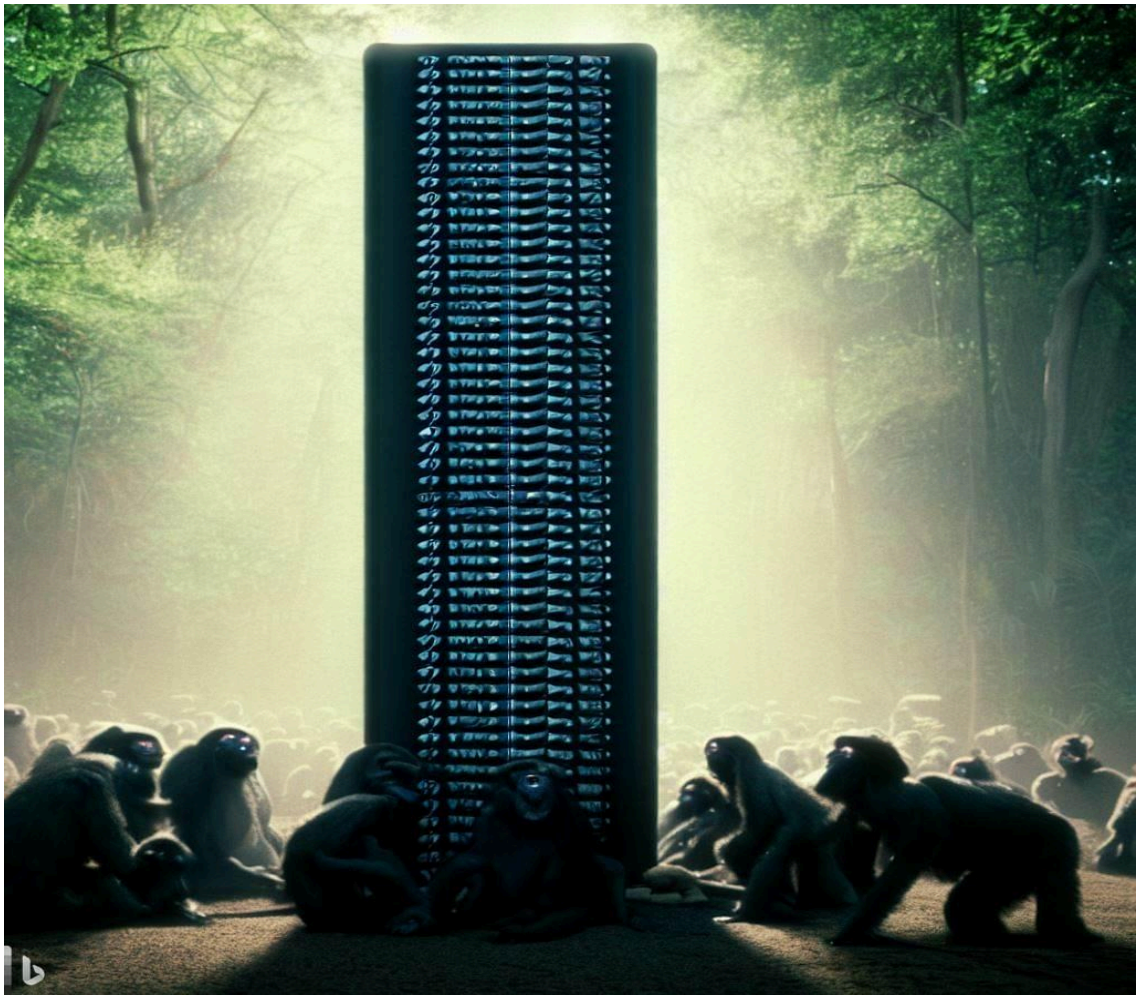
IBM Mainframe: Migrating to an Open Architecture

How to deconstruct a mainframe and deploy the code to Kubernetes



Introduction

Which industry or sector of the economy can compete with technology developed in the 1980s?

For a number of reasons, including significant investment, the loss of technological expertise and the challenges associated with implementing transformation projects, this technological base has become the norm in a significant proportion of the financial sector.

It can be observed that IBM mainframe technology maintains a considerable market share within the financial sector. A considerable number of organisations within the sector, including financial institutions such as banks and insurance companies, have elected to retain their operational systems on IBM technology. This is despite the fact that many of the designs and products in question date from the end of the last century.

How does the use of such technologies affect banks' IT organisations?

In these companies, the IT departments are frequently characterised by inefficiency, with costs that are relatively high in comparison to other industries. Furthermore, the development cycle for new solutions is often lengthy, and there is a notable deficiency in the ability to attract or retain talent.

It is, however, possible to implement strategies that will allow you to:

- Reduce operating costs, resources can be freed up for use in other businesses
- Significantly enhance the productivity of development teams, thereby increasing the capacity to deliver new products and services
- Attracting new talent to the organisation

These strategies are supported by capabilities that enable the migration of code developed on the IBM Mainframe platform to an open hybrid architecture based on Kubernetes.

Executive summary

The deployment of IBM mainframe technology constituted a pivotal moment in the twentieth century, facilitating the automation of financial sector operations. IBM's dominance in this sector was such that it came close to monopolising it. However, this competitive advantage has now become a significant disadvantage, impeding innovation and the introduction of new solutions.

In order to maintain competitiveness with major digital players, IBM would be required to implement significant disruptive changes to its platform. Such a scenario would result in the non-functioning of millions of programs, written more than two decades ago, which form the basis of the banking business. This results in the creation of a niche platform that is no longer aligned with market standards and best practices.

How can the mainframe platform be eliminated while safeguarding the entities' main assets of value (COBOL code and data)?

Previously, strategies for eliminating the mainframe involved converting COBOL code or emulating the mainframe platform on a different technical architecture.

However, with the open source technology available today, we believe there is an alternative approach.

- Compiling COBOL code on Linux platform
- Deploying CICS/IMS transactions and batch processes as microservices on a Kubernetes platform
- COBOL microservices will be interoperable with those developed in other languages
- The code is managed through an automated pipeline (CI/CD) to ensure efficient and streamlined development processes

Kubernetes is a platform that has been widely adopted and developed by the leading digital players. COBOL programs on the mainframe platform can be migrated to this execution architecture, which allows them to be integrated into the microservice ecosystem. Such a transition yields immediate advantages, including enhanced security, monitoring, automated operation, deployments, portability, and more.

Financial institutions are provided with the flexibility to select the location at which they wish to run their workloads. This may be on-premises, where Kubernetes can be installed on the DC, or

on-cloud, where it can be deployed on any of the hyperscalers, including Google, AWS, and Azure. Alternatively, a hybrid architecture may be employed. This obviates the necessity for code alterations and guarantees that they will remain agile and flexible.

The anticipated advantages of adopting this approach are as follows:

- A reduction in operational expenditure is a primary objective. It is notable that the cost of operation can vary significantly between different entities. A straightforward calculation that incorporates the expenses associated with hardware, software licences, the z/System maintenance team, and the cost of the data centre can result in a figure exceeding 100 million euros per year in a medium or large entity
- The objective is to enhance the productivity of development teams, with the goal of doubling their output and reducing the time required for new products to reach the market. This will be achieved by implementing automated microservices deployment pipelines in Kubernetes, which will facilitate the development process and enable the autonomous testing of COBOL
- The solution has the capacity to attract talent, unify the technical platform on the most in-demand technology currently available on the market, and facilitate the introduction of new frameworks (Spark, AI, etc.). The distinction between teams specialising in legacy technologies and those specialising in modern technologies has become obsolete. All teams utilise the same tools and platform, with the only differentiating factor being the programming language employed (COBOL, Java, Python, Go, and so forth).

Background

This document is not intended to provide a comprehensive technical architecture of the IBM Z mainframe platform. However, it is important to highlight some of its most relevant features.

- The origins of the current platform can be traced back to the S/360 models of the mid-1960s and subsequent S/370 and S/390 iterations. During that period, IBM developed its own "proprietary" standards (EBCDIC, SNA, etc.), which are still present to a greater or lesser extent in the current models
- The limitations of computing in those years directly impacted the capabilities offered by the operating system, COBOL language, storage subsystem, and other components, which in turn affected the functionality of the entire system
- The high cost of computing these early models prompted IBM to implement a strict backward compatibility strategy to protect customers' software assets. This strategy has remained in place to this day, enabling customers to run programs developed in the 1970s on a current mainframe

This led to IBM becoming the dominant player in the financial sector during the last century. However, these advantages have become a liability for today's financial institutions, as they are tied to an obsolete technology that acts as a barrier to technological advancement.

The technological revolution of the 21st century (the rise of the internet, the mobile phone as a universal connectivity tool, open source software, cloud computing, big data, AI, etc.) offers corporations the potential to innovate in ways that were previously unfeasible, opening up significant opportunities to increase their relevance in the market. However, with some exceptions, large banks have been unable to leverage this revolution to build new solutions that expand their customer base and maximise their profitability compared to other industries.

While new companies are being established on a daily basis to develop products based on technologies that did not exist 5-10 years ago, the financial sector continues to invest significant financial and human resources in further evolving its traditional mainframe-based systems. However, these systems are unable to offer customers experiences similar to those they encounter when consuming digital services designed in the last 5 years.

However, what does IBM say about its mainframe platform?

"Z systems cost less than other platforms on the market, are extremely robust, secure and allow for faster implementation of business solutions."

This assertion may be open to question given the limited or non-existent presence of IBM mainframe technology in key sectors other than finance.

The mainframe technology (zSystems) has a low total cost of ownership (TCO), below competitor products.

To gain a deeper understanding of this statement, let's break down the cost.

The **hardware** is tied to a proprietary IBM platform. IBM's long-term strategy has been to prevent the execution of mainframe workloads on third-party architectures (e.g. Intel x86[1]). Instead, it has entered into agreements or developed proprietary technology to allow the execution of Linux systems on its proprietary processors/architecture.

Despite ongoing investment in its hardware division, IBM has been unable to keep pace with the competition (i.e. Intel) in the development and evolution of its processors. Furthermore, the company lacks the economies of scale required to compete on price.

The recent industry moves towards ARM technology and the development of AI, including those by hyperscalers and Apple, will further accentuate these differences.

Software, regardless of the total cost of software licences, IBM has encouraged its customers to enter into long-term agreements and to guarantee a minimum consumption in order to qualify for a discount on list prices. In practice, this removes any incentive for customers to replace IBM technology.

It is not uncommon for financial institutions to find that IBM products do not perform as well as the competition (DB servers, J2EE servers, etc.) due to the perception that they are "cost-free". However, this cost is incorporated into a long-term contract that is challenging to renegotiate. For almost any product in IBM's portfolio, there is an alternative on the market offering enhanced performance or reduced maintenance costs.

[1] IBM has the technology to run an image of its operating system (z/OS) on an Intel platform, but does not allow its use in production environments.

The cost of operating a platform typically excludes the expense of **maintaining or developing** new business applications, which often requires collaboration across teams. This cost is typically the most significant item in a technology department budget and is directly correlated with the platform's productivity.

It is rare for a developer to be productive on a mainframe platform. There are a number of reasons for this, including:

- The limitations inherent to the traditional programming languages used (COBOL, PL/I) present a challenge
- The difficulty in the initial phases of development (coding, unit testing, integrated testing, etc.) is often encountered when developing on a mainframe platform
- The lack of a modern CI/CD process with tools for agile and collaborative development hinders efficiency
- The radical separation between Dev and Ops teams, with different teams, tools and processes, objectives and cultures, makes it difficult to streamline processes and foster collaboration

Mainframe technology (zSystems) is robust and secure.

This capability is not exclusive to this type of technology.

Applications developed on mainframe architectures are "monolithic" systems due to the high cost of the hardware and the limited number of processors and memory available at the end of the 20th century.

In a z/System, processes share memory as well as access to the storage subsystem. The most efficient method of communication[2] between these processes is through the use of shared memory, which results in a high level of integration between the various products and systems developed.

There are no application programming interfaces (APIs) available to expose business functionality, access a database, and so forth. Instead, application programs exchange memory addresses (pointers) with pre-established data structures.

The only way to expand such architectures is to add more resources (processors, memory, etc.) to the existing hardware[3]. It is therefore of the utmost importance to ensure a very low error/failure rate on the hardware platform.

IBM's claims of reliability and security are based on its purported minimal error rate on the hardware platform. However, it is important to note that no system is immune to human error or a poor technical decision.

In modern architectures, such as those based on microservices/kubernetes, hardware reliability is no longer a critical factor. Instead, growth is achieved horizontally, through the deployment of new instances of components over a distributed network, storage and compute infrastructure.

In the event of an irrecoverable error on a mainframe, the most common contingency mechanism is to have an equivalent hardware configuration on an alternative data centre. The strategy is to replicate data over an alternative data centre using IBM products.

[2] Don't communicate by sharing memory; share memory by communicating
[3] In a Sysplex architecture, a cluster of machines sharing memory can be configured, moving from a monolithic architecture to an even more complex distributed monolith, which requires even greater maintenance

A modern, stateless architecture allows for the decomposition of systems into different, independent services, as well as the implementation of fully or partially active-active[4] recovery strategies. There is no need to invest in alternative data centres. The capabilities of hyperscalers can be used to ensure reliability and robustness. This can be achieved through a hybrid on-premise/on-cloud multi-AZ deployment in a single region, multi-region deployment, deployment in different cloud providers, and so on.

The use of mainframe technology (zSystems) enables the rapid implementation of business solutions.

In fact, the process and tools used by a COBOL developer have remained largely unchanged over the past 30 years.

IBM has not invested in enhancing the capabilities of traditional products (COBOL, CICS/IMS, Batch, etc.) on which the majority of critical banking functionality has been built. Instead, IBM has concentrated its efforts on integrating open-source capabilities, specifically Linux, into its mainframe platform.

The effectiveness of this strategy is yet to be determined. It is evident that traditional solutions still have significant shortcomings and are unable to support new products and services with the necessary agility. Conversely, "open" solutions are not a viable option in comparison to the capabilities offered by other companies or hyperscalers. Organisations are constrained in their capacity to enhance their development cycle to the extent that IBM deems viable. The strategic technology decisions and innovation paths are no longer at the discretion of the organisations, and are instead dependent on IBM's long-term business strategy.

Furthermore, IBM has been investing the cash (operating cash flow) it obtains with this technology in various future initiatives. However, it appears that in all of them it has arrived late or with an insufficient focus (cloud, AI, etc.). The recent acquisition of Red Hat represents IBM's last opportunity to avoid becoming a mere also-ran in the years ahead.

[4] The active-active configuration of databases is conditioned by the technology used

Proposed solution

Although it is not currently possible to modify the fundamental technology and architectural paradigms that underpin a significant proportion of the industry's operations, there is a well-defined route for the strategic evolution of mainframe platforms towards approaches that have been demonstrated to be effective for major digital organisations.

Problems in the past

In order to gain insight into this transformation, we will examine the manner in which analogous initiatives have been addressed and the reasons behind their failure in major financial institutions.

Converting the code to a modern programming language

This approach automates (or semi-automates) the parsing and conversion of COBOL code to another programming language, such as Java.

- Transactional systems, CICS/IMS, COBOL and DB2 are moved to a J2EE, Java and relational database environment (Oracle, PostgreSQL, etc.).
- In order to emulate the operational methodology of transactional monitors, particularly those associated with CICS, it is necessary to develop the requisite "sentences." The complexity of the process is dependent on the number and type of CICS statements used in the application programs.
- DB2 database access statements are static and must be adapted to the target database (Oracle, PostgreSQL, etc.).
- Batch has special characteristics. To simulate JCLs/JES, JCLs are usually transformed into bash and Java processes are run on J2EE application servers.

This approach has a number of drawbacks, which are described below.

As mentioned above, systems developed on the ZSystems platform are highly coupled (monolithic architecture). This is especially critical in certain modules on which common application logic rests.

The possible alternatives for dealing with this problem are always complicated to manage:

- We must create a coexistence architecture that allows us to progressively migrate the

code[5]. IBM's proposal is to develop in Java on the Mainframe platform and allow communication between COBOL/Java programs by means of JNI. This option makes no sense except for IBM's commercial department

- It is not feasible to implement a big-bang strategy for medium and large financial institutions. While this may be a suitable approach for self-contained, low-volume/criticality applications, the significant risk and cost involved make it unfeasible in the majority of cases
- The current plan is to maintain two versions of the common systems in COBOL and Java until the end of the project, which will result in duplicate maintenance costs. This option is only applicable in cases where the number of systems to be duplicated is limited and their maintenance requirements are minimal.

It is essential to understand the project's final outcome in order to assess its impact on the technology organisation, particularly the development team.

The COBOL code developed over the last 30 years is typically characterised by the following features:

- Insufficient or no documentation[6]
- The code is challenging to comprehend. To optimise memory usage, programs are restricted to 8 characters. The names of DB2 tables and program variables are also subject to these limitations. Variables used in programs are not significant; instead of using terms like 'married' or 'single', a numeric variable of length 1 is used. The same approach is taken with return codes, errors, and so on
- It is not standard practice to implement the referential integrity model on top of the DB2 database. This information must be derived from the application code
- The COBOL language is designed to optimise processor usage, ensuring efficient and effective processing of data. These include static variables, fixed-length alphanumeric, fixed-length signed/unsigned numeric with decimal mask, packed decimals, and so on
- Procedural language. The code is packaged into distinct "subroutines" that are called dynamically or statically through the exchange of data structures (copybooks)

[5] How to connect a COBOL program running on a mainframe with a Java class running on a J2EE server on an Intel platform?
[6] In most cases the only documentation is the COBOL code itself

This code is transformed by an automatic process into a Java class:

- This strategy will require a significant adaptation from the COBOL Mainframe developers to maintain the code efficiently. Depending on the code conversion strategy used, the result may be to make the code unmaintainable
- A new development team with advanced Java skills will find it challenging to understand the logic and structure of the generated code, making it difficult to maintain in the future

Mainframe emulation on a different hardware architecture

In this case, the COBOL code is compiled on a new hardware platform, emulating the functionalities of the IBM products necessary for its execution (CICS/IMS sentences, JCLs, access to the DB2 database, etc.).

This approach is exemplified by Oracle's initiatives to migrate mainframe code to Tuxedo/Oracle DB and Microfocus suite of products.

This approach has several significant drawbacks.

- Firstly, all the inherent problems of the mainframe platform are carried over to the new architecture, including monolithic systems, high coupling, and difficult development
- The decision to replace a technical platform (IBM Mainframe) with minimal evolution in recent years with a proprietary platform that is unlikely to offer enhanced evolution or support compared to the original is a suboptimal choice
- As in the previous case, a coexistence architecture must be provided to allow a progressive migration of the code, avoiding big-bang strategies

In the vast majority of cases, this type of initiative leads to a very long and costly project that leaves the organisation in an equal or even worse technological situation.

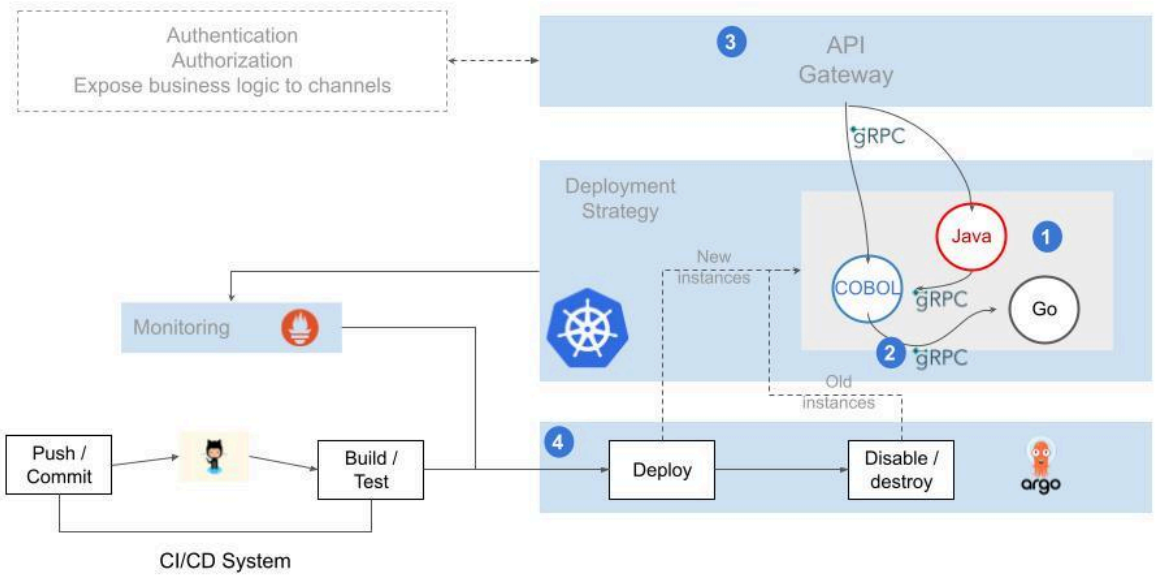
The promise of reduced operating costs is quickly compromised by the cost/length of the project. The end result is a dead end that will irremediably involve a new technological transformation project in the medium term.

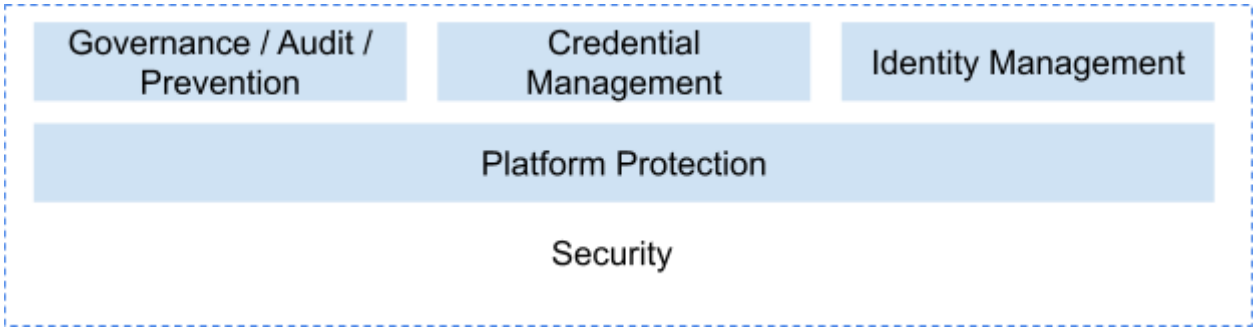
driver8 solution

Driver8's solution is based on the following premises;

- *Dual approach*: Separating the flow of new projects from the stock of mainframe applications.
    - Flow: A microservices architecture model to intercept new business initiatives for deployment on a Next-gen infrastructure based on Kubernetes.
    - Stock: The progressive and risk-minimised migration of COBOL (Online/Batch) Mainframe workloads to this Next-gen infrastructure.
- Use of *Open Source* projects. The target architecture is based on products and standards supported by the main technology companies. Applications can be deployed on on-prem infrastructure (on existing DCs), on the cloud (Google, AWS, Azure have solutions valid in different geographies) or in a hybrid architecture
- *Integrated platform*. New functionality (microservices built in Java, Python, Go, etc.) and mainframe COBOL code can be deployed on the same infrastructure and technical architecture. Developers use the same CI/CD tools (repo, pipelines, etc.), with the only difference being the language in which the microservices are built.
    - Mainframe (Online) transactions are deployed as COBOL/gRPC microservices in a Kubernetes cluster
    - In the case of Mainframe Batch processes, the JCLs are converted to YAML/JSON files and interpreted by a Kubernetes Batch Scheduler specialised in the execution of massive processes (computation and data)
- *Coexistence mechanisms*. Two levels of coexistence are defined to ensure a progressive and risk-free migration of Mainframe code. Each entity will be able to define its plan and establish the deadlines for undertaking the migration project.
    - Coexistence between next-gen platform and Mainframe. The solution allows read/write access to the Mainframe platform from the microservices deployed on the Next-gen platform (Kubernetes) by means of two basic connection mechanisms: SQL access to the DB2 Database (proxy on the DB2 odbc driver) and execution of CICS/IMS transactions. TCP/IP socket connection with transaction handlers
    - Coexistence between microservices, regardless of the programming language used (COBOL, Java, Go, etc.). They expose an interface following the gRPC

standard that allows their transparent integration (COBOL Copybooks are exposed as gRPC proto messages)





1. The solution allows developers to code services in modern and attractive languages, while also allowing the use of parts coded in "legacy" languages. This avoids the unnecessary waste of resources that would result from recoding

2. Communication between the different services, internal communication, is implemented by means of a light and efficient protocol
3. Services are invoked from front-ends or third-party systems (third-party payment platforms, partner software or other entities, etc.) via a secure, resilient and easily scalable mechanism
4. The operation is supported by deployment automation pipelines and advanced observability capabilities that allow an integrated and consistent view of the entire application flow and the health status of the elements involved
5. Security is embedded in the platform with standard components that implement advanced mechanisms to provide the necessary capabilities according to the requirements of the financial industry.