SPEAKER 1: And so managing the early stages of the COVID pandemic. And what we wanted to do is we wanted to basically have a series of grand rounds that would focus on different elements of the pandemic, how it's being managed, and different issues that might come up or different things we might be exposed to over the course of this entire series of events.

So in the interests of having the second lecture on this, we actually wanted to focus on the role of digital therapeutics, specifically what we kind of refer to as digi-ceuticals, namely how digital therapies or digital tools might come to play a part in our overall-- in the work we're doing. So let me just share this.

So I'm going to be presenting this on with one of my friends and colleagues Ramesh Raskar at MIT who I'll introduce in a little bit. So what I want to kind of focus on is how our digital tools are helping us in addressing the COVID-19 pandemic, and also touching on how this might alter our kind of long term vision within medicine, both in terms of how we manage the spread of disease, as well as how we manage patients in general.

There are no relevant disclosures to this presentation. So COVID-19's really caused the collision with the digital reality around us. The fact is, medicine is really not the same as it was 10 years ago, and I think very quickly people are realizing that. When we look at aspects of virtual appointments, and non face-to-face visits and what we can actually do through digital technology. Medicine really does not carry the same characteristics of the assumptions that we have to see a person face-to-face, or that we have to make a home visit to check in on them, that there are other ways to potentially achieve that.

And one of the biggest things we see in medicine is that even though things can run relatively slowly at first, sometimes in points of crisis we're forced to make changes that we otherwise will take years to achieve. And by the way, anybody who's not on mute, if they can mute themselves, that'll be great as well just to avoid feedback and other issues.

So the second thing is that we're also starting to realize that patients are actually expecting increased connectivity to both their health data and their physiologic state, and this is not a new thing. The reality is there are surveys dating back to the mid 2000s, and I'll go through some of those, that show that patients actually expect to be able to use their digital tools or smartphones and other devices.

And finally, it's a point that big data, in terms of what's medically relevant, falls well beyond traditional data sets. In other words, when we think of big data today, we think of things like the Medicare data set, the Optum data sets, traditional health data. But the reality we're finding is that other data might be highly relevant in the work that we're doing.

So when we think about the COVID-19 role in digital tools and how digital tools are interacting with the COVID-19 pandemic, there are two ways. One is patient engagement and follow up. And that's something we've been actively engaged with in cardiology and in the institution over the course of the last month, really. And then the second point I want to bring out is that of managing epidemic spread. Can we actually use digital tools as a therapeutic tool, as a management tool, to address the public health issues in play?

Now back in 2018, Deloitte actually released a survey of US health care consumers. And they looked at how people with chronic conditions felt about virtual visits, and how satisfied they were overall. And interestingly, irrespective of whether they were impacted by chronic disease minorly or majorly, they actually found a high level of satisfaction with virtual visits. And those in particular who had major impact from chronic disease, about 88%, were satisfied with care they received through virtual visits.

And a large part of that reason probably has to do with the fact that they-- some may feel they have easier access to a physician or a clinician of any sort, and that they don't necessarily have to come in because you can imagine those the chronic conditions are often limited in terms of their ability to travel or in terms of their ability to leave the home. And it requires effort and they worry about exposures even before this pandemic.

In addition to that, what is interesting is they surveyed how interested users would be using technologies, for any one of a number of reasons, in management of how they work from day-to-day. And they show that typically people use technology for any other reason versus those who are completely adverse to technology. Amongst

Those who use technology for other reasons, they generally like the idea of having technology heavily integrated into their health plan, into how they manage their health, whether it be simple things like measuring fitness and health improvement goals. If you think of things like Fitbit or step trackers. Or even things like receiving alerts, or reminders to take medications for actual monitoring of their health issue. Or for accessing storing and transmitting personal health information or records to the clinician. People want that level of increased connectivity, and this was actually about two to three years ago.

So what has happened during COVID? The unique things that happened during COVID have occurred because of the realities of a pandemic and how we need to address that pandemic in this particular situation, namely, to enable people to have access to care, to discussing with their physicians, to determining if they're urgent enough to result in them having to leave the house to have an exposure.

They had to decide, OK, well we have all of these restrictions. We have these restrictions on intrastate licensure. We have restrictions on what can be done over the phone, and within what period of time of seeing the patients, over what is actually reimbursed and how it's reimbursed. And all of those issues, essentially, were the death knell, for the most part, to telehealth in many ways or for the advance of telehealth.

And what happened over the course of COVID is the reduced restrictions on HIPAA, which is one of the biggest things. And why that's relevant is the actual regulations stated that you can really use almost any modality to contact patients or to converse with patients, whether it be Zoom, Doximity. And while effort should be made to make sure you enable patient privacy, and using private rooms to talk to patients and whatnot, the reality is they also said this is a secondary consideration to giving access to the patients themselves.

In addition to that, they loosened intrastate licensing restrictions. The ability to talk to a patient who you already have a relationship with across state lines, so that they don't actually nee anything in this current situation because of how difficult it is for otherwise patients to get access to their physicians because they can't get there.

Now what's interesting within that is, they stated that while there should be a pre-existing relationship between the physician and a patient, they outrightly stated in the regulations that they have no plan to audit to make sure that physician that there was a physician patient relationship preceding this.

The last thing is Medicare offered equivalent reimbursement rates to inpatient-- in-person visits. Namely, that spending that 30 minutes, 45 minutes over the phone with the patient would be considered equivalent to spending that 30 to 45 minutes in person with a patient. And a lot of insurance companies responded in kind in order to facilitate that interaction.

And with all of that, the new world order's impact on private telehealth industries has exploded. Despite everything that's happened in the stock markets over the course of, really, the last few weeks there are companies-- like this is the largest company related to telehealth, called Teledoc, where you see their stock price exploded in the process the people realizing the value of virtual visits and people engaging services more. We see this also with other enabling programs, like Zoom, where people started using it a lot more in order to facilitate patient care.

In addition to that, there's been an explosion of emergency authorization requests from the FDA. The reasoning behind it being that's well, great we can talk to the patient, but we still need to monitor them. We still need to be able to extract vitals from them and other data from them.

And one of the most recent ones you've heard about from Mike Ackerman and Peter and Paul, is that of the Kardia AliveCor application where they recently got emergency use authorization for use of a QT monitoring tool, especially with the explosion of interest of hydroxychloroquine and azithromycin for treatment of patients with COVID.

But even more than that, there's several other pipeline devices that actually allow for multiple vital acquisition that are currently in FDA review and expected to undergo some sort of evaluation up or down within the next week to two weeks. For example, this particular device in the middle is called an Aidar device. Just from breathing in and out of it, it actually acquires your ECG, you respiratory rate, your level of oxygenation, PFTs. It has multiple chemical tests as far as your glucose level and other factors.

In addition to that, there's this particular device that similarly was recently piloted at CES, but essentially has a camera that, in addition to all of that, can actually obtain photoscopic evaluation, skin evaluation, so you can act-- there's a camera-- a high-definition camera embedded in it. And the theory behind it being the patients used it on themselves at home.

So practically, we can do an entire physical examination within a short period of time, just with singular devices. And both of these have audio enabled ones, that can actually obtain things like heart and lung sounds. So the point of having almost the entire physical examination enabled through a singular digital tool. And the interest has exploded, again, largely because of the realities of the current situation, not being sure how long this situation is going to last, and the thought that, OK, it's going to require more than just talking to the patient over the phone.

So how has this changed our paradigm? We forced the issue, in some ways, that people becoming comfortable with telehealth, whether that be on the provider side or on the patient's side. Because the reality is that if, in the current situation, people want to engage with their health care providers, they're going to need to have some way of accessing them. There's also the question of integrating virtual physical examination, so we can complete the patient interaction.

Now there are some countries that are a little bit ahead of us right now, and those include places like Singapore that are actively and have been actively engaging ways of getting physical understand-- physical examination understanding for patients without having to have them come in. And what we might see in the next few months is this continue to expand within the United States.

And it does bring up the question, overall, of and this is more a provocative question than anything else, is a face-to-face visit really needed to properly evaluate, treat, and provide for our patients in the way we need right away? I'm not saying that face-to-face aren't critical to the care of patients in the long term, but with the digital tools we have, once we take the regulations out of the picture, are we really providing worse care to our patients? Or are we actually providing equal or even perhaps better care to our patients by not engendering their need to come all the way here?

But digital tools can do a lot more. And this raises kind of the second half of our discussion here, which is, what else can we track? What else can we understand about the course of human disease without actually having them come into the hospital or using devices are now being delivered to consumers? This is an example of the Kinsa of thermometer, which I'm sure a lot of you have heard about in the media lately.

So the Kinsa the thermometer actually has about 70% to 80% US penetration with about 2 million users. And what it does is people just use it to record their temperatures whenever they don't feel well or are concerned, and then they upload them. And there's privacy enablement, so people can't really track who's temperature was up. But we can know, regionally, when temperatures go up.

And what's interesting is they actually predicted in some ways the Brooklyn outbreak, before anybody knew about it. These are the temperature curves which they often track over the course of the influenza season. But we see this sudden spike that goes outside their statistical predictive elements of what the temperature range should be in this brief period of time in the beginning of March. And what we see here is this temperature spike actually correlated with the Brooklyn outbreak. And they actually suggested this also in a couple of other areas, where they have high penetration and high distribution of users.

So it becomes interesting from a public health perspective they using data that's collated or brought together from multiple different users, even outside the realm of traditional health care environments, we might be able to actually predict what's going on before it becomes readily apparent.

In addition to that, people have probably heard a lot about something called contact tracing. Now just to kind of explain what that is quickly, and then I'm going to give it over to Dr. Ramesh Raskar The concept the contact tracing is, in some ways, being able to understand patient zero. Traditionally, contact tracing, if you watch movies like *Contagion* and *Outbreak,* we always try to trace all the way back, where did this all start? And there's a lot of reasons to know that. By understanding the source of a particular virus or outbreak, by understanding how it was initiated, it might allow us to better understand how to direct therapy. And where else it might spread.

But wouldn't it be better if we could go in the opposite direction? We can know from who was infected, we can know exactly who was exposed along the way, even before they become symptomatic and continue to spread. And that's where smartphones come into play. And I know people have probably seen this in the news extensively, especially as it applies to Singapore and South Korea.

And if you think about Singapore and South Korea, even though Singapore is having a little bit of a spike right now, the way they were able to avoid lock downs and full stay-at-home orders and closing down everything, was by actually tracking individuals in terms of who was infected, who was exposed, and how did that progressed over time. In that way, they could actually go to those who were exposed as public health experts, and say hey, you were exposed. We need to test you, or we need to have you be quarantined for some period of time.

So you actually take the elements that are driving infectious spread through the community, out of the community, rather than having to, in a general, take all community out of the community because you can't otherwise track the spread. And the theory behind it being that recognizing interactions of an individual discovered to be infected with others based on the history of a shared geolocation can allow curated identification of the at risk individuals downstream.

And if you can, in a curated way, identify who those at risk people are downstream, based on their intersections, based on phone proximity, especially when we have high penetration of smartphone utilization, by informing users of exposure, it mitigates subsequent interactions, and as a result limits the exponential spread.

So with that, a group of us from MIT, Harvard, Ramesh leading the way, basically said, well, what's the problem here? And he'll go into this. It's a question of personal privacy, and not giving it up. And we put out this white paper to discuss how the concern of privacy goes along with this kind of digi-ceutical to address mitigation of the pandemic spread.

And it's been heavily discussed in a lot or recent, very recent articles from the*Wall Street Journal,* Stat news. It was mentioned in Science recently, about how in democracies where we're used to individual rights, individual privacy rights, individual data privacy, how can we allow for such a tool that actually has apparent public health benefits to still be deployed, given the fears that people have about adoption.

And this is where I'm going to transition to Ramesh and talk about the work that's being done in order to allow in an open source, free way deployment in democracy. So introducing Ramesh, he's an associate professor and head of the MIT Media labs camera culture.

He's had an extraordinary extensive history of discovery and development, ranging from mobile devices to calculate eyeglass prescriptions automatically using your iPhone, to inventing femto photography, which he gave and amazing TED talk on recently. He holds over 90 patents on a variety of areas. In addition to developing a version of federated learning, called split learning, in order to enable privacy with digital data sets.

He also won the $500,000 Lemelson-MIT prize in 2016, which on a lot of people might know about that prize, but it's a fairly-- pretty equivalent to a Nobel for engineers. So I'm going to hand it over to Ramesh, who will now start talking about this idea of contact tracing and where we go from here. Ramesh?

RAMESH RASKAR: Hello, everyone. And it's so wonderful to be here with you here in Cambridge at MIT. Thank you so much for that introduction. And let me talk about PrivateKit Safe Paths, how privacy aware contact tracing solutions that, in the short term, would be about publicly health, but in the long term would be really starting our economies and creating resilient societies.

So contact tracing, many of you are familiar, this patient 31 in Korea, this woman who went to the hospital because she had a car accident. Then she went for lunch. She went to the church, came back to the hospital, and in the end ended up interacting with more than 1,000 people. And authorities have had to interview all these folks and back trace to see who could be affected, who could be exposed to avoid further spread.

The challenge is if you do that, it requires significant manpower. And at the same time, if you start doing that using digital technologies, it could lead to a surveillance state, a Big Brother situation. So how come we can we achieve both reliable contact tracing without creating privacy concerns?

So contact tracing, idea is straight forward. Warn if a healthy person has crossed paths with a contagious person, and then we want to use proximity technology such as GPS and Bluetooth to solve this problem.

Now, let's compare the situation with Google Maps. We all love to see the reds and the greens of the traffic on Google Maps, and that's because we all give up our privacy of our GPS Location of our car, and that way Google can tell us where the traffic is and what parts you can take to avoid the traffic. So that's great. For very low price, you get amazing utility.

On the other hand, in health, the challenge that because of privacy and regulations, the data is not available broadly, and so the predictions becomes challenging. And the current epidemic is a classic challenge. One would argue that if you had a bird's eye view of everything that's going on, who is meeting who, are they maintaining social distance, what treatments are working, which hospitals have the best treatment plans, what are the outcomes. If you have a bird's eye view, we could probably handle this epidemic very quickly, but we simply cannot do that because of privacy and regulatory constraints.

So PrivateKit Safe Paths is an approach that can possibly have both utility as well as privacy. And when say I privacy it's not just about human privacy, as you would think about as if you're on a Facebook platform, but it's about consent. It's about regulations, like HIPAA regulations that [INAUDIBLE] talked about. Its trade secrets between organizations and hospitals and insurance providers and governments. And it's also a national security issue because a social graph of the country is a national secret. And even if you do all of this, what's the incentive for people who are already healthy?

And you would also say, what's the big deal? GPS is such a low stakes information. We should give it away, especially if we can't anonymize and aggregate that. The challenge is that, even in such a format, it can reveal quite a bit. A very good example is Strava, which many of you probably use for jogging and running and outdoor activities.

And Strava released these heat maps, anonymized and aggregated, but they ended up exposing the forward bases of the US Army in Niger and Syria because only Westerners use this app. So they clearly outline those bases. Or in Taiwan it showed a social graph of the nuclear scientists who walk away using the Strava app, away from those nuclear facilities.

What about Bluetooth? You would think that's more secure because it doesn't share any location information? The problem is that if your phone is emitting any signal at all, like a Bluetooth beacon or a Bluetooth ID, then it can be snooped by third party apps. So imagine there's an app that has 100 million, 500 million downloads, that app can start snooping on all the signals, and create a global map. And an app that has say 500 million downloads, can fully create the physical, social graph of the US in a matter of days.

So that seems challenging. S how does PrivateKit solve this problem? So let me briefly describe the key ideas, and we can discuss more. So PrivateKit is effectively your personal diary. You download the app. It doesn't ask for your name, or phone number, or even address or anything like that.

You download the app and start logging it. Think of this as effectively a dosimeter, that some of you may be familiar with how for keeping track of radiation exposure. You just start keeping your personal diary, and then once in a while, you can compare with public infection data that you just download. So it's completely private. It stays local.

In version two, we expect the public health officials to release redacted trails of infected individuals, and I explain that on the next slide. And then every individual, every healthy individual, can download these redacted trails from a public health department and see if they intersected with this public trail. So maybe infected person and a healthy person went to Starbucks on Tuesday at 2:00 PM, or they went to a wedding on Saturday at 4:00 PM.

And the public health can release information completely anonymized, completely aggregated that says hey there was an infected case at Starbucks on Tuesday at 2:00 PM, or there was an infected case at this wedding location on Saturday at 4:00 PM. And our app which is keeping track of your personal diary, will download this information and give you an alert, the healthy person an alert, that looks like you were also at Starbucks at 2:00 PM on Tuesday, so we want you to call the authorities. In this sense, we maintain complete privacy, and as I will talk in the later slides, can also create tools for public health officials.

And then in version 3, we want to reduce the burden on health officials further of keeping track of transferring the trails of infected person and doing the redaction and so on. And we will do that by creating solutions based on self reporting, authenticating those self reports, and also using computational methods where this can be done using encrypted solutions.

So these are some screens from our app that you're welcome to download and play with. It's in a beta version. [INAUDIBLE] very soon, literally in the next few, as you start getting information from public health officials, how you will be able to create this early warning system.

So what about tools for public health? For public health, they would like to dramatically improve and make faster and more accurate a traditional patient interviews. So somebody walks in, they have no app, or anything like that. You would interview and say where have you been? And the infected person might say, hey, I was in the Starbucks, I live here, I went to a wedding, and so on, and health officials can take that data and start redacting those trails.

It can-- they can remove the location of their house, but keep the location of the Starbucks and the wedding location because it's not identifiable to that individual. And they can merge all these trials from multiple infected people in the town, and then release these anonymized and aggregated trials using our web tool called Safe Places. So in that sense, the privacy of the infected patient is achieved because they would be under the HIPAA regulations, and the public health authorities can release this redacted trails, which should just look like hot spot and not reveal much about the individual.

So a combination of the two would work in the village to where let's just redacted trails are made available in public domain, then all healthy individuals in town can download those trails and check if they went to a grocery store Monday evening. That's not a problem. But if they went to Starbucks on Tuesday 2:00 PM, then in fact they could have been exposed. And then they can call public health authorities to start the next steps.

Now because it's privacy preserving you will say, hey, this is not as good a tool for public health, right? So public health actually requires more solutions than what we described. So if we see on the right, public health would require the ability to actually call the infected person or ask at-risk person. And that ability is not available if you make a privacy preserving solution where only the healthy individual has the complete power to decide what they want to do.

Public health would also like to understand where are the hotspots, and start predicting the spread, right? So it turns out-- and at the same time for an individual, they would like to get personal guidance. They don't want to get an alert in an app that says you could have been exposed. They need much more information than that. And they want to talk to somebody on the phone or get a very personal guidance. Individuals on the phone also want symptom check.

And so the combination of these two should be achieved in a private preserving way, and we can talk about that of how we're going to do that. It's beautiful It uses techniques-- computational techniques, not just techniques of policies but privacy by computation.

Some other things we will have in upcoming features is, at home, you would like to achieve quarantine verification, again, without giving up privacy. You don't want someone to call you or knock on your door to verify that you've been staying in your own house for 14 days. Individuals will also like to get immunity passport, and they want to also get incentives. If they're quarantined and they cannot leave for 14 days, they will like to get sick leave payments, sick leave authorization, they even would like to get payments as an incentive to stay home.

And public health would like to coordinate this at home population in a privacy preserving way. I mean, right now public health actually has the names and phone numbers and addresses of infected people, but one could argue that if that data stays and leaks, that could create large challenges. And we have solutions that are currently privacy preserving and work in the software flow.

In addition, public health would also like to manage this workflow of going from positive test to certifications like quarantine and immunity passport and sick leave validations. So all these tools are coming in the upcoming versions of Safe Paths. And we would love to have conversation with you.

So as [INAUDIBLE] said, this is a fantastic alliance, initially led by myself and MIT faculty, but now we have WHO and HHS, and people like [INAUDIBLE] from Mayo Clinic. And we have wonderful mentors who are experts in computational privacy and machine learning and health diagnostics. And of course, we are also working with Dr. [INAUDIBLE] in this.

And because we the largest open source non-profit working on this, backed by some of the largest tech companies who are contributing engineers and code base and child services, many other teams have also joined forces with us. And we're already on the app store for last several weeks in a beta mode.

So some of you might have questions about what does it mean Friday's announcement from Google and Apple that they're also going to do contact tracing. Actually, it's a misnomer. What Google and Apple are doing is actually creating a new proximity API on Bluetooth. And that's very important, but still one piece of the puzzle. And so we're very delighted to work with Google and Apple because those APIs will be available in Safe Paths as soon as they're released. And they will be available in a free, non-profit, open source way for anybody who wants to create their own apps or anybody who wants to use our flagship apps based on our open source code base.

And to wrap up then, these privacy preserving pools are not just for dealing with the current public health crises, either tools for health officials or individuals that are also important for starting economies. As we're starting more serological tests and immunity passports and giving these early warning systems. And all the time we think, this epidemic will teach us how we can become resilient, so that we can do the orchestration and coordination among citizens and governments and health authorities. Thank you.

SPEAKER 1: Thanks, Ramesh. And just switching back over. So kind of just last slide here. So the question people might ask is, so what is a digi-ceutical and how do we implement it? It's just a term that's used to discuss how digital tools are used as therapeutic tools.

And it's a mechanism to allow, for example, care at a distance in an either self-contained, automated, or position enabled manner. But in addition to that, we can also see digital tools as a way to manage tracking of exposure, quarantine, facilitating distribution of resources, or like Ramesh said, opening up of the economy, which we actually have another white paper coming out regarding how that can be facilitated in terms of economic growth.

By doing so, however, we need to make sure that we have the proper research methodologies to facilitate deployments. And with that, we also need to manage or balance individual privacy concerns against societal good. And there's a Viewpoint article that Ramesh, John [INAUDIBLE] and myself have about how he balanced that in kind of figuring out that equation from a medical perspective.

Now before I, Ramesh I want to address a couple of questions to you. But one of the big questions is hey where is this as far as deployment and implementation. Actually, I'll let Ramesh talk a little bit about that, but within the US, as we all know fairly well, it's a question of how things occur at a communal, state, or national level, and who kind of takes the reins of this.

So there's been multiple discussions with state governments throughout the US, New York, Florida, et cetera, as well as discussions Mayo. And we felt part of the reason it'll be good for our group to understand what this is, and what it might mean is because, either in our personal and private lives, or with regards to our patients, there is a very high chance it'll kind of come into their daily life in a way that's going to be relevant. Ramesh, do you want to comment about deployment?

RAMESH RASKAR: Definitely, yeah wonderful. So we have we have three different strategies for deployment, which is we have the flagship app and the web tool. We also have our open source GitHub repo that you are welcome to play with. And we are helping many national governments and health jurisdictions to use that code base to launch their own apps. And third, is also creating interoperable standards that we think will allow this mushrooming of digital solutions to talk to each other.

So for example the Indian government has launched an app based on the Safe Paths, and I'm on the advisory board, and the already have 20 million downloads in less than a week. And they expect to have over 200 million downloads over the next few days. And that gives us a fantastic platform, as I said, if you want to create these dashboards for public health, and figuring out what's working or what's not working, and hotspots. And so if you want to work with us, we have ability to work with this 20 million user base already, that's not based on traditional surveillance data, but it's data that's coming from ground up.

So it's just a fantastic opportunity, and we're already working with about 50 different jurisdictions to see how we can help them, as well. So we are less worried about having one massive app. That it's more important for us to have an ecosystem that can all talk to each other.

SPEAKER 1: And so Ramesh Tom [INAUDIBLE] had a question regarding what percent of the American public actually have smart devices and positioning on, and with that, what percent of population is blocked during any given time because of building's, remoteness from rural towers. So how much will all of that, whether you don't have positioning on or issues with some blocking from tall buildings or rural locations affect the ability for this to function?

RAMESH RASKAR: Very good question. So the technological question's an important one. Fortunately, in the US, the smartphone penetration is pretty high. The benefit of PrivateKit Safe Paths, it does not require any data plan at all. It doesn't require any cell coverage at all because the GPS locations are simply being logged on your own phone as a private diary, as if you're taking your personal notes. So it doesn't require any data plan or cell phone reception at all. All the information can stay logged on your phone. If you're home and you connect to your Wi-Fi network, at some point you're connected to the network, you download the data, and it can get going.

Let me also distinguish between the app versus the web tool that will be used for public health officials. On the web tool, if you're in public health, especially, you can take your existing interview process, which is infected person comes in, and you use some kind of a tool to create their trails.

And you can use those Safe Places web tool that we already have for you open source, and start creating completely redacted trails and publish it. Publish them on your own website, or on your Twitter, feed or show them on your 7 o'clock news. You don't need any app at all.

So if you just showed that Tuesday at 2:00 PM Starbucks. Saturday at 4:00 PM at this wedding. And if we just flash that on the screen on your Twitter feed or your website or 7 o'clock news, that's enough for the population to figure it out if they came-- if they were exposed. And that alone, without any fancy technology, no app, no, no nothing. Just simple public awareness can completely change the game. And this is what they did in South Korea, and many other countries in the beginning.

So as much as we're talking about a two sided problem of an app as well as a web tool, step zero here is for public health officials to simply take those hot spots and give a warning saying, if you're at the Starbucks at 2:00 PM, please call us. Or if you have any symptoms, then you know here's an email address or here is a way to get in touch with us.

So this is the way we can kind of contain this disease because often the challenge is not about finding people who live in the same house, or work in the same place as the infected person, but all this so-called community spread where we don't know that you encountered the same person in Starbucks, and that continues to spread. So I just want to make sure that, yes, for the full-fledged solution, we need technology but the initial idea behind it privacy preserving solution is to just start to releasing these hotspots on 7 o'clock news.

SPEAKER 1: And so, Ramesh, another question was we always worry about how this fits into case law. So have there been Amendment Four challenges to this case law yet? I know you had a lot of discussions with White House and Congress and CDC, but what are your thoughts as far as the impression Congress will have regarding big tech, and doing work like this?

RAMESH RASKAR: That's a very good question. I'm glad you asked because I think, not only there is a question about whether we should trust big tech companies to do this, an even bigger question is if we start creating privacy preserving solutions, it will cannibalize their business in other sectors. Because through this epidemic, if companies start providing privacy preserving solutions, consumers will start asking them to provide all of their solutions, know mapping, and email, and texting, and messaging, also in a privacy preserving way. and that could completely cannibalize the business of these big tech companies because they do need information about their users to sell them ads and create very targeted solutions.

So on both hands I don't think it's a good idea for tech companies to-- we can expect tech companies to provide end-to-end solutions. What they're doing is the right thing, which is they're releasing APIs so that other people can build apps which are nonprofit or open source or have no revenue model around exploiting this data and so on. And they can be audited and validated and their source code can be public domain. So I think there's a very good role big tech can play by releasing these APIs to enable an app ecosystem or digital solution ecosystem.

SPEAKER 1: And another question that people have that you can address is, a couple of people had a question. So with GPS, and primarily using GPS, two people might be in the same location that a lot of questions of contagion relate to how close you are to somebody, right? So for example, you might want accuracy to the level of six feet to say he was [INAUDIBLE]. So you avoid unnecessary anxiety, provocation, or issues like that. So when we think about like closed buildings like a hospital or desire to have close exposures, how do you consider that in the context of what's being built out there?

RAMESH RASKAR: That's a very good question. Again, there is technology and that's what's important for this epidemic. And then, yes, we should be agnostic to the technology, whether it's cell phone tower data, GPS, Bluetooth, and a Wi-Fi hotspot. Those are the four main ways to compute [INAUDIBLE]. And then when it comes to within six feet, probably the best technology is either Wi-Fi stations or Bluetooth. And that's already supported in Safe Paths. And announcement by Google and Apple you'll create an API is also a good one because that allows you to get really, really close.

At the same time, you have to realize that every technology has false positives and false negatives. It's quite possible that the person who was infected has their phone off while they were there, or they-- you were at a wedding, and the person who was infected left their phone in their bag and they're walking around at the buffet line, and so on. So we cannot rely on technology alone to deal with because you always have false positives and false negatives. That's why we think the combination of GPS and Bluetooth can solve those problems.

As far as solutions for public health and solving these problems in hospital, we actually already have a trial going on here at Harvard on using Safe Paths with Bluetooth technology. So it's very exciting, and hopefully we some of the results for you. And there's also something you can do short term, which is hospitals can start sprinkling Bluetooth beacons--

[AUDIO PLAYBACK]

- You're conference is scheduled to end in two minutes.

[END PLAYBACK]

RAMESH RASKAR: --and maintain privacy, and Safe Paths also supports that kind of out of the box. So any kind of hospital HR management system or patient-doctor encounter systems are completely compatible with things like Safe Paths.

SPEAKER 1: And with all these efforts, I would have to add that [INAUDIBLE] working with a lot of computational, modelers mathematical modelers, to aggregate the data from all of this to actually look at how we can understand spread. And I would point out that where this becomes interesting is relevant for the pandemic acutely. But actually becomes more interesting when we start thinking about hospital based outbreaks, like we think about VRE C. diff. Or when we start thinking about other epidemics because certainly this was not the first or the last pandemic even in our generation, probably not to this degree.

So the last couple of questions, and then I'll let everybody go. So Francisco had the question of, and I know the answer to this, but I'll let you answer, Ramesh. Well this app account for a length of time exposed, rather than just saying who was in the path. Because obviously there's a critical amount of time exposure needed to transmit virus.

RAMESH RASKAR: Yeah, let's give it a valid question. And we want you to work with our team, with Safe Paths. And if there are any ideas you can either create so-called issue or just send us an email at PrivateKit@media.mit.edu. And this specifically about what about frequency or intensity of exposure is a very critical one. And fortunately we can support that computationally.

But we can build anything out in technology. What we want from you is suggesting to us a list of ideas and prioritize them, so that the community can go and build those solutions. And if you cannot build them we'll make that into a research question, and say, how can we achieve this particular--

[AUDIO PLAYBACK]

- Your conference is now over. Goodbye.

[END PLAYBACK]

RAMESH RASKAR: --what are the--