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The Plan of Reshaping Smart and Resilient Transit Mode Share for Boston 2040

1 Overview: status quo

Here are two illustrations from Go Boston 2030 to give a brief overview of the status quo. One is the walking access that a dense transit network is easily accessed by foot in only some parts of the city; the other is the growth of bicycling with fragmentized bicycle facilities. As shown in Fig. 1. Both the pictures reveal the underlying challenge that might undermine transport justice in the long run. In other words, less respect is given to the active transportation and thus the tragedy of the commons occur. It is responsible for the authorities to prioritize the non-car users and encourage transit mode share.

To strive to a more sustainable mobility future in Boston, we need to shift from the conventional auto-centric mode to a way that joins together mobility with more resilient public realm. It is urgent to strike a balance among accessibility (connectivity), safety (protectivity), and affordability (equity). In the following sections, we propose and detail our plan of reshaping smart and resilient transit mode share for Boston 2040.

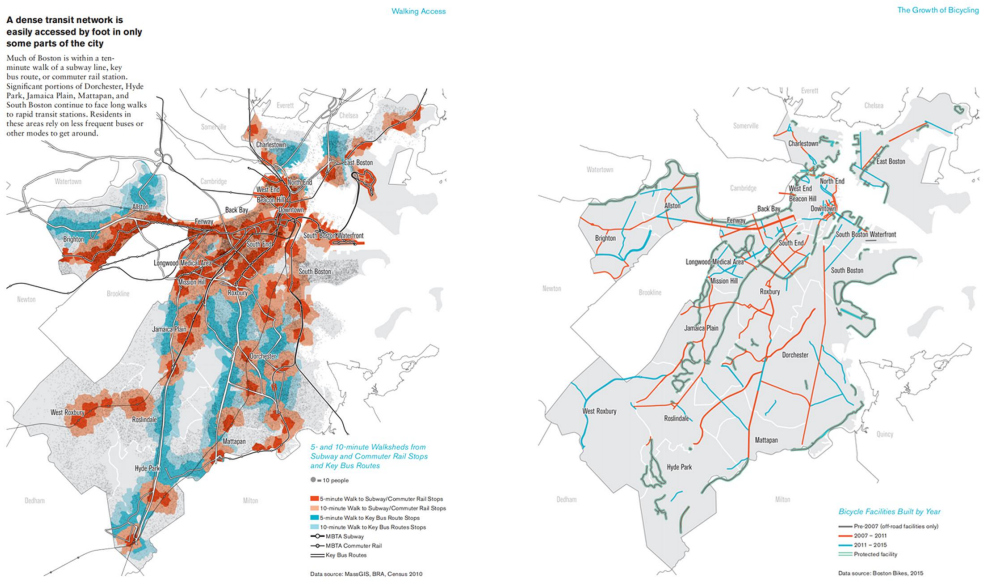

Fig. 1. Overview of walking access and bicycle facilities (from Go Boston 2030)

2 Timeline plan: combination of Daas, MaaS, and IaaS from three scales

As a planner working for the MBTA, the current issue is to help the agency to displace the transit mode share to a significant degree, thus to encourage a safer, and more health-resilient public realm. To decipher the word "resilient"-which means being sustainable in the long run- it is inspiring to let the transit mode itself become an intelligent entity. The transit mode should think within humanity aided by technology, in order to provide better service for the citizens. Therefore, we need to figure out the hierarchical relationship among technology, mobility and human to blueprint the reshaping plan.

In terms of the connection between cyber technology and physical space in transit, it is a key strategic priority to link the vehicles and infrastructure that enables a much more efficient mobility. This is mentioned in the conference of *"Seamless travel: Navigating the challenges (Nov. 6th, 2019)"*, which emphasizes on the construction of an ecosystem for transit mode share. Another worthy reference is from the *"Urban mobility in a digital age"*, led by LADOT. It established the platform for mobility innovation, with "data as a service", "mobility as a service" and "infrastructure as a service". I will recap the modified definition of these key concepts and elaborate them as follows.

a) *Data as a service (DaaS)*.
   To construct a database that store the information (i.e. commute time, regular route, destination purpose, etc.) of the mobility users (pedestrian, cyclist, rider on bus/subway, etc.). The data is recorded through smart phones and uploaded to personal iCloud with privacy protection. This interactive process is real-time. After anonymous manipulation, the data is given to service providers and government for a better customer portrait and security surveillance. As a result, the service from the "individual" perspective would be the foundation to optimize transit safety, efficiency and experience, for further transit mode share.

b) *Mobility as a service (MaaS)*.
   To maintain a customer-centric, intelligent mobility management and distribution system, with integration of multiple transport services into a single API available upon request for seamless travel. The main purpose is to supplement existing public transit (i.e. first/last mile mobility) for sustainability, rather than as a substitute. Stakeholders include operators, providers, government and DOT, data and tech platform, ICT infrastructure, payment system, etc. SUMP would assist the collaboration network from the following four steps- analysis of problems and opportunities conclusion; vision, objectives and targets agreed; sustainable urban mobility plan adopted; measure implementation evaluated[1]. MaaS provides a demand-responsive online framework to connect with the physical infrastructure in the city, which would be envisioned as the "O2O infrastructure" in future mobility.

[1] Mobility as a service and sustainable urban mobility planning.

c) *Infrastructure as a service (IaaS).*

To call for an autonomous, shared and accessible multimodal future. A new framework for smart and resilient city with transit mode share will emerge based on sensor technology, changing lifestyles and mobility accessibility. This part would leverage the renovation of infrastructure, such as changing some expressways into slow streets and protect the equity of the users, redesigning the blocks for autonomous vehicles, installing digital curb with time variation near bus/subway stations. The infrastructure revitalization with more humanity will activate the street use in post-COVID period, and finally turn to be a smart and resilient "urban system" for transit mode share.

Table 1 shows the combination of DaaS, MaaS and IaaS from three scales in the next twenty years (2020-2040).

	Individual data	O2O infrastructure	Urban system
Short-term (1-3 yrs) implementation	information collection cloud database privacy policy	IOT sensor deploy cross-department API responsive transit	Test area (Vision Zero Boston Action Plan) 2 vsion zero corridors 2 slow street zones
Intermediate (4-9 yrs) outcome	customer portrait scenario planning social interaction	community shareability specialized corridor pricing & regulation	Important node public transit +15%, walk/bike +5%, carpool +10%, drive alone -25%, waiting time -10%
Final (10+ yrs) impact	customized system real-time surveillance personal credit rating	autonomous vehicle smart corridor AI optimization	Urban network transit mode share +40% equity on commute to work transparent governance

Table 1. Overview of timeline plan from three scales

The detailed time periods with respective scales are as follows.

2.1 Short-term (1-3 yrs) implementation- test area

Initial target areas are referred to Vision Zero Boston Action Plan. Two neighborhood slow street pilot zones (including Stonybrook and Talbot-Norfolk Triangle) and two vision zero priority corridors (including Massachusetts Ave and Codman Square) are selected as test areas in the first three years. Locations are shown in Fig. 2.

(0) Preliminary: Restart from post-COVID-19 era

During pandemic, many streets and regions are locked down. For those reopening areas, spaces that are open and safe are severely needed. People are supposed to restore from social distancing into a more health-resilient city environment. Thus the walking space should be put forward as a priority[2]. It is the right time to develop social equity within long-term economic performance.

[2] The WalkUp Wake-up Call Boston

The first point is the investment and development strategies. For real estate investors and policymakers, the proportion of walkable neighborhoods should increase. The land use with more accessibility could promote the whole leverage of the area function and have more economic gains. In return, more preservation of affordable housing and transit mode share (i.e. bus transit, biking and walking infrastructure) insists. Also in this economic cycle, the walkable neighborhoods will be more stable with the support of institutional investors (insurance companies, pension funds, REITs, etc.) attracted by the high value of the land.

The second point is the policy implications. The government should give higher tax for the outdated, auto-oriented zoning codes and parking regulations, both the land owners and users. And a legal proportion of walkable properties should be set. The eventual payback of the accessibility-oriented capital can be invested in the next several rounds of development.

The third point is the transportation and infrastructure. Transportation infrastructure such as bus and rail transit facilitates walkable urbanism. With the growing investment in public transit, the walkable urban development also generates higher economic development and fiscal returns. It should noticed that in this knowledge-based economy era, educated people can be the major driven-force of one region. For them, they would be drawn to the metro areas with more walkable facilities. This preference is also rooted in the mind of the millennial generation. Therefore, the advocate of transportation infrastructure provides the foundation of future economy and tax base of metro Boston.

The fourth point is protecting social equity. Instead of considering the long-term walkable urbanism with even higher rents and prices, short and mid-term strategies are more available to the citizens. The government should expand the current tax system for low-income housing, and commercial-supported dwelling units. Also, it should be encouraged for the investment of public and nonprofit land for affordable housing. Both the tactics aim to match with more opportunities of accessibility.

Following the rehabilitation of mobility in post-COVID era, a systematic proposal of implementation is suggested. Although this is a technology-driven memo, the objective is not to challenge the equity or burden the underprivileged, but to optimize the demand-responsive support. It is the government and the tech companies that should undertake the responsibility to maintain the ease and robustness of the tech system behind tangible mobility, and this system should continue to be modified based on the voice from users.

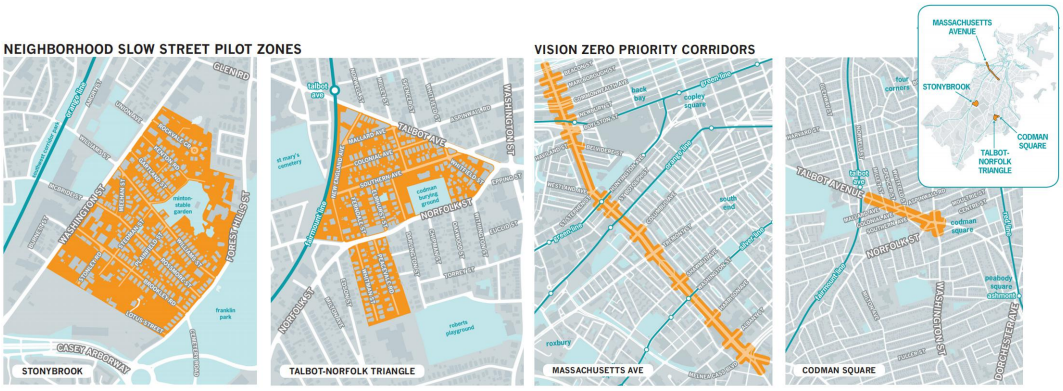

Fig. 2. Test area location in Boston (from: Vision Zero Boston Action Plan)

(1) Individual data

- To collect the data of the mobility users.
  - *Regular routine and the frequency.* The tech platform could record the user data through the mobile phones of different groups in different time periods. The recording helps to identify the street with demand but currently with lower accessibility or transit facilities. The data-mining strategies thus assist the decision-makers to reasonably consider potential renovation.
  - *Destination function.* People move to different places with functions such as residence, commerce, entertainment, traffic and work, etc. The connectivity to specific place often determines people's choice of transit mode. Thus the strengthened mobility network around the regional core has a significant radiation effect. For instance, people will participate in active transportation more frequently in their daily life in the living neighborhoods based on the function-intense transportation network.
  - *Mobility choice due to COVID-19.* The pandemic has unfortunately shutdown many streets and blocks, and the reopening should depend on the demand and safety of the use frequency. So the data of necessary mobility provides the metric of trade-off between demand and reopening security. The policy-makers could emphasize on where (street No.), when (time variation), and how (which transit mode) to restart the mobility vibrancy.
- To construct the cloud database.
  - *User data uploaded by smart phone.* To store and protect the data of mobility users, the collaboration between government and ICT companies is needed. Data is the petroleum of the 21st century, while the data with well-round protection that embodies the characteristics of specific users just serves as the foundation to shift from inherently political to democratically technological. Also via the database, people with disability of movement or those living in neighborhoods with poor accessibility can

be recorded and subsidized accordingly.

- Privacy protection policy from multiple sides.
  - *Ecosystem of data producer, operator and governor.* Taken into account the multifaceted stakeholders of the mobility data, a secure and resilient consensus needs approach. The enclosed ecosystem such as Blockchains can be adopted to guarantee the privacy of data and equal rights of multiple sides. While the data can be clustered according to the mobility quality of the neighborhoods, thus the evaluation and surveillance can be established especially for the gradual upgrade of mobility-poor areas.

(2) O2O infrastructure

Concerning the core of city protocol, it is inspiring to bring in the framework of "City Anatomy[3]", which can give an overview of the systemic urban infrastructure. To tackle with the uncertainties of future mobility, an interoperable and collaborative innovation platform should be advocated. The key approaches are, "Performance is the objective; Practice is the method; Platform is the product." The target scenarios of City Anatomy include task-and-finish-teams, urban planners and policy-makers, commercial and non-profit organizations, as well research institutions. Specifics go from the initial period.

- IOT sensor deployed in car, bus, bike for environment detection.
  - *Virtual transit map for sensible city.* The environment along routes of different transit modes can vary in different times of a day. And the variation demonstrates the activity and demand of mobility. The environment metrics detected by IOT sensor from multiple transit modes can draw an overall quality of regional mobility. By comparing the metrics of traffic volume, congestion time, street green view, etc. (i.e. some researches done by MIT Sensible City Lab using machine learning), a real-time surveillance and response can be given. Thus the underlying voices are augmented and tangible implementations are eligible.
- Cross-department API for data sharing and collaborative governance.
  - *Increase capacity of safe, efficient and accessible transit.* The citizens need a government with in-time feedback and transparent management. Cross-department protocol is needed for the network connection to share the encrypted data in daily mobility. This would be a highly-efficient collaboration mode for modifying the deployment of infrastructure. And for the disabled people, a special message can be informed previously to the targeted mobility system for reservation and necessary care on.
- Responsive transit mode based on behavior database.

  This part focuses on the short-term rehabilitation of the urban streets and blocks in the post-COVID era. Specific infrastructure intervention from the MBTA is needed, such as the prototype of specialized open corridors to lessen the density of the core area for mobility safety, responsive bus lanes serving for regulated amount of

[3] City Anatomy: A Framework to Support City Governance, Evaluation and Transformation.

people each day during pandemic. The streets should turn to be the responsive infrastructure that provides new possibilities for people with essential trips and healthy activities. This anatomy of infrastructure helps to form the future cities we are obligated to build. A critical response to the current crisis is to create safe and walkable streets as the foundation of transit mode share and log-term economic recovery that is equitable, sustainable and enduring[4].

We should rethink streets in a time of physical distance. Rather than being infrastructure providing mobility and accessibility, it should also encompass social services in order to allow the reopening strategy with security. Pop-up functions can be considered such as walking, slow/shared streets, cycling, markets, transit, school streets, dining, loading, pick-up/queuing, health/sanitation, open/play streets, and communication, etc.

Emerging practices can be materials and design (visible and reflective signs and markings for separation), network strategies (multimodal share to construct prioritized transit-dependent neighborhoods, guidance on all-ages-and-abilities bike/walk networks, equitable distribution of slow/play/open streets in residential and mixed-use neighborhoods), and auxiliary facilities (i.e. critical services, speed management, sidewalk extensions, safe crossings, streets for protest/events).

Dynamic perspectives can additionally include:

- *Responsive ride.* To establish dedicated bus lanes and add potential stops in mobility-poor area based on behavior network; to prioritize protected cycling with high accessibility in rush hours to mitigate with the WFH living mode; to build passenger zones alongside with less traffic disruption.
- *Responsive regulation.* To leverage the behavior database for regulation administration. Take the parking management for instance. The prices of parking lots should varied in different time period of a day and in different car-use-intensity urban areas; the space for micromobility parking should connect with the nearby functional hubs, and its accommodation and the deposit location can adapt.

(3) Urban system

- For neighborhood slow street pilot zones:
  - *Optimization of guidance to the desired destination.* With the statistics of user mobility preference, the recommended scenario of travel is provided. And with the desired destination that caters to a majority of people, an upgrade of visual guidance should be implemented. Also some special corridors within the neighborhoods can be opened for the groups of people with moving disability to raise equity of accessibility.
  - *Evaluation of the function distribution of the community.* By calculating

[4] Streets for Pandemic Response& Recovery.

the data of the users in daily scenarios, the Hill numbers (including POI richness, entropy (orderliness), simpson (evenness)) measuring POI diversity can be obtained. This is a vital metric of equitable neighborhoods to optimize the location of daily functions or to supplement necessary bike sharing, micromobility such as scooters, and the demand-responsive EVs for better access.

- For vision zero priority corridors:
  - *Test the travel efficiency and safety especially at crossings.* The safety protection project should reduce traffic fatalities and severe injuries across Boston. Improvement includes shortening the crossing distance, lengthening the time of walk signals, restricting the turn movements of cars, etc. Also, the streets should be with a combination of protected bike lanes, pavement sidewalk, and short-term parking to synergize transit mode share from different users.

2.2 Intermediate (4-9 yrs) outcome- important node

For the mid-term action, the important node selection is based on Go Boston 2030. This includes 15 walk-and-bike friendly main streets, along with neighborhood micro mobility hubs. The purpose is to strengthen the correlation of the main streets and the catalyzing microHubs, taken into account the experience from the first-three-year test area. MicroHubs and main streets are illustrated in Fig. 3.

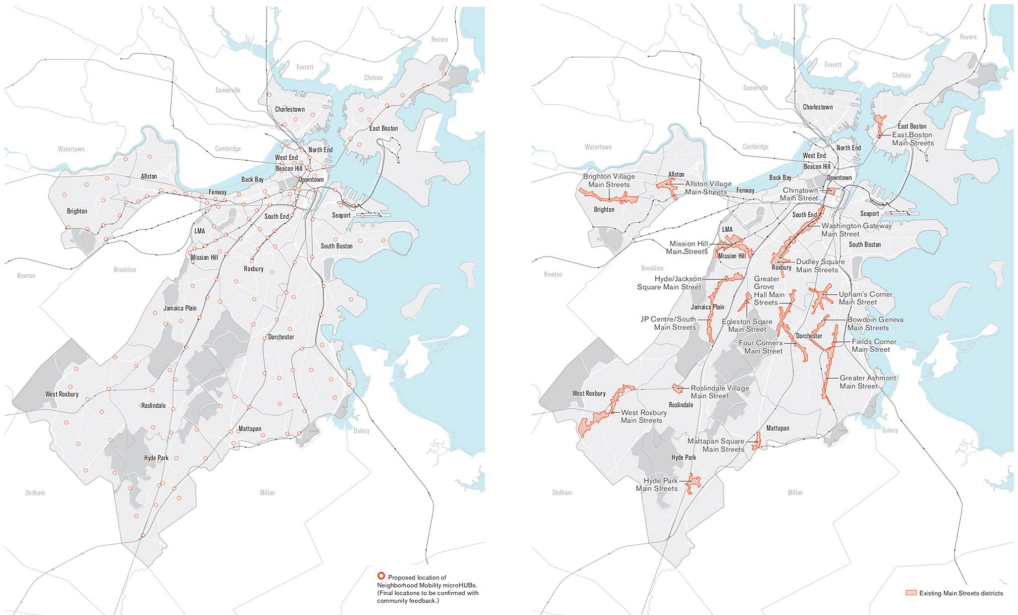

Fig. 3. Neighborhood microHubs and walk-bike friendly main streets (from Go Boston 2030)

(1) Individual data

- Customer portrait for further service matching based on individual data.
  - *People with different age, class, salary, distance to nearest hub.* To construct the potential social network for mobility users. This accelerates

the regional fusion and neighborhoods in equity.

- *People in different areas and variations of time in a day.* The daily routine and distribution of function selecting will be prioritized. Even the marginalized groups will not be omitted with dense data network.

- Scenario planning for prediction.
  - *Matching with the optimal transit mode based on previous data.* People can be aware of their willing choice and mobility mode when they see the recommendations. This saves decision-making time and also optimizes the real-time transit mode, thus saving cost and energy.
  - *Remind of potential danger of COVID, congestion.* The risk and resilience system is important under many uncertainties. The overall surveillance of COVID and traffic congestion based on cross-department data can give a smart response to the travelers.

- Encourage social interaction for transit mode share
  - *People with similarities on transit portrait could go together more frequently.* Communications are encouraged in this situation. People in carpool can not only make their travel cost-effective, but also more enjoyable. It is more likely that these people will choose transit mode share next time.

(2) O2O infrastructure

Previous experience comes from the plan of London 2030[5]. The future of mobility revolves around several fundamental principles. Ensuring safety, equity, accessibility and environmental conservation. By 2030, it should be benefitting from proven connected and automated mobility, with an increasingly safe and secure road network, improved productivity and greater access to transport for all. Next-generation services and technology should be designed and developed.

- Community shareability to transit mode share.
  - *Community-constrained database* help the people living in suburban areas get to public transit more efficiently. Compared to the conventional database that is single-centered, the clustered multi-centered unit can better cater to the in-time demand response. With the time-efficient method, community shareability experience can be continually upgraded.

- Specialized corridor for transit equity.
  - *Protected cycling lanes, dedicated bus lanes.* Upgrade based on 1st period.
  - *Reserved lanes for AVs.* The development routes of autonomous vehicles is in hierarchy that it is needed to reserve the future development space.

- Pricing and regulation strategy.

[5] UK Connected and Automated Mobility Roadmap to 2030

- *Pricing relates to the orientation to public transit.* Dynamic charging happens due to the contributions to transit mode share.

(3) Urban system

- Increment: public transit +15%, walk/bike +5%, carpool +10%
- Reduction: drive alone -25%, waiting time -10%

2.3 Final (10+ yrs) impact- urban network

In Go Boston 2030, more than 4,000 people participated in selecting projects and policies. The four prototypes- go local, crosstown, regional, and tech- could serve as the experiment urban network for the optimization of future transit mode share. They are depicted in Fig. 4.

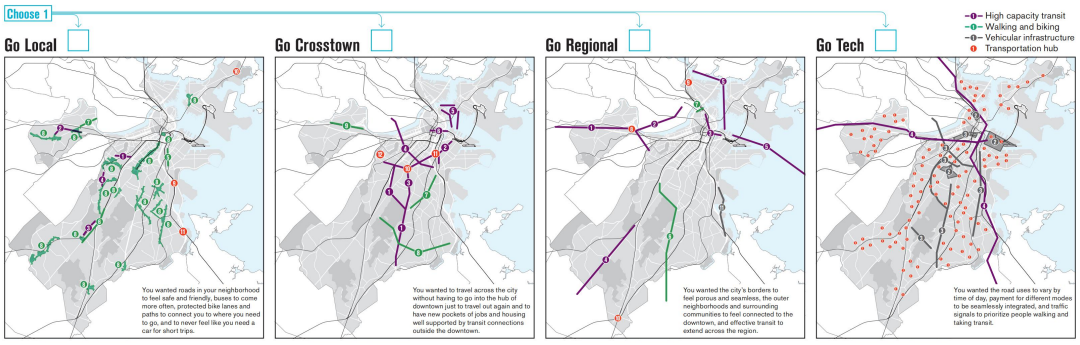

Fig. 4. Four prototypes of urban network for future transit mode share (from Go Boston 2030)

(1) Individual data

- Customized system established.
  - *Regular mobility toolbox for each user.* People can have their own smart mobility helper for daily travel. This synergized tool forms the network that each one in the ecosystem can take full advantage.

- Real-time surveillance for the optimal function of transit mode share
  - *Safety in the surrounding environment.* Recognition of intelligent building and smart city as a whole system.
  - *People who are in need to transit.* Care for the specialized people such as moving disability, suffering from loss/injury, etc.

- Personal credit rating recorded.
  - *People's contribution* to public transit/carbon emission is recorded to their credit rating system quarterly. This cooperates with the individual carbon footprint tracking system to encourage a zero carbon future.

(2) O2O infrastructure

- Level 5 AV is in adaptation to real city environment.
  - *Reconsider the street space, transit mode and urban design.* Future urban planning needs to consider the dynamic accessibility of autonomous

vehicles. This self-automated system can provide network service with limited physical space, thus becoming more resilient and enduring.

- Smart corridor as a new governance
  - *Road uses to vary by time of the day.* Customized scenarios on streets. The streets no more merely become the infrastructure, but rather role play the catalyzed connection between human and urban environment.
  - *Digital curb responds to post-COVID demand.* The curb space can also be multi-functional adaptions to integrate with the interactive mobility ecosystem.

- AI optimization for urban space renovation and transit planning
  - *Machine learning to analyze the future TOD experience.* A synergized planning with AI data and planners/policy-makers provides a more reasonable sustainable mobility. Places that need renovation can also be detected and given feedback.

(3) Urban system
- Goal: transit mode share +40%
- Principle: equity on commute to job opportunities by self-adapted mobility densification
- Sustainability: transparent governance based on protective data interaction

3 Collaboration: policy and finance

3.1 Policy and intervention

(1) Forging ahead public engagement[6]
- The engagement process includes transparent (share information), proactive (reach out to impacted communities), iterative (feedback to communities), and accessible (especially access to persons with disabilities).
- The engagement strategy should contain virtual public meetings, and open platform of online feedback tools. All engagement content with MBTA Public Engagement Plan.
- The audiences can be divided into two categories. One is the internal, MBTA workforce and unions; the other is the external, such as riders, advocates, business community, elected officials, and municipal partners.
- To encourage the opportunity of public outreach. This may be to provide feedback on many facilities, i.e. digital station screens, on-vehicle and in-station print media, newspaper ads, website and social media, community partners.

(2) Principles to guide COVID-19 response& recovery
- Support the most vulnerable people first. Considering the disproportionate impact on the society's most marginalized, financial and social resources should be

[6] Forging Ahead: Scenario and Service Planning.

ensured.

- Safer streets for today and tomorrow. Cities must prioritize streets for public transportation, cycling, and walking today.
- Street designs should support economic rehabilitation by providing space for businesses, schools, and institutions to safely reopen.
- Partner with community based organizations. Ensuring the voices of a wide variety of local stakeholders is essential to project development and implementation. While the local groups can create community mobility needs wider and deeper than government typically can.

(3) Pros and cons adaptation of MaaS[7]

- Establishing industry standards for passenger-data ownership and privacy.
- Launching open-data initiatives to make traffic information available.
- Encouraging open-access technology development ecosystems, which helps to lower the barrier for developing MaaS products and entering the market.
- Developing planning strategies for reuse of infrastructure to restore street vibrancy.
- Investing in public education campaigns to communicate the financial, social, health and environmental benefits of MaaS to foster public acceptance and trust.

(4) Shaping AV policy (refer to NACTO)

- Promote safety. This includes different components like pedestrians, bicyclists, transit riders, automated vehicle passengers, and all street users.
- Incentivize shared, automated, electric vehicles. This is to reduce environmental impacts and recall on MaaS.
- Support the future vision of communities. Change land use by disruptive technology and specially care for equity in neighborhoods.
- Rebalance the use of the right-of-way. To create less space for cars and more space for active transportation.
- Support public transit. To provide first/last mile connection to major transit lines via shared AVs and demand-responsive routes.
- Modernize plans for expressways. Management optimization can displace the unnecessary new physical capacity.

(5) Data governance policy

- Construct privacy-protected database (i.e. blockchains) from a bottom-up order.
- Develop and implement robust data-sharing ecosystem.
- Approach to consensus with cross-department stakeholders.

(6) City planning policy (resonating with transit revolution)

- Set the stage for modernized freight and delivery
- Support metropolitan modelling for transit
- Federal and state level funding for infrastructure should reflect the restructuring of the transportation system

[7] Rethinking Transportation 2020-2030.

- Future visioning of AV should begin from the centers of economy, and the land use affected by transportation

3.2 Finance and funding

The whole proposal emphasizes on the technology application in the long run to make the smart and resilient system in the future. In this process, the economic gains can also be consistent due to the benefits shifted from mobility to other related sectors in urban areas, which is the "agglomeration effects". The concentrated rehabilitation of development can trigger additional value and in turn maintain social equity with more funding sources. To draw a big picture of view, both the upstream and downstream entities that serve as the beneficiaries should be charged since there is no "free lunch".

The general fund of MBTA may derive from the increase taxes on sales, gas, carbon emission, TCI support, etc. More specifically speaking, there are five distinct sources of finance[8]. They are users (public transport fares, road tolls, road congestion pricing, vehicle parking charging), taxpayers (national taxation and intergovernmental transfers, local taxation, earmarked taxation), lenders to government (sovereign borrowing, local governmental borrowing), landowners or developers (betterment levies, impact fees and developer exactions, land value exploitation in integrated development, selling development rights), and direct private investors (PPP, privatization). Concerning the application of technology, the benefits can be transferred to other sectors for general stakeholders, such as housing subsidy, security protection, and efficiency promotion. Detailed funding is illustrated as follows.

(1) Higher taxes on gas[9]

- Commonwealth could generate additional funding for transportation and make the tax system more progressive. One is to rely more on progressive taxes (i.e. personal income taxes, corporate taxes, estate taxes). One is to implement a gas tax increase with tax credits to ease the impact on lower-income families. And the other is to pair the gas tax increase with earned income tax credit, which could offset the tax changes for the lower households.

(2) Funding from user and non-direct user[10]

- Increased fuel taxes (incentive for more fuel-efficient cars, encourage for cycling/walking), VMT taxation (converting auto insurance into variable cost), congestion charging (high income drivers, revenue for bus service and infrastructure, car owners and buy-in).
- Taxation of beneficiaries of accessibility due to "value capture". Free rider problem should be avoided. The business beneficiaries support the contribution based on an increased business levy. This helps to collect money from a substantial revenue stream, decrease parking and increase transit mode share, incentivize

[8] Lessons from Economics: Mechanisms for Financing Mobility
[9] Pros and Cons of Higher Gas Taxes, and How They Could Be Offset for Lower-income Families.
[10] Accessibility and Transportation Funding.

transit-oriented locations for new development. Also, property taxes and parking fees contribute as well.

(3) Individual carbon footprint tracking system

- To record individual carbon footprint when taking public transit. The accumulated miles of public transit and the relative reduction of carbon consumption can be credited for less taxation or housing subsidy.
- More taxation for users with higher carbon footprint frequently using private mobility. The individual carbon footprint system can indicate the daily, weekly and monthly metrics and anticipate the next year demand. The predicted taxation can be the reminder both for the user and the revenue taker.
- A penalty/reward system should be built. This enables people with unnecessary carbon consumption more taxes annually, and will continue to increase according the proportion of transit mode share. While for people who pursue active transportation and more transit mode share, a remedy would be achieved for individual mobility.

Estimating personal vehicle energy consumption is important for nationwide climate policy, local and statewide environmental policy, and technology planning[11]. The individual carbon footprint tracking system can similarly link small-scale variation in vehicle technology and driver behavior with large-scale variation in travel patterns, which build the metrics of cost and energy savings, and thus the taxation.

(4) AV investment

- Funding from various sources is expected, including but not limited to government, venture capitalists and private equity. The roadmap of the timeline proposal can be demonstrated, which shows the definition and agreement of new benefit metrics and new approaches to mobility and infrastructure. The compelling business cases can as a result attract more investment.

(5) State and local funding

Development-financed funds for multimodal transportation. This incentivizes more non-auto travel and infrastructure as part of new land developments. Developers out of parking requirements can improve housing quality; the funds raised can build central parking and other infrastructure improvements. Also, instead of parking minimums, developers can pay into green-transit funds, which can be used to enhance walkability of a neighborhood, add bikeshare stations, install protected cycling infrastructure, help pay additional bus service, etc.

- Municipal TNC fees
- State transportation bond issue
- MPO “Complete Streets” initiatives

[11] TripEnergy: Estimating Personal Vehicle Energy Consumption

(6) Foundations

- Boston's philanthropic community
- OMF (open mobility foundation)

(7) Federal programs

- BUILD Program/TIGER Grants
- FAST Grants

(8) PPP (Public-private partnership)[12]

- Boston can leverage both public investment and private capital, and the mobility hub can be built according to shared interests between both parties. The potential benefits include: lower expenses related to the design, construction and maintenance of a mobility hub; faster project completions; drawing on private sector expertise and new sources of capital. The mobility hub can bridge the gap between initial grant investment and the measurable impacts on the community such as health services, education and other services via reliable and affordable methods of transportation.

4 Discussion: Challenges and opportunities of tech application[13]

The technology promoted proposal encompasses public participation, and the special catering and care to the social equity with respect to income, education and age, etc. would be inherently modified. We hold a critical eye to observe the obstacles and opportunities of tech application in mobility. For the large number of stakeholders and interests, several public private actors interfere in the provision and operation of public transport. We need to strengthen the relationships within mobility network and develop alliances with actors sharing same vision. For the society vision, it is both the market and public issue. We need to improve democracy, education and citizenship. For the cost of services, we need to develop new transport technology and system, which adapt to local industry and business environments. Finally for the government capability, we need to strengthen links with agencies in charge of urban planning and public services, in order to improve democracy and sustainable mobility.

[12] Mobility Hubs: Advancing Equitable and Sustainable Mobility

[13] Public Transportation