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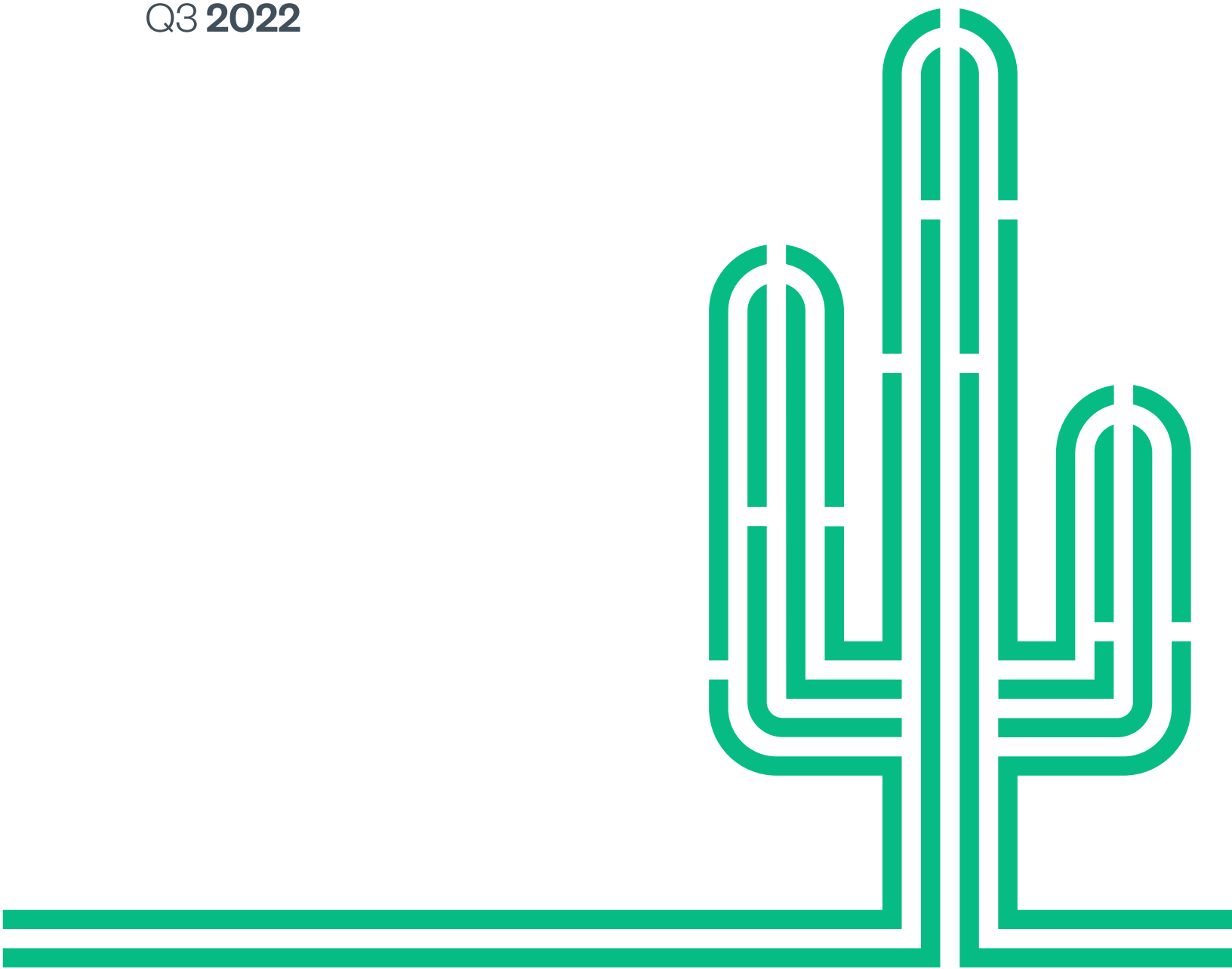
Saguaro Insights

Intel

Q3 **2022**



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Intel (INTC)

We never plan to introduce a company in the same quarter that we sell it, especially in our first letter. Nevertheless, our commitment is for candid communication. This means sharing both the positives and the negatives of our decision-making process with the same level of disclosure and transparency. Additionally, the best way to learn about someone is by observing their successes, failures, and especially what they do in the face of adversity. We hope the following illuminates not just Intel but also our process.

Saguaro prides itself on identifying game-changing businesses early, and we admit we were late to the game with Intel. Bruce didn't start following it until 1978, six years after its founding.[1] While one of us undoubtedly interacted with Intel memory chips in the early 1980s, Jim became a heavy user of Intel processors starting with the 80486 in the early 1990s.[2] Subsequently, several of us have built, used, and tested PCs, servers, and other devices using both Intel chips and chips from its competitors.[3] In short, we have a long history with the product.

For well over a generation, Intel was the undisputed king of both the PC and server processor markets. Most believed this was due to Intel's chip design prowess, and while it did produce the world's best PC & server CPUs, its largest competitive advantage was not its design team or even design intellectual property; it was its manufacturing.[4] Intel's manufacturing or fabrication facilities, also known as fabs, were always a generation (2-3 years) ahead of the competition. Manufacturing a silicon wafer of fully functional chips is a very different technical challenge than designing an integrated circuit.[5] In the 1990s & 2000s, Intel's chip design competitors played with one hand tied behind their backs. They did not have access to Intel's fabrication technology or facilities.

Historically, Intel has faced two types of competitors: integrated device manufacturers and "fabless" chip designers. Integrated device manufacturers are like Intel in that they both design chips and then attempt to manufacture them in their own facilities. AMD competed this way until spinning out its fabrication facilities in 2008 (creating what is now GlobalFoundries). Samsung currently designs and produces many of its own chips. "Fabless" chip designers design but do not manufacture their own silicon. Companies like Qualcomm, NVIDIA, Apple, and AMD (post-2008) fall into this category. They outsource their manufacturing to GlobalFoundries, Samsung Foundry, and most importantly to

[1] Bruce was offered a job at Intel immediately following his graduation in 1978. We'd love to tell you the story sometime.
[2] That processor ran at 25Mhz, and the computer had 2MB of RAM, less memory than most modern processors feature on its L2 Cache.
[3] Primarily AMD, but Jim did build one computer with a Cyrix 6x86 P200+ in the mid-1990s.
[4] Despite being the creators of the x86 architecture upon which much of modern computing is based. We will return to this topic further in.
[5] It is rare for every chip on a wafer to function and therefore a lot of focus is placed on yield, i.e. what percentage of chips manufactured on each wafer are functional.

Taiwan Semiconductor Manufacturing Company (TSMC). Intel's advantage has been accentuated by their ownership of the x86 architecture[6] and its specialization towards PC and server chips.

What makes fabs, or foundries as they are also called, such a competitive advantage? First, their cost. The highest-end, largest fabs in the world can cost upwards of $20B. For comparison, the US Navy's most recent aircraft carrier, the CVN-78 USS Gerald R. Ford, cost only a modest $13B. Second, what takes place in a modern foundry borders upon science fiction. Current lithography (using light for etching features onto silicon) has accuracy on par with striking a quarter with a laser shot from the moon. Certain coatings are applied so precisely that a similar layer applied to a modern city the size of LA would have no imperfections of even a single millimeter. The three key statistics for any foundry are:

1

The size silicon wafer it can handle or manufacture. Typically, 200, 300, or 450mm in diameter. No individual production line can handle more than a single size.

2

The capacity of the plant. The number of wafers it can manufacture in a given month or year.

3

The technology or process "node". This refers to the smallest sized feature that can be manufactured, placed, or etched onto the wafer. Usually measured in nanometers.

All else being equal, smaller features or transistors are better. You can fit more into the same amount of space, they require less energy to run, and you get bragging rights. In the clean-room transistor-measuring contest, the smallest one wins. The capital intensity that makes fabs special also makes them economically dangerous; they are a high-volume game. The marginal cost of producing more wafers is very low, but the fixed costs to build the facility are extremely high. When Intel had 99% of the server market and 90%+ of the PC market, no other fabricator could justify matching Intel's capital expenditures. Their volume wasn't high enough to spread out the fixed costs. In the mid-2000s, this situation looked to be a permanent competitive advantage in Intel's favor.

Cue Steve Jobs. In 2005, Jobs approached Paul Otellini (then CEO) at Intel about a chip for the still-to-be-launched iPhone. Unfortunately, the price Apple wanted to pay was below Intel's forecasted cost per chip. Little did Intel know that its forecasted cost would prove wrong and that the iPhone's volume would be 100x greater than predicted. In addition to creating an entirely new product

[6] x86 architecture is a family of instruction set architectures originally developed by Intel for the 8086 and 8088 microprocessors. Most PC and Server CPUs over the years have been built on this architecture. An instruction set architecture is the design or "model" of a computer that defines how a CPU (and other systems) operate and how they can be controlled by software.

category, the iPhone turbocharged both ARM-based designs[7] and the foundry that won Apple's business, TSMC.

TSMC was founded in 1987 by Morris Chang as the world's first "pure-play" foundry. He had no ambition to design chips but rather to perfect the manufacture of functional integrated circuit wafers. Armed with cash flow from Apple's business, TSMC was able to invest at a higher level and not only close the gap with Intel but become the technology leader in semiconductor fabrication.[8] Not only does TSMC have the world's smallest process node[9] (ability to manufacture at the smallest scale), but Intel itself uses TSMC to manufacture the GPU component of their "Meteor Lake" series of chips. TSMC's edge is formidable for four reasons:

1. **Scale** TSMC isn't limited to PCs and servers but also produces for AMD, Broadcom, Apple, NVIDIA, Google, Qualcomm, and many others.[10] It simply manufactures a much larger number of chips.

2. **Diversification** TSMC can spread its capital expenditures across many different projects as opposed to just one at a time, making it more likely that the company will earn a positive return overall. In markets with disruption, TSMC still wins.

3. **Cost** In addition to economies of scale, TSMC manufactures the lion's share of its silicon in Taiwan. Taiwanese engineers have a salary 1/6th that of their American counterparts.

4. **Platform** TSMC has a common design language for its customers, suppliers, etc. AMD does not have to design its own memory caches for chips, as TSMC has empowered specialized design firms to provide these services via its ecosystem.

Today's semiconductor industry has only the four players we've mentioned who can mass-produce the world's highest-performance semiconductors: Intel, TSMC, Samsung, and GlobalFoundries.[11] The investment case for this industry is simple: semiconductor demand is projected to grow 8-12% annually over the next decade.[12] That means doubling the world's fabrication capabilities within ten years.[13] While TSMC is the undisputed leader, it is not without risk. Despite a handful of token projects in the US, virtually all TSMC's manufacturing capabilities are based in Taiwan. Let the reader

[7] ARM is an instruction set architecture that competes with x86. Most mobile devices are built using an ARM instruction set as they are more power efficient than x86 designs. The creators of the original x86 architecture never thought of optimizing their instruction set for power efficiency in 1978.
[8] TSMC chose to go all-in with Extreme Ultra-Violet Lithography technology produced by ASML, while Intel attempted to manufacture its current generation of chips by more proprietary means. Intel has reversed course and has placed massive orders for ASML equipment for its next generation of chips.
[9] Although IBM has produced the first 2 nm node chip in 2021, TSMC still has the smallest processing node in production.
[10] While Intel does manufacture Wi-Fi cards, USB controllers, and other ancillary devices, this is not its profit center.
[11] Please note that Intel is two generations behind on process nodes, though they are committed to using Extreme Ultra-Violet lithography (EUV) technology from ASML to catch up within five years. GlobalFoundries has thus far eschewed the use of EUV due to cost and will fall further behind over time.
[12] Multiple sources, including Gartner, IDC, McKinsey, and Fortune.
[13] This is a large part of our thesis for MKS Instruments and Teradyne too, as you cannot build fabs without them.

interpolate the risk. Second, most industry participants want more than one supplier. Intel is best positioned to prosper.

While Intel has lost ground over the last fifteen years, it still has strong structural advantages. First, it owns the x86 instruction set architecture license.[14] If you want to produce an x86 chip, you must license the IP. Second, because Intel created this IP and has used it for over forty years, the company has unmatched chip design expertise. Third, when you are an integrated device manufacturer, your production lines can be optimized for your chip design. In essence, if your manufacturing tech is equal to your competitor, this gives you an edge. If Intel is simply "tied" with TSMC, then its chips should outperform AMD, etc. Finally, the US government acknowledged it is in the interest of the United States to have a strong domestic semiconductor manufacturing industry by passing the $53B CHIPS for America Act.[15] While Intel's financial performance hasn't been lacking, a strong CEO could use these advantages to produce something truly astounding.

Pat Gelsinger appears to be this CEO. He has been a mainstay in the valley since 1979. Graduating high school at 16, Gelsinger started at Intel as a quality control technician at 18. While working, he attended Santa Clara University, graduating with a degree in Electrical Engineering, Magna Cum Laude. He followed this with a Master's in Computer Science and Electrical Engineering from Stanford, and more importantly, was the lead designer for Intel's 80486, the same chip on which Jim cut his computing teeth! This success led to personal mentorship from Andy Grove and being the youngest VP in Intel's history at 32. By 40, he was Chief Technical Officer and served in this role from 2001 until leaving in 2009 to become President & COO at EMC.[16] Three years later, he was named CEO at VMware, where he led until returning to Intel in February of 2021.

Gelsinger wasted no time stating his intention to catch rivals TSMC and Samsung from a technical perspective within five years. Intel immediately began planning the construction of two $20B fabs in Arizona, one in Ohio, and another similar fab in Germany, along with significant upgrades to many of its existing facilities. The plan is not exclusively about catching up but also changing Intel's business model. **Called IDM 2.0, the plan calls for Intel to take a page from TSMC's book and offer foundry and manufacturing services to its "fabless" chip design competitors.** ASML, Google, Microsoft, Qualcomm, and others have expressed support for Intel's integrated foundry plans. While there is much work to do to create a common design language, an ecosystem of partners, and the actual facilities, the mindset change demonstrates that this is a different Intel. So different that Gelsinger even plans to separate design and manufacturing. We believed this new Intel to be dominant in its PC and Server niche, and it now had a clear vision for strengthening its competitive advantages over the coming decade.

Our thesis for Intel was straightforward. In the global market for both server and PC CPUs, Intel commanded > 80% share; AMD and TSMC simply cannot fulfill all demand for this market, no matter

[14] For the purists, we acknowledge that AMD owns the x86-64 license, but as you are a purist, you know that Intel and AMD cross-license this IP which effectively makes them a duopoly in the space.
[15] Our internal estimate sees up to $39B of these funds being allocated to Intel though we acknowledge the uncertainty around this as *very high*, and it never factored into our valuation.
[16] We find it interesting that Intel's technical decline coincides precisely with Gelsinger's absence.

how strong their technology.[17] Intel owns the key IP for designing and manufacturing these chips. Being an IDM, Intel can optimize their manufacturing lines for their products. The historic financial results for Intel have been incredible, though perhaps a bit overstated due to underinvestment. And finally, the market faces a secular mismatch between demand and supply driven by the internet of things and humanity's insatiable desire for ever more data and compute. Most fabs should be able to run their facilities at or near capacity earning wonderful returns. To top this off, it once again has management in place who understands the company's position and has a plan to strengthen its advantages. This belief was bolstered by the successful release of Intel's "Alder Lake" chips (Gelsinger's first big release as CEO) which were on schedule and performed well.

Every report we create for our businesses also outlines their potential risks. In Intel's case, its chief advantage is also its Achilles heel. Its wonderful historic returns have been driven by their production volumes. Any threat to these volumes or the need to drastically reduce the price to maintain these volumes will generate lower returns. In March, while discussing the x86 industry (two players, Intel and AMD) and the global foundry industry (TSMC, Intel, Samsung, and GlobalFoundries), we developed only two realistic scenarios with probabilities that we could define as material risks.[18] Risk one: Intel produces chips that simply do not function as advertised, impairing their brand, reputation and significantly impacting volumes. Risk two: if Intel falls significantly behind its release schedule, volumes could be substantially impacted. For instance, if your 4th-generation chip is 12 months late, it will find itself fighting the competitor's 5th-generation chip, leading to market share losses, reduced volumes, lower returns, and impaired cash flows.[19]

We hadn't received our confirmation email about purchasing Intel before the bad news started to pour in.[20] First, despite shipping their initial Sapphire Rapids chips (Xeon server CPUs) in Q1 2022, Intel couldn't scale production due to testing & validation issues. Second, the company's higher-end Arc desktop GPUs were delayed from early summer to early fall due to software issues. Next, the Granite Rapids server chip release date was pushed from 2023 to 2024. In addition, Intel is being non-committal about release dates for its other chips as well. While all integrated circuit manufacturers fall behind on release schedules from time to time, as new technologies often cause production issues, this is something different. The issue was not isolated to a single new product or a single new technology. These issues are for different products, manufactured in different locations, with different types of issues (manufacture, software, & testing). This was our top risk materializing at rapid pace. In response, we placed Intel in the penalty box and lowered our valuation.

[17] AMD chips power the Xbox Series X, PlayStation 5, and Steam Box. Years after release, it is still challenging to purchase one of these systems at retail due to chip shortages.

[18] Please note that we categorize unknown risks or risks that are extremely hard to quantify as uncertainty. Also, note that we define a material risk as something that would cause a permanent loss of capital. In addition, we do not factor in "portfolio complete" risks or "universal" risks to our investment underwriting process. These would include nuclear conflict, acts of God, or an everything bubble. We leave it for more astute analysts to properly discount a Chicxulub-type event for any investor unable to live off-Earth.

[19] This is precisely what is happening with Intel's Sapphire Rapids chipset. It was supposed to compete with AMD's Zen 3 EPYC chip but will now find itself competing with the Zen 4 EPYC. Good luck.

[20] At least it felt this way.

While we expected bumps with Intel and believed Gelsinger needed time to right the ship, we were now concerned things might be worse than underwritten. Intel released its Q2 earnings on July 27, 2022, and removed all doubt. Three data points concerned us the most. First, Intel confirmed our fears about the release dates discussed above. Second, the financial results in Q2 were not just below our predicted range but were worse than we thought possible. Third, the management team didn't see this coming, given their optimistic outlook at the Investor Meeting five months prior in February and their comments three months prior on the Q1 earnings call.

Since 2018, Intel has lost ten percentage points of PC CPU market share to AMD, going from 90% to 80%. Likewise, in servers, AMD has increased their market share from 2% in 2018 to 15% in 1H 2022.[21] It appeared that these trends stopped in the back half of 2021 and that the new chips, released on time, would perhaps even reverse the trend. Q2 made it abundantly clear that this isn't the case. Not only did these trends continue to explode in the wrong direction, but Intel's GAAP Gross Margins (37% in Q2 2022 vs. 62% in 2018) imply that share losses would have been even worse if Intel hadn't conceded on price to try and protect volumes. This, combined with continued product delays, does not bode well. We can abide by temporary market slowdowns; our long-term time horizon even encourages investments during these drawdowns. We can stomach new entrants like Apple, Google, Amazon, and others designing proprietary silicon for their own use; this is a big market. What we cannot endure is watching the walls of our competitive position crumble away.

Our previous understanding was that many, if not most, server chips are sold as part of large-scale projects. Typically, there is significant lead time on these data centers, and they are designed to optimize the chips or silicon chosen. It is thus rare to have rapid market share shifts due to this lock-in. Intel's repeated delays to their "Sapphire Rapids" server chips have allowed AMD's "EPYC" server CPUs to make real headway and take share faster than we thought possible. We don't see this cycle abating in the near term. The server market has consistently generated huge amounts of cash for Intel. A material reduction in that cash flow could affect its ability to invest aggressively enough to compete with TSMC. Its recent deal with Brookfield Asset Management to share ownership of its newest fabs suggests that this fear is all too real. Nevertheless, even if Intel can spend enough to compete, a study of AMD's returns prior to spinning out its foundry business in 2008 provides a portrait of what can happen to an IDM with insufficient scale. Intel is a long way from that form of AMD, but it is not hard to imagine a future Intel with margins and returns far below its historic monopoly-type levels. In summary, Q2 raised the probability that Intel's future generates less free cash flow and lower returns than acceptable for an SCM top-100 business. That this seeming implosion was not communicated in the months leading up to it did not help Intel's investment case.

The street was also caught off-guard by the magnitude of Intel's change of fortune

We were not alone in being caught unprepared. The street was also caught off-guard by the magnitude of Intel's change of fortune. Despite management's media blitz in the immediate aftermath

[21] Yes, Intel had almost 99% server market share in 2016.

declaring that Q2 is "the bottom" and committing to "do better", we were taken aback by management's inability to see this coming. Intel was already in our penalty box due to the release schedule slippages, but to see our top risk materialize at this pace is astounding. While we, and others, still believe Intel may prove to be a great investment, the probability of that outcome is much lower today than it was even in March of this year. Best case, Gelsinger's starting position is materially worse than we previously supposed. Worst case, Intel may be truly broken.

For these three reasons, and despite its remaining strengths, Intel has lost its place on our list of the 100 best businesses on Earth and, therefore, its place in our portfolios. While we never want to underweight or overweight recent information, we've learned through painful experience that when something exceeds your worst-case scenario, it is time to act, not sit on your thumbs. As Paul Samuelson, 1970 winner of the Nobel Prize in economics, put it, "When events change, I change my mind. What do you do?" At Saguaro Capital Management, we do not consider sunk costs and will always act to best position the portfolio for the future. We fully exited our Intel position in the third quarter.

We followed our process, and despite purchasing Intel with what we believed was a substantial margin of safety, it led to a permanent loss of capital for us and for you, our client partners. As portfolio manager, the responsibility for this loss is on me. This will not be my last mistake. I applaud the whole team for their engagement through the process and their commitment to rationality and following the data rather than emotion. The team strives not just to minimize errors but to derive value from them. They are the most powerful tools we carry to prevent similar losses in the future.