Above the clouds: a brief overview of Microsoft Azure environments and applications

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Abstract

Recent times different developments have had varying influences in information technology. Indeed, developments are pushing businesses and various institutions to react, become accustomed and use new technologies which are less expensive. This research presents the Cloud computing as one of the best contemporary answers to this need. Moreover, it intends to explore Microsoft Azure as a flexible cloud platform that helps grow with greater efficiency and be more responsive to changes. The study focuses on Microsoft's Windows Azure platform as the Operating System for the Cloud and comprises a group of cloud technologies with each of them providing a specific set of services. This article presents an outline of cloud computing and Microsoft Azure, its benefits, security, storage, price, usage and its data centers.

Keywords: Microsoft Azure, cloud computing, technology, operating system.

1. Introduction

Along with the needs of the society, the evolution of the internet signifies one of the most successful examples of dedication to research and development of information infrastructure in the past decade. The internet has simplified the way community communicates, both on a professional and personal level. Until lately, most of the computing people relied on their device's own hardware from the IT infrastructure. After some time, they started pulling information from other machines, in order to view various types of web content. Then those websites performed more and more tasks for the users, it was the time when they started using distant machines to do computing and simply using the own devices as portals to the resulting output.

Cloud computing doesn't represent a new concept in the computing world, although the idea has existed for a longer time. Anyway, everyone should bear in mind that "the cloud" is not this imaginary world of computers, but it is a collection of physical data centers placed geographically in a strategic way.There are number of companies that offer cloud computing services like Amazon offers something called Amazon Elastic Compute Cloud (EC2), Google with its own cloud computing offering, Google App Engine and Microsoft offers Microsoft Azure [33].From a customer point of view, the different kinds of services that cloud computing platform can provide, it can be broadly grouped together into three categories called service models: Platform as a Service (PaaS), Software as a Service (SaaS) and Infrastructure as a Service (IaaS).Microsoft Azure is simply an assortment of different kinds of cloud services and as a cloud platform developed from Microsoft Corporation, provides a huge range of diverse services that allow users to build, deploy and manage answers for almost any reason that can be imagined. In other words, Microsoft Azure represents a world of unlimited possibilities.

For most of internet users and people to who may be concerned, it's easy to imagine that all the web portals and applications we use in everyday life, exist in some invisible land. Obviously, in reality all the information that gets channeled to our devices has to be stored in some physical location and for applications to work data has to be processed by an actual machine somewhere. This research introduces the Microsoft Azure platform and describes the different services and types of solutions that this platform makes possible. As a Microsoft's Cloud Computing Framework it provides a broad range of Internet services that are consumable from both on-premises environments and even the internet.

2. Overview of Cloud Computing

Even if it is one of the most discussed topic recent years, we anyways might learn something valuable that can expand our knowledge or help businesses grow and meet the challenges they face in the marketplace.

In the first impression it is understood as a large collection of water drops in the sky, but however Cloud Computing is an infrastructure that enables the development and deployment of various applications in the cloud, or said differently, in remote servers.

Anyway, cloud computing is a nascent business and technology concept with different meanings for different people [29]. It represents the way the data as well as programs are stored and accessed over the internet, instead of hard drive, but it has to be mentioned that Cloud platform hides the complexity and details of the underlying infrastructure from the users, by providing very simple graphical interface or API.

In traditional hosting, the software company has to deal with licensing costs, protection of data, frequent upgrades to latest technologies, operating system, maintenance and upgrading of hardware and other services. It is totally the contrary on cloud, since the data are built in data centers and they are remotely hosted. The platform uses different data centers that are fully managed by the service provider like Microsoft, Amazon on any other provider. It may be defined as a phenomenon that promises to increase business agility by increasing the velocity with which applications are deployed and lowering the costs [15]. Moreover, companies with large batch-oriented tasks can get results as quickly as their programs can scale, since using 1000 servers for one hour costs no more than using one server for 1000 hours [13]. Note that Cloud Computing is not a technology revolution. Rather, it is a business and process evolution.

A. CLOUD SERVICE MODELS

In practice, service providers tend to offer cloud services that can be grouped into three categories: IaaS, PaaS and SaaS, as explained below. However, as the cloud matures, the distinction among these is being eroded [1].

- *SOFTWARE AS A SERVICE (SaaS)* - Is a software distribution model in which a third-party provider hosts applications and makes them available to customers over a network, typically the Internet [24]. The user doesn't have any important task, besides using the software. Dropbox, Facebook, Gmail, Skype, YouTube etc. are some of the examples of this model.
- *PLATFORM AS A SERVICE (PaaS)* - As a model where the service provider offers all the necessary tools and the hardware, it supports computing a platform which typically includes operating system, programming language, execution environment, database, web server. The user is responsible for applications creation and data management. For instance: Windows Azure, Google Apps etc.
- *INFRASTRUCTURE AS A SERVICE (IaaS)* - Is the basic layer in cloud computing model which provides the infrastructure such as virtual machines (VM). Unplanned maintenances are triggered by unexpected physical infrastructure problems such as network failures, rack-level failures and other hardware failures. When such a failure is detected, Azure automatically moves the VMs to a healthy host [16]. It allows the use of a hardware computing resources as a service provider, but anyway the user should take care of the operating system, deployment of the applications and managing the data. Typical examples are: Amazon Web Services, firewalls, Rackspace Hosting etc.

Since those three models differ from each-other in several aspects, a clear presentation of what is discussed above is provided in figure 1.
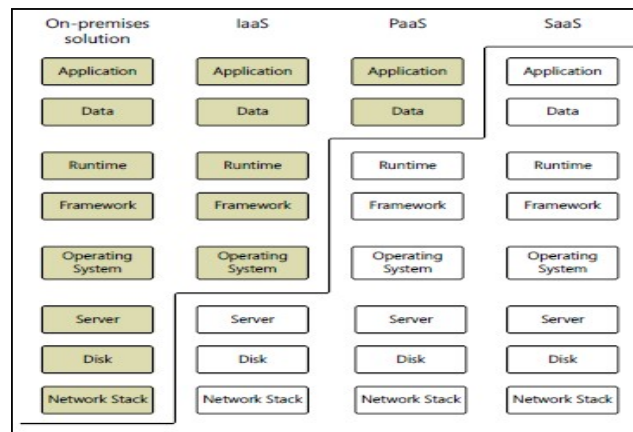

Fig. 1. Differences and relationships between IaaS, PaaS and SaaS [2]

B. Why to resist the Cloud

Beside all the advantages that cloud provides, there are still some issues why the organizations resist moving to the cloud. There are several possible reasons for this:

- Lack of knowledge about the infrastructure used by the hoster and the reliability of the hosting provider for providing cloud services to customers can make some organizations to hesitate about moving to the cloud.
- The large investments in traditional IT infrastructure also represent another resistance why companies resist in migrating their applications to the cloud.
- Loss of data continues to be a primary concern, even if cloud duplicates them in an entirely different region, has data recovery plan and suitable backup procedure. The causes of most data loss are no different than in a local data center.
- Business politics can also be a reason that organizations refuse to use cloud computing approach. The long-established in-house IT culture of control can make it difficult to embrace the cloud.
- When using the cloud, the customer probably won't know exactly where your data is hosted or what country it will be stored in. Taking into consideration that different countries have specific jurisdictions, users are doubtful to obey local privacy requirements.
- Organizations that have special requirements in the areas of security and compliance might have legal or regulatory requirements that inhibit them from implementing different forms of cloud computing [3].

The most of cases those resistances come from already experienced known outages of cloud services. Some of them were quite lengthy. For instance, Microsoft Azure had an outage that lasted for 22 hours in 13-14 March 2008, as showed in Table 1 [26].

Table 1. Outages in different cloud services

Service and Outage	Duration	Date
Microsoft Azure: malfunction in Windows Azure	22 hours	March 13-14, 2008
Gmail and Google Apps Engine	2.5 hours	Feb 24,2009
Google search outage: programming error	40 min	Jan 31, 2009
Gmail: site unavailable due to outage in contacts system	1.5 hours	Aug 11,2008
Google AppEngine partial outage: programming error	5 hours	June 17,2008
S3 outage: authentication service overload leading to unavailability	2 hours	Feb 15,2008
S3 outage: Single bit error leading to gossip protocol blowup.	6-8 hours	July 20,2008
FlexiScale: core network failure	18 hours	Oct 31, 2008

The outage, which apparently started on afternoon, had affected data centers in Ireland, Chicago and San Antonio, but there were no reports of data loss. The issue was quickly triaged and it was determined to be caused by a software bug. The Azure team apologized for any inconvenience this disruption has caused the customers [27].

C. Why to use the Cloud

In recent years, organizations generally consider moving their applications to the cloud for one of three reasons: speed, scale, and economics. In below text we will try to briefly examine each of these advantages that cloud computing can afford.

- *Speed* - Reducing "time to market" and "time to develop" impacted the developing team to be more agile in servicing needs of the business, move them forward against the competition and meet the requirements of the clients. On the contrary, purchasing new servers, configuring and integrating them into new environment tend to be time-consuming and costly as well. With Azure, the application can be set up and start building it out in minutes.

  Developing applications that run in the cloud can be significantly faster than traditional application development for two reasons. First, you don't have to deploy, configure, and maintain the underlying computing, storage, and networking infrastructures on which your applications will run. Instead, you can utilize infrastructure resources provided to you by your cloud hosting provider. A good analogy is lighting up your house. If you need to not only purchase and install light bulbs but also pull wires, install switches, buy and set up a generator, and purchase gasoline for your generator, it's going to take a while until you get your house lit up. But if your light bulbs can leverage the wiring installed by the contractor

who built your house and electricity provided by your city's power station, you'll be able to get your house lit up in next to no time.

A second reason why cloud-based applications can be faster to deploy has to do with the process of how applications are developed. In a typical enterprise environment, developers create and test their applications in a test environment that only partially simulates the final production environment. For example, an application might be developed and tested on a no-clustered host for eventual deployment into clustered hosts. Mismatches like this between the development and production environments can slow the development process for business applications because certain problems might be missed in testing and only become apparent when the applications are deployed to production, which might necessitate further testing and development until the applications are behaving as intended. With the cloud, however, the developer can perform the development and testing in the same kind of environment that the applications will be deployed upon—the computing, storage, and networking resources provided by the hoster. This can make testing applications simpler and more reliable, thereby reducing the time to deployment [3].

- *Scale* - Cloud applications can scale out fast because the various service compute, storage, and networking resources are pooled by the hoster, therefore it can be provisioned to different businesses as the request arises.

  It presents the best approach when the application needs more compute resources to fulfill the increasing requirements from the customers and also it helps to remain competitive in today's global economy since cloud provides an almost infinite set of computing resources.

  When the cases of downturn in the marketplace mean that there is no need for all that compute capacity the hoster is providing for the applications, there is required to scale down the hoster's compute capacity that the business is using. This means that depending on the demand, the applications can easily scale up or down and the owner does not have to worry about running out of capacity or worry about over provisioning because cloud uses just enough resources as is needed.

- *Economics*- As related to the economic efficiencies, many organizations decide to move to the cloud because the cost of running their business applications in the cloud can be considerably lower than running them on-premises. At the other hand, on-site servers usually require a lot of maintenance: climate control, electricity, disaster recovery, backups, security. Moving to the cloud means setting free the application so the people engaged can focus on new projects instead of routine maintenance.

  Definitely the best option that cloud provides is that you pay only for what you use, therefore businesses only pay for the resources they actually consume. This in itself saves money for any app that has variable computing needs. Another fact that is worth mentioning is that cloud computing can also make economic sense for businesses when it comes to hardware acquisition costs.

3. Overview of Microsoft Azure

On the RGB color wheel, "azure" (color #007FFF) lies between blue and cyan, that is often described as the color of the sky on a clear day. However, in the technology context, here are a lot of definitions related to Azure platform. The simplest one is that it's an operating system in the cloud, which can be used for building and deploying cloud-based applications.

According to Microsoft [4] official definition, Azure is a cloud computing platform and infrastructure created by Microsoft for building, deploying, and managing applications and services through a global network of Microsoft-managed data centers. Microsoft Azure is a growing collection of integrated cloud services—analytics, computing, database, mobile, networking, storage, and web—for moving faster, achieving more, and saving money. With Azure, every client can be up and running fast, scale up or down as needed, and avoid high capital costs—paying only for what you use [11].

It is also referred as a cloud computing service created by Microsoft for building, deploying, and managing applications and services through a global network of Microsoft-managed data centers [19]. It provides platform as a service and infrastructure as a service [25], [31] and supports many different programming languages, tools and frameworks, including both Microsoft-specific and third-party software and systems. Azure was announced in October 2008 and released on 1 February 2010 as Windows Azure, before being renamed to Microsoft Azure on April 2014 [5].

As per Steven Martin, the General Manager of Microsoft Azure at Microsoft this change reflects Microsoft's strategy and focus on Azure as the public cloud platform for customers as well as for Microsoft own services Office 365, Dynamics CRM, Bing, OneDrive, Skype, and Xbox Live. The commitment to deliver an enterprise-grade cloud platform for the world's applications is greater than ever. Is being supported one of the broadest set of operating systems, languages, and services of any public cloud—from Windows, SQL and .NET to Python, Ruby, Node.js, Java, Hadoop, Linux, and Oracle. In today's mobile-first, cloud-first, data-powered world, customers want

a public cloud platform that supports their needs—whatever they may be—and that public cloud is Microsoft Azure [5].

1. Key Components

There are three main components in the Azure Platform. These are Windows Azure, SQL Azure and Windows Azure AppFabric. Each of them is described in the following text:

- *Windows Azure* - Is one of the main components of Azure and represents the cloud operating system or runtime where the cloud applications can be executed. It is designed to run on cheap commodity hardware and on same time provides scalable compute, storage facilities and a Windows-based environment for storing data on servers in data centers managed by Microsoft [7].

- *SQL Azure* -As a cloud-based relational database, makes the power of Microsoft SQL Server available in a Cloud Hosted offering. In fact, is an extension of Microsoft SQL Server and runs in the Azure cloud. Additionally, SQL Azure offers standard relational database features such as views, triggers, stored procedures and indexes. The data in the SQL Azure database can be accessed by the Tabular Data Stream (TDS) protocol [21]. SQL Azure offers a relational database service called Microsoft SQL Azure Database, and using SQL Azure Database, the user can easily deploy a large number of relational database solutions.

- *AppFabric* – This platform provides cloud services for connecting applications running in the cloud or on-premises. As a feature, it allows developers to connect applications and services, to secure cloud or off the cloud services with new or existing security frameworks [17]. Windows Azure AppFabric can be seen as an entity that interconnects on-premises solutions to Windows Azure solutions, and even Windows Azure solution to other solutions within the cloud.
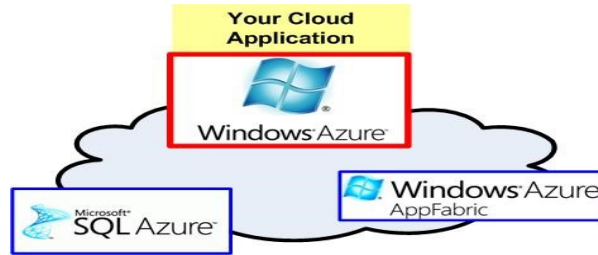

Fig. 2. Azure components

Microsoft Azure supports many different programming languages, tools and frameworks of both Microsoft and third party software's, like:

- Supports Microsoft centric technologies like .NET and several scripting languages
  - C#, VB, C++, Java, ASP.NET, WCF, PHP, Python
- Runs on Microsoft data centers
  - Commodity hardware
- Supports different OS's
  - Windows and Linux
- Several Storage Options
  - BLOBs and simple data structures
  - Traditional Relational, SQL Azure Database
- Connectivity with various devices
  - Android Mobiles, iOS, Windows Phones

Fig. 3. Azure supported technology and tools

A. Azure Usage

Clients are continuing to increase their usage in Azure and there is a significant need to know the resource usage, optimize it as far as possible, look for ways to cut costs and plan for future growth of the organization. An important issue is that Azure allows non-Windows applications to run on the platform [28]. There are several aspects where Azure is mostly used. Each of them is briefly explained in the text below.

- *Cloud Services* - The main usage of Microsoft Azure is to build and deploy applications. In all the cases, the developers create the code with the help of tools provided by Azure, and then, by using Windows Server, the virtual machines execute the application. Since the development and hosting tools are purchased through a subscription, Azure Cloud Services is an example of what's called PaaS or Platform as a Service. For instance, the latest version of Microsoft Azure platform provides Windows Azure Marketplace, which offers ready-to-purchase applications and data [30].

- *Virtual Machines* - The Azure cloud application will run on virtual machines, in which Azure will install the operating system and continuously update it with any new patches. Azure gives the ability to create VMs in a simple manner by indicating the size and the Virtual Hard Disk (VHD) that will be used. The VHD is the virtual version of a hard drive on a traditional computer. It presents the space where the applications are saved. Since Azure provides access to both Windows and Linux VHDs, developers have the freedom to choose what they want to work with and the payment is done according to how much time the VM is actually running. The VMs can also be used to enhance on-site data centers with the aim to increase the power of applications like SharePoint. Those VMs give the computing substrate for the applications through a service subscription; therefore, it belongs to the category of IaaS or Infrastructure as a Service.

- *User Roles* - Another usage approach of cloud services is to create different roles for users, known as web users and workers. With Azure it's really easy, as it is with all other Azure tools. It also gives the opportunity to scale up or down more or less users. A Web role, which deals with front end web communications, can be implemented with any of Internet Information Services (IIS), 7 compatible technologies, including ASP.NET, PHP, and Node.js. Secondly, a Worker role performs background tasks including data processing and supporting jobs for Web roles, and can host any type of application [32].

- *Web Sites* - An important field where Azure can be used is like a platform while creating and hosting websites and web applications. Web Sites support several various development tools and content management systems, and Azure offers a low cost technique to make the web site available, no matter how many visitors use it without having to maintain or upgrade any on-site servers.

- *Mobile Services* - Among different cloud applications, Azure's Mobile Services provides the tools to create and deploy applications that are used on mobile devices, like Android and Windows Phone [8].

B. *Azure Providers*

Based on the Clutch survey [9] related to companies that offer some component of cloud computing – regardless it is an IaaS, SaaS or PaaS to other businesses or individuals, which are called cloud computing providers, Amazon Web Services is still leading the market [10]. Microsoft Azure is on the second place of this cloud providers list. The rest eight providers are listed below.

Top 10 Cloud Computing Providers:

1. Amazon Web Services
2. Microsoft Azure
3. Google Cloud Platform
4. IBM Cloud
5. Rackspace
6. GoDaddy
7. 1&1
8. VMware
9. Red Hat
10. Oracle Cloud

C. Azure Price

The price of using Azure is also an important topic to deal with. However, there is no fixed price about it since it depends on various factors like the number of Virtual Machines, their size, the total memory they need to run, how much bandwidth they use, and what kind of support is needed from client's side.

Approximately, cloud services can move from $60 a month to over $60,000 a month, with Microsoft covering all kinds of special deals to businesses as an incentive to make the move to the cloud. Anyway, if we want a fixed price the best approach is through the Azure website and try the cost calculator that is provided online. It can be reached on the following link: https://azure.microsoft.com/en-us/pricing/calculator/[20].

D. Azure Security

When managers and employees are asked, the most common concern they mention about the cloud is security. Even if they both agree that cloud computing is actually more secure than using your own servers for usually the same reasons that keeping money in the bank is safer than hiding them in your own house.An undeniable fact is that Microsoft's datacenters provide a high scale of security. This is said because the access in those datacenters is restricted with RFID and biometric controls. Data is also encrypted and multifactor authentication is used for signing in. All this happens in order to convince the clients that their enterprise apps run securely, reliably and the service they are using is trustwothy.

However, to have a secure environment, companies must assure IT staff to manage assets like existing servers and IT infrastructure that run on a different operating systems, databases and tools from several IT vendors. The apps are moreover written in numerous languages and frameworks. In other words, the IT environment is diverse and complex. Also latest IDC findings show 40% of enterprises are already adopting hybrid clouds today [12].

E. Azure Storage

Cloud computing enables new scenarios for applications requiring scalable, durable, and highly available storage for their data – which is exactly why Microsoft developed Azure Storage. Microsoft's goal is to create storage that is durable and secure, scalable and efficient [18]. In addition to making it possible for developers to build large-scale applications to support new scenarios, Azure Storage also provides the storage foundation for Azure Virtual Machines, a further testament to its robustness [6].

- *Blobs* - The word blob is an acronym for binary large object. They are basically files for storing binary data, like those that we store on the computer (or tablet, mobile device, etc.). They can be pictures, Microsoft Excel files, HTML files, virtual hard drives (VHDs)—pretty much anything [13].
- *Queue*s - As usually, queues are known as data structures that mainly are used to store data which according to FIFO (First in First out) rule. It means that a data item can be inserted from back of the queue and can be retrieved from front. Same happens to Azure queues, they are used to store the messages in a queue. The communication, known as a background work processing, consists of a sender that in all the cases sends the message and a client that receives and processes them. A message has few attributes attached to it, for example expiry time [14]. The main aim of a queue is the inter service communication between the apps that run in the cloud, whose messages can be up to 64 KB in size [13].
- *Tables* - Those data structures are used for storing tabular data, however, storing a table does not mean relational database here. Azure Storage can store just a table without any foreign keys or any other kind of relation. These tables are highly scalable and ideal for handling large amount of data. Tables can be stored and queried for large amount of data [14].
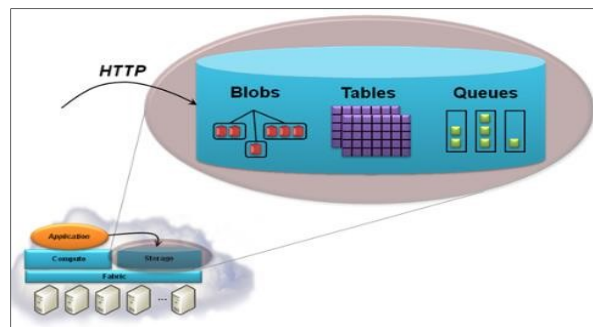

Fig. 4. Azure storage services

4. Azure Data Centers

Many of us have been working with software for years, and some of us even decades. As such, we have an implicit understanding of our environment and we know what kind of architectural patterns to apply and what kind of code to write for our environments that will work. There are other non-application developers taking care of these details for us so that we can focus on the architectural design of our software and writing code to implement those designs.

With all this having been said, we certainly would all agree that our software environment has an influence on the style of code that we write, without understanding our environment, we would likely make many missteps in the design and coding of our software. It is for this reason that we are spending a brief amount of time telling a little more about the environment, indeed the main reason is because it helps us design and write applications better for the cloud. Geographic expansion is a priority for Azure because it enables the customers to achieve higher performance and it supports their requirements and preferences regarding data location.

Microsoft Data Centers are a big part of the Azure story. Microsoft is building large, sophisticated cloud data centers around the world to complement its existing data centers. Each region contains one or more datacenters.

Over the last years the team delivered a huge infrastructure to enable growing the services around the globe. Whether it's the data center in Washington, Chicago, Virginia, or some of the newly announced facilities in Shanghai, Australia and Brazil, it is really important to make smart investments around the world to deliver services in a resilient and reliable fashion.

Maybe the most frequent asked question about the datacenters is how Microsoft decides where to place the datacenter investments? Of course, there are over thirty-five factors in site selection criteria. But really, the top elements are around proximity to customers, the energy and fiber infrastructure, insuring that the chosen place has the capacity, support on a 24x7x365 basis and the growth platforms to be able to grow the services.

Another important criterion is the skilled workforce, the main objective is to insure that there are the right people to run and operate the datacenters on everyday basis.

5. Conclusion

Since the market for cloud technologies and services is evolving dynamically and rapidly, there is no simple way to summarize the components that are part of it. One of them is Microsoft Azure, the flexible cloud platform that facilitates the user to quickly build, deploy, and manage applications across global networks which are hosted in several datacenters. With this novelty Microsoft has been making headway into the cloud market.
This research represents an approach where Microsoft Azure is explained in detail, its advantages, disadvantages, components, usage, storage, security data centers and practical examples. In order to stack up against the competition, Azure offers many benefits to enterprises, businesses, industries, and organizations because it provides a variety of cloud services that can allow the client do a wide range of things, starting from hosting the company's website to running big SQL databases in the cloud.

One of the greatest advantages of this framework is that mirrors the solutions, i.e. the data is stored in multiple data centers which are mostly of the time in different geographical locations, meaning that the same application is going to be replicated in couple data centers. If any of those data centers goes down, the application will still continue to run through another data center. In case of disasters, cloud solutions are the perfect way of ensuring that we will not have even the minimum occlusion for our application.
An issue that is worth mentioned is that Azure pricing model is charge based on usage. It also has several options so everyone can choose what's most appropriate for his own application or business. Beside the fact that Windows Azure platform can be used to develop new applications, it also is used to improve the existing applications using Cloud-based technology. It allows developers to create solutions and applications in the Cloud with a growing list of application development technology and several programming languages that it supports.

Although the future of cloud computing looks to be bright, but with all this huge amount of data around us, data that cannot be seen, every one of us should ask themselves: What if it will start to rain? It seems to be quite a simple question, but it's actually not. We are witnesses that it is changing our life style, transforming how we live and work, and maybe this question will lead us to another universe, where data lives.

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