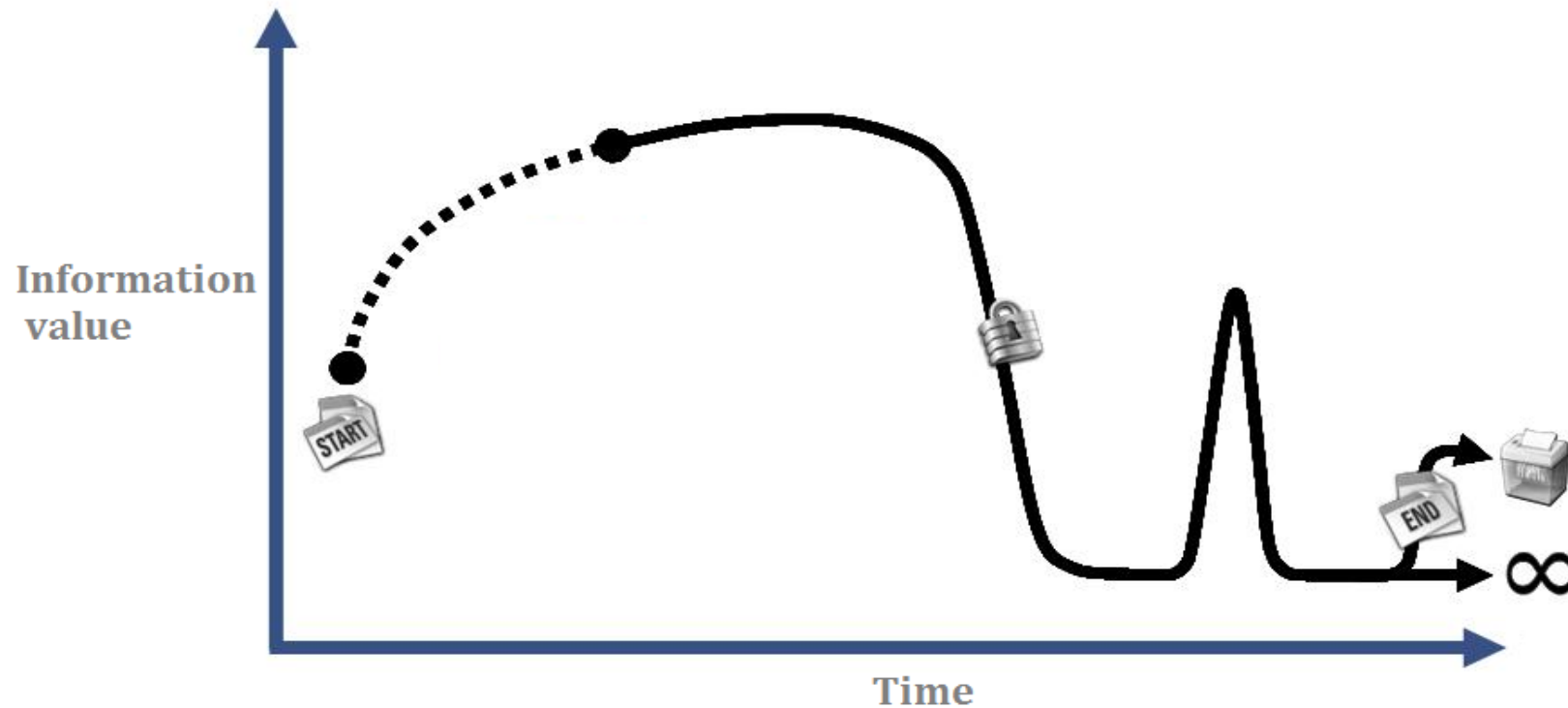
Topics	URL	Notes
Storage Management	https://www.techopedia.com/definition/30481/storage-management	This link explains about basic concept of storage management
Concept of Data and Information	http://www.differencebetween.info/difference-between-data-and-information	You will learn in details how data differs from information. This link provides a tabular comparison between data and information
Storage Technology Evolution	http://www.siemon.com/us/white_papers/14-07-29-data-center-storage-evolution.asp	This link explains about how storage technology has evolved over the years

Introduction to Storage and Data Centers Information Storage

Video Links

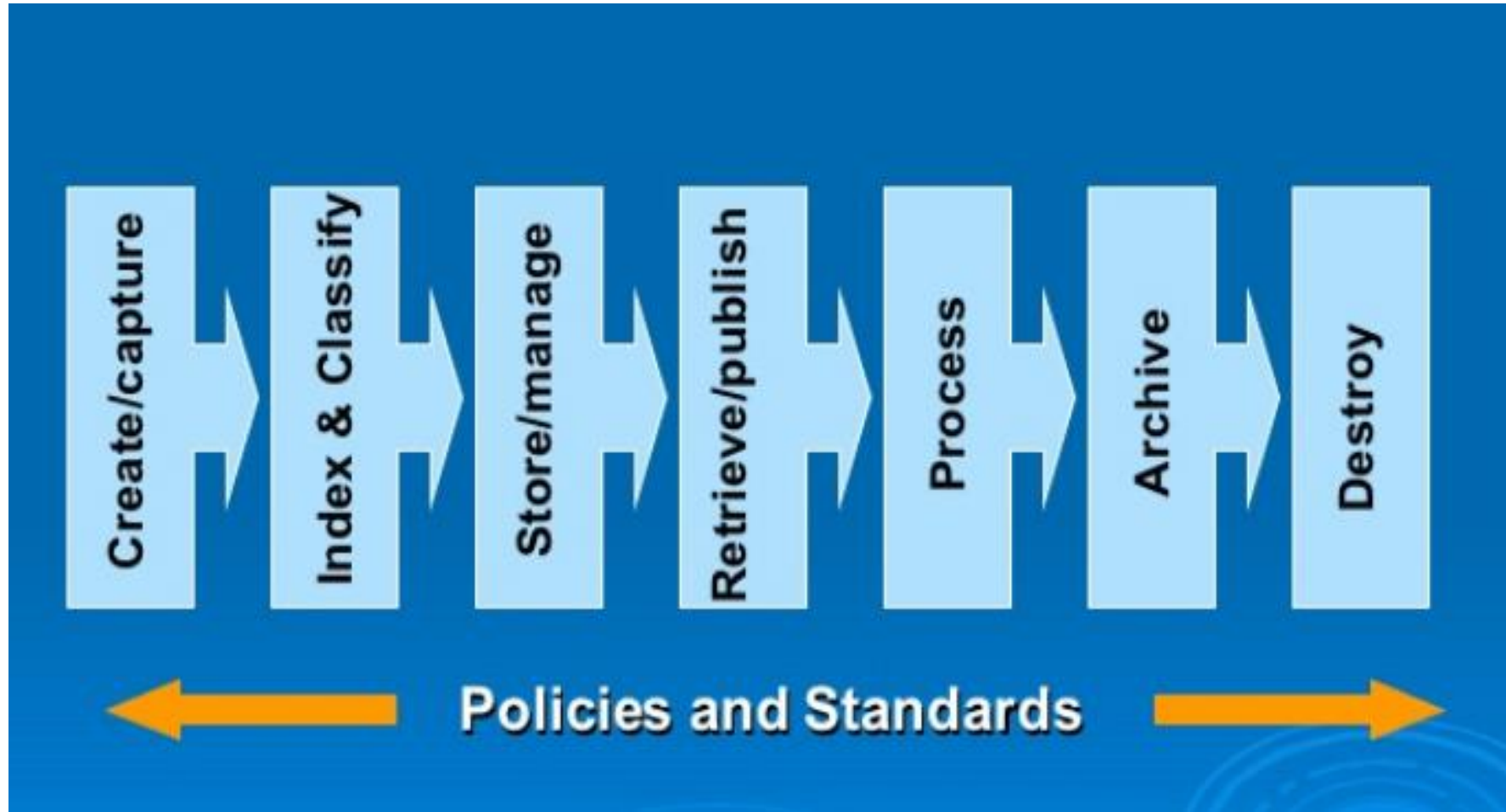
Topics	URL	Notes
Overview of data and information	https://www.youtube.com/watch?v=mUgEgkV16Bw	This video explains about data and information and their relation
Types of data	https://www.youtube.com/watch?v=WBU7sW1jy2o	A detailed description about types of data is presented in this video with enough real-life examples

Information Lifecycle



Change in the value of information with time, from its creation until disposal

Stages in Information Lifecycle

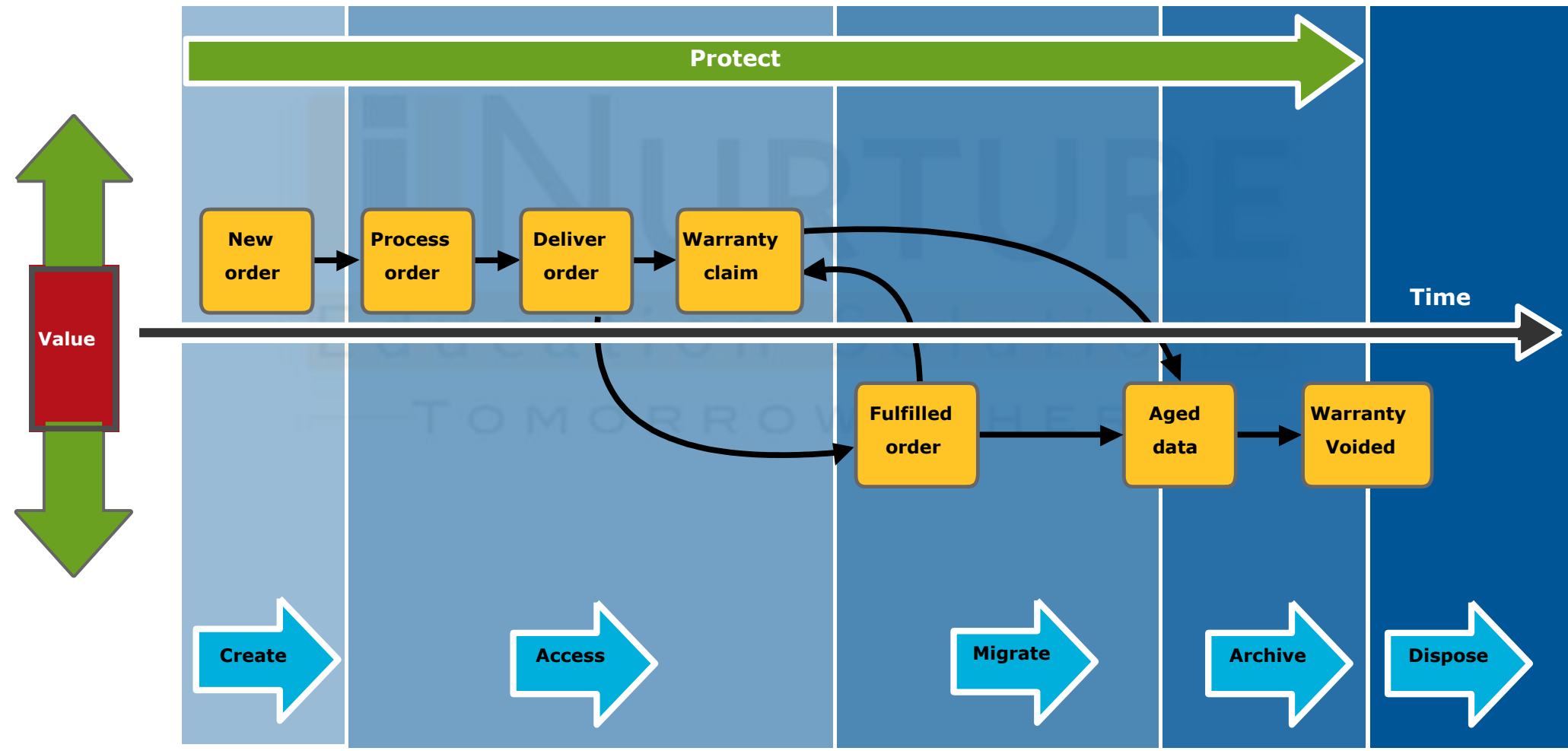


Information Lifecycle Management (ILM)

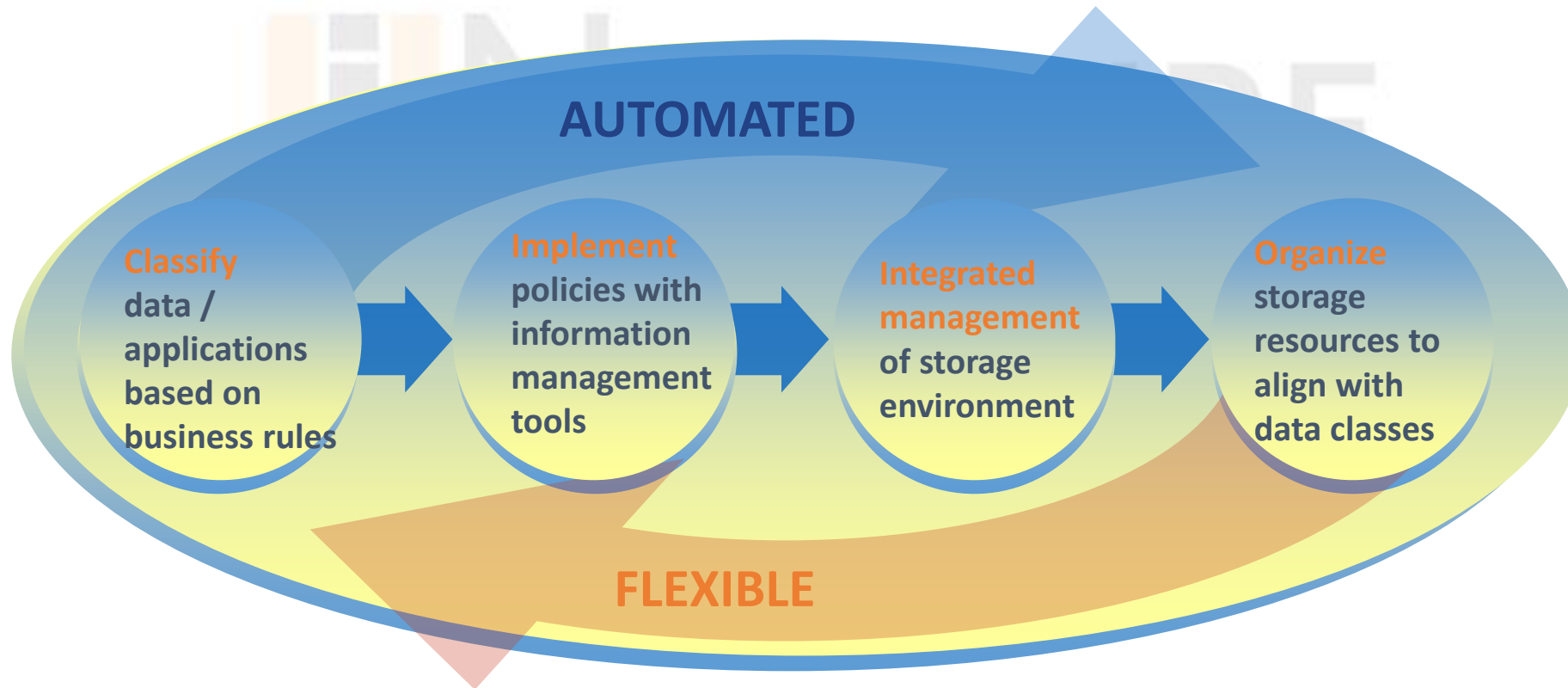
ILM refers to the creation and management of wide-ranging set of strategies for streamlining the storage infrastructure and the data within it. It is a comprehensive approach in managing the flow of data from its creation to its disposal.



Information Lifecycle Management (ILM) Example



Information Lifecycle Management (ILM) Process Overview



Information Lifecycle Management (ILM) Characteristics

ILM should possess the following characteristics to obtain and maintain an ILM strategy:



Business-centric



Policy-based



Optimised



Centrally-managed



Heterogeneous

Information Lifecycle Management (ILM) Benefits

Information retrieval is quick

Management is simplified

Compliances and governance is managed

Operations cost is lowered

Utilisation is improved

Provides wide range of options

TCO is lowered

How good ILM can be for your organisation?

- **Improved utilization**
 - Tiered storage platforms
- **Simplified management**
 - Processes, tools and automation
- **Simplified backup and recovery**
 - A wider range of options to balance the need for business continuity
- **Maintaining compliance**
 - Knowledge of what data needs to be protected for what length of time
- **Lower Total Cost of Ownership**
 - By aligning the infrastructure and management costs with information value

Self Assessment Questions

3. The best storage technology for global data sharing is:

- a) SAN
- b) NAS
- c) RAID
- d) IP-SAN

Answer: d)

4. The value of information _____

- a) Remains constant
- b) Changes over time
- c) May change or may not change over time
- d) None of above

Answer: b)

5. Which of these is not a stage of Information Lifecycle?

- a) Data creation
- b) Data sharing
- c) Data archival
- d) None of the above

Answer: d)

6. DAS is a kind of storage that is directly connected to a computer.

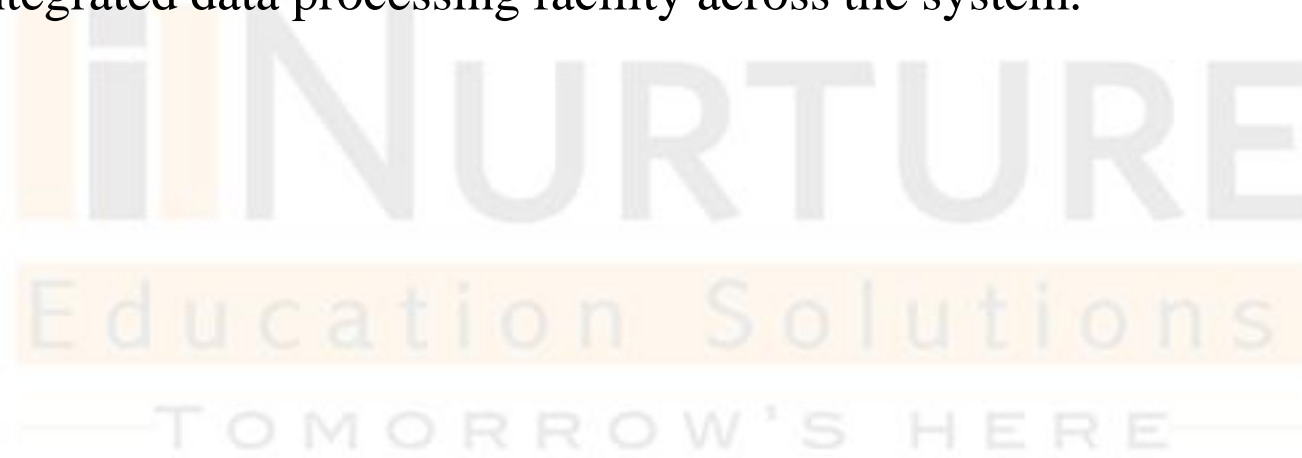
- a) True
- b) False

Answer: a)

INTRODUCTION TO DATA CENTER

What is a data center?

Data centers store and manage a large volume of mission-critical data. Organizations maintain data centers to provide integrated data processing facility across the system.



Goals of Data Center

- Support for business operations around the clock (resiliency)
- Protection of data against disaster and multiple software/hardware failure
- Safe custody of huge amount of data
- Lowering the total cost of operation and the maintenance needed to sustain the business function

Facilities offered by Data Center

- Helps distribute data processing workloads for large organisations.
- Combines various storage architectures to meet the storage requirements of organisation
- Uninterrupted and seamless operation

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How a Data Center look like?



Introduction to Storage and Data Centers Information Storage

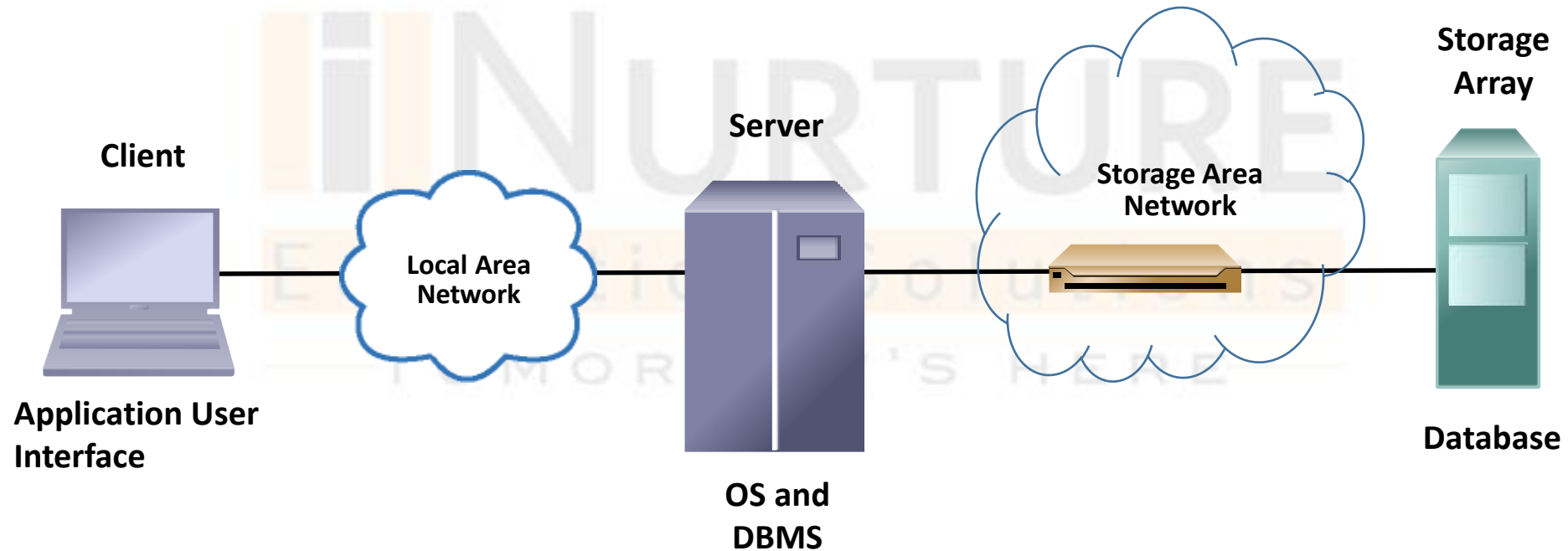
Inside of Facebook data center



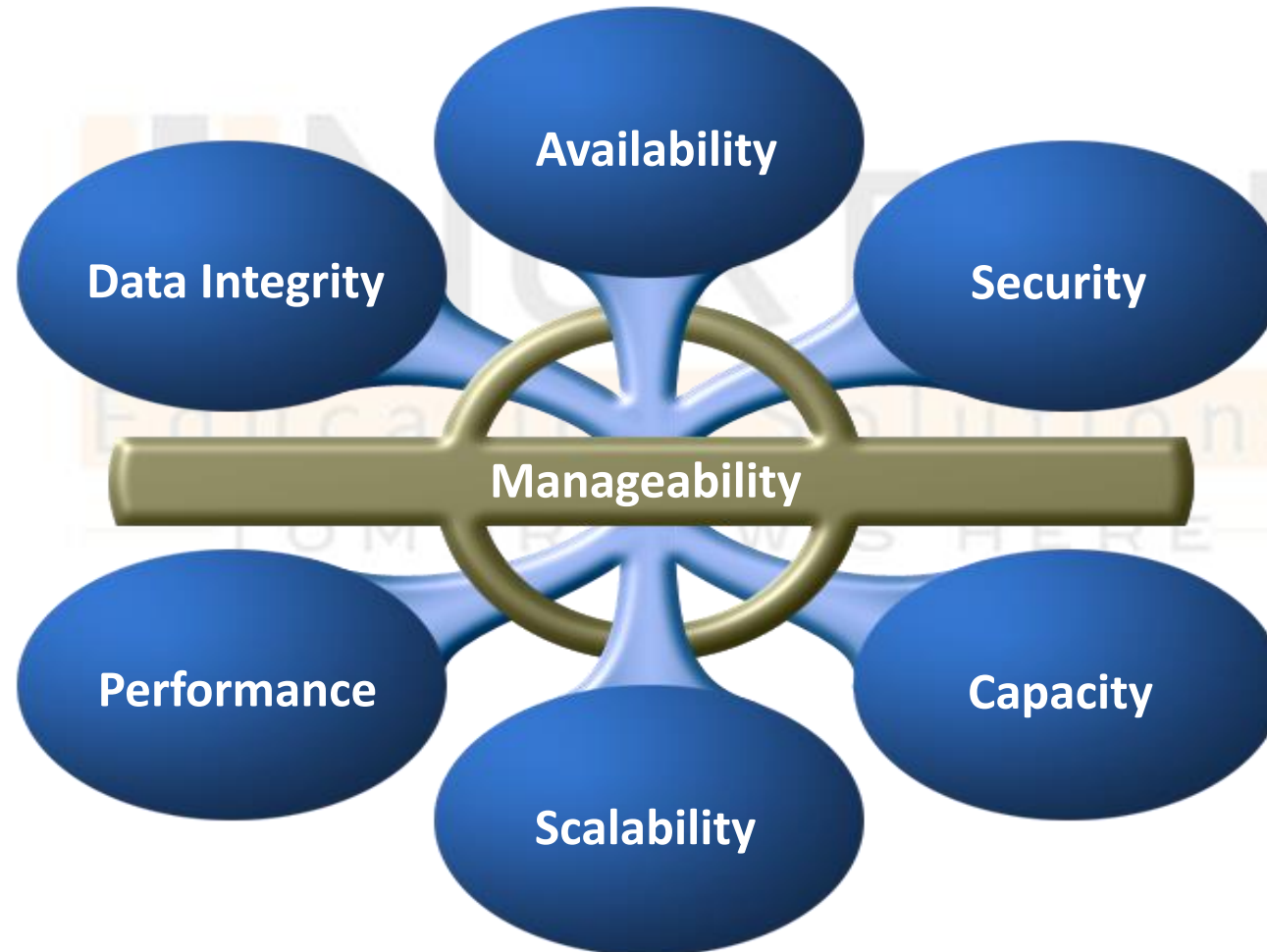
Core Elements in Data Center Infrastructure

- Applications
- Databases – Database Management System (DBMS) and the physical and logical storage of data
- Servers/Operating systems
- Networks (LAN and SAN)
- Storage arrays

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What key factors to ensure for the success of a Data Center?



Key Requirements for Data Center Elements

1. Availability
2. Location and facility
3. Uptime
4. Cooling
5. Security
6. Facility maintenance
7. Scalability
8. Change Management

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Availability: All data center elements should be designed to enable accessibility. The ability of users to access data when necessary can have a positive impact on a business.



Location and Facility: Location can have a considerable impact and could serve as an opportunity to enhance the company's ability to address network expectancy, disaster recovery, and data control. When determining the location of a data center, it is also necessary to consider the geographical location with respect to the service provider.



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Uptime: Organizations can lose a lot of money during the downtime due to the inaccessibility of necessary information and resources. The service provider's track record of uptime should be tested and it should be determined whether the provider has been able to maintain 100% availability for electrical and mechanical systems in the past.



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Powerful backup arrangement to provide 100% Uptime



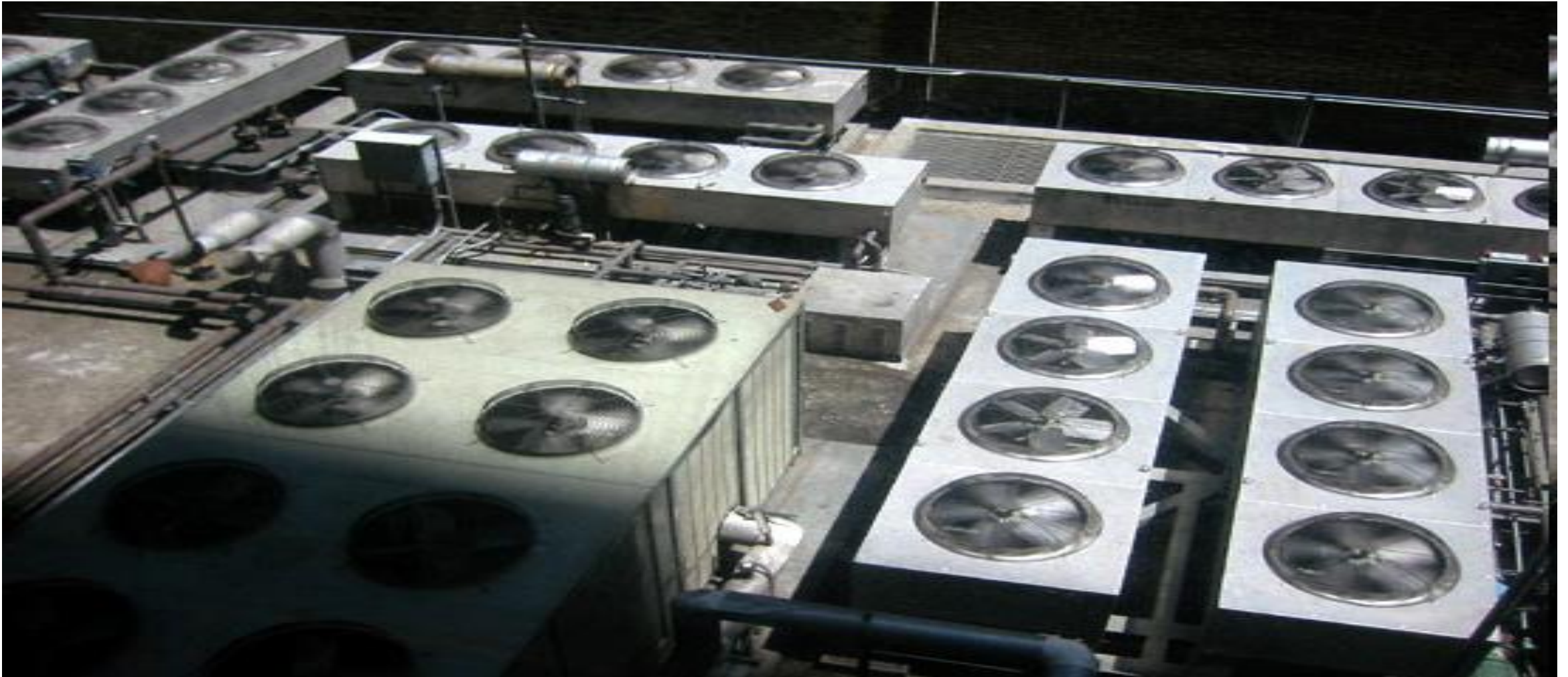
Key Requirements for Data Center Elements

Cooling: The establishment of a data center involves a combination of utilities, generators, and a range of power supplies that emit excessive heat. It is essential to have a robust cooling infrastructure to ensure cost efficiencies and a viable environment to establish the data center.



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Cooling arrangement in data center environment



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Security: The security of the data center is equally important. It is necessary to establish policies and procedures, and ensure proper integration of the data center core elements in order to prevent unauthorized access to information. To maximize protection, the facility should be fabricated with military-grade security measures.



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Facility Maintenance: During the installation of a data center, it is important to consider the maintenance and management aspects. The provider should have sufficient insight of the facility and its efficiencies to ensure that the entire system is being observed and any issues can be quickly addressed before they cause any outage.



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Scalability: Data center operations should be able to allocate additional on-demand storage or processing capabilities, without interrupting business operations. For the growth of a business, it is often necessary to install more servers, additional databases, and new applications. The storage solution should also be able to grow with the business.



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Change Management: Proper guidelines for change management ensure that there is no alteration in the data center that has not been planned, scheduled, discussed, and approved. It is also necessary to provide back out steps or a Plan B. Whether bringing new amendments to the system or making old practices obsolete, data centers must follow the change management process.



Self Assessment Questions

7. Which of these is a data center element?

- a) Databases
- b) Servers
- c) Applications
- d) All of these

Answer: d)

8. Availability of data center elements refers to _____ of the elements.

- a) Accessibility
- b) Robustness
- c) Scalability
- d) Optimality

Answer: a)

9. While determining site for a data center, the most important factor to consider is _____

- a) Cost
- b) Geographical location
- c) Workforce
- d) None of these

Answer: b)

Introduction to Storage and Data Centers Information Storage

Document Links

Topics	URL	Notes
Data Center Elements	https://www.techrepublic.com/blog/10-things/10-critical-elements-of-an-efficient-data-center/	This link explains about typical elements that an efficient data center is expected to have. The success of data center depends on proper management of these elements

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Video Links

Topics	URL	Notes
Data Center Basics	https://www.youtube.com/watch?v=UnBrZUj38oU	This video discusses everything from data center basics and the components inside a Data center and covered some of the available Data center certifications and website for certifications

Role of Data Center in the Enterprise

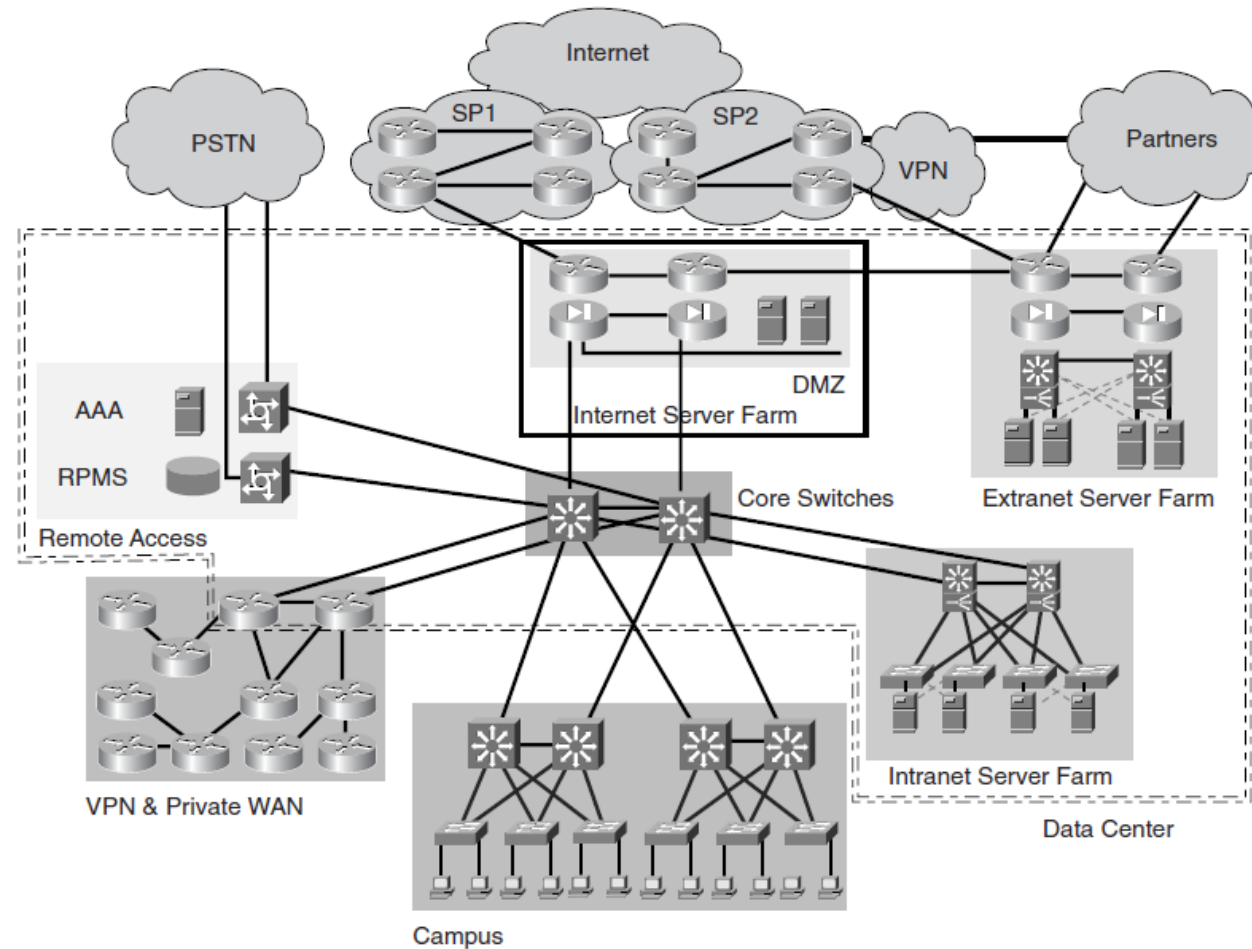
Introduction to Storage and Data Centers Information Storage

The building blocks of a typical enterprise network include:

- Campus network
- Private WAN
- Remote access
- Internet server farm
- Extranet server farm
- Intranet server farm

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Data Centers in the Enterprise



Introduction to Storage and Data Centers Information Storage

- Data Centers typically house many components that support the infrastructure building blocks, such as the core switches of the campus network or the edge routers of the private WAN.
- Data Center designs can include any or all of the building blocks as shown in previous slide figure, including any or all server farm types. Each type of server farm can be a separate physical entity, depending on the business requirements of the enterprise.

Role of Data Center in Service Provider Environment

Introduction to Storage and Data Centers Information Storage

Data Centers in service provider (SP) environments, known as Internet Data Centers (IDCs), unlike in enterprise environments, are the source of revenue that supports collocated server farms for enterprise customers.

The SP Data Center is a service-oriented environment built to house, or host, an enterprise customer's application environment under tightly controlled SLAs for uptime and availability. Enterprises also build IDCs when the sole reason for the Data Center is to support Internet-facing applications.

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Self Assessment Questions

10. Which of the following is a building block of a typical enterprise network?

- a) Private WAN
- b) Remote access
- c) Extranet server farm
- d) All of these

Answer: d)

11. IDCs are

- a) Data centers in Enterprise environment
- b) Data centers in Service Provider environment
- c) Data centers in local environment
- d) None of the Above

Answer: b)

Data Center Architecture

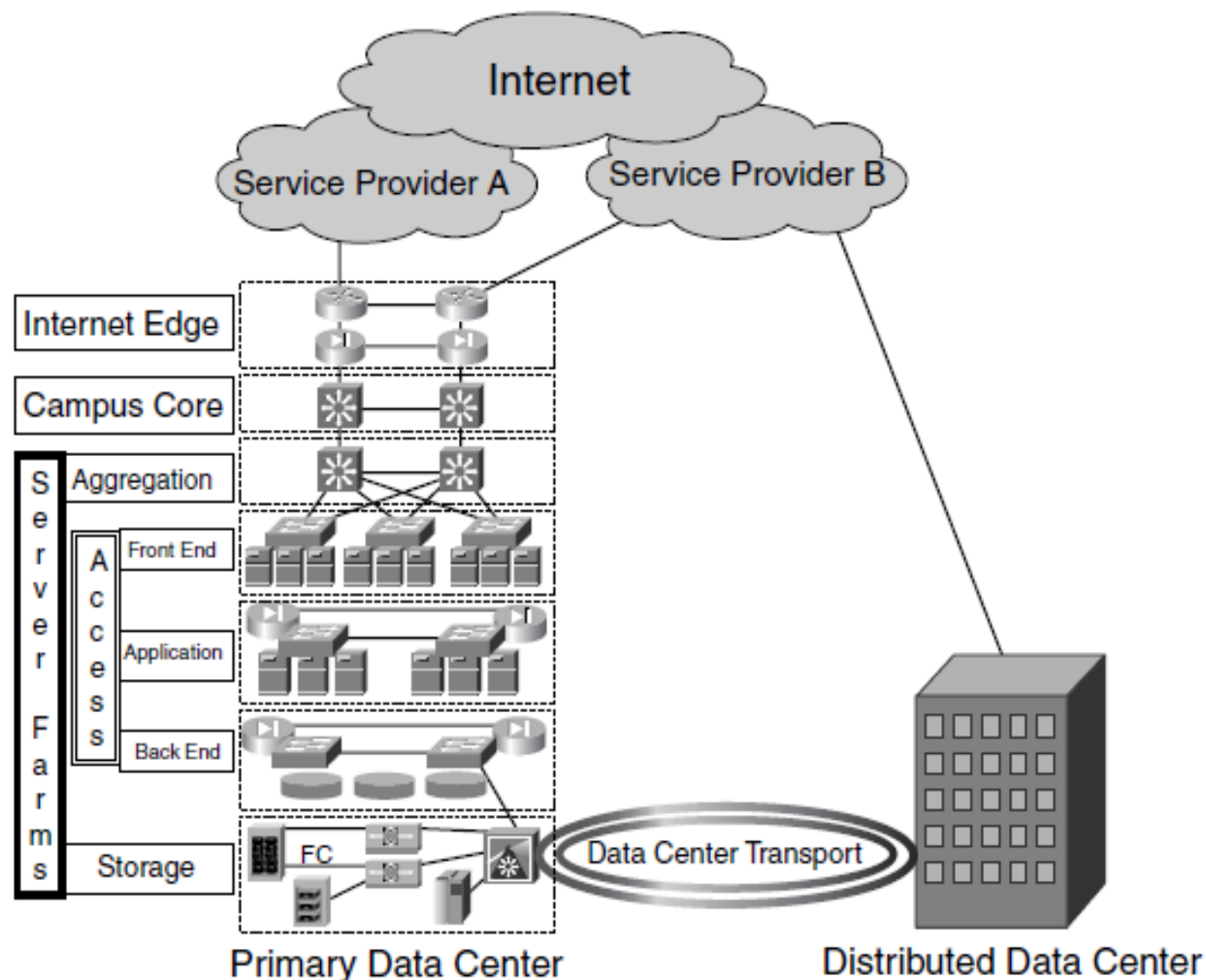
Introduction to Storage and Data Centers Information Storage

In this section, we shall discuss the architecture of a generic enterprise Data Center connected to the Internet and supporting an intranet server farm.



Topology of an Enterprise Data Center Architecture

Introduction to Storage and Data Centers Information Storage



Internet Edge

The Internet Edge provides the connectivity from the enterprise to the Internet and its associated redundancy and security functions, as following:

- Redundant connections to different service providers
- External and internal routing through exterior border gateway protocol (EBGP) and interior border gateway protocol (IBGP)
- Edge security to control access from the Internet
- Control for access to the Internet from the enterprise clients

Campus Core Switches

The campus core switches provide connectivity between the Internet Edge, the intranet server farms, the campus network, and the private WAN.

The core switches physically connect to the devices that provide access to other major network areas, such as the private WAN edge routers, the server-farm aggregation switches, and campus distribution switches.

Network Layers of the Server Farm

Aggregation Layer

Access Layer

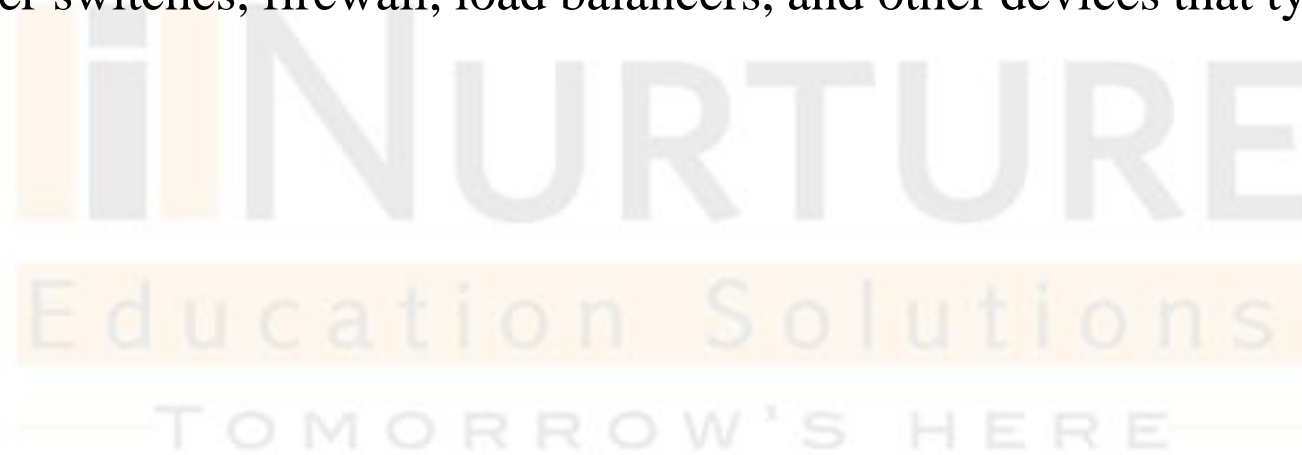
Storage Layer

Data Center Transport Layer

Aggregation Layer

The aggregation layer is the aggregation point for devices that provide services to all server farms. These devices are multilayer switches, firewall, load balancers, and other devices that typically support services across all servers

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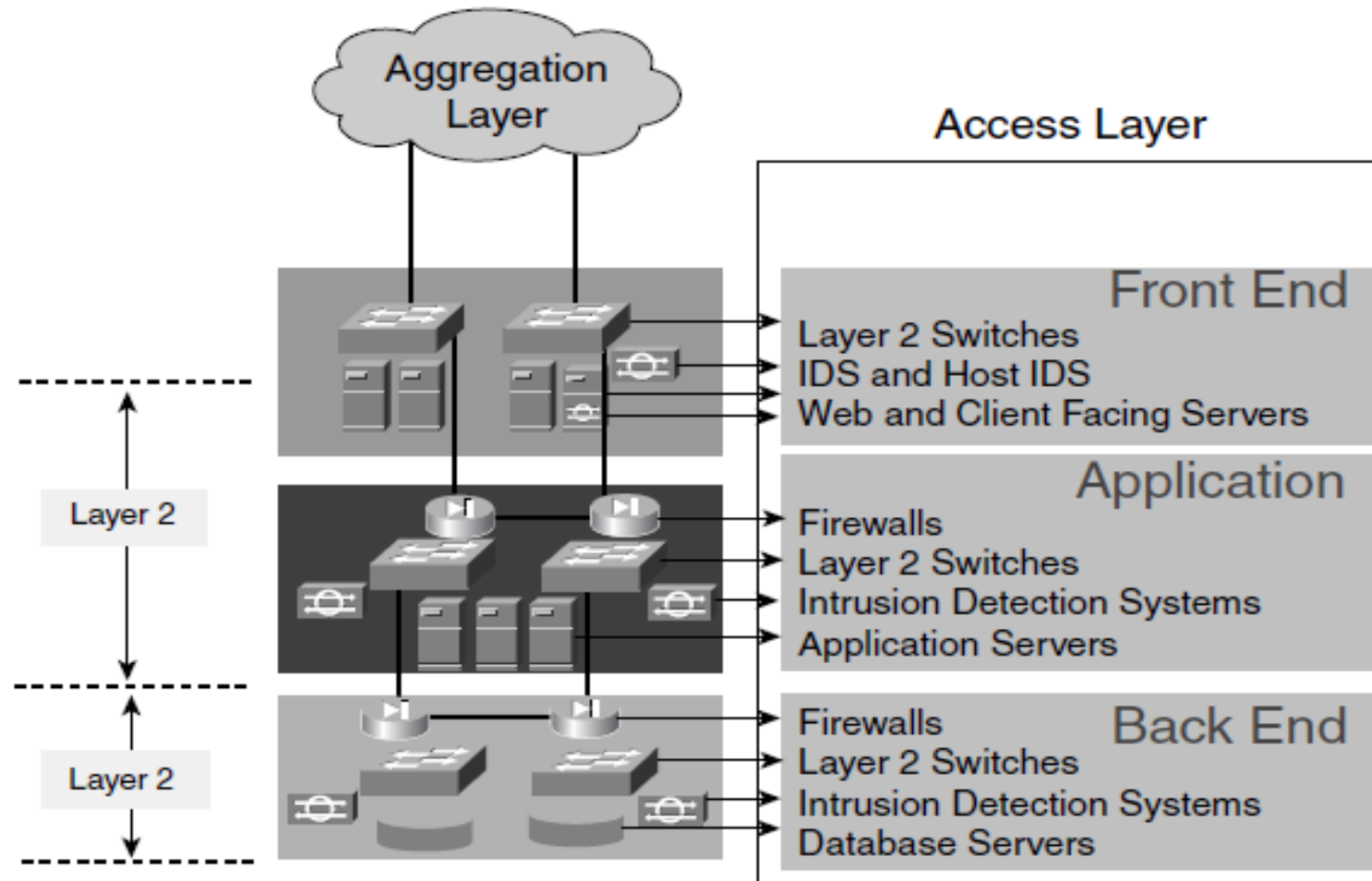
Access Layer

The access layer provides Layer 2 connectivity and Layer 2 features to the server farm. In a multitier server farm, each server function could be located on different access switches on different segments. The three segments are: Front End segment, Application segment and Back End segment.



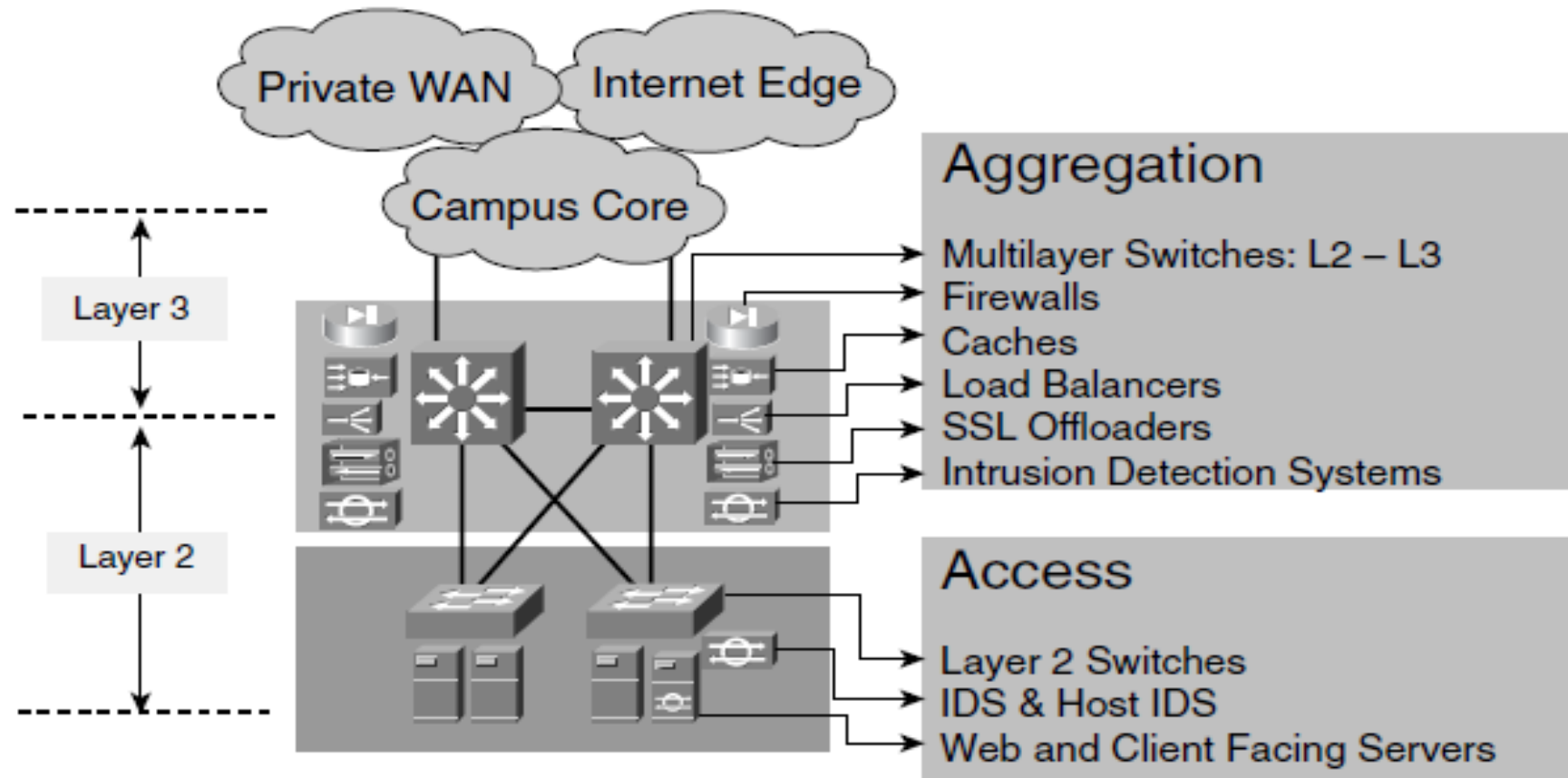
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Access Layer Segments



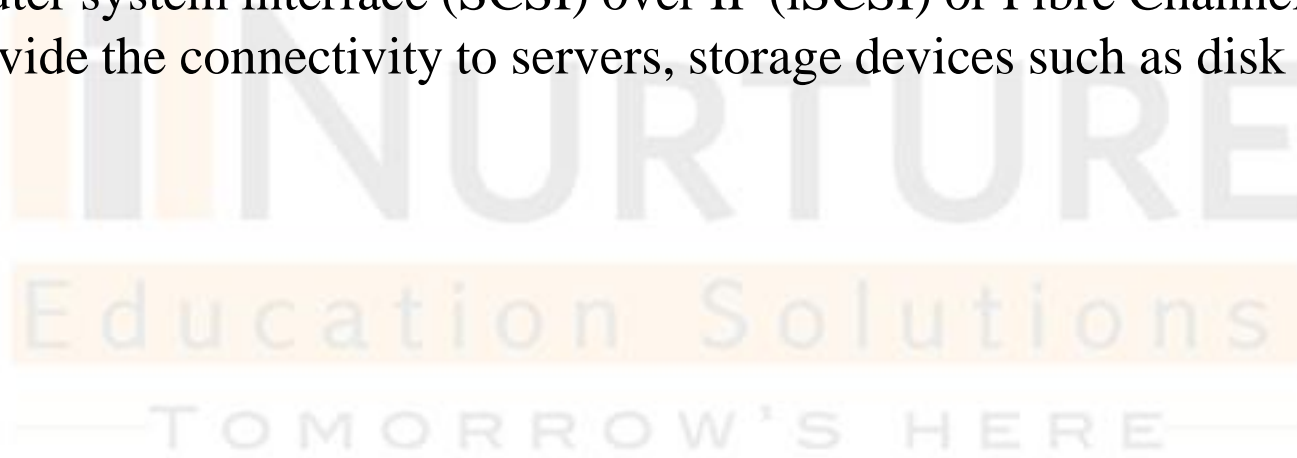
Aggregation and Access Layers

Aggregation and Access Layers



Storage Layer

The storage layer consists of the storage infrastructure such as Fibre Channel switches and routers that support small computer system interface (SCSI) over IP (iSCSI) or Fibre Channel over IP (FCIP). Storage network devices provide the connectivity to servers, storage devices such as disk subsystems, and tape subsystems.



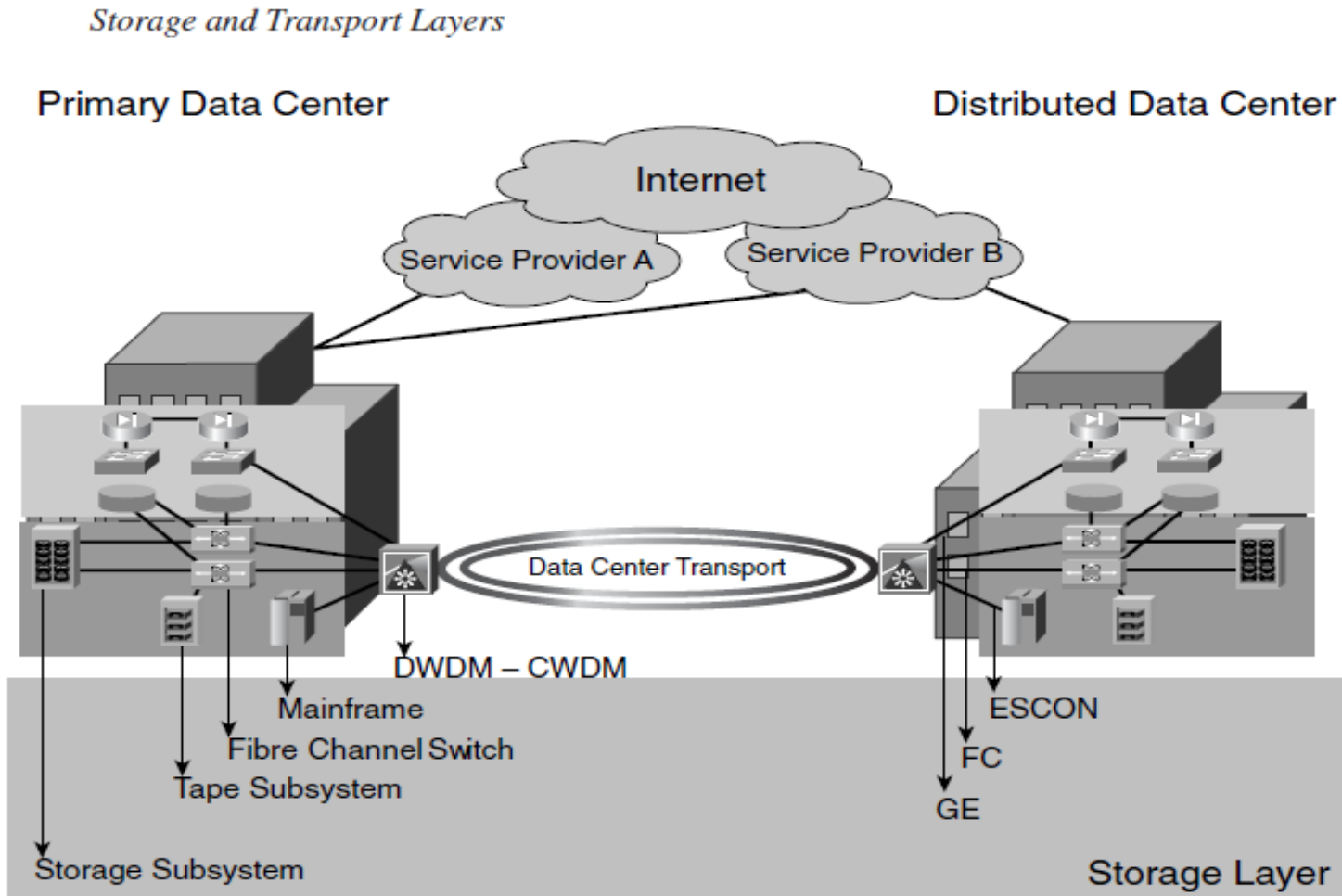
Transport Layer

The Data Center transport layer includes the transport technologies required for the following purposes:

- Communication between distributed Data Centers for rerouting client-to-server traffic
- Communication between distributed server farms located in distributed Data Centers for the purpose of remote mirroring, replication, or clustering

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Storage and Transport Layers



Self Assessment Questions

12. _____ provides the connectivity from the enterprise to the Internet.

- a) Internet Edge
- b) Campus Core Switches
- c) Access layer
- d) Storage layer

Answer: a)

13. The _____ provide connectivity between the Internet Edge, the intranet server farms, the campus network, and the private WAN.
- a) Internet Edge
 - b) Campus Core Switches
 - c) Access layer
 - d) Storage layer

Answer: b)

14. Access layer provides Layer 2 connectivity and Layer 2 features to the server farm.

- a) True
- b) False

Answer: a)



Introduction to Storage and Data Centers Information Storage

Document Links

Topics	URL	Notes
Data Center Architecture	https://www.fiberoptics4sale.com/blogs/archiv-e-posts/95041990-what-are-data-centers	This link explains about the detailed architecture of data center, in particular enterprise data center
Data Center Strategy	http://focus.forsythe.com/articles/396/10-Steps-to-a-Successful-Data-Center-Strategy	This link explains the steps to a successful Data Center strategy

Introduction to Storage and Data Centers Information Storage

Video Links

Topics	URL	Notes
Data Center Deployment	https://www.youtube.com/watch?v=McVZ01kn-lQ	This video explains about real life data center deployment and best practices
Data Center Topology	https://www.youtube.com/watch?v=8M0XPOiKC7I	In this Video, you will learn about details of Data Center topology

Self Assessment Questions

15. In data center environment, cooling is required because

- a) Workers may feel hot
- b) Workers can work comfortably
- c) Equipments emit excessive heat
- d) None of these

Answer: c)

16. Accessibility of data center elements will have no impact on business.

- a) True
- b) False

Answer: b)



17. Good location of data center indicates _____

- a) Continuous service availability
- b) No impact on service
- c) Better service quality
- d) None of these

Answer: a)

18. Uptime indicates _____

- a) Time in which all services are up and running
- b) Time in maintenance operation of the data center
- c) Time in which some services are temporarily suspended
- d) None of these

Answer: a)

19. Powerful backup solution guarantees _____ uptime

- a) Low
- b) Medium
- c) High
- d) None of these

Answer: c)

20. The term _____ indicates additional on-demand capabilities.

- a) Robustness
- b) Scalability
- c) Accessibility
- d) Fault tolerance

Answer: b)

21. Which of these is true about change management?

- a) No unplanned alteration in the data center
- b) Enforces changes in data center from time to time
- c) Manage various changes that take place in data center
- d) None of the above

Answer: a)

22. It is important to have a Plan B in place in a typical data center environment. State whether True or False.

- a) True
- b) False

Answer: a)



23. In a multitier server farm, each server function could be located on different access switches on different segments. State true or false.

- a) True
- b) False

Answer: a)

24. Which of these is not a segment of Access Layer?

- a) Front end segment
- b) Back end segment
- c) Application segment
- d) Middle level segment

Answer: d)

Summary

- Data is a collection of raw facts from which the required output is extracted.
- Information is processed data. The value of information changes over time.
- Storage technology has evolved through configurations such as RAID, DAS, SAN, NAS, and IP-SAN.
- The change in value of information with the change in time is called information lifecycle.
- ILM is a comprehensive approach in managing the flow of data from its creation to its disposal.
- The key requirement for data center, elements are availability, location and facility, uptime, cooling, security, facility maintenance, scalability, and change management.

Assignment

You need to answer below sets of problem. These sets of questions are meant for testing unit I.

1. Define data and information with real life examples.
2. Explain in your own words, how structured and unstructured data differs?
3. Write a description on evolution of storage technologies.
4. Explain the different stages of Information Lifecycle.
5. What is ILM ? Explain the various ILM benefits.
6. Why do we need data centers? Explain.
7. Name and explain the core elements in data center infrastructure.
8. Explain the architecture of Enterprise Data Center.

Introduction to Storage and Data Centers Information Storage

Document Links

Topics	URL	Notes
Cover Story: Storage Management	http://www.networkmagazineindia.com/200309/coverstory01.shtml	This link explains a general overview of storage management, along with expert's opinion
Storage infrastructure management is still elusive	http://searchstorage.techtarget.com/opinion/Storage-infrastructure-management-is-still-elusive	You will learn Basic challenges associated with Storage and its management
Steps to ILM implementation	http://www.networkworld.com/article/2300188/data-center/six-steps-to-ilm-implementation.html	This link explains about the six steps to successfully implement ILM
Information Lifecycle Management	http://searchstorage.techtarget.com/definition/information-life-cycle-management	This link explains about ILM approach in industry
Data Center Architecture	https://www.fiberoptics4sale.com/blogs/archive-posts/95041990-what-are-data-centers	This link explains about architecture of data center , with emphasis to enterprise and discussing each component in details
Data Center Strategy	http://focus.forsythe.com/articles/396/10-Steps-to-a-Successful-Data-Center-Strategy	In this link, you will learn about the steps for adopting a successful Data Center Strategy

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Video Links

Topics	URL	Notes
Types of storage technologies	https://www.youtube.com/watch?v=bpUzGZLO948&list=PLWDUzz3hCDJFiOO_zpMTbiHUNPDpU3xb	This link compares DAS, NAS and SAN technologies
Overview of data and information	https://www.youtube.com/watch?v=mUgEgkV16Bw	This link explains what is data and information. A short description on how data differs from information.
Inside a Google Data Center	https://www.youtube.com/watch?v=XZmGGAAbHqa0	This link takes us to a virtual tour inside a Google Data Center

Introduction to Storage and Data Centers Information Storage

E-Book Links

Topics	URL	Page Number
Building a Modern Data Center	https://www.actualtechmedia.com/wp-content/uploads/2016/05/Building-a-Modern-Data-Center-ebook.pdf	Page Number 14 to Page Number 22
Information Storage and Management	http://www.academia.edu/19388733/1_1_Information_Storage_and_Management_2nd_Edition	Page Number 4 - Page Number 15