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Chapter 3: Cloud-based infrastructure as the backbone of scalable financial intelligence platforms

3.1. Introduction

Cloud-based Infrastructure as the Backbone of Scalable Financial Intelligence Platforms. The history and trends of cloud computing are analyzed, including development motives, a reference architecture, and fast growing AI centers. Cloud-based vendors face unsustainable maintenance and operational costs as their cloud services scale, creating a dilemma for software vendors. Many data-centric software vendors now provide their products on public cloud infrastructures. The challenges of cloud resource provisioning are analyzed and classified into four levels, including long-term trends, medium-term demand, short-term demand, and real-time adaptation. The Coarse grid-based resource allocation algorithm is designed to make efficient cloud resource allocation decisions at the fine allocation level. The algorithm and access patterns are exposed to cloud resource allocation decision makers (Pandey, 2024; Shaban & Zeebaree, 2025; Vankayalapati, 2025).

Cloud computing is a large-scale distributed computing and storage integrated system composed of massive physical resources, including data centers, servers, storage devices, and networks. Cloud computing promises its users with on-demand, elastic, cost-effective, reliable, orderly, location-independent, multi-tenancy, pay-per-use computing resources and associated services. Financial social media has attracted extensive attention in academia and the industry. Users share financial information with various forms by posting, reviewing, liking, or forwarding. The experimental results of the pilot test of more than 700 investors show that investors' financial intelligence is generally low with great hierarchical aggregation, and the financial intelligence level has been improved and be more rational via investment experience. The development of financial social media has led to data explosion in the finance domain, causing great pressure on corporate data processing and analysis. However, many information systems and platforms of financial institutions work in silos with isolated data.The further popularization of cloud storage has long been hampered by concerns for safety and unawareness of its necessity. Subsequently, in order to overcome these two barriers, a modularized infrastructure of cloud computing technique-based financial intelligence platforms is established. Then, 13 types of financial intelligence platforms are coded using the modularized infrastructure to broaden the financial cloud scope, and the methodology for determining the appropriate cloud computing scheme is proposed to eliminate the concerns for safety and privacy. In short, the goal of this effort is to construct a scalable financial intelligence platform for cloud computing technique and data manipulation. Much effort is contributed to achieve this goal. It is expected that the proposal of data powered intelligence platforms will promote further exchanges on the furnishing of cloud computing or big data based financial intelligence platforms (Egbuhuzor et al., 2021; Faizal & Aisyah, n.d.; Katari & Ankam, 2022).

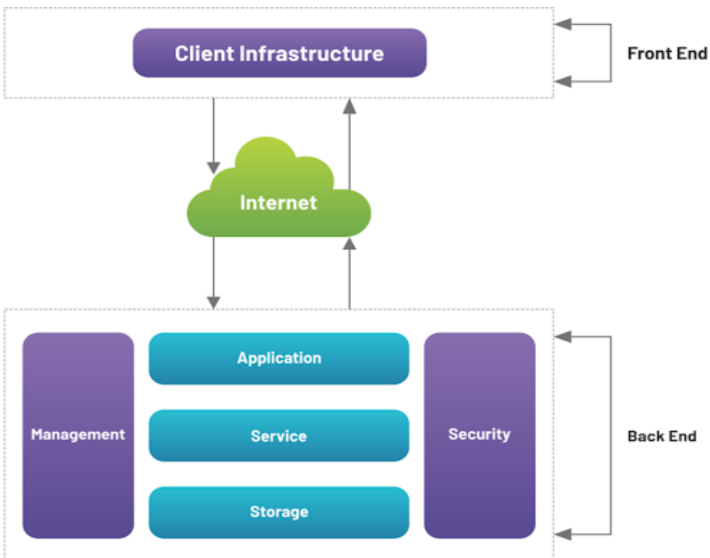

Fig 3.1: Cloud infrastructure

3.1.1. Background and significance

In the past ten years, with the rapid development of the Internet and the popularization of mobile devices, data has exploded. Financial was born at the same time. Under the combined impulse of these two forces, cloud computing has become its natural carrier. Financial intelligence cloud gradually emerged, and its research and exploration gained momentum. In the past related research, the construction of the financial intelligence cloud followed the highly mobile multi-source data environment, and focused on future-oriented financial intelligence analysis and application technologies such as online analytical processing, data mining and intelligent filtering. Work such as the establishment of a real-time global financial news monitoring platform and a Chinese stock prediction engine based on a recurrent neural network model was completed, which laid the foundation for further research. However, it is worth noting that there are also two obstacles in intelligent financial cloud construction. The first is the necessity and significance of cloud computing scheme selection. Although there are professional guidelines for this aspect, there are few studies on how to make scheme decisions under multiple criteria. Elsewhere, there is also the problem of financial intelligence cloud standardization.

3.2. Understanding Financial Intelligence

There are various unobtrusive predictors of financial opinions: on a high level, it involves analyzing the changes of a target's stocks based on relevant contents, posts, news stories, responses, and other information, including the pros and cons of the defined opinion, concerning shareholders, individuals, and societies. more micro-level, it involves inferring the stocks' values based on exchanges defined features. Both high- and low-level attention are to be further explored. FinTech events and stock effects analysis: FinTech events will attract sudden attention, and within hours or days it is possible to investigate various stocks' reactions toward the events in the defined time series. There is a need to understand the flow of FinTech events, users' preference changes over time, and how such a sort of event dramatically alters the behavior of various stocks from different industries . From a micro perspective, there is a vision of modeling stock trading based on the attention distributions of various users. Only dependency and heterogeneity based approaches can be applied: the aim is to detect stocks' trading behaviors, the daily adjustments of stock currencies as the trading information, and the feature definitions on historic attention distributions. Though there are some similar works in event prediction and reaction modeling, it is still an unexplored territory to have a broader perspective across diverse stock prediction domains. In addition, stock construction from external users listing: the Revolution of Granger-causality Check is addressed as a sort of causality probe as well as Constructing a Unique Graph. While in most analysis scenarios, a multi-level focus is incompatible with multi-scale data, detecting financial opinions on a newspaper collection can have an indirect but unobtrusive assessment toward various stocks. Since most news articles are collectibles of newspaper posts collected within a defined time span, the attention of detecting.

3.2.1. Definition and Importance

The term cloud-based infrastructure comprises the delivery of hardware components desired for business solutions that would include servers, data storage, networking devices, and virtualization software, as well as the availability of the main operating systems. Cloud-based infrastructure is sought to be a key concept for the offshore business. Deploying Information Analysis Tools in the financial industry is limited by several formalities and precious proprietary data leakage. Therefore, cloud computing is desired to establish a new weaker shadow in computing infrastructure where main resources are reserved on the site and availability of services hosted within Computation as a Service is controlled via strict IP networking policies.

Business Intelligence (BI) leverages a broad range of tools and technologies used to improve data analysis procedures and management decision-making processes. BI platforms serve a multitude of solutions addressing diverse needs. Among them are Data Warehouses covering organization-wide storage of historical enterprise data and OLAP systems delivering a user-oriented interface over multidimensional data plots. BI tools on the raw data level comprise Data Integration/Disco entry solutions performing data cleansing and ETL scenarios. Data Mining techniques are employed for advanced statistical interpretation of heterogeneous cross-section data. Further heaps of BI tools are developed based on these technologies helping business sector specialists in widespread financial data management. Since changing the official members of the computing facility or core business platform is not permitted due to contractual obligations or other issues, BI tools on the raw data level are comfortably requested and connected in the cloud.

Technologically pertinent resources of such cloud-based solutions are mostly limited, scattered on several hosts, and accessible via loosely specified data access policies, and possibly delegated service levels. Also, such cloud BI tools often address and process semi-structured or unstructured data available in various data formats and access modes, with suspicious mechanism consistency and compatibility. Security systems, accounting surveillance and controls, and configuration definitions of BI tools present in contractual agreements are missing on the shared public cloud. Individual user accounts have to be concerned with the default scheduling of such tools in the cloud.

3.2.2. Key Components of Financial Intelligence

Historically, financial technology firms had limited opportunities for development, making it impossible for small, medium, and even some large firms to innovate. In recent years, supported by the rapid development of deep learning technology and massive amounts of open social network data, financial technology firms have emerged rapidly and made finance improve. The usage of technology for financial insight evaluation has increasingly gained attention since the. The term "financial intelligence" is used to describe the cognitive chains from financial insight prediction tasks to data acquisition tasks. There are mainly three different kinds of financial insight prediction tasks: prediction of firms-to-firm relationships, raking prediction of stock price indices, and anticipation of corporations' reputation. These financial intelligence tasks are sophisticated tasks consisting of a hierarchy of low-level perceptual and cognitive tasks. Financial intelligence is defined as a knowledge-based and insight-oriented concept in finance, social networks, and artificial intelligence (AI) that can perceive and reason financial insights over the cloud. Initially, focusing on the analysis mechanisms of financial insights over social network data, financial intelligence consists of two chains of astute knowledge-based data processing tasks: the lower one data perception and mining knowledge acquisition tasks and the upper one data reasoning insight inference-based fabricating knowledge tasks. Different machine learning methods and approaches with different features are glanced at, and links to financial intelligence tasks, constructs, or the future of financial prediction research works are highlighted when available.

3.3. Cloud Computing Fundamentals

In today's era of "big data," cloud computing has more often than not been regarded as a panacea to enhance productivity and operational efficiency . Cloud computing is a model that enables ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction. One of its services, cloud storage, allows users to store vast amounts of structured and/or unstructured data online, removal of control of IT infrastructure components from the user, ease of accessibility, and availability over the Internet. There are four main types of cloud computing viz. Private Cloud: A private cloud is the next cloud computing model to a public cloud. However, while public clouds are designed to provide services to multiple customers, a private cloud's architecture enables it to serve a single organization solely. The services and infrastructure are hosted either in the organization's on-premise data center or off-premise within the CSP's data center. This allows companies to have control over the entire cloud environment, including security, privacy, operations, management, and more. There is also a hybrid cloud – A hybrid cloud consists of two or more cloud environments. It allows organizations to share data and applications hosted in an individual cloud system across environments. This way, they can choose a deployment option that fits their needs. Multi-Cloud: A multi-cloud environment is a solo architecture focusing on a single service type but typically involving multiple CSPs. Searching multiple public cloud resources from different providers using a dashboard or a federated workflow manager would be an example of this architecture.

While cloud computing is still considered a newly emerging technology, “as-a-service” software services such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS), have continued to grow in an exponential manner. IaaS is a form of cloud computing that provides virtualized computing resources over the internet. On the IaaS cloud, the customer possesses self-service provisioning of computing capabilities, on-demand network access to a shared pool of configurable computing resources, and elastic provision and release of resources. PaaS provides a cloud platform and the environment to allow developers to build applications and services over the internet. The vendor provides several services on the cloud like hardware and software infrastructures, programming languages, databases, and technologies, allowing you to build your applications while consuming the services and getting rid of technologies you do not want to manage directly. SaaS is a software distribution model in which a service provider hosts applications and makes them available to end-users over the internet. The term is often used to refer to web-based applications that are run and managed on cloud servers.

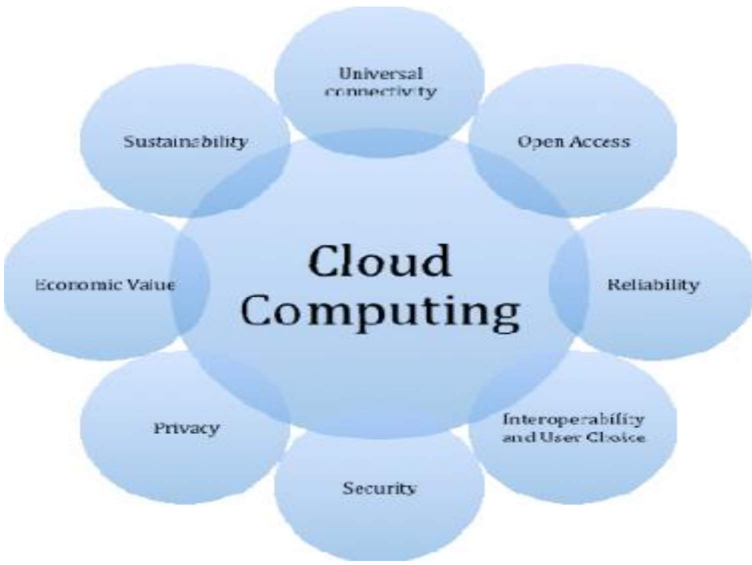

Fig 3.2: Fundamental Elements of Cloud Computing

3.3.1. Types of Cloud Services

The cloud computing infrastructure can be categorized into two major categories: cloud services and cloud deployment models. Cloud services can be classified into three basic service models for a cloud-based infrastructure, namely: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS).

Infrastructure as a Service (IaaS) is a service model around servers, storage capacity, and network bandwidth. Users rent a set of hardware elements from an infrastructure service provider and on an hourly basis, users consume the capacity they need . They need to install, configure and use the software elements. These services make sense for massive server farms and flexible infrastructures. The main limitations are related to the fact that the responsibility regarding security and management is split among the IaaS provider and the client. Businesses do not need to invest in expensive hardware in order to construct a large-scale server farm. If there is no access to the Internet, the whole cloud vanishes.

Cloud-computing solutions that are PaaS have an externally managed, scalable solution for developing, deploying, and managing applications. The main advantages are the choice of programming language, data storage solution, and an environment for developing applications without worrying about the infrastructural platform.

3.3.2. Benefits of Cloud Computing

Cloud computing is gradually gaining popularity among many corporations, which prefer the time and cost saving characteristics over the traditional self-hosted IT infrastructures. It is a promising outsourcing paradigm that offers IT resources on-demand as service over the Internet, making it possible to buy computing, storage, and data service resources from other corporations instead of having to invest in hosting one's own IT resources . Cloud BI is highly resource intensive, requiring large-scale parallel processing systems and significant storage capacities to host the data warehouse. In self-hosted environments, it is feared that Cloud BI will eventually face a resource crunch situation, because it would not be feasible for companies to keep adding resources to host a never ending expansion of data warehouses and the online analytical processing (OLAP) demands on the underlying networking. Cloud computing has instigated a new hope for future prospects of BI.

The topic of financial information processing is of major importance for financial institutions . Applying the cloud computing model to the processing of financial information has become a major trend in today's financial industry. While cloud services have proved absolutely effective in many domains such as online retail, media streaming, and social networks, the financial industry has been generally cautious about adopting cloud technology, because adopting cloud computing would expose financial institutions to many unprecedented risks in the processing of financial information. Since 2009, however, interest in the cloud computing model has become increasingly apparent among regulatory bodies, commercial banks, information technology (IT) vendors, and academia. The intersection of cloud computing and financial information processing has also drawn significant attention and interest from both industry and academia. In particular, the realization of cloud computing in the financial industry requires the development of intelligent prediction and assessment technologies for the time, form, and consequence of hazards, and the costs and benefits in terms of cloud service adoption and implementations.

3.4. The Role of Cloud Infrastructure in Financial Services

The financial service industry is one of the key areas to benefit from technological advancements, including cloud-based business models and big data analyses. This is also the area with the earliest usage of technologies such as machine learning, data mining, and other data-related technologies due to the rapid generation and accumulation of financial data arising from the ever-growing demand for digital financial services, business models, and products. Massive financial transactions, news, research reports, reports, and other data have prompted investment banking companies, stock exchanges, banks, funds companies, asset management companies, and other financial institutions to allocate huge human and material resources to analyze and mine the financial intelligence hidden behind. However, most of the financial institutions employ an independent approach when developing their stacks of financial intelligence platforms, resulting in complicated, overspecialized, and hard-to-adapt-to-variant-environments-application architectures and implementations.

To reduce financial risks and allow more institutions and individuals to participate in and invest in digital financial services, a cloud-based financial intelligence platform is proposed that includes a series of analytical and inference algorithms on different aspects of financial service systems. Different extents of services can be flexibly issued to users with different security requirements, which can help reduce acquisition and usage costs. Cloud machine-learning-as-a-service is one of the key modules of the platform that allows the clients to learn their models from their own data and submit for infrastructural parameters and learning instances. The learning service is implemented in a federated learning manner, and the server-agents apply the multi-party computation technique to preserve the gradients during the global aggregation. Furthermore, the correctness of model learning is also validated in a cryptographic manner .

3.4.1. Enhancing Data Accessibility

Cloud computing technology has changed firms' data accessibility. With cloud technology's continuing maturity and diffusion, more firms implement it in their business intelligence (BI) . A few years ago, firms had their data stored in their local infrastructure, which demanded, often enormously, their time and resources. IT management with on-premises BI was getting complicated as firms grew larger or demanded more BI. Compared with on-premises BI, cloud BI is a new wave of BI applications delivered as SaaS.

Firms can access BI applications and their data through the Internet. This drastic change in data accessibility alleviates firms' heavy burden in IT management. Cloud BI systems work behind the scenes. Internal and external data are accessible via the Internet through data warehouses. Scalability and flexibility enhance firms' data analytics without investing much time and money. Cloud BI is becoming the trend for scalable speedy financial intelligence platforms, allowing timely data accessibility and analytics.

Data accessibility is vital for making effective BI and decision-making. On-premises BI required firms to invest enormously in acquiring hardware and software infrastructure. Firms needed to reinforce efforts at managing IT systems, and this was tough communities for analysis, modeling, and research works to comprise various kinds of financial analyses, forecasting models, or data sources. Academic cooperation across institutions became very difficult under the general local-installed system. As larger firms partly outsource their BI to consulting firms, smaller firms, previously too small for a dedicated BI team or data analysts began to utilize SaaS or cloud BI. It lifted the entry barrier for firms to leverage BI for driving their data-oriented strategy.

3.4.2. Improving Security and Compliance

Financial institutions that gather information from various systems and sources of market data face an arduous task of storing and managing this data. However, traditional database architecture may not be sufficient due to inevitable market events that may place an exceedingly demanding burden on the systems, resulting in unusually high data traffic load . Recovery solutions must be implemented to prevent persistent corruption of system states from unforeseen market events. Regulatory requirements and compliance monitoring systems collectively exacerbate the problem since the timely delivery of an answer to complex queries is imperative for compliance before policy action becomes ineffective.

Current designs of financial systems can be categorized into two. Most institutions are hobbled with traditional systems based on RDBMS or custom-built databases. These systems have excessive short-term operational cost and lack viability for growth due to inaccessibility of core primitives for large scale analytics. There exists a class of startups that have made their base of technology innovations on these systems but without formal performance, safety, and fairness guarantees. As the markets' intensities and respective volumes of data traffic increase, these systems can be pruned of their uneconomic overheads. Adverse selection may continue their proliferation in the markets while populating a milieu for predatory action.

Database Cloud Services provide access to a proprietary database engine over the Internet and range from generic offerings to application and domain-specific solutions. While accessing hosted services mitigates distress of maintenance burdens and peak loads, critical questions arise on data integrity, confidentiality, compliance, and effective tariff of services. For an institution representing a significant portfolio of funds and data, a loss of confidentiality would require an exercise of considerable damage control. A security audit can last a year or longer and exhibit significant upfront investment for a mere speculative indication of compliance to a set of constantly evolving standards and controls.

3.5. Scalability in Financial Intelligence Platforms

Economic cycles shape the financial crime threat landscape, which varies between economic aspects such as share prices, jobs, financial dialogue, and inflation. For that reason, flexible, scalable, and easily adjustable data selection, storage, and processing is a necessity when developing scalable financial intelligence approaches. Early attempts in financial counselling, such as traditional Business Intelligence environments designed around visualization tools and with backend traditional data warehouses, are limited to deal with more than one million transactions in an acceptable time frame. One way to approach this demand is to focus on cloud technologies. The cloud brings with it the need for online data selection, storage, and processing engines. Full models and systems of cloud-based allocation engines, decision trees, and selection/bidding engines can also accommodate that need. However, incorporating these elements remains a daunting task and in order to accomplish it many different design decisions need to be made, as well as technical and scientific challenges to be overcome. Hence, along with the increased opportunities stemming from cloud technology availability, novel problems arise with research potential.

Properly designing online engines that use cloud technology while dealing with very different systems is a scientific challenge on its own. These essential components often involve fast statistical analyses of random variables under expanding sample sizes, game-theoretic multilayer models and simulations ensuring stable allocations, and random processes with eventual steady-state distributions. These processes must then be efficiently implemented in a programming model and in mathematical frameworks. Since existing cost-efficiency measures of such engines in both theory and practice are focused on single transactions, a new comprehensive theoretical and practical framework for cost-efficiency measures and models must be developed in order to accommodate possibly competing processes and resource long-time allocations. Another design consideration is related to system/servicing speed. Testing a production-data size continuous-based engine on a few thousands of data objects should simply not be feasible. Using easier-to-test components such as an online discrete mechanism storing a hash table of the old database while continuously appending new entries at an expected rate should raise attention instead. Such alternatives must be well-defined, convincing, and formally analyzed, insightful for questions arising at a later date, and encompass processes of smooth transitions between similar levels of old and new data storage and vice versa.

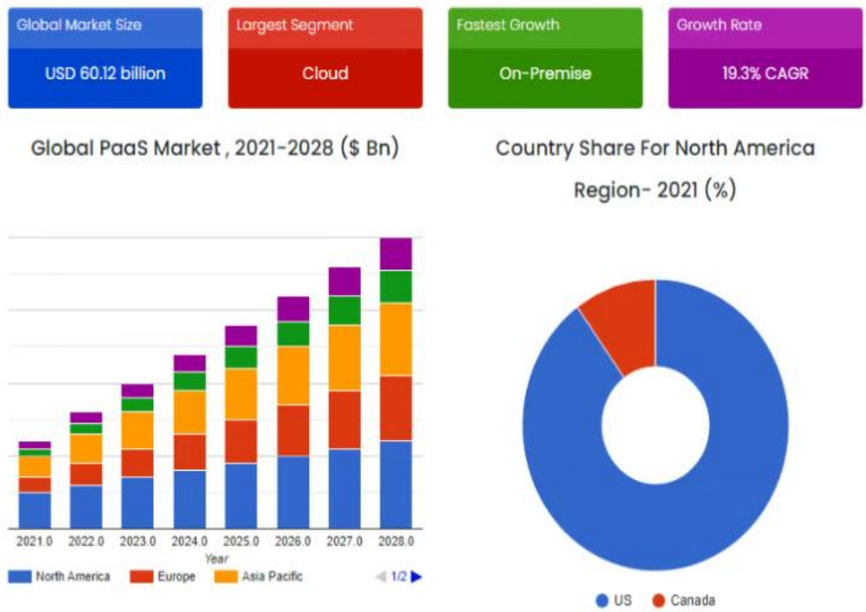

Fig : Cloud Computing Statistics

3.5.1. Defining Scalability

Scalable systems scale well under increasing workloads. Generally, a scalable system is defined as a system that efficiently handles an increase in demand by increasing resources. A scalable imaging system can handle an increase in demand by efficiently increasing the number of resources. If, in contrast, image processing slows down significantly with more workers or processors or with an increased number of images, the system is no longer scalable. Scalability refers not to the performance of a system in absolute terms but to performance variation under the growth of workload and/or resources.

A 'system' is understood in this context as an identified combination of components or modules. An imaging system may consist of the image ingest component, the parallelization and worker task assignment component, the pool of workers, the image processing component, etc. Such a system can be analyzed for its scalability. A component of the system can also be treated as a ‘system’ in its own right. For instance, the set of file workers may be analyzed for their scalability. Or, individual components or modules such as clustering, laplacian-of-gaussian, and smoothing filter functions in an image processing math library can be examined for scalability as well.

Recent developments on Serverless Cloud Computing (SCC) and Internet of Things Cloud (IoT-C) technologies have led to more interest in automatically handling a variety of workloads and attending to huge amounts of incoming data streams . Data, computation, and decision-making still need to be served and handled in a timely manner under variances in demand for service and incoming workloads. Making efficient use of allocated resources, preventing under- and over-provisioning of resources, minimizing cloud costs while maintaining a high service level, etc., are some of the research challenges in Cloud Computing, SCC, and IoT-C. Scalability is an important aspect of QA but is a relatively underexplored area of research.

3.5.2. Challenges in Scaling Financial Platforms

The transformation of various industries towards digitization and intelligence has become an irresistible trend. Digitization refers to perceiving with measurement, marking, and summarizing. Operable, tradable, and analyzable digital assets have produced an increasing number of massive and complicated data with the rapid development of the Internet, blockchain, smart sensor networks, and edge computing. Intelligence refers to the ability to perceive, recognize, predict, comprehend, reason, learn, and make decisions based on the judgments and evaluations of the significance of knowledge for a specific purpose. Intelligence has elevated the traditional data processing and analysis methods conceptually and technologically in an important sense. Cloud computing can provide an enormous computing resource pool with unrestrictedly resource access that is fully compliant with pay per use, from a few units of power to thousands of millions of millions. This advantageous computing method gives continuous advancements in the efficiencies of numerical computation, matrix computation, optimization, and machine learning. However, the inborn parallel computation method of cloud computing has posed important challenges for traditional centralized intelligence algorithms in handling current enormous and complicated information. First, the extensive migration of various personal data to public cloud platforms raises an unprecedented privacy protection problem. Privacy leakage and abuse incidents have been widely reported, harming personal users and resulting in severe lawsuits and financial losses for platform providers. Various angel companies or risk monitoring platforms have emerged to track potential privacy abuse and crime acts. Second, the complexity growth law with the increasing data scale has compelled traditional intelligence algorithms to depend on advantages that result in the difficulty of protecting existing and potentially suspicious data inputs under the monitoring of numerous cloud computing nodes. Security reduction incidents function as a kind of new data-stealing methods with the assistance of machine learning technologies. Such situations have threatened the compliance of these public cloud platforms against local security laws. Third, independent data producers who have traded their data with the cloud service provider are unable to assess the security risks of the trading instance on the huge and pervasive cloud centers, leading to fraud and default in the service contract. Such situations have plagued final users or creators very seriously and are difficult to relay complaints to the proper regions. Although the cloud service platform has professed to be compliant with the terms of service contracts, which are black-boxed and often untraceable, it becomes unnecessary to attract the trust of the cloud data.

3.6. Conclusion

As cloud computing has continued to penetrate the core operating and risk management functions of firms, data-driven analytical platforms leveraging cutting-edge data analytics and AI technologies have emerged as bespoke key enablers of financial intelligence in the financial industry. Facing the unprecedented challenges of the pandemic and a growing array of systematic risks from environmental, social, and governance (ESG) factors, stresses from geopolitical conflicts, climate change, and more, firms in the financial industries have been reinforcing their core functions. These include prudent risk management of new asset types, deeper insights about and better engagement with clients, effective and efficient compliance, and timely and informative reporting and disclosure .

Financial intelligence, as a multifaceted landscape, encompasses diverse analytical use cases across different functions and departments of firms. There is a plethora of key business problems across a wide spectrum of use cases. At the same time, cloud-based financial intelligence platforms need to follow a unified technical architecture for financial intelligence spanning across these diverse AI/ML analytics use cases. The former is about what platforms do, while the latter is about how platforms do it. To facilitate communication and further discussion with external stakeholders, a high-level agglomeration view of cloud-based financial intelligence platforms for firms is presented, highlighting the confidence intervals of the trends in the upcoming decade.

3.6.1. Future Trends

The cloud computing ecosystem is changing on a variety of levels, from new architectures to changes in cloud service use, management, and charging models.

Dramatic advancements in virtualization security are also anticipated to deter cyber attacks in the future. Cloud infrastructure is anticipated to gradually change from proprietary hardware to completely evolvable and programmable virtualized architectures to work with even more application multi-tenancy use cases. In addition to accepting a wider variety of types of data sources for the ETL process, cloud BI is expected to start incorporating AI for more excellent data mining.

More sophisticated charges are anticipated for the future use of complex BI services in the cloud. In the future, BI processes can be distributed across several On-Premise HOPEs, with the capability of dynamically moving them among the offerings as needed. In addition, cloud-based HOPEs are anticipated to become more intelligent and automated.

Next-generation cloud technology is primed to undergo unique changes to be entirely effective. Future cloud systems will aim to become more ambient, pervasive, and ubiquitous in terms of users and devices. The push to deploy larger numbers of vastly different devices, sensors, and clouds will continue to facilitate the efforts of the IoT and greater proliferation of ubiquitous/peg computing.

Additionally, as the power and size of hardware accelerators increase, especially in the coming years, the AaaS space is anticipated to grow in parallel with their use. In line with the overall trends of the service sphere toward specialization, hardware accelerators are anticipated to proliferate and diversify in cloud space. Services may target specific application areas through a diverse mixture of general purpose and standard hardware accelerator offerings. Multiple hardware parameters, such as number of cores, memory size, interconnection architectures, and physical form factor, will likely illustrate the diversity of offerings for cloud-based hardware.

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