High Capacity Transit Task Force for the 2045 Long Range Plan

Phase I Analysis and Deliverable

Houston-Galveston Area Council

With consultant support from

Texas Southern University

Phoenix Infrastructure Group

1. Example Regions and Cities

A list of twelve cities and regions in the United States, Canada and the United Arab Emirates was developed, based on whether they had one or more characteristics in common with Houston/Galveston Region:

- Urban form (lower-density, automobile-oriented)
- Regional population size
- Climate
- Geography and topography
- Relatively recent (within 40 years) HCT investment
- Traffic congestion dynamics

Originally these were called “Peer Cities,” but it was decided that they better were termed “example” cities due to the rigor that the word “peer” connotes. Older, denser cities that were largely developed before the advent of the automobile, such as New York City, Boston, Philadelphia, Chicago or San Francisco, were excluded from the list of potential example cities. The cities or regions selected, and the Workgroup(s) they were considered for, are as follows:

Country	City or Region	Economic Impact	Service Concepts	Innovative Funding
	Atlanta	☑	☑	
	Austin		☑	
	Cleveland	☑	☑	☑
	Dallas/Fort Worth	☑	☑	
	Denver	☑		☑
	Los Angeles		☑	
	Miami		☑	☑
	Seattle	☑		☑
	Washington, DC	☑	☑	☑
	Ottawa			☑
	Vancouver		☑	
	Dubai		☑	

This exercise was not intended to be “apples-to-apples” comparison; it is recognized that different cities and regions have different funding sources and authority and differing governance structures than what is currently existing and available in the H-GAC region. The purpose of the Example Cities exercise is to provide examples/case studies from other regions:

- What did they do and how did they do it?
- How can we tailor that experience to our region

2. Service Concepts for High Capacity Transit

Introduction

The Service Concept Workgroup has been working under the auspices of the Houston-Galveston Area Council (H-GAC) and its High Capacity Transit (HCT) Task Force, which was appointed in 2017 by the Transportation Policy Council. This Phase One Report comprises the results of the work by the Service Concepts (SC) Workgroup between the date of commissioning and December 15, 2017.

Mission Statement

The following is the Mission Statement approved by the SC Workgroup in their December 1, 2017 meeting.

> *Propose Recommended Corridors with preferred High Capacity Transit Service Concepts and Modes, as determined by workgroup criteria, simplified modeling output information and service concept attributes.*

The work product(s) of the SC Workgroup during the course of its study are intended to have the following content:

- Definitions of Service Concepts, and the possible technologies and service modes that comprise the SC options.
- Examples of SC applications in other cities and regions.
- Preliminary Assessment of the SC options for the multiple travel corridors within the H-GAC regional transportation planning area in accord with defined criteria and ridership estimates.
- Handoff of the SC reports and associated reference data to other workgroups under the HCT Task Force auspices and support of their interpretation by others.
- Handoff of the final work products to the appropriate local/regional transportation agencies.

The process undertaken during the Phase 1 work involved a series of meetings for the entire workgroup, and for a special subset of workgroup members, as follows:

- Four workgroup meetings: September 29, October 20, November 13, December 1
- Extensive discussion about evaluation criteria, service categories, technologies and deliverables
- Three Levels of Service were developed for simplicity
- Service concepts matrix refined by smaller group (see Table 1 below)

Objective of a Broad Policy Framework

The primary objective of the SC Workgroup is to prepare information and preliminary assessment that will foster the HCT Task Force preparation of a broad Policy Framework for HCT applications within the H-GAC region. This framework will address a multimodal view of existing transit services, potential new applications of existing technologies/services, as well as the addition of future transportation technologies where full automation becomes practical for general use.

Definitions of Terms for Technologies and Service Modes

In the definition of transit applications in specific corridors and districts and the associated use of the Evaluation Criteria in the assessment of the overall Service Concepts, the following definitions are relevant to consider:

Transit Technology – the class of vehicle technology typically defined by means of:

- Guidance, propulsion and suspension,
- Vehicle configuration (e.g. vehicle size, number of seats and permanent connections through articulation),
- Right-of-Way (ROW) requirements,
- Entrainment (e.g. single vehicle, multiple vehicles coupled together, or virtual entrainment through automated vehicle platoon),
- Methods of vehicle control (e.g., with a human driver, with an automatic train control system, or with an automated driving functions in the vehicle that can replace the human operator).

Service Mode – The way that transit vehicles are operated, typically defined in terms of:

- Alignment of the transit route and stations (e.g., line-haul corridor service, district circulator service, or point-to-point connection of major population/employment nodes or high demand locations).
- Dispatching approach to vehicle trip assignments (e.g., fixed route, demand-responsive flex-routes, or point-to-point demand-response dispatching – advanced reservation of in real-time).

Evaluation Criteria for Corridor Service Concepts

Throughout the course of the SC Workgroup's deliberations, there has been a progressively developing set of key evaluation criteria by which the conceptual applications of technologies and modes will be assessed for the H-GAC regional transportation corridors, urban centers and major activity centers. These criteria have not been established as "pass" or "fail" criteria, but rather as points of consideration that give insight into the benefits of certain options over other options for a given technology and service mode application.

1. Does the proposed option improve access and mobility to and from major activity centers such as:
    - Workplaces/Employment Centers?
    - Health and Education Centers?
    - Economic Centers?
    - High Capacity Transit Hubs?
2. Does the proposed option present the best travel alternatives to heavily congested freeways and roadways?
3. Does the proposed option contribute to the economic development of the region or its standing as an international City/Hub?
4. Does the proposed option enhance the full spectrum of livability (live, work, play; see H-GAC Livable Centers studies) for people of all incomes, abilities and ages?
5. Does the proposed option allow sufficient flexibility to change service patterns as warranted by evolving demand?
6. Does the proposed option provide connectivity for an integrated multimodal HCT system with system-wide, cohesive connections from start-to-finish (for the maximum span of service hours possible)?
7. Does the proposed option make the transit system more resilient in the event of extreme demand or catastrophe?
8. Does the proposed option allow transit users and non-users to travel safely?
9. Does the proposed option contribute to emissions reductions?

Service Concepts, Attributes and Levels of Service

Each of the service concepts that have been identified by the SC Workgroup have been studied in light of the typical application in major cities/regions that have been studied. From these examples, as well as through literature research and expert opinion of the H-GAC staff and consultant team, the definitions of the basic Service Concepts have been defined in terms of their functional purpose and characteristics/attributes, organized in accord with specific categories

- Right-of-Way (ROW)
- Speed (mph)
- Ridership Capacity (passengers per hour per direction – pphpd)
- Spacing Between Stops
- Level of Service – High, Medium and Low

Level-of-Service – Passenger "level-of-service" (LOS) attributes for a given technology and mode application have been defined in terms of a general "low", "medium" and "high" passenger accommodations. These attributes were evaluated in accord with transit service characteristics of:

- Headways – "Maximum" average frequency (in minutes) of transit vehicle service at a specific location, e.g., shortest wait time between trains/vehicles that a passenger would typically experience.
- Service Period – Portion of the day (in hours) that is provided transit service, typically identified separately for weekday and weekend service
- Days of Week -- Number of days-a-week transit service is provided

Service Concept Definitions

The SC definitions have been categorized in in accord with the scale and distance over which passengers typically travel on a given technology/mode. In other words, a SC category involves transit travel not requiring a transfer between transit vehicles, thereby providing a "one-seat" ride while using the specific Service Concept. Of course, convenient transferring between different Service Concepts along the travel route is also a consideration of the SC Workgroup, since this connectivity is what comprises the desired integration of a connected and integrated multimodal HCT transit system.

The basic definitions of Service Concepts have therefore been grouped into these categories:

- Local Service
- Subregional Service
- Regional Service

The following definitions have been developed within each category and sub-category to describe each specific Service Concept being studied.

- LOCAL
  - Local Circulation and Connectivity Service – Conventional Public Transit modes operating primarily on-street on arterial network
  - Local District Circulator – Conventional and unconventional modes providing circulation within a specific urban/employment District or Major Activity Center

  - Local First-Mile/Last-Mile Service – Connecting service between a High Capacity Transit station and nearby Major Activity Center/District
- SUBREGIONAL
  - Subregional Corridor and Internodal Service – Fixed route transit service (station spacing less than 3 miles) along high-demand corridors and between major trip-generation "nodes"
- REGIONAL
  - Regional Commuter/Express Service – Longer distance express service (station spacing greater than 3 miles) between population centers and high employment/activity centers
  - Mega-Regional Service – Very long distance service (greater than 100 miles) between the centers of two or more large metropolitan regions

Finally, the different SC attributes for each category are uniform for ROW, average speed (mph), average station spacing (miles) and typical directional capacity (pph-passengers per hour). However, the LOS attributes of High, Medium and Low are defined differently between the different Service Concepts—i.e., a High LOS for Local District Circulator is defined as 2 to 5 minute headways, compared to a High LOS for a Regional Commuter/Express Service with 15 minute headways.

Peer City Analysis Methodology

In order to provide examples of technology and service mode applications within each of the Service Concept categories and sub-categories, a set of "peer cities" was defined – not to represent a holistic comparison of all the H-GAC attributes, but rather to represent relevant examples of technology and service modes for other major cities with transportation challenges and environmental characteristics somewhat similar to Houston. Refer to the discussion of Peer City selection criteria and purpose in Section 1 of this document.

Statistical data has been assembled from the representative Service Concepts in each of the Peer Cities that have been studied. These data are given in Appendix A, and comprise an overview of how the various technologies and service modes are typically applied in urban and regional settings similar to the Houston-Galveston Region. Organization of the statistical data has been made according to:

- Route/Alignment
- Performance
- Passenger LOS
- Capacity

The sources referenced for the statistical data have been a combination of published schedules and time tables by the transit operator (primary information source), supplemented by internet research on vehicles and system suppliers to assess the vehicle size and seating capacities, as well as expert knowledge of the specific city or technology class by individuals within the SC Workgroup, as well as within the H-GAC staff and consultant team.

The average values of the detailed statistical data are also shown in the appendix, which has provided some guidance to the range of performance and level of service values used for comparison in the discussion below concerning the simplified attributes and characteristics that will be used for the corridor assessments and evaluations (see Table 1 and the associated discussion in the following subsection for more details).

For purposes of discussion, each Service Concept in the following subsection includes photographs and performance, alignment and service mode characteristics drawn from selected examples of the Peer City transit services. These "examples" of each category of HCT Service Concepts for selected technologies and service modes are drawn from both the existing METRO services in Houston and from other selected Peer Cities.

In these examples and in the discussion which follows in the subsequent section, the following simplified metrics have been used to provide a suitable comparison between the different technologies and modes.

- Right-of-Way
    - Street
    - Semi-Exclusive
    - Exclusive
- Operations
    - Speed
    - Ridership Capacity
    - Spacing Between Stops
- Level of Service
    - Low
    - Medium
    - High

The following exhibits are intended as illustrative examples and not as comprehensive descriptions of the Service Concepts. Additional technologies and service modes may also be included in the overall assessment of High Capacity Transit within the Houston region, depending on the SC category. Refer also the discussion and summary table that follows for a more complete listing of the options being considered.

Local Circulation & Connectivity Service

Bus Rapid Transit Characteristics

Example taken from Houston METRO Bellaire Quickline BRT

Right-of-Way			Operations			Level-of-Service		
Street	Semi-Exclusive	Exclusive	Speed (miles/hour)	Ridership Capacity (1,000s/ hour/ direction)	Spacing Between Stops Low (Blocks), High (5+ mi.)	High	Medium	Low
X	X		15-25	1 – 4 *	Mid	15 Min; 20 Hrs; 7 Days	30 Min; 20 Hrs; 7 Days	60 min; 12 Hrs; 5 Days

* Presence of bypass lanes at Bus Rapid Transit stations can increase ridership capacity, but requires additional ROW

Other Examples of Local Circulation and Connectivity Service

Light Rail Transit

Example taken from Houston METRO Main Street LRT – Red Line

Local Fixed-Route Bus

Example taken from Los Angeles METRO Wilshire Blvd Bus Line

Local District Circulator Service

Streetcar/Tram

Example taken from Dubai UAE, RTA Al Sufouh District Tram

Right-of-Way			Operations			Level-of-Service		
Street	Semi-Exclusive	Exclusive	Speed (miles/hour)	Ridership Capacity (1,000s/ hour/ direction)	Spacing Between Stops Low (Blocks), High (5+ mi.)	High	Medium	Low
X	X		10-15	1 – 8 *	Low	5 Min; 20 Hrs; 7 Days	15 Min; 20 Hrs; 7 Days	Special Events

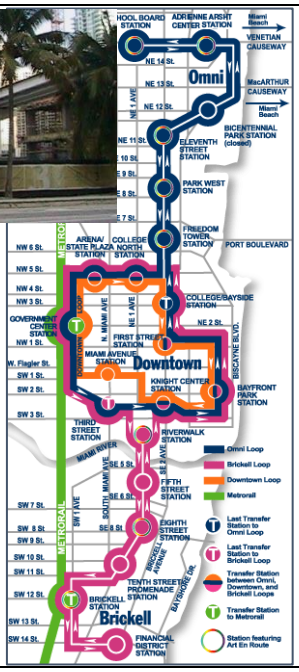
* Upper end of ridership capacity assumes large trams with full load standing passengers, very close headways and dedicated ROW/stations

Other Examples of Local District Circulator Service

Automated People Mover (APM) Transit

Example taken from Miami-Dade Transit Downtown Metromover

Original Downtown Loop Service Began 1986
North and South Extensions Service Began 1994



Local First-Mile/ Last-Mile Service

APM System

Example taken from Dubai UAE, RTA Metrorail FM/LM Connector to Bluewaters District

Right-of-Way			Operations			Level-of-Service		
Street	Semi-Exclusive	Exclusive	Speed (miles/hour)	Ridership Capacity (1,000s/ hour/ direction)	Spacing Between Stops Low (Blocks), High (5+ mi.)	High	Medium	Low
		X	15-20	2 – 8 *	Low	2 Min; 20 Hrs; 7 Days	5 Min; 20 Hrs; 7 Days	15 Min; 12 Hrs; 7 Days

* Wide Range of Vehicle Sizes from 24 pass. to 100 pass., very close headways and protected ROW/stations

Other Examples of Local First-Mile/Last-Mile Service

Rapid Bus Transit

Example taken from Washington DC Union Station Circulator – Typ. Route To Navy Yard-Ballpark

Demand Response Transit

Example taken from Houston METRO Acres Homes Community Connector

Subregional Corridor and Internodal Service

Automated Transit System (ATS)

Example taken from Dubai UAE, RTA Metro -- Al Sufouh 2 Line

Right-of-Way			Operations			Level-of-Service		
Street	Semi-Exclusive	Exclusive	Speed (miles/hour)	Ridership Capacity (1,000s/ hour/ direction)	Spacing Between Stops Low (Blocks), High (5+ mi.)	High	Medium	Low
		X	25-35	6 – 28 *	Mid	15 Min; 20 Hrs; 7 Days	30 Min; 20 Hrs; 7 Days	60 min; 12 Hrs; 5 Days

* Grade separation and train length are variables affecting ridership capacity.

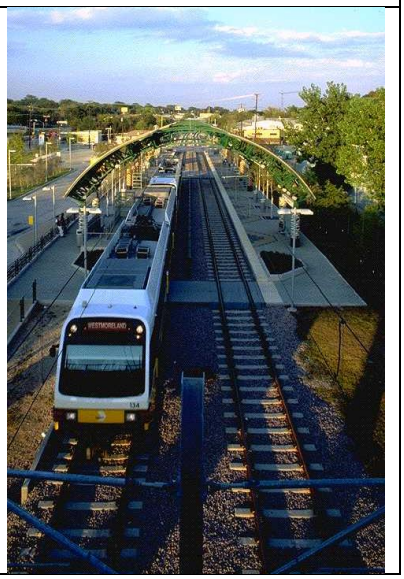
Other Examples of Subregional Corridor and Internodal Service

Bus Rapid Transit

Example taken from Los Angeles Metro's Orange Line BRT

Light Rail Transit

Example taken from Dallas DART Red Line



Regional Commuter/Express Service

Commuter Rail

Example taken from Los Angeles Metrolink Commuter Rail System

Right-of-Way			Operations			Level-of-Service		
Street	Semi-Exclusive	Exclusive	Speed (miles/hour)	Ridership Capacity (1,000s/ hour/ direction)	Spacing Between Stops Low (Blocks), High (5+ mi.)	High	Medium	Low
	X	X	30-55	2– 7 *	Mid-High	15 Min; 20 Hrs; 7 Days	30 Min; 20 Hrs; 7 Days	60 min; 10 Hrs; 5 Days

* Grade separation and train length are variables affecting ridership capacity.

Other Examples of Regional Commuter/Express Service

Light Rail DMU

Example taken from Austin Metrorail Red Line to Leander

Express/Limited Stop Bus

Example taken from Woodlands Township Express Park and Ride

Mega-Region Service

High Speed Rail

Example taken from Texas Central Partnership, Japanese Shinkansen Technology

Right-of-Way			Operations			Level-of-Service		
Street	Semi-Exclusive	Exclusive	Speed (miles/hour)	Ridership Capacity (1,000s/ hour/ direction)	Spacing Between Stops Low (Blocks), High (5+ mi.)	High	Medium	Low
		X	125-150	2 – 4	High	30 Min; 20 Hrs; 7 Days	60 Min; 20 Hrs; 7 Days	180 min; 10 Hrs; 5 Days

Other Examples of Mega-Regional Service

Intercity High Speed Rail

Example taken from Amtrak Northeast Corridor – Bombardier Acela Train

Intercity Passenger Rail

Example taken from Amtrak California Service through LA Union Passenger Terminal

Summary of Service Concept Attributes and Characteristics

The Workgroup has produced a simplified summary table showing typical ROW, operations and LOS values drawn from a combination of the Peer City statistical data as well as literature search and expert opinion for the purpose of facilitating the on-going comparative assessment process. This summary table is found in **Table 1** on the following page. **Table 1** is the primary work product of the SC Workgroup's Phase 1 activity, and it will be the foundation for the subsequent work described in the following section titled Next Steps.

Overview of Emerging Technologies

The SC Workgroup has determined that an assessment of emerging new technologies in the field of public transit is also essential to include with the technologies described above. Therefore, a preliminary investigation into the future technology developments for roadway transit vehicles when operating under a fully automated dispatch and supervisory system has been done, with a view toward automated roadway vehicle (AV) technology applicability to the various Service Concepts.

The following considerations are being given to the assessment of Emerging Technologies.

1. Autonomous technology can be added to all transit modes (both bus and rail) and will make them better:
    - more frequent service
    - greater reliability
    - lower operating costs
    - more precise stopping at stations
    - faster service
    - greater capacity
1. Large Transit vehicles (i.e., heavy rail, light rail, BRT) will get even more efficient
2. Small automated/autonomous shuttles may also be able to serve public transit markets not served today

With respect to the impacts of automated "autonomous" vehicles, the workgroup has concluded that transit services will still be more space efficient for moving people along available roadway ROW. Consider the points of comparison between present day and possible future conditions that are shown in **Figure 1**.

Overall, the workgroup conclusions are that:

1. Autonomous single occupant cars in the future will still carry fewer people than human operated Bus Transit does today in the same space, and in fact will carry multiple times as many people when comparing automated transit with automated cars, since:
    - ***Future Capacity Advantage:*** Autonomous buses will carry:
        - 23 times as many people as single-occupant autonomous cars
        - 10 times as many as 3-passenger shared-ride autonomous cars
    - ***Unchanging Capacity Limitation:*** Capacity also limited by loading/unloading rates for both cars and transit at stations/stops – "People won't get faster"

Table 1 Overview of HCT Service Concepts – Performance Characteristics and Level of Service

HCT Service Concepts - Performance Characteristics and Level of Service Matrix

			Right-of-way			Speed (mph)	Ridership Capacity (1,000s/hr/direction)	Spacing between Stops	Level of Service		
	SERVICE CONCEPTS	Modes	Street	Semi-Exclusive	Exclusive			Low – Every Block High – 5+ Miles	High	Medium	Low
Local	**Local Circulation & Connectivity Service**										
		Local fixed bus	x			8-15	1-4	Low	Frequent service: 7 days a week, headways of at least every 15 min 6 am to 7 pm or later; nighttime service can be less frequent (See METRO "Red Route") Total span of service: at least 20 hours/day	Basic service: 7 days a week, headways of at least every 30 min 6 am to 7 pm or later; nighttime service can be less frequent (see METRO "Blue Route") Total span of service: at least 20 hours/day	Coverage service : 5-7 days a week, headways of one hour or less; limited evening service (see METRO "Green Route") Total span of service: at least 12-14 hours/day
		Streetcar	x			10-15	1-4	Low			
		Deviated Fixed route	x			15-25	*	Low			
		Paratransit	x			8-15	*	Low			
		Demand-response	x			15-25	*	Low			
		Bus Rapid Transit	x	x		15-25	1-4[2]	Mid			
		Light Rail/Tram	x	x	x	10-25	2-8[1]	Mid			
	District Circulator Service										
		Demand-response	x			15-25	*	Low	Every 5 min, 7 days a week	Every 15 min, 5-7 days a week	Special purpose: peak or special events only
		Streetcar	x	x		10-15	1-4	Low			
		APM			x	10-15	2-8	Low	Every 2 min, 7 days a week	Every 5 min, 7 days a week	Every 15 min, 5-7 days a week
	First Mile/Last Mile Service										
		Demand-response	x			15-25	*	Low	N/A[3]		
		Rapid Bus	x			10-20	1-3	Low	Every 2 min, 7 days a week	Every 5 min, 7 days a week	Every 15 min, 5-7 days a week
		APM			x	15-20	2-8	Low			
Sub-Regional	**Sub-Regional Corridor and Internodal Service**										
		Express/ Limited-stop Bus	x	x		30-55	1	Mid-High	7 days a week, headways of at least every 15 min 6 am to 7 pm or later; nighttime service can be less frequent Total span of service: at least 20 hours/day	7 days a week, headways of at least every 15 min during peak; at least every 30 min off-peak Total span of service: at least 20 hours/day	Peak focused: rush hour only overlay on local service
		Bus Rapid Transit	x	x	x	10-25	1-4[2]	Low-Mid			
		Light Rail	x	x	x	10-25	2-8[1]	Mid			
		Heavy Rail			x	25-35	6-28[1]	High			
		ATS			x	25-35	6-28[1]	Mid			
Regional	**Regional Commuter/Express Service**										
		Express/Limited-Stop Bus	x	x		30-55	1	Mid-High	7 days a week, headways of at least every 15 min 6 am to 7 pm or later; nighttime service can be less frequent Total span of service: at least 20 hours/day	7 days a week, headways of at least every 30 min during peak; at least every hour off-peak Total span of service: at least 20 hours/day	Peak focused: frequent sevrice at peak in rush hour direction, limited off-peak
		Bus Rapid Transit	x	x	x	15-35	1-4[2]	Mid-High			
		Light Rail DMU	x	x	x	10-25	2-8[1]	Mid-High			
		Heavy Rail			x	25-40	6-28[1]	Mid-High			
		Commuter rail		x	x	30-55	2-7[1]	Mid-High			
	Mega Region Service										
		Intercity Rail		x		50-60	1-2	High	Frequent: 7 days a week, at least every 30-60 min all day	All-day 7 days a week, every 30-60 min peak, every 1-3 hours offpeak	Basic: 2-5 round trips a day
		High Speed Rail			x	125-150	2-4	High			
		Intercity Bus	x			50-60	1-2	High			

Emerging Technologies - Autonomous Vehicles

Modes	Timing	Street	Semi-Exclusive	Exclusive
Cars	2020-2030	x	x	x
Local Fixed Bus	2020-2030	x	x	x
Express/ Limited-stop bus	2020-2030	x	x	x
Bus Rapid transit	2020-2030	x	x	x
ATS/Automated Rail	present-2030			x

These modes and technologies can serve a variety of service concepts and types; some characteristics of these technologies (such as capacities) are still under analysis and research

Sources and references (available upon request): "Planning and Urban Design Standards" (2006); METRO New Bus Network fixed-route service standards; H-GAC Regional Transit Framework Study; analysis of service concepts and examples from other cities

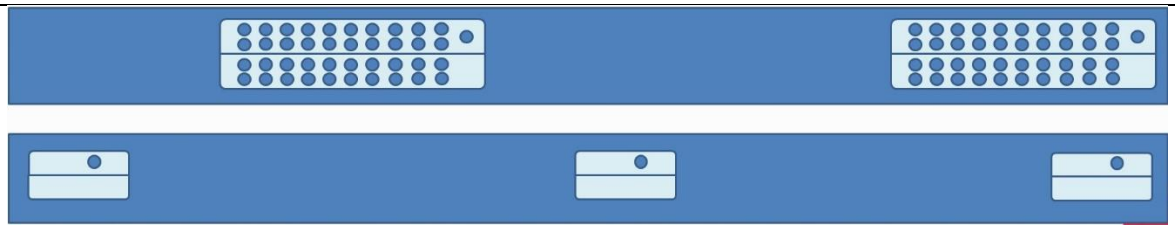
1. **Grade separation and train length are variables affecting ridership capacity**: fully-separated systems, such as MARTA in Atlanta or the Washington METRO, are not subject to limitations such as street block lengths or intersection geometries and therefore have higher capacities than systems that are only partially grade-separated, such as DART light rail in Dallas, or systems that operate almost entirely at-grade, such as Houston's METRORail.
2. **Presence of bypass lanes at Bus Rapid Transit stations can increase ridership capacity, but requires additional ROW**: the Silver Line busway in Los Angeles has bypass lanes tand can therefore accommodate more vehicles providing a variety of services; the Orange Line busways in Los Angeles, however, has no bypass lanes and buses must stop at every station, thereby limiting the number of vehicles and services that can be provided.
3. **Highly variable: service provided on demand**

* **flexible/coverage modes: very low capacities**

7-Dec-17

Present Day Example with Human Drivers

- 100 feet of traffic lane carrying 0.5 people: Single occupant vehicle, 15 feet long at 65 mph, and a 2 second (roughly 200 ft) gap between vehicles
- 100 feet of traffic lane carrying 17 people: 40 foot bus, all 40 seats full, 15 feet long at 65 mph, and a 2 second gap between vehicles
- ***Present Day Result:*** Bus Transit caries 35 times as many people as single occupant car in the same travel-lane space



Future Example With More Efficient Automated/Autonomous Vehicles

- 100 feet of traffic lane carrying 3 people: Single occupant vehicle, 15 feet long at 65 mph, 20 foot gap between vehicles
- 100 feet of traffic lane carrying 67 people: 40 foot bus, all 40 seats full, 15 feet long at 65 mph, 20 foot gap between vehicles

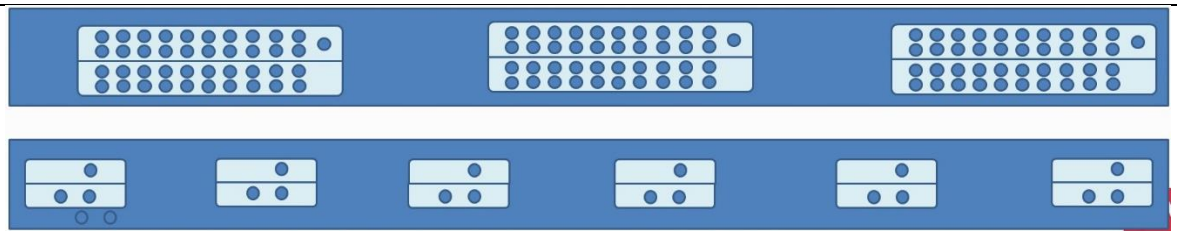


Figure 1 Comparison of Present Day Transit with Future Automated Transit Technology Benefits

2. Autonomous vehicles do not automatically make congestion go away
    - If autonomous vehicles ***are shared***:
        - more vehicle miles as empty vehicles wait, travel to next pickup
        - more curb space required for loading and unloading (which may mean fewer travel lanes are available)
        - parking still required to store spare vehicles outside rush hour
        - ability to do work during commute means people will choose longer commutes
        - intersections (shared with pedestrians, bikes, likely non-autonomous vehicles) still limit capacity of roads

A recommended reference document concerning the considerations of emerging technologies in transit planning exercises that has been used within the SC Workgroup deliberations is titled "Why Uber Won't Kill Transit"[1]. Further assessment of emerging technologies will be incorporated into the continuing work of the SC workgroup, as discussed below.

[1] http://transitcenter.org/wp-content/uploads/2016/12/FactSheet_Final.compressed.pdf

3. Funding Opportunities for High Capacity Transit

Introduction

This deliverable document is the summary of Innovative Finance workgroup efforts to identify, analyze and present potential innovative structures and concepts for investment in high-capacity transit (HCT) in the Houston-Galveston region. In-person workgroup sessions, webinar sessions, and phone calls with workgroup leaders throughout the fourth quarter of 2017 has culminated in an extensive exploration of past cases, current trends, and future opportunities in HCT sources, tools and investment structures. Specific tasks completed over the quarter include the following:

- Work Group Session: 29th of September
- Webinar Sessions: November 26th and December
- Workgroup Calls: October 26th and December 8th

This deliverable is not a recommendation of a specific structure or utilization of specific tools in the financing of HCT infrastructure in the Houston-Galveston region. Rather it is a review of the vast options and potential structures, vehicles and participants available for HCT investment, as well as an overview of what has been done in other regions globally. The final work product provided here is intended to contain the following:

- Identification of conventional sources of HCT infrastructure investment in the US and abroad
- Identification of new and alternative sources of HCT infrastructure investment
- Analysis of various structures of HCT investment
- Review of application of HCT investment structures in real world examples in the US and globally

The mission of the High Capacity Taskforce is to explore concepts and innovative financing structures in both theoretical and in real-life scenarios to better understand possibilities for financing of HCT in the Houston-Galveston region. To complete this task the workgroup is tasked to review the following:

- Review of selected asset classes within HCT: Bus rapid transit, light rail transit and related/effected infrastructure including road and sidewalk development
- Review of available vehicles and tools available to finance HCT infrastructure (conventional and alternative)
- Peer City Innovative Funding Review

Finally, the difference between funding and financing must be noted henceforth as these terms will be utilized distinctly in this discussion. Funding is capital available to offset costs of a project or to support financing options. Financing is the utilization of tools to make funds available when needed, requiring a payback of funds at a later date, plus interest.

Overview and Evaluation Criteria

Overview

There is a need for HCT infrastructure investment not only in the Houston-Galveston region but across the globe. In 2017, the American Society of Civil Engineers released their semi-annual infrastructure report card for the nation and individual states. In transit, the United States registered a “D-“ according to the society, with over $90 billion in backlog identified for investment across the country. The state of

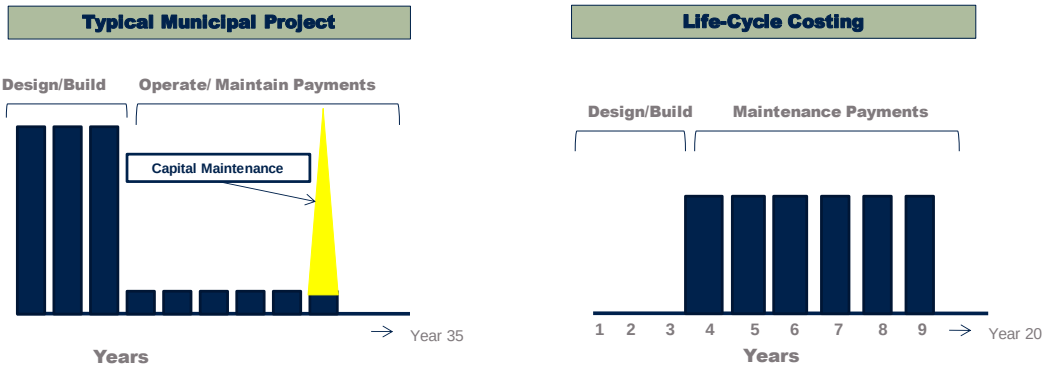
Texas was noted for having over 250 million annual unlinked passenger trips via any type of transit (bus, transit and commuter trains), indicating a lack of cohesion in the overall system [2].

The question in the Houston-Galveston region is not necessarily whether to finance HCT infrastructure, but rather how to. With the selection of sources for funding being very broad, from grants to lending programs at the state and federal level, to various tax structures, there are a variety of means to finance HCT infrastructure as well.

In addition, there are several considerations to make in not only selecting proper financing tools, but also proper financing structures. Some of these include the following:

Life Cycle Costing: In financing infrastructure, a significant issue that arises for public sponsors is the financing of long-term life-cycle maintenance costs. Although these costs have not been budgeted and financed for infrastructure assets, now financing of deferred maintenance concurrently in the life cycle is an accepted practice of mitigating emergency costs and supporting predictable budgeting. An illustration of hypothetical life-cost financing is illustrated below:

Figure I: Life-Cycle Cost Financing



It is important that prospective financing tools and structures take into account the need to meet long term life-cycle costs for the infrastructure being paid for.

Procurement and Project Time/Cost: Time and cost efficiency in procurement for HCT infrastructure must also be taken into account in the use of certain tools and application of certain financial and funding structures. Certain procurements will provide the flexibility of financing and mitigating the risk inherent in procurement construction costs of time and money.

Long-term Capital and Asset Planning: Depending on long-term capital planning strategies, certain financial tools and certain financial structures will be feasible and most appropriate. In addition, some assets are more appropriate for certain types of tools and structures given their life-cycle, construction cost, and operational costs.

Project Innovation: Project and asset innovation is part of life-cycle costing. Depending on the type of innovation pursued and the cost of that innovation (both initially and over time), a certain type of structure will be most appropriate. Certain structures lend themselves to innovation through their procurement process, while others may not.

[2] Source: "2017 Infrastructure Report Card"; American Society of Engineers

Evaluation Criteria

The workgroup has over the course of three months developed an evaluation criteria that would comprehensively review all applicable tools to finance numerous forms of HCT infrastructure through varying degrees of participation by local, state and federal governments as well as private partners. As the conversation, research and analysis moved forward, the evaluation criteria evolved as well. The result is a very broad review that will:

1) Identify the breadth of tools available for HCT investment:
    a. What are the specific financing tools?
    b. Do they require local public subsidy? State public subsidy? Federal public subsidy?
    c. What is the mechanism for financing and funding?
    d. What is the flow of funds to HCT infrastructure investment?
    e. Is there any limitation of usage towards HCT?

2) Explore the breadth of structures of those tools:
    a. What is the level of participation amongst local, state, and federal government?
    b. What is the degree of private participation?
    c. What is the value of one structure over another? Why?

3) Analyze various structures of HCT investment as applied by peer cities in case study examples:
    a. What were the pre-transactional dynamics for the peer city and its HCT project?
    b. What decisions were made and why?
    c. What was the final structure and what were the pluses/minuses?

Traditional Sources for HCT Investment

The workgroup has identified traditional tools for HCT investment to be considered and evaluated. For the most part, these are traditional municipal and federal vehicles that are used and have been used to finance and fund a variety of HCT infrastructure over time.

General Obligation Bonds: Otherwise known as GO bonds, is a bond underwriting secured by the state or local government's pledge to use available resources, including tax revenues to repay bondholders. The capital raised from GO bond issuances comes in two forms, limited and unlimited obligation pledges. Limited obligation pledges require the government entity to utilize property taxes to meet the obligation to a certain limit, whereas unlimited obligation pledges to raise any other forms of tax to any degree to meet obligations and is approved upon via voter authorization or referendum. The result is the creditworthiness of unlimited GO bonds is higher than that of limited GOs. Generally, GOs are used to finance assets and facilities that the public uses often, such as government buildings, stations and schools.

Revenue Bond: Bonds backed by user fees and other charges generated by the public works project, they are typically used to finance rapid transit systems (user fee being the source of revenue). The risk in this type of financing is the ability to payback bondholders via the project itself. There are two types of revenue bonds that deal with this risk to bondholders, net revenue pledge and gross revenue pledge. Net revenue pledges the revenue of the project to operational costs first, and then the bondholders. Gross revenue pledges pay the bondholders first. Gross revenue pledges have a higher credit rating due to the fact that the risk to bondholders is less than net revenue bondholders.

Sales Tax Revenue: Infrastructure sales taxes are taxes tied to area (county, City of State) jurisdictions to support designated capital infrastructure projects exclusively. Examples of projects include building transit systems, resurfacing of roads and building of sidewalks. Local entities are usually limited by state law as to the amount of increases on the current sales tax. Sales tax increases for infrastructure projects are typically established and renewed via public referendum.

Grant Anticipation Notes: A bond issued by a state government or state highway bank that is secured by future, expected federal highway funding. States issue grant anticipation notes to provide cash for immediate or time sensitive needs related to highway construction or maintenance. There is no guarantee the state will receive anticipated funding; however, once it is received, it is used to repay the bond. A grant anticipation note is also called a grant anticipation revenue vehicle or a GARVEE. *(Note: In the state of Texas, grant anticipation notes and bonds may be only applied towards for highway projects exclusively).*

State Infrastructure Bank (SIB): Currently capitalized in 33 states, state infrastructure banks provide low-interest loans for agency approved infrastructure projects. Essentially SIBs are funds established and operated by a State (usually a State Department of Transportation Office). It has the capacity to offer direct loans and various types of credit enhancement products to surface transportation infrastructure projects. Federal and State funds are used to capitalize the SIB. A percentage of Federal funds are transferred from specific modal accounts, and these funds are matched with State money in a prescribed ratio. *(Note: Under current law, in the case of the state of Texas, state infrastructure funds can only be applied to highway transportation projects)*.

Additional State Sources of Financing and Funding: Two additional sources of funding from state level departments of transportation, State Dedicated Fund (SDF) and State Operating Assistance (STOA). Both sources provide direct funding to designated projects and programs as requested by localities and approved by state DoTs. This funding is specifically for capital and operating expenses.

- SDFs: Provide funds for capital projects. These are dedicated to improvements of the systems and providing funds for innovative capital projects. In some cases fund is designated for transit it is for county and projects and pieces surrounding the metropolitan transit systems, but may not supplant available state, federal or local funding. Eligible projects include replacement buses; facilities/garage modernization; transit related equipment (bus washers; service vehicles); and other federally-eligible projects.

- STOA: Provides operating monies to transit agencies and authorities based on vehicle miles and passenger revenue service. Recipients are often designated into recipient regions, and revenues for assistance can come from sources such as gas tax, corporate tax surcharges, sales taxes, and taxes based off of existing lines of transit or transportation.

Figure II: Traditional Tools for HCT Investment Summary

Financial Tool	*Public Subsidy or Support?*	*Financing or Funding?*	*Mechanism for funding/financing*	*Flow of funds to HCT infrastructure*	*Limitation on Usage?*	*Authorization/Application to HCT in Texas?*
General Obligation Bonds	Yes	Financing	Dedicated source or general obligation pledge of taxing entity (e.g. municipality)	Directly to projects designated via program or referendum	Entity debt capacity	Yes - No legal limitation
Revenue bonds	Not directly	Financing	Debt secured by specific revenue stream (fares, rents, etc)	Directly to projects designated	Based upon project credit, forecast, etc	Yes - No legal limitation
Sales Tax Revenue	Yes	Financing	Financing secured by commercial sales within selected entity tax borders	Yes - can be directly to designated project (determined via referendum usually)	Based upon public appetite for tax and state law	Yes - No legal limitation
Property Tax Revenue	Yes	Financing	Fianncing secured by property tax levies within selected entity tax borders	Yes - can be directly to designated project (determined via referendum usually)	Based upon pulbic appetite for tax and county law	Yes - No legal limitation
Grant Anticipation Notes	Yes	Financing	Debt secured by anticipated future federal grants	Directly to projects or program via grant	Limited by the value/parameters of federal grant	State grants cannot be applied to HCT projects
State Infrastructure Bank	Yes	Financing	Loan and Credit enhancements to sponsors of particular capital projects	Yes - to sponsors private and public	Limited by project type	Limited to highway-related projects only
Tax Increment Financing	Not directly	Financing	Financing secured by property tax revenues increases within specified area or district	Directly to infrastructure within designated area	Increase in tax base according to ordinance	Yes - No legal limitation
State Sources: SDFs and STOAs	Yes	Funding	Funding programs designed to provide direct, designated investments from state DoTs to transit projects and programs. Usually outside of metropolitan transit agencies.	Directly to programs and projects	Limited by state-level determination on funding	Limited to highway-related projects only

Alternative Sources for HCT Investment

In addition to traditional sources for HCT infrastructure investment, there are a variety of more recent, alternative vehicles and programs oriented towards innovative structures for investment. The common factor with these tools is that their dependency on public subsidy is limited, however as a result the level of control by the municipal public sector is limited as well.

Private Activity Bonds (PABs): A PAB is a bond issued by a public entity for a project on behalf of a private entity. The projects financed are those that have significant public use but are being developed by the private entity. The benefit to the private entity is a lower cost of capital in development (due to the public entity sponsorship), and the benefit to the public entity is the development of a project by the private sector. PABs are applied to a variety of infrastructure projects. Private investment partners are critical to P3s, and there is a broad swath of potential private partners for the public sector in P3s, including pension funds, private equity funds (infrastructure funds), insurance companies, social impact funds, and similar financial entities seeking assets with risk and return profiles of infrastructure.

Transportation Infrastructure Finance Innovation Act (TIFIA): The TIFIA program is a financial program sponsored by the US Department of Transportation providing credit assistance for large scale surface transportation projects including highway, transit, intermodal freight and port access. TIFIA is designed to fill the financial gap for these projects by providing subordinate secured loans at significantly low interest rates compared to the market for up to 49% of the value of the project. Eligible sponsors include state and local government entities and private firms sponsoring public-related projects. The TIFIA program has loaned to over 62 projects totaling over $23 billion in projects able to be levered to over $83 billion.

FRA Railroad Rehabilitation and Improvement Financing (RRIF): The RRIF program is a financing program designed to provide direct loans to finance rail infrastructure brought forth by public and private entities. Priority of the program is given to projects that support public benefits such as economic development. Up to 100% of projects can be financed through RRIF lending with 35 year repayment periods.

Public-Private Partnership (P3): P3s are a contractual agreement between a private investor/developer/operator and a public entity/agency to develop or manage infrastructure projects. They are utilized to transfer financial, operational, and developmental risk from the public sector to the private sector in the development of public projects by leveraging the expertise and capabilities of the public sector. P3s must be legislated at the state and local level to be structured for projects (note that 33 states out of 50 have P3 legislation).

Value Capture: Value capture mechanisms are a type of public financing that captures increases in land value resulting from public investment in a transit project. These captured values are then used to help fund the transit project itself (either capital or operating costs, or both). Value capture mechanisms can generally support from 10% to 50% of project costs . Types of value capture include the following:

- Tax Increment Financing: A Tax Increment Financing, otherwise known as a TIF, is not a bond but rather a financing mechanism. A TIF enables municipalities to divert future property tax revenue increases from a defined area or district toward an economic development project or public improvement project in the community. The determination of the project to be funded is at the discretion of the city of county administration.
- Special Assessment Districts: These districts are areas in which property owners agree to pay an assessment to fund a project from which they will directly benefit. The assessments can be bonded against by the district.
- Impact Fees: These fees are a type of development exaction that requires real estate developers to contribute capital to public facilities, infrastructure, and/or services. Oftentimes they are used to defray costs of extending public services to the development and not for funding existing deficiencies.
- Joint Development: A joint real estate development project undertaken by a public agency and a private partner in which transit agencies can obtain lease revenues through station space, land, or air rights. In this situation developers can share costs of construction and/or maintenance of stations or other facilities

Figure III: Alternative Tools for HCT Investment Summary

Financial Tool/Program	*Public Subsidy or Support?*	*Financing or Funding?*	*Mechanism for funding/financing*	*Flow of funds to HCT infrastructure*	*Limitation on Usage?*	*Authorization/Application to HCT in Texas?*
Private Activity Bonds (PABs)	In some cases	Financing	Tax-exempt debt issued by state or agency to provide financing for a private entitiy	Directly to project/private entity for which bonds are underwritten	State debt capacity for PABs as designated by federal law	Yes - No legal limitation
Transportation Infrastructure Finance Innovation Act (TIFIA)	Federal Subsidy	Financing	Subordinate loan (up to 49% of project) secured by the federal government	Directly to projects designated	Based upon project credit, forecast, etc	Yes - No legal limitation
FRA Railroad Rehabilitation and Improvement Financing (RRIF)	Federal Subsidy	Financing	Subordinate loan (up to 100% of project) secured by the federal government. Specifically for rail infrastructure	Directly to project designated	Based upon project credit, forecast, etc	Yes - No legal limitation
Public -Private Partnerships (P3s)	In some cases	Both	Private Investment combined with public investment if applicable	Directly to project designated	None financially, legal limitations dependent upon public agency	Yes - No legal limitation
Value Capture (Includes	In some cases	Funding	Sponsorship or business partnership with private entity based upon perceived value of public asset	Directly to project designated	None	Yes - No legal limitation

Innovative Structures Combining Finance Tools

Innovative structures bring forth the possibility of additional financing tools, procurement methods, and project partners. In combining traditional and alternative tools for infrastructure investment, innovative structures for financing are possible. The following basic principles will drive any innovative structure:

- Mitigation of construction risk
- Mitigation of financing risk
- Addressing of life-cycle costs
- Innovation of project and financing to meet long-term infrastructure and financing challenges
- Procurement feasibility and efficiency
- Mitigation of demand and revenue risk (depending on project agreement)

At the heart of innovative financing is the ratio of participation between traditional and alternative tools, as well as the ratio of participation and responsibility of risk between the public and private sector. The following chart depicts this relationship:

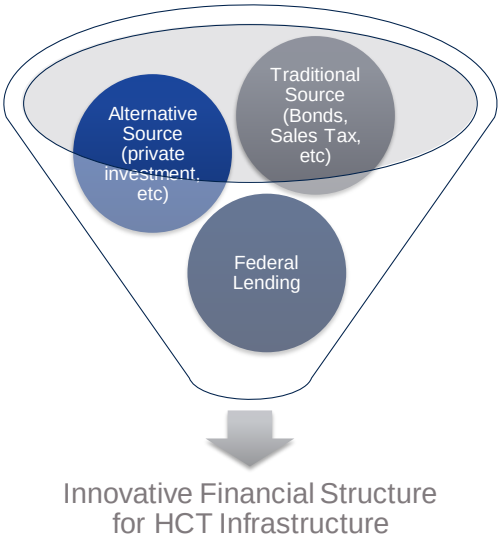
Figure IV: Risk Allocation for Major Projects

	Typical Allocation of Major Project Risks						
Delivery Method	**Design**	**Construct**	**Operate**	**Maintain**	**Finance**	**Demand**	**Revenue**
Design-Bid-Build	○	○	○	○	○	○	○
Design-Build	●	●	○	○	○	○	○
Design-Build-Operate-Maintain	●	●	●	●	○	○	○
Design-Build-Finance-Operate (Availability)	●	●	●	●	●	○	○
Design-Build-Finance-Operate (Shadow Tolls)	●	●	●	●	●	●	○
Design-Build-Finance-Operate (Full Concession)	●	●	●	●	●	●	●

KEY:
○ Risk retained by public sponsor
● Risk transferred to private partner/developer

It is the task of the public entity and sponsor to determine the details and dynamics of the project, designate the risks inherent in the procurement, development and maintenance of the project, and identify the proper financial tools, financial structure and financial partners required to complete the project in the short and long-term.

Figure V: Innovative Structure Mix for HCT Infrastructure



This may or may not include alternative tools or additional partners/participants so long as it is the structure that brings forward the most value for money for the public.

Additional Considerations and Tools

Through additional conversations and workgroup sessions, the Innovative Finance workgroup developed additional considerations for innovative financing and funding beyond the scope of initially identified tools and programs. They include the following:

Passenger Facility Charges (PFCs) for transit funding: PFC charges are charges applied to passengers by the airport agencies. They are capped at $4.50 per flight segment and with a maximum of $18 per round trip flight. Airports use PFC charges to fund projects that enhance safety, security, or capacity; reduce noise, or increase carrier competition. Traditionally PFC charges could be used only for direct airport facilities, but recently the FAA has begun to amend the legislation related to PFC charges to include related transit projects such as people movers and transit lines that lead to airports [3]

Transportation Reinvestment Zone (TRZ)s: The state legislature of Texas has enabled municipalities to establish TRZs in order to innovatively fund transportation projects. Similar to TIFs, TRZs require the municipality to designate a zone in which it will promote the transportation project and enable incremental increases in funding to be applied to a specific transportation project with the designated one. The projects include transit projects and have the following basic project requirements: The area of the TRZ will 1) promote public safety; 2) facilitate the improvement, development or redevelopment of property; 3) facilitate the movement of traffic; and 4) enhance the local entity's ability to sponsor transportation projects.

Local Investment Requirements (for Private Investors): There are several examples of P3 engagements requiring local equity participation in the same vein that other services such as construction or design

[3] Federal Register, US Department of Transportation; https://www.gpo.gov/fdsys/pkg/FR-2016-11-04/pdf/2016-26630.pdf

are mandated in design-build contracts for infrastructure. Examples of such programs include Washington DC's Certified Business Enterprise equity requirements. Additional requirements include those for minority/women business enterprise requirements.

Community Development Block Grant Program (CDBG): The workshop identified CDGB as having potential as an innovative tool for financing for HCT infrastructure. Specifically, Section 108 presents itself as a tool for financing infrastructure projects related to community and economic development. Section 108 offers state and local governments the ability to transform a small portion of their Community Development Block Grant (CDBG) funds into federally guaranteed loans large enough to pursue physical and economic revitalization projects capable of revitalizing entire neighborhoods. Such public investment is often needed to inspire private economic activity, providing the initial resources or simply the confidence that private firms and individuals may need to invest in distressed areas (e.g. transit-oriented development projects)

Loans typically range from $500,000 to $140 million, depending on the scale of the project or program.

Peer City Case Studies Comparison

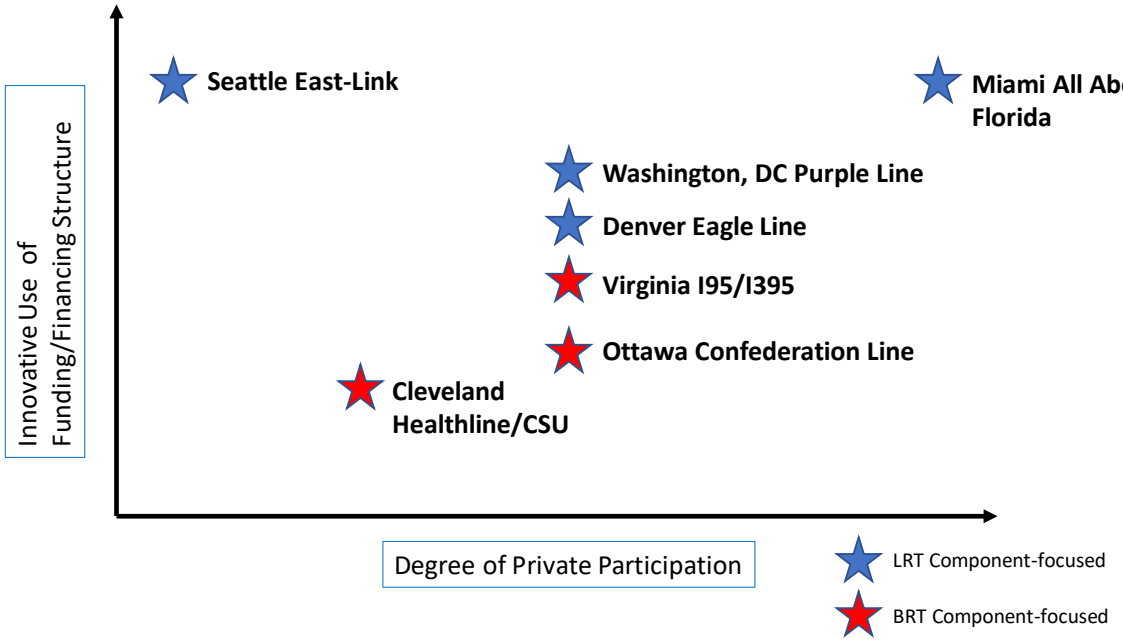
Essential to gaining a deeper understanding of innovative financing for HCT infrastructure is a comparative analysis of various structures in the United States and abroad. The workgroup has assembled, analyzed and compared various HCT investments in order to understand the real-world application of innovative finance structures. The sample of cities and projects compared to the Houston-Galveston region is depicted below:

Figure V: Comparison Peer Cities for Innovative Financing Strategies in HCT

Washington, DC (Purple Line)	Population: 6,131,977
	Density: 997 persons/sqmile
Seattle (East Link)	Population: 3,798,902
	Density: 586 person/sqmile
Miami (All Aboard Florida)	Population: 6,066,387
	Density: 1,096 persons/sqmile
Denver (Eagle Line)	Population: 2,812,732
	Density: 305 persons/sqmile
Ottawa (Confederation Line)	Population: 1,323,783
	Density: 507 persons/sqmile
Virginia (I95/I395)	Population: 2,055,612
	Density: 1,040 persons/sqmile
Cleveland (Healthline/CSU)	Population: 2,055,612
	Density: 1,040 persons/sqmile

These cities/regions and their projects present a broad swath of the types of innovative structures that are applicable for LRT, BRT and related infrastructure. They have varying degrees of traditional tools of financing versus alternative financing, local versus federal financing as well as varying degrees of private and public participation. A graphical chart of these projects is below:

Figure VI: Peer City Comparison



Washington, DC (Purple Line) – Public Private Partnership with Federal Funding:

- **Background**
  - P3 with Federal Funding: Contracted agreement to design, build, operate, finance and maintain 16-mile light rail system connecting counties
  - Montgomery and Prince George's Counties for decades were designated for a single light rail line connecting the two and providing a transit link between the two.
  - Prohibitive costs for a potential project, combined with limited bonding capacity for MTA and the state of Maryland made this potential project difficult via traditional finance.
- **Financing**
  - Total Project Size: $5.6bn

- Private Investment: $138mm
- TIFIA loans: $875mm
- Private Activity Bonds: $313mm

- **Additional**
  - The Silver Line extension of WMATA included the development of a special tax district for counties within the lines path.
  - Project Sponsors: Maryland Dept. of Transportation, Maryland Transit Agency
  - State lender: US Department of Transportation
  - SPV: Purple Line Transit Partners, LLC

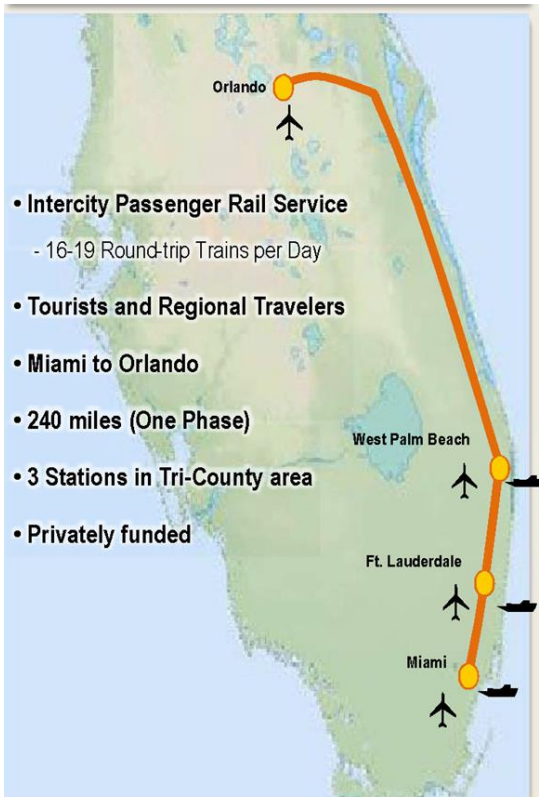
Seattle, Washington (East Link) – Public (Local) to Public (Federal) Partnership including sales and income tax bases as sources of financing:

- **Background**
  - Innovative structure to finance 15 mile light rail transit extension and HOV lane expansion connecting population and employment centers
  - The Seattle/Belllevue region featured growing sales and income tax bases that were able to support rail projects, but the overall scale of this project was too large for the debt profile for Sound Transit or the surrounding cities.

  - Sound Transit could, however, serve as the counterparty for a TIFIA loan from the federal government and utilizing the region's tax base. Loan analysis would be up to USDoT.
- **Financing**
  - Total Project Size: $4.03bn
  - Private Investment: None
  - TIFIA loans: $1.33bn
  - Sound Transit Tax Revenues: $1.086bn
  - Bond Proceeds: $1.06bn
  - Cash Contribution: $281mm
  - Grant Revenue: $89mm
  - City of Bellevue: $184mm
  - Project Sponsors: Sound Transit; USDOT; City of Bellevue
  - Lenders: US Department of Transportation; Sound Transit
- **Additional**
  - Project Sponsors: Sound Transit; USDOT; City of Bellevue
  - Lenders: US Department of Transportation; Sound Transit

Miami (All Aboard Florida) – All Private Investment:

- **Background**
    - FDOT has long identified an opportunity in connecting the populous cities along the Atlantic Coast/I-95/Florida Turnpike of Florida by light rail.
    - The costs for an innovative and effective rolling stock and rail project were prohibitive, along with the complexity of procurement via traditional methods.
- **Financing**
    - Total Project Size: $2.5bn
    - Private Investment: Over $1billion in cash equity including ROW land purchases; $345 in cash equity in project
    - All Aboard will be participating in all passenger revenues
    - Project includes Miami Central Station, a private real estate project including 11 acres and 3 million sq/ft of retail and office space above and beneath the rail tracks.

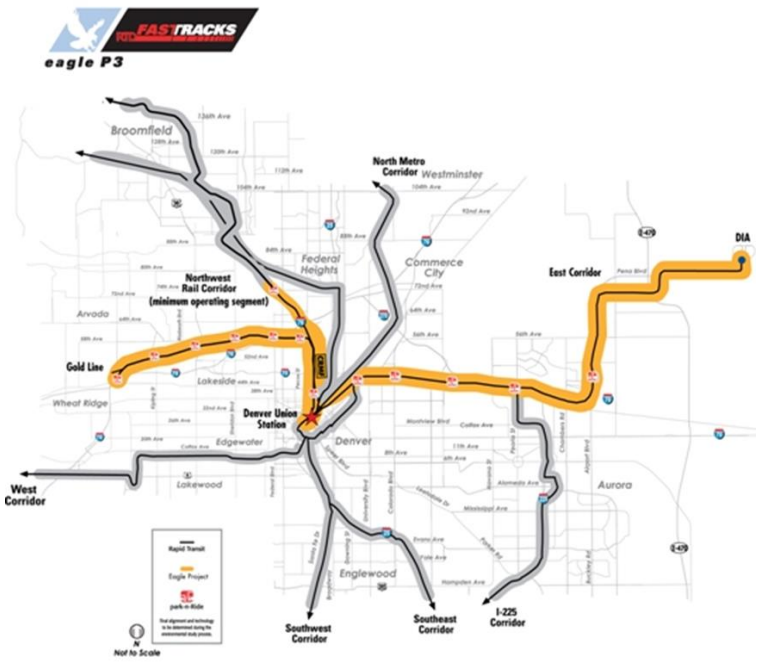


- **Additional**
    - All Aboard Florida (A private entity consisting of investors and developers including Fortress Fund); US Department of Transportation; FDoT; Cities along rail route including Miami and Orlando

Denver (Eagle Line) – Utilization of Sales Tax Referendum, PABs with Public-Private Partnership:

- **Background**
    - Denver RTD realized the need to finance a rail line from the airport to its downtown. As the region entered into a P3 to finance the downtown train station, a P3 was also being considered for the rail.

- The cost of the rail line was prohibitive for RTD to do alone, a combination of private and federal support would need to be utilized.



- **Financing**
  - Total Project Size: $1.64bn
  - Public Sources of Funding:
  - TIFIA Loan
  - Regional Sales Tax (two .4% increases)
  - $44mm from Denver RTD
  - Includes TIF District for Union Station Metropolitan District based on .4% sales tax increase
  - Private Sources of Funding:
  - $54mm in equity from private investor
- **Additional**
  - Project Sponsors: Denver Regional Transit Department
  - Private Investors: Fluor-led consortium
  - Regional towns and the City of Denver; Denver International Airport

Ottawa (Confederation Line) – Public Private Partnership for BRT:

- **Background**
  - $2.1 billion Light Rail Transit (LRT) system that will run primarily along the City of Ottawa's existing Transit way from Tunney's Pasture in the west to Blair Station in the east.

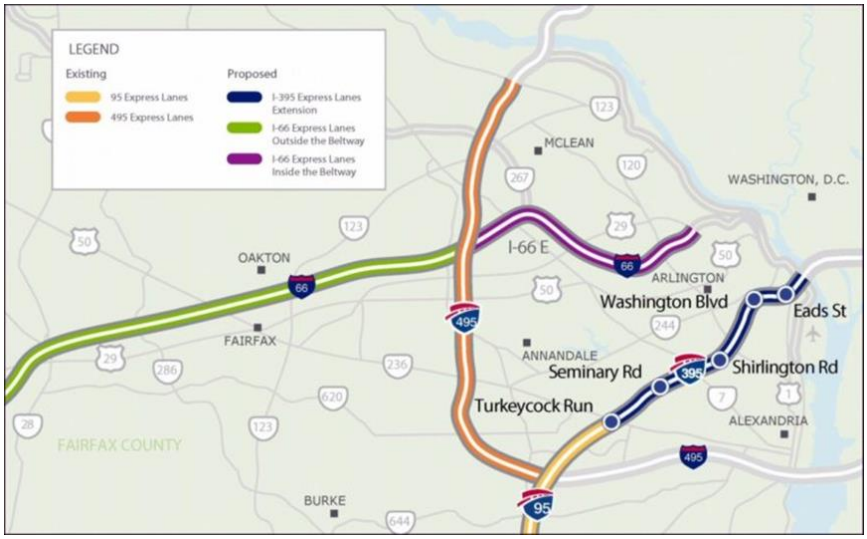
  - Intermodal Connection: Project includes financing of highway along transit route, as well as development of stations connecting transit users to bus rapid transit (BRT)
  - Public-private partnership (P3) between the City of Ottawa and RTG, with financial commitments from the Government of Canada and the Province of Ontario.
- **Financing**
  - Term: 30 Years

- Long term debt: $225M
- Long term equity: $75M
- Short term debt: $232M
- Construction Budget Funding
- Gas taxes - $449M
- Development charges - $291M
- Transit taxes - $190M
- Federal and provincial grants - $1.2BN

- **Additional**
  - Project Sponsor: City of Ottawa
  - SPV: Rideau Transit Group GP
  - Bank lenders: Sumitomo Mitsui, National Bank of Canada, Scotiabank, MUFG
  - Long term lenders (bond): Sun Life, National Bank Financial
  - Equity providers: ACS, SNC Capital, EllisDon
  - Procurement Advisor: Infrastructure Ontario

Virginia (I95/I395) – Highway and Sidewalk Investment via Public-Private Partnership and Federal Funding:

- **Background**
  - VDOT partnered with Fluor-Transurban in the development of high-occupancy toll (HOT) lane projects for Interstates 95/395 and the Capital Beltway/Interstate 495. The I-95/395 project expands the existing HOV lanes on I-95/395 from two to three lanes



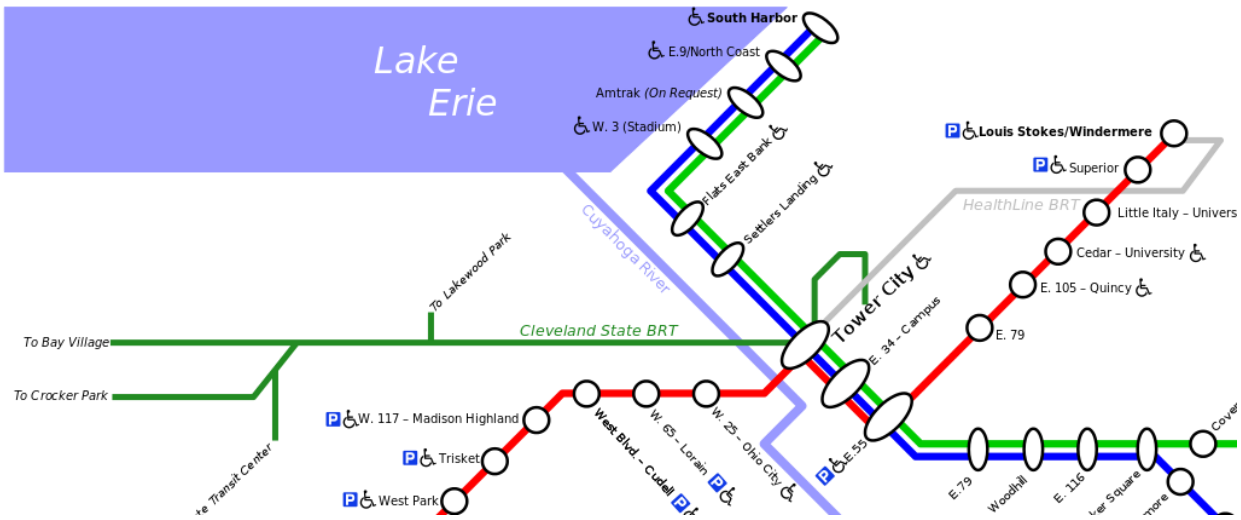
  - Two HOV/Bus/HOT lanes have been added in each direction.
  - BRT and LRT transit enhancement station and line improvement
- **Financing**
  - $253 million PABs issue; a $300 million subordinated TIFIA loan; and $280 million in private equity. The PABs are the senior debt on the project
  - All financing sources for the project are backed by tolls and other project revenues.
  - VDOT directly contributed $83 million at financial close combination of Federal and state funds.
- **Additional**

- Virginia Department of Transportation (VDoT)
- Virginia Railway Express (VRE)
- USDoT (TIFIA lenders)
- Fluor-Transurban (Private Investors)

Cleveland (Healthline/CSU) – Value Capture:

- **Background**
  - In 2005, RTA began building the Silver bus rapid transit line.
  - Naming rights for the line were purchased by the Cleveland Clinic and University Hospitals for twenty-five years. Additionally, naming rights for another line have been purchased by Cleveland State University

- **Financing**
  - RTA was the first transit system in the nation to sell naming rights sponsorships to its assets. The HealthLine is sponsored by the Cleveland Clinic and University Hospitals, and connects the Medical Center to downtown. $50mm of the $200mm project was devoted to BRT, with the rest for road improvement.
- **Additional**
  - Contract for $150K per year
  - CSU sponsorship on 16 custom-designed buses; seat backs on all vehicles, and the 32 new bus stations and 243 stops and shelters along the route and in related materials.
  - Line runs from downtown Campus to West Shore area.



Additional Peer City (Los Angeles Measure M)

Background: In the Fall of 2016, the County of Los Angeles passed a referendum to invest in its local transit and transportation in order to achieve the following goals:

"Improve freeway traffic flow; reduce bottlenecks and ease traffic congestion; expand the rail and rapid transit system; accelerate rail construction and build new rail lines; enhance local, regional, and express bus service; and improve system connectivity; repave local streets, repair potholes, synchronize signals; improve neighborhood streets and intersections, and enhance bike and pedestrian connections; keep the transit and highway system safe; earthquake-retrofit bridges, enhance freeway and transit system safety and keep the transportation system in good working condition; make public transportation more accessible, convenient, and affordable for seniors, students, and the disabled and provide better mobility options for our aging population; Embrace technology and innovation; incorporate modern technology, new advancements, and emerging innovations into the local transportation system; create jobs, reduce pollution, and generate local economic benefits; increase personal quality time and overall quality of life; provide accountability and transparency; protect and monitor the public's investments through independent audits and oversight"

Financing: Measure M included two major phases toward financing and achievement of these goals. First is a county sales tax and county base sales tax each increase ½ a penny. The base tax would then be raised 1% in 2039. This would raise $120 billion over 40 years, and $860 million in the first year. Measure M also defines a process in which the County and related agencies (LA Metro) can receive unsolicited bids for projects from private investors for public-private partnerships, thus increasing the potential funding of projects exponentially.

Projects: 35% of Measure M financing will go towards new transit projects, 17% will go to highway projects. 2% will go towards bike and pedestrian projects and 17% will be returned to 88 cities of LA County for transportation projects including sidewalks and streets. The remainder will go towards bus and rail operations and infrastructure maintenance.

Additional: Decongestion is a significant goal of the Measure M program. Los Angeles, similar to Texas has a jurisdictionally-based multiple transit provider governance system.

Regional Governance Models

Throughout the United States, different regions have developed alternative governance models to plan, operate, and administer successful regional transit systems. There is no universal regional transit governance model that will be successful in every region; however, learning about the governance models of other regional transit programs is useful in helping the H-GAC region consider what might work best locally for guiding a community from the development of a long range regional transit philosophy to someday realizing that vision.

Governance can include many different tasks and responsibilities. As a part of the 2010 RTFS effort, governance models in five other urban regions (Atlanta, Denver, Miami, San Diego and Seattle) were surveyed. For the purposes of understanding regional transit governance in these other regions, the following elements were considered:

- Structure of policy/decision making bodies of primary transit agencies

- Transit operations responsibilities
- Long range transit planning responsibilities

The structure and make-up of policy and decision making bodies (i.e. board, council, commission, etc.) vary among regions across the county. Some transit agencies, such as the RTD in Denver, are governed by directly elected members, while others rely on political appointments. In addition, where there are multiple transit operators in a region, the level of coordination may vary. In the Seattle region, Sound Transit's Board of Directors helps provide regional continuity through incorporating board members from other transit agencies in the region.

For transit operations, different regions have evolved into systems that are generally separated by operations mode or geography. In the Miami region for example, one agency operates regional commuter rail, while other agencies in the region provide the local rail and bus services.

Similar among all the peer regions reviewed, long-range regional transit planning activities are primarily coordinated or directly managed by the local metropolitan planning organization (MPO) or council of governments (COG). However, the level of planning or coordination within each region varies. In the case of the San Diego region, the regional planning agency is more significantly involved in regional transit planning and project development than others.[4]

COMPARISON OF REGIONAL TRANSIT GOVERNANCE STRUCTURES

Considering regional transit governance from this perspective there are three general governance models utilized by the regions reviewed:

- Single Regional/Local Transit Provider (Denver)
- Jurisdictionally Based Multiple Transit Provider (Atlanta and San Diego)
- Market Based Multiple Transit Provider (Seattle and Miami)

Single regional/local transit provider agencies like Denver RTD deliver transit services primarily through a single decision-making body that encompasses the broader region. Benefits of this governance model include the ability to apply uniform service standards and deliver a more coordinated regional transit network. A potential benefit or drawback, depending upon beneficiary, is the possibility of an uneven distribution of transit services and facilities based on jurisdictional contribution to the system. For example, every dollar of revenue generated in a community may not be returned to the same community based on regional priorities determined by the transit provider's governing body.

Jurisdictionally-based multiple transit provider agencies such as Atlanta and San Diego deliver regional transit services through more than one agency. While this type of governance structure is similar to the market based multiple transit provider, it is primarily different in that jurisdictionally based providers don't typically have significant overlaps in service area or authority. One of the most obvious benefits of this type of governance structure is local control over decision making. Potential drawbacks may include

[4] In some metropolitan regions of the United States, MPOs operate transit services directly. For example, the Regional Transportation Commission of Southern Nevada (RTC) operates transit services in the Las Vegas metropolitan area.

non-uniform service standards and uncoordinated services. The transit service governance structure in the Houston-Galveston region is most closely related to this model.

Finally, **market based multiple transit provider** agencies such as Seattle and Miami also deliver regional transit services through more than one agency; however, one difference is that market based structures have allocated responsibilities for regional and local transit to different transit provider agencies. Under this governance model, regional services such as express bus, commuter rail, or other high capacity transit services are provided by one agency, while local services (single jurisdiction) are provided by a different transit provider or providers. Benefits of this governance model include the ability to apply uniform service standards for regional services, while providing local control over local services and freeing local transit providers from the potential burden of regional service operations. Drawbacks include non-uniform transit service standards between local transit providers and the regional transit provider.

Questions as to which agency or entity (or combination thereof) will operate new transit services considered in this long range regional transit framework, how funding will be generated to support future regional transit investments, and how uniform regional transit standards may be enacted, directly relate to the issue of regional transit governance. In the short term, the region's providers will continue to operate under the current governance structure, with increasing emphasis being put on coordination between providers. Longer-term, the region may wish to give thought to a preferred regional transit governance structure, including the current governance structure, for the Houston-Galveston area.

Country	City or Region	Single Regional/Local Provider	Jurisdictionally-based Multiple Provider	Market-based Multiple Provider
	Atlanta		☑	
	Austin		☑	
	Cleveland		☑	
	Dallas/Fort Worth		☑	
	Denver	☑		
	Los Angeles			☑
	Miami			☑
	Seattle			☑
	Washington, DC			☑
	Ottawa		☑	
	Vancouver	☑		
	Dubai	☑		

4. Economic Impacts of High Capacity Transit

Introduction

This deliverable document is the summary of the Economic Impact workgroup efforts to identify, analyze and present all potential economic impacts for investment in high-capacity transit (HCT) in the Houston-Galveston region. In-person workgroup sessions, webinar sessions, and phone calls with workgroup leaders throughout the fourth quarter of 2017 has culminated in an extensive exploration of the best way in which to identify, examine and report economic impacts for HCT investment for the Houston-Galveston region. Specific tasks completed over the quarter include the following:

- Work Group Session: 29th of September
- Webinar Sessions: November 26th
- Workgroup Calls: November 10th

This deliverable is not a recommendation of a specific analysis or economic impact perspective for HCT infrastructure in the Houston-Galveston region. Rather it is a review of the vast options and potential economic impact analyses as well as an overview of what has been done empirically. The final work product provided here is intended to contain the following:

- Review and analysis of economic impact theory and analysis methods including best practices and shortcomings
- Review of specific methods and forms of economic impact analysis and reporting as related to infrastructure investment
- Develop a method for analyzing the economic impact of HCT investment in infrastructure ?
- Provide recommendations for the Houston-Galveston region?

The mission of the High Capacity Taskforce is to explore potential economic impacts of HCT investment in the Houston-Galveston region as a standard for future analysis and reporting. To complete this task the workgroup is tasked to review the following:

- Review of best practices in economic impact analysis
- Establishment of a standard analysis and reporting method to be utilized in the future
- Peer City Innovative Funding Review

Finally, the definition of economic impact must be underlined for the sake of this deliverable. Economic impact analysis focuses specifically on measurable changes in the flow of money (investment) going to households, businesses, and communities including both spending and productivity effects.

Economic Impact Analysis Overview

Why Measure Economic Impact in HCT: The importance of the measurement of investment in HCT infrastructure is several-fold:

- It is essential to determining the actual effects of investments made and actions taken in an evolving transit and transportation environment over a specific period of time and place.
- It is important to have a standard for analysis to be applied to a specific region, businesses, communities from a project or program over a period of time in order to determine its performance, necessary improvements or obsoleteness.
- It is essential to have a standard method of presenting performance of project and programs investments in order to explain them clearly and effectively to critical parties, stakeholders and

the general public. In addition, economic impact analysis review is essential to determining broad policy goals are being met via HCT project or program investment.

What is Economic Impact and How Has It Been Evaluated: From the outset the major focus and discussion of the workgroup has been how best to define and report comprehensive economic impacts that are also comprehensible and defensible. Possible difficulties discussed included the following:

- **Definition of Economic Impact:** No clear identification on what defines a positive economic impact versus a negligible or a negative impact. For example:
    - Decongestion (analyze costs of congestion vs. benefits): Is it an indication of positive economic impact?
    - Are rider savings or transportation choice the standards for determining positive economic impact for commuters?
    - How can economic growth (GDP, tax revenue, etc.) be used to determine the success of a given project?
        - Growth will happen regardless of transit investment due general economic expansion.

- **Input/Output Analysis-** There is no clear delineation of where each dollar of investment goes in an input/output analysis. For example:
    - Impact and Growth can occur regardless of savings, investment, or optionality, simply due to macroeconomic factors – how do we best attribute certain investments inputs to specific output results?
    - We need to attempt to identify the direct effects of investment

- **The Value of Peer City Review -** Peer City analysis is presented to provide perspective:
    - Will this provide empirical themes across regions?
    - Regional review may also provide some perspective on input output impact of investment
    - Peer City Review could potentially show what kind of HCT investments produce what kind of economic effects

- **The Value of Mobility** - Mobility, as a positive effect
    - Is the need for mobility the cause of problems, or is the provision of mobility the solution to problems – which is it?
    - Mobility and production – what is the relationship and how is it best identified and defined?

The exploration and assessment of the utility of these variables in economic impact analysis has been a focus of the workgroup as it seeks the best way to both analyze the potential economic impacts of HCT infrastructure investments and to present them to the public. The workgroup began with a short review of some of the traditional methods for economic analysis. Given that the members of the workgroup were knowledgeable of the different methods and applications of economic impact analysis, this was a straightforward process.

Empirically Accepted Impacts and Utilized Measures for Transit and Transportation Investment Economic Impact

- **Input/Output Analysis:** Input-output analysis ("I-O") is a form of economic analysis based on the interdependencies between economic sectors and influences including services like transit. This method primarily used for estimating the impacts of positive or negative economic shocks and analyzing the ripple effects throughout an economy. I-O tables organize the business sector of an economy in terms of who makes what outputs and who uses what inputs. In essence, it is a matrix. I-O models are useful for estimating how an increase in demand for a product or service of one industry could influence other industries and the economy as a whole.

  I-O models estimate three types of impacts, direct, indirect, and induced. These terms are another way of saying initial, secondary, and tertiary impacts that ripple throughout the economy. In the example of building of a bridge in a community:

  - Direct: The direct impacts of an economic shock are the initial change in expenditures. For example, building a bridge would require spending on cement, steel, construction equipment, labor and other inputs.

  - Indirect: The indirect, or secondary, impacts are due to the suppliers of the inputs hiring workers to meet demand.

  - Induced: The induced, or tertiary, impacts result from the workers of suppliers purchasing more goods and services.

  In sum, I-O models produce a monetary value derived from a points/unit system of inputs versus outputs. By using I-O models, economists can estimate the changes in inputs across industries resulting from a change in output in one or more specific industries

  Challenges: Difficult to tie specific input flows to specific output results

- **Travel Improvement Impact: Cost Savings, Time Savings and Safety and Decongestion Analysis:** Efficiencies and decongestion analysis has a symbiotic relationship with the analysis of the economic impact of HCT transit investments. This method of analysis focuses on the experience and benefits of the driver/user of the transit and transportation systems due to HCT investment. These experiences and benefits fall into four core categories: (1) travel time savings, (2) travel cost savings, (3) reliability improvements and (4) safety improvements. All four types of benefits can provide monetary savings for both public transportation passengers and for travelers who continue to use other transportation modes.

  Metrics utilized to determine the value of these impacts, include the following:
  - Vehicle hours traveled (VHT)
  - Vehicle miles traveled (VMT)
  - Vehicle accidents per hours and miles traveled

  Unit costs, such as expenditure per vehicle mile or costs per accident, are applied to these metrics to assess their monetary value for travelers. In addition to the direct user benefit, the indirect benefits of HCT investment upon travel improvement are benefits to other vehicles on the road (such as commercial vehicles) that are traveling in reduced congestion. In the case of

commercial vehicles, the benefit to companies can be identified by measuring increased efficiency and reduced costs per vehicle. The resulting savings and efficiencies can be identified in terms of the following:

- Travel Time Savings
- Reliability Benefits (service improvement, and decongestion)
- Safety Benefits (Accident reduction)
- Travel Cost Savings

Challenges: Analysis scope likely to expand exponentially; does not take into account the cost of inputs necessary to achieve given outputs/value; provides a relatively subjective assessment of overall economic impact (impact on businesses and communities).

- **Growth and Productivity Analysis:** Growth and productivity economic impact analysis is based upon the theory that direct investment will lead to immediate and consequential micro and macroeconomic effects that are symbiotic and scalar in nature. This analysis focuses on increases and decreases in the economic growth and productivity of individuals, businesses, communities, and regions. Numerous factors can be identified as part of growth and productivity analysis, the following is a sample:
  - Gross Domestic Product (for business, families and communities)
  - Property, sales and (corporate and individual) income tax revenues
  - Jobs created
  - Commercial and Residential property values
  - Spatial Agglomeration Economies (determined by company formation and community development)

  Challenges: Accuracy of growth and productivity data, accuracy of relationship between HCT investment and growth/productivity results.

- **Non-Monetary Impacts:** The effects of non-monetary and non-economic impacts should also be accounted for in economic impact reviews. Two consistently significant impacts are traveler optionality and environmental benefits.
  - Traveler Optionality: The traveler's ability to choose the public transportation option. Public transportation mitigates common challenges and impediments for transportation users such as financial constraints, congestion, weather, and vehicle unavailability in the short or long term.

  - Environmental Benefits: Benefits to the environment are a quantifiable non-monetary impact. Air quality and pollution reduction is the most consistently identified environmental benefit, with investment in HCT infrastructure reducing individual vehicle utilization, in turn reducing emissions

  Challenges: Accuracy of estimation and analysis data, application of metrics to non-monetary benefits

Workgroup Developed Analysis of Economic Impact of HCT Investment

Development and Application of a Standard: The workgroup seeks to provide economic impact analysis that is both understandable and transparent. The working group felt that presenting the results from

the perspectives of the individual traveler, businesses, and communities impacted by HCT Investments would be the most effective way to present economic impact. A review of this standard is below:

Figure I: Economic Impact Criteria

Economic Impact Criteria for HCT Investments

- **Individual Citizen**
  - Optionality: Increased transportation options *(Qualitative)*
  - Mobility: Increased ability to travel efficiently *(Qualitative)*
  - Savings/Efficiency: Decreased transportation costs *(Quantitative)*
  - Safety: Increased safety in transportation *(Quantitative)*
- **Businesses/Employers**
  - Mobility and Market Access: Increased propinquity to customers and market clusters *(Quantitative)*
  - *Corporate Revenues (Quantitative)*
  - Access to employees: Increased ease of access to employee and employee centers and communities *(Qualitative)*
  - Economic Spatial Agglomeration: Increased ease of access to related and complimentary businesses and clusters *(Quantitative)*
- **Communities/Region**
  - Connectivity to jobs and employment: Increased access for distant communities to business clusters *(Qualitative)*
  - Increased connectivity to other communities: Increased access of regional communities to each other *(Qualitative)*
  - Real property value enhancement: Increased real property value due to investment *(Quantitative)*
  - GDP for region and community *(Quantitative)*
  - *Property, Sales and Income Taxes (Quantitative)*

For each of these impact factors (individual, businesses, and communities), the workgroup has identified empirically utilized analysis tools for economic impact (input/output, growth, etc), and the applicable metrics or values for analyzing impact.

Individual Citizen:

- Who: All citizens within the selected region and utilizing transportation

Metrics Applied and Reasoning:

- User Optionality
- User Mobility
- User Cost and Time Savings/Efficiency
- Travel Safety

Businesses and Employers:

- Who: All businesses located within the selected region with commercial and employment activities within the region

Metrics Applied and Reasoning:

- Access to Employees
- Jobs created
- Mobility and Market Access
- Corporate Revenues
- Economic Spatial Agglomeration - Access to Other Businesses

Communities and Regions:

- Who: Proximate neighborhoods, districts, cities counties and regions impacted by the HCT project

Metrics Applied and Reasoning:

- Connectivity to Companies, Employment, Communities
- Real Property Values
- Regional Gross Domestic Product
- Property, Sales, and Income Tax Revenue

Peer City Case Studies Comparison

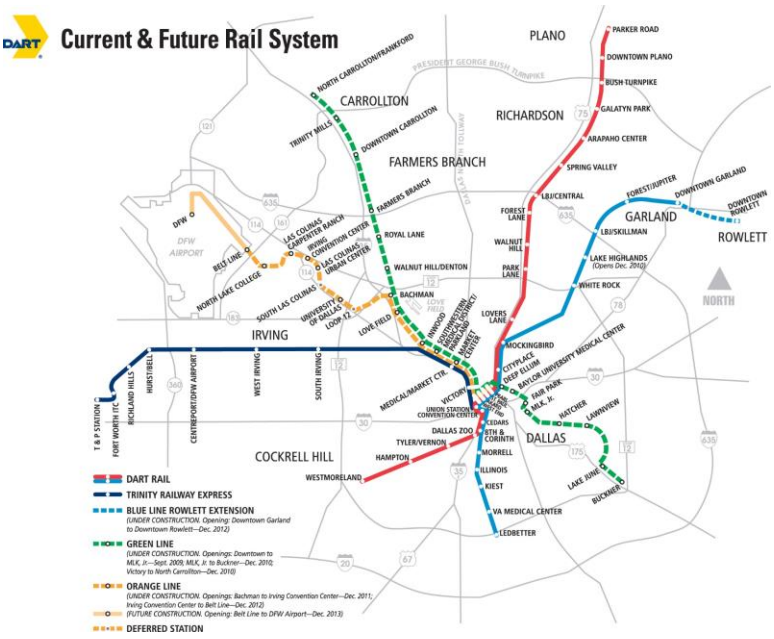
An additional task that the workgroup concluded would provide perspective and support to economic impact analysis of HCT investment is a peer city review of comparable cities that have taken on HCT infrastructure investment in the recent past. A peer city review focused on the standardized criteria for reviewing HCT investment should provide context for our region's assessment of the potential economic impacts of various types of HCT investment.

The following graph presents the cities selected for peer review and their characteristics:

Figure II: Selected Peer Cities for Economic Impact Review

Dallas (Dallas Area Rapid Transit)	Population: 6,131,977
	Density: 997 persons/sqmile
Seattle (East Link)	Population: 3,798,902
	Density: 586 person/sqmile
Washignton, DC (WMATA)	Population: 6,131,977
	Density: 997 persons/sqmile
Denver (Eagle Line)	Population: 2,812,732
	Density: 305 persons/sqmile
Atlanta (MARTA)	Population: 5,789,700
	Density: 632 persons/sqmile
Cleveland (Healthline/CSU)	Population: 2,055,612
	Density: 1,040 persons/sqmile

***Dallas, Texas (DART)*[5] [6]**



- 2016 Estimated MSA Population: 7,233,323
- 2010 Census MSA Density: 634 persons/square mile
- DART (Light Rail) – first section opened 1996
- TRE & DCTA A-Train (Commuter Rail)
- Streetcars: heritage (McKinney Ave Trolley) and modern (Dallas Streetcar)
- Las Colinas People-mover (Automated Guideway Transit)

Transit Features

- Date Opened: 1996
- Route Length: 83.8 miles
- Four Lines (Red, Orange, Blue, Green)
- 39 stations currently

Individual Impacts:

• Travelers experienced ___ fewer hours of travel delay per year
• Travelers utilizing high capacity transit experienced savings averaging approximately ___ per year or trip

Business Impacts:

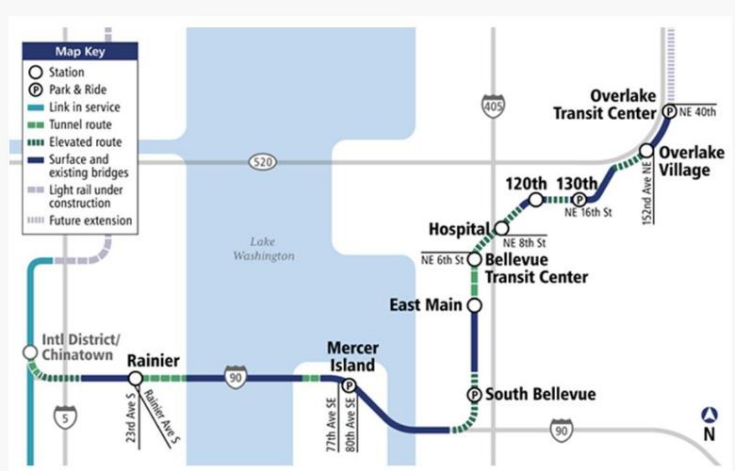
•Over $1.5 billion in yearly labor income in businesses near stations
•Over 30,000 Direct/indirect jobs supported annually
•Construction jobs created in the Dallas-Fort Worth region- 20,741
•Employee compensation created by public development- $1.3 billion

Regional Impacts:

- Over $400 million in property income has come from DART system buildout
- Over $100 million of indirect business taxes of businesses near DART stations
- Property value within a quarter-mile of DART LRT stations as of 2013- $5.3 billion
- Public development property value- $1.81 billion
- Economic impact produced by public development for the Dallas-Fort Worth region - $3.36 billion
- State and local taxes revenue- $105 million
- Federal tax revenue- $278 million

[5] Dallas Area Rapid Transit "The Economic and Fiscal Impacts of Development near DART stations", 2017
[6] http://www.dart.org/about/economicimpact.asp

Seattle, Washington (East Link Project)[7]



Financing & Funding Approach

- Total Project Size: $4.03bn
- Private Investment: None
- TIFIA loans: $1.33bn
- Sound Transit Tax Revenues: $1.086bn
- Bond Proceeds: $1.06bn
- Cash Contribution: $281mm
- Grant Revenue: $89mm
- City of Bellevue: $184mm

Stakeholders Participating

- Project Sponsors: Sound Transit; USDOT; City of Bellevue
- Lenders: US Department of Transportation; Sound Transit

Anticipated Economic Impacts:

- *Individual Impacts:* Expected travel time savings expected to save $65mm annually; 10,000 vehicle hours per day. Passenger optionality in transportation choice
- *Business Economic Impacts:* 40,000 jobs in construction and future economic development
- *Business **and** Community Impacts:* Connecting residential communities to over 200,000 existing jobs due to access to rapidly growing software and biotech industries in the greater metropolitan area

Washington, DC (WMATA)[8]

Background Information

- 2016 Estimated MSA Population: 6,131,977
- 2010 Census MSA Density: 1,084 persons/square mile
- METRO (Heavy Rail) – first section opened in 1976; continuously expanded

[7] Source: Soundtransit.org
[8] Smartgrowt.org

Individual Impacts:

- 65% of Metrorail riders are considered to be choice riders; over 42% of bus riders are choice riders

Business Impacts:

- Between 1980 and 1990, 40% of the region's new retail and office space was built within walking distance of a Metrorail station
- Over $30 billion of commercial, office and retail growth near metro stations and lines
- Jobs created- over 15,000 with $1.1 billion in private investment.

Regional Impacts:

- Over $15 billion in economic activity
- 40% of the region's new retail and office space was built within walking distance of a Metrorail station
- Over $30 billion of commercial, office and retail growth
- Property values within half mile- 6.8% increase in residential, 9.4% in multi-family, and 8.9% in commercial office properties.
- The real estate within half mile and quarter mile generated approximately $3.1billion
- Assessed valuation of the 35-block area increased from $535 million in 2001 to $2.3 billion in 2007.
- Annual savings from lower car operation costs to individuals/families- $342 million ($2010)
- Congestion: 148,000 hours/day saved from being lost to traffic congestion. [9]

[9] https://www.wmata.com/initiatives/case-for-transit/upload/WMATA-Making-the-Case-for-Transit-Final-Tech-Report.pdf

Denver, Colorado (Eagle Line)[10]

Background Information
• 2016 Estimated MSA Population: 2,812,732 • 2010 Census MSA Density: 305 persons/square mile • RTA Lines C D E F H R W (light rail; regional/metro service)– first section opened 1994 • RTA Lines A B (light rail; regional/commuter service) – first section opened 2016
• 122 miles of new light and commuter rail • 18 miles of bus rapid transit (BRT) • 57 new transit stations Enhanced bus/rail connections with conveniently timed transfers PARK-n-RIDES 31 new Park-n-Rides ● 21,000 new parking spaces at rail and bus stations ENHANCED BUS NETWORK

Individual Impacts:

- Direct rail connection of the airport to downtown Denver eases access of business to downtown and provides optionality and mobility for citizens, reducing travel costs and risks.

Business Impacts:

- Over $1.4 billion injected into Denver economy from the project exclusively including, wages, subcontractors, equipment and services
- Contributed $1.319 billion to the local economy as of September 2015
- Job growth up 2.66% in first year of after construction
- DTP wages paid: $219 million
- Equipment, services and supplies: $537 million
- Subcontractors: $563 million

Regional Impacts:

- Over $3 billion in economic activity since the project inception
- Concurrent development of $300 million privately funded FasTracks hub Denver Union Station

[10] Rtd-fastracks.com

Atlanta, Georgia (MARTA)[1112]

Background Information

- 2016 Estimated MSA Population: 5,789,700
- 2010 Census MSA Density: 632
- Some topographic differences (hills), but no geographic limitations and similar climate
- MARTA (heavy rail; metro service) – first section opened 1979
- Modern streetcar (district circulator)
- 8th largest transit system in the US; largest in the Southeast

Transit Features

- Service area of 500 square miles
- BRT: 532 buses; 91 routes; 8,954 stops
- LRT: 38 stations; 48 miles of rail track; 318 cars

Individual Impacts:

•Increased optionality employees as well as for Senior citizens
•Expanded transit options allow some workers to access work opportunities not otherwise be available to them, as well as saving time and transportation costs
•Nearly 180,000 workers in metropolitan Atlanta utilize MARTA for daily commute, including car owners
•Over $700 million generated in personal income in Georgia

Business Impacts:

•14 of the 18 fastest growing sectors in Atlanta employ workers who rely heavily on MARTA
•24,864 Direct/indirect jobs supported annually
•The economic activity of the nearly 100,000 MARTA-dependent workers support another 80,000 additional jobs.
•65,000 workers use MARTA for their daily commute

Regional Impacts:

- 14 of the 18 fastest growing sectors in Atlanta employ workers who rely heavily on MARTA
- Businesses near stations have experienced higher revenue performance.
- MARTA has brought forth approximately $2.6 billion in economic activity annually
- MARTA supported jobs in Georgia total over 20,000 annually

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[11] Source: Metropolitan Area Rapid Transit Authority, 2015
Atlanta Journal-Constitution "MARTA economic engine for region, study says", November, 2012
[12] http://caes2.caes.uga.edu/center/caed/pubs/2012/documents/MARTAFinalReport.pdf

- Expected impact: job growth to reach 104,267 by 2040

Cleveland, Ohio[13] [14]

Regional Information

- 2016 Estimated MSA Population: 2,055,612
- 2010 Census MSA Density: 6,166 persons/square mile
- Cleveland RTA (established 1975): 1 rapid transit; 2 interurban/light rail; 1 light rail: Waterfront 60 bus routes; 2 Bus rapid transits; 4 Freeway-Flyer

Background

- In 2005, RTA began building the Silver bus rapid transit line.
- Naming rights for the line were purchased by the Cleveland Clinic and University Hospitals for twenty-five years. Additionally, naming rights for another line have been purchased by Cleveland State University

Healthline Contract

- RTA was the first transit system in the nation to sell naming rights sponsorships to its assets. The Healthline is sponsored by the Cleveland Clinic and University Hospitals, and connects the Medical Center to downtown. $50mm of the $200mm project was devoted to BRT, with the rest for road improvement.

CSU Contract

- Contract for $150K per year
- CSU sponsorship on 16 custom-designed buses; seat backs on all vehicles, and the 32 new bus stations and 243 stops and shelters along the route and in related materials.
- Line runs from downtown Campus to West Shore area.

Individual Impacts:

- 13,000 jobs created along the Healthline
- Increased mobility for residents and patients along the Healthline
- Increased access to work and healthcare

Business Impacts:

- Over $62 million in tax revenue from the Healthline
- Development of over 4000 new residential units

Regional Impacts:

- Over $8 million in economic activity brought forth from the BRT line
- Value Capture:
    - $180 million invested by Cleveland State University (CSU)
    - $500 million invested by University Hospital
    - $350 million invested by Cleveland Museum of Art
    - $506 million invested by Cleveland Clinic Heart Center
    - $27.2 million invested by Museum of Contemporary Art
- Economic development revenue generated- $114.54, Along the Euclid Corridor- $6 billion
- Property values- increased by 30 to 100%
- Ridership- served more than 5 million customers in 2014 (4.7% increase over 2013)
- More than 29 million riders from 2008-14.
- Annual ridership has increased about 60 percent over the previous years

[13] Rideerta.com/healthline

[14] www.policylink.org/sites/default/files/FINAL%20PolicyLink%20Business%20Impact%20Mitigation%20Strategies_0.pdf