Jacksonville
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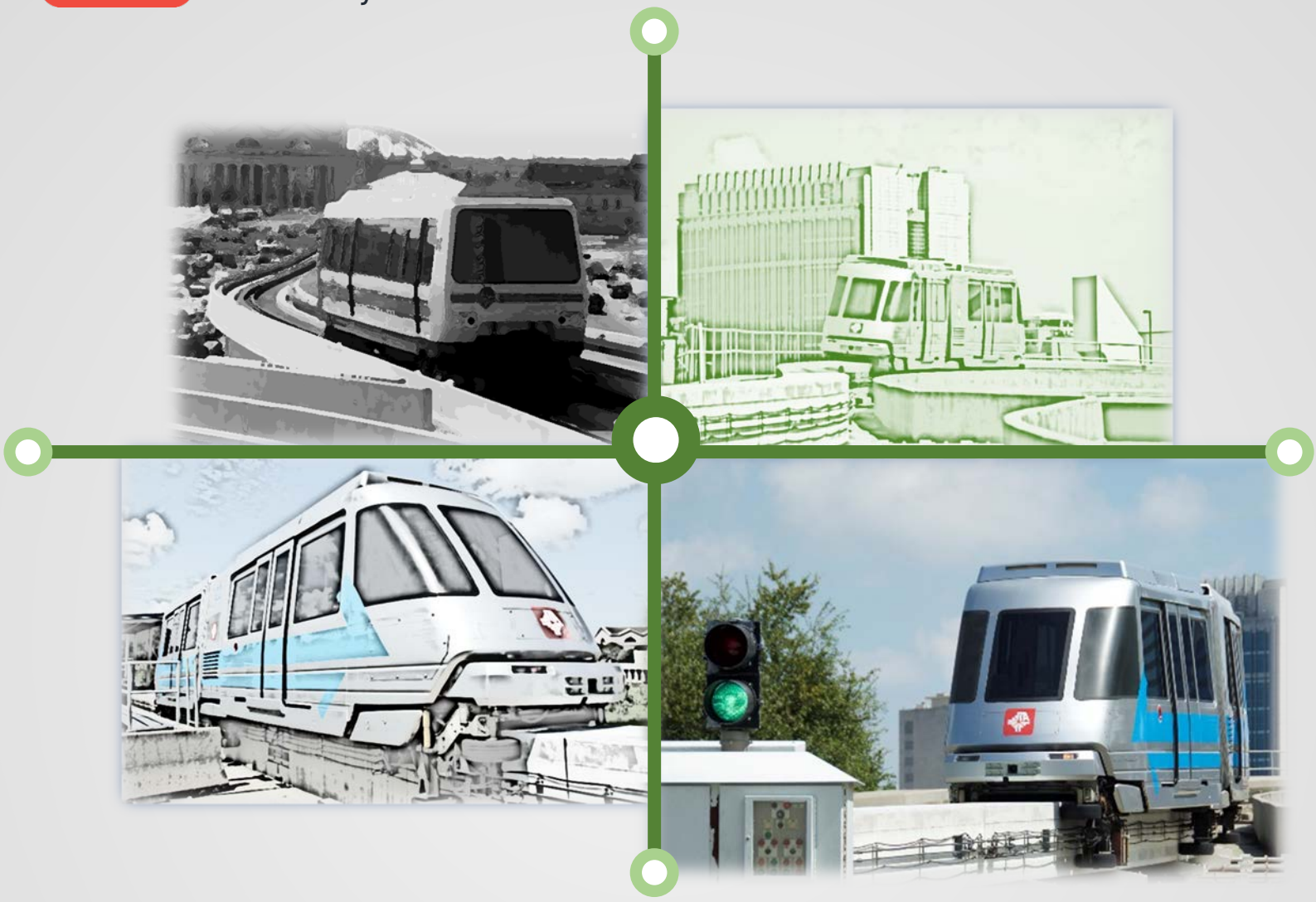

JTA Skyway Modernization Program

Technical Memorandum II: Operations Plan

Final Report, April 2017

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Executive Summary

Project Context

This operations planning technical memorandum is provided as one of a series of technical memoranda developed in an effort to examine the potential for improvement and expansion of the Skyway – the Skyway Modernization Program – by the Jacksonville Transportation Authority. The purpose of this far-reaching effort is maximize existing operations and address future system expansion opportunities to support the existing, emerging, and future mobility needs of downtown Jacksonville and adjacent neighborhoods.

Technical Memorandum 1, examined and demonstrates that population and economic growth is strong in and around downtown through the current 2040 planning horizon. Linking downtown and adjacent growth communities improves economic development prospects for Jacksonville. Mobility improvements are essential to foster and to support this growth.

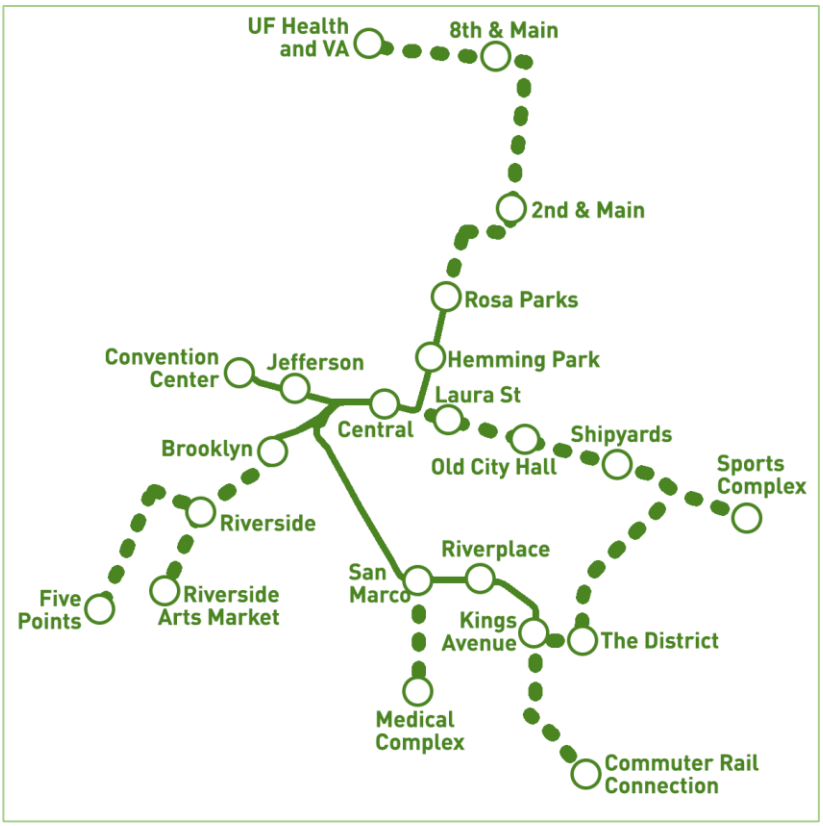
Mobility improvements are required to drive economic growth and support continued population growth. These mobility improvements span a wide range of modes – auto, rail, freight, transit, pedestrian, bicycle – and they are currently programed by a wide range of agencies – FDOT, FTA, and the City. These mobility improvements need to be coordinated and leveraged, especially in and around downtown. The Skyway Modernization Program serves as a strategic platform for this transportation systems coordination – considering the future of the Skyway with land use, economic development, housing, mobility needs and modal integration. The Skyway Modernization Program serves as a means for the careful facilitation of a transition from the existing Skyway system to appropriate emerging mobility technologies to assure Jacksonville is not saddled with disconnected and obsolete transportation infrastructure and systems. This transition is critical for supporting growth, economic development, and improved quality of life in Jacksonville. The Skyway Modernization program is designed to define and transition mobility in downtown Jacksonville over the coming 20 and more years.

Summary of Key Findings

This Technical Memorandum steps through the high level operational considerations of transitioning the Skyway from existing services to future mobility over the periods: immediate enhancements, 2020 improvements, 2030 system, and 2040 plus system. The immediate enhancements and 2020 improvements are designed to take advantage of the existing infrastructure while investing in changes in technology, service delivery, and infrastructure. The improvements in 2030 and 2040 are not focused on any particular new technology or infrastructure, but are intended to define the existing, growing, emerging activity centers downtown and nearby, that should be incorporated into an expanded mobility system.

The activity centers identified to be connected to the existing Skyway stations by 2040 are illustrated below (Figure ES-1).

Figure ES 1: 2040 System Expansion



The activity centers and stations represented include the existing Skyway stations: Rosa Parks, Hemming Plaza, Central, Jefferson, Convention, San Marco, Riverplace, and Kings Avenue.

The expansion includes: Five Points, Riverside, Brooklyn, Laura Street, Old City Hall, Shipyards, Sports Complex, MD Anderson, and Commuter Rail Connection (East San Marco). The expansion plans for 2040 also includes extending service north from Rosa Parks to service to Springfield along Main Street to 8th Street and to UF Health. Further, it is envisioned that a second St. Johns River crossing will be built to connect the eastern South Bank (San Marco, Riverplace, The District, Kings Avenue) with service along Bay Street.

Primary operating considerations for the expansion and modernization of the Skyway include: vehicle type, runningway, service levels, operating costs, and the transition from existing operations to future operations. The existing vehicle type is obsolete and potential future options include: reconditioned vehicles, new vehicles designed to operate on existing guideway, and vehicles that can operate on a modified structure and at-grade. All operations planning to date has focused on mode neutral market demand and requirements to extend the life of the existing system into transition to an alternate mode. Vehicle considerations include capacity, speed, and runningway characteristics. It is assumed that vehicles will be automated. The existing guideway has a useful life of approximately 25 years. The runningway requirements for future operations include consideration of vehicle type, size, capacity, speed, and elevated or at-grade operations. Ideally, the modernization of the Skyway will include elevated and at-grade operations in mostly dedicated runningway. Dedicated runningways afford significant advantage to transit systems, including future systems designed to provide more personalized mobility options within downtown and adjacent neighborhoods.

It is inevitable that future operations will include limited mixed traffic operations with transit preferential treatments. The advantage of including some mixed traffic operations is primarily related to capital costs. Given the advances of new autonomous vehicle (AV) and related mobility on demand technology, the integration of transit and private mobility hold significant promise to retain a high degree of advantage for transit and thus for adjacent land uses.

The operating scenarios that encompass existing service out to year 2020 focus on leveraging the existing system and increasing service levels which benefit mobility, population, businesses, economic development and access to opportunities. Service expansion between today and 2030 is envisioned to consist of increasing service frequencies, extending operating hours weekday, weekend service, and the addition of stations at Five Points, Riverside, Brooklyn, Laura Street, Old City Hall, Shipyards, and the Sports Complex.

Between today and 2020 service hours are expected to increase from about 16,000 annually to 43,000 annually. This will increase annual operating costs from about $6.2 million to about $17 million in 2020 assuming the existing technology and cost basis. However, there are opportunities to reduce this cost impact through improvements to the interim vehicle fleet. In addition, the cost per hour of operation is very high for Skyway because of the high overhead required – systems, infrastructure, maintenance, management – whether JTA operates 1 vehicle of 100. As the number of vehicles and vehicle service hours increase the overhead cost per service hour will be reduced and system efficiency will increase. While we cannot accurately predict the reduction of average cost per vehicle service at this time, with further research and decisions concerning short term vehicle fleet operating strategies, we can expect the reduction to be significant.

The 2030 to 2040 system expansion plans include the expansion of service north to UF Health, an extension from the San Marco station to MD Anderson, connections to The District, extension from Kings Avenue to the Commuter Rail Connection (East San Marco), extension north into Springfield to UF Health, and a new St. Johns River crossing (transit/pedestrian) to Bay Street. The service expansion and resulting operating hours and operating costs associated with the service expansion scenarios for 2030 and 2040 are less well defined at this point because the replacement technology and runningway characteristics have yet to be defined. However, the future per service hour operating costs are certain to be less than existing costs primarily due to the efficiencies of new distributed AV technologies. Defining the transition from the existing Skyway system to future modes is a critical element of the Skyway Modernization Program. The phasing from existing to future systems and services will need to be defined to be constructive towards the ultimate Skyway Modernization Plan.

Introduction

Purpose

This operations planning technical memorandum is provided as one of a series of technical memoranda developed in an effort to examine the potential for improvement and expansion of the Skyway – the Skyway Modernization Program – by the Jacksonville Transportation Authority. The purpose of this far-reaching effort is maximize existing operations and address future system expansion opportunities to support the existing, emerging, and future mobility needs of downtown Jacksonville and adjacent neighborhoods. The study area includes the evaluation of the East-West corridor from Riverside to the Stadium/Shipyards and San Marco to the Southbank. The assessment will include identifying travel demand within the study area, developing realistic options for future expansion, and support the Downtown Investment Authority (DIA) plans and future development. Also included in this report are several service plan scenarios that will be used to develop preferred expansions, potentially phased, and prioritized for the Skyway circulator.

The overall planning effort considers expected growth in population, employment, and associated development in downtown Jacksonville and adjacent neighborhoods – Brooklyn, Riverside, Five Points, San Marco, and Springfield - through the year 2040. The mobility and capacity improvements required to support this growth are defined through a series of planning scenarios – from existing operations to the needs of the community in 2040.

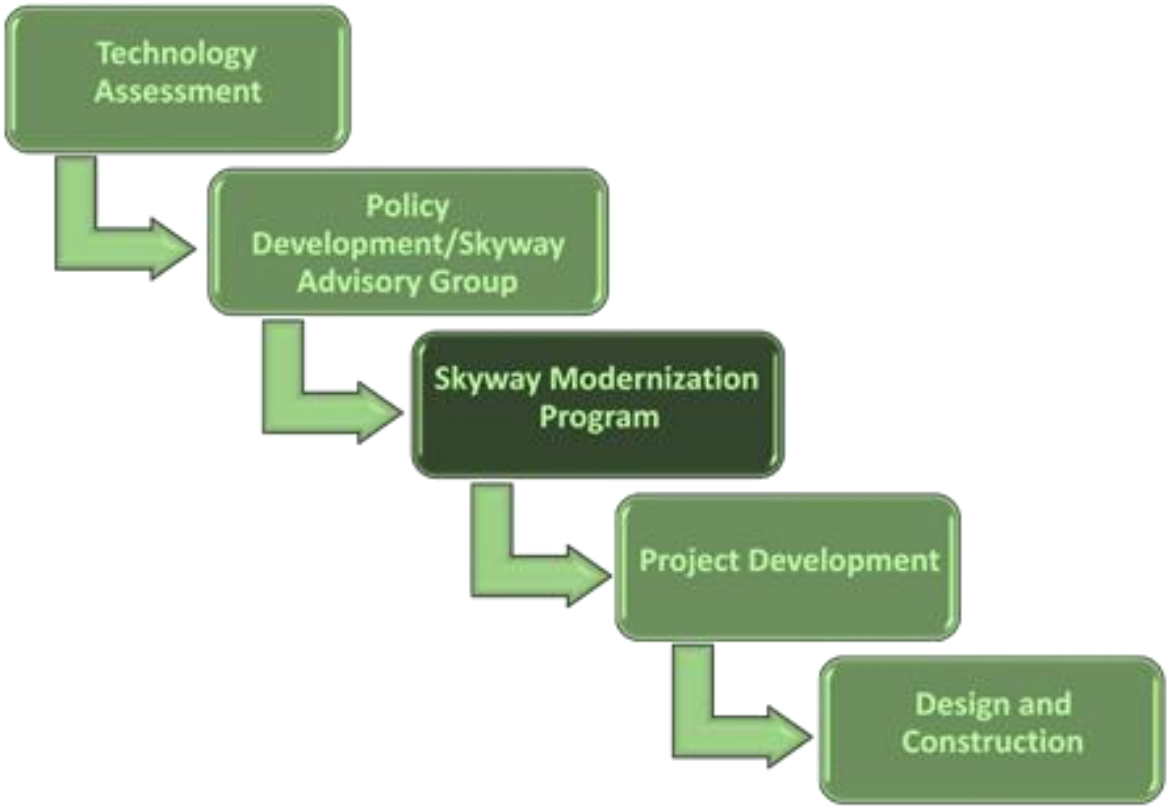
The operational considerations addressed in this technical memorandum include an assessment of the existing Skyway operations, rolling stock, and infrastructure as well as opportunities for programming a phased service expansion and transition from obsolete technology to adopt and deploy a range of new transportation technologies. Central to the overall assessment of the role of the Skyway today and in the future is a balancing of maximizing existing investments and leveraging resources to develop a transportation system to serve the mobility needs of the future.

Operating scenarios include five (5) time periods which correspond to the vision of enhancing and expanding mobility of the existing and future Skyway system. These scenario periods include:

- Existing – a description of existing Skyway services and operations.
- Immediate – enhanced service levels based on the existing Skyway infrastructure.
- Year 2020 – enhanced operations and initial expansion of services to Brooklyn.
- Year 2030 – expansion of services to Five Points and Sports Complex.
- Year 2040 – expansion of services to MD Anderson, Commuter Rail Connection (East San Marco), UF Health, eastern St. Johns River crossing.

The Skyway Modernization Program is the current component of a five phase program designed to assess existing and future technology, develop recommendations for future transportation investments, and then program and fund these investments through a series of future projects. The overall program is identified in Figure 1.

Figure 1: Skyway Modernization Program Phases



Contents

This technical memorandum is comprised of the following sections.

- Operating Framework
- Existing Operations Assessment
- Opportunities to Maximize Existing System
- System Expansion Operating Considerations

Operating Framework

Transit operations are defined based on service policies, operating considerations, and the characteristics of the market being served.

Service policies establish the amount or degree of service delivery. Service policies are set by the authority and reflect: service span, days of operation, headways (frequency of service). These elements define vehicle service hours and effectively the cost and quality of the service. Operating considerations primarily define the physical characteristics of the service. These include the alignment, length, service area coverage, dwell times, service access times, stops/station locations and characteristics, runningway characteristics, operating speeds, and vehicle characteristics – type, capacity, operating limitations.

Service market characteristics, primarily density of demand – largely define the type of service needed. The physical relationship between the transit service and adjacent land uses is critical to creating effective, convenient, and attractive connectivity and mobility for customers thus serving and supporting economic activity and access to opportunities.

The operating framework analyzed for the Skyway Modernization Program focuses primarily on service policies and operating considerations which are used to define a series of future operating scenarios to maximize existing operations and address future system expansion. The operating scenarios reflect existing and future market conditions as defined in Technical Memorandum 1: Systems Plan.

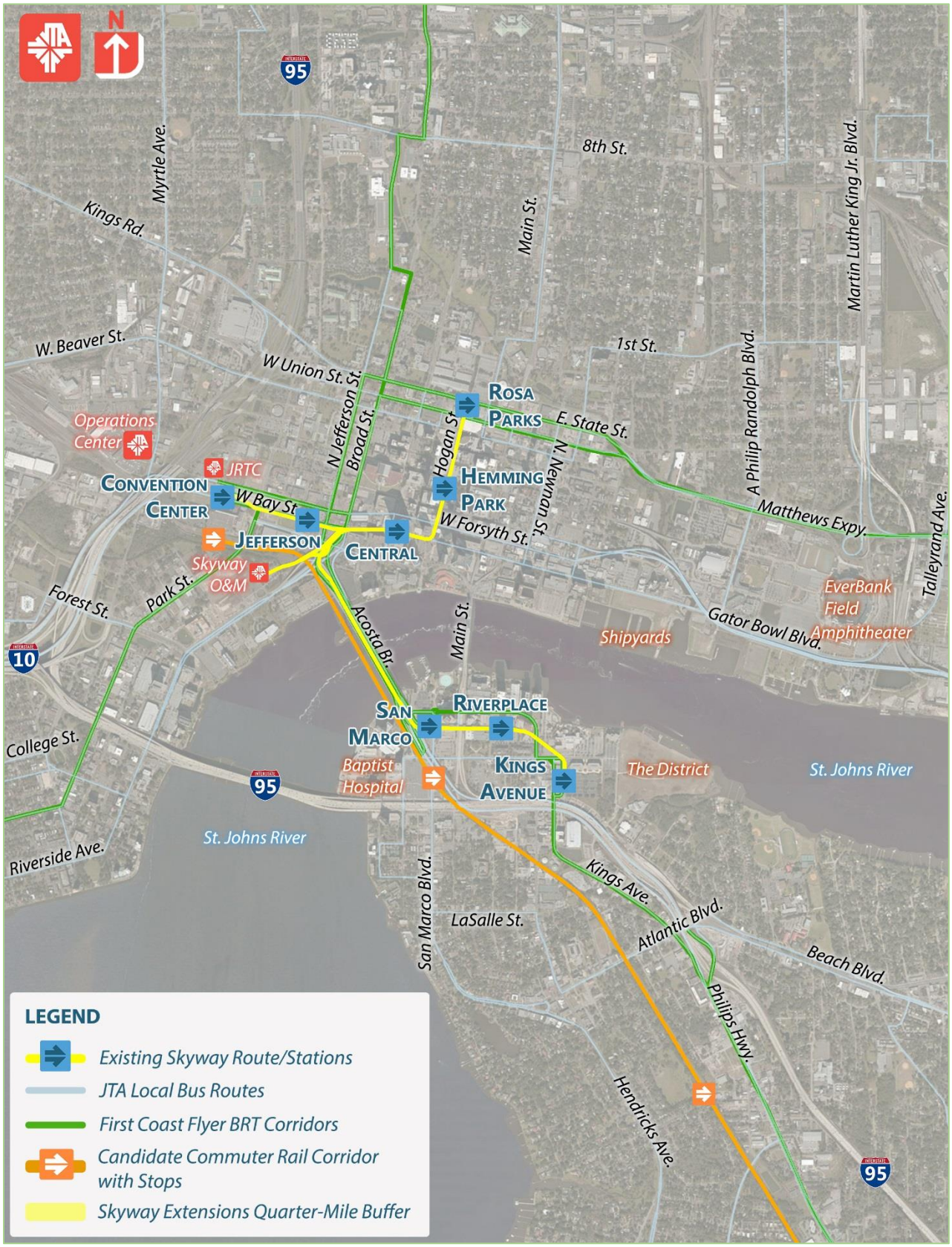
Existing Operations Assessment

Existing System

The existing Skyway system (Figure 2) is a true monorail operating on an elevated guideway platform with beam. The existing Skyway generally operates along two routes utilizing five vehicles. The existing Skyway infrastructure was constructed with the potential to remove the beam. Existing Skyway vehicles are no longer in production and parts are difficult to obtain. The JTA operates and maintains the service through a significant dedication to resourceful vehicle maintenance.

The Technology Assessment effort of the Skyway Modernization Program is focused on examining alternatives for maintaining, repairing, replacing vehicles as well as developing recommendations for relevant and cost-effective alternative vehicle technologies for consideration through a phased expansion and modernization of the Skyway system.

Figure 2: Existing Skyway System



The existing Skyway operations are affected by existing vehicle capacity, vehicle operating condition, and the characteristics of the Skyway guideway, stations, and switching configurations. These impact operating speeds, ability for vehicles to pass, the number of vehicles that can be operated, service hours, and operating costs.

TA generally operates two routes. The A-Route runs between the Convention Center station and the Rosa Parks Station. This route also serves the following stations: Jefferson, Central, Hemming Plaza. The A-Route requires two (2) vehicles and operates on a cycle time (round trip time) of 15:50. The D-Route runs between the Kings Avenue station on the Southbank, to Rosa Parks station. The D-Route also serves the following stations: Riverplace, San Marco, Central, Hemming Plaza. The D-Route requires three (3) vehicles and operates on a cycle time of 21:43. The JTA can operate other route or patterns besides the A and D routes. During special events and when operating demand warrants, the JTA will modify operations. However, the primary operating patterns are the A and D routes.

Service Hours

The existing Skyway system operates weekdays only from 6:00 AM to 9:00 PM. The Skyway frequency of service or headways, based on the cycle times of the A-Route and the D-Route, are 7-8 minutes. Given five (5) vehicles operating weekdays between 6:00 AM and 9:00 PM, a daily service span of 15 hours, existing Skyway operations results in 75 vehicle service hours each weekday.

Cost to Operate

Traditionally transit operating costs are 70-75% based on operating labor, primarily the cost of the driver. The Skyway is an automated system which presumably would reduce the operating costs because a driver is not required for each vehicle. However, the Skyway is burdened by a combination of obsolete vehicles that require extensive maintenance and an operating system that is too small for the base control system required to operate the vehicles.

While the efforts required to maintain and dwindling fleet of obsolete vehicles is easy to comprehend, the ratio of base operations to system operated may need some explanation. For the Skyway, and automated monorail, to function, it requires a complex operating system that is staffed with professionals and must be monitored, managed, and maintained continually. This requirement is true whether the Skyway operates over a 2.9 mile system or a 20 mile system. Because the Skyway operates over a short system (2.9 miles) rather than a larger, more extensive system, the overhead costs associated with the control room, operations management, and maintenance, is much higher than otherwise would be the case.

The existing cost per vehicle service hours to operate the Skyway is $394.32 based on existing operations. This is high primarily due to the inherent overhead discussed above and the extensive maintenance efforts required to keep obsolete vehicles running. Because the overhead cost is not linear, this costs per hour will be reduced as vehicle service hours are increased. In addition, replacement vehicle fleet improvements will reduce operating and maintenance costs compared to existing.

The cost to operate Skyway, based on existing operations, five vehicles operating 15 hours each weekday, equates to approximately $6.2million.

Opportunities to Maximize Existing System

Service Expansion

Initially, consideration of the expansion of the Skyway must by definition be framed by what is possible and pragmatic within the existing system. This inherently limits considerations to the following short-term options:

- Expand service span – hours of operation
- Expand operating days – add weekend service
- Increase operating headways – increased frequency of service
- Augment vehicle fleet – repair and or replace with like vehicles

The opportunities to augment the existing vehicle fleet is addressed in the Technology Assessment. In simple terms, the options to augment the fleet include:

- Find or manufacture parts and rebuild existing non-working vehicles
- Find and procure same vehicles from other sources – likely will require rebuilding
- Procure new spec-built vehicles to fit the guideway
- Procure alternative vehicles modified to fit the guideway

The question of augmenting the existing fleet is important because, as described herein, the initial expansion of existing operations will require more than the six (6) serviceable vehicles currently available to JTA. As noted above, JTA currently requires five (5) vehicles to operate service. In addition, a spare vehicle is required, thus JTA has a fleet of 6 serviceable vehicles. If JTA were to expand the days and hours of operation, a fleet of six (6) vehicles would suffice, assuming breakdowns are minimized through careful vehicle rotation and maintenance. However, if JTA were to increase operating headways (the frequency of service), then additional vehicles are required.

Service Hours and Vehicle Requirements

Expanding service span from the existing 6:00 AM – 9:00PM to 6:00 AM – 11:00 PM Monday through Thursday and operating until 2:00 AM on Fridays, is proposed to improve accessibility of the Skyway and to serve existing and emerging development and market demand. In addition, expanding service to the weekends, 6:00 AM – 2:00 AM Saturdays and 8:00 AM – 11:00 PM on Sundays, is proposed. These improvements expand service span and operating days and could be accomplished within the existing system.

Increasing headways on the A-Route and the D-Route from every 7-8 minutes, to every 6 minutes would require an increase in the available serviceable vehicles. Service frequency, cycle time, and vehicle requirements all go hand-in-hand.

For the A-Route with a cycle time of 15:50, two (2) vehicles provide service roughly every 8 minutes. If we increase the headway to 6 minutes, the A-Route will require 2.6 vehicles. Since we cannot operate a fraction of a vehicle, this is rounded up to three (3) vehicles. This creates an effective headway of a vehicle every 5.5 minutes.

The D-Route with a cycle time of 21:43, two (2) vehicles provide service roughly every 7 minutes. If we increase the headway to 6 minutes, the D-Route will require 3.6 vehicles, effectively four (4) vehicles. This also creates an effective headway of a vehicle every 5.5 minutes. Combining the A-Route and D-Route, the sections between Central, Hemming, and Rosa Parks stations, where these routes overlap, the effective service frequency becomes a vehicle every 2.7 minutes.

The impact of the expanded service span, operating days and increased headways on service hours is significant. While the existing Skyway operations add up to 75 vehicle service hours per weekday, and no weekend service, the expanded operating scenario will require 103 hours for service Mondays – Thursdays, 129 hours Fridays, 100 hours on Saturdays, and 75 hours on Sundays and Holidays.

The vehicle requirements in this immediate term expansion of existing services jumps for a fleet of 6 vehicles (5 operated in maximum service) to a fleet of 9 vehicles (7 operated in maximum service).

Operating Costs

The expansion of Skyway service based on existing operations, as described above, with an expanded fleet and increased headways, service span, and days of operation, will result in annual vehicle service hours of 29,300 compared with 15,700 for existing operations. The annual cost of the expanded service scenario is $11.5 million, about 85% over today's cost.

System Expansion Operations

The system and service expansion scenarios for years 202, 2030, and 2040 are described in the following pages. The future scenarios and scenario periods include:

- Year 2020 – enhanced operations and initial expansion of services to Brooklyn.
- Year 2030 – expansion of services to Five Points and Sports Complex.
- Year 2040 – expansion of services to MD Anderson and East San Marco.

Service Policy Assumptions

Service policy assumptions presented herein, reflect the fundamental understanding that service demand is a direct function of service availability. The more ubiquitous the service availability, the greater the share of real demand that will be manifest as ridership. In a practical sense, this translates to *service span* – how many hours each day does the service operate; *headways* – how frequently does the service operate; and *operating days* – what days or week and holidays are served. These service policy considerations also drive service hours and operating costs.
The service policy assumptions are presented in the following tables for each scenario year. Tables compare existing operations, the immediate improvement scenario and future scenarios.

Table 1: Service Span

Service Policy and Operating Assumptions	Existing	Immediate	Near-Term by 2020	Mid-Term by 2030	Long-Term by 2040
Service Span Time Periods					
Monday - Thursday	6AM - 9PM	6AM - 11PM	6AM - 11PM	6AM - 11PM	6AM - 11PM
Friday	6AM - 9PM	6AM - 2AM	6AM - 2AM	6AM - 2AM	6AM - 2AM
Saturday	None	6AM - 2AM	6AM - 2AM	6AM - 2AM	6AM - 2AM
Sunday	None	8AM - 11PM	8AM - 11PM	8AM - 11PM	8AM - 11PM

The existing service spans are limited to 6AM to 9PM Monday through Friday. The proposed service span policy would extend service spans to be 6AM to 11PM Monday through Thursday, 6AM to 2AM Fridays and Saturdays, and 8AM to 11PM Sundays and Holidays. Service span is a critical element to improving the attractiveness of the transit service.

Table 2: Daily Hours of Operation and Operating Days

Service Policy and Operating Assumptions	Existing	Immediate	Near-Term by 2020	Mid-Term by 2030	Long-Term by 2040
Service Span					
Monday - Thursday	15	17	17	17	17
Friday	15	20	20	20	20
Saturday	0	20	20	20	20
Sunday	0	15	15	15	15
Operating Days					
Monday - Thursday	203	203	203	203	203
Friday	52	52	52	52	52
Saturday	0	52	52	52	52
Sunday/Holiday	0	58	58	58	58

As a result of the expanded service span policies, the hours of operation will increase by 2 hours Monday through Thursday, from 15 to 17 hours. On Fridays, hours of operations will increase by 5 hours, from 16 to 20 hours. The increased late night service on Fridays and the introduction of service on weekends and Holidays adds 20 hours to daily operating hours on Saturdays and 15 hours on Sundays and Holidays. This improvement in operating days and daily hours of operation improve demand for a service that economically supports the market it serves. Resulting from the proposed expansion of daily service hours and days of operation, the Skyway is proposed to increase from a primarily weekday operation, approximately 255 days a year, to an operation closer to 365 days per year. The primary increase is reflected in weekend and Holiday service.

Table 3 reflects the existing and proposed peak service times for each future service year scenario. The peak service periods are constant for each service scenario.

Table 3: Peak Service Times

Service Policy and Operating Assumptions	Existing	Immediate	Near-Term by 2020	Mid-Term by 2030	Long-Term by 2040
Weekday Peak Hours + Lunch					
AM Peak	6AM - 9AM	6AM - 9AM	6AM - 9AM	6AM - 9AM	6AM - 9AM
PM Peak	4PM - 7PM	4PM - 7PM	4PM - 7PM	4PM - 7PM	4PM - 7PM
Lunch	11AM - 2PM	11AM - 2PM	11AM - 2PM	11AM - 2PM	11AM - 2PM

Based on the proposed daily service spans and peak service periods, Table 4 reflects the corresponding service hours by each future service year scenario for peak service and off-peak periods and for Saturday and Sunday/Holiday operating periods.

Table 4: Peak and Off-peak Service Hours

Service Policy and Operating Assumptions	Existing	Immediate	Near-Term by 2020	Mid-Term by 2030	Long-Term by 2040
Weekday Peak Hours + Lunch					
AM Peak	6	6	6	6	6
PM Peak	6	6	6	6	6
Lunch	3	3	3	3	3
Base Hours (Off-peak)					
Monday - Thursday	6	8	8	8	8
Friday	6	11	11	11	11
Saturday	0	20	20	20	20
Sunday/Holiday	0	15	15	15	15

Table 5 presents the policy headways proposed for future service year operating scenarios. Headways represent the service frequencies between vehicles along each route operated. It is important to note that the effective headway is more frequent where routes overlap.

Table 5: Peak and Off-peak Headways

Service Policy and Operating Assumptions	Existing	Immediate	Near-Term by 2020	Mid-Term by 2030	Long-Term by 2040
Service Period Frequencies (Headways - peak, base, lunch)					
Peak	8	6	6	6	6
Base	8	8	8	8	8
Lunch	8	6	6	6	6
Weekend - all day	0	10	10	8	8

Operating Scenarios and Considerations

Operating considerations represent those service and operating factors that, in addition to service policies, impact the amount of service, operating requirements, such as number of peak and off-peak vehicles, and vehicle revenue service hours service hours. Vehicle revenue service hours is a critical metric as it determines operating costs.

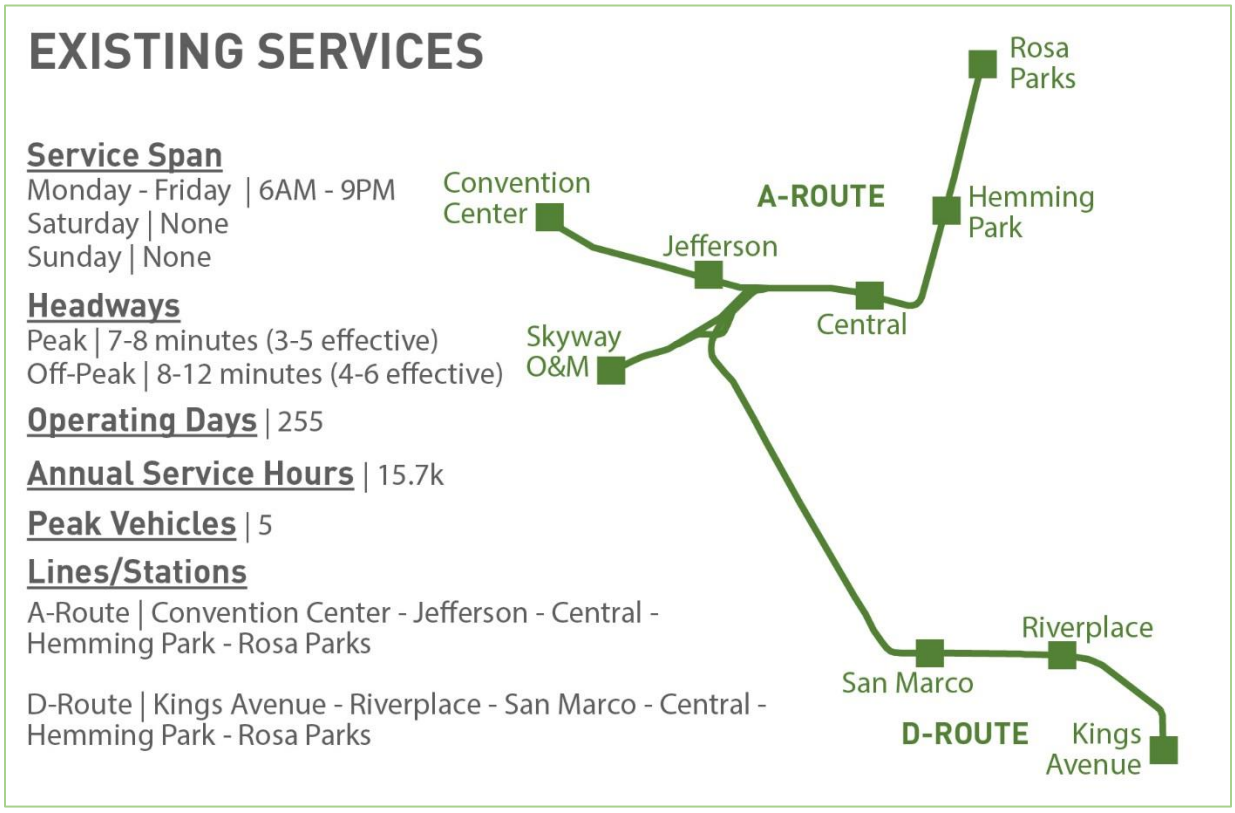
Table 6 presents the service improvements and operating expansion scenarios for future service year scenarios. The service improvements proposed include expansion of service spans, operating days, and service frequencies as immediate improvements. By 2020, service expansion will include the expansion associated with a new Brooklyn station. By 2030, service expansion will include service between Five Points and the Sports Complex and Kings Avenue to the Sports Complex. In 2040, the service plan may include extensions to MD Anderson from San Marco, connections to The District, a St. Johns River crossing, extension to Springfield and UF Health, and an expansion from Kings Avenue to Commuter Rail Connection (East San Marco).

Table 6: Service Improvements and Operating Expansion

Service Policy and Operating Assumptions	Existing	Immediate	Near-Term by 2020	Mid-Term by 2030	Long-Term by 2040
Service Improvements	None	Span & Headways	No change	No change	No change
Expansions	None	None	Brooklyn	Five Points to Stadium	Medical Complex; The District; Springfield/UF Health; Commuter Rail Connection; St. Johns River Crossing
Operating Days	None	Weekends	Weekends	No change	No change

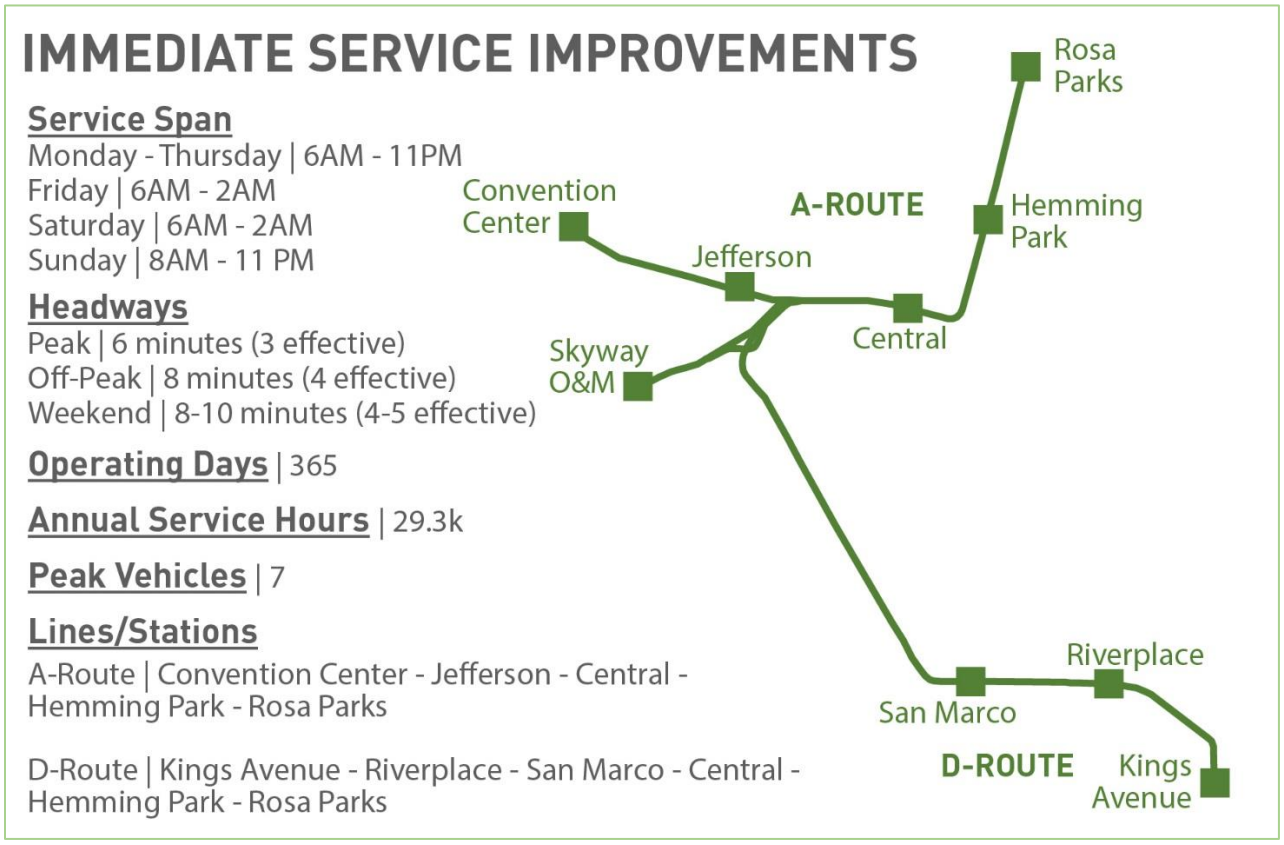
The expansion scenarios described in Table 6 for years 2020, 2030 and 2040 are illustrated in the Figures below. Each schematic summarizes the system as well as key operating information – service span, headways, operating days, service hours, peak vehicles, and routes operated.

Figure 3: Existing Skyway Schematic



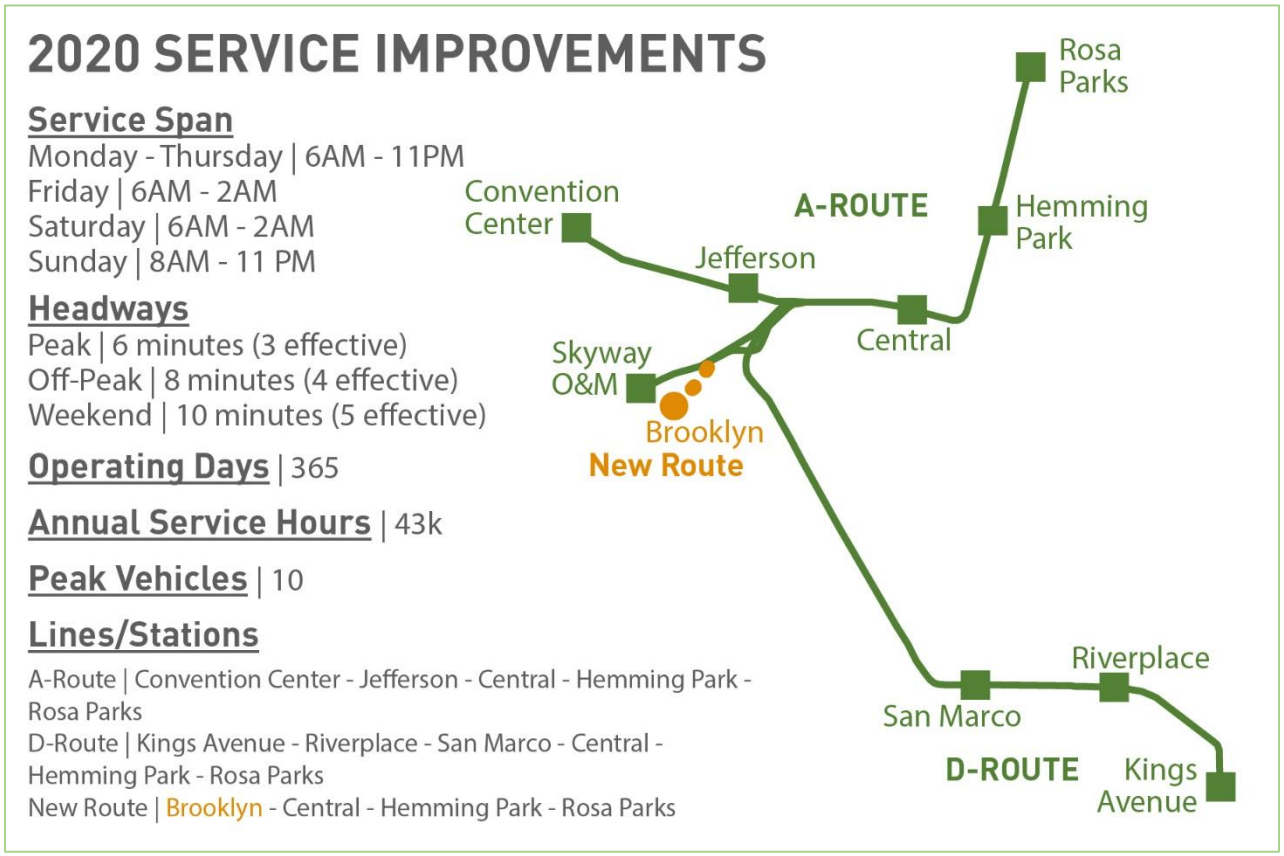
The existing operating schematic reflects the A-Route, Convention Center to Rosa Parks and the D-Route, Kings Avenue to Rosa Parks.

Figure 4: Immediate Service Expansion Scenario Schematic



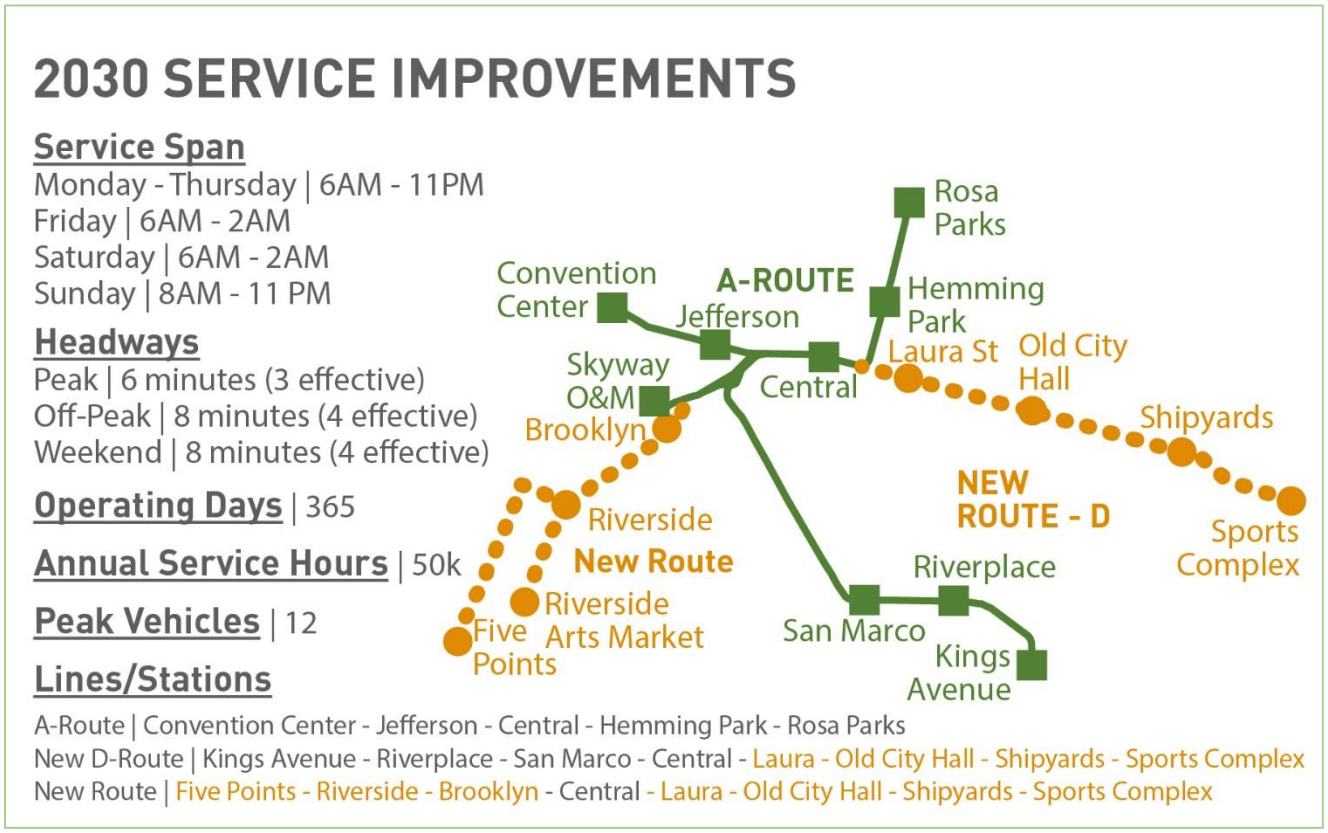
The immediate service improvements schematic reflects the existing A-Route and D-Route but with expanded service span, and operating days and increased headways – service frequency.

Figure 5: 2020 Skyway Service Expansion Schematic



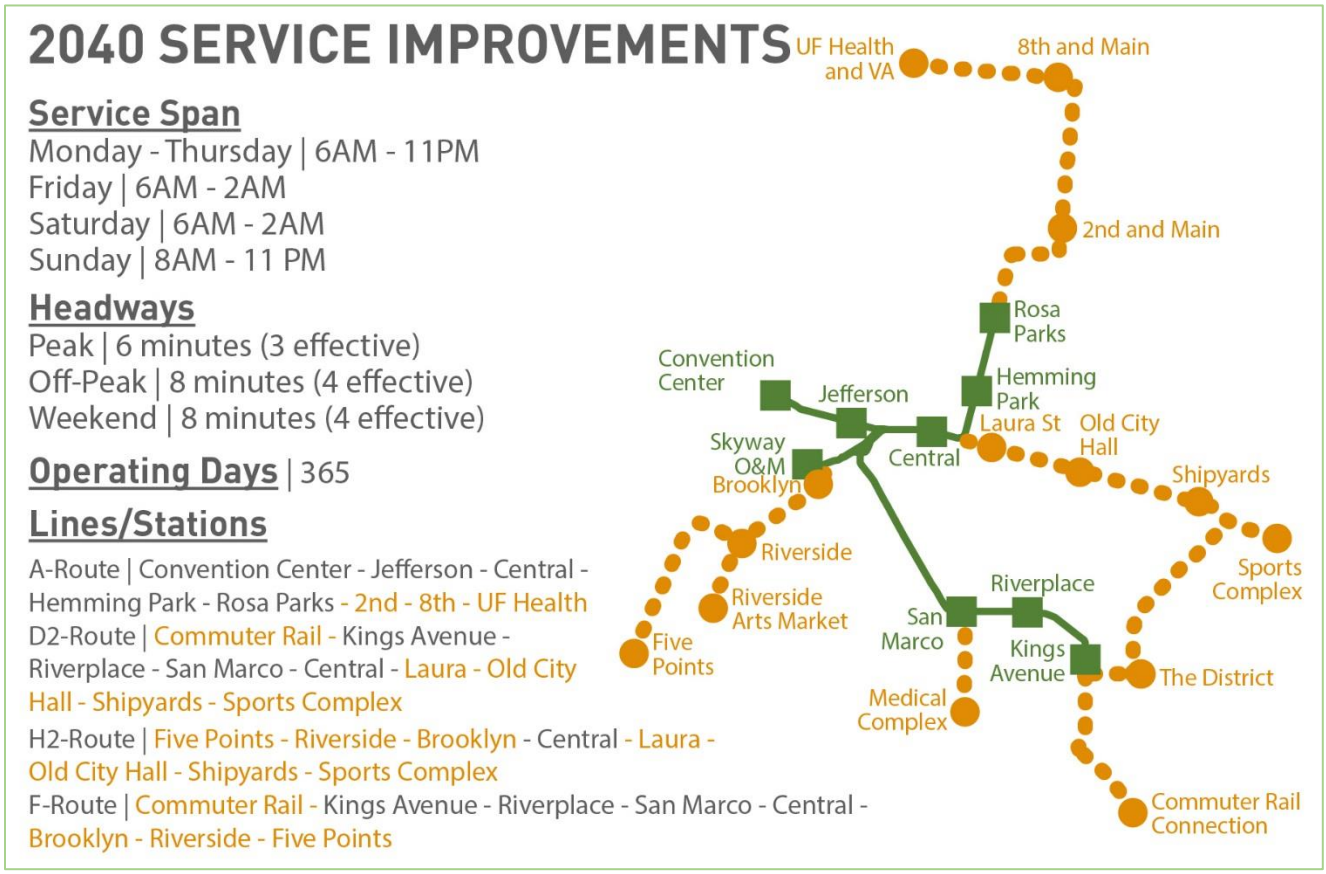
The 2020 Service schematic reflects the A-Route and D-Route and adds a new route linking a station at Brooklyn to Central, Hemming Plaza, and Rosa Parks stations.

Figure 6: 2030 Skyway Service Expansion Schematic



The 2030 Service Expansion schematic includes the A-Route plus expanded service connecting Kings Avenue to Central and new service with stations at Laura Street, Old City Hall, Shipyards, and the Sports Complex. In addition, new service at stations in Five Points, Riverside, connecting to Brooklyn and Central stations and stations between Laura Street and Sports Complex.

Figure 7: 2040 Skyway Service Expansion Schematic



The 2040 Service Expansion schematic builds on the 2030 scenario and adds extensions from San Marco to MD Anderson, a connection to The District, extensions to UF Health, and an extension from Kings Avenue to Commuter Rail Connection (East San Marco). The 2040 expansion plan also includes a transit/pedestrian St. Johns River crossing.

The 2040 expansion scenario does not reflect annual vehicle service hours or vehicle requirements. These will be calculated at the point when further definitional work is completed, primarily with regard to the guideway and vehicle characteristics. These considerations are required to assess how these extensions will be operated and what series of operating patterns – sequential linkages of stations served – are operationally feasible.

Based on the operating scenarios described, the following resulting operational factors and requirements are presented. Dwell Times and station access times are factored into operations and ridership estimation. Dwell times reflect the time during which the vehicle pauses (dwells) at each station to discharge and board passengers. In this case, the dwell times per station are set to 30 seconds up to year 2020. Assuming additional technological improvements are made for expansion in years beyond 2020, the dwell times are set at 20 seconds in years 2030 and 2040.

Passenger station access time is used in estimating ridership as a time cost associated with station ingress and egress. Station access times reflect a time "penalty" when calculating ones likelihood to use the transit service versus other modal options. The average station access time for the Skyway is 1.12 minutes (1:07 minutes). Stations with more vertical access, such as San Marco, have longer access times. A station access time of 1.12 is assumed for all scenarios. When vehicle and modal technologies are further defined, the station access times will be adjusted accordingly.

Table 7 reflects the effective operating speeds for each route and each service scenario. The existing and immediate scenario operating speeds are based on JTA schedules for the A-Route and the D-Route. The operating speeds for 2020, 2030, and 2040, are based on speeds derived from existing Skyway operations including dwell times and layover time assumptions for each scenario year. The effective operating speed is calculated based on round trip distance divided by cycle time and are represented in miles per hour. The existing travel speeds are slow and improvements in vehicle (modal) technology and runningway characteristics an applied technology should be designed to increase operating speeds as the system expands. Increases to operating speeds will increase service demand (ridership) as well as may reduce operating requirements (vehicles). Future operating speeds are expected to be faster than present based on developing Automated Vehicle technology and runningway design characteristics.

Table 7: Operating Speeds

Service Scenario Year and Route – Average Speeds	Existing	Immediate	Near-Term by 2020	Mid-Term by 2030	Long-Term by 2040
Route-A Rosa Parks to Convention Center	8.7	8.7	8.7	8.7	8.7
Route-D Rosa Parks to Kings Avenue	11.6	11.6	11.6		
Brooklyn to Rosa Parks			9.3		
Five Points to Kings Avenue				11.9	11.9
Stadium to Kings Avenue				13.0	13.0

The runningway characteristics – the transit guideway – directly impacts operating speeds, vehicle requirements, service hours and operating costs. A grade-separated or dedicated runningway provides unrestricted operations as opposed to a mixed-traffic runningway where vehicle operations are subject to adverse influences by other modes. In this assessment the assumption has been that the existing operational characteristics prevail through 2020 and may change in 2030 and 2040 based on alternative vehicle (modal) and technology considerations. Future runningway characteristics may include dedicated at-grade and/or elevated operations. Transit operations in mixed-traffic are not desirable with current technology. As Automated Vehicle technology develops, it is likely that limited operations in mixed traffic will be possible with robust transit priorities within a more managed future operating environment.

The primary disadvantage of mixed traffic operations with current technology is the significant adverse impacts to transit speed and reliability and impacts to ambient general traffic. Expansion for the Skyway – whether elevated or at-grade in dedicated lanes – should be prioritized to provide a distinct advantage to the rider, the operating agency, and the surrounding development. The investment in infrastructure and operations to support significant growth and development downtown and in adjacent neighborhoods justifies the preferential treatment of transit as a critical mechanism to facilitate mobility. Operating transit in mixed traffic will degrade the service, benefits to riders, and surrounding development, and the investment into mobility services and infrastructure. The benefits of dedicated runningways accrue primarily to the land uses adjacent to the guideway and the riders within the market served by the system. Cycle times are the sum of running time, dwell time, and layover time. The cycle times for existing and immediate improvements are based on existing services. The cycle times for 2020 include the addition of the Brooklyn station. Cycle times for 2030 and 2040 reflect the addition of service Five Points to the Sports Complex and the Sports Complex to Kings Avenue. Estimates are not included for 2040 improvements. These will be defined as the initial expansion plans are refined.

Table 8: Cycle Times

Service Scenario Year and Route – Cycle Times	Existing	Immediate	Near-Term by 2020	Mid-Term by 2030	Long-Term by 2040
Route-A Rosa Parks to Convention Center	0:15:50	0:15:50	0:15:50	0:15:50	0:15:50
Route-D Rosa Parks to Kings Avenue	0:21:43	0:21:43	0:21:43		
Brooklyn to Rosa Parks			0:14:41		
Five Points to Kings Avenue				0:28:10	0:28:10
Stadium to Kings Avenue				0:21:08	0:21:08

Vehicle Requirements and Service Hours

The vehicle requirements for each expansion scenario are presented in Table 9. These reflect vehicles operated in maximum service (VOMS) and vehicle fleet requirements which assumes a spare ratio of 20% over the number of vehicles required in maximum service. The number of vehicles required for policy service is calculated based on cycle time and headway. In future planning, the impact of demand to vehicle capacity will also be calculated.

Table 9: Vehicle Requirements

Vehicle Requirements	VOMS	Fleet
Existing	5	6
Immediate	7	9
Near-Term by 2020	9	11
Mid-Term by 2030	11	14
Long-Term by 2040	11	14

Vehicle service hours are the calculation of vehicle operations over the operating year. Vehicle service hours reflect the number of vehicles in operations times the peak and off-peak service hours and weekend service hours times associated operating days of service. Vehicle service hours is a critical measure as it is the basis for calculating annual operation and maintenance costs. Table 10 presents the annual vehicle service hours for each scenario year.

Table 10: Annual Service Hours

Annual Vehicle Service Hours	Service Hours
Existing	15,748
Immediate	29,272
Near-Term by 2020	42,928
Mid-Term by 2030	50,328
Long-Term by 2040	50,328

Annual service hours for 2030 and 2040 reflect the same operating and service expansion assumptions. The planed extensions of service for 2040 are not reflected in the 2040 service hours.

Operating Costs

Using the existing cost basis of $394.32 per vehicle service hour, the estimated annual cost for each expansion scenario is provided. This cost basis per service hour is very high due largely to the amount of overhead required just to operate a single Skyway vehicle. With improvements in the short term – existing to 2020 – to the vehicle replacement fleet, these costs will be reduced. In addition, just by virtue of operating more vehicle service hours, the cost per vehicle service hour will decline. In addition, by 2030 and 2040, infrastructural improvements and new vehicle technology and modes will have a significant impact on reducing these costs.

Table 11: Estimated Annual Service Hours and Operating Costs

Service Policy and Operating Assumptions	Existing	Immediate	Near-Term by 2020	Mid-Term by 2030	Long-Term by 2040
Annual Vehicle Service Hours					
Annual Vehicle Revenue Service Hours	15,748	29,272	42,928	50,328	50,328
Annual Operating and Maintenance Costs					
Annual O&M Costs (based on 2014 NTD)	$6,209,751	$11,542,500	$16,927,257	$19,845,215	$19,845,215

It should also be noted that extensions in 2040 have not been estimated due to operations considerations that still need to be made with regard to vehicle technology and guideway characteristics. Further, the costs associated with years 2030 and 2040 and beyond should be reduced by virtue of new technology and more efficient mobility on demand service delivery models.