2018

Wireless Power's Transformation of the IoT Product Ecosystems

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IMPORTANT INFORMATION

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1 Introduction to Wireless Power

Wireless power has the potential to dramatically change the way we use devices and have far-reaching changes in the way many devices and IoT products are used. What is wireless power? Quite simply, it is power that is received without wires. End-user devices as well as IoT devices can receive power anywhere in a room where wireless power is available. This technology allows devices to slowly charge and be powered within any room where a wireless power base is located. This can fundamentally change the way consumer devices are used, the way smart home sensors can be powered and placed, and the way commercial and industrial applications can be made more feasible.

1.1 The Difference Between Wireless Charging and Wireless Power

There is a difference between wireless power and the type of wireless charging that more people are familiar with today. The wireless charging that is becoming more well known today might be better described as contactless charging or near-field charging. One does not need to plug in a cable or slide the phone onto a cradle's connector to charge a device with wireless charging. The device merely needs to rest on a wireless charging cradle, box, or surface. The device needs to be in very close proximity to the charger). Wireless power is far-field, a device can be placed anywhere in a room and can be used to continuously power a device or, more likely, provide scheduled trickle charging. This provides many benefits, most notably that devices are able to be designed with much smaller batteries or for ultra-low power devices, even without a battery.

2 Types of Wireless Power

2.1 Induction / Magnetic Resonance

Induction and magnetic resonance are the methods that today's wireless charging cradles and pads use. The device has to be in close proximity to the charger. Qi uses induction, which is a little more forgiving than magnetic resonance. Magnetic resonance requires more precise placement of the device in relation to the charger, but is capable of deliver more power for larger electronic devices. Tens of millions of devices support wireless charging. Induction and magnetic resonance, however, do not allow for the practical and comfortable use of devices while charging. They will charge devices faster than far-field solutions can, so the inclusion of wireless power will occur alongside the current growth of wireless charging solutions.

2.2 Ultrasound

Ultrasound allows for a lot more power – enough to charge a laptop – at range across a room. However, ultrasound-based wireless power solutions require a 1-to-1 configuration of wireless charger to receiving product. This is a very inefficient way to deliver power.

2.3 Laser

Lasers can be used to deliver wireless power at a few hundred feet. The receiving product must be in the line of sight of the charger. This is only practical for products that are fixed in position and mounted out of the way because of potential safety issues with the lasers. In many cases wired power would be a more practical solution.

2.4 RF

RF-based wireless power solutions can use beamforming and can go through walls. They can also use reflective paths to steer around objects to deliver power, making the technology both efficient and safe. RF is capable of delivering 1 Watt at up to 30 feet. It can use unlicensed bands. Current prototypes use the 2.4 GHz band, but since that band has more limited spectrum, there are plans to use the 5 GHz band too.

2.5 Wireless Power Comparison

When looking at range, non-line-of-sight capability, and safety, only RF-based wireless power solutions hit all three of those.

Wireless Power Tech	Range Across Room	Non-line-of-sight	Safe
Induction / Magnetic Resonance		X	X
Ultrasound	X		
Laser	X		
RF	X	X	X

3 Technology Ecosystem

3.1 Trade Organizations

Induction and magnetic resonance are the most development methods of wireless charging. There were three competing trade organizations at one point, but eventually the Alliance for Wireless Power (A4WP) and the Power Matters Alliance (PMA) agreed to share their technology with each other for compatibility in 2014. In 2015, they merged into the AirFuel Alliance. A competing trade organization, the Wireless Power Consortium, is behind the Qi standard used in many smartphones today. Qi is based on induction. There are currently no trade organizations for far-field wireless power.

3.2 Technology Vendors

There are only a handful of wireless power companies that have products or prototypes that can deliver power across the room. Only one company – Ossia – offers IP for any other technology vendors to incorporate into their own chipsets and charging stations.

3.3 Summary Table of Vendors and Technology

The following table includes 10 companies, the wireless charging method used, the range claimed, their IP or product, and some notes.

Company	Tech	Range	IP	Product	Note
Energous	RF 918MHz (2.4/5 GHz in pipeline)	3 ft		WattUp	Short range, direct beam
Humavox	RF	< 1 ft		ETERNA	Short range, in box or bowl
Ossia	RF 2.4, 5 GHz	30 ft	Cota		Only company to offer IP, 30 ft
Pi	MR	< 1 ft		Pi	Qi + changes angle of magnetic field, up to 10W
Poweramp	Induction / MR				
PowerCast	RF RF (915MHz)	45 ft		Powerharvester, PowerSpot	Maximum power transmitted 4W
Qi (multiple)	Induction / MR				
Ubeam	Ultrasound	15 ft			
Wi-Charge	Infrared Laser	15 ft			
WiTricity	Induction	2 ft			Charging mat for cars

4 Key Vertical Markets and Use Cases

4.1 Consumer Devices

Consumer devices is a key category for wireless power, this includes smartphones, tablets, and wearables such as smartwatches and fitness bands. It is likely that the consumer space will lag behind others such as retail and industrial applications, which are expected to be the first to adopt. Smartphone market adoptions is likely to be led by one of the major vendors (e.g. Apple or Samsung) or an upcoming vendor looking to differentiate its products from the competition. Earlier innovation may start in smaller volume markets such as smart watches, but this category will be dominated by smartphones.

4.2 Smart Consumer Spaces

A proliferation of battery powered devices is expected in the home in the next few years, while many devices such as TVs and appliances will remain mains powered a rapidly growing number of sensors and smart home products will be battery powered. These include everything from detection sensors, through to thermostats and even smart speakers.

With the smart speaker space taking off, smaller smart speakers would be a key device to power wirelessly, so they can more easily be placed anywhere instead of near a power outlet. Larger smart speakers would likely require too much power for their amplifiers.

Wireless power stations would be placed in key areas in the home. The living room would be an obvious one. The kitchen would be as well, where an increasing number of electronic devices are found.

Smart home sensors are designed with a very long battery life, but then every once in a while, sensors need to have their batteries changed. Even with a nearly 10-year lifespan, this may become something tedious and dreaded for consumers. They have purchase new batteries, and replace them in the device. This could be for door and window sensors, motion detectors, or any other sensors. Smoke, carbon monoxide, methane gas, and pollution sensors would also benefit from wireless power with batteries for backup.

4.3 Retail

The retail sector is an interesting vertical market that would benefit from wireless power. This sector is constantly experimenting with new technology to better track foot traffic, as well as update labels. These are smaller devices with small batteries that would benefit from having smaller batteries or no batteries at all. Bluetooth beacons and electronic shelf labels are two examples of the types of retail products that can benefit.

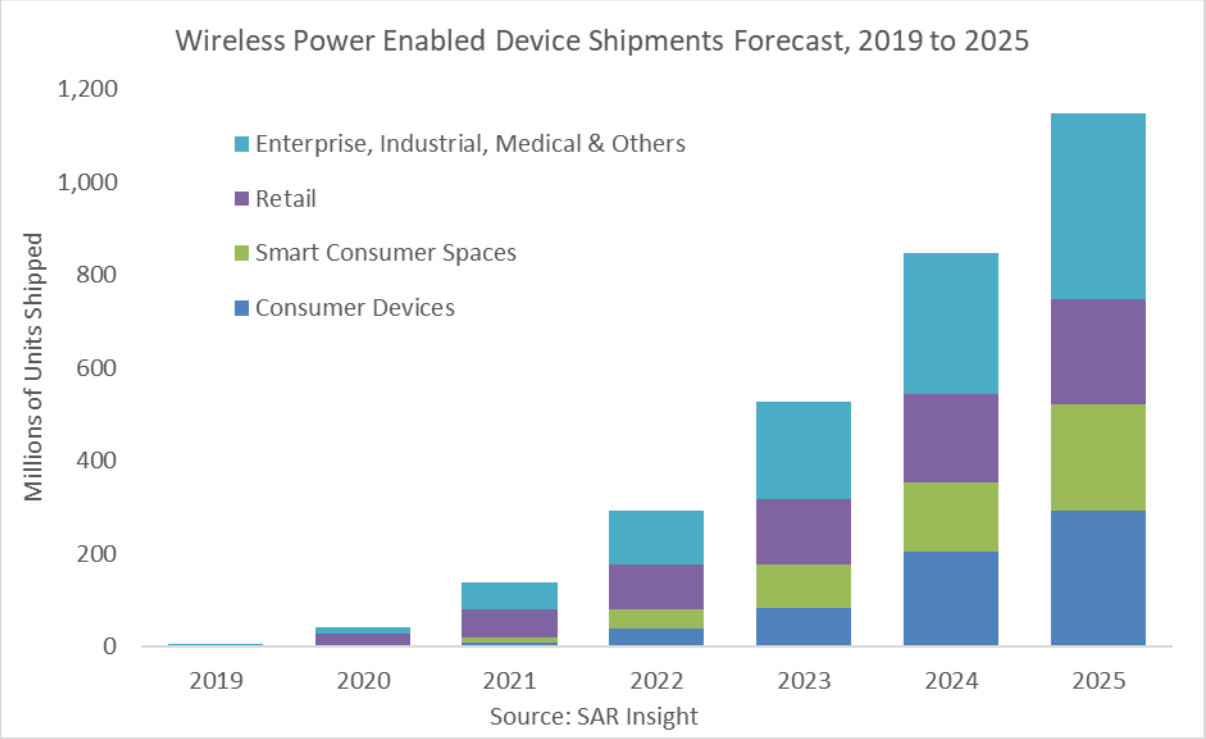
4.4 The Wider IoT Space: Automotive, Enterprise, Industrial, Medical & Others

The office is another key area that could benefit from wireless power. Stations would be placed in key areas as needed – in executive offices, alongside cubicles, and in conference rooms. Workers increasingly rely on their mobile devices to access e-mail, texts, corporate applications, and more.

The car is a perfect place to include wireless power. Consumers take their mobile devices and wearables into their cars, and the cabin of even larger cars and SUVs are of limited size. Devices can easily be trickle

charged in the car. Perhaps more importantly, wireless power in vehicles could be used to power wireless sensors such as the tire pressure sensors in wheels. Sometimes a sensor battery in the wheel runs out of power and must be replaced. Also, the wiring of cars to feed power and data is expensive and adds extra weight to the vehicle.

Wireless power stations could be placed in every type of transportation – public and private – including trains, buses, and planes, as well as at train stations, bus stops, and airports. Restaurants, coffee shops, and stores could offer wireless power as an amenity to customers. Aside from being used to power end-user devices, wireless power could power a range of commercial and industrial products such as electronic shelf labels, Bluetooth beacons, and tags with wireless connectivity.



5 Ramifications of Wireless Power

5.1 Safety

Induction and Magnetic Resonance are completely safe. These solutions are lower power, rely on proximity, have been well tested, and are commercially shipping today in the tens of millions of units per year. Ultrasound, however, can cause tissue damage and create an extremely unpleasant sound for many pets. RF that tries to form a direct beam to another device could pose a minor safety risk to people. RF that is directed around obstacles by bouncing off walls is safe. These types of RF power avoid directing energy at people, which is safer and more energy efficient, allowing for more power at greater distances.

5.2 Device Use

When using wireless power, devices such as smartphones will be able to be used for longer periods in the day, while being able to keep energy hungry functions such as screens on brighter settings. Wireless power will eventually become ubiquitous enough that it will be available on public transportation, in cars, and on planes as well. Battery life will be less of a concern than it is today. Bulky power adapters and extra charged batteries that can be swapped out can be left at home. Devices will charge while in use, while left anywhere in a room with a wireless charging station, including if they are left in a coat pocket or bag. Even if the devices power usage results in a net drain while receiving wireless power, the power drain will be slower than if the device were not receiving wireless power.

5.3 Product Design

Mobile devices are already undergoing changes so that they can be designed thinner and lighter. Headphone jacks are disappearing. Swappable batteries are increasingly rare. Devices are increasingly more water resistant. One limitation today is the charging port, typically a micro USB or USB-C connector. These connectors have a height to them that limits how thin the phone can be. The other factor that limits how thin and light the phone can be is the battery, which must store a certain capacity that support usage for at least a good portion of the day. With wireless power and widespread availability of wireless charging stations, mobile device batteries can be reduced in size, reducing device weight and cost. The effect on IoT product design will be even greater. Sensors could become smaller and cheaper when they do not have to be designed around a battery that can provide a decade of power. Beacons and electronic shelf labels can be designed sleeker and eventually at a lower cost.

5.4 Batteries

Batteries that are discarded separately or in old devices are very harmful to the environment. Additionally, there is a limited supply of cobalt in the Earth. Wireless power can allow for reduced battery size and even the elimination of batteries in many IoT products.

5.5 Energy Harvesting

Energy harvesting is one way to power products with very low power requirements. However, many methods of energy harvesting may not be reliable enough and they do not generate enough power for most products with current technology. Wireless power would be a more reliable way of powering IoT devices. Also, many IoT devices will do more edge computing or on-device computer vision, machine

learning, or inference. Energy harvesting will not provide the amount of power required for these products.

6 Conclusion

Wireless power at a distance can fundamentally change the way products are used and designed.

In the smart home, sensors can be placed anywhere, and batteries will not have to be changed. Sensors in the car, such as the pressure sensors in wheels, will not fail due to a dead battery, and some of the power cables and harnesses can be eliminated.

Commercial and industrial tags and labels can be powered wirelessly instead of needing a battery change or to be wired. Commercial and industrial IoT products will be easier to set up and power.

People will not have to be as mindful of their devices' power levels when using them nor have to worry about carrying a charger and charging a device with a cord or placing the device down on a near-field wireless charger. Devices could be designed much thinner without the charging port and with smaller batteries that reduce cost. Even if while using the device, the drain on the battery is greater than the rate the device is wirelessly charged, the net effect will be that the battery will deplete more slowly when near a wireless power station. This is something that would be of great interest to consumers.

Of course, wireless charging and wireless power are very complimentary. Wireless power can trickle charge phones and slow down their net power drain while being used, and wireless charging will be used to easily top off devices when the user can put the phone down on a wireless charging cradle or surface. Eventually, smartphones that do not have wireless charging will be at a disadvantage to those that do. As wireless power leverages the economies of scale of the smartphone market, more R&D will occur leading to technological improvements and its expansion into new markets.