THE ANALYSIS OF THE INTERNET-OF-THINGS INDUSTRIAL CHAIN BASED ON HYPERCYCLE THEORY

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Abstract: This paper analyzed the development characteristics of China's internet-of-things industrial chain based on hyper cycle theory. It considered the development of the internet-of-things industrial chain as the result of hyper cycle, just like the origin of life. After that, it analyzed the development status of this industrial chain and the mechanism of its hyper cycle structure. After all, the internal and external factors had been explored in order to provide some reference for the development of the internet-of-things industrial Chain in China.

1 INTRODUCTION

The internet-of-things is to connect all the objects with the internet by RFID and information sensing devices such as barcode. Its ultimate purpose is to reach the goal of identifying and managing wisely. Besides RFID technology, the sensor technology, nanotechnology, intelligent terminal technology will also get more extensive application (Wei Liu et al. 2010). In China, the development of the internet-of-things is still in the early stage and there is still no uniform and standard definition about it.

The establishing process of China's internet-of-things industrial chain can be considered as the forming process of an organism. The current domestic research of the internet-of-things mostly concentrated in the technical level. For its industry chain is seldom researched. This paper analyzed the internet-of-things industry chain based on the hyper cycle theory. It can provide theory foundation for the policy making and strategic plan of the internet-of-things industrial chain.

2 THE PRESENT DEVELOPMENT SITUATION OF CHINA'S INTERNET-OF-THINGS INDUSTRIAL CHAIN

The concept of 'internet-of-things' is based on the premise that using RFID, intelligent terminal technology to identify the objects and using network to undertake data exchange. And then it has been constantly extended and perfected.

In China, the development of the internet-of-things is in the initial stage and domestic manufacturers have just realized some small range of applications such as Electronic Toll Collection (ETC).

However, there are still a series of problems in China's internet-of-things industry chain development. For example, the development of each unit on the industry chain is imbalance. Also, there are obvious differences in the order of obtaining profit and the future development space. What's more, the leader of the industrial chain is not clear and external support is not enough. These problems need further and in-depth analysis in order to explore effective and reasonable solution.

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3 THE SELF-ORGANIZING FEATURE OF THE INTERNET-OF-THINGS INDUSTRIAL CHAIN

Self-organization means that various components of the system interact and cause the system to achieve the development of natural evolution without the pushing of external forces. The hyper cycle theory in the self-organization theory system can be used to analyze the development process of industrial chain. And that can provide some reference for the problems such as the composition of the industrial chain, the value chain in the industrial chain, etc.

Firstly, the formation of a self-organizing system needs 5 main conditions: the system is open; the external input reaches a certain threshold; the system is far from equilibrium; the system is a nonlinear system; the system faces fluctuation. (Guangming Zhang et al. 2010)

(1) The openness of the internet-of-things industrial chain

The development of China's internet-of-things industrial chain started evening compared with developed country. So we should continuous learn the advanced experience and technology from the other countries. So it is obvious that the internet-of-things industrial chain system is open.

(2) The external input reaches a certain threshold

The research on China's internet-of-things industrial chain now emphasizes on technical level. And the research on something beyond technology such as the privacy security, legal protection and the public approval degree is far from enough. Only when the external input reaches a certain threshold can the internet-of-things industrial chain system reach an orderly state, and realize a stable development.

(3) The system is far from equilibrium

The development of the units in the industrial chain is not balanced. For example, the number of the enterprises who manufacture application equipment and provide the system integration is large, while the links of chip designing and manufacture as well as software application and development is relatively weak. Anyhow, the difference between units in the industrial chain fully explained its character of far from equilibrium.

(4) The system is a nonlinear system.

The development of the internet-of-things industrial chain is not the simple algebra addition of the technology and service of every enterprise in the industrial chain. The function inside the internet-of-things industrial chain is nonlinear and can emerge new qualitative.

(5) The system faces fluctuation

Fluctuation is the random disturbance on the system and its structure. Only by enlarge the function of fluctuation and create "giant fluctuation", can the system break the bondage of original inertia and bring about qualitative change. (Guangming Zhang et al. 2010)

Judging from worldwide, the development of the internet-of-things is imbalance. Europe and Japan-Korea countries are in the lead, while many developing countries are just in the beginning stages. So, the exchanges between counties will create a "giant fluctuation".

All in all, the internet-of-things industrial chain has the feature of self-organizing. In the next step, the author will use the hyper cycle theory, which is a kind of self-organized theory, to analyze the industrial chain specifically.

4 THE HYPERCYCLE EVOLU-TIONARY PRINCIPLE OF THE INTERNET-OF-THINGS INDUSTRIAL CHAIN

4.1 The Evolutionary Principle of Hypercycle

The hyper cycle theory stated that the origins and evolution of life is realized through the form of hyper cycle organization. The formation process of hyper cycle organization is as follows:

I_1 and I_2 are replicators which are closed and quantitative. The replicate enzyme of I_1 is $E_1$and the one of I_2 is E_2. Their replicate enzymes can recognize the two DNA sequences which have a bit difference. They are more conducive to replicate either itself or the opposite side just because the close degree in which their replicate enzyme and DNA sequences combine is different. There are 4 coupling way between the two replicators and their replicate enzymes.

If E1 can help to catalyze the self-replication of I1 and can help to catalyze the self-replication of I2, the competition between them is enhanced. Even I_1,

I_2, E_1, E_2 is said to be in equilibrium, this balance is fragile. And the result is 'Survival of the fittest or Survival of the luckiest'. (Figure 1(a))

If both E1 and E2 are more suitable to catalyze the self-replication of I1 (I2) than I2 (I1), the result is the self-replication of I1 (I2) is enhanced and the self-replication of I2 (I1) is weakened. (I1) will be replaced by I1 (I2) in the competition. (Figure 1(b), Figure 1(c))

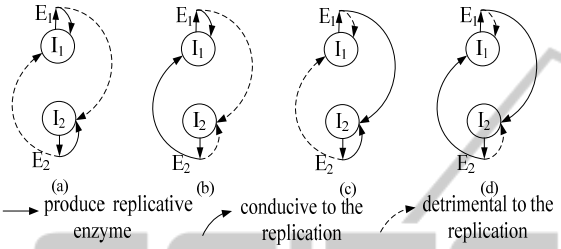

Figure 1: The interaction forms between replicators and replicate enzyme.

However, if E1 can help to catalyze the self-replication of I2 and can help to catalyze the self-replication of I1, there will be no winner in the competition between I1 and I2.Both of them are forced to cooperate. The system which is composed of replicators and replicate enzymes ultimately develops the coupled mode of self-enhancement and mutual enhancement and forms the two-unit hyper cyclic structure.(Figure 1(d)) Only in this way of hyper cycle can the organism be formed. After that, the mutant of I1 called I1'may appear.(Figure 2(a)) If E1' is more helpful for I_1 to replicate than E2, or for I1 and I2 to replicate, the mutant I1' will enter the hyper cycle as I3. With the increasing emergence of aberrance and natural selection, more and more replicators can generate nonlinear interaction by functional coupling, form complicated multi-unit hypercyclic structure.

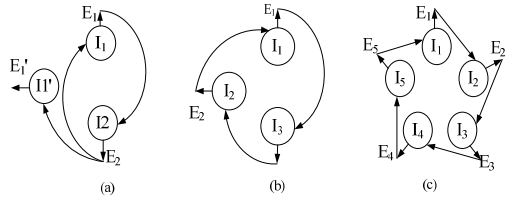

Figure 2: The forming process of the multi-unit hypercyclic structure.

4.2 The Characteristics of the Hypercycle Structure of the Internet-of-things Industrial Chain

The formation and development of the internet-of-things industrial chain has the characteristics of self-organized. If we regard the industrial chain as living organisms, then the units in the industrial chain are the replicators of the organisms (I_i in the hyper cycle structure).Every replicator replicate in order to enhance and consolidate its status in the internet-of-things industrial chain. If there appears the mutant I_1' in the process of aberrance, that means new units has joined in the industrial chain. As long as the units want to keep its status in the industrial chain, they must play their core superiority as well as they can. And they may affect the value creation of the others through function coupling. That is the coupling effect created by the self-enhancement and mutual enhancement between replicators and replicate enzymes. But there is a little difference between living organisms and the industrial chain. That is, the purpose of the organisms is to form a life, while the purpose of the self-replication and coupling of the units in the industrial chain is to create value.

The simulation relationship between the internet-of-things industrial chain and organisms is as follows:

Table 1: The simulation relationship between the internet-of-things industrial chain and organisms.

the hyper cycle structure of organism	the internet-of-things industrial chain
replicators which are closed(RNA)I_1,I_2	The units in the industrial chain. Such as RFID & sensor provider, the internet-of-things operator.
Replicate enzymes(information encoded by RNA)E_1,E_2	The core technology, profitability, business level, innovative ability, cooperation inclination of the units in the industrial chain.
Replication of replicators	The units manage its own core technology and try technology innovation and business expansion.

Table 1: The simulation relationship between the internet-of-things industrial chain and organisms (Cont).

Replicate enzymes is helpful for the self-replication of replicators	The units try to achieve a favorable development by using its own comprehensive strength and the information obtained from the external.
Replicate enzymes is more helpful for the other replicator to replicate	If the technology innovation and information of one unit is helpful for the development of another one, then they can promote each other by information sharing, communication and cooperation.
The aberrance of replicators (there appears the mutant of I_1 called I_1')	New unit wants to join the industrial chain. It can either perfect the function of the industrial chain or form a contrast competition relationship with a certain unit.
The aberrance is meaningful. In other words, the replicate enzyme of I_1'is more helpful for I_1 to replicate than E_2. In this case, I_1'will become I_3 and it can join the hyper cycle structure.	If the technology and professional ability (professional software products) of the new unit I_1' can meet the needs of I_1 (operators and service providers) and it is more conducive to the cooperation with I_2, then I_1' will join in and form a better structure.

5 THE ANALYSIS OF THE HYPERCYCLE STRUCTURE OF CHINA'S INTERNET-OF-THINGS INDUSTRIAL CHAIN

5.1 Internal and External Analysis

Firstly, analyze from the perspective of the units inside the industrial chain. The communication network industrial chain can be regarded as a relatively stable hyper cycle structure. All the units in the industrial chain can be regarded as close replicators in this hyper cycle structure. They use their own replicate enzymes (core technology, profitability, business level, and innovation ability, cooperation orientation) to catalyze the self-replication and mutually enrich. Along with the development of the internet-of-things, besides the original demands in the communication network industrial chain, there exists new demands such as internal technical demand, external policy demand and environment support.

Driven by the new demands, the units in the industrial chain begin corresponding technical innovation and business expansion. They try hard to meet these needs and improve its status in the industrial chain. At the same time, relevant enterprises outside the industrial chain (including domestic and abroad) hope to join this emerging industry chain relying on its technical superiority and to obtain corresponding interest distribution.

In this process, on the one hand, communication module providers and operators use their own replicate enzymes (core technology, profitability, and business level, innovation ability) to catalyze the self-replication and aberrance. On the other hand, there existed the mutant of the original replicators from outside the industrial chain, such as RFID & sensor providers.

5.2 Problems

To the current situation, both the internal units and the external environment are quiet incomplete and unstable, for instance:

(1) The Lack of dominant. The development of any industry must depend on the convergence and coordination of all units in the industrial chain and reasonable distribution of benefits. So, to achieve good development of internet-of-things industrial chain, there must be a dominant to promote the development of the whole industrial chain. Now，there is still no dominant in the internet-of-things industrial chain.

(2) The development of the units in the industrial chain is unbalance and the coupling capability between them is weak. This mainly reflected in the RFID technology. Low-frequency RFID technology is more mature while UHF and microwave RFID lack of domestic technology. Links which need relatively high technological content such as IC design, software applications and development are relatively weak.

(3) The lack of support from the external environment. The current national policy guidance has been adequate. But relevant laws and regulations, security measures and public recognition are far from enough.

5.3 Suggestions

To conclude, for the current development of the internet-of-things industrial chain in our country, the investment and research should be strengthened in the following aspects:

(1) Determine the leader of the industrial chain. The leader of the industrial chain should have a considerable degree of control. On one hand，it should restrict the upstream equipment suppliers, on the other hand it should increase control through cooperation, specifically, in the form of purchasing products and services.

(2) Continue to strengthen the research in technology, especially in weak links such as chip technology and related interface standards.

(3) Establish the reasonable mechanism for cooperation and competition, and also the mechanism for profit distribution. The mechanisms should have the function of helping the units to do the self-replication. At the same time, the replicate enzymes are complementary. It means that the units can achieve co-evolution by exchange of information and complementary of resources.

(4) The formulation of related laws and regulations is important, so is the research on safety and security program. Also, it is necessary to increase the propagandas among the public.

6 SUMMARIES

According to the analysis, the internet-of-things industry chain in China is constitute of RFID and sensor technology provider, communication module provider, middleware provider, system software integration provider and internet-of-things operators. Then, it analyzed the hypercycle structure of both the internal units and external environment. In this way, it deeply analyzed the problems existing. Such problems have the following impact: Firstly, it can affect the self-replication of the units in the industrial chain. Some units, especially the technology provider, may be affected for the lack of effective replicate enzymes, for example, technical standards. Secondly, it can affect the coupling capability between the units in the industrial chain. This is has no good for the cooperation and competition between units. What's more, it can affect the ability of selection and mutation of the units. Such facts may bring about the threats of Information security.

To conclude, the development of China's internet-of-things industry chain can not only limits in terms of technology. It is also important to formulate relevant standards and regulations, determine the leader of the industry chain and strengthen the propaganda among the public.

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