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Hey everyone and welcome back to FYI, the four-year innovation podcast. I'm Michael Cromer, a product marketing manager here at Arc. So according to Arc's research, five innovation platforms are converging to create unprecedented growth trajectories. Artificial intelligence is the most important catalyst, its velocity cascading through all other technologies. The market value of disruptive innovation platforms could scale 40% at an annual
rate during this business cycle from $13 trillion today to $200 trillion by 2030. In 2030, the market value associated with disruptive innovation could account for the majority of the global equity market capitalization. Our Chief Futurist, Brett Winton, has more on today's episode. Please enjoy.
Hi, I'm Brett Winton, Chief Futurist at Arc Invest and I'm extremely proud to talk about big ideas 2023, our annual report on the state of technology and how we see technology changing and evolving. Today, I'm going to talk about convergence. This has been a year of convergence. There's no question that technologies are reinforcing each other and expanding even faster than we anticipated a year ago and two years ago. There are risks of investing in innovation and this is a disclosure slide talking about some of those risks. I think it's fair to say that technology investing involves all kinds of known and unknown uncertainties and the actual results could and likely will differ materially for how we think they will. We think part of the value app for us at Arc Invest and the research we do is we do try to quantify and put numbers to the technologies that are growing and changing the world and really trying to determine how big and how valuable these technologies are going to be and then comparing those numbers to how they're valued in the marketplace today. That's how we identify the inefficiencies that we try to invest in to take advantage of the asset approval that we anticipate.
It's clear to us, given how technologies are reinforcing each other, that this really is a technological boom, that future historians will look back upon this business cycle and say we can't believe that all of these technologies were hitting critical stages of inflection at the same time. In fact, if you total up all of our forecasts, you'll find that we believe that disruptive technologies that we focus on are going to accrue hundreds of trillions of dollars in value over the course of this business cycle through 2030. Today, we think that disruptive technologies are valued in the marketplace at roughly $13 trillion and we think the value approval will exceed $200 trillion by 2030. More than half of global equity market capitalization will be comprised of disruptive technologies and the innovation platforms that we focus on.
It's our reminder. These are the five innovation platforms that we think will define this decade. Public blockchains, particularly cryptocurrencies, smart contracting protocols, and the digital wallets that allow people to access those public blockchains will, in our view,

change people's financial lives. They'll change the incentive structures for how capital is deployed in the economy and they'll reduce the net drag, the economic rent that's charged by financial intermediaries on every single transaction worldwide. We believe that public blockchains are going to scale into the tens of trillions of dollars in value over the course of this decade. Artificial intelligence, I think everybody can see that the pace of change is accelerating with artificial intelligence. This innovation platform has the steepest cost decline of any of our innovation platforms and it's most critical to catalyzing other innovations, as I'll talk about. The AI software is going to become the dominant form by which software advance is delivered over the course of this decade and command more than $10 trillion a year in revenue, in our view. Multiomic sequencing is the idea, multiomics is actually a term that some of you might not be familiar with, but it's not just the DNA, which is the recipe for your body that's important to developing biological understanding of what's going on. It's also the things that are on top of the DNA that control which genes are expressed, as well as all of the data that's feeding from digital health platforms that help us to tie kind of what's going on at the molecular biological level to the actual diseases that people have. And it's going to, we believe, change cancer care with multiomic technologies that precision therapies will be developed that will be worth trillions of dollars and that emerging capabilities in programmable biology will change the way that food is produced and how expensive it is. On the energy storage side, this for us comprises both electric vehicles as well as kind of autonomous mobility solutions. And in over the course of this business cycle, this may have the most tangible impact to people's day-to-day lives as owning a car, for example, could become really optional for people even in the Western world, since it'll be cheaper to ride around in the robot taxi that delivers you from place to place for tens of cents per mile is safer, more convenient, and allows you to sit in the backseat and watch Netflix while you're getting to or from work. And then the earliest and most emerging, I think, of these innovation platforms is in the robotic space. Robots have been around for a long time in the industrial automation setting. The advance here is robots that can operate alongside humans, reusable rockets that can deliver low-earth orbit communications constellations that radically reduce the cost of connectivity on a global basis and 3D printing that can allow manufacturing to happen closer to the end user with an infinite variety of parts available to the manufacturing entity regardless of supply chain vulnerability. And so these five innovation platforms are both self-reinforcing in all the critical stages of inflection. And so one of the things, one of the activities we've undertaken is to score these innovation platforms on the degree to which they're converging is how does an advance in neural networks impact the rate of change for next-gen cloud or the capabilities of multi-ohmic technologies or autonomous mobility? And so this visualization on the right is actually a mapping of that convergence scoring. A few things here. You can see that each color represents one of the innovation platforms I was talking about in the previous slide and that this network graph actually emerges from that convergence mapping to reveal the 14 underlying technologies that we focus on from digital wallops to advanced batteries from adaptive robotics to precision therapies and that the five innovation platform buckets we talk about emerge organically from this mapping of convergence. So you can see that our kind of the definition of five innovation platforms maps to these 14 technologies and these 14 technologies themselves are more tightly interwoven at that innovation platform level. So the next-gen cloud is going to be required to allow neural networks to be trained and to operate

at scale. The capabilities of neural networks are going to reinforce and in fact be critical to whether or not augmented reality glasses actually become viable devices for people to buy and they'll feed straight into the capabilities of the smartphones that you have today.
So I talked about convergence. If you unpack this graph to measure the relative convergence importance of each technology, you can see that neural networks are artificial intelligence deep learning systems are by far the most important in terms of their ability to catalyze other technologies. On the left is a quantification of that. Roughly the way in which the convergence scoring is quantified is that an order of magnitude increase in the address of the market for another technology is essentially a score one and everything is scaled on that basis. So you can say that in advance in neural nets, if AI accelerates, we believe that corresponds to basically four other technologies, roughly increasing their addressable market by an order of magnitude. And so you can see it's tied into, advances in neural nets are tied into almost every other technology that we focus on, but it's critically tied into, for example, autonomous mobility and the ability of adaptive robotics. And so one of the advances that we've seen over the last year that really gives us confidence across all of the technologies is that neural nets, AI capability is happening faster than even experts in the field anticipated. Inverting it, this is a measure of how sensitive the technologies we focus on are to other catalysts. So autonomous
mobility systems are the most sensitive to accelerations in other areas. This makes a conceptual sense that a reduction in the cost or an increase in the energy density of battery systems means that you can have more form factors that the aerial drones will become more capable and have longer range at lower costs. And in advance in neural networks allows and in fact is required for autonomous mobility to operate in really challenging open space driving situations, for example. And so essentially accelerations in other technology lead to a potential to order of magnitude increase in the addressable market for autonomous mobility in our view.
And so just to focus again on artificial intelligence and how that acceleration is feeding into these other technologies, it's clear that advances in AI are driving, so to speak, robotaxies. So in Tesla's AI day, they talked about how the system can approach an intersection that it's never seen before and understand essentially the taxonomy of how you can drive through that intersection. Where are the likely pathways of travel? How do lanes merge or unmerge in, if you have two left turn lanes, how does that feed into the four lane road on the other side, for example. And the way they solve this problem is using what's called the transformer architecture,
which was originally introduced in 2017 as a way to make AI systems better at translating language. So in advance in an AI language translation system, which became the advance that has driven all of the innovation you've seen in large language models and AI natural language processing fed directly through into the ability of a robotaxie to understand an intersection. And so this is, and it's not just robotaxies. If you look at long read sequencing within the multiomics technology space, this is a long read sequencer, something that can read your genome. And instead of cutting up the genome into really little bits, it constructs the genome out of longer clumps of DNA and stitches them together to understand the genome and actually to more completely understand the genome than is possible with small bits. One of the drawbacks that that approaches is those DNA chunks had had a higher error rate. Well, by using that same transformer technology and applying it to a long read sequencer, there is a 59% reduction in that error rate

realized over a couple of years of just deploying that transformer architecture against long read sequencing. And so again, it's an advance that happened because we were trying to translate language better with AI. And lo and behold, it turns out it makes a long read sequencing box reduces its error rate by almost 60% without any change to the box itself. It's just an AI software upgrade to the box. And it's not just long read sequencing. If you go over to the robotic space, that same transformers advance from 2017, you would think, well, it makes sense that it would be useful to be able to talk to a robot in natural language and say, hey, go pick up that object over there. But this is actually at a more profound architectural level, where by using that transformer architecture for neural nets and applying it to a robot, you can see that the robot gets much more performant on tasks it's seen before. The error rate, it was only completing it 70% of the time roughly without transformer architecture, without this AI language architecture, helping it to understand the underlying tasks that it's doing. And then that completion rate improved to 97%. And then on tasks that robots have never seen before, these papers
were robots that were in a kitchen being asked to lift up a spatula, for example. The completion rate improved from 19%. So only one out of five times would get the thing right to more than seven out of 10 times was the robot successfully completing this task. And so, you know, net of all of the technologies we look at, the rate change in AI accelerating is the one that feeds most importantly through to the other technologies. And so we see all of the innovation happening in the AI space today and say, hey, this means that everything is going to go faster, not just AI, that multiomics and energy storage, that robotics and public blockchains are all going to be driven forward by advances in AI. And it's not just AI that's feeding through to other technologies here, we're showing how kind of our convergence form indicates that, you know, advances in batteries feed through to advances in intelligent devices. The iPhone that you buy today has three times as much battery as the iPhone that you bought in 2008. And if you look at the critical path for developing augmented reality goggles or VR headsets that are performative and can last long enough to be interesting and not too heavy, well, it runs through the quality of the battery and the density, energy density of the battery you can put into that headset. So an advance in electric vehicles can actually accelerate the adoption and the performance of the intelligent devices that we're going to buy and use to access the AI, advanced AI systems that we think are going to be deployed over the next few years. Similarly, an advance in robotics also feeds into a more capable set of intelligent devices. That we can launch a lower-thorbit satellite constellation inexpensively allows that telecom satellite constellation to provide our smartphones with capabilities that they simply didn't have a few years ago. T-Mobile is going to allow you, a user of an iPhone, to access satellite connectivity from, you know, anywhere in the world where they
can strike an agreement. And conceptually, it could be anywhere in the world. It could be in the middle of the ocean. And your iPhone will suddenly have a signal via a lower-thorbit satellite constellation made possible by SpaceX's rockets. And if you look, you could have done this in 1998, there was actually a lower-thorbit constellation lofted, but you would have required a specialized headset that would have cost 15 times more than an iPhone. And your cost per minute at the time would have been roughly 40 times more than what T-Mobile is going to monetize of that. Whereas today, it's going to be the headset or the handset that you have, the smartphone that you have. And T-Mobile is just going to bundle it in the plant. It'll become, you know,

part of this is what we expect cell phones to be able to do. And on the cryptocurrency side, I think many don't appreciate that public blockchains and cryptocurrencies in particular are not just a potential alternative currency that offers user self-sovereignty. They're also an important energy tool. And so we have previously demonstrated that if you deploy a solar system, you can provide somebody with 40% of their electricity needs. But if you start making the system bigger than that, then the electricity you generate begins to get more costly because you're generating too much electricity during very sunny parts of the day. And the person can't use it at that time, so it's just spill over its waste effectively. And so you can attach a battery system to that solar installation. And that helps somewhat, but also you run up against the limit of the economic size of the battery system you can install. If you attach Bitcoin mining as well, then you can make both the solar system and the battery system larger. And anytime there's excess energy coming off the large solar system, the Bitcoin miner can mine and compete in the economic game to produce Bitcoin. And this allows a solar system to scale from 40% of the end-use needs of the user all the way to 99 plus percent, effectively make the system grid independent. And it can do so because you can build larger solar and a larger battery system since you have essentially an outlet mechanism for the excess energy that the system produces into Bitcoin mining. And so the size of the battery, which is represented on the y-axis here, gets larger, the economic size of the battery, you can build gets larger as you attach Bitcoin mining. And so a more valuable Bitcoin network actually feeds into more demand for battery systems. So what is all of this add up to? These converging technologies are, we think, going to lead to remarkable macroeconomic growth. And here we're presenting a long history of macroeconomic growth and demonstrating in the purple bars that actually discontinuous changes in the annual rate of real economic growth are the norm, not the exception. Driven by technology over the course of distinct time periods defined by technological transitions, we have gone from doubling and 10xing kind of the rate of macroeconomic growth per year. Now, in the red bar here, you can see that the consensus forecast is this long technological economic history is over. The assumption is that the advances that we've had all the way from year one to year 2021, that that technological advance, that the march of technological history is ending, we're at the end of technological history. We think that's actually wrong. And the data would suggest, and you can see as we've transformed the x-axis here, that a forecast consistent with technological economic history would suggest that we are moving from a 3% real growth rate per year into a domain of 8% plus real growth per year. What does this mean tangibly? It means by 2030 we could have 20,000 real GDP per capita, as opposed to the consensus, which is 15,000 real GDP per capita. And the growth rate would not slow down. We think it would accelerate from there. Now, this is a very crude forecast necessarily because we're taking a very long data series and we're saying, well, this is what it looks like could happen. So I would not be confident in this forecast if we weren't able to point to the technologies that are going to deliver that result. A note of caution. Macro economic statistics have a hard time taking on and embedding disruptive technologies. So somebody buying an electric vehicle today, as you can see on the left, they're paying maybe one and a half times the purchase price. This is comparing a Tesla Model 3 to a Toyota Camry. But they are reducing their ongoing operating costs of that vehicle over time. So it looks like they're spending a lot of money. In actuality, the total cost of ownership for that vehicle is lower. And the future expenses

are diminished. The amount of oil demand clearly falls off cliff. And even if you accommodate the need for electricity or the need for repairs, you end up with a bringing forward of demand and then a reduction of demand in future years. On the right was showing if somebody cuts the cable cord, if they stop paying for pay TV and switch to streaming services, that looks like degrowth from a macroeconomics perspective. They're spending less for TV. So it's a lower GDP. But clearly from the consumer perspective, this is more valuable, entertaining. A consumer can switch over to streaming for a lower aggregate cost and get the same number of entertainment hours
on demand without commercials. And so the disruptive technologies are often mismeasured and can found the measurement of macroeconomic statistics. So with that as a caveat, we can point to the technologies that we've modeled, the five innovation platforms, and say with some degree of confidence that we think that that macroeconomic forecast of accelerating growth, the one that's consistent with technological history, is likely to come true. If you look at energy storage largely driven by robo taxis, we think that robo taxis are going to deliver $26 trillion in real GDP incremental to consensus by 2030. And then robotics as well as they infiltrate people's homes, and they allow manufacturing processes to accelerate, will deliver an excess of $10 trillion in real GDP growth in incremental GDP relative to consensus by 2030. Adding up those two innovation platforms alone, and those are ones that are more likely to be captured in the macroeconomic measurements, would suggest that we are on the green trajectory here rather than the red trajectory. So while I would be cautious about this particular forecast, if I were using these data alone, the fact that our modeling of individual technologies platforms that are at a critical stage of inflection suggest that the green trajectory is right and going to be realized over the course of this decade suggests to me that we are in a state of discontinuous change in macroeconomic growth. On the right side of this forecast, I'd say there's less certainty about how kind of these technologies will be measured in the macroeconomic statistics, but it's very clear given the cost decline in AI, given the human health impact of multi-ohmic technologies, and given the efficiencies that were likely to ring out of having truly digitized finance, that there could be tens or even hundreds of trillions of dollars of additional macroeconomic product delivered by these technologies. The largest bucket here, of course, is AI software, where we think the best way to think of AI software is it is a knowledge worker force multiplier. So an analyst becomes that much better. A CFO becomes that much more powerful and precise. An administrator can actually manage more assets, and that would feed back into the real growth that we see in the economy and the actual produced items that we get. So, of course, large macroeconomic growth, large value add to the economy, we think will lead to large market value accrual.
On the left, we have roughly the state of the equity markets at the end of 2022.
You had $84 trillion in non-disruptive innovation-exposed market capitalization, and roughly $13 trillion in disruptive innovation-exposed market value, inclusive of public blockchain protocols. By 2030, we think that those legacy businesses, they might approve value, but it won't be at any kind of extranormal rate. It will basically be on a real basis of 2% compounding, and that the innovation platforms, as they infiltrate every sector in the economy, as they deliver profound productivity advances, are going to approve profound value. We think more than $200 trillion in value will accrue to these innovation platforms, and all with growth rates in the excess of 25%, and that the shape of exposure to equity markets will change,

that more than half of equity markets will be disruptive innovation-exposed, that public blockchain protocols will be seen truly as a new financial category that allocators will need to be exposed to, and that if you're not aggressively exposing yourself to innovation now, you'll be left behind by the growth. Just like we think that the macroeconomic growth is going to surprise to the upside driven by innovation, we actually think equity market appreciation is going to surprise to the upside driven by innovation, and accruing to the benefit of the companies that are enabling these innovation platforms that have ownership of the innovation platforms themselves, or aggressively using these tools to enable them to deliver better cash flow to their shareholders and better end product to their customers. That's how we think technologies are converging, and what we think is in store for both the market and the economy over the next decade. I appreciate the time and attention, and look forward to seeing how this technological boom plays out. ARC believes that the information presented is accurate and was obtained from sources that ARC believes to be reliable. However, ARC does not guarantee the accuracy or completeness of any information, and such information may be subject to change without notice from ARC. Historical results are not indications of future results.

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