**D-Wave Analyst Day Presentation – 5-12-22 - Transcript**

Jen Houston: Good morning and good evening and good afternoon I'm Jen Houston I am thechief marketing officer at D-Wave.

Jen Houston: And we are excited to invite you all today to our first analysts day so thanks forjoining us a couple housekeeping things you'll note at the bottom of your screen, there is a Q&A button, if you do have any questions, please send those questions.

Jen Houston: Through the Q&A button just click on it.

Jen Houston: Right your question in everything that is all questions are anonymous so the only person that will see them is me and the panelists and we'll make sure we get your questionsanswered, we know that's really an important part of the day today.

Jen Houston: The other opportunity will have for Q&A that will be at the end, the otheropportunity will have for Q&A is we actually have a customer panel.

Jen Houston: During the middle of the session we'll make sure we open it up for questions there, so if you have questions during the session throw them into the Q&A and I'll track them,and if you have questions.

Jen Houston: At during the actual customer or the end Q&A will bring those all back in at that time so welcome, I would like to first start by welcoming all of you and introducing Alan Baratzour CEO of D-Wave, Alan.

Alan Baratz: Thank you Jen. As Jen said, my name is Alan Baratz I'm the CEO of D-Wave I'vebeen with the company for about five years now.

Alan Baratz: I joined originally to run the R&D organization and I took over as the CEO abouttwo and a half years ago.

Alan Baratz: If we go a little further into my background I was the first President of JavaSoft atSun Microsystems where I was responsible for bringing the Java technology to market.

Alan Baratz: Growing the revenue growing the developer ecosystem, a lot of what we did, thereis similar to what we're doing now at D-Wave as we're creating an entirely new industry and building a new ecosystem here.

Alan Baratz: I've also been a senior executive at a number of other large companies.

Alan Baratz: I've been a private company CEO three times prior to D-Wave and I've been a venture investor as a managing director at Warburg Pincus and I opened their first Bay areaoffice.

Alan Baratz: Educationally I have a doctorate from MIT in theory of computation so while I'mnot a quantum physicist I do a pretty good job of holding my own with our spectacular engineering and science team and now I'll turn it over to John to introduce himself.

John Markovich: Good morning, everybody, and thank you for joining us today, I joined the D-Wave as Chief Financial Officer at middle part of last year, previously I've served as a CFO.

John Markovich: For about 25 years in various sectors of the technology industry across allstages of development and I have previously led to traditional IPOs.

Alan Baratz: Thanks John, and I mean a flip through the disclaimers and turn it over to Emil tointroduce himself.

Emil Michael: Morning everyone, this is Emil Michael I'm the chairman and CEO of theDPCM Capital SPAC. I was formerly the chief business officer of Uber which was about myfourth startup in Silicon Valley.

Emil Michael: As you can see from the pictures on the slide, we have surrounded ourselves thatare back with all former entrepreneurs and operators and some current.

Emil Michael: Including Eric Schmidt, the former CEO of Google, Betsy Atkins, who is world class governance expert, Peter Diamandis who is a futurist and founder of Singularity University, andthe idea behind our SPAC was to find a management team that was thinking about long term value creation.

Emil Michael: And us not being financial engineers, but instead being entrepreneurs andoperators partnering with that team in a deep way for the long term.

Emil Michael: I intend to join the board after the D-SPAC and I'm very much looking forward topartnering with Alan, John and the team to build a great company for the long term.

Alan Baratz: Alright, thanks Emil so let's go ahead and get into it. We're really excited to be ableto spend the next two hours with you. We're going to cover the business and products as Jen said, we're going to give you an opportunity to hear from some of our customers.

Alan Baratz: And we're going to give you a demo of one of our new product capabilities that'sreally interesting and really exciting, it should be a fun morning so let's go ahead and get started.

Alan Baratz: First of all, and in some sense most important D-Wave view is quite unique in thatwe are the first and currently only commercial quantum computing company.

Alan Baratz: We have over two dozen Fortune 2000 customers working on real businessapplications to benefit their business operations.

Alan Baratz: So while everybody else in the industry, talks about government research funding as revenue, and they talk about national labs and academic institutions as customers, we talk about companies like Volkswagen or Johnson and Johnson, GlaxoSmithKline, DENSO, and Save-on-Foods as our customers and we are talking about the actual applications that we're working on with them to help benefit their business.

Alan Baratz: We got here by taking a very different approach to quantum computing and as we go through the discussion, it will become clear what that approach was and why it is so valuable.

Alan Baratz: Just to start with a few key facts regarding D-Wave, first of all, we are a full stackquantum provider. We develop and provide everything from the quantum computers to the quantum cloud service to the software development tools, all the way up through to professional services.

Alan Baratz: Our current generation quantum computer is our Advantage quantum computer,it's a 5000 qubits system, it's our fifth generation system, our quantum cloud services called Leap we launched it back in 2018. It was then and still is the only real time quantum cloud service.

Alan Baratz: We own all of the key intellectual property for all of our products, in fact, we haveover 200 US granted patents and over 100 in process worldwide, and these patents cover everything from superconducting circuit fabrication, because we do use superconducting technology, to quantum circuit design to IO to refrigeration all the way up through to hybrid algorithms and applications. In fact, in we were in the top five for quantum patents alongside IBM Google Intel and Northrop Grumman and well ahead of any of the independent quantum computing companies.

Alan Baratz: Our business model is primarily a cloud-based recurring revenue quantum- computing-as-a-service model, and by that I mean that our customers have applications that require quantum computing cycles and they pay us on a recurring revenue basis to access those computing cycles through our Leap cloud service.

Alan Baratz: However, currently many of our customers require help understanding whichapplications can most benefit from quantum.

Alan Baratz: And how to build out those applications, and so we also have a professionalservices component to our business model.

Alan Baratz: Currently, about 50% of our revenue is professional services and 50% is quantum-computing-as-a-service.

Alan Baratz: However, as we look out over the five-year horizon we pretty rapidly get to thepoint where well north of 90% of our revenue is recurring quantum computing as a service.

Alan Baratz: And that's really where we want to be because that's what's allowing us to buildbacklog and have more predictable revenue growth.

Alan Baratz: And the reason we get there is because the professional services engagements arerelatively short upfront engagements but, once the applications move into production, they run, year after year after year and continue to generate recurring revenue for us.

Alan Baratz: And as you can see from this chart we have a strong and growing customer base Iname some of them, but just to name them again Volkswagen, Johnson and Johnson, GlaxoSmithKline, Deloitte, BBVA, Save-on-Foods and the list goes on and on.

Alan Baratz: Okay, so what is quantum computing.

Alan Baratz: Very simply quantum computing is all about using quantum mechanical effects tobe able to solve hard computational problems faster than they can be solved using existing classical computers.

Alan Baratz: And there are two classes of problems that quantum computers can be used tosolve. There's what I'll call revolutionary problems, problems that are currently unsolvable. Things like global weather modeling - the solutions tothese problems will deliver unimaginable impact on society and, as well as businesses.

Alan Baratz: Then there are what I call more evolutionary applications, these are applicationsthat businesses are using today to help run their operations.

Alan Baratz: But these problems are so hard that what businesses do today is they use heuristics to try to come up with good enough solutions, but with quantum computers, we candeliver optimal or better solutions to help improve their business operations, reduce costs anddrive revenue.

Alan Baratz: So let's talk a minute about how quantum computing works and I'm going todescribe it by using a specific application.

Alan Baratz: This is an application that we developed for the Department of Homeland Securityin the height of the pandemic.

Alan Baratz: The problem is as follows, you have a set of hospitals and hospitals have resources these resources can be things like beds or ventilators. Some hospitals have more resources thanthey need - those are depicted by the small blue circles in the large circle on the right.

Alan Baratz: Some hospitals have fewer resources than they need - those are depicted by thesmall red circles in the large circle on the right.

Alan Baratz: The problem is simply to group hospitals together so that collectively they have allthe resources they need to cover the geographic area that they need to cover.

Alan Baratz: Sounds like a very simple problem, but actually it's computationally very complexin fact it's what we call an exponentially hard problem.

Alan Baratz: At just 1000 hospitals, this is out of the reach of classical computers to be able tosolve optimally so, how does quantum computing help you with this.

Alan Baratz: Well, traditional classical computers use bits to store information, a bit can beeither zero or a one at any given point in time.

Alan Baratz: What this means is that at any point in time, a classical computer is looking at onepossible solution to the problem evaluating it and then trying to see if there's a better solutionbut it's essentially sequential.

Alan Baratz: With quantum computers, we use qubits. Qubits can be in the state zero and one,at the same time, we call this superposition. What this means is that essentially quantum computers can "see all the possible solutions at the same time" and we quickly iterate to find the optimal solution.

Alan Baratz: There are two primary approaches to quantum computing. There's what's calledannealing quantum computing and what's called gate model quantum computing.

Alan Baratz: D-Wave we decided early on that we wanted to take a practical approach toquantum computing.

Alan Baratz: And, by that I mean an approach that would allow us to get quantum computersout into the hands of developers, customers, users as quickly as possible so that we and they could learn from the use of those systems.

Alan Baratz: As a result, we selected annealing we decided to start with annealing quantumcomputing.

Alan Baratz: And we selected annealing for three reasons. First of all it's much easier to scaleannealing quantum computers, that's why we're now at 5000 qubits when everybody else who's working on gate model is at about 50 qubits.

Alan Baratz: Annealing quantum computers are much less sensitive to errors, we can delivergood solutions to hard problems without the need for error correction.

Alan Baratz: And finally annealing quantum computers are very good at solving optimization problems, and optimization represents most of the important hard problems that businessesneed to solve.

Alan Baratz: These are things like employee scheduling or autonomous vehicle routing for manufacturing plant for optimization or bin packing containers on ships or on freights to improve supply chain operations or peptide designed for use in new drugs. As you can see,these are all very important problems.

Alan Baratz: They also happened to be very hard problems, and they are optimization problemswhich are well suited to annealing quantum computers, so how does annealing work?

Alan Baratz: Well, annealing quantum computers do only one thing, but they do it really well.What they do is they find the lowest point in a multi-dimensional landscape.

Alan Baratz: And what's so interesting and important about this is that all optimization problems can be mapped into that problem, that's why we say that annealing is natively anoptimization engine.

Alan Baratz: This also means that it's very easy to program annealing quantum computers, all you have to do is take your optimization problem and reformulate it as that low point in a multi-dimensional landscape, which is a very straightforward process. So annealing represents a much easier on ramp to quantum computing.

Alan Baratz: And because it's easy to build an annealing system, we've been able to get to thepoint where we are in fact commercial today. Let's talk for a minute about gate model.

Alan Baratz: Gate model systems are a bit more like classical computers in the sense that youprogram them by specifying the sequence of instructions needed to solve the problem.

Alan Baratz: The difference is the instructions are very complicated, and in fact there's a verysteep learning curve to programming gate model systems.

Alan Baratz: Moreover, gate model systems are very sensitive to noise and errors, you neederror correction to be able to compute solutions to problems.

Alan Baratz: And they're very, very difficult to scale - after you know 20 plus years we're stilltalking about 50 qubits on gate model systems.

Alan Baratz: In fact, we believe that it's going to take seven or more years to get to the pointwhere gate model systems are commercial in the way that annealing systems are today, but gate model systems are very important because gate model systems are very good at solving a different class of problems -differential equations.

Alan Baratz: And this is required to solve problems like quantum chemistry or computational fluid dynamics, which are required for important problems like new drug discovery, developingdesigner drugs, new material design, long lasting batteries and so on.

Alan Baratz: Moreover, over the course of the last year we, and by we I mean the academiccommunity as well as the industry, learned something very important about these two approaches to quantum computing and the problems that they can solve.

Alan Baratz: We learned that there's actually a bifurcation in the application market, namely while annealing is very good at solving optimization problems, gate model systems are not verygood at solving optimization problems. In fact they likely will never be able to deliver speed upson optimization problems. However, gate model systems are very good at solving differential equations and annealing systems are not.

Alan Baratz: And so we're in an environment where will always need annealing for some classesof problems and gate model for other classes of problems, and then there are problems where either quantum computer will work and these fall into the area of linear algebra. That's
essentially machine learning problems and factorization which is really crypto basedapplications.

Alan Baratz: Well, I said that annealing quantum computers are easier to build than gate modelsystems, but even at that quantum computing is not for the faint of heart. It took us well over 10 years to get to the point where we had a commercial quantum computer, as you can see, onthe top line on this chart our Advantage quantum computer is our fifth generation system.

Alan Baratz: 10 plus years after we get began development and the first 10 years were primarilyabout government and academic research to try to understand, on the one hand what types of problems were well suited to annealing and on the other hand, how to best build out the annealing quantum computer, but with our Advantage system launched, about a year ago, we are now at the point where annealing system systems are commercial.

Alan Baratz: Gate model model systems, however, are still in their infancy.

Alan Baratz: Today, what we have in the gate model space are what's called noisy intermediatescale quantum computers, these are small systems, maybe 50 qubits without error correction.

Alan Baratz: That aren't really particularly good for doing anything but research experimentation, kind of where we were back in 2011 with the D-Wave One.

Alan Baratz: And there are many transitions that we're going to need to go through with gatemodel systems.

Alan Baratz: We're going to need to start seeing partial error correction, than full error correction, than scalability before we can get to the point where gate model systems arecommercial.

Alan Baratz: And this is why I say that we believe it's seven plus years before we get to the pointwhere gate model systems are commercial.

Alan Baratz: Okay, so I started talking about what makes D-Wave unique when I described annealing versus gate model and the fact that we decided to start with annealing quantumcomputers, however.

Alan Baratz: Because of the fact that our annealing quantum computers are now commercial.

Alan Baratz: And, as a result we've solved most of the really hard research problems that needed to be solved to get here, so we're transitioning our annealing program to a more traditional product development cycle every couple of years, you know larger systems with more performance, that means that we now have research bandwidth to apply to another classof hard problems.

Alan Baratz: In addition, as we developed our annealing quantum computers, we developedsome very important technologies that we can also apply to another class of problems.

Alan Baratz: And for that reason we announced about six months ago that we are now alsobuilding a gate model system.

Alan Baratz: Applying our research capabilities and some of the important technologies that wehad to develop for our annealing systems to building a scaled error corrected gate model system.

Alan Baratz: What this means is that D-Wave is now the only company in the world, focused onboth annealing and gate. The reason is we're the only company in the world that does annealing and now we're adding gate, so the only company in the world, doing both annealing and gate.

Alan Baratz: As I mentioned previously, we are a full stack provider providing everything from the quantum computers to the cloud service to the software development tools, all the way upthrough to professional services, in fact, the only company that has as complete a stack as oursis IBM.

Alan Baratz: However, we are far more complete than any of the independent quantumcomputing companies.

Alan Baratz: A third important point of differentiation is our quantum cloud service we run ourown quantum cloud service called Leap, we launched it back in 2018.

Alan Baratz: To support real time access to the quantum computer, but we designed it, not justto support research experimentation but also to support business applications in production - worrying about reliability, availability, security, and privacy. In fact we've had to pass audits with customers on those capabilities of our systems.

Alan Baratz: We've got a proven track record of on time product delivery both hardware andsoftware, as I said, our Advantage quantum computer is our fifth generation quantum computer.

Alan Baratz: And we've developed demonstrated significant speed ups on important real worldproblems.

Alan Baratz: The problem referenced here 3 million times speed up is a magnetic materials phase transition computation. This is known as the Kosterlitz Thouless phase transition. The theory behind it won the Nobel Prize back in 2016 and we've been able to perform that computation 3 million times faster than it can be performed using Monte Carlo on a classicalsystem, which is the approach of choice for classical system solving this problem.

Alan Baratz: And finally, because of the fact that we are commercial today with our annealingquantum computers, we have a very important first mover Advantage.

Alan Baratz: We're out there in the market today, building the customer base, developing applications, and then able to take our customers through the various transitions as the annealing quantum computers become more powerful and as we start introducing the gatemodel systems.

Alan Baratz: This also means that we don't have to worry about how long it's going to take to get to the point where gate model systems are commercial and generate revenue, because wecan build our business today on annealing and then integrate gate model as they become available.

Alan Baratz: The quantum the total addressable market for quantum is very large.

Alan Baratz: This chart is based on the Boston consulting group data, it's pretty much the datathat everybody in the quantum industry uses.

Alan Baratz: BCG puts the TAM for quantum at two to 5 billion in the near term growing to 450to 850 billion in roughly the 20 year time frame.

Alan Baratz: Moreover, BCG estimates that about 20% of this TAM is what's available to the quantum hardware, software and services providers that's us and others in the industry and those are the green numbers at the bottom so you know, for the quantum players it's 400 million to a billion in the near term going to about 90 to 150 hundred and 70 billion in roughlyto 20 year time frame.

Alan Baratz: Moreover, BCG does divide the TAM into the four technology areas I mentioned previously, common tutorial optimization that kinds of problems that I previously mentioned, scheduling autonomous vehicle routing and so on, linear algebra machine learning factorizationcrypto, and differential equations for simulation or quantum quantum chemistry or computational fluid dynamics.

Alan Baratz: BCG estimates that about a quarter of the TAM is allocated to each of thesetechnology areas.

Alan Baratz: What that means is that a quarter of this TAM is available to only D-Wave, becausewe are the only company in the world that provides annealing quantum computers and annealing is required for optimization and so that portion of the market is ours.

Alan Baratz: The rest of the market is competitive across all the players, including D-Wave aswe're now entering the gate model space.

Alan Baratz: Okay, so as you evaluate different quantum technologies and quantum providerswhat's important.

Alan Baratz: You'll hear most people in the industry talk about things like gate fidelity or coherence time or logical qubits or connectivity and they come up with esoteric technologybased metrics to evaluate themselves against one another.

Alan Baratz: But the reason they're doing that is because their systems aren't yet capable ofrunning real applications.

Alan Baratz: But at the end of the day, that's really what matters, what matters is, can you run acustomer's application can you deliver better performance at reasonable cost on those applications, and so, really, what matters at the end of the day in evaluating quantum technology is what it takes to be commercial.

Alan Baratz: So what does it take to be commercial? You need products, the applications running on those products, because nobody buys hardware for hardware, you buy it because ofthe applications, it runs and there needs to be a market and you need to have market adoption.

Alan Baratz: Well, at D-Wave we've already talked about our products and I've already mentioned a number of applications that can run on our products but I'll talk a bit more aboutthat in a minute.

Alan Baratz: I'd also like to point out that in 2021 last year, over two thirds of our quantum-computing-as-a-service revenue came from commercial customers.

Alan Baratz: And as I've already said more than two dozen fortune global 2000 customers are in that group. Collectively we have over 55 commercial customers so we've got the products, and we have customers that are leveraging those products.

Alan Baratz: And for sure the market is ready.

Alan Baratz: If the fact that we actually have customers, like those I mentioned previously running applications, like some of those I mentioned previously isn't enough, there have been anumber of studies done on the market demand for quantum about two years ago by 451 research surveyed about 1000 fortune 5000 companies.

Alan Baratz: And what they found was that over 40% of those companies had an application that they wanted to use on quantum sometime within the next three years, but almost 40% ofthose companies said that they had a quantum use case that they were working on at that point in time.

Alan Baratz: Hyperion has just recently done a similar survey and in that survey the number isnow over 60% of companies surveyed actually are working on a quantum application today.

Alan Baratz: For D-Wave, we are focused initially on three verticals - we're focused on manufacturing and logistics as the first vertical, pharma is the second and finance, as the third.

Alan Baratz: Every application that you see on this chart is an application that we have worked on are working on with one of our customers. So you know I talked about bin packing for being able to optimize how packages or containers are loaded onto ships or rail in support as a supplychain, employee scheduling, last mile routing for e-commerce delivery, protein folding in the development of new peptides for various therapeutics optimizing clinical trials, portfolio risk reduction or portfolio optimization within a given risk profile fraud detection, these are all applications that we have worked on with customers, and these are customers like Volkswagenor DENSO or Save-On-Foods, Johnson and Johnson. GlaxoSmithKline.

Alan Baratz: In the finance area BBVA, Bank of Canada, Caixa Bank just some examples of you know, the fact that we are commercial today, working with real customers on real applicationsto benefit their operations.

Alan Baratz: We engage with our customers through a four phase engagement model.

Alan Baratz: The first phase is a two month $50,000 application evaluation, where we work withour customer to help them understand which of their applications can best benefit from our quantum systems and services.

Alan Baratz: We then move on to a five months $350,000 proof of concept, where we build aproof of concept for one of their applications.

Alan Baratz: Then another five months $350,000 pilot deployment, where we help them bringthat application up in their environment on a small scale.

Alan Baratz: And then, finally, the application moves into full scale production, where we charge between $500,000 and a million dollars per year per application to access the quantum computing cycles required to run the application and the amount we charge is based on the sizeand complexity of the application, as well as the frequency with which it needs to access the quantum computer.

Alan Baratz: The first three phases are professional services, the fourth phase is that recurringquantum computing as a service.

Alan Baratz: Revenue moreover, an important component of this model is upsell.

Alan Baratz: We have had multiple customers who have started with a single proof of concept, move that to the pilot and then come back to work on a second or a third application so there'sa very important upsell component to this model as well.

Alan Baratz: Okay we're at a really interesting and important moment in the quantum computing industry a watershed moment we are just now, at the point where quantumcomputing is becoming commercial.

Alan Baratz: Admittedly it's annealing base quantum computing and it's D-Wave that's leading the charge with our first mover Advantage, but we are at the point where quantum is becomingcommercial.

Alan Baratz: And quantum represents a huge market opportunity, in fact, if you look back over the last 40 years or so, at some of the key innovations technological advances in the businessesthat were built on them from the personal computer through the Internet smartphones, AI, MLand you look at the mature market tab where those terms are today.

Alan Baratz: You know quantum computing exceeds all of them, so it's a really exciting time anda really exciting moment in time for us.

Alan Baratz: What we want to do now is let you hear from some of our customers, and so whatI'm gonna do is I'm going to turn it back over to Jen who is going to introduce our panel of customers and we'll do a little bit of Q&A with them Jen over to you.

Jen Houston: Great Alan Thank you so much, and thanks to everyone we're starting to getquestions, I just want to remind you, if you do have a question.

Jen Houston: Please put it into the Q&A box, instead of the chat and we'll make sure we're tracking those questions and we'll also have about five minutes at the end of the customer presentations with customer conversation to answer a couple questions, as well as with them,so do be thinking about your questions.

Jen Houston: So I want to welcome Kate Abrey from Deloitte, Sam Mugel from Multiverse andDustin Johnson from Save-on-Foods, three fabulous people who have, I think, really unique perspectives about quantum from three different vantage points so Alan I'm going to hand them over to you and get back to you and start the fireside chat.

Alan Baratz: Okay sounds good and hopefully they've all turned on their video and I'm going to I'm going to actually start with Kate from Deloitte. So you've got a broad view of the enterprise market and emerging technologies and your role at Deloitte what I'm wonderingis what's your view of the state of the quantum industry and quantum customers.

Kate Abrey: And thanks for having me nice to meet you and nice to chat with you today so yeahwe do have a broad perspective as to where clients are from quantum and what I would say is really there it's in its infancy.

Kate Abrey: Clients are very interested in quantum and they are starting to finally askedquestions about how quantum applies to them.

Kate Abrey: But they're in the experimental phase, they don't yet have a vision, as to how toscale it and what I think it's fascinating about, that is, it allows us to stand with them, side byside with D-Wave.

Kate Abrey: To discuss and plot out a logical journey that allows them to do it in a sensiblefashion.

Kate Abrey: Achieving business value along the way, and and thinking about how it's a quantum plus traditional computing story versus an either or and I think that there's an educational element that you know we're in the process of working with you and others to really help our clients to understand what is quantum mean for them, and how can they use itand apply it to their business, given that you know.

Kate Abrey: It's a big word that's out there, I can tell you, even within the air force just thisweek.

Kate Abrey: We've had multiple clients say come talk to me about how quantum would work forus, so it's a great time it's exciting and they're looking at all sorts of problems sets from supply chain to personnel vetting to hiring to logistics to intelligence, so a wide swath of opportunities.

Alan Baratz: That's great Kate can you just say a little bit more about how you're working withD-Wave and what excites you.

Kate Abrey: Oh yeah I mean D-Wave has been a fantastic partner is so differentiated in terms ofwhat you guys are bringing to the market.

Kate Abrey: The thing that I'm most excited about is to give you an example we're workingwith the Savannah school of Art and Design together.

Kate Abrey: To develop a prototype around scheduling, and this is really, really interestingbecause it's scheduling.

Kate Abrey: A use case for the Transportation Security Administration, something that we allfeel and sense, every day, which is the folks at the checkpoint when we're traveling.

Kate Abrey: And it seems like it's a simple problem but it's really not it's very, very complicatedhow those folks are scheduled, they have a huge call out right there's a logistics problem, so what we're doing is we're working with you at D-Wave.

Kate Abrey: Very thankfully for that to create a way to help both the employee better scheduletheir time and the manager better optimize the schedule, and so it helps TSA from a workforceperspective when there's this war of war on talent.

Kate Abrey: It helps us the traveling public because it means we don't have to wait in as manylines, because they can do a better job of scheduling.

Kate Abrey: And it helps the manager so that they're not doing all this manual back endprocessing and we're wrapping it with a very user centered easy to use process.

Kate Abrey: Powered by the amazing computing knowledge power and algorithms that D-Wavebrings to bear so that's just one example of something I'm really excited about with D- Wave and it's going live in the beginning of June and I'm pumped to get it out and market together.

Alan Baratz: That's great Kate and it's a pleasure to be working with you and let's move to Samnow from Multiverse so Sam good to see you again.

Alan Baratz: Arguably Multiverse maybe one of the first quantum ISVs so you also have a unique perspective on the industry, what are you seeing from customers you're working withon quantum applications.

Sam Mugel: Hi Alan thanks for having me yeah so we're seeing a huge interest from industry to pick up on what Kate was saying, I think there's an awful lot of people that clearly really wantedthe quantum see potential in they don't necessarily realize that we can we can deliver like industrial value today.

Sam Mugel: And so that's really excited to take them through this journey and show them the products able to bring them value. I think where I've seen a big change recently has been where it used to be the quantum champion in an organization would reach out to us and say hey let's do a project together now, even people that are not quantum savvy in a way, are looking to do projects with us, and I think this is a very good sign, I think this shows the people,even though don't have a background in like physics are seeing that there's something really important that's happening with quantum computing.

Sam Mugel: And people want to use quantum themselves and they want to use it, even if theyare not themselves quantum experts so yeah I think that's very exciting situations.

Alan Baratz: And Sam I think I think you made a great point there that you know you know, untilrecently, when you engage with a business customer, you are typically talking to the innovationteam.

Alan Baratz: But now we're seeing the beginnings of that moving to the line of business, whichis also very important transition.

Alan Baratz: By the way, I should also point out that when I mentioned the BBVA and CaixaBank and Bank of Canada previously that's actually work that Multiverse did leveraging the system, working with those customers so Sam, can you tell us a bit more about some of the use cases and applications that you've actually worked on in quantum.

Sam Mugel: Oh absolutely so BBVA this was one of our first projects and really, really excitingon portfolio optimization. We saw this as a low hanging fruit because optimization is so muchmore developed in quantum than other hardware and.

Sam Mugel: We use this opportunity to make and publish an awful lot of benchmarking the really showed okay so what's the direct return on investment to using quantum today and we got some super exciting results we saw the D-Wave, in particular, and D-Wave hybrid technology was able to do huge program sizes, that the standard methods could not even begin to approach so that was super exciting.

Sam Mugel: We've recently finished, a project with Bank of Canada. I think this was exciting in adifferent way, we were looking at how to predict the effects of regulations and I'd say this is exciting, because this is something we're incredibly bad at doing as a society today. So it's basically we're crew this isn't a place where quantum computing can really create a market andfinally we're starting a project with Bosch is going to be a multi-year project on predictive maintenance, a multimillion-dollar problem for Bush.

Alan Baratz: Right thanks Sam and Dustin good to see you again as well, you all are quantumpioneers.

Alan Baratz: You're on track to be one of the first companies in the world, putting a quantumhybrid application into production so, can you maybe take a minute to tell us about your journey, how did you get here and why are you excited about your work in quantum.

Dustin Johnson: Yeah, good morning thanks Alan I'm excited to be here as well, and I'll kind ofbranch off a little bit what Kate was discussing but during covid, but for the past two years, I know we started engaging withthe D-Wave early covid days, and we were at a time in the grocery space so Save On Foods.

Obviously, we oversee we amassed to about 300 stores across Western Canada through the Yukon and now down to the state of Oregon and we're vertically integrated so whenyou're facing all these events there's so much volatility these days we've got you know we're in the midst of war we've got.

Dustin Johnson: You know we've got covid - we're still seeing the effects of covid and at that time the business was really craving faster information, how can we make better decisionsfaster, and that was that was the key to us.

Dustin Johnson: Starting to look for different opportunities, because we need, we need to react fast we couldn't wait one week two weeks to get the results we needed to make quick decisionsabout our supply chain about to operate and support our stores.

Dustin Johnson: So that led us down the journey, and you know I had a close relationship with alot of the you know physicists that moved over from D-Wave from previous lives I'm like hey you know what there was a great opportunity there.

Dustin Johnson: To have a collaborative research agreement and, and so we connected with you guys, Alan, and for the past two years we've been trying to solve that problem gettinginsights to the business faster and we're now at a state to where you know, over time, building the teams.

Dustin Johnson: So one thing is, you know getting the teams to mesh together with a D-Waveit's and getting the business to understand the value of a quantum and that's always been a challenge.

Dustin Johnson: In the early stages of you know we're jumping into this new technology, but now that we're starting to see the results and the impact we're now moving to deployment andwe're months away from getting you know going live in in terms of you know, rolling out this new quantum opportunity.

Alan Baratz: Thanks Dustin and can you tell us just a bit more about the application what you'velearned through the process.

Dustin Johnson: Yes, so.

Dustin Johnson: There was day yeah in terms of getting to that stage, I think one of the biggest challenges was really good is quantum is this kind of new beast that enters the marketand it's really getting the business Save-on-Foods, 100-year-old company, how do we get the business to understand the value of quantum.

Dustin Johnson: Right, it's and where are we seeing quantum annealing come into applications and it's really to solve these very complex customized problems that black these

traditional kind of black box solutions just don't handle and so you see a lot of this out thereright AI models come in and they try to fill a need.

Dustin Johnson: A general need, but where we started to see quantum come in, is really theability we needed to be fine-tuned we have a unique problem we have a unique business.

Dustin Johnson: And the ability to bring in grow a team and collaborate with quantum engineers to be able to develop these fine-tuned solutions that's where we started to see thevalue.

Dustin Johnson: So well in my point of view, in terms of learnings and hopefully for otherorganizations out there, facing the same thing.

Dustin Johnson: The you know the value, I see, and kind of the learnings is really building up that strong team of machine learning engineers data, scientists and really getting the business to understand you know, to really building up that team building that relationship with the business to understand how we can get achieve faster results faster speed and be able to support their fine to needs more effectively.

Alan Baratz: Thanks Dustin I have just one more question for all of you, and then I'm going toturn it back over to Jen who will field, some questions from the folks listening in.

Alan Baratz: So the question is for all of you to think about what's one piece of advice that you would want the audience to know about quantum that you wish, you had known when you gotstarted.

Alan Baratz: And so, let me start with Kate what's that one piece of advice that you wish, youhad known when you got started.

Kate Abrey: I think it goes back to something that I said previously, which is it's not quantum or traditional computing it's quantum and traditional computing device.

Alan Baratz: Absolutely it's all about hybrid you've got to bring the two together and Samhow about you.

Sam Mugel: Yeah well, building up a mesh so you can actually deliver value before we reach Advantage, and I think this is something that lots of people do realize that, even if we do have a problem, the quantum computers can solve like way better than that a classical computerconsole says there's definitely like place for both to exist to coexist.

Alan Baratz: And Dustin what's that one thing you wish, you had known when you started.

Dustin Johnson: That it's achievable it's right there in our hands, right now, and I think working with working with D-Wave the Leap platform may has made it so accessible that ourteams are doing quantum.

Alan Baratz: That's great okay Jen do we have some questions from the.

Jen Houston: Video yeah, I think we have one we have got some time, for I think one question and I think it's a good one um.

Jen Houston: One of the questions is are there metrics that can be discussed that illustrate thisspecific commercial use cases in which quantum annealing can is it advantageous over commercial.

Jen Houston: Over classical and Dustin, I know you have a very specific sort of numbers that you've used before, do you think about that that what metrics you're utilizing want to send that to you.

Dustin Johnson: For sure.

Dustin Johnson: So I can't dive into the specific details of our problem at this time, but in termsof how we've how we've approached this from so our problem very large-scale problem and how we assess that we had to needs get insight to the business faster.

Dustin Johnson: And achieve obviously optimal solution, so we what we were what we lookedat, we benchmark against the classical method, what have we been doing, traditionally, and what we observed, it was taking.

Dustin Johnson: It was almost taking a week in some instances, to be able to get that to makethe right decision for the business.

Dustin Johnson: So pulling in quantum and benchmarking that we're able to bring that downfrom hours and some cases weeks down two minutes and even seconds.

Dustin Johnson: So it's really the at what we observed, without any statistical variation or difference between the optimal solution, so we could achieve the same results in a much quicker, yeah much more efficient amount of time, and that has led us in a lot of ways to be able to simulate outcomes now do things that we couldn't have achieved in the past, so that's been an exciting area we're approaching now.

Jen Houston: That's great Sam I'm going to ask you the same question what metrics are using anew you mentioned.

Jen Houston: The BBVA case study and I'm pretty sure that the Tensor networks, there wassomething about the delta between a Tensor network and what you saw with hybrid I don't know if other things you want to talk about specifics around metrics.

Sam Mugel: Yeah, firstly metric is always dollars, we will always try to translate, I think.

Sam Mugel: Solving a problem well what the metric will be well very few problems problem, butthe end of the day, what's really important is what does it mean dollars.

Jen Houston: Okay, and Kate thoughts on metrics and the things that you should be thinkingabout as you help your customers get to business value.

Kate Abrey: Yeah, I think it's an interesting question I was trying to think about it a different way to approach it.

Kate Abrey: One of the things I would love to see from a metrics perspective as we're implementing this project with span is, I want to see the end customer value, so how is itimproving like, for example.

Kate Abrey: The number of call outs, the TSA is having I wanted to find really, really specific enduser value measures because I think that is what will help to drive additional adoption.

Kate Abrey: Is if they can see that to the bottom line so it's not just you know the leadingindicator but it's almost like deleting outcome yeah.

Jen Houston: That's great well, thank you to our panelists.

Jen Houston: Thank you all, Sam and Dustin fabulous to have you here, and Alan I'm goingto hand it back to you to keep going with the rest of the show.

Alan Baratz: Thanks Jen before I move on, let me also thank all the panelists and I so want toreinforce a couple of points, Kate's point about it's all about.

Alan Baratz: The important metrics are the value to the customer so quantum volume meansnothing, which is what you know the industry may say as an important measure for quantummath, now it's all about the value to the customer, I also want to reinforce appointed Dustin made, he said, now we can get the same solution faster.

Alan Baratz: Well, there are two things that quantum can do for you, one of them is actuallygive you the optimal solution faster than you are currently getting it.

Alan Baratz: Significantly faster, the other is, you may not be getting the optimal solution, andso in the amount of time allotted.

Alan Baratz: It can get you to a better or to the optimal solution so it's both about the speed ofthe computation as well as the quality of the solution okay with that let's go ahead and move forward.

Alan Baratz: So, as I mentioned D-Wave does have a complete technology and product stack sowe're going to switch gears a little bit now and start talking about our product set.

Alan Baratz: Our products include the quantum computers, the quantum cloud servicedevelopment tools and professional services.

Alan Baratz: Our current generation annealing quantum computer our Advantage quantum computer is a 5000 qubits system that was the first system that got us to the point where wecould start tackling real business problems at commercial scale.

Alan Baratz: That is accessible through our Leap quantum cloud service, as I said, design, notjust this word research experimentation, but also real business applications in production, infact, since we've launched it, we've had 99% uptime.

Alan Baratz: With real time access to the quantum computer.

Alan Baratz: We have our complete suite of software development tools for simplifying thedevelopment tasks.

Alan Baratz: And our software development tools are available both within our Leap cloud service, so if you're signed on to lead the tools are all there you can develop your applicationright there inside Leap.

Alan Baratz: Or they're open source, you can download them, you can install them on your localsystem, you can do your development locally and then submit just the application.

Alan Baratz: Through a Leap to the quantum computer and finally there's that for phaseprofessional services engagement model which we call our launch model.

Alan Baratz: I mentioned the Leap cloud several times and I cannot underestimate the value ofthe cloud component of our products that we decided early on.

Alan Baratz: That we wanted to develop our own cloud service, now we do work with partners,for example, if you're an AWS bracket customer, which is the AWS quantum cloud service, you can access our quantum computer through bracket.

Alan Baratz: But you can't get all of the capabilities in the Leap environment, you can get accessto our quantum computer, but through AWS Braket you don't get our hybrid solvers you don't get you know our online developer environment you don't get our application templates and so on.

Alan Baratz: As I said, we decided early on that was very important for us to have our own cloudservice.

Alan Baratz: First of all, that allows us to always ensure that our customers are getting the bestpossible experience when leveraging our quantum computing systems and our hybrid solvers.

Alan Baratz: Moreover, there are some serious issues associated with just handing over accessto your products to a third party.

Alan Baratz: Which is pretty much what everybody else in the quantum industry is doing.

Alan Baratz: They're basically you know the way you access is, as you go through AWS Braket orAzure quantum or Google, but there are some real challenges and issues with that first of all.

Alan Baratz: You basically get limited access to your customers, you know very little about theircustomers, you have very little influence over their journey and ensuring that they have a goodexperience with your products.

Alan Baratz: You don't get the same insights from them, as you would, if you had that directrelationship with them.

Alan Baratz: And so you have less of ability and have an ability to leverage the work that they'redoing to help you understand how to better your products.

Alan Baratz: And of course the economics, are not as good when you're working through a third party partner versus having your own cloud and infrastructure.

Alan Baratz: So we are strong believers in the importance of our Leap quantum cloud serviceand the value that that brings to us relative to.

Alan Baratz: Ensuring that our customers always have the best possible experience always had immediate access to the latest and greatest technology and were able to learn from their use ofour systems.

Alan Baratz: And in fact today we made two announcements of new capabilities that are bothenhancing our Leap cloud service.

Alan Baratz: The first is that we announced the immediate availability of our third Leap Advantage system located at the information sciences Institute of USC in Marina del Reysouthern California.

Alan Baratz: So this is the first us based Advantage quantum computer that's a part of our Leapcloud service.

Alan Baratz: This is added to the Advantage system that we already have operational up inVancouver at our Vancouver headquarters.

Alan Baratz: As well as the Advantage quantum computer that we have operational in Germanyat the Julich supercomputing Center, so there are now three Advantage quantum computers.

Alan Baratz: In the Leap cloud service one in Canada, one in the US and one in Europe, and now,for the first time, US base customers who want to ensure that their applications are running on a US based quantum computer will have the ability to do that.

Alan Baratz: The second thing we announced is a really important enhancement to one of ourhybrid solvers.

Alan Baratz: At our customer conference last October we announced a hybrid solver that wecall the constrained quadratic model solver.

Alan Baratz: This is a really important solver in the sense that it opened up our quantumcomputer to a broad array of important optimization problems.

Alan Baratz: At that time the constrained quadratic model solver good handle two types ofvariables, it could handle binary variables, where the values would be 01.

Alan Baratz: And it could handle discreet variables, where the values could be an element froma set like one of the colors in red, green blue or one of the integers between one and 10.

Alan Baratz: Now we are enhancing the constrained quadratic model solver to also saw handlecontinuous variables.

Alan Baratz: What this means is any real numbers, so you could have a variable that's that takeson the value 8.159.

Alan Baratz: This once again opens up an even broader class of applications for the constrainedquadratic model solver and some very important applications what I'm going to do now is I'm going to stop my screen share.

Alan Baratz: And I'm going to hand it over to Alex Condello who is going to give you a demo ofthe constraint quadratic model solver with continuous variables and talk a little bit about the importance and the types of applications that are enabled by that so Alex over to you.

Alexander Condello: Hey Everyone, and thanks Alan.

Alexander Condello: Hey everyone, so my name is Alex Condello and I'm the director ofalgorithms performance and tools here at the way systems.

Alexander Condello: And I'm really excited here to show you a demo to give you an idea of howwe think about solving problems here at the way.

Alexander Condello: As well as to show off the new capability that Alan just mentioned, which isour support for continuous variables.

Alexander Condello: So I've been doing now for six years I've worked in professional servicesI've developed hybrid solvers I'd built Open-Source tools.

Alexander Condello: And over that time I've given a number of talks at conferences and one ofthe questions that I get fairly frequently is what sorts of problems aren't good for quantum computing.

Alexander Condello: And up until today my answer would have been problems with continuousvariables, but, as of today, we are the first quantum provider to provide problem.

Alexander Condello: Solver that solves problems with continuous variables, I believe this is thefirst in the industry and it's been an absolute game changer in terms of our ability to solve practical problems for customers okay so let's jump into the demo.

Alexander Condello: So I want to start right here on our lead dashboard.

Alexander Condello: This is what you will see if you were deciding to leave right now, and you had a free account, which you can make right now, you could literally follow everything that I'mgoing to be doing live as I do it because everything, I'm going to be doing is available in leave an open source.

Alexander Condello: Rather than sort of show you though unfortunately all the cool chuffingweek I'm going to jump straight into our set of examples.

Alexander Condello: This set of examples are a set of demonstrations of how we think aboutsolving problems using our quantum computer and our hybrid solace.

Alexander Condello: Many of these examples are industrially motivated either built off of aproject that.

Alexander Condello: We use it with a customer, but some of them are fun so things like sudokuas well, so there's a lot of different varieties of problems here, but the whole idea here is that you can very easily jumpstart your application by starting with one of these examples.

Alexander Condello: I'm actually going to hone in on a specific one which is called 3D binpacking.

Alexander Condello: Now 3D bin packing is in that category of industrially derived applicationsin fact this demo is an offshoot of work that we did with Johnson and Johnson, a few months ago.

Alexander Condello: So this problem is actually derived from a practical application that weworked with a specific customer as part of our launch program.

Alexander Condello: When you sign in when you open up this example and lead you're given a couple options, you can actually go and look at the source code for it, or you can open this up inour online integrated developer environment which I'm going to go ahead and do in another tab.

Alexander Condello: But before I jump over to that that integrated developer environment, Iwant to take a moment to talk a little bit about what is 3D bin packing and why might thatmatter to you all, or to some sort of operations research or industrial company.

Alexander Condello: So 3D bin packing is actually.

Alexander Condello: A application that Alan mentioned earlier, the basic idea is this let's say I have a set of boxes of different sizes shapes weights characteristics, I want to ship those to somewhere else, and I want to do that as efficiently as possible oops the demo is very eager tostart.

Alexander Condello: I want to do that, so I want to pack them into a set of bins let's say shipping containers, or maybe their delivery trucks or you know, maybe their shelves at a store,I want to do that as efficiently as possible.

Alexander Condello: So, for instance, you can see sort of an image here like what this problemmight look like here, I have a set of different boxes all have different sizes and I want to pack them as efficiently as possible into this space.

Alexander Condello: There's also here a demo description of how we think about solving the problem, and unfortunately not going to have time to go into the really cool depths of this, butjust to give you a little bit of a taste.

Alexander Condello: There's an idea of like why this problem is complicated.

Alexander Condello: The reason it's complicated is that there's actually an infinite number ofsolutions these boxes can exist anywhere in 3D space.

Alexander Condello: And not only can those boxes be moved around in 3D space, they can alsohave many different orientations, they have you know at least six different orientations and

once you start multiplying all this together, the total solution space for this problem is trulyenormous.

Alexander Condello: When we think about solving problems here at D-Wave there's sort of afew concepts that we want to have.

Alexander Condello: The first one is the concept of variables that actually defines the solutionto your problem, and this is where those continuous variables come in.

Alexander Condello: So, for instance in this problem, we have a set of binary variables, thoseare the ones that are you know either yes or no true or false zero or one.

Alexander Condello: So, for instance there's a binary variable that says we use a certain binthat you know we either use that bin or we didn't.

Alexander Condello: There's also continuous variables in this problem, and this case we usethose continuous variables for two things.

Alexander Condello: The first thing is to map as a variable that represents the height of the topmost case in the bin.

Alexander Condello: In general, we want to be lowering the cases have the cases as low as possible, so that a we can make reasonable configurations of cases that map to the real worldand be so that you know we can create space that maybe other things could be put on top of them.

Alexander Condello: We also use continuous variables to define the location of the case in thebin so you know those existed in 3D space, so I could be.

Alexander Condello: 1.5 feet from the wall, I could be pie feet from the wall, I could be 8.7 feetfrom the wall, you need these continuous values in order to represent those distances.

Alexander Condello: The other two things that we think about here, in the context of how wesolve problems is we think about having an objective, so in this case, our objective in.

Alexander Condello: Put in in a high level terms is to pack things as efficiently as possible.

Alexander Condello: We also have a set of constraints and those constraints have things like theboxes, need to be in the bin or the boxes need to not overlap with each other or a box can't be in two places at once.

Alexander Condello: These sorts of these constrained problems are why we use are constrainedquadratic solver, I’ll also mention and note that I have not talked about quantum here at all.

Alexander Condello: I actually think there may be was a question earlier about.

Alexander Condello: You know how do you abstract the quantum away from the user, and thisis the answer is that we use our hybrid solvers to specify problems in the way that customers want to solve them, which are these sort of easily understood constraints.

Alexander Condello: Around locations of boxes and you know where they are and no needto get into the details of quantum unless you want to.

Alexander Condello: Okay, so enough math and enough static images let's jump into the funpart.

Alexander Condello: So I'm going to be doing a live demo and Just to give you a sense of likewhat this looks like let's start with a simple problem.

Alexander Condello: I'm going to make a couple changes, the first thing I'm going to do is I'mgoing to fix a random seed so that I'm running the same problems.

Alexander Condello: Just so we can do to a comparison I'm also going to run this for about eightseconds because I'm running live.

Alexander Condello: I'm going to start off with just 15 cases of and these cases are going to bebetween one and five feet in each dimension.

Alexander Condello: I'm also going to be packing these into a shipping container which I believeis about 20 feet by eight feet by eight feet. I have constructed a problem I'm going to be giving our hybrid solver eight seconds.

Alexander Condello: It's going to be putting 15 cases into one bin those cases are between oneand five feet in dimension and we're putting them into a shipping container.

Alexander Condello: So let's go ahead and give that a run and this time what it's going to doinstead is that it will very successfully run on our hybrid solver, which is our solver that combines both quantum and classical resources available in the cloud.

Alexander Condello: What we see here is the hybrid solver has in fact solved this problem,which is that is put a set of boxes down onto the floor of our shipping container

Alexander Condello: Okay, so what we also like to do in these sorts of demos is we do like tocompare ourselves to what is available in the market right now.

Alexander Condello: And so to that end I'm going to actually run that exact same problem againwe've set the scene.

Alexander Condello: On a classical solver this particular classical solver Coin-or “branch and cut"or CBC, this is an open source solver for this problem class, and you know it's Open Source but it's actually quite popular in the industry, for instance Google's operation research tools makes use of the solver and many, many other packages.

Alexander Condello: And so, like before under the same conditions, the solver was also able tosolve this problem.

Alexander Condello: But actually oh yeah you can even see it here and we already see, we havea little bit of a problem which is that one of our boxes is not perfectly on the ground, so this solver in the same amount of time wasn't able to find quite as good as solution as as we were.

Alexander Condello: So far, also this problem isn't all that difficult you can sort of see that I canpretty much just put everything straight onto the ground here this isn't a very constrained problem it's not a very difficult problem.

Alexander Condello: So let's actually just make it up just a little bit harder and instead of solving15 cases I want to solve 17 so just a few more cases into the mix which hopefully now starts to make this where we genuinely have to start stacking them on top of each other.

Alexander Condello: And when we do this again solving on our classical solver we see that sortof same pattern, it is in fact able to find a solution, but this solution isn't really what we want these boxes are hanging in the air.

Alexander Condello: You know they're not really optimally place it was just able to put theminto the case in that amount of time.

Alexander Condello: So, of course, by the way, that I've constructed this demo you can imaginewhat comes next, which is that I'm now going to run this on our hybrid solver and so in this time, rather than running it on the classical one.

Alexander Condello: That we've pulled for open source we're going to be making use of thehybrid solver in Leap for that same amount of eight seconds.

Alexander Condello: And as we can see it does a much, much better job with that problem inthe same amount of time.

Alexander Condello: So we're really starting to see some of that that power, and this is a theme,with the wave and we've seen with our customers over and over again, which is that.

Alexander Condello: Customers often have a very short amount of time that they want to solvetheir problem, and they want the best solution, they can possibly get in that time so here in thiseight second time window, we were able to go from.

Alexander Condello: You, we were able to get much further into our solving then, then thealternative.

Alexander Condello: So I want to one last demo here, which is rather than just trying to packone bin which I think you know anyone who's packed a vehicle you know, probably you're thinking, maybe I could have done this.

Alexander Condello: Let's go ahead and two and we're going to pack those as often as possible,and this time we're going to use 35 boxes instead and we're going to run that get one last time on our hybrid.

Alexander Condello: So when we do this, this is actually made the problem, a lot more complicated, and specifically if added something called interactions between variables.

Alexander Condello: This is a technical term, but the basic idea is that there are some of thebinary variables that encode, whether it be in is used and the binary variables that encode which boxes in which bin have to have this second order interaction.

Alexander Condello: And you can see that, here in the sort of quadratic terms, that meansinteractions.

Alexander Condello: So you can see now that it's done a pretty good job it's put all the boxes, most of the boxes rather into one of the two bins and there's just a couple left over that didn't fit which have been put into the second thing.

Alexander Condello: I'll just end this demo by seeing one more error message, which is that I'mgoing to attempt to run this now on the classical solver, but when I do that it's actually going totell me.

Alexander Condello: That it doesn't support quadratic interactions those second order interactions that I was describing before and so not only can we solve the problem, relative tothis particular solver better we also can solve problems that that it can't.

Alan Baratz: Thank you Alex that was a great demo and I do want to reiterate something that Alex said, which is that this is now just in our Leap quantum cloud service and anybody can signup for free time on Leap if you go to our website, you can get through to Leap it takes about 30seconds to sign up you get a minute of free time.

Alan Baratz: If you're willing to open source, the work that you're doing you can renew thatminute every month, and so you can go to Leap, and you can actually run this demo for yourself and see exactly how this works.

Alan Baratz: Okay, so one of the things that Alex did show you was the Leap dashboard so I'vetalked a lot about our Leap quantum cloud service. This demo is done inside our Leap cloud servers that's the production quantum cloud service. This production cloud service consists ofsoftware that we developed running on AWS servers.

Alan Baratz: There are two access points.

Alan Baratz: Within AWS for accessing Leap, you can either come in through the AWS West inOregon access point or you can come in through the AWS EU central in Germany access point.

Alan Baratz: So we have some redundancy in the system to ensure high availability.

Alan Baratz: And then we've got direct connections from AWS in the U S to our quantum computers in Marina del Rey California and bring to be Canada and direct connect from AWS in Europe to our quantum computer at

Germany.

Alan Baratz: And then all of our Leap software, including the front end the integrated developer environment that.

Alan Baratz: Alex started to show you and all the hybrid solvers the constraint quadratic modelsolver cqm, as well as our other solvers they all run on AWS servers both cpus and gpus.

Alan Baratz: And we spin them up and down as we need them, I also want to point out that thethree pictures, you see here are actual photos of the three systems at their locations in Marinadel Rey.

Alan Baratz: So this system is a you know, a commercial grade system fully up and running, this is what we use when we're working with our customers and what our customers use when theyaccess Leap.

Alan Baratz: Okay, I talked a bit about the annealing quantum computers and in particularly theAdvantage system, but I want to spend just a minute talking a bit more about our annealing quantum computers.

Alan Baratz: So yeah as I've already said, our current generation system which we launched, about a year ago, and then we launched a performance update to that about six months ago it'sthe 5000 qubit quantum computer.

Alan Baratz: Were incubated is connected to 15 others when combined with our hybrid solvers it's able to support problems with up to 1 million variables, and this is what allowed us to get tothe point where we can solve real commercial problems at production scale today.

Alan Baratz: The big circle on the right is what an Advantage quantum computer looks like the small circle at the bottom that's a look inside the refrigerator at the IO wiring from room temperature down to the chip that runs at superconducting temperatures, then the picture above that is our superconducting circuit card that the chip mounts into and the picture small picture at the top, is our superconducting quantum cpu that or, you know as we affectionatelycall the quantum processing unit or the QPU.

Alan Baratz: And as you can see, this is all commercial grade technology you're not looking at you know, a bunch of wires wrapped around the room and some you know crazy fashion, this isall commercial grade technology.

Alan Baratz: About six months ago, we also announced the roadmap for our next generation Advantage system Advantage 2. We said, it will have over 7000 qubits each qubit will be connected to 20 others and we will continue down our path of reducing noise and increasing coherence time, allowing us to solve larger and more complex problems, faster and that's ourmodel now every couple of years, increase the performance of the system to be able to solvelarger and more complex problems faster.

Alan Baratz: With respect to gate model systems, I mentioned that we are now, also developinga gate model system, and we are going to be using superconducting technology for our gate model system as well, and I wanted to take a minute to talk about why.

Alan Baratz: You know the obvious reason that you might think of is that well our annealingquantum computers are built on superconducting technology.

Alan Baratz: We know and understand it in fact we're world leaders with superconducting technology, arguably, our Advantage processor chip is one of the largest superconducting chips in the world.

Alan Baratz: So yeah it's natural for us to do superconducting but there's another reason.

Alan Baratz: A more important reason we are strong believers that superconducting is the best approach to a scaled error corrected gate model of quantum computer better than ion trap systems and better than photonic systems, which are the twoother primary approaches that are being explored today.

Alan Baratz: And I wanted to talk about why we are strong believers in superconducting and Iwant to do it by talking about a specific application.

Alan Baratz: The application that I want to talk about is Shor's algorithm for factoring large semiprime numbers, these are numbers that are a product of two primes.

Alan Baratz: And the reason why factoring large semi primes is so important is that that's whatRSA cryptography is based on, if you could factor large semi primes quickly you would break RSA and basically break what you know most industry runs on with respect to crypto and security.

Alan Baratz: So a lot of work has been done to try to understand what it would take to run Shor's algorithm on various quantum computers and there's a body of academic research andwork and papers that have been written on this what we now know is that if you want to run Shor's algorithm on a superconducting quantum computer.

Alan Baratz: It will require about eight hours to factor let's assume you want to do this with a2000 bit number, because that state of the art for RSA today, so you want to factor 2000 bit number.

Alan Baratz: Running Shor's algorithm on a superconducting quantum computer will take about eight hours, and it will require about 20 million qubits.

Alan Baratz: So you can see that 50 qubits on a gate model system we're a ways off from that again, the reason why I say we're seven plus years away from commercial gate model systems,however.

Alan Baratz: If you want to factor that same 2000 bit number on an ion trap system it's not going to take eight hours it's going to take 100 days it will take almost a third of a year and it will require a billion qubits.

Alan Baratz: If you wanted to factor it on a photonic system, it would take a full year and also a billion qubits So why is this, why is it that superconducting is so much faster and requires fewer qubits.

Alan Baratz: It has to do with the gate speeds, the gates, are you know basically those instructions in the algorithm when you're programming a gate model quantum computer.

Alan Baratz: And if we just look at superconducting versus iron trap for a minute superconducting gates run at about 20 nanoseconds.

Alan Baratz: Ion trap gates run at about 500 microseconds this means ion trap gates are 1000 to10,000 times slower than superconducting gates that's why problems will run so much faster ona superconducting quantum computer.

Alan Baratz: Moreover, you don't need coherence times that are as long on a superconducting quantum computer because the computations are so much faster.

Alan Baratz: So when you talk to an ion trapped person, they may say to you, well, ions are perfect qubits they have their much higher quality, they have much longer coherence times than superconducting qubits this is true.

Alan Baratz: But they're not 1000 to 10,000 times better.

Alan Baratz: And in fact when you wrap together the qubits with the gates, it turns out thatsuperconducting is far more efficient, it requires fewer qubits and allows you to perform computations much faster and that's why we are strong believers that superconducting is the right approach to gate model quantum computing.

Alan Baratz: Okay So what about the D-Wave approach to building a gate model system, first ofall.

Alan Baratz: I mentioned noisy intermediate scale quantum computers were not interested in missile systems, this systems are basically fabricates qubits attach some IO lines and try to whittle the qubits and get them to do something there's no evidence.

Alan Baratz: That these system can deliver any application value it just hasn't been demonstrated, yet there are toy problems, but no evidence that you can do this at commercialscale.

Alan Baratz: So for us it's all about getting to a scaled error corrected gate model systembecause we're all about commercial and everything we do is focused on trying to get to commercial as quickly as possible.

Alan Baratz: So our roadmap for a scaled error corrected gate model system has multiplephases over a number of years.

Alan Baratz: The first phase is just fabrication of the qubits and demonstration of the coherencetimes required.

Alan Baratz: And the reason why I say this is because we're using very different qubits from what everybody else is using even different from what the other superconducting vendors areusing.

Alan Baratz: So fabricate the qubits and demonstrate the coherence time.

Alan Baratz: The next thing we need to do is put control on the same chip, we have that today.

Alan Baratz: On annealing systems I'll talk about in a minute why that's so important, nobody else is able to do that today we do it on our annealing systems.

Alan Baratz: We're going to do it on a gate model system, so we need to be controlling the samechip and demonstrate that we can maintain the same coherence times with control.

Alan Baratz: That will then allow us to build our first prototype error corrected logical qubitssmall scale, to start with, but built in a module that is itself scalable.

Alan Baratz: On to the final phase where we build that scaled error corrected gate model quantum computer.

Alan Baratz: Now there are a number of important technologies that we had to develop for ourannealing quantum computer that are directly applicable to building this scaled error correctedgate model system.

Alan Baratz: First is the type of qubit everybody else in the superconducting space uses what'scalled transmon qubits these are controlled by voltage.

Alan Baratz: We use flux qubits they're controlled by magnetic flux and current there's an important reason why we use flux qubits we use them in our annealing systems and we will beusing them in our gate model systems, first of all.

Alan Baratz: Voltage controlled qubits require microwave lines gigahertz speed or greater linesand that's very costly and very complicated.

Alan Baratz: With flux base qubit we do not require microwave lines, we can run it a couple ofhundred megahertz, which is much less costly and much easier to build and manage.

Alan Baratz: Also flux base qubits have much higher inductions than the transplant qubits and what this means is that when you're trying to connect qubits on different chips, if you want to scale out horizontally and have different chips with qubits on them and connect between thosechips what you need in order to preserve entanglement between those chips is high inductionsand flux HQ that's have much higher inductions then transmission voltage controlled qubits, so we will be using flux based qubits.

Alan Baratz: Secondly, we fabricate our qubits in a multi-layer stack ,everybody else fabricateskeep it in a single layer on the way, for we use a multi-layer stack.

Alan Baratz: This is what allows us to get the density that we have today and that's why wehave 5000 qubits on a single chip, however.

Alan Baratz: When you have that kind of density, you're very sensitive to small differences in thefabrication process across the chip.

Alan Baratz: And so, your qubits need to be to nimble so that you can homogenize their operation, this means you need to design and build qubits where you can read  parameters from this qubits and adjust those parameters to homogenize the operation of the qubits. We'vegot a lot of IP built around created around building to nimble qubits and how to tune those qubits and then, finally, that on chip control on controlling the same chip as the cube is it's what it's what really allows us to do the tuning of the qubits.

Alan Baratz: It also gives us a dressing and pipeline so, for example, we're able to control 5000qubits with 200 lines, whereas everybody else uses one I line per quit.

Alan Baratz: The point is, these are very important technologies hard to develop that we've developed and proven out through our annealing program that are directly applicable to ourgate model system, and we believe it'll allow us to move more rapidly toward a scaled error corrected gate model system than others.

Alan Baratz: And then, finally, we have a complete management team that's everything from goto market to our end through to DNA from a go to market perspective.

Alan Baratz: You've already met Jen Houston she's our host and moderator today Jen is ourchief marketing officer with over 20 years of experience in commercial marketing.

Alan Baratz: And then, our sales and professional services organization is run by Mark Snedeker.Mark joined us about a year ago he came to us from Accenture where he ran their federal business.

Alan Baratz: As I said, we have a complete R and D organization, the software and cloudservices are led by Michelle McCready and the systems by Mark Johnson.

Alan Baratz: We have you know you know roughly 40 PhDs in the company and we have a complete G&A organization, including John Markovich our CFO who you met earlier and will betaking you through the numbers in just a minute.

Alan Baratz: I just wanted to conclude this section by reiterating the fact that D-Wave is the firstand only commercial quantum computing company.

Alan Baratz: We got here by taking a very different paths to quantum from everybody else, wedecided to start with annealing.

Alan Baratz: Which is what has allowed us to get here and we now know that annealing isalways will be an important part of the computing landscape.

Alan Baratz: Because there's classes of problems that require annealing in order to be able toget a speed up, but we are going to be focused, not just on annealing but annealing engage.

Alan Baratz: Currently we're working with our customers on what I'll call evolutionaryproblems.

Alan Baratz: These are problems that they need to solve today they are solving today butthey're hard problems they're using your risks to get good enough solutions.

Alan Baratz: But with quantum computing we can give them better solutions or faster solutions,giving them business benefit on our path to those revolutionary applications that really open upthe market for quantum.

Alan Baratz: And hand it over to John to take you through the financials.

John Markovich: In preparation for our dispatch transaction we developed a very comprehensive bottoms up five year financial plan and we are projecting revenue cake, orapproximately 160% over the next five years, commencing with a targeted $11 million in revenue this year that represents approximately.

Alan Baratz: Sorry John sorry John Alex, could you please go on mute again, thank you.

John Markovich: Okay, so we're targeting $11 million in revenue for this year that represents alittle over 75% increase over our revenue in 2021.

John Markovich: In 2021 as Alan highlighted earlier, we had 55 or 55 commercial customers andthat represents an increase of approximately 28% in the number of commercial customers over the prior year.

John Markovich: And we also had over two dozen global 2000 customers last year there represents about a 60% increase over the number of global 2000 customers that we had in2020 as we entered.

John Markovich: Over 40% of our targeted $11 million in revenue was supported by 2021 year and for backlog and contracts that we entered into empire periods that renew throughout 2022.

John Markovich: Going forward, the growth and our revenue will be driven by the broadening ofour customer base through a significant expansion of our direct sales organization.

John Markovich: As well as our network of channel partners, with approximately 25% of the useof proceeds from this transaction to be applied towards our various go to market initiatives.

John Markovich: In addition, a continued expansion in the number of applications that we areaddressing with our customers.

John Markovich: As well as an expansion of number of applications use per customer as wesolve increasingly larger and more complex problems as well as an increasing the average transaction size or revenue per customer over the forecast period.

John Markovich: So underpinning our internal growth initiatives is the projected growth of theoptimization portion of the tam that we highlighted earlier.

John Markovich: Although we believe that we have virtually no competition in the optimizationsector, the tam our financial projections assume that we only capture 15 to 30%.

John Markovich: Of the tam depending upon the year and our projections do not include any revenue contribution from the linear algebra and factorization portions of the tam that are annealing technology can address nor does the revenue projections include a contribution fromour gate model program.

John Markovich: The 57 to 84% increase in our gross margins is principally driven by the gradualshift in a revenue mix.

John Markovich: Towards the higher margin cloud based quantum computing as a service recurring revenue that increases from about 50% of total revenue this year to in excess of 90%of the total revenue in 2026.

John Markovich: The expansion and our EBITDA margins closely correlates with the expansion inthe gross margins that reflects the high degree of operating leverage that is inherent in our business model with Eva da projected to turn positive in the second quarter of 2025.

John Markovich: Next slide.

John Markovich: So, with respect to the cash dynamics to the business the targeted netproceeds from this transaction provides us with a fully funded business plan.

John Markovich: Over the next several years we plan to invest aggressively in software andsystems development.

John Markovich: With approximately 30% of the use of proceeds from this transaction to beapplied to our investments in internally developed software.

John Markovich: And approximately 40% of the use of proceeds to be applied towards ourannealing gate model systems development with a significant portion of our systems development spend.

John Markovich: Applicable to both platforms, we are projecting that the business terms cashflow positive on a sustained basis in the first quarter of 2025.

John Markovich: We have a very capital efficient business model, due to the relatively low costof building our annealing systems that cost less than $2 million to build in calibrate.

John Markovich: As Alan mentioned earlier, we also have very substantial annealing productioncapacity, already in place with each of our annealing quantum computing systems capable of supporting between 25 and $30 million of annual revenue.

John Markovich: With that I'll hand it over to Emil to talk about the transaction.Emil Michael: I, yes, if someone can start my video there that would be great.

Emil Michael: Good to see everybody.

Emil Michael: This is a very typical de-SPAC transaction, as you can see, we have $300 million intrust we have commitments to for $40 million in the pipe.

Emil Michael: At essentially a pre money value of 1.2 billion.

Emil Michael: You can see the sources and uses or the uses of the cash there.

Emil Michael: And I'm going to hand it over unless there's anything.

Emil Michael: For questions here to John to talk about a unique structure we put in place to thebenefit of a future shareholders and us.

John Markovich: But when we announced the transaction early February we announced a 5million share bonus structure this that this chart outlines.

John Markovich: And this is designed to lower the cost basis for the public SPAC shareholderswho do not redeem those shares this 5 million share bonus structure will be allocated to the non-redeeming SPAC shareholders on a pro rata basis upon the closing of the transaction.

John Markovich: The structure is designed to incentivize the public's back investors to retain andnot redeem their shares the DPCM Capital SPAC.

John Markovich: So I'll provide a couple of examples so under the first column under a scenariono redemptions.

John Markovich: The actual cost basis afforded to the public SPAC shareholders is $8 and 57cents or 14% discount to the $10 under a 30% redemption scenario.

John Markovich: Again, that 5 million shares gets allocated pro rata to the non-redeeming shareholders that results in a cost basis per share of a little over $8 or $8 in an eight cents.

John Markovich: And so on and so forth, with respect to higher rates of redemptions. We havealso developed a separate bonus pool for our pipe investors, such that the cost basis for both the public SPAC shareholders and the pipe investors will mirror one another.

Alan Baratz: Okay, thanks John and thanks to me I'll just to close out before we hand it back toJen to moderate the Q&A.

Alan Baratz: You know, as I pointed out, we are quite unique in the quantum industry.

Alan Baratz: We decided to start with annealing now a building annealing engaged systems, but, starting with annealing has given us a first mover Advantage when it comes to commercial we'reout there today.

Alan Baratz: Building the business with customers and applications that benefit their business operations, and we have a complete suite of products to be able to support that with that I amgoing to turn it over to Jen to moderate the Q&A great.

Jen Houston: Thanks Alan thanks Emil thanks John thanks Alex it was a great presentationtoday we have a lot of really fabulous questions so I'm just going to jump in.

Jen Houston: I'm just a really great questions, thanks to everyone who's added them reminder,if you do want to ask a question put it into the Q&A and I will see it no one else will it's anonymous and I'm not going to name, who said, these things I'm just going to ask the question, so the first question is.

Jen Houston: As sort of a statement, you are the only company that that doesn't annealing based systems Is there anyone else that is close and how long the lead, do you have Alan themand ask that to you.

Alan Baratz: Now, so the answer to that question is there's nobody else that's close, there are acouple of companies we've heard of that have said that they are interested in getting started inthe annealing space, but they're like where we were 10 years ago.

Alan Baratz: So we actually have a huge lead in this space, as I said, it's taken us 10 years to get to this point and we're not standing still we're continuing to enhance our systems, moreover, wehave that huge 200 US granted patent mode.

Alan Baratz: That we've built around our technology that, frankly, would make it very difficultfor anybody to come into this space, even if we were to stumble and you know, have a hard time.

Alan Baratz: Continuing to enhance our products, but we don't believe that to be the case we'vegot a stellar track record of product delivery and we expect that to continue.

Jen Houston: That's great thanks Alan I have a sort of a follow up to that and I think you hit on acouple of points, but I wanted to just make sure we get it.

Jen Houston: um do you expect your current IP will protect this segment of the market andwhat's your best guess as to why no one else has been working on anything.

Alan Baratz: Yeah so first of all our current IP is quite extensive around this segment but it's actually even a bit broader into the gate model space we've, you know as we've worked throughour IP strategy and you know, driven the patent activity within the company we've tried to be asbroad as possible with the patenting of our technology to first of all, protect the annealing space, but also to have some IP in the gate model space as well and that'll now start growing as we were developing and gate model system with respect to nobody else decided to go into the annealing space, this has to do with history.

Alan Baratz: You know, as I said, we got started in the space over 10 years ago and 10 years agoit was actually not even believed that you would be able to build the gate model system with some you know early research going on, but nobody really had line of sight to how to build a gate model system.

Alan Baratz: But it was believed that you could build an annealing system, and so, since we gotstarted at that point in time.

Alan Baratz: We said well let's go build an annealing quantum computer we knew that therewere some advantages. We knew that it would be really good at solving this important optimization classic problem we knew it could not solve all quantum problems, but we nonetheless thought that that was the right starting point.

Alan Baratz: Five years ago, when pretty much everybody else decided to jump into thequantum space.

Alan Baratz: At that point in time, the science and engineering had advanced, to the pointwhere it was believed that you probably could build a gate model system.

Alan Baratz: And at that point in time, it was also thought that again model quantum computercould solve any quantum problem.

Alan Baratz: So if you're going to get started, then, if you if you think you can build a modelsystem and you think it's going to be able to do anything you might as well, build that.

Alan Baratz: Because while annealing may be easier to build, we know that there are somethings that does well and some things that can't do.

Alan Baratz: So that's why everybody else jumped on the game ah, but what happened was lastyear, new science right, I mean you know the research in this area just is amazing, and continues.

Alan Baratz: And, and last year, what we learned is that there is this application bifurcation.

Alan Baratz: That while annealing is really good at optimization K model systems are not good atoptimization and likely will never be able to deliver a speed up in that area.

Alan Baratz: So the assumption, five years ago that the gate model system could do anything was just an incorrect assumption and that's why we ended up in the situation where we are theonly ones doing anything and that's created a huge market opportunity for us.

Jen Houston: Thanks Alan I'm going to actually put put a little bit of point on the the optimization question we did get asked, can you explain in greater detail on why only annealingcan do optimization problems, maybe talk a little bit more about that.

Alan Baratz: Yeah so as I mentioned early on.

Alan Baratz: Annealing quantitative computers do only one thing they find a low point in a multidimensional landscape and any optimization problem can be mapped into that.

Alan Baratz: So that's why annealing quantum computers are so good at solving optimizationproblems.

Alan Baratz: So what's the problem with gate model systems, well, the problem with gate modelsystems is that they're not native optimization engines.

Alan Baratz: And in order to get them to solve an optimization problem you need to wrapclassical computer around them, it needs to be hybrid right part classical part quantum.

Alan Baratz: Well, the research results that came out middle of last year, pointed out that thecost of that classical computing required to get a gate model system to solve an optimization problem is so high that it outweighs all of the benefits that the underlying quantum computercan provide.

Alan Baratz: So in fact not only can you not get a speed up typically if you try to use the gate model system to solve and optimization problem it'll run worse than if you just tried to solve itclassically.

Jen Houston: Great Thank you so um I have a couple of more technical questions that annealingand then a couple gate questions because you can imagine that the group has some questions about that, so one question was.

Jen Houston: How was an annealing cupid produced we hear about freezing temperatures andfragile systems that the gate needs just curious about how day we do a produces qubits and ifit's any easier.

Alan Baratz: So annealing qubits are created through superconducting wires loops.

Alan Baratz: And so you know the point of superconducting is that when you inject current intoa wire that superconducting it flows uninhibited no friction.

Alan Baratz: And so what we do is we create loops on our chips out of superconductingmaterial.

Alan Baratz: We run them at superconducting temperatures and then we inject current flowingin both directions clockwise and counterclockwise clockwise in the loop and that's the superposition Okay, and then we put various biases or forces on the current in that loop, in order to bias a set to the solution of the problem.

Jen Houston: And I think the follow up to that Alan was is it any easier to produce asuperconducting qubit for gate versus annealing.

Alan Baratz: um so creating the qubit is no harder.

Alan Baratz: If you're creating a superconducting gate model qubit than if you're creating asuperconducting annealing qubit, however.

Alan Baratz: gate model qubits need longer coherence times than annealing qubits because, because the annealing computer runs just that one algorithm the annealing algorithm but lowpoint in a multi-dimensional landscape.

Alan Baratz: And that runs in a relatively short period of time, the coherence times for annealingdon't need to be that long.

Alan Baratz: Right, so you can get really good results with 10 or 2o nano seconds go here andsigns amazing results with hundred nanosecond coherence.

Alan Baratz: A microsecond coherence time on annealing system is just like nirvana right for gate model systems, you really need to be at between 10 and 100 microseconds right, so youknow 10 to 100 times longer coherence times that's the challenge around building the gate model qubits great.

Jen Houston: Let's talk a bit about gate model, since you ended there sort of a two questionswhat's the timeline for the waves gate model quantum computer and are you, starting witherror correction at launch or will error correction come later yeah.

Alan Baratz: So it is a multiyear program.

Alan Baratz: We have not announced the time to get to a fully scaled ever corrected system butyou've heard me say that, I think, for everybody it's seven plus years to get to the point where you have that fully scale our characters I mean think about Shor's algorithm 20 million qubits ona superconducting system.

Alan Baratz: Even if we started with 50 qubits, which is where gate is today and doubled everytwo years, it would take 20 to 25 years to get there, so.

Alan Baratz: You know, even at seven years, you know, some might argue that being a bit optimistic, but but that's kind of what we think it's going to take the industry to get to thatscaled error corrected system that can solve commercial problems.

Alan Baratz: So it's going to take time to get there, however, we are doing it in steps and yes.

Alan Baratz: Every step along the way, will include error correction, except the first two steps,the first two steps are basic technology build a qubit.

Alan Baratz: With the right coherence time add control to the chip, so that we can build out therest of the modules and then our first system will be a small scale partially error corrected system.

Alan Baratz: It will basically be a small surface code 17 physical qubits per logical qubit with arelatively large number of logical qubits on the chip.

Alan Baratz: Just demonstrating a partially error corrected system but done in a module that we can then scale out both in terms of size of the service code for better error correction, as well asa number of logical qubits that's great.

Jen Houston: um we had a quick question who makes your chips.

Alan Baratz: So all of the IP for the fabrication of those chips is D-Wave IP.

Alan Baratz: We designed the process for fabrication we designed the materials for fabrication,however.

Alan Baratz: Those processes can be run on standard CMOS tools and as a result, we do nothave our own clean room we partner with Sky Water in Minnesota.

Alan Baratz: That became public when Sky Water went public and had to talk about some oftheir large customers so Sky Water fabricates our chips, but they fabricate them using our process and materials to our specs and they are able to use those processes for us only.

Jen Houston: Thanks okay what learnings from super connected to conducting technology canwe leverage from our annealing systems to help develop the gate model systems, I know you touched on that, but at a high level.

Alan Baratz: Yeah It really is from a system perspective, it really is those key core technologiesaround flux based qubit

Alan Baratz: On chip control on chip addressing and pipeline, those are really the things that werealized were required for a commercial system and that we had to design and develop and frankly commercialize that we now believe we can apply to a gate model system, however.

Alan Baratz: We've also learned a lot about hybrid algorithms You know, as we now havemultiple hybrid algorithms that are a part of our system.

Alan Baratz: Our Leap quantum cloud service, and so we will bring that to the gate model spaceas well, so it's both systems and software and, of course, once our gate model systems are available, they will be available in Leap alongside the annealing systems and we will have integrated tools for the use of those quantum computers.

Jen Houston: Great question on a strategy behind systems deployments how many systems willyou need to deploy in order to meet the financial metrics that you set out today.

Alan Baratz: Yeah so John touched on this.

Alan Baratz: First of all over the five year projection period we are assuming only optimizationand as a result only in annealing so there's no gate model in those projections.

Alan Baratz: Given that an annealing quantum computer can support between 25, 30 milliondollars-worth of revenue per year.

Alan Baratz: So what this means is that you know you know, three years from now, we actuallyneed only three annealing quantum computers to support you know when you order 75 millionof revenue, if we go out five years with 550 million of revenue.

Alan Baratz: Okay, at that point we're talking about 20 to 25 systems so as John said, this is not acapital intensive business.

Alan Baratz: Great.

Jen Houston: So I'm going to move to software because there's a great question here aboutsoftware, it seems like quantum computing is as much about software as the hardware.

Jen Houston: This person was listening deeply because that's a true statement you talked aboutvarious generations of the hardware Where are you on the hybrid solver and what is the cadence with which you iterate on that solver.

Alan Baratz: Yeah so we actually have three hybrid solvers our very first hybrid solver waslaunched oh well over a year ago.

Alan Baratz: Yeah February 2019 2019 That was our binary quadratic model solver and that'sover could support only binary variables, we then.

Alan Baratz: Launched I don't know six months, a year after that are discrete quadratic modelsolver that solver could support binary variables, as well as discrete variables.

Alan Baratz: Whereas this discrete variables, are you know, an element from a set a not just 01but maybe one of the integers between one and 10.

Alan Baratz: Then about six months ago at our customer conference last October we announcedour constrained quadratic model solver.

Alan Baratz: This is a solver that actually allows us to incorporate constraints into the problemsthat are solved in a native fashion.

Alan Baratz: And that really made it much simpler to build applications on our system and theapplications can be much more compact meaning, we could solve much larger problems.

Alan Baratz: The other thing that was really important about the constraint quadratic modelsolver was that it for the first time, raised the level of abstraction for building the system.

Alan Baratz: Now, if you were a data scientist or data analyst who was used to linearprogramming or mixed integer programming or quadratic programming.

Alan Baratz: You did not have to reformulate your problem for the quantum computer you couldsimply specify in a symbolic language, the objective function and constraints.

Alan Baratz: To our system to the constraint quadratic model solver and it would go ahead andsolve the problem mapping to the quantum computer as needed.

Alan Baratz: And then, today we announced the incorporation of continuous variables into theconstraint quadratic model solver.

Alan Baratz: So you know we have a history of roughly you know every six to eight months delivering updates to the hybrid solvers that's a really important component of our productsthat.

Alan Baratz: And, and we do enhancements to our software, in fact, our Leap quantum cloudservice we update the software every two weeks every Wednesday.

Alan Baratz: We do a push of functionality and we're constantly enhancing the system, sometimes it's adding administrative functionality to make it easier for our customers ourpartners to administer the system.

Alan Baratz: Sometimes it's improving functionality that's there, like our integrated developerenvironment we just made available version two of our integrated developer environment which provide some enhanced capabilities.

Alan Baratz: Or the constraint quadratic model soccer so we're constantly enhancing oursoftware that's right.

Jen Houston: And I made a mistake it's 2020 that the first solver came out February 2020 so justFN I think Alan you said yeah we're on two week sprint so every other Wednesday we put those out there okay so here's another question which I thought, and I thinkyou began to touch on but just to dive in a little bit more and we probably have time for aboutthis question and maybe one other one on.

Jen Houston: The front ends at was you had mentioned that the front ends at an app's hide thecomplexity of the quantum process behind from end users can you give some examples of how do you hide that complexity and makes it easier for people to get started in.

Alan Baratz: quantum well you know, honestly, the best example is when I just gave you on aconstraint quadratic model solver right now, you know if you've got.

Alan Baratz: If you've got a quadratic program you've got an objective function you've got a setof constraints that.

Alan Baratz: That define your problem, and this is the language of data, scientists and dataanalysts they use these problems, all the time.

Alan Baratz: You can just take that specification and feed it into our constraint quadratic modelsolver and will handle the mapping to the quantum computer so.

Alan Baratz: So, that really is raising the level of abstraction and we're going to start doing that in other application domains as well linear programming, was the first domain we're gonna start doing that in other domains okay.

Jen Houston: And then we also got a question about sort of How does that onboarding work ofbringing on the for phase model and, specifically, can you use as an example, like, how do you how do you help get customers there quickly.

Alan Baratz: Yeah so first of all, one of the things that I did not mention was those first twophases, where we do the application, evaluation and.

Alan Baratz: We build out the proof of concept with our customer they bundle together everything that's needed for those projects so that includes the professional services time.

Alan Baratz: That includes the Leap quantum and hybrid solver access time that's required, andthat includes training we have, as you know, Jen a training program because you run training forus.

Alan Baratz: Which is a very comprehensive training program that customers can they either.

Alan Baratz: Get integrated as a part of the first two phases of the lunch program or you can buyseparately or, if you have additional training needs.

Alan Baratz: You know, you can purchase a seat for one of your developers or you can purchasea whole session for 20 or 30 of your developers so.

Alan Baratz: The first two phases bundle everything you need to get started, including training.

Alan Baratz: But you can also operate outside of the lunch program if you wanted to you couldbuy training get started, and then buy some Leap time separately, because that do it yourself.

Alan Baratz: We don't encourage that, because what we find is that it's easy to get started andget something up and running on the quantum computer, but when you want to scale that andget the best possible performance.

Alan Baratz: It's better if we help you do that, at least through the first application then onceyou've worked with us through that first application.

Alan Baratz: You know it's much easier for you to do it, a second or third time and Zach.

Alan Baratz: You know Dustin from Save On Foods that fell into that category, we did a first application with them and then, when they moved on to their second application, they just bought some advisory services for us, but they did from us, but they did the bulk of the heavylifting themselves.

Jen Houston: Okay got one more I know we're at time, but this is a great question, what areyour thoughts on the current benchmarking schemes and how should investors compare performance characteristics among the various competitors.

Alan Baratz: It's such a sad story.

Alan Baratz: The, we know that the problem is really at the end of the day, all you care about isapplication benchmarking.

Alan Baratz: That's really all that matters, but the problem is, except for the D-Wave annealingsystem, there is no quantum computer out there that can actually run applications so you're getting all these esoteric benchmarks or approaches to benchmarking.

Alan Baratz: That really are not helpful in understanding when and where you can use aparticular quantum computer.

Alan Baratz: So I just think we're in a world of hurt when it comes to benchmarking, but it's kindof obvious why the systems, other than the doa the annealing system just aren't capable of solving real problems.

Alan Baratz: And, as a result they're not capable of running the benchmark that customers reallycare about, but you can benchmark on our annealing systems with real applications right.

Jen Houston: Well we're out of time, I want to thank everyone for joining us today, I know thatthere were questions we didn't get answered so.

Jen Houston: happy to follow up if there are questions that you'd like to have specifically have aconversation with us about.

Jen Houston: I know, Alan and John in particular are looking forward to spending some time with you all so let's do some follow up, thank you very much, thanks, a meal and and John andAlan and Alex and the whole team for joining us today have a wonderful afternoon.

Alan Baratz: And thank you Jen for putting this all together.Jen Houston:

So welcome.