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# Cloud Computing for Network Management in the Challenged Environments

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**Abstract:** Information Technology (IT) solutions for businesses and enterprise are increasingly becoming service oriented. Instead of system management tools, the IT sector has started offering service management tools that provide user-friendly solutions and require less human effort. The service management takes into consideration the customers' viewpoint of the IT services, and hence are preferred by technical and non-technical users alike. On the other hand, the concept of cloud computing is also gaining immense popularity because it also adds significant value to businesses. Cloud computing ensures high scalability and availability of the infrastructure that may not necessarily belong to the business itself. This paper attempts to develop an association between cloud computing and service management techniques. It starts with an overview of both and explores the opportunities and challenges that are faced while merging these two together.

Secondly, this paper explores the application of the clouds in challenged environments. It introduces vehicular communication as a potential application area of cloud computing.

**Keywords: Cloud Computing, Grid Computing IaaS, ITSM, SaaS, Vehicular Communication.**

## INTRODUCTION

IT Service Management (ITSM) has emerged as an innovative trend in the IT industry. ITSM generally requires the IT service providers to consider a customer-eye view of the services they provide. Instead of talking about the systems and technical aspects of these services, ITSM focuses more on the quality of products and services as seen by the users, and their monitoring and management. Several software packages are switching towards the so-called ITSM framework concept. IBM Tivoli (Joshi *et al.,* 2007), for instance, is a complete management framework that provides a set of services to monitor and update the information systems. This provides integrated service management which comes with various tools such as the storage manager, monitor, asset manager, and security and risk management modules etc. **(Fig, 1)** shows the architectural basics of the IBM's Tivoli Storage Manager (TSM), which shows the storage devices and the backup-archives. The main advantage of integrated service management is to get the ability "to do more with less". The business resources are always subject to various constraints. ITSM tools allow the businesses to free some of their resources that are otherwise distributed inefficiently for the same purpose. The monitoring ability associated with the ITSM allows proactive decision making and early diagnosis of the problem. This significantly reduces the number of service complains that are routinely reported via the help desk.

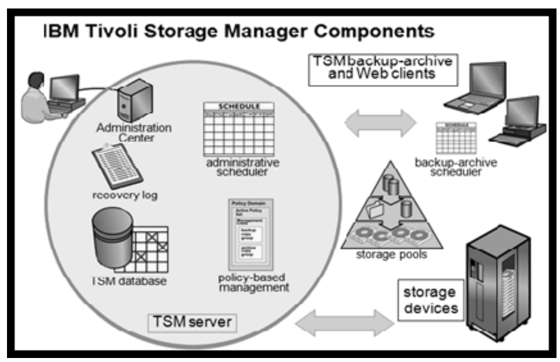


**Fig. 1: Architecture of IBM Tivoli Storage Manager**

Software as a Service (SaaS) is another relevant trend in the ITSM that allows the use of software to manage the networked components for an enterprise. The main idea is to move away from the legacy use of software and make it manageable by the non-experts. Front Range Solutions is one of the IT services providers that have recently switched to the SaaS environments. This allows them to increase the services they offer to their customers. Because SaaS environments offer centralized software support, any change in the main software does not require the installation of separate patches and codes at individual network nodes. Note that ITSM provides means to interconnect the resources of an organization and provides a central point of operation.

While this increases the organizational efficiency, it does not provide means to increase the scalability of the resources and their availability. In these lines, the introduction of cloud computing can drastically increase the overall performance of the ITSM thus improving the quality of service offered to the customers. The concept of cloud computing is fundamentally derived from the "Infrastructure as a Service" (IaaS) idea. The main idea is to rent the hardware (servers and processors etc) from service providers instead of purchasing them. This allows the businesses to increase or decrease the computational power as per need.

The rest of this paper is organized as follows. Section II introduces cloud computing highlights the associated issues and compares it with grid computing. Section III develops a link between the legacy ITSM and cloud computing concepts. In Section IV, vehicular communication has been introduced and the application of cloud computing in this context is highlighted. This paper concluded in Section V while the acknowledgement and references are given at the end of the paper.

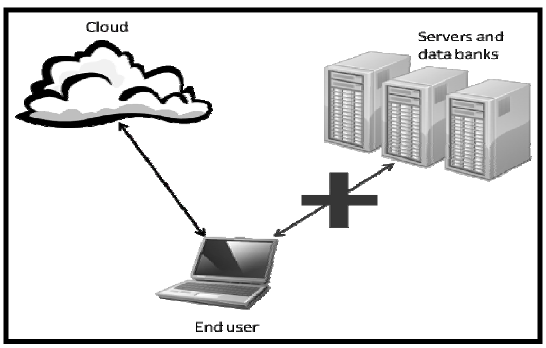


**Fig. 2: The end user stores data in the cloud instead of the dedicated servers.**

## METHOD – Cloud Computing

Cloud computing is a method of using the resources such as databases, servers and even the processors as services in a pay-as-you-go manner. As mentioned previously in Section I, cloud computing revolves around the concept of IaaS in which the storage infrastructure may be used as a service instead of dedicated hardware. Enterprises and businesses can use cloud computing to store and retrieve data without having to own the servers containing this data (Mishra, 2010). In other words, cloud computing allows the users to rent a server when need arises, pay the bill for the time the server is used and release it when it is no longer required. The billing mechanism may make use of the amount of storage used instead of the usage time. Other billing mechanisms may also be preferred by different cloud service providers.

The cloud service providers offer not only software for data transaction but their own personal hardware for data storage (Zhang *et al.,* 2010). Figure 2 shows that the user stores and retrieves data from the "clouds" instead of personal servers and data banks. The notion of cloud refers to the fact that the location at which the data is stored is irrelevant as long as the data is retrievable at all times. Since enterprises no longer need to have their own dedicated servers and data banks, cloud computing is a cost effective way of handling large volumes of data. Not only cost, the IT professionals save themselves from the hassle of installing and managing hardware, and instead focus on services that matter more (Zhang *et al.,* 2010b).

Cloud computing comes with two distinct advantages. One is the scalability, which indirectly refers to the ability of handling large volumes of data without too many resources. For example, when a website begins to serve large number of users, it requires larger data banks to keep the service in flow. Without cloud computing, the web designers would require to scale up their site by adding servers and storage media. Instead of dealing with traffic by installing more hardware, cloud computing allows instant scalability without having to purchase the resources. The second big advantage of cloud computing is availability of resources. In the same website example, arranging and installing new servers to meet large data traffic requires time and effort. During this time, the website would fail to serve the customers, which significantly reduces the quality of service available to the end users. Using cloud computing, the additional storage capacity can be acquired instantly, thus allowing extensions in storage and processing capacity that is actually seamless to the end user.

### *A. Cloud Computing versus Grid Computing*

Cloud computing is actually an evolved version of grid computing. Grid computing is also concerned with making external hardware available to users based on certain billing mechanism. However, in grid computing, a fixed number of resources are allocated that may not be sent back to the grid if they are not in use. In this sense, cloud computing gets rid of the problem of "over provisioning" of resources to the end user (Zhang *et al.,* 2010). Although not implied, but the notion of cloud computing is increasingly used to highlight the cloud's ability to hold a large volume of data whenever required. Grid computing, on the other hand, offers the computation capabilities to the end users in addition to the storage space. The fundamental difference between cloud and grid computing is that the former allocates the resources to the end user, while in grid computing, the end user assigns a big task to the grid. The grid is then responsible to carry out an otherwise huge task that may not be performed with smaller hardware resources. Cloud computing, however, only reserves resources and leaves the rest to the end user.

### *B. Issues with Cloud Computing*

The concept of cloud computing is a comparatively new one. Famous industrial names are gradually starting to offer cloud services. The North Carolina (NC) cloud (Vouk, 2008) provides computing services to its various campuses. It is built on IBM equipment and uses several management nodes in the cloud that share the utilities among the end users. Although there is an increasing interest in cloud computing, it still faces some serious research issues. Probably the biggest one of them is the security. Since the cloud is shared by multiple organizations and enterprises, integrity and privacy measures must be highly robust. (Jensen *et al.*, 2009) have studied various vulnerabilities in the security mechanisms of cloud computing. In particular, the XML-based authentication (signature and encryption) is subject to the wrapping attacks, in which the original message sent can be eavesdropped and altered. The malicious content can then be sent to the cloud that can comprise the security mechanism. In the web browser based usage of cloud, one of the main forms for authentications is via the Transport Layer Security (TLS). TLS itself has several vulnerabilities that are highlighted in (Jensen *et al.*, 2009). Therefore, security of the clouds still offers various venues for future research. Apart from the security issues, the demand and supply management of the cloud resources is also important. (Vouk 2008) have studied the demand of cloud services through a time period of 4 years. Since the NC cloud is dedicated to offer services to the academic units, the peak demand periods are the semester times throughout academic year. One important research challenge is therefore the distribution cloud resources during peak demand periods.

## DISCUSSION

*A. Integrating Cloud Computing with ITSM*

As mentioned earlier, cloud computing and ITSM both aim at improving the services offered to the customer. **(Fig. 3)** shows Campus Service Impact Analysis (CSIA) architecture as envisaged by Wan and Chee in (Zhang *et al.,* 2010b). CSIA is basically a monitoring tool that keeps track of the service impact and specifically highlights the services affected and their respective impact levels. This helps the service managers to react in a suitable way without involving the helpdesk. This may be considered as a decent example of ITSM systems and tools that specifically target the monitoring aspect of an enterprise. Note that the server portion of the ITSM has been circled in Figure 3, which is monitored in addition to the networking components. We believe that cloud computing can be merged with ITSM by replacing these servers with clouds. Instead of storing data on the local servers, the same task may be assigned to the cloud to attain larger scalability. Not only does this reduce the costs and effort in installing and managing local servers, it also reduces the number of systems to be monitored. If the cloud replaces the local servers, they may no longer have to be monitored.

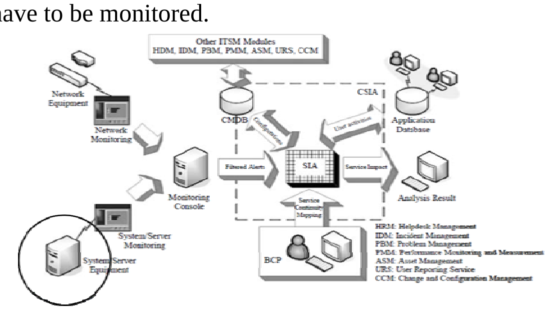


**Fig. 3: Replacing servers with clouds in the ITSM architecture discussed in (Zhang *et al.*, 2010b).**

*B. Vehicular Communications*

The Intelligent Transportation System (ITS) (Joseph, 2006) has introduced the idea of enabling vehicles to communicate with each other for improving on road safety for passengers. Vehicular communication is concerned with the use of Information and Communication Technologies (ICT) for data exchange between the vehicles and between vehicle and roadside base stations. The idea is not completely new because it existed in the form of telematics previously; however, the development of small-sized low-power communication devices has boosted research in this domain.

The ongoing research in vehicular communication explores various different directions ranging from throughput, latency, modes of communication, standardization, etc. The debate as to which communication technology best suits the vehicular context is also ongoing. Various previous works have studied WiMAX, cellular, Wi-Fi (IEEE 802.11 networks) and even Bluetooth for vehicular communications. The use of 802.11 networks in vehicular communications is beneficial in two ways. One, they support high throughput hence can allow quicker communication between the vehicles and between the vehicles and roadside infrastructure. Secondly, several cities across most of the developed world already contain numerous 802.11 Access Points (APs) alongside roads. In other words, the roadside infrastructure already exists if 802.11 networks are used in the vehicular context. Having an already deployed infrastructure of base stations shall save heavy financial and labour intensive investments. Due to these two main reasons, reasonable effort has been made in addressing the challenges associated with the 802.11-based vehicular communications. For example, Cabernet has been introduced as a system that facilitates communications between the vehicles and the roadside APs (Eriksson *et al.*, 2009). While the idea to use 802.11 APs from vehicles is interesting and beneficial, it comes with certain limitations and constraints. In this work, the authors limit themselves to the problem of disruption as found in 802.11-based vehicular communication.

The 802.11 APs are inherently designed for use in the indoor setup. Therefore, their use from vehicles in rapidly changing outdoor environments intuitively poses various challenges. One of them is concerned with their deployment. Since these APs are not deployed for providing connectivity to the vehicles, they cannot support continuous network services on the move. Unlike the cellular base stations, these APs are deployed randomly in houses, offices, coffee shops, restaurants, etc, and hence provide disrupted network services from vehicles. A vehicle trying to access these APs from outdoors faces periods of connectivity and disruption as shown in **(Fig. 4)** The disruption period is one during the vehicle is not within the coverage range of any AP.

It can be seen from the Figure 4 that the vehicle trying to use 802.11 networks on the move often faces undesired irregularity in the offered services. Tolerating or reducing this intermittency (or disruption) is a dedicated area of research called the Disruption Tolerant Networking (DTN). While the literature reports several techniques to tolerate disruption in vehicular communications, a relatively popular technique has been discussed by Ott and Kutcher (2006).

*C. Role of the Clouds in tolerating Disruption*

Ott and Kutcher (2006) have introduced the notion of saving the ongoing session of the vehicle in a dedicated proxy as soon as the connectivity from the APs diminishes. As soon as the connectivity is reinstated, the proxy restores the session of the vehicle. Note that this technique aims at tolerating disruption. It does not completely eradicate the disruption available in vehicular communication. **(Fig. 5)** shows the proxy placed over the wide network which is proposed to be used for this purpose. In this context, note that the cloud may replace the dedicated proxy. Instead of deploying dedicated proxies for storing and retrieving the sessions, the same session of the vehicle can be stored in the clouds. This idea further gives rise to various other issues. For example, the latency in communicating with the cloud and storing and retrieving the session shall be pivotal. The vehicle generally spends 10-15 seconds within the footprint of an AP (Hasan *et al.,* 2009).

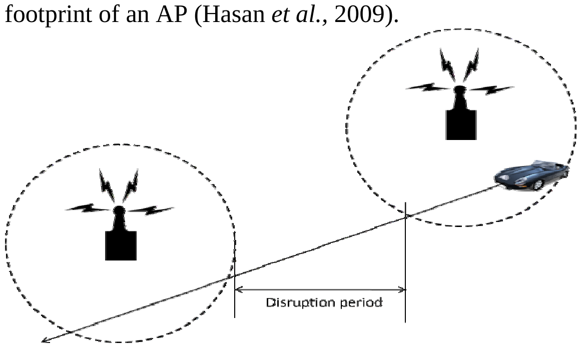


**Fig. 4: 802.11 networks offer disrupted network services from vehicles.**

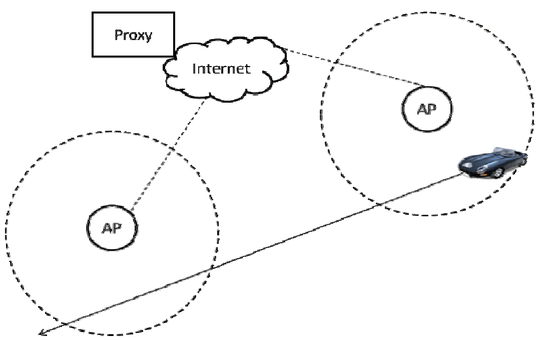


**Fig. 5: Proxy in the internet saves and retrieves the session for the vehicle.**

In order for it to make the most of this small connection time, it is important that it retrieves its session from the cloud very quickly and save it when leaving the footprint. Another challenge would be to detect when the vehicle is stepping out of the AP footprint. The vehicle must be able to predict its departure AP footprint so that its session does not end abruptly; rather, it is properly saved within the cloud for retrieving it later on.

## CONCLUSION

This paper overviews the general concepts of ITSM and Cloud computing to highlight their combined use in commercial applications. Both ITSM and cloud computing increase the efficiency of the business and reduce their expenditure. Using ITSM and cloud computing in conjunction with each other can increase the benefits by many folds. On one hand, ITSM can provide an integrated set of software services, while cloud computing can provide the hardware as a service.

Secondly, this paper examines the use of cloud computing in vehicular communications. It gives basic introduction to the 802.11-based vehicular communications, identifies the challenge related with disruption and proposes a basic idea. To be specific, it proposes to use the clouds to save the sessions of the vehicular nodes during the disruption periods. The clouds would restore the session as soon as the connectivity from the roadside APs is reinstated. This way, clouds may be used as a replacement of dedicated proxies.

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