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Emerging Technologies in Software Systems

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ABSTRACT

A software system is a system of intercommunicating components based on software forming part of a computer systems. It has many more components such as specification, test results, end-user documentation, maintenance records It consists of several separate computer programs and associated configuration files, documentation, etc.[10], that operate together. The concept is used in the study of large and complex software, because it focuses on the major components of software and their interactions. This paper presents general computation trends and a particular set of emerging technologies to support the trends for software-reliant systems . Software-reliant Systems now tend to be highly distributed software systems, formed from constituent software systems that are operated and managed by different organizations. These Software are moving from a directed management structure[4] (in which constituent systems are integrated and built for a specific purpose) to a virtual one (in which there is no central authority or centrally agreed purpose). This shift is introducing a need for new technologies to deal with the lack of central authority or centrally agreed purpose. This paper includes an overview of emerging technologies like cloud computing , green computing[3] , mobile computing , grid computing , data intelligence over social computing for meeting these trends.

Keywords
Technologies , Cloud Computing , Grid computing , Social Computing

1. INTRODUCTION

Emerging technologies are technologies that are perceived as capable of changing the status quo. These technologies are generally new but include older technologies that are still controversial and relatively undeveloped in potential. As software becomes increasingly important to the everyday processes of the enterprise, developers are being relied on more than ever before to create new and exciting programs. A variety of new software trends will play a key role. Systems that relies heavily on software to accomplish its goal tend to be highly distributed software systems formed from constituent software that are operated and managed by separate organizations[12]. The purpose of this paper is to present an informal survey of technologies that are, or are likely to become, important for software-reliant Systems in response to current computing trends. This paper includes some general computing trends over the past few years and it also includes an overview of emerging technologies like cloud computing , green computing , mobile computing , grid computing , data intelligence over social computing for meeting these trends.

2. General Computing Trends

With the growing need for business agility and environmental awareness, several general computing trends are shaping the way that organizations are building systems to support their business and operational needs. These trends are discussed below:

2.1 Loose Coupling

Loose coupling is a low degree of dependence between system elements that potentially leads

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to high modifiability, because changes are localized. An abundance of technologies promote two types of loose coupling:

- **B**etween capabilities and the consumers of those capabilities to ease integration
- Between system elements that contain capabilities and the interfaces exposed to consumers of those capabilities such that implementation details are hidden from consumers .

2.2 Global Distribution of Hardware, Software, and People

Software systems are often built by multinational teams. Many organizations use off shoring as a way to reduce costs of software development. Large web-based systems often use distributed caching services for better response times. this trend requires greater coordination of distributed hardware, software, and people—as well as better technologies for fault detection and recovery in distributed systems.

2.3 Horizontal Integration and Convergence

A single manufacturer controls platform, middleware, and applications, bundling them into solutions for delivery to customers. Conversely, in horizontal integration, applications are expected to run on any middleware and middleware is expected to run on any platform. In addition, applications are expected to exchange data seamlessly. An example of horizontal integration is seen in the way that a Smartphone user can provide address data that can be used to invoke a map application and the map application can then invoke a "restaurant finder" application.

2.4 Virtualization

Virtualization in general is the abstraction of computing resources. Common forms of virtualization include :

- **Network virtualization :-** network virtualization has referred to the division of available bandwidth into channels that can be assigned to a particular resource in real time.

- **Storage virtualization :**-This type of virtualization involves the combining of physical storage devices into what appears to be a single storage device (e.g., a SAN or storage area network).

- **Server virtualization: -** This type involves the hiding of server resources (number and identity of individual physical servers, processors, and operating systems) from server users (e.g., VMs or virtual machines).

2.5 Commoditization of Technology

Most people have access to computers, many organizations offer online services, and advances in handheld devices are making it possible for people to have access to these services at any time. In addition, because of commoditization, it is becoming difficult for technology vendors to differentiate their products or to hold large market shares for a long period of time. To sustain market share, technology vendors have to add value through customizing their products or create new products to continually differentiate themselves from their competitors.

2.6 End-User Empowerment

End users want access to large amounts of information in real time. Because of technology commoditization, and because technology is getting easier to use, end users are also tending to be more competent with technology. End users want technologies that will help them get access to this information and process it without having to wait for developers to create the proper programs and reports.

2.7 Large-Scale Data Mining

Data is everywhere. There is more and more data to analyze, process, and transform into useful information in real time. Data warehouses and business intelligence are common products and technologies in industry. There is active research in this area for mining of business, scientific, and practically any other type of large heterogeneous data sets[17].

2.9 Multi-Core and Parallelization

Multi-core processors have two or more independent cores in order to process multiple

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instructions in parallel. Multi-core processing seeks to improve performance through this parallelism, instead of by trying to make individual cores faster. However, the performance gained by use of multi-core processors highly depends on software algorithms and implementation that can be parallelized.

3. Emerging Technologies

This section provides a list of technologies that are emerging to meet the computing :

3.1 Cloud Computing

Cloud computing is a distributed computing paradigm that focuses on providing users with access to scalable and virtualized hardware or software infrastructure over the internet. Based on capabilities, there are three types of cloud computing implementations:

1. Infrastructure as a Service (IaaS)
IaaS is mainly computational infrastructure available over the internet, such as compute cycles and storage, which can be utilized in the same way as internally owned resources. IaaS providers enforce minimal restrictions on their consumers to allow them maximum control Examples of commercial IaaS providers include Amazon Elastic Compute Cloud (EC2), Amazon Simple Storage Solution (S3), IBM Computing on Demand (CoD), and Microsoft Live Mesh .

2. Platform as a Service (PaaS)
PaaS refers to application development platforms—hardware and software components—that enable developers to leverage the resources of established organizations in order to create and host applications of a larger scale than an individual or small organization would be able to handle. Services include, but are not limited to, software installation and configuration, resource scaling, platform maintenance and upgrading. Examples of commercial PaaS providers include Akamai EdgePlatform, Force.com, Google App Engine, Microsoft Azure Services Platform, and Yahoo! Open Strategy (Y!OS) .

3. Software as a Service (SaaS)
SaaS focuses on providing users with business-specific capabilities—hardware and software applications. In general, SaaS is a model of software deployment in which a provider li-censes an application to customers for use as a service on demand. Examples of commercial SaaS providers include Google Apps, Salesforce.com, and Zoho.

3.1.1 Related Technologies

- **Grid Computing** : Grid computing is a form of distributed computing based on “a hardware and software infra-structure that provides dependable, consistent, pervasive, and inexpensive access to high-end computational capabilities” [15]. It is very similar to IaaS implementations of cloud computing. The main difference is that cloud computing adds an on-demand provisioning aspect and greater resource management capabilities.
- **Utility Computing: Utility** computing is a service provisioning model in which consumers use services on a pay-per-use basis. Utility computing is also similar to IaaS implementations of cloud computing [14]. However, the main difference is that utility computing is simply a “re-sources for rent” model as opposed to the much broader approach defined by cloud computing for designing, building, deploying, and running applications in the cloud.
- **Containerized Data Centres** Containerized data centres are portable data centres that contain all the power and cooling equipment to run a data centre in an energy-efficient manner. Some industry players in this growing market are Google, HP, IBM, Rackable Systems, Sun, and Verari Systems [16].

3.2 Data Intelligence

Data intelligence is the mining, aggregation, fusion, selection, search, and exploitation of huge volumes of disparate data coming from diverse sources such as databases, events, sensor net-works, human observation, human judgment, RSS (or really simple syndication) feeds, and GPS (global positioning system) data. Data-centric software systems may rely

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on data intelligence techniques to operate on data from heterogeneous, constituent systems. Software Engineers, in addition to concentrating on data processing algorithm complexity, will have to focus on data transformation and mediation algorithms that can be just as complex, especially when dealing with disparate data models.

3.2.1 Related Technologies

MapReduce
MapReduce is a software framework that was made popular by Google to support distributed computing on large data sets on clusters of computers. It enables a big task (such as data processing) to be divided into discrete tasks that can be done in parallel, by means of map and reduce functions that are applied to the data. MapReduce is an emerging technology to process large amounts of data and solve complex data analytics problems .

3.4 End-User Programming (EUP)

End-user programming (EUP) describes the practice where end users write computer programs to satisfy a specific need, even though they have not necessarily been taught how to write code in conventional programming languages [11]. EUP has been around for a while, in the form of shell scripts and Excel spreadsheets that allow users to quickly automate tasks. However, the advent of the internet, and the recent explosion in the availability of web technologies, has made it much easier for end users to produce and customize software. From the end-user perspective, the construction of these applications can be done simply through a set of drag-and-drop operations that pull together capabilities from different sources to build a desired functionality.

3.4.1 Related Technologies

- **Intentional-Programming:-** Intentional programming is a concept that was introduced by Microsoft Research in the early 1990s [3]. The basic idea is that a software designer or programmer represents the elements of a particular domain as “intents” that correspond to high-level programming constructs. there are tools that take these composed intents and translate them into lower-level programming languages.

- **Edge Programming :-** Edge programming refers to the decentralized programming of complex systems. The main concept is that programming happens at the edge of these complex systems.
- **Gesture Programming :-** Gesture Programming is a form of programming by human demonstration. The main concept is the capture of gestures that are translated via tools into code. A gesture could be a particular hand movement, the movement of a mouse, or the pressing an area of a touch screen [13]

3.5 Green Computing

Green computing refers to the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems—such as monitors, printers, storage devices, and networking and communications systems—efficiently and effectively with minimal or no impact on the environment [12]. Software-related green practices that lead to reduced power and cooling include Algorithmic efficiency, which translates into code that optimizes computational resource usage such as memory consumption and execution speed .

3.5.1Related Technologies

- **Energy-Efficient Computing :-** This concept refers to the design, development, and use of computers and computer components targeted at optimized energy consumption.
- **Smart Grid :-**The Smart Grid is a modernization project for the United States electricity grid. The main idea is the overlay of the electricity distribution grid with an information and metering system [5]. An advantage of the Smart Grid approach is two-way digital communication between the grid and its consumers.

3.6 Mobile Computing

Mobile computing is a generic term that describes the possibility to use computing

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technology “on the go” through devices such as Smart Phones, PDAs (personal digital assistants), portable computers, and wearable computers. [1]. Mobile users expect seamless access to information anytime, anywhere, and from any device. The concept of application stores or “app stores” will become a mixed-approach to the delivery of capabilities where application logic will be downloaded and installed on mobile devices with reach-back capabilities into other constituent systems such as enterprise systems.

3.6.1 Related Technologies

- **Location-Based Services** :-Location-based services take advantage of capabilities of mobile devices and the mobile network to determine a user’s location in order to deliver services that are tailored to the user’s location. Location-based services are used in applications such as social applications for finding close friends or restaurants, transportation applications to track vehicles or parcels, and e-commerce applications to recommend stores or coupons in the area or emergency systems to inform of problems in the area.
- **Physical Computing :**-Physical computing refers to systems that combine hardware and software such that systems can sense and respond to the physical world. Common elements in physical computing are sensors, microcontrollers, and electro-mechanical control devices. Other elements include the support for computer vision, motion detection, and voice recognition capabilities [4].

3.7 Opportunistic Networks

Opportunistic networks, or oppnets, are different from traditional networks because they are not pre-designed in terms of number and location of nodes. Link performance in oppnets is often highly variable [8].

3.7.1Related Terms and Technologies

Mobile Ad-Hoc Network (MANET)

A MANET is a self-configuring network in which nodes are mobile devices connected by wireless links [7]. Oppnets are considered specializations of MANETs. The main differences between oppnets and MANETs are that in MANETs Communication is usually synchronous.

Unstructured Peer-to-Peer (P2P) Network

P2P networks are distributed networks in which each node shares resources such as CPU cycles, storage, and bandwidth with other nodes in the network, without the need for a central coordinator. All nodes are both suppliers and consumers of resources. Typically, an overlay layer is created on top of the network layer for connectivity, routing, and messaging[9].

Wireless Sensor Network

A wireless sensor network is another form of ad-hoc network in which nodes cooperate to monitor physical or environmental conditions, such as temperature, sound, vibration, light intensity, motion, or proximity to objects [6].

Cognitive Network

A cognitive network is a form of ad-hoc, self-organizing network that has a cognitive process at the node and network levels. The cognitive process is used for perceiving current network conditions and then planning, acting, and deciding on those conditions in order to meet certain goals [2]. Cognitive networks therefore have the capability to adapt in response to certain conditions, based on prior reasoning and acquired knowledge.

3.8 Social Computing

Social computing is a area of computer science that is concerned with the intersection of social behaviour and computational systems. The better-known side of social computing is related to social software such as wikis, blogs, instant messaging, and collaboration tools .In socially inspired computing, groups of people carry out the computation; examples of this type of social computing include :

- **Collaborative Filtering** :-Collaborative filtering refers to mechanisms for making automated predictions for a user based on similar data from other users.

- **Online Auctions** :- Online auctions enable the electronic selling and buying of products and services via auction sites such as eBay (http://www.ebay.com).
- **Prediction Markets :-**Prediction markets are specialized, small-scale financial markets operated to predict future events Examples of prediction market sites are InTrade (http://www.intrade.com) .

3.8.1Related Terms and Technologies

- **Enterprise 2.0** :- Enterprise 2.0 refers to the use of social computing within the enterprise. The scope of enterprise in this context incorporates business partners as well as customers and the public [10].
- **Social Information Processing :-** Social Information Processing is another term that refers to the collective creation, annotation, evaluation, and sharing of content via social computing tools and technologies.

4. Conclusion

This Paper discusses computing trends and emerging technologies, as they relate to software system environments. Emerging technologies can be used in combination (as well as in conjunction with existing technologies) to enable the highly distributed, heterogeneous, loosely coupled characteristics of Softwares and their constituent systems. In addition, while extensive, the list of emerging technologies presented in this paper is not meant to be inclusive and will change over time. Further, as software system move from a directed to a virtual management structure, more complex technologies will be necessary to deal with problems stemming from the lack of central authority or centrally agreed purpose. However, not every System must be a fully virtual system, and not every system must be fully-directed to be successful the focus on emerging technologies in this report should not be taken to imply that solving problems begins with choosing a technology. It must be acknowledged that many problems are behavioural and not solvable with technology. Where technology adoption can provide a solution in a software-reliant system environment (really any system environment), the key is to start with the problem and then seek technologies that match it and fit the organizational context.

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