# Mainframes as mainstays of digital transformation

*A foundation for hybrid cloud optimization and AI innovation*

IBM

## How can IBM help

IBM can help organizations unlock full potential from their mainframes and drive business value through AI-driven innovation and hybrid cloud environments. With its deep industry, functional, and technical expertise, IBM can provide customized solutions to modernize mainframe applications, leverage AI-powered tools, and integrate mainframes with public cloud services.

**For more information about:**

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– What is mainframe modernization, visit ibm.com/topics/mainframe-modernization

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# Key takeaways

*Mainframes help unlock the full potential of AI-driven digital transformation, accelerating ROI, and enabling business innovation and growth.*

## Hybrid-by-design environments thrive on a mainframe foundation.

Organizations can unlock higher returns on investment and achieve better business outcomes by integrating mainframe reliability with public cloud services. This approach has been proven to deliver significant ROI, with companies adopting hybrid by design achieving more than 3X higher returns from their digital transformation efforts.

## A fit-for-purpose strategy helps optimize application performance.

Organizations can achieve optimal application performance by assigning workloads to the most suitable computing environment. Leveraging strengths in secure and reliable transaction processing, mainframes handle 70% of the world's transactional workloads including critical applications for top airlines, retailers, banks, and government agencies.

## Mainframe application modernization enables hybrid cloud transformation.

Mainframe application modernization is a critical component of digital transformation, with 88% of executives citing its importance to long-term success and recognizing that simplifying and integrating information sharing and data access across platforms is vital to benefiting from hybrid cloud architectures.

## AI with the mainframe unlocks new possibilities.

79% of IT executives agree that mainframes are essential for enabling AI-driven innovation. By leveraging AI, organizations can enhance transactional workloads, accelerate modernization and development, and improve mainframe operations.

# Introduction

In the world of technology, where AI, cloud, quantum, and other trends grab headlines, another breed of machines hums steadily behind the scenes, handling more than 70% of the world's transactional workloads.[1] After six decades of evolution, mainframes are mainstays, storing and processing vast amounts of business-critical data. For example, 43 of the world's top 50 banks and 8 of the top 10 payment companies rely on mainframes as their core computing platform.[2][3]

Today's mainframes hold up to 40 terabytes of memory and can process up to 30,000 transactions per second.[4] These workhorses provide massive amounts of memory and high-speed data processing to databases, transaction servers, and applications that require the highest levels of reliability, security, and resilience.

Industrial-strength hybrid transactional/analytics processing (HTAP) capabilities of modern mainframes also enable seamless integration of transactional and analytical workloads for unparalleled performance and scalability. This makes mainframes ideal for providing real-time insights and enabling data-driven decision-making.

Surprisingly, even though mainframes handle 70% of transaction workloads, they account for only 8% of total IT spend, costing less than one-tenth of all other technologies and platforms combined.[5] In new research from the IBM Institute for Business Value (IBM IBV), 75% of more than 2,500 global IT executives surveyed say that mainframes are equal to or better than cloud computing in terms of total cost of ownership, indicating they remain a cost-effective option for optimizing IT budgets.

From inception, mainframes have built an unrivalled reputation for reliability and availability. Today, organizations can achieve up to eight-nines availability, which in practical terms, translates to less than one-third of a second of downtime annually.[6] That's why so many enterprises run mission-critical applications on mainframes and why two-thirds of executives agree that mainframe-based applications are central elements of their computing strategies.

As organizations embark on AI-driven digital transformation journeys, mainframes will play a critical role in extending the value of data. Through their proven reliability, security, and resilience, mainframes can help leverage vast stores of data to deliver insights, innovation, and business outcomes.

# The great mainframe differentiator

For many organizations, mainframes are trusted enterprise systems. However, as the tech landscape evolves, some organizations see mainframe systems as legacy instead of valuable assets worthy of investment and modernization. Viewed in this context, limited mainframe investment translates into limited results.

Data tells another story. Our research revealed a significant subset of organizations that truly recognize modern mainframe potential and understand how to address its limitations. These standout organizations view mainframes as strategic assets rather than technical burdens. They are willing to invest in modernization efforts to optimize business value in a modernized mainframe environment. We call these organizations "Adaptive Enterprises," and they share these key characteristics:

– Promotion of hybrid architecture approaches, placing workloads optimally across multiple platforms and focusing on seamless integration and data sharing

– Emphasis and valuing of mainframe roles in resiliency, security, and data privacy in IT infrastructure

– Investment in exploring mainframe potential in AI-driven innovation and value creation.

Adaptive Enterprises embrace a hybrid-by-design philosophy and lean into opportunities to innovate on mainframes. Their success translates into business results. For example, Adaptive Enterprises outperformed competitors over the past three years:

– 14% higher revenue growth and effectiveness

– 8% greater profitability and efficiency

– 7% more innovation

– 9% higher customer engagement

– 20% more ecosystem engagement.

# Mainframes
## The backbone of digital transformation

Digital transformation is a top priority for business leaders, with 87% placing it high on their strategic agenda.[7] However, the success rates for these initiatives are dishearteningly low, with around 70% failing to meet their objectives.[8] Contributing to this disparity is the complexity of integrating data and applications, which is exacerbated by the exponential growth of data across multiple systems.

Leading organizations are addressing this challenge by adopting a data-centric strategy that synchronizes mainframe application data with the cloud. By leveraging mainframes as the backbone of their digital transformation, organizations can unlock the full potential of their enterprise data, ensuring real-time access to data for analytics, reporting, and other business-critical applications. This approach is essential, given that 78% of executives agree that mainframe-based applications will continue to have an important role in digital transformation, a significant increase from 66% in 2021 and 64% in 2023.

Modernizing mainframe applications and improving mainframe integration with other computing assets is crucial for successful digital transformation. By doing so, organizations can tap into the vast reservoir of business-critical data that resides on their mainframes, driving informed decision-making, improving operational efficiency, and enhancing customer experiences. The data-centric approach is not just a tactical solution, but a strategic imperative for organizations seeking to thrive in today's digital landscape.

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Mainframes are a vital component of an organization's digital transformation strategy. By leveraging the power of mainframes, organizations can improve scalability, security, integration, and cost-effectiveness, while also enabling innovation and business growth.

# Optimizing tech estates with a hybrid-by-design framework

Today, most enterprises have built tech estates on hybrid cloud architecture. In fact, 91% of IT executives agree that their organization promotes hybrid architectures. With workloads distributed across cloud, mainframe, and edge assets, these environments are flexible, yet highly complex. When hybrid cloud is built piecemeal, or rather by default, it leads to fragmented systems, silos, higher costs and limited innovation opportunities.

A hybrid-by-design framework meets these challenges by intentionally aligning hybrid cloud and digital transformation with key business goals (see Figure 1). With this business-centric mindset, business priorities drive technology decisions instead of tech decisions superseding business needs. On average, just 23% of an organization's tech budget is available to invest in performance improvement for areas that actually produce business income.[9] Hybrid by design promotes a more dynamic allocation of compute resources in response to changing market conditions.
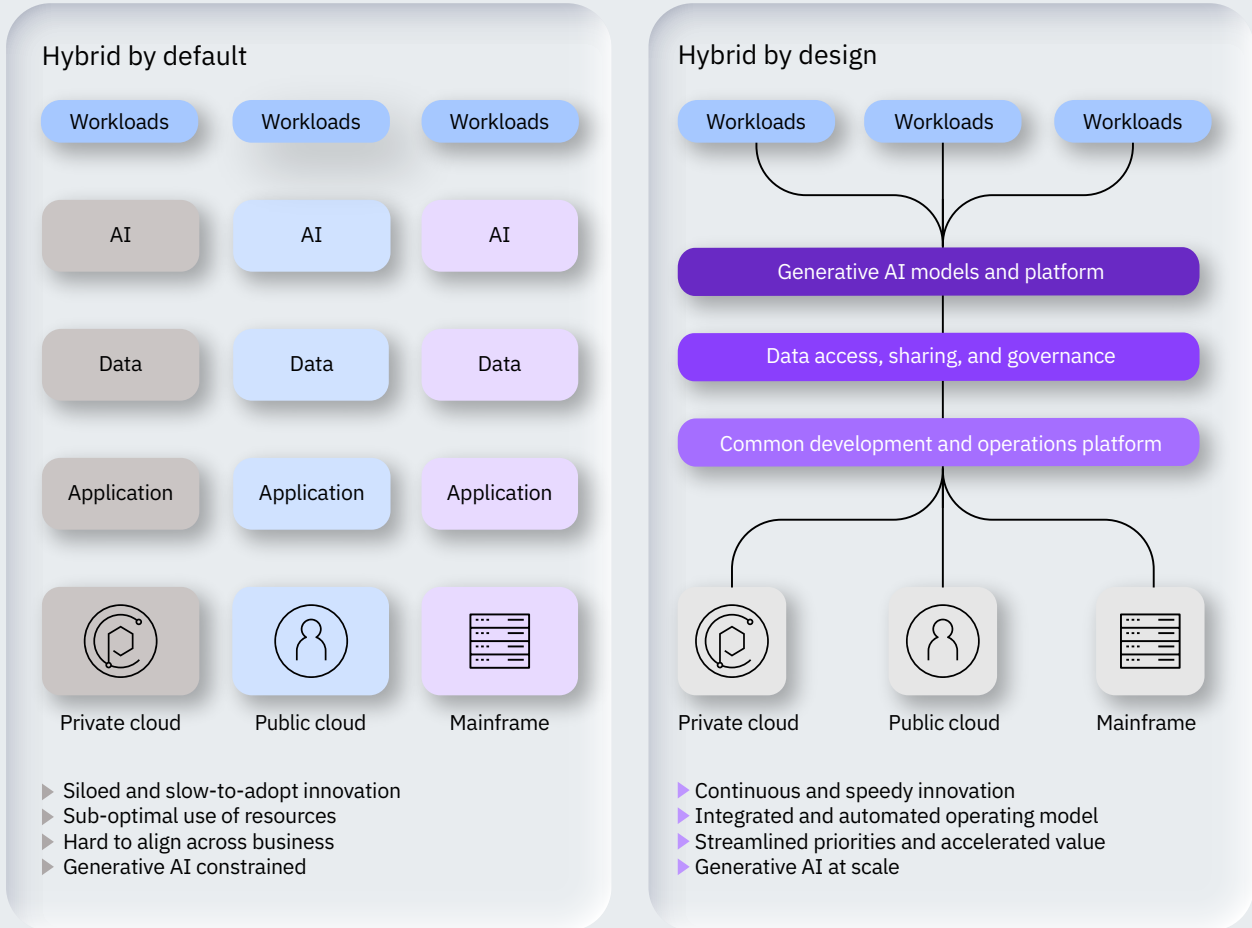
A hybrid-by-design approach recognizes the central role of mainframes in storing and sharing critical data and 81% of IT executives agree, saying it is important for mainframes to easily integrate with other technologies. This intentional and disciplined approach facilitates enterprise-wide integration, allows organizations to leverage mainframe strengths in transaction processing and data security, while harnessing the flexibility and scalability inherent in public cloud-based solutions.

A fit-for-purpose strategy, which enables hybrid-by-design, helps ensure that applications run in suitable computing environments—mainframe, public cloud, distributed, or edge. Mainframes are well-suited for application workloads that require the highest levels of security, reliability, and scalability, such as financial transactions, healthcare records, and government services. Assigning these workloads to mainframes can deliver virtually unequalled performance and efficiency, while helping reduce costs and risks.

Enterprises adopting a hybrid-by-design approach can expect to unlock more than three times higher ROI than a hybrid-by-default approach.[10] Furthermore, hybrid by design improves consistency in sharing skills and data across platforms, as well as consolidating operations and unifying security and compliance policies, with over three-quarters of executives reporting positive results in these areas.

FIGURE 1

How hybrid by design delivers three times higher ROI
than other computing architectures

## Hybrid by default

| Workloads | Workloads | Workloads |
|-----------|-----------|-----------|
| AI | AI | AI |
| Data | Data | Data |
| Application | Application | Application |
| Private cloud | Public cloud | Mainframe |

▸ Siloed and slow-to-adopt innovation
▸ Sub-optimal use of resources
▸ Hard to align across business
▸ Generative AI constrained

## Hybrid by design

| Workloads | Workloads | Workloads |
|-----------|-----------|-----------|

Generative AI models and platform

Data access, sharing, and governance

Common development and operations platform

| Private cloud | Public cloud | Mainframe |
|---------------|-------------|-----------|

▸ Continuous and speedy innovation
▸ Integrated and automated operating model
▸ Streamlined priorities and accelerated value
▸ Generative AI at scale

A hybrid-by-design strategy empowers enterprises to accelerate their hybrid cloud journey, driving faster and more effective digital transformation.

# Modernizing mainframe applications to enable digital transformation

88% of surveyed executives say that modernizing mainframe applications in a hybrid-by-design environment is a crucial step in their digital transformation journey. They recognize that simplifying and integrating information sharing and data access is vital to reap benefits from hybrid architecture (see Figure 2). Combining on-premises mainframes with hyperscalers can create an integrated operating model that enables agile practices and interoperability between applications.

**Top priorities for modernizing applications on mainframes**



1 — Integrate across hybrid cloud

2 — Simplify information sharing and data access

3 — Optimize existing applications

Over half of executives prioritize business criticality when choosing which mainframe applications to modernize. Another 45% identified cost savings as key considerations and 44% pointed to application age and obsolescence as driving factors.

Of all the organizations that modernized applications on their mainframes, more than 90% of executives say that modernization processes met or exceeded their expectations in terms of budget, timeline, and scope, with the median percentage of modernized applications standing at 28%. A further 95% agree that connecting workloads has become easier in recent years, and 85% reported being satisfied with the outcome, citing achievement of their business objectives.

# Mainframe advantages for cybersecurity



In 2024, the global average cost of data breaches reached $4.88 million, up 10% from 2023. A further 70% of impacted organizations reported that breaches caused significant or very significant disruption.[11]

In this threat environment, mainframes prove their mettle. For example, only about one-tenth of one percent of mainframe customers experience data breaches.[12] In recognition of this performance, 63% of executives say that enhanced data security is a key source of mainframe business value. Enhanced data security is the most cited source of mainframe value to executives, surpassing other priorities such as higher system reliability and higher volume of data processing.

Mainframes also provide an environment for AI tools, which can identify shadow data, monitor for data access abnormalities, and alert cybersecurity teams about malicious threats. This enables detection and remediation of issues in real time. 82% of IT executives say that leveraging AI for monitoring, analyzing, detecting, and responding to cyber threats is important to their organizations.

And, as hackers seek to intercept and store vast amounts of encrypted computer traffic—with intent to decrypt this data when quantum computers become viable—modern mainframes encrypt data with quantum-safe algorithms. This precaution is designed to keep vital information safe for decades to come.[13]

The proliferation of cyber threats from nation-state actors, with the resources and expertise to launch devastating attacks, underscores the urgent need for robust security measures.

# Running AI models on mainframe to boost cybersecurity performance[14]

In the US, 60% of credit card holders have been victimized by fraud, and 45% have experienced fraud multiple times.[15] A large North American bank has dedicated significant resources to fight credit card fraud on behalf of its customers. And to stay ahead of today's tech-savvy criminals, the bank decided to modernize its credit card authorization process.

The bank had developed an AI-powered, rules-based credit scoring model and deployed it on an on-premises cloud platform. However, only 20% of credit card transactions could be scored in real time. To reduce latency and have the continuous availability required by its credit card authorization application, the bank deployed complex fraud-detecting AI models on its mainframe system.

Before mainframe implementation, 80% of bank credit card transactions went unscored. Now, the bank can score 100% of its transactions in real time—15,000 transactions per second—leading to significant fraud reduction and increased customer satisfaction.

Each transaction used to take over 80 milliseconds to score. Moving to a mainframe-based solution reduced latency, leading to response times of two milliseconds per transaction or less. In addition, the bank estimates it has saved over $20 million in annual fraud prevention spend without impacting service-level agreements.

**$20MM** savings in annual fraud prevention spend

**100%** scoring of credit card transactions in real time

**15,000** transactions per second scored by AI

# AI and mainframe

A symbiotic relationship for enhanced innovation

Together, modern mainframes and AI drive innovation and create value. IT executives already depend on mainframes for storing and processing business-critical data and transactions—now they are turning to AI for enhanced decision-making, cybersecurity, and systems management. In fact, 79% of IT executives agree that mainframes are essential for enabling AI-driven innovation and value creation, and 84% say incorporating AI into mainframe transactions is important.

Modern mainframes provide robust foundations for AI in-transaction workloads. This is not surprising, given that 78% of IT executives say their organization is either piloting or implementing projects or operationalizing and optimizing initiatives that incorporate AI capabilities into mainframe applications and transactions (see Figure 3).

With integration of AI accelerators on mainframes, organizations can leverage state-of-the-art AI in workloads for virtually every transaction. For example, an embedded on-chip accelerator can scale to process millions of inference requests per second at extremely low latency, which is particularly crucial for transactional AI use cases, such as detecting payment fraud.

Modern mainframes also support Ensemble AI, combining the strengths of traditional models and large language models (LLMs) to make business outcomes more accurate and precise. For example, traditional AI may be used to assess whether a bank payment is fraudulent, and LLMs may be applied to make prediction more accurate.

Organizations can now leverage state-of-the-art AI in mainframe workloads. On-chip accelerators scale and process millions of inference requests per second at extremely low latency rates.

New and advanced mainframe capabilities that support a hybrid-by-design approach for AI workloads enable organizations to scale processing power and effectively use traditional AI models, large language AI models, and new Ensemble AI methods. They also help reduce energy consumption and data center footprints (see Perspective, "Using mainframes to meet sustainability goals").
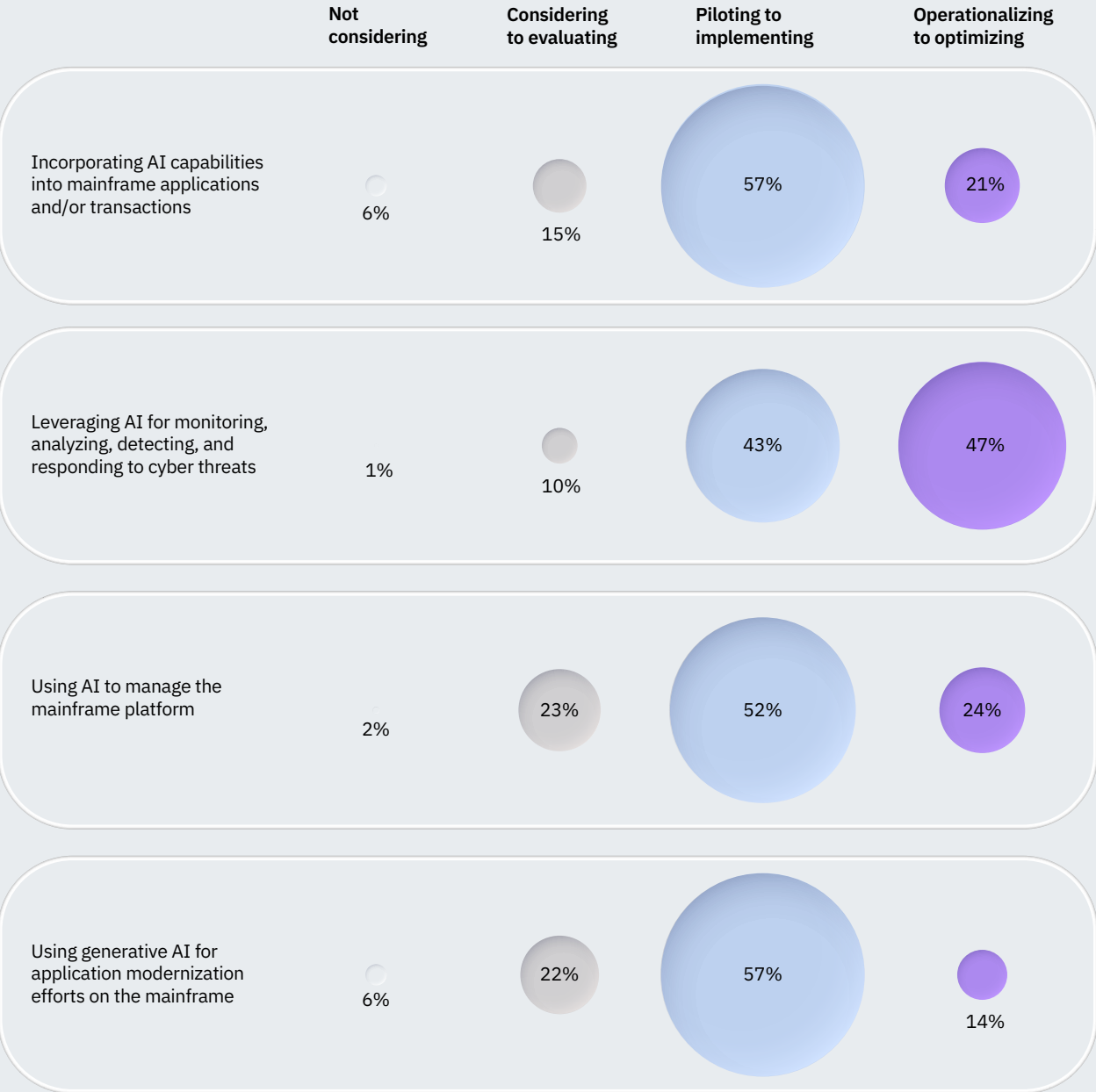
In addition to AI-driven business innovation use cases, organizations also use AI with mainframes for cybersecurity and operations. In fact, 82% of executives cite mainframe importance for monitoring, analyzing, and responding to cyber threats. 90% acknowledge that their organization is piloting or implementing projects or operationalizing to optimizing AI-powered cybersecurity initiatives (see Perspective, "Mainframe advantages for cybersecurity").

And as mainframes continue to play critical roles in many organizations' infrastructures, adoption of AI-powered mainframe management is becoming increasingly essential for innovating in fast-paced digital environments. 74% of executives cite the importance of integrating AI into mainframe operations and transforming system management and maintenance. AI-powered automation, predictive analytics, self-healing, and self-tuning capabilities, can proactively detect and prevent issues, optimize workflows, and improve system reliability.

FIGURE 3

**AI initiatives on mainframes, by phase**

| | Not considering | Considering to evaluating | Piloting to implementing | Operationalizing to optimizing |
|---|---|---|---|---|
| Incorporating AI capabilities into mainframe applications and/or transactions | 6% | 15% | 57% | 21% |
| Leveraging AI for monitoring, analyzing, detecting, and responding to cyber threats | 1% | 10% | 43% | 47% |
| Using AI to manage the mainframe platform | 2% | 23% | 52% | 24% |
| Using generative AI for application modernization efforts on the mainframe | 6% | 22% | 57% | 14% |

**Case study**

# Accelerating mainframe application development with AI[16]

Westfield Insurance, a leading US-based property and casualty insurance company, relies on advanced technology to help balance business needs against industry challenges such as cost and competitive pressures, ever-changing regulations and economic uncertainties. To keep up with the changing demands, Westfield sought to integrate generative AI capabilities to support application development and onboarding of new talent for COBOL/ Assembler/JCL on its mainframe environment.

Westfield conducted a pilot project demonstrating how a code assistant could improve overall developer productivity by using generative AI capabilities. During the pilot, the Westfield developer team saved 150 hours, a 30% decrease in time, while sifting through 47,000 lines of code. An additional 20 hours saved in application discovery analysis equated to time savings of 80%.

The pilot also determined that a gen AI assistant helping the developer to more quickly understand the application and its dependencies as well as streamline documentation could lead to faster onboarding of new developers needing an understanding of business-critical mainframe application. The updated change management and process documentation could also help mitigate misreporting to Insurance Services Office, Inc. (ISO), an industry policy and rating organization.

By using more efficient, time-saving capabilities of gen AI solutions, Westfield can continue to invest in customer-centric activities while reducing costs.

**30%** time savings by using AI assistant to sift through code

**80%** time savings in application discovery analysis

# Developing mainframe talent and closing skills gaps

Mainframe applications, often written in older programming languages, can be complex. Like all applications, they require expert understanding of business logic and data dependencies. This challenge is magnified by an "aging out" of professionals with mainframe skill sets, and limited pools of new mainframe talent.

Nevertheless, many organizations are making progress in overcoming these skill-related challenges by recruiting new talent and leveraging open technologies, contemporary coding languages, and generative AI capabilities. In fact, 63% of executives cite recruitment of skilled mainframe personnel in contributing to closing mainframe skills gaps in their organization, while 53% attribute it to procurement of third-party mainframe services (see Figure 4).

Other research suggests that up to 86% of mainframe executives are meeting their talent requirements.[17] This success is due, in part, to initiatives like the Mainframe Skills Council and other programs supporting development of new mainframe talent.[18]

Today, gen AI-driven application modernization tools are revolutionizing mainframe modernization strategies, accelerating time to value, and closing mainframe skills gaps by enabling developers to modernize or build applications faster and more efficiently. In fact, 61% of executives said using gen AI for application modernization efforts on mainframes is important to their organization.

FIGURE 4

Top factor that most contributed to improving
mainframe skills

Recruitment of skilled
mainframe personnel

63%

Procuring third party
mainframe services

53%

Better training and
education programs

46%

Gen AI code assistants support application
developer lifecycles with discovery and analysis,
code explanation, automated code refactoring, code
optimization advice, COBOL to Java transformation,
and validation.

# Using mainframes to meet sustainability goals



As worldwide reliance on IT systems continues to grow, sustainable operations have become a pressing concern. Environmental impacts related to data centers account for 3% of global total energy use.[19] It's a problem that's only expected to worsen as demand for computing services increases. However, mainframe systems are bucking this trend with their high levels of energy efficiency.

These powerful machines are designed to handle large volumes of data with reduced energy consumption, making them a game-changer for organizations looking to reduce environmental footprints. In fact, consolidating x86 workloads onto mainframes can reduce energy consumption by 75%. This not only saves energy, but also reduces physical space requirements for data centers by 50% and slashes carbon emissions by over 850 metric tons annually for every five machines worth of workload consolidation.[20]

IT leaders are increasingly prioritizing sustainability and mainframes are becoming key elements in their strategies. According to recent research, 89% of executives agree that their organization accounts for the environmental impact of available IT options when making decisions. And 86% say that mainframes can contribute to their organization's pursuit of sustainability objectives.

**Case study**

## Meeting sustainability goals with mainframe computing infrastructure[21]

With over $1.6 trillion in assets and over 600 branches, Citi is one of the largest banks in America and has made sustainability one of its highest priorities. Citi's sustainability strategy is driven by a commitment to advance solutions that address climate change and support transition to a low-carbon economy. Operationally, Citi is also focused on reducing environmental footprints of its facilities.

Recognizing that data centers are energy intensive and can account for a large portion of enterprise energy use, Citi looked for an infrastructure solution that could help meet its sustainability goals, while meeting performance objectives for security and scaling workloads non-disruptively, with cloud-like flexibility.

By consolidating Linux workloads on five mainframe systems, Citi reduced its energy consumption by 75%, space requirements by 50%, and carbon footprint by over 850 metric tons annually for every five machines worth of workload consolidation.

Now, instead of adding more physical servers and increasing floor space to accommodate server infrastructure, Citi is able to vertically scale workloads and optimize data centers while lowering its overall carbon footprint.

**75%** reduction in energy consumption

**50%** reduction in space requirements

**850** metric ton reduction in carbon footprint per 5 machines worth of workload consolidation

# Action guide
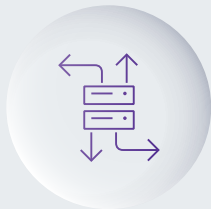
## Be intentional about your IT foundation.

– Commit to a hybrid by design strategy. Optimize business value across your technology estate through an intentional hybrid-by-design approach.

– Modernize mainframe applications. Create an application modernization strategy aligned to business objectives. Assess each application to determine opportunities to lower technical debt and optimize efficiency based on fit-for-purpose. Consider modernization opportunities such as containerization, and refactoring of mainframe applications to improve overall competitiveness, reduce costs, and enhance response to changing business requirements.

– Develop a clear integration and data sharing strategy. Prioritize integration between mainframe and other technologies for seamless data exchange, API connectivity, and workflow orchestration to optimize investments and enable business innovation and agility.

## Lean into AI innovation.

– Empower DevOps teams through gen AI tools. Equip developers with gen AI-assisted tools that accelerate application discovery, analysis, and modernization. These tools can explain code, refactor automatically, provide optimization advice, transform COBOL to Java, and validate code to help streamline modernization at lower cost and with less risk.

– Enhance mainframe operations with AI. Improve operational functions by employing smart aids and next generation chatbot assistants. These tools span linguistic query handling, mechanized duty execution, regular servicing oversight, thus enhancing uptimes and diminishing error rates while allowing humans agents to focus on high-impact assignments.

– Infuse AI into business transactions. Leverage AI for in-transactions insights to enhance business use cases including fraud detection, anti-money laundering, credit decisioning, product suggestion, dynamic pricing, and sentiment analysis.

## Invest in advanced mainframe capabilities and skill sets.

– Leverage today's mainframe capabilities. Exploit new mainframe capabilities, such as advanced encryption and authentication to enhance security, advanced processor chips and specialized AI accelerators to support traditional and gen AI, and new architectures and processing capabilities to improve performance and efficiency and drive greater return on investment.

– Cultivate a diverse and skilled mainframe workforce. Address skills gaps through targeted skilling initiatives, mentorship programs, enterprise standardization and open-source tooling and standards to ensure that mainframe professionals have the skills required to manage and operate in a hybrid environment.

– Upskill with AI for mainframe success. Empower mainframe professionals with AI-tooling, assistants, and collaborative initiatives like the Mainframe Skills Council to drive business success in a hybrid cloud and AI-driven world.

By upgrading to the latest mainframes, organizations benefit from increased scalability and flexibility, enhanced virtualization and containerization support, simplified management and maintenance, and advanced automation and monitoring tools.

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## Study approach and methodology

The IBM Institute for Business Value (IBM IBV), in collaboration with Oxford Economics, conducted a comprehensive survey of 2,551 technology leaders during Q1 2024 to investigate the role of mainframes in the era of hybrid cloud and AI. These leaders included Chief Information Officers (CIOs), Chief Technology Officers (CTOs), Chief Enterprise Architects, Directors and Vice Presidents of Mainframe Infrastructure and Operations, Directors and Vice Presidents of Mainframe Application Development, and Mainframe Application Owners. The respondents represented 27 industries and 25 countries across major global regions, including the US, Canada, the UK, Japan, India, Singapore, UAE, and Australia.

To carry out the study, IBM IBV developed an executive survey questionnaire comprising 27 mainframe-related questions. Oxford Economics conducted a double-blind data collection process over an eight-week period. Research assistants verbally provided survey question and response options and recorded responses from the executives.

A series of persona and cluster analyses were conducted to identify common patterns of responses among respondent groups for questions related to their organization's (1) promotion of a hybrid architecture approach, (2) emphasis on and valuation of mainframes' role in providing resiliency, security, and data privacy in IT infrastructure, and (3) commitment in exploring mainframes' potential in AI-driven innovation and value creation. The analysis revealed three distinct groups, with the "Adaptive Enterprises" group being highlighted in the final report.

By examining the survey results and identifying key patterns, this study provides valuable insights into the importance of mainframes in the context of hybrid cloud and AI-driven digital transformation.

## Contributors

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