

where we're going now if you have any thoughts on any of the topics covered be sure to share them right here in the live chat because we want to hear your take some of the high points have to include the mind-blowing developments regarding presence platform web xr and so much more don't forget there's even more info on all of these topics in our phenomenal sessions that are now unlocked and can be found right now via our connect 2021 playlists including mari's building an accessible future in vr session which is such an important topic check that out along with many of our other sessions with just fantastic speakers and dive even deeper into all the topics you're excited about okay now it's time to take a time for the one and only john carmack how exciting is this going to be he is the quintessential leader cto everything that we're excited about so let's go to him right now

welcome to connect everyone so my process for these talks is that i basically go back through the last year of internal posts and public tweets that i've made looking for things that are interesting and worthwhile to talk about and then i try to roughly sort them into some kind of a coherent topic flow and then usually one or two days before the show i wind up kind of feeding those notes over to comms to make sure nobody is going to absolutely freak out about anything that i say and normally there's just a little bit of kind of gentle push back on a couple things and only one time in the history of all the times that i've done this has anyone ever said it's like no don't talk about this and that was about calling out slam or simultaneous localization and mapping before we had kind of quest's insight tracking working which is really a silly thing in retrospect but so i'm usually a bit of a counterpoint to the grand strategic visions because i'm all focused on the nuts and bolts of things and i'm also usually the one that's a lot more kind of grumpy and unhappy with uh with the way things are going as i always want more and faster progress but this year i really have a lot of things to be quite happy about by far the most important is that quest 2 has been a really big success and it was you know it was a heroic effort to get it out when it was last year in the space of all the headwinds that we had but it was better faster cheaper one of those just rare combinations that you almost never get to have in a product and while there's still like a couple minor things where some people do still miss the oled displays or the continuous ipd adjustment it really was a fantastic product and the market has responded very positively to it i mean it would be a really big danger sign if we had been able to do all of that and we didn't have this integer multiple uptick that we saw with quest two over quest one but so that's a sign that things are looking good for that and the whole ecosystem has been benefitting and it's been a really good thing but there's a bunch of other things that i've often talked about in these past i connect talks that i've been complaining about how we should really have this why don't we have this yet and a bunch of them did land this year uh airlink got released where we had oculus link out and it was doing better than people expected internally lots of uptake for it and we had the existence proof of virtual desktops streaming steam games and there was a lot of internal debate about this about whether we needed to make completely custom hardware to be able to do wireless wi-fi but we shipped it it's great lots of people love it it doesn't work for everybody not everyone has good enough wi-fi for it to be a good solution for them but it does work for a lot of people and it's kind of funny how we've got the obvious extensions to this where you've got airlink to your own pc there's a bunch of language right now where they're kind of carefully protecting certain use cases but there's obvious things that we'd like to be able to offer i'd like to be able to offer where you should be able to airlink to your friend's pc uh one small step from that to some kind of a cloud link where you could play vr games i am you know on cloud servers onto your mobile system potentially anywhere now there's even more challenges for that and there's always been this spectrum from obviously pure native is best wired link has the next fewest problems wi-fi has the next fewest problems going all the way to cloud brings in a whole new set of issues and we're going to have the exact same arguments that we always had on every single one of these steps it's not going to be great for everybody it cuts off more potential users but there's going to be a bunch of people that can find something like that valuable and in fact it's been almost funny how the conversation has changed so much that cloud vr rendering is now almost looked at as a plan of record for some of the metaverse options that we're looking at where cloud rendering couldn't get the time of day a year ago but now it's almost looked at as plan of record to the point that i'm even gently pushing back a little bit on it with like oh you know whoa hold up there's still a lot of challenges with cloud rendering there's a lot of negatives and other things that we need to factor into maybe we shouldn't jump right to that but it's been great to see the progress and most importantly for me the user value that we've delivered with that app lab got released which has been from the beginning this long tension between more open application development versus carefully curated spaces and again enormous internal battles about this over who's going to control access to the vr screen what we're going to allow in and i we finally shipped it and we've already got some really amusing data points that are happening like gorilla tag having more concurrent multiplayer users than big budget titles that have had millions and millions of dollars poured into them and i want to keep coming back to this sense of we should trust the market rather than sort of our internal content czars that want to pick and choose the winners with it but there's still while it's supposed to not be the full store review process there's still a significant review process and we've been backed up for multiple months at times with this and i do think that really needs to get solved in some way and i've always suggested that we should be able to get to a reactive approach rather than a filtering approach i mean you couldn't run like a social media network if every post had to be approved you obviously get to the point where you let everything go out and when something is problematic then you go back in you worry about taking it down and i think we should be able to get there with app lab as well but that's not our current plan of record and that's just something that needs to be pushed on and i certainly have some sympathy for the review schedule where i had promised to do more kind of public app reviews and i'm not even done with my third one yet it's just hard to kind of get through all of these things so again i'm pushing for more of a kind of open-ended approach there another thing that was really kind of a niche feature but 120 frames per second support landed this year and that's been another kind of fun one with the internal arguments about it where in previous years i had talked about how we had found out that the original quest 1 hardware could actually run at 90 hertz not just 72 and it would have been nice to be able to do that the theory was that some applications could be lightweight enough to be able to run at that speed and maybe it'd be great for oculus link support i'd be able to run pc content at sort of its original cb1 native rates but i we never were able to get that one through there was this idea that well changing the clock rate on that we would have to get it fcc certified again recertify the device and that was never going to happen for a device at that point and it's in its kind of lifespan but on quest 2 there were no clock changes it was just changes in kind of what goes into the timings to be able to do that but we still ran into a ton of internal resistance about it from display teams about well it's not certified to do that um you know it might not always switch it might have ghosting and we had people going and say well let's go walk go into a walk-in refrigerator and try it in there in the worst case for an lcd screen it's like okay maybe you can see a touch of ghosting but it's just not that big of a deal i am people saying it's like well nobody will actually take advantage of this 120 frames per second is too hard but then it came down to some more arguments about well okay maybe it works on our display now but what if we want to second source something what if we want to go ahead and uh you know use displays from another vendor where we've kind of said we want this 90 hertz but maybe not everything can be pushed to 120. and there's there's something to that argument where it's always better for hardware vendors when you're making a piece of hardware to be able to have multiple sources for the components that you use it's important in case something catastrophic happens to one of them but it's also important to give you a little bit of leverage with the companies if a company knows that they make the only part in the world that you can use they've kind of got you over a barrel and it hurts your negotiating position for everything but if there's at least two companies sourcing components you're in a much better position to be able to say well i'm just going to take the one that meets my minimums and i am you know and is the cheapest at that point and this winds up i am impacting us on a bunch of other things like we only found out kind of this year that we have a couple different skus of flash vendors and they have slightly different performance characteristics it's not anything that you would notice they all met the specs that we listed but some of them are a little bit better than the specs that we had and if you write really hardcore i o tests you can tell the difference between some versions of quest but i we did finally get it out and it was literally over a year from the point where it was demonstrated that 120 hertz works to the time that we could actually ship it and i found that ludicrous that it took that long it was just not much code at all but it's out there and it's a success story and that's one of the poster childs that i get to use internally now about how sometimes our process messes things up and we do have applications uh that are taking advantage of it like one of the first ones that was a cheerleader for this was 11 table tennis you know ping pong simulator game where that sort of super fast reactions and twitches on that are super important and it was simple enough that they could cut down the scenes as much as necessary to get to a stable frame rate there and interestingly that game also pointed out some of the issues with the extrapolation of our controllers where they you know they see certain problems with even only extrapolating 30 milliseconds into the future that serious players can actually tell the difference so we've still got room to grow at the high end for our responsiveness in vr for some applications and then uh one of the ones that's very near and dear to my heart is just this last week we were able to release the unlocked oculus go system software release and this has been far longer in the making than uh then you're likely to consider because even before oculus go existed when we were planning to ship our first standalone headset there were serious discussions internally about well can we let users have root and there's always been the breakdown between usually the people on the system software side and a lot of the engineers like yes that would be a wonderful thing to offer users but people will wind up coming up with reasons about how well that might undermine some of our you know our platform integrity it might have privacy compromise issues it might have all it's easy to come up with a big list of reasons why it's not a good idea so oculus go went through its sales life i am you know and it's no longer on sale and we've already reached the point where we've stopped accepting new applications to the store for it so i was able to make the pitch again it's like okay we are going to discontinue this product in a finite amount of time you know basically the policy is that you get two years of support from the last time that it was on sale uh so there's a clock ticking at that point um no more support is guaranteed i mean it's not a guarantee that will shut it off immediately but there's no more obligation to do so so given that there's this very finite time coming up

i am let's talk again about how we're going to have this stuff these hardware you know a lot of them there's well over a million oculus goes out there and they at some point things stop working and they become sort of e-waste this is a problem that people talk about a lot and there's a clear thing that you can do with that you can go ahead and let it be used for more things and i'm it's been looking back over just i made vague reference to vague references to this a couple times over the year but there's been a semi-serious effort going on for most of last year and it finally got through everything at the end to get the go-ahead and surprisingly the resistance wasn't from where you'd expect the legal team was supportive of this a lot earlier than i would have expected they went out and they did a bunch more work than i thought was going to have to be necessary talking with partners we even had some partner contracts updated for this and i wish i could give a shout out thanks to these but apparently they didn't want to be explicitly named for this but some of our partners that had no real need to do this did go out of their way and execute a new contract with us that allowed us to go through and do this but we had more people internally on the product teams worrying about oh you know hand-wringing what could this do could somebody be able to go in and in some way like expose some security issue with our system software um get at it in some way just just issues but eventually everything got settled down we got to do it and i'm real happy that it's out there one of the scenarios that i've said that i always want to care about is i want somebody five years from now to find a dusty old shrink wrapped box in a closet uh take the shrink wrap off um power something up and load the last operating system version onto it rather than whatever first was originally in the factory flash with no over-the-air updates available but still this is only step one where the next step is going to be preserving the content ecosystem i'm still trying to fight that battle internally to let us do something official and all-encompassing but it's possible that may still need to fall to third parties where everyone that's gotta go back up your software off of it make sure that it lives somewhere so if we do need to piece together the content repository years from now from you know a thousand separate little hard drive images we at least have the possibility to do that but i am hoping that we can do something better internally now obviously the metaverse is the dominant topic of the day and i i was quoted all the way back in the 90s as saying that building the metaverse is a moral imperative and even back then most people missed that i was actually making a movie reference but i was still at least partially serious about that i really do care about it and i buy into the vision but that leaves many people surprised to find out that i have been pretty actively arguing against every single metaverse effort that we have tried to spin up internally in the company from even pre-acquisition times i am you know i want it to exist but i have pretty good reasons to believe that go setting out to build the metaverse is not actually the best way to wind up with the metaverse and uh kind of my primary thinking about that is a line that i've been saying for years now i in general relation to my arguing against these efforts is that the metaverse is a honeypot trap for architecture astronauts and i'm architecture astronaut is a kind of chidingly pejorative term for a class of programmers or designers that are that want to only look at things from the very highest levels that don't want to talk about gpu micro architectures or merging network streams you know or dealing with any of the architecture asset packing any of the nuts and bolts details but they just want to talk in high abstract terms about how well we'll have generic objects that can contain other objects that can have references to these and entitlements to that and we can atomically pass control from one to the other and i just want to tear my hair out at that because that's just so not the things that are actually important when you're building something but um you know but here we are mark zuckerberg has decided that now is the time to build the metaverse so enormous wheels are turning and resources are flowing and the efforts definitely going to be made so the big challenge now is to try to take all of this energy and make sure it goes to something positive and we're able to build something that has real near-term user value because my worry is that we could spend years and thousands of people possibly and wind up with things that didn't contribute all that much to the ways that people are actually using the devices and hardware today so my biggest advice is that we need to concentrate on actual products rather than technology architecture or initiatives now i didn't write game engines when i was working at id software i wrote games and some of the technology that was in those games turned out to be reusable enough to be applied to other things but it was always driven by the product itself and the technology was what enabled the product and then almost accidentally enabled some other things after it and it's hard for a lot of people to really accept how rarely future proofing and planning for broad generalizations of things turns out to really deliver value it is really shocking how often that winds up getting in your way making it harder to do the things that you're trying to do today in the name of things you hope to do tomorrow and it's not actually there or doesn't actually work right when you get around to wanting to do that so horizon worlds is a product you know a product can be clearly judged how many people are using it you know what are they doing in it i am how much commerce is going on in it uh all those sorts of things um horizon workrooms is a product how do we compete against zoom meetings and i'm i'm pretty excited about some of the prospects some of the early signs that we're seeing with this where you know everybody's in a lot of zoom meetings and sometimes when you're in work rooms or horizon interacting with a producer a tpm a few other people it winds up really actually being better than staring at the wall of faces in the you know on the zoom screen and i i was also super excited where i heard people spontaneously commenting about how conversation in work rooms was better than what they were seeing in some of the other vr apps and also a lot of the traditional video conferencing systems and that was become because workrooms had redone the audio stacks so that their voice communication had a couple hundred milliseconds less latency than what you were seeing in horizon or most other places and i've always cheered the fact that these things matter you know we can get a whole lot better and even where we're at in work rooms is still far from sort of the speed of light of what we could be with this but people noticed and we can get twice as good as we are right there and get that much better but it was interesting when i was kind of digging down into some of those latency issues i'm unfortunately the speed of light the minimum kind of loop back latency has actually gotten worse from oculus go into quest two i when you kind of do this where you just make a loop back where you can play a chirp out of the speaker and see when it comes back into the microphone it's a little bit better with uh when you don't have any processing going on but when you've got echo cancellation and some of the other dsp processing that happens it's it's really annoyingly high right now it's over a hundred milliseconds as the very minimum even if you do kind of nothing wrong above that um so that's one of those things where you know i'm sort of hoping i can i can harness all this crisis energy with the metaverse going around it's like okay we need to dig down into like the little dsp chip how the android passes things into this re-implement algorithms ourselves and let's claw back that 100 milliseconds you know let's go ahead and get our echo canceled voice communication over the network down under 100 milliseconds let's aim for 50 milliseconds let's not settle at you know 450 or even 250 let's be better than anything that anybody's ever seen and that's that type of nuts and bolts level thing that we can put a couple people on that are really good at nailing that down and we can make an improvement that's going to affect everything our existing products let's take that let's make work rooms horizon social home all of these things just much better directly so unlike products architectures and technologies you know sdks and toolkits they can always claim victory and just say we made a wonderful architecture um nobody used it correctly nobody picked it up um the applications didn't take advantage of it in the right way and it is so easy to let yourself off the hook like that so i'm you know you've got to actually be using the things to make value from it you know i worry about this in a lot of ways with our advanced technologies where we you know we're happy when interesting little proof of concept things come out but if it's not showing up kind of on the big board as like okay hundreds of thousands of people are using this it's you know it's delivering millions of hours of value maybe they actually aren't all of the all that important and maybe other things could have been more important to to focus on so um her horizon has some strong points i'm you know i do enjoy being in that talking to people i think the social conversation uh i've said i it feels like we've got line of sight on that sort of co-presence social aspect when everybody's holding their controllers right nothing's looking goofy you're looking at each other the conversation works pretty well when you get reduced latency from the the audio it makes it more and more lifelike and there's some good things there but still you know it's a far cry from the metaverse you know of our visions and what we'd like to see i'm like the q a session that i'm doing after this talk we're gonna have 16 audience members in there that's a far cry from just even the hallway talks like when i would be physically at connect there would often be 50 60 people kind of in a crowd around me in the eye just in the hallway where we're talking about you know whatever anybody wants and last year we had a little bit of a random entry whereas whoever kind of hopped through the portal first got into the q a session so i'm a little disappointed we're almost backing away from the virtual session here but really what we want to have is something that feels like that session you know like the the real connect where thousands of people are here milling around some of them cluster around me outside we all crowd into a room for the big keynotes and you get all of that ability without having to have people fly across the country or across the world to get there you know that's that's what we've always been pitching is the value of vr so i'm you know i really do want us to pitch kind of connect as the north star event of what we're doing we've got an event that we do every year here we've got a user base for this we should be doing this in the metaverse if we can't handle this we can't handle sort of the vision and we could do this by next year i mean i thought we could have done it by this year if we had really kind of made this a frontline focus but we didn't have that focus like like we do now a year ago but i'll be really disappointed if i'm sitting here next year in front of a video crew and a camera in physical reality doing this talk i want to be walking around the halls or walking around the stage as my avatar in front of thousands of people getting the feed across multiple platforms i i mean i'm laying that down laying that gauntlet down right now we should be able to do that this should be exactly in line with what our stated mission is so we should make this happen to make sure that we're doing something that's valuable to at least us and then it will very likely be valuable to a lot of other places so the problems with that with i am capacity planning where if you're in horizon now and you've got 16 people in there they're already popping down to low fidelity avatars getting pointy elbows and i kind of jittery updates as the system tries to kind of manage all of that and that's just 16 people maybe 20 total when you've got cameras and other things going on there it's not

that much how do we get to something that looks like this i'm you know a small even a large meeting you know it's a problem in work rooms we can't have our vr leads meeting because there's too many people on the call we can't all fit into work rooms how do we get that scaled out how do we scale to the point where even a small club concert these become uh you know really challenging things there's no way that you can just spawn 80 entities in unity like this with our horizon avatars and expect to have it work so the the magic that is being reached for in many cases is that well cloud rendering would let us use much more powerful systems than uh than the current headset systems and we could add a bunch more on there and like i said earlier i'm very supportive of cloud rendering architectures but i have to pull back a little bit and say that well you know there's going to be a lot of cost there that would cut off a lot of people that don't have the bandwidth to be able to have that high quality of a connection um you know it does have some some negatives on the quality when you're dealing with the cloud connections versus local rendering uh and the step after that what i had suggested well before we really spun up this metaverse stuff is that we should do a horizon in the cloud as a separate technology development project where we can certainly run it as a cloud application now just compile the pc version and run it globally and that's the most flexible way to do things but it runs into some of these you know quality challenges there now there's a ton of other things that you can do with sort of hybrid applications where you want to say like your local hands or controllers and your local uis you could make an application where all of that is done locally on your headset and only the crowd of other people is done with cloud rendering and kind of pulled into it um and i think that there's talk about wanting to make that sort of a general purpose uh application interface and i don't think that's gonna work i i don't think many applications are interested in refactoring the way they do things it's not a trivial thing just run your app in the cloud is pretty trivial you bite off a whole lot of downsides but it just works splitting your application up into locally rendered things and compositing with cloud fragments that's the type of thing that i think is application specific and rather than spinning out some general technology sdk we should just try to take horizon and work all of that out maybe we find out there are some great uh kind of ways to slice it that are maybe more general purpose but i'm concerned that it would be pretty specialized and but it could still be sort of what we want to do for for cloud rendering i am or for horizon at least now this actually goes back to like the wheel of technology just kind of reincarnating over and over again way back in hex probably the late 80s there was a windowing system called news that let you write certain ui things to be executed on your local system that might be connected by a very low bandwidth connection or modem link or something to a larger system that's doing the rest of the rendering and people had a hard time with that then and i think it's very much the same thing and people will continue to have a hard time with it but sometimes if you've got to solve a problem it's the the thing to do but even with cloud rendering there um it's not a panacea where the uh pcs are fast they're 10 times faster than what we have on our mobile headsets but there's already a dozen metaverse wannabe vr applications running on the pc using all of the power of the pc and none of them are magic and are making everything amazingly work and even with the power of the pc you can't scale up both avatar count and avatar quality at the same time we can't talk about codec avatars and crowds of people you know they just don't work right together and even worse the economics of this get really bad we can't just take i you know the very latest 30 90 gpu and run all of those in cloud instances for everyone that's just fundamentally expensive even before you account for sort of the nvidia data center tax of running things there and in fact nvidia is building all these technologies to let you fragment up uh cloud gpus into smaller pieces so you can give less power to individual cloud instances and that's useful for some things but we might wind up with cloud instances that are only two times as powerful as our mobile system and then you run encoding and all the other things on there and the other downsides and it might wind up being almost a wash or not such a great idea perhaps the biggest saving grace for it would be that cloud rendering lets us then sort of project the metaverse onto any device really trivially anything that could accept a video stream could go ahead and have full featured interface there easy to port easy to bring up lots of you know lots of benefits there but still if someone had asked me in the year 2000 like i'm working on doom 3 at the time and they said could you build the metaverse if you had 100 times the processing power that you've got on your system today and that's about where we are like our modern mobile systems are about 100 times as powerful as a lot of pcs of that era and i would have said yes it would have been a serious optimization challenge there's all these things that you might have had to do to make it work out well but you know if i had to make the metaverse work just on our mobile hardware today i think it could um you know it would take it would be an optimization challenge which is sort of the problem where everybody that wants to work on the metaverse talks about the limitless possibilities of it but i it's not limitless it is a challenge to fit things in but you can make smarter decisions about exactly what is important and then really optimizing the heck out of things like that i am but that's different than just saying i want magic technology to fix all of this i want to be able to have my designers not care what's going on they should just be able to do amazing cool stuff and that's not really you know where we are so i and then to be even more contrary in here uh i have to say it's like are we necessarily even aiming for all the right targets with the social metaverse where the feeling of co-presence is the big bet and that is it's completely understandable why you know a company like facebook or meta would you know would make that play it's what's you know it's what the company is built on but you know in truth a lot of the luxury items in reality are freedom from co-presence you know it's a private office a private beach a private plane you know sometimes these things are just add people is not always a positive especially for people that are a little more on the introverted side of things and there's also this notion that building all of these 3d things 3d art 3d objects that these are the critical factor that people are going to love so much in the metaverse and i do keep coming back to this point that i've made a few times that i'm almost all of the value of the stuff that we've built in our culture today is represented on flat screens now there's trillions of dollars of all the software and media and assets and things that that are built around flat screens and i've made the pitch before that perhaps a sufficient um argument for vr is to just say it's screens and people as the primary thing where you've got that ability to have your friends together in a small room and you've got the ability to bring up all of the things that you do on your other devices in vr in more flexible screens and then the vr specific things i you know the actual games the beat savers and things that those may be sort of the interstitial things that complement rather than define the medium and i made a you know an extension of that where for the metaverse maybe the metaverse is just lots of screens and lots of people that maybe there is a screen focused world where everything that people do with photography and videography and all of that just has this amazing place in a virtual world where you've got the flexibility to have those presented all over the place where everybody can do magical things with video today and photos where not everybody can do that many magical things with 3d modeling and 3d art some can but it's a tiny fraction of the people maybe it extends like video has and it gets democratized so that everybody gets to take part in that but also maybe that takes a while so i kind of keep pushing on it's like let's make sure that we get all of our screens right that we get the ability to handle everything all the types of apps all the types of cloud services that everything that anybody does on a piece of glass today you should be able to do in the metaverse hopefully more flexibly and better in various ways than you can on the existing devices because i want our vr headsets to subsume and replace other devices i don't want it to be the thing that you have in addition to your tvs and consoles and computers and laptops and all these things it needs to take the place of at least one and hopefully more things that's been so much of the value that mobile phones have brought into the world where they replaced a whole pile of things and brought you know all their new value in addition to that but it's this kind of subsuming the other things that i think is you know is really core part of the value now everybody agrees that a closed platform doesn't deserve to be called the metaverse but there's a spectrum where you can have completely open wild west sorts of things and then you can have completely locked down single application platforms and it's you know it's a pretty good bet that we're not going to be all the way over on the wild west side of things i'm you know i'm certainly partial to that direction but a lot of the strenuous advocates for that i'm it has to be accepted that centralized systems provide most of the value in the world today and there's reasons for that other than just accidents of history it is easier to make better more valuable experiences in many ways with a centralized system i mean all the issues with federation and standardization there's good value that comes out of all of that but it comes at a cost and you can't really just ignore it i am you know unlike on the commerce side of things everybody agrees you have to be able to make a living in the metaverse commerce is going to be some part of it but i i usually have like i use adult entertainment as a litmus test for how open a platform is there um you know if there's adult entertainment it's a very very open platform from a commerce standpoint uh we probably won't be there you know i halfway jokingly suggest certain things along those lines occasionally but i you know it's unlikely that we're going to be in the completely open crypto world of things i'm you know the libertarian in me loves the idea of unstoppable global cash transactions but you know i'm also well aware of the kind of swamp of scams and the spam that i have to clear out of my timeline every morning dealing with that side of things so i've actually got a bet that i'm kind of sorting out with somebody about the relative adoption of federated versus closed systems over the next 18 months and it's going to be interesting how things play out because i can envision worlds where it goes either way and we really don't know at this point so we're still kind of figuring a lot of these things out now the most obvious path to the metaverse is that you have one single universal app something like roblox where if you've got a turing complete extension language and you've got sufficient interfaces in theory you can do anything inside any app i mean we're all running all of our apps inside the operating system and it just kind of defines however many turtles you stack on top of things i kind of opens up the levels of abstraction there but i'm you know it's it's probably i doubt a single application will get to that that level of taking over everything uh the problem is that if you make a bad decision at the central level nobody can fix it you know you can you can kind of cut off entire swaths of possibility things that might be super important and i just don't believe that one player you know one company winds up making all the right decisions for this so the next step down would be to have you know our metaverse be something like a giant unity plugin so that anybody could build an app with this massive base layer of functionality and that's sort of where we are today where we have i am horizon worlds horizon workrooms horizon venues that are all unity applications built using many of the same technologies but it's far from a clean integration right now it's huge issues where workplace goes and does all this great

work it doesn't flow back into horizon it's a mess right now but we can imagine that getting straightened out to the point where you drop in this huge block of code on top of things and you've got this baseline functionality so it's kind of like i'm i remember asking my younger son why he was enjoying kind of playing with minecraft mods a little more than roblox mods because minecraft had all of this stuff already there while more things had to be built from scratch in roblox so there's interesting aspects there and then the the lowest level would be just kind of sharing avatars profiles friend graphs things like that kind of like we do is just cleaning up the apis that we already offer to places and it is great when you get i mean i love vr applications where i've got friend scoreboards and i can see profile pictures from them there and it's easier to kind of invite your friends to things and those are all good things but you know it's really not the metaverse but on the other side of that where while horizon worlds workrooms and venues are all unity apps horizon home is really a rebranding of vr shell where it's a c plus application so we have to interact with all of these things to get the avatars and the profiles and all of these things that happen in the unity world happening in our c-plus-plus world and we're still spinning that up and there's a bunch of challenges for it so um there's some styling of the upcoming hardware as being kind of metaverse oriented and i really don't like that and i keep pushing back wherever i hear some of these things where it's important to say that all of these future of work and metaverse things all of them will work just fine on quest 2 where the upcoming high-end hardware will add some of these features like facial tracking and more world understanding that might add some things on top of these but they are not central to the experience and it is going to be significantly more expensive so it's going to be uh you know really interesting to see the relative adoption of this now hardware development takes a long time and i am we have multiple new headsets in the pipeline and this is the first year in a while that we haven't announced a headset at i'm at connect uh part of that really is an artifact of again truly heroic effort to actually get quest 2 shipped last year but it's still true that there's only so many points that we can test the solution space for hardware is large you can say more or less of a whole whole slew of different things and you can say binary features of have or have not on lots of other things i'm so we get to make kind of one bet a year about this and that is point sampling a complex high dimensional function and hoping that we can pull a lot of good information out of it you know in the eventually the mature vr headset market should cover all the niches that mobile phones do everything from fifty dollar budget phones to two thousand dollar ultra luxury phones uh but we only get to make a couple points we used to early on in oculus talk a lot about the possibility of kind of second or third party headsets that could interoperate with our ecosystem that turned out to be really challenging to do because uh like mark said we sell our headsets you know at a loss or break even uh there's no profit in the headset so there's there's no way that a company could go and say i want to make a budget headset i'm going to undercut the prices here without wanting to be able to negotiate for a cut of the eco system revenue you know that's just kind of the way those things work and on the high end while we could imagine somebody going saying well i'm going to make a very expensive headset most of the interesting features that we talk about things like eye and face tracking and world tracking these are things that require deep core system software integration to really make them valuable and so we can't work that closely with another company dealing with that it's just really really challenging there's still a couple spots where it might work if a company made a super wide fov headset or a super high resolution headset that was still basically the same thing it's still exactly the same sensors or exactly the same modalities that we have in quest two maybe something like that could work but there's nothing like that kind of really going on right now so i'm cost is really critical i i always worry about kind of disruptive innovation where so much of the time the things that come out uh come out as being cheaper than the things where people were focusing on quality and i worry a lot that we have people in research and product that have access to the best things that we could possibly build and you know they then look at that and say well we should be building the best thing we can build uh not necessarily the most cost effective thing and it's easy for people to fall into the trap of saying well i've seen better so this is garbage even if millions of people are getting a lot of great value out of it so i'm and there's also lots of evidence from a lot of consumer devices about very non-linear demand curves where sometimes lowering the price by fifty dollars or a hundred dollars can be way larger increases in uh in the number of sales that you get than you know than you would think from just linearly looking at it and we can't disentangle that so much with quest two because again quest 2 was better faster and cheaper and it went up very non-linearly but i still suspect that the price point was i you know was pretty important um there's but the other side of that is that we have people that we have demonstrated existence proof that there are people for which zero dollars is not cheap enough to make the current headsets valuable because there are plenty of quest 2 headsets in closets now that are not being regularly used we have lapsed vr users now there are no lapsed mobile users essentially everybody uses a mobile phone they might switch to a different brand but they never just give it up but there are right now a whole lot of people that are lapsed vr users that just did not find the experience valuable enough for them to even take something out of their closet that they already own so obviously more value needs to be delivered for us to get to the value point that a mobile phone has um it's an open question how much of that comes from software versus hardware obviously some has to come from both but like one of the test points that we're looking very closely at a lot of consoles go through this cycle where you get lapsed users and they resurrect when hot new content comes out so resident evil is one of our biggest tentpole releases and we're looking very closely at this to see does that bring cause people to bring the headset out of the closet play resident evil and then check out what else is new and how much better the ecosystem has evolved um but it is possible that we need higher end systems that we need systems with features that that we don't have now like some people really do believe that the facial tracking sensors that ability to be able to smirk or smile or look sadly for lauren at something in vr is i'm you know will take it over like a significant milestone that there will be some bright line that we cross there where it gets that much better that the experience is worth that much more than it was before you know maybe the sensing your environment letting you do more in the mixed reality side of things is critical lots of people i am you know respectable positions to take make that bet but personally i still think that the fundamental capabilities of quest that we just extended in quest 2 to are a sufficient baseline that if we could do another better faster cheaper of quest ii uh that it would be fantastic and we would see another significant uptick just like we saw with this so uh the untapped possibilities with that baseline and better software you know the normal improvements that you'll just always get camera resolution will go up ram will go up flash will go up processor speeds will go up or at least wider with more cores we're gonna get that anyways uh it's the question about these binary new things do we need to go from four cameras to six eight ten twelve i mean there are headset designs that have been proposed with a straight face that have like a dozen cameras on them and i think that's madness i you know i think that you're never going to get down to this low end potentially 50 budget phone thing with a dozen cameras software will let us get uh improve things in a lot of ways while discrete physical components are going to have a real price floor on them but i can be wrong so we're running the experiment with a higher end headset coming up next we will see how much value it adds to people uh they were intentionally very vague with the tease about what's going to be there but it's you can sense iron facial sensors uh better world sensors and then the pancake lenses and the pancake lenses are i'm they're much more expensive but they are much more compact um you know they're you can make a headset that is a lot smaller slimmer i'm potentially better looking and they're also potentially a lot clearer where one of the points that i've made is quest 2 over most of its field of view is optics limited rather than resolution limited you are more limited by our optics train when you're looking at things away from the very center of the screen than you are by the display you know if we double the display resolution most of it would just be a waste right now we need something that's going to add some additional clarity so i'm hoping that that really works out but that also might put a price floor on you know future budget systems if we wind up adopting that for everything um thermals drives so much of the design where i'm running out of time fast on this i am you know in so many ways we are already limited by just the power that we can dissipate for things where you know our system that we've got in quest one if we're able to run that at maximum clocks for everything it could do most of the things that quest 2 has and if we could run quest 2 at full clocks for everything you know it would probably have more performance than whatever the next gen soc is and we are we are very conservative about what we're willing to do on thermals at oculus i mean everybody is justifiably concerned about you don't want to have sort of a battery fire or you don't want to have something cooking and smoking on someone's head but i think in many cases as as i've seen over and over with like our displays and some of the other things i think we're overly conservative where i keep saying it's like all right you want to talk about we're going to damage something i want somebody to blow something up in front of me i want to see smoke coming out of this soc before i will really agree that okay there is a fundamental limit here uh so many of the and we went through all this back with gear vr where so many of the limits that people pick for how hot can we run something are just numbers picked out of thin air they are not something where there's a fundamental bright line here that we're going to cross so we've got a ton of different optimizations and things that we can add a lot of value to our systems if we allow ourselves to um there's the spectrum where you go from actively cooled systems like quest and quest 2 to where we've got a fan on there and a big heatsink and it blows through it to passively cooled systems like the oculus go where you can have a lighter system that's quieter um and then you get to systems that you might want to wear all day long you know the the notional future ar glasses you want to have something that you pick up in the morning pull off your nightstand put on your head and it's on your head for 16 hours and it's functioning like that that gets really really hard as you're going from not only is it passively cooled but a microscopically small battery relative to these large systems has to run it for that long of the time and then you're hoping people are actually engaging with it that it's not just a passive system so the challenges of energy are really one of the primary things that we have to deal with you know there's you know controllers didn't get much attention in anything being talked about today i'm you know i historically i completely own the fact that i underestimated the amazing value that we get in gaming from the sixth off controllers but it's still clear that we are going to wind up in a world where you can eventually get you know a headset without controllers where you just use your hands it's nascent now

it's got lots of room to improve but eventually we'll get to something like that or maybe it uses the brain computer interfaces i using more voice i'm you know other camera sensors for watching your eyes different things like that but the point i made a long time ago is it's clear we're not going to be walking around the world with you know dual sixed off controllers and holsters on our hips that's just not going to be the platform that gets out to a billion people but they are marvelous for games and there are all of these things that we can still improve the controllers we can wind up you know letting them track themselves so they don't have to be viewed by the headset we can let them be passively tracked so they can be cheaper you know we can wind up with things that allowing you to use your hands in place of controllers even in the existing applications but all these are things that just take work um and one of the designs that i'd like to see is i'd love to see an embrace of actual flexibility in the headsets you know our headsets are these big rigid things and i complain that we have to build these like tonka toys with uh you know big plastic toy shells around them where i'd love to see us go ahead and take something that was you know break up the modules into independent things so you can move them across let it be bendable there so you've got any ipd and make them more like giant swim goggles and track from there we can improve the you know the field of view with canting it there uh solve all of the ipd and placement issues let people get it really where they need to have it for the best sighting and uh and make a lot of progress so but still i think we could add a lot more value with software improvements than with hardware or at least with convenience which may involve some hardware elements one of the things that i revisited recently that in retrospect is even more striking where we have these few data points this half dozen different headsets that we've built and when you kind of compare aspects of them gear vr to oculus go was a really interesting comparison where by the time oculus go shipped samsung phones already had faster processors and better screens than what we shipped on go and yet oculus go had integer multiples better retention than what we were seeing on gear vr and it was all because docking your phone taking it out of the you know your case and putting it into a headset was just an enormous pain once you got there the quality of software was better than go but that friction of getting in there was again enormous integer multiples of difference in in i you know in our retention you know we fight over small percentage digits and this is multiples so i tend to believe that we have advantages like that just to be gotten by making our current platform just magically awesome you just put it on everything is perfect you know right now you put on a quest to there's seems like sometimes a 50 50 chance you're gonna have to redraw guardian depending on what time you la day you last used it you have to tap through accepting a couple different things you wait for home to load a whole bunch of panels then you finally launch something to go do it and it takes another 20 30 seconds or more to get into it and i tell people imagine if your phone was like that imagine you pulled your phone out of your pocket and it took you two minutes to get to do the thing that you wanted to do instead of two seconds there is an enormous value that we can tap into that to make it a lot better so sort of related to that the ultimate in inconvenience was we had the recent uh facebook outage which left a lot of people with headsets that were very broken and there is no real apologizing for this it was horrible that that happened but we had a really fantastic internal effort where there was a team of people that were going through cataloging everything that didn't work while that was going on it's like the saying is never let a crisis go to waste and i thought about asking if i could publicly release this because it would have shown how much we really are trying to figure these things out and make it better but uh but it had two it had far too much really internal stuff to just kind of dump that out but i really thought that was a very positive thing with people looking at that and it's a clear case of you can't you can't break people stuff like that we need to be delivering value not kind of inhibiting it or taking it away and the things that we're just starting to see the kind of the advance of multitasking into our systems where you know you can have the multiple web browsers and we have the ability to pull up the different android apps and the media apps and being able to arrange some of these like i was delighted the last time i was looking at something i thought the keyboard was awkwardly far away and it's like oh yeah i can just grab that and move it up to where i want it to be now that just worked magically well we have cases where like oh i can just now upload a screenshot directly to twitter from browser uh it just works now um okay now we can start doing copy and paste some of these things that you expect to be there you've kind of conditioned yourself haven't been there in vr because the platform's too young but they're starting to come in one at a time and we are going to get to this place where it is a more flexible work environment than any single glass screen that you've got that you could do things on and i you know we've got to do a bunch of serious work in there figuring out desktop all that management stuff we need to get virtual memory working like real swapped virtual memory none of this you know do a little bit of compressed swap for there we need to be able to have five applications that you've opened up let one of them page out if necessary so things don't just crash and disappear as you work on something else but we can get there we have huge internal battles about the different things like we're our plan of record here is where we're big on web apps but i keep making this point it's like the platforms that succeed wind up having native apps as well we run android apps now for some of our oculus tv systems i we should be running all android apps you know we should be able to pull in the long tail of applications where we have a few hundred applications in vr real platforms have millions of applications you know we are not going to bridge that by having people kind of bring them over one at a time but we get you know we i have arguments with people about how oh we need to get people to add vr affordances to their applications and the thinking is well maybe we can get the top 50 apps uh to come over and put in like extra ways to explicitly look for scrolling events and different things like that but i think it's actually our obligation and duty to figure out on our side what can we do to make the vr platform take advantage of this again trillion plus dollars worth of content on all of the flat screens we need to figure out how to take advantage of that rather than saying oh they need to change their applications to come to us you know we want to work on android apps cloud windows desktops remote desktop applications i want to bring everything in so that everything can be done there but on us maybe that means like i would love it if we made a decision on next-gen controller whatever we do to make it easier to act as a tv set or a laptop or anything like that you know it should be on us so we actually have a ton of features that are sort of not well exposed right now and there's a problem like for years we've had all of these options in uh like for video recording we've got all of these ways that video comes out of our systems we're streaming to the desktop pc browsers streaming to the fb live streaming to your phone with twilight recording it and generally our defaults are like not so great we've got all these options for changing the bit rate changing the aspect ratio and resolutions and you can get these through like our oculus developer hub application if you're a developer but i'm you know for conventional users there's not really anything that uh that lets you get there and i kind of wish that we had a the equivalent of the old quake console where you do some magic cord and you get like an old school text terminal and you could just type in different things to like turn features on and off because when we make an official feature it's got to go through our design department it's got to be internationalized for all of this and the way things are set up that has to be going through separate processes usually for running the panel displayed communicating with what's actually done and it is such an enormous tax on what we can actually accomplish and we need to find ways to go faster with that but i'm you know there's there's a lot of value that should just come with a simple little toggle i had um something i did recently where i saw someone make internally make a they had a big post about how to capture stereoscopic video from uh from inside vr and i was like well how did they do that we don't actually save that out and i was horrified to find that they actually did a full adb record of the distorted 2i view and then undistorted that to make a i you know to make a stereo video which we could then play back and i'm like oh my god that's that's just horrible that's i that's not the way you should do something but they cared enough to do that and they knew that getting it through our full system design process it just wasn't really going to happen it wasn't going to rise to the top but that was the type of thing like no that's actually not that hard i i took an afternoon and it just took a few hours for me to go in and put the the real way to do that but it's controlled by a system pref that you have to set over adb right now where i'd love to get that in an advanced settings option on all the record things uh but you know that's just that's going to be a thing that'll take six months for us to wind up getting something like that done so we need to figure out how to move faster on so many of those things we have more than enough people in the vr organization working on all of these features but we trip over our own feet in so many ways and i am totally running out of time here you know i think i'm going to try to do something uh that i've never done before here where i'm going to take these notes that i've got that i'm kind of scanning through here that i'm only maybe two-thirds of the way through and i'm just gonna dump them up on on a facebook post and send a link to it this will be an interesting insight into how i wind up doing these things i am because yeah i've got a bunch more talking about the system software stuff talking about developer things and then a few miscellaneous things coming in on the end and maybe these turn into topics that i'm you know that we can explore in some other ways but i did want to close with just i one funny little anecdote where i play a lot of beat saber and sometimes i actually put on arm weights i know that's not recommended for a lot of people you can strain your elbows and so on but i worked up to it it's part of my exercise regimen i but there was a time this year where i was playing beat saber i had my arm weights on i tell people don't hit me with e plus and camellia songs when i'm playing with my arm weights but sometimes people still do and it's it's pretty rough but in one of those sessions i got a phone call that i had to take and i had to just like jump out of vr and everybody else in the room was like john's little avatar just fell over and stopped moving did we give him a heart attack playing those songs in beat saber and i had to late come back after i was finally done on twitter it's like no i'm actually okay people were ping me it's like did you have a heart attack are you all right but i yeah i have a grand time in vr i am proud of the work that we do and i'm still very excited about the future so i'll see a bunch of you in a half hour at the q a session oh fantastic thank you so much john