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MAPPING PARTNERSHIPS IN THE GLOBAL CLOUD PLATFORM ECOSYSTEM: A NETWORK ANALYSIS

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ABSTRACT

As a distributed computing paradigm, cloud computing has removed the geographical and physical limitations of computing resources and storage, making it a key driver in the development of the contemporary internet economy. With the rapid advancement of cloud computing technology and the diversification of market demands, cloud services have adopted platform models that integrate multiple business and development needs. Leading cloud platforms increasingly build their own business ecosystems, reshaping the industry landscape of cloud computing.

Recognizing the growing influence of platforms, scholars in communication studies and business management have begun to adopt an ecosystem perspective to analyze the multifaceted interactions between platforms, partners/complementors, and consumers. However, cloud platform ecosystems have not received sufficient academic attention. This study integrates theories from platform ecosystem research in both fields and employs network analysis to map the partnership networks of five globally leading cloud platforms—AWS, GCP, Salesforce, Oracle Cloud, and Alibaba Cloud. By analyzing the topological structure of these networks and the interactions between platforms and their partners, this study reveals the characteristics and dynamics of the global cloud computing ecosystem.

The findings indicate that the cloud computing ecosystem primarily consists of multiple communities centered around cloud platforms. The formation of these partnership networks is influenced by the 'walled garden' strategies and most partners establish partnerships with only a single platform, with the partnership level being generally low. Platform support and resources are often concentrated among a small number of partners who possess significant advantages in technology, talent, and market presence, resulting in a distinctly uneven distribution. Additionally, the study identifies a small subset of multilateral partners within the ecosystem that collaborate with multiple platforms. These multilateral partners are typically well-established global IT consulting and service firms that exhibit higher-than-average partnership levels across platforms. Their strong resource capabilities enable them to engage in deeper collaborations with multiple platforms, creating a 'strong alliance' dynamic within the partnership ecosystem.

This study not only provides new insights into understanding the business ecosystems of the cloud computing industry but also sheds light on the complex interactions between platforms and partners. It contributes to both theoretical research and practical applications of cloud computing and its platform model, inspiring future research to examine the dynamic development of the global cloud computing platform ecosystem.

INTRODUCTION

Cloud computing technology has profoundly transformed the infrastructure and business models of the internet, becoming a key driver of digital transformation. With continuous technological evolution and diverse market demands, cloud computing not only provides computational resources and storage services, but has also gradually evolved into a multifunctional ecosystem using a platform model for integration, establishing itself as a significant type within the platform economy (Srnicek, 2017). In the context of the platform economy, platforms are increasingly becoming the infrastructure of contemporary society, offering essential support for various services and business activities (Plantin et al., 2018).

Within this platform ecosystem, cloud computing platforms also serve as foundational infrastructure for other platforms, supporting their operations and development (Van Dijck, 2021). Consequently, cloud computing platforms have become a crucial driver of the expansion of the platform economy while simultaneously advancing their own growth (Narayan, 2022). Like other developments within the platform economy, the cloud computing industry, characterized by an oligopolistic market structure, sees a few leading platforms building and expanding their business ecosystems through collaboration with a wide range of third-party vendors, developers, and service providers. As cloud environments continue to grow increasingly complex, they require greater support to maximize the return on customers' investments within these environments. As a result, customers are increasingly reliant on partners to assist with the effective planning, creation, and management of these environments. This is why, when visiting the official websites of major cloud platforms, one often sees a diverse, comprehensive, and professional partner network prominently highlighted as a key competitive advantage of their cloud services. It is the mutually beneficial partnerships that ensure the innovation, vitality, and competitive edge of cloud computing platform ecosystems, enabling them to maintain strong resilience and growth potential in the rapidly evolving digital economy landscape.

There is a growing body of scholarship focusing on platform ecosystems and partnerships. On one hand, some perspectives stem from management and organizational studies, where the business ecosystem approach is applied to platform research (e.g., Alaimo et al., 2020; Kretschmer et al., 2022). On the other hand, communication studies contribute by examining platforms' technological architectures, regulatory power, and increasing societal influence (e.g., Van Dijck, 2021; van der Vlist, 2022). However, two key research gaps have emerged. First, there is a divergence in how these perspectives conceptualize platform ecosystems: management studies often adopt a micro-level approach, focusing on ecosystems centered around a single platform and its interactions with various actors; in contrast, communication studies tend to adopt a macro-level view, examining broader industry dynamics and the role of multiple platforms within a platform society. These two perspectives, while distinct, could complement each other. Second, there is a notable lack of research that applies the platform ecosystem perspective specifically to cloud computing and its services. Furthermore, studies that focus on the partnerships within cloud platforms are almost nonexistent. This is the primary theoretical and empirical concern that this paper aims to address.

The structure of this paper is as follows: the first chapter focuses on the theoretical foundation, providing a comprehensive literature review on the research subject of 'cloud platforms' and the core concept of the 'platform ecosystem'. This section emphasizes the integration of perspectives from communication studies and business management, highlighting the importance of understanding the platform ecosystem from multiple disciplinary viewpoints. It also introduces the conceptual framework based on this theory, along with the specific research questions and hypotheses that guide the study. The second Chapter addresses the research design and methodology, discussing the rationale for choosing network analysis as the primary research method. It includes a review of relevant studies that have employed network analysis in related fields, demonstrating the suitability and effectiveness of this approach for examining platform ecosystems. Building on this foundation, the section details the selection of samples, data collection methods, and data processing procedures used in this study. It also provides a critical reflection on the limitations of the methods and data, acknowledging the constraints and challenges encountered during the research process. The third chapter presents the analysis and discussion. It begins by constructing a partnership network to analyze the sample data, using general statistical indicators to describe the structural characteristics of the cloud platform ecosystem's network. It then focuses on the differences and specific characteristics of partnerships across various platforms, examining the interactions between platforms and partners in conjunction with additional materials. Furthermore, the last section delves into the subset of multilateral partners, constructing a separate network based on their data set to investigate the characteristics of multilateral partners, their interactions with platforms, and their overlap with high-level partnership partners. Finally, the research concludes with a summary and reflection on the partnership network characteristics within cloud platform ecosystems.

THEORETICAL CHAPTER

This chapter is organized into three sections. The first section introduces key concepts and theories related to the study, reviews critical theoretical and empirical literature that has inspired this research, and highlights the current research gap. Building on this literature review, the second section establishes the theoretical framework for the study. The third section identifies the primary research questions and sub-questions, grounded in the identified research gap and relevant practical issues.

Literature Review

This section is divided into three parts: first, it discusses the evolution of cloud computing from a technology to a service platform and clarifies key concepts; second, it compares the differing perspectives on 'platform ecosystems' between the fields of communication studies and management and organization study, and then highlights the unique position of cloud computing platforms within this ecosystem; finally, it reviews key literature on platform ecosystems that focuses on partnerships, which has informed and inspired this research.

The Platformization of Cloud Computing Service

Cloud computing today is not just a technology but a socio-technical system that provides services through a platform model. The concept of computing as a scalable utility began to take shape in the latter half of the 20th century. Central to this idea was the notion of delivering computing resources on-demand, similar to utilities like water, electricity, and gas, ultimately enabling a pay-as-you-go model for computing services (Amoore, L. 2018). Entering the 21st century, the advent of cloud computing marked the gradual realization of this vision. As a scalable computing technology, cloud computing has not only transformed how individuals and businesses compute but has also enabled the migration of data storage, computing and analysis from traditional personal PCs and private servers to massive internet-based data centers.

The architecture of cloud computing forms a service ecosystem by aggregating different service types, most notably including Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) (Kushida et al., 2015). IaaS, the foundational mode of cloud computing services, allows providers to lease the computational capacity of hardware infrastructure (such as servers) as a service, thereby eliminating the need for customers to invest in expensive local IT hardware configurations. SaaS predates the widespread adoption of cloud technology, with the earliest example dating back to 1999 when Salesforce introduced its Customer Relationship Management (CRM) platform—the first SaaS solution built from the ground up (Fryer, 2023). This innovation allowed users to lease ready-made software directly via the internet, further reducing software costs for businesses. Since the launch of Amazon Web Services' (AWS) Elastic Compute Cloud (EC2) in 2006, PaaS has grown into a significant service category, providing a platform for application development and deployment in the cloud, significantly easing the technical management burden on customers. Additionally, with the rise of new technologies such as AI, cloud platforms like Alibaba Cloud have introduced new service types like MaaS (Model as a Service), which treats AI models as fundamental production elements, allowing customers to access, use, and integrate these models at a low cost. While some scholars equate cloud platforms entirely with PaaS (Giessmann & Legner, 2016), this is inaccurate. The continuous evolution of the XaaS model has turned cloud computing into an integrated service ecosystem, where various service layers collaborate to provide users with a highly flexible and scalable computing environment. This evolution is inherently a gradual platformization of cloud computing.

The transformation from cloud computing to cloud platforms is not merely a technical innovation but also an innovation in applying the platform model to cloud service business models. Some management scholars describe this evolution as platformization based on ‘decoupling’, emphasizing its core as creating opportunities for access and interaction centered around the core service (platform) within an ecosystem of consumers, complementors, and other stakeholders (Benlian et al., 2018). In this ecosystem, the collaboration and interaction among various parties become key to realizing platform value. The success of cloud platforms depends not only on their technical capabilities but also on the ability to strategically design pricing models, maximize revenue, establish business barriers, capture market share, and build their own business ecosystems and commercialization strategies. These strategies include generating profits through leasing cloud computing resources and maximizing commercial gains through platform economics. These tasks place higher demands on cloud platform operators, requiring them to take the initiative in market competition and rapidly adapt to market changes.

As technology companies like Amazon, Google, and Alibaba establish their own cloud infrastructures and platforms, they have gradually developed business models centered on the platform model. By constructing and operating massive data centers and cloud platforms, these companies not only provide computing services to users but also maximize their commercial profits through the logic of platform economics. As Srnicek (2017) points out, contemporary capitalism has adopted platforms as a new business model for extracting and controlling vast amounts of data, which has emerged as a core method for maintaining economic growth and vitality. Cloud platforms have become one of the main types of platform economy, similar to advertising platforms, product platforms, etc., each adhering to the logic of platform capitalism and forming its unique business model and logic. Moreover, the process of platformization of cloud computing can also be understood as a process of assetization of technical infrastructure (Birch, 2020). In this process, technological assets are transformed into services through leasing models and ultimately monetized through platformization. In other words, platforms are not merely an integration of technology and services; they are also tools of capitalization and commercialization. Through these tools, companies can convert their technological advantages into sustainable economic benefits and secure a significant position in the market.

In summary, the process of platformization from technology to service in cloud computing has not only altered traditional computing models but has also given rise to new business ecosystems and economic forms. The platform-based business model has not only helped cloud computing companies consolidate their market positions but has also enabled efficient allocation of cloud computing resources, thereby driving the rapid development of the cloud computing industry globally.

Platform Ecosystem

Research on cloud computing often adopts two perspectives: one views it as a form of technological innovation, while the other emphasizes the management of technology assets and their business value (Venters & Whitley, 2012). Scholarships in communications on cloud platforms typically adopts political economy and technical perspectives, focusing on platform integration models, technological evolution, and their broad socio-economic impacts. These studies emphasize the potential roles of cloud platforms in resource integration, efficiency enhancement, and social governance, delving into how platforms reshape traditional industry structures through technological innovation and market forces (e.g. Srnicek, 2017; Narayan, 2022). However, these perspectives can sometimes be overly focused on macroeconomic and technical analyses, often neglecting the complex interaction mechanisms within platforms and the micro-level dynamics among various stakeholders.

In contrast, management and organization studies were quicker to conceptualize platforms as ecosystems. By adopting this ecosystem perspective, researchers can gain a more comprehensive understanding of the complex relational structures within platforms, particularly the interactions and cooperation between platform owners, complementors, and third-party entities. Indeed, within the business context, the platform model has consistently been a focal point in 'ecosystem' studies. Initially, scholars viewed platform economies as multi-sided markets, primarily emphasizing the direct economic relationships between platform owners and complementors or third-party entities (Rieder & Sire, 2014). This multi-sided market perspective highlights the platform's role in coordinating supply and demand, facilitating transactions, and reducing market friction. However, this view often oversimplifies the situation, overlooking the structure of interdependence among actors and the complexity of partner relationships and links. This complexity manifests in various aspects, including technological collaboration, market positioning, resource sharing, and profit distribution.

According to Adner (2017), the concept of an ecosystem can be understood as 'the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize'. This concept underscores the importance of partner alignment and multilateral links in the complex web of relationships, where the actions and decisions of each participant influence one another, collectively driving the realization of value within the ecosystem. Hence, the application of the ecosystem concept has gradually become a significant focus in platform research. Through this lens, researchers can not only explore how platforms coordinate various forces to achieve their business objectives but also deeply analyze the mechanisms through which these forces are formed and maintained within the platform (Alaimo et al., 2020). This research approach offers a more comprehensive and effective framework for explaining the complex industry dynamics of platform economies. Traditional conceptual tools, such as supply chain analysis, often emphasize linear relationships and unidirectional dependencies, failing to adequately capture the multidimensional and multi-layered complexity of interactions in platform economies. Therefore, the ecosystem perspective not only addresses the shortcomings of traditional research methods but also provides new theoretical tools and practical guidance for understanding and optimizing platform business models.

In the field of communication studies, research on platform ecosystems originates from a different perspective. As platform economy gradually becomes the central business model in contemporary capitalism, platforms are widely adopted across various industries for the integration and distribution of resources (Srnicek, 2017). This widespread application has transformed platforms from mere technical tools into infrastructure-like entities that deeply permeate various societal levels and sectors (Plantin et al., 2018). Through this process, our society is increasingly evolving into a 'platform society' (Van Dijck et al., 2018), where platforms serve as core nodes, connecting industries and societal sectors into a complex network of interactions. As the role of platforms continues to expand, scholars have begun to employ broader concepts and frameworks to explain and analyze the power and influence of platforms in society. This research not only focuses on the technical functions of platforms but also explores their position within social structures and their profound impact on economic and social dynamics.

Benjamin Bratton (2016) introduced the concept of the 'stack', offering a unique perspective for understanding the multi-layered structure of platforms. He argues that the technologies and applications of platforms are diverse, arranged in an orderly fashion, and closely interconnected, much like the layers of an architectural structure. In this framework, different platforms, such as smart grids, cloud computing, and mobile applications, do not evolve as independent entities. Instead, they function as components of a new computational apparatus, collectively forming a novel governance architecture (Bratton, 2016). Within this theoretical framework, cloud computing plays a crucial role as one layer within the platform technology stack. However, as the power of platforms continues to grow, they have transcended their original role as mere aggregations of technology. Platforms are increasingly infiltrating the realm of social infrastructure and are forging deeper connections with political and economic systems. Simultaneously, the variety of platforms has expanded, and their internal dynamics have become increasingly complex. Therefore, while the 'stack' concept provides a foundational understanding of platform technology composition, it may not fully capture the complexity and dynamic nature of contemporary platform ecosystems (Van Dijck, 2021). In fact, platforms are not just a part of the technological stack; they are also central nodes within a larger online media ecosystem (Donovan, 2019).

Moreover, platforms have, in many cases, become the backbone of ecosystems themselves, or even the core of entire ecosystems. One of the most comprehensive theoretical models of platform ecosystems in the field of communication studies is Van Dijck's 'tree-shape model' (2021). In this model, all platforms are positioned in the trunk layer, acting as intermediaries of data, connecting industrial and societal sectors in the branch layer, and linking to infrastructure providers in the root layer. This 'tree-shape model' (see Figure 1) illustrates how the roots of digital infrastructure converge in the intermediary platform trunk, which then extends into various industrial and societal sectors. These sectors, in turn, grow their own branches and leaves, forming a 'living' dynamic system that is constantly evolving and co-shaping its species. Notably, in Van Dijck's 'tree-shape model', cloud services are positioned at the base of the trunk, serving as a crucial link between the trunk and the roots of digital infrastructure. This placement underscores the foundational and critical role of cloud computing within the entire model, indicating that cloud computing is not merely a component of platform technology but rather the core infrastructure that supports the operation of the entire ecosystem. Narayan (2022) and other scholars further develop this perspective, emphasizing that cloud computing functions as vital infrastructure rather than as a platform within the ecosystem. Specifically, cloud infrastructure drives the growth of the outsourcing economy and serves as one of the fundamental drivers behind the expansion of platform economies.

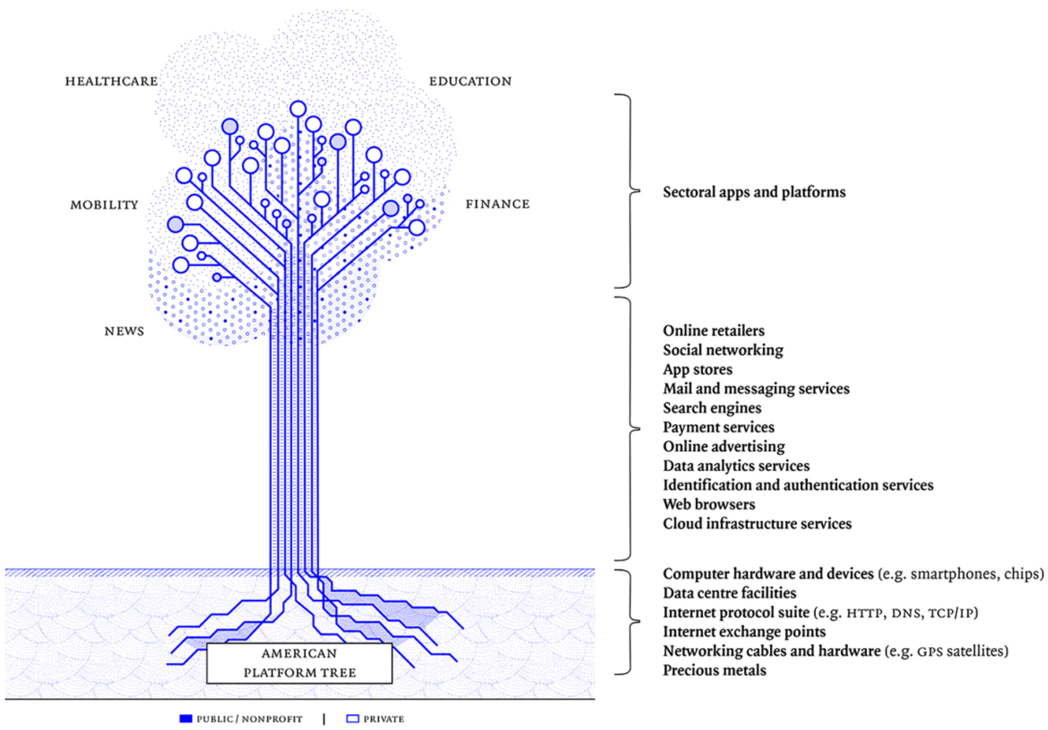


Figure 1 The 'Platform Tree' Model by Van Dijck (2021)

It is important to clarify that the understanding of platforms as ecosystems in this context does not refer to a single platform's services constituting an ecosystem (Alaimo et al., 2020). Instead, it refers to the broader industry and market environment in which all platforms operate, collectively forming a complex ecosystem. Within this ecosystem, platforms engage in intricate interactions with their respective industries and markets. However, some scholars have identified limitations in Van Dijck's model, noting that it may overlook the contextual positions of service providers, users, and governance entities, all of which are crucial stakeholders within the ecosystem (Tang, M., 2022). Despite this recognition, further research on this issue remains limited. However, this aspect has been emphasized in management and organization studies. Figure 2 presents the ecosystem-based value system proposed by Jacobides et al. (2018). As shown, the term 'platform ecosystem' refers to a smaller-scale ecosystem centered around a single platform. In this model, upstream suppliers in the value chain are considered 'outside the ecosystem', while the main roles within the ecosystem are the focal firm product, complementary players, and consumers. This article will draw on this model to supplement the understanding of the platform ecosystem within the field of communication studies.

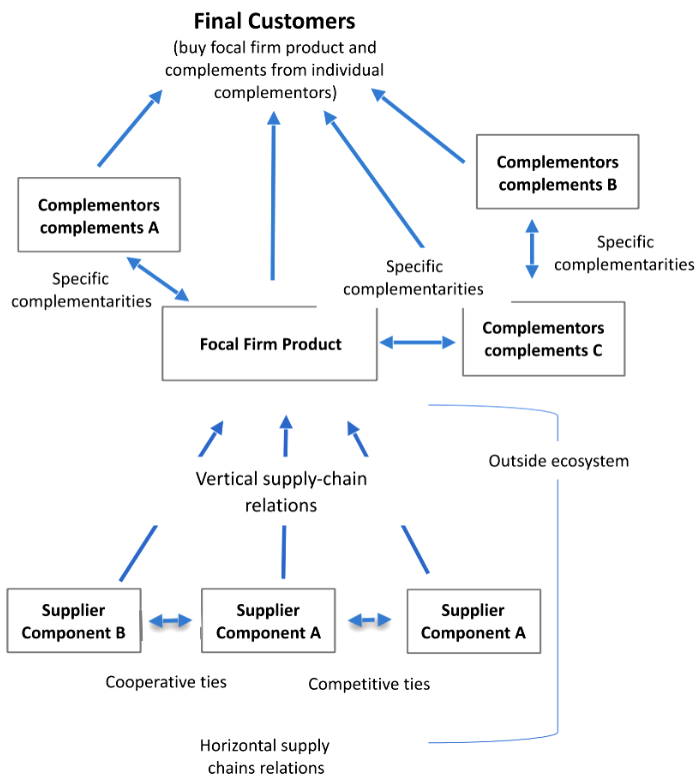


Figure 2 The Ecosystem-based Value System by Jacobides et al. (2018)

Cloud Platform and Partnership

When accessing the official website of a cloud service platform and navigating to the partnership page, one often encounters slogans like 'Welcome to our partner ecosystem/network'. This not only highlights the platform's emphasis on its partners but also reflects its strategic vision of establishing itself as an ecosystem. The concept of this ecosystem here extends beyond technical considerations and is predominantly understood from a business perspective. How to comprehend a cloud platform as an ecosystem in this context?According to the aforementioned model (Jacobides et al., 2018), an ecosystem consists of the platform's sponsor and all complementors that enhance the platform's value to consumers. By connecting to the platform, these complementors can foster complementary innovation and gain direct or indirect access to the platform's customer base. In the cloud computing service industry, suppliers typically refer to hardware manufacturers, who are not considered part of the cloud platform ecosystem. Instead, the ecosystem's core entity is the platform itself, the cloud service provider.

Additionally, various types of complementors act as intermediaries between the platform and consumers, delivering services that are co-provided by the platform and its complementors, who are strategically labeled as 'partners' by the platform. In this sense, Jacobides et al. distinguish two types of complementarity within an ecosystem: one where 'A doesn't function without B' and another where 'more of A makes B more valuable' (Jacobides et al., 2018). Cloud platform partners typically fall into the latter category. These partners play a crucial role in service delivery, business process optimization, and meeting personalized customer needs. As Salesforce has stated, partners have made an incredible impact across it and are involved in with almost every Salesforce customer: 'In fact, nine out of 10 Salesforce customers rely on partner apps and experts' (Berg, 2021). Therefore, studying cloud platform ecosystems requires a close examination of the interactions between platforms and partners, as well as the complex network structures they form.

Scholars in both communication and management studies (e.g., McIntyre & Srinivasan, 2017; Helmond et al., 2019; Kapoor et al., 2021) have actively called for greater attention to the role of partners within platform ecosystems, despite the fact that there are deep power asymmetries between the dominant platform and its partners (Nieborg & Poell, 2018). The term 'partner' can be replaced with 'complementors', etc., depending on the specific type of platform. The shared meaning refers to all actors within the platform ecosystem, aside from the dominant platform and customers, who positively contribute to the ecosystem. For example, Helmond et al. (2019) investigated Facebook's corporate partnerships and the expansion of its platform boundaries, tracing the evolution of Facebook's partner ecosystem and partner categories. They found that the focus of these partnerships shifted from working with developers to engaging with advertisers and marketing developers, that is, broader media and content partners, thereby extending Facebook's power and establishing it as platform infrastructure. van der Vlist & Helmond (2021) examined partnerships within social media ecosystems, revealing how advertising, marketing, and data partners mediate and shape platform power. In these ecosystems, platforms and partners hold audience data in a distributed manner, while platforms control partners through mechanisms such as agreements and APIs. These alliances, reinforced by exclusionary mechanisms, have driven the completion of platform B2B ecosystems and the infrastructuralization of platforms. Rietveld et al. (2020) studied how the growing dominance of multisided platforms like app stores and Steam influences the status, impact, and value production of complementors within ecosystems. They observed that as platforms grow within the ecosystem, the total value created at the ecosystem level increases, but the average demand for individual complementors declines and becomes more concentrated. These studies conceptualize the network of interactions between platforms and other actors (partners, complementors, consumers) as an ecosystem, focusing on their evolving status and power dynamics.

However, as a significant type within the platform economy and a critical infrastructure of the platform society, the ecosystem and commercial partnerships of cloud computing platforms have yet to be adequately examined. Although the value of cloud platforms as third-party service partners has been studied (e.g., Schreieck et al., 2021; Liu et al., 2016; Narayan, 2023), research specifically addressing the ecosystem perspective within the cloud computing industry itself is scarce. For instance, Narayan (2023) investigated how Indian startup software companies develop cloud-based software by renting cloud infrastructure services, exploring new scenarios affecting platform monopolies and competition. However, there is a notable lack of scholarly work applying an ecosystem perspective to examine the interactions between cloud platforms and their partners. To better understand how complementors support the platform, it is necessary to investigate their attributes and structural positions within the platform-complementor ecosystem (McIntyre & Srinivasan, 2017). Thus, further research into the topologies of global dominant cloud service platforms and their partnerships is essential for a more comprehensive understanding.

Conceptual Framework and Research Questions

The conceptual framework of this study is grounded in the fields of communication studies and management research. It builds upon a review of theoretical and empirical studies on platform ecosystems, focusing specifically on cloud computing service platforms. By examining the partnerships between dominant platforms and their complementors, this study maps out the structure and characteristics of their ecosystems. In the cloud platform partnership network constructed in this study, the concept of the 'platform ecosystem' can be understood from both a micro and macro perspective. On one hand, drawing from ecosystem theories in business research, the study constructs small-scale ecosystems centered on individual cloud platforms, each comprising multiple partners. These small ecosystems reflect the uniqueness and diversity of different cloud platforms in their ecosystem-building strategies. On the other hand, the study adopts Van Dijck's perspective (2021) on platform ecosystems, where multiple sub-ecosystems, each centered on a single platform, are integrated into a larger ecosystem. This macro-level approach helps to uncover the systemic characteristics of the cloud computing industry as it leverages platform models for integration. Therefore, the definition of the core concept of the 'platform ecosystem' in this study integrates dual perspectives from different disciplines. This approach allows for a more in-depth analysis of the complex dynamics within the cloud computing industry.

This integrative approach resonates with scholars such as Narayan (2023) and van der Vlist and Helmond (2021). van der Vlist and Helmond argue that analyzing the organizational structure of platform ecosystems can reveal diverse relational networks and provide insights into platform power from various angles. Narayan also emphasizes that platform studies are increasingly recognizing the limitations of focusing solely on dominant technology companies as isolated entities and are shifting towards examining networked relationships. In this context, critical platform studies should draw from management and organizational literature on ecosystems to more comprehensively understand the complexity and dynamics of platform ecosystems.

Therefore, the research question of this paper is:

What are the features of the industrial ecosystem of cloud service platforms, and how do platforms interact with their partners?

To address this general question, this study breaks it down into several sub-questions:

Sub-question 1: What is the topology of the partner network?

Sub-question 2: What differences exist between partner networks of different cloud platforms? Do different platforms have different levels of cooperation with partners?

Sub-question 3: Which partners overlap across multiple cloud platforms? Do multilateral partners have higher collaborative level with platform compared to unilateral partners?

In addition to the complexity arising from the power asymmetry symbiotic relationship and between platforms and partners (Rietveld et al., 2020), this paper posits three hypotheses:

Hypothesis 1: More powerful platforms (those with a larger market share) have stronger partnerships compared to other platforms.

Hypothesis 2: Due to commercial competition and the existence of platform walled gardens, only a small fraction of partners maintain partnerships with multiple dominant platforms simultaneously.

Hypothesis 3: Partners with high-level partnerships often overlap significantly with multilateral partners (i.e. those who maintain a high degree of partnership with a platform are frequently the same partners that collaborate across multiple platforms).

RESEARCH DESIGN AND METHODOLOGY

This chapter is divided into two sections. The first section focuses on the methodology, network analysis, including the rationale behind the selection of this method, a review of relevant literature, and the application of this method in the current study. In light of the characteristics of the research object and the limitations of the available data, the study has made specific choices and adaption to the research method. The second section addresses data collection and preprocessing, offering a detailed account of the selection of cloud computing platform partnership samples, the procedure of data collection, and the processes involved in data preprocessing, accompanied by reflections on the data limitation. This section lays the groundwork for the subsequent data processing and analysis.

Partnership and Network Analysis

Social Network Analysis (SNA) is an effective analytical method for examining relational data, particularly well-suited for studying the infrastructure, content, participants, and processes within the field of communication (Scott, 1992; Friemel, 2017). The core of network analysis is its focus on the interconnections among entities—such as media content, individuals, or organizations—rather than treating them as isolated units. This approach is especially valuable for analyzing commercial entities that are linked through various types of relationships. For example, the relationships between businesses can include multiple forms, such as customer, supplier, partner, and competitor. These relationships may exist in different combinations among various entities and can dynamically evolve over time (Basole, 2008).

In the context of this study, the interactions between cloud platforms and their business partners fundamentally represent relationships among actors. Cloud platforms recruit third-party service providers to become certified partners within their ecosystems. These partners offer a range of complementary services to customers, such as data analysis, data migration, integrated marketing, and consulting services, while receiving commercial and technical support from the platform as certified partners (Califf et al., 2016). Thus, if we conceptualize the cloud platform ecosystem as a complex network, the platforms and their partners are the nodes within this network, and their collaborative relationships form a network centered around the platform. This network structure can be further viewed as comprising multiple subnetworks that aggregate into a larger ecosystem. Although the entirety of the cloud computing industry's ecosystem network cannot be fully captured, analyzing a subset of these nodes and their interrelations can still reveal key structural characteristics and dynamics of the ecosystem.

The focus of network analysis is on various network attributes, such as clustering properties and the distribution of node centrality. A fundamental axiom of network analysis is that a node's position within the network partially determines the opportunities and constraints it encounters (Borgatti et al., 2009). For instance, all other variables being equal, a platform that serves as a central node with more connections to other nodes likely possesses greater access to partnership resources. Conversely, if a partner node is connected to multiple platforms, it suggests that this partner has a higher level of adaptability to different platform technologies and offers a more diverse range of services.

Therefore, by analyzing the positions and attributes of nodes within the cloud platform ecosystem, one can better understand the 'opportunities' and 'challenges' these nodes face in business collaboration. In addition, another significant advantage of network analysis lies in its capacity for visualization. By visualizing relational data, it becomes easier to discern structures, patterns, relationships, and themes that may not be immediately apparent from the raw data. This process helps uncover hidden insights within the data. While small networks are often effective for highlighting specific connections and interactions, large networks primarily capture the overall topology and provide a more abstract representation of the network structure, thereby revealing the general characteristics of the ecosystem (Moody et al., 2005). Analyzing network metrics such as node degree, centrality, overlap, and modularity can provide deeper insights into the complex structure and functional characteristics of the cloud platform ecosystem.

Several studies in related fields have successfully employed network analysis, providing valuable insights that have inspired the present research. For instance, van Angeren et al. (2016) investigated the collaborative network relationships of application developers within the distinct platform ecosystems of Google and Microsoft. They treated companies as nodes and examined network characteristics such as clustering. Their data were collected through a combination of web scraping scripts and manual methods, while also acknowledging the data's incompleteness. Similarly, Helles et al. (2020) tracked third-party service (TPS) data used by the 150 largest websites in the EU region, deriving their data from TPS metadata and focusing on characteristics like the number and proportion of nodes of specific categories. van der Vlist and Helmond (2021) analyzed partnership data from the top 20 social media platforms, investigating the mediating role of business partners on dominant social media platforms. Their data were obtained from publicly available partner directories across various platforms, as well as additional directories derived from a subcategory of partners, with a focus on parameters such as the number and proportion of different types of nodes. These studies demonstrate that, in applying network analysis to related fields, scholars often prioritize network scale, node count, and the proportions of nodes with distinct characteristics—mainly due to data limitations and specific research objectives.

The present study, which examines the characteristics of cloud platform ecosystems, follows a similar approach. Additionally, it is important to note that two general types of networks can be distinguished based on the number of node sets involved: unimodal and bimodal networks (Friemel, 2017). In unimodal networks, each node can potentially connect with any other node, allowing for a fully interconnected structure. In contrast, bimodal networks consist of two distinct sets of nodes, where connections are only allowed between nodes belonging to different sets, not among nodes within the same set. In this study, the platform-partner relationships are considered as a bimodal network, thereby excluding connections between partners and between platforms.

Data Collection and Processing

To investigate the ecosystem of global cloud service platforms, this study focuses on the dominant cloud platforms in the global market and their partnerships. The global cloud services industry is characterized by an oligopolistic market structure. According to the Cloud Provider Market Share statistics for Q4 2023, the top three cloud service providers—Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP)—together hold a 66% market share (31%, 24%, and 11% respectively). The top eight providers globally—adding Alibaba Cloud, Salesforce, IBM Cloud, Oracle Cloud, and Tencent Cloud to the aforementioned three—account for 79% of the market share (Synergy Research Group, 2024). The partnerships of these platforms largely reflect the ecosystem of the global cloud market. Considering data accessibility and completeness, 5 platforms (AWS, GCP, Salesforce, Oracle Cloud and Alibaba Cloud) were ultimately collected as the sample.

The data for this study is sourced from publicly available partnership directories on the official websites of multiple cloud platforms. These websites typically feature dedicated partner pages that serve two main purposes: 'find a partner' for consumers and 'become a partner' for third-party companies. Nearly all major platforms disclose either their complete or partial lists of partners to some extent. Typically, these lists can be filtered by various criteria, such as region, industry, and service type. However, significant differences exist between platforms in how they recruit, categorize, and rate their partners, resulting in considerable variation in how partnership directories present and evaluate partner information. For example, AWS's most important evaluation criterion for partners is AWS competencies, defined as 'Partners associated with these AWS Competencies have demonstrated the highest level of specialization, deep AWS technical expertise, and proven customer success'[1], which refers to the service capabilities of partners certified by AWS. Research indicates that 87% of customers consider AWS Specializations to be among the top three criteria for selecting a

[1] See https://aws.amazon.com/cn/partners/programs/competencies/ for more information.

partner, while 60% of customers regard specializations as the most important criterion in their partner selection process (Canalys, 2023). Similar criteria include GCP's 'Specialization'[2] and Salesforce's 'Salesforce Expertise'[3], although there are specific differences in their evaluation methods. Additionally, AWS includes some highly qualified partners in 'Partner Programs', and similar initiatives can also be found on GCP. However, AWS's 'Service Validations' and Salesforce's 'Premier Partner' are platform-specific evaluation standards that do not have equivalent metrics on other platforms. It is evident that the metadata concerning partner information is quite heterogeneous in terms of type and structure, necessitating the selection and reprocessing of platforms and data to establish a dataset with a unified structure.

This study utilizes custom Python scripts to scrape partnership data from the official websites of leading cloud service providers. I reviewed the partnership directories of the top eight global cloud service providers. However, due to limitations in website configurations and the degree of public accessibility, partnership information for Microsoft Azure, IBM Cloud, and Tencent Cloud could not be effectively retrieved. Consequently, the final dataset comprises partnership data from five platforms (AWS, GCP, Alibaba, Salesforce, and Oracle), totaling x entries. During the data collection process, I observed substantial variability in the type of partner information disclosed by each platform, resulting in different data metrics. For instance, the partner data for AWS includes Company names, AWS Competencies, Partner Programs, and AWS Service Validations, while Salesforce provides information such as Company names, Certified Experts, and Salesforce Expertise. Table 1 presents the specific sample sizes and metrics collected from each platform during the initial data collection phase.

[2] Specialization is the highest technical designation a partner can earn. Partners who have achieved a Specialization in a solution area have an established Google Cloud services practice, consistent customer success, and proven technical capabilities, vetted by Google and a third-party assessor. See https://cloud.google.com/partners?hl=en for more information.

[3] Salesforce measures and validates a partner's expertise based on three attributes: knowledge of Salesforce products, experience in projects delivered, and quality of customer experience. See https://appexchange.salesforce.com/learn/how-to-find-the-right-salesforce-certified-partner-expert for more information.

Table 1 Overview of sample sizes and metrics obtained from each platform during the initial data collection phase

Platform	Number of Partners (Original)	Metrics of Partnership
Amazon Web Services	8482	Company Name, AWS Competencies, Partner Programs, AWS Service Validations
Google Cloud Platform	11165	Company Name, Specializations, Premier Partner, Initiatives
Salesforce	3043	Company Name, Certified Experts, Salesforce Expertise
Oracle Cloud	741	Company Name, Expertise
Alibaba Cloud	195	Company Name
Sum	23626	-

To construct a structured dataset suitable for further analysis, this study involved the filtering, integration, and scaling of the raw data. First, in the filtering process for the AWS partner list, I selected AWS Competencies as the primary metric to assess the depth of partnership and the level of recognition a partner receives from the platform. Partners without at least one AWS Competency were considered as not having achieved substantial collaboration with the platform (i.e., merely registered as 'partners' without further endorsement). Out of the total 8,482 AWS partners, this criterion yielded 1494 valid data points. Similarly, for the GCP platform, I used the presence of at least one Specialization as the filtering criterion, which resulted in 491 valid data points from a total of 11,165 partners. For Salesforce, partner competencies are evaluated through different levels of Expertise, which are categorized into three levels: Level I, Level II, and Expert, with respective values assigned as 1, 2, and 3. By calculating the total sum of all Expertise subcategories, I established a comprehensive metric for measuring the depth of partnership for each partner. Based on this metric, 814 valid entries were extracted from a total of 3,043 Salesforce partners. For Oracle, the total number of Expertise served as the metric to evaluate the depth of partnership, and based on this measure, 720 valid entries were selected from 741 partners. As for Alibaba Cloud, since no specific assessment criteria were disclosed for its partners, I retained 192 partners and assigned a uniform partnership level of 1 to each. To ensure comparability across different platforms and to observe variations in partnership levels within the network, all partnership level value were scaled to a range of [0, 1] using the Min-Max Scaling method, with a value of 0.001 added to all to eliminate zero values. The structure of the processed sample data is presented in Table 2.

Table 2 Structure of the processed sample data after filtering and standardization of metrics

Platform	Number of Partners (Preprocessed)	Metrics of Partnership (Normalized)
Amazon Web Services	1494	Company Name, AWS Competencies
Google Cloud Platform	491	Company Name, Specializations
Salesforce	814	Company Name, Salesforce Expertise
Oracle Cloud	720	Company Name, Expertise
Alibaba Cloud	192	Company Name
Sum	3711	-

The limitations of this dataset require detailed explanation. Firstly, due to differences in website design structures and the varying degrees of data accessibility, it was not possible to obtain complete data for all 8 platforms. This lack of comprehensiveness in data collection can affect the integrity of constructing and analyzing the cloud platform ecosystem network. Secondly, due to the varying standards and evaluation criteria for partner admission across different platforms, it is challenging to make straightforward and effective comparisons of the partnership levels. Although we attempted to standardize and consolidate the data structures of different platforms during the preprocessing stage, the inconsistency in the criteria used by each platform for partner selection, evaluation, and ranking results in a degree of heterogeneity among the data. This heterogeneity leads to discrepancies in the meanings of partnership metrics across different platforms, which may cause interpretative bias when making cross-platform comparisons. Despite these limitations, this dataset can still provide insights into the fundamental characteristics of cloud platform ecosystems and their partnership relationships, and it can help address the research questions posed in this study.

ANALYSIS AND DISSCUSIONS

This chapter provides a network analysis and discussion of the cloud platform ecosystem, divided into three sections. The first section outlines the process of mapping the partnership relationships, which involves generating the ecosystem network, and provides a basic description of the resulting network. The second section focuses on the structural characteristics of the ecosystem and the overall features of the partnership relations. The final section emphasizes the role of Multilateral Partners, who are connected to multiple platforms, and offers a deeper analysis and interpretation of their impact within the ecosystem. By mapping out these connections and examining the structural attributes, this chapter aims to shed light on the complexity and dynamics of cloud platform partnerships. It discusses how these relationships contribute to the formation of a robust and interconnected ecosystem, highlighting key elements that define the network's cohesiveness and integration.

Mapping Partnerships in the Cloud Platform Ecosystem

This study conducted a network analysis of partnership information from 3,711 partners across five cloud platforms, with the network visualization created using Gephi software. The procedure followed several key steps:

Constructed the node table. For the node data, I included five platforms as nodes in the sample, using company names as node labels and assigning each a unique ID number while removing any duplicates to construct a node table. This resulted in a total of 3,509 nodes (N=3,509). Additionally, each node was assigned a distinct color attribute based on the core platform to which the partner belongs, enhancing visual clarity (partners associated with multiple platforms were given a unique color attribute). The node size was determined by ranking nodes according to their degree.

Constructed the edge table. Given that the partnerships represent mutual agreements, the edges were considered undirected, resulting in a total of 3,711 edges (E=3,711). Each edge is assigned an attribute called 'Partnership Level', which is derived from normalized metrics of partnership. The values of this attribute range from 0.01 to 1.01.

Data import and network layout. The data was imported into Gephi, where the OpenOrd algorithm was employed for network layout. OpenOrd is specifically designed for drawing large-scale undirected graphs, incorporating techniques such as edge-cutting, a multi-level approach, average-link clustering, and parallel implementation. At each level, vertices are grouped using force-directed layout and average-link clustering. The clustered vertices are then re-drawn, and the process is repeated (Martin et al., 2011).

Visualization adjustments. After applying the algorithmic layout, we made subtle adjustments to enhance the visual clarity and aesthetic appeal of network visualization. The final network visualization is presented in Figure 3.

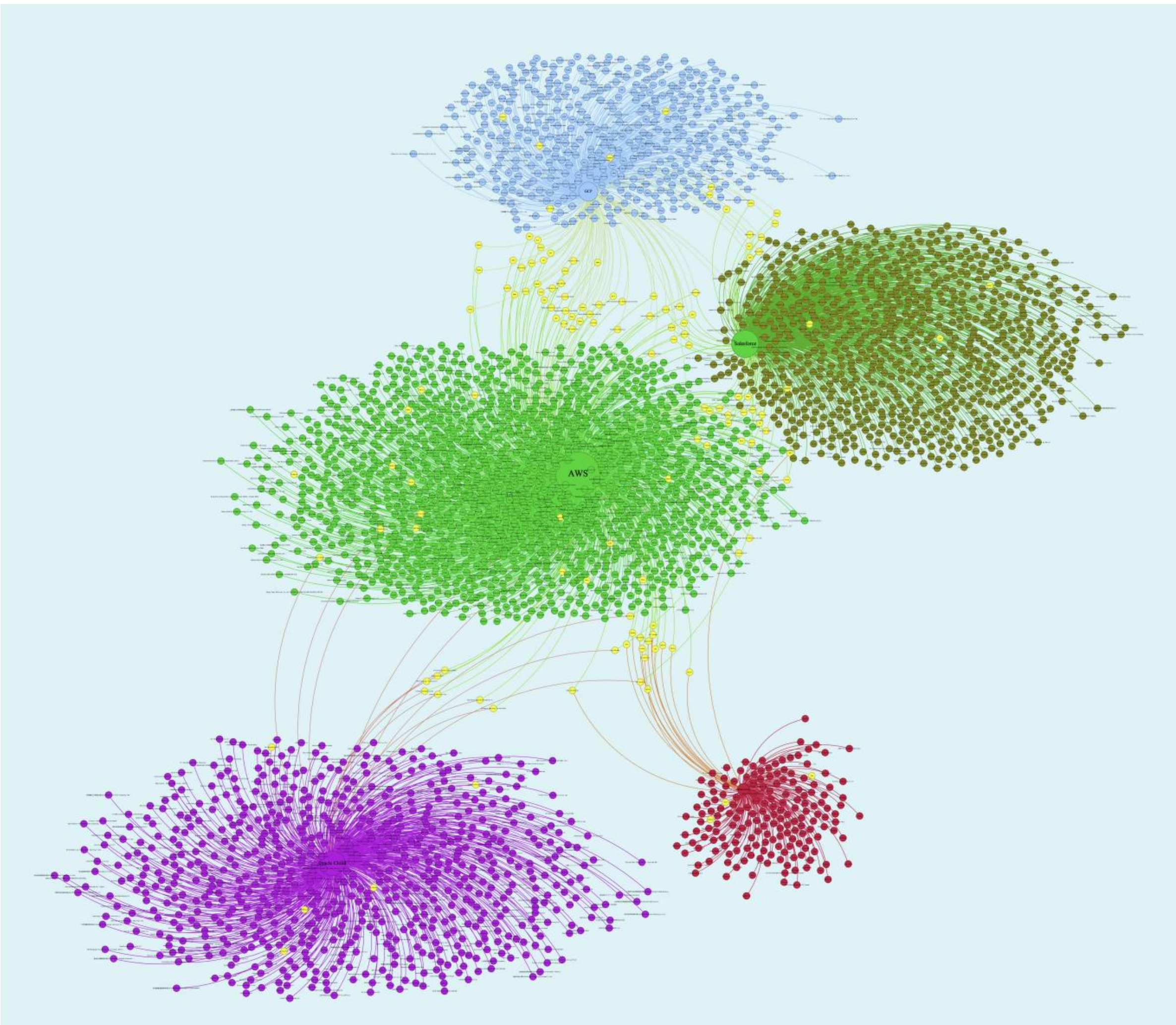


Figure 3 The Cloud Computing Service Platform and Partner Ecosystem (N=3,509; E=3,711)

To provide further clarification on the network visualization: the different colors of the nodes represent partners that have formed partnerships with different platforms. If a partner has only established a partnership with one of the five platforms, its color will match that of the respective platform node. Specifically, nodes associated with AWS and its exclusive partners are colored green, GCP nodes are blue, Salesforce nodes are brown, Oracle Cloud nodes are purple, and Alibaba Cloud nodes are red. Additionally, partners who have established collaborations with multiple platforms are represented by yellow nodes. The size of each node is ranked based on its degree, meaning that nodes representing the five platforms appear significantly larger than others. The color of the edges is determined by the 'Partnership Level' attribute; the higher the Partnership Level, the darker the edge color. This ranking is particularly meaningful for AWS, GCP, Salesforce, and Oracle Cloud, where the Partnership Level provides an insight into the strength of relationships. In contrast, for Alibaba Cloud, which lacks a specific evaluation metric, all Partnership Levels are uniformly set to 1, resulting in edges of consistent color for all its partnerships.

Table 3 Summary of Network Metrics

Average Degree	2.115
Average Weighted Degree	0.264
Network Diameter	4
Modularity	0.685 (Statistical Inference: 14638.558)

The following section describes several key metrics, with an overview of the parameters and their values related to the overall network structure provided in Table 3. The data collected for this study focuses primarily on platform-partner relationships, making it a bimodal network. This structure results in a radiating pattern where multiple partners are connected to several individual platforms. Due to the lack of publicly available data on the partnerships between individual partners, a more in-depth exploration of these connections is not feasible. Consequently, the values of certain parameters may have limited interpretative significance. However, It is worth noting that a partnership has been established exclusively between the AWS and Salesforce platforms, a unique occurrence within the network, which will be further explored later. The network's Average Degree is 2.115, while the Average Weighted Degree is 0.264. This difference arises because the study uses normalized partnership levels as the 'weight' for these connections. The relatively low average connection strength per node is due to the absence of internal connections within the same node set. The Network Diameter is 4, indicating that the longest shortest path between any two nodes in the network consists of 4 edges. This reflects a limited extent of partner sharing across different platforms. The Modularity score is 0.685, with a high level of statistical significance, suggesting a pronounced community structure in which nodes are more likely to connect within specific groups rather than with external nodes. This also highlights the issue of low partner sharing across platforms, which will be analyzed in detail later.

Based on the network visualization and basic statistical indicators, the structure of this partnership network can be described as follows: the network consists of five distinct communities, each centered around a platform node representing AWS, GCP, Salesforce, Oracle, and Alibaba. The partner nodes are densely clustered around these platform nodes, highlighting the platforms' central roles as hubs of cooperation and influence. Within these communities, the majority of partners are connected to a single platform node, indicating their affiliation with a specific community. However, there are also some partners that are linked to multiple platform nodes, acting as 'boundary' nodes that span across different communities. Notably, on the boundaries between any two communities, there tends to be a group of multilateral partners who may engage in business with multiple platforms or maintain open collaborative relationships. This phenomenon of multiple connections adds complexity to the network's structural characteristics, particularly as different platforms have varying criteria and strategies for evaluating and collaborating with partners.

The visualization also reveals a clear diversity in the depth and intensity of partnerships within the network. For example, by examining the color gradients of the edges, it is evident that the majority of partners maintain a relatively low level of engagement with the platforms, which could suggest that many of these relationships are at an initial or superficial stage. This diversity also reflects the different approaches and priorities that platforms might have in selecting and maintaining their partnerships, leading to a varied distribution of partnership intensities across the network. Overall, this structure reflects a complex and multi-layered network of partnerships, showcasing the central position of each platform within its respective ecosystem and the varied strategic influences they exert.

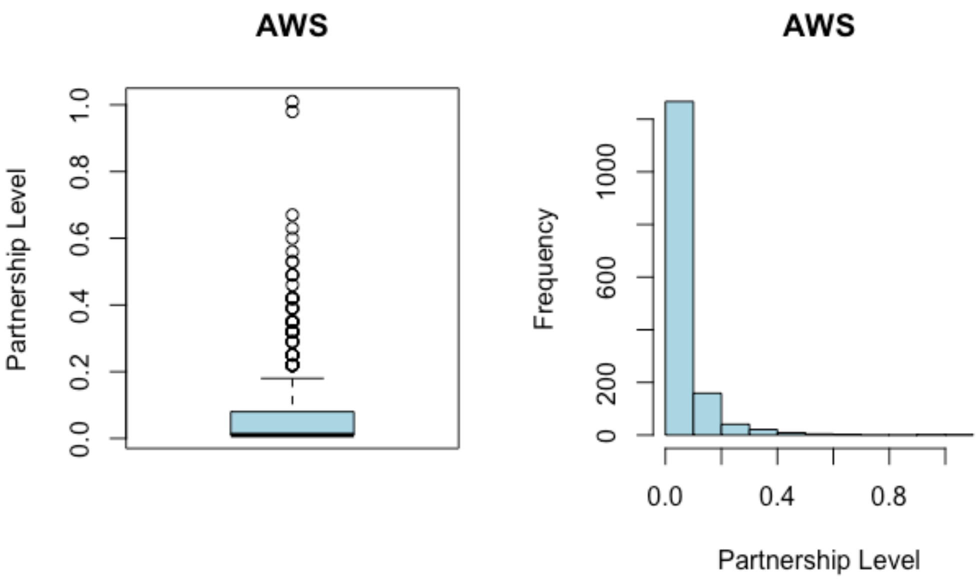
The Structure of the Ecosystem and Features of Partnerships

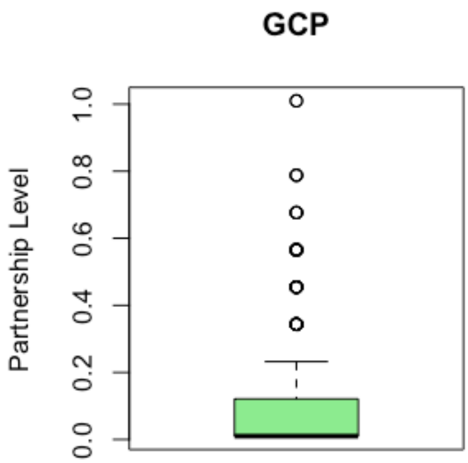
As mentioned earlier, when considering ‘weight’, the Average Weighted Degree shows a significant difference compared to the Average Degree. This discrepancy arises partly because there is a notable variation in the degree of cooperation between different partners and platforms, and partly because different platforms have varying criteria for evaluating their partners. This section aims to explore Sub-question 2: What differences exist between partner networks of different cloud platforms? Do different platforms have different levels of cooperation with partners? Additionally, it seeks to test Hypothesis 1: More powerful platforms (those with a larger market share) have stronger partnerships compared to other platforms. To address these questions, this study provides a detailed analysis of the statistical metrics for the five major nodes representing the platforms (see Table 4). The analysis includes metrics such as Average Degree, Average Weighted Degree, Modularity, Clustering Coefficient, and others, which highlight key differences in the structural properties of the partner networks for each platform. Furthermore, by examining specific cases, the study analyzes the partnership dynamics of different platforms, shedding light on how variations in partner engagement and platform evaluation standards contribute to the observed differences in partnership strength and network configuration.

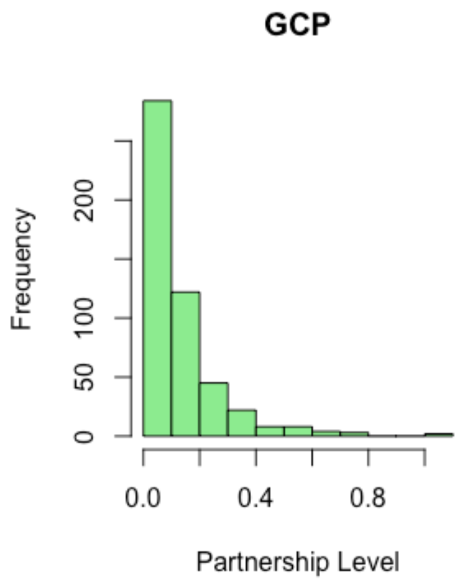
Table 4 Summary of Platform Node Metrics

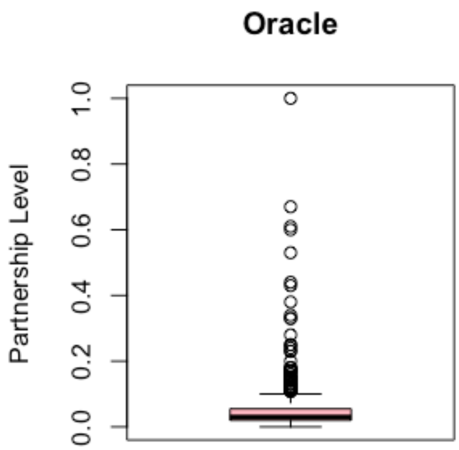
	Degree	Weighted Degree	Modularity Class	Eigenvector Centrality
AWS	1494	81.91	0	1.0
GCP	491	50.58	2	0.208
Salesforce	814	119.13	1	0.405
Oracle Cloud	720	35.68	3	0.310
Alibaba Cloud	192	-	4	0.062

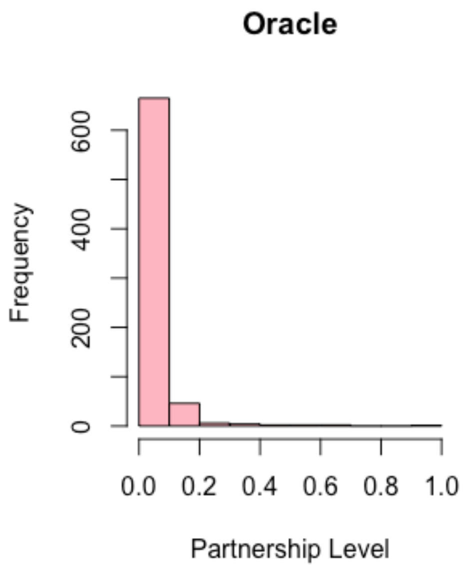
Accoding to the metrics in Table 4, the Degree values correspond to the number of samples collected for each platform, and Eigenvector Centrality is highly correlated with these values. This metric not only considers the number of connections a node has but also accounts for the centrality of the nodes it is connected to. Given that most partners are connected to a single platform and only a few are linked to two or more, the ranking of Eigenvector Centrality values aligns closely with that of the Degree. AWS emerges as the most important node in the network, followed by Salesforce, Oracle Cloud, GCP, and Alibaba Cloud. This ranking does not correlate with the market value of these platforms. The Modularity Class divides the five platforms and their respective partners into five distinct modules. Finally, it is essential to explain Weighted Degree. The order of values here differs from that of the degree, mainly due to the varying assessment systems platforms use to evaluate partner capabilities. Owing to the differences in these evaluation standards, this study has constructed boxplots and frequency histograms based on each platform's samples (excluding Alibaba Cloud, which lacks a publicly available evaluation system) (see Figure 4). The data reveals a clear right-skewed distribution for partners across all four platforms, indicating that only a small fraction of partners are highly engaged and certified by the platforms, while the majority are at lower levels of engagement. This can be interpreted as a preference among customers for the few 'high-quality' partners when seeking services on the platform, leaving most partners with limited opportunities to assist in serving customers.




GCP
Partnership Level
0.0 0.2 0.4 0.6 0.8 1.0


GCP
Frequency
0 50 100 200
0.0 0.4 0.8
Partnership Level


Oracle
Partnership Level
0.0 0.2 0.4 0.6 0.8 1.0


Oracle
Frequency
0 200 400 600
0.0 0.2 0.4 0.6 0.8 1.0
Partnership Level

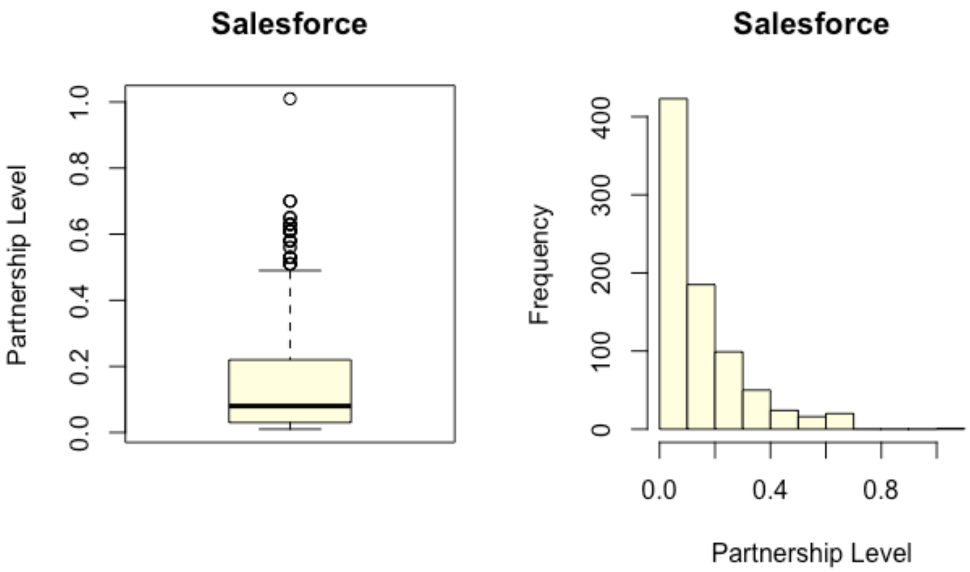


Figure 4 Boxplots and Frequency Distributions of Partners by Platform

For example, Mission Cloud, a partner based in Los Angeles that collaborates exclusively with AWS, has a partnership level of 0.458, ranking 16th among all partners in the AWS network. Mission Cloud describes itself as a 'next-gen cloud services provider empowering businesses to invent a greater future in the cloud by leveraging AWS'. The company holds 12 AWS competencies, participates in 9 partner programs, has obtained 6 AWS Service Validations, and has successfully completed over 2,000 AWS customer launches. Among these, the AWS competencies are the most critical, as access to USD 307.2 billion of the USD 512.0 billion AWS partner economy significantly depends on the number of competencies a partner possesses (Canalys, 2023). Without these competencies, partners are unlikely to make it to the final stages of a customer's procurement process.

In terms of visibility, AWS ensures that its Specialization Partners gain early access to new product roadmaps, unlock additional opportunities to engage with AWS experts, earn financial incentives, and enhance their AWS skills. Moreover, these partners increase their visibility with customers and sales teams, which in turn generates greater demand for their services[4]. In other words, compared to normal partners, those establish a collaboration with the platform and receive recognition from it can further benefit from the valuable resources provided by the platform. This recognition allows them to become more closely integrated with the platform, creating a positive feedback loop that further

[4] See https://aws.amazon.com/partners/programs/specialization-benefits/.

reinforces their advantageous position. The stronger partners, with their stable and close collaboration with the platform, become a key pillar supporting the platform's partner ecosystem. Other platforms follow a similar approach. For example, GCP (Google Cloud Platform) indicates that its partners can gain access to additional benefits, such as partner discounts and financial incentives. Achieving a specialization, which is considered the highest technical designation, enables these partners to better demonstrate their success with customers, thereby attracting greater customer attention[5]. This enhanced visibility and credibility not only strengthens the partner's market position but also aligns their capabilities more closely with GCP's strategic goals, ultimately fostering a more integrated and effective partner ecosystem.

However, there are notable differences among the four platforms in this regard. Compared to AWS and Oracle, GCP and Salesforce have a higher proportion of partners whose partnership levels fall between 0.1 and 0.6. In other words, if we consider customers as resources, platform resources are more concentrated in AWS and Oracle than in GCP and Salesforce. Therefore, it cannot be assumed that more powerful platforms (those with a larger market share) necessarily have stronger partnerships compared to other platforms. At least in terms of the concentration of resource distribution, there is no significant positive correlation. The strength of partner networks across different platforms is closely tied to their specific business strategies and evaluation criteria. This observation raises another question: What characteristics do highly engaged partners have? Regarding this point, there are notable differences among the four platforms. It is evident that compared to AWS and Oracle, GCP (Google Cloud Platform) and Salesforce have a higher proportion of partners with a partnership level between 0.1 and 0.6. In other words, if customers are considered a resource, then this resource is more concentrated in AWS and Oracle than in GCP and Salesforce. This observation raises another question: What are the characteristics of partners with a high level of collaboration with the platform? To explore this, the study focuses on the four partners with the highest level of collaboration with AWS, GCP, Salesforce, and Oracle Cloud. Accenture appears as the top partner for both AWS and Oracle Cloud, SADA for GCP, and Coastal for Salesforce. Accenture is a globally recognized company specializing in IT services and consulting, with a strong cloud consulting division. It holds 30 AWS competencies and has supported over 2,000 customer launches. In Oracle Cloud, Accenture has achieved 308 certified expertise. Notably, Accenture collaborates with

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[5] See https://partners.cloud.google.com/?hl=en.

all five platforms analyzed in this study. SADA, on the other hand, is a premier cloud solutions provider specializing in technology consulting, IT services, application development, and managed services. SADA's operations also span multiple regions worldwide, and it maintains a unique partnership with GCP, holding 10 GCP specializations. Coastal is a consultancy that collaborates exclusively with Salesforce, boasting 18 categories of Salesforce expertise, 11 of which have reached the highest expert level. These observations lead to another important question: To what extent do partners with a high level of collaboration with a platform overlap with the group of multilateral partners? How should the exclusivity and diversity of a partner's collaborations be interpreted? These issues will be explored in the next section.

Multilateral Partners and 'Walled Garden'

This section focuses on partners that collaborate with more than one platform simultaneously. These partners operate on the periphery of different communities, in contrast to the 'walled garden' strategy that platforms often strive to cultivate. The key questions to explore are: How do these multilateral partners manage to maintain relationships with multiple platforms? Does this practice contradict the platform's efforts to establish ecosystem barriers? Are these multilateral partners considered highly valuable and significant collaborators for the platforms? These questions will be addressed in the following discussion.

To begin with, it is essential to clarify the relationship between partners and customers, as this understanding helps elucidate the kind of 'leverage' that partners may hold when dealing with platforms. The process of data migration, deployment, leasing, usage, and maintenance of cloud computing resources is inherently complex, meaning that cloud procurement processes are not instantaneous. Research indicates that 46% of customers took up to three months to select a new cloud partner, and when these partnerships are formally established at the end of a procurement process, they tend to be deeply valuable and relatively 'sticky'. Over half of the customers do not engage new partners for cloud transformation. Even when new partners are engaged, 32% of customers will still leverage their existing partners during the selection process if the existing partner lacks the necessary expertise (Canalys, 2023). Thus, customers are not only dependent on cloud platforms (Mammoth, 2021) but also prefer to maintain long-term relationships with established third-party service providers. This approach aligns with the platform's and partners' mutual strategy of increasing customer stickiness, effectively locking users into the platform's ecosystem. This alignment between platforms and partners ensures a consistent strategy to enhance customer retention, thereby strengthening the ecosystem lock-in effect.

This strategy is often referred to as ‘walled gardens’, where commercial platforms establish barriers to gain competitive advantages and consolidate user bases, effectively locking users within their own ecosystems (Plantin et al., 2018). This strategy plays a significant role in the process of platformization across industries, particularly in markets characterized by oligopolistic monopolies. Cloud platforms are a prime example of this approach. In the realm of cloud computing, the concept of ‘platform lock-in’ arises when the complex configuration of a platform's cloud infrastructure makes it extremely difficult for users to migrate to another platform. Recreating a similar cloud infrastructure on a new platform typically requires substantial time and resources.

Additionally, there is the issue of ‘architectural lock-in’, which occurs when customers rely on multiple services from a single cloud platform. If they decide to switch platforms, the entire application architecture must be re-engineered—a particularly challenging process in cases of high customization. Furthermore, ‘legal lock-in’ is also prevalent in cloud service agreements. Customers are often required to sign long-term enterprise service agreements that stipulate fixed terms and strict conditions for termination, thereby further constraining their ability to migrate. The complexity of data management requirements is another significant barrier, often necessitating careful planning and incurring substantial costs (Mitchell, 2023). Adding to these challenges, platform migration often involves substantial ‘hidden costs’ beyond the obvious technical hurdles (Mammoth, 2021). These costs can include scenarios where service providers, citing various reasons such as the end of service, refuse to open necessary data migration ports or deliberately limit the speed and bandwidth of data transfers. These tactics are designed to make migration more difficult, thereby reinforcing user dependence and control. Hence, cloud platform lock-in strategies are not only about technical and legal constraints but also strategically aim to deeply bind users within their platform ecosystems.

To explore the relationship between multilateral partners and platforms, I selected all partners that collaborate with two or more platforms and constructed a separate network (see Figure 1).

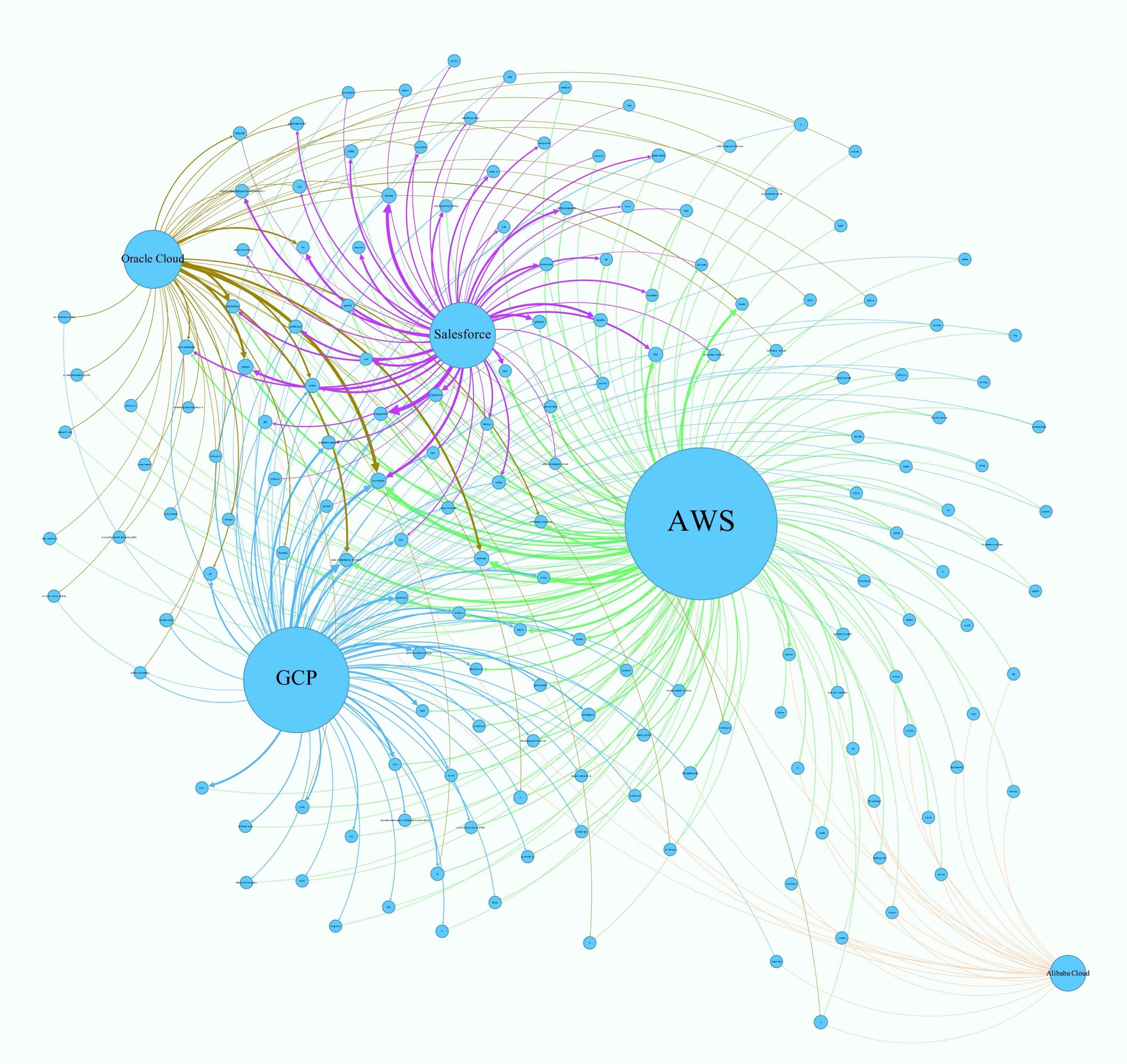

Figure 5 Network of Partnership between Multilateral Partners and Platforms (N=172, E=376)

This network comprises 172 nodes (N = 172) and 376 edges (E = 376), indicating that 167 multilateral partners formed 376 collaborative relationships with the five platforms, averaging 2.25 platforms per partner. Among these, 130 partners collaborate with two platforms, representing 77.8% of all multilateral partners; 30 partners collaborate with three platforms, accounting for 17.9%; 5 partners collaborate with four platforms, comprising 3.0%; and 2 partners collaborate with all five platforms, representing 1.2%. This suggests that even among multilateral partners, most tend to limit their collaborations to a few platforms. This is likely because partnering with multiple platforms requires substantial technical, human, and financial resources to meet the diverse needs of different cloud service systems. Consequently, only a small number of partners can manage to collaborate with multiple platforms simultaneously. The partners collaborating with four platforms are Deloitte, IBM, Wipro, Tech Mahindra, and Inetum, while Accenture and Infosys are the only partners working with all five platforms. Deloitte is one of the 'Big Four' accounting firms globally, IBM is a renowned IT hardware and software manufacturer and consulting firm, and Accenture is a leading global management consulting company. Infosys, Wipro, and Tech Mahindra are the second, third, and fifth largest IT companies in India, respectively, and Inetum is a leading digital company in Europe. Thus, it is primarily the industry leaders in IT and consulting services that have the capacity to establish broader and deeper collaborations with the top cloud platforms.

Table 5 Summary of the Multilateral Partner Network

	Number of Multilateral Partner	Proportion of Multilateral Partners to the Total (%)	Average Partnership Level of Multilateral Partners	Average partnership Level of All the Partners
AWS	146	9.77	0.143	0.055
GCP	98	19.96	0.154	0.102
Salesforce	57	7.00	0.324	0.146
Oracle Cloud	49	6.81	0.127	0.049
Alibaba Cloud	26	13.54	-	-
Sum	167	4.51	0.173(Alibaba Excluded)	0.129(Alibaba Excluded)

The modularity of this network is only 0.369, significantly lower than that of the network of all partners. This is expected, as multilateral partners do not belong exclusively to any single platform, resulting in a lack of distinct community divisions. However, the status of multilateral partners varies across different platforms, as illustrated in Table 5, which presents relevant statistics for each platform. Overall, multilateral partners constitute only 4.51% of all partners, a small percentage that strongly supports the 'walled garden' strategy mentioned earlier, demonstrating its presence within platform partner ecosystems. However, there are notable differences across platforms: AWS has partnered with 146 multilateral partners, representing 9.77% of its total partner ecosystem, while GCP has the highest proportion of multilateral partners at 19.96%. In contrast, Oracle Cloud has the lowest proportion at just 6.81%, suggesting that, to some extent, Oracle Cloud's partner ecosystem is more exclusive. This does not necessarily imply stronger or weaker platform barriers in other respects. For example, when considering the barriers to cloud migration, moving away from GCP often presents more complex challenges and higher costs compared to other platforms (Rose-Collins, 2024), which contrasts with its seemingly more ‘open’ partner network.

Multilateral partners often possess stronger technical and resource capabilities, enabling them to provide services across different cloud environments. Meanwhile, partners with a high level of partnership with a platform typically indicate that their exceptional capabilities have been recognized by the platform. This raises the question: do multilateral partners significantly overlap with those having a high partnership level? Table 5 shows that the average partnership level of multilateral partners across all five platforms is significantly higher than the average partnership level of all partners, and this trend holds overall. This suggests that multilateral partners are often also the ones with deeper engagements with the platforms. For instance, Accenture, one of the top partners for both AWS and Oracle Cloud, also maintains partnerships with all four platforms. This observation further substantiates the earlier point that platform resources tend to concentrate on these partners. As a result, they are able to gain the most benefits from the platforms while simultaneously receiving support from multiple platforms (though they are also expected to provide equally high-quality services to the platforms' customers). This creates a dynamic similar to a ‘winner-takes-all’ situation.

CONCLUSION

This study is inspired by platform research in communication studies and ecosystem research in business and management studies. It integrates both theoretical perspectives, using the concept of platform ecosystems as the core theoretical framework. By employing network analysis, the study maps the partnership characteristics of the global cloud platform ecosystem, using data scraped from the publicly available partner lists of five globally leading cloud platforms (AWS, GCP, Salesforce, Oracle Cloud, and Alibaba Cloud). Through this analysis, the study addresses three research questions posed, tests three hypotheses, and contributes to the literature on cloud computing business ecosystems and platform studies.

Based on the topology of cloud platform partnerships, the study draws the following conclusions:

i) The cloud computing industry is an oligopolistic market, dominated by a few providers who control the majority of the market share. These providers leverage the platform model to integrate technological and service resources, creating a partner ecosystem centered around them. Consequently, their partnership networks exhibit strong community characteristics, with AWS's partner network being significantly stronger than those of the other platforms. Most partners, due to the constraints of walled gardens and their own resources, can only establish partnerships with a single platform.

ii) Platforms differentiate partners by partnership levels through various qualification standards, with partners holding higher-level competency/specialization/expertise receiving more platform support, including technical assistance, financial incentives, and market exposure. However, despite differences among platforms, the majority of partnerships remain at a low level, with more concentrated support provided to a small number of ‘premium’ partners who possess significant advantages in technology, talent, and other resources, creating a positive feedback loop of mutual benefit. Specifically, AWS and Oracle Cloud demonstrate higher resource concentration and more uneven distribution compared to GCP and Salesforce.

iii) Besides the majority of partners forming alliances with a single platform, a small group of multilateral partners can engage with multiple platforms simultaneously. However, only a few of these multilateral partners manage to partner with more than three platforms, as this requires resources capable of adapting to diverse cloud environments, indicating that platforms also employ ‘walled garden’ strategies when building their partnership networks. Notably, GCP and Alibaba Cloud have a higher proportion of multilateral partners compared to the other three platforms. Moreover, the study finds that, both overall and on each platform, multilateral partners have a higher average partnership level than the general average. It reveals that these multilateral partners are often those with deeper collaborations with the platforms, due to their strong resource advantages, creating a ‘winner-takes-all’ situation.

This study also has its limitations. Due to the restrictions imposed by the visibility of public data, differences in data structures, and the inherent variations in the data content, the data processing in this research is highly complex and somewhat subjective. For example, partners may register on different platforms using different names and other information, which can lead to overlapping or missing nodes in the data. Additionally, the varying partnership evaluation systems across different platforms pose challenges to data standardization. While this study has undertaken steps such as filtering and screening the data to mitigate the impact of these limitations on the analysis, certain shortcomings are unavoidable. More detailed information about the platforms and their partners could provide further insights into the complex dynamics of these partnerships.

Overall, this study offers several implications for future research: It conducts foundational research on cloud platform partnerships, contributing to the understanding of the cloud computing industry ecosystem from the theoretical perspective of platform ecosystems. As cloud computing represents a key technology in the modern internet industry, future research should pay more attention to cloud computing and its platform model. Additionally, beyond the macro perspective of platform ecosystems (Van Dijck, 2021), attention should also be given to the sub-ecosystems that compose the larger ecosystem. Additionally, the roles of partners and complementors as mediators within the ecosystem should be emphasized, where the perspectives from communication studies and business and management research can complement each other in this context.

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SUPPLEMENTARY MATERIALS

The data that supports the findings of this study are openly available on Google Drive at: https://drive.google.com/drive/folders/1hawncME_ZPngn5X01gYrQ8eRTJV3YSAC?usp=share_link.

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