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Possati, Luca M.; Vermaas, Pieter

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The rationality and morality of connecting quantum computers

Luca M. Possati¹ · Pieter Vermaas²

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Abstract

In this study, we explore the complexities and implications of connecting quantum computers. This connection is in the literature seen as an obvious and fast way forward to arrive at a large quantum computer that can deliver the promises of quantum computing. We explore this option by understanding the conditions and contexts under which different scenarios of connecting these computers are most beneficial for quantum computer owners, be it for practical gains or moral considerations. “Introduction” and “Quantum Computing” Sections introduce quantum computing, laying out the broader framework of our study. Then “Connecting Quantum Computers” Section delineates three scenarios for connecting quantum computers: no connection, a connection that is “blind” for the uses of the linked systems, and a “governed connection” in which these uses are subjected to rules. These scenarios are evaluated against five criteria: the ability of computer owners to leverage quantum strengths (quantum advantage), the benefits of cooperative efforts for owners (collaboration gain), ensuring equitable benefits between owners (equality), maintaining clarity and openness about the connection to the owners (transparency), and preserving the independence and self-direction of the computer owners (autonomy). The evaluation does not single out a scenario as the clear winner. Rather, it reveals two significant moral trade-offs, showing that no one scenario is best for all situations. As a result, the choice of which trade-offs to accept and which scenario to choose depends greatly on the context. To highlight this, “Ethical Analysis of Scenarios” Section offers a detailed example for each of the three scenarios, explaining the reasons for choosing a particular option for each trade-off given the specific situation.

Keywords Quantum computing · Blind computing · Quantum advantage · Ethics · Values

Introduction

The questions at the heart of this paper are as follows: Is it rational to connect quantum computers? Are there contexts in which connecting or disconnecting quantum computers is more ethically beneficial? In other words, do actors who in the future may own quantum computers, such as states, hospitals, and companies, obtain a significant advantage from connecting their computer to another quantum computer owned by other actors? At first glance, it appears rational—and beneficial—to collaborate by connecting quantum computers. Quantum computers are currently built for delivering types of computing that classical (super) computers cannot.

For making these calculations available, quantum computers need to have a large number of qubits—the quantum technological counterparts of bits of classical computers—but creating computers with many of these qubits is one of the main challenges in quantum computing, and technologically not an easy one. However, one way to achieve a high-qubit quantum computer rapidly is by linking two or more existing devices. This option is available to any individual state or company that owns two or more quantum computers. It is also available to different states or companies when they partner and link their quantum computers.

In this paper, we investigate the rationality of this joining forces, that is, the rationality of actors connecting their quantum computers to each other. We understand the term “rationality” in a strategic and moral sense at the same time; thus, a “rational” action is an action that has advantages on the strategic level and the ethical level in the sense that it promotes or protects a value or set of values. Therefore, the paper raises questions about the strategic and moral implications of connecting quantum computers. For example, in a

✉ Luca M. Possati
l.m.possati@utwente.nl
Pieter Vermaas
P.E.Vermaas@tudelft.nl

¹ University of Twente, Enschede, Netherlands

² Delft University of Technology, Delft, Netherlands

world where quantum computers can break classical encryption methods used for protecting the content of digital communication, a decision to connect could have global security implications. From an ethical standpoint, decisions about who controls connected quantum computers, what they are used for, and who has access to their output become paramount. These questions are crucial because they address the intersection of rapid technological advancements in quantum computing with the broader societal, strategic, and ethical implications. Given the potential for quantum computing to revolutionize industries and impact global security, these questions are not just technical but deeply philosophical and ethical (see also Helbing & Ienca, 2024; Veluwenkamp and van den Hoven 2023; Kop, 2023).

After describing the development of quantum computers, we introduce three possible scenarios in "Connecting quantum computers" Section: no connection, blind connection, and governed connection of quantum computers. We evaluate the scenarios following five criteria: quantum advantage, collaboration gain, equality, transparency, and autonomy.

The analysis does not identify a definitive best scenario. Instead, it uncovers two major ethical trade-offs, that can also become dilemmas, indicating that there is no one-size-fits-all solution. Consequently, the decision on which compromises to make and which scenario to select is largely influenced by the specific circumstances. To underscore this point, "Ethical analysis of scenarios" Section provides in-depth examples for each of the three scenarios, detailing the rationale behind selecting a specific option for each trade-off based on the context. The cases feature competing states, cooperative companies, and the e-healthcare system. Finally, as a first step to supporting actors, "Towards governance" Section sketches a five-criterion framework to decide when and how to link quantum computers.

Quantum computing

A quantum computer is a type of computer that utilizes the principles of quantum mechanics to store and process information (Barral et al., 2025; Caleffi et al., 2024; Chae et al., 2024; Di Vincenzo, 1995, 1997; Scholten et al., 2024; Singh & Kumar, 2024). It is designed to take advantage of quantum properties, such as superposition and entanglement, to perform specific types of calculations much faster than classical computers. Quantum computers will therefore not replace classical computers and solve all problems; they are and will gradually be applicable only to specific types of complex problems. The type of computation they develop is different from classical computers and offers a strategic advantage on a large scale. According to researchers, quantum computers will provide new resources of enormous importance for tackling crucial problems for our age, such as climate

change, food production, the development of more sustainable sources of energy, better batteries, and cleaner water. Quantum computing will enable us "to solve these types of problems that impact all of us. That's our north star. We want to solve some of the world's hardest challenges with the quantum machine."¹ For instance, tech companies claim that quantum computers can make a difference in chemistry by finding new and useful molecules. This is because predicting the behavior of complex molecules is a difficult task for classical computing, due to the immense computation time it requires. Quantum computers could in theory swiftly model how different molecules work, and this would allow researchers to discover new drugs or find new materials to build better batteries, tackle climate change by finding a molecule that can capture carbon in the air or help identify less energy-intensive processes for producing fertilizers.²

One of the most studied and advanced applications of quantum computing is cryptography. The discovery of Shor's algorithm, which is able to break any number into prime numbers very quickly, has had a huge impact on the world of quantum computing and its development (Shor, 1997). Shor's algorithm can efficiently break today's standard public-key cryptosystems. Developments in quantum cryptography therefore pose a potential threat to governments and businesses, with the ability to put entire infrastructures, networks, and applications at risk (Grobman et al., 2020; Purohit, 2023; Kiesow et al., 2023).³

Beyond the debates on the effective scope of quantum computing, it is clear that this new technology has a very strong geopolitical impact. In the post-Cold War world, where there is no longer peace guaranteed by the nuclear tension between two superpowers, technological development is even more important from a strategic point of view. In late August 2020, the Trump administration announced a \$1 billion program to advance American leadership in quantum computing and artificial intelligence. The program contains more than \$300 million from industry and academia for five new research centers within the Department of Energy and another \$140 million in funding for the

¹ <https://www.ft.com/content/f25038fd-a48f-4010-94a6-63e000fae2d>

² <https://www.ft.com/content/f25038fd-a48f-4010-94a6-63e000fae2d>

³ <https://www.forbes.com/sites/forbestechcouncil/2022/01/11/the-quantum-threat-to-cryptography-dont-panic-but-prepare-now/?sh=485ad7e5713a>

⁴ Quantum technologies also offer the resources to develop very secure communication systems, in which the level of confidentiality and privacy is extremely high. Communication systems such as the quantum internet offer a type of security based on the laws of quantum mechanics and not on computational complexity; this makes them unbreakable.

National Science Foundation.⁵ China is the main competitor of the United States. In 2014, China was already filing about the same number of quantum-computing patent applications as the United States. By 2017, there were twice as many Chinese filings as American ones. Beijing missed the digital revolution and now intends to be the protagonist of the new quantum revolution.⁶ Alongside these two main actors, there are also other competitors, such as states in Europe, the European Union as a whole, and the United Kingdom, Canada, Japan, and Russia (Fedorov et al., 2019), which are betting on quantum technologies to make themselves more autonomous.

Qubits are the essential building blocks of quantum computers. A classical computer encodes information in bits (i.e., strings of ones and zeros). A quantum computer has qubits—bits that are in a quantum state. To tackle computational problems that are practical meaningful in the sense that they cannot be done efficiently on classical (super) computer and that they allow solving technical problems, researchers estimate that a quantum computer will probably need at least a million qubits (Aaronson & Hung, 2023). Our current quantum computers do not have that many qubits. For example, Google Quantum AI's most recent processor, named Willow, features 105 superconducting qubits. The biggest known quantum computers in the world, for instance those developed by IBM, have 1000 + qubits. Scaling up a quantum computer from just a few dozen or a few hundred qubits to a million qubits is a huge technological challenge. Progress of this type requires economic resources and more. That is because qubits are notoriously fragile. They are made of single subatomic systems in delicate quantum states and keeping them stable in those quantum states is difficult.

Different tech companies and labs are testing approaches to building quantum computers. They use different materials to make their qubits, and they try different ways of cutting out the noise and reducing the computing errors that noise creates. However, it is not yet clear which approach works best. Microsoft's Azure program is developing a new approach to scale up and fill the remaining gap faster.⁷ Google has announced that it has reached a key milestone in error reduction, but this is still an experimental result that needs to be developed.⁸

The challenge of developing quantum computers with higher numbers of qubits will for sure continue and possibly

lead to the situation that single quantum computers have a sufficient number of qubits to deliver on their own the practical advantages many actors are aiming at. As long as this situation is not reached an option for an actor to increase the number of qubits available is connecting their quantum computer to a second quantum computer. In case the actor owns more than one, the connection can straightforwardly be materialized between two or more of the actor's quantum computers. The case we focus on in this paper is that an actor owns one quantum computer and considers the option of connecting it to a quantum computer owned by another actor. This option is in literature discussed under the heading of distributed quantum computing, where the quantum internet serves as the means by which different quantum computers are actually connected (e.g., Acampora et al., 2023; Caleffi et al., 2022; Cuomo et al., 2023; He et al., 2024; Jiang et al., 2024; Li et al., 2024; Ngoenriang et al., 2023; Singh & Bhangu, 2023). On first sight this option seems a quick and rational way to arrive at a (combined) quantum computer with a much larger number of qubits than the actors each have separately. We argue however that the rationality and morality of this option is much more complex, in part by the vast advantages quantum computers can bring.

Connecting quantum computers

When considering the possibility of connecting quantum computers, three scenarios can be discerned: no connection, blind connection, and governed connection. In this section, we describe these three scenarios and then evaluate them in a general manner using five criteria that we consider fundamental to the sociotechnical context of quantum computing.

This general evaluation does not lead to a single verdict of the rationality of connecting quantum computers but results in two trade-offs owners of quantum computers should make before connecting them: a trade-off between the computational superiority and equality of the actors; and a trade-off between the transparency and autonomy of the connection. We argue in the next section that there is no generic way in which these trade-offs can be made by analyzing several key cases of quantum computer usage.

Three scenarios

The three possible scenarios are:

1. No connection: Two actors A and B with their own quantum computers decide not to connect their devices. Each maintains its own quantum computer separate from the other. The decision of A or B for this scenario may depend on different types of reasons: geopolitical choices, commercial objectives, and ideological tensions.

⁵ <https://www.gisreportsonline.com/r/quantum-computers/>

⁶ <https://foreignpolicy.com/2023/04/24/america-has-dictated-its-economic-peace-terms-to-china/>

⁷ <https://azure.microsoft.com/en-us/blog/quantum/2025/02/19/microsoft-unveils-majorana-1-the-worlds-first-quantum-processor-powered-by-topological-qubits/>

⁸ <https://www.nature.com/articles/d41586-023-00536-w>

2. **Blind connection:** Two actors A and B owning quantum computers connect their devices in blind computing mode. Blind quantum computation is a family of protocols whereby a client delegates a quantum computation to one or more quantum servers in such a way that a) the server learns nothing about the client's input data; b) the server learns nothing about the algorithm being executed—only that “some” universal quantum circuit is run; c) the server learns nothing about the result.⁹ In this scheme of blind computing the client can in principle be a third actor, giving A and B the role of server providers. The scheme also allows for the asymmetric situation where only A is the client of the connected quantum computers, reducing only B to a service provider. In this study we only consider the symmetric case in which A and B decide to connect on the condition that they both can be the clients of the connected quantum computers.

3. **Governed connection:** Two actors A and B with their own quantum computers decide to connect their devices by agreeing on a series of rules to be respected. This would mean, for instance, setting up a common center to access the connected computers. The two actors can have again common interests to connect their quantum computers, but also a need that one actor can monitor what the other one is doing on the connected computer.

Five criteria

We evaluate the three scenarios just described by five criteria that capture generic aims and values of the actors A and B driving their decision to connect or not. The actors A and B may have additional more specific aims and values relevant to this decision, and we include them in our analyses of the scenarios in the next section. The five criteria are:

1. **Practical Quantum Advantage (Qadv):** This criterion emphasizes the inherent capabilities of quantum computers in comparison to classical supercomputers. It is essential to consider this because the primary reason to invest in and utilize quantum computers is their unique computational power and ability to solve problems that classical computers cannot efficiently address. This criterion helps to establish whether, in any given scenario,

an actor truly leverages the quantum capabilities of their device.

2. **Collaboration Gain (Cgain):** An increase in collective computational power relative to what the devices can do separately is the incentive for both owners of the computers to pursue their collaboration.
3. **Equality (Equal):** This is an important criterion for equitable partnerships and fair competition. It ensures that one actor is not disproportionately more powerful than the other in terms of quantum computing capabilities. If there is a significant disparity, it could introduce power dynamics that might deter collaboration or connection. Evaluating equality ensures that both parties have balanced capabilities and neither feels threatened or undermined by the other.
4. **Transparency (Trans):** In scenarios where quantum devices are connected, it may be important to each actor to understand what calculations are being run on their machine. This is particularly vital when considering the blind connection scenario, where tasks are executed without the owning actor's knowledge. Transparency speaks to the trust between actors and can influence decisions around which type of connection to pursue.
5. **Autonomy (Auto):** The freedom to decide what applications a quantum computer runs is paramount for many actors. Autonomy ensures that each actor retains control over their machine's tasks and is not unduly influenced or forced by the other party. It speaks to an actor's agency and the preservation of their interests and intentions.

These five criteria were chosen because they holistically encapsulate the technical, collaborative, ethical, and strategic considerations that actors A and B would weigh when deciding to connect their quantum computers. Each criterion addresses a distinct aspect of the connection decision, ensuring a comprehensive evaluation of the three scenarios.

To be more specific, these five mutually independent pillars form a rigorous, end-to-end framework that aligns the extraordinary promise of quantum computing with the practical realities of collaboration and risk management. Practical Quantum Advantage ensures that any federation delivers a true computational leap—far surpassing classical or standalone performance—while Collaboration Gain makes the incremental benefit to each partner explicit and quantifiable. Equality precludes disproportionate leverage that could corrode trust or stifle new entrants, and Transparency embeds full auditability to safeguard intellectual property and prevent covert or malicious workloads. Finally, Autonomy guarantees every owner retains sovereign control over scheduling, resource allocation, and disconnection, preserving strategic flexibility and containing liability. Together, they empower actors A and B to assess—and confidently

⁹ Technically, a blind computing scenario between two full-blown quantum nodes is nothing more than two back-to-back instances of the asymmetric BQC protocol. (Broadbent et al., 2009) The properties a) to c) achieved by the client encoding the computation in randomly rotated quantum states (or with hidden measurement angles in the measurement-based model), so that—even though the server physically implements all the gates and measurements—it cannot correlate its operations with any plain-text algorithm or data. Information-theoretic proofs show the server's view is statistically independent of the client's secret.

pursue—quantum linkages that are both high-impact and resilient.

Assessing the scenarios

Let us now assess and compare the three scenarios by means of the five criteria. We order the results in Table 1, in which the following conventions are used:

- Actor A has a quantum computer with a qubits.
- Actor B has a quantum computer with b qubits.
- If A and B have quantum computers of different sizes, then A is assumed to have the largest computer, i.e., $a \geq b$.
- q is the minimum number of qubits a quantum computer needs to have for enabling practical quantum advantage over classical (super) computers.

The assessment in Table 1 reveals that the two scenarios for connecting quantum computers are neither morally unconditionally advantageous over the one of not connecting, nor over each other. Connecting the computers does give their owners more quantum computation strength, leading in some cases even to practical quantum advantage. Yet, it confronts the owners with two overall value trade-offs. The first is about connection or not, and once the choice is for connecting, the second is about choosing between a governed or blind connection:

1. Superiority versus Equality: If the sizes of the quantum computers of A and B differ, then A must make a trade-off between having computational superiority over B and being equal in (increased) computational strength to B.
2. Transparency versus Autonomy: When connecting their quantum computers, A and B must make a trade-off between transparency about the calculations done on their computer and their autonomy about what calculations they can do on the connected computers.

Ethical analysis of scenarios

The evaluation of three scenarios for connecting quantum computers did not result in a definitive preference for any single approach. Instead, it highlighted two main trade-offs, indicating that in practical applications, there is no one-size-fits-all solution. Further analysis of these scenarios reveals that the choice to prioritize certain trade-offs and select among the three options is context-dependent. This suggests that the effectiveness and appropriateness of each scenario can change based on the particular circumstances at hand.

To support this conclusion, we provide a concrete case for each of the three scenarios, demonstrating why it is rational to opt for that particular scenario.

No-connection: competing and mistrusting states

Consider China and the United States and assume that they are at the forefront of quantum computer development,

Table 1 An assessment of the three scenarios

| Scenario: | No connection | Blind connection | Governed connection | Comments blind connection | Comments governed connection |
|-----------|--------------------|------------------|---------------------|---|---|
| Case: | | | | | |
| a = b | Qadv: both | Qadv: both | Qadv: both | Both A and B gain computational power but lose transparency | Both A and B gain computational power but lose autonomy |
| a > q | Cgain: no | Cgain: yes | Cgain: yes | | |
| b > q | Equal: yes | Equal: yes | Equal: yes | | |
| | Trans: both | Trans: neither | Trans: both | | |
| | Auto: both | Auto: both | Auto: neither | | |
| a > b | Qadv: both | Qadv: both | Qadv: both | Both A and B gain computational power but lose transparency | Both A and B gain computational power but lose autonomy |
| a > q | Cgain: no | Cgain: yes | Cgain: yes | | |
| b > q | Equal: no, A leads | Equal: yes | Equal: yes | | |
| | Trans: both | Trans: neither | Trans: both | A gives up its superiority over B; B gets on equal level as A | A gives up its superiority over B; B gets on equal level as A |
| | Auto: both | Auto: both | Auto: neither | | |
| a = b | Qadv: neither | Qadv: both | Qadv: both | Both A and B gain computational power and quantum advantage but lose transparency | Both A and B gain computational power and quantum advantage but lose autonomy |
| a < q | Cgain: no | Cgain: yes | Cgain: yes | | |
| b < q | Equal: yes | Equal: yes | Equal: yes | | |
| a + b > q | Trans: both | Trans: neither | Trans: both | | |
| | Auto: both | Auto: both | Auto: neither | | |
| a > b | Qadv: only A | Qadv: both | Qadv: both | Both A and B gain computational power but lose transparency | Both A and B gain computational power but lose autonomy |
| a > q | Cgain: no | Cgain: yes | Cgain: yes | | |
| b < q | Equal: no, A leads | Equal: yes | Equal: yes | | |
| a + b > q | Trans: both | Trans: neither | Trans: both | A gives up its superiority over B; B gets quantum advantage and an equal level as | A gives up its superiority over B; B gets quantum advantage and an equal level as A |
| | Auto: both | Auto: both | Auto: neither | | |

competing for scientific and technological fame, yet also mistrusting each other for the calculations the other wants to do on quantum computers. The two countries are not only competing in having the largest quantum computing but also in using quantum computers for getting an economic or strategic edge over each other by breaking the encryptions of one another's digital communication and in technological and military research. By their shared aims of building large quantum computers, it may appear logical for the two countries to link their quantum systems. Such a collaboration would position them as pioneers in the quest to construct increasingly powerful quantum computers, and maybe be the first to achieve quantum advantage. However, the competitive nature of their race to advance quantum technology, combined with a reluctance to share progress due to political motives, logically argues against such a connection. Indeed, the country with the larger quantum computer may deny access to the other party in order to maintain an unequal distribution of computational power. Therefore, the most rational choice is to resolve the first trade-off (superiority vs. equality) in favor of superiority: there are good political reasons why a country with a larger quantum computer may be disinclined to connect its device with that of its adversary.

Assume now, for the sake of argument, that there is a wave of global détente, and that the competitors want to wave their supremacy and make the first trade-off in favor of equality. Then the second trade-off determines the type of connection. Opting for autonomy would mean freedom to each to do the calculations they are interested in, but also that each is allowing the other to do so, from scientific to military research. Given that a détente does not imply trust and that each wants to know what the competitor is up to, it seems more rational that they make the second-trade off in favor of transparency. This implies that in the special case of détente, governed connection may be possible, which would also mean that the competitors cannot do their more secretive calculations on the connected computer.

Governed connection: collaborating commercial companies

Let us consider secondly a case where two commercial companies both own a quantum computer. Assume that they operate in different markets, say one in pharmacy and the other in engineering, and both are subject of normal commercial law. What is the most rational choice from an ethical and strategic point of view? In this case, both trade-offs are involved.

From an economic and commercial standpoint, it is in the best interest of both companies to connect their computers because this connection guarantees both greater computational power and possibly even achieving quantum advantage (obviously in the case where neither of them has already

achieved it). Connecting the quantum computers means improving the organization and increasing the productivity of both. Therefore, in this case, the first trade-off (superiority vs equality) is resolved by choosing equality. This seems to be the most rational choice. However, this raises an issue of responsibility and liability, which are relevant values in this case. Indeed, the ethical and legal repercussions of using a quantum computer require adherence to these values.

The choice for equality in the first trade-off and the choice to connect their quantum computers necessitates resolving the second trade-off (transparency vs autonomy) in favor of transparency. Any computational activity carried out by one of the two companies must be recognizable and traceable. A lack of transparency could lead to situations where illegal or damaging activities are conducted without the knowledge of one or more involved parties, potentially resulting in legal consequences and harm to third parties. Therefore, the option of a blind connection is excluded, while the more rational choice is that of a governed connection, where the companies establish clear rules for the use and development of the quantum computer network.

In the alternative situation of two companies competing in the same market, this second case may resemble the first one of competing and mistrusting states. No connection may then become the scenario the two companies will opt for.

A final remark is one from an outside societal and political point of view. In this second case, it is rational for companies to connect their quantum computers. This holds for two companies and extends to multiple companies owning quantum computers. Thinking through this case, it is possible that eventually different conglomerates of companies arise that connect their quantum computers leading to composite computers that can reach practical quantum advantage. These conglomerates may in turn become monopolies when excluding newcomers to join. For countering detrimental impact of such monopolies on competition and innovation governance seems required in this case.

Blind connection: e-healthcare

The third case concerns healthcare in which values like health, quality, and privacy stand central. Let us assume that two hospitals each have a quantum computer (size and quantum advantage do not matter in this case).

In this case we are not dealing with merely two actors, that is, the hospitals, but we also have an additional stakeholder, i.e., the group of patients, who demand health care but also privacy protection. The two hospitals have no interest in competing against each other because they must join forces to protect patients from the threat of possible hacking.

Now, if we interpret this situation in terms of the two trade-offs, we get the following result:

The first trade-off is inevitably resolved in favor of equality. As mentioned, the hospitals are not in competition, so the most rational choice seems to be to share the computational power of their quantum computers. By this, each hospital has the benefits from the increased shared computational power and can offer patients better health care through improving diagnostic analysis and through better planning of work in the hospitals.

Regarding the second trade-off, autonomy emerges as the most logical resolution. Indeed, autonomy stands as the paramount method for safeguarding patient privacy. Enhancing autonomy naturally leads to heightened security, which, in turn, necessitates a decrease in transparency. Within this framework, essential values such as responsibility and reliability are maintained.

Concern about security and privacy, and perceived control over collection and use of health information are related to withholding of health information from healthcare providers (see Agaku et al., 2014; Gunter & Terry, 2005; Li et al., 2013; Fernández-Alemán et al., 2013; Narayanan & Shmatikov, 2008; Shams et al., 2023; Pruski, 2023; Hull, 2023). On the contrary, as mentioned, blind computing would allow each patient to freely connect to the quantum network, enter their data, and receive a diagnosis in a completely safe and autonomous way. This would allow for the highest level of confidentiality.

Towards governance

So, from the previous analysis, we have three paradigm cases, as described in Table 2.

By not singling out one best scenario for connecting quantum computers, the analysis in this paper leads to the task for actors—be they owners of quantum computers or governing bodies regulating quantum computing—to decide in individual cases if it is rational and morally advantageous to connect quantum computers. Building on the presented five criteria we can lay out a framework for supporting these decisions. This framework translates the paper's five evaluation criteria—Practical Quantum Advantage, Collaboration Gain, Equality, Transparency, and Autonomy—into a clear decision process.

First (1), actors compare their individual capacities (a and b qubits) and their combined capacity ($a + b$) against

the quantum-advantage threshold q . If neither standalone nor joint resources exceed q , the framework prescribes no connection, since linking would fail to yield meaningful speedups and would merely introduce complexity. Next (2), if they can exceed q together, partners assess equality by computing the ratio a/b . Should this exceed a modest cap—say if the ratio about 2 or more—then resource asymmetry threatens to skew power dynamics. In such cases, connection is deferred until the parties negotiate either capacity-parity guarantees or equitable revenue-sharing contracts subject to independent audit.

Once near-parity is assured (3), the focus shifts to the Transparency versus Autonomy trade-off. For highly sensitive workloads—genomic analyses, proprietary IP, or personal financial data—the framework directs actors toward blind connections, which employ symmetric blind-quantum-computation protocols so that servers learn nothing of inputs, circuit topology, or outputs. Conversely, when accountability and rapid incident response are paramount—typical in regulated finance or defense—partners should adopt governed connections, embedding cryptographic compliance proofs and hardware “kill switches” to enforce oversight.

Before finalizing any link (4), both parties must validate that the connection meets baseline performance metrics—minimum fidelity, maximum error rate, and acceptable latency—so that Collaboration Gain translates into genuine quantum advantage rather than degraded throughput. Finally (5), quarterly empirical reviews of the connection should be carried out.

Conclusions

The central issues taken up in this paper were the strategic and moral complexities and implications of connecting quantum computers. We aimed at understanding the conditions and contexts under which different scenarios of connecting these computers are most beneficial for quantum computer owners, be it for practical gains or moral considerations. We therefore defined three scenarios for connecting quantum computers: no connection, blind connection with no regulation of the use of the linked computers, and governed connections in which this use is regulated. We evaluated these scenarios against five criteria: the ability of computer owners to obtain quantum advantage and cooperation gain, to reach equality, to have transparency about the use of the connected computers and to preserve autonomy in this use. Then we identified two fundamental ethical trade-offs: transparency vs autonomy, superiority vs equality. We examined possible solutions to these two in three cases: competing states, commercial collaboration, and healthcare. Finally, we argued that there is no clear and unequivocal preference for

Table 2 Three paradigm cases

| | Trade-off 1 | Trade-off 2 | connection type |
|---------|-------------|--------------|-----------------|
| Case 1: | Superiority | – | Non |
| Case 2: | Equality | Transparency | Governed |
| Case 3: | Equality | Autonomy | Blind |

any of the three scenarios for connecting quantum computers. Therefore, the choice among the three scenarios depends on the context.

Looking ahead, while the global networking of quantum computers may not happen overnight, the future may bring such connections and lead to useful additional computing power. Hence, this future may lead to decisions about connecting quantum computers, which may be taken on the basis of the presented analysis and sketched supporting framework.

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Declarations

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Ethical Approval This article does not contain any studies with human participants performed by any of the authors.

Informed consent This article does not contain any studies with human participants performed by any of the authors.

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