



Patrick Moorhead: Rene, it's great to see you this year for this Six Five Summit, 2022. Gosh, you have been a busy guy over the last couple years, but thanks for coming on.

Rene Hass: It's been a very busy couple years and the last 90 days or so have been even busier.

Patrick Moorhead: It has. You've probably been back on the road talking to folks about the investment opportunity, and by the way, speaking of this, you just announced record revenues up 35% year on year, and I have to say, I didn't know that the company was this profitable, and you and I had a conversation the first time you had disclosed and it's like, hey Pat, check this out, and I'll admit it, I was super impressed and I think it's fair to say that your performance is one of the key indicators of the health of the entire semiconductor industry, and I'm curious, and your business spans...

I mean, literally A to Z, what areas are you seeing the most growth? What do you think are the biggest opportunities and what major factors are driving this performance? I somehow managed to pack three questions into one.

Rene Hass: There is a lot to unpack out of that long set of questions/data, but first off, we announced our results a few weeks ago, and as you obviously know, we were under an acquisition for the last year and a half. We weren't talking publicly about how ARM was doing or what our results looked like, or any of that. We were very excited to be able to tell the world what the new ARM looked like, if you will. It's a very different company, and I know, Pat, you've followed us for many, many years. It's a very different company than we were the last time we talked publicly about our business, if you go back to 2016, we had a great business, but ARM was really largely associated with smartphones and under SoftBank's ownership since 2016, it gave us the space we needed to pivot our strategy a bit. To invest in some areas that we wanted to put more engineering horsepower into and then some change some things.

One of the biggest things we did is we put a much greater emphasis on the compute, on the compute platform. We shed away some other businesses such as video and display, things that we did not feel highly differentiated in, and then we also put a much greater emphasis into new markets that we felt were going to be growth areas for us, and specifically that's around infrastructure, automotive, IOT, and infrastructure, by the way, is both the hyperscaler as well networking and things of that nature.

Coming out the other side, yeah, we had terrific growth, record revenue as you say. We are thrilled about that, but to answer your question, really about the growth areas, it's been in the spaces where we put the big investment. Automotive up 117% year on year. Infrastructure up 57% and IOT 50%, and I think what you're seeing there is a combination of insatiable need for compute, but at the same time, insatiable need for compute efficiency, and that's an area that as you know, ARM does really, really well, and combined with working with our partners across the broader ecosystem, what we're now starting to see is the fruits of that strategy starting to pay off.



Patrick Moorhead: Yeah. It's interesting. I have a special relationship with chip providers and being a pundit, I will tell you, has been a lot easier than actually doing it at my 11 years in the chip industry myself.

One of the things I definitely... I did expect ARM to do really well in IOT and automotive just based on the status of the company before some of these big investments were made. I was super... Well, not surprised. I think it was a matter of time at how well you're doing in the infrastructure space, and it's been fun. It's been fun to watch, and whether it's AWS, whether it's Oracle, it's been a lot of fun.

Now, the question is, you can have the greatest technology in the world, but can your partners deliver it? And that brings me to the chip shortages. Do the chip shortages affect your business? And I'm curious how you see this moving forward and impacting the industry in the short term and the long term.

Rene Hass: Yeah. Going back to touch on your comments on infrastructure, and then I'll talk about the chip shortage and such. We had the confluence of a number of things that all came into place at the same time. We had early people, as you remember, doing work on ARM and in the cloud. Largely with our 32-bit cores, and a number of years ago we introduced 64-bit cores and then did a lot of work with the software ecosystem around SUSE and Red Hat Linux to get distros for the ARM implementations, and then our 64-bit performance, we invested quite a bit in it during the last number of years, which was really around Neoverse.

When you combine those areas around software ecosystem and great performance, at the same time, what became very, very key was going back to the sufficiency piece, and AWS talking publicly about Graviton seeing price performance at 40% better than what they see on x86, that's a pretty big deal, and when you think about expansion in the data center, it's really about performance per square foot, because you only have so many megawatts that can go into the facility. You only have so much rack server space.

That's a really great place for ARM. To plug that a little bit in terms of what we've seen, and there's a lot of folks as part of your Six Five Summit, Pat, who are Silicon partners, whether it's Rene Renesas for automotive, Qualcomm and Lenovo for PC, Microsoft, AWS for infrastructure, who are doing stuff on ARM.

That all means we see the chip shortage thing up close and personal. Our ARM, because we play so broadly now. We have a really good picture in terms of what's going on, and I think you've got two things going on with the chip shortage. You certainly have this acceleration of all things digital that's taking place across all the markets, which means increased demand for products beyond what was originally forecasted during the pandemic area. You have that.

You know, as a semiconductor veteran, it takes a long time to put in additional fab capacity, and so that's a huge issue, and then you also have a lot of different components that would go into a system that aren't just your five nanometer complex SLC, if you don't have substrates, you're not going to be able to ship a chip, if that chip goes into a board and you don't have the power



amplifiers or what you need for the power supplies, that's going to be a problem too. I think you've got a combination of huge demand for semiconductors.

Patrick Moorhead: Right.

Rene Hass: Wafers and substrates being difficult to predict and allocate, and then everything else that goes into a system that make it really, really difficult to predict what's going on. I think this is with us for a while, from a standpoint of if, again, if you think about what's gone on with the pandemic, with different parts of the world stopping and starting, these supply chains, and you know this well, these are not things that you can stop and start on a dime, and when you start to think about logistics around containers and where are things held up, I still think we're going to see these issues with us for a while longer.

Patrick Moorhead: I had the honor of doing a keynote speech for a foundry company last week, and I was enthused. What I heard, but also what I'm seeing, which is this element of co-investment. It used to be as a foundry, right? You take between five and 10 billion dollars and you took all the risk, and now we see a lot of end users making investments in that as well. It's more sharing of risk, which I think, at least what I've seen, is enabling a lot bigger investments out there. Yeah.

Rene Hass: Yeah. No, I think you're right, and many, many years ago, TI used to do that kind of thing, if you remember. Decades ago they had joint ventures with Acer in Taiwan and other folks in Japan. I think they kicked it off with that notion, and then years went on and TI got out of some of those markets, but fast forward, I do think that is a logical model, and when you think about companies who pay a lot for advanced capacity anyway, and they're putting hundreds and hundreds of millions of dollars into capacity that is allocated to them that is not anything that they can cancel, may as well own a piece of the farm. Right? And then be able to make sure you can harvest that part of the crop, and I think these very, very large companies who are consistent consumers of advanced node technology, it makes a ton of sense.

Patrick Moorhead: Absolutely. ARM for years, reset expectations of energy efficiency. Now, ironically, people used to say, oh, but they're energy efficient, but they're not performance. Well, here we are today. ARM powers the highest performance HPC machine out there. Your architecture powers the highest performance personal computers in the industry, and obviously, you have the highest performance smartphone platform out there as well, but I want to shift back to energy efficiency, because energy efficiency is becoming important in areas that you may not have expected like automotive. Right? It's like, well, wait a second. It's going down the road. It has a massive battery. It generates a ton of electricity as it moves down the road. Why is energy efficiency still so much important across the industry?

Rene Hass: Well, gosh, if you think about, and many people don't know ARM, and you and I have chatted about that for many years, and it's a story of an amazing company, but a lot of people don't know much about us, and with that, a lot of people don't know, really, how the company was born, but the company was really born out of energy efficiency.



For those of us old enough to remember the Apple Newton, which was the very first PDA that hit the planet that was trying to do all kinds of complex things, such as handwriting recognition and contact management and calendaring. That SOC was based on ARM, and that was a technology born with... It had a display. It didn't have any communication capability at that time, it was just too early for it, but it had a lot of compute capability, because you had to do handwriting recognition and you had to do a lot of complex management.

That's kind of how ARM was born, and if you fast forward 30 years, that's a sensibility around power efficiency and designing low power, but still with a high degree of performance to do some complex tasks, and that runs through the DNA of the company, and that runs through the DNA, when people start thinking about how they design products, it's not that they start thinking, oh, I've got to assume the product's not going to be plugged into a wall, it's how people grew up and design techniques that they learned.

Fast forward to today, when you think about everything going on with ESG requirements, we've only got, obviously, so much natural elements to work from in terms of oil and gas, et cetera. Efficiency is everything. It's the right thing to do for the planet, and the computational requirements aren't going down, and when you think about everything that goes on with, take automotive, right?

When you think about everything going on in a car today, that is a lot of computational type of work. When you start thinking about driverless cars, that problem goes up exponentially, and you're talking about kilowatts of compute power that need to go to hundreds of watts. That's a great place for ARM, and then you think of it in an EV, where already you don't want to take one ounce of driving distance and capacity and throw it over to your computer. It becomes really, really important.

I think all of the things really line up for, whether it's around battery cars, whether it's around bay stations, but probably most importantly, we only have so many resources on the planet. I think for energy efficiency, it's one of the key things in terms of any computing design.

Patrick Moorhead: Yeah. You've cited some great examples of power efficiency. We talked earlier about density in the data center, why it's important in cars, particularly EVs. I think it's very well understood why smartphones and energy efficiency is important here, but the question is what new possibilities and potential market opportunities does this open up for people moving forward into the future? And I hate to ask it this way, but, what is the next smartphone in your eyes?

Rene Hass: Yeah. The metaverse is something that gets a lot of air, both in terms of real positive feedback and a lot of people who like to abuse it in terms of what that actually means. I do think there is an opportunity for a hybrid environment around augmented reality that makes things a little bit better, a little bit smarter.

I think if there're glasses that you could wear, or are wearing, that when you're driving, that can make things a lot easier in terms of sites you're trying to get to. I think when you're talking about



anybody who's in the professional medical field, or anything, it's an instrumentation that could benefit from that.

I do think there is something there. I'm not sure I'm completely comfortable with a world where everything has gone virtual and you have an avatar of yourself, but I think the area around doing more with augmented reality is going to be a pretty large space, and I think there's a lot of things around industrialization that can be done with that. Certainly in areas that don't have a lot of infrastructure that need to put up new sets of areas for factories and delivery.

I think delivery is a huge area. I mean, whether it's around, I don't know if it's drones that can get a kind of ubiquitous type of takeoff, but I think that's another place, but back to your question on the smartphone. The smartphone is such a powerful device because of all the things it replaced in your life that are now in one place, that I think it will continue to be a fundamental platform for how things get done.

Now, it may exist in certain forms. We've seen it already with a watch, and I think you'll probably see spinoffs of that, but having something that's tethered to you, if you will, that is your communicator? I think that's here to stay for a long, long time.

Patrick Moorhead: Yeah. I'm a big believer in VR, in the metaverse. It's just a matter of when, and yeah, I saw an interesting keynote probably five years ago from Facebook that said this would be a 10-year run. It was the CTO of Oculus, and it's pretty much looking like going to take 10 years to get to the point where it becomes popularized for consumers.

Although, even though people are using it in enterprises today to do some really interesting thing, and whether it's visualizing how to install an elevator or being able to decrease the time to fix something that's industrial by have everything automatically come up on your screen and tell you exactly what it is, and I'm actually very happy to see the industry keep investing in it, because quite frankly, we've seen a lot of technologies come and go, and whether that was AI in the 60s, which is a 60s algorithm, quantum computing, which is a 70s algorithm, and people stopped investing after it hit the trough, but I'm pleasantly surprised to see companies like ARM continuing to invest in things that have a potentially longer payoff. I think that's important and not enough companies are doing that.

Rene Hass: I think, back to the metaverse or AR/VR, I do think that will, at some point, take off. I think that Delta may be around the display technology that's used and you may get something that's more of a hologram or a holographic type of image, and when you think about a holographic image, you then get into power consumption and efficiency, because to render something like that real time and to have the compute power to be able to do that without having to send information from a device in the cloud, is going to be very, very complex.

You've got the display area with it, which is a complex problem in and of itself, but the compute piece is not a small task as well, but you see it in cars today with heads up displays, right?

Patrick Moorhead: Right.



Rene Hass: That, in a way, is a hologram type of application, which it's not invasive, and you don't have to have a helmet on to use it.

Patrick Moorhead: Right.

Rene Hass: But at the same time it adds a lot of value, and I do think when we get to a point where that can be done in a energy efficient way on the display side, then I think we could see some things take off, and that's where the area I think I'm... And I think ARM will be there, because again, that's a very, very compute intensive type of piece of work.

Patrick Moorhead: Well, another thesis of how we can possibly get there earlier is to do some of the compute in the cloud and, dare I call it virtual hardware, and I think we saw that with remote desktop when the pandemic really led to, hey, getting 50,000 workers that had to suddenly be productive at home when they had desktop computers at their office, and I'm curious when it comes to this virtual hardware, how critical has this been for the industry to maintain the pace of innovation?

Rene Hass: Well, there's a product we have called ARM Virtual Hardware, and what that actually is... Going to lead into your question and then talk about what that is, ARM Virtual Hardware, and for those in the world, I know that you've lived in this space for a long time, embedded computer designs typically mean you have to physically build a prototype and you have to have the hardware in your hands and then only when you have the hardware in your hands, can you develop a software that's going to run in that hardware.

That takes a long time. That's a long time for product development, and we've come out with a concept called ARM Virtual Hardware, which basically allows you to take all the elements you would need for an SOC and start to build them and prototype them and write code for it before you get the actual chip back, which is an example of a virtual world where in the old world, not only would you need to have the physical hardware in your hand and you have to test the board and you have to have logic probes and such, but you physically had to be there. Right? You have to actually be in the lab and have all the instrumentation required to go off and do the test and debug.

This ARM Virtual Hardware takes that one level deeper in terms of the amount of work that can be done in remote area, and just from the ARM side, I was in the UK last week and we met with a number of graduates and more senior engineers, and we asked them about hybrid working and what was it like to solve complex problems when everyone was doing it from home, and we've come a long way in terms of the tools required, and there's obviously a lot of work that people can do not in a lab, but I do think, and we heard this from the engineers we spoke to, that the level of collaboration and innovation that you can do, particularly solving hard problems remotely, still hasn't been quite figured out, and I think that's the next place to get to in terms of what could replace a real in-person collaborative environment virtually.

We haven't figured it out yet. We spent a week together, as I said, we met with a number of different engineering teams, and then we had an offsite where we solved a whole bunch of



problems that we would not have been able to have done in any other way other than face to face.

Patrick Moorhead: Yeah. The great part is we still have a lot of things to work on in this industry, but you did pique my interest on your offering. I'm going to go read a little bit more into it.

By the way, one of the biggest changes that I've seen in, I guess, the over 30 years that I've been doing this in the tech industry, is software augment. I was a hardware jockey. That's where I started from, but I'm amazed at this new sense of balance to hardware and software. I mean, we've seen companies with the ability to increase performance with orders of magnitude through software, and you couldn't necessarily do that on a standard homogeneous architecture, a homogeneous CPU, but when it comes to things like accelerators, it's absolutely possible, and the other thing is, customers are less desire a bag of parts and also would like a full solution out there, and is this why investing in software is so important for the ecosystem? What does it unlock for semiconductors? This is massive investments. I mean, you hear companies spending as much in software or more than they do in hardware.

Rene Hass: Wow. A lot to unpack around that. First off, back on the AI piece, or accelerators, a lot of people would be surprised to know that there's a lot of AI and machine learning that gets done on standard ARM processors. We have a number of extensions that allow people to do complex math and things such as accelerated extensions in/around machine learning.

To the software issue, at the end of the day, any compute platform is only as good as a software that runs on it. A very symbiotic relationship between the software ecosystem and the compute platform is absolutely critical, and when you think about either around the development systems, as you know, you attend our Dev Summit, which we have every year in October, and that used to be called TechCon, and we've pivoted that, now, really towards developers, and you'll see more and more from us around that area when you attend in the fall. You'll see an even higher degree of emphasis around the software developers and the software ecosystem, because that is really ultimately where we see huge investments taking place.

To your point, as you said, it's really as much about the software as the hardware, but again, the symbiotic relationship between the two, and then as you get into these complex workloads, complex data structures, how do you partition the task between what gets done in accelerator versus what gets done in the core? Really modeling the entire subsystem is very, very critical. Back to your point around solutions, that's something we think a lot about here, and I think as you've seen the pivot of the company over the last number of years, away from a general purpose product, more towards solutions that are tuned to the markets, you'll see more and more from us, Pat, that'll be really linking that software and hardware solution together.

Patrick Moorhead: Gosh, I think I heard a little stay tuned there, for Dev Summit there. You sure you don't want to break the news here on the Six Five Summit?



- Rene Hass: Book your ticket in advance. Virtually or in person. Actually, I think we're going to do it in person this year.
- Patrick Moorhead: That's great.
- Rene Hass: We are, but COVID notwithstanding.
- Patrick Moorhead: Yeah.
- Rene Hass: We have shifted that event over the last number of years and we've seen a huge reception for it.
- Patrick Moorhead: Yeah. I've been super impressed with... The more work that ARM does and the more solutions that they do earlier, the more quickly it enables your tens of thousands of partners to bring out some really cool stuff, and I think that's important, and I think essentially you're shrinking time to market with what you need to do and your partners can focus on doing differentiated things as opposed to rewriting things a thousand times that quite frankly, don't add customers and customer value.
- Rene Hass: Yeah, and we have to stand on the shoulders of our partners there, because the ubiquitous of the ARM architecture, 29 billion chips last year, 229 billion chips in our lifetime, 15 million app developers, 10 million apps. We're a company of 5,000 plus. We can't touch all those people. Not by...
- Patrick Moorhead: Yeah.
- Rene Hass: Not by a long shot. We need to stand on the shoulders of our partners to be able to reach and communicate and engage that community, which is so critical for us, and again, back to all the markets that we engage in, but it is an area that we're going to continue to emphasize and put more horsepower into.
- Patrick Moorhead: Well, I will be waiting to hear all the great stuff, and Rene, I just want to thank you for coming on the Summit, here. It's been great to get to know you over a little over a decade here, and congratulations on the new role. I should have said that up front, but I guess better late than never.
- Rene Hass: Thank you. Yeah. I think we met many years ago when you were launching your own gig, which has done great. Congratulations for all the success you've had, but very happy to be here talking about ARM and really proud of what our company has achieved.
- Patrick Moorhead: Yeah. Good luck on the IPO. I'll be watching all of it as it unfolds, and listen, just when you thought the amount of activity would go down, here you are on the gear again. Good luck with the IPO, Rene.
- Rene Hass: Thank you.





Patrick Moorhead: Thanks for coming on.