

**ΟΙΚΟΝΟΜΙΚΟ
ΠΑΝΕΠΙΣΤΗΜΙΟ
ΑΘΗΝΩΝ**



**ATHENS UNIVERSITY
OF ECONOMICS
AND BUSINESS**

**ΣΧΟΛΗ
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**ΜΕΤΑΠΤΥΧΙΑΚΟ
ΔΙΟΙΚΗΤΙΚΗ ΕΠΙΣΤΗΜΗ
& ΤΕΧΝΟΛΟΓΙΑ**
**MSc IN
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MASTER OF SCIENCE THESIS

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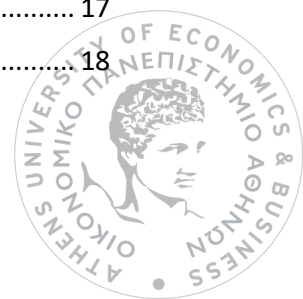
THESIS TITLE

Data Center Transformation



Contents

THESIS TITLE	1
1 Introduction	4
1.1 Data Centers of today	4
1.2 Data centers of future	5
1.3 Business Innovation from the new model.....	6
1.4 Disrupt or be Disrupted.....	8
1.5 Inhouse model limitation	9
1.6 CAPEX/OPEX of the Inhouse.....	10
1.7 Hybrid Model	11
1.8 Public Cloud	12
[5] Hybrid identity reference architecture(https://azure.microsoft.com/en-us/solutions/hybrid-cloud-app/)	12
1.9 Introduction to DevOps.....	13
2 Modern IT	14
2.1.1 Public Hyperscale's.....	15
2.1.2 Virtualization Norm.....	17
2.1.3 Digital Transformation	18



2.1.4	Focus On Features.....	21
2.1.5	Data Driven Model	21
2.1.6	Data Center Efficiency.....	22
2.1.7	Data Center Disaster Recovery.....	24
2.1.9	Business Continuity of the Cloud Model	29
2.1.10	Data Center Transformation	30
2.1.11	Example from the mobile ecosystem.....	32
2.1.12	Application Migration	34
2.1.13	Post migration.....	36
3	Foundation Elements of the Innovation.....	38
3.1	Change of thought	39
3.2	Supporting Innovation	40
3.3	Waterfall Model.....	40
3.4	Agile	42
3.5	Containers.....	43
3.6	MicroServices.....	44
3.7	DevOps.....	46
3.8	Conclusion.....	48
3.9	References/Citations/Bibliography	49



1 Introduction

The scope of this thesis is to demonstrate the transformation that is ongoing on the Information Technology sector. Having been educated in the past two years in the AUEB and having gained the fundamental description of innovation in business and the notion of disrupt or be disrupted I tried to write my experiences from my more than 16 years experience in the IT sector and relate the valuable fundamentals from the business school. My goal was not to write only for the technology that is been evolving and how the established are trying to be modern and not to be vanish in the past. Transformation is a key hype that everybody in the business is referring to and moreover digital transformation is also a key word from the executives. Digital transformation is not a technology but the notion of using portable devices from anywhere and buy services in 365 24X7 basis. Nonetheless as may can translate it to a marketing trick underlying the modern society has changed dramatically with the domination of web technologies and their applications. As a consequence the applications are becoming more and more universally a continuous service that cannot be established upon yesterdays data centers. Therefore the requirement of service to be available to the clients globally and without interruption regardless their value. Its a matter of survival for the modern business to adopt a new architecture either with the introduction of public cloud data center or local to be evolve in a modern and rapid data center. Software in our days I written in different manner thus all the fundamentals have to be changed in order to be relevant today. My attempt was to describe the motivation of the business of today to transform as the technology evolves and the various options that they have to stay relevant.

1.1 Data Centers of today

Todays datacenters are rapidly transforming in order to stay relevant in the new model of rapid development of of applications and the need for fast go to market with new features that are giving business the edge in the competition. The public cloud computing has penetrated the silo of the data centers of todays and the adoption is gaining traction as we can see from the stocks of the public cloud providers (aka service providers). The legacy model is situated around the following norms:

- Data Center Facilities in the customer premises
- Purchase of Hardware equipment
- Infrastructure teams that are solely responsible for the environment
- Deploy of the requested services
- IT budget for just maintaining the equipment



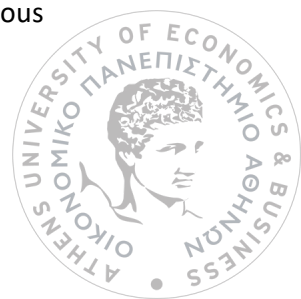
This model is around the decade of 1990 and has been not replaced in fast way since this decade. The supporting infrastructure is limited both in time and scale as the enterprise customers although they invest in the supporting infrastructure they haven't limitless budget and the services that are deployed are not fast enough to support today's business environment. On the other way there is also a need of the Enterprises to focus in their core business and not to be involved in the auxiliary supporting environment. As the need of transformation is evident there also limitations to offload the whole paradigm with a new model. There are various securities obligations for data exchange, processing and archive and not all the applications can be migrated to a third party regardless his reputation and his security measures. Thus although the need is here for changing the model the process is going to be gradually shifted and there will be compromises in the evolution

1.2 Data centers of future

Modern IT datacenters are based on the cloud computing principles and the need of minimizing the OPEX in IT budgets. Basic Principles of the cloud computing are the following

- Resource Pool based Computing
- Pay as Use Model
- Grow without limits
- Deploy in minimum time

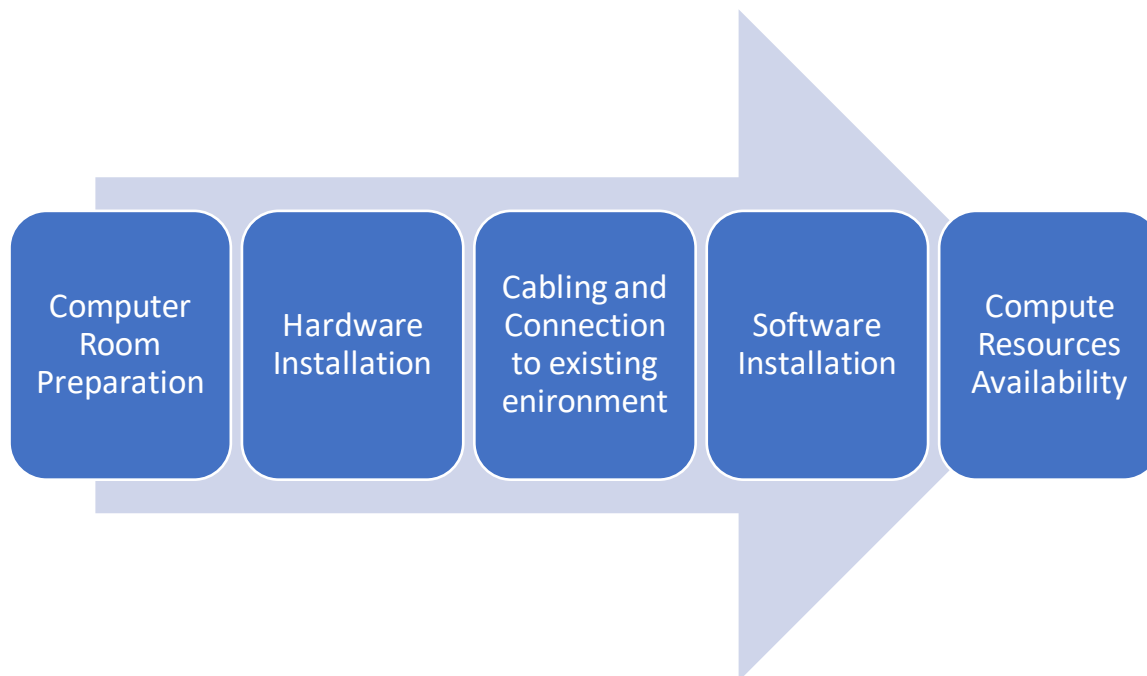
The Resource Pool based model depicts that customer purchase a resource pool based on his needs and deploy his application in that tenant. The principle of pay as you use is the foundation of the billing procedure. Clients are billed upon their consumption of services something that is radically different from the old model which the client was forced to pay the needed hardware and software equipment and the consumption was not guaranteed. The grow without limit principle is based on the enormous scale that public cloud can provide and their limitless scale up model. Furthermore the automation of the public cloud providers guarantees their ability to respond to the client needs in seconds. It is not unusual that a customer with a credit card can support developers needs of his team in an hour. Having said the principles of cloud computing is evident that the business of today are inclined to use their model as they save time effort and money to support a radical changed environment of continuous evolution rapid execution and intense competition from a global enterprise pool of companies.



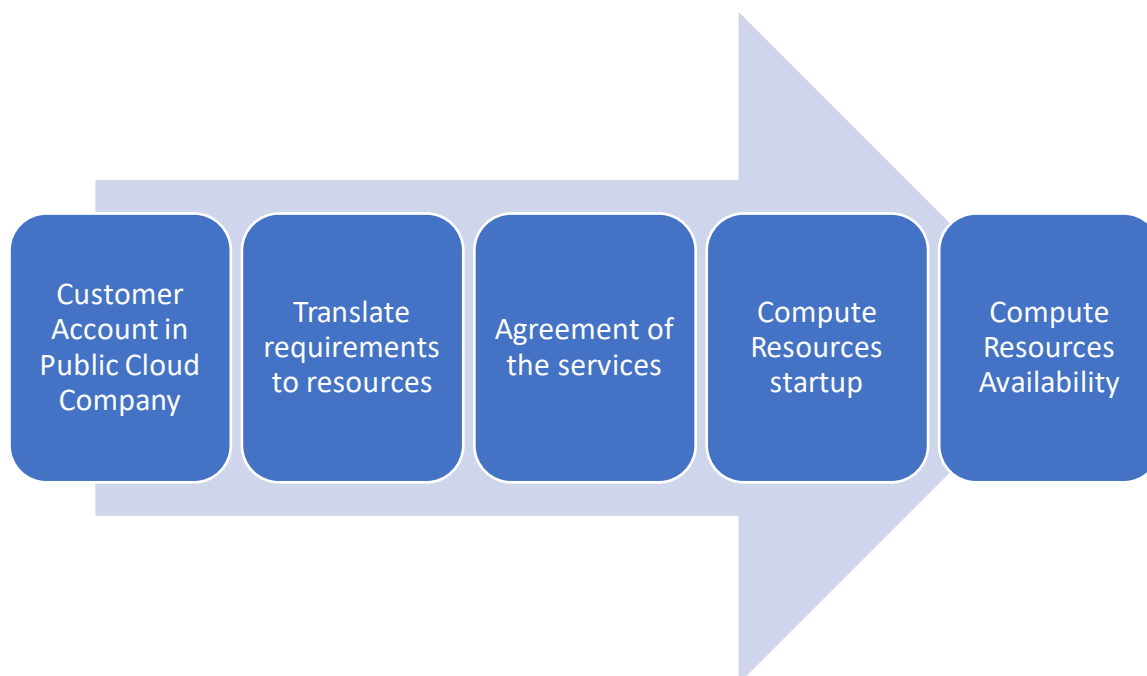
[1] Cloud Design Patterns (<https://docs.microsoft.com/en-us/azure/architecture/patterns/>).

1.3 Business Innovation from the new model

The crucial benefit of the new model is to offload the business from auxiliary activities like building computer rooms ,purchasing hardware and provide data center facilities .The current lifecycle is as depicted in the following diagram. Overcoming the traditional approach is fundamentally shifting the requirements from a slow approach to a modern fast an agile approach that has given the enterprises the edge in the competition. Focused on their core business and not in the associated routing work that has to be done in order to give them services is a core competency of the modern competition edge.



Radically changed the new business model has not physical mandatory requirements and can be depicted in the following figure . Customer has the unique option of purchase in few clicks what can give him the required infrastructure. Design of his services is helped from the enormous capabilities of hyper scalers thus he avoids to spend time in designing and implementing best practices and follow the long cycle of traditional approach. Cloud providers give automation tools in order to translate requirements to the infrastructure. Much needed security and concerns are not any more an obstacle as the reputation of the cloud companies is beyond any suspicion today .They have enormous clients base and they comply to the strictest regulations in order to provide the products in the scale that they do now. Operation and maintenance activities are becoming less a concern for the enterprises as the burden now falls in the shoulders of the providers. As a consequence the OPEX of the equipment is reduced to zero something unique now. No more the cost of maintaining the equipment is a budget constraint for investing and the offload is significant. Moreover a significant investment that previously should be done in designing Disaster Recovery data centers now is becoming a simpler radical and way more economical .Disaster recovery operation can be inherited from the service provider implementation and provide one click disaster recovery operation.



The new model process has outstanding benefits from the old one as it gives the organization IT department compute resources in minutes instead of months thus enabling its resources to focus on their development needs and feature creation .The whole cycle of procurement process is minimized to



the placement of an order on the Public Cloud Provider and there is no need of supply chain activities like transportation delivery of equipment [2].

[2] Enterprise Integration in Azure(<https://docs.microsoft.com/en-us/azure/architecture/reference-architectures/enterprise-integration/basic-enterprise-integration>)

1.4 Disrupt or be Disrupted

The term disruptive technologies was first introduced by Clay M.Christensen in his article Catching the Wave. His goal was to target executive management who make the funding and define the strategy of their companies .The term was gradually transformed to the current disruptive innovation in order to clarify that the main focus is the business-modelling is central to the evolution of the business .The concept of disruptive technology continues along tradition of identifying radical changes in the innovation .In summary the following are the main characteristics of disruptive innovation:

- Disruption is a process not a product or service.
- Originate in low-end or new market.
- Success is not a requirement and some can fail.
- New firms business model differs significant from the existing ones.

The theory behind the scenes has its roots in the simplistic idea that an established firm fails because it doesn't keep up technologically with other firms. This hypothesis is completely mistaken as already has been proved that good firms are usually aware of the innovation ,but their business environment does not allow them to pursue them when they first arise due to the fact that are not profitable enough and because of their development can take scarce resources away from core business In Christensen terms a firm's existing value place an obstacle to allow its pursuit to new innovations and its leadership must find the balance in order to stay current.



1.5 Inhouse model limitation

The Data Center design incorporates all of the following requirements in the corporation:

- Space ,Power and Cooling on dedicated room
- Fire protection ,Security of the physical access
- Quality Standards assurance

Disaster Recovery Preparation

All of the core requirements of the data center in house model resulting in heavy costs in the corporations. Furthermore there are strict rules nowadays for complying with quality standards and environmental conditions that corporations should be compliant raising the capital and operations expenses .Large corporations also like Banks have rules that have to be applied to their data center design like availability requirements of up to five nines meaning that a failure must not result in services unavailability .Incorporated with that there are requirements for avoiding natural disasters consequences and minimizing data loss in that cases.The standards of the data centers are published from The current structure of the data center in house of a corporation is situated around the idea of building a dedicated space in the buildings of the corporations to house the computing resources and the components related to itTelecommunications Industry Association and Uptime Institute and have the following form [3].

- Tier I lacks redundant IT equipment, with 99.671% availability, maximum of 1729 minutes annual downtime
- Tier II adds redundant infrastructure - 99.741% availability (1361 minutes)
- Tier III adds more data paths, duplicate equipment, and that all IT equipment must be dual-powered (99.982%, 95 minutes)
- Tier IV all cooling equipment is independently dual-powered; adds Fault-tolerance (99.995%, 26 minutes).

It is evident that not all of the corporation can easily invest in this kind of scale to have a proper design and structure for the data center and they in the end compromise quality and cost .Added to that new requirements that may arise in a corporation may overcome the current structure of their facilities. For example a corporation can easily consume the space of the building that they have designed for computer resources and the slightest new need will result in the need of new building. Scale is one of the biggest limitation of the current model



[3]AWS Disaster Recovery (<https://aws.amazon.com/disaster-recovery/>)

1.6 CAPEX/OPEX of the Inhouse

The capital expenditure or capital expense of the datacenter is the capital that the corporation consumes to buy for the needed equipment for the data center construction and the Operational expenses of the datacenter is the capital expenses for operating and maintain the needed equipment. The following list is an example of this cost and not a complete list of the needed equipment

- UPS and Power Equipment Facilities
- Servers and Network Equipment
- Storage and Archival Equipment.
- Telecommunications Equipment.
- Network Hardware Equipment.

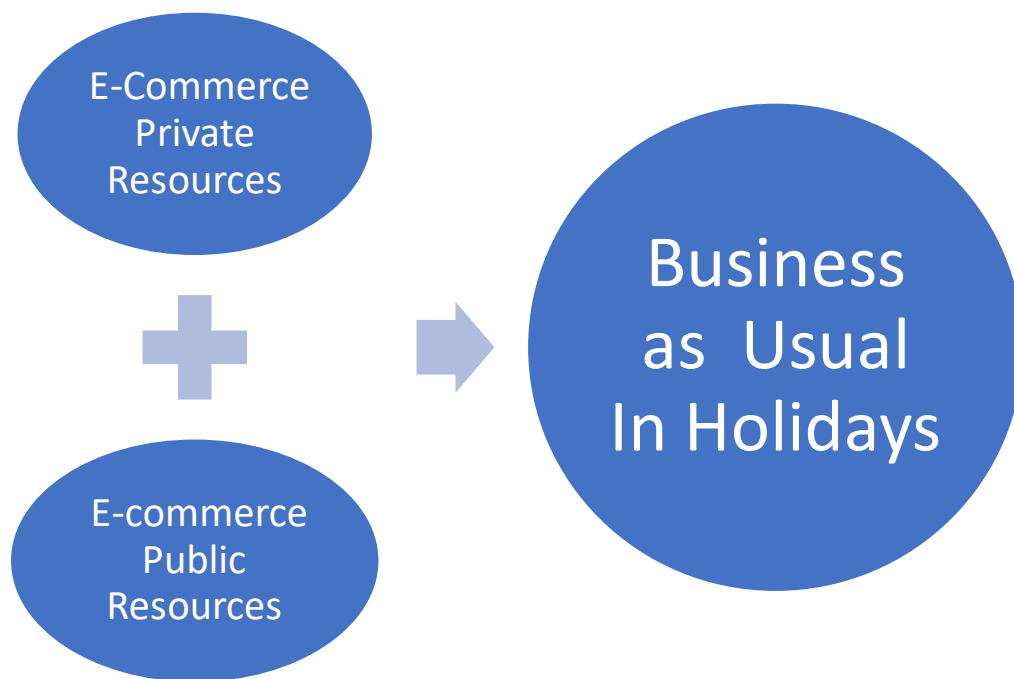
On top of the needed capital for the primary data center , after the September 2001 attacks in USA that resulted in the complete shutdown of the NY economy it was evident that a unexpected event cannot result in the complete shutdown of all the basic services thus was created the need for the secondary datacenter a facility constructed far enough to accommodate the alternative solution of the unexpected event .Given the fact that the corporations are largely depending on modern applications like e-commerce ,online banking ,CRM(Customer Relationship Management) [4]the underlying failure of the supporting equipment results in immediate financial loss the CAPEX and OPEX is immediately doubled upon creation of the secondary data center.

[4] Modern Sales Team,Yesterdays CRM? (<https://www.salesforce.com/form/sales/modern-day-sales-team-yesterdays-crm/?d=cta-body-promo-33>)



1.7 Hybrid Model

Not all the corporations can immediately be moved to the cloud computing environment. Hybrid model is a combination of public cloud and the private premises of the company. A valid example of this model is that a corporation uses public email provider for its mailing platform but for its core web application that stores customer profiles has an application situated in its premises. Another practical example would be the same company to have its e-commerce platform which in normal days experiences normal traffic and its current infrastructure can satisfy the need but when there is a holidays season or a marketing promotion there are extra needs to be fulfilled. Thus a solution called cloud bursting can be introduced which gives the corporation the extra needed power to meet the demand. In that way incidents of the past where in the holidays season or in peak hours of a sales discount event the business could stop to function in a meaningful way are avoided.



1.8 Public Cloud

Public cloud can be defined as the service provided by a corporation publicly to the clients for hosting their applications and computing needs. Currently public cloud providers with the leading market share are Amazon Web Services ,Microsoft Azure Google GCP and Alibaba from China.The idea of the public cloud was in the corporations for years and small players were existing before Amazon but the true breakthrough was made from Amazon which had enormous compute resources and department for accommodating the e-commerce giants needs and the scale of their applications. Having understood that they were servicing a giant company and had self developed custom solutions the idea was simple to extend their customer base not only in their corporation but also in the public. The primary notion of the cloud computing is on demand pay per use purchase and consuming of computing resources like cpu memory and storage .The model has been extended to provide as a service applications and platforms [5].The following table depicts the as a service notion of the public cloud.

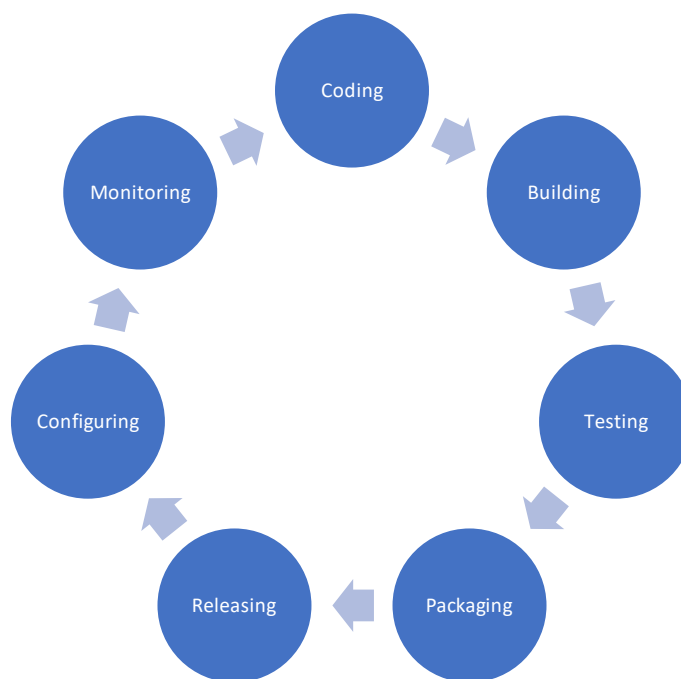
Model	Charasterictics
Infrastruecture as a Service	The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources
Platform as a Service	The capability provided to the consumer is to provision needed platforms for application development
Software as a Service	The capability provided to the consumer is to provision directly the needed application for development

[5] Hybrid identity reference architecture(<https://azure.microsoft.com/en-us/solutions/hybrid-cloud-app/>)



1.9 Introduction to DevOps

A main ingredient of the new Modern IT infrastructure that has been implemented for use firstly in the public cloud is the DevOps model. The term is described as the combination software development operations in order to make software development cycle faster ,efficient and automated. t provides necessary tools to the software development in order to make the process robust and quick.In the following figure the main tools are depicted:



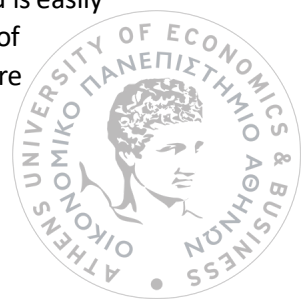
2 Modern IT

The new IT approach is following the trends of the new shift in business. The era of global commerce has been established in more than one decade and the corporations cannot be guaranteed that their established presence and their market share cannot be threatened for a long time period .Competition is beyond local markets and they cannot predict the entry of new comer in their core business ..As a consequence innovation is fundamentally the core ingredient of the success.The following principles are set from business and the IT must conform with them.

- **Ultimate goal of business is to bring new customers** . This means that a corporation has to focus to give products that cover new or established needs of customers .Its core functions are product development and marketing the rest are supporting functions and must be offloaded
- **Effectiveness and efficiency** . No business can be successful if cannot find its way to produce products with efficiency meaning that the cost and the quality are optimized ,Effectiveness is also a must have value as without having results the business can not sell. Both values have tpo be executed with success otherwise the business will fail eventually.
- **Customers value security and trust**. It has been proved that customers are willing to pay a premium if they know that the product is of quality proven tested and their security is not compromised. A breach of trust can result to financial loss and in many circumstances in the complete failure of the enterprise.

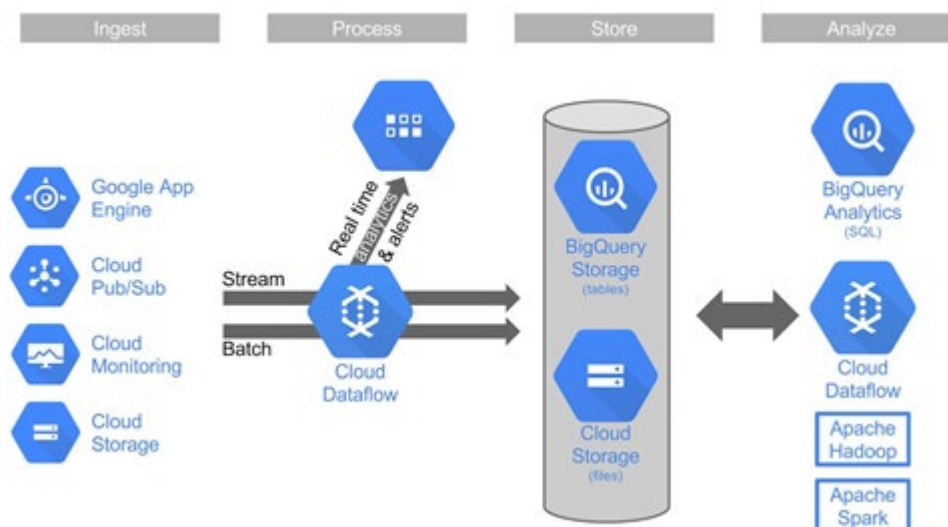
Having the ultimate goal of complying with business modern IT has designed with.

- **Effectiveness and Efficiency of underlying infrastructure**. Hardware is standardized and is easily expandable in order to accommodate any customer need. To scale up there is no need of expensive and dedicated hardware but software adds the needed standardized hardware



2.1.1 Public Hyperscale's

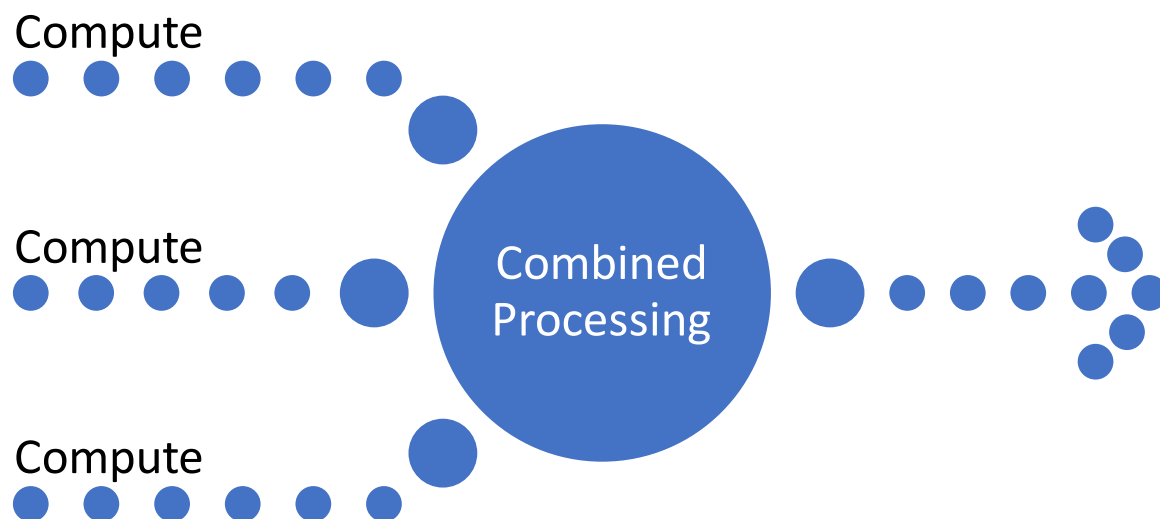
Currently the cloud computing is dominated from the big service providers that have used and developed for the needs the vast datacenters for consuming on their own departments and extended their offering to the public. In computing hyperscale is defined as the ability to seamlessly provide needed compute power without limits. Google, Twitter, Facebook, Amazon are the examples of the enterprises that developed architectures for limitless computing needs. For example the core value of Google LLC its search engine required enormous computing resources for processing data quantities of unprecedented scale. The already established IT of the era couldn't provide the needed power in a costly effective manner and with time accuracy. That forced Google LLC [6] to develop its datacenters in a new architecture of distributed processing. The distributed architecture was based on parallel processing of compute nodes.



[6] Google Compute Basics(<https://cloud.google.com/compute/docs/>)

(https://www.google.com/search?q=google+compute&rlz=1C1GCEU_en_844_844&sxsrf=ACYBGNRFa-26102ICMlv9H-

[za1XDHNu62w:1574152902225&source=lnms&tbm=isch&sa=X&ved=0ahUKEwihnbzE8PXIAhUCLFAKHWnQDjIQ_AUIEigB&biw=1280&bih=529#imgsrc=KRVgGm1pq-WOgM](https://www.google.com/search?q=google+compute&rlz=1C1GCEU_en_844_844&sxsrf=ACYBGNRFa-26102ICMlv9H-za1XDHNu62w:1574152902225&source=lnms&tbm=isch&sa=X&ved=0ahUKEwihnbzE8PXIAhUCLFAKHWnQDjIQ_AUIEigB&biw=1280&bih=529#imgsrc=KRVgGm1pq-WOgM))

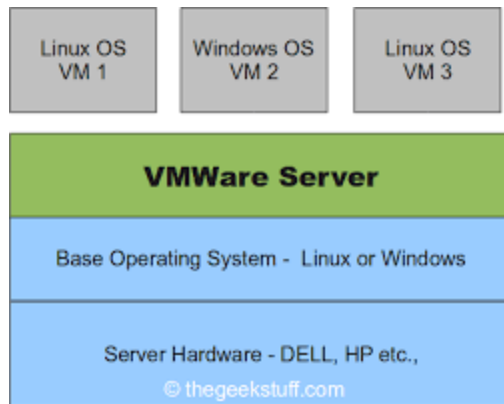


2.1.2 Virtualization Norm

At the start of the previous decade there was gradually started the movement to decouple the Operating System from the underlying hardware. The use of physical machines for each application was spending the compute resources and there were times that valuable hardware resources that has cost enterprises capital sitting idle. As there was evident the wasting of resources VMware Corp [7] pioneered the new way of delivering the compute power of applications with abstracted the underlying resources. The main benefits of virtualization are the following:

- **Server consolidation:** Physical servers are replaced with Virtual Machines and the configuration can be standardized.
- **Standardization of equipment** . The hardware is modular and more expensive type which was needed for the more demanding applications is mitigated.
- **Backup and restore Operations.** The backup and restore operations are more easily configured and the notion of the snapshot is used.
- **Ease of relocation/migration.** As the Virtual machines are logical concepts the disaster recovery operations are becoming way easier than before .
- **Maintenance optimization.** Due to the fact that the Virtual Machines are not tied to a hardware resource they can be migrated to another hardware resource and the machines are operational during migration or maintenance activities.





[7]VMware vSphere Documentation(<https://docs.vmware.com/en/VMware-vSphere/index.html>)

2.1.3 Digital Transformation

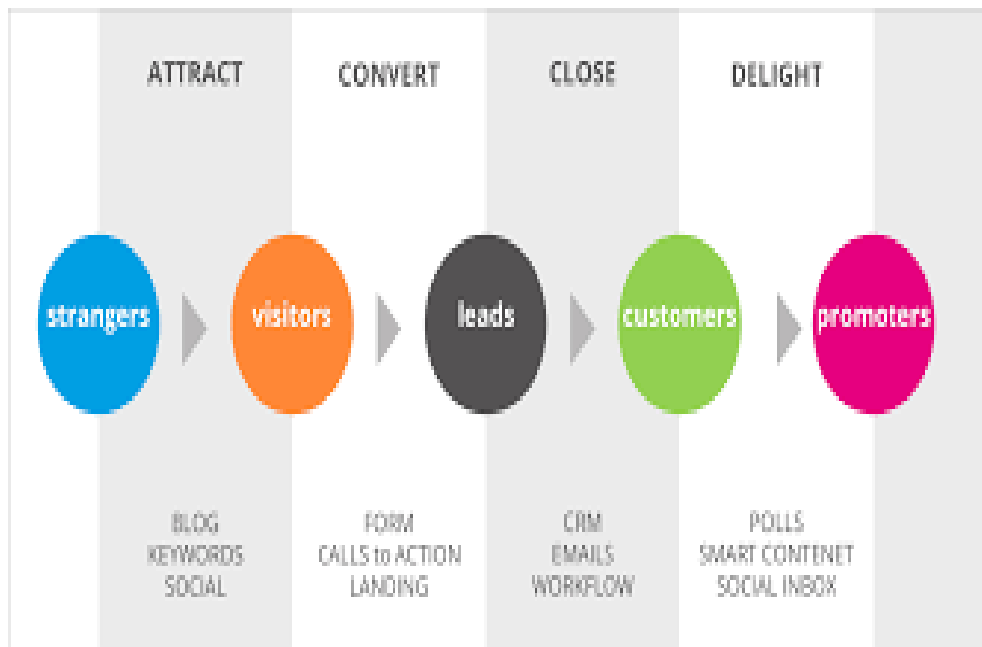
One cannot explain the rise of the new computing environment in the corporations today without explaining also the new era that has been defined in our ages .The term is popular in these days and tries to describe how the modern corporations of various industries like retail, manufacturing are being transformed using the new datacenters (aka cloud computing) for producing services that customers consume for things that 20 years ago were not possible. Purchases from credit cards mobile payment systems are services that are transforming the way of life. For previous generations was unimaginable that they could avoid long standing in queues to pay their bills for everyday needs .Public sector everywhere is also trying to evolve and modernize with the use of technology .Every aspect of modern life is changes through the use of technology and the modern instruments of contacting business are portable like smartphones and tablets .In a rapidly changed



business environment standstill is not an option as for example banks are trying in every way to move to the online digitized model as the competition for new companies that try to get to the finance business .FinTech companies as the are named have architecture their business from the start embracing the digital environment and thus the pressure in the banking sector is evident .Cloud Computing gives the chance to companies of all the industries to use the services from cloud computing and with services that are guaranteed in regular monthly subscription they are able to finance their core development activities .Digital transformation can be successful through the use of standardized software that providers can produce.

Online marketing activities from Customer Relationship Management systems [7] are crucial for the corporations in order to understand their customers their habits and their inclinations through the use of the provided tools they can target range of customers with precision. A CRM system before a decade needed at least a purchase cycle of 90 days to be procured and three times that time to be deployed .Its not uncommon today to have a CRM subscription ready for use in minutes with one available credit card for the payment and one simple registration process.





[7] Get more from your Leads (<https://www.salesforce.com/form/sales/get-more-leads/?d=cta-body-promo-31>)



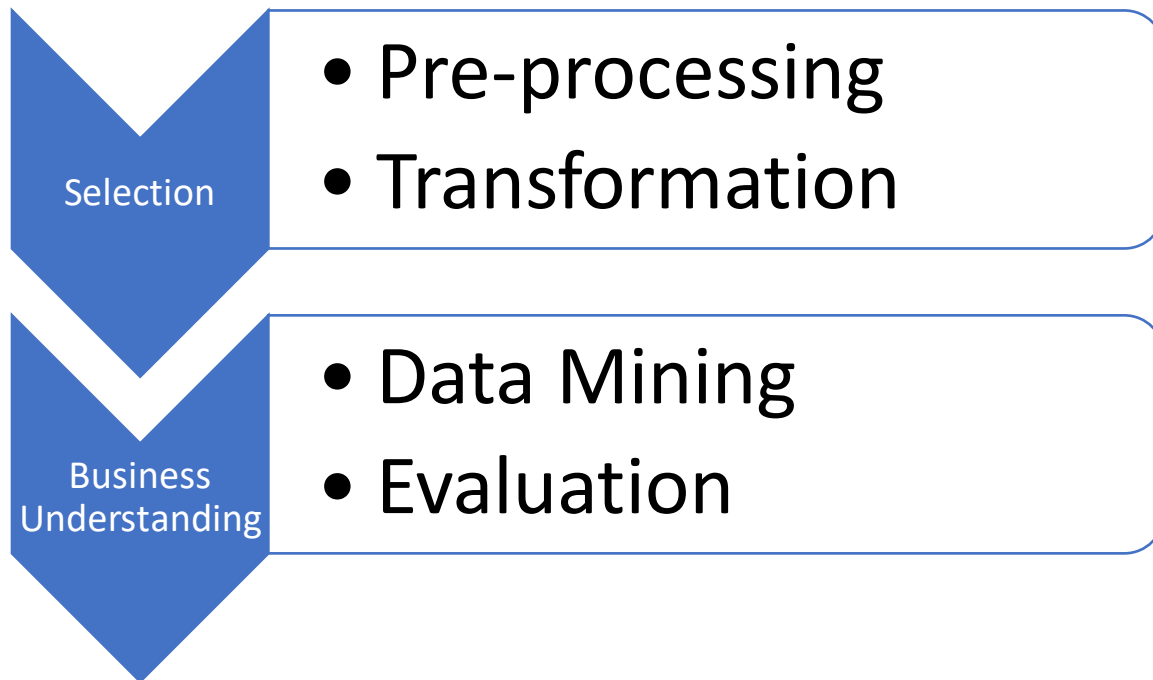
2.1.4 Focus On Features

E-Commerce ,Banking,Healthcare,Hospitality management are examples of the new era of doing business. For the hospitals the use of technology for example is an outstanding factor and key performance indicator of their core value. The digital marketing of the hotel is more and more the main value that have to produce and the competition is fierce Young generations and also more older people are more than inclined to use digital means for booking .Online travel agencies like Expedia and Booking.com are more than vehicles for hotels to achieve their goals. With the rise of cloud computing hotels can invest on designing their applications and the management software and focus on the functionality that apart them from competitors.The vehicle of cloud computing is an instrument for the corporations in order to focus on features .As another example the hotels can extract data from their app to observer customer behaviors even measure time for staying in the cafeterias or their order preferences.

2.1.5 Data Driven Model

It is evident that all corporations have to use data to drive their organization behavior. The cloud computing gives them the possibility to measure the date and they way to get the statistics from data in minutes.Every organization now must have data in their hands to support their decisions and the reporting and measuring activities on data are more than critical. Another popular term associated the data driven change is machine learning.One example of the data driven model is Association Mining .Association Mining is involve in various type of marketing activities like basket data analysis,cross-marketing ,loss-leader analysis. The concept uses statistics that correlated a set of items that are statistically bind together in the form 90 percent of buyers that buy from tires will buy also a service to install them. Such type of activities require heavy computing power in order to find the correlations and give statistic models the power of exploring data.There are predefined steps in databases tha has to be performed in order to apply data mining in data .A simple graphic illustrated better the process.

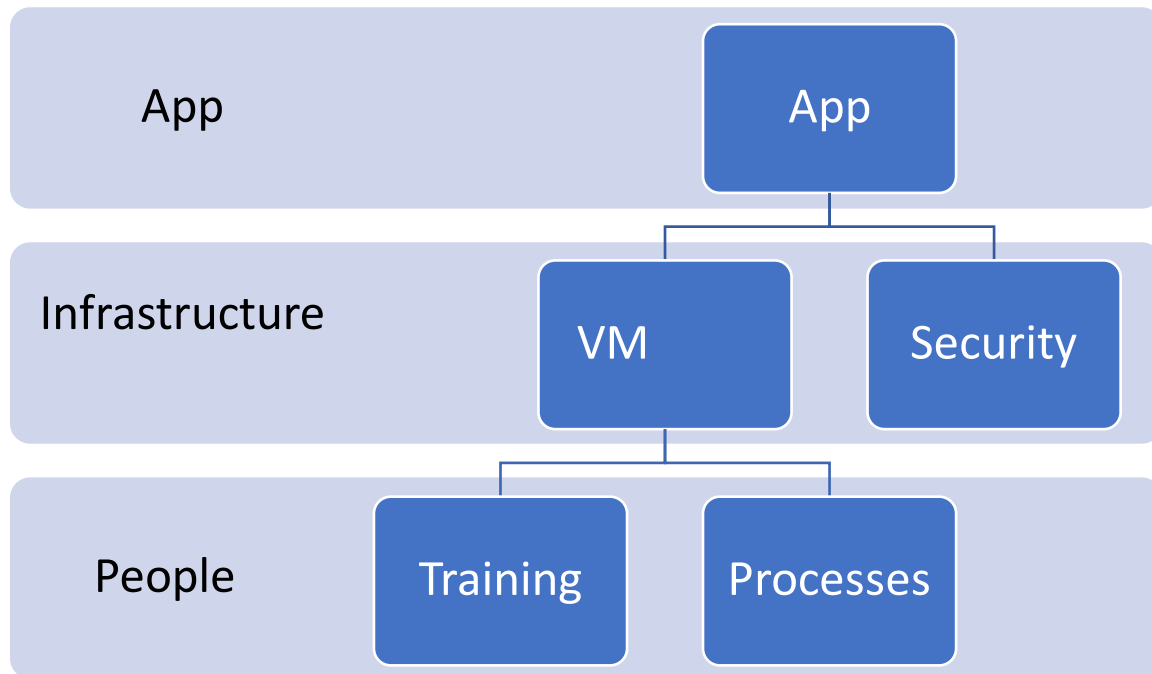




2.1.6 Data Center Efficiency

No matter the size of enterprise of medium and above scale the fact is that in order to provide computation needs some kind of datacenter must have been constructed .But on the contrary of the need to have a datacenter the way that they implement is far from uniform. Structured cabling ,power grid implementation, cooling equipment ,safety measures are all in the decision of the business in what quality manner will be implemented. This often yields to unstructured bad designs error prone and inefficient .Combined design and process are critical in order to have the datacenter efficiency and as the journey to cloud will be a slow process and the implementation will be a compromise of public cloud and local datacenter the corporations must design their activities in order to have a stable proven and reliable design for supporting their core business. The following graphic depicts the needed structure.

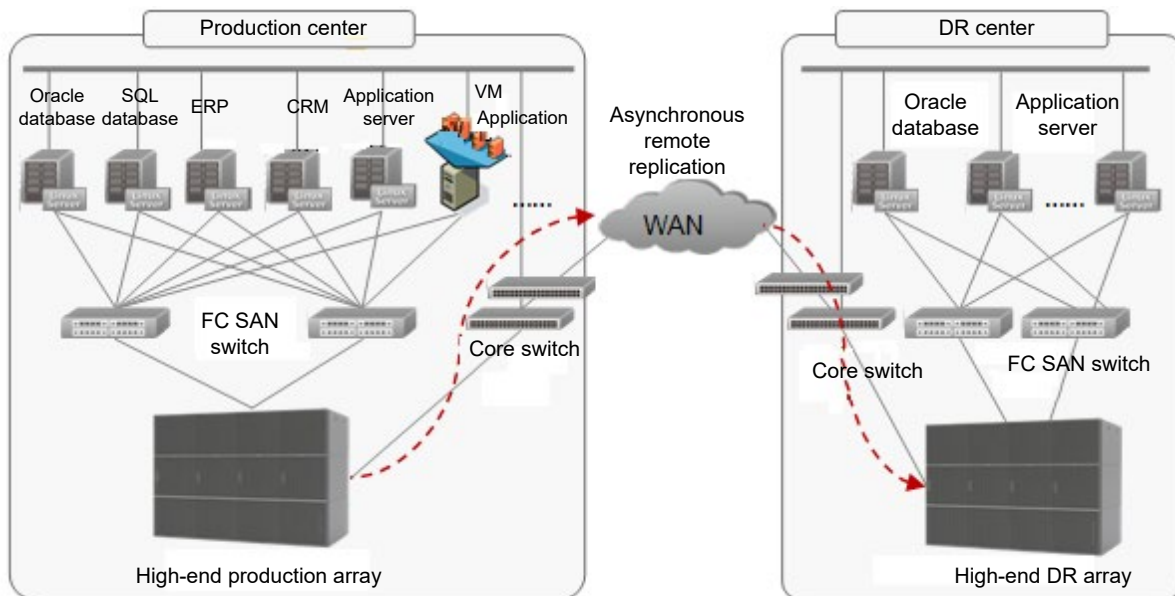




2.1.7 Data Center Disaster Recovery

Crucial to the IT operations of today is the assurance that enterprise has the means ,the functions and the design to prepare its business continuity in the event of catastrophic failure. After 11September attacks and Japan natural disasters that caused abundant economic loss except from the lives it was evident that the model was with fundamental flaws. A rapid change of design was mandated from the failure of the enterprises to adopt to random event s.the below figure shows an architectural approach that has natural barriers to the random and not predicted event and faces the challenges of the unknown .Disaster recovery is a set of policies ,methods and procedures that have been established from the enterprise in order to use them for business continuity operations.

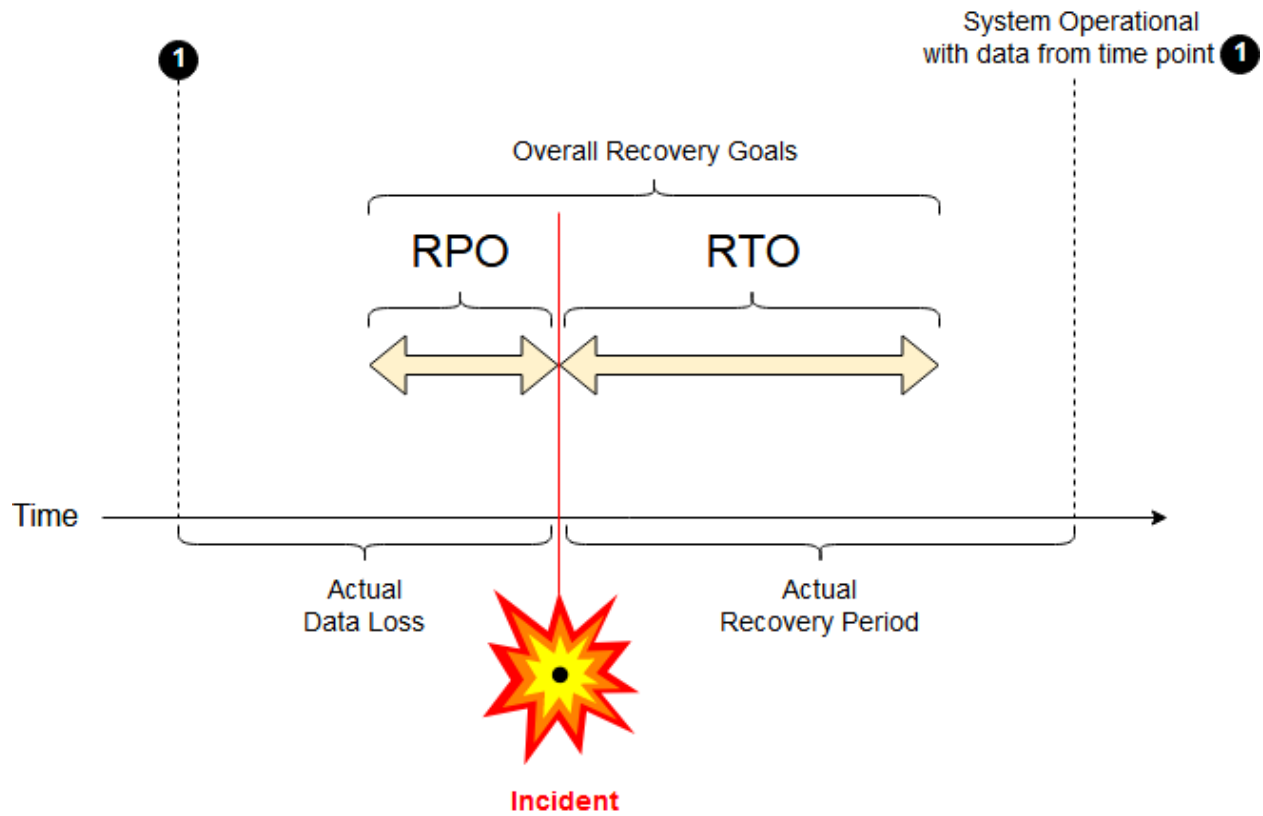
Active-Standby Data Center



The whole design is based on the fact that a production data center has all the required components to support the business. It has the compute network for supporting the applications and their deployment in the main building. The first building has connection to a second building located far from the first resilient thus to unknown events in the town that is located .the main building. Upon the catastrophic event all the services that has been stopped in the main building can be switched to the second building located far from the main. The process has a lot of choices to be designed and the fundamental design is based on the notion of the two most important concepts RTO and RPO.

- RTO .Recovery Time Objective is the time that business has accepted to be required in order to failover to the new data center upon the failure, Its minimum value is 0 and can be achieved with the active-active data center design which is the most expensive design but it leads to the ultimate business continuity.
- RPO. Recovery Point Objective is the amount of data that business has accepted to lose upon the failure .For example the business has accepted to lose transaction of 1 minute upon catastrophic failure and can be tolerated from business This minimum RPO is again 0 and this inherits the active-active data center design approach which leads to costly investments.

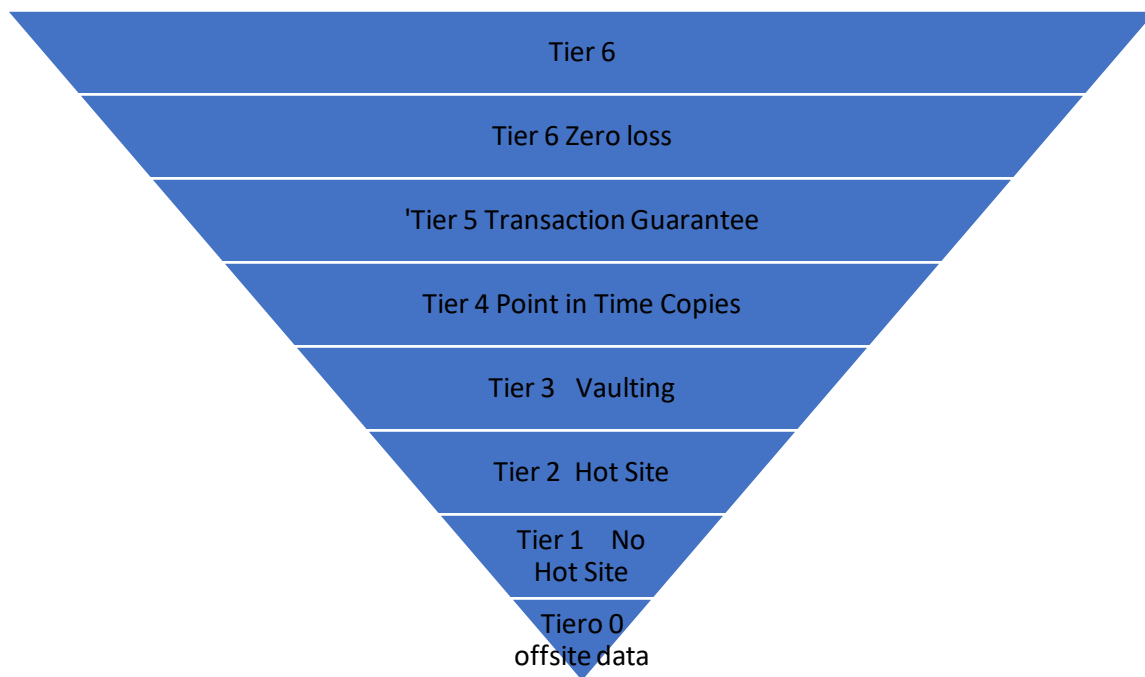




[10]RPO/RTO (https://upload.wikimedia.org/wikipedia/en/6/69/RPO_RTO_example_converted.png)



Classification of the disaster recovery data centers has been proposed from SHARE Corp and has the following structure.



In the preceding graphic the depicted | the evels of Disaster Recovery Operations and the short explanations are following

- Tier 0. There is no backup plan neither a disaster recovery schedule .Thus the classification means that the data center is not protected and the lowest possible protection is achieved .The recovery time is unpredicted as there are no measures to prevent it.
- Tier-1.Data backup only and no disaster recovery site. The procedure is not applied to the a second data center thus can lead to weeks of unavailability and no guarantee in a timely restore of operations.
- Tier 2. Hot Site is inserted in the architecture and the data backup is applied to the hot site .While this is an orchestrated approach and leads to a full recovery it doesn't provide a guarantee in the RPO and thus lit can lead to a restore operation of several days and the business is stopped during the recovery
- Tier 3. This tier combined Tier2 functions with electronic vaulting of data thus the data that have to be restored in the second site is minimized and the restore operation is minimized.
- Tier 4 . This Tier is inserting the notion of point in time copies of the data thus meaning that disk based technologies like storage replication has been introduced and the business requires the automated replication of data between sites in predefined intervals that minimize the RPO of the enterprise. This Tier guarantee that services are restarted in the hot site and the data allradyu exists there thus the operation can be resumed in the predefined RPO that the enterprise has designed.
- Tier 5. This Tier guarantees the transaction integrity of the data.The disk technologies that were introduced in this level outline that the data integrity of the transactions is achieved and thus the data that are on the primary data center are mirrored in real time in the second data center. Critical data like transactions of bank accounts or carriers Call Data Records are of most importance as no client can accept its loss thus this Tier gives them the safety required.
- Tier 6. This guaranteed RPO and RTO of zero value and achieves the highest possible application service continuity and operation. The applications are running in the two data centers in parallel and thus a disaster event in on site doesn't affect any service. This design provides the maximmm availability of services but has the high cost of the implementation associated with that.



2.1.9 Business Continuity of the Cloud Model

As the public cloud is based on as a service approach the same is applied to the Disaster Recovery Operation. The notion of DRaaS meaning Disaster Recovery as a Service. As a leading public cloud vendor Microsoft has introduced the Site Recovery. Site Recovery in the Microsoft case is providing the replication of various types of workloads from a site to another. The solution can be comprised from the Microsoft data centers that provide the availability zones or the customer on premises site. A relation of a customer data center to a Microsoft data center can be established in order to provide the required RPO and RTP objectives that have been setup from the enterprise. Azure provides the so-called regions for designing the solution. Regions are comprised from a geographic region that has one or many data centers and are typically near the customer in order to reduce the required network bandwidth. The Azure can provide either backup service or Site Service or both. The following are the provisions that can be made in the Azure platform and lead to the modularity of the disaster recovery operations.

- OnSite Premises to Azure. A service is provided to open the Azure Data Centers for replicating the whole on premises data center.
- Azure VM replication. Customer has purchased already Virtual Machines on one Microsoft region and the service provides the replication of the machines to a second geographically dispersed site far from the first. As the Microsoft data centers are not immune to physical disasters and they have been occasions that unavailability was caused the solution provides the true disaster operation of a real service.
- Workload replication. The solution doesn't not provide the bottom level approach but gives the enterprise the application tier of the disaster recovery. Common applications that can be deployed in high availability manner is SharePoint, Exchange etc. Thus the Service Level Agreements are based upon the real application and not the underlying platform.
- RTO and RPO targets. The service permits the client to set the recovery time and point objectives and the platform arranges the resources.

Nonetheless the procedure also for the clients in the case of public cloud implementation a detailed design with meaningful targets must be followed. The service provider doesn't guarantee the application continuity nor the backup procedures of the enterprise. Thus it is the clients responsibility to formulate his plan accordingly follow his procedures with the goal of achieving true business continuity.



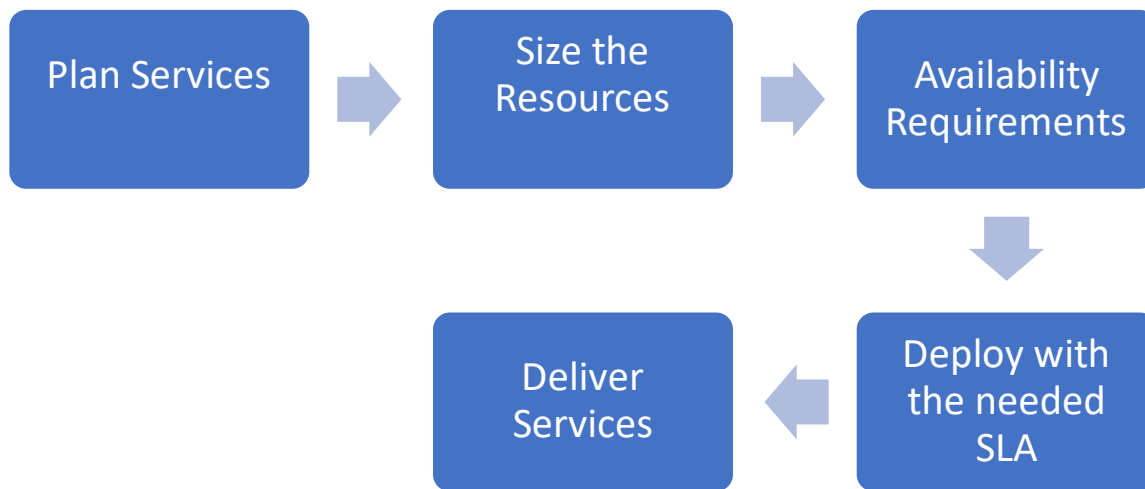
[8] DRaaS (<https://docs.microsoft.com/en-gb/azure/>)

2.1.10 Data Center Transformation

It is almost inevitable today to hear the term Digital Transformation. It is prevalent from the various executives to refer to the term in order to describe the necessity of the corporations to offer digital services of various types like mobile payments ,mobile catalogues, online shopping [8] .All have the fundamental meaning that services are to be accessed from anywhere and anytime from a portable device that customer uses. Almost none of them has ever said the term data center transformation which is fundamentally the underlying term .For the delivery of digital services in global reach and not a minute unavailability you must have an underlying infrastructure both efficient and fault tolerant. Thus the promise cannot be fulfilled if there are legacy data centers as failures happen every day and the operation personnel is not often employed in 24X7 manner. On the occasion that failures strikes and is not in the normal working hours the required personnel can take hours to be fully engaged and thus the integrity of services are compromised. Needless to say that the delivery of services in four of five nines availability needs an investment that few can manage.It is evident that as the services have been

involved the data center must consequently and in parallel involve.The public cloud companies can deliver the transformation as they are of enormous scale they have the investment and the structure to support uninterrupted services .The needed process for transforming the datacenter can be summarized in the following diagram





[9] SAP Hybris Architecture(<https://www.sap.com/documents/2018/12/c2943dbc-b97c-0010-82c7-eda71af511fa.html>)



2.1.11 Example from the mobile ecosystem

At basic level an application that an e-commerce should deploy must have the following ingredients.

- Customer facing application
- Ordering System
- Supply Chain Inventory

The needed elements must be interfacing each other and the transactions should be guaranteed to be integral in all the application subsystems. The need of sizing the environment is a dynamic process. The corporation can face increase demand in the ordering system and the other subsystems can be stable. Thus there must be a modular scale as needed architecture. Almost identically the supply chain can be modified independently . As a consequence a design that was drafted before three years can face challenges to accommodate the dynamic requirements .For example in order to scale up the ordering system the business could be obliged to bring new database servers and new application servers for the required change .This could lead to months of deployment that are wasted and the corporation sees market eruption and revenues miss.Below a schematic version of a e-commerce application.





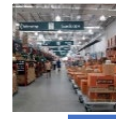
Customers

- Name
- Credit card
- Address



Ordering

- Item ID
- Price List
- Discount
- Item Availability

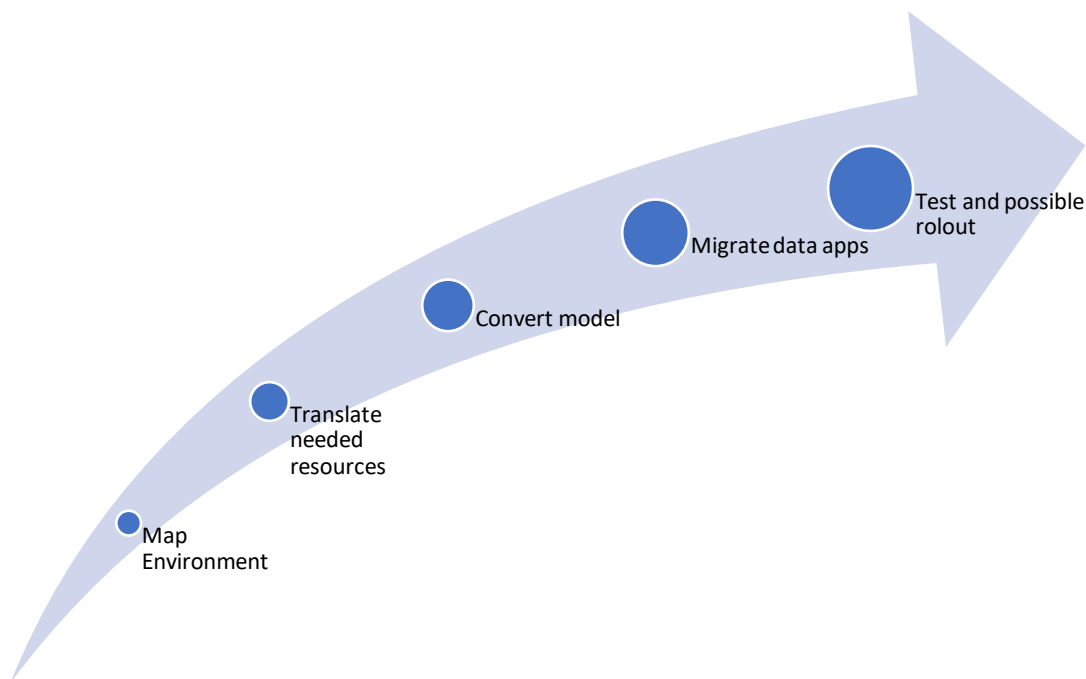


Supply Chain

- Item ID
- Warehouse Number
- Delivery Method

2.1.12 Application Migration

Having outlined the necessity of the new way of business adoption of the new way of transacting with clients it is evident that the existing applications must be moved from the current status .The migration process is one of the most difficult parts as it requires people to move from their comfort zone that were using for years and education in new technologies. A common set of tools and techniques must be introduced in order to accommodate the transition to the new reality. Careful preparation should be executed and the all the supporting functions of the business should be aligned in order to mitigate the errors in the process .One can define the cycle hierarchy of the processes like below.



The first step of the process is to gather the required information of the existing resources how the application is functioning the required information that has to be gathered in order to view the clear the architecture of the application. This step requires the corporation to involve all the associated departments like operations ,development ,security to write down all the steps and work that applications require to function. It is crucial to have the whole map of the applications ingredients in order to design a solution for the migration. Aside of the technical work that has to be done such as the database s,middleware and web layers that are critical for functioning of a system the business also provide its high availability requirement the necessity of its functioning .For example different recovery functions are needed for a bank transaction system and different for a reporting environment.

Secondly the design must take place in order to size the environment .Performance of the system has to be collected and the required functionality is thoroughly tested.In this step one has to think the various pieces of the system software for example the application of the transactions system may need the client to authenticate through a custom authentication server or some commercial.It has to be determined if the process has to be repeated in the new system or to take advantage of the new platform functions and rewrite the application if it is feasible. Also the process must prioritize the applications by value such as

- Type like commercial software or open source
- Business availability
- Complexity

The convert model process translated the pieces of the existing software that are used now in the new platform .Databases that exist in the old model are replaced from the platform databases the software that is provided from the new platform is used to host the required code. Workshops must be contacted for teams to give their requirement to test the functionality and provide valuable guidance in the areas that may cause problems. Various tools can be used for the migration phase of the data and the apps that exist on the public service provider to accommodate the transition .Finally the last phase involves the testing of the functionality of the apps and the roll back plan in case of failure.



2.1.13 Post migration

Having migrated the application on the cloud or to the new datacenter its not the end of the data center transformation .The minimum steps that have to be implemented after migration are:

- Optimization
- Backup Plan
- Disaster Recovery

The optimization stage involves the company to assess the performance of the applications if it is satisfactory for their core business. Reporting tools and operations management tools are involved for showcasing the Key Perform Indicators .One fundamental error that most enterprises have done in the past of the data center transformation is that the backup and disaster recovery of the public cloud platforms save from the necessity of the backup design and rollout of the Disaster Recovery Plan fpr each application. This has caused downtime and dissatisfaction but it is commonly recognized that no platform no matter how efficient it is can give solution to everything if the design of the client is error prone.It is paramount to schedule various backup mechanisms and follow the e 3-2-1 Backup Rule. The 3-2-1 backup rule is an easy-to-remember acronym for a common approach to keeping your data safe in almost any failure scenario. The rule is: keep at least three (3) copies of your data, and store two (2) backup copies on different storage media, with one (1) of them located offsite.



3-2-1 backup strategy steps



3

data copies
(1 primary and
2 backups)



2

**types of
storage**



1

**off-site
storage**

ILLUSTRATION: MAGLARA/ADOBE STOCK

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Illustration of the 3-2-1 Backup Rule

[10] 3-2-2 Backup Rule(<https://searchdatabackup.techtarget.com/definition/3-2-1-Backup-Strategy>)



3 Foundation Elements of the Innovation

Innovation can be defined as the introduction of a new ideas ,thought that gives better solutions ,new requirements .This takes place through the process of introducing new products ,services ,technologies or business models that can be used from all the types of the society. Lessons from the past has demonstrated that people are resisting change and many times the main barrier is the thinking of them .There are times that innovation comes with the means of technology automation resulting in headcount reduction which gives the people the motivation to resist the change. This requires careful preparation for the business to help reorganize and give the people the whole idea of what is required what will be the driving force for the change and how they can be valuable in assisting the change and not resisting .For example in the motorways automation has been introduced and many people are redundant in this process. In that case a plan should be drafted in order to give people training and help in order to be useful .In the same way data center transformation will cause many organic positions to be redundant and without plan the dissatisfaction will arise and the trend to resist .But with careful drive of the organization they can influence the people to learn excel in the new technologies and adopt to the new environment.



3.1 Change of thought

Undoubtedly organizations of all size are taking decisions using data .Key Performance Indicators of the business are a typical use of data for decision making and influencing. Thus the organizations increasingly use the Information Technology tools to make decisions. Long past the time that the key people used their feeling to make the decision making and their .Thus employees who are resisting the change must arguably support their decisions with the data provides. Organizations should adopt the open mind approach and dynamically move to the new environment .The first step in the process is to not to stick with a tactic but make plans for new actions.Associated with the change is also the assessing the risk but also have the will to take the risk also.This will other lead to success or will lead to controller failure as follows:



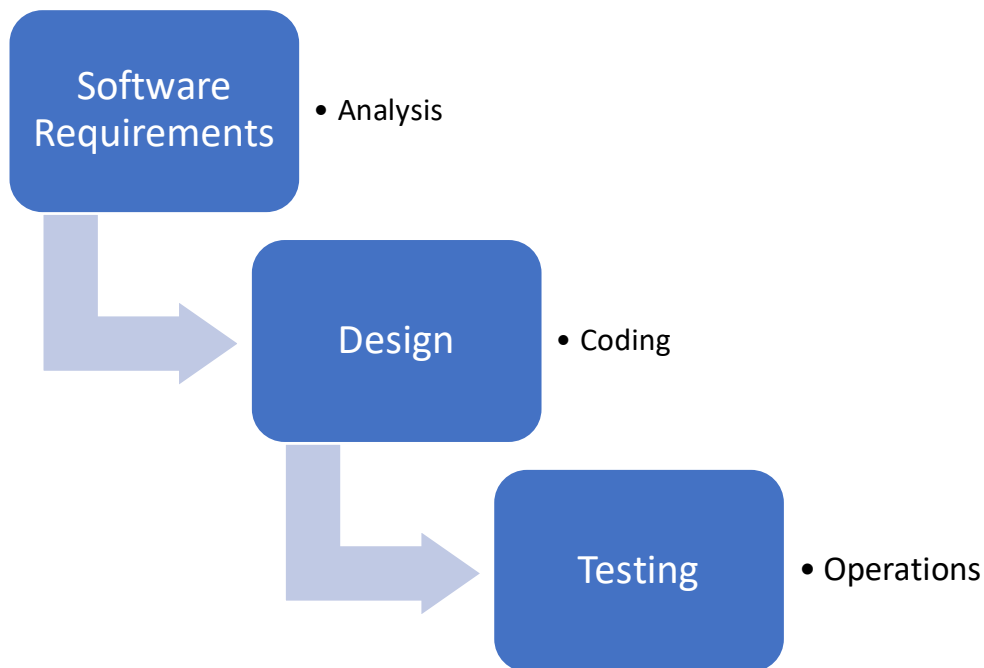
3.2 Supporting Innovation

The final part of this document tries to show the available tooling for supporting innovation in the business through data center transformation and the cloud journey .New concepts of software development have been introduced that are unified under the term Agile Development and are replacing the classic Waterfall Model which was the standard way of producing software for a long time. Added with the new models new ways that are software can be deployed are introduced today as the containers the microservices which closely are forming the term DevOps.A brief descriptions will be given in order to make the terms more clear and showcase their use in the new way of producing software.

3.3 Waterfall Model

In software development the waterfall model is a breakdown of activities that must produced in sequence one by one in order to achieve the required product. Its process are going in one directions and are depending one in each other to have the desired outcome . This leads to static process that are difficult to be changed during the process and innovation cannot be introduced during the phases as it will lead to the cancelling of the project. Typically the following are the elements of waterfall model in sequence:





The main characteristic of the model is that in order to proceed to one phase you have to complete the previous one is completely verified and tested Any revisions in design phase are real obstacles in the process as the alterations cannot be satisfied in parallel but the whole project should be modifies step by step. Waterfall model was a solution for a more static environment of the past and in todays dynamic environment organizations that have adopted it are struggling with coping the ever changed functionalities of the market. Another issue with waterfall model is the amount of investment for producing the required software. Market changes or tough economic situations clould lead to low demand in which this design cannot be altered either you produced it or not and the steps cannot be altered.

It is not uncommon that a whole software cycle can take as far as six months in order to be released. The startup design is a glue in the whole process and thus a wrong decision in the start cannot be altered. Maintenance is delivered through the phases of bug phases that are software enhancements releasing the knows issues of the product and upgrade patches that provide needed new functionality in order to stay competitive .Another inherited aspect of the waterfall model is that achieves value and commercial price only after the whole process is finished. As such the whole process needs initial big capital investment and the return will be after the whole process ends. Either you spend the whole capital and wait for the outcome of the sales either you abandon the project and take the associated financial loss.



3.4 Agile

A modern approach in the software development has been adopted to the ever changing environment. The solution is called Agile Software Development and it's a combined use of many different approaches to produce software with collaborative and cross-functional teams. Its main characteristics are adaptive planning, evolutionary development, early delivery and improvement in every stage. Main rules that Agile development follows are the below"

- **Combined interactions.** Teams that produce different stages are interacting together
- **Customer Feedback.** Customer influences the design and features
- **Change is appreciated.** Change now takes place in every phase and as the process is parallel is not anymore an obstacle.
- **Continuous Integration and development.** Reduce human intervention through standardized and automated testing and deployment of code.
- **Shorten delivery time.** The process leads to producing in weeks instead of months

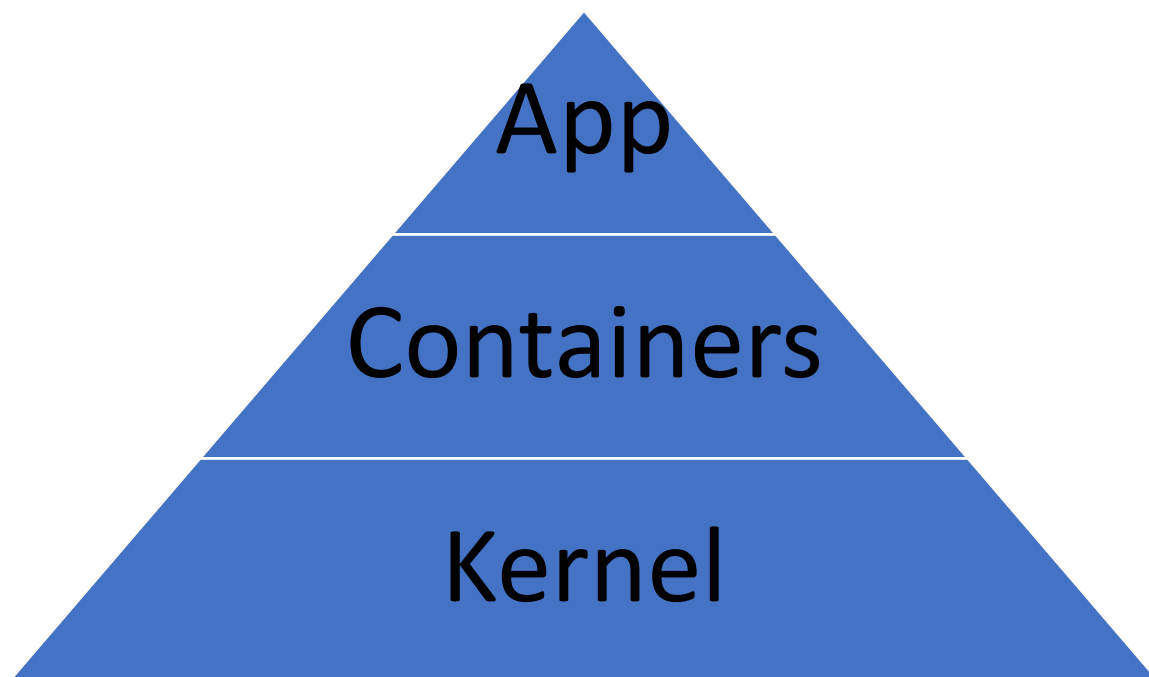
This approach breaks software development into small pieces that are modular and minimize the planning and the compatibility of the various pieces. The code is iterated (sprints) are short time periods (weeks). After each sprint the required teams that collaborate to produce it working in all functions of the process like analysis, design, coding, unit testing. The goal of each iteration is not to deliver every market functionality but to have a quick go to market effect and deliver value to the company stakeholders. Multiple sprints may be required to produce the full features that a new release in the waterfall model was producing but due to the fact that the process is adopting in the changing need the shortcoming of the waterfall model are avoided.

Development team approaches now are different. Now the goal is not process oriented but outcome oriented. The frequency and the efficiency now become the important elements of the software cycle thus the combined efforts are crucial. Staging automation quality control are becoming joined operations and war rooms are established in order to coordinate the needed teams to produce the required code. Six-week software products the so called sprints deliver features and not the required product as a whole. The innovation in the process is that the producing of short term code (aka sprint) can adapt to the changing business environment and lead to efficient go to market strategies.



3.5 Containers

Associated with the agile model is the containers tooling [9]. As the demands are getting more and more complicated and the software development must be shortened in weeks opposed to the old of months so the Operating system deployment should change. In the current situation we have passed from physical machines to Virtual machines in operating system deployment and so the time has been shortened considerably for Operating System deployment. But still the resources are static and deployed once and for all. A new approach has been introduced for Operating System deployment and the solution is called containers. On the contrary of the virtual machines containers provide minimal footprint and instant startup. They can meet test and development workloads and after the testing they can be deleted instantly. If the application needs to be patched we can build a new container in no time and migrate the workload in seconds. They give more flexibility than virtual machines. Depicted below is a brief visualization of this type of operating system. The abstraction layer from the kernel permits the applications to be portable to have minimal footprint and to be executed universally,



[11] Docker Concepts (<https://www.sap.com/documents/2018/12/c2943dbc-b97c-0010-82c7-eda71af511fa.html>)

3.6 MicroServices

As the application environment evolves the fundamental requirement is to decouple application development from the underneath physical environment. Microservices can provide the solution to the problem of monolithic applications .They provide the segmentation of application code in modular way. Modular pieces of software provide specific functions and it is reusable.Their introducing of them in application development leads to the following value:

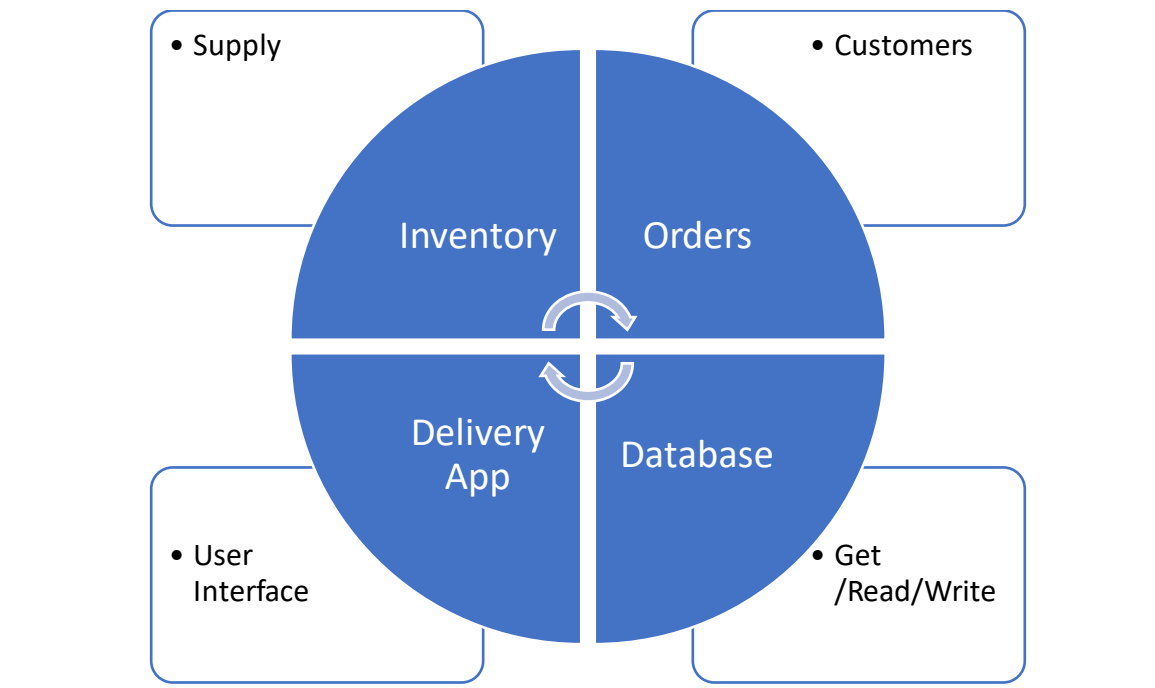
- **Continuous delivery of software.** Changes in small parts of the whole project require only coding and redeploying of that modular part and not for the whole software.
- **Independent deployed services** .Functions can be released per required value not per whole software release.

For example in a classic web ordering system the software may need to deploy several sub functions as function for orders, function for customers, functions for logistics. In a classical environment software changes in each function should require the whole software to be rewritten and recompiled. With the functions of micro services the segmentation leads to a service that is separately deployed and the required recoding is minimized considerably. Below the logical diagram of the segmentation of web



application that has a stock system a database system and a user interface that can the customer react order and implement the delivery operations.

Web APP Logical Segmentation

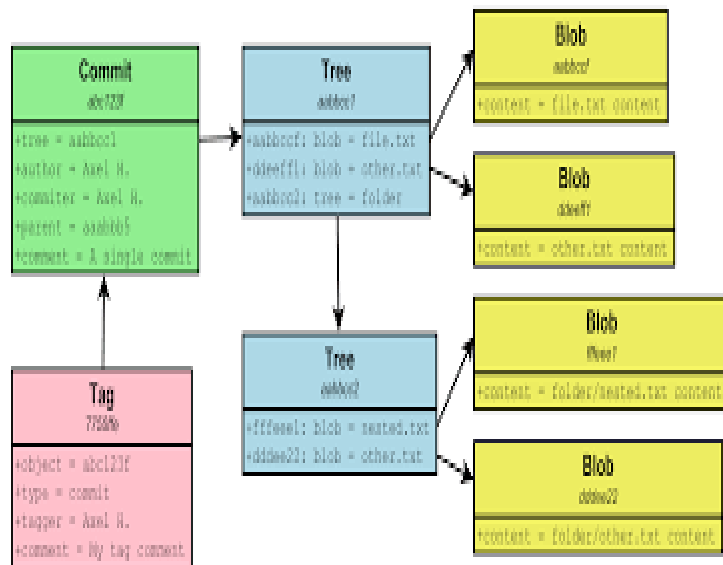


3.7 DevOps

IT departments are historically organized into several sub departments. Development teams are usually in different departments from operation departments. The former are organized in order to build the code and the latter to deploy support it and organize the process .This leads to suboptimal paths for applications as they have extended release time for delivering software for use .DevOps are not a tool but a change in thought in modern IT .Different procedures are introduced in order to be compliant with the modern requirements .Plan ,Develop, Test phases are considerably modified in order to achieve new goals and the approach is drastically different .Collaboration is the new de facto in the industry and the outcome of the process is associated with that. Following are major differences in the cross functional approach.

- **Coding** .Shorter release cycles and rapid features delivery
- **Building** .Continuous delivery tools integration like github [10] for code collaboration and merging of source code of different developers.
- **Testing** .Introduce of integrated testing tools and automated tools in software development pipeline in order to reduce the Systems development life cycle.
- **Packaging** .Repository for software archive and storage ,It organized the way that organizations store their binary code .
- **Configuring** .Automating infrastructure with machine readable code for provisioning,





[12] GitHub Operations (<https://help.github.com/en/github/getting-started-with-github/set-up-git>)

3.8 Conclusion-Summary

Innovation and transformation are reshaping all the industries today .From banking ,telecom ,energy ,retail sector everything has now its basis in the provision of services from anywhere to everyone .Clients are often buy with their shopping experience on first priority and the digital means in the services are prevalent now. Data is the fundamental decision making tool that guides corporations to draft their next steps and their strategy. Business to Business models and client to business are based on globally supply of products and in order not to be commoditized they have to bring new features that are unique to them. Public cloud has emerged as a tool for helping business to deliver services with unmatched availability and pay per use model helps to offload the costs that would have been a barrier to all of them to produce high quality digital services .But not everything can be based on external corporations and so the business must invest to their own capabilities and also their own infrastructure to deliver optimal results. Transformation will be the pillar to stay relevant and in order to achieve the wanted digital transformation also the data center transformation should proceed in parallel .A change of thought is a prerequisite as the journey to a new way of doing business is already evident . Digital services like rental of estate or banking experience is already here and the trend is to become digitized in every aspect of commercial life. New tools education and perseverance is the only option to survive and to gain market share .Quality is based on the underlying fundamentals and the services will become key to gain the status and thrive in the new digital era.



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