Priority Area Two: Service Planning

The operating partners in the Triangle Region have developed a vision for Transit Service Planning where staff across the region have access to a suite of high quality, cost effective, and interoperable tools that facilitate the service planning process, and includes tools for scheduling, run cutting, optimizing run times, optimizing on time performance, implementing service changes, publishing schedules and General Transit Feed Specifications (GTFS), and rider engagement. The objective of this memo is to address service planning technology recommendations for standards and features for regional interoperability.

Initial Findings and Survey Results

Initial findings:

Agencies in the Triangle Region have transit service planning tools currently in place to serve operational, financial, and even rider-facing data needs. Operating partners rely on their respective tools to gain local system insights into:

- Ridership Patterns
- On-time Performance
- Run Times
- Fare Use Data
- Timed Transfers
- Rider Demographics
- Rider Engagement Data
- Public Outreach (live demonstrations)
- Proposed Service Changes in GTFS
- Route/Segment Speeds
- Block/Run cuts
- Service Changes
- Federal Transit Administration (FTA) Reporting
- Title VI Reporting
- Schedule Planning
- Operator Input

The tools save agencies time and assist in planning service. Service planning tools can serve in real-time capacity if there are on-board connections and sufficient hardware available to support communications. Service planning tools use the General Transit Feed Specification (GTFS) to communicate. GTFS ensures data is consistently structured. Planning tools also rely on Application Programming Interfaces (APIs) to provide a mechanism for transit systems to interact/access the data in real time. Used together it opens opportunities to improve transit agency reporting, and serve riders with more reliable information that is based on actual measured data.

When data is made available through common data standards, they enable transit systems, applications, and agencies to share/use transit information in a synchronized way. In short, interoperable systems and tools are necessary for single agency and regional service planning.

Agencies in the Triangle Region are of different sizes and serve a wide demographic across a large, three-county area. Some are highly proficient with service planning tools while others have a more limited view of service planning provided to them or private operator dashboards. Planning resources, skillsets, and agency budgets factor into the amount of in-house service planning expertise that is available.

Currently, operating partners have independent service planning solutions and contracts that are not necessarily aligned in scope, terms, and duration with others in the region. Operating partner agencies have differing contracting mechanisms that are specific to the agency. Survey Responses:

Figure 1 summarizes the survey results for current service planning tools used by agencies in the region and the tasks that each operating partner accomplishes with each tool. The tools rely on communication with on-board systems such as Computer Aided Dispatch (CAD) / Automated Vehicle Location (AVL) systems, Automatic Passenger Count (APC) systems together with available GTFS feeds.

Figure 1. Survey Responses: Service Planning Software Tools by Agency and Function

AGENCY	Transit Service Monitoring Tools (OTP, ridership)	Service Change Planning Tools	Run-cutting / blocking tools
CAMPO		Remix	
GoTriangle	CAD/AVL system-Swiftly, and TripSpark ViewPoint from TransTrack for analysis and dashboards APC ridership counts-UTA	Swiftly and Remix	TripSpark and Trapeze systems
Go Raleigh	CAD/AVL reports-Clever Devices APC ridership counts-UTA	Remix	Optibus used by RATP-Dev for run-cuts
Go Durham	APC ridership counts-UTA OTP- Swiftly	Remix OTP- Swiftly	Optibus used by RATP-Dev for run-cuts
Go Wake Access	*GoCary provides:* CAD/AVL System-.TripSpark Hopthru (Swiftly) *GoTriangle provides:* CAD/AVL system- Swiftly and TripSpark APC ridership counts – UTA	*GoCary provides:* TripSpark streets report Remix *GoTriangle provides:* Swiftly and Remix	*GoCary provides:* TripSpark streets report Remix *Go Triangle provides:* TripSpark and Trapeze systems
GoCary	CAD/AVL System– TripSpark Hopthru (Swiftly)	TripSpark Streets report Remix	TripSpark Schedule MV (service operator) performs run-cuts.
Morrisville	*GoCary provides:* CAD/AVL System– TripSpark Hopthru (Swiftly) Via for live data dashboard to track and manage trips in real time. Send updates through app (push/in-app notifications)	*GoCary provides:* TripSpark streets report Remix	*GoCary provides*: TripSpark schedule MV (service operator) performs run-cuts. Via to manage driver's shifts
Apex	*GoCary provides:* CAD/AVL System– TripSpark Hopthru (Swiftly) Apex: Spreadsheets	*GoCary provides*: TripSpark streets report Remix Apex: Spreadsheets	GoCary provides TripSpark streets report Remix Apex: Spreadsheets

AGENCY	Transit Service Monitoring Tools (OTP, ridership)	Service Change Planning Tools	Run-cutting / blocking tools
Orange County	EcoLane	Remix - GIS Run-cutting:	EcoLane
Chapel Hill Transit	CAD/AVL System-GMV (used for OTP). APC ridership counts-UTA	Optibus	Optibus
UNC-Chapel Hill	CAD/AVL System. – GMV (Fixed route buses)	Vendor GMV and Spare (pilot for on-demand service)	Vendor GMV and Spare pilot for on-demand service with point to point app with a built in trip planner.
Go Wake Forest	Proprietary platform operated by Via Transportation.	Proprietary platform operated by Via Transportation.	Proprietary platform operated by Via Transportation.
NC State Wolfline	CAD/AVL System- Passio (data reports, fleet status, GTFS-RT) APC ridership data-Hopthru (now under Swiftly) NTD ridership data-UTA	Passio	Contractor, Transdev, uses Hastus for runcuts.

As summarized in the table, operating partners use at least two different software tools to analyze, monitor and predict service. For example, automatic passenger counts have a hardware component and system provided by one vendor but, on time performance is captured by another tool that uses data from a hardware component on the vehicles. While various modules are commercially available to supplement service planning tools, agencies (or their private operators) use only select modules to perform service planning. Selection of tools are made independently by each agency.

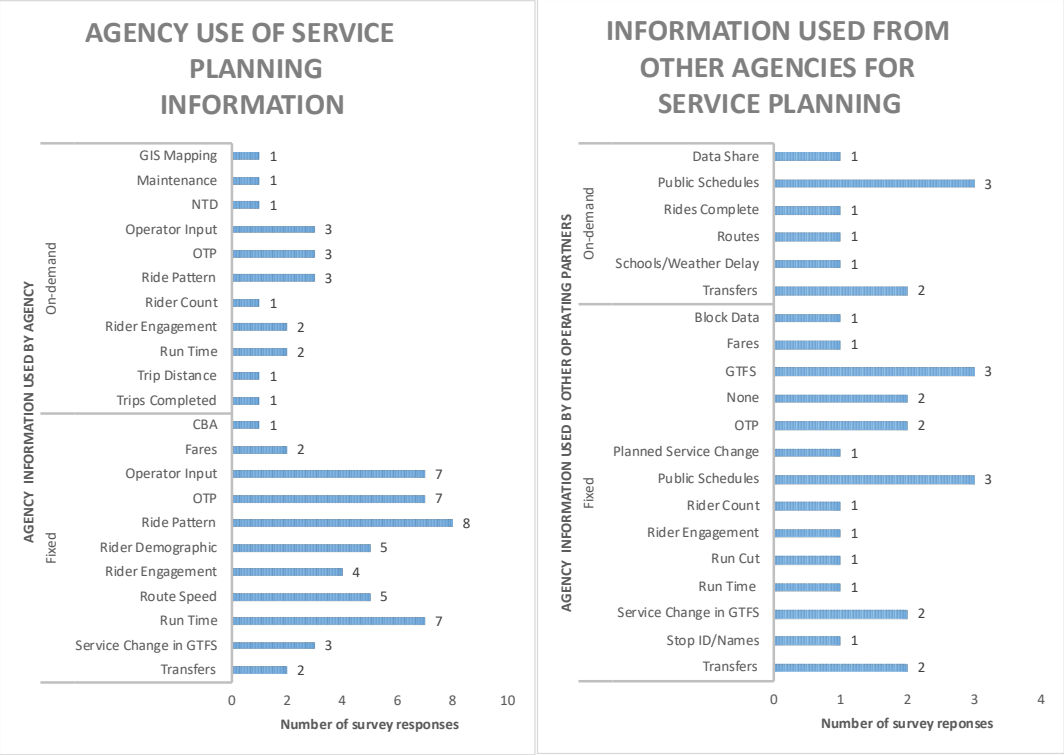
Agencies use a mix of common service planning tool vendors. At the time of this memo there is no clear industry leader that provides an all-inclusive Commercial-off-the-Shelf (COTS) solution for service planning.

The Town of Apex is an operating partner with a single fixed route and on-demand services operated by GoWake. The town noted in the survey response that they "see benefit in a regional contract(s) for service planning tools that would allow different agencies/services to make use of tools as needed (thinking for long-term flexibility, interoperability, cost-savings, data sharing, and/or knowledge sharing)…[and] strongly support the idea of regional coordination." Regardless of who operates the service. Survey respondents see "integration of data," "access to data" or "reliability of data" as the top service planning tool areas for improvement.

Figure 2 illustrates service planning tools that are used by operating partners to analyze on-time-performance (OTP), rider engagement, and demographic information. Agencies who use *other* operating partner information for service planning inquire about *other* operating partner's public schedules, GTFS feeds, and transfers.

The responses are classified by service type (fixed and on-demand) to reveal different informational needs. Fixed routes include university shuttle services, Chapel Hill Transit, Orange County Public Transportation, GoDurham, GoRaleigh, and GoTriangle. The on-demand service classification groups together GoWake Access, GoWake Forest, Go Cary, and the Morrisville Smart Shuttle service.

Figure 2. Survey Results: Types of service planning information used by agencies in the region by service type



Service planning tools used by agencies to plan local routes are scaled to the size of the agency, the number of assets (i.e., vehicles) and the modes provided. Further factors include whether the agency operates the service or whether the agency has a private operator.

Operating partners in the Triangle are motivated by providing the highest quality service possible within the confines of the budget provided. Private operators may have revenue-based considerations that may conflict with optimal scheduling for rider convenience on local routes or for regional connections.

Still, outsourcing service planning activities typically streamlines operations and may reduce costs for an agency because the private operators often have national contracts with service planning vendors. Agencies can then leverage innovations and service planning dashboards or software as part of the contracted services. Operating partners surveyed indicate having access to the service reporting (OTP, APCs) and others have dashboards to plan and monitor service. Depending on the future agency needs, there may be a time when control over the operational performance reporting and analytic sources that drive the Key Performance Indicator (KPI) metrics will be an in-house activity.

Survey data reveals that operating partners who use private operators for fixed route service spend more time troubleshooting run-cutting activities than operating partners who plan and operate their own service for fixed routes. The on-demand routes reported by Cary, Wake, and Morrisville expressed most time trouble shooting the service monitoring tools available to them.

The limits of the survey do not cover the specifics of the troubleshooting reported by agencies. Still, the operational toll on continued troubleshooting should be considered when assessing the value that a service planning tool delivers to an agency, locally. The impact to regional service planning is also a consideration. In a regional context, easily available service planning data and real-time activity for consumption is a necessary step toward interoperability.

Survey responses indicate the desire for regional visibility to service planning tools. As for the case of the Town of Morrisville, they have access to a data dashboard from the operator to track and manage trips in real time, manage driver's shifts, and send updates through the app. The survey responses indicate the desire for the agency to provide shuttle users with insights into the current routes as well as the surrounding operating partner routes that are not included in the Morrisville service area. Similarly, GoWake Access planners reported the desire to have a greater ability to coordinate with other Microtransit services throughout the region. The business case could be made here to incorporate GTFS Flex so that service planning tool data feeds (regardless of operator or agency) have access to the regional microtransit options in the region with data presented in a meaningful way to plan a regional journey on transit.

Partner Interviews:

GoDurham and GoTriangle planning staff presented their service planning technologies to explain the benefits of service planning tools on-site. Staff focused on internal efficiencies and rider-focused services. Swiftly software is used by both GoDurham and GoTriangle.

1. **Internal planning efficiencies:** OTP and Runtimes are a key metric that are monitored. Planners demonstrated the ability to link a construction activity to a detoured transit route which resulted in a decrease in OTP. Historical data and real-time data can be exported into other service planning software such as Remix to analyze better route and scenario planning to improve service. Staff report reviewing potential service changes and visualizing options occurs in minutes, not hours.
2. **Rider facing information:** The real-time tracking feature of service planning tools benefits regional call centers. The call center can access the software and provide riders with factual answers to questions about bus arrivals or the specific location of a bus. In the case of a route disruption, the agency can enter details about route detours and the Swiftly service planning module provides updates to the app to alert riders.
3. **Performance KPIs:** Swiftly's OTP module creates quarterly OTP reports as required for the Wake, Durham, and Orange County transit plans. Staff reported the ability to review route performance at a granular level to corroborate late bus reports.
4. **Route visualization:** Given the correct data input like GTFS routes and fencing, the product is useful for shared stop locations in the region, so they are accurate and still visually clear. The shared stop feature is also important to analyze in the event of a missed connections for a GoTriangle bus that was late in connecting with another operating partner's route.

Swiftly helps review these instances to adjust service and improve transit performance for passengers using multiple transit providers.

5. **Customer service:** Diagnosing issues that riders report about transit service is simplified with real time views and historical data to confirm customer service issues.
6. **Planning new routes:** Service planning tools help agencies model how new routes might perform against current services that are performing in terms of OTP and other service metrics prior to implementing service. They also monitor service expansion to help meet the goals of the county transit plans.

As transit service expands to serve new areas, it is critical for service planners to understand how new routes are performing in terms of OTP and other service metrics to maintain a prominent level of rider satisfaction. Prior to the 2022 adoption of Swiftly, staff would create spreadsheets of data on transit routes that would require weeks of time spent on pivot tables and manual data cleansing to understand on-time performance. Staff from both Go Durham and Go Triangle point to service planning tools as a source of efficiency. Jay Heikes, Transit Service Planning Manager, GoTriangle, summarizes the improvement seen since beginning to use Swiftly:

> *"Not only can we get the data, but we can have it at our fingertips in a few clicks, and in a couple of moments, we can answer questions that it previously took 8 hours to answer."*

Surveys, discussions, and interviews confirm that service planning tools in the region are scaled to the size and complexity of the services an agency operates. The region has different profiles and different tools to plan fixed, in-demand, and paratransit services. In a regional context, however, service planning activities are a collection of the surrounding agencies and their services, regardless of size or complexity. Regional service planning benefits from standardized data achieved either by use of common tools or integrating disparate tools to become interoperable so multiple operating partners use the data that is shared.

Survey data and interviews indicate that stakeholders collectively understand the importance of a formalized, common transit data standard that promotes full system(s) interoperability.

Opportunities

A high-quality selection of service planning tools with modular solutions is available today. There is healthy vendor competition with Software-as-a-Service (SaaS) solutions that are cloud-based, scalable and increasingly interoperable. First-adopter lessons are abundant, and it is known that structured, interoperable data enhances transit reliability and riders have greater trust in reliable transit.

The timing is opportune to explore a coordinated regional service planning effort because:

- FTA, American Public Transportation Association (APTA), vendors, providers, and agencies are developing standards to increase opportunities of data sharing and the efficiencies that they will bring. Current technologies are categorized in three areas below to show the layers of interoperability required for an integrated transit system.
    - **System architecture design:** The Transit Operational Data Standard (TODS) Transit Integrated Data Exchange Specification (TIDES) are standards that are gaining traction for data management query and system architecture.

    - **System Data feeds:** General Transit Feed Specification (GTFS) Defines transit schedules, routes, and fares in a machine-readable way for integration with mapping, trip planning, and service planning. GTFS Real time (GTFS RT) is a data standard that provides real-time updates on vehicles, service alerts, and trip updates in a machine-readable format. Real-time information, trip planning, and operational efficiencies give riders reliable information about bus arrivals. In 2024, GTFS Flex was folded into the base GTFS standard. There are now specific fields to populate on-demand information. Agencies must also provide their GTFS feeds for fixed route service as reporting requirement to National Transit Database (NTD).
    - **System Infrastructure:** Information Technology for Public Transport (ITxPT) is an APTA supported effort to standardize IT systems by defining an open architecture specification for on-board technology.
- More commercial-off-the-shelf (COTS) service planning tools are available. COTS solutions are products that have been built, tested and optimized to meet typical service planning needs. Commercially available products or COTS tend to require less time for agencies to deploy and generally offer the most economical solution. Products are scalable and supported by regular updates. Standardized interfaces between existing software and hardware that promote interoperability are common terms in vendor agreements.
- The future Bus Rapid Transit (BRT) lines will benefit from regional service planning exercises since routes and connections rely on coordinated arrivals and departures. Regional express routes across multiple counties also rely on quality, structured data to enhance transit information that is accurate so riders can travel with confidence and trust in the system.
- Individual agencies use tools to analyze service change scenarios, on-time performance (OTP), and ridership metrics to drive decisions. Aggregate reporting, from individual agencies, gives a regional view of metrics and route scenarios for an overall regional service analysis. For example, transit service planning data aids in the design of more accurate and reliable schedules and routes. A regional service planning analysis backed by measurable data could inform operating partners, as a region, on where capital investments should be made in order to maximize capital budgets. The tools can analyze data and inform agencies about the:
    - number of buses needed for revenue service,
    - estimates of in-service costs and vehicles hours,
    - visualization of service routes in different scenarios for OTP and impact to travel times,
    - analysis of demographics and Title VI impacts when considering route changes,
    - data collection to help long range planning,
    - analysis of station passenger flow and of strategies to optimize, and
    - use of micromobility/on-demand service modes as part of service planning.
- Strategic state, regional, and local goals are in alignment for greater interoperability of transit services in North Carolina (e.g., NCDOT's Strategic Plans, NCDOT's Integrated Mobility Division, and Short Range Transit Plans in the region). Interoperability goals are mirrored nationally with FTA circulars, APTA working groups, and coalitions like Mobility Data Interoperability Principles (MDIP).

When information is made available through common data standards like GTFS and is connected by integrated interfaces (APIs), opportunities to measure data with confidence, improve transit agency reporting, and serve riders with reliable transit information. A data map is a common way to develop consensus around who needs what data, where and when. Written performance metrics and standards or agency business rules inform which data points will meet an agency or region's transit service planning, definition or calculation metric. Currently, Durham's Mobility Services Financial Analyst, Quentin Martinez maintains a data map master to record the interconnectedness of the system. This is a living document that will continue to be populated in order to develop a larger, comprehensive visualization showing data connections, sources and metrics. The opportunity to develop a master data map for the region to outline data requirements and needs will help visualize the need and gaps in standardized data required for interoperability of service planning tools in the region.

Service Planning Standards

The standards described in this memo balance industry best practices, reporting requirements, and technological feasibility to support the region's mission of "connecting people and the region with high quality transit."

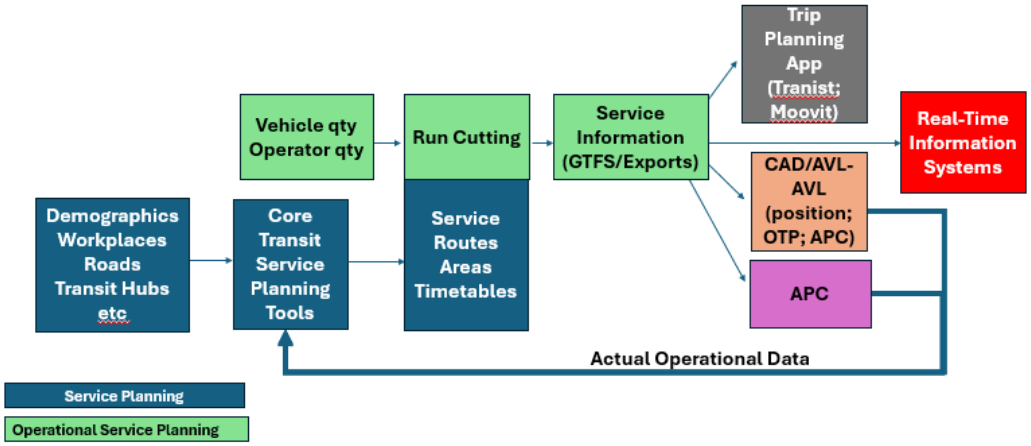
USDOT's *Intelligent Transportation Systems Deployment Tracking Survey: 2023 Transit Management Survey Findings* reports that 68% of agencies surveyed use one or more types of Intelligent Transportation System (ITS) data for service planning. The types of data include vehicle time and location, passenger count, passenger trip information, trip planning records, and vehicle monitoring status. Some of these data types are also used in the transit signal priority (TSP) discussion that follows. Service planning tools consist of a technology stack of software that are coordinated by a platform which communicates with vehicle systems on-board such as:

Computer Aided Dispatch/Automatic Vehicle Location (CAD/AVL) is a dispatch system that tracks vehicle location in real time. The system conveys and stores data through hardware and interfaces. CAD/AVL monitors vehicle locations and controls service performance in real-time. It manages communications between dispatch and the vehicle operator, generates data for on-time performance, and provides rider updates to riders by apps or on-board displays. This can include the generation of the GTFS real-time feed data. CAD/AVL also often manages and collects data for APC data and video systems, including event tagging, passenger load and management of situational issues such as accidents, incidents, or emergency situations. Additional interfaces with fare collection devices are often integrated with the CAD/AVL to manage operator login and ensure consistent route, stop, and run information. The communication system used by the CAD/AVL processor is often the transport mechanism for the real-time data necessary to support this operation. As more modules rely on the communication path CAD/AVL provides, integration must be planned in order to maintain sufficient capacity for CAD/AVL delivery of information to agencies *and* riders before, during and after a transit journey. Figure 3 illustrates the technology stack and required information for the core service planning software tool.

Automatic Passenger Counters (APC) rely on WLAN, Cellular, On-board Router to transmit passenger count data gathered from equipment on buses. APC equipment uses InfraRed (beam breakage), Light beams (curtains), video, or a combination of technologies to determine the number (and sometimes specific) passenger that boards or alights the vehicle. Real-time

communication is required to communicate bus load. The on-boarding and alighting data is analyzed to support transit service planning decisions. APCs can be a separate vendor or part of CAD/AVL offering but integration with the CAD/AVL system can provide route and stop level analysis.

Figure 3. Interconnects & Feedback of Transit Service Planning Tools



Core service planning software are visualization tools that allow for planning new services and collecting operational data. They also help identify performance issues/improvements in existing services. Some allow predictions of service changes. The tools can also provide modules for charge management systems for electric buses and automated vehicle fleets. Service planning tools are typically subscription based with modules that can supplement the base product offering. Modular add-on packages give agencies scalable options for transit services being offered.

As the industry grows with service planning technology platform providers, so will the number and types of solutions to service planning. Vendors are adding modules that provide the actual operational data (trip planning, CAD/AVL and APC technologies) to their offerings for real time standardized offerings. Planning tools that are readily integrated with a transit system have these interoperable characteristics:

Characteristics that facilitate interoperable service planning include:

- Standard system architecture, design and interfaces that conform to industry specifications like TODS or TIDES.
- Ample APIs to support regional integration and an open data platform.
- Robust self-serve reporting features for ad-hoc reports.
- Easy data extraction for required FTA NTD reports. (i.e., miles traveled, passenger count, GTFS feeds).
- Standardized presentation of data using the General Transit Feed Specification GTFS standards at all opportunities.
- Minimal hardware installation requirements so agencies can still use existing systems in place. Alternatively, install integrations with various hardware on vehicles.

Transit service planning tools are used in conjunction with one another to fulfil service planning tasks. These tools should be able to assist with the creation of timetables, route drawings, bus stop locations/data and scheduling.

Minimum Functionalities of Service Planning Tools:

1. **Data import and integration:** ingest and process GTFS data for static schedules, routes, stops, and fares; ingest and process GTFSRT for vehicle location and service update.
2. **Route and schedule planning**: visualize transit network for service planning staff to use in reviewing potential impacts to routes, stops, and schedules .
3. **Demand forecasting:** uses data from mobile apps, APCs sensors, or ticketing systems.
4. **Service Analysis:** simulates a full range of service planning options from full network redesigns to small service adjustments. Recommendations can be made for optimal fuel efficiencies, minimal travel times, or other coverage outcomes. Visualization of OTP to view which routes are not performing as expected at various times of the day allows service planning staff to then diagnose transit issues in a more efficient manner.
5. **Flexible timetables:** uses real-time conditions to create a flexible, adjusted timetable in response to unexpected events/disruptions so OTP can be maintained.
6. **Passenger flow:** collects on-board cameras, APC, smartcard taps, and other inputs to analyze passenger flow.
7. **Real-time monitoring:** can be integrated with traffic cameras and bus GPS systems to suggest alternate routes in the event of a disruption.
8. **Visualization of real-time** and historical data to guide service planning staff with estimating vehicle arrival times along routes and provides visual insights into overall system performance.
9. **Integration capabilitie**s with other service planning tools that are used in the region. These integrations would improve transit service planning efficiency and allow staff in the region to better serve riders that use the system regionally. Examples of achieved efficiencies include

    a. Sharing real-time and historical bus operational performance data to more efficiently perform scenario planning and create more accurate and reliable transit schedules. Staff will also be better able to see travel speeds and dwell times for different routes, which in turn allows them to create more accurate transit schedules that better reflect actual travel times.
    b. Sharing real-time transit information to trip planning apps can be facilitated through production of a data feed following GTFS RealTime standard (GTFS-RT). The GTFS RealTime data can be used to provide next vehicle arrival information to passengers and can also be collected and analyzed by service planning tools to generate statistics about trip performance for service planning improvements.
    c. Sharing real-time vehicle locations along a route as part of a future Transit Signal Priority (TSP) implementation in the region. Integration with cloud-based TSP vendors can allow for sending of TSP requests when buses meet a schedule adherence threshold to cloud-based TSP software systems.

Transit service planning tools should also demonstrate operational resiliency to changes in CAD/AVL systems that may occur over time with partner agencies. As long as a static GTFS feed is provided along with real-time GPS coordinates, transit service planning tools should be able to produce the same type of visualizations and dashboards for service planning staff regardless of the hardware vendor chosen for CAD/AVL operations.

Market Analysis

The market analysis classifies service planning tools according to the services to which they are tailored: fixed route and on-demand. Fixed route service includes buses and shuttles traveling along a pre-determined route. On-demand service classification groups together paratransit, micromobility, and demand-response service types for the purpose of this analysis.

Fixed and on-demand services benefit from different service planning tools. The dynamic nature of on-demand services leans heavily on routing algorithms, often with dynamic changes, and dispatching in addition to the vehicle location information. Fixed route services require tools that take into account repetitive trips, fixed stops, and accommodate interlining of routes and run-cutting to ensure service planning for the operators as well as the service routes. The size of the agency and the service also can demand more automated analysis and planning tools to determine the performance of the service overall. Trouble-shooting performance issues for a two-route service is vastly different than performing the same troubleshooting for a larger scale service and the ability to collect and analyze data becomes central to the process of maintaining a well-performing service. Regional planning coordination with local agencies is also important since express routes/regional routes and BRT routes traverse different cities. Planning at a regional level is optimized when local service planning data is available and consumable.

The vendors identified below have a market presence with large, mid-size, and small agency representation, and ability to serve a multi-agency configuration. The vendors are classified by fixed route or on-demand service. Some offer solutions for both. Review of vendor websites, literature, industry reports, newsletters, and project insights refine the service planning tools market analysis. Figure 4 below lists the tools by service mode, optional equipment and services offered, and a brief description of the solution offered by the vendor. The machine learning Artificial Intelligence (AI) modules for the respective vendors are indicated by a checkbox in the first column. Optional equipment and service offerings CAD/AVL and APC are indicated by a checkbox in the first column.

Figure 4. Service Planning Tools Market Analysis

Service Mode Featured AI Optional offering	**Vendor** **Technology/** **Offering**
☒ **Fixed Route** ☐ **On-Demand** ☒ AI ☒ CAD/AVL ☐ APC	**Optibus** Artificial intelligence focuses on strategic planning optimization for dispatch. Algorithms help perform route optimization, vehicle and driver scheduling, and rostering to improve transit route and network efficiency. Offers simplified GTFS management in support of real-time information. Interoperability with existing CAD/AVL, HR, fleet, and operational systems for dispatch-driver communication.
☒ **Fixed Route** ☐ **On-Demand** ☒ AI ☒ CAD/AVL ☐ APC	**Swiftly** Integration with GPS on-board for real-time vehicle tracking (AVL). Platform makes data available in the cloud for agencies to see optimize fixed routes, identify service disruptions, and publish real-time information. Swiftly data integration and analytics, focus on real time conditions go beyond traditional CAD/AVL offerings. Swiftly acquired Hopthru in 2024 to add ridership analysis and NTD reporting to its transit data platform. Offers TransTime for real-time passenger information, Metronome for vehicle operations management, and Insight for analytics.
☒**Fixed Route** ☒ **On-Demand** ☐ AI ☐ CAD/AVL ☐ APC	**Remix by Via** Cloud-based platform that uses GTFS and GTFSRT data to optimize transit networks. Assists with route planning, route optimization, interactive mapping and scenario planning by using real-time transit data. Supporting both fixed route and on-demand modes gives opportunities to plan a comprehensive network.
☒**Fixed Route** ☒ **On-Demand** ☐ AI ☒ CAD/AVL ☒ APC	**TripSpark** Offers modules for fixed route, campus, paratransit, rideshare, microtransit and community non-emergency medical transportation (NEMT). Fixed route and on-demand functionality with TripSpark Streets for scheduling and route. Tracks fixed routes and demand on single screen. Paratransit, on-demand, microtransit (RidePro), Performs run cuts, blocking, schedule rosters, booking, and fare prepayments. It has CAD/AVL in vehicle devices and passenger app for automated ride scheduling, 'Ripple' IVR solution offers real time/SMS trip text reminders. 'Novis' demand-response accounts features multi-agency coordination with one instance of Novis.
☒ **Fixed Route** ☐ **On-Demand** ☒ AI ☒ CAD/AVL ☐ APC	**GMV GP Planner, Module: GP Designer** Provides full suite of services planning tools transit service changes, optimize fixed routes, identify service disruptions, publish real-time information. Generation of trips and schedules, integration with city IT systems. Features multi-mode management synchronizing between different modes, operational dispatch support Global ITS and autonomous driving expertise.
☒**Fixed Route** ☒ **On-Demand** ☐ AI ☐ CAD/AVL	**Bentley OpenPaths CUBE** Mobility modules to visualize and perform demand modeling, network modeling, mapping, editing, and visualization. Uses ArcGIS and dovetails with all Bentley products. Offers a travel demand visualization module

Service Mode Featured AI Optional offering	**Vendor** **Technology/** **Offering**
☐ APC	
☐ **Fixed Route** ☒ **On-Demand** ☒ AI ☐ CAD/AVL ☐ APC	**Via Transportation (Via Mobility)** Transit platform that optimizes routes in real time. Proprietary algorithms for vehicle locations and mapping simulation tools for data visualization. AI assists with optimization, dynamic routing, and demand-predict improves as it gathers more operational data. Full integration with Swiftly. With advanced integration it is possible that Via's trip planning module could show a full system map with all mode options. (Statewide contract)
☐**Fixed Route** ☒ **On-Demand** ☐ AI ☒ CAD/AVL ☒ APC	**TripMaster** CTS Software's TripMaster serves the paratransit, NEMT, and on-demand/microtransit industries to support trip scheduling and vehicle tracking for real time interfaces. TripMaster is part of the Transit Technologies family of companies which includes: TripShot, Ecolane, Passio, Vestige, and MJM Solutions. (Statewide contract)
☐**Fixed Route** ☒ **On-Demand** ☒ AI ☐ CAD/AVL ☐ APC	**RideCo** Tools for routing, scheduling, and real-time tracking for on-demand and flexible route transit. Helps agencies plan, operate and optimize services. Features AI agent to book/cancel rides. Full .csv ride data exports for planning. Multimodal module shows options for ADA paratransit and fixed-route modes in one trip. Offers app for riders. (Statewide contract)
☐**Fixed Route** ☒ **On-Demand** ☒ AI ☐ CAD/AVL ☐ APC	**Spare Labs** Microtransit and paratransit platform that optimizes routes, enhance service reliability, and increase scheduling efficiency. Supports real-time updates for riders. Integrates payment systems and can support fare capping rules. Riders can book, manage and pay for trips. Integrates with Transportation Network Companies (TNCs) (Uber, Lyft) to enhance options on Spare App. Open fleets module combines agency's fleets with TNCs for more options in dynamic transit models. (Statewide contract)

The market analysis compares several transit service planning tool software solutions with integration features that aim to promote regional and local service planning capability.

In fact, integration is even a selling point for many service planning tools as shown in Figure 5 and Figure 6. Other vendors are integrating by acquiring complementary companies to help transform rider experiences and manage operational costs. For instance, TripSpark acquired Routematch in

Figure 5. Vendors integrate APIs as a market response to demand.

Figure 6. TripSpark website announcement.

2022 as shown in Figure 6. TripSpark's core routing, scheduling and operational software and in-vehicle hardware is now complemented by Routematch's fixed route transit and paratransit tools for trip planning and vehicle tracking, payment. TripSpark's stated goal to better serve customers in the small to mid-size, urban and rural transit agency sector.[1]

Similarly Clever Devices acquired RideCheck Plus, one of the leading APC analysis tools for route and stop level APC data analysis for service planning as well as NTD reporting.

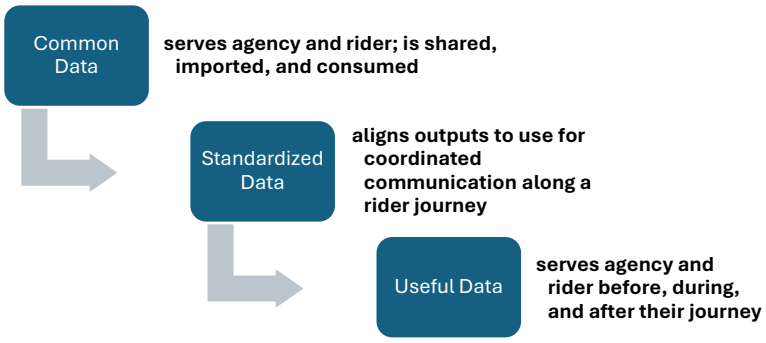
Agencies have more options with Software-as-a-Service (SaaS) solutions for service planning. Software selection focuses on how well it meets the overall needs of the agency. As mentioned earlier, standardized system architecture allows for greater interoperability. To further the integration, APTA has standards committees that focus on open systems for buses for information sharing. The introduction of the ITxPT standard for connections on buses for information sharing is a good example of the work of these committees. As a result of the ITxPT standard, the architecture, communication protocols, and data models necessary for plug-and-play capabilities across various IT modules allows different systems to communicate, reducing the reliance on proprietary

[1] https://www.tripspark.com/blog/modaxo-acquires-routematch-joins-tripspark/

interfaces. Commercial vendors have responded to the marketplace by providing custom APIs to integrate with other brands and competitors with the knowledge there are sufficient connections available with the ITxPT cabling on-board.

Service planning data feeds are the third area where industry integration advancements continue. In 2024 GTFS added GTFS Flex to integrate on-demand transit and flexible routing options into the transit data. While GTFS focuses on fixed routes, GTFS Flex allows agencies to model then share data that deviate from fixed routes. Agencies can incorporate these flexible services into the overall service network for a more comprehensive system. Service areas, booking rules and times for picking riders up can help service planning of an agency resource. Historical insights captured by analyzing the GTFS Flex data provide planners with data-backed insights when adjusting schedules and service boundaries. The standardization of the services and routes also helps coordinate multi agency or multi-mode journeys in the region. The GTFS Flex format is another example of an industry shift that promotes the progression of data that is from standard data to useful because it is increasingly interoperable as illustrated in Figure 7.

Figure 7. Levels of Data Integration



With ‘Standardized Data’ comes the opportunity to create ‘Useful Data’. Service planning algorithms for prediction models and optimization models reveal useful data or trends. Planners use historical data, traffic patterns and other operational factors to improve schedules, headway times, or deadhead miles. Planners in the region also use scenario planning to predict OTP impacts as well as impacts to equity and access for underserved areas when testing service changes.

The interoperability of these tools can also help aggregate data from disparate systems in a muti-agency region to achieve a greater level of data integration and provide a more unified view of regional performance. The regional optimization of transfer and schedules is also promising.

AI capabilities in large agencies since costs are high to adopt the technology. Still, AI can be adapted to smaller systems where the focus is typically on cost efficiencies, route improvements, and response to local growth patterns. The challenge with incorporating AI rests on an agency or region’s ability to present structured, quality data for the AI tool to analyze. Inconsistent or incomplete data can reduce the result or the accuracy of the AI analysis.

Common tools vs. disparate tools Costs and Benefits

Currently, operating partners have independent service planning solutions and contract terms to meet their transit needs. In the last decade the shift away from closed proprietary systems has opened the door for competing vendors to achieve transit service planning solutions by integration of software tools. Since integrated technology solutions share data, they do not act independently of one another. Layering of products helps align disparate data to be consumed in a standard format. As a result, aggregated information can be presented in a dashboard format for analysis. As a multi-agency region, there is a benefit from interoperable service planning data that is aggregated at a regional level, to gain insight for regional movement.

Figure 8 illustrates the advantages/disadvantages of multiple tools *vs.* a suite of consistent tools used regionally as a unified planning solution.[2] Each area has a 1–5-star rating scale with 5 stars being superior in the area under comparison.

Figure 8. Advantages / Disadvantages of Multiple Service Planning Tools and Consistent Service Planning Tools

Areas of Comparison	**Multiple Tool Solution Rating**	**Multiple Tool Solution**		**Unified Regional Solution Rating**	**Unified Regional Service Planning Solution**
Initial Software Costs	★	Higher, multiple vendors and multiple licenses, subscriptions		★★★★	Lower cost is likely, especially if licenses are bundled
Risk Profile	★★★	More resilient due to multiple providers		★	Increased risk if a single vendor fails or stagnates
System Maintenance	★★★	Multiple support contracts		★★★★	Single vendor with a common support option
Data Flow, Technical integration	★★	Prior standardization plan, APIs integration, more complex with multiple services, layering of products		★★★★	Integration less complex, one vendor workflow, built in operability more frequent use of same product
Agency Alignment	★★	Alignment of differing tool sets can be complex, potential API customization		★★★★	Standard workflows simpler with single vendor
Depth of functionality	★★★★★	Module toolset built for specific function		★★★	Tradeoffs frequent during integration
Updates and Innovations	★★★★	More agile with specialized tool updates		★★	Dependent on vendor R&D development plan
Learning Curve and Onboarding	★★	Potential learning curve for new, multiple platforms not currently used; multiple help desk support contacts		★★★	Potential learning curve if new platform is not currently used, single platform streamlines training
Strengths	Agency independence maintained Developed for specific, robust purposes.			Streamlines workflow, scaling and administrative coordination.	
Weakness	Costs of integration to individual agencies and region for full capabilities.			A single solution may not serve all agencies' needs including future needs; vendor lock in.	

[2]Analysis grid adapted from The National Center for Mobility Management.

Further Considerations

Researching the region's service planning tools requires analysis of the financial, operational, and collaborative implications in choosing between multiple, distinct transit planning tools or adopting a single comprehensive software solution. Further internal review and coordination will need to account for cost structures, contract durations, workflow efficiencies, adaptability, and inter-agency coordination required to achieve an interoperable service planning solution.

Procurement of future service planning tools should include provisions for regional data sharing. Such provisions mean continued development of regional technology without hindrances of, for example, a custom work order to integrate a local solution/operator solution to the region. To this end, North Carolina has statewide contracts for Ride Co, Via Mobility, Spare Labs, and TripMaster. The California Integrated Travel Project (Cal-ITP)[3] encourages the use of statewide, pre vetted contract templates, vendor bid data, and other comparative tools. Cal-ITP has a marketplace to allow transit agencies to join group procurements. Even if agencies do not join procurements, Requests for Proposals (RFPs) and contracts are available with agency registration. If a unique RFP is required, the Mobility Data Interoperability Principles Coalition provides example language to include interoperability in a transit technology procurement.[4]

Cost Estimate

Figure 9, below, presents an example cost estimate that assumes one (1) primary agency and five (5) additional agencies which are using a combination of the eight tools listed. The cost estimate also assumes the unified platform approach will include service planning tools currently used by at least 3 partner agencies.

Each agency currently uses a different combination of software tools to support operations. While the different combinations of software tools may function to provide service to designated service routes, on-demand, and paratransit for an agency, they may not be sufficiently robust or integrated to achieve the level of interoperability necessary to affect fully reliable regional planning. The region is growing and integration towards an interoperable transit system makes transit more attractive.

[3] https://www.camobilitymarketplace.org/contracts/
[4] https://www.interoperablemobility.org/

Figure 9. Cost Estimate Comparison of Multiple Service Planning Tools and Consistent Service Planning Tools

Cost Element	Separate Tools (across 6 agencies) *Estimated Range*	Unified Platform Adopted by all Agencies (same combination of tools) *Estimated Range*
Licensing & Subscriptions (Year 1)	$470,000 – $510,000	$325,000 – $490,000
Initial Training & Onboarding	$150,000 – $170,000	$96,000 – $180,000
Data Integration & Management (Annual)	$230,000 – $270,000	$165,000 – $275,000
Interagency Planning and Coordination (Annual)	$140,000 – $180,000	$92,000 – $145,000
Year 1 Total Estimated Cost	**$990,000 – $1,130,000**	**$678,000 – $1,090,000**
Annual (Multi-Agency) Cost	$740,000 – $800,000	$390,000 – $420,000

Note: Costs in this table are aggregated and blended from a review of the USDOT ITS Costs and Benefits database available at: https://www.itskrs.its.dot.gov/costs/

In addition to the capital and operating costs, agencies must consider key factors such as workflow efficiency and inter-agency collaboration requirements.

Recommendations for Transit Service Planning Tools

Operating partners in the region have a workable path to greater service planning interoperability while still keeping existing systems in place in the near term.

Commit to Interoperability

NCDOT is part of a co-author coalition responsible for the Mobility Data Interoperability Principles (MDIP) where open standards drive interoperable technology components that work together in real time and with standard data formats. Following MDIP, the main focus in the region is the continued effort to standardize data from desperate platforms used by operating partners. Without a clear commitment to interoperability, stakeholders in the region are restricted from achieving a regional approach to service planning. Ultimately then, the lack of innovation and broader impact on riders who see transit as a less attractive alternative is a risk of not committing to interoperability. Without interoperability there is little value in investments like artificial intelligence modules since the module relies on quality, standardized data.

Interoperability considers existing systems as a starting point. Depending on agency need, age and the remaining useful life of the system in place, integration efforts may not make financial sense. This is also true when an agency needs outgrow the service planning tools in place.

Service planning software that supports modular integration and open data standards is recommended, especially in a multi-agency region. Service planning tools that are interoperable and built to "talk" to one another minimize data silos and, for example,

- facilitate service change coordination,
- reporting of region-wide performance metrics, and
- add reliability to customer-facing tools.

Currently, agencies in the region may benefit most from adopting a blended approach. For instance, core service planning functions such as route design and service performance tracking can be managed with a consistent combination of service planning tools throughout the region, much like is the case today.

This hybrid strategy allows agencies to maintain access to specialized features that are tailored to their needs, while still building a foundation for system-wide interoperability. In environments where resources are limited and service expectations are high; such an approach not only reduces risk but also improves scalability and resilience as transit systems evolve in the region.

Align Metrics for Regional Service Planning Data

Interoperable data is based on a common set of metrics. Operating partners need to determine a common set of metrics and operate under this agreed upon regional set of metrics. Starting simply with, for example, Early/Late definitions for measuring On-Time Performance will give service planners regional data that can be performed with an “apples to apples” approach. The region is both rural and urban and features a student population that uses campus shuttles. Some agencies charge fares for their service, while others do not. Each of these circumstances comes with unique service planning constraints. Transit operating partners in a data-rich ecosystem should support regional data standards for common metrics. However, agencies are still free to adopt more than the standardized regionally set metric if there is a local need. Service planning tools that present innovative technologies must be able to integrate with legacy systems. APIs and data standards are increasingly recognized as hallmarks of successful implementation.

Sponsored capital projects like GoTriangle’s Raleigh Union Station Bus Facility and GoTriangle's Triangle Mobility Hub increase the need for enhanced transit service planning. They serve as connections points for routes run by different operating partners. Intersecting routes here should be analyzed from a regional perspective and operating partners should consider service metrics, OTP times, and best possible station flow for efficient transfers.

Transfer points and shared stops are a priority for regional synchronization of routes in service planning. Riders can count on reliability of service, trip planning, and any real-time next stop arrival systems being deployed. The challenges in setting a regional OTP are establishing and following consistent OTP definitions to ensure service reliability across the region.

From a regional planning viewpoint if there are multiple product solutions the likelihood of slightly differing predictive timings can be exacerbated, especially in the case of transfers between operating partners. Efforts to reduce discrepancies for on-time performance (OTP) between software are not inherent since each product uses a proprietary algorithm. Methods to align OTP as a region could include ‘ETA Accuracy benchmark’ measures as a means to determine the accuracy

of real-time ETA predictions[5]. Standardizing data by adopting this extra step towards a common methodology for OTP predictions and can give agencies common variables in the "transit equation" when not using the same service planning predictive tools.

Resolving these inconsistencies operationally will foster a greater ability to rely on regional data points. Other examples that foster regional alignment include the alignment of boarding unit of measure by hour or by trip throughout the region and alignment of route performance (i.e., a flat percentage (<50%) or below a predetermined benchmark).

Align GTFS and GTFS RT feeds

Complexities of fixed route, mixed public/private travel modes, multiple operators, reliance on paratransit and non-fared transit services mean the most important common denominator remains the respective GTFS and GTFS/RT feeds. At the very minimum, GTFS alignment is critical for a regional approach.

GTFS can be consumed by service planning tools to, for example, to predict arrival times when local agencies can output common GTFS data that is consistent and complete. When this common data (e.g., GTFS, GTFS Flex GTFS/RT,) is regionally consistent and complete, it is useful data. Agencies have an opportunity to consume and analyze it to better understand performance trends in regional transit ecosystem. While there is no set frequency, GTFS RT, synchronous updates for vehicles range between 15-30 seconds. As a result, riders can see real time vehicle movement. Trip planning amongst and between multiple agency's service has the potential to increase visibility and potentially ridership. Finally, the reliability of transfers at major hubs is increased when data is reliable (real-time) and consistent across agency platforms and rider-facing apps.

Reliability, visualization and predictive arrival time rely on GTFS data feeds that are provided by robust on-board, AVLs that regularly report vehicle location.

Use a process to consider new transit technology solutions.

Transit technology is rapidly evolving. The marketplace offers solutions that were not available five years ago. It is reasonable to expect that technologies and solutions that are seen as current today may be disrupted by a solution outside of recommendations of the regional technology plan. New technologies that lack competition or interoperability features should be carefully vetted. To help with future technology selections, the Mobility Data Interoperability Principles Coalition developed five principles of interoperable transit technology to help navigate decisions. [6]

1. All systems creating, modifying, or consuming mobility data should be interoperable.
2. Interoperability should be achieved through the development, adoption, and widespread implementation of open standards that support the efficient exchange and portability of mobility data.
3. Transit agencies and other mobility service providers should have access to tools that present high-quality mobility data accessibly, equitably, and in real time to assist travelers in meeting their mobility needs.

[5] https://github.com/TransitApp/ETA-Accuracy-Benchmark
[6] https://www.interoperablemobility.org/

4. Transit agencies, other mobility service providers, and travelers should be able to select the transportation technology components that best meet their needs.
5. All individuals and the public should be empowered through high-quality, well-distributed mobility data to find, access, and utilize high-quality mobility options that meet their needs as they see fit, while maintaining their privacy.

Use procurement strategies that promote interoperability

The State's Integrated Mobility Division established four vendor purchasing contracts[7] for ride scheduling software for the following vendors, RideCo Us, Inc., Spare Labs, Inc., Via Mobility, and TripMaster.

This statewide contract option aims to lessen the administrative burden of agencies having to develop an RFP so the agency can focus on other parts of their own procurement process for the software. Procurement documents should clearly outline the requirements and remedies to ensure scope is met. Towns and municipalities throughout the Triangle region could leverage a statewide contract to support service planning and scheduling microtransit in their areas.

Use of the same vendor for transit planning tools but with different service agreements has the potential for duplication and leaves room for exploring contractual consolidations. The potential for agencies to share license instances is another opportunity for operating partners to integrate more efficiently. This case is particularly important for agencies that have services which are run by other operating partners.

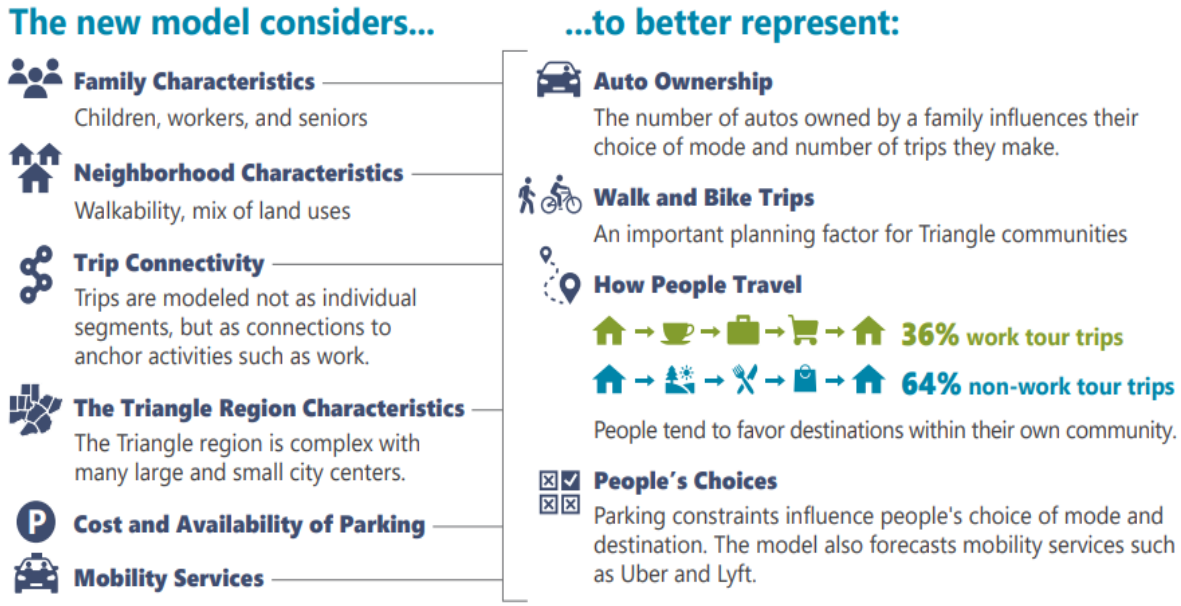
Vendor discussions that leverage existing service planning tools are possible ways to implement a common service planning tool throughout the region. This may work to minimize the duplication of effort for each agency to stand up a dedicated in-house solution. Operating partners could have a consistent platform but with individual software setups tied to their unique operating requirements.

Leverage and engage universities

Transit is increasingly reliant on a data-rich environment to accomplish efficient and smart transit. The region has major universities and colleges. The Institute for Transportation Research and Education (ITRE) is a source for potential internships or studies given their institutional insight into NCDOT and regional technology studies they perform. University partnerships can be an opportunity to further integrate regional data and also develop a potential employment pipeline of homegrown transit professionals. The Triangle Regional Model Generation 2 is an example of the synergies between universities, the State, and the transportation planners in the region. The model now includes a regional aspect and trip connectivity, as shown in Figure 10. These advances lead to improved visualization and scenario planning to help inform decisions for the region.

[7] https://connect.ncdot.gov/business/Transit/Pages/Transit-Procurement.aspx.

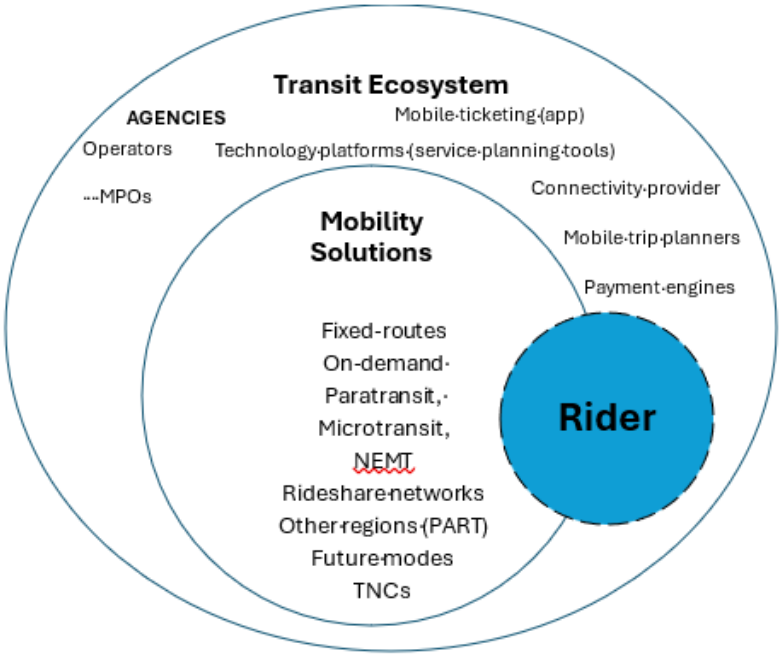
Figure 10. Triangle Regional Model Generation 2 improvements



A rider-centric focus keeps the interoperability goal in the forefront.

The best practice of service planning must be looked at in the larger context in which it operates. Transportation Research Board presenter, Yi Ho, says mobility is "The quality of our transportation

Figure 11. Transit Ecosystem



to connect people to goods, services, and employment that define a high quality of life."[8] And while service planning tools are an important technology for agency planning and operations, it is important to remember they are part of a larger mobility solution within the transit ecosystem that includes the rider as shown in Figure 11.

Surveys, strategic plans, and investments indicate that operating partners are aligned with goals to promote a rider-centric transit system. However, adopting a rider-centric focus in a multi-agency region often promotes a change in internal agency workflows. A multi-agency approach often includes processes and working groups to ensure stakeholder engagement before, during and after technology is implemented.

Roadmap and Resiliency Plan for Service Planning Tools Future Years

Service Planning Resiliency

The APTA standard, APTA-SS-SEM-S-001-08[9], Continuity of Operations Plan (COOP) for Transit Agencies suggests a COOP be developed and maintained every two years to ensure the agency can continue operation of essential functions during a broad range of natural or other emergency. For Raleigh, the private operator provides the COOP. The elements needed to develop a COOP include database and system backups amongst others such as:

- Alternative operating facilities, adequate for 30 days of operations;
- allocate mobile communications equipment such as mobile phones and laptops;
- human capital to perform contingency operations; **vital records, databases and system backups** legal and financial documents and obligations are to be available for use;
- delegation of authority in place;
- current contact lists;
- training for those filling essential roles different responsibilities than normal;
- devolution provides planning and program guidance to ensure the continuation of any essential functions in the event of the loss of capabilities; and
- reconstitution procedures that define the processes to return to normal service.

Vendors of SaaS solutions may have various availability terms and Service Level Agreements for system backup. Agencies should coordinate with SaaS solution vendors to ensure compliance with their COOP.

[8] Ho, Yi, et al. "A Novel and Practical Method to Quantify the Quality of Mobility: The Mobility Energy Productivity Metric." Transportation Research Board Annual Meeting. Golden, CO: Preprint: National Renewable Energy Laboratory. NREL/CP-5400-72889, 2020. 24. <https://docs.nrel.gov/docs/fy20osti/72889.pdf>

[9] https://www.apta.com/wp-content/uploads/APTA-SS-SEM-S-001-08_Rev2.pdf

Service Planning Tools Roadmap

Figure 12 presents a roadmap that takes into consideration existing service planning tools and ongoing efforts to standardize and then integrate data. The steps are proposed over five years of time but may stretch to shorter or longer periods based on progress made by transit agencies with respect to service planning and regional operations.

Figure 12. Roadmap of Recommendation Strategies for Service Planning Tools

Step 1: Inventory existing systems **Partners Coordination** • Existing contract terms & specs • Identify Data needs • Rank needs and capabilities. • Establish rules of engagement **Coordinate with MPOs** • planning and metrics Updates **Investigate 'sister city' agencies** for insights, lessons-learned, metrics, gaps, KPIs, and improvements).	→	**Step 2: Determine connectivity goals** • Identify data needs for each agency (master data map) • Rank data needs and goals • Identify APIs present or needed • Develop regional data reporting standards • Develop regional approach to data sharing and methods	→	**Step 3: Identify Staff Resources** **Current Service Planning** • SOPs for each Agency • Staff • Processes • Tools • Staff roles **Coordinate Regional solution** • Resource interaction • Role Changes • Additional needs • Workflow changes required
Years 0-1		**Years 1-2**		**Year 2**
Step 4: Identify Potential Regional Solutions **Advertise Industry RFI** • Hardware upgrades • Software upgrades • Open payments • Interoperability **Determine level of effort** • Lead agency or individual procurements • Separate tools or unified platform **Coordinate regional efforts to interface with** • TSP signal priority upgrades • Emergency responders protocols • Data feedback loop for Triangle Regional Model to include data feedback loop	→	**Step 5: Identify Service Planning Approach as a Region** • Develop rider-data journey map. • Total Cost of Ownership study over 5 years. • Submit for competitive grants. (NCDOT grant application cycle April – June).	→	**Step 6: Consider opportunities for economies of scale** • Revisit or update the regional Origin-Destination study. • Confirm regional alignment of data and process to enable route planning as a region • Joint procurements • Statewide pre-vetted contracts from NCDOT
Years 2-3		**Year 4**		**Years 4-5**

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