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DEPARTMENT: MICRO LAW

Analysis of Historical Patenting Behavior and Patent Characteristics of Computer Architecture Companies—Part XII: Patent Families

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In prior parts of this series, I analyzed

- The numbers of issued patents and computer architecture patent.
- The prosecution time and effective patent term.
- The number of claims, breakdown of independent and dependent claims, and effect that excess claim fees had on the numbers of total and independent claims.
- The type of claims (apparatus, method, or Beauregard), and the effect that the Supreme Court's decision in *Alice v. CLS Bank* had on the number of independent and dependent method claims.
- The number of "backward" citations to U.S. patents and publications, foreign patents, and Other References, and the number of "forward" citations to a patent by another U.S. patent or U.S. patent publication.
- The correlation between prosecution time and number of claims, and the effect of the technology center on the correlation.
- The characteristics of patent families, including the percentage of patent families with only one issued patent, the average number of patents per family, and the correlation between the number of patents in a company's portfolio and the average number of patents in its multipatent families.
- The number of all patents and the number of computer architecture patents in the five largest patents families for each company, and the percentage of all patents and computer architecture patents in the five largest patent families.
- The average number of total, independent, and dependent claims for single-patent and multipatent families for patents issued to 18 leading computer architecture companies that were filed between 1996 and 2020.

This article continues analyzing the characteristics of patent families, which is particularly interesting because larger patent families are generally considered to be more valuable and may cover more significant inventions.

In this article, patents are in the same family if they have the same U.S. Patent and Trademark family identification (FMID) number. A patent has the same FMID if it is a continuation patent (a patent that claims priority to another patent) or continuation-in-part patent (a patent that claims priority to another patent but includes some new material, i.e., not in the priority patent, that has a later priority date). The FMID does not appear to include divisional patents (a patent that claims priority to another patent but covers a different invention, so that it is "divided" out).

Table 1 lists the number of patents that were filed between 1 January 1996 and 31 December 2020 and that issued by 31 March 2022 for each of the 18 companies. The right-most column lists the number of patents that are classified as computer architecture patents,[a] while the middle column lists the number of all patents, i.e., computer architecture and noncomputer architecture ("All Patents"). During this timeframe, some companies merged (e.g., Dell merged with EMC) or made significant acquisitions (e.g., Avago acquired Broadcom). To ensure that the results

[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–V of this article series.

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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 refer to companies with multiple entities generally by the parent company's name. More specifically, I 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 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.

The results in the last article in this series showed that, for 11 of 17 companies (AMD, Broadcom, Dell+EMC, IBM, Intel, Marvell, Microsoft, MIPS, Nvidia, NXP, and Samsung), the average number of total claims for multipatent families was lower than the average number of total claims for single-patent families. The results also showed that although the average number of *total* claims was *higher* for the remaining six companies, the average number of *independent* claims was *lower* for three of those companies (ARM, Renesas, and Via).

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

Company	All Patents	Computer Architecture Patents
Amazon	16,383	9268
AMD	11,189	4631
Apple	27,968	12,308
ARM	2782	2372
Broadcom	14,757	6292
Dell+EMC	21,427	18,264
IBM	133,932	82,821
Intel	45,680	24,467
Marvell	8626	5185
Microsoft	47,562	31,999
MIPS	273	271
Nvidia	3957	3057
NXP	11,831	3729
Qualcomm	29,242	10,082
Renesas	14,384	4021
Samsung	136,054	33,301
Via	1981	1320

This article continues to analyze the average number of total claims for multipatent families to gain insight into 1) why the average number of total claims was lower for multipatent families for some companies and 2) why the average number of independent claims for multipatent families was lower while the average number of total claims was higher for some companies.

One reason why the average number of total claims for multipatent families may be lower than the average number of total claims for single-patent families is because some companies may effectively view multipatent families as a single patent with a very large number of claims spread over multiple patents. In other words, rather than file a single-patent application with a very large number of claims, e.g., 100 total claims, a company may opt to split those 100 claims into five different patent applications. One potential advantage of this approach is that the prosecution time of each individual patent may be faster, so the patent will issue sooner. Another advantage is that reducing the number of total claims and independent claims in a pending application to 20 total and three independent claims allows the applicant to avoid paying excess claim fees. The current fee for excess claims is $480 for each independent claim in excess of three, and $100 for each total claim in excess of 20.[1,b] Assuming that the single-patent application would have had 100 total claims, of which 15 were independent claims, the total excess claim fee would be $13,760 (or $23,200 in 2025). By contrast, the filing fee for a patent application is $320 ($350 in 2025).[2] Although attorney's fees to prosecute a patent may range from $7000 to $16,000, the cost of an additional patent application with the same specification and figures is likely to be much closer to $7000, or even lower.[3]

Table 2 shows the average number of total claims for single-patent families and for multipatent families with two to five patents per family. The reason why Table 2 shows only multipatent families with up to five patents per family is because multipatent families with two to five patents account for 93.5% (Via) to 99.3% (Microsoft), with a median of 97.6% of all patents in a multipatent family.[4] In other words, almost all patents in a multipatent family are in a family with two to five patents. Some entries in Table 2 are blank, i.e., MIPS, NXP, and Via for five-patent families, as these companies did not have patents with that family size.

[b]The fees for excess claims is scheduled to increase to $600 for independent claims in excess of three and $200 for each total claim in excess of 20 starting in 2025. *Setting and Adjusting Patent Fees During Fiscal Year 2025*.

Columns 7–10 show the difference between the average number of total claims for a multipatent family and the average number of total claims for the single-patent family. As described earlier, the difference is negative for 11 companies (AMD, Broadcom, Dell+EMC, IBM, Intel, Marvell, Microsoft, MIPS, Nvidia, NXP, and Samsung). This is due to two- and three-patent families having a negative difference. More specifically, because two- and three-patent families account for 82.6% to 95.7% of all patents in multipatent families, the negative difference (the average number of total claims for multipatent – the average number of total claims for single patent) is largely due to a negative difference for two- and three-patent families.[4]

For IBM, Intel, Marvell, Microsoft, MIPS, and Samsung, the difference is negative for two- through five-patent families. Furthermore, the difference is negative for two- through 10-patent families for IBM, Intel, Marvell, and Samsung.

These data support the theory that these 11 companies—and especially IBM, Intel, Marvell, and Samsung—use multipatent families as a way to split claims across patents (as compared to having one big patent). For example, for IBM, the average number of total claims for single-patent families is 18.3, but the corresponding numbers for its two- and three-patent families are 13.9 and 13.9, respectively. As such, the overall number of claims in a family for IBM's two- and three-patent families is 26.8 (13.9 × 2) and 41.8 (13.9 × 3), respectively. By contrast, for Amazon, the average number of total claims for two- through seven-patent families is 21.8, 22.2, 22.5, 23.4, 28.2, and 28.1, respectively. In other words, the patents in Amazon's multipatent families have a much higher average number of total claims than its single-patent families, in addition to also having more patents. This may indicate that Amazon considers that its multipatent families cover particularly significant inventions, that both require more patents and more claims to adequately protect.

Given that IBM's multipatent families have significantly fewer total claims than its single-patent families, this could indicate that IBM's multipatent families are more akin to splitting up a single patent with a large number of claims into multiple patents, as compared to Amazon's approach. Similarly, AMD,

TABLE 2. Average number of total claims for single-patent families and for multipatent families with two to five patents per family, and the difference in the average number of claims between each multipatent family size and single-family patents.

		Multipatent Size				Difference (Multisingle)			
Company	**Single**	**2**	**3**	**4**	**5**	**2**	**3**	**5**	**2**
Amazon	20.2	21.8	22.2	22.5	23.4	1.6	2	2.3	3.2
AMD	19.8	15.9	16.9	22.6	23.1	−3.9	−2.9	2.8	3.3
Apple	21.9	22.4	22.7	23.3	22.8	0.4	0.7	1.4	0.9
ARM	19.3	19.2	20.6	28	25.6	0	1.4	8.7	6.3
Broadcom	21.3	20.9	21.6	21.3	21.4	−0.4	0.3	0	0.2
Dell+EMC	18.9	18.4	19.1	20.2	21.1	−0.5	0.1	1.3	2.2
IBM	18.3	13.9	13.9	12.2	13.6	−4.4	−4.4	−6.1	−4.7
Intel	20.7	18.5	17.9	18.2	18.3	−2.2	−2.8	−2.4	−2.3
Marvell	25.7	21.8	21.8	22.5	23.4	−3.9	−3.9	−3.1	−2.2
Microsoft	20.6	19.8	19.3	19.7	18.8	−0.7	−1.2	−0.9	−1.8
MIPS	26.3	24.2	24.6	24.1	—	−2.2	−1.8	−2.2	—
Nvidia	20.3	19.4	19	20.9	16.3	−0.9	−1.3	0.6	−4
NXP	17	15.4	14.2	17	—	−1.6	−2.8	0	—
Qualcomm	29.5	29.9	29.4	30.2	30.4	0.4	−0.2	0.6	0.8
Renesas	13.7	13.9	13.7	13.6	13.4	0.2	0	−0.1	−0.3
Samsung	17.3	15.8	16.4	16.9	15.2	−1.6	−1	−0.5	−2.1
Via	17	15.7	14	24.4	—	−1.2	−3	7.4	—

Broadcom, Dell+EMC, Intel, Marvell, Microsoft, MIPS, Nvidia, NXP, and Samsung may also use this approach.

THIS MAY INDICATE THAT AMAZON CONSIDERS THAT ITS MULTIPATENT FAMILIES COVER PARTICULARLY SIGNIFICANT INVENTIONS, THAT BOTH REQUIRE MORE PATENTS AND MORE CLAIMS TO ADEQUATELY PROTECT.

Another reason that companies like IBM and Samsung—which historically have been two of the companies that have received the most patents—may prefer this approach is that it allows them to potentially significantly increase the number of issued patents each obtains. Having a larger patent portfolio has many potential benefits, including increasing barriers to entry for would-be competitors, which potentially increases the amount of money a company might receive from licensing its portfolio; providing more potential patents to assert during litigation or to sell, which contributes toward the potential value of the company;[4] and providing positive publicity for the company, which includes enhancing a company's image as a technological leader.

TABLE 3. Slope of best fit line (least squares) for average number of total claims as a function of family size.

Company	Slope of Best Fit
Amazon	1.45
AMD	1.72
Apple	0.1
ARM	1.99
Broadcom	−0.24
Dell+EMC	0.21
IBM	0.23
Intel	0
Marvell	0.48
Microsoft	−0.05
MIPS	−0.55
Nvidia	−1.13
NXP	0.01
Qualcomm	0.36
Renesas	0.21
Samsung	−0.48
Via	1.64

To quantify whether the average number of total claims generally increases or decreases as the multipatent family size increases, Table 3 shows the slope of the best fit line (least squares method) for the average number of total claims as a function of the number of patents in the multipatent family. The best fit line was calculated for family sizes between two and seven patents. One reason for limiting the best fit calculation to this range is because almost all companies have families with these sizes; the exceptions are ARM (does not have a seven-patent family), MIPS (does not have five- and six-patent families), NXP (does not have a five-patent family), and Via (does not have six- and seven-patent families). Another reason is that this range of family sizes accounts for 97.2% (Via) to 100% (MIPS) of all patents in multifamily, with a median of 99.5%. Concomitantly, limiting the family size to two to seven patents minimizes the effect that larger family sizes—which have a low frequency of occurrence—have.

The results in Table 3 show that the slopes for four companies (Amazon, AMD, ARM, and Via) are both positive and relatively large (1.45, 1.72, 1.99, and 1.64, respectively). In other words, for these companies, when the family size increases from two to seven patents, based on their respective slopes, the average number of total claims would increase by 7.2, 8.6, 9.9, and 8.2, respectively. This increase is even more significant for Amazon and ARM as almost all of the increase in the number of total claims would be subject to excess claim fees.

It is important to note that the slopes for AMD and ARM may be inflated given that both of these companies have a relatively small percentage of their multipatent families with family sizes in the top half of this range. More specifically, AMD has 760 multipatent families with a family size of two to seven patents, but only six families with a family size of five to seven patents. Similarly, ARM has 147 multipatent families with a family size of two to seven patents, but only five-patent families with a family size of five to seven patents. Although five to seven patents account for a relatively small percentage of multipatent family patents, their average number of total claims is also significantly higher than the average number of total claims for two-to-four-patent families. For example, the average numbers of total claims for AMD's two-to-four-patent families are 15.9, 16.9, and 22.6, respectively, while the average numbers of total claims for its five-to-seven-patent families are 23.1, 18.8, and 26.7, respectively. Similarly, the average numbers of total claims for ARM's two-to-four-patent families are 19.2, 20.6, and 28, respectively, while the

average numbers of total claims for its five-to-six-patent families (ARM does not have a seven-patent family) are 25.6 and 26.7, respectively. Therefore, although the average numbers of total claims are higher for five-to-seven-patent families, because their frequency of occurrence is much lower, the slope of the best fit line for two-to-seven-patent families might be "inflated" due to the higher average numbers of total claims for five-to-seven-patent families.

The results in Table 3 also show that the slopes for two companies (Marvell and Qualcomm) are positive but are not as large as the slopes for Amazon, AMD, ARM, and Via. But, for Qualcomm, given that the starting point for that slope (two-patent families) is very high to begin with (29.9), the smaller slope is still significant.

The results in Table 3 show that the slopes for Apple, Intel, Microsoft, and NXP are essentially zero (0.1, 0, −0.05, and 0.01, respectively). The slopes for Dell+EMC, IBM, and Renesas are slightly larger (0.21, 0.23, and 0.21, respectively) but still somewhat close to zero.

Finally, the results in Table 3 show that the slopes for Broadcom, MIPS, Nvidia, and Samsung are negative (−0.24, −0.55, −1.13, and −0.48, respectively). In other words, when the family size increases from two to seven patents, based on their respective slopes, the average number of total claims would decrease by −1.2, −2.8, −5.6, and −2.4, respectively. Of these companies, the average number of issued claims to Broadcom is more than 20 for family sizes between two and seven patents. As such, Broadcom may be reducing its average number of claims to reduce its excess claim fees. For the other three companies, their average number of claims is generally less than 20 (except for Nvidia's four-patent family, which has an average number of total claims of 20.9). As such, these companies are generally likely to be able to avoid excess claim fees without needing to decrease their average number of total claims.

As described earlier, both IBM and Samsung may be choosing to have more patents with fewer claims than have fewer patents with more claims. But, to the extent that this is true, IBM has a small, positive slope, i.e., the average number of total claims increases with increasing family size, while Samsung has a small, negative slope. This difference may be due to the fact that IBM's average number of total claims is generally lower than Samsung's (the average number of total claims for IBM is 13.9, 13.9, 12.2, 13.6, 14.2, and 15.1 for two-to-seven-patent families, respectively, while the corresponding numbers for Samsung are 15.8, 16.4, 16.9, 15.2, 15.8, and 13.1). Therefore, although IBM has a positive slope, because it has a lower average number of total claims for two-patent families, the increasing number of total claims generally likely does not result in excess claim fees.

Finally, it is important to note that the magnitudes of the slopes for MIPS, Nvidia, and Samsung may be somewhat inflated by the average number of total claims in their seven-patent families. For MIPS, the average number of total claims for its seven-patent family is 21.7, while the average number of total claims for its two-, three-, and four-patent families is 24.2, 24.6, and 24.1, respectively (MIPS did not have any five- or six-patent families). Therefore, the seven-patent family has a significant effect on the slope. Excluding this family from the slope calculation changes the slope from −0.55 to −0.02. Similarly, excluding the seven-patent family from the slope calculations changes the slope from −1.13 to −0.5 for Nvidia and −0.48 to −0.1 for Samsung.

Table 4 shows the slope of the best fit line (least squares method) for the average number of independent claims as a function of the number of patents in a multipatent family. As was the case in Table 3, the slopes were calculated for family sizes between two and seven patents.

The results in Table 4 show that the slopes for AMD, MIPS, Via are both positive and relatively large (0.55, 0.19, and 0.21, respectively). In other words, when the family size increases from two to seven patents,

TABLE 4. Slope of best fit line (least squares) for average number of independent claims as a function of family size.

Company	Slope of Best Fit
Amazon	−0.06
AMD	0.55
Apple	−0.02
ARM	0.08
Broadcom	−0.06
Dell+EMC	−0.02
IBM	−0.01
Intel	−0.04
Marvell	0.06
Microsoft	0.04
MIPS	0.19
Nvidia	−0.2
NXP	0.08
Qualcomm	0.07
Renesas	0.02
Samsung	0.04
Via	0.21

based on their respective slopes, the average number of independent claims would increase by 2.8, 0.9, and 1.1, respectively. To put that in context, that would be 110.4%, 26.3%, and 46.1%, respectively, higher as compared to the average number of independent claims in a two-patent family.

That said, the slope for AMD may be inflated given that the average number of independent claims for the seven-patent family is 6, which is significantly higher than the corresponding numbers for the two-to-six-patent families (2.5, 2.5, 3.1, 4.5, and 2.7, respectively). Excluding the seven-patent family from the slope calculation for AMD changes the slope from 0.55 to 0.23, which would still be the highest magnitude slope.

The results in Table 4 show that the slopes for Apple, Dell+EMC, IBM, Intel, Microsoft, Renesas, and Samsung are essentially zero (−0.02, −0.02, −0.01, −0.04, 0.04, 0.02, and 0.04, respectively). Similarly, the slopes for Amazon, ARM, Broadcom, Marvell, NXP, and Qualcomm are slightly larger (−0.06, 0.08, −0.06, 0.06, 0.08, and 0.07, respectively) but still somewhat close to zero.

The results in Table 4 show that the slope for Nvidia is both negative and relatively large (−0.2). In other words, when the family size increases from two to seven patents, based on its slopes, the average number of independent claims would decrease by −1. To put that in context, that would be 32.3% lower as compared to the average number of independent claims in a two-patent family.

That said, the magnitude of the slope for Nvidia may be somewhat inflated given that the average number of independent claims for the seven-patent family is 2.1, which is significantly lower than the corresponding numbers for the two-to-six-patent families (3.1, 3.2, 3.3, 2.7, and 2.7). Excluding the seven-patent family from the slope calculation for Nvidia changes the slope from −0.2 to −0.14.

Finally, of the six companies that had a higher average number of total claims for patents in their multipatent families, only three companies (ARM, Renesas, and Via) have a negative difference in the average number of independent claims for patents in their multipatent families as compared to the average number of independent claims for their single-patent families. Of these three companies, the percentage decrease for ARM and Via is very small (0.3% and 0.5%, respectively). For Renesas, the decrease in the average number of independent claims is 5.8%, which is more significant.

Analyzing the data for Renesas's independent claims shows that average number of independent claims is lower than (or equal to) the average number of independent claims for single-patent families for all multipatent family sizes, except for two. More specifically, although the average number of independent claims for single-patent families is 2.5, the average number of independent claims for all multipatent families (except for family sizes of 13 and 14 patents) is less than 2.5. More specifically, the average number of independent claims for family sizes of two to 11 patents ranges from 1.8 to 2.4, with a median of 2.3.

Furthermore, Table 4 shows that the slope of the best fit line for Renesas's average number of independent claims as a function of increasing family size is 0.02. Therefore, the negative difference in the average number of independent claims for patents in its multipatent families as compared to the average number of independent claims for single-family patents is not due to some of Renesas's multipatent families being abnormally small, which would result in a negative difference. Rather, the negative difference is due to Renesas's multipatent families consistently having a smaller average number of independent claims. This may be due to Renesas's desire to avoid excess independent claim fees or because Renesas did not believe that it was necessary to draft similar independent claims using several claiming approaches (e.g., apparatus, method, means plus function, Beauregard, and so on) as a subset of those types may be sufficient.

The next article in this series will continue to examine the characteristics of the patent families for patents issued to these computer architecture companies.

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