Driving Toward Tomorrow: A Deep Dive Into Autonomous Vehicle Innovation

Executive Summary

In the last decade, the realm of Autonomous Driving has witnessed a surge in innovation, reflected in an explosive proliferation of patents. This report looks to patent data to navigate the dynamic landscape, highlighting key trends that define the industry's trajectory.

Competition within the Autonomous Driving sector is fierce, with traditional automotive giants like Toyota Motor engaging in high-stakes battles against tech behemoths such as Amazon. Intensifying the rivalry are strategic moves from companies like Alphabet, GM, and Baidu. Baidu has taken on a special self-driving project called Apollo, and Alphabet and GM have acquired specialized Autonomous Driving companies, Waymo and Cruise, respectively. All of these players already have commercial driverless taxi operations in some locations which speaks to the level of development already achieved.[1] The combination of automotive expertise and tech intelligence has amplified the innovation race, resulting in an ecosystem where patents have become a powerful currency. The patent landscape, encompassing a wide array of inventions, indicates an industry where protection measures are both robust and expansive.

Despite the remarkable strides and increases in patent activity and strength, mainstream implementation of Autonomous Driving technology might still be on the distant horizon. While the potential impacts of Autonomous Driving are profound, reshaping urban mobility, reducing accidents, and revolutionizing transportation logistics, the journey to widespread adoption remains complex.

Looking ahead, the implications of this ongoing evolution are far-reaching. Autonomous Driving technology serves as a linchpin, influencing not only the automotive sector but also intersecting with fields such as artificial intelligence, connectivity, and smart infrastructure. This collaboration ushers in a new age of innovation, where progress in one field fuels advancements in others.

[1] https://www.reuters.com/technology/baidu-wins-licence-operate-driverless-taxis-shenzhen-2023-06-16/
https://www.cnbc.com/2018/12/05/waymo-starts-commercial-ride-share-service.html

Contents

Executive Summary 2

Autonomous Driving and the Implications of Revolutionizing Roads 4

Measuring Innovation in Autonomous Driving 5

Key Players and Trends in Autonomous Driving Patent Development 6

Analyzing the 3 Main Sub-Technologies in Autonomous Driving 10

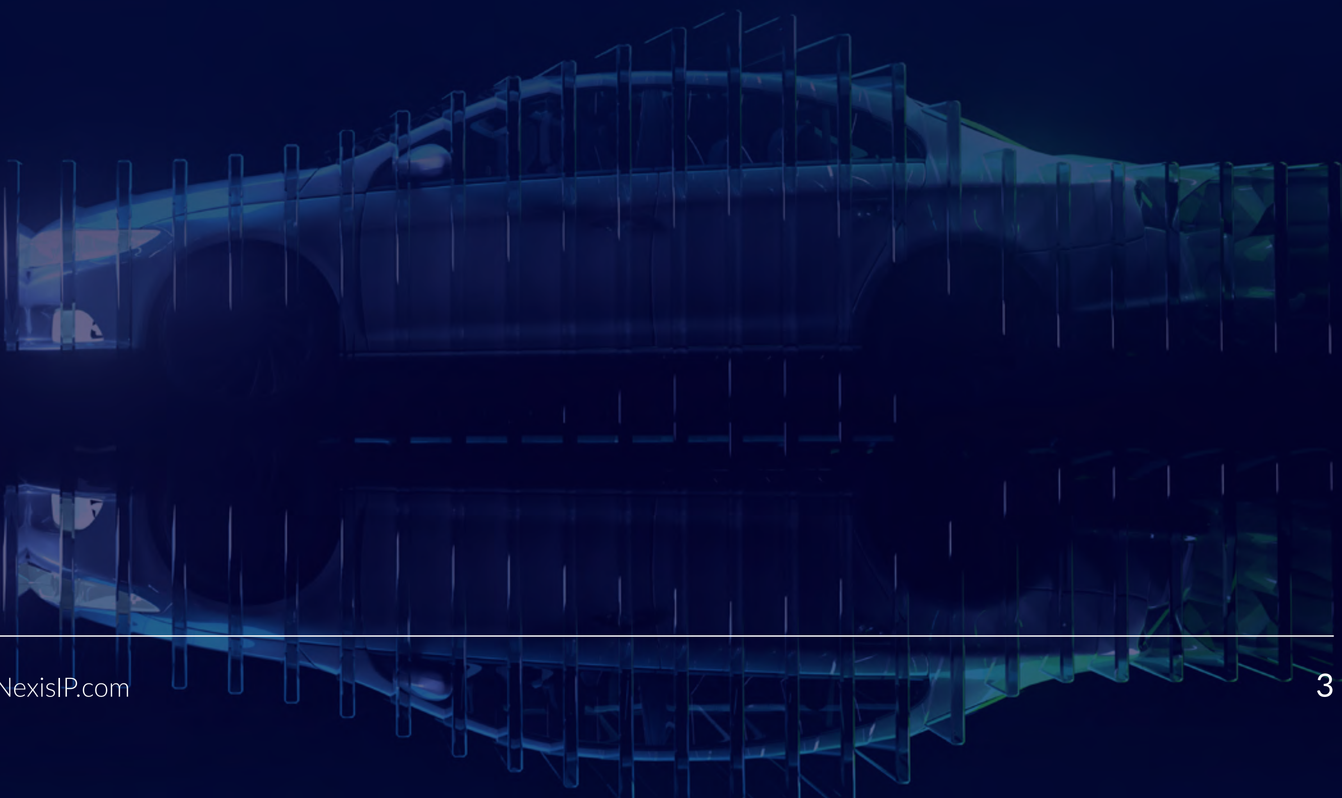
- Smart: Intelligent Algorithms 12
- Security: Safety & Security Systems 14
- Interaction: Interactive Experience 16

Tracing the Path of Advancements in Autonomous Driving Innovations 18

Navigating the Complexities of Commercializing Autonomous Driving 20

Appendix

- About the Authors 21
- About the Patent Asset Index 22
- About LexisNexis® PatentSight® 23
- About Cipher Classification 23
- About LexisNexis® Intellectual Property Solutions 23



Autonomous Driving and the Implications of Revolutionizing Roads

The concept of self-driving vehicles has been around for almost as long as cars themselves. This has been a mainstay in futuristic and science fiction media; however, the true realization of this dream remains elusive today.

The purpose of Autonomous Driving technology is clear: to provide passengers with the convenience of not having to actively drive and instead be able to relax or be productive during their journey. From an economic standpoint, the elimination of the need for drivers would result in significant cost savings across various industries. The potential impact of this technology on the economy would be immense, with the possibility of reducing everyday expenses and the creation of a multi-billion-dollar industry. However, this could also lead to unemployment as drivers are replaced by machines. Eurostat estimates that about 5% of all employed individuals work as drivers, putting their jobs directly at risk.[2]

Although there are economic benefits and risks involved, there are also significant personal safety implications to consider. One advantage of autonomous vehicles is that they could potentially eliminate the number of fatalities resulting from accidents on the road. For example, in the United States, the National Highway Traffic Safety Administration (NHTSA) reports that there are over 100 fatalities per day.[3] This is not to mention the countless non-fatal injuries that occur as well.

While the legal and social acceptance issues surrounding the implementation of Autonomous Driving are major hurdles to overcome, this report solely concentrates on technological innovation. It discusses how the technology is developing, identifies the key players driving innovation, and explores the innovations they are pursuing to one day make Autonomous Driving a reality.

The potential economic impact of Autonomous Driving technology would be immense, with the possibility of reducing everyday expenses and the creation of a multi-billion-dollar industry.

[2] *https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20210923-2*
[3] *https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812451*

Measuring Innovation in Autonomous Driving

While there have long been aspirations to create self-driving cars, only in the most recent years has there been concerted development of the technology to realize this.

As patents are novel and forward-looking, and 80% of all technical information is found only in their documentation, they are an ideal indicator for the current and future progress of technology innovation. In Figure 1, the number of unique inventions in Autonomous Driving is displayed based on the number of active simple patent families, referred to as the Portfolio Size. Additionally, the strength of the portfolios is shown by the Patent Asset Index, a scientifically developed measure of patent strength. (To learn more about the Patent Asset Index, see page 22.)

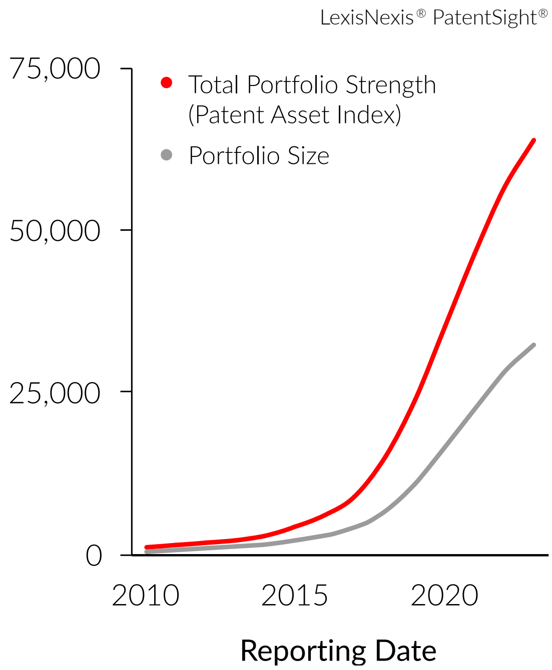


Figure 1: Development of the field of Autonomous Driving in terms of Total Portfolio Strength (Patent Asset Index) and Portfolio Size

There has been some development in the field going back several years, however, this only started to take off just after 2015. We do not only see an increase in patents around Autonomous Driving, but we also see that the strength of these patents is developing even stronger as the gap between to two lines increases.

Though there appears to be a slight slow down at the most recent data point, this most likely will increase again once data for the entirety of 2023 is available. It is difficult to say if we are at the beginning, middle or towards the end of the S-curve of innovation. Given the pace of development, and that Autonomous Driving technology is not as readily available the way electric vehicles are today, it is likely this is only the start.

> ***The surge in Autonomous Driving patent development is relatively recent, taking off after 2015.***

Key Players and Trends in Autonomous Driving Patent Development

A variety of players are involved in Autonomous Driving, from traditional auto original equipment manufacturers (OEMs) like **GM** to tech companies like **Alphabet**. Digitization has led to tech companies entering traditional industries, including the automotive market.

Figure 2 shows the top 25 patent owners in the field of Autonomous Driving by their Patent Asset Index and their portfolio size. Topping the list is **Baidu**, followed by **Alphabet**, two leading tech giants from China and the US, respectively, highlighting the necessary technology development and skills required to advance this field.

Following are **GM**, **Ford**, and **Toyota Motor**, so while Autonomous Driving is currently led by the tech industry, the automotive players still have a significant hand in the technology development.

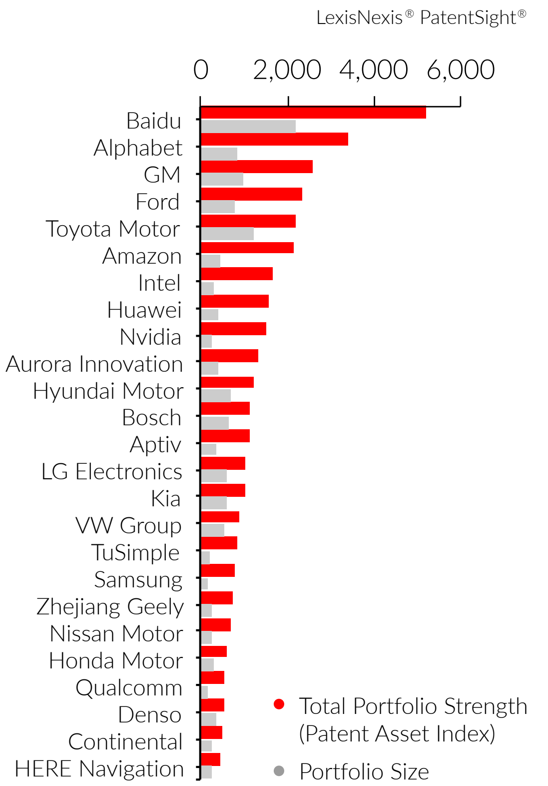


Figure 2: Top 25 players in the field of Autonomous Driving in terms of Total Portfolio Strength (Patent Asset Index) and Portfolio Size

The remainder of the list follows mostly the same pattern with a mix of traditional automotive OEMs and suppliers, along with tech companies.

Other notable players are **Nvidia** and **Qualcomm** who both work on chip designs, some of which are specialized for Autonomous Driving applications. There are also a couple of companies specialized in Autonomous Driving like **Aurora Innovation** and **TuSimple**.

It is also worth noting that **Amazon**, **Intel**, and **Nvidia's** positions would have been lower on the list if only the volume of their patents was considered, highlighting the importance of also considering patent strength when measuring innovation.

Additionally, Figure 3 reveals the Competitive Impact of the portfolios owned by these companies. The Competitive Impact metric is used to gauge the strength and to sum up the Patent Asset Index, which is indicated by the size of the bubbles in this chart. The Patent Asset Index is calculated by multiplying Competitive Impact by Portfolio Size. This means that two companies can have the same Patent Asset Index even if they have vastly different Competitive Impact and Portfolio Size.

Again, **Baidu** is the clear leader, and with this view, the wide margin between them and the second strongest company, **Alphabet**, becomes much more apparent. Moving to the left we can see the huddle of OEMs; **Ford**, **GM**, and **Toyota Motor**, all with a similar Competitive Impact as **Baidu**.

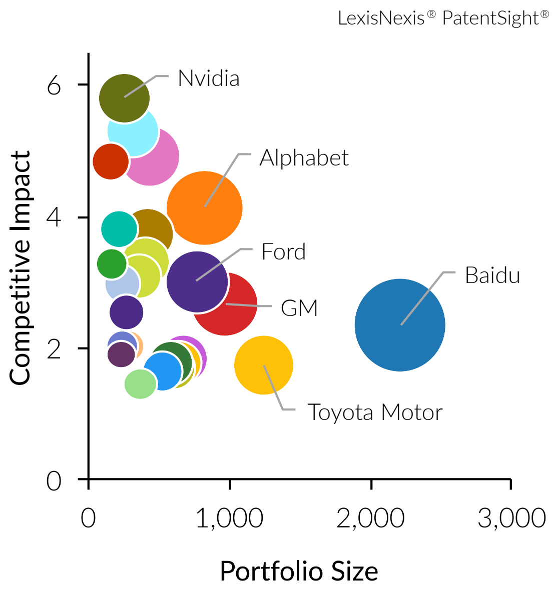


Figure 3: Strategic position of the top 25 players in the field of Autonomous Driving in terms of patent portfolio Competitive Impact and Portfolio Size

Moving up the graphic, we find **Alphabet** with a smaller Portfolio Size but a higher Competitive Impact which is why they make it to the second spot on the Figure 2 list of Autonomous Driving leaders. Even higher on the chart we find **Nvidia**, with still a smaller Portfolio Size, but higher Competitive Impact, albeit not high enough to offset the smaller size as **Alphabet** does.

While not all patent owners are explicitly listed in Figure 3, a consistent pattern emerges: traditional automotive players exhibit a lower Competitive Impact, whereas tech giants like **Alphabet** demonstrate a higher Competitive Impact. This pattern isn't unexpected; conventional auto companies focus on technology applicable in their vehicles today, whereas tech firms channel profits from their core markets into future investments.

> ***A consistent pattern emerges in Autonomous Driving patents: the strength of the traditional automotive patents is lower, whereas the portfolios of the tech giants like Alphabet are stronger.***

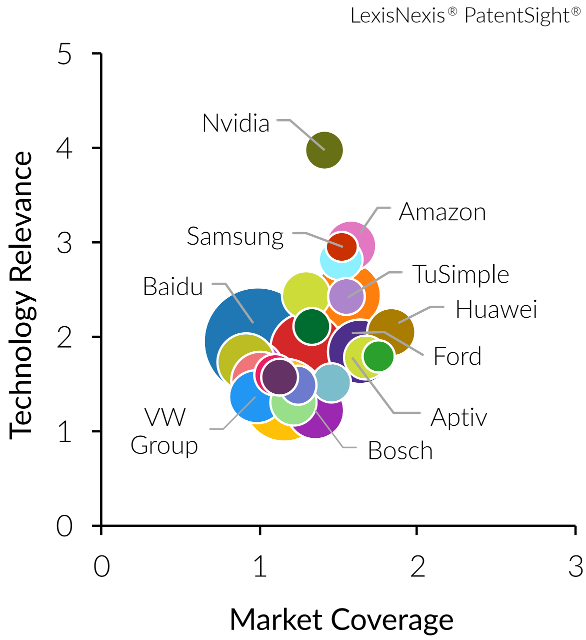


Figure 4: Subcomponents of the Competitive Impact of portfolios of the top 25 players in the field of Autonomous Driving

To dive deeper into assessing the strength of the players, Figure 4 presents the subcomponents contributing to Competitive Impact. This calculation involves multiplying Technology Relevance, a citation-based measure, with Market Coverage, derived from the Gross National Income (GNI) of the countries where the patent is protected, benchmarked against the US GNI as the largest today giving a value largest today, giving a value of 1, followed by China, Japan, and Germany. For instance, **Baidu** demonstrates a Technology Relevance of approximately 2 and a Market Coverage of about 1, resulting in a Competitive Impact of around 2. Similar to Figure 3, this chart showcases a clear clustering of patent owners, with traditional automotive players generally exhibiting lower Technology Relevance. In contrast, tech players tend to display higher Technology Relevance, indicating a notable distinction between the two industry sectors.

No clear correlation emerges between the players and Market Coverage, irrespective of their type or headquarters location. However, a subtle relationship exists between Technology Relevance and Market Coverage, suggesting they tend to rise and fall together. This is not uncommon as applicants often protect inventions they perceive as stronger on a broader scale to maximize their protections. This observed correlation implies the Autonomous Driving players have a reasonable internal understanding of the strength of their innovations.

> ***A correlation between Technology Relevance and Market Coverage implies the Autonomous Driving players have a reasonable internal understanding of the strength of their innovations.***

Autonomous Driving is a fast-moving technology and the status and competitive situation today are unlikely to be the same tomorrow, so to have an idea of what the future holds, we should look at how the past developed. Figure 5 shows the development over time for the Portfolio Size (left) and Patent Asset Index (right). The trend for increasing portfolio size started around 2018, with only a few traditional automotive companies such as **Toyota Motor** and **GM** starting earlier. The most significant growth has been seen in **Baidu**, which has gone from being at the back of the pack to taking the top spot in just a few years since 2018.

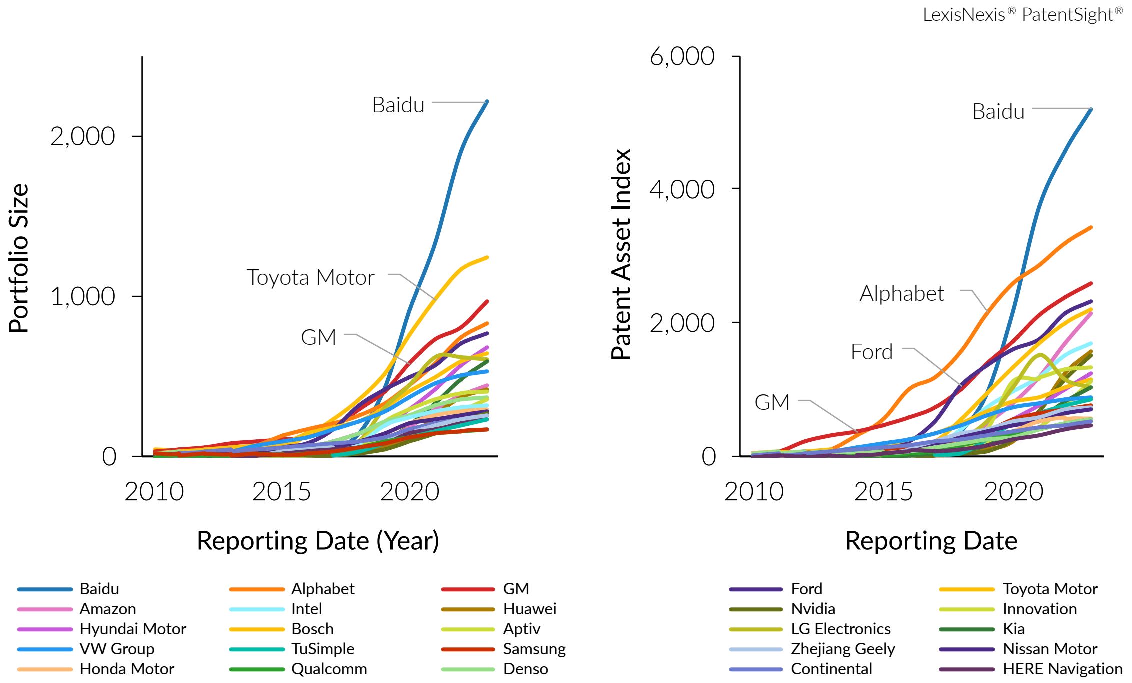
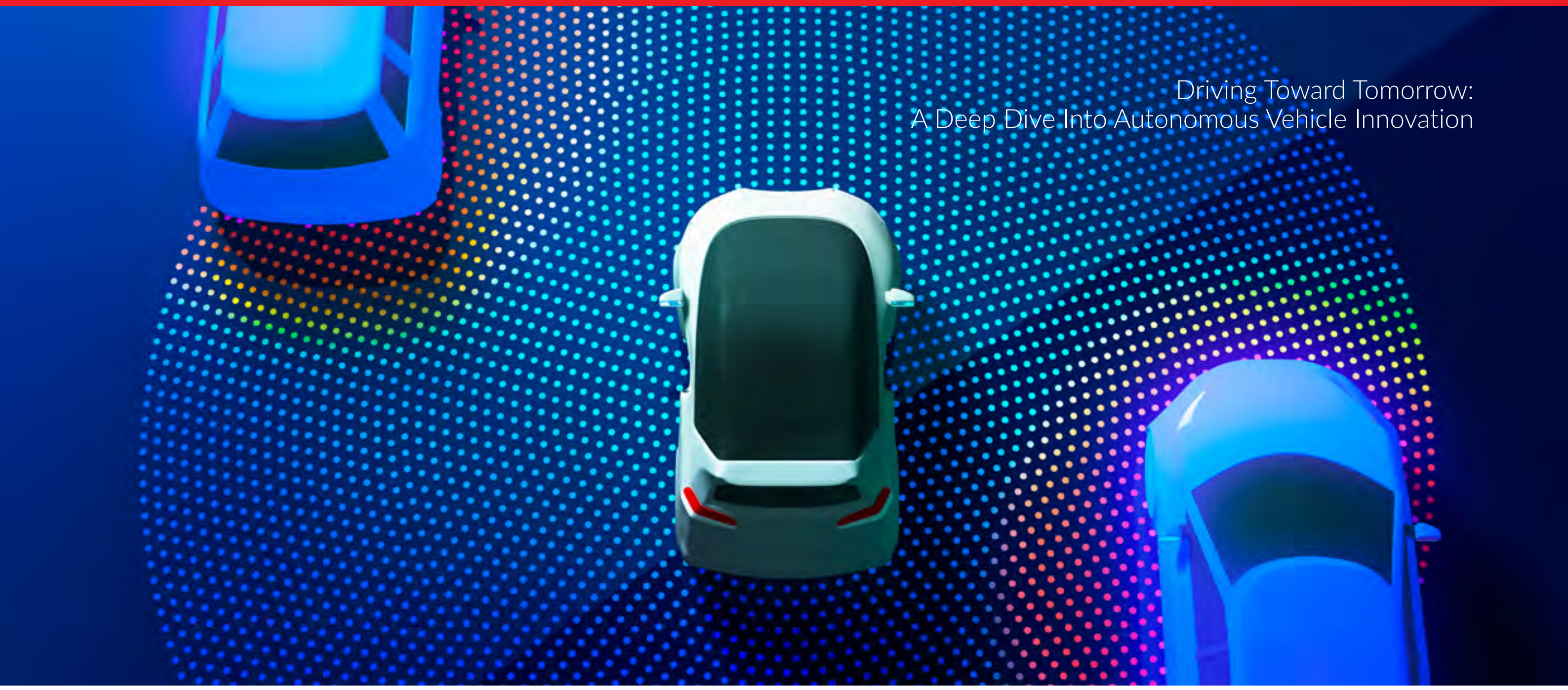


Figure 5: Development over time of the top 25 players in the field of Autonomous Driving by Portfolio Size (left) and Patent Asset Index (right)

The trend for **Baidu** is reflected in the Patent Asset Index as well. However, there is more competition in this area. Though **Toyota Motor** and **GM** are still visible, the relative value of the early work from **GM** is more apparent now, which is not the same for **Toyota Motor**. **Alphabet** is also not readily noticeable, having developed early like **GM** and progressing at a steady pace, which a few years ago looked like it would be the industry leader. However, the recent development from **Baidu** is on another level. No other owner today seems to be on a trajectory to match this.



Analyzing the 3 Main Sub-technologies in Autonomous Driving

There are a large number of technologies that need to be developed to realize a commercially viable Autonomous Driving system. The following analysis splits Autonomous Driving into three sub-technologies leveraging the Cipher Classification system, which uses AI to pull relevant patents into the classifiers. The three categories are:

1

Smart:
Intelligent Algorithms

Core autonomous vehicle technology including the awareness of surroundings, processing of this data, object tracking, mapping, and controlling the system.

2

Security:
Safety & Security Systems

All safety and security systems including breaking, evasion, planning, emergency operation, and supporting sensors.

3

Interaction:
Interactive Experience

Passenger experience and interaction with the system including user experience design, interaction methods, infotainment systems and other communication of actions to passengers.

It is worth noting that there is some overlap between these technologies, and there are minor elements of Autonomous Driving not included in these sub-technologies.

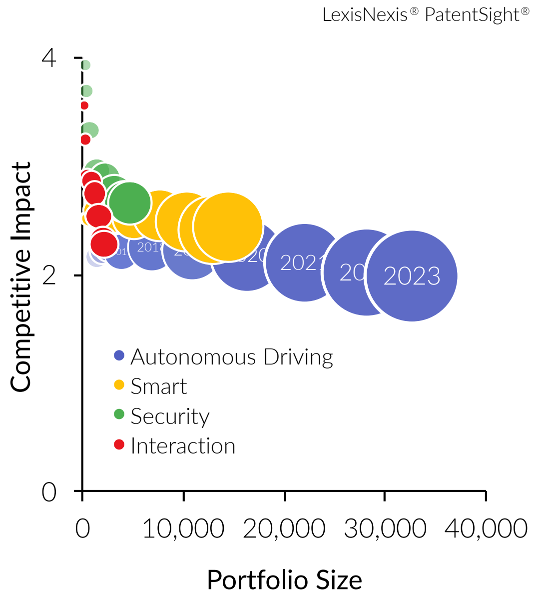


Figure 6: Position and development over time of the Competitive Impact vs Portfolio Size of the field of Autonomous Driving and sub-technologies

> ***The disparity suggests that there is work left before this technology can be made widely available to the public.***

In Figure 6, we can see the relationship between Competitive Impact and Portfolio Size for the three sub-technologies in the Autonomous Driving field, as well as the overall development over the past 10 years. It is evident that Smart technology has undergone the most development, which is not surprising since it is the core technology. Security has seen much less progression in recent years, while Interaction has experienced a decline in Competitive Impact despite a slight increase in Portfolio Size.

In the process of technological advancement, a common pattern emerges: addressing the core problem, ensuring safety, and eventually making it accessible to the average consumer. In mature technologies, innovation often far surpasses the initial problem, especially in enhancing user experience. However, in the context of Autonomous Driving technology, we do not witness this trend. The disparity suggests that there is work left before this technology can be made widely available to the public.

Smart: Intelligent Algorithms

The Smart sub-technology serves as the fundamental framework for enabling Autonomous Driving. It's the largest among the three sub-technologies and mirrors the overall landscape of the field. In Figure 7, you'll find the top 10 players in this domain, along with the Competitive Impact and Portfolio Size of patents in their portfolios.

These players are shown in order of their Patent Asset Index, allowing for a direct comparison with the overall Autonomous Driving rankings. Notably, **Amazon** and **Aurora Innovation** have significantly improved their positions.

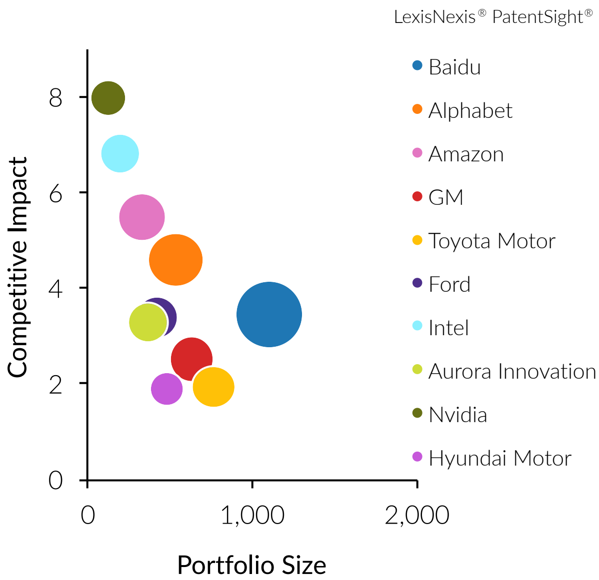


Figure 7: Strategic position of the top 10 players in the sub-technology field of "Smart" in Autonomous Driving in terms of patent portfolio Competitive Impact and Portfolio Size

Once again, the players in Smart technology can be categorized into tech and traditional automotive clusters. Tech giants dominate the upper echelons, boasting higher Competitive Impact. In contrast, traditional automotive players, positioned at the bottom, possess a slightly larger Portfolio Size but lower Competitive Impact.

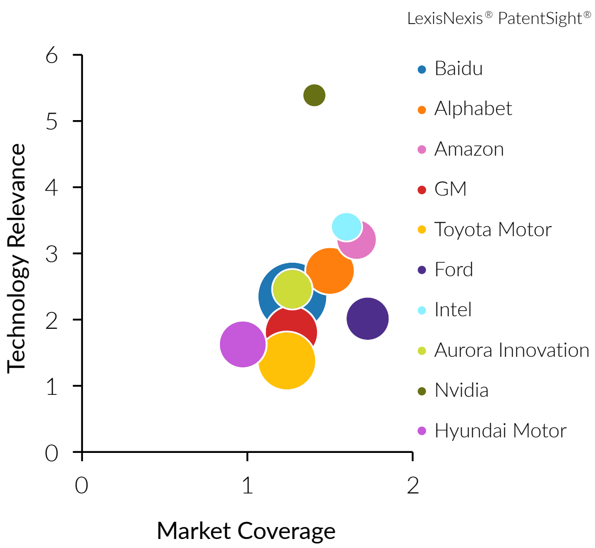
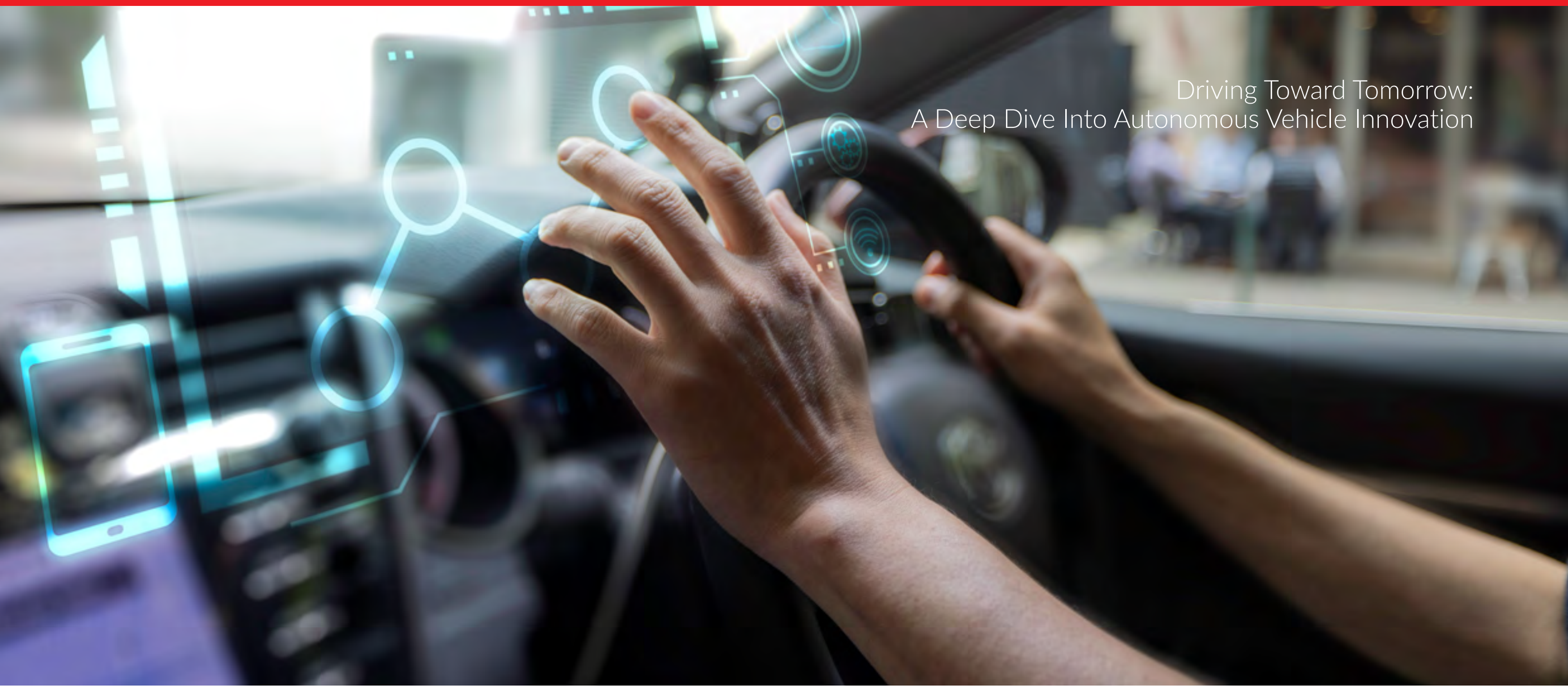


Figure 8: Competitive Impact subcomponents, Technology Relevance and Market Coverage, of portfolios of the top 10 players in the sub-technology field of "Smart" in Autonomous Driving

For a more detailed breakdown, refer to Figure 8, which illustrates the Technology Relevance and Market Coverage of each player. **Nvidia** stands out, not just for its top position in Figure 7 but also for its exceptionally high Technology Relevance, driving its lead. **Nvidia**'s focus on advancing processing technology for this application is unique, setting them apart from the rest. **Intel**, though present, owes its position mostly to its Mobileye division, follows a distinct strategy from **Nvidia**.



This explains the status today and the underlying factors. However, it is important to consider the historical development that led us here, as this may be an indication of the future. In Smart, similar to the overall Autonomous Driving field, development in the space has been recent and rapid, and **Baidu**'s position at the top is relatively recently achieved, overtaking **Alphabet** around 2020, as seen in Figure 9. **Alphabet** continues to have a steady increase year-on-year. While the pace is less than what has been recently observed from **Baidu**, it is more than sufficient to continue a comfortable second position. The remainder and the majority of the top 10 in the Smart sub-technology follow a very similar development path to each other. Noticeable exceptions are **Hyundai Motor** which has a slightly slower development pace, and **Nvidia**, which has significantly increased in the past 1-2 years.

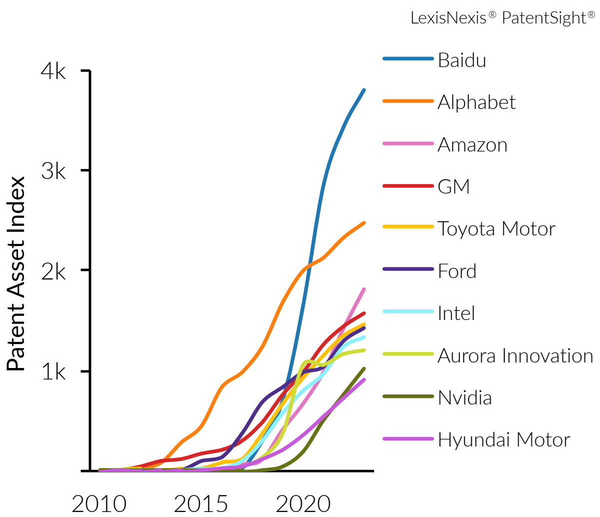


Figure 9: Development over time of the Patent Asset Index of portfolios of the top 10 players in the sub-technology field of "Smart" in Autonomous Driving

> ***The Smart category is the largest among the three sub-technologies and serves as the fundamental framework for enabling Autonomous Driving.***

Security: Safety & Security Systems

The Security sub-technology focuses on all security and safety aspects of Autonomous Driving. While there's some overlap with the Smart sub-technology, Security specifically encompasses dedicated sensors and processing elements tailored for safety, extending beyond Smart's scope. And although Security is a smaller field than Smart, it stands out with higher average strength, evident in the top 10 players. In this realm, **Intel** and **Nvidia** shine with the highest Competitive Impact, seen in Figure 10. Notably, **Amazon** has surged ahead, surpassing **Alphabet** and securing a higher position than in the broader field, although it still trails behind **Baidu**, the leader in this sub-technology.

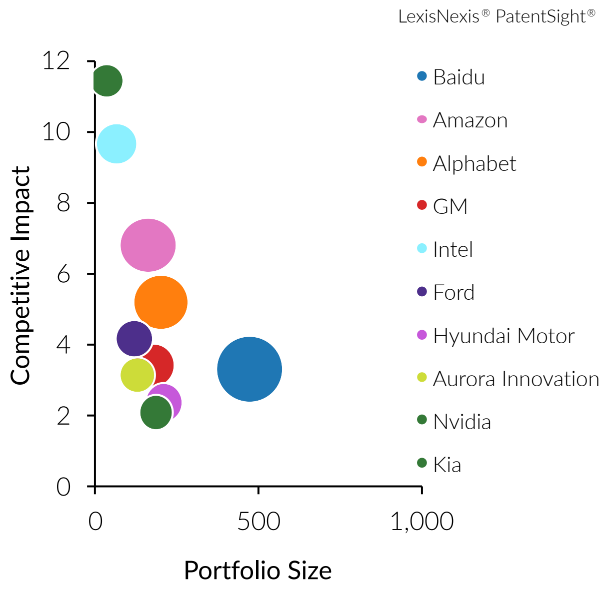


Figure 10: Strategic position of the top 10 players in the sub-technology field of "Security" in Autonomous Driving in terms of patent portfolio Competitive Impact and Portfolio Size

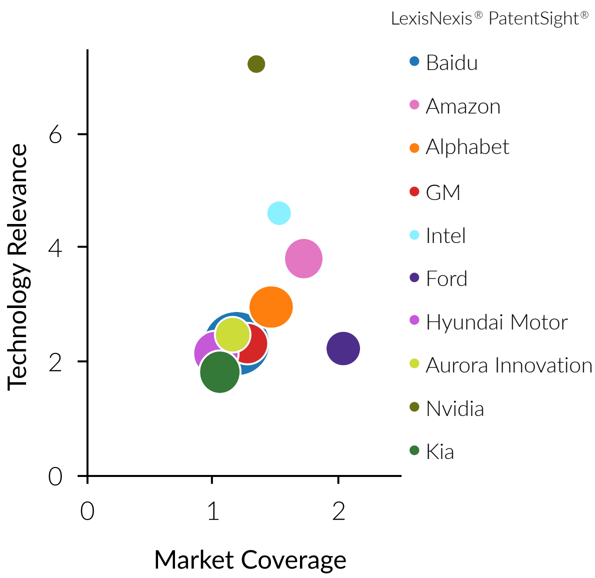
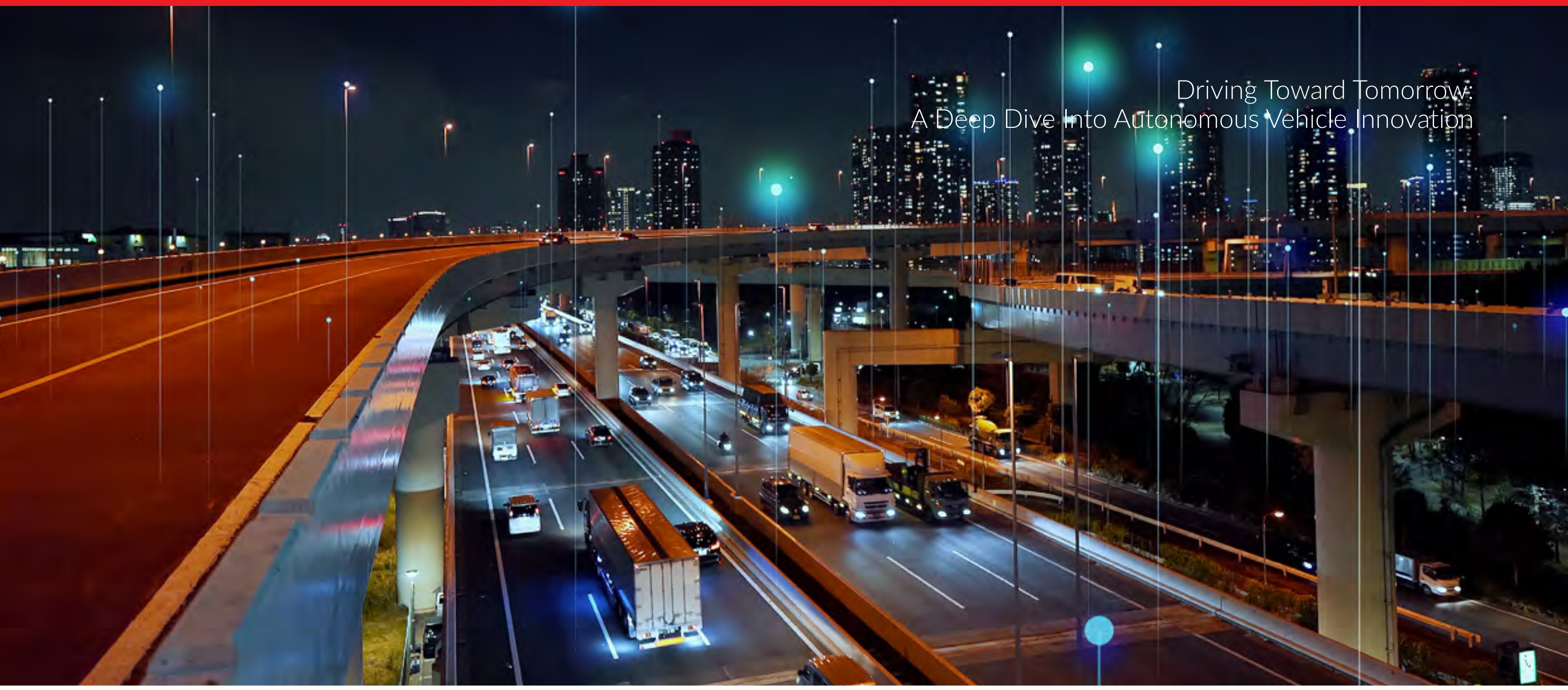


Figure 11: Competitive Impact subcomponents, Technology Relevance and Market Coverage, of portfolios of the top 10 players in the sub-technology field of "Security" in Autonomous Driving

A few significant shifts include **Toyota Motor** dropping out of the top 10, while **Kia** climbed the ranks compared to their overall field positioning. The heightened Technology Relevance of **Nvidia** and **Intel** is evident here in Figure 11, but there's a unique case with **Kia**. **Kia** stands out due to its Market Coverage, deviating from the typical relationship between Technology Relevance and Market Coverage. This anomaly likely pushed them into the top 10. While it may be that these patents are slightly overprotected given their technological strength, it's worth monitoring **Kia**'s progress to see how this dynamic unfolds in the future



In terms of development over time, there is a similar pattern for **Baidu** in the Security sub-technology as there was in Smart. However, that is not the case for **Alphabet**. Since around 2020, **Alphabet**'s development has stopped, with only a minor increase, as seen in Figure 12. This could indicate a significant change in strategy for the company, perhaps refocusing efforts elsewhere. The growth of **Amazon** is also prominent in the field of Security. Although the company demonstrated positive development in the Smart category, they have distinguished themselves from their competitors in Security. In fact, **Amazon** has surpassed **Alphabet** in this sector over the past year, benefiting from both the changes within **Alphabet** and their own significant growth.

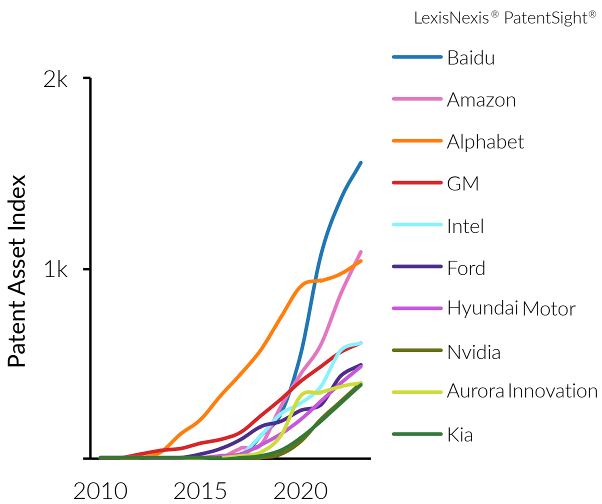


Figure 12: Development over time of the Patent Asset Index of portfolios of the top 10 players in the sub-technology field of "Security" in Autonomous Driving

> ***The Security sub-technology encompasses elements tailored for safety and stands out with patents higher than average in strength.***

Interaction: Interactive Experience

Interaction represents the smallest sub-technology, focusing on the interaction between users or passengers and autonomous vehicles. Unlike the other two sub-technologies and the broader Autonomous Driving field, player positions here are significantly more varied. In Figure 13, we see that **Baidu**, which held the top spot in other domains, is displaced by **Ford**. **Uber** enters the top 10 in this sub-technology, reflecting their progress in implementation and commercialization, a development not surprising given their active involvement in this area. Additionally, **Aptiv**, previously part of **Delphi** and **GM**, emerges in the top 10. **Aptiv** specializes in digital vehicle elements such as processing, connectivity, and software, with a specific focus on Autonomous Driving.

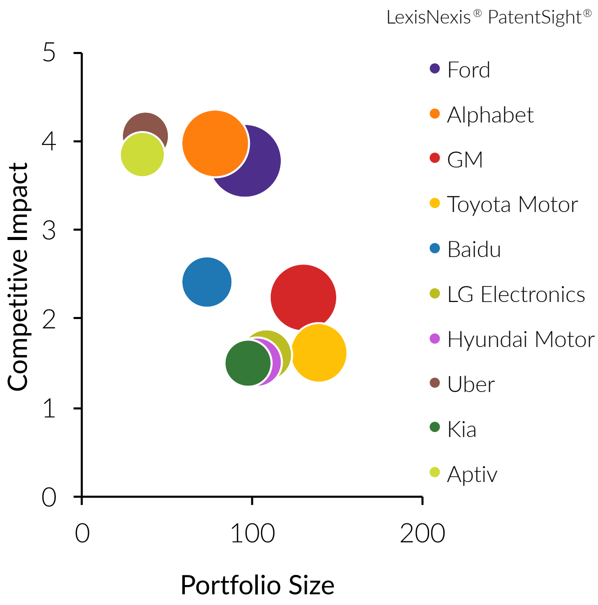


Figure 13: Strategic position of the top 10 players in the sub-technology field of “Interaction” in Autonomous Driving in terms of patent portfolio Competitive Impact and Portfolio Size

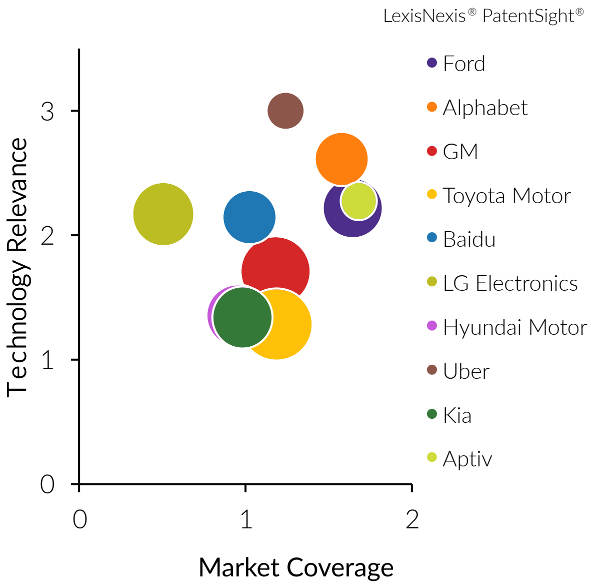


Figure 14: Competitive Impact subcomponents, Technology Relevance and Market Coverage, of portfolios of the top 10 players in the sub-technology field of “Interaction” in Autonomous Driving

The diverse player positions extend to the breakdown of Competitive Impact, seen in Figure 14. For instance, **LG Electronics** boasts high Technology Relevance but low Market Coverage, likely centered around protection mainly in South Korea. In contrast, Ford shares similar Technology Relevance but boasts remarkably high Market Coverage, safeguarding interests in the USA and China. This diversity illustrates the early developmental stage of this sub-technology. Significant work remains in refining core technologies before substantial progress in user experience can be achieved. Consequently, the current landscape comprises a mixed assortment of technologies and implementations.

The development over time provides a view of which of these companies is more consistently innovating in the Interaction sub-technology. **Ford**'s position, while continuing an upward development, is largely a result of an increase around 2016, as seen in Figure 15. Conversely, **Alphabet** and **GM** have more long-holding stable increases which may overtake **Ford** in the coming years. Though all the other players have upward developments, they are sporadic and limited in the scale of the upward trend.

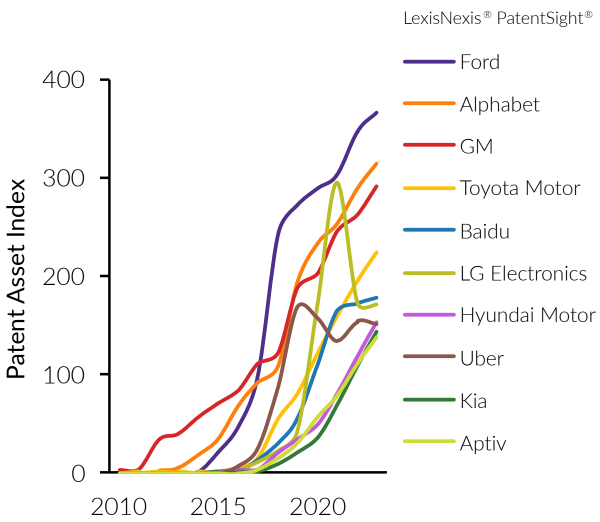


Figure 15: Development over time of the Patent Asset Index of portfolios of the top 10 players in the sub-technology field of "Interaction" in Autonomous Driving

The Interaction category is the smallest of the Autonomous Driving sub-technologies and shows much variability in player positions.

Tracing the Path of Advancements in Autonomous Driving Innovations

Beyond the established technologies and familiar players, Figure 16 aims to identify the innovation areas propelling overall advancements in Autonomous Driving. Each line on the chart represents an International Patent Classification (IPC) used for categorizing patents into technologies. These classifications, while not specifically tailored for Autonomous Driving, have been simplified for clarity. Only a select few lines are highlighted and named in the chart, indicating deviations from the majority trend. The classifications are:

- Control in two dimensions
- Control of position, course, ...
- Control of autonomous vehicles
- Lidar
- Recognition using electronic means
- Neural networks

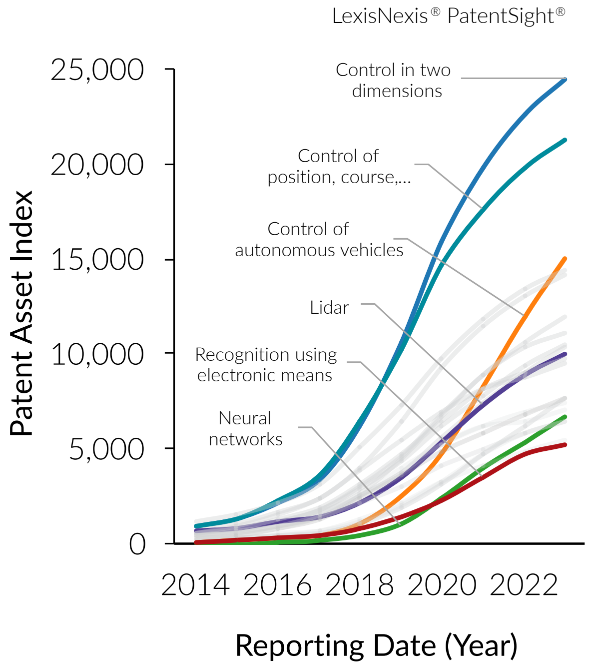
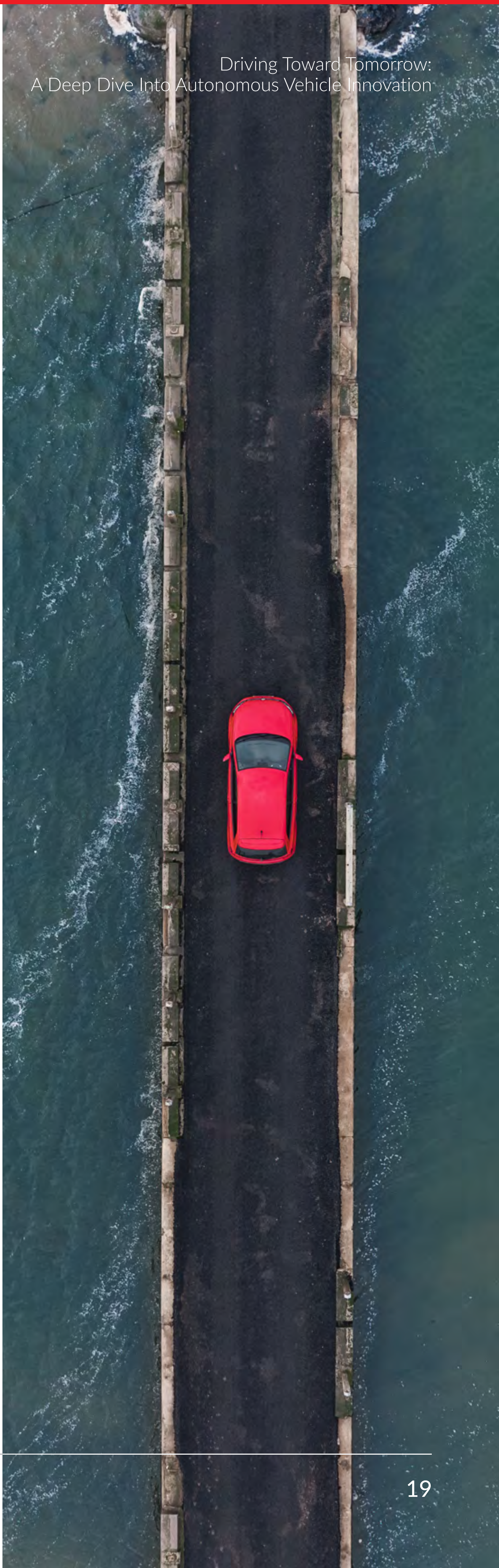


Figure 16: Development over time of the top 25 IPC subgroups in the field of Autonomous Driving with a selected 6 highlighted

At the top are technologies concerning vehicle control in two dimensions, encompassing position and course. This core Autonomous Driving technology naturally occupies a prominent position. Notably, there's an IPC specific to controlling autonomous vehicles, indicated in orange. Its development initiates later than the overall field and exhibits a steeper trajectory, signifying a shift from basic control systems to truly autonomous systems.



Next, there is **Lidar**, which was once hailed as the core technology to realize Autonomous Driving. Initially, Lidar sensors faced challenges such as unconventional placements on vehicles, fragile moving parts prone to damage, and high costs. Consequently, not all players embraced Lidar; instead, many focused on integrating simpler sensors and processing power effectively. While Lidar has undergone developments, marked by reduced costs and complexity, the leveling trend suggests potential stagnation, possibly replaced by the last two noteworthy technologies.

The final highlighted technologies include electronic recognition systems and neural networks, which have exhibited a distinct upward trajectory in recent years. The crux of achieving truly autonomous vehicles appears to lie in processing and decision-making capabilities. While vehicle control and robust sensory input are crucial, without the ability to process information and make sound decisions, these elements become redundant. This aspect represents the cutting edge of Autonomous Driving, explaining why numerous major tech players dominate leading positions in the field.

Navigating the Complexities of Commercializing Autonomous Driving

Autonomous Driving stands as a complex technology, comprising numerous components that must seamlessly integrate to create a commercially viable product. Substantial progress has been made in digitizing vehicles, making them ready for autonomous operation, and in enhancing environmental sensing for informed decision-making and added safety measures. However, completely replacing human drivers with machines remains a challenge. Leading tech and automotive companies are vigorously working on both hardware and software, aiming to create a system capable of taking over driving duties. Advanced processing methods are continuously under development to tackle this challenge, driven by the substantial benefits such a system could offer. Despite the absence of a guaranteed market-ready solution, the innovative drive within the industry remains robust, fostering rapid development.

In this dynamic landscape, patent data and analytics serve as invaluable tools. They provide insights into current advancements, future prospects, key sub-technologies, and the industry leaders in the Autonomous Driving domain. By analyzing patent data, industry players can gain a competitive edge, positioning themselves strategically and fostering innovation. Patent analytics play a pivotal role in comprehending the ongoing innovations within Autonomous Driving, shaping the future of this promising field.

> ***Despite the absence of a guaranteed market-ready solution, the innovative drive within Autonomous Driving remains robust, fostering rapid development.***

About the Authors

William Mansfield
Head of Consulting and Customer Success
LexisNexis® Intellectual Property Solutions

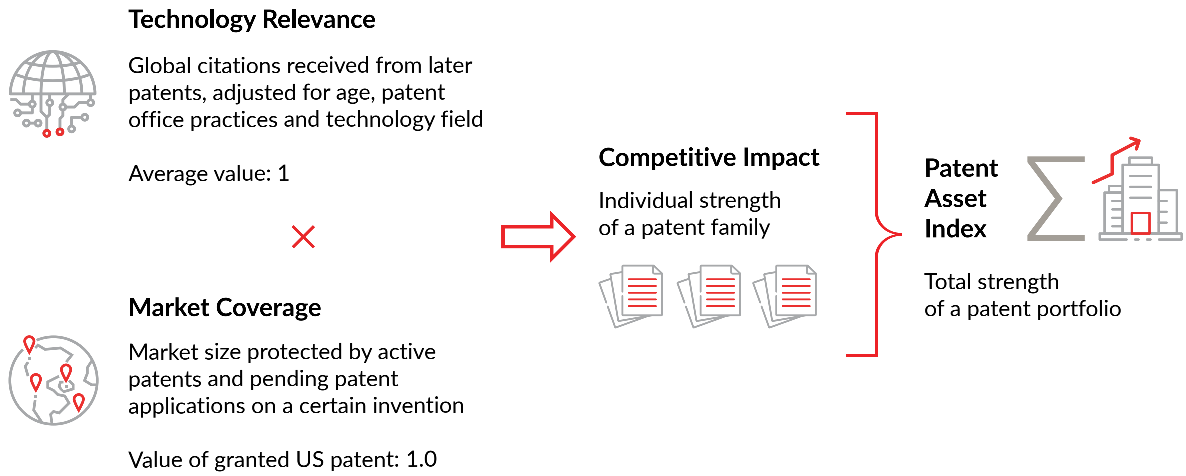
William Mansfield is the head of consulting and customer success in the Americas and EMEA for LexisNexis® Intellectual Property Solutions. He is responsible for overseeing the negotiation, creation, and delivery of customer consulting, along with managing the Customer Success team. He works closely with numerous international and Fortune 500 companies and others to ensure effective deployment of patent analysis for business strategy, M&A due diligence, portfolio management, and other needs. William Mansfield has an economics background and experience in market and R&D strategy in the solar industry.

Siddhartha Singh
Cipher Solutions Analyst
LexisNexis® Intellectual Property Solutions

Sid is a Cipher Solutions Analyst for LexisNexis® Intellectual Property Solutions. He is responsible for the creation and delivery of Cipher custom classifiers and customer consulting, helping provide actionable insight to clients. Sid is also a part of Cipher's Risk team, which focuses on helping clients optimize their patent portfolio by identifying areas of potential under and over balance. Sid Singh has a background in Chemistry with a specialization in Computational Chemistry.

About the Patent Asset Index

The Patent Asset Index represents a measure of the innovative strength of a patent portfolio. A patent family is more valuable when other innovations build on the technology protected by this patent family and by the scope of protection that the patent family holder considers appropriate.



Ernst, H., Omland, N. (2011): The Patent Asset Index - A New Approach to Benchmark Patent Portfolios. World Patent Information 33, pp. 34–41.

Technology Relevance is a measure of the importance of a patent family and the technological invention it protects. It is calculated based on the total number of worldwide citations that are received from other patent families and is adjusted for the facts that (1) older patents are cited more often, on average, than younger patents; (2) international patent offices follow different citation rules; and (3) different citation practices are prevalent in different technology fields.

Market Coverage is measured as the size of the markets in which a patent family is protected, as benchmarked against the world's largest economy—the United States. In this context, the gross national income (GNI) of a country is used as a proxy for the relative size of its national market. Market Coverage is calculated based on granted and pending patents, adjusted for the patent family's protected market size.

Competitive Impact represents the individual strength of a patent family and is obtained by multiplying the Technology Relevance and the Market Coverage of each patent family. It is stated relative to the other patent families in the same field. For example, a value of three means that the patent family is three times as important as the average patent family in the field. The value obtained by adding up all the Competitive Impact values of all patent families constituting the portfolio is defined as the Patent Asset Index, which measures the overall strength of a patent portfolio.

The Patent Asset Index methodology is based on many years of scientific research and was validated in peer-reviewed academic publications and studies. Our patent analytics platform LexisNexis® PatentSight®, featuring the Patent Asset Index, has been used for several years by leading companies in many industries, as well as governmental bodies and organizations, e.g., in antitrust consideration or merger clearances. Numerous companies trust the Patent Asset Index to illustrate the strength of their patent portfolios in annual shareholder reports and other stakeholder communications.

About LexisNexis® PatentSight®

PatentSight® is a powerful and easy-to-use analysis platform that makes quick answers accessible to both top management and intellectual property experts, as well as data experts in a wide array of application areas. The software and its underlying data enable the evaluation of companies and technologies, as well as deep, varied, and practical analysis for strategic decision making. It also enables searching of patent families and viewing of individual patents and important patent details. PatentSight is recognized for its intuitive usability, flexibility, and powerful visualizations. The business intelligence platform compiles bibliographic patent data from over 95 authorities worldwide utilizing the DOCDB, the European Patent Office's master documentation database with worldwide coverage, and has vast full-text patent data, with over 147 million patent documents in English, approximately 700 million drawings and illustrations of inventions, and nearly 100 million PDFs that are searchable (via OCR) and quickly downloadable.

About Cipher Classification

With millions of patents across the globe, how can you zone in on the patents that are relevant to the technology areas you operate in? By building a classifier that is defined for you.

LexisNexis® PatentSight® uses Cipher Classification system, which leverages AI to read millions of patents globally and pull the relevant patents into your classifier. The classifier is defined by you and the machine does all the hard work of going and finding the right patents. The machine can read more than 60 million patents an hour and looks at 200,000 data points in the patent.

About LexisNexis® Intellectual Property Solutions

LexisNexis® Intellectual Property Solutions bring clarity to innovation for businesses worldwide. We enable innovators to accomplish more by helping them make informed decisions, be more productive, comply with regulations, and ultimately achieve competitive advantage for their business. Our broad suite of workflow and analytics solutions (LexisNexis® PatentSight®, LexisNexis® Cipher, LexisNexis® IPlytics, LexisNexis PatentOptimizer®, LexisNexis PatentAdvisor®, LexisNexis TotalPatent One®, and LexisNexis® IP DataDirect), enables companies to be more efficient and effective at bringing meaningful innovations to our world. We are proud to directly support and serve these innovators in their endeavors to better humankind.

Our Mission: Bringing Clarity to Innovation

At LexisNexis® Intellectual Property Solutions, we believe when a person works on a patent and understands the future trajectory of a specific technology, that person has the potential to fundamentally change how society operates. We are proud to directly support and serve these innovators in their endeavors to better humankind.

LexisNexis® Intellectual Property Solutions
Bringing clarity to innovation.

To learn more visit us at
www.LexisNexisIP.com

Publication Date: November 2023

LexisNexis®