Cloud computing has progressed from simply being a “nice to have” component of an enterprise IT strategy to a strategic imperative. In fact, it is today a fast-evolving multidimensional phenomenon—evolving not only in terms of deployment (private, public, hybrid, and community), but also in terms of service delivery models (Fig. 1). Whether one is considering Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), or Business Process-as-a-Service (BPaaS) individually and collectively, these service models, when effectively deployed, enable companies to reduce capital investments in IT hardware and software, and achieve greater business agility.

As an increasing number of enterprises are opting for at least one cloud-based service, CIOs and C-suite executives need to understand the strategic and cost impact of cloud services on businesses to be able to engage in more meaningful dialogue with their cloud vendor and leverage its advantages.
This article presents an in-depth review of each of these delivery models and adoption scenarios, including case studies of deployment of each, and a perspective on “what’s next” for each service type.

As public clouds mature and incorporate private cloud features, such as security and availability, both public and hybrid cloud computing is likely to witness higher adoption among enterprises. According to IDC, global spending on public cloud services will reach $107 billion in 2017 from $47.4 billion in 2013 (CAGR 23.5%). Hosted private cloud services market (including both dedicated private cloud and virtual private cloud), on the other hand, will reach $24 billion through 2016.

The following (Fig. 2) is an analysis of public cloud IT services market maturity and growth rates:

**Figure 1 - Evolution in Cloud Computing Service Delivery Models**

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<th>Enterprise IT</th>
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**Figure 2 - Public Cloud Services Maturity Matrix**

The size of the circle represents relative market size in 2013

Source: Gartner (2010, 2013)
IaaS

Higher adoption of cloud computing by enterprises is leading to an increase in spending on infrastructure-related cloud services. As per Gartner estimates, between 2011 and 2016, the global IaaS market will be the fastest-growing segment in public cloud computing and will achieve a CAGR of 41.3% to reach $24.2 billion.

IaaS vendors provide IT hardware, including network systems, storage, and servers, while enabling the enterprise to run its operating system and applications on virtualized servers. One of the key benefits of virtualization is its ability to support flexibility in workload management and service availability.

IaaS could be a solution where:

- The demand for infrastructure is volatile
- New organizations lack the required capital to invest in hardware
- The organization is growing rapidly and hardware scalability would be an issue
- The organization is trying to limit capital expenditure and move to operating expenditure
- There is a need for trial or temporary infrastructure requirements

IaaS may not be the best option where:

- The organization has to meet strict regulatory guidance on data storage and processing, and offshoring/outsourcing is difficult
- The organization needs to meet the highest levels of performance and monitoring partner commitment to SLAs is not preferred
- On-premise or dedicated hosted infrastructure can meet the organization’s needs

The IaaS market is dominated by VMware and Amazon Web Services (AWS), although Microsoft and Google are expected to make a dent in their market dominance. The choice between vendors will be driven by a myriad of factors, of which price will be an important one. Therefore, by March 2013, Google, AWS, and Microsoft had all announced significant price cuts in their IaaS offerings. However, price is not always the most critical factor, as enterprises need to consider the differences in terms of design, technology type, and maturity to consider a vendor. For example, unlike AWS instances, Google instances have only network storage and no local storage. On the technological maturity front, Microsoft tends to use relatively older CPUs than AWS and Google.

For all players, network systems will be the next IaaS frontier as these systems are entering a period of innovation and transformation. The hierarchical network architecture (access, aggregation, and core) is making way for flatter architectures, virtualized application software is replacing network appliances, and network infrastructure is becoming more programmable.

It is also indicated by an increasing interest of large IaaS vendors in Software-defined Networking (SDN). SDN is an emerging concept of network architecture that decouples the control plane (systems that control network intelligence and policy making) and the forwarding plane (systems that forward data traffic to the selected destination) for easier optimization. It overcomes the shortcomings of traditional network architectures that are struggling to keep pace with an ever-increasing demand for speed, scalability, and resilience. SDN automatically and dynamically addresses changing network requirements, thus

Case Study: Virgin Management Moves to IaaS for Flexibility

In October 2013, Virgin Group’s management services subsidiary—Virgin Management—migrated its IT infrastructure to an IaaS platform to reduce IT costs and provide users with Bring Your Own Device (BYOD) capabilities.

Need: Decisions to relocate its UK head office in Brook Green, London, to a new corporate headquarters near Paddington, London, prompted Virgin Management, a subsidiary of Virgin Group, to evaluate its IT requirements. This evaluation of its existing IT systems highlighted that the infrastructure was restrictive and unscalable. The evaluation team also found that its hardware was approaching the end of its warranty period and lacked a robust disaster recovery strategy. The company needed a solution to provide a centralized and scalable platform along with a disaster recovery plan to its employees, and lower management costs.

Solution: Virgin Management opted for a Virtual Desktop Infrastructure (VDI) hosted on Codestone’s (an infrastructure and SAP cloud application provider) IaaS platform, built on Dell servers, EMC storage area network (SAN), and VMware’s vSphere hypervisor technology. It also replaced the existing Dropbox solution with Citrix ShareFile to allow users access their files securely from anywhere and work online/offline. As an additional security layer, the IT team integrated two-factor authentication with the system.

Benefit: The “full cloud” option removed the need for dedicated hardware in the company’s regional offices as all services were delivered from the IaaS platform. Further, the platform enabled the company with high-performance computing on a shared or dedicated basis, helping it save costs. It also gained a 99.99% system uptime by sustaining multiple points in case of simultaneous failure.
reducing both Capex and Opex for enterprises while delivering agility.

**Paas**

Paas extends the premise of IaaS by providing hardware computing resources, operating systems, platforms, and tools. It also helps enterprises deploy and run self-created or acquired applications built using the provisioned tools. Gartner estimates that the global public PaaS market, by value, will grow at a 27.7% CAGR between 2011 and 2016, and will become the preferred option for rapid development and deployment of greenfield applications.

Paas is comparable to SaaS, except that SaaS is software delivered over the cloud, and Paas is a platform for software creation, which is delivered over the Web. Recent Paas offerings have evolved from being a simple collaborative platform—focused only on workflow management and offered by early providers such as Google App Engine, Heroku, and Engine Yard—to a newer container-based platform (mainly Linux containers) that can be deployed and managed on the premises offered by Docker, Pivotal, and Red Hat.

Areas where Paas could be a solution include the following:

- Multiple developers work on a single project
- Organizations with an existing data source wish to leverage proprietary data for application creation (such as Force.com Paas by Salesforce.com)
- Developers wish to automate testing and deployment services

Paas may not be the best option where
- Applications need to be highly portable in terms of where they are hosted
- Proprietary languages or data will impact the development process
- Use of a proprietary language will create obstacles in vendor change
- Application performance requires customization of the underlying hardware and software

In future, a majority of web applications are expected to run on a Paas vendor infrastructure, driven by rising demand for agile software development and deployment. Hence, to meet the needs of enterprise IT in terms of control and data security, Paas vendors will also need to supply software as SaaS—to simplify deployment of web applications—and the underlying infrastructure for these applications.

**SaaS**

SaaS is an extension of Paas as it allows enterprises to provision custom software applications on top of hardware computing resources, operating systems, and platforms/tools. Gartner defines SaaS as software that is owned, delivered, and managed remotely—usually on a subscription basis (rather than a one-time license fee). It is widely believed that SaaS was brought mainstream by Salesforce.com’s customer relationship management (CRM) product. While CRM is the most popular SaaS application area, human resource management, collaboration software (email, etc.), procurement, expense management, and customer service solutions are also prominent.

Gartner estimates that the global SaaS spending (public cloud) will grow at a CAGR of 19.5% between 2011 and 2016 to reach $32.8 billion. CRM will continue to be the largest global market within SaaS—forecast to grow at a CAGR of 16.3% between 2012 and 2016. SaaS witnessed the highest adoption by enterprise IT, as it lowers infrastructure and application maintenance costs.

SaaS could be a solution where:

- Organizations wish to avoid spending significant resources on installing, migrating, testing, and deploying general-use business applications
- The solution is mostly undifferentiated and does not offer competitive advantages, such as email solutions
- Organizations run applications that need constant web or mobile access, such as mobile sales management software
- Organizations such as start-ups and SMEs lack the initial capital outlay required to purchase licensed software

SaaS may not be the best option where:

- Organizations have significant data security concerns

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**Case Study: JPMorgan Chase Migrates to Cloud with Private Paas**

In March 2013, JPMorgan Chase Global Technology Infrastructure (GTI) leveraged Paas to migrate its .NET and Java application portfolio to cloud.

**Need:** Its large application portfolio, along with long lead times for application deployment, inflexible capacity management, and underutilization of physical and virtual infrastructure, led the IT team to adopt a new operating model with Paas.

**Solution:** The company deployed Apprenda’s Private Paas globally, which is used by more than 430 development teams. It supports about 2,000 .NET and Java applications, while 600 applications were deployed within one year.

**Benefit:** Apprenda’s platform improved average application time to market by 59 days. Further, the bank witnessed a 300% increase in infrastructure utilization rate and 700% improvement in developer productivity for application deployment through standardization across teams.
Case Study: BAE Systems Automates its Purchase-to-Pay Process with Exostar’s SaaS

BAE Systems, a global defense and aerospace company, wanted to standardize and improve the efficiency of its purchase-to-pay (P2P) process across all business units.

Need: Its legacy P2P process involved long lead times between PO generation and acceptance by suppliers. Further, invoicing involved too many manual steps, leading to errors and delays in processing and approval. BAE Systems needed a standardized and automated P2P process to support its global multi-tier network of suppliers.

Solution: The company selected Exostar’s SaaS Supply Chain Platform (SCP) created especially for the Aerospace and Defense (A&D) industry. The SCP, powered by E2Open software, uses a flexible service-oriented architecture and multiple integration options. It bypassed the existing ERP system and corporate database, and directly integrated with the supplier gateway.

Benefit: The new SaaS platform reduced the P2P cycle time and associated operational expenditure. Further, it reduced errors due to manual intervention, and improved visibility and collaboration across all business units. Automation streamlined the accounts payable process and improved supplier relationships.

- Regulatory guidelines do not permit externally hosted data
- Fast processing of real-time data is required (latency issue)
- Organizations do not have access to high-speed internet

2014 onwards, cost is not likely to be the prime driver of SaaS adoption, as factors such as agility, speed of implementation, and faster delivery of new functionality become more important. Moreover, besides CRM, spending is also likely to increase in varied SaaS areas, such as ERP, project and portfolio management, supply chain management, and enterprise content management (Fig. 3).

BPaaS

Looking forward, the next logical step in this evolution would be the move of traditional business process outsourcing to the cloud, also known as BPaaS. This involves an integrated set of collaborative activities with the aim of accomplishing a specific organizational goal, enabling organizations to focus on their core business, while support processes (such as HR and payroll) are remotely run and monitored in the cloud. BPaaS brings together the architectural, technical design, planning and modeling, and monitoring competencies of IaaS, PaaS, and SaaS to deliver low-cost, scalable, and reliable business solutions to their enterprise customers.

In this regard, BPaaS shifts the focus from a supplier’s operational performance levels to its ability to meet the customer’s business outcome. As such, a few SaaS vendors have transformed their solutions to incorporate BPaaS competencies. For instance, Oracle’s SaaS offering does not include discrete applications. Instead, it focuses on integrating its SaaS applications into end-to-end processes – for example, its “B2C customer experience” suite provides consistent and personalized experience across all interaction channels.

The BPaaS model is still at a nascent stage, but is projected to grow at a 10.7% CAGR (by value) between 2011 and 2016. Gartner predicts that the market will grow from $28.8 billion in 2011 to $47.9 billion in 2016. Further, operations management (14.7% CAGR) and e-commerce enablement (13.6% CAGR) will be the fastest-growing subsegments. By 2016, enablement through BPaaS is expected to be a $9 billion market.

Figure 3 - SaaS Revenue Share within Enterprise Software Market (2011, 2014E, 2016F)

Source: Gartner (2010, 2013)
**Case Study: Global Payments Chooses BPaaS for Managing its Finance and Accounting (F&A)**

In 2013, the Brazilian operations of Global Payments, a provider of electronic transaction processing services, implemented a BPaaS solution for enabling its end-to-end Finance, Accounting, and Payroll business processes.

**Need:** The company needed to reduce its capital and operating expenses, and at the same time deploy a scalable F&A solution that could support its expansion plans and meet regulatory requirements. Further, it was considering extending front-office functionalities with a minimum increase in cost.

**Solution:** Global Payments opted for Wipro’s recently launched F&A BPaaS, developed in partnership with NetSuite (provider of cloud-based ERP services). The NetSuite platform combined with Wipro’s process capabilities delivered a comprehensive end-to-end solution to its enterprise customers.

**Benefit:** The solution was implemented within five months, thus saving significant cost and resources and improving operational efficiency to over 99.5%. Further, it provided a 100% variable pricing model (transaction-based), requiring no capital expenditure.

**Cloud Acts as Key Enabler for Social Media, Mobile, and Analytics (SMAC)**

The impact of SMAC on business models cannot be ignored when considering cloud enablement of business processes. On a standalone basis, social networking, mobile, and analytics have limited benefits. However, its true value is realized when combined with cloud computing (through SaaS or PaaS).

For instance, applications are being assessed for their mobile and cloud deployment capabilities, while enterprises are demanding a “social media” like look and feel from the front-end applications of their ERP systems. Big Data generated from these interactions, when analyzed, can provide useful and actionable insights. This confluence of technologies is making way for a range of new digital operating models.

Further, SMAC impacts business processes, such as HR, F&A, Procurement, and Customer Service, and is likely to become the foundation of all enterprise applications. Gartner estimates that SMAC will drive more than 26% of enterprise software revenue by 2017 (from 12% in 2012).

**Conclusion**

By 2015, while cost will continue to be the primary driver for initial cloud investments, more CIOs are likely to opt for cloud-based business transformation rather than other short-term tactical approaches.

While IaaS, PaaS, and SaaS are the current trends within cloud computing, BPaaS represents the future with entire business processes being hosted in the cloud. Certainly, BPaaS holds significant potential for businesses. For example, BPaaS provides a 30–40% reduction in total cost of ownership over traditional Finance and Accounting Outsourcing (FAO) for small and midsized businesses. Further, BPaaS solutions are highly standardized, which reduces deployment time and enables enterprises to realize value faster. Besides the economic benefit and ease of delivery of BPaaS solutions, a key benefit is that line-of-business managers can test various services before actually replacing or integrating with existing business process.

Going forward, this evolution may lead to the evolution of a whole host of new cloud-based delivery models—Disaster Recovery as a Service (DRAaaS), Metal as a Service (MaaaS), Mobile Backend as a Service (BaaS), Desktop as a Service (DaaaS), etc. It is clear that the cloud and the subsequent “As-a-Service” models are here to stay.