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DEPARTMENT: MICRO LAW

A Review of *Wisconsin Alumni Research Foundation v. Apple*—Part VII

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Part I of this series introduced the *Wisconsin Alumni Research Foundation v. Apple* cases and described the asserted patent (U.S. Patent No. 5,781,752). That article also summarized some recent large verdicts for patents asserted by academic institutions and provided several reasons why this series may be of interest to the readership of *IEEE Micro*, most notably because the inventors are well-known and several well-known computer architects worked as experts on this case. Part II described the complaints; namely, it described the plaintiff, Wisconsin Alumni Research Foundation ("WARF"), the inventors, and WARF's allegations as to how the Apple's products infringed WARF's patent. Part III described Apple's answer to the allegations in WARF's complaint, Apple's counterclaims, and WARF's response to those counterclaims. Part IV examined Apple's allegation of inequitable conduct by the inventors, a technical analysis of that allegation, and Judge Conley's legal analysis of the sufficiency of Apple's allegations. Parts V and VI reviewed WARF's motion to compel Apple to produce executable versions of the simulators for its A6, A7, and A8 processors (hereinafter "Accused Products") and the hearing that Magistrate Judge Crocker (hereinafter "Judge Crocker") had on that motion.

MOTION TO COMPEL INFORMATION REGARDING FUTURE PROCESSORS

In addition to WARF's motion to compel Apple to produce executable versions of the simulators of the accused processors, WARF filed three more motions to compel. This article covers the first and second of those motions; the third one will not be covered in this article series as it likely is of less interest to the readership of *IEEE Micro*.

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Digital Object Identifier 10.1109/MM.2025.3638484
Date of current version 24 December 2025.

WARF filed the first of these motions to compel on 10 October 2014, just one week after it filed the simulator-related motion to compel (see *Wis. Alumni Rsch. Found. v. Apple, Inc.*[1]). In this motion WARF requested that the Court order Apple to produce documents, source code, etc. for additional accused processors (A8 and two future, unreleased processors) that likely use the patented invention (see pages 1–2 *Wis. Alumni Rsch. Found. v. Apple, Inc.*[1]).

With respect to the A8 processor, Apple responded that "[o]nce products incorporating the A8 processor were released for sale to the public, and WARF actually accused the A8 processor of infringement on September 16, 2014, Apple informed WARF that it would produce discovery for the A8" (see page 5 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[2]). With respect to unreleased processors, Apple argued that they were "still undergoing major design changes" and were "not finalized" (see page 2 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[2]). Apple argued that the on-going design changes and the accompanying documentation would: 1) require "repeated collections and productions of documents and source code through the end of fact discovery," which will impose a significant burden on Apple, and 2) result in WARF constantly changing its infringement theories and expert reports of those infringement theories to track Apple's design changes (see page 3 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[2]).

Judge Crocker held a telephonic hearing on 31 October 2014 for this motion and the motion to compel regarding production of an executable version of the simulator (see *Wis. Alumni Rsch. Found. v. Apple, Inc.*[3]). Based on the redacted transcript, it appears that the parties agreed that the A8 and A8X processors should be included in this case and that Apple would produce documents, source code, etc. for those processors (see page 21 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[4]). But Judge Crocker denied WARF's motion regarding the two future processors for apparently three reasons. First, Judge Crocker agreed with Apple that the fact that the future processors were not released meant "it's a moving target. Every day something new

and different happens" (see page 21 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[4]). Second, the future processors may not be released prior to trial (see page 22 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[4]). Third, including the future processors in this lawsuit might delay the trial date (see page 21 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[4]). Judge Crocker said that while he did not prefer to have "piecemeal" cases and that it would be more efficient to have all accused processors in a single trial, he had to "draw the line somewhere" and WARF could include the future processors in a second lawsuit, which WARF ultimately did (see pages 32, 20–21, 22, 32–33 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[4]).

With respect to the future processors, I agree with Judge Crocker's second and third reasons. While it may be more efficient to have a single trial for all accused processors, including the future processors at this stage in the case might delay the trial. But I disagree with his first reason that the design of future processors is a "moving target," which necessarily requires that Apple will need to repeatedly collect documents and could require that WARF change its infringement theories and expert reports to track Apple's on-going design changes. The reason for this is because an architectural-level feature, such as tracking potential dependences across memory accesses, is very unlikely to meaningfully change—let alone change enough to affect the patent infringement analysis—after the architectural design stage. Furthermore, the further into the design process the future processor is, e.g., register transfer level, verification, synthesis, physical design, design for test, tape-out, silicon testing, etc., the less likely that there will be *any* architectural-level changes, let alone patent infringement-relevant changes. For example, during layout, the designers may realize that a buffer may need to have one fewer (or can have one more) entry or that the access time might be a little higher. But none of those kinds of lower level changes would affect whether Claim 1 of the WARF's patent would be infringed:

1) In a processor capable of executing program instructions in an execution order differing from their program order, the processor further having a data speculation circuit for detecting data dependence between instructions and detecting a mis-speculation where a data consuming instruction dependent for its data on a data producing instruction of earlier program order, is in fact executed before the data producing instruction, a data speculation decision circuit comprising:
   - a predictor receiving a mis-speculation indication from the data speculation circuit to produce a prediction associated with the particular data consuming instruction and based on the mis-speculation indication; and
   - a prediction threshold detector preventing data speculation for instructions having a prediction within a predetermined range.

—U.S. Patent No. 5,781,752, Claim 1.

Rather, Claim 1 requires that there is a predictor and a prediction threshold detector that each operate in a particular way. Given that Claim 1 focuses on high-level components that are very unlikely to change after the architectural design stage, even if the future processor is still being designed, it is very unlikely that there will be any design changes that would require that Apple will need to repeatedly collect documents or could require that WARF change its infringement theories or expert reports to track Apple's on-going design changes. Rather, it is fairly likely that the only documents Apple would need to collect and produce are those that existed at the end of the architectural design stage. Similarly, it is also fairly likely that WARF would not need to change its infringement theory or its expert reports, as it is unlikely that there will be any meaningful changes at an architectural level that would change WARF's infringement analysis.

Finally, with respect to Judge Crocker's comment that the design is always changing, to the extent that future processors, e.g., an A9 processor, also use the data-dependency predictor,[a] that data-dependency predictor is likely to be the same—at least in terms of the components required by WARF's patent—as what the A8 processor uses. For example, while the A9 processor may use a more sophisticated predictor than the A8 processor, all that Claim 1 requires is "a predictor receiving a mis-speculation indication from the data speculation circuit to produce a prediction... based on the mis-speculation indication[.]" As such, as long as the predictor in the A9 processor receives a misspeculation indication from the data speculation circuit and bases its prediction on the misspeculation indication, for the purposes of infringement, the predictor in the A9 processor would operate in the same infringing manner as the predictor in the A8 processor.

Similarly, while the A9 processor may use a more sophisticated prediction threshold, e.g., one that dynamically varies, the fact that both the A8 and A9 processors might have a prediction threshold means that, for the purposes of infringement, the prediction

[a]This article uses the term "data-dependency predictor" to refer to the accused feature in the accused products.

threshold in the A9 processor would operate in the same infringing manner as the prediction threshold in the A8 processor.

As such, rather than the design constantly changing as Judge Crocker believed, the high-level designs may be effectively identical, only differing by their implementation. Given that the asserted patent is not limited to a particular implementation, the implementation differences of the data-dependency predictor in the A8 and A9 are irrelevant. In that case, including the future A9 processors into WARF's original lawsuit probably will not delay the trial.

MOTION TO COMPEL TO PRODUCE SPECIFIC VERSIONS OF ACCUSED PROCESSORS

As described in Part VI of this series, WARF filed a motion to compel to require Apple to produce an executable version of the simulator for the Accused Products (A6, A7, and A8 processors). The reason WARF did this is so that they could measure the performance benefit of the asserted patent in those processors. With respect to this issue, Part VI of this series commented that "Apple never appeared to suggest that, as an alternative to producing an executable version of the simulator (which it also argued was not relevant and was an undue burden), that WARF should run the workloads on actual silicon of the Accused Products. This tends to indicate that there was no way to turn off the data-dependency prediction feature in the Accused Products, and thus there would be no way to measure the speedup of the patent."[5] But that speculation was incorrect.

On 20 February 2015, WARF filed its next motion to compel (second of the three remaining motions to compel). In this motion, WARF requested that the Court order Apple to produce specific versions of the Accused Processors in order to measure the performance benefit of the Accused Products (see page 1 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[6]). More specifically, WARF stated that it tried to get the performance information, first by asking, via an "interrogatory" (i.e., a written question where the answer is under oath), whether there was a way to disable to the data-dependency predictor (see page 1 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[6]). WARF then stated that "[f]our months later, Apple identified only a technical manual describing a technique it knew WARF would be unable to use due to Apple's security controls (but neglected to disclose this to WARF)" (see page 1 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[6]). Rather, according to WARF, "***only Apple*** has the security keys to permit the [data-dependency predictor] to be flipped" (see page 1 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[6]) (emphasis in WARF's brief).

When WARF asked Apple to produce sample devices that had the data-dependency predictor disabled, Apple stated that such devices "do not presently exist at Apple" (see page 1 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[6]). But after deposing Apple's engineers, WARF learned that Apple had several such devices that its engineers "routinely used" to "perform exactly the kinds of experiments WARF seeks to run" (see page 2 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[6]). WARF argues that, despite those facts, "Apple *still* refused to let WARF inspect and test the devices on the familiar ground that it would be too burdensome" (see page 2 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[6]) (emphasis in WARF's brief).

To support its motion, WARF retained an expert, Prof. Glenn Reinman of the University of California, Los Angeles, to provide an expert declaration (see page 1 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[7]). While portions of his declaration are redacted, Prof. Reinman appears to have tried to disable the data-dependency predictor on a commercial iPhone, but was unable to do so given that the particular variable "resides in a protected portion of memory controlled by the operating system" (see paragraph 9 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[7]).

WARF requested that the Court order Apple to do one of three[b] alternatives (see page 24 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[6]). Unfortunately, due to the redactions in WARF's brief, Prof. Reinman's declaration, Apple's brief, and Apple employee Peter Bannon's declaration, it is very difficult to determine what the three alternatives are. That said, reading between the lines, the first alternative may be that Apple provides their typical test setup, that includes a JTAG interface, so Prof. Reinman can "plug a cable directly into the board/device in which the chip is installed and interact directly with the processor" (see paragraph 17 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[7], and page 24 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[6]). The second alternative may be that Apple provides the iOS source code and its compiler so that Prof. Reinman (or alternatively Apple itself) can manually change iOS in order to create a "side build" of iOS that disables the data-dependency predictor (see paragraph 12 of *Wis. Alumni Rsch.*

[b]Apple describes WARF's requests as only being two alternatives, which could mean the first and third alternatives are either similar or overlap, or are otherwise combined (see page 1 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[8]).

Found. v. Apple, Inc.[7], and page 24 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[6]). The third alternative may be that Apple provides devices where the data-dependency predictor is somehow disabled and possibly where iOS has not been installed (see paragraph 10 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[7], and page 24 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[6]).

In its response, Apple argues that it provided WARF with "substantial performance-related discovery," including "all results that it could locate of the simulations or experiments created by Apple engineers during the development of the accused A7, A8, and A8X processors," "emails or other documents" discussing those results, source code for those processors, depositions of the Apple engineers who designed the accused feature, etc. (see pages 1, 6–8 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[8]).

Apple makes three arguments against WARF's requests that the Court should order Apple to undertake one of the alternatives. First, Apple argued that WARF's requests would require Apple to create documents or things (see pages 1, 6–8 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[8]). In other words, Apple argued that because none of the things that WARF requests exists, Apple would have to create them, which is beyond the scope of what is required under the Federal Rules (see page 10 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[8]). Furthermore, Apple said that WARF's requests are significantly beyond what courts have granted in other cases (see page 13 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[8]).

Second, Apple asserted that creating and producing what WARF requests would impose an "undue burden" on it (see page 14 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[8]). In particular, Apple stated that it would be "deprived [of] valuable engineering time" in order to meet WARF's requests and to monitor "WARF's use of the equipment due to security risks presented by their production" (see pages 14–17 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[8]).

Third, Apple said that WARF "greatly overstates the relevance of additional performance data" (see page 17 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[8]). In particular, as described above, Apple argued that it already produced "all simulations or experiments created by Apple engineers during the development of the accused A7, A8, and A8X it could locate" (see page 18 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[8]). Apple also argued that WARF already questioned Apple's engineers about the performance aspects of the accused feature in depositions (see page 18 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[8]).

In addition, Apple argued that "testing performed on the requested devices would be of limited relevance" (see page 19 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[8]). More specifically, Apple argued that the modifications that WARF products may have "unknown and unintended effects" that may affect the test results (see page 19 of *Wis. Alumni Rsch. Found. v. Apple, Inc.*[8]).

On 11 March 2015, Judge Crocker held a telephonic hearing for this motion (see *Wis. Alumni Rsch. Found. v. Apple, Inc.*[9]). The meeting minutes that were published on the docket state that Judge Crocker "granted the motion in the manner and for the reasons stated during the hearing" (see *Wis. Alumni Rsch. Found. v. Apple, Inc.*[9]). Unfortunately, the redacted version of the hearing transcript is not publicly available, so Judge Crocker's reasons are unknown.

In general, I agree with Judge Crocker's decision. Measuring the exact performance impact of the data-dependency predictor in the Accused Products is critically important to determining the damages due to Apple's alleged infringement of the asserted patent. Obviously, if the data-dependency predictor has a speedup of 20%, then it is more valuable than if it provides a speedup of 2%. While the damages may not be 10× higher with the former as compared to the latter, the former should be significantly more valuable. Therefore, in order to provide the jury with accurate data upon which they can make an educated decision regarding the damages for Apple's alleged infringement of the asserted patent, it is necessary to measure the performance of the data-dependency predictor in the accused products.

With respect to Apple's argument that the modifications WARF requested may affect the test results, I do not believe that the modifications that WARF requested are likely to affect the test results at all, let alone significantly. More specifically, WARF's requested modifications only changes one parameter: whether the data-dependency predictor is on or off. As such, given that there is a single change, the likelihood that the test results may be affected is low. Furthermore, WARF and Apple can compare WARF's test results to the results that Apple generated while designing the accused processor to "sanity check" whether WARF's test results are reasonable. Finally, this kind of test is exactly what engineers typically do to measure the performance of a particular feature.

With respect to Apple's arguments that creating and producing what WARF requests is an undue burden, I disagree for at least two reasons. First, creating a side version of iOS—one where the only difference from public releases of iOS versions is that it disables the data-dependency predictor—seems to be incredibly easy for Apple's iOS software engineers to do. Second, Apple's arguments regarding security appear to

be exaggerated, as WARF's testing would likely occur in the same place that WARF reviewed Apple's source code. Given that Apple does not appear to have significant issues with WARF reviewing its source code in that location, Apple likewise should not have any significant issues with WARF testing specific devices with the data-dependency predictor turned off or on in the same location.

The next article in this series will continue to examine what happened in this case.

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