



CLOUD COMPUTING OPPORTUNITIES, CHALLENGES, AND BEST PRACTICES



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Cloud Computing Overview

Cloud computing is a virtualized computing platform that provides infinite resources (compute, storage, and network) for running your applications. It leverages economies of scale to save you money by only requiring you to pay for what you use.

A major appeal of cloud is that it enables business to get out of the business of maintaining infrastructure. Convergence of advances such as hardware virtualization, Utility and Grid Computing, SOA, and Data Center Automation has led to the advent of cloud computing.

Cloud computing is a key strategy to manage increasing demand for IT services, as businesses face the growth of the digital universe and proliferation of data across the enterprise.

Some of the forces driving companies to cloud computing:

- Increase in consumer connected devices
- Faster pace of market change
- Reduced IT budgets
- Need to innovate and deliver new services quickly and profitably
- Need to increase the amount of available storage that is accessible for archived data
- Number of FTEs needed to support a cloud platform is often dramatically less than a traditional on-premises solution

Opportunities Landscape

In today's world, we see a plethora of use cases for companies to come up with cloud-based solutions as illustrated below.



- Voting system
- Marketing Campaign for newly released products
- WorldCup/Railway/Bus Ticketing system
- Digital Asset Management
- Help Desk solutions
- Food Festival
- ScrumWall
- Home Appliance / Auto dealer
- Gaming Apps
- Cloud-based Social Network
- New website or the next Facebook application
- Dashboard Application
- Fleet Management System
- Travel Application
- DBaaS, Testing-as-a-Service, SPaaS, Storage-as-a-Service, etc.
- IaaS, PaaS, SaaS, XaaS

This list continues to grow; there is a lot of scope for innovation in the Cloud in the near future.

Let's look at some of the major customer challenges, assessment criteria, and migration complexity of existing applications or new apps to be developed on cloud.

Major Customer Challenges

- Unstructured Content: Prepare for digital universe explosion—34.2 zettabytes of growth by 2020
- Distributed Big Data: Aggregate data as a business advantage; manage as one system
- Accessibility: Make available around the globe—from any device—any location

Portfolio Analysis for Assessments

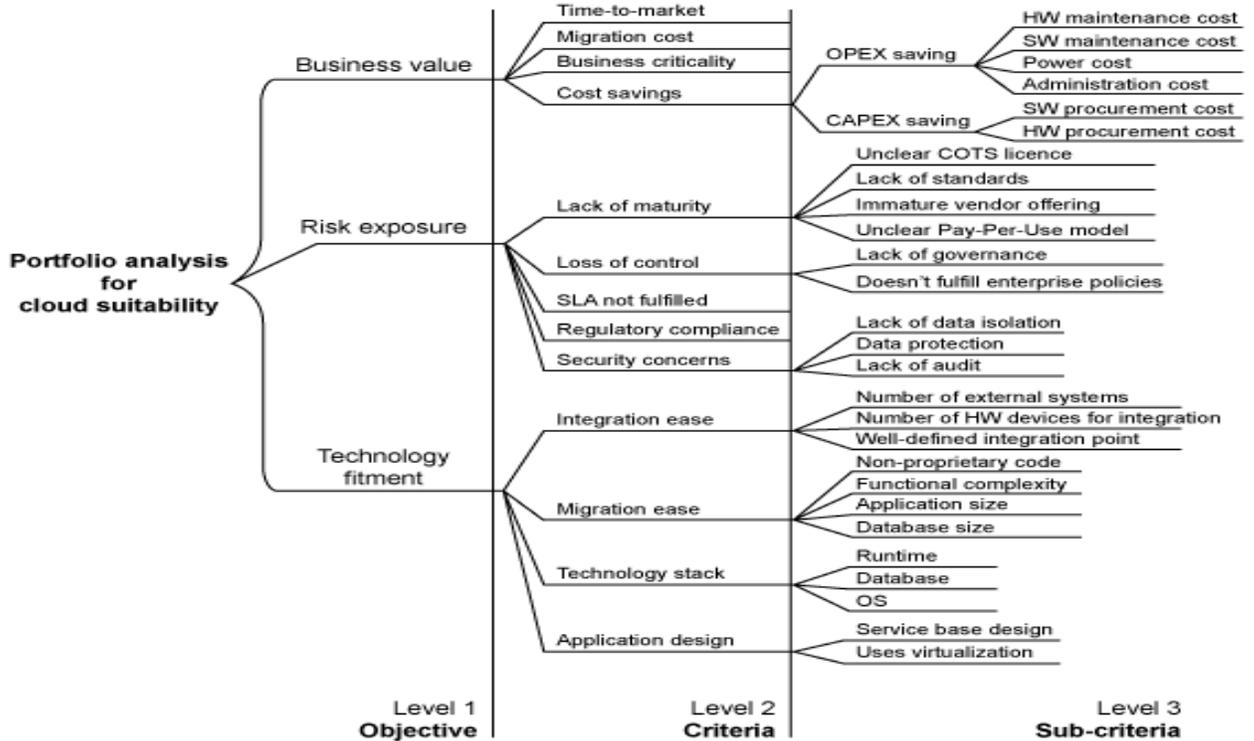


Figure 1

Figure 1 illustrates criteria hierarchy for three dimensions (Business, Risk, and Technology).

By 2014, the largest driver of Cloud IT workloads will be the redeployment of on-premise applications and business productivity capabilities, and migrating traditional workloads, collaboration infrastructure, and general purpose IT infrastructure to public and private clouds.

Migration Complexity

OS	Framework	Runtime	Services	Database & Instance Name	Compliance	Authentication
Windows 7	.NET 2.0	CLR	OData services	SQL Server 2005	SAS 70	Windows
Windows Vista*	.NET 3.0	JVM	WCF	SQL Server 2008	FISMA	Claims Based Auth
Windows XP*	.NET 3.5		WebServices	Access	ISO 27001	OpenID
Windows Server 2008 R2	.NET 4.0		Windows Services	MySQL	HIPAA	FBA(Forms based Auth)
Windows Server 2008	.NET CF			Oracle	PCI DSS	Biometric
Windows Hyper-V Server 2008 R2				Sybase		
Windows Hyper-V Server 2008				SQL Azure		
Windows Server 2003 R2				SQL Server 2008 R2		
Windows Server 2003				SQL Server 2012		
Windows 2000 Server				SQL Express		
Windows 2000 Professional				SQL Azure		
Linux**						
HP-UX						
VMware ESXi						
VMware ESX						
VMware Server v2						



Name
 Web Applications
 Application Size
 3rd party S/W
 Database & Instance Name(SQL Express,SQL Server)
 Database Path
 Database Size
 Server Name
 Application Complexity
 Business Criticality
 Unique Users
 Application Templates Used
 OS
 Framework
 Runtime Services
 Powershell/SQL scripts
 Geographic Constraints
 Data Sensitivity
 Compliance
 Component Dependency
 Component Licensing
 VSTO
 Authentication
 Secure Anonymous Access
 Session State
 MSMQ/MQSeries Usage
 SQL Server Reporting Services
 CLR Stored Procedures
 Extended Stored Procedures
 SQL Server Integration Services
 Domain Accounts
 Logins
 # of External Systems
 # Types of H/W devices
 AD Directory Services
 Uses Local File System
 Long Database Connection
 Database Emails Notifications
 Complex Deployment
 Screenshot Reference
 Migrate?

There are many permutations and combinations to consider before migrating existing applications or developing and deploying new solutions from scratch on Cloud; such as OS and mobile variants, framework, runtime, services, database, compliance, authentication, etc.

From the Application portfolio, we should assess whether the application can be migrated or not based on the business value, technical complexity, and risk factors.

Typically, we have 5-step process:

1. Select Candidate Applications
2. Determine Migration Complexity
3. Plan Migration
4. Build Prototype Applications
5. Migrate Cycle

A number of potential migration scenarios exist in today's business world. In some cases, many existing applications are redundant or unused. So don't be intimidated by high application counts—many are redundant, irrelevant, or unused. Also, process applications that include sophisticated logic are often a minor percentage of the pie, +/- 10%.

Challenges

- Selecting a Cloud Service Provider (CSP)
- Security and Compliance
- License Issues
- Migration
- Security Concerns and Threats
- Multi-tenancy
- Chargeback model
- Governance, Risk, and Compliance (GRC)
- WAN optimization/performance
- Cloud Federation
- Develop/Manage Team

Key challenges include:

Selecting a Cloud Service Provider (CSP)

- How easy is it to add/remove services?
- Does the provider have good customer service support?
- What happens when the provider upgrades their software? Is it forced on everyone? Can you upgrade on your own schedule?

Security and Compliance

- Does the system contain highly sensitive data or data that is subject to regulatory restrictions?
- Does the application have geopolitical restrictions?
- Identify risk tolerance and security threats for an application.
- Understand regulatory/contractual obligations to store data in specific jurisdictions.
- Explore whether the Cloud Vendor offers
 - choice of selecting geographic location to store the data.
 - guarantee that data doesn't move unless the organization decides to move.
- Explore options to retrieve all data from the cloud when required.
- Identify the download or delete option of data, if required.
- Identify the choice of encryption of data when in transit and at rest.

Security Concerns and Threats

- Multi-tenancy
- Velocity of Attack
- VM Theft and Escape
- HyperJacking
- Data leakage
- Denial of Service (DoS) attack

WAN Optimization/performance

Bandwidth, congestion, latency, and dropped packets are common challenges associated with replicating data across an IP wide area network(WAN). These problems can impede replication processes or prevent them from happening entirely. These issues can also increase WAN infrastructure and support costs, which have a significant impact on the total cost of ownership (TCO) for offsite data protection.

Combining EMC industry-leading replication products with Silver Peak's data center-class WAN optimization solution enables enterprises to protect more data across longer distances. In addition, replication can be performed over cost-effective shared WANs, resulting in significant cost savings.

The joint EMC and Silver Peak solution is a good fit for business when:

- Disaster recovery traffic is competing with other applications for shared WAN resources.
- Initiatives are in place to improve Recovery Time Objective (RTO) and Recovery Point Objective (RPO) across the WAN.
- Replication traffic is consuming too much WAN bandwidth.
- WAN bandwidth accounts for a significant portion of total disaster recovery costs.

Cloud Federation

Cloud Federation is the key to maximizing agility and efficiency to enable easy movement of workload and services between different IT infrastructures within the enterprise and ultimately moving workloads between private and public clouds.

Also, we have challenges in cloud-to-cloud synchronization as data can be shared between multiple databases, irrespective of whether the databases are in the same data center or span multiple geographic regions.

If the assumption is that the company is already virtualized, how do we analyze the current virtual infrastructure, not just the applications and VMS?

- What is the layout of the existing infrastructure?
- Will it support cloud?
- Current Hypervisor? Are there more than one?
- Why was it designed that way originally?
- How much are you paying now?

Develop/Manage Team

Cloud computing puts even greater pressure on IT professionals—Developers/Architects/PM/Business Analyst/Tester—to acquire business skills. Key considerations to develop and manage the team include understanding and gaining deeper skills in:

- Various cloud service models and service model architectures.
- Synchronization of data.
- Security implications of cloud-based applications as well as the data storage options available.
- Good resource allocation, potential cost impact of different architectural decisions.
- Deployment models and upgrading.
- How to migrate existing applications, services, and data.
- Diagnostics and health of applications and services.
- How to integrate cloud applications with external resources.
- Re-architecting existing applications, services, and data.

Cloud Service Architecture – Building Blocks



Figure 1

Figure 1 shows typical cloud building blocks, Cloud Service Consumers, and Cloud Service Delivery teams to be considered as part of the architecture. It also depicts components as Service Management Orchestration and Business Service Orchestration on top of the Service Automation layer.

Cloud Management is very challenging in the current environment where most services are being offered using cloud computing technology. Services such as computing, managing data centers across different locations, scalability, security, and monitoring applications and processes are available from a number of Cloud Management Tools vendors.

Best Practices

- Involve security advisor early in the process
- Validate your approach in the cloud early on
- Run a minimum of two server instances for high availability
- Take advantage of data center affinity
- Migrate applications one tier at a time
- Understand the security requirements of the service being designed or migrated
- Leverage CDNs, as it can result in large performance benefits for many systems
- Use the “Gatekeeper” design pattern to separate role duties and isolate privileged access
- Use Application Blocks such as Autoscaling and Fault Transient Handling
- SOA best practices apply to the cloud
- Plan for world-class physical security for data centers such as 24x7 secured access, electronically controlled access systems, video camera surveillance, motion sensors, and security breach alarms
- Use the best cloud management tools for troubleshooting and debugging cloud-based solutions
- Align to open and interoperable standards and collaborate with the Open Data Center Alliance
- Trade-offs for sending emails using SMTP
- Cloud strategy

Now, let’s look at a few scenarios that must be well thought out when proposing cloud-based solutions.

PaaS

Platform as a Service (PaaS) provides not just infrastructure but also a platform to help reduce configuration and change management, server administration, network administration, storage management, backup and disaster recovery management, security (physical & logical), and facilitates management. Try to leverage existing benefits of PaaS and quickly build SaaS solutions.

Data Security Analysis

Regardless of data security constraints, it is essential to conduct a thorough data security analysis of the existing system prior to migration. This analysis should include an examination of the security of all data used in the system. There are three main areas to be analyzed. It is common for a system to require all three but each should be examined in turn to ensure the application reaches the level of protection desired. The three areas are:

1. Storage security – This is how the data is stored when it is not being used. The two most common methods to resolve these concerns is to use access controls to ensure only the proper individuals access the information or to use encryption when access controls alone are not sufficient.
2. Transmission security – This refers to how the data is moved from one place to another. This often refers to how it moves from storage into the process that needs the data but can include other transmissions. The most common resolution for this concern is to use Secure Sockets Layer (SSL).
3. Active security – This refers to the security of data when it is “in-memory” and being used by the application processing the data. This level of security can range from ensuring removal from memory when no longer needed to full encryption even while being accessed. There are numerous methods for resolving this concern.

Content Delivery Network

The Content Delivery Network (CDN) caches frequently used Blob data in various locations around the world so that delivery of that content to the end user can be done as quickly as possible.

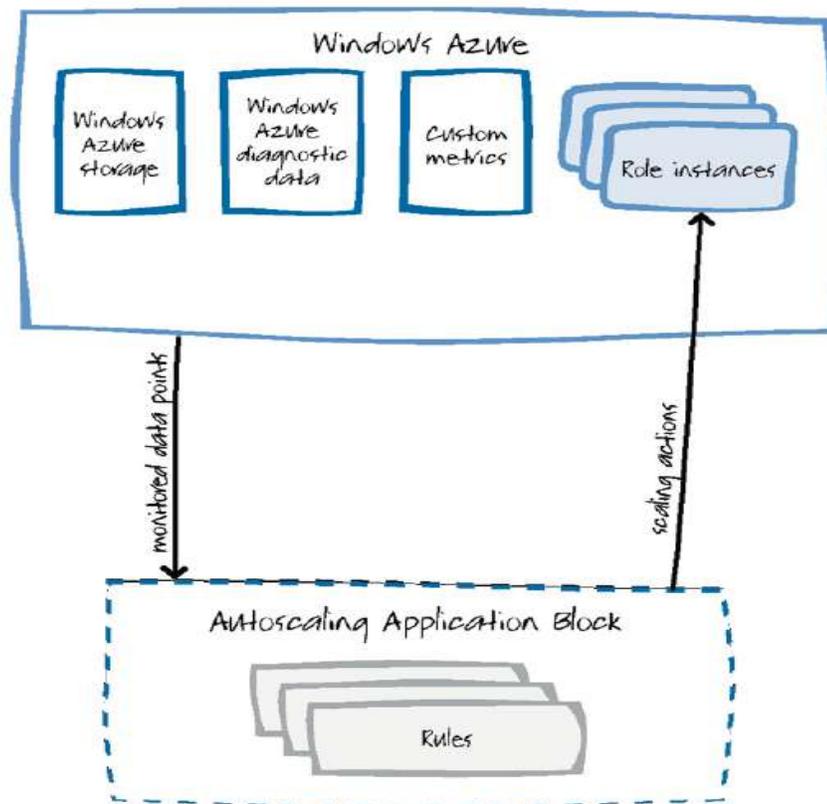
For instance, if you load a file into a Blob in the North Central US data center, all requests for that data will need to be routed across the Internet to that location. If a user is in Australia, that request may take longer because of the lengthy journey. If the CDN is utilized, that blob may be cached in another location much closer to Australia. Perhaps there may be a CDN node in New Zealand; when the user in Australia requests the data, the request will be routed to New Zealand instead of having to travel all the way to the United States.

CDNs, understandably, can have large performance benefits for many systems. However, if you have data that falls under one of the geo-location concerns described above you should be careful using the CDN since the data will be cached, for a time, in various locations outside of your control. This temporary cache may be delayed for some users depending on their location in relation to the CDN.

Application Blocks (Autoscaling and Fault Transient Handling)

Enterprise Library provides many highly configurable features that make it much easier to manage repetitive tasks—known as crosscutting concerns—which occur in many places in applications. These tasks include logging, validation, caching, exception management, and more.

- The Autoscaling Application Block helps automatically scale your applications.
- The Transient Fault Handling Application Block helps make your applications more resilient when they encounter transient fault conditions.



The Autoscaling Application Block and Windows Azure

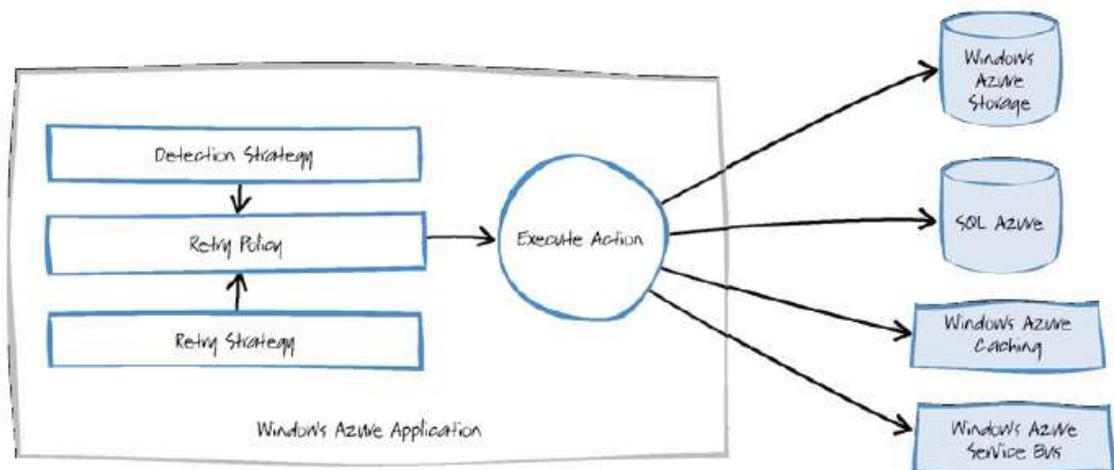
The Autoscaling Application Block supports the following techniques for handling varying load levels:

- **Instance Scaling.** The Autoscaling Application Block varies the number of role instances to accommodate variations in the load on the application.
- **Throttling.** The Autoscaling Application Block limits or disables certain (relatively) expensive operations in your application when the load is above certain thresholds. These two autoscaling techniques are not mutually exclusive; both can be used to implement a hybrid autoscaling solution in your application.

What Are Transient Faults?

When cloud-based applications use other cloud-based services, errors can occur because of temporary conditions such as intermittent service, infrastructure-level faults, or network issues. Very often, if you retry the operation a short time later (maybe only a few milliseconds later) the operation may succeed. These types of error conditions are referred to as transient faults.

Transient faults typically occur very infrequently, and in most cases, only a few retries are necessary for the operation to succeed. Unfortunately, there is no easy way to distinguish transient from non-transient faults; both would most likely result in exceptions being raised in your application. If you retry the operation that causes a non-transient fault (for example a “file not found” error), you most likely get the same exception raised again.



The Transient Fault Handling Application Block

Built-in retry strategies allow you to specify that retries should happen at fixed intervals, at intervals that increase by the same amount each time, and at intervals that increase exponentially but with some random variation. Table 1 shows examples of all three strategies.

Retry strategy	Example (intervals between retries in seconds)
Fixed interval	2,2,2,2,2,2
Incremental intervals	2,4,6,8,10,12
Random exponential back off intervals	2, 3.755, 9.176, 14.306, 31.895

Table 1

All retry strategies specify a maximum number of retries after which the original exception is allowed to bubble up to your application.

Long connections to a database may close unexpectedly. There could be a variety of reasons related to network connectivity between the client and the remote data center: quality of network, intermittent network faults in the client's LAN or WAN infrastructure, and other transient technical reasons.

All application communication with the database should include logic to validate the connection and retry on disconnection.

Open Data Center Alliance

The Open Data Center Alliance (OCDA) is working actively to shape the future of cloud computing—a future based on open, interoperable standards.

OCDA is an independent organization created in 2010 with the assistance of Intel to coordinate the development of standards for cloud computing. Approximately 100 companies, which account for more than \$50bn of IT spending, have joined the Alliance, including BMW, Royal Dutch Shell, and Marriott Hotels. The Alliance's Cloud 2015 vision is aimed at creating a federated cloud where common standards will be laid down for those in the hardware and software arena.

The ODCA also hope to lay the foundation for a set of future work by the ODCA Data Services Working Group (DSWG). ODCA's DSWG was established in 2012 to bring solution providers and big data consumers (enterprises) together to help drive the creation of Big Data technologies that are open and standards-based, with a greater degree of interoperability and cost effectiveness for large enterprises in line with the overall mission of the Alliance.

To find out more about the ODCA Data Services Working Group, please visit www.opendatacenteralliance.org.

Is the application sending emails using SMTP?

Many systems need to send emails for various reasons including notifications, alerts, and various integration scenarios.

Why?

Traditionally, corporate email is sent in a secured manner through the corporate intranet and then delivered via the Internet as necessary. Security between the application and the SMTP server is often sent without TLS or SSL since the communication channels are considered secure within the corporate intranet. Moving these communication channels outside the corporate intranet—and firewall—will often require implementing additional security measures.

Also, most recipient mail systems implement a number of spam prevention measures designed to reject, delay, or ignore messages that do not comply with their system's email policy.

Remedies

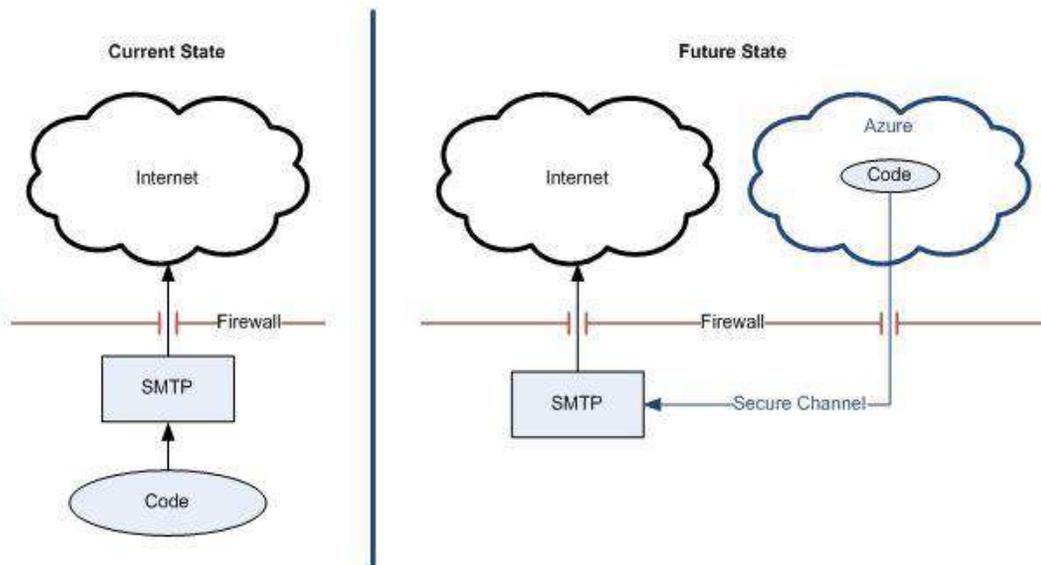
There are a number of remedies that could be applied to this situation. The most appropriate remedy will depend on the specific needs of the application.

Leverage existing (on-premises) SMTP servers

In most cases the SMTP infrastructure and corporate domain email policies continue to reside on-premises. Applications wishing to send emails from the corporate domain are often simplified by being able to route these emails through the existing on-premises SMTP servers. Each of these options requires establishing a secure communication channel between the application and the SMTP server.

Expose SMTP relay to the Internet but secure via TLS / SSL

The security of the corporate SMTP relay could be changed to allow the cloud application access from outside the corporate firewall. Thus, the application would continue sending emails through the current SMTP relay but the communication would be secured using TLS and SMTP AUTH.



However, with this option, care must be taken to ensure the mail relay is not opened to an extent as to allow insecure access to the mail system. Also, the SMTP AUTH credentials will need to be kept securely by the application.

Cloud Strategy

Your cloud strategy must answer some important questions.

- How do I compare cloud costs to my current Enterprise costs?
- How do I determine which applications go where?
- How do I enable my applications for the cloud?
- How do I protect my information and that of clients?
- Can cloud really change my business?

Birds-eye view of Cloud - Key consideration to Knowledge Areas (KAs) of PmBOK

PmBoK KA's	Cloud Computing Key Considerations
Integration Management	EEF & OPA will have cloud components that need consideration; Understand the usage pattern and optimize resource consumption, Relinquish idle resources
Scope Management	Multi-tenancy, Capacity Planning, Chargeback model, Identity Management, Cloud performance consideration
Time Management	Time required for choosing the CSPs, service models (IaaS, PaaS, SaaS), and their integration impact needs to be considered for Project Schedule.
Cost Management	Understanding various pricing options and hidden charges—connectivity and additional services, foreclosure terms, and long-term TCO—needs careful consideration. Use existing license- /SaaS-based Cloud service, ROI calculator
Quality Management	Understanding the SLAs, service management processes for the cloud services, governance model
HR Management	Challenges for HR & PM; multiple PM roles and responsibilities (Cloud Service Provider PM / Network and Security PM / Performing Organization PM), Staffing challenges, Develop and Manage Teams with Cloud Skills
Communication Management	Cloud-based tools (ScrumWall, TFS, Office 365, Social collaboration, Portals)
Risk Management	Geopolitical restrictions, Regulatory Compliance, Interoperability, Supportability, Security & Availability, Business Continuity & Disaster Recovery(DR) options for Production Sites
Procurement Management	Clear knowledge on Cloud Services Pricing Model, IaaS Provisioning aspects

It's important to follow all the knowledge areas for successful product delivery and acquire deeper skills in functional domain, ROI, consumer centricity, strategic outlook, and broader vision of the product.

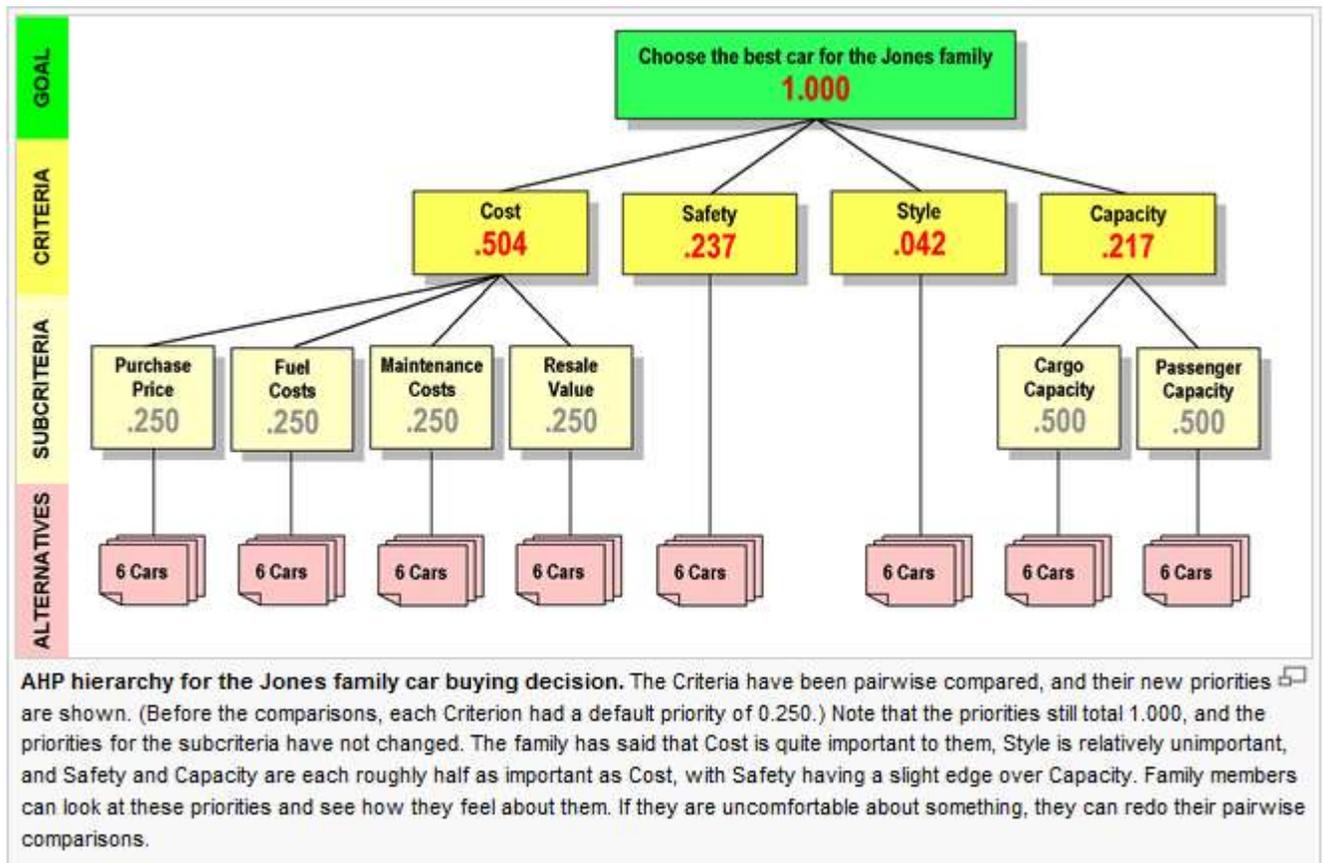
Tools and Techniques

Accelerator Toolkits are important and very much in demand these days especially for Windows Phone, iOS, Android, social games, etc. as the companies have a strong need to innovate and deliver new services quickly and profitably.

Analytic Hierarchy Process (AHP) is one of multiple criteria decision-making methods originally developed by Prof. Thomas L. Saaty (1977). As we have complexity involved in migrating on-premise applications to cloud and developing new applications, AHP comes in handy to come up with accurate Work Break-down Structure (WBS) and estimates to share with stakeholders.

A practical example: choosing an automobile

In an AHP hierarchy for a family buying a vehicle, the goal might be to choose the best car for the Jones family. The family might decide to consider cost, safety, style, and capacity as the criteria for making their decision. They might subdivide the cost criterion into purchase price, fuel costs, maintenance costs, and resale value. They might separate Capacity into cargo capacity and passenger capacity. The family, which for personal reasons always buys Hondas, might decide to consider the Accord Sedan, Accord Hybrid Sedan, Pilot SUV, CR-V SUV, Element SUV, and Odyssey Minivan as alternatives.



Why AHP?

AHP can be used for various scenarios such as:

- Cost/Benefit Analysis
- Strategic planning
- R&D priority setting and selection
- Technology choice
- Investment priority
- Priority for developing tourism
- Evaluation of new telecommunications services
- Choosing an automobile

AHP technique can also be applied for better management of Cloud Disaster scenarios; namely, crisis avoidance, crisis management, and disaster management.

Another scenario can be in software testing. Most software testing takes place at a relatively low level. Testing an application's individual methods for functional correctness is one example. However, some important testing must take place at a very high level—for example, determining if a current build is significantly better overall than a previous build. A powerful technique such as analytic hierarchy process will enable you to perform high-level quality analysis of software systems.

Conclusion

- Cloud computing is the technology of the future. It's changing the way technology supports the business. Yet embracing that technology requires strong project management leadership and technical expertise to ease the transition for stakeholders and end users.
- Cloud computing puts even greater pressure on IT professionals—Developers/Architects/PM/Business Analyst/Tester—to acquire business skills.
- Key benefits of cloud computing include reduced IT cost, business agility support, flexible scaling, high availability, and lower energy consumption.
- To reap the benefits of cloud projects, organizations must define strategic goals, address risks, and carefully monitor progress through implementation and beyond. Only when they follow these vital project management steps can they achieve the greatest ROI in cloud computing and communicate that success

across the organization. Also, it becomes important to align cloud solutions to security compliance standards such as SAS-70 Type II, ISO 27001, and so on.

Summary

This article provides insight on cloud computing, opportunity landscape, customer challenges, and best practices to be followed for cloud solutions. It covers portfolio assessment criteria, migration complexity involved in developing applications on cloud, and typical cloud service architecture building blocks. Tools and techniques such as Analytic Hierarchy Process (AHP), mapping key cloud areas to nine knowledge areas (KAs) of PmBOK, and patterns to be considered for organizations moving onto cloud are also discussed. The article also highlights key aspects to consider for team development and management during cloud adoption.

Appendix A – Abbreviations

AHP	Analytic Hierarchy Process
BLOB	Binary Large Object
CAPEX	Capital Expenses
CDN	Content Delivery Network
CIO	Chief Information Officer
CSP	Cloud Service Provider
DR	Disaster recovery
EEF	Enterprise Environmental Factors
FTE	Full Time Employee
GRC	Governance, Risk, and Compliance
HR	Human Resource
IaaS	Infrastructure as a Service
KA	Knowledge Area
M&E	Media and Entertainment
MCDM	Multi-Criteria Decision Making
ODCA	Open Data Center Alliance
OPA	Organizational Process Assets
OPEX	Operational Expenses
OS	Operating System
PaaS	Platform as a Service
PM	Project Manager
PmBOK	Project Management Body of Knowledge
PMIS	Project Management Information System
ROI	Return on Investment
RPO	Recovery-Point Objective
RTO	Recovery-Time Objective
SaaS	Software as a Service
SLA	Service Level Agreement
SOA	Service Oriented Architecture
SSL	Secure Socket Layer
TCO	Total Cost of Ownership
WAN	Wide Area Network

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Patterns & Practices Windows Azure Guidance

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MSDN Source for article on The Analytic Hierarchy Process by James McCaffrey

Cloud Computing will destroy jobs?

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Author's Biography

Lokesh SG is an EMC Professional Services Senior Consultant. He has been in the IT industry for 14 years, at EMC for 3.5 years. He has experience in Solution Architecting on Windows- and Web-based applications (Portals & Collaboration) in domain areas such as GPS,GSM, USB, Mobile, Automotive, and Medical applications with emphasis on Delivery, Consulting, Pre-sales, People, and Project Management. Active involvement in Cloud Computing related to RFPs and Windows Azure (cloud-based) Assessment projects. Lokesh possesses a Masters degree in Computer Science & Engineering and industry certifications from Microsoft and PMP certified. He also holds EMC Proven Professional Cloud Infrastructure and Services certification.

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