THE MAINFRAME TO CLOUD EXPERTS

WHITE PAPER
APRIL/2021

IBM z/OS Mainframe to Google Cloud Platform Reference Architecture Guide

Abstract

In businesses today, across all market segments, cloud computing has become the focus of current and future technology needs for the enterprise. The cloud offers compelling economics, the latest technologies and platforms, and the agility to adapt your information systems quickly and efficiently. However, many large organizations are burdened by much older, previous generation platforms, typically in the form of an IBM mainframe computing environment.

Although old and very expensive to maintain, the IBM mainframe platform continues to run the most important information systems of an organization. The purpose of this reference architecture is to assist business and IT professionals as they prepare plans and project teams to start the process of moving IBM mainframe-based application portfolios to the Google Cloud.

We will also share various techniques and methodologies that may be used in forming a complete and effective Legacy Modernization plan.

In this document, we will explore:

- Why modernize an IBM mainframe
- The challenges associated with IBM mainframe modernization
- An overview of the IBM mainframe
- The IBM mainframe to Google Cloud Reference Architecture
- An overview of Google Cloud services
- A look at the Astadia Success Methodology

This document is part of the Astadia Mainframe to Cloud Modernization Series that leverages Astadia's 25+ years of mainframe platform modernization expertise.

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Introduction

The Google Cloud computing platform is an excellent target environment for transitioning from an IBM z/OS mainframe workload to a cloud implementation. With the security features of Google Cloud and the ability to scale based on demand for the services, Google Cloud offers a complete operational environment in support of z/OS mainframe workloads that have been migrated to the Cloud. In addition, Google Cloud supports new innovation of the application portfolio, previously held captive by the inflexible nature of a z/OS mainframe computing model, improving the productivity of application developers and support personnel.

Even more than a typical IT project, planning to modernize IBM z/OS mainframe applications is the most important phase of the total project effort. A good place to begin is with a thorough assessment of the existing overall IBM mainframe application portfolio. Through the assessment process, all aspects of the existing portfolio will be inventoried and examined in detail, resulting in a catalog of each application, database, technology platform and business user profile currently in use. Once completed, the results of this application rationalization will then guide the sequence of application migration, as well as the different modernization strategies and techniques that may be called upon over the course of the entire project. We've included an overview of how Astadia tackles Legacy Modernization projects with our Success Methodology to give you an idea of what's involved.

Don't let the enormity and importance of an IBM z/OS mainframe modernization project deter you from getting started. The skilled individuals needed to continue to maintain mainframes are increasingly leaving the workforce through retirement and are not being replaced. Hardware and software maintenance costs continue to escalate and the demands of customers, employees and partners require greater innovation than IBM z/OS mainframe platforms can support.

How to Use This Reference Architecture Guide

Begin by reading the "Why Should I Migrate" section first. From there:

- Mainframe Experts: Skip to the IBM z/OS Mainframe to Google Cloud Reference Architecture and the Understanding Google Cloud sections.
- Google Cloud Experts: Start with the Understanding IBM z/OS Mainframes section, followed by the Reference Architecture.
- Business Leaders: Spend time with the "Why Should I Migrate…" section and the Ensuring Project Success section at the end.

ABOUT ASTADIA

Astadia has been in the legacy modernization business since 1994 and has successfully completed more than 200 mainframe modernization projects. Our repeated success has allowed us to develop a comprehensive methodology, proprietary software tools and techniques, as well as the "know how" that comes with more than 25 years of experience handling mission critical applications and data. We're pleased to share some of that experience with you through our Mainframe to Cloud Modernization Series of reference architectures, webinars, whitepapers and more.
Visit our website at www.astadia.com for additional information.

Why Should We Migrate Our IBM z/OS Mainframe Applications & Databases to the Google Cloud Platform?

Over the past 10 years, public cloud computing has emerged as the foundation of future enterprise technology. In terms of technology generations, mainframes are at least two generations old, perhaps three. Yet, they still survive today and are responsible for running key financial, healthcare and other vital and sensitive systems around the world.

So, why should you migrate your IBM z/OS mainframe workloads, why migrate them to the Google Cloud and why is now the right time?

Benefits of Mainframe Modernization

The specific benefits in moving any IBM z/OS mainframe workload will vary between organizations and even at the application and database level. In general, here are three of the top reasons driving legacy modernization projects today:

Cost – The economics of Google Cloud computing are compelling when compared with the status quo of maintaining an IBM z/OS mainframe environment. A total cost of ownership (TCO) evaluation of the subscription-based, consumption driven cost model of the Cloud versus the exorbitant hardware & software maintenance costs of mainframes will show a very appealing and short-term achievable ROI (potentially less than 12 months from project completion).

People – IBM z/OS Mainframe-specific technical skills are not being replaced by today's college or technology trade school graduates. The pool of available talent with relevant knowledge and experience is shrinking exponentially each year. The Google Cloud leverages modern technology and its use is ingrained into young software engineers worldwide.

Flexibility – The Google Cloud offers an Open Systems environment in which high productivity and rapid innovation happen at a tremendous rate. A properly designed implementation of a Google Cloud infrastructure scales easily and quickly, both expanding and collapsing to synchronize with business demand. Backup, redundancy and disaster recovery is seamless. Support for multiple end-user platforms and devices is inherent. Database sharing across the enterprise with high performance is achievable.

Approaches to Mainframe Modernization

You may notice throughout this document that we use the terms "Mainframe Modernization" and "Mainframe Migration". Migration is a type of modernization, whereas modernization encompasses a broader set of strategies or options. In many cases, you will employ a combination of these strategies, the right mix of which ones will be determined during the critical application portfolio rationalization step of the project's assessment phase. Here are three of the most common approaches:

Replatform – Often called "lift and shift", this is a process that reuses the existing code/program/applications, typically written in COBOL, by moving them off the mainframe, and recompiling the code to run in an IBM z/OS mainframe emulator hosted in a Google Cloud instance. This approach minimizes the upfront risks and the length of the project, realizing hardware and software cost savings soonest.

Running IBM z/OS mainframe applications in a Google Cloud-hosted emulator also opens the possibility of new innovation leveraging APIs to previously inaccessible programs and data.

ReFactor – In many situations, moving to a Cloud platform is best when the application code is automatically transformed to Java or C#. These programming languages are Object Oriented languages and are better suited to Cloud-based applications. There are many ways to accomplish this, but the goal is to get from a procedural language like COBOL, to an Object-Oriented platform. This process will involve millions of lines-of-code, so automatic transformation is the only practical strategy. Manual rewrites are not practical in time, cost and human error terms.

Rewrite – It may be tempting to say, "Let's just write new programs from scratch," to modernize the IBM z/OS mainframe applications. This approach is extremely risky and fails a vast majority of the time. It is complex, costly, and time consuming. The resources and investment required tends to greatly exceed the forecast.

A new, modern codebase may still be the correct end objective, but a better approach would be to first move the applications to a Google Cloud-based emulator, migrate the database to a Google Cloud-based database, then focus on replacing modules/code over a deliberate, multi-phased approach. When it is time to rewrite, there are several code transformation engines you can choose from to reduce the effort and minimize the risk.

Replace – Another IBM z/OS mainframe modernization approach is to completely replace the mainframe functionality with a program or suite of programs, typically a Software-as-a-Service (SaaS) application. You typically see this with purpose-built solutions for finance, human resources, manufacturing, enterprise resource planning, etc. There are also industry specific apps that may solve the problem that a custom IBM z/OS mainframe solution was needed for decades ago. The upside of using SaaS is that your organization no longer worries about maintaining code. However, you will find that while you can configure a SaaS application with various options provided by the vendor, you will not be able to customize your instance, as the shared codebase runs all tenants (customers/organizations) using the "service".

Retire – In some cases, it might sense to simply retire an old application. You may find that the application is no longer useful, and there are other ways to get the same information. This becomes cost/benefit analysis, as the overhead involved with maintain an entire application can be expensive.

There are additional variations on these five modernization approaches and you'll likely use several strategies in achieving your goal to completely migrate from the IBM z/OS mainframe. It is commonly accepted best practice among legacy modernization practitioners to primarily use the lower-risk, lower-cost RePlatform approach first to capture the gains and benefits in the shortest time possible, followed by a deliberate and phased approach to Refactor, Rewrite or Replace the applications.

Challenges of Mainframe Modernization

Mainframe migration projects are complex and require close management of the process, budgets and timelines that have been set as project goals. A Reuse approach will involve replatforming (from an IBM z/OS mainframe to the Google Cloud) and likely some re-engineering and refactoring to complete an entire IBM z/OS mainframe migration. It will also involve data and file conversions for transitioning the mainframe databases to the Google Cloud database platform.

As we've been emphasizing, the first challenge of any IBM z/OS mainframe modernization project is to develop a rock-solid plan built upon a thorough application portfolio assessment and rationalization. As you put your plan together and begin to execute, here are additional factors you'll need to watch out for:

Documentation

Many IBM z/OS mainframe environments with large and complex application portfolios do not have documentation that details what these IBM mainframe applications do, and how they do it. Many applications are decades old, so the original system, with changes likely every year, has become a maintenance challenge. The external interaction with these systems, the Input/Output, is how these systems get defined to the business, and the rest of the system is just a black box.

Migrating a minimally documented system of this nature is tricky and the testing prior to the "go live" deployment is critical to mitigating this issue. (And, of course, copious documentation should be captured for the resulting new target system).

Application-Specific Challenges

There are a couple of general points about the application portfolio that should be noted. As mentioned above, the lack of documentation on these aging systems makes the migration effort more difficult. The project team that drives a migration project must then resort to "mining" the business rules from the actual application source code to determine exactly the behavior of the application.

Another important application-specific issue for consideration is discovering the integration requirements and dependencies of the application with other systems and databases. These integrations and dependencies must be clearly identified and, if still needed, they must be re-connected (possibly rebuilt manually) and made operational along with the migrated system.

Running Parallel Systems

For a short while, there may need to be some parallel processing between the IBM z/OS mainframe application, while it is still being used in production, and the newly migrated system, on the new platform. Planning and executing this parallel processing will be a challenge, and will require extra time and attention to make it successful.

Another example of when you may choose to run parallel systems is if you want to achieve quick reductions in IBM z/OS mainframe processing consumed by moving the development and test environments to a Google Cloud while keeping the production system on the IBM z/OS mainframe for the interim. This strategy will enable a move into a DevOps style of computing, along with a Test Automation and CI/CD operation.

Data Integrity

Moving the contents of large databases is very challenging on a number of levels. Typically, a database "cleanup" will be necessary to ensure that the contents of the new target database is as accurate, and as complete, as possible. An IBM z/OS mainframe modernization project is a good time to transform, correct and validate the organization's data.

Speed to Completion

In almost every project, speed will be a top priority. The costs and complexities of extended project cycles can have an enormous negative impact in tangible and intangible terms. As project cycles get extended, staff attrition can become a big issue and staff fatigue may also become a factor.

Paying for a continuation of the primary production system and funding the development efforts of the new system at the same time will have a temporary financial impact for as long as that duality continues. Getting to a "go live" status quickly and efficiently with the new system, and retiring the old system, will keep unexpected costs to a minimum.

Project Funding

It is very important for any modernization project to be properly funded and supported by the business management team and the executives. This support is essential to maintain project continuity and funding throughout the project cycle. Since we stated earlier that speed will be a factor in the project execution, funding must be in place to sustain that speed.

Expertise

IBM z/OS Mainframe migration projects come in many forms. In every case, a variety of specialist skills will be needed on the project team. These specialists may include business analysts working to "harvest" and understand the business rules embedded in the legacy applications.

It will also include experts in specific programming languages, databases, networks, terminal devices and many other components of the total application portfolio that will need to be addressed over the course of the migration to the Google Cloud Platform. Staff must also be available to address any specific functionality or use case of the IBM z/OS mainframe application environment.

All this technology must be transferred to the equivalent functionality on the target Google Cloud Platform and work as it did in the original IBM z/OS mainframe environment. Thorough testing by the project team, followed by testing amongst the business users of the original IBM z/OS mainframe application system, is an absolute requirement. Once testing is completed, a final performance and tuning (P&T) exercise will ensure that the new Google Cloud deployment is performing at optimal levels.

Organizations keep discovering new and improved benefits for moving their IBM z/OS mainframe (as well as other) workloads to the Google Cloud such as flexibility, scalability, automatic backups, automatic software upgrades, cost model optimization, versioning control and adding multiple security layers, just to name a few.

The Google Cloud is a recognized leader in the public cloud segment with a diverse customer base and a broad range of use cases. They also have the largest compute capacity in use by paying customers. This attracts open source and application developers as well as service providers to make their applications compatible or add their services to the Google Cloud.

THE BENEFITS OF MIGRATING YOUR IBM Z/OS MAINFRAME TO THE GOOGLE CLOUD ARE:

Easy to Use – Google Cloud is designed with simplicity in mind. You can request new services and host your applications using the "simple to use" web-based Google Cloud Management Console. All the services are well-documented and there is a wealth of forums, white papers, and discussion boards.

Flexible - You can select from a wide variety of virtual environments where you choose the software and services your application requires. If you find that the environment selections are not adequate, you can simply provision different types of instances or add compute and/or storage on demand.

Cost-Effective – Google Cloud services are billed in a consumption model, where you only pay for the compute and storage resources you use with no upfront commitments and contracts. Alternatively, if you know you have a minimal level of needs, you can sign longer-term contracts for additional savings.

Reliable - With the Google Cloud, you are taking advantage of its highly redundant, worldwide computing infrastructure that is built to guarantee high availability that rivals or exceeds what you have come to expect from IBM z/OS mainframes.

Scalable – the Google Cloud includes features such as Auto Scaling and Load Balancing which allow your application to scale up or down, if you design/architect this into your solution. Google Cloud's massive compute and storage infrastructure guarantees that resources will be available when they are needed.

High Performance – Google Cloud offers a wide selection of compute and storage options to replicate or exceed the performance needs of your formerly IBM z/OS mainframe-based applications. Compute and storage can be provisioned as they are needed, so if your application is CPU intensive you can have a larger CPU/I-O ratio and vice versa.

Secure – Google Cloud provides several security capabilities and services to improve privacy and network response. These include network firewalls, Google Cloud Virtual Private Cloud (VPC), encryption in transit, and private or dedicated network connections.

Achieving the Positive Impact of Change

In any IBM z/OS mainframe migration project, the results of a cloud-based application set may be daunting. The change will impact the technical staff, as they will likely need to learn new skills.

The end-user community may not notice too many changes using a new system if the interfaces are preserved. In fact, the move to the cloud could fuel innovation resulting in new capabilities down the road, which are likely not available to IBM z/OS mainframe users today.

The overall impact of a successful IBM z/OS mainframe migration project is a positive one for the entire organization. A new and better application portfolio, a cloud platform to enable innovation, and a large cost savings in the operational and systems software maintenance categories will be realized. It's not unusual to repurpose IT staff after redeploying the IBM z/OS mainframe portfolio to the cloud. The Google Cloud Platform has many other benefits, but flexibility, innovation and cost takeout are at the top.

Understanding Typical IBM z/OS Mainframe Architecture

Since their development in the late 1940s, general-purpose IBM mainframes were the computing workhorses for more than 50 years. Over that time, each IBM mainframe has been continuously enhanced such that their unique architectures outperform competitors and meet evolving business demands. IBM eventually dominated the market and became the gold standard of mainframe computing. This **IBM z/OS Mainframe to Google Cloud Reference Architecture Guide** is part of the *Astadia Mainframe-to-Cloud Modernization Series* of architectures, whitepapers and webinars.

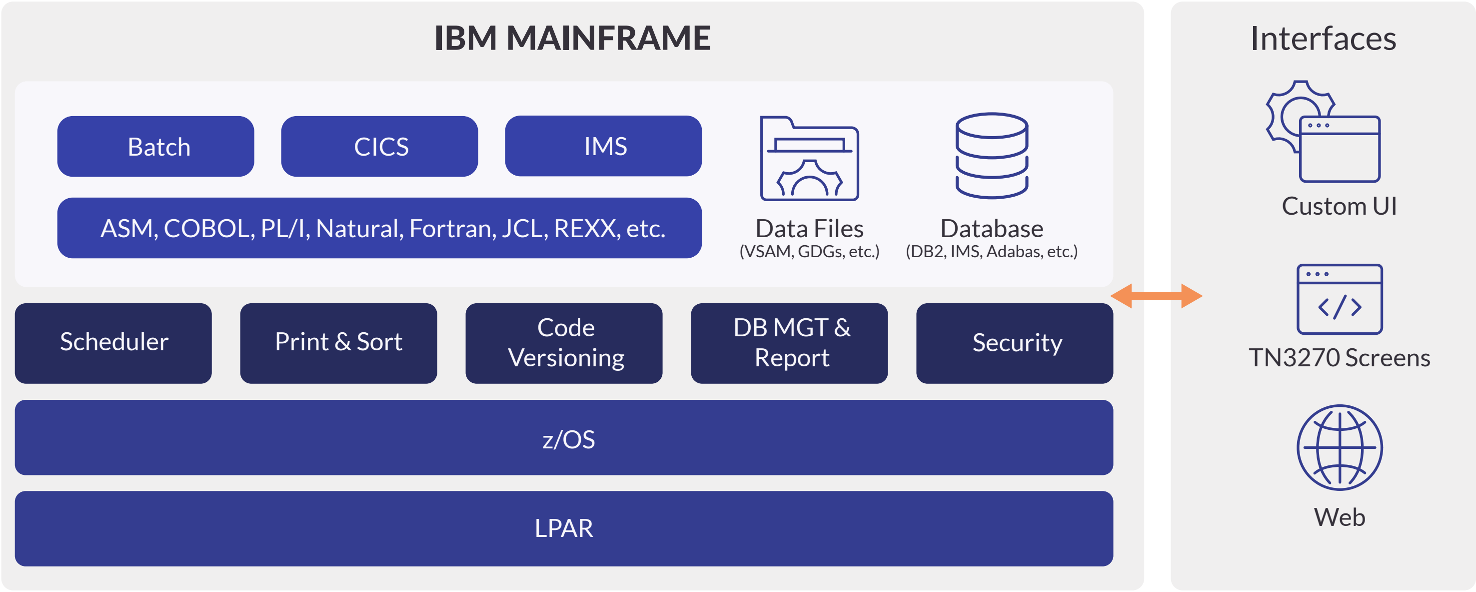
IBM Mainframe Heritage

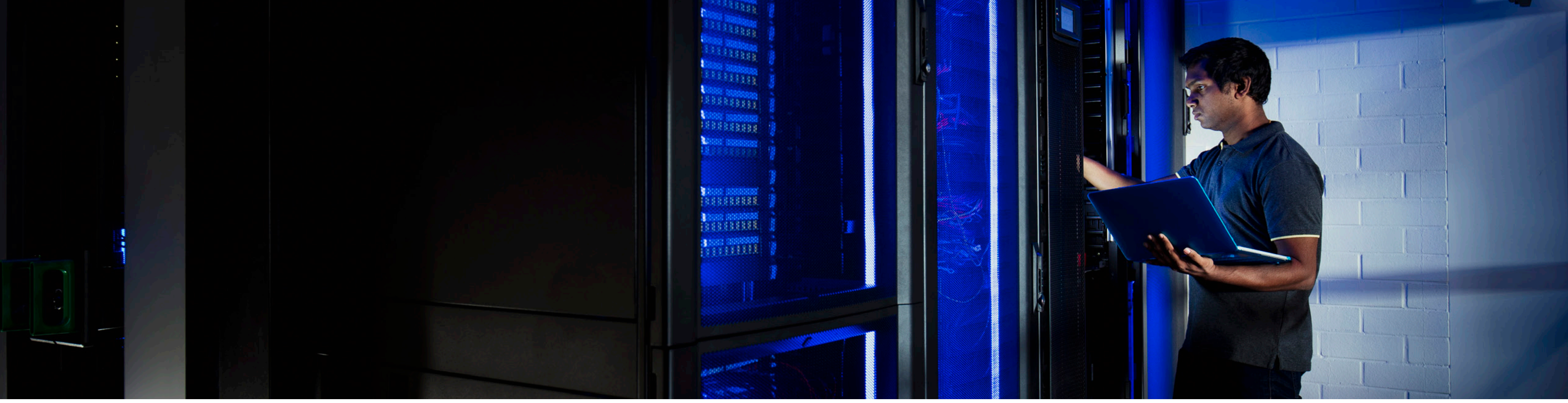
IBM began producing mainframes in 1952. These early models, known as the IBM 700 Series, were based on vacuum tube technology. The next generation, IBM 7000 Series, saw the introduction of transistor technology and became the mainstay of their mainframe business for many years, with some models remaining in service up to the 1980s.

In 1964, IBM announced availability of the System/360, with the "360" representing the idea of 360 degrees – as in, an all-around computing system. Previous IBM mainframes were delivered with no software since it was expected that the customer would write all programs. These programs were loaded and executed manually, one at a time. With the release of the System/360, IBM delivered software such as compilers for programming languages (e.g. COBOL) and early operating systems. Instead of these very expensive machines sitting idle while operators loaded jobs manually, programs could be executed using a queuing mechanism to improve efficiency and ROI. IBM-provided software quickly grew in its complexity and became an important piece of IBM mainframe computing solutions.

The System/360 also consolidated support for processing features, like decimal arithmetic, floating-point arithmetic, and byte addressing. These features were previously available only in models built for specific purposes like business or scientific calculations.

As technologies and software advanced, newer models were released as System/370 and System/390, culminating in the 64-bit eServer zSeries, z Systems, and IBM's current line of zEnterprise mainframes. The "z" refers to "zero downtime" since the models are built with components that provide hot failover capabilities.





IBM Mainframe Components

USER INTERFACES

Users access the mainframe application through a variety of means. They could use green screen terminal emulators that provide character mode interface (TN3270).

Alternatively, a variety of custom user interfaces could be built on top of the character mode interface that allows a more user-friendly interface to IBM z/OS mainframe applications. One such user interface could be a web-based or mobile application serving as a front end to the IBM z/OS mainframe.

BATCH

IBM z/OS mainframes provide batch environments that handle bulk data processing workloads. Jobs are submitted to the system using JCL and processed with minimal operator interaction. Output from the batch jobs is spooled, printed and distributed to users.

TRANSACTION PROCESSING

Transaction processing is at the core of most mission-critical applications with thousands or millions of transactions being processed daily. IBM z/OS mainframes provide online (real-time, on-demand) processing environments (most commonly, CICS and IMS/DC) that make this possible. Security, transaction integrity, and predictable response times are of particular importance for this type of workload.

PROGRAMMING LANGUAGES

IBM z/OS mainframes provide an assortment of programming languages to suit customer needs. Most applications are written in COBOL but other languages are also used: IBM Assembler, PL/I, Software AG's Natural, Fortran, REXX, etc. 4GL development products like Cincom's Mantis, Informix 4GL, and APS (AppMaster) are also used to develop IBM z/OS mainframe applications.

DATA FILES

Mainframes store data in files with different record organizations and media types. Data files can be sequential, direct access, fixed and variable lengths, blocked or unblocked, etc. Data files can be stored on disks, magnetic tapes, CDROMs, etc. Some examples include VSAM and ISAM. For the most part, data in these files are stored in EBCDIC (Extended Binary Coded Decimal Interchange Code), an eight-bit character encoding system used primarily on IBM and Unisys mainframes.

DATABASES

IBM z/OS mainframes provide high performance database management systems to support online mission critical applications. In general, these databases can be hierarchical (IMS/DB) or relational (DB2), and they provide high levels of availability, integrity, consistency, reliability, security, and auditing.

Database software makes intensive use of the computing and input/output capabilities of the mainframe to provide optimal response times. IBM offers specialized processors for database workloads to reduce the burden on general processors.

ENVIRONMENTAL SOFTWARE

IBM mainframes require software to support the management, operation, application development, and security of the system.

Software tools like IBM's Time Sharing Option (TSO) and Interactive System Productivity Facility (ISPF) are used by administrators and programmers to create, store, print and delete datasets as well as submit batch jobs.

Job scheduling software is used to automate and manage batch job execution and workflow streams. Output management systems handle the collection, storage and distribution of reports to users. Source management systems are used to maintain application source code by tracking version as well as release lifecycles.

Terminals and terminal emulation software allow users to interact with mainframe software and applications. The 3270 communication protocol is used to communicate between the IBM mainframe and a terminal session.

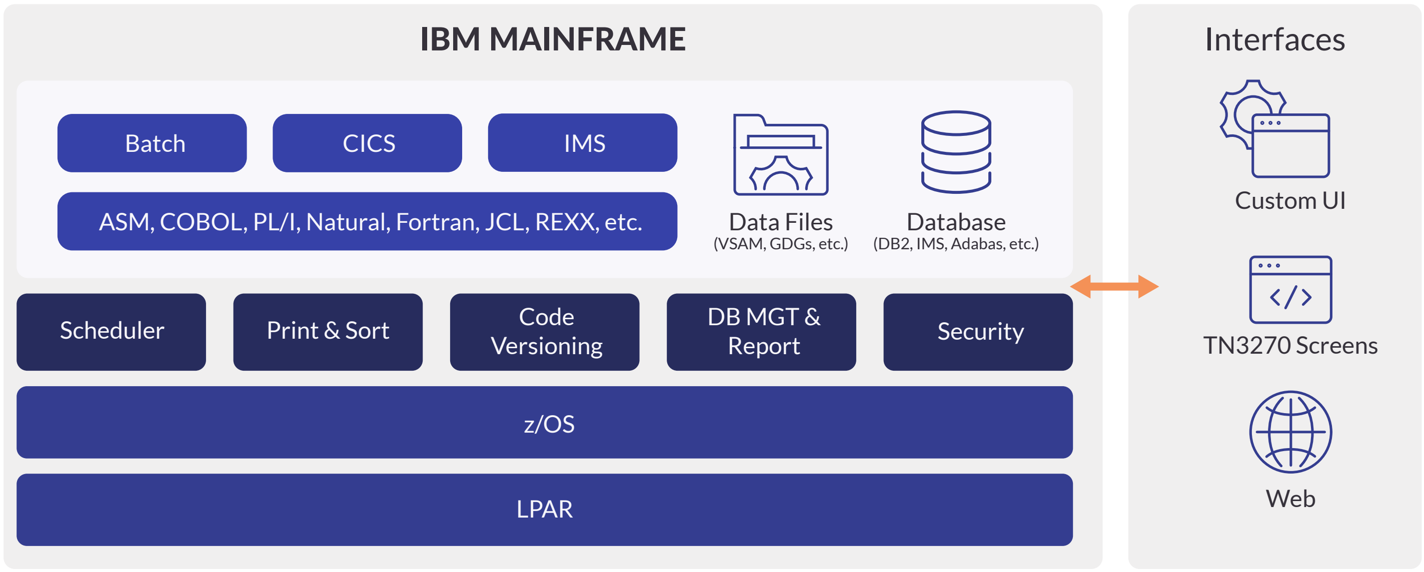
Security is tightly controlled at all levels of the mainframe software. Software provided by IBM, such as Resource Access Control Facility (RACF) and Access Control Facility 2 (ACF2) by Broadcom/Computer Associates, cooperate with system components to provide a robust yet secure environment for applications and data. Security software is designed to minimize the risk of data exposure and provide regulatory compliance.

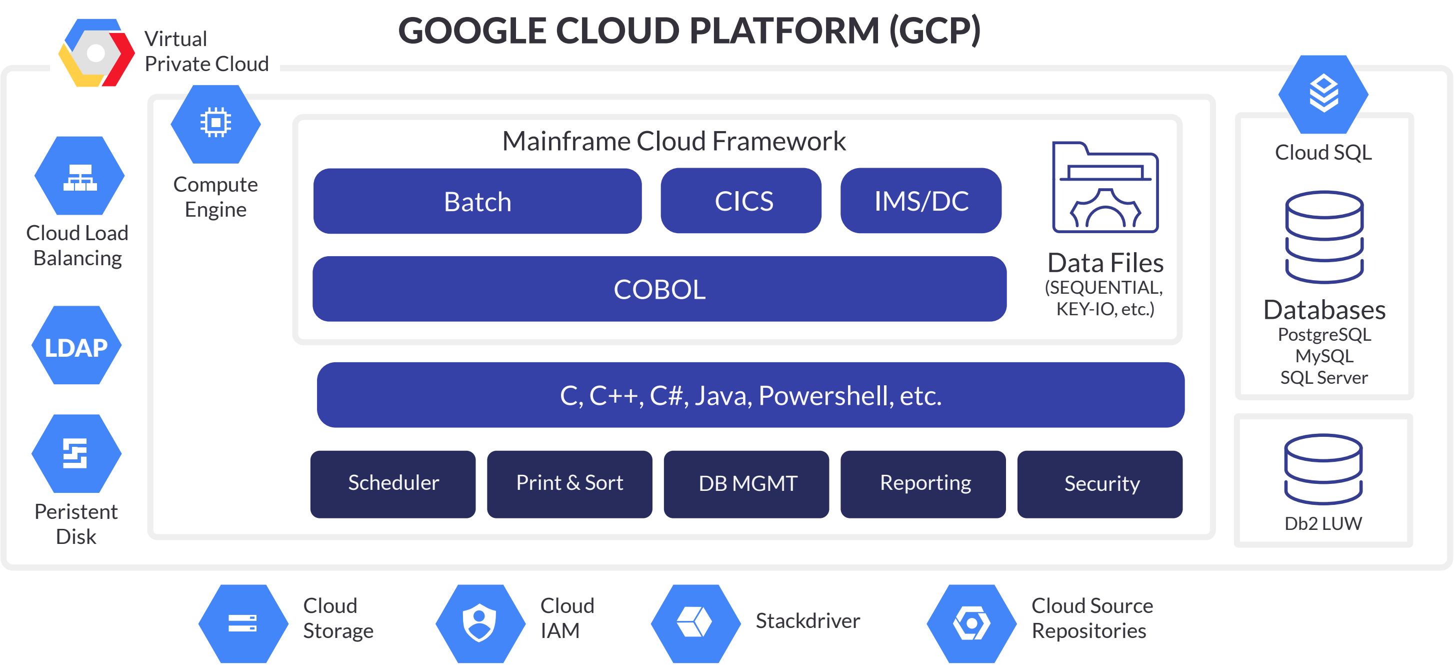
IBM z/OS to Google Cloud Platform Reference Architecture

As a Reference Architecture, the following diagrams, and discussion, addresses a typical use case. However, each implementation is sure to have its own customizations and variations, which is why a thorough application portfolio inventory, assessment and rationalization is critical to a successful outcome.

Below, you will see a design that includes details such as the Google Cloud Platform components, batch requirements, programming language conversions and replacements, integration with external systems, 3rd-party software requirements, and planning for future needs.

In an actual project, you would also consider any unique features that would necessitate custom-made solutions. We would recommend proof-of-concept conversions on application subsets to test the model selected, discover any weaknesses, and prove the viability of the design.





Code Modification

As part of any mainframe modernization project, there will be a need for partial or, in some cases, extensive code modification. Leveraging our past experience in developing productivity software (XGEN and OpenMCS), Astadia has developed its own code transformation and mainframe emulation technologies. We use these in concert with trusted third party products to modify source code for deployment to the Google Cloud Platform. What follows is a description of our approach.

Astadia employs an iterative, hybrid process of automated code conversion and human intervention. The technology behind the automation is Astadia's Rules-Based Transformation Engine.

This tool preserves the business logic and rules of legacy applications while removing proprietary code that can only execute in the source environment and not in the Google Cloud Platform. Its code migration filters ensure the preservation of mission-critical applications and back-end components such as transcodes, security policies, and message routing.

Though the Rules-Based Transformation Engine is a proven technology, Astadia augments our technology with years of hands-on migration experience and collaboration with partners. The combination of automation and human intervention ensures that legacy applications will work in the Google Cloud Platform without sacrificing their original functionality.

Although every mainframe migration is unique, there are general source-to-target mappings for application components that apply to most projects, as shown in the following table:

CODE MODIFICATION MAPPING TABLE

SOURCE	TARGET
z/OS	Google Cloud Platform & LUW (Windows, Linux, or UNIX)
CICS & IMS/DC	Google Cloud Platform
COBOL	COBOL, Java, C#
Natural	COBOL, Java, C#
REXX & EGL	Java, C#
ASM--Assembler	Java, C#, or mapped to OS functions
C & C++	Java, C#
FORTRAN, PL/I	FORTRAN, PL/I, Java, C#
JCL for Batch Processing	PowerShell, other scripting

These mappings are only a guideline for the most common mainframe technologies. Other technologies are addressed on an as-needed basis.

Database Migration

In parallel with code modification, data specialists will need to perform a thorough analysis of the legacy databases and files, then develop a detailed data migration strategy.

We recommend an iterative extract, transform and load (ETL) process to identify potential data-typing issues, develop fixes, and collaborate with the application subject matter experts (SMEs) to validate their efficacy. This iterative process continues until every issue is eliminated.

In most cases, hierarchical and flat file data structures will be replaced with RDBMS solutions, but other solutions may be implemented to address unique technical requirements or preferences.

After the target database and file structures have been created and validated, static data can be migrated to the Google Cloud Platform's production environment. For dynamic or other data that is created and/or modified frequently, a data migration strategy must be implemented as part of the production cutover process.

Like the application component mapping above, there are general source-to-target data mappings employed by most IBM z/OS mainframe-to-Google Cloud Platform (GCP) migrations:

DATABASE MIGRATION MAPPING TABLE

SOURCE	TARGET
DB2	DB2 LUW, Oracle, MS SQL Server, PostgreSQL, MySQL, etc.
IMS/DB	DB2 LUW, Oracle, MS SQL Server, PostgreSQL, MySQL, etc.
VSAM, other flat files	ISAM, flat files, DB2 LUW, Oracle, SQL Server, PostgreSQL, MySQL, etc.
ADABAS, DATACOM, IDMS, TOTAL & other third-party DBMS Platforms	DB2 LUW, Oracle, MS SQL Server, PostgreSQL, MySQL, etc.

These mappings are only a guideline for the most common IBM z/OS mainframe database and file technologies. Other technologies are addressed on an as-needed basis. Oracle is only available on the Google bare Metal Platform. Third party databases should be evaluated on a case-by-case basis, as each databases product has its own data architecture.

IBM z/OS Mainframe & Google Cloud Platform Integration and Parallel Operations

For some organizations, a one-time deployment and cutover of all IBM z/OS mainframe applications to the Google Cloud Platform simply is not feasible.

There may also be organizations that prefer to move applications one at a time, or in smaller groups, as a way of gradually embracing the Google Cloud Platform as a solution for their big-iron applications.

Still others may intend to keep their IBM z/OS mainframes indefinitely for a subset of strategic, mission critical applications while migrating less critical applications to the Google Cloud Platform as a means of reducing their costs or delaying upgrades to existing IBM z/OS mainframe hardware. This is also an issue when an IBM mainframe lease renewal is pending.

There's good news here - it is possible to do a phased rollout of migrated applications and still have ongoing communication and integration with applications residing on the IBM z/OS mainframe. This kind of mixed environment can be achieved with the proper planning.

Understanding the Google Cloud Platform

The Google Cloud Platform provides the technology and services that make running the IBM z/OS mainframe applications in the cloud a safe, secure, reliable way to achieve high performance results and fuel future innovation for the organization.

There are specific elements of the Google Cloud Platform that are relevant to an IBM z/OS mainframe modernization project. Below, we address some of these – this is not the extent of all Google Cloud Platform services nor is it meant to exclude the use of other Google Cloud Platform service offerings.

The Google Cloud Platform provides a broad set of infrastructure services, such as computing power, storage options, networking and databases that are delivered as a utility: on-demand, available in seconds, with pay-as-you-go pricing. From data warehousing to deployment tools, directories to content delivery, several Google Cloud Platform services are available.

New services can be provisioned quickly, without upfront capital expense. This allows enterprises, start-ups, small and medium-sized businesses, and customers in the public sector to access the building blocks they need to respond quickly to changing business requirements.

The Google Cloud Platform serves millions of active customers in more than 190 countries. Google is steadily expanding global infrastructure to help our customers achieve shorter latency times and higher throughput, to ensure that their data resides only in the region they specify. As customers grow their businesses, Google Cloud Platform will continue to provide infrastructure that meets their global requirements.

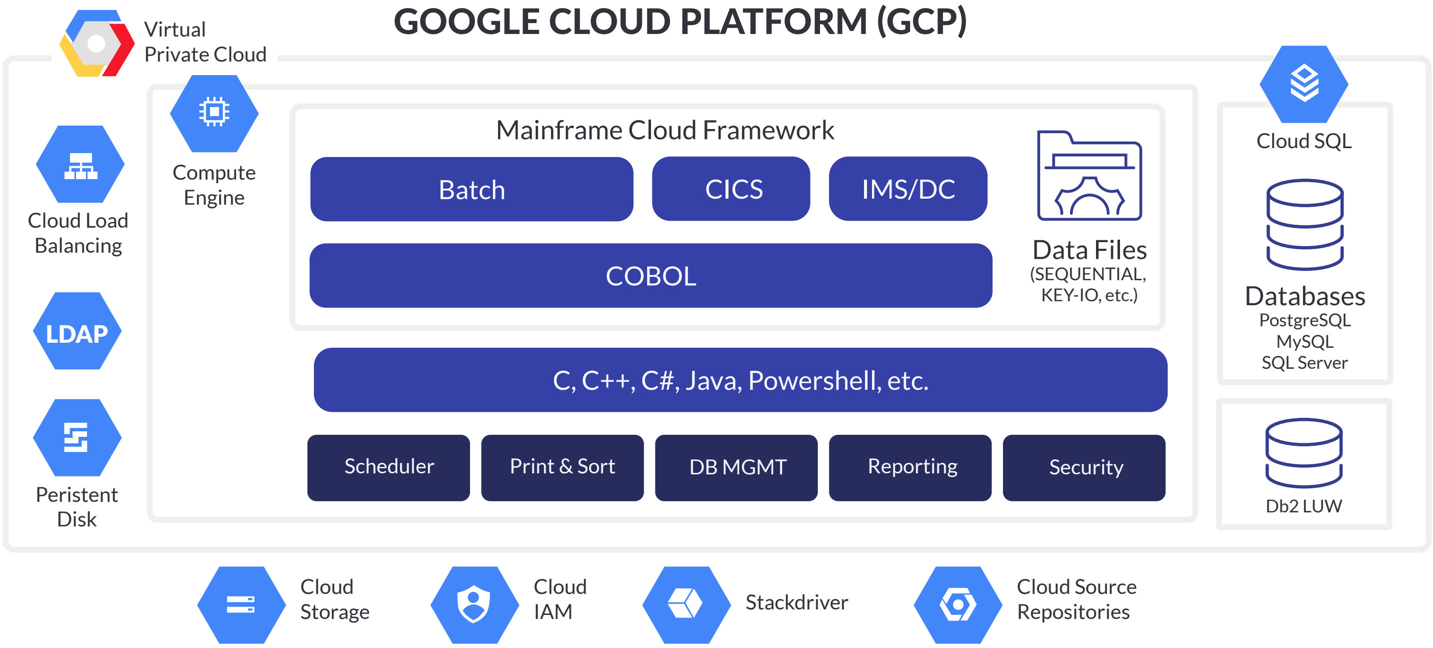
The Google Cloud Platform infrastructure is built around Regions and Availability Zones (AZs). A Region is a physical location in the world where Google has multiple AZs. AZs consist of one or more discrete data centers, each with redundant power, networking, and connectivity, housed in separate facilities. These AZs offer our clients the ability to operate production applications and databases that are more highly available, fault tolerant, and scalable than would be possible from a single data center. The Google Cloud Platform operates multiple AZs within several geographic Regions around the world, with more Availability Zones and more Regions coming online in 2020.

Each Google Cloud Region is designed to be completely isolated from the other Google Cloud Regions. This achieves the greatest possible fault tolerance and stability. Each AZ is isolated, but the AZs in a Region are connected through low-latency links.

Google Cloud Platform provides clients with the flexibility to place instances and store data within multiple geographic Regions as well as across multiple Availability Zones within each Region. Each Availability Zone is designed as an independent failure zone. This means that Availability Zones are physically separated within a typical metropolitan region and are located in lower risk flood plains (specific flood zone categorization varies by Region).

In addition to discrete uninterruptable power supply (UPS) and onsite backup generation facilities, they are each fed via different grids from independent utilities to further reduce single points of failure. AZs are all redundantly connected to multiple tier-1 transit providers.

In the following section, we'll take a deeper look at the Google Cloud Platform portion of the Reference Architecture and the components identified.



The Google Cloud Platform Environment

The Virtual Private Cloud (VPC) lets you provision a logically isolated section of the Google Cloud Platform where you launch and manage Google Cloud resources in a virtual network that you define. It's your private area within the Google Cloud Platform.

You can think of this as the fence around all the systems you have in the Google Cloud. You have complete control over your virtual networking environment, including selection of your own IP address range, creation of subnets, and configuration of route tables and network gateways. You can use both IPv4 and IPv6 in your VPC for secure and easy access to resources and applications.

Computing Resources

The Google Cloud Platform provides secure, resizable compute capacity in the Google Cloud. It serves as the foundation upon which your application sits. It is the container that holds the operating systems, mainframe emulators, application executables, and other supporting software that make up your application.

Depending on your specific circumstances, you may separate some pieces into their own individual instances, or you may run everything in one instance. For example, maybe you'll have a section dedicated to Batch COBOL and another dedicated to Online COBOL. You may even segregate sections by applications.

Storage

Google Cloud mass storage can be thought of as a hard drive for storing data. Lots of data. The Google Cloud serves as the primary storage "device" for all instances running migrated applications.

The Google Cloud also offers a low-cost, reliable service for backup and archiving of all types of data.

These services are combined to meet the storage requirements of your IBM z/OS mainframe applications.

Databases

Google's Cloud SQL Relational Database Service is where all your legacy relational data will reside. This includes any flat file data that has been converted to relational. For example, all your IBM z/OS flat files & Indexed Sequential data structures, and IMS and DB2 data that has been converted to relational and migrated to Google's Cloud SQL Relational Database Service.

This service is optimized for database performance. It's cost-efficient, has resizable capacity, and is designed to reduce time-consuming database administration tasks.

The Google Cloud Platform support is available in several familiar database engines, including Microsoft SQL Server, PostgreSQL and MySQL. You can also set up a DB2 LUW server instance. Oracle is only available on Google Bare Metal.

An analysis of your existing legacy databases and applications will reveal all the changes required to migrate your data to Google's Cloud SQL Relational Database Service, or any other RDBMS running on the Google Cloud Platform.

Load Balancing

Applications with a high volume of transactions require something to balance the workload. The Google Cloud Platform does just that. It automatically distributes incoming application traffic across multiple instances to achieve scalability, high-performance, and fault tolerance in your migrated applications. It provides the load balancing capability needed to route traffic evenly among your applications and keep them performing efficiently.

Security

In the Google Cloud environment, you'll be using Lightweight Directory Access Protocol (LDAP) for accessing and maintaining distributed directory information services. While there are other possibilities, this is most likely where you'll map your legacy application user IDs, passwords, permissions, etc.

Hosting LDAP services on a smaller separate instance often makes it easier to maintain independently of applications. However, a full analysis of your legacy security environment is required to determine how to best architect and configure security in the migrated system.

Monitoring

Every IT system needs to be monitored. The Google Cloud Platform uses a monitoring service for cloud resources now running the legacy applications you deployed to the Google Cloud.

This tool is used to collect and track metrics, monitor log files, set alarms, and automatically react to changes in your Google Cloud resources. This data is used to resolve problems quickly and keep your migrated applications running smoothly – much like you do on the IBM z/OS mainframe today. Other cloud-ready monitoring tools are available from 3rd parties as well.

Source Control

Just as you have products and processes to control your application sources and manage application releases on your IBM z/OS mainframe today, you need to have a similar set of tools in the Google Cloud.

Google Cloud uses a fully managed source control service providing secure and private GIT repositories. It eliminates the need to operate your own source control system or worry about scaling its infrastructure.

This facility is where you will store your migrated application source code and binaries, new source and binaries, and anything else you want to archive.

Ensuring Project Success

Astadia's Legacy Modernization practice has more than 25 years of experience migrating legacy applications to modern platforms. Since IBM z/OS mainframe applications are the mission-critical systems of the enterprise, Astadia goes to great lengths to ensure a thorough and complete project plan is developed for each legacy modernization project we undertake.

Astadia's methodology recognizes the organizational impact that any project of this nature will have on day-to-day operations, as well as the financial and business implications for organizations in both the short and long term. Return on Investment (ROI), and Total Cost of Ownership (TCO), are carefully calculated during this process, and are closely managed throughout the project lifecycle. Astadia's IBM z/OS Mainframe-to-Google Cloud Success Methodology has been refined over the course of 200+ successful legacy migration projects, and has become an industry leading approach for our medium and large-scale IBM z/OS mainframe clients.

Discover

Catalog and analyze all applications, databases, networks, platforms, and processes in the client's portfolio. Document the interrelationships between applications, and all external integration points in the client's configuration. This is a key input to Application Portfolio Management and Application Rationalization.

Design

Astadia's project team analyzes source code, data structures, end-state requirements, and Google Cloud components to design and architect the solution. The design includes details such as types and instances of Google Cloud components, transaction loads, batch requirements, programming language conversions and replacements, integration with external systems, 3rd-party software requirements, and planning for future requirements.

Modernize

Astadia employs an iterative, hybrid process of automated code conversion and human intervention to perform the necessary application changes. The technology behind the automation is Astadia's Rules-Based Transformation Engine. This tool preserves the business logic and rules of the client's legacy applications while removing proprietary code that can only execute in the source environment and not in the Google Cloud. While a minimal-change, lowest-risk approach is employed, some source code or supporting components may be converted to new languages for technical reasons or to comply with client preferences.

Test Automation

Testing is highly automated through the use of tools. Test Automation delivers a productivity boost to the development team, saving time and resources, as well as improving overall software quality by the reduction in human error using manual processes. The end result is faster and better cycle times from development work to version release. For online applications, a transaction content comparison tool is necessary. This tool may also provide an automated regression test suite for an application. Another important feature is centralized test recording for capturing all user interactions, as well as visualizing test scenarios and sessions. The user can replay the recorded scenarios, either against the migrated application (as a migration testing tool) or against the original application (as a regression testing tool). Normal replay can either include or leave out user think time. Stress-testing replay can launch many scenarios in parallel. The integrated diff tool shows a side-by-side comparison of a recorded scenario and its replayed counterpart. Test Automation provides detailed analysis of response times and throughput, and contains helpful utilities to detect performance problems. It calculates elaborate test scenario coverage statistics and the pass rate of replayed tests.

Implement

When migrated applications have been tested, verified, and optimized, the process of deploying those applications may begin. In reality, many deployment activities are initiated in parallel with earlier phases – things like creating and configuring the Google Cloud component instances, installing and configuring mainframe emulation software, migrating static data, and other infrastructure or framework activities. In some cases, environments may be replicated to achieve this, or existing environments may be re-purposed. The specifics of this may depend upon application and data characteristics and client preferences. After dynamic data is migrated and validated, cutover to Production mode can be completed.

Manage

Astadia offers a full range of managed services solutions. Having gained significant application knowledge from the architecting and implementing the Google Cloud solution, Astadia is well suited to take on the burden of managing and maintaining the migrated applications and their Google Cloud environments, or the dual environment in the case of a partial migration. This offers clients an opportunity to focus their development efforts on strategic initiatives as well as address concerns of finding programmers skilled in maintaining the legacy components still in use.

Conclusion

The Google Cloud Platform (GCP) and Astadia combine to create a perfect next generation platform for your IBM z/OS mainframe applications portfolio.

Once the mainframe application set has been fully deployed on the Google Cloud Platform, you will have the freedom to re-engineer traditional applications in to a more contemporary computing style, modernize legacy interfaces and integrate with other applications. In addition, many new services, like mobile and wireless, can be easily connected to the Google Cloud platform, thus enhancing the overall power of your new cloud computing environment. Your investment will serve to support all the needs of your enterprise and the future requirements of your business.

You don't have to tackle this alone. Astadia has the experience, skilled experts and the technology to successfully help you complete Legacy Migration projects of all scopes and sizes.

Astadia would be happy to hear from you about your specific Legacy Migration needs and how we may be of service to you as you prepare to leverage the Google Cloud Platform.

To connect with an Astadia expert, please contact us at:

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Astadia™

ABOUT ASTADIA

Astadia has been in the legacy modernization business since 1994 and has successfully completed more than 200 mainframe modernization projects. Our repeated success has allowed us to develop a comprehensive methodology, proprietary software tools and techniques, as well as the "know how" that comes with more than 25 years of experience handling mission critical applications and data. We're pleased to share some of that experience with you through our Mainframe to Cloud Modernization Series of reference architectures, webinars, whitepapers and more.

Visit our website at www.astadia.com for additional information.