EDITOR: Joshua J. Yi, josh@joshuayipatentlaw.com

DEPARTMENT: MICRO LAW

Analysis of Historical Patenting Behavior and Patent Characteristics of Computer Architecture Companies—Part VI: Relationship Between Prosecution Time and Claims

Joshua J. Yi, *The Law Office of Joshua J. Yi, PLLC, Austin, TX, 78750, USA*

In prior parts of this series, I analyzed the following:

- The numbers of issued patents and computer architecture patents,
- 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 types 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, as well as the number of "forward" citations to a patent by another U.S. patent or U.S. patent publication,

for patents that were issued to 18 leading computer architecture companies that were filed between 1996 and 2020.

This article examines the effect that the number of claims has on the prosecution time.

Table 1 lists the number of patents that were filed between 1 January 1996 and 31 December 2020 and that were 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] 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 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) they had a significant number of patents.

To improve readability, I generally refer to companies with multiple entities 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.

Table 2 shows the average (mean) prosecution time for all issued patents and for computer architecture patents only.

The results in the second column of Table 2 show that the average prosecution time for all patents ranges from 17.3 months (SiFive) to 49.7 months (MIPS), with a median value of 36.0 months. The results in the third column of Table 2 show that the average prosecution

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

Company	All Patents	Computer Architecture Patents
Amazon	16,383	9268
AMD	11,189	4631
Apple	27,968	12,274
ARM	2782	2372
Broadcom	14,757	6292
Dell + EMC	1427	18,264
IBM	133,932	82,821
Intel	5680	24,639
Marvell	8626	5195
Microsoft	47,562	32,145
MIPS	273	271
NVIDIA	3957	3139
NXP	11,831	3742
Qualcomm	29,242	10,175
Renesas	14,384	4401
Samsung	136,054	37,174
SiFive	14	9
Via + Cyrix	1981	1325

TABLE 2. Mean prosecution time (in months) for all issued patents and for computer architecture patents.

Company	All Patents	Computer Architecture Patents
Amazon	36.4	37.5
AMD	32.7	36.8
Apple	33.3	37.6
ARM	35.0	35.9
Broadcom	40.5	42.3
Dell + EMC	36.0	36.9
IBM	34.5	37.1
Intel	38.1	39.9
Marvell	31.9	32.3
Microsoft	42.9	45.8
MIPS	49.7	49.8
NVIDIA	47.1	48.0
NXP	37.3	41.0
Qualcomm	40.1	41.4
Renesas	28.2	29.8
Samsung	33.4	36.9
SiFive	17.3	15.5
Via + Cyrix	35.9	38.5

time for computer architecture patents ranges from 19.8 months (SiFive) to 49.8 months (MIPS), with a median value of 37.6 months. Comparing the results in the second and third columns shows that the mean prosecution time for computer architecture patents is higher than the mean prosecution time for all patents for all companies. One potential reason for this may be that computer architecture patents have a higher average number of claims than for all patents. A larger number of claims can increase the prosecution time because it may take more time for the examiner to analyze whether there are prior art references that disclose the limitations of each claim and to check whether each claim satisfies all statutory requirements. Furthermore, a larger number of claims also means that it may take more time for the applicant's attorney to respond to the examiner's arguments and to amend the claims.

Table 3 shows the correlation between the prosecution time for a patent and the number of claims in that patent both for all patents and for computer architecture patents.

The results in Table 3 show that correlation for all patents ranges between −0.051 (NXP) and 0.715 (SiFive) with a median of 0.097; the second highest correlation after SiFive is 0.290 (Apple). Therefore, with the exception of SiFive, the correlation between the prosecution time and the number of claims is very low and, for two companies, slightly negative. The results in Table 3 also show that the correlation for computer architecture patents ranges between −0.052 (NXP) and 0.856 (SiFive), with a median of 0.086; the second highest correlation after SiFive is 0.285 (Apple). For all companies, the correlation for computer architecture patents is generally similar to the correlation for all patents.

The results in part II of this series, which was published in the January/February 2022 issue of *IEEE Micro*, show that the average prosecution time for all companies generally increased from 1996 to approximately 2005 before steadily decreasing. For example, the prosecution time for Qualcomm is exemplary. In 1996, the average prosecution time for Qualcomm was 34.1 months. Between 1996 and 2005, the average prosecution time increased by more than 100%, from

TABLE 3. Correlation between the prosecution time for a patent and the number of claims in that patent for all issued patents and for computer architecture patents.

Company	All Patents	Computer Architecture Patents
Amazon	0.286	0.246
AMD	0.093	0.002
Apple	0.290	0.285
ARM	0.148	0.154
Broadcom	0.010	0.044
Dell + EMC	0.101	0.100
IBM	0.121	0.115
Intel	0.082	0.065
Marvell	0.250	0.239
Microsoft	0.248	0.068
MIPS	0.092	0.095
NVIDIA	0.067	0.076
NXP	−0.051	−0.052
Qualcomm	0.035	0.032
Renesas	−0.019	−0.026
Samsung	0.180	0.204
SiFive	0.715	0.856
Via + Cyrix	0.034	0.045

34.1 to 68.6 months. Then, between 2005 and 2018, the average prosecution time decreased from 68.6 to 23.8 months.[b] One potential conclusion from these results is that the correlation between the prosecution time and the number of claims may be artificially low because the average prosecution time increased dramatically from 1996 to approximately 2005 before dropping below its 1996 average, when the number of claims did not change by the corresponding amounts.

This trend could explain why the correlation for SiFive is so high. More specifically, because SiFive is a very new company—its first patents were filed in December 2018—it missed the increase in the average prosecution time that occurred between 1996 and approximately 2005 and the subsequent decrease in the average prosecution time that occurred from approximately 2005 until 2018 or so. Because the average prosecution time has been relatively constant in recent years and because the average prosecution time for all companies is similar, it is not surprising that the number of claims may have a larger effect on the prosecution time when the prosecution time is not dominated by factors such as delays at the Patent Office.

Figure 1 depicts the correlation between prosecution time and the number of claims based on the filing year of the patent for each company. Figure 1(a) depicts the correlations for the companies with the largest number of issued patents (Amazon, Apple, Broadcom, Dell + EMC, IBM, Intel, Microsoft, Qualcomm, and Samsung), while Figure 1(b) depicts the correlations for the remaining companies.

These figures shows several interesting results. First, the scale for the y-axis in Figure 1(b) ranges between −1.0 and 1.0, while the scale for the y-axis in Figure 1(a) ranges between −0.3 and 0.5. The reason that the correlations in Figure 1(b) span a larger range is generally due to a small number of patents being filed in a particular year. For example, in 1996, NVIDIA filed two patents that were eventually issued. The prosecution times for the two patents were 52.7 and 16.8 months, while the corresponding numbers of issued claims were 16 and 15, respectively, which results in a perfect correlation of 1.0. On the other hand, in 1996, Marvell filed two patents that were eventually issued. The prosecution times for the two patents were 12.0 and 17.3 months, while the corresponding numbers of issued claims were eight and six, respectively, which results in a perfect negative correlation of −1.0. Similarly, the remaining large positive or negative correlations in Figure 1(b) are due to small sample sizes, e.g., Marvell in 1998 (five patents), NXP in 1999 (10 patents), and MIPS in 2012 (two patents) and 2013 (two patents).

Second, for most companies, the correlation between the prosecution time and the number of claims is generally positive. For example, for Apple, Intel, and Samsung, none of the correlations between 1996 and 2018 were negative. Similarly, Dell + EMC and Microsoft each only had two years where the correlations were negative, while IBM and NVIDIA each only had three years where the correlations were negative. The majority of years between 1996 and 2018 for Amazon, AMD, ARM, Marvell, and MIPS had positive correlations. Therefore, for these companies, increasing or decreasing the number of claims will at least somewhat increase or decrease the prosecution time.

On the other hand, for Broadcom, NXP, Qualcomm, and Renesas, a majority of years had negative correlations. However, for each of these companies, the median correlations between 1996 and 2018 are −0.008, −0.011, −0.006, and −0.022, respectively, which are very

[b]The average prosecution time continued to decrease in 2019 and 2020, but it is difficult to determine whether that represents an actual decrease or whether it was because many patent applications that were filed in those years are still pending.

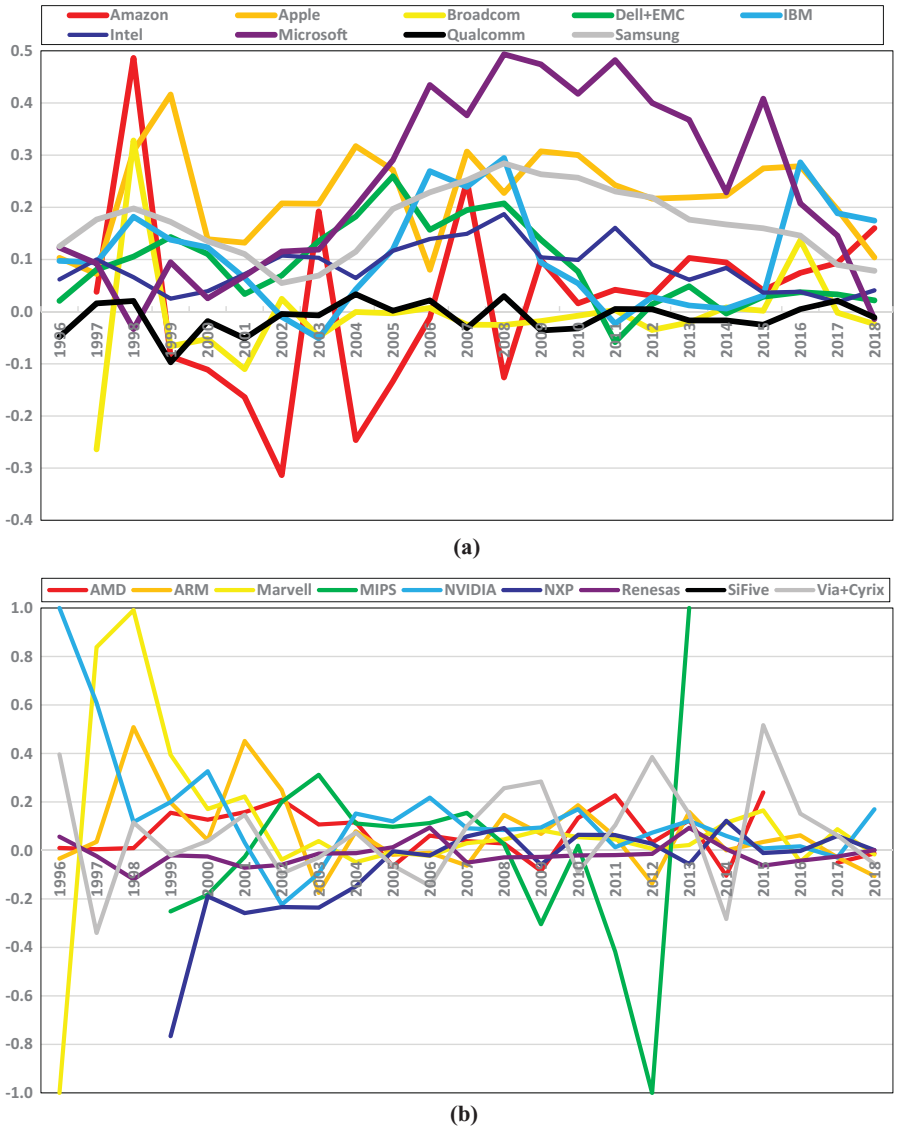

FIGURE 1. Correlation between prosecution time and the number of claims based on filing year of the patent.

weak negative correlations. As such, while the median correlation is negative, because the absolute value of the correlation is very small, the correction is effectively zero.

Third, for some companies, the correlation is relatively low early on but then increases significantly in the middle of this timeframe before tapering off to roughly the starting correlation value. Microsoft is a good example of this behavior. Table 4 shows Microsoft's correlation and the average number of claims for this timeframe.

The results in Table 4 show that the correlation ranges between −0.033 and 0.123 between 1996 and 2004. However, from 2005 to 2015, the correlation increases to a range of 0.290 to 0.493. Finally, from 2016 to 2018, the correlation decreases to a range of −0.014 to 0.207. The average number of claims in each of these phases generally tracks the correlation. Between 1996 and 2004, the average number of claims ranged between 21.7 and 28.7. Between 2005 and 2015, the average number of claims ranged between 15.1 and 17.5.[c] Finally, from 2016 to 2018, the average number of claims ranged between 18.5 and 19.1. In other words,

[c]The reason that the average number of claims is significantly lower from 2005 onward, as compared to before 2005, is because the U.S. Patent Office started to charge fees for patent applications that had more than 20 total claims and/or three independent claims.

TABLE 4. Comparing 1) the correlation between prosecution time and the number of claims for all issued patents and 2) the average number of claims for Microsoft.

Year	Correlation	Average Number of Claims
1996	0.123	26.8
1997	0.092	28.7
1998	−0.033	27.2
1999	0.095	27.3
2000	0.026	25.4
2001	0.068	24.4
2002	0.115	26.6
2003	0.119	26.6
2004	0.202	21.7
2005	0.290	15.1
2006	0.434	15.1
2007	0.376	16.5
2008	0.493	16.3
2009	0.474	16.8
2010	0.417	17.5
2011	0.482	16.0
2012	0.400	15.9
2013	0.367	15.6
2014	0.229	17.2
2015	0.408	16.3
2016	0.207	18.5
2017	0.146	18.6
2018	−0.014	19.1

the correlation was relatively high between 2005 and 2015, which occurred when the average number of claims was lower than it was before 2005 and after 2015. This result may imply that, when the average number of claims is lower, fewer factors affect the prosecution time as compared to when the average number of claims is higher, so the prosecution time is concomitantly lower. For example, when the number of claims is higher, the examiner may (or may not) need more time to find additional prior art for the additional claims and/or may need more time to check whether each claim satisfies all statutory requirements. Similarly, the prosecuting attorney may (or may not) need more time to respond to the examiner's rejections and/or need more time to amend the claims based on the examiner's rejections. In other words, when there are more claims, the prosecution time may (or may not) increase due to these and other reasons.

In addition to Microsoft, IBM between 2005 and 2008 and Intel between 2005 and 2009 had similar—albeit less dramatic—behavior.

Fourth, the yearly correlations for most companies decrease toward the end of the timeframe of Figure 1 (through 2018) and continue to decrease in 2019 and 2020. For example, in 2016, the correlation for Broadcom was 0.137, but it decreased in each of the next four years to −0.002, −0.024, −0.043, and −0.626 in 2017, 2018, 2019, and 2020, respectively. One likely reason for this is that all patents filed in 2017 to 2020 may not have been issued; i.e., some may still be pending. Therefore, the patents that have been issued have artificially lower prosecution times, which then decreases the correlation between the prosecution time and the number of claims.

More generally, the correlations for most companies decreased in 2018 and 2019 from the previous year. The correlations for 2020 decreased for approximately half the companies, which may suggest that there are other factors that overshadowed the artificially low prosecution time.

THE CORRELATIONS FOR 2020 DECREASED FOR APPROXIMATELY HALF THE COMPANIES, WHICH MAY SUGGEST THAT THERE ARE OTHER FACTORS THAT OVERSHADOWED THE ARTIFICIALLY LOW PROSECUTION TIME.

The next part in this series will continue to analyze potential factors that contribute to the prosecution time.

JOSHUA J. YI is a solo practitioner at The Law Office of Joshua J. Yi, PLLC, Austin, Texas, 78750, USA. Contact him at josh@joshuayipatentlaw.com.