

Strategy of Intellectual Property Right for the Internet of Things: How IPRs Strategy Adds Value?

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Abstract--The Internet of Things are thought to be the third wave of IT-driven competition, which is expected to be a much bigger revolution than the past two waves, computer and the Internet. As IoT involve multiple technologies, and intellectual property rights (IPRs) are especially important for industries involving multiple technologies, firms shall develop a proper IPRs strategy to gain the rent that a firm deserves.

This research aims to analyze the IPRs strategy for value creation of the IoT industry. Patent strategy based on theories of Granstrand, Fisher III & Oberholzer-Gee and Reitzig are integrated, with the possibilities of securing freedom to operate or to share/license the IPRs. A questionnaire is used and interviews are carried out with IoT firms to evaluate and formulate practical IPRs strategies.

This paper identified IoT competition as between alliances and standards, and that a proper IPRs strategy needs to be tailored according to such competition and each individual firm's condition.

I. INTRODUCTION

Though the forecasted global Internet of Things [1] market can be as high as \$11 trillion in 2025, there are challenges to be overcome such as inadequate security protections, limited customer demands, a lack of consistent standards and fragmented markets [2]. The IoT markets can be niche with low volume, and the current industry players may not be able to rely on the present business model, but they have to explore new ways to become profitable [2].

The distribution of IoT patents is very fragmented, with the top filers account for only about 5% of the total patents. This could mean the industry players will need huge amount of cross-licensing, merge/acquisition or collaboration [3], and this may cause extra costs, delay of schedule and/or risks of

litigation.

At this stage of IoT development with the ambiguous industry future mentioned above, it is necessary for the industry players to formulate suitable strategies to ensure foothold from the beginning. IPRs strategy will be one of the important strategies to be implemented.

There have been many discussions about how to formulate IPRs strategies [4-11]. This research aims to review these discussions and formulate the IPRs strategy for the IoT industry for value creation.

In this paper, the strategies of Granstrand [7], Fisher & Oberholzer-Gee [6] and Reitzig [12] are integrated to formulate practical IPR strategies for the IoT industries.

II. LITERATURE REVIEW

A. Internet of Things

Internet of Things [1] have been termed in different ways - the Cloud of Things (CoT), Industrial Internet, Internet of Everything, Web of Things, Machine to Machine (M2M), Smarter Planet, and Digital Life [13].

IoT are also called smart objects which are consisted of different technologies as shown in Figure 1 [14].

Some define the essential IoT technologies as including radio frequency identification (RFID), wireless sensor network (WSN), middleware, cloud computing and IoT application software [15]. Specifically, the semiconductors to be applied in IoT can include microcontrollers, sensors, connectivity, and memory, and in addition to these are technologies such as network, servers, and system integration [2].

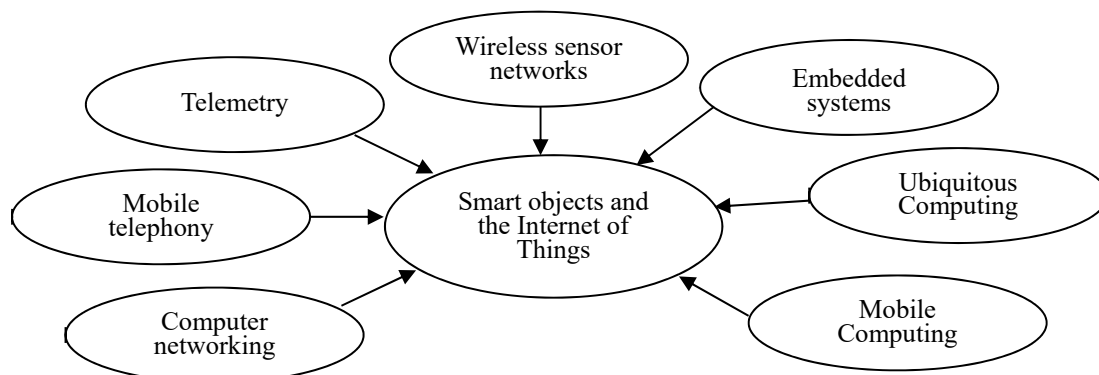


Figure 1 Smart objects are the intersection of embedded systems, ubiquitous computing, mobile telephony, telemetry, wireless sensor networks, mobile computing, and computer networking.

Source: Jean-Philippe Vasseur, Adam Dunkels, Interconnecting Smart Objects with IP - The Next Internet, Elsevier Inc., USA, 2010

TABLE 1: DEFINITIONS OF INTERNET OF THINGS

Source	Definitions
International Telecommunication Union, 2012	A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.
Mattern & Floerkemeier, 2010	Communication and cooperation, Addressability, Identification, Sensing, Actuation, Embedded information processing, Localization, User interfaces.
Porter & Heppelmann, 2014	Smart, connected products include physical components, smart components, connectivity components, and there are three forms of connectivity: one to one, one to many, and many to many.
Sundmaeker, Guillemin, Friess, & Woelfflé, 2010	Internet of Things is an integrated part of Future Internet and could be defined as a dynamic global network infrastructure with self configuring capabilities based on standard and interoperable communication protocols where physical and virtual “things” have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network.
Vasseur & Dunkels, 2010	An item equipped with a form of sensor or actuator, a tiny microprocessor, a communication device, and a power source.

More definitions of IoT are shown in Table 1. So far there’s no consensus on the definition of IoT, this paper defines IoT as broad applications of technologies and components that are interconnected with existing and evolving interoperable information and communication technologies [16]. On the other hand, such definition can be expressed as “an item equipped with a form of sensor or actuator, a tiny microprocessor, a communication device, and a power source.” [14].

According to a McKinsey MGI report, IoT may cover six most promising markets: wearable devices, smart-home applications, medical electronics, industrial automation, connected cars, and smart cities [2]. It is estimated that there are more than 7 to 10 billion connected devices around the world now, and this number is expected to increase to 26 billion to 30 billion devices by 2020, and a potential global

economic impact will be \$4 trillion to \$11 trillion in 2025 [17].

Though the forecast is optimistic about the development of IoT, lacking innovative and unique solutions for a successful business model may be a fundamental for IoT firms. Further, IPRs strategy is considered an important part of business and technological strategy [7], it is necessary for IoT industry players to develop a proper IPRs strategy to ensure competitive advantage of the firms.

B. IPRs Strategy

IPRs in this paper are considered as patent, trademark, copy right, industrial design and trade secret.[18]

There have been plenty of discussions about formulating IPRs strategies [4-11], these IPRs strategies are summarized and discussed from several perspectives as listed in Table 2.

TABLE 2: IPRS STRATEGIES

Scholars	Focus of IPRs Strategy
Fisher III, W.W. & Oberholzer-Gee, F.,2013	IPRs Strategy: 1. Offensive: exercise market power, sell, license, collaborate, donate 2. Defensive: assert a legal privilege, develop an alternative, get permission, détente, rapid dissemination
Granstrand, O., 1999	1. Patent Strategy: Ad hoc blocking, strategic patent searching, blanketing and flooding, fencing, surrounding, and combination into patent network. 2. Secrecy strategy 3. Trademark strategy 4. Multipleprotection strategy: trade secrets, patents, copy right, designs, open information/prophylactic publishing and mask work protection
Nystrøm, H, as cited by Reitzig, M. in 2007	An integrated IP strategy should theoretically span the entire “IP value chain” - from the generation of intangible assets in departments such as research and development to the protection of intellectual property in patent and legal departments and finally to its use by enforcement lawyers, branding specialists and licensing professionals.
Peters, T., Thiel, J. Tucci, C. L., 2013 Reitzig, M., 2007	Strategic disclosure 1. IP management at the the business-unit: The integration of patent- and trademark-related considerations in decisions that involve creating competitive advantage, choosing the scope of strategy, differentiating products, setting barriers to entry and managing vertical competition. 2. IP management at the top-management level: Overarching and long-term considerations such as the choice of future R&D trajectories, the management of corporate reputation and the coordination of cross-area tasks related to IP. 3. IP strategy today should theoretically encompass the entire “IP value chain” of a company — from IP generation to enforcement — and should involve the corporate, business-unit and functional levels of the organization.
Somaya, D.	Domains: rights, licensing, enforcement Strategic Management of patents: Patents as real options; Signaling and information disclosure; Nonmarket strategies; Patent management capabilities

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Granstrand's IPRs strategy is formulated by observing big Japanese companies and by taking technology space and product/technology life cycle at the patent portfolio level. Strategies of secrecy, trade mark, and an integrated multiprotection have been proposed as well. As a rule of thumb, IPRs strategies of different combinations shall be evaluated against conditions of the firms [7].

From a management point of view, IPRs strategies can be devised to help managers better manage the IPRs and thus gaining competitive advantages [10, 12].

IPRs strategy can also be formulated from the legal perspective as offensive strategies for IPRs owners and defensive strategies for non IPRs owners as listed in table 2 [6].

In addition to owning or not owning the IPRs, strategic disclosure can be considered as a part of an integrated IPRs strategy. Such disclosure may save the costs bundled with patent filing and maintenance, make it more difficult for competitors to apply patents related to that information, and at the same time discourage competitors from entering the same research area. By strategically revealing just enough information firms may still keep the research secret and file their own patents [19].

C. IPRs Policy of IoT Alliances

The IoT firms have been forming alliances to consolidate standards to enable interoperability of the devices and services. Among them, 6 largest ones currently are OIC (Open Interconnect Consortium), AllSeen, IIC (Industrial Internet Consortium), OneM2M, Thread Group and Apple HomeKit.

Each alliance has an IPRs policy to allow its members to grant the copy right of their contribution to the alliance or to prevent patent assertions among alliance's members. The only exception is Apple HomeKit, an IPRs policy or agreement similar to those of other alliances is not found on the Apple web page. A summary of the IPRs policies of these alliances are listed in table 3.

OIC, IIC, OneM2M and Thread Group apply a RAND (Reasonable and Non-discriminatory) /RAND-RF (Royalty-Free) principle for the alliance IPRs policies, and AllSeen has the open source principle according to OSI (Open Source Initiative). AllSeen's Alliance Contribution Agreement requires the members to grant the copy rights of their contributions to the Alliance, and the Alliance will grant back the copy rights of modified contributions to the members. And, for example, patent non-assertion principle is requested by AllSeen to its members.

TABLE 3 IPRS POLICIES OF IOT ALLIANCES

Alliance	Documents	IPRs Policy	Data source
OIC (Open Interconnect Consortium)	Intellectual Property Rights Policy Section 3	Limited patent license grant; Reasonable and non-discriminatory (RAND) license obligation for excluded necessary claims	[20]
AllSeen	AllSeen Alliance Contribution Agreement Section 2	Copy right assignment/Copy right grant-back license Copy right license	[21]
	IP Policy	Outbound Distributions: release Alliance Code under the ISC License (Open Source Initiative) Inbound Distributions: all Contributions shall be made pursuant to the ISC license Conditional patent non-assertion pledge; permitted termination; open source principle according to OSI (Open Source Initiative)	[22]
IIC (Industrial Internet Consortium)	Intellectual Property Rights of the Policies and Procedures of the IIC Section 4.2 Section 4.5 Patents	Nonexclusive, irrevocable, sublicensable, royalty-free, paid up, worldwide license of copy right to members No patent license or rights are granted by any Member(s) to any other Member(s) or third parties. Joint copyright for type 1 partner; Joint trade mark; Open the intellectual property policy to other members; Partner Type 2 and oneM2M member contributing to the technical work of oneM2M shall grant a perpetual, worldwide, royalty-free, non-exclusive license to the technical contribution.	[23]
OneM2M	oneM2M Partnership Agreement Section 7 Annex 1 Intellectual Property Rights (IPRs) Principles Governing oneM2M Work Section 2 General Principles	"IPR" shall mean any intellectual property right conferred by statute law including patents and published patents applications All the Partners Type 1 of oneM2M have IPR policies that support a FRAND (Fair, Reasonable and Non-Discriminatory) IPR regime The Thread 1.0 specification will be contributed to the Alliance by the Founding Members.	[24]
Thread Group	Thread Group Intellectual Property and Confidentiality Policy Section 3	3.6 Each participant will grant every other Participant a RAND-RF License for the Thread 1.0 Specification. 5.5 Patent non-assertion against members	[25]

III. METHOD

A. Identification of the target IoT firms

In order to identify IoT firms that are active in engaging IPRs strategies, the authors tried to identify firms with high IoT patent filings, because patent is one of the IPRs which is open to the public. The authors searched the USPTO and TIPO (Taiwan Intellectual Property Office) patent databases, and patents with assignee country as Taiwan are selected. By further referring to the report of Intellectual Property Office, UK [26], the top 10 IPC subgroups of IoT technologies are applied to select companies with high patent filings under these subgroups. These subgroups are listed in table 4.

The IoT technology domain can be too broad to be covered by naming all the categories – the technologies can be applied to many areas, such as aerospace, automotive, health care, clothing, building, agriculture, home, consumer products, and, eventually, everything – but the backbone of all these applications are the ICT technologies. The technologies mentioned in the IoT patent analyses available

now [3, 26] are related to the ICT technologies too. On the other hand, this paper aims to cover the strategy development for all IPRs which is a broad domain in one research, to keep this research focused, the ICT technologies are taken as the center of the IoT IPRs without considering technologies beyond them, so the authors decided to apply those top 10 IPC subgroups to represent the IoT technologies in this paper.

By using a patent search program, MTrends, a list of about 500 companies with patent filings in the 10 subgroups is obtained. This list is provided to an expert at IEK, ITRI (Industrial Economics and Knowledge Center, Industrial Technology Research Institute) to help identify firms involved in IoT product development. At the same time the authors called 30 companies with top patent filings on the list and asked them to provide opinions about IoT IPRs strategy by filling out a questionnaire. Twelve companies agreed to look at the questionnaires, while six companies filled out the questionnaire. The background of these 6 companies is listed in table 5. The IoT technology categories listed in table 5 follow the categorization by LexInnova, a patent research firm [3].

TABLE 4 TOP 10 IPC SUBGROUPS OF IOT

IPC Subgroups	Description
H04L29/08	Communication control Communication processing → characterized by a protocol → Transmission control procedure, e.g. data link level control procedure
H04L12/28	Data switching networks → characterized by path configuration, e.g. LAN (Local Area Networks) or WAN (Wide Area Networks)
04L29/06	Communication control; Communication processing → characterized by a protocol
G06F15/16	Digital computers in general; Data processing equipment in general→ Combinations of two or more digital computers each having at least an arithmetic unit, a programme unit and a register, e.g. for a simultaneous processing of several programmes
G05B19/418	Programme-control systems → electric → Total factory control, i.e. centrally controlling a plurality of machines, e.g. direct or distributed numerical control (DNC), flexible manufacturing systems (FMS), integrated manufacturing systems (IMS), computer integrated manufacturing (CIM)
H04W84/18	Network topologies → Self-organizing networks, e.g.ad hoc networks or sensor networks
H04W4/00	Services or facilities specially adapted for wireless communication networks
G08C17/02	Arrangements for transmitting signals characterized by the use of a wireless electrical link → using a radio link
H04W72/04	Local resource management, e.g. selection or allocation of wireless resources or wireless traffic scheduling → Wireless resource allocation
H04B7/26	Radio transmission systems, i.e. using radiation field → for communication between two or more posts → at least one of which is mobile

Source: UK Intellectual Property Office Informatics Team [26]

TABLE 5 BASIC INFORMATION OF THE FIRMS INVOLVED WITH IOT PRODUCT DEVELOPMENT

Firms	Annual revenue	Category of IoT technology
Company A	More than USD330 Million	Wired networking ¹
Company B	Under USD 3 Million	Wireless networking ²
Company C	More than USD330 Million	Wireless networking ²
Company D	Under USD 3 Million	Wired networking ¹
Company E	Between USD150 Million to 210 Million	Control system, Power Management, Hardware - Circuits, Sensors
Company F	More than USD330 Million	Encryption ³

Note: 1. Wired networking: Communication protocol, Resource Management, Multiplexing Methods, Topology Management)
 2. Wireless networking: Resource Management, Topology Management, Communication Protocol, Multiplexing Methods, Radio Frequency Protocols, Baseband Processing)
 3. Encryption: (Error Correction, Data Security, Data Encryption); Memory Management (Information Retrieval)

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The first question in the questionnaire is grouped by 7 questions, they ask whether the companies protect technologies/products by combining more than one intellectual property right: trade secret, patent, copy right, trade mark, industrial design, disclosure/publishing, and cross-licensing. Each company can choose more than one answers in the questionnaire.

The responses were shown in fig. 1, all the firms protect their IP by patents, while 67% of the firms combine patents with trade secrets, 50% couple patents with trade mark or copy right, 33% with design/disclosure, while 17% combine with cross-licensing.

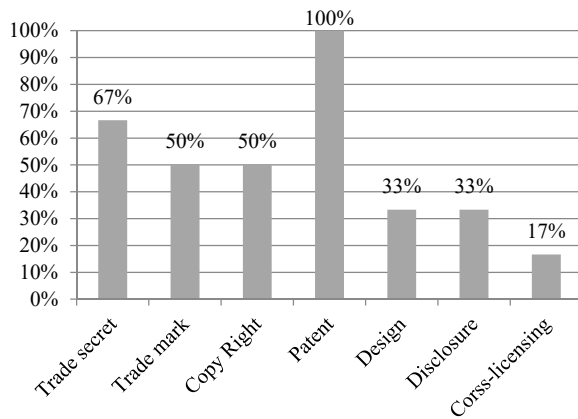


Fig. 1 Multiple IPRs Protection

The second question is about Granstrand's patent strategies as ad hoc blocking, strategic patent searching, blanketing and flooding, fencing, surrounding, and combination into patent network, the firms are asked if they apply similar patent strategy/strategies.

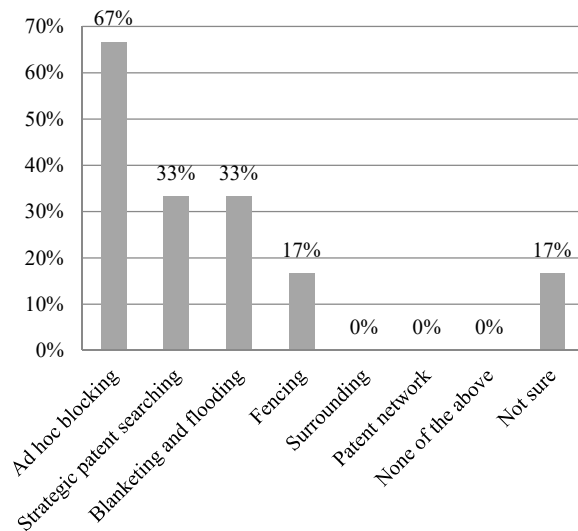


Fig. 2 Type of Patent Protection

As shown in figure 2, 67% of the companies answered with ad hoc blocking, 33% with strategic patent searching or

blanketing and flooding, 17% with fencing, while 17% is not sure. No company answered with surrounding or patent network. The result suggests that these companies use patents mainly for defensive purpose, there's no aggressive intention for offensive use to "attack" competitors' patents.

The 3rd question is about strategy of IPRs owner of Fisher III & Oberholzer-Gee (2013), whether the firms take similar actions as exercising market power, selling (IPRs), licensing, collaborating, or donating the IPRs.

As shown in figure 3, 67% of the firms replied they will exercise market power, while 17% replied with none of the actions and 17% is not sure. No company answered with selling, licensing, collaborating or donating. It seems these companies do not involve in complex activities to appropriate their IPRs, because there's no selling nor licensing in their options. But they will react with legal actions if there's infringement to their IPRs.

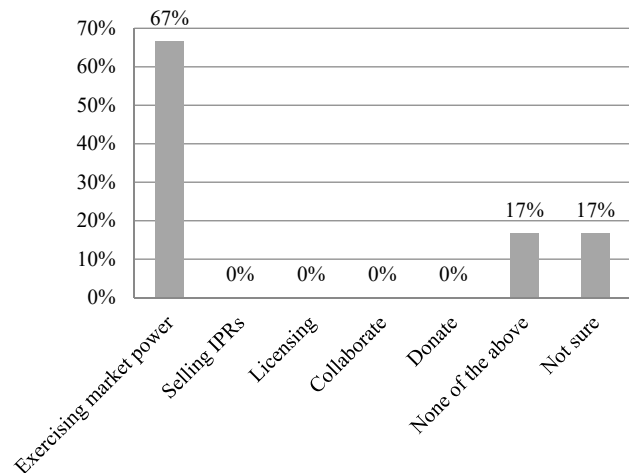


Fig. 3 Strategy of IPRs Owner

The 4th question is about non-IPRs owner's strategy of Fisher III & Oberholzer-Gee (2013), whether the firms take similar actions as asserting a legal privilege, developing an alternative technology, licensing the IPRs, détente, or disseminating a potentially infringing technology.

Figure 4 shows the answers of the firms. 50% will assert a legal privilege, 17% will develop an alternative technology or détente, while 17% is not sure. No company answers with licensing the IPRs or disseminating a potentially infringing technology. These answers suggest that the firms are not interested in paying for the IPRs licenses – they would rather claim that the patents are invalid or other firms have the legal power to use them. The firms prefer developing own technologies to design around. However, there's no intention to infringe IPRs either, as no firm would disseminate a potentially infringing technology.

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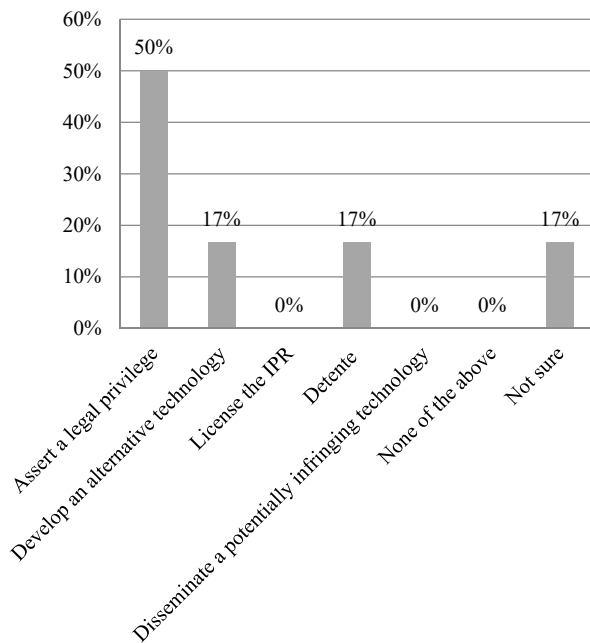


Fig. 4 Strategy of Non-IPRs Owner

B. Interviews

Five companies in the list of IoT patent filings were contacted, the CEO of company C accepted an interview regarding his company's IPRs strategy for IoT products.

Company C in Table 5 is specialized in technologies of wireless communication. It has more than 4,000 employees with an annual revenue of about USD500 million. The interview of the CEO was conducted in January 2016.

Company C has both legal department and IPRs department. Its IPRs department is in charge of handling IPRs related issues with external institutions. Internally this department is responsible for the IPRs policy and maintains the company's portfolio. It also works with the R&D department at the development stage to perform prior art search and patent applications, to a certain degree the IPRs portfolio is planned before the R&D development begins.

The company owns technologies that can be used for IoT applications, company C has been looking for the development of suitable IoT applications. To make sure the company will not fail in the product development, company C participates in as many IoT alliances as possible. It usually identifies competitors' IPRs in advance and tries to design around to avoid possible infringement or future litigation. At the moment, the IoT alliances the company attends offer certain technology standards for product development, therefore there's no urgent demand to acquire new technologies, hence the CEO assumes their IPRs portfolio now is sufficient for IoT products.

However, NPEs (None Practicing Entities) are problems as the company have confronted with and negotiated with them over the past years. The company had also experienced patent litigations or even "patent wars" with

competitors. These problems shall be settled with careful negotiations, and are not limited to only IoT products. They happen to all company's technologies and products.

Company C protects its IPRs by filing law suits when other companies infringe its patents. Such cases can usually be settled and therefore infringements have not raised big concern for the company.

One of the most challenging problems of IPRs is the protection of trade secrets – if experienced high-ranked employees were hired over by competitors, though some legal processes can be taken, there's almost no way to protect the trade secrets. Therefore, the communication with employees is very important, suitable measurements shall be applied to keep the important employees and the trade secrets in the company.

The CEO pointed out that the most important concern for IoT is the applications. Once the "right" applications are identified, the IPRs strategy can be formulated accordingly. In fact, Company C has been trying its best to look for applications which utilize standards so that no licensing fees are required.

On the contrary to company C's and to most firms' IPRs strategies, company G has an unique IPRs policy. Company G did not fill out the questionnaire, but its CEO agreed to an interview in January of 2016. Company G is a public company with specialized technology capabilities in developing industrial network applications. The CEO of company G pointed out that their policy is to avoid filing patents, and this is done with intention. This traces back to the history of the company. At the time that company was founded, the key technologies were protected by large firms with patents and trade secrets, which made the development of the company quite difficult. However, it managed to develop its own technological solutions, and through careful study of the IPRs the company decides to adopt a different business model with an IPRs strategy that patents will only be filed if the company thinks it's very critical. Otherwise patents will not be considered as necessary.

The company also tries to embed the knowledge in the whole company system by utilizing knowledge management system, so that the knowledge cannot be "stolen" in case well-experienced employees defected to competitors. It happened in the past that senior colleagues and even a whole team were defected to another company which impacted the company profoundly, however, the company regained its competitiveness in a short time because the knowledge is still in the company.

Though company G is a public company with about 8,000 employees, it has only 1 person in the legal department, and there's no IPRs department. Some functions of IPRs department is covered by the single employee in the legal department. The basic reason is that the cost of maintaining a huge group of legal/IPRs personnel is higher than managing IPRs portfolios and related issues.

Company G did encounter IPRs litigations in the past, but

there is usually no huge payments. There are several reasons. First, the company focuses mainly on niche markets, so that the volume in each market is small. Such small volumes are not attractive to companies only interested in collecting licensing fees. By having many small niche markets, company G manages to generate a revenue of more than USD 3 billion with a gross profit of 40%. Second, the company avoids merging/acquiring companies mainly for the reason of IPRs. It prefers to pay for licensing fee rather than buying a whole company to acquire new technologies, even though the inventions are very important that may block its technology development. Third, the company focuses on sales and marketing forces rather than only on technology. Preventing other companies from copying its technologies or applications is not a main concern, but on the contrary, it welcomes broad applications of the same technologies, because in this way the total market grows bigger, and the revenue of company G will grow at the same time.

For company G, competitors are not a main concern, but market sector is more important and firms shall follow every change in it closely. Company G usually does not pursue the newest innovations either, but it looks for and waits for the best solutions. Sometimes it does lose some cases to competitors, but it will catch up very soon because the market changes rapidly. To sum up, company G is not interested in blocking other companies by IPRs, but it prefers following market trends, and this is how the company keeps its competitive advantage.

In March 2016, the authors interviewed 2 more companies H and I. These 2 companies did not fill out the questionnaire, but CEO of company H and the leader of IPRs department of company I agreed to an interview.

Company H is specialized in producing electronic components and modules. The company has an annual revenue of about USD900 million, and it belongs to a corporate group with an annual revenue of USD9 billion. There are about 8,500 employees in the company.

The CEO has a special strategy to promote IPRs by setting patent quota for the engineers. At first, engineers were rewarded as long as they file patents. After the engineers are used to filing patents, the company can further request to improve the quality of the patents. In doing so, the CEO had an experience of having more than 4,000 patents filed in 12 years. And during that time the company has not paid for any licensing fee to other companies. In addition to filing patents, acquiring companies, investing in other companies or licensing technologies are necessary measurements to ensure IPRs protection. Moreover, engineers must check roadmap with patent map – engineering roadmap is not considered as effective before patent map is checked. On the other hand, innovation is very important – the CEO has no big concern about imitation or infringement by other companies, in fact, he does not prefer suing companies that may infringe their patents, because the cost of law suits is very high. By keeping inventing new

technologies a company can keep its leadership, and this is considered an efficient way of defeating competitors. And this is also good if experienced employees could be hired over by competitors, because they cannot gain advantage if they do not have new inventions.

Specific for IoT, hardware, software, algorithm and even cloud are important – especially algorithm patents, and these are related to domain knowledge. Time is also important, so it is even better to acquire/merge a company rather than developing the technologies in house.

In March 2016, the authors interviewed the leader of the IPRs department of company I. The company specializes in design and marketing of electronic components, and it has an annual revenue of around 5 billion USD and 8,000 employees. Company I has quite aggressive strategy in protecting its IPRs – during the development stage of a new product, it will try to ensure that it has leadership in technology and also in IPRs portfolio. The IPRs department plays an important role in the company for IPRs education, IPRs protection, patent application and also IPRs related litigations. The IPRs department does its best to make sure aggressive legal steps can be taken to protect the company. The number of patents that could be involved in its products can be more than 100,000 – it's not possible to clarify if a product infringes any existing patent before product development begins. Therefore, a best policy is to ensure a strong IPRs portfolio so that the company has good negotiation power in case infringement is claimed. The company will also try to invalidate patents of other companies or engage in litigation if its IPRs are threatened. It once had litigation with a big competitor and the trial went on for about 10 years – finally, after spending much time, effort and money, knowing that it will fail, that competitor agreed to settle just before a court hearing began. To sum up, company I will never give in in a single infringement claim or litigation case to prevent anyone to follow suit.

IV. IPRS STRATEGY FOR IOT INDUSTRY PLAYERS

A. Principles

IoT applications can have huge amount of different combinations of technologies, the IoT markets can be very fragmented with low volumes. Nowadays there're no dominating technologies for IoT applications, and there's no unified standard to connect all the devices. But the devices shall be connected to communicate to each other – for this sake common standards for different IoT suppliers are essential. Based on these findings, the authors propose to combine IPRs strategies of Ove Granstrand [7], Reitzig [12], Fisher III & Oberholzer-Gee [6] as well as experiences of the IoT firms to formulate the IoT IPRs strategies.

There are at least two reasons for the IoT industry players to collaborate together to form the IPRs strategy. First, the IoT devices need to be able to be connected to communicate to each other, this will require the IoT players to follow same

standard to develop the products. Second, if one firm develops IoT products for only one market segment, the volume can be low due to the fragmentation of markets. These reasons will push the industry players to share their IPRs with partners so as to increase the applications of same technologies and hence the market share. Instead of defending a single firm by strategically blocking other companies by organizing patent portfolios in strategic ways [7], or asserting market power or collecting licensing fees [6], a collaborating or even donating strategy of the IPRs [6] shall be a more preferable way for IoT industry. By inviting more partners and forming open standards it will be possible to increase the market share of the technologies.

B. The strategies

The authors propose the IPRs strategies for IoT industry as follows.

1. To apply patent granting/non-asserting/donating strategy
The IoT industry players are now working towards forming alliances for standards, and most of them have the FRAND/RAND-RF IPRs policies, and they encourage patent non-assertion to alliance members (see table 3). Referring to the questionnaire data of this analysis, licensing fees are not preferred by the companies. Patent owners have to think out of ways to make profit in other sectors such as services rather than collecting licensing fees or engaging litigations.
2. To share the copy right
The same as for the patent, it is better to share the copy rights to increase the application base. By increasing the application base, the copy right owner may have a larger market share for IoT applications. It is remarkable that the alliance AllSeen releases the Alliance code under the ISC license which permits ‘to use, copy, modify, and/or distribute’ the software ‘for any purpose with or without fee’, as long as the ISC copy right and permission notice is shown [22].
3. To combine alliance trade mark and own trade mark
Trade mark of the alliances may play an important role since it can indicate the ability to connect to a big base of applications and devices. For this sake it is important for the industry players to combine the alliance trade mark with own trade mark to gain a positive image.
4. To protect trade secrets
On the contrary to the patent and copy right strategies, the IoT firms have to evaluate carefully about what to share with industrial partners and what to protect as trade secrets. For the parts to be protected as trade secrets, the firms shall implement all necessary measurements for the protection. The possible damages of hiring-over of employees by competitors shall be prevented as well.
5. To utilize design as one of the IPRs
One remarkable part about both company C and company G is that they are very concerned about industrial design. Products in different series of company C are designed

with different colors and outlooks, so that it is easy to tell from the outlook what category the product belongs to. Also the distinct product outlook of company C makes them stand out from the same kind of products. This is the same with company G. Though company G is for industrial application, its industrial designs used to win important design awards. Industrial design is a good way to make the products different and attractive if the products are of the same technology standards.

6. To consider disclosure/publishing rather than patenting
Disclosure is a good measurement to ensure freedom to operate and to save the costs of filing and maintaining patents. For IoT it may be better to disclose or publish than patenting, because inviting more partners to increase the market share is more important than seeking protection by IPRs. The IoT industry players may evaluate the advantages/disadvantages of patenting or disclosing/publishing carefully to make the right choice.

C. The process to formulate the IoT IPRs strategy

The process to formulate the proper IoT IPRs strategy can be illustrated in Figure 5.

V. CONCLUSION AND FUTURE WORK

Due to the reasons that there are no dominating technologies and the markets are fragmented, the IoT industry can be quite specific for the forming of IPRs strategy. There are alliances trying to establish standards – but the standards of the alliances are different, and there can be problems for devices of different alliances to communicate to each other. The competition is among alliances – the IoT industry players shall attend the “right” alliance to win the competition – the question is that it’s not easy to tell which alliance will win at the current stage. Or they need to attend as many alliances as possible so that they won’t miss the “right” one.

At the current stage of IoT development, the competition is in market share and to win the “format war”. For this reason the industry players shall do their best to increase the market share rather than blocking other firms by IPRs or collecting high licensing fees. For example, firms may share the IPRs with other industry players free of charge or collect only a minimum licensing charge to increase the application base of the technologies, and they need to find a suitable business model to be profitable from services, other products or value-added activities. This may seem contradictory to the nature of IPRs, but it is indeed a suitable IPRs strategy. Again, the IoT IPRs strategy shall address the need to increase the market share, and a proper IPRs strategy of patent, copy right, trade mark, trade secrets and disclosure/publishing must be carefully formulated to address this need.

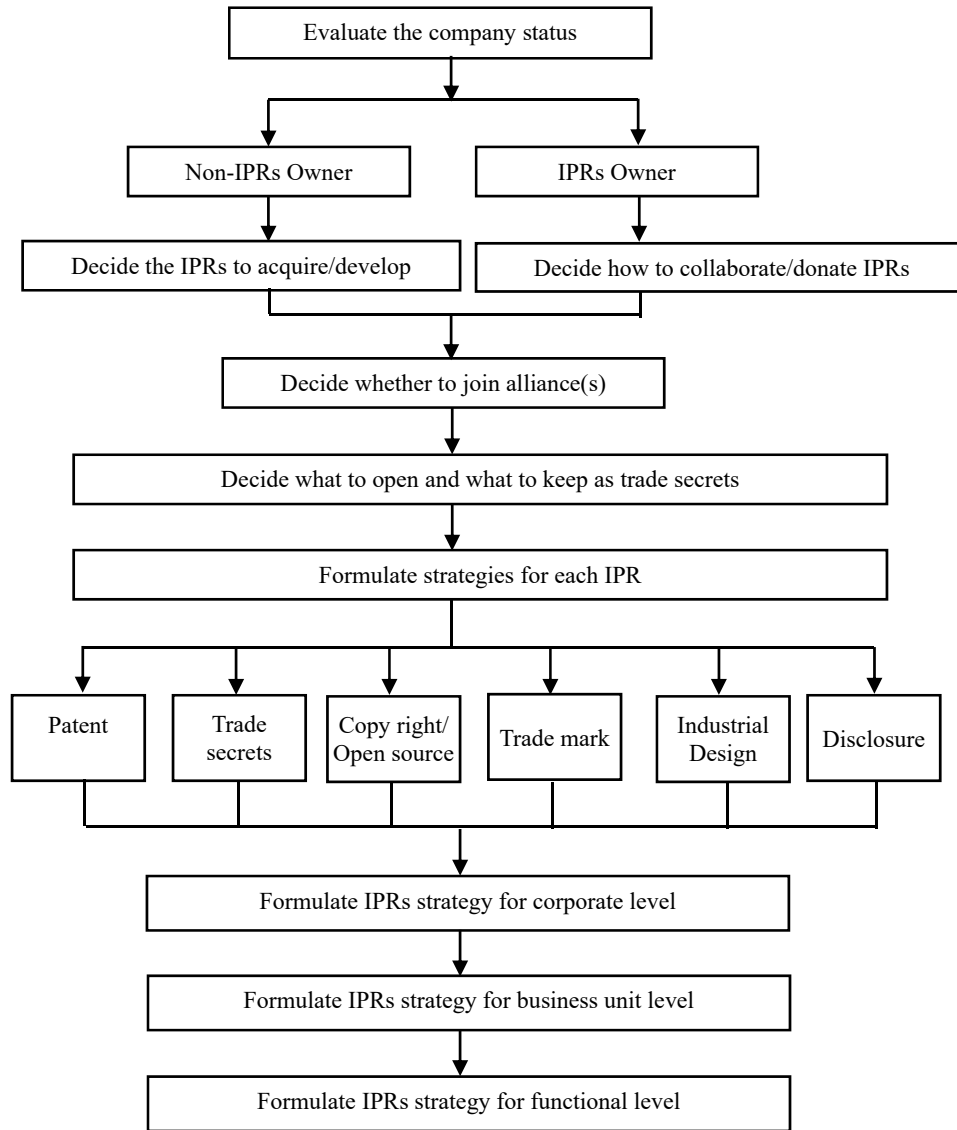


Figure 5.

Future research may study the competition among the alliances to understand how the standard battle will end. On the other hand, the role of open source software and its impact to IoT development can be analyzed further, because its development has been remarkable in IoT, some companies now offer their source code free of charge – such open source software is no longer an innovation of end users [28]. AllSeen has the ISC (Internet Software Consortium) License in its IPRs policy, and almost every alliance has RAND/RAND-RF in the IPRs policy and agreement, it will be worthwhile looking at the development of these trends to understand more about the relationship of profitability, business model and IPRs strategy of the IoT industry.

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Appendix

Questionnaire about Intellectual Property Strategy of Internet of Things

Intellectual Property Strategy for Internet of Things – How IP Strategy Adds Value?

Dear Sir,

This is a questionnaire about Intellectual Property (IP) Strategy of the Internet of Things [1]. The collected data will only be used for academic analysis and publishing, your responses will not be identified with your company name and will be kept strictly confidential, Data from this research will be reported only as a collective combined total. Please have no concern to fill it out it. To show our gratitude to your help, the summary of the analysis will be sent to you for your company's reference. (Please fill out the questionnaire only once for each company, but the link of the questionnaire can be mailed to other companies that are considered suitable to fill it out. Thank you!!)

Institute of Technology Management, National Chun Hsing University

Professor Dr. Ta-jung Lu

PhD student Iris Chen

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*Required

I. Basic data *

1. Annual revenue of your company:

- 1 Under USD 3 Million
- 2 Between USD3 Million to USD30 Million
- 3 Between USD30 Million to USD 90 Million
- 4 Between USD90 Million to 150 Million
- 5 Between USD150 Million to 210 Million
- 6 Between USD210 Million to USD 270 Million
- 7 Between USD270 Million to USD330 Million
- 8 More than USD330 Million
- Others :

2. Number of employees: *

- 1. Under 10 persons
- 2. 10~100 persons
- 3. 101~200 persons
- 4. 201~300 persons
- 5. 301~400 persons
- 6. 501 persons or above

3. Annual R&D budget: *

- 1. Under 1% of annual revenue
- 2. Between 1%~3% of annual revenue

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- 3. Between 3%~5% of annual revenue
- 4. Between 5%~7% of annual revenue
- 5. Between 7%~9% of annual revenue
- 6. Between 9%~10% of annual revenue
- 7. More than 10% of annual revenue
- Others :

4. The percentage of R&D budget related to IoT: *

- 1. Under 20%
- 2. Between 20%~40%
- 3. Between 40%~60%
- 4. Between 60%~80%
- 5. Between 80%~100%

5. Category of your IoT technology: *

Choose all that apply

- 1. Wired networking: Communication protocol, Resource Management, Multiplexing Methods, Topology Management)
- 2. Wireless networking: Resource Management, Topology Management, Communication Protocol, Multiplexing Methods, Radio Frequency Protocols, Baseband Processing)
- 3. Algorithm: Routing Algorithms, Image Processing, Character Recognition
- 4. Encryption: (Error Correction, Data Security, Data Encryption); Memory Management (Information Retrieval)
- 5. Control system, Power Management, Hardware - Circuits, Sensors
- 6. Applications (Home Automations, Transportation, Home Security, E-Commerce, Healthcare, Entertainments, Alarm Systems); Measurement/Testing
- Others :

6. How many employees are there in the Legal Department? *

- 1. 0 (There's no Legal Department)
- 2. 1~5 employees
- 3. 6~10 employees
- 4. 11~15 employees
- 5. 16~20 employees
- 6. More than 20 employees

7. How many employees are there in the Intellectual Property Department? *

Choose all that apply

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- 1. 0 (There's no Intellectual Property Department)
- 2. 1~5 employees
- 3. 6~10 employees
- 4. 11~15 employees
- 5. 16~20 employees
- 6. More than 20 employees

8. The Name of your company:

9. Your Department and Title:

II. The measurements to protect intellectual property *

1. How often does your company protect your technology/product by trade secrets? (1 denotes least frequency, 5 denotes the highest frequency)

1 2 3 4 5

Never by trade secret Always by trade secret

2. How often does your company protect your technology/product by patent? (1 denotes least frequency, 5 denotes the highest frequency) *

1 2 3 4 5

Never by patent Always by patent

3. How often does your company protect your technology/product by trade mark? (1 denotes least frequency, 5 denotes the highest frequency) *

1 2 3 4 5

Never by trade mark Always by trade mark

4. How often does your company protect your technology/product by copy right? (1 denotes least frequency, 5 denotes the highest frequency) *

1 2 3 4 5

Never by copy right Always by copy right

5. How often does your company protect the technology/product by industrial design? (1 denotes least frequency, 5 denotes the highest frequency) *

1 2 3 4 5

Never by industrial design Always by industrial design

6. How often does your company protect technologies/products by disclosure/publishing to ensure freedom to operate? (1 denotes least frequency, 5 denotes the highest frequency) *

1 2 3 4 5

Never by disclosure/publishing Always by disclosure/publishing

7. How often does your company protect technologies/products by cross-licensing? (1 denotes least frequency, 5 denotes the highest frequency) *

1 2 3 4 5

Never by cross-licensing Always by cross-licensing

8. Does your company protect technologies/products by combining more than one intellectual property right: trade secret, patent, copy right, trade mark, industrial design, disclosure/publishing, cross-licensing? If yes, what IPRs are combined? *

Choose all that apply

- 1. Trade secret
- 2. Trade mark
- 3. Copy right
- 4. Patent
- 5. Industrial Design
- 6. Disclosure/publishing
- 7. Cross-licensing
- 8. Protection by only one IPRs, no combination.
- 其他 :

9. Professor Ove Granstrand listed patent strategies below, does your company apply similar patent strategy/strategies? *

Choose all that apply

- 1 Ad hoc blocking: apply one patent or a few patents for one technology
- 2 Strategic patent searching: very powerful claim for one technology, it can block the other companies to file patents of similar technology.
- 3 Blanketing and flooding: multiple patents are filed for a certain technology space to build a mine field.
- 4 Fencing: to 'line up' several patents for form a 'fence' to prevent other companies to break through.
- 5 Surrounding: to surround an important central patent of competitor with multiple patents.
- 6 Combination into patent network: to build a patent portfolio to strengthen overall protection and bargaining power.
- 7 None of the above
- 8 Not sure
- Others :

10. Professor W. W. Fisher III listed IP strategy for IP owners as below, does your company apply similar strategy/strategies? *

Choose all that apply

- 1 Exercising market power
- 2 Selling IPRs
- 3 Licensing
- 4 Collaborate: attend standard-setting organization to

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- 5 Donate the IPRs to partners
- 6 None of the above
- 7 Not sure
- Others :

11. Professor W.W. Fisher III proposed IPRs strategy for non IP owner (defensive) as below, does your company apply similar strategy/strategies? *

Choose all that apply

- 1 Assert a legal privilege - challenge the validity of patent
- 2 Develop an alternative technology and patent it
- 3 License the IPRs
- 4 Detente - to build large patent portfolio to threaten the competitors.
- 5 to disregard the potential claims of rivals and instead disseminate a potentially infringing technology in rapid fashion.
- 6 None of the above
- 7 Not sure
- Others :

12. Thank you for filling this questionnaire out! Please leave your name and e-mail below, I'll send you the summary of the questionnaire analysis.