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Application Modernization in the Enterprise: **Architectural, Operational, and Delivery Impacts**

Larry Carvalho April 2020



IDC OPINION

The usual first step of cloud adoption typically includes lift and shift of workloads from on-premises datacenters to the public cloud. However, businesses can derive more value from a cloud migration if they can take complete advantage of emerging cloud technologies.



Migrating workloads to the public cloud, if well planned, offers an opportunity for environments to be quickly replicated in production-like settings, and rapid testing of new features enables developers to accelerate innovation. The benefits of adapting applications to new delivery methods are so great that enterprises are on a continuous application improvement cycle. The pace of innovation is magnified when workloads take advantage of new cloud features such as functions as a service, containers, and microservices. The adoption of these managed services has a big impact on organizational operations — eliminating the need to patch, update, and scale application infrastructure.

Monolithic applications have been built with traditional infrastructure and software architecture for decades and saddle organizations with a solution portfolio that is unable to respond to business demands for digitization

in a timely fashion. Legacy applications offer limited flexibility and reduce the agility of teams. Traditional applications also absorb a high proportion of information technology (IT) spend for maintenance, giving organizations limited budgets to enhance the existing solution portfolio. Cloud technology is evolving at a rapid pace, and enterprise application architecture needs to adapt to modern functionality that gives developers a new mindset and tools to speed up the pace of delivering new features and enables operations teams to play a more strategic role in the business.

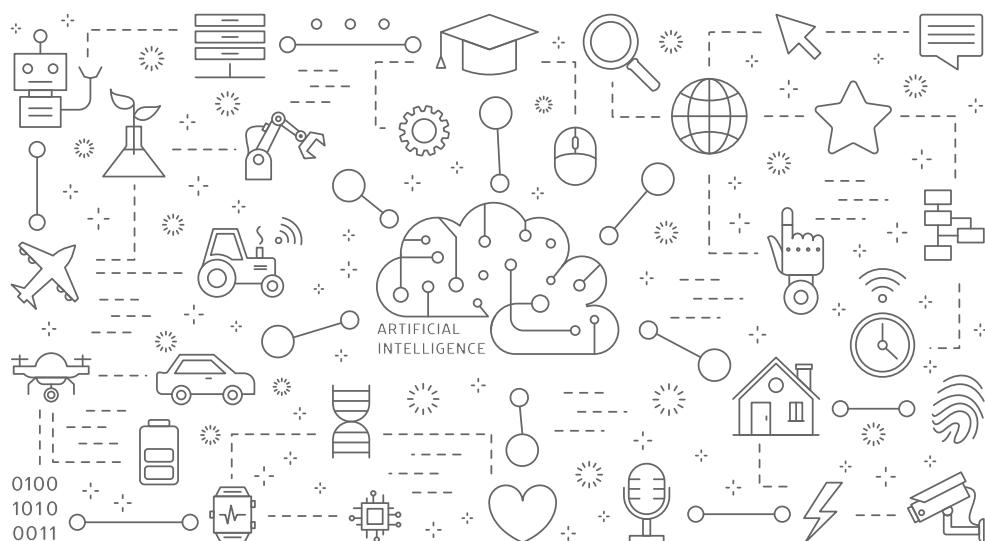
Several large enterprises with a portfolio of legacy applications are taking steps to modernize and, ultimately, use application development to create new digital experiences for their customers as a competitive market advantage. Cloud-native architectures help organizations become more agile, reduce time to market for new

applications, and provide the user experience expected by customers accustomed to interacting with consumer applications in their day-to-day life. The serverless operational model — in which a cloud provider takes care of all the infrastructure management required by an application — accelerates the frequency of software releases by completely freeing developers and operation teams to reallocate time toward new designing and releasing new features. For many companies with applications on-premises, their first step in application modernization takes the form of containers, which offer excellent portability and flexibility but still require an element of infrastructure management. For many, the goal of modernization is to adopt functions as a service, which completely abstracts away infrastructure management tasks. Expedia, an online travel company, shared lessons learned while modernizing applications.

Refactoring involves undertaking the journey from traditional architectures consisting of application servers and a single data store to a modern architecture built with

multiple runtimes, distributed services, and smaller data stores. Modern release pipelines consist of automated development life cycles accelerating the path from source code management to deployment. IDC surveys show that less than one-fifth of developers are extremely familiar with cloud-native technologies such as containers, container orchestration, serverless, and microservices. This calls for IT management to prioritize education of developers while freeing up IT budget to modernize applications.

Latest application trends consist of autonomous development teams breaking up applications into microservices and optimizing on containers or serverless cloud technologies. This approach eliminates traditional code to deployment barriers while enabling innovation at scale and removing the risks of security breaches and downtime. With the goal to stay ahead of competition and disruptive trends, enterprises need to put application modernization at the top of their priorities and dedicate a significant amount of attention to this effort.





IN THIS WHITE PAPER

The reasons for prioritizing application modernization are covered in this White Paper as are recommended steps to be taken to undertake a successful refactoring effort. IDC interviewed Expedia Group, that shared their experiences with application modernization using AWS services, and their lessons learned are covered in this document.



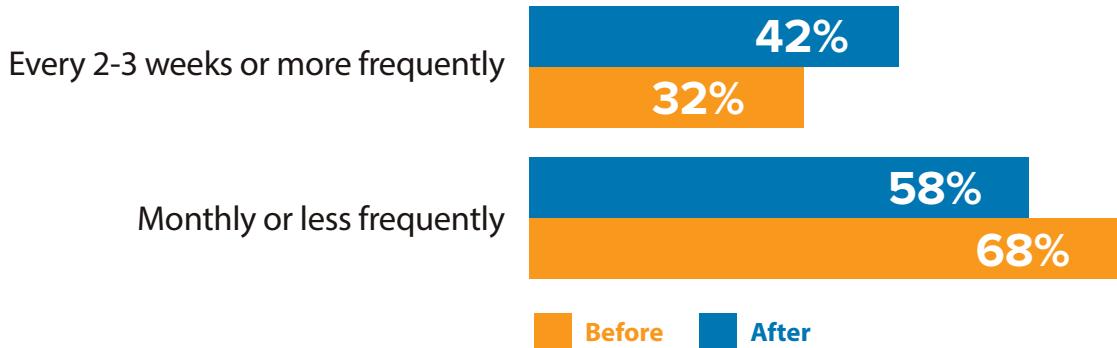
SITUATION OVERVIEW

The Business Imperatives of Application Modernization

The need for a modern application architecture is driven by organizational need to compete in a market that is moving faster than ever. Line-of-business requirements for new features and capabilities in applications are continuously changing, and developers are challenged to keep up with change requests using traditional application development tools and underlying infrastructure. One of the steps to be taken to develop and deliver new applications faster is DevOps adoption. DevOps is a development methodology in which the operation of the application begins with the design stage, and developers and operators work in tandem to build, release, and operate applications. Organizations use this approach to deliver value rapidly and reliably to their customers. DevOps methodology accelerates deployment frequency as evidenced by a survey of developers, IDC's PaaSView and the Developer Survey, showing the number of organizations that were able to deploy code releases weekly doubled after implementing DevOps (see Figure 1).

Figure 1. Acceleration of Deployment Frequency after Modernization

Q. After implementing DevOps, how often, on average, does your organization deploy code releases?



Source: IDC's PaaSView and the Developer Survey, 2019

Modern applications empower developers to safely experiment with new features without the fear of causing major disruption as components are independent of each other. They also fundamentally change the role of operations teams, who are often relieved of manual tasks such as installing software updates in favor of a more strategic position establishing guardrails, training and hiring employees with modern skills, and managing application wide health checks. Features can be delivered and tried out with a fraction of users and, if necessary, changes can automatically be rolled back. This process lowers the cost of pursuing multiple viable solutions, raising the likelihood of success in enterprise modernization.

There are several reasons that a modern application architecture benefits an organization:

- **Time to market for new features:** One of the benefits of a modular application is that changes can be made and tested solely to the component necessary and, being independent of others, this reduces the time taken from code change to deployment. While traditional applications may have feature releases that take months, a refactored application can go from accepting a request for a new or changed feature to modifying code and complete deployment and availability to users in minutes.



- **Agile infrastructure:** The availability of containers and serverless technologies for deployment is giving developers the opportunity to optimize cloud services to instantly scale infrastructure to match the varying demands for an application. Instead of scaling the entire infrastructure supporting a monolith application, a subset of containers that match the specific user demand can be scaled up in microseconds.



- **End-to-end security:** The acceleration of application changes brings challenges to handle security issues that potentially could be introduced when modifying code. The checkpoints that are added into a development life cycle using modern architectures can ensure all security aspects are managed and enforced in a modern architecture.



- **Continuous course correction:** Monitoring of outages and portability of containers allow an application that is distributed across regions to recover easily and, consequently, high availability becomes a standard for these applications. One of the important benefits from using public cloud technology is the ability to monitor every step of the application development life cycle. This provides a closed feedback loop to constantly improve applications as new features are released and consumed.



- **Aiming for a common goal:** Because of huge technical debt of legacy infrastructure, development teams are burdened with a backlog of projects. Senior management faces board and shareholder pressures to respond faster with modern technologies. CIOs now report to CEOs, and some non-software enterprises are recruiting CEOs from software companies. Line of business often loses trust in its IT department that has to "keep the lights on" while retooling to meet new demands. Investing in modern application development tools and a DevOps methodology is a win-win scenario that aligns the goals and vision of line-of-business management and IT teams.



Steps to Be Taken to Modernize Applications

With the technical debt incurred at organizations over the years, there is a challenge to prioritize tasks and allocate the right staff and budget for a modernization effort. IDC predicts that by 2025, nearly two-thirds of enterprises will be prolific software producers with code releases deployed daily, over 90% of new apps cloud native, 80% application components externally sourced, and 1.6x more developers. Long-term benefits from applications built on a modern cloud architecture bring agility at lower costs, resulting in budgets being freed up to further accelerate the modernization effort.

There are several steps an organization can take to move to a modern application architecture:

- **Acquire or develop skills:** There is a significant deficit in employees with knowledge of modern enterprise architecture consisting of functions, containers, and microservices in organizations. Enterprise development teams lack competence in understanding how to write new stateless applications without VM-oriented technologies. Operation teams must set up complex monitoring and logging systems, resulting in automatically addressing issues in real time. Figure 2 shows that only one-fifth of employees are extremely familiar with emerging development technologies. Cultural change is necessary to adapt to a new way of delivering applications that require a workforce familiar with all aspects of the benefits a modern cloud technology can provide.
- **Analyze the portfolio:** Modernizing enterprise applications is a journey that begins with an analysis of the existing portfolio to match line-of-business needs with solutions that deliver the highest value to an organization. Some applications have components that are more appropriate to leverage cloud-native technologies and these should be identified and broken out into microservices. When solutions face spikes in demand, they are good candidates for refactoring to microservices. Features like this, that need to scale up and down are isolated from the rest of the monolith application. Planning for integration with existing portfolio is important to ensure that legacy applications can handle demands from refactored applications. Prioritizing applications where return on investment from refactoring efforts can be realized early helps establish confidence and momentum.

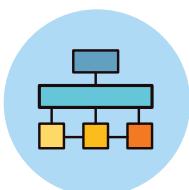


- **Build a security strategy:** While time to market and speed to deploy applications are important, building a pipeline with security checkpoints along the development and deployment life cycle is crucial to success. Regulatory and compliance guidelines require that data sovereignty and data privacy requirements are met. Applying common security features to all refactored applications allows reusability and lowers overall efforts.



Since modern application architecture is dependent on individual services connected through application programming interfaces (APIs), a security policy that combines the identity and access management (IAM) infrastructure with the API gateway is essential for data and application security. An end-to-end security policy can ensure secure communications between the greenfield and API-enabled monolith or packaged applications.

- **Take advantage of a modular architecture:** Microservices change the course of software development, with developers creating independent services connected through APIs. Being independent and specialized, microservices deliver several benefits including reusability, better ability to handle scaling, and reduction of development time. Application modules decomposed into individual standalone microservices can be independently invoked using APIs that allow coexistence with existing applications through integration. Enterprises should evaluate circumstances that benefit application capabilities such as improving horizontal scaling while also considering challenges of data synchronization that decoupling can bring. As an example, partners like hotels or homeowners upload photos and images of their property to Expedia Group websites, and an image transformation microservice can be independently called from any application. Decomposing applications into microservices with its own data store will enable continuous delivery. Decoupling applications allows scalability by only addressing resources that are in higher demand, for example, in a particular geography.



- **Accelerate the life cycle:** Development processes around containers, microservices, and functions are constantly evolving and accelerating the path from source code management to deployment. Adopting a DevOps model improves the agility and speed in responding to application feature requests. All steps in the pipeline, including testing and packaging, should be automated with scripts.





- **Automate and monitor for feedback:** When automating the pipeline including the build, test, and deployment steps, it is important that the process is monitored with the developer getting immediate feedback on any failure. Feedback enables identification of areas where there is opportunity for improvement and steps that can be automated in the future.



- **Leverage value of data with the right database:** Several different choices are available when picking the appropriate database type to handle the scale, security, and availability of a distributed application. Relational, graph, key-value, and time series databases are some of the options available to support use cases varying from ecommerce, gaming, geospatial, and Internet of Things (IoT) applications. Open source database instances reduce costs, and in-memory caching services deliver the capability to service high volumes of requests from mobile and web applications.



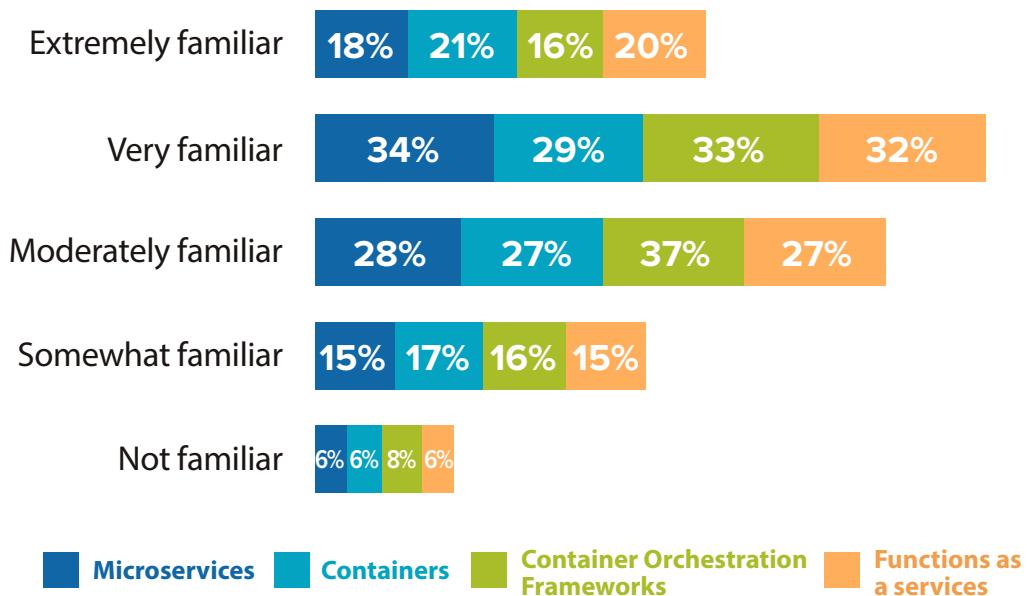
- **Leverage the serverless model:** Serverless technologies reduce infrastructure management and offer built-in high availability, allowing developers to focus on writing business logic in the language of their choice. Payment is measured by units of work and priced by duration of execution that can automatically scale up and down, resulting in lower total cost of ownership. Adopting a serverless operational model allows developers to focus on core competencies while offloading non-value-added work to the cloud service provider. Consider cold starts when evaluating a serverless model. The time required to initialize "cold" functions can pose a challenge for applications that require rapid scaling, though many vendors are offering solutions to this through pre-warmed functions. As serverless technologies evolve to address cold start and awareness of new development architecture grows, more enterprises are picking a serverless architecture as the first choice when developing applications.



- **Consider containerization as a getting started strategy:** Cloud services make it possible for the provider to take over most of the responsibilities for infrastructure at varying levels that abstracts workload management complexity from the user. For container-based applications, cloud service providers manage the clusters, while for event-driven applications, the complete back end is managed. IoT and stream processing applications are ideal for event-driven computing. A growing number of companies are choosing serverless as the primary option for all new applications, giving them a leg up on competitors.

Figure 2. Familiarity with Modern Application Architecture

Q. *Describe your personal level of familiarity with the following: functions as a service, container orchestration frameworks, containers, and microservices*



■ Microservices ■ Containers ■ Container Orchestration Frameworks ■ Functions as a service

n = 2,500 Source: IDC's PaaSView and the Developer Survey, 2019





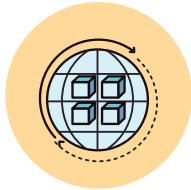
AWS Customer Profile: expedia group™

Expedia Group is an online travel company, with an extensive brand portfolio that includes some of the world's leading online travel brands. Expedia Group aims to constantly improve customer experience in an industry where challengers are harvesting data and rapidly delivering innovative choices for customers.

The hospitality industry is continuously changing to deal with customer preferences in a price-sensitive market, and travel platforms are aiming to simplify the customer experience by giving customers a wide range of options when making vacation plans. Companies offering travel platforms powered by monolithic applications find it a challenge to provide customers a unique experience that involves connecting data from a growing number of travel suppliers through a single interface. Customer use of travel platforms varies greatly by time of day, geography, and season, requiring technology that can scale based on demand while providing high availability to users connecting through a variety of interfaces.

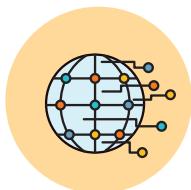
The Expedia Group consists of a collection of travel brands that strive to bring together a unique experience to customers looking for the perfect travel getaway. Collectively, the Expedia Group brands cover virtually every aspect of researching, planning, and booking travel, from choosing the best airplane seat to reading personal travel reviews of hotels to planning what to do in a destination once you arrive. The Expedia Group portfolio serves both leisure travelers and business travelers with tastes and budgets ranging from modest to luxury. Updating or enhancing a travel platform that connects travel suppliers — including over a million properties, more than 500 airlines, and dozens of cruise lines — requires a modern architecture where features can be rapidly tested and released independently of each other.

IDC had a conversation with Kuldeep Chowhan, distinguished engineer of Vrbo, part of Expedia Group, who shared some of the best practices in the company's journey from monolithic apps to modern architecture through refactoring:



- **Commonality/reuse:** Expedia Group operates a large number of travel booking websites that are used in a wide range of countries. To be able to operate at that scale, Expedia Group takes common application components and packages them for reuse among the applications powering the 200+ travel booking websites used in 70+ countries. Expedia Group took this approach to operating more than 4,000 microservices because these common components create business value in the form of efficiency, simplicity, or scale across the organization. AWS Lambda is also being leveraged to assist with data prep for some of these common components.

As the technology value drivers are identified, Expedia Group's engineering culture quickly kicks in to get to align on a common scalable pattern that enables all the business and technology teams to maximize leverage. The distributed nature of Expedia Group's systems architecture enables teams to iterate and evolve organically, which enables Expedia Group's technology to continuously evolve, without disruption to the continually growing business. It's a fine balance fueled by Expedia Group's agile and engineering excellence culture. The company remains humble — it acknowledges that it has not mastered any of this, but its engineering excellence culture ensures that it evolves.



- **Rapid deployment:** One of the benefits of refactoring applications to use a modern architecture is to reduce the time it takes for feature changes to be deployed into production with a high degree of confidence that it will work. The key to making this work is to automate the continuous integration/continuous deployment pipeline of the application life cycle. Expedia Group uses the A/B testing framework to roll out and test features to a subset of customers. This approach lets developers experiment with new features and roll out only those that meet customer needs before global release. This approach also lets Expedia Group deploy changes in a few minutes, reducing the backlog of feature requests from business users compared with the weeks or months that changes took when the application was still a monolith. Modern release pipelines provide Expedia Group high agility by leveraging the ability to turn features on and off and then bake those features into its applications globally in about an hour.

Reducing the risk of deployment involves routing just 5% of traffic to a page that contains new features and ensures that the new code is working correctly without any adverse impact on users. After validation of success, the next step is to increase the routing from 5% in steps of five all the way to 100%. As confidence in the new features increases, traffic goes quickly from testing with 5% of the users directly to 100% of the traffic, showing that maturity exponentially accelerates the deployment pace.



- **DevOps:** One of the core engineering principles at Expedia Group has been “you build it, you own it” from an application standpoint. The previous practice was that certain deployment functions were restricted to a certain set of individuals, and now it is the responsibility of the application team itself. An engineering team builds all the tooling, so developers can build the applications and deploy the applications with all monitoring solutions such as logging metrics and distributed tracing. DevOps practices provide development teams with the tools to manage applications, removing any friction from the source code to deployment life cycle. Overall, IDC observes the steps taken by Expedia Group to refactor its current applications to use containers, microservices, and the serverless platform give it a significant advantage in accelerating its speed to market. Expedia Group reduced the time to release new applications and features from months with the monolithic application to multiple times a day with a modern application platform. With investments in modernizing the application architecture and DevOps practices, Expedia Group has seen an order of magnitude increase in features that are shipped to the customers (e.g., Vrbo brand has seen a 12x increase in release velocity in the past three years). The ease of experimentation with new features enables Expedia Group to reduce the risk of delivering new functionality to its customers, and reuse enables acceleration for the development of the features within the organization.



APPLICATION MODERNIZATION WITH AMAZON WEB SERVICES

Businesses increasingly view application design as a core component of how they compete in the market, and so the decision to modernize applications ultimately comes from a need to solve a business problem. Companies want to win new customers by building delightful products and delivering them faster. Application modernization is how they are achieving this outcome.

The AWS portfolio is designed specifically to enable organizations to build modern applications and modernize legacy applications. AWS has a depth of expertise and offers all of the services needed to build and operate modern applications, including serverless technologies, containers, a range of purpose-built databases, developer tooling, and machine learning. This is why millions of customers — including the fastest-growing start-ups, largest enterprises, and leading government agencies — trust AWS to power their infrastructure, become more agile, and lower costs.

Many AWS offerings are managed on serverless tools that change the roles that developers and operators have within an organization. For example, with AWS Lambda, companies only write business logic code — provisioning, scaling, and patching are all taken care of by AWS. The increased use of managed services, combined with an increase in automation for things such as release pipelines, enables operations teams to play a more strategic role in the business and developers to design with deployment in mind. The result of this shift is the creation of a small, autonomous, cross-functional team unified around a product. Developing a modern team and culture are as important as the technology itself in reaping the rewards of modern applications.

FUTURE OUTLOOK



Digital transformation has become the top priority for enterprise initiatives and a critical need in an environment when traditional businesses are increasingly disrupted by savvy start-ups leveraging technology as their core strength without being saddled with technical debt. Cloud providers offer a variety of cloud-native services that help enterprises in their digital transformation journey by improving infrastructure efficiency while accelerating application development. The cost to support legacy applications is accelerating with an aging workforce, so initiatives to modernize applications by taking advantage of a cloud-native architecture is becoming an urgent need for enterprises.

A modern application development and delivery platform allows monolith applications to be refactored into components, or microservices; a serverless operational model reduces the complexity in managing these resources. Enterprises need to ensure that a set of developer tools is available from their cloud provider to securely manage these resources as they move from code change to production.



CHALLENGES/OPPORTUNITIES

While enterprises understand the challenges of meeting business demands with existing technologies, cultural challenges to adapt a new cloud technology paradigm in their day-to-day operations is a high hurdle for information technology departments. DevOps can automate and accelerate the application development and delivery life cycle, but employees accustomed to manually reviewing developer submissions are reluctant to automate software release processes. While AWS has a collection of services built with internal experience to transform the building and delivery of software through automation, there is a need for skills transfer to enterprises helping them embark on their journey and maintain the momentum of cloud technology adoption. Customers would benefit from assistance from a larger ecosystem of AWS partners with specialized cloud skills.



CONCLUSION

New business opportunities require a modern technology platform to be successful. A modern technology platform requires a change in culture as well as new skills to apply modern development tools. Refactoring existing applications is an essential step as enterprises continue their cloud adoption journey. IDC predicts that by 2023, over 50% of information communication technology (ICT) spending will be directly for digital transformation and innovation. To achieve digital transformation goals like Expedia Group interviewed for this White Paper, enterprises must adopt an agile posture in developing and delivering application functionality to meet business needs by embracing modern software delivery methods and tools.

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