CIPHER

IP STRATEGY REPORT

Technology disruption through a patent lens
July 2018

About Aistemos and Cipher

Aistemos is an intellectual property analytics company based in London. By applying AI and machine learning to comprehensive IP data, we have developed Cipher and Cipher Automotive, the world's most definitive sources of patent analytics to enable companies to navigate complex technology landscapes.

About this Report

Our IP Strategy Report 2018 studies the impact of disruptive technologies such as AI, autonomy and 3D printing, and the challenges this disruption places on the teams responsible for intellectual property (IP) and specifically patents. The report is based on 165 responses to our IP Strategy Survey conducted between February and April 2018, and is supported by a series of industry reports analysing patenting trends in automotive, aerospace and defence, fintech, industrial automation and technology, as well as extensive interviews with senior industry representatives. Unless otherwise attributed, all data is generated by Cipher or Cipher Automotive. Our thanks to everyone who participated and contributed to this report.

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“The secret of change is to focus all your energy not on fighting the old, but on building the new”

Socrates, 399 BC

Introduction

Half of the Fortune 500 companies in 2000 have disappeared and the average age of an S&P 500 company is under 20 years old, down from 60 years in the 1950s. The disruptive force of technology is the main cause. Kodak went from its top 50 spot in 1995 to a Harvard case study on the impact of disruption.

This report studies the impact of technology in financial services, aerospace and defence and automotive, as well as the more ubiquitous impact of Industry 4.0. Our approach is to analyse disruptive technology through a patent lens. This is a unique perspective, itself made possible by advances in artificial intelligence (AI) and the abundant supply of low cost computing (the Cloud). There are over 100 million patents, registered to over a million owners in over 100 countries. Each one creates a legal right to exclude others. It represents the largest body of scientific information in the world, with one overarching requirement that inventors publish what they seek to protect, and that the information be accessible to the public.

As with many rich sources of insight, there is a difference between accessible and available. This research is made possible by Cipher, the first software to aggregate, analyse, and visualise the world’s patent information.

THE FINDINGS FROM OUR RESEARCH ARE:

- **Patents are important:** there is increased recognition that patents are an important part of an organisation’s innovation strategy. Different sectors adopt different strategies and there is currently a stark difference between how financial services at one end of the spectrum and technology companies at the other approach patents.
- **Start-ups can participate:** across all the sectors we have studied, the market is dominated by incumbents, whether they are OEMs, A&D primes or the major banks. However, in many of the technologies likely to disrupt, from blockchain to 3D printing to autonomous driving, there are no insurmountable barriers to entry to the vibrant community of start-ups across the globe.

- **Technology companies are ahead:** IBM owns 5x more patents than all of the banks put together. This report provides many examples of where the foundational technologies required for the future are in the hands of tech companies both old (e.g. IBM, Microsoft, Intel) and new (e.g. Google, Apple, Amazon). This reality will drive increased collaborations and licensing, but also a transfer of value which will add fresh stress into many sectors that have delicately balanced low margins with market stability.
- **Litigation risk will increase:** there have been patent wars since the 1850s, dating back to the early days of the electric bulb and the telephone. But the major players in the sectors we studied have largely taken a different approach, summed up by the quote from Patent Wars "… a patent war is like a nuclear war, the only winning move is not to play."

  This move is only viable when two sides see the position in the same way. Our analysis of telecoms standards (e.g. 4G and 5G) necessary for the autonomous connected car illustrates why the détente that exists in many of the sectors may very likely not continue.
- **More M&A, collaborations and licensing:** all evidence supports the contention that there will be more acquisitions and collaborations across and between sectors. Intellectual property will be an important consideration in all of these situations.
- **The importance of data:** many of the sources of disruption are fuelled by the ability to capture and analyse vast amounts of data relating to location, performance, environment, etc. Patent analytics respond on all these levels, and are increasingly being integrated into corporate strategy.

  Patent information is a comprehensive dataset of who is doing what and where. It is increasingly being recognised as an essential input into a range of strategic, commercial and technical decisions.

> *"What's dangerous is not to evolve"*
>
> Jeff Bezos

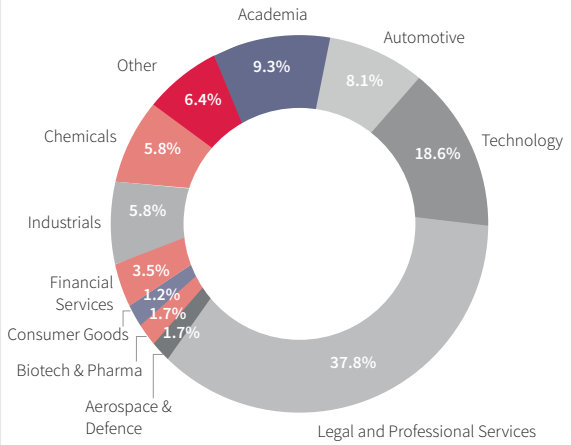
This report introduces a fresh source of data for those formulating strategies to meet the disruptive force of technology. Patent analytics are now readily accessible and should be integrated into mainstream corporate strategy. The evidence is that, in areas at the epicentre of disruption, many of the required patents are in the hands of new market entrants, all whose sights are set on the next Darwinian award for Survival of the Fittest.

Nigel Swycher, CEO
July 2018

1. IP STRATEGY SURVEY

The IP Strategy Survey was conducted between February and April 2018 and received 165 responses. Survey respondents are from a range of industries (Chart 1):

Chart 1 What sector best describes your business?



Other includes Media & Telecoms, Energy, Healthcare, Oil & Gas, Cosmetics, Diagnostics and Medical Devices and Agriculture. The respondents' main areas of responsibility are Intellectual Property and Legal (94%) and also R&D and Finance.

The structure below follows the themes of the IP Strategy Survey. The full survey results are available on request.

1.1 THE IMPORTANCE OF INTELLECTUAL PROPERTY

There is increased recognition that investors and stakeholders must deliver comprehensive and trusted information about matters that go to the heart of corporate value.

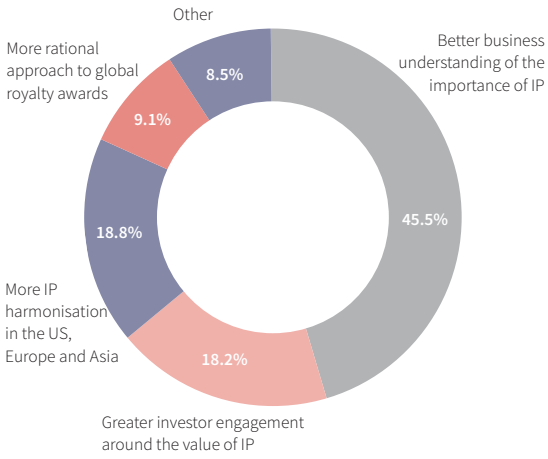
This needs to include intellectual property, which now accounts for a vast part of the enterprise value for the companies disrupted by technology. Within intellectual property, patents are generally accepted as the best way to protect investment in R&D and innovation.

Jan-Menko Grummer, partner with Ernst & Young, believes this requires action not words:

"Companies are not good at articulating long term value for their stakeholders. The Innovation work stream in the Embankment Project, driven by the Coalition of Inclusive Capitalism, is working on objective indicators to measure innovation performance and the impact of long-term value creation and protection. Big data is providing new ways of measuring value and we believe that global patents data could be a mine of useful information – one that has been largely ignored by investors up to this point."

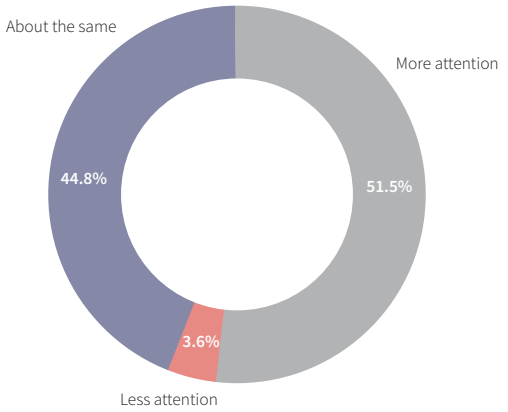
Over 63% of respondents agree that the next 12 months will be a period which sees a better understanding of the importance of IP (45.5%) and greater investor engagement around the value of IP (18.2%) (**Chart 2**).

Chart 2 What do you think will be the most important IP development in the next 12 months?



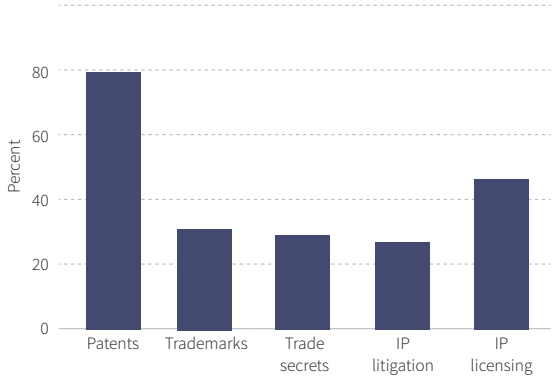
This optimism is somewhat diminished by the fact that only 51.5% of respondents believe that more attention is being given to IP strategy (**Chart 3**). Thankfully, there are only 3.6% who say that IP strategy has been given less attention.

Chart 3 Has there been a change over the last 12 months in the approach to intellectual property as part of corporate strategy?



When analysing the areas that receive the most attention, patents are the stand-out winner (79.4%). We regard it to be entirely positive that IP licensing (46.7%) is in second place, and that IP litigation is bottom of the class (25%), behind both trademarks and trade secrets (**Chart 4**). Litigation is slow, expensive and inefficient.

Chart 4 Which area is currently getting the most attention in your business?



It remains difficult to extract evidence about how companies are responding to the importance of trade secrets. There is, however, no shortage of news about cybersecurity and the real risks of corporate espionage. It is on the back of these realities that trade secrets are coming to the forefront, including when it comes to deals.

Brian Schettler, MD of the HorizonX fund for Boeing, explains the position as follows:

"Continuing to generate defendable technology is obviously critically important. I have seen over 2,000 start-ups over the last year who all think that they have something unique in aerospace. What it comes down to is who has protection. There are entrepreneurs who are making selective decisions on what parts they protect and which parts they keep at trade secret level. Publishing details in full view in a patent of how you are approaching your solution has its strengths and weaknesses. The really impressive entrepreneurs can balance appropriately what to protect formally with patents while worrying about publishing their ideas which may make them more vulnerable."

Similarly, many Chief Intellectual Property Officers are conscious of striking the right balance between patents (which cost and are public) and trade secrets (which potentially last forever, but can be easily lost). As R&D and finance teams pay closer attention to patents, you are beginning to hear the question "how many is enough?" which will increase pressure on companies to balance their protection strategies between patents and trade secrets. In contrast, the financial services sector has been slower to engage with patents - as discussed in the Fintech section.

Calum Smyth, Global Head of IP at Barclays, says:

"In a digital context, technology and markets develop quickly, and I think an understanding of patents can leverage value beyond just enforcement. I want a solid strategy built on real data and access to analytics that can support insights on technology trends and activity at a granular level. Sources of digital innovation are very fragmented so the more useable the information you have, the more sensible the decisions you make."

From a commercialisation perspective, this is also a way of addressing the difficulties associated with bare patent licensing. While patent reform and recent court decisions have made this more difficult, companies who can use trade secrets and know-how to add value are able to do better.

Pat Patnode, President of Licensing at GE Ventures, explains the shift in the following terms:

"Today, success around our IP is defined more broadly. We now actively seek out and collaborate with partners who can apply our creations to new industries and offerings around the world. While these deals are harder and more complex to do and require careful management both before and after the deal, there is less resistance to this approach from licensees and it gets more partners thinking about, and using, GE technology to solve important problems."

When asked about IP budgets, 56.7% had remained the same, with 26.1% increasing and 17.4% decreasing.

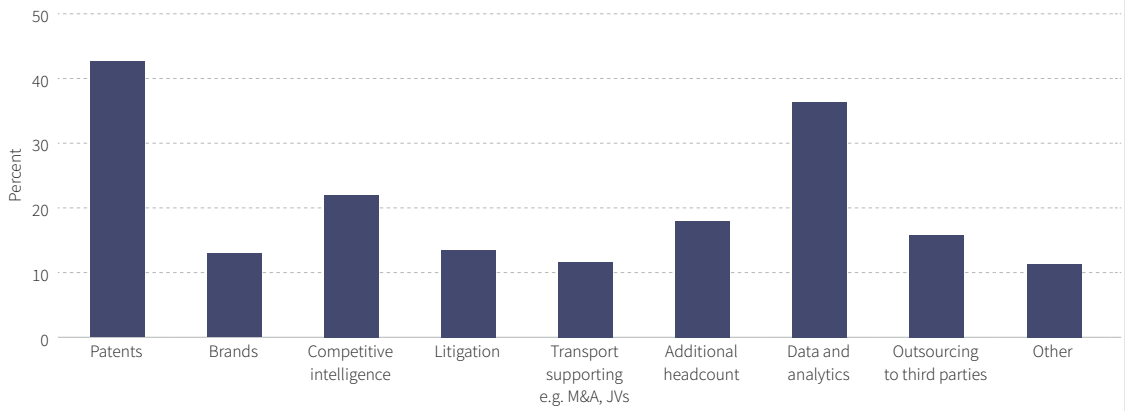
Where there is an increase, **Chart 5** shows which areas have benefited from increased allocation.

Patents once again lead (43%) and, together with data analytics (37%) and competitive intelligence (23.6%), provide evidence to suggest that there are many companies who, in the face of technology disruption, are both attending to their own portfolios and monitoring and analysing patent portfolios of others.

Dr. Bobby Mukherjee, Chief Counsel, Intellectual Property and Technology Law at BAE Systems, considers analysis of this type to be a key element of his IP strategy:

"It's really important to understand the patent landscape and what is going on because that is a vital element to the wider strategy. It's about having the right resources, about knowing what landscape you are operating in and where you're going. It's important to engage with people in the business and get that feedback and not to operate in isolation."

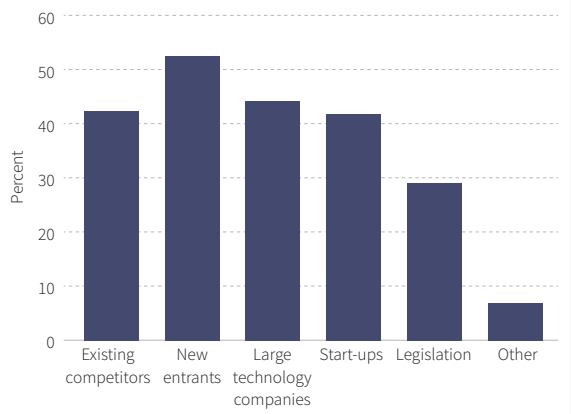
Chart 5 Which areas have benefited from increased budget allocation?



1.2 THE SOURCES OF DISRUPTION

Respondents were asked to identify the likely sources of disruption (**Chart 6**) and agreed that disruption is coming from all directions: the highest scores were from new entrants (52.1%) and large technology companies (44.2%). Start-ups (42.3%) scored almost the same as existing competitors (41.7%). The Other category included Brexit, court decisions and Standards.

Chart 6 What are the likely sources of disruption in the markets that you operate in?



The sources and impact of disruption sit at the heart of our industry reports. Common to each include the following:

- The barriers to entry for start-ups are now significantly lower. There are few companies that can build 5 million cars, or design a fighter jet, or handle over $1.5 trillion in bank deposits. This does not mean that Ford, BAE Systems or Bank of America are insulated from competition. More than ever, the incumbents are acquiring, investing and collaborating with start-ups. The Boeing HorizonX fund and the Nomura fintech fund are both good examples of that.
- Established technology companies will have a bigger role to play. In this category are both the well established (e.g. IBM, HP, Intel) and the newly established technology companies (e.g. Google, Amazon, Apple). This cohort, taken as a whole, understand the importance of patents, and know exactly how best to leverage intangible assets to deliver tangible returns.
- Expect higher levels of patent litigation. Our research suggests an era where there is widespread acceptance of the need for more collaboration. At the same time, while the automotive sector is hoping for the best, they are preparing for the worst.

1.3 TECHNOLOGIES WITH THE CAPACITY TO DISRUPT

Following on from the sources of disruption, our survey asked about technologies that will cause the disruption. **Chart 7** shows the broad spectrum.

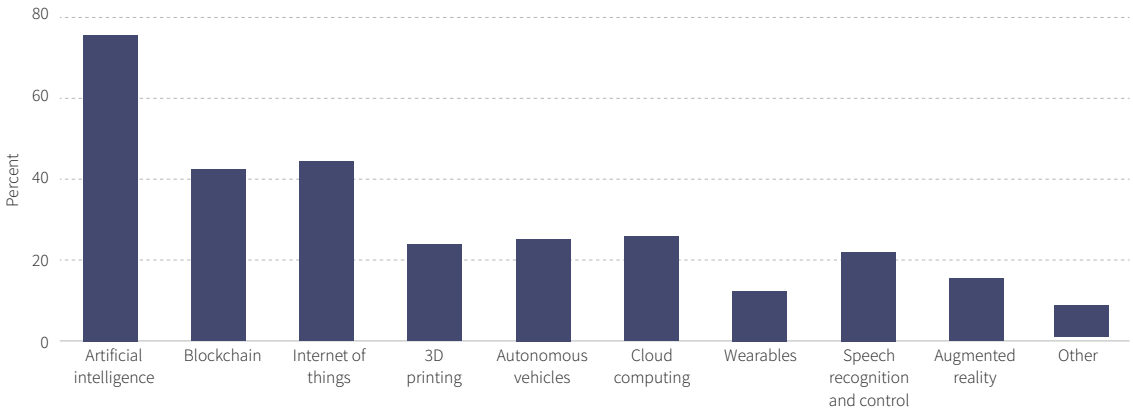
Artificial intelligence (75.8%) leads Internet of Things (44.2%), closely followed by Blockchain (42.4%). Within Other, respondents included automotive electrification, personalised medicine and biometrics. There was one optimist who replied *"None of the above"* on the basis that *"All are enablers, not disrupters"*.

The range of technologies is very broad. Bobby Mukherjee at BAE Systems gave these examples:

"Robotics, autonomy, human machine interfaces, cybersecurity and drones are key areas for us and for our competitors. It's important to recognise that there is an intensely competitive landscape. The barriers to entry are very relevant in that regard. So with respect to the movement from traditional to non-traditional players, it's really important that we understand what the landscape is and what IP rights are out there, not just for the traditional players, but also for the non-traditional players."

What is reinforced by the sector studies is how universally applicable these technologies will be. Using AI and machine learning as an example, it has a broad application. For example in fintech, it is being deployed in the back-office (risk assessment) and on the front line interacting with customers. Both automotive and A&D are investing in AI for autonomy on land, air and sea. Other sectors embracing AI include healthcare (the primary focus for IBM Watson), retail (recommendation engine) and social media (face recognition).

Chart 7 What technologies have the capacity to disrupt your business?



Seán Harte, Regional Counsel for Intellectual Property at MasterCard, lists a range of active initiatives:

"Artificial intelligence for fraud solutions, biometric solutions for faster and more secure payments, augmented reality shopping, solar panels for those without access to electricity, in-car payments, applications for wearables. The more diversity that you can bring into the payment ecosystem, the more likely people will move away from cash to digital and card-based payments."

Meanwhile MasterCard, which has always seen itself first and foremost as a technology company, sees the primary competition as being cash.

Our research elicits the same reaction to Internet of Things. From an IP perspective, these topics represent a catch-all that requires further analysis to understand who is investing in particular areas. Our Industry 4.0 report explores this area in more detail.

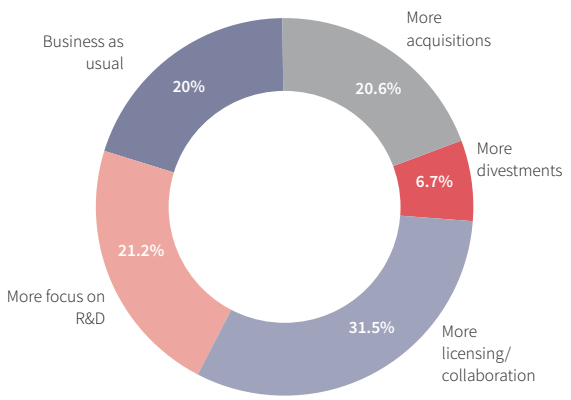
The more granular approach is necessary when considering the impact on particular companies. No one company is planning to "own" AI or IoT. There are complex technology jigsaws that require close and careful analysis.

> *"Artificial intelligence, deep learning, machine learning - if you don't understand it, learn it. Otherwise, you are going to be a dinosaur within three years"*
>
> Marc Cuban

1.4 BUSINESS REACTION TO DISRUPTION

Half the Fortune 500 companies in 2000 have disappeared. No CEO is looking for that "Kodak Moment" on their watch. All the evidence suggests that companies are responding to the challenges.

Chart 8 Do you think the disruption will cause your business towards:



Over half of all organisations surveyed think that there will be more licensing and collaborations (31.5%) and more acquisitions (19.5%). A significant number of respondents selected more focus on R&D (21.2%) and only a few saw divestitures as the likely way forward (6.7%) (**Chart 8**).

Over 20% of respondents saw the future as 'business as usual' (20%). This smacks of fiddling while Rome burns. This view is not supported by either our sector reports or our additional research. Automotive, Fintech, A&D and Technology all report increased collaboration, licensing and acquisitions with more to come. Similarly, the analysis of patenting trends also highlights an increased focus in new technology areas. The notable exceptions are the banks where, with the exception of Bank of America, most other banks have been slow to appreciate the importance of patents.

Even here, Keith Agisim, Chief IP Counsel for Bank of America, does not see the position as black and white:

"Banks for a long time have partnered with technology companies. We recognise that there are places where technology companies are better equipped or are better able to innovate and that's when we want to partner. It's symbiotic. There are things that fintech companies do well, and others where it's the traditional banks. There are places they may compete, there's places they may cooperate. I see a situation where we coexist."

Automotive also has different characteristics, as there continues to be a very substantive investment in patenting conventional technologies, such as the internal combustion engine. Despite the rate of change predicted by everyone we asked, for the next decade at least there will be significant revenues attributable to vehicles that fall a long way short of an all-electric autonomous car.

1.5 RESPONDING TO THE INCREASED LEVELS OF IP RISK

We have analysed the current levels of patent litigation in our sector reports. Many of these areas including automotive, A&D and financial services have historically experienced low levels of patent litigation, and all expect this to change as new technologies increase in importance. The primary reasons given relate to NPEs, aka patent trolls, and the strong patent portfolios in the hands of technology and telecoms companies.

As examples, IBM own 5x more fintech patents than any other bank, and in 3D printing, HP owns more patents than any other company. For drones, DJI have the largest portfolio. In this case it outnumbers both Boeing and Amazon. In our automotive report, we do consider the impact of cars being "smartphones on wheels" and the real risk that the need for both 4G and 5G will lead to a flood of phone-war style litigation. Our expectation is, however, that parties will choose amicable licensing and rational royalty rates over a period of epic litigation.

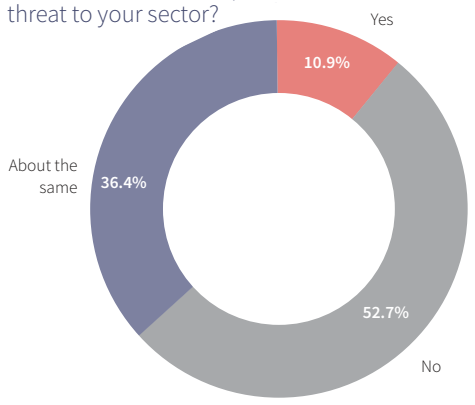
The survey specifically addressed the litigation risk posed by Non-Practising Entities (often referred to as patent trolls) (**Chart 25**). The data suggests that this source of dispute is in decline. Legislative reform, court decisions and organisations like RPX, Unified Patents and LotNet have all contributed to making litigation as pure financial arbitrage less profitable.

This trend is supported by the survey where over half of respondents (52.7%) see no increased risk (**Chart 9**), with 36.4% seeing litigation levels at about the same. 10.9% see the risk increasing. This may be attributable to the fact that fintech, A&D, automotive are now moving into technology areas that fall in the web of existing NPE portfolios.

Agisim, Bank of America, sums up the general mood:

"NPE risk is obviously significantly down from its peak 5 years ago. But I don't think it's going away. There's a rhythm and the pendulum at some point will swing back. I don't know if it will ever get back to the peaks we saw in the early to mid-2000s, but at the same time, you see people talk about the whole model being dead and never coming back. It's not that clear cut."

Chart 9 Are NPEs (aka patent trolls) an increasing threat to your sector?

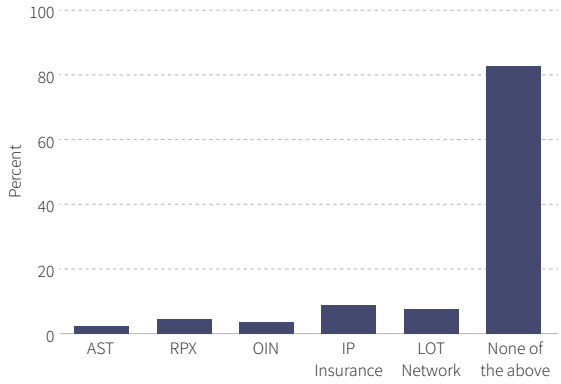


It is also clear that the large multi-nationals are in no mood to encourage this type of activity. This harder line from companies was reinforced by Bobby Mukherjee:

"If NPEs don't have a case, we will not pay them to get them off our back. Under my watch that's not what we do."

In terms of combatting the increased risk, the survey asked about alternative risk mitigation strategies (**Chart 10**).

Chart 10 Is your organisation involved in alternative IP risk mitigation strategies?



At first blush, the responses are cause for concern. 80.6% of respondents were not engaging with the range of risk mitigation strategies that are proving to be popular in the US (e.g. OIN in relation to Linux kernel, LotNetwork in relation to NPE risk). This may be explicable by our feeling that the majority of survey respondents were from Europe.

Of the strategies that are being adopted, it is encouraging that IP insurance is ahead of others (10%). Our own experiences suggest that the market is growing quickly, particularly for SMEs.

Erik Alsegard, CFC Underwriting, sees the following trend:

"IP strategy can be as much about risk as it is about opportunity. For instance, not every business has a valuable patent portfolio but almost every business could face an allegation of infringement. As a result, IP strategy and risk management should go hand in hand. While not an alternative to sound IP strategy, IP insurance can play a valuable role in risk management for smaller companies."

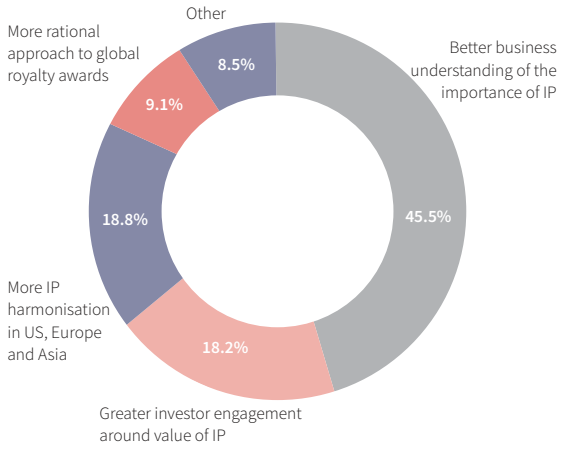
While IP litigation looks set to increase, it is to be hoped that the experiences over recent decades are sufficient to find resolutions that do not require greater involvement from the courts. In a global economy, this is frequently not the shortest route to a final outcome.

1.6 DEVELOPMENTS IN IP LAW AND PRACTICE

In the last 30 years, the law and regulation governing the ownership and use of IP has not kept up with the rapid advance of technology.

This is neither a criticism nor a cause for concern. Intellectual property, in its many forms, is a state sanctioned monopoly in an era that strives for fair competition. In the survey, we asked about developments that might impact IP in the next 12 months (**Chart 11**).

Chart 11 What do you think will be the most important IP development in the next 12 months?



In this context, we highlight the view that there will be more IP harmonisation in the US, Europe and Asia (18.2%) and a more rational approach to global royalty awards (9.1%). The Other category includes greater uncertainty for software patents, a Unified Patent Court, advances in IP management, open innovation, open source and global harmonisation.

Our additional research finds support for IP harmonisation and rational royalty rates, but in a novel combination. Harmonisation is slow and complex and, while the EU is something of a poster child in relation to both patents and trademarks, the events of the last 12 months (or 20 years, depending on your perspective) in relation to the Unified Patent Court speak volumes.

In contrast, there have been recent decisions (*Huawei* in the UK and *TCL v Ericsson* in the US) that are encouraging signs that the judiciary want to move from national disputes over a single patent towards portfolio licensing on a global scale. Whilst it is beyond the scope of this report to predict how this may evolve going forward, it would be at the intersection of the topics identified by survey respondents - a harmonised approach to achieve global settlements.

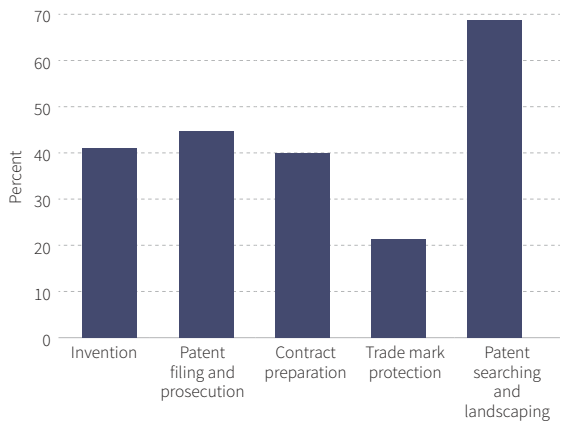
1.7 THE IMPACT OF AI ON IP

AI of all shapes and sizes will impact everyone. Earlier in the survey, it was the technology selected as having the greatest capacity to disrupt. Taken together, there are understandably mixed views about AI.

The survey asked specifically about how AI will impact various aspects of IP law and practice (**Chart 12**). The results paint a positive picture for the IP and legal professions' willingness to engage with AI. 69.1% of respondents saw AI as helping in the area of patent searching and landscaping. This dovetails well with the increased budget that is being allocated to both competitive intelligence and data analytics (refer back to **Chart 5**).

This is a theme we have explored over the last year, not least because of our patent analytics software, Cipher, is the most advanced use of AI and machine learning to enhance the analysis of complex and patented technology landscapes.

Chart 12 Which do you think will be impacted by developments in AI?



There is also confidence that AI will impact many other areas such as patent filing and prosecution (44.2%), invention creation (42.4%) and contract preparation (42%). Our own work, however, suggests that there is still some resistance to change. Part of this is the natural reaction to some of the wilder assertions that 47% of jobs in the US and 35% in the UK are at "high risk" of being automated over the following 20 years.

While we recognise the power of AI to replace manual tasks, Aistemos CEO Nigel Swycher, himself a former lawyer and partner with Slaughter and May, sees the position as follows:

"At this stage, AI is well adapted to analysing patents in ways that would have taken teams of highly trained lawyers huge amounts of time and money to achieve. The opportunity is there to redeploy this energy into activities that add substantive value to the business - these advances are to be welcomed."

Whilst it is reasonable to assume that Industry 4.0 (the Fourth Industrial Revolution) will disrupt, that is not in itself a reason to resist change. Coming back to patent analysis, it is beyond argument that AI in this context is some combination of faster, better, cheaper. We are not, however, speaking of technological singularity leading to unfathomable changes to human civilisation – we are talking about what machines do well: count and sort. We predict that AI in the field of IP will liberate the IP profession from vast amounts of repetitive, low value work, enabling it to be more engaged in the formation and execution of corporate IP strategy which will benefit everyone.

2.1 Aerospace and Defence

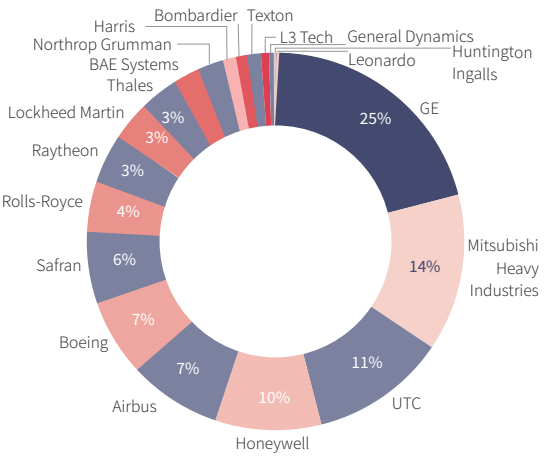
Under attack from innovation

UNDER ATTACK FROM INNOVATION

It must be tempting as the CEO of a major A&D company to believe that your position is unassailable. The industry is large. You have relationships with MoD and DoD that go back decades, and there are always wars to fight. You have a long history of R&D and leadership in innovation and technology. Best of all, you have cash.

THE TOP A&D COMPANIES ARE MAJOR PATENT OWNERS

Chart 13 Top 20 A&D patent owners



Over the last 10 years, there has been a constant growth in patenting, and the Top 20 A&D companies (**Chart 13**) own over 125,000 patent families (this excludes patents owned by GE and Mitsubishi in unrelated areas).

Chart 14 is a more detailed breakdown applied to the Top 5. Cipher, our AI enabled patent analysis software, makes it easy to analyse both the macro and micro views.

THE A&D TECH OF TOMORROW IS VERY DIFFERENT

Disruption impacts A&D in the same way as many other sectors. For example:

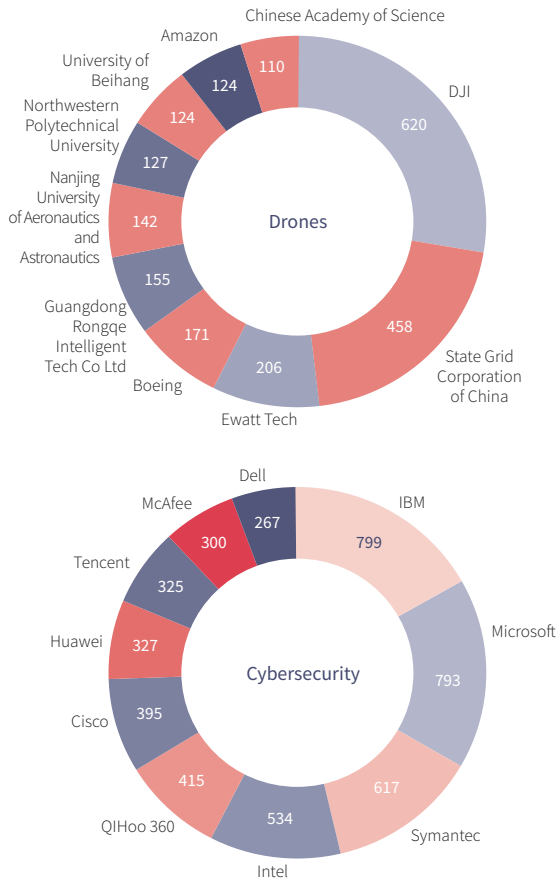
- IoT, sensors and connected devices are leading to more efficient maintenance and support
- Wearables are essential for a range of military applications
- 3D printing is transforming the way parts are made and supplied
- Cybersecurity is fast becoming both as a shield and a sword
- Autonomous systems on land, air and water, including in this category drones

Chart 14 Analysis of Top 5 A&D patent owners

	GE	UTC	Honeywell	Airbus	Boeing
Motorization	12,433	10,247	2,970	3,279	2,187
Materials & processes	825	313	229	1,205	1,235
Miscellaneous	2,472	949	1,945	559	585
Aircraft design & chassis	1,585	829	772	3,490	2,205
Electric systems	2,189	757	949	283	591
Temperature management	190	1,073	131	41	36
Air traffic management & cockpit layout	508	148	1,157	794	899
Wireless & communication	2,076	300	2,110	646	1,150
Fuel	609	150	2,627	69	85
Navigation & positioning	506	83	668	486	740
Optics & imaging	1,238	73	241	123	268
Software & interface	1,024	232	1,019	377	857
Elevator systems	36	1,356	21	8	16
Payload & ammunition	12	16	5	31	33
Total	**25,703**	**16,526**	**14,844**	**11,391**	**10,887**

Chart 15 is an analysis of the Top 10 patent owners in drones and cybersecurity.

Chart 15 Drones and Cybersecurity, Top 10



The reality is stark. While A&D companies have their toes in the water some of the time, the investment is being led by other companies (e.g. IBM, Intel, Microsoft) and in other geographies (e.g. China, in the case of drones).

This makes it imperative to monitor patenting trends. While few can handle the onerous requirements of being a defence contractor, we have witnessed the impact of an era of GAFA (Google, Apple, Facebook, Amazon) across a number of sectors and technologies and A&D is not immune. The US DoD has been critical of the levels of R&D (c.2% in A&D compared to over 7% in tech) and have signalled their willingness to engage with smaller tech companies.

The signal emitted from patent information improves screening for potential acquisitions and collaborations. A&D would not be the first sector that struggled with the innovator's dilemma. Big Pharma have been tackling this for years and have a tried and tested model for in-licensing (and acquisitions). It can also help counter the impact of Silicon Valley. In 2015, the Pentagon set up DIUx in Moffett Airfield in Mountain View, California to increase access to innovative, leading edge technologies from high-tech start-ups and entrepreneurs. Airbus was quick to follow suit by setting up a West Coast VC fund in the same year.

LITIGATION IS LIKELY TO INCREASE

Chart 16 is a chart of the litigation against the Top 20 A&D companies. Apart from the rise (and fall) of NPEs, there have been very low levels of patent litigation. This good news is outweighed by the fact that the absence of IP risk often equates to lack of attention in the boardroom. As A&D feels the impact of disruptive technologies, expect to see an increase in litigation.

Chart 16 Litigation against Top 20 A&D companies (ex GE and MHI)

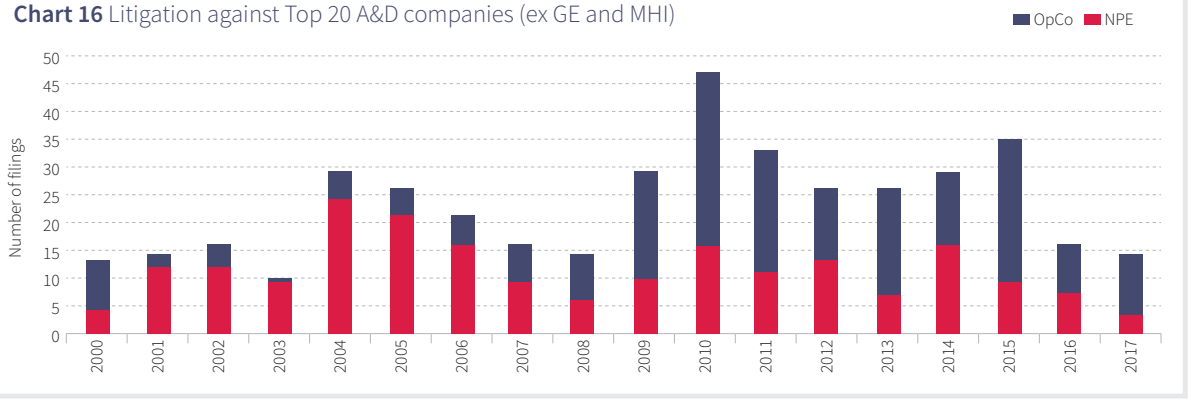
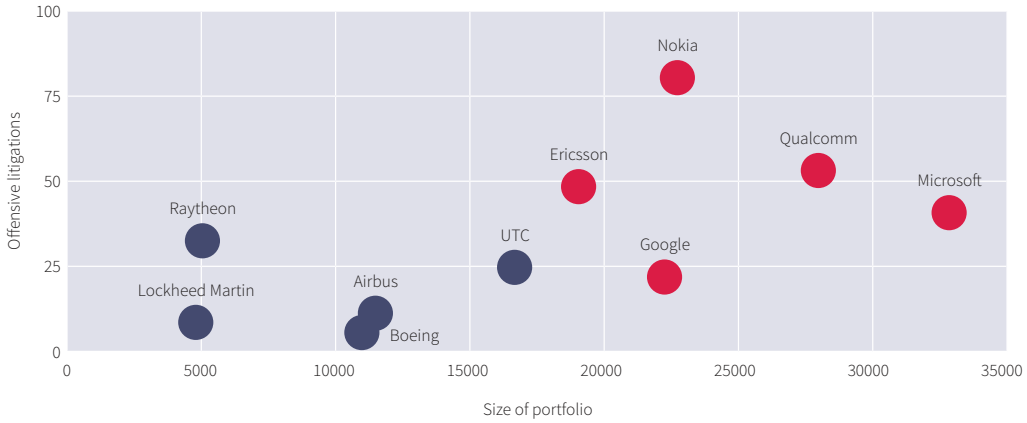


Chart 18 compares the Top 5 in A&D with a selection of tech companies. Technology portfolio sizes are larger and they tend to litigate more often.

Chart 18 Offensive litigation vs portfolio size, A&D vs technology companies



PATENTS ARE IMPORTANT WHEN COMBATING NEW FORCES

While patents have historically been important to A&D, the way in which they have been understood and exploited is about to change. There are a variety of reasons. First, the legacy A&D portfolios will need to adapt to disruptive technologies. Secondly, patents are currency in technology deals - in traditional A&D supply chains the role of patents has been largely passive. Thirdly, litigation risk in A&D has traditionally been low. This is likely to change in a connected and autonomous world, where the fight has already started for intellectual property supremacy.

2.2 Fintech

Understanding the role of patents

UNDERSTANDING THE ROLE OF PATENTS

When banks say that they are technology companies or heavily investing in fintech, what's the right performance measure? Many CEOs or CTOs point to the sheer size of their engineering team, others refer to their R&D spend. Both are valid measures, but are only inputs.

We compare banks and established technology companies through a patent lens. This is a tangible measure of how companies protect the output of their investment. All data has been generated using Cipher, our leading analytics software, using AI and machine learning to analyse patent information.

BANKS DO PROTECT THEIR INVESTMENT IN TECHNOLOGY

There is a massive difference in the attitude towards patenting across the financial services sector.

This is a familiar pattern which has been observed in other sectors disrupted by technology.

There are always those that see the tech tsunami coming, and others who prefer strategies based on wait and see. The music and retail sectors are both excellent case studies.

Chart 17 analyses the patent portfolios of banks in the US, Europe and Asia. Bank of America is the stand-out winner using this metric, and has been building its portfolio for over a decade. As a generalisation, the US banks (e.g. JP Morgan, Goldman Sachs and Morgan Stanley) are all more patent savvy than the European banks (notably BNP and Deutsche). This type of analysis also helps with an understanding of specific technologies.

If you look at the banks as a whole, you see an increase in patenting over time.

Chart 17 Who protects what?

	Bank of America	Barclays	BNP	Capital One	Citigroup	Deutsche Bank	Goldman Sachs	Japan Post Bank	JP Morgan Chase	Mitsubishi UFJ	Morgan Stanley	RBC	TD Bank	UBS	Wells Fargo
ATMs	63	0	0	7	9	0	0	0	18	1	0	0	0	0	7
Banking IT infrastructure	999	56	0	161	71	0	0	18	207	125	0	19	46	27	48
Call center and support	55	0	0	3	10	0	0	0	11	2	0	0	0	0	4
Cash handling	53	0	0	0	1	0	0	1	2	1	0	0	0	0	0
E-commerce	6	2	0	2	2	0	0	0	3	0	0	0	2	0	3
OCR	86	0	0	2	3	1	0	0	17	2	0	0	3	3	7
Online and mobile banking	517	24	0	33	26	0	13	0	58	9	19	4	21	14	24
Payment cards	35	1	1	42	22	0	0	1	29	5	0	0	0	1	8
Security and authentication	104	14	0	11	15	0	0	2	26	44	0	1	3	3	11
Social media and data	83	6	0	18	5	0	0	0	18	4	0	1	5	2	3
Transaction data processing	546	57	0	56	31	2	144	22	126	65	122	6	10	26	26
Total	**2,547**	**160**	**1**	**335**	**195**	**3**	**157**	**44**	**515**	**258**	**141**	**31**	**90**	**76**	**141**

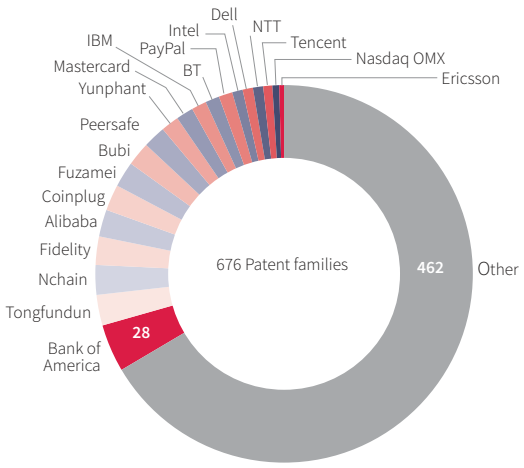
Granted and pending patent families in 2017

THE INFLUENCE OF BLOCKCHAIN

Legend has it that the first blockchain began with Satoshi Nakamoto in 2008, which became the foundational technology for Bitcoin. It wasn't until 2013 that companies started patenting blockchain and its many applications.

There has been substantive growth in blockchain patenting since 2009. Chart 18 is a pie chart representing the top owners. The main point is that there are over 250 companies owning 676 patent families. Analysis of this sort is an essential source of competitive intelligence, e.g. as a way of keeping track of Chinese companies such as Tongfudun, Fuzamei, Bubi and Yunphant.

Chart 18 Who owns blockchain patents?



HOW DO BANKS COMPARE TO TECHNOLOGY COMPANIES?

Chart 19 compares the patents owned by the banks with a range of technology companies. The stark difference reflects fundamentally different business strategies. Technology companies understand the role of intellectual property to define and protect markets. This is all relatively new to the financial services sector. IBM owns 5x more fintech patents than all the banks put together.

Chart 19 Banks vs the major tech companies

	Banks	IBM	Oracle	Hitachi	SAP	Google	Microsoft	HPE
Transaction and data processing	1,240	5,538	1,660	1,072	1,635	2,306	4,571	764
Online and mobile banking	762	5,541	1,786	745	926	1,744	4,401	1,011
ATMs	105	322	135	88	46	148	218	41
Security and authentication	234	986	298	252	138	533	925	204
E-commerce	20	354	106	77	61	158	429	38
OCR	1,778	9,266	3,053	1,647	2,090	3,728	7,331	1,407
Banking IT infrastructure	124	546	141	72	118	247	597	41
Social media and services	145	366	76	59	83	353	458	28
Cash handling	58	56	16	114	5	19	12	14
Payment cards	146	568	214	200	133	272	422	80
Call centre and support	85	321	72	45	36	249	306	57
Total	**4,697**	**23,864**	**7,557**	**4,371**	**5,271**	**9,757**	**19,670**	**3,685**

BANKS HAVE BEEN A TARGET FOR PATENT LITIGATION

There has been virtually no IP litigation between banks, which is one of the reasons why it has not historically been necessary for them to build an arsenal of IP assets. Chart 20 is an analysis of the litigation against banks, and specifically the actions brought by Non-Practising Entities. There has been a notable decline in NPE actions since 2012, in part because of US legislative reform.

Chart 20 Patent litigation against banks

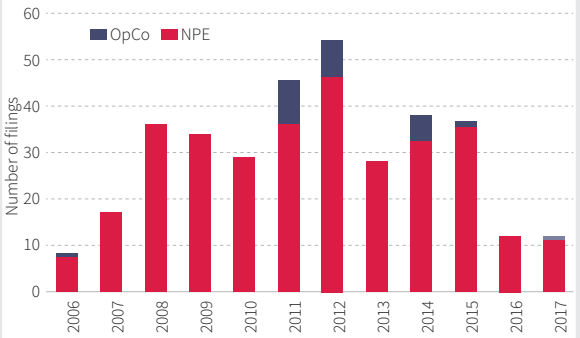


Chart 21 contains a helpful reminder that delivering complex B2C solutions requires many different technologies, the vast majority of which are not developed in-house e.g. mobile banking, location based services and e-commerce.

WHAT NEEDS TO BE DONE?

In a recent interview, Cathy Bessant, Chief Operations and Technology Officer of Bank of America, suggested that even if the banks are not fintech companies, they will have to buy, partner and compete with them. In this reality, fintech companies are the disruptive new entrants. To this, we would stress the importance of the major technology companies, such as Microsoft and IBM, who have been investing in these technologies for years. Our view is that many of the banks may have significantly underestimated the importance of patents. Patents are no longer merely weapons of war but can play an important role on a number of levels.

First, as an essential source of competitive intelligence. As more fintech patents are filed, there is more information to monitor and IP analytics is an effective way to screen quickly and economically. Second, as currency in the collaborations and licenses that is the inevitable path to interoperability and standardisation. Third, as a way of protecting investment in proprietary technology. If you think of all great inventions from light bulbs to cars to mobile devices, no one prospered without a decent understanding of patents.

Chart 21 Analysis of NPE litigation by technology area

	Bank of America	JP Morgan	Citigroup	Wells Fargo	Bank of NY Mellon	TD Bank	Capital One	Barclays	Morgan Stanley	Goldman Sachs	Deutsche Bank
Web and mobile	49%	52%	16%	37%	25%	25%	33%	38%	30%	57%	0%
Software and UI	15%	13%	36%	11%	60%	0%	23%	0%	33%	0%	0%
Financial products and trading	8%	12%	16%	42%	0%	0%	26%	63%	0%	0%	100%
Data transfer	5%	3%	4%	0%	15%	0%	2%	0%	18%	43%	0%
Data analysis	9%	10%	5%	0%	0%	75%	0%	0%	0%	0%	0%
Call center and support	8%	0%	22%	0%	0%	0%	5%	0%	18%	0%	0%
E-commerce	6%	7%	0%	3%	0%	0%	10%	0%	0%	0%	0%
Location based services	0%	3%	0%	8%	0%	0%	1%	0%	0%	0%	0%

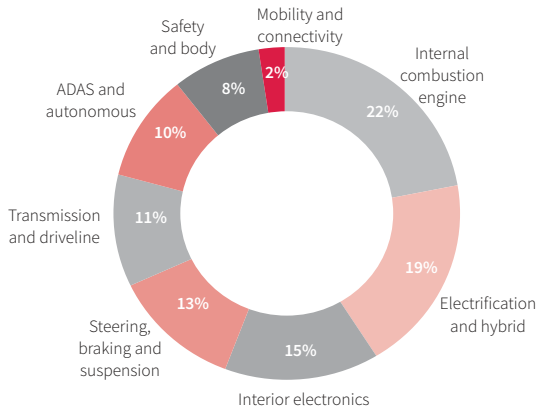
2.3 Automotive

The future of mobility

THE FUTURE OF MOBILITY

There are many sectors that have been and will be disrupted by technology, but perhaps none more so than automotive. For over 50 years, there has been relative stability in the roster of who makes (the OEMs) and who are the major suppliers to the manufacturers (collectively the Tier 1s). From a patent perspective, there has been little to disturb the natural order. This is all about to change. Chart 22 represents the technologies patented by the global OEMs and their suppliers.

Chart 22 OEMs and suppliers, what they protect



AUTOMOTIVE SECTOR HAS ALWAYS INVESTED IN PATENTS

Over the last 15 years, the number of automotive patents has doubled. That's hundreds of thousands of patents, and billions of IP related costs. In the charts that follow, we analyse active patent families (both pending and granted). This analysis has been conducted using the taxonomy developed in collaboration with a number of OEMs and Tier 1s.

Chart 23 applies this taxonomy to the Top 10 OEMs. What is immediately striking is its sheer number of patents. The combined group owns a quarter of a million patents.

Chart 23 Top 10 OEMs and Tier 1s, who owns what?

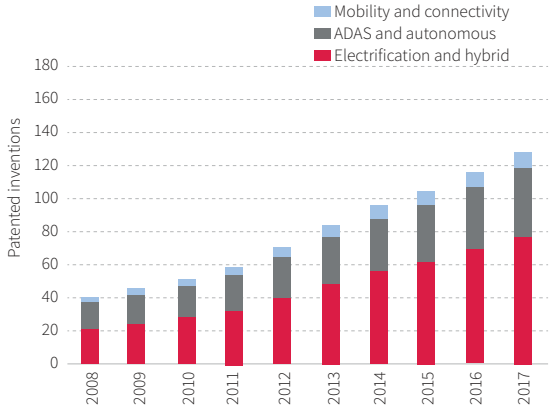
	ADAS and autonomous	Electrification and hybrid	Interior electronics	Internal combustion engine	Mobility and connectivity	Safety and body	Steering, braking and suspension	Transmission and driveline	Other
Toyota Motor Corp	5,581	21,233	4,412	12,390	1,159	3,380	3,761	4,497	25,931
Honda Motor Co Ltd	2,650	5,970	2,196	5,449	336	1,588	2,570	3,040	10,300
Hyundai Motor Group	2,243	4,080	3,030	4,627	421	1,305	2,305	3,511	8,232
Volkswagen AG	2,279	2,309	2,634	3,135	441	1,292	1,821	1,348	6,399
Nissan Motor Co Ltd	2,269	5,521	788	2,684	277	533	1,070	2,332	3,591
General Motors Co (GM)	1,295	2,591	1,370	2,858	506	774	666	2,161	5,818
Ford Motor Co	1,432	2,218	1,118	3,749	356	1,117	859	881	4,452
Groupe PSA	360	602	526	1,147	67	450	488	398	2,860
Renault SA	361	694	347	1,233	51	346	420	363	1,986
Fiat Chrysler Automobiles NV	224	317	273	659	50	461	245	356	1,945
Total	**18,694**	**45,535**	**16,694**	**37,931**	**3,664**	**11,246**	**14,205**	**18,887**	**71,514**

AUTOMOTIVE PATENTING STRATEGY RESPONDS TO FRESH CHALLENGES

As the sector evolves, there is a fundamental change in the technologies that the automotive sector needs to develop and protect. **Chart 24** shows the growth in ADAS, battery and connectivity patenting.

Just as interesting is the dramatic shift in what constitutes the automotive ecosystem. The Microsoft licensing arrangements with Toyota and the collaboration with Nvidia all illustrate the increased dependence on the broad range of technologies necessary to make the connected car a reality.

Chart 24 Growth in patenting: mobility, electrification and ADAS technologies

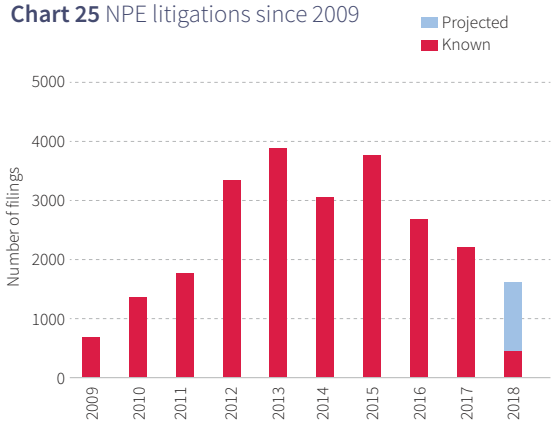


THE SECTOR FACES UNPRECEDENTED LEVELS OF IP RISK

As the trend to full autonomy accelerates, it is not unreasonable to regard cars as "smartphones on wheels". The IP wars that have raged in that arena for decades are seen as an omen for what the future of automotive has in store.

The NPE threat has not gone away but is in decline. **Chart 25** presents all NPE litigations since 2009. There is no doubt that the NPEs see a technology enabled automotive sector as a hot target and that the battleground may shift from the US to Europe and perhaps even to China. Their impact will, however, be diminished as a result of an adverse legislative and judicial climate and an era of well organised defence, such as LotNetwork, Unified Patent and RPX.

Chart 25 NPE litigations since 2009



Litigation between automotive companies has historically been a rarity. The question is whether this will change as both the car and associated business models (e.g. car ownership and ride-sharing) undergo a radical transformation. One particular area of concern is connectivity and and specifically 3G, 4G and soon 5G Standards Essential Patents (SEPs). This is not something that the OEMs and suppliers have ever had to face, and the SEP owners are highly experienced, battle-hardened and already standing in line.

While this creates the potential for disputes, it is to be hoped that the experience over the last 20 years of how to determine a fair royalty can be more efficiently applied to cars than was previously the case for phones. What is already clear is that connectivity is not one thing, but many. There are significant differences between the functionality delivered by in-car services such as OnStar (GM's security, navigation and remote diagnostic service) and an 'always-on' connected car, constantly communicating with other cars and the infrastructure.

IT WON'T JUST BE THE CAR THAT'S CONNECTED

There is also a marked increase in M&A as automotive companies recognise the need to meet the challenges ahead (most recently Daimler and BMW's announcement of the intention to merge their mobility businesses).

Similarly, there are more acquisitions by the tech sector who appreciate the significant potential that automotive offers (for example, Intel's acquisition of Mobileye). A complex network of relationships can be observed in areas such as ride-sharing, e.g. Waymo partnering with Lyft, itself a company backed by General Motors.

The position is summed up perfectly by Mary Barra, CEO, and Chairman of General Motors, who states her belief that "we are in the midst of seeing more change in the next five years than we've seen in the last 50 years". With over a billion vehicles on the road today, the changes will inevitably have consequences not only for those who make and sell cars, but also for those who finance, insure and beyond.

This report is based on an article published in IAM magazine under the title "The future of mobility – can patents keep up?" Nigel Swycher and Steve Harris, December 2017.

2.4 Industry 4.0

Revolution or evolution?

"It's time to answer the question: is it really different this time? Will machine intelligence automate most human jobs within the next few decades, and leave a large minority of people – perhaps a majority – unable to gain paid employment?"

Calum Chance, The Economic Singularity: Artificial Intelligence and the death of capitalism

HOW MANY REVOLUTIONS CAN YOU HAVE IN 300 YEARS?

Humans have been around for a long time, well over 2 million years, and homo sapiens for at least 300,000 years. Industrial revolutions date back to the 18th century with the shift to urbanisation. The second revolution (mass production) was 200 years ago. The third (digital revolution), began in the 1980s and is still disrupting and transforming.

The fourth industrial revolution is waiting in the wings. Often referred to as Industry 4.0, it will bring intelligent machines and factories communicating with each other and collecting and analysing data. These capabilities will allow organisations to fundamentally improve and transform production, and make processes faster, more flexible and more efficient.

This willl have a dramatic impact on the vast asset-heavy industries such as manufacturing, chemicals and mining. Bain predicts that Industry IoT will generate over $300bn of revenues by 2020, and is already fuelling significant M&A and investment activity. This report analyses the impact of these changes through a patent lens for world's largest manufacturing and engineering companies.

PATENTS HAVE ALWAYS BEEN IMPORTANT

Chart 26 analyses the patent portfolios of 10 of the largest manufacturing companies. There are significant differences across the board reflecting their corporate histories and the customers they serve. There are also significant areas of overlap, specifically in areas such as engines, turbines and electronics.

Chart 26 Top 10, patent portfolio size by cluster

	Bosch	Siemens	GE	BASF	3M	ABB	Emerson	Mitsui	Thyssen Krupp	Arcelor Mittal
Sensors, imaging, data processing and auto	3994	14127	10923	431	2446	1772	1394	252	169	22
Electronics, power & energy storage	6997	6543	3039	670	739	4932	1580	447	262	14
Materials	631	668	1330	11521	3485	178	70	4353	670	243
Engine & exhaust	11273	2568	2417	894	585	346	2000	375	373	11
Gas & wind turbines	747	4786	10493	354	485	317	284	107	317	45
Machines & appliances	9875	1696	6248	241	468	477	486	207	274	18
Driver assistance systems	5771	1249	0	77	119	115	113	101	219	8
Automotive components and systems	3276	1492	715	49	74	160	88	35	764	23
Communication systems	883	1972	223	9	33	237	157	6	12	0
Miscellaneous	4864	3104	2260	880	1966	380	294	907	1191	22
Total	48311	38205	37648	15126	10400	8914	6466	6790	4251	406

INDUSTRY 4.0 IS NOT ONE THING BUT MANY

Industry 4.0 is not the consequence of one thing, but the rapid and simultaneous development of multiple technologies including IoT (Internet of Things, itself a set of sensor and communication technologies), robotics, 3D printing, cloud computing, augmented reality and the ubiquitous rise in AI.

In **Charts 27A** and **27B**, we analyse the Top 10 owners of patents in the areas Robotics and Sensors. What is striking is the limited overlap between the owners of these technologies and the Top 10 in **Chart 26**.

Chart 27A Robotics, Top 10

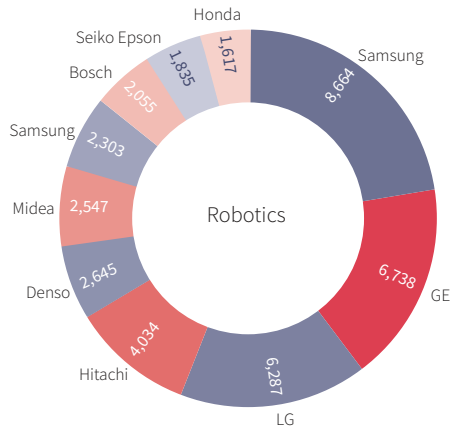
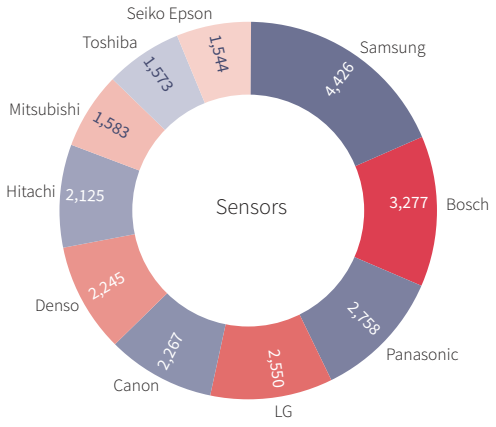


Chart 27B Sensors, Top 10



This suggests a world where it is more difficult to dominate across multiple business lines. For Robotics, the levels of patenting across the automotive OEMs and their suppliers suggests that this community is going to take the lead. For Sensors, Samsung, Panasonic and Hitachi all feature strongly. What seems like disruption for the incumbents is an opportunity for those strong in the foundational technologies.

This expansion of the ecosystem and supply chains is a driving force behind many recent acquisitions and collaborations. GE's AI and IoT acquisitions include *wise.io*, Bit Stew and its collaboration with TAMR. Mitsui has invested in OSIsoft and GRID, and Siemens has acquired Mentor Graphics. The technologies also motivate significant internal investment, such as Bosch's plan to build a $1bn factory to power the new wave of smart technologies. No one is ignoring the opportunity.

NEW TECHNOLOGIES COME WITH NEW RISKS

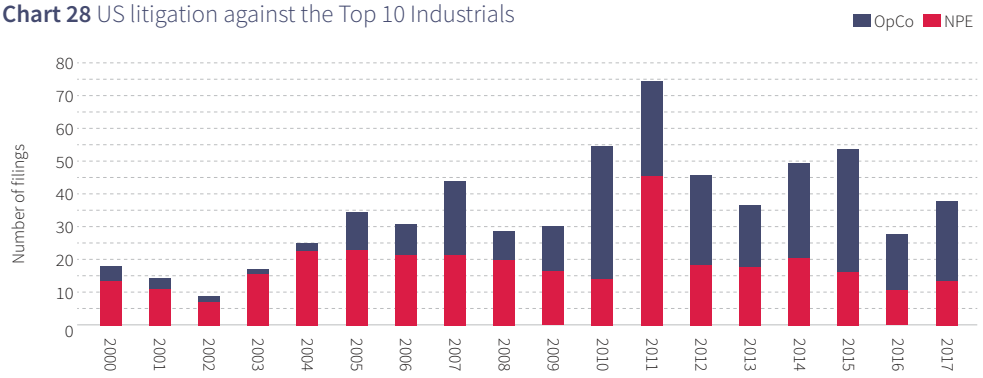
A valid concern is whether these trends will see an increase in patent risk. **Chart 28** is the US litigation profile for the same cohort over the last 10 years. This is a familiar pattern of relative stability, spoilt only by the surge in NPE litigation. With this source of litigation in decline, the question is whether peace will prevail.

What seems certain is that there will be a need for greater collaboration between the tech sector and the major Industrials, with greater focus on the start-ups and many winners and losers. With technology and patents being currency in this equation, expect to see a much greater awareness of and attention on intangibles.

> *"The value of an idea lies in the using of it"*
>
> Thomas Edison

There have been many debates over the years about whether patents aid or inhibit innovation. Cipher, our advanced analytics platform, helps you rethink this question and value patents as an essential source of scientific intelligence. This allows companies to make connections and build the relationships necessary to enable Industry 4.0 to be more of an evolution than a revolution.

Chart 28 US litigation against the Top 10 Industrials



THE END OF THE BEGINNING

Industry 4.0 will have a greater economic impact than its predecessors. It will also herald unprecedented increases in efficiency that will reduce cost and improve performance across all aspects of industrial performance.

This transition is fuelling new levels of innovation which disrupt and empower in equal measure. While this puts pressure on the leaders as they stand today, there is no doubt that they are up for the challenge. What is essential at these inflection points is the accessibility of the right information at the right time. This means enabling the patent system to do what it was intended to do - communication. In that way, we can all stand on the shoulders of giants and mitigate the risk of standing on each others toes.

2.5 Technology

A sector beyond definition

TECHNOLOGY – A SECTOR BEYOND DEFINITION

We use TLAs (three letter acronyms) gratuitously, while the use of 4 letters is typically reserved for those who strive to reduce war or poverty such as NATO. By the time you reach 6 letters you are aiming to save the planet - UNICEF. Where in the spectrum is FAMGA?

FAMGA is the acronym used to capture the phenomena caused by Facebook, Apple, Microsoft, Google and Amazon. What is it about these companies that require their own definition? Arguably it is because they cannot be comfortably confined within a single sector.
When Google reorganised and created Alphabet, it communicated elegantly that it intended to invest across a spectrum of products and services, from bioscience to connected homes. Amazon's development of Alexa and their acquisition of Whole Foods evidences a strategy one step short of world domination.

Common to all these companies is their ability to harness disruptive technology. For that reason, this report analyses the patented technologies owned by FAMGA companies and how they compare to others. In terms of market cap, they are the among the most valuable companies in the world. However, when plotted on the tectonic plates of innovation and disruption, these organisations face competition like anyone else and from all quarters.

Chart 29 compares FAMGA companies with BAT (Baidu, Alibaba and Tencent), the Chinese equivalent. This shows a huge diversity in what is protected, not to mention patenting on a massive scale.

Chart 29 FAMGA compared to BAT companies

	Google	Microsoft	Apple	Amazon	Facebook	Tencent	Baidu	Alibaba
Website and searching	3141	5335	965	657	356	2487	2410	2153
Software	1782	5653	2075	678	239	2178	852	1325
Social network and recommendations	3061	3931	613	1474	1317	1125	464	1647
Data storage	1490	4106	618	1072	330	1733	512	1103
Instant messaging	1430	2552	519	697	301	2896	650	1612
Hardware	2778	2399	3496	613	324	478	190	177
Video	2094	2449	1403	436	186	1145	280	195
Communication	2337	987	1864	204	170	564	163	208
Image recognition and graphics	1251	2235	836	339	169	821	394	430
Speech recognition	775	867	280	271	25	219	398	62
Navigation and GPS	524	298	286	61	12	127	252	48
Miscellaneous	1568	2426	2243	558	124	593	418	372
TOTAL	**22231**	**33238**	**15198**	**7060**	**3553**	**14366**	**6983**	**9332**

ARE WE LOOKING IN THE WRONG DIRECTION?

As an alternative to analysing whether technology companies disrupt, it can be more instructive to focus on the key technologies. Two of the most ubiquitous are artificial intelligence and cloud computing. **Chart 30A** and **30B** analyse these technologies using classifiers, itself a well-established field of data science. We exclude Chinese patenting, a region we return to later.

Chart 30A Top 10 Deep Learning owners (excluding China)

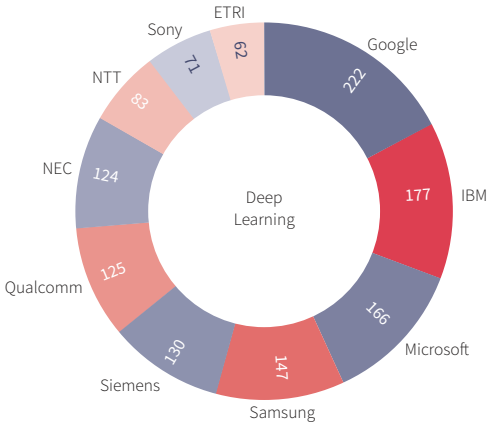
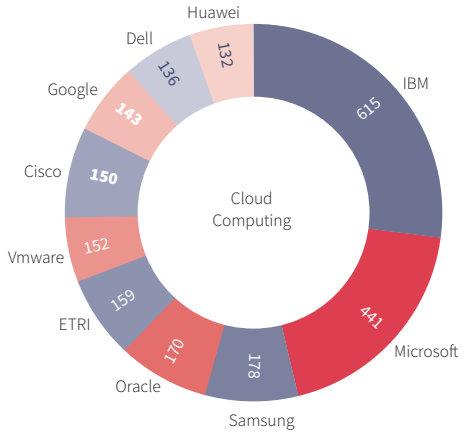


Chart 30B Top 10 Cloud owners (excluding China)



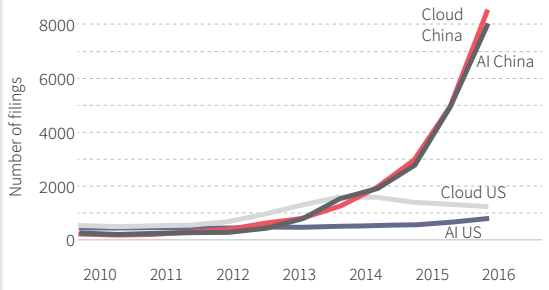
The fact that the top owners in each area differ and that there are over 1,000 unique owners for each technology suggests that we are heading for a situation where it is not only devices that are connected, but companies both within and across sectors. Some commentators equate these technologies to electricity, essential but not determinative of commercial success. While Edison and Westinghouse controlled their markets for a while, history teaches that evolution is continuous. On this analysis, it is the technology which is disruptive, rather than one or more market participant.

LEOPARDS CHANGE THEIR SPOTS

The West has been slow to adjust to the fresh approach to patents in China. Analysing the data provides evidence that requires close attention. More patents are filed in China than the US and Europe combined. **Chart 31** compare the US and China patenting in Deep Learning and Cloud. Data speaks.

These positions of strength are bolstered by significant investment in R&D and M&A. Alibaba has backed Sensetime, Tencent is investing in a range of AI start-ups such as UBTECH. Baidu is putting AI at its core, including setting up the Baidu Institute of Deep Learning with the full support of the Chinese government.

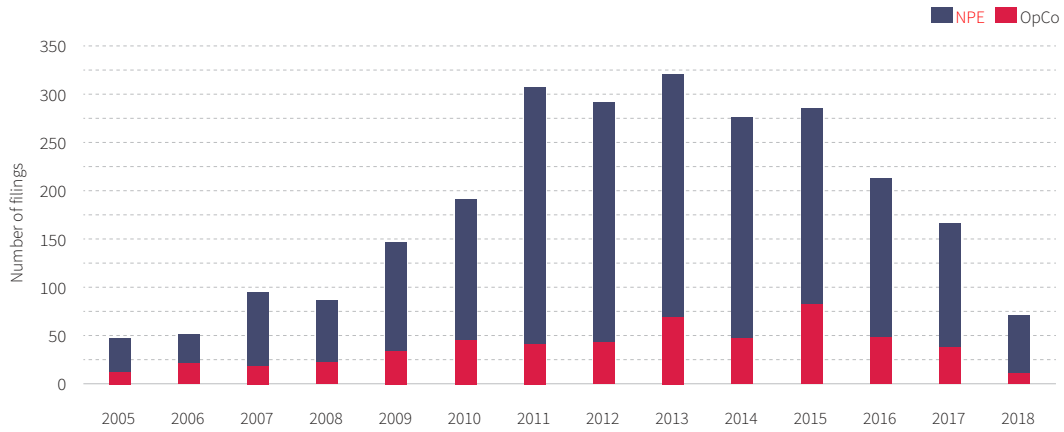
Chart 31 US vs Chinese tech companies: Cloud and AI



LITIGATION IS NOT THE MAIN EVENT

It is accepted wisdom that the technology sector is highly litigious. This may be to confuse two different issues. First, the undeniable fact that they were the number 1 target for NPEs. **Chart 32** shows the levels of litigation reached in their heyday. Secondly, technology companies do not naturally use litigation as their preferred means of dispute resolution against other operating companies. This suggests that while patents will play an important role in everything from M&A to licensing, we should not expect a massive rise in litigation, but a greater awareness of the importance of patents.

Chart 32 US litigation against FAMGA and BAT



HOW TO RESPOND MEANS UNDERSTANDING THE QUESTION

This is the last of our reports on disruptive technologies, which we began from the perspective of sectors such as automotive, financial services, industrials and aerospace and defence that are adapting to disruption. This technology report ends with the suggestion that disruption is not one thing but many. Disruption by what? Disruption by whom? Disruption from where? Cipher, our analytics platform views these questions through a patent lens and is uniquely positioned to support the multi-disciplinary teams tasked with answering these questions.

All patent data is sourced from Cipher and Cipher Automotive, which harnesses artificial intelligence to map patents to technologies. For more information go to www.cipher.ai