

## Cloud Solutions – Infrastructure, Platform or Software: Where should you go?

### Introduction

According to PRNewswire, 90% of medium to large enterprises plan to increase or maintain annual spending on cloud computing solutions in 2016, with 47% of those surveyed citing increased efficiency as the main reason [1]. Clearly cloud computing is here to stay. Furthermore, according to Bernard Golden of CIO Magazine, the battle of the infrastructure is over, applications will be the push going forward. [2] More and more organizations are starting to move their applications into the cloud.

Cloud Computing as defined by National Institute of Standards and Technology (NIST):

*“Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.”[3]*

Although the term cloud computing is relatively new, the concepts and technologies behind cloud computing have been emerging and evolving for some time. Consumers of cloud computing access hardware, software and networking capabilities from a third party provider in much the same way they get electricity or water from their utility companies. This utility computing model offered in the cloud is likely to bring benefits – especially to small and medium enterprises as well as startup businesses. In addition to the cost saving associated with not having to purchase the hardware, software and infrastructure associated with running a business, cloud solutions bring agility, scalability, portability and on-demand availability.

While the potential for cost savings is real, there is no such thing as a free lunch. A company with firmly entrenched legacy systems needs to think about the trade-offs associated with migrating from the status quo into the cloud. Migration could spur a host of activities. These include issues of installation and configuration, possible code changes, migration of data, integrations with other systems not to mention the changes in business processes and culture that are sure to occur.

Migration of capability to the cloud comes with several planning and management challenges. How does an organization determine the right solutions to migrate and the right platform for migration? What challenges do the various cloud solutions present: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), or Software as a Service (SaaS). This paper intends to delve into the specifics of each of these three cloud solutions; the challenges, benefits and obstacles. The second section of this paper provides a brief overview of cloud computing and presents the different types of cloud platforms. Section three goes into the particulars of Infrastructure as a Service, Platform as a Service and Software as a Service. Section four presents a case study showing how each of these models might be evaluated by an organization considering a migration of specific capability to the cloud. Section five contains a general discussion about the limitations of the case study, other cloud related considerations and final thoughts on the subject.

## Cloud Computing

According to NIST, cloud computing delivers five essential characteristics [3]:

- On demand self-service – required IT resources are available when and where they are needed
- Broad network access – all one needs is a browser and a network connection to get to their applications and data.
- Resource pooling – the location of the data centers is irrelevant – allowing cloud providers to pick locations where real estate and power are affordable
- Rapid elasticity – through virtualization and distributed processing the offerings expand and collapse based on the users requirements for resources
- Measured service – infrastructure is in place to monitor and measure service deliveries – with automatic correction and optimization.

Chances are good that you are already a consumer of cloud computing in some form or fashion. If you have a gmail or Hotmail account, you are using a browser based system to access your mail which is stored in a datacenter somewhere in the world. The pictures, messages and videos that you post to Facebook, Twitter, Instagram, etc. are similarly housed in the cloud.

Clouds can be classified into one of three categories:

- **Public Cloud** – available to any user of the Internet willing to meet the terms and conditions of the cloud service provider. A key characteristic of public cloud computing is multi-tenancy which is an architecture in which one instance of a software application may service multiple customers.
- **Private Cloud** – cloud computing infrastructure and technologies are maintained and operated for a single organization, department or agency. The private cloud could be housed on premise or remotely and could be run by internal IT resources or a cloud computing provider. Private cloud applications service a single customer.
- **Hybrid cloud** – this is an intermingling of private and public clouds in a way that allows organizations to take advantage of public cloud benefits where appropriate, while utilizing private cloud and/or on premise systems for applications that are poor candidates for the public cloud (because of data rights, legal issues, security, etc.)

## Picking the right ‘as a Service’

In addition to there being three different types of clouds as described above, there are also three different cloud solution offerings which are briefly described here:

- **Infrastructure as a Service** - Computer infrastructure is accessed via the cloud. Cloud providers manage the hardware and network, cloud consumers manage runtime, data, applications and security.
- **Platform as a Service** – Development environment is accessed through the cloud. Cloud providers manage all of the infrastructure, supporting software and runtime environment, cloud consumers manage the data and applications.

- **Software as a Service** – Software applications and data are accessed through the cloud. Cloud provider provides the entire software stack, cloud consumer runs the application through a browser or front end (usually on a mobile device) and stores their data in the cloud provider's data centers.

Figure 1 depicts the different cloud models indicating which responsibilities lie with the cloud provider and which lie with the cloud consumer

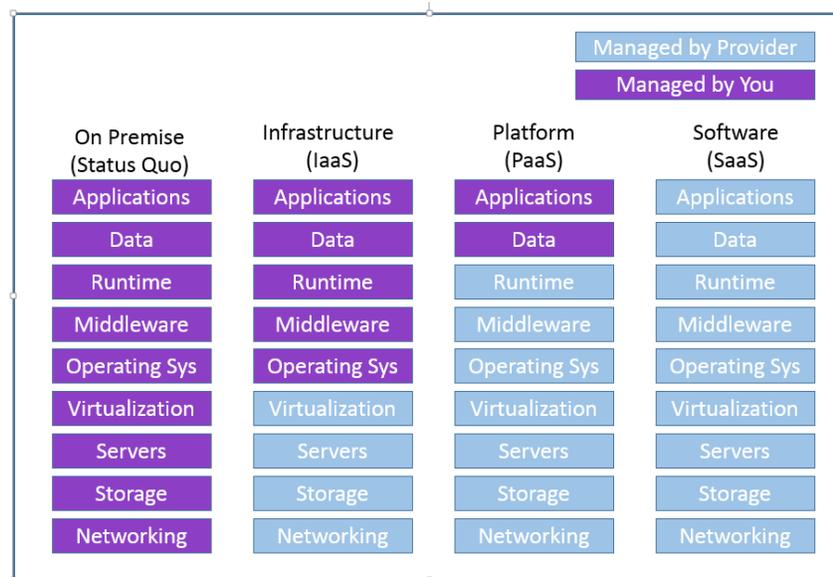


Figure 1: Cloud solution models

## Infrastructure as a Service

Infrastructure as a Service is the most versatile of the three solutions with respect to providing an environment where the cloud consumer has nearly unlimited flexibility with respect to the solutions they deploy on the IaaS. It provides a self-service model where the consumer can access, monitor, and manage infrastructure from a remote data center. Consumers purchase computing power, storage space, networks and networking services, using some type of consumption model. In addition to being responsible for the maintenance of all the hardware resources, the IaaS provider is also responsible for virtualization.

The IaaS consumer is responsible for everything else. They need to manage the Operating System, runtime environments, middleware, applications and data. An organization transitioning from on premise to IaaS will still need to maintain most if not all of their in-house IT skill sets. Basically one can think of IaaS as a direct translation of data center capabilities into a cloud environment, appealing to operators who are left to make decisions about how many virtual servers are required and proper network topology.[4] An organization would choose an IaaS to reduce operational costs associated with care and feeding of the hardware needed to run their business.

Obviously, the effort to migrate an application to an IaaS will be significant. The technician starts by getting virtual machine(s) provisioned and installing the database management system. Any necessary operating systems, middleware or runtimes that are not installed need to be installed. The database needs to be provisioned and configured before the application can be deployed. Load balancing and management of virtual machines and database management systems is also the responsibility of the cloud consumer – including issues associated with updates, service packages and backups. It should be noted that some IaaS solutions do include operating systems and database management systems but not all. Consumers need to make sure they understand what is and isn't available from their vendor.

While there's a fair amount of overhead that needs to be accomplished to prepare for an application migration to IaaS, there is an upside. Because the entire software stack can be migrated to the IaaS, including operating system, middleware, database, etc. moving the application itself to the cloud platform can often be accomplished with less drama than PaaS. Of course, if the application is not designed to take advantage of cloud features such as virtualization and scalability, rework of the application will be necessary to address these issues.

IaaS from the public cloud has huge potential for cost savings. Instead of an organization provisioning all of the hardware and infrastructure they need for peak demand, they are able to pay as they go. And since the cloud providers have many customers taking advantage of their IaaS services, the costs get shared by all the consumers. IaaS allows organizations to divorce themselves from their hardware – making it possible to be more mobile and more global.

### Platform as a Service

Platform as a Service creates an environment that allows the developers of products to take a step away from the IT distractions associated with product development and truly focus on the business logic of the products they are developing. Organizations that use PaaS develop and deploy their applications in a cloud environment taking advantage of cloud characteristics such as scalability, multi-tenancy and high availability. Many SaaS application providers use PaaS to develop and deploy their SaaS solutions. PaaS providers supply all of the hardware and software necessary to build, test, deploy and execute applications; PaaS consumers write and manage the application and associated data.

In general a PaaS environment provides a very feature rich environment for development, testing and deployment of applications, usually across multiple development and runtime environments. Most of the software stack is provided by the PaaS provider, with many services and API's available to construct an application. Rather than writing a ton of code, the programmer only needs to write code to implement the business logic then assemble the rest of the services to support and deliver that business logic. The types of middleware services available to PaaS consumers include database management, integration services, business process management, business analytics, etc. Another PaaS benefit is governance within the enterprise since it naturally enforces development policies and procedures across languages and frameworks.

The process to migrate or deploy an application to a PaaS environment is quite simplified as compared to an IaaS. The programmer needs to provision the database and create tables then deploy the application.

A downside of PaaS is that the development is constrained to the development tools provided by the PaaS provider. In the case of a migration this may be problematic if the application being migrated was developed in a different programming language (even possibly a different version of the same programming language) or requires services not available through the PaaS. As with IaaS – applications that are not developed to handle virtualization or those that don't have a suitable GUI for browser based execution may also require rework. As an organization transitions from localized application to PaaS, the skill set of the development team should transition as well to address skills specific to architecting and developing cloud based applications.

Because the developer is freed from the many distractions associated with traditional development, PaaS solutions can create an environment of extreme agility with rapid deployments, more frequent deliveries of functionality using continuous integration and automated testing, and automatic application deployments.

### Software as a Service

Software as a Service is the most restrictive type of a cloud solution in that the consumer is only able to run and configure the application. The SaaS provider assumes all responsibility for providing, executing and maintaining the application and all associated data. Many SaaS applications are accessed by the consumer using a web browser interface but it is not uncommon for the SaaS providers to offer specialized front end applications especially in cases where the application is likely to be accessed from a mobile phone or tablet. The front end application accesses the SaaS through the use of an API. It is also interesting to note that it is becoming more common for SaaS providers to publish APIs for their solutions to be accessed via applications written independently of the SaaS. [5] These APIs allow for tailoring, customization and extension of the SaaS capability.

There is really no technical skills required to use a SaaS solution, one just turns on the browser and takes off. The consumer may need to do some tailoring and configuration to conform the SaaS solution to their business operations. In the case of a migration from a home grown solution to a SaaS solution, the migration of data to the SaaS solution would be necessary

### IaaS, PaaS, SaaS Case Study

With a better understanding of the differences between the three flavors of cloud solutions, it is time to consider how an organization wishing to move capability to the cloud would determine which way to go. Certainly there a lot of factors to be considered including but not limited to:

- Current on-going costs of the capability to migrate
- Cost to accomplish the migration
- On-going costs after the migration
- Skills of the technical staff (familiarity with cloud solutions, etc.)
- Flexibility of the organization with respect to the capability being migrated
- Suitability of this capability for cloud deployment (proprietary data, data rights issues, etc.)

Consider the following scenario:

*The Ajax Company sells widgets. They have 100 employees doing sales and sales support. They have 5000+ customers worldwide. They currently use Seibel for Customer Relationship Management (CRM) along with a custom application they have developed to handle internal reporting requirements and analysis functions. For some time business leaders have seen the value in moving to the cloud and see CRM as a good place to start. They have been concerned as to how this would impact this custom capability on which they have become very dependent. At this time they have decided to do a more detailed analysis of what a move to the cloud would entail and what the benefits would be. For completeness they have decided to consider the various cloud platforms before deciding. The options they are considering include:*

- 1. Status quo - Stick with Seibel*
- 2. SaaS - Migrate to Salesforce.com and create an interface with their custom application using Salesforce.com APIs*
- 3. PaaS – Migrate to Salesforce.com and use force.com to develop and integrate report and analysis capability with their Salesforce database*
- 4. IaaS – Migrate the entire solution to Rackspace*

*Ajax has decided to do a 5 year cost projection for each of the four scenarios mentioned above. This projection will include*

- Recurring costs to use the solution (licensing or cloud service fees)*
- Costs of personnel devoted to IT Operations and Programming as related to support of the CRM process*
- Estimated costs of migration for each of the 'aaS' options*
- Estimated costs for support of servers devoted to the CRM operations*

*For simplicity all other costs are assumed to be the same in all four cases. Costs for migration activities, training and equipment maintenance will be estimated using a commercial estimating tool – TruePlanning® though the methodology and thought process can be applied with any commercial or home grown estimating process.*

## **Status Quo – Stick with Seibel and the custom application**

The current situation has three technicians and two programmers full time supporting the entire enterprise. They currently have 3 servers and 125 end user devices that are being supporting – one of these servers is devoted exclusively to the CRM activity. They approximate that 40% of the IT technicians' time is dedicated to activities related to CRM operations including maintenance of server, updates, upgrades, database maintenance and configuration, internal help desk support, etc. They estimate that 50% of the programming time is spent maintaining and updating the custom application. They have 100 Seibel licenses at a discounted annual rate of \$1000 per user. Based on all this, the five year projection of costs for the status quo is shown in Table 1 based on the following calculations

The following assumptions were made to get to this estimate:

- 2% annual inflation

- IT Tech salary at 50K annually with 130% burden (40%\*3\*50000\*2.3)
- Programmer salary 80K annually with 130% burdening
- 33% of cost model spread for server maintenance costs (as one server is devoted to CRM)

	Five Year Cost	2016	2017	2018	2019	2020
Licensing	\$ 520,404	\$ 100,000	\$ 102,000	\$ 104,040	\$ 106,121	\$ 108,243
IT Operations	\$ 718,158	\$ 138,000	\$ 140,760	\$ 143,575	\$ 146,447	\$ 149,376
Development	\$ 957,543	\$ 184,000	\$ 187,680	\$ 191,434	\$ 195,262	\$ 199,168
Server Maintenance	\$ 96,884	\$ 19,560	\$ 19,224	\$ 17,202	\$ 24,455	\$ 16,443
<b>Total</b>	<b>\$ 2,196,105</b>	<b>\$ 422,000</b>	<b>\$ 430,440</b>	<b>\$ 439,049</b>	<b>\$ 447,830</b>	<b>\$ 456,786</b>

Table 1: Five Year project for status quo

## SaaS – Migrate to Salesforce.com and create interface to custom application

This would be the simplest migration though it would come with some costs. Time would be required for IT technicians to come up to speed with respect to the data migration effort as well as actually accomplishing that migration. It was decided to outsource the integration with the custom software integration to a firm familiar with the Salesforce API. The Custom application is approximately 500 Function points and it is determined that approximately 10% of that functionality would require modification for the integration to Salesforce API. There would also be training associated with the end user base. Taking all this into account an estimate was prepared of the total cost to Ajax of the Migration as shown in Figure 2.

The screenshot shows the 'Results' window in Microsoft Project. The left pane displays a 'Product Breakdown Structure' with a tree view containing: Migration to Salesforce.COM, Migration Effort, Migration Oversight, Migration Integration and Testing, Data Migration, End User Training, and Integration with Salesforce API. The right pane shows a summary table for the project.

Migration to Salesforce.COM		3/1/2016	4/1/2016	5/1/2016	6/1/2016
Cost:	\$89,868	100.00%	Labor Requirement:	757.32	hours
Project Cost:	\$89,868		Project Labor Requirement:	757.32	hours
Phase Set: A		Worksheet Set: A			
Costs (No Roll-Up Included) : Migration to Salesforce.COM - [System Folder] Currency in USD (\$) (as spent)		<b>Total</b>			
1	Migration Oversight	9,734	2,106	2,847	2,824
2	Migration Integration and Testing	42,249	4,229	7,083	10,695
3	Data Migration	9,082	2,068	3,443	2,463
4	End User Training	10,170	5,059	2,565	2,544
5	Integration with Salesforce API	18,633	4,967	7,487	6,179
6	<b>Total</b>	<b>89,868</b>	<b>18,430</b>	<b>23,425</b>	<b>24,704</b>

Figure 2: Salesforce Migration and Custom Integration

Research into Salesforce.com shows that the Professional CRM offering is the most appropriate for Ajax as it appears to meet all of their CRM needs. The license cost is \$65 per user per month. While Ajax will continue to require the additional server to maintain the custom software, it is determined that the migration will free up approximately half of the IT technicians' time devoted to maintaining and supporting CRM after the solution is fully deployed. The first year the percent of time is determined to continue to be 40% (as the migration will be accomplished with internal resources). The following four

years the percent drops to 20%. It is assumed that the programming requirement for supporting the custom software will not change. For purposes of transitioning, the first year of licensing costs assumes 12 months of Seibel and 6 months of Salesforce. Table 2 shows the projected five year costs of this SaaS solution.

Five Year Cost	Total	2016	2017	2018	2019	2020
Licensing	\$ 460,485	\$ 139,000	\$ 78,000	\$ 79,560	\$ 81,151	\$ 82,774
Migration Project	\$ 89,868	\$ 89,868	\$ -	\$ -	\$ -	\$ -
IT Operations	\$ 428,079	\$ 138,000	\$ 70,380	\$ 71,788	\$ 73,223	\$ 74,688
Development	\$ 957,543	\$ 184,000	\$ 187,680	\$ 191,434	\$ 195,262	\$ 199,168
Server Maintenance	\$ 39,244	\$ 8,068	\$ 7,209	\$ 7,096	\$ 10,088	\$ 6,783
<b>Total</b>	<b>\$ 1,935,976</b>	<b>\$ 550,868</b>	<b>\$ 336,060</b>	<b>\$ 342,781</b>	<b>\$ 349,637</b>	<b>\$ 356,630</b>

Table 2: Five Year Projection for SaaS

## Platform as a Service

Since we are once again migrating our CRM capability to Salesforce.com all of the previously discussed costs apply with the exception of the development of an interface between the custom application and the Salesforce APIs. The cost we need to consider now is the cost of developing the custom application's capability in the Force.com platform. Analysis of the services available from force.com identifies that the force.com Enterprise edition is adequate and that through the APIs and services available, there only remains about 100 function points of business logic that needs to be implemented to recreate the custom application capability. The Enterprise addition of force.com costs \$25 per user per month but unlike the CRM solution only about 40% of the employees use the custom application so only 40 users need licenses. Once again this development will be outsourced as neither of the programmers on staff has much web development experience. Figure 3 shows the estimate updated with this information.

Migration to Salesforce.COM with force.com custom app		Total	3/1/2016	4/1/2016	5/1/2016	6/1/2016	7/1/2016
Cost:		\$99,770					
Project Cost:		\$99,770					
Costs (No Roll-Up Included):							
Migration to Salesforce.COM with force.com custom app - [System Folder]							
Currency in USD (\$) (as soent)							
1	Oversite	13,617	1,636	4,075	4,871	2,700	334
2	Integration and Testing	13,003	0	2,141	3,030	4,420	3,412
3	Data Migration	12,502	3,700	4,992	2,703	989	119
4	End User Training	6,817	3,384	1,726	1,704	3	
5	Custom application development for ...	53,831	2,026	16,963	23,291	11,551	
6	<b>Total</b>	<b>99,770</b>	<b>10,746</b>	<b>29,897</b>	<b>35,599</b>	<b>19,664</b>	<b>3,865</b>

Figure 3: Salesforce.com with force.com implementation

Once this solution is stabilized Ajax can eliminate one of the servers. They could also have eliminated one of the IT technicians but because one of the technicians already had a cloud savvy skill set, they chose to eliminate one of the programmer positions and train the technician in force.com. This results in an increase in the IT technicians' participation in CRM to an anticipated 25% (given the rapid productivity associated with PaaS development) but eliminates one of the programmers. The five year cost profile can be seen in Table 3.

	Five Year Cost	2016	2017	2018	2019	2020
Licensing	\$ 515,944.72	\$ 145,000.00	\$ 90,000.00	\$ 91,800.00	\$ 93,636.00	\$ 95,508.72
Migration Project	\$ 99,770.00	\$ 99,770.00	\$ -	\$ -	\$ -	\$ -
IT Operations	\$ 448,848.46	\$ 86,250.00	\$ 87,975.00	\$ 89,734.50	\$ 91,529.19	\$ 93,359.77
Development	\$ 570,771.69	\$ 184,000.00	\$ 93,840.00	\$ 95,716.80	\$ 97,631.14	\$ 99,583.76
Total	\$ 1,635,334.88	\$ 515,020.00	\$ 271,815.00	\$ 277,251.30	\$ 282,796.33	\$ 288,452.25

Table 3: Five Year Projection for PaaS

## Infrastructure as a Service

Moving the whole operation to the cloud will require less programming but more participation from the IT technicians as they will have to install (potentially) the operating system, the database management systems, any supporting applications or middleware along with the CRM system and the companion custom application. Analysis has determined that the custom application needs about 10% rework to operate in a virtual environment and to take advantage of cloud scalability features. End user training and data migration are no longer necessary as there is no new tool to learn and the data can be ported directly into the new environment. Estimated cost for the IaaS migration activities can be seen in Figure 4.

Migration of existing applications to Rackspace							
Cost:		\$63,019		100.00%		Labor F	
Project Cost:		\$63,019				Project	
Costs (No Roll-Up Included):		Total	3/1/2016	4/1/2016	5/1/2016	6/1/2016	7/1/2016
Migration of existing applications to Rackspace - [System Folder]							
Currency in USD (\$) (as spent)							
1	Over-site	8,866	2,694	2,030	2,065	1,265	477
2	Integration and Testing	16,597	0	817	2,726	4,357	5,118
3	Mods to custom application for cloud...	24,591	1,031	8,635	10,346	4,579	
4	Database management provisioning ...	5,733	2,679	2,579	447	24	3
5	Set up cloud environment and install...	7,232	7,232	0			
6	<b>Total</b>	<b>63,019</b>	<b>13,638</b>	<b>14,062</b>	<b>15,584</b>	<b>10,226</b>	<b>5,599</b>

Figure 4: Moving the CRM System to Rackspace

This scenario provides for the elimination of 1 server reducing responsibility of the IT technician but not eliminating it. While there will be no server maintenance required on premise there are activities associated with maintaining the virtual machine and applications in the cloud that must be performed by on-site personnel. The IT Technicians involvement in CRM related activities is expected to be about 20% of an IT Technicians' time. Using the Rackspace calculator the estimated cost for the required computing power, bandwidth and storage comes to \$8396.00 per month. Table 4 shows the five year projections for this option.

	Five Year Cost	2016	2017	2018	2019	2020
Licensing	\$ 573,941.45	\$ 150,376.00	\$ 102,767.04	\$ 104,822.38	\$ 106,918.83	\$ 109,057.20
Migration Project	\$ 63,019.00	\$ 63,019.00	\$ -	\$ -	\$ -	\$ -
IT Operations	\$ 359,078.77	\$ 69,000.00	\$ 70,380.00	\$ 71,787.60	\$ 73,223.35	\$ 74,687.82
Development	\$ 957,543.39	\$ 184,000.00	\$ 187,680.00	\$ 191,433.60	\$ 195,262.27	\$ 199,167.52
Total	\$ 1,953,582.61	\$ 466,395.00	\$ 360,827.04	\$ 368,043.58	\$ 375,404.45	\$ 382,912.54

Table 4: Five Year Project for IaaS Solution.

## Discussion and Final Thoughts

There is an element of disingenuousness associated with this simplistic comparison because it's unlikely that several of the proposed solutions would even be considered. The intent wasn't actually to help the reader understand what the Ajax Company should do as a solution to their CRM woes but rather to walk through the various things that the Ajax Company would need to consider as they were contemplating a move of their CRM capability to the cloud. It was also intended to give some sort of an apples to apples comparison of the different activities associated with migrating to each of the different flavors of cloud solutions.

There are several other limitations of this study worth note. First of all there was no consideration of power or cooling costs. The elimination of a server would result in cost reductions that were not captured and should be in a real analysis. Furthermore because the maintenance and upkeep of the hardware items is including in the costs for IT operations – which is solely based on people in this simplified example, elimination of some IT hardware did not automatically translate to cost savings. This is in fact representative of real world situations. Part of the analysis of cloud migration should include how much capability needs to be moved before staffing levels can change or alternately how much more value can the organization get from the IT people as capability is shifted to the cloud. This too was not part of this analysis. Finally costs of purchased items such as supporting hardware, upgrades for supporting software and middleware, replacement hardware as equipment ages, etc. were not included in the study but should definitely be considered in instances where they are significant and a migration to the cloud would impact them

With all of the aforementioned caveats, the clear results for the Ajax Company would be a recommendation that they launch an investigation into migration to salesforce.Com or some other SaaS CRM solution. The first step in that would be to evaluate the capabilities they would lose as well as the benefits they might gain. Some of the things they would need to assess as they were considering this move include much more than just cost and cloud solution model but also:

- Do we have the right IT skill set to consider an IaaS, PaaS, SaaS cloud solution
- Are we willing to spend the money to develop cloud skills
- Are we comfortable housing our client information in the cloud
- Is Public, Private or Hybrid cloud solution suitable for our applications
- What issues are associated with integrating cloud based capability with on premise capability

The intent of this paper was to introduce and describe the three kinds of cloud solutions and the factors that should be considered when considering a migration to the cloud:

- Infrastructure as a Service – provider provides the infrastructure, consumer manages the software, applications and data
- Platform as a Service – provider provides the infrastructure and platform, consumer manages the application and data
- Software as a Service – provider provides the infrastructure, platform and applications.

Organizations need to not only understand their options when considering a cloud solution but also need to understand the activities and skill sets required to be successful with the option they select.

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