iCV TA&K
Technology Advisory
& Knowledgebase

2026

Global Quantum Computing Cloud Platform Evaluation Report

July 2026

Quantum Annual Series Report

Declaration

This evaluation report (hereinafter referred to as the "Report") is independently compiled by ICV TA&K (hereinafter referred to as the "Evaluator") based on the testing and analysis of selected quantum computing cloud platforms. To clarify the scope, basis, and limitations of the Report, the following statements are hereby made:

01 Scope of Evaluation

The Report focuses on the technical performance, usability, and service capabilities of the evaluated quantum computing cloud platforms (specifically including [List of Evaluated Platforms, e.g., "IBM Quantum Experience, Amazon Braket, Google Quantum AI Platform"]). The evaluation covers core indicators such as quantum processing unit (QPU) qubit count, gate fidelity, quantum volume, task execution latency, cloud service availability, completeness of developer toolchains, and responsiveness of technical support. The Report does not involve the internal technical architecture, commercial secrets, or undisclosed R&D pipelines of the platform providers, nor does it evaluate non-technical factors such as the platforms' long-term commercial viability or strategic layout.

02 Evaluation Standards and Methods

All evaluation work is conducted in accordance with publicly available international technical standards (including but not limited to IEEE 1138-2022 "Standard for Quantum Computing Performance Metrics" and ISO/IEC 19790:2023 "Information Technology—Quantum Computing—Vocabulary and Concepts") as well as the scientific evaluation framework independently developed by the Evaluator (ICV TA&K). The testing process adheres to strict experimental protocols: each technical indicator is measured no fewer than 30 times under a unified hardware and software environment (e.g., identical quantum circuit input, consistent network bandwidth conditions) to ensure data reproducibility. However, it should be noted that due to the rapid iteration of quantum computing technology, the performance data presented in the Report only reflects the status of the platforms during the evaluation period (01/2026 – 07/2026) and may not fully represent their subsequent performance after version updates or hardware upgrades.

Declaration

03 Data Sources and Objectivity

The data in the Report is derived from two sources: (1) Publicly disclosed parameters and technical documents released by the evaluated platform providers; (2) Independent testing results obtained by the Evaluator (ICV TA&K) through legal access to the platforms' public APIs and testing environments. The Evaluator has taken reasonable measures to verify the accuracy of the data, including cross-validation with third-party technical literature and repeated experimental verification. However, due to inherent limitations in quantum computing testing (such as quantum random noise, environmental interference, and differences in API call priorities), there may be minor deviations between the test results and the actual long-term operating performance of the platforms. This Report provides objective analysis based on currently available data, with no intentional bias or subjective preference toward any specific platform.

04 Limitations and Disclaimer of Liability

Technical Limitations: Quantum computing is still in the early stage of industrialization, and the technical indicators of cloud platforms (such as qubit coherence time and error correction capability) are updated and iterated rapidly. The conclusions in the Report are only applicable to the current technical stage and should not be regarded as a long-term evaluation basis for the platforms' competitiveness.

Usage Limitations: This Report is for reference only (e.g., for enterprises, researchers, or institutions to understand the current status of quantum computing cloud services) and does not constitute any investment advice, procurement recommendation, or legal commitment. Any decisions made based on this Report (such as selecting a cloud platform for business or research purposes) shall be the sole responsibility of the decision-maker, and the Evaluator (ICV TA&K) shall not be liable for any direct or indirect losses arising therefrom.

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Declaration

05 Contact Information

ICV TA&K is dedicated to research in cutting-edge technologies such as quantum science and technology. In terms of quantum computing cloud platform evaluation, the company will maintain an evaluation cycle of 6 to 12 months. The initial evaluation plan and initial evaluated platforms will also be dynamically adjusted in line with technological development. For discussions on technical aspects or evaluation plans, please feel free to contact us.

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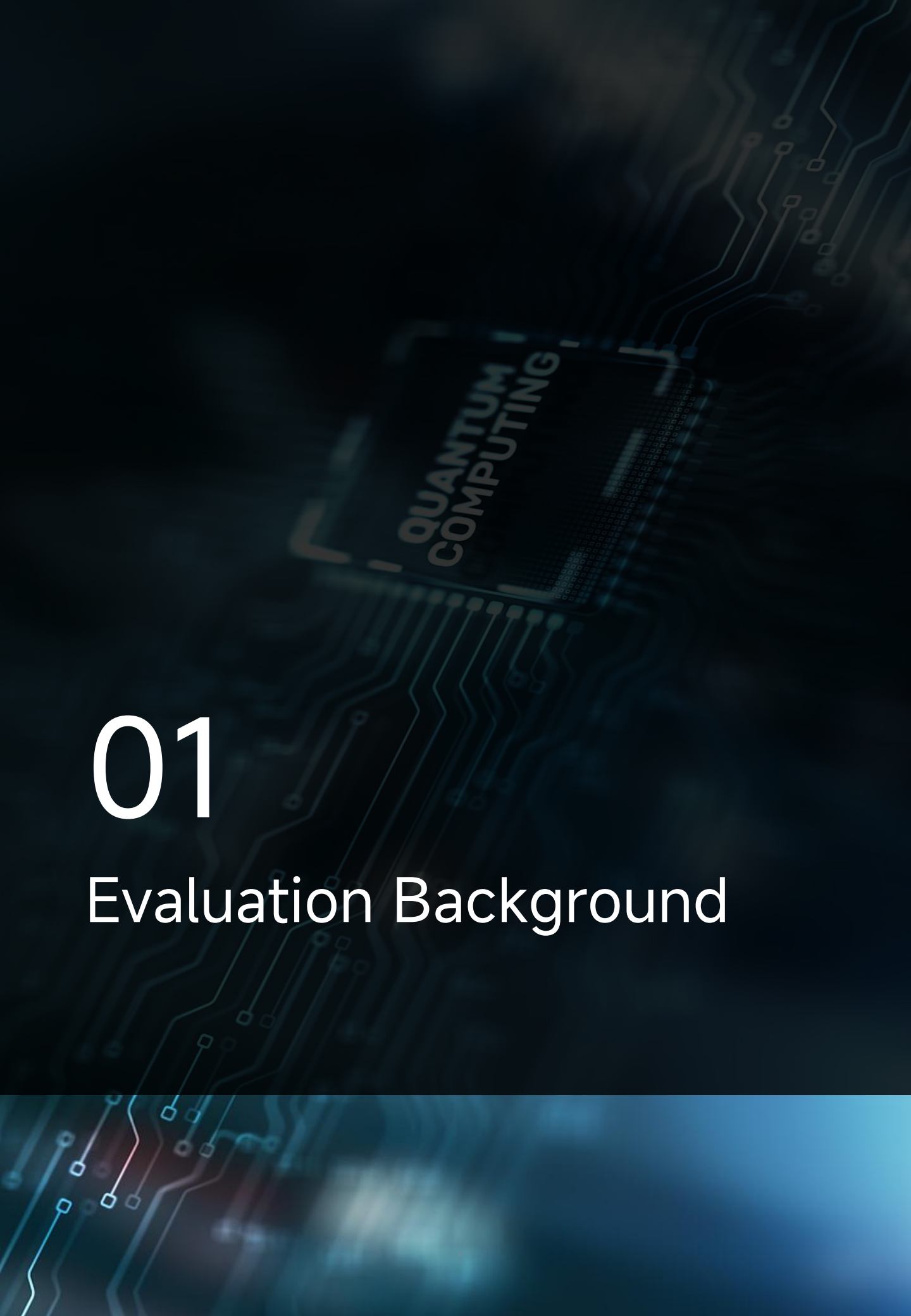
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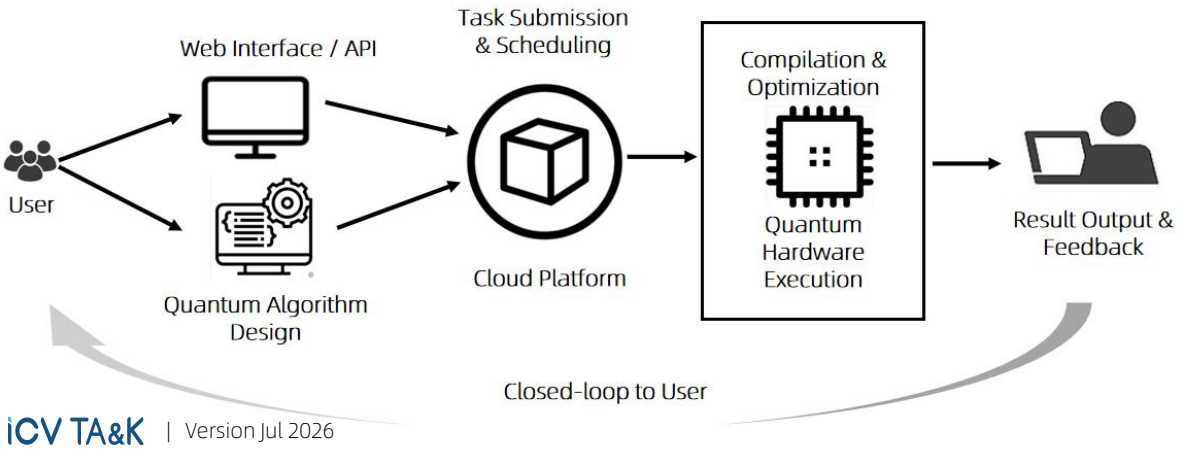
01

Evaluation Background

01 Quantum Computing Cloud Platforms as the Core Gateway for Open Quantum Computing Resources

Quantum computing is gradually moving from laboratory validation toward cloud-based access and application-oriented exploration. Because real quantum processors impose stringent requirements on cryogenic cooling, precision measurement and control, chip calibration, system operation and maintenance, and hardware-software co-optimization, most research institutions, university teams, enterprise users, and developers do not have the capability to independently build and maintain quantum hardware systems. In this context, quantum computing cloud platforms have become the core gateway connecting underlying quantum hardware with external users.

Figure: Workflow of Quantum Computing Cloud Platforms



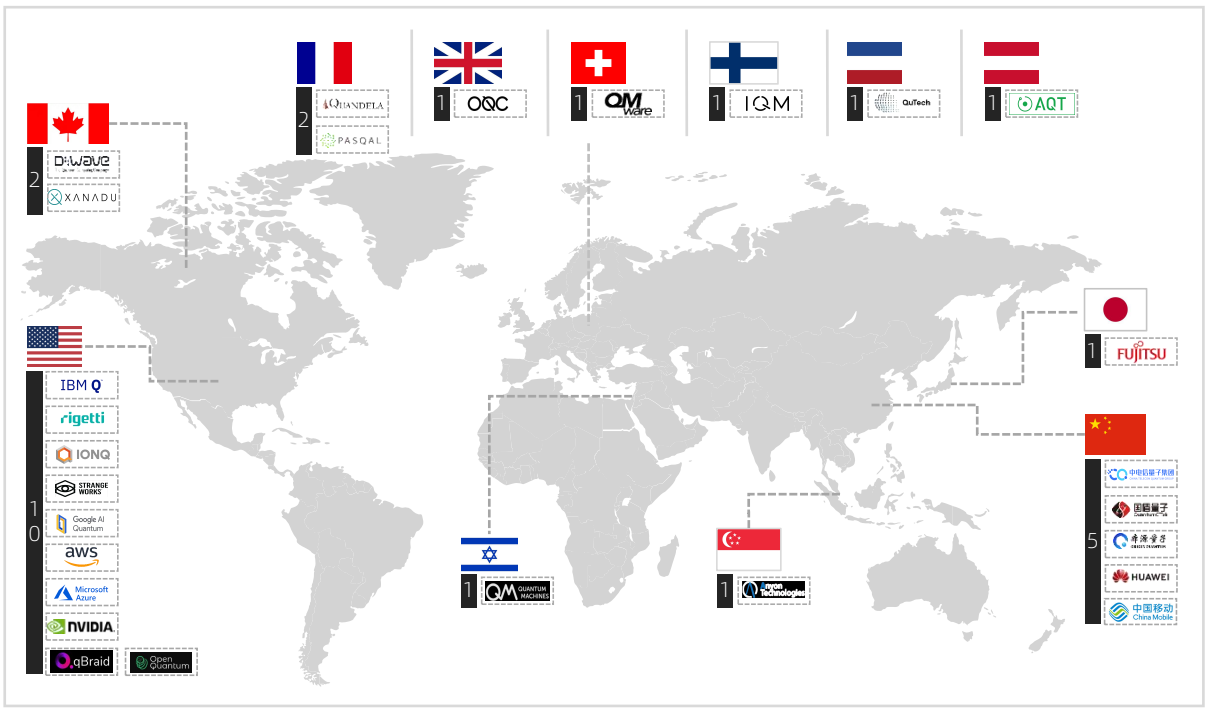
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Unlike conventional remote computing platforms, a quantum computing cloud platform does not merely provide an access interface to a quantum processor. Instead, it integrates quantum processors, classical simulators, compilation systems, task scheduling systems, quantum programming frameworks, result-analysis tools, and user service portals into a unified cloud service environment. Through web interfaces, SDKs, APIs, or notebooks, users can design quantum circuits, submit tasks, select backends, run experiments, and retrieve results, thereby conducting quantum algorithm research and application validation without building local quantum experimental systems.

At present, leading quantum computing cloud platforms worldwide are evolving from “hardware-access portals” into “integrated quantum computing service platforms.” On the one hand, platforms must continuously improve qubit scale, gate-operation accuracy, readout reliability, and system stability of real quantum hardware. On the other hand, they also need to provide high-performance classical simulation, user-friendly development tools, transparent device parameters, comprehensive documentation and courses, and an active developer ecosystem. The capability level of a cloud platform now directly determines whether users can effectively access quantum computing resources, interpret quantum results, and conduct reproducible experimental research.

The field of global quantum computing cloud platforms is currently developing rapidly, with approximately 24 companies having launched such platforms. Notable examples include IBM's IBM Quantum Experience, Google AI Quantum, Microsoft's Azure Quantum, Amazon AWS's Braket, D-Wave's Leap, Rigetti's Quantum Cloud Services, Xanadu's Xanadu Cloud, Strangeworks' Strawberry Fields, IQM's Resonance, Japan's Fujitsu, Singapore's Anyon Technologies, Origin Quantum Cloud Platform, Tianyan Quantum Computing Cloud Platform, and QuantumCTek Computing Cloud Platform, among others. These cloud platforms exhibit significant diversity in backend hardware, simulators, and pricing structures, comprehensively reflecting the dynamic development trends within the commercialization process of the quantum computing industry and continuously driving quantum technology from theory toward practical application scenarios.

Figure:Global Distribution of Major Quantum Computing Cloud Platform Companies and Institutions



The global competitive landscape of quantum computing cloud platforms currently presents a tripartite balance of power with North America, Europe, and Asia at its core. North America dominates this landscape through its absolute advantages in semiconductors, software ecosystems, and cloud computing, led by tech giants including IBM, Google, Microsoft (aggregating multiple hardware providers through its Azure Quantum platform), and AWS (with its Braket service), which have established a mature business model centered on cloud access and developer ecosystem development. Meanwhile, Canada's Xanadu has secured its position in the global cloud services market through its photonic quantum computing approach. Europe's development path is more distinctive, rooted in profound scientific research foundations. Beyond the rapid growth of startups like France's Pasqal (neutral-atom approach), UK-based OQC and other enterprises are actively advancing commercialization in superconducting quantum computing, while US company IonQ (trapped-ion approach) has established R&D centers in Europe to attract talent, collectively forming an innovation cluster with close industry-academia-research collaboration.

In Asia, China is rapidly rising with a firm stance on independent innovation, demonstrating a development path distinct from North America and Europe. China emphasizes technological self-sufficiency and a closed-loop ecosystem, having formed a complete industrial chain driven by enterprises and promoted through industry-academia-research collaboration. Representative companies include China Telecom Quantum Group, which promotes the integrated innovation of "quantum computing + secure communications"; Origin Quantum, which provides full-stack solutions; and QuantumCTek, which focuses on core components and system integration. This pattern, guided by national strategy and characterized by diverse market participation, is accelerating the advancement of Chinese quantum computing from research and development to practical application.

China Telecom Quantum Group has successfully developed the superconducting quantum computer "Tianyan-287." Equipped with a chip identical to the Zuchongzhi-3, the system demonstrates quantum computational advantage. For specific problems, its processing speed is up to 450 million times faster than that of the most advanced supercomputers currently available. The system is slated for integration into the "Tianyan" Quantum Cloud Platform, marking its first global release of application services. The "Tianyan" platform has already achieved large-scale online service capabilities, recording over 44 million cumulative visits from users across more than 60 countries, and facilitating over 3.4 million cumulative experimental tasks.

Meanwhile, QuantumCTek centers its offerings on providing open access to authentic quantum computing resources via the cloud. The company delivers a combination of multiple real quantum computers and quantum simulators, supported by a comprehensive development and experimental environment. This ecosystem includes SDKs/toolboxes, graphical laboratories, circuit translation capabilities (e.g., QASM↔QCIS), hardware mapping, and Pulse-level control. Furthermore, QuantumCTek provides engineering support tools such as signal analysis, data management, online demodulation, and feedback control, enabling users to seamlessly execute program development, operational verification, and data processing workflows entirely in the cloud.

The quantum computing cloud service market currently exhibits a highly concentrated structure, dominated by a few major players while also featuring several actively developing participants, collectively forming a dynamic competitive landscape. Based on regional distribution differences, we have analyzed quantum computing cloud platforms from eight companies in North America, six companies in Europe, and eleven companies in Asia. The analysis covers multiple dimensions including platform ownership, launch timeline, country of origin, hardware technology, accessible qubit count, and real device availability.

Figure:Global Quantum Computing Cloud Platform Comparison

Company/Institution	Quantum Cloud Platform	Launch Date	Country	Hardware Technology	Qubit Count	Real Device/Simulator Access
North America						
IBM Q	IBM Quantum Experience	2016	United States	Superconducting	133,127, 156	Real Device Simulator Accessible
Google Quantum AI	Cirq	2018	United States	Superconducting Trapped Ion Neutral Atom	105	Real Device Inaccessible (Requires Application)
rigetti	QCS	2018	United States	Superconducting	108	Real Device Inaccessible (Requires Application)
aws	Braket	2019	United States	SuperconductingTrapped IonPhotonic Neutral Atom	8-100+	Real Device Inaccessible
Microsoft Azure	Azure Quantum	2019	United States	Trapped IonSuperconducting Neutral Atom	8-100+	Real Device Accessible (Account Creation Required)

D-Wave The Quantum Computing Company	Leap	2018	Canada	Quantum Annealing	5000+ 2000+	Real Device Inaccessible
STRANGE WORKS	QC™	2021	United States	SuperconductingTrapped IonNeutral Atom Quantum Annealing	8-400	Integrating real-device and simulator resources from other providers (e.g., IBM)
XANADU	Xanadu Cloud	2020	Canada	Photonic	8,12	Real Device Simulator Inaccessible (Requires Application)
Europe						
QuTech	Quantum Inspire	2018	Netherlands	Photonic Silicon Spin Superconducting	8 5 2	Real Device Accessible
IQM	Resonance	2024	Finland	Superconducting	16,20,54	Real Device Accessible
QM ware	Alpha	2022	Switzerland	-	-	No Real Device Inaccessible (Requires Application)
OQC	Computing-as-a-Service	2021	United Kingdom	Superconducting	4	Real Device Inaccessible (Requires Application)

PASQAL	Pasqal Cloud Services	2022	France	Neutral Atom	140+	Real Device Simulator Accessible (Payment Required)
QUANDELA	Quandela Cloud	2022	France	Photonic	6,12	Real Device Partially Accessible
Asia						
中电信量子集团 CHINA TELECOM QUANTUM GROUP	Tianyan Quantum Computing Cloud Platform	2023	China	Superconducting, photonic	504, 105, 66, 66, 24 superconducting qubits; 2000+ photons	Real Device Simulator Publicly Accessible
本源量子 ORIGIN QUANTUM	Origin Quantum Cloud	2017	China	Superconducting	72,102,180	Real Device Simulator Publicly Accessible
HUAWEI	Huawei Quantum Cloud HiQ	2018	China	Simulator	Full amplitude 42 Single amplitude169	Simulator Publicly Accessible
中国移动 China Mobile	China Mobile "WuYue" Quantum Cloud	2023	China	Photonic	100 single-unit qubits, cumulative grid-connected qubits: 590	Real Device Simulator Accessible
国盾量子 QuantumCTek	Quantum Computing Cloud Platform	2023	China	Superconducting	66	Real Device Simulator Accessible
北京量子信息科学研究院 Beijing Academy of Quantum Information Sciences	Quafu	2022	China	Superconducting	136,18,10	Real Device Simulator Accessible (Account Registration /Guest Login)

02 From Hardware-Parameter Competition to Comprehensive Service-Capability Competition

Early competition among quantum computing platforms focused primarily on hardware parameters such as the number of qubits, single-and two-qubit gate fidelities, and coherence time. These parameters remain essential for assessing the capability of a quantum computing system. However, individual hardware metrics alone can no longer fully capture the user experience or the quality of results when a platform is used in practice. For cloud users, the practical value of a platform also hinges on task execution stability, result reliability, usability, adequate simulation resources, and complete documentation & technical support.

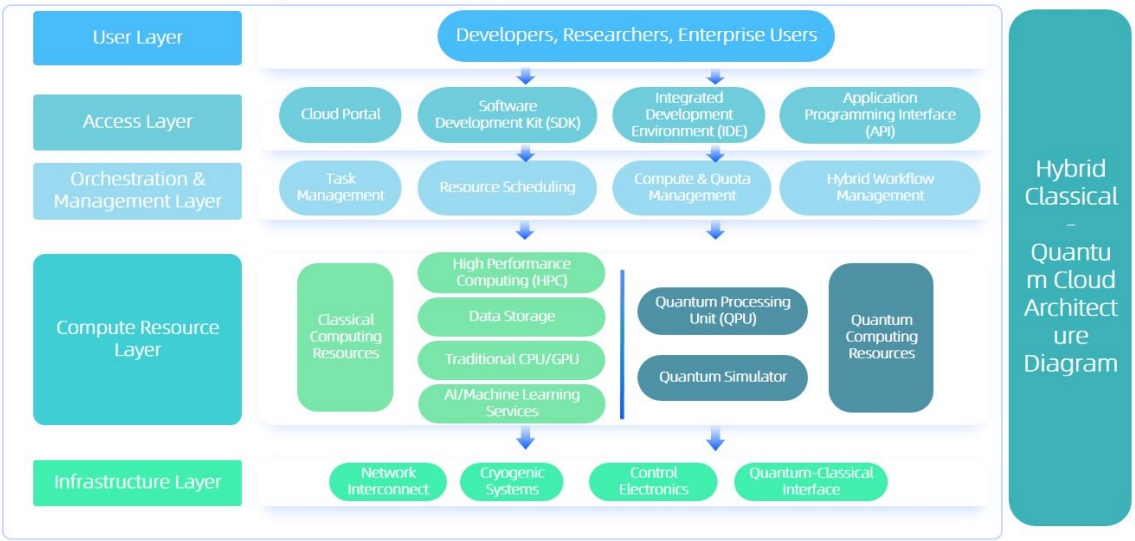
Accordingly, the evaluation of quantum cloud platforms must expand from a comparison of individual hardware parameters to a comprehensive assessment of hardware, software, service, and ecosystem capabilities. The underlying quality of real quantum processors determines whether a platform can execute quantum circuits; multi-qubit entangled-state preparation and random circuit sampling reflect system-level execution capability; state-vector simulators demonstrate the platform's support for classical computing resources and algorithm validation; platform architecture and functions determine whether users can smoothly complete the end-to-end experimental workflow; and ecosystem operations influence whether a platform can continuously attract users, accumulate applications, and develop a developer network.

This report constructs a quantitative evaluation framework oriented toward real user scenarios in response to this shift. The framework evaluates not only whether a platform provides quantum hardware, but also whether it can execute tasks stably, support algorithm debugging, provide a complete toolchain, and build a sustainable ecosystem. This approach more closely reflects the practical value of quantum computing cloud platforms and provides clearer references for researchers, industrial users, and platform providers.

03 Evaluation Objects and Testing Boundaries

This evaluation focuses on superconducting quantum computing cloud platforms with open-access capabilities in China and abroad. Seven representative platforms are selected as evaluation objects: IBM Quantum Platform, Rigetti Quantum Cloud Platform, IQM Resonance Quantum Cloud Platform, China Telecom Quantum's Tianyan Quantum Computing Cloud Platform, Quafu Quantum Computing Cloud Platform of the Beijing Academy of Quantum Information Sciences, Origin Quantum Cloud, and Wuyue Quantum Computing Cloud Platform developed by China Mobile-related entities. These platforms provide cloud-based access to quantum computing resources to varying degrees and possess certain foundations in user services, development tools, or ecosystem operations.

Figure: Quantum Computing Cloud Platform Functional Framework



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In terms of hardware-system selection, this report focuses on the superconducting quantum computing systems that are publicly available and either the best performing or the most representative on each platform, including IBM_marrakesh, Rigetti Cepheus-1-108Q, IQM Emerald, Tianyan-287,BaiHua, Origin Wukong 180, and Wuyue 1. The testing is conducted within the scope of publicly accessible platform capabilities and does not involve undisclosed internal architectures, trade secrets, R&D roadmaps, or future plans. For data that cannot be stably obtained through public platforms, this report explicitly marks such cases to avoid replacing measured or publicly verifiable results with unverifiable information.

The purpose of this evaluation is not to rank all quantum computing technology routes comprehensively, but to observe the real performance, service completeness, and ecosystem maturity of different platforms within the scope of open-access superconducting quantum cloud platforms. Given the rapid iteration of quantum computing technologies, platform status, hardware parameters, and service capabilities may change with version updates. Therefore, the conclusions of this report should be understood as a capability profile during the evaluation period rather than an absolute judgment of long-term competitiveness.

04 Evaluation Logic and Application Value of This Report

This report builds its evaluation framework around the "on-demand, ready-to-use" capability of quantum computing cloud services. "Ready-to-use" does not imply that quantum computing has reached the maturity level of conventional cloud computing. Rather, it emphasizes that users should be able to access quantum resources through a relatively clear, stable, and reproducible workflow, and complete meaningful experiments or algorithm validation. To achieve this, a platform must provide not only real quantum hardware, but also reliable task-entry mechanisms, interpretable backend information, executable programming tools, high-performance simulation resources, and a continuously operated user ecosystem.

Based on this logic, the report establishes six core evaluation dimensions: Basic Error Rate Indicators, Entanglement Scale , Multi-Qubit XEB, Simulator Performance, Platform Architecture and Functions, and Ecosystem Operations. Basic Error Rate Indicators assess the underlying hardware quality of real quantum processors; Entanglement Scale evaluates the system's capability to prepare and maintain multi-qubit global entangled states; Multi-Qubit XEB measures the system-level execution fidelity of random quantum circuits on real hardware; Simulator Performance evaluates the scale and efficiency of classical simulation resources; Platform Architecture and Functions examine service portals, programming modes, and resource management capabilities; and Ecosystem Operations assess the user base, partnership network, application services, courses, events, and community building.

The value of this report lies in providing structured references for different types of users. For research users, it helps identify which platforms are more suitable for multi-qubit circuit experiments, entangled-state preparation, or algorithm validation. For industrial users, it helps assess the maturity of platforms in application services, toolchain support, and operational stability. For platform providers, it can help identify shortcomings in hardware performance, simulation capability, service experience, and ecosystem operations. Overall, this report aims to provide a clearer and more traceable basis for cross-platform comparison through a unified testing scope and scoring framework.

02

Cloud Platform Providers in This Evaluation

01 Overview of the Seven Cloud Platforms and Representative Hardware Systems

This evaluation covers seven platforms: IBM Quantum Platform, Rigetti Quantum Cloud Services(QCS), IQM Resonance, Tianyan Quantum Computing Cloud Platform, Quafu Quantum Computing Cloud Platform, Origin Quantum Cloud and Wuyue Quantum Computing Cloud Platform. For each platform, the publicly available hardware system with relatively strong performance or clear representativeness is selected for testing, so as to reflect, as far as possible, the upper bound of the platform's current open-access capability.

Table: Details of the five major Quantum Computing Cloud Platforms

Provider	Cloud Platform	Representative Hardware System	Platform Positioning
IBM	IBM Quantum Platform	IBM_marrakesh	Global quantum hardware access, Qiskit tools, learning resources, and a mature developer ecosystem.
Rigetti	Rigetti Quantum Cloud Services(QCS)	Cepheus-1-108Q	Delivers a full-stack quantum computing platform with cloud access, QPUs, and programming tools, serving research and industry use cases.
IQM	IQM Resonance	IQM Emerald	Offers superconducting QPUs and cloud-based access, tailored for HPC and research.
China Telecom Quantum Group	Tianyan Quantum Computing Cloud Platform	Tianyan-287	Open superconducting QPUs, high-performance simulators, and Cqlib tools for research, education, and industry.
Beijing Academy of Quantum Information Sciences	Quafu Quantum Computing Cloud Platform	BaiHua	Research-oriented real-QPU access and testing services linking hardware R&D with algorithm exploration.
Origin Quantum	Origin Quantum Cloud	Origin Wukong 180	One-stop platform for real QPUs, simulators, programming tools, and application services.
China Mobile / China Mobile Cloud	Wuyue Quantum Computing Cloud Platform	Wuyue 1	Cloud-network platform exploring hybrid classical-quantum services for research and industry scenarios.

From the perspective of representative hardware systems, all seven platforms are based on superconducting quantum computing. However, they differ significantly in qubit scale, topology connectivity, readout error, gate error rates, entangled-state preparation capability, and random circuit sampling performance. Tianyan and IBM show relatively close performance in this evaluation, especially forming a leading comparison in Multi-Qubit XEB and system-level execution capability. Origin Quantum Cloud has a certain degree of platform completeness and ecosystem accumulation, but its hardware performance and simulation efficiency still need improvement. Quafu has a relatively large-scale hardware foundation, yet its overall services and simulation capabilities remain uneven. For Wuyue, some key data cannot be obtained stably, so it is considered more as an exploratory platform-building case than as an object for full ranking.

02 Platform Positioning and Capability Features of Major Providers

IBM Quantum Platform is one of the more mature representatives among international quantum computing cloud platforms. Built upon IBM's long-term accumulation in superconducting quantum hardware, the Qiskit software toolchain, documentation, learning resources, and global developer communities, it has formed a relatively complete quantum cloud service ecosystem. In this evaluation, IBM performs best in Platform Architecture and Functions as well as Ecosystem Operations, demonstrating mature productization capability and global ecosystem influence. In hardware performance, IBM_marrakesh also maintains strong competitiveness in Maximum Available Qubits, Two-Qubit Gate Error Rate, and random circuit sampling performance. IBM's advantage lies not in a single hardware parameter, but in the coordination among hardware access, software tools, learning resources, and the community ecosystem.

Rigetti Quantum Cloud Platform is a representative international superconducting quantum computing cloud platform, built on Rigetti's full-stack capabilities in superconducting processors, control systems, compilers, and cloud access. The platform supports real QPU and simulator access through tools such as pyQuil and related software interfaces, and is suitable for algorithm research, experimental testing, and benchmarking tasks. In this evaluation, Rigetti shows a solid foundation in hardware access and workflow execution, but its device availability, documentation completeness, scheduling transparency, and third-party access experience still limit reproducible testing. Therefore, Rigetti is included as an important international benchmark, while its results should be interpreted together with calibration status, compiler mapping, and access stability.

IQM Resonance Quantum Cloud Platform, built by IQM Quantum Computers, is a European superconducting quantum cloud platform oriented toward research, education, and application exploration. The platform provides access to IQM QPUs and supports mainstream quantum software frameworks, with technical features such as superconducting processor architecture, tunable couplers, and API-based access. In this evaluation, IQM demonstrates clear hardware potential and growing cloud service capability, especially in QPU design and algorithm development support. However, compared with more mature platforms such as IBM Quantum Platform, IQM still needs to strengthen public documentation, developer ecosystem, learning resources, and benchmark reproducibility. Overall, IQM should be regarded as a fast-developing superconducting quantum cloud platform with strong hardware potential but still-growing platform maturity.



Tianyan Quantum Computing Cloud Platform, launched by China Telecom Quantum Group, is an important representative of domestic public quantum computing cloud services. China Telecom Quantum Group and QuantumCTek jointly completed the construction, control, and calibration of the quantum computing hardware and integrated it into Tianyan Quantum Computing Cloud Platform, under the guidance of CAS Center for Excellence in Quantum Information and Quantum Physics. The platform provides quantum computers, high-performance simulators, and the Cqlib programming framework for research, education, and industrial applications, emphasizing cloud-based access to quantum computing resources and quantum-supercomputing integration. In this evaluation, Tianyan's main strengths are concentrated in real quantum hardware performance and simulator performance. Tianyan-287 performs strongly in Entanglement Scale and Multi-Qubit XEB tests, indicating competitive capability in multi-qubit entanglement preparation, complex circuit execution, and simulation support. Its main weaknesses lie in ecosystem operations, where user scale, application services, course resources, and community building still have room for improvement.



Quafu Quantum Computing Cloud Platform, developed by the Beijing Academy of Quantum Information Sciences and related institutions, has a strong research-platform orientation. The platform integrates superconducting quantum chips, measurement and control equipment, a quantum operating system, and application software, providing real quantum processor access for research testing and quantum algorithm experiments. The BaiHua system has a certain foundation in qubit scale, but this evaluation shows that its readout error rate, two-qubit gate error rate, Entanglement Scale scale, Multi-Qubit XEB fidelity, and platform-function completeness still have substantial room for improvement. In addition, relatively insufficient simulator services and ecosystem operations have a significant impact on its overall score.



Origin Quantum Cloud is a one-stop quantum computing cloud service platform launched by Origin Quantum. Built around an independent quantum hardware-software system, it provides quantum learning resources, programming tools, real quantum computers, simulation resources, and application development services. Origin Quantum Cloud has accumulated a certain foundation in platform-service completeness, event operations, course resources, and application services, reflecting strong productization awareness and an application-oriented approach. Origin Wukong 180 provides a foundation in available qubit scale and platform service experience, but gaps remain against leading platforms in Two-Qubit Gate Error Rate, Multi-Qubit XEB performance, and state-vector simulation efficiency.



Wuyue Quantum Computing Cloud Platform, built by China Mobile-related entities, is positioned as a full-stack quantum computing cloud service system integrating classical and quantum computing resources. The platform explores quantum cloud service capabilities for research users and industry scenarios such as finance, transportation, and biomedicine, with advantages in cloud-network integration and industry-scenario connectivity. Based on this evaluation, Wuyue has a certain foundation in its service portal, but its public data and documentation are incomplete or inconsistent in some aspects, making key indicators such as readout error rate, gate error rates, and Multi-Qubit XEB not effectively measurable. Therefore, this report treats Wuyue as an object of observation and analysis, but does not include it in the final overall ranking.

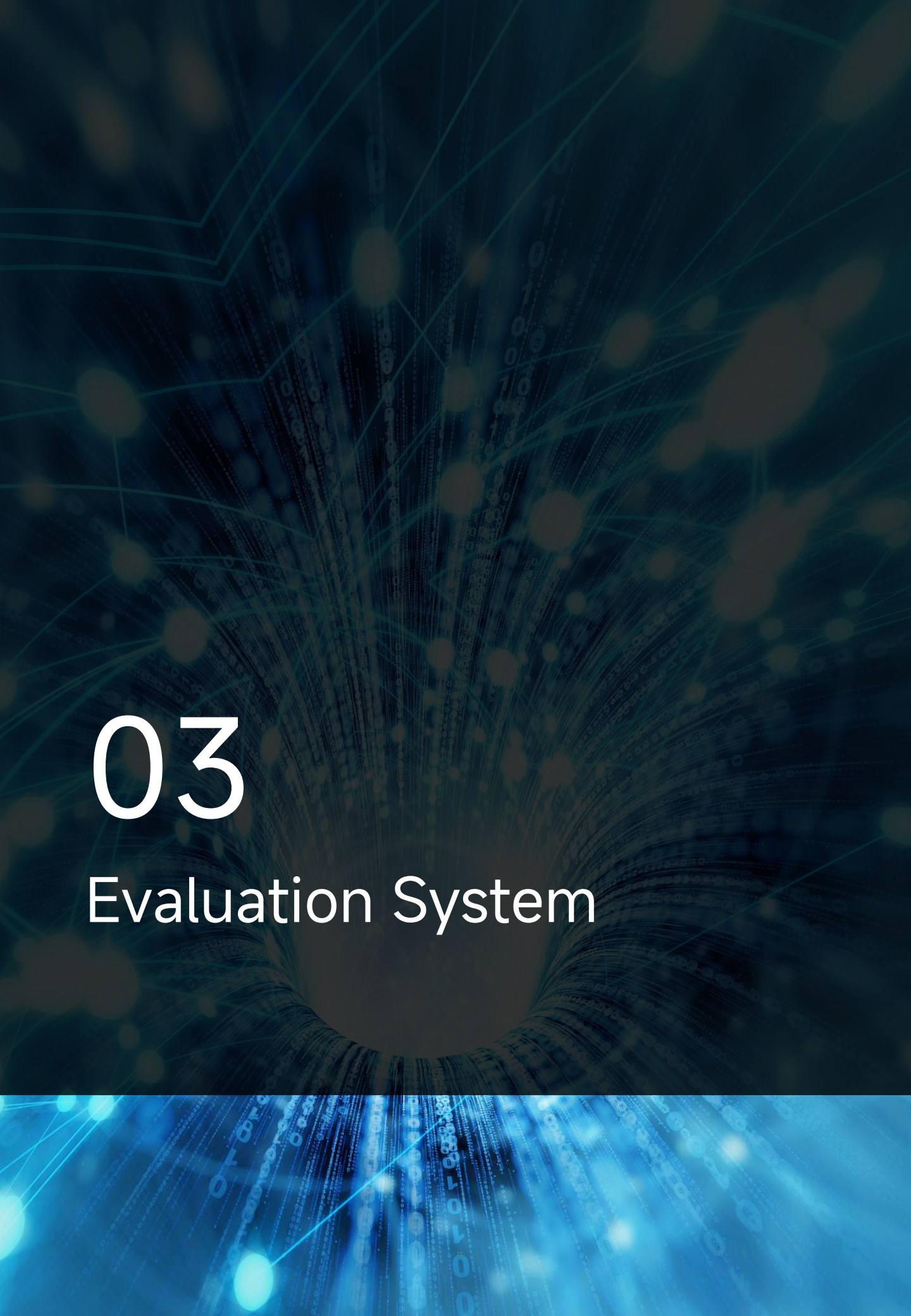
03 Provider Landscape and Subsequent Evaluation Focus

Based on the provider composition and preliminary capability performance observed in this evaluation, global quantum cloud platform competition is forming a relatively clear hierarchy.

IBM Quantum Platform maintains a leading position in comprehensive capability through its mature hardware system, Qiskit toolchain, and global ecosystem operations. Tianyan Quantum Computing Cloud Platform performs prominently in hardware-system performance and simulator performance, making it the closest platform to IBM in this evaluation. Quafu has a research-platform orientation and a hardware foundation, but still needs to strengthen platform functions, simulator resources, and ecosystem services. Origin Quantum Cloud is positioned in the second tier, with certain accumulation in ecosystem operations and application services, although its system-level hardware performance still needs improvement. Wuyue reflects the exploration of telecommunications cloud providers entering the quantum cloud service field, but at this stage it still needs to improve data transparency, functional stability, and testing availability.

This landscape indicates that competition among quantum cloud platforms is no longer purely a hardware race. The number of qubits remains important, but if gate error rates, readout stability, entanglement scale, random circuit sampling fidelity, or task-service capability are insufficient, the practical usability of a platform will still be constrained. Likewise, even platforms with strong hardware performance will find it difficult to develop sustained service capability without user-friendly programming tools, transparent backend management, sufficient simulation resources, and a continuously operated developer ecosystem.

Therefore, subsequent chapters will conduct a systematic evaluation around six core indicators: Basic Error Rate Indicators for assessing underlying hardware quality; Entanglement Scale and Multi-Qubit XEB for observing system-level quantum circuit execution capability; Simulator Performance for evaluating classical simulation support; Platform Architecture and Functions for measuring the completeness of user service workflows; and Ecosystem Operations for examining long-term platform development and user-organization capability. Through quantitative scoring across these dimensions, this report will further present the capability differences and development gaps of the seven platforms at the current stage.



03

Evaluation System

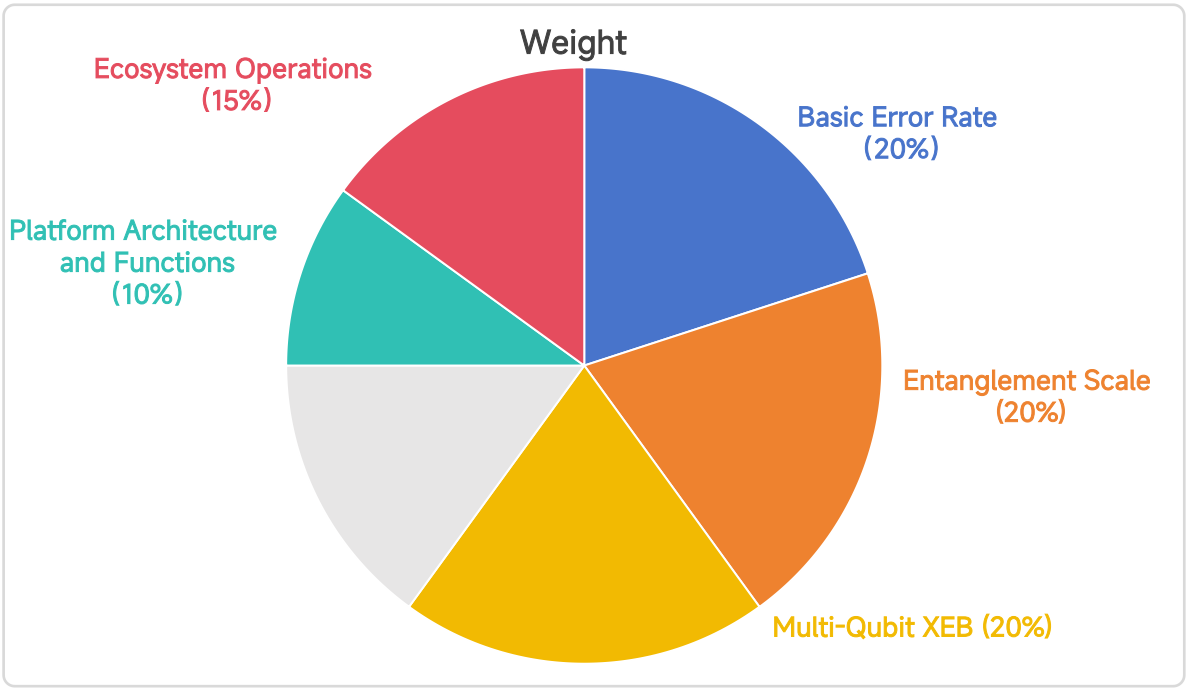
01 Evaluation Mechanism

To objectively and comprehensively evaluate the overall capabilities of leading global quantum computing cloud platforms, this scoring system is designed from the perspective of practical user experience. It emphasizes service efficiency and usability, uses quantitative indicators to compare platform strengths and weaknesses, and provides users with a clear reference for platform selection while supporting providers in service optimization.

The system quantitatively assesses each platform's integrated capability to provide ready-to-use quantum computing cloud services. The weighting scheme is as follows: Basic Error Rate, 20 points; Entanglement Scale, 20 points; Multi-Qubit XEB, 20 points; Platform Architecture and Functions, 10 points; and Ecosystem Operations, 15 points. (The total is 85 points)

The final weights are defined as follows:

Figure: Quantitative Scoring Weight Distribution



Basic Error Rate

The basic error rate is a fundamental hardware noise metric for evaluating the underlying quality of a quantum computing platform. Specifically, it refers to the average error probability of elementary single-qubit quantum gates, such as X, Y, Z, H, S, and T gates, and is mathematically defined as one minus the average gate fidelity. This metric focuses on errors introduced by the gate operation itself, while excluding state preparation and measurement errors through standardized benchmarking procedures. Physically, it reflects the probability that a quantum bit deviates from the intended unitary transformation during single-qubit gate execution due to factors such as decoherence, control pulse distortion, thermal noise, and charge fluctuations.

The basic error rate is selected as a core evaluation dimension because single-qubit gate fidelity provides a fundamental limit on the reliability and scalability of quantum computation. Most quantum algorithms, including VQE, QAOA, quantum machine learning, and error correction protocols, are built from large numbers of single-qubit operations combined with multi-qubit gates. Since single-qubit gates are executed frequently throughout quantum circuits, their errors accumulate with circuit depth and directly affect the maximum size and reliability of executable workloads. A lower basic error rate enables deeper circuits, improves algorithmic stability, and provides a stronger foundation for practical quantum computing.

From the perspective of quantum cloud services, the basic error rate offers a universal reference across different application scenarios. Whether users run simple demonstrations, quantum simulation workloads, or early fault-tolerant computing experiments, all tasks rely on reliable single-qubit operations. Lower error rates provide higher baseline computational fidelity, while more consistent error performance across qubits improves platform stability and scheduling flexibility. Compared with application-specific benchmarks such as GHZ-state preparation or XEB, the basic error rate provides a broader evaluation dimension applicable to general quantum workloads.

In this evaluation, the basic error rate is assessed through standardized benchmarking methods such as randomized benchmarking (RB) and cross-entropy benchmarking (XEB), which provide quantitative measurements of gate fidelity. Meanwhile, the long-term relevance of this indicator is also reflected in quantum error correction, where physical gate error rates must remain below fault-tolerance thresholds. The basic error rate therefore serves as an important indicator of whether a quantum processor can progress toward scalable and practical quantum computing.

Beyond the basic error rate, this report also considers complementary hardware dimensions, including available qubit scale, readout error rate, two-qubit gate error rate, and qubit connectivity. Qubit scale determines the size of executable workloads; readout error affects the accuracy of final results; two-qubit gate error characterizes the quality of entangling operations that are critical for practical algorithms; and connectivity influences compilation overhead, SWAP insertion, circuit depth, and error accumulation. Together, these indicators provide a comprehensive evaluation of the hardware foundation of quantum cloud platforms.

Entanglement Scale

The entanglement scale indicator measures the maximum size of multipartite entanglement that a quantum computing system can reliably generate and preserve. It reflects the ability of multiple qubits to maintain coordinated quantum correlations under the combined effects of state initialization, entangling-gate execution, circuit compilation, decoherence, and final measurement. Compared with individual gate-error metrics or single-qubit parameters, entanglement scale provides a more comprehensive assessment of a quantum processor's performance during coordinated multi-qubit operations.

In this report, entanglement scale is evaluated primarily through GHZ-state preparation, a representative method for characterizing global multipartite entanglement. A GHZ state is a coherent superposition of the all-zero and all-one states across multiple qubits. The specific evaluation criterion is the maximum number of qubits for which the prepared GHZ state retains a fidelity above 50%. As the number of participating qubits increases, gate errors, decoherence, readout errors, and compilation overhead accumulate, generally causing the measured fidelity to decrease. The largest qubit count satisfying the fidelity threshold is therefore used as an operational measure of the effective entanglement scale supported by the platform. Where available, other multi-qubit benchmarking results may be used as supplementary evidence, but GHZ preparation remains the primary standardized test adopted in this evaluation.

Entanglement scale is included as an independent evaluation dimension because multipartite entanglement is a fundamental resource underlying quantum computation and a prerequisite for many forms of potential quantum advantage. Although basic error rates describe the quality of individual operations, they cannot fully capture correlated errors, accumulated noise, or the preservation of global coherence during multi-qubit execution. Entanglement-scale testing therefore provides a system-level view of how effectively a processor can coordinate larger numbers of qubits and offers a closer approximation to the hardware requirements of practical quantum algorithms.

Multi-Qubit XEB

XEB, or cross-entropy benchmarking, is a system-level evaluation method based on random circuit sampling and is widely used to characterize the overall performance of quantum processors. It evaluates the overall fidelity with which a quantum processor executes multi-qubit random quantum circuits. Its basic principle is to execute random circuits of specified scale and depth on real quantum hardware and compare the sampled outputs with the ideal quantum-state probability distribution, thereby quantifying the consistency between the practical outputs of the processor and theoretical expectations. Compared with measurements of individual gate error rates, XEB more effectively captures the integrated behavior of complex circuits executed on realhardware.

This report adopts the fidelity of 11-qubit, 20-layer random quantum circuits as the evaluation criterion for multi-qubit XEB. An 11-qubit circuit provides a nontrivial multi-qubit testing scenario, while a depth of 20 layers introduces a sufficiently long sequence of operations to expose the effects of decoherence, crosstalk, compilation and mapping errors, and gate errors. By fixing both the number of qubits and the circuit depth, different platforms can be evaluated under comparable testing conditions, making differences in practical circuit-execution capability more transparent.

Multi-qubit XEB is included as a core evaluation indicator because the practical value of quantum cloud hardware ultimately depends on its ability to execute general quantum circuits with high fidelity. GHZ testing focuses on the preparation and preservation of a specific entangled state, whereas XEB assesses the general execution quality of random circuits and jointly reflects qubit scale, gate fidelity, connectivity, system noise, crosstalk control, and compiler optimization. For evaluating the general-purpose circuit-execution capability of a quantum processor, multi-qubit XEB is closer to practical computational workloads than isolated hardware parameters.

Platform Architecture and Functions

Platform architecture and functionality evaluate whether a quantum computing cloud platform provides complete, clear, and usable service capabilities. A quantum cloud platform is not merely a quantum processor connected to the internet; it must package underlying hardware, compilation systems, task scheduling, simulation resources, development tools, and user interfaces into cloud services that are accessible, manageable, and reusable. For users, platform architecture and functions

directly determine whether they can smoothly complete the full workflow from account access, circuit design, job submission, backend selection, and result retrieval to subsequent analysis.

This report evaluates five aspects: service portal function, graphical programming service function, code-based programming service function, quantum computer management function, and classical simulator resource management. Service portal functionality measures whether the platform provides a complete entry point, including registration and login, resource display, task access, documentation access, and user information management. Graphical programming functionality primarily serves beginners, teaching scenarios, and rapid circuit construction, examining whether visualization reduces the barrier to quantum circuit design. Code-based programming functionality targets professional developers and focuses on the completeness of SDKs, APIs, Notebooks, sample programs, and job-submission interfaces, which determine whether the platform can support advanced research and engineering development. Quantum computer management functionality assesses whether backend devices, topologies, calibration parameters, task queues, and run states are clearly displayed. Classical simulator resource management functionality evaluates the configuration, selection, submission, and result management of different simulation backends.

The significance of this indicator lies in the fact that competition among quantum cloud platforms occurs not only at the hardware layer but also in service encapsulation and user interaction. If hardware capability cannot be presented to users through stable, transparent, and easy-to-use platform functions, it is difficult to translate into scientific and industrial value. A well-designed platform architecture lowers usage barriers, improves development efficiency, strengthens task manageability, and provides the basis for expanding more quantum hardware, simulation resources, and application services.

Ecosystem Operations

Ecosystem operations measure the long-term development capability of a quantum computing cloud platform in user outreach, partnership networks, application accumulation, event organization, talent development, and community building. As quantum computing moves from laboratory research toward cloud-based access and industrial exploration, platform value is no longer limited to individual job execution; it increasingly depends on whether the platform can continuously attract users, support developers, connect industrial partners, and form closed-loop application feedback. A mature quantum cloud platform should not only provide accessible quantum computing resources but also sustain ecosystem operations and expansion.

This report evaluates ecosystem operations across six aspects: registered users, strategic partners, application services, event operations, science popularization and courses, and community building. Registered users reflect market reach and user base. Strategic partners indicate the breadth of collaboration with universities, research institutions, enterprises, and industrial partners. Application services show whether the platform has transformed quantum algorithms, industry cases, and tool capabilities into callable services. Event operations reflect the ability to activate users through competitions, seminars, developer activities, and industrial exchange. Science communication and courses measure investment in quantum computing education, talent training, and technology popularization. Community building reflects whether the platform supports developer communication, issue feedback, knowledge sharing, and user co-creation.

Ecosystem operations are included as a core evaluation dimension because the long-term competitiveness of a quantum computing cloud platform depends on the joint development of technological capability and user ecology. Hardware and platform functions determine whether users can complete computational tasks, while ecosystem operations determine whether users are willing to continue using, learning from, developing on, and contributing to the platform. For quantum computing, which remains in the early stage of industrialization, active users, rich application services, sustained courses and events, and open community mechanisms help build a positive cycle from technology supply to application validation and industrial cooperation.

Table: Scoring Items and Weight Allocation

Primary Dimension	Secondary Indicator	Core Evaluation Content of Secondary Indicator
Basic Error Rate (20 pts)	Maximum Available Qubits (3 pts)	Evaluates the effective qubit scale that the platform makes publicly available and that can participate in circuit execution, entangling operations, and readout.
	Readout Error Rate (5 pts)	Evaluates the probability that measured quantum-state outcomes deviate from the true states, reflecting the reliability of final sampled outputs.
	Single-Qubit Gate Error Rate (5 pts)	Evaluates the average error of elementary single-qubit gate operations relative to ideal evolution, reflecting basic quantum-control precision.
	Two-Qubit Gate Error Rate (5 pts)	Evaluates the error level of two-qubit entangling-gate operations, reflecting the platform's key capability for executing multi-qubit interaction circuits.
	Connectivity (2 pts)	Evaluates the topology through which qubits can directly execute two-qubit gates, reflecting circuit-mapping complexity and additional error overhead.
Entanglement Scale (20 pts)	Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50% (20 pts)	Uses a GHZ-state fidelity threshold of 0.5 to evaluate the maximum global multi-qubit entanglement scale that the platform can stably prepare and preserve.
Multi-Qubit XEB (20 pts)	Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits (20 pts)	Evaluates system-level precision in executing complex multi-layer quantum circuits using cross-entropy fidelity for fixed 11-qubit, 20-layer random quantum circuits.
Platform Architecture and Functions (10 pts)	Service Portal Function (2 pts)	Evaluates the completeness and usability of the platform's user entry, account management, resource display, task navigation, and basic service access.
	Graphical Programming Service Function (2 pts)	Evaluates the platform's ability to lower quantum-program development barriers through visual circuit editing, drag-and-drop modeling, and result presentation.
	Code-Based Programming Service Function (2 pts)	Evaluates how SDKs, APIs, Notebooks, and sample code support circuit construction, job submission, and result parsing.
	Quantum Computer Management Function (2 pts)	Evaluates the platform's ability to manage and present real quantum backend status, topology, calibration parameters, queue information, and job results.
	Classical Simulator Resource Management (2 pts)	Evaluates the platform's unified support for simulator backend types, available scale, parameter configuration, task scheduling, and result management.
Ecosystem Operations (15 pts)	Registered Users (3 pts)	Evaluates the platform's user base and market reach, reflecting usage coverage and potential ecosystem scale for quantum cloud services.
	Strategic Partners (2 pts)	Evaluates the breadth of stable partnerships with universities, research institutions, enterprises, and industrial partners, reflecting ecosystem connectivity.
	Application Services (2 pts)	Evaluates how extensively the platform turns quantum algorithms, industry scenarios, and tool capabilities into directly callable application services.
	Event Operations (3 pts)	Evaluates the platform's operational capability to continuously activate users and partners through competitions, seminars, developer activities, and industrial exchange.
	Science Popularization and Courses (2 pts)	Evaluates the completeness of quantum computing education, training, and outreach resources for beginners, developers, and industry users.
	Community Building (3 pts)	Evaluates whether the platform provides developer communication, issue feedback, knowledge accumulation, and user co-creation mechanisms, reflecting sustainable ecosystem operations.

02 Evaluation Framework

Basic Error Rate

Basic error rate is a core dimension for assessing the underlying quality of a quantum cloud platform's real quantum processor. It reflects qubit scale, readout reliability, quantum-gate control accuracy, and chip topology, and determines the foundational stability for running real quantum circuits.

Table: Basic Error Rate Evaluation

Dimension	Concept and Importance
Maximum Available Qubits	Maximum available qubits refer to the number of effective qubits that the platform makes available to users and that can participate in circuit execution, entangling operations, and readout. This dimension determines executable circuit scale and problem-encoding space, and is a basic measure of hardware-resource availability.
Readout Error Rate	Readout error rate measures the probability that measured quantum-state outcomes differ from the true states, directly affecting the reliability of sampled outputs and computational results. A lower readout error rate indicates greater stability in the measurement chain, signal discrimination, and result return.
Single-Qubit Gate Error Rate	Single-qubit gate error rate reflects the deviation from ideal evolution when a single qubit performs elementary quantum-gate operations. As the basic building block of quantum circuits, its precision directly affects shallow-circuit execution quality and the rate of overall error accumulation.
Two-Qubit Gate Error Rate	Two-qubit gate error rate measures the error level of entangling-gate operations between two qubits and is a key parameter for evaluating multi-qubit quantum computing capability. Because complex quantum algorithms typically rely on two-qubit gates to establish entanglement, this dimension directly affects executable circuit depth, entanglement scale, and algorithm success rate.
Connectivity	Connectivity describes the topology through which qubits can directly execute two-qubit gates or establish entanglement. Higher connectivity helps reduce additional SWAP gates and extra depth during circuit mapping, thereby lowering error accumulation and improving the executability of complex circuits.

Entanglement Scale

Entanglement Scale evaluates a quantum system's ability to prepare and preserve global multi-qubit entangled states. GHZ states place stringent requirements on multi-qubit control, coherence preservation, entangling-gate quality, and readout stability, thereby reflecting system-level capability for entanglement-based circuit tasks.

Table: Entanglement Scale Evaluation

Dimension	Concept and Importance
Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50%	Using a GHZ-state fidelity of 0.5 as the threshold for effective entanglement, this dimension measures the largest global multi-qubit entangled state that the platform can stably prepare and preserve. A larger value indicates stronger performance in multi-qubit gate-sequence execution, noise suppression, and global coherence preservation.

Multi-Qubit XEB

Multi-qubit Cross-Entropy Benchmarking (XEB) evaluates the overall execution fidelity of quantum processors via random circuit sampling under fixed qubit scale and circuit depth. It comprehensively characterizes multiple adverse factors including gate errors, crosstalk, decoherence, topological wiring constraints and compilation overheads, making it a critical benchmark for quantifying the execution quality of real quantum circuits.

Table: Multi-Qubit XEB Evaluation`

Dimension	Concept and Importance
Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits	This dimension calculates cross-entropy fidelity for random circuits with 11-qubit, 20-layer random quantum circuits. Fixing qubit number and circuit depth creates a unified workload and enables clearer comparison of overall execution precision across platforms.

Platform Architecture and Functions

Platform architecture and functionality measure a quantum cloud platform's ability to package real quantum hardware, classical simulation resources, compilation systems, task scheduling, and development tools into usable cloud services. This dimension focuses on whether users can efficiently complete resource access, circuit construction, job submission, backend selection, result retrieval, and experiment management.

Table: Platform Architecture and Functions Evaluation

Dimension	Concept and Importance
Service Portal Function	Service portal functionality covers basic access capabilities such as registration and login, account management, resource display, task entry, documentation search, and service navigation. The portal experience determines the convenience of accessing quantum computing resources and directly reflects platform accessibility and service completeness.
Graphical Programming Service Function	Graphical programming functionality supports quantum-program development through visual circuit editing, drag-and-drop gate configuration, circuit preview, and result display. This capability lowers usage barriers for beginners, teaching users, and non-specialist developers, improving platform accessibility and ease of use.
Code-Based Programming Service Function	Code-based programming functionality supports programmatic quantum-circuit development through SDKs, APIs, Notebooks, sample code, and job-submission interfaces. This capability determines whether the platform can support complex algorithm development, batch experiments, automated tasks, and integration into research and engineering workflows.
Quantum Computer Management Function	Quantum computer management functionality covers the display and management of real quantum backend status, available qubits, topology, calibration parameters, task queues, run states, and result records. Clear and transparent backend management helps users select appropriate quantum resources, assess experimental conditions, and interpret result differences.
Classical Simulator Resource Management	Classical simulator resource management covers simulator types, supported qubit scale, circuit depth, execution backend, task scheduling, and result output. Complete simulation-resource management supports circuit validation, performance estimation, and algorithm iteration before hardware execution, improving quantum experiment R&D efficiency.

Ecosystem Operations

Ecosystem operations measure the sustained development capability of a quantum cloud platform in user base, partnership networks, application accumulation, event organization, course and outreach resources, and community co-building. Mature ecosystem operations help the platform evolve from compute-resource access toward application cultivation and a service network jointly involving developers, research institutions, and industrial users.

Table: Ecosystem Operations Evaluation

Dimension	Concept and Importance
Registered Users	Registered users reflect the breadth of platform coverage across researchers, developers, students, and industrial users. A larger user base helps generate sustained feedback, demand-driven development, and application validation, serving as an important indicator of platform influence and ecosystem scale.
Strategic Partners	Strategic partners reflect the breadth of formal cooperation with universities, research institutions, enterprises, government bodies, and industrial partners. A richer partnership network indicates stronger capability in research collaboration, industry implementation, and resource integration.
Application Services	Application services measure how extensively the platform packages quantum algorithms, industry cases, development tools, and solutions into directly callable services. More complete application services indicate a stronger ability to translate underlying quantum computing and simulation resources into scenario-oriented capabilities.
Event Operations	Event operations include user-activation activities such as developer competitions, technical seminars, industrial exchange, training camps, and online/offline promotion. High-quality events expand platform influence, strengthen user engagement, and promote algorithm development and application exploration.
Science Popularization and Courses	Science communication and courses measure the platform's ability to provide quantum computing fundamentals, programming instruction, experimental cases, and systematic training resources for users at different levels. Complete educational content lowers learning barriers, cultivates potential developers, and provides talent support for long-term platform development.
Community Building	Community building focuses on the completeness of mechanisms for user communication, issue feedback, developer mutual assistance, case sharing, and co-creation. A mature community accumulates knowledge and experience, improves issue-response efficiency, and helps the platform form a continuously active developer ecosystem.

03 Scoring Implementation Process

To systematically assess the comprehensive capabilities of leading global quantum computing cloud platforms, this study establishes a 100-point quantitative scoring framework comprising five core dimensions and more than ten detailed indicators, together with a complete standardized implementation process. From the perspective of practical user applications, the process integrates official documentation, measured data, and multi-source information. Through standardized quantum experiments, such as GHZ-state preparation and fidelity analysis, and a systematic scoring mechanism, the report evaluates basic error rate, entanglement scale , multi-qubit XEB,cloud platform architecture and functions, and ecosystem operations. The following sections present the full workflow from data collection and experimental validation to quantitative scoring and result output through the scoring implementation flowchart, detailed scoring procedure, and quantum cloud platform evaluation tables.

Figure: Scoring Implementation Flowchart

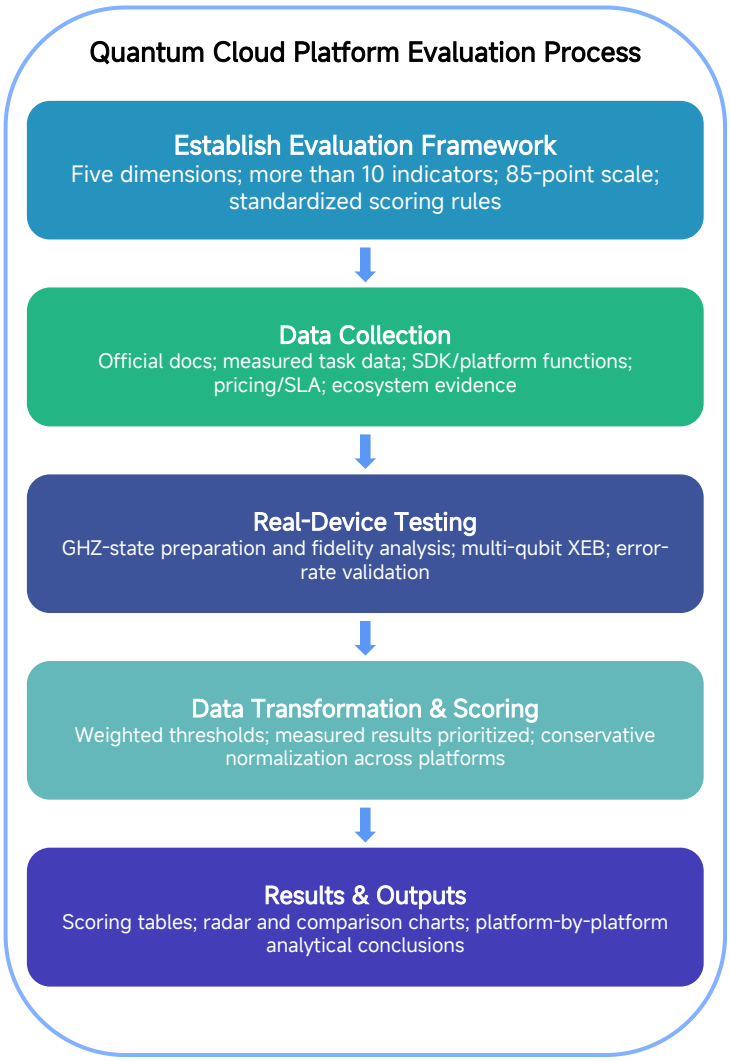


Figure: Detailed Scoring and Evaluation Process

Establish Evaluation Framework	To ensure fairness and comparability, this study defines a 100-point framework with six core dimensions: Basic Error Rate, Entanglement Scale , Multi-Qubit XEB, , Platform Architecture and Functions, and Ecosystem Operations. More than ten detailed indicators are mapped to measurable evidence, enabling consistent evaluation across different quantum cloud platforms.
Data Collection	Data collection integrates official documentation, platform manuals, SDK information, public hardware parameters, task records, user-facing service descriptions, ecosystem materials, and multi-source third-party information. The collected evidence covers qubit scale, error and fidelity indicators, coherence information, simulator access, pricing and SLA visibility, usability, and community or partner activity.
Real-Device Testing	Real-device testing focuses on standardized experiments that can be reproduced across available superconducting quantum systems. Entanglement Scale preparation and fidelity analysis are used to evaluate multi-qubit entanglement capability, while multi-qubit XEB and related measured data are used to characterize random-circuit execution fidelity, error accumulation, and system-level performance under practical cloud-access conditions.
Data Transformation & Scoring	Collected and measured data are transformed into comparable scores through unified thresholds and weights. Basic error rate, GHZ, XEB, platform architecture, and ecosystem operations are normalized into their assigned point ranges. When public documentation and measured results differ, measured results are prioritized, and conservative scoring is applied to preserve comparability.
Results & Outputs	The final output combines quantitative scoring tables, radar charts, comparison charts, and analytical comments. Results present platform-by-platform performance across the six dimensions, identify strengths and weaknesses, and support a transparent assessment of real-device capability, software and cloud-service completeness, simulator resources, and ecosystem maturity.

To systematically evaluate the actual performance of each quantum cloud platform in core capabilities and service quality, this scoring table further defines quantitative criteria for secondary indicators under the six-dimensional framework: basic error rate, entanglement scale , multi-qubit XEB, cloud platform architecture and functions, and ecosystem operations. Each indicator is assigned explicit thresholds for "Excellent," "Qualified," and "Unqualified," with measured data, official parameters, and user feedback used as scoring references. This ensures that the evaluation process is measurable, comparable, and traceable, and that it accurately reflects the comprehensive capability of each platform.

The detailed quantum cloud platform evaluation tables are as follows:

Table: Basic Error Rate (20 pts), Entanglement Scale (20 pts) and Multi-Qubit XEB (20 pts)

Secondary Indicator	Quantitative Scoring Criteria	Remarks / Examples
Maximum Available Qubits	Excellent: ≥100 qubits; Qualified: 20–99 qubits; Unqualified: <20 qubits	Calculated based on each platform's currently usable QPUs; ≥100 qubits indicates strong scalability, while 20–99 qubits can support medium-scale experiments.
Readout Error Rate	Excellent: ≤3%; Qualified: >3% and ≤8%; Unqualified: >8% or not measurable	≤3% indicates a highly stable readout regime; 3%–8% remains usable but with evident noise, while >8% significantly weakens sampling reliability.
Single-Qubit Gate Error Rate	Excellent: ≤0.10%; Qualified: >0.10% and ≤0.20%; Unqualified: >0.20% or not measurable	≤0.10% indicates high basic control accuracy; 0.10%–0.20% is usable but entails more visible error accumulation, while >0.20% constrains circuit stability.
Two-Qubit Gate Error Rate	Excellent: ≤0.80%; Qualified: >0.80% and ≤2.00%; Unqualified: >2.00% or not measurable	≤0.80% indicates high-quality entangling gates; 0.80%–2.00% can support basic multi-qubit tasks, while >2.00% significantly limits circuit depth.
Connectivity	Excellent: ≥3.0; Qualified: 1.5–2.99; Unqualified: <1.5 or not measurable	≥3.0 can significantly reduce SWAP insertion; 1.5–2.99 supports conventional mapping, while <1.5 indicates clear topological constraints.
Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50%	Excellent: ≥20 qubits; Qualified: 5–19 qubits; Unqualified: <5 qubits or not measurable	≥20 qubits reflects strong global entanglement capability; 5–19 qubits indicates basic multi-qubit entanglement preparation capability but limited scalability; <5 qubits is insufficient for stable preparation of effective many-body entangled states.
Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits	Excellent: ≥0.60; Qualified: 0.10–0.60; Unqualified: <0.10 or not measurable	≥0.60 indicates high-quality random circuit sampling; 0.10–0.60 can complete random circuit sampling but with clear noise and compilation-error effects on fidelity; <0.10 indicates a large deviation from the ideal distribution and insufficient general circuit execution capability.

Table: Platform Architecture and Functions (10 pts)

Secondary Indicator	Quantitative Scoring Criteria	Remarks / Examples
Service Portal Function	Excellent: complete functions and clear entry points (2 pts); Qualified: core entries are usable but some functions are missing (1.2–1.9 pts); Unqualified: basic entries are missing or usability is affected (<1.2 pts)	Registration and login, resource display, task entry, help documentation, and service navigation are core items; their completeness directly affects user access efficiency.
Graphical Programming Service Function	Excellent: complete circuit editing and result display (2 pts); Qualified: basic graphical development can be completed (1.2–1.9 pts); Unqualified: key functions are missing or unusable (<1.2 pts)	Focuses on visual circuit construction, quantum gate configuration, circuit preview, and result display, which determine platform friendliness for beginners.
Code-Based Programming Service Function	Excellent: complete SDK/API/example system (2 pts); Qualified: basic programming interfaces are available (1.2–1.9 pts); Unqualified: interfaces are missing or have severe issues (<1.2 pts)	Focuses on SDKs, APIs, notebooks, sample code, and task-submission interfaces, which determine support for complex experiments and automated workflows.
Quantum Computer Management Function	Excellent: complete and transparent backend information (2 pts); Qualified: main management information is available (1.2–1.9 pts); Unqualified: management information is severely missing (<1.2 pts)	Focuses on device status, available qubits, topology, calibration parameters, queues, and result records, which affect backend selection and result interpretation.
Quantum-Resource Classical Simulator Management Function	Excellent: complete simulation-resource management (2 pts); Qualified: basic simulation management is available (1.2–1.9 pts); Unqualified: simulation resources are unavailable or information is missing (<1.2 pts)	Focuses on simulator types, qubit scale, circuit depth, execution backend, scheduling, and result management, supporting validation before real-hardware execution.

Table: Ecosystem Operations (15 pts)

Secondary Indicator	Quantitative Scoring Criteria	Remarks / Examples
Number of Registered Users	Excellent: ≥50,000 users; Qualified: 10,000–50,000 users; Unqualified: <10,000 users or not statistically available	≥50,000 users indicates strong user coverage; 10,000–50,000 users indicates a basic ecosystem scale; below 10,000 users or unavailable statistics indicates insufficient support.
Number of Strategic Partners	Excellent: ≥100 partners; Qualified: 10–99 partners; Unqualified: <10 partners or no publicly disclosed partnerships	≥100 partners indicates broad collaboration; 10–99 partners indicates a certain cooperation foundation; fewer than 10 partners suggests weak ecosystem connectivity.
Number of Application Services	Excellent: ≥30 services; Qualified: 5–29 services; Unqualified: <5 services or no application services	≥30 services indicates rich application accumulation; 5–29 services provides basic scenario coverage; fewer than 5 services indicates insufficient application conversion.
Event Operations	Excellent: frequent and diverse events; Qualified: limited event quantity or diversity; Unqualified: few events or long-term absence	Events should cover developer competitions, technical seminars, industry exchanges, training, and ecosystem collaboration; both quantity and type determine operational quality.
Science Popularization and Courses	Excellent: systematic and continuously updated courses; Qualified: basic outreach or course resources are available; Unqualified: no usable educational resources	Courses should cover outreach, programming instruction, experimental cases, and training resources; the degree of systematization determines talent cultivation and user conversion capability.
Community Building	Excellent: active community with a complete feedback mechanism; Qualified: basic communication or feedback channels are available; Unqualified: no community function or inactive community	The community should support communication, feedback, experience sharing, and co-creation mechanisms; its activity level determines the sustainability of the developer ecosystem.

04

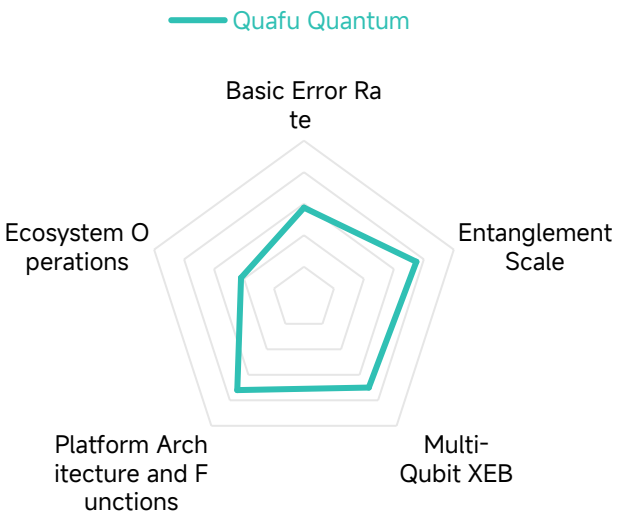
Evaluation Process

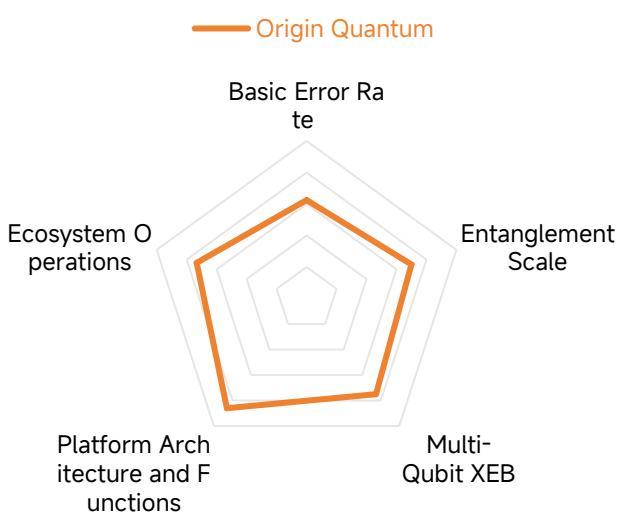
01 Evaluation Results

To present the evaluation results intuitively, this report uses radar charts based on the six quantitative dimensions. Radar charts visually display the relative performance of each platform across different dimensions, enabling readers to quickly compare platform strengths and weaknesses. Overall, the radar chart not only provides a clear capability profile for each individual platform, but also offers an intuitive framework for cross-platform comparison. The following sections present the evaluation results for each platform in sequence.

Figure: Scoring Implentation Flowchart




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02 Platform-by-Platform Evaluation Results

IBM Quantum Platform

IBM Quantum Platform is IBM's quantum computing service platform for global users, integrating quantum hardware access, Qiskit software tools, developer documentation, and learning resources. Supported by mature superconducting quantum hardware and a strong developer ecosystem, the platform has significant influence in research, education, and algorithm validation.

Table: Quantitative Scoring and Performance Evaluation of IBM Quantum Platform

Primary Dimension	Secondary Indicator	Max. Score	Score	Scoring Basis
Basic Error Rate	Maximum Available Qubits	3	3	156 functional qubits.
	Readout Error Rate	5	4	2.37%
	Single-Qubit Gate Error Rate	5	5	0.03%
	Two-Qubit Gate Error Rate	5	5	0.24%
	Connectivity	2	1.5	2.18
Entanglement Scale	Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50%	20	18	20 qubits.
Multi-Qubit XEB	Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits	20	19	0.6560
Platform Architecture and Functions	Service Portal Function	2	2	Unified portal for resources, workloads, documentation and learning.
	Graphical Programming Service Function	2	2	Composer provides drag-and-drop circuit building and visualization.
	Code-Based Programming Service Function	2	2	Qiskit SDK, Runtime, APIs and notebooks support coding workflows.
	Quantum Computer Management Function	2	1.8	Minor gaps between published and measured device metrics.
	Classical Simulator Resource Management	2	2	Aer and local/fake backends support noisy and noiseless simulation.
Ecosystem Operations	Registered Users	3	3	IBM reports 600,000+ users and use by 700 universities.
	Strategic Partners	2	2	IBM reports a quantum network of 340+ organizations.
	Application Services	2	2	Functions and add-ons cover chemistry, optimization, ML and PDEs.
	Event Operations	3	3	Challenges, hackathons, Fall Fest, summer school and meetups run globally.
	Science Popularization and Courses	2	2	Structured learning pathways, courses, tutorials and labs.
	Community Building	3	3	Slack/Discord, GitHub and 1,200+ Advocates in 70+ countries.

Rigetti Quantum Cloud Services

Rigetti provides superconducting quantum computers through Rigetti Quantum Cloud Services and partner channels including Amazon Braket, Microsoft Azure Quantum and qBraid. Cepheus-1-108Q adopts a modular chiplet architecture with twelve interconnected 9-qubit chiplets. The tested data shows high qubit scale and strong connectivity, but current readout error, GHZ and 11-qubit XEB results are materially weaker than the leading reference platforms.

Table: Quantitative Scoring and Performance Evaluation of Wuyue Quantum Computing Cloud Platform

Primary Dimension	Secondary Indicator	Max. Score	Score	Scoring Basis
Basic Error Rate	Maximum Available Qubits	3	3	107 functional qubits.
	Readout Error Rate	5	3	7.51%
	Single-Qubit Gate Error Rate	5	3	0.15%
	Two-Qubit Gate Error Rate	5	3	1.17%
	Connectivity	2	2	3.57
Entanglement Scale	Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50%	20	14	5 qubits.
Multi-Qubit XEB	Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits	20	12	0.0532
Platform Architecture and Functions	Service Portal Function	2	1.8	Portal covers programming, real/virtual backends, job submission and results.
	Graphical Programming Service Function	2	1.2	Graphical programming relies on third-party platforms.
	Code-Based Programming Service Function	2	1.9	Code interfaces are mature and support multiple frameworks.
	Quantum Computer Management Function	2	1.9	Most device metrics are public but vary across access channels.
	Classical Simulator Resource Management	2	1.8	Simulator supports SDK and local backend options.
Ecosystem Operations	Registered Users	3	1.5	Registered user base is not publicly disclosed by Rigetti.
	Strategic Partners	2	1.8	Moderate number of strategic partners across cloud platforms.
	Application Services	2	1.4	Relatively limited application services, focused on hardware access.
	Event Operations	3	2	Events are active, with emphasis on research and customers.
	Science Popularization and Courses	2	1.3	Science popularization resources are relatively limited and tutorials are available.
	Community Building	3	2.5	No dedicated community function.

IQM Resonance

IQM Quantum Computers provides full-stack superconducting quantum computers and cloud access through IQM Resonance and Amazon Braket. Emerald is a 54-qubit superconducting transmon QPU based on the Crystal 54 architecture; the test snapshot used here exposes 49 available qubits. In this evaluation, IQM shows strong basic calibration metrics and GHZ scalability, while the 11-qubit XEB result remains modest and simulator performance was not directly measurable in the tested workflow.

Table: Quantitative Scoring and Performance Evaluation of Origin Quantum Cloud Platform

Primary Dimension	Secondary Indicator	Max. Score	Score	Scoring Basis
Basic Error Rate	Maximum Available Qubits	3	2	49 functional qubits.
	Readout Error Rate	5	5	1.39%
	Single-Qubit Gate Error Rate	5	4	0.07%
	Two-Qubit Gate Error Rate	5	5	0.50%
	Connectivity	2	2	3.10
Entanglement Scale	Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50%	20	17	13 qubits.
Multi-Qubit XEB	Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits	20	10	0.0087
Platform Architecture and Functions	Service Portal Function	2	1.8	Portal covers programming, quantum backends, job submission and results.
	Graphical Programming Service Function	2	1.2	Graphical programming relies on notebook tools.
	Code-Based Programming Service Function	2	1.9	Code interfaces support Qrisp, IQM SDK and Braket.
	Quantum Computer Management Function	2	1.8	Most device metrics are public through available cloud access channels.
	Classical Simulator Resource Management	2	1.7	Simulator supports SDK and local backend options.
Ecosystem Operations	Registered Users	3	2	Registered user count is not publicly disclosed by IQM.
	Strategic Partners	2	1.8	Moderate number of strategic partners across European cloud platforms.
	Application Services	2	1.5	Relatively diverse application services, including mitigation and workflows.
	Event Operations	3	2	Events are active, with emphasis on institutions and developers.
	Science Popularization and Courses	2	1.8	Science popularization resources are relatively rich and tutorials are structured.
	Community Building	3	1.5	No dedicated community function.

Tianyan Quantum Computing Cloud Platform

Launched by China Telecom Quantum Group, the Tianyan Quantum Computing Cloud Platform provides superconducting quantum hardware, high-performance simulators, and the Cqlib programming framework for research, education, and industrial applications. With a focus on cloud-based quantum computing access and quantum–classical integration, it is a representative public quantum cloud service platform in China.

Table: Quantitative Scoring and Performance Evaluation of Tianyan Quantum Computing Cloud Platform

Primary Dimension/	Secondary Indicator	Max. Score	Score	Scoring Basis
Basic Error Rate	Maximum Available Qubits	3	3	104 functional qubits.
	Readout Error Rate	5	4.5	1.85%
	Single-Qubit Gate Error Rate	5	4	0.08%
	Two-Qubit Gate Error Rate	5	4	0.60%
	Connectivity	2	2	3.50
Entanglement Scale	Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50%	20	19	26 qubits
Multi-Qubit XEB	Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits	20	19	0.6521
Platform Architecture and Functions	Service Portal Function	2	2	Portal integrates programming, resources, job submission and results.
	Graphical Programming Service Function	2	1.6	Graphical programming lacks real-time Bloch-sphere visualization.
	Code-Based Programming Service Function	2	1.6	Limited number of code-based programming interfaces.
	Quantum Computer Management Function	2	2	Cloud workflow manages QPU access and task status.
	Classical Simulator Resource Management	2	2	Five simulator types support cloud jobs and result management.
Ecosystem Operations	Registered Users	3	1.8	Small registered user base, about 17,000 users.
	Strategic Partners	2	1.6	Limited strategic partners, only 22.
	Application Services	2	1.4	Limited application service software, only 9.
	Event Operations	3	2	Event volume is limited; industry–research activities are insufficient.
	Science Popularization and Courses	2	1	Few science popularization activities and insufficient course offerings.
	Community Building	3	0	No community function.

Quafu Quantum Computing Cloud Platform

Developed by the Beijing Academy of Quantum Information Sciences and partners, the Quafu Quantum Computing Cloud Platform integrates superconducting quantum chips, measurement and control systems, quantum operating systems, and application software. Centered on open access to real quantum hardware and research-oriented testing services, it connects quantum computing technology development with algorithmic application exploration.

Table: Quantitative Scoring and Performance Evaluation of Quafu Quantum Computing Cloud Platform

Primary Dimension	Secondary Indicator	Max. Score	Score	Scoring Basis
Basic Error Rate	Maximum Available Qubits	3	3	154 functional qubits.
	Readout Error Rate	5	1.5	13.10%
	Single-Qubit Gate Error Rate	5	3.5	0.11%
	Two-Qubit Gate Error Rate	5	3	1.13%
	Connectivity	2	0.5	1.29
Entanglement Scale	Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50%	20	15	6 qubits.
Multi-Qubit XEB	Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits	20	14	0.2148
Platform Architecture and Functions	Service Portal Function	2	1.6	Missing functions on service portal pages.
	Graphical Programming Service Function	2	1.6	Several graphical programming functions are missing.
	Code-Based Programming Service Function	2	1.6	Code interfaces are limited and contain multiple bugs.
	Quantum Computer Management Function	2	1.4	Published device metrics differ substantially from measured values.
	Classical Simulator Resource Management	2	1	Limited simulator types and qubit scale.
Ecosystem Operations	Registered Users	3	1.4	Small registered user base, about 5,000 users.
	Strategic Partners	2	1.3	Limited strategic partners, only 10.
	Application Services	2	0	No application service software.
	Event Operations	3	2.3	Event types are broad, but total activity is limited.
	Science Popularization and Courses	2	1.3	Courses exist on the organization site, not the cloud platform.
	Community Building	3	0	No community function.

Origin Quantum Cloud Platform

Origin Quantum Cloud is a one-stop quantum computing cloud service platform launched by Origin Quantum, providing quantum learning resources, programming tools, real quantum hardware, simulation resources, and application development services. Built around an independently developed quantum hardware–software ecosystem, the platform supports research experiments, educational training, and industry application validation.

Table: Quantitative Scoring and Performance Evaluation of Origin Quantum Cloud Platform

Primary Dimension	Secondary Indicator	Max. Score	Score	Scoring Basis
Basic Error Rate	Maximum Available Qubits	3	3	170 functional qubits.
	Readout Error Rate	5	3	6.02%
	Single-Qubit Gate Error Rate	5	3	0.14%
	Two-Qubit Gate Error Rate	5	3	1.42%
	Connectivity	2	0.5	1.12
Entanglement Scale	Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50%	20	14	5 qubits.
Multi-Qubit XEB	Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits	20	15	0.2376
Platform Architecture and Functions	Service Portal Function	2	2	Portal covers learning, programming, real/virtual backends and task results.
	Graphical Programming Service Function	2	1.8	Graphical programming lacks real-time Bloch-sphere visualization.
	Code-Based Programming Service Function	2	1.6	Code interfaces are limited and contain multiple bugs.
	Quantum Computer Management Function	2	1.6	Some device metrics are missing or differ from measured values.
	Classical Simulator Resource Management	2	1.6	Simulator supports a relatively small qubit scale.
Ecosystem Operations	Registered Users	3	2.6	Registered user base is relatively small, about 80,000 users.
	Strategic Partners	2	1.8	Moderate number of strategic partners, 103 in total.
	Application Services	2	1.8	Relatively limited application service software, only 34.
	Event Operations	3	2.9	Events are diverse, with emphasis on competitions and industry.
	Science Popularization and Courses	2	1.9	Science popularization activities are relatively rich and courses are diverse.
	Community Building	3	0	No community function.

Wuyue Quantum Computing Cloud Platform

Developed by China Mobile, the Wuyue Quantum Computing Cloud Platform is positioned as a full-stack quantum computing cloud service system integrating classical and quantum computing resources. It provides multi-modal quantum computing resources, diversified application design capabilities, and multi-scenario quantum algorithm services for research users and industries such as finance, transportation, and biomedicine.

Table: Quantitative Scoring and Performance Evaluation of Wuyue Quantum Computing Cloud Platform

Primary Dimension	Secondary Indicator	Max. Score	Score	Scoring Basis
Basic Error Rate	Maximum Available Qubits	3	2	57 functional qubits.
	Readout Error Rate	5	0	Not measurable
	Single-Qubit Gate Error Rate	5	0	Not measurable
	Two-Qubit Gate Error Rate	5	0	Not measurable
	Connectivity	2	2	3.23
Entanglement Scale	Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50%	20	14	5 qubits.
Multi-Qubit XEB	Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits	20	0	Not measurable
Platform Architecture and Functions	Service Portal Function	2	2	Portal integrates quantum/classical resources, simulation and task workflows.
	Graphical Programming Service Function	2	1.4	Several graphical circuits are unavailable; functions are missing.
	Code-Based Programming Service Function	2	1.4	Code workflow is fragmented and difficult to use.
	Quantum Computer Management Function	2	1.8	Published device metrics differ slightly from measured values.
	Classical Simulator Resource Management	2	1.6	Simulator supports a relatively small qubit scale.
Ecosystem Operations	Registered Users	3	1.5	Registered users are shared with Mobile Cloud and not separately countable.
	Strategic Partners	2	1.4	Limited strategic partners, only 14.
	Application Services	2	0.7	Limited application service software, only 3.
	Event Operations	3	2.2	Events mainly cover industry cooperation and ecosystem building.
	Science Popularization and Courses	2	1.6	Science outreach is conducted centrally by Mobile Cloud.
	Community Building	3	0	No community function.

03 Summary and Analysis of Evaluation Results

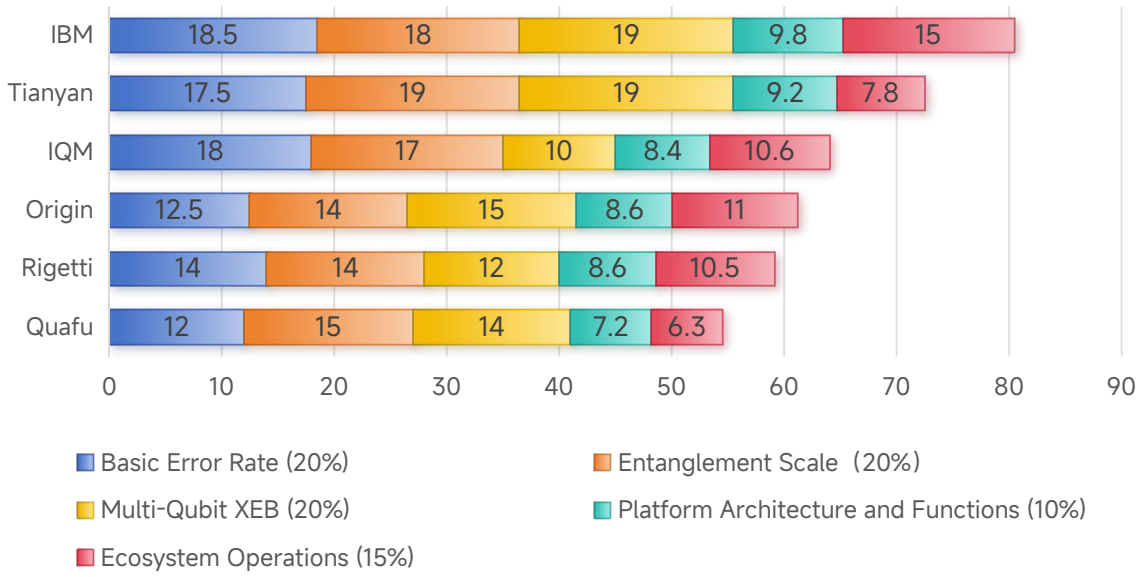
To clearly show differences in overall platform capability, the table below summarizes the final scores, core strengths, and applicable scenarios of six global quantum computing cloud platforms. The scoring results reflect each platform's performance across the full chain of hardware capability, service experience, and ecosystem development, while also highlighting the differentiated competitiveness and operating models of different technology routes such as superconducting, trapped-ion, neutral-atom, and photonic quantum computing. The findings provide direct reference for user platform selection and provider strategy optimization.

Comprehensive Score Summary of Global Quantum Computing Cloud Platforms

Platform	Basic Error Rate (20%)	Entanglement Scale (20%)	Multi-Qubit XEB (20%)	Platform Architecture and Functions (10%)	Ecosystem Operations (15%)	Total Score (85%)
IBM	18.5	18	19	9.8	15	80.3
Tianyan	17.5	19	19	9.2	7.8	72.5
IQM	18	17	10	8.4	10.6	64
Origin	12.5	14	15	8.6	11	61.1
Rigetti	14	14	12	8.6	10.5	59.1
Quafu	11.5	15	14	7.2	6.3	54

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Table: Comparative Analysis of Comprehensive Scores of Major Global Quantum Computing Cloud Platforms



Analysis Conclusions

1. The overall competitive structure is clearly stratified, with IBM and Tianyan forming the leading group.

IBM Quantum Platform ranks first with an overall score of 80.3, followed by Tianyan Quantum Computing Cloud Platform at 72.5. IBM performs particularly well in platform architecture, service functions, and ecosystem operations, reflecting mature cloud-service capabilities and strong global influence. Tianyan leads in overall hardware performance, making it the closest competitor to IBM in this evaluation.

IQM Resonance ranks third with 64.0 , follow by Origin Quantum Cloud at 61.1,Rigetti Quantum Cloud Services at 59.1, and Quafu at 54. Wuyue is not included in the final ranking because several key indicators could not be reliably measured.

2.Tianyan has clear advantages in hardware and simulation, while ecosystem development remains its main weakness.Tianyan-287 achieved the best entanglement scale result, with a maximum effective entanglement scale of 26 qubits.

However, Tianyan still trails IBM in registered users, strategic partnerships, application services, course resources, and community building. Strengthening these areas will be important if Tianyan is to translate its technical advantages into broader platform influence.

3.IQM Resonance performs strongly in basic calibration metrics and received the highest basic error-rate category score in this evaluation. It also achieved an effective GHZ scale of 13 qubits, ranking behind only Tianyan and IBM. However, its 11-qubit XEB result was relatively weak. Its platform functions and ecosystem are developing but remain less mature than IBM's.

4.Origin leads the second tier, while IQM and Rigetti show distinct strengths but also clear performance gaps.Origin Quantum Cloud delivers the most balanced performance among the second-tier platforms. It provides usable hardware, simulation, platform functions, and a relatively developed ecosystem. Nevertheless, its two-qubit gate error rate, multi-qubit XEB performance, and simulation efficiency remain behind the leading platforms.

5.Rigetti provides a relatively large accessible qubit scale and strong device connectivity. Its cloud access channels, code-based development tools, and open-source ecosystem also provide a reasonable foundation for developers. However, its readout error was comparatively high, while the effective GHZ scale and XEB performance remained below the leading platforms.

6.Quafu has a sizable hardware foundation but remains weak in readout performance, platform functionality and ecosystem development.

7.Wuyue is not yet suitable for inclusion in the overall ranking.Because several hardware indicators could not be measured reliably and some public documentation was inconsistent with the accessible platform information, Wuyue was excluded from the final overall ranking. Based on the measurable components, its service portal and quantum–classical resource integration are relatively complete. However, graphical programming, code-based programming and community operations still require further improvement.

05

Summary and Outlook

01 Quantum cloud platforms are movingfrom hardware access toward utility-oriented,hybrid computing services

Hardware performance remains the foundation of platform capability, but the basis of competition is broadening. The next phase will depend increasingly on whether cloud platforms can translate differentiated devices into repeatable workloads, integrate quantum resources with classical computing, and support domain users through stable development and operating environments.

The objective is shifting from isolated performance metrics toward verifiable quantum utility

Qubit count, gate fidelity and circuit depth remain essential, yet they do not by themselves demonstrate practical value. IBM defines quantum utility more cautiously than quantum advantage: utility-scale systems can address problem sizes beyond brute-force exact classical simulation, while practical advantage still requires evidence that a quantum method is cheaper, faster or more accurate than all known classical alternatives. This distinction suggests that cloud platforms will be evaluated not only on peak hardware metrics, but also on the quality of experiments, reproducibility, workload relevance and the evidence used to compare quantum and classical approaches.

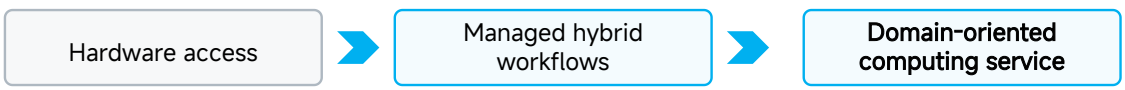
Quantum–classical hybrid computing is becoming the practical operating model

Most near-term algorithms rely on repeated interaction between classical optimization and quantum execution. AWS Braket Hybrid Jobs already packages classical resources, QPUs, managed environments, queue priority and monitoring into a single workflow. Azure Quantum supports more tightly coupled programs using mid-circuit measurement, classical control flow, qubit reset and real-time classical computation on supported targets. These implementations show that platform differentiation is moving toward orchestration efficiency, data and tool integration, predictable execution and the ability to embed quantum tasks into existing enterprise and scientific workflows.

Quantum + AI is likely to develop as a two-way capability relationship

Quantum computing may eventually support selected simulation, optimization and machine-learning workloads, but AI is already contributing to the operation of quantum systems. Research on AlphaQubit demonstrates that learned decoders can improve error interpretation under realistic noise. The implication for cloud platforms is broader than offering a stand-alone quantum-machine-learning toolkit: AI may become part of calibration, compilation, error mitigation, scheduling and user support, while quantum resources become one component within larger AI and high-performance-computing workflows. The commercial maturity of these use cases should still be assessed cautiously.

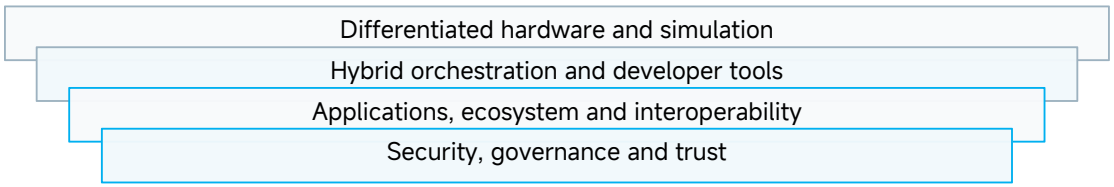
Figure: Quantum Cloud Platform Capability Evolution Path



02 Interoperability, ecosystem depth and security will determine whether technical capability can scale

As quantum cloud platforms connect more hardware types, programming frameworks and enterprise environments, their long-term value will depend on more than access to a differentiated QPU. Users will also require portability, comparable performance evidence, stable development tools and security architectures that can support sensitive workloads.

Figure:Quantum Cloud Platform Layered Capability Architecture



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Ecosystem competition is expanding toward interoperability and standard-setting

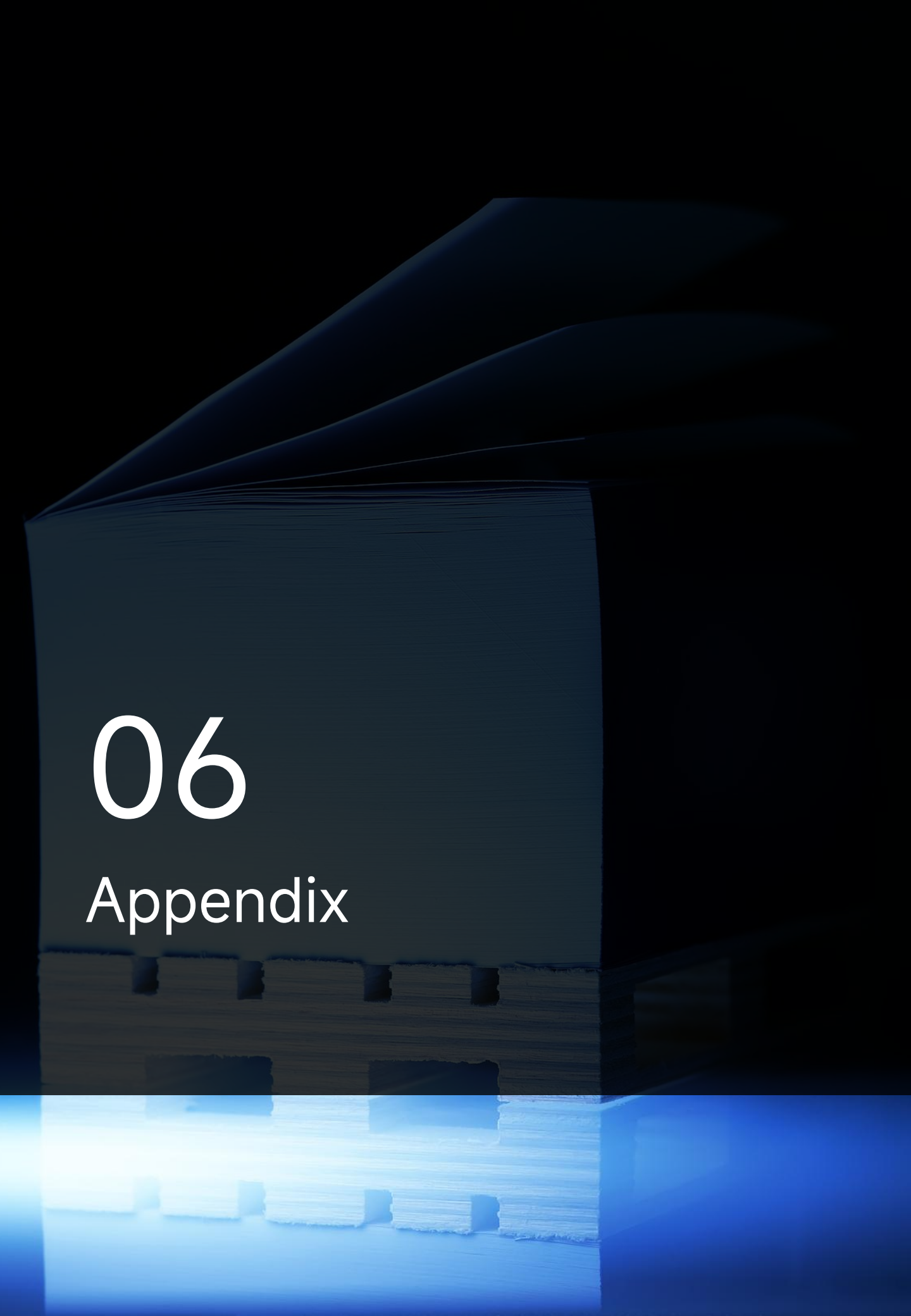
The diversity of quantum hardware and software stacks creates a risk of fragmented tooling and platform lock-in. The Quantum Intermediate Representation initiative addresses this by defining a hardware-agnostic layer between programming languages and heterogeneous processors, building on the classical LLVM ecosystem. For cloud-platform providers, participation in open interfaces, benchmark methods, developer communities and shared libraries can reduce integration effort and broaden the range of workloads that reach their hardware. Ecosystem influence should therefore be viewed as a mechanism for converting technical differentiation into accessible and repeatable use—not simply as a measure of community size.

Security and trust are moving from future concerns into current engineering requirements

NIST has finalized its first three post-quantum cryptography standards and encouraged organizations to begin transition planning. This does not mean cryptographically relevant quantum computers are already available; it means migration timelines, long-lived data and infrastructure dependencies require preparation before the threat fully materializes. Quantum cloud platforms serving finance, government and other sensitive sectors will increasingly be assessed on identity and access controls, data isolation, cryptographic agility, PQC migration support and, where relevant, integration with QKD-based services. Trust will become part of the platform architecture rather than a separate compliance statement.

Implications for the evaluated platforms

The evaluation confirms that differentiated hardware remain important foundations. Tianyan's measured performance in entanglement scale , XEB and state-vector simulation provides a solid technical basis for expanding domain applications, hybrid workflow support and ecosystem participation. More broadly, every platform will need to connect its technical strengths with developer experience, interoperable tooling and security-by-design. The emphasis is therefore not a replacement of hardware competition, but a widening of the capabilities required to translate technical progress into sustained platform value.



06

Appendix

01 Evaluation result

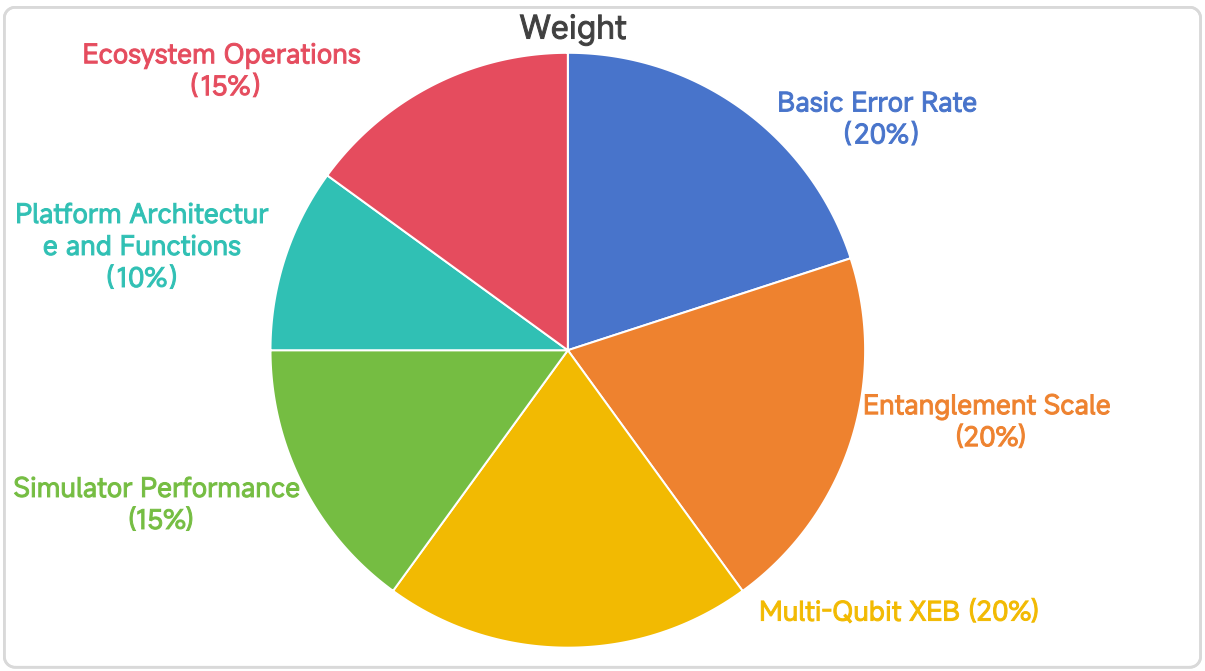
Since some cloud platforms provide simulator services, we propose a more comprehensive evaluation mechanism :

Evaluation Mechanism（with simulator）

The system quantitatively assesses each platform's integrated capability to provide ready-to-use quantum computing cloud services. The weighting scheme is as follows: Basic Error Rate, 20 points; Entanglement Scale, 20 points; Multi-Qubit XEB, 20 points; Simulator Performance, 15 points; Platform Architecture and Functions, 10 points; and Ecosystem Operations, 15 points.（The total is 100 points）

The final weights are defined as follows:

Figure: Quantitative Scoring Weight Distribution



Simulator Performance

Simulator performance measures a quantum cloud platform's capability to support classical quantum-circuit simulation. Quantum computing remains in the noisy intermediate-scale quantum (NISQ) era, in which real quantum hardware is still constrained by availability windows, queueing mechanisms, noise levels, and executable circuit scale. For researchers, algorithm developers, and industrial users, high-performance simulators are not only essential for debugging quantum circuits, but also serve as infrastructure for validating algorithmic logic, benchmarking against hardware results, and supporting education and training. Thus, the comprehensive capability of a quantum cloud platform depends not only on real QPUs but also on stable, efficient, and scalable classical simulation services.

State-vector simulators typically use state-vector simulation methods, storing and evolving all complex amplitudes of the complete quantum state. Since an n-qubit system contains 2^n complex amplitudes, computational and memory costs grow exponentially with qubit count. State-vector simulation capability is therefore a comprehensive test of a platform's classical computing power, memory resources, task scheduling, and simulator software optimization. This report evaluates the dimension from two perspectives: maximum supported circuit scale and runtime for 30-qubit, depth-5 circuits. The former reflects the upper bound of simulation task scale, while the latter reflects execution efficiency under a fixed workload.

Simulator performance is included in the scoring system because a mature quantum computing cloud platform should provide both quantum hardware access and simulation-based validation. Real quantum hardware is suitable for obtaining samples from physical devices, while state-vector simulators provide reproducible, noise-free, and theoretically comparable baselines. In early-stage algorithm development, users typically need to design circuits, tune parameters, and verify results in simulation before submitting jobs to real quantum processors. This indicator therefore captures the platform's complete support capability under a hybrid "quantum hardware + classical simulation" service model.

Simulator Performance

Simulator performance measures the scale limit and execution efficiency of a platform's classical quantum-circuit simulation resources. State-vector simulation stores and evolves all complex amplitudes of a quantum state, making it an essential capability for circuit debugging, algorithm validation, hardware comparison, and batch experiments.

Table: Simulator Performance Evaluation

Dimension	Concept and Importance
Maximum Supported Circuit Scale	Maximum supported circuit size refers to the largest number of qubits that a state-vector simulator can completely simulate without approximation, truncation, or subspace decomposition. Because memory and computational costs in state-vector simulation grow exponentially with qubit count, this dimension reflects classical computing power, memory capacity, and simulator software optimization.
Runtime for 30-Qubit, Depth-5 Circuits (s)	Using a 30-qubit, depth-5 circuit as a fixed test task, this dimension measures the actual time required for a state-vector simulator to complete circuit evolution and result output. Shorter runtime indicates higher resource-scheduling efficiency, backend execution capability, and engineering optimization in large-scale state-vector simulation.

Table: Scoring Items and Weight Allocation (with simulator)

Primary Dimension	Secondary Indicator	Core Evaluation Content of Secondary Indicator
Basic Error Rate (20 pts)	Maximum Available Qubits (3 pts)	Evaluates the effective qubit scale that the platform makes publicly available and that can participate in circuit execution, entangling operations, and readout.
	Readout Error Rate (5 pts)	Evaluates the probability that measured quantum-state outcomes deviate from the true states, reflecting the reliability of final sampled outputs.
	Single-Qubit Gate Error Rate (5 pts)	Evaluates the average error of elementary single-qubit gate operations relative to ideal evolution, reflecting basic quantum-control precision.
	Two-Qubit Gate Error Rate (5 pts)	Evaluates the error level of two-qubit entangling-gate operations, reflecting the platform's key capability for executing multi-qubit interaction circuits.
	Connectivity (2 pts)	Evaluates the topology through which qubits can directly execute two-qubit gates, reflecting circuit-mapping complexity and additional error overhead.
Entanglement Scale (20 pts)	Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50% (20 pts)	Uses a GHZ-state fidelity threshold of 0.5 to evaluate the maximum global multi-qubit entanglement scale that the platform can stably prepare and preserve.
Multi-Qubit XEB (20 pts)	Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits (20 pts)	Evaluates system-level precision in executing complex multi-layer quantum circuits using cross-entropy fidelity for fixed 11-qubit, 20-layer random quantum circuits.
Simulator Performance (15 pts)	Maximum Supported Circuit Scale (5 pts)	Evaluates the maximum qubit scale that a state-vector state-vector simulator can fully store, evolve, and measure.
	Runtime for 30-Qubit, Depth-5 Circuits (s) (10 pts)	Evaluates computational efficiency under typical large-scale state-vector simulation tasks using the runtime for 30-qubit, depth-5 random circuits.
Platform Architecture and Functions (10 pts)	Service Portal Function (2 pts)	Evaluates the completeness and usability of the platform's user entry, account management, resource display, task navigation, and basic service access.
	Graphical Programming Service Function (2 pts)	Evaluates the platform's ability to lower quantum-program development barriers through visual circuit editing, drag-and-drop modeling, and result presentation.
	Code-Based Programming Service Function (2 pts)	Evaluates how SDKs, APIs, Notebooks, and sample code support circuit construction, job submission, and result parsing.
	Quantum Computer Management Function (2 pts)	Evaluates the platform's ability to manage and present real quantum backend status, topology, calibration parameters, queue information, and job results.
	Classical Simulator Resource Management (2 pts)	Evaluates the platform's unified support for simulator backend types, available scale, parameter configuration, task scheduling, and result management.
Ecosystem Operations (15 pts)	Registered Users (3 pts)	Evaluates the platform's user base and market reach, reflecting usage coverage and potential ecosystem scale for quantum cloud services.
	Strategic Partners (2 pts)	Evaluates the breadth of stable partnerships with universities, research institutions, enterprises, and industrial partners, reflecting ecosystem connectivity.
	Application Services (2 pts)	Evaluates how extensively the platform turns quantum algorithms, industry scenarios, and tool capabilities into directly callable application services.
	Event Operations (3 pts)	Evaluates the platform's operational capability to continuously activate users and partners through competitions, seminars, developer activities, and industrial exchange.
	Science Popularization and Courses (2 pts)	Evaluates the completeness of quantum computing education, training, and outreach resources for beginners, developers, and industry users.
	Community Building (3 pts)	Evaluates whether the platform provides developer communication, issue feedback, knowledge accumulation, and user co-creation mechanisms, reflecting sustainable ecosystem operations.

The complete detailed quantum cloud platform evaluation tables (with simulator) are as follows:

Table: Basic Error Rate (20 pts), Entanglement Scale (20 pts), Multi-Qubit XEB (20 pts), and Simulator Performance (15 pts)

Secondary Indicator	Quantitative Scoring Criteria	Remarks / Examples
Maximum Available Qubits	Excellent: ⩾100 qubits; Qualified: 20–99 qubits; Unqualified: <20 qubits	Calculated based on each platform's currently usable QPUs; ⩾100 qubits indicates strong scalability, while 20–99 qubits can support medium-scale experiments.
Readout Error Rate	Excellent: ⩽3%; Qualified: >3% and ⩽8%; Unqualified: >8% or not measurable	⩽3% indicates a highly stable readout regime; 3%–8% remains usable but with evident noise, while >8% significantly weakens sampling reliability.
Single-Qubit Gate Error Rate	Excellent: ⩽0.10%; Qualified: >0.10% and ⩽0.20%; Unqualified: >0.20% or not measurable	⩽0.10% indicates high basic control accuracy; 0.10%–0.20% is usable but entails more visible error accumulation, while >0.20% constrains circuit stability.
Two-Qubit Gate Error Rate	Excellent: ⩽0.80%; Qualified: >0.80% and ⩽2.00%; Unqualified: >2.00% or not measurable	⩽0.80% indicates high-quality entangling gates; 0.80%–2.00% can support basic multi-qubit tasks, while >2.00% significantly limits circuit depth.
Connectivity	Excellent: ⩾3.0; Qualified: 1.5–2.99; Unqualified: <1.5 or not measurable	⩾3.0 can significantly reduce SWAP insertion; 1.5–2.99 supports conventional mapping, while <1.5 indicates clear topological constraints.
Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50%	Excellent: ⩾20 qubits; Qualified: 5–19 qubits; Unqualified: <5 qubits or not measurable	⩾20 qubits reflects strong global entanglement capability; 5–19 qubits indicates basic multi-qubit entanglement preparation capability but limited scalability; <5 qubits is insufficient for stable preparation of effective many-body entangled states.
Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits	Excellent: ⩾0.60; Qualified: 0.10–0.60; Unqualified: <0.10 or not measurable	⩾0.60 indicates high-quality random circuit sampling; 0.10–0.60 can complete random circuit sampling but with clear noise and compilation-error effects on fidelity; <0.10 indicates a large deviation from the ideal distribution and insufficient general circuit execution capability.
Maximum Supported Circuit Scale	Excellent: ⩾35 qubits; Qualified: 30–34 qubits; Unqualified: <30 qubits or not measurable	⩾35 qubits reflects strong state-vector simulation capability; 30–34 qubits can support conventional large-scale simulation validation but with limited scalability; <30 qubits is insufficient for mainstream large-scale circuit simulation and comparison with real-hardware results.
Runtime for 30-Qubit, Depth-5 Circuits	Excellent: ⩽30 s; Qualified: >30 s and ⩽240 s; Unqualified: >240 s or not measurable	⩽30 s is suitable for high-frequency debugging; 30–240 s can complete tasks but with moderate efficiency, suitable for low-frequency validation or non-real-time scenarios; >240 s or not measurable is insufficient for efficient R&D.

Figure: Scoring Implentation Flowchart



IBM Quantum Platform

IBM Quantum Platform is IBM's quantum computing service platform for global users, integrating quantum hardware access, Qiskit software tools, developer documentation, and learning resources. Supported by mature superconducting quantum hardware and a strong developer ecosystem, the platform has significant influence in research, education, and algorithm validation.

Table: Quantitative Scoring and Performance Evaluation of IBM Quantum Platform

Primary Dimension	Secondary Indicator	Max. Score	Score	Scoring Basis
Basic Error Rate	Maximum Available Qubits	3	3	156 functional qubits.
	Readout Error Rate	5	4	2.37%
	Single-Qubit Gate Error Rate	5	5	0.03%
	Two-Qubit Gate Error Rate	5	5	0.24%
	Connectivity	2	1.5	2.18
Entanglement Scale	Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50%	20	18	20 qubits.
Multi-Qubit XEB	Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits	20	19	0.6560
Simulator Performance	Maximum Supported Circuit Scale	5	5	36-qubit state-vector simulation.
	Runtime for 30-Qubit, Depth-5 Circuits (s)	10	8	22.09 s for the 30-qubit, depth-5 test.
Platform Architecture and Functions	Service Portal Function	2	2	Unified portal for resources, workloads, documentation and learning.
	Graphical Programming Service Function	2	2	Composer provides drag-and-drop circuit building and visualization.
	Code-Based Programming Service Function	2	2	Qiskit SDK, Runtime, APIs and notebooks support coding workflows.
	Quantum Computer Management Function	2	1.8	Minor gaps between published and measured device metrics.
	Classical Simulator Resource Management	2	2	Aer and local/fake backends support noisy and noiseless simulation.
Ecosystem Operations	Registered Users	3	3	IBM reports 600,000+ users and use by 700 universities.
	Strategic Partners	2	2	IBM reports a quantum network of 340+ organizations.
	Application Services	2	2	Functions and add-ons cover chemistry, optimization, ML and PDEs.
	Event Operations	3	3	Challenges, hackathons, Fall Fest, summer school and meetups run globally.
	Science Popularization and Courses	2	2	Structured learning pathways, courses, tutorials and labs.
	Community Building	3	3	Slack/Discord, GitHub and 1,200+ Advocates in 70+ countries.

Rigetti Quantum Cloud Services

Rigetti provides superconducting quantum computers through Rigetti Quantum Cloud Services and partner channels including Amazon Braket, Microsoft Azure Quantum and qBraid. Cepheus-1-108Q adopts a modular chiplet architecture with twelve interconnected 9-qubit chiplets. The tested data shows high qubit scale and strong connectivity, but current readout error, GHZ and 11-qubit XEB results are materially weaker than the leading reference platforms.

Table: Quantitative Scoring and Performance Evaluation of Wuyue Quantum Computing Cloud Platform

Primary Dimension	Secondary Indicator	Max. Score	Score	Scoring Basis
Basic Error Rate	Maximum Available Qubits	3	3	107 functional qubits.
	Readout Error Rate	5	3	7.51%
	Single-Qubit Gate Error Rate	5	3	0.15%
	Two-Qubit Gate Error Rate	5	3	1.17%
	Connectivity	2	2	3.57
Entanglement Scale	Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50%	20	14	5 qubits.
Multi-Qubit XEB	Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits	20	12	0.0532
Simulator Performance	Maximum Supported Circuit Scale	5	0	Not measurable
	Runtime for 30-Qubit, Depth-5 Circuits (s)	10	0	Not measurable
Platform Architecture and Functions	Service Portal Function	2	1.8	Portal covers programming, real/virtual backends, job submission and results.
	Graphical Programming Service Function	2	1.2	Graphical programming relies on third-party platforms.
	Code-Based Programming Service Function	2	1.9	Code interfaces are mature and support multiple frameworks.
	Quantum Computer Management Function	2	1.9	Most device metrics are public but vary across access channels.
	Classical Simulator Resource Management	2	1.8	Simulator supports SDK and local backend options.
Ecosystem Operations	Registered Users	3	1.5	Registered user base is not publicly disclosed by Rigetti.
	Strategic Partners	2	1.8	Moderate number of strategic partners across cloud platforms.
	Application Services	2	1.4	Relatively limited application services, focused on hardware access.
	Event Operations	3	2	Events are active, with emphasis on research and customers.
	Science Popularization and Courses	2	1.3	Science popularization resources are relatively limited and tutorials are available.
	Community Building	3	2.5	No dedicated community function.

IQM Resonance

IQM Quantum Computers provides full-stack superconducting quantum computers and cloud access through IQM Resonance and Amazon Braket. Emerald is a 54-qubit superconducting transmon QPU based on the Crystal 54 architecture; the test snapshot used here exposes 49 available qubits. In this evaluation, IQM shows strong basic calibration metrics and GHZ scalability, while the 11-qubit XEB result remains modest and simulator performance was not directly measurable in the tested workflow.

Table: Quantitative Scoring and Performance Evaluation of Origin Quantum Cloud Platform

Primary Dimension	Secondary Indicator	Max. Score	Score	Scoring Basis
Basic Error Rate	Maximum Available Qubits	3	2	49 functional qubits.
	Readout Error Rate	5	5	1.39%
	Single-Qubit Gate Error Rate	5	4	0.07%
	Two-Qubit Gate Error Rate	5	5	0.50%
	Connectivity	2	2	3.10
Entanglement Scale	Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50%	20	17	13 qubits.
Multi-Qubit XEB	Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits	20	10	0.0087
Simulator Performance	Maximum Supported Circuit Scale	5	0	Not measurable
	Runtime for 30-Qubit, Depth-5 Circuits (s)	10	0	Not measurable
Platform Architecture and Functions	Service Portal Function	2	1.8	Portal covers programming, quantum backends, job submission and results.
	Graphical Programming Service Function	2	1.2	Graphical programming relies on notebook tools.
	Code-Based Programming Service Function	2	1.9	Code interfaces support Qrisp, IQM SDK and Braket.
	Quantum Computer Management Function	2	1.8	Most device metrics are public through available cloud access channels.
	Classical Simulator Resource Management	2	1.7	Simulator supports SDK and local backend options.
Ecosystem Operations	Registered Users	3	2	Registered user count is not publicly disclosed by IQM.
	Strategic Partners	2	1.8	Moderate number of strategic partners across European cloud platforms.
	Application Services	2	1.5	Relatively diverse application services, including mitigation and workflows.
	Event Operations	3	2	Events are active, with emphasis on institutions and developers.
	Science Popularization and Courses	2	1.8	Science popularization resources are relatively rich and tutorials are structured.
	Community Building	3	1.5	No dedicated community function.

Tianyan Quantum Computing Cloud Platform

Launched by China Telecom Quantum Group, the Tianyan Quantum Computing Cloud Platform provides superconducting quantum hardware, high-performance simulators, and the Cqlib programming framework for research, education, and industrial applications. With a focus on cloud-based quantum computing access and quantum–classical integration, it is a representative public quantum cloud service platform in China.

Table: Quantitative Scoring and Performance Evaluation of Tianyan Quantum Computing Cloud Platform

Primary Dimension	Secondary Indicator	Max. Score	Score	Scoring Basis
Basic Error Rate	Maximum Available Qubits	3	3	104 functional qubits.
	Readout Error Rate	5	4.5	1.85%
	Single-Qubit Gate Error Rate	5	4	0.08%
	Two-Qubit Gate Error Rate	5	4	0.60%
	Connectivity	2	2	3.50
Entanglement Scale	Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50%	20	19	26 qubits
Multi-Qubit XEB	Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits	20	19	0.6521
Simulator Performance	Maximum Supported Circuit Scale	5	5	36-qubit state-vector simulation.
	Runtime for 30-Qubit, Depth-5 Circuits (s)	10	9	15.67 s for the 30-qubit, depth-5 test.
Platform Architecture and Functions	Service Portal Function	2	2	Portal integrates programming, resources, job submission and results.
	Graphical Programming Service Function	2	1.6	Graphical programming lacks real-time Bloch-sphere visualization.
	Code-Based Programming Service Function	2	1.6	Limited number of code-based programming interfaces.
	Quantum Computer Management Function	2	2	Cloud workflow manages QPU access and task status.
	Classical Simulator Resource Management	2	2	Five simulator types support cloud jobs and result management.
Ecosystem Operations	Registered Users	3	1.8	Small registered user base, about 17,000 users.
	Strategic Partners	2	1.6	Limited strategic partners, only 22.
	Application Services	2	1.4	Limited application service software, only 9.
	Event Operations	3	2	Event volume is limited; industry–research activities are insufficient.
	Science Popularization and Courses	2	1	Few science popularization activities and insufficient course offerings.
	Community Building	3	0	No community function.

Quafu Quantum Computing Cloud Platform

Developed by the Beijing Academy of Quantum Information Sciences and partners, the Quafu Quantum Computing Cloud Platform integrates superconducting quantum chips, measurement and control systems, quantum operating systems, and application software. Centered on open access to real quantum hardware and research-oriented testing services, it connects quantum computing technology development with algorithmic application exploration.

Table: Quantitative Scoring and Performance Evaluation of Quafu Quantum Computing Cloud Platform

Primary Dimension	Secondary Indicator	Max. Score	Score	Scoring Basis
Basic Error Rate	Maximum Available Qubits	3	3	154 functional qubits.
	Readout Error Rate	5	1.5	13.10%
	Single-Qubit Gate Error Rate	5	3.5	0.11%
	Two-Qubit Gate Error Rate	5	3	1.13%
	Connectivity	2	0.5	1.29
Entanglement Scale	Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50%	20	15	6 qubits.
Multi-Qubit XEB	Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits	20	14	0.2148
Simulator Performance	Maximum Supported Circuit Scale	5	0	Not measurable
	Runtime for 30-Qubit, Depth-5 Circuits (s)	10	0	Not measurable
Platform Architecture and Functions	Service Portal Function	2	1.6	Missing functions on service portal pages.
	Graphical Programming Service Function	2	1.6	Several graphical programming functions are missing.
	Code-Based Programming Service Function	2	1.6	Code interfaces are limited and contain multiple bugs.
	Quantum Computer Management Function	2	1.4	Published device metrics differ substantially from measured values.
	Classical Simulator Resource Management	2	1	Limited simulator types and qubit scale.
Ecosystem Operations	Registered Users	3	1.4	Small registered user base, about 5,000 users.
	Strategic Partners	2	1.3	Limited strategic partners, only 10.
	Application Services	2	0	No application service software.
	Event Operations	3	2.3	Event types are broad, but total activity is limited.
	Science Popularization and Courses	2	1.3	Courses exist on the organization site, not the cloud platform.
	Community Building	3	0	No community function.

Origin Quantum Cloud Platform

Origin Quantum Cloud is a one-stop quantum computing cloud service platform launched by Origin Quantum, providing quantum learning resources, programming tools, real quantum hardware, simulation resources, and application development services. Built around an independently developed quantum hardware–software ecosystem, the platform supports research experiments, educational training, and industry application validation.

Table: Quantitative Scoring and Performance Evaluation of Origin Quantum Cloud Platform

Primary Dimension	Secondary Indicator	Max. Score	Score	Scoring Basis
Basic Error Rate	Maximum Available Qubits	3	3	170 functional qubits.
	Readout Error Rate	5	3	6.02%
	Single-Qubit Gate Error Rate	5	3	0.14%
	Two-Qubit Gate Error Rate	5	3	1.42%
	Connectivity	2	0.5	1.12
Entanglement Scale	Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50%	20	14	5 qubits.
Multi-Qubit XEB	Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits	20	15	0.2376
Simulator Performance	Maximum Supported Circuit Scale	5	4	30-qubit state-vector simulation.
	Runtime for 30-Qubit, Depth-5 Circuits (s)	10	6	192.55 s for the 30-qubit, depth-5 test.
Platform Architecture and Functions	Service Portal Function	2	2	Portal covers learning, programming, real/virtual backends and task results.
	Graphical Programming Service Function	2	1.8	Graphical programming lacks real-time Bloch-sphere visualization.
	Code-Based Programming Service Function	2	1.6	Code interfaces are limited and contain multiple bugs.
	Quantum Computer Management Function	2	1.6	Some device metrics are missing or differ from measured values.
	Classical Simulator Resource Management	2	1.6	Simulator supports a relatively small qubit scale.
Ecosystem Operations	Registered Users	3	2.6	Registered user base is relatively small, about 80,000 users.
	Strategic Partners	2	1.8	Moderate number of strategic partners, 103 in total.
	Application Services	2	1.8	Relatively limited application service software, only 34.
	Event Operations	3	2.9	Events are diverse, with emphasis on competitions and industry.
	Science Popularization and Courses	2	1.9	Science popularization activities are relatively rich and courses are diverse.
	Community Building	3	0	No community function.

Wuyue Quantum Computing Cloud Platform

Developed by China Mobile, the Wuyue Quantum Computing Cloud Platform is positioned as a full-stack quantum computing cloud service system integrating classical and quantum computing resources. It provides multi-modal quantum computing resources, diversified application design capabilities, and multi-scenario quantum algorithm services for research users and industries such as finance, transportation, and biomedicine.

Table: Quantitative Scoring and Performance Evaluation of Wuyue Quantum Computing Cloud Platform

Primary Dimension	Secondary Indicator	Max. Score	Score	Scoring Basis
Basic Error Rate	Maximum Available Qubits	3	2	57 functional qubits.
	Readout Error Rate	5	0	Not measurable
	Single-Qubit Gate Error Rate	5	0	Not measurable
	Two-Qubit Gate Error Rate	5	0	Not measurable
	Connectivity	2	2	3.23
Entanglement Scale	Maximum Effective GHZ Entangled Qubit Count with Fidelity > 50%	20	14	5 qubits.
Multi-Qubit XEB	Fidelity of 11-Qubit, 20-Layer Random Quantum Circuits	20	0	Not measurable
Simulator Performance	Maximum Supported Circuit Scale	5	4	30-qubit state-vector simulation.
	Runtime for 30-Qubit, Depth-5 Circuits (s)	10	5	234 s for the 30-qubit, depth-5 test.
Platform Architecture and Functions	Service Portal Function	2	2	Portal integrates quantum/classical resources, simulation and task workflows.
	Graphical Programming Service Function	2	1.4	Several graphical circuits are unavailable; functions are missing.
	Code-Based Programming Service Function	2	1.4	Code workflow is fragmented and difficult to use.
	Quantum Computer Management Function	2	1.8	Published device metrics differ slightly from measured values.
	Classical Simulator Resource Management	2	1.6	Simulator supports a relatively small qubit scale.
Ecosystem Operations	Registered Users	3	1.5	Registered users are shared with Mobile Cloud and not separately countable.
	Strategic Partners	2	1.4	Limited strategic partners, only 14.
	Application Services	2	0.7	Limited application service software, only 3.
	Event Operations	3	2.2	Events mainly cover industry cooperation and ecosystem building.
	Science Popularization and Courses	2	1.6	Science outreach is conducted centrally by Mobile Cloud.
	Community Building	3	0	No community function.

Summary and Analysis of Evaluation Results

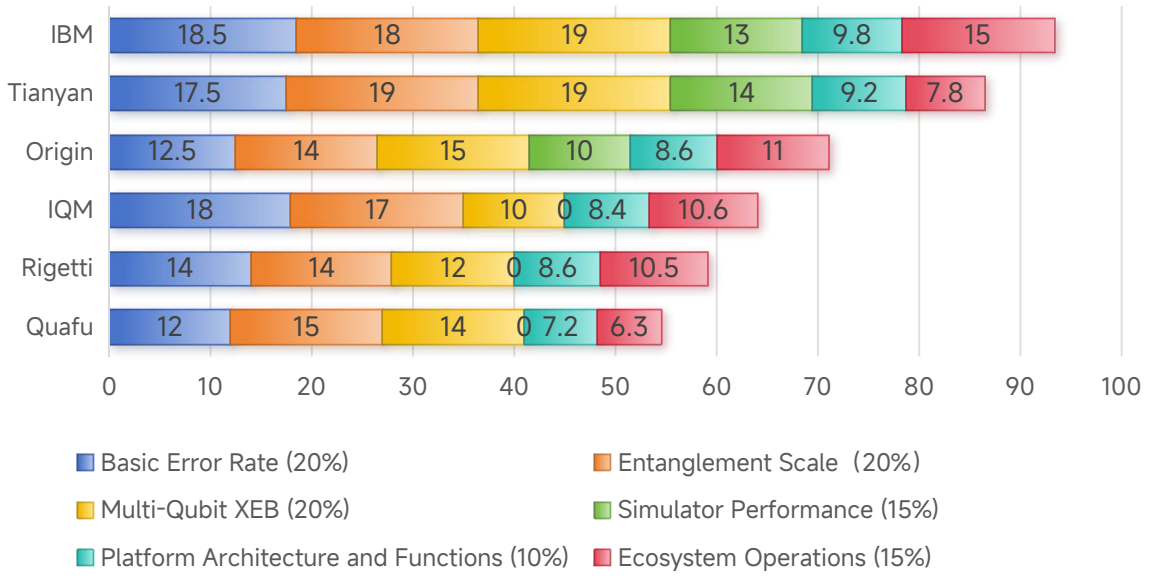
To clearly show differences in overall platform capability, the table below summarizes the final scores, core strengths, and applicable scenarios of six global quantum computing cloud platforms. The scoring results reflect each platform's performance across the full chain of hardware capability, service experience, and ecosystem development, while also highlighting the differentiated competitiveness and operating models of different technology routes such as superconducting, trapped-ion, neutral-atom, and photonic quantum computing. The findings provide direct reference for user platform selection and provider strategy optimization.

Comprehensive Score Summary of Global Quantum Computing Cloud Platforms

Platform	Basic Error Rate (20%)	Entanglement Scale (20%)	Multi-Qubit XEB (20%)	Simulator Performance (15%)	Platform Architecture and Functions (10%)	Ecosystem Operations (15%)	Total Score (100%)
IBM	18.5	18	19	13	9.8	15	93.3
Tianyan	17.5	19	19	14	9.2	7.8	86.5
Origin	12.5	14	15	10	8.6	11	71.1
IQM	18	17	10	0	8.4	10.6	64
Rigetti	14	14	12	0	8.6	10.5	59.1
Quafu	11.5	15	14	0	7.2	6.3	54

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Table: Comparative Analysis of Comprehensive Scores of Major Global Quantum Computing Cloud Platforms



Analysis Conclusions

1. With the addition of the simulator criterion, the results remain largely unchanged. The overall competitive structure is clearly stratified, with IBM and Tianyan forming the leading group.

IBM Quantum Platform ranks first with an overall score of 93.3, followed by Tianyan Quantum Computing Cloud Platform at 86.5. IBM performs particularly well in platform architecture, service functions, and ecosystem operations, reflecting mature cloud-service capabilities and strong global influence. Tianyan leads in overall hardware performance and state-vector simulation, making it the closest competitor to IBM in this evaluation.

Origin Quantum Cloud ranks third with 71.1, followed by IQM Resonance at 64.0, Rigetti Quantum Cloud Services at 59.1, and Quafu at 54. Wuyue is not included in the final ranking because several key indicators could not be reliably measured.

2. Tianyan demonstrates notable strengths in simulation, achieving the fastest measurable runtime in the 30-qubit, depth-5 state-vector simulation test and supporting up to 36-qubit simulations. This places its simulator performance among the top tier in the evaluation.

3. Origin provides usable simulation services, yet its simulation efficiency still lags behind the leading platforms, indicating that further optimization is needed to close the gap.

4. For IQM Resonance, simulator performance could not be directly measured within the tested workflow, which precludes a full assessment of its simulation capabilities in this evaluation.

5. Similarly, Rigetti's state- vector simulator performance was not directly measurable during this evaluation, leaving its simulation strength unquantified compared to platforms where such metrics were obtained.

6. Quafu remains relatively weak in simulator services. In particular, the absence of measurable simulator results had a significant impact on its overall score, highlighting this as a critical area for future improvement.

7. Wuyue's simulator scale is still insufficient and requires further development to reach a level comparable to other platforms, as current capabilities do not yet meet the evaluation standards.

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