

**A**advanced

# 2022 Mainframe Modernization Business Barometer Report

A glimpse into the post-pandemic  
era of digitalization



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# Introduction

The era of digitalization has arrived, bringing with it a tsunami of innovation and change.

Its catalyst, the pandemic, drove a keen awareness of the need to accelerate modernization programs and adoption of emerging technologies across every sector. Those who adapted survived, while those who shackled themselves to old fashioned business practices were uprooted and have all but fallen by the wayside. In the wake of these unprecedented circumstances, enterprises across the globe are now vigorously embracing change as a certainty and increasingly viewing their outdated, expensive mainframes as agents of risk that stand in the way of agility and success.



**Change is here and If you want your business to survive, you need to embrace it.**

Change is cascading across every aspect of modern life. It's even lapping at the shores of institutions left largely undisturbed for decades. In 2019, [fewer than 6 percent of Americans worked primarily from home](#). During the pandemic, that figure surged

to [35%, ultimately waning to 26%](#) by late 2021. Today, most employees who can do their jobs from home have elected to continue to do so, transforming the landscape of employment and commercial real estate. Three years ago, online grocery shopping was a microscopic sliver of food retail. Fast-forward to present day, roughly 60% of U.S. consumers have purchased groceries online, with most saying they plan to keep doing so according to a report from [Coresight Research](#). These tales of transformation are speckled all across the business landscape. In fact, transformation and innovation enablement was named the top strategic initiative of 2022 by 47% of our survey respondents. No matter the sector, the message is clear: Change is here, it's happening everywhere, and if you want your business to survive, you'd better embrace it.

**47%**

of our survey respondents named transformation and innovation as their top strategic initiative for 2022.





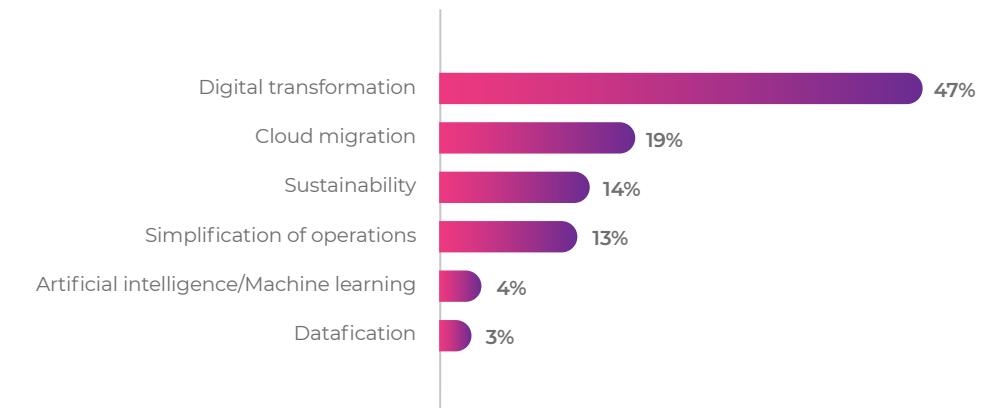
Unsurprisingly, businesses are feeling the most pressure to adapt to this new normal in their IT and operations departments, where mainframes take top spot. In the third annual 2022 Mainframe Modernization Business Barometer Report, we examine the current state of the mainframe and the challenges facing enterprises worldwide with annual revenues of more than US \$1 billion. And, crucially, we explore the impact of the new era of digitalization and change on the current state of legacy systems and organizations' modernization plans.

The results demonstrate that, for the first time since our research began, digitalization is the driving force across the enterprise. Organizations are migrating workloads to cloud platforms en masse. They're not just embracing cloud hyperscalers as infrastructure providers; they're inviting them into the critical operations of their businesses with open arms. Multi-cloud strategies are now commonplace, and while not ubiquitous, they predictably emerge as an organization's cloud maturity rises. Hybrid work made data accessibility a top priority across the board, which in-turn gave rise to the complex challenge of extending adequate accessibility to legacy systems. As a result, data security concerns have risen to the top of the list of respondents' motivations for modernization. The push for data accessibility has also resulted in a substantially increased interest in AI (Artificial Intelligence) and ML

(Machine Learning), which are seen among respondents as key building blocks for successfully embracing and implementing emerging technologies intended to drive value and differentiation in the market.

This orchestra of trends, in concert with sharply rising mainframe costs and a rapidly shrinking legacy talent pool, have transformed the prevailing attitude around mainframe modernization from the "if" of yesteryear to the "when and how" of today.

#### **Most important strategic initiative for 2022**



**For the first time since our research began, digitalization is the driving force across the enterprise.**

# Report summary

The 2022 Mainframe Modernization Business Barometer Report summarizes key findings from a survey conducted by Coleman Parkes in early 2022

It polled leaders across C-Suites, IT, Operations, and Program Management from 416 enterprises that utilize mainframes. These companies vary widely by size, income, and industry, though each on average employ 4,727 people and produce US \$4.2 billion in annual revenue, allocating 11% of that income to their IT budget.

Each company who participated in our survey currently operates at least one mainframe. As you'll discover in these pages, they all have plans to modernize - even though their approaches vary widely from one organization to the next. Great pains were taken to ensure our pool of respondents accurately represented the population of global mainframe customers.

- 71% are headquartered in the United States
- 13% hail from various parts of EMEA
- 12% are in the United Kingdom
- 4% operate out of countries peppered throughout APAC

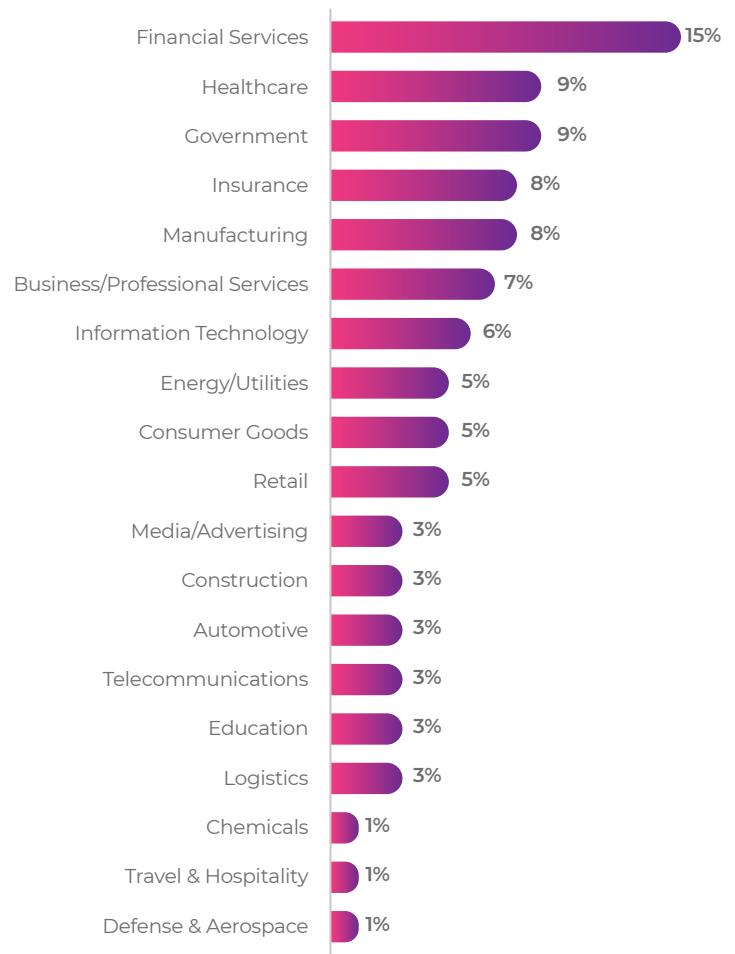
Nineteen sectors are represented in our respondent pool, with financial services (15%), healthcare (9%), and government entities (9%) holding the top three positions by respondent count.

This report provides an overview of the mainframe environments survey participants preside over while highlighting trends, challenges, and lessons learned from their experiences with big iron (a common colloquialism for mainframes). In these pages, we explore the top motivating factors driving the pursuit of mainframe modernization, why they're impactful, and how respondents across various sectors are traversing them.

Our analysis also extends into respondents' modernization experiences, with 85% reporting that they have modernized workloads in the past. We examine the strategies they chose (or plan to choose) and why, as well as shared lessons learned and best practices that emerged from the research. With many reporting a continued reliance on legacy systems in the short-term, we unpack how respondents are planning next steps and what you should be aware of in your own modernization pursuits.

The report closes with an overview of modernization results including cost savings, impacts on sustainability, expectations versus reality, as well as the operational and staffing impacts of liberating legacy systems.

**Audience profile: Sector**



# Click the section you would like to view



## Today's mainframe environments

[Visit section →](#)

## Modernization drivers

[Visit section →](#)

## The path to modernization

[Visit section →](#)

## Modernization results

[Visit section →](#)

A photograph of two professionals, a man and a woman, standing in a server room. They are both looking intently at a laptop screen held by the woman. She is wearing a white shirt and a blue lanyard. The man is wearing a grey sweater over a collared shirt. In the background, there are rows of server racks. The image has a purple overlay.

# ① Today's mainframe environments

# Today's mainframe environments

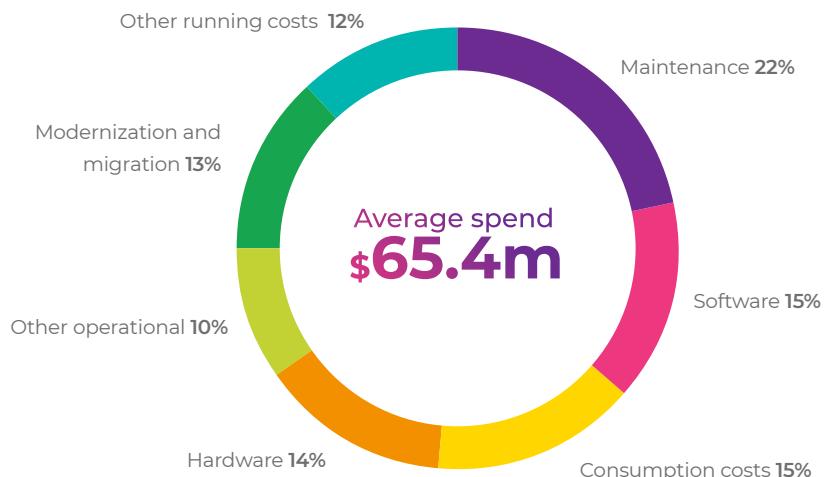
It would be downright irresponsible to write about the state of mainframes in 2022 without some mention of Mark Twain's famous quote, "Reports of my death are greatly exaggerated." Predictions around the final nail in the mainframe's coffin have been swirling since at least the late '90s. The Y2K fiasco, the rise of the smartphone, and the mainstream adoption of cloud technology each brought a surge of assurances that the mainframe would soon be no more. However, big iron keeps chugging along. In fact, [according to IBM](#), as of 2020, 44 of the top 50 banks, and all of the top 10 insurers around the globe, still use mainframes.

These computational behemoths, are powerful, secure, and have been the workhorses of high-speed transaction processing and large-scale data warehousing since before the Apollo space program began. They have also defined the gold standard of reliability throughout their long history, with annual downtimes measured in mere minutes. On account of their remarkable track record and pedigree, mainframes have been entrusted to run the most business-critical applications that belong to the organizations they serve.

Mainframes are also very expensive to operate. Companies report they are spending an average of \$65 million annually on big iron, with one-fifth of that figure allocated just to

maintenance. As the price of cloud infrastructure declines, licensing and staffing costs in the mainframe world rise, and as a result, most of the companies we surveyed are feeling increased pressure to enact change. One respondent, a Healthcare provider in the United States, reported that 75% of its annual IT budget is spent maintaining its mainframe. Another noted that "our organization is reducing its dependency on mainframe-based legacy systems because they require very hefty maintenance, and the cost of maintaining a legacy system is probably more than upgrading it."

**Annual spend on mainframes**



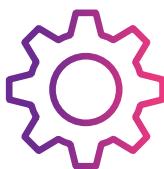
**44** of the top **50** banks, and **all of the top 10 insurers** around the globe, still used mainframes as of 2020.

**\$65 million**

Average spent on mainframes annually, with one-fifth of that figure allocated just to maintenance.

Mainframes host massive, complex applications. Survey respondents reported that their mainframe-based applications consist of an average of 3.6 million lines of code, and although size and complexity varied widely, the median (27%) report applications ranging between 500,000 and 2 million lines. Line of code count is often used as shorthand to determine level of effort calculations for modernization projects in their infancy, but they don't tell the whole story. Cyclomatic and heuristic complexity assessments can help bring the task further into focus, but a multitude of additional factors, including an assessment of consumption, as well as languages, and data structures used, contribute to defining the true shape and size of a legacy system and the modernization effort required to extricate the business from it.

Most respondents reported that their mainframe ecosystems were built using multiple legacy languages, but COBOL is the most common, with 42% flagging it as their most widely utilized.

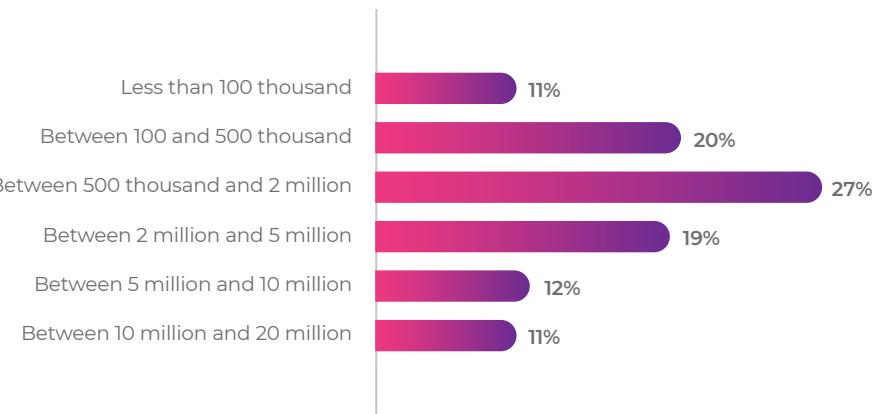


**42%**

named COBOL as their most prominent legacy language

This is unsurprising, as COBOL has been widely reported as the king of mainframe programming languages for decades. In fact, according to [Reuters](#), 70% of large corporations still rely on COBOL for mission-critical work. Furthermore, roughly 43% of banking systems use COBOL. Each time you swipe an ATM card, there's a 95% chance that your transaction executes COBOL somewhere behind the scenes.

#### Lines of code in mainframe-based applications



Survey respondents reported that their mainframe-based applications consist of an average of **3.6 million** lines of code.



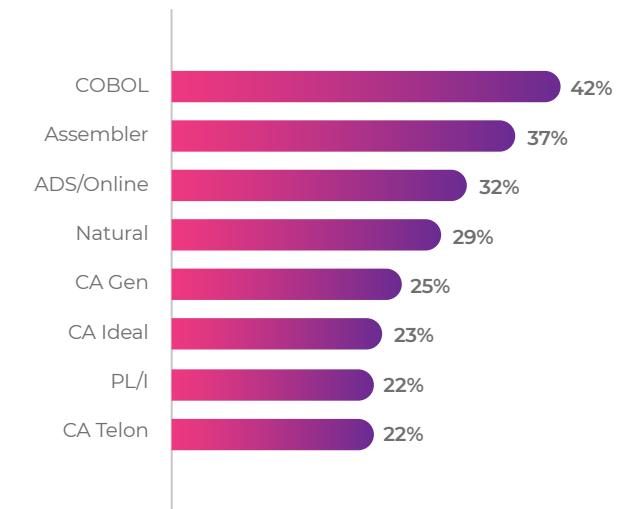


Although COBOL holds the crown, there are plenty of contenders for the top spot. Thirty-seven percent of those surveyed identified High Level Assembler as their most prominent language, followed by ADSO (32%), and Software AG's Natural (29%).

In the world of mainframes, consumption is most often measured in MIPS (millions of instructions per second) or MSUs (million service units). While both terms are meant to define the amount of work a machine is performing, the former is a measurement of the number of instructions a mainframe can process in one second, while the latter 'an IBM-originated term' is based upon the amount of processing work a mainframe can perform in one hour. While consumption varies widely by environment, the average reported MIPS per respondent was 17,283, with 41% indicating their consumption hovered between 10,000 and 20,000 MIPS.

These statistics further emphasize what we know to be true: Mainframes in use today are complex and expensive, and their tendrils of influence extend into countless areas of the business.

#### Most prominent legacy languages reported



#### MIPS consumption



A photograph of three professionals in an office environment. In the center, a man wearing glasses and a grey blazer is smiling. To his right, a woman with blonde hair and a striped shirt is also smiling. In the background, another man with a beard and glasses is partially visible. The scene is overlaid with a large white geometric pattern of triangles.

## ② Modernization drivers

# Modernization drivers

The topic of legacy modernization is complex and nuanced.

While the general consensus leans towards eventual modernization away from mainframes altogether, there remains a strong desire among many to retain these systems for as long as possible. Why would a company choose to stay on the mainframe then?

Reasons for retention vary, but often the choice to continue with big iron is simply due to the perceived risks that arise from the task of modernization itself. On the one hand, it's a reliable and complex legacy system with a multi-decade track record for housing business-critical applications. On the other, it's growing much more expensive to operate. It's getting a lot harder to find people capable of maintaining and extending the applications it houses as well.

What's more, in the world outside of the mainframe, innovation continues to accelerate, with modern application development tools and practices growing increasingly divergent from those wielded in the realm of big iron. From elasticity, automation, and orchestration to staples such as cloud-native architectures and infrastructure as code (IaC), the modern application development landscape is increasingly alien compared to its procedurally-oriented ancestry.

Most of these concepts echoed throughout the responses we received from survey respondents, but when it came to ranking top drivers for modernization decisions, a handful of commonalities surfaced. It is worth noting that while IT skills shortages were tagged as the top driver by only 16% of respondents, survey interviews clearly illustrate that this shrinking talent pool of capable legacy systems experts plays a major recurring role in almost all the drivers we highlight and throughout the modernization journey.



**75%**

are concerned about having access to the right IT talent to maintain and manage their mainframes



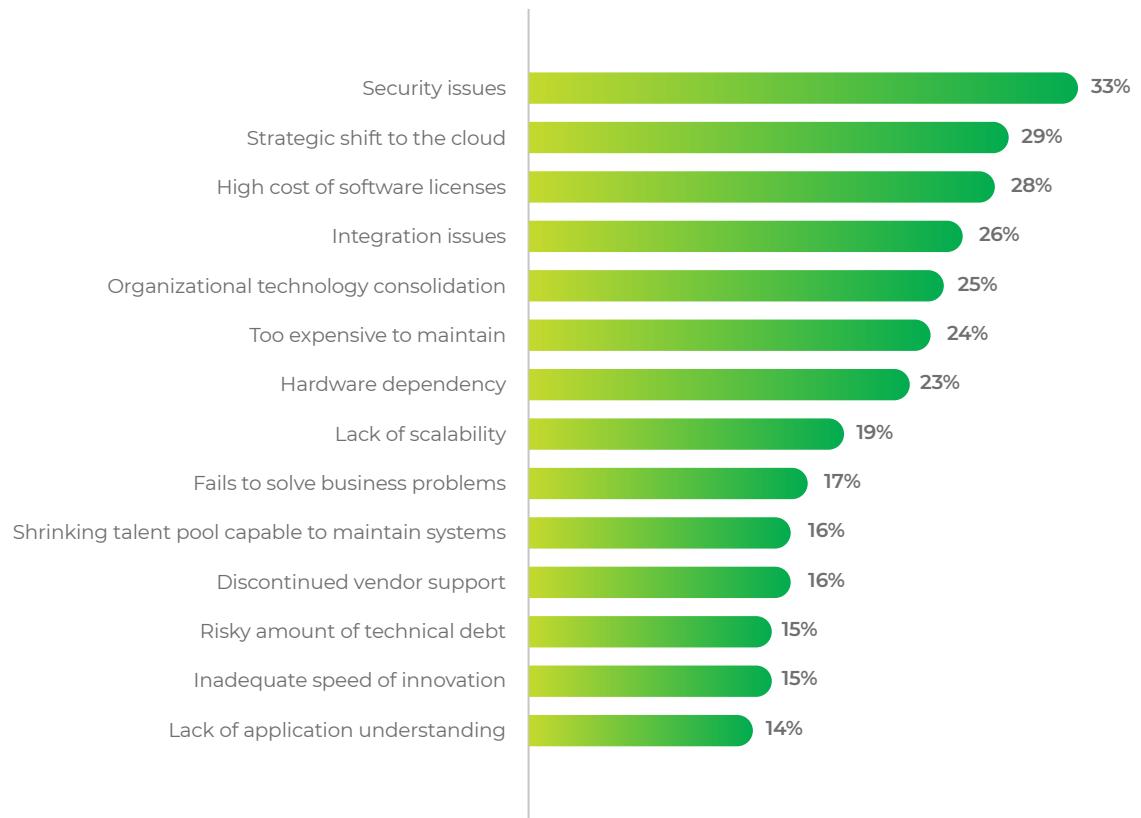
# Security

Security was not only reported as the primary driver for modernization, it was also ranked by 41% of respondents as the key element taken into account when prioritizing their mainframe modernization strategies. This may surprise many readers since the mainframe is legendary for its security.

However, data, regulatory compliance, and infrastructure management were frequently highlighted as causes for security-specific concerns. On the subject of compliance, one U.S. federal government agency commented, "most vendors do not fully support legacy systems since they continue to use outdated software that has not been upgraded to meet the most recent security regulations. No matter how much money we budget for IT, maintaining these systems requires ongoing maintenance, necessitating ongoing security expenditure, when we could make one sizable investment and catch up with the systems of this time." Concerns around security of the data itself arose often in conversations with respondents as well. A German software company said, "Our country has the strictest data protection. We are a software company providing IT services for tax consultants, auditors, lawyers, and big clients; we need to ensure security, so that is our main concern."

Interestingly, accountability for infrastructure management arose as connective tissue between most respondents' security concerns. One Enterprise Architect with a U.S. federal agency summed it up by saying, "While we must secure the data, cloud service providers have the necessary procedures and technologies to guarantee the security of their solutions." This concept of accountability over infrastructure extends to the growing ecosystem of software (for tasks such as API enablement) required to achieve adequate connectivity between the mainframe and its modern surroundings. These patches, connectors, and fixes grow the attack surface associated with mainframes and introduce greater risk, complexity, and cost.

**Top reported reasons for modernizing mainframes**



# The role of the cloud

Perhaps less surprising is the pervasive desire amongst respondents to move workloads to the cloud. It is clear from survey results that the mass disruptions caused by the pandemic significantly accelerated the push for cloud migration across all sectors and geographies. One U.S. healthcare provider stated, "Our organization has efficiently adapted the hybrid working model. Cloud played a significant role in its success because it has countless benefits like no geographical limitations because of real-time communication platforms, increased productivity because of readily available data to make decisions, cutting-edge security, and accessibility."

Respondents indicated that the most attractive characteristic of migrating to the cloud is the near-infinite horizontal scalability and elasticity (41%) it offers. Additionally, the myriad of managed solutions that cloud providers extend within their ecosystems was cited by many participants (23%) as the most valuable consequence of migrating to the cloud. However, respondents also cited numerous, operationally specific improvements they experienced as a result of migrating legacy systems to the cloud. One UK-based manufacturing firm explained, "Cloud has positively impacted us in many ways - improved our user experience and is very useful in modifying existing applications. With mainframe modernization and cloud, the new segment of semi-autonomous

and autonomous cars has become more effective and reliable. Operating these cars would be nearly impossible without the proper use of IoT and the cloud."

The majority of survey participants (68%) indicated that they preferred [migrating mainframe workloads to public cloud environments](#) such as AWS, Google Cloud, Oracle Cloud, or Microsoft Azure. However, 54% indicated private cloud environments are also utilized in certain circumstances.

A large number of respondents are operating hybrid and multi-cloud ecosystems across a combination of public cloud providers, private cloud environments, and/or mainframes. Interestingly, 25% of participants indicated that hosted mainframe environments were the preferred destination for their on-premises legacy workloads, signaling a continued, albeit shrinking, commitment to big iron, among some. Commentary from those who prefer to migrate workloads to hosted mainframe environments indicated that in doing so, they seek to reduce the physical footprint and associated facilities and maintenance costs of their legacy systems while retaining the functionality and structure of their contents.

## Most attractive cloud feature/solution



"Our organization has efficiently adapted the hybrid working model. Cloud played a significant role in its success because it has countless benefits."

United States, Healthcare

Our survey also shows that organizations that identify as having a moderate to high level of cloud maturity are most likely to utilize multi-cloud ecosystems, while companies with low to moderate cloud maturity are more likely to work with a single cloud provider. However, hybrid cloud environments are commonplace across the maturity gradient. We believe this is based upon a number of factors.

Cloud-mature firms running hybrid environments are most common in industries such as manufacturing, aerospace, and automotive, where on-premises and edge computing plays a key role in operations. Most of the organizations on the low to moderate side of the maturity gradient with hybrid environments either continue to operate mainframes for a subset of critical business functions or began the bulk of their cloud migration activity as a result of disruption caused by the pandemic.

For example, an Application Manager from a major U.S. financial services company recalls, "we had to deploy a remote workforce overnight. Considering our company, we had immense queries and transactions arising due to panic situations, and our servers were almost crippled.

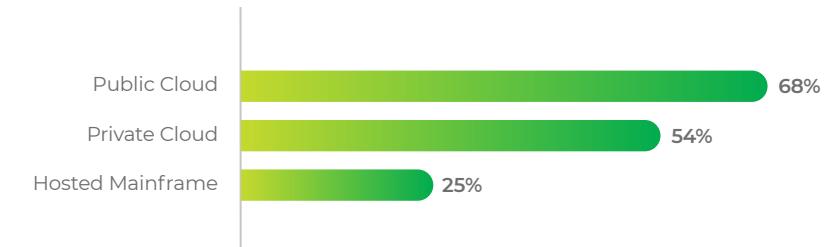
This resulted in delays and people losing faith in our business. Now, we run a hybrid model and perform our tasks seamlessly, resulting in speedy redressals and better customer satisfaction."

Regardless of the specific methods and means, survey results clearly indicate significantly accelerated cloud migration plans across the board. As one French retailer put it, "The world is changing, and new technologies are changing the whole canvas of operations. Old mainframe systems cannot integrate with the ongoing and upcoming trends and technologies. To maximize the effective use of new technologies, we have to choose and use cloud services, which significantly helped us in many ways."

**"Cloud has become the primary key to storing data safely and securely for data-driven companies and those who are into manufacturing."**

Germany, IT Services

#### **Target platforms for migration**



# Cost reduction

If the mainframe existed back in 1789, Benjamin Franklin's famous quote "in this world nothing can be said to be certain, except death and taxes" may have also included commentary on rising mainframe software licensing fees. Increases in annual software costs (for packages including the likes of Software AG's Natural programming language and Broadcom's CA IDMS network database management system) have been commonplace since time immemorial. Flagged by 28% of survey respondents as a top reason for modernizing, high and rising licensing costs are just the tip of the iceberg when it comes to the ever-expanding price tag associated with operating mainframes. One responded stated, "there has been an estimated waste of \$11.6 million in mainframe maintenance and \$1.5 million in overuse of its licensing and software subscription support costs, which can be saved once our six-year project of mainframe modernization is completed."

Although survey participants identified the cost of software as the key motivating factor for modernization, they named maintenance, which consumes 22% of their annual mainframe budgets on average, as the costliest component of mainframe operations. In addition, the relative cost to operate a mainframe is rising due in part to the decreasing cost of cloud consumption.



**70-80%**  
annual cost savings from  
mainframe modernization realized  
by a Japanese utility provider

Hardware, facilities management, physical security, environmental, and dedicated operations staff, which can all be eliminated or significantly reduced by migrating workloads from the mainframe to a public cloud environment, all result in cost savings as well.

*"There has been an estimated waste of \$11.6 million in mainframe maintenance and \$1.5 million in overuse of its licensing and software subscription support costs, which can be saved once our six-year project of mainframe modernization is completed."*

United States, Federal Government Agency



# Talent shortage

The talent pool capable of maintaining and extending legacy systems is drying up with most of its population nearing retirement age. Since legacy languages and databases are growing scarcer as companies move workloads away from the mainframe, most universities have ceased providing students with the knowledge to pick up where their retired counterparts leave off. What's more, there is little interest among newly minted developers and DBAs to learn obscure legacy technologies.

Unsurprisingly, three-quarters of our survey respondents indicate they are concerned about having access to the right IT talent to properly maintain legacy systems, with 49% reporting that the pool of mainframe-capable skills is decreasing more rapidly than ever before. One respondent from an Indonesian financial services company stated, "Mainframes are a key component of our operations, and while we presently have a strong IT team, the scarcity of experienced IT talent might become a bigger challenge in the long term. We still have certain job opportunities that aren't filled because we can't find the appropriate people since there aren't enough qualified individuals to fill them."

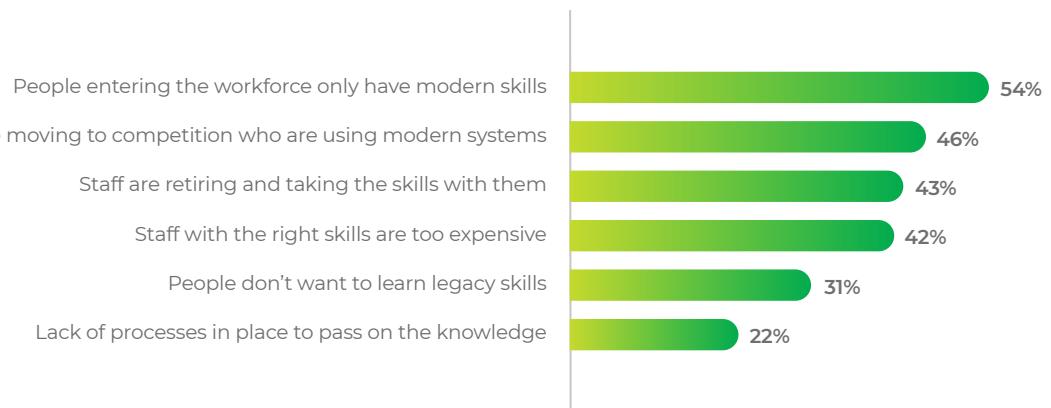
This growing talent scarcity is impacting multiple facets of the business. From a cost perspective, this shrinking supply coupled with a growing demand translates to a rising cost to procure

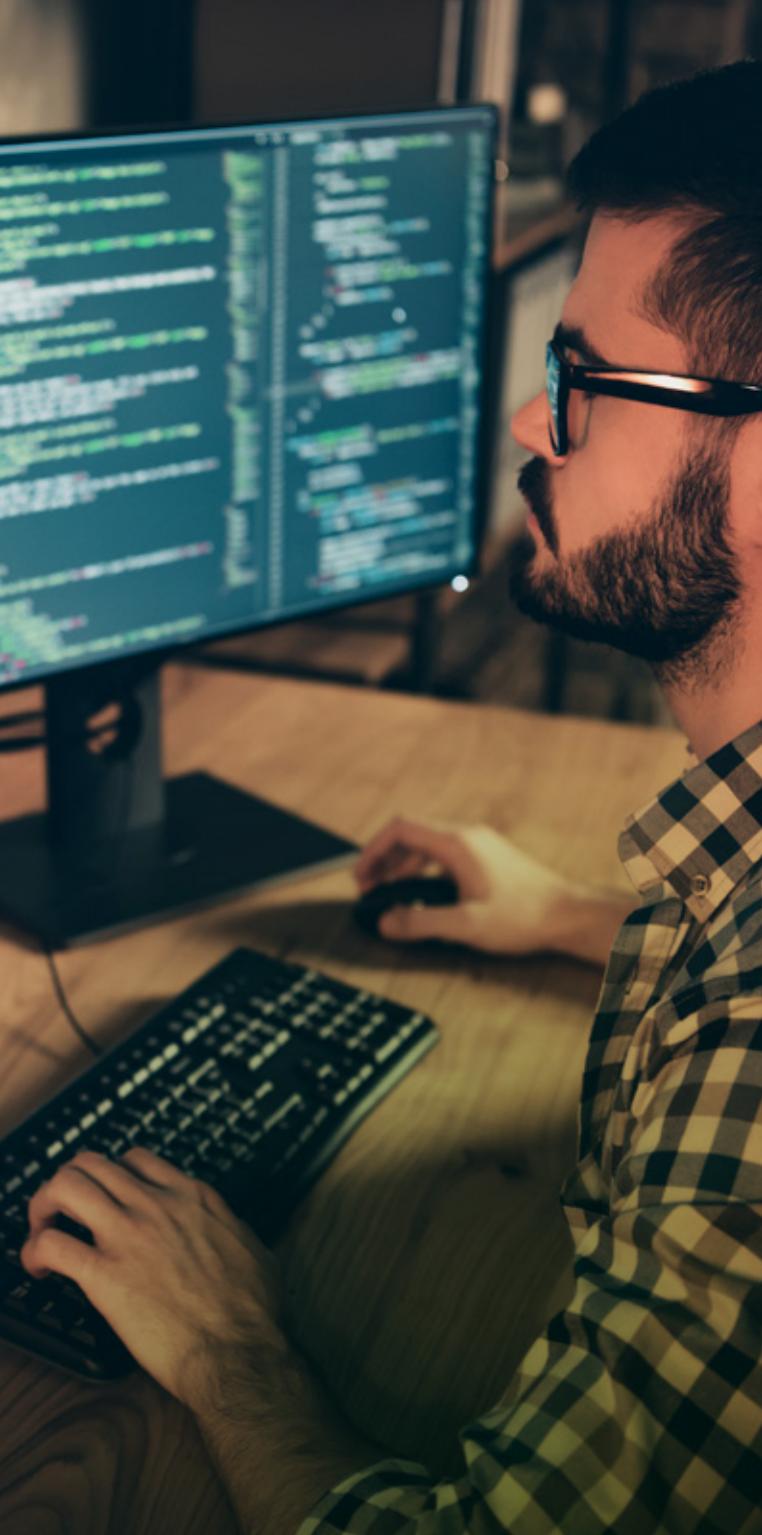
legacy systems-related services and staff. In fact, 42% of survey participants indicated that individuals with the right legacy skills are too expensive. To complicate matters, 22% of respondents report they lack the systems and processes to adequately transition the knowledge of their legacy systems to the new employees tasked with presiding over them. The staffing conundrum also introduces new security concerns. In today's environment, a working knowledge of the legacy estate is inadequate to ensure its security. Staff must possess both a working knowledge of the estate as well as the ability to understand and preside over the growing number of ancillary integrations and utilities that are required to operate mainframes in harmony with modern infrastructure. These same individuals are commonly charged with updating documentation and other administrative tasks to maintain regulatory compliance, resulting in an even greater workload burden.

**"Having the right IT personnel is crucial as it saves both time and cost, but in recent years there has been a crunch in the IT talent who can maintain and manage our mainframe system; this has been a problem for the entire industry and not just us."**

Indonesia, Finance

**Top reported talent shortage concerns**





Although the talent shortage poses significant challenges, respondents have chosen a variety of strategies to reduce the impact. A majority (52%) have prioritized modernization tasks to focus on workloads impacted most by talent pool scarcity. 48% have chosen to outsource the legacy systems work to independent contractors such as global systems integrators (GSIs). Some survey participants (29%) have developed effective cross-training programs to ensure existing staff has the skills necessary to continue to carry the legacy systems torch in case of attrition. One financial services company commented that they have found relief through “various methods, such as leading a learning workshop, skill training, and career development workshops, which assist and encourage personnel, improving the service quality.”



**52%**

have prioritized modernization tasks to focus on workloads impacted most by talent pool scarcity.

Ultimately, the talent pool of capable skills will continue to decrease while the complexity of maintaining and integrating the mainframe steadily climbs. This will result in rising costs and risk that inevitably leads to modernizations stricken by a lack of knowledgeable resources. As we will discuss later in this report, modernization projects with these less-than optimal staffing circumstances tend to be far more costly and higher risk than those with adequate, knowledgeable support both internally and externally.

#### **Addressing the decreasing talent pool**

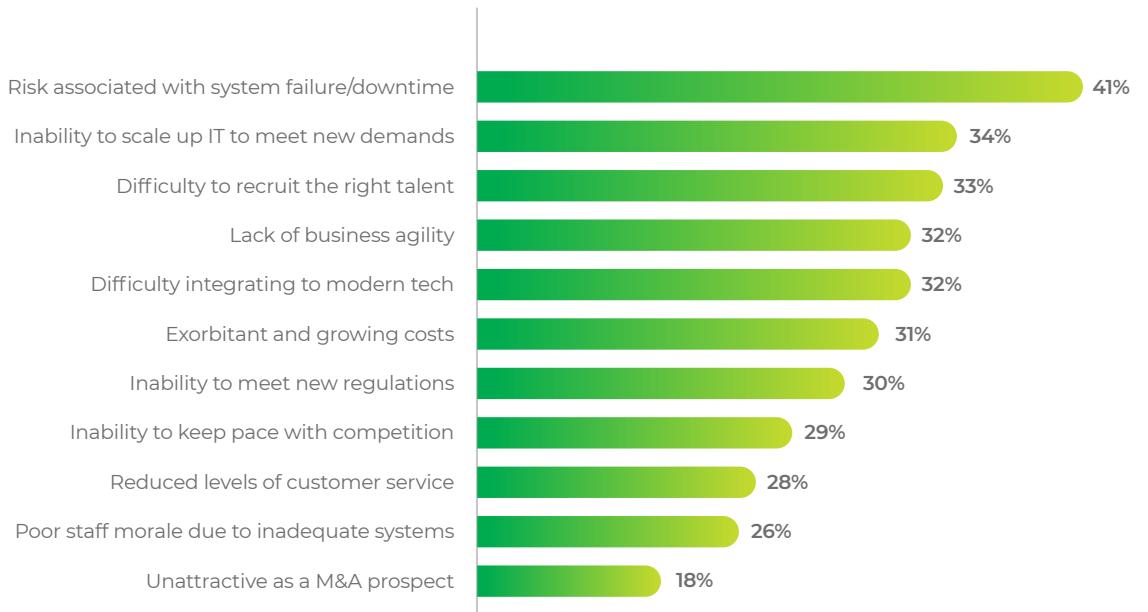


# Other modernization drivers

Survey participants provided a wealth of knowledge around their most pressing modernization catalysts. While security, cloud strategy, and software licensing costs accounted for most of the responses, there are additional drivers worth noting in this report. Integration issues (26%), organizational technology consolidation (25%), hardware dependency (23%), and lack of scalability (19%) all point to platform-specific challenges that are increasing in intensity as the rift between legacy systems and modern IT environments like the cloud grows wider. In the words of one automotive manufacturer in Europe, “automation and cloud simplify processes and require less time, resulting in increased productivity.”

When asked about the consequences of choosing not to modernize, most survey participants (41%) believe retaining legacy systems increases the risk associated with system failure and downtime. Many cite an inability to scale to meet new demands (34%), a lack of business agility (32%), and difficulty integrating with modern tech (32%) as direct consequences of foregoing modernization as well.

## Consequences of choosing not to modernize



*“A key driver to mainframe modernization is a simplification of processes and cost savings.”*

United States, Finance

### ③ The path to modernization



# The path to modernization

Thus far, we have illustrated a high-level view of the complex nature of modern mainframe ecosystems and highlighted many of the drivers that motivate survey respondents to modernize them.

Historical data suggests these factors evolve over time, a phenomenon that applies to modernization strategies and tactics employed by survey respondents as well.

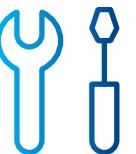
Today, a majority of organizations are actively aiming to reduce their dependency on legacy systems such as mainframes. Motivation to begin the modernization journey has intensified in recent history across all surveyed industries and geographies, with 41% of respondents indicating they have modernized mainframe workloads within the past year. Nine in ten of the firms surveyed report having undergone this transformation within the past three years, while only 11% undertook modernization initiatives prior to 2019. We believe this trend is due in part to inertia created by rapid cloud migration and hybridization of critical systems in the early days of the Covid-19 pandemic.



**90%**

of respondents have modernized mainframe workloads in the past three years

**Vs**



**11%**

undertook modernization initiatives before 2020





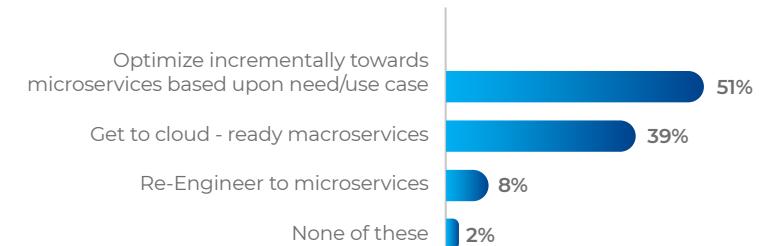
# The cloud

When asked to rank various target platforms as modernization destinations by preference, public cloud took top marks with 68% of the vote. Although much of the focus of modernization involves conversations about cloud technology, private clouds and bare metal data centers remain a strong preference for many, landing them in second place with 54%, while hosted mainframe environments took third place at 25%.

It is worth noting that while many respondents name public cloud providers as deeply trusted partners, the architectural and functional advantages of cloud-native technologies can pay dividends outside of the public cloud. In fact, products such as Microsoft Azure Stack, AWS Outpost, Google Anthos, and Rackspace's OpenStack extend cloud services and capabilities to the customer's environment of choice, from private data centers to edge locations. This simplifies hybrid cloud deployments and enables powerful automation while extending many of the unique advantages of cloud technology to modern computing platforms (typically x86 or Linux). This is a common practice, especially among organizations that operate complex geographically disbursed physical assets, such as those in manufacturing, automotive, aerospace, and critical infrastructure. One Japanese utility provider commented, "we have enabled our power plants with AI and IoT, and the whole ecosystem is connected with clouds that provide real-time data access."

Modernization initiatives are as unique as fingerprints, and each organization takes a slightly different approach to them. Among respondents who indicated that cloud migration was a goal of their efforts, 51% reported that they planned to migrate by optimizing incrementally towards microservices based on need or use case. Many participants (39%) reported that getting mainframe workloads into the cloud in the form of macroservices was preferred as a first step, leaving the potential to further optimize from within the ecosystem for cloud characteristics such as elasticity, statelessness, microservices, etc. Only 8% indicated a desire to re-engineer to microservices as a first step and 2% have chosen to take other avenues.

## Most common cloud migration strategies



When asked about the preferred cloud partner (a.k.a. hyperscaler) for mainframe workload migration, respondents gave a myriad of answers, most of which were contingent on the involvement of that hyperscaler in other areas of the business or on a particular technical capability unique to said provider. For example, a major manufacturer in the UK stated, "We use multiple cloud services for different purposes; AWS, Microsoft Azure, Adobe, and Google Cloud are our main partners. We use AWS to gather information from the sensors of our vehicles to provide a dynamic driving experience to our customers, Adobe services to strengthen our sales and marketing division, Google Cloud augmented reality to provide a virtual experience with various customization options, and Microsoft Azure to run our global operations."

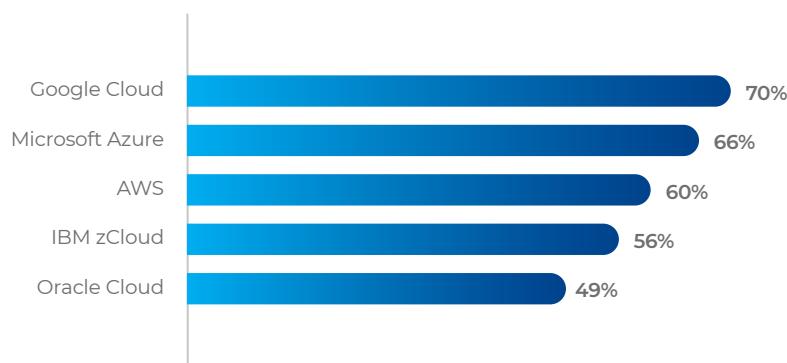
Another survey participant, a government agency in Oceania, painted a similar picture saying, "We indeed follow a multiple cloud strategy as we have worked closely with two cloud providers, Microsoft and AWS. Microsoft provides risk assessment and better wind speed analysis. We are also using AWS for our operations, which run around 80 digital services and applications."

Since our cloud-bound target demographic tends to utilize more than one hyperscaler, we asked respondents to rank their preferences. Given the size of our survey population and low standard deviation between answers, there is little evidence to support an overwhelming desire to migrate workloads to one

hyperscaler over another. However, 70% of the vote went to Google Cloud, 66% to Microsoft Azure, 60% to AWS, 56% to IBM zCloud, and 49% to Oracle Cloud.

When asked what the top driver for choosing their highest ranked cloud provider was, 31% of respondents cited security, 20% indicated cost, and 19% chose track record of success. Interestingly, while respondents show a clear preference to move workloads away from the mainframe, the relative performance of IBM zCloud in responses to this question illustrates participants' active interest in hybridizing existing mainframe workloads to either further enable services or as part of a phased approach to modernization.

**Preferred cloud providers**



"We use multiple cloud services for different purposes; AWS, Microsoft Azure, Adobe, and Google Cloud are our main partners. We use AWS to gather information from the sensors of our vehicles to provide a dynamic driving experience to our customers, Adobe services to strengthen our sales and marketing division, Google Cloud augmented reality to provide a virtual experience with various customization options, and Microsoft Azure to run our global operations."

United Kingdom, Manufacturing

# The modernization journey

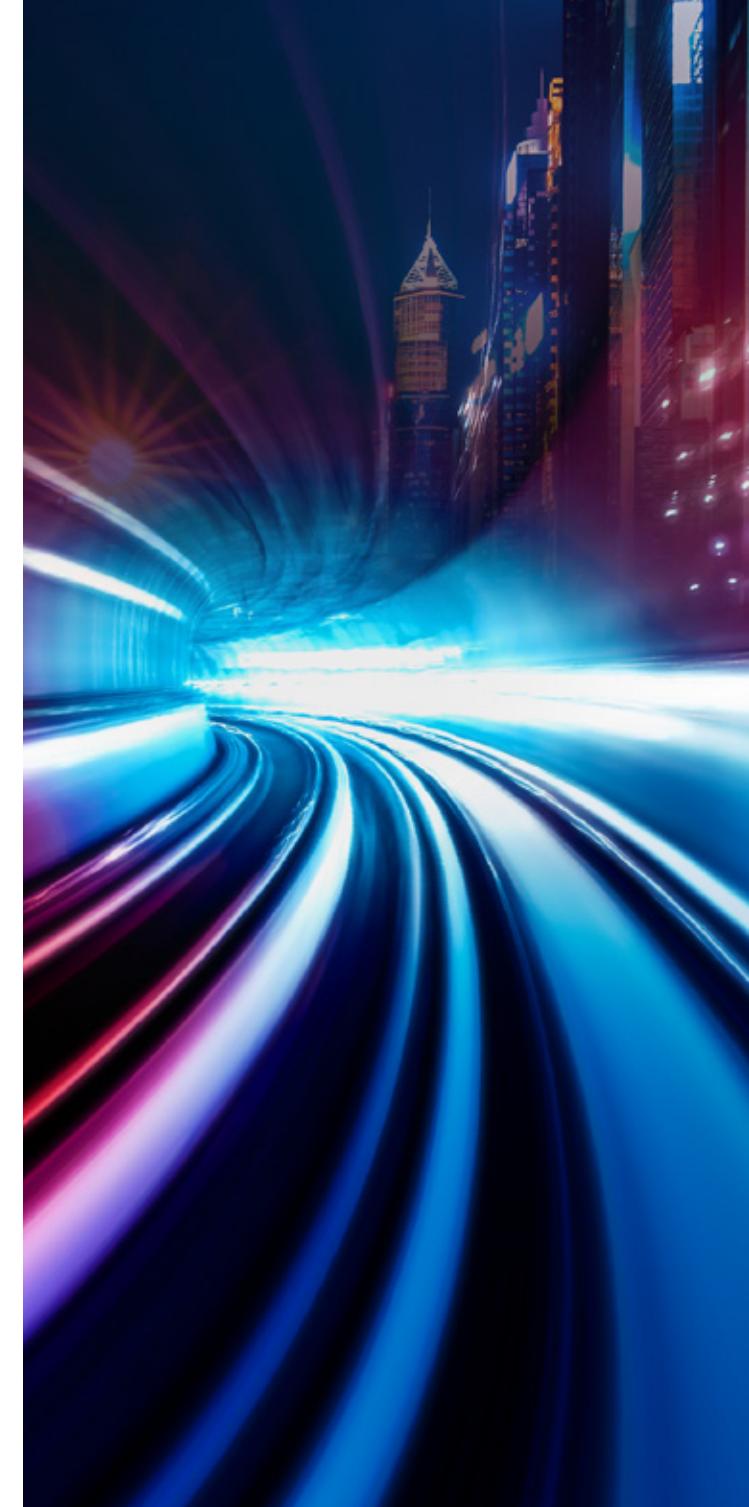
In 2010, [Gartner](#) introduced nomenclature to categorize the migration paths (also referred to as disposition strategies) available to organizations with a desire to modernize legacy systems. Originally dubbed “The 5 Rs,” they were rehost, refactor, revise, rebuild, and replace. Since then, mainframe modernization industry participants have pegged their products and services to different variations and extensions of the original five. While the names may differ slightly depending on where you look, the concepts remain the same. To provide clarity, we defined the following terms and the disposition strategies they represent for survey participants:

- **Rehost/Replatform:** Retains the application code ‘as is’ and an emulation environment is used to run the code on a modern platform.
- **Refactor:** The application code is converted from one language to another using automated tooling. A turnkey modernization of the procedural codebase (or 4GL) to object-oriented code and the non-relational database to a relational model deployed to the cloud or in open systems on premises.
- **Replace:** Purchasing commercial off-the-shelf (COTS) packages to take the place of applications developed and running on the mainframe.
- **Rewrite/Re-Engineer:** The manual transformation of the legacy code by taking the functionality of an existing application and re-writing the application in a new language.

- **Retire:** Getting rid of the mainframe entirely, inclusive of its applications and databases

You can read more about disposition strategies [here](#).

We then asked respondents to provide details of their modernization plans and experiences based on the aforementioned definitions. It is clear from survey results that there is no “one size fits all” or “silver bullet” approach to broad mainframe modernization strategy. The process is implicitly complex and as bespoke as the systems it targets. While rehost/replatform may be optimal for one financial services provider with COBOL applications and Db2 databases on a mainframe backed by a large, capable team of developers and DBAs, it may not be a viable option for a university with CA Gen and Db2 on a similar platform who struggles to find capable development resources. In addition, many report utilizing multiple disposition strategies across their mainframe estate based upon the needs of the business. As one manufacturing company in the UK put it, “We are using a combination of approaches when it comes to mainframe modernization. These are rehost/replatform, refactor, and retire. Despite the importance and benefits of the cloud, the mainframe system is still vital for us. We had invested a lot in the mainframe, and completely replacing it with cloud is not an easy task for us.”



When asked about their preferred mainframe modernization disposition strategy, 33% of respondents reported a preference for refactoring, 24% chose rehost/replatform, 22% indicated that replacing mainframe functionality with commercial off-the-shelf software (COTS) was their method of choice, and a small number (13%) state that they prefer a rewrite/re-engineer approach.



**48%**

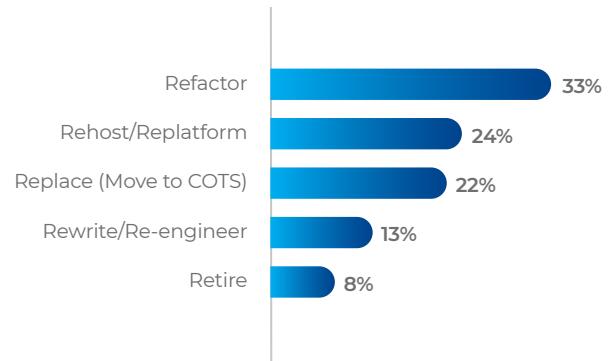
indicated that improved security was the primary reason for their decision

On the subject of refactoring, one Australian government agency opined "We have been working on refactoring our current capabilities for a couple of years instead of just adding more application programming interfaces." Alternatively, an Indonesian financial services company commented, "We prefer using rehost/replatform, which basically lifts the data and shifts it to the cloud." Our survey also prompted participants to provide some insight into the reasoning behind their choice over other available modernization strategies. Nearly half (48%) indicated that improved security was the primary reason for their decision, 44% reported that their preferred disposition strategy was more cost effective than alternatives, and 41% selected their strategy because their applications would be easier to maintain and extend in their modernized target state.

On average, nine in ten organizations trust the modernization disposition strategy they've used in the past and would choose the same route again. Among those who refactored, 91% would choose the same approach again. One respondent defended their stance by stating, "Refactoring consists of changing the internal structure of the code in a way that doesn't modify its behavior. This makes the code more maintainable and easier to understand. It enables the developers in the team to keep complexity under control." Another said simply, "it's simple, cost effective, dependable."

Survey participants who rehosted/replatformed in the past showed a similar loyalty to their chosen approach, with 89% reporting they would modernize using the same strategy again. When asked why, one participant said that "the replatformed approach factored properly will have greater availability, improved scalability, and faster performance." Another responded by stating that "it's innovative and reliable." Respondents who chose to replace their mainframe functionality with COTS software were least likely to repeat the process again, however that number stands strong at 80%. Reasons for choosing whether to replace again varied widely but revolved primarily around the cost effectiveness and trustworthiness of the target state software. Interestingly, 84% of respondents who opted to rewrite/re-engineer mainframe workloads said they'd do it again, with most citing information security as a key reason.

#### Top mainframe modernization strategies

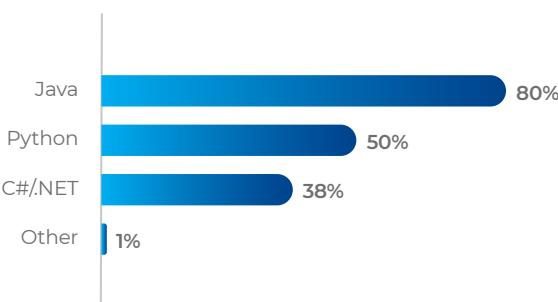


"We have been working on refactoring our current capabilities for a couple of years instead of just adding more application programming interfaces."

Oceania, Government Agency

Strategies such as refactoring and rewrite/re-engineering are rooted in the transformation of legacy code from the mainframe into modern object-oriented languages. Most survey respondents (80%) indicated Java as their most preferred modern language, but signaled this preference isn't absolute, given that 50% listed Python as a desired target as well. Additionally, 38% say they are seeking transformations to C#/.NET. The overlap in language preferences among survey participants is likely a product of appropriateness and task-orientation. For example, Python tends to be more suitable for data science and artificial intelligence. AI developers often prefer it because of its simplicity, ease of use, and accessibility. On the contrary, a big advantage Java has over Python is in the realm of performance. Java is arguably the most efficient language when it comes to speed and optimization. Therefore, it is reasonable to assume that respondents could make use of both languages side-by-side with a preference towards Java in the context of modernization due to the alignment of its strengths with the demands of applications coming from the mainframe.

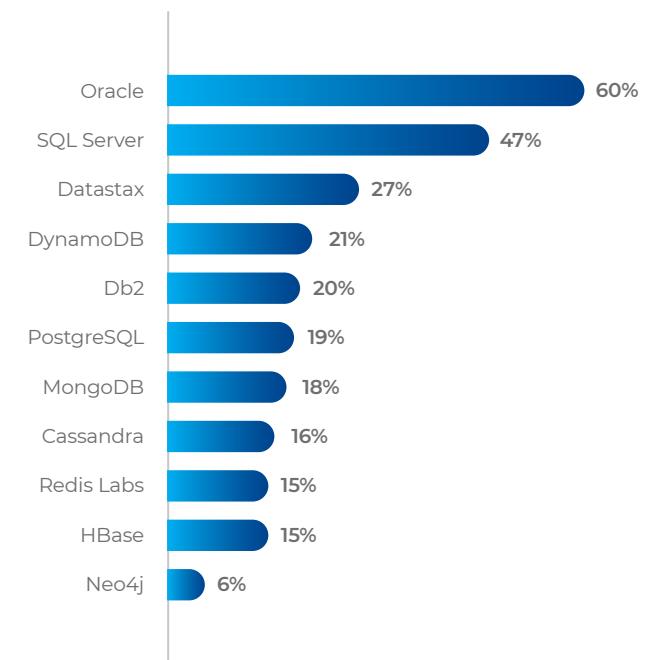
#### Languages targeted for mainframe modernization



Unlike programming languages, data and databases are often transformed across all of the disposition strategies covered in this report. For example, a South African insurance provider implementing a rehosting/replatforming strategy may opt to retain applications in their original Natural programming language while choosing to migrate their Adabas database to Oracle in the process. A large retailer in Spain may choose to replace the functionality of their mainframe applications with COTS packages but will need to migrate historical data from IMS-DB to PostgreSQL to access it from the new software.

Even companies considering mainframe retirement strategies need to account for data migration to meet retention requirements in their industries and jurisdictions. As a result, opinions around preferred target database vary widely. A whopping 60% of respondents named Oracle as their most popular data destination, while SQL Server ranks in second place with 47% naming it as a target. Datastax (27%) and DynamoDB (21%) narrowly outranked the historically popular Db2 (20%) for third and fourth place respectively. Unsurprisingly, cloud-managed databases are rising in popularity as well. When cloud-bound respondents were asked about their propensity to utilize these solutions, 46% named Google Cloud SQL as their most likely candidate, 29% named Azure SQL as their preferred cloud-managed database, and 18% named AWS RDS as their preference.

#### Databases targeted for mainframe modernization



**60%**  
of respondents named  
Oracle as their most  
popular data destination

# Roadblocks and challenges

The prospect of modernization can be daunting in the early stages. In many cases, simply communicating the need to stakeholders can be a challenge. It can be difficult for some stakeholders to grasp the benefit of modernization in contrast to the potential cost, complexity, and risk introduced by the migration project. The old "if it ain't broke, don't fix it" adage is often uttered in boardroom transformation discussions for this very reason. However, mainframe outages during the onset of the pandemic effectively highlighted the strategic advantages of running mission critical workloads on modern platforms with on-demand horizontal scale, which led to the rapid increase in modernization interest previously discussed in this report. However, 38% of survey participants report that key members of leadership still lack an understanding of the business benefits of cloud migration and IT in general.

Successful modernization requires expertise in the technical domain, but more importantly it requires expertise in the process of legacy modernization itself. Many companies begin their modernization journeys by attempting to migrate legacy systems to their desired state using internal resources alone, but run into difficulty as the true breadth and depth of the modernization task reveals itself. As one European automotive manufacturing firm said, "The most profound challenge was the lack of understanding of the complexities of mainframe systems. Inadequate knowledge and lack of proper planning became the major challenge."

Survey respondents named code quality issues (19%), scope creep (18%), and inadequate expertise (14%) as the top unforeseen challenges that arose from tackling modernization projects. Further investigation reveals a plethora of root causes behind these claims. Code quality issues were most commonly associated with poor vendor performance. For example, one vendor's conversion tooling was designed to refactor the COBOL generated by a customer's CA Gen application development environment instead of its encyclopedia, resulting in code that was not maintainable by developers in the target state. While scope creep was attributed to a wide array of circumstances, it was particularly common amongst organizations attempting to bootstrap a modernization project internally. Inadequate expertise was attributed to a variety of focus areas from capable legacy language and database experts to legacy modernization talent, business process representatives, testing resources, etc.

**Single most unforeseen challenge to successful mainframe modernization**



**38%**

of survey participants report that leadership still lack an understanding of the business benefits of cloud migration and IT in general.

## ④ Modernization results



# Modernization results

The journeys companies make to arrive at modernization success can vary widely. However, there are a few notable characteristics shared among successes uncovered in our research.

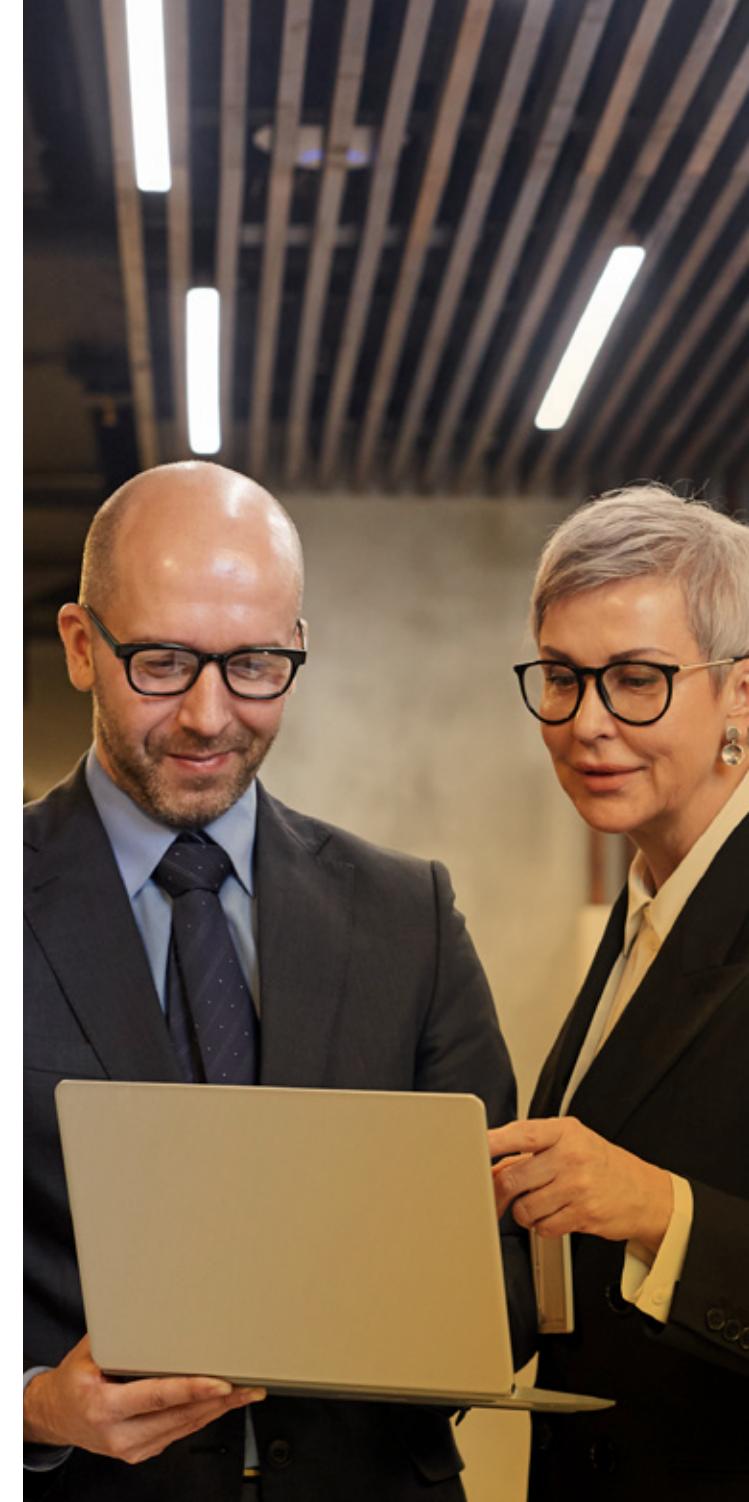
First, modernization experience appears to be the best insurance policy against failure. Survey participants broadly reported that anointing seasoned modernization experts to key roles in their projects drastically increased the odds of success. Second, successful survey participants achieved cross-functional executive sponsorship, carefully documented and assessed their legacy estates, reasonably accounted for unforeseen challenges, and assigned adequate time and resources to the entire project (especially testing).

Upon successful completion of modernization initiatives, the downstream effects reported by survey participants fall into four broad categories: Cost savings, reduced operational and staffing risk, increased agility, and a net positive impact on sustainability.

One state government agency in the U.S. said, "We saved around \$20-25 million dollars due to mainframe modernization.

With more time, we could save a lot more, as we have seen that we can lower our operational costs. Automation and cloud simplify processes and require less time, resulting in increased productivity." A Japanese utility provider stated, "Mainframe modernization saves up to 70-80% of annual mainframe operating costs because it optimizes hardware and software costs while helping to increase speed in application performance and management. Integrating mainframe modernization helps unlock additional revenue by increasing access to mainframe data for analytics, AI through an API, and the data modernization strategy."

**\$20-25m**  
saved by a U.S. state government agency  
due to mainframe modernization.



Cost savings are not only realized in the arena of budgetary spend, but in risk reduction as well. The cost to procure adequate development resources is high for legacy systems such as the mainframe because they are scarce. When legacy languages and databases are eliminated through modernization, the available talent pool expands drastically, decreasing people costs and eliminating the risk associated with scarce legacy-capable resources. The risk and resulting cost of potential downtime is also a factor. There were a multitude of news stories featuring mainframes that buckled under the pressure to horizontally scale rapidly in the early days of the pandemic, bringing their organizations and customers to their knees. Fortunately, properly deployed modern cloud infrastructure effectively eliminates the horizontal scaling constraints that led to these disasters.

Commenting on the downstream impacts of a recent project, one respondent said, "Modernization has helped us gain the flexibility to experiment and innovate." In fact, participants who migrated workloads to the cloud reported a marked increase in agility, both technically and competitively. Modernization opened doors to cloud-native paradigms such as microservices and infrastructure as code (IaC), which are core components of modern cloud deployment and central to effective DevOps. They also act as a foundation for innovative cloud-native concepts such as automated orchestration and elasticity.

As cloud infrastructure evolves, powerful new abstractions will continue to arise. For example, secure access service edge (SASE), which enables developers to code their applications to automatically spin up purpose-built on-demand, ephemeral overlay networks using the internet without any requiring any human intervention. Tools such as these rely on the cloud as a prerequisite and their adoption will incrementally increase the distance between the capabilities of legacy systems and these new, disruptive modern descendants.

As organizations continue to look forward, their focus on tackling environmental, social, and governance (ESG) issues are sharpening, with legacy modernization taking center stage in attaining their goals. Respondents overwhelmingly (89%) report that their mainframe modernization initiatives resulted in a positive impact on sustainability goals for their organizations, a 17% increase from last year's survey. A healthcare provider in the United States commented, "It significantly reduces our energy consumption while providing more processing speed at the same time. Also, it substantially reduces the load a server undergoes, thereby reducing the power required for cooling and maintaining ambient temperature for productivity." Another respondent, a British manufacturer said, "By way of mainframe modernization, we have not only reduced mainframe demand and provided the best service to our customers but also optimized our electricity consumption by reducing mainframe dependence."



**89%**

reported that mainframe modernization resulted in a positive impact on sustainability goals for their organizations. That's a +17% increase vs last year's survey.



**60-70million**

euros saved annually as a result of mainframe modernization,

United Kingdom, Government Agency

**"It significantly reduces our energy consumption while providing more processing speed at the same time."**

United States, Healthcare

# Closing

While the remnants of the pandemic fade into the past, the era it ushered into existence burns with growing intensity.

Companies around the globe are grappling with the reality of an ever-changing new normal, setting their sights on strategies such as legacy modernization that maximize their ability to adapt and respond to disruption while enabling the agility necessary to capitalize on opportunities which arise as consumer demands evolve with change and digitalization.

The decision of whether to modernize legacy systems and when, is complex. Every enterprise faces unique challenges in this pursuit. Our survey results suggest that although mainframe modernization can be a challenging endeavor, informed decision-making can mitigate much of the common pain points felt by those who have traversed the path before.

Overall, survey participants suggest success depends on careful modernization vendor selection, comprehensive early-stage planning backed by experts with demonstrated track records, effective scope reduction exercises such as the identification and removal of dead or unused code, and a participatory culture shared by cross-functional teams. As one anonymous industry expert put it, "modernization isn't something that's done for you, it's something you do."





## About Advanced

Advanced is a leading international provider of application modernization services, with unique expertise in the legacy modernization market.

With more than **500 modernization projects** completed worldwide, and **2.5 billion lines of code processed** through our solutions, we have been driving IT efficiency, agility, and competitive advantage for customers through core application and database transformations for over **40 years**.

Over that time, we have helped organizations across all sectors including the UK's Department for Work and Pensions, FedEx and The New York Times.



Intelligent modernization,  
unparalleled experience.

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