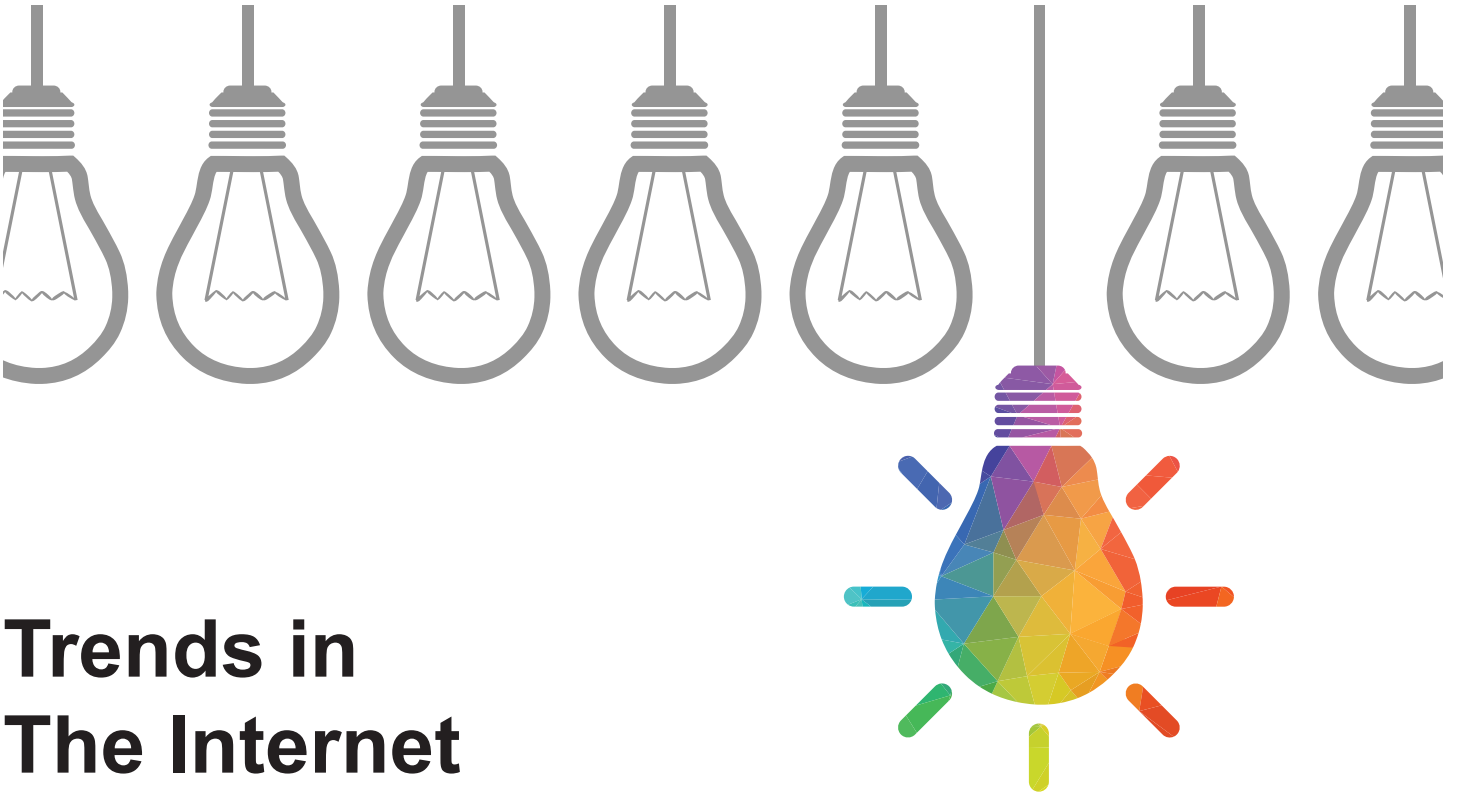
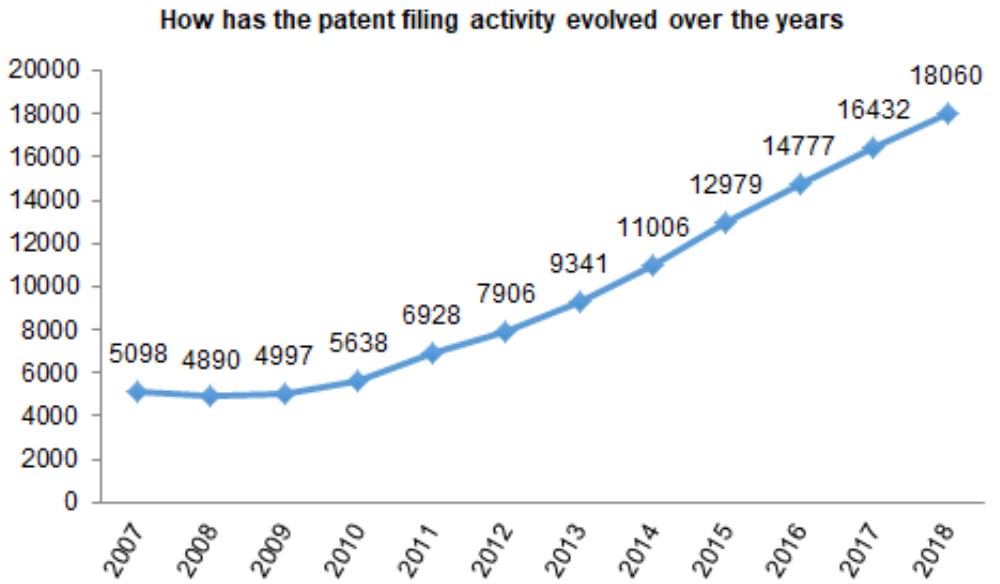


Trends in The Internet of Things (IoT)

The high volume of patent filings relating to applications of IoT is a strong indicator of an ever-increasing role for this technology in the economy.

Patent filings relating to the Internet of Things ("IoT") are skyrocketing. A rapidly increasing number of patent filings is consistent with the fact that IoT is one of the most innovative and competitive industries right now and that it is likely to continue to innovate for years to come.



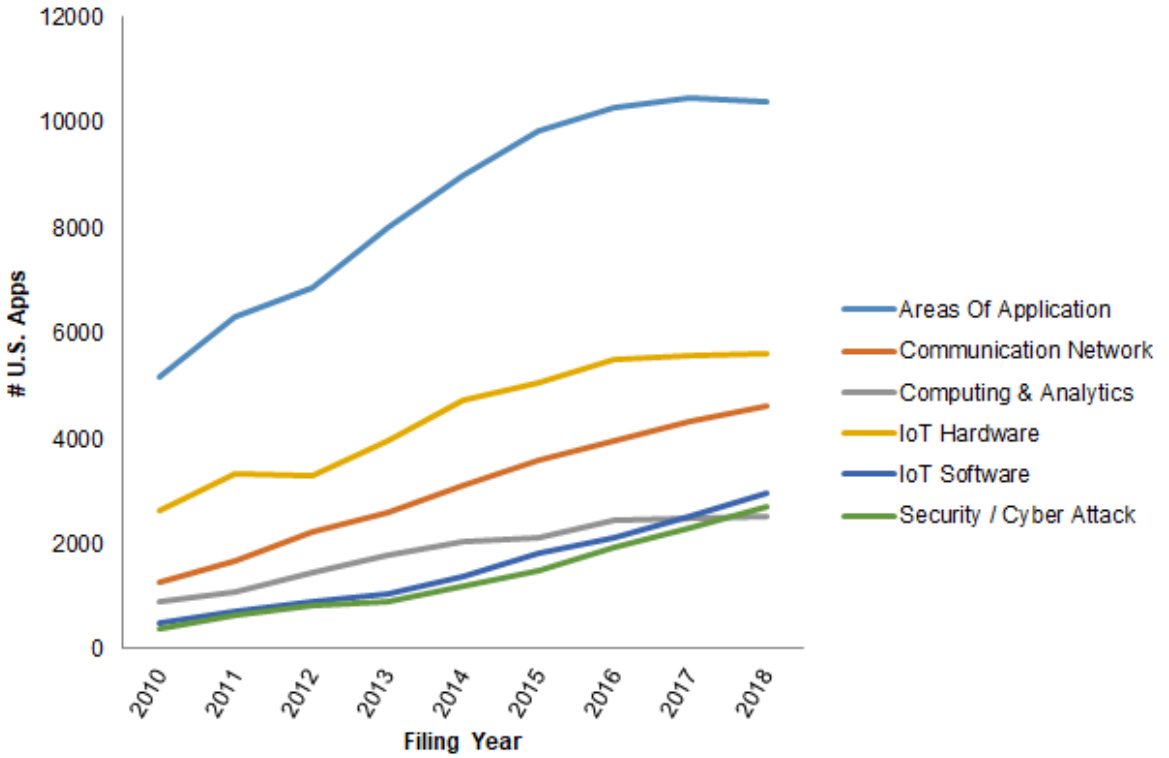
IoT is impacting and changing a wide range of industries, while also still developing as a technology itself. Indeed, the total size of the IoT market is predicted to grow to between $1.4 and $3.7 trillion by next year.[71] As it becomes integrated into more and more aspects of our lives and businesses, IoT also must address a number of concerns, including security, privacy, and compatibility. To delve deeper into the trends of patenting IoT innovation, we have defined the following technology clusters within the general industry of IoT:

Taxonomies and expanded definitions of these clusters are included in appendix A.

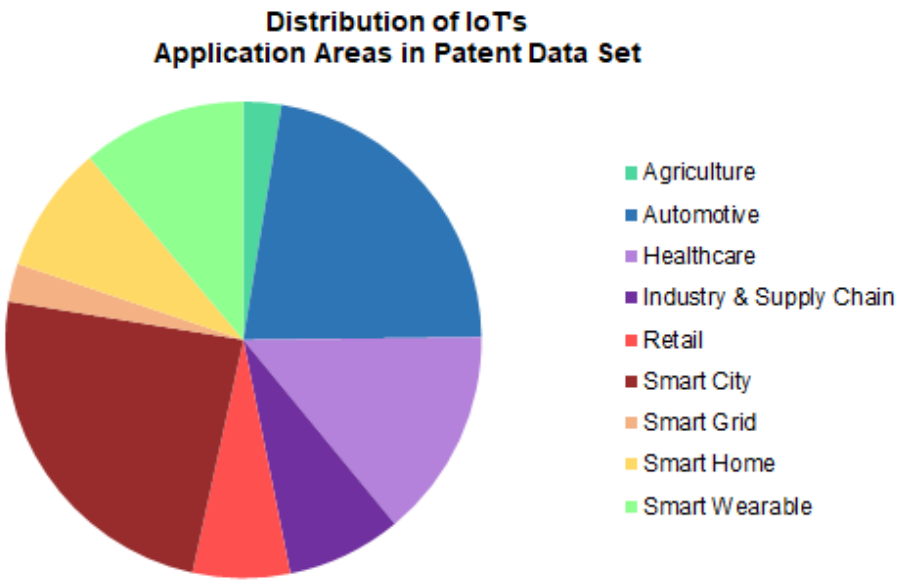
IoT-Level I Clusters	Level II Clusters
Application Area	Agriculture
	Automotive
	Healthcare
	Industry & Supply Chain
	Retail
	Smart City
	Smart Grid
	Smart Home
	Smart Wearable
Application Software	
Backbone Network (Network Infra	
Cloud Computing And Analytics	
Communication Network	Communication Techniques
	Mesh Networking
	Wireless Protocols
Edge Computing And Analytics	
Gateway Equipment	
Operating Systems	
Security/Cyber Attack	
Sensors And Actuators	
Storage & Servers	

[71] https://www.forbes.com/sites/louiscolumbus/2018/06/06/10-charts-that-will-challenge-your-perspective-of-iots-growth/#659607643ecc; https://www.forbes.com/sites/louiscolumbus/2018/06/06/10-charts-that-will-challenge-your-perspective-of-iots-growth/#7a6fdea63ecc

The majority of patent filings relate to the applications of IoT, with heavy emphasis on smart cities, automotive, and healthcare



Virtually every industry could be made more efficient and productive by incorporating IoT capabilities into its operations, and virtually every industry has taken notice of this technology and is spending heavily on IoT integration.[72] The high volume of patent filings relating to applications of IoT is a strong indicator of an ever-increasing role for this technology in the economy.



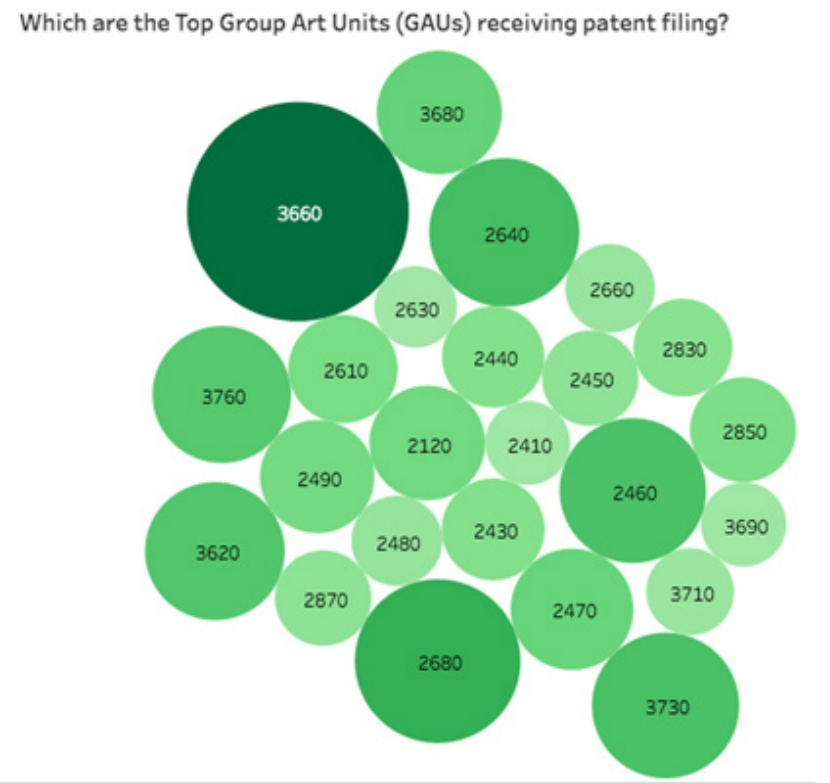
[72] https://innovationatwork.ieee.org/industry-iot-growth-trends/

Smart City IoT has the highest number of patent filings. This finding may be due both to the wide range of activities (from public safety to traffic regulation to air quality) in which the deployment of IoT would be beneficial in an urban setting and to the growing adoption of IoT projects by local governments.[73]

In the United States, there is also a strong emphasis on IoT innovation in the healthcare and automotive industries.[74] In healthcare, the majority of IoT applications relate to patient monitoring, energy metering, and imaging devices.[75] In automotive, IoT has gained acceptance throughout the lifecycle of the vehicle - from the design stage, to manufacturing, to making the driving experience easier, safer, and more enjoyable.[76]

The technical diversity in IoT innovation is evidenced by the large number of Art Units examining IoT applications

As noted above, the applications of IoT span many technological areas. Thus, it is perhaps not surprising that IoT patent applications are assigned to a wide variety of Art Units at the patent office. In fact, the applications are broadly dispersed across multiple different technology centers (each of which relates to a high-level type of technology). Given that different Art Units are associated with different allowance rates, applicants in the IoT space are likely to encounter a broad distribution of allowance prospects.



[73] https://www.mckinsey.com/~/media/mckinsey/industries/capital%20projects%20and%20infrastructure/our%20insights/smart%20cities%20digital%20solutions%20for%20a%20more%20livable%20future/mgi-smart-cities-full-report.ashx
[74] https://iot-analytics.com/top-10-iot-segments-2018-real-iot-projects/
[75] https://healthtechmagazine.net/article/2018/08/why-healthcare-iot-rise-infographic
[76] https://www2.deloitte.com/insights/us/en/focus/internet-of-things/iot-in-automotive-industry.html

USING 2016 DATA:				
		# Apps Filed in this Year assigned to Art Unit w:		
		Most Industry Apps	**2nd Most Industry Apps**	**3rd Most Industry Apps**
		Art Unit	Art Unit	Art Unit
IoT		3667	3663	3762
Level I		3667	3663	3762
Areas of Application		2412	2471	2646 | 2462
Communication Network		3667	2122	2859
Computing & Analytics		3762	375	3736
IoT Hardware		3664	2179	3667
IoT Software		2497	2436	2435
Security/Cyber Attack				
Level I	**Level II**			
Areas Of Application	Agriculture	3671	2836 | 2887	2436
	Automotive	3667	3663	2668
	Healthcare	3762	3735	3763
	Industry & Supply Chain	3625	3628	3627
	Retail	3625	2687	2859
	Smart City	3667	2663	3661
	Smart Grid	2836	2859	2842
	Smart Home	2844	2121 | 2127	2126
	Smart Wearable	3762	2872	2859
Communication Network	Communication Techniques	2471	2412	2915
	Mesh Networking	2887	2685 | 2844	2412 | 2464
	Wireless Protocols	2645	2646	3715
Computing & Analytics	Cloud Computing And Analytics	3667	2859	2456
	Edge Computing And Analytics	2122	2457	2456
IoT Hardware	Backbone Network (Network Infrastructure)	2645	2649	2685
	Gateway Equipment	3625	2457	2645
	Sensors And Actuators	3762	3735	3736
	Storage & Servers	3664 | 2421	2136	2424
IoT Software	Application Software	3664	2179	3667
	Operating Systems	2497	2195	2116

Cellular phone, cloud-based service, and artificial intelligence leaders are filing large numbers of patent applications related to IoT

IoT is dependent on high-speed wireless networks, cloud-based computing and APIs that enable greater and faster integration between the IoT component and the existing network.[77] In addition, the use of A.I. is growing in IoT. For example, as IoT sensor and monitors generate data (*e.g.*, temperature, humidity, or vibrations), A.I. can be used to detect anomalies and particular types of events much faster and with greater accuracy.[78]

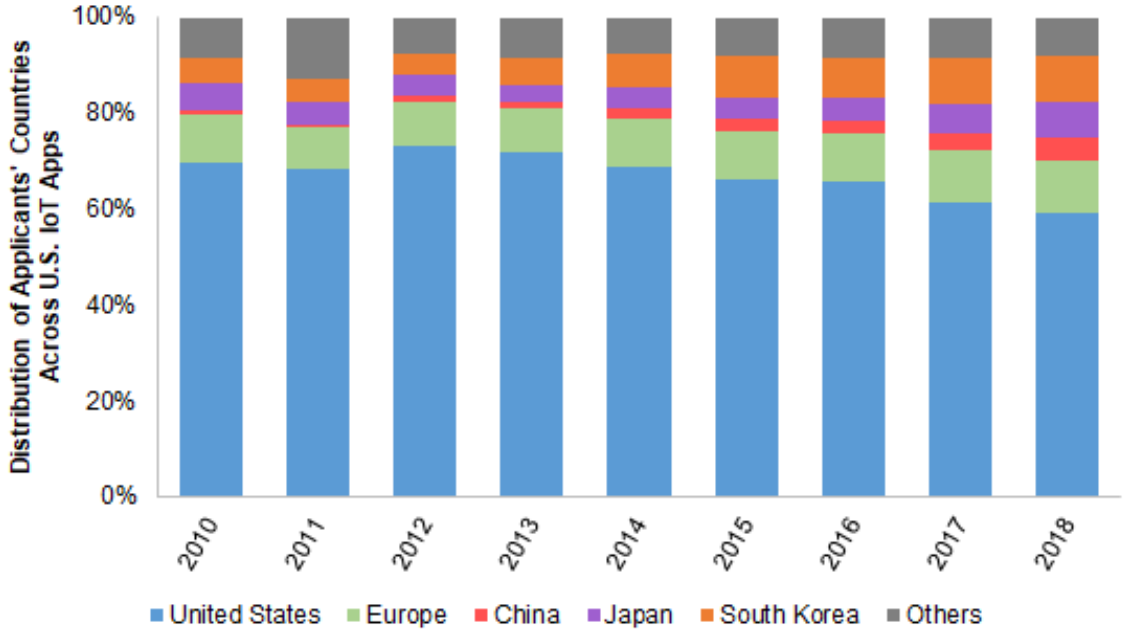
The technology leaders who are filing the most patents in IoT are major players in these fields. Companies with expertise in high-speed wireless networks – like Qualcomm, LG, Cisco, and Intel – are vying for leadership in the IoT space, alongside leaders in cloud-based services and A.I. – like IBM and Microsoft.

USING 2016 DATA:		
		Most Families Flied by
		(Applicants listed in alphabetical order)
IoT		Ford, IBM, Intel, Qualcomm Samsung
Level I		
Areas Of Application		Ford, General Motors, IBM, Samsung, Toyota
Communication Network		AT&T, Ericsson, IBM, Intel, Samsung
Computing & Analytics		Cisco, IBM, Intel, Microsoft, Qualcomm
IoT Hardware		Ford, IBM, Intel, Qualcomm, Samsung
IoT Software		General Electric, IBM, Microsoft, Samsung SAP SE
Security / Cyber Attack		Cisco, IBM, Intel, Qualcomm, Samsung
Level I	**Level II**	
Areas Of Application	Agriculture	Cnh Industrial America, Deere And Co., IBM, King Fahd University Of Petroleum And Minerals, The Climate Corp.
	Automotive	Ford, General Motors, Hyundai, Samsung, Toyota
	Healthcare	Cardiac Pacemakers, General Electric, IBM, Samsung, Tosense
	Industry& Supply Chain	Blackberry, Beneral Motors, IBM, Intel, Kyland Technology Ca, Walmart
	Retail	Century Link Intellectual Property, IBM, Microsoft, Samsung, Walmart
	Smart City	Ford, Honeywell, IBM, Samsung, Toyota
	Smart Grid	ETRI, General Electric, IBM, Kyland Technology Co., LG, Qualcomm
	Smart Home	Echostar Technologies International Corp., Google, Honeywell, Johnson Controls Technology Co., Samsung, Siemens
	Smart Wearable	Apple, IBM, Intel, Micmac$ Qualcomm, Samsung
Communication Network	Communication Techniques	

[77] https://www.forbes.com/sites/louiscolumbus/2018/06/06/10-charts-that-will-challenge-your-perspective-of-iots-growth/#659607643ecc
[78] https://www.wired.com/brandlab/2018/05/bringing-power-ai-internet-things/

	Mesh Networking	AT&T, IBM, Intel, Quo Silergy Semiconductor Technology (Hanzhou)
	Wireless Protocols	AT&T, Ericsson, Intel, Qualcomm, Samsung
Computing & Analytics	Claud Computing And Analytics	General Electric, IBM, Intel, Microsoft, Qualcomm
	Edge Computing And Analytics	AT&T, Cisco, IBM, Intel, Microsoft
IoT Hardware	Backbone Network (Network Infrastructure)	AT&T, Intel, Qualcomm Samsung, Veniam
	Gateway Equipment	AT&T, Cisco, Hyundai, Intel, Qualcomm, Verizon Patent And Licensing
	Sensors And Actuators	Ford, IBM, Intel, Qualcomm, Samsung
	Storage & Servers	Capital One Services, Ford, IBM, Intel, Microsoft, Qualcomm, Samsung
IoT Software	Application Software	General Electric, IBM, Microsoft, Swing, SAP SE
	Operating Systems	General Electric, IBM, Intel, Microsoft, NXP, Samsung

The percentage of patent applications relating to IoT filed by U.S.-based applicants is falling



The percentage of U.S. patent applications originating in China, Japan, and Korea has grown dramatically over the last five years and has contributed to U.S.-based application accounting for less than 60% of filings last year. This trend may represent a rise in IoT innovations originating from these countries and/or an increased emphasis on globalization and international patent protection. For example, it is possible that the relative rate of IoT innovation across countries has remained stable over the past decade, whereas the observed trend is explained by a change in foreign entities' prioritization of securing patent protection in the U.S. for their technologies.

Security is a critical issue for IoT

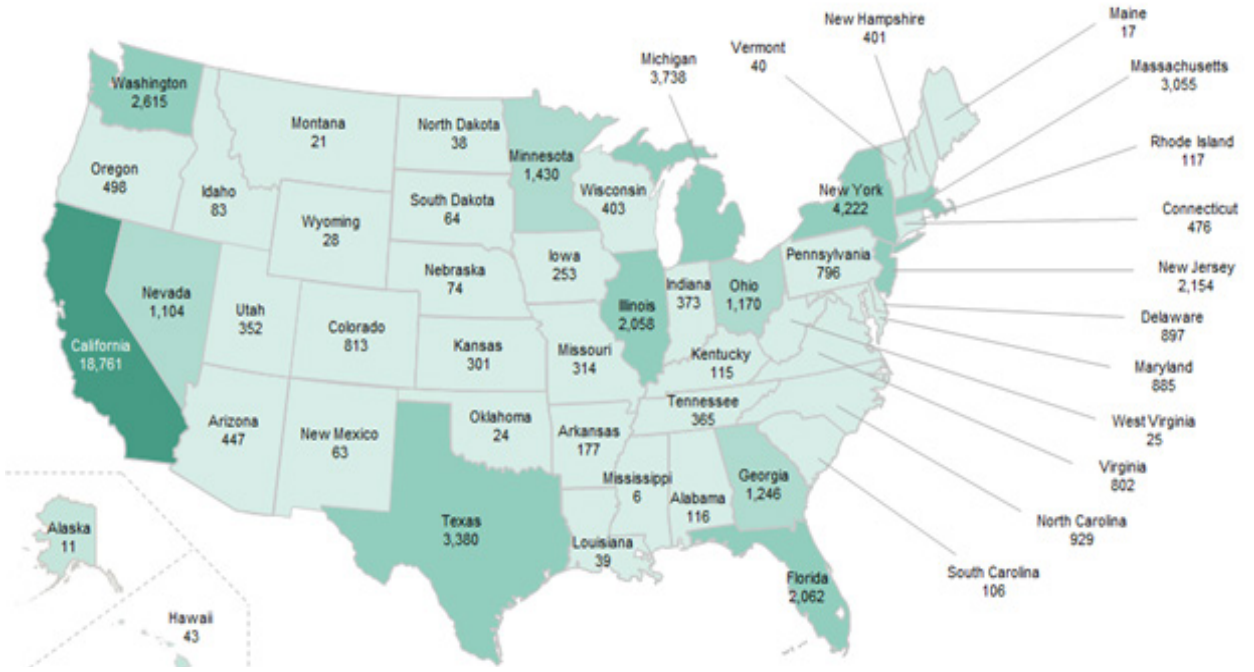
As IoT is adopted by more and more sectors of the economy, its vulnerability to cyberattacks and other malicious interference is becoming a more pressing threat. To date, there have already been documented attacks on IoT in building infrastructure, communications, and industrial infrastructure.[79]

Our study finds that security-related IoT patent filings have been steeply increasing year over year, although the overall percentage of patent applications in this space remains small. As the urgency of creating better security for IoT mounts, however, and as companies innovate to make their IoT assets less vulnerable,[80] we anticipate this technology cluster to increase in patenting activity.

IoT-related innovation is distributed across the United States

IoT innovation is taking place not only in diverse industries but also in diverse geographies. While the majority of IoT-related patent activity is concentrated in California, residents of many other states have filed a significant number of patent applications in this technology area. Residents from each of the following states have filed at least 1000 applications: Florida, Georgia, Illinois, Massachusetts, Minnesota, New Jersey, New York, and Texas.

Distribution of filings across states for the IoT industry



[79] https://www2.deloitte.com/content/dam/Deloitte/ch/Documents/innovation/ch-en-innovation-IoT-defense-policy-and-the-internet-of-things.pdf
[80] https://www.csoonline.com/article/3289392/staying-secure-as-the-iot-tsunami-hits.html

KILPATRICK TOWNSEND

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