**Exchanges at Goldman Sachs**

**Are we on the cusp of a generative AI revolution?**

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**Allison Nathan:** As artificial intelligence technologies such as ChatGPT capture the public's imagination, are we at a tipping point in technological advancement? Or is this just another fad?

**Eric Sheridan:** I think every product you touch on the consumer side is going to have more AI in it in the next six to 12 months than it did in the last five years. I think that's going to speed up a lot of adoption of products, improve a lot of efficiency on consumer habits. So, we're pretty excited about AI becoming more deeply embedded in pretty much every consumer internet of product in the next 12 to 18 months.

**Allison Nathan:** I'm Allison Nathan and this is Exchanges

at Goldman Sachs.

[MUSIC INTRO]

**Allison Nathan:** There seems to be a bright spot in the tech industry, which is otherwise facing a tough economic climate and massive layoffs. It's known as generative AI, of which the poster child is ChatGPT and the company behind it, OpenAI.

To understand these technologies, the investments, and the challenges and opportunities in this space, I'm sitting down with my colleagues in Goldman Sachs Research, Eric Sheridan, head of our internet coverage, and Kash Rangan, head of our software coverage. Eric, Kash, welcome to the program.

**Eric Sheridan:** Thank you for having us. Super excited.

**Allison Nathan:** Let's dive into this fascinating topic. ChatGPT is the most visible of these new AI technologies. So, just to level set, why is there so much excitement over it and other similar platforms? Kash, maybe you can start us off.

**Kash Rangan:** So, we need to just take a few steps backward to understand what AI has done and what this chapter of generative AI is going to do for us in the future. AI has been pretty good about predicting things. So, if you are going to be clicking on a search engine, it's gotten pretty good at identifying what is that you're going to be typing next, your intent. They've gotten pretty good with machine learning and being able to show you right videos that are likely to attract your attention, that sort of thing.

So, it's been largely an exercise in predicting people's behavior. This new chapter of AI is potentially even more exciting. It's not just about prediction. But it's about generating. Hence the word that you know as generative AI. It can generate not only content, not only videos and images, but it can also generate code. So, people tend to caught up with this idea, fascinating that ChatGPT is a search engine, which it is, right? But I think the real power of this technology is the ability to generate new content and generate new code. So, there's a lot of enormous implications for how we automate our lives even more going forward. Right?

The world has seen a tremendous amount of automation with the advent of PCs, Microsoft Word allowed you to squeeze more and more content out of your limited number of hours. I think we take that to the Nth degree. So, at a super high level, it is about generating new content, new code, automating a lot of our day to day processes from the consumer angle, or the enterprise angle, as the economy slows down, productivity boost is the new order. And I think we're going to open up some fascinating new avenues.

**Allison Nathan:** Eric, do you have anything to add in the sense of, again, you've seen a lot of these companies investing in AI for quite some time. Kash paints this picture. This is really quite transformative. Do you have anything else to say about that?

**Eric Sheridan:** Yeah. I think there's going to be a lot of different mediums. There's going to be a lot of different elements of input and output of these technologies. Images. Audio and video files. Text based interactions. Up to this point, most of the internet is consumption of written text, primarily through reading, and input of written text into formats that the consumer and enterprise have gotten used

to. We've seen the beginning of elements of using of images and audio and videos. And there's going to be output of this as well.

So, I think you could almost break the world down into various different input and output formats, as Kash talked about, improving productivity and efficiency. Reducing friction. And speeding time to market in a lot of different verticals, not just search, but we could wind it out to a lot of different areas.

**Allison Nathan:** You think about all these headlines we're seeing, it seems that this AI technology, this new technology, has really generated sort of an AI arms race of sorts. We've seen product announcements and investments from Microsoft, from Alphabet in recent weeks. So, are we likely to see the big tech companies accelerate and, I would say, even divert future investments into this space at the expense of other products? What's the broader context here?

**Eric Sheridan:** Yeah. I think one thing I would highlight there is I think there are elements of there has to be products that are interesting and intriguing to consumers

and enterprises to adopt that are forward facing to the outside world. The development costs around those products are not low. And secondarily, the computing costs to fuel these platforms is quite high. Kash and I have written a lot over the years about the Cloud computing space. I cover Amazon and Alphabet that have [UNINTEL] Clouds. There's Azure, a Cloud based platform behind Microsoft. You're going to have to have a lot of computing power, a lot of R&D talent. And you're going to have to get the front facing component of this to the consumer and the enterprise right.

So, therefore, we could see startups emerge in this area. But it is going to be quite expensive. And that will be something we'd keep in mind when you think about who's going to develop a lot of these or where some of the developed platforms will grow up in terms of within what companies.

**Kash Rangan:** And to add to that, if I may, Allison, it's a great question. Will companies divert their tech investments towards generative AI? I think it's inevitable. And if you don't, it's going to be a problem because the way modern applications that are software programs that allow

you to interact with your business are written, it's gotten too complicated. You have a dazzling area of user interface. So, you wouldn't, if you [UNINTEL] smartphone, there's so many apps, right? And somewhere it gets just too complicated. And how do you simplify this platter? And how do you use natural language search, natural language approaches to asking some really basic questions. But where to get the answers is an extremely complicated process. Shortening the curation. Being able to accelerate the process of developing insights, that's where we're going. And it's inevitable that companies, at least software companies, have to do [UNINTEL] their investment priorities towards making their software programs more accessible, more intuitive, more ready to jump in and add value to your life, your business life or personal life.

**Allison Nathan:** And Eric, you started to talk a little bit about who the key players might be and thinking about startups versus the more established players. A lot of people seem to be debating whether or not a winner take all dynamic is at play. Do you think that's relevant here?

**Eric Sheridan:** I think when you're talking about this scale of needed investments to build platform economics,

the likely you're going to have one winner is probably low. Typically, what you see is a handful of players emerge in these types of technologies where scale matters. But there is also going to be competition and choice.

There are two competing mobile operating systems between iOS and Android. There are three competing large-scale public Cloud platforms, maybe even four or five [UNINTEL] send it out and get some of the legacy companies in software that Kash covers. Social media. There always seems to be the new hot thing emerging versus the incumbency position. Even something where there's disproportionate market share like search, there is still Bing to compete with Google and [UNINTEL] in a developed market like the United States.

So, I don't think you see one winner takes all. I do think you do see a handful of players that take most.

**Allison Nathan:** So, both of you have talked at a high level about the potential applications of this generative AI technology. But give us some really tangible concrete examples of this.

**Eric Sheridan:** I could jump in on the consumer. I think lower friction and speeding [UNINTEL] information, maybe even a predictive matter. For instance, think about using a product like Google Maps and you're driving along and you're getting turn by turn directions, which nobody thinks about is AI generative. [UNINTEL]. And Google Maps realizes there's a faster route to get from point A to point B. Or there's a traffic accident coming up and you should get off the road and take the back roads to go from point A to point B. You would multiply that across every application on your phone, a lot of applications on your desktop, the recommendation engines in Netflix and YouTube so that you're thinking less, more is being suggested to you, productivity is rising, efficiency is rising, those would be elements where you could see real world application of artificial intelligence improving speed to make it simple.

**Allison Nathan:** But we do have some of that already, right? I do have my traffic app that tells me the best route to go. So, are you basically saying that it will just be a better version of that? Or are we really breaking new ground?

**Eric Sheridan:** Well, I think some of the interfaces will

change. You think about something like ChatGPT that we talked about earlier, this is a conversational dialogue between a computer and you as an individual. The voice assistance, which have not been widely adopted to the degree that maybe people thought a couple years ago, Alexa and the Google assistant and Siri. You could have a constant audio and text dialogue with computer interfaces. And we may have only just scratched the surface on how some of those might evolve in the years ahead.

**Allison Nathan:** And Kash, as we turn back to you in terms of thinking about some of the examples in the enterprise universe.

**Kash Rangan:** Massively consequential. So, I don't know where to begin. Right, let's just say that you are in production department and you've got a supply chain bottleneck and it has a ripple effect on your ability to deliver a product on time because there's a sequence of activities that go on. And to be able to just ask a question, "Where are the bottlenecks in my supply chain? What are the orders that I've committed to that are going to be compromised? How can I make the best out of a bad situation?" These are the questions you've dreamt of asking

the computer. But you could never do this. You had to hire a programmer to go build interfaces and query languages that had to accommodate a variety of constraints in a way that the computer could understand.

But now, as Eric said, the barrier between the human and the computer goes away. You don't need to learn how to code. You can ask these questions as opposed to spending hours and hours looking for what was my most profitable product today as a result of doing this promotion? That would entail like hours and hours of work. Boom. It exists today, the technology to do this exists today because we've got all the qualitative content that the world has ever produced. It's been ingested by this enormous framework.

And it also is very good at analyzing quantitative information at tremendous speed, short circuiting a lot of the barriers. There's plenty more.

**Allison Nathan:** Well, and it seems almost too good to be true, Kash. I mean, ultimately, at the end of the day when you think about, I'm still like, old school data in, data out, so when you look at these AI generative technologies at the end of the day, they're basing their conclusions off of the

input. I know this is maybe just a bit of a theoretical question, but how can we have confidence that input is relevant, comprehensive enough to be able to actually direct us in our business decisions that could mean the life or death of our company, for example?

**Kash Rangan:** I have something to tell you. That this generative AI is not going to be able to predict things. But it's basing its output based on everything that you and I have told it in the past several years. It's not a leap of faith, if you will. It's like somebody's paying attention to everything that you write and everything that you speak from a business context. And comes back to you and says, "Let me keep you honest. This is [UNINTEL] that Eric and Kash have exhibited in their client interactions, etcetera. I'm noticing a pattern here. This is what you tried to say. This is your past in conclusion." So, it's not a leap of faith. It's as if somebody was listening with keen intent and made a conclusion in a way that [UNINTEL] what I've been saying all these days. New insights.

**Allison Nathan:** Fascinating. But if we think about these technologies to this point, they're free. Anyone can really access these AI chatbots. And a lot of people have been

experimenting with that in lots of different capacities. But what's the commercial potential once companies start charging for this capacity?

**Eric Sheridan:** I can jump in. On the consumer front, charging is possible. We certainly have seen plenty of subscription models grow up inside the internet. Though, there are plenty of examples where these models end up being either ad supported or commerce supported at the end of the day. When you start talking about putting generative AI into a search engine, whether it be Bing or it ends up being Google Search, a lot of the times the commerciality of that is going to come through better predictive recommendations to the consumer, higher click through rates, higher conversion rates, higher advertising rates.

Putting the right product that you want to buy in a commerce environment in front of you based on five, ten, 15 years of shopping history that leads to higher conversion can lead to a commerce output. So, you certainly could see the products being subscribed to.

I would say on the consumer side, it ends up being more

driven by commerce and ads than it does subscription. Media seems to me the main mechanism that has a subscription long tailed component to it. But in Kash's world, then I'll turn it to Kash, subscription is an element that is much more likely than in the consumer side of the equation.

**Kash Rangan:** That's a good one. We can see how enterprise software companies can charge for a new SKU that delivers that ability to generate new content. You asked a question earlier, Allison, is this field open for new entrants? I absolutely think so. Every time there is a platform shift, the old stalwarts, I shouldn't say old, the industry is still very young, right, still find a way to make themselves relevant.

And I think what's happening here is this generative AI is all about looking at all kinds of data that's been generated. So, there are going to be new software companies that will exploit these platforms. There will be a handful of these platforms. OpenAI is not the only thing. I think Eric's mentioned [UNINTEL] Lamda and maybe Meta has some. And maybe other companies have their platforms too. The world cannot tolerate too many platforms. We'll settle on a

few. Then there will be applications that will be built on top of these platforms that opens up opportunities for new companies and for existing companies to charge for new content generation capability. That I think is going to be the way you get paid through a subscription in the enterprise work.

**Allison Nathan:** And you both have made quite clear, this is not just a search engine. But when we think about some of the practical capabilities that you've been talking about, how will it change the way we really use search? I Google things literally ten, 20, 50 times a day. Is that going to change as this is really put to greater and greater use?

**Eric Sheridan:** Look at the history of search. What I first searched 15 - 20 years ago, it was blue links. And there was a list of blue links. Now if I did a search for hotel New York or restaurant nearby or FedEx nearby, whatever you did a search for, at the end of the day, a map pops up. There's much more interactivity. There are much more pictures. There are images. Search has evolved and changed to become more graphical and more action oriented nature over time rather than just a list of blue links.

This will take it to another iteration. Help me understand how to plan a vacation in Europe that will be ten days in length at the end of August. And there'll be a response. And there'll be a back and forth. There could be a conversation that ensues.

I happen to use a lot of voice assistant products, especially the Google assistant in some of my consumer computing. That is a much more back and forth interaction. Are the Knicks playing tonight? Are tickets still available? How's the fastest way to get Madison Square Garden from Goldman Sachs's offices? This is a much more interactive conversational nature that has a commercial throughput at the end of that interaction. And I think that's how you're going to see search change. It'll become much more conversational. It'll become much more rich. And it'll become much more actionable at the end of the day.

**Kash Rangan:** And one more thing to add to what Eric said. It learns. It learns at a rapid clip. And the answers are not going to be the same to the same question that you asked of the system tomorrow. That's not the way it's been so far. And the ability to learn, rapidly compound, and

become an intelligent human who is your co-pilot in life, that's a fascinating thing to watch for. We'll all have co-pilots.

**Allison Nathan:** Indeed. Interesting. But of course this whole area of technology does raise a lot of ethical issues. We are already, as a society, very focused on the spread of misinformation. There's been a lot of concern that these technologies could be used to plagiarize and cheat. I can speak from personal experience. I know many schools are scrambling to already incorporate rules against the use of these technologies in their handbooks and so forth. So, are these concerns warranted? And how do we address them?

**Eric Sheridan:** Well, I think you bring some really interesting points, Allison. And you brought it up earlier as well. At the end of the day, and we've seen it with almost every form factor on the internet, there will eventually need to be content moderation. There will eventually need to be some guardrails. There will potentially need to be a lot of focus on bias and how information is presented and how information proliferates and get disseminated far and wide very quickly.

And if anything, one of the things I think Google or Alphabet as a company is struggling with, and they've talked about it in the public domain, is when you're coming at this from almost an incumbent position, it's very difficult to just go fast and break things and put a lot of disinformation and bias into the public domain because there eventually will be a backlash.

So, I think while there's a shiny new object in generative AI, and there's a lot of excitement around it, I think a lot of these companies in Silicon Valley, based on the lessons learned over the growing pains of social media over the last five, six, seven years, they're already starting to think about some of these guardrails and having to go a little bit slower than maybe they'd like. Think through some of the social ramifications of all this information getting aggregated and then spit back out and disseminated very quickly. And think through some of the consequences of that.

So, I think there'll be fits and starts with some of these technologies when we do run into some of these broader social issues as they come to the forefront.

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So, I think there'll be fits and starts with some of these technologies when we do run into some of these broader social issues as they come to the forefront.

**Kash Rangan:** If I may add, rather, OpenAI, which is one of the frameworks, in their doctrine is a principle that their technology will not be used for abusive purposes. But solely for the benefit of humanity. And that's a very broad statement to make. But I think it's within our power, honesty, is to be able to code, codify in these frameworks, that limits any potential negative [UNINTEL].

Having said that, as Eric pointed out, that is the main risk

that we automate ourselves to extinction, which is unlikely, but it's something that's out there. It bothers some fringe elements of the work.

**Allison Nathan:** Right. Well, it's a noble, I guess, mission or mandate. At the end of the day, how do you enforce it? So, I guess the question is are we really just talking about a lot of regulation that needs to come into this space? And how can that happen? What would that look like?

**Eric Sheridan:** I'll throw in at this way, there's technically not been as much governmental regulation of speech or privacy on the internet in the last couple years as you would think based on what you've read in the media and the press about the internet and tech getting broadly regulated. But there has been societal backlash to seeing things and not wanting platforms to put certain types of content in front of individuals.

You've seen some self policing from the companies. I think you've also seen some industry-wide policing by the industry as well. So, I think there are multiple layers of what form and function it might take. Some will definitely be governmental. We need to be careful about [UNINTEL]

certain content, how it's presented, how it's aggregated and disseminated. You're going to see some responsibility by the companies themselves to want to be protective about the user experience.

And then as an industry as a whole, people are excited about these technologies. They want them out there. They want the productivity and efficiency gains that these technologies can generate. But there is responsibility they know that comes with putting these technologies into the hands of consumers and businesses.

**Allison Nathan:** And with that increase in efficiency, often we're talking about replacing jobs. And that's the other big area of concern here. How far do you think that would run? What sectors of the economy are most vulnerable?

**Kash Rangan:** It's fair to say that the middle of the bell curve, the knowledge worker is going to have to face a very different era, hopefully it happens in the next five - ten years or so. It's not an overnight thing. So, knowledge workers being anybody that sits in front of a computer and is able to ask questions and get an update on the business

or even writing a research report. All of these things can be automated with a fairly high degree of precision in the future.

Extremely advanced scientific, academic research on the other side of the bell curve will not be interrupted that much. On the other side of the bell curve, very services intensive, laborious things where we really need to get a service, we need to be entertained on stage, we need to be going to a restaurant, those things will not change. But middle of the bell curve, it is fair to say that we have probably underestimated, given the hype cycle today, how much more automation there is going to be. And that's going to reshape the labor market tremendously. We're going to see customer support functions be automated with this, even marketing campaigns, content generation, creative process can be automated to a certain degree. But at the end of the day, I look at my [UNINTEL]. I work the same number of hours a day. But today, the same number of hours, we're producing much better research, better content, more companies covered. I'd like to say as a species, we've become more intelligent with the help of automation. And we're likely to be working equally hard at uncovering new insights and the labor market will

[UNINTEL].

**Eric Sheridan:** Just to make a broader point. I mean, every wave of technology has led to a move from physical, hard labor to more qualitative, quantitative broader thinking and analytic labor. And I think this will be yet another wave of that. I'll date myself. When I was in grammar school, you'd do a research report based on going to a set of encyclopedias. Now you'll use generative AI to generate a lot of information that would speed up the time to market. I think those are just the way technology works.

There are waves that will improve productivity and efficiency, layers of the workforce will have to become more analytic. But I'm not sure we're going to be necessarily working any less hard, just probably more efficiently.

**Allison Nathan:** And what I'm hearing from you though is a lot of the analytics can be achieved through this technology. I'm less convinced that the creative aspects-- you did mention this Kash, so I'm grabbing onto that.

**Kash Rangan:** Yeah. The creative aspect is going to be huge. Have you tried Dall-E, which is one of the

applications enabled by the OpenAI framework. My kid was playing with it the other day. He said, "Dad, what would the Bay Bridge," which is next to me, I can say the Bay Bridge here. It's covered by fog today. "Look like if Van Gogh painted it?" It was shocking as to how beautiful it was and how the Bay Bridge would look like if it was painted by Van Gogh. And this is just the beginning.

Yesterday, I asked Dall-E, what would [UNINTEL] look like if he played the guitar? And it generated an unbelievable image which could not have been conceived by any creative person. You take that and then you pick a more creative on top of that. So, I think we're going to be shocked how far this stuff goes. And it's still in the early innings.

**Eric Sheridan:** Yeah. Maybe if I could just jump in there. Just last week, Google released a content generation model that they said they won't release to the public just yet, but it was able to create audio files and music creation based on basically having been trained off music to date. And you can say, "Make me this kind of song. Make me that kind of song." And people were blown away with the content that it was creating. So, this will touch all aspects. Content creation will not be immune to this from what

Kash and I can tell.

**Allison Nathan:** But of course we've seen this cycle before where a tech trend quickly moves from hype to bubble to bust. Web3.0. The metaverse. Just to name a few that haven't really taken off as expected. So, what are some of the challenges AI chatbots face to being more widely adapted?

**Eric Sheridan:** Maybe I'll jump in first. I think we've seen a similar playbook play out. Kash and I have looked at technology trends for decades each in our careers. You think you see something gain awareness in the public domain and there's an initial wave of appreciation and excitement and adoption.

And then you look over three, six, 12, 18 months for what sort of momentum builds behind it. What are people building? How quickly can it be built? How long is the attention span held around a certain technology? And you look for telltale signs. That doesn't many shouldn't get excited about the technologies. We tend to get excited about every technology that comes along because we're always looking for the next big thing that can move

technology ways, in one direction or another.

But there are some patterns that emerge. Capital gets put behind a technology. A momentum sustains in the public domain. You quickly see it getting brought out in terms of use cases. Gets put into everyday products that widen out a user base very quickly. Those will be the things we'll be watching for.

Things like the metaverse, now to stick with the analogy, you know, have to get built at scale. And there is some technology challenges with the consumer hardware for something like the metaverse that make it quite challenging to make a price [UNINTEL] on the consumer side and have it widely disseminated to create network effects.

When you start talking about software, and I'll hand it over to Kash on this, it's less difficult to scale at lower cost points and to capture imagination in software than it is in something that's very heavily dependent on technology hardware.

**Kash Rangan:** So, when it comes to whether this stuff

is hyperbole, overblown, etcetera, it comes down to one thing. Business value. Are we going to be able to extract more productivity dollars for the same capital investment outlay? Are we going to be able to offer new kinds of insights? The firms that do will gain market share ultimately. So, there has to be business value these days.

I remember 12, 13 years back, there was this concept of big data. [UNINTEL] big data. Today, everybody knows what big data is, at least in the tech world, right? So, these things, to Eric's point, they may get overblown in the very short term. But we may grossly underestimate what these things can do in the long run.

I'll wrap it up with this example. When Salesforce went public in [UNINTEL] 2005, the concept of Cloud did not exist. There was not a Cloud company that got to within a billion dollars of revenue. But fast forward 15 years, we have an entire ecosystem covered by Eric and I called Cloud infrastructure, which is a $100 billion industry. That's the biggest, besides search, the largest piece of the technology pie. How did that happen? We underestimated 15 years ago how big this could be.

**Allison Nathan:** So, I'll put you on the hot seat now and ask for your predictions. How big and how fast do you see this space evolving?

**Eric Sheridan:** I'll jump in first on the consumer side. I think this has been building for the last five, six years. I go to Google's Developer Conference every year in Mountain View. And they first introduced the Google assistant, I think it was over six years ago. The idea of a product called Duplex that would make phone calls for you to make restaurant reservations and local services appointments was introduced five years ago. I think this has been building underneath the shift to mobile computing for years. I think every product you touch on the consumer side is going to have more AI in it in the next six to 12 months than it did in the last five years. I think that's going to speed up a lot of adoption of products, improve a lot of efficiency on consumer habits. So, we're pretty excited about AI becoming more deeply embedded in pretty much every consumer internet of product in the next 12 to 18 months.

**Kash Rangan:** I don't know if I can make a prediction. But I'll give you a backward-looking fact. When I started

covering software in the US, software was 50 basis points of US GDP. Today it's 350 basis points. It's route of share is up 7X. And to put a different lens, global software industry, 560 - 570 billion dollar industry, it's maybe 20 basis points of global GDP. And this is where we're going. The world is getting digitized through generative AI, hopefully going forward, in part.

So, the share of software and some of the companies that Eric covers in internet, is going to just continue to expand as a percentage of global GDP as we continue to automate. Right? So, nothing but bright, beautiful days ahead. I'm extremely optimistic.

**Allison Nathan:** Eric, Kash, thank you both for joining us and having this conversation about this fascinating space that is going to change all of our lives, it seems. Thanks again.

**Kash Rangan:** Thank you for having us.

**Allison Nathan:** Thanks for listening to another episode of Exchanges at Goldman Sachs recorded on Monday, February 13th, 2023. If you enjoyed this show, we hope

you follow on your platform of choice and tune in next week for another episode.

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