Application Modernization

It Takes a (Cloud) Village

Jean Atelsek, Senior Research Analyst, Cloud Transformation and Digital Economics Unit

William Fellows, Founder & Research Director, Cloud Native

For many enterprises, hybrid and multicloud deployments are born of necessity: the resources and organizational disruption needed to go "all-in on cloud" are simply not worth the risk when existing systems are still paying the bills. But the market is not standing still – providers and startups are developing frameworks and automating the examination of code bases to identify routines that can be effectively refactored into cloud-native blocks for faster and more nimble development. This report examines the range of approaches stakeholders are taking to help customers determine whether, when and how to adapt applications to take advantage of the benefits of cloud.

To learn more or to request a demo, visit spglobal.com/marketintelligence.

451 Research

S&P Global
Market Intelligence

Table of Contents

Executive Summary

Introduction

Many enterprises have already picked the low-hanging fruit of cloud transformation – the easy wins in terms of ROI. This includes HR, customer relationship management (CRM), sales and productivity suites that have largely moved to subscriptions and SaaS. The next phase – decomposing gnarly, monolithic legacy applications by carving away functional blocks that can be maintained independently – is tougher.

Large enterprises may have thousands of applications running in their IT environments, ranging from off-the-shelf software to mainframe systems that process millions of business-critical transactions per day. A common approach to modernization is to sort these applications into buckets using the five Rs: refactor, replatform, rehost, retain and retire. But determining which motion to pursue requires deep insight into existing operations, application interdependencies and the organization itself. Is it best to lift-and-shift VMs to the cloud and then refactor, or to refactor and then shift? Should data schemas be updated to take better advantage of low-code analytics platforms, or is it better to set up connectors without disturbing the underlying data?

Figuring out which applications can be cost-effectively modernized and refactored and where they can run best outside the monolith takes knowledge and expertise. Many organizations prefer to take a "consume, not build" approach to the tools needed for this effort, and as a result, stakeholders, including those examined in this report, are developing frameworks and automating the examination of code bases to speed the process.

For vendors seeking to realize the revenue potential of application modernization, the opportunity is not only about the platform, the tools and landing zone. The range of buyers and personas involved in the application modernization "supply chain" encompasses the breadth of the organization, from developers and platform architects to the DevOps team and CIO – the latter because these initiatives often involve professional services, so CIO buy-in is critical. Because application modernization may necessitate changes in the organization itself – to breach silos that have grown up around legacy operations routines or to compensate for in-house skills shortages – enterprises are utilizing outside development for this purpose, accelerating the march to managed services, hosting, outsourcing and professional services.

Public cloud providers offer frameworks, documentation and tools to help buyers assess their on-premises environments and determine which are likely to have the speediest ROI with the shift to cloud. Each hyperscaler has its own "highway code" and journey planners for modernization. Partners and startups alike have riffed on these frameworks to develop their own SaaS tools and methodologies for carrying out this work. But for businesses with software developed in the pre-cloud era, the ROI is hard to discern, plus the options for the target environment are in a state of flux. Assessment tools giving customers a "personalized" view of their environment (e.g., HPE CloudPhysics, CloudHealth by VMware, IBM Turbonomic, NetApp CloudCheckr, Densify) can give a holistic view before undertaking modernization projects.

About This Report

This report examines the range of approaches stakeholders are taking to help customers determine whether, when and how to modernize applications to take advantage of the benefits of cloud. It investigates the drivers of application modernization, how organizations plan to modernize brownfield applications and the range of services available on the market in support of application modernization.

Reports such as this showcase insights derived from a variety of market-level research inputs, including financial data, M&A information and other market data sources both proprietary to S&P Global and publicly available. This input is combined with ongoing observation of markets and regular interaction with vendors and other key market players.

Application Modernization: It Takes a (Cloud) Village

This report specifically includes data from the following sources. See the Methodology section at the end of the report for more details.

- **451 Research's Voice of the Enterprise: Cloud, Hosting & Managed Services, Workloads & Key Projects 2021** – This web-based survey was fielded in Q1 2021 among approximately 450 IT and line-of-business decision-makers worldwide.

- **451 Research's Voice of the Enterprise: DevOps, Organizational Dynamics 2021** – This web-based survey was fielded from August 26 to September 3, 2021 among approximately 500 IT decision-makers and technology practitioners primarily based in North America.

- **451 Research's Voice of the Enterprise: Digital Pulse, Application Modernization 2021** – This web-based survey was fielded from June 29 and August 16, 2021 among approximately 357 IT and line-of-business decision-makers worldwide.

- **451 Research's Voice of the Enterprise: Digital Pulse, Budgets & Outlook 2021** – This web-based survey was fielded from September 15 to November 18, 2020 among approximately 507 IT and line-of-business decision-makers worldwide.

Key Findings

Today's abundance of deployment options for IT infrastructure and services has increased the complexity of maintaining increasingly distributed IT estates. Contributing to this complexity are pockets of technical debt: software and infrastructure that requires increasing maintenance to keep it aligned with more modern applications and workflows. With many organizations facing challenges around refactoring applications for cloud (including skills shortages), it is a tremendous opportunity for managed service providers (MSPs) and ecosystem partners who develop expertise in this work.

For most organizations, the coronavirus pandemic has had a positive (44%) or neutral (45%) impact on their digital transformation efforts, according to a recent survey. The abrupt shift to remote work in 2020 did, however, increase the level of cooperation between business functions and IT, setting the stage for greater collaboration in efforts to reduce technical debt.

Organizations cite a variety of reasons for pursuing application modernization. Top drivers are to improve application performance/reliability, make back-end business processes more efficient, reduce operating costs, improve the customer experience, improve data access and integration and enable greater organizational flexibility.

The practices and technologies underpinning born-in-the-cloud applications make manifest the potential of modernization efforts to create responsive systems that are more resilient, secure and updatable. Components of cloud-native stacks include containers, container orchestration tools, microservices, high-level programming languages and libraries, DevOps methodologies, data management and analytics, CI/CD pipelines, observability and service mesh.

While new applications can take advantage of best-of-breed services on public clouds, brownfield applications are more stubborn. Two options for modernizing legacy applications are containerization and carving away microservices from inflexible, monolithic code bases.

Survey research highlights the top obstacles to modernizing legacy applications: cost limitations, lack of in-house skills, opportunity cost (resources needed on other projects) and business risks associated with changing mission-critical applications.

Modernization of an application portfolio happens in three broad phases: discovery/assessment of the current environment, analysis of code and application topology to find components that can be cost-effectively updated, and the actual replatforming or refactoring of the programs.

The Take

Net new and modernized applications are increasingly being deployed on cloud-native platforms. Meanwhile, legacy monoliths (which, granted, are still paying the bills at many organizations) are limiting the ability to reap the full range of cloud benefits: lower costs due to more efficient infrastructure usage; greater agility in updating software to meet customer expectations; more modern and secure data stores; and the ability to apply machine learning and AI for greater leverage versus disruptive competition. While decomposing these monoliths is not easy or straightforward, vendors and ISVs are tackling the challenge with modern techniques that promise to reduce the toil and speed up ROI.

So why modernize applications that are still doing their job efficiently on existing infrastructure? Enterprises see this as a strategic move – although cloud-native patterns are still evolving, the technical debt that builds by continuing to support pre-cloud infrastructure reduces an IT organization's ability to deliver value to the business quickly and cheaply. Starting on the modernization path – often by carving out customer-facing services that can more easily be separated – begets greater knowledge of the application and opportunities for further innovation.

With access to talent now more of a constraint than access to capital, partners are critical for bringing cloud-native expertise, application and infrastructure modernization skills and value-added services. A modernization partner can help IT operations teams by taking care of the infrastructure and the orchestration platform. This saves developers, DevOps teams and site reliability engineers (SREs) from manual configuration tasks, so that they can instead focus on new features, new products and innovation.
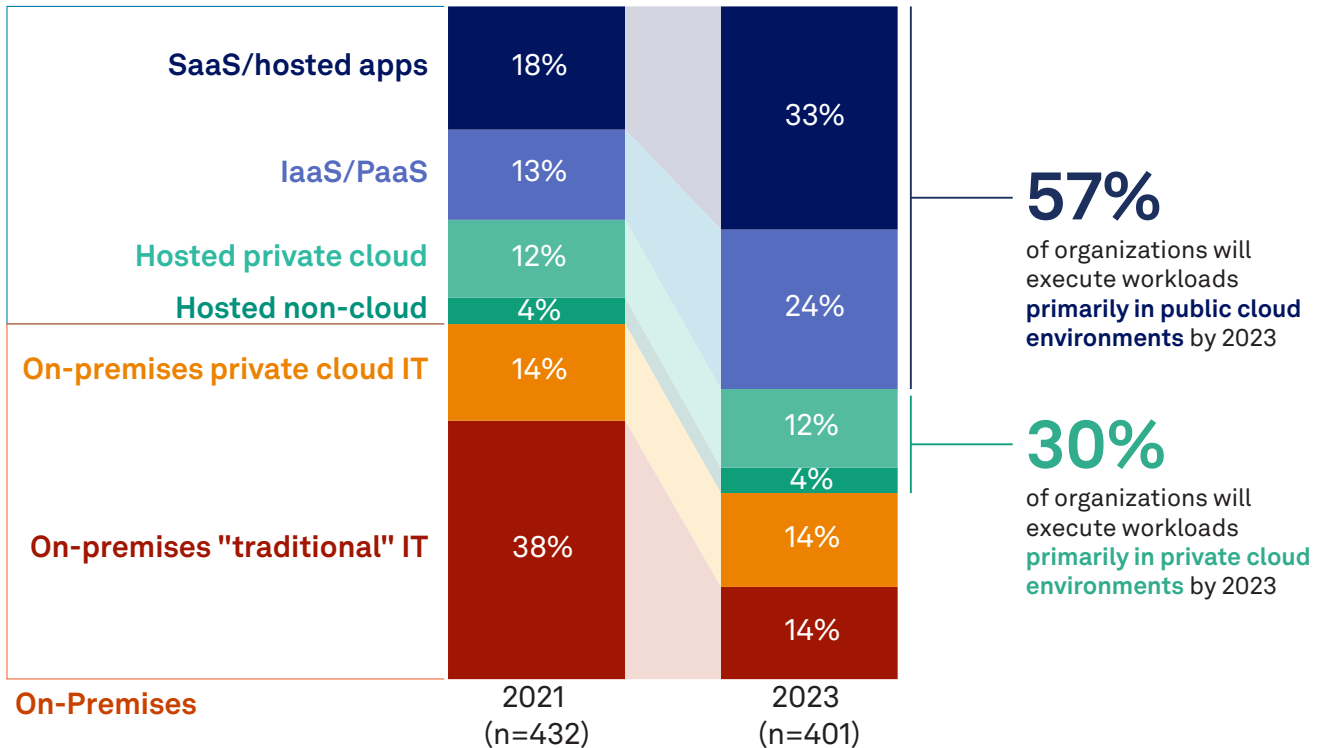
Why Modernize?

For buyers, application modernization is a moving target in terms of where to invest in this work, in what order, and how to best improve ROI through accelerating assessment and the use of refactoring tools. For vendors, the challenge is to map the transformation journey; to foresee what applications, over what period of time, go into what venues; and to identify how and where the vendor can intersect with that process. 451 Research's Voice of the Enterprise: Cloud, Hosting & Managed Services, Workloads & Key Projects 2021 survey finds that cloud is becoming the primary venue for both public and private hosted workloads (see Figure 1).

Application Modernization: It Takes a (Cloud) Village

Figure 1: Cloud Is Becoming the Primary Venue for Applications/Workloads

Off-Premises

	2021 (n=432)	2023 (n=401)
SaaS/hosted apps	18%	33%
IaaS/PaaS	13%	24%
Hosted private cloud	12%	12%
Hosted non-cloud	4%	4%
On-premises private cloud IT	14%	14%
On-premises "traditional" IT	38%	14%

On-Premises

57% of organizations will execute workloads **primarily in public cloud environments** by 2023

30% of organizations will execute workloads **primarily in private cloud environments** by 2023

Q. Which of the following best describes the primary environment used to operate your organization's workloads/applications today?
Q. Which of the following best describes the primary environment in which your organization's workloads/applications will be operated two years from now?
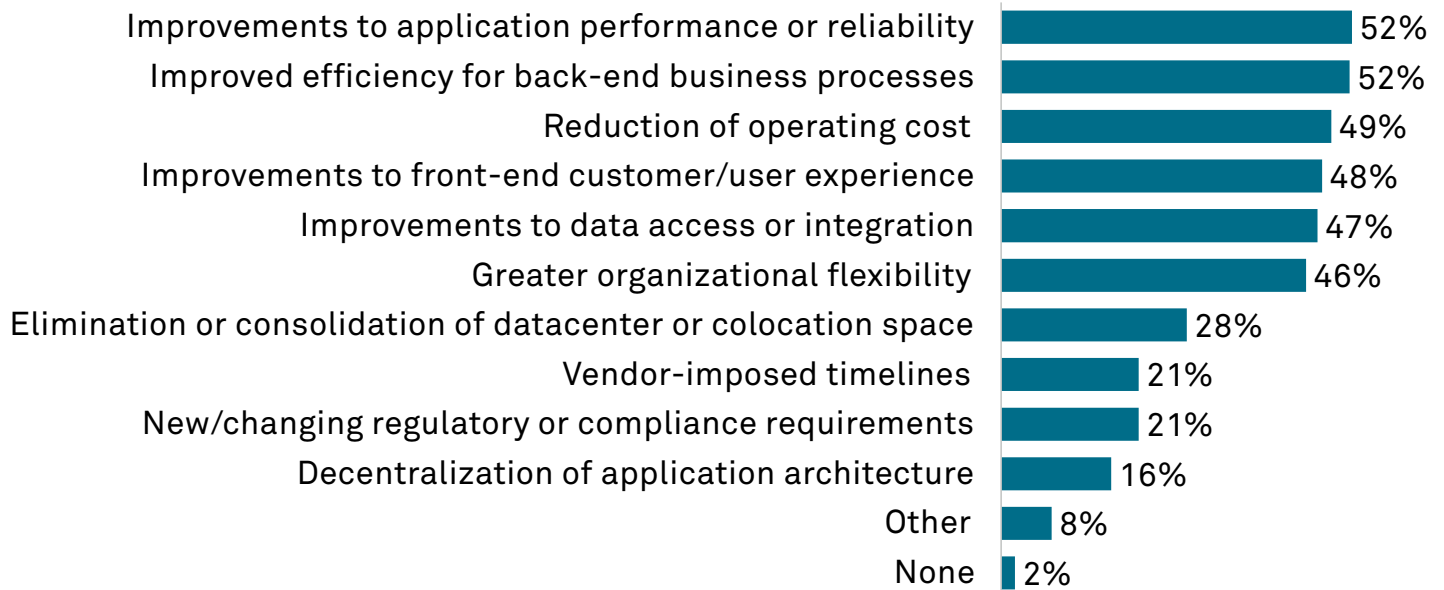Base: Respondents with workloads/applications
Source: 451 Research's Voice of the Enterprise: Cloud, Hosting & Managed Services, Workloads & Key Projects 2021

As part of this transition, many businesses are modernizing legacy applications to take full advantage of cloud benefits, breathe new life into their IT environment and make it possible to attract and retain good technology talent. The process is not without risks, and navigating the abundance of architectural options can be difficult. But as businesses start realizing gains in terms of cost-effectiveness, smoother operations and customer-facing innovation, this effort can be a catalyst for transforming the organization itself and putting it in a better position to compete and thrive (see Figure 2).

Application Modernization: It Takes a (Cloud) Village

Figure 2: Top Drivers for Modernizing Legacy Applications

Driver	Percentage
Improvements to application performance or reliability	52%
Improved efficiency for back-end business processes	52%
Reduction of operating cost	49%
Improvements to front-end customer/user experience	48%
Improvements to data access or integration	47%
Greater organizational flexibility	46%
Elimination or consolidation of datacenter or colocation space	28%
Vendor-imposed timelines	21%
New/changing regulatory or compliance requirements	21%
Decentralization of application architecture	16%
Other	8%
None	2%

Q. Which of the following – if any – are the primary drivers for your organization's efforts to modernize legacy applications?
Please select all that apply.
Base: Organizations expressing need for some degree of modernization (n=292)
Source: 451 Research's Voice of the Enterprise: Digital Pulse, Application Modernization 2021

Despite the promised benefits, many organizations stumble on the path to application modernization. Transitioning applications that embody the very essence of a company's value requires hard work – to untangle dependencies, modernize data stores and architect more nimble systems – with little initial visibility in terms of ROI.

Lack of skilled staff is another blocker. Many organizations without sophisticated IT engineering resources are turning to third parties (ideally ones with the experience, knowledge and tools to de-risk the transformation) to help them set up modern data and service foundations and provide guidance as to what components can be successfully transitioned and in what order. A recent 451 Research survey found that 85% of IT decision-makers are bringing in external resources for assistance with application modernization.

Simply lifting and shifting on-premises applications to cloud platforms can result in cost overruns and disappointment. Especially for larger, more complex systems, achieving the efficiency, scalability and innovation benefits of cloud deployment requires a new view of data and application architecture – one that can be difficult to navigate when working from within organizations that have evolved around outmoded systems and processes.

Containerizing brings benefits, but optimization can fund modernization. Containers represent an easy win in terms of making applications more portable and cost-efficient, but 451 Research's Voice of the Enterprise: DevOps, Organizational Dynamics 2021 survey finds that 32% of organizations using containers are running them on top of or inside VMs (usually to gain more mature security and other enterprise-hardened aspects of VMs or to take advantage of already available skills), resulting in a "hypervisor tax" on processing power. Rightsizing instances and leaning in on commitment discounts (which range up to 80% versus on-demand pricing) can further reduce cloud bills, freeing up funds to do the heavier work of carving out microservices from monolithic applications.

As IT environments become more diverse and distributed, the process of managing, upgrading and iterating applications and infrastructure requires superhuman capabilities – in other words, automation. Part of any modernization strategy should be to ensure that repetitive manual procedures are taken off the plate of IT operations teams and built into software. With faster release cycles, modern-day monitoring tools make it possible to identify and remediate problems quickly and, ideally, autonomously.

Application Modernization: It Takes a (Cloud) Village

Some businesses have grown up around old-fashioned methods of software development, operation and security. Modernizing IT foundations means disruption or substitution of legacy processes. The people who use and maintain systems know best where blockers are in current processes; addressing current operational pain points has the side effect of cultivating champions for modernization within teams. Often the initial moves to adopt cloud-native models come from developers and line-of-business stakeholders, but executive-level buy-in is critical to realize the full potential of cloud across the organization.

The Ideal: A Cloud-Native Application Stack

To get a sense of the benefits of modern applications, it pays to look at born-in-the-cloud companies that have disrupted entire industries by building responsive platforms that prioritize the user experience and "serve" consumers with content adapted to their location, preferences and activities – think Uber, Lyft, Spotify, Airbnb and Netflix. While these businesses were not built on a common substrate, each relies on a combination of modern-day (and in many cases open-source) technologies that power everything from the user's interaction with the application to back-end billing and payment systems.

In addition to the underlying physical infrastructure for delivering compute, storage and network functions, these businesses' IT environments may take advantage of the following elements:

– **Containers and container orchestration:** Containers are fundamental to most cloud-native application stacks – they bundle software code and dependencies in a lightweight package that is decoupled from the underlying infrastructure, making it possible to run software consistently in a variety of locations ranging from bare metal to VMs to edge. Container orchestration systems – Kubernetes is the most popular and is widely available via cloud managed services – control how and where containers run across many physical hosts.

– **Microservices:** In a cloud-native model, application components may be separated into independently updatable components called microservices, each of which performs a distinct function with a specific purpose (e.g., separate recommendation, ordering and billing functions for an e-commerce application). Containers are often used to package these microservices as self-reliant parcels of code and libraries. Serverless is a model whereby microservice code can be executed in response to events or triggers (such as a database write or notification) without regard to the underlying infrastructure.

– **Programming languages and libraries:** Developers are key consumers in the cloud-native ecosystem, and developer enablement is a strategic enterprise priority. This has led to a set of frameworks and tools that accommodate a variety of high-level languages, such as Go, Python and Java, enabling greater productivity with the use of libraries for building user interfaces such as React, Vue and Angular.

– **DevOps methodology and tools:** DevOps practices and tools are important enablers and accelerators of cloud-native application delivery. Fundamentally, this is a practice of joining software development and IT operations functions, enabling more frequent application updates and greater innovation in service of business outcomes. DevOps tooling is available from cloud hyperscalers, independent software vendors (ISVs) and open-source platforms and tools such as Atlassian, GitHub, GitLab and Hashicorp.

– **Data management and analytics:** Much of the power of cloud nativity comes from the ability to organize and generate insights from data. Born-in-the-cloud companies may use information about customer location, viewing/listening habits and purchasing activity to power recommendation engines, content feeds and ad targeting. For enterprises, creating and maintaining a consistent data layer opens up a world of leverage for data-driven decision-making and product/service evolution. Examples of projects that read and analyze data include Apache Spark and Kafka.

Application Modernization: It Takes a (Cloud) Village

- **CI/CD pipelines:** Continuous integration and delivery (CI/CD) is a fundamental complement to DevOps and represents the infusion of automation into software development by using infrastructure as code to automate the building, testing and deployment of new features into production. CI packages microservices and libraries into an image that can be used to replace components like-for-like. These images are stored in a registry and are provisioned to the application via CD, which swaps the old code for the new code. The image provides a unit of code that can be provisioned repeatedly to make the component scale to changing demands. Jenkins and CircleCI are popular open-source pipelines.

- **Observability:** As enterprises shift to microservices and containers, new tools and standards (such as the Cloud Native Computing Foundation's OpenTelemetry project) are necessary to help engineering and operations teams keep pace and ensure application availability and reliability. Observability goes hand in hand with service-level objectives and error budgeting, concepts closely tied to SREs. Because of this, getting the most out of observability is not just about tooling but also about methodology, process and culture – much like how DevOps is not solely about the tooling involved in CI/CD. Well-known open-source options include Prometheus, Jaeger and Grafana.

- **Service mesh:** Companies with an abundance of microservices knitted together in distributed applications need a way to authenticate and route traffic between them without traversing the network. This is the role of an application-level service mesh (Istio and Linkerd are examples) – to regulate and direct communication between microservices. As the number of microservices increases, the service mesh keeps traffic flowing as services are introduced, updated and removed by the container orchestration platform.

- **Application programming interfaces (APIs):** Along with autoscaling, API provisioning is one of the key characteristics/capabilities of cloud-native architectures. Most vendors build a lot of their cloud-native functionality into APIs, which also serve as the basis for integrations.

Not every one of these components needs to factor into a cloud-native deployment, but applications that take maximum advantage of the scalability, flexibility and speed of cloud infrastructure will use some or all of them – not to mention payment processing systems, content delivery networks, container security platforms and other enabling technologies that help power modern IT operations.

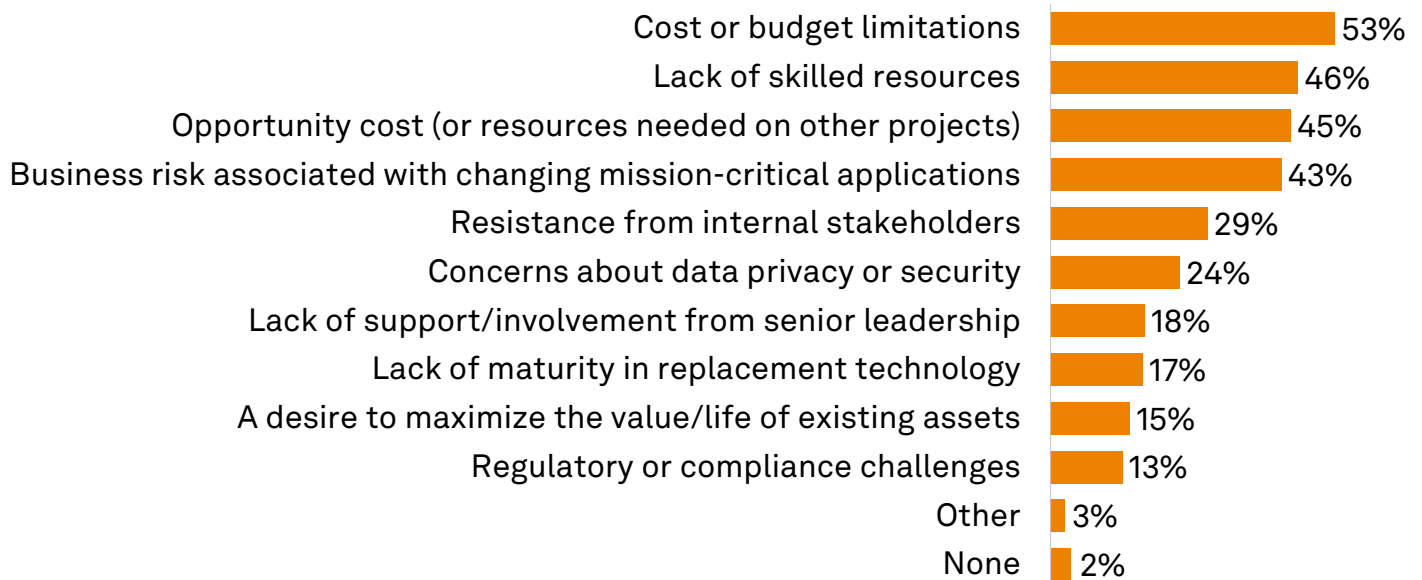# Getting From Here to There: Modernizing Brownfield Applications

In a modern enterprise, new applications are built to take the best advantage of the tools available to them, in some cases choosing best-of-breed services from multiple vendors and clouds. This way, the business can use pay-as-you-go billing to try new services with minimum investment and can take advantage of optimization built into Kubernetes platforms that scale infrastructure up or down in response to application demands.

Building new cloud-native applications is one way to chip away at modernizing an application portfolio, but similar benefits are available for legacy applications. There are two main options for achieving this: migrating existing apps from VMs into containers (also known as rehosting), and carving away microservices that can be iterated and upgraded independently and reused in a modular way from inflexible, monolithic code bases. Containers offer a lightweight, efficient way of packaging these services, and Kubernetes has become the standard way of coordinating the operation of all these containers. While changing legacy software to use this type of architecture can be difficult, many see it as the best way to take advantage of the more nimble product development enabled by cloud – and the competitive advantage that confers.

An issue arises in terms of whether and how much to modernize legacy data architectures: Should relational databases be maintained separately or merged into a data warehouse? The latter is a serious undertaking that requires refurbished security and governance policies, but has the potential to multiply the data's value to the business and also make it easier to gain insights from information using low-code/no-code tools. This is an area of active investment from many quarters, including startups as well as traditional storage vendors such as NetApp, Dell EMC and HPE.

The strategic and competitive advantages of modernizing applications do not come without effort. Budget limitations, lack of in-house skills and strained resources are among the obstacles that companies may encounter along the way (see Figure 3).

Figure 3: Top Obstacles to Modernizing Legacy Applications

Obstacle	Percentage
Cost or budget limitations	53%
Lack of skilled resources	46%
Opportunity cost (or resources needed on other projects)	45%
Business risk associated with changing mission-critical applications	43%
Resistance from internal stakeholders	29%
Concerns about data privacy or security	24%
Lack of support/involvement from senior leadership	18%
Lack of maturity in replacement technology	17%
A desire to maximize the value/life of existing assets	15%
Regulatory or compliance challenges	13%
Other	3%
None	2%

Q. And which of the following – if any – are the primary obstacles to your organization's efforts to modernize legacy applications? Please select all that apply.
Base: Organizations expressing need for some degree of modernization (n=289)
Source: 451 Research's Voice of the Enterprise: Digital Pulse, Application Modernization 2021

Application Modernization: It Takes a (Cloud) Village

Yet the effort has the potential to pay off not only with more efficient operations and greater developer productivity, but also with the adoption of practices and technologies that can inspire organizational change, leading to happier teams and a more competitive market position. This means taking a more expansive view of what application modernization is – methodologies such as DevOps and platforms such as Kubernetes make it possible to take something users are familiar and comfortable with (e.g., a certain operations suite or development framework) and build scaffolding that helps transition the organization to new ways of working.

Order of Operations

DISCOVERY/ASSESSMENT

The first step in evaluating an application portfolio for modernization is assessment and discovery: taking inventory of software in production (as well as any "zombie applications" that are still running but are no longer maintained), reviewing their dependencies, and identifying candidates for retainment, retirement, rehosting or modernization.

Not all workloads will benefit from refactoring – at least not yet. Many applications still run very effectively on mainframes, which deliver high-volume, low-latency processing for millions of transactions per day. Mainframes have been evolving to meet the needs of modern-day workloads, including AI inferencing, security and cyber resiliency, and modernization to smoothly integrate into hybrid cloud environments.

Discovery and assessment of application portfolios can be done with software composition analysis and cloud management tools. The goal is to examine architectural dependencies and, ideally, receive recommendations for which applications may be cost-effectively migrated to off-premises environments (see Discovery/Assessment Tools, within the Modernization Market and Players section below, for a list of relevant tools). This assessment can happen at the infrastructure level, at the application level or within monolithic code bases.

ANALYSIS

Once candidates for modernization have been identified, the heavy lifting begins. Analyzing applications and code bases for potential transformation ideally includes static analysis (i.e., looking at subroutines in a monolithic application that can be beneficially carved out as more nimble microservices) and dynamic analysis (identifying calls and dependencies during operation that might add complexity and latency in a more distributed architecture). This process demands intense familiarity with the subject applications and IT infrastructure – there is no "easy button."

That said, research organizations, startups and academic labs are applying the principles of natural language processing to parse code bases and identify seams that can be effectively exploited for more efficient development and operations (see the Code Analysis Tools section below for examples).

TRANSFORMATION

The work of replatforming (which usually involves containerizing) or refactoring candidate applications with microservices is often done within larger modernization frameworks, which may include documentation, checklists and software for working through the transition. These are available from global systems integrators (GSIs), hyperscalers, incumbent software vendors and, increasingly, from hardware suppliers pivoting to as-a-service delivery, often with an emphasis on harmonizing storage via a data fabric that enables access and to data without necessarily moving it to cloud (see the Transformation Methodologies and Frameworks section below for examples).

Modernization Market and Players

Application modernization helps align the organization around business objectives and improve collaboration rather than having siloed teams built around legacy processes and systems. Often, someone outside the business can better identify where points of friction can be resolved.

In terms of techniques, the strangler pattern is a common method for incrementally migrating and modernizing a legacy system. Here, the legacy application is assessed for where functional separation is most promising, microservices are created from those elements and dependencies updated, and clients are pointed to the refactored services as the monolith shrinks. This approach reduces the risk of this transition and, ideally, enables rollbacks to undo any breaking changes. It may start with customer-facing front-end services, whereby developers expose APIs via a web/mobile application that can be quickly updated while keeping the back end the same, effectively buying time for refactoring more complex systems (or not).

Not all workloads belong in the cloud or in containers. As we have seen with mainframes and common business-oriented language (COBOL)-based applications still prevalent in the public sector, entrenched systems can have staying power due to dependencies with on-premises systems, regulatory restrictions, the need for low-latency access to nearby data or simple inertia. IBM, whose mainframes remain central to the operations of many banks, insurers, retailers and telcos, has been undertaking its own modernization to give customers more architecture choices and evolve the original mainframe into a modern platform. The IBM z16, unveiled in April, enables the mainframe to be central to hybrid cloud environments. The z16 Cloud Modernization Stack, based on the Red Hat OpenShift container platform, pulls together common tools and capabilities for development, deployment and configuration, ranging from application analysis, API creation and deployment, cloud-native development and standardized IT automation for z/OS.

Part of the whole modernization promise involves using systems' own data and intelligence to automate tedious and fiddly manual processes – a feat that surpasses human comprehension as things get more diverse and complex and ever-more connections need to be managed and secured. The consensus seems to be that the software itself needs to be set up to enable monitoring, security and automation of these processes, rather than adding on capabilities when development is further along; this is where the multi-Ops phenomenon comes into play (i.e., DevSecOps, FinOps, AIOps/MLOps, etc.). As applications become more complex, having more discrete parts (microservices) and greater levels of abstraction (containers, Kubernetes), it is only with increased levels of automation that the greater quantities or greater dispersal of services will be tamed. None of this happens independently of the cultural and organizational change needed to deliver it. It is not just technology – shifts in the software development mindset, such as the move to cloud native and agile, are complex processes that may face resistance from stakeholders who feel that existing methods are sufficient.

Who Are the Players?

The usual suspects include the GSIs with large application modernization businesses (Accenture, Capgemini, Atos, IBM, TCS), especially the more applications-focused among them (Wipro, Cognizant, HCL); software-centric vendors with mainframe roots (Microfocus, Compuware, CA Technologies); technology vendors that work with the public cloud providers and enable hybrid IT models, increasingly through their own cloud managed platforms (VMware, Dell, Hitachi, Fujitsu, Cisco, etc.); and, of course, public cloud providers (Amazon Web Services [AWS], Microsoft Azure, Google Cloud, IBM Cloud, Alibaba and Oracle to name a few) via their own services, as well as through vendors in their marketplaces and partner ecosystems.

Taking a more expansive view, DevOps and Kubernetes themselves can be considered tools for application (and organizational/cultural) modernization. The goal is to take something users are familiar and comfortable with (e.g., vSphere) and create scaffolding for transitioning organizations and processes to modern methods and technologies. The key players are the hyperscalers (AWS with options including Well-Architected Framework and Refactor Spaces, Azure with DevOps and developer tools, Google with GKE, Cluster API, Knative and Istio), IBM/Red Hat (Migration Toolkit for Applications and CodeEngine), VMware (Tanzu and CloudHealth), Oracle (Cloud Lift), and HPE (Ezmeral), as well as Mirantis (with Docker Enterprise), SUSE (with Rancher), NetApp (with Spot portfolio), Canonical, Kubermatic and Platform9.

Application Modernization: It Takes a (Cloud) Village

A Smorgasbord of Products, Projects and Frameworks

Some of the offerings from the vendors mentioned above come bundled with professional services engagements, but others – and some individual software tools – are available for the various phases of legacy application modernization: discovery/assessment, code analysis and transformation.

VFunction stands out with capabilities in all three of these areas, and some incumbent providers are using the software to power their own modernization capabilities. The company has spent five years refining its technology and user interface for programmatically breaking monolithic Java applications into microservices, effectively applying process automation to the gnarly task of evaluating monolithic code bases, carving away microservices and tying new containers back to the monolith. While vFunction started primarily in the banking industry, it is using venture funding to scale its offering via direct sales, SI partners and cloud service providers.

DISCOVERY/ASSESSMENT TOOLS
Some of these are part of larger suites of security scanning, code inspection or dependency mapping tools.

- **[CAST Software](#)** is a SaaS tool that examines the structure of custom-built software and recommends actions to automate decision-making.
- **Synopsys Coverity** does static code analysis and can be deployed on-premises or as SaaS within the Polaris Software Integrity Platform (which also includes Black Duck Software Composition Analysis).
- **Flexera One** is a SaaS product that visualizes hybrid IT estates (on-premises, SaaS and cloud) for the purposes of cloud migration planning, cost assessment and workload placement.
- **Veracode** is an agent-based SaaS product that performs static analysis, dynamic analysis and software composition analysis of applications with a focus on finding vulnerabilities in commercial and open-source code.
- **Checkmarx** offers software composition analysis, source code scanning and other capabilities primarily for application security testing.
- **AWS Application Discovery Service** collects information about on-premises servers, maps dependencies and measures performance with the goal of helping to plan migration projects.
- **Azure Migrate: Discovery and assessment** is an agentless appliance that finds on-premises software using server credentials; it can also perform agentless dependency analysis for VMware VMs and (in preview) for Hyper-V VMs and physical servers.
- **Google Cloud StratoZone** discovers and assesses on-premises servers based on configuration, utilization, network dependencies and installed applications.
- **IBM Application Discovery and Delivery Intelligence** is designed to help developers identify API candidates and modernize z/OS applications for hybrid cloud execution.
- **IBM Cloud Transformation Advisor** discovers and analyzes on-premises workloads; it can run in a Red Hat OpenShift cluster or locally and is included with IBM WebSphere Hybrid Edition, IBM Cloud Pak for Applications and IBM Cloud Pak for Integration.

CODE ANALYSIS TOOLS
Some more sophisticated options that apply natural language processing to source code for the express purpose of identifying candidates for microservices deployment are being refined in academic and lab settings.

- **VMware Application Transformer for Tanzu** has functions for discovery, analysis and containerization of legacy applications via VMware vCenter Server.
- **VMware Cloud Suitability Analyzer** (fka Pivotal Software Application Analyzer) is an open-source tool that scans code and generates a score to help determine an application's readiness for cloud deployment.
- **Konveyor Move2Kube** is a command-line tool that accelerates the process of replatforming to Kubernetes/ OpenShift by analyzing the environment and source artifacts and asking for guidance from the user when required.
- **IBM Mono2Micro** uses runtime and static evaluation of code and then creates scaffolding for microservices deployment; it is sold as part of IBM's WebSphere Hybrid Edition.

Application Modernization: It Takes a (Cloud) Village

TRANSFORMATION METHODOLOGIES AND FRAMEWORKS
These programs are often tied into professional services engagements to help navigate the modernization process. Naturally, the offers have an affinity for the vendors' own services and platforms.

– **IBM Accelerator for Application Modernization with AI** is a suite of services (including Application Containerization Advisor, Candidate Microservices Advisor and Modernization Workflow Orchestrator) developed by IBM Research that leverages natural language processing and machine learning to speed application transformation.

– **Red Hat Migration Toolkit for Applications** is a set of tools supporting large-scale Java application modernization and migration projects; Red Hat offers a highly automated, instrumented full-stack approach for customers who have more of a "consume, not build" attitude toward application modernization.

– **VMware Application Navigator** is a four- to six-week consulting engagement with Tanzu Labs designed to assess the customer's application environment, analyze the software supply chain and create a roadmap for migration and refactoring.

– **Hitachi Vantara E3** (Envision, Evaluate, Execute) methodology is a cloud-agnostic framework for mapping application portfolios to business needs and applying modern design patterns to update the customer environment and run it as a managed service.

– **AWS Migration Hub** is a centralized repository for discovery, assessment and planning for migration and refactoring of applications and databases to AWS. It integrates with Refactor Spaces (for incremental refactoring to microservices), AWS Application Migration Service, AWS Server Migration Service, AWS Database Migration Service, and ATADATA ATAmotion.

– **HPE Edge-to-Cloud Adoption Framework**, launched in Q3 2021, is based largely on the technology and methodology acquired with Cloud Technology Partners; it addresses the cultural as well as technology aspects of application modernization.

– **HPE Ezmeral Application Workbench** is a stand-alone Python-based software development kit for building or converting applications into standard Kubernetes clusters; it uses KubeDirector, an open-source custom controller from HPE that addresses stateful application deployment in standard K8s clusters

– **Azure Migration and Modernization Program** is a framework for customers, partners and Microsoft account teams; it includes FastTrack for Azure, Azure Migrate (a hub for migration activities that includes an application containerization tool) and a multitude of tools and templates.

– **Oracle Cloud Lift Services** include guidance from cloud engineers, assistance with shifting Oracle workloads (including custom applications built on Exadata and Oracle Database) to Oracle Cloud, and advice for onboarding non-Oracle workloads to Oracle Cloud.

– **Google Cloud Application Modernization Program** (CAMP) is a framework designed to guide organizations through the assessment, analysis and execution phases of application transformation; Migrate for Anthos and GKE, based on Google's acquisition of Velostrata, analyzes applications for "de-composability" and containerization.

– [**Quali**](#) **CloudShell** enables users to model complex application blueprints with built-in orchestration, in order to set up and tear down interconnected virtual machines in the target cloud of choice in sandboxes or other environments.

Application Modernization: It Takes a (Cloud) Village

Managed Services

With access to talent now more of a constraint than access to capital, partners are critical for bringing application and infrastructure modernization skills, and value-added services that can be applied at any stage of the customer's journey. A modern cloud partner can take a lot of work off the IT operations teams by taking care of the infrastructure and the orchestration platform. This saves developers, DevOps teams and SREs from focusing on configuring their environments and manual tasks so that they can instead focus on new features, new products and innovation. It is a continuous improvement benefit from using a feedback loop – enterprise engagement with managed services will reveal additional opportunities for application modernization and innovation. Ultimately, the relationship must encompass strategy and assessment, migration, application modernization, modern cloud management and optimization. Specific demonstrations of value including security, improved automation, cost control and new revenue streams in modernization programs will be most impactful.

In a recent survey, 85% of IT decision-makers said they would go outside the organization for application modernization services (see Figure 4); 70% acknowledged that a shortage of in-house skills required them to seek support from external parties.

Figure 4: Where Businesses Will Turn for Outside Help With Application Modernization

Category	Percentage
Systems integrators or consultants	55%
Services partners of the application vendor	43%
The vendor of the application(s) being modernized	38%
Public cloud vendors	28%
Vendors of related or complementary software	26%
Infrastructure/hardware vendors	20%
Other (please specify)	2%
None (we will handle it internally)	15%
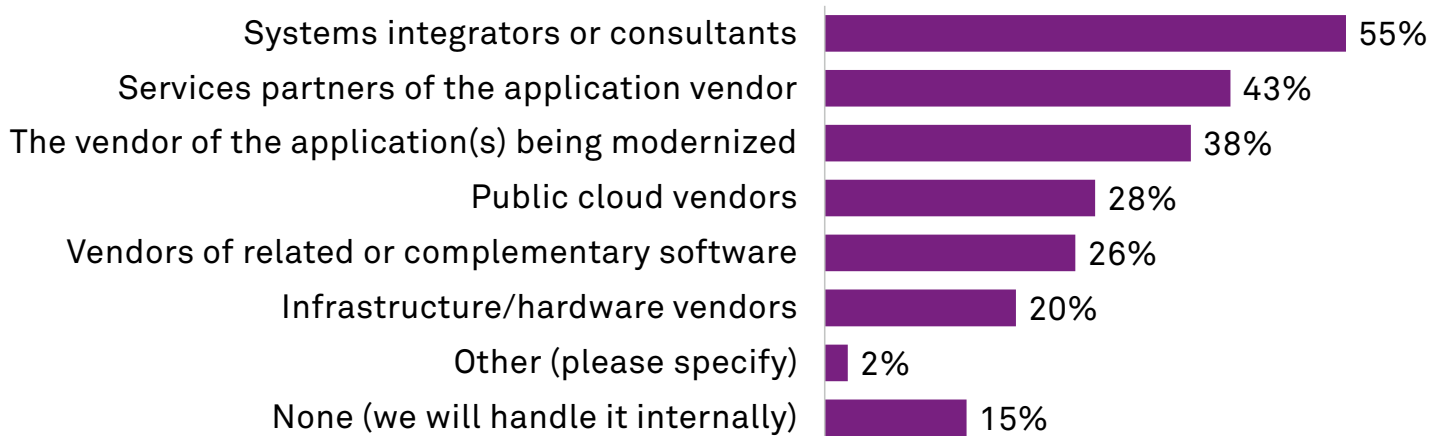
Q. Who is your organization likely to turn to for assistance or services related to its application modernization efforts? Please select all that apply.
Base: Organizations expressing need for some degree of modernization (n=289)
Source: 451 Research's Voice of the Enterprise: Digital Pulse, Application Modernization 2021

Conclusions

Technology waits for no one. With many companies struggling to find and retain IT staff, undertaking digital transformation can seem like a herculean effort. But as time passes, legacy applications accrue technical debt and make companies vulnerable to disruptive competition. The sooner a business starts transitioning to cloud-native deployment models and ways of thinking, the faster it will develop the knowledge and productivity gains to propel it to the next level.

In less than a decade, cloud nativity has been established as the prevailing mindset and methodology for application and infrastructure architecture. The next steps are to reduce its complexity and improve integration of its parts to drive increased developer productivity. Much ecosystem effort is currently focused on helping enterprises get out of the starting gate by accelerating and scaling software delivery, abstracting away complexity and securing software supply chains. Additional abstractions and managed services are common approaches to dealing with the complexity of cloud-native constructs and the ephemeral services they support.

Taking a people-first approach to application modernization can deliver benefits and encourage buy-in. Even with accelerators along the way, no one knows better where the blockers are in current systems than the people who use and maintain them. Familiarize teams with the end-state possibilities and give them a stake in the outcome.

It is wise to set expectations fairly, but do not undervalue the intellectual property and learning being developed even as setbacks occur. Accelerating technology and tools are continually being refined. Taking an application-centric approach to updating infrastructure, data models and connectivity puts a new lens on IT value that will ultimately benefit the organization.

Further Reading

Voice of the Enterprise: Cloud, Hosting & Managed Services, Workloads & Key Projects 2021

– [Advisory](#)

Voice of the Enterprise: Digital Pulse, Application Modernization 2021

– [Crosstabs](#)

– [Customer Narratives](#)

– [Enterprises cite major modernization requirements, with strategies still to come – Highlights from VotE: Digital Pulse](#)

Voice of the Enterprise: Digital Pulse, Budgets & Outlook 2021

– [Advisory](#)

Voice of the Enterprise: DevOps, Organizational Dynamics 2021

– [Advisory](#)

[IBM z16 takes the mainframe into AI inferencing for transactions in real time, April 2022](#)

[What's Driving SMEs to Adopt a Digital Transformation Strategy?, April 2022](#)

[CAST Software targets cloud migrations with its software composition analysis tools, November 2021](#)

[Quali positioning itself to scale business, targeting transformation and application modernization, October 2021](#)

[Coverage Initiation: vFunction takes patented approach to Java app modernization, February 2021](#)

Methodology

Reports such as this showcase insights derived from a variety of market-level research inputs, including financial data, M&A information, and other market data sources both proprietary to S&P Global and publicly available. This input is combined with ongoing observation of markets and regular interaction with vendors and other key market players.

Data from the following surveys is included: Voice of the Enterprise: Cloud, Hosting & Managed Services, Workloads & Key Projects 2021; Voice of the Enterprise: Digital Pulse, Budgets & Outlook 2021; Voice of the Enterprise: Digital Pulse, Application Modernization 2021; Voice of the Enterprise: DevOps, Organizational Dynamics 2021.

Reports such as this one represent a holistic perspective on key emerging markets in the enterprise IT space. These markets evolve quickly, though, so 451 Research offers additional services that provide critical marketplace updates. These updated reports and perspectives are presented on a daily basis via the company's core intelligence service, 451 Research Market Insight. Forward-looking M&A analysis and perspectives on strategic acquisitions and the liquidity environment for technology companies are also updated regularly via Market Insight, which is backed by the industry-leading 451 Research M&A KnowledgeBase.

Emerging technologies and markets are covered in 451 Research channels including Applied Infrastructure & DevOps; Cloud & Managed Services Transformation; Cloud Native; Customer Experience & Commerce; Data, AI & Analytics; Datacenter Services & Infrastructure; Information Security; Internet of Things; and Workforce Productivity & Collaboration.

Beyond that, 451 Research has a robust set of quantitative insights covered in products such as Voice of the Enterprise, Voice of the Connected User Landscape, Voice of the Service Provider, Cloud Price Index, Market Monitor, the M&A KnowledgeBase and the Datacenter KnowledgeBase.

All of these 451 Research services, which are accessible via the web, provide critical and timely analysis specifically focused on the business of enterprise IT innovation.

For more information about 451 Research, please go to: www.451research.com.

Index of Companies

About the Author

Jean Atelsek

Senior Research Analyst, Cloud Transformation and Digital Economics Unit

Jean is an analyst working across the Cloud Transformation team and Digital Economics Unit of 451 Research, a part of S&P Global Market Intelligence. In addition to producing the quarterly Cloud Price Index deliverables, Jean covers vendors and cloud providers that offer technology or services to manage or improve public and private cloud TCO, performance or consumption. In the cloud-native universe, she focuses on container-native software, serverless architectures and service mesh.
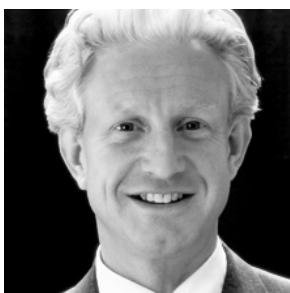
William Fellows

Founder & Research Director, Cloud Native

Market Intelligence. With a 20+ strong team of collaborators, this Channel provides a point of intellectual convergence for 451 Research around cloud native computing and offers customers a direct path to understand its adoption and impact across all sectors.

William has a long history of tracking cloud infrastructure, beginning with its foundational elements such as distributed and grid computing and virtualization, establishing and running 451's Cloud Transformation Channel for more than a decade. He created 451 Research's early adopter research program, working with enterprise end users and innovators, and he created 451's Digital Economics Unit in 2014 and the Blockchain Center of Excellence in 2017. In 2020 he formed the Cloud Native Channel to focus on the re-platforming to cloud native constructs and such as containers, service mesh, Kubernetes and serverless, from application and infrastructure perspectives. William has been a member of the European Commission Cloud Expert Group, co-authored The Future of Cloud Computing Report and worked on various EC-funded cloud projects.

About 451 Research

451 Research is a leading information technology research and advisory company focusing on technology innovation and market disruption. More than 100 analysts and consultants provide essential insight to more than 1,000 client organizations globally through a combination of syndicated research and data, advisory and go-to-market services, and live events. Founded in 2000, 451 Research is a part of S&P Global Market Intelligence.