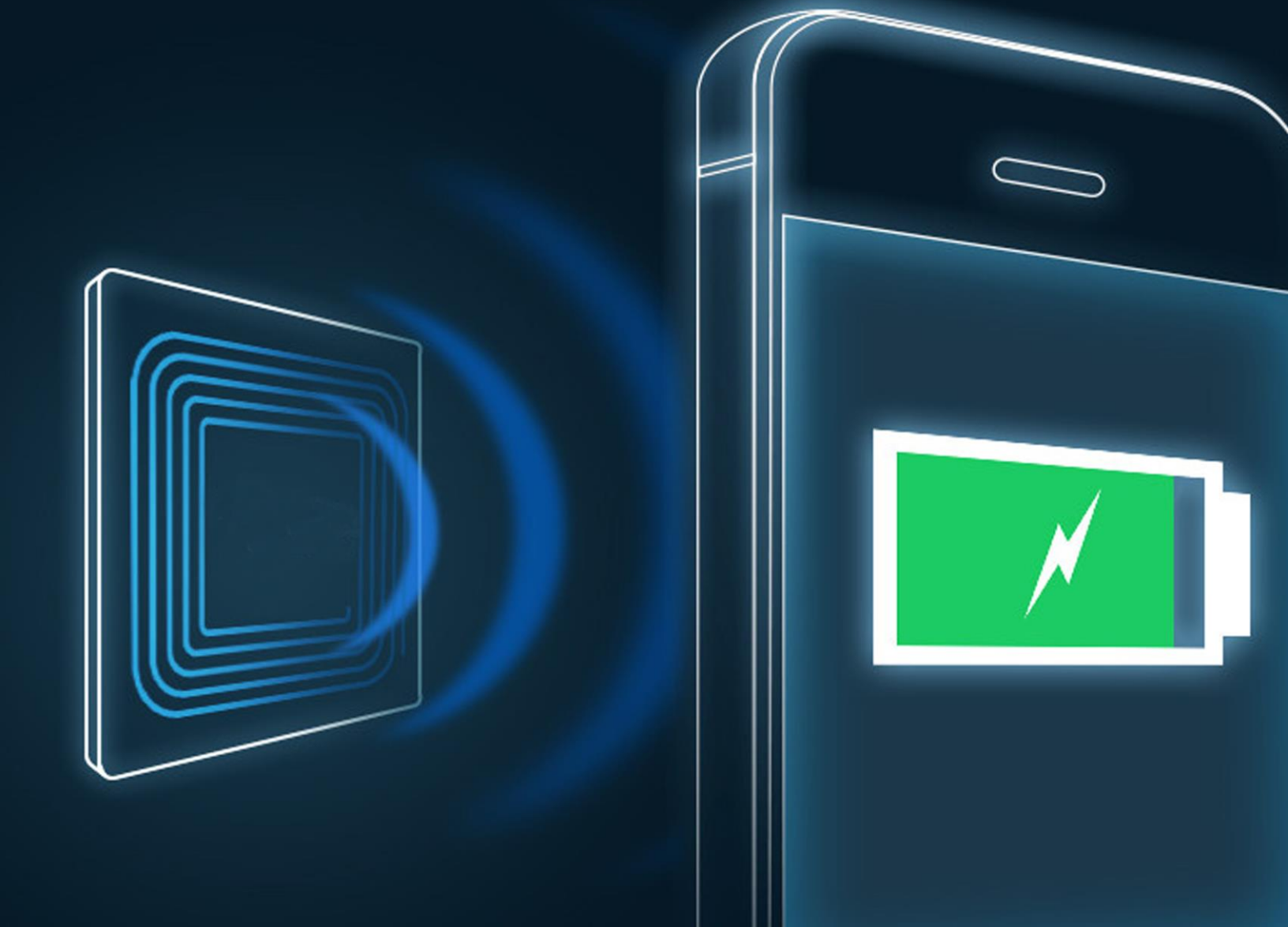
LexInnova

WIRELESS POWER

Patent Landscape Analysis



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Executive Summary

As mobile technology advances and adds more and more features, devices such as wearables, tablets and smartphones get used for longer durations. With this development, the need to keep the devices adequately charged at all times becomes important. Most of these devices are mobile and do not require wires for data connectivity, however charging still demands tying up these devices to a cord. Wireless power aims to cut these cords and transmit power to these devices wirelessly. This is done by transmitting power from source to device in the form of an electric field, magnetic field, or electromagnetic radiation.

In this report, we study the technological landscape of this impactful technology from the perspective of Intellectual Property (Patents). We find that the majority of patenting activity under this technology has occurred in inductive coupling technology. Smartphones, cameras, laptops and computers are the most common application areas of wireless power transmission technology. We also find that a large number of the patents and patent applications are distributed among top three companies. Samsung is at the top and holds around 1,136 patents/patent applications. Samsung is followed by Qualcomm and LG with a significant number of patents in their portfolio. The share of these top 3 assignees is around 20% of the total patents/patent applications (considered for analysis) in this technology domain. Geographically, China has seen the maximum patent filings related to this technology domain followed by USA, Japan and South Korea.

Using our proprietary patent analytics tool, LexScore^{TM}, we identify Qualcomm as the leader in this technology domain, with a high quality patent portfolio and high patent filing activity. Samsung also holds a significnt number of patents in this domain. Toyota and Access Business Group have filed more than 95 percent of patents after 2009 and have showed potential to compete with Qualcomm as market leaders.

Startups like WiTricity Corporation and Mojo Mobility Inc. also have considerable number of high strength patents. Our analysis also highlights that Qualcomm dominates the long range power transmission sub-domains such as “Microwave power transmission.”

The following sections contain our detailed analysis of the Patent Landscape of this technology domain.

Introduction

Back in 1890s, Nikola Tesla showed the world that electricity could be transferred without the use of a wire. He invented a device (Tesla coil) that could transfer electricity over the air. More than 100 years later, the world has adapted this breakthrough technology for commercial application to recharge a variety of electronic items, beginning with the electric toothbrush. Wireless power technology is evolving rapidly, with an increasing number of applications coming to market in the last few years. As more gadget makers warm up to a world without wires, this technology category is positioned to explode. The growth in mobile computing has led to more slim and stylish devices without connectors. Most of the data transfer in mobile devices is done wirelessly through Wi-Fi and mobile data network. It is only natural to eliminate the power chord needed to charge these devices to make them truly wireless. With the advent of more pervasive mobile computing technologies, the need to keep these power-hungry devices charged without wires has initiated the next wave of innovation in wireless power transfer. Wireless charging finds its application in smartphones, tablets, Bluetooth headsets, portable computers and game controllers. Smartphone manufacturers have already released phones with built in wireless charging capability. Several select Starbucks outlets already offer wireless charging pads.

A new highlight in the series of Wireless Power developments is RRC, which is a proprietary 20-Watt transmitter and receiver system solution.

So the big question is – how does wireless charging work?

At present there are two primary methods by which wireless charging can be done. These are called non-radiative and radiative methods. In near-field or non-radiative techniques, power is transmitted over a short distance via coupling between coils of wire using magnetic induction or by capacitive coupling between electrodes. In radiative or far-field techniques, also called power beaming, power is transmitted by means of electromagnetic waves or laser beams. In this scenario waves or beams should be directed towards a particular receiver.

Cota Wireless Power Solution Improves With Long Range Charging Through Closed Doors

Wireless charging technology has diverse application in the electronic industry. The Total Available Market (TAM) for wireless power charging is high due to a large number of mobile devices and is expected to grow by more than forty times in terms of revenue by 2018[1]. Pike Research has forecasted that the number of wireless power systems in mobile devices will grow from 3.74 million in 2012, to 27.63 million in 2016[2]. Another market research by the marketing consultancy company Markets & Markets suggests that the wireless power

[1] Global Market Revenue for Wireless Charging to Rise by Nearly Factor of 40 by 2018,.IHS, March 13, 2014
[2] Wireless power for mobile devices market to reach $5 billion by 2020, Information Age, 16 November 2014

sector will generate revenues of $17.04 billion by 2020 with an estimated CAGR of 60.49%[3].

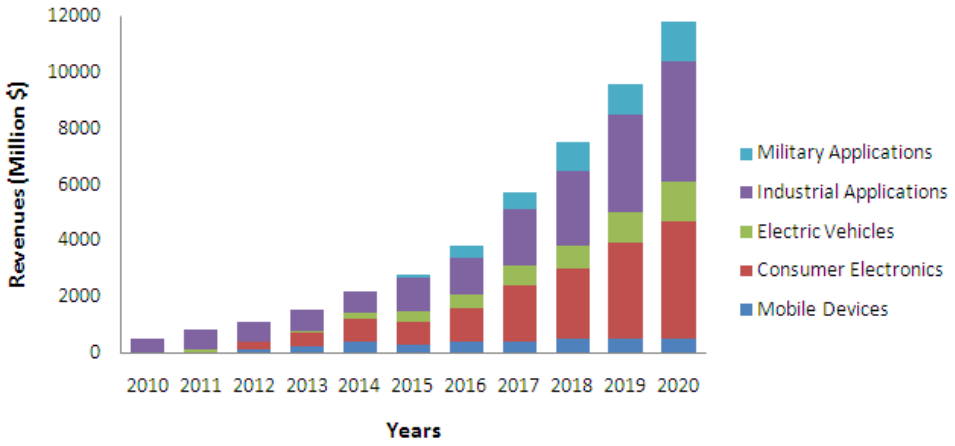

Figure 1: Market Revenue Prediction (Source: Pike Research)

Smartphone manufacturers have already started integrating wireless charging features in their flagship smartphones as early as 2013. Nokia (Lumia 830), Samsung (Galaxy S4), LG (Nexus 4) and HTC (Droid DNA) already incorporate wireless charging feature. Wireless charging in mobile devices is expected to become as ubiquitous as Wi-Fi and Bluetooth. Intel has promised the world its first complete wireless computer by 2016.

Toyota, in association with WiTricity, has introduced a wireless charging device for automotive use. Researchers at Stanford University have undertaken a research to study the feasibility and applicability of cars powered wirelessly through electricity induced via magnetic coils on a highway[4]. Thoratec, a health care company has also partnered with WiTricity to facilitate wireless charging of heart pump and other medical equipment. Lockheed Martin, the aeronautics defense major, is looking at wireless power transmission to charge drones mid-air. Researchers at NASA have already flight-tested a small model aircraft powered by propulsive power from a ground based infrared laser[5]. The scientific development has not only been restricted to the academic world, but is also being developed for commercial application in the aviation industry. Leggett and Platt automotive in association with AML is developing a PED wireless charger for the aviation industry[6].

Also WiPower, a Qualcomm patented technology has made its commercial debut last year in Qualcomm Toq™, the first smartwatch to include wireless charging. Qualcomm is actively out-licensing its wireless power reference design

Global home furnishings retailer IKEA announced a product launch of Qi-powered bedside tables, lamps and desks that eliminates cable mess and makes it easier to stay connected with always-charged mobile devices.

[3] Wireless Power Transmission Market worth $17.04 Billion by 2020, Markets and Markets.
[4] Wireless power could revolutionize highway transportation, Phys.org, 1 February 2012.
[5] NASA Armstrong Fact Sheet: Beamed Laser Power for UAVs, Dunbar, B., NASA, 28 February 2014.
[6] Inductive Wireless Charging (IWC), Aviation Modification Leaders Inc.

to licensees, giving them the tools and know-how to incorporate WiPower in their products. The list of WiPower licensees continues to grow. These are companies that have signed agreements specifically to work with the WiPower solution, and include key consumer electronics accessory manufacturers, Tier One automotive suppliers, furniture manufacturers, and more.

Long range wireless power transmission techniques are being tested to check feasibility of power transmission from space. If successful, these techniques could enable satellites to transfer the harvest solar energy to earth. Mitsubishi has already conducted a successful ground demonstration of long range wireless power transmission. In this demonstration, 10 kW of power was sent via microwaves to a receiver 500 meters away, causing an LED light to blink at the receiving end. Japan shows interest in long-range wireless power transfer to solve its perennial energy needs.

Although wireless power was named one of the top 5 disruptive technologies at CES 2013 by Forbes, it has still not met its full market potential[7]. This is primarily because the technology is still in its nascent state and would require more research and development. Secondly, the failure of the two power associations, namely, Wireless Power Consortium (WPC) and Power Matters Alliance (PMA) to converge on common standards has subdued research and mass commercialization efforts**.** The presence of various standards had made the industry highly fragmented. Wireless power technology appears to be headed towards a convergence of standards since last year as PMA and A4WP have agreed to partner. Qi is a wireless charging standard established in 2008 by the Wireless Power Consortium, and is supported by notable companies such as IKEA, Verizon, Samsung, Motorola, Philips, Haier, Sony, Panasonic, LG, Microsoft, Haier, Texas Instruments, etc. After the merger of A4WP and PMA it became one of the two biggest power consortiums that are trying to establish a standard for wireless charging. This merged standard group includes high revenue companies like Samsung, LG, Broadcom, Qualcomm, Microsoft, Haier, Asustek, Acer, HTC, Toshiba, Motorola, Texas Instruments, etc. Interestingly few companies like Samsung, Qualcomm, LG, and Texas Instruments were members earlier of WPC and made a switch to A4WP. They have started to invest increasingly in A4WP as these companies believe that this standard has potential for becoming the wireless charging technology of the future with its advantage over the Qi standard because of a 'one to many' kind of charging principle and a longer charging range.

Intel Corporation announced that it has acquired more than 1,400 patents and patent applications from The Gores Group, a private equity firm. The patents belonged to Powerwave Technologies

[7] The Five Most Disruptive Technologies at CES 2013 by Larry Downes | Forbes, 12 January 2013.

	Wireless Power Consortium	PMA	A4WP
Member Companies	140+ members	80+ members	40+ members
Active Consortium	Yes	Yes	Yes
Specification Published	Yes WPC1.1, public	Yes PMA1.1, members only	Yes V1.0, members only
Approved Tx Types	>20	In development	In development
Test Houses Established	9	In development	In development
Certified Products	160	In development	In development
IC Solution Available	Yes (~5 suppliers)	Two in development	None public
Production Coil Set Available	Yes	In progress	In progress
Regulatory Approvals	Yes	Yes	No
Infrastructure Play	U.S., Japan, Europe	U.S., Europe	None
Comments	Well established, products in market, wide design flexibility	Strong U.S. player, strong AT&T support, early stage	Strong push by Samsung and Qualcomm, active development ongoing

Figure 2: Wireless Power Associations (Source: Global Wireless Power Standard by Niranjan Pathare)

It is not just big companies that are tapping into this highly profitable vertical; there are many startups that are entering this market as well. One of the most prominent of all such start-ups is WiTrcity. WiTricity started as a project under MIT professor Marin Soljačić in 2007. Since then, it has become the industry pioneer in coupled magnetic wireless power transfer. In the last few years it has expanded into automotive, aviation, consumer electronics, healthcare and military industries by collaborating with big players such as Toyota and Therotac, by providing them with wireless power applications and technologies. It has Intel, Mediatek, Toyota, IHS, TDK and Delphi as licensees.

In such a financially lucrative and fast evolving market, safeguarding a company's interest using Intellectual property is an important strategy for market players. Assessing the IP landscape is therefore an important exercise for current market players as well as new entrants in this market. In the following paragraphs, we analyze the patent landscape of Wireless Power Transmission. First, a technological taxonomy is presented, followed by a discussion on the important players in this market.

Imagination Technologies announced low-power wireless IP for wearable and IoT

Leading Battery Charger Manufacturer CTEK announces a technology and patent license agreement with WiTricity Technology to help revolutionize the battery charging industry

Taxonomy

Wireless power transmission is being targeted for application in products of companies who are constantly trying to provide a better user experience. It has created huge opportunities for new technology companies such as WiTricity and Ubeam, who are trying to eliminate wired charging cord for all home appliances. However, wireless power transmission is not limited to wirelessly charging and powering household devices. Techniques such as microwave power transmission and power beaming are coming up, which aim to transmit power over longer distances. These techniques are being applied for automotive vehicle charging, aerial vehicle propulsion and solar power satellites.

In our study, we have classified patents and patent applications according to technology, performance, hardware and application.

The mobile smartphone, laptop, and computer domains have the highest number of patent filings with 7,769 and 6,691 patents/patent applications respectively, along with 6,991 patents/patent applications belonging to the inductive technique domain. This is because of the growing mobile smartphone market and the increasing growth of power intensive apps and devices. So, keeping smartphones charged without needing to be bogged down by a wire has become the prime driver of the wireless technology.

Magneto-dynamic coupling and Defense have the least number of patents filings with only 138 and 516 patents/patent applications, respectively. Such a small number of patent filings in the magneto dynamic coupling domain can be owed to the fact that magneto dynamic coupling is a very new technology and there are hardly any products in the market pertaining to this technology. Defense has seen increased number of wireless power applications in recent years with Lockheed Martin and NASA attempting research on charging drones wirelessly, but this research is yet to materialize into products.

The definitions of Level 2 domains are given in appendix.

Powermat CEO Thorsten Heins says any future Samsung smartphone with wireless charging will include his company's wireless charging standard.

Qualcomm's WiPowerBand Extends the Apple Watch Battery Life

Level 1	Level 2	Total Documents
Technology	Inductive technique	6991
	Magnetic resonance coupling	2991
	Magneto-dynamic coupling	138
	Capacitive coupling	4499
	Microwave power transmitter	2571
	Laser	2223
Performance Parameters	Distance Range	3851
	Directivity	870
	Frequency	5460
	Efficiency	2058
	Power Capacity	2233
Hardware	Oscillator	564
	Control Circuit	4521
	Power Amplifier	1024
	Transmitter	4102
	Receiver	6194
	Rectifier	1735
Application	Automotive	4874
	Healthcare	2568
	Industrial	5121
	Mobile Smartphones and cameras	7769
	Defence	516
	Home Appliances	1920
	Laptops and computers	6691

Figure 3: Taxonomy

Top Assignees

The figure below shows the assignees with maximum number of patents/patent applications related to wireless power transmission. Samsung, Qualcomm and LG are the top 3 patent filers in this domain with 1,136, 1,014 and 723 patents/patent applications respectively.

The top assignees mainly consist of companies operating in the electronics domain. Toyota with 353 patents/patent applications and Mitsubishi with 130 patents/patent applications are two leading automobile manufacturers also appearing in the list indicating that the automobile industry will soon incorporate wireless power transmission technology to power vehicles.

Electronics companies seem to be the early adopters of wireless charging products in the market. Most of the leading smartphone manufacturers have already released phones that support wireless charging.

Samsung has patents/patent applications on wireless power technology that relate to smartphones and cameras. Samsung's patent landscape reveals a lack of filings of patents on directivity and magneto-dynamic coupling.

Qualcomm has majority of its patents pertaining primarily to the inductive technique. The patent filing trend indicates that Qualcomm hasn't focused on magneto-dynamic coupling. LG has a strong portfolio in Inductive technique, Magnetic Resonance coupling and mobile computing device.

LG Innotek has been providing power transmission modules for wireless charging to global smartphone companies since 2012 including LG Electronics, Motorola, and Kyocera.

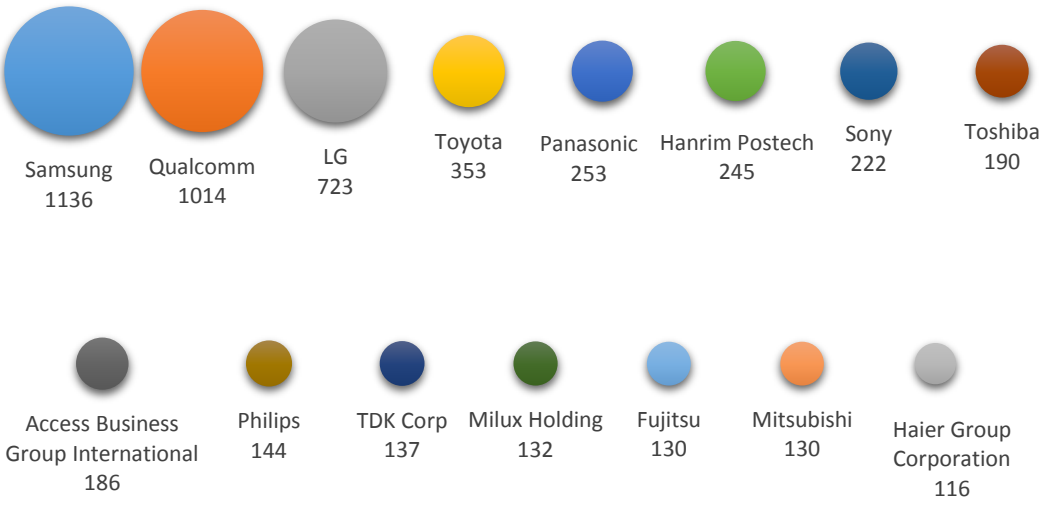

Figure 4: Top Assignees

LexScore™

We use LexInnova's proprietary LexScore™ framework to identify intellectual property portfolio strength and weakness in wireless power transmission technology. The figure below depicts the competitive positioning of the top 15 assignees in the wireless power transfer domain. The assignees are compared on the basis of filing score and quality score. We use our proprietary algorithm (based on bibliographical information and claim characteristics of an invention) to calculate the quality of inventions.

The green region comprises of the assignees with the best patent portfolios, which are exemplary in terms of quality and number of patents. Qualcomm is the only assignee lying in the green region of the chart and it can be assumed that it dominates the domain in terms of intellectual property. Samsung and LG are in orange region that implies assignees with large patent portfolio in terms of number of patents but lacking in quality. LG and Samsung lag behind Qualcomm owing to their lower citation and geographical score. The geographical score can be improved by filing the patents in foreign jurisdictions. LG and Samsung have filed most of the patents in last 5 years (2010-2014) resulting in a low citation score. We expect the citation score of these assignees to improve as further research is carried out in this domain.

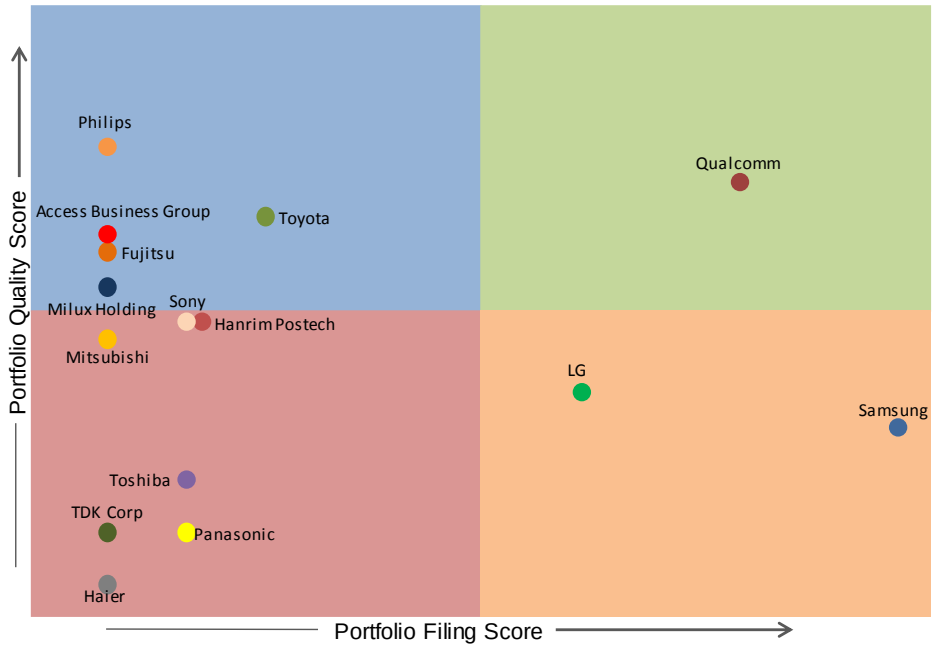

Figure 5: LexScore™

Assignees in the blue region possess patent portfolios of good quality but lack in the number of filings. Toyota, Access Business Group, Philips and Milux Holdings are the assignees in this region. Toyota is the 4th largest assignee in terms of patent filings after LG, Samsung and Qualcomm. Toyota and Access Business

Hanrim Postech unveils wireless charger dubbed as "Etoss" for Samsung Electronics' Galaxy S4 and S3 LTE models in compliance with Qi standards

Powermat Acquires Finland's PowerKiss, Stirs up Wireless Power Standard War

Group have filed more than 95 percent of patents after 2009 and seem to be advancing towards the green region.

Remaining top assignees lie in red region that comprises of assignees with patent portfolios lacking in quality as well as in number of filings.

AT&T's LG G3 supports PMA wireless charging, instead of Qi

Patent Strength

2015 model year Toyota Camry to have wireless charging available as an option

The patents in our report are ranked automatically by our proprietary tool that relies on the algorithm developed by Mark A. Lemley, Kimberly A. Moore, John R. Allison, and R. Derek Trunkey in their research paper, "Valuable Patents". Historical research has proven that 97% of the litigation-worthy patents in a portfolio are found in Top bracket of the patents ranked by using this algorithm.

Qualcomm has 121 high strength patents (which lies in the top bracket), which is maximum for any company related to this sector. Samsung also has 55 high strength patents, which is low as compared to its competitor, Qualcomm. Moreover, new companies in this sector such as WiTricity Corporation, Mojo Mobility Inc. also have 22 and 19 patents respectively in the top bracket. Many non US companies like, Semiconductor Energy Lab Corporation and Hanrim Postech Corporation also have patents that feature in the top bracket. An important point to note here is that there are companies like Fujitsu that does not appear in this list but still they have possess pretty good patent portfolio. This is due to the fact that although they don't have many prolific patents (patents appearing in the top bracket), the average patent strength of their portfolio is better than others.

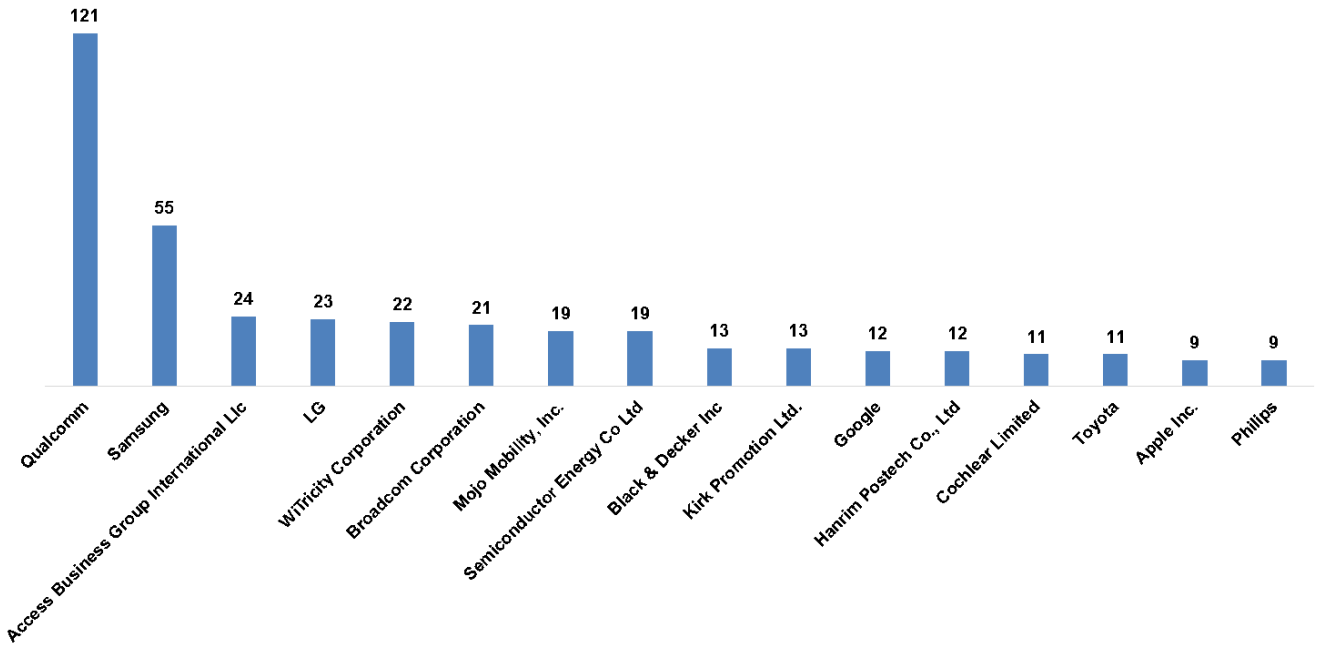

Figure 6: **Companies with maximum number of High-strength patents**

Licensing Heat Map

We use our LexInnova's Licensing-Heat Map (Figure 7) framework to identify sub-domains in the field of wireless power transmission where licensing activity is expected to be high. The size of the sections (representing different technology domains) in the Heat Map indicates the number of patents/patent applications filed in this domain. This implies the relative importance of the sub-domain whereas the color represents the chances of future licensing activity in this domain. We study the patent holding pattern to color code the technology sub-domain for future licensing activity.

Red color (and shades thereof) signifies a high chance of licensing activity in a certain sub-domain whereas the green color (and shades thereof) represents a low chance of licensing activity in the sub-domain. We follow 80-20 rule to decide the colors, yellow is assigned to the domains that lie on the average case (i.e. 20% assignees having 80% of the patents/patent applications). The color drifts towards shades of red if 20% assignees possess less than 80% of the patents/patent applications, while it drifts towards shades of green in the reverse case.

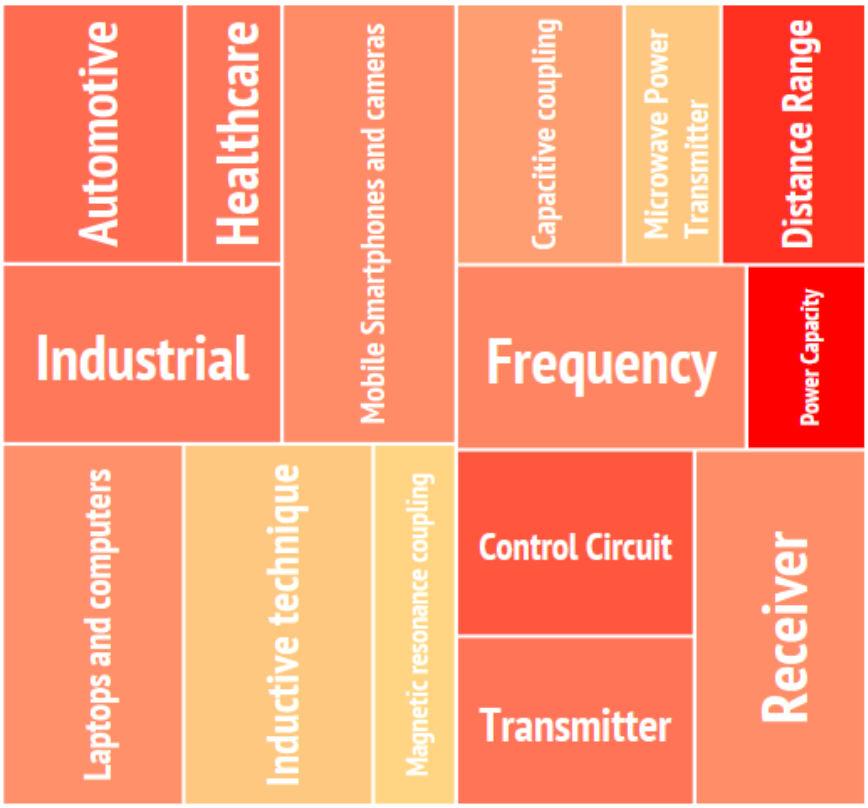

Figure 7: Licensing Heat Map

Japanese car giant Toyota - which made an early investment in Witricity - now plans to introduce wireless charging in the 2017 Prius.

Toshiba Launches Wireless Power Receiver IC Supporting Quick Charging

WattUp router can beam wireless power to 12 devices 15 feet away

It is evident from the above figure that Inductive technique, Magnetic Resonating coupling and Microwave Power transmission are the sub-domains where top assignees possess a good share of patents.

'Inductive technique' utilizes magnetic coupling to transfer energy from one coil to another. Nickola Tesla introduced/invented this technique for wireless power transmission. This is the most field technology sub-domain and 7 out of the top 15 assignees have extensively filed in this domain. Access Business Group International, Fujitsu, Haier Group Corporation, Hanrim Postech, LG, Milux Holding, Mitsubishi, Panasonic, Philips, Qualcomm, Samsung, Sony, TDK Corp, Toshiba, Toyota are the top filers in this domain.

'Magnetic resonance coupling' is a modification of inductive coupling that increases the range of the inductive coupling significantly. LG, Qualcomm, Samsung and Toyota are the top filers in this domain. 'Distance Range' and 'Power capacity' are dark red in color which reflects a very distributed portfolio with no monopoly of any assignee in these domains, hence have higher chances of licensing activity. While on the other hand, domains like 'Inductive techniques' & 'Magnetic Resonance coupling' fall in the lighter shades reflecting that the patent portfolio in these domains is predominantly held by some top players.

The next-generation Qualcomm® Snapdragon™ 810 processors will support Qualcomm® WiPower™ technology, bringing wireless charging to the chipset level on devices powered by these Snapdragon processors.

Geographical Coverage

China is the Jurisdiction that has witnessed maximum patent filings with 4,770 patent applications. The US is in the second place after China with 3,845 patent application filings followed by Korea and Japan. Remaining countries have less than 200 patents/patent applications.

China is ahead in the total number of filings in spite of the fact that top 5 assignees have more patent filings in USA than in China. This could be due to the fact that there are numerous universities and academic institutions along with a number of small-scale organizations that have 5 or less patents/patent applications filed in China. China as a nation is putting its resources to lead the intellectual property creation activity in the world in wireless transmission of electricity. Assignees with more patent application filings in China in compared to that in USA are, Haier Group, Huawei, ZTE and Tianjin Polytechnic University with 76, 43, and the other two with 41 patents/patent applications each in China and with 2, 6, 5 and zero patents/patent applications in USA respectively.

Overall the maximum numbers of patent filings in China are filed by Qualcomm, Samsung, Haier and LG with 129, 82, 76 and 62 patent applications respectively. Whereas the maximum numbers of patent filings in USA are filed by Qualcomm, Samsung and LG with 376, 237 and 120 patent applications respectively.

Ossia raises $10M from KDDI and Others to Help Bring Wireless Power to Japan

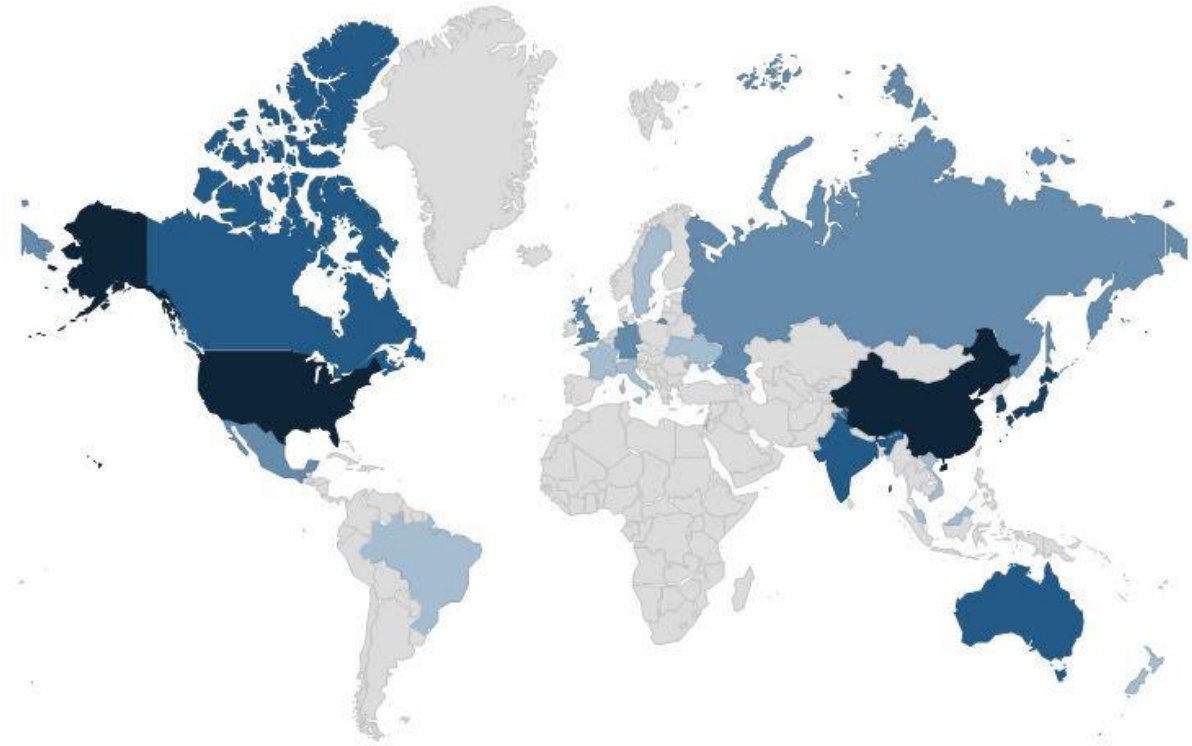

Figure 8: Geographical Coverage Heat Map

Products

Samsung showcased an IoT based wireless charging solution at CES 2015. The device is a table for cafes and store with a display, wireless charging facility and wireless communication technology[8]. Samsung has also released a wireless charging pad. The pad charges devices that have a compatible wireless charging cover and other Qi compatible devices[9]. Samsung is top filer of patents in the wireless power transmission domain and has actively participated in the standards (Qi, PMA, Rezence).

Figure 9: Samsung's wireless charging table for Cafes

Qualcomm has also actively filed in wireless power transmission domain and occupies second spot after Samsung. Qualcomm has announced that Qualcomm Snapdragon 810 processor will support wireless charging, extending the wireless charging technology to chipset level. Qualcomm Halo is another leap of faith that Qualcomm has taken in the direction of wireless charging. The Qualcomm halo project is a venture of Qualcomm and the University of Auckland to create a wireless ecosystem for wireless charging of electric vehicles.

LG, Toyota and Panasonic are the other top assignees in the wireless power transmission domain. LG has introduced phone (such as LG Optimus F5, LG Optimus G Pro, LG LTE2 and LG Spectrum 2) that are compatible with wireless charging systems. They also have released WCP-700 and WCP-300 that charge wireless charging pads for charging Qi enabled products. Toyota plans to introduce Witricity wireless charging systems in its car models Prius and Avalon. Panasonic is coming up with wireless power control IC's that are intended to support all electronic devices (such as DSC, DVC, portable audio, cellphone, smartphone, etc.) that comply with Qi standard. Panasonic has introduced transmission control IC (NN32251A) for wireless chargers and receiver control IC for (AN32258A) the electronic devices compatible with wireless charging. "The combination of NN32251A and AN32258A allows the extension of high-power transmission of up to 10 W from the WPC 1.1 (Qi standard)-compliant 5 W output."[10]

Figure 10: Panasonic wireless charge pad

[8] Samsung Electro-Mechanics Unveils Smart Wireless Charging Solution| Samsung Electro-Mechanics, 06 January 2015.
[9] Wireless Charging Pad Mini | Samsung
[10] Wireless Charging System ICs | Panasonic

Appendix: Taxonomy heads definition

Taxonomy Heads	Definition
Inductive coupling:	The electro-dynamic induction wireless transmission technique relies on the use of a magnetic field generated by an electric current to induce a current in a second conductor. This effect occurs in the electromagnetic near field, with the secondary coil in close proximity to the primary coil.
Capacitive Coupling:	In capacitive coupling (electrostatic induction), the power is transmitted by electric fields between electrodes such as metal plates. The transmitter and receiver electrodes form a capacitor, with the intervening space as the dielectric. An alternating voltage generated by the transmitter is applied to the transmitting plate, and the oscillating electric field induces an alternating potential on the receiver plate by electrostatic induction, which causes an alternating current to flow in the load circuit.
Magneto-dynamic coupling	In this method, power is transmitted between two rotating armature (containing magnets), one in the transmitter and one in the receiver, which rotate synchronously, coupled together by a magnetic field generated by permanent magnets on the armatures.
Magnetic Resonance Coupling	Magnetic Resonant power transmission is a special, but widely used method of inductive power transmission and is limited by the same constraints of magnetic fields emissions and efficiency.
Microwave power transmitter	Power transmission via microwaves can be made more directional, allowing longer distance power transmission, with shorter wavelengths of electromagnetic radiation, typically in the microwave range.
Lasers	In the case of electromagnetic radiation closer to the visible region of the spectrum (tens of micrometers to tens of nanometers), power can be transmitted by converting electricity into a laser beam. This mechanism is generally known as "power beaming" because the power is beamed at a receiver that can convert it to electrical energy.
Distance Range	Distance range refers to that performance parameter that denotes the range, that is, the distance up to which transmission of power can be achieved effectively.
Directivity	It mostly refers to directional power transmission that is employed in far field power transmission. It is a parameter of performance for wireless power transmitters.
Frequency	This parameter mostly refers to power transmission technique that involves resonance and electromagnetic radiation. For example in the case of microwave power transmitter frequency becomes the primary decisive factor that determines the power transmission range.
Efficiency	It is simply the ratio of power received by the receivers to the power transmitted by the transmitter.

Power Capacity	These parameters simply refer to the maximum power that can be effectively transmitted by a wireless power transmitter.
Oscillator	An electronic oscillator is an electronic circuit that produces a periodic, oscillating electronic signal. Oscillators convert direct current (DC) from a power supply to an alternating current signal.
Control Circuit	A type of circuit that uses control devices to determine when loads are energized or de-energized by controlling current flow to the transmitters and from the receivers.
Power Amplifier	A power amplifier is a device that is usually employed whenever a voltage is to be increased in a wireless power system for transmission in order to achieve the desired power output.
Transmitter	A circuit that accepts signals in form of electric current and translates them into a magnetic field or an electric field or a radio wave that can be sent across a medium.
Receiver	Circuits that receive transmitted signals from a transmitter and convert it into a usable form of electric power.
Rectifier	A rectifier is an electrical device composed of one or more diodes that converts alternating current (AC) to direct current (DC). A diode is like a one-way valve that allows an electrical current to flow in only one direction.
Automotive	This refers to application of wireless power system in vehicles and vehicular transportation
Healthcare	This domain refers to application of wireless power systems in health care systems like a wirelessly powered heart pump and other health monitoring system.
Industrial	This domain refers to the application of wireless power systems in Industrial sector, particularly in manufacturing and production sector. It may also be used in places where switches and traditional electricity is hazardous to use like in the case of coal mines, refineries and oil wells.
Mobile Smartphone and cameras	This domain refers to the charging of mobile smartphones and cameras wirelessly.

Defense	This refers to wireless power transmission in defense establishment and devices, for example wirelessly powered drones that can be used for surveillance.
Home Appliance	Wireless powering of domestic appliances like, fans, bulbs, air conditioner is what this domain is all about. Although it is pretty far-fetched, developments are going on pretty rapidly.
Laptops and Computers	Powering laptops and computers wirelessly via transmitters and receivers is what this domain deals with.

Table 1: Taxonomy Definitions

IS 607655

FS 614196

ABOUT US

LEXINNOVA TECHNOLOGIES LLC DRAWS ON A COMBINATION OF TECHNICAL AND LITIGATION EXPERTISE TO SOLVE THE CHALLENGES THAT ARISE AT THE INTERSECTION OF TECHNOLOGY AND THE LAW.

OUR CREDENTIALS

ISO 27001:2013 CERTIFICATION DESIGNATION VALIDATES LEXINNOVA'S COMMITMENT TO INTERNATIONALLY RECOGNIZED SECURITY STANDARDS

ISO 9001:2008 CERTIFICATION DESIGNATION VALIDATES LEXINNOVA'S COMMITMENT TO INTERNATIONALLY RECOGNIZED QUALITY MANAGEMENT STANDARDS

DISCLAIMER

LEXINNOVA HAS PREPARED THIS RESEARCH INDEPENDENTLY BASED ON RELIABLE PUBLIC DATA AND REVIEWED THE RESULTS BASED ON ITS PROPRIETARY METHODOLOGY, WITH THE BELIEF THAT IT IS FAIR AND NOT MISLEADING. THE INFORMATION AND ANALYSIS IN THIS REPORT IS TECHNICAL IN NATURE, AND SHALL NOT BE CONSTRUED AS LEGAL ADVICE OR A LEGAL OPINION OF LEXINNOVA.

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