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DEPARTMENT: MICRO LAW

Analysis of Historical Patenting Behavior and Patent Characteristics of Computer Architecture Companies—Part IV: Claims

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Part III of this series analyzed the 1) number of claims; 2) the breakdown of independent and dependent claims; and 3) the effect that excess claim fees had on the number of total and independent claims for patents that were issued to 18 leading computer architecture companies for patents that were filed between 1996 and 2020. This article builds on that work by analyzing the type of claims (e.g., apparatus or method), and the effect that the Supreme Court's decision in *Alice Corp. v. CLS Bank Int'l* had on the average number of method claims.

Table 1 lists the number of nondesign patents that were filed between January 1, 1996 and December 31, 2020, and that issued by March 31, 2022 for each of the 18 companies. The data in this article excludes design patents because design patents do not have apparatus or method claims; as such, that including them would be irrelevant. The right-most column lists the number of patents that are classified as computer architecture patents.[a]

During this timeframe, some companies merged (e.g., Dell merged with EMC) or made significant acquisitions (e.g., Avago acquired Broadcom). In order to ensure that the results accurately reflect the present form of combined companies, I included the merged or acquired companies if 1) the companies were computer architecture companies and/or 2) had a significant number of patents. To improve readability, I will refer to companies with multiple entities generally by the parent company's name. More specifically, I will refer to AMD+ATI as "AMD," Dell+EMC+VMware as "Dell+EMC," Marvell+Cavium as "Marvell," NXP+Freescale as "NXP," Renesas+Dialog+IDT+Intersil as "Renesas," and Via+Cyrix as "Via." In addition, I will refer to Avago+Broadcom as "Broadcom" as the latter may be the more well-known company and the company that is more relevant with respect to computer architecture.

TYPES OF CLAIMS FOR ALL PATENTS

Claims are generally either an apparatus claim or a method claim. The former describes a system of components while the latter consists of one or more steps. The following exemplary apparatus and method claims are from U.S. Patent No. 7,617,409, which was issued to ARM:

1. An integrated circuit comprising:

processing logic circuitry; and
a clock-signal comparator having:
a reference input port for receiving a reference clock signal;
at least one further input port for receiving a respective further clock signal; and
checking logic circuitry configured to check for a correspondence between a clock edge of said reference clock signal and a corresponding clock edge of said further clock signal within a predetermined time window;
wherein said checking logic circuitry is configured to check for said correspondence during operation of said integrated circuit, wherein said checking logic circuitry comprises a reference signal path and a further signal path, and

[a]I classified a patent as a "computer architecture" patent if it was classified in the 345, 708, 709, 710, 711, 712, 713, or 714 patent classes of the U.S. Patent Classification System or G06F, G06T, G09G, G11B, G11C, H03M, or H04L patent classes of the Cooperative Patent Classification System. These are the same patent classes that I used in Parts I–III of this article series.

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TABLE 1. Number of all patents and computer architecture patents filed between January 1, 1996 and December 31, 2020 that issued by March 31, 2022, excluding design patents.

Company	All patents	Computer architecture patents
Amazon	15,905	9,271
AMD+ATI	11,173	4,631
Apple	24,414	12,279
ARM	2,777	2,372
Avago+Broadcom	14,750	6,295
Dell+EMC+VMWare	21,091	18,260
IBM	133,738	82,812
Intel	45,405	24,643
Marvell+Cavium	8,621	5,193
Microsoft	43,602	32,144
MIPS	273	271
NVIDIA	3,948	3,139
NXP+Freescale	11,827	3,742
Qualcomm	29,190	10,155
Renesas+Dialog+IDT+Intersil	14,378	4,403
Samsung	124,578	37,173
SiFive	12	9
Via+Cyrix	1,967	1,325

wherein said further signal path comprises at least one data-capture element clocked by said reference clock and at least one data-capture element clocked by said further clock.

34. A method for detecting a time difference between clock edges in an integrated circuit, said method comprising the steps of:
    receiving a first clock signal at a first input port;
    receiving a second clock signal at a second input port;
    checking for a correspondence between a clock edge of said first clock signal and a corresponding clock edge of said second clock signal within a predetermined time window;
    wherein said checking is performed during operation of said integrated circuit;
    wherein said checking is performed by checking logic comprising a reference signal path and a further signal path; and
    wherein said further signal path comprises at least one data capture element clocked by said first clock signal and at least one data capture element clocked by said second clock signal.

Claim 1 is an apparatus claim while Claim 34 appears to be the corresponding method claim. Companies frequently use both apparatus and method claims for the same invention, so patents typically contain both types of claims. A method claim is infringed when someone performs the steps of the method claim. An apparatus claim is infringed when someone, for example, makes the apparatus or offers it for sale.

One potentially relevant difference between method and apparatus claims is the timeframe that the patent owner may recover damages over. From a 30,000 foot view, a patent owner may recover damages for up to six years prior to filing a patent infringement lawsuit ("presuit damages") for a method claim. To recover presuit damages for an apparatus claim, the patent owner must "mark" its own products that use the patent by listing the numbers of the patents that the product uses. While a failure to mark its products will prevent a patent owner from recovering any presuit damages for an apparatus claim, because a patent owner is not required to mark its products with respect to method claims, the patent owner may be able to recover up to six years of presuit damages for a method claim without marking its products.

A "computer readable medium" claim, which is also known as "Beauregard claim," is a hybrid of an apparatus and a method claim. In a Beauregard claim, the computer readable medium, e.g., a floppy disk, stores a set of instructions that, when executed by a computer, cause the computer to perform a specified method. As such, a Beauregard claim is like an apparatus because it uses a computer readable medium and a computer; on the other hand, a Beauregard claim is like a method claim in that it recites a series of method steps that the computer executes. Given that computer architecture is at the intersection of hardware and software, Beauregard claims could be particularly popular for computer architecture patents, in comparison to other technologies. Claim 42 appears to be the corresponding Beauregard claim to Claims 1 and 34 from the '409 Patent that was issued to ARM:

42. A computer-readable medium comprising a hardware description model of a circuit in a hardware description language, said hardware description model comprising representations of:

a clock-signal comparator having:
a reference input port for receiving a reference clock signal;
at least one further input port for receiving a respective further clock signal; and
checking logic circuitry configured to check for a correspondence between a clock edge of said reference clock signal and a corresponding clock edge of said further clock signal within a predetermined time window;
wherein said checking logic circuitry is configured to check for said correspondence during operation of said circuit, wherein said checking logic circuitry comprises a reference signal path and a further signal path, and wherein said further signal path comprises at least one data-capture element clocked by said reference clock and at least one data-capture element clocked by said further clock.

Figure 1 shows the average number of independent/dependent method, apparatus, and Beauregard claims for each of the 18 companies.[b] Figure 1(a) depicts the results for all patents while Figure 1(b) shows the results for computer architecture only patents.

The results in Figure 1(a) show that the average number of independent method claims ranges from 0.80 (Renesas) to 1.95 (Microsoft). As shown in Part III of this article series, Renesas had the lowest average number of independent claims (and the lowest average number of total claims), so it is not surprising to see it also has the lowest average number of independent method claims. Renesas is also the only company where its average number of independent method claims is less than 1.0. Renesas also had the lowest average number of independent method claims by a significant amount; the next closest company, Samsung, had an average number of 1.04 independent method claims, which is more than 25% higher than Renesas. On the other hand, four companies had an average number of independent method claims that was more than double Renesas's average of 0.80; those companies were Microsoft (1.95), MIPS (1.79), Qualcomm (1.77), and AMD (1.76).

The results in Figure 1(a) also show that the average number of independent apparatus claims ranges from 1.15 (IBM) to 2.80 (Qualcomm). IBM has the lowest average number of independent apparatus claims by a significant amount. More specifically, the next closest company, AMD, had an average number of 1.39 independent apparatus claims, which is more than 21% higher than IBM. On the other hand, three companies had an average number of independent apparatus claims that was greater than 2.0; those companies were Qualcomm (2.80), MIPS (2.22), and Intel (2.15).

THE RESULTS IN FIGURE 1(A) SHOW THAT THE AVERAGE NUMBER OF INDEPENDENT METHOD CLAIMS RANGES FROM 0.80 (RENESAS) TO 1.95 (MICROSOFT). THE RESULTS IN FIGURE 1(A) ALSO SHOW THAT THE AVERAGE NUMBER OF INDEPENDENT APPARATUS CLAIMS RANGES FROM 1.15 (IBM) TO 2.80 (QUALCOMM).

Comparing the average number of independent method claims to the average number of independent apparatus claims shows that only four companies have a higher average number of the former. More specifically, Microsoft has an average 1.32 independent method claims for every independent apparatus claim while the corresponding ratios for AMD, IBM, and Dell+EMC are 1.27, 1.20, and 1.11, respectively. Given that these companies 1) are different, as compared with each other, and 2) do not share any obvious commonalities, as compared with the other 14 companies, the fact these companies appear to favor independent method claims over independent apparatus claims may just be due to each company's preference.

On the other hand, the companies with the lowest ratios of independent method claims to independent apparatus claims are Renesas (0.47), Intel (0.57), and Samsung (0.58). In other words, each of these companies has approximately two independent apparatus claims for each independent method claim.

More generally, given that the vast majority of companies have a larger average number of independent apparatus claims than independent method claims indicates that computer architecture companies generally prefer apparatus claims.

The results in Figure 1(a) also show that computer architecture companies generally do not have independent Beauregard claims. More specifically, the

[b]Independent claims do not depend on another claim, i.e., they are "independent" of other claims. By contrast, dependent claims depend on at least one other claim and add at least one additional limitation to the parent claim.

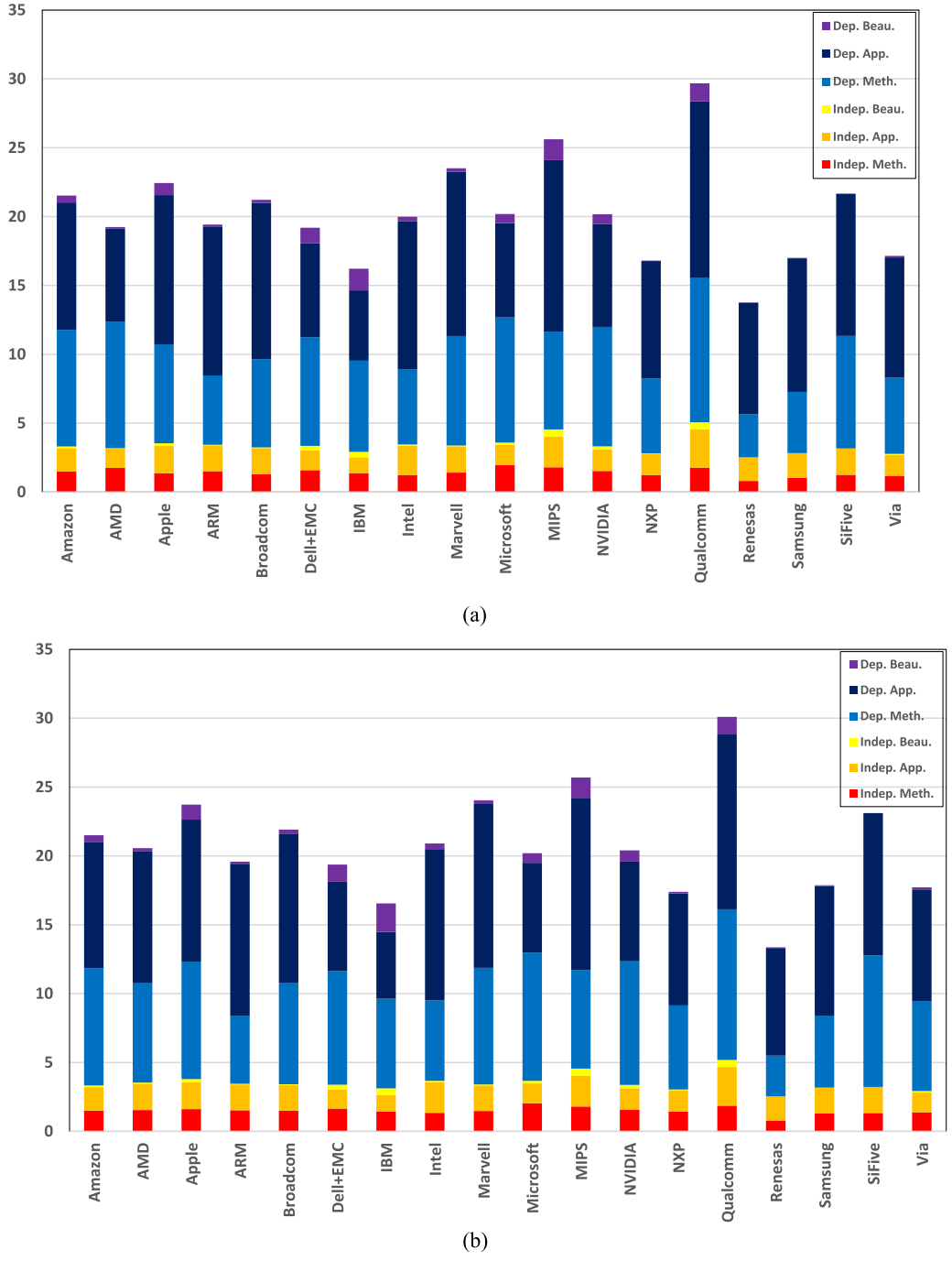

FIGURE 1. Average number of independent/dependent method, apparatus, and Beauregard claims for each patent. (a) All issued patents. (b) Computer architecture patents only.

average number of independent Beauregard claims ranges from 0.00 (SiFive) to 0.52 (MIPS). Examining the results more closely shows that 10 companies have fewer than 0.1 independent Beauregard claims, which is less than approximately 3% of independent claims. On the other hand, the companies with the highest average number of independent Beauregard claims are MIPS (0.52), Qualcomm (0.50), and IBM (0.39). The fact that MIPS had the highest average number of independent Beauregard claims is surprising given that Beauregard claims recite software steps while MIPS is a hardware company that primarily designed

microprocessors. One reason that could account for this is that MIPS has the second highest total number of independent claims. As such, MIPS may have resorted to drafting additional independent claims in Beauregard format in order to increase its numbers of independent claims. The same reason may hold true for Qualcomm, which had the highest average number of independent claims.

Dependent claims need to be of the same type—method, apparatus, or Beauregard—as their parent claim, which is generally an independent claim. The results show that the ratio of dependent claims to independent claims can vary significantly based on the type of the claim. More specifically, for method claims, the ratio of dependent claims to independent claims ranges from 3.33 (ARM) to 6.53 (SiFive), with a median of 4.91. The companies at the endpoints of the range are particularly interesting given that both are fabless companies, which may indicate that fabless companies are somewhat indifferent to having additional dependent claims for validity. ARM's ratio of 3.33 is by far the lowest ratio; the next lowest ratio is 3.89 (Renesas). On the other hand, SiFive's ratio of 6.53 is by far the highest ratio; the next highest ratio is 5.92 (Qualcomm).

For apparatus claims, the ratio of dependent claims to independent claims ranges from 4.44 (IBM) to 6.26 (Marvell), with a median of 5.25. As compared to the range of ratios for method claims, the range of ratios for apparatus claims is smaller (1.82 for apparatus claims and 3.20 for method claims). The smaller range of ratios for apparatus claims may indicate that computer architecture companies place similar value on dependent apparatus claims. By contrast, the larger range of ratios for method claims indicates that computer architecture companies have a difference of opinion in how valuable dependent method claims are and/or how much validity protection dependent method claims actually provide.

For Beauregard claims, the ratio of dependent claims to independent claims ranges from 1.43 (Via) to 4.47 (Apple), with a median of 3.32. Given that computer architecture companies have a very low average number of independent Beauregard claims, it is not surprising to see that the median ratio for Beauregard claims is lower than the median ratios for apparatus and method claims as these companies appear to place a lower value of Beauregard claims in general.

Comparing the results in Figure 1(a) (all issued patents) and (b) (computer architecture patents) shows that, for most companies, the average numbers of independent/dependent method and apparatus claims for computer architecture patents is very similar to the average numbers of independent/dependent method and apparatus claims for all issued patents. More specifically, with only a few exceptions, the difference is generally less than ±5%.

AMD is the biggest outlier to that general trend. AMD has the largest differences in the average numbers of independent/dependent method and apparatus claims for its computer architecture patents. The average number of independent method claims and dependent method claims for AMD's computer architecture patents, as compared to all of AMD's issued patents, is 11.9% and 21.5%, respectively, lower. By contrast, the average number of independent apparatus claims and dependent apparatus claims for AMD's computer architecture patents, as compared to all of AMD's issued patents, is 38.2% and 42.0%, respectively, higher. The decreases in the average numbers of method claims in conjunction with increases in the average numbers of apparatus claims appears to indicate that AMD generally prefers using apparatus claims for its computer architecture patents, as compared to all issued patents. AMD may prefer to do this because 1) AMD believes computer architectures patent claims are more naturally drafted as apparatus claims and/or its patent attorneys find it easier to draft computer architecture claims as apparatus claims; 2) it may be more difficult to prove infringement of a computer architecture method claim as it would need to show that the accused infringed performed all of the method steps within the United States or, conversely, it is easier to prove infringement of a computer architecture apparatus claim; and 3) AMD believes it can more effectively mark its computer architecture-related products (as compared to other companies) and/or its computer architecture-related products do not use the patented invention (which means it does not need to mark its products).

For independent method claims, only Apple, Broadcom, NXP, Samsung, and Via have a greater than ±10% difference for its computer architecture patents as compared to all of its patents. For these companies, the computer architecture patents had 16.4% (Broadcom) to 25.9% (Samsung) more independent method claims as compared to all issued patents. These five companies were also the only ones that had greater than ±10% difference in the number of dependent method claims for their computer architecture patents as compared to all of their issued patents.[c] Collectively, these results could indicate that

[c]SiFive also had a difference that was greater than 10% for its dependent method claims, but given that SiFive had only 12 issued nondesign patents and nine computer architecture patents, that result may be due to a small sample size.

these companies believe that method claims are more valuable than apparatus claims for their computer architecture patents.

For both independent and dependent apparatus claims, with the exception of AMD, none of the companies had a difference greater than ±10% difference for its computer architecture patents as compared to all of its patents. In fact, with the exception of AMD and Via, no company had a difference greater than ±5% difference in the average numbers of its apparatus claims for its computer architecture patents as compared to all of its patents. For the companies where the average number of independent method claims increased by more than 10% (Apple, Broadcom, NXP, Samsung, and Via), the number of independent apparatus claims for computer architecture patents decreased by 0.1% (NXP) to 5.6% (Via) for the non-Samsung companies, while the number of independent apparatus claims for Samsung increased by a modest 3.8%. The number of dependent apparatus claims for these five companies also decreased by approximately the same amount (i.e., less than 5%).

Comparing the percentage changes in the average number of method and apparatus claims for their computer architecture patents, as compared to all of their patents, shows that AMD is taking the opposite approach from that of Apple, Broadcom, NXP, and Via. More specifically, AMD decreased its method claims by 20.0% while increasing its apparatus claims by 41.4%. While Apple, Broadcom, NXP, and Via increased their method claims by 13.2% (NXP) to 18.7% (Apple) and decreased their apparatus claims by 3.8% (NXP) to 7.1% (Via). There does not appear to be any obvious reason—apart from preference—why AMD has an entirely different approach than these four companies.

Turning to Beauregard claims, the first result is that SiFive did not have any Beauregard claims. This is likely a consequence of having only 12 issued nondesign patents and nine computer architecture patents. For the remaining companies, the number of independent Beauregard claims ranged from 0.0% (MIPS) to 127.1% (NXP) higher for computer architecture patents as compared to all the issued patents. Similarly, for companies other than Qualcomm, the number of dependent Beauregard claims was 0.7% (MIPS) to 163.5% (NXP) higher for computer architecture patents as compared to all the issued patents. By contrast, Qualcomm experienced a 3.0% decrease in the number of dependent Beauregard claims for their computer architecture patents as compared to all issued patents.

Although there is a wide range of percentages for independent and dependent Beauregard claims, the companies can be divided into three groups. In the first group are the companies where the percentage increase was relatively modest (less than approximately 15%); these companies are MIPS, Qualcomm, Amazon, ARM, Microsoft, Dell+EMC, NVIDIA, and Marvell. In the second group are the companies where the percentage increase was much larger (20% –45%); these companies are Intel, Apple, IBM, Broadcom, and Via. In the last group are companies where the percentage increase approached or exceeded 100%, namely, Samsung, AMD, Renesas, and NXP. Unsurprisingly, the results for dependent Beauregard claims were the same, namely, the same companies were in each group and the percentages were very similar.

Overall, these results tend to indicate that computer architecture companies believe that it is more important—to varying degrees—to use Beauregard format for its computer architecture patents as compared to all its issued patents. From a technical perspective, this makes sense as Beauregard claims are directed at the hardware and software interface, which is what computer architecture is generally directed to. As such, they may more naturally fit computer architecture patents, which may naturally involve the combination hardware and software and the fetch-execute model.

Figure 2 shows the percentage of each claim type—method, apparatus, and Beauregard—for all issued patents for all 18 companies.

The results in Figure 2 show that method claims account for 28.5% (Renesas) to 56.9% (AMD) of all claims, with a median of 39.7%; apparatus claims account for 38.5% (IBM) to 71.2% (Renesas) of all claims, with a median of 57.2%; and finally, Beauregard claims account for 0.0% (SiFive) to 12.1% (IBM) of all claims, with a median 1.7%.

THE RESULTS IN FIGURE 2 SHOW THAT METHOD CLAIMS ACCOUNT FOR 28.5% (RENESAS) TO 56.9% (AMD) OF ALL CLAIMS, WITH A MEDIAN OF 39.7%; APPARATUS CLAIMS ACCOUNT FOR 38.5% (IBM) TO 71.2% (RENESAS) OF ALL CLAIMS, WITH A MEDIAN OF 57.2%; AND FINALLY, BEAUREGARD CLAIMS ACCOUNT FOR 0.0% (SIFIVE) TO 12.1% (IBM) OF ALL CLAIMS, WITH A MEDIAN 1.7%.

EFFECT OF CHANGES IN THE LAW

The results in the previous section show that the distribution of method, apparatus, and Beauregard claims

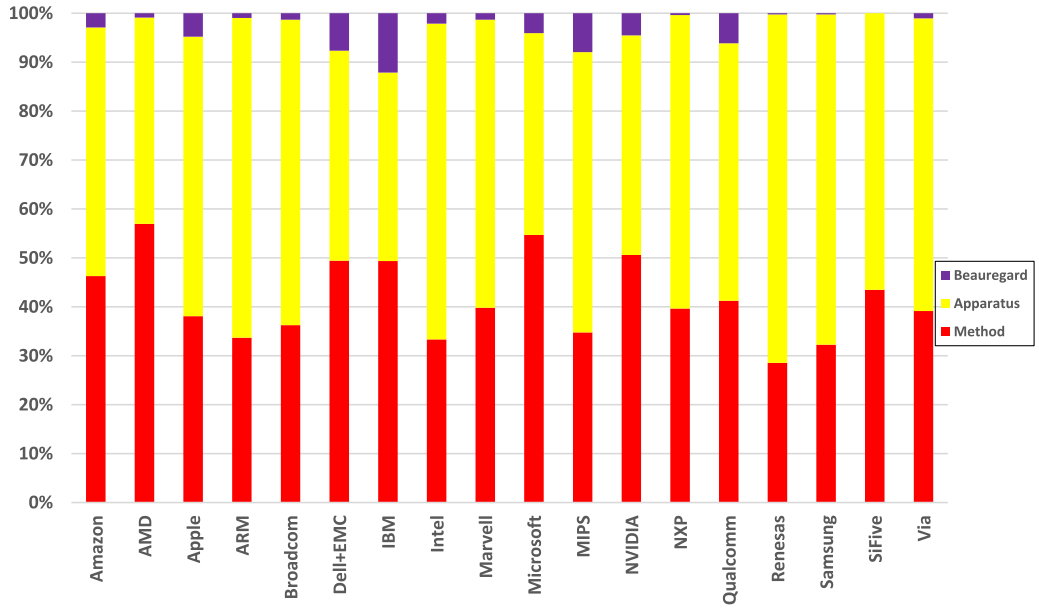

FIGURE 2. Percentage of method, apparatus, and Beauregard claims for all issued patents.

depends on 1) what a particular company prefers and 2) the type of technology, e.g., computer architecture. Another significant factor that could change the frequency of method claims—and concomitantly the distribution of method versus apparatus and Beauregard claims—are changes in the law.

On June 19, 2014, the Supreme Court of the United States decided *Alice Corp. v. CLS Bank Int'l*, in which the Supreme Court decided what inventions are eligible for patent protection. In particular, the Supreme Court held that, *inter alia*, abstract ideas are generally not patentable, i.e., are invalid. According to the Supreme Court, an example of an abstract idea is a "method of organizing human activity." Immediately after that decision, attorneys speculated whether *Alice* would invalidate method claims and software patents (which are frequently implemented as method claims).[d]

Table 2 shows the average numbers of independent and dependent method claims per patent for each of the 18 computer architecture companies before and after the Supreme Court's *Alice* decision. The pre-*Alice* timeframe in Table 2 includes patents that were filed between December 8, 2004 (the date that the United States Patent and Trademark Office started imposing fees for excess numbers of claims) and June 18, 2014, (the day before the Supreme Court issued its *Alice* decision). As shown in Part III of this article series, the imposition of excess claim fees dramatically reduced the average number of claims per patent; as such, limiting the pre-*Alice* timeframe to start only after the imposition of excess claim fees eliminates the sharp drop-off in the average number of claims per patent, which provides for more of an apples-to-apples comparison in order to detect post-*Alice* changes. The post-*Alice* timeframe in Table 2 includes patents that were filed between June 19, 2014 until December 31, 2020, which issued by March 31, 2022. Table 2 does not include MIPS and SiFive as MIPS has pre-*Alice* patents only while SiFive has post-*Alice* patents only, which makes it irrelevant to compare their pre/post-Alice changes.

Comparing the average number of pre-*Alice* independent method claims with the average number of post-*Alice* independent method claims shows that, with the exception of Marvell and NVIDIA, the average number of independent method claims decreased by 5.1% (ARM) to 36.4% (Apple), with a median decrease of 16.7%. By contrast, the average number of independent method claims for Marvell and NVIDIA increased by 2.1% and 12.8%, respectively. There does not appear to be any obvious reason why these two companies increased the number of independent method claims post-*Alice*.

The change in the average number of pre-*Alice* dependent method claims with the average number of

[d]Goodwin Procter LLP, *Impact of the Alice v. CLS Bank Decision – A Year-End Review*. Accessed: July 20, 2022. [Online]. Available: https://www.goodwinlaw.com/publications/2014/12/impact-of-the-alice-v-cls-bank-decision-a-year_end-review; Fredrikson & Byron P. A., *Are Any Method Claims Safe from Alice?*. Accessed: July 20, 2022. [Online]. Available: https://www.fredlaw.com/news__media/2014/11/04/704/are_any_method_claims_safe_from_alice/

TABLE 2. Average numbers of independent and dependent method claims per patent before and after *Alice*.

Company	Pre-Alice		Post-Alice	
	Indep. method	Dep. method	Indep. method	Dep. method
Amazon	1.65	10.03	1.38	7.31
AMD+ATI	1.70	8.66	1.41	7.32
Apple	1.60	8.28	1.02	5.69
ARM	1.56	4.45	1.48	4.77
Avago+Broadcom	1.16	5.60	1.03	4.82
Dell+EMC+VMWare	1.64	8.47	1.49	7.55
IBM	1.30	6.25	1.19	6.40
Intel	1.18	5.52	0.94	4.08
Marvell+Cavium	1.34	7.57	1.37	8.07
Microsoft	1.79	8.69	1.44	7.27
NVIDIA	1.38	8.18	1.56	9.24
NXP+Freescale	1.26	5.71	1.05	4.47
Qualcomm	1.84	10.60	1.53	10.59
Renesas+Dialog+IDT+Intersil	0.76	2.91	0.71	3.13
Samsung	1.13	4.90	0.84	3.85
Via+Cyrix	1.17	5.91	1.07	5.40

post-*Alice* dependent method claims is similar. More specifically, with the exception of ARM, IBM, Marvell, NVIDIA, and Renesas, the average number of dependent method claims decreased by 0.0% (Qualcomm) to 31.3% (Apple), with a median decrease of 15.9%. For ARM, IBM, Marvell, NVIDIA, and Renesas, the average number of dependent method claims increased by 7.1%, 2.4% 6.6%, 12.9%, and 7.8%, respectively. There does not appear to be any obvious reason why these companies increased the number of dependent method claims or any commonality between these companies that would explain the increase.

Based on these results, for Amazon, AMD, Apple, Broadcom, Dell+EMC, Intel, Microsoft, NXP, Qualcomm, Samsung, and Via, because there was a decrease in both the average numbers of independent and dependent method claims post-*Alice*, it appears that these companies may have reduced the number of method claims in their patents due to concerns about the potential validity of their method claims. By contrast, Marvell and NVIDIA were apparently so unconcerned about the impact of *Alice* that they actually increased the number of their method claims. The remaining companies (ARM, IBM, and Renesas) had a relatively small decrease in the average number of independent method claims (–8.2% to –5.1%) but had a large enough increase in their dependent method claims that the total number of method claims (i.e., independent and dependent) slightly increased post-*Alice*. These results indicate that these companies believe that method claims are still valuable, but they have concerns of the validity of these claims.

THE REMAINING COMPANIES (ARM, IBM, AND RENESAS) HAD A RELATIVELY SMALL DECREASE IN THE AVERAGE NUMBER OF INDEPENDENT METHOD CLAIMS (–8.2% TO –5.1%) BUT HAD A LARGE ENOUGH INCREASE IN THEIR DEPENDENT METHOD CLAIMS THAT THE TOTAL NUMBER OF METHOD CLAIMS (I.E., INDEPENDENT AND DEPENDENT) SLIGHTLY INCREASED POST-ALICE. THESE RESULTS INDICATE THAT THESE COMPANIES BELIEVE THAT METHOD CLAIMS ARE STILL VALUABLE, BUT THEY HAVE CONCERNS OF THE VALIDITY OF THESE CLAIMS.

The explanation for ARM, IBM, and Renesas's approach may be their belief that dependent claims could provide an "inventive concept" such that the otherwise unpatentable abstract idea becomes patent-eligible. More specifically, the Supreme Court in *Alice* held that even if an invention is directed to an abstract idea, the invention may still be patentable if the patent recites an "inventive concept" that transforms the claimed abstract idea into a patent-eligible invention. One such way to do that is to add additional limitations—i.e., through a dependent claim—where the additional limitations—alone or in conjunction with other limitations—may provide an inventive concept. In other words, ARM, IBM, and Renesas may have "exchanged" some of their independent method claims for dependent method claims in the hopes that the additional limitations in the dependent method claims can help provide an inventive concept that makes the method claim to be valid under *Alice*.

Part V in this series will analyze the number and type of references for these companies for patents filed between January 1, 1996, and December 31, 2020.

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