Convergence of Social, Mobile and Cloud: 7 Steps to Ensure Success

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The *Convergence of Social, Mobile & Cloud: 7 Steps to Ensure Success* is a collaborative effort that brings together diverse customer-focused experiences and perspectives into a single guide for IT and business leaders who are considering cloud adoption. The following participants have provided their expertise and time to this effort.

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Executive Overview

As the adoption of social, mobile and cloud computing continues to transform industries, organizations increasingly value how these technologies can improve customer engagement, forge new partnerships and drive competitive advantage. Although these technologies are innovative and disruptive on their own, together they are revolutionizing business and society, disrupting old business models and creating new leaders.

The Aberdeen Group positions the converged technologies as follows: "cloud is the core, mobile its edge and social the connections between endpoints. It places the disruptive technologies that are transforming businesses in context, and describes the technical and services infrastructure needed to provide that ideal end-user experience where everyone's connected (social), everywhere they go (mobile), and have access to data when they need it (cloud)." [1]

Gartner asserts that "these forces are intertwined to create a user-driven ecosystem of modern computing. The individual is empowered. People expect access to similar functionality across all their roles and make fewer distinctions between work and non-work activities. People have come to expect and make use of presence and location services, contextual search results, and spontaneous interaction with their social networks to enhance everyday experiences. And they spread those experiences across multiple devices, often at the same time." [2]

As great as the promise of convergence is, many organizations are still struggling to reinvent their business operations and keep pace with the explosion of mobile channels and volume of data being generated.

The aim of this guide is to provide a practical reference to help enterprise information technology (IT) and business decision makers as they analyze and consider the implications of the convergence of social, mobile and cloud technologies on their business. The paper includes a list of steps, along with guidance and strategies, designed to help decision makers evaluate and compare offerings in key areas from different providers.

Along with the base technologies of social, mobile and cloud, the paper highlights and discusses the importance of *supporting* technologies like integration, Big Data analytics and Devops that enhance the business value of convergence.

The section titled "Business Innovation & Transformation" provides an overview of the impact that convergence of social, mobile and cloud technologies will have on new and existing business processes. This section provides cross industry and industry specific use cases to illustrate business impact.

The section titled "Roadmap for Social, Mobile and Cloud Solutions" is the heart of the guide and includes the steps that can be used as a basis for evaluation of vendor offerings. It details both strategic and tactical activities for decision makers implementing converged solutions, and provides the insight needed to make informed IT decisions on their treatment.

Business Innovation & Transformation

The simultaneous adoption of social, mobile and cloud is having a profound impact on businesses. Even though each of these technologies provides a different value for organizations, the synergistic effect of all three technologies is becoming more evident, and is providing new ways for businesses to innovate and create value.

The convergence of these technologies has been driven both by market forces like consumerization of technology, and complementary capabilities of social, mobile and cloud. In a very short amount of time, social interactions have migrated from traditional online social websites to mobile devices. Development of mobile applications including social applications for mobile have grown at a rapid pace, leading to growth of social mobile communities and encouraging ubiquitous sharing and collaboration. While mobile has emerged as the primary platform for social, cloud infrastructures and cloud services have become critical for the seamless delivery of cost effective and scalable mobile and social solutions. It is common for mobile applications to offload storage and processing to the cloud thus removing the limitations of mobile devices with respect to storage and computing capabilities, and even security.

Many interesting and valuable use cases are beginning to emerge that highlight the convergence between social, mobile and cloud. For example, in medicine many hospitals and physicians are embracing secure social networks run in the cloud to collaborate on complex cases. Physicians can take pictures or video of physical symptoms using their mobile devices, and share them immediately with other physicians. The richness of the interaction and discussion facilitated by these medical social networks cannot be replicated with conventional technologies like email, text and voice. Even patients using certain mobile applications have the capabilities to record blood sugars levels, log migraine headaches and digitally share data with their physicians. Suddenly physicians have a temporal record of physiological activity which can provide better insight and improve patient outcomes.

Another, recent example of the effective convergent use of social, mobile and cloud was witnessed at the recent Boston marathon bombing. One of the reasons the FBI was able to capture the suspects within 4 days was because of the analysis of mountains of cell phone tower call logs, text messages, social media data, tweets, photographs and video surveillance footage to quickly pinpoint the suspects. Leveraging cloud infrastructure was critical in analyzing the data, which had immense variety. Specifically to analyze social data, the FBI used a cloud tool that had indexed the social web. Furthermore, Boston residents themselves took to a cloud-based file storage system, and created a list of thousands of names, addressed and phone numbers of those offering aid and shelter to those impacted by the bombings.[1]

Another key area in the convergence of social, mobile and cloud is the increasing use of contextual information. Contextual information provides a richer view of the user's environment and is collected by mobile devices. Contextual information (location, weather, mood, nearby people & devices, etc.) adds

[1] https://docs.google.com/spreadsheet/pub?key=0AoXVKFw1Uci5dFNpRGdWd2pXZTN4a3Fza0VhVTRVaGc&output=html

significant richness and greater visibility into the nature of social interactions, and individual consumer behavior. For example specific ads can be shown to consumers based on their current location, weather, their mood as expressed on a social network, etc. It is important to understand that even though mobile devices are being used to collect the context data, the processing of the data to run analytics or other application processing is offloaded to the cloud. The common pattern is that mobile devices become the front end platform, social provides a layer of rich information about the customer and their interactions, and cloud provides the underlying infrastructure for analytics, processing, storage and other compute intensive activities.

Many specific areas and processes in the enterprise can benefit from the convergence of social, mobile and cloud. Some of the keys benefits include:

- *New channels for reaching customers.* With the increasing popularity of social media and mobile devices, it is in the enterprise's best interest to interact with customers on their preferred communication channels. For example, to satisfy customer demand, financial institutions are doing whatever they can to provide secure banking applications over channels like mobile. The back end for these applications run at the bank's data center or private cloud. Adoption of newer channels like social and mobile is accelerating, and engagement through these channels can bring rich rewards for enterprises.

- *Deeper customer insight & customer care.* Analysis of social media interactions and customer behavior can help companies develop richer insight into customers and their preferences. Social networks can also act as a channel for providing customer care, a place where customers can post questions which can be answered by users or by customer service reps - this helps influence the broader community.

- *Innovative applications due to sensors and context.* Mobile devices are becoming nearly ubiquitous. In addition, mobile smartphones have been enhanced with a variety of sensors, such as accelerometers, microphones, cameras, medical sensors, etc. These sensors and their capacity to capture user context can contribute to development of new and unique applications. Furthermore, use of context information can provide key insights into user behavior that can be targeted by companies in myriad of ways. Some of the context and sensor information that can be captured using mobile devices includes location, weather, current activity (walking, driving etc.), bio-metrics (heartbeat, pulse), nearby attractions, and many more.

- *Enhanced collaboration.* Social networks have become unique touch points to engage communities, initiate conversations and develop innovative ideas. Organizations are leveraging social technologies to build knowledge ecosystems with customers, prospects, and employees. Companies are recognizing, that independent of location, employees and partners using mobile and social technologies can exchange knowledge discuss new ideas, identify expertise, enhance overall group dynamics, and increase overall productivity.

Roadmap for Social, Mobile and Cloud Solutions

This section provides a prescriptive series of steps that should be taken by end users to ensure successful deployment of cloud-based social and mobile solutions. The following steps are discussed in detail:

1. Adopt an Open IT Strategy and Architecture
2. Establish Cloud as the Core
3. Prioritize Mobile Access
4. Extend Social Interaction
5. Leverage Analytics to Gain Insight
6. Establish a DevOps Capability for Rapid Delivery of Innovation
7. Adopt a Flexible Integration Model

Requirements and best practices are highlighted for each step. In addition, each step takes into account the realities of today's landscape and postulates how this space is likely to evolve in the future, including the important role that open standards will play.

Step 1: Adopt an Open IT Strategy & Architecture

It is critical for business leaders to realize that convergence of social, mobile and cloud does not start with technical implementation of disparate technologies. Rather the convergence presents an opportunity to improve business processes across a whole spectrum of activities - from increased collaboration, improved innovation, better customer insight and support, etc. Expanding this further, consider an example of increased collaboration in an organization - a common initiative among many companies. Enterprises need to realize that successful collaboration outcomes will require collaboration strategies, architectural solutions, governance and overall IT strategy that are flexible. These strategies need to account for the unique communication and collaboration needs of internal employees, customers, suppliers, and public collaborators in this new social/mobile/cloud environment.

The potential disruption due to the convergence of social, mobile and cloud will impact many facets of businesses, thus making the process of planning IT strategy a challenge. Some of the important steps to consider are:

- *Align to business objectives*. Assess current capabilities with respect to your business goals, and develop an understanding of how your current social, mobile and cloud capabilities can contribute to the achievement of your business objectives. Conduct a proper review to identify where current IT resources and processes might be able to support new organizational activities, and where new capabilities may be required. Increased complexity is a common side effect when implementing new technologies and social, mobile and cloud are not an exception. Thus, it is important to conduct careful assessment of whether the new technologies being adopted will improve achievement of business objectives without significantly increasing costs, risks and complexity that have the potential to undermine the expected gains.

- *Identifying experts*. It is common for organizations to lack expertise in the areas of social, mobile and cloud. Enterprises should identify subject matter experts within or outside their company through collaboration with technology partners.

- *Measure success*. The convergence of social, mobile and cloud can contribute to significant business transformation, and it is critical that an IT strategy include the capacity for organizations to develop and track key metrics to measure the implementation and success of business objectives. The metrics framework will be developed through a collaborative effort between business units and IT. It is important that organizations ensure that the metrics developed are useful in measuring business objectives, and that they are transparent and precise. For example, measurement of customer support due to implementation of social technologies may be tracked with metrics like number of service issues addressed in social media, percentage of issues escalated and resolved inside/outside social media, number of positive ratings and reviews, etc. In measuring risks in various IT implementation projects, key risk metrics should be developed that highlight the severity of the IT risks and the impact on individual business objectives.

- *Adapt IT governance*. IT governance must adapt to better accommodate the new technologies of social, mobile and cloud. It is common in enterprises to see many of these new systems under the control of business stakeholders rather than enterprise IT. But these business stakeholders still depend upon IT for support, integration, etc. Since the procurement of social, mobile and cloud technologies can be easily done by individual business units, a fragmented IT governance model can impose risks in an organization. It is important for IT and business units to collaborate and view technology governance as a core part of business strategy. IT can assist business units in certifying different social, mobile and cloud technologies, rather than having a direct role in the technology selection itself. The democratization of technology decision making can bring enormous productivity gains to an organization, but requires participation of stakeholders throughout the organization and shifting of responsibilities for success to the stakeholders in individual business units.

Architecture

The convergence of social, mobile and cloud can pose challenges to current enterprise architectures. In this new world, organizations have to develop scalable, agile, and fault tolerant applications that use disparate services/technologies that exist both inside and outside the organization. This requires enterprises to use flexible, decoupled services architectures like an Event-Driven Architecture (EDA) also known as Event-Driven SOA.

Event-Driven SOA is built on a publish-subscribe (pub/sub) asynchronous pattern, where events are pushed to subscribers through some intermediary (middleware), and the publisher of the event does not wait for a response. The message driven asynchronous nature of Event-Driven SOA along with use of intermediaries for event management (middleware) provides the essential ingredients for building highly decoupled, highly scalable, and fault tolerant systems. In comparison, traditional service oriented architecture (SOA), a common architecture in enterprises today, is primarily based on a synchronous

request/response model. In traditional SOA, a requesting service needs to know exactly which services to call, how to call them, and their availability and throughput. This leads to dependencies between services which impact performance, fault tolerance and scalability.

It is important that enterprises understand that Event-Driven SOA is not suitable for all business services and applications. The general rule of thumb to follow is that a synchronous request-driven pattern, as used in traditional SOA, is appropriate when the client (requestor of a service) depends on the response from a service to complete its execution. In order to achieve scalability and fault tolerance, enterprises can try to model traditional SOA applications to Event-Driven SOA. This will require modeling and implementation of services that are autonomous, and do not have physical and logical dependencies.

Another area where Event-Driven SOA provides a major benefit is in the area of Complex Event Processing (CEP). CEP is event processing that combines data from multiple sources to infer events or patterns that suggest more complicated circumstances. The goal of complex event processing is to identify meaningful events and respond to them as quickly as possible.[2] Interpretation of such meaningful patterns can provide enterprises with higher levels of business visibility, insight and agility to respond to new business scenarios.

One example of CEP usage is the investigation of social media sites for early warning detection of possible disease outbreaks by the U.S. Centers for Disease Control (CDC) and several international health organizations. Mentions of various symptoms and sentiments on social media sites can be aggregated, sorted and analyzed based on time and location. This in turn can help these health organizations determine possible outbreaks of disease. A similar example was the recent experiment by Google which provided good indicators for flu activity based on aggregated search data over certain search terms.

It is extremely difficult to implement Event-Driven SOA without a proper middleware solution. Event-Driven SOA middleware should provide a proper messaging infrastructure that will insure durability, Quality of Service (QoS) guarantees, and mediation services that provide routing, transformation, data integration, etc. for event notifications. The middleware should also provide multiple types of events processing including simple and complex event processing.

The rise of social, mobile and cloud has impacted other areas of enterprise architecture. The significant increase in unstructured data requires organizations to look beyond the traditional relational database. Unstructured data tends to be human-generated and people-oriented content that does not fit neatly into database tables. For example, tweets, blogs, customer reviews, etc. are weakly structured pieces of text, while images and video are structured for storage and display, but not for semantic content and search. Organizations should explore the use of NOSQL databases to store unstructured data. Unlike relational databases, NOSQL databases handle unstructured data such as e-mail, multimedia, and social media efficiently. Transforming unstructured content into a structured format for analysis is also a major challenge for enterprises. Step 5 below on analytics provides further details on dealing with challenges related to the rise of unstructured data.

[2] See http://en.wikipedia.org/wiki/Complex_event_processing for more information.

Additionally, many of the new business services being developed for social, mobile and cloud are using weak transaction semantics. These services must support requests with low latency (tens of milliseconds) to users worldwide and must have high throughput (tens of thousands of reads and writes per second). Weak transactional semantics becomes an important architectural choice for scaling and reduced operational costs. Weak transactional semantics do not guarantee strong consistency as in ACID[3] style transactions and are not appropriate for all applications. For example, a banking application may need strong consistency guarantees, but applications like Twitter can scale without having to worry about ensuring every subscriber receives a text message instantly.

Step 2: Establish Cloud as the Core

Cloud provides the platform that supports the reach, speed and scale required by the rise of mobile and social applications. Per Gartner, "It is the model for delivery of whatever computing resources are needed and for activities that grow out of such delivery. Without cloud computing, social interactions would have no place to happen at scale, mobile access would fail to be able to connect to a wide variety of data and functions, and information would be still stuck inside internal systems." [2]

The cloud essentially provides access to power and capabilities that are otherwise inaccessible. The benefits of cloud all come down to access – services and capabilities placed at the fingertips of business and IT users. When this happens, the way people work, as well as the relationship between individuals and their enterprises, is transformed.

"With cloud, everything shifts to the culture of the consumer and the externalized view of computing which allows the forces to converge and thrive. Mobile independent software vendors using cloud services have more options to access information and processes than ever before — without having to own it all. Crowdsourcing can be done through mobile communities because the cloud allows them all to exist in the same *workspace* rather than being isolated in enterprise or single-PC environments. And, the cloud is the carrier ecosystem for a wide variety of data forms, both structured and unstructured. This data can be gathered from cloud-based communities, through cloud services, from mobile endpoints, and all in a consistent and globally available environment." [2]

There are two primary reasons for migrating existing applications to the cloud:

- *Optimization*. Delivering the same level of service for less cost. These cost savings are often achieved through automation or reduction of infrastructure footprint. Applications that fall into this category are often strategic and have significant labor based cost drivers. The selection process for this migration is usually ROI based. The application is modernized and incorporated into a mobile or cloud platform for this purpose.

- *Innovation and Business Model disruption*. While not mutually exclusive from optimization, this kind of change is usually driven by the Line of Business rather than the IT organization. As these technologies converge, the LOB will look to IT to deliver new and innovative ways to interact

[3] ACID stands for Atomicity, Consistency, Isolation, and Durability.

with customers. For example, a new mobile application will drive elasticity requirements to existing back end systems, which may not be ready for this kind of use case.

Cloud computing offers a value proposition that is different from traditional enterprise IT environments. By providing a way to exploit virtualization and aggregate computing resources, cloud computing can offer economies of scale that would otherwise be unavailable. Because virtual instances can be provisioned and terminated at any time and the user organization pays only for the computing resource they are employing, costs can be lower. In addition, cloud computing increases business agility by providing access to computing resources on an immediate basis, rather than a need to first invest time and skilled resources in designing and implementing infrastructure (hardware and middleware) and then implementing and testing it. Here are the essential characteristics of cloud computing that contribute to and enhance the reach and scale of mobile and social applications:

- *On-demand self-service*. A consumer can provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service's provider.

- *Broad network access*. Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and personal digital assistants (PDAs)).

- *Resource pooling*. Cloud computing pools a provider's computing resources to serve multiple consumers using a multi-tenant model, with different physical and virtual resources assigned and reassigned according to consumer demand. Examples of resources include storage, processing, memory, network bandwidth, and virtual machines.

- *Rapid elasticity*. Resources can be rapidly and elastically provisioned, sometimes automatically, to scale out quickly, and rapidly released to scale in quickly. To consumers, the resources often appear to be unlimited and can be purchased in any quantity at any time.

- *Measured Service*. Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction suitable to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Providers and consumers can monitor, control, and report on services with transparency, empowering consumers with the ability to precisely match expenses to IT demand.

To ensure a successful cloud deployment, one that adequately supports the specific requirements of mobile and social business solutions, the following critical requirements must be taken into consideration: *deployment and service models, security & privacy, service level agreements, governance, legal & regulatory requirements, interoperability,* and *integration with existing systems*. Refer to the following CSCC whitepapers for specific information on each of these areas:

- The *Practical Guide to Cloud Computing* provides a set of guidelines and strategies to help decision makers address each of these key considerations related to implementing cloud solutions. [3]

- The *Practical Guide to Cloud Service Level Agreements* provides specific guidance on what to expect and how to compare cloud SLAs. [4]

- The *Security for Cloud Computing: 10 Steps to Ensure Success* whitepaper provides a practical reference to help enterprise information technology (IT) and business decision makers as they analyze and consider the security implications of cloud computing on their business. [5]

Step 3: Prioritize Mobile Access

Mobile applications are powerful assets that enterprises can harness to engage with their customers, business partners and employees anytime, anywhere and on any device. In fact, mobile applications are at the front end of the new systems of interaction, which are people-centric as opposed to traditional systems of record, which are process-centric.

Customers can engage directly with the enterprise brand anytime, anywhere and take the next most likely action in their immediate context and in their moments of need; employees can collaborate and work effectively to accelerate their business decisions and to increase their overall productivity. In addition to empowering consumers and employees, mobile applications are also the control interface to extend product value and differentiation by integrating context-awareness, customer feedback and predictive analytics. However, to truly deliver on these new systems of engagement and to get a return on experience, mobile applications have to be done right.

With these possibilities come a new set of challenges. Developing and managing mobile applications is inherently different. Not just smaller in footprint, mobile applications deliver a different set of capabilities, with more user and context-awareness, in a smaller form factor. Unlike traditional web applications, interruption in service is the norm, not the exception. Managing application distribution and governance means working with several public AppStores – each with their own approach and limitations outside of an enterprise's control. Synchronization with enterprise systems poses a new set of requirements, as customers demand a seamless omni-channel experience as they move from transacting on the Web to mobile and back again. And, because the devices they run on are outside of IT control, mobile applications pose greater challenges associated with application security, governance and version management.

To address these challenges, organizations are evolving their thinking about the way they design, develop, deploy and manage mobile applications. Moving beyond treating mobile applications as one off projects, leaders are increasingly adopting an extensible Mobile Application Platform (MAP) approach. The MAP (sometimes referred to as an MEAP (Mobile Enterprise Application Platform) or MDAP (Mobile Development Application Platform) includes a mobile-optimized development environment, a mobile application server, and a client device layer that deliver essential data transformation, synchronization and other middleware services. A robust MAP solution is based on an open and extensible architecture

that can be extended as needed with key device management, security, and analytics capabilities. In assessing an effective mobile application platform, four key questions can guide the evaluation process.

- **Can the platform scale application delivery, using existing skills and resources?**
  Mobile applications are much more iterative, have faster lifecycles with high degree of fragmentation of devices, platforms, networks, operating systems and languages. Application development in a multi-platform environment needs a strategy that addresses agile development, time to market, end-to-end cross-platform testing and automation with optimized tools for collaboration. Platforms that are built on open, standards-based development environments, such as the Eclipse development environment, can help organizations leverage the skills base they already have, while taking advantage of the rich and growing ecosystem of third-party development frameworks and libraries.
- **Will it help my organization connect to data, applications and cloud services?**
  Mobile applications have to integrate with backend services, have to scale to handle the increasing volume of transactions and have to deliver on advanced mobile services such as *push* notifications and *geo location* services. These advanced capabilities should be provided, out of the box, by a scalable, mobile optimized middleware layer. Providing a seamless, consistent user experience across all channels needs synchronization of data, integration with backend services and atomization of workflow processes that gets complex as new devices and new models of engagement are factored-in.
- **Will it help me maximize the value of mobile engagement by delighting customers?**
  Systems of engagement are focused on creating an excellent customer experience, and that depends on transforming data into actionable insights. Addressing customer context is an essential component, so the data gathered must include location data, social network information, customer preferences, sentiment, and usage intent. Increasingly leveraging this data to perform predictive analytics plays a key role in delighting customers.
- **How well can I reduce security risk across my mobile enterprise?**
  A robust mobile strategy must include both mobile device (endpoint) management and mobile security management competencies capable of addressing threats at every layer of the mobile transaction stack. Mobile applications present greater security risks of exposing applications and data on small, light and always on portable devices. Mobile security has to be dealt with in the context of these usage patterns and threat models. Every end point involved in a mobile transaction-- including the mobile device, the applications running on the mobile device, the data accessed by the application, and the backend executing transactions -- must be secured – it is no longer “good enough” to simply focus on the enterprise’s perimeter.

In response to these considerations, organizations are improving their mobile maturity in four key capability areas: mobile development and connectivity, device management, security and analytics. Let’s explore each in turn.

Mobile Application Development and Connectivity

Various Mobile Application Platforms (MAPs) exist to enable enterprise developers to code, test, integrate, publish and manage business-to-consumer (B2C), business-to-business (B2B) and business-to-

enterprise (B2E) mobile applications. Choosing the right MAP is critical for enterprises as the market shifts to the second wave of smarter connected applications, which integrate with a business' overall mobile strategy.

Often, MAP vendors have it backwards. They provide tools to quickly generate applications that work with a few pre-defined systems, but crumble when the application needs to scale across custom back-ends running in disparate network configurations of public cloud, private cloud and on-premise deployments. For the second wave of mobile applications, enterprises will need a MAP with an extensible mobile middleware layer to deliver a unique mobile experience, which is much more than a client side framework needed to build the application.

There are multiple approaches to building mobile apps: *Native*, *Web* and *Hybrid*. Each approach carries inherent benefits and limitations. With no single panacea, the MAP you select should have the ability to support all mobile development approaches. This level of flexibility allows the development of your mobile portfolio to be driven by business requirements as opposed to religious technology debates.

- *Native approach.* Pure native applications deliver the best device fidelity and an optimal user experience at significant cost of time and skill. Because native applications require platform-specific languages, tools and skills that cannot be shared across platforms, they are more costly to develop and maintain.
- *Web approach***.** Web applications run in the local browser of the device and are built using standard web programming languages such as HTML5, CSS and JavaScript. Easy to write and deploy, these applications have limited access to device capabilities and features.[4] As a result, Web applications suffer from security limitations and lack of advanced user experience.
- *Hybrid approach.* Hybrid development uses Web standards such as HTML5 and provides plug-ins for accessing native device capabilities. It allows developers to build the majority of the application using web languages that are cross-platform by default, while optimizing the code according to the functional and design guidelines of its target environment. [5]

For most organizations and use cases, hybrid applications provide the best of both worlds: developers can maximize code reuse with optimal user experience, without compromising any of the native capabilities and features. Since hybrid applications can scale quickly, they help enterprises unlock new markets with speed and scale. Despite these advantages, there are circumstances for which either native or web approaches would make the most business sense, so it is important to maintain flexibility.

[4] As HTML5 continues to evolve, multiple UI frameworks such as JQuery Mobile and Sencha have emerged to provide mobile components and extensible plugins to solve some of the inherent issues of web applications related to UI controls.

[5] On average, the result of the Hybrid approach is a mobile app that can consist of ~80% web code that is shared across different environments and ~20% environment-specific code that ensures the optimal user experience.

Mobile Device Management

Prioritizing mobile access means responding effectively to the growing demand for BYOD (bring your own device) policies that empower employees to utilize the most productive devices – whether laptops, smartphones or tablets – to get the job done. These mobile endpoints give workers new levels of flexibility, and in turn drive new levels of productivity. But unlike traditional endpoints, which IT organizations have managed for years, mobile device platforms present unique management needs that do not fit the traditional endpoint management paradigm. Unable to accommodate these devices using their existing management technologies and infrastructures, IT organizations often find themselves scrambling to find an efficient and secure way to manage employee use of mobile devices in the workplace.

Rather than implementing a separate management infrastructure and processes solely for mobile devices, organizations can benefit from a single solution that provides unified endpoint management—a solution that provides high levels of application and security management across all types of endpoints while effectively accounting for the unique needs of mobile devices. The ideal unified management platform should secure and manage traditional endpoints as well as smartphones and tablet computers.

Mobile Security

The security of mobile devices has become a top concern for many IT executives. Data loss, security risks and malware are real. Because many mobile platforms are not natively designed to provide comprehensive security, hackers have a strong incentive to develop new techniques to create mobile centric malware for these devices. The most frequent mobile device security threats are: l*oss and theft, Bluetooth and Wi-Fi attacks,* m*alware, spam, and phishing*.

To defend against these threats, enterprises need to develop an effective strategy for enterprise mobility security that establishes policies and procedures regarding what content is allowed to be accessed on these devices, how it will be accessed and how the organization will handle lost or stolen devices that may contain business data.

- Protect data with on-device encryption of user data, SSL encryption, secure offline access, and remote data wipe.
- Control access through single sign-on and multi-factor authentication.
- Run an antivirus program on any device with access to the corporate network.
- Run a firewall program on all mobile devices.
- Secure applications with protection against reverse-engineering vulnerabilities, remote disable of applications, and enforcement of client upgrades.
- Enforce compliance with regulatory mandates through secure shells that can be deployed throughout your mobile portfolio.
- Set Bluetooth configurations such that mobile devices are not discoverable.

Mobile Analytics

To succeed in the mobile channel, organizations must deliver mobile services and features that their customers will adopt and use productively. Yet most businesses today have a limited understanding of how their customers are engaging with them on mobile channels.

Given the magnitude of mobile variables—including the abundance of devices and browsers—the risk of customers encountering obstacles is inherently greater. While some of these obstacles are technical in origin, others are related to business process and usability, making them harder to detect, diagnose and effectively resolve.

A new generation of customer experience management analytics solutions is specifically designed for the mobile channel. These new capabilities enable organizations to efficiently instrument mobile applications in order to capture the complete mobile interactions of every mobile user. The results of this analysis delivers unprecedented visibility into mobile usage patterns and behaviors, enabling companies to pinpoint and resolve mobile obstacles, make the right investment decisions, and raise customer conversion and acquisition rates.

Step 4: Extend Social Interaction

Per Gartner, "social technologies both drive and depend on mobile and cloud computing:

- *Social provides an important need for mobility:* Accessing social networks is one of the primary uses of mobile devices. Indeed, it is the main reason that many people acquire more powerful smartphones instead of simple portable phones. Social interactions are transient, fleeting and spontaneous. They have much more value when they are possible wherever the user is located.

- *Social depends on cloud for scale and access:* Social networks benefit from scale, the kind of scale that is really only practical through cloud deployment.

- *Social feeds and depends on deep analysis:* Social interactions provide a rich source of information about connections, preferences and intentions. As social networks get larger, participants need better tools to be able to manage the growing numbers of interactions, which drives the need for deeper social analytics." [4]

Social business applies social networking tools and culture to business roles, processes and outcomes. It enables people to engage productively in new and innovative business contexts through collaboration on enhanced business activities interconnected with social content from internal and external networks of partners and customers. A social business monitors and analyzes social data to discover new insights that, when acted on, can drive business advantage, for example, faster problem solving, improved customer relations, and more effective prediction of market opportunities. Social business delivers the following benefits:

- Activate people to create a smarter workforce
    - *Improve productivity.* Connect employees with the right experts and information to anticipate and meet clients' needs. By connecting people with the right expertise and

information within the context of their work, people in a social business can be more effective and drive greater business value.

  - *Accelerate innovation.* A social business engages people more meaningfully. As barriers between employees, customers, and partners disappear, organizations can develop and apply collective intelligence, advocacy, and distributed talent to drive business results. It helps groups of people bind together into communities of shared interest and coordinate their efforts to deliver better business results faster. It encourages, supports and takes advantage of innovation and idea creation and builds on the intelligence of the crowd.
  - *Connect with clients.* Engage with clients in new ways through dedicated communities. Connect client, transaction and social data so you know your customers better than the competition.

- Delight Customers
  - *Drive loyalty.* Engage customers in dynamic, personalized experiences to keep them coming back.
  - *Anticipate problems*. Listen to and analyze customer feedback to understand emerging issues.
  - *Respond faster*. Accelerate value by deploying technology designed to reach people where they are and to integrate rapidly with systems in place today and those that may be deployed in the future. A social business makes real time use of current knowledge, leverages situational awareness and uses social intelligence in decision making.
  - *Enable self-service.* Help clients find the answers they need 24/7.

Creating value across every level of the organization, be it in marketing, product development, sales, research and development, or customer service, etc. requires a range of social business technological building blocks including:

- *Profiles.* The foundation for building and expanding a personal network, helping users develop and maintain personal relationships across reporting structure, department, geography, etc.
- *Activity Streams*[6]*.* The common, central place from which all users can see what's happening across their network, whether they are on the Home page or in a community.
- *Wikis.* Technology to make online publishing and content generation easy enough for people without Web development skills.
- *Blogs.* Provide a medium with which to share knowledge and build networks and relationships. Blogs can be used for many different business purposes, ranging from sharing product direction, asking and answering questions, gathering feedback, and learning best practices, etc.
- *Instant Messaging.* Allows someone to communicate with another person over a network in real time, in relative privacy.[7]

[6] See http://en.wikipedia.org/wiki/Activity_stream for more information.

[7] See http://en.wikipedia.org/wiki/Instant_messaging for more information.

- *Files.* Allows users to easily find a person's files, share a file with a Community, and create folders of files to aid organization. Businesses struggle with the problem of sharing files. Large file-system shares on network drives allow users to store a file for group access, but they do not handle access control levels, comments and ratings, versioning, or even provide context for the file.
- *Communities.* Provides the means for users to stay in touch, share information, and exchange ideas. Communities provide an excellent way to connect members of a project team, organize a task force researching an emerging technology, or bring together a group of people who share any interest.
- *Social Analytics.* Combines software and services that bring Big Data analytics into the hands of today's social savvy and mobile workforce. Organizations can apply analytics to their social business initiatives, allowing them to gain actionable insight on information generated on networks and put it to work in real-time. [8]
- *UI components.* Sometimes known as gadgets, UI components are web-based software components based on HTML, CSS, and JavaScript. They allow developers to easily write useful web applications that work anywhere on the web without modification. They are defined to be embedded into various contexts: standalone web pages, web applications, even other gadgets. A gadget may be a simple widget, a reusable component, or a full-blown application, possibly utilizing or communicating with other gadgets. [6] Integrating the component model with an API for accessing information about users profile information and their *social graph* (including things such as their friends and activities), allows applications to be integrated and made interoperable with each other in the context of a broad set of social networking sites. [7]

Standards enable combining these building blocks with software tools to provide a platform where a more expansive approach to social business can flourish. Platform driven social business organizations are more effectively able to share resources, skills and insight**s** within and across work processes and organizational boundaries. Here are the critical steps and requirements for deploying an effective social business platform:

- *Take a strategic approach*. Becoming a social business is not simply a matter of deploying some collaboration tools and hoping for the best. It is a long-term strategic approach to shaping a business culture and is highly dependent on executive leadership and effective corporate strategy, including business processes, risk management, leadership development, financial controls and business analytics. Realizing the potential value of social business is predicated on an organization's ability to recognize and design for this transformation. Inherent in this transformation is recognizing the convergence of technologies such as social, mobile and cloud.

- *Apply to the most common activities.* As organizations either expand globally or participate in global supply chains, information and insights become scattered around the world. Such knowledge as how to solve problems, handle exceptions to normal processes and address local market conditions often resides in widely separated, often unconnected repositories. Also,

[8] See http://en.wikipedia.org/wiki/Social_Analytics for more information.

customers expect suppliers to understand past business transactions and tap into the collective expertise of the organization to solve problems.

- *Build trusted relationships*. The rapid growth of social networking and mobility has erased some of the boundaries that separated individuals in the past. People increasingly use their relationships with other people to discover and use information to accomplish innumerable tasks. New opportunities for growth, innovation and productivity exist for organizations that encourage people—employees, customers and partners—to engage and build trusted relationships. Individuals are using social networking tools in their personal lives, and many are also incorporating it into their work lives— regardless of whether it's sanctioned by their employers.

- *Apply analytics*. Enterprises can integrate and analyze massive amounts of data generated from people, devices and sensors and more easily align these insights to business processes to make faster, more accurate business decisions using a platform approach. By gaining deeper insights in customer and market trends and employees' sentiment, businesses can uncover critical patterns to not only react swiftly to market shifts, but predict the effect of future actions.

- *Monitor and measure.* Measuring the impact of social business remains a significant barrier for many organizations, pointing to the need for standardization to provide cost effective flexible solution patterns understood by the majority of the participating ecosystem.

The relative immaturity of social business technology and scenarios still challenges success criteria. However, leveraging adjacent technologies like cloud and mobile provide a social platform with the additional long term investment protection and reach capabilities, required to meet investment criteria and business objectives as social business matures. Various cloud deployment options flexibly extend the network value proposition, and mobile strategies enable new forms of participation.

Mobility itself has become an essential part of social business, by extending access to the social business value proposition beyond the traditional corporate domain and time clock. The always-on, personalized attributes of mobile devices create support for new and unanticipated scenarios for staying connected with colleagues, partners and business tasks regardless of time or location; and cloud provides the means for faster project completion, faster product introduction, lower operations costs, instant collaboration, and lower infrastructure spend; required as elements of a successful social business strategy.

Leveraging a standards based approach is the final ingredient for achieving success in a space that contrasts the immaturity of social technologies and scenarios with the dynamic rate of change being realized with cloud and mobile technologies. The resulting roadmap places heavy initial leverage on a hybrid cloud model capable of interoperating across enterprise resources and with other cloud environments. This approach enables an enterprise striving to integrate existing systems of record in support of emerging systems of engagement to move forward as requirements, best practices and technologies mature.

Step 5: Leverage Analytics to Gain Insight

The rise in the amount of both structured and unstructured data being generated is phenomenal. By some estimates, over 4 million petabytes of new data will be generated in 2013. Social, mobile and cloud applications are generating enormous amount of data which has brought Big Data analytics to the fore. The analysis of data generated in the social, mobile and cloud domains can bring significant value for enterprises across many diverse areas such as product innovation, marketing, customer care, pricing, application management, and countless more.

Big Data is a term that refers to the collection, storage and analysis of data that is very large in size. The sheer volume of the data, of course, is a major challenge, but other challenges include *variety* and *velocity*. Variety refers to the heterogeneity of data types, representation, and semantic interpretation. Velocity encompasses both the rate at which data arrive and the time in which it must be acted upon.

To effectively handle large volumes of data, a proliferation of new Big Data engineering solutions have emerged including NOSQL databases, distributed file systems, and programming paradigms like map-reduce. Big Data infrastructures rely on core architectural principles such as linear scalability, deployment and execution flexibility, massively parallel processing, in-database execution, storage virtualization, and mixed-workload management, etc. These are consistent and complementary with the core cloud principles.

Advanced analytics and Big Data can help unify an enterprise's investments in social, mobile and cloud technologies, delivering powerful insights that leverage all three categories of investment.

Big Data analytics can be a central component of an enterprise's social business strategy, powering an approach called "next best action," a customer-centric paradigm that considers the different actions that can be taken for a specific customer/stakeholder and decides on the 'best' one. The next-best-action (an offer, proposition, service, etc.) is determined by the customer's interests and needs on the one hand, and the organization's business objectives, policies, and regulations on the other. Next-best-action, driven by Big Data, powers social business in either of the following patterns:

- *Outbound engagement*. This refers to the practice of monitoring social network traffic for stakeholder intelligence (awareness, sentiment, and propensity) and using that feed to trigger next-best-action models that send finely targeted outbound response messages. In a business-to-consumer (B2C) social context, inbound intelligence might be used to trigger next-best-action models that target outbound marketing promotions or respond to specific product issues. In an employee-to-employee (E2E) social context, the next-best-action models might generate reminders to take particular HR actions by a specific deadline or to address a specific technical issue that an employee is having with a piece of equipment. In a business-to-business (B2B) social context, the triggered messages might provide guidance to partners inquiring about the delivery status of particular shipments.

- *Inbound engagement*. This involves tuning social-channel conversations through automatically generated scripts, screens, and applications that shape how employees interact with external

stakeholders and with each other. In a call center environment, for example, customers interact with channel personnel who speak from online scripts and other guidance that is auto generated by the next-best-action infrastructure. In social channels, an enterprise might have diverse human and automated agents handling diverse interaction scenarios that span a wide range of customer, employee, and/or partner segments. Furthermore, an enterprise might be orchestrating these social interactions in order to achieve diverse business objectives, such as reducing customer and employee churn, boosting sales and profits, and achieving greater efficiency throughout the supply chain.

As mobile has become the primary delivery platform for social applications, smartphones and other mobile gadgets have become important sources of the data pouring into Big Data platforms. The ability to personalize mobile service delivery increasingly depends on the collection and analysis of massive streams of data at the device, application, and user levels. Every transaction, interaction, event, signal, ambient, behavioral, geospatial, and other datum that can be acquired from employee and customer gadgets will be crunched by Big Data platforms. Furthermore, the trend is toward organizations moving most of their transactional, productivity, and e-commerce applications to mobile devices.

Enterprises can ensure exceptional, consistent, and secure experiences across all mobile devices by implementing the following Big Data powered infrastructure services:

- *Cloud services ensure Big Data is always there for your mobile access.* Most business users and consumers won't be storing petabytes on their smartphones anytime soon. Rather, they will be maintaining growing volumes of information in the cloud, accessing it from various mobile devices, and selectively synchronizing and caching what is needed locally. As we conduct more of our lives on mobile and social services, we will persist more of our data in the cloud on massively parallel file systems, databases, and other Big Data repositories.

- *Stream computing enables real-time mobile experiences.* Users today depend on continuous real-time connectivity to mobile services many of which leverage Big Data analytics. Mobile applications using Big Data will grow at a rapid pace. Furthermore, many of the mobile services that process high volumes of data in real time or near real time will require stream computing. Stream computing, which will become standard in many mobile services, ensures a continuous flow of alerts, notifications, events, sensor data, transactions, social media updates, video and audio streams, and other types of information between all endpoints and infrastructure services. [8]

- *Machine data is what your mobile device feeds to Big Data cloud analytics*. The typical user won't be manually pushing data from their mobiles into the Big Data cloud. Instead, the gadgets will be feeding data automatically, silently, and in the background into the cloud, under policy controls defined and enforced within mobile device management tooling. Much of this will involve voluminous "machine data"--such as geospatial coordinates, sensor readings, and event logs--that the devices generate continuously. Before long, machine-to-machine mobile connectivity will be embedded into every artifact, possession, and environment in our world.

Wearable and implanted devices will generate machine data on user vital signs, helping people to monitor their lifestyles or alerting emergency services to urgent life-or-death situations.

- *Location analytics use Big Data to orient your mobile device on the ground*. Users won't be performing resource-intensive geospatial analytics locally on most mobile gadgets. Typically, they will be feeding streams of geospatial data from those devices to Big Data cloud services. The cloud-based services will help devices track users' precise locations and to recalculate the best route to wherever they need to be, based on dynamic conditions in their environment. To realize the promise of intelligent location services, the cloud-based Big Data infrastructure will need to continuously correlate real-time feeds of traffic, weather, event, and other dynamic environmental data.

- *Next-best-action leverages Big Data analytics for continual mobile guidance.* Users won't be constantly interacting with mobile devices to determine the optimal road to take, the optimal recommendations to heed, the optimal commercial offer to accept, the optimal streaming media to consume, and the best course of action to take in every situation. Instead, users will frequently lean on Big Data powered cloud services with embedded decision-automation capabilities to recommend their next course of action. Next-best-action infrastructures will continually provide contextual guidance that is personalized to each mobile endpoint. They will continually calculate guidance by leveraging segmentation, propensity, graph, semantic, experience, and other advanced analytic models built by data scientists.

Most of us don't think of Big Data as a personal resource for social mobility, but, clearly, that thinking will need to change. Smarter mobility depends on the ability to serve all of our mobile devices from an intelligent Big Data cloud infrastructure.

Cloud-based Deployment

One of the key questions for enterprises is how to prepare their Big Data deployment for delivery into a cloud-based, production ready IT environment. It is important to realize that production ready Big Data deployment demands a lifecycle focus that encompasses all of the enterprise's Big Data platforms, not just a single one (e.g., Hadoop), and should address more than just a single requirement (e.g., availability, scalability, security, backup and recovery, etc.).

Here are several high-level considerations to keep in mind as enterprises ready their Big Data initiatives for primetime cloud-based deployment:

- *Stakeholders*. Has the enterprise aligned its Big Data initiatives with stakeholder requirements? If stakeholders haven't clearly specified their requirements or expectations for your Big Data initiative, it's not production-ready. The criteria of production readiness must conform to what stakeholders require, and that depends greatly on the use cases and applications they have in mind for Big Data. Service Level Agreements (SLAs) vary widely for Big Data deployed as an enterprise data warehouse (EDW), as opposed to an exploratory data-science sandbox, an unstructured information transformation tier, a queryable archive, or some other use. SLAs for performance, availability, security, governance, compliance, monitoring, auditing and so forth

will depend on the particulars of each Big Data application, and on how each enterprise prioritizes them by criticality.

- *Stacks*. Has the enterprise hardened its Big Data technology stack – databases, middleware, applications, tools, etc. – to address the full range of SLAs associated with the chief use cases? If the Big Data platform does not meet the availability, security and other robustness requirements expected of most enterprise infrastructure, it's not production ready. Ideally, all production-grade Big Data platforms should benefit from a common set of enterprise management tools. Key guidelines in this respect are:
    - Leverage a Big Data solution provider's high availability, security, resource provisioning, mixed-workload management, performance optimization, health monitoring, policy management, job scheduling and other cluster management features;
    - Ensure high availability on Big Data clusters by implementing redundancy across all nodes, with load balancing, auto-failover, resynchronization and hot standbys;
    - Perform thorough regression testing of every layer in the target Big Data deployment prior to going live, making sure data, jobs and applications won't crash or encounter bottlenecks in daily operations; and
    - Avoid moving Big Data analytics jobs to clusters until they have been hardened for 24x7 availability and ease of configuration and administration.
- *Scalability*. Has the enterprise architected its environment for modular scaling to keep pace with inexorable growth in data volumes, velocities and varieties? If new storage, compute and network capacity cannot be provisioned, added, or reallocated on the Big Data platform in a fast, cost-effective, modular way to meet new requirements, the platform is not production ready. Key guidelines in this respect are: [9]
    - Scale your Big Data through scale-in, scale-up and scale-out techniques;
    - Accelerate your Big Data with workload-optimized integrated systems fit for cloud deployment;
    - Optimize your Big Data's distributed storage layer; and
    - Retune and rebalance your Big Data workloads regularly.
- *Skillsets*. Has the enterprise beefed up its Big Data skillsets for maximum productivity? If staff lacks the requisite database, integration and analytics skills and tools to support Big Data initiatives over their expected life, the platform is not production ready. Don't go deep on Big Data until staff skills are upgraded. Key guidelines in this respect are:

- Upgrade the skills of DBAs, data integration specialists, data scientists and business analysts to support Big Data best practices in deployment, modeling, management and optimization;
- Leverage Big Data experts and consultants to assist in initial Big Data planning, project deployment, development, modeling, optimization and management; and
- Connect the team into the worldwide community for your Big Data technology or platform in order to learn from emerging best practices.

- *Seamless service*. Has the enterprise re-engineered its data management and analytics IT processes for seamless support for disparate Big Data initiatives? If trouble response, user training and other support functions cannot be provided in an efficient, reliable fashion that's consistent with existing operations, your Big Data platform is not production ready. Key considerations in this respect:
  - Provide Big Data users with a "single throat to choke" for support, service and maintenance;
  - Offer consulting support to users for planning, deployment, integration, optimization, customization and management of their specific Big Data initiatives;
  - Deliver 24x7 support with quick-turnaround on-site response on issues;
  - Manage an end-to-end Big Data environment with a unified system and solution management consoles; and
  - Automate Big Data support functions to the maximum extent feasible.

Cloud based Big Data environments will rarely be centralized in a single cluster. Instead, multi-tier distributed cloud architectures are needed to scale back-end data collection transformations and front-end queries independently of each other, and perhaps also provide data scientists with their own analytic sandboxes for exploration and modeling. The huge range of access points, applications, workloads, and data sources for any cloud-centric Big Data environments demand an architectural flexibility that traditional premises-based data warehouses, have rarely needed.

The main Big Data deployment tiers are:

- *Back-end tier*. This is the tier of the Big Data cloud architecture that handles data discovery, extraction, collection, staging, landing, transformation, cleansing, enhancement, and pre-processing. This tier will typically need different preprocessing clusters for each of the disparate sources of social, mobile, and other new data sources: structured, semi-structured, and unstructured. Disparate clusters may need to be configured with different underlying data platforms-- HDFS, HBase, Cassandra, NoSQL, stream computing, etc.---to handle these requirements. This tier is where most high-volume, high-velocity, and high-variety Big Data sets

are processed on the most scalable Big Data platforms. Frequently, this will run in a public cloud, SaaS, or other hosted environment with on-demand scale-out and elastic provisioning.

- *Middle tier*. This is the tier that supports aggregation, governance, and master data management on the Big Data that is preprocessed in the back-end tier. In the middle tier (sometimes known as a "data warehouse"), a relational database is typically used with massively parallel processing, rich metadata, and in-database execution components. In most instances, this is a private cloud or other on-premises deployment, due to the security requirements of governing the "single version of truth" data sets in-house.

- *Front-end tier*. This is the tier that supports access, query, exploration, statistical modeling, sandboxing, presentation, and interaction on data that is pulled from the middle tier. In the front-end tier (sometimes known as a "data mart"), various combinations of in-memory, columnar, OLAP, dimensionless, and other database technologies might be required to deliver the requisite performance on diverse analytic applications, ranging from operational BI to advanced analytics and complex event processing. Due to the speed requirements and the need for tight control over the environment by teams of data scientists, this tier might often be deployed on premises. To the extent that the front-end tier interfaces to multiple middle-tier data warehouses and/or back-end landing layers--on-premises and/or in a public cloud--there might be a data virtualization, abstraction, or federation layer that mediates these interactions, enables seamless query, handles on-demand joins, and other middleware functions.

Step 6: Establish a DevOps Capability for Rapid Delivery of Innovation

Businesses are under tremendous pressure to deliver new and innovative solutions to their customers to capture market opportunities. Customers are much more empowered than in the past and they demand a higher quality customer experience. Just look at your own experience with mobile applications. Would you continue to use an application that had a poor user experience and was only updated once a year? Disruptive technology trends such as mobile, social, cloud, and big data analytics are another factor adding pressure for more rapid releases of innovation. Companies that learn how to be effective leveraging these technologies are increasingly able to out innovate their competition.

Adopting cloud is a major first step to increase an organization's ability to provision environments quicker and more frequently; however, adopting cloud is not enough. It has been shown that high performing organizations are turning to DevOps to help them take a business idea and rapidly deliver it as new function to their clients in a high quality manner. For a business to have a competitive advantage based on innovation they must be able to adopt DevOps and make the most of new technology trends to transform into a high performing organization.

> *DevOps is a software development method that stresses communication, collaboration and integration between software developers and IT professionals. DevOps is a response to the*

interdependence of software development and IT operations. It aims to help an organization rapidly produce software products and services.[9]

DevOps is a core capability to rapidly deliver changes to seize market opportunities and make improvements based on timely customer feedback while balancing cost and quality. DevOps embraces the new *continuous delivery* concept. In this environment, clients expect fixes and enhancements to arrive quickly, seamlessly, and continuously. Increasingly users expect to see a fix or enhancement applied with no disruption in service or loss of context/data. To effectively adopt Devops, organizations must address several challenges:

- Differences between production and development environments due to a lack of standards and poor configuration management.
- Inability to rapidly provision and deploy an application into an environment for testing.
- Dependence on manual processes and tribal knowledge requiring heroic feats for every release making them risky and error prone.
- Lack of customer feedback, quality metrics, and business requirements making it difficult to determine the business value of released changes.

There are several key tenants when implementing a DevOps solution that an organization should aspire to achieve.

- Establish executive support for cultural and process changes that will be required. Once buy-in from executive champions has been established, DevOps requires a culture which facilitates continuous participation from lines of business doing the day-to-day work.
- Agree upon DevOps practices that are important to your organization (i.e., continuous integration, automated deployment, configuration management, continuous testing, continuous monitoring and reporting) and assess current maturity level.
- Reduce waste (wait time and manual hand-offs) across processes for delivering change (often requires the automation of procedures).
- Establish meaningful measurements of progress. Progress can often be measured by increased development capabilities even before the first delivery. The first feature delivery may be the slowest as new processes are created and adopted.
- Change the culture by institutionalizing tools that embrace DevOps. Encourage the design and implementation of collaborative tools to be consumed internally by development, testing, quality assurance, and operations groups. Leverage version controlled source code

[9] See http://en.wikipedia.org/wiki/DevOps.

management tools to adequately handle rapidly changing application code (with multiple branches for development, staging, and production).

Recognize that improved processes such as automated build-and-deploy processes, improved testing processes, and version controlled source code management processes provide better quality code and faster continuous integration of new features. To keep in step with more rapid development of capabilities, consider leveraging the use of a service catalog if features can be shipped as modular, re-usable service components.

Leveraging a DevOps reference architecture is important to help organizations define the capabilities and tools that will be used to implement their DevOps environment. The reference architecture should embrace open standards where possible. Figure 1 includes an example DevOps reference architecture with key standard technologies called out specifically in the area of cloud and lifecycle integration.

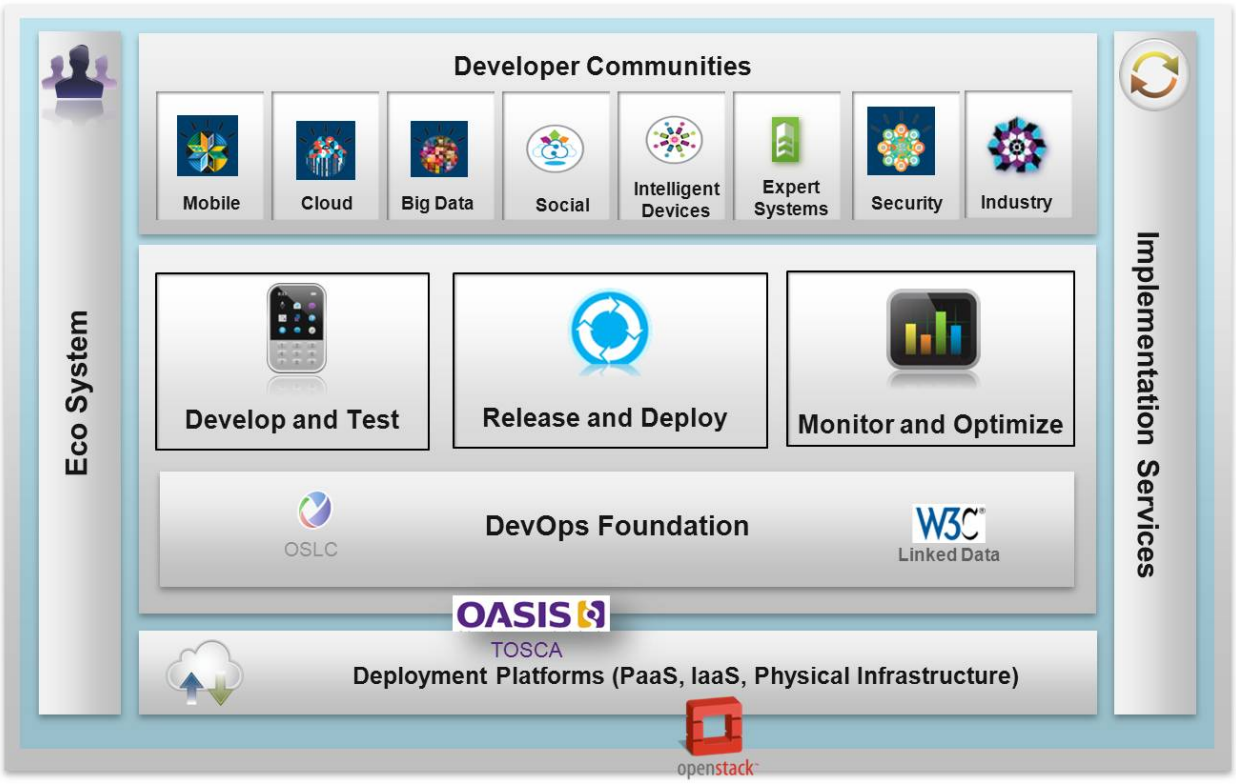

Figure 1: DevOps Reference Architecture

The example DevOps reference architecture contains the following layers:

- *Deployment Platforms.* This layer includes cloud and physical infrastructure, including platforms based on standards (e.g., OpenStack[10]), for hosting the DevOps platform as well as a target for deployed workloads using the DevOps services.

[10] See http://www.openstack.org/ for details.

- *DevOps Foundation*. A set of common services such as user authentication, reporting, event messaging, etc. to provide integration across a set of tools for the DevOps tool chain. The foundation is based on standard interfaces such as OSLC[11] and the W3C Linked Data.[12]

- *Develop and Test.* Capabilities that are necessary to support the development and change management of software and the ability to track and automate tests, both unit and functional tests.

- *Release and Deploy.* Capabilities to enable automated cloud resource provisioning, application deployment automation, and application release management that together provide repeatable and reliable processes to manage and deploy changes into environments.

- *Monitor and Optimize***.** Capabilities for capturing customer sentiment and monitoring the effect of the delivered changes into an environment. Once captured, the feedback is reported to the development and operations teams to ensure the application can be optimized to meet the demands of the customer.

- *Developer Communities.* Refers to the technologies and workload types that are being developed and delivered using the capabilities from below.

- *Ecosystem & Implementation Services*. The architecture embraces an ecosystem and community of tools and content, and leverages implementation service teams to help organizations transform their business by adopting the DevOps practices and reference architecture.

DevOps Tool Chain

When implementing a DevOps reference architecture, it is often best to consider the DevOps tool chain that will be used to manage and deliver changes. A tool chain will identify the tools that implement key phases of a delivery process.

[11] See http://open-services.net/ for details.

[12] See http://www.w3.org/standards/semanticweb/data for details.

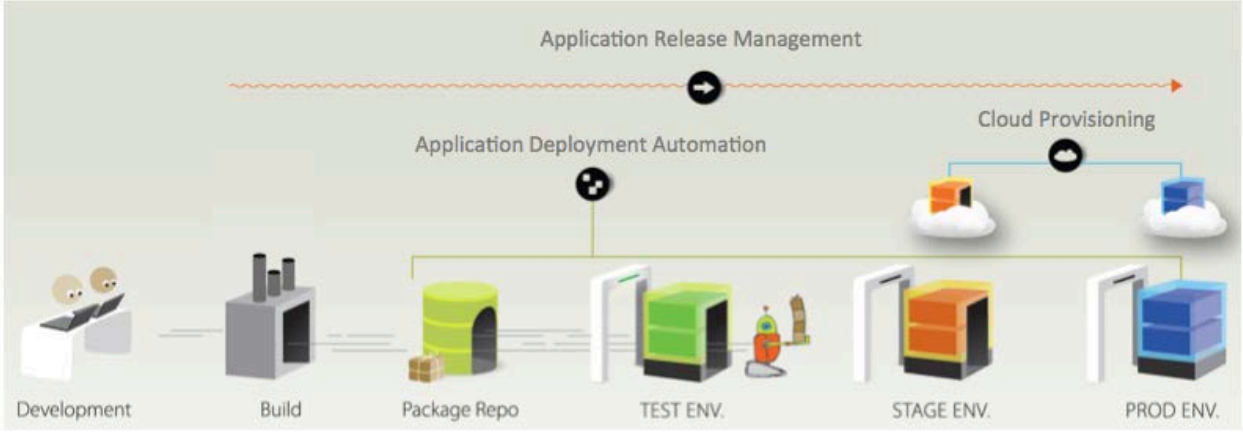

Figure 2: DevOps Tool Chain

A DevOps tool chain defines the set of tools that are "chained" together to provide an integrated set of capabilities that enable an organization to rapidly develop and deliver changes to clients and then monitor and respond to feedback. Key phases included in a typical DevOps tool chain include:

- *Development*. Tools to develop the application source code.
- *Build*. Compile and package the source code into a deployable package.
- *Application Deployment Automation*. Define and manage configuration data across testing and production environments for an application and automate the processes to deploy the application into each environment. ADA often includes test automation technologies to ensure the deployed changes are automatically tested to verify function against business requirements.
- *Cloud Provisioning*. A provisioning system that automates the provisioning of virtual resources within the cloud. Ideally the cloud provisioning technology will support the provisioning of standard environment patterns that greatly reduce errors and improve consistency across deployments.
- *Application Release Management***.** It is important that an application release management system is used to plan, track, and govern the application release process. By using an ARM system, operational releases will be structured and clearly defined reducing errors and, ultimately, risk to the releases that will increase your organizations ability to release more often and with greater speed.

Monitor and Optimize

Convergence of technologies has driven an evolution in applications from a traditional multi-tier architecture to a hybrid architecture, featuring different – sometimes dispersed – components:

- Multiple user interfaces: social media, web sites, mobile and APIs.

- Use of multiple programming languages – the new systems of engagement are leveraging multiple languages such as Java, Javascript, Python, etc.
- Internal business services and application programming interfaces from external parties.
- Deployment models ranging from private, public and hybrid clouds.

Given this level of complexity, IT organizations faced with goals of continuous uptime may look at this with fear and concern. It is this reason why an effective management environment should be built. This includes:

- Ensure the right monitoring and debugging tools are in place in order to trap and determine the cause of failures. This is a common pitfall to migrating applications to the cloud today. Many firms move applications "as-is" and may not consider the complexity requirements of a platform.
- Mitigate the risk of change management through fault tolerant application design. It is highly unlikely that all of these pieces will change in concert with one another, and constant change should be anticipated. A design technique that can mitigate this would be to design applications to tolerate failure of any or all of these components.

In such an environment change management becomes critical. Not only are the applications becoming more complex, the line of business is expecting more changes to an application faster. Tracking and testing those changes are now more important than ever.

Reduced visibility of application and infrastructure health and performance is a key challenge of cloud computing. Without direct control over the cloud infrastructure itself, traditional application performance management (APM) tools may prove impractical to deploy and manage. Add to this limited visibility the rapid (and sometimes merciless) feedback channel that social media provides, and you have a potential powder keg on your hands when cloud applications fail to perform. Cloud application outages "trend" wildly when they occur, and it can be difficult to determine if the problem is with the application itself, or the cloud platform.

Cloud application owners – like traditional data center administrators - need to see how their cloud-hosted applications are performing. They need tools to ensure that they're getting the performance they expect from the cloud, and that their applications are serving customers and delivering value to the business. But the abstraction of physical resources that virtualization engenders can render traditional performance management solutions impractical. In this environment, user experience monitoring is the key measure of application performance, because it takes into account the redundancy and resource sharing of cloud delivery, and paints an intuitive picture of health.

Another key to getting the intended value from workloads executing in a public cloud is establishing what kind of demand those workloads are facing, how well the cloud is scaling (or not scaling) to meet the demand, and correlating that with end user experience. That means that cloud tenants must also monitor their virtual machine operating systems, to ensure that they're getting the resources and

performance promised to them by cloud administrators. In short, user experience monitoring tells them how their application is performing, and VM monitoring tells them how their cloud provider is performing.

When designing such a solution, application teams, in these circumstances, don't have the ability to deploy management servers and other monitoring components to the cloud infrastructure, as they would in a traditional data center deployment. Instead, they require a lightweight solution that can be deployed by the application teams themselves (rather than cloud administrators) alongside the application workloads. To adhere to the dynamic provisioning model, the monitoring technology must be embeddable in virtual machine base images or patterns, and work with multiple provisioning solutions. Integration with the provisioning engine allows each new VM instance to be automatically discovered by the monitoring infrastructure and associated with the correct business application, so existing application dashboards are updated to reflect the addition of new virtual machines in seconds. This is the essence of concepts like continuous application delivery, where the rapid self-provisioning features of the cloud encourage application teams to frequently update their production applications. To be effective, an application monitoring solution for this environment must be similarly nimble.

Step 7: Adopt a Flexible Integration Model

The technology shifts created by social, mobile and cloud are drastically changing the business landscape. Successful businesses must find ways to extend and connect their existing infrastructures to the billions of mobile devices that exist today and the massive amount of data that is being generated, much of which will be stored in the cloud. They must adopt a flexible and secure integration model so that back-office systems can keep pace with this rapid change.

Today, companies are increasingly considering a *hybrid cloud* approach for deployment of their mobile and social enterprise applications. The availability and security advantages of established internal systems combined with the on-demand and elasticity advantages of Public cloud deployment provide an environment that delivers maximum benefit with appropriate risk mitigation. Special attention must be given to integration requirements. The main concern is integrating the mobile and social applications which, in a hybrid environment, typically run in the cloud with backend systems of record that typically run on-premise.

In hybrid cloud environments, security and compliance requirements dictate where data and processes can be distributed. As a result, there are increased demands on the controlled process communication between heterogeneous distributed systems - specifically the secure, reliable and transactional transfer, as well as the transformation and integration of data and services. For this purpose, different integration strategies can be used:

- *Established connectivity, messaging and integration approaches like EAI/ESB*. The central function of an Enterprise Application Integration (EAI) solution is the exchange of data between IT systems or their components. Today's established technology is the Enterprise Service Bus (ESB) which is responsible for supporting connectivity and transport, protocol conversion, data transformation, and routing.

- *Special cloud integration solutions*. These solutions connect SaaS applications and cloud services for mobile and social solutions to internal enterprise applications. They provide a graphical configuration interface to help integrate applications quickly and simply. This differs from the traditional EAI/ESB approach which requires more custom coding to complete integration. The cloud integration solutions use preconfigured templates based on common integration scenarios to accelerate integration between legacy and new social and mobile services deployed in the cloud. Additionally, they often provide capabilities for API management – extremely helpful to manage external developer communities utilizing social and mobile APIs.

As highlighted in Figure 3 below, the increasing need for agility and ease-of-use solutions are making the capabilities of the new cloud integration approaches more attractive than established EAI solutions.

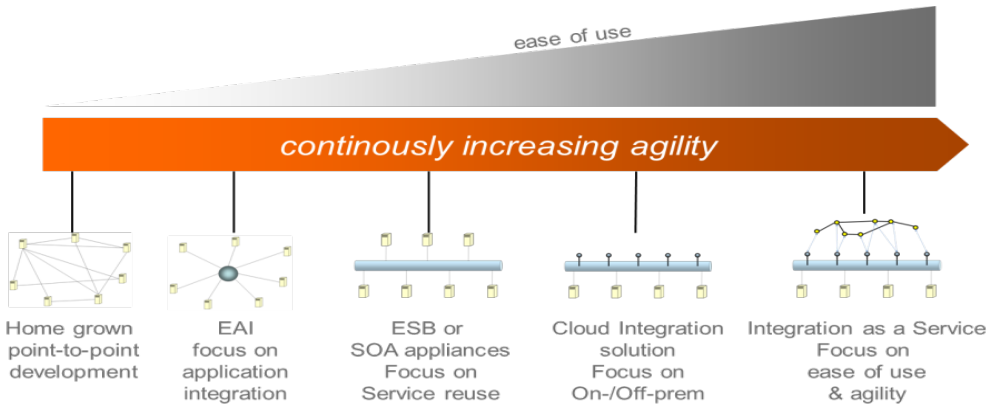

Figure 3: Integration continuum

In order to determine which of the two integration approaches are most appropriate, enterprises must develop an overall integration strategy and, based on specific needs, determine to what extent a preconfigured solution can be used. Of course, the basic parameters are essential:

- What processes and applications are to be implemented by IT staff?
- How well-prepared are the applications for the on/off premise integration?
- How stable are the underlying data models?

Cloud integration solutions are most effective when applied to business objects with stable, typed data structures. A good example is cloud-based CRM integration with backend ERP solutions which involves primarily "static" data structures which are perfect for a mapping pattern. Such mappings can be predefined in an integration package requiring relatively minor customized mappings and transformations.

Cloud integration solutions are less effective with internally developed applications or lesser known SaaS solutions since the pre-configured mappings, which are based on de facto standard data models, require significant customization in these cases. Furthermore, if you need to integrate a large number of distributed services (like a social business service provider with different mobile client APIs with

different legacy interfaces) and require high reuse of mediation services, the pre-built cloud integration templates are not an optimal solution. The established EAI and ESB solutions fit much better for these scenarios.

The collection, consolidation and normalization of large volumes of data collected from different mobile devices and social media sources for analytical purposes is a critical point of integration that needs to be specifically addressed in the converged environment. An integration platform must be able to handle and route tremendous volumes of messages. Such a requirement fits nicely with established connectivity solutions.

An effective solution is to leverage a messaging network and extend it outside the datacenter, scaling to handle concurrent connectivity between a multitude of devices and applications with predictable latency. This event-driven, interactive infrastructure will provide the level of performance and value to support new systems of interaction with people, mobile devices, sensors, machines and applications by unlocking information in systems of record and enabling business to be conducted anywhere, anytime, by anyone or any *thing*. The solution must provide:

- *Scalability and high performance.* High throughput for persistent and non-persistent messages.
- *Reliability.* Assuring critical messages are delivered.
- *Developer-friendly APIs and libraries.* Native and hybrid application development.
- *Security*. DMZ-ready with no user level operating system.

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