PATENT DISPUTES BETWEEN SMART CAR MANUFACTURERS AND NON-PRACTICING ENTITIES (NPES)

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ABSTRACT

Smart cars in the vehicle market continue to show substantial growth, which has been driving the automotive industry to focus on advancing related technologies by integrating technologies from various areas. As information and communications technology (ICT) melds with automotive technologies, the rapidly increasing activities of non-practicing entities (NPEs) have caused concern. An NPE is any entity that earns or plans to earn the majority of its revenue from licensing or enforcing its patents. In this study, we analyzed US litigation data on smart car patents to suggest preventive measures that can facilitate strategic decision-making for efficiently confronting NPEs. We performed correlation analysis to identify the factors that relate to disputes against NPEs in the

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automotive sector. Next, we analyzed the patent acquisitions of NPEs to interpret the characteristic patterns of lawsuits. Finally, we showed that our network analysis of patent litigation provides insights for establishing successful strategies against unanticipated patent disputes.

Keywords: Patent Dispute, Smart Car, NPE, PAE, Litigation, Intellectual Property

I. Introduction

Interest in smart cars in the vehicle market has rapidly expanded since these advanced vehicles evolved toward autonomic driving and active accident prevention (Robert, 2000). Smart cars have actively integrated information and communications technology (ICT) into automobile technologies to introduce a new era of autonomous vehicles (Ralph et al., 2008). Various types of sensors, radio frequency (RF) devices, processors, software, actuators, and human-interface components have merged into vehicle control systems to achieve the safety, convenience, and sensibility needed to realize the goals of smart cars (Robert, 2000). Therefore, smart cars have been considered the future answer to the paradigm shifts in automobiles, and related technologies will continue to evolve with market growth (Adrian, 2006).

Worldwide automobile sales are estimated to grow at an average yearly rate of 6%, and the share of smart cars in the automobile market is expected to reach 65% by 2016. From 2014 to 2016, smart car sales have been estimated to grow at an average yearly rate of 38%, establishing the basis for the claim that smart cars are providing new growth opportunities for the automobile industry.

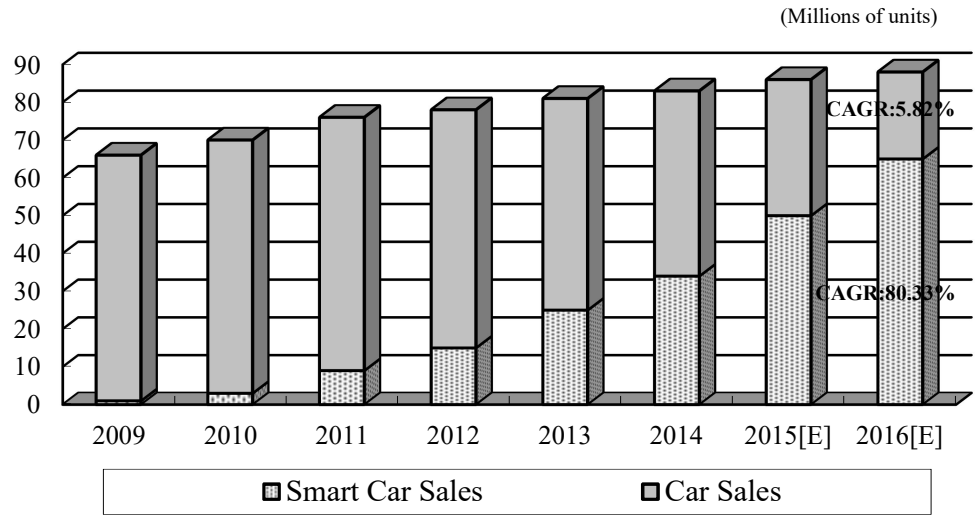


Figure 1: Smart cars in the vehicle market[1]

[1] Mirae Asset Research Center/Smart Cars in the Vehicle Market (2015)

Smart car technologies have been steadily evolving to fulfill the needs of a new era that requires integrated forms of diverse, advanced technologies, such as communications and sensors. Companies in the automobile industry have been actively forming partnerships with companies in various industries to surpass industrial and technological boundaries. As technological integration proceeds, however, the automobile industry has been subject to intense patent litigation. Recent analysis indicates that most litigation has been initiated by non-practicing entities (NPEs). NPEs are used to mostly focus on ICT for filing patent litigation; however, ICT patents have led NPEs to broaden their areas of interest to include the automobile industry, where ICT is actively melding with automobiles to achieve breakthroughs in advanced vehicle controls and conveniences, which are considered aims of smart cars.

NPEs have continuously evolved to sustain their businesses by designing swift and effective patent disputes. For example, NPEs can file complaints with the ITC (International Trade Commission) for injunctions on the products of targeted companies. Once the complaints are filed with the ITC for injunctions, targeted manufacturing companies can choose either to pay the NPEs for reconciling settlements, or prepare effective and timely countermeasures under the threat of import prohibition. Since the only possible countermeasure is to nullify the related patent, this scheme has been considered an effective way of imposing pressure on the targeted manufacturer and driving the reconciling settlements in their favor.

To the best of our knowledge, patent disputes have mainly been studied within the electrical and electronics industries; most prior studies discuss prevention through reconcilement by cross-licensing or patent nullifications via intensive claim analysis. However, such ex-post measures have exposed critical weaknesses in confronting NPEs, which have established powerful patent portfolios by aggressively acquiring patents, with the aim of launching patent disputes and litigation. Therefore, there is a need for studies that suggest effective and strategic means for preventive actions.

In this study, we focus on developing strategic measures for smart cars in the vehicle industry, which has seen ongoing growth, by suggesting effective tools to reduce the threat of patent disputes from NPEs. For this purpose, we used patent lawsuit data on US smart cars from major global automakers to perform correlation analysis; this allowed us to extract the factors that make companies vulnerable to NPEs. Next, we investigated patent assignee histories to capture the behavioral patterns during preparations for patent lawsuits. We conducted network analysis to identify and suggest the effective use of indices for monitoring the characteristics of NPEs in patent litigation.

Our study is composed as follows. In Section 2, we define smart car technologies, and discuss patent disputes initiated by NPEs. In Section 3, we examine patent disputes on smart cars using correlation and network analysis to identify the behavior of NPEs preparing lawsuits. In addition, we propose proactive countermeasures to prevent patent disputes from NPEs. Our conclusion is provided in Section 4.

II. Smart car technologies and NPEs

In Section 2, we describe smart car technologies to discuss the links through which NPEs have been entering the automobile industry. Smart car technologies can be categorized, as shown in Figure 2.

A. Smart Car Technologies

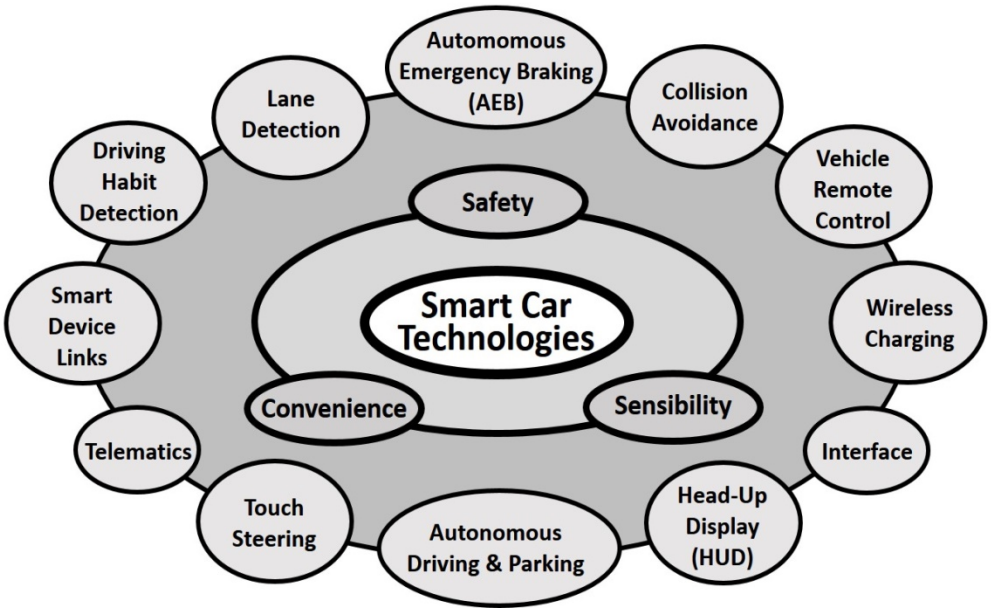


Figure 2: Categories of smart car technologies[2]

Smart car technologies require advanced technologies from various areas such as communication, mechatronics, and material science. However, smart car technologies have been mostly developed by automobile companies to integrate

[2] These categories of smart car technology were defined by the International Standards Organization Technical Committee 204 (ISO/TC204)

advanced functionalities into vehicles. ICT has become significant in facilitating the functionalities that are vigorously embedded in automobiles. The functionalities can be grouped in terms of objectives, which lead to the following categories of technology for smart cars:

1. *Preventive technologies*, which use cutting-edge sensors and high-speed computation to prevent potential traffic accidents. This technology aims to reduce the causes of traffic accidents by monitoring drivers' conditions, such as negligence or drowsiness, as well as driving habits.

2. *Advanced driver assistance systems (ADAS)* and *vehicle dynamic control (VDC)* keep cars under control and protect passengers, especially during accidents. ADAS may require vehicle-to-vehicle (V2V) or vehicle-to-infrastructure (V2I) systems, with car data networks to accomplish advanced control; this hints at the possibility of increased investment in smart cars from diverse business areas. VDC has been widely applied in automobiles in the form of anti-lock braking systems (ABS) and vehicle stability control (VSC); it is expected that VDC will integrate data networks to actively prevent accidents.

3. *Technologies that enhance driving efficiencies*, which include advanced steering and engine control systems. The advanced steering systems require intelligence in steering systems to compensate for external disturbances in dynamic control functionality.

For our analysis in the next section, we created a smart car technology tree, derived from the "Issue Report on Smart Car IP Utilization and Risk Response" Bae, J.W. (2014); this tree categorizes the technology patents that apply to smart cars. Based on the technology tree, we used the USPC (United States Patent Classification) system to extract each category of technology, in order to identify the pieces of litigation that involve smart car technology issues.

Table 1: Smart car technologies and the USPC system[3]

LV1	LV2	LV3	USPC
Smart Car	**Safety**	Autonomous Emergency Braking	701/301;701/117;
		Lane Sensing	701/023;180/179;318/587; 701/300;701/532;
		Collision Detection/Avoidance	340/901;340/435;340/436;340/903; 340/904;348/118;348/148;
	Convenience	Driving Habit	701/032.5;340/439;701/033.4; 701/033.6; 701/033.9;
		Autonomous Vehicle	701/023;180/167;701/002;
		Connect Smart Device	342/357.31;701/532;
		Telematics	701/538;340/988;340/990; 340/995.26;701/540;701/541;
		Remote Control	340/988;340/426.14;340/426.16;340/ 426.28;342/457; 455/404
		Wireless charging	320/109;180/313;322/002R; 361/235;701/022;
	Sensitivity	Voice Recognition	704/273;704/274;704/275;
		Action Recognition System	382/104;348/154;701/045;
		Head Up Display	345/007;250/330;348/115; 348/E05.09;
		Touch Steering	362/501;070/239;070/278.1; 362/085;362/394;
		Haptic	345/156;345/157;345/161; 715/701;715/702;
		Eye/Face Recognition	382/118;382/171;382/173;382/257;

[3] Issue Report on Smart Car IP Utilization and Risk Response (Bae.J.W, 2014)

B. Current status of smart car patent disputes

Advancements in smart car technologies have accelerated the fusion of technologies among various kinds. Among them, as we observe from the categories of smart car technologies, ICT has been the main driver of progress and innovation. ICT has brought intelligent functionalities to automobiles, and enabled the existence of smart cars by providing breakthroughs in electrical applications. However, ICT has also brought the threat of intense litigation in the automobile industry, and a sharp increase in technology patent disputes. In the US, the number of patent litigations related to smart cars increased approximately tenfold, from 40 in 2009 to 381 in 2013. Of these cases, we have paid attention to the NPEs whose activities were mostly in the realm of ICT.

Among the entirety of patent lawsuits over US smart cars in 2013, NPEs initiated 353 cases, escalating their portion of patent litigations to 92.6%. These figures imply a shift in patent litigation in the automobile industry, where manufacturing companies have been considered less involved in patent disputes compared to companies in other industries. The composition of patent litigation relationships should be examined in greater detail.

The number of defendants in patent lawsuits over smart cars increased by 153%, from 137 in 2009 to 347 in 2013, whereas the number of plaintiffs rose slightly, from 31 in 2009 to 39 in 2013. The composition of defendants and plaintiffs depicts the aggressiveness of NPEs against global automobile companies since smart car concepts were first developed. Therefore, concerns have been raised over the passive reactions from smart cars in the vehicle industry for developing appropriate strategies against NPEs, which are equipped with litigation competencies and experience.

C. NPEs

The term “NPE” characterizes entities that focus on pursuing profits through lawsuits, rather than using patents to foster innovation.[4] The patent law system

[4] The US Federal Trade Commission (2011)
Category 1 NPEs: All other entities that do not manufacture products that practice the asserted patents, including inventors who may have done R&D or built prototypes but do not make a product covered by the asserted patents and therefore rely on licensing to meet the domestic industry requirement; research institutions, such as universities and laboratories, that do not make products covered by the patents, and therefore rely on licensing to meet the domestic industry requirement; start-ups that possess IP rights but do not yet manufacture products that practice the patent; and manufacturers whose own products do not practice the asserted patents.
Category 2 NPEs: Entities that do not manufacture products that practice the asserted patents and whose business model primarily focuses on purchasing and asserting patents.

incentivizes innovation, with the ultimate goal of promoting the progress of science and technology. The Patent Act encourages inventors to disclose their inventions by compensating them with a limited form of monopolistic capabilities. This right allows the patentee to demand that others refrain from infringements and claim compensation for losses caused by unauthorized infringements. However, there has been increasing concern over the trend of utilizing intellectual property merely as a means to profit from litigation. Additionally, there has recently been more concern over the possible degradation of creative intentions among innovating entities, which may lead the patent system's fundamental aim to regress.

Rather, they defend their rights against infringement. These entities profit from payments opportunistically or on purpose by companies that inadvertently infringe on NPEs' intellectual property rights (Henkel and Reitzig, 2008). There is a fear that in most cases, these small entities use courts as a mechanism to extract economic rents from large companies (Ball and Kesan, 2009; Bessen et al., 2011).

Table 2: Previous research

Author	Summary
Hagiu (2013)	Hagiu claims that it highlights the importance of the intellectual property loyalty market, which allows for the trading of knowledge in a time when knowledge is property, as the current manufacturing-oriented industry transforms into an intellectual economy.
Sandburg (2010)	A patent troll is defined as a "company that does not currently invent patents or is not willing to do so regarding a patent right, and is trying to earn a tremendous amount of money using a patent that was never utilized in most cases in the past."
Tyler (2014)	Tyler claims that patent trolls can organize inventions and bring about orderly, cumulative development of innovation in the process of purchasing patents and creating a portfolio.
Femil (2010)	Femil claims that patent trolls have an advantage in supporting funds to get rights transferred from an individual inventor who cannot produce or commercialize products.
McDonough (2009)	McDonough claims that patent trolls are not illegal, since they are exercising their exclusive rights, and that they very much contribute to revitalizing intellectual property.

Aeppel (2010)	Aeppel claims that the abuse of patent rights increases lawsuit expenses, and that thoughtless lawsuits hamper economic development and cause excessive, unnecessary litigation.

In the past, patent disputes among automakers or research institutes could be reconciled or cross-licensed and resolved at a minimum cost. However, as industries have evolved through omnidirectional integration, patented technologies have become valuable in areas that used to be considered less relevant. NPEs have been establishing strong portfolios by aggressively acquiring patents, with the aim of profiting from claiming patent rights.

As ICT has been integrated into automobile technologies, the automobile industry has become the new target of NPE profits from ICT patents. NPEs are expected to search for assailable points in patent portfolios of targeted automakers with experience in ICT. Thus, a significant portion of patent litigation initiated by NPEs against automakers is over automotive applications, in which the fusion between ICT and automobiles is most actively observed. Since 2010, NPEs have been purchasing automobile patents with ICT elements, such as vehicle controls.

One of the most aggressive NPEs is Beacon Navigation GMBH (Beacon), which has filed 64 patent litigations against 14 automakers (2014). American Vehicular Sciences LLC (AVS), another active NPE, acquired 255 patents from other NPEs in 2013, and filed 29 patent lawsuits against 6 automakers in 2012.[5] It is highly possible that the patents acquired by NPEs will be used for litigation. As we observed in the cases of Beacon and AVS, NPEs have been establishing their portfolios by purchasing patents from various sources, including NPEs; therefore, NPEs are making rapid progress in preparing for a full-scale patent war against automakers, which rationalizes the claim that proactive risk management strategies for manufacturing companies needed.

III. Analysis

In Section 3, we analyzed the behavior of NPEs by focusing on their actions prior to filing patent disputes. We discuss such behavior based on our findings for deriving further understandings of NPEs.

[5] http://english.etnews.com/news/article.html?id=20140417200005

A. Correlation analysis

Table 3 shows the list of the top ten global automakers in order of net profit margins. For our analysis, the cases that involve the companies in Table 3 were extracted from data on US patent disputes from 2009 to 2014, and are displayed in Figure 3. We performed correlation analysis on these automakers to identify the factors that relate to patent lawsuits against NPEs.

Table 3: Global automakers ranked in terms of net profit ratios[6]

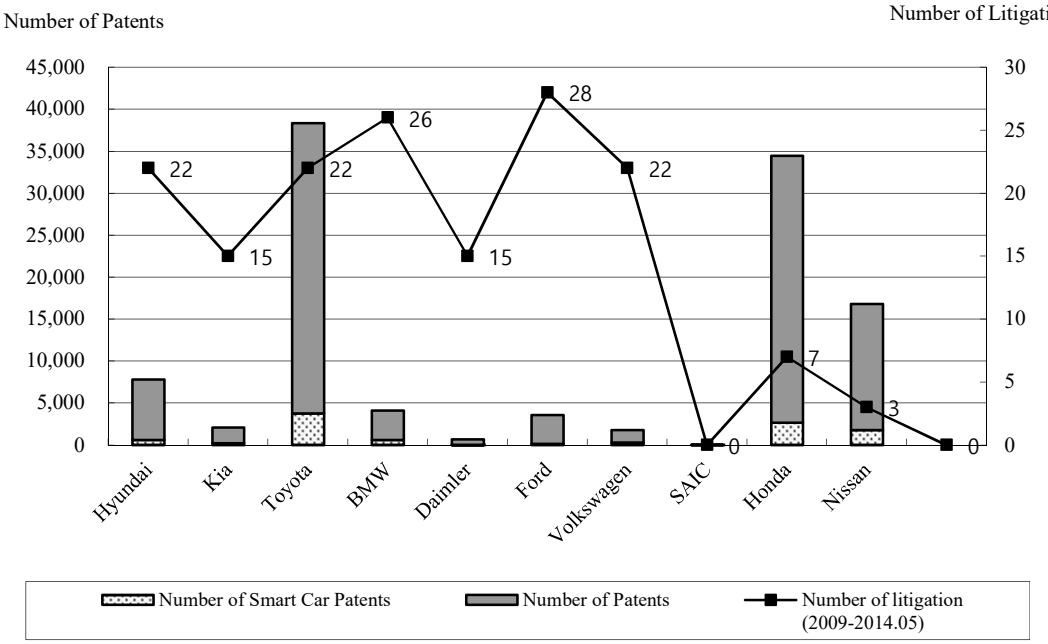
[Unit: $100 million]

No	Company	Nationality	Net profit margin (2013)	Sales account	Net income	Number of employees
1	Hyundai	Korea	9.78%	798	78	59,831
2	Kia	Korea	8.03%	435	35	33,456
3	Toyota	Japan	7.37%	2,556	189	333,498
4	BMW	Germany	6.99%	1,010	71	11,351
5	Daimler	Germany	3.30%	1,566	91	275,384
6	Ford	US	4.87%	1,469	72	181,000
7	Volkswagen	Germany	4.60%	2,615	120	572,800
8	SAIC	China	4.57%	882	40	105,953
9	Honda	Japan	4.17%	1,177	49	19,338
10	Nissan	Japan	3.79%	1,040	39	166,881

In our correlation analysis, we included the total number of patents, smart car patents, sales, net profits, employees, and patent lawsuits. We used the USPC to extract 15 technology classes from the 45 patents with the highest number of citations in the smart car technology tree, in order to classify smart car patents from all of the 99,471 patents of the listed companies. We limited our considerations to US patent registrations assigned to the companies in Table 4. Following an analysis of patent litigation, the author found that corporations in Japan have made various efforts to secure patents in the US. Corporations in Germany are frequently sued because they have several technologies that infringe on US patents, and they have not made adequate efforts to secure patent rights in the US.

[6] The World's Largest Companies 2014, Forbes

Figure 3: The number of patents and lawsuits of global automakers



Notes: Downloaded from the Wisdomain patent database; Patent litigation data was excerpted from PatentBlast

Notably, the correlation coefficients shown in Table 4 show that the patent lawsuits have negative correlations with the number of smart car patents, and positive correlations with net income or sales. Overall, the results imply that companies should be more prepared with stronger patent portfolios as they improve their financial performance.

Table 4: The correlative coefficients between patent lawsuits and company factors[7]

Correlation Coefficients		Number of Smart Car Patents	Number of Patents	Number of Litigations
Smart Car Patents	Pearson Correlation	1	.980**	-.332
	Sig.(2-tailed)		.000	.382
	N	9	9	9
Patents	Pearson Correlation	.980**	1	-.360
	Sig.(2-tailed)	.000		.341
	N	9	9	9
Lawsuits	Pearson Correlation	-.332	-.360	1
	Sig.(2-tailed)	.382	.341	
	N	9	9	9

The results of the analysis lead to deductions about the behavioral characteristics of NPEs in filing patent litigations. As shown in Table 4, NPEs exhibit preferences in selecting which companies to sue, implying that the NPEs consider manufacturing firms to be the main targets of litigation. Thus, a company with a stronger patent portfolio would be considered a less attractive target for NPEs, since a lawsuit against such a company may take longer, cost more, or be dismissed without any desired outcome. On the other hand, a company with a greater net income may expect an increased risk of being targeted since it can have more solvencies; furthermore, NPEs can attribute a manufacturing company's performance to the contributions of its patents. By filing a dispute for patent infringement, the plaintiff can request court injunctions against the rights of the accused companies to manufacture and sell the relevant products.

[7] Correlative coefficients are statistically significant at $p=0.01$

B. The analysis of NPEs' litigation patterns

Patent acquisitions are the core activity of NPEs at the onset of patent lawsuits. Generally, the activities of NPEs are incursions in that the accusations are secret until the brink of lawsuit filings. Regardless of a patent's practical and technological importance, patent rights invest the holder with the ability to apply for injunctions against the right to conduct any activities on relevant products, including manufacturing and selling, until the filed litigations conclude in favor of the manufacturing companies. Therefore, NPEs could keep their acquisition traces as minimal as possible to make it virtually unworkable for targeted counterparties to detect their moves in advance and perform neutralizing actions, such as bypassing or nullifying patent claims. We analyzed the assignee histories of patents acquired by NPEs for litigation to find a notable pattern that describes such concealment strategies.

As shown in Figure 4, Beacon displays the archetypical concealment, which includes delegating to other entities for acquiring and transferring patents. Generally, small NPEs or shell companies perform patent acquisitions, mainly to screen the warnings of pending litigations. For patent lawsuits in 2013, Beacon, which is known as an aggressive NPE, delegated other companies to acquire patents, and had assignees frequently transferred until the patent disputes began.

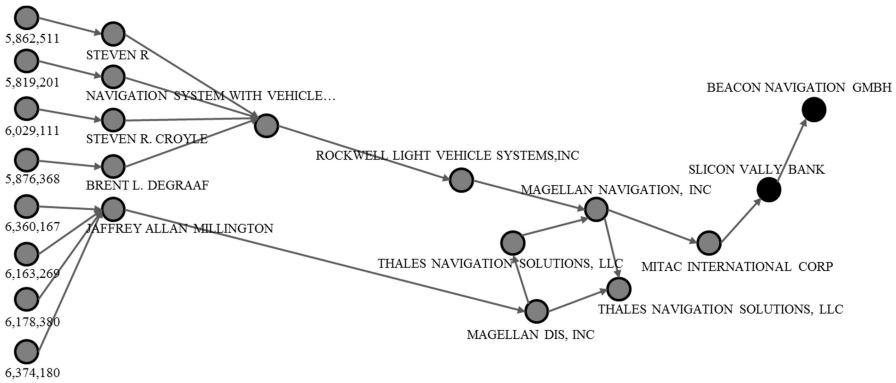


Figure 4: Beacon's patent acquisition channels[8]

Notably, as shown in Figure 4, Silicon Valley Bank participated as one of the assignees during the concealment process. We presume that the purpose of including this capital bank was to handle a financing problem; in other words, to obtain litigation funds from the financial institution by loaning or mortgaging the acquired patents. Such a financing strategy that requires strong reliance on banks or

[8] Beacon acquired eight navigation patents for 126 lawsuits in 2013.

capital banks is typical, especially among NPEs, which secure a relatively small number of patents for lawsuits and aggressively initiate disputes against manufacturing companies.

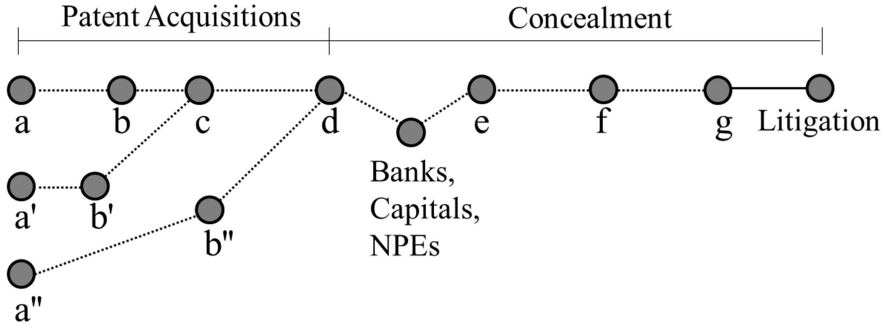


Figure 5: Generalized patent acquisition patterns of NPEs

As generalized in Figure 5, NPEs proceed with patent concealment after acquisition, which involves banks or capital banks as mid-assignors, presumably to insure that their investments are used for patent litigations. We tracked the patent assignee transfer histories during concealment; Table 5 shows the results of the analysis. Compared to the general practice of US patent assignee changes in the automobile industry of 2.3 times on average, the patent assignees of NPEs change 6 times on average; this implies that frequent assignee changes can be used for early detection of patents being collected for future litigation.

Table 5: The NPEs that filed lawsuits against the top 10 automobile companies

NO	Types[9]	NPEs	Total number of litigations	Number of patents under litigation	Days of patent litigation after purchase	Number of changes in the assignor	Mid-Assignors	
							Bank/ Capital	NPEs
1	Assaultive	PJC Logistics, LLC.	5	1	16	17	√	
2		Beacon Navigation GmbH.	19	8	15	13	√	
3		Delaware Radio Technologies, LLC.	6	3	6	17	√	
4		Signal IP, Inc.	5	2	5	6	√	
5		Innovative Display Technologies, LLC.	5	6	1	6		√
6	Inventive	Joao Control& Monitoring Systems, LLC.	5	7	450	2		
7		Novel Point Tracking, LLC.	12	1	236	1		
8		American Vehicular Sciences, LLC.	21	22	180	3		
9		Affinity Labs of Texas, LLC.	5	6	95	4		
10	Hybrid	Clear With Computers, LLC.	3	3	45	3	√	√

Notes: Patent litigation data taken from PatentBlast (as of May 2014)

In Table 5, we categorize the NPEs that filed patent disputes against the top ten global automobile companies, as listed in Table 3, based on the patterns of how litigation formed. The "assaultive" NPEs purchased patents to initiate disputes within relatively short periods of time, with vigorous use of concealment. On average, assaultive NPEs filed 8 lawsuits against the top ten global automakers, 8.6 days after undergoing 12 assignee changes on 4 patents. The "inventive" NPEs had research and development (R&D) competencies and facilities for autonomously

[9] 2013 NPE Litigation Report, RPX

creating intellectual properties to initiate litigation within relatively longer periods of time. This concealment strategy is uncommon among inventive NPEs, which indicates that speed is one of the compelling attributes for concealment. We speculate that inventive NPEs choose to secure dominant positions in disputes with superior patent portfolios; in contrast, assaultive NPEs rely heavily on the aggressive nature of litigation.

Despite the limited number of instances, "hybrid" NPEs made the best use of leverage by incorporating both the strategies of assaultive and inventive NPEs. Hybrid NPEs operate R&D capabilities to keep patent portfolios engineered and maintained; however, the litigation involves capital banks during concealment. Surmising from the types of NPEs, incorporating financial institutions during concealment can impose time constraints on litigation, depending on the nature of the funds available.

C. Predicting patent lawsuits

Based on the patterns of patent lawsuits over smart cars, we searched for patents registered in the US using the search queries below.

Table 6: Search queries to predict patent lawsuits

Queries	A) and B)
A)	Patents whose assignors have changed more than 6 times
B)	When mid-assignors or assignors have assignees on the list of banks, capital banks, and NPEs
* Detailed search formula (Number of changes in assignors >= 6) and ((Mid-Assignors == *BANK* or Mid-Assignors ==*Capital* or Mid-Assignors == NPEs list) or (Assignors == *BANK* or Mid-Assignors ==*Capital* or Mid-Assignors == NPEs list))	

The number of US patents that were retrieved from the aforementioned queries was 2,240 (from January 2008 to May 2015), 122 of which were classified as patents in the automobile industry. Among them, 12 patents had already experienced lawsuits and accounted for 10 percent of the automobile-related patents in this study. Using the aforementioned queries makes it possible to identify the patents that showed similar patterns to the ones facing lawsuits.

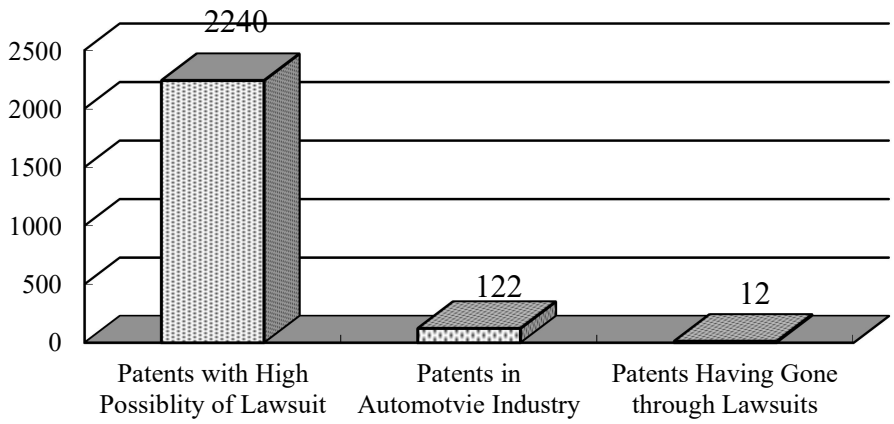


Figure 6: Predictions of patent lawsuits

Monitoring patents facing lawsuits makes it possible to respond to lawsuits brought by NPEs in advance, including making an invalidation case. Moreover, when variables such as forward citation counts by examiners, whether rights are transferred to tax havens, and certain types of law firms, are used with the OR condition(a type of search query), the prediction rate of patent lawsuits could increase by more than 10 percent.

IV. Conclusion

In this paper, we studied patent litigations on US smart cars initiated by NPEs, focusing on their patent acquisition and litigation patterns. We performed a correlation analysis to determine the overall preferences of NPEs in selecting litigation targets, and analyzed patterns in patent acquisition to reveal the characteristics of NPEs in terms of litigation strategies, with which we categorized NPEs as “assaultive,” “inventive,” or “hybrid.” We showed that the patent acquisitions of the assaultive and hybrid NPEs are followed by patent concealments, for which the NPEs delegate other entities, including financial institutes or shell companies, to change patent assignees frequently. The assaultive NPEs, generally funded by banks or capital banks, compel targeted manufacturers to make decisions under time constraints and injunction threats. The inventive NPEs are capable of generating intellectual property with their own R&D capabilities. Compared to the assaultive NPEs, the inventive NPEs usually hold more comprehensive patent portfolios, and invest more time in preparing for patent disputes. The hybrid NPEs, despite being scarce, own R&D capabilities and plan disputes by including banks, capital banks, or other NPEs in patent concealments.

Understanding NPEs and analyzing the intentions of their disputes can facilitate reasonable outcomes with minimal risks and costs; however, identifying NPEs or shell companies may not be possible without extraordinary investments in a database. Our findings suggest that the signals from banks and capital banks, which may be actively involved in litigation plans and processes of concealing the patent assignee, should be observed. Our network analysis on patent litigation data on US smart cars shows the prospective advantages of network centrality indices in monitoring NPEs to establish counteracting strategies in an expedited manner.

For practical implications, we suggest calculating the degree and betweenness centrality indices in order to capture the dispute intentions and litigation competencies of NPEs. By continuously updating degree centralities, NPEs in the litigation network can be rapidly identified, the intentions of disputes can be captured, and decisions of the corresponding mode of countermeasures can be facilitated. Additionally, continuous monitoring and analysis of the betweenness centralities of the entities in the litigation network can expedite the establishment of comprehensive dispute tactics. Manufacturing companies have been responding to the demands from NPEs in a diversified manner, which is depicted by the betweenness centralities. Therefore, betweenness centrality analysis can be a valuable source of information for selecting appropriate tactics.

By exercising intellectual property rights, NPEs make the best use of the legal system by first filing patent infringement lawsuits against multiple companies and demanding indemnifications. Normally, the accused manufacturers consider accepting the offer over the risk of having court injunctions against them, despite the excessive claim for compensation. Therefore, actual lawsuits may not be the most desirable outcome for both NPEs and manufacturers.

In 2012, the US government initiated the America Invents Act (AIA) to impose consolidated regulations on patent disputes; this has decelerated the rate of litigations. Our study shows that automakers and original equipment manufacturers (OEMs) have generally been passive in responding to patent disputes; however, NPEs may encounter a new environment. Inferring from the observations of cases with financial institutions, it is possible to conclude that NPEs could evolve by forming coalitions with other entities, including OEMs and automakers. Prospective studies could consider these evolutionary aspects in conjunction with intellectual property markets, in order to suggest strategies for developing manufacturing industries, including smart cars in the vehicle industry.

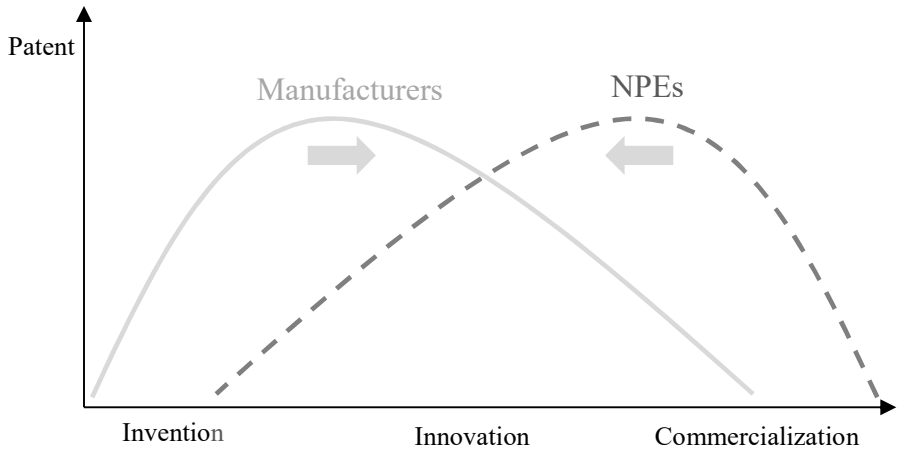


Figure 7: NPEs and manufacturing businesses

Patents have recently emerged as a new investment product and capital flows have increased in the patent business because core businesses are expected to file for patents in the future. Historically, there have always been fierce patent disputes in new markets. In essence, those who try to advance into the market use patents as weapons; at the same time, those who occupy the market use patents as shields. As demonstrated above, as NPEs and manufacturing businesses supplement each other and become similar in terms of their structure and how they litigate, NPE businesses will continue to evolve regarding the buying and selling of intellectual property.

It is unfortunate that I was not able to include all existing automobile manufacturers in this study. General Motors was not included because its net profits turned out to be low since it had too many affiliates. In addition, the study would be improved if the number of patents held by automakers in their countries, as well as the US, were considered. In the future, should I investigate this matter further, I would include more automobile companies.

Appendices

Network analysis

We analyzed the networks of the data on patent disputes over US smart cars in order to comprehend litigation relationships. The links between the nodes are directed so that the litigation relationships between entities can be described as follows: An outgoing arc indicates that the entity is the litigator, while an inbound arc depicts the defendant. The indices we used for interpreting the results from the network analysis are degree centrality, closeness centrality, and betweenness centrality.

(1) *Degree centrality* measures the direct relationships of a node with respect to the other nodes within the network. Degree centrality only considers the direct connectivity within the network; thus, only the relation within a local range can be analyzed.

(2) *Closeness centrality* incorporates both direct and indirect connections to measure the relational position of a node within the entire network. Generally, closeness centrality represents the influence of a node within the network in terms of information flow.

(3) *Betweenness centrality* portrays the role of a node in terms of the contributions to the mutual connections as a mediator between the nodes in the network.

We used the software Gephi (v0.8.2) for our network analysis of patent litigation data on US smart cars to obtain the results, as shown in Figure 8. In interpreting the results, we found that cases of technology patent disputes among the major automakers and OEMs are scarce, and most lawsuits filed by the automakers and OEMs are for trademark infringements. The major automakers were accused of 212 cases of technology patent infringement from 2009 to 2014, mostly filed by entities listed as NPEs.[10]

In Table 5, we categorized Beacon as “assaultive” and AVS as “inventive,” considering that AVS operates R&D facilities. Both NPEs have been triggering a series of litigations against automakers and OEMs. From 2009 to 2014, AVS and

[10] Comparison and confirmation between the NPE list of PatentFreedom, and the NPE list by the Korea Intellectual Property Protection Association (KIPRA)

Beacon filed 30 and 59 patent litigations, respectively.[11] Our degree centrality results, as shown in Table 7, indicate that the two NPEs have been engaged in 40 patent disputes against the top ten global automakers, as listed in Table 3.

Table 7: Degree centralities of NPEs

Types	NPEs	Degree Centralities	
		In-Degree	Out-Degree
Assaultive	PJC Logistics, LLC	0	5
	Beacon Navigation GmbH	0	19
	Delaware Radio Technologies, LLC	0	6
	Signal IP, Inc.	0	5
	Innovative Display Technologies, LLC	0	5
Inventive	Joao Control & Monitoring System, LLC	0	5
	Novel Point Tracking, LLC	0	12
	American Vehicular Sciences, LLC	0	21
	Affinity Labs of Texas, LLC	0	5
Hybrid	Clear With Computers, LLC	0	3

The degree centrality of an entity is the total number of in-bound and out-bound connected arcs. Table 7 shows the in-degree and out-degree centralities of the NPEs. Observing the litigation data through network analysis, the NPEs show distinct characteristics compared to other entities. Including AVS and Beacon, the NPEs listed in Table 7 have zero in-degree centralities, which implies that the NPEs have not been sued, even on counterclaims. Therefore, the degree centralities from the network of litigations could be used as indices to monitor the nature and intentions of NPEs, in order to decide how to reply expeditiously before establishing further countermeasures.

As observed in Table 8, the NPEs with higher possibilities of holding key patents can be deduced by considering the degree centralities with the number of patents used for litigation filings.

[11] The patent litigation data were rearranged according to the civil action number, and overlapping data have been removed.

Table 8: NPEs' dispute filings and patent holdings

Types	NPEs	Disputes Files (a)	Patent(s) in disputes (b)	(a)/(b)
Assaultive	PJC Logistics, LLC	5	1	500%
	Beacon Navigation GmbH	19	8	238%
	Delaware Radio Technologies, LLC	6	3	200%
	Signal IP, Inc.	5	2	250%
	Innovative Display Technologies, LLC	5	7	71%
Inventive	Joao Control & Monitoring System, LLC	5	7	71%
	Novel Point Tracking, LLC	12	1	1200%
	American Vehicular Sciences, LLC	21	22	95%
	Affinity Labs of Texas, LLC	5	7	71%
Hybrid	Clear With Computers, LLC	3	3	100%

In contrast, the results shown in Table 9 imply that automakers have been handling the litigations in a receptive way, including those not initiated by NPEs. BMW has an exceptionally high number of litigation filings; however, BMW did not accuse any of the NPEs.

Table 9: Litigations related to major automakers

NO.	Automakers	Accused cases(a)	Litigation Filings(b)	(a)/(b)
1	Hyundai Motor Corp.	22	1	5%
2	Kia Motor Corp.	15	3	20%
3	Toyota Motor Corp.	22	0	0%
4	BMW AG	26	52	200%
5	Daimler AG	15	1	7%
6	Ford Motor Co.	28	2	7%
7	Volkswagen Group	22	5	23%
8	SAIC Motor Co., Ltd.	0	0	-

By definition, the betweenness centrality of a node in directed (i.e., organized) litigation networks represents the number of in-bound and out-bound arc pairs, which are intermediated by the node. Toyota, the company with the highest number of smart car patents, has been accused in 22 patent infringement cases. However, Toyota has not responded with countermeasures, and has a zero out-degree centrality, which consequently produces a zero betweenness centrality. Further investigation shows that Toyota acquired patents US8394618, US8324295, and US7290627 from the NPEs that presumably filed lawsuits that used these patents in order to close the cases without further dispute. Therefore, Toyota is considered to use the exemplary strategy of "technology absorbing." In contrast, BMW has been active in patent disputes and has the highest betweenness centrality. As shown in Table 10, the betweenness centrality indices of automakers is spread over a relatively broad range, from 0 to 958, which implies differences in the tactics that automakers use to counteract lawsuits against them.

Table 10: Betweenness centralities of automakers in the network of litigations

NO.	Automakers	Betweenness Centralities
1	Hyundai Motor Corp.	11
2	Kia Motor Corp.	34
3	Toyota Motor Corp.	0
4	BMW AG	958
5	Daimler AG	9
6	Ford Motor Co.	38
7	Volkswagen Group	80
8	SAIC Motor Co., Ltd.	0
9	Honda Motor Co., Ltd.	20
10	Nissan Motor Co., Ltd.	0

The implications of the betweenness centralities suggest that they are effective indices for inferring relationships among the entities and litigation competencies. For example, analyzing the betweenness centralities of the accused entities in the litigation network can establish efficient counteracting tactics against NPEs. Examining the litigation history of NPEs by focusing on the accused entities can provide ample information for litigation strategies. NPEs search for vulnerabilities in the patent portfolios of targeted companies in order to successfully litigate. Therefore, an analysis of litigation histories and outcomes can suggest lucrative

counteractions, including coalitions with other entities. In contrast, the NPEs that engaged in lawsuits against BMW can be considered competitive.

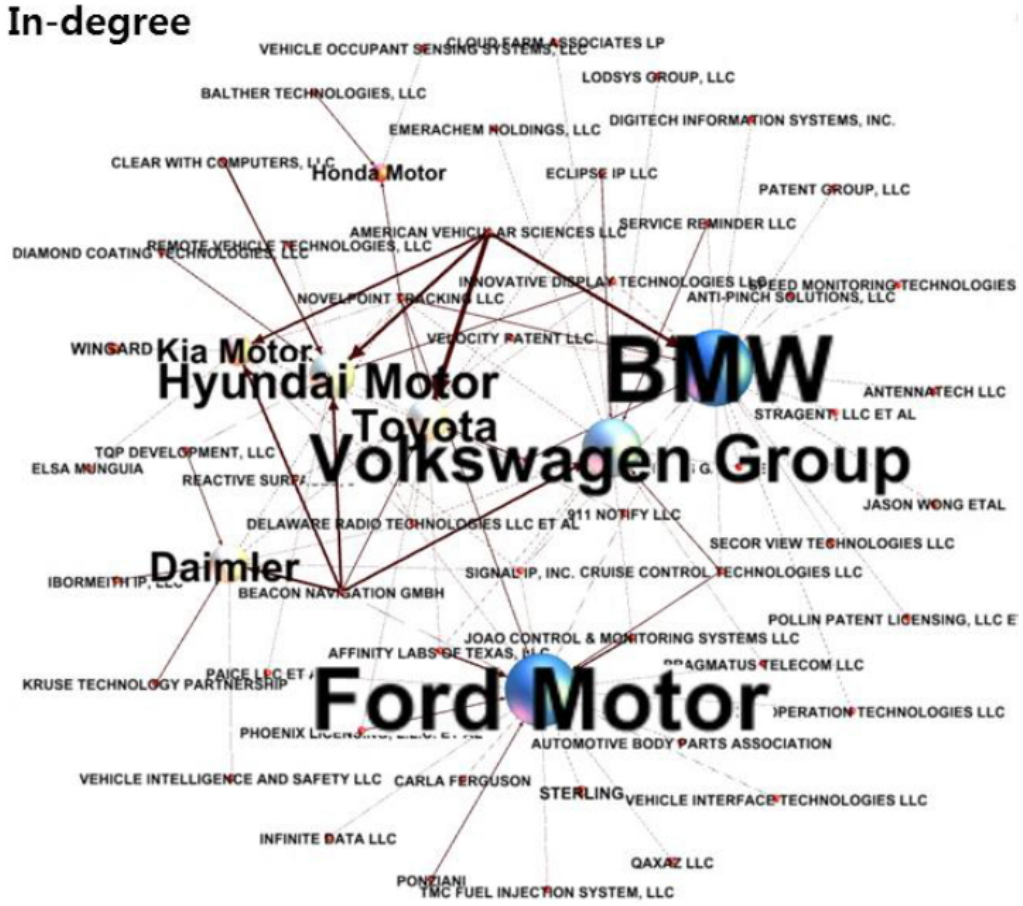


Figure 8: The network of patent lawsuits on US smart cars (in-degree)[12]

12 Graphic results by Gephi0.8.2 (Layout option: Fruchterman Reingold drawing method)

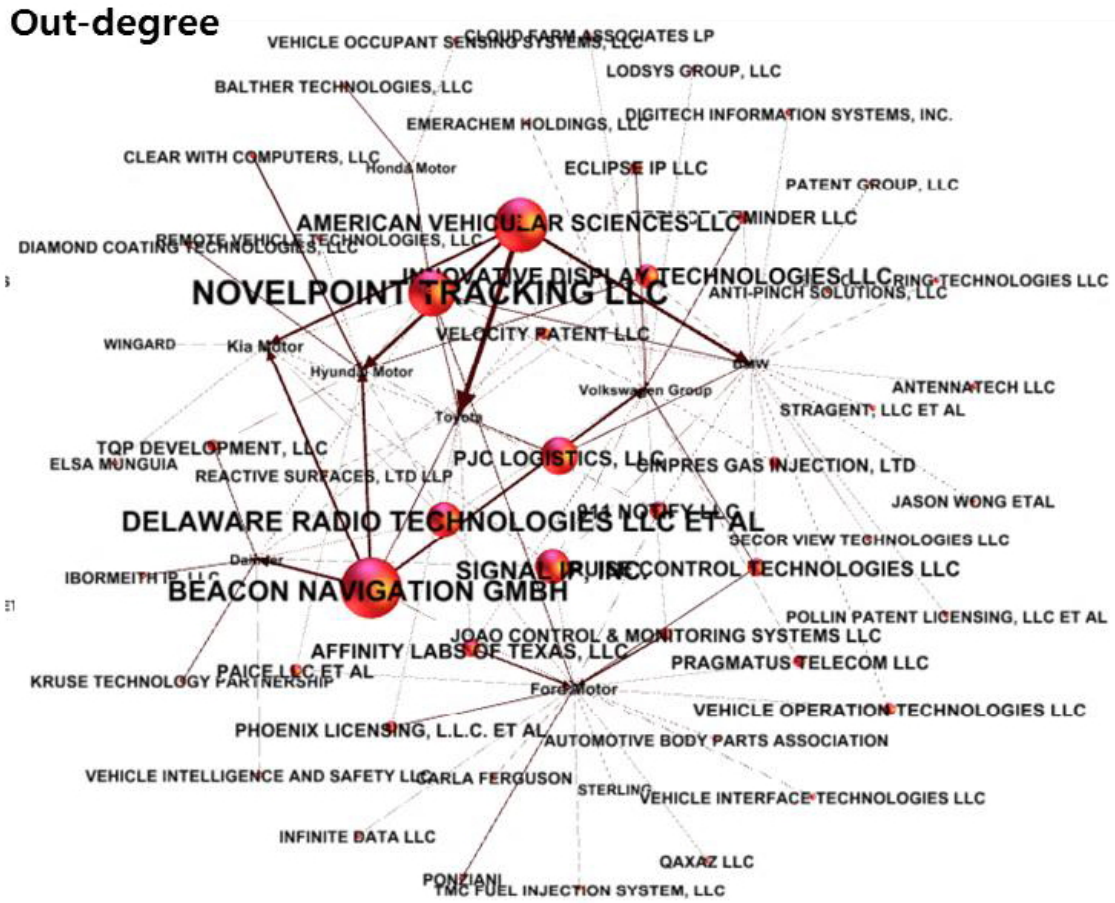


Figure 9: The network of patent lawsuits on US smart cars (out-degree)

In Figure 10, we show the examples of litigation networks of AVS and Beacon.

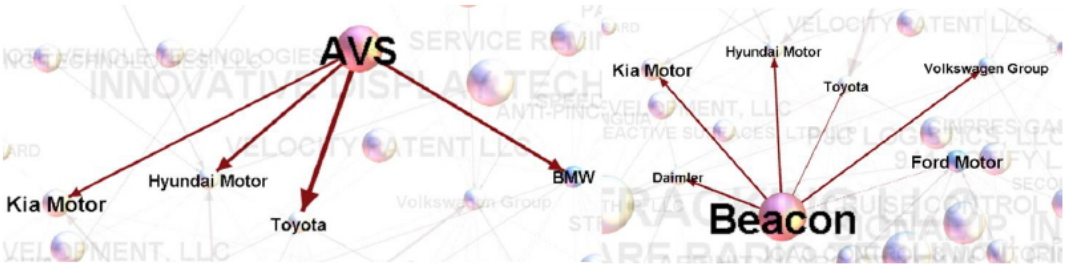


Figure 10: Patent dispute networks of AVS and Beacon

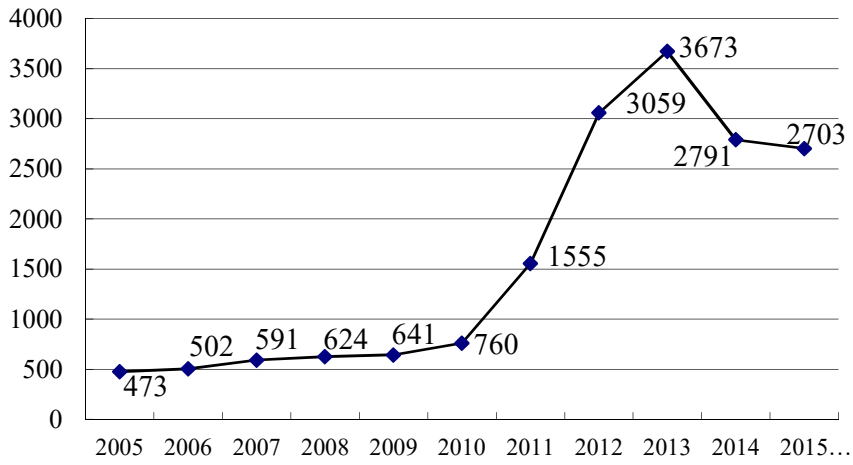


Figure 11: Operating company parties in NPE lawsuits over time
Source: RPX corp. Data captured as of January 10, 2016.

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