ALBERT ZULPS: --first of all, that there will be some audience participation today. So if you're sitting near the front, too bad. You're stuck. I already know your faces, so you're going to be singled out to help us out here.

So my name is Albert Zulps. I'm the VDC director at Skanska. And first of all, I want to say thanks to everybody for coming here and supporting this. And I think you'll hopefully appreciate it at the end. We've got some pretty cool stuff planned for you and should have a good time.

My background is as an architect and an engineer. And I'm lucky to be working with Redpoint on some pilot projects doing real-time location. And I'm going to bring to you the contractor's perspective, and Jonathan is going to bring the technical perspective. And he's obviously the one that really knows his stuff. So I'll give you an overlay of what actually is happening.

And I think both Jonathan and I, personally, we're very frank people. So you're going to hear the real information. If you have any questions, we're happy to answer them. And we're definitely pretty candid in our answers as well, too. So, Jonathan?

JONATHAN HORNE: So thank you, Albert. My name's Jonathan Horne. I'm one of the co-founders of Redpoint. We're a relatively young company, and we've been at this for about five years, developing indoor positioning systems with a real emphasis on construction. So thanks for your time today.

ALBERT ZULPS: Without further ado-- so we have some summary of information. We just redid the handouts last night, so if you've downloaded the handouts previously, you might want to download the most recent ones. They make a bit more sense, and they're more succinct. So if you haven't downloaded them, I think they're worth having as reference.

So I won't go through all this jargon here, but I will say that there is a lot of connotations to being tracked and knowing where people are. So I was just wondering who here in the audience has any negative feelings towards being tracked, like you don't want anyone tracking you? Can you put your hands up?

OK. And who here doesn't mind being tracked, if you see the value to it? I expected the opposite. So I had a couple punchlines for that, than the other way around. So you really

messed me up here.

OK. So I think what's happening is there's a lot of misinformation on GPS and tracking and indoor GPS. So have any of you followed the airlines news recently, on Delta Airlines tracking baggage? It's been in the news the last couple of days.

OK, so those that don't know, they made an announcement that Delta is going to track bags. And they're going to use-- first they said a GPS tag on the bag, and they showed on the news how this wonderful GPS could show exactly where your bag was. And they had an aerial Google Maps view, and they showed a bag moving around an airport. I thought that's really not going to happen. And they showed this paper tag being wrapped around the luggage, and it probably has an antenna and a RFID chip in it.

So right there, the media is misrepresenting tracking technology. And one of the newscasters made a comment, you better clip that tag off your bag before you go home, or they're going to follow you home. They'll know where you went. So there's that idea that you can be tracked anywhere at any time. And you can't opt in or opt out.

So since then, I think NBC last night reran the same story. And they were clear to say that it was actually RFID. So I imagine what happens is-- I don't know the whole system, but you go through a gantry point, and it knows you in that area, and so it marks that's where your luggage is. So it kind of tracks it through milestones. But it doesn't know at any point in time, if you stole it and ran off with it, where it is.

So I think part of what we want to do today is dispel some of those myths and give you a better understanding of GPS, how it relates to construction, and Jonathan's company also works outside of construction. So I think there's a lot of great uses for knowing where things are as well, too.

So the objectives for today, then, are really learning what real-time location system is, and also some of-- we say practices and pitfalls, but it's still really emerging technology. So some of the things we've noticed in our startup projects, and we're addressing them as we go along, and where it is right now, and where we think it's headed as well, too.

And then I think there's an awful lot of future potential for real-time location. So I had a friend that lived in Singapore, and he worked in Australia. He started his own Chinese restaurant. And what he would do is he put MSG on everything, and everyone loved it. No one likes

monosodium glutamate, but it made everything, he said, more pow! Like, more better.

And I think that's kind of what real-time location does. Anything you have, if you add location to it, it's more better. It's actually really cool. So I think having that real-time location overlaid on different applications has tremendous value, and we'll try to show you some of that today as well. So Jonathan?

JONATHAN HORNE: I said, there's an Emeril reference in there, I think. Bam! Let's see. So when I'm preparing these slides, I have a million ideas that I want to communicate with you guys. And I know that when I'm standing up here, I kind of get that deer in the headlights look and I forget what I'm going to say. And it's really helpful for me to have this kind of interactive back-and-forth to get things warmed up and started. So I thought we'd begin with a review of some of the terminology that you're going to hear during this talk.

So here's a bunch of acronyms. One of them-- well, let me ask, from the audience, here's a softball. What is BIM? Anybody. At Autodesk University, what is BIM? What does it stand for?

AUDIENCE: Building Information Modeling.

JONATHAN HORNE: Yeah, that's right. And it's a really powerful part of what we're going to be talking about today. What about BLEs? Anybody know BLE?

AUDIENCE: Bluetooth Low Energy.

JONATHAN HORNE: Yeah, Bluetooth Low Energy. You've probably heard of this. Google's got their Bluetooth beacons. Apple's got iBeacons. These are devices that are constantly emitting Bluetooth signals that can be picked up by your phone.

What about M2M? Anybody? M2M? M2M is machine-to-machine communications, and that's what you get when the Pepsi machine downstairs starts getting low on soda, and it sends a message to another machine to automatically restock that. You're going to be hearing a lot about that.

And GPS, of course, we all know. You've got it in your phone. You might have used it to drive here today. So Global Positioning System. There's also kind of this generic term called GNSS, Global Navigation Satellite Systems.

Wi-Fi, of course, some of us would rather give up beer than Wi-Fi. IOT is the Internet Of

Things. It's what happens when your gerbil runs out of water and the water bottle automatically tweets you and tells you he's thirsty.

IOT is happening. It's not just a buzz word. It's actually happening everywhere. And there are all sorts of enabling technologies for that.

UWB is a big one for us today, this Ultra WideBand. And we're going to talk about different wireless technologies. But like Wi-Fi, like Bluetooth or BLE, this is another wireless standard that we'll use for indoor location.

RFID you may be familiar with, Radio Frequency Identification. There was a big push some years back by companies like Walmart that wanted to put these little tags on everything that came into the store. The thought is they could keep track of the materials or supplies from the moment they're shipped, to the moment they go out of the store. So you load up your shopping cart in the store, and this little antenna that's stuck to each item in your shopping cart automatically gets scanned as you leave the store. No human interaction needed.

The promise of RFID is that it's really cheap, that these little tags cost pennies. And it's yet to be realized, to get the mass traction that they were hoping for. But it is starting to pop up everywhere, even on job sites.

ALBERT ZULPS: And probably Delta Airlines. That's what they're using for their baggage handling.

JONATHAN HORNE: Yeah, exactly. All right. So today we're going to focus on IOT, BIM, and the big one here, RTLS, Real-Time Location Systems. RTLS, an indoor positioning system that shows you where someone or something is in real time.

So how does RTLS, BIM, and IOT, how do those come together on the job site? And why do we care? Well, here's a little motivation. So let's look at each of these issues.

First of all, how can we find someone or something? You want to be able to answer the question, where is Bob? Right? And if he's in this room, it's an easy question to answer. But if he's anywhere in the casino, not so easy. Same thing goes for tools. Where is that concrete saw?

Next up, alerts. There is a hazardous operation going on over here. Maybe it's a lifting operation. There's a crane doing some stuff. You want to know when somebody steps beneath that crane. You want to alert that person, and you want to alert somebody who can

either stop the crane or maybe take care of that on the back end.

And then reports-- you want to be able to understand how long it took to accomplish some job. OK, so I was building this wall on the second floor and it took us two weeks. We go up to the third floor. It's the same wall. How come it took three weeks?

And then for safety, you want to understand not just in real time when somebody is doing something they shouldn't, but how many of those accidents could have occurred but didn't turn into accidents? So here, four roof workers violated the edge safety zone on the roof. Now you have a record of when that happened.

And then just visual, being able to look at a given area without actually going up into your building, to sit there in your job trailer, or halfway around the world, and be able to see we've got 12 workers there right now. And they were supposed to have seven. What's going on?

And then tracking materials is important, too. So your piping just showed up. Your ducts just showed up on the fifth floor. Send me a message when that happens.

I was downstairs and I fired up Apple Maps on my phone and said OK, show me where I am. And this is what it came up with. There I am, that blue dot, somewhere in this area that's that blue circle. That's the kind of accuracy that you get with GPS today. It's really a marvel of technology. The fact that it gives you this today in your pocket is amazing.

But if you're trying to get from here to the Platz, not very useful. Why? And it's because GPS doesn't work indoors, at least not reliably. And it's because the signals being sent out by the satellites are being blocked by the structure around us.

How do we deal with that? Well, this is where RTLS comes in. This is the indoor positioning system. We can fake it. We can install our own satellites inside of the building, and that's what we've done today, and what we're going to demonstrate for you.

There are a bunch of different technologies and techniques that you can do used to do that. And we'll talk about some of them.

So in terms of techniques, some of these will be familiar, and maybe some won't. Our bodies, everything around us is constantly being bombarded with electromagnetic radiation. We've got zillions of Wi-Fi access points. You've each got a phone in your pocket or your purse. We've got FM radio stations beaming down to us, satellites, you name it. It's all over the place.

Those signals are unique. Whether I'm standing here or here, it's going to have a different what we call fingerprint, or signature. And if you can be intelligent about reading those and looking at those signals, you can figure out where you are. You can now map this room. You can make a recording that says, OK, I'm over here and I see these signals. And I move over here and I see these signals. And then you can interpolate between them.

This is being used today to good effect in hospitals-- and other environments, too-- using Wi-Fi RTLS systems. So today, if you go into a hospital, a modern hospital, oftentimes they will give you, as a patient, a tag. And this will allow the administration to see where you are, where the doctors are, where the equipment is. And it's all based on Wi-Fi RTLS.

You might have heard the term "pedestrian dead reckoning," or "dead reckoning," or "PDR." And the concept is really simple. It's just a matter of integration, right? So if I take five steps this way, and then I take another five steps this way, I can add those up. I get a vector sum, and I know that I'm now here.

Conceptually, it's very simple. In practice, it takes some pretty sophisticated equipment to make those measurements. Typically that's done with a device called an accelerometer, and if you've got a smartphone, you've got one of those in it. If you've played with an augmented reality or a virtual reality headset, those have it in it. When you're looking through one of these headsets and you turn your head, it's actually the accelerometers and gyroscopes in that device that are registering that movement, integrating it, and calculating your position as you do that.

Angle of arrival, or triangulation, is another technique that gets used. There are some sophisticated RTLS systems that are doing this. It's also the same system that you use when you're in the back country, or if you're on a boat.

So if you're in the eastern plains of Colorado and you look west, I can look to the north and I see Long's Peak at 290 degrees. And I can look to the south and I see Pike's Peak at 190 degrees. And based on those angles, I can figure out, OK, I can draw two lines from those peaks at the angles I measured, and they're going to intersect, and that's where I am on the map. We're doing the same sort of thing indoors using this AOA technique.

Signal strength is probably the most important technology that you'll see used today. And that's probably because of the ubiquity of Bluetooth beacons. So if you walk into a Starbucks,

and they have a Bluetooth beacon, your phone can listen for that.

And now it says, hey, you know what? I hear a signal, and it's kind of weak. But if I walk a little bit this way, the signal gets louder. And I walk a little bit further, it gets even louder.

And eventually, you're closing in on that center of that beacon. So based on that signal strength, you can tell how far you are, your phone is, or whatever this receiver is, from that beacon. That's important location information.

Now, it's not going to tell you which side of this wall you're on. In fact, that wall may accidentally interfere with that signal strength. Or, if your phone is here and the beacon's behind me, it's going to be weaker here than it is here, because my body is attenuating that signal. Good enough for selling you a latte, but not necessarily good enough for figuring out exactly where you are in this room.

The last main technology I wanted to talk about is time of flight. And you can think about this as sort of like a boomerang, right? So I'm here, and I throw a boomerang, and I hit that target, and it come back to me. And I measure how long it took to make that round trip. I can use that information now to figure out how far away I am.

In this case, the signals that we're sending are traveling at the speed of light, so quite a bit faster. Takes some pretty sophisticated technology to measure something that travels that fast, but you can do it. And so if you look in the corners here of the room, you see these little red devices. They're sending out timing signals in the same way that GPS satellites do.

If you have just one of them, you can get that same sort of radius information that you get from the signal strength techniques. Or if you look at three of them, now you can do trilateration, or four of them, or more, it can be multilateration. Basically, you're looking at the intersection of these circles here.

So coming back to construction, we're going to take these RTLS techniques. And any number of them could apply. And which technology is appropriate for the job site is really going to be a function of what you're trying to do with it.

So if you're looking for a scissor lift, it's enough to get to this room. If you get to this room, you found it. And so in that case, maybe having a Bluetooth beacon strapped to that is enough. If you're trying to locate building materials, and they're in your laydown yard, strapping a GPS transmitter to your ducting, that's going to allow you to find it, even though it's not going to give

you better than five-meter accuracy.

If you're indoors, and you're creating a punch list item-- you know what? That wall socket doesn't look great. I'm going to take a picture of it and create an issue. Now suddenly, that accuracy matters, right? Whether you're on this side of the wall or that side of the wall makes a big difference to what you're fixing. And in that case, this five-meter accuracy is not good enough.

And then, of course, if you're doing layout, you want to establish your control points, you're going to need better than that still. Now you're talking total stations, robots, and other techniques.

So the different technologies that you can use, there's actually a bunch of them. And you're going to hear-- as you walk around the conference today, you'll hear terminology like SLAM, Simultaneous Location And Mapping, and some other optical techniques. But really, these are the big ones. And these are all radio-based.

And there's a definite trade-off between cost and accuracy. At the low end, you've got passive RFID, like we talked about with Walmart. You've got active RFID, which kind of extends that. So passive RFID is a device where you've got this just cheap, stamp-sized thing that's collecting energy from an antenna and then reradiating it.

Active RFID adds a battery. So now you've got this device that doesn't need to collect energy. It can just radiate on its own.

Bluetooth does the same sort of thing. Bluetooth beacon is sending out a pulse. Wi-Fi, we talked about that. That's using the electromagnetic fingerprinting. And then ultra wideband, using time of flight.

So accuracy, ultra wideband's going to be the best. Cost, passive RFID is definitely going to be a winner.

So what value does RTLS bring to the construction site? Well, there's really four parts to this. The first one is visibility. Just understanding, being able to look at an iPad and see where these different trades are moving, it's really kind of mesmerizing the first time you see it-- just these bunch of colored dots and how they interact with each other. It's really cool to see. But it actually is pretty valuable as well.

And then having the ability to filter that view based on the role. So a builder can see all of the subcontractors, but maybe not necessarily who those subcontractors are. Right, so Skanska can see, hey, there's a bunch of electricians. I don't need to know that that's Jim Smith. I just need to know that he's a blue electrician, or yellow, in this case.

Safety is-- this is really going to be a key point here for us. If each individual on a job site is being tracked, there's a lot of things that you can do with that. The first one we've already talked about a little bit, right? It's creating these hazard zones, places where you just don't want that person to be.

And it can be credential-based too. So hey, you know what? This person is allowed in the subbasement, because he's been certified in confined spaces. But the other guy, no, he's not allowed there. And if he goes there, we're going to alert him.

And then sensor events-- this is where the IOT part of this comes in. This RTLS system that we're talking about is actually a full-on IOT network. It's passing data back and forth. Position data is just one of those things.

Sensor data is there as well. So if you want to measure vibration, dust, humidity, you can do that, and record it not just globally for the site, but for that specific location. If you want to understand the noise exposure that I'm experiencing right here, you now know, with eight-inch accuracy, how much noise I heard over the course of the day.

And then mustering-- this is a big one, too. Right now the mustering process is really pretty-- I mean, it hasn't changed much in the last couple hundred years, right? But now, if everybody on the site is being tracked, you can see, hey, look. Everybody, you can watch them flow out of the building, and they've gone to the muster point, except that blue dot over there. What's he doing up on the fifth floor? Better go check that out.

Or if it's not a muster, let's say it's a weather event. There's a storm coming in. You need everybody off the roof. You can do that and make sure that there is nobody up there.

Analytics-- another big piece of this. You've been tracking everybody on the job site for purposes of safety, for purposes of visibility. That leaves a trail. Every one of those position reports gets sent back to a server. It gets logged and recorded.

Now you can run some really powerful analytics on that and say, hey, you know what? What's

taking the most time? Where can I improve this by moving materials closer? Or, I don't know, I guess we'll come back to the dashboard later.

And then understanding incidents. Like we talked about for safety, how many violations happened, even if they didn't turn into accidents?

And then, just at a very basic level, understanding time and attendance. If you want to know how many workers you had on site, or how many of each subcontractor were on site, or how many people were working in this particular zone at a given time, you can answer those questions.

And then the last part of this is messaging. And so if you've got this IOT network, and you've got a communicator on everybody, you can send a message to those people. It can be an individual. Hey, Bob, we need you down at the trailer. Or, I want to send a message to all of the drywall folks. Hey, we've got a meeting in 15 minutes. Or, everybody off the roof.

And then it's a two-way network too, right, so you can send help messages back if you've got a button, right, that you can push, or some way of communicating back to a supervisor. You can say, anybody in the third floor, go check out the northwest corner, because somebody has triggered an alarm.

So if you deploy a system like this on a job site, this is kind of what it looks like. If you've got a vertical structure, you end up putting in these devices here. Those red circles are anchors, or beacons, or whatever your technology calls for. Here, we're focused on ultra wideband. That's what Redpoint does. That's what I know best. So we're talking about those.

Those red circles are the same thing as these red devices in the corner here. And they're talking to each other. They're forming a mesh network. And they're sending out timing signals at the same time.

These red dots here, these are people being tracked. Those are badges that are being worn by people. And they're listening for those timing signals, constantly understanding where they are, and sending that location information back through the mesh network to a server. That server lives in the cloud there, and it's connected wirelessly. And so that every one of those people gets a location sent to the cloud once a second, or four times a second, or however frequently you want.

And that's where you can then access the cloud data with your analytics and dashboarding

and so on. Please?

AUDIENCE: What's a mesh network?

JONATHAN HORNE: Question is, what's a mesh network? So there are different wireless architectures. There's kind of a star topology, right, where you've got a master device that's talking to a bunch of other remote devices, and then there's kind of a bus network, where they're all kind of in parallel.

And then a mesh network is this system where a device talks to all the devices around it. That device talks to all the devices around it. And in that way, you can cover an entire area. And if you need to send a message from over here to over here, it doesn't go directly, because they can't hear each other. Instead, it will pass from point A to B to C through this mesh.

In this case, the mesh is this wireless setup that we've put in the building, right? So we're basically establishing a means of communication across each of those nodes in the structure.

And then the last part of this are these zones that we create. And these are virtual geofences. They're not actual physical zones, although they might be. They might be that somebody is digging a trench over there, or it might be a laydown yard over here.

Whatever it is, you go and you create, on your iPad, or on the web interface, you can say, hey, you know what? This is a zone that I care about, either for safety reasons or for analytics. You know what? Every time somebody steps in that zone, I want an alert. Every time a piece of equipment moves into this zone, send an alert. And that can be a message pushed to my phone. It can be logged on the server. However you want to configure that.

So then the last piece of this is just kind of the networking aspect. OK, so you've got this mesh network that you've built out in the structure, and that's done using these devices called anchors, UWB anchors. These tracking tags are what's talking to those.

So we think of it-- this is your GPS receiver, and these are the satellites. So these guys send timing information to the tag. Tag figures out where it is, sends out location information back to the anchors, and one of those is going to be connected either directly or through the mesh to a cellular access point. That cellular modem pushes all that information up to the cloud. And then once it's in the cloud, you can access it via your tablet, your PC, what have you.

So we talked a little bit in the last slide about zones. Here's what it looks like in the field. So you can create keep-in zones, keep-out zones, and use Rules Engine to configure what happens

when somebody gets into that zone, or what happens when somebody leaves a zone, someone or something. And it's as simple as really just kind of clicking on the iPad interface here. And we're going to show you that in a few minutes.

ALBERT ZULPS: Like right now, actually.

JONATHAN HORNE: Yeah.

ALBERT ZULPS: So you guys ready to have some fun now?

AUDIENCE: Yeah.

ALBERT ZULPS: OK. So Jonathan is going to actually get the live demo working. We're taking a chance. So this is live. It could actually backfire, but I think it's going to go great. And also this is being recorded, so if it does backfire, you can forward it and tweet it and do whatever you want, because we can't stop you.

So I need-- I think I need three volunteers out of the audience. Do I have three people that want to be tracked, that don't mind? OK, one, got one. Back there, number two. And number three. OK, come on up here.

OK, so I guess this is Las Vegas. They do cosplay or something here. People do roleplaying stuff. So who would like to be the drywall person? OK, you're drywall. OK. You get the cool vest. So just showing you some different technology.

OK, we have a couple tags here. You can get this ready while I do that. So if you can read what it says on your tag?

AUDIENCE: Electrician.

ALBERT ZULPS: OK, we have electrician over here. And here's your tag. What are you?

AUDIENCE: Flooring.

ALBERT ZULPS: Flooring. OK, so we have three different tradespeople. So just start wandering around. You can stick together, move around, do whatever you want to do. You can start seeing on the screen, you'll notice a little bit about the accuracy, the latency. It's-- don't go too near the door, though. We haven't really adjusted this too well.

How did you leave the building? Come back this way. I think we have to fix the anchor in the corner. But generally, it gives you pretty good accuracy.

The vest is actually an older device. The tags you have are brand new. They're only a few weeks old, and the tags allow the two-way information to go back and forth.

But you can see, you can tell pretty much where people are, where they're moving around. And what we did was we built a 3D model of this space. We used building information modeling. And then-- that electrician. I don't know.

JONATHAN HORNE: Where's that electrician? What's he doing?

ALBERT ZULPS: Yeah, the battery's going to be going low, because it was working well earlier. So anyways, you're wandering around a little bit. And you can see that latency is OK. It's actually pretty good. So this is the basic scenario here.

So imagine if you are looking for somebody, and you look on the fourth floor, and you know right away the electrician's working in a corner somewhere, and where the flooring guy is. But if you start seeing the colors all stacking together, you probably know that you've got trade stacking going on. There's probably a problem. So if you give these tags a color code by trade, I think there's tremendous value, just this in itself, having a real-time image. But imagine that you can actually record this.

You got to come back. You keep moving around too much. I think the batteries are going--

JONATHAN HORNE: What's that electrician guy doing?

ALBERT ZULPS: I think the batteries are going a little low in that. But basically, we can track where the people are, and you can see if they're working in the right areas. You're getting a good workout there too. You know what's going on there?

JONATHAN HORNE: I don't know why that's doing that.

ALBERT ZULPS: Probably because you have your arms crossed. Maybe just uncross your arms for a second. Yeah, because I think what's happening is that's an older tag, and it's buried inside, and you're

actually blocking the signal when you cross your arms. Or maybe not.

AUDIENCE: Or maybe not.

ALBERT ZULPS: Or maybe not. OK. So next, we're going to actually create an exclusion zone. So I'm putting Jonathan on the spot with his dexterity, but you notice over here, there's some yellow tape on the floor. So Jonathan knows approximately where that is, but that actually represents-- it could be a welding zone or a hazard zone of some sort. It could be a fall protection area. We could have some core drilling going on up above.

And it could be actually a rolling exclusion zone. It doesn't show, but he's actually programmed it. So wherever the core drilling machine is, the floor below creates an exclusion zone. So if we don't have a sentry there, we'll know then to actually-- when you walk in, you'll notice a beep going on.

So now he's created that zone. If anybody wants to walk over into this zone and see what happens. [BEEPING] So you notice first of all, the tags-- the badges give an alert. The vest actually starts flashing. So there's different ways of doing this.

This could also send a signal back to an iPhone or an iPad or your supervisor, or it could be something where we just don't want electricians working in the same area as a flooring guy, because the flooring guy has been complaining that he keeps messing up my floor all the time. So it could be something we note, and later, if there's any kind of a claim, we can go back and we can process it.

So that's kind of the system live. But now I'm going to ask Jonathan to do some jujitsu here. So if you can maybe do some playback, first of all, just see what happened.

So there's some features in here that it's actually a pretty rich dashboard here. But it will allow you to play back this at any point in time, and create heat maps, and do all sorts of analysis as well, too. So later, if you have a claim, you can dial back to that day and by the color coding, tell who was doing what when. So I think, immediately, you can see the value of something like that. So here we go.

So the next thing maybe we can show is the heat map. OK. And then on the console on the bottom, I won't ask Jonathan to go through it, but you can see some tabs down here. So there's actually-- you can create and modify your zones to create permissions and things. You can actually go into the data and you can change the-- you can push messages out to the

tags, and you can change the names on them, because you'll notice the tags themselves, if we title it "electrician," it comes through as "electrician."

Here's a heat map to show where people are working. So you can imagine you can overlay the heat map of where the electrician was working all day with the heat map of where the flooring guy was working all day, superimpose the two, and immediately you can kind of tell intuitively if there's any kind of conflict. So there's some value there as well.

On the analytic side as well, you can feed out into reports as well. So you can do time and attendance and things like that as well. So this is kind of the wow factor. Anything you want to add to this, Jonathan?

JONATHAN HORNE: Yeah, I want the electrician to leave because he's ruining our demo.

[LAUGHTER]

AUDIENCE: Well, he did leave.

ALBERT ZULPS: There he comes. He's coming back.

AUDIENCE: [INAUDIBLE]

ALBERT ZULPS: Is that you?

JONATHAN HORNE: Do you have a pacemaker or something?

ALBERT ZULPS: Oh, electrician is this one. Oh, that's the vest. You're the drywall guy. We got you all mixed up.

AUDIENCE: I'm [INAUDIBLE].

JONATHAN HORNE: Oh, you know what? Your tag is actually flipped around. I don't know if that makes a difference or not. He had it flipped towards his body.

ALBERT ZULPS: So as I said, this is still in the kind of beta testing progress. But I have to say that as a contractor, my perspective is it's extremely promising. It works most of the time. And we're getting rid of some of the bugs that we were noticing.

And in the next coming slides, we'll actually show you how we actually implemented it in a

project, the pros and cons, and how fast it's changing. This technology is getting better and more accurate every day, too. So anything else you want to add before we go off the demo?

JONATHAN HORNE: Just to mention, though, you did this drawing in CAD, right?

ALBERT ZULPS: Yeah, or in Revit or ARCHICAD or something. Actually I did ARCHICAD, but let's say Revit, for the record. I used Revit.

[LAUGHTER]

JONATHAN HORNE: Just to bring that back around, right, is that this is tied to the model. You've got your model for the building. You'll export the drawings for this. And here you are. This same floor plan shows up either on your iPad or on Windows, like we're showing here, or on the web.

ALBERT ZULPS: OK, thanks for volunteers. I hope we didn't embarrass you guys too much. I hope you had fun, too. That was great. Thanks. So I think you're still up, right?

JONATHAN HORNE: I can't remember. So I just wanted to circle back around, and we showed a-- well, so you saw kind of the real-time benefit of tracking like that, and the kind of the alerts that you can generate, the safety benefits. And this is just to circle back and say that we are recording every one of those position updates, and it gets logged in this database that you can then use to generate real-time KPIs, key performance indicators, and alerts here on this dashboard, that again, you can see while you're sitting there on site, on your iPad right in front of you, or from halfway around the world.

You've got this real-time visualization and messaging. So you can say, hey, I see that guy in that exclusion zone. I'm going to send him a message. Or, I want to send a message to everybody on the roof, or each of the electricians.

And then you've got these reports. You can generate daily, weekly reports and do all sorts of breakdown by trade or company or individual. I think that's it.

ALBERT ZULPS: OK. Thanks for this one, Jonathan. You're making my life easier selling it on our projects.

JONATHAN HORNE: So one of the first things that we get a lot in-- maybe not in this crowd, because there weren't too many of you that seemed reluctant to be tracked-- but everybody says, wow, that's very Big Brother. And yeah, maybe it is. But it's also got a tremendous amount of utility.

Privacy concerns are first and foremost. People say, hey, I don't want you watching me go to the restroom. And I certainly don't want you to know how much I'm smoking.

And so I think about it in terms of this van here. Where I live, we've got these radar vans. So if you're driving along-- and I tend to speed. I've got a bit of a heavy foot. I hate seeing these things.

And even though there's a sign that says "Radar Van Ahead," and then I blow by this. I'm like, argh! But it works. Right, it definitely changes my behavior, whether I like it or not. And this sort of system hopefully will change behavior for the better. Yeah, so maybe there's that smoking aspect of it that people don't like, but there's also the "it's going to keep you safe" behavior that's going to change as well.

And then there are environments where people are tracked anyway, or should be tracked. And this comes up in construction in projects like schools or active hospitals. If you're renovating an active hospital, you definitely do not want the construction guys walking through the OR. We can tell you when that happens. Airports are another.

And then the end goal is, first, make the place safer, but then also provide tremendous utility. So utility to the builder, and utility to the end workers. So if you've got this location information, that's a really powerful tool for navigating around your model in real time, for connecting to your AR and VR gear, for taking punch list items and georeferencing them to the model. All sorts of things you can do. Hey, you want to know where that drill is? Oh, it's up on the fifth floor.

And then, of course, safety is the big one. And so there are a number of components to that. One of them is this real-time alerts. Hey, you shouldn't be there. Get out.

Another one is, man down. You know, and hey, that tag over there hasn't moved for 10 minutes. Maybe we should go check on it. You know, maybe they just kind of set it down and forgot about it. Or maybe he fell and nobody knew he was there.

And then the last one is mustering. And we talked about that a little bit, but being able to tell people where they should go. You know what? You're on the third floor? You should exit by the northwest staircase. You're on the second floor? There is your muster point. Go there.

And those people who are monitoring this can see in real time, have we got everybody out?

And if not, where they are, and what to do to go get them.

And then there are some real challenges to implementing an RTLS system on a job site. One of them is this cloud connectivity. Again, we talked about, well, you have the option of having a server onsite if you want. But it's much, much easier for everybody involved if that data lives in the cloud, because now you can access it from anywhere. To get that data out from the site back to the cloud, you've got to have some sort of internet connection. Today, we're using cell phones for that.

And I'm going to flip ahead just to show you this picture. This is just a map of the cell phone connectivity for T-Mobile over at 101 Seaport that Albert was talking about. You can see there are some spots that's green. That's really good coverage. Other spots are red, and that means we've got really crummy data connectivity. And when we're going to a new job site, we don't necessarily know in advance which of those colors we're going to have.

So we end up trying to diversify our support for carriers. We have T-Mobile, AT&T, Verizon. And who we end up using is very much a function of that, and we have no control over it. If we get backed into a corner, we can use Wi-Fi. We can install Wi-Fi access points, and those have to be cabled up somehow-- to fiber, to cable, what have you-- and then Wi-Fi to the UWB access points.

AUDIENCE: I have a question.

JONATHAN HORNE: Yes?

AUDIENCE: So when people are walking around the building, how are you getting that information? Like, are you getting it from the physical vest on the man?

JONATHAN HORNE: That's a great question. So I didn't explain too much about the architecture of the system that we have set up in here. The question was, how are we getting the location information out from the system that you just saw in the demo?

The short answer is there is a server sitting under the table in the back corner, and it's connected to one of these anchor points with that cable. So it's going-- any location data gets sent to one of these anchors, and they're all meshed, so it's going to send it from that anchor point back to that-- we call it a bridge, which goes then to the server. Now we can query the server.

And then these anchors, today we stuck them up. They're battery-operated devices that we just stuck to the wall using sticky tack, and it works pretty well for the demos. On an actual job site, we'll use a ruggedized device. It can also be battery-powered, and it's a much bigger, more ruggedized device that can last for a much longer period than these little guys.

But if you're going to have an installation that's designed to be permanent-- in other words, if this is going to stay, for example, you are building a hospital, and now you want this to be used not just during the construction phase, but by the owner when it's all done, you're going to want to wire those devices in. We do that using cat5.

And on a job site, it can be pretty awkward. You can see this is an actual site here with cat5 cable running up to this precariously positioned anchor. And then, of course, wall materials. These are radio signals, and they're not going to penetrate concrete, not going to penetrate steel, brick.

We can get around that problem on the job site by building out a mesh. Right, we do this, we see this a lot with elevator cores, as an example. We just build the mesh around them. But it is a consideration when you're deploying the system.

And then, wearability considerations. Right, we had these badges, and they're designed to be clipped to a vest. You could put it on a lanyard. You could clip it to your waist.

But where is it going to be tolerated? And this is something that we're still exploring. Maybe armbands are the right place for it. Everybody wants it on the hardhat, but you can see the size of the device. Not real practical. And maybe not great for alerting either. Definitely room for exploration, improvement.

And then Albert's going to talk about some of the real-world experiences with onboarding. But when you've got a bank of 100 or 500 of these things, how do you keep track of them? Who do you assign to-- which subcontractor is it, and how do you sort all that out? It's a real issue that's being worked through.

And then I think Albert here will talk about--

ALBERT ZULPS: I'll carry on from here. So I'm going to talk now about an actual case study. So we've actually done three pilot projects. Two of them are more confidential. They're health care projects, so we can't really disclose the client. So I'll relate some of that just through this one project.

This is 101 Seaport, in the innovation district in Boston. And we actually built this building ourselves. Skanska CD was the owner. And Skanska USA Building and Civil put this thing together.

And we actually inhabit the second floor here. So we thought this was a great place for a pilot project. The project was underway when we started doing this.

So you know, one issue we had was, can we get people to wear it once the contracts are signed? And so rather than even go down there, we looked at this more as testing hardware. And a few people voluntarily wore tags. But for the most part, this was a proof of concept to see how it worked.

But then we decided to leave this in place, hardwire it, with the idea, the business case, that maybe we install the system during construction, and then afterwards, the people in operations, like the hospitals and other owners, might actually see benefit. You know, they can track their equipment or their personnel. So the idea that this becomes a living lab. So this is a partnership between Redpoint and Skanska, and they come by all the time and they change out sensors and we try different things, and it's almost a daily, maybe a weekly basis that we try something new there. So it's pretty cool.

So I'll skip over some of this stuff, and what I'll do is go over just the pragmatics of how it was put together. So I don't know-- who here is involved in construction and construction projects? Most of you? OK, good. OK. So a lot of contractors will put digital resource stations or some sort of--

JONATHAN HORNE: [SNEEZE] Sorry.

ALBERT ZULPS: Ah! I thought I died. Oh, gesundheit, by the way, too.

JONATHAN HORNE: Everybody awake?

ALBERT ZULPS: Yeah. He sneezes and my nose actually sniffles. I don't know what's going on.

So the digital resource station is just a way to get this out in the field. So one concept is the transparency. So if you're setting up a system like this, what we notice right away is there's

rumors going around, like, oh, they're going to start spying on us. And the tradesmen, a lot of times-- they're tradespeople, woman-- they will actually imagine the worst. And they're always-- they're suspicious.

So by having it right out in the open, by saying, hey, this is what we're doing. This is the digital resource station. You can grab your drawings. You can go here to find out what the weather is.

But also, you can track people here. You can track your trades. So if you're an electrician, you could come to this resource station and say, where is the rest of my crew?

And we don't want to track by individual. We prefer to track by trade, to keep it somewhat anonymous. So you can see, oh, the electricians are working on the fourth floor. The drywall is working on the fifth floor.

So you can immediately save a lot of time. You can tell that benefit there that's kind of like a Lean tool to use. But also doing that transparently is really good. So having this digital resource station, setting it up there, we're able to actually walk people through and show them what's happening, and dispel some of the suspicion that was happening too.

So similar to the room here, we wired these little-- I think there's a laser pointer on here somewhere. Give me a sec. I don't know where it is.

So up there, there's a little-- one of the anchors. And you can see them in the room here as well. So the difference here is you can notice there's cat5 cable plugged into it. So the building was basically a core and shell at the point we did the starting fit out.

And it's a good time to actually install a system like this. They can be weather protected, but this makes it much cheaper and easier. And that cat5 cable, the LAN cable, just powers it. So when we located these anchors, we did it in locations where when the building was finished, we could just pop them on top of a ceiling tile and adjust things.

So there's some issues with some of the signal strength, but for the most part, we were able to locate these during construction, and then as the building got finished, we could just shove them up in the ceiling and keep it working, and occasionally augment what we had with another anchor. So that's what you see up here.

What you see over here is the idea of tracking tools. You don't need the resolution that you

might need for an individual to make sure they're on the right side of a barrier, but you want to know where that tool box is, which floor it's on. So you can use an iBeacon or a Bluetooth device.

So using that IOT network, the dual band, working in ultra wideband and Bluetooth, allows a lot of different things to tie in. You probably can't see it, but there's a USB connection on the side of those anchors as well. So you could plug in a lighting sensor or something else. So you're really creating an infrastructure that can be used for a lot of different purposes in your building.

So this is what we did during construction. This is what the floor plan looked like. So I turned on all the layers here, so you can see these are the fixed and the bridge, the red and the blue. They're the anchors.

So normally you'd have all this turned off. I turned it on just you could see how many we had over the space. So roughly, I think, about 100 to 150 feet, they can get a signal to work fairly well in a building. So we look at conveniently where to put them, and then the yellow tags you see there, those are the different tags that actually track people.

So generally, I just turned this on to show you the array of how we do this. And then this is available for anybody to see. You can go online and get at this dashboard, or you can use your iPad and see that. So this is how it was set up. That's their actual floor plan right there.

So we can make this work in two ways. One is we can have a server in the building and connect it to the internet, and that's what we did it at 101 Seaport. This is from a different project where we used the cell phone carrier and Mi-Fi type of card.

So one of the first things we came across was, how important is the data? And if it is, how do you back it up? If the cell phone stops working, and everything's cached to the cloud, you're losing that data stream until that system works again.

So you might need a local server to cache that information, keep it local. Or perhaps you feel more comfortable having a local server and then tying it right in with fiberoptic cable to Verizon or Fios or something like that. So there's different ways of setting it up.

101 Seaport was kind of hardwired in from the beginning. Some of these projects here are set up with different cell phone carriers, and in hedging our bets, even using two different carriers in the same project, and also noticing that sometimes things work and sometimes they don't.

So even a carrier with good coverage, there can be lightning in the area or other reasons why the system doesn't work so well.

So those are things we're trying to figure out. And if it's a mission-critical, life-or-death thing, the system has to keep running. But if it's data you want to use historically for claims avoidance, perhaps, and you can miss a day or two here or there, then you can go for a simpler system, just going right to the cloud instead.

So the other thing was wiring-- just putting the cat5 cable in and wiring is still a fair bit of work, and figuring out the contracts, who does that? Do you tie it in to an electrician? Do you have the people, like Redpoint, come onsite and put it in? Does Skanska do it? So figuring those issues out.

The idea is if you're not going to migrate the system over to operations, building operations, maybe you just want to use battery-powered anchors instead. And this is an idea we figured in one of our projects where we just take the fire extinguisher stands, which are actually, by code, required at less than the distance that's ultimate for Redpoint, so it's actually a really good array of fire extinguisher stands. Putting the battery in the stand, and then basically the system is kind of a self-healing mesh.

So if you were to move one of these out of the way, as long as the other ones stay, it localizes that one to its new position, and it uses it kind of like you'd use a badge. It kind of reports back where it is. Or you can put it back. We could put lines on the ground and do a chalk outline, so that when a scissor lift came by, if you had to move your fire extinguisher stand, you could put it back when you're done.

The interesting thing is, there's a lot of Bluetooth-enabled devices you can use, including a fire extinguisher that can report back the pressure and the location. So what happens a lot is a welding sentry will borrow a fire extinguisher, forget to put it back. Well, that's a life safety device. That's really important.

So by making this visible, by putting these beacons in a place where maybe there's issues of vandalism or people are suspicious, you know, making it public, making it part of the safety system, it's more likely that it will be successful. So this is where we are right now. We're kind of doing prototypes of battery-powered fire extinguisher stands to set the system up.

And then you saw on the front here, if anybody is curious after, you're welcome to come up

and talk to us, but Jonathan actually brought one of the charging banks with the badges in it. And so this brings up a whole other level of exploration we're doing, and how to actually manage the system. We're still trying to figure it out right now.

But one concept is that the subcontractors put a deposit on a bank of a 10-pack of badges. So they come in a charger with 10 badges in it, so if they have 30 people on the job site, they probably have to have three banks. And then they're responsible for charging it and administering it every day.

On one of the projects we're doing now, we actually do that. And it gets to be a bit of trouble when you change the trades from this trade to that trade. You have to go back in and reassign the badges.

So that administration, we're trying to figure out where it belongs. Do we want to be administering these badges every day? Do we want to assign them to an individual? Do we want to assign them to a company and they put a deposit down? So those are things we're figuring out.

But suffice to say that actually it looks pretty promising to give these to the subcontractors, let them manage it. And one way of looking at it is if you don't have a badge that works when you come on site, you're not getting paid. So it's in their best interest to keep it going.

And then University of Michigan did some studies for us where they sent some questionnaires out to union and nonunion personnel to say, would you mind being tracked at a job site? And I really am very impressed that the people here are open-minded, because I thought a lot of this would be trying to steer your opinion. But I think everybody is in the same train of thought that it's a pretty good idea to do this type of thing.

And what they found in their study was that the younger generation just starting out is more into the social aspects. So if it's, like, a FitBit type of band, if it looks cool, if it can help them network with each other, find each other on the job site, they're all in. The older generation and the management are more about the value. If they see the value of tracking progress or productivity, then they're all in. But there really wasn't the kickback we thought that we would have from this, which was a little surprising.

And I think one of the key things is if you're working transparently, then everybody knows what's happening. And before a project starts, you can set the expectations, make sure

everybody is on board. It's a hard technology to bring in mid-project, like a lot of things, like BIM or anything else. And then with the unions having a clear project labor agreement from the start, it is really helpful too.

So if you know you're going to have a project that's unionized, we have one project on the West Coast, union personnel had no issues. They just wanted to make sure they're tracked by trade, not by individual. But it was never a problem. So we perceive all these problems in tracking people, but a lot of times they aren't there. They're in our own mind, but we can easily work around them.

And I think this is just basically some ideas. I thought in our outline we had some very specific things we could do to help with efficiency. So what we're finding right now is creating safety exclusion zones, there's tremendous value to that, to doing it accurately. So I think that the benefits for safety are immediate, and we're already starting to see them.

For efficiency, I think for Lean planning, if you can just look at something as simple as how far somebody has walked, and reduce that distance by-- they walk five miles a day in their job, reduce it to four miles by better strategically putting equipment and materials, you're actually increasing your productivity pretty dramatically. And that's what we found in one of our projects. We were able to reduce the walking just by a few percent, and actually help on productivity too. So for Lean planning, making sure people are where they say they are, that they're following their manpower loading and things like that are extremely important too.

The idea of doing automated reporting, you know, if there's ever a claim, there's usually two or three different versions of who was on the job site. There could be an MWB number. There could be the number from the job itself. The subcontractor will have their own numbers.

So if it ever went to court, you have all these competing numbers. So knowing upfront, everybody, from the beginning, where those numbers come from and that the system works, it helps in communication and transparency and expectation, and hopefully avoids some of those claims that are really hard to dispute or figure out what happened.

Just locating people is really valuable, too. Just knowing where someone is. Trying to find the foreman of a project. You know, you can spend a lot of time running up and down a large building.

I know that we do have a lot of projects where you can get disoriented really quickly. We had--

I think it was the Harvard Fogg project, where the basement has incredible mechanical spaces, and even people at work on that project were getting disoriented. You'd go down in mechanical spaces and you'd walk around and you'd-- if there was an emergency, getting out could be difficult. So the wayfinding aspect of it I don't think should be sold short either. It's really important.

So those are some of the things that we look at for construction that we're pretty excited about. And then I think Jonathan and I just talked a bit about the future. We have just a couple of minutes. So I think we're running a bit late. We wanted to have time for questions. So anybody that wants to stick around afterwards can definitely ask us questions too.

So I will skip this. This was just showing that when you overlay two bits of data on top of each other, there's tremendous value. But I won't go too much into this.

I will say that 3D Data is a company that does kind of real-time laser scanning. So the promise of the future could be something like a 3D-- you know, a real-time laser scan with one of Redpoint's heat maps. Put those two on top of each other and you know what's happening and when it happened. I think that's pretty cool. So when you start overlaying different technologies together, I think it's very powerful.

And I think Jonathan is going to close with this slide here.

JONATHAN HORNE: Just a couple bullet points to mention, that I think RTLS, it's not a question about is it going to happen? It's happening already. And there are a couple of things that are making that possible. One is BIM. Right, now BIM is finally getting that ubiquity that the vision predicted.

And IOT is also happening. We're just kind of on the frontier, but everything is starting to talk to everything else. And then RTLS, we demonstrated a technology today. There are several out there. You're going to see this more and more, whether it's shopping malls, hospitals, or job sites.

And then some of the trends that you're seeing, just in general, that are going to make this possible, is that everybody in here, I'm guessing, has a smartphone. This is the new generation. Kids are growing up and it's expected they're going to have phones and know how to use them. It's this familiarity with technology that's going to make this so that they don't just allow for this to work, but they expect it to work.

And then there's also this kind of overall willingness to trade privacy for convenience. Right,

you enable this location information in your Facebook because it gives you all these immediate benefits. Same sort of things can happen on job sites.

And then just overall, technology is accelerating. The pace of adoption and innovation with the cloud, with BIM, with RTLS, with IOT is just getting faster and faster. So it's going to be here before you know it.

And then lastly, just that you probably saw a lot of excitement downstairs about AR and VR and 3D visualization. All of these things are going to come together to make this happen.

ALBERT ZULPS: So I think that's it. I just want to mention one thing. BIM 360 Field, having a program like that, and having location enabling within that, would be extremely powerful.

So there's a lot of applications you probably use. If you added the construction, the location, that would be extremely powerful. So I wanted to close on that.

It actually is-- we have four minutes left, so we'll open up to questions. But if anybody wants to leave now, I totally respect your time. So I won't take it personally if you walk out on us now. So with that, we'll start with questions. OK, we'll start over here.

AUDIENCE: Does your insurance carrier weigh in this technology and what saves there could be on your insurance policies for the worker's compensation? Or is it still too soon?

ALBERT ZULPS: It's a little soon. I think Jonathan might have a comment. But there's obviously value in the insurance industry, and there's another similar idea out there. Human Condition was a company that was bought by AIG, like, an insurance carrier. So I think that there's tremendous potential there, and we're not there to make an intelligent conversation about it yet. But Jonathan, do you have any comments on that?

JONATHAN HORNE: No, no, no. Sorry. I just wanted to make a connection there.

ALBERT ZULPS: Any comments on the insurance issue?

JONATHAN HORNE: Yeah, just to reiterate what you just said. I think it's too early. The insurance companies are very much looking for this data, and they want to understand it, but are waiting to have that proof point.

ALBERT ZULPS: Up here?

AUDIENCE: What's the ratio of these [INAUDIBLE]?

JONATHAN HORNE: Yeah, so the individual radio devices have a range of 50 meters, so 170 feet. But you can extend that network as far as you need to just by building out the mesh.

AUDIENCE: [INAUDIBLE] 50 meters.

JONATHAN HORNE: 50 meters.

ALBERT ZULPS: Over here?

AUDIENCE: You sort of went over this, but [INAUDIBLE] Was there any indication from that project site as far as, down the road, [INAUDIBLE], it's going to be a non-issue? Could you elaborate on that?

ALBERT ZULPS: Yeah, I could say, like, at 101 Seaport, that actual project, when I approached my internal people and asked them if we could do this, we have a person that negotiates project labor agreements within Skanska, and he wasn't comfortable going and having the conversation with the unions now. So we didn't even put it on the table to test the waters. So he said, in five years' time. That was his way of looking at it, his stance. And he was originally affiliated with the unions.

So I think that there's change happening, and I think unions realize that. But we're also aware that some unions are more powerful than others. And I think there's-- some steel workers are exempt from a lot of really practical safety laws, because their union made them exempt. So there's things that OSHA can't even enforce on some workers.

So I think that we just have to choose fertile grounds for this. There's different areas of the country that work better than others for things like this. And I think once they become successful, then it's going to be hard to refute that it works. Yeah?

AUDIENCE: I have two main questions. Number one, [INAUDIBLE] great example, the area is already built. Like, were there applications post-construction, for this application of maintenance/repairs/improvements of an existing building? So what if you build ground-up? So I guess my question is, I can see it's pretty mobile, but are you every three weeks resetting the things after you build more? Or are you waiting? I'm talking typical example of this from

ground zero. And number two, a typical 7,000 square feet, 40 guys, the number of beacons that you show approximately costs-- is it maintenance fee? I mean, high-level, is this built for a typical small construction?

JONATHAN HORNE: So for the deployment, right, starting from the ground up, you got to consider that there are multiple technologies that are viable. When you're outdoors, you got a big open field, there's no reason not to just use GPS. Time to switch to a system like this, as soon as the roof goes on. You start putting the walls up, the steel's up, and you get floors, now all of a sudden you've got this precision location information. That's the right time.

And it's actually-- because they are battery-operated, it's easy to move the devices around as you need to. And there's some intelligence in the system to detect when they're moved, so it can-- we call it recalibrating. It's not actually a calibration process, but it can sense that and figure out where they are.

ALBERT ZULPS: Yeah, we had a conversation actually earlier today about that, about maybe you only have two floors that need the devices, and you move them up per floor. But the reality is that trades follow each other. They go through the-- you know, they put the sheet rock up, or the studs and the sheet rock, and then the electrician comes in, and there's all this routine. So the bottom floors are still being worked on right until the point where it's finished, and then maybe you want to make sure nobody's in those rooms when they finish.

Sometimes we lock a room up and make sure nobody goes in to damage it, so that we can get paid without having to make changes. And that's important to know if people go in those rooms as well. So it might be that, as the building goes up, we just increase the number of beacons in the building and the number of anchors and things.

JONATHAN HORNE: And then you had a second question about costs and coverage.

AUDIENCE: Typical high level.

JONATHAN HORNE: Yeah, so to ballpark it, it depends on the structure and the way the building's organized. But on average, each one of these devices covers about 2,500 square feet. In terms of cost, there's a lot of considerations that go into that. How many people are you tracking? How many times a second? How long is this thing going to be running? How much data do you want to store in? And so how much it costs is a hard question to answer on the spot.

ALBERT ZULPS: I think it would be less than you'd expect, though. I mean, because given just the hardware cost, just of a tag, a tag is probably $100 to $150 for a tag, I think, which is not like $1,000 or anything like that.

JONATHAN HORNE: And there are different business models that we're looking at, too. I mean, ultimately, we would like to get to the point where every site gets instrumented, right, so the costs of the infrastructure is virtually free for the builder. Of course, there is an underlying cost, but there are some creative ways to subsidize that.

ALBERT ZULPS: And we're still working through the business model-- you know, us as the client, and Redpoint as the vendor. And we're open to ideas, too. If anybody has any ideas of what would work, definitely talk to us.

Any more questions? In the back? He's behind-- he already had a question, right? You've done it. No more for you!

AUDIENCE: The last slide kind of mentioned AR. And knowing what people face in the field every day and what kind of information they need to make a decision, how far in, say, months, are we away from the point where somebody could pick up their phone, throw on a set of goggles real quick, and their phone will be located on this dock where they won't need a patch or something like that. Maybe they plug in something to the bottom of their smartphone, just some of this short-range stuff, but is that part up? Because I'm looking at this and you have all the location information, right? So how much more worth it is it to get it to the point where it plugs it back in to the [INAUDIBLE] Does that make sense?

JONATHAN HORNE: Yeah, it's a good question.

ALBERT ZULPS: We talked about that this morning, too, I think. Or last night.

JONATHAN HORNE: I'm not an AR/VR expert, so I can't speak too intelligently about that. But what I do know is that we can get this precision location information and feed it directly to the phone today via Bluetooth link between these tags and the phone itself. So to get to the point where you can have an AR heads-up display, I think is probably pretty close.

ALBERT ZULPS: Yeah, I think if a company like [INAUDIBLE] or an AR type of company were to work with Redpoint, my guess is they could get some benefit. But these companies also have their own

way of figuring out where you are using, I guess, SLAM or different technologies that probably don't work 100%. So I think they could use the extra help of really knowing where they are. But I think that there might be political reasons why those marriages aren't always made.

AUDIENCE: [INAUDIBLE] AR in your demo. I think you would [INAUDIBLE].

ALBERT ZULPS: Yeah. Also, the idea of using augmented reality is almost like having a cell phone in front. You probably are going to get-- you're probably not paying attention. So it would help to have a buzzer go off and say, hey, you're going into a hazard zone. So there might be an overlay that helps you when you're using AR too.

AUDIENCE: Yeah, I'm thinking, like, the start of a shift, you know, you all share the goggles or whatever, look around at what you're doing and what other things are in place. So that way, you could put in some [INAUDIBLE] and know what else is around and things to avoid. So there's a lot of instances where some of those [INAUDIBLE]

ALBERT ZULPS: OK, one more question from somebody who hasn't asked one. So you had a question? No, you've already asked a question, so no more questions for you, too.

JONATHAN HORNE: We'll be here--

ALBERT ZULPS: And we'll stay here afterwards to answer. So, question.

AUDIENCE: Yeah, I was wondering, at Redpoint, have you guys ever thought about doing the development of an API or a web dev connection to a software solution [INAUDIBLE]

JONATHAN HORNE: Yeah, so Redpoint does provide APIs for both the back end at the server and at the tags themselves. And we are working with third-party providers like Autodesk to integrate--

ALBERT ZULPS: I might mention, even Synchro has a plug-in API. I work with Synchro too.

JONATHAN HORNE: Synchro and Autodesk and some others as well.

AUDIENCE: I was wondering [INAUDIBLE]

JONATHAN HORNE: We do.

AUDIENCE: [INAUDIBLE]

JONATHAN HORNE: Yep. Absolutely. Get with me and we can work to--

ALBERT ZULPS: OK, well, thanks also for coming. We didn't get much clapping now because everyone's gone.

[APPLAUSE]

I hope you had fun, too. I hope it was stimulating as well. Thank you.