



NEW RELEASE

AUGUST 2025

Updated Trend Analysis,
Technology Cost of
Goods Breakdown, and New
Sustainability Analysis



Technology Investment Analysis

Linking IT Choices to Market Leading Business Performance

Commissioned by  **BROADCOM**
MAINFRAME SOFTWARE

How to Optimize Technology Investments for Business Advantage

Global technology spending is approaching \$8.3T annually, with IT spend in the business community reaching peaks of 34% of operating expense across industry sectors. With that much money being poured into technology, it is crucial that organizations manage their technology investments both efficiently and effectively. But upon what basis should you make technology-oriented decisions? More specifically, **how do you evaluate and leverage the right technologies – both longstanding and more recent – to drive optimal business performance?**

To answer this question, Broadcom Inc. teamed up with Dr. Howard A. Rubin to conduct an in-depth, data-driven study. The result was the creation of Technology Asset Class Optimization, an economic construct based on extensive research and analysis by Rubin Worldwide that draws upon data from approximately 2,400 organizations across 20+ sectors. The original report, published in May 2023, first set forth the reasoning and insights from this new discipline, “An Economic Model for Optimizing Technology Investments.” In this revised edition, we include updated statistics coupled with commentary that sheds light on recent trends.

[See Appendix A](#) for a map showing the data points by region.



NEW ANALYSES FOR DETERMINING PLATFORM VALUE: *ROI, Run:Change Ratio, and the Technology Cost of Goods*

This year's report incorporates the findings from several **new areas of analysis**. These additional sections provide new insights on the value organizations can expect to receive from differing IT investment strategies, specifically those that optimize their mix of technology asset classes and those that do not. These analyses look at which IT investment strategies enable organizations to:

- realize greater revenue per IT dollar spent
- devote increased percentages of their IT spend toward transforming the business, and
- achieve the lowest cost per industry-specific transaction, good, or business process run

Technology Asset Class Optimization provides a framework for evaluating and planning technology investments with the same rigor and language used to manage personal financial investments – giving IT executives **a better way to make winning, performance-based investment decisions for their tech stack.**



Dr. Howard Rubin, co-founder and CEO

of Rubin Worldwide, is a pioneer in the areas of digital and technology economics and has built the world's largest database in the field, consisting of business, national, and technology data captured continuously since 1994. With these insights, he monitors technology-economic trends across companies and organizations that account for roughly 20% of the world's GDP and an equivalent amount of technology spending/investment.

Dr. Rubin is personally retained as a strategic advisor by many of the world's largest and most successful businesses and government organizations. He provides competitive calibration via benchmarking and advice on business-technology investment strategy, trends and outcomes.

Technology Asset Class Optimization

In the world of finance, an asset class is a group of financial instruments that have similar financial characteristics and which behave in the same way in the marketplace. Financial asset classes include equities, bonds, cash, and cryptocurrency. Each asset class has its own profile of returns and risks. People and organizations manage their investments by selecting a balance of asset classes, with specific allocations determined by investment goals ranging from conservative to aggressive growth.

The same concept – that of asset classes – can be applied to technology investments.

Infrastructure technology refers to a mixed set of computing, storage, software, and services made up of on-premises infrastructure (such as distributed, mainframe, and private cloud services) and external public cloud. Orchestration of the various platforms creates a unified “investment portfolio.” As in the financial asset class model, each of these technology asset classes has a particular value proposition and can be evaluated in terms of key attributes, risk, business impact, and return on investment (ROI).

(See Appendix B for an explanation of the attributes shown here in the word cloud.)

Technology Asset Class Optimization provides value to IT executives in two distinct ways. First, it offers **deep insights into the technology asset class distribution used by best-in-class organizations** based on actual business performance against industry competitors and relying on standard measures such as infrastructure efficiency and operating margins. Second, it provides a framework that organizations can use to arrive at their own optimized technology investment mix – one designed to meet their unique business performance goals.

Availability
DORA Metrics
Business Operating
Margin Impact **Software**
Automation Maturity **Capabilities**
Information Security **Scalability**
Talent Availability
Environment and
Sustainability Impacts



The attributes of each technology asset class (public cloud, distributed servers, and mainframe) reveal insights tied to critical performance measures.

Attributes		Public Cloud	Distributed	Mainframe
DORA Metrics	Scalability	Moderate - 2x scale growth results in 18% unit cost reduction	Low - 2x scale growth results in 9% unit cost reduction	High – 2x scale growth results in >67% unit cost reduction
	Time to Restore	~3 hours	~3.5 hours	~2.8 hours
	Delivery Lead Time	~7 days	~9 days	~7.5 days
	Deployment Frequency	4	4.8	3.5
	Change Fail Rate	1.5%	1.75%	1.5%
Software Capabilities	Automation Maturity	Moderate	High	High
	Availability	Close to never down	99.9990%	99.99999%
	Information Security	Low – does not meet regulatory requirements for all sectors; low maturity	Moderate – typically meets regulatory requirements	High – most secure and mature of all platforms
	Business Operating Margin Impact	Supports some low-cost IT with margin impact depending on contract factors	None	Highest-margin firms in most sectors use mainframes
	AI/ops & Automation	Moderate	High	Very High
	DevOps & App Development	Moderate	High	Very High
	Security Controls & Monitoring	Moderate	High	Very High
	Compliance & Data Protection	Moderate	High	Very High
	Talent Availability	Moderate	High	Moderate-to-Low
	Environment and Sustainability Impacts	High – massive power draw and water usage	Moderate – similar to public cloud at smaller scale	Low – efficient use of power and resources at any scale

Note: Figures in this table are representative of average or typical deployments.

Specific metrics and performance measures will vary for different organizations based on factors such as configurations, individual contract agreements, and technology currency posture.

Trend Analysis:

Since the first edition of this report was published in 2023, scalability efficiencies have decreased slightly for both public cloud (down from 20% to 18% unit cost reduction) and for distributed servers (down from 10% to 9% unit cost reduction). Simultaneously, there has been an increase in the efficiency of scale for mainframe: over the past year, the unit cost reduction achievable from a 2x growth in mainframe capacity rose from 60% to 67%. These numbers show that mainframe is not only holding its own, but is actually increasing the value it delivers (both in absolute terms and when compared to cloud and servers) as organizations scale up.

(See [page 26](#) for a closer look at the scalability and related cost-effectiveness of different asset classes.)

Tracking Technology Trends

Before we examine how to leverage the different technology asset classes for maximal effect, it is helpful to take stock of three current trends impacting IT planning and investment decisions.

TREND #1: IT inflation is outpacing IT spending

In a first-in-a-lifetime technology event, IT inflation – currently at 4.8% – has exceeded GDP growth, the consumer price index, and global and U.S. inflation. The impact of this trend is driving new technology spending and investment patterns; for most organizations, this high rate of inflation is outpacing the rate of increase in IT spending.

To put this in context, consider that the 2024 projected IT spending increase in the Banking and Financial Services sector is 4.1%. That figure does not even cover the 4.8% inflationary increase in cost for the sector's basic IT components (including compensation, hardware, software, SaaS, cloud, network, and outsourced service).

This same squeeze caused by inflation is being felt by IT decision-makers across industries. For many, it leads to the same, predictable outcome: when budgets are unable to keep up with inflation, new investment suffers.



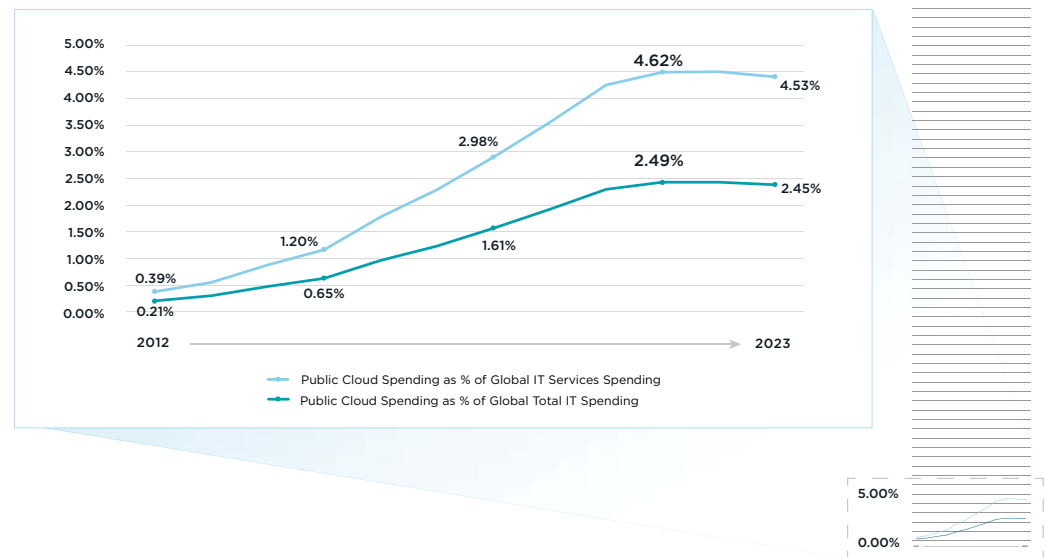
TREND #2: Movement to the public cloud is cooling and becoming more measured

Approximately one quarter of the 4.8% IT inflation rate is due to the rising cost of cloud. This is not an arbitrary cost hike; it has been necessitated by price increases in areas such as compensation, hardware, software, SaaS, networks, and more. Nevertheless, since cloud has long been promoted as a means for organizations to lower their costs, the fact that the technology is getting more expensive, not less, has resulted in a growing level of disaffection with the platform.

This perceived diminution in the promise of cloud is increasingly impacting investment decisions. While cloud continues to be a valuable part of many organizations' hybrid IT environments, organizations are no longer engaging in a rush to the public cloud. Rather, they have become more selective concerning the workloads they decide to move to the cloud. This has resulted in a modest but continued downward shift in cloud spending (measured both as a percent of global IT services and as a percent of global IT spending).

When you compare the revenue attributed to public cloud at Amazon Web Services, Microsoft Azure, Google Cloud, and IBM against **\$8.3** trillion in worldwide IT spend, it does not even reach **10%**.

Public Cloud Spending as a Percent of Global IT Services and Global Total IT Spending - 2012 - 2024



87%

of compute
power is
on-premise

While cloud offers important value, the vast majority of compute power globally – 87% – is still on-premise. Organizations are engaged in a rebalancing act as they assess which platforms are the most appropriate for specific workloads. As a result, some workloads that have been on the public cloud are being repatriated to on-premise platforms. This is due in part to unforeseen costs of running certain workloads on the public cloud and to unexpected expenses from the related efforts to rearchitect and migrate to the cloud.

TREND #3: The value of the mainframe is rising.

Mainframe costs, like all other technology costs, are going up with IT inflation. However, the greater unit cost efficiency of workloads run on mainframe positions the platform as a better value for organizations. This unit cost differential positions mainframe with a de facto cost advantage over cloud, SaaS, and other technologies where the inflationary impact of increased prices ends up being felt more acutely. **The result is that organizations are finding that they gain more value from their mainframe spend, with their costs per transaction on the mainframe being significantly lower relative to other platforms.**

The cost efficiency of the platform incentivizes organizations to continue to choose the mainframe, particularly for their most business-critical and high transaction volume workloads. The platform has always been widely recognized for its scalability, reliability, availability, and security. Now, the mainframe is also frequently seen as a valuable “safe harbor” in the midst of IT inflation turbulence.

The mainframe offers organizations a cost performance advantage on a unit cost basis, positioning it as **a safe harbor that delivers reliable performance without increasing risk.**

Top Performers Have a Hybrid Mix of Asset Classes

With so much riding on an organization's IT, those tasked with steering technology investments often come back to a commonly-asked question: "Is there a single best technology asset class for all organizations?" The rush toward public cloud that played out over recent years and the fact that new businesses are often cloud native, having never owned a server or given thought to a mainframe, make this question understandable but ultimately misguided. More mature organizations can feel tempted – even pressured – to move away from existing infrastructures for no other reason than that they are not as new as the most recent, trending technology. This approach falls into the trap of basing technology investments on what an asset class *isn't* – in this case, "new" – rather than by weighing its value for what it *is*.

The siren song of the "latest and greatest" can be compelling, but the truth is that organizations are relying on a hybrid mix of asset classes. **The priority is making the right technology investments at the right time on the right platform – including mainframe, distributed, private cloud, and public cloud – to achieve the greatest total value.**

Consider again the analogy to financial investing. It would rarely, if ever, be wise for someone to liquify a robust stock and bond portfolio to invest exclusively in cryptocurrency or non-fungible tokens (NFTs) simply because they are a new financial asset class. Why, then, would that make sense for technology assets? Yet those who fail to view their technology assets from a technology economics standpoint can be lured into going all-in on public cloud or other current headline-grabbing technology without examining asset balance or the direct relationship the new technology may have to their specific business performance.

Just as individuals invest in a financial portfolio aligned to their particular growth goals and risk tolerance, **companies should match their mix of technology asset classes to their specific business objectives.**

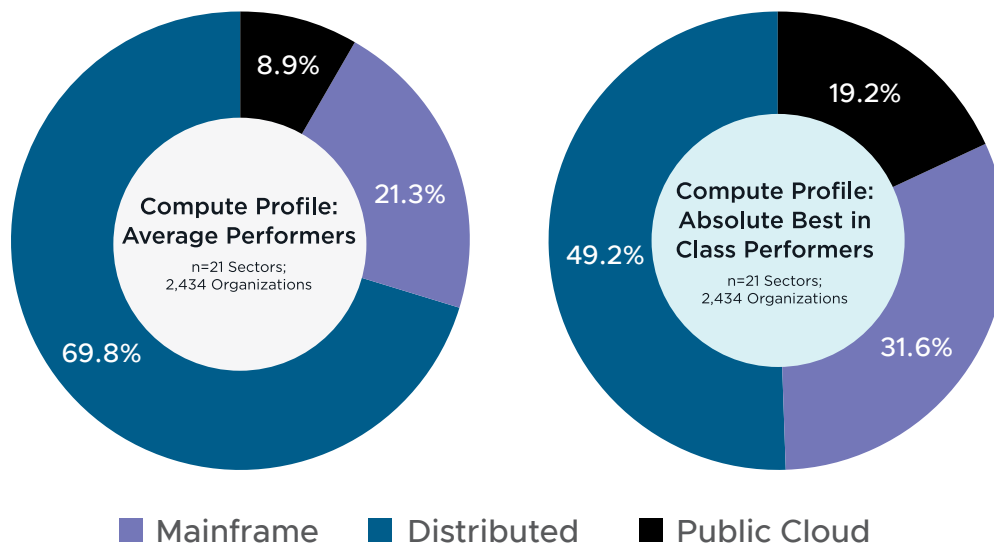
The goal is to achieve an optimized balance of technologies that delivers **the highest value with the greatest economic efficiency** for your organization.

Technology Investment Profiles of Best-In-Class Performers

Virtually all organizations utilize a mix of mainframe, distributed, private cloud, and public cloud assets – a hybrid portfolio. Most aim for a hybrid mix tuned, at least in theory, to their business needs and risk profile. However, when looking at the technology investment profile of average organizations versus top performers in a given industry, clear differences become apparent.

First, consider average performers. These organizations use distributed technologies for a heavy majority (69.8%) of their compute power. Mainframe compute makes up 21.3% and public cloud 8.9% of their tech stack.

Compare that to the profile of the “absolute best-in-class” organizations – those that demonstrate the strongest business performance inclusive of topline revenue, operating margin, infrastructure economic efficiency, availability/uptime, and DORA metrics. Best-of-the-best organizations use significantly more public cloud in their overall IT mix than average performers (19.2% vs. 8.9%), but they also use significantly more mainframe compute power (31.6% vs. 21.3%). In the area of distributed compute, the situation is reversed, with top performers using a lower level of distributed resources than the average performer (49.2% vs. 69.8%).



Compared to average performing organizations, the absolute best-in-class organizations use an overall IT mix with **more public cloud, more mainframe, and less distributed** compute power.

The following table shows how average performers and absolute best-in-class performers in 21 industries compare in their utilization of technology asset classes.

Performance Profile Based on Operating Margin, Infrastructure Economic Efficiency, Availability/Uptime, and DORA Metrics

	IT Economic Profile				% of Compute Activity by Asset Class					
	IT Spend as % Revenue		IT Spend as % of Operating Expense		Public Cloud		Mainframe		Distributed	
	Absolute Best-in-Class	Average Business Performance	Absolute Best-in-Class	Average Business Performance	Absolute Best-in-Class	Average Business Performance	Absolute Best-in-Class	Average Business Performance	Absolute Best-in-Class	Average Business Performance
Banking/Fin. Services	8.52%	9.40%	17.60%	12.50%	13.6%	5.3%	42.0%	29.4%	44.4%	65.3%
Chemicals	0.91%	1.43%	1.58%	1.66%	19.1%	7.3%	32.0%	20.3%	48.9%	72.5%
Construction/Natural Res.	1.40%	1.29%	2.13%	1.49%	20.0%	6.9%	28.0%	16.4%	52.0%	76.7%
Consumer Products	2.56%	2.93%	3.54%	3.54%	18.0%	8.2%	34.0%	22.7%	48.0%	69.2%
Education	5.82%	6.30%	7.18%	6.60%	19.0%	11.3%	27.0%	16.7%	54.0%	72.0%
Energy	0.98%	1.55%	5.99%	2.04%	16.2%	9.5%	23.0%	13.1%	60.8%	77.4%
Food/Beverage Processing	1.91%	1.51%	2.04%	1.97%	20.8%	7.8%	37.0%	24.1%	42.2%	68.1%
Gov't – National/International		0.00%	13.50%	11.02%	15.0%	5.8%	42.0%	31.8%	43.0%	62.5%
Gov't – State/Local		0.00%	8.12%	4.96%	17.0%	5.9%	39.0%	28.7%	44.0%	65.4%
Healthcare Providers	5.18%	4.61%	6.33%	4.80%	16.8%	9.9%	35.0%	26.5%	48.2%	63.6%
Indust. Electronics/Equipment	2.18%	2.56%	3.62%	2.90%	18.8%	7.7%	32.5%	22.9%	48.7%	69.5%
Indust. Manufacturing	1.97%	2.12%	2.65%	2.40%	17.5%	6.8%	36.0%	21.7%	46.5%	71.5%
Insurance	3.69%	3.66%	5.79%	4.20%	18.0%	8.1%	47.0%	33.4%	35.0%	58.5%
Media/Entertainment	5.37%	6.51%	9.42%	8.02%	21.2%	9.1%	26.0%	16.8%	52.8%	74.1%
Pharma./Life Sciences/Med.	3.15%	3.30%	5.20%	4.56%	24.5%	14.6%	31.0%	22.7%	44.5%	62.7%
Professional Services	5.25%	6.06%	9.34%	7.02%	23.5%	14.3%	22.5%	14.5%	54.0%	71.2%
Retail/Wholesale	2.04%	1.80%	2.58%	1.96%	22.5%	9.5%	34.0%	25.6%	43.5%	64.9%
Software/Internet Services	7.49%	8.62%	10.77%	9.03%	27.0%	16.9%	9.5%	6.2%	63.5%	76.9%
Telecommunications	4.73%	5.14%	6.70%	6.00%	16.3%	6.8%	28.0%	19.4%	55.7%	73.8%
Transportation	2.88%	3.30%	4.58%	3.71%	18.1%	6.3%	26.5%	12.4%	55.4%	81.3%
Utilities	3.11%	3.62%	5.62%	4.46%	13.1%	4.5%	35.0%	31.3%	51.9%	64.2%
Average	3.7%	3.6%	6.4%	5.0%	19.2%	8.9%	31.6%	21.3%	49.3%	69.9%

Trend Analysis

Over the course of 2023-2024

- Percent of compute activity for mainframes went up slightly for Best-in-Class performers and down slightly for Average performers
- Percent of compute activity for public cloud went up slightly for both Best-in-Class and Average performers
- Percent of compute activity for distributed went down slightly for both Best-in-Class and Average performers

This cross-industry sector analysis reveals that Best-in-Class performers are continuing to lean into an optimized IT mix with growing percentages of both public cloud and mainframe. Meanwhile, distributed computing, though still representing the dominant percentage in the overall IT mix for organizations across most industry sectors, is gradually losing ground in both Best-in-Class and Average performer categories.

A Global View of Value: Workloads vs. Cost

Even with public cloud and distributed servers comprising the lion's share of global IT environments, mainframes account for as much as 74% of the world's transactional workloads. This represents a 2% increase over the previous year and just 8% of total IT spend. In essence, the platform continues to do more for less when it comes to the heavy lifting of transactional workloads.

The remarkable cost efficiency of the mainframe stands out when contrasted with on-premise distributed servers. In 2023, on-premise servers handled 13% of the world's transaction workloads yet consumed a staggering 65% of total spend. This asymmetry makes it unsurprising that organizations have shifted workloads in search of cost efficiencies: in 2024, distributed servers claim just 11% of global transaction workloads while eating up an outsized 62% majority of total cost.

Technology Asset Class	% of World's Transaction Workloads	% of Total Cost
Public cloud*	4%	15%
Distributed servers	11%	62%
Private cloud	2%	3%
Mainframes	74%	8%
Other	9%	12%

* includes cloud service provider charges and in-house costs

Public cloud sits in between these two asset classes; it decreased in 2024 from 5% to 4% of the world's workloads but increased from 14% to 15% of overall spend. Meanwhile, private cloud experienced a modest uptick in its workloads, handling 2% of all transaction workloads at 3% of total cost. Private cloud's gain came largely from public cloud's loss; organizations have been repatriating applications (and their workloads) to their private clouds due to the higher than anticipated costs of cloud computing.

Mainframes currently account for **74%** of the world's transactional workloads yet only represent **8%** of total IT spend.

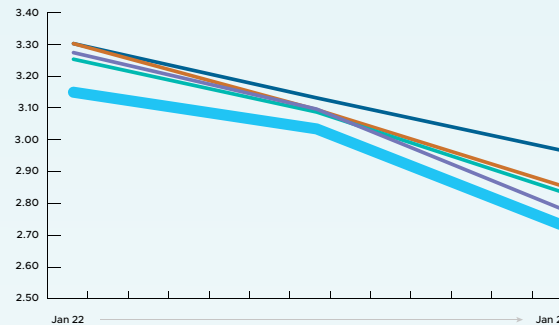
Boost DORA Metrics with Hybrid IT

DORA metrics (named for Google's DevOps Research and Assessment team) are commonly used to measure an organization's DevOps performance. DORA metrics are bellwether measurements that reveal how efficiently an organization can leverage its software capabilities to meet customer, market, and operational demands. The four DORA metrics are:

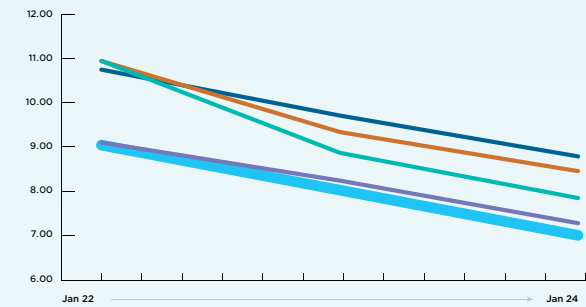
- Time to Restore Service
- Delivery Lead Time
- Deployment Frequency
- Change Fail Rate

The Technology Asset Class Optimization model shows that, while each asset class has its own characteristics, a well-engineered hybrid "mix" of asset classes outperforms any individual asset class in the context of the four DORA metrics.

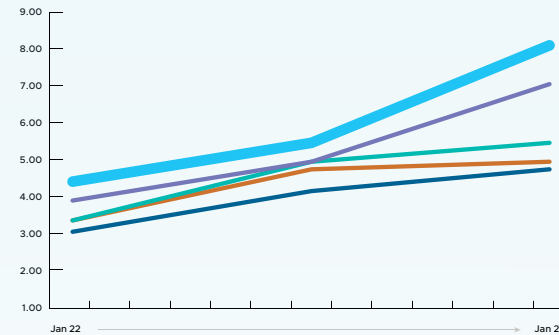
Time to Restore Service



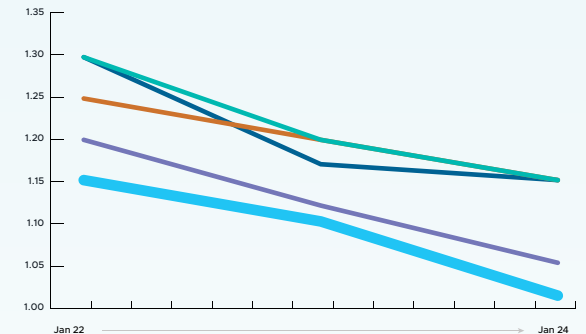
Delivery Lead Time



Deployment Frequency



Change Fail Rate



Distributed



Private Cloud



Public Cloud



Mainframe



Hybrid

By measuring software capabilities, DORA metrics reflect qualities such as an organization's agility, responsiveness, innovation, and user experience. These qualities are critical across industries for sustainable business success. Businesses should take into account the positive impacts a hybrid technology portfolio produces on DORA metrics when making technology investment decisions.

NEW - Determining Platform Value Using Key Fiscal Measures ROI, Run:Change Ratio, and the Technology Cost of Goods

Earlier, we explored how much Best-in Class and Average performers spend on IT as a percent of revenue. Here, we reverse the lens to examine how much revenue these respective categories of performers attain from each IT dollar spent. The results again reinforce how working with the right balance of technology assets can improve the return on your IT investments. In addition to examining platform performance based on longstanding fiscal metrics – revenue per dollar spent and run:change ratio – the report also includes a new first-of-its kind analysis (Technology Cost of Goods) that provides an insightful look at the cost of specific transactions within multiple industries based on the IT mix being used.

Airlines Retail
 Oil & Gas Financial services
 Technology performance **Mainframe**
 Information **Healthcare** Technology investments
 technology Market gains **Cloud computing**
 Utilities Investment performance Railroad
 Investment portfolio Banking
 Global business



Enhancing Revenue per IT \$

An assessment of twelve industry verticals shows that Best-in-Class performers (those who optimize their overall hybrid technology mix) realize greater revenue per IT dollar spent compared to their more average-performing counterparts. In practice, this means those who are running the right workloads on the right platform, including more cloud and mainframe, are getting a better return on their IT investment. This trend is true across industry sectors.

For some industries, like Airlines and Retail, the difference per IT dollar spent is quite substantial. In other industries, like Consumer Banking or Healthcare Providers, Best-in-Class performers continue to hold an advantage over Average performers, but the delta per IT dollar is smaller. Even in these cases, however, the dramatic impact of the advantage is apparent when you multiply the per dollar cost differential by the amount of the industry's total overall IT spend.

	Best-in-Class Performance Revenue per IT \$	Average Performance Revenue per IT \$
Airlines	\$47.62	\$28.57
Banking and Financial Services (Consumer)	\$13.08	\$12.69
Banking and Financial Services (Investment)	\$10.31	\$8.62
Chemicals	\$80.07	\$71.56
Oil & Gas	\$101.92	\$64.64
Healthcare Providers	\$25.36	\$24.06
Insurance (Individual Life)	\$30.30	\$29.40
Insurance (individual Annuities)	\$24.39	\$19.34
Railroad	\$34.68	\$21.88
Retail	\$55.57	\$30.30
Trucking	\$12.26	\$11.52
Utilities	\$32.11	\$27.64

Turning the Run:Change Ratio to Your Advantage

Organizations of all stripes face an ongoing need to balance the efforts and resources they put toward running their enterprise versus changing it. Keeping the status quo can reduce risks, but without change there is no growth. And, in a world marked by constant change, cleaving too closely to the status quo presents its own set of risks.

The run:change ratio is a key performance indicator often used to measure the health of an IT organization. The more resources an organization is able to allocate to change, the better positioned it will be to adjust quickly to rapidly evolving business environments and needs. An analysis across industries shows that Average performers devote a greater percent of their IT spend toward efforts aimed at just running the business – maintaining normal business activities and daily operations, a/k/a “keeping the lights on” – compared to Best-in-Class performers. This leaves them with lower levels of IT investment to devote toward efforts aimed at enhancing their capabilities, launching new projects, transforming operations, and bringing new advances to market than their Best-in-Class competitors. In short, it places them at a disadvantage.

	Best-in-Class Performance Run:Change Ratio	Average Performance Run:Change Ratio
Airlines	64:36	72:28
Banking and Financial Services (Consumer)	56:44	65:35
Banking and Financial Services (Investment)	56:44	65:35
Chemicals	57:43	73:27
Oil & Gas	65:35	72:28
Healthcare Providers	66:34	72:28
Insurance (Individual Life)	58:42	66:34
Insurance (individual Annuities)	59:41	67:33
Railroad	69:31	76:24
Retail	57:43	63:37
Trucking	70:30	74:26
Utilities	61:39	67:33

Reducing Cost per Transaction

An evaluation of the cost of an individual industry-specific transaction (or other comparable metric, such as specific business process run or asset produced) provides another compelling case for the value of an optimized mix of technology asset classes. This study presents an effective snapshot of the Technology Cost of Goods, or TCOG. Across industry sectors, it is clear that the more optimized an organization's hybrid mix of technology assets (running the right workloads on the right platform), the better it will be able to reduce its cost per transaction.

It is perhaps not surprising at this point to find that Best-in-Class organizations outperform their Average peers when we dive down to the granular level. However, this TCOG analysis provides additional insight that shows how it is not the mere existence of a hybrid strategy that yields advantage, but the degree to which that hybrid strategy is optimized.

While Best-in-Class performers will all have hit the optimized IT “mark” (or come close to it) with IT mixes similarly suited to their particular industries, their Average counterparts can miss that mark in different ways. Depending on the nature of the miss, the impact can be greater or lesser. This becomes clear when we examine the metrics for Average performing organizations that rely on the mainframe to run the largest percentage of their workloads (Heavy Mainframe) versus those that depend on the cloud for the bulk of their workloads (Heavy Cloud).



Despite an overreliance on mainframe, Heavy Mainframe organizations consistently outperform those with an overreliance on cloud, or Heavy Cloud organizations. What is more, Heavy Mainframe organizations also consistently outperform the overall set of Average performers. In other words, companies that have not yet optimized their mix of technology assets will generally achieve better cost performance by erring on the side of the mainframe. Relying too heavily on cloud, in contrast, produces the least favorable cost performance.

This should not be taken to minimize the important role that cloud plays in Technology Asset Class Optimization. The lesson to be drawn is the importance of achieving the right mix: an optimized hybrid strategy that matches each workload to the most appropriate platform. As already demonstrated, the cloud is a critical part of the technology profile of Best-in-Class performers. These figures simply emphasize again the value of truly optimizing your IT environment.

	Technology Cost of Goods Metric	Best-in-Class Performance	Average Performance	Average/ Heavy Mainframe	Average/ Heavy Cloud
Airlines	Cost per Enplaned Passenger	\$6.47	\$10.78	\$7.63	\$11.71
Banking and Financial Services (Consumer)	Cost per Mobile Retail Transaction*	\$0.07	\$0.09	\$0.08	\$0.10
Banking and Financial Services (Investment)	Cost per Trade*	\$0.11	\$0.12	\$0.13	\$0.12
Chemicals	Patent	\$41,556.58	\$57,717.47	\$46,637.86	\$48,775.00
Oil & Gas	Per Barrel of Oil	\$1.79	\$2.41	\$1.91	\$2.56
Healthcare Providers	Cost per Bed per Day	\$56.03	\$72.96	\$58.49	\$66.11
Insurance (Individual Life)	Cost per Million Coverages (Ind Life)	\$6.75	\$9.38	\$8.16	\$10.22
Insurance (individual Annuities)	Cost per Million Coverages (Ind Annuity)	\$10.66	\$14.88	\$12.96	\$15.22
Railroad	Cost per Ton Mile*	\$0.0012	\$0.0019	\$0.0014	\$0.0022
Retail	Cost per Store/Door	\$433,191.00	\$542,330.00	\$447,600.00	\$532,432.00
Trucking	Cost per Road Mile*	\$0.16	\$0.20	\$0.17	\$0.20
Utilities	Cost per Megawatt Hour*	\$2.48	\$2.58	\$2.50	\$2.61

*although the monetary difference per transaction is small, the volume/scale is so large that the consequences are significant

The Real Cost of Lift and Shift

It can be tempting to abandon existing technologies in favor of the promise of newer ones – despite the fact that existing technologies are tried, tested, and proven. For example, there was a period of time where the trend was to “move off the mainframe” just because it was mainframe. However, **doing a massive lift and shift to new technology frequently places companies at high risk, jeopardizing quality of service (QoS) while at the same time inflicting substantial cost.** In many cases, migration has reduced a company’s scale and transactional performance and introduced a massive amount of new security problems.

For larger mainframe users, moving mainframe workloads to the cloud could cost in excess of 5x more in total cost of ownership (TCO). This dramatic increase in cost does not even include the expense associated with the migration itself. Nor is the added financial cost the only drawback. This is why, while utilization of public cloud is growing, it is growing at the expense of distributed compute power, not mainframe compute power.

Moving mainframe workloads to the cloud could cost in excess of **5X more in total cost of ownership (TCO)**



Global Commerce Responsibility: How the Platforms Stack Up

While technology investment strategies typically include an assessment of a platform's strengths, such as speed, scale, availability, and security, there is another fundamental consideration that merits attention. That is the overall global business revenue that each platform supports. These macro profiles are a useful means of viewing a platform's overall performance value "forest" beyond examinations of its more specific use case "trees," although both views are relevant.

An analysis of the portion of World GDP that each platform supports is revealing. In 2024, World GDP was approximately \$110T. Of that total, the mainframe supported nearly two-thirds of the economic activity (66.3%), equivalent to \$72.93T. Distributed supported 28.69%, accounting for \$31.56T, and public cloud was accountable for just 5.01%, or \$5.51T in monetary terms. The fact that the mainframe's share of support for the World's GDP significantly exceeds the share of distributed and public cloud platforms combined provides weight to the view of the mainframe as the backbone of economic activity around the world.

\$T of World GDP Supported by Platform

Sector	2024 GDP \$T	% of 2024 GDP	\$T of World GDP Supported by Platform			
			Mainframe	Distributed	Public Cloud	
Agriculture	\$29.70	27.0%	\$14.85	\$13.66	\$1.19	
Industry	\$30.80	28.0%	\$18.48	\$10.47	\$1.85	
Services	\$49.50	45.0%	\$39.60	\$7.43	\$2.48	
Total	\$110.00		\$72.93	\$31.56	\$5.51	\$110.00
\$ of GDP Supported			66.30%	28.69%	5.01%	

At 66.3%, equivalent to \$72.93T, mainframe's share of 2024 World GDP significantly exceeds that of distributed and public cloud platforms combined.

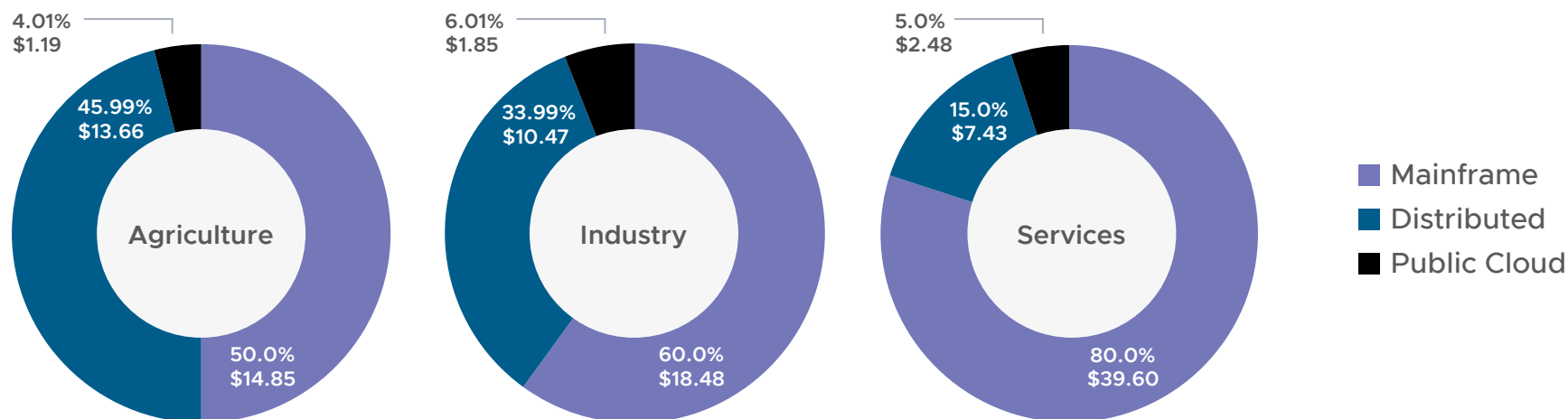
These numbers suggest an IT platform reality that cuts through common perceptions about cloud dominance. While public cloud adoption is still growing, when it comes to the economic systems and applications that underpin and sustain the world's business functions, mainframe and on prem distributed systems remain essential and advantageous.

A closer look at GDP by sector reinforces this dominance. The Services sector—the largest and most complex segment of the global economy—relies heavily on the mainframe, with 80% of its \$49.5T total output supported by the platform.

This sector encompasses industries such as banking, insurance, healthcare, government, transportation, and retail, among others, all of which demand exceptional levels of reliability, throughput, and security at scale. Mainframe's share of the Services sector (\$39.6T) greatly exceeds the contributions from distributed (\$7.43T) and public cloud (\$2.48T).

Mainframe powers 80% of the world's Services sector GDP, spanning finance, insurance, healthcare, retail, and government.

\$T Share of Economic Sectors by IT Platform



In the Industry sector, which includes mining, manufacturing, energy, and construction, mainframe supports 60% of global GDP (\$18.48T of the sector's \$30.8T total), illustrating its sizable role in operational infrastructure. Distributed plays the next largest role, claiming \$10.47T, and public cloud represents \$1.85T.

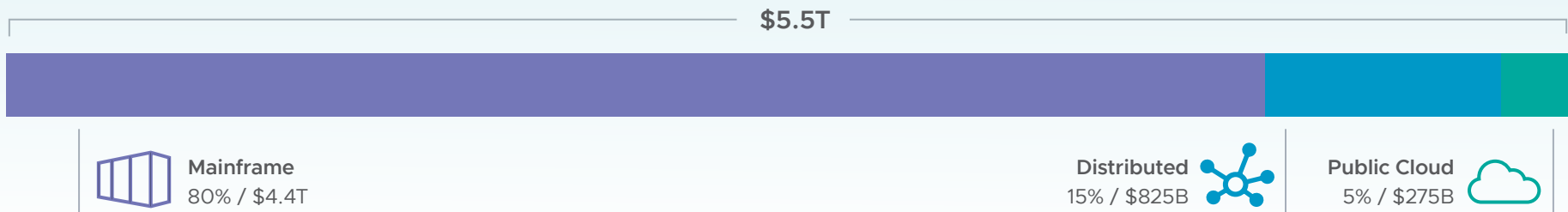
Even in Agriculture—an area not typically associated with complex compute workloads—mainframe supports half of global GDP, with \$14.85T of the \$29.7T sector total. Here again, distributed and public cloud trail, though by a lesser amount with distributed supporting \$13.66T and public cloud \$1.19T.

These percentages are more than symbolic; they represent the actual flow of global commerce. For example, in 2024, U.S. credit card transactions reached \$5.5T. Of that, 80% (\$4.4T) flowed through mainframe systems, 15% (\$825B) through distributed, and 5 percent (\$275B) through public cloud.

Organizations seeking to apply the Technology Asset Class Optimization model to their hybrid IT investment strategy will be aided by factoring in this broad view of each platform's revenue responsibility.



U.S. Credit Card Transactions in 2024 by IT Platform



Striking the Right Balance Is a Question of Value

Organizations are steadily shifting workloads, where appropriate, from distributed servers to other platforms, including public cloud, private cloud, and mainframe. This is in line with the transition from a blanket cloud-first approach to a more sophisticated approach that prioritizes making technology investments based on the best fit for purpose.

In one instance, a large financial institution did a study on what it would take to move away from the mainframe, which serves as the core of its infrastructure. The study showed that such a move would cost \$500M, take approximately 5-7 years, affect 25-57 critical applications, and introduce unnecessary and serious risk without providing any new value. The business realized that its greatest needs at the time were to support increasingly rigorous regulatory requirements and deliver new value to their end customers. Switching platforms could negatively impact both those key objectives. Therefore, the institution determined to leverage its existing technology asset classes and build them out in a way that enabled it to gain the desired value without incurring the cost, time, and risk associated with a lift and shift.

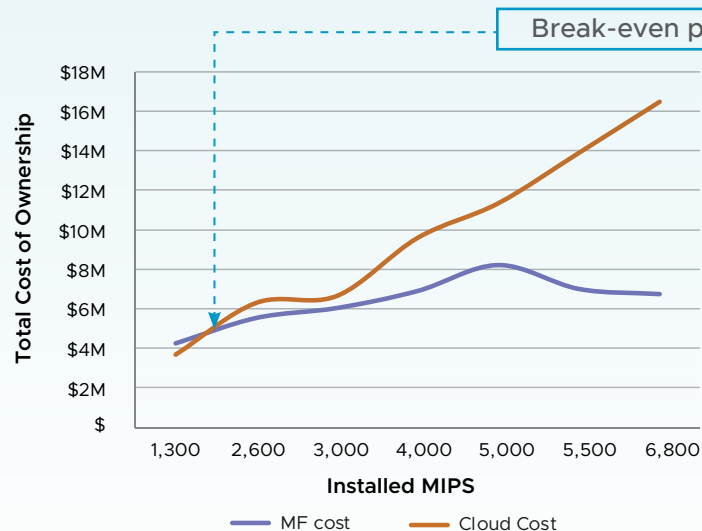
Trend analysis

This institution's decision is typical of the vast majority of organizations today. The top priority is delivering value to customers. As in this example, the way organizations accomplish that goal is by modernizing in place, specifically in a manner that ensures healthy optimization of all technology assets. Technology Asset Class Optimization provides an economic framework that guides and validates the related technology investment decisions. Top-performing businesses assess the technology they already own, identify what they need to add to provide ongoing value for their customers, and actively rebalance their technology stack accordingly. This enables them to refine their hybrid architecture on an ongoing basis to ensure quality business outcomes.

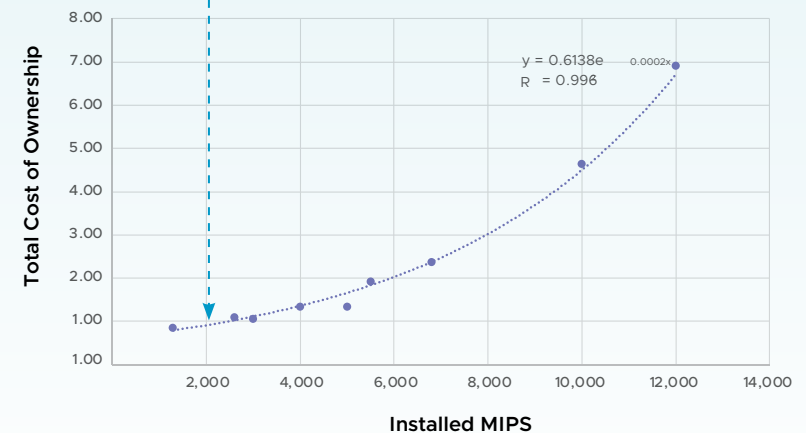
From 2023 to 2024, the breakeven point has come down from 3,500 MIPS to approximately 2,000 MIPS. For anything above this point, mainframe's cost advantage over cloud grows. This is a strong proof point for the cost efficiency and value of the mainframe, particularly as organizations scale.

The graphs below show the cost performance and relative cost efficiency of cloud and mainframe. This data is representative across industries. Each organization's unique metrics could vary depending upon numerous factors.

TCO per Mainframe Native MIPS and TCO per "Cloud"



Ratio of Cloud Cost to Mainframe Native Cost



Three Guidelines to Evaluate Your Technology Costs

Evaluating technology costs and how you pay for assets is a key consideration to take into account when seeking the best balance of your technology investments. Here are three guidelines to keep in mind when considering your IT infrastructure costs:

Understand your contracts and their ramifications.

If you pay a provider for services, you need to have a thorough understanding of your contractual arrangements and how those arrangements work out under a variety of scenarios. Take the public cloud, for example. The payment structure of most cloud provider contracts can make the true cost hard to determine. This can lead to a form of sticker shock where an organization's need to cover unexpected charges leaves it dissatisfied with the platform's promise of cost-efficient elasticity.

Plan for business volatility.

It would be ideal if your business continued on a steady upward trajectory with predictable highs and lows in compute power usage. But, that is not always the case. Whether due to a global crisis like a pandemic, a national recession, or a purely individual business setback, you cannot know what the future holds. For that reason, you need to plan for the unexpected.

As you review your current technology profile and make decisions about where to invest in technology, be certain to play out "worst case scenarios," factor in the importance of business resilience and compliance, and evaluate how specific technology asset classes and your technology stack as a whole will fare in terms of cost and value.



Consider the scalability of each asset class.

Each asset class differs in terms of scalability. As you consider your long-term business growth and the short-term variations in your needed compute power (e.g., due to seasonal highs and lows), you will want to be sure that your technology assets scale appropriately and cost-effectively. With that in view:

- Cloud scalability and cost is governed by contract commitments. This is another reason it is important to understand the contract fully. Additionally, bear in mind that clouds are built on servers, which are costly to scale. The cost of cloud compute power is based on the economics of the vendors and how they purchase and manage their servers. If you work with a hyperscaling cloud provider, a 2x scale growth in cloud usage could potentially result in a 18% unit cost reduction.
- Distributed servers offer moderate scalability. You can continue purchasing processing power, but you end up stacking them in racks upon racks. Overall, as contrasted with a hyperscaling cloud scenario, a 2x scale growth in distributed servers results in just a 9% unit cost reduction.
- Mainframe has the highest level of cost-effective scalability. Mainframe scales easily and well since it is designed as an extendable platform. Over the past year, the unit cost reduction for a 2x growth in mainframe capacity grew significantly from 60% to 67%. Mainframe is therefore not only holding its own, but is actually increasing the value it delivers (both in absolute terms and when compared to cloud and servers) as organizations scale up.

2x scale growth

in public cloud

18%

unit cost reduction

distributed servers

9%

unit cost reduction

in mainframe

67%

unit cost reduction

Engineering the Right Mix of Assets for Your Business

The Technology Asset Class Optimization model provides a blueprint for maximizing the value of your technology infrastructure while optimizing its cost and your overall business performance. The key is to determine the mix of asset classes that is the right match for your organization's profile and needs. This is the technology equivalent of how an investor will balance risk and return through a distribution of financial asset classes in alignment with their investing objectives.

An organization's evaluation will involve individual factors such as how it weighs operational costs, the ability to deliver products to market, value production, customer-facing performance, information security and privacy, and regulatory and compliance concerns. You can also consider factors from a sector perspective.

Research data reveals that each sector has a unique profile in terms of how intensely it prioritizes technology economics, information security, public cloud penetration, and technology talent. For example, Banking/Financial Services holds technology economics and information security as top priorities but puts public cloud usage and investment far down the list. In contrast, the Software Publishing/Internet Services and Food & Beverage Processing sectors give precedence to public cloud. Categorizing which of these four areas are greater and lesser priorities for your organization can help inform your technology asset class selection.



The Potential Environmental Sustainability Advantages from Technology Optimization

Technology Asset Class Optimization brings another benefit to businesses across industry verticals: improved ability to gauge and address their environmental sustainability performance.

Environmental accountability has become an increasingly hot topic across industries worldwide these days, and focus on IT's environmental sustainability – how much energy, water, and other resources a particular technology consumes – has grown along with it. Increasingly, companies are being required to report their carbon emissions, both direct and indirect across their value chain. Businesses must now adopt scalable, reliable, and energy-efficient technologies not only to advance their environmental sustainability goals, but also to meet the escalating array of environmental sustainability-related expectations and disclosure regulations. They are looking to maximize processing efficiency, optimize workload management, minimize energy usage, and reduce their carbon footprint to meet these objectives.

An analysis of data from companies across industries uses their Average Carbon Footprint per Transaction (tonnes of CO₂e per year) as a measure of environmental performance. The measurement encompasses a broad range of metrics associated with carbon production, including energy usage, cooling, server utilization, and building infrastructure / physical footprint. The findings further underscore the overall merits of an IT platform model that aligns with the Technology Asset Class Optimization approach.

Organizations that fully optimize their mix of technology asset classes to fit their unique profile and needs could achieve **a lower average carbon footprint per transaction, which could contribute to the company's environmental sustainability goals.**

Average Carbon Footprint per Transaction (tCO₂e per year)

Large Enterprise >\$100B Revenue

	Transaction	Best in Class	Average	Heavy Mainframe	Heavy Public Cloud
Airlines	Cost per Enplaned Passenger	4,481	5,399	3,819	3,968
Banking and Financial Services	Cost per Mobile Retail Transaction	10,577	12,743	11,097	9,663
Banking and Financial Services	Cost per Trade	20,370	24,543	25,694	26,695
Oil & Gas	Cost per Barrel of Oil	9,192	11,076	13,971	14,515
Healthcare Providers	Cost per Bed per Day	2,350	2,832	4,304	4,472
Insurance (Individual Life)	Cost per Million Coverages	2.07	2.50	4.57	4.75
Railroad	Cost per Ton Mile	269	324	715	743
Retail	Cost per Store/Door	4,648	5,601	14,888	15,468
Trucking	Cost per Road Mile	35,480	42,749	136,916	142,252
Utilities	Cost per Megawatt Hour	52,820	63,640	245,585	255,157

1st best

2nd best

3rd best

4th best (worst)

Medium Enterprise \$20B to \$100B Revenue

	Transaction	Best in Class	Average	Heavy Mainframe	Heavy Public Cloud
Airlines	Cost per Enplaned Passenger	5,745	6,922	4,896	5,087
Banking and Financial Services	Cost per Mobile Retail Transaction	11,752	14,159	12,330	10,737
Banking and Financial Services	Cost per Trade	26,115	31,465	32,941	34,225
Oil & Gas	Cost per Barrel of Oil	10,446	12,586	15,876	16,494
Healthcare Providers	Cost per Bed per Day	2,612	3,147	4,782	4,968
Insurance (Individual Life)	Cost per Million Coverages	2.25	2.71	4.97	5.16
Railroad	Cost per Ton Mile	286	345	761	790
Retail	Cost per Store/Door	5,223	6,293	16,728	17,380
Trucking	Cost per Road Mile	36,577	44,071	141,150	146,652
Utilities	Cost per Megawatt Hour	57,413	69,174	266,940	277,345

1st best

2nd best

3rd best

4th best (worst)

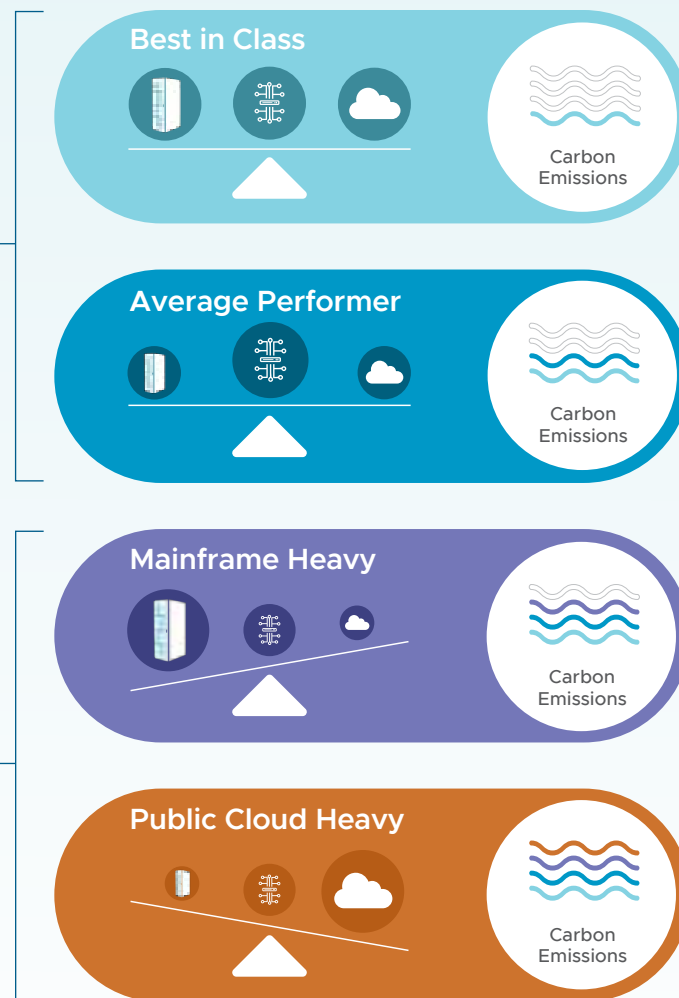
Small Enterprise \$1B to \$20B Revenue

	Transaction	Best in Class	Average	Heavy Mainframe	Heavy Public Cloud	
Airlines	Cost per Enplaned Passenger	6,550	7,891	5,582	5,799	1st best
Banking and Financial Services	Cost per Mobile Retail Transaction	12,692	15,292	13,316	11,596	2nd best
Banking and Financial Services	Cost per Trade	31,338	37,758	39,529	41,069	3rd best
Oil & Gas	Cost per Barrel of Oil	10,968	13,215	16,669	17,319	4th best (worst)
Healthcare Providers	Cost per Bed per Day	2,794	3,367	5,117	5,316	
Insurance (Individual Life)	Cost per Million Coverages	2.48	2.98	5.46	5.68	
Railroad	Cost per Ton Mile	298	359	791	822	
Retail	Cost per Store/Door	5,536	6,671	17,732	18,423	
Trucking	Cost per Road Mile	37,309	44,952	143,973	149,585	
Utilities	Cost per Megawatt Hour	60,283	72,633	280,287	291,212	



Organizations with an optimized mix of technology asset classes (consisting on average of 10% more cloud and 10% more mainframe) achieve a lower carbon footprint per transaction than their average counterparts.

On average, organizations with an IT mix where Mainframe is the dominant platform have lower carbon footprints per transaction than those with an IT mix weighted more heavily toward Public Cloud.



Best-in-Class organizations run the right workloads on the right platforms and tend to invest in 10% more cloud and 10% more mainframe than their average counterparts. Among organizations that either failed to achieve a fully optimized mix or chose not to, those with a profile that was overly Mainframe heavy generally outperformed those with a profile weighted heavily toward the Public Cloud.

The depiction is based on data collected and analyzed by Rubin Worldwide.
Illustrative representation. Images not to scale.

These findings hold true regardless of the size of the organization. When divided into categories by revenue – small: \$1B - \$2B, medium: \$20B - \$100B, and large: > \$100B – the same industry performance trends apply.

Within these broad trends, it is worth noting that, as a general rule, **when organizations increase in size, their efficiencies of scale translate into opportunities for increased cost efficiency**. In other words, organizations with higher revenues overall tend to realize greater cost efficiencies and a lower average carbon footprint per transaction (measured as metric tonnes of CO₂e per year) than their industry peers with lower revenues, even though the benefits of technology asset class optimization apply equally across the board.



Key Insights

Over and above these individual and sector variables, however, Technology Asset Class Optimization provides a cross-sector framework for engineering and implementing judicious and effective technology strategies. The model shows that:

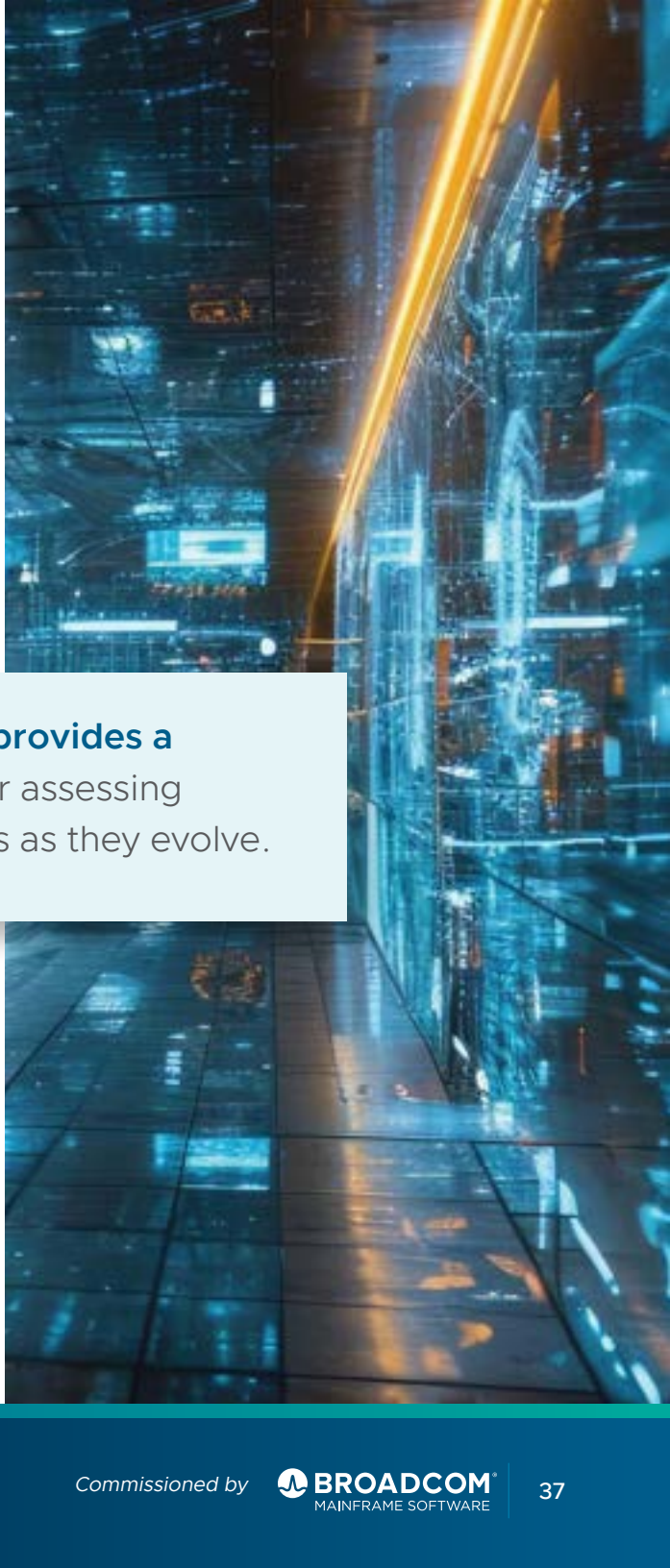
- With IT inflation running high, cloud is getting more expensive, not less, and its usage is still well below that of mainframe and distributed for both average and top-performing organizations.
- The move to public cloud is slowing and becoming more selective as companies look for “safe harbor” options, such as mainframe. This trend is reflected in a modest but continued shift downward in cloud spending (measured both as a percent of Global IT Services and as a Percent of Global IT Spending).
- A hybrid IT stack outperforms any individual asset class in terms of improving the four DORA metrics.
- For top-performing organizations, there is a direct and positive correlation between their tech stack investments and their overall performance relative to others.
- Best-in-class performers are investing 10% more in public cloud and 10% more in mainframe than their average-performing peers.
- For most organizations, the difference in unit cost per transaction in an optimized model can be significant and provide a cost performance advantage on a unit cost basis.
- “Cloud first” thinking needs to be replaced by an approach that prioritizes making technology investments based on the best fit for purpose.

The Future of the Technology Asset Class Optimization Model: Emerging Technologies

New technologies will arise. Generative AI and quantum computing provide prime examples. How will such developments impact Technology Asset Class Optimization? The model provides a blueprint for assessing technologies as they evolve. You can appraise any new technology in terms of its attributes, risks, and cost, and then evaluate the technology based on its potential value. Some of these factors, such as the impact on DORA metrics, only become clear over time as a technology matures and gradually finds its place in the computing paradigm.

The model encourages logic, persistence, and patience. Rather than buying into a new technology in the inflated hope that it will be a “silver bullet,” treat it more realistically as a financial investment. Educate yourself, do your research, and ask probing questions. Envision how the new technology might work in both positive and negative business circumstances. Pay attention to early adopters and track their experience and learnings. Listen to all relevant voices, from public opinion to your industry peers to the regulatory authorities.

For each new technology that emerges, you want to understand how it functions within your business model, how it does or does not support your goals and objectives, and how it interacts with the technologies you already have in place. Only with that data in hand can you decide how the technology may or may not fit into your tech stack. For this reason, **strategically investing in technology scanning, technology labs, and technology prototyping is vital to the continuous optimization of your technology asset class allocation.**



The model provides a **blueprint** for assessing technologies as they evolve.

A Critical Competitive Advantage

Engineering a hybrid IT environment with optimized technology asset class allocation positions your organization with a critical competitive advantage. By applying the insights of the model, you can make technology investment decisions with the same rigor that you would apply in financial investing, leading to improved risk management, maximized return, and greater value.

The model provides you with a clear, concise way to talk about technology investments, compare technology asset classes, and discuss technology economics. Plus, the profiles of best-in-class organizations demonstrate that certain technology mixes consistently outperform others as drivers of business success.

Through the model, it becomes clear that technology asset class optimization is an ongoing process – one that involves a continual assessment of how your current tech stack is supporting your business, how existing technologies are evolving and changing in terms of their capabilities and cost, and how emerging technologies might deliver value for your organization.

While the future cannot be predicted, it can be prepared for. Technology Asset Class Optimization provides you with a framework for making strategic technology investment decisions that deliver the value, economy, and agility you need to succeed both today and for years to come.

Technology Asset Class Optimization provides you with a clear, concise way to talk about technology investments, compare technology asset classes, and discuss technology economics.

Appendix A: Data points by region



Region	Countries per Region	Data Points per Region
APAC	15	372
EMEA	45	901
LA CARIB	17	158
NA	3	996
Total	80	2427

Appendix B: Attributes to Guide Investment Decisions

A substantial part of any investment decision is assessing and balancing levels of perceived risk and potential value. In the financial arena, investors carefully weigh variables such as returns, liquidity, and sensitivity to economic cycles. Among technology asset classes, investors should consider the following attributes:

Attribute	Description
Scalability	The ease with which capacity changes can be made due to volume volatility, coupled with the concurrent cost structure response time
DORA Metrics	Performance in terms of key DevOps metrics: Time to Restore Service, Delivery Lead Time, Deployment Frequency, Change Fail Rate
Automation Maturity	The availability of tools to enhance productivity, reliability, and quality
Availability	The operational profile of providing end-to-end business system and data access
Information Security	The degree to which organizational needs are supported in terms of regulatory requirements
Business Operating Margin Impact	How the cost structure impacts the business bottom line through efficiency and engineered elasticity
Software Capabilities	The availability of mature management toolsets in key domains such as AIOps and Automation, DevOps and Application Development, Security Controls and Monitoring, Compliance and Data Protection
Talent Availability	The job market availability of the needed talent for the successful operation of the environment
Environment and Sustainability Impacts	The degree and manner in which the technology affects the environment and environmental resources



Rubin Worldwide

Founded by Dr. Howard Rubin and Mr. Jed Rubin, Rubin Worldwide leverages the world's largest IT and business database to provide a depth of technology economics research that is unmatched in the industry. As an innovator and leader in the field of technology economics, Rubin Worldwide provides the information and insights global leaders need in order to master technology investment strategies and use technology for significant competitive advantage.

Dr. Rubin and Mr. Rubin have served as senior advisors to corporate and political leaders around the globe while at Rubin Systems, META Group, Gartner, and Rubin Worldwide. Their work has helped leading companies and nations use technology to drive measurable change and continuously enhance performance.



Broadcom Mainframe Software Division specializes in DevOps, AIOps, Security, Data Management, and Core Infrastructure software solutions for vital infrastructure. We enable our clients to adopt common tools using industry standards, integrate Mainframe as part of their hybrid cloud, and partner to drive greater value and overall success with the platform.