

MBTA Spec — FAQ

6.033 2021

Common Misconceptions

- **Your job is to design both the passenger-feedback app and the data collection associated with that, *and* the means by which data (such as passenger-count data) is transferred from buses to the MBTA servers.**
- **Your system is not responsible for making the decision about what to do in a failure** (see top of p. 12 in the spec). It should enable any of the possible actions, in the sense that it will need to send alerts to various people. But your system does *not* have to decide, e.g., whether to move a bus from one route to another, re-route a bus, etc.
- **Your system does not need to guarantee that the MBTA meets the targets in Table 1.** Those targets are given to you for context. The MBTA designs its routes to meet those targets under normal operation, and strives to meet those targets even in the case of failure. Part of your job, with the passenger-feedback app, is to assess whether the targets themselves are appropriate. For example, suppose that the passenger-to-seat ratio is ≤ 1.4 at least 96% of the time on every bus (as the targets recommend), but every passenger is still complaining about buses being crowded. That's a cue to the MBTA that it needs to reassess the target itself (maybe the passenger-to-seat ratio should be 1.3, for instance).

Scope of your system

Is the system that we're designing mainly focused on connecting the passenger-feedback app to the current monitoring system, or also redesigning the current system?

Your goal is to design both the passenger-feedback app and the monitoring system. The latter means that you'll need to describe how various data (e.g., passenger-count data) is collected from the buses and stored at the MBTA warehouse.

Is it our job to design a system that meets the targets listed in Table 1 (p. 10)?

No. Those targets are given to you for context. The MBTA uses them to plan its routes, and to determine what to do in response to failures. We're not asking you to design the algorithm that responds to failures, so you do not need to guarantee that your system meets those targets.

Potential changes

The spec states that “For now, assume all passengers have smartphones with the app enabled...” The wording suggests that this might change, so should we also consider if not everyone has the app or that a consistent percentage of passengers have the app?

Right now, we’re only asking you to design a system for a world where everyone has a smartphone with the app enabled. This means that you don’t have to build anything into the system to support non-smartphone users. But certainly, you might think about how this system would need to evolve if that weren’t true, just like you should think about how your system will evolve if certain things fail (servers, etc.). A good design will be able to respond to changing requirements.

Bus Load and Coverage

The definition for comfort as described by the design project is “96% of the time, the maximum passenger-to-seat ratio should be ≤ 1.4 ” (p. 10). Does this mean for all buses in the MBTA, all buses along a route, or for every single bus?

For each bus, but this shouldn’t matter too much for your design (see the third misconception at the top of this document).

What threshold of number of people makes a bus ‘crowded’? Who determines this and how?

If it’s coming from the passenger-feedback app, the passenger will be deciding whether the bus is crowded. In fact, that’s part of the point of the app: the MBTA has pre-defined notions of crowdedness (Table 1, p. 10), and they want to use the passenger feedback to determine whether those targets should be adjusted in any way.

How many bus stops are there?

About 8,000. And you can look this type of data up! Some useful resources:

- <https://www.mbta.com/guides/bus-guide>
- <https://cdn.mbta.com/sites/default/files/2021-03/2021-03-14-mbta-system-brochure.pdf>

What does the census data, route and schedule data, and alternate stop data look like?

You can assume that it’s available in a spreadsheet-like format, but the internals of the data format — e.g., what columns are in each sheet — are unlikely to be too important to your design. (If you feel differently, post a private question on Piazza and tell us a bit about your design, so we can assess.)

Should our system have tools for administrators to create or analyze the existing datasets?

No, you don't need to provide those tools. Your main question when thinking about how to aid MBTA administrators in analyzing data is what data to store, and for how long.

Are we allowed to modify the buses in any way? E.g., move sensors.

No. You cannot change the bus itself.

Passenger Feedback & Impact on Phones

Can we trust that passengers will not enter fake data or spam? Could we impose a limit on the size and frequency of passenger complaints to prevent it?

We'll assume that passengers are entering truthful data and not intentionally spamming the system. That said, a passenger could certainly report that the same bus was crowded at multiple points on its route.

How can we evaluate the impact of the feedback app on phones, especially considering passengers may have different kinds of smartphones?

We'll give more specific guidelines for this type of evaluation after the DPPR, but it's fine to assume that passengers are using an "average" smartphone. You can also think about this app in the context of your own experience (e.g., what are the impacts of an app that is constantly running in the background of your phone vs. one that you only use occasionally throughout the day).

MBTA Admin and Operators

What responsibilities does the MBTA system administrator have, and are we allowed to give them further responsibilities?

The MBTA system administrator is responsible for making the decisions of what to do during a failure; your system is *not* responsible for making that decision, only for enabling the actions of the administrator, alerting passengers and bus operators, etc.

If you'd like to have the system administrator involved in other parts of this system, you may argue for that.

Can we explicitly limit the role of the operator to merely operating the bus?

That is already the bus operator's primary responsibility, so if you added no additional responsibility, that would be fine.

Do bus operators also use the passenger-feedback app?

No, they don't.

Are bus operators part-time? If so, are we allowed to amortize the average number of operators, i.e. hire less on some days and more on others? This would allow us to stay under our required budget, while providing more flexibility for edge cases.

You're not allowed to change the bus-operator's schedules; that's the MBTA's job, not yours.

Bus Control

How much memory and/or storage (persistent or not) does the bus control have?

You can specify the specs of the bus-control, but keep in mind that it's meant to be a fairly small device. For instance, a "reasonable" spec for storage would be 64-128MB, not terabytes of data.

Historical Data

How far back should historical data go, and in how much detail? Can the system differentiate between short term and long term data?

This is up to you to decide, and defend. Keeping data for as long as possible would likely enable the MBTA to do some interesting types of analysis. But of course, storage is not infinite.

Data Storage

Are we allowed to use third-party cloud services such as Amazon Web Services or Google Cloud for our server, or are we required to maintain everything on our own servers?

The MBTA wants you to maintain everything on their own servers; they don't have an agreement set up with any other provider.

Security & Privacy

Overall, what security implications do we have to consider? Are communications encrypted in any way? Do we have to store the data on the MBTA server in a cryptographically safe manner?

Right now, you don't have to worry about encryption, because we haven't taught you anything about encryption yet in 6.033. It's worth thinking about what data is sent over the network/stored on the servers, and what implications there would be if someone outside of the MBTA — or even inside the MBTA — were to get access to that data; you will likely think about that as part of your privacy considerations. But we won't expect you to cryptographically secure any of it.

Are there certain metrics that we have to meet for taking passenger's privacy into account? For example, is it completely up to us, or would we be able to customize certain aspects of data collection in response to individual privacy preferences?

It's completely up to you. If you wanted to add certain customizations, that's allowed (the tradeoff would be that allowing customizations often adds complexity).

Communication Protocols

Can we assume that all phones with the passenger feedback app have access to GPS? Are we allowed to access these GPS systems, in order to determine which people might be affected by a certain change and send notifications accordingly?

You can assume that passengers' smartphones have GPS sensors. However, some passengers may prefer to not give up their GPS location, and will not allow the app to access it; you'd want to have a backup plan for those users, and also consider the implications on performance of using GPS.

How much of the radio's bandwidth does voice communication take up, and how can we quantify that?

It's small enough to be negligible; you shouldn't need to quantify this (but if you feel differently, post a private question on Piazza with some details about your design and we'll take a look).

In what cases would we want the bus control to transmit to the MBTA server? When can we wait for the bus to return to the warehouse and transmit via wireless?

That's up to you! You can think about, e.g., whether there is data that would be useful for the MBTA server to have almost immediately as opposed to waiting until the end of the day.

"The MBTA's trunked radio network only has 10 frequencies allocated to it, and there are 1036 buses in the system. As more buses attempt to communicate at the same time, the delay to receive a vacant frequency will increase." (pg. 7) Are there any specific

numerical estimates of these delays? Or, are there any numbers we can use to deduce estimates to plan better?

Those delays will depend on your own system. Since you control the data sent over that network, you'll be able to figure out the likely amount of time that a bus would need to use a frequency, the number of buses that might be waiting for a frequency, etc.

Scaling & Budget

How scalable does our system need to be? (e.g, thousands of busses? Hundreds of millions of buses?)

We rarely talk about scalability in absolute terms, in the sense that we don't often have systems that need to scale to size X and absolutely no further. But the context in which the system is operating matters. Certainly your system needs to be able to handle the scale of the MBTA bus system. If your system can't scale beyond that *at all* — i.e., if a single additional bus would break it — that's an incredibly fragile system. At the same time, bus systems tend to operate within cities; we don't see a single, dense network of buses across the United States.

Should we quantify any incurred expenses, if we choose to purchase or upgrade any products required in our design?

That would likely be a useful part of your justification, yes.

Accessibility

Should we incorporate and provide any information about accessibility (i.e. wheelchairs, bikes, or passengers with small children)?

We have not asked you to, but that could certainly be useful! Especially in the context of alerts about changes in service.

Use Cases

Should our system also include the capability to generate new bus route plans?

No; that would be the MBTA's job, if needed.

In general, how much on-command (i.e. not directly related to real-time tracking) data processing capability should our system provide?

Very little. Your system needs to meet the goals we've set out. That said, it's useful to think about what other things your system — particularly the data that it stores, and how long it keeps that data — would enable. For example, if you deleted data every 24 hours, that would make it very challenging to handle the fourth use case.

Evaluation

Why are bus transfers the only measure of value to the network? I understand that less transfers indicate more convenient routes, but I wonder if additional metrics exist as well.

They're not the only metric, just one. That said, it's not your job to consider route planning, so you shouldn't need to worry about additional metrics in this space. (If you feel differently, post a private Piazza question with some details about your design, and we'll take a look.)

Can we make the assumption that all passengers will be paying by ticket or Charlie Card and not cash?

No; you cannot mandate that passengers pay in a particular way.

Should two consecutive cash bus trips count as a transfer?

This would be very difficult to assess! Indeed, customers who pay in cash present a challenge when it comes to tracking transfers. You may make some inferences here, or you may need to justify giving a less accurate count.