Security Cooperation Mechanism Analysis of Cognitive Wireless Network based on Non-Competitive Strategic Alliance

Guang Yang[1,*], Jianbing Yin[2]
[1]Nanjing Vocational College of Information Technology, Nanjing, China
[2]Wuxi Institute of Technology, Wuxi, China
**Corresponding author.*

Abstract

Nowadays, with the rapid improvement of economic level and the rapid development of technology, mobile intelligent terminals become more popular. They bring great convenience to our life, but raise a security issue leading to personal privacy exposed to all. The research on the generated structure evolution of Node-centric Federation (NF) strategic alliance's synergy mechanism indicates the alliance system structural evolution reasons and conditions, and lays foundation for deeper study of relationships between users' advantage approaches and synergy mechanism. The analysis of stability of the evolution of the NF alliance structure shows that the non-competitive alliance of structural evolution tending to the stable state, must rely on the Strategic Alliance Synergy Mechanism. Only if the alliance system approaches to the evolutionary stable state will the alliance value be greater than the non-union state. Alliance Synergy Mechanism optimizes the structure of alliance system, increasing the total value of security, which is also the product of each subsystem cooperation.

Keywords: *structure evolution; NF alliance; synergy mechanism; value of security*

I. Introduction

Wireless communication plays an indispensable part in real life and has great social influence. In many industries, especially those related to military, electronic commerce, electronic banking, medical information application, the security of wireless transmission is very important. However, the broadcast and overlay characteristics of wireless channel bring great challenges to the security of wireless transmission. With the rapid development of wireless communication technology, the network structure becomes more and more complex, making wireless transmission easy to eavesdrop and attack. In recent years, how to obtain the enduring advantages of security cooperation has become a key issue scholars pay attention to, so the research of secure communication has extremely important theoretical and practical significance, which is a hot button issue right now.

II. A problem to be raised

Different from the traditional cryptography, more and more literatures study how to strengthen the security of the existing wireless communication from the physical layer, so as to adapt to the demand of the emerging wireless network[1]. The basic principle of physical layer security is to make use of noise and the randomness of wireless channel to realize information encryption, generate passwords, identify legitimate users, etc., and the study of wireless communication security from the physical layer has the advantage of antagonizing illegal eavesdroppers with unlimited computing power. In a real wireless network, each node has its own goal and is unwilling to help others without any benefit. With the rapid development of wireless communication, the spectrum resources are increasingly scarce. In cognitive radio networks, secondary users are willing to collaborate with primary users to improve the security of the primary link in order to be able to use the authorized frequency band to send data. When Dr. Ma Yayan used game theory to study the security cooperation between cognitive wireless network nodes, she proposed the Basic Stackelberg Game Cooperation Scheme and two-level game cooperation scheme improved the performance of both sides, and compared with the Basic Stackelberg game cooperation scheme, the two-level

game cooperation scheme gives full play to the competition among secondary users, strengthens the dominant position of primary users, and thus increases the cooperation opportunities of primary and secondary users, better increases revenue for both parties[2]. In Dr. Ma Yayan's paper, several cooperation schemes based on Stackelberg Game, second-price auction game and two-level game are proposed, which are of great practical significance to the security cooperation between primary and secondary users in cognitive wireless networks, in order to achieve a win-win situation[2].

According to the forecast, the wireless mobile network will continue to develop rapidly in the foreseeable future. Unlike traditional networks, wireless mobile networks are characterized by the manipulation of mobile devices[3]. As online social networks have exploded, social connections have changed the way people interact with each other, and thus the communication networks that they hold on to mobile devices. Many researchers began to try to combine "Social Tie" with Game Theory and apply it to the research of physical layer security collaboration[2].

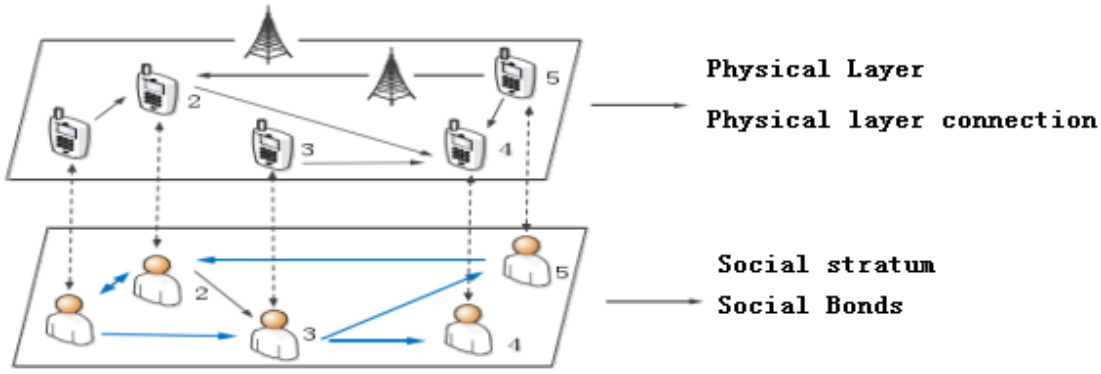

Figure.1 the superposition system of communication network and virtual social network

From this point, the infinite mobile network can be regarded as the superposition system, that is, the virtual social network is under the physical communication network. Therefore, the researchers reconsidered the system model involving a pair of transceiver nodes, an additional eavesdropper, and multiple jammers. When the jammer and the transceiver node are in the same alliance (such as the circle of colleagues, classmates, friends, etc.), they will act as the friendly jammer to help the transceiver node improve the security performance, and the closer the transceiver node is, the more willing they are to participate in friendly jamming cooperation, the more concerned they are with the increase in the achievable safe rate between the sending and receiving nodes, as shown in Figure 1.

From the point of view of the current research situation, the academic circles mostly study the competitive and cooperative relationship between users from the perspective of Game Theory, among which there are many achievements in obtaining the cooperative relationship with the main user through the game competition among secondary users[4]. However, there is a lack of research on how to establish non-competitive strategic alliance between primary and secondary users in order to obtain the security benefits of cooperative alliance.

III. Theoretical assumptions related to the alliance of Node-centric Federation (NF)

3.1 Strategic alliance

Strategic alliance has been known as one of the most important organizational innovations in the 20th century, a new form of cooperation and competition, a modern approach to enhancing the competitive advantage. The emergence and development of strategic alliance has a great impact on the traditional theories of strategic management, because the competition and cooperation between alliances has replaced confrontation. Strategic alliances have become more and more popular in adjusting or restructuring of nodes, further optimizing resource allocation, and enhancing competitiveness[5]. However, with the increase of strategic alliances, many empirical evidences show that the strategic alliance has an inherent instability, lack of a system coordination mechanism,

thus, limiting its further development, and affecting the value creation. As we know, the strategic alliance is a new form of self-organizational evolution.

3.2 "The entropy decreasing mechanism" of strategic alliance

In recent years, strategic alliance has become a hot topic of research. Strategic alliance emerges in competition and cooperation instead of confrontation, which is regarded as an advanced organization form. However, the instability of the self-organization of alliance gave birth to a more advanced organization form, that is Node-centric Federation (NF), which has characteristics of Entropy Reduction[5]. Based on the hypothesis of "Entropy Decreasing Mechanism", the following text makes an analysis of a new formation mechanism.

In the 19th century, physicists discovered the second law of thermodynamics in the initial study of the thermal system, namely the Entropy Law, which describes the transformation direction of system energy: in a closed system, energy only irreversibly attenuates. That is expressed in mathematical language: $dS=diS\geq 0$ (dS is an overall entropy change of system, diS is an entropy change inside system). The concept of entropy is brought into the field of System Science, and transformed into its own category. When out of order in coordination between internal elements, or due to a certain extent, input uncontrollably by the external environment, the system is very difficult to control around the target in self, which exhibits some degree of disorder in function. The state of system is called an increasing effect of the system's entropy value.

Entropy Law shows the increasing confusion trend exists inevitably in any system. But life, social or economic system obviously shows an inevitable process of progress or development, which thus arouses scientists to think seriously. On one hand, it is admitted all systems including social ones have such a tendency. On the other hand, considering there is a special mechanism in system, and system can overcome resistance in the entropy production process, forming a self-organized motion, that is, "Entropy Decreasing Mechanism". Of course, such self-organizations are of openness generally.

Non-competitive strategic alliance between primary and secondary users is an allied form of Node-centric Federation (NF), in strategic needs of some collaboration innovation, and is also an inevitable product of the primary and secondary users'self-organization motion of safeguard. In fact, some internal instability appears in the original alliance system of primary and secondary users, even threatening its survival. In that case, Node-centric Federation (NF) has got to seek ways to solve problems from outside. NF exchanging outside will inevitably lead to a further integration of environmental resources and a formation of greater alliance, e.g. more creditable users. Under such background, NF between primary and secondary users comes into being. This is hypothesis: the strategic alliance's advantage is acquired as a result of the cooperative principle of Entropy Decreasing Mechanism.

3.3 Analysis of Node-centric Federation (NF) synergy

3.3.1 Synergy

Synergy, according to Hawking's view[6], is a coordination, cooperation, synchronized joint action, or collective behavior among various subsystems. Synergy is an inner expression of system integrity and relativity. Self-organization evolution power comes from two forms of internal interaction: competition and cooperation. Sub system's competition(e.g. secondary users) leads to system's imbalance, which is an above-all condition of self-organization. The coordination between inner and outer of system in non-equilibrium conditions promotes some moving tendency more and more obvious, so as to occupy the dominant position, and dominate the whole system evolution. From a view of System Science macro qualitatively, there are various perplexing relationships and interactions in a complex system. This kind of interaction is often nonlinear, and it makes the new whole coupling effect between elements, not simply the numbers superposition.

3.3.2 Synergistic Node-centric Federation (NF): a new self-organization evolution

NF is also a product of security cooperation in cognitive radio networks' self-organization adjustment[7]. Self-organization is a structural system, independently from disorder to order, without specific instructions, but self-organized, self-created, self-evolution. The "specific" means that the structure or function is not imposed from outside to the system. During the period of security cooperation in cognitive radio networks, there exist some fatal defects. In order to enable cooperative nodes to adapt to the competing environment, a wider range of resources in environment must be integrated by NF. Thus, the formation of a comprehensive alliance will be producing strategic alliances centered in security cooperation in cognitive radio networks.

Self-organization theory says, the dissipative structure plays an important role in system evolution. According to the dissipative structure theory, it must be an open system, which must be far away from the equilibrium state, and has nonlinear effect on the system. The Node-centric Federation(NF)'s self-organization mechanism has all the above basic conditions. In an equilibrium state, the alliance system neither has any communication with environment, nor do the state variables change as time goes. But the reality is not like that. As we mentioned above, currently, owing to the rapid development of wireless communication, the wireless spectrum resource becomes scarce, security cooperation in cognitive radio networks' system has been far away from equilibrium, and the inner linear innovation model is difficult to keep up with the demand of times' development which is a necessity for security cooperation in need of adjustment. That is why cooperative nodes have to integrate kinds of resources such as other nodes(e.g. secondary users) into more advanced alliance systems under different times or backgrounds. Thus, Synergistic Node-centric Federation(NF) can be seen as an adjustment product of self-organization in the real wireless networks. Once the Node-centric Federation(NF) has developed into a macro self-organization system, since then, its subsystems' evolution must be restricted in a specific mode which embodies a domination by using a rule: synergy and co-evolution.

3.3.3 A basic condition to guarantee NF 's dynamic development: openness

As a system, NF is a product of communication or integration centered in security cooperation in cognitive radio networks, with external resources or abilities. Openness is a basic condition of adapting to environment for the self-organization to survive and develop. It has two connotations: open to the outside and open to the inside[8]. The former is not only open to other sub-systems in the same level, but also open to social relationships. The latter is open to affinity or co-force among subsystems, strengthening the whole system's functions. As a complex system, the strategic alliance must be adjusting itself according to the external factors, especially disturbance factors(e.g. potential eavesdroppers) input from outside, in order to achieve self-stabilization. In that case, the strategic alliance, namely NF, has the probability to change potential eavesdroppers into potential friendly jammers.

3.3.4 A reliable guarantee for nonlinear innovation: synergy mechanism

(1) Synergy mechanism. Mechanism refers to the mutual connections, or interactions between different elements of internal or external systems, which make the whole system run in a certain way. Synergy mechanism is a dynamic one, which provides power to promote motivation, operation and development, and consists of economic relations, and various organization rules. Synergy mechanism can be divided into two types: endogenous mechanism and incentive mechanism. Endogenous mechanism is an inherent spontaneous power, and incentive mechanism mainly comes from the external environment. The alliance of NF is characteristic of both endogenous mechanism and incentive mechanism[9]. That is, each member needs an inherent regularity mechanism for innovation, based on the common competitive advantages as well as the strategic objectives.

(2)The alliance of NF is centered to maintain a non-linear mechanism. From the perspective of non-linear system, the interaction between parts of sub-systems is a nonlinear function, which differs from linear plus, although some (one) can be separated from the whole alliance, which will have impact on the overall function of alliance. So the alliance is in organic and complex relations, whose functions are not added in only a mathematic way, but come into being by changing qualitatively into a whole function of system. The changing power is exactly from the non-linear innovation mechanism for the security interests of all parties.

The important distinctness of the alliance of NF from other network organizations is that each node is independent from each other. But the reality is that the demand of security interests of each node is still the source power for the cooperation in cognitive radio networks. Strengths and advantages of each node are not equal to each other, but resources in innovation are complementary. So the alliance's innovation must be market demand-oriented and it must be the only topological alliance structure, like Figure 2.

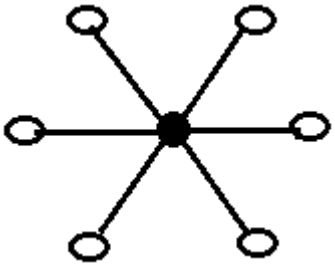

Figure.2 Center-oriented strategic alliance structure

Nowadays, with the rapid improvement of economic level and the rapid development of technology, mobile intelligent terminals become more popular, which brings great convenience to our life, but raises a security issue leading to personal privacy exposed to all. In the real wireless networks, each node has its own aim, and it's reluctant to help other nodes in the case they don't benefit. In the cognitive radio network, the secondary users are willing to cooperate with the primary user to enhance the security of the primary link for the usage of the authorized spectrum[10]. But this is not enough to deal with potential danger, because at present, they only cooperate with the primary user on the basis of their own interests, not from the common interests with each other to carry out strategic synergy.

The structural forms of alliance are including non-competitive alliance and competitive alliance. Non-competitive alliance comes from different industries. The alliance of NF is characteristic of non-competitiveness. Its structural form is taken on like this: the secondary users help their partner, that is, the primary users, to enhance competitiveness in the real wireless networks. Of course, the secondary users of alliance are also characteristic of competitiveness and cooperation. The structural form can be described into three types: supply-sharing alliance, centralization-alike alliances and complementary alliance[11]. In summary, the strategic alliance of NF itself has the nature of self-organization, and its operation rules are contrary to a closed system. It is an open system exchanging with the external environment, forms a mature coordination mechanism, and has the feature of "Entropy Reduction".

3.4 Connotation of the NF system structural evolution

Because the alliance of NF is market-oriented and characterized as non-competitive alliance, we can define the NF system structural evolution to be like this: accompanied by alliance development and environmental changing, the alliance continuously makes readjustment of relevant aspects of the system structure so as to adapt the changing environment and user’s security need.

3.4.1 Instability and fluctuation of alliance system

System Theory emphasizes that stability is the condition for functioning, and the starting point where people begin to observe, study and control system. In a sense, loss of stability is one of the negative factors to be avoided by people. Generally, alliance with high stability under external disturbances and deviation from the original state reverts quickly, but the one with low stability reverts slowly. If it does not return to the normal state for long, the size of the deviation is growing with time, which is called loss of stability. Self-organization Theory, especially Synergy, is more concerned about the loss of old system structure and the emergence of new structure. The fluctuation is considered to be deviation from system's state variable average. The fluctuation is orderly formed, and it plays a very important role in the formation of alliance system.

3.4.2 Evolution and coordination of the NF alliance

Due to the nonlinear mechanism of strategic alliances, if the random events from internal or external alliance appear, such as new members to join the alliance, a new technology birth, may depend on the nonlinear mechanism to select. If the random event is conducive to alliance's development, it will be magnified and produce new structural features of emergence.

The NF alliance synergy mechanism will have this effect. By the nonlinear mechanism including the synergy mechanism itself, when the impact of fluctuation appears below the critical state, the fluctuation returns, strengthening the original alliance structure. When the impact of the fluctuation exceeds the critical state, the original structure of alliance will lose stability, forming bifurcation, alliance structure jumping. The jump in the alliance development leads to uncertainty and it is only through the coordination mechanism that the fluctuation promotes the evolution of alliance system structure. For example, when a node (e.g. primary or secondary users) in security cooperation in cognitive radio networks, with external resources or abilities has made a pioneering work in some technology or relation, the synergy mechanism will have great impact on the entire alliance system, which leads to series of coordination, and thus, promotes the whole alliance structure jumping as well as the acquisition of alliance synergy advantage[12].

IV. Deduction of the NF alliance's evolution model

4.1 Formation of the evolution model

With more research on the System Theory, the Logistic Equation is introduced into the self-organization theory to describe the dynamic evolution. The Logistic Development Regularity, also known as the Logistic Rule, originates from the basic principles of ecological growth system and typical self-organization mechanism. And the like, social systems, such as social bonds, will be restricted by its own growth competence and environment resources, and its developing evolution is limited[13]. We can describe the limited developing evolution to be like the Logistic Equation (1).

$$X_{t+1} = rX_t(1 - X_t) \tag{1}$$

Equation (1) describes the dependent relationship of states at Time "t+1" on Time "t". The NF alliance's structure evolves according to the Logistic Rule. This paper supposes that the NF alliance consists of a primary user "Node A", and a secondary user "Node B", and uses the security value(benefits) created by the NF alliance as state variable which embodies its development scale.

(1) X_i is used as the value created by individual and then, X_1, X_2 respectively as the value created by Node A or Node B at Time "t".

(2) $N_i(N_1, N_2)$ is used as the maximum value by individual independently, with the limit of resource scarcity, and $N_i > 0$.

(3) $r_i(r_1, r_2)$ is used as the inherent growth rate of individual relying on only the intrinsic core competence of alliance in a certain environment. $r_i > 0$, that is the average growth rate of benefit rate created by Node A or Node B. It is related to the inherent characteristics of the security cooperation itself. r_1, r_2 are assumed to be constant. Therefore, in an independent evolution state, the Logistic equation can be described like this: Formula (2).

$$\frac{dX}{dt} = rX(N - X) \tag{2}$$

Formula(2) shows that the individual creation of value is in in accordance with the Logistic Growth Law. $(N - X)$ in the equation mean is called Reduction Factor, which decreases with time goes. Prigogine in the book "Non-balanced Self-organization System", described of the growth law of the complex social system consisting of two competitive subjects with the Logistic Equation as follows:

$$\begin{aligned} \frac{dX}{dt} &= r_1 X_1 (N_1 - X_1 - \beta X_2) - d_1 X_1 \\ \frac{dX}{dt} &= r_2 X_2 (N_2 - X_2 - \beta X_1) - d_2 X_2 \end{aligned} \tag{3}$$

In Formula (3), factor β stands for the relationship between two bodies' interaction, that is, the common use of some resources, and influence on each other is equal. If $\beta = 1$, both sides utilize the same resource, in a cut-throat competition. When $\beta = 0$, they do not utilize any resources in common. Some coincidence is represented by β between 0 and 1. d stands for the reduction rate of value creation in process of a single body's development. We can understand the NF alliance's cooperative relations as a value between 0-1.

4.2 Analysis of the non-competitive strategic alliance of NF structural evolution

In current environment, the NF comes into a non-competitive strategic alliance system from external environment. On one hand, the alliance partnership allows complementary resources to be utilized efficiently, promoting the bilateral economic or interest growth of security. On the other hand, the contribution of economic or interest growth of security includes not only production factors, but the synergistic effect of both sides, that is to say, the factors synergy level also decides efficiency of the economic or interest growth of security.

This paper considers the utility of production factors of the NF alliance system is to be decided by the level of synergy mechanism. Thus, the parameter δ_i is introduced, and $\delta_{ij}(0 < \delta_{ij} < 1)$ denotes the impact of "j" on "i" in alliance cooperation and synergy mechanism. δ tends to 1, which shows that "j" has a positive effect on "i" in the value creation. δ tends to 0, which indicates "j" has zero effect on "i" in the value creation of cooperation and synergy, that is to say, there is no significance of alliance.

$\delta_{ij} X_j$ is added in the factor (N-X) of Formula (3) which is modified into the evolution model of non-competitive strategic alliance structure as shown in Formula(4).

$$\begin{cases} \frac{dX_1}{dt} = r_1 X_1 (N_1 - X_1 + \delta_{12} X_2 \\ \frac{dX_2}{dt} = r_2 X_2 (N_2 - X_2 + \delta_{21} X_1 \end{cases} \tag{4}$$

The equation (4) is a nonlinear autonomous equation group, fixed point can be available by linearization.
Supposing:

$$\begin{cases} r_1 X_1 (N_1 - X_1 + \delta_{12} X_2) = 0 \\ r_2 X_2 (N_2 - X_2 + \delta_{21} X_1) = 0 \end{cases} \tag{5}$$

The solutions of algebraic equations (5) are equilibrium points of Equation (4), that is, P_1, P_2 (6):

$$P_1(0,0), P_2(\frac{N_1 + \delta_{12} N_2}{1 - \delta_{12}\delta_{21}}, \frac{N_2 + \delta_{21} N_1}{1 - \delta_{21}\delta_{12}}) \tag{6}$$

4.3 Stability analysis of the strategic alliance of NF structure evolution model

Characteristic matrix of Evolution Equations (7) for stability analysis of any equilibrium:

$$A = \begin{bmatrix} \frac{\partial \dot{X}_1}{\partial X_1} & \frac{\partial \dot{X}_1}{\partial X_2} \\ \frac{\partial \dot{X}_2}{\partial X_1} & \frac{\partial \dot{X}_2}{\partial X_2} \end{bmatrix} \tag{7}$$

After calculation, the following characteristic matrix is shown(8):

$$A = \begin{bmatrix} r_1(N_1 - 2X_1 + \delta_{12} X_2) & r_1 \delta_{12} X_1 \\ r_2 \delta_{21} X_2 & r_2(N_2 - 2X_2 + \delta_{21} X_1) \end{bmatrix} = \begin{bmatrix} l & m \\ n & o \end{bmatrix} \tag{8}$$

The characteristic equation of Matrix A is $\lambda^2 + b\lambda + c = 0, b = -(l + o), c = lo - mn.$

The characteristic roots(9):

$$\lambda_1 = \frac{-b + \sqrt{b^2 - 4c}}{2}, \lambda_2 = \frac{-b - \sqrt{b^2 - 4c}}{2} \tag{9}$$

According to the differential principle, $b, c, b^2 - 4c$ or λ_1, λ_2 can be used to judge stability of the equilibrium points.If $c < 0$, the equilibrium point is saddle. If $b > 0, c > 0, b^2 - 4c > 0$, the equilibrium point is stable node. If the equilibrium point is unstable node:

(1)Put $P_1(0,0)$ into A, and the characteristic matrix is $A_1 = \begin{bmatrix} r_1 N_1 & 0 \\ 0 & r_2 N_2 \end{bmatrix}$.

$$b = -(r_1 N_1 + r_2 N_2) < 0, c = r_1 N_1 \times r_2 N_2 > 0, b^2 - 4c = (r_1 N_1 - r_2 N_2)^2 > 0 \tag{10}$$

So the point $P_1(0,0)$ is unstable point.

(2)Put $P_2(\frac{N_1+\delta_{12}N_2}{1-\delta_{12}\delta_{21}},\frac{N_2+\delta_{21}N_1}{1-\delta_{12}\delta_{21}})$ into A, and the characteristic matrix is

$$A=\begin{bmatrix} -r_1\frac{N_1+\delta_{12}N_2}{1-\delta_{12}\delta_{21}} & r_1\delta_{12}\frac{N_1+\delta_{12}N_2}{1-\delta_{12}\delta_{21}} \\ r_2\delta_{21}\frac{N_2+\delta_{21}N_1}{1-\delta_{21}\delta_{12}} & -r_2\frac{N_2+\delta_{21}N_1}{1-\delta_{21}\delta_{12}} \end{bmatrix}$$

$$b=-(-r_1\frac{N_1+\delta_{12}N_2}{1-\delta_{12}\delta_{21}}-r_2\frac{N_2+\delta_{21}N_1}{1-\delta_{21}\delta_{12}})=\frac{r_1(N_1+\delta_{12}N_2)+r_2(N_2+\delta_{21}N_1)}{1-\delta_{21}\delta_{12}}$$

$$c=r_1r_2\frac{(N_1+\delta_{12}N_2)(N_2+\delta_{21}N_1)}{1-\delta_{21}\delta_{12}}$$

$$b^2-4c=\left\{\frac{r_1(N_1+\delta_{12}N_2)+r_2(N_2+\delta_{21}N_1)}{1-\delta_{21}\delta_{12}}\right\}^2-4r_1r_2\frac{(N_1+\delta_{12}N_2)(N_2+\delta_{21}N_1)}{1-\delta_{21}\delta_{12}}$$

$$=\frac{[r_1(N_1+\delta_{12}N_2)-r_2(N_2+\delta_{21}N_1)]^2+4r_1r_2(N_1+\delta_{12}N_2)(N_2+\delta_{21}N_1)\delta_{21}\delta_{12}}{(1-\delta_{21}\delta_{12})^2}>0 \quad (11)$$

$\delta_{ij}(0<\delta_{ij}<1),\beta_{ij}(0<\beta_{ij}<1)$,so $1-\delta_{12}\delta_{21}>0.$ $c>0,b>0,b^2-4c>0,$ so P_2 is considered to be the equilibrium point. The analysis above shows that only if the NF alliance (non-competitive strategic alliance structure) runs in collaborative relationships, the strategic alliance structure will be enhanced to be the optimal one.

In addition, if the NF alliance runs in a steady state, the two sides' value of security will be superior to the respective(e.g. the security cooperation between the primary users and secondary users based on Stackelberg game, the second-price sealed-bid auction and the two-layer game), which also shows that because of alliance or synergy mechanism. the NF alliance has an easier approach to gaining the advantages of security value creation . That is as follows(12).

$$\frac{N_1+N_2+\delta_{12}N_1}{1-\delta_{12}\delta_{21}}>N_1+N_2 \qquad P_1(0,0),P_2(\frac{N_1+\delta_{12}N_2}{1-\delta_{12}\delta_{21}},\frac{N_2+\delta_{21}N_1}{1-\delta_{21}\delta_{12}}) \quad (12)$$

V. Conclusion

This paper presented an hypothetical study on the security cooperation mechanism, which can further enrich the research on the security cooperation in cognitive radio networks. The following conclusions can be drawn from this study.

Firstly, the analysis of stability of the evolution of the NF alliance structure shows that the non-competitive alliance of structural evolution tending to the stable state must rely on the Strategic Alliance Synergy Mechanism. Secondly, only if the alliance system approaches to the evolutionary stable state will the alliance value be greater

than the non-union state. Thirdly, alliance Synergy Mechanism optimizes the structure of alliance system, increasing the total value of security, which is also the product of each subsystem cooperation.

Acknowledgements

In this paper, the research was sponsored by the Philosophy and Social Science Foundation of Jiangsu Universities, "Research on value co-creation mechanism of virtual brand community based on new social network embedding" (Grant: 2018SJZDI077).

References

[1] Zhang N, Cheng N, Lu N, et al. Partner Selection and Incentive Mechanism for Physical Layer Security. IEEE Transactions on Wireless Communications, 2015, 14(8):1-1.
[2] Ma Yayan. Security Cooperation in Cognitive Radio Networks using Game theory. Dissertation Submitted to Nanjing University of Posts and Telecommunications for the Degree of DOCTOR OF PHILOSOPHY, 2016.
[3] Alok Kumar, Prabhat Thakur, S. Pandit, G. Singh. Threshold selection and cooperation in fading environment of cognitive radio network: Consequences on spectrum sensing and throughput.AEU-International Journal of Electronics and Communications, 2020, 9(117): 229.
[4] K. Elangovan; S. Subashini.Particle bee optimized convolution neural network for managing security using cross-layer design in cognitive radio network.Journal of Ambient Intelligence and Humanized Computing, 2018,14(29): 1-9.
[5] Linnan. Social Capital: A Theory of Social Structure and Action. Cambridge University Press.2001:85-114.
[6] H. Haken. Information and Self-Organization A Macroscopic Approach to Complex Systems. S Pringer-Verlag. 1988: 11.
[7] Finsterer Josef Fractal genetics and heterogeneous phenotypes of mitochondrial disease require appropriate logistics of managing network structures. Molecular genetics and metabolism reports, 2019, (20):133.
[8] John B. Cullen. Jean L. Johnson, Tomoaki Sahano. Success Through Commitment and Trust: The Soft Side of Strategic Alliance Management Journal of World Business, 2000, 35(3). 223.
[9] Stalk G, Evans P., Shulman. Competing on Capability: the New Rules of Corporate Strategy. Harvard Business Review.1995, (6): 121-132.
[10] Telefonaktiebolaget LM Ericsson (publ). Controlling Energy Consumption of A Wireless Network Node. Published Online (USPTO 20200163029). Telecommunications Weekly, 2020.
[11] Johnson. J., Cullen. J.B., Sakano, T. & Takenouehi. Setting the Stage for Trust and Strategic Integration in Japanese-U.S. Cooperative Alliances. Journal of International Business Studies. 1996, 27(5): 981-1004.
[12] Ma Yayan, Wang BaoYun. Improving wireless security for cooperation of untrusted secondary transmitters. International Journal of Security and Its Applications, 2016, 10(1):1-12.
[13] Vito Albino A, Garavelli C. Knowledge transfer and inter-firm relationships in industrial districts: the role of the leader firm. Techonvation.1999, (19): 53-63.