WINDOWS AZURE PAAS CLOUD: AN OVERVIEW

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Abstract

Cloud Computing is an emerging technology in which the research community and industries have recently embarked. However, the infrastructures of most cloud computing systems today are invisible to the research community, or are not explicitly designed to the researchers interested in cloud computing systems. Windows Azure is Microsoft's PaaS (Platform as a Service) Cloud offering to help its customers realize the benefits of cloud computing. It is the platform of Microsoft implementation of cloud computing. This paper covers detailed introduction to Windows Azure Platform, its components, Architecture and provides insights into different aspects of Azure based development especially for those who are interested in adopting Windows Azure within their Enterprise IT landscape. This paper also described the latest development of the windows azure, that is used the cloud computing platform.

***Keyword**-Cloud Computing, Windows Azure, PaaS, Azure Storage, Azure Marketplace, Cloud Architecture, Cloud Applications*

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1. Introduction

Windows Azure is a cloud computing platform offering by Microsoft. Azure is a Platform as a Service that provides developers with on-demand compute and storage to host, scale, and manages web applications on the internet through Microsoft datacenters. Industry and academia are starting projects related to Cloud computing. For example, Microsoft has published its Cloud computing system- Windows Azure Platform. Amazon Elastic Compute Cloud; IBM's Blue Cloud; HP, Intel Corporation and Yahoo! Inc. recently announced the creation of a global, multi-data center, open source Cloud computing test bed for industry, research and education. In the last few years, virtualization has introduced some novel system techniques so that the cloud-provider can transparently satisfy its cloud customers' requirements without impacting their own system utilization. Cloud computing differs from grid computing in this regard, it can run in conjunction with

the original business workloads. Moreover, novel virtualization technologies e.g. live migration and pause-resume give rapid and transparent solutions, interference may not occur between the original systems and the cloud workloads. Consequently, several business cloud models rapidly evolved to harness the technology by providing computing infrastructure, data-storage, software applications and programming platforms as services. However, the inter-relations inside cloud computing system have been ambiguous and the enable feasibility of inter-operability has been debatable while referring to the core cloud computing services. Furthermore, every cloud computing service has an interface and employs a different access control protocol. A unified interface for each cloud computing service to support integrated access to cloud computing services is not existent, though portals and gateways can provide unified web-based user interface. So, the introduction of the cloud computing domain, its components and their inner relations are necessary to help the researchers achieve a better understanding of the novel technology.

Windows Azure is a foundation for running applications and storing data in the cloud. Rather than providing software that Microsoft customers can install and run themselves on their own computers, Windows Azure today is a service: Customers use it to run applications and store data on Internet-accessible machines owned by Microsoft. Those applications might provide services to businesses, to Consumers or both. Microsoft's Windows Azure Platform is an internet-scale cloud platform. Azure's flexible and interoperable platform can be used to build new applications to run from the cloud or enhance existing applications with cloud-based capabilities. Windows Azure is a cloud services operating system that serves as the development, service hosting and service management environment for the Windows Azure Platform. For example, physical hardware resources are abstracted away and exposed as compute resources ready to be consumed by cloud applications. Physical storage is abstracted with storage resources and exposed through well-defined storage interfaces. A common Windows fabric abstracts the physical hardware and software platform and exposes virtualized compute and storage resources. In addition, each instance of the application is monitored for availability and scalability, and automatically managed.

Windows Azure runs on machines in Microsoft data centers. The goal of Windows Azure is to provide developers with an on-demand compute and storage platform to host, scale, and manage internet or cloud applications. The platform itself provides and maintains its own copy of Windows. Developers focus solely on creating applications that run on Windows Azure. Windows Azure supports a consistent development experience through its integration with Visual Studio. Windows Azure is an open platform that supports both Microsoft and non-Microsoft languages and environments. Windows Azure welcomes third party tools and languages such as Eclipse, Ruby, PHP, and Python. Windows Azure provides a Windows-based computing and storage environment in the cloud. Running applications and storing data in the cloud is the right choice for many situations. The

various parts of Windows Azure work together to make this possible. Windows Azure Tables provide scalable, available, and durable structured storage in the form of tables. The tables contain entities, and the entities contain properties. The tables are scalable to billions of entities and terabytes of data, and may be partitioned across thousands of servers. Windows Azure Blobs provide a simple interface for storing named files along with metadata for a file. Windows Azure Queues provide reliable storage and delivery of messages for an application and are the most common basis for Web and Worker role communication.

The Windows Azure programming model can be useful for anybody who wants to create easier to administer, more available, and more scalable applications. Windows Azure is an operating system for windows cloud. Windows cloud is a set connected servers on which developers can install and run services. we can also store and retrieve data from the servers. Imagine to build a desktop application might include the below steps.

Step 1: Selecting the hardware for the application.
Step 2: Selecting the storage mechanism.
Step 3: Writing some Job schedulers.
Step 4: Writing an application installer for the application etc.

The above four steps are normally done by every developer in day-to-day activities. So Windows Cloud replacing all the above steps. Running applications on machines in an Internet-accessible data center can bring plenty of advantages. Yet wherever they run, applications are built on some kind of platform. For on-premises applications, this platform usually includes an operating system, some way to store data, and perhaps more. Applications running in the cloud need a similar foundation. The goal of Microsoft's Windows Azure is to provide this. This track is dedicated to provide the foundational knowledge IT Professional needs to be successful with the Windows Azure.

2. Microsoft Cloud Computing

Microsoft's cloud includes SaaS (Software-as-a-Service) offerings such as Windows Live and the Business Productivity Online Suite and the PaaS (Platform-as-a-Service) offering currently branded as the Azure Services Platform.

Layer zero (Showing in Fig. 1) is Microsoft's Global Foundational Services. GFS is like the hardware abstraction layer (HAL) in Windows. It is the lowest level of the software that interfaces directly with the servers.
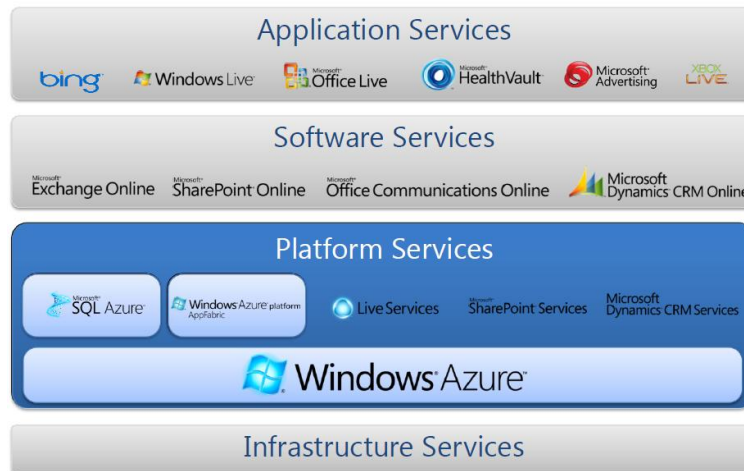
Fig 1. Microsoft Cloud Computing Architecture (Source Microsoft)

Layer one is the base Azure operating system. This is what used to be codenamed "Red Dog" . Red Dog is what networks and manages the set of Windows Server 2008 machines that comprise the Microsoft-hosted cloud. At the highest level, Red Dog consists of four "pillars": Storage (like a file system); the "fabric controller," which is a management system for modeling/deploying and provisioning; virtualized computation/VM; and a development environment, which allows developers to emulate Red Dog on their desktops and plug in Visual Studio, Eclipse or other tools to write cloud apps against it. The way Red Dog is architected is Microsoft only has to deploy Red Dog on a single machine and then multiple instances of it can be duplicated on the rest of the servers in the cloud using virtualization technology. Layer two is the set of building block services that run on top of Azure. Developers are not required to use these services and will be able to mix and match among them. The initial set of services include Live Services (a k a the Live Mesh platform); SQL Server Data Services (now known as SQL Services); .Net Services (formerly known as "Zurich"); SharePoint Services and Dynamics CRM Services. Developers will be able to build on top of these lower-level services when constructing cloud apps. SharePoint Services and CRM Services are not the same as SharePoint Online and CRM Online; they are just the platform "guts" that don't include user-interface elements. Layers one and two together called as "Azure platform" which is briefly known as "Windows Strata". Layer three are the Azure-hosted applications. Some of these are from Microsoft and include SharePoint Online, Exchange Online, Dynamics CRM Online. Others will be authored by third-party developers.

3. Windows Azure Components

Azure is Microsoft's cloud computing solution. It consists of three parts: storage, scalable computing, and the base fabric to hold everything together across a heterogeneous network. Figure 2 shows a high level overview of Azure's structure:
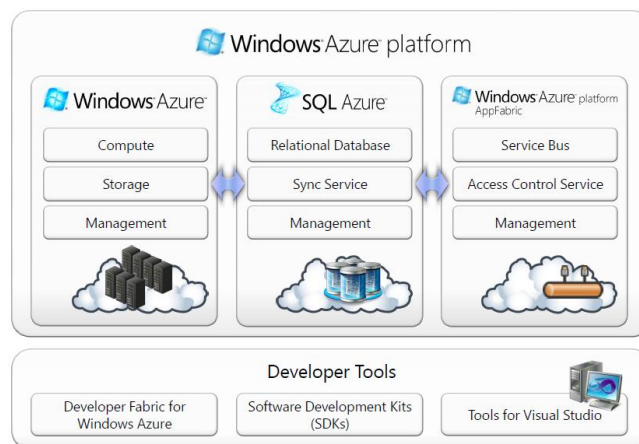
Fig 2. High Level View of Microsoft Windows Azure Platform (Source Microsoft)

Windows Azure platform comprises the following:

- Windows Azure
- Microsoft SQL Azure
- Windows Azure Platform AppFabric

3.1 Windows Azure

Windows Azure platform offers runtime execution environment for managed code to host and run scalable solutions. Each Windows Azure Compute instance is also a Virtual Machine (VM) instance created by the platform and only the number of instances is configured by the team hosting the application. Every VM instance runs an Azure agent to connect and interact with the Windows Azure fabric. Every VM has a local file system which can be utilized by the web/worker role instance during their life-time, but once the VM instance is shut down, VM and local storage will go away. Azure maintains 3 different instances of every application on the cloud and the end-user will not be aware of which instance is serving the specific request. Hence persistent storage is required to support the application data and this can be met using the Windows Azure Storage Service. With geographically distributed centers, Windows Azure Compute provides developers with the functionality to build, host and manage applications on the cloud. Application developers can connect to Windows Azure portal using Windows Live ID and choose a hosting account to host applications on the cloud and a storage account to store data or any relevant content on the cloud. Certain applications can use either the hosting or storage accounts or both. The accounts enable developers to host and deploy applications on the Windows Azure platform. Windows Azure presently supports three roles; web role instance, worker role and VM role.

- Web Role is customized for web application programming and supported by IIS 7.

- Worker Role is used for performing the background process for the web role. Message queue endpoints are, in general, configured in the worker role to generate programs in an asynchronous mode.

- VM Role runs an image (a VHD) of a Windows Server 2008 R2 virtual machine. This VHD is created using on-premises Windows Server machine, then uploaded to Windows Azure. Customers can configure and maintain the OS and use Windows Services, scheduled tasks etc. in the VM role. Once it's stored in the cloud, the VHD can be loaded on-demand into a VM role and executed. The VHD can be used as the base image for all instances of a VM Role.
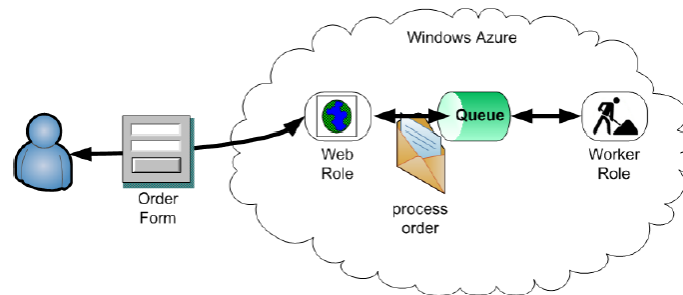

Fig 3. Windows Azure Supporting Roles (Source Microsoft)

Windows Azure compute instances have four unique sizes to enable complex applications and workloads as described in the following table. This enables enterprises/users to choose the appropriate Virtual Machine size to run their applications based on the application complexity and resource requirements. Windows Azure Compute Instances can support native code execution and applications running on the .NET framework, PHP, Java, Apache TOMCAT, MySQL. However, future expansion of Windows Azure will enable support of multiple languages and frameworks, such as, Ruby on Rails, Python and so on. Further, applications deployed can use Web and Worker Role instances together for the user load. Multiple Web and Worker role instances can be configured using the service configuration file. One point to remember is that Windows Azure further provides a capability to retain the VMs where any crash leads to debugging and reusing the storage state to investigate the causes of the crash.

Windows Azure Storage: Windows Azure provides three types of storage in the cloud as defined in figure 4.

Azure Blob provides storage for large binary objects such as video and images.
Azure Table provides structured storage for maintaining service state.
Azure Queue helps in sending asynchronous work request dispatch to enable communication.
Azure XDrive helps in storing the data in a durable drive in the cloud.

Blob: Blob is a set of blocks which can store text or binary data. A block blob is optimized for streaming workloads up to 200GB in size and page blobs are used for random read/write access of 1TB.

Table: Tables are another storage representation on cloud where data is stored in the form of entities and properties. Tables enable data storage across machines and enables scale-out storage. Tables can be consumed using REST APIs. This provides the ability to store huge volume of entities in tables that scale into terabytes.

Queues: Queue helps in storing messages that may be accessed by a client. A queue's prime function is to enable communication between Web and Worker Role instances. Web Role instances can place user requests which need to be processed in the background while the Worker Role monitors the queue to process the request and respond back via the same queue or any other queue to the Web Role instance.
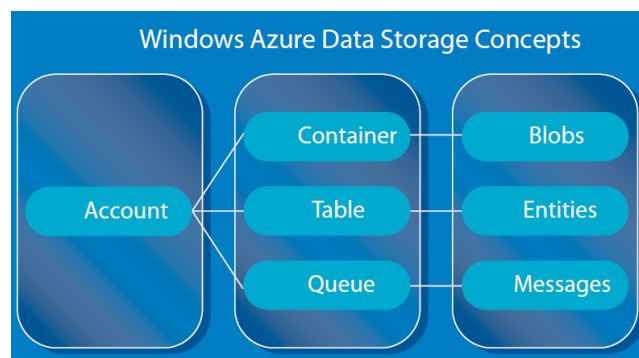

Fig 4. Windows Azure Storage Architecture (Source Microsoft)

Windows Azure XDrive: XDrive allows Windows Azure to compute applications running in the cloud and use the NTFS APIs to store data in a durable drive. This drive allows Windows Azure applications to mount a page blob, which is a single volume NTFS VHD. All areas in the application can be integrated with the blob, and reads come out of the local VM cache or the page blob if there is a cache miss. This allows applications to upload/download VHDs via blobs, and the VHD remains durable and able to survive the failure of the VM, since it is backed by a paged blob.

The entire storage areas can be accessed using REST APIs or HTTP standard calls as blobs, tables and queues are represented using URIs. Irrespective of the storage types - data in blobs, tables and queue get replicated a minimum of 3 times within the Windows Azure storage across the virtual machines to ensure there is NO data loss. This also equips the self-heal capacity to recover the data and handle fault-tolerant situations and increase availability under extreme conditions as well. This data replication is possible via the association of VM agents with the Windows Azure fabric, which manages and monitors the applications on Windows Azure platform.

Windows Azure Fabric: One of the key features of the Windows Azure is to provide highly scalable solutions to support large volumes of simultaneous users accessing many different applications hosted on the platform. This capability is handled by providing a scale-out feature within the platform to manage a sudden increase in the volume of users accessing the system. The fabric controller manages and controls the Windows Azure Fabric and is responsible for automating the load balancing to ensure the required scalability is achieved. Windows Azure Fabric has parallel virtual machines running the image of the applications utilizing a Hyper-V, which is a fine-tuned version specific to Windows Azure. The following figure displays the Windows Azure Fabric.

Fabric controller utilizes the visibility of the configuration file indicating deployment requirements, such as, storage issues, number of Web and Worker Role instances and so on. The fabric controller is notified if a machine fails and configures a new virtual machine with the same configuration and adds it to the Windows Azure Fabric to serve the needs immediately. This ensures service availability without seriously impacting the end-user. Multiple deployment topology configurations can be customized using the inter-role communication feature of Windows Azure which has the capability to communicate between individual role instances in the user application. This supports complex topology configuration within Windows Azure as it is better supports message infrastructure and mapping.

3.2 Microsoft SQL Azure

One of the key attributes of any application within the enterprise, over web, is data. As time passes, data grows immensely attributed to different sources, different devices and different systems. To address the growing size and scale of the data - we need a solution which can address the primary data challenges associated to manageability, scalability and availability. SQL Azure is the cloud-based technology solution to deal with relational and other types of data as part of Windows Azure platform. It contains two primary parts as given below.

- SQL Azure Database
- SQL Azure Data Sync.

SQL Azure database addresses few key areas of concern in terms of database administration functions, such as, disaster recovery, replication, backup and others. The data in the SQL Azure database can be accessed by the Tabular Data Stream (TDS) protocol.

Advantages of SQL Windows Azure Platform:

Relational Database Management Services

- Create, access, manipulate tables, indexes, views, roles, stored procedures, triggers and functions.
- Execution of complex queries and joins across multiple tables
- Constraints
- Transactions
- Temp tables
- Basic aggregation functions Ex: String aggregations, math, date/ time
- Support for tracking billable metrics in real-time and for historical analysis

Programmability

- Managed ADO.Net data access
- Native ODBC
- Support for PHP

Tools

- SQL Azure Account portal - to provision logical servers and databases
- SQL Server Management studio - an integrated environment to configure and access the databases on cloud
- Visual Studio 2010 - Supports building applications with data connections to SQL Azure to design queries and perform data binding operations in their applications.

3.3 Windows Azure Platform AppFabric Services

To build applications on Windows Azure, the Windows Azure platform AppFabric services can be leveraged including the Service Bus and Access Control Services - this

helps in connecting applications residing on premises to the cloud. The AppFabric includes the following:

Service Bus - Service Bus is used to enable applications and services to communicate across the network and organizational boundaries for both on-premise and cloud applications.

Access Control - Access Control helps to create highly secure authorization for applications, services and users using an organization's existing infrastructure.

Access Control Services provides a claims-based identity model to support single-sign-on, federated identity and role-based access. This service orchestrates the authentication and authorization of users using Windows Live ID, active directory or any other user identity store to support standard identity federation protocols. Access control services comprise three entities: a Security Token Service (STS), administration portal and administration API. STS issues security tokens, administration portal helps use tokens and defines claim types, rules and authorized STS providers. Administration API is used to program and construct configuration settings. Claim based identity management is the future for managing identities and this is enabled by the access control service of AppFabric. So designing applications to accept identity and perform authorization based on claims will enable the integration of applications deployed in the private cloud with those in the public cloud.

Service Bus represents an enterprise service bus pattern designed to operate on highly scalable data centers working within the scope of the internet. Microsoft service bus provides federated identity and access control mechanisms, a dynamic service registry and a robust messaging fabric capable of overcoming the connectivity challenges. An important component of service bus messaging fabric is a centralized relay service supporting many transport protocols and web service standards (such as. REST, SOAP). The relay service provides different relay connectivity options and helps in negotiating peer to peer connections. Service bus functionality is built on top of the Windows Communication Foundation.

The Service Bus provides a secure, standards-based messaging fabric for connecting applications across the Internet, making it possible to pass through difficult firewall and NAT obstacles when necessary. It offers a new set of WCF bindings without significantly altering the rest of the WCF programming model. A few such bindings include Net TCP Relay Binding, Net One Way Relay Binding, Net Event Relay Binding and so on. In short, the service bus enables Windows Azure applications with existing applications and databases; it acts like a bridge for on and off-premise applications and also constructs composite applications.

4. Windows Azure Architecture

Windows Azure is actually the cloud OS that serves as the "development, run-time, and control environment" for the Azure Services Platform. The platform enables developers to build, host, scale, and deploy web applications in the cloud. These can be consumer-level web apps (like Bluehoo, which was demonstrated today) or they can be enterprise applications. The Windows Azure platform is a flexible cloud computing platform that lets you focus on solving business problems and addressing customer needs. This platform can be Used both by applications running in the cloud and by applications running on local systems. Windows Azure is a cloud platform offering that "provides a wide range of Internet services that can be consumed from both on-premises environments and the Internet. Azure Services Platform is an application platform in the cloud that allows applications to be hosted and run at Microsoft datacenters. It provides a cloud operating system called Windows Azure that serves as a runtime for the applications and provides a set of services that allows development, management and hosting of applications off-premises. Windows Azure is a service, Customers use it to run applications and store data on Internet-accessible machines owned by Microsoft. Those applications might provide services to businesses, to consumers, or both. Here are some examples of the kinds of applications that might be built on Windows Azure. Windows Azure is an operating system that serves as the development, service hosting, and service management environment for the Windows Azure platform. The Windows Azure platform consists of an infrastructure of hardware, software, network, and storage resources. Windows Azure handles load balancing and resource management and automatically manages the life cycle of a hosted service based on defined requirements. Developers can build and deploy applications as a hosted service for Windows Azure by using the .NET Framework, unmanaged code, or other approaches.

A Windows Azure hosted service can contain web role, worker role, and VM role instances. As its name suggests, a web role instance can accept incoming HTTP or HTTPS requests and can support web application programming hosted in IIS. Worker role instances are similar to, but not quite the same as a web role. The main difference is that a worker role instances is not hosted by IIS. Instead, they are executable in their own right. A VM role differs from a web role and a worker role, because with these roles, you focus on creating and running your code in an operating system that is managed by Windows Azure; for the VM role, you provide a preconfigured operating system image. Applications can consist of solely web role instances, only worker role instances, only VM role instances, or a combination of all three. When the load increases for your application, you can request more instances of any of the defined roles. By running multiple instances of a role, Windows Azure helps the application scale. Scalability is achieved through virtualization. As you need to scale capacity, you can spin up new virtual machines to

handle the added traffic and when the extra capacity is no longer needed you can release them.
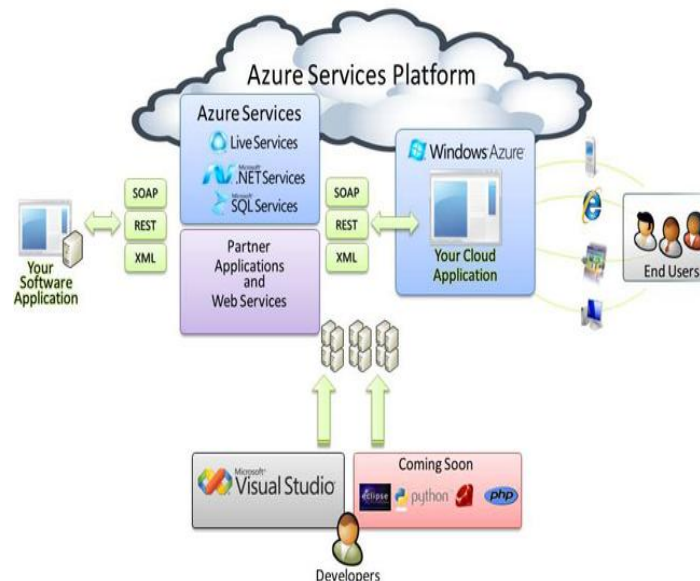

Fig 5. Architecture of Microsoft Windows Azure PaaS Cloud (Source Microsoft)

Windows Azure is Microsoft's operating system for cloud computing. As with other technologies for cloud computing, Windows Azure is intended to simplify IT management and minimize up-front and ongoing expenses. To this end, Azure was designed to facilitate the management of scalable Web applications over the Internet. The hosting and management environment is maintained at Microsoft data centers. Windows Azure can be used to create, distribute and upgrade Web applications without the need to maintain expensive, often underutilized resources onsite. New Web services and applications can be written and debugged with a minimum of overhead and personnel expense. New capabilities can be added 'on the fly' to existing packaged applications. The Azure operating system is the central component of the company's Azure Services Platform, which also includes separate application, security, storage and virtualization service layers and a desktop development environment. A feature called Automated Service Management facilitates application upgrading without compromising performance. Functions such as load balancing, caching, fault tolerance and redundancy are included to ensure high availability. Windows Azure supports a wide variety of Microsoft and third-party standards, protocols, programming languages and platforms. Examples include XML (Extensible Markup Language), REST (representational state transfer), SOAP (Simple Object Access Protocol), Eclipse, Ruby, PHP and Python.

A Windows based environment for running applications in Microsoft data centers. Windows Azure is a cloud platform offering that "provides a wide range of Internet services that can be consumed from both on-premises environments and the Internet.

Azure Services Platform is an application platform in the cloud that allows applications to be hosted and run at Microsoft datacenters. It provides a cloud operating system called Windows Azure that serves as a runtime for the applications and provides a set of services that allows development, management and hosting of applications off-premises. Windows Azure runs on machines in Microsoft data centers. Rather than providing software that Microsoft customers can install and run themselves on their own computers, Windows Azure is a service, Customers use it to run applications and store data on Internet-accessible machines owned by Microsoft. Those applications might provide services to businesses, to consumers, or both. Here are some examples of the kinds of applications that might be built on Windows Azure.

5. Benefits of the Windows Azure Platform

Web / Social: The window Azure Services platform provides web developers easy to use development tools and cloud infrastructure to build rich internet applications targeted for the browser and digital devices. Create socially aware solutions and connect with network of millions live users.

Development Tool: Any web developer can use the platform. Developers familiar with .NET and Visual Studio can their existing skills to extend or create new cloud based applications that dynamically scale. Applications written in PHP or other languages can also run on and take advantage of the Windows Azure infrastructure and services.

Interoperable: Windows Azure services use REST and SOAP web communications standards to interoperate with other platforms and services, run applications on browser, create and expose your own services and utilize the services regardless of platform or programming language.

Power of choice: The Windows Azure platform allows developers to take advantage of one or more combinations of services. New applications or augment on-premises software with cloud services to create a new breed of rich internet based solutions.

Economical: The Windows Azure Platform reduce onsite infrastructure need and allows developers to continue using skills they already know from familiar development tools , all lading to lower cost and faster time to market.

6. Conclusion

Cloud computing brought a significant change to internet generation; it can feel the dramatic impact from the upstream of industry to consumers. Windows Azure provides a Windows-based computing and storage environment in the cloud. In this paper we find

out the Architecture and design of Microsoft Windows Azure platform. These papers also discuss the features and benefits of the windows azure PaaS cloud components. Microsoft's Windows Azure platform with its infrastructure and platforms services will support and drive the development culture shift from on-premise application developers to cloud developers. The Windows Azure platform can gain maturity by addressing the concerns associated with each stakeholder and helping them realize its business value. We believe that Windows Azure platform has a bright future and will go a long way to help realize the power of cloud computing.

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