The Impact of Cloud Computing on Web 2.0

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Abstract

The Web, which began as a global hypertext system, has evolved into a distributed application platform, in which the application logic and user interface are two separate entities. As we move toward the next generation Web platform, Web 2.0, from Web content to Web of applications, the bulk of user data and applications will reside in the network cloud.

Web applications are a critical part of Internet infrastructure and are used for banking, email, financial management, online shopping, auctions, social networking, and the like. Corporations such as Amazon, Google, Microsoft, and Yahoo expend considerable effort to keep up with the growing demand for communication-heavy Internet services which require image and video sharing, social networking, and searching. There is a shift from displaying information using locally installed programs towards displaying information on a browser. For example, the Google Docs word processor and spreadsheet is already visible when using simple e-mail services such as Google Gmail. In this paper, we emphasize the connection between cloud computing and what is now called Web 2.0; we list the advantages of cloud computing, and survey challenges and issues related to cloud computing.

Keywords: *browser, cloud computing, network cloud, web applications, Web 2.0*

I. INTRODUCTION

Web applications are distributed client-server applications in which a Web browser provides the user interface, the client browser and the server side exchange protocol messages represented as HTTP requests and responses. Due to current implementation methods, it is difficult to ascertain if a certain application enforces adequately the confidentiality or integrity of the information it manipulates. Indeed, 69% of all Internet vulnerabilities are related to Web applications [1].

Browsers are the main engine of the Internet experience, and subsequently have encountered the most security problems that plague a personal computer and the network alike. Early browsers started with cookies and simple encryption mechanism (if any) to ease accessing the same webpage, and have enabled the start of e-commerce. Cookies, an essential mechanism for many websites, store text data about a user or a session, have a maximum size of 4KB, and can be erased using a dialog box. Unfortunately, they can be stolen, forged, or abused for denial-of-service attacks [2]. Today's browsers have more sophisticated features – Flash cookies and media display (e.g., animation, audio, and video). A Flash cookie or Local Shared Object (LSO) are part of Adobe Flash Player. Such a cookie can have up to 100 K bytes, and cannot be easily erased [3]. It is the browser's responsibility to warn users about sites with invalid HTTPS certificates, URL addresses that are phished, or download non-signed files. The general trend in latest browser versions is to block access to non-trusted sites and require explicit over-ride action from the user. Firefox and Google's Chrome browser have implemented *sandboxes*, in which the code executed by the browser is run with limited resources and with limited access to the user's local data [6]. IE uses a zone-based security model in which the security features depend on the site being accessed. In Vista, this is called *protected mode*, and limits browser access privileges.

The vast amount of content available via URLs is now accessible by highly reactive user interfaces via CSS, HTML, and JavaScript. Most browsers allow JavaScript code to issue its own HTTP requests, a functionality used in the AJAX (Asynchronous JavaScript and XML) development approach [4]. Using AJAX, a web page can contain executable code that connects your computer to a server and the virtual connection bypasses the security mechanism integrated into your browser. The underlying mechanism of AJAX is the function XMLHTTPRequest [5], which allows a remote procedure call to a server on the Internet. The output of that call is then used in the context of the webpage. This function, initially introduced by Microsoft IE is now supported by open-source projects such as Firefox, Safari, and Opera.

Web 2.0 is the result of applying Web technologies to the Web, in which the user has final control over the visual presentation and user interaction. For example, weather forecasts were available on Web 1.0, but in Web 2.0 such weather forecasts are integrated into the context of user tasks (such as travel reservations, for example) using XMLHTTPRequest and by an asynchronous refresh through JavaScript callbacks. Web gadgets such as specialized browsers automate away a large part of the user actions when navigating through websites and directly embed the target webpage into the user browser. Browsing the Web on small devices (mobile phones, PDAs) relies on Web API, Rich Site Summaries (RSS), and Atom feeds [7]. Instead of exporting the entire website to the browser, a set of articles and summaries is extracted. Such web gadgets provide specialized browsing functionality and are hosted in a variety of environments ranging from server-side containers to client-end user. Users can drastically alter the interaction with Web content through scripting. Greasemonkey, a Firefox extension has enabled users to attach arbitrary scripts to Web content [8]. To enable scripting (HTML Document Object Model) Google offers Google-AxsJAX [9] – a JavaScript library which helps developers to enhance accessibility for users with special needs (such as hearing and visual impairment) [10],[11].A new paradigm of computing has started to evolve in recent times called *cloud computing*. In this environment, the applications, data, and software no longer exist on the client side, instead they are treated as abstract services and reside in a cloud. A cloud can be a network of nodes which exist on the server side [12].

The rest of the paper is organized as follows. In Section 2 we describe cloud computing. In Section 3 we discuss advantages and issues related to cloud computing. We further elaborate on important issue of energy consumption and data servers in Section 4 and we conclude the paper in Section 5.

II. WEB APPLICATIONS AND CLOUD COMPUTING

Cloud computing is a new method to add capabilities to a computer on the fly, without licensing new software, investing in new hardware or infrastructure, or training new personnel. Applications are purchased, licensed and run over the network instead of a user's desktop. It provides common business applications online that are accessed from a web browser, while the software and data are stored on the servers. The services are accessible anywhere in the world, with the cloud appearing as a single point of access for all the computing needs of consumers. New advances in processors, virtualization technology, disk storage, broadband Internet access and fast, inexpensive servers have all combined to make cloud computing a compelling paradigm. Cloud computing allows users and companies to pay for and use the software and storage that they need, when they need them and, as wireless broadband connection options grow, where they need them. This type of software deployment is called Software as a Service (SaaS) [13]. (The acronym "SaaS" was coined in February 2001 in a white paper [14].)

In general for a new paradigm to mature and make its impact, it takes a number of years, perhaps around 10-15 years. In the case of cloud computing, it is not an entirely new shift in the way communication and data storage are managed. Many of the underlying technologies such as grid computing, peer-to-peer computing have a direct contribution to cloud computing. In order to understand what type of components exist in a cloud, we first need to enumerate the typical components of an application development. The components (excluding human resources) are: (i) infrastructure resources, (ii) software resources, (iii) application resources, and (iv) business processes [15]. In the cloud computing paradigm, all of the above components are treated as services, and are in the "cloud"; users do not have to invest or pay huge licensing fees to own any of the above resources. Infrastructure resources are storage, computing power, and so forth, which can take advantage of already existing technologies such as *grid computing*. The software resources include application servers, database servers, IDE, and so on. The application resources include applications deployed as SaaS (for example Google docs).

The business process resources can be a standard set of common business utilities given as services to clients. An example is ERP software such as SAP and Oracle providing standard business workflows in the cloud. Some of the major players in cloud computing are Amazon[16], Google [17], IBM [18], Joyent [19], Microsoft [20], and SalesForce [21].

Current cloud computing services are storage services, spam filtering, performing applications in high level programming languages such as Java and Python, or the use of some kind of database. In 2008 Google has released Google App Engine [17], a cloud-based platform used for running applications by both individuals and businesses. Microsoft has released Windows Azure [20], a cloud-based operating system, for the Community Technology Preview. Amazon's Elastic Compute Cloud (EC2) [16] is a web service cloud that provides expandable computing power and storage for consumers. IBM's CloudBurst [18] is a self contained, pre-packaged cloud that includes hardware, software, applications, and middleware for faster application development and deployment turn around time.

III. ADVANTAGES AND ISSUES RELATED TO CLOUD COMPUTING

There are several advantages to cloud computing and some of them are presented below:

- **Price:** It is easy to see that start-up enterprise companies do not have to invest huge sums of money into setting up infrastructure such as huge application servers, data servers, database administrators, people resources for managing such critical systems including back up and recovery, etc. Instead, enterprise companies pay for services based on usage.
- **Simplicity:** It is simple to use and set up all the services without having to worry about resource management, and other hassles that come with infrastructure set up and management
- **Reliability:** Network and data access are guaranteed to be reliably maintained as the service providers are experts in maintaining the infrastructure, and such reliability is backed by some kind of "money back guarantees" or penalties for the providers, in the event if they have a down time.
- **Flexibility:** Service consumers have the flexibility to "outsource" parts of the infrastructure and can still maintain to some extent proprietary data at their own site
- **Focus:** Service consumers can focus on the important details of running their business rather than worrying about infrastructure set up. This is especially relevant to start up and mid size companies.
- **Collaboration:** Since all the applications are on the cloud, it becomes a natural fit for consumers to effectively collaborate on a common project or application.

There are several issues related to cloud computing and some of them are presented next

Privacy and Security

How exactly are the security policies enforced? How strictly are privacy issues handled? What about access control policies? While cloud computing allows users to add more capacity, more services, and seamless software patches, despite the existence of encryption and access-control software, some organizations will be reluctant to put their proprietary data in a public-access cloud. From a practical point of view, does the data still remain proprietary if it is stored on a public server? What laws will protect such data in case of software piracy? Anyone who stores data on the memory bank could theoretically access locations outside their space. How is security of the data handled in this case? From both privacy and security points of view, the more restricted the access to the data is, the easier it is to protect it. In order to ensure fast access to data stored and to prevent the loss of data in case of failure of one data center, the users' data may be mirrored on two or more sites, making it even more vulnerable. On the other side, grouping such a massive amount of data in one physical location makes it prone to catastrophic failures (due to natural or man-made disasters, for example). To prevent such large-scale failures, the data should be stored on sites that are geographically far apart.

Emergency Situations

During a massive catastrophic event will the continuity of services be guaranteed? It is understandable that the time to access such data and/or services will be longer than usual, but are there certain upper bounds on the delay time (and for what period of time)?

Standards

There need to be standards governing regulations which ensure uniformity in how the applications are accessed, stored, and modified. Otherwise (for example if the service provider were to go out of business) consumers have fewer options to move their entire operations because of cost considerations. However, with standards, enterprises will have neutrality in picking the service provider. Yet, at this time of this writing, none of the entities have started describing such standards. To be effective, major players need to join to agree on standards.

Legality

Who owns the enterprise data? Do the service providers also have ownership? Even if non-disclosure agreements are signed, these might be waived when government agencies are involved. This begs the question whether the client might be ready to forgo the rights of their data. As well, issues arise regarding intellectual property rights when data and services are hosted by a third party site.

Mentality

For wide acceptance of cloud computing it requires consumers to relinquish the ownership mentality some extent and to develop a somewhat broader mindset. Indeed once service for cloud computing is accepted, it will be hard to go back to older ways.

Pricing Theory

If prices do become prohibitive then pricing theories and mechanisms need to be revisited certainly in the long run. Are the service providers willing to give discounts based on length of usage, frequency of usage, etc? It is hard to impose limits on a free market where the survival of the company depends on cloud computing services employed.

IV. DATA SERVERS AND MANAGING ENERGY CONSUMPTION

As of 2009 the majority of cloud computing infrastructure consists of reliable services delivered through data centers and built on servers with different levels of virtualization technologies. Data centers are the physical manifestation of cloud computing. The idea is to move computing and storage from the user's desktop or laptop to remote locations where a huge collection of servers, storage systems, and network equipment can form a seamless infrastructure for applications and storage.

Data centers are warehouse-like buildings with thousands of servers. They are built by the Internet giants such as Amazon, Google, Microsoft, Yahoo, based on affordable land, readily available fiber-optic connectivity, abundant water, inexpensive electricity, and relative good weather (especially cooler temperature year-round). Today, most advanced data centers store tens of thousands of servers, perhaps reaching a million in the not so distant future. Each server has the dimension of a pizza box and contains one or more processors, memory, a hard-disk, a network interface, a power supply, and a fan. A rack holds up to 400 such blade servers, slid vertically like books on a shelf. Vendors like IBM, HP, Sun Microsystems, Rackable Systems, Verari Systems, use containers to house servers, acting as building blocks for a data center. Sun Microsystems was the first to offer a container module (see Fig. 1). FOREST of Verari Systems houses 1400 blade servers, can use either self-contained or chilled water cooling, and uses 400 kW. ICE Cube of Rackable Systems has a self-contained cooling system, allowing the containers to handle a power density of 16 kW/m^2, DC power. Chicago facility of Microsoft has a hybrid design: 200 units packed at 45 degree angle, similar to RV campsites.

Fig. 1. Sun Microsystems' MD S20 includes 280 blade servers, monitoring and control equipment, using a total of 187.5 kW [26]

Energy efficiency reduces greenhouse gas emissions, saves money and water. Power plants require an average of two gallons of water per kW-hour electricity produced. In 2007, US Environmental Protection Agency (EPA) confirmed that the data centers spend almost half of their energy consumption on power converters and cooling systems for the servers [22],[23].

The computing components - the CPUs and the memory - receives around two thirds of the total energy consumed by a server, the rest is lost. A major loss occurs when converting electricity from AC (power outlet) to a set of low DC voltages. The voltage regulator circuitry - on the motherboard - converts further the low DC voltages to the voltages required by the microchips. The data center is supplied by high-voltage AC that needs to be converted to the standard 120 or 208, with up to 9% loss. Additionally, the components of a server use DC, so an AC-to-DC conversion is needed, that generates additional loss. Distributing high-voltage DC power throughout the data center may reduce the loss.

The new Nehalem servers of Intel will have voltage regulators, software tools to monitor power consumption (e.g. Dynamic Power Node Manager), a power-efficient motherboard that uses 85W instead of 115 W in idle mode, and Xeon processors (due to be released in 2009 [24].) Also Intel is planning to re-organize the motherboards in a way to group together the "hot" components (components that use the most power). To manage power better, Microsoft plans to adjust power supply by closely monitoring the servers' activity (a dual-processor server demands 200W at peak performance, but less if it is idle). Google uses stripped-down desktops: cheap computers, with unnecessary components removed (such as graphics chips) and fans running only as necessary to keep the server temperature below a threshold. Machines are equipped with high-efficiency power supplies and variable-speed fans. Google also considers a new CPU power-management feature called dynamic voltage/frequency scaling. This reduces the processor's voltage or frequency during certain periods - for example, when results are not needed instantaneously.

Still, better designs are needed to improve the power needs. The Climate Saver Computing Initiative is a group of industry partners which includes Intel and Google. The initiative advocates efficient computing and is committed to cut the energy used by computers in half by 2010.

V. CONCLUSION

Web 2.0 is the result of applying Web technologies to the Web, in which the user has final control over the visual presentation and user interaction. As we move toward the next generation Web platform referred to as Web 2.0 – from Web content to Web of applications – the bulk of user data and applications will reside in the network cloud. Cloud computing is currently gaining popularity as an inexpensive way of providing storage and software. A new paradigm of computing has started to evolve in recent times called cloud computing. As wireless broadband connection options grow cloud computing allows users and companies to pay for and use the software and storage as needed. In this environment, applications, data, and software no longer exist on the client side, instead they are treated as abstract services and reside in a cloud. A cloud can be a network of nodes that are located on the server side. Many of the underlying technologies such as grid computing, peer-to-peer computing have a direct contribution to cloud computing. We have emphasized the connection between cloud computing and what is now called Web 2.0. We have listed advantages of cloud computing and have highlighted challenges with cloud computing.

Special software tools like virtualization allow a single machine to be seen as multiple independent machines. In this way, a server can increase its utilization to up to 80%, compared to the average of 16% obtained currently. Self-management of such servers will involve controlling power usage, sharing of the distributed data, and failure detection and correction. Open standards and open source software are also critical to the growth of cloud computing. Ubuntu, the Linux distribution maintained by Canonical, plans to include support for some cloud computing applications [25]. It is planned to add Elastic Compute Cloud (EC2), the cloud computing service run by Amazon Web Services. This will enable Linux applications, and a portfolio of standard Amazon Machine Images (AMIs), and allow enterprises to create EC2-style computing clouds in their own data centers by using a new open-source tool called Eucalyptus.

Many companies are moving forward with the intention of building easy to use clouds. There is tremendous potential for consumers to exploit the cloud computing technology. With that in mind, in this paper we have given an introduction to the technology and discussed the advantages as well as the challenges associated with it. We hope to have put forward social and technological challenges involved in using cloud computing technology.

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