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ECONOMIC IMPLICATIONS OF AUTOMATIC INJUNCTIONS IN GERMAN PATENT LITIGATION

Bargaining, settlement outcomes, and patent valuation

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EXECUTIVE SUMMARY

Automatic injunctions within the German patent system distort bargaining power in settlement negotiations

The German patent litigation framework's use of automatic injunctive relief shifts bargaining power between the plaintiff and defendant relative to a typical negotiation, which impacts settlement behavior and the price at which parties settle. The settlement range can be determined based on the economic value of the defendant's product, as opposed to the economic value of the invention in question.

In general, a patent grants a right to exclusivity, and an injunction is a mechanism to protect exclusivity by preventing a defendant from making, using, or selling the end-product that is found to infringe.

In German litigation the so-called automatic injunction shifts the bargaining power between a patentee (plaintiff) and an implementer (defendant) relative to a litigation framework or a typical bilateral license negotiation without threat of automatic injunction. The automatic injunction has predictable economic implications for settlement behavior of the parties.

The defendant risks losing the right to use, make or sell its own end-product due to an automatic injunction, irrespective of where the infringement is occurring within its supply chain, because the patentee has the right to select the place in a vertical where it wishes to litigate. Unlike in litigation without automatic injunctive relief or in a bilateral negotiation, re-design may be unavailable to the defendant due to time constraints under the German system, and thus the only practical way to avoid an injunction is a settlement between the plaintiff and defendant. Thus, a defendant

risks the loss of the full value of its end-product, i.e. its entire revenue and profit from the sale of its end-product, upon an automatic injunction. This risk can be anticipated by the plaintiff.

However, because both the plaintiff and the defendant are aware that the defendant bears this risk, the plaintiff does not need to constrain its settlement terms to the value of the patent, as in a typical negotiation. In a typical negotiation, if a patentee is interested in granting access to its patent(s) to other parties through licensing, the patentee (licensor) may bargain over the terms and conditions, including financial terms, for which it is willing to license its patent to an implementer. If a negotiation is unsuccessful, the patentee may litigate against any company with a product alleged to incorporate the patent and request an injunction.

This results in a different outcome relative to the case with automatic injunction. In fact, the parties may not need to even consider the economic value of the infringed patent. As a result, the price of settlement may surpass the economic value of a patented invention by far and may even approach the value of the defendant's product.

We explain the economic theory related to bargaining and this shift as a result of the threat caused by automatic injunction and provide a case study based on a dispute and settlement between Broadcom and Volkswagen and Audi. Consistent with economic theory, we find no connection between the expected settlement value and the value of the Broadcom patent.

1 THE GERMAN PATENT SYSTEM ALLOWS FOR AUTOMATIC INJUNCTIONS

The German patent litigation system is known for its fast and efficient resolutions, with infringement findings announced within eight to 15 months, where injunctive relief is a remedy for infringement. This creates distortions that may increase the rate of settlement. While the German system is admired and in fact often selected for its speed, this creates technical and commercial challenges. As industries become increasingly complex and integrated, the German system's benefits may disproportionately favor patentees/plaintiffs, with the challenges borne by defendants.

1.1 Patents¹

A patent grants an exclusive right for a defined set of patent claims that may have economic – in addition to technical – value. A patent is a means to protect technical inventions, including innovative products or processes, against unwanted use. To be patentable, an invention must be new, industrially applicable and involve an inventive step. After filing an invention at the German Patent and Trade Mark Office (*DPMA*), a detailed process is conducted to ensure the invention is patentable. First, a legally prescribed examination procedure is conducted, and must conclude with a positive result. During that procedure, several factors are examined: whether the subject matter of the application is new to a person skilled in the art (*novelty*), whether the invention is based on an *inventive*

step, and whether the invention is disclosed in a way that allows it to be implemented (*industrially applicable*). The patent claims ultimately define the scope of protection of a patent.

Patents confer an exclusive right of use, as well as the right to prevent third parties from making, using or selling the invention without the owners' consent, for a fixed amount of time. The exclusivity comes into effect in Germany with the publication of the grant in the Patent Gazette (*Patentblatt*). The patentee may transfer or grant access to this right of use as it wishes, through sale or licensing. A granted patent is generally in force for a maximum of 20 years, counted from the day following the application.

¹ German Patent and Trade Mark Office (2019). *Patent Protection – Overview*. Last accessed: 03 June 2019. Source: https://www.dpma.de/english/patents/patent_protection/index.html;
German Patent and Trade Mark Office (2019). *Patents – An Information Brochure on Patent Protection*. Last Accessed: 06 June 2019. Source: https://www.dpma.de/docs/english/broschueren_eng/bro_patents_en.pdf

1.2 Patent litigation²

Optional pre-litigation notice

Prior to filing a patent infringement suit, the patentee may serve the alleged infringing party with a cease and desist letter requesting the alleged infringing party to refrain from future patent infringements and to declare that intention in a legally binding way. Serving a cease and desist letter protects the patentee from the risk it will bear the costs of a later infringement suit.³

Patent infringement and validity

A patentee may assert its patent(s) against an implementer. In the German patent litigation system, validity and infringement are dealt with in two different courts, and thus patent validity is not assessed during infringement proceedings.⁴

Patent infringement matters are dealt with at the 12 Regional Courts (*Landgericht*) in the first instance with a majority of patent infringement suits in Düsseldorf, Mannheim and Munich, and the Higher Regional Courts (*Oberlandesgericht*, or OLG) in the second instance. The duration of first instance proceedings is approximately eight to 15 months. The cases are heard by three legally qualified judges (who generally do not have a technical background).

In a patent infringement claim, the patentee asserts a claim based on the compensation it believes it ought to receive for past infringing use. German law⁵ constrains the amount of compensation the plaintiff may claim – in other words, a plaintiff cannot make a limitless claim against a defendant.⁶

The validity of a patent can be challenged in a nullity action, dealt with by the Federal Patent Court (*Bundespatentgericht*, or BPatG) in the first instance, where the case is heard by two legally qualified and three technically qualified judges. The duration of first instance proceedings is approximately 25 months. In the second instance, appeals are heard by the Federal Court of Justice.

Given the differences in proceeding duration, it is possible that an infringement judgment is handed down before the invalidity proceedings are completed. The possibility of finding infringement for an invalid patent is not merely theoretical. (See Box 1 below).

² We reference several sources throughout this section: Müller-Stoy and Haertel (2018). *National Patent Litigation – Germany*. Les Nouvelles Licensing Executive Society International, Vol. LIII No. 4. (“LESI”); Margue, Reichl, Basra and Crewett (2017). *UK: IP Litigation in Germany – A Brief Outline*. Mondaq. Last accessed: 03 June 2019. Source: <http://www.mondaq.com/uk/x/639178/Patent/IP+Litigation+In+Germany+A+Brief+Outline> (“Mondaq”); Meissner Bolte. *IP-Litigation in Germany*. Last accessed on 04 June 2019. Source: https://www.meissnerbolte.de/uploads/media/IP-Litigation_in_Germany.pdf (“Meissner Bolte”); Kühnen & Claessen (2013). *Die Durchsetzung von Patenten in der EU – Standortbestimmung vor Einführung des europäischen Patentgerichts*. GRUR 2013, 592. (“Kühnen & Claessen”); Henkel & Zischka (2018). *How many patents are truly valid? Extent, causes, and remedies for latent patent invalidity* (“Henkel & Zischka”); Cremers et al. (2016). *Journal of Economic Behavior and Organization*. *Invalid but infringed? An analysis of the bifurcated patent litigation system* (“Cremers 2016”).

³ Mondaq

⁴ LESI.

⁵ German Civil Code BGB Section 242, *Performance in good faith*.

⁶ For example, a plaintiff may not claim compensation for €10 million, but then determine that damages only support compensation of €500 000. However, it can be difficult to ascertain *ex ante* whether a claim is or is not reasonable.



Box 1 Proceeding outcomes

The German courts do not publish proceeding statistics. Accordingly, the statistics on proceeding outcomes are incomplete. We summarize some (relatively) recent results:

Validity proceedings between 2010 and 2012, resulted in findings of full invalidity in 41 to 53% of cases, and partial invalidity in 24 to 40% of cases – with only 7 to 35% of patents remaining valid as granted at BPatG in the first instance.

Despite the high likelihood of full or partial invalidation, requests to stay are generally granted infrequently. Between 2009 and 2011, the Regional Courts granted requests to stay infringement proceedings in about 9 to 12% of cases. In the OLG Dusseldorf, requests to stay were granted in about 4 to 17%. The success of the request for stay of the infringement proceeding due to a pending nullity action is affected by the preliminary opinion issued by the nullity court. We understand that the requests most likely to be granted are those where the patent novelty is questioned, rather than those centering on e.g. high technical questions of inventive steps.

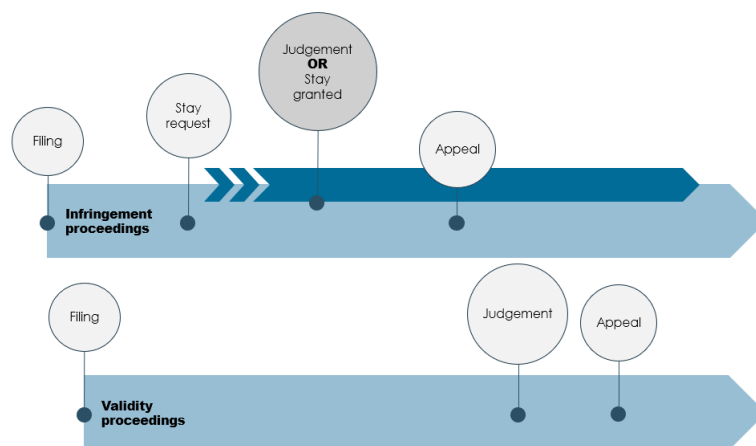
Settlement in German courts is common. More than half of all validity suits before BPatG in the periods 2000 to 2008 and 2010 to 2012 settled. Just over half of infringement cases in the Regional Courts settled from 2000 to 2008. This may be the result of the high share of matters with infringement gaps, and in which about 12% of all infringement cases with parallel invalidity proceedings resulted in "infringed but invalid" decisions from 2000 to 2008. If settlements are excluded, this share increases to 41%.

Sources: Kühnen & Claessen; Henkel & Zischka; Cremers 2016.

To avoid an injunction for a patent yet to be confirmed valid, the defendant may request a stay (Aussetzung) of the infringement proceedings due to an ongoing nullity action. The Regional Court decides whether to grant the request based

on relevant facts, including the defendant's interest not to be enjoined based on an invalid patent and the plaintiff's interest of a timely completion of the infringement proceedings. We summarize the timeline of proceedings in Figure 1 below.

Figure 1
Summary of infringement and validity proceedings



Note: Proceedings over time
Source: Copenhagen Economics

Remedies available to patentees include injunction and compensatory damages

German law includes the possibility of injunctive relief to protect the patentee's right to exclusivity as well as compensatory damages for past infringing use.

For findings of infringement, an injunction is automatically granted (hence the term automatic injunction).⁷⁸

Given that the plaintiff can litigate at any point in the vertical, the infringement may have taken place in any preceding step of the supply chain.

Irrespectively, if the Regional Court hands down a finding of infringement and thereby automatic injunctive relief, the defendant must cease to sell its own product.

The plaintiff may also then make a claim for compensatory damages, which are awarded for past infringing use.⁹ The three methods to calculate damages are 1) the plaintiff's own lost profits, 2) the infringer's profit, or 3) a reasonable royalty.¹⁰ A plaintiff is prohibited from making unreasonable claim demands. However, many plaintiffs and defendants settle their cases out of court and thus do not continue to this round of trial.

⁷ Preliminary injunctions (distinct from automatic injunctions) are also available at the Regional Court's discretion and depending on specific facts of a case. In Germany preliminary injunctions are granted at a rate of about 75 to 77% of all applications filed. (Mondaq)

⁸ The Regional Court's first instance finding may be enforced provisionally if the plaintiff furnishes a security deposit of an amount fixed by the court. If this first instance decision is set aside at a later time, the plaintiff must compensate the defendant for losses caused by a provisional enforcement. While this in theory allows a defendant to receive compensation for loss suffered due to a preliminary injunction, in practice, such a loss must be proven and requires additional legal claims for reimbursement. Losses may occur into the future and present a significant administrative burden. The court generally considers the disputed amount, as well as the defendant's reported expected loss if enjoined. This requires the defendants to

disclose to the plaintiff the amount it stands to lose if enjoined; in practice, settlement will be expected to occur before this is necessary, as we will discuss in the following sections.

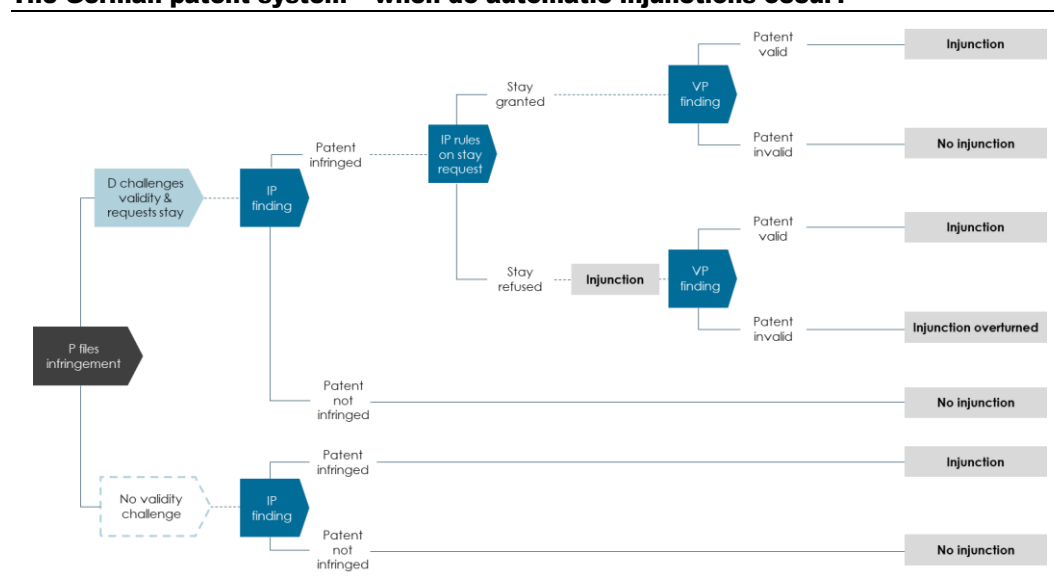
⁹ The German patent system also allows some recovery of fees. The losing party must reimburse certain costs to the winning party; the amount of the court and attorney's fees reimbursement is calculated according to statutory guidelines and depend on the disputed amount in both nullity cases and infringement cases. In general, the statutory attorney fees do not cover all actual attorney costs. (Müller-Stoy and Haertel (2018). *National Patent Litigation – Germany*. Les Nouvelles Vol. LIII No. 4.)

¹⁰ LESI. As a result of a decision from the German Federal Supreme Court, since 2001, the infringer's profit is the most common method used for calculating damages. Meissner Bolte.

The possible outcomes given the German patent system are illustrated in Figure 2 below.¹¹ We indicate whether each outcome results in an automatic injunction. Once a patentee files a claim, the defendant can choose whether to challenge the patent validity and request a stay; otherwise

the courts hand down decisions on nullity and infringement. Possible outcomes include findings of infringement, (and thus automatic injunctive relief), and either non-infringement or invalidity (and thus no injunctive relief).

Figure 2
The German patent system – when do automatic injunctions occur?



Note: P = Plaintiff, D = Defendant, IP = Infringement proceeding, VP = Validity proceeding / Dotted line represents a change in court venue

Source: Copenhagen Economics

1.3 Patent valuation without the threat of automatic injunction

Below, we explain that factors that underpin a typical patent license negotiation, and in particular the economic value of a patent, for later comparison to the determination of a settlement amount under the German system.

In general, parties considering a license will bargain over the economic benefit of a patent. Certain patentees have an interest in granting licenses (under varying terms and conditions) to third parties interested in using the patented inventions. In such cases, the patentee (*licensor*)

and the potential implementer (*licensee*) consider several categories of information:

1. The economic value of the patented invention. The economic value of the patented invention can generally be assessed in terms of the incremental profit the invention provides, through revenue generation and/or cost saving. The licensor considers the economic value to itself (if it in fact uses the inventions e.g. to design, manufacture, or sell products) as well as the economic value to the licensee (if the patentee does not use the invention itself, but also

¹¹ The finding of infringement and the decision on stay request may happen simultaneously. And, if the stay is granted, the initial determination of infringement may not be disclosed to the parties, and rather can be evaluated

(again) following the Validity proceeding. We understand that this is the most typical process, though certain cases may diverge from this order, e.g. if a stay is granted before a finding of infringement.

if the licensee may use the invention for a different purpose or in a different market than the licensor). In some cases, this information may be asymmetric – in other words, one party may have limited information relative to the other, which can complicate the determination of the economic value of an invention to a licensee.

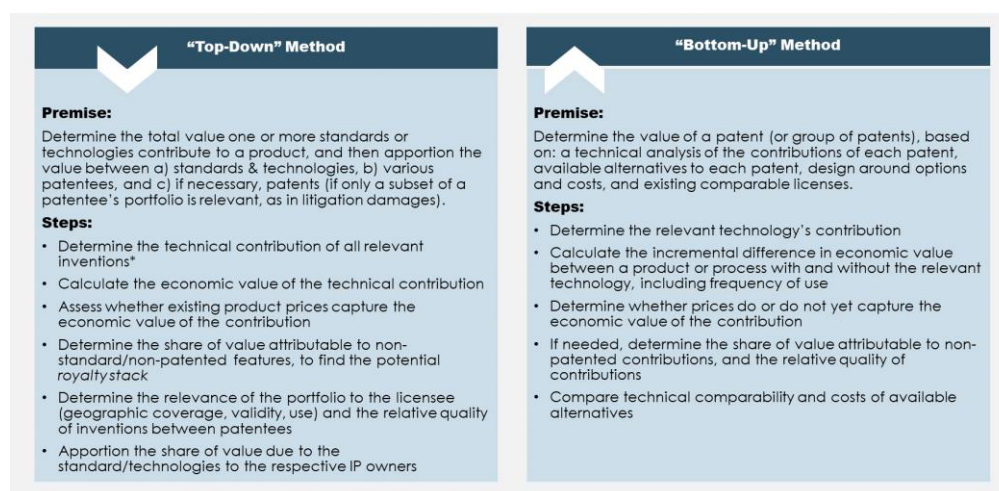
Then, the parties generally bargain over the incremental profit such an invention would provide (usually through a particular product or process). For example, if a patented invention is expected to decrease the cost of goods for

each product produced by \$1, then the implementer would expect to receive incremental profit per unit of \$1 if the product price is unchanged.¹²

This exercise is conceptually similar for highly complex product that incorporate many hundreds or thousands of inventions, owned by dozens of patentees. In such complex products, two basic frameworks can be used to assess the economic value of patented inventions and patent portfolios (see

Figure 3).

Figure 3
Frameworks for valuing patented inventions in complex products



Note: * Both methods consider technical contributions of relevant inventions, which can include implementation patents, standards, and own contributions through e.g. trade secrets and other know-how. / In any methodology considering complex technical products, relative contributions of companies, as well as patents, are important parameters that can be difficult to observe, and which may differ significantly between products or companies, depending on own contributions, and precise implementations of patents, etc.

Source: Copenhagen Economics

2. The commercial relationship of the licensee. Both parties consider their respective commercial positions, and in particular, whether they compete with one another, or will reasonably be expected to compete with one another due to the licensee's potential use of

the invention. For example, a licensor may not be willing to grant a license to a potential competitor *for the same price* at which the licensee may be willing to grant a licensee to a company with whom it does not compete (e.g. a company that operates in a geographic area distinct from

¹² Other reasons may exist that would encourage an implementer to also lower the price per product, if for example

the implementer would expect to sell more units and generate even greater profit overall. We illustrate the example in its most simplistic form here.

the area where the licensor sells its own products). Such decisions are highly industry and company specific, and must consider the dynamics of two individual parties in a negotiation.

Some patentees seek to license their inventions generally as part of an overarching business model, or as part of a commitment to a technology standard.

3. Common licensing practices. Parties to a negotiation may also consider typical licensing practices within an industry or even within a technology area, if enough public information exists. In some industries, patent licensing is commonplace and either the licensor or the licensee may have several existing license agreements with which to consider common terms and conditions, including financial terms and structures. Within such industries, license conditions may be public for a subset,¹³ either due to non-confidential agreements¹⁴ or due to licenses contracted because of litigation.¹⁵ When available, existing licenses may be informative as to the economic value of patented inventions, for e.g. a particular use, industry, or geography.

4. Contributions by the implementer and any available alternatives to the patented invention. Licensors and licensees also consider other technologies that may be used by the licensee, which can help determine the economic value of the patented invention relative to other options. This includes both technical and economic contributions by the

implementer (licensee) as well as potential alternatives that could be used instead of the patentee's claimed invention.

As discussed above, the profit generated with a particular product may differ from the profit generated by an invention. Consideration of the contributions of both licensor and licensee allows the two to allocate incremental profit between them.

In addition, it allows the parties to consider the limits of what a licensee could reasonably be expected to pay, given existing technologies and their commercial acceptability. For example, imagine a product that can use one of two inventions: One is patented by the licensor, one by the licensee. If the licensee's customers have a slight preference for the licensor's method and are willing to pay 2 cents more per unit for 10 000 units, the licensee will expect to make an incremental revenue of \$200. However, the licensee will also incur costs of redesigning its product with the licensor's invention plus the fee to license the invention. If this cost is equal to or greater than \$200, the licensee will not switch (because incremental profit is equal to or less than zero). To induce the implementer to make the switch, the licensor can lower the fee it requires to grant a license, to ensure the licensee's incremental profit is positive, and to increase its own profit relative to if it were to not license. The companies also typically consider costs of designing around patented inventions, the timelines to make changes to innovation, as well as the expected trajectory of technology development in an industry or application.

¹³ In other industries, licensing behavior may not be transparent at an industry level, due to non-disclosure agreements and confidentiality provisions, of the parties as well as suppliers.

¹⁴ University technology transfer is one example, generally related to early stage technologies in pharmaceutical, biotechnology, etc. Industry data are available through databases such as ktMINE (ktMINE (2019). *IP Strategy & Valuation*. Last accessed on 04 June 2019. Source: <https://www.ktmine.com/ip-strategy-valuation/>) and AUTM (AUTM (2019). *Databases*. Last accessed on 04 June 2019. Source: <https://autm.net/surveys-and-tools/databases>)

¹⁵ Court documents and decisions may opine on evidence in a case related to licensing behaviour and typical terms and conditions. Such information is most common in common law jurisdictions rather than civil law jurisdictions; examples include but certainly are not limited to: *Georgia-Pacific Corp. v. United States Plywood Corp.*, 318 F. Supp. 1116 (S.D.N.Y. 1970); *In re Innovatio IP Ventures, LLC*, Case No. 1:11-cv-09308 (N.D. Ill. Sep. 17, 2013); *Microsoft v. Motorola*, 696 F.3d 872 (United States Court of Appeals for the Ninth Circuit 2012). *Ericsson, Inc. v. D-Link Sys., Inc.*, 773 F.3d 1201, 1226 (Fed. Cir. 2014) *VirnetX Inc. v. Apple, Inc.*, Appeal Nos. 2017-2490, -2494 (Fed. Cir. Dec. 10, 2018).

These factors will be considered by both licensor and licensee and allow two parties to bargain over the terms and conditions of a license agreement, including the financial terms.

However, a patentee may opt to litigate if license negotiation is unsuccessful and it believes the patented invention is already in use by the licensee. In some cases, where the two parties have made some progress, but cannot otherwise agree on specific terms such as the structure of compensation for use, the parties may engage in alternative dispute resolution. Disputes provides a mechanism to ensure patentees owner retain right to exclusivity, or receive appropriate compensation i.e. damages for past use. If two parties are unable to agree on terms and conditions, both parties know that the patentee may assert its patent(s) against the implementer in order to strike a contract.

Both parties can already in their pre-litigation negotiations consider the possible outcomes of such litigation. For example, both parties know that the patent's validity may be challenged, or that the patent may not be infringed. If the patent is infringed, both parties know that damages will

be calculated based on the economic value of the patented invention.¹⁶ The litigation will also result in costs to each party. Because this eventual process is known to each party, both can in the license negotiation predict one another's behavior and thus avoid litigation.¹⁷

This is also true in cases where a patentee chooses to assert its patents against an end-user (who may indirectly infringe through use of sub-parts). As discussed above, a patentee has the legal right to select any company within a vertical supply chain where it wishes to litigate, irrespective of which company it (may have) initially bargained with. Even in cases where a patentee may intend to eventually grant a license to an implementer, a patentee may instead forgo a license negotiation and instead go straight to assertion, to pressure an implementer to accept a license or settlement which the patentee would not otherwise be able to induce.

Under the German system, this can result in settlement payments that differ from those expected under a typical license negotiation or in a legal system without automatic injunction.

1.4 The threat of automatic injunction shifts bargaining power and increases settlement

The German patent litigation system and its a) brevity of patent infringement findings, b) the public nature of the defendant's exposure, and c) the frequency of patent claim invalidations, significantly alters the bargaining dynamics of the parties, especially in industries with complex supply chains.

In complex supply chains, companies that sell end-products rely on dozens or hundreds of suppliers and sub-suppliers, which can result in a patentee asserting its patent against an end-user for infringement through its use of a sub-component that is implemented several tiers below within the supply chain. As industries are evolving, increasing integration and overlap is occurring, causing supply chains to become even more complex.¹⁸

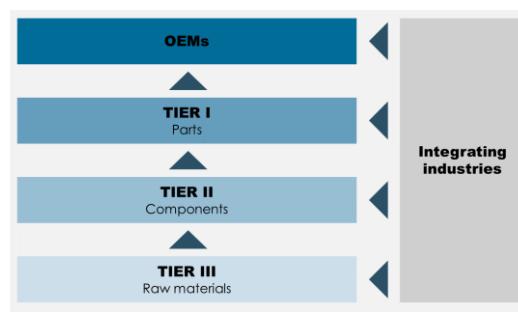
¹⁶ National laws differ in how damages are calculated, however in general, the economic value of an invention to the patentee for direct loss (e.g. lost profit), as well as the value to the implementer (e.g. incremental value or the infringer's profits) can be awarded. We do not discuss these differences here as the general point is that some form of damages may be awarded.

¹⁷ See e.g. Serrano (2005). *Nash Program*. Department of Economics, Brown University. Source: <https://www.brown.edu/Departments/Economics/Faculty/serrano/pdfs/2008NPDENash.pdf>

¹⁸ PwC (2016). *Connected car report 2016 – Opportunities, risk and turmoil on the road to autonomous vehicles*. Last

For example, with the incorporation of non-traditional innovations into vehicles, the automotive supply chain has become increasingly integrated as original equipment manufacturers (OEMs) and their suppliers are expanding. Suppliers are redesigning existing products with newer technologies, and outside companies are entering the automotive sphere, e.g. related to software development, cellular and other connectivity, safety features, lighting systems, etc.¹⁹ Instead of one vertical supply chain, new contributors do business with and between various tiers of suppliers, including the OEMs (See Figure 4 for an example in automotive.)

Figure 4
Automotive industry supply chain



Note: "Integrating industries" refers to technology providers from outside the automotive industry, whether recently developed or simply new to automotive

Source: Copenhagen Economics

Traditional industries, such as automotive, with well-established vertical supply chains are also facing increasing litigation from other traditional industries, for use of components and sub-components that use "other" technologies²⁰ – i.e. technologies that were typically contained within a separate vertical. The horizontal integration e.g. of automotive with telecommunications, semiconductors and other technologies has created increasingly complex infringement questions.

While this is not unique to Germany, and rather represents an increasingly global intellectual property infringement challenge, the German remedy of automatic injunctive relief imposes a specific constraint. Compared to a system without the threat of automatic injunction, the German patent system has a significantly higher settlement rate.²¹

Critically, the timing of infringement proceedings impacts a defendant's ability to resolve cases in a manner that is consistent with the economic value of a patented invention. In other words, settlement under threat of injunction may require defendants to compensate the plaintiff for a fee that is untethered from the economic value of the infringed invention. In theory, a defendant has several choices. See Figure 5 for a summary of the defendant's possible choices and their results.

accessed: 06 June 2019. Source: <https://www.strategyand.pwc.com/media/file/Connected-car-report-2016.pdf>; Water Street Partners (2016). *Autonomous Vehicle Partnership – How Tech Companies and Automakers are Using Joint Venture to Innovate the Future*. Last accessed: 06 June 2019. Source: <https://www.waterstreetpartners.net/blog/autonomous-vehicle-partnerships-how-tech-companies-and-automakers-are-collaborating-to-innovate-the-future>

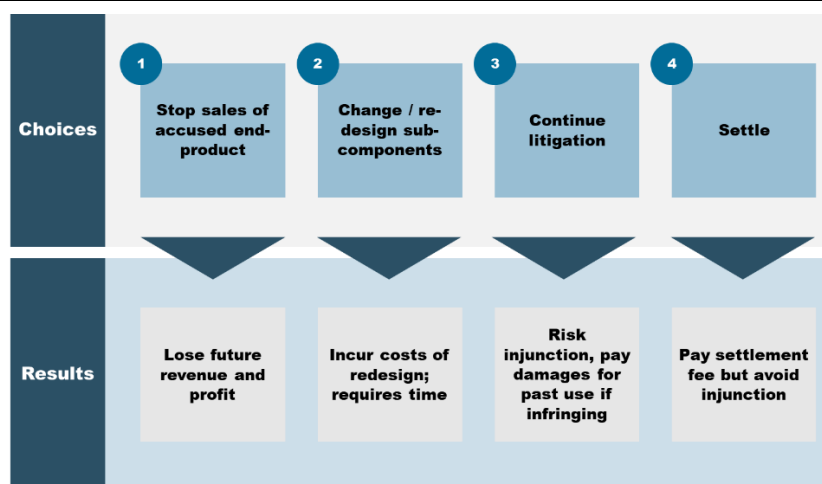
¹⁹ McKinsey (2018). *Rethinking car software and electronics architecture*. Last accessed on 04 June 2019. Source: <https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/rethinking-car-software-and-electronics-architecture>; Berylls (2018). *Die weltweit 100 größten Automobilzulieferer im Jahr 2017*. Last accessed on 03 June 2019. Source: [https://www.berylls.com/wp-](https://www.berylls.com/wp-content/uploads/2018/07/20180704_Studie_Top_100_2018.pdf)

[content/uploads/2018/07/20180704_Studie_Top_100_2018.pdf](https://www.berylls.com/wp-content/uploads/2018/07/20180704_Studie_Top_100_2018.pdf)

²⁰ See e.g. The Financial Times (2013). *High-tech cars spark fears of auto patent wars*. Last accessed on: 26 June 2019. Source: <https://www.ft.com/content/f3875250-40a3-11e3-ae19-00144feabdco>; Bardehle Pagenberg (2019). *Automotive Patent Wars*. Last accessed on: 06 June 2019. Source: <https://www.bardehle.com/ip-news-knowledge/ip-events/detail/events/info/automotive-patent-wars.html> Kilpatrick (2019). *Connected car patent pools are inevitable, say telecoms and automotive companies*. Last accessed: 06 June 2019. Source: <https://patentstrategy.managingip.com/articles/33/last-weeks-most-read-connected-car-patent-pools-are-inevitable-say-telecoms-and-automotive-companies>

²¹ See, e.g. Creemers 2016.

Figure 5
A defendant's possible choices in litigation



Source: Copenhagen Economics

First, the defendant can choose to stop selling the accused end-product and forgo future revenue and profit (i.e. exit).²² If exiting the market is not of interest, the defendant has several other choices.

Second, if the defendant has technically and commercially acceptable alternatives to the asserted technology, it can either a) change sub-components; or b) redesign existing sub-component. Either avoids infringement, but both impose switching costs, including funding and time. The court's infringement decision naturally does not consider, whether another technical alternative is available to the defendant, and whether that technical alternative is commercially acceptable to its customers. The parties may consider such options, but may have 1) different information, and/or 2) insufficient time to implement options relative to the potential injunction: Precisely because a patentee may select any party within a supply chain to litigate, a defendant may require greater resources to evaluate possible alternatives (to be implemented

somewhere down the supply chain). An OEM will likely be less informed as to the details of its sub-supplier's actions and technical options and thus requires time to gather such information, as well as cooperation from the suppliers. Furthermore, the timing of infringement proceedings under the German system (with rulings in 8-15 months) may effectively disallow time and thus possibility for re-design even if technically and commercially feasible. This problem is further increased, if the OEM is sued out of a number of patents and would have to change e.g. a number of systems in numerous car models. Timing is particularly critical in certain industries such as automotive, which not only have complex supply chains, but also must comply with critical regulatory requirements and safety standards.

Third, the defendant can choose to continue litigation, considering its expected likelihood of success in a nullity action (if relevant) and its expected likelihood of infringement, and thus risk

²² Such a choice may also seek to minimize reputational harm caused by imposition of an immediate automatic injunction, which can be incredibly disruptive to customers, whether wholesalers, distributors, or public consumers.

injunction as well as damages for past use. However, an injunction is akin to exiting the market immediately if imposed.

This leaves a potential fourth option, should the patentee/plaintiff be willing: the defendant can accept a settlement offer to the litigation, considering its expected exposure if an injunction on its end-product is granted.

The immediacy of the injunction coupled with the increasing complexities of supply chains (e.g. through and horizontal integration of traditionally vertical industries) distorts the bargaining positions of the plaintiff and defendant compared to a negotiation (licensing or litigation) without the immediate threat of injunction.

Without settlement, the defendant will forgo all revenue and profit it would otherwise expect to receive for its (potentially) infringing products into the future, or until it can implement technically and commercially feasible alternatives to ensure its products do not infringe. An injunction may also have on-going repercussions beyond the infringing products, for example if customers decide to switch to competing products, or if the company's reputation is irreparably harmed.

Because this exposure is generally known to both parties, *both* can estimate the *defendant's* expected loss if an injunction is granted and remains in effect for a specified period of time.²³

As a conclusion, settlement is the only practical option to avoid an automatic injunction and thus avoid substantial business disruption, due to 1)

information asymmetry that may exist between an OEM that incorporates sub-components, the patentee, and other parties within the supply chain; 2) the time to implement a technical switch and bring an end-product to market, and 3) as a consequence of the German system's automatic injunction.

While this explains why it is favorable for a defendant to settle, is it also the case that a plaintiff will favor settlement? The plaintiff, as patentee, is entitled to exclusivity and thus makes a strategic choice to offer a settlement.²⁴ One reason is that the plaintiff may also incur (substantial) risk in litigation, particularly in cases where it faces nullity actions. If, a patentee risks full, or even partial invalidation, of its patent(s), the patentee may also stand to lose e.g. licensing revenue from third parties, or monopoly profits²⁵ on its own use of its inventions. Or, a patentee who intends to continue asserting its patent against several defendant's may lose the opportunity if its patent is revoke. Unlike the defendant's exposure, which can be estimated by both parties, or may even need to be disclosed by the defendant for the determination of a security deposit, the plaintiff's exposure is likely much less transparent to the defendant.²⁶

While the implications of the German system are generally accepted to indicate the preferences of all involved parties for settlement,²⁷ economic theory can provide context for explaining why this is not only typical, but why it is also rational and at what price. However, the settlement price need not be constrained by, or even consider, the economic value of the patented invention, as we

²³ We discuss this in more detail below.

²⁴ We do not suggest that all plaintiffs will always decide to offer or accept settlement deals. However, in many cases, it is in the interests of both parties to resolve disputes with settlement as we illustrate below.

²⁵ Monopoly profits may arise in a situation where the patentee is the only supplier and can hence extract potentially higher monopoly prices than in a competitive market with more than one supplier. See e.g. Tirole, *Theory of Industrial Organization*, Chapter 7 Product Differentiation: Price Competition and Non-Price Competition, 1994.

²⁶ This may be due to confidentiality of license agreements, lack of publicity regarding the plaintiff's litigation tactics,

or lack of information about the purported use of the patented invention.

²⁷ See e.g. (1) Global Legal Insights (2018). *Litigation & Dispute Resolution 2018 / Germany*. Last accessed on 03 June 2019. Sourced from www.globallegalinsights.com/practice-areas/litigation-and-dispute-resolution-laws-and-regulations/germany

(2) Cremers et al. (2017). *Patent litigation in Europe*. Last accessed on 03 June 2019. Source: <https://link.springer.com/article/10.1007/s10657-016-9529-0>

(3) Meissner Bolte

illustrate below. Rather, the outcome (i.e. the price) of a settlement in Germany will favor the plaintiff, given the disclosure of the defendant's exposure. Here, we look to game theory, the study

of strategic decision making: We outline the general background of game theory as it relates to settlement negotiations and explain the application to litigation under the German system.

2 EVALUATING SETTLEMENT NEGOTIATIONS USING GAME THEORY

2.1 In general

Game theory helps explain how decisions are made when two or more players' decisions affect each other's payoffs.²⁸ In its simplest form, game theory builds on mathematics of decision theory, in which an individual envisions a chain of decision points (known as a decision tree) to evaluate each option and which action to take for each decision to maximize her *payoff*. The individual can be expected to start with a decision (the root) and consider one or more actions each of which lead to a payoff (terminal point). In a game, the decision tree includes two or more players,

whose actions at each decision node will impact the players' payoffs. A game that can be repeated (sub-games) and in which both players know what actions previously occurred is known as a sequential or dynamic game. An *equilibrium* is the set of strategies, where each player has a strategy, from which neither will deviate. The strategies of a sequential game and the payoffs can be illustrated in an *extensive form decision tree*. We define key terms in

Table 1.

²⁸ See e.g. Tirole, *Theory of Industrial Organization*, Chapter 11 Game Theory User's Manual. 1994.

Table 1
Summary of game theory terminology

TERM	DESCRIPTION
Game	A set of circumstances that has a result dependent on the actions of two or more decision-makers (players).
Players	A strategic decision-maker within the context of the game.
Nature	A third party who can impact the possible decision nodes within a game but who has no strategic interest in the outcome of the players. This party's actions are referred to as "moves by nature."
Strategy	A complete plan of action for a player given the set of circumstances that might arise within the game.
Information set	The information available at a given point in the game. The term information set is most usually applied when the game has a sequential component.
Sub-game	A subset of the initial game tree that begins in one node, is closed under succession, and is such that all information sets of the subgame are information sets of the initial game.
Perfect information	When all players know all actions taken by the other players.
Complete information	When all players know the strategy and payoffs available to the other players.
Payoff	The payout a player receives from arriving at an outcome. The payout can be in any quantifiable form, from money to utility.
Terminal point	The point(s) in a game where both players have made their decisions and reach an outcome.
Equilibrium	The set of strategies where each player has a strategy from which neither will deviate

Source: See e.g., Tirole.

Backward induction is a process of reasoning backwards in time, from a terminal point, to determine a sequence of optimal actions for each decision node.²⁹ This is done for every possible terminal point (thus for every information set). In this way, game theory allows us to predict the

optimal strategy for each rational player from the root. If, as in litigation, decisions can also be made by a third party with no strategic interest in the outcome, this party is referred to as *nature* – here, the courts take the role of nature.³⁰

2.2 Illustration of litigation considerations under the German system

With the help of the basics of game theory, the parties can estimate their own payoffs for each possible terminal point. In Box 2 below, we summarize the characteristics of a sequential game based on the German system.

²⁹ John von Neumann and Oskar Morgenstern suggested solving zero-sum, two-person games by backward induction in their *Theory of Games and Economic Behavior* (1944). See also, Tirole, 1994.

³⁰ Moves by nature are an integral part of games of incomplete information, and typically have associated probabilities.

Box 2 Basic litigation characteristics

A game can be imagined in which a Plaintiff (P) files a suit (infringement claim), and the Defendant (D) can choose to file a counter-suit (nullity action) and request of stay of the infringement proceedings. Here, and at other certain points in the game, moves by nature (i.e. the courts) occur as the courts hand down findings that affect the strategies of the players. D will ultimately be found to either infringe and face an injunction or be found not to infringe with no penalty.

During this process, either player can also decide whether to extend a settlement offer, which is followed by a decision by the other player, who can accept or reject the offer, given several sequential games. If neither player decides to offer a settlement, the sequence of games continues as above, and if a settlement is offered and accepted, an outcome is reached.

At every decision point, both the P and D know what moves have been made by the other player, thus this is a game of perfect information. However, at every decision point, both P and D may not know the strategies and payoffs of the other player and this may be a game of incomplete information. While P and D know their own strategies and payoffs, and both P and D may have an estimate as to D's payoff, D is unlikely to know P's payoff if its patent is invalidated. Depending on the moves by nature, this strategy may be terminated, and thus this may become a game of complete information in a sub-game.

We also expect that both P and D have expectations of the probability of outcomes pending moves by nature. P and D have expectations of the likelihood that:

- The court grants a stay of infringement proceedings
- D is found to infringe, and an injunction is granted
- P's patent is invalidated in full

We illustrate the timeline of proceedings under the German system with a numeric example of each party's potential payoff at each terminal point. After P files an infringement claim, the typical process would comprise the following stages:

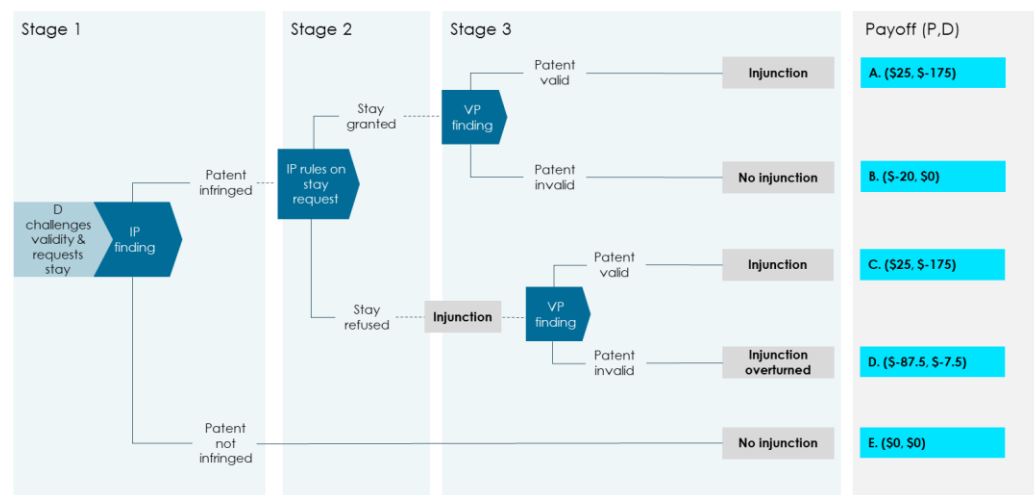
- Stage 1 - D can choose whether to challenge the patent and request a stay of infringement proceedings; and the court decides on infringement and whether to grant a stay; and
- Stage 2 - the court can grant a stay, in addition to or instead of handing down a judgment of infringement. If the finding is non-infringement, the nullity action may be withdrawn. If there is a finding of infringement,

automatic injunctive relief is granted. If the case is stayed pending invalidity, an infringement decision may not be handed down;

- Stage 3 – In either case, with or without a grant of a stay, a third stage occurs in which the court hands down a finding related to a patent's validity. (It is important to note that the timing of this stage will differ depending on whether or not a stay is granted.)

Given the possible combinations of court findings, we summarize the outcomes possible in Figure 6 below.

Figure 6
Illustration of payoffs at each terminal point with automatic injunction



Note: IP = Infringement proceeding / VP = Validity proceeding / Dotted line represents a change in venue. Payoffs in thousands.

Source: See chapter 2.1 above.

As shown, each result has an associated payoff for both P and D.

- A and C: When D is found to infringe and the patent is valid (in full or in part), it will suffer the injunction and compensatory damages: Its payoff is negative, we illustrate with a loss of \$150,000, due to injunction exposure and another \$25,000 for damages, or a total loss of \$175,000. P will in turn, receive compensation for damages and exclusivity through injunctive relief: Its payoff is positive, we illustrate with a gain of \$25,000 for damages.
- B: If a stay is granted and the patent is later found invalid (in full), D has a payoff of zero: D forgoes the negative payoff. However, P will risk an invalidation of the patent: Its payoff is negative, we illustrate with a loss of \$20,000.³¹
- D: If a stay is refused, and D is found to infringe and suffers a preliminary enforcement of the injunction, but the patent is later invalidated, D will suffer the injunction for the interim period (i.e. it will not expect to lose

\$100,000 as in A or C, but a fraction of that) but receive the amount of the security deposit: Its payoff is negative, we assume it only receives a security deposit of 90% of its exposure, we illustrate with a loss of \$7,500. P will lose the amount of the security deposit, as well as any future value associated with its patent: Its payoff is negative, we illustrate with a loss of \$67,500 for the security deposit plus a loss of \$20,000, for a total loss of \$87,500.³²

- E: If D is not found to infringe (and thereby a stay is not relevant), both D and P have a payoff of zero: D avoids the negative payoff and P avoids the positive payoff associated with injunction and damages. The nullity action is likely withdrawn, so P also avoids the loss of future value associated with its patent.

Each party P and D would consider their own payoffs, as well as their expectations of the other's payoffs. We summarize these results in Table 2, again with the sample numeric values:

³¹ In this example, we exclude costs of litigation for simplicity.

³² This scenario would require that D first incur the injunction, and later attempt to recoup losses, which requires

further time and effort, and as indicated may not be recouped in full.

Table 2**Illustration: Example of how payoffs can be contemplated under the German system**

SEQUENCE	OUTCOME	PAYOFF, PLAINTIFF (\$)	PAYOFF, DEFENDANT (\$)
Infringed, Stay granted, Valid	A	25,000	-175,000
Infringed, Stay granted, Invalid	B	-20,000	0
Infringed, Stay declined, Valid	C	25,000	-175,000
infringed, Stay declined, Invalid	D	-87,500	-7,500
Not infringed	E	0	0

Note: Values are for illustration only, but contemplate a situation where the P stands to receive damages if a patent is infringed, and stands to lose future revenue if the patent is invalidated. D stands to be enjoined on a product that is more valuable than the contribution of the invention, in addition to owing damages.

Source: Copenhagen Economics

As shown, the maximum payoff P can expect is \$25,000, if D is found to infringe, and the maximum payoff D can receive is zero (no loss) if it is found not to infringe. However, if P's patent is invalidated, its payoff may be as low as a loss of \$87,500; while D's payoff will be a loss of \$175,000 if it is enjoined and owes damages.

Without an automatic injunction, both D's and P's payoffs at certain terminal points would improve relative to if a stay had been granted.

- A and C: When D is found to infringe, it will "lose" *only* compensatory damages owed for its infringing use (only \$25,000, instead of \$175,000). P's payoff is unchanged (it receives damages of \$25,000).³³
- B: If a stay is granted and the patent is found invalid, D does not infringe, payoffs for P and

D are unchanged (P loses the future value of its patent of \$20,000, and D's loss is zero).

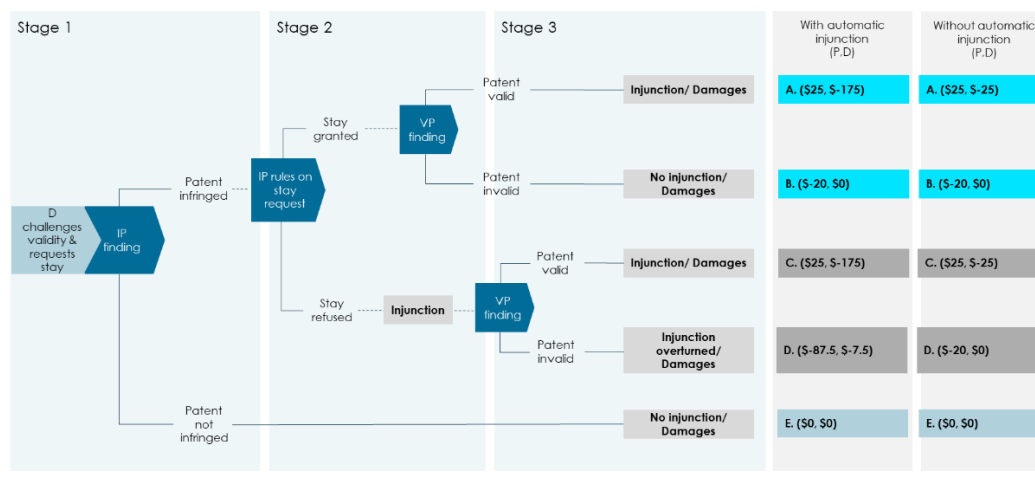
- C: If a stay is refused, and the patent is later found valid, D will lose only compensatory damages for its infringing use (\$25,000, instead of \$175,000); P's position is unchanged.
- D: If P's patent is invalidated, its payoff is P will suffer a loss of \$20,000 due to invalidation, but its position improves (in relative terms) as there can be no preliminary enforcement of an automatic injunction. For this reason, D also suffers no loss, i.e. its payoff is zero.

See Figure 7 below for a comparison of the expected payoffs with and without automatic injunction:

³³ Here we assume the Plaintiff receives utility rather than compensation equal to the defendant's exposure. If plaintiff's payoff was based only on monetary value, it would expect to receive only compensation for damages (which

would only equal the defendant's exposure if the patented invention accounted for 100% of the profit on the defendant's infringing product).

Figure 7
Illustration of payoffs at each terminal point, with and without automatic injunctions



Note: IP = Infringement proceeding / VP = Validity proceeding / Dotted line represents a change in venue. Payoffs in thousands.

Source: See chapter 2.1 above

This difference results in a substantial change in bargaining power between P and D, as D's injunction exposure increases the range of payoffs in the event of an injunction.

We can then compute an expected value to each P and D conditional on the likelihood of the court's findings in each stage. In Table 3, we summarize the probability associated with each court decision for request to stay, validity, infringement:

Table 3
Proceeding statistics, assumptions

REQUEST TO STAY (1)	INFRINGEMENT PROCEEDING (2)	VALIDITY PROCEEDING (3)
Granted	Infringed*	Valid
0.11	0.83	0.55
Declined	Not infringed	Invalid (in full)
0.89	0.17	0.45

Note: *Infringed includes partly infringed and settled to avoid undercounting the likelihood of infringement.

Source: We use the most recent data available for each category: (1) Kühnen & Claessen (2013) / (2) Cremers et al (2016) / (3) Henkel & Zischka (2018).

In Figure 8 below, we illustrate the computation of the expected value to P and D based on the payoffs described above and using the probabilities associated with each court finding (i.e. decision) as listed above.³⁴ In the illustrative game,

the defendant expects *ex ante* a loss of \$81,773 based on its expectations about the court decisions, while the plaintiff expects a loss of \$18,796.

³⁴ It is not necessary that P and D have identical expectations as to the likelihood of court findings, however we use this assumption for simplicity.

Figure 8
Illustration of expected value to each party based on likelihood of court decisions and resulting payoffs

Stage 1		Stage 2		Stage 3		D Payoff (\$)	Proba- bility	Prob.- weighted payoff (\$)	Prob.- weighted ex- pected value (\$)
Infringed	0.83	Stay granted	0.11	Valid	0.55	-175,000	0.05	-8,454	-81,773
				Invalid	0.45	0	0.04	0	
		Stay declined	0.89	Valid	0.55	-175,000	0.40	-70,806	
				Invalid	0.45	-7,500	0.34	-2,513	
Not infringed	0.17					0	0.17	0	

Stage 1		Stage 2		Stage 3		P Payoff (\$)	Proba- bility	Prob.- weighted payoff (\$)	Prob.- weighted ex- pected value (\$)
Infringed	0.83	Stay granted	0.11	Valid	0.55	25,000	0.05	1,208	-18,796
				Invalid	0.45	-20,000	0.04	-800	
		Stay declined	0.89	Valid	0.55	25,000	0.40	10,115	
				Invalid	0.45	-87,500	0.34	-29,319	
Not infringed	0.17					0	0.17	0	

Note: The plaintiff's payoff is based on the assumption that it receives damages. Payoffs are in USD. Rounded to the nearest dollar. / *Valid includes findings of full and partial validity. / We find that the parties would settle rather than suffer injunction.

Source: Copenhagen Economics

As each stage passes, (i.e. as the courts hand down decisions), remaining strategies in the game transpire, and the probability weighted payoff of each party can be re-calculated. As a result the payoff will change at each sub-game.

Given the decision nodes, could and should either party extend a settlement offer to maximize its payoff? If a settlement offer improves the pay-

off to both rational parties, then it should be extended and accepted. To determine the amount of such a settlement offer, the plaintiff can, based on its knowledge about it and the defendant's payoffs, calculate the expected values³⁵ to it and the defendant. The defendant can do the same, though the defendant will be less equipped to predict the extent of the plaintiff's payoff (i.e. the negative consequences) if its patent is invalidated in full.

³⁵ Expected values are calculated based on the probability of each possible move by the court. For example, if there is a 90% chance of a finding of infringement, which will result

in a payoff of -\$100, and a 10% change of non-infringement, which will result in a payoff of zero, the expected value is equal to -\$90 [= 0.9 * -\$100 + 0.1 * 0]

In the sequence where the court hands down a finding of infringement and the stay is declined, we expect that the parties would settle: D will expect to be found to infringe (pending the validity findings by BPatG) and both P and D anticipate D's expected loss if injuncted.

If we then recompute the probability weighted payoffs, with the expectation of settlement for no less than the amount of damages claimed, we find that the defendant's and plaintiff's positions improve relative to the case without settlement. See Figure 9 below. Based on the expectation of

settlement in the event that the court finds a) the patent is infringed and also b) the stay is declined, P and D would be willing to settle for an amount in the range of more than \$18,900 and less than \$26,946 (where, if the court finds infringement in stage 1, P's expected value would increase, and D's expected value would decrease to an even greater extent, resulting in a wider range with a higher upper bound.³⁶ The precise settlement value will differ within such a range, depending on the parties negotiating and their respective bargaining positions.

Figure 9
Illustration of expected value to each party based on likelihood of court decisions and resulting payoffs, settlement

Stage 1		Stage 2		Stage 3		D Payoff (\$)	Proba- bility	Prob.- weighted payoff (\$)	Prob.- weighted ex- pected value (\$)
Infringed	0.83	Stay granted	0.11	Valid	0.55	-175,000	0.05	-8,454	-26,946
				Invalid	0.45	0	0.04	0	
Not infringed	0.17	Stay de- clined	0.89	Settle		-25,000	0.74	-18,492	
						0	0.17	0	

Stage 1		Stage 2		Stage 3		P Payoff (\$)	Proba- bility	Prob.- weighted payoff (\$)	Prob.- weighted ex- pected value (\$)
Infringed	0.83	Stay granted	0.11	Valid	0.55	25,000	0.05	1,208	18,900
				Invalid	0.45	-20,000	0.04	-800	
Not infringed	0.17	Stay de- clined	0.89	Settle		25,000	0.74	18,492	
						0	0.17	0	

Note: The plaintiff's payoff is based on the assumption that it receives damages. Payoffs are in USD. Rounded to the nearest dollar. / *Valid includes findings of full and partial validity. / We find that the parties would settle rather than suffer injunction

Source: Copenhagen Economics

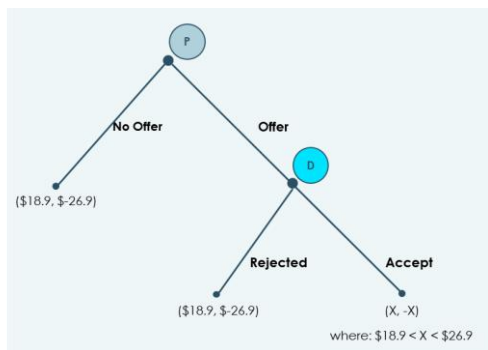
³⁶ In addition, the D could anticipate settlement even if the stay is granted.

To continue with the illustration, P can reasonably anticipate D's exposure. Therefore, P may expect D to settle rather than risk injunction. In this case, P would not expect to have to suffer any loss in the form of a security deposit, which would in general increase the expected payoff to P. Thus, P may expect a gain, rather than a loss.

We can translate this process to a decision tree in which the players P and D make decisions about settlement based on the expected likelihood of findings of infringement (and thus an injunction) with the following decision. As moves are made by nature (i.e. as the courts hand down decisions), the sub-game and the remaining actions (and their respective payoffs) become apparent.

We illustrate a game in Figure 10 below, where P extends a settlement offer prior to Stage 1, and D accepts or rejects. If D rejects, it may be found not to infringe, to infringe a valid patent, or the patent may be invalidated. In this simple tree, where P can extend an offer or not, and D can accept the offer or not, where no offer (or no acceptance of an offer) results in the probability weighted expected values shown in Figure 9 above.

Figure 10
Simplified game tree

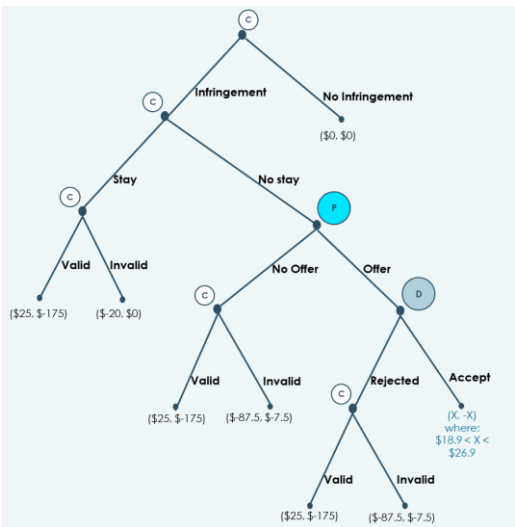


Note: P = Plaintiff, D = Defendant
Source: See Figure 9.

If P offers D a settlement for an amount that is less than D's expected value, D ought to accept that offer.³⁷ D's expected value will change, depending on the stage (sub-game) of the litigation process. Meanwhile, P will have its own expected value at each stage. P will only expect a positive payoff if D is both found to infringe, and if damages are awarded. But because P can reasonably anticipate D's payoff if it is enjoined, P can instead make a settlement offer during the litigation. Less transparent is P's exposure if its own patent is invalidated; this could result in loss if the patent is expected to be asserted again in the future, or it may cause no monetary loss.

The game tree as envisioned in Figure 8 and Figure 9 above is illustrated in Figure 11.

Figure 11
Illustration of game tree



Note: P = Plaintiff, C = Court (i.e. Nature), D = Defendant.
Source: See Figure 8 and Figure 9.

A defendant should agree to any settlement which allows it to minimize the loss of product revenue and profit it expects to suffer due to the injunction. This potential loss is also known to the plaintiff, and allows the plaintiff to expand its

³⁷ Contingent upon the parties' expected gains/losses, and their respective bargaining power. However, as a patent

grants a legal right to exclusivity, which necessarily affects bargaining power to favour the plaintiff/patentee.

settlement demands beyond its own expected payoff. Thus, the defendant's expected profits are available for the plaintiff and defendant to bargain over.

The above outcome of the game makes clear that the precise value of the patented invention is conspicuously absent from the factors that the parties must evaluate *in determining the upper bound of a settlement amount*. If the Plaintiff's claim for damages is appropriate, damages and thereby the invention value it can be considered as part of the exposure, but if the accused product contains features beyond the patented invention, the *upper limit* that the parties will contemplate will be based on the *defendant's* exposure. This will result in outsize payments any time the defendant's risk is greater than the value of the patented invention, as is almost exclusively the case in complex supply chains with dozens or hundreds of contributors. Furthermore, the defendant faces such risk for each patent infringement claim it faces, from each plaintiff it faces.³⁸

In addition to a price that is untethered from the value of the patented invention, the threat of automatic injunction also allows the plaintiff to demand terms and conditions of the settlement that differ drastically from economically supported terms and conditions, beyond price.

In the context of German litigation, a plaintiff is technically prohibited from making unreasonable claim demands; but in the context of settlement, a plaintiff may make demands that differ substantially, due to the common knowledge that the defendant will risk injunction of its entire product, irrespective of the relative value of the infringement, and that effectively forces settlement. Under the guise of settlement, a plaintiff may offer something *other than* a license to the patent at issue, such as e.g. a patent portfolio license.

The evolution of industries towards increasing connectivity and integration leading to more complex supply chains also presents practical challenges for defendants in such cases, as the German system not only allows, but may in fact create, separation between a patented invention and the cost of (resolving) litigation. This separation results from technical challenges, regulatory and safety challenges, and asymmetric information between the (allegedly infringing) supply chain. While it may be difficult for an OEM to precisely estimate the value of an invention to its end-product, this can - in theory - be done with time and expense. However, even if the defendant makes an offer based on the value of the invention, the plaintiff has little incentive to accept it.

³⁸ This may result in more complex sequences of games, where the plaintiff and defendant adjust their expectations not only based on the decisions handed down by the court, but also based on their experiences in prior litigations (which are here excluded as separate games). Both plaintiff and defendant may also expect to engage it games with

third-parties, e.g. one or more litigations involving other patents or parties. The settlement decisions may also be affected by each parties' perception of these future, but expected, games.

3 CASE STUDY: BROADCOM AND THE VOLKSWAGEN GROUP

Here we consider the 2018 dispute between Broadcom and Volkswagen AG and Audi AG, related to connected vehicles. we estimate a range of settlement values based on the parties' payoffs considering 1) Volkswagen and Audi exposure to automatic injunction of their end-product (i.e. vehicles) and 2) Broadcom exposure to potential patent invalidation. While we show above that settlement does not need to consider the patented invention value, we consider whether the estimated settlement range could still be consistent with the economic value of the inventions.

3.1 Case background³⁹

In September and October 2017, Broadcom Inc.⁴⁰ filed 18 patent infringement suits related to eleven patents in the Regional Court of Mannheim against Volkswagen and Audi. The alleged infringement claimed implementation within vehicle navigation and entertainment systems.⁴¹ Broadcom ultimately made a patent claim of \$1 billion (approximately €876 million).⁴²

Volkswagen and Audi formed a joint defense group along with several companies within their supply chains, consisting of Becker Automotive Systems,⁴³ Texas Instruments, Conti Temic,⁴⁴

Robert Bosch, the chip manufacturers Marvell Technologies and Nvidia Corporation, as well as LED manufacturer Nichia.⁴⁵ The alleged infringement generally related to sub-parts within a vehicle such as the instrument cluster or infotainment unit,⁴⁶ which contain semiconductor chipsets from several suppliers. Certain of these chipsets are alleged to infringe, though we understand specific vehicle models are not defined, and nor sub-parts.

Volkswagen and Audi challenged all patents, requesting nullity actions or preparing such. For

³⁹ We have received factual background from personnel at both Volkswagen and Audi. This information, along with cited sources, informs our understanding of the case and relevant technology.

⁴⁰ Broadcom describes itself as “a global technology leader that designs, develops and supplies a broad range of semiconductor and infrastructure software solutions.” Last accessed on 03 June 2019. Source: <https://www.broadcom.com/> For automotive, Broadcom offers “automotive semiconductor solutions addressing a wide range of needs in vehicle connectivity and networking, optical isolation and sensing, wireless communications, and LED lighting.” Last accessed on 03 June 2019. Source: <https://www.broadcom.com/applications/industrial-automotive/automotive-solutions>

⁴¹ The seven patents in question were registered by Broadcom Corporation and Avago Technologies, companies which have operated under the umbrella of Broadcom Inc. since 2015. JUVE Patent (2018). *Warning, trolls ahead*. Last accessed on 28 May 2019. Source: <https://www.juve-patent.com/news-and-stories/cases/warning-trolls-ahead/> (“JUVE Patent 1”)

⁴² JUVE Patent (2018). *Regional Court Mannheim creates antitrust chamber*. Last accessed on 28 May 2019. Source: <https://www.juve-patent.com/news-and-stories/people-and-business/regional-court-mannheim-creates-antitrust-chamber/>; Spiegel Online (2 Nov. 2018). *US-Chipkonzern verlangt von VW eine Milliarde Dollar*. Last accessed on 28 May 2019. Source: <https://www.spiegel.de/wirtschaft/unternehmen/volkswagen-broadcom-verlangt-von-vw-eine-milliarde-dollar-a-1236443.html>; JUVE Patent (2019). *Next Broadcom battle over Daimler and BMW*. Last accessed on 19 June 2019. Source: <https://www.juve-patent.com/news-and-stories/cases/next-broadcom-battle-over-daimler-and-bmw/> (“JUVE Patent 2”).
Converted using the exchange rate of 2 Nov. 2018 (1.1417 EUR/USD). European Central Bank (2019). Last accessed on 19 June 2019. Source: https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-usd.en.html (“ECB FX Rates”)

⁴³ A subsidiary of Harman Becker.

⁴⁴ A subsidiary of Continental.

⁴⁵ JUVE Patent 1.

⁴⁶ Instrument clusters and infotainment units generally help support a range of functionalities in a vehicle, from entertainment and navigation systems, including audio visual functions to play DVDs and music, to internal vehicle controls, such as voice control of traditional vehicle functions that typically were adjusted manually with knobs or buttons, as well as to safety features, including vehicle status and service reminders, driver assistance, blind spot notifications. These types of systems may enable passengers to use their cell phone hotspots to access WiFi or use Bluetooth.

some patents, the court found no infringement. Volkswagen and Audi requested that the infringement proceedings be stayed until a finding of validity could be handed down, however no stay was granted.

Two hearings occurred on 29 June and 14 September 2018 at the Regional Court at Mannheim. The Court saw no grounds for infringement of

patents EP 1 475 859 and EP 1 162 666 and dismissed the case, leaving the possibility for Broadcom to appeal.⁴⁷

Before all hearings occurred, Volkswagen and Audi agreed on a settlement with Broadcom no later than November 2018.⁴⁸ The settlement terms, including financial terms, are undisclosed.

3.2 Settlement outcomes given the threat of injunction

Based on the infringement claims by Broadcom, we understand that Audi and Volkswagen both sold vehicle models with infotainment systems that were alleged to infringe one or more of Broadcom's patents. Given this, and given Broadcom alleged its eleven patents warranted a claim of \$1 billion, what might we expect a settlement value to be?

First, we consider the payoffs to the Volkswagen Group ("VW Group") via Volkswagen and Audi, and to Broadcom and their respective expected values at each stage of litigation.

VW Group

To determine VW Group's payoff contingent upon litigation, we must determine the affected units; the value of the infringing units, and the duration of the injunction impact.

Affected units. We define affected units at those vehicles that are potentially infringing and may be enjoined. The vehicle models accused of infringement in this matter were not publicly disclosed. However, we understand that German courts may take a relatively broad interpretation

of infringement (whether direct or indirect). Vehicles sold under the brands Volkswagen (Passenger cars) and Audi are manufactured in full or in part in Germany, and we consider that these vehicles may infringe. VW- and Audi-branded 2018 worldwide vehicle sales were approximately 5.182 million vehicles per year.⁴⁹ An injunction could prevent Volkswagen and Audi from selling certain of these vehicles - we refer to these affected units as the "VW and Audi vehicles".

We understand that the accused functionality is optional in certain models, in which case not all VW and Audi vehicles would be affected by an injunction. Rather, between 10% to 50% of all VW vehicles may be affected, and 80% to 100% of Audi vehicles may be affected. We thus estimate affected units in 2018 of approximately 1.545 to 3.325 million vehicles (rounded) based on potentially infringing 2018 VW and Audi vehicles.⁵⁰

Value of the affected units. If enjoined, VW Group will suffer a loss of expected future operating profit on the VW and Audi vehicles.

⁴⁷ Case numbers 2 O 166/17 and 2 O 167/17. JUVE Patent (2018). *False start for Broadcom and Grünecker in suit against Audi and VW*. Last accessed on 03 June 2019. Source: <https://www.juve-patent.com/news-and-stories/cases/false-start-for-broadcom-and-grunecker-in-suit-against-audi-and-vw/>. Also based on interview with Audi.

⁴⁸ JUVE Patent (2018). *Broadcom settles dispute with VW and Audi*. Last accessed 03 June 2019. Source: <https://www.juve-patent.com/news-and-stories/cases/broadcom-settles-over-connected-cars/>

⁴⁹ Based on vehicle sales numbers on Volkswagen Passenger Cars and Audi vehicles in Volkswagen AG Annual Report 2018, page 23. Source: https://www.volkswagen-nag.com/presence/investorrelation/publications/annual-reports/2019/volkswagen/en/Y_2018_e.pdf ("VW AG Annual Report 2018")

⁵⁰ The estimated VW and Audi vehicle sales for the years 2019 to 2022 assume no growth in vehicle sales since 2018, i.e. they are assumed to remain stable after 2018. The share of affected units relative to the total sold VW and Audi vehicles is hence 29.82% (10% VW, 80% Audi affected) to 64.15% (50% VW, 100% Audi affected).

Total sales revenue of all VW and Audi vehicles in 2018 was approximately €143.8 billion.⁵¹ Total operating result from VW and Audi vehicles sales was approximately €7.9 billion in 2018, which is an operating margin of 5.52%.⁵²

However, VW Group *will also suffer an additional financial burden* due to additional costs that have already been incurred and which it cannot now recover given the injunction. As VW Group cannot sell affected vehicles, it will lose future revenue on those vehicles. VW Group will have incurred costs of sales for some of these vehicles and will have incurred some operating expenses associated with vehicle sales. These losses are not currently captured in VW Group's actual operating profit.

We estimate a total value of the affected units of €4.1 to €6.3 billion, based on operating result for all affected units (VW and Audi vehicles in 2018).⁵³ This is approximately €1,902 to €2,646 per affected vehicle, and does not account for the additional financial burden VW Group would suffer if enjoined.

Duration of impact. The duration of the impact depends on at least two factors: first, VW Group's ability to design around, or replace, infringing parts in the VW and Audi vehicles; and second, VW Group's customers sensitivity to the injunction disruption.

If a vehicle is found to infringe, it may take many months to several years to replace an infringing

semiconductor component and re-release the same vehicle. It can take anywhere from eight weeks to six months from consumer order placement to sale of a vehicle model that has been approved and tested from VW Group. The vehicles available for order have typically been in development for several years. A newly released vehicle model that becomes available for order today will have been in the developing process for approximately 48 months. The first 15 months define the product characteristics and the technical concepts.⁵⁴

Even if, as we understand to be the case, Audi or Volkswagen have several tiers of suppliers who supply alternative (non-infringing) parts, there may be production issues, or other supply chain issues that can delay vehicle release. The connectivity of the chips used in the vehicles increases the complexity of an exchange of the chip with a new chip in the vehicle's infotainment system. At least the software running on the semiconductor would need to be completely new designed, since a different semiconductor would be used. As a result, we expect that all infringing models for which injunctive relief is granted will be disrupted for approximately 48 months. Taking into account that the time from being served with the lawsuit until the injunction is granted will last about 18 months, there may be 30 months of injunction, even if the automotive OEM starts the necessary developments at the time the complaint is served.⁵⁵

⁵¹ VW AG Annual Report 2018, page 23.

⁵² Based on VW Group Annual Report 2018, page 23. Operating result is the sum of the operating result of VW Passenger Cars and Audi vehicles. We note that the operating result is before special items. Excluding the special items to the operating result avoids undercounting of the exposed operating result in future years. The operating margin is the weighted average of the operating result margin [Total operating result / Total sales revenue] of VW and Audi vehicles. The operating margin in 2018 of VW Passenger Cars is 3.83% and of Audi is 7.94%.

⁵³ We assume that no change was expected to occur in the future injunction period in performance, based on units, revenue, or profits, for simplicity.

⁵⁴ Volkswagen Inside (2018). *Wie Autos effizienter gebaut werden*. Source: inside.volkswagen.de/Effizienter-Autobau.html; In addition, as safety regulations and environmental standards evolve, additional changes, testing, and approval are required.

⁵⁵ Customers who are negatively impacted by an automatic injunction may temporarily or permanently adjust their preferences for vehicle manufacturers. Depending on the extent of the reputational harm, this harm may be irreparable, or potentially recoverable in later years. For example, for customers who lose faith in the company, VW Group may lose their business from VW and Audi vehicles in perpetuity as the customers can select other manufacturers. For other customers, VW may be able to salvage

We assume that the vehicle disruption could last for 30 months, but not beyond the expiry date of all asserted patents.

Damages compensation. If Volkswagen and Audi are found to infringe and if VW Group does not settle with Broadcom, it will also owe Broadcom damages in addition to any other loss it may incur due to an injunction.

Analysis and Computation. We then compute VW Group's payoff for each possible outcome to determine a possible settlement range. VW Group's maximum payoff is zero, if it is found not to infringe, or if the patent is invalidated in full. We expect VW Group's minimum payoff is a loss of *at least* €876 million, based on the claim made by Broadcom of \$1 billion, and the expectation that VW Group would settle if the patent is found

infringed (either without a stay, or with a stay and if the patent is later found valid).⁵⁶ If a finding of infringement occurs, and thus expected injunction, VW Group could expect to offer Broadcom the amount of the claim, whether or not VW Group believes a damages award would warrant such a price. This would allow VW Group to avoid injunction, and the payoff to Broadcom would be no less than if it received damages for the claimed amount.

Based on the probability of each outcome, we compute the probability weighted expected values. Prior to stage 1, and conditional on the likelihoods of infringement, stay, and validity, VW Group's expected value (loss) is approximately €690 million; see Figure 12.

Figure 12
VW Group's probability-weighted expected value, prior to stage 1

Stage 1		Stage 2		Stage 3		VW Group's Payoff	Probability	Prob.-weighted payoff	Prob.-weighted expected value
Infringed	0.83	Stay granted	0.11	Valid / Settle	0.55	-876	0.05	-42	-690
				Invalid	0.45	0	0.04	0	
		Stay declined	0.89	Settle		-876	0.74	-648	
Not infringed	0.17					0	0.17	0	

Note: € Millions

Source: Copenhagen Economics

Here, Broadcom or VW Group could opt to extend a settlement offer, and VW Group would reasonably accept a settlement for a price less than €690 million. If settlement does not occur prior to the court's decision in Stage 1, VW Group's expected value will change depending on

the courts' findings in as shown in Figure 13 below. If for example VW Group is found to infringe, the relative likelihood of success in the nullity action indicates that VW Group's expected loss increases to €834 million.

their relationship at some point in the future, e.g. in two years. There may be some customers who are unconcerned with the injunction and will purchase a car when available.
⁵⁶ Exposure to the VW Group is significantly greater, based on the affected vehicles and related profit, as explained

above. This is precisely why it is in a defendant's interest to settle. We provide a cap on settlement value based on the plaintiff claim. This does not assume that VW Group believes damages would have been awarded for a total of €876 million.

Figure 13**VW Group's probability-weighted expected value, stages 1-3, infringement**

Stage 1		Stage 2		Stage 3		VW Group's Payoff	Probability	Prob.-weighted payoff	Prob.-weighted expected value
Infringed	1.00	Stay granted	0.11	Valid / Settle	0.55	-876	0.06	-51	-834
				Invalid	0.45	0	0.05	0	
		Stay declined	0.89	Settle		-876	0.89	-782	

Note: € Millions

Source: Copenhagen Economics

If settlement does not occur prior to the court's decision in Stage 1, and VW Group's request for stay is declined, VW's expected value will again

change, to an expected loss of €876 million; see Figure 14.

Figure 14**VW Group's probability-weighted expected value, stage 1-3, infringement and stay declined**

Stage 1		Stage 2		Stage 3		VW Group's Payoff	Probability	Prob.-weighted payoff	Prob.-weighted expected value
Infringed	1.00	Stay declined	1.00	Settle		-876	1.00	-876	-876

Note: € Millions

Source: Copenhagen Economics

Again, if VW Group did not consider settlement, it could risk up to €4.1 to 6.3 billion in lost profit on affected vehicles for each year of injunction.⁵⁷ VW Group had several patents asserted again it and a finding of infringement with no stay on any one may be sufficient to induce settlement. Based on its payoffs for each terminal point, and its probability weighted expected value (loss) in the event injunctive relief is granted, we expect VW Group could have settled for an amount up to €876 million.

Sensitivity. This result relies on several conservative assumptions about VW Group's exposure, as described in detail in this section. If VW Group's exposure increases (i.e. if its payoff decreases), then its probability-weighted expected value will also decrease.

If VW Group was less optimistic about the court findings, its probability-weighted expected values would also change. For example, if it expected a higher likelihood of infringement than that actual historical results in court, then its probability weighted expected value will also decrease.

⁵⁷ Based on 2018 VW and Audi vehicles operating result of €7.9 billion, adjusted for frequency of use.

As a result, it is possible that VW Group expected an even more substantial loss – which would indicate it may have accepted an even higher settlement price.⁵⁸

Broadcom

To determine Broadcom's payoff contingent upon litigation, we must determine the expected damages compensation if VW Group is found to infringe; and the value of Broadcom's asserted patents.

Damages compensation. Broadcom's payoff in the event VW Group is found to infringe includes the opportunity to claim damages (this assumes that Broadcom and VW do not reach settlement agreement). As explained above, a plaintiff is not legally entitled to make a limitless or unsupported claim. Here, it is important to note that this payoff does not need to be perfectly transparent to VW Group (as this is a game of incomplete information), nor do Broadcom and VW Group need to have identical expectations of Broadcom's payoff.

We assume that Broadcom does in fact believe that its claim of €876 million is the amount of compensation a German court would award if its patents were found infringed. While we discuss this assessment below in chapter 3.3 in detail, we begin with this estimate to be conservative in estimating the price at which Broadcom could be expected to settle.

Value of Broadcom's asserted patents in unrelated litigations. Broadcom has a sizeable patent portfolio, and generates business both from products and software, as well as from patent and settlement licensing. Because Broadcom selected these specific patents to assert against VW Group in this matter, it is likely that Broadcom either believes these patents are particularly valuable (in terms of commercial value, technical value, and may be least likely to suffer invalidation). We assume that, if Broadcom's asserted patents are found to be invalid, Broadcom will lose at least some share of licensing revenue (whether through bilateral negotiations, or through litigation settlements) in the future. For example, if Broadcom also planned to assert these patents against other OEMs in Germany, any compensation for infringing use, or settlement revenue would be lost.

By March 2019, reports surfaced that Broadcom had in fact asserted patents against both Daimler and BMW in Germany at High Court Mannheim.⁵⁹ We estimate Broadcom's potential claim against Daimler and BMW based on their collective market share relative to VW and Audi.⁶⁰ Based on the 2018 share of vehicle sales of Daimler (2.383 million)⁶¹ and BMW (2.491 million)⁶² relative to VW Group (10.900 million)⁶³ of approximately 45%, we estimate Broadcom's potential loss in the event its patents were invalidated. Compared to Broadcom's claim against VW Group of €876 million, we estimate its claim against Daimler and BMW is approximately €392 million.⁶⁴

⁵⁸ It however important to note that the exposure VW Group faces per vehicle is constant for each patent infringement claim it faces, given it faces the threat of automatic injunction of the vehicle for each claim, irrespective of the implementation, substitutability, etc.

⁵⁹ According to JUVE, the amount of the claim in these matters is undisclosed. JUVE Patent 2.

⁶⁰ In this estimation, we implicitly assumed that at least one of the patents asserted against Volkswagen or Audi has also been asserted against BMW and Daimler, for simplicity. We also make no assumptions on the frequency of infringements of vehicles.

⁶¹ Daimler (2019). *Daimler 2018 Annual Report - Mercedes-Benz cars*. Last accessed on 19 June 2019. Source:

<https://annualreport.daimler.com/ar2018/the-divisions/mercedes-benz-cars#>

⁶² BMW Group (2018). *BMW Group remains world's leading premium automotive company in 2018*. Last accessed on 19 June 2019. Source: <https://www.press.bmw-group.com/global/article/detail/To289883EN/bmw-group-remains-world%E2%80%99s-leading-premium-automotive-company-in-2018?language=en>

⁶³ VW Annual Report 2018, page 23.

⁶⁴ This does not include other OEMs who also manufacture or deliver vehicles in Germany, though Broadcom may have additional plans for patent monetization. This also does not include potential loss due to its pending suit against Nintendo, which we understand relates to EP 531

We thus assume the amount Broadcom expects to lose €392 million in future revenue if all asserted patents are invalidated, or if Broadcom's bargaining position were substantially affected.⁶⁵

Computation. Based on these two factors, we compute Broadcom's payoff for each possible outcome. Broadcom's payoff is €876 million if VW Group is found to infringe and settles for Broadcom's asking price. If VW Group is found

not to infringe, Broadcom's payoff is zero – it receives nothing from VW Group. Broadcom's payoff is a loss of €392 million if all asserted patents are invalidated in full. Based on the probability of each outcome, we compute the probability-weighted expected values. Prior to stage 1, and conditional on the probabilities of each move by the courts, Broadcom's expected gain is approximately €675 million; see Figure 15.

Figure 15
Broadcom's probability-weighted expected value, prior to Stage 1

Stage 1		Stage 2		Stage 3		Broadcom's payoff	Probability	Prob.-weighted payoff	Prob.-weighted expected value
Infringed	0.83	Stay granted	0.11	Valid / Settle	0.55	876	0.05	42	675
				Invalid	0.45	-392	0.04	-16	
		Stay declined	0.89	Settle		876	0.74	648	
Not infringed	0.17					0	0.17	0	

Note: € Millions / We assign probabilities to each stage based on actual first instance decisions. These are likely conservative, as cases where a defendant is most likely to infringe, or a plaintiff is most likely to have a patent invalidated, may also be most likely to settle. / We assume only patents that are invalidated in full are invalid. / We exclude litigation costs.

Source: Copenhagen Economics

Here, Broadcom or VW Group could opt to extend a settlement offer, and Broadcom would reasonably accept a settlement for a price greater than €675 million (assuming it expects all patents are valid and infringed).

If settlement does not occur prior to the court's decision in Stage 1, Broadcom's expected value will change. If for example VW Group is found to infringe, the relative likelihood of success in the invalidity proceeding indicates that Broadcom's expected gain increases to €815 million.

and its own incorporation of one or more Nvidia Tegra SoCs. For comparison, Nintendo of Europe GmbH's 2018 revenue was €2.286 billion. This implies approximately €487 million is at risk, based on Germany's share of European GDP in 2018 of 21.3%. Eurostat (2019). *GDP and main components (output, expenditure and income)*. Last accessed on 4 July 2019. Source: http://appsso.eurostat.ec.europa.eu/nui/show.do?query=BOOKMARK_DS-406763_QID_23BE6D65_UID_-3F171EBo&layout=UNIT,L,X,O;GEO,L,Y,O;TIME,C,Z,O;NA_ITEM,L,Z,1;INDICATORS,C,Z,2;&zSelection=DS-406763TIME,2016;DS-406763INDICATORS,OBS_FLAG;DS-406763NA_ITEM,B1GQ;&rankName1=INDICATORS_1_2_-1_2&rankName2=NA-

[ITEM_1_2_-1_2&rankName3=TIME_1_0_0_0&rankName4=UNIT_1_2_0_0&rankName5=GEO_1_2_0_1&rStp=&cStp=&rDCh=&cDCh=&rDM=true&cDM=true&footnes=false&empty=false&wai=false&time_mode=ROL-LING&time_most_recent=true&lang=EN&cfo=%23%23%23%2C%23%23%23.%23%23%23](#)

⁶⁵ As noted above, we do not know which patents Broadcom asserts. We use this to illustrate that Broadcom also faces exposure as part of on-going litigation, through loss of patents, as well as through e.g. reputational harm due to assertion of many invalidated patents, which could impact its ability to negotiate future settlements or other patent licensing deals.

Figure 16
Broadcom's probability-weighted expected value, Stages 1-3, infringed

Stage 1	Stage 2		Stage 3		Broad-com's payoff	Proba-bility	Prob.-weighted payoff	Prob.-weighted ex-pected value
Infringed	1.00	Stay granted	0.11	Valid / Settle	0.55	876	0.06	51
				Invalid	0.45	-392	0.05	-19
		Stay declined	0.89	Settle		876	0.89	782

Note: € Millions
Source: Copenhagen Economics

If settlement does not occur prior to the court's decision in Stage 1, and VW Group is found to infringe and stay is declined, Broadcom's expected value will again change from the expected loss, depending on the courts' findings in as shown in Figure 17 below. In this case Broadcom's expected value increases to €876 million. This implies that Broadcom's willingness to accept a settlement value less than €876 million may have

changed with decisions on infringement. In other words, with respect to a single patent, Broadcom's settlement price likely increased as VW Group was found to infringe (assuming here its expectation of validity remained constant, for simplicity).

Figure 17
Broadcom's probability-weighted expected value, Stages 1-3, stay declined

Stage 1	Stage 2		Stage 3		Broad-com's payoff	Proba-bility	Prob.-weighted payoff	Prob.-weighted ex-pected value
Infringed	1.00	Stay declined	1.00	Settle	876	1.00	876	876

Note: € Millions
Source: Copenhagen Economics

However, we understand that certain of Broadcom's patents were in fact found not infringed before settlement was reached. As a result, the expected payoffs to Broadcom and VW Group may have developed over time. On the one hand, VW Group continues to face the threat of automatic injunction for each and every patent infringement claim. Thus, its exposure if enjoined

would remain unchanged (assuming a constant share of vehicles are alleged to infringe, probabilities, etc., as we illustrate above in the VW illustrations above). On the other hand, Broadcom may have adjusted its expected payoff.⁶⁶ If we assume, for simplicity, that Broadcom expected its payoff to be quartered due to the findings of non-

⁶⁶ For example, if Broadcom expects that it would not be able to collect damages of its amount of its initial claim, or if it expects its bargaining position is weakened. In either case, this would indicate a lower payoff relative to a situation where no patents were invalidated. (We note this

may also have affected VW Group's expectations, however as information is not perfect and complete, this information is less transparent.)

infringement of certain patents, and age of remaining patents, its probability weighted expected value would decrease to €189 million. This illustrates the sensitivity of the calculations, based on Broadcom's private information. While our results generally consider an individual patent assertion, given the number of cases filed, Broadcom likely also adjusted its expectations

over time, and with consideration of the different cases. Thus the price at which Broadcom would be willing to settle would likely have decreased over time in view of a) decisions that VW Group did not infringe select patents, and b) the continuation of validity proceedings, though the amount of the decrease is less transparent.⁶⁷

Figure 18
Broadcom's probability-weighted expected value, Stages 1-3, infringed, adjusted payoff to account for non-infringement of patents

Stage 1		Stage 2		Stage 3		Broadcom's payoff	Probability	Prob.-weighted payoff	Prob.-weighted expected value
Infringed	1.00	Stay granted	0.11	Valid / Settle	0.55	219	0.06	13	189
				Invalid	0.45	-392	0.05	-19	
		Stay declined	0.89	Settle		219	0.89	196	

Note: € Millions

Source: Copenhagen Economics

Sensitivity. This result relies on several conservative assumptions about Broadcom's payoffs at each terminal point, as described in detail above. If Broadcom's expected benefits decrease or if its exposure increases (i.e. its payoff decreases), then its probability-weighted expected value will also decrease.

If Broadcom had different expectations about the court findings, its probability-weighted expected values would also change. For example, if it expected a higher likelihood of infringement than that actual historical results in court, then its probability-weighted expected value will also increase.

As a result, it is possible that Broadcom expected VW Group to suffer an even more substantial loss

– which would indicate it may demand an even higher settlement price.

Estimated settlement range

Based on our estimations regarding VW Group and Broadcom payoffs under the German system, the settlement value may reasonably be in the range of approximately €189 million (based on Broadcom's payoff) to €876 million (based on VW Group's minimum loss, which represents a positive payoff to Broadcom under settlement). If the parties split the settlement range equally at 50/50, the settlement price would be approximately €533 million.⁶⁸

As explained in chapter 3, while both Broadcom and VW Group are exposed to risk in litigation and face constraints in the settlement amounts each can reasonably demand, it is VW Group's

⁶⁷ One or both parties may also adjust its expectations of litigation outcomes, in the remaining infringement proceedings, and as the validity proceedings unfold. For simplicity, we do not show such adjustments in our tables. In addition, each party will likely have different expectations of probabilities with respect to each asserted patent.

⁶⁸ The precise division would be based not only on each party's expected payoff, but also on the transparency of the expected payoffs, and the bargaining dynamics of the two parties. This equal division implicitly assumes complete and perfect information, and equal bargaining power once the decision to settle is made.

exposure that will inform the upper bound of settlement range. VW Group's exposure and thus its payoff under settlement is based on its end-product and is transparent to both it and Broadcom. While Broadcom's payoff may increase between sub-games due to infringement findings, it may in fact decrease between separate games, e.g. due to findings of non-infringement of some of its patents, the associated payoff is less transparent to VW Group.

3.3 Economic value of a patented invention

If the settlement price was approximately €533 million, could this also be consistent with the economic value of the patent that an injunction could be based upon, e.g. the EP 1 177 531 B1 ("EP 531") invention? While economic theory is sufficient to show that conceptually, this simply does not need to be the case, we consider whether the estimated settlement price could be supported based on the economic value of Broadcom's patent.

We have not undertaken a technical analysis, and rather illustrate how to isolate the value that could be attributable to the asserted Broadcom patent. We rather attempt to be conservative in Broadcom's favor, i.e. to avoid reducing the potential value. We estimate a range of values of the asserted patents.

First, we discuss the technology, including the patented inventions and their application to vehicles. Then, considering the two general frameworks for valuation,⁶⁹ we use the top-down, to evaluate EP 531. Finally, we compute the number of potentially infringing units for which VW and

As a result, the bargaining power is necessarily distorted to benefit Broadcom as plaintiff, because VW's probability-weighted expected value effectively anchors the upper limit. Broadcom's own exposure is less transparent to VW Group, and even if Broadcom considers the true economic value of the patented invention, Broadcom will be able to leverage its knowledge of VW Group's exposure to conclude a settlement.

Audi ought to compensate Broadcom. We use this to compute a price per vehicle, for discussion.

Technology. As explained briefly in chapter 3.1, the Broadcom patents relate generally to sub-parts within a vehicle such as the instrument cluster or infotainment unit. EP 531 relates to a graphics processing function within a chip that enables processing a plurality of texture portions in parallel.⁷⁰

The inventions claimed by EP 531 were allegedly implemented by GPU chipsets in certain instrument clusters and infotainment systems. These are sub-parts that may be built and designed in part by VW Group sub-suppliers, who source components and subcomponents from many other suppliers. The allegedly practicing sub-component products included the Nvidia Tegra 3.⁷¹ The estimated price per unit for such a sub-component product is, at most, \$25 per unit based on the previously published prices of the Nvidia Tegra 3 as of 2012.⁷² The component is

⁶⁹ See chapter 2.

⁷⁰ European Patent Office Patent Specification EP 1 177 531 B1.

⁷¹ Moreover, these are parts that VW and Audi and its suppliers have been developing for years, based on proprietary hardware and software. For example, Audi and Nvidia have been in partnership since the mid-2000s to develop a modular infotainment system. The project focused on "decoupling software from hardware development and cutting down the development time for a new system from as long as seven years to just one." PwC (2016). *Connected*

car report 2016 – Opportunities, risk and turmoil on the road to autonomous vehicles. Last accessed: 06 June 2019. Source: <https://www.strategyand.pwc.com/media/file/Connected-car-report-2016.pdf>;

⁷² Based on 2012 information from Nvidia, indicating that the price is higher than \$15 but not necessarily higher than \$25. Nvidia (2012). *Tegra 3 Set for Fast Start as Nvidia Reveals Results for Q3.* Last accessed: 06 June 2019. Source: https://web.archive.org/web/20120606100000/http://www.nvidia.com/object/tegra3_q3_2012.html

sold by Nvidia to at least four other VW Group suppliers.

Valuation. Using a top-down valuation methodology, we illustrate in general terms the categories of information needed to determine the value of a patent. We find that it is highly improbable that Broadcom's asserted patented inventions support an economic value of €533 million based on the estimated settlement range.

Top-down methodology. First, we summarize the steps of a top-down methodology. We provide a calculation based on the Nvidia chipset level in Table 4.

For some technologies in some industries, patents are licensed and evaluated based on their implementation within a chip.⁷³ In others, licensors may use a chipset or other unit as a metering device, but the technology rather contributes value beyond that which is contained in the chipset.⁷⁴ This illustration provides a range, to assess

whether the settlement value per vehicle could in fact be supported by the value of the EP 531 patented invention.

We walk through our computations here, as shown below: The current Nvidia Tegra 3 price is likely no more than \$25 per unit, or €21.83 (step a).⁷⁵ We then estimate operating profit based on Nvidia, to compute operating profit per unit (steps b and c). We assume that *all* profit is allocable to third-party technologies (steps d and e). We estimate a minimum number of patents implemented in each product, for illustration (step f). For Nvidia, we assume no less than 3,000 patents are implemented.⁷⁶ We then calculate the average operating result per patent, based on the estimated patents per unit (step g).

As shown below, even with conservative estimations, we estimate a range of value per chip of €0.0010 to 0.0013.

[chive.org/web/20120606080956/http://www.tegra3.org/tegra-3-set-for-fast-start-as-nvidia-announces-high-profits-for-q3/](http://www.techhive.org/web/20120606080956/http://www.tegra3.org/tegra-3-set-for-fast-start-as-nvidia-announces-high-profits-for-q3/) Generally, semiconductor component prices decline over time, and pricing information is very sensitive and thus not publicly disclosed.

⁷³ The Nvidia Tegra 3 implements at least 15 standards. Some of these are typically licensed at the chipset level and may be based on chipset price.

⁷⁴ An instrument cluster, which includes significantly more functionality, can be priced at several levels; because the accused functionality is included in the most basic models, we believe it is appropriate to consider the lower price range, as any additional features or functionality in the more advanced models must be the result of contributions made by e.g. Nvidia, Audi, Volkswagen, and/or other third-parties. However even a basic instrument cluster includes substantial features and functionality beyond the invention claimed in the EP 531. The price of instrument clusters and navigation systems vary and can range from €150 to €650 for example.

⁷⁵ Exchange rate of 31 Dec. 2018 (1.1450 EUR/USD). Source: ECB FX Rates.

⁷⁶ Based on the standards used by the Tegra3 chip:

- H.264-Standard, about 2400 SEPs (according to *Microsoft v. Motorola*).
- VC-1 Standard, about 500 SEPs according to MPEG-LA
- Open GLES, 38 Patents according to Khronos-Website

For other standards implemented by the Nvidia Chip include UART, I2S, SPDIF, VESA, DSI, ECC, HDMI, CSI, SD, JEDEC, ONFI, and DDR. We note that even within standards, determining the precise number of patents is difficult, due to declarations and expirations, as well as due to the implementation of any standard on any particular product.

However also based on our experience in semiconductor licensing and damages computations, the semiconductor company that designs or manufactures may implement several thousands of patents or more on their own products, including processing patents. This number could reasonably be over 10,000 patents for one semiconductor chip such as the Nvidia Tegra 3, not including standard essential patents and licensed third-party patents. See also for example, PatSnap, Source: <https://www.patsnap.com/resources/innovation/semiconductor-memory-chips>

Table 4
Top down illustration, for Nvidia Tegra 3

ROYALTY BEARING UNIT		ANALYSIS		NOTES AND SOURCES
Step:		Scenario A	Scenario B	
a	Price per unit (€)	21.83	21.83	
b	Operating profit margin	14.29%	17.50%	NVIDIA; Scen. A: 2012 TTM as of April 30 2012 (to align with the price estimate); Scen. B: FY 2016 (adjusted for unusual expenses,) just prior to Nvidia's newest product launches.
c	Operating profit per unit (€)	3.12	3.82	$c = b * a$
d	Maximum share of profit attributable to third-party technology	1	1	We conservatively assume 100% of profit is allocable to third-party technology; i.e. the seller does not retain any profit.
e	Maximum profit attributable to third-party technology (€)	3.12	3.82	$e = c * d$
f	Minimum number of third-party owned patents practiced by each product	3 000	3 000	We conservatively assume a low number of implemented patents in the Tegra 3t; however, at least 15 standards are implemented on the NVIDIA Tegra 3.
g	Average value per patent (€)	0.0010	0.0013	$g = e * f$; we assume all patents are of equal quality

Source: Copenhagen Economics; individual sources as listed. Values rounded.

Infringing units and total payment. To estimate the number of infringing units, we consider the infringement period and the frequency of implementation of the infringing feature.

We conservatively assume that the past five years of VW and Audi vehicle sales infringe, which includes about 28.15 million vehicles.⁷⁷ We then add another 6.91 million vehicles, based on the VW and Audi vehicles that are expected to be sold from 2019 to approximately April 2020⁷⁸ (i.e. that could otherwise infringe or be injuncted). We compute a total vehicle count of up to about 35.06 million vehicles for the period 2014 to April 2020.

We then include adjustments for the frequency of use for these features. As reported above, the frequency of infringement is approximately 64.15% at most, and may be 29.82%.

This implies a total payment of *at most* €28,644 for all allegedly infringing VW and Audi vehicles. *Even if* we assume all VW Group worldwide vehicle sales would be found to infringe, or that the parties simply wanted a global license for this individual patent, the total payment would be approximately €85,116 (rounded).

As a result, we do not find it plausible that the settlement range related to Broadcom's patent infringement claim in fact considered the value of its asserted patents.

⁷⁷ VW Annual Reports 2014-2018, page 23.

⁷⁸ Based on our understanding that the EP 531 patent will expire no later than May 3rd 2020, and assuming no

growth in VW and Audi vehicle sales from 2018, and assuming monthly sales equal to 2018.