A TRACE OF HISTORICAL LINKAGE OF COMPUTER CONNECTIVITY FRAMEWORKS: FROM COMPUTER NETWORKS TO THE CLOUD OF THINGS

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Abstract: A lot of advancements have taken place and still taking place in computing. Gone are the days that people had to rely on inevitable standalone computer to meet their needs. With advancement in technology, computing is turning the world to a better place. Even physical objects are now connected to the internet with the help of wireless sensor networks. This paper traces the historical linkage of different computing frameworks from computer networks to cloud of things with a view to helping researchers and organisations understand the various evolution phases of computer networks. The progression of ideas from the advent of computer networks to six (6) different computer connectivity frameworks like distributed computing, cluster computing, grid computing, cloud computing, internet of things and the cloud of things was examined making all the developments that have taken place to be easily seen in a single medium. The emergence of each framework as well as the strengths, weaknesses and motivation for each of the emerged paradigm was briefly described. A generalized framework with the latest paradigms which anchor the era of big data was also presented.

Keywords: Big data, computer networks, cloud computing, utility computing

Introduction

The trend we are experiencing in computing is like what happened around a century prior when processing plants that utilized self-produced electric force noticed that it was less expensive simply connecting their machines to the recently framed electric force. That is, IT is changing from in-house computing into utility computing as services conveyed over the internet (Carr, 2008).

PCs have turned out to be all the more effective throughout the years. More memory, quicker processors and bigger storage make each new era of PCs superior to the past one. A consistent consumer-grade PC you can purchase at your nearby gadgets store has computing power that far surpasses that of specific research-grade PCs from two decades back. The types of issues we are utilizing PCs for additionally have turned out to be more intricate; we are no more simply utilizing PCs to add up numbers and sort our reports.

Gone are the days that only the computing resources such as memory, processing power and disk space, etc. remain a challenge. The demand of the current applications is also the availability of these resources at any point in time when a request is made. These posed a great challenge to the hardware and software development in computing (Baker *et al*., 2000).

The rest of the paper runs through the historical linkage and the developmental stages that have evolved.

Computer networks

A standalone's counterpart is the computer network. The need for standalone computers to talk to one another motivated the development of computer networks. The invention of the telegraph, telephone and radiotelegraph began the history of computer networking in the 19th century (Handy, 2009). By 1965, Thomas Marill and Lawrence G. Roberts had created the first Wide Area Network (ICP Networks, 2016). Basically, a network can be described as an interconnection of two or more computers or simply a group of separate computers connected together. It is one of the most essential ways of sharing information. A peer-to-peer network is the simplest form, because it simply connects computers together in a circular fashion. Other strategies, for example, client-server are controlled by a central point.

Strengths of computer networks

i. File sharing: You don't have to make duplicates of documents as all PCs can have access to all documents that resides on any of the PCs on the network. This greatly helps in saving time
ii. Resource sharing: All the resources like scanners, printers, etc. connected to the network can be shared.
iii. Security: System administration becomes easier because access to the computers within the network can easily be managed.
iv. Central maintenance and support: Hardware and software upgrades can be carried out easily as the network administrator can add a component and install an upgrade both on the server and client machines.

Weakness of computer networks

i. Expertise: Technical knowledge is needed to manage and administer a network
ii. Cost: Although a network will eventually be profitable, setting up a network comes with high cost
iii. Accessibility: Whenever the server is down the whole system may go down, which implies clients won't have access to the network resources.

A Trace of Connectivity Frameworks from Computer Networks

The need to solve problems with the help of computer networks gave birth to several frameworks. The emergence of a new framework does not necessarily stop the usage of the older ones instead it strengthens them and/or opens up a new vista in their usage. Fig. 1 shows a pyramid of the timeline of the different connectivity frameworks. Everything rose from the concept of computer networks and had progressed to an era generally known as Big Data. The shaded portion at the pinnacle of the pyramid holds promises for future advents of other frameworks. Each of the frameworks is described in this section. Fig. 2 shows the strengths and weakness of each framework.

Distributed computing

Present day PC is moving far from standalone computing into distributed computing. Computing resources over the network are harnessed to accomplish a job. The question is "how do we expand the processing capacity of a PC?" Computer producers are ceaselessly growing speedier PC chips, yet there are specialized points of confinement on how much quicker one PC chip can be. Another methodology is to utilize more than one PC at the same time. This methodology of utilizing various PCs to tackle an issue brought forth distributed computing (Tannenbaum & Vansteen, 2007). The history of

Distributed computing dates back to the 1960s with the introduction of the ARPANET email application which was noted as the earliest and most successful application of the distributed framework. Local Area Network in the 1970s and the explosion of the internet and Usenet groups were successes of the Distributed computing (Anderson *et al.*, 1995). Distributed computing frameworks are employed for high performance applications originating from the field of parallel computing. Distributed frameworks are made up of independent PCs that cooperate and appear as a solitary coherent system (Baker *et al.*, 2001).

Distributed computing is utilized to tackle complex issues that can't be handled by a single PC within shortest possible time. Time spent is reduced by harnessing the power of various PCs. One critical point of interest is that they make it simpler to coordinate distinctive applications running on diverse PCs into a single system. Another point of preference is that when legitimately planned, distributed framework scale well with regards to the underlying network. These points of interest frequently come at the expense of more degradation of performance, complex software, and weaker security. All things considered, there is considerable interest worldwide in building and introducing distributed framework (Tannenbaum & Vansteen, 2007).

In distributed computing there is neighbourhood independence and offer capacity; the geological conveyance of an organization can be reflected in the scattering of data. Customers at one site can get to data stored at diverse destinations; data can be set at the site close to the customers who frequently use the data. Hence, customers have neighbourhood control of the data. It is a well-known fact that it costs substantially less to combine smaller PCs with the proportional power of a single extensive PC. This is financially viable as various offices spanned across geographical locations can acquire separate PCs.

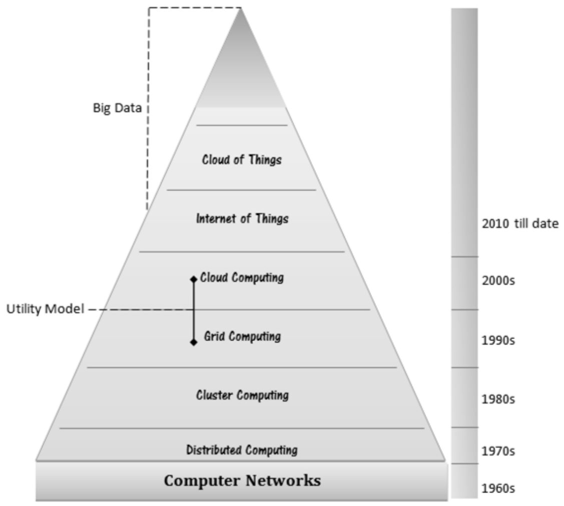

Fig. 1: Timeline of connectivity frameworks

Cluster computing

Cluster computing was borne out of developing need where conventional distributed computing had been used; there is requirement for accessibility of developing programming parts, rapid systems and intense chip to get together with this developing need. ARCsystem, developed by Datapoint in 1977 was the first commodity clustering product followed by VAXcluster, released by DEC in the 1980's. Today many leading software companies are offering clustering packages but Linux operating system had been the most widely used for cluster computers across the globe (Sharath, 2015).

Distributed computing lost its fame due to high cost, program and upgrade trouble. This brought forth cluster computing (Anderson *et al*., 1995). Scholastic undertakings that brought forth cluster platforms are Beowulf, Berkely NOW (Network of Workstations) and HPVM (HP Integrity Virtual Machines). These ventures showcased the geniuses of clusters over distributed systems. These points of interest include scalability, technology tracking, open source platforms, accessibility, not being limited to as specific vendor product to say yet a few.

These points of interest took cluster computing into business commercial centre. Essentially, cluster computing comprises of parallel programming whereby a solitary system is running in parallels on different machines. A single master node controls several nodes. The principal function of the expert hub is running the middleware necessary for program execution as well as administration of the group (Baker *et al*., 2001).

Strengths of cluster computing

i. Single system image: The details behind cluster architecture are hid from the user. The user sees himself or herself working with a single system whereas in actual sense the user is dealing with many components.
ii. Availability: Failure of any component as a result of technical reason does not affect the system because all components are copies of each other.
iii. Manageability: For the fact that large components are combined as single entity in cluster computing system, management becomes easy.

Weaknesses of cluster computing

i. Troubleshooting: Identification and location of specific component(s) that have issues may be a problem for the fact that we are dealing with a single entity.
ii. Programmability: Combining components which may be of different programmability as a single entity may pose a problem or difficulty.
iii. Expertise: A level of expertise is needed to manage computing architecture that are of same or different programmability (Buyya *et al*., 2011).

Utility computing

The idea of utility computing dates back to 1961 by John McCarthy who predicted that computing may someday become a public utility like the telephone system. Utility computing in itself is not a computing framework but a business and service model (Boswas, 2011a, 2011b). It helps users to leverage on computing frameworks like Grid and Cloud to rent the resources or services they need. Its implementation became popular after the emergence of Grid computing and found a commonplace in the era of cloud computing.

With expanding popularity and use, extensive grid installations are not without challenges, for example, excessive demand for resources as there were no means to checkmate the amount of resources requested by users nor urgency of work considered. These problems with grid gave birth to utility computing whereby, clients appoint "utility" worth, that catches different nature of administration referred to as QoS (Quality of Service) requirements (due date, significance and fulfilment) (Baker *et al*., 2000).

Delivery computing as a utility entails delivery of services as demanded in a scalable, security-rich-shared manner over the internet for a fee (Keahey *et al*., 2005). This is both productive to both suppliers and the customers of IT services in that suppliers of IT services can influence on operational expense to give different arrangements and serve numerous clients which prompts expanded effectiveness and return on investment (ROI) and also lower expense of possession.

Likewise, consumers can achieve reduction on IT-related expenses by deciding to get less expensive services from providers instead of intensely investing on IT infrastructure and staff employment (Perry, 2008).

Better economy is a result of utility figuring. There is effective use of resources. Users can simply pay and get resources at whatever point there is need because there is no need to house infrastructure (Padmapriya, 2013). We look at the two computing frameworks that use the utility computing model.

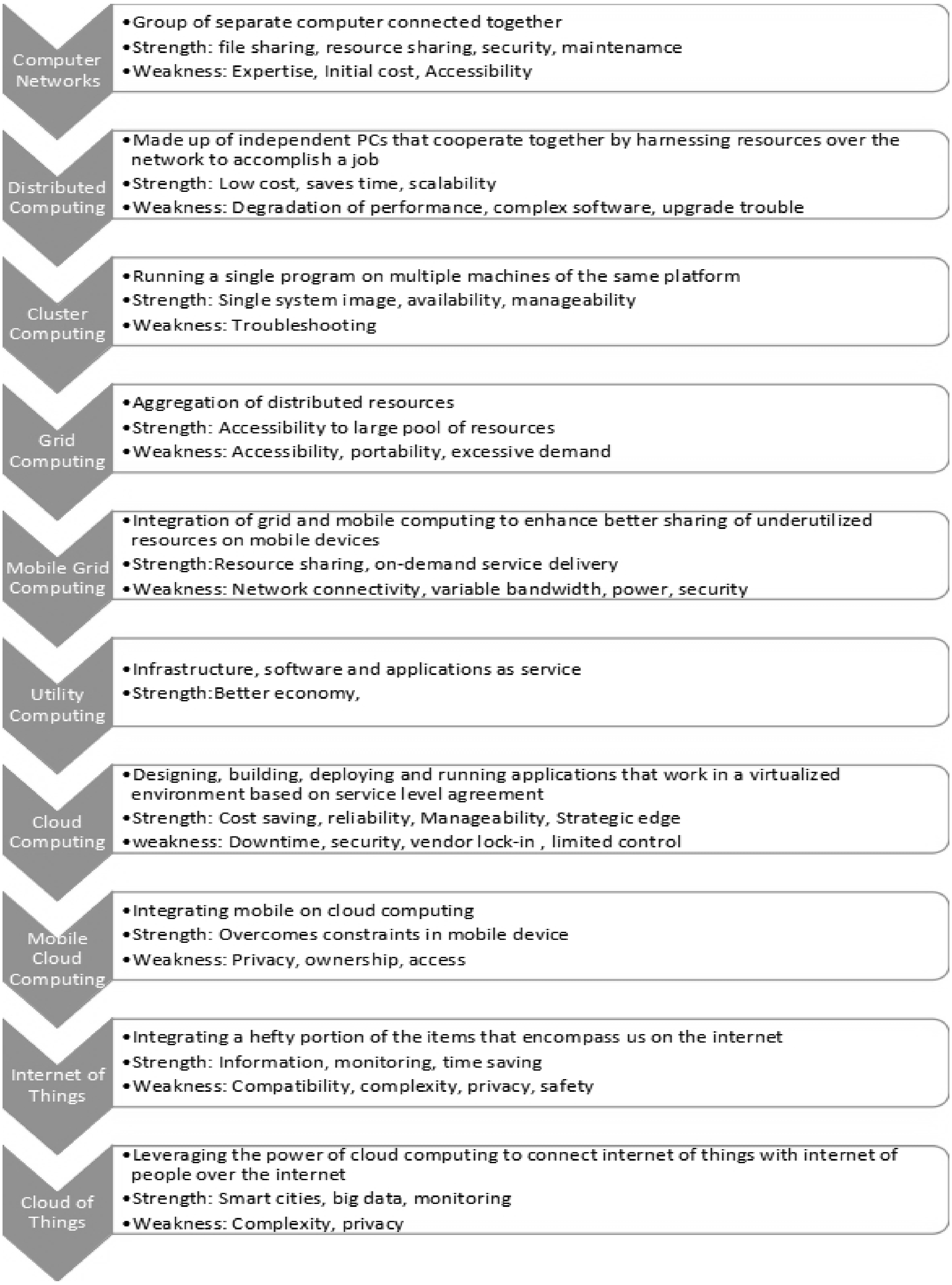

Fig. 2: Strengths and weaknesses of connectivity frameworks

Grid computing

Following the analogy to the electric power grid and its distribution, the availability of high speed wide area network became the inspiration behind the idea of Grid computing as far back as in the 1990s. The inspiration was to have a computing infrastructure that would provide access to computing on demand just like the electricity and the telephone system. This idea was harnessed by researchers

over the years until leading key industry players like Amazon Web Services and Microsoft Azure started implementing it in the 2000s (Foster & Kesselman, 2014). In 2002, the Grid Global Forum (now Open Grid Forum) declared the Open Grid Services Architecture (OGSA) (Sharma *et al*., 2014).
Homogeneity is the main distinguishing mark of cluster computing when compared with grid computing. Most often, cluster computing system consists of the same computer, operating system and network. Interestingly, high degree of heterogeneity is a characteristic feature of grid computing system as you need to take into consideration management of different operating systems, hardware, networks, etc. (Baker *et al*., 2001).

Harnessing resources from different sources in grid computing is a key. This is being realized as a virtual organization whereby all the people or institutions belonging to that organization can access the pool of resources that are provided. Grid computing allows aggregation of distributed resources as well as transparent access to them (Keahey *et al*., 2005; Buyya & Venugopal, 2009).

With grid computing, there is on-demand service delivery as a result of standardized protocol. However, guaranteeing proper administration, that is, quality of service in grid is an issue (Bichawat & Joshi, 2010). Lack of performance isolation has prevented grids, particularly where resources are oversubscribed or clients are uncooperative.

Another issue that has prompted dissatisfaction when utilizing grid is the accessibility of assets with differing programming setups. Thus, with portability barrier on grid, it is not generally adopted as a utility (Nandeppanavar, 2010).

Virtualization innovation is an answer for baffling issues as a subsequent of utilizing grid framework, which incorporates facilitating wide range of applications on a single platform (Buyya & Venugopal, 2009).

Grid also found application in mobile devices. Mobile grid integrates both mobile and grid computing features to enhance better sharing of the underutilized resources on the mobile devices (Foster, 2002). With persistent improvement in device technology, power and memory constraints will not be an issue. Mobile devices can utilize resources in the network for any task.

Combination of both grid and mobile computing comes along with combined issues from both area; you need to take into consideration scheduling, security, fault-tolerance, resource management on the part of grid as well as network connectivity, variable bandwidth, power, and security on mobile device (Singh, 1996).

For quality and reliable service with mobile grid, quality of service parameters must be taken care of. For example, there could be communication break while executing a job which translates to the fact that job is suspended until connection is re-established. As a result, there is performance degradation. Scheduling of jobs effectively in grid is a challenge which is more complicated with mobile grid as a result of unreliable communication (Broberg, 2008). Mobile grid is susceptible to attacks due to its nature. With mobility, security measure must prevent unauthorized personnel from accessing the network as well as theft of resources.

Cloud computing

Cloud computing is a more extensive concept of utility computing than Grid computing. It identifies with the fundamental structural architecture in which the services are planned. The distinction between utility computing and cloud computing is pivotal. Utility processing identifies with the plan of action in which resources (software/hardware) are conveyed while cloud computing has to do with designing, building, deploying and running applications that work in a virtualized environment (Sosinsky, 2011; Apostu *et al*., 2014; Nedelcu *et al*., 2015).

The application of cloud computing framework dates back to 1999. It started with Salesforce.com providing enterprise applications through websites. Amazon Web Services in 2002 and Google Docs in 2006 helped to popularize the framework (Boswas, 2011b)

According to Buyya & Venugopal (2009), cloud is a parallel and distributed systems comprising interconnected and virtualized computers that are dynamically provisioned and preserved as one or more unified computing resources based on service level agreement (SLA) established through negotiation between service provider and consumers.

The progression in cloud computing can be linked to availability of low-cost PCs, storage capacity, high-capacity networks, hardware virtualization, utility and autonomic (Shawish and Salama, 2014; Anurisha and Lalitha, 2017). Organizations can scale up or scale down based on computing needs. In cloud computing, clients are able to focus on those things that will boost the economy of the business as they don't have to bother on how to acquire infrastructure.

Like in the Grid, cloud computing also found application in mobile devices. In cloud computing, resources are provided by internet on-demand basis. Mobile cloud computing is essentially cloud computing in which a portion of the gadgets included are mobile. There is an additional advantage with mobile cloud computing. Cloud computing overcomes the normal constraint in mobile devices such as desirability for lower weights, smaller sizes, longer battery life, storage capacity, etc. by allowing more intensive jobs done on systems without these limitations and having the outcome sent to mobile device. Along these lines, mobile cloud computing is an exceptionally engaging and possibly lucrative pattern (Moon *et al*., 2004).

One noteworthy concern toward cloud computing is privacy. Some of the client's information is stored remotely which prompts worries in that other clients will utilize or offer this data which could be given to government offices without the client's consent or learning.

Purchased resources ownership is another issue. Since purchased media files can be stored remotely there is a danger of losing access to the bought media due to one reason or the other. In addition, accessibility and security are also related issues. In the event that an application depends on remote information storage and internet access can fundamentally affect the client. For instance, if a client stores the greater part of their schedule and contact data on the web, power failure can influence their capacity to work (Vaquero *et al*., 2009).

Mobile cloud computing is especially helpless because of different points at which access can be intruded. Gathering and rapid accessibility can shift incredibly for mobile gadgets. Notwithstanding, specific services utilized may have downtime. At last, there can be issues of information getting locked to a specific service.

Strengths of cloud computing

i. Cost savings: You can have access to resources in cloud without necessarily installing a single in-house server and application. You pay for what is utilized and withdraw at whatever point you like.
ii. Reliability: Cloud registering is significantly more dependable and predictable compared to infrastructure installed at your own end. There is Service Level Agreement which ensures all-day and 99.99% accessibility. Organization can profit by gigantic pool of excess resources, and also speedy failover system, i.e. peradventure a server fails, other available servers can be switched to.
iii. Manageability: IT base upgrades and support are sole obligation of service provider. With a SLA set up, there is guaranteed timely service delivery.

iv. Strategic edge: Organization can deploy critical mission applications that convey noteworthy business advantages, with no upfront expenses which gives competitive advantage.

Weakness of cloud computing

i. Downtime: Due to expanding number of requests from expanded number of customers there is probability that your business procedure be briefly suspended. You must be on-line at whatever point you need to get to any of your applications, information or server from the cloud.
ii. Security: Access to critical information are given to provider which opens up them to security challenges. Additionally, hosting many clients on the same server may give room to hackers to have access to information of other clients. In any case, such adventures are not prone to surface.
iii. Vendor lock-in: Switching cloud administrations is something that has not yet totally developed, i.e. moving service from one provider to another may be challenging as a result of support issues and interoperability. For instance, applications created on Linux platform may not function properly on Microsoft platform.
iv. Limited control: Organizations does not have control on the infrastructure but applications, services and data. Key managerial chores like shell access, upgrading and firmware administration for instance may not be done by client (Kharif, 2009).

Internet of things

The advent of the Internet of Things framework was impacted by the influence of the previous connectivity frameworks discussed earlier as well as various network advances like the TCP/IP in 1974, the Domain Name System in 1984 and the World Wide Web by Tim Berners-Lee in 1989. The term Internet of Things (IoT) was coined by Kevin Ashton in 1999. It was fully implemented by 2009, a year in which Cisco Internet Business Solutions Group (IBSG) noted that more things or objects were connected to the Internet than people (Evans, 2011).

The Internet of Things (IoT) is a late correspondence worldview that imagines a not so distant future, in which questions of ordinary life will be furnished with microcontrollers, handsets for advanced correspondence and suitable conventions stacks that will make them ready to speak with each other and with the clients, turning into a necessary piece of the web (Atzori *et al*., 2010).

In IoT worldview, a hefty portion of the items that encompass us is going to the system in one structure or the other. Radio Frequency Identification (RFID) and sensor system innovations will ascend to meet this new challenge, in which data and correspondence frameworks are undetectably installed in the earth around us (Gubbi, 2013). This result in era of colossal measure of information which must be stored, handled and displayed in a consistent, effective, and effortlessly interpretable structure. Cloud computing can give the virtual foundation to such utility computing which incorporates observing gadgets, storage gadgets, explanatory instruments, perception stages and customer conveyance.

According to Atzori *et al*. (2010), Internet of things can be acknowledged in three ideal models; internet-oriented (middleware), things-oriented (sensors) and semantic-oriented (knowledge). The convenience of IoT can be unleashed just in an application domain where the three standards intersect.

Smart connectivity with current networks and context-aware computation utilizing system resources is a key portion of IoT. With the developing vicinity of Wi-Fi and 4G-LTE remote web access, the advancement towards universal data and correspondence system is now apparent. However for IoT vision to effectively rise, the figuring worldview should go past customary mobile computing processing situations that utilize advanced mobile phones and portables, and develop into uniting ordinary existing objects and installing knowledge into our surroundings (Gubbi *et al*., 2013).

The IoT idea, thus, goes for making the Internet considerably more immersive and pervasive. Besides, by empowering simple access and cooperation with a wide assortment of gadgets, for example, home machines, reconnaissance cameras, checking sensors, actuators, presentations, vehicles, etc.; the IoT will cultivate the advancement of various applications that make utilization of the conceivably colossal sum and assortment of information created by such questions give new administrations to subjects, organizations, and open organizations. This worldview without a doubt finds application in various spaces, for example, home computerization, modern mechanization, restorative guides, versatile human services, elderly help, clever vitality administration and savvy frameworks, car, traffic administration, and numerous others (Bellavista *et al*., 2013).

Then again, such a heterogeneous field of usage makes the identification of courses of action prepared for satisfying the necessities of all possible application circumstances a forcing test. This difficulty has provoked the development of various and, on occasion, conflicting suggestion for the helpful affirmation of IoT structures. In this way, from a structure perspective, the affirmation of an IoT framework, together with the required backend framework organizations devices, still does not have a developed best practice as a consequence of its interest and disperse quality (Laya *et al*., 2013).

Despite the specific difficulties, the gathering of the IoT perspective is in like manner hindered by the nonappearance of an unmistakable and extensively recognized arrangement of activity that can pull in dares to propel the sending of these advances (Schaffers, 2011). In this many-sided circumstance, the use of the IoT perspective to an urban setting is particularly paramount, as it responds to the strong push of various national governments to get ICT courses of action in the organization of open endeavours.

Strength of IoT

i. Information: It is clear that having more information helps settling on better options. Whether it is unremarkable decisions as hoping to acknowledge what to buy at the market or if your association has enough contraptions and supplies, knowledge is key.
ii. Monitoring: The second most apparent purpose of inclination of IoT is checking. Knowing the exact measure of supplies or the air quality in your home, can further give more information that couldn't have heretofore been assembled easily. For instance, understanding that you are low on milk or printer ink could save you another outing to the store soon.
iii. Time: As inferred in the past cases, the measure of time saved as a consequence of IoT could be extremely far reaching. Besides, today's available day life, we all could use extra time.
iv. Money: The best purpose of inclination of IoT is saving money. If the expense of the naming and checking equipment is not exactly the measure of money saved, then the Internet of Things will be by and large grasped.

Weakness of IoT

i. Compatibility: Currently, there is no worldwide standard of similitude for the naming conventions. A standard is needed to be agreed upon, for instance, Bluetooth, USB, et cetera.
ii. Complexity: As with each complicated system, there are more risks of frustration. With the Internet of Things, disillusionments could take off. For instance,

assume that both you and your accomplice each get a message saying that your milk has finished, and both of you stop at a store on your way home, and you both purchase milk.

iii. Privacy/Security: With the larger part of this IoT data being transmitted, the threat of losing insurance increases. For instance, how very much encoded will the data be kept and transmitted with? Do you require your neighbours or chiefs to know what medicines you are taking or your budgetary condition?

iv. Safety: Imagine if a notorious software engineer changes your remedy. Then again if a store hence dispatches you an indistinguishable thing that you are allergic to, or a flavour that you couldn't care less for, or a thing that has terminated. Along these lines, wellbeing is in the end in the hands of the customer (Phillip, 2015).

Cloud of things

Integrating cloud computing with IoT is becoming necessary on account of measure of data IoT's could produce and their necessity to have the benefit of virtual resources in order to create brilliant applications for the clients. This IoT and cloud computing combination is alluded to as Cloud of Things. The Cloud of Things (ClouT's) is an advanced concept of the Internet of Things (IoT). Some researchers and practitioners believed that in fact the term IoT should now be called the ClouT's owing to the fact that the full benefits of the IoT can only be exploited through cloud computing and storage. Krautkremer supported this view by noting that all his connectivity are now cloud-based including network, devices, security, analytics and data storage (Taylor, 2014).

The volume of data being generated and velocity at which it is being generated is massive. We are in information era or to better say we are in the era of what is known as big data. Big data refers to the volume, variety and velocity of structured and unstructured data pouring through networks into processors and storage devices, along with the conversion of such data into business advice for enterprises (Wise, 2014). Coping with this enormous amount of data is a challenge. However, the emergence of ClouT meeting the era of big data is a good success story because several projects are being launched which leverages the framework for effective implementation. An example is the recent BigClouT project launched in 2016 by the European Commission and the National Institute of Information and Communications Technology (NICT) in Japan.

Cloud of Things (ClouT's) general idea is utilizing the Cloud Computing as an empowering agent to connect the Internet of Things with Internet of People by means of Internet of Services, to set up a productive correspondence and coordinated effort exploiting all conceivable data sources to make the urban communities more intelligent and to help them with facing the rising difficulties, for example, financial development, energy administration, and advancement.

There is a well related combination between big data and cloud computing. Intel (2015) supported this by arguing that the two IT initiatives which are currently top in mind for organizations across the globe are big data and cloud computing. This is elaborated by Google Trends as depicted on Fig. 3 showing global interest on both. Although interest on Big Data is growing rapidly above Cloud Computing, big data has been successfully deployed on Cloud Computing thereby making the two work hand-in-hand. Practically, Cloud Computing, using the Internet of Things (IoT) generates lots of unstructured data for Big Data processing and analytics.

With trend in ubiquitous computing, everything will be associated with the Internet and its information will be utilized for different dynamic purposes, making data from it, as well as learning and even insight.

The era of the ClouT's deal with two major concepts: The Internet of Everything and the Internet of Living Things.

Cisco defined the Internet of Things (IoT) as "the networked connection of physical objects" but defined the Internet of Everything (IoE) as "the networked connection of people, data, process and things" (Cisco, 2017). It is the advances in technology in the area of Internet of Things that gave birth to the era of Internet of Everything where things as well as people are now connected.

The other concept that is currently emerging is the Internet of Living Things (IoLT) where specifically all living things (plants and animals) are involved in the internet connectivity. As at 2013, researchers had started experimentations with the IoLT concept with "a cyborg cockroach that could be controlled from a smartphone through electrodes attached to its antennae and a wireless unit on its back" (Cronin, 2014). According to Finley (2015), the IoLT concept can be effectively used in monitoring and maintaining personal healthcare system.

In Fig. 4, we present a generalized framework diagram showing the Internet of Things, Everything and Living Things as a unified concept connecting devices, data, processes and all living things.

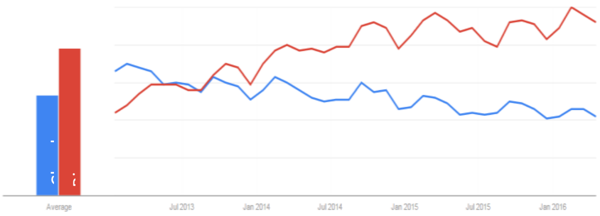

Fig. 3: Big data vs. cloud computing (Source: Google Trends)

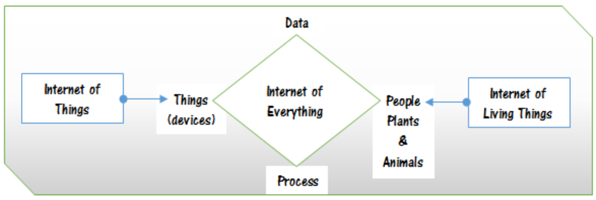

Fig. 4: Generalized framework

This unified concept can engage the utilization of almost all the frameworks discussed in this paper. It can maximize their strengths and minimize their weaknesses. Following the successes of the other frameworks, it is noteworthy to identify that the connection of devices, processes and all living things still results in big data generation. As at 2013, Dean (2014) noted that the democratization of data began; an era where everyone generates data using personal smartphones, tablets, and Wi-Fi. Schneider (2016) showed that on average over 500 million tweets occur every day on Twitter and 4.5 billion "likes" occur every day on Facebook. This huge unstructured datasets do not just occur over social networks but also through signals generated by devices and living things.

Conclusion

In this paper, we have tried to trace the evolution of computing connectivity frameworks from computer networks to cloud of things. The paper had briefly described each concept and also brought out the strength and weakness of each paradigm. The historical timeline of the evolution had also been traced from the 1960s to date. We established that the resultant effect of the evolutions is the fast generation of large amount of data in diverse formats which are generally known as big data.

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Conflict of Interest
The authors declare that there is no conflict of interest.

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