

# **A Study of Data Center Design and Implementation in Bangladesh**

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# Approval Certificate

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## **Abstract**

A data center is a facility used to houses various equipment such as computer systems, servers like web servers, application servers, database servers and associated components, such as and storage telecommunications systems. A data center usually includes redundant power supplies, redundant data connections, fire suppression, air conditioning, and various security devices. For an industrial scale operations, a large data center using as much electricity as a small town.

Nowadays, Human activities such as telecommunications, energy, transport, health, security systems, banks, internet, lighting, entertainment, urban traffic and even physical integrity are mastered by a data centers.

Shortly, the prosperity and security of human beings is passed on to these centers of control and supervision of data and information. Most common people may not concern too much about it. However, big organization and public institutions, on the other hand, have a responsibility to act seriously against such affairs.

In this study, we presented the scenario of Data Center Design and Implementation in Bangladesh.

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The Author

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# Chapter 1

## 1. Introduction

### 1.1 Data Centre

A data center contains servers, storages, databases, networks, security devices, access controls, software and applications which is situated in a centralized location with fully computing resources and crucial telecommunication connections.

Extremely trained resource, government or private sectors control the industry. Because of strange power consumption and high operational costing data center was considered a villain of the environment.

However, the scenario has been changed; nowadays the data centers are much smaller and modular than previous years. Though the large corporate tendency is to grow the modular facilities of a data center, it does not have operational impact in the long life cycle of a data center. Comparing to previous data center concept, the modern data centers consume less power and space occupancy also less. Considering service demand the data center growth depends. However, there are positive results for the companies themselves, within the philosophy of “green technology” the sustainability and its effect on the environment is a real concern.

### 1.2 History of a Data Centre

Data center was first introduced in the year 1950-60 however their structure and functions are far different from the present era. Throughout the year 1970s and 80s due to the cost of power computing was so costly to manage and organizations could not think to maintain data in-house ‘machine –room’. They preferred to outsource the service.

The year 1990s is the period of mushroom growth of microprocessor, internet evolution and the development of client-server computing models. Gradually, the microprocessor computers acting as servers had replaced old main frame computers and that was the base of data center. After standardization of design, structure, operations we are working with

the modern look data center. In the year 2000s, data centers are being developed and different types of tiers are introduced.

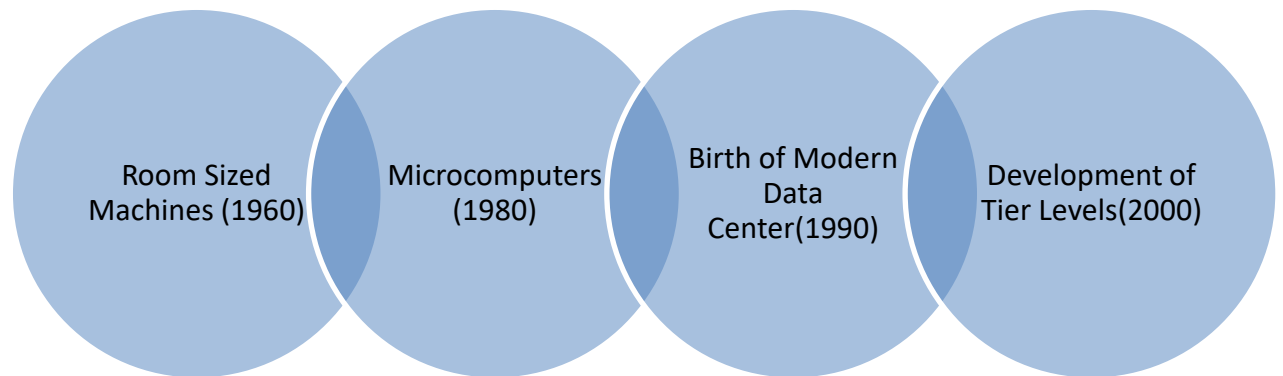


Figure 1.1: Flowchart showing the growth of datacenter over the year.

### 1.3 Data Centre do

To run a business, organization, charities and so on it is very important to keep their documents, customer details and financial information safe from being accidentally deleted or may be from lost. To keep them safe they need locally connected internet connection so that they can store their data on a simple server on the premises. However, this locally connected internet connection is helpful only to keep store of small amount of data. Once the organization grows bigger, they need to store more data; and unavoidably they need more servers and an entirely separate server room instead of computers connected with local networks. However, maintaining a server room is not an easy task. Because they create lots of heat and keeping them cool is a very expensive one. On the other hand, to run their functions around the clock an IT professional is needed to keep an eye on it so that it can run reliably. So maintaining an in-house server room by owns it has required a serious financial and logistic involvement. Taking in account of all these challenges the idea of data center has been emerged.

A data center is a highly equipped place that has computer-friendly environment and safe and secure as it is maintained by IT specialists, mechanical experts and electrical engineers around the clock to keep it in an appropriate condition so that it can serve and perform at their best. The performance of a data center is depending on a balanced investment in the facility and equipment housed.

## **1.4 Case study**

Instead of a single data center, the modern business houses use two or more data center across multiple locations for better performance and resilience for their organization. The user will face lower latency and job will be faster.

Worldwide the advancement of cloud computing is an important matter for officials and regulators. The cloud computing holds out benefits for governments, service providers and various industries. To get full benefits of these data protection and data integrity has to be established.

A data center not consider through physical size or style. A small business organization may have several servers, storages and networking equipment with in a small room. However, the bigger organization like Facebook, Amazon or Google, may have large data center with fully equipped and infrastructure as like as a massive warehouse. In the other hand, a data center can have mobility as per requirement, like a shipping containers which also known a data center in a box.

However, a data center has defined in four tiers according to various levels of reliability or resilience. Data center design and implementation guidelines has been published by the Telecommunications Industry Association (TIA) and the American National Standards Institute (ANSI), standard ANSI/TIA-942 which defined the four tiers of data center.

## **1.5 Data Center or Cloud computing: definitions and characteristics**

Nowadays, some business houses do not having their own IT assets, they are getting all IT services through cloud-enabled services such as virtualization and employees using their personal desktops or notebooks on their office networks. The business houses reduced their hardware cost. However, if enterprise IT budget become narrow or reallocating in different project, the enterprise IT staff also will be reduce or reskilled to meet the new requirements.

### **1.5.1 Definition**

A data center provide a secure facility for housing vital IT services across the world. Without direct service provider interaction, a shared pool of configurable computing resources can be rapidly provision and released to the client. According to a research from

university of Oxford, the benefits of data centers are reduced risk, Security, Energy efficiency and reduced costs. A data center can house IT equipment like servers, switches, firewalls, SAN disk systems, NAS storage that are rack-mounted. Each can have their own secure space, networking and 24/7 access.

### **1.5.2 Characteristics of Data Center**

The characteristics of cloud computing service differentiate their service from other technologies.

- The cloud computing users use external data center and as a rule, they do not have their own IT resources.
- The cloud computing users pay to vendor per usages basis for the services.
- The cloud computing users are often virtual and resources or services are share with several users.
- The cloud computing services are provide through the Internet.

Cloud-computing technology is the new concept which providing expected flexibility and modularity to access IT resources as well as software with a very competitive price.

### **1.5.3 Description of the main Data Center cloud computing services**

There are five types of services included in cloud computing:

- i. Infrastructure as a Service (IaaS): virtualized data center, on-demand server, storage, firewalls, security services, flexible local networks (LANs) etc.
- ii. Platform as a Service (PaaS): Cloud computing providing Customer service management, billing, etc as a PaaS.
- iii. Software as a Service (SaaS): Cloud computing provide service for small and medium sized enterprises and the services include electronic marketplace, customer relations and support (CRM), finance (ERP), HR, online payments, business applications etc.

- iv. Communication as a Service (CaaS): Unified communications, data sharing (web conference), instant messaging, audio/video communication services, e-mail, collaborative services,
- v. Network as a Service (NaaS): Virtualized networks (VPNs), flexible and on-demand bandwidth, managed Internet.

## **1.6 The situation of Data Center in Bangladesh**

Bangladesh's journey towards building Digital Bangladesh began in January 2009. The government under the visionary leadership of Prime Minister Sheikh Hasina aims to establish a Bangladesh where information and Communication Technology (ICT) would be the driving force of economy. The seventh five-year plan prepared by the government also stressed the need for using ICT as a tool for the development of economy. In line with its plan to build Digital Bangladesh the government set the target of ICT export at 5 billion US dollars and increase the number of IT professionals 2 million by 2021. As our honorable Prime Minister Sheikh Hasina, has a dream to make Digital Bangladesh and it will be a first step of digitalization.

There are several data center projects are now on process or under construction with international and national economic operators in Bangladesh.

In this subcontinent, the characteristics of data center cloud computing is very suitable. Various stakeholders already shown the interest of the benefits of cloud computing. Hence, necessary training should be arrange within people of these subcontinental countries.

There are two particular accountability to make a significant contribution to reducing the digital boundary in Bangladesh. They are:

- i. For latest innovations should have immediate accessibility.
- ii. Considering irregularity of the electric power supply in Bangladesh, the possibility for an organization to do away with heavy investment in infrastructure, particularly where computation centers are concerned

## Chapter 2

### 2. Data Center Design and Implementation

#### 2.1 Project Planning Sequence

Build and upgrade a data center project typically have a good planning. Planning a data center is an art more than science. A small change of planning become a big disasters and cost consequences of a data center become high. The data center planners should present the proposals with technical details and they need to make decisions in every steps.

Consulting engineers accumulate the experience from decades of a data center planning now they can share the knowledge for more standardized approach and provide quality of planning for provider and customer both.

In a data center planning, if the right people make the right decisions in the right sequence, most of the problem can avoid.

The diagram (2.1) below shows, two portions of planning sequence for a data center. The plan portion inclosing prepare and design phases of a data center that are very vital portion for the project. Hence, it should be prepare very carefully. The Build portion contain two phases; one is acquire and another is implement.

**System planning:** In these steps, hardware arrangement, data flow, critical guidance, dependencies and system planning effort should have detailed structure and clear guideline should come from the planner.

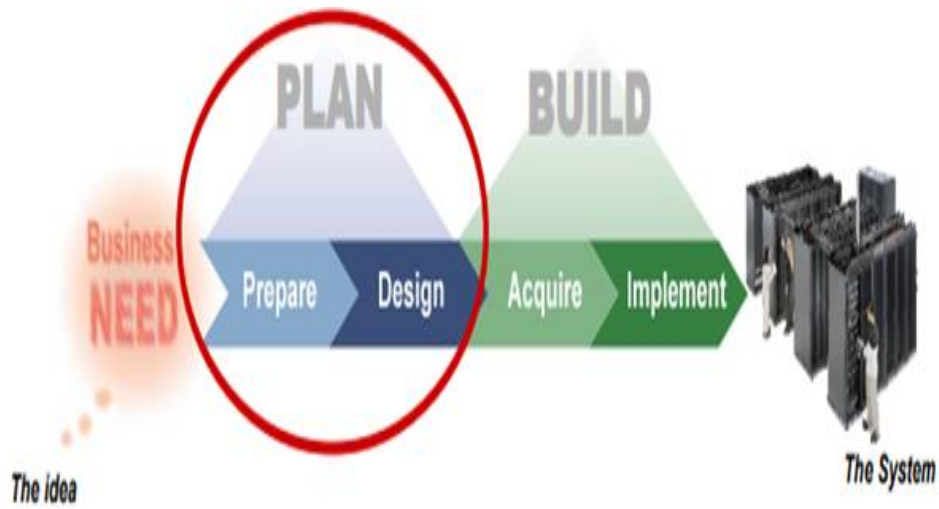


Figure 2.1: The process lays the groundwork for the project

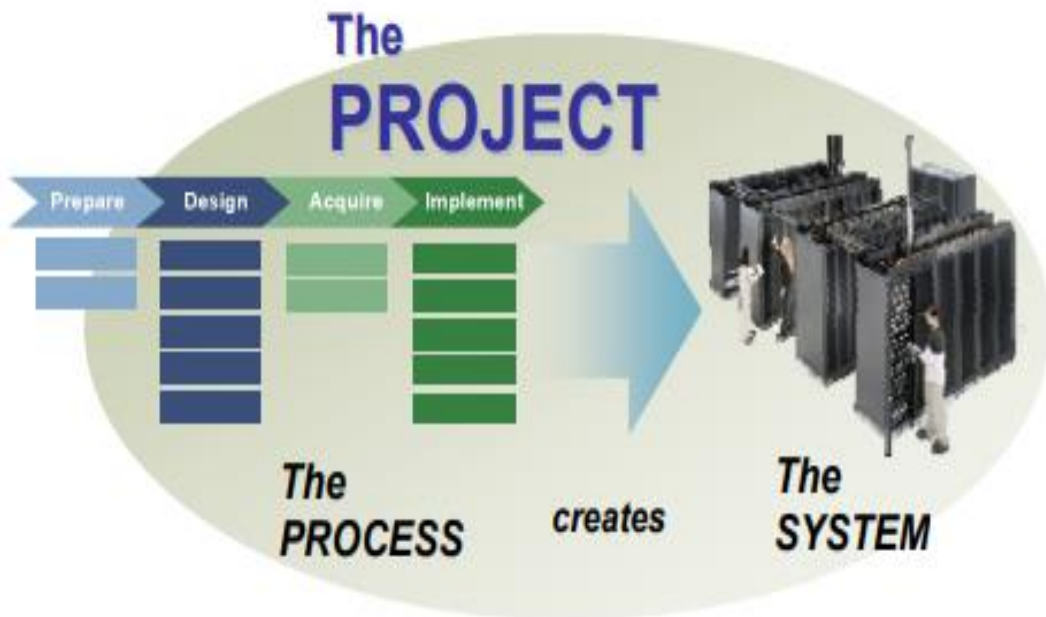


Figure 2.2: The planning sequence of the project

The IT layers of a data center included physical infrastructure, computing and network functions as well as power, cooling and protection of the data center.



## 2.2 System Planning Sequence

The “System planning Order” is a flow that is logical flow, activity, and it is a matter of data transformation from initial steps to the main broad idea.

Prepare and designing phase of the project, there are five tasks take places in system planning sequence. These five tasks arise within the overall product and project such as proposal generation, budget analysis, hiring of service providers and the preliminary system. It is the final design that will be implement with the reference design. Figure2.3: shows five tasks that cover system development, Prepare and Design phases.



Figure 2.3: Five tasks of the System Planning Order

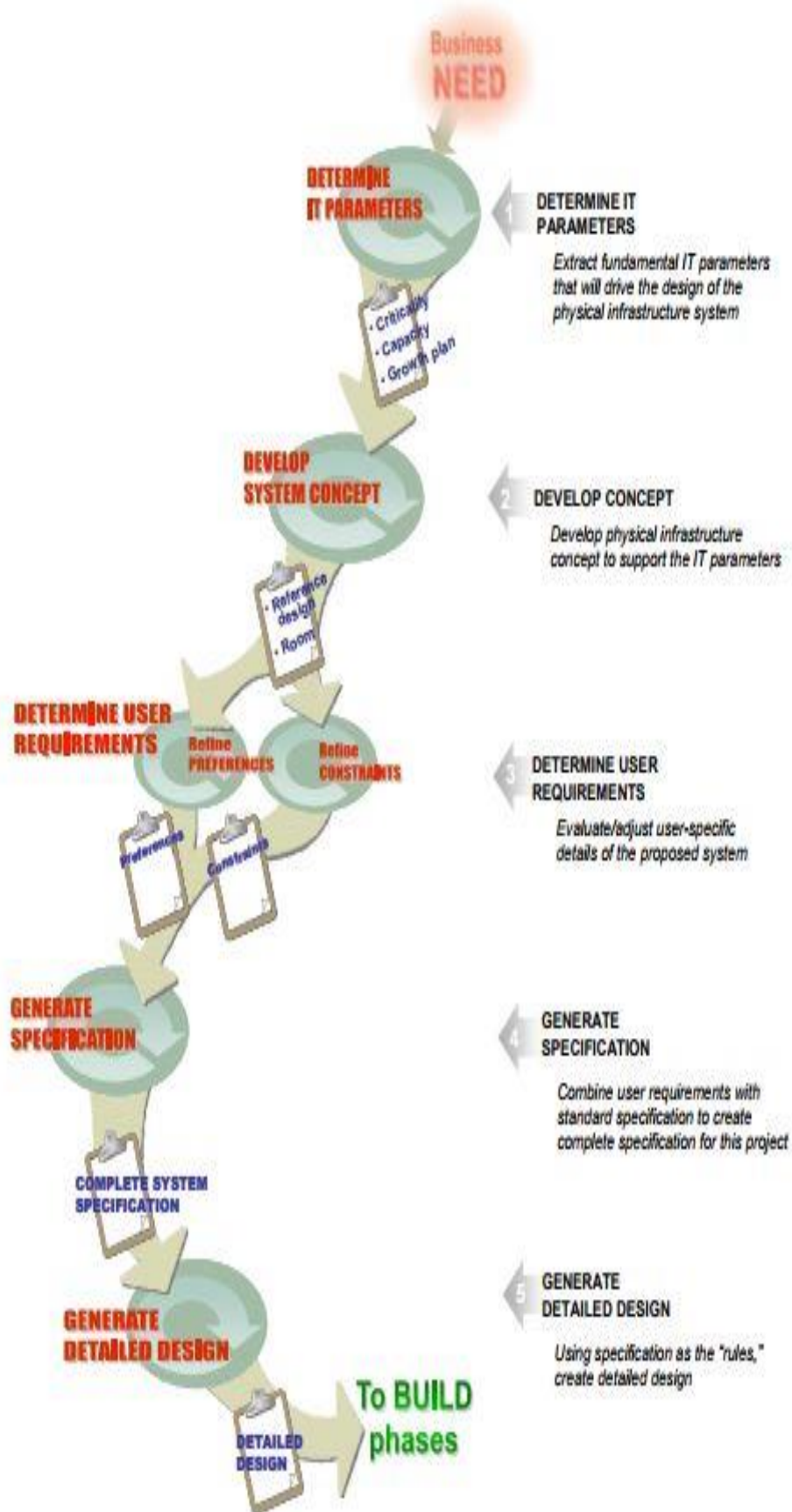


Figure 2.4: The main responsibilities of the system planning order

## 2.3 IT Design Development

Three fundamental IT parameters will directly affect the design of the physical infrastructure system:

- Criticality – Business importance
- Capacity – The IT power requirement
- Growth plan – A description of maximum power requirement, incorporating uncertainty

A system design concept is determined, once these fundamental IT parameters are define. Selecting one or more “reference designs” that are compatible with the three parameters, and compatible with the physical characteristics of the room that will be used for the installation.

The user requirements, combined with a standard data center specification, become the complete specification for the user’s data center. The server is still installed according to the server information and planning. Server planning in the base step will be maintain by the council of the Data Center.

The basic development of the data center design, from abstract to specific, different skills and expertise contribute to the process. At the earliest stages, business leaders supply the vision of the need that drives the project. After that, decision-making shifts to individuals or groups who understand the technicalities and tradeoffs involved in how the physical infrastructure relates to other systems, including the IT system, existing electrical and mechanical facilities, and utilities.

Figure 2.5 shows how criticality, capacity, and growth plan of IT design development of a data center.

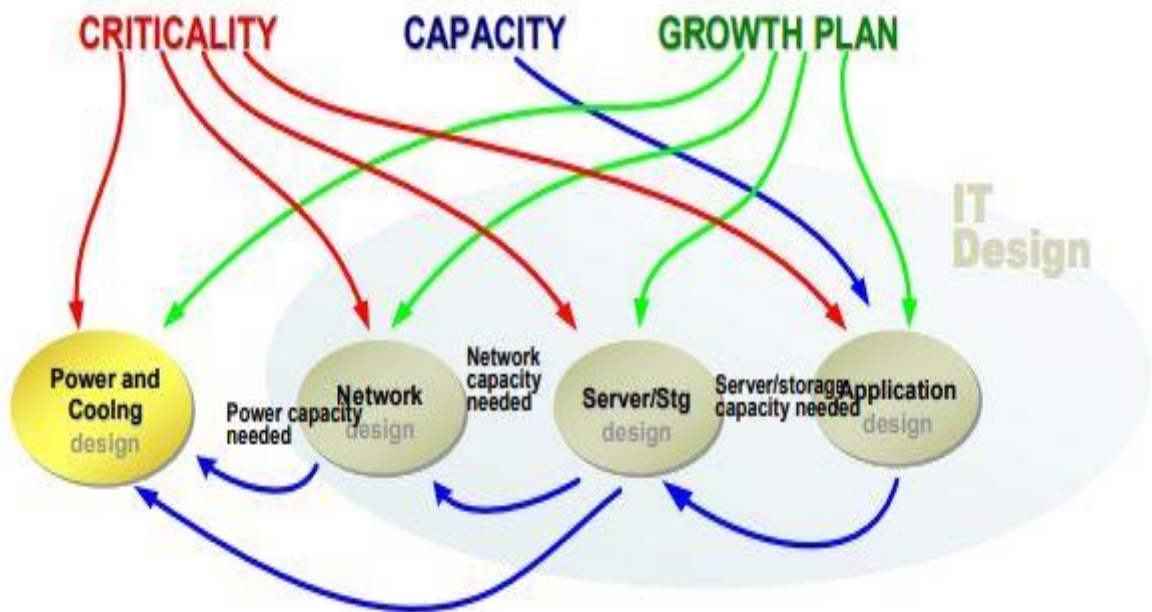


Figure 2.5: The three IT parameters affect all layers of data center design

### 2.3.1 CRITICALITY

In terms of toleration for downtime criticality is a number that representing the importance of data center’s operation in to the business. Criticality is a growth of the familiar concept of availability “tiers.” redundancy of power and cooling systems, as well as the strength of system monitoring and various room creation details that affect reliability, the selected criticality will regulate the major characteristics of the system manner.

### 2.3.2 CAPACITY

Over the data center lifetime, capacity is the estimated maximum IT power load for the data center. The power capacity of the physical infrastructure system to be design by this planning sequence is not the main point – rather, it is a best guess of the maximum IT load that will supported during the data center lifetime. This will play an important role in GROWTH PLAN.

### 2.3.3 GROWTH PLAN

Growth Plan is an important perimeter of data center IT design development – a set of four numbers that describe the expected growth of the IT power load, expressed in kW. These

four facts form the IT load profile that will logically guide the design of the power system. Hesitation about future growth is handled in a simple manner by providing both a maximum final load and minimum final load, and assuming the option of a scalable system design that approaches the maximum value in increments over time. In the Growth Plan the development is the continue process of the CRITICALITY and CAPACITY.

## **2.4 Reference Design**

Reference design is the design that contains the minimum acceptance of required features. This feature are stand as a reference. A reference design is an actual system design that is a prototype or “shorthand” representation of a collection of key attributes of a hypothetical user design. Reference designs have a practical range of power dimensions for which they are suited. The great power of reference designs is they afford a shortcut to effective calculation of alternative designs without the time-consuming process of actual specification and design.

The reference design chosen to support the criticality, power capacity, and growth plan that have been determined of the planning sequence. A reference design will have characteristics that make it malleable in each of these areas. For example, a reference design may be design for one criticality level, and it will may allow modifications to adjust the criticality up or down. A reference design may be able to support a range of power loads. A reference design may be scalable or not.

A library of reference designs will be particularly useful if it has a software tool to assist in selecting an appropriate reference design. Input to such a “selector reference design” would be the foundational IT parameters established in the previous determine IT Parameters task – criticality, capacity, and growth plan. Other essential requirements may also need to be included to further narrow down the possible reference designs, such as type of cooling or power density. The automatically selected reference design(s) can reviewed for additional considerations that may not be handle by the selector tool, such as location of doorways, support columns, or other significant constraints.

## **2.5 Floor Plan**

The floor plan is important in the location of rows, but does not need to require whether individual rack positions within each row contain IT or physical infrastructure equipment. The principal design element in the floor plan is the row. In the conception of the detailed design, some rack locations will be disbursed for physical structure devices. If the design includes devices that are not rack-compliant, for example wall-mount CRACs, there a space allocated for space row.

### **2.5.1 Room-level specifications**

Few specifications always applied at the level of room, for example as basic room level security, Fire suppression, utility power obligation. In few projects the existing conditions that must be included with all the specifications; with all the parameters. Few types of conditions can specified at the room level, or optionally at the row or rack level. In few sector securely examined with extreme cases.

### **2.5.2 Server Rack Strategies**

Considering airflow, upfront costs of the rack and basic functionality the data center rack should design. The biggest energy costs in running a data center is in cooling, so having a sound server rack strategy is critical for overall data center energy feasting and operating costs. Over the coming years, most medium to larger organizations will be adopting virtualization and higher density servers. As energy, costs continue to rise and as the data center grows and companies will look to their facilities and data center executives for sound strategies on how best to address those rising energy costs.

The server enclosure is a principal of the data center. The makeup of a server enclosure remains consistent: folded and welded steel, configured to secure servers, switches, and connectivity- the lifeblood. The enclosure comes in a variety of dimensions and is often customizable to a user's individual needs with provisions for cable management and PDU installation. For common 42U server rack dimensions.

### 2.5.3 Hot and Cold Aisle Server Rack Layout

Hot state aisle/cold aisle is an accepted best practice for cabinet layout within a data center. The design uses air conditioners, fans, and raised floors as a cooling infrastructure and focuses on separation of the inlet cold air and the exhaust hot air.

Hot aisle/cold aisle data center design involves lining up server racks in alternating rows with cold air intakes facing one way and hot air exhausts facing the other. The rows allow us to compose of rack fronts are called cold aisles. Typically, cold aisles face air conditioner output ducts. In the vertical axis, the rows implemented according to the floor plan. Containment systems started out as physical barriers that simply separated the hot and cold aisles with vinyl plastic sheeting or Plexiglas covers. The rows the heated consumes pour into are called hot aisles. Typically, hot aisles face air conditioner returns ducts.

A containment system can be used to isolate hot aisles and cold aisles from each other and prevent hot and cold air from mixing.

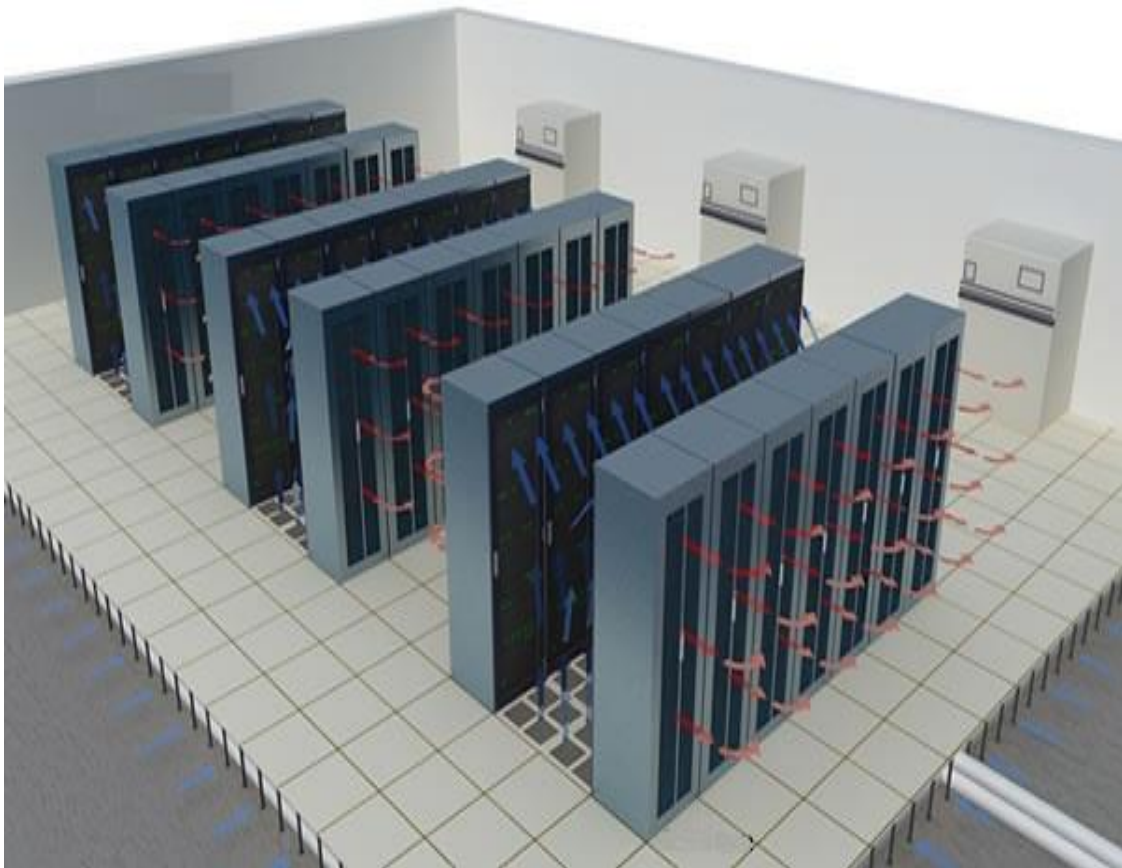


Figure 2.6: Server Rack layout

In this structure, the cabinets are connected into a series of rows, resting on top floor. The front of each row becomes a cold aisle, due to the front-to-back heat dissipation of most IT equipment. Air conditioners, positioned around the perimeter of the room, push cold air under the raised floor and through the cold aisle, where the servers ingest it. As the air moves through the servers, it has heated and eventually dissipated into the hot aisle. The exhaust air is routed back to the air handlers.

Best practices for hot aisle/cold aisle containment include:

- i. Raising the floor one and half feet so that air circulation being pushed by air conditioning equipment can pass through.
- ii. Arranging high cubic feet per minute in a server rack grills that have outputs.
- iii. Locating devices with side or top consumes in their own part of the center.
- iv. Installing an automatic door in the data center with a security alarm.

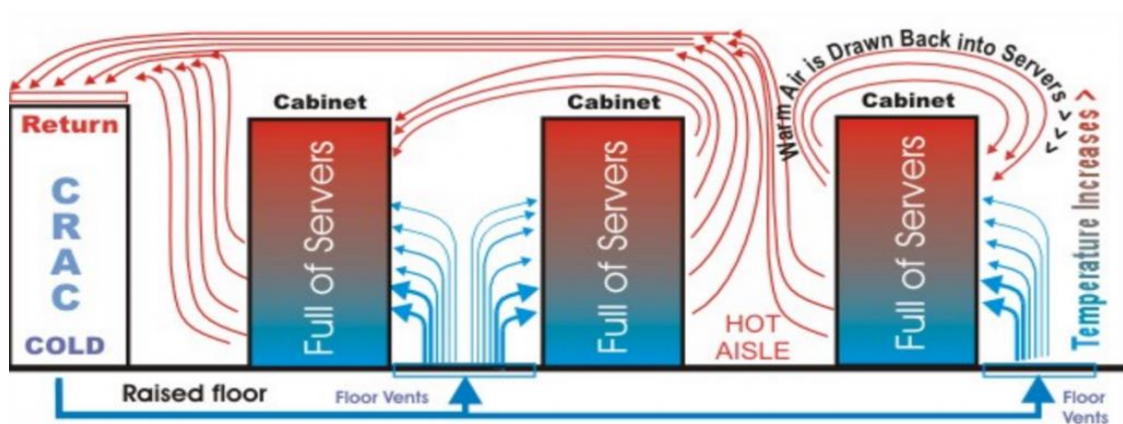
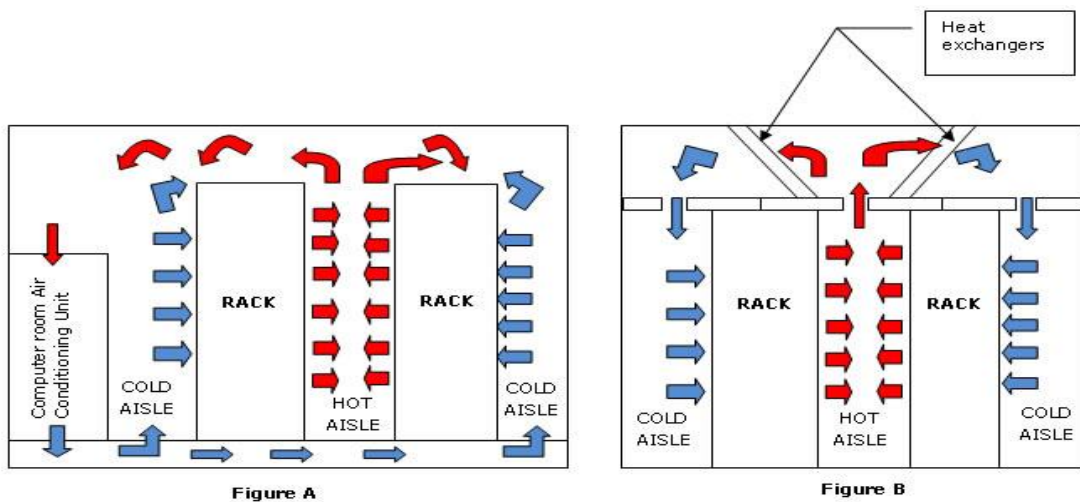


Figure 2.7: Hot and cold aisle layout of server rack



The server enclosure, once an afterthought in data center planning has become a pertinent talking point, for no cooling strategy can exist without it. Many data center authorities stress that new cooling approaches are essential to achieving energy efficiency. The process begins, according to The Green Grid, with airflow management-an understanding of how air gets around, into, and through the server enclosure.

## 2.6 Cabling for Data Centers

Cabling is one of the vital thing for a data center. Most of the time cabling is pre determine for a data center based on distributions of bandwidth required to use for the equipment. Coper power cable (AC/DC), and grounding and network cabling like UTP or fiber optic cabling used for a data center.

There are two types of cabling; one is structured and another one is unstructured. Data center should be structured wired cabling. The connection points and pathways of cabling design should be predefine and standard.

The network cabling should well organized following designed wiring and labeling also should properly. Although a structured cabling is costly in initial stage, the life cycle will be higher than unstructured cabling and considering longevity the operational cost will become less. To ensure appropriate performance of required bandwidth for a data center, structured cabling is mandatory.



Figure 2.8: Structured caballing of a data center

The unstructured cabling do not maintain any standard and those types of cabling is not predefined, hence, the connection points and pathways of cabling sometimes fail to perform properly. Unstructured cabling should not consider for a data center, it could bring problem for operation and it is difficult to maintain or upgrade the systems or relocate the cabling if required. Although the cost Comparison between structured and unstructured cabling; unstructured cabling take less time to install and lower initial cost but overall life cycle is shorter and performance is poor.

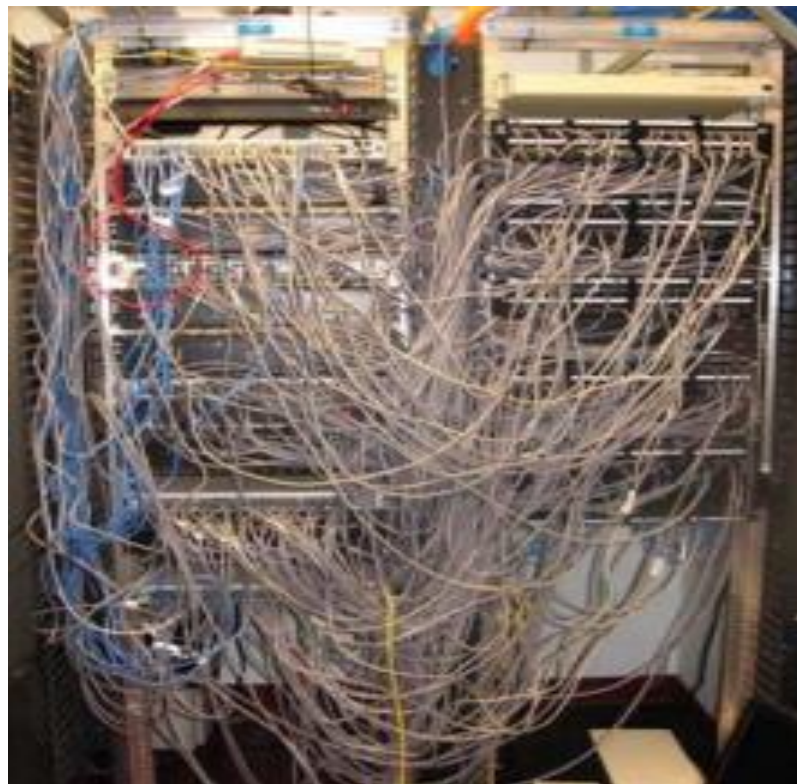


Figure 2.9: Unstructured caballing of a data center

## **2.7 Fire Fighting**

Safe data centers are the indispensable backbone of today's highly engineered society. They are processing an ever-increasing quantity of videos, voice and data throughout a global network of several billion devices. Applications such as social media, cloud computing, online banking and e-healthcare solutions affect our life every day. In today's world, no one can afford not to be connected.

Failure of the internal data center or of the vital data center that serves the public, poses a significant problem within a short time. Employees who are not able to carry out their work and unhappy customers, who cannot get in touch with their service provider or contractor, represent merely the tip of the iceberg of our technical vulnerability.

Therefore, the most important objective in a data center is maximum availability (99.995% per year). It is thus understood that data centers have to be designed, implemented and operated in such a way that a high level of availability can be guaranteed, even in case of a fire. High availability can be achieved if all relevant influencing factors are planned, implemented and put into effect in the company in a coordinated and consistent way.

### **2.7.1 Fire Hazards in Data Centers**

The fire hazards is one of the main challenges in a data center. Human failure or technical reasons can lead to a fire incident. A latent risk of fire exists because of the presence of Anticipation source of electricity supply. Sometimes inflammable materials such as plastics or low quality circuit boards used for electric wiring cause short circuits that might happen and data centers fall in a big risk. Major fires rarely occur for a data center but minor occurrences also can cause a vital trouble. However, fire hazards in a data center, the business impact is huge and fire protection measures should be taken very seriously to avoid the unwanted incidence.

### **2.7.2 Fire load**

Fire load calculation is very important before planning a data center. Low to medium, there are two types of typical fire load calculation for a data center. The fire load can be reduced by considering electronic equipment, cabling, fittings, furniture, fixtures etc. Older data centers have a huge fire load compared to new data centers because of typical construction, equipment installation and technical expertise. In the planning period, a data center fire load should be considered for further reconstruction, remodeling or modernization.

### **2.7.3 Fire risks**

Fire risk should be considered always for a data center. Data center fire risk happens because of the following four reasons:

- i. Heavy power load: heavy power loads occurs due to faulty power equipment and the circuit might overheating and short.
- ii. Electrical fire risk: Due to burnable electrical materials or explosion source of electricity.
- iii. Infrastructure: widespread cabling or if the raised floors become particularly lower.
- iv. Ventilation: Consequential higher air exchange because of inclusive air-cooling increases risk of scattering the fire.

**Risk = probability of occurrence x effect**

During the past years, integrated risk management has become increasingly more relevant for companies as well as for data centers. Risk management must take into account external circumstances or requirements, such as trends and new developments, legal stipulations or "best practice". Not only has the objective risk played an important role in risk identification, but also the subjective risk perception and the change of risks. It does not suffice to consider experiences made in the past. In the future, risks may occur that have been hitherto unrecognized or underestimated, as single risk or in combination. It is therefore of utmost importance for the fire safety and security managers to continually expand their expertise in the fields of security and fire safety, to exchange knowledge and experience, and thus be able to learn from each other.

#### **2.7.4 Fire Protection for Data Centers**

To protect people, assets, data and environment from the risk and possessions of fire and ensure loss of data, consequent loss of business, operational interruptions and and to minimize material damages, fire protection should be guaranteed and should have suitable fire safety standards for a data center.

There are few objectives of typical fire protection as below:

- No business interruptions.
- Keep data safe always.

- Personal injury
- Minimum asset damage
- Environmental damage

## **2.7.5 Fire Protection Concept**

Fire protection concept consists of series of coordinated measures. Only the combination of these measures results in the desired protective effects. Structural/mechanical, organizational/personnel and technical measures are important elements for a fire protection concept for data centers. The required protection effect based on a systematic risk analysis, on the individual risk policy; an example protection objective, legal constraints and on the appropriate resources; an example: financial, personnel.

## **2.7.6 Fire Protection Measures**

There are two types of fire protection measures, one is passive and another one is active measures.

### **i. Passive Measures**

Building structure, fire resistant materials of a building, building construction methods and local circumstances are the passive measures of fire protection. The structured fire protection measures also included the below elements:

- A building should categorize for fire.
- Use of materials to avoid building collapse.
- Fire-resistant construction elements to limit spread.
- Provision of fire-resistant leakage routes/exits/staircases/elevators.
- Selection of materials to reduce fire load.
- Selection of materials to prevent toxic vapors.

### **ii. Active Measures**

Active protection can divided into the following measures:

- Organizational measures and staff-related measures
- Structural and mechanical measures

- Technical measures
- Detection measures
- Alarm and evacuation measures
- Intervention measures

### **2.7.7 Alarming and Evacuation**

A person or an automatic detector can start a manual call point, if fire has detected, then fire detection system should generate preprogrammed control and alarm signals.

They need to demonstrate and understand these procedures and protocols. In each alarm situation, trained personnel are expect to maintain a professional behavior and guide people to the nearest exit.

#### **i. Alarming**

Personnel in data centers should be train on the procedures and protocols on how to perform intervention during a fire alarm. If the presence of a fire occur within the premises, the purpose of fire alarm is to inform the people for nearest safe exit.

In a data center these type of volunteer people should divided in to three target groups:

- Selected staff members.
- Staff working in the building (in general) or visitors
- The public fire service

These target groups alert the people in an appropriate and efficient manner.

#### **ii. Alerting Selected Members of Staff**

For investigation purpose, the in-house staff may generate alarms immediately. It is very important to be work under in a critical session.

- Mobile phone (SMS): Announcement of a preprogrammed text message.
- Local audio: promptness of buzzers in staff areas only: control room, facility management, site or manager's office.

#### **iii. Smoke Control**

Conducting the heat and smoke through the installed ducting into the external atmosphere, customized smoke control systems should be designed to hamper the fast of fire and smoke in a Data center.

#### iv. Evacuation

The people who are in threatened area need to move in a place of safety.

For the reason it is authoritative, smoke is restricted to the speedy locality of the fire for as long as possible. Key objectives:

- As long as possible, the people should remain undisturbed in the building.
- As soon as it becomes unavoidable, an evacuation should be initiated.
- As quick as possible the evacuation should be carried out efficiently.

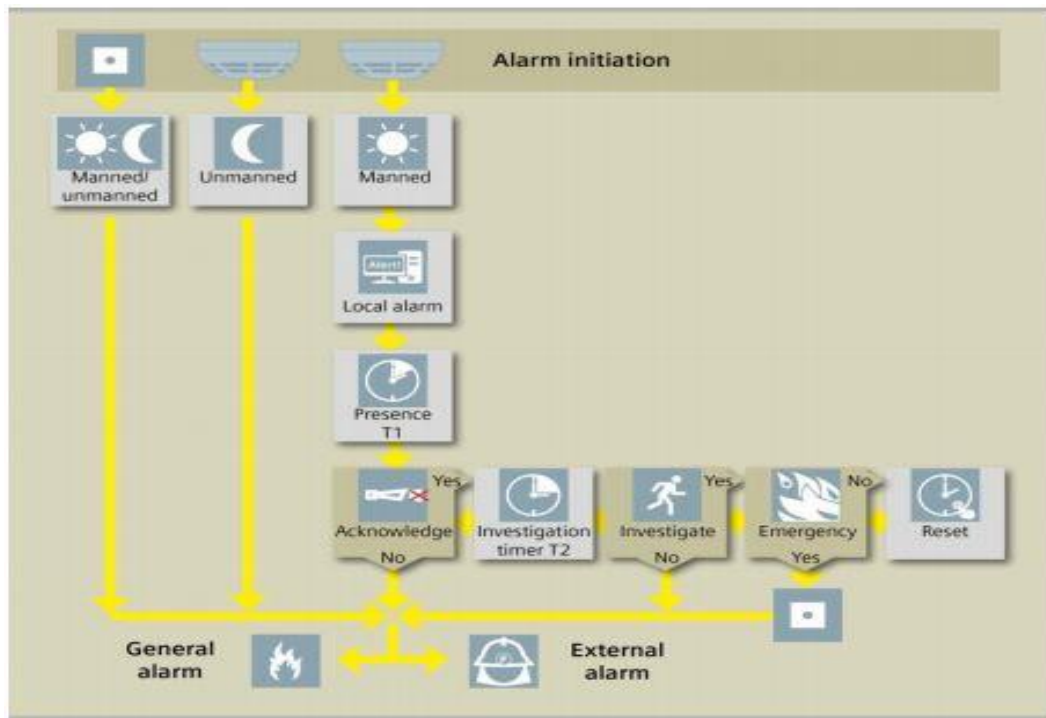


Figure 2.10: Alarm Verification Concept

### 2.7.8 Extinguishing Agents

A diversity of extinguishing agents use in a data center that utilizes one of the below mentioned mechanisms:

## ❖ Gas

As extinguishing agents, Gases are very fast, electrically non-conductive, clean and highly efficient for a data center. For ignition process, extinguishing gas agents use oxygen or chemical prohibition.

- Natural gases : The following natural gases are suitable for extinguishing purposes:
  - ✓ Carbon dioxide (CO<sub>2</sub>)
  - ✓ Nitrogen (N<sub>2</sub>)
  - ✓ Argon (Ar)
- Chemical extinguishing gases

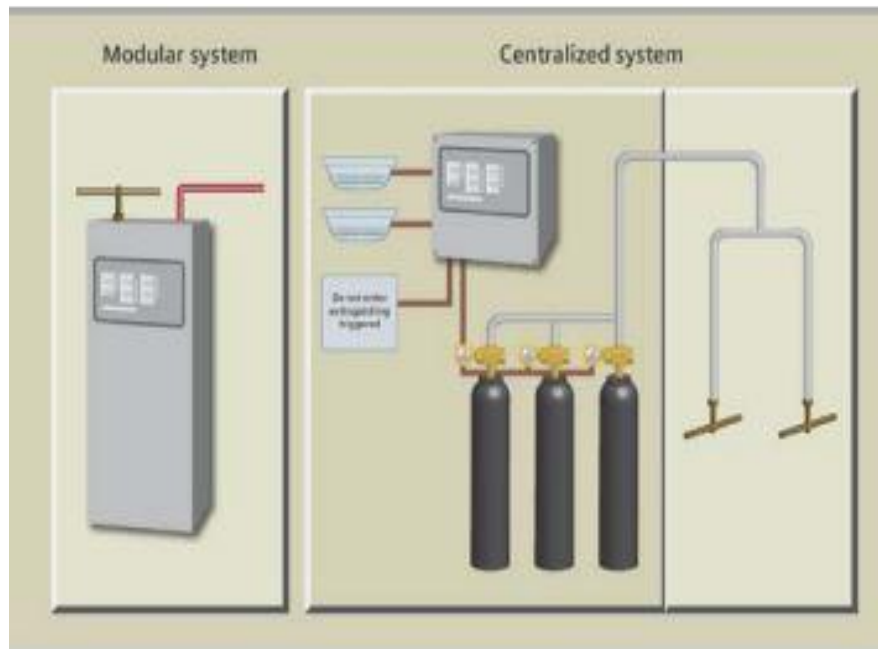


Figure 2.11: Modular system and Centralized system

## ❖ Chemical powder

Chemical powder is one of the extinguishing agents mainly used in fire extinguishers. Disadvantage of using chemical powder that it is highly destructive and leaves fine dust that is very difficult to remove; sometimes powder is unsuited for electronic and electrical equipment.



## ❖ Water

Water is most commonly used extinguishing agent. It is very effective agents readily available, inexpensive and ecologically acceptable. As an extinguishing agent of water relies to burning materials and make the cooling immediately.

### 2.7.9 Extinguishing Systems

#### ❖ Gas extinguishing systems

In a protection of a close room, the gas extinguishing system is more appropriate. The extinguishing systems commonly used that rooms that contain sensitive objects like electrical equipment and computer. Hence, gas-extinguishing systems is advice for data center extinguishing.

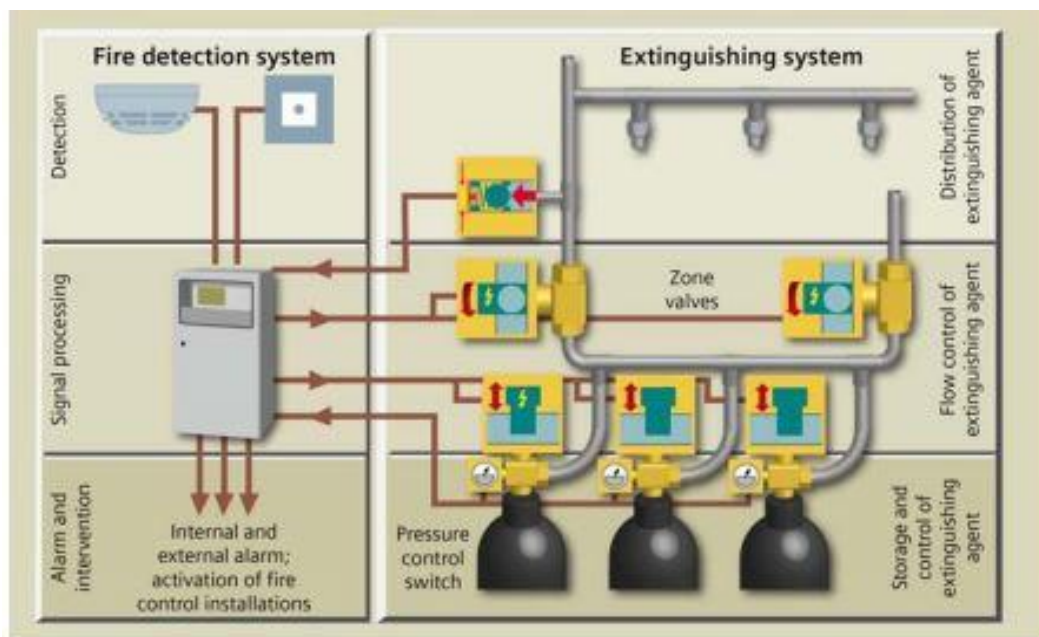


Figure 2.12: Principle of a gas extinguishing system

The extinguishing gas directed through a piping network to nozzles that evenly distributed on the ceiling. The gas quickly fills the room and a standardized concentration throughout the room. The concentration must be maintain over a sufficiently long period to complete extinguishing the fire.

## **2.8 Data Center Security**

### **2.8.1 Access Control & Surveillance Monitoring**

An important aspect of IT safety is the protection from unpermitted access to systems by employees or externals. In principle, only few employees should have access to the data center, not only to reduce the danger of unintentional damages, but also, to prevent intentional manipulation or data leakage.

The data center is a neuralgic point of a company representing a target for interception and damages to your business. Therefore, it is important to control access to a data center. Doors of safety rooms- and cabinets should be secure by access control systems. The market offers different systems that vary considerably in investment costs but also in degree of safety that they offer.

The technically simplest solution is a safety lock. Adversely to this is, however, not only can a key be copied relatively easily, but also only, as many persons have access as keys are available. Furthermore, with loss of a key the whole lock must be exchange. For key locks, it is important that the key can only be remove when the door is lock to prevent that the data center remaining inadvertently open.

Instead of mechanical key electronic keys can be use in the form of transponders or chip cards. These offer the advantage that new keys simply can be program and in case of loss of a key, the lock will not have to be exchange as it can be reprogram. More so, one also can supervise and store data of electronic keys.

For data centers with high security requirements, we recommend biometrical access control systems. Usually through identification via fingerprint or iris scan, as known through the media. This system offers all advantages of other electronic access systems, but additionally biometrics data cannot be stolen or copied. At present, these access control systems will be install only on demand. In larger data centers, single areas can be define and assigned with individual access rights only.

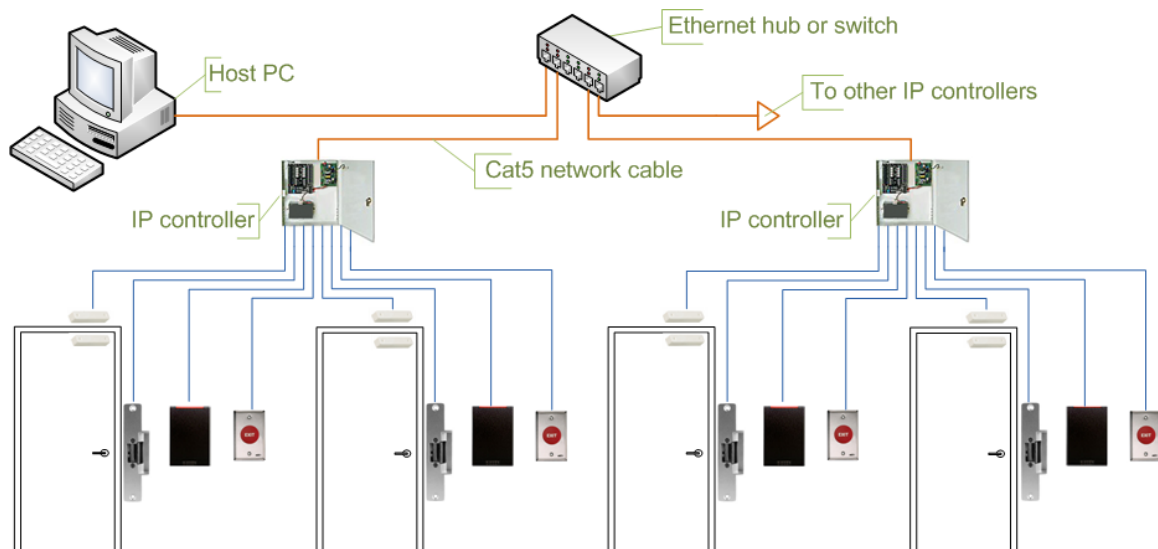


Figure 2.13: Access Control design

❖ **Three approach to Keep Data Center safe:**

- Access control technology, which forms a physical barrier around data center protecting it from threats.
- Surveillance monitoring to keep track of what is happening at the data center in real time.
- Security alarms and notifications, can respond to situations as a threat occurs.

## 2.8.2 Access Control Technology

An effective access control strategy is the first step toward ensuring a secure data center. While there are other elements that make up a complete security strategy, access control, if done correctly, should allow you to ward off most of the threats facing your data center. Access control is about more than just locking the doors to your data center at night. To get the best results from access control technology, need to institute a 24/7 locking perimeter that requires photo ID to access.



Figure 2.14: Photo ID card to Access

The use of photo ID cards as part of your access control strategy also allows you to restrict access to certain areas based on identity or job role. In addition, ID card access control provides the added benefit of making sure that legitimate employees who have a valid business reason to be in your data center are able to come and go as they please, with as little hassle as possible.

### **2.8.3 Surveillance Monitoring**

It is very important to have surveillance monitoring to make sure you can account for what occurs if there is ever a breach of your perimeter; access control can help to keep most malicious intruders out of your data center.

Today's surveillance systems provide tremendous flexibility, allowing you to monitor live events as they happen and record them to view again later. Video clips can also be linked to access events, allowing you to provide evidence and physical identification that can help you prosecute if a malicious attack occurs.

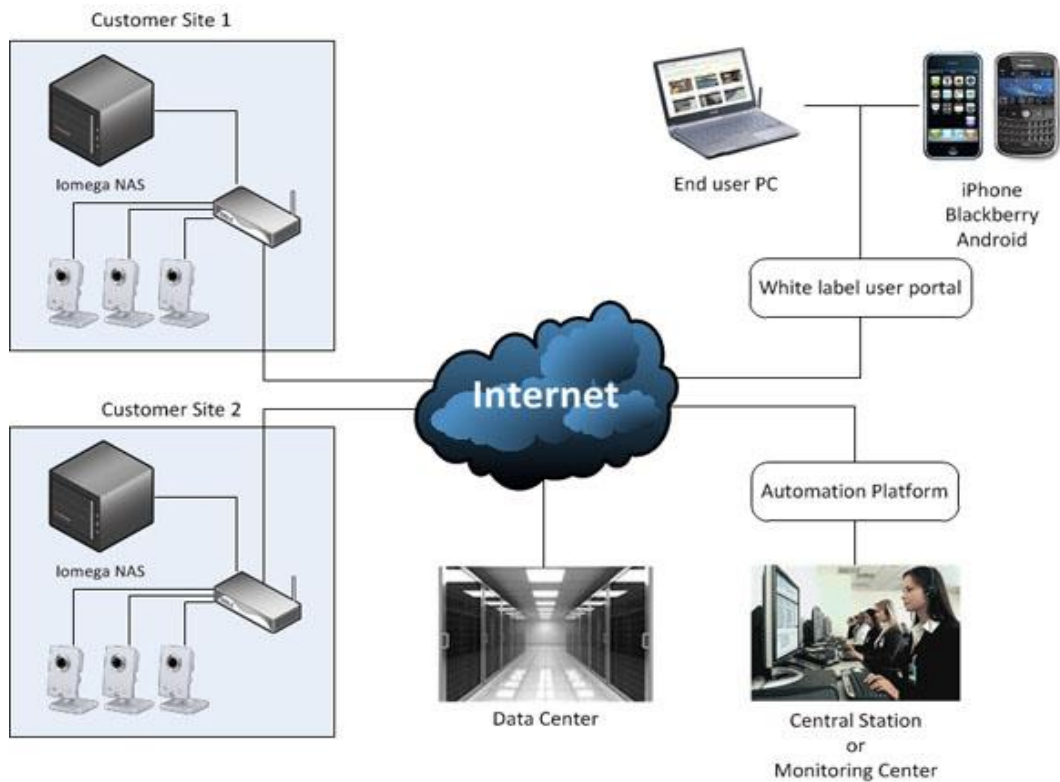


Figure 2.15: Surveillance Monitoring

### 2.8.4 Security Alarms and Notifications

Surveillance monitoring is not just useful as a tool to let you know what is already gone wrong in your data center. Ideally, your security infrastructure would alarm your staff about breaches and intrusions as they happen, giving you the opportunity to respond immediately and stop the event from causing damage.

You can also configure your security notifications to conduct lock-downs in the event of a possible security risk. Your lock-downs can be customized to include certain vulnerable parts of your infrastructure, or your entire site. Either way, the use of access controls can help ensure that your authorized emergency response personnel are still able to access the lock-down zone, so that they are able to perform their responsibilities with no interruptions.

## Chapter 3

### 3. Data center Feasibility analysis in Bangladesh

A data center is an advantage of information technology equipment. This is the houses for process, communicate and store the data for our digital activities. Earlier the term 'data center' located in an office building with some small amount of server facilities. However, in recent years, a data center located in a large stand-alone building.

Now a day we are confide on IT equipment and fundamental software in our daily activities such as navigation, entertainment, communication, finance and securities. The principal components that make up a data center are Building shell, IT equipment, Electrical infrastructure and Mechanical infrastructure. That's why the data center are classified as a mission critical facilities.

Considering performance, investment and return on investment (ROI) data center tiers are standardized.

#### 3.1 Brief of Data Center Tiers

##### 3.1.1 Tier-1 Data Centre

- Tier-1 data center is applicable for typically small business organization.
- To run this data center single path of power supply and cooling are used.
- This data center runs with single uplink and servers.
- There are no redundant components of this date center.
- This data center is guaranteeing 99.671% availability for service (1,729 minutes of annual downtime)
- Experience of downtime is 28.8 Hours per year of this data center

##### 3.1.2 Tier-2 Data Centre

- Tier-2 data center is applicable for Medium-size business organization.
- Tier-2 data center having single path of power & cooling system but it has some redundancy in power and cooling system.

- This data center is guaranteeing 99.741% availability for service (1,361 minutes of annual downtime)
- Experience of downtime is 22.00 Hours per year of this data center

### **3.1.3 Tier-3 Data Centre**

- Tier-3 data center is applicable for large business organization.
- Tier-3 data center support multiple power and cooling distribution paths.
- However, the equipment are introduced by one distribution path, but if one path goes fail, another path active as a failover.
- This data center support multiple power sources for all IT equipment.
- Maintenance or updates can be done without making any downtime following specific procedure.
- Fault tolerant of this data center is (N+1)
- This data center is guaranteeing 99.982% availability for service (95 minutes of annual downtime)
- The data center able to sustain 72-hours power outage protection.
- Experience of downtime is 1.6 Hours per year of this data center
- In the event of serious incidents tier-3 data center will not be protected from outages on different infrastructure components. The Tier-3 data center do not support total modular redundancy.

### **3.1.4 Tier-4 Data Centre**

- Tier-4 data center is applicable for Multi-million dollar business organization.
- Tier-4 data center meets all requirements of Tier-I,II and III
- Tier-4 data center is fully fault tolerant; it can function as normal, even one or more equipment failures.
- This data center having two independent utility paths.
- This data center is fully redundant (2N+1)
- The data center able to sustain 96-hours power outage protection.
- This data center is guaranteeing 99.995% availability for service (26 minutes of annual downtime)
- Experience of downtime is 0.04 hours per year of this data center

- Tier-4 data center is fully redundant: Network, chillers, electrical circuits, power sources, backup generators, multiple cooling units, etc. If one equipment fails, redundant will start up and output will be replace promptly.
- This architecture of the data center can withhold most serious technical incidents.

### **3.2 Data Centre Tier, Considering for an organization**

Determining the availability of facility, a data center tier is measured. According to business needs a data center tier is chooses for particular organization.

#### **❖ Tier-1**

The minimum reliable tier is a tier-1 data center, considering components capacity, redundancy and distribution path. The tier-1 data center design as a single and non-redundant path according to customer needs with their budget. During major power outage or any disaster occurs, the equipment go offline and though there are no backup system, business may hamper.

#### **▪ Merits**

- Tier-1 data centers provide accessible service considering cost.

#### **▪ Demerits**

- Tier-1 data center is not suitable for the customer who run their business in 24/7.
- For maintenance purpose, tier-1 data center should require to shut down for a while.

#### **▪ Appropriate for**

Appropriate for small internet based companies like web-marketing companies, companies who having e-commerce facilities on-site but do not have customer support.



## ❖ Tier-2

Although the tier-2 data centers are subject to problems with uptime, considerably more reliable than tier-1 data centers. Tier-2, data center meets all facilities of tier-1 data center and ensuring fully redundant of all components capacity.

### ▪ Merits

- Equipment uptime does not affected during planned service
- Tier-2 data center is costlier than tier-1 data center but cheaper than tier-3 or 4 facilities

### ▪ Demerits

- Compare to tier-3 facilities, lower uptime guarantee during unplanned outages. Entire facility should shut down during major maintenance and repair work.

### ▪ Appropriate for

- Tier-3 data center is appropriate for internet based small companies who can emulate with occasional downtime and the companies that do not support to customer for 24/7.

## ❖ Tier-3

Tier-3 data centers are the most cost effective solutions for medium to large businesses house, ensuring minimal downtime with 99.98% uptime. Tier-3 data center equipment should have maximum two hours of downtime in a year. Tier-3 data center should have dual-powered, multiple uplinks and should ensure the requirements of tier-1 and tier-2 for all equipment.

### ▪ Merits

- Considering facilities tier-3 data center is cheaper than tier 4 data center.
- The facilities of tier-3 data center deliver most cost-effective solution for the majority of businesses
- For planned maintenance all equipment will be safe

- All equipment required to have dual power inputs, ensuring through one input fails, the other system picks up the slack
- Though tier-3 data center having dual power inputs, if one input fails, other input system picks up automatically.
- Without impact of equipment all major maintenance can be performed.

- **Demerits**

- In Tier-3 data center all equipment are not fully fault-resistant

- **Appropriate for**

- Tier-3 data center is appropriate for the Companies who having worldwide business presence.
- Tier-3 data center is appropriate for the Companies who having 24/7 operational hours
- The organizations that require consistent uptime due to financial penalty issues can think about tier-3 data center.
- Call centers, E-commerce running full online operations, VOIP companies
- Companies with heavy database driven websites and the Companies that require a constant web presence

- ❖ **Tier-4**

A tier-4 data center generally designed for most expensive businesses organization. Tier-4 data center is fully fault-resistant and meet all the requirements of tiers 1, 2 & 3 as well as ensuring that all equipment having same copy, which known as N+N.

- **Merits**

- Tier 4 data centers ensure the high availability and the percentage of over 99.99%
- Planned & unplanned outages should not goal any disruption to equipment
- Tier-4 data center's all equipment must have dual-powered
- Without impact of equipment all maintenance can be performed
- All equipment are fault-resistant

- **Demerits**
  - Tier-4 data center are more expensive than most of tier 3 data centers.
  - Tier-4 data center is very costly solution for an organization.
  - Improvement in availability compared to tier 3 facilities is under 0.02%
  
- **Appropriate for**
  - Tier-4 data center is appropriate for large multinational companies
  - Tier-4 data center is appropriate for major worldwide organizations.

### **3.3 Data Center in Bangladesh**

#### **3.3.1 National Tier-3 Data Center**

A tier-3 data center is operating in Bangladesh that is insufficient to meet the country's demand. There is a demand for over 200 racks at the National Board of Revenue, Land Ministry, DLRS, banking and financial institutions, educational institutions and power division. All necessary mission architecture have fully redundant package. The system is flexible to adding additional network architecture if required. EPI India certifies the data center and the design standard by TIA 942 & Uptime Institute. The data center contain multiple active power and cooling distribution paths though currently one path is active, containing redundant components and concurrently maintainable and ensuring 99.982% uptime availability.

#### **3.3.2 Tier-4 Data Center in Bangladesh**

First Tier-4 national data center has permitted to proceed in Bangladesh by the global regulatory commission that will promoted the data storage capacity. The uptime institute has given the certificate after examined the design, documents, construction facility and operational sustainability for tier-4 data center of Bangladesh. The data center would help to ensuring cyber security and safeguarding digital contents of the country.

The data center will be build inside the Bangabandhu Hi-Tech City at Kaliakoir in Gazipur district. Considering standard the center might become first in Asia and sixth in all over the world. The construction of the data center is progressing faster. After implementing the center, government activities will be paperless.

The cost of the data center is Tk 1,516.91 crore. Bangladesh government will provide Tk 317.55 crore and as a project assistance, rest of the amount will come from the Export-Import Bank of China.

Bangladesh government already imported server, storage, power, cooling, fire systems, networking and other equipment for the data center. Almost 70% of installation work has completed. The project is developing by ZTE Corporation one of the renowned Chinese vendor.

### **3.3.3 Background of the Tier-4 Data Center**

Bangladesh have huge potentiality to develop ICT sector. The government is working to become Digital Bangladesh by 2021. Our honorable ICT advisor Sajeeb Wazed Joy, who is an expert in IT and a scientist, is monitoring it. He is a young and dynamic leader and the architect for building Digital Bangladesh.

To improve governance, Infra-Sakar Phase 1 and Phase 2, which are to set up the optical network throughout the country for government connectivity.

Nowadays, total 52 ministries and 4 independent governing bodies, most of government employees are using e-services such as e-filing and e-mail. Though Bangladesh government have established good network infrastructure for them, however still do not have a strong and secure data center for them. High demands of private sector; like Bank, Insurance, Media, Telecom, International companies a tier-4 data center is very essential in Bangladesh for their data storage, security, and they are ready to take lease the data center infrastructure.

New data center will become the heart of building of Digital Bangladesh that is very important for preserving, securing and sharing critical data.

### **3.3.4 Advantages of National Data Center**

We have many big databases, for example, the election commission database and the passport database. We have many big applications, like e-filing. We need to preserve them and make them secure as well as user friendly. National Data center will help us sharing data among the important stakeholders.

The National Data Center will provide many services in future, such as cloud computing, cloud desk and cloud storage. Those services will help people as well as government taking advantage of e-services on demand.

### 3.3.5 Approach to National Data Center Reliability

National Data Center will use 2N structure, designed for Tier IV standards, will provide 99.995% reliability. The entire system is fault tolerant, which means that the data center can sustain failures and planned or even unplanned events without affecting the core business. Two connections are going to establish for the data center, main line and redundant line. Therefore, from Dhaka to Kaliakoir there will be two hyperactive connections. Each connection also has its own redundancy.

### 3.3.6 Ensuring Compliance of Tier-4 Standard

ZTE and China HP have carried out all the design, ZTE has a good reputation in the data center market worldwide. During the design phase, technical committee from Bangladesh Government are monitoring whole activities. Uptime Institute is guiding to ensure the standard; ZTE and China HP are resolving all kinds of problem in time in the design phase.

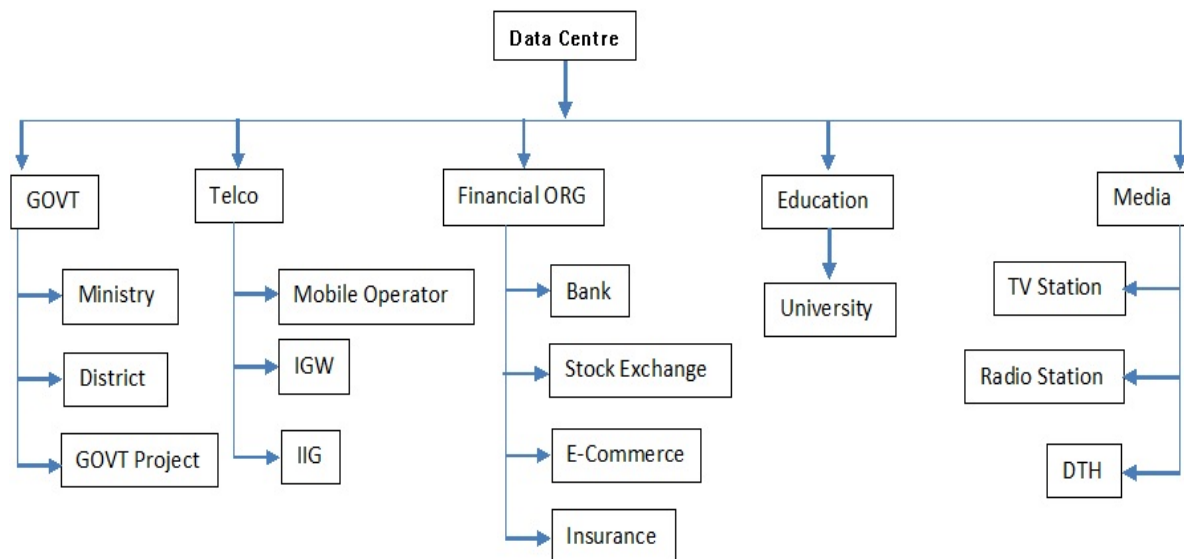


Figure 3.1: Data Center Usages Scenario in Bangladesh

## Chapter 4

### 4. Conclusion

Nowadays, Human activities such as telecommunications, energy, transport, health, security systems, banks, internet, lighting, entertainment, urban traffic and even physical integrity are mastered by a data centers.

Shortly, the prosperity and security of human beings is passed on to these centers of control and supervision of data and information. Most common people may not concern too much about it. However, big organization and public institutions, on the other hand, have a responsibility to act seriously against such affairs. However, today, the scenario is much different. The new age data centers are much smaller and modular. This is the big corporate trend, the modular growth. If compared with old data centers, these new modern data centers have four times higher processing capacity and occupy only 40% of the space.

Accurately saying, it is not because of the retrenchment of components, but due to the ongoing research for all overall system efficiency which consists of the concepts of virtualization and cloud computing.

The world's largest cloud platforms – the likes of Google, Facebook, and Amazon -- need a lot of space and power, and the last few years have seen an unprecedented amount of data center capacity built to support their growth. As more and more users and businesses sign up for software services and content delivered over the internet or private networks, the number of massive data centers designed specifically to deliver services at that scale is ballooning. There will be more than 390 hyper-scale data centers in the world by the end of the year, according to the latest estimate by Synergy Research Group, which tracks IT and cloud related markets. An overwhelming majority of those facilities 44 percent are in the US, China being a distant second, with 8 percent, followed by Japan and UK, each home to 6 percent of the world's hyper-scale data centers, and Germany with 5 percent.

### Hyperscale Data Center Operators Data Center Locations by Country - December 2017

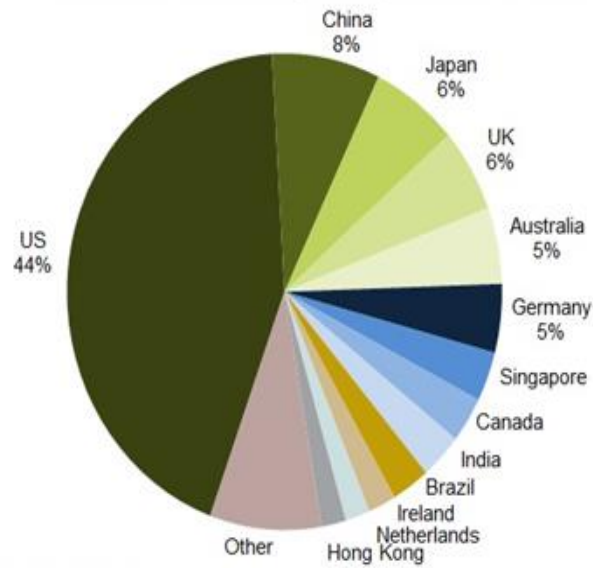


Figure 4.1: Hyper-scale Data Center Operator around the world

Nowadays, people are more dependents on a data center for their data security, flexibility and accessibility of critical information. People are more concern about advance technologies in their daily life.

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## **6. Appendix A**

1. The interpretation of CAPACITY parameter is “maximum IT load”. This is determine the non-scalable elements of a data center such as service entrance and physical room size.
2. If there is another candidate that meets the desired criteria, a reference design need not come from a prepared library of designs.