BRIEF ANALYSIS ON PROFITS ALLOCATION OF IOT INDUSTRY CHAIN

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Abstract: The development of Internet of Things (IOT) is in its infancy in China, many key technologies and core problems of the industry chain are not resolved, including how to allocate profits of companies on the industry chain to promote the development of the whole industry is important. This paper analyzes the IOT industry chain under the model dominated by Chinese Telecom Operator, and put forward the basic principles of the benefits distribution and proposes own view on the whole industry chain in the distribution of interests of all parties by using the Shapley-value model.

1 INTRODUCTION

The "Internet of things" is going popular in China, many areas with government support, strongly build industrial park of IOT, however, the domestic research on the Internet of Things is still in the initial stage, most researches like all business areas in Chinese market have the problem of "important hardware, less software", as the situation is often a talk about IOT is the sensor, chip, RFID, communications modules and other technologies, and the researches on development of industry and industry chain as a whole are very few. Therefore, a full understanding of the structure of IOT industry chain, coordinating upstream and downstream business activities in industry chain, potential customers of the classification, definition, needs analysis as the core, diversification of production, personalized information products, to expand the services market , to bring more revenue for the members of the industry chain than the previous collaboration, those are significant.

To maintain sound and stable industrial chain, the distribution of benefits is the key, if the distribution of benefits on the industry chain is not fair; it will affect the enthusiasm of cooperation and partnership and could even lead to failure. Thus, in the initial stage of IOT in China, we should adhere to the principle of fair and equitable, considering the investment of core business (such as telecom operators, system operators) in the industrial chain as well as to take the risks, to establish a rational profit distribution mechanism , balanced the interests of members of the industrial chain business , so that the members can fully share the incremental benefit of the industry chain, stabilizing relations of cooperation, optimize the industrial chain.

2 INTERNET OF THINGS INDUSTRY CHAIN

2.1 Definition

The paper "Internet of Things" is called the third wave of the world information industry, following the computer and the Internet. Early in 1999 China put forward the "Internet of Things" concept, but instead it was called sensor network is not called "Internet of Things." November 27, 2005, in Tunis Summit on the Information Society, International Telecommunication Union (ITU) released the "ITU Internet Reports 2005: Internet of Things", formally proposed the concept of IOT. Internet of Things is based on the computer, the use of RFID, wireless data communications technology, to construct internet of things covered everything in the world. In this network, the Goods (commodities), and between objects, people and goods can all "communicate" with each other. In actually it uses radio frequency identification (RFID) technology, through the computer internet realized goods (products) of the automatic identification and interconnection and

sharing of information.

Industry chain is a kind of vertical Strategic alliance relational chain, in which the relevant enterprises in different industries products, technology and capital as the link with the value added in a certain geographic area. Different scholars give a different definition of different chain, but one thing is consistent point of view, that within the specific industry chain, in all aspects of the industrial chain the close alliance and collaborative relationship, and midstream and downstream industry links, even the entire life cycle, are ultimately designed to meet consumer demands.

IOT in their own development, led the microelectronics, sensing devices, automatic control, machine intelligence, intermediary services, systems integration and a series of sustainable development of related industries, bringing huge industry cluster effect, and form a unique IOT chain. IOT chain refers to the economic activities of IOT, based on the inherent economic and technological relations, the relevant enterprises linked together, end-to-end forming the interlocking chain structure. The formation is not only to make his related companies value added, the value of industry chain is greater than the overall value of various enterprises, but also make things a sustainable development.

In short, the formation of the industrial chain of IOT, their value added, can be able to achieve the purpose of "win-win" and sharing risk.

2.2 Structure and Relationship of IOT Industrial Chain

IOT are divided into three components: perception layer (providers of sensor information or services that base on sensor information), transport layer (intermediates who provide the market platform to connect providers and customers), application layer (consumers querying information).However, the division of the industrial chain of IOT does not correspond to them. The participants are the sensor equipment suppliers, sensor information providers, content providers, system integrators, network operators, terminal providers, users and so on. Among them the telecommunications network operators have the source of valuable customers and operational support platform, then become the core of the industrial chain.

IOT needs a broad network of industry applications, but the development of industries are not balanced, as a whole, IOT industry in china is still at an early stage, technologies, standards, products, and market are all not mature, there are
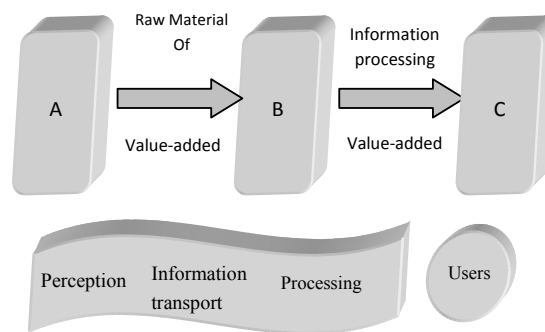

Figure 1: Structure diagram of IOT industry chain. A stands for sensor supplier; B stands for network operator; C is for system integrator.

many problems in the Internet of things industry chain, one of them is that profits distribution of the members affects the stability and improvement of the industrial chain, and restricts the creation and increase of the overall value in the industrial chain. The following section will specifically discuss the content of the interests distribution of the industry chain.

3 THE RELATIVES OF BENEFITS DISTRIBUTION IN IOT INDUSTRY CHAIN

3.1 The Theoretical Basis of the Benefits Distribution

Enterprises stakeholder theory referred to as "stakeholder theory", the theory holds that every enterprise can not develop without the input and involvement of various stakeholders. In the search for their own interest, other stakeholders' interests could also be taken into account. In the chain, every enterprise contributes their core competence to the collection of information of products, contents, services and so on, and links together to achieve resource sharing, risk sharing, control the market demand and aims at "win-win".

3.2 Interests Allocation Relations among the IOT Industry Chain

Enterprises in the industrial chain stays in interest alliance, mutual influence, mutual development, interdependence, among them there are highly dependent on the needs of the chain, through information products, technologies or services to associate the enterprises. Companies (network

operators, system integrators, etc.) in the downstream industry chain, only a few, basically have a monopoly. For there are a lot of similar companies, suppliers are in the fierce competition, the product demands of upstream and downstream enterprises are very important for suppliers, if not demands for its products, supplier may be closed, while the information products of suppliers are also very important to downstream enterprises, and are the existence foundation of the market.

In industry chain enterprises are independent stakeholders, the distribution of benefits between them need the price of intermediate information product flowing on in the chain. Sales revenue of perception layer is the cost of the downstream businesses, the former companies would want intermediate products to have the higher price, the better will be. The latter is the reverse, which wants the prices as low as possible; there is a game relationship between them.

3.3 The Principles of Benefit Distribution in IOT Industry Chain

In the industry chain of IOT, it is known that the link of network operators is more mature, whose advantage lie in operations support platform and client resources, can act as the organizer of the industrial chain, IOT is providing a turning point in the development of network operators, they no longer satisfy with the information plumber's role, using their own advantage actively to improve and perfect the industry chain. Now we mainly talk about some principles of the benefits distribution under the network operator-led model in IOT industrial chain.

* Equality and Justice

Equality and justice are the basic principles of the benefits distribution of IOT industry chain. The management equity theory tells us that enterprises in the chain not only concern about the interest increase of their own, but also concern about the benefits increment of the relatives, in order to determine the reasonableness of their own interests acquired. It greatly affects the basis of stability in the entire industry chain. As the core business, network operators should regulate the interests-flow reasonably in the chain, avoiding too little interests for sensor suppliers, frustrating the enthusiasm of suppliers, then affecting the fundamental things of the formation of IOT.

* Incentives for Suppliers

It is necessary to establish incentives for information suppliers. At present it is in its infancy for IOT development, industrial chain links are not perfect, there are various key technical issues, For example, and the sensor ports are not unified in the phase of WSN. For that it will need to pour into many funds and undertake high risk in developing core technologies, generally suppliers can not afford, and require the support and guidance of network operators.

* Initial Price must be Low

The key problem of benefits distribution is about pricing intermediate product, which mainly divided into three categories: the negotiated transfer pricing, the market transfer pricing and the cost of transfer pricing. The pricing of Information products is different from that of traditional commodities; the pricing based on fixed costs is not established. Because of network effects, customers making access to the market of IOT will become more, and more information products used, greater the value of the product will be, then lower the cost. At one stage, information services may even be free and available to all consumers. When at low prices, the value of the product has to be increased, to attract more consumers to join and expand the market of IOT, and then create more value in the whole industry chain.

4 MODEL FOR THE DISTRIBUTION OF BENEFITS IN IOT INDUSTRY CHAIN

The enterprises on the chain have a win-win cooperation relationship; their problem is essentially a matter of cooperative game interests' distribution. This paper will carry out a study into benefits distribution of the participants in the chain with Shapley- value, then to establish the model of benefits distribution.

In game theory, Shapley -value model was presented by Shapley In 1953, describes one approach to the fair allocation of gains obtained by cooperation among many actors, and has wide application prospects in cost distribution for many participants. The basic premise is as follows: a coalition of actors cooperates, and obtains a certain overall gain from that cooperation. When people have non-antagonistic activity of the interests, the cooperation does not cause the increase in the number of benefit reduction. For example, a piece of

cake, more big, if add more people, although less share, but there is an increase in the cake.

The cooperation of all n individuals should bring the greatest benefits, in a cooperative game among the enterprises; each enterprise shall deserve their share. Since some participants may contribute more to the coalition than others, the question arises how to distribute fairly the gains among the participants. Or phrased differently: how important is each player to the overall operation, and what payoff can they reasonably expect?

We start out with a set I (of n players), S (S is disjoint subsets of I and it is super additive.) and a function V, that goes from subsets of players to real's and is called a worth (or value) function, with the properties.

$$v(\Phi) = 0 \tag{1}$$
$$v(S1 \cup S2) \geq v(s1) + v(s2), s1 \cap s2 = \phi \tag{2}$$

The interpretation of the function v is as follows: if S is a coalition of players which agree to cooperate, then v(S) describes the total expected gain from this cooperation, independent of what the actors outside of S do. The super additivity condition (second property) describes the fact that collaboration can only increase the benefits but never hurt in a cooperative game.

$$\sum_{i=1}^{n} x_i = v(I), i = 1, 2, \ldots n \tag{3}$$

$$x_i \geq v(i), i = 1, 2, \ldots n \tag{4}$$

Where: x_i is the share of i player from the maximum benefit of the cooperation v (I), clearly, the successful cooperation must meet the above requirements. The function (3) is called collective rationality conditions; the sum of all the players' value should equal the maximum available from the game.

v (I) must be splitting. Otherwise the players will not agree. Also, the distribution of the total can not exceed total benefits, or distribution would be a "blank check". These two cases both meet this function: $\sum_{i=1}^{n} x_i \leq v(I)$.

Function (4) is called the individual rationality conditions. We can understand that if player obtains less in cooperation than it did alone, obviously, it will not participate in the IOT industry chain.

When $i \in s \subset I$,

$$v(s) = v(s - \{i\})$$ is set up ,

Then

$$\phi_i(v) = 0 \tag{5}$$

This means that no contribution, no benefits. S_i is disjoint subsets of I and contains player i.

$\phi_i(v)$ is the amount that player i gets if the gain function v is being used. The Shapley-value is given as follows:

$$\phi_i(v) = \sum_{s \in s_i} w(|s|)[v(s) - v(s \setminus i)], i = 1, 2, \ldots, n \tag{6}$$

$$w(|s|) = \frac{(n - |s|)!(|s| - 1)!}{n!} \tag{7}$$

$|s|$ is the number of players in the subset s. v(s) is the amount of utility that the players of coalition s can obtain from the game. $v(s \setminus i)$ means the gains of coalition s without i players. $w(|s|)$ is weighted gene.

The distribution of benefits based on Shapley-value model is neither the average distribution, but also different from the distribution of proportion of investment costs, but on the importance to be assigned a distribution produced in the process of the overall profits in the IOT industry chain. In comparison, the method has certain rationality and superiority. However, this method also has some limitations in considering the relationship among enterprises, whose affection is not deep enough.

5 EXAMPLE ANALYSIS

Consider an industry chain of IOT, forming by three companies A, B, C, A is provider for the sensor, B is the telecom operator, C is the system service provider.

Let A, B and C have 5, 10, 6 million RMB.

The coalitions $\{A, B, C\} = 30$ million RMB; $\{A, B\} = 20$ million RMB; $\{A, C\} = 15$ million RMB; $\{B, C\} = 22$ million RMB.

If the total profits divided equally, each firm gains 10 million. Clearly, this method can not inspire the parties, especially for B Company, the interest did not increase, therefore, may be unwilling to join the industrial chain. How to allocate 30 million reasonable? The Shapley value method will give us the answer.

We say that the coalitions $\{A, B, C\}$ is I= {1, 2, 3}, And note independent business profit v (1) = 5, v

(2) = 10, v (3) = 6. The value of a coalition S = {1，1 U 2，1 U 3，1 U 2 U 3} is the sum of parties for the efficient allocation when the set of participating agents must include 1.From the above, we can know v (1 U 2) = 20, v (1 U 3) = 15, v (2 U 3) = 22, v (1 U 2 U 3) = 30. Grinding through the Shapley value calculation (see the third section), the value of the B enterprise distribution of benefits is calculated as follows:

Table 1: Shapley- value calculated.

s_2	{2}	{1,2}	{2,3}	{1,2,3}
v(s)	10	20	22	30
$v(s/2)$	0	5	6	15
$v(s)-v(s/2)$	10	15	16	15
$w(|s|)[v(s)-v(s/2)]$	10/3	5/2	8/3	5

$$\phi_2(v)= \sum_{s \in s_2} w(|s|)[v(s)-v(s \setminus 2)] =13.5$$

Similarly we can easily get $\phi_1(v)$ =7.5 million, $\phi_3(v)$ =9 million. Finally, we get the allocations of A, B, C which add up to the entire 30 million.

The share of three enterprises is greater than the interests of their individual production or greater than any gain from the two co-production, that is ,greater than the overall effectiveness of their production and operation of a gain, which is not only the basis of stability of industry chain, but also the reason why we should establish the industry chain of IOT.

We set the initial data by analyzing the importance and risks taken by the players and other factors. With the development of the industrial chain, the distribution of benefits will gradually be clear and data oriented. In short, the construction of the industrial chain of IOT is very important, and the reasonable profits allocation is the foundation of the development of the chain.

6 CONCLUSIONS

This paper analyzes the relationship and interaction among various enterprises in the IOT industrial chain. In order to promote the collective interests and to resolve the distribution of benefits in the industry chain, product pricing from the middle of a detailed analysis of the distribution relationship between the interests of enterprises then establish the distribution of benefits with Shapley-value model, further analysis positive relationship between distribution benefits and contribution of participants in industry chain. Besides, the distribution of benefits should follow the principles as put forward, there is some reference significance.

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