# si$^3$-Industry: Cloud Computing in Industry 4.0

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**Abstract**

The name "Cloud computing" has been named after the fact of information's that are retrieved is generally found remotely either in the cloud or on a virtual space. Companies providing cloud services facilitates to the users, helping them to store files and applications at remote servers and thereafter accessing all data's through the Internet. This implies the flexibility for the user to be able to access the resources and allowing them to work remotely as per their convenience. The concept of Cloud computing takes away the heavy burden of lifting required in the procedure of crunching and processing data off the devices the user carries around or sit and work at. The technology also moves all of these work into huge computer clusters present far away in cyberspace. Here the Internet takes place of the cloud, where the data, work, and applications are accessible from any device which can be connected to the Internet, irrespective of the geographic location. Recently the concept of cloud computing has contributed towards causing a major shift in the IT industry. Various new technologies have evolved, introducing new methods to virtualize IT systems and to access the required applications over the Internet, through web-based applications removing the need of any IT related costs for both hardware and servers.

**Keywords**

Cloud technology for industry · Cloud infrastructure · Cloud in manufacturing · Cloud integration

## 1 Introduction

As we all know typically an IT environment building involves purchasing of servers, hardware's, licenses as well as installation of software. This process is considered as lengthy along with being expensive which brings along many infrastructural demands and long deployment cycles [1]. This complete IT based internal model can said to be a common place. But as we know IT sector is coming up with lot new technologies. Currently we can state that, utility based and service-oriented IT model is no more a plain mere hardware or software market. Recently the industries have offered various email apps, production systems security, option storage, as well as the backup services and many more or just a few of IT components which can be moved onto the cloud [2, 3].

This trend in the IT sectors and the software developers have influenced various industry where the industrial sectors are trying to incorporate and adjust to these recent innovations in order to benefit themselves. The various aspects of cloud in industrial sector can be seen in Fig. 1. Few variations caused in the industry due to the incorporation of cloud can be listed as follows [3, 4]:

1. **Traditional IT job skills are being revamped** as new skills and specialties are increasing. Prior to make a move to cloud, the IT staff is required to completely understand the benefits of the cloud computing as well as ways of integrating it to the current business model. Here security as well as the maintenance issues are required to be discussed at a priority basis with the cloud. Computing vendors along with the reputed IT department who would oversee the process of migration and ongoing relationship with the cloud providers [5].
2. **The IT infrastructure undergoes crucial changes**: With majority of applications being transferred to the cloud, i.e. public or a private cloud. Here the software developers

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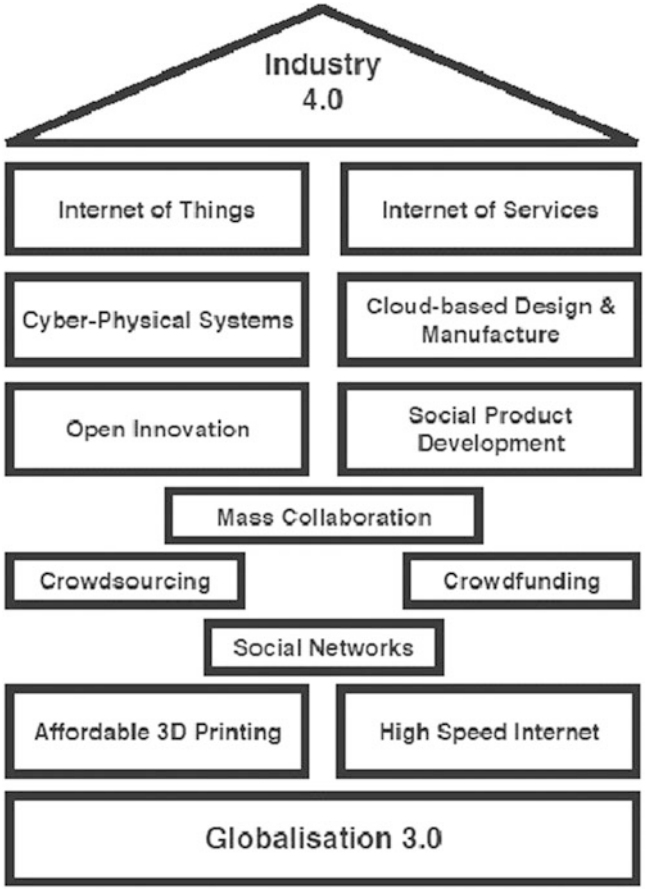


**Fig. 1** Contribution of cloud computing in industry

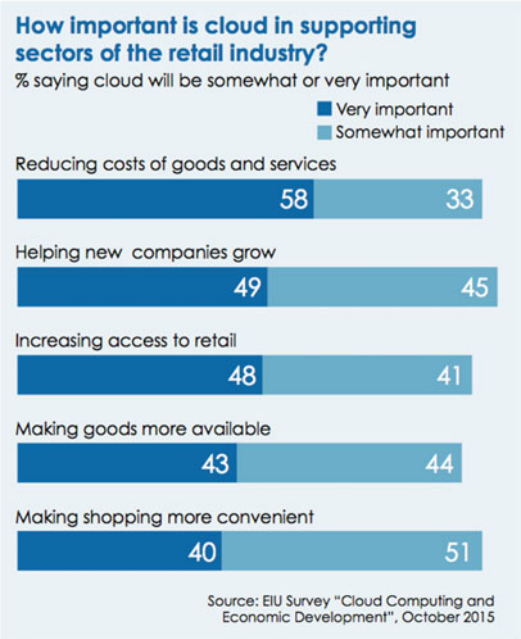


**Fig. 2** Contribution of cloud in retail industry

are required to make an adjustment to the ways the applications are created as well as delivered.

3. **The number of employees required as a support**: Staff is reduced along with the reduction in desktop support. However, the need of training the employees to work with and understand the new system and application is added [6].
4. **The efforts needed in order to maintain the data is also diminished**: The relocation of data's and resources to the cloud front results in loss of physical control reasoning to its storage at the vendors data centre. The clients here undergo stress regarding security as well as accessibility aspects, hence making it all the more important to meet both the requirements.
5. **Security**: the cloud providing firms offering a managed cloud solution induct security experts as staff who manage the application as well as handle security related issues.
6. **Highly Customizable software**: Majority of the software's used by industry can be said as 'non cloud appropriate'. This issue is addressed by the software developers who intervene by creating cods specially designed for clouds. However, the cloud providers should also contribute in order to make the transition an easy process. Once applications are SaaS, the job of IT department trouble shooting reduces [7, 8].

As appropriately defined, cloud computing is all about shifting the physical resources in order to increase both the efficiency as well as utility. Figure 2 shows the contribution of cloud computing in retail industry.

Incorporating cloud services also allows the companies to focus on other production activities rather than in IT process [9].

The chapter addresses the various contributions of the cloud computing in order to enhance as well as revolutionise the industry as a whole. In Sect. 2, cloud based infrastructure is presented, Sect. 4, is about independent as well as integrated modelling, Sect. 5, discusses sustainable governance with wide and affordable information access and finally the chapter is concluded in Sect. 6.

## 2 Cloud Based Infrastructure for Industry

The concept of cloud is no more new, but its contribution is still revolutionary evolving various technology in divergent fields. It has completely evolved the business computing and software architectures, converting the right set of services into iterative and scalable set of applications that has constantly transformed in order to meet out the requirements of companies as well as consumers [10].

In the current era of rapidly changing, hyper competitive landscape the business world is required to offer superior flexibility and speed to accomplish the operational success in the form of satisfaction to the customers demand following the solutions provided in spite of its non-scalability or incapable of delivering services at a required speed may be a cause of failure in business. This incompetency in performance at the business front may be due to lack of scalable technology in the hosted platforms which cause them to fail in performance while handling large number of subscribers leaving many of them in dark [10, 11]. As we know, the technology that cannot scale would ultimately crash and similar result can be expected for the customer base if they don't adapt and grace themselves with needed updates.

A fail in meeting this requirement can put the entire industry in a problematic state. The technology as of now is rapidly growing where the constant factor seen is change. The contribution of cloud technology in meeting the current marketing strategy, upcoming business requirements and operational challenges are [12]:

1. **The power to Transform**: the cloud platforms carry with them the resource to globally scale up as well as down, spontaneously as the demand fluctuates, making way for unlimited opportunities for the business as well as customers.
2. **Cost Reduction**: They assist in reduction of cost since business charges are made by cloud service provider when the customer makes use of their platform.
3. **Ease of Collaboration**: The cloud facilitates easy collaboration across various locations present in the global world that are marked by strict deadline and expanding the customers as well as employee bases where the move of the cloud is considered to be imperative for industry to dealt with [13, 14].

For start-ups as well as big and established industries the cloud concept have supported them to better manage any form of disruptions, reinvent the business models and have pumped up the massive improvement in the areas of delivery of appropriate services. For e.g., five years back Adobe noticed that a perpetual licensing model limited is quite capable to deliver new innovations and other capabilities with invention of new technology and launch of trendy and powerful devices like phones, browsers, mobile apps, the costumed based requirements are continuously revolutionising. In order to update itself to meet this requirement, adobe had to move from the traditional boxed software model to a subscription-based licensing management model which later on evolved as the adobe creative cloud [15, 16]. This shift on to the cloud gave a boost to both usage as well as flexibility, for customers as well as the adobe's business prospects. This transition brought about greater flexibility, scalability and more transparency into how users were managing licences.

Based on the recent 'Gartner Research Report', the concept of cloud computing has gained lot of popularity across huge number of industries for the basic business support functions. The research shows, cloud computing concept is being availed for much more than more IT functions. Many industries currently view cloud computing with the context of its support into succeeding in case of evolving market place.

## 2.1 Regulated Industries and Cloud Computing

The research shows the contribution of cloud computing is considered as vital in many kinds of industries like banking insurance etc. who use the cloud iterative in order to sere various competitive functions.

1. **Insurance**: In case of the insurance company the private clouds are preferred since they are more secured in comparison to the public cloud. However, it is predicted that, by 2015 the industry association with the community clouds would gain its popularity.
2. **Banking**: In case of the banking sectors, the major concern is regarding the security aspects of cloud environment. Hence the banking sectors make use of the clouds for administrative functions like e-mails, file sharing, as well as sharing of notes.
3. **Government**: Having multiple opportunities of being used in a variety of ways always exist in case of a cloud computing. But it is still not accepted though its biggest opportunity are in areas of cloud computing, reasoning the security issues related to it.

## 2.2 Unregulated Industry and Cloud Computing

The industries need both the private as well as public cloud in a far more ardent manner. Certain specific ways where the industry make use of the cloud computing are [19, 20]:

1. **Retail**: in the areas of retailing industry, clouds are mostly implemented as IaaS, or PaaS solutions. The aspects of security, availability, as well as vendor maturity are considered while deciding what functions they would like to deploy from cloud.
2. **Media**: the current era audience are able to access contents of all forms in a variety of ways. The service providers as well as application developers, both explore a vision based on cloud to enable multiscreen entertainment.
3. **Manufacturing**: the industry may make use of cloud for planning the logistics, functionalities for sales and support, Human Resource Management, Product

development process, as well as the life cycle management along with certain manufacturing operations.

The cloud computing has been adopted by variety of industries at varied levels due to the security causes, and certain other features needed by them [20].

## 3 Cloud Based Framework for Production

The futuristic vision of all the manufacturing environments is the ability to customize products easily at a low cost. In order to meet this requirement for customization of individual component/parts in a relatively easier manner CAD, CAM technologies have been used. Figure 3 shows the components of a MaaS environment [21].

1. **CAD**: Computer Aided Design is basically a computer technology which is about designing products along with documenting the entire designing process. CAD basically facilitates the process of manufacturing by transferring the diagrammatic data's of the products material process, tolerance and dimension considering the specific conventions for the product. The CAD is generally used for producing either 2-Dimensional or 3-Dimensional diagrams which may later on be rotated in order to behave viewed from any angle. Here a special printer or plotter is ideally needed for printing professional design [22].
   The CAD may also be termed as a Computer-Aided-Geometric Design (CAGD) when meant to design geometric shapes or Computer Aided design and Drafting (CADD) while performing designing and drafting nature of work.
   The CAD systems are basically used for majority of computer related platform such as Windows, Linux, Unix, Mac, OS. The whole idea of combining a CAD into a Cloud began in 2012, with the advent of auto desk with launch of fusion 360. Here the CAD users had a software option which offered few of the benefits of clouds like access mobility i.e. anywhere, platform agnosticism, comparatively preferable, collaboration convenience, high flexibility etc. [23, 24].
   The entire concept of moving onto the clouds is to improve the product quality as well as catering to the customer services which is definitely an important criterion met by industry via cloud [24].
   ***CADD is typically used for***
   1. Production of detailed engineering related designs via 2D and 3D diagrams of the physical components of manufactured products.
   2. It can create conceptual design, product layout, strength and dynamic analysis of the assembling and the manufacturing process.
   3. To prepare reports regarding its environmental impact, where the computer aided designs are generally used in case of photographs for both producing as well as rendering of the appearance while new structures are being built [25].
2. **CAM:** The CAM or Computer Aided Manufacturing concept is about using software in order to take over the machine tools that are related once in the manufacturing process of the work pieces. CAM can also be defined as the usage of computer in order to help out operations of

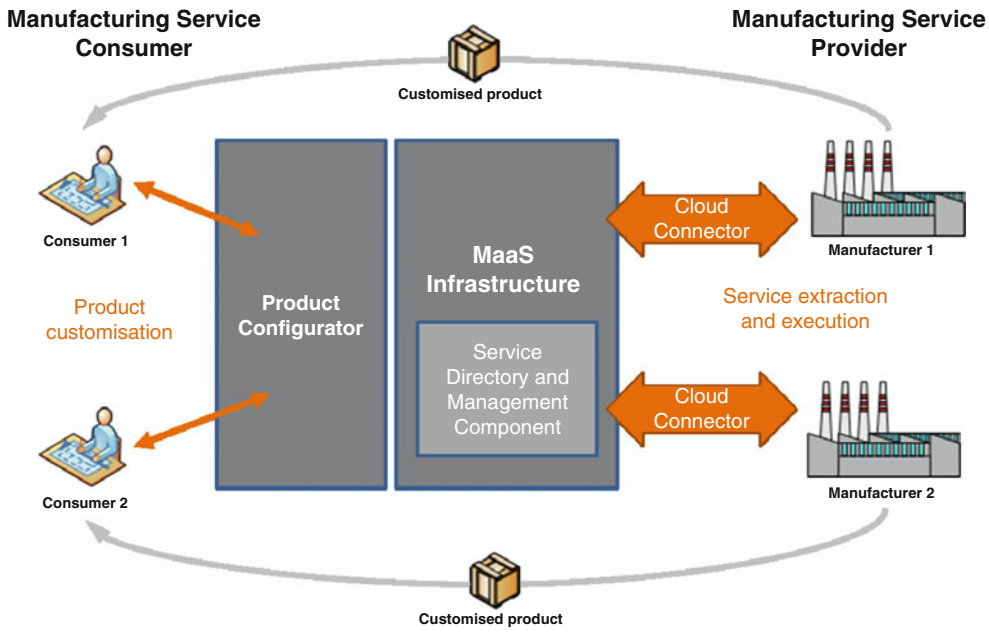


**Fig. 3** Processing of manufacturing service descriptions in the MaaS environment

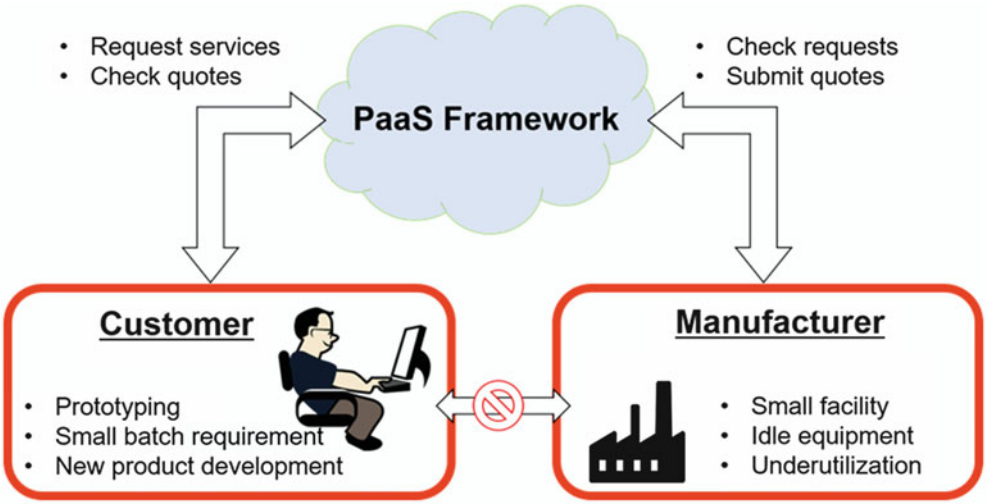


**Fig. 4** Platform as a service framework

the manufacturing plants which include the procedure of planning, management, transportation and storage. Its main area is creation of a process that can enhance the production rate, components as well as tooling with more accuracy in dimensions along with material consistency. In majority of cases only required amount of raw materials are used, thereby minimizing the waste which in the other hand reduces the energy consumption [26].

Apart from this requirement there has been even greater need of producing bespoke devices as well as machine that could represent the assembling of many individual tailored components. Such kind of products generally need a supply chain that involves different manufacturers whose outputs are coordinated so as to extract the subcomponents that are needed to construct a given design. It has been vividly clear that creation of such a flexible production network requires a sophisticated IT infrastructure which can relate and map the customer specific product configuration to the specific process plants that are generally put to work in a flexible manufacturing network [27, 28]. This leads to a two-way exchange, which is needed between the suppliers manufacturing the capability which includes the functionality, cost and availability.

Here the customized products have a detailed description of the components parts that it needs in a language analogue with respect to the capability of individual suppliers. In case of an advanced manufacturing environment envisaged, no reason holds for allowing the designers in order to specify the size that are larger than that of production systems currently can possibly manufacture. As a result, it is required that the background limits of the manufacturing resources that are currently present for a product designer that are reflected in the design environment along with limiting the range of size should be considered for usage [29]. This possibility of the dynamic supply network for retail of consumer products that have been expressed by multiple online retailers.

The cloud computing framework is quite common being almost more than a decade old. It is defined by key features such as scalability, location transparency, etc. the main efforts are concentrated at realising the desire to demonstrate the cloud manufacturing environment that can transmit the key characteristics of cloud-based applications into the manufacturing paradigm [30]. Here the final resulting framework manufacturing as a service (MaaS) may be conceptually similar to paradigms like platform-as-a-service (PaaS) System as shown in Fig. 4, Software-as-a Service, or Infrastructure-as-a-Service, but involves unique variety of challenges that need new technology-based solutions to make it a reality.

## 3.1 Cloud Based Design and Manufacturing

The concept for cloud computing has proved itself as a disruptive technology during its internal application field in IT. It takes the benefits of existing technologies like utility computing, parallel computing, as well as virtualization [31]. Few of its main features includes, scalability, elasticity on demand computing, as well as self service provisioning [2]. It has been picked up from the original cloud computing paradigm and incorporated into the stream of computer aided product development process.

The concept of cloud based design and manufacturing as shown in Fig. 5 has gained major speed and attention from both the field of industry as well as academia. The CBDM concept is

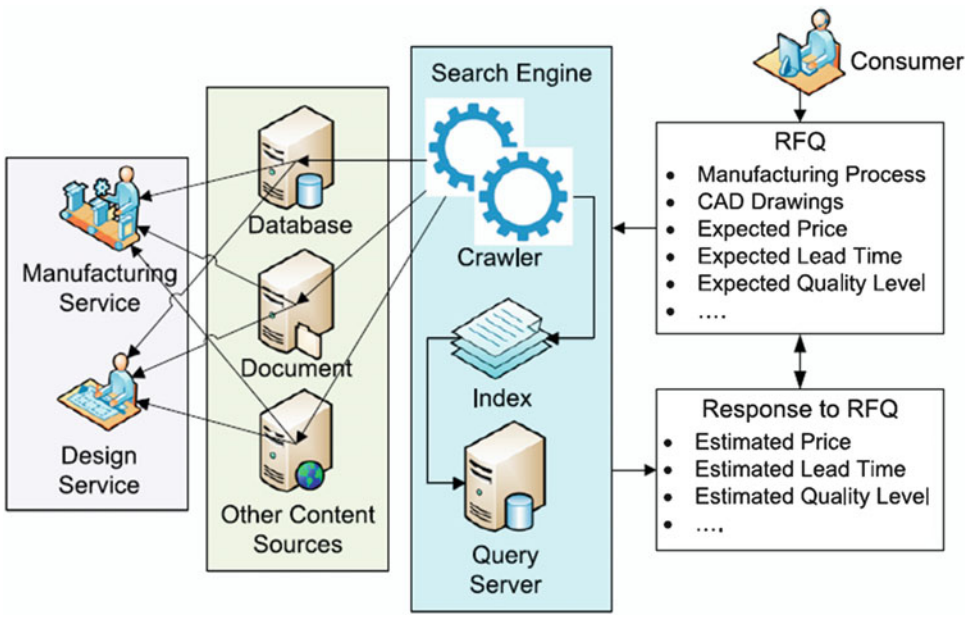


**Fig. 5** Services provided by cloud to consumers in manufacturing and design sector of industry

all about a service oriented networked product development model where the consumers generally fail to configure, select, utilize customised product realization resources and services consisting all from CAE software to reconfigurable manufacturing system. The various paradigms of cloud manufacturing can be seen in Fig. 6. This task has been realised via the synergetic integration of the four key cloud computing services models i.e. IaaS, PaaS, HaaS, SaaS etc. [3, 31–33].

To completely understand the concepts like breadth, depth, along with the other opportunities of CBDM as an emerging paradigm for distributive as well as collaborative product development [25]. It is necessary to perform an indepth study, over Cloud Based Design (CBD), Cloud Based Manufacturing (CBM).

**CBD:** the concept of CBD indicates a networked design model which makes use of cloud computing, Service Oriented architecture (SOA), web 2.0 along with the semantic web technologies, in order to facilitate the cloud based engineering design services in a distributive as well as collaborative environment [7, 34]. Certain vital needs of a CBD system consists of

(a) It should be cloud computing based.
(b) It should be commonly available to all the mobile devices.
(c) It should be able to handle the complex information flow.

In case of absence of a proper CBD system, certain organizations have also tried into developing, providing as well as selecting the critical components for a CBD system e.g. autodesk offers a cloud based platform i.e. Autodesk


**Fig. 6** Paradigms of cloud computing in manufacturing

360 [17, 18, 35] that enables the users into converting the photos of the artifacts into 3D models, creating as well as editing the 3D models, generation of associated prototypes, with the remote 3D printers accessed via internet. In addition autodesk also offers a cloud based mobile application.

AutoCAD 360 allows the design engineers into viewing, editing as well as sharing the auto CAD digital files while using the mobile devices e.g. smartphones or tablets e.g. 100kgarages.com is a social network site that connects the consumers with small as well as the medium sized designed companies [36].

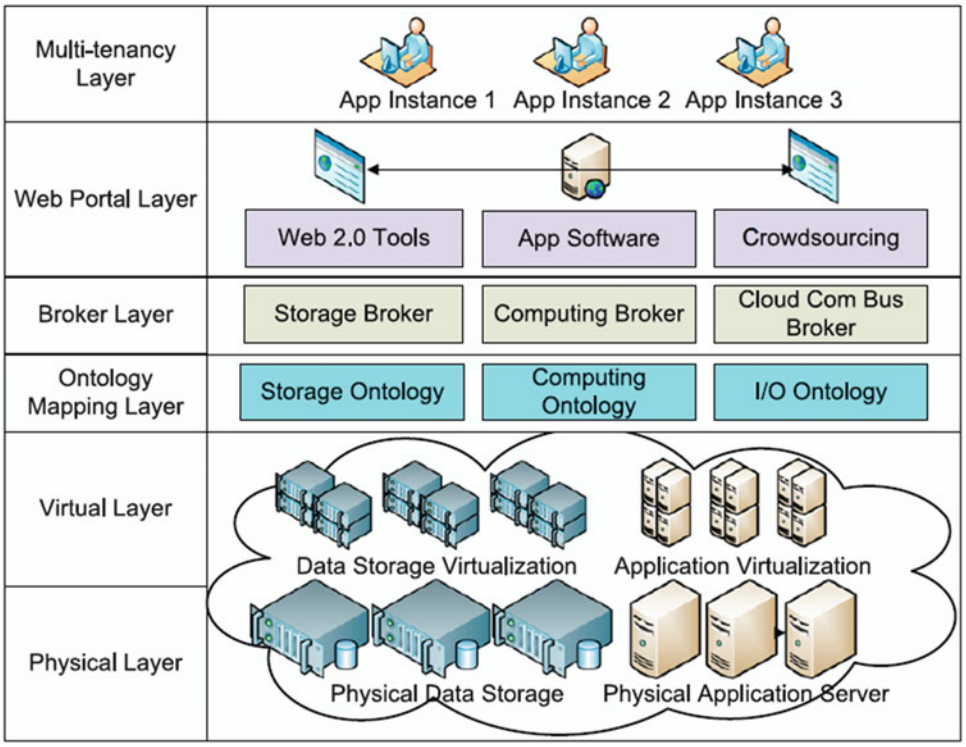


**Fig. 7** Features of the social product development

***Cloud Based Manufacturing (CBM)*** The concept of CBM points to a networked manufacturing model which makes use of the on-demand access to a shared collection consisting of a diverse as well as distributed manufacturing resources which can form temporary reconfigurable, production lines that can increase the efficiency, reduce the product lifecycle cost, as well as allow optimal resource allocation as a response to variable demand customer generated tasking.

***Quick Parts*** The quick part can be explained as a cloud based sourcing platform that concentrates over the low volume production for a custom manufactured rapid prototypes. It acts as a bridge between the service consumers and providers via an infant quoting engine that can convert into sourcing process from manual to the real time as well as automated one. Quick part supports users into uploading their CAD data from a variety of commercial CAD software packages e.g. CATIA and solid works. Basing upon the geometric analysis, quick parts is capable of instant generation of a list consisting of qualified service providers that can manufacture these digital models [37, 38]. It is practically a cloud based sourcing platform focusing over achieving high volumes production.

***Live Source*** The concept of live source, pioneered by MFG.com permits service consumers for making requests for quotations that is being sourced by almost 200,000 global service providers. Live source enables the whole of service consumers in order to discover as well as make a collaboration with the quality service providers at small duration of delivery times, giving way to reduced costs as well as more flexible supply chain.

Along with both the cloud based sourcing platforms, 3D Hubs [17, 39], and web based 3D printing platforms assist in establishing a connection between 3D printing service consumers with those of the providers in the local area. In accordance to 3D hubs, majority of the 3D printer owners make use of the devices, for about less than 10 h a week. The aim of these 3D hubs is to allow the 3D printer owners for establishing the social connections within the local 3D printing community in order to raise the use of their device [40]. The concept of 3D hubs as of now has provided an innovative business model which creates as well as delivers values to both the 3D printing service consumers as well as the providers.

## 3.2 Social Product Development

The concept of social product development does not deal with inventing social related products (i.e. the products which can facilitate the social interactions), in-fact it is all about the developing of the product socially. The social

product, social computing technologies regarding the aspects of product development can be interpreted in many ways [1]. The concept of social tool allows a broader pool of people in order to make contributions to product development. The key features for the social product development is about describing as well as qualifying the present crowd, by method of granting or limiting the access, creating the relations within the contributed content along with the experience of contributor and skillset or even establishing the communities in order to practice for certain functional specific collaboration, the web 2.0 tool may be used to obtain feedback from the customers partners, cross functional team members as well as other within the specific crowd. But the freedom is always there with the core product development team to take decision regarding how the feedback can be incorporated into the given feedback [39]. The central concept of the social product development as seen in Fig. 7 is generally aroused by using various social tools in order to improve the value of participants in the product development network [41].

Considering this factual information, the concept of social product development can be defined as "proper use of Web 2.0 technology and patterns of PLM where the social computing can be considered more as an infrastructure upgrades for PLM, specifically for its collaborative pieces".

A product Development/Marketing design where product or service organizations employ engagement or open innovation along with both internal as well as external stakeholders in order to develop both the products or services at different stages of product development life cycle. The crowd sourcing can make itself a part of social product management strategy [15].

The strategy social media marketing combined with the concept of collective intelligence gives way to social product innovations [6, 42]. Open Innovation along with the internet, social media and social technology facilitates the concept of knowledge sharing collaboration, open discussion, relationship building for communities of people, with common interest's needs or problems. Hence it can be said that Social media added to the product development gives social product innovations. Which supports social principles, technologies, that facilitates innovations achieving business goals, product development process etc. [8]. These definitions almost overlap each other with respect to certain aspects that are specific to only to only one definition [43].

Few of the commodities can be drawn from various existing definitions in order to help as well as characterise Social product Development.

1. The social Computing technologies, Social Tools, Social Media utilised influences to a great extent the product life cycle at all stages.
2. A specified crowd that are qualified for internal or external entities
3. The concept of open innovation and crowd sourcing forms example of the social product development, but do not make the definition themselves.
4. Its main goal is towards enhancing the communication value via means like creation of relationship, establishing the communities, and encouraging the collaboration.

The qualified crowd here does not indicate a high ability crowd which is in fact qualified for the task in hand. There are many occasions where an average individual is found absolutely fit for the social product development task [44].

## 4 Independent and Integrated Cloud Model

The Concept of cloud integration is all about putting together various cloud-based systems into a whole integrated form. The term indicates the joining of a cloud-based systems with other on-premise systems [42]. The main goal of cloud integration is into connecting the divergent elements of various clouds as well as the local resources with a unit environment that is ubiquitous in nature as well as allows the administrators to seamlessly avail as well as manage various applications, data's, services and systems as can be seen in Fig. 8.

The raise in public cloud computing has supported the enterprises in order to use a wide assortment of highly scalable resources and services on demand, instead of constructing as well as maintaining them in-house. However, in certain organisations, the arrival of these diverse resources and services have given way to IT Silos as the management struggle to handle as well as maintain every divergent cloud resources or data set. Without cloud integration, IT administrators have to perform every integration work separately as well as manually, a process which involves time, as well as increase the opportunity for errors [12, 45].

**Cloud Integration Platforms and Tools**

The organisation can themselves build a customised cloud integration platform themselves, though they might be complex in nature apart from being expensive. Many organisations make use of the third-party integration tool, such as integration platforms like, iPaaS.

### 4.1 How Cloud Integration Tool Works

The implementation of cloud computing concept cannot be achieved via a single means but include several common

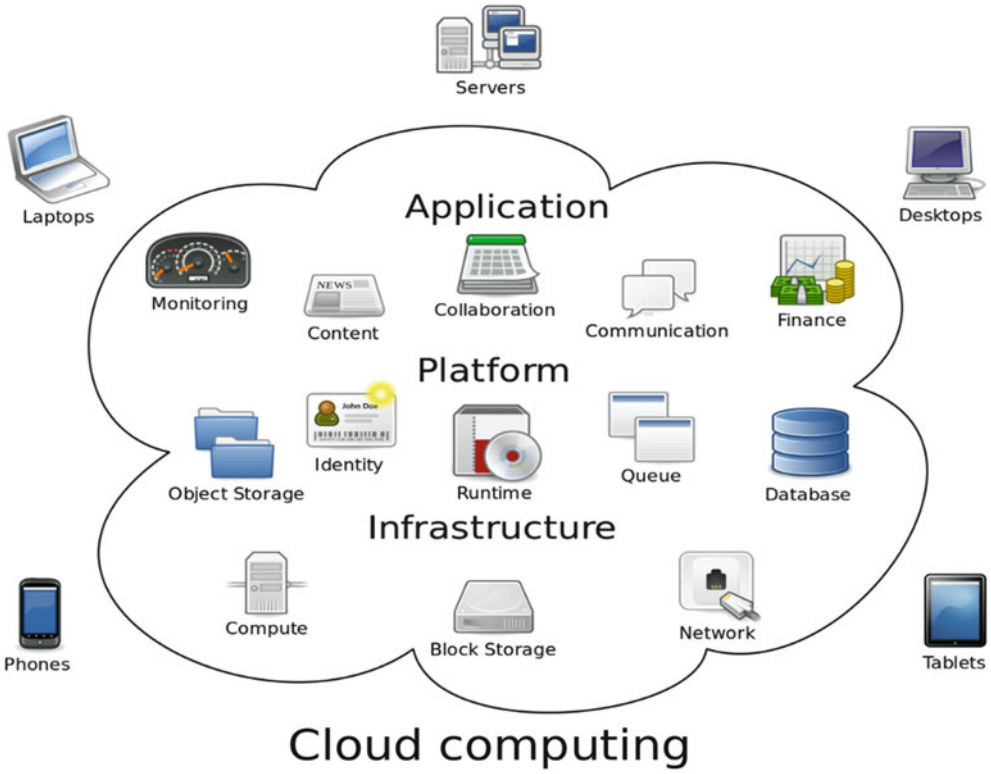


**Fig. 8** Integrated cloud computing platform

concepts to be worked upon. E.g. the concept of mediation, or federation, using cloud integration. The mediation is achieved working between the application where the cloud integration platform identifies an event within one application and eventually triggers the response which is transmitted to another connected application [34, 41].

In comparison to mediation federation act as a front end for two or more federation applications where cloud integration platform performs the interception as well as processing the events from outside of these applications triggering the corresponding actions. These two approaches can eventually be combined, such that mediation would handle the actions between applications where as the federation can handle the applications from outside the connected applications.

***The cloud integration can be performed by:***

1. Asynchronous Method
2. Synchronous Method

***Asynchronous Method*** The synchronous method communicates with both the data as well as commands without the need to wait for a response from the receiving application. The method prevents possible delays while sending or originating as it does not need to wait for the receiver or the target application to respond [42].

***Synchronous Method*** This mode typically has to wait for the arrival of a response from the receiving application ensuring the synchronization of all applications prior to its continuation.

The actual time needed for conducting a process of cloud integration can diverse typically IT organisation which may finish off certain integration tasks like automatic synchronization, fairly fast, where other tasks may need more amount of time, hours days, typically in case the process of synchronization involves a human flow.

The platform of cloud integration makes use of adapters, connectors, etc. which are software modules which communicates with a typical business application. Hence the cloud integration platform may implement a central interface or middle man that can take care of issues like security, authentication when specific adapters adjust to the application that are being integrated. Here the notifications as well as the communications are being performed by the connectors.

***Connectors*** The connectors here may be used for certain specific application e.g. SAP, which may have attributes

like being vendor neutral, using Standard Communication Protocols like SMTP message exchanges, Simple Object Access Protocol (SOAP), messaging application program interfaces, (APIs), and Java Connector Architecture (JCA).

For Data integration task the cloud integration platform makes use of an application independent data format, e.g. XML. Here every connector translates the applications specific format, into an independent form prior to any translations or conversions post to which they may exchange the common data with the receiving application.

***Types of Cloud Integration*** The IT team may implement many types of cloud integration which includes:

1. Cloud to Cloud: between cloud platforms
2. Cloud to local: between cloud and on premises environment.
3. Or a mix to both.

The various types of cloud integration tools available in the market are [46–50]:

**MuleSoft Anypoint Platform**—It adds various tools for the purpose of developing, managing as well as testing Application Programming Interface (APIs).

**Dell Boomi**—This platform enables the customers for designing a cloud-based integration processes termed as *Atoms* and it transmits data's among the cloud and on-premises applications.

**IBM App Connect**—the platform allows administrators into setting up the workflows which describes how data is transmitted from one application to another.

**Cleo Integration Cloud**—the platform provides a digital integration agility across various clouds and on-premise based applications.

**Microsoft Azure Logic Apps**—It allows the administrators for providing an automated workflow which can integrate the application software's with the data across cloud services and on-premises systems.

**Apache Libcloud**—it is a Python library that allows the administrators for managing various cloud-based resources via a Unified Application Programming Interface (API).

**Benefits and Challenges**

Though the cloud integration process don't change any data or perform any modification over the application, it can synchronise data and applications across an enterprise. Once implemented properly, the process of integration may automate complicated work flows along with reducing or eliminating the redundant data which may make way for operational errors. In due course, cloud integration process can improve the operational efficiency, flexibility and scalability as well as lessening the operational costs.

Apart from the stated benefits the cloud integration puts forth some challenges, majority of which arises due to lack of standardization. Currently there has been no universal or a standardized approach in order to integrate the cloud resources and services.

At certain time, make use of various communication schemes which makes it all the more difficult in order to communicate with different elements of the cloud along with the local environment [25]. The updates as well as patches formed over the applications may make changes to way these applications are communicated and may need updates to the time-consuming connectors. There are also additional problems that may cause a disruption to the cloud integration project. The complex form of integrations may need technical expertise and hence is always advisable to have a dedicated staff who can manage it.

## 5 Sustainable Governance with Wide and Affordable Information Access

The current government of all the developed as well as developing countries have realised the importance of an affordable broadband internet access which can provide a wide range of benefits and opportunities to the new generations in terms of innovative technologies like cloud, Artificial Intelligence, Data Analytics, Internet of Things, etc. Few countries have shown extra need to have this broadband since an affordable internet access is a prerequisite necessity in order to achieve the Sustainable Development Goals (SDGs) adopted by United Nations in 2015 [43].

### 5.1 The Challenge

Though cloud-based service has become the vital in our daily lives, never the less it demands for a robust, ubiquitous, and affordable broad-band connectivity making it quite critical. There are major gaps which always exist across as well as within countries [20] e.g. internet penetration, which is close to almost 100% in countries like Korea, Saudi Arabia, Qatar, etc. it is estimated that by 2020 only 16% of the world wide population belonging to poor and 3% of global population would be connected to internet. This estimation has failed to meet the expected achievement targeted by Universal Internet Access standard for a low-income nations.

All the more the ongoing popularity of Internet of Things has created a huge demand for Internet Access. Cisco Visual

Network Index (VNI) has forecasted that by 2021 the number of connected devices would increase from 17 billion to 27 billion. A majority of these requirement would need a low-cost wireless connectivity to the cloud through internet.

## 5.2 Policy Recommendations

A successful closure of existing apps for disjointed ones would require an innovation in policy, technology as well as the business model. The size of existing gap indicates, that it cannot be simply closed via business in a casual manner. There are few policies which create obstacle for investment by favouring the particular technology industrial sector or incumbent. The various regulations supporting the business models should be used else in fact may result in no-competition, poor service, as well as high prices. Here with the acceleration in the pace of change and agility, it becomes necessary for current policy makers. Here the forth coming challenge is how to develop the appropriate enabling environment that could give way to sustainable growth. In order to achieve this the promotion of the following is needed [38].

**Policy Innovation**
For the programs related to expansion of internet access the related laws need to be reformed in order to enhance the programs. Various initiatives like alliance for obtaining affordable internet UN broadband commission for a sustainable development along with the I-world connected project plays vital role in the process of highlighting for example policy innovation around the world would assist the policy makers for understanding why certain countries are succeeding in order to make the internet access more affordable [29, 38]. The process of innovation incurs simulating the competition, eradicating the financial barriers, alteration of tax policy, migration of government services and much more. Here both creation of open as well as a competing broadband market provides a market in respective countries should be a core policy objective and it must mean that policies must remove obstacles that limits opportunities that provide access and are vitally important.

**Technology Innovation**
Here the technology is under rapid change which is quite an evident in wireless communications. Here the ability to harness spectrum from broadband moved over exponentially in a few decades in collaboration with certain technology which is able to provide gigabytes per second connectivity. Hence access to spectrum suffers obstacle by a regulatory model which was evolved at its nascent phase over a century ago. It was optimised around exclusive usage of license protected by swathe of unused spectrum as a buffer from potential interference. Though the model is apt for certain kinds of services, the current technologies allow the sharing of spectrum, that gives an outcome of bigger reuse of the spectrum at a lower cost which improves an access for all. Currently more than half of the world's internet traffic is through unlicensed and shared spectrum. The policy makers should put effort in order to accelerate the time for deployment of these recent technologies while reviewing as well as revising their approach to the spectrum [41].

**Spectrum Management**
The policy makers here are needed to accelerate the efforts in order to start new low-mid as well as high frequency bands for both kind of license as well as unlicensed use. The TV white space is quite an example of the technological innovation pertaining to the areas of low band spectrum controlled by the data bases, in case of an unlicensed access to the TV white space provides affordable internet connectivity in the current era across the several countries where regulators do allows it without incurring any harmful interference to any protected service [41]. Here the unlicensed spectrum is comparatively less in cost than the licensed spectrum since there are no auctions or any licensing fee that needs to be considered into account for an operator's business model that enables more rapid as well as low cost deployment scenarios. Considering the spectrum from the deployment results in the artificial scarcity that may tend to high price for access. Here the policy makers need to ensure that any spectrum licensed on the basis of special cause can be explored through 'use it or lose it' policy. The spectrum regulators can also adopt the policies which can support the sharing of underutilised spectrum as a massive resource as the digital fuels to the digital economy.

**Business Model Innovation**
The current condition of a telecommunication landscape is quite variant from the one in the past, when national monopoly careers have launched the circuit switched voice services with that of the treaty based international connections. The current environment consists of numerous public as well as the private networks that are interconnected through a wide range of the commercial agreements [39]. The current internet network build up is in fact an enabler for a digital transformation of business, government as well as leisure. Here the policy environment actually invites the experimentation over a newly developed business models as well as the partnerships, where unique conversions can be seen

occurring, e.g. impact of mobile money in countries like, Africa. The policy makers must be on the process of look out for the policy as well as regulation which can carry out with such innovations.

Explaining this factor in finance sector, various governments have levied rules and restrictions over the foreign investments in the field of telecommunications, mobile as well as broadband infrastructure, and have also imposed various other investment policies which can put constraints on the process of entrepreneurs looking for establishing themselves in the market. Policies which support the concept of public-private partnerships and understands the structural requirements of various funding institutions are required to facilitate the access to capital [45].

Moreover, in majority of countries, broadband access is considered to be a as a luxury need which serves as counterproductive since it reduces investment that is contributed for its infrastructural development on the other hand increasing its cost of access, along with underestimating the importance of broadband access in its utility towards day to day services. These kind of policies are interested to contribute into widening of economy as well as divide socially. Here the Policymakers should adopt tax policies which stimulate the rapid investment into and adoption of the connectivity solutions which can optimize the taxation regimes that can help them in achieving the goals designed to establish the connectivity aspect.

The Policymakers here play the role of being innovative while adopting telecommunications policies which on the other hand reduces unnecessary regulation pertaining to services along with triggering the competitiveness. It supports the underlying goals of access and adoption [44, 45]. Example, reformation of universal services, and funds in order to incorporate the funding for broadband, assuring of net neutrality, triggering innovativeness in services, and reducing the regulatory burden over the operators that are all overall quite helpful. On the other hand, the growth of regulators with freedom attained from regulatory capture, both are quite critical for stimulating the investment.

Finally, it can be stated that there are quite a number of modes which can stimulate as well as accelerate both investment and deployment, e.g. “dig once” policies that ensures new highway and rail infrastructure projects which includes channels designed for covering fibre optics. In addition, infrastructures that shares the transmission towers can avoid redundancy of any form. The Demand-side stimulation obtained through deploying online government services along with the growth of content and services relevant to the local mass may contribute to certain extent [45].

## 6 Conclusion

Cloud is currently a vital aspect of the technical growth in the society where, majority of industries and services rely over it to carry in major day to day activities. With uplift of technology and growth of digitization all over the world, many industrial organizations have incorporated the electronic and digital mode of work management, and depends greatly over the recent technologies in order to enhance its productivity.

The chapter primarily concentrates over the contribution of cloud computing over the various industrial sectors. It discusses on the cloud infrastructure for industries. Further, it presents various framework for its production which includes design, manufacturing as well as the social product development. The chapter discusses the various independent as well as integrated cloud models and finally the government undertakings to provide the internet services in a cost-effective manner.

With the growth of various recent sectors in field of cloud technology, it has provided the industry with various benefits of shedding the overhead of having hardware infrastructure to support the various IT related work.

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