BOSTON Public Schools
Focus on Children

TRANSPORTATION CHALLENGE

Solving Routing and Bell Times

April 1, 2017

Event Sponsors:

HARVARD Kennedy School
RAPPAPORT INSTITUTE for Greater Boston

DISTRICT HALL
A NEW HOME FOR INNOVATION IN BOSTON

Agenda

Welcome –Steve Poftak, Rappaport Institute Executive Director

Opening Remarks – Dr. Tommy Chang, BPS Superintendent

Transportation Challenge Overview – John Hanlon, BPS Chief of Operations

Panel Discussion

Breakout Sessions

- *Stop Assignment*
- *Route Creation*
- *Bell Times*
- *Policy & Regulations*

Closing Remarks

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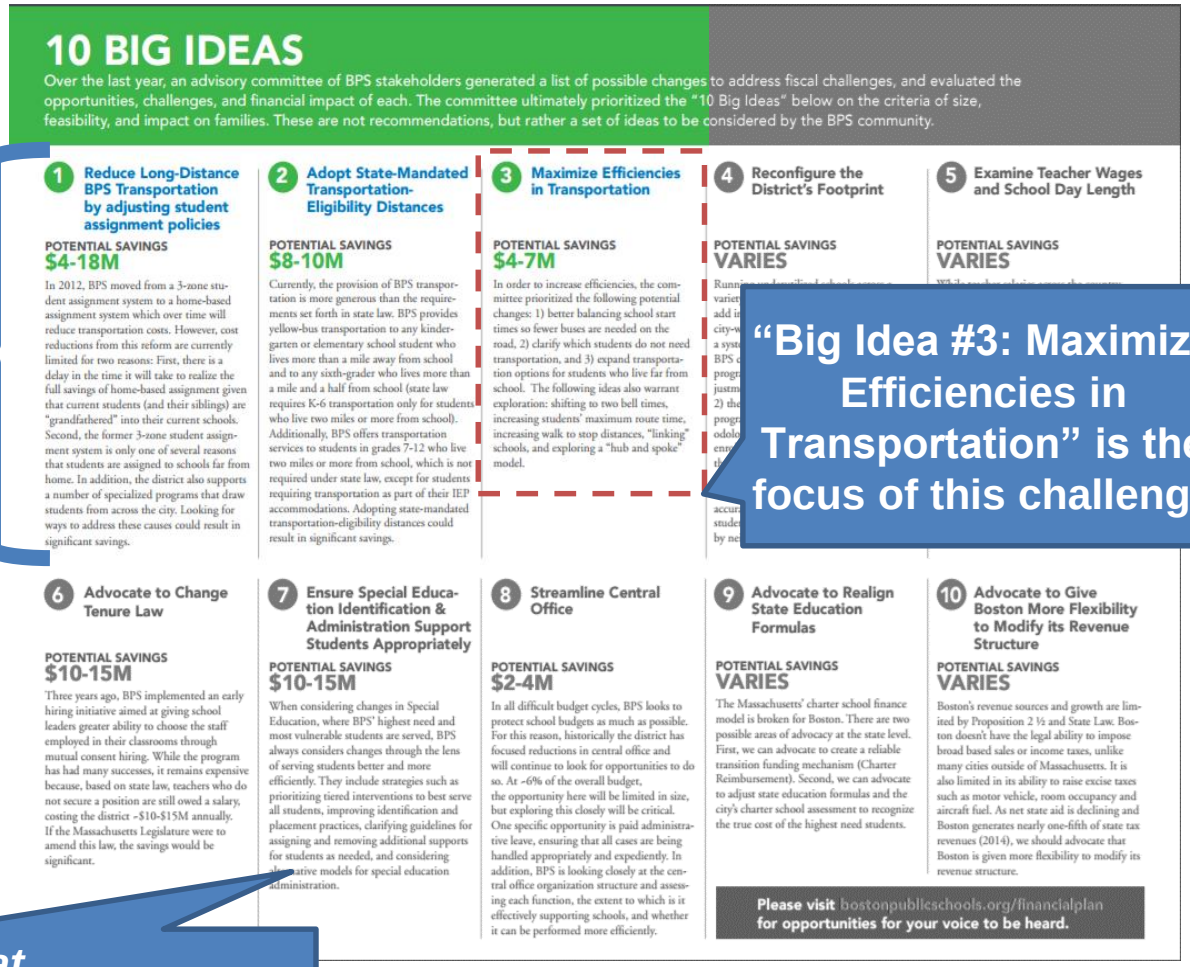
Transportation Overview

Our long term financial plan highlighted these challenges

Fixing transportation challenges comprised a third of the "10 Big Ideas" in our Long Term Financial Plan



10 BIG IDEAS

Over the last year, an advisory committee of BPS stakeholders generated a list of possible changes to address fiscal challenges, and evaluated the opportunities, challenges, and financial impact of each. The committee ultimately prioritized the "10 Big Ideas" below on the criteria of size, feasibility, and impact on families. These are not recommendations, but rather a set of ideas to be considered by the BPS community.

1 Reduce Long-Distance BPS Transportation by adjusting student assignment policies

POTENTIAL SAVINGS
$4-18M

In 2012, BPS moved from a 3-zone student assignment system to a home-based assignment system which over time will reduce transportation costs. However, cost reductions from this reform are currently limited for two reasons: First, there is a delay in the time it will take to realize the full savings of home-based assignment given that current students (and their siblings) are "grandfathered" into their current schools. Second, the former 3-zone student assignment system is only one of several reasons that students are assigned to schools far from home. In addition, the district also supports a number of specialized programs that draw students from across the city. Looking for ways to address these causes could result in significant savings.

2 Adopt State-Mandated Transportation-Eligibility Distances

POTENTIAL SAVINGS
$8-10M

Currently, the provision of BPS transportation is more generous than the requirements set forth in state law. BPS provides yellow-bus transportation to any kindergarten or elementary school student who lives more than a mile away from school and to any sixth-grader who lives more than a mile and a half from school (state law requires K-6 transportation only for students who live two miles or more from school). Additionally, BPS offers transportation services to students in grades 7-12 who live two miles or more from school, which is not required under state law, except for students requiring transportation as part of their IEP accommodations. Adopting state-mandated transportation-eligibility distances could result in significant savings.

3 Maximize Efficiencies in Transportation

POTENTIAL SAVINGS
$4-7M

In order to increase efficiencies, the committee prioritized the following potential changes: 1) better balancing school start times so fewer buses are needed on the road, 2) clarify which students do not need transportation, and 3) expand transportation options for students who live far from school. The following ideas also warrant exploration: shifting to two bell times, increasing students' maximum route time, increasing walk to stop distances, "linking" schools, and exploring a "hub and spoke" model.

4 Reconfigure the District's Footprint

POTENTIAL SAVINGS
VARIES

5 Examine Teacher Wages and School Day Length

POTENTIAL SAVINGS
VARIES

6 Advocate to Change Tenure Law

POTENTIAL SAVINGS
$10-15M

Three years ago, BPS implemented an early hiring initiative aimed at giving school leaders greater ability to choose the staff employed in their classrooms through mutual consent hiring. While the program has had many successes, it remains expensive because, based on state law, teachers who do not secure a position are still owed a salary, costing the district ~$10-$15M annually. If the Massachusetts Legislature were to amend this law, the savings would be significant.

7 Ensure Special Education Identification & Administration Support Students Appropriately

POTENTIAL SAVINGS
$10-15M

When considering changes in Special Education, where BPS' highest need and most vulnerable students are served, BPS always considers changes through the lens of serving students better and more efficiently. They include strategies such as prioritizing tiered interventions to best serve all students, improving identification and placement practices, clarifying guidelines for assigning and removing additional supports for students as needed, and considering alternative models for special education administration.

8 Streamline Central Office

POTENTIAL SAVINGS
$2-4M

In all difficult budget cycles, BPS looks to protect school budgets as much as possible. For this reason, historically the district has focused reductions in central office and will continue to look for opportunities to do so. At ~6% of the overall budget, the opportunity here will be limited in size, but exploring this closely will be critical. One specific opportunity is paid administrative leave, ensuring that all cases are being handled appropriately and expediently. In addition, BPS is looking closely at the central office organization structure and assessing each function, the extent to which is it effectively supporting schools, and whether it can be performed more efficiently.

9 Advocate to Realign State Education Formulas

POTENTIAL SAVINGS
VARIES

The Massachusetts' charter school finance model is broken for Boston. There are two possible areas of advocacy at the state level. First, we can advocate to create a reliable transition funding mechanism (Charter Reimbursement). Second, we can advocate to adjust state education formulas and the city's charter school assessment to recognize the true cost of the highest need students.

10 Advocate to Give Boston More Flexibility to Modify its Revenue Structure

POTENTIAL SAVINGS
VARIES

Boston's revenue sources and growth are limited by Proposition 2 ½ and State Law. Boston doesn't have the legal ability to impose broad based sales or income taxes, unlike many cities outside of Massachusetts. It is also limited in its ability to raise excise taxes such as motor vehicle, room occupancy and aircraft fuel. As net state aid is declining and Boston generates nearly one-fifth of state tax revenues (2014), we should advocate that Boston is given more flexibility to modify its revenue structure.

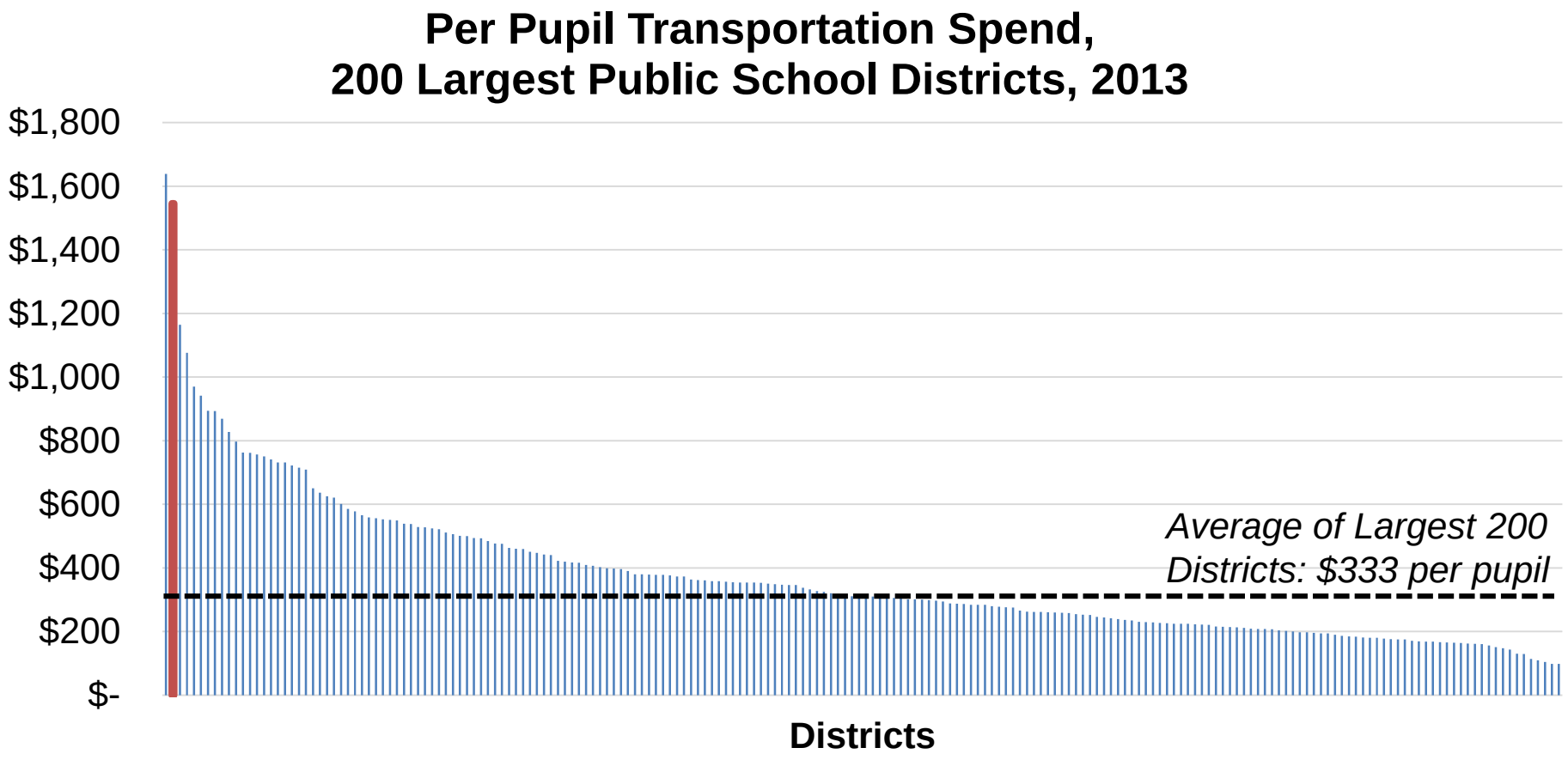
Please visit bostonpublicschools.org/financialplan for opportunities for your voice to be heard.

"Big Idea #3: Maximize Efficiencies in Transportation" is the focus of this challenge

Learn more about the LTFP at bostonpublicschools.org/financialplan

Transportation Overview

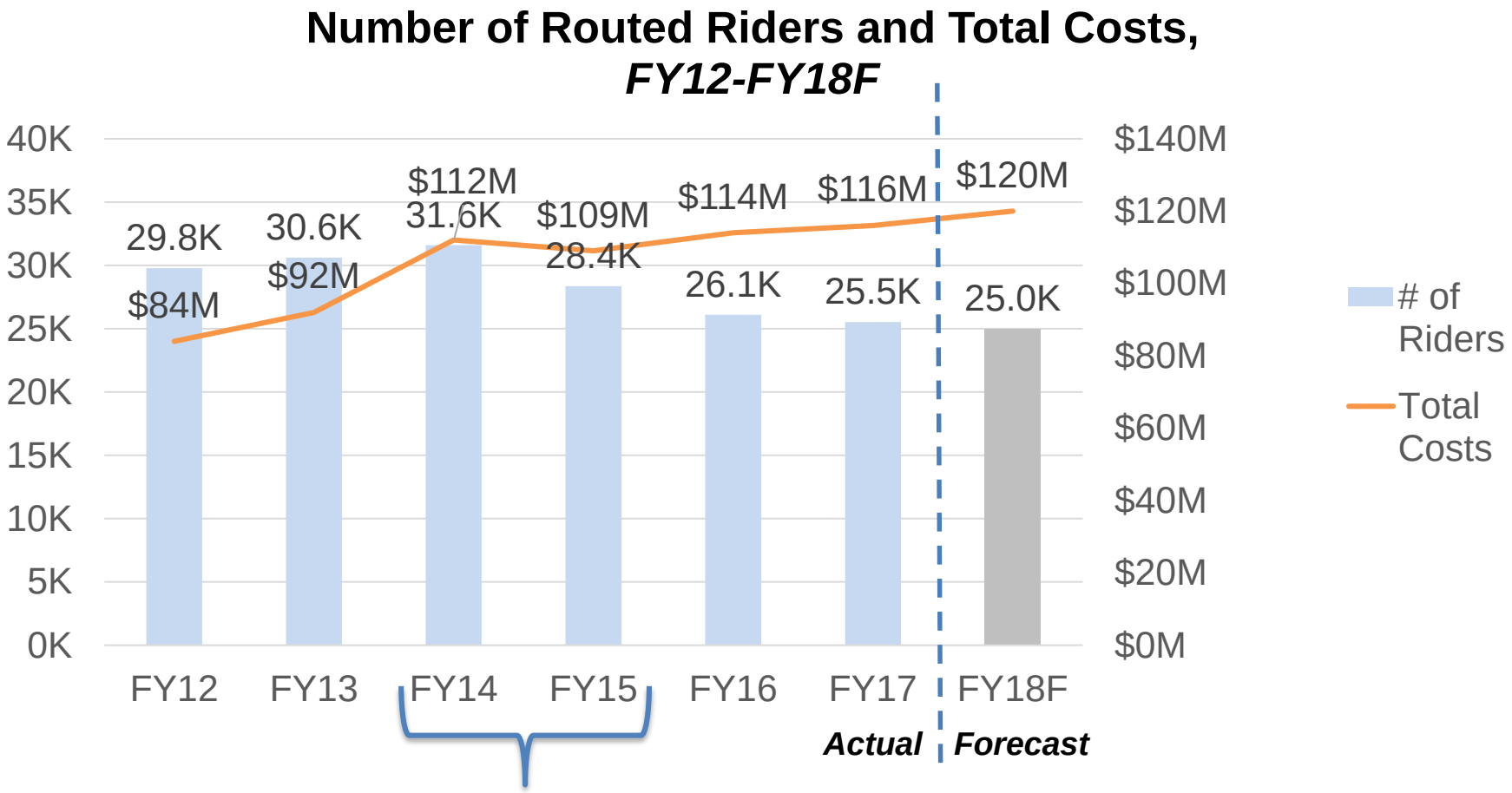
BPS spends the 2nd most per student on transportation nationally



Note: Largest 200 indicate the districts with the largest fall enrollment. The 200th district for reference had an enrollment of 31.4K
Source: US Census 2013 Survey of School System Finances

Transportation Overview

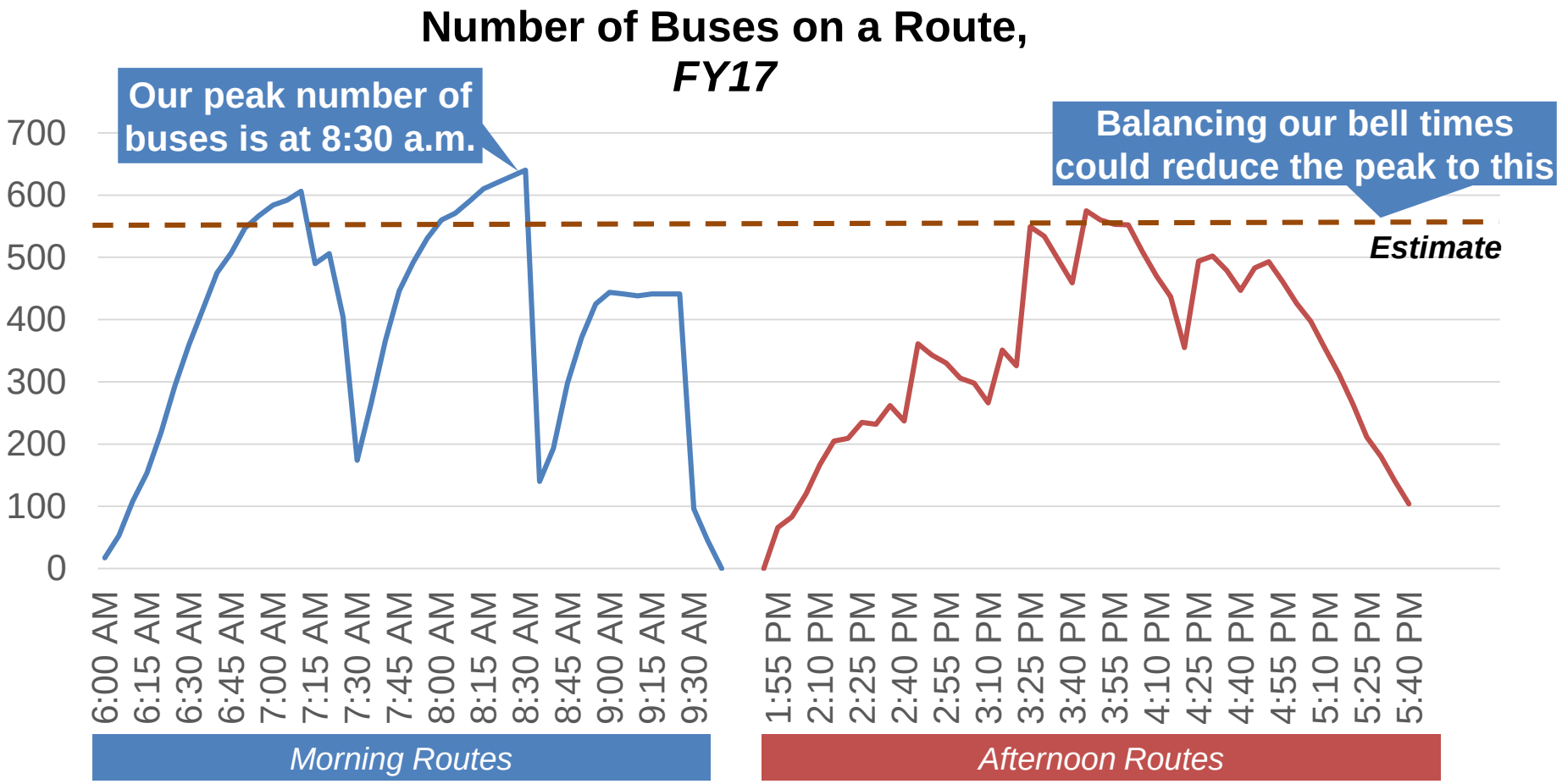
Meanwhile, our transportation costs have continued to rise even as the number of total riders has fallen



This decline reflects the impact of home-based assignment and the shift of 7th & 8th graders to the MBTA

Transportation Overview

Meanwhile, our bell times are not perfectly balanced increasing the number of "peak" buses



Note: The number of active routes varies throughout the school year therefore these numbers are constantly changing

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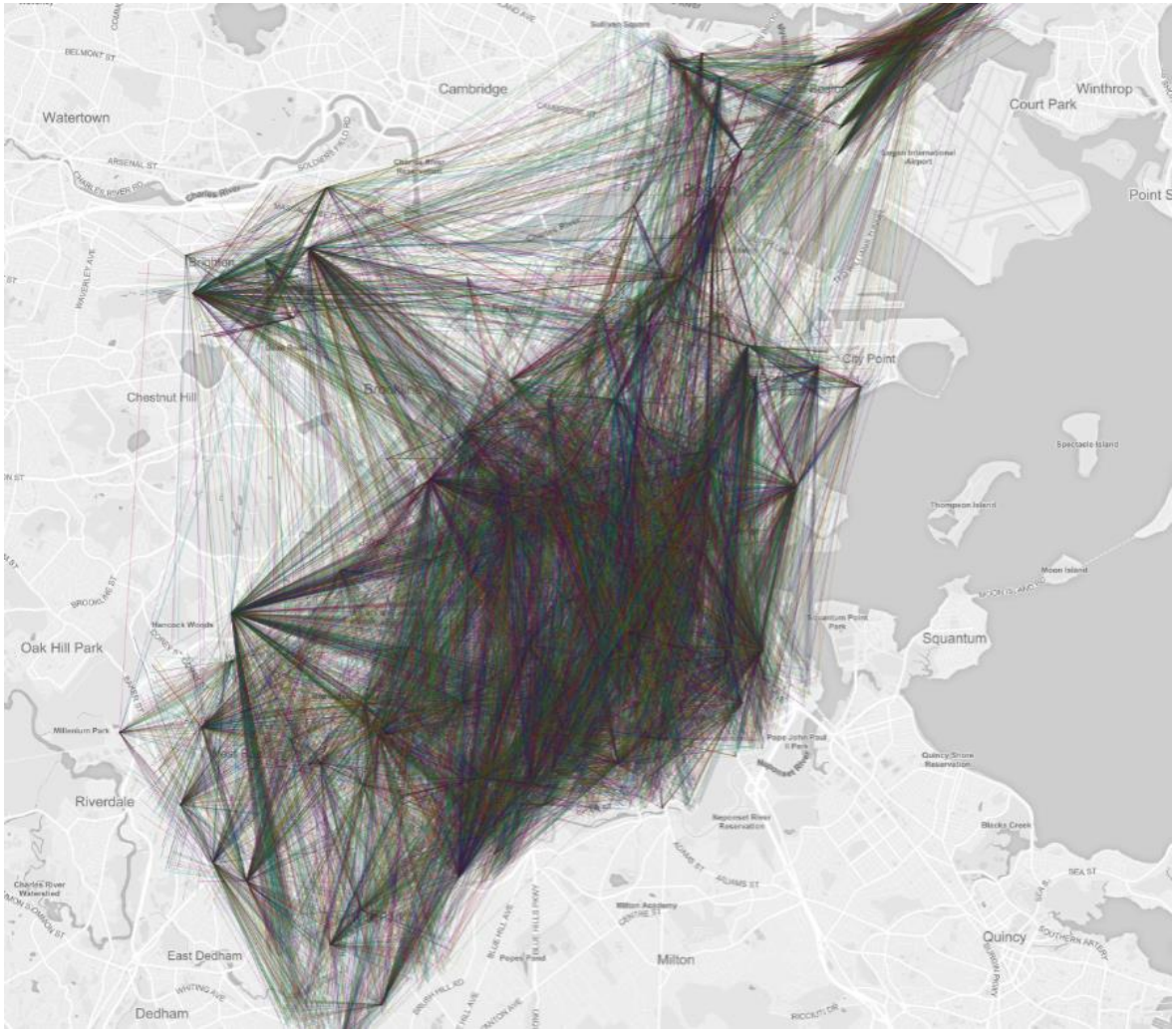
Closing Remarks

This is our starting point



The above is a graphical representation of all student-school assignment in our simulated data file (dense nodes are schools). This was helpfully created by a group of faculty and students at Boston University's Hariri Institute.

Route Creation

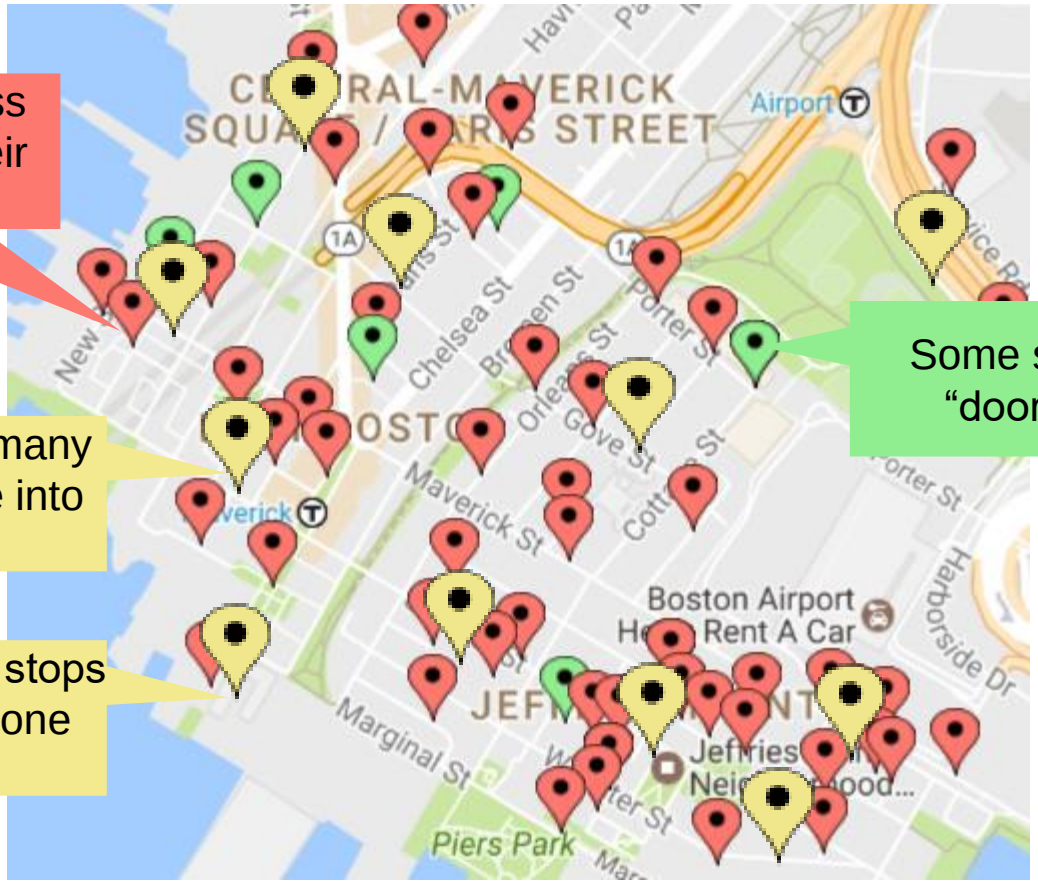
Creating a route for a given bus is a multi-step process

1 ***Given our existing student locations, we pair students with bus stops***

All students walk less than 0.5 miles to their nearest bus stop

We try to cluster as many students as possible into one stop…

…But often there are stops that can only serve one student



Some students require a "door to door" pickup

Legend

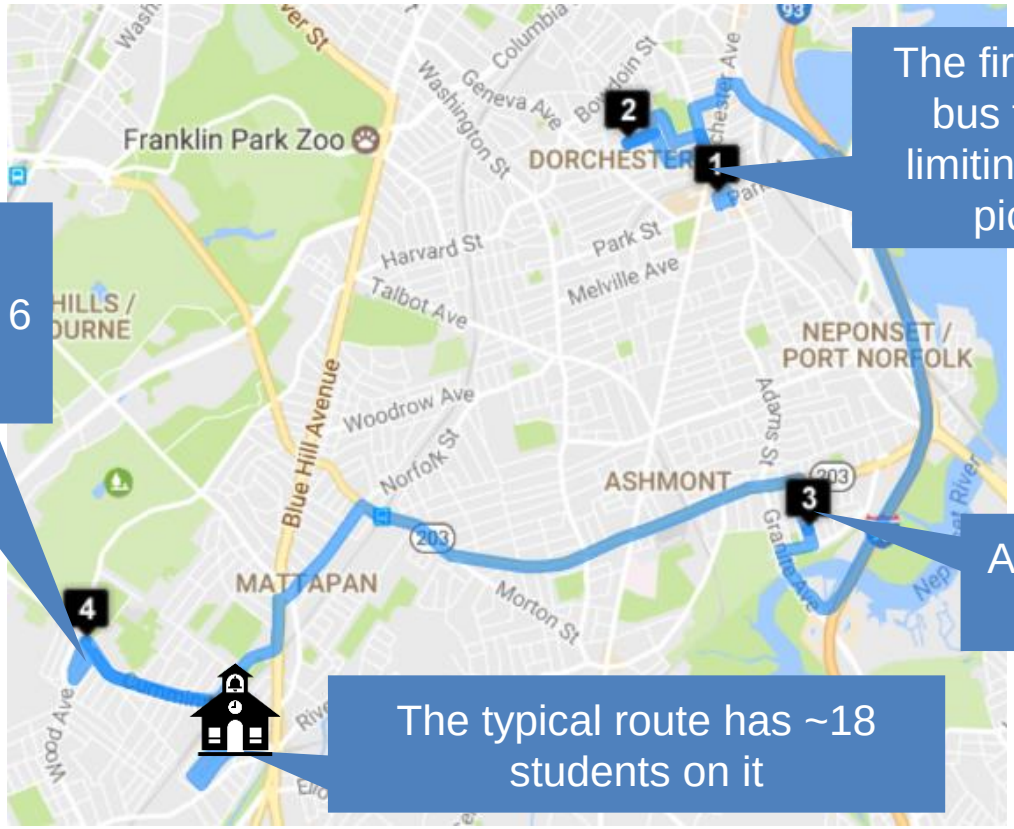
- Door to Door Students
- Corner Students
- Stops

Note: These are randomly selected addresses. BPS students may or may not live at these stops

Route Creation

Creating a route for a given bus is a multi-step process

2 ***We then work to connect these bus stops into efficient routes***



The first student cannot ride the bus for longer than an hour, limiting the possible number of pickups along the route

The average route connects 6 bus stops

At a typical stop, we see ~3 students get on

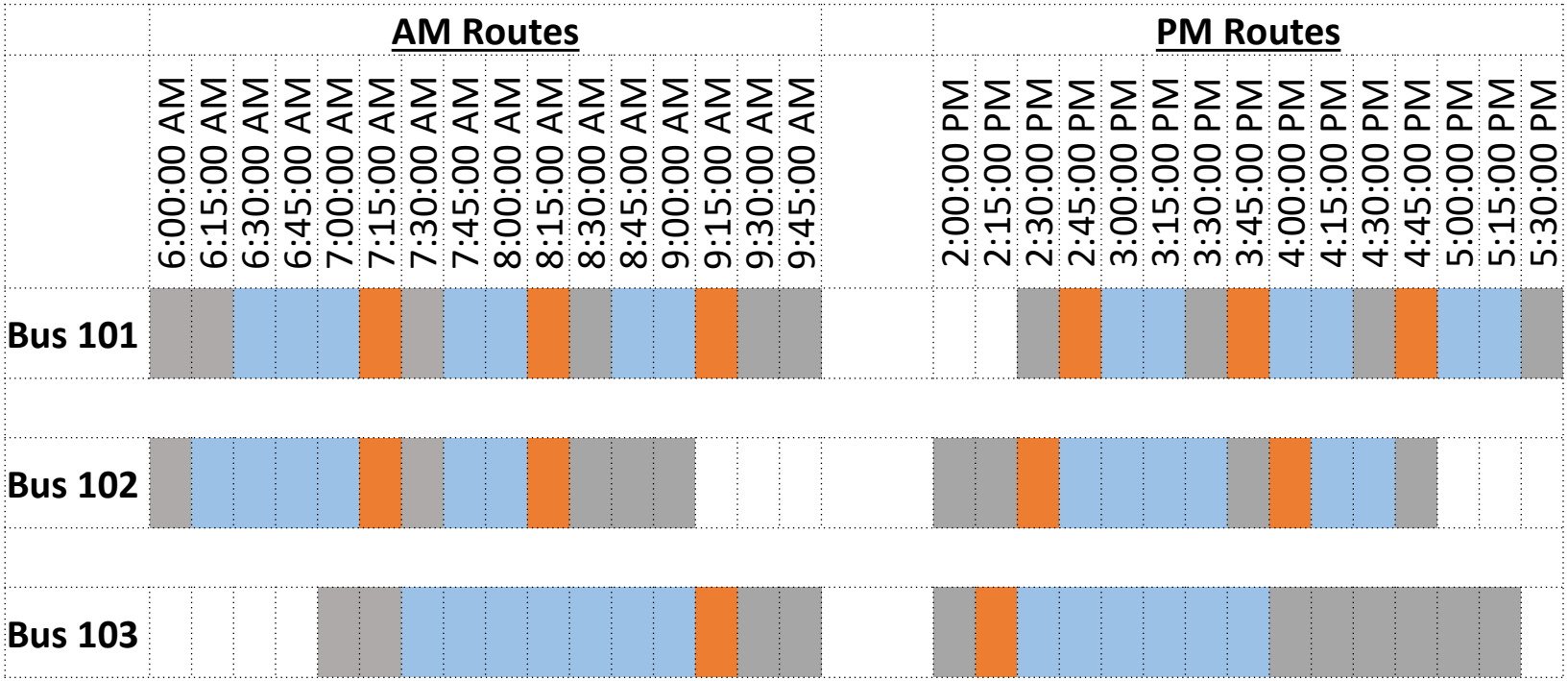
The typical route has ~18 students on it

Note: These are randomly selected addresses. These may or may not reflect actual stops

Route Creation

Creating a route for a given bus is a multi-step process

3 ***Buses will then serve as many schools as possible during the day***



Dead-head time *(i.e., driving from last stop of one route to first pick-up on the next route)*

Drive Time *(i.e., picking up / dropping off students)*

Dwell Time *(i.e., time at school, loading or unloading the bus)*

System Overview

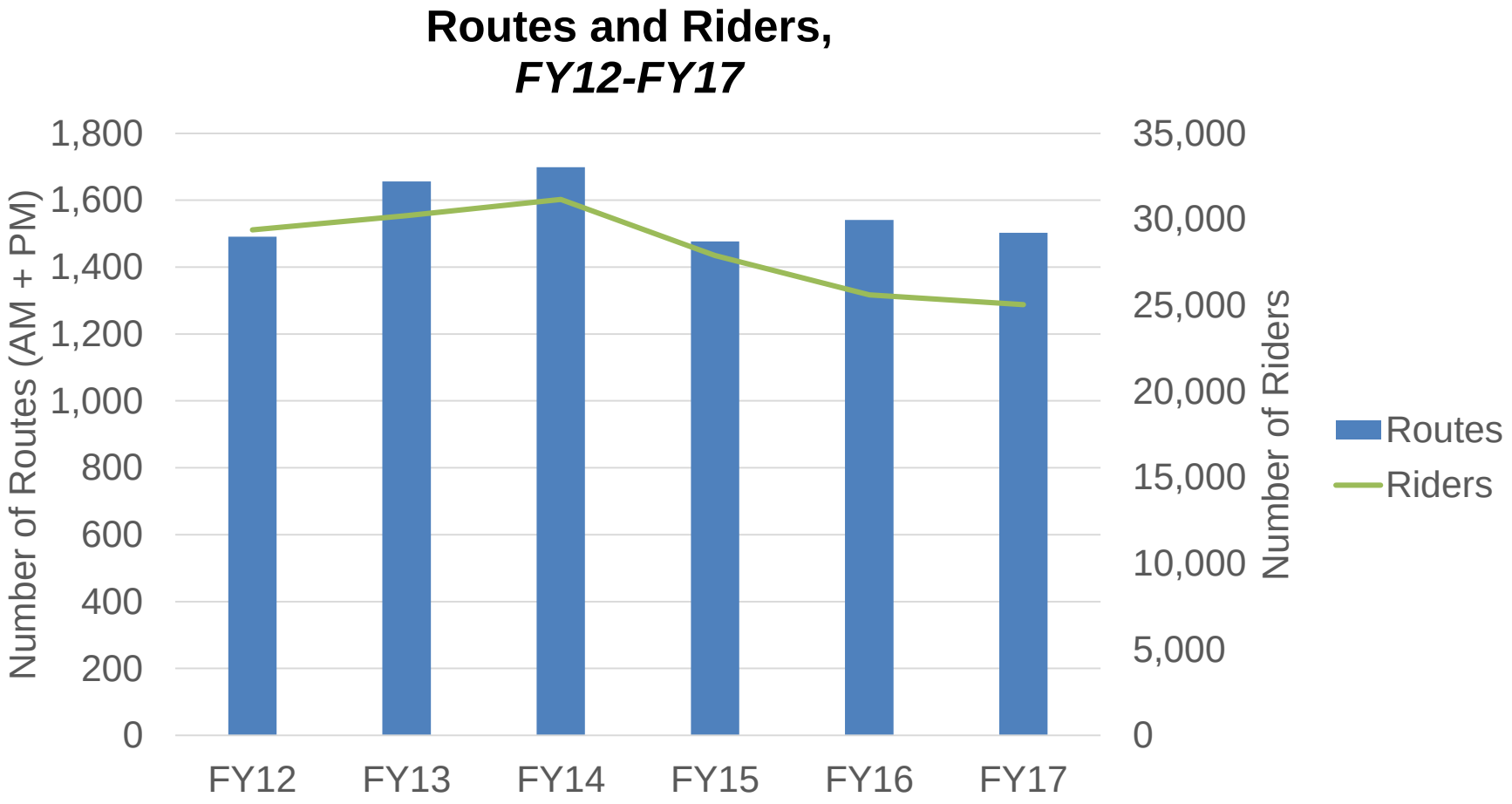
These routes and trips add up to a large and complex system

~25,043 daily routed riders	**231** schools served	**646** buses running each day
3,536 daily trips	**20,204** times a bus stops each day	**44,937 miles** driven per day
4,759 bus stops	**170,000 pounds** of daily carbon dioxide (CO2) emissions	**$120M** FY18 requested budget

Note: All figures above are snapshots in time and fluctuate – sometimes significantly – throughout the year. They are intended to suggest scope and scale only.

Transportation Overview

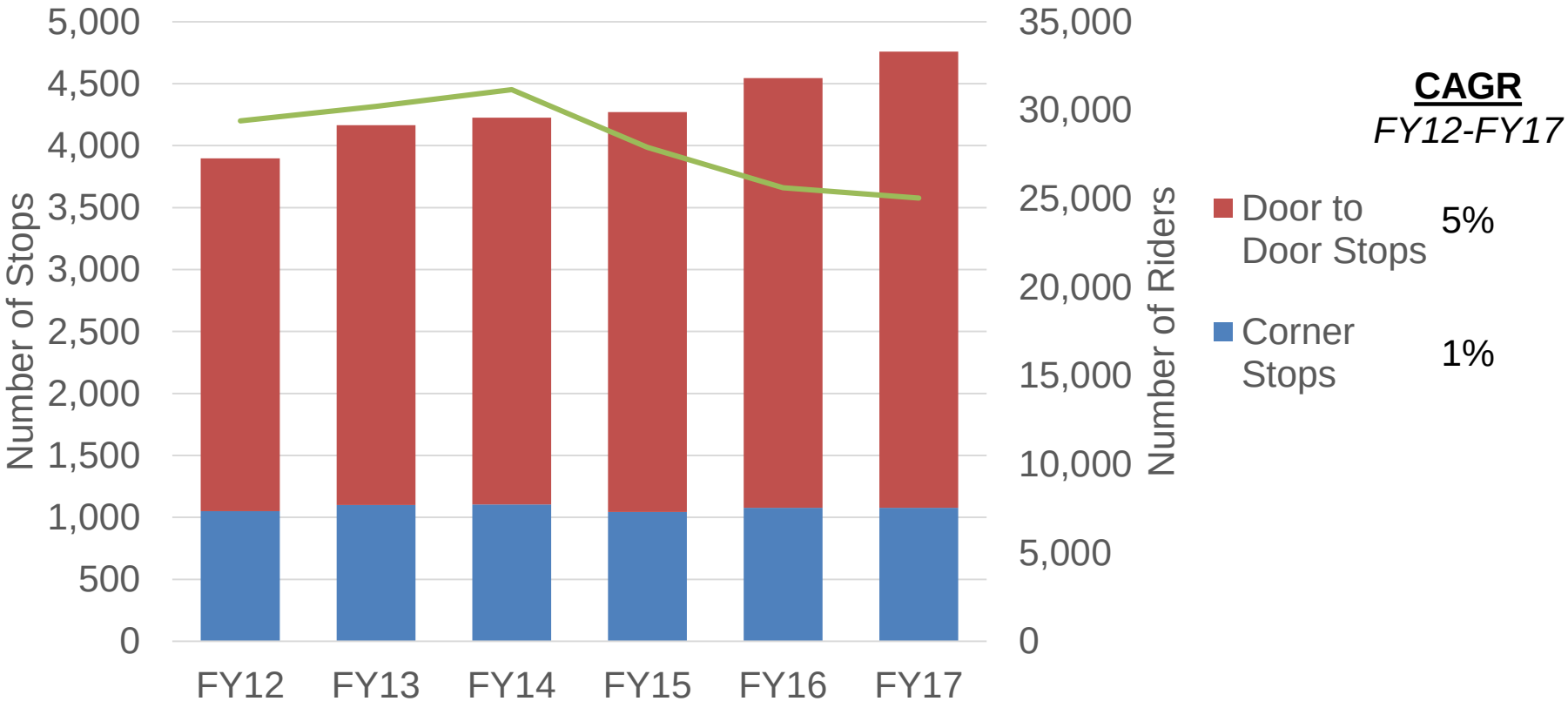
Ridership has decreased, but the number of routes has plateaued



Transportation Overview

Part of this is because the number of stops – especially door to door stops – has increased over that time frame

Number of Active AM Bus Stops by Stop Type, *FY12-FY17*



Transportation Challenge Overview

The transportation challenge has two goals:

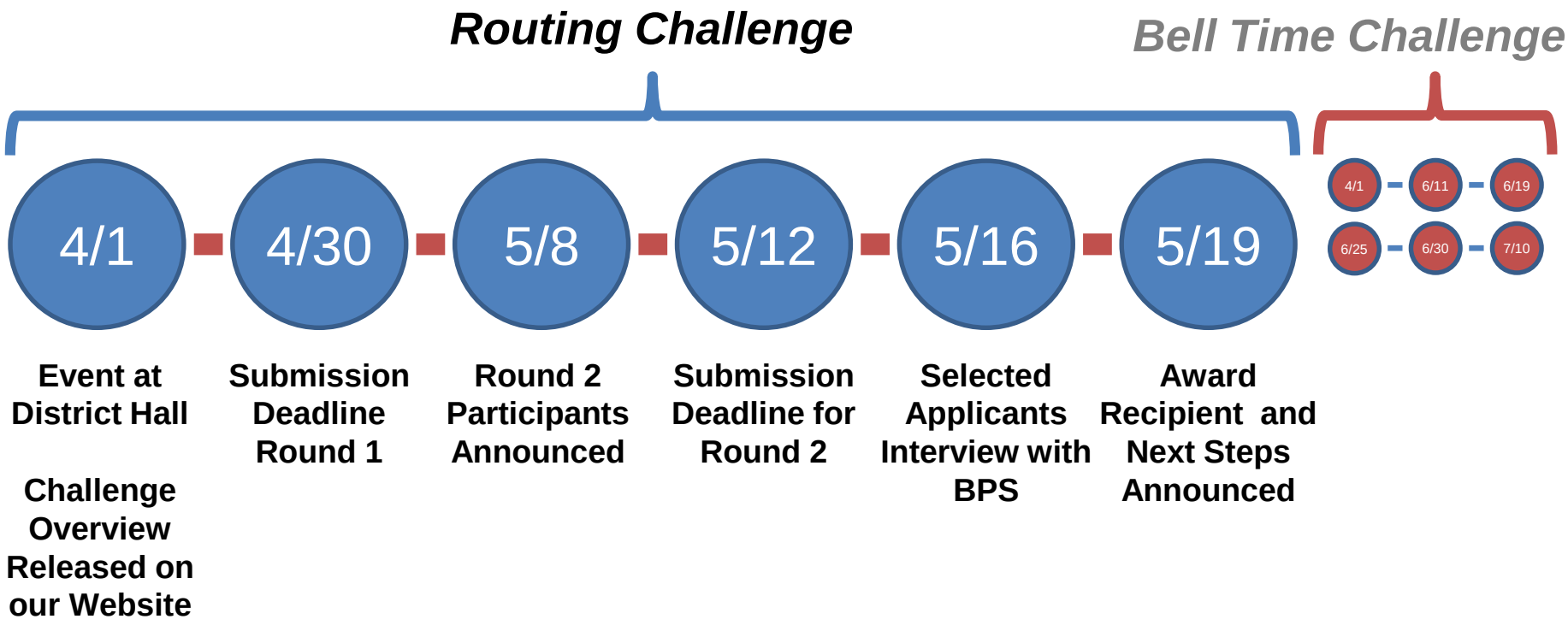
1. **Using anonymized student location data, create an algorithm that will optimally route all of our buses, producing efficient routes and improving on-time performance**

2. **Create a series of bell times that are equitably and efficiently balanced, reducing transportation costs and accommodating community feedback**

These two are inextricably linked, as it is difficult to adjust school start times without factoring in how buses are routed

Transportation Challenge Overview: Routing Challenge

This is not a one day event – participants have time to perfect their solution



Routing Data *released on a rolling basis to applicants* ***who submit an NDA***

Challenge timelines are subject to change; any changes will be communicated to all participants.

Transportation Challenge Overview: Routing Challenge

The Routing Challenge involves more than just efficient routing

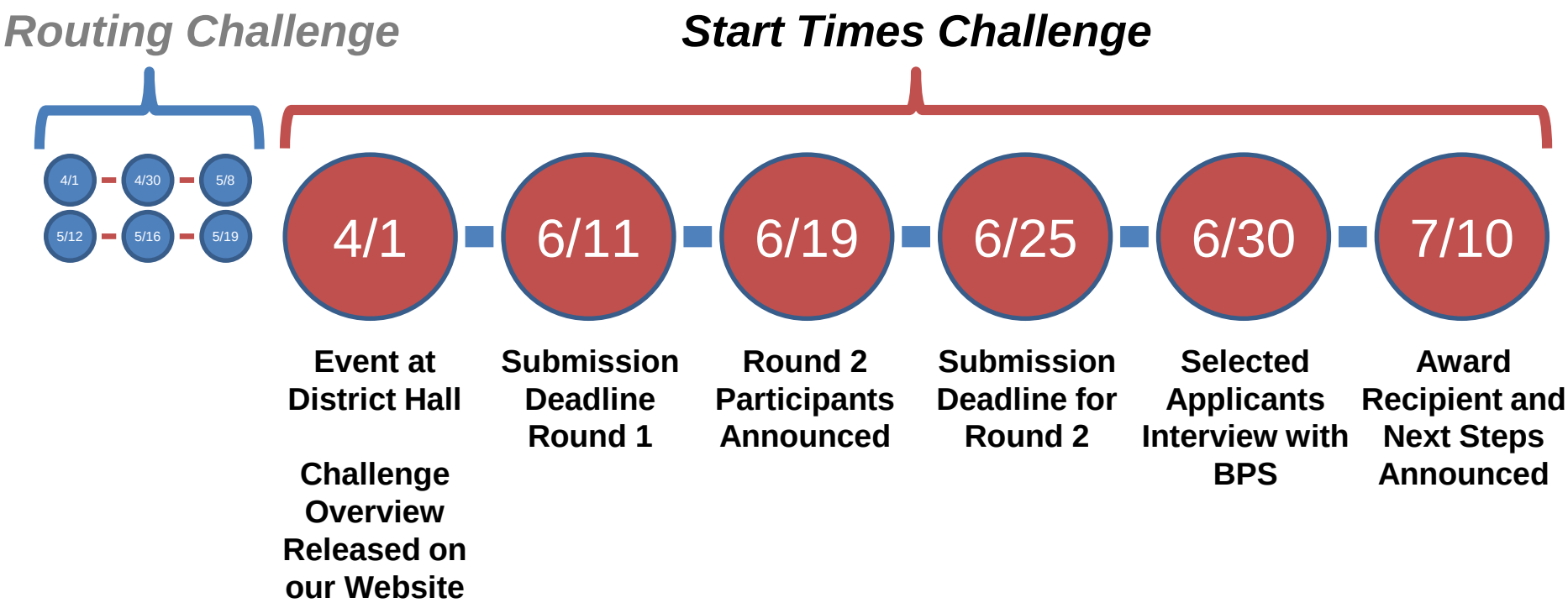
The desired outcome of the Routing Challenge will:

1. Allow us to **automate our routes efficiently and reliably**
2. Enable our buses to achieve **high levels of on-time performance**
3. Consider **creative solutions**
4. Function as a **flexible tool**, making it possible to **test multiple scenarios** based on **changes to policy and practice**

*This will allow us to **prove the costs of different policy choices and current practices** such as walk-to-stop distances, maximum ride lengths, grandfathering transportation eligibility from previous assignment systems, etc.*

Transportation Challenge Overview: Start Times Challenge

This is not a one day event…



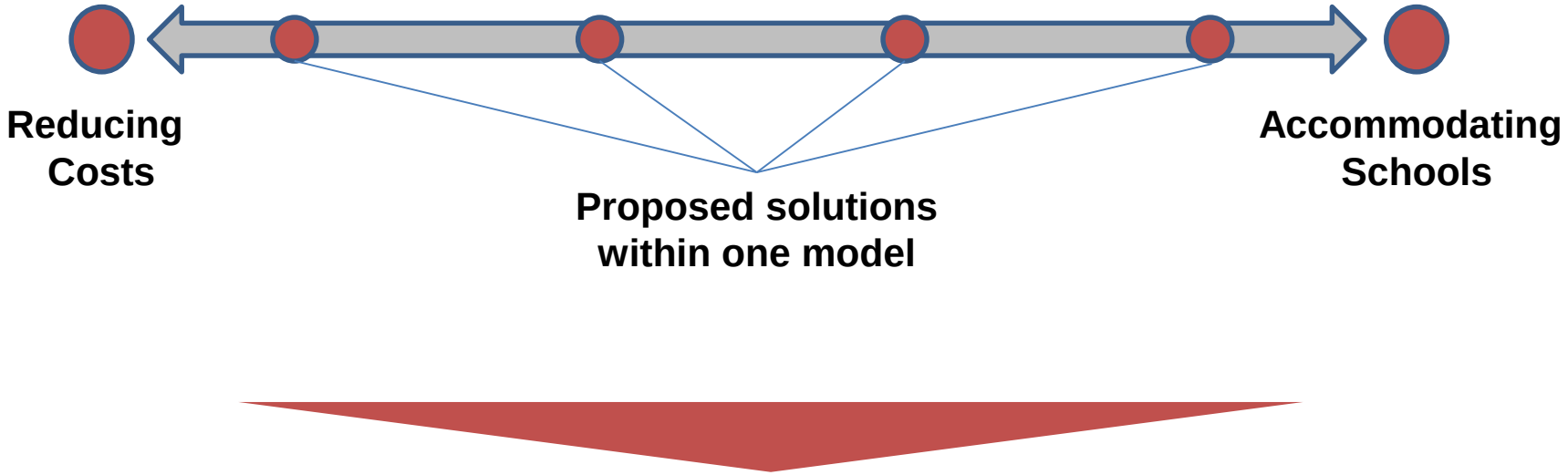
Routing Data *and* ***Start Time Preference Data*** *released on a rolling basis to applicants* ***who submit an NDA***

Challenge timelines are subject to change; any changes will be communicated to all participants.

Transportation Challenge Overview: Start Times Challenge

Solutions for the Start Times Challenge must address a tension point in the system

The desired outcome of the Start Times Challenge will *help us to understand and quantify the* ***tradeoffs between reducing costs*** *and* ***accommodating schools' preferences*** *for start times.*



The above will allow us to bring multiple plausible solutions to the community

Transportation Challenge Overview

We're letting participants look under the hood by releasing never-before-available data

	Publicly Available	Available with Submitted and Approved NDA

Routing Data	• Fictionalized route information
	  ○ Student address (and lat/long)
	  ○ School assignment and school info
	  ○ Type of rider (corner or D2D)
	  ○ Estimated walk-to-stop distance
	• Fleet information (buses by type, buses by lot)
	• "Rules of the Road"
	• "Principals Handbook"
		• Anonymized route information
		• List of currently in-use stops
		• Route overview (e.g., stops on each route)

Start Time Preference Data	• Aggregated survey results by school will be available	• Individual start time preferences at the school level

We are not publicly releasing everything to protect student privacy

Transportation Challenge Overview

To help us evaluate submissions, we are looking for three things within each challenge:

1. ***A short memo or presentation outlining how you solved this problem***

+

2. ***<Optional> If you see us partnering together in the future, describe what that partnership would look like (e.g., "my solution will be open source")***

+

3.

Scenario	# of Required Buses	Service Hours	Service Miles	Dead-Head Hours	Dead-Head Miles	Metric Measuring School Preference
Current System	630	3,600	44,500	1,400	2,300	*Text*
Your proposed system	###	###	###	###	###	*Text*

Primary criteria for Round 1 of Routing Challenge

Only required for Bell Time Challenge

Transportation Challenge Overview

Thank you to our Event Sponsors

HARVARD Kennedy School
RAPPAPORT INSTITUTE
for Greater Boston

Harvard University's Rappaport Institute for Greater Boston aims to improve governance of Greater Boston by fostering better connections between scholars, policy makers, and civic leaders. Steve Poftak and the Rappaport Institute have been instrumental in planning and hosting today's event.

The generous donation of space from District Hall has enabled us to host this event in such a wonderful space that truly champions innovation -- both private and public -- in the City of Boston.

DISTRICT HALL
A NEW HOME FOR **INNOVATION** IN BOSTON

Transportation Challenge Overview

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Microsoft

Microsoft's support has been instrumental in building support and engaging community stakeholders across Boston. They have also made available Microsoft Azure to all participants.

Google has generously donated one billion point to point distance calculations for participants who complete an NDA to use as part of this challenge.

Google

BU Rafik B. Hariri Institute for Computing and Computational Science & Engineering

The Hariri Institute has helped us develop a more robust anonymous routing dataset to publicly post on our website – an essential step in encouraging widespread participation while protecting student data.

SAS has donated nearly a thousand pro-bono hours of computer science support to improve our stops and routes. The progress that they have made has opened our eyes to the power of computer science and is one of the inspirations for the Transportation Challenge.

sas THE POWER TO KNOW.

Transportation Challenge Overview

Longfield FAMILY FOUNDATION

Awards

Thanks to the generous donations of the Longfield Family Foundation and an anonymous donor we are pleased to announce that we will give out awards at the end of each challenge:

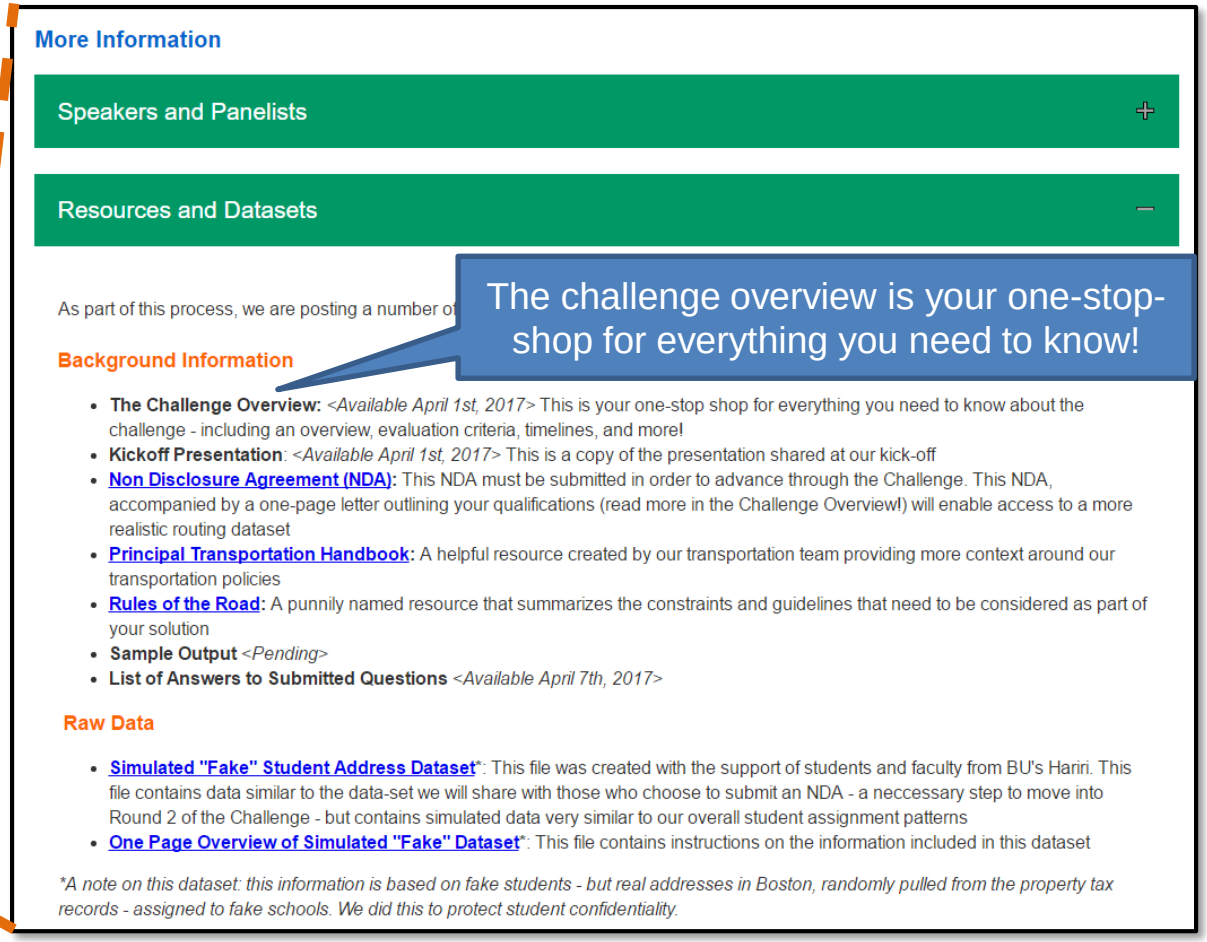
	Award Amount for Best Idea		***Award Amount for Proving It Works***		
Routing Challenge	**$9,000**	+	**$6,000**	=	**$15,000**
Start Times Challenge	**$9,000**	+	**$6,000**	=	**$15,000**

More detailed terms and conditions, will be announced on our website

Transportation Challenge Overview

Where can I go to learn more?

www.bostonpublicschools.org/transportationchallenge



The challenge overview is your one-stop-shop for everything you need to know!

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THANK YOU!!