

Process Model for Cloud Service Engineering

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Cloud computing is a model for on-demand and convenient network access to a shared pool of computing resources that can be easily used and provide services with the minimal management effort. Cloud engineering is a discipline for the systematic and scientifically development of the good and economic cloud that focus on providing cloud services to requested users. In order to create the economical and good quality cloud, the structure of cloud engineering is important. This structure consists of four components: Base, Cloud development life cycle (CDLC), Tools and Techniques, Management. Cloud Development life cycle (CDLC) is one of the important component of structure which has iterated life cycle model for development, deployment and delivery of cloud. CDLC has six phases which is flexible, simple in nature and having feedback to first phase. These phases are organized in a linear order and processed in an isolated manner. This paper discusses each phase of CDLC in detail one by one.

Keywords

Cloud Computing, Cloud Engineering, Cloud Development Life Cycle, Service level agreement

1. INTRODUCTION

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort [1] [2]. The aim of the cloud computing is to provide scalable and inexpensive on-demand computing infrastructures with good quality of service levels [3] [4] [5]. Like other engineering disciplines, the cloud engineering discipline also has own life cycle model for the systematic and scientifically development of the cloud known as cloud development life cycle model. The CDLC is the iterated life cycle model for development, deployment and delivery of cloud. It is the simplest and flexible process model, which states that the phases are organized in a linear order and each phase is processed in an isolated manner. The output of the one phase of CDLC becomes input to another phase. In this model, a cloud development begins with Understand requirement and analysis phase. Upon successfully demonstrating and understanding requirement, the Architect phase begins. The Quality Assurance and verification phase starts after the Implementation and Integration is complete, and Monitor, Migrate & Audit begins after the Deploy, Testing & Improvement is complete. This paper discusses the understand requirement and analysis phase in detail in the following section [6].

2. PHASES OF CDLC

The figure 1 depicted the linear order of the various activities and feedback of CDLC to obtain desired cloud. In this life cycle model feedback is used in which a phase gives the information to desired upper phase [6].

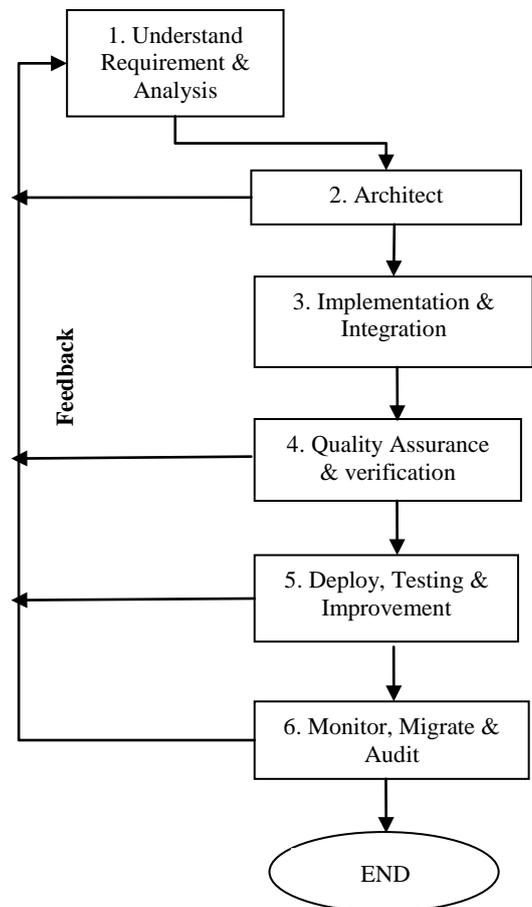


Fig 1: The CDLC

Among these phases, the second, fourth, fifth and sixth phase has the feedback process to first phase. The six phases of cloud development life cycle is presented and discussed in detail here [6].

2.1 Understand Requirement and Analysis

This phase of cloud development life cycle model evaluates and understands the needs of end user. This is done by knowing the complaints from user, network solution, management and customers of the current system. When this complaint is seriously studied, they highlight some new requirements and deficiencies. Then it searches for the tentative cloud computing solution and defines

cloud computing strategy which meets requirement and minimize deficiencies. It also accesses that cloud computing solution on the various factors such as computing cost, scalability, organizational agility and benefits. It also consider various aspects of adopting cloud computing solution such as privacy, security, immaturity of organization, risk involvement, reliability, performance and portability.

2.1.1 Cloud Requirements

The basic requirement for the development of cloud are Identity, open client, security, service level agreement (SLA), location awareness, metering and monitoring services, industry specific standards and protocols, common virtual machine formats, data formats and API. The identity is a process which recognize and authenticates the end user. The open client means access to cloud service without any use of platform. Security in cloud should be more advanced and sophisticated level. Service level agreement is the agreement which ensures minimum service to the end user and this agreement will be much simpler than those for enterprise. Cloud provider must be clear about the guarantees of service which they provide. Location awareness is the location of data servers depending on the kind of data the enterprise is managing on the user's behalf such that there is no legal restriction on the location of the physical server. Metering and monitoring service means the all clouds service must be metered and monitored for cost control, chargeback and provisioning. Industry specific standards and protocols are the application standards, common virtual machine formats, data formats and API.

VMware's cloud blueprint [7] gives basic, operational and content requirements for the construction of good quality IaaS cloud. Cloud must be built on a pooled and virtual infrastructure such as the CPU, memory, storage, networking resource. The cloud should provide application, service and consumer mobility between clouds. The use of existing consumer tools for performing the migration of workloads to or from the cloud is highly desirable. The cloud should be open and interoperable so that consumer consumes cloud resources over open, Internet standard protocols. The cloud consumer should only pay for resources they consume. The cloud should be a secure and trusted location for running cloud consumer workloads. The cloud consumer should have the option and the ability to protect their cloud-based workloads from data loss. The cloud consumer must not be responsible for the maintenance of the shared infrastructure. The cloud should be available to run with high availability workloads and any faults occurring in the cloud infrastructure should be transparent to the cloud consumer. The cloud should have a built-in orchestration framework that enables the quick scaling of infrastructure for cloud consumers. The cloud consumer should have access to detailed logs from the cloud environment. These logs should show only the entries pertinent to the cloud consumer's workloads. The cloud consumer should have a mechanism to balance the load between their workloads across the cloud infrastructure. There should be some mechanism for cloud consumers to take snapshots of their workloads and save them for future use. There should be some way for the cloud provider to monitor capacity and performance of the environment and workloads to ensure SLA. The cloud consumer and provider should have a location for storing and using their own common set of images templates in

catalog. These cloud requirements are well understood by figure 2.

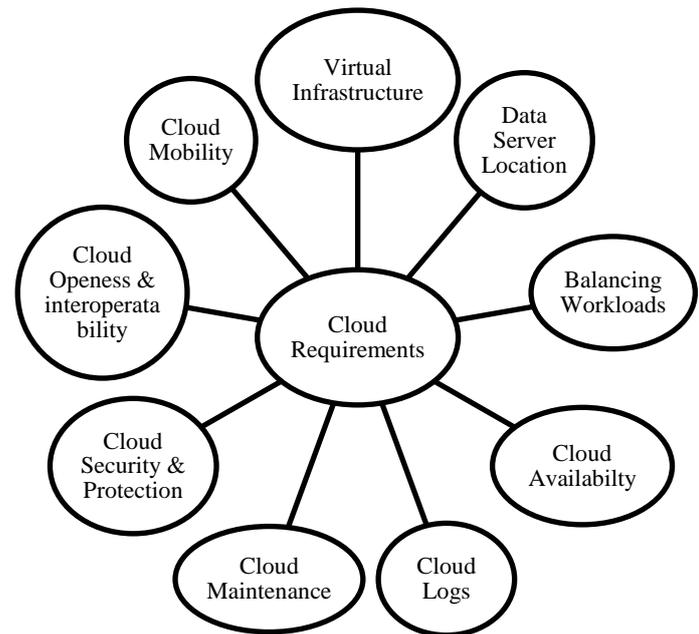


Figure 2: Cloud Requirements

2.1.2 Cloud Analysis

The Analysis part of this life cycle phase performs the analysis of their cloud computing solution with another available computing solution such as grid computing, volunteer computing, utility computing, autonomic computing, and dynamic datacenter alliance solution [8]. This analysis consider many factors while comparative analysis such as emerging trends, changing market conditions, competitive challenges, potential growth opportunities, cost-efficiency and on-demand capacity. To perform analysis a cost-benefits analysis model is present which compares and contrast the performance and monetary cost-benefits of clouds ranging in computational size and storage [9]. Cost-benefit analysis considers performance tradeoffs in platforms, specific resource requirements, monetary costs of creating and deploying applications, combination of cloud computing platform with desktop grids factors [9].

2.2 Architect

Architecture of a cloud solution is the structure of the cloud system, which comprises on-premise resource, cloud resources, cloud services, cloud middleware, software components, data server location and externally visible properties of data server location. These all structure of the cloud system are described in cloud architecture document. Documenting facilitates communication between stakeholders. Document helps in early decisions about high-level design, and allows reuse of design components and patterns.

The major building blocks of architecture are Reference architecture, Technical architecture and Deployment and operational architecture are well depicted in figure 3 [10].

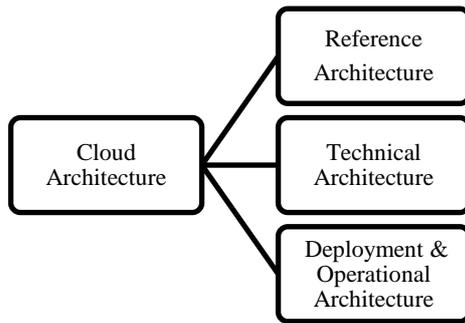


Figure 3: Cloud architecture

Reference Architecture become the basis for documentation, project communication, stakeholder communication, team communication, payment, contract, and cost models. Technical Architecture is the Structuring of cloud according to XaaS stack, adopting cloud platform paradigms, structuring cloud components, showing relationships, external endpoints, Middleware and communication. Deployment Operation Architecture is the architecture of legal issues, export control, operation and monitoring [10].

There will be some minimum architectural requirement which will be considered while developing a cloud. Cloud architecture should have the ability to associate a cloud consumer with other clouds through a common interface across several cloud environments. There should be some protection method for the cloud consumer to protect their workloads from network attacks by the use of firewall services. Each cloud should works in an isolated workload manner for the rich networking environment. The cloud environment should be able to pass a PCI standard, international audit standard and transparent to cloud consumer. The cloud provider should ensure a high-level SLA by providing an implemented disaster recovery plan [7].

This phase prepares the plan about development and implementation map of cloud known as cloud architecture blue print also known as implementation plan or transition plan. The cloud blueprint is a uniform abstract description of a XaaS offering. In general, XaaS offerings fall into three types: complete and monolithic; complete and customizable; and incomplete depends on the types of their XaaS offerings.

2.3 Implementation and Integration

Third phase of CDLC is related to actual creation and enablement of the private, public, community, hybrid, inter and hosted cloud solution of a computing problem.

2.3.1 Implementation

Implementation phase addresses the implementation issues such as privacy, security, standard, legality, mentality, inter-machine communication and privacy theory [11]. This phase implements two components of cloud computing platform. First is the implementation of file system. The file system is the key component of the system to support massive data storage and management. Second is the implementation of Map-Reduce system [12]. This phase also perform the task of integrating the various cloud solution in one cloud environment. It deploys various resource, service and applications to the cloud and also gives cloud training to end user so that user can easily adopt the new network solution.

2.3.2 Integration

Integration has the ability to connect with both source and target systems and then how to extract data from the source system, mediate the semantics and technical differences, and publish the data to the target. Although cloud-to-enterprise integration pattern, cloud-to-cloud integration and very complex integration paths or pattern that can span dozens of cloud computing-based systems. There are some integration tools which address the integration need such as software-based on-premise integration tools, on-premise appliance-based integration tools, and the cloud-delivered integration tools. Traditional integration server software's running on an on-premise server to drive integration among any number of systems, whether cloud computing or on-premise. While typically higher in price, they are more advanced and richer in features, considering the amount of time they have been around and the number of iterations the integration software has gone through. Providers here include IBM, Software AG, Oracle, and Informatica.

In the current economy, businesses and enterprises are moving to the cloud due to the lower costs, scalability and autonomous IT constrained and development resources. However, benefits may be short-lived without a plan that places cloud computing in the context of overall business strategy. Large enterprises, in particular, need to integrate cloud computing into existing IT systems and applications. Given that most will not move all business processes to the cloud at once, Jitterbit [13] shares five recommendations for solving the integration puzzle.

1. Create a plan and set realistic goals
2. Learn from the other's experience
3. Require IT specialist team
4. Address security concerns
5. Maximize connectivity options

These recommendations are based on Jitterbit's direct interactions with enterprises considering or making a move to cloud computing, but concerned about integration [13].

2.4 Quality Assurance and Verification

This phase is related to ensure the quality of cloud network by audit the cloud and, verify the performance, reliability, availability, elasticity and security of cloud network at the service level against specification, agreement and requirement.

2.4.1 Quality Assurance

Cloud quality is the combination of availability, performance and security that ultimately will inspire end users to adopt cloud computing. Quality assurance also provides assurance to relevant stakeholders that privacy requirements are met. Cloud quality is itself dependent on the quality of local infrastructures, Internet traffic, application performance, data safety and control, and risk of outages. For productivity applications, such as Office and email, Internet and infrastructure shortcomings present serious obstacles for cloud adoption by end users.

2.4.2 Verification

Verification is all necessary to basic system evaluation and adoption but when the system and data sources are distributed, these tasks are invariably done in an ad hoc or random manner. The cloud computing verification on demand solution provides massively scalable verification via Amazon Web Services. This solution provides the

flexibility to add compute resources to meet surge verification demands, as well as the flexibility to remove resources as verification demand drops [14].

2.5 Deploy, Testing and Improvement

In the “Deploy, Testing and Improvement” phase various platform service providers significant reduces the deployment cost of the application by pre-building and pre-configuring a stack of application infrastructure.

2.5.1 Deploy

For the deployment of cloud, the developer chooses one of the available six deployment models. Figure 4 shows the types of cloud deployment models. Each model can exhibit their own characteristics, scope and access of published cloud services, as they are made available to service consumers.

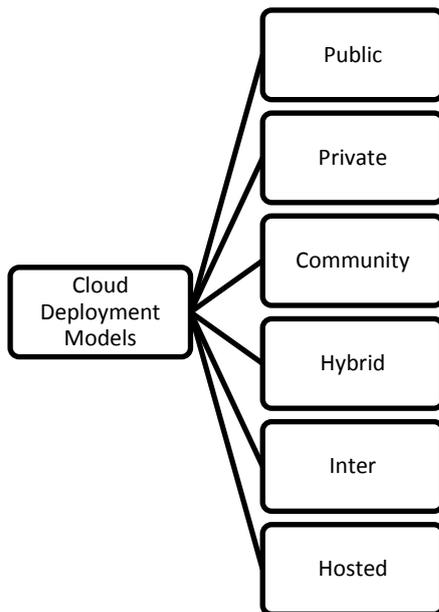


Fig 4: Cloud Deployment Models

2.5.1.1 Public Cloud

Public cloud is also known as external cloud or multi-tenant cloud. This model represents a cloud environment that is openly accessible to end users. It provides an IT infrastructure in a third-party physical data center that can be utilized to deliver services without concerning with the underlying technical complexities. Public clouds can host individual services as well as collections of services that allow for the deployment of service compositions and even entire service inventories. Public cloud is work on pay-as-you-go based infrastructure, owned by a company but offered to other cloud providers as well as end users.

2.5.1.2 Private Cloud

Private cloud is also referred to as internal cloud or on-premise cloud. This model intentionally limits access to its resources to service consumers that belong to the same organization that owns the cloud. In other words, the infrastructure that is managed and operated for one organization only has primarily to maintain a consistent level of control over security, privacy, and governance. Private cloud is owned or leased by a single organization and operated solely for that organization only.

2.5.1.3 Community Cloud

This deployment model refers to the special purpose cloud computing environments which is shared and managed by a several related organizations participating which supporting a specific community that has shared objectives in a common domain or vertical market.

2.5.1.4 Hybrid cloud

The hybrid cloud is also refereed as enterprise cloud. The hybrid cloud is another model which comprised of both private and public cloud environments. In other words, it is the mixture of two or more cloud types such as private, community or public cloud, which bound together to enable data and application portability.

2.5.1.5 Inter cloud

The inter cloud is not deployment model rather than it is a concept based on the aggregation of deployed clouds. Like the Internet and World Wide Web, which is a network of networks, inter cloud refers to an inter-connected global cloud of clouds which represents a massive collection of services that organizations can explore and consume.

2.5.1.6 Hosted cloud

The hosted cloud is also refereed to as dedicated cloud or virtual private cloud. Hosted cloud represents cloud computing environments which is hosted and managed off-premise or in public cloud environments, but dedicated resources are provisioned solely for an organization's private use. Hosted cloud run at a service provider on resources that are walled off with enterprise-class protections but managed as a pool.

Private clouds and enterprise cloud proved particularly popular in terms of overall preference, responders. Strong upward swing for the popularity of enterprise cloud is expected in subsequent years, as companies gain awareness of both the benefits of a hybrid approach and limitations of the private cloud model with regard to cost savings and scalability.

However, there are some deployment toolkits available in market. The Cloud Deployment Toolkit provides an abstraction to multiple IaaS cloud platforms allowing developers to create and work with the production environment. With the help of a cloud deployment toolkit, developers test code, changes for both functionality and performance, that speed up the development process. Through this toolkit, developers can provide IT management with resource usage and associated costs

2.5.2 Testing

Testing test the various functionality of the servers and their cloud services, that comes between the cloud network and end user. Testing evaluates the service availability on scalability, uptime etc. One of the major benefits of the Cloud Computing is the ability to test a concept relatively quickly and easily. Normal test strategies for testing code, applications or architecture may not be applicable in a cloud, software developed for a non distributed environment may not work in the same way in a cloud and multiple thread, network and security protocols may inhibit normal working. The future of testing will be different under new environments, novel system testing strategies may be required to facilitate verification and new metrics will be required to describe levels of system competence and satisfaction. Testing can be applied to systems, security, architecture models and other constructs within

the Cloud environment. Failure analysis, taxonomies, error handling and recognition are all related areas of potential research.

This phase perform full cloud integration tests. It is needed and worthwhile because when there is movement of any system into the cloud, it introduces a range of new variables that are beyond the experience and direct control, such as security, performance etc. this testing effort requires extra time, capital, and human capital resources. It also checks the computing capacity and adapt quickly to dynamic loads, and their service or application will take advantages of cloud infrastructure. It also provides adequate training and mentorship-providing a broad base of fundamental security, data privacy and risk management knowledge.

2.5.3 Improvement

Cloud improvement is the enhancing the entire development, deployment and testing process of cloud environment. However, there is so much need of improvement the development of cloud computing environment and test groups in an enterprise. There are major different ways in which cloud computing strengthens development and test groups such as self-service capability, resource availability, environmental fidelity, hosted tools and increased focus [15].

These ways illustrate that cloud computing does indeed enhance development and test efforts just as they boost administrative and operational tasks [15]. For the cloud computing industry, increasing adoption by development and test groups could lead to widespread grassroots movements that further spread the use of cloud computing throughout enterprises [15].

2.6 Monitor, Migrate and Audit

This phase continues monitors the cloud environment so that it can measure the performance of the system. "Monitor, migrate and Audit" phase discusses the total cost and value that a user bears while evolving and moving to cloud approaches from traditional service-oriented environments and also integration with existing systems.

2.6.1 Monitor

After moving a significant number of applications to the cloud, the organization needs to assess its current performance based on six categories on cloud adoption:

1. Planning & Strategy
2. IT Performance Management
3. Vendor Management
4. IT Asset Management
5. Staff Management
6. Financial Management

These demonstrate a performance view in each category and understand whether effort in each aspect is adequate or not. It also provides diagnosis on the impact from bad or decent performances. Additionally, the questionnaire offers advice on how to make improvements in cloud adoption. Like electricity became purchased as a utility rather than being generated locally, electricity meters were developed to measure usage. Similarly, if utility computing is going to become popular, suppliers will need to measure usage for provisioning, and users will need to measure usage to determine. The aim of monitor phase is to develop new techniques and metrics for measuring cloud computing performance and verifying service-level agreements within

clouds, which may be difficult when the cloud itself is designed to be "invisible".

2.6.2 Migration

Migration is the cost and value that a user bears while evolving and moving to cloud approaches from traditional service-oriented environments. Microsoft's VP of Online Services, a well executed cloud migration tool available by Microsoft. A new transition plan is prepared for migration that considers the hardware, software and network necessary requirement for the migration of the current application in business and technical environment to cloud computing network. The cloud migration services includes migration planning impact analysis, applications re-factoring, application packaging & deployment, application Testing and switch over to cloud environment. The cost and time to move data around is currently one of the major bottlenecks in the cloud. Users with large volumes of data may wish to specify where and when that data should be made available. Furthermore, laws, national jurisdictions and regulations such as data protection regulations place some restriction for the proper movement of data. There is also need of practical issues which affect data migration and specify policies on data migration.

2.6.3 Audit

Cloud audit is the audit of cloud for compliance, regulation, security, governance and risk. The goal of cloud audit is to provide a common interface and namespace that allows cloud computing providers to automate the Audit, Assertion, Assessment, and Assurance of their infrastructure, platform, and application environments and allow authorized consumers of their services to do likewise via an open, extensible and secure interface and methodology. It is an effort from the best minds and talent in Cloud, networking, security, audit, assurance and architecture backgrounds. While performing auditing of the cloud the main focus is on client-server or on-premise IT and processes.

3. CONCLUSION & FUTER WORK

The cloud engineering is emerging as a new engineering discipline for the development of cloud computing solution. Cloud engineering in its own domain requires extensive research on specific areas and dealing with unique challenges such as multi-tenancy, development support for cloud pattern, cloud business continuity services. As a component of cloud engineering structure, cloud development life cycle (CDLC) is emerging as a new development life cycle model like the System development life cycle model (SDLC). There is also need of practical issues which affect data migration and specify policies on data migration. The implementation and integration phase is less complex as compared to "Architect" phase. These phases of CDLC are yet to be explored and require many refinements. The structure of the cloud engineering and phases of Cloud Development Life Cycle (CDLC) is yet to be explored.

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