RAIL VISION

RTAC Meeting

OCTOBER 10, 2018

massDOT
Massachusetts Department of Transportation

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Presentation Agenda

1. Welcome
2. Evaluation Framework
3. Tier 1 Service Concepts (Presentation & Discussion)
4. Introduction to the Tier 1 Models
5. Public Comment

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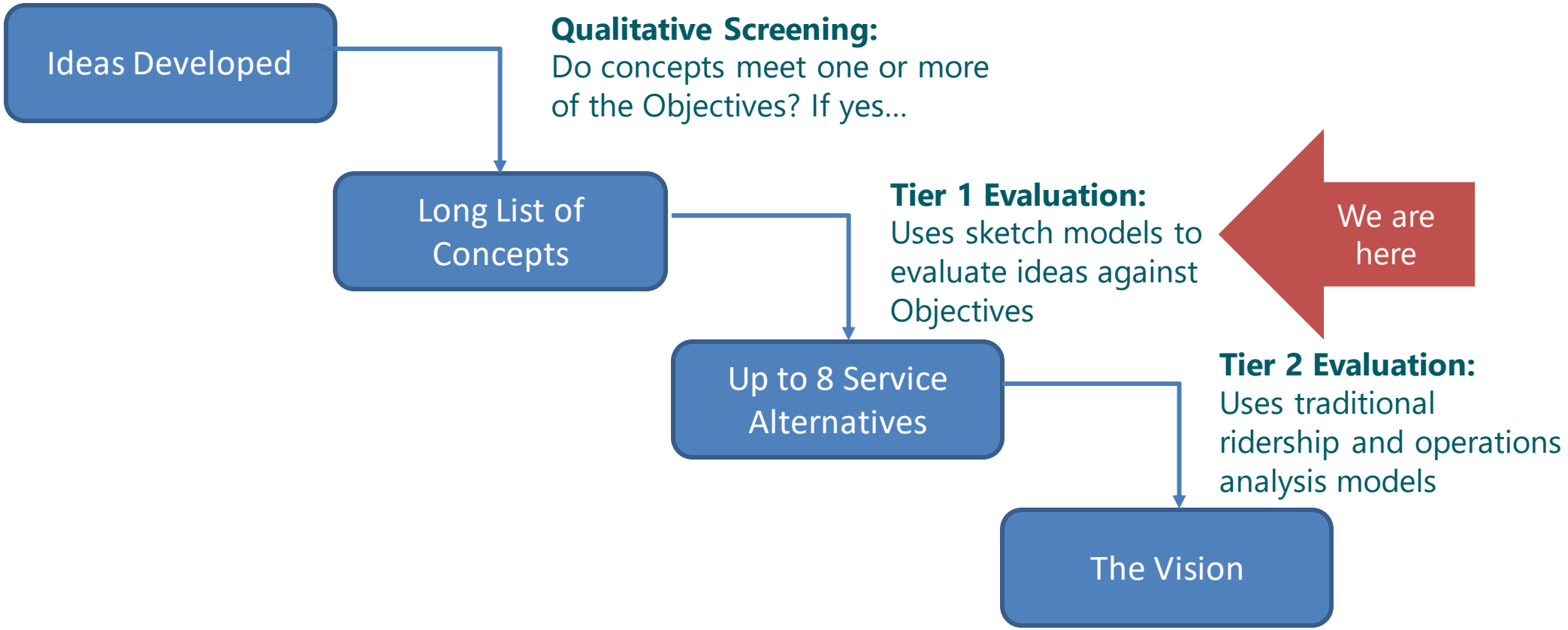
Evaluation Framework

Evaluation Process



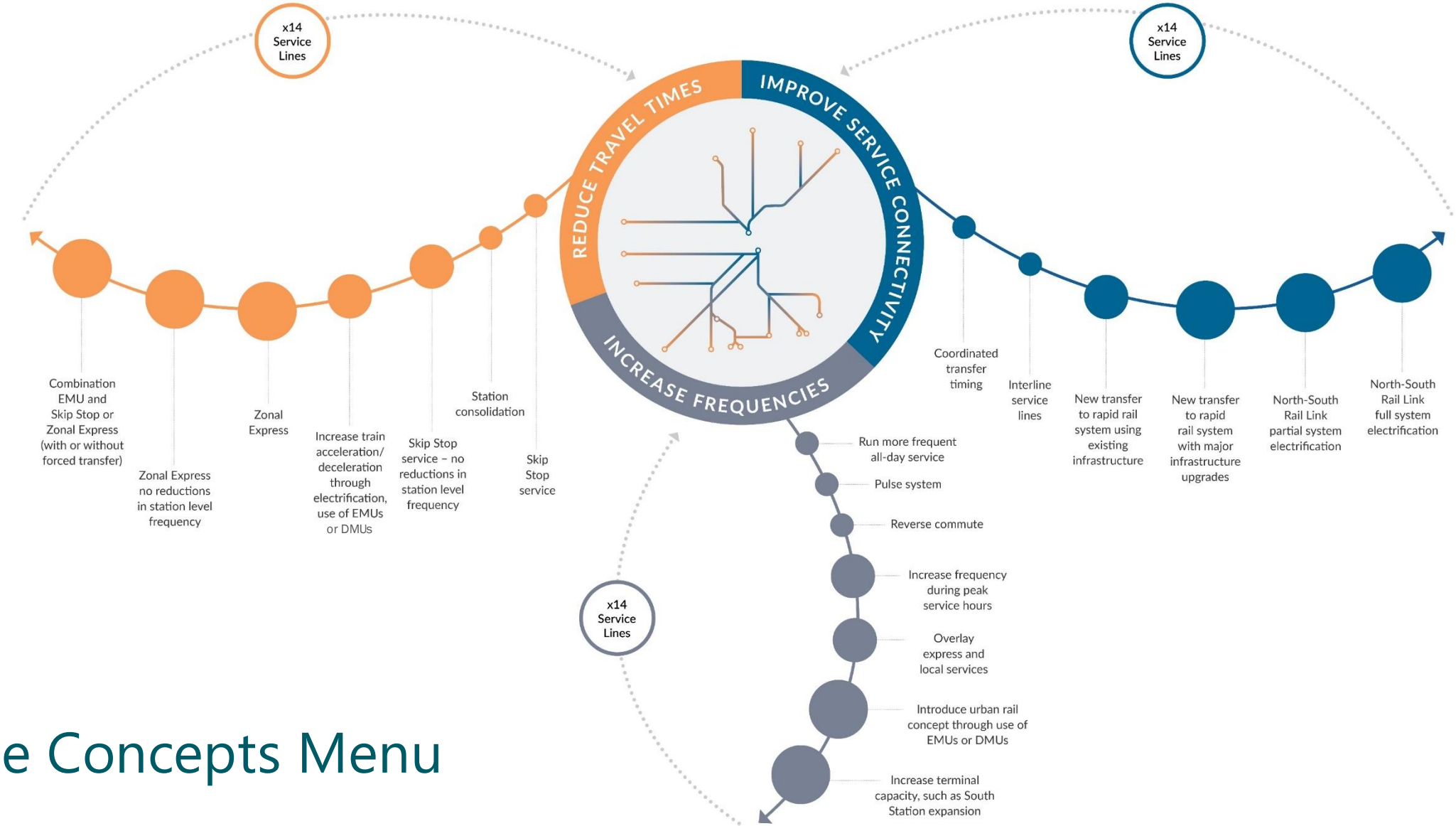
The Tier 1 Evaluation

- Begins with service concepts that do one or more of the following:
  - Reduce travel time
  - Increase service frequency
  - Improve system connectivity
- Concepts vary in terms of cost and complexity
- Tests each concept on each line for effectiveness, and identify challenges

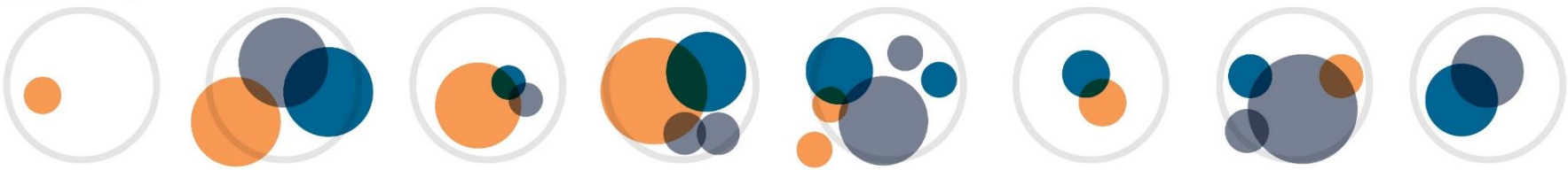
We are here

- Evaluates "packages" of concepts on a system-wide basis to develop up to 8 service alternatives
- **IMPORTANT: Not all service concepts will make sense for all lines**

Service Concepts Menu



UP TO 8 SERVICE ALTERNATIVES



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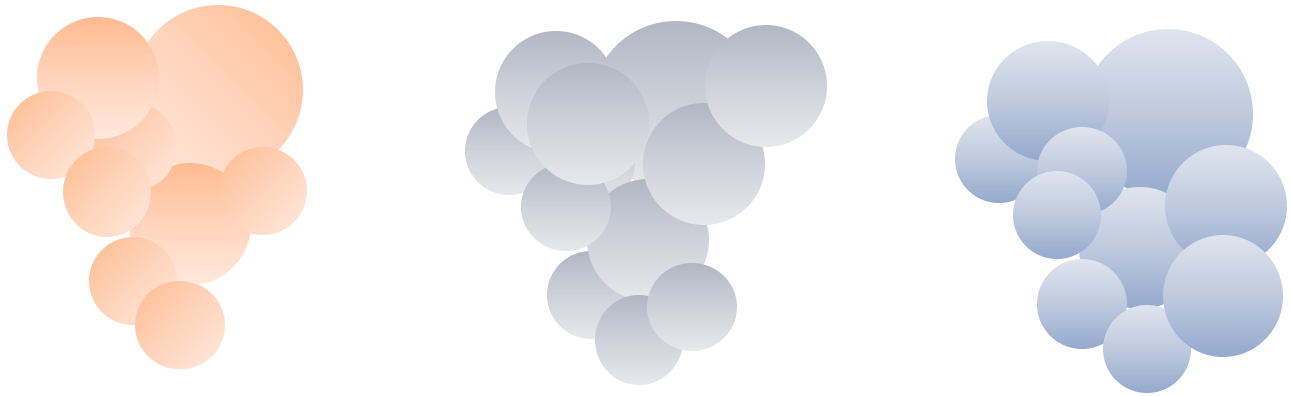
REDUCE TRAVEL TIME

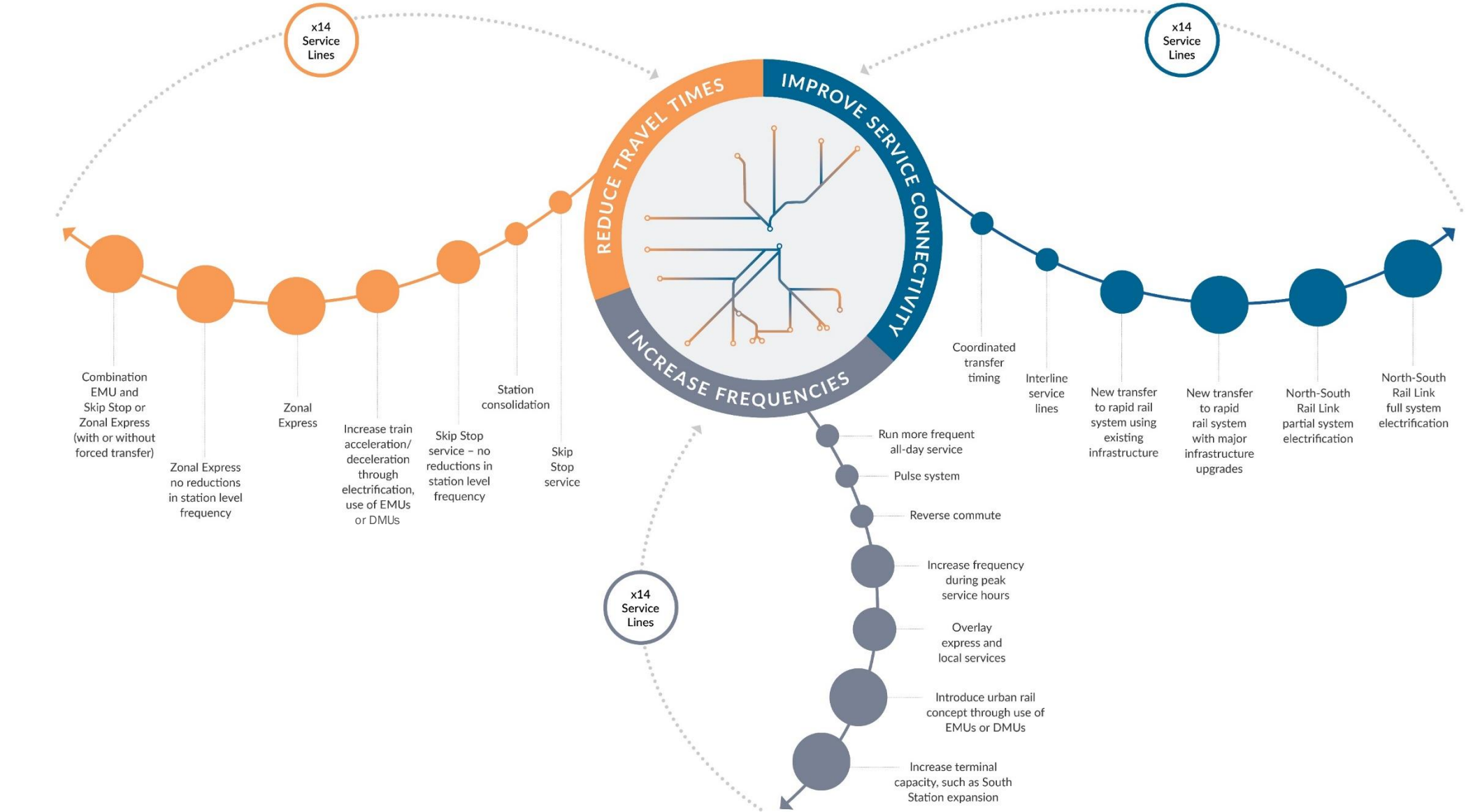
INCREASE FREQUENCIES

IMPROVE SERVICE CONNECTIVITY

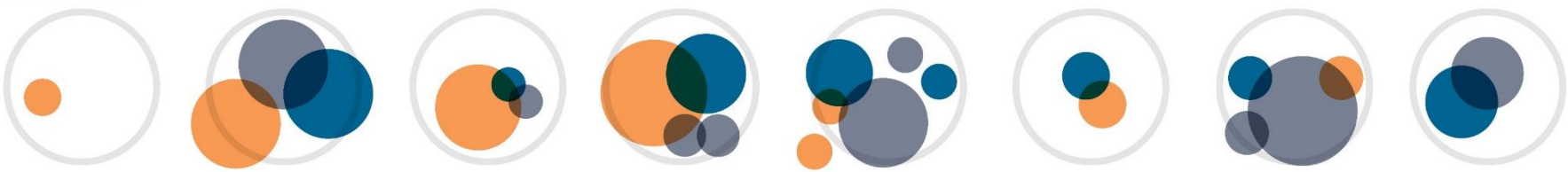


UP TO 8 SERVICE ALTERNATIVES

8 Service Alternatives



UP TO 8 SERVICE ALTERNATIVES



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Tier 1 Sketch-Level Models

- *ATTUne* – scheduling model that will show what train operations are possible at a high level given certain investments
- *Operating Cost Model* – calculates operating cost implications of transit investments
- *Regional Dynamic Model (RDM)* – dynamic sketch model that calculates ridership estimates for different types of investments *and* addresses how transit investment affects land use

Tier 2 – will use traditional RTC model to evaluate operations, the CTPS model to evaluate ridership, and the RDM model to evaluate land use effects for the 8 service alternatives

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Tier 1 Service Concepts

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Service Concept Idea

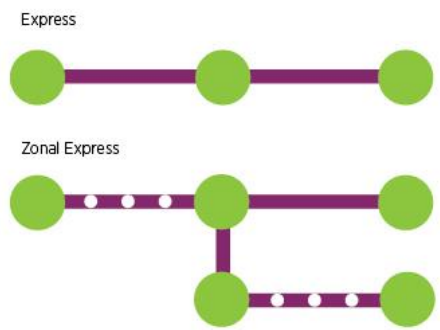
Express or Zonal Express

- Reduces Travel Time
- Increases Frequency

Express service makes few if any stops between terminal points. Would be combined with local service.

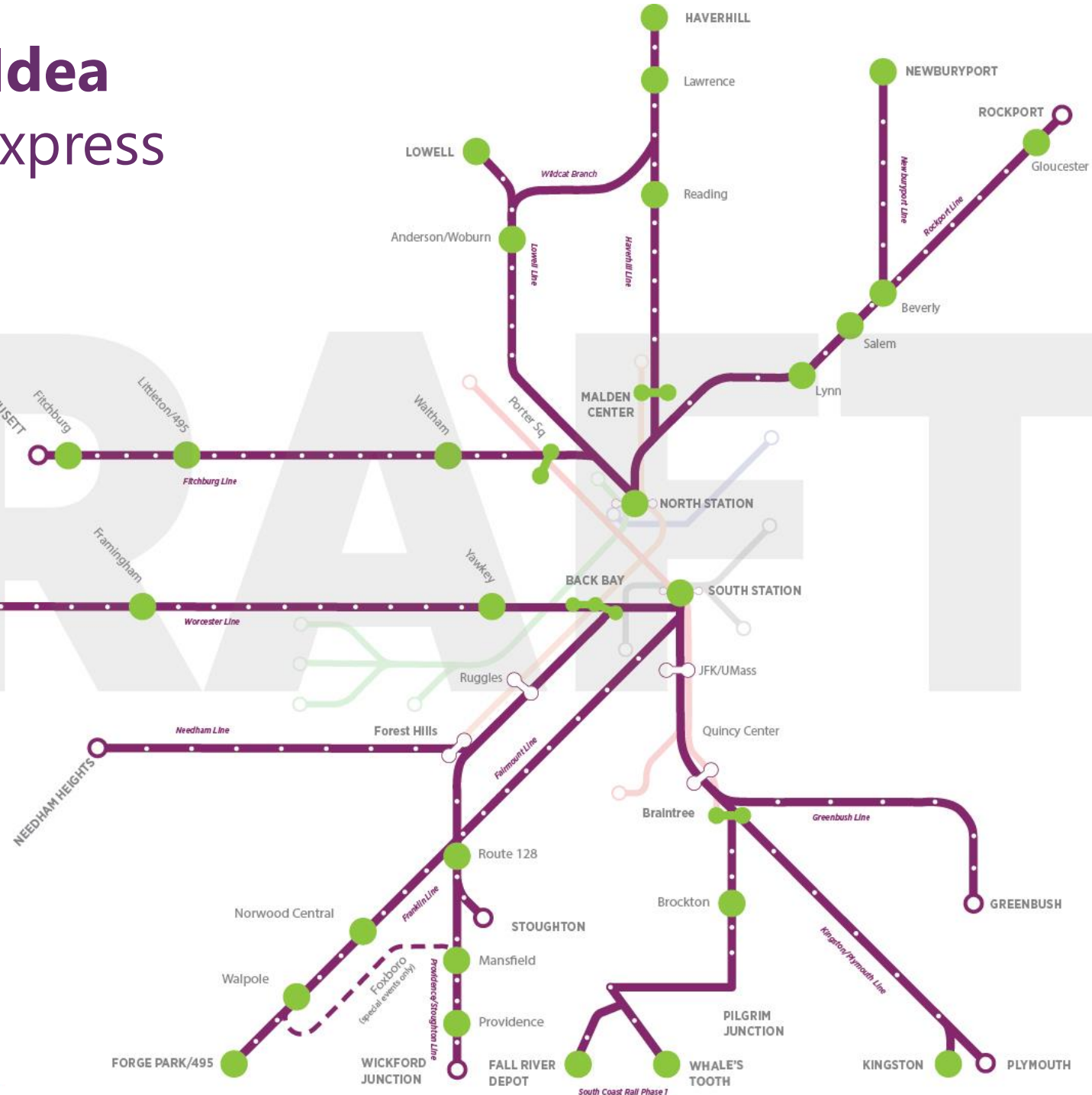
Zonal Express provides local service from an outer to intermediate stop, and express service to the core. Other service begins at the intermediate stop and provides local service to the core.

Tradeoffs Question: Are the Express Stations in the right locations? Is reducing travel time from high ridership, outer stations desirable if it requires a transfer for those traveling to or from lower ridership stations?



Express station / transfer point

Local station



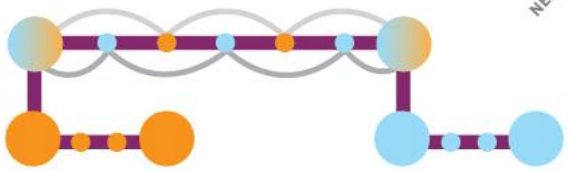
Service Concept Idea

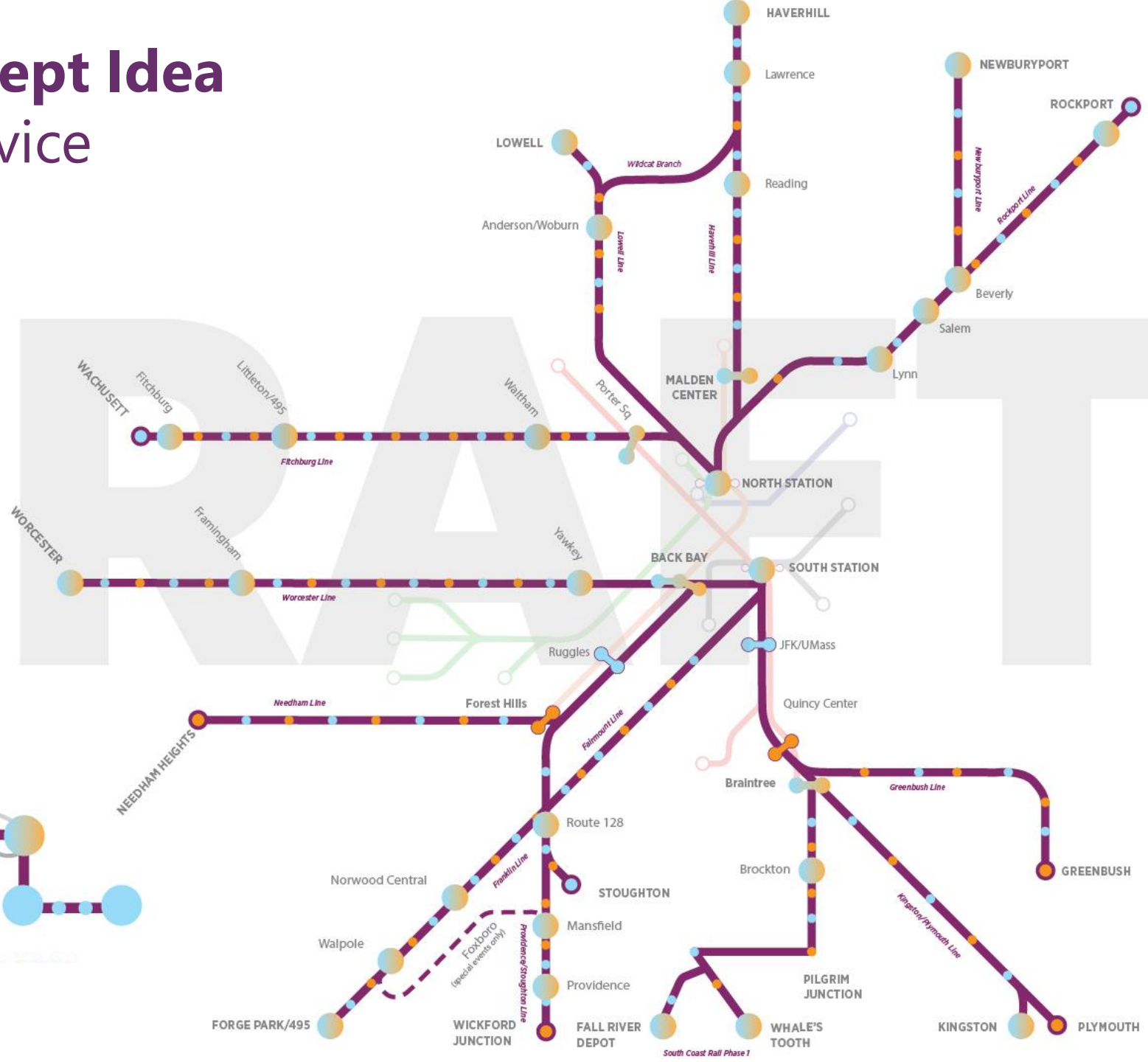
Skip Stop Service

- Reduces Travel Time
- Increases Frequency

Skip Stop provides an equivalent level of service as seen today at each station but reduces overall travel times by having trains skip service at select stations (ex: every other station).

Tradeoffs Question(s): Is it acceptable to require a transfer to reach some intermediate stations?





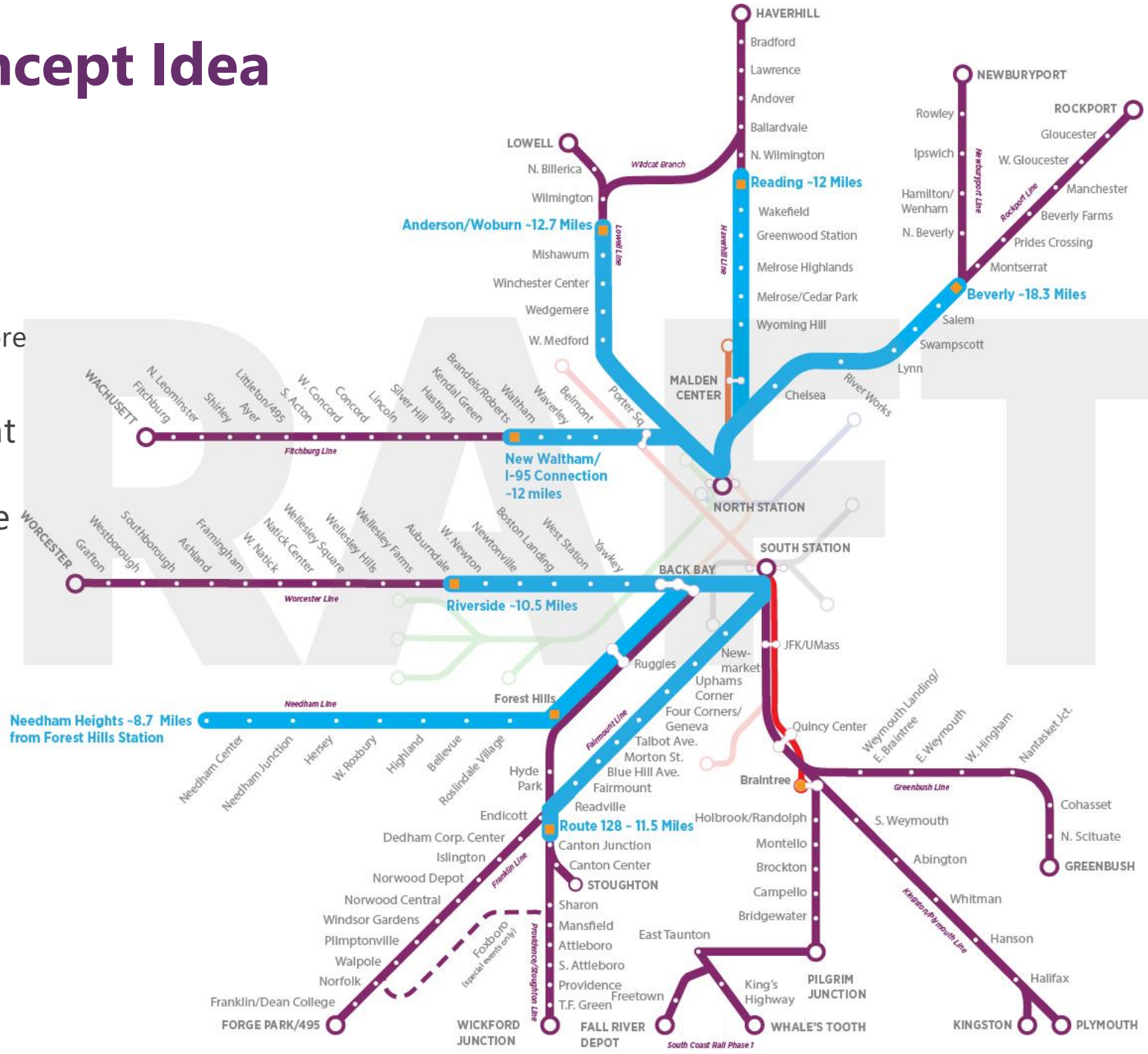
Service Concept Idea

Urban Rail

- Increases Frequency
- Improves Connectivity

Service Concept: Frequent, all-day service connecting higher density stations in the inner core using new vehicle technology

Tradeoffs Question: Are these the right portions of the lines? Is Urban Rail worth the investment if it requires more transfers? If it increases travel time to some locations?



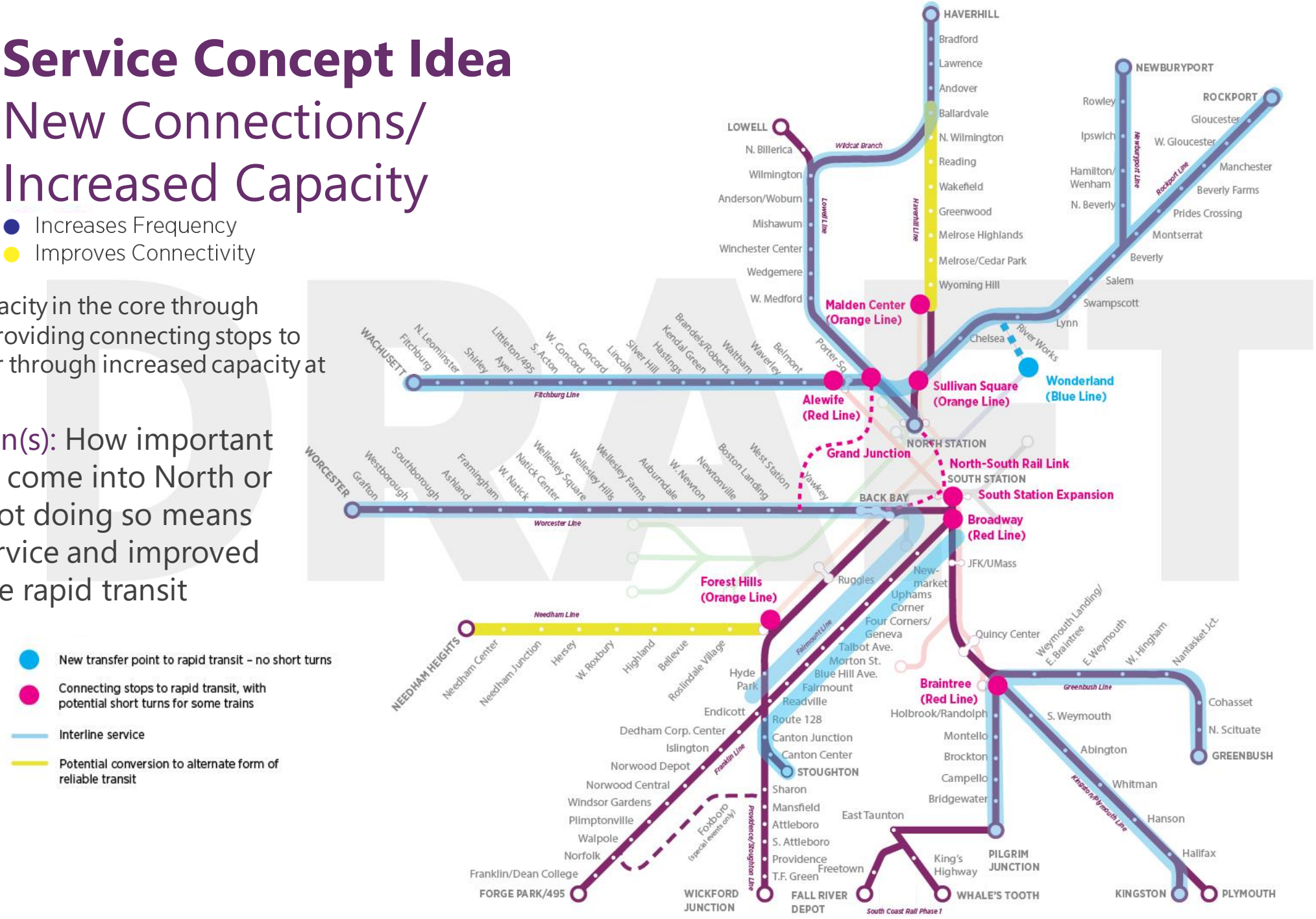
Service Concept Idea

New Connections/ Increased Capacity

- Increases Frequency
- Improves Connectivity

Increases terminal capacity in the core through pairing service lines, providing connecting stops to rapid transit service, or through increased capacity at or between terminals.

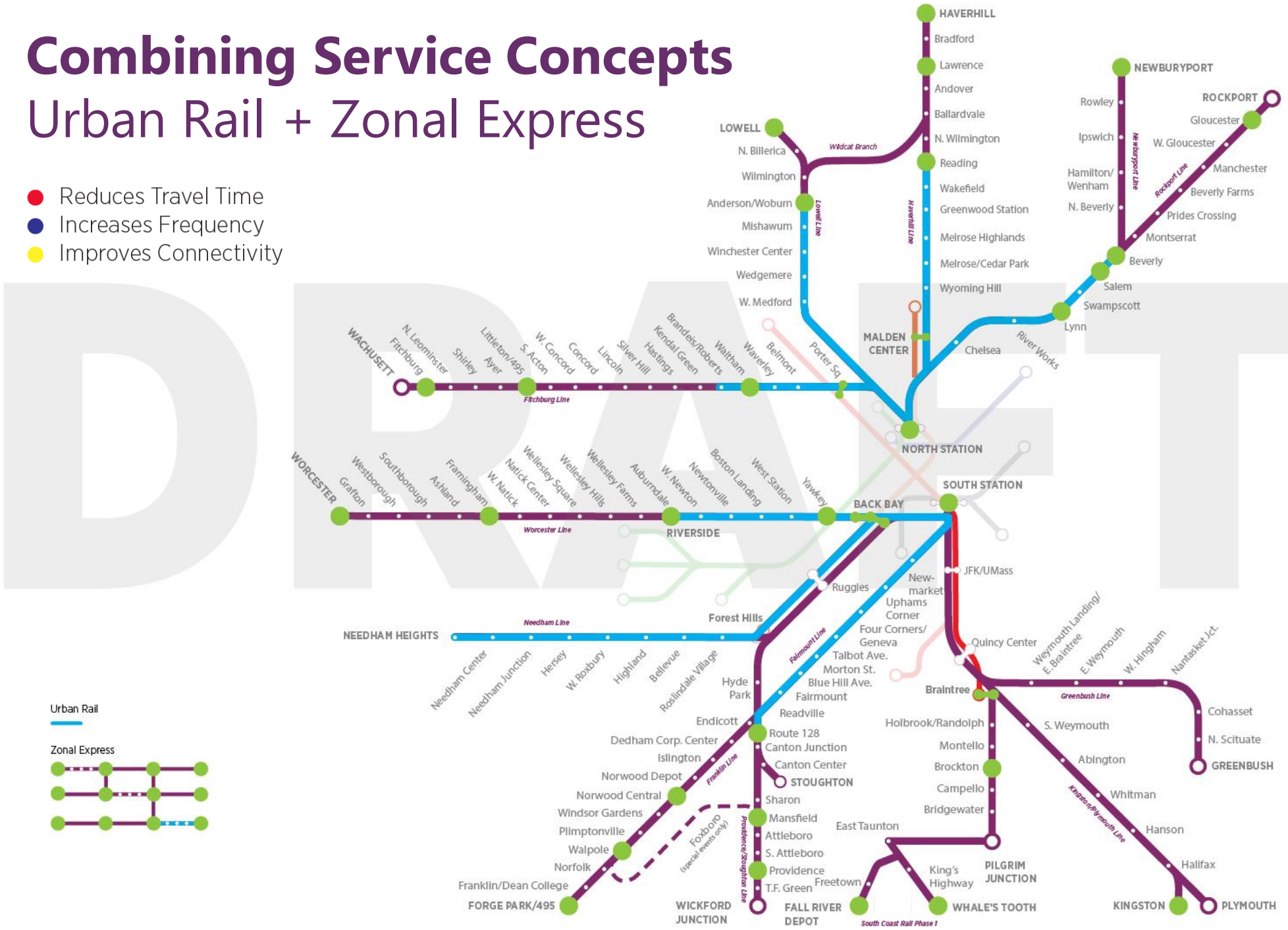
Tradeoffs Question(s): How important is it for all trips to come into North or South Station if not doing so means more frequent service and improved connections to the rapid transit network?



Combining Service Concepts

Urban Rail + Zonal Express

- Reduces Travel Time
- Increases Frequency
- Improves Connectivity



Urban Rail

Zonal Express

Service Concepts Discussion

- Are any Big Ideas missing?
- How should we approach creating combinations of concepts?

Modeling Tools

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ATTUne

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Overview of ATTUne

What is it?

- A **tool** that checks operating schedules against planning rules

What information does it use? What are the outputs?

- Inputs: **rail infrastructure and schedules**
- Outputs: assessment of the **operational feasibility** of various service concepts, along with key statistics – such as vehicle miles, travel time savings

How will it help us in our evaluation?

- Assesses service concepts at a **conceptual level**, without the need to develop a detailed RTC model simulation

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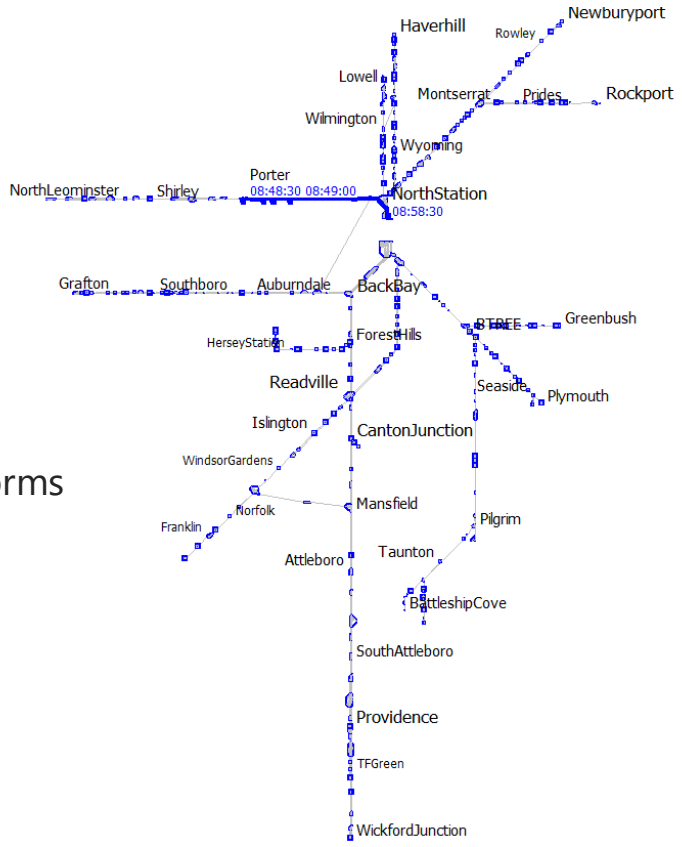
ATTUne Consists of Two Primary Elements

Geography

Inputs:

- Rail network
- Tracks
- Station platforms
- Interlockings



Timetables

Inputs:

- Lines
- Trains
- Dwell times
- Run times
- Arrival and departure times

WTT - Worcester to SouthStation

Split Overtaken Trains | Show Passes | Include Guessed Times | Actual Routeing | Show Names | Conflicts | All L

			6	7	8	9
Formed By						
Signal ID			WO0584	WO0506	WO0586	WO0508
Orig. Dep. Time			06.39	06.22	07.15	06.57
Orig. Loc. Name			Framingham	Worcester	Framingham	Worcester
Dest. Loc. Name			SouthStation	SouthStation	SouthStation	SouthStation
Timing Load			D	D	D	D
Operating Characteristics						
TOC			MB	MB	MB	MB
Day of Operation			SX	SX	SX	SX
Changes			New	New	New	New
To Form						
Worcester	dep	1	-	**06.22**	-	**06.57**
Grafton	arr	2	-	**06.34½**	-	**07.09½**
	dep	3	-	**06.35**	-	**07.10**
Westboro	arr	4	-	**06.38½**	-	**07.13½**
	dep	5	-	**06.39**	-	**07.14**
Southboro	arr	6	-	**06.47½**	-	**07.22½**
	dep	7	-	**06.48**	-	**07.23**
Ashland	arr	8	-	**06.51½**	-	**07.26½**
	dep	9	-	**06.52**	-	**07.27**
Framingham	arr	10		**07.02½**		**07.37½**
	dep	11	**06.39**	**07.03**	**07.15**	**07.38**
WestNatick	arr	12	**06.43½**	**07.07½**	**07.19½**	**07.42½**
	dep	13	**06.44**	**07.08**	**07.20**	**07.43**
Natick	arr	14	**06.48½**	*07/11½*	**07.24½**	*07/46½*
	dep	15	**06.49**	*07/11½*	**07.25**	*07/46½*
WellesleySquare	arr	16	**06.53½**	*07/15*	**07.29½**	*07/50*
	dep	17	**06.54**	*07/15*	**07.30**	*07/50*
WellesleyHills	arr	18	**06.57½**	*07/17½*	**07.33½**	*07/52½*
	dep	19	**06.58**	*07/17½*	**07.34**	*07/52½*
WellesleyFarms	arr	20	**07.00½**	*07/19½*	**07.36½**	*07/54½*
	dep	21	**07.01**	*07/19½*	**07.37**	*07/54½*

Example Service Concept: Zonal Express along Worcester Line

- Alternating express zones between Worcester and West Natick, between West Natick and Back Bay
- Explores the following:
  - Reduced travel times
  - Increased frequency at Worcester Station

Existing Timetable for Worcester Line Commuter Rail

WTT - Worcester to SouthStation

Split Overtaken Trains | Show Passes | Include Guessed Times | Actual Routeing | Show Names | Conflicts | All Locations | Edit Bank | Excel

			6	7	8	9	10	11	12	13	14	15	16	17	18
Formed By															
Signal ID			WO0584	WO0506	WO0586	WO0508	WO0588	WO0510	WO0590	WO0512	WO0514	WO0516	WO0518	WO0520	WO0592
Orig. Dep. Time			06.39	06.22	07.15	06.57	07.49	07.24	08.34	08.50	10.35	12.05	13.55	15.50	17.40
Orig. Loc. Name			Framingham	Worcester	Framingham	Worcester	Framingham	Worcester	Ashland	Worcester	Worcester	Worcester	Worcester	Worcester	Framingham
Dest. Loc. Name			SouthStation	SouthStation	SouthStation	SouthStation	SouthStation	SouthStation	SouthStation	SouthStation	SouthStation	SouthStation	SouthStation	SouthStation	SouthStation
Timing Load			D	D	D	D	D	D	D	D	D	D	D	D	D
Operating Characteristics															
TOC			MB	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB
Day of Operation			SX	SX	SX	SX	SX	SX	SX	SX	SX	SX	SX	SX	SX
Changes			New	New	New	New	New	New	New	New	New	New	New	New	New
To Form															
Worcester	dep	1	-	**06.22**	-	**06.57**	-	**07.24**	-	**08.50**	**10.35**	**12.05**	**13.55**	**15.50**	-
Grafton	arr	2	-	**06.34½**	-	**07.09½**	-	**07.36½**	-	**09.02½**	**10.47½**	**12.17½**	**14.07½**	**16.02½**	-
	dep	3	-	**06.35**	-	**07.10**	-	**07.37**	-	**09.03**	**10.48**	**12.18**	**14.08**	**16.03**	-
Westboro	arr	4	-	**06.38½**	-	**07.13½**	-	**07.40½**	-	**09.06½**	**10.51½**	**12.21½**	**14.11½**	**16.06½**	-
	dep	5	-	**06.39**	-	**07.14**	-	**07.41**	-	**09.07**	**10.52**	**12.22**	**14.12**	**16.07**	-
Southboro	arr	6	-	**06.47½**	-	**07.22½**	-	**07.49½**	-	**09.15½**	**11.00½**	**12.30½**	**14.20½**	**16.15½**	-
	dep	7	-	**06.48**	-	**07.23**	-	**07.50**	-	**09.16**	**11.01**	**12.31**	**14.21**	**16.16**	-
Ashland	arr	8	-	**06.51½**	-	**07.26½**	-	**07.53½**		**09.19½**	**11.04½**	**12.34½**	**14.24½**	**16.19½**	-
	dep	9	-	**06.52**	-	**07.27**	-	**07.54**	**08.34**	**09.20**	**11.05**	**12.35**	**14.25**	**16.20**	-
Framingham	arr	10		**07.02½**		**07.37½**		**08.04½**	**08.44½**	**09.30½**	**11.15½**	**12.45½**	**14.35½**	**16.30½**	
	dep	11	**06.39**	**07.03**	**07.15**	**07.38**	**07.49**	**08.05**	**08.45**	**09.31**	**11.16**	**12.46**	**14.36**	**16.31**	**17.40**
WestNatick	arr	12	**06.43½**	**07.07½**	**07.19½**	**07.42½**	**07.53½**	**08.09½**	**08.49½**	**09.35½**	**11.20½**	**12.50½**	**14.40½**	**16.35½**	**17.44½**
	dep	13	**06.44**	**07.08**	**07.20**	**07.43**	**07.54**	**08.10**	**08.50**	**09.36**	**11.21**	**12.51**	**14.41**	**16.36**	**17.45**
Natick	arr	14	**06.48½**	*07/11½*	**07.24½**	*07/46½*	**07.58½**	**08.14½**	**08.54½**	**09.40½**	**11.25½**	**12.55½**	**14.45½**	**16.40½**	**17.49½**
	dep	15	**06.49**	*07/11½*	**07.25**	*07/46½*	**07.59**	**08.15**	**08.55**	**09.41**	**11.26**	**12.56**	**14.46**	**16.41**	**17.50**
WellesleySquare	arr	16	**06.53½**	*07/15*	**07.29½**	*07/50*	**08.03½**	**08.19½**	**08.59½**	**09.45½**	**11.29½**	**12.59½**	**14.49½**	**16.44½**	**17.53½**
	dep	17	**06.54**	*07/15*	**07.30**	*07/50*	**08.04**	**08.20**	**09.00**	**09.46**	**11.30**	**13.00**	**14.50**	**16.45**	**17.54**
WellesleyHills	arr	18	**06.57½**	*07/17½*	**07.33½**	*07/52½*	**08.07½**	**08.23½**	**09.03½**	**09.49½**	**11.33½**	**13.03½**	**14.53½**	**16.48½**	**17.57½**
	dep	19	**06.58**	*07/17½*	**07.34**	*07/52½*	**08.08**	**08.24**	**09.04**	**09.50**	**11.34**	**13.04**	**14.54**	**16.49**	**17.58**
WellesleyFarms	arr	20	**07.00½**	*07/19½*	**07.36½**	*07/54½*	**08.10½**	**08.26½**	**09.06½**	**09.52½**	**11.36½**	**13.06½**	**14.56½**	**16.51½**	**18.00½**
	dep	21	**07.01**	*07/19½*	**07.37**	*07/54½*	**08.11**	**08.27**	**09.07**	**09.53**	**11.37**	**13.07**	**14.57**	**16.52**	**18.01**

Today, not all trains begin or end their trip in Worcester

Example: Zonal Express Worcester Line Timetable

WTT - Worcester to SouthStation

Split Overtaken Trains | Show Passes | Include Guessed Times | Actual Routeing | Show Names | Conflicts | All Locations | Edit Bank | Excel

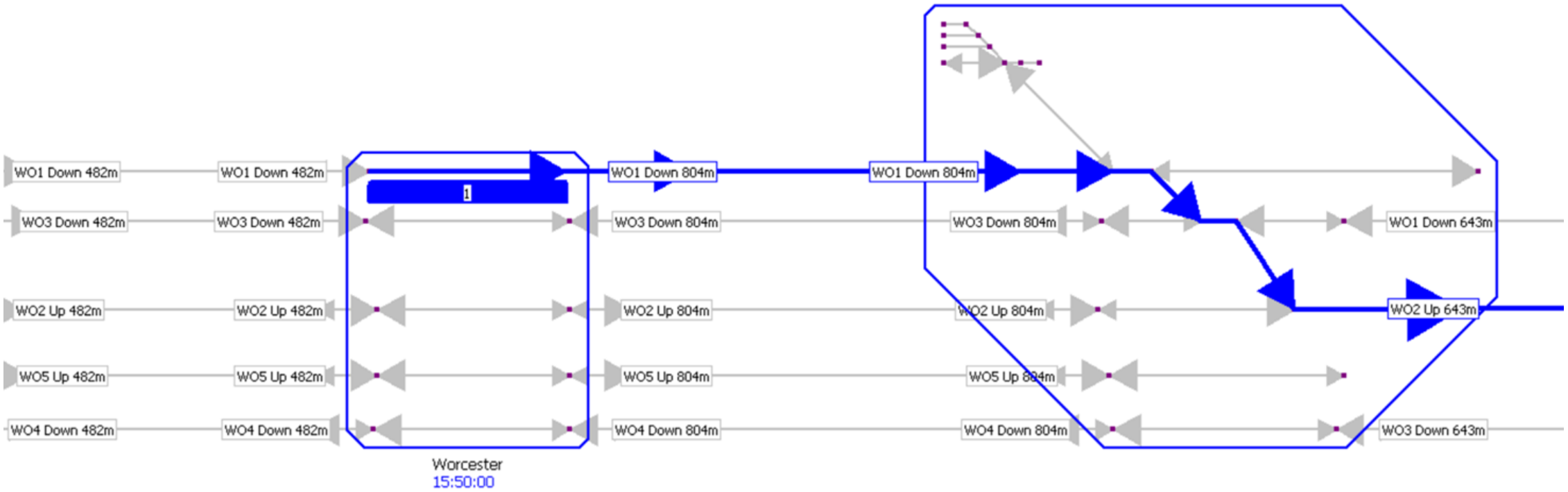
			1	2	3	4	5	6	7	8	9	10	11	12	13
Formed By															
Signal ID			WO5550	WO5600	WO5552	WO5602	WO5554	WO5604	WO5556	WO5606	WO5558	WO5608	WO5560	WO5610	WO5562
Orig. Dep. Time			05.00	05.20	05.30	05.50	06.00	06.20	06.30	06.50	07.00	07.20	07.30	07.50	08.00
Orig. Loc. Name			Worcester	Worcester	Worcester	Worcester	Worcester	Worcester	Worcester	Worcester	Worcester	Worcester	Worcester	Worcester	Worcester
Dest. Loc. Name			SouthStation	SouthStation	SouthStation	SouthStation	SouthStation	SouthStation	SouthStation	SouthStation	SouthStation	SouthStation	SouthStation	SouthStation	SouthStation
Timing Load			D	D	D	D	D	D	D	D	D	D	D	D	D
Operating Characteristics															
TOC			MB	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB
Day of Operation			SX	SX	SX	SX	SX	SX	SX	SX	SX	SX	SX	SX	SX
Changes			New	New	New	New	New	New	New	New	New	New	New	New	New
To Form															
Worcester	dep	1	05.00	05.20	05.30	05.50	06.00	06.20	06.30	06.50	07.00	07.20	07.30	07.50	08.00
Grafton	arr	2	05.12½	...	05.42½	...	06.12½	...	06.42½	...	07.12½	...	07.42½	...	08.12½
	dep	3	05.13	...	05.43	...	06.13	...	06.43	...	07.13	...	07.43	...	08.13
Westboro	arr	4	05.16½	...	05.46½	...	06.16½	...	06.46½	...	07.16½	...	07.46½	...	08.16½
	dep	5	05.17	...	05.47	...	06.17	...	06.47	...	07.17	...	07.47	...	08.17
Southboro	arr	6	05.25½	...	05.55½	...	06.25½	...	06.55½	...	07.25½	...	07.55½	...	08.25½
	dep	7	05.26	...	05.56	...	06.26	...	06.56	...	07.26	...	07.56	...	08.26
Ashland	arr	8	05.29½	...	05.59½	...	06.29½	...	06.59½	...	07.29½	...	07.59½	...	08.29½
	dep	9	05.30	...	06.00	...	06.30	...	07.00	...	07.30	...	08.00	...	08.30
Framingham	arr	10	05.40½	...	06.10½	...	06.40½	...	07.10½	...	07.40½	...	08.10½	...	08.40½
	dep	11	05.41	...	06.11	...	06.41	...	07.11	...	07.41	...	08.11	...	08.41
WestNatick	arr	12	05.45½	05.54½	06.15½	06.24½	06.45½	06.54½	07.15½	07.24½	07.45½	07.54½	08.15½	08.24½	08.45½
	dep	13	05.46	05.55	06.16	06.25	06.46	06.55	07.16	07.25	07.46	07.55	08.16	08.25	08.46
Natick	arr	14	...	05.59½	...	06.29½	...	06.59½	...	07.29½	...	07.59½	...	08.29½	...
	dep	15	...	06.00	...	06.30	...	07.00	...	07.30	...	08.00	...	08.30	...
WellesleySquare	arr	16	...	06.04½	...	06.34½	...	07.04½	...	07.34½	...	08.04½	...	08.34½	...
	dep	17	...	06.05	...	06.35	...	07.05	...	07.35	...	08.05	...	08.35	...
WellesleyHills	arr	18	...	06.09	...	06.39	...	07.09	...	07.39	...	08.09	...	08.39	...
	dep	19	...	06.09½	...	06.39½	...	07.09½	...	07.39½	...	08.09½	...	08.39½	...
WellesleyFarms	arr	20	...	06.11½	...	06.41½	...	07.11½	...	07.41½	...	08.11½	...	08.41½	...
	dep	21	...	06.12	...	06.42	...	07.12	...	07.42	...	08.12	...	08.42	...

With the Zonal Express service concept:

- All trains begin or end their trip in Worcester
- Service pattern shows alternating trains:
  - Local stops Worcester to West Natick, express to Boston OR
  - Express Worcester to West Natick, local stops to Boston

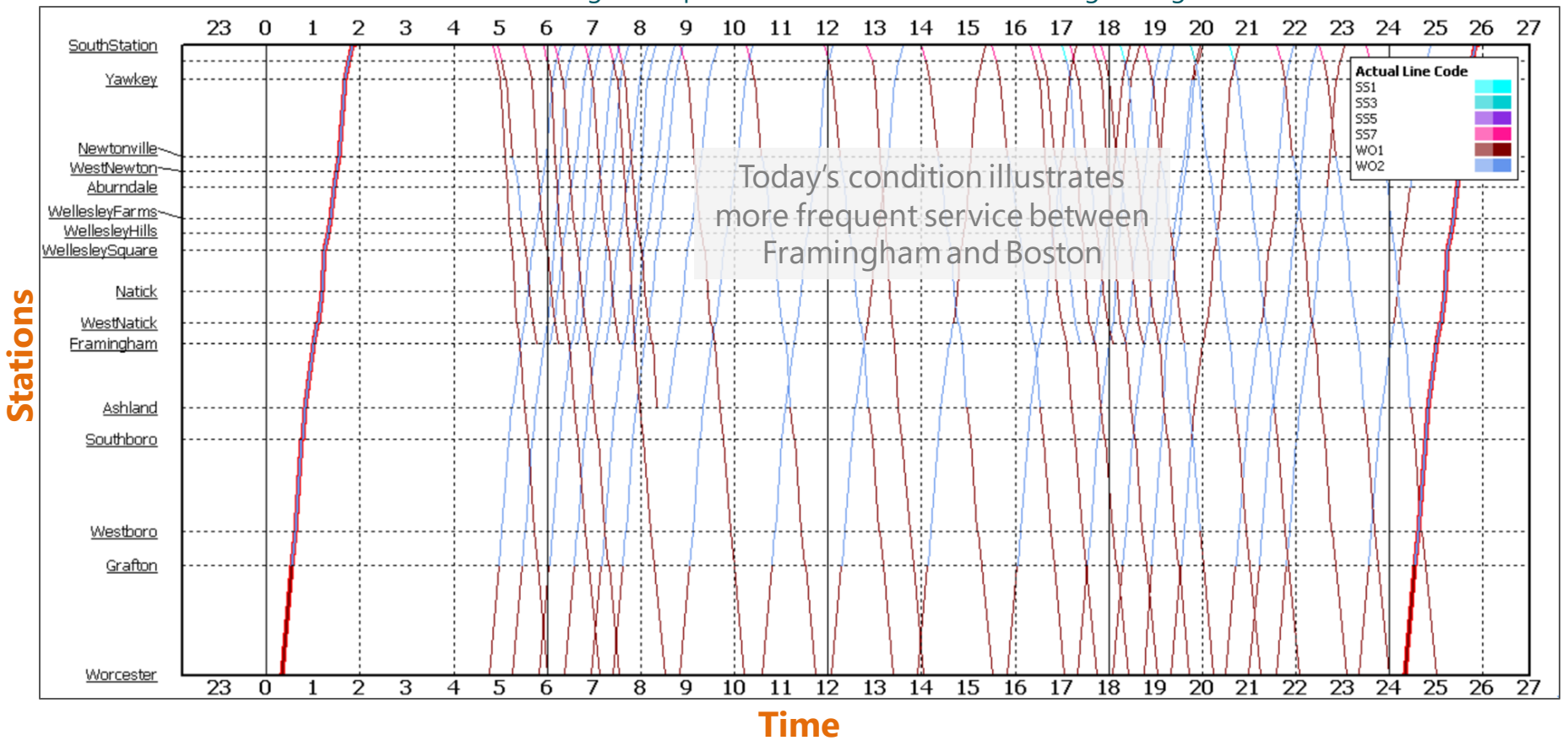
Infrastructure on Worcester Line (at Worcester Station)

ATTUne routes all trains through the rail corridor based on the proposed timetable, to identify areas of conflict or capacity limitations



Existing Worcester Line String Line Chart

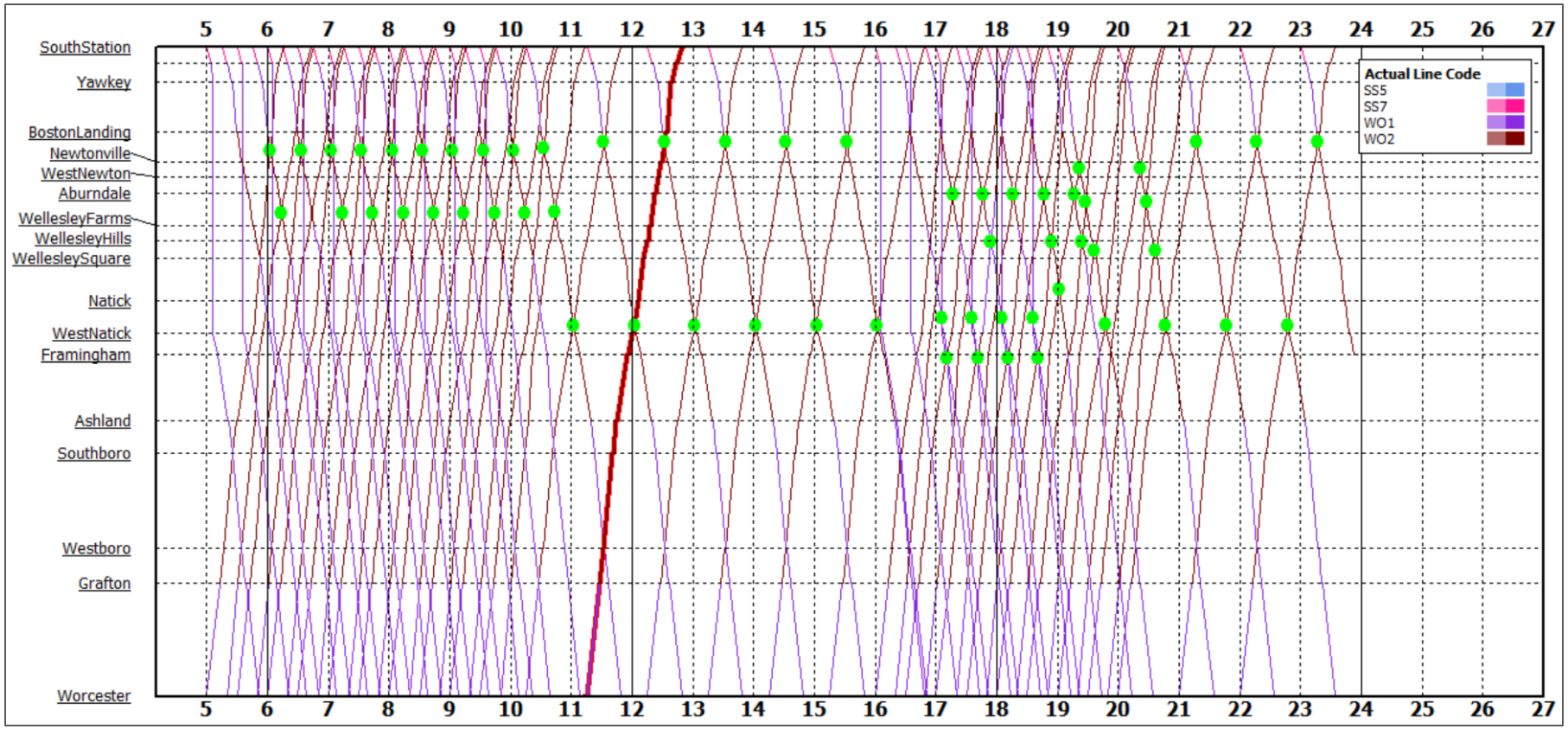
NOTE: Each line on this string line represents an individual train moving through the corridor



- String line charts show how trains interact – where are the meets, passes, and conflict points
- No conflicts shown in ATTUne for today's condition

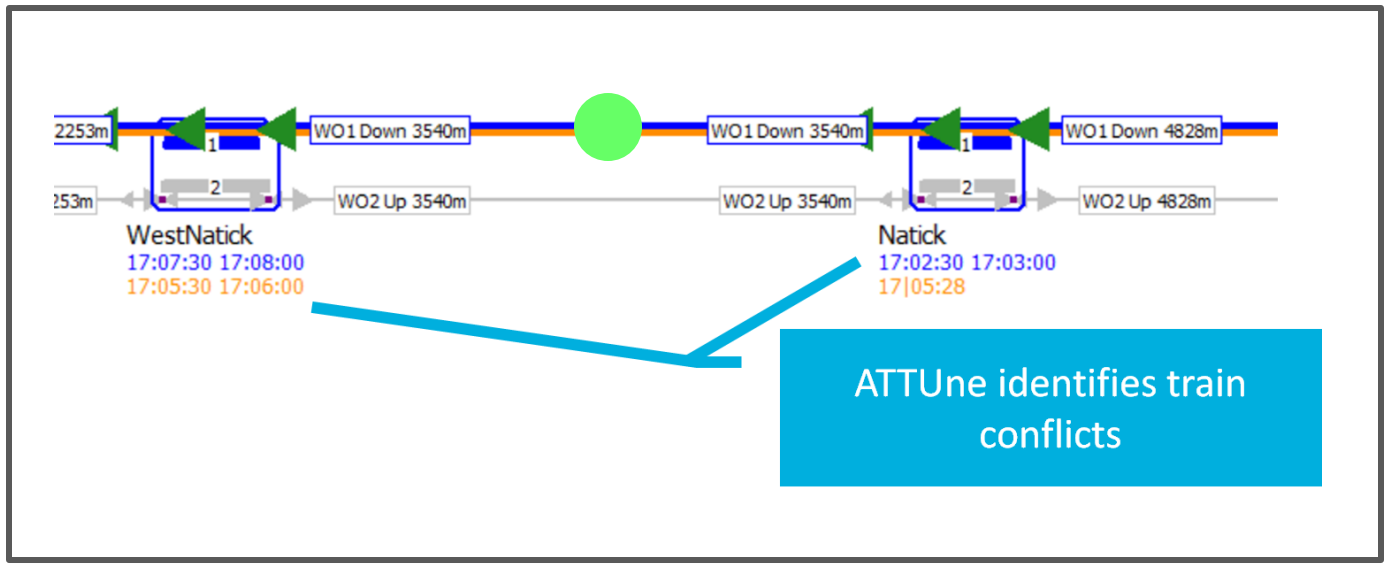
Example: Zonal Express Worcester Line String Line Chart

NOTE: Each line on this string line represents an individual train moving through the corridor



- **Green dots** show conflicts between trains
- ATTUne *identifies,* <u>but does not solve,</u> conflicts
- Up to reviewer to assess possible solutions:
  - adjust timetables
  - add capacity through infrastructure

ATTUne Identifies Conflicts on the System



- Example: ATTUne shows express (orange) train passing local (blue) train between Natick and West Natick
- Conflict: this is not possible in the existing condition
- Solutions to be considered
  - adjust timetables
  - add capacity

ATTUne allows for a high level look at conflicts to identify the magnitude of investment needed to resolve

ATTUne Output – Travel Time Savings

- ATTUne calculates the potential travel time benefits and penalties of a service concept accrued daily at stations and on the line
- Provides an early opportunity to weigh potential benefits against needs

	Worcester	Grafton	Westborough	Southborough	Ashland	Framingham	West Natick	Natick Center	Wellesley Square	Wellesley Hills	Wellesley Farms	Auburndale	West Newton	Newtonsville	Boston Landing	Yawkey	Back Bay	South Station
Daily Inbound Boardings	1,475	724	759	1,051	691	1,299	1,121	1,077	804	562	558	325	284	293	N/A	21	26	N/A
Local Travel Time to Boston	1:34:00	1:21:00	1:17:00	1:08:00	1:04:00	0:53:00	0:48:00	0:43:00	0:38:00	0:34:00	0:31:00	0:26:00	0:23:00	0:20:00	0:15:00	0:10:00	0:05:00	0:00:00
Non-stop West Natick-Back Bay	**1:16:00**	**1:03:00**	**0:59:00**	**0:50:00**	**0:46:00**	**0:35:00**	**0:30:00**	0:43:00	0:38:00	0:34:00	0:31:00	0:26:00	0:23:00	0:20:00	0:15:00	0:10:00	0:05:00	0:00:00
Time Saved to Boston	***0:18:00***	***0:18:00***	***0:18:00***	***0:18:00***	***0:18:00***	***0:18:00***	***0:18:00***	***0:00:00***	***0:00:00***	***0:00:00***	***0:00:00***	***0:00:00***	***0:00:00***	***0:00:00***	***0:00:00***	***0:00:00***	***0:00:00***	***0:00:00***
Passenger Travel Time Saved	**442:30:00**	**217:12:00**	**227:42:00**	**315:18:00**	**207:18:00**	**389:42:00**	**336:18:00**	**0:00:00**	**0:00:00**	**0:00:00**	**0:00:00**	**0:00:00**	**0:00:00**	**0:00:00**	N/A	**0:00:00**	**0:00:00**	N/A

Total (Daily) Travel Time Savings on Worcester Line: 2,136 total hours

ATTUne's Role in the Tier 1 Evaluation

- Tests service concepts for conflicts, time, and distance relatively quickly
- Allows testing of concepts first on individual lines, which can then be used for developing full alternatives
- Outputs from ATTUne feed into both the
  - Operating Cost Model (vehicle-miles)
  - RDM (travel times + frequency)

RAIL VISION

Regional Dynamic Model (RDM)

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Overview of the RDM

What is it?

- A **strategic simulation** model focused on how transportation, land-use, population, and employment interact

What information does it use? What are the outputs?

- Inputs include existing demand by mode, existing transportation options, and anticipated future growth
- Typical outputs include:
  - Rail ridership and revenue
  - Passenger miles traveled
  - Access to opportunities
  - Economic growth

How it will help us in our evaluation

- Understand effects on ridership, vehicle capacity constraints, and land use
- Relative success of different transportation scenarios
- Enables a relatively quick testing of service concepts

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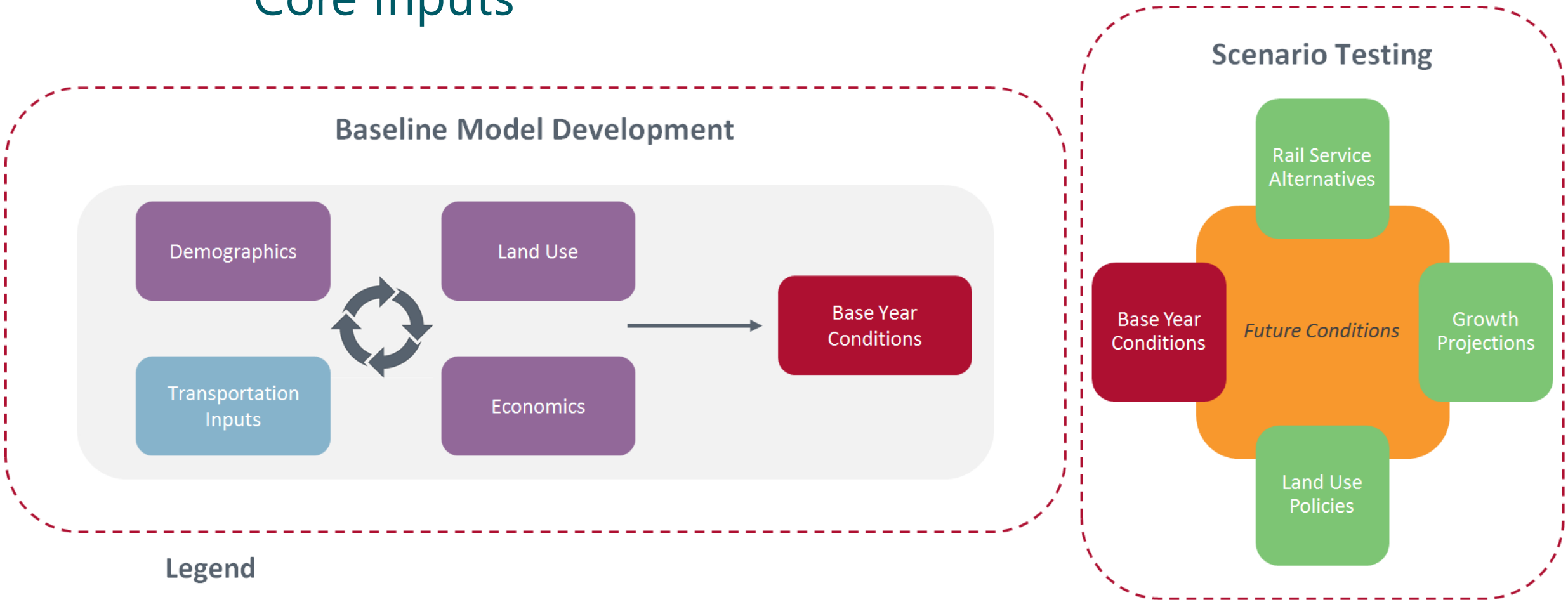
RAIL VISION

Core Inputs



Legend

- Inputs from CTPS
- Inputs from CTPS, MAPC & others
- RDM Internal Outputs
- Inputs for Scenario Testing
- RDM Model Outputs

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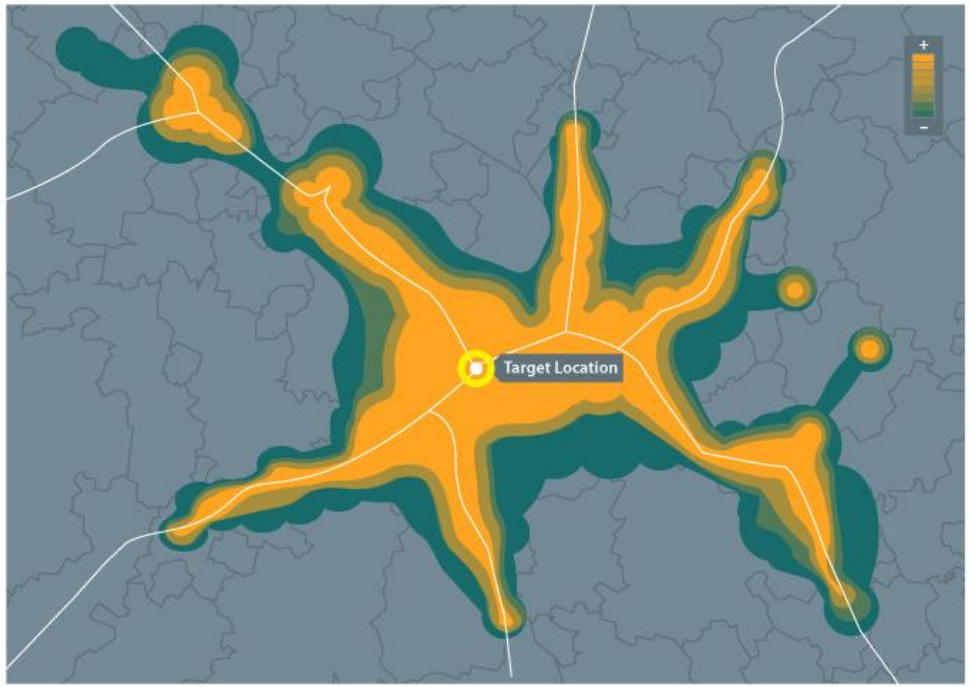
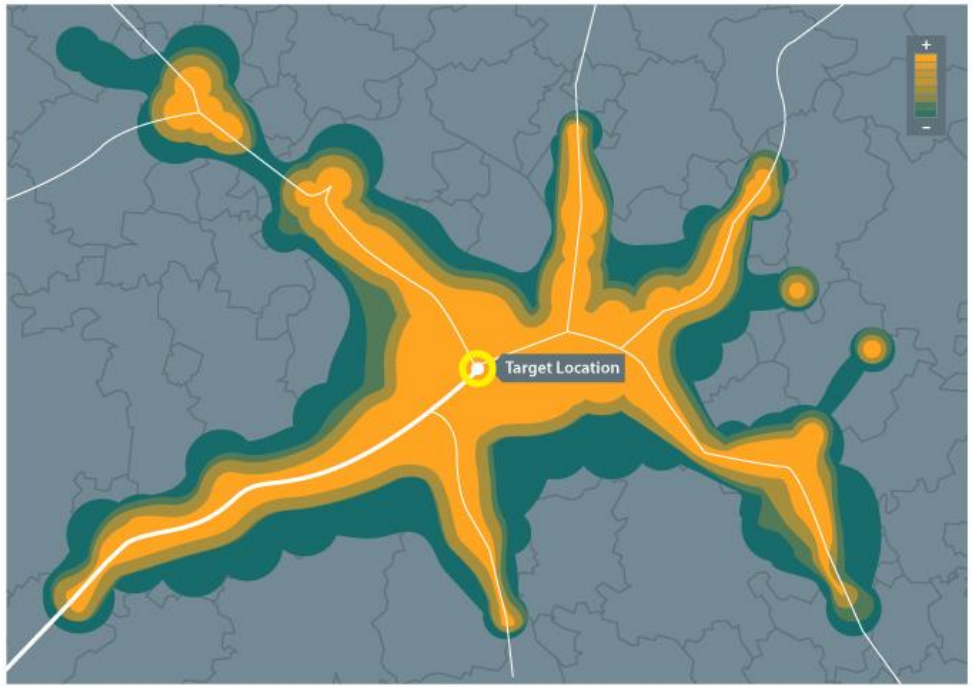
Outputs Example

Current Condition



- Employers in the analysis area have a pool of job seekers from whom they can recruit

With Transit Investment



- Transit investment reduces transportation costs and
  - increases the number of available workers
  - increases the number of potential employers
- Job seekers in each analysis area have more opportunities within a reasonable commute time
- Employers are in greater competition for workforce

RAIL VISION

Outputs Example: Ridership

Projected Change in Public Transportation Trips

	Current Condition	With Transit Investment	Difference (Absolute)	Difference (%)
District 1	6,400	6,700	300	4.7%
District 2	9,800	9,900	100	1.0%
District 3	11,300	12,700	1,400	12.4%
District 4	1,500	3,900	2,400	160.0%
Sub-Total	29,000	33,200	4,200	14.5%
Other Districts	102,900	102,900	-	-
Total	131,900	136,100	4,200	3.2%

- The RDM was also used to output statistics comparing projected public transportation ridership under different scenarios

Operating Costs Model

RAIL VISION

Overview of the Operating Costs Model

What is it?

- Calculates the **ongoing cost implications** of service concepts

What information does it use? What are the outputs?

- Grounded in **existing cost data** from the MBTA commuter rail
- Outputs are projections of future operating costs, including incremental impacts of each service concept by cost element

How it will help us in our evaluation

- Will be used throughout the analysis (both in Tier 1 and Tier 2 evaluation processes)
- Allows us to test key risks related to costs, and the **cost and revenue implications** of different alternatives

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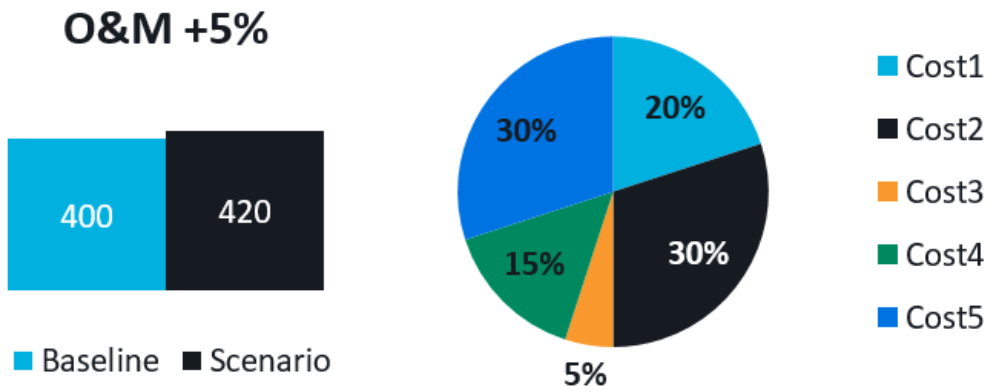
Outputs of the Operating Costs Model

- Outputs include both detailed operating cost projections by year and summary graphics highlighting key impacts of scenarios

Baseline			
Cost Category	**RY 2021**	**RY 2022**	**RY 2023**
Staff	$190,027,975	$193,334,836	$195,239,068
Vehicle operations	$57,568,930	$58,363,496	$62,386,145
General Administration	$80,451,968	$82,164,117	$84,639,738
Vehicle maintenance	$90,376,925	$91,759,991	$92,101,022
Non-vehicle maintenance	$49,721,292	$50,561,760	$52,059,610

Scenario 1 - Incremental			
Cost Category	**RY 2021**	**RY 2022**	**RY 2023**
Staff	$6,784,403	$14,515,029	$14,093,289
Vehicle operations	$2,223,519	$4,235,381	$4,218,243
General Administration	$3,793,907	$7,341,158	$7,434,428
Vehicle maintenance	$2,745,432	$4,397,625	$4,240,664
Non-vehicle maintenance	$1,889,686	$2,979,003	$3,236,971



All values presented are dummy values, provided for demonstrative purposes only

Using Operating Costs Model for Service Alternative Development

- Directly linked to outputs from ATTUne and the RDM
- Understand ongoing cost implications of service alternatives
- Test key risks related to costs and the cost and revenue implications of different alternatives

Next Steps

- Evaluate line-by-line service concepts against:
  - Travel time savings
  - Ridership and land use benefits
  - Operational efficiencies
- Identify up to 8 draft service alternatives to carry into the Tier 2 evaluation
- Hold public meeting(s)