United States Court of Appeals for the Federal Circuit

CARNEGIE MELLON UNIVERSITY,
Plaintiff-Appellee

v.

MARVELL TECHNOLOGY GROUP, LTD., MARVELL SEMICONDUCTOR, INC.,
Defendants-Appellants

2014-1492

Appeal from the United States District Court for the Western District of Pennsylvania in No. 2:09-cv-00290-NBF, Judge Nora Barry Fischer.

Decided: August 4, 2015

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Before WALLACH, TARANTO, and CHEN, *Circuit Judges.*

TARANTO, *Circuit Judge.*

Carnegie Mellon University ("CMU") sued Marvell Technology Group, Ltd. and Marvell Semiconductor, Inc. (collectively "Marvell") for infringing two patents related to hard-disk drives. A jury found for CMU on infringement and validity, and it awarded roughly $1.17 billion as a reasonable royalty for the infringing acts, using a rate of 50 cents for each of certain semiconductor chips sold by Marvell for use in hard-disk drives. The district court then used that rate to extend the award to the date of judgment, awarded a 23-percent enhancement of the past-damages award based on Marvell's willfulness (found by the jury and the district court), and entered a judgment of roughly $1.54 billion for past infringement and a continuing royalty at 50 cents per Marvell-sold chip.

Marvell appeals. We affirm the judgment of infringement and validity. As to the monetary relief: We affirm the rejection of Marvell's laches defense to pre-suit damages. We reverse the grant of enhanced damages under the governing willfulness standard, which does not require that Marvell have had a reasonable defense in mind when it committed its past infringement. We reject Marvell's challenge to the royalty (past and continuing) with one exception.

That exception involves an issue of extraterritoriality—whether the royalty, in covering all Marvell sales of certain chips made and delivered abroad, improperly reaches beyond United States borders. We conclude that the royalty properly embraces those Marvell-sold chips that, though made and delivered abroad, were imported into the United States, and we affirm the judgment to the

extent of $278,406,045.50 in past royalties (50 cents for each of the 556,812,091 chips the jury could properly find were imported), plus an amount to be calculated on remand that brings that figure forward to the time of judgment, and the ongoing royalty order to the extent it reaches imported Marvell-sold chips. But as to the Marvell chips made and delivered abroad but never imported into the United States, we conclude that a partial new trial is needed to determine the location, or perhaps locations, of the "sale" of those chips. To the extent, and only to the extent, that the United States is such a location of sale, chips not made in or imported into the United States may be included in the past-royalty award and ongoing-royalty order.

BACKGROUND

CMU owns U.S. Patent No. 6,201,839, titled "Method and Apparatus for Correlation-Sensitive Adaptive Sequence Detection," and related No. 6,438,180, titled "Soft and Hard Sequence Detection in ISI Memory Channels," both granted to Drs. Aleksandar Kavcic and José Moura. The patents' written descriptions are largely identical, and both patents claim methods, devices, and systems for improved accuracy in the detection of recorded data when certain types of errors are likely due to the recording medium and reading mechanism. The inventions are particularly suited for the magnetic data-storage media of hard-disk drives in computers.

The record in the case teaches that a storage disk in a typical hard-disk drive is coated with microscopic granular magnetic material segmented into vast numbers of magnetic "bit regions" arrayed in concentric tracks. Each region may be polarized so that its north pole may point in either of two directions, and that choice of polarity allows for recording of digital data. In particular, data may be encoded in transitions, *i.e.*, in how one magnetic region's orientation compares with (is the same as or

differs from) the orientation of the next magnetic region in line as one moves in a particular direction. In a hard-disk drive, a read-write head hovering above the disk, moving along a track, can detect the orientations of neighboring magnetic regions, thereby reading data, or alter the regions' orientations, thereby writing data.

Although hard-disk drives constituted a mature and well-known technology by the time of the '839 and '180 patents, the demand to store ever more data on each disk gave rise to ever new challenges. One way to store more data is to make the magnetic regions on the disk smaller and smaller, thereby increasing the number of changes in magnetic polarity within each track. But shrinking the magnetic regions makes it difficult in practice for a read head—which detects magnetic forces and translates them into electrical signals, the so-called "measured signals"—to accurately identify the actual polarities and transitions on the disk. It becomes harder to distinguish region-to-region boundaries at which polarity changes from those at which it does not.

Two such difficulties are central to this case. First, a change in magnetic polarity at one region-to-region boundary can affect the measured signal the read head obtains from more than one magnetic region. How much that spill-over effect occurs—how much "noise" there is in the measured signal obtained by the read head—can depend on what polarity changes there actually are, *i.e.*, on the actual "signal" encoded on the disk. The patents term this "signal-dependent noise." Second, nearby (adjacent or almost adjacent) regions and boundaries tend to have related amounts of measurement error. The patents term this "correlated noise." Those two noise effects are sometimes together called "media noise." For technical reasons the parties have not treated as critical to the issues on appeal—including properties of the materials composing the magnetic regions and properties of the read heads—the noise problems become more signifi-

cant when the size of the magnetic regions shrinks below certain levels. *See* J.A. 2210 (signal distortion occurs when magnetic region size nears media grain size).

Although increasing miniaturization of disks' magnetic regions permits the storage of more data in the same amount of space, the benefit can be lost if the data cannot be read accurately because of noise problems. Working together at CMU's Data Storage Systems Center, Dr. Kavcic, as a graduate student, and Dr. Moura, as a professor renowned for expertise in signal processing, conceived of ways of reducing the errors due to media noise and reliably detecting the data recorded on a hard disk. Their solution, embodied in the claims of the two patents at issue, uses a form of maximum-likelihood detection to estimate, given a measured signal (*e.g.*, a sequence of voltage levels produced by a read head's response to detected magnetic forces), the most likely sequence of data symbols actually recorded (by polarization of magnetic regions) on the disk. In theory, for a measured signal consisting of N "samples" taken from N recorded symbols, the most likely recorded-symbol sequence could be determined by comparing every possible N-length sequence of symbols with the measured N-sample signal to determine which sequence best matches the measured signal, by some measure of similarity. But the number of possible sequences to compare grows exponentially with N. More efficient methods are desirable.

One such method (on which the patents at issue here build) takes its name from Andrew Viterbi, a founder of Qualcomm Inc. The Viterbi method proceeds, in effect, two symbols at a time. It starts with the set of possible first symbols for the sequence and possible second symbols and determines which pair makes the measured signal sample most likely. For example, if symbols correspond to single bits and the first symbol is 0, the Viterbi method compares whether a measured sample (say of 0.2 Volts) is more likely if the next recorded bit is a 0 or a 1

(*i.e.*, if the sequence begins 00 or 01).[1] It then iterates the process with the next symbol. It ultimately produces a sequence of most likely symbols, and by discarding unlikely pairings as it goes along, it demands far fewer computations, and far less data retention, than an all-possible-sequences comparison approach. Those savings can make a large practical difference.

In the language of the patents, which is common to the field, each potential pairing of one symbol to the next (*e.g.*, a first bit of 0 with a second bit of 0) is called a "branch." That usage reflects how the possible symbols at any time of sampling can be displayed in matrix form, with the columns representing times of sampling (t_0, t_1, t_2, etc.) and the items in each column the possible symbols at that time; the matrix looks like a "trellis," and the lines connecting pairs of symbols in adjacent columns are "branches." The Viterbi method assigns to each branch a "branch metric," a value representing the likelihood of the measured signal sample arising given the symbol pairing of that branch. Importantly for present purposes, a user

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[1] Each "symbol" need not be a single bit, *i.e.*, a 0 or 1. It might instead, for example, be two bits (00, 01, 10, or 11), thereby creating more possibilities for each symbol and more possible pairings of symbols. It is also possible to use 0, 1, and -1 as choices—for example, to represent, respectively, no change in polarity, a polarity change from north-facing-back to north-facing-forward (considering the direction of the read head's scanning), and a polarity change from north-facing-forward to north-facing-back. We identify one simple choice in text for illustrative purposes. The parties have not identified any way in which the symbol choice affects the issues before us.

of the method must choose one or more "branch metric functions" to calculate and assign each branch metric.[2]

Applying a Viterbi "detector" (an implementation of the Viterbi method) to hard-disk drives was not an innovation of the CMU patents. Instead, the patents claim an improvement over existing detectors by teaching use of branch metric functions that are specifically adapted to reduce the effects of the most likely errors caused by the ever smaller magnetic regions used for storing data on hard disks. Specifically, the patents teach that (1) different functions may be used for different branches, depending in particular on the measured signal samples, and (2) each branch metric function can take as its input a plurality of adjacent signal samples, rather than a single sample. The former addresses signal-dependent noise, the latter correlated noise.

In 1997, Drs. Kavcic and Moura filed a provisional patent application. In May 1998 they published a paper in the IEEE Transactions on Magnetics called *Correlation-Sensitive Adaptive Sequence Detection*. The '839 patent issued in March 2001 from an application filed in April 1998, and the '180 patent issued in August 2002 from a continuation-in-part application filed in March 1999.

Claim 4 of the '839 patent is representative of the asserted claims:

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[2] *See Harris Corp. v. Ericsson Inc.*, 417 F.3d 1241, 1246 (Fed. Cir. 2005) (In "Maximum Likelihood Sequence Estimation using the Viterbi Algorithm, . . . the receiving device compares distorted sequences of received symbols to hypothetical sequences of transmitted symbols to find the sequence of symbols that was most likely transmitted. The hypothetical sequences are distorted in accordance with a model of the transmission medium.").

> 4. A method of determining branch metric values for branches of a trellis for a Viterbi-like detector, comprising:
>
> selecting a branch metric function for each of the branches at a certain time index from a set of signal-dependent branch metric functions; and
>
> applying each of said selected functions to a plurality of signal samples to determine the metric value corresponding to the branch for which the applied branch metric function was selected, wherein each sample corresponds to a different sampling time instant.

'839 patent, col. 14, lines 10–19; *see also* '180 patent, col. 15, lines 39–51 (claims 1 and 2).

Marvell, located in California, designs and sells semiconductor microchips, and it hires foreign companies to manufacture them. It is a major seller in the market for integrated circuits that control the read-write heads used in hard-disk drives. No later than 2001, Marvell became aware of the work that Drs. Kavcic and Moura had just done to improve the accurate detection of data recorded on hard disks. Based on that work, Marvell engineers, as they were designing chips in the competition for the next generation of read heads, built a simulator to use as a "gold standard" for testing their chip designs, and they paid tribute to their source in dubbing the simulator "Kavcic Viterbi." Marvell engineers later designed what they considered a "sub-optimal" version of the Kavcic Viterbi for use in a new generation of Marvell chips, and they again acknowledged Dr. Kavcic's work as a source, internally naming their design the "KavcicPP" ("PP" for "post-processor"). Still later, Marvell created a detector that its engineers recognized "turn[ed] out to be the original structure that Kavcic proposed in his paper." J.A. 46,779. From 2003 to 2012, Marvell sold 2,338,380,542 chips built around those designs. J.A. 6.

In 2009, CMU sued Marvell for patent infringement based on Marvell's development, use, and sale of those chips. The parties went to trial on whether Marvell infringed claim 4 of the '839 patent and claim 2 of the '180 patent under 35 U.S.C. § 271(a), § 271(b), or § 271(c). A jury found that Marvell infringed both claims under all three subsections. The jury also found that Marvell had failed to establish by clear and convincing evidence that either claim was anticipated or would have been obvious in light of the prior art.

Based on CMU's evidence at trial, the jury awarded CMU $1,169,140,271 as a reasonable royalty for Marvell's use of CMU's inventions, corresponding to a 50-cents-per-chip royalty on Marvell's worldwide sales. The district court added $79,550,288 to bring the award up to the date of judgment to reflect Marvell's continued sales of accused chips. Under 35 U.S.C. § 284, the court enhanced the damages by 23%, adding $287,198,828.60 to the award, based on its own assessment of the lack of objective reasonableness of Marvell's defenses at trial and the jury's determinations that Marvell knew of CMU's patents and knew or should have known that its actions were likely to infringe (and, also, that it had no objectively reasonable defenses). The district court separately denied Marvell's affirmative defense that CMU's delay in bringing suit should bar pre-suit damages under the equitable doctrine of laches, concluding that the equities ultimately favored CMU because of Marvell's copying.

Marvell appeals rulings on infringement, invalidity, and damages, as well as willfulness and laches. We have jurisdiction under 28 U.S.C. § 1295(a)(1).

DISCUSSION

We review rulings on issues not unique to patent law under the standards of the relevant regional circuit. *Info-Hold, Inc. v. Muzak LLC*, 783 F.3d 1365, 1371 (Fed. Cir. 2015). Accordingly, here we review the denial of judg-

ment as a matter of law de novo and must affirm if "there is sufficient evidence to support the verdict, drawing all reasonable inferences in favor of the verdict winner." *Blum v. Witco Chem. Corp.*, 829 F.2d 367, 372 (3d Cir. 1987). We review for abuse of discretion the denial of a new-trial motion challenging the verdict as against the weight of the evidence. *Rinehimer v. Cemcolift, Inc.*, 292 F.3d 375, 383–84 (3d Cir. 2002). We review jury instructions de novo, asking "whether the charge, taken as a whole and viewed in light of the evidence, fairly and adequately submits the issue in the case to the jury." *Abrams v. Lightolier Inc.*, 50 F.3d 1204, 1212 (3d Cir. 1995) (quotation marks and citation omitted). Other standards of review are noted as needed below.

I

The general contours of the parties' dispute on liability—on invalidity and infringement—are familiar ones. CMU developed what it believed to be a new and improved way of doing something useful—here, detecting recorded data accurately. In the written-description portions of its patents, it presented, among other things, an optimal way to achieve its stated advance. Its claims, however, were not limited to the optimal embodiment. They claimed not only the optimal approach but also a broader class of processes that exploit the inventors' key insight to solving the problems of the prior art—here, dealing with the difficulty of detecting densely packed data on hard disks by changing the way one calculates the branch metric functions used for retrieving that data.

Marvell does not dispute that CMU made an advance over the prior art or that the claims have support in the written description. Instead, Marvell asserts, on the one hand, that it never implemented CMU's claimed methods because it developed a "suboptimal" solution different from CMU's primary embodiment in the patents. And it asserts on the other hand that, if CMU's claims are con-

strued beyond the optimal embodiment, they must be held invalid for claiming processes already known in the art.

We conclude that the jury, properly instructed on the applicable burdens of persuasion, could properly reject both of Marvell's arguments. The jury could find that the claims at issue are not so broad as to encompass the prior art at issue, but define a class of processes limited to those not taught or made obvious by that prior art. Nor is there any legal significance, standing alone, to Marvell's use of a "suboptimal" solution. The jury could find that Marvell's work differed from a particular embodiment of CMU's claims but came within the limitations set forth in the language of the claims, which define the scope of the protected invention. In other words, the jury could find that the claims are located at the spot on the breadth spectrum occupied by any valid, infringed claim: they are broad enough to encompass the accused processes but not so broad as to encompass the old or obvious.

A

Marvell argues that there was overwhelming evidence that the asserted claims were anticipated by U.S. Patent No. 6,282,251, granted to Glen Worstell, or, in the alternative, that the claims would have been obvious in light of the Worstell patent. In Marvell's view, the evidence of invalidity on those grounds was so strong that the jury could not reasonably reject it, entitling Marvell to judgment as a matter of law, and in any event the verdict must be set aside as against the weight of the evidence, requiring a new trial. Like the district court, we conclude otherwise—for reasons that simultaneously dispose of both of Marvell's evidence-deficiency motions.

"The burden of establishing invalidity of a patent or any claim thereof shall rest on the party asserting such invalidity," 35 U.S.C. § 282, which the party must prove by clear and convincing evidence, *Microsoft Corp. v. i4i Ltd. P'ship*, 131 S. Ct. 2238, 2251–52 (2011). "Anticipa-

tion requires the presence in a single prior art disclosure of all elements of a claimed invention arranged as in the claim." *Connell v. Sears, Roebuck & Co.*, 722 F.2d 1542, 1548 (Fed. Cir. 1983). Marvell's invalidity challenge fails, because the jury could properly find that Marvell failed to show by clear and convincing evidence that the Worstell patent discloses, or makes obvious, "selecting a branch metric function for each of the branches at a certain time index from a set of signal-dependent branch metric functions," as required by claim 4 of the '839 patent and, in slightly different language, by claim 2 of the '180 patent ("selecting a branch metric function at a certain time index . . . wherein the branch metric function is selected from a set of signal-dependent branch metric functions").

The district court construed "signal-dependent branch metric function" to mean "a branch metric function that accounts for the signal-dependent structure of the media noise." *Carnegie Mellon Univ. v. Marvell Tech. Grp.*, No. 09-cv-00290, 2010 WL 3937157, at *20 (W.D. Pa. Oct. 1, 2010) (quotation marks omitted). Under that construction, not contested here, Marvell contends that Worstell discloses a set of branch metric functions that account for the signal-dependent structure of the media noise. Anticipation depends on that contention, and so does obviousness, because Marvell makes no substantial argument for obviousness independent of its contention about Worstell on this point.

Marvell points to a brief comment in Worstell that a previously described branch metric function "can be further modified to take into account transition noise," '251 patent, col. 10, lines 48–50, and argues that experts for both sides agreed that "transition noise" is a type of signal-dependent noise. The passage Marvell points to explains that, rather than applying an identical branch metric function to every branch, the function "can be modified by multiplying the metrics which correspond to transitions by a fraction which depends on the transition

noise standard deviation." *Id.* col. 10, lines 54–56. ("Transition" here refers to a change in magnetic polarity, as might occur when a 0 is followed by a 1, or vice-versa.) In Marvell's view, the passage teaches two branch metric functions—one for branches that do not correspond to a transition and another, the same as the first but multiplied by a single fraction, for branches corresponding to a transition. The two functions, Marvell says, form the required "set" of signal-dependent branch metric functions.

The jury could reject Marvell's position. Marvell's expert himself noted that the branch metric function without the fraction does not account for signal-dependent noise and "it's just that additional modification [*i.e.*, the additional fraction] [that] takes into account the signal dependency." J.A. 44,661–62. Moreover, the branch metric function with the fraction is a single function: the fraction that distinguishes it from the original, non-signal-dependent Worstell function is a constant, not varying from time to time, and any branch assigned that function uses the same fraction-containing function. *See Carnegie Mellon Univ. v. Marvell Tech. Grp.*, No. 09-cv-00290, 2011 WL 4527353, at *8 (W.D. Pa. Sept. 28, 2011); Worstell '251 patent, col. 9, Equation 20 and accompanying text (filter tap weights W_i are constant); *id.* col. 10, lines 48–66 (additional fraction is constant); J.A. 44,957–58 (CMU expert); Oral Argument, No. 2014-1492, at 5:25 (Marvell agrees that additional fraction is constant). On this record, it was not unreasonable for the jury to conclude that Worstell discloses at most one signal-dependent branch metric function—the one with the fraction—and not the claim-required "set." There is no dispute that "set" here requires more than one such function, as the claims require selecting among a plurality of such functions at a given time index.

When Marvell argues here that "[b]oth functions must be used to account for signal-dependent noise," pointing to

the function without the fraction and the function with it, Marvell Opening Br. 36, it confirms the basis for the jury's verdict. Marvell's language confirms that the unmodified and modified functions are each "functions." Only one, however, is signal-dependent. Marvell cannot describe the *choice* between the two options as itself the "function," because that too would give Worstell only a single "function," not a "set." Accordingly, Marvell's position is essentially that it is sufficient for the *set* collectively to account for the signal-dependent nature of the noise. But that is wrong under the clear claim language as construed, which requires each of the *functions* themselves, the elements in the set, to account for that noise.

Marvell never points to any evidence that Worstell discloses multiple functions, each function possessing the required property of accounting for signal-dependent noise. The jury could find insufficient evidence that Worstell teaches or suggests what the claim requires. We therefore affirm the verdict of no proven invalidity.

B

The jury found that Marvell both directly and indirectly infringed the two (method) claims at issue by developing, testing, and selling to its customers—notably, some of the world's leading makers of hard-disk drives—products that practice the claimed methods. Marvell rests its challenge to the jury's finding solely on arguments about whether its chips' operation and one of its testing activities meet the claim limitations. Marvell raises no issue about other elements of infringement, such as the knowledge element of indirect infringement. We reject Marvell's challenges, concluding that the jury had substantial evidence to support its verdict.

1

The jury had sufficient evidence to find that use of the products incorporating Marvell's Media Noise Processor

(MNP) and Enhanced Media Noise Processor (EMNP) designs infringes CMU's patent claims—products we may discuss together, Marvell not having identified differences between them material to the outcome. CMU presented substantial evidence that Marvell's MNP and EMNP post-processors carry out every step of the claimed methods. *See* J.A. 41,815–28 (expert testimony); J.A. 34,941–59 (jury slides). CMU used Marvell's internal documents to show that Marvell's devices first use a traditional Viterbi detector (with traditional branch metric functions) to identify the most likely symbol sequence and then use a "post-processor" that recalculates branch metrics for a subset of the branches corresponding to the most likely errors. J.A. 34,941–59. Marvell's devices calculate those subsequent branch metrics using functions that change over time, *i.e.*, they select at certain times new parameters that define a new branch metric function, and they apply the different functions to multiple signal samples. *See* J.A. 46,588. That essential characteristic is reflected in the fact, noted above, that Marvell internally named its post-processor the "KavcicPP" after one of CMU's inventors. For at least that subset of branch metric calculations, therefore, CMU presented evidence that Marvell's devices practiced the patents' claims.

Marvell argues that its method is carried out in a post-processor and not a Viterbi detector, does not occur "in a 'trellis,'" and therefore is outside the claims. Marvell Opening Br. 41–42. The parties stipulated that the term "branch" means "a potential transition between two states (nodes) immediately adjacent in time in a 'trellis.'" J.A. 3179. Marvell characterizes the calculations performed by its MNP/EMNP post-processors as an evaluation of error sequences, not branch metric calculations, because they do not occur in a traditional Viterbi detector.

The district court's unappealed claim construction of "Viterbi-like" defeats Marvell's argument. As noted above, a "trellis" (a lattice whose nodes form a matrix) is

used as a graphical representation of the Viterbi detection method. A trellis diagram shows all the possible branches (symbol-to-symbol steps) for a given system. During claim construction, Marvell argued to the district court that the phrase "Viterbi-like" in the preamble to claim 4 of the '839 patent limited the claim to detectors that calculate a branch metric or perform "a step similar to calculating branch metrics" for *every* branch of the Viterbi trellis. *Carnegie Mellon Univ.*, 2010 WL 3937157, at *22 (quotation marks and citation omitted). It argued that "Viterbi-like" does not cover a post-processor that calculates a branch metric for only some, not all, branches, citing the fact that during prosecution CMU distinguished a prior-art reference that included a post-processor.

The district court rejected Marvell's arguments and adopted CMU's construction, which the parties and the court understood to encompass a post-processor that calculated some but not all branch metrics "in a trellis." *Carnegie Mellon Univ.*, 2010 WL 3937157, at *22–25. The district court properly concluded that CMU distinguished the prior-art reference during prosecution not on the ground that it used a post-processor but on the ground that its post-processor did not apply branch metric functions to a "plurality of time variant signal samples." *Id.*; *see also* J.A. 41,631–32 (Dr. Kavcic testifying to same at trial). The court's construction made clear, therefore, that claim 4 of the '839 patent is broad enough to cover a method that calculates some but not all branch metrics in accordance with the other claim limitations, regardless of whether those calculations occur in a "Viterbi" detector. And that is true *a fortiori* of claim 2 of the '180 patent, which does not even have the qualifier "Viterbi-like" before the word "detector."

Given that construction, CMU's evidence establishing that Marvell's post-processors carry out every step of the claimed methods cannot be held insufficient on the ground that the post-processors do not calculate metrics

for every branch of a trellis. Nor is the evidence made insufficient by Marvell's expert testimony that the Marvell post-processor calculations do not produce branch metrics because they calculate only the "difference" between two branch metrics of the Viterbi trellis branches. J.A. 44,522–25. The parties' stipulated construction of "branch metric" requires simply a "numerical value of a 'branch,'" J.A. 3179, and CMU presented evidence that Marvell's post-processors use and produce branch-specific "numerical values." J.A. 41,816–22, 44,017–20, 46,587–88, 47,924, 54,266. For those reasons, the infringement finding for the MNP and EMNP products must stand.

2

The jury also had sufficient evidence to find that Marvell infringed claims through its next-generation Non-Linear Detector (NLD) chips. Marvell challenges that finding on the ground that its NLD chips do not apply a branch metric function to a "plurality of signal samples" as required by the claims. We reject Marvell's challenge.

In Marvell's NLD chips, the first stage of each branch is a "noise whitening filter" that takes as input multiple signal samples and produces a single combined output that is then used to calculate the final branch metric. J.A. 48,240–41, 48,249; *see also* J.A. 34,984. It is undisputed that the filter calculations may vary by branch and with signal samples, and as Marvell's own engineers recognized, applying a "different noise whitening filter for each branch" was "the original structure that Kavcic proposed in his paper." J.A. 46,779. For its NLD chips, Marvell may have made some changes to eliminate some redundancy in calculations, but it does not dispute that, for at least some branches, its NLD chips take multiple signal samples as their inputs, select parameters for the function applied to those samples, and produce a branch metric as a result. Marvell has not shown why that is not enough under the claims as construed. And CMU's expert

carefully showed element by element that the NLD chips perform each of the claim-required steps. J.A. 41,847–57 (testimony), 34,976–87 (slides). The verdict of infringement for the NLD chips therefore must stand.

3

Finally, the jury had sufficient evidence to find that Marvell infringed when it used what Marvell called a "simulator," notably, when it used a computer to practice the same methods it eventually implemented in its MNP/EMNP and NLD chips. Marvell challenges that finding on the grounds that "a *simulation* of a detector is not itself a detector" and that, in any event, its simulations did not apply branch metric functions to a plurality of *signal samples* as the claims require. Marvell Opening Br. 44. We reject Marvell's challenge.

Marvell mischaracterizes the claimed invention. As used in the claims, the word "detector" does not refer to a component for sensing the magnetic forces from the hard disk, as Marvell suggests, a function performed by certain electro-magnetic components in a "read head" in a hard-disk drive—shown as a separate unit from the "detector" in Figure 1 of the patents. The "detector" processes the signal samples produced by the read head from its sensing of the magnetic regions on a disk. The detector thus indirectly detects the most likely orientations of the magnetic regions (which encode data) given the signal samples. The jury could find that Marvell was using just such a "detector" in its "simulations" using a computer more general than special-purpose chips.

There was, additionally, ample evidence that Marvell's "simulations" operated on signal samples produced from physical hard disks in hard-disk drives. CMU showed that Marvell used its simulations to detect "data that comes from a Toshiba hard drive." J.A. 41,883 (also noting similar evidence regarding Hitachi hard-disk drives). Marvell notes in its brief here that its simula-

tions process "data files (copies of actual wave forms)." Marvell Opening Br. 44. The evidence, in short, was sufficient to establish that Marvell's simulations used "detectors" on "signal samples." At the same time, because it is undisputed that the simulations used branch metric functions, the evidence also sufficed to establish that the simulations applied branch metric functions to a plurality of signal samples.

Contrary to Marvell's contention, *Harris Corp. v. Ericsson Inc.* does not show lack of infringement here. The simple problem in *Harris* was that the claim required an actual "communication system," but Harris did not prove that Ericsson's actions, in "simulating" certain techniques (also involving Viterbi detectors), involved any actual communication system. A claim element was not proved to be present. 417 F.3d at 1256. This case sharply differs because no claim element was missing. Here, even the "simulations" involved use of "signal samples." The meeting of all claim elements is the critical question, not the use of the word "simulation," which can mean different things in different contexts.[3]

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[3] In a single clause, when introducing its *Harris* argument, Marvell states that if the claims reached its simulations they would "cover an abstract idea not otherwise subject to patenting." Marvell Opening Br. 44. The fleeting reference to "abstract idea" is not enough to raise an issue of subject-matter ineligibility, and Marvell's actual argument following the reference rests on *Harris*, which does not address that issue. Marvell neither cites nor discusses either 35 U.S.C. § 101 or any case law under it, much less any authority finding ineligibility of an unconventional method, like CMU's, for improving a physical process by overcoming limitations in physical devices—discerning more accurately what is on a physical recording medium from what a read head has sensed. *See*

II

Marvell's remaining arguments challenge the monetary remedies given for the infringement of CMU's patents—the damages award and the continuing royalty. We agree in part with Marvell's challenges. We find error in the enhancement of damages and error regarding adherence to the territorial limits on the available remedy. We reject Marvell's other challenges.

A

Marvell challenges the district court's rejection of its argument that the equitable defense of laches should bar CMU's recovery of damages for Marvell's infringement pre-dating CMU's filing of this action. Although laches requires proof of unreasonable, prejudicial delay in filing suit, "[t]he application of the defense of laches is committed to the sound discretion of the district court." *A.C. Aukerman Co. v. R.L. Chaides Constr. Co.*, 960 F.2d 1020, 1032 (Fed. Cir. 1992) (en banc). "A court must look at all of the particular facts and circumstances of each case and weigh the equities of the parties." *Id.* Here, the district court weighed the equities and concluded that Marvell was not entitled to a laches defense to pre-suit damages. We affirm.

The district court conducted a thorough review following the principles of our en banc decision in *Aukerman*.[4]

Alice Corp. v. CLS Bank Int'l, 134 S. Ct. 2347, 2354 (2014) ("[A]n invention is not rendered ineligible for patent simply because it involves an abstract concept. '[A]pplication[s]' of such concepts 'to a new and useful end,' we have said, remain eligible for patent protection." (citations omitted; second and third alterations in original)).

[4] CMU has preserved the contention that *Aukerman* should be overruled, insofar as it allows a laches

It found that CMU's delays in not filing suit until 2009, after having notice of Marvell's potential infringement as early as 2003, "were unreasonable and inexcusable." *Carnegie Mellon Univ. v. Marvell Tech. Grp.*, No. 09-cv-00290, 2014 WL 183212, at *29 (W.D. Pa. Jan. 14, 2014). The district court also determined that Marvell suffered some evidentiary prejudice as a result of the delays, but rejected Marvell's contention that it had suffered economic prejudice, finding that Marvell, for its own economic reasons, would have gone ahead with its infringement regardless, accepting the risk of liability. *Id.* at *29–37. Having found that Marvell satisfied the threshold requirements to invoke laches under *Aukerman*, the district court considered the entirety of the circumstances and concluded that "the equities clearly favor CMU . . . rather than Marvell, which copied CMU's patents consciously and deliberately for an entire decade." *Id.* at *37.

Marvell's challenge to that conclusion rests entirely on *Serdarevic v. Advanced Medical Optics, Inc.*, 532 F.3d 1352 (Fed. Cir. 2008), where we said that "a plaintiff relying on the unclean hands doctrine to defeat a defense of laches must show not only that the defendant engaged in misconduct, but moreover that the defendant's misconduct was responsible for the plaintiff's delay in bringing suit." *Id.* at 1361. According to Marvell, the district court could not weigh CMU's delay in bringing suit against the evidence of Marvell's conscious copying without first

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defense to pre-suit damages at all, in light of *Petrella v. Metro-Goldwyn-Mayer, Inc.*, 134 S. Ct. 1962 (2014), a question currently under en banc consideration in *SCA Hygiene Products Aktiebolag v. First Quality Baby Products, LLC*, No. 13-1564, 2014 WL 7460970, at *1 (Fed. Cir. Dec. 30, 2014). Our affirmance of the denial of laches does not depend on that broader legal contention.

concluding that the conscious copying caused CMU's delay. Marvell overreads *Serdarevic*.

The plaintiff in *Serdarevic* made vague allegations of misconduct, claiming "that the defendants' 'particularly egregious conduct' was the omission of Serdarevic as a co-inventor." *Id.* (citation omitted). We concluded that those allegations did not rise to the level of particularly egregious conduct that would defeat an otherwise-applicable laches defense. We explained that, in previous disputes about inventorship, courts had found a defendant's misconduct to be particularly egregious when it contributed in some substantial way to the plaintiff's delay. We rejected the suggestion that any misconduct, including "the very same conduct that forms the basis for [plaintiff's] inventorship claims," sufficed to weigh against laches. *Id.* at 1361–62. "[I]n the context of an inventorship action," we explained, a plaintiff must go beyond bare allegations of such conduct and show "that the defendant's misconduct was responsible for the plaintiff's delay in bringing suit." *Id.* at 1361.

The holding of *Serdarevic*, keyed to the inventorship context, does not undermine the district court's rejection of laches in this case, based on its well-reasoned conclusion that Marvell's blatant and prolonged copying of CMU's inventions met the standard of particularly egregious conduct. *Serdarevic* did not involve copying, let alone egregious copying, and we did not hold that such copying, to defeat laches, must have caused the unreasonable delay. Nor does any other precedent cited by Marvell restrict the relevance of copying.

Indeed, the en banc court in *Aukerman* specifically instructed district courts to consider such copying, and it did so without requiring that the relevant copying have caused the delay: "Conscious copying may be such a factor weighing against the defendant . . . ." 960 F.2d at 1033; *see also Gasser Chair Co. v. Infanti Chair Mfg. Corp.*, 60

F.3d 770, 775 (Fed. Cir. 1995) ("[T]he district court erred in not considering that Infanti's copying of Gasser's chairs could be egregious conduct."). *See also McIntire v. Pryor*, 173 U.S. 38, 53–55 (1899) (discussing long history of barring laches where defendant committed fraud, even if fraud not responsible for plaintiff's delay). That approach is consistent with the equitable nature of the laches determination, considering all relevant factors once the threshold requirements are met.

In this case, the district court went beyond the mere conclusion of conscious copying. It considered the extent and egregiousness of Marvell's copying, the culpability on the part of CMU in delaying suit, and the ramifications for public policy of allowing a laches claim. It did not abuse its discretion in concluding that the equities favored CMU and defeated Marvell's defense.

B

Marvell challenges the district court's enhancement of damages under 35 U.S.C. § 284, which says that "the court may increase the damages up to three times the amount found or assessed." Where, as here, enhancement is not asserted to rest on the infringer's actual knowledge that it was infringing, our precedent prescribes that a district court may enhance damages only upon proof of willfulness, which we have held to require "clear and convincing evidence that the infringer acted despite an objectively high likelihood that its actions constituted infringement of a valid patent" and "this objectively-defined risk . . . was either known or so obvious that it should have been known." *In re Seagate Tech., LLC*, 497 F.3d 1360, 1371 (Fed. Cir. 2007) (en banc); *see also Safeco Ins. Co. of Am. v. Burr*, 551 U.S. 47, 57–58 (2007) ("standard civil usage" of "willful" reaches both knowing violations and those done in "reckless disregard"). We have held that the second requirement is a factual matter subject to review for substantial evidence. *See SSL*

Servs., LLC v. Citrix Sys., Inc., 769 F.3d 1073, 1090–91 (Fed. Cir. 2014). But we also have held that the first requirement is not met when the infringer, whatever its state of mind at the time of its infringement, presents in the litigation a defense, including an invalidity defense, that is objectively reasonable (though ultimately rejected), and we have deemed that question a matter of law subject to de novo review on appeal. *See Halo Electronics, Inc. v. Pulse Electronics, Inc.*, 769 F.3d 1371, 1381–83 (Fed. Cir. 2014). Following that approach, we reverse the willfulness determination and hence the enhancement.

1

We begin with the findings and evidence regarding what Marvell knew and should have known. The jury found that Marvell knew of the patents before this action began. J.A. 34,184–85. It also found that "Marvell actually knew or should have known that its actions would infringe" the two claims at issue. J.A. 34,185–86. And the district court itself made a "finding that Marvell acted in a subjectively reckless manner with respect to the risk of infringing the subject patents." *Carnegie Mellon Univ. v. Marvell Tech. Grp.*, 986 F. Supp. 2d 574, 633 (W.D. Pa. 2013). We reject Marvell's contention that those findings cannot stand.

Marvell concedes that its engineers "evaluated Dr. Kavcic's algorithm when designing the MNP" and does not dispute that it knew Dr. Kavcic's work was patented. Marvell Opening Br. 71; *see Carnegie Mellon*, 986 F. Supp. 2d at 632 ("Marvell's engineers worked on multiple projects bearing Kavcic's name . . . ."). A January 2002 email from Marvell's Greg Burd noted: "Kavcic's detection scheme is patented (assignee: Carnegie Mellon University, 2001)." J.A. 34,027. As indicated in Marvell's repeated use of "Kavcic" in naming its work internally, the evidence showed that "Marvell's engineers duplicated the technology described in Dr. Kavcic and Dr. Moura's pa-

pers in their chips and simulators"; "shortly after beginning work on the Kavcic model, Mr. Burd prepared a preliminary write-up of the KavcicPP detector which referenced the work of Dr. Kavcic and Dr. Moura," a write-up that "became the MNP circuit"; "Mr. Burd stated that he was 'generally following the papers,' not the patents, and that he 'left it at that,'" but "the papers are virtually identical to what is described in the patents"; and "when Kavcic's name was disassociated with the project, there was no functional difference between the old and new computer codes" and "the NLD used the original structure proposed in Dr. Kavcic's paper, and subsequently in the CMU Patents." *Carnegie Mellon*, 986 F. Supp. 2d at 632–33.

Marvell's only responses to this robust evidence are that it did not adopt the detailed algorithm laid out in the CMU papers and the written description of the CMU patents and that it obtained its own later patents for what Mr. Burd described in the provisional application as a "sub-optimal version of Kavcic's detector," J.A. 54,264. Marvell Opening Br. 71–72. Neither response undermines the foregoing evidence. Indeed, the weakness of Marvell's responses tends to confirm the strength of the evidence on what Marvell knew and should have known.

That Marvell may not have ultimately copied the patents' preferred embodiment does not show that it was, or even thought it was, doing something outside CMU's *claims*—which the evidence from Marvell's own documents and employees indicates it simply chose to ignore. Similarly, as confirmed by the commonality of dominant/subordinate patents, that Marvell sought and obtained its own patents on particular detection techniques does not mean that those techniques, much less the specific accused Marvell actions, avoided the CMU patent claims at issue. Many patents claim products or processes that supplement or refine, and remain fully covered by, inventions claimed in others' earlier patents. *See In re*

Kaplan, 789 F.2d 1574, 1577–78 (Fed. Cir. 1986); *AbbVie Inc. v. Mathilda & Terence Kennedy Inst. of Rheumatology Trust*, 764 F.3d 1366, 1379 (Fed. Cir. 2014). Thus, the facts that Marvell sought and obtained patents gave it no defense to patent infringement, *see* 35 U.S.C. § 282(b), and did not establish a good-faith basis for believing that it was not infringing.

2

We agree with Marvell, however, that the enhancement of damages must be reversed because the invalidity defense it presented in this litigation was objectively reasonable. Although we conclude that a jury could properly reject Marvell's invalidity defenses based on Worstell, there was enough uncertainty about what Worstell discloses and what CMU's claims require that we cannot say that the defenses were objectively unreasonable. In this regard, it is significant, though hardly dispositive, that the district court itself referred to Marvell's invalidity defense as a "close call" at the summary-judgment stage. *Carnegie Mellon Univ. v. Marvell Tech. Grp.*, No. 09-cv-00290, 2011 WL 4527353, at *1 (W.D. Pa. Sept. 28, 2011). We do not reprise the analysis of invalidity set forth above. That analysis, we conclude, shows simultaneously that the jury verdict rejecting the invalidity defense must be upheld and that Marvell's position on invalidity was substantial enough that our enhancement standard is not met.

The district court, in concluding that the first *Seagate* requirement is met, relied on several premises that are contrary to governing law. The court reasoned that, because invalidity "was a factual determination to be made in this case[,] . . . the reasonableness of reliance on such invalidity defense was also the prerogative of the jury." *Carnegie Mellon*, 986 F. Supp. 2d at 630–31 (footnote omitted). That view contradicts our standard of de

novo review of objective reasonableness as a legal matter based on underlying facts.

The court also relied on the proposition that it mattered whether Marvell developed its invalidity defense when undertaking its infringing activity. It said: "[I]n order for Marvell to have a 'reasonable defense' to infringement for the time period of 2001–2009, there needs to be some proof that the basis for such invalidity defense was known to the infringers or even the person having ordinary skill in the art." *Id.* at 630. The court stated that "Marvell proffered no evidence that anyone at Marvell knew of the Worstell Patent from 2001 until this litigation began in 2009," adding: "Even if the Court concluded that Marvell has now put forth a reasonable defense to infringement that has been developed during litigation, such a determination would not be dispositive." *Id.* But our precedent is to the contrary. "The state of mind of the accused infringer is not relevant to th[e] objective inquiry" into the risk of liability to the defendant necessary for a finding of recklessness. *Seagate*, 497 F.3d at 1371. On that basis we have repeatedly assessed objective reasonableness of a defense without requiring that the infringer had the defense in mind before the litigation. *See Halo*, 769 F.3d at 1381–83; *Bard Peripheral Vascular, Inc. v. W.L. Gore & Assocs., Inc.*, 682 F.3d 1003, 1008 (Fed. Cir. 2012); *iLOR, LLC v. Google, Inc.*, 631 F.3d 1372, 1377 (Fed. Cir. 2011); *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 567 F.3d 1314, 1336 (Fed. Cir. 2009).

The district court further seemed to confine its consideration of Marvell's defenses to those raised at trial, excluding arguments presented earlier in the litigation, such as at the summary-judgment stage. *Carnegie Mellon*, 986 F. Supp. 2d at 630–31 ("To the extent that Marvell again believes the Court should deny a finding of willfulness on the basis that the earlier defenses that were not presented to the jury were reasonable, the Court

disagrees. If Marvell thought that any of those 'other' defenses were reasonable, it should have presented them to the ultimate finder of fact, the jury."). We see no basis for that distinction. A defense may be objectively reasonable and yet properly not be presented to the jury; examples include legal arguments such as claim-construction arguments, but there may be other defenses that are objectively reasonable yet not make the cut for consuming the precious time and attention of the jury. Thus, we have said that whether an infringer faced an objectively high risk of liability should be "determined by the record developed in the infringement proceeding," *Seagate*, 497 F.3d at 1371, and that the record is not limited to evidence presented to the jury.

On the full record here, we conclude that Marvell had an objectively reasonable defense to infringement. The district court's reasoning does not convince us otherwise. We therefore reverse the enhancement of damages.

C

Marvell presents several challenges to the jury's royalty determinations. It argues that the district court abused its discretion in not excluding the testimony of CMU's damages expert, criticizing her qualifications and her methodology. It argues that the evidence precluded a royalty measured by 50 cents per unit and required a flat, lump-sum fee not metered by the extent of benefit to Marvell. And it argues that award improperly includes "foreign chips in the royalty base." Marvell Opening Br. 52. We reject all the challenges except the last: on that issue we conclude that a partial new trial is needed, as to those chips which never entered the United States, to determine whether their "sale" can be said to have occurred in the United States. With that exception, which warrants a partial remand, we affirm (a) the judgment of damages to the extent of $278,406,045.50, consisting of 50 cents per chip for the 556,812,091 chips that the jury

could find were imported for use in the United States, (b) the judgment bringing the royalty award forward in the supplemental damages, though the amount must for the time being be adjusted by the district judge on remand to chips imported, using a reliable estimate of chips imported (based on the method of estimating imports presented to the jury or another reliable method), and (c) the order of an ongoing royalty of 50 cents per chip, also to be limited on remand, pending a new trial on the remanded issue, to a reliable estimate of chips imported.

1

Marvell challenges the admission of the testimony of CMU's damages expert, Ms. Lawton, because in its view she lacks relevant expertise and disregarded evidence that Marvell believes favored its much lower damages estimate. Ms. Lawton filed voluminous, thorough, clearly structured, comprehensively documented expert reports. The district court conducted an extended live preview of her testimony and determined that she was qualified and her methodology was sound. We review the admission of her testimony for an abuse of discretion. *General Elec. Co. v. Joiner*, 522 U.S. 136, 138 (1997). We find no abuse.

Rule 702 of the Federal Rules of Evidence sets standards for an expert witness's qualification and the substance of the expert's testimony. As relevant here, the witness must be "qualified as an expert by knowledge, skill, experience, training, or education." The testimony must be "based on sufficient facts or data" and be "the product of reliable principles and methods" that the expert "reliably applie[s] . . . to the facts of the case." The latter requirements are rooted in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 592–93 (1993) (requiring that "the expert's opinion will have a reliable basis in the knowledge and experience of his discipline . . . properly . . . applied to the facts in issue").

Ms. Lawton does not have a Ph.D. or a traditional academic appointment, but those credentials are not required by Rule 702's qualification standard. Indeed, even "education" and "training" impose no such requirement, and the Rule provides for "knowledge," "skill," and "experience" as other bases for qualification. The Third Circuit allows "a broad range of knowledge, skills, and training to qualify an expert" as such. *Pineda v. Ford Motor Co.*, 520 F.3d 237, 244 (3d Cir. 2008) (quotation marks and citation omitted). That approach is consistent with the post-*Daubert* emphasis on the substance of expert testimony and with the facts that experience can be gained in many venues and that knowledge can be demonstrated by mastery displayed in an expert's analysis and responses to questioning about it.

The district court acted well within its discretion in rejecting Marvell's attacks on Ms. Lawton's qualifications and general methodology. The court considered Ms. Lawton's "range of knowledge, skills, and training" and, like the many other courts before which she has appeared, deemed her qualified to testify as an expert on reasonable-royalty damages. *See Carnegie Mellon Univ. v. Marvell Tech. Grp.*, No. 09-cv-00290, 2012 WL 6562221, at *14 (W.D. Pa. Dec. 15, 2012). The court also examined the basis for Ms. Lawton's testimony by reviewing her lengthy expert report, two updated expert reports, and a supplemental report and by holding an extended *Daubert* hearing at which CMU's counsel "essentially conducted his direct examination of [Ms.] Lawton." *Id.* at *1. For areas outside her expertise, such as details unique to the semiconductor industry, the district court properly concluded that Ms. Lawton could, indeed must, rely upon CMU's other experts having such industry-specific experience. *Id.* at *14; *see Apple Inc. v. Motorola, Inc.*, 757 F.3d 1286, 1321 (Fed. Cir. 2014) ("Experts routinely rely upon other experts hired by the party they represent for expertise outside their field."), *partly overruled in respect not rele-*

vant here by Williamson v. Citrix Online, LLC, No. 2013-1130, 2015 WL 3687459, at *6 (Fed. Cir. June 16, 2015) (en banc in part). And, as noted more fully below, Ms. Lawton in fact took reasoned account of the evidence that Marvell says that she "disregarded." Marvell Opening Br. 47. In these circumstances, the district court did not err, as to either qualifications or substantive methodology, in admitting Ms. Lawton's testimony.

2

Marvell's challenge to the jury's award of a 50-cent-per-chip royalty is similarly unfounded—whether this challenge is viewed as going to evidentiary sufficiency, weight, or admissibility. Marvell challenges both the choice of a per-unit license instead of a flat fee and the rate of the per-unit license. We see no reversible error in either respect.

35 U.S.C. § 284 guarantees to a patent holder "in no event less than a reasonable royalty for the use made of the invention by the infringer." One approach to calculating a reasonable royalty that measures the value of the use of the patented technology posits a "hypothetical negotiation" between a "willing licensor" and a "willing licensee" "to ascertain the royalty upon which the parties would have agreed had they successfully negotiated an agreement just before infringement began." *Lucent Techs., Inc. v. Gateway, Inc.*, 580 F.3d 1301, 1324–25 (Fed. Cir. 2009). That approach, like any reconstruction of the hypothetical world in which the infringer did not actually infringe but negotiated in advance for authority to practice the patents, does not require "mathematical exactness," but a "reasonable approximation" under the circumstances. *See Dowagiac Mfg. Co. v. Minn. Moline Plow Co.*, 235 U.S. 641, 647 (1915).

A key inquiry in the analysis is what it would have been worth to the defendant, as it saw things at the time, to obtain the authority to use the patented technology,

considering the benefits it would expect to receive from using the technology and the alternatives it might have pursued. *See AstraZeneca AB v. Apotex Corp.*, 782 F.3d 1324, 1334–35 (Fed. Cir. 2015). Thus, a "basic premise of the hypothetical negotiation" is "the opportunity for making substantial profits if the two sides [are] willing to join forces" by arriving at a license of the technology. *Gaylord v. United States*, 777 F.3d 1363, 1368 (Fed. Cir. 2015) (discussing reasonable royalty damages in a copyright suit). At the same time, "[t]he economic relationship between the patented method and non-infringing alternative methods, of necessity, would limit the hypothetical negotiation." *Riles v. Shell Expl. & Prod. Co.*, 298 F.3d 1302, 1312 (Fed. Cir. 2002); *see Aqua Shield v. Inter Pool Cover Team*, 774 F.3d 766, 771 & n.1 (Fed. Cir. 2014).

In the determination of what the negotiation over opportunities and alternatives would have looked like, "the nature of the invention, its utility and advantages, and the extent of the use involved" are important considerations. *Dowagiac*, 235 U.S. at 648. Past licensing practices of the parties and licenses for similar technology in the industry may be useful evidence. But such evidentiary use must take careful account of any "economically relevant differences between the circumstances of those licenses and the circumstances of the matter in litigation." *Gaylord*, 777 F.3d at 1368; *see Ericsson, Inc. v. D-Link Sys., Inc.*, 773 F.3d 1201, 1227–28 (Fed. Cir. 2014); *VirnetX, Inc. v. Cisco Sys., Inc.*, 767 F.3d 1308, 1330–31 (Fed. Cir. 2014); *Finjan, Inc. v. Secure Computing Corp.*, 626 F.3d 1197, 1211–12 (Fed. Cir. 2010).

This court has noted the common (not universal) economic justifications for using per-unit royalties for measuring the value of use of a technology: doing so ties compensation paid to revealed marketplace success, minimizing under- and over-payment risks from lump-sum payments agreed to in advance. *Lucent*, 580 F.3d at 1325–26; *see Gaylord*, 777 F.3d at 1369. In common-sense

terms, a per-unit royalty here allowed Marvell's payments to vary with the sales its infringing activity produced, which are a good way of valuing what it was worth to Marvell to engage in that activity. Marvell nevertheless contends that the evidence of the parties' past practices compels a finding that the parties would have agreed to a flat fee, not a per-unit royalty. But because CMU presented sufficient evidence pointing to "economically relevant differences" between those past practices and the circumstances of the negotiation here, neither CMU's expert nor the jury was required to agree with Marvell.

Although Marvell points to three lump-sum license agreements that CMU granted to others for permission to practice these patents, CMU explained to the jury that the licensees in each of those instances had longstanding, collaborative research partnerships with CMU and had invested substantial sums over the years in CMU's hard-disk-drive focused research. Significantly, those licenses were granted *before* CMU ever developed the patentable technology; the licensees gave CMU money with no guarantee that any usable technology would result, sharing the costs of uncertain research in the hope of a future potential benefit. CMU likewise offered sound economic reasons to distinguish the other licensing example Marvell relies on—an offer to Intel to grant it, in return for a lump-sum payment, a license to a portfolio of patents that included one of the patents at issue here. Unlike Marvell, Intel was a longstanding partner of CMU's, contributing substantial funds over the years to CMU's research efforts. And Intel was not in the read-channel business; CMU sought to license its patents to Intel to get its "stamp of approval" as a boost to its other licensing efforts. J.A. 41,299–300. In short, there was sufficient evidence to find that a royalty—by which the total dollar (but not per-unit) amount of Marvell's payment would increase with the volume of sales it made based on its use of the technology—was an economically reasonable pay-

ment mechanism within the confines of the hypothetical negotiation here.

There also was ample evidence that 50 cents was an appropriate amount for the per-chip license. CMU offered evidence that, at the time of the hypothetical negotiation, Marvell had no alternative to CMU's technology, a conclusion Marvell has not disputed here. *E.g.*, J.A. 42,127 (CMU's industry expert testifying that it was "life or death" for Marvell to use CMU's technology). There is evidence too, after the fact but still relevant, that CMU's technology is so significant that it is used industry-wide. J.A. 42,121, 42,127. At the time of the hypothetical negotiation, Marvell faced strong market pressure to improve the performance of its chips, and testimony and internal documents showed (in sometimes-dramatic language) that its previous attempt to produce a new design was failing because the resulting chips produced excessive heat. Finally, the evidence supported a finding that, if Marvell could use CMU's technology, it could pay CMU 50 cents per chip and still meet its reasonable profit goal—indeed, it would end up keeping upwards of three quarters of the per-chip profit. J.A. 43,325–27.

On the evidence presented at trial, the jury could properly find that a royalty of 50 cents per chip reasonably valued Marvell's use of CMU's technology and would have been a good deal in the hypothetical negotiation. Accordingly, subject only to the legal constraint based on territorial limits, discussed next, the jury's royalty determination must stand.

3

What remains is Marvell's invocation of the general bar on extraterritorial application of our patent laws to challenge the inclusion in the (past and ongoing) royalty base of all of the chips resulting from Marvell's "infringing" use of the patented methods that Marvell sold, worldwide. Specifically, Marvell contends that the dis-

trict court "erred in denying JMOL (and new trial or remittitur) striking the portion of the damages award that rested on sales of foreign chips that were manufactured, sold, and used abroad without ever entering the United States." Marvell Opening Br. 52. That contention, notably, is limited, and appropriately so: Marvell makes no meaningful extraterritoriality argument against—and we see no problem with—applying the royalty rate to chips that do enter the United States. But there is a potential problem with including the chips made and delivered abroad, and never imported into the United States, unless those chips can fairly be said to have been sold here. That question requires a remand.

a. We begin with the governing law. The Supreme Court has confirmed that the patent laws, like other laws, are to be understood against a background presumption against extraterritorial reach. *Microsoft Corp. v. AT&T Corp.*, 550 U.S. 437, 454 (2007); *Deepsouth Packing Co. v. Laitram Corp.*, 406 U.S. 518, 531 (1972) (superseded by statute, *see Microsoft*, 55 U.S. at 442–45); *Halo*, 769 F.3d at 1378–81; *see Kiobel v. Royal Dutch Petro. Co.*, 133 S. Ct. 1659, 1669 (2013) (similar principle applied to Alien Tort Statute); *Morrison v. Nat'l Australia Bank Ltd.*, 561 U.S. 247, 255 (2010) (Securities Exchange Act). The background principle applies not just to identifying the conduct that will be deemed infringing but also to assessing the damages that are to be imposed for domestic liability-creating conduct. *Power Integrations, Inc. v. Fairchild Semiconductor Int'l, Inc.*, 711 F.3d 1348, 1371–72 (Fed. Cir. 2013) (applying principle in lost-profits case, precluding damages for certain lost foreign sales); *see also WesternGeco LLC v. ION Geophysical Corp.*, No. 2013-1527, 2015 WL 4032980, at *7–10 (Fed. Cir. July 2, 2015) (rejecting lost-profits damages as improperly based on foreign *use* in case under 35 U.S.C. § 271(f)(2)).

Domestic actions often have extraterritorial effects, and foreign actions domestic connections. Two sovereigns

often might be able to apply their laws to closely related aspects of what amount to an integrated economic activity—such as making something one place and selling it elsewhere, or selling something one place to be put to essentially its only use elsewhere. What constitutes a territorial connection that brings an action within the reach of a United States statute must ultimately be determined by examining the "'focus' of congressional concern" in the particular statute. *Morrison*, 561 U.S. at 266–67.

For the present context, we think that § 271(a) provides the basis for drawing the needed line. It states a clear definition of what conduct Congress intended to reach—making *or* using *or* selling in the United States *or* importing into the United States, even if one or more of those activities also occur abroad.[5] Where a physical product is being employed to measure damages for the infringing use of patented methods, we conclude, territoriality is satisfied when and only when any one of those domestic actions for that unit (*e.g.*, sale) is proved to be present, even if others of the listed activities for that unit (*e.g.*, making, using) take place abroad. Significantly, once one extends the extraterritoriality principle to confining how *damages* are calculated, it makes no sense to

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[5] 35 U.S.C. § 271(a) provides: "Except as otherwise provided in this title, whoever without authority makes, uses, offers to sell, or sells any patented invention, within the United States or imports into the United States any patented invention during the term of the patent therefor, infringes the patent." We need not separately discuss "offers to sell," which, we have held, requires a United States location for the sale that is offered, not for the offer. *See Transocean Offshore Deepwater Drilling, Inc. v. Maersk Contractors USA, Inc.*, 617 F.3d 1296, 1309 (Fed. Cir. 2010).

insist that the action respecting the product being used for measurement itself be an *infringing* action. Thus, here the claim is a method claim, but the damages-measuring product practices the method in its normal intended use, *cf. Quanta Computer, Inc. v. LG Electronics, Inc.*, 553 U.S. 617 (2008) (applying exhaustion to sale of unit that sufficiently embodies a method claim); and the hypothetical negotiation would have employed the number of units sold to measure the value of the method's domestic use (before production and after), as discussed above. In these circumstances, the inquiry is whether any of the § 271(a)-listed activities with respect to that product occur domestically.

This approach accords with precedent. In *Goulds' Manufacturing Co. v. Cowing*, 105 U.S. 253 (1881), the Supreme Court approved an award, based on an accounting of the defendant's profits, reaching units made in the United States though some were to be used only abroad. *Id.* at 256. In *Railroad Dynamics, Inc. v. A. Stucki Co.*, 727 F.2d 1506 (Fed. Cir. 1984), this court held that a royalty award could reach units made in the United States—valued at their sale price—regardless of whether they were sold abroad. *Id.* at 1519. On the other hand, in *Power Integrations*, we rejected a claim to lost-profits damages based on the defendant's "entirely extraterritorial production, use, or sale of an invention patented in the United States," pointing to § 271(a). 711 F.3d at 1371–72; *see also WesternGeco*, 2015 WL 4032908, at *7–10 (rejecting foreign *use* as basis for lost-profits damages).

There are significant conceptual differences between different measures of monetary compensation for infringement—including between what agreement the parties would have reached to value a defendant's use of the patentee's technology (reasonable royalty) and what amount of otherwise-made profits, based on sales at certain prices, the patentee lost as a result of the defendant's use of the patentee's technology (lost profits). *See*

AstraZeneca, 782 F.3d at 1334–35; *Warsaw Orthopedic, Inc. v. NuVasive, Inc.*, 778 F.3d 1365, 1377 (Fed. Cir. 2015). But in the respect that is crucial here, we think that there is a related constraint. In the lost-profits context, this court indicated in *Power Integrations* that, where the direct measure of damages was foreign activity (*i.e.*, making, using, selling outside § 271(a)), it was not enough, given the required strength of the presumption against extraterritoriality, that the damages-measuring foreign activity have been factually caused, in the ordinary sense, by domestic activity constituting infringement under § 271(a). 711 F.3d at 1371–72. We think that the presumption against extraterritoriality, to be given its due, requires something similar in the present royalty setting. Although all of Marvell's sales are strongly enough tied to its domestic infringement as a causation matter to have been part of the hypothetical-negotiation agreement, that conclusion is not enough to use the sales as a direct measure of the royalty except as to sales that are domestic (where there is no domestic making or using and no importing). As a practical matter, given the ease of finding cross-border causal connections, anything less would make too little of the presumption against extraterritoriality that must inform our application of the patent laws to damages. *See Morrison*, 130 S. Ct. at 2884 ("[I]t is . . . a quite valid assertion . . . that that presumption here (as often) is not self-evidently dispositive, but its application requires further analysis. For it is a rare case of prohibited extraterritorial application that lacks *all* contact with the territory of the United States. But the presumption against extraterritorial application would be a craven watchdog indeed if it retreated to its kennel whenever *some* domestic activity is involved in the case.").

b. Marvell implicitly recognizes the significance of the line for this case when it effectively limits its challenge to inclusion in the royalty base of chips that were "manufactured, sold, and used abroad without ever entering the

United States." Marvell Opening Br. 52; *id.* at 55 ("total sales are an impermissible measure of damages because they correlate with the number of chips ***used worldwide***, and thus do ***not*** estimate use of the patented method ***in the United States***"); *id.* at 58 (making a similar argument against the jury instruction). In any event, we see no extraterritoriality bar to including within the royalty base those chips which were imported into the United States for use in the United States. Section 271(a) makes clear that Congress meant to reach such "import[ation]" and "use[]" as domestic conduct. And we have been presented no basis on which to deem legally insufficient, or of deficient weight for new-trial purposes, the evidence CMU submitted to the jury, based on industry data sources, of how many of Marvell's hard-drive chips were imported into the United States.

We therefore deny JMOL as to the royalty based on those chips. We also deny a new trial as to royalties based on those chips. Marvell's claim of error in the jury instructions affects only royalties based on chips whose inclusion depends entirely on the location of sale. We therefore affirm the judgment insofar as the royalty rests on imported chips. The amount is certain (stated above) up to the close of the damages period before the jury. On the other hand, a recalculation by the district judge is needed to confine the supplemental damages to such chips (pending a retrial on the remaining-chip issue), and a similar narrowing is needed for the collection of ongoing royalties (pending retrial).

c. As to the remaining chips, avoiding extraterritoriality in relying on those chips in the royalty base depends here on whether they were sold in the United States, there being no other applicable basis in § 271(a) to justify

including those chips.[6] As to those chips, we draw two conclusions. First, Marvell is not entitled to JMOL on the evidence and legal arguments presented to us. Second, a new trial is needed to determine whether the sales are properly said to have been in the United States.

The standards for determining where a sale may be said to occur do not pinpoint a single, universally applicable fact that determines the answer, and it is not even settled whether a sale can have more than one location. *See Halo*, 769 F.3d at 1378–79 (collecting cases; relying in part on *N. Am. Philips Corp. v. Am. Vending Sales, Inc.*, 35 F.3d 1576, 1579 (Fed. Cir. 1994)). Places of seeming relevance include a place of inking the legal commitment to buy and sell and a place of delivery, *see id.*; *Transocean*, 617 F.3d at 1311; *cf. Norfolk & W. Ry. Co. v. Sims*, 191 U.S. 441, 447 (1903), and perhaps also a place where other "substantial activities of the sales transactions" occurred, *Halo*, 769 F.3d 1379 & n.1 (focusing on where "substantial activities of the sales transactions" occurred, but declining to decide whether the location of contract formation on the facts of that case would have established a sales location). At this point, we do not settle on a legal definition or even to say whether any sale has a unique location. The governing legal standards have not been the subject of meaningful briefing here. Identifying those standards, along with relevant factual development, is better undertaken in the remand we order, in part because further factual development may narrow the legal issues actually requiring decision. At present, we do not have a full understanding of, among other things, what a "design win" meant legally and practically, how such a "design win" in the United States in this case compares

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[6] For the ongoing royalty, the question is a present- and future-tense question. For simplicity, we refer just to the past in our discussion.

with the activities that occurred in the United States in *Halo* (which were insufficient), and where specific chip orders were negotiated and made final. Until fuller exploration of factual and legal issues occurs on remand, it is premature to rule on whether sales occurred in the United States for the chips at issue.

We do hold that, on the arguments presented to us, Marvell is not entitled to JMOL that the sales did *not* occur in the United States. The district court explained that Marvell had the opportunity to present evidence at trial that the sales took place only abroad and simply failed to do so. *Carnegie Mellon*, 986 F. Supp. 2d at 644. The court concluded that the record made at trial, including but not limited to a joint stipulation about the sales process, permitted the "jury to find that the sales occurred in the United States." *Id.* at 645, 646. We cannot conclude otherwise on the record here and on the limited effort Marvell has made to develop legal arguments about sale-location standards.

Chip designers like Marvell sell customized chips with designs specifically tailored for incorporating into customers' products. J.A. 42,123–24 (Marvell VP of sales: "[E]very chip that Marvell designs for a customer is specifically aimed for that particular customer. It's not, cannot be sold to the, you know, in the general market."). Because of the customized nature of the chips, designers and potential customers put themselves through a lengthy "sales cycle," involving extensive joint work over several years, before any sale is made and chips enter mass production. Only at the end of that sales cycle, if the chip designer is successful, does it secure a "design win," but that win generally results in a customer's exclusive use of that designer's customized chip for a certain period, amounting to tens or hundreds of millions of chips over several years. J.A. 43,654–55 (parties' joint stipulation on the sales cycle); *see* J.A. 44,426 (executive at Western Digital testifying that when he "recommend[ed]

that Marvell be selected as the read chip channel supplier," Marvell would become "the exclusive read chip channel supplier"). One executive from a now-defunct chip maker called the industry a "winner takes all business." J.A. 42,121.

Marvell's facilities are in northern California, and CMU's industry expert, Dr. Bajorek, showed that "with the exception of the chip making . . . all the activities related to designing, simulating, testing, evaluating, qualifying the chips by Marvell as well as by its customers occur[] in the United States." J.A. 42,159; *see also* J.A. 35,075–77 (charts showing relevant activity and where it occurred); J.A. 43,650–55 (parties' joint stipulation). He also used Marvell's records to show that Marvell, from California, provided potential customers with samples and simulations incorporating its designs. *E.g.*, J.A. 42,147–48; J.A. 53,570, 53,572, 53,612, 53,613. Marvell itself stipulated that "[d]uring [its] sales cycle, [its] engineers assist [its] customers in implementing [its] solutions into their product." J.A. 43,654. And there was some evidence suggesting that specific contractual commitments for specific volumes of chips were made in the United States. *Carnegie Mellon*, 986 F. Supp. 2d at 645 (referencing testimony that sales were "signed off on" in California); J.A. 42,162 (similar testimony by CMU's industry expert). Marvell points us to no evidence to the contrary.

On this record, we cannot say that a jury could not find the chips to have been sold in the United States (perhaps not only in the United States). The parties' chip stipulation, cited above, suggests a substantial level of sales activity by Marvell within the United States, even for chips manufactured, delivered, and used entirely abroad. That evidence is strengthened by the record details regarding Marvell's contracting process, and Marvell has not pointed us to significant evidence that would block an inference that sales commitments oc-

curred in the United States. On this record, and the current set of legal arguments about "sale" standards, Marvell is not entitled to JMOL that the royalty base must exclude chips not imported into the United States.

On the other hand, we do not think that CMU is entitled to affirmance with respect to those chips. In the portion of the jury instructions at issue here, the district court first confirmed a limit on *infringement* liability: "Marvell cannot be found to have directly or indirectly infringed in connection with chips that are never used in the United States." J.A. 45,456. It then added: "To the extent, however, that Marvell achieved sales resulting from Marvell's alleged infringing use during the sales cycle, you may consider them in determining the value of the infringing use." J.A. 45,456. Marvell challenges that instruction on the ground that it "includ[ed] sales of chips manufactured and sold abroad without entering the United States." Marvell Opening Br. 58.

Marvell is wrong to the extent it argues that the objected-to sentence is incorrect. The jury properly was told that it "may consider" any sales that resulted from the infringing use in order to value that use: for the reasons stated above, consideration of such sales was a sound part of determining the reasonable royalty for the infringing use. But Marvell is right in identifying something missing from the instructions, namely, an instruction that required the jury to find a domestic location of sale as to those chips not made or used in, or imported into, the United States. For those chips, but not for those which did enter the United States, the instructions did not "properly apprise[] the jury of the issues and the applicable law." *Dressler v. Busch Entertainment Corp.*, 143 F.3d 778, 780 (3d Cir. 1998) (quotation marks and citation omitted).

If Marvell had properly objected to the omission of such an instruction, we would apply the usual instruction-

review standards to find the omission erroneous, and we would find the error harmful as to those chips not made or used in, or imported into, the United States. *See Forrest v. Beloit Corp.*, 424 F.3d 344, 349 (3d Cir. 2005) ("An error will be deemed harmless only if it is 'highly probable' that the error did not affect the outcome of the case."). Marvell makes no meaningful argument about the jury instructions except for the non-imported chips. And CMU makes no meaningful argument—at most it makes a passing assertion—that the record effectively compelled a finding as to the domestic location of all of the chip sales.

As the district court pointed out, however, Marvell did not properly object to the omission of an instruction focusing on the place of sale for those chips which were not made or used in, or imported into, the United States. *Carnegie Mellon*, 986 F. Supp. 2d at 644–45. Marvell does not show otherwise on appeal. And it has pointed to no place in the record supporting its assertion that, before the time arrived for presenting proposals, objections, and arguments regarding jury instructions, the district court had declared that the location of sales was legally immaterial. Accordingly, we consider Marvell's objection here only under the standard of "plain error." *See Franklin Prescriptions, Inc. v. New York Times Co.*, 424 F.3d 336, 339–40 (3d Cir. 2005) ("Where a party fails to object properly, we may review for 'plain error in the instructions affecting substantial rights.' Fed. R. Civ. P. 51(d)(2).").

We think that the plain-error standard is met in the circumstances of this case. "Plain error review is discretionary—it should be exercised sparingly and should only be invoked with extreme caution in the civil context." *Id.* at 341 (internal quotation marks omitted). We are to determine if the error was "fundamental" and caused "prejudice resulting in a miscarriage of justice," considering "the obviousness of the error, the significance of the interest involved, and the reputation of judicial proceed-

ings if the error stands uncorrected." *Id.* at 340–41 (internal quotation marks omitted). Here, we conclude, the standard is met because of the fundamental importance of the extraterritoriality principle; the degree of obviousness of the error in light of *Power Integrations*, decided after the trial in this case; and the centrality of a sale-location determination to satisfying the extraterritoriality principle for the bulk of the chips used for the royalty determination. That is enough for a "miscarriage of justice" under a rule whose function is to produce only a new trial, not a judgment as a matter of law for the objecting party.

We accordingly must vacate the portion of the damages award, original and supplemented, and the portion of the ongoing-royalty order, which apply the royalty rate to chips not made or used in, or imported into, the United States. A new trial is required to determine whether those chips were sold in the United States.

CONCLUSION

For the foregoing reasons, we affirm the judgment finding patent infringement by Marvell and rejecting Marvell's invalidity defenses. We affirm the denial of Marvell's laches defense. We reverse the enhancement of damages. We affirm the royalty awards, past and ongoing, in part, and we vacate in part and remand as described in this opinion.

No costs.

AFFIRMED IN PART, REVERSED IN PART, AND VACATED AND REMANDED IN PART