The Interdependent Part of Cloud Computing: Dew Computing

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Abstract Consumers educe umpteen advantages by placing private data enclosed by cloud computing utilities, although the hindrance of keeping data in such kind of services is the unavailability of consumers own data in absence of Internet connection. To figure out this enigma in an effective and excellent manner, new computing that is independent as well as collaborative with the cloud computing is emerged denoted as Dew computing. The Dew computing is revealed and realized as a fresh layer in the currently distributed computing hierarchy. Dew computing is placed as the base level for the Fog and Cloud computing archetypes. Hierarchical and interdependent separation from Cloud to Dew Computing satisfies the necessity of low and high-end computing demands in day to day life. These new computing paradigms diminish the expense and enhance the execution especially for ideas like Internet of Everything (IoE) and the Internet of Things (IoT). This paper presents basic concepts as well as cloud–dew architecture with working flow of dew computing, the correlation among Cloud Computing, Fog Computing, and Dew Computing along with comparison among all these paradigms.

Keywords Dew computing · Fog computing · Cloud computing · IoT

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1 Introduction

The way to store and retrieve personal as well as commercial information has been totally refined due to enormous innovations in today's world. With the fast growth of Internet, users can access their data anywhere in the world without carrying the data on physical devices. In early 2000, the new notion was introduced titled as "Cloud Computing," which is the technology of storing and accessing data as well as applications over an Internet network. Cloud computing uses a network of shared large pools of systems, resources, and servers. With the concept of pay on use, cloud computing architecture allows the client to procure services at different level of abstraction such as Platform as a Service, Software as a Service, and Information as a Service, depending upon their requirements [1]. It gives users the freedom from location bounding as users can access services everywhere with the help of availability of Internet and a standard web browser; allow working on a single project from multiple Geo-distributed workplaces.

Today's tech-savvy world is brimful of electronic gadgets, sensors, robots, machines, appliances, equipments, and actuators which all are smart objects programmed to carry out functions mainly as stand apart devices and are interconnected through either wired or wireless links to form a one universal network which is known as into the Internet of Things [2].

Registration to the cloud provides the privilege of accessing data from service providers in any part of the world, but this ease comes up with the hazards of security as well as privacy. This provokes the idea of intercept concentrating on cloud and initiate unraveling how to store and operate the spurt of data that is being yielded by IoT. IoT demands mobility support, broad range of Geo-distribution, location awareness, as well as low latency qualities. Thus, the Internet of Things wields an augmented configuration of Cloud Computing designated as Fog Computing. Fog Computing is an articulation between the powerful Cloud Computing and the network of incalculable smart devices. Whereas the Cloud Computing accredit its client computers by sharing resources for computing and data storage located in the server at a remote data center known as Cloud, Whereas the fog computing provides resources to the networked clients by proximate to the source of the data. The whole system using Cloud and Fog Computing for Internet of People and Internet of Things is known as Internet of Everything.

As we know, Cloud and fog computing require Internet connection. The evident detriment of keeping data using the Cloud utility is forfeiting access in the absence of Internet connection. Because all resources are far from user's premises and out from user's control, if an Internet connection is lost, the user will not be able to access the user's own data. To eliminate this problem one more new concept comes into picture known as "Dew computing" [3].

1.1 What is Dew Computing?

Dew Computing is a prototype whose objective is to wholly grasp the abilities of personal computers as well as cloud services. In such kind of archetype, organization of software on a personal computer is based on the Cloud–dew Architecture which offers lavish utilities independent and collaborates with cloud services. Dew Computing is the future direction of on-premises computer applications [4].

"Dew computing is a method where the on-premises computer provides utilities which are independent and also collaborative with cloud services. The goal of Dew computing is to fully realize the potential of on-premise computer and cloud services." [5, 6]

The independence feature encourages using on-premises resources as far as possible before sending requests to cloud services to fully understand the power of on-premises computers [5]. The meaning of Collaboration is an exchange of information with cloud services automatically during dew computing application's operation. Collaboration may involve synchronization, correlation, or any other type of interoperations. The collaboration feature realizes the potentials of cloud services by promoting the use of cloud services together with on-premises computers. Independence suggests inherently distributed nature of application whereas collaboration suggests inherently connected nature of dew computing application [5].

1.2 The Correlation Amidst Cloud Computing, Fog Computing, and Dew Computing

Like, a cloud is far away from the ground, fog is closer to the ground and dew is on the ground, cloud computing is remote, fog computing is in the neighborhood of

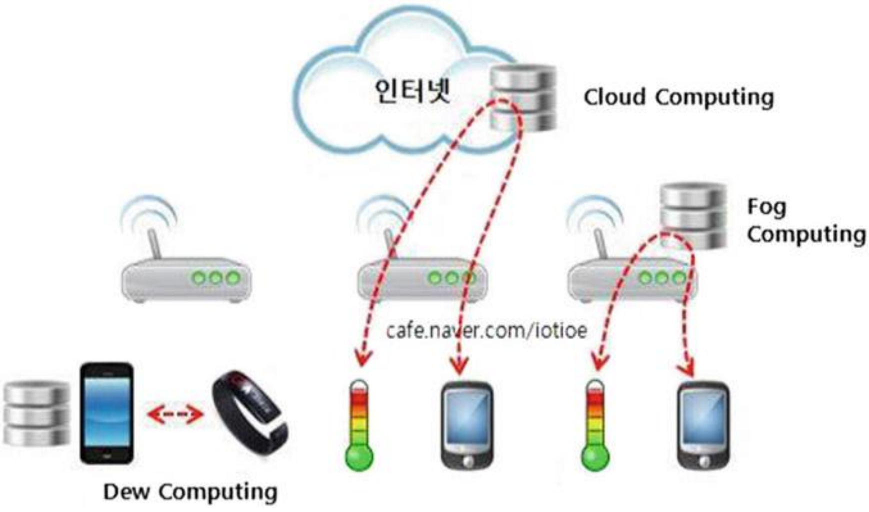

Fig. 1 Pictorial view of cloud, fog, and dew computing [11]

users and dew computing is at the user end itself. Figure 1 shows the pictorial view of cloud, fog, and dew computing.

2 Cloud-Dew Architecture

The task of making synchronization between data on the cloud and local computer is very trivial in the case of complex data. In [7] author's architecture follows the conventions of Cloud architecture, in addition to Cloud servers, there are dew servers which are situated on the native system and act as a buffer between the local user and the Cloud servers, also abstain the enigma of data becoming out of synchronization. This dew server would essentially host scaled-down variants of websites, full of pre-downloaded contents, which the user could access without Internet connection [8]. The major two functions performed by dew server and its related databases are: providing the client services same as services provided by the Cloud server and another is, maintaining synchronization between databases of dew server and cloud server. Cloud-dew architecture is an extension of the client-server architecture [9]. This architecture is represented in Fig. 2. A dew server has the following features [10]:

1. A dew server is a light weight web server, which is able to serve only one user.
2. A dew server can store only user's data because a dew server is very small like a drop of dew while a cloud server is very big like a real cloud.
3. A dew server is as week as a real drop of dew because a dew server's data vanishes easily due to hardware failure, infection of virus, etc.

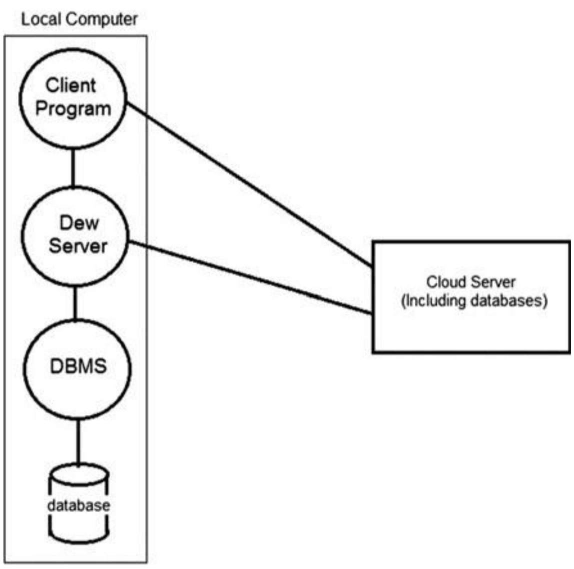

Fig. 2 Cloud–dew architecture [7]

4. Because cloud can provide all the necessities, after disappearance dew will come out again, similarly vanished dew server can be entertained once again because of copy of all dew server data in the cloud servers.
5. A dew server is running on the local computer, so it is available with or without an Internet connection.

This architecture can furthermore be employed to make available websites offline. Suchlike system can diminish the overhead of Internet data for an organization having weak Internet connectivity. Many functions like displaying files or images, playing audio or video would be possible without Internet connection but provided that data had been synchronized to the "dew site" from the web over the last connection interval.

3 Existing Architecture Analysis

We found that only few authors have worked on the concept of Dew computing, so first let us clear what existing scheme is. In existing cloud–dew architecture, two kinds of URLs are considered: regular URL such as https://www.test.com and local URL such as https://mmm.test.com. On user's local computer the website is hosted, which is known as "dew site." Here mmm can be used to indicate dew site whereas www is used to indicate website. All names of the dew sites that user wants on his dew server must be placed in the host file, which is available in almost all operating system and maps host names to IP addresses. A dew server can be accessed with the help of local host. When a user enters URL in the navigation bar of the browser, if a URL corresponds to a website then browser follows the steps to map the domain name to the IP address using DNS server and display website content and if a URL corresponds to a dew site then dew server check the existence of domain name in host file. If host file does not contain requested domain name then dew server will send a request for script and database of requested website to the remote domain (cloud server). When the re requested is approved by remote domain then script and database of the website will be integrated into dew server. Then local URL will be mapped to the local host. Dew server will then find target host name by using an environmental variable. The URL request will be then redirected to the corresponding dew site script. The user will then perform an operation on dew site [7]. Synchronization with cloud server will be started on the availability of the Internet connection. Now, to perform synchronization between the content of dew site and website, user has to be logged into the website. Once the user is logged into the website, after doing internal mapping of user id of dew site and user id of the website, a link is created between a user on dew site with website and synchronization will be started automatically [7]. Through Fig. 3, we speculate the steps describe above of dew computing process.

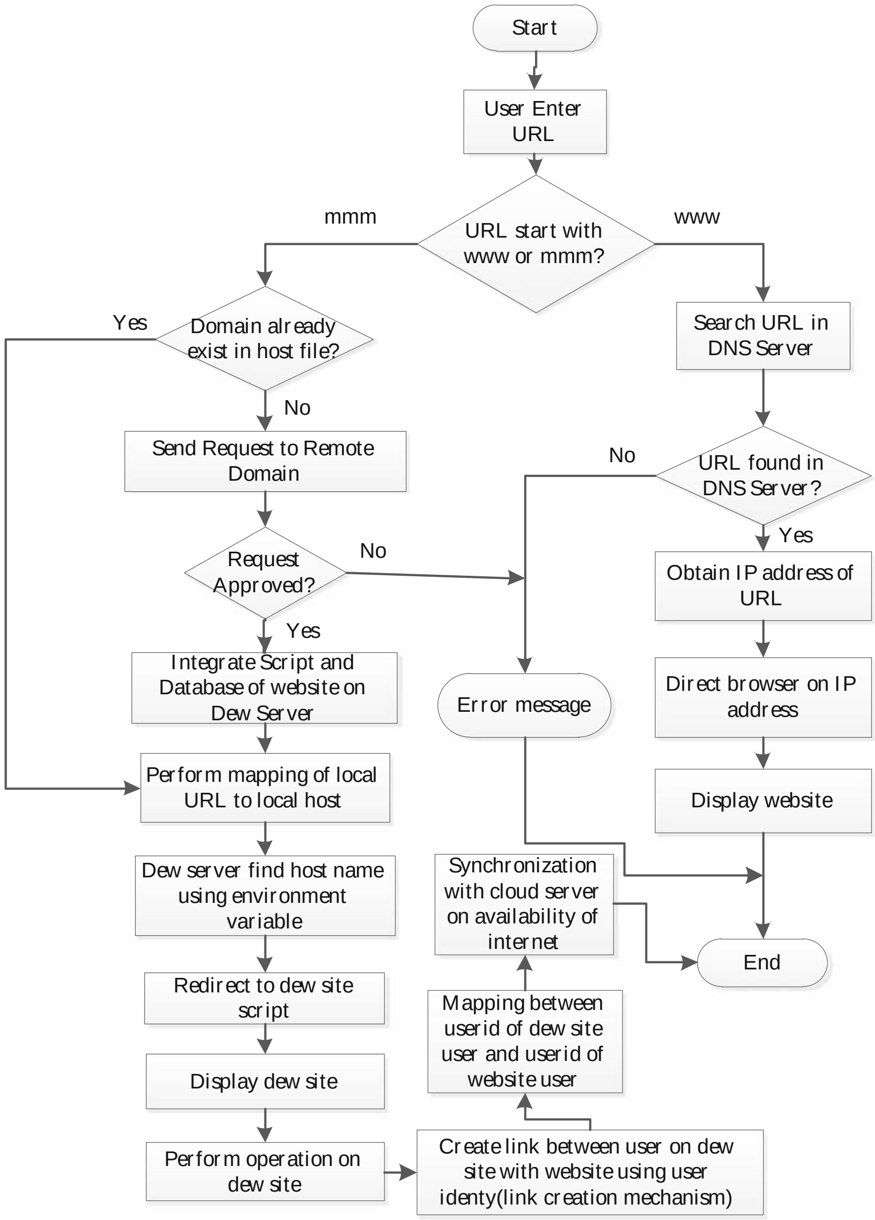

Fig. 3 Dew computing process flow

4 Our Contribution

In Sect. 4.1, we are trying to do basic analysis of currently available distributed computing paradigms based on general parameters in Table 1, based on location-based parameters in Table 2 and networked-based parameters in Table 3. Section 4.2 contains Table 4, which includes comparative exploration of Cloud, Fog, and Dew Computing.

4.1 Basic Analysis

See Tables 1, 2 and 3.

Table 1 Analysis based on general parameters

No	Requirement	Cloud computing	Fog computing	Dew computing
1	Goal	Providing services on demand	Make IoT more efficient	To achieve the potentiality of personal computers and cloud services
2	Peculiar feature	Providing scalable and measured resources on demand using Internet technologies	Proximity to end user, dense geographical distribution, mobility	Productive as well as cloud friendly cooperative services to users
3	Amount of data handle	Medium	Large	Low
4	Computing devices used	High configured computer (server) + Automation devices	Automation devices (sensors, controllers, chips, disks, network devices)	Computer
5	Database used	Huge sized	Large sized	Middle sized
6	Support IoE?	Yes	Yes	Yes
7	Eliminate bottleneck	No	Yes	Yes
8	Fault tolerant	No	Yes	Yes

Table 2 Analysis based on location parameters

No	Requirement	Cloud computing	Fog computing	Dew computing
1	Location of resource	Remote	At proximity of user/on edge of network	Right at user end/on the same machine
2	Location information available during data analytics?	Not available	Available	No need of location information
3	Remoteness between client and server	Numerous hops	One hop	On the same machine
4	Geo-distribution	Centralized	Distributed	Personalized
5	Mobility	Limited	Supported	Limited

Table 3 Analysis based on network parameters

No	Requirement	Cloud computing	Fog computing	Dew computing
1	Data traffic	High	Medium	Low
2	Service latency	High	Medium	Low
3	Satisfy need of IoT	No	Yes	Not proposed for IoT, but used in organizing IoT control
4	Internet or IoT	Internet	IoT	Internet
5	Number of nodes	Few	Large	One
6	Security level	Low	Medium	High
7	Internet connection required?	Yes	Yes	No
8	Delay jitter	High	Very low	Not present
9	Improve QoS	No	Yes	Yes
10	Scalability	No	Yes	Yes
11	Reliability	No	Yes	Yes
12	Barrage on data during routing	High probability	Very low probability	Very low probability
13	No of servers	Few	Large	One

4.2 Comparative Exploration of Cloud, Fog, and Dew Computing

See Table 4.

Table 4 Comparative exploration of cloud, fog and dew computing

No	Cloud computing	Fog computing	Dew computing
1	Processing of data applications is time consuming because of working from centralized cloud	Because of processing of data is done on the network edge, less time is required in operation	Dew works off line, but when Internet is available, data and applications are updated on the cloud. So it is very fast in processing
2	Each bit of data is sent to the centralized cloud which causes bandwidth problems	Relatively less number of bandwidth problem, as every bit of data is collected at some access point, instead of sending over cloud	No bandwidth is required in collection of data but when network is available, synchronization of data and applications done on cloud channel
3	Slow response time and scalability problems as a Result of depending servers that are located at remote places	It is possible to solve response time and scalability issue by placing tiny servers known as edge server in proximity of user	Good response time and no scalability problem
4	It is widely used in the business community to fulfill high computing demands on low cost using utility pricing model	It is preferable for batch processing jobs adopted by business world	It is used in everyday life. For example, integrated traffic control system of a town, which enable auto-adaptive traffic control behavior [9]

4.3 Technical Challenges of Dew Computing

As far as our knowledge is concerned, we are the one among the others to provide various future issues and challenges which may become obstacles for the adoption of dew computing and may also become new research direction. Here we list out the issues as follows:

1. Although dew computing will provide to user some services offline, the time for which will be in an incompatible state with the cloud, it is also one of the important concern. Intricacy of compatible matters will expand integrally with increasing number of users.
2. For synchronization of data on a local computer with cloud services, local machine has to run all the time, which consume too much energy.
3. It is required to design OS which implements and manages the collaborate feature of dew computing.
4. When more than one dew sites are created on a single dew server running on a local computer, there may be chances of conflicts for usage of available ports and other resources between dew sites, so it will raise the requirement for the development of new communication protocol transferring data between dew sites and remote cloud servers.

5. It is not safe to store user credentials in the database of dew server running on the local computer, because there may be chances of accessing a database of dew server by using some malicious software running on the local computer. So, database security is also one of the major concerns.
6. Dew site developer becomes bounded to use set of platforms and databases that are only dew capable. So that it does not allow much freedom in developing dew site. This leads to finding the solution of developing dew site independent of platform and database.
7. As time goes on, dew server will download more and more data which eventually cause available storage out of run, so there must be a requirement of developing a mechanism for replacement of downloaded content.
8. As dew servers must have to synchronize with cloud server periodically, hence there may be chances of out of synchronization related issues.

5 Conclusion

Dew computing is grounded on a micro service idea in vertically distributed computing classification. The ability to provide a web-surfing experience without an Internet connection is the realization of the distributed systems. This paper includes various fundamentals of a new concept of dew computing along with a comparative exploration of cloud computing, fog computing and dew computing, which can be used to understand strengths, limitations as well as applications of these paradigms. We have also discussed various future issues and challenges which may become obstacles for the adoption of dew computing and which may also provide a new direction of research. In summary, we can conclude that dew computing is closely connected to cloud computing. Dew computing which is supportive in perceiving the vigor of cloud computing is not isolated from cloud computing, but it is the interdependent part of cloud computing. Without cloud computing, dew computing would not be possible.

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