PROFESSOR: But today, we'll start with the customer information one, which I really will admit that probably some of you folks know more about this than I do at this point. But what I'm going to do is cover the trends that have been happening in the last couple of years. And then I'd like to get into a discussion, towards the end, about where we should go. Because where we're starting to do some research on this. Apar, who's usually in the class, who's doing some stuff here. And we can talk a little bit more about this.

This is the outline essentially just saying where we've been and where we're going and some ideas, essentially-- both my personal ones and others'. This is actually a lecture that started -- The first version of this was done by Nigel Wilson. So I gotta give him a lot of credit for this. And then we've evolved it, as it went, over the last several years.

So this is a spectrum of components of customer information-- or characteristics of customer information, really-- and how it's evolved from what transit agencies are providing to their customers. On the left is what was the old stuff. On the right is where it's going. And it's not all there yet. But generally, things have been moving, and fairly quickly in the last couple of years, from an operator view to a customer view. Operators used to just tell people what their schedule was and barely where the trains were. There were some maps out there. But way-finding was very, very bad.

And so, essentially, you have to pick up these pieces of paper, which were static. And now it's moving to a more dynamic real time perspective. Everything was always pre-trip or pre-planning your trip. And now, there's some indication that things are getting more en route. You have these real time apps that we'll talk a little bit about.

The last two are the ones that probably haven't moved quite as fast as some would have hoped. I think most of the customer information that's out there still treats everyone as a generic customer. It doesn't really see your particular needs, although there are things like service alerts that you sign up for very specific routes and things like that. But there's not too

much specific to you. And then, generally, you've got to look still for the information and pull it up yourself. It's not coming to you without you taking any action, in most of these apps, although some of the apps are starting to move that way. So, yeah.

AUDIENCE: The active systems and passive systems, is that supposed to be the other way around? What's with the active part?

PROFESSOR: The active part is from the perspective of the customer. The customer has to actively seek out the information as opposed to it coming to him without doing anything. OK. Yeah. And anybody, you can interrupt, as well. I like the give and take.

It's the technologies that allow these things to include things that you've pretty much talked about here, probably already, automatic vehicle location systems, automatic scheduling systems, so that the whole data of the mission of the transit agency is now in digital form. And more generally, is available to the public through what most [INAUDIBLE] used to call the Google Transit Data Feed. And now it's the General Transit Data Feed. Because, basically, everybody adopted what Google started. And it provides universal formats that all the transit agencies have basically converted their data to.

GPS and Wi-Fi cell phones. GPS is used on the vehicles, generally, sometimes in the cell phones. But essentially, provides your location. And this is where the customer specific stuff has gotten better. Because that technology has allowed it. If you didn't have a phone that told everybody where you were you wouldn't be able to get information as good as you do now. AFC provides a database on your trip-making. And that's important for two reasons. One, it allows the agency to know where people are traveling much better than they used to. And it also allows them, if they so desire, to start to develop stuff for you based on your history.

And this is a little bit controversial. We still have a lot of discussions with transit agencies about the privacy of the data and tracking you through there and your taps. But frankly, all the commercial people were doing this. And I think, the customers come to expect it. And the agencies have to get over this hump, do a privacy policy that says, we're going to use this data in these ways. And we're going to give people information based on their previous travel.

I don't think too many people have done that yet, but they're thinking about it. And unfortunately, sometimes the government lawyers are more obstinate about doing things like this than the private sector lawyers who generally-- my biased observation is, the private lawyers finds a way to do with the company management wants them to do. The government

lawyers finds a way to tell management they can't do what they want to do, in many cases. And it's unfortunate from that perspective. And then, obviously, wireless communications and the apps that have been developed.

So before Google Transit, and this is probably ancient in your eyes, but there used to be a bunch of-- not a bunch-- about three or four or five-- software companies worldwide who did these things. And they were doing it with really old technology. And they were mainframe systems. And they collected literally, $1 million for each Transit Authority. And it was funny to see Google do this for free, essentially. Because these companies almost-- a lot of them just died because of the competition.

So when they first did this, we were all amazed. Because a lot of the big transit authorities had invested lots and lots of money to the majority of planners. And they involved a tremendous amount of data preparation and a lot of customization for each city. And this was a breakthrough that nobody ever saw. Nobody quite understood why Google was doing it at the time. But it was welcomed.

And there's some funny stories about how it was then adapted. Because a lot of the big transit authorities already had these trip planners that they invested these millions of dollars on. And they were loathe to give them up. And they were loathe to then change the input to the Google Trip input. Because all the formats of these other things were all proprietary. And they basically had to do a lot of work to get it into Google transit.

But they got embarrassed into it by students, students even on the high school level, who really took their towns' schedules and put them into Google transit. And this was done in city after city, really. In some cases, in big cities, to show them up. And other cases, in little cities, because they just didn't have the staff to do it. So it was a great development.

You've seen the apps that-- next vehicle arrival times, but on your phone, which you all probably use. There's many new apps. Some of them are good. Some of them aren't so good. Give the Google data out. And have other people write the apps. That was the chosen path, because they realize they couldn't do it as quickly as private people could do it. And they, essentially, let this go.

My criticism of this approach-- I think in Boston we had between 35 and 45 transit apps, none of which were well supported for about two or three years. Nobody quite knew. The people who really cared-- there was a little bit of word-of-mouth that went around. There was the

rating systems online and things like that. But when you ask around, there was at least a half dozen that were being used and nobody quite knew whether they were good or not. And basically, everybody had a different standard with respect to whether they would use them.

And so, recently, they've changed. They've started to endorse apps. The MBTA this year endorsed Transit as their app. In a lot of cities, City Mapper has been become the standard for most people. And so, there's two or three that are reasonably good both in the design and in the information. But I'll talk about the good and the bad of these in a second here So I've put three-- yeah. Go ahead.

AUDIENCE: So regarding these apps [INAUDIBLE] have you also looked at different levels of perspective of how people use the information, especially how features, about income levels--

PROFESSOR: Yeah. There's been very little. And there is some research going on. It's a real question. The research question is, have these changed people's habits? Has it changed their behavior? And there's not a lot of evidence. I don't know. Gabrielle, do you have any examples that you'd like to throw out?

AUDIENCE: [INAUDIBLE]

PROFESSOR: Yeah. Candace Brakewood, who was a graduate student here and then went on to get her PhD at Georgia Tech, has done some good research on this. But it's limited, in terms of the samples. And it's not conclusive with respect to across the spectrum of the use of the thing.

AUDIENCE: I ask because not only because the process being used [INAUDIBLE] but because many of these points that we were just talking about are being emulated in the development world. And I think it's the way we should go. But if access to this data-- if people are not using this data in the developed world, then I also believe that policy is geared towards encouraging people or making this data more accessible [INAUDIBLE] people [INAUDIBLE]

PROFESSOR: Yeah. And I think-- my feeling about this whole area is it's got more questions left than answers. There's not a definitive way, essentially. So I think we should we should talk about it as we go here. We'll see. So the basic aspects of these things you probably know. The best ones really depend on knowing your location. So again, you have to give the app permission to know your location through your smartphone. If you don't do that, they don't work well at all. Because, basically, then you have to tell them where you are. And most of them don't even have a good way to do that.

The NextBus one, which was the earliest one, does have a drop-down menu, if you don't want to tell them your location. And you can just pick as you go down. But the other ones don't really offer that. You basically have to tell them the location. And it works well. It knows where you are right away. It looks at everything around you and it gives you the schedules, the next couple buses that are right around you. And so you can download any of these things and see how it works. I go between NextBus and Transit. I haven't used CityMapper that much. Although in Europe, almost everyone uses CityMapper much more than any of these other ones.

The newest thing has been providing these other modes. So essentially on Transit now, you can order an Uber. And you could look at anyone who wants to give them data, essentially, of options. And so, I don't think Bridge is on there. But I've seen the car sharing things on there, too. So it becomes other mobility services as well as public transit. Yeah.

AUDIENCE: I suspected that when those Uber services TNCs started popping up on the transit apps, I suspected that they might be paying those apps to have that option. Because those options didn't exist until not too long ago. And suddenly, you see this option. Is there any truth to that?

PROFESSOR: Well, the first one that tried is a thing that's extinct now. It's called RideScout. RideScout was the first one who tried to put all these things together. And they actually got resistance at first from Uber and Lyft. Because at the beginning, Uber and Lyft felt like they had all the demand that they could handle. And they wanted people to go to their app. They didn't want to pay them. Now, I don't know. This Transit app clearly has it. And a lot of the other ones-- CityMapper also does. Yeah. So I think they are paying them. But that's the maturity of the TNCs as well. Because they're trying to get as much market share as they can. And also because Uber has so much money, they just throw it at everything in order to get as much as they want. Don't worry, I'll make other editorial comments about Uber as we go along. [LAUGHING]

All right. So this is the possibilities. And the last is, can we attract more customers using these? And that's the open question. There's some indication that we can. I think, from a research side, we want to do more testing of pilot projects to see if we can. I believe the second point is really important. We need not only information, but integrated payment mechanisms on the phone so that you don't have a separate barrier to taking transit, which is, you gotta get a fare card or you gotta put money in the fare box or you gotta-- there's some transaction cost with

the way fares are in Transit.

If it's all on the phone and it's all together, it really makes it a lot easier, I think. And so, feel that if you put the two together, you get more. There aren't too many people that have done that. Chicago has the Ventra system that does, to a large degree, do this. They're only doing it for transit systems in Chicago. They're doing it for the CTA. But you can buy a metro ticket now. So it's actually multi operator in the Chicago area. It's the commuter rail. And you can also use it for PACE.

So it's an account based system on an app. And then you can get information in terms of the services as well. So it's getting there. There aren't too many systems. Dallas uses information app that includes payment as well-- unlimited. There's a few of them out there. London's got the payment. And now they're doing the app for the information. So they were ahead in terms of different payment mechanisms.

So it's getting there. The question really is, what do you need to get people's eyes on it? And right now, I believe it's mostly word-of-mouth. Those transit agencies spend very, very little on marketing. They used to do advertising and things like that. All that stuff's gone by the board with the operating resource constraints they've had. So it's like a lot of things. There's all these new things out there. But how do you get people to even look at it. And that's a big question that the big companies know how to do. The transit agencies clearly haven't figured that out yet.

goes a little further. So this is an idea that when London was talking about integrated payment on a phone and using your credit card account to do it. George Kocher said, yeah, don't stop there. Do all the information, as well. And you can essentially just have the whole transaction with public transit and, potentially, other mobility services right in your pocket.

The public sector has been wary of is this whole idea of tracking your movements and keeping it. And that has been a difficult thing to get over even in the research. We've tried to do little pilot projects. And the amount of bureaucracy you have to go through in order to essentially ask people if we can track their movements-- which, by the way, when you do ask them, and you tell them what you're doing it for, especially for transit, over 50% is our experience actually agree. So it's a large sample of the users agree to this. Because, essentially, they see the value at some of the information that's coming back.

So the challenges that are left. There's still some agencies, when you go from city to city, that

don't have a lot of good real time information. So the apps don't work very well. And for the life of me, it's just a matter of inertia, I believe, in these places. Although in some cases, they just don't have the technology staff. I mean, they're below water all the time, in terms of the projects they have on technology. And this is not their highest priority. But we still have a lot of cities that aren't releasing the real time data. So some of these apps just don't work.

The standard format for the schedule data is pretty much established-- the general transit data feed. But the GTA [? available ?] time is not that well established. And most cities that provide real time data to the public do it this way. But they sometimes do it in a different way. So actually, MBTA has two formats. And it turns out that right now-- the GTA vest format, and you can correct me on this one, Gabrielle. But the GTA vest format requires the developers to download all of the data for all of the routes when they ask for it. It's setup for somebody who wants to pull every route, whereas in some cases, if you want to do this faster and you want to do it smarter, you don't want to keep pulling the whole system. Because you can't do it fast enough.

And I think this is something we found when we were actually using it for a different purpose-- for an internal purpose. But we wanted to use their separate API to their database where this data resides. Is that--

AUDIENCE: It's mostly correct. One distinction [INAUDIBLE] [? format ?] [INAUDIBLE] data [INAUDIBLE] agencies like the [? MBTA ?] [INAUDIBLE] one example [INAUDIBLE] is the waiting time for the Green Line. So they've developed a custom API [INAUDIBLE].

PROFESSOR: Based on that. The biggest issue with all of these apps, really, is they don't work well in predicting when the bus is going to arrive unless there's no traffic out there. So when there are generally good conditions in terms of traffic, they're generally good at predicting the arrival. When there's disruptions and when there's any significant level of congestion, they always underestimate the time that you're going to wait. And you can see this. And people get very, very frustrated when it says it's going to arrive in 4 minutes, and it takes 8 or 9 minutes. Yeah. Yeah.

AUDIENCE: Can you say something about when the code shows the vehicle [INAUDIBLE]

PROFESSOR: Yeah. Well, the Transit app does that. You can push it and see the map and see where the bus is. And so, that helps. Because when you get to know your route and you get to know how long it generally takes when-- I take the route 1 bus towards Harvard. So I look out over the

bridge. And if the bridge is backed up and it says 3 minutes, I know it's really about 8 to 10 minutes. So you're right. It does help when it does that.

But frankly, for everyone, that's another button. You have to scroll through the map to see if it's there. The vehicles don't always show up. Because that vehicle hadn't been pulled in the last-- whatever-- minutes or something. And there's a lag time. There's a lag time with the update on this thing.

There's a student in electrical engineering who wants to do his master's thesis on throwing out-- most of these predictions in Boston are based on the NextBus black box algorithm. And we don't know exactly what's in there. It's mostly based on historical information about travel times on the route. So the way the algorithm generally works is historical travel times on the route by time-of-day. And then it puts in a little bit of the last one or two buses. But we don't think it puts in enough of that.

So there is a student in electrical engineering who wants to perhaps do a master's program. Because he is very frustrated at the MIT shuttle predictions, which are always not very accurate. And he wants to throw out the NextBus predictions and put in the homegrown prediction. And so we'll see how that works out.

AUDIENCE: I guess, the next level for these apps is to pull data from Waze or some live data I think it's the big problem which is how much longer it actually will take the bus to get from A to B. And then there's the advantage, thinking of Waze, of having that they're linking a lot more vehicles and people are transmitting this, well then integrate expected Transit travel times and the actual travel time on the road. We could integrate that. And it would be a very powerful tool.

PROFESSOR: Yeah. That's exactly what he is going to do. He's going to use the Google real time traffic. And then, so, yeah.

AUDIENCE: [INAUDIBLE] when you the [INAUDIBLE] transit [INAUDIBLE]

PROFESSOR: It's using their--

AUDIENCE: [INAUDIBLE]

PROFESSOR: I think on Google Transit, there's a little indicator whether it's real time or not real time. And if that's bolded, you know it's real time. And it's based on something. But again, those companies-- it's just like NextBus. They have their own algorithm. And the question really is-- I

don't know who the people in the traffic field are, whether they're looking at these predictions. But I know if you look at the Bluetooth signs on the traffic side, there's a huge lag effect.

So when traffic is building up, you never get enough-- the Bluetooth prediction is too low. When traffic is coming down, the Bluetooth projection is too high. And I look at this all the time on the highways. Because I gotta go back and forth to Cape Cod. And it's amazing to see, it is better than the Transit predictions, I can tell you that. The other issue with the Transit predictions is they've got issues that the Traffic doesn't have.

They got dwell time at the stops. And all it takes is one wheelchair at Central Square to be loaded and that thing is off by 2 or 3 minutes, just like that. Because it takes 2 or 3 minutes to load a wheelchair and secure the wheelchair. And then there's sometimes a crowd coming out of the subway. And depending on the driver, they wave on the people who they think have passes. Other drivers, they tell him to get on the back door. There's other drivers say, no, you gotta-- and then other drivers insist you get behind the yellow line. And they'll sit there at the stop for awhile.

So there's all this driver behavior, not to speak of the difference in pulling in and out of stops among drivers, which you don't have in the general traffic flow. So you got the general traffic, you got the dwell times for things like handicap vehicles. So it's a huge problem. It's not it's not a simple algorithm to solve. It's one of those things that we should be looking to do better.

In major disruptions, it really becomes an issue of how much do you tell the public, let's do something else. This bus is not coming in any reasonable amount of time. You can walk there a lot faster. And all the transit agencies have been reluctant to figure that out. Although London is a lot closer to thinking about, how do we tell people about disruptions? And how much do we divert them from their normal path? But there's not a lot of real good research out there about how to do that.

There is an issue with the transit agencies that, again, it's because it's a government agency. And this is probably more in the US than anywhere else. But because of the Americans with Disabilities Act, certain types of information can't be given out to the public by the transit agency unless it's fully accessible. And so, one of the reasons we don't have more bus stop signs is because small bus stop signs on small monitors are not accessible under the terms of the Americans with Disabilities Act.

So they have to spend a lot more money doing accessible signs. And I would argue that this is something that's-- you can buy every disabled user an accessible smartphone app built for that cheaper than making every piece of information accessible. But there's been no movement on this. That's just an accepted fact. What they've done to get around this a little bit is they say to the cities and towns or somebody else-- the federal transit agency has their interpretation of an accessible sign, and other people have different interpretations.

So there is some movement allowing. Like these private transit screens you see, they have to be paid for with non-federal money, essentially. And they're paid for, usually, by private people or by the city under some non-federal grant. Yeah.

AUDIENCE: Do they have to work with the NextBus commission [INAUDIBLE]

PROFESSOR: Have to have an audible thing or a Braille thing or something like that. Yeah. And finally, this idea of private ride sharing. And so, we have all these systems and private operators that are being incorporated here. But why not-- you can find me. If I want to give you a ride from MIT to west Cambridge, why can't I get in that app? And then you could pay me a few bucks for that ride.

And there's a few people who are developing mostly web applications right now, but are starting to develop the phone apps to do private ride sharing in this, as well. The Ubers of the world don't like these things at all. And I don't really have any good examples of people doing it on a wide-scale basis. But MIT is very interested in doing this within their mobile app. So--

AUDIENCE: Yeah. If I can give you an example. In Israel, where I come from, Uber and Lyft have not been allowed in Israel. But they have allowed Google. And Google started privately developing consultant areas where people use exactly these services where if a private individual says, I'm going from a suburb to the beach right now at this time of day. If you want to join me and pay me a few bucks for the ride. So Google actually has started a pilot [INAUDIBLE].

PROFESSOR: Yeah. So I would argue that this might not be the best thing for Transit if we got everybody sharing rides all the time. But for the metropolitan area and urban area, it's probably a great thing. And it's better than having Uber and Lyft drivers who, when they're not full, running around empty. Because they're basically a purposeful trip that's being made, as opposed to just being a business.

So these are potential research questions. I think I've talked about the arrival predictions. The

second one is important. We do a lot of research in the Transit lab about this using the real time information, both from their vehicles and from customers. Much less, thus far, from customers in a real time framework. But if we have that kind of information coming in all the time, how do they make adjustments to the operating plan?

So for example, the simplest one of these is on ball game days. They store trains outside of Kenmore Square and outside of the Boston Garden. And then they only release them when the crowd shows up on the platform. But it's still very low tech. There's a guy down there. And he says, send one in. [LAUGHING]

But if you think about that on a smaller scale, if a school gets out, and it's on the Riverside line on the D branch, instead of on the even headway at 3:48, you dispatch it a little bit early. Because you knew the school just got out. And you will pick up that school load right away. And then the next bus can pick up all the rest of the passengers. Or maybe they'll put two in a row or something like that. This is good research. It's still in its infancy, I would suggest, at this point.

The travel behavior question is paramount. And as I said, I don't know of really good research on this. And the bad part about it is I think any research that relies on surveys, revealed behavior, or stated behavior is just no good anymore. It may have been good in the past or they may have been lying to us about how good it was. But right now, we need something that looks at the real data. And so, this is where the tracking data is key. And it's starting to be done.

AUDIENCE: [INAUDIBLE] I worked in industry data before this. Most of the issues we had in the private sector were overcome by making the data fully anonymous. Is that still not the case with these Transit systems? Couldn't you just have instead of me being Scott Foster, I'd be number 12379.

PROFESSOR: Yeah. It is clearly doable. And it is done. We hashed the names and the serial numbers and all that stuff. But-- I just had a conversation about this with a public agency person this morning-- they get very concerned about small numbers. And on Transit, there's a lot of small numbers. If you're actually looking at OD movements from A to B in the early morning, there may be only a couple of people doing that. And so then they get nervous about doing that.

And I would argue that those are the very things we want to learn about. Because you look at the bus. And you know it's full at 8:00 in the morning. But where should that bus be, maybe, at

6:00 in the morning? It maybe should be somewhere very different. And we have to use this automated data to do that. And we'd like to track who who's using it and how they're using it. Because they might be using it very, very differently.

I don't know if you've noticed this advocacy group, Transit Matters in the Boston area, but they have this proposal for all night service. And it's different than the late night service proposal in that it's looking at service for workers early in the morning and at the airport and things like-- this guy knows it. Yeah. He did. Yeah. OK.

But anyway, it's just, that makes sense. But what you don't have is good data about who's using it where. And there's not enough out there to really measure it, in that particular case. Because there would be induced demand.

AUDIENCE: So we can guess at where people are going just by where [INAUDIBLE] can't get the regularity when you get the small [INAUDIBLE] And the private sector is the same thing. You have to make sure you don't come close to identifying an individual-- customer level data. So it's always aggregated in some way to make sure that you couldn't figure it out. You have all the people maybe getting on [INAUDIBLE] between 5:00 AM and 6:00 AM knowing that they got on at 5:05.

PROFESSOR: Yeah. And there's a whole spectrum here of what is acceptable and what is not. I guess, I just argue, and I've said-- I had a TRB talk about five years ago about how the phone knows when I'm near a pizza spot. And it sends me an ad. And I said, you know, and if you actually look at the terms of use of Google on those phones, it's like they can do anything with that. They can look at your phone call. If you actually read those things, they use every piece of data that they have accessible almost any way they want. And if you say you decline, then you're location stuff doesn't work ever. So it's a mess.

And if these folks can get you to do it, I say, well, the private sector is doing it. There isn't many bad things in the public sector. People think, oh, they'll arrest you or something. And maybe, in this case, maybe these days they will. I don't know. [LAUGHING] But in the old days, when I was talking about this, I said, you know, come on. Let the government do its job in the sense of planning services. Yeah.

So one thing that comes out of this, and this is customer information and marketing combined, if we have a lot of this automated fare data, on a voluntary basis, we can create customer panels. So you can ask people, we'd like to help plan things better. Let's put these panels

together. We're going to use your data for two months. And we want to ask you some questions about your attitudes and things. And this is done a lot in the private sector.

When we've done it, a lot-- anywhere between 35% and 50% have said, yes. You can essentially do this on an ongoing basis. And you can create a very large panel. And you can randomly select them for other little surveys. And then you could see if they react with respect to their particular travel behavior. And so, I think this is the way we learn the travel behavior impacts. But you gotta get a big panel.

And so far, the transit agencies have been a little worried about this, again, from the privacy perspective. I say, if people agree, there's no privacy issue. And then you can continually enrich this. You could keep recruiting people for this so that there is a lot of churn in the transit ridership-- that people don't stay forever riding the bus. Because they move or they get a new job or they buy a car.

The thing you could then move to is pilot programs. And you could select people on these panels to be offered new things. And so this thing that we're trying to get started with the CTA is to do mobility as a service. So they have this Ventra app. It works really, really well for transit. Well, why not put bike sharing, car sharing, potentially TNCs on this app? And do it in a way that the transit agency dictates who gets paid and how much they get paid.

And this is a big sell. Because they see Ubers and Lyfts and the car-sharing people as the evil empire. But what we say is, do it on a pilot basis, because you can get these individual panels. You could do it on a general public basis, if they volunteer. Or you could do it through employers, which, then, is another way transit, I think, has underutilized their market strength, in a sense.

Employers, in large cities, have a motivation to promote transit. Because if they don't promote transit, they have to make sure that their employees can find parking near their offices. So they either have to provide the parking or they have to provide a parking subsidy. As many of you know, we have been doing a lot here in MIT with this and trying to change the behavior by essentially giving a free transit pass to every employer and charging daily for parking as opposed to what used to be a Either, Or. You pick transit or you pick parking.

You can do all these things to learn. But what it all depends on is this mobile data and other automated data sources to tie it all together. I think one of the issues that this will also help is

you can get feedback from people about what they want to know when they want to know it. So you can't do that in a fully-automated fashion. So these panels are the only way that you can get to a large representative group of people and quiz them about when they had bad service and what they did and what kind of information that you need to get to them.

So the next four slides are from Montreal. And Isabelle Trottier presented them a couple of years ago when she came down here to what we call the Transit Leaders Roundtable. And they are a little bit ahead of the curve in terms of providing mobility as a service. And I'll just give you some examples. This is mostly oriented towards biking in Montreal and bike sharing. But I picked it, because I have an ax to grind about the biking. And so, I'm not quite as bad as Fred. But I have a good example here.

So the bicycles are growing in popularity. I don't know exactly what passport mobility is. I don't remember what it is. But it's essentially a way to buy things. I think it's an account that you can use.

AUDIENCE: [INAUDIBLE]

PROFESSOR: Yeah. So the reason I picked the bicycle here is this is a place that has been very successful at combining bikes and buses in the same lane, which we're having a huge fight here in the Boston area about, whether it's safe or not. And they have done and recently have been doing studies of this and looking at where it works and where it doesn't work. And they've brought the bicycle people in to see the data and do it transparently. And I argue, we have to do this in Boston or else the MBTA is dead.

There's a bunch of examples. The conclusion drawn from the first pilot project was it's both possible and even desirable. It's safe, and it's functional. The cyclists like it. The bus performance-- they used to have the lane by themselves. Now they don't. It's not gone down. And they're deploying it now, on a case by case basis, depending a little bit on the layout of the streets and the lanes. And so my little commercial is we need to do this for mobility in the Boston area.

So my final slide in this whole area is Lead to a Re-definition of Public Transit. And I think that we're almost there, at this point. All these mobility services are being-- the same people are using all of these mobility services. There are now the private car users. And there are people using mobility services. And they're using a combination of them. I did talk two years ago when they did the first study of users in the New York City area of Uber and taxis and public transit.

And at the time, the Uber fare in Manhattan averaged about $20, which was still pretty high. And the analysis said that if it got down to around $10, on average, and people used 1/3 third of their trips-- all their trip making on Uber-- and 2/3 on transit, you would actually spend less on that combination than buying a car even in the outer Boroughs of New York.

So what's happened in the meantime is that Uber fares have come down. And they're probably at that level, as an average, now. So that means if you're economically savvy, you're crazy to be operating a car. Because, generally, for the longer trips you can take the subway. And for the shorter trips you take Uber.

And the question is, has it changed behavior? The New York City people say, there's more cars in Manhattan. So that indicates there are more people using Uber. Because they're not using more private cars in Manhattan. Because they have no place to park. So this is a thing that transit is extremely worried about but it's doing very little. And the question is, can we control this in any way? And I would argue, the only way they can do it is by having a joint deal where they give information and payment together on an app. And they give you unlimited rides on transit. And they give you a certain number of rides on these other modes. And basically, it's a good economic deal for everyone. And you market it like that.

Because frankly, transit has been cutting back the really bad off-peak services. Because they can't afford to subsidize it at $10 a ride. And if they only subsidize-- for example, you might give them a certain number of Uber trips that are just to and from rail stations. Because they can do this geofencing thing. Or you might give a subsidy for Uber trips up to a certain amount per trip for a certain number of trips. There's a whole bunch of bundling that you can do here.

And what I'm saying is that we gotta do this in a series of controlled experiments and learn what people want and what people use and learn, frankly, whether we're going to end up being just high frequency corridor routes left. And there is a real debate about this. And there's a real debate about whether this is where we're going to end up or whether Uber and Lyft are going to go out of business. Because they, right now, have unsustainable fares. That's what the transit people hope and bet on. But I'm not sure that's going to happen or not. So, yeah.

AUDIENCE: That's what's really interesting to me. I definitely agree these are going to have phenomenal impact.. But in London, they are investing huge amounts of money for Crossrail and Crossrail 2, which are high frequency routes. But in cities where the road layout is not a grid they have to scale larger, [INAUDIBLE]

PROFESSOR: Yeah. And London's doing it largely on the economic theory of agglomeration-- that they have such a density of employment opportunities and other activities that are altogether, they should have an economic benefit to the thing. Frankly, every developed country, every almost developing country in the world is doing more investment in transit than the United States. And Fred would argue that we should just forget about all this stuff and just build more rail lines in certain places.

I think that, in many cities, we're beyond a little bit of that. Because the sprawl is so great. It's right. In the big old cities, the densities-- if we want to increase the density in Boston or in New York or Philadelphia, yes, you have to have rail. Because essentially, you can't increase the density anymore. Because there's no place to put the cars. But in some of these other cities that are spread out more, it's just not as clear of what you should do in terms of investment. Yeah.

AUDIENCE: I'm sorry. You said that transit authorities are worried about this. [INAUDIBLE]

PROFESSOR: Nationally, for the last decade, transit ridership has gone up steadily. And everybody was really happy. The last two to three years, bus ridership-- not rail ridership-- bus ridership has gone down. And all the large cities. And everybody's debating about what's the cause of that. Is it just the gas prices? Is it Uber and Lyft? What is it? And they're worried. Yeah.

AUDIENCE: [INAUDIBLE]

PROFESSOR: Nationally? Yeah. There's a big debate about why did D.C. has gone down. Because they've had all these disruption because of the safety and because of the reconstruction of things. So D.C. is a special case. But New York flattened out. That's right. And New York was going up. And nobody can argue it's the economy, because the economy has been growing. Yeah.

AUDIENCE: [INAUDIBLE]

PROFESSOR: Go ahead. [LAUGHING] He knows this better than I do.

AUDIENCE: [INAUDIBLE]

PROFESSOR: They're skeptical in Montreal?

AUDIENCE: Can't decide it. There is skepticism in Montreal. In theory it should work. Because buses and

some high schools average the same speed. In practice, the cyclist goes 15 miles an hour. The bus goes zero/thirty zero/thirty So there might be a leapfrog leaping out anyway. I think what the issue is that cyclists feel that they might get squeezed [? there. ?] There's two issues. One is that if you just have-- I think for really short segments, these makes sense. For [INAUDIBLE] you're probably thinking of [INAUDIBLE]. A couple hundred yards with a huge bottleneck. And frankly, if a bus had to follow a cyclist at 8 miles an hour, [INAUDIBLE]

PROFESSOR: It wouldn't matter.

AUDIENCE: It would still be much faster than a car going two or three lights. But in longer corridors, especially where you have the bus pulling from the curve and back, it becomes more of an issue. There's the question of whether you could build some kind of floating bus stop. So you'd have separation at the bus stops. And the vehicles would never have to cross paths. And the buses could pass the cyclists. And the cyclists could pass the buses where needed. But that's more, I think, cities sort of see this as a panacea where they can lay down some [INAUDIBLE] for that. And it's not a problem [INAUDIBLE] mention that in [INAUDIBLE] in Madison they have shared bus bike lanes. And they work pretty well. And I don't disagree. But those are also some five lane wide streets where they can provide a really wide facility.

PROFESSOR: Yeah. It does depend on the width of the lane. I agree [INAUDIBLE] agree that we could do a lot with queue jump lanes-- not fully dedicated lanes. We can't give up a full lane all the way up and down Mass Ave. But in front of MIT, we can. From the river to Albany Street, we can. Because there's no commercial activity. We have 17 parking spaces out here in front of 77 Mass Ave. 17 spaces. You can put them on Amherst Alley really easily and have all this space that we could devote for bikes and buses.

So what I would argue is, we need queue jump lanes. A lot of people talk about-- did Peter Firth talk about TSP yet? OK. He's coming. Peter's going to come and talk about Transit Signal Priority. And listen carefully. Because transit signal priority provides very, very small improvements, especially if the bus is stuck behind a car. And so, the question is, transit signal priority works well when at the congested intersections we have a queue jump lane that the bus can get around the long line of cars that might be there in the rush hour. And so we need both. And what I would argue is that in those small segments, the buses can share it with bikes.

AUDIENCE: [INAUDIBLE]

PROFESSOR: Enforcement. Yeah. I mean that's the only--

AUDIENCE: In San Francisco [INAUDIBLE] driver literally busted out camera in front of driver [INAUDIBLE]

PROFESSOR: They can push. Yeah.

AUDIENCE: Take pictures [INAUDIBLE]

PROFESSOR: Yeah. I think a lot of people do that. Yeah. I think London does the same thing. London has a lot of these. And they--

AUDIENCE: [INAUDIBLE] Bus lanes and there are also taxi lanes [INAUDIBLE]

PROFESSOR: And they're also bike lanes. And in London, it looks scary to me. Because they go so fast. But around here, as Ari says, you know if we get seven or eight miles an hour out of a bus, we're happy. Because they're only average four or five. [LAUGHING]

AUDIENCE: That seven or eight miles an hour is enough to get to a light that's actually held green for ten seconds so if that light changes [INAUDIBLE].

AUDIENCE: I don't see why that problem is unique to the facility. Because even if the bus is sharing a lane of traffic and the bike lane is not a bike lane, there's still [INAUDIBLE] conflict.

AUDIENCE: That's certainly true. I think what the issue is that cyclists-- some cyclists can be very special. And I'm not talking about anyone who works at the City of Cambridge.. There are some cycling advocates who would rather-- there are some cyclists and cycling advocates who don't understand that there were transit issues before traffic [INAUDIBLE]. And there needs to be a bit of a detente between the cyclists and the transit users. The problem-- I think Frank pointed this out-- is that the cyclists are meant for [INAUDIBLE] more organizers than cyclists who are put in mortal danger every time they're going somewhere. And transit users are just like [INAUDIBLE]. And there's a difference between those two groups. And I know that this past November, I think in the past fall I'm on the Cambridge Cycling Committee and I try to be a voice of reason for transit as well on those bicycle committees. [INAUDIBLE]

PROFESSOR: The only voice of reason. No. [LAUGHING]

AUDIENCE: [INAUDIBLE] sometimes there can be [INAUDIBLE] bus stops on Mass Ave.

PROFESSOR: Because 40% of the people on Mass Ave in the rush hour are on buses. Yeah.

AUDIENCE: And 50% of them are on bikes.

PROFESSOR: It's even more. Yeah. It's almost 50%. Yeah. And a lot of the arterials around here, that's the percentage. It's between 35% and 50% of the people are on buses.

AUDIENCE: [INAUDIBLE] The bike doesn't take up that much room. So the issue, I think, winds up being that--

PROFESSOR: We're off topic here. [LAUGHING]

AUDIENCE: We had a nice conversation. I think when you get people in the same room they start to understand that there's a give and take. [INAUDIBLE] and I said, if you're doing planning an isolation where you talk to bike people and they, say, we want X and you talk to transit people and they say they want Y, the easiest thing is to do nothing. [INAUDIBLE]

PROFESSOR: Yeah. I think the bus lane actually gets-- although, these days I'm not sure-- but I would say that the bus lanes get more adverse reaction from the drivers than the bike lanes do. Because they don't seem to take away driving lanes. Whereas a bus lane seems to either take a driving or a parking lane away. And so, it gets more opposition from the drivers. But there's a quote. I forget the quote now. But basically, urbanologists-- people-- have started to realize that we're spending tons and tons of money doing bike facilities in these urban areas. And we're spending nothing on transit facilities. And that's a long-term disaster. Because essentially, there is a limit on the amount of bike use, I think, in any of these places. Because there's lots of people.

I used to bike. I live four miles away. I used to bike. I'm getting old. So I'm losing a little bit of my perception and stuff like that. I had a couple of close calls. I stopped. I basically just stopped. I said, I'll bike when I go to Cape Cod. I'm not going to bike in these streets. Mainly I was afraid of the other bikers then I was as opposed to being afraid of the cars. And there's lots of people that just can't. And a lot of those people want to take buses. But they also don't want to be held up in congestion streets all the time.

So can we switch? I don't know your computer. Can we switch to the other one? We'll just get started on the Performance Measurement. And then we'll go into the next one. Great. The reading, I think, is important. It's a dry topic. It's how transit authorities evaluate themselves and how they evaluate themselves with respect to other transit authorities. But it's important. Because if they don't do performance measurement, nobody improves.

And there's example after example. The two best examples, from my perspective, are the CTA, about five years ago, instituted this rigorous performance measurements regime that the general manager sat at a weekly meeting on a rotating basis with every department and developed performance measures and tracked them for each department. And the performance, almost universally, went up. There's a set of slides that I can't go over. But we'll put on Stellar about this. It's an amazing story, I think.

The GM was only there for two years. He was one of these management by data types. And then he got moved to run the school department, for God's sake. I don't know why. But, anyway. And the other example really is the MBTA under the fiscal management control board, where they've insisted that there be regular updates and data-driven analyses.

And if you look at the progress on things like Overtime, and essentially, things that are inefficient, generally, they've improved. And there's a lot more to improve here at the MBTA. And there's a lot of issues that can't be solved just by better management and performance measurement. But there's a lot that can. And so, I think this is a really important topic.

So what we have here is a little bit of justification of doing this. There is an older report that's really good-- TCRP 88 that essentially is a cookbook on how to develop a performance management system for your transit agency. And it's a really good report with respect to the measures you use. And they divide into small, medium, and large urban areas. And they give different measures for four different ones.

A lot of people want to compare themselves to other people. There's this national database. And this is the website. And you can see performance measures from everyone in the country on a pretty much equitable reasonable basis. And then there's the concept of performance audits, which we'll talk a little bit about.

So why do it? Basically, whatever gets measured gets noticed by management. And everybody's into these new management dashboards with key performance indicators. It can be done and not have an impact. But I feel like, whatever that indicator is, people manage to it. Sometimes the indicator is the wrong indicator. And it's not so good. Because it's the easy one to measure as opposed to what they should be focused on. Many of them are-- the measures that the board and the top management look at are oriented to the supply of the transit-- what the vehicles did as opposed to what the passenger experienced.

The best example of that is when you look at on-time performance. They measure it within 2 or 3 minutes. And that doesn't mean anything if the bus is supposed to come every 7 or 8 minutes. Because basically, there's this phenomenon of long gaps and then followed by bunches. There's very few passengers on the bunch buses, especially the second and third one. And most of the people are on the crowded bus who had to wait, which is the first one. And they had to wait much longer for that. So the wait time for passengers is not linearly related to this on-time performance measure that they have. So you actually should be trying to measure effective wait time for all passengers. And that should be your measure for most of the transit services.

They also use some of the performance measures on a system basis for funding allocation. I'll mention a few things there. I talked about this TCRP Report. It's nice. And I think it used to have a website associated with it. So you could actually go in there and put your own program together. I'm not sure if it still does. Because it's fairly old. But it's nice in that it isn't one prescribed thing. It gives you a lot of different options. And you can tailor it to your urban area.

This is the process that they recommend in the report. Again, this is an internal performance measurement system-- performance management system. And it's a top-down to find your goals and objectives get management support. And I guess, the second one is extremely important. I used to, as my olden days as a consultant, I used to do transit performance audits for transit agencies. And the experiences varied further than anyone could imagine.

I'd been in some transit authorities. The first meeting was with the general manager. And he says, go get 'em. And he says, and come back with all the information, because I want to know it. And you would do it. And we'd come back with the indicators. And he'd say, OK, what do I do about this? What I do about this? He'd bring the departments in and says, I'm not blaming anybody. We just gotta develop action plans to get these things better.

And I've been in other properties where the general manager said, literally, on the first meeting, you're here because the state makes me do this. So I want you to get in and out of here as quick as you can. And basically, I know how to manage my place. You don't have to tell me anything. And now, all of these were relatively small properties. We did some larger properties. But basically, there's a tremendous variation among management styles on this. And so, if you're going to do this, you want top management to be supportive right from the start and to participate in developing it.

The rest of it is intuitive. The most important thing is, how do the results, when you update all these measures, get integrated into how you actually carry out the business? And that is a hard part sometimes. And it's a part that you need to think about. And you gotta think about, what can I do about this indicator? And I think part of when you're deciding what the indicators are, that's a big part is thinking about that step 7 and 8. And essentially, if something's working and you're making progress, you keep it in. If you don't, an 8, you throw it out and try something else.

This is the way they've got lists and lists of measures. They've got bunches of tables. And again, they have them for large properties. It makes sense for large properties, medium, small, actually under 50,000 people in the metropolitan area. So they basically say, this is kind of what we think your capabilities are based on staffing and these kind of properties. There's some more. I'm not going to go through these.

The NDT data. How many people have actually gone in and looked at these tables? Anybody? Two. OK. You should all do this. It's pretty interesting. They've got a whole range of transit properties across the country. And you can sort them in various ways. You can download reports. You can download it in CSV files. You can see how your city stacks up against other cities. Consultants use these all the time.

And the good thing about it is at the beginning when they first developed this, definitions were variable across cities. And each year, the government has done what big bureaucracies do well. They started to standardize this. And they call you up if they don't like your number. And they also call you up if your numbers change from year to year too much. And they ask you why. And so there's an auditing process of the data that's in here.

Now the only downside of it is it got big quick when they first developed it in the 80s. And then there was a backlash from the transit agencies in the city saying, you're asking us for too much information. This costs too much. And so, I don't think they've added the proper updating of it with respect to developments that have been in the transit over the last 10 or 15 years or so.

And there still is some inconsistency. There's still a little bit of latitude on how you allocate your costs. That's the hardest thing. And have you guys had cost allocation models? Yeah. So you saw the uncertainty of exactly what you put-- all these costs-- what category you put them in. And so, that part, while they define a lot of it, they don't define it down to the bottom. And so, I

think that there is, especially in the costs. So the cost effectiveness numbers that come out of here aren't necessarily directly comparable depending on the property and how seriously they take it.

The other issue with this is this is another thing where the management style-- some management actually ask their people to look at other properties here and report back. And they care about it. And other management says, just get that report done. Get it out of here. So this is a similar thing. Leadership is important.

So this issue of performance audits. So outside of doing it with key performance indicators going to the board, there's also these efforts to do it comprehensively, maybe a deeper dive, than you would do on a regular basis. And they usually bring in outside people consultants or maybe a state group that comes in. And they go around, especially, like, say, for the RTAs here in Massachusetts that are all much smaller than the MBTA-- they have a standardized performance audit group that goes around. And they give them information.

I think the big issue, especially in the smaller properties, is they don't have the resources to find out what other people are doing very easily as compared to the larger cities who just call up people and say, I'm going to come down. I want to hear about this. Or they set up a special panel and they bring in some experts on a particular issue. What this process allows is identifying critical issues that are performance issues and then allowing the consultant to focus just on those two or three issues or the outside group and say, give us information about how we can improve just in these areas. And then it brings information from other properties. Because these people have been doing it in other places.

And the big debate when this first all started and among the people who did it was, should you focus on internally in the trends in your internal operation or should you focus on how you compare to other people? And there's no the answer here. I always said, it doesn't hurt to look at outside. But clearly, if you're looking internally first, you can see whether you're getting better or worse. And you know the data is consistent. And you know the issues that you're having trouble with. Because intuitively, you know it as well as from the data.

So I would say, generally, the peer comparisons were often used by the outside groups to say, where should we focus going in? And let's dig deeper in these areas, because these numbers look a little bit out of context. Almost done here. So I'm going to press on for-- to--

So the bulk of the effort was internally. One thing that this allows is because you have this

facilitator and the outside group, it allows you to tell them, like a counselor, this is why I really can't get my job done. And we really developed a mode with these folks. You can tell us. We're not going to attribute it to you. We're not going to necessarily go to your direct boss about your complaint to the direct boss. But we might mention this to somebody higher up in a more general way. And we had ways of assuring them. And so, employees liked this, especially if they were hitting roadblocks in doing a better job. And in small properties, sometimes personalities got in the way. And so we would provide that feedback to the top management as long as they wanted it.

And just I'm aware of a very significant state program in California. They have to do this every three years. It started at two. Now it's down to three. And they have a set format. And they send the same kind of people around to each one. And there's some compliance with state requirements and funding and things like that. But it really was a comprehensive. And they looked in these five focus areas. And they essentially-- when you got the feedback from most of the smaller properties, at least, they felt like this was a great program. Because it gave them the ability to focus harder on things on a periodic basis. And then when you came back, you measured those areas and said, OK, what else was going on at that point?

I think that's where I'm going to stop. Yeah. Anybody have any last questions? We can pick this up a little bit in the service contracting stuff. Because it comes up there, too. The difference between performance in your internal operations and performance by your contractors is nothing. In fact, it's harder to manage the service contract. And we can talk about that at the next one. OK. Anybody? Great. Thanks.