

A Method for Emerging Innovation and DX by Using P2P and Go

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Abstract— In 1995, a research project started at the NTT Laboratories with the goal of fostering innovation (creating new values through new ideas) and promoting DX (digital transformation of society, business, and organizations) through the “loosely connected and autonomous networks” of computers. This became known as “the Brokerless Theory,” the world’s first P2P (Peer-to-Peer) theory, which attracted global attention. From this new concept of “loosely connected and autonomous networks,” numerous innovative social models, business models, and internet services emerged, including Skype (Sky P2P), social networking services, blockchain, and so on. Recent research has revealed that a new concept called “the External Vector” is effective for fostering innovation and DX. The concept of The External Vector means building new, weak, loose, and autonomous connections between different fields, from which new value can be created. New value created by connections between resources through the External Vector is positioned as one of the two wheels for innovation and DX emergence. The other is technological innovation creating new values with technological progress.

This paper proposes the following three points:

- The External Vector is effective for fostering innovation and DX.
- Building connections through the External Vector requires verbalizing (theorizing) the concept of the External Vector and training in the practical use of this concept.
- The combination of “P2P Concepts and Principles” and “Go Concepts and Principles” is effective for verbalizing (theorizing) and training.

Keywords— P2P Theory, Go, Innovation, DX, External Vector, Internal Vector, P2P Network, Communications

I. INTRODUCTION

Some issues such as depopulation in rural areas and financial difficulties caused by a declining birthrate, aging population, and urban concentration are accelerating the decline and depopulation of local regions in Japan. In such a situation, we have to promote regional innovation and regional DX, that is, the creation of new values and the transformation of society, business, and organizations in local regions as soon as possible in order to revitalize those local regions.

Therefore, this paper proposes the methods for fostering regional innovation and regional DX for regional

revitalization as shown in Figure 1 [1], [2]. The following items are suggested here.

- In regional innovation and regional DX, the External Vector (building new, weak, loose, and autonomous connections across different fields) is effective in creating new values rather than relying on strong connections (the Internal Vector), which have been considered common sense until now. By connecting regional resources through the External Vector, new values are created from these connections.

In other words, the External Vector is effective in generating innovation from connections between regional resources. At the same time, a shift in thinking from the Internal Vector to the External Vector is necessary, and it is important to balance the use of both the Internal and External Vectors.

- Building connections through the External Vector requires verbalizing (theorizing) the concept of the External Vector, that is, the essence of connections.

- Training to build connections through the External Vector, in other words, fostering an awareness of weak and loose connections, is required. It is not easy to acquire awareness to connect weakly and loosely because we usually and unconsciously try to connect strongly. Therefore, training to practically utilize the concept of the External Vector is necessary.

- It is effective to combine the concepts and principles of P2P and Go as a theory and training on how to generate regional innovation and regional DX, that is, how to build connections among regional resources through the External Vector. Go, a board game for securing positions, and P2P, a network theory, have a high degree of similarity as shown in Table 1, so a synergistic effect can be obtained by combining the two.

II. EFFECTIVENESS OF THE EXTERNAL VECTOR

This chapter verifies the effectiveness of the External Vector (building new, weak, and loose connections across different fields) for fostering regional innovation and regional DX.

A. Weak connections

Reference [3] pointed out from a sociological perspective that new values do not emerge from those connected by strong connections, such as family, close friends, coworkers, or groups with clear and shared goals and empathy. This means that new values are unlikely to emerge from internal planning meetings or within single industries or fields that share common values. Such connections, which were defined as "strong ties" in [3], are called "strong connections" or "the Internal Vector" in this paper. In short, it is difficult to create new values from strong connections.

On the other hand, it is more likely that new value will be created when social connections are weaker, such as friends of friends, casual acquaintances whose age, occupation, or address are unknown, acquaintances of acquaintances, and mom friends who meet occasionally. These connections defined as "weak ties" in [3] are referred to as "weak connections" in this paper.

For example, according to [4], 33% of employees in the U.S. are enthusiastic about working, while in Japan the figure is the lowest at 5%, or about a seventh of the U.S. level. Therefore, the percentage of employees who are willing to learn (reskilling) is also overwhelmingly low in Japan, at a third of that in the U.S. As a result, a vicious cycle has developed in which wages do not increase in Japan. This is due to the fact that most Japanese companies adopt a membership-based employment system. In a membership-based employment system, the company and employees are connected by "strong connections" as if they were parent and child. In contrast, in the U.S., a job-type employment system is adopted. In the job-type employment system, the company and employees maintain an equal relationship and are connected by "weak connections."

B. Loose and Autonomous Connections

Reference [5]-[10] proposed a new network model called "the Brokerless Theory" in 1998 from the perspective of network engineering. This later became known as "P2P (Peer to Peer)." In the P2P network model, computers or groups of computers can loosely and autonomously connect to each

other, creating new value from these connections, without the need for servers positioned as brokers (intermediaries). This led to the creation of innovative services and business models such as Skype, SNS, P2P insurance [11], P2P electricity, virtual currency, blockchain, and NTT's grid computing service [12]. In this paper, the loose and autonomous connections proposed by P2P are simply referred to as "loose connections."

The mechanisms for constructing "loose connections" provided by the Brokerless Theory (i.e. P2P) include Brokerless, Servant, Simultaneous Participation Concatenation (chain reaction) [13], [14], Self-organization, Semi-Pure Model, "value in connections" and others as shown in Figure 2-5, respectively. Furthermore, "value in connections" means that connections are more valuable than things (peers).

Case1: Client Server Model: Before the introduction of Brokerless Model (P2P Model) in 1998, the internet was generally based on a network model called Client Server Model. In Client Server Model, the server, acting as an intermediary for the clients, connects the clients to each other. This means that the server and the clients are connected by "strong connections (the Internal Vector)" like a parent-child relationship.

This is Top-Down Type and centralized. Therefore, the client-server model has the following problems. The server's processing capacity decreases as the number of clients increases, clients cannot be connected to each other if the server goes down, and the cost of operating the server becomes burden. The strong connections come with costs, making it difficult for new value to emerge.

In contrast, Brokerless Model (P2P Model) created new value by loosely and autonomously connecting clients without relying on the server's existence.

Case2: Problem-Solving Model and Regional Revitalization Platform Model: The problem-solving model aims to solve various existing problems, difficulties, and

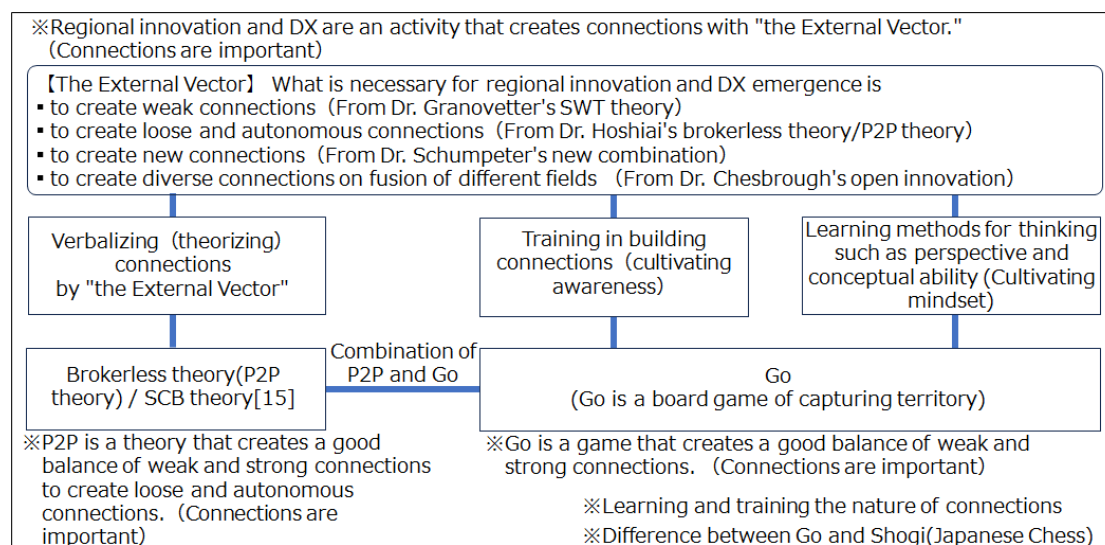


Figure 1. Proposed method for regional innovation and DX emergence (Connections construction method using "the External Vector")

issues. Most of the efforts of local governments so far have been the problem-solving model. Since the goal of this model is to solve the problem, it has not led to the creation of new values or transformation (social transformation and organizational transformation).

On the other hand, it is important to construct logical frameworks that promotes the creation of new values and transformation (social transformation and organizational transformation) from the data, know-how, and knowledge obtained through specific problem-solving. In other words, “the cross-cutting efforts” of individual initiatives will promote the creation of new values and transformation. These are the basic concepts of the framework-based innovation model and the main difference from the problem-solving model.

Therefore, reference [15] and [16] proposed a hierarchical structure for regional revitalization, innovation and DX. It will be layered into regional revitalization applications and regional revitalization platforms. This was inspired by the fact that ICT systems are composed of two layers: applications and an operating system.

However, if the regional revitalization platform is constructed and operated with strong connections (centralized and top-down), the cost and sustainability of doing so become issues. Therefore, it is important to build a regional revitalization platform by connecting regional resources, which are positioned as constituent elements of the regional revitalization platform, through “loose connections.” In addition, in the problem-solving type, the cost of problem-solving is a burden because the inner vector toward problem-solving is applied.

C. Diverse Connections

Reference [17] shows that it is valid to secure diversity and fusion of different fields in order to create new values. This means that no matter how many resources in closed areas such

as within a single domain or a single industry, are connected, innovation is unlikely to emerge from them.

For example, on the internet, one can easily be surrounded by information to which one’s hobbies, tastes, and ideas are close. Reference [18] pointed out that online advertising based on users’ search and click history tend to provide information strongly connected to oneself. Furthermore, reference [19] mentioned that in the closed space of SNS, where users with shared empathy follow each other, one’s thoughts and ideas are easily affirmed, leading to the illusion that one’s ideas are correct. In other words, the internet environment makes it difficult to ensure diversity through connections built on “shared empathy and values,” and new discoveries are hard to obtain.

D. New Connections

Reference [20] emphasized the importance of “new connections (new combinations)” between resources. This means that new discoveries and stimuli can be obtained from new connections, rather than from well-known and familiar connections.

For example, the QR code was born from the new connections between the existing and well-known barcode and Go.

III. THE NECESSITY OF VERBALIZATION AND TRAINING

This section discusses why verbalizing (theorizing) and training are necessary to construct connections through the External Vector.

Building new connections between diverse resources across different fields is not easy, given the differences in language, customs, and thinking in each field. It is not simple to build sustainable, reproducible, and general-purpose connections at low cost, low risk, and with high reliability.

For example, various cross-industry exchange meetings have been held nationwide. The goal is to create new values

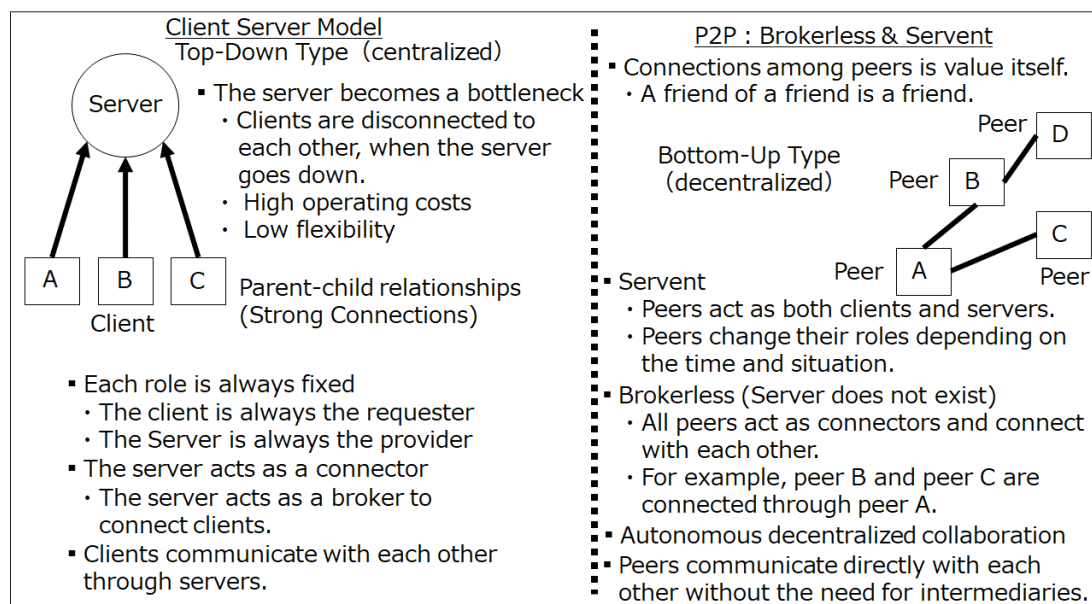


Figure 2. P2P: Brokerless & Servent

by connecting regional resources across different industries. However, in most of these efforts, no new values that would promote transformation have been created.

The main reason for this is that the connections between resources across different industries have not been verbalized (theorized). For example, there is a need for a “theory” that serves as a common language that can be shared across all industries, such as “plus” and “minus,” or “YES” and “NO.”

Reference [21] pointed out the necessity of theory and the importance of balancing theory and practice by stating, “Practice without theory is a reckless act, and theory without practice is vain.”

Similarly, many lectures by successful individuals have been held in seminars, but the success stories shared there are just one example and nothing more. On the other hand, to make success stories universal, they need to be generalized. In other words, rather than simply conveying successful experiences as examples and stories, it is necessary to perform scientific mapping for others by verbalizing and theorizing successful experiences.

Reference [22] defines this as “a personal theory and a theory” and clearly points out the usefulness of theory, “Mere success stories are defined as personal opinions and verbalized ones as theories.”

Reference [22] also shows the usefulness of theories with the following excerpt: “The difference between personal opinions and theories. There are many successful entrepreneurs, but it is not certain that other entrepreneurs who follow their personal opinions will achieve similar results. On the other hand, a well-researched theory can be considered universal.”

At the same time, it is necessary to acquire the common language (theory) for constructing connections through the

External Vector and to undergo training to utilize it.

This is because we must change our way of thinking from an “the Internal Vector” to “the External vector”. In addition, in order to use “the Internal Vector” and “the External Vector” as two wheels in a well-balanced manner, it is necessary to cultivate an awareness of weak and loose connections.

However, in the current situation where strong connections are practiced unconsciously as common sense, it is not easy to consciously aim for weak and loose connections.

IV. SIMILARITIES BETWEEN P2P AND GO AND THE EXTERNAL VECTOR

In order to foster regional innovation and regional DX, it is necessary to create new values and promote transformation from the connections between regional resources. Based on the analysis of previous research, we considered necessary to construct not only strong connections (the Internal Vector) between regional resources, but also new, weak, and loose connections across different fields to foster new values and transformation in the region. We defined these connections as “the External Vector.” They are decentralized and bottom-up connections. It is essential to balance both the External Vector and the Internal Vector, and the mechanisms for doing so are the “semi-pure model” in Figure 5 [16] and the “simultaneous participation concatenation (chain reaction)” in Figure 3 [13], [14].

Moreover, for the sake of constructing sustainable connections through the External Vector and connecting diverse resources across different fields, it is necessary to have a theory (verbalization) and training (cultivating awareness of connections). In other words, the “verbalization of connections” and the training are crucial in order to construct connections through the External Vector, leading to regional

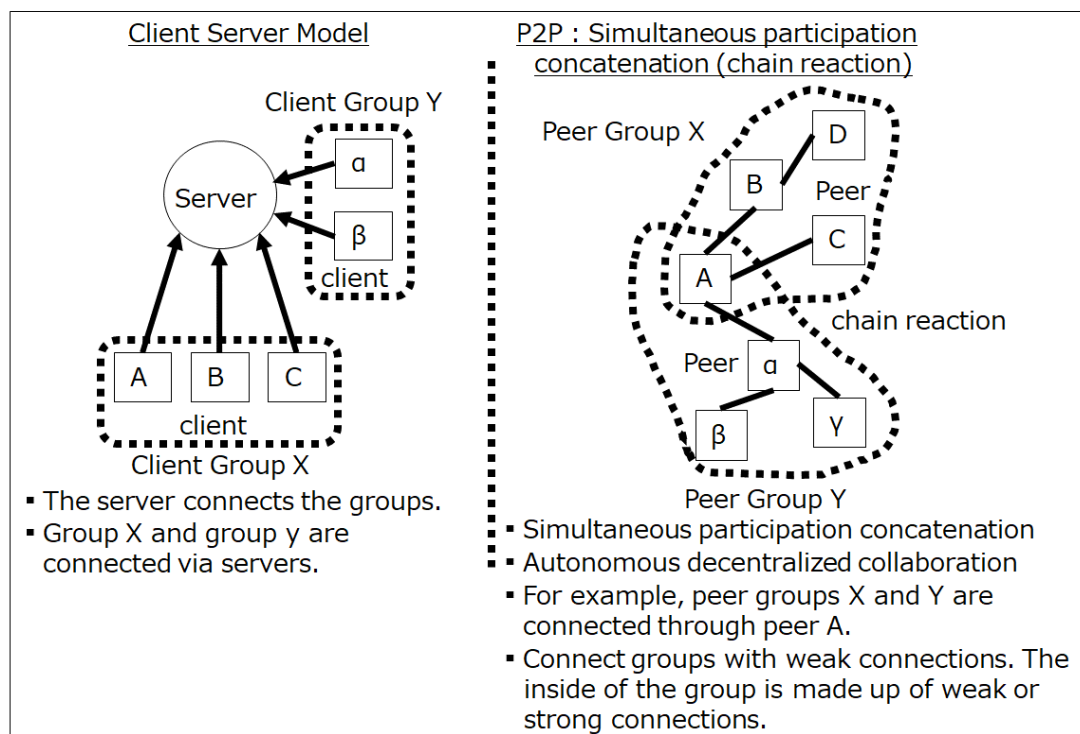


Figure 3. P2P: Simultaneous participation concatenation

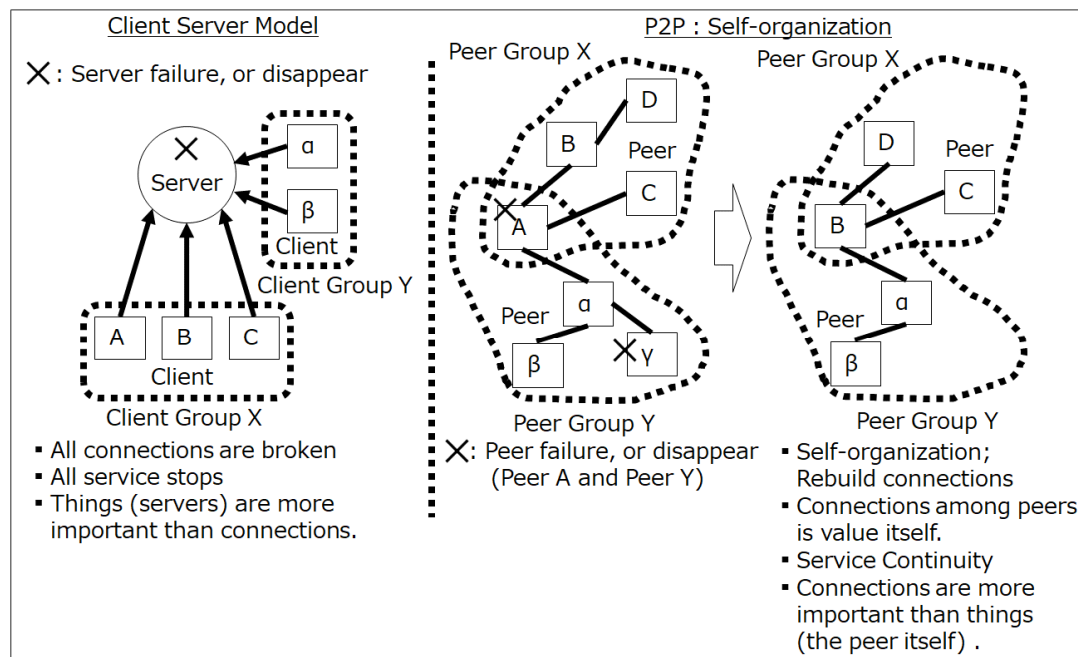


Figure 4. Self-organization & The value of connections

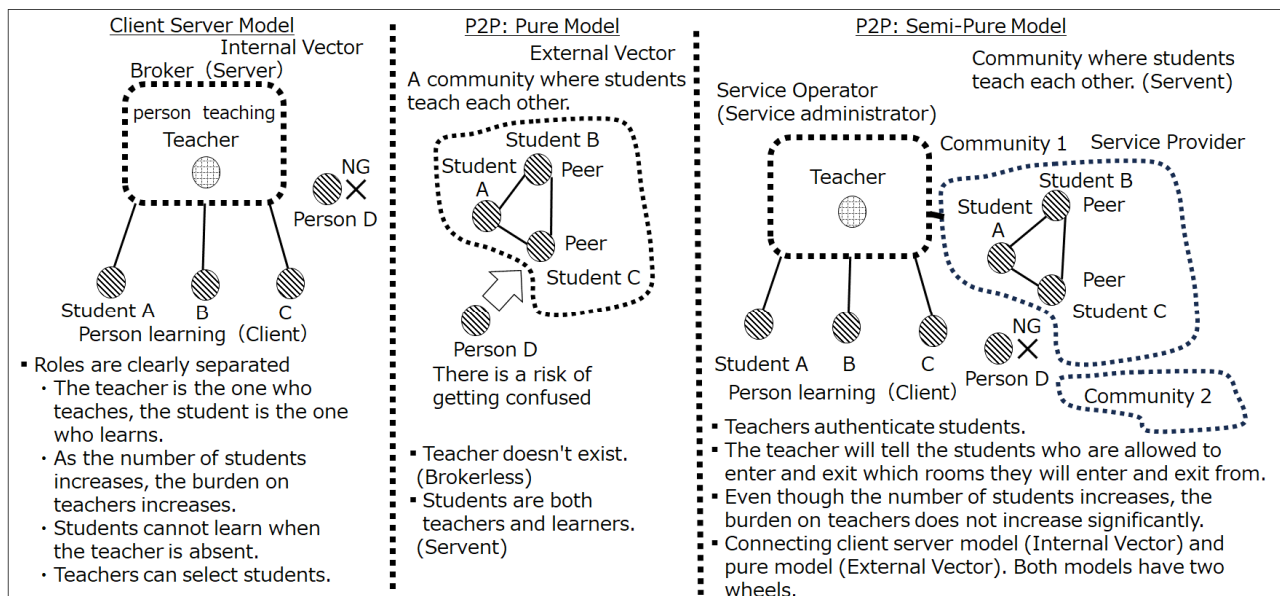


Figure 5. Semi-Pure Model (A method to connect Internal Vector and External Vector: place of learning as an example)

innovation and regional DX.

Regional innovation and regional DX are essentially efforts to create connections through the External Vector, and for this, the “P2P theory,” which provides a theory for creating loose and autonomous connections, is considered optimal. Additionally, for training and cultivating awareness of building the External Vector, the game of Go, which demand us to create a good balance between weak and strong connections, is considered effective.

Furthermore, we proposed the idea of combining the “concepts and principles of P2P” and “those of Go.” As shown in Table 1, to clarify the effectiveness of combining P2P and Go, we evaluated (a) the similarities between P2P

and Go, and (b) the similarities between the Client Server Model and Shogi, the Japanese chess game. Moreover, we evaluated the differences between (a) and (b).

Furthermore, since P2P and Go have a high affinity with the External Vector, synergy effects can be expected by combining them.

V. CONCLUSION

This paper analyzes the issues related to fostering regional innovation and regional DX, revealing that the External Vector is effective in creating new values. It also proposes a new method for fostering regional innovation and regional DX by combining Go and P2P, and qualitatively clarifies its

effectiveness as shown in Table 1. Demonstration experiments using the proposed method are currently being conducted by industry, government, and academia for the purpose of quantitative evaluation of the proposed method.

The essence of the External Vector (P2P) is to create new value from loose connections.

Therefore, we are proceeding with efforts to create new value from these connections by loosely connecting regional resources scattered throughout the region using the External Vector. For example, the Sojo University IoT/AI Center is operated by a community built through loose connections between companies, local governments, universities, students, high school students, and citizens [24]. This has made it possible to operate an IoT/AI center with high sustainability, reproducibility, versatility, and reliability at low cost.

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TABLE 1. "①Similarities between Go and P2P" and "②Similarities between Shogi and client server", and "Differences between ① and ②"

External Vector		Internal Vector	
Go(IGO)	P2P	Client Server	Shogi(Chess)
- There are no predetermined roles for Go stones. - Go stones change their roles depending on the time and situation.	- Servent (Fig.2) - Peers act as both clients and servers. - Peers change their roles depending on the time and situation.	- Each role is fixed and never change. (Fig.2) - The client is the requestor. - The server is the provider.	The role of the pieces is fixed and does not change.
- Even if one position or Go stones is lost, it is important to create another position or connections among another Go stone. - Go is a game where you compete for position by giving and taking.	- Self-organization (Fig.4) - If peers goes down, the remaining peers will rebuild and continue service.	All services stop when the server goes down. (Fig.4)	The game is over when the king is captured. A game to capture the king.
There is value in the connections between Go stones. Each Go stone becomes a connector and connects the Go stones together.	- Connections among peers is value itself. (Fig.4) - Brokerless (Fig.2) - Since there is no broker that connects peers, each peer becomes a connector and connects each other. - Simultaneous participation concatenation (Chain reaction) (Fig.3) - Peers connect peer groups.	- The server persistence has value in itself. - The server is a broker that connects clients. - When the server stops, the connections between clients is broken. (Fig.2, Fig.3)	- The lifespan of a king is value itself. - It is important to cooperate with other pieces centered on the king, such as capturing the opponent's king and protecting your own king.
The game starts with no Go stones placed on the board.	The network or service starts with zero peers.	A network or service starts after arranging servers in advance.	The game starts after the pieces are placed in predetermined positions.
A game that creates a good balance of weak and strong connections.	- A network in which peers are connected by "loose and autonomous connections". - Bottom-Up Type/ decentralized - Semi-Pure (Fig.5) - Connect weak connections and strong connections.	- A network in which clients and servers are connected by a "strong connections." - Top-Down Type/centralized (Fig.5)	A game in which the king and other pieces are connected by strong connections.

※Reference [23] recommends "multitasking," where employees perform multiple tasks. Multitasking corresponds to servant and simultaneous participation concatenation in P2P.

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Takashige Hoshiai was born in Japan, 1962. He received the Ph.D. degree in Engineering. He was a visiting researcher at Bell Laboratories from 1995 to 1997, and proposed the brokerless model in 1998, and invented the semantic information network architecture SIONet, which is the technology to realize the model. In 2011, he proposed Social Community Brand (SCB theory) that utilizes P2P for local revitalization. He is currently conducting research on regional revitalization and the emergence of regional innovation using SCB theory. He is currently a president of Sojo University IoT/AI Center, a professor of the Faculty of Computer and Information Sciences, Sojo University, an invited researcher of Waseda University, a director of the SCB Laboratory and a principal of SCB Innovation Academy.



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