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ARTICLE

ARE MARKET PRICES FOR PATENT LICENSES OBSERVABLE? EVIDENCE FROM 4G AND 5G LICENSING

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Despite the pervasiveness of patent licensing in many industries, there is a dearth of publicly available information on licensing transactions. Notably, information on price—i.e., the royalty agreed upon by licensor and licensee—is purposefully kept secret. We assess to what extent "market prices" on patent licenses are observable by assembling all publicly available information on royalty amounts associated with the licensing of 4G and 5G standard essential patents (SEPs). Our data come from a range of sources including court verdicts and litigation settlements, arbitration awards, public announcements, and published licensing agreements. We show that even for a highly visible technology such as mobile broadband, the available price points are few and far between. Moreover, any comparison of the available data points, let alone their aggregation, is extremely challenging due to largely unobservable heterogeneity in the terms and scope of the underlying licensing agreements. Our results point to a lack of transparency in the market for patent licensing that might adversely affect market participants and competition more broadly.

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I. INTRODUCTION

Many scholars have analogized patent rights to land, securities, commodities, and other forms of property with readily observable market prices.[1] Patent law itself also incorporates the notion that licensed patents have a market royalty rate. Rules for calculating damages have long called for consideration of whether prior licenses of the infringed patent reveal "an established royalty,"[2] and courts

[1] *See, e.g.*, Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265, 271–75 (1977) (analogizing patent rights to "mineral claims" held by prospectors); Richard A. Epstein, *The Disintegration of Intellectual Property: A Classical Liberal Response to a Premature Obituary*, 62 STAN. L. REV. 455, 456 (2010) (arguing "that the understandings of property law that have developed in connection with the traditional forms of tangible property can be carried over to intangible property," such as patents and copyrights); Michael Risch, *Patent Portfolios as Securities*, 63 DUKE L.J. 89, 89 (2013) ("This Article . . . propos[es] that patent portfolios be treated as securities.").

[2] Georgia-Pac. Corp. v. U.S. Plywood Corp., 318 F. Supp. 1116, 1120 (S.D.N.Y. 1970) (setting forth what has become known as the *Georgia-Pacific* factors). For a discussion of similar frameworks used by courts in other countries, see THOMAS F. COTTER, COMPARATIVE PATENT REMEDIES: A LEGAL AND ECONOMIC ANALYSIS 268, 321–22 (Oxford Univ. Press 2013).

regularly allow litigants to introduce evidence of "comparable licenses" of other, similar patents which may also shed light on "the market's actual valuation" of the patented technology.[3] Competition law likewise presumes that patent licenses have market prices. Resolution of a claim that a standard-essential patent (SEP) licensor breached "fair, reasonable, and non-discriminatory" (FRAND) licensing commitments, for example, typically involves the synthesis of prior, comparable licenses into an objectively FRAND royalty for the SEPs at issue.[4] In short, the concept of "market prices" for patent licenses—i.e., relatively deterministic royalty rates or amounts that reflect prior market activity—is well ingrained in both patent and competition law and policy.[5]

However, there are at least two reasons to doubt that the patent licensing industry actually matches this ideal. First, markets for tangible property (the markets for used cars and residential real estate, for example) involve products with readily observable characteristics (mileage, condition, square footage, and the like) that drive value. Given the intangible and inherently "fuzzy" or "probabilistic" nature of patent rights,[6] it is not clear that markets for run-of-the-mill, tangible property offer an apt comparison. Instead, markets for assets with significant intangible components, which are commonly characterized

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[3] Commonwealth Sci. & Indus. Rsch. Org. v. Cisco Sys., Inc., 809 F.3d 1295, 1303 (Fed. Cir. 2015). Courts in other countries generally agree. *See* COTTER, *supra*, at 268, 321–22.

[4] *See, e.g.*, TCL Comm. Tech. Holdings Ltd. v. Telefonaktiebolaget LM Ericsson, No. 8:14-cv-341, 2018 WL 4488286 (C.D. Cal. Sept. 14, 2018) (determining FRAND rates for Ericsson's portfolios of 2G, 3G, and 4G cellular SEPs), *vacated*, 943 F.3d 1360 (Fed. Cir. 2019); Unwired Planet Intl. Ltd. v. Huawei Tech. (UK) Co., No. [2017] EWHC 711 (Pat) (determining FRAND rates for Unwired Planet's portfolio of 2G, 3G, and 4G cellular SEPs); Microsoft Corp. v. Motorola, Inc., No. 10-cv-1823, 2013 WL 2111217 (W.D. Wash. Apr. 25, 2013) (determining FRAND rates for Motorola's portfolios of Wi-Fi and H.264 video compression SEPs).

[5] As we use the term in this paper, "market price" refers to the royalty that a licensor and licensee are expected (on the basis of prior, relevant market activity) to agree to in a negotiation for a license to one or more patents in a particular context. To be clear, this definition is distinct from an *average aggregate* royalty burden (aggregated across all patents related to some technology category and/or across all participants in some market). In the specific context of wireless communication SEP licensing in the smartphone market, average aggregate royalties arguably may be estimated using public information. *See* Gregory J. Sidak, *What Aggregate Royalty Do Manufacturers of Mobile Phones Pay to License Standard-Essential Patents?*, 1 CRITERION J. INNOV. 701, 702 (2016) (estimating that "the aggregate SEP royalty that implementers paid in 2013 and 2014 was between 4 and 5 percent of global handset revenues for handsets practicing the 3G and 4G standards"); Alexander Galetovic, Stephen Haber, & Lew Zaretzki, *An Estimate of the Average Cumulative Royalty Yield in the World Mobile Phone Industry: Theory, Measurement and Results*, 42 TELECOMM. POL'Y 263, 266 (2018) (estimating that the "average cumulative royalty yield [in 2016] was $7.20 per phone, or 3.3 percent of the average selling price of the average phone").

[6] *See* Mark A. Lemley & Carl Shapiro, *Probabilistic Patents*, 19 J. ECON. PERSP. 75, 95 (2005) (explaining that patents should be viewed as "probabilistic rights" given the uncertain nature of their value, validity, and scope).

by substantial search costs and price dispersion, may be a better conceptual fit.[7] Second, descriptive studies of the patent licensing industry suggest that the market operates in a near vacuum of public pricing information.[8] According to these accounts, license agreements are virtually always negotiated on a confidential basis between parties that strongly prefer to maintain the secrecy of licenses and their terms.[9] If the patent marketplace indeed exhibits a high degree of price dispersion and confidentiality, it may well lack observable market prices, which may in turn have implications for competition law, patent law, and related literatures.

To shed light on the availability of pricing information in the patent licensing market, we examine the market for "fourth generation" and "fifth generation" (4G and 5G) mobile broadband standard-essential patent (SEP) licenses.[10] We choose this market segment due to several unique characteristics that make it unusually likely to produce and reveal "market prices." Compared to the patent licensing market as a whole, the SEP licensing sector features: (i) relatively sophisticated licensors (ii) that hold relatively well-defined patent portfolios, (iii) which they

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[7] Consider, for example, the primary market for contemporary art, which (much like the patent licensing market) features a low level of price transparency and high degree of price dispersion. *See, e.g.*, Canice Prendergast, *The Distribution of Contemporary Art*, 2 PORTABLE GRAY 263, 265–68 (2019) (discussing pricing of contemporary art and reporting, *inter alia*, that "art prices . . . . are almost never publicly advertised"); Juan Prieto-Rodriguez & Marliena Vecco, *Reading Between the Lines in the Art Market: Lack of Transparency and Price Heterogeneity as an Indicator of Multiple Equilibria*, 102 ECON. MODELLING at *1 (forthcoming 2022) (noting that "the art market has been characterized by its lack of transparency," with "data regarding gallery sales and private deals . . . mostly impossible for outsiders to find," leading to "prices that . . . present a very high dispersion").

[8] *See* Mark A. Lemley & Nathan Myhrvold, *How to Make a Patent Market*, 36 HOFSTRA L. REV. 257, 257 (2007) (characterizing the market for patent licenses as "a blind market" in which "the terms of [patent] licenses, including the price itself, [are] almost invariably . . . confidential"); Anne Kelley, *Practicing in the Patent Marketplace*,78 U. CHI. L. REV. 115, 130 n.82 (2011) ("The vast majority of IP licenses and technology sales occur on confidential bases, except where the provisions are material for the purposes of securities laws or where there is some related court adjudication. Indeed, confidentiality is often highly negotiated between the parties."); Andre Hagiu & David B. Yoffie, *The New Patent Intermediaries: Platforms, Defensive Aggregators, and Super-Aggregators*, 27 J. ECON. PERSP. 45, 46 (2013) (noting that patent buyers and sellers "usually negotiate under enormous uncertainty" because "prices of similar patents vary widely from transaction to transaction and the terms of the transactions (including prices) are often secret and confidential").

[9] In addition to vigorously protecting the confidentiality of their own prior licenses, market participants have even been known to support their bitterest foes' efforts to do the same. Consider, for example, Uniloc USA, Inc. v. Apple, Inc., a U.S. patent suit in which both the licensor (Uniloc) and prospective licensee (Apple) joined forces to oppose the court's (rare) decision not to seal a collection of 109 Uniloc patent licenses that were requested by Apple in the course of discovery. 508 F. Supp. 3d 550 (N.D. Cal. 2020), rev'd 25 F.4th 1018 (Fed. Cir. 2022).

[10] For a detailed overview of mobile networking technologies, see, e.g., MARTIN SAUTER, FROM GSM TO LTE-ADVANCED PRO AND 5G: AN INTRODUCTION TO MOBILE NETWORKS AND MOBILE BROADBAND (4th ed. 2021).

are obligated to—and repeatedly do—license (iv) on "non-discriminatory" terms (v) to companies that produce relatively homogeneous products with well-defined technological capabilities.[11] Moreover, among SEP licensing markets, the market for licensing mobile broadband SEPs presents what can fairly be described as a best case scenario (under current market conditions, that is) for the collection of public licensing data. In recent years, this area has seen a large number of high profile litigations across the globe—battles in the so-called "smartphone patent wars"—including a large number of high profile trials and court decisions, which generated an unusually rich stream of public information.[12] In addition, most major players in this licensing market are publicly traded companies, including several of the most active non-practicing entities (NPEs), which are virtually always privately held in other licensing segments.[13] This, combined with the fact that many licenses are relatively large in magnitude (given the immense size and profitability of the smartphone market[14]), increases the likelihood that financial disclosures required by securities law will reveal at least some licensing information that otherwise would remain hidden from public view.[15] In short, if market prices fail to emerge in the mobile broadband SEP licensing market, it seems quite likely that most other patent licensing sectors lack them as well.

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[11] Technology standards are typically developed by standard-setting organizations comprised of market incumbents, all of which commit ex ante to (1) publicly disclose any patent rights they hold that are "essential" to implement the standard, and (2) license those rights on "fair, reasonable, and non-discriminatory" (FRAND) terms, meaning that they must license all market players and do so in exchange for similar, reasonable royalties. For an overview of how patent rights are handled in the standard-setting context, see Jorge Contreras, *Technical Standards, Standards-Setting Organizations and Intellectual Property: A Survey of the Literature*, *in* 2 RESEARCH HANDBOOK ON THE ECONOMICS OF INTELLECTUAL PROPERTY LAW 185 (Peter S. Menell & David Schwartz eds., Edward Elgar 2019) (summarizing the relevant literature).

[12] Since 2010, many hundreds (if not thousands) of U.S. patent suits have alleged infringement by smartphone manufacturers. *See* Ronald A. Cass, *Lessons from the Smartphone Wars: Patent Litigants, Patent Quality, and Software*, 16 MINN. J.L. SCI. & TECH 1, 5 (2015) (noting that "[h]undreds of cases involving the major producers of [smartphones] have been filed in the courts and with the U.S. International Trade Commission," including "scores of claims" litigated just between Apple and Samsung). *See also Smartphone Patent Wars Explained*, PCMag.com, Jan. 19, 2012 (depicting the web of major patent litigation among smartphone manufacturers and SEP licensors filed Jan. 2010 to Jan. 2012).

[13] Publicly traded non-practicing entities (sometimes referred to as "Public IP Licensing Companies" or PIPCOs) that enforce mobile broadband SEPs include: InterDigital, Unwired Planet, Vringo, and WiLAN. Other PIPCOs that license SEPs include Acacia, Marathon Patent Group, Rambus, VirnetX, and Xperi. *See, e.g.*, Galetovic et al., *supra* note 5, at 275, tbl. A1.

[14] Here and throughout, all references to "smartphones" should be read to include other 4G and 5G enabled end user communication devices, i.e., tablets, "phablets," smartwatches, and the like.

[15] As discussed in greater detail *infra*, public companies are required to disclose all facts that are "material" to their finances, which can include information on patent licenses and litigation settlements. *See* Robert S. Thomas, *The Materiality Standard for Intellectual Property Disclosures*, 42 IDEA 205, 225 (2002).

We collect all publicly available information concerning 4G and 5G mobile broadband SEP licensing, including: royalty rates announced or otherwise demanded by licensors; licenses, settlements, and arbitration outcomes that became public though financial disclosures or as a result of litigation; and court rulings. We explain how we collected this data and what specific data are (and are not) available. We then explore to what extent the available data allows us to infer market prices for 4G and 5G SEP licenses.[16]

Overall, our results suggest that confidentiality is widespread and effective in this market sector. Despite an exhaustive search, we were able to uncover relatively few publicly available price points for 4G and 5G SEP licenses.[17] Moreover, despite a relatively high rate of litigation and participation by publicly traded firms, the royalty information that we do uncover is frequently incomplete and, importantly, lacks the context necessary for reliable analysis and synthesis. In addition, to the extent that our data points are actually comparable, our results are indicative of substantial heterogeneity in royalty structures and amounts, as well as with respect to licenses' technological and geographic scope. Even among licenses granted by the same patentee in the same context, we observe substantial variation that cannot be accounted for with available data. Accordingly, despite the existence of FRAND licensing commitments, our data suggests a high level of price dispersion, perhaps as a result of opportunistic behaviors, differences in bargaining power, and other unobservable factors. While some level of royalty variation is to be expected (even among FRAND-compliant licenses negotiated within the same general product market[18]) given heterogeneity in the parties, technology, market scope, use cases, and patents involved, our findings suggest that the available information is unlikely to fully explain the observed differences among publicly available royalties.

Given the level of confidentiality and price variation indicated by our data, we conclude with a brief assessment of potential implications. Perhaps most importantly from a policy perspective, our results suggest that experienced incumbents are advantaged in patent licensing markets to the extent that they

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[16] To be clear, our goal is not to determine whether observed licensing prices are indeed FRAND. Our goal is more modest: we simply ask whether it is *even feasible* to infer market prices for 4G and 5G SEP licenses based on publicly available information.

[17] Experienced market participants may have additional *private* information (not available to us or the general public) that allows them to gauge market prices for some subset of standard essential patent or portfolio licenses. However, our focus is (as it necessarily must be) on whether the *public* information available to market entrants, policymakers, regulators, and other market observers is sufficient to reveal market prices.

[18] While a FRAND commitment naturally limits a licensor's ability to price discriminate, it is generally accepted that it does not require perfectly uniform pricing. *See* Jorge Contreras, *A Brief History of FRAND: Analyzing Current Debates in Standard Setting and Antitrust Through a Historical Lens*, 80 ANTITRUST L.J. 39, 78 (2015) (reporting that "[m]ost commentators agree that 'non-discriminatory' does not mean that all licenses must be granted on identical terms").

possess private information gleaned from prior transactions and thus need not rely exclusively on the sparse public record. Our results may also suggest that confidentiality and price dispersion can be contributing factors to opportunistic behaviors like "holdup" and "holdout," both of which leverage (at least to some extent) information asymmetries about what royalty rates actually (or should) prevail in the market.[19] Finally, our results call for further theoretical and empirical study of the patent licensing market. While there exists an extensive theoretical literature on the impact of information and its strategic revelation on bilateral bargaining in the context of patent licensing, this literature focuses on the role of private information on bargaining *prior* to reaching an agreement.[20] To date, there has been no analysis of the incentives that both licensor and licensee have to disclose information *after* an agreement has been reached, nor of the impact that secrecy has on the licensing market and innovation more broadly. In addition, little empirical analysis of patent licensing markets has been attempted, and what few empirical studies exist both rely on confidential datasets and fail to consider what effect a lack of public price information may have on observed royalties agreed upon by different types of market participants.[21]

The remainder of this article is organized as follows. Part II briefly summarizes available sources of public patent licensing information. Part III explains our methodology for collecting 4G and 5G patent licensing data and presents what little information we were able to uncover. Part IV discusses major challenges that make it practically impossible to synthesize the data that we collected into market prices, and Part V discusses the implications of our conclusion that market prices appear not to exist in this context.

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[19] For an overview and empirical analysis of holdup and holdout, see generally Brian J. Love, Yassine Lefouili, & Christian Helmers, *Do Standard-Essential Patent Owners Behave Opportunistically? Evidence from U.S. District Court Dockets* (2021) (unpublished working paper), *available at* https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3727085 [https://perma.cc/T7JA-3XHQ]; Brian J. Love & Christian Helmers, *An Empirical Test of Patent Hold-Out Theory: Evidence from Litigation of Standard Essential Patents* 13–14 (2021) (unpublished working paper), *available at* https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3950060 [https://perma.cc/J5R2-UQZG].

[20] *See, e.g.*, Nancy T. Gallini & Brian D. Wright, *Technology Transfer under Asymmetric Information*, 21 RAND J. ECON. 147, 148 (1990) (presenting a model of patent licensing in which the prospective patent licensor can reveal to prospective licensees private information about the value of the patent technology); A. W. Beggs, *The Licensing of Patents Under Asymmetric Information*, 10 INT'L J. INDUS. ORG. 171, 171–72 (1992) (presenting a model of patent licensing in which the prospective patent licensee may reveal private information concerning patent value to prospective patent licensors); Ana Mauleon, Vincent Vannetelbosch, & Cecilia Vergari, *Bargaining and Delay in Patent Licensing*, 9 INT'L J. ECON. THEORY 279, 281 (2013) (presenting a model of patent licensing in which both prospective licensors and licensees may reveal private information).

[21] *See, e.g.*, Mariko Sakakibara, *An Empirical Analysis of Pricing in Patent Licensing Contracts*, 19 INDUS. & CORP. CHANGE 279 (2010) (analyzing a set of 661 Japanese patent licenses executed between 1998 and 2003 with assistance from a particular market intermediary).

II. SOURCES OF PUBLIC LICENSING INFORMATION

While it is widely reported that commitments of confidentiality are almost uniformly sought and obtained during the process of negotiating patent licenses, there are nonetheless several avenues through which licensing details may become public knowledge.[22] The most important of these mechanisms are litigation, mandatory financial disclosures, and voluntary strategic disclosures.

A. Litigation

The richest source of licensing information is court dockets. Court proceedings are public affairs that aggregate a great deal of presumptively public information about the litigants and their dispute.[23] Throughout the various milestones of a patent suit, there are a variety of opportunities for previously confidential information to slip into the public sphere. Particularly in the context of SEP suits that involve counterclaims rooted in competition law, a prospective licensee (or even licensor) may reveal in its pleadings at least some details of the parties' licensing negotiations, including royalty rates or amounts that were proposed prior to litigation.[24] Provided that a case continues to progress beyond the pleading stage, discovery offers yet another opportunity for the aggregation of otherwise confidential licensing details. Parties can obtain from each other confidential documents and other evidence related to prior licenses, and may additionally be able to obtain the same from third parties.[25] At the conclusion of fact discovery, dueling expert witnesses hired by each party will typically filter, summarize, and analyze licensing information in "expert reports" that reveal the damages-related arguments and positions that the respective parties' anticipate advancing if the case proceeds to trial.[26] At trial, licensing information will arise

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[22] *See* Mark R. Patterson, *Confidentiality in Patent Dispute Resolution: Antitrust Implications*, 93 WASH. L. REV. 827, 841–850 (2018) (summarizing a number of avenues through which otherwise confidential license details may become public, including civil litigation, arbitration, and voluntary disclosure); Lemey & Myhrvold, *supra* note 8, at 258 (explaining that "the law already requires patent owners to disclose their license terms in a few circumstances," including when "pharmaceutical companies settle with a generic competitor" and when "the transaction is large enough that it is material to the bottom line of a publicly-traded company").

[23] *See, e.g.*, U.S. v. McVeigh, 119 F.3d 806, 811 (10th Cir. 1997) ("It is clearly established that court documents are covered by a common law right of access" according to which "judicial documents are presumptively available to the public." (citing Nixon v. Warner Communications, 435 U.S. 589, 599, 602 (1978))).

[24] *See* Love & Helmers, *supra* note 19, at xiii-xvi, app. D (providing several examples).

[25] For a summary of the discoverability and admissibility of prior settlements and licenses, see Patterson, *supra* note 22, at 842–48 (summarizing relevant U.S. law); Peter Georg Picht, *Confidentiality in SEP/FRAND Cases: A Critical Overview of the Recent Legal Developments*, Max Planck Institute for Innovation & Competition Research Paper No. 19-08 8-14 (2019) (summarizing the relevant legal rules in the UK, France, and Germany).

[26] *See, e.g.*, Thomson Reuters Practical Law, *Patent Litigation: Damages Expert Report* (Patent Owner), https://us.practicallaw.thomsonreuters.com/w-007-8894?view=hidealldrafting

again in expert witnesses' testimony, and following trial, jury verdicts and court decisions—e.g., rulings that award infringement damages, determine FRAND rates, or scrutinize damages-related evidence presented at trial—provide another potential opportunity for licensing details to emerge.[27]

While it is true that confidential licensing information collected and used in the course of litigation is likely to be nominally shielded from the public's view by protective orders and serial requests to seal or redact court filings,[28] such protections are not absolute. In the U.S. at least, courts have wide discretion to handle such matters as they wish and not all judges grant requests to seal with a rubber stamp.[29] In addition, unless a court filing is completely sealed, and thus removed entirely from public view, a sealed document will eventually become available to the public in redacted form. Depending on the extent to which redactions are made, important partial information may still be intentionally or inadvertently revealed to the public.[30] In addition, some information simply cannot be sealed given the inherently public nature of court systems. The amount of damages awarded at trial are always released to the public, and courts are particularly reluctant to heavily redact their own rulings because those rulings thereafter become precedent on which future litigants and courts are expected to rely.

In addition to traditional patent infringement litigation—or, in the SEP context, litigation to determine FRAND rates—confidential licensing information also plays a major role in other adversarial proceedings from which it may emerge. Particularly in the context of disputes concerning amounts owed under existing licensing agreements, licensors and licensees may opt to engage in private arbitration, rather than public court proceedings.[31] Arbitrations commonly resemble court proceedings in many respects and, for example, may similarly involve the exchange of confidential information, the use of expert witnesses, and

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notes [https://perma.cc/AY9X-LVEZ] (last accessed Sept. 8, 2022) (providing a "model damages expert report on behalf of a patent owner in a patent litigation").

[27] *See infra* Table 1.

[28] *See* Uniloc USA, Inc. v. Apple, Inc., 25 F.4th 1018, 1022–23 (Fed. Cir. 2022) (explaining that information concerning patent licenses generally may be sealed on the grounds that it constitutes a trade secret).

[29] *See* Bernard Chao, *Not So Confidential: A Call for Restraint in Sealing Court Records*, PATENTLY-O PATENT L.J. 6, 7–10 (2011) (discussing a number of cases litigated across districts with large patent caseloads).

[30] *See* Richard A.H. Vary, *Arbitration of FRAND Disputes in SEP Licensing*, *in* THE GUIDE TO IP ARBITRATION (John V.H. Pierce & Pierre-Yves Gunter, eds., 2021) ("[E]ven with confidentiality measures in place, there have been leaks of confidential information from court proceedings. Bloggers have tweeted royalty rates from hearings . . . . [and c]ourts have inadvertently released information in judgments. This can be because . . . it is possible . . . to reverse-engineer the redactions . . . . [o]r it may simply result from a mistake . . . .").

[31] *Id.* (providing an overview of the use of arbitration to set FRAND royalty rates for SEP patent portfolios).

detailed written decisions issued by arbitrators, who are typically former judges.[32] While arbitrations provide a much higher degree of secrecy than court proceedings—indeed, secrecy is a central reason for their appeal—arbitration outcomes are occasionally revealed in, or may be inferred from, publicly traded companies' financial disclosures.[33] More directly, arbitrations themselves occasionally spill over into collateral court proceedings initiated to challenge or enforce arbitration awards.[34]

Finally, because sharp practices involving patent rights (and especially SEPs) may draw scrutiny from competition law authorities, licensors are from time to time ensnared in competition law enforcement activities, during the course of which they may be compelled to disclose details of their licensing histories.[35] In turn, agency communications concerning these investigations, including announcements of agreed resolutions, or court rulings vindicating or rejecting authorities' allegations of misconduct, may reveal previously confidential licensing information.[36]

B. Financial Disclosures

Mandatory financial disclosures are another widely used source of public licensing information. By law, publicly traded firms must make periodic financial disclosures to the public. Under U.S. law, for example, publicly traded companies must release quarterly and annual financial reports and, more generally, are required to disclose all facts that are "material" to their finances,[37] which can include notices regarding patent licenses and litigation outcomes and settlements, particularly when patent royalties constitute a significant portion (if not the entirety) of a company's revenue stream.[38] While such disclosures rarely involve

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[32] *Id.*

[33] *See, e.g.*, Jussi Rosendahl & Tuomas Forsell, *Nokia Posts Weak Network Profits, Sees Market Decline in 2018*, Reuters (Oct. 26, 2017) (reporting based on Nokia's financial disclosures "a one-off payment of 180 million euros from a settled patent arbitration with LG").

[34] *See generally* THE GUIDE TO CHALLENGING AND ENFORCING ARBITRATION AWARDS (J. William Rowley ed., 2021).

[35] *See, e.g.*, FTC v. Qualcomm, Inc., 411 F. Supp. 3d 658, 697–751 (N.D. Cal. 2019), *rev'd* 969 F.3d 974 (9th Cir. 2020) (summarizing in great detail Qualcomm's modem chip licensing practices with respect to more than a dozen (actual and potential) licensees 2006-2016).

[36] *Id. See also* China National Development & Reform Commission, Administrative Sanction Decision No. 1 [2015] (Feb. 9, 2015) (announcing antitrust sanctions against Qualcomm); Press Release, Korea Fair Trade Commission, Strict Sanctions on Qualcomm's Abuse of Cellular SEPs 13 (Dec. 28, 2016) (same), *available at* https://www.qualcomm.com/content/dam/qcomm-martech/dm-assets/documents/kftc_issued_press_release_dated_december_28-2016-unofficial_english_translation.pdf [https://perma.cc/M7B7-EP67].

[37] SEC Rule 10b-5, 17 C.F.R. § 240.10b-5.

[38] *See* Thomas, *supra* note 15, at 225 (explaining that "[w]hether detailed information concerning a company's patent is considered material may depend on the company's level of financial dependence on the patent;" for example, "[i]f the corporation's principle revenue producer is a patent, the information will almost always be considered material").

the wholesale dissemination of complete agreements, securities filings commonly report at least quarterly and annual licensing revenue totals and frequently further apportion those revenues across technologies or licensees.[39] Particularly when combined with other public information—such as a licensees' sales statistics or earning calls, and licensors' press releases announcing the consummation of new licenses and the time periods which they span—lump sum figures may in fact reveal enough information to allow the public to reverse engineer at least approximate royalty amounts or rates for individual licenses.

C. Voluntary Disclosures

In addition to mandatory securities filings, patent licensors sometimes disclose relevant information on a more ad hoc, if not also truly voluntary, basis. For example, licensors commonly issue press releases announcing the execution of license agreements, particularly when those agreements have impressive licensees or royalty amounts attached.[40] While these announcements often include exceedingly few details or do little more than presage information that will later appear in a financial report, this is not always the case, and such releases can be a source of additional, more granular information even for publicly traded licensors.

Licensors have also been known to unilaterally disclose not just ex post licenses, but also ex ante royalty expectations. In the context of SEP licensing, and mobile broadband SEP licensing in particular, this practice appears to be an emerging routine, with no fewer than nine licensors announcing expected royalty rates for 4G SEPs between 2008 and 2009,[41] and more recently no fewer than four (Ericsson, Nokia, Qualcomm, and InterDigital) making similar announcements for 5G SEPs.[42] Relatedly, many patent "pools"—i.e., organizations formed to license a portfolio of technology-specific patents contributed by multiple, independent patent owners—disclose royalty rates, and often even sample licensing agreements, on their websites.[43] While enhancing the efficiency of

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[39] *See, e.g.*, InterDigital, Annual Report 2020 10, 49 (2020) (reporting that "Apple, Samsung and Huawei comprised approximately 31%, 22% and 15% of our total 2020 revenues, respectively").

[40] *See, e.g.*, Press Release, InterDigital, Inc., InterDigital Announces Patent License Agreement with Samsung (June 3, 2014).

[41] Eric Stasik, *Royalty Rates and Licensing Strategies For Essential Patents on LTE(4G) Telecommunication Standards*, XLV LES NOUVELLES 114, 116, tbl 1 (2010) (reporting royalty rates published by Alcatel-Lucent, Ericsson, Huawei, Motorola, Nokia Corp., Nokia Siemens, Nortel, Qualcomm, and ZTE); *see also* Table 3 below.

[42] Eric Stasik & David Cohen, *Royalty Rates and Licensing Strategies for Essential Patents on 5G Telecommunication Standards: What to Expect*, LV LES NOUVELLES 176, 180, tbl. 2 (2020); *see also* Table 3 below.

[43] *See, e.g.*, *Mobile Communication Platform: License Terms*, Sisvel, https://www.sisvel.com/licensing-programs/wireless-communications/mcp/license-terms [https://perma.cc/AC9B-FD6Y] (last visited Nov. 16, 2021); *LTE License Fees*, Via Licensing,

future licensing may play a role in these disclosures, it seems reasonable to assume that strategic considerations are at play as well. Among other factors, announced royalties may represent an effort to artificially inflate future royalties by "anchoring" the market to rates that, in reality, are "aspirational" at best and diverge significantly from actual license agreements.[44]

III. 4G AND 5G SEP LICENSING DATA

To assemble public information about the market for 4G and 5G SEP licensing, we searched domestic and foreign databases of the sources introduced above. Here, and with greater specificity in Tables 1-4, we summarize what information we were able to uncover and where we found it.

A. Search Methodology

To collect mobile broadband SEP licensing information disclosed in the course of litigation, we began by reviewing the public court dockets of all U.S. suits filed 2010-2019 to enforce or challenge at least one patent with a family member that was declared essential to the standards covered by sixteen SSOs included in the Searle SEP database.[45] In the process, we identified all cases concerning mobile broadband technology and, for each of those cases, reviewed all court filings that might plausibly reveal licensing data, including: all pleadings, all discovery-related motions and rulings, all motions and rulings concerning expert witness reports, all jury and bench verdicts, and post-trial motions and rulings (including motions for a new trial on damages and motions for ongoing royalties), as well as all appeals of any relevant rulings.

To locate information disclosed in the context of litigation outside the U.S., we searched all (official and unofficial) collections of foreign court rulings and

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https://www.via-corp.com/licensing/long-term-evolution-lte/lte-license-fees/ [https://perma.cc/9FS S-VA2J] (last visited Oct. 28, 2021).

[44] *See* Stasik, *supra* note 41, at 116–17 ("[A]n 'announced' royalty rate may be significantly different than the 'actual' royalty rate resulting from a bi-lateral negotiation. Having made a public announcement, a potential licensee might reasonably expect this to be the opening offer in a negotiation. That is all that should be assumed from these announcements."). Relatedly, it has also been suggested that licensors sometimes collude with early licensees to structure their licenses so that they incorporate inflated royalty rates (off-set, for example, by deflated royalty bases) so that these artificial rates can be strategically disclosed in later negotiations or litigation. *See* Jonathan S. Masur, *The Use and Misuse of Patent Licenses*, 110 NW. L. REV. 115, 142–44 (2015).

[45] For details regarding the construction of our database of declared SEP cases, *see* Brian J. Love & Christian Helmers, An Empirical Test of Patent Hold-Out Theory: Evidence from Litigation of Standard Essential Patents 13–14 (2021) (unpublished working paper). For information on the Searle SEP database, see generally Justus Baron & Daniel F. Spulber, *Technology Standards and Standard Setting Organizations: Introduction to the Searle Center Database*, 27 J. ECON. & MGMT. STRATEGY 462 (2018); Justus Baron & Tim Pohlmann, *Mapping Standards to Patents using Declarations of Standard-Essential Patents*, 27 J. ECON. & MGMT. STRATEGY 504 (2018).

filings of which we are aware. Among others, we searched BAILII to locate relevant decisions issued in England and Wales,[46] as well as the websites of German Regional Courts,[47] the District Court and Court of Appeals of The Hague,[48] the Paris Court of Appeal,[49] and the 4iP Council to locate relevant rulings made in Germany, the Netherlands, France, and other jurisdictions.[50]

In addition to court filings and rulings, we made extensive efforts to locate all other public information that might directly or indirectly reveal relevant quantitative data. To locate information disclosed in press releases or media reports, we searched LexisNexis' "News" and "Legal News" databases for reports of licenses, settlements, and arbitration decisions involving all (currently and formerly) active mobile broadband SEP licensors. We also visited both current and prior[51] versions of all mobile broadband SEP licensors' webpages to search for additional press releases, white papers, or other public "statements" to the media, as well as all current and prior mobile broadband royalty rates and sample licensing agreements that were made available to the public. Further, we collected and reviewed annual and quarterly reports for all publicly traded mobile broadband SEP licensors, and when available, additionally reviewed transcripts or summaries of earnings calls,[52] as well as related commentary from stock market analysts.[53]

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[46] BRITISH AND IRISH LEGAL INFORMATION INSTITUTE, https://www.bailii.org/ [https://perma.cc/D287-6LMJ] (last accessed Sept. 6, 2022).

[47] *See, e.g.*, Landgericht Mannheim, https://landgericht-mannheim.justiz-bw.de/pb/,Lde/1168387 [https://perma.cc/9EL3-QWF9] (last accessed Sept. 8, 2022).

[48] DE RECHTSPRAAK, https://www.rechtspraak.nl/ [https://perma.cc/2XN5-SUAN] (last accessed Sept. 8, 2022).

[49] Cour d'appel de Paris, https://www.cours-appel.justice.fr/paris [https://perma.cc/7HHX-ADEG] (last accessed Sept. 8, 2022).

[50] 4iP Council, CASE LAW POST CJEU RULING HUAWEI V ZTE, https://caselaw.4ipcouncil.com/ [https://perma.cc/5DXQ-XYNM] (last accessed Sept. 6, 2022).

[51] We accessed archived versions of licensors' webpages using the Internet Archive's WayBackMachine. Internet Archive, WayBackMachine, https://web.archive.org/ [https://perma.cc/PF6N-WEPS] (last accessed Sept. 6, 2022).

[52] *See, e.g.*, Transcript of Qualcomm Q3 2020 Earnings Call 3 (July 29, 2020) ("'We recently signed a new long-term global patent license agreement with Huawei, including a cross-license, granting back rights to certain of Huawei's patents. We also entered into an agreement settling amounts due under the prior license agreement.'" (quoting Steven M. Mollenkopf, CEO, Qualcomm)).

[53] *See, e.g.*, Jonathan Ratner, *Wi-LAN Shares Soar on Samsung Deal Renewal*, Financial Post (June 21, 2013), https://financialpost.com/investing/trading-desk/wilan-shares-soar-on-samsung-deal-renewal [https://perma.cc/E9FU-YGAU] ("No terms of the agreement were disclosed, but analysts said . . . it could be for more than five years [in duration] . . . [and] the annual revenue potential from Samsung is between $15-million and $20-million for Wi-LAN.").

As a final check, we exhaustively reviewed prior efforts in the literature to collect similar data,[54] as well as the archives of IP law media outlets and blogs with a focus on patent remedies, SEPs, or important foreign jurisdictions for patent litigation (including China, Japan, and India),[55] to ensure that our data included all information previously referenced by researchers, legal practitioners, and other industry observers.

B. Results

A summary of the data that we aggregated is presented below in Tables 1-4. Tables 1 and 2 present third party adjudications of 4G SEP royalties by courts and arbitrators, respectively.[56] Table 3 presents data on public royalty announcements and negotiation demands by 4G and 5G SEP licensors, and Table 4 aggregates royalty information drawn from licenses and litigation settlements involving 4G and 5G SEPs. When interpreting and comparing the observable data reported in Tables 1-4, it is important to keep in mind the different contexts in which each type of information was generated and the different circumstances under which it was disclosed. Here, we briefly describe the data reported in each table.

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[54] *See, e.g.*, Stasik, *supra* note 41, at 116, tbl. 1; Ann Armstrong, Joseph Mueller, & Tim Syrett, *The Smartphone Royalty Stack: Surveying Royalty Demands for the Components within Modern Smartphones* *13–14 (2014) (unpublished manuscript), *available at* https://www.wilmerhale.com/-/media/files/shared_content/editorial/publications/documents/the-smartphone-royalty-stack-armstrong-mueller-syrett.pdf; Joseph A. Alfred, *Licensing Standard Essential Patents (SEPs): Round Two*, LES NOUVELLES, Dec. 2019, 250, 254–55; Stasik & Cohen, *supra* note 42, at 179–80; Sidak, *supra* note 5, at 704–709; Galetovic, *et al.*, *supra* note 5, at 275, tbl. A1 (reporting actual and estimated royalty revenues for SEP licensors between 2000 and 2016).

[55] Including, among others: China Patent Blog, http://www.chinapatentblog.com/ [https://perma.cc/6E8Z-6BKF] (last visited Oct. 28, 2022); ChinaIPR, https://chinaipr.com/ [https://perma.cc/L9ZV-XAPX] (last visited Oct. 28, 2022); Comparative Patent Remedies, http://comparativepatentremedies.blogspot.com/ [https://perma.cc/N5HD-FBB8] (last visited Oct. 28, 2022); FOSS Patents, http://www.fosspatents.com/ [https://perma.cc/K2AE-6D77] (last visited Oct. 28, 2022); Intellectual Asset Management, https://www.iam-media.com/ [https://perma.cc/J7LZ-W9MY] (last visited Oct. 28, 2022); IPKat, https://ipkitten.blogspot.com/ [https://perma.cc/7B6H-C962] (last visited Oct. 28, 2022); Kluwer Patent Blog, http://patentblog.kluweriplaw.com/ [https://perma.cc/J43X-BR9S] (last visited Oct. 28, 2022); Managing IP, https://www.managingip.com/ [https://perma.cc/5BHH-7NGT] (last visited Oct. 28, 2022); Spicy IP, https://spicyip.com/ [https://perma.cc/MV8Q-YQUL] (last visited Oct. 28, 2022); Essential Patent Blog, https://www.essentialpatentblog.com/ [https://perma.cc/8JB9-5YV5] (last visited Oct. 28, 2022); and Sufficient Description, http://www.sufficientdescription.com/ [https://perma.cc/M833-V9P9] (last visited Oct. 28, 2022).

[56] While some 5G SEPs have recently been asserted in litigation, *see, e.g.*, 5G IP Holdings, LLC v. Samsung Elec. Co., No. 4:21-cv-622 (E.D. Tex.); OPPO v. Nokia, No. 2 O 112/21 (Mannheim Regional Court), no such cases have been decided to date.

1. Royalties Adjudicated by Courts, Agencies

In Table 1, we identify thirteen litigation decisions that set royalties for 4G mobile broadband SEPs. These adjudications, which span the period 2013-2020, include decisions from the courts of three nations, with the majority of adjudications (eight) taking place in U.S. courts, followed by decisions from China (four) and the UK (one). Six adjudications are jury verdicts awarding damages for U.S. patent infringement. The remaining seven declare national or international FRAND royalties; six are judicial decisions and one an explanation of sanctions imposed by competition law authorities. Interestingly, six of these adjudications (three jury verdicts and three judicial decisions) were subsequently called into question because the outcome was either directly vacated or indirectly mooted by the invalidation of one or more asserted SEPs.

Collectively, the thirteen litigation outcomes that we were able to observe involve a total of nine unique licensors[57] and eight unique (prior, current, or prospective) licensees. The majority of licensors (six) are non-practicing entities (NPEs), including two that license patents divested from active, operating licensors (a practice sometimes referred to as "privateering"), two publicly traded IP licensing companies (InterDigital and Wi-LAN), and one sovereign patent fund. In contrast, the set of licensees is relatively homogeneous: all but one produce or sell smartphones and (unsurprisingly) all but one adjudication generated royalties that apply to smartphone revenue. Just two decisions address a royalty base other than smartphone price, and both concern network infrastructure. No decision that we were able to identify addresses how royalties should apply to the production or sale of standard-supporting components (i.e., 4G chipsets or modules), nor to mobile broadband applications in, for example, the residential, automotive, or healthcare product sectors.

Interestingly, despite a high level of homogeneity among licensors and accused products, we observe a high level of heterogeneity with respect to the characteristics of royalties awarded and declared. While courts setting FRAND royalties almost uniformly calculated royalty rates (i.e., percentages applied to sales revenue), damages awarded by juries were most often based on flat, per unit royalty amounts (i.e., dollar values applied to sales volumes). What rights these royalties purchase varies across decisions as well. While some decisions generate royalties for just a handful of specific SEPs issued by one country, others determine royalties for licensors' entire national or international portfolio of relevant patents. In addition, while all thirteen decisions involve 4G technology, not all relate exclusively to 4G. Some decisions appear to apply generically to smartphones that both are and are not 4G compatible. Moreover, among decisions that do focus on 4G, some are limited to rarely sold "single mode" devices that rely exclusively on 4G, while others (additionally or alternatively) address much

[57] Note that we aggregate companies at the business group level.

more common 4G "multimode" devices that are backwards compatible with earlier mobile broadband standards. Finally, we observe a high degree of variation in the magnitude of royalty rates and amounts as well. Flat per unit royalty awards vary by a factor of more than thirty—from $0.08 to $2.50 per phone—and royalty rate awards span an even larger chasm from 0.0018% to 3.25%. As we discuss in greater detail below, while observable differences in license scope undoubtedly factor into this variation,[58] it is unlikely that such differences can fully account for such sizable variation.

2. Arbitrations

In Table 2, we present the royalty data that we were able to source from public information about arbitrations of 4G SEP licensing disputes.[59] Unsurprisingly, when disputes are arbitrated rather than litigated, much less public information is produced. In all, we were able to uncover at least some quantitative information for just four arbitrations, which collectively involve just two licensors and four licensees. All licensors and licensees are large publicly traded companies that are or were active in the smartphone market as both licensors and licensees of 4G technology. With one exception (an arbitration award that was used as a comparable license in a public court ruling), this data is further limited to lump sum amounts that lack important context. While we can reasonably infer that these awards predominantly represent royalties for 4G smartphone sales, most other details remain unclear, including precisely which products, standard(s), and time periods were at issue, as well as the extent to which the lump sums awarded represent not paid-in-full royalties for one-way licenses, but rather compensation for the marginal underpayment of royalties owed under prior cross-licensing agreements. Without additional information on the patents and licenses in dispute in these arbitrations, it is difficult to assess and compare the enormous variation in royalty amounts shown in Table 2.

3. Announced Rates and Licensing Demands

In Table 3, we document all public statements from 4G and 5G SEP licensors about expected royalties, as well as all 4G SEP licensing demands that were revealed in court filings. In all, we were able to identify statements from eighteen

[58] To be clear, these royalty determinations were made under dissimilar circumstances and apply to dissimilar sets of patents. On the low end, we reference jury verdicts for infringement of a few highly selected patents held by NPEs (IP Bridge and Conversant), while on the high end, we reference FRAND rate determinations for portfolios held by large operating licensors (Ericsson and Qualcomm). Though these two sets of data points involve differing numbers of patents, we note that patent licensors regularly argue in court that a small minority of patents account for the majority of their portfolio's value. *See, e.g.*, Ericsson Inc. v. D-Link Corp., No. 6:10-cv-473, 2013 WL 2242444, at *3 (E.D. Tex. May 21, 2013) (addressing Ericsson's argument that the six U.S. patents asserted in the case accounted for "at least 50 percent of the total value of the Ericsson 802.11 Portfolio").

[59] We are unaware of any arbitrations to date that specifically concern 5G-compliant devices.

licensors, including three patent pools (Avanci, Sisvel, and Via Licensing),[60] five NPEs, and ten operating companies. All eighteen licensors made at least one public royalty announcement or demand for their 4G SEP portfolio and six additionally made a 5G royalty rate announcement.

As with litigation outcomes, our data here pertains almost exclusively to smartphones. Only one announcement—by Avanci, a patent pool for automotive applications[61]—provides an anticipated royalty rate for a product other than a handset. Despite the homogeneity of licensed products, we yet again observe substantial heterogeneity with respect to the scope and structure of royalties announced or demanded. While half of these licensors requested a royalty rate, six licensors instead requested a flat dollar value per unit royalty, and three requested either a rate or flat amount depending on license details. Notably, the three patent pools that made public announcements all requested flat amounts. Also, while 4G announcements/demands requested a royalty rate more than twice as often as a flat amount, 5G announcements requested a flat amount twice as often as a royalty rate, which may indicate a market trend toward flat rates.[62] In addition, announcements mirror the available data on court decisions in Table 1 in that while some appear to apply without regard to backward compatibility, others apply exclusively to phones with single- or multimode capabilities. Further, a significant minority of announcements specify not a single portfolio royalty rate or amount for a given set of capabilities, but instead specify a menu of royalties that additionally vary based on, for example: how quickly a prospective licensee executes a licensing agreement, a licensee's sales prices and volume, and in which geographic markets a licensee operates.

Relative to litigation outcomes, these data points span a wider time period (with early 4G announcements starting in 2008 and 5G announcements following in 2017) and a narrower band of higher royalties. Though royalty rate requests on the whole are more tightly clustered than rates awarded by courts, this is substantially attributable to the fact that licensors (naturally) do not *request* relatively low royalty rates. In fact, they appear (as would be expected) to request relatively high payments.[63] For example, the maximum royalty rate requested in our data is 65% higher than the maximum rate awarded in litigation. Another indication that the requests listed in Table 3 are inflated is the fact that they stack

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[60] Note that Sisvel joined Avanci in 2019 for the licensing of its portfolio in the automotive market. *See* Press Release, Avanci & Sisvel International S.A, Sisvel Joins Avanci Licensing Marketplace (May 15, 2019), (available at https://www.businesswire.com/news/home/20190515005164/en/Sisvel-Joins-Avanci-Licensing-Marketplace [https://perma.cc/ZB3B-SQ38]).

[61] Avanci, https://www.avanci.com/ [https://perma.cc/24M9-BXN3] (last accessed Sept. 8, 2022).

[62] Since flat rates impose a relatively higher royalty burden on products with lower sales prices, this trend may possibly reflect an attempt to boost overall royalty revenue as 4G and 5G smartphone sales prices inevitably fall over time.

[63] *See supra* note 44.

to form a combined royalty of over 17% on a $300 4G multimode smartphone.[64] If further combined with other public requests for SEP royalties related to Wi-Fi, video codec, near field communication, and other standards, the cumulative (and still very incomplete) royalty burden on a cellular device would likely be at least two to three times higher, a potentially prohibitive amount.[65] Accordingly, it is important to take these figures with a grain of salt. Rather than corresponding to royalties actually agreed upon, these rates in effect represent an opening offer in anticipated future negotiations. Nevertheless, they offer an upper bound on royalties demanded by some of the most important licensors in the 4G and 5G SEP space.

4. Public Licenses and Settlements

In Table 4, we collect public, quantitative data on 4G and 5G SEP licenses and litigation settlements.[66] These data incorporate: comparable licenses discussed in judicial decisions, royalties disclosed in financial reports, and a small number of additional royalties reported by the press.

Relative to the data discussed above, we report here a greater number of perhaps less representative data points. That is, while we document a total of thirty licensing relationships, these licenses involve just nine unique licensors and are dominated by an even smaller subset of licensors that (i) have relatively extensive SEP portfolios and litigation histories, (ii) produce relatively detailed financial disclosures, and/or (iii) are the subject of relatively thorough media coverage. For example, twelve are Ericsson licenses sourced from two U.S. court opinions, and another six are derived from royalty streams disclosed in InterDigital's annual reports. These data points involve a larger number of distinct licensees; however, all twelve are large established operating companies. For six licensees, we also observe multiple agreements. For example, we observe royalty data for licenses that Apple negotiated with Ericsson, InterDigital, Nokia, and Qualcomm.

Once again we find that the data almost exclusively concerns smartphone licenses. Just two of thirty agreements involve another product, and both of these

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[64] This combined royalty represents a simple summation of the requested royalties (percentages and flat amounts) reported in Table 3 that would apply to a 4G multimode phone sold in a major market. The rate, therefore, does not include any additional, unobservable royalties that might be requested by all other holders of 4G (declared and undeclared) SEPs.

[65] *See* Armstrong et al., *supra* note 54, at 68–69 (aggregating royalty announcements across smartphone modules and concluding that "the potential royalt[y] demands on a smartphone could equal or even exceed the cost of the device's components").

[66] While some of the agreements reported in Table 4 are clearly settlements, other licenses may well have been executed under imminent threat of suit. We include only licenses/settlements for which we found at least some royalty-related information; i.e., we do not include all known licenses/settlements, but rather only those for which we also uncovered some payment-related data.

licenses cover network infrastructure. We also observe yet again substantial heterogeneity among reported licenses despite the fact that almost all involve quite similar products and licensees. As with the data provided in Tables 1-3, the licenses and settlements reported in Table 4 are varyingly structured as royalty rates, per unit royalty amounts, and/or one-time lump payments; diverge in their applicability to previous-generation and/or backward-compatible products; and sometimes also vary with the price and location of licensees' sales.

In addition, comparison and synthesis of real-world licenses between operating technology companies are further complicated by the fact that both parties commonly have patent portfolios and, moreover, complimentary business interests. Seven of the licenses included in Table 4 are expressly identified in public documents as including a cross-license or patent transfer from the licensee,[67] and we suspect that an even larger share would be revealed as such were more information publicly available. Some licenses also involved collateral business arrangements, such as Qualcomm's common (and controversial) practice of merging SEP licenses and chip purchase agreements.[68] While cross-licensing and business considerations undoubtedly impact licensing negotiations and agreed-upon royalty rates, that effect is extremely difficult, if not impossible, to quantify.

To a much greater extent than before, Table 4 also allows us to compare royalties across licenses executed by the same licensor or licensee. Surprisingly, we observe significant intra-licensor and intra-licensee variation. For example, public information reveals that Ericsson sometimes licensed its portfolio of mobile broadband patents to 4G smartphone producers in exchange for a flat per unit amount and other times in exchange for a percentage of sales. Further, Ericsson's royalty rate varied from as low as 1% to as high as 3%, with per unit royalty floors and caps that ranged from $1–2 and $4–5, respectively. Similarly, Apple entered into both rate-based and amount-based royalties, and may have achieved a substantially more favorable deal with Ericsson relative to its deals with two similarly situated licensors, Nokia and Qualcomm.

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[67] *See, e.g.*, Qualcomm Earnings Call, *supra* note 52; InterDigital, Annual Report 2016 9 (2016) ("During third quarter 2016, we entered into a multi-year, worldwide, non-exclusive, royalty-bearing patent license agreement with Huawei . . . [that] sets forth cash payments to InterDigital and a process for the transfer of patents from Huawei to InterDigital, as well as a framework for discussions regarding joint research and development efforts.").

[68] *See, e.g.*, FTC v. Qualcomm, Inc., 411 F. Supp. 3d 658, 771 (N.D. Cal. 2019), *rev'd* 969 F.3d 974 (9th Cir. 2020) ("In 2016, QTL offered Motorola a chip incentive fund that Motorola concluded would reduce Motorola's effective royalty rate to 3.8% only if Motorola purchased 100% of its modem chips from Qualcomm."). *See also* InterDigital, *supra*.

IV. OBSTACLES TO OBSERVING A MARKET PRICE

We next consider the extent to which market observers can use the public information described above to generate meaningful market prices. In this section, we outline several challenges that make such a task extremely difficult, if not practically impossible.

A. Variation in Royalty Structures

First, as detailed above in Part III, royalties in the public arena take a variety of forms. Before these data points can be compared or synthesized, they must be translated into a common form; i.e., rates must be converted to flat per unit amounts or vice versa. While in theory either royalty form may be combined with a sales price to generate the other, in practice this exercise is not so simple. For one, there is a wide range of average selling prices (ASPs) across smartphone manufacturers, product lines, and geographic markets.[69] In addition, the price of a given smartphone changes over time. For example, the ASP of 5G enabled smartphones has already decreased by 25–30% since mid-2019 according to one report.[70] Accordingly, even otherwise straightforward comparisons across royalty types are fraught with a great deal of uncertainty based solely on selection of ASPs and corresponding assumptions about underlying market demand. Consider, for example, an attempt to compare across jury verdicts in Table 1. If (as is usually the case) it is not revealed in a public court docket what specific time period(s) were at issue at the time of trial, should the comparison be made using the ASP of the respective accused infringer's relevant products[71] at the time of the award, two or more years earlier at the time of the lawsuit's filing, or perhaps averaged across the period beginning up to six years prior to suit and ending approximately at the time of trial? Given the large volumes commonly involved in 4G and 5G licensing disputes,[72] small differences in applicable ASPs can result in significant differences in royalty payments.

An additional layer of complexity is introduced by the fact that royalty rates/amounts themselves also commonly vary with sales price and volume. Some

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[69] *See, e.g.*, Smartphone Average Price Forecast in 2019, by Region, Statista, https://www.statista.com/statistics/283334/average-smartphone-price-by-region/ [https://perma.cc/8ELW-TVHW] (last accessed Sept. 8, 2022) (reporting that average sales prices in North America are more than double those in the Middle East and Africa).

[70] Press Release, Counterpoint Technology Market Research, US Smartphone Market Grows 19% YoY in Q1 2021; 5G Smartphone Sales Eclipse 53 m Units (April 30, 2021), *available at* https://www.counterpointresearch.com/us-smartphone-market-q1-2021/ [https://perma.cc/789F-EYXD].

[71] To the extent that we can determine what specific products were at issue.

[72] *See, e.g.*, Number of Smartphone Unit Shipments in the United States from 2013 to 2025, Statista, https://www.statista.com/statistics/619811/smartphone-unit-shipments-in-the-us/ [https://perma.cc/8SGR-HN3K] (last accessed Sept. 8, 2022) (reporting an annual volume exceeding 150 million units each year 2013–2019).

royalty rates are paired with price floors and price ceilings, which guarantee at least some minimum royalty per unit and no more than some maximum royalty per unit. Other royalties decrease as sales volume increases. To properly account for these license terms, a market observer must know not just a licensee's overall ASP, but also its product-specific ASPs and product-specific sales volumes. In addition, we were generally unable to determine from public information whether reported volume discounts reset monthly, quarterly, annually, or not at all.

Finally, we note that royalty amounts awarded or disclosed in lump sum form are especially difficult to interpret because their conversion to a rate or per unit amount additionally requires (at least) knowledge of the time span covered by the royalty payment. As shown below in Tables 2 and 4, we were frequently unable to determine what time period should be attributed to reported lump sum royalty amounts. Without this crucial piece of information, lump sum amounts are little more than black boxes, even if a market observer can piece together a licensee's relevant ASPs and sales volumes.

B. Uncertainty with Respect to Technological Scope

Ambiguity with respect to the technology or technologies covered by a license adds to the uncertainty. First, as introduced above, it is often unclear in the public record precisely which mobile broadband standard(s) are covered by a given royalty. Deployment of mobile broadband generations takes place over time with cellular carriers' networks typically supporting multiple generations at the same time.[73] Accordingly, licensees commonly sell contemporaneous products that are compatible with different or multiple generations of network technology, and licensors commonly license patents declared essential to different or multiple generations.[74] How this reality maps onto disclosed royalty data is frequently opaque, which obscures precisely which mobile broadband standard(s) are being licensed with respect to precisely which phones.

In addition, it is commonly unclear whether royalties were paid exclusively for a license to mobile broadband patents or for a license covering mobile broadband *and* other complementary technologies. Many active licensors of mobile broadband patents—including at least Ericsson, Qualcomm, Nokia, InterDigital, and Wi-LAN—are also active licensors of patents that allegedly cover Wi-Fi and/or video codec standards, both of which are supported by smartphones.[75] While it is generally unclear from the public record, we suspect

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[73] 3G mobile broadband, which achieved widespread deployment in the U.S. by the mid-2000s, is still supported by some U.S. wireless carriers. *See, e.g.,* FCC, Plan Ahead for Phase Out of 3G Cellular Networks and Service, https://www.fcc.gov/consumers/guides/plan-ahead-phase-out-3g-cellular-networks-and-service (last accessed Sept. 8, 2022).

[74] *See infra* Table 4.

[75] *See infra* Table 4. For a summary of Wi-Fi and video codec SEP ownership, *see, e.g.*, Nakane & Yuji Orita, *Data Analysis: Essentiality Report on Wi-Fi 6 Patents 2021*, Managing IP

that the royalties reported in Tables 2 and 4 for these licensors cover *all* relevant technologies for which the licensor holds patent rights.

Further, non-royalty compensation nebulously factors into many licensing agreements with practicing licensors. On one side of the bargain, licensees in this market may have patent rights of their own which practicing licensors might plausibly infringe.[76] On the other, practicing licensees like Qualcomm and Ericsson may wish to wrap product sales into licensing agreements, as well.[77] While the public record sometimes notes the mere existence of related cross-licenses or product sales, it reveals neither which specific patents were cross-licensed nor how the parties valued those rights or promised product sales.[78]

In short, for at least these reasons, licenses executed between operating technology companies are rarely limited to a single technology and, absent a great deal of additional information, there is no straightforward way to identify all technologies involved, let alone to disaggregate their contributions to a given royalty rate.

C. Uncertainty with Respect to Geographic Scope

Another source of complexity in interpreting publicly available information is ambiguity about how to account for geography. While some licenses specify different royalty rates or amounts for different markets, most others in the public domain either (i) are unobservably limited in geographic scope, (ii) actually do apply generically across borders, or (iii) lack important context that would allow market observers to determine how royalties actually diverge across nations or borders under the terms of the relevant license agreement. What little data we do have, suggests that geographic variation is both important and not readily predictable. As shown below in Tables 1, 3, and 4, royalty rates can vary substantially across markets, with rates at the high end frequently (yet inconsistently) exceeding those at the low end by a factor of two or more. In the absence of consistency in cross-border variation, data points that are limited to one nation or market—a category that includes the majority of court decisions—become less useful because they cannot readily be used to estimate

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fig. 1 (Nov. 15, 2021), https://www.managingip.com/article/2a5d08lcu0fnaw1v6eh34/data-analysis-essentiality-report-on-wi-fi-6-patents-2021 [https://perma.cc/6ZU2-9XE5]; Gaurav Agnihotri, *High Efficiency Video Coding: How the Video Ecosystem is Evolving*, https://ipwatchdog.com/2018/07/11/high-efficiency-video-coding-video-ecosystem-evolving/id=99094/ [https://perma.cc/KJU3-6BGZ] fig. 2 (July 11, 2018).

[76] *See supra* note 67.

[77] *See supra* note 68. *See also* Memorandum of Findings of Fact and Conclusions of Law, TCL Comm'n Tech. Holdings, Ltd. v. Telefonaktiebolaget LM Ericsson, No. 8:14-cv-00341 (C.D. Cal. Nov. 8, 2017) (disclosing that a January 2014 global portfolio cross-license between Ericsson and Samsung included a commitment from Samsung to purchase Ericsson modems).

[78] *See infra* Table. 4.

what royalties might be due for a license that covers additional or different jurisdictions.

Relatedly, while smartphones are sold all over the world, few mobile broadband SEP families include members issued in more than a handful of countries.[79] In addition, patent infringement litigation is all but unheard of in many nations, including some major markets.[80] How market observers should account for this is also unclear. At the very least, while it may be tempting to compare lump sum awards or reported royalty revenue totals with licensees' global revenues or global sales volumes, doing so ignores the reality that licensing takes place in the shadow of patent litigation, which in practice is rarely pursued in more than a handful of jurisdictions.[81]

D. Uncertainty with Respect to Scope of Patent Rights

Yet another challenge is ambiguity with respect to what patent rights should be attributed to a given royalty. For one, licensors' portfolios change over time as relevant patents are granted or expire. As with uncertainty surrounding the proper time period for use in determining ASPs and sales volumes, it is likewise unclear how a market observer should take into account fluctuations over time in a licensor's portfolio size and quality[82] and, indeed, it would appear from licenses in the public domain that the relationship between portfolio and royalty size is complex. Perhaps most notably, Qualcomm appears to have requested and frequently received similar royalties for 3G and 4G smartphones despite the fact that it held a much smaller share of the overall pool of 4G SEPs.[83]

Accounting for this is especially tricky in the context of litigation. For one, it is challenging to determine what link, if any, should be presumed between the patent rights on which a court award was based and the present totality of a licensor's related patent rights. Each patent infringement award reported in Table 1 is expressly based on no more than a handful of patents that were selected for litigation and, thereafter, selected for trial. While it is clear that such patents should not be considered typical of the relevant licensor's entire portfolio, it is unclear just how special they are. Should such patents be assumed to represent the

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[79] *See* Love & Helmers, *supra* note 19, at tbl. A-2 (reporting that the average SEP family includes at least one member application filed in less than five countries).

[80] *See, e.g.,* Council of the European Union, *Towards an Enhanced Patent Litigation System and a Community Patent: How to Take Discussions Further*, Working Doc. 11622/07 (July 12, 2007), *available at* https://data.consilium.europa.eu/doc/document/ST-11622-2007-INIT/en/pdf [https://perma.cc/T8C9-N946] (reporting patent case counts for all EU member states).

[81] *Id.*

[82] To the extent that patent quality can actually be measured and reliably accounted for.

[83] Qualcomm's ability to charge consistent royalties despite contributing fewer patents to successive mobile broadband generations was noted by both the Korean Fair Trade Commission, *see* Press Release, *supra* note 36, and Judge Koh in FTC v. Qualcomm, Inc., 411 F. Supp. 3d 658, 783-90 (N.D. Cal. 2019), *rev'd* 969 F.3d 974 (9th Cir. 2020).

majority, and perhaps even the overwhelming majority, of the licensor's portfolio value in the relevant country?[84] If so, what effect should a market observer assign to such a patent's expiration or invalidation, as occurred multiple times following a court award included in Table 1? In addition, if litigation filed in one or more nations settles and monetary details of the settlement become public without additional context, should the royalty paid be attributed to (i) only those patents that the licensor selected for litigation, (ii) only the portion of the licensor's portfolio that covers the nation(s) in which litigation was filed, or (iii) the licensor's worldwide portfolio?

Patent transactions present another, related hurdle. In addition to the issuance, expiration, and invalidation of relevant patents, a thorough market analysis also would require observers to identify and account for the flow of patents among market participants. For example, many mobile broadband licensors periodically divest portions of their portfolios on unclear terms to NPEs,[85] which commonly proceed to request or obtain royalties that are arguably inconsistent with earlier or subsequent requests or licenses involving the larger SEP portfolio from which their patents originated. In our data, many 4G SEPs licensed by Unwired Planet and Conversant were purchased from Ericsson and Nokia, respectively.[86] Though both sales took place after the public rate announcements from Nokia and Ericsson shown in Table 3,[87] it is not clear from the royalty rates reported in Table 4 that either company's subsequent licensing activity was significantly impacted by these sales, despite the fact that both NPEs went on to request and obtain sizable royalties for the purchased patents. Why that might be the case is unclear. Portfolios may also consolidate over time due to corporate mergers and

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[84] Patent enforcers commonly argue that this is the case. In Ericsson, Inc. v. D-Link Corp., for example, Ericsson's argument that the six U.S. patents asserted in the case accounted for "at least 50 percent of the total value of the Ericsson 802.11 Portfolio" was accepted by the court as "a realistic and thorough attempt to apportion revenue to only the asserted patents." No. 6:10-cv-473 at *3 (E.D. Tex. May 20, 2013).

[85] This practice is sometimes referred to as "patent privateering." *See, e.g.*, D. Daniel Sokol, *Patent Privateering: The Rise of Hybrid Patent Assertion Entities*, *in* Patent Assertion Entities and Competition Policy 73 (D. Daniel Sokol ed., 2017); Tom Ewing, *Indirect Exploitation of Intellectual Property Rights by Corporations and Investors: IP Privateering and Modern Letters of Marque and Reprisal*, 4 HASTINGS SCI. & TECH. L.J. 1 (2012).

[86] Unwired Planet acquired a portfolio of 2G, 3G, and 4G SEPs from Ericsson in 2013. *See, e.g.*, Ingrid Lunden, *Unwired Planet Has Bought 2,400+ Wireless Patents From Ericsson To Beef Up Its Patent Fights Against Google, Apple And RIM*, TECHCRUNCH.COM (Jan. 10, 2013), https://techcrunch.com/2013/01/10/unwired-planet-has-bought-2400-wireless-patents-from-ericsson-to-beef-up-its-patent-fights-against-google-apple-and-rim/ [https://perma.cc/B89K-9CCJ] . Conversant, formerly known as Core Wireless, licenses patents that its parent, Mosaid, acquired from Nokia in 2011. *See, e.g.*, Chris Velazco, *Mosaid Acquires 2,000+ Nokia Patents, Will Handle Licensing & Litigation for a Cut*, TECHCRUNCH.COM (Sept. 1, 2011), https://techcrunch.com/2011/09/01/mosaid-acquires-2000-nokia-patents-will-handle-licensing-litigation-for-a-cut/ [https://perma.cc/7SJW-WW5X].

[87] *Id.*

acquisitions or portfolio sales by firms that are winding down or transitioning. For example, during the period covered by our data, a significant portfolio of 4G SEPs held by Nortel was purchased in a bankruptcy auction by a consortium of companies (including Ericsson and Apple) acting jointly through a newly formed NPE.[88]

E. Strategic Disclosures

A final source of complexity worth mentioning is bias caused by the circumstances that led royalty information to become public in the first place. Royalty information that becomes public is, of course, far from random, and there is good reason to believe that it is not just highly selected, but also strategically presented when it becomes public.

Most patent licensing demands do not lead to litigation,[89] and the vast majority of patent suits terminate before trial.[90] Accordingly, cases and patents that result in court awards have passed through multiple, highly-selective filters that cast serious doubt on their general applicability.[91] Similarly, litigants have obvious incentive to strategically select the prior licenses that they enter into the record in litigation and, moreover, may have incentive to artificially manufacture them for this purpose.[92]

Likewise, data that becomes available through financial disclosures is skewed by the fact that this information is only produced by publicly traded companies and, moreover, the fact that such companies are only required to disclose information that is "material" to their finances.[93] Presumably, both effects tend to bias public information in favor of relatively large royalties.[94] In addition, as with licenses disclosed in litigation, the disclosing party has incentive to present the

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[88] For more details on this purchase and the myriad transactions that followed, see, e.g., Martin Bijman, *Nortel Patents Make News Again: Rockstar Patents Sold to RPX*, TechInsights Blog (Dec. 24, 2014), https://www.techinsights.com/blog/nortel-patents-make-news-again-rockstar-patents-sold-rpx [https://perma.cc/YM8X-NH5Y].

[89] *See* Mark A. Lemley, Kent Richardson, & Erik Oliver, *The Patent Enforcement Iceberg*, 97 TEX. L. REV. 801, 816 (2019) (reporting survey results indicating that approximately half to two-thirds of patent licensing demands are resolved without the filing of litigation).

[90] According to DocketNavigator and LexMachina, approximately 75–80% of U.S. patent suits terminated 2008–2021 settled before reaching even a partial determination on the merits.

[91] *See, e.g.*, Kathryn E. Spier, *Litigation*, *in* HANDBOOK OF LAW & ECONOMICS 259, 326–27 (A. Mitchell Polinsky & Steven Shavell, eds., 2007) (reviewing the literature on selection effects in litigation).

[92] *See* Masur, *supra* note 44, at 142–44.

[93] *See* Mark A. Lemley & Carl Shapiro, *Patent Holdup and Royalty Stacking*, 85 TEX. L. REV. 1991, 2022 (2007) ("[L]icense agreements that involve the payment of a large sum of money are more likely to be material—and therefore more likely to show up in a public database—than license agreements that involve a small payment, a walkaway, or a cross license.").

[94] *Id.*

information in the best light possible, which may mean that important context may be intentionally obscured or omitted.

Other public disclosures, for example licenses and dollar figures announced in press releases, are also likely to be strategically selected and presented. Indeed, their very existence is evidence that the disclosing party views the information provided as a positive development. This is particularly true with respect to announcements of prospective royalty expectations, which (unlike financial disclosures) are not regulated by law and (unlike retrospective announcements of settlements) are not necessarily even derived from actual market developments.[95]

As a result, public royalty rates and amounts are unlikely to be representative of the broader market and, moreover, are likely unrepresentative in unique ways that make it difficult to compare data points across sources.

F. Combined Effect

In combination, the uncertainties identified above make it extremely difficult, if not impossible, to determine—based on publicly available information—even a reasonable range of royalties that a licensee might be expected to pay for a given patent, portfolio, or standardized technology. While court awards provide input from neutral third-parties, most are limited in that they expressly apply to a single jurisdiction and, further, to a handful of patents carefully selected from a potentially sizable portfolio.[96] In the absence of additional information allowing rates to be reliably translated across markets and the relative importance of individual patents to be reliably assessed across portfolios, sporadic court decisions are unlikely to allow the reliable calculation of generally applicable portfolio-wide royalty rates.

All other public data suffers from similar deficiencies and, moreover, was selectively provided by a party with a direct financial stake in its interpretation. Like court awards, arbitration decisions hold out the promise of neutral analysis of patent value and, even better, typically concern amounts owed under portfolio-wide licenses. Nevertheless, we were able to identify just a handful of awards—all but one of which was disclosed as a lump sum that covers a period of indeterminate length and an unobservable assortment of technologies incorporated into an unknown selection of products that were sold in an unknown selection of markets.[97] Unless a market observer is somehow able to acquire a great deal of confidential, collateral information, these data alone are of minimal use.

Announcements of royalty expectations are not required or regulated by law and, thus, need not be derived from any underlying facts or market realities. At

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[95] *See supra* note 44.
[96] *See infra* Table 1.
[97] *See infra* Table 2.

best, they place an aspirational cap on royalty payments with an unclear link to rates that will be bargained for years later. Finally, while they are at least derived from actual market transactions, public disclosures of licenses and settlements are nonetheless, at best, mandated by securities regulations that plainly skew disclosures[98] and, at worst, represent strategic attempts to influence courts, juries, future licensees, and investors.[99]

On the whole, it is therefore unclear that even price points within individual categories, let alone all public royalty data, can be reliably compared and consolidated. Without more, the sparse, incomplete, and biased nature of the data appears unlikely to allow the observation of market prices.

V. IMPLICATIONS

The mobile broadband licensing ecosystem presents what may be a best case scenario for the observation of price points in the context of patent transactions. The fact that we fail (after an exhaustive search) to uncover public information from which mobile broadband royalty rates can be computed, suggests that such information may generally be absent across the broader patent licensing market. If so, this lack of information has important implications for patent and antitrust policy, as well as potentially for innovation writ large in technology sectors where patent licensing is a necessary part of product development.

First, we note that a widespread lack of data on patent licensing is not possible without some consensus among market participants, both licensors and licensees, to keep such information private. Our data suggest that such a consensus does exist, but it cannot explain why this market dynamic prevails, nor do we know how it affects patent licensing transactions. At present, we are aware of no existing theoretical studies of post-transaction confidentiality in the patent market.

Next, we note that a lack of pricing transparency means that patent licenses will commonly be negotiated on a case-by-case basis by parties that each bring with them very different, incomplete sets of information pertaining to the value of the relevant technology. In such a scenario, the distribution of information and resulting asymmetries are likely to play an outsized role in patent licensing outcomes, affecting royalty rate and structure,[100] and perhaps leading some market participants to incur large search costs or avoid licensing altogether in the face of such costs. While the net effect of this state of affairs on active licensors and licensees is ambiguous—that is, it could tend to benefit repeat licensors or repeat

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[98] *See supra* note 93.

[99] *See supra* note 44.

[100] Heywood et al., show theoretically that private information held by licensees about the value of a technology affects a licensor's optimal license structure. *Per Unit vs. Ad Valorem Royalties under Asymmetric Information*, 37 INT'L J. INDUS. ORG. 38 (2014). *See also* sources cited *supra* note 20.

licensees depending on the characteristics of a given licensing ecosystem—a lack of pricing information is likely to disproportionately impact companies that lack relevant licensing experience. Whether they be licensors or licensees, inexperienced firms will be at a disadvantage due to their relative lack of access to confidential market information gleaned from prior transactions.

In addition, a general lack of public pricing information has implications for the law of patent infringement damages. Courts around the world have adopted compensation rules that implicitly assume the existence of observable market royalty rates.[101] If, however, the true norm in the patent licensing market is case-by-case negotiation that results in substantial price dispersion, litigants and courts may well be searching in vain for "market" royalty rates that, in effect, do not actually exist. In such a context, parties have strong incentives to engage in opportunistic behavior and strategically select whatever available damages-related evidence is most favorable to them,[102] which may commonly lead to court awards that are over- or under-compensatory.

Our data also has implications for the narrower context of SEP licensing. Much like the law of patent damages, the concept of FRAND licensing implicitly assumes the existence of "non-discriminatory" market prices for SEP licenses. If neither market participants nor market observers can reliably estimate market rate licenses, a prohibition on discriminatory licensing may be an effectively incoherent concept. Absent evidence of subjective intent to gouge licensees or engage in exclusionary conduct, it is unclear by what standard licensing offers may be judged to be "unreasonable" or "discriminatory" in a market with low price transparency and high price dispersion. As a result, FRAND violations may be challenging to identify and prove, particularly by competition regulators and inexperienced licensees that presumably stand at an informational disadvantage relative to active licensors.

Moreover, widespread confidentiality and price dispersion may contribute to what some claim to be widespread "holdup" and "holdout" by SEP licensors and licensees. For example, asymmetric information in the licensing market may facilitate "holdup" by allowing repeat licensors to leverage their informational advantage to inflate royalty demands against relatively inexperienced licensees.[103] Likewise, repeat licensees may be able to exploit inexperienced licensors' lack of information by "holding out" for what in reality are unreasonably low royalty payments.[104] In addition, some instances of alleged "holdout" by inexperienced licensees may be explained in part by their relative inability to quickly assess the

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[101] *See supra* notes 2–4.
[102] Masur, *supra* note 44, at 142–44.
[103] *See generally* Love, et al., *supra* note 19.
[104] *See generally* Love & Helmers, *supra* note 19.

reasonableness of licensing offers that, from their perspective, are presented in a near vacuum of information.

Finally, in the specific context of mobile broadband technology, we note a stark contrast between the licensing market's near uniform focus on smartphones and the industry's much-predicted expansion into almost every aspect of modern life.[105] It is unclear what, if anything, a prospective manufacturer of "smart" mobile broadband-enabled home appliances, medical devices, automated robots, or oil rigs (just to name a few) can infer from existing smartphone licensing data. In addition, as prospective market entrants, new smart product manufacturers will presumably face a significant informational disadvantage in future licensing negotiations relative to licensors that negotiated and litigated for years against smartphone makers.

VI. Conclusion

While it has long been recognized that confidentiality is widespread in the patent licensing market,[106] this equilibrium is undertheorized and its implications underexplored. In the context of an unusually uniform, unusually active, and unusually valuable segment of the patent licensing market, we show that detailed information on patent licensing agreements is, despite favorable conditions, scarce in the public domain. In addition, we show that the data made available through litigation, mandatory financial reporting, and voluntary disclosures is almost without exception incomplete and, thus, quite challenging to interpret, compare, and synthesize. Further, to the extent that we are able to analyze the market, we observe a great deal of heterogeneity with respect to royalty structures and amounts across agreements. Accordingly, our data may suggest that, in practice, licenses are commonly negotiated on a case-by-case basis between parties with unique circumstances and asymmetric levels of incomplete information about the broader market. In such a context, it is not clear that a market price for patent licenses exists.

If the concept of a market price is, indeed, commonly an elusive one in the patent licensing market, courts, regulators, and policymakers may wish to take note. In the absence of reliable market data, experienced licensors may be able to engage in opportunistic conduct, potentially resulting in patent holdup. In addition, potential licensees may be particularly unable to prove that such conduct has taken place. At the same time, licensees might also exploit the lack of

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[105] *See, e.g.*, *Building the Future with Software-Based 5G Networking*, MIT Tech. Rev. (Dec. 15, 2021), https://www.technologyreview.com/2021/12/15/1042187/building-the-future-with-software-based-5g-networking/ [https://perma.cc/4EVS-UXJU] ("'New IoT apps combined with both public and private 5G is going to create a 'Cambrian explosion' of new ideas that will manifest in ways that if we were to try to predict, we would get it wrong.'" (quoting Nick McKeown, Senior VP Intel Corp.)).

[106] *See supra* note 8.

information by bargaining more forcefully, including to the extent that their conduct could be described as holdout.

Finally, there appears to be substantial room in the literature for theoretical and empirical analysis of market realities in the patent licensing industry. Few markets embrace confidentiality to such a great extent and the literature has yet to explore why and how market participants reach such strong consensus in favor of secrecy. In addition, few have studied how prices are determined in licensing negotiations when so few pricing signals are available.

Table 1: Jury Verdicts & Court/Agency Rulings

Licensor	Licensor Type	Licensee	Standard	Award Type	Award	Add'l Award Details	Case No. (Court) (Country)
Conversant Wireless / Core Wireless	NPE	Apple	3G, 4G	Lump Sum	$7.3 million ($3.4 million* for '151 patent; $3.9 million for '536 patent)	Jury verdict (Dec. 15, 2016) of infringement of U.S. Patent Nos. 6,477,151; 6,633,536 ('151 patent invalidated post-trial)	No. 5:15-cv-05008 (E.D. Tex.) (U.S.)
Conversant Wireless / Core Wireless	NPE	Huawei	4G Only 4G Multimode	Rate Rate	0.00225%* 0.0018%*	Court ruling (Sept. 16, 2019) declaring FRAND rate for China Patent Nos. ZL00819208.1; ZL200380102135.9; ZL200580038621.8; ZL200680014086.7 (in ongoing parallel proceedings, '208.1, '621.8, and '086.7 patents have been ruled invalid)	No. (2018) Su 01 Min Chu No. 232, 233 and 234 (Nanjing Intermediate People's Court) (China)
Conversant Wireless / Core Wireless	NPE	LG	3G, 4G	Lump Sum (Flat)	$2,280,000* ($0.05* per handset per infringed patent)	Jury verdict (Sept. 16, 2016) of infringement of U.S. Patent Nos. 6,633,536; 7,804,850 (motion for a new trial on damages granted Sept. 27, 2018 on grounds that Core Wireless' damages expert failed to "separate the value of the standard's adoption from the incremental value of the patents")	No. 2:14-cv-00911 (E.D. Tex.) (U.S.)
Ericsson	Op Co	HTC	4G Multimode	Flat Rate	$2.50 (Dec. 2016 offer) 1% (June 15, 2018 offer)	Court ruling (May 23, 2019) declaring that "Ericsson's offers to HTC—$2.50 or 1% with a $1 floor and a $4 cap per 4G device—were fair, reasonable, and non-discriminatory"	No. 6:18-cv-00243 (E.D. Tex.) (U.S.)
Ericsson	Op Co	TCL	4G Only	Rate	0.314%–0.450%* (depending on market)	Court ruling (Nov. 8, 2017) declaring FRAND rate for portfolio license in the U.S. (0.450%) and the "rest of the world" (0.314%) (reversed on appeal on grounds that damages should have been tried to a jury)	No. 8:14-cv-00341 (C.D. Cal.) (U.S.)
Godo Kaisha IP Bridge	NPE / Sovereign Patent Fund	TCL	3G, 4G	Lump Sum (Flat)	$968,086.96 ($0.04 per handset per infringed patent)	Jury verdict (Nov. 8, 2018) of infringement of U.S. Patent Nos. 8,385,239; 8,351,538	No. 1:15-cv-00634 (D. Del.) (U.S.)

Licensor	Licensor Type	Licensee	Standard	Award Type	Award	Add'l Award Details	Case No. (Court) (Country)
Huawei	Op Co	-- Samsung	4G 4G	Aggregate Rate Rate	6–8% 1.5%	Court ruling (Jan. 11, 2018): -determining, in a top-down analysis, that the aggregate royalty rate for all 4G SEPs is 6–8% -declaring Huawei's 1.5% portfolio offer FRAND-compliant (anti-suit injunction granted in parallel U.S. litigation)	(2016) Yue 03 Min Chu No. 1382 (Shenzhen Intermediate People's Court) (China)
Intellectual Ventures	NPE	Ericsson / T-Mobile	4G (infrastructure)	Lump Sum	$43 million† ($34 million against T-Mobile; $9 million against Ericsson)	Jury verdict (Feb. 8, 2019) of infringement of U.S. Patent Nos. 6,628,629; 7,412,517; RE46206 (accused technology was network infrastructure, not handsets)	No. 2:17-cv-00577 (E.D. Tex.) (U.S.)
InterDigital	NPE	Huawei	2G, 3G, 4G	Rate	0.019%*	Court ruling (Feb. 4, 2013) declaring FRAND rate for Chinese portfolio license (reversed on appeal in 2018 by Supreme People's Court)	(2011) Shen Zhong Fa Zhi Min Chu Zi No. 857 (Shenzhen Intermediate People's Court) (China)
Qualcomm	Op Co	--	4G Only 4G Multimode	Rate Rate	2.275% (3.5% of 65% of price) 3.25% (5% of 65% of price)	Agency decision (Feb. 9, 2015) "For licenses of Qualcomm's 3G and 4G essential Chinese patents for branded devices sold for use in China, Qualcomm will charge royalties of 5% for 3G devices (including multimode 3G/4G devices) and 3.5% for 4G devices (including 3-mode LTE-TDD devices) that do not implement CDMA or WCDMA, in each case using a royalty base of 65% of the net selling price of the device."	National Development & Reform Commission, Administrative Sanction Decision No. 1 [2015] (China)
Unwired Planet / Optis	NPE	Huawei	4G	Lump Sum (Rate)	$10,553,565 (2.00%) ($102,742 (0.02%) for '216 patent; $1,733,862 (0.335%) for '569 patent; $753,276 (0.145%) for '284 patent; $246,844 (0.048%) for '293 patent; $7,716,841 (1.45%) for '238 patent.)	Jury verdict (Aug. 27, 2018) of infringement of U.S. Patent Nos. 6,604,216; 8,208,569; 8,385,284; 8,437,293; 7,769,238	No. 2:17-cv-00123 (E.D. Tex.) (U.S.)

Licensor	Licensor Type	Licensee	Standard	Award Type	Award	Add'l Award Details	Case No. (Court) (Country)
Unwired Planet / Optis	NPE	Huawei	4G Multimode (handsets) 4G Only (infrastructure)	Rate Rate	0.026%–0.052% (depending on market) 0.026%–0.051%† (depending on market)	Court ruling (May 4, 2017) declaring FRAND rates for worldwide, portfolio licenses	No. [2017] EWHC 711 (Pat) (High Court of England & Wales) (UK)
Wi-LAN	NPE	Apple	4G	Flat	$0.45*	Jury verdict (Jan. 24, 2020) of infringement of U.S. Patent Nos. 8,457,145; 8,537,757 (reversed on appeal by U.S. Court of Appeals for the Federal Circuit on Feb. 4, 2022 on grounds that Wi-LAN's damages expert made "methodological and factual errors in analyzing the comparable license agreements")	No. 3:14-cv-02235 (S.D. Cal.) (U.S.)

* Subsequently reversed or otherwise called into question † Royalty on network infrastructure, not user equipment

Table 2: Public Arbitration Awards

Licensor	Licensor Type	Licensee	Standard	Royalty Type	Royalty	Add'l Royalty Details	Source
Ericsson	Op Co	Huawei ⁂	4G Multimode	Rate	0.590%‡	"In January 2016, after an arbitration designed to resolve a negotiating impasse, Ericsson and Huawei executed a global patent cross-license to their respective 2G, 3G, and 4G Essential Patents until December 31, 2018 . . . The arbitrators determined that Huawei would pay running percentage royalty rates . . . for multi-mode 4G"	Memorandum of Findings of Fact and Conclusions of Law, TCL Comm'n Tech. Holdings, Ltd. v. Telefonaktiebolaget LM Ericsson, No. 8:14-cv-00341 (C.D. Cal. Nov. 8, 2017)
Nokia	Op Co	Blackberry	WiFi, 3G, 4G	Lump Sum	$137 million‡	Arbitration initiated in 2016 to resolve disagreement about 2012 license	*See, e.g.*, Jussi Rosendahl & Morgan Sharp, BlackBerry Loses Payment Dispute with Nokia, to Pay $137 Million, Reuters (Dec. 1, 2017)
Nokia	Op Co	LG	3G, 4G	Lump Sum	€180 million‡	"a one-off payment of 180 million euros from a settled patent arbitration with LG"	*See, e.g.*, Jussi Rosendahl & Tuomas Forsell, Nokia Posts Weak Network Profits, Sees Market Decline in 2018, Reuters (Oct. 26, 2017)
Nokia	Op Co	Samsung	3G, 4G	Lump Sum	€1.3 billion (€200–€250 million per year)‡	"As part of the settlement, Nokia is expecting to gain 1.3 billion euros" total, or "200 million to 250 million euros from Samsung" annually "Samsung and Nokia entered into a binding arbitration in 2013 to settle additional compensations for Nokia's phone patents for a five-year period starting from early 2014."	*See, e.g.*, Sumit Passary, Nokia Resolves Patent Dispute with Samsung But Not Everyone Is Happy, Tech Times (Feb. 1, 2016); Jussi Rosendahl, Nokia Patent Sales Forecast from Samsung Deal Hits Shares, Reuters (Jan. 31, 2016)

⁂ Observable, despite redactions in court filings, when combined with additional public information
‡ License may also cover Wi-Fi, video codec, and/or other (standard-essential or non-essential) patents

Table 3: Announced Rates & Licensing Demands

Licensor	Licensor Type	Standard	Royalty Type	Royalty	Add'l Royalty Details	Source
Alcatel-Lucent	Op Co	4G	Rate	2%	"for handsets at a discounted royalty of no greater than 2%"	Statement, Alcatel-Lucent LTE Licensing (undated, available by at least Dec. 4, 2008)
Avanci	Pool	eCall, 4G Multimode	Flat	$15‡ (per vehicle)	Rate applies to "connected vehicles" and "will never increase . . . . regardless of: The number of 2G, 3G and 4G essential patents added to the license; How many new companies join the Avanci marketplace . . . ; The number of connections included in a vehicle"; 4G rate "includes 2G/3G and eCall"	Avanci, Marketplace, https://www.avanci.com/marketplace/#li-pricing, (last visited Nov. 16, 2021)
Conversant Wireless / Core Wireless	NPE	4G Only 4G Multimode	Rate Rate	0.033% / 0.050% / 0.149% (depending on market) 0.16% / 0.17% (depending on market)	"0.149% du Prix Net de Vente pour chaque Dispositif d'Utilisateur Final conforme au moins à la norme 4G qui est vendu dans les Marchés Principaux de la norme 4G ; • 0.170% du Prix Net de Vente pour chaque Dispositif d'Utilisateur Final conforme au moins aux normes 4G et 3G qui est vendu dans les Autres Marchés de la norme 4G qui sont également les Marchés Principaux de la norme 3G ; • 0.160% du Prix Net de Vente pour chaque Dispositif d'Utilisateur Final conforme avec au moins les normes 4G, 3G et 2G qui est vendu dans des marchés qui sont les Autres Marchés 4G et 3G et qui sont également les Marchés Principaux de la norme 2G ; • 0.050% du Prix Net de Vente pour chaque Dispositif d'Utilisateur Final conforme au moins à la norme 4G qui est vendu dans les marchés qui sont les Autres Marchés des norms 4G, 3G et 2G ; • 0.033% du Prix Net de Vente pour chaque Dispositif d'Utilisateur Final conforme au moins à la norme 4G qui est vendu en Chine" (demand made Dec. 6, 2017)	Conversant Wireless Licensing SARL v. LG Electronics France SAS, No. 061/2019, RG 15/17037 (Court of Appeals of Paris, April 16, 2019)
Ericsson	Op Co	5G Multimode 4G	Flat Rate	$2.50– $5.00 1.5%	"royalty rate of $5 per 5G/NR multimode compliant handset"; "In exceptional circumstances . . . as low as . . . a floor of $2.5 per 5G/NR multimode compliant handset" "around 1.5 percent for handsets"	Statement, Ericsson's FRAND Licensing Terms for 5G/NR in 3GPP Release 12 (March 3, 2017) Ericsson, Licensing Programs (undated, available by at least July 16, 2009)
Harfang IP (Hedwig Wireless Tech. LLC)	NPE	5G 4G	Flat Flat	$0.07 $0.06	"standard rate" of $0.09 on pre-license sales "standard rate" of $0.08 on pre-license sales	HWT Patents and Rates, https://harfangip.com/home/licensing/portfolios/hwt/hwt-patents-and-rates/ (last visited Oct. 28, 2021)

Licensor	Licensor Type	Standard	Royalty Type	Royalty	Add'l Royalty Details	Source
Huawei	Op Co	5G Multimode	Flat	$2.50	"for every multi-mode 5G smartphone . . . a reasonable percentage royalty rate of the handset selling price, and a per unit royalty cap at US$2.5"	Press Release, Huawei Releases White Paper on Innovation and Intellectual Property 2020 (Mar. 16, 2021)
		4G	Rate	1.5%	"some flexibility, but not to exceed 1.5 percent" on "end-user products"	Stasik (2010) (quoting an undated press release last accessed on July 21, 2009)
InterDigital	NPE	5G Multimode	Rate	0.6%	rate on handset price, with $60 price floor and $200 price cap	Rate Disclosure, https://www.interdigital.com/rate-disclosure (last visited Oct. 28, 2021)
		4G Multimode	Rate	0.5%	rate on handset price, with $50 price floor and $200 price cap "royalty rate that would apply would be that related to the most advanced technology present on the device. So, if it is a 4G phone (with 3G backwards capability), the royalty rate that applies is the 4G rate."	
INVT SPE	NPE	4G Only	Flat	$0.23	"$ 0.30 per end user device enabled for both 3G and LTE, $ 0.23 per end user device enabled for LTE but not 3G" (date of demand not specified)	Answer to Complaint, INVT SPE LLC v. HTC Corp., No. 2:17-cv-03740, at *31 (D.N.J. Nov. 10, 2017)
		4G Multimode	Flat	$0.30		
Motorola	Op Co	4G	Rate	2.25%	"approximately 2.25 percent"	Statement, Motorola LTE Essential Patent Licensing (undated, available by at least Jan. 7, 2009)
Nokia	Op Co	5G	Flat	€3.00	"capped at €3 per device"	Press Release, Nokia Licensing Rate Expectations for 5G/NR Mobile Phones (Aug. 21, 2018)
		4G Only	Rate	1.5%	"in a range of 1.5 percent from the sales price of an end-user device" and not "higher than 2.0 percent from the sales price of an end-user device for [all Nokia] IPR that is essential to wireless communication"	Statement, Nokia Licensing Policy on Long Term Evolution and Service Architecture Evolution Essential Patents (undated, available by at least Jan. 7, 2009)
		4G Multimode	Rate	2.0%		
Nokia-Siemens	Op Co	4G	Rate	0.8%	"in the region of 0.8 percent of the selling price" of "end-use terminal devices"	Statement, Our Licensing Policy for Long Term Evolution and System Architecture Evolution Essential Patents (undated, available by at least Jan. 7, 2009)

Licensor	Licensor Type	Standard	Royalty Type	Royalty	Add'l Royalty Details	Source
Nortel	Op Co	4G	Rate	1%	"about one percent subject to [unspecified] terms"	Press Release, Nortel Publishes LTE Rates (May 5, 2008)
Philips	Op Co	3G, 4G	Flat	$0.75‡	"In het voorstel van Philips is een wereldwijde licentie opgenomen voor de volledige voor UMTS en LTE relevante octrooiportefeuille . . . , tegen een vergoeding van USD 0,75 per gelicentieerd product . . . (het compliance-tarief) en USD 1,-bij non compliance en voor verkopen in het verleden . . . ." (offer made July 28, 2015) "De voorgestelde royalty bedroeg $ 0,75 per product met UMTS- en/of LTE-functionaliteit. Over de reeds verkochte producten diende een royalty van $ 1,- per product te worden afgerekend . . . ." (offer made July 28, 2015)	Koninklijke Philips N.V. v. WIKO SAS, No. GHDHA:2019:3613 (Court of Appeal The Hague, July 2, 2019) Archos S.A. v. Koninklijke Philips N.V., No. , ECLI:NL:RBDHA:2017:1025 (District Court of The Hague, Feb. 10, 2017)
Qualcomm	Op Co	5G Only 5G Multimode 4G Only 4G Multimode	Rate Rate Rate Rate	2.275%‡ 3.25%‡ 3.25%‡ 5%‡	In 2018 "Qualcomm said it would cap the phone price that is the basis of the [royalty] calculation at $400" "An effective running royalty rate of 2.275% of the selling price of branded single-mode 5G handsets; and . . . 3.25% of the selling price of branded multi-mode (3G/4G/5G) handsets" "approximately 3.25 percent of the wholesale selling price" and "with respect to multi-mode LTE/3G CDMA Devices . . . Qualcomm expects that it will not charge a royalty rate on such multi-mode devices for use of both Qualcomm's standards essential LTE and . . . 3G CDMA patents that is greater than Qualcomm's standard 3G CDMA royalty rate [5%], subject to certain standard terms and conditions."	Stephen Nellis & Sonam Rai, Qualcomm Easing Licensing Terms in Bid to Strike Deals, Reuters (April 25, 2018) Statement, Qualcomm 5G NR Royalty Terms Statement (Nov. 2017) Statement, LTE/WiMax Patent Licensing Statement (Dec. 2008)
Qualcomm	Op Co	4G Multimode	Rate	4%‡ (with chip purchase requirement)	"[On] November 19, 2013 . . . Qualcomm [offered to] rebate Lenovo $5 for every Qualcomm modem chip Lenovo purchased, up to a total of $180 million. . . . . [In return,] Lenovo would have to '[e]nter into a 4G SULA . . . with Qualcomm that is generally on Qualcomm's standard terms including royalties of 4% of the net selling price' and '[c]ommit to purchase [a minimum number of chips]' . . . . Lenovo did not accept . . . ."	FTC v. Qualcomm, Inc., 411 F. Supp. 3d 658, 718-19 (N.D. Cal. 2019)

Licensor	Licensor Type	Standard	Royalty Type	Royalty	Add'l Royalty Details	Source
Qualcomm	Op Co	4G Multimode	Rate	3.8%‡ (with chip purchase requirement)	"In 2016, QTL offered Motorola a chip incentive fund that Motorola concluded would reduce Motorola's effective royalty rate to 3.8% only if Motorola purchased 100% of its modem chips from Qualcomm."	FTC v. Qualcomm, Inc., 411 F. Supp. 3d 658, 771 (N.D. Cal. 2019)
Sisvel	Pool	4G Only	Flat	€0.4–€0.99 (depending on volume) €0.53	"early bird" rates €0.24 - €0.6 applied if license completed "within 270 days from the first contact established with Sisvel" (before Jan. 2018) "standard rate" of €0.66 applies to pre-license sales (since March 2018)	LTE/LTE-A: License Terms, https://web.archive.org/web/20171227212035/http://www.sisvel.com/licensing-programs/wireless-communications/lte-lte-a/license-terms (archived Dec. 27, 2017) Mobile Communication Platform: License Terms, https://www.sisvel.com/licensing-programs/wireless-communications/mcp/license-terms (last visited Nov. 16, 2021)
Unwired Planet / Optis	NPE	4G	Rate	0.161% / 0.41% (depending on market)	"for end user devices compliant with 4G, the royalty rates . . . in this offer [are] 0.41% for Major Markets and 0.161% for Other Markets or China"	Optis Cellular Tech. LLC v. Apple Retail UK Ltd., [2019] EWHC 3538 (Pat), at ¶ 18 (Dec. 17, 2019)
Via Licensing	Pool	4G	Flat	$2.10–$3 (depending on volume) $0–$2.10 (depending on volume)	"Original LTE pool rates" (before March 2017) "Modified LTE pool rates" (since March 2017)	LTE License Fees, https://www.via-corp.com/licensing/long-term-evolution-lte/lte-license-fees/ (last visited Oct. 28, 2021); Jack Ellis, Via Licensing Revises Royalty Rates in Effort to Appeal to SMEs and Asian Wireless Device Makers, IAM Market Blog (March 14, 2017)
ZTE	Op Co	4G	Rate	1%	"a maximum 1 percent from the sales price of an end user device"	Press Release, The Licensing Policy on LTE Essential Patents of ZTE (Dec. 22, 2008)

‡ License may also cover Wi-Fi, video codec, and/or other (standard-essential or non-essential) patents

Table 4: Public Licenses and Settlements

Licensor	Licensor Type	Licensee	Standard	Royalty Type	Royalty	Add'l Royalty Details	Source
Ericsson	Op Co	[Redacted]	4G	Rate	1.0%‡	"1.0% of the net selling price of 4G handsets with a floor of $1.00 per handset and a cap of $4.00 per handset"	HTC Corp. v. Telefonaktiebolaget LM Ericsson, 407 F. Supp. 3d 631, 639 (E.D. Tex. 2019)
Ericsson	Op Co	[Redacted]	4G Only 4G Multimode	Rate Rate	1.5% (China)‡ 2.4%–3.0%‡	"1.5% of the net selling price for 4G handsets sold in China with a floor of $1.30 per handset and a cap of $2.00 per handset. 2.4% - 3.0% of the net selling price for 4G multimode handsets sold outside of China with a floor of $2.00 per handset and cap of $5.00 per handset."	
Ericsson	Op Co	[Redacted]	4G	Flat	$2.20‡	"approximately $2.20 per 4G handset"	
Ericsson	Op Co	[Redacted]	4G	Flat	$2.30‡	"$2.30 per 4G handset"	
Ericsson	Op Co	[Redacted]	4G	Rate	1.3%‡	"1.3% of the net selling price of each 4G handset with a floor of $1.25 per handset and a cap of $4.00 per handset."	
Ericsson	Op Co	[Redacted]	4G	Rate	1.4%‡	"1.4% of the net selling price of each 4G handset with a floor of $1.50 per handset and a cap of $4.50 per handset."	
Ericsson	Op Co	[Redacted]	4G	Lump Sum / Rate	$39 million per quarter‡, plus 1.0%‡	"Payments of $39 million per quarter from 2018–19Q1. Then, additional payments of 1.0% of the net selling price of each 4G handset with a floor of $1.25 per handset and a cap of $4.00 per handset."	
Ericsson	Op Co	Apple **	4G	Rate	0.314%‡	Rate derived by "unpacking" a December 19, 2015 global portfolio license (covering the period Jan. 2015 to Jan. 2022) that included a redacted lump sum payment amount and a cross-license to "Apple's infrastructure SEPs"	Memorandum of Findings of Fact and Conclusions of Law, TCL Comm'n Tech. Holdings, Ltd. v. Telefonaktiebolaget LM Ericsson, No. 8:14-cv-00341 (C.D. Cal. Nov. 8, 2017)
Ericsson	Op Co	HTC **	4G	Rate	0.398%–0.662% (depending on unpacking methodology)‡	Rate derived by "unpacking" a December 31, 2014 global portfolio cross-license covering a period beginning in 2014 (with no end date provided)	

Licensor	Licensor Type	Licensee	Standard	Royalty Type	Royalty	Add'l Royalty Details	Source
Ericsson	Op Co	[Redacted]	4G	Rate	1.0%‡	"1.0% of the net selling price of 4G handsets with a floor of $1.00 per handset and a cap of $4.00 per handset"	HTC Corp. v. Telefonaktiebolaget LM Ericsson, 407 F. Supp. 3d 631, 639 (E.D. Tex. 2019)
Ericsson	Op Co	[Redacted]	4G Only 4G Multimode	Rate Rate	1.5% (China)‡ 2.4%–3.0%‡	"1.5% of the net selling price for 4G handsets sold in China with a floor of $1.30 per handset and a cap of $2.00 per handset. 2.4% - 3.0% of the net selling price for 4G multimode handsets sold outside of China with a floor of $2.00 per handset and cap of $5.00 per handset."	
Ericsson	Op Co	[Redacted]	4G	Flat	$2.20‡	"approximately $2.20 per 4G handset"	
Ericsson	Op Co	[Redacted]	4G	Flat	$2.30‡	"$2.30 per 4G handset"	
Ericsson	Op Co	[Redacted]	4G	Rate	1.3%‡	"1.3% of the net selling price of each 4G handset with a floor of $1.25 per handset and a cap of $4.00 per handset."	
Ericsson	Op Co	[Redacted]	4G	Rate	1.4%‡	"1.4% of the net selling price of each 4G handset with a floor of $1.50 per handset and a cap of $4.50 per handset."	
Ericsson	Op Co	[Redacted]	4G	Lump Sum / Rate	$39 million per quarter‡, plus 1.0%‡	"Payments of $39 million per quarter from 2018–19Q1. Then, additional payments of 1.0% of the net selling price of each 4G handset with a floor of $1.25 per handset and a cap of $4.00 per handset."	
Ericsson	Op Co	LG **	4G	Rate	0.328%–0.499% (depending on unpacking methodology)‡	Rate derived by "unpacking" a June 27, 2014 global portfolio cross-license (covering a period beginning in 2013 and concluding on a redacted date) that included redacted annual payment amounts and the transfer of ten U.S. patent families from LG to Ericsson	

Ericsson	Op Co	Samsung [**]	4G 2G, 3G, 4G	Rate Lump Sum	0.413%–0.524% [‡] (depending on unpacking methodology) SEK 4.2 billion[‡]	Rate derived by "unpacking" a January 2014 global portfolio cross-license (covering a period beginning in 2011 and concluding on a redacted date) that included a redacted one-time lump sum payment amount, plus a redacted annual payment amount or per unit royalty, and a commitment from Samsung to purchase Ericsson modems "On January 27, 2014, Ericsson and Samsung signed an agreement on global patent licenses between the two companies . . . . The cross-license agreement covers patents relating to GSM, UMTS, and LTE standards for both networks and handsets. The agreement includes an initial payment and ongoing royalty payments from Samsung to Ericsson for the term of the new multi-year license agreement. The transaction contributed to net sales of SEK 4.2 billion, operating income of SEK 4.2 billion and net income of SEK 3.3 billion in 2013."	Memorandum of Findings of Fact and Conclusions of Law, TCL Comm'n Tech. Holdings, Ltd. v. Telefonaktiebolaget LM Ericsson, No. 8:14-cv-00341 (C.D. Cal. Nov. 8, 2017) Ericsson, Annual Report 2013 37 (2013)
InterDigital	NPE	Acer	4G Only 4G Multimode	Rate Rate	1.5% 2%	"4G Only Licensee Terminal Units: 1.50% of Deemed Price 4G Multi-mode Licensee Terminal Units: 2.00% of Deemed Price"	Anne Layne-Farrar, InterDigital v. Arima Arbitration Demonstratives (Dec. 9, 2013) (citing arbitration exhibit 427)
InterDigital	NPE	Apple	3G, 4G	Lump Sum	$111.7 million[‡] per year	"During fourth quarter 2016, we entered into a multi-year, royalty-bearing, worldwide and non-exclusive license agreement with Apple . . . . including, but not limited to, its 3G, 4G and future generation cellular and wireless-enabled products. The agreement gives Apple the right to terminate certain rights and obligations under the license for the period after September 30, 2021, but has the potential to provide a license to Apple for a total of up to six years." InterDigital, Annual Report 2016 (2016).	InterDigital, Annual Report 2020 (2020) ($111.7 million); InterDigital, Annual Report 2019 (2019) ($111.7 million); InterDigital, Annual Report 2018 (2018) ($111.7 million); InterDigital, Annual Report 2017 (2017) ($111.7 million); InterDigital, Annual Report 2016 (2016) ($169.3 million, including $141.4 million for past sales)

Licensor	Licensor Type	Licensee	Standard	Royalty Type	Royalty	Add'l Royalty Details	Source
Ericsson	Op Co	[Redacted]	4G	Rate	1.0%‡	"1.0% of the net selling price of 4G handsets with a floor of $1.00 per handset and a cap of $4.00 per handset"	HTC Corp. v. Telefonaktiebolaget LM Ericsson, 407 F. Supp. 3d 631, 639 (E.D. Tex. 2019)
Ericsson	Op Co	[Redacted]	4G Only 4G Multimode	Rate Rate	1.5% (China)‡ 2.4%–3.0%‡	"1.5% of the net selling price for 4G handsets sold in China with a floor of $1.30 per handset and a cap of $2.00 per handset. 2.4% - 3.0% of the net selling price for 4G multimode handsets sold outside of China with a floor of $2.00 per handset and cap of $5.00 per handset."	
Ericsson	Op Co	[Redacted]	4G	Flat	$2.20‡	"approximately $2.20 per 4G handset"	
Ericsson	Op Co	[Redacted]	4G	Flat	$2.30‡	"$2.30 per 4G handset"	
Ericsson	Op Co	[Redacted]	4G	Rate	1.3%‡	"1.3% of the net selling price of each 4G handset with a floor of $1.25 per handset and a cap of $4.00 per handset."	
Ericsson	Op Co	[Redacted]	4G	Rate	1.4%‡	"1.4% of the net selling price of each 4G handset with a floor of $1.50 per handset and a cap of $4.50 per handset."	
Ericsson	Op Co	[Redacted]	4G	Lump Sum / Rate	$39 million per quarter‡, plus 1.0%‡	"Payments of $39 million per quarter from 2018–19Q1. Then, additional payments of 1.0% of the net selling price of each 4G handset with a floor of $1.25 per handset and a cap of $4.00 per handset."	
InterDigital	NPE	Blackberry	3G, 4G	Lump Sum	at least $71.6 million‡	"In 2003, we entered into a worldwide, non-exclusive, royalty-bearing patent license agreement with Research In Motion . . . covering certain 2G products, and, in 2007, the agreement was amended to extend the term for a multi-year period and to add coverage for certain 3G products. In 2012, the agreement was amended again to extend the term for a multi-year period and to add coverage for 4G products . . . . The Blackberry PLA expired at the end of 2017. During 2017, we recognized a total of $71.6 million of revenue associated with the Blackberry PLA." InterDigital, Annual Report 2017 (2017)	InterDigital, Annual Report 2017 (2017) (13% of 2017 total annual revenue, including $70.7 million for past sales, plus "< 10%" of 2016 and 2015 total revenue)

InterDigital	NPE	Huawei	video codec, WiFi, 3G, 4G, 5G	Lump Sum	$52.1 million‡	"During second quarter 2020, we entered into a multi-year, worldwide, non-exclusive, royalty-bearing patent license . . . with Huawei . . . . [that] covers the sale of certain of Huawei's 3G, 4G, and 5G terminal unit products, including the use of Wi-Fi and HEVC in those products. . . . and extends through December 31, 2023. During 2020, we recognized a total of $52.1 million of revenue associated with the Huawei PLA . . . , which included $19.2 million of past sales" InterDigital, Annual Report 2020 (2020) "During third quarter 2016, we entered into a multi-year, worldwide, non-exclusive, royalty-bearing patent license agreement with Huawei . . . [that] covers sales of Huawei and its affiliates' 3G and 4G terminal unit products and sets forth cash payments to InterDigital and a process for the transfer of patents from Huawei to InterDigital, as well as a framework for discussions regarding joint research and development efforts.. . . . During 2016, we recognized a total of $154.8 million of revenue associated with the Huawei PLA, which included $121.5 million of past sales." InterDigital, Annual Report 2016 (2016)	InterDigital, Annual Report 2020 (2020) ($52.1 million, including $19.2 million for past sales); InterDigital, Annual Report 2017 (2017) ($76.4 million, including $8.4 million for past sales); InterDigital, Annual Report 2016 (2016) ($154.8 million, including $121.5 million for past sales)
			3G, 4G	Lump Sum	$231.2 million‡		
InterDigital	NPE	LG	3G, 4G, 5G	Lump Sum	$31.8 million‡ per year	"During fourth quarter 2017, we entered into a multi-year, worldwide, non-exclusive patent license with LG . . . . [that] covers the 3G, 4G and 5G terminal unit products of LG and its affiliates and sets forth a royalty of cash payments to InterDigital . . . . We recognized $42.4 million of revenue under this patent license agreement during 2017, including $34.5 million of past sales." InterDigital, Annual Report 2017 (2017)	InterDigital, Annual Report 2019 (2019) ($31.8 million); InterDigital, Annual Report 2018 (2018) ($31.8 million); InterDigital, Annual Report 2017 (2017) ($42.4 million, including $34.5 million for past sales)

InterDigital	NPE	Samsung	3G, 4G	Lump Sum	$78.3 million‡ per year 2018–2022 $69 million‡ per year 2013–2017	"Samsung did not elect to terminate [the 2014 license agreement] . . . and the period for such election has expired. Accordingly, the term of our patent license agreement with Samsung ends on December 31, 2022. During 2018, we recognized a total of $78.3 million of revenue associated with the Samsung PLA." InterDigital, Annual Report 2018 (2018) "During second quarter 2014, we entered into a patent license agreement with Samsung. . . . covering the sale by Samsung of 3G, 4G and certain future generation wireless products. The agreement provides Samsung the ability to terminate certain rights and obligations under the license for the period after 2017 but has the potential to provide a license to Samsung for a total of ten years, including 2013 . . . . During 2014, we recognized $138.0 million of revenue . . . ." InterDigital, Annual Report 2014 (2014)	InterDigital, Annual Report 2020 (2020) ($78.3 million); InterDigital, Annual Report 2019 (2019) ($78.3 million); InterDigital, Annual Report 2018 (2018) ($78.3 million); InterDigital, Annual Report 2017 (2017) ($69 million); InterDigital, Annual Report 2016 (2016) ($69 million); InterDigital, Annual Report 2015 (2015) ($69 million); InterDigital, Annual Report 2014 (2014) ($138 million for 2013-2014)
InterDigital	NPE	Sony	3G, 4G	Lump Sum	approx. $40 million‡ per year	"During third quarter 2015, we entered into a new patent license agreement with Sony . . . . for the three-year period that commenced on December 1, 2015. In addition, the new Sony PLA covers Sony's covered product sales that occurred during certain prior periods and that were not covered under our prior agreement with Sony . . . . During 2015, we recognized a total of $60.1 million of revenue associated with this prior agreement and the new Sony PLA, which included $21.8 million of past sales under the new Sony PLA." "In fourth quarter 2012, we entered into a patent license agreement with Sony that covers Sony's sale of 3G and 4G products . . . . During 2013, we recognized $40.0 million of revenue associated with the Sony PLA . . . . Our agreement with Sony includes a three-year license . . . effective January 1, 2013, and an amount for past patent royalties. Under the arrangement, we expect to collect a total of $125.0 million of cash and have also acquired certain patents covering non-baseband technologies from Sony."	InterDigital, Annual Report 2015 (2015) InterDigital, Annual Report 2013 (2013)

Licensor	Licensor Type	Licensee	Standard	Royalty Type	Royalty	Add'l Royalty Details	Source
Ericsson	Op Co	[Redacted]	4G	Rate	1.0%‡	"1.0% of the net selling price of 4G handsets with a floor of $1.00 per handset and a cap of $4.00 per handset"	HTC Corp. v. Telefonaktiebolaget LM Ericsson, 407 F. Supp. 3d 631, 639 (E.D. Tex. 2019)
Ericsson	Op Co	[Redacted]	4G Only 4G Multimode	Rate Rate	1.5% (China)‡ 2.4%–3.0%‡	"1.5% of the net selling price for 4G handsets sold in China with a floor of $1.30 per handset and a cap of $2.00 per handset. 2.4% - 3.0% of the net selling price for 4G multimode handsets sold outside of China with a floor of $2.00 per handset and cap of $5.00 per handset."	
Ericsson	Op Co	[Redacted]	4G	Flat	$2.20‡	"approximately $2.20 per 4G handset"	
Ericsson	Op Co	[Redacted]	4G	Flat	$2.30‡	"$2.30 per 4G handset"	
Ericsson	Op Co	[Redacted]	4G	Rate	1.3%‡	"1.3% of the net selling price of each 4G handset with a floor of $1.25 per handset and a cap of $4.00 per handset."	
Ericsson	Op Co	[Redacted]	4G	Rate	1.4%‡	"1.4% of the net selling price of each 4G handset with a floor of $1.50 per handset and a cap of $4.50 per handset."	
Ericsson	Op Co	[Redacted]	4G	Lump Sum / Rate	$39 million per quarter‡, plus 1.0%‡	"Payments of $39 million per quarter from 2018–19Q1. Then, additional payments of 1.0% of the net selling price of each 4G handset with a floor of $1.25 per handset and a cap of $4.00 per handset."	
IPCOM	NPE	Deutsche Telekom	3G, 4G	Lump Sum	estimated €100–€400 million	referencing "[t]he €100 million that Deutsche Telekom paid to IPCom in 2013" and noting that "[i]f sources close to the parties are to be believed, the final sum was . . . . as much as €400 million." "A deal announced last month settled all 20 cases between IPCom and Deutsche Telekom over patent infringements, but neither party gave financial details at the time. IPCom will receive 'a low-to-medium triple-digit million euro' amount from Deutsche Telekom, the two sources told Reuters."	Mathieu Klos, How IPCom Kept the Mobile Phone Industry on Tenterhooks for 13 Years, Juve Patent (Feb. 19, 2020) IPCom Lands Cash Bonanza from D.Telekom Settlement-Sources, Reuters (July 3, 2013)

Licensor	Licensor Type	Licensee	Standard	Royalty Type	Royalty	Add'l Royalty Details	Source
Ericsson	Op Co	[Redacted]	4G	Rate	1.0%‡	"1.0% of the net selling price of 4G handsets with a floor of $1.00 per handset and a cap of $4.00 per handset"	HTC Corp. v. Telefonaktiebolaget LM Ericsson, 407 F. Supp. 3d 631, 639 (E.D. Tex. 2019)
Ericsson	Op Co	[Redacted]	4G Only 4G Multimode	Rate Rate	1.5% (China)‡ 2.4%–3.0%‡	"1.5% of the net selling price for 4G handsets sold in China with a floor of $1.30 per handset and a cap of $2.00 per handset. 2.4% - 3.0% of the net selling price for 4G multimode handsets sold outside of China with a floor of $2.00 per handset and cap of $5.00 per handset."	
Ericsson	Op Co	[Redacted]	4G	Flat	$2.20‡	"approximately $2.20 per 4G handset"	
Ericsson	Op Co	[Redacted]	4G	Flat	$2.30‡	"$2.30 per 4G handset"	
Ericsson	Op Co	[Redacted]	4G	Rate	1.3%‡	"1.3% of the net selling price of each 4G handset with a floor of $1.25 per handset and a cap of $4.00 per handset."	
Ericsson	Op Co	[Redacted]	4G	Rate	1.4%‡	"1.4% of the net selling price of each 4G handset with a floor of $1.50 per handset and a cap of $4.50 per handset."	
Ericsson	Op Co	[Redacted]	4G	Lump Sum / Rate	$39 million per quarter‡, plus 1.0%‡	"Payments of $39 million per quarter from 2018–19Q1. Then, additional payments of 1.0% of the net selling price of each 4G handset with a floor of $1.25 per handset and a cap of $4.00 per handset."	
IPCOM	NPE	Samsung	3G, 4G	Lump Sum	$12.5 million	"At the first oral hearings in the SEP lawsuit between IPCom and Nokia . . . Wolfgang von Meibom, senior partner of Nokia's go-to law firm Bird & Bird . . . . pointed out that [$12.5 million] is exactly the same amount that Samsung pays to IPCom."	Mathieu Klos, How IPCom Kept the Mobile Phone Industry on Tenterhooks for 13 Years, Juve Patent (Feb. 19, 2020)

Nokia	Op Co	Apple	video codec, 3G, 4G, other	Lump Sum / Rate or Flat	€1.7 billion,‡ plus undisclosed ongoing royalties	"We contacted Nokia to confirm if the 'up-front cash payment of €1.7 billion ($2 billion) (of which a part was recognized in Q2 results)' is from Apple, and Nokia's PR team confirmed that . . . . Apple will continue to pay royalties, along with the rest of this up-front payment." "According to Nokia, it's been a longstanding infringement as Apple has allegedly relied on some of Nokia's patents since the iPhone 3GS. Those patents are related to software, video coding, chipsets, display, UI and antenna." "Swedbank AB analyst Jari Honko estimated Apple's one-time payment to Nokia could be around €500 million, or about $720 million" "MKM partners' Tero Kuittinen also had a crack at guessing the numbers. 'I am assuming that the licensing fee would be probably 4 euros per iPhone' he said. And the Globe and Mail reports that 'Analysts said Nokia could be estimated to get between 1 and 2 per cent of iPhone revenue.'"	Apple Agreed to Pay One-Time Up-Front €1.7 Billion to Nokia for Patents, NokiaMob (July 27, 2017) Romain Dillet, Apple Paid Nokia $2 Billion as Part of a Patent Lawsuit Settlement, TechCrunch (July 28, 2017) Nokia, Apple Make Up, Wall Street Journal (June 15, 2011) Charlie Sorrel, Nokia Beats Apple in Patent Dispute, Wired (June 14, 2011)
			video codec, 3G, 4G, other	Lump Sum / Flat (Rate)	Estimated €500 million,‡ plus estimated €4 or 1%–2%		
Nokia	Op Co	Blackberry	WiFi, 3G, 4G	Lump Sum / Flat	€50 million one-time payment, plus estimated $2–$5‡	"Research In Motion . . . paid rival Nokia €50m ($65m) to settle a patent dispute between the two companies related primarily to WiFi networking . . . . Analysts estimate that in addition to the lump sum settlement RIM will pay Nokia a licence fee of between $2 and $5 for each handset it sells . . . ."	Paul Taylor, RIM Paid Nokia €50m to Settle Dispute, Financial Times (Jan. 2, 2013); Research in Motion, Inc, Form 6-K 27 (Dec. 21, 2012)
Nokia	Op Co	Huawei	3G, 4G	Lump Sum	€94 million[107]‡	"During the fourth quarter 2017, Nokia Technologies entered into a multi-year patent licensing agreement with Huawei and received an arbitration ruling related to a contract dispute with BlackBerry [$137 million, see above]. As a result, Nokia Technologies recognized approximately EUR 210 million of non-recurring net sales."	Nokia, Report for Q4 and Full Year 2017 30 (2017)

[107] €210 million less €116 million (approximately $137 million at the USD/EUR exchange rate as of December 2017).

Qualcomm	Op Co	Apple	3G, 4G	Flat	$7.50‡	"Apple struck a deal with Qualcomm in 2007 to set royalties on iPhones at $7.50 per handset. In 2011, the two struck a deal to keep royalties at the same level while giving Qualcomm 'short-term' exclusivity as the iPhone's cellular baseband supplier."	Rick Merritt, Apple Reveals Qualcomm Patent Fees, EE Times (Jan. 14, 2019); *see also* FTC v. Qualcomm, Inc., 411 F. Supp. 3d 658, 724-30 (N.D. Cal. 2019)
			4G, 5G	Lump Sum / Flat	estimated $4.5–$4.7 billion one-time payment, plus estimated $8–$9‡	"On April 16, 2019, we entered into settlement agreements with Apple and its contract manufacturers to dismiss all outstanding litigation between the parties. We also entered into a six-year global patent license agreement with Apple, effective as of April 1, 2019, which includes an option for Apple to extend for an additional two years, and a multi-year chipset supply agreement with Apple. While we continue to assess the accounting impacts of the agreements, our financial guidance for the third quarter of fiscal 2019 includes estimated revenues of $4.5 billion to $4.7 billion resulting from the settlement" "Apple probably also agreed to pay between $8 and $9 in patent royalties per iPhone"	Qualcomm, Earnings Release Q2 2019 5 (2019) Kif Leswing, Apple Paid Up to $6 Billion to Settle With Qualcomm, UBS Estimates, CNBC (Apr. 18, 2019)

Qualcomm	Op Co	Huawei	4G Only 4G Multimode 4G, 5G	Rate Rate Lump Sum	3.5%‡ 5%‡ $1.8 billion one-time payment, plus estimated $200–250 million per quarter‡	"On December 15, 2014, Huawei and Qualcomm entered a Subscriber Unit License Agreement ('2014 SULA'), with an effective date of July 1, 2014 . . . [that] requires Huawei to pay a 5% running royalty rate on devices containing WCDMA technology and a 3.5% running royalty rate on devices containing LTE technology, and includes a royalty cap of [redacted]." "We recently signed a new long-term global patent license agreement with Huawei, including a cross-license, granting back rights to certain of Huawei's patents. We also entered into an agreement settling amounts due under the prior license agreement . . . . We expect to record approximately $1.8 billion of revenue in our fourth fiscal quarter for amounts due under the settlement agreement relating to the prior license period and the new license agreement for the first half of calendar 2020." "In addition to the $1.8 billion payment of back royalties, Rolland estimates Huawei will pay $200 million to $250 million in Qualcomm technology licensing, or QTL, royalties per quarter."	FTC v. Qualcomm, Inc., 411 F. Supp. 3d 658, 712 (N.D. Cal. 2019) Qualcomm, Earnings Call Q3 2020 Wallace Witkowski, Qualcomm Stock Streaks Past $100 as Huawei Settlement Clears Last Barrier to 5G Licensing, MarketWatch (Aug. 1, 2020)
Qualcomm	Op Co	Sony	4G Only 4G Multimode	Rate Rate	3.5%‡ 5%‡	"[O]n May 3, 2012, Sony and Qualcomm entered into a Subscriber Unit Patent License Agreement, effective February 16, 2012 through September 30, 2012 . . . . Sony agreed to provisionally pay Qualcomm a 5% royalty on CDMA handsets . . . . [O]n November 12, 2012, Sony Mobile and Qualcomm entered into a Subscriber Unit Patent License Agreement, effective beginning October 1, 2012 . . . Under that agreement, Sony paid Qualcomm a 5% royalty on CDMA handsets . . . On September 29, 2015, Qualcomm and Sony Corporation entered into a CDMA Complete Terminal Patent License Agreement, with an effective date of October 1, 2015 . . . . [under which] Sony pays Qualcomm a 3.5% running royalty on handset sales . . . . Qualcomm granted Sony 'a discount from our standard royalty terms' because 'Sony granted Qualcomm a very robust cross-license to what we considered a commercially valuable portfolio of patents.'"	FTC v. Qualcomm, Inc., 411 F. Supp. 3d 658, 704-05 (N.D. Cal. 2019)

Licensor	Licensor Type	Licensee	Standard	Royalty Type	Royalty	Add'l Royalty Details	Source
Ericsson	Op Co	[Redacted]	4G	Rate	1.0%‡	"1.0% of the net selling price of 4G handsets with a floor of $1.00 per handset and a cap of $4.00 per handset"	HTC Corp. v. Telefonaktiebolaget LM Ericsson, 407 F. Supp. 3d 631, 639 (E.D. Tex. 2019)
Ericsson	Op Co	[Redacted]	4G Only 4G Multimode	Rate Rate	1.5% (China)‡ 2.4%–3.0%‡	"1.5% of the net selling price for 4G handsets sold in China with a floor of $1.30 per handset and a cap of $2.00 per handset. 2.4% - 3.0% of the net selling price for 4G multimode handsets sold outside of China with a floor of $2.00 per handset and cap of $5.00 per handset."	
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Ericsson	Op Co	[Redacted]	4G	Flat	$2.30‡	"$2.30 per 4G handset"	
Ericsson	Op Co	[Redacted]	4G	Rate	1.3%‡	"1.3% of the net selling price of each 4G handset with a floor of $1.25 per handset and a cap of $4.00 per handset."	
Ericsson	Op Co	[Redacted]	4G	Rate	1.4%‡	"1.4% of the net selling price of each 4G handset with a floor of $1.50 per handset and a cap of $4.50 per handset."	
Ericsson	Op Co	[Redacted]	4G	Lump Sum / Rate	$39 million per quarter‡, plus 1.0%‡	"Payments of $39 million per quarter from 2018–19Q1. Then, additional payments of 1.0% of the net selling price of each 4G handset with a floor of $1.25 per handset and a cap of $4.00 per handset."	
Sol IP / ETRI	NPE / Sovereign Patent Fund	Ericsson	4G (infrastructure)	Lump Sum	$13 million†	"Ericsson has . . . resolved the previously communicated litigation with Sol IP, concerning alleged infringement of 20 patents declared to the LTE standard . . . . The settlement will have a negative impact for 2020 of approximately USD 13 million . . . ."	Ericsson, Annual Report 2019 (2019).
Unwired Planet	NPE	Lenovo	3G, 4G	Lump Sum	$100 million	"The company's only previous licensing deal with Lenovo Group in 2014 yielded $100 million."	Kit Chellel, Unwired Planet is Taking on Samsung and Google, Irish Times (Oct. 5, 2015)

Licensor	Licensor Type	Licensee	Standard	Royalty Type	Royalty	Add'l Royalty Details	Source
Ericsson	Op Co	[Redacted]	4G	Rate	1.0%‡	"1.0% of the net selling price of 4G handsets with a floor of $1.00 per handset and a cap of $4.00 per handset"	HTC Corp. v. Telefonaktiebolaget LM Ericsson, 407 F. Supp. 3d 631, 639 (E.D. Tex. 2019)
Ericsson	Op Co	[Redacted]	4G Only 4G Multimode	Rate Rate	1.5% (China)‡ 2.4%–3.0%‡	"1.5% of the net selling price for 4G handsets sold in China with a floor of $1.30 per handset and a cap of $2.00 per handset. 2.4% - 3.0% of the net selling price for 4G multimode handsets sold outside of China with a floor of $2.00 per handset and cap of $5.00 per handset."	
Ericsson	Op Co	[Redacted]	4G	Flat	$2.20‡	"approximately $2.20 per 4G handset"	
Ericsson	Op Co	[Redacted]	4G	Flat	$2.30‡	"$2.30 per 4G handset"	
Ericsson	Op Co	[Redacted]	4G	Rate	1.3%‡	"1.3% of the net selling price of each 4G handset with a floor of $1.25 per handset and a cap of $4.00 per handset."	
Ericsson	Op Co	[Redacted]	4G	Rate	1.4%‡	"1.4% of the net selling price of each 4G handset with a floor of $1.50 per handset and a cap of $4.50 per handset."	
Ericsson	Op Co	[Redacted]	4G	Lump Sum / Rate	$39 million per quarter‡, plus 1.0%‡	"Payments of $39 million per quarter from 2018–19Q1. Then, additional payments of 1.0% of the net selling price of each 4G handset with a floor of $1.25 per handset and a cap of $4.00 per handset."	
Vringo	NPE	ZTE	4G (infrastructure)	Lump Sum	$21.5 million†	"On December 7, 2015, Vringo . . . entered into a Confidential Settlement and License Agreement (the "Settlement Agreement") with ZTE . . . . ZTE will pay . . . a lump sum of $21.5 million"	Vringo, Form 8-K (Dec. 7, 2015).
Wi-LAN	NPE	Samsung	3G, 4G	Lump Sum	estimated $15–20 million per year‡	"Wi-LAN . . . announced an expansion and renewal of its existing deal with Samsung Electronics Co. Ltd. No terms of the agreement were disclosed, but analysts said . . . . it could be for more than five years . . . . [and] the annual revenue potential from Samsung is between $15-million and $20-million for Wi-LAN."	Jonathan Ratner, Wi-LAN Shares Soar on Samsung Deal Renewal, Financial Post (June 21, 2013).

⁂ Observable, despite redactions in court filings, when combined with additional public information

† Royalty on network infrastructure, not user equipment ‡ License may also cover Wi-Fi, video codec, and/or other (standard-essential or non-essential) patents