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Analysis of Historical Patenting Behavior and Patent Characteristics of Computer Architecture Companies

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In my last article, which appeared in July–August 2021 issue of *IEEE Micro*, I analyzed the patents that were issued to seven leading computer architecture companies—IBM, Samsung, Microsoft, Dell/EMC,[a] Intel, Amazon, and Apple—in the first quarter of 2021, and highlighted one patent from each company that might be particularly interesting.

In this article—which is Part I in a series of articles—I expand upon that work in several ways. First, in addition to these seven companies, this series of articles adds AMD, ARM, NVIDIA, NXP/Freescale,[b] and SiFive.[c] I added these companies due to their importance in computer architecture and/or potential level of interest to the readership of *IEEE Micro*. It is important to note that a patent is associated with a particular company only if the company is the original assignee. Consequently, the results in these articles only provide an indication of the number of patents in a particular company's portfolio; the actual number may be higher (e.g., due to acquisitions) or lower (e.g., due to assignments, patent term expirations, etc.).

Second, this series expands the timeframe from the first quarter of 2021 to the last 25 years, namely, January 1, 1996, to December 31, 2020. But rather than counting how many patents were issued in a particular timeframe (e.g., year), this series of articles counts the number of patents that were *filed* in a particular timeframe that eventually resulted in an issued patent. In other words, this series of articles counts issued patents based on their *application* date as opposed to their *issue* date. There are at least three reasons why counting based on the application date provides more insight than counting by the issue date. First, counting by the application date makes it easier to determine how many patentable inventions a company came up with the given year. By contrast, due to differences in the prosecution time (i.e., the time from filing to issuance), counting by the issue date makes it impossible to determine how many patentable inventions a company had in a given year (unless one reverts to using the application date). Second, counting by the application date makes it easier to correlate the number of patents with factors that relate to the creation of those inventions or the filing of the associated patents, e.g., R&D spending or annual net revenue. Third, counting by the application date makes it possible to divide patents into those that were filed before and after the change in the patent term. More specifically, patents that were filed prior to June 8, 1995, had a 17-year term from the date of *issuance*. By contrast, patents that were filed on or after June 8, 1995, have a 20-year term from the earliest *filing* date, e.g., the filing date of the first patent in the family. This change also affects the patent term of descendant patents. For example, in the latter situation, a descendant patent that is filed 19 years after the filing of the first application in the family would only have an effective patent term of one year. By contrast, a descendant patent that is able to claim priority to an ancestor that was filed before June 8, 1995 would have a patent term of 17 years from when the descendant patent issues, whether that is 10, 25, 50, or even 100 years after the first patent in that family is filed. As

[a]Because Dell and EMC are currently a single company, like my previous article, this article presents the combined results for the two companies.
[b]NXP acquired Freescale Semiconductor in 2013. Given the size of that acquisition, I included Freescale's patents with NXP's in order to provide a more accurate picture of NXP's patenting behavior and patent characteristics. The remainder of this article will refer to the combined company as NXP+Freescale or NXP+FSL.
[c]Unfortunately, due to time limits, I was not able to add other companies, e.g., Qualcomm, although I hope to do so in the future.

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TABLE 1. Number of patents filed between January 1, 1996, and December 31, 2020, that were issued by July 9, 2021.

Company	Number of Patents	Ave. Patents / Year
Samsung	129,382	5,175
IBM	128,566	5,143
Microsoft	46,060	1,842
Intel	43,820	1,753
Apple	26,063	1,043
Dell+EMC	16,373	655
Amazon	15,046	602
NXP+Freescale	11,564	463
AMD	10,137	405
NVIDIA	3,811	152
ARM	2,394	96
SiFive	12	0.5

such, counting based on the application date versus the issue date removes pre-June 8, 1995 filed patents from the data set for this series, which ensures that any analysis will be an apples-to-apples comparison of the patent term.

THIS SERIES OF ARTICLES WILL ANALYZE THE TYPES OF PATENTS (E.G., UTILITY PATENTS VERSUS DESIGN PATENTS), THE PROSECUTION TIME (I.E., THE TIME BETWEEN THE FILING DATE AND ISSUE DATE), THE NUMBER OF EACH TYPE OF CLAIM (INDEPENDENT AND DEPENDENT), ETC.

Finally, this series of articles provides deeper analysis than simply counting the number of patents that were issued to each company in a specific timeframe. Rather, this series of articles will analyze the types of patents (e.g., utility patents versus design patents), the prosecution time (i.e., the time between the filing date and issue date), the number of each type of claim (independent and dependent), etc.

Number of Issued Patents

Table 1 presents the number of patents that were filed between January 1, 1996, and December 31, 2020, that were issued by July 9, 2021. The table is arranged in descending order of the middle column. The results in the right column show the average number of patents per year.

The results in Table 1 show that the companies can be grouped into seven groups. In the first group are Samsung and IBM with an average of over 5,000 patents per year. Microsoft and Intel are in the second group, with an average of around 1,800 patents per year. Apple is the only company in the third group, averaging just over 1,000 patents per year. Dell+EMC and Amazon are in the fourth group, both averaging over 600 patents per year. NXP+Freescale and AMD are in the fifth group, both averaging over 400 patents per year. NVIDIA and ARM are in the sixth group, respectively, averaging 152 and 96, respectively, patents per year. Finally, because SiFive is a very new company, it is not surprising to see that it only has 12 issued patents during this timeframe.

Figure 1 presents the number of issued patents over time based on the application year of each issued patent. Due to the difference in the number of issued patents for Apple, IBM, Intel, Microsoft, and Samsung (26,063 or more) as compared to the number of patents for the remaining seven companies (16,373 or fewer), in order to provide an appropriate *y*-axis scale for both the former and latter groups of companies, Figure 1(a) presents the results for the former group of companies while Figure 1(b) does the same for the latter group of companies. It is important to note that the sharp declines in 2018 to 2020 are due to the fact that many applications that were filed in those years are still being examined.

The graph lines for most companies in Figure 1 exhibit the same high-level behavior, namely, the average number of issued patents in the last few years (between 2013 and 2017) is multiple times higher than it was in the late 1990s. For example, for patent applications filed between 1996 and 2000, IBM averaged 3804 issued patents. But for patent applications filed between 2013 and 2017, IBM averaged 8028 issued patents or 2.1 times more patents as compared to the 1996–2000 timeframe.

Table 2 compares the average number of issued patents for patent applications filed between 1996 and 2000 versus 2013 and 2017 for all companies except for SiFive. Table 2 does not include SiFive because SiFive did not have any patents until 2018.

For all companies except for AMD, each had between 2.1 times (IBM) and 144.7 (Amazon) times more issued patents for applications filed between 2013 and 2017 than issued patents for applications filed between 1996 and 2000. Four of the five highest

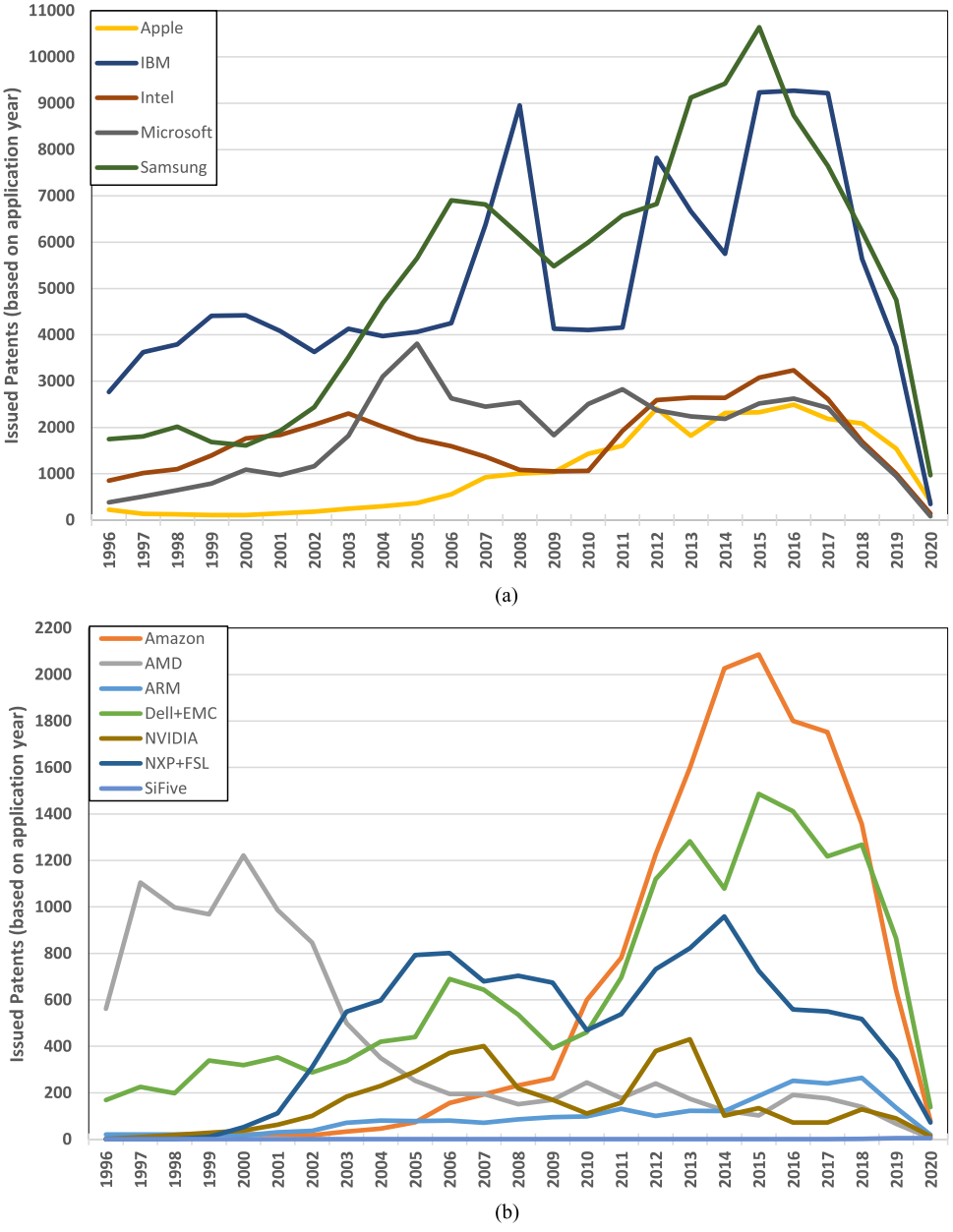

FIGURE 1. Number of patents filed between 1996 and 2020 that were issued by July 9, 2021. The lower number of patents between 2018 and 2020 is because relatively few patents that were filed in these three years have actually been issued. (a) Companies with a comparatively larger number of patents. (b) Companies with a comparatively smaller number of patents.

multiples, i.e., for Amazon, NXP+Freescale, ARM, and NVIDIA (the lone exception being Apple), appear to be potentially due to a small average number of patents for applications filed between 1996 and 2000. Conversely, the lowest multiples, i.e., 2.1 times for IBM to 5.2 times for Dell+EMC, appear to be due to a significant higher average number of patents for applications filed between 1996 to 2000, e.g., 250 for Dell+EMC to 3804 for IBM. Apple fits into neither category. Rather, for Apple, the average number of issued patents for applications filed between 1996 and 2000 is 140, which is a significant number, but its corresponding multiple is 16, which is perhaps even more significant.

The only exception to this trend is AMD. In fact, the averages in Table 2 for AMD show the opposite

TABLE 2. Comparison of the average number of issued patents for applications filed between 1996 and 2000 versus 2013 and 2017, arranged in descending order of column 4.

Company	1996–2000 average	2013–2017 average	2013-2017 average / 1996-2000 average
Amazon	13	1853	144.7
NXP+Freescale	13	723	57.4
Apple	140	2228	16.0
ARM	20	184	9.4
NVIDIA	19	162	8.6
Dell+EMC	250	1295	5.2
Samsung	1773	9115	5.1
Microsoft	683	2398	3.5
Intel	1226	2841	2.3
IBM	3804	8028	2.1
AMD	971	153	0.2

TABLE 3. U.S. patent classification system classes that appear to be most closely related to computer architecture.

Class	Title
345	Computer graphics processing and selective visual display systems
708	Electrical computers: arithmetic processing and calculating
709	Electrical computers and digital processing systems: multicomputer data transferring
710	Electrical computers and digital data processing systems: input/output
711	Electrical computers and digital processing systems: memory
712	Electrical computers and digital processing systems: processing architectures and instruction processing (e.g., processors)
713	Electrical computers and digital processing systems: support
714	Error detection/correction and fault detection/recovery

result, namely, 6.3 times the number of issued patents for applications filed between 1996 and 2000 as compared to the number of issued patents for applications filed between 2013 and 2017. One potential reason that may account for at least part of this trend may be AMD's annual net income. In general, a higher annual net income in one year might allow a company to increase its R&D spending in the following year while a lower net income in one year might cause that company to decrease its R&D spending the following year.

Using the Pearson correlation coefficient to quantify the correlation between AMD's net income from 1995 to 2016 and the number of issued patents for applications filed between 1996 and 2017 indicates a weak correlation of 0.29. Therefore, other reasons [e.g., 1) prioritizing quality over quantity or 2) increasing the number of claims per patent, but fewer patents versus fewer claims per patent, but more patents] could account for AMD being the exception to this trend.

Issued Computer Architecture Patents Over Time

The above results are for all technologies and not only for computer architecture-related patents. Due to the interest of the *IEEE Micro* readership in the latter, Figure 2 depicts the number of computer architecture-related patents filed each year that resulted in an issued patent.

To determine which patents are related to computer architecture, I used both the U.S. Patent Classification System and the Cooperative Patent Classification System. Prior to January 2013, the U.S. Patent and Trademark Office (PTO) used the U.S. Patent Classification System to classify patents.[1] After January 2013, the PTO discontinued using the U.S. Patent Classification System in favor of the Cooperative Patent Classification System.

On each issued patent, the first class listed under the U.S. Patent Classification System is the class that best describes the inventive step of the patent.[2] The classes within the U.S. Patent Classification System that appear to most closely correspond to computer architecture are shown in Table 3.

Unfortunately, there does not appear to be a direct or official mapping between classes in the U.S. Patent Classification System and classes in the Cooperative Patent Classification System. To determine the potential mapping, I reviewed the Cooperative Patent Classification System classes with the highest number of patents for each company and selected the set of common classes as shown in Table 4.

To quantify how well this set of Cooperative Patent Classification System classes corresponds to the above set of U.S. Patent Classification System classes, I randomly selected 1,546 patents whose first class was in one of the eight U.S. Patent Classification System classes shown in Table 3. I then counted how many of them had G06F, G06Q, G06T, G09G, G11B, G11C, H03M, and H04L as its first Cooperative Patent Classification System class. These results showed that for 93.7% patents, a first class of 345 and 708 to 714 in the U.S. Patent Classification System

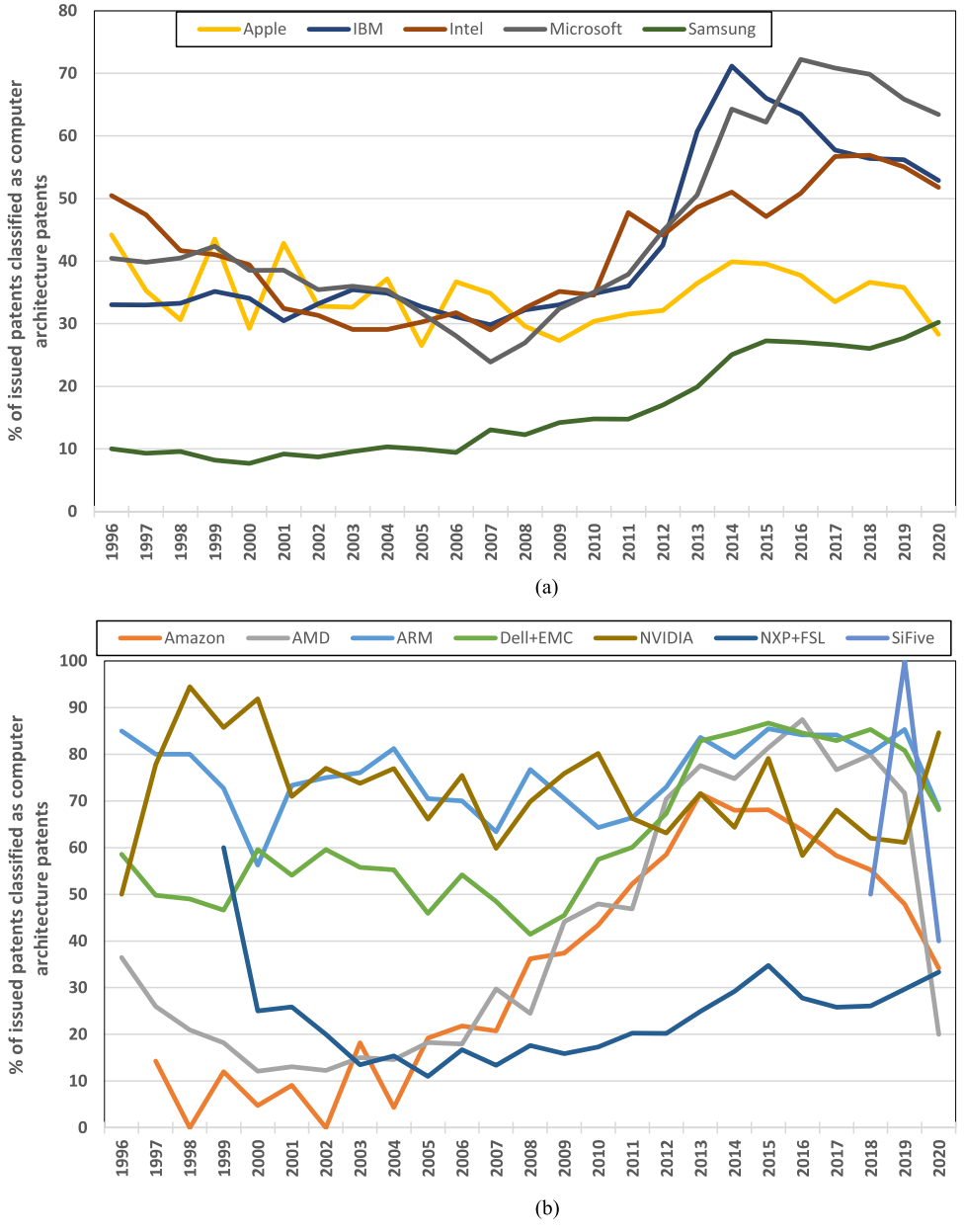

FIGURE 2. Percentage of issued patents that are classified as computer architecture patents. Note: Because NXP+FSL did not have any issued patents in 1996 and 1998, and had zero issued patents in 1997, those years for NXP+FSL are not depicted in (b).

corresponds to a first class of G06F, G06Q, G06T, G09G, G11B, G11C, H03M, and H04L in the Cooperative Patent Classification System. Given this high level of correspondence between these two sets of classes, the results in the remainder of this section will use the classes in Tables 3 and 4 as computer architecture classes.

Table 5 presents the percentage of the total number of issued patents filed between 1996 to 2000 that are computer architecture-related patents. The companies are arranged in descending order of the percentage of the total number of patents that are computer architecture patents, which is presented in column 4.

TABLE 4. Cooperative patent classification system classes that appear to be most closely related to computer architecture.

Class	Title
G06F	Electric digital data processing
G06Q	Data processing systems or methods, specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes; systems or methods specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes, not otherwise provided for[a]
G06T	Image data processing or generation, in general
G09G	Arrangements or circuits for control of indicating devices using static means to present variable information
G11B	Information storage based on relative movement between record carrier and transducer
G11C	Static stores[b]
H03M	Coding; decoding; code conversion in general
H04L	Transmission of digital information, e.g., telegraphic communication

[a]The notes for this class recite that "Groups G06Q 10/00 - G06Q 50/00 and G06Q 99/00 only cover systems or methods that involve significant data processing operations, i.e., data processing operations that need to be carried out by a technological, e.g., computing, system or device," which indicates that at least parts of this class relate to computer architecture.
[b]The notes for this class recite that "This subclass covers devices or arrangements for storage of digital or analogue information: in which no relative movement takes place between an information storage element and a transducer; which incorporate a selecting-device for writing-in or reading-out the information into or from the store."

The results in Table 5 show that the companies fall into four groups based on the percentage of patents that are computer architecture patents. In the first group are SiFive, ARM, Dell+EMC, and Amazon, all of which have a percentage which is 58.7% or greater. This relatively high percentage may be partially due to the fact that these companies have comparatively few issued patents. NVIDIA is the sole company in the second group with a percentage of 51.2%. In the third group are IBM, Microsoft, Apple, and Intel with percentages ranging from 29.3% to 34.7%. One potential reason why these percentages may be lower than the companies in the first group is because these four companies have four of the five largest number of issued patents. As such, the denominator for this percentage is particularly large and may simply overshadow the numerator, which is the number of computer architecture patents. Finally, in the last group are NXP+Freescale, Samsung, and AMD, with percentages ranging from 13.3% to 18.1%.

In order to understand what kind of noncomputer architecture patents each company has been issued,

TABLE 5. Percentage of the total number of issued patents filed between 1996 and 2020 that are computer architecture patents, arranged in descending order of the percentage in column 4, which is the percentage of the total number of patents which are computer architecture patents.

Filing Year	Total	Comp Arch	% Comp Arch
SiFive	12	8	66.7%
ARM	2394	1569	65.5%
Dell+EMC	16 373	9865	60.3%
Amazon	15 046	8837	58.7%
NVIDIA	3811	1951	51.2%
IBM	128 566	44 637	34.7%
Microsoft	46 060	15 132	32.9%
Apple	26 063	8430	32.3%
Intel	43 820	12 852	29.3%
NXP+Freescale	11 564	2088	18.1%
Samsung	129 382	20 807	16.1%
AMD	10 137	1346	13.3%

Table 6 presents the three most frequent noncomputer architecture classes, i.e., whose first class is not in Tables 3 or 4, but excluding design patents (which are analyzed more fully in the next section), for each company.

The first notable result in Table 6 is that none of the listed classes appear to be clearly computer architecture classes. This indicates that Tables 3 and 4 capture most/all of the computer architecture-related classes.

The second notable result in Table 6 is that the percentages for the top three noncomputer architecture classes are relatively low. Other than AMD and SiFive, the highest percentages are for Samsung and NXP+Freescale (approximately 7.0% to 9.0%). Of the remaining companies, the highest percentage is 6.1% (for Apple). In general, these relatively low percentages are not surprising given that each company has issued patents in hundreds of patent classes. This indicates that these companies create inventions that span a wide range of technologies.

The relatively high percentage of noncomputer architecture classes for SiFive is because issued patents for SiFive fall into one of three patent classes: G06F (computer architecture), H03K (not computer architecture), or in a design patent class.

For AMD, the two highest percentage noncomputer architecture classes are 438: Semiconductor device manufacturing: process and 257: Active solid-

TABLE 6. Three most frequent noncomputer architecture classes (not including design patents) for each company and as a percentage of the total number of patents.

Company	Class and Class Title	% Total
Amazon	705: Business processing using cryptography	4.2%
	H04N: Pictorial communication, e.g., television	4.0%
	G10L: Speech analysis or synthesis; speech recognition; speech or voice processing; speech or audio coding or decoding	2.7%
AMD	438: Semiconductor device manufacturing: process	29.5%
	257: Active solid-state devices (e.g., transistors, solid-state diodes)	10.5%
	365: Static information storage and retrieval[a]	4.3%
Apple	H04W: Wireless communication networks	6.1%
	715: Data processing: presentation processing of document, operator interface processing, and screen saver display processing	3.0%
	H04N: Pictorial communication, e.g., television	2.8%
ARM	365: Static information storage and retrieval	3.2%
	H03K: Pulse technique	1.9%
	327: Miscellaneous active electrical nonlinear devices, circuits, and systems	1.7%
Dell + EMC	707: Data processing: database and file management or data structures	4.0%
	361: Electricity: electrical systems and devices	3.4%
	H05K: Printed circuits; casings or constructional details of electric apparatus; manufacture of assemblages of electrical components	2.0%
IBM	H01L: Semiconductor devices; electric solid state devices not otherwise provided for	5.5%
	438: Semiconductor device manufacturing: process	4.1%
	707: Data processing: database and file management or data structures	3.4%
Intel	H04W: Wireless communication networks	4.9%
	H01L: Semiconductor devices; electric solid state devices not otherwise provided for	4.8%
	370: Multiplex communications	4.0%
Microsoft	715: Data processing: presentation processing of document, operator interface processing, and screen saver display processing	5.6%
	717: Data processing: software development, installation, and management	3.6%
	382: Image analysis	2.9%
NVIDIA	H04N: Pictorial communication, e.g., television	2.3%
	370: Multiplex communications	2.0%
	G09G: Arrangements or circuits for control of indicating devices using static means to present variable information	1.8%
NXP + Freescale	438: Semiconductor device manufacturing: process	9.0%
	H01L: Semiconductor devices; electric solid state devices not otherwise provided for	8.3%
	257: Active solid-state devices (e.g., transistors, solid-state diodes)	7.0%
Samsung	H01L: Semiconductor devices; electric solid state devices not otherwise provided for	8.1%
	257: Active solid-state devices (e.g., transistors, solid-state diodes)	4.4%
	438: Semiconductor device manufacturing: process	3.7%
SiFive	H03K: Pulse technique	16.7%

[a]Based on the notes, this class appears to be primarily directed towards circuit-level implementations and/or storage materials.

state devices (e.g., transistors, solid-state diodes). Together, these two classes account for 40% of AMD's issued patents. Because these patents were likely obtained in connection to its fabrication division, which AMD spun off as GlobalFoundries starting in 2008, excluding fabrication patents when calculating the percentage of issued patents that are computer architecture patents provides a number that more

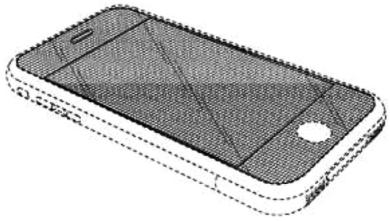

FIGURE 3. A figure from U.S. Patent No. D618,677, which was assigned to Apple and asserted against Samsung.

accurately reflects what AMD is as a company today. After excluding these two noncomputer architecture patent classes, the percentage of AMD's issued patents that are computer architecture patents increases from 13.3% to 45.7%, which would be the sixth-highest percentage in Table 6.

Finally, Figure 2 depicts the percentage of the total number of patents that are classified as computer architecture patents for applications that were filed between 1996 and 2020. As was the case for Figure 1, the number of patents for a given year are those issued by July 9, 2021. Figure 2(a) and (b) each depicts the same companies that were depicted in Figure 1(a) and (b), respectively.

The graph lines in Figure 2 fall into one of two categories. For companies in the first category, which includes Apple, ARM, Intel, NVIDIA, and Samsung, the percentage of issued patents that are computer architecture patents fluctuates within a bounded range. The best example of this behavior is Apple. Between 1996 and 2000, the median percentage was 35.3% while the median percentage between 2013 and 2017 was 37.7%.

For companies in the second category, the percentage that are computer architecture patents was largely flat or declined between 1996 and 2006 or 2007 before increasing significantly from 2006 or 2007 to 2016, and then flattening off after 2016. The best example of this is Microsoft. Between 1996 and 2007, the percentage of patents issued to Microsoft that are computer architecture patents decreased from 40.5% to 23.9%. But between 2007 and 2016, that percentage increased from 23.9% to 72.2% before slightly declining to 63.4% in 2020.

Types of Patents

The next analysis examines what percentage of the total number of issued patents are utility patents. A utility patent is what one typically thinks a patent is, namely, it is a "new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof." 35 U.S.C. § 101. While a utility patent protects how an article is *used and works*, design patents, by contrast, protect how an article *looks*, or its "ornamental appearance." An inventor may obtain both a utility patent and a design patent for an article. Unlike utility patents which have a 20-year term from the filing date of the earliest ancestor patent, design patents only have a 15-year term. Figure 3 is an example of a design patent is Figure 1 from D618,677, which was assigned to Apple.

TABLE 7. Percentage of issued patents that are utility patents, presented in descending order of the number of issued patents.

Company	Number of Patents	% Utility Patents
Samsung	129,382	91.37%
IBM	128,566	99.85%
Microsoft	46,060	91.45%
Intel	43,819	99.40%
Apple	26,063	87.31%
Dell+EMC	16,373	98.11%
Amazon	15,046	97.21%
NXP+Freescale	11,564	99.97%
AMD	10,137	99.88%
NVIDIA	3,811	99.79%
ARM	2,394	99.87%
SiFive	12	83.33%

Even though a design patent only covers the appearance of an article, it can be very valuable. For example, when Apple sued Samsung alleging infringement of this design patent and two other design patents, after the Supreme Court reversed an earlier jury verdict of $399 million in Apple's favor, a second jury awarded Apple even more, $539 million.

Other than utility and design patents, other types of patents include plant patents and reissue patents. As its name implies, a plant patent is a patent on a plant. 35 U.S.C. § 161. Reissue patents are not a distinct type of patent, but rather fix an error in a previously issued patent or changes the scope of the claims. 35 U.S.C. § 251(a).

The results in Table 7 show the percentage of issued patents that are utility patents. Because a reissue patent is a reissue of a previously issued patent, e.g., a previously issued utility patent, the results in Table 7 count reissued patents based on the originally issued patent, e.g., a reissue of a utility patent is counted as a utility patent.

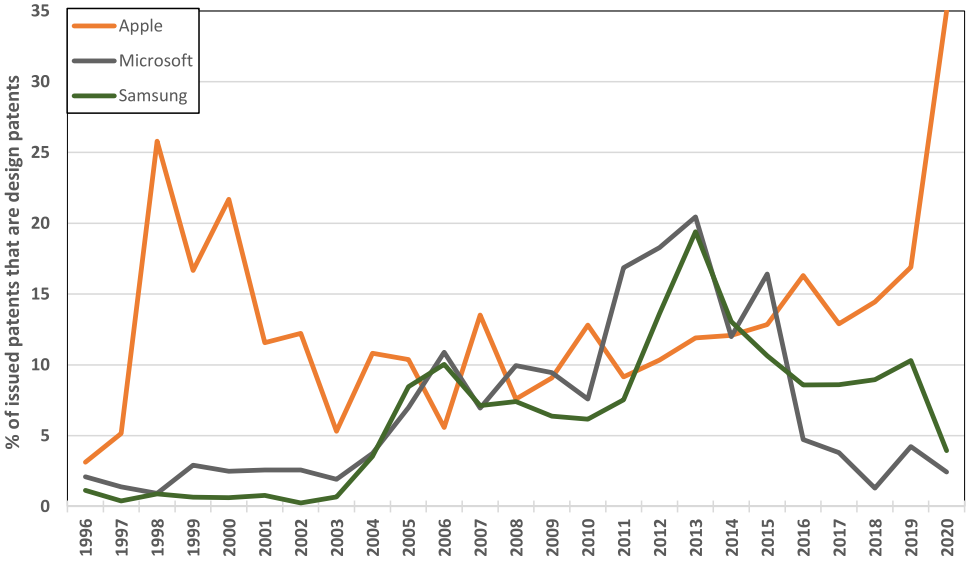

FIGURE 4. Percentage of issued patents that are design patents.

The results in Table 7 show that for IBM, Intel, NXP+Freescale, AMD, NVIDIA, and ARM, over 99% of their issued patents are utility patents. This result makes sense in that the appearance of these companies' products does not matter as much as the consumer of these products is not frequently looking at the product, so protecting its appearance may not have much value. The percentages for Dell+EMC and Amazon, 98.11% and 97.21%, respectively, are almost as high as those for IBM, Intel, NXP+Freescale, AMD, NVIDIA, and ARM. This 1%–2% difference between Dell+EMC and Amazon and the other companies may be due to the fact that Dell+EMC and Amazon may sell more end-products to customers, as compared to components of end-products, e.g., that Intel, NXP+Freescale, AMD, NVIDIA, and ARM sell. For Samsung, Microsoft, and Apple, the percentage of issued patents that are utility patents is significantly lower, at 91.37%, 91.45%, and 87.31%.[d] These comparatively low percentages are due to the fact that these three companies have a significant number of design patents. It makes sense that these companies would have a significant number of design patents given that they make end-products for the consumer where the appearance of those products may be important. For example, D924,279, which was originally assigned to Samsung, is an ornamental design for a shelf for refrigerator; D924,250, which was originally assigned to Apple, is an ornamental design for "display screen or portion thereof with graphical user interface;" and D924,334, which was assigned to Microsoft, is an ornamental design for a gaming console.

It is worth noting that the relatively large percentage of design patents may partially explain why the percentage of issued patents classified as computer architecture patents is lower than one might expect for Samsung, Apple, and Microsoft.

Figure 4 depicts the percentage of total issued patents that are design patents for Samsung, Microsoft, and Apple. As was the case for Figures 1 and 2, each year depicts the number of patents that were filed that year that eventually issued.

The graph lines in Figure 4 show that the trendlines for Microsoft and Samsung are similar. Namely, the design patent percentage is less than 5% between 1996 and 2004 but increases to between 5% and 11% between 2005 and 2009. That percentage increases between 2009 and 2013 to a peak value of approximately 20% in 2013. Finally, this percentage somewhat monotonically decreases between 2013 and 2020 to around 10% for Samsung and less than 5% for Microsoft. It is unclear whether the lower 2020 percentages for these two companies is due to the fewer design patent applications or insufficient time for filed applications to issue.

[d]Microsoft was the only company that had a patent that was not a utility patent nor a design patent. In particular, Microsoft Corporation of Redmond, WA, USA received PP14,757, a plant protection patent titled "Apple Tree Named 'Burchinal Red Delicious.'"

The graph line for Apple in Figure 4 increases to over 25% in 1998 and stays over 15% until 2001. Between 2001 and 2015, the percentage oscillates, but stays between 5% and 15%. From 2015 to 2019, the percentage increases from 12.8% in 2015 to 16.9% in 2019. Finally, the large jump to 35% in 2020 is probably because the average prosecution time of a design patent is approximately half of the prosecution time of utility patents. As such, a few months to a year after the applications of a group of design patents and another group of utility patents, many design patents have already issued while relatively few utility patents have issued, which artificially increases the percentage of the total patents that are design patents in the shortterm.

Finally, although SiFive only has 12 issued patents, two of them are design patents. This is interesting both because SiFive has very few issued patents overall and also because SiFive does not appear to make end products for consumers, but rather designs components for those end products. SiFive's two design patents are related and are directed to an ornamental circuit board.

In Part II in this series, I will examine the prosecution time and potential effective patent term for these companies for patents filed between January 1, 1996, and December 31, 2020.

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