Section 5: Metro Service Planning and System Development

This section discusses how Metro plans and implements transit service in King County. This section includes materials on how Metro transit's system has evolved and what factors are considered in planning and implementing transit service. Metro's current methods for planning, distributing and putting service on the street are outlined. Restructures and system integration are also discussed to provide perspective on Metro's role in the regional transportation system and its coordination with other transit agencies. A brief piece on Metro's performance and monitoring practices is also included to provide a summary of Metro reports and practice in this area.

Information you'll find in this section:

- The Evolution of Metro's System: Service Initiatives and System Development
- Transit System Coordination
- Sound Transit and Metro Transit Coordination
- Service Planning: Principles of Route and Network Design
- Service Change Process
- Metro Transit Route and Schedule Change Process
- Monitoring Performance and Defining Success
- Purpose Driven Public Transport: creating a clear conversation about public transport goals

Links to Additional Resource Materials:

Metro Reports:

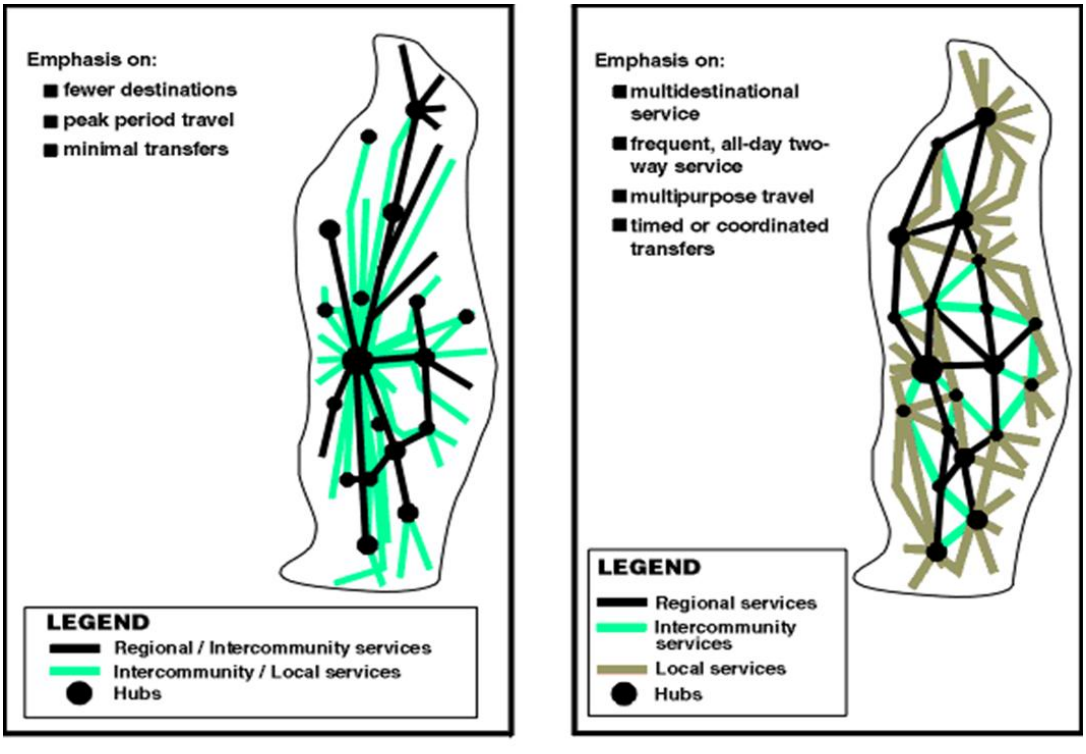
- Annual Management Report
- Route Performance Report
- Annual Rider/Non-Rider Survey
  http://metro.kingcounty.gov/am/reports/reports.html

The Evolution of Metro's System: Service Initiatives and System Development

King County Metro Transit provides an array of services to meet the many different travel needs of passengers and support the varying land uses throughout the county. Metro has an extensive fixed route network that is comprised of core, peak and local routes. This network is supplemented by vanpools and ridesharing programs for trips that are less convenient by bus and Access paratransit service for citizens who are ADA eligible. The system is expected to serve a wide variety of travel markets and a diverse set of users. Striking a balance for multiple users with differing travel needs is one of the largest challenges that Metro faces, given limited resources. The planning framework helps guide what that balance should be.

Metro's System Design

Metro's existing network of services comprises a multi-centered system focused on connections to and between centers, with higher frequency services in key corridors. This multi-centered approach was first established through adoption of the 1993 Comprehensive Plan for Public Transportation and the subsequent 1996 Six-Year Plan, and has been expanded over the years.



Past ***Present***

The shift in orientation was prompted by changing demographics in King County and rapid growth in areas outside the City of Seattle. During the 1990's, demand for Metro service grew,

as people wanted to access a broader range of destinations. This demand was accommodated with more efficient use of fleet and service hours.

Notable gains in ridership followed the first stages of Metro's shift to a multi-centered approach. Overall transit use increased, as did the number of households with residents using transit. At the same time, single-occupant vehicle travel declined. Between 1994 and 2000, the proportion of households using transit increased to 31 percent from 28 percent. Service hours also increased steadily from 1995 to 1999 to a system size of just over 3.3 million annual service hours, also a reflection of Metro's healthy financial position.

During the same period, much of the region's growth occurred outside of Seattle, in south and east King County. Between 1994 and 2005, roughly 50 percent of the growth in population occurred in South King County, with 30 percent in East King County. 20 percent of the overall growth occurred in Seattle and West King County.

Expanding the Core Network

Metro's 2002-2007 Six-Year Development Plan continued to emphasize improvements to core corridors to make services that connect activity centers more frequent and convenient. At the same time, there was a focus on increasing service to park-and-rides and improving connections to regional services. Metro's Transit Speed and Reliability Program achieved speed, safety and reliability improvements in a number of important transit corridors. Methods used to achieve program objectives include improved signal coordination, consolidation of stops, queue bypass, customer comfort and safety improvements at and around bus stops, and improved transit access/egress from key locations. Such improvements were completed on both a corridor and spot basis, in coordination with jurisdictions and entities in various locales through Metro's service area.

Restructuring for Efficiency

Metro capitalized on the corridor emphasis to also improve service efficiency and make service more attractive through consolidation of routes. By consolidating routes that originally operated on multiple corridors to a single corridor, it is often possible to create a single route that is more frequent, productive and reliable. These higher frequency routes tend to be more attractive to riders, and Metro has found that such consolidations and restructures often result in increased ridership. A detailed example of a restructure process is described below.

Delridge-Ambaum: Example of a Successful Service Restructure

The Delridge-Ambaum restructure was accomplished without the investment of additional service hours. Service on the corridor was improved by reallocating and consolidating services.

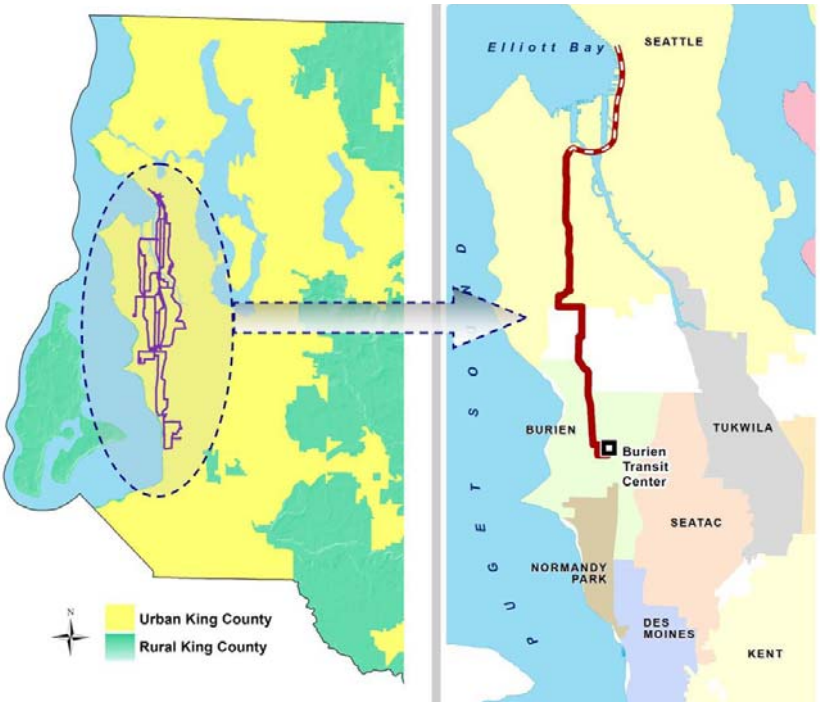
Goals: The goals of the service restructure were to:

- Improve all day transit connections,
- Provide higher levels of transit service without additional resources, and
- Improve passenger experience.

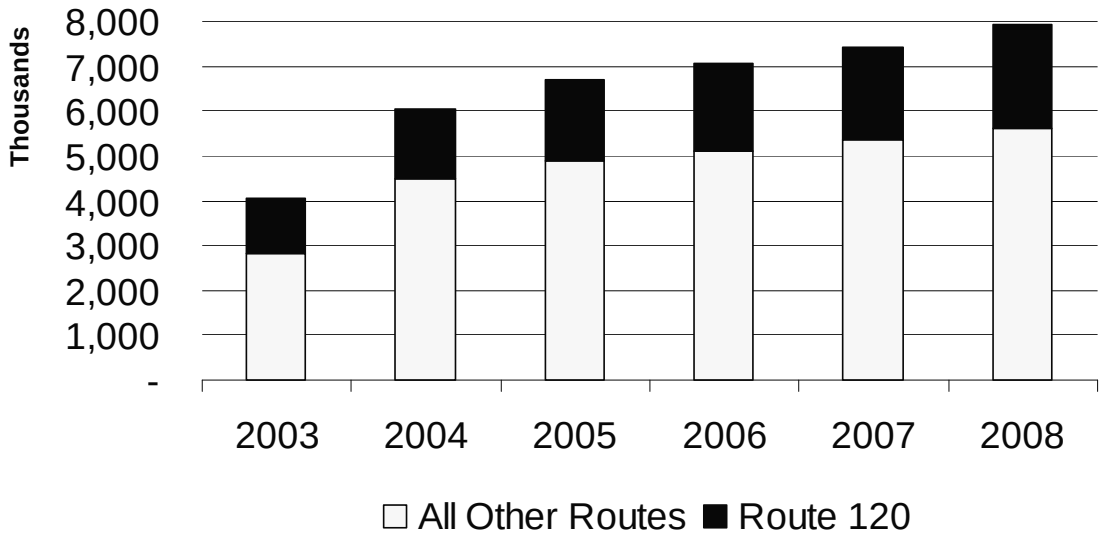
Details of the Service Restructure:

- The primary service, the Route 120, replaced multiple routes that operated less frequently and were less direct – it became an all day, two-way service featuring 15 minute headway throughout most of the day, seven days a week
- Some commuter express service was maintained, but other service was changed to reduce duplication, resulting in some new transfers for riders
- Bus stops were removed to help speed the service. Many of the remaining stops were upgraded with shelters, benches, enhanced lighting, wayfinding and fresh curb paint to mark the bus zones.
- Transit Priority measures were implemented
- New air-conditioned, low-floor articulated buses were assigned to Route 120
- New Route 125 provided replacement service to South Seattle Community College with expanded peak 15-minute service in both directions, more 30-minute service evenings and weekends, and later hours of operation. Trips on Route 125 also were through-routed with Route 11 to provide a no-transfer "college-to-college" connection between South Seattle Community College and Seattle Central Community College on Capitol Hill.
- Less productive midday express trips on SR-509 express services were reduced by 50%, and the three SR-509 routes were renumbered for better distinction between freeway and local arterial services.
- Local service between White Center, Highland Park, and downtown Seattle was consolidated into a single new route, Route 23, and 30-minute frequency was maintained.
- Local all-day transit service between Burien and Park Lake (adjacent to White Center) was consolidated from two routes to a single new route, Route 131.

Completed: 2004



Results: This restructure resulted in a 45% increase in ridership along the corridor compared to 22% system-wide during the same time period, shown in the chart below.



Summary of Ridership Results from Restructures

Metro has implemented similar restructures in other areas. Seven of the major consolidation initiatives since 2003 are listed in the chart below, along with the ridership changes.

		Annual Ridership					
Year	**Area/Route**	**Before**	**Spring 2008**	**Net Change in Boardings**	**% Change in Boardings**	**Added Service Hours**	**Boardings per Added Service Hour**
2003	North King County	2,912,160	4,064,950	1,152,790	40%	4,300	268.1
2003	Rt 358	2,292,340	3,203,730	911,390	40%	8,000	113.9
2004	Federal Way	2,311,640	3,598,320	1,286,680	56%	12,600	102.1
2005	Ambaum-Delridge	4,371,220	5,723,300	1,352,080	31%	12,800	105.6
2005	Rt 7/49 Split	5,829,710	6,092,086	262,376	5%	10,400	25.2
2006	Rt 150/180	2,328,900	3,618,140	1,289,240	55%	20,600	62.6
2008	Central Eastside	1,507,710	1,776,520	268,810	18%	16,600	16.2
		21,553,680	**28,077,046**	**6,523,366**	**30%**	**85,300**	**76.5**

A New Type of Network Improvement: RapidRide

Metro will be implementing further network improvements with the launch of its new RapidRide bus rapid transit service in 2010. RapidRide is streamlined bus service that will provide frequent, all-day service along key corridors. Everything about RapidRide—the buses, the stops, the way it operates—is being designed to keep people moving quickly throughout the day in these heavily used transit corridors. Buses will arrive frequently—at least every 10 minutes during the busiest travel hours. Stations will have distinctive shelters, seating areas, and customer information. Electronic signs at the stations will provide real-time information about when the next bus will arrive. In short, RapidRide will be a more convenient and comfortable way to travel.

The first phase of RapidRide implementation targets six corridors across King County. Four of the six RapidRide bus rapid transit lines will start service between 2010 and 2012, increasing the overall number of service hours operated by Metro. As the agency moves towards the future, Metro will continue to improve and change service to better meet the mobility and travel needs of King County residents.

Other Innovative Programs

Metro engages in an array of activities to improve people's access to public transportation and other alternative choices to the SOV. As of 2009, over 2,000 employers in King County chose to purchase transit passes and other products from Metro. The employees that receive these benefits from their employers are a significant share of Metro's customer base. Likewise, revenues from employers represent over half of Metro's fare revenue. Metro engages in other activities in partnership with local jurisdictions, the Washington State Department of Transportation, and private partners to accomplish mutual goals. These supplemental activities help create success for Metro in terms of ridership, revenue, and improved efficiency of the transportation system in King County. Metro's innovate programs include:

- Commute Trip Reduction Program
- Employer Pass Programs (FlexPass and ORCA Business Account Products)
- Metro's Bike Program
- Jobs Access / Reverse Commute Program
- Residential Programs (In Motion, Partners In Transit)

Partnerships

One source of Metro's success in gaining ridership over the years is its approach to partnerships. Metro simply would not be able to provide as much service, meet as many customer needs, or provide travel options to as many county residents and commuters without the help of partners. The partnerships include a broad array of activities and partners:

- Providing regular transit service (Transit Now Service Partnerships)
- Helping improve the efficiency of the state highway system (WSDOT Commute Trip Reduction and construction mitigation activities)

- Building transit and vanpool use in major employment centers with services provided by third parties and cities (Redmond's R-TRIP program, Commute Seattle, Bellevue's Choose Your Way)
- Helping social service agencies, workforce training groups, and low income / immigrant communities improve access to alternative transportation (Jobs Access / Reverse Commute, human services ticket program)
- Building third party capability to meet travel needs that Metro cannot but supplement people's ability to meet mobility needs without owning a car (Flexcar, now Zipcar).

Carsharing: A Success Story

Carsharing is a good example of why Metro engages in innovative activities. Carsharing is a service where members can reserve and use personal vehicles that are parked at key places within a community. Use of the vehicles is charged by the hour, as opposed to renting a vehicle for a day. Metro sought to bring carsharing to King County as a supplement to the transit system. The value proposition to the user was a way to meet mobility needs not served by the transit network that was less expensive and resource-heavy than car ownership. The value proposition to employer customers was a less expensive way to provide mobility for employees during the workday and not incur employee parking costs or maintenance of a fleet. The value proposition to Metro was an increase in ridership by customers who would rely on the transit system more if they gave up their personal vehicle.

After issuing an RFP for a carsharing service, Metro helped found Flexcar. Several federal grants and private investment funded the startup and early operation of Flexcar. Flexcar has since merged with Zipcar and is the largest provider of carsharing services in North America. Metro and Zipcar still coordinate regularly, still conduct joint promotions, and share access to customers. But Zipcar is on its own and receives no operating subsidies from Metro. And, Zipcar's operation in King County is even making a profit.

Transit System Coordination

Agencies in the Region

There are eight transit agencies in the Puget Sound Region – King County Metro Transit, Sound Transit (ST), Community Transit, Everett Transit, Pierce Transit, Seattle Center Monorail, Kitsap Transit, and the Washington State Ferries (WSF). In addition, Metro collaborates with the Washington State Department of Transportation (WSDOT), the Puget Sound Regional Council (PSRC), and various local and regional jurisdictions. Metro coordinates and forms partnerships with these different agencies and jurisdictions in the region to deliver service, construct capital projects and enhance system continuity. Of the seven other transit agencies in region, coordinate most closely with Sound Transit, Community Transit and Pierce Transit

Levels of Coordination

There are various levels of coordination that take place in the region when planning transportation. These levels include:

- **Governing boards**, such as the King County Council and Regional Transit Committee, and the Sound Transit Board.
- **Management coordination** such as the Transit Operators' Committee, and the Transit Integration Group.
- **Project Teams** such as the Alaskan Way Viaduct Replacement Project construction mitigation team, the SR 520 Replacement Project team, the Eastside Corridor Tolling Study team, and the Metro-Link Light Rail Integration team.
- **Staff Coordination,** ranging from formal to informal coordination.

Areas of Coordination

Agencies coordinate in the following areas:

- **Planning**: Agencies plan projects together, both short and longer range. They coordinate on day to day service, major service changes, and regional corridor projects and plans.
- **Service and Operations**: Agencies coordinate service and operations throughout their systems. Some examples include the Downtown Seattle Transit Tunnel, intermodal and interagency connections, regional ridematch and vanpools, facility use, and customer service.
- **Fare Integration**: In order for the fare system to work best, agencies need to coordinate on its implementation and use. Puget Sound regional agencies coordinate through a Regional Fare Agreement, the ORCA smart card, and Regional Employer Agreements.
- **Joint Facility Construction**: Where appropriate, agencies collaborate on construction of facilities including transit centers, park-and-rides, and transit priority facilities.
- **Major Projects**: Transit agencies collaborate on major projects that are needed to keep the region moving.

Sound Transit and Metro Transit Coordination

Sound Transit (ST) and King County Metro collaborate and coordinate their services that run in King County. Metro operates eight routes for Sound Transit, which account for 54 percent of ST express bus service in the region. Metro and Sound Transit also work together to integrate bus service, light rail and commuter rail service.

Regional Express Buses

The ST Express bus system operates fast, frequent, two-way service connecting the major urban centers of Pierce, Snohomish and King Counties. There are a total of 19 express bus routes, providing connections to local transit routes, and other ST express buses, commuter rail, light rail, Amtrak, ferries and the Sea-Tac International Airport[1]. In 2008, Sound Transit Express bus service carried 12.5 million passengers in the three-county area.

ST Express routes that Metro operates include connections between communities such as Kirkland, Bellevue, Woodinville, Issaquah, and Redmond to the University District, downtown Seattle, and Sea-Tac Airport. Metro coordinates service investments with Sound Transit, including the most recent Transit Connections project, which restructured bus service in Southeast Seattle and Southwest King County to better serve Link Light rail stations when Central Link began service. Metro and Sound Transit have coordinated service investments for the State Route 520 Urban Partnership Agreement, where both agencies are contributing to improve services in this key corridor.

Commuter Rail

Sounder commuter rail provides two-way, peak-hour train service using existing railroad tracks between Everett, Seattle, and Tacoma. Sounder commuter rail offers a fast, dependable and easy-to-use commute option, linking major destinations in Snohomish, Pierce and King counties.

Two commuter rail lines are currently in operation, Everett to Seattle (North Line) and Tacoma to Seattle (South Line). There are currently nine daily trips including two reverse commute trips between Tacoma and Seattle and four trips between Everett and Seattle. The Sounder averages over 9,000 daily trips on the South Line and 1,200 daily boardings on the North Line.

Metro works with Sound Transit to provide bus service to and from several of the Sounder Stations to allow riders to connect to commuter rail service there. Routes that serve the Kent, Auburn, and Tukwila Stations are designed to meet morning and evening Sounder commuter trips and provide riders with a reliable transfer between these two modes. In the year 2013,

[1] Sound Transit 2009 Adopted Budget

Metro will implement a sixth RapidRide line, Line F, which will connect Burien to Renton and will connect to Commuter Rail, Link Light Rail, and RapidRide Line A.

Link Light Rail

Light rail adds a new form of high-capacity transit to the region. Future light rail service is designed to connect Northgate, Roosevelt, the University District, Capitol Hill, First Hill, downtown Seattle, the Rainier Valley area and SeaTac. These are the state's highest employment areas with the highest transit ridership in the region.

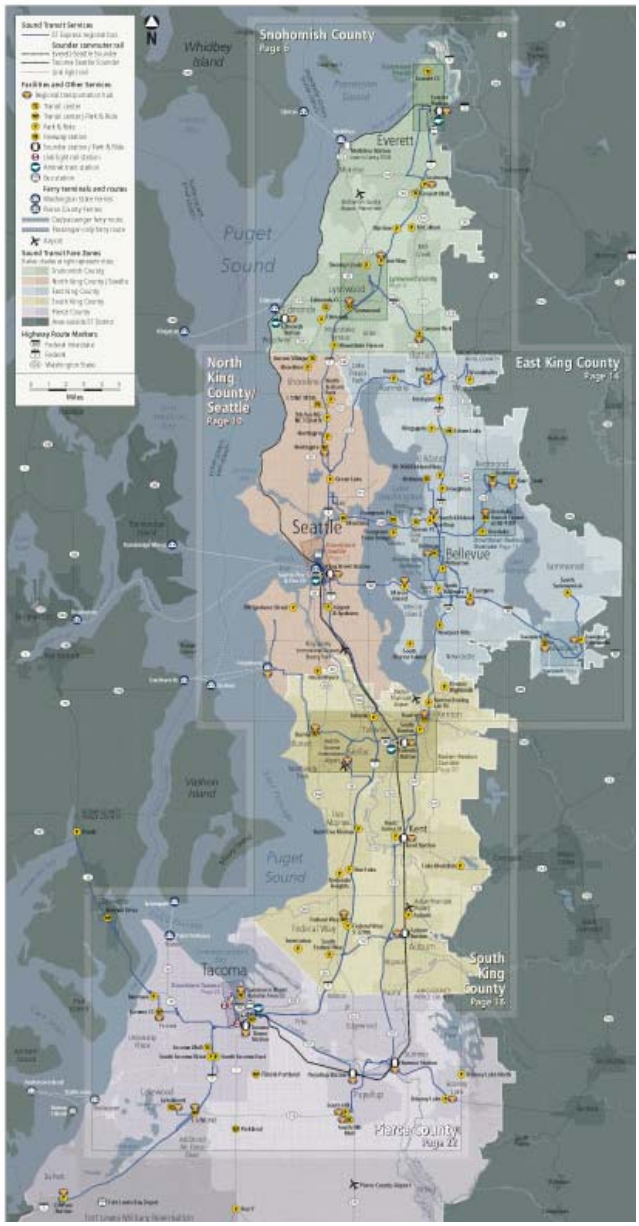
In July 2009, Sound Transit opened the initial segment of Central Link between Tukwila and downtown Seattle with trains operating every seven minutes during the peak commute periods. The remaining segment between Tukwila and Sea-Tac International Airport opened in December 2009, providing a 35-minute ride between downtown Seattle and the airport. Link Light Rail operates in the Downtown Seattle Transit Tunnel along with several Metro bus routes. Operations and maintenance of the Central Link system is performed by Metro.

During 2008-2009, Metro worked in coordination with Sound Transit to develop a link integration plan, which restructured Metro's bus system in Southeast Seattle and Southwest King County to better serve light rail stations, and allow customers to connect easily between bus and light rail. In January 2010, Link light rail averaged 15,985 weekday riders, an increase of 8.3% from December 2009.

Two additional Link light rail segments that will be built to make a total of three segments of what is currently planned and funded. The second segment, which will run between downtown Seattle and the University District via a tunnel under First Hill, Capitol Hill and the Ship Canal, is known as University Link and is anticipated to open in 2016. The third segment of the light-rail line, funded by the Sound Transit 2 plan, will operate between the University District and Northgate, with an anticipated completion date of 2020. Metro will continue to work with Sound Transit to integrate bus service and light rail as these additional segments are completed.

Service Planning: Principles of Route and Network Design

Planning a transit system is a difficult and complicated endeavor, as can be seen from the regional transit map on the right. There are many factors that influence effective route and network design, all of which involve trade-offs. Transit can be designed as a lifeline for people who need it, as insurance for people who might need it, and as a way to reduce the number of vehicles on the road for those who chose it over driving. Each of these purposes has an effect on the quality of life of a community, on air quality, and on congestion. Because resources are limited, designing a network to meet any one purpose, means that other transit needs could be negatively affected.



In short, transit cannot meet the mobility needs of all people in all situations. It also cannot achieve all the potential benefits that transit can potentially offer simultaneously, since some of these benefits are mutually exclusive. Therefore, transit planners and decision makers need to prioritize and decide what the purpose of transit will be for the area it serves. Metro planners consider a number of factors and adhere to several planning principles when designing the transit network that seek to balance the different purposes of the transit network, making it as efficient as possible for the most number of riders.

External Factors to Consider when Planning a Transit Network

External factors impact Metro Transit service and affect King County Metro's strategic planning process, including demographics, traffic, transit financing, and proposals and plans to change the region's transportation system. Some of these factors are described in more detail below.

- **Economics and Demographics:** These factors affect the transit network for many reasons. As a population grows, as the Puget Sound Region is projected to do, there are more residents who have various mobility needs, many of whom will use transit. In addition, employment can affect transit needs people adjust their travel patterns as the job

market expands and contracts. Other factors, such as changing demographics, can also impact an area's need for transit. For example, an aging population may rely more on transit for their travel needs than a younger population. In short, the number of people in an area and their unique characteristics impact how transit is designed and provided.

- **Federal Requirements:** King County Metro is required to comply with two federal requirements - Title VI of the Civil Rights Act and the Americans with Disabilities Act (ADA) - that are integrated in all service proposal assessments.

  The objectives of Title VI are to ensure that the level, quality and distribution of transit services, as well as participation in transit planning, are provided to ensure equal access and mobility without regard to race, color or national origin. In anticipation of significant transit system modifications, King County Metro Transit will identify resulting service levels and quality of service for minority and non-minority communities, and make such information available to policy makers.

  The Americans with Disability Act (ADA) requires that complementary paratransit service be comparable to non-commuter, fixed route service for the general public in several ways, including service area, days and hours, response time and fares. The minimum complementary paratransit service area, as defined by federal regulations, is based on Metro's non-commuter fixed route service. When non-commuter fixed route service changes occur, the paratransit service area is adjusted to reflect these changes as needed.

- **Congestion:** As population and employment grow, traffic congestion generally increases. As congestion grows in a region, as it has in the Puget Sound Region, operating conditions for transit deteriorate. The amount that people drive, measured as vehicle miles traveled (VMTs) has increased significantly in this area. The amount of congestion on the region's roadways has a direct impact on the effectiveness of transit.

- **Changes to the Region's Transportation System:** The Puget Sound Region's transportation is constantly changing and adapting to the mobility needs of its residents. There are many plans and proposals for improvements and expansions to the transportation system in this area. Regional transit agencies must coordinate amongst themselves, other transportation agencies and jurisdictions, and other interested parties. King County Metro actively participates in regional transportation planning and the development of transportation system changes to ensure coordinated efforts that include transit-supportive elements. King County Metro also participates in regional planning efforts to make certain that transit service implications of regional transportation projects are integrated into King County Metro's strategic plan.

- **Major Transportation Corridor Projects:** Several major construction projects are underway on multiple corridors concurrently in the Puget Sound Area. Maintaining mobility throughout the construction period may be one of the region's more significant transportation challenges. Implications of these construction projects for King County Metro are multi-layered. Foremost, Metro will be faced with the challenge of keeping buses moving through construction-related congestion that will affect the whole region. Secondly, King County Metro service could potentially be an important part of efforts to

mitigate construction-related congestion. Some of the major transportation projects and proposals that may affect mobility include:

- **Alaskan Way Viaduct (AWV) Replacement.** The Alaskan Way Viaduct Central Waterfront section will be replaced by a tunnel. Construction will impact roads and transit service through Downtown Seattle. This will influence overall accessibility into downtown Seattle, transit operating speed and costs into and through downtown, and the amount of transit service needed in the affected corridors during and after project construction. Since a majority of Metro Transit service passes through downtown Seattle, small increases in travel speed or reliability have a large impact on both ridership and the cost of operation.
- **SR-520 Bridge Replacement and HOV Project.** State and local governments continue to work with neighborhoods and local organizations to refine designs for a bridge replacement and decisions about freeway options through the Montlake area. Although construction is not scheduled to begin until 2013, King County Metro will work actively with local groups and the state to maintain transit-friendly features of the project and address potential impacts to transit.
- **Urban Partnership.** Related to the SR 520 project, and in partnership with the Puget Sound Regional Council and the Washington State Department of Transportation, King County is one of the metropolitan areas selected for federal funding and technical assistance for planning innovative approaches to congestion reduction. The proposal would implement tolls on SR-520 subject to legislative authorization, and fund transit improvements in the corridor. Experience gained from the urban partnership program could affect plans to implement tolls on other freeways, providing increases in ridership demand and, potentially, in revenues for transit.

Internal Factors to Consider when Planning a Transit Network

Planning a transit network requires a delicate balance between many things. In addition to the external challenges of planning and implementing a transit network, internal challenges also complicate transit planning. Once a decision has been made about how to best balance the many trade-offs and competing goals, normally an iterative process, plans are formulated for how to work towards system goals. Effective network design is an important factor in meeting varying trip needs and balancing some of these goals.

Each decision will affect transit riders and the transit agency in a different way. Often times, an improvement in one aspect of the network can negatively impact another. Therefore, route design is inherently a juggling act of trade-offs and choices. The factors that can be affected by network design are:

- **Travel Time**: Travel time for riders is the cumulative time needed to get from the origin to the destination. This time includes:
  - **Access Time**: The time it takes to access the bus from the origin point.
  - **Wait Time**: The time it takes for the bus to arrive at the bus stop.

  - **Travel Time**: The time spent on the bus.

- **Ridership and Fare Revenue:** The more riders who are attracted to taking the bus, the greater the fare revenue will be. If routes are designed to be lifeline services for people, they are typically not going to generate a substantial amount of revenue.
- **Efficiency:** The number of rides per hour that a bus provides is an indicator of how efficient the service is.
- **Community Integration**: A goal in network design is to integrate a bus route into the community it serves. This could refer to how easy the route is to operate and how much bus service impacts pedestrians, residents, businesses and automobiles.

This document describes effective planning principals that are used by Metro planners to the extent possible to create an effective and efficient transit system. For each principle listed below, a diagram is included that indicates how each principle generally affects the four factors listed above. Travel time is broken into its three components. In each of these graphics, an arrow pointing up means that the factor increases and an arrow pointing downward means that the factor decreases. This could produce a negative or positive effect depending on the factor. These graphics show the general trend, yet there could be specific instances where the impact is different than what is shown in the graphic.

Planning Principles

Planning principles are generally focused on improving the customer experience and enhancing transit operations. 12 planning principles are described in more detail below:

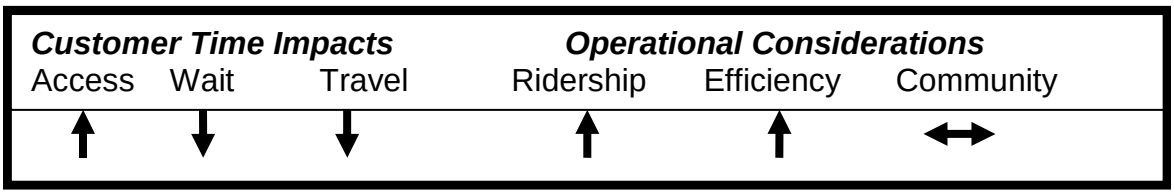
- **Principle 1 – Routes should be direct**

  The shortest distance between two points is a straight line. Routes that operate directly along a corridor without deviating off the corridor are faster and more attractive to customers once they are on the bus. The tradeoff of a direct route is that the route will serve a smaller geographic area, meaning some customers may have to walk further to get to access a bus stop.

  Route should only deviate off of a direct pathway where the number of riders boarding/alighting on the deviation is significantly more than the time lost for through riders. In addition, it makes sense for a route to deviate off a direct pathway if it would be difficult or unsafe for customers to walk between the main pathway and the destination.

  Small loops and Circulators are popular in theory because they can come closer to providing direct access for people. However, routes that travel in circles tend to attract low numbers of riders. Small loops at the end of routes are acceptable as a means to increase service coverage and turn the bus around.

  The graphic below shows the typical impacts of making routes more direct. Access time to the route tends to increase, which is a negative impact. However, wait and travel times tend to decrease and ridership and efficiency tend to increase, all positive impacts.



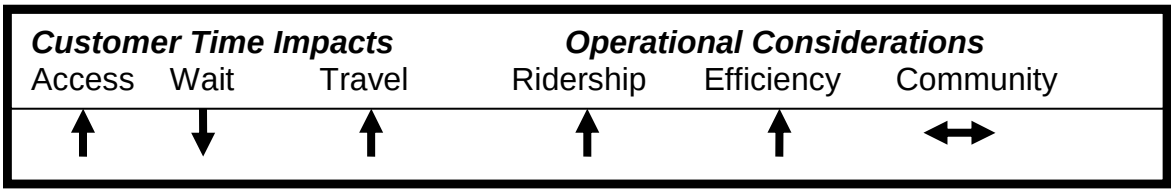
- **Principle 2 – Generalized service is more desirable than specialized service**

  Generalized service attempts to serve many customer groups. Through diversification of customer groups, generalized services can withstand major changes in travel patterns by a single group fairly easily. However, by serving several customer groups, generalized services tend to require more frequent service and longer service hours than do specialized services. The higher service level of generalized services can create a "virtuous cycle" of ridership gain followed by further service level improvements. The higher service levels are also more efficient as riders can use the bus to travel in both directions at all times of day. Additionally, buses on frequent service routes are often used more efficiently than those on infrequent service routes.

  Differing from generalized service, specialized service that is designed for a specific group of customers provides a high level of service only to that group of customers. By doing this, specialized services tend to ignore all other groups of customers. The success of a specialized service is linked directly to the single customer group and is significantly impacted by any changes in group travel patterns. Specialized service often heavily favors travel in a single direction with buses travelling empty or nearly empty in the other direction.

  Despite these negative characteristics, specialized services can be used effectively. Good examples of specialized services operated by King County Metro are the routes designed to carry customers to the University of Washington. Trips are scheduled specifically to serve major class start/end times and major shift times for workers. In addition, ridership varies significantly over the course of the year which allows Metro to reduce service on many of the routes during the summer and term breaks.

  The graphic below illustrates the impacts of generalized services. Access time and travel time on the route tend to increase, which is a negative impact. However, wait times tend to decrease and ridership and efficiency tend to increase, all positive impacts.



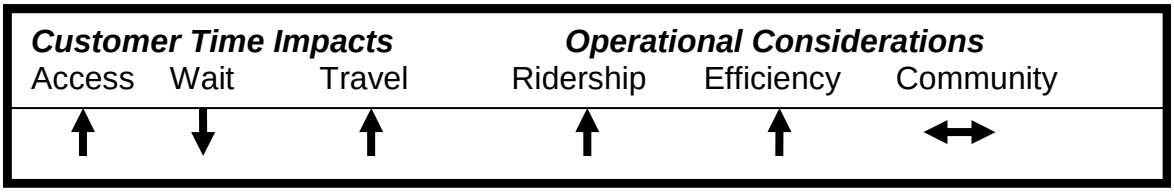
- **Principle 3 – Routes should serve multiple destinations**

Routes designed to serve multiple destinations tend to have higher ridership and more seat turnover than routes that only serve a single destination. In order for a route to have a single destination, the market for that destination must be sizeable, exceeding the sum of the markets of multiple destinations.

Serving multiple markets with a single route can be tricky as the markets served should be chosen in a way that complement one another and provide insurance for one another if either market is failing. Choosing markets that are too closely related can result in a "perfect storm" of either severe overcrowding or under utilization.

Examples of multi-destination, complementary market King County Metro routes are Routes 64 and 303 which serve both Downtown Seattle and First Hill. Customers on First Hill tend to arrive and leave work earlier than those in Downtown Seattle. Therefore early trips on these routes have a higher percentage of First Hill riders while later trips have more Downtown Seattle riders. By combining these markets, Metro is able to offer a wider diversity of trip times to both markets than could be afforded by a single-destination route.

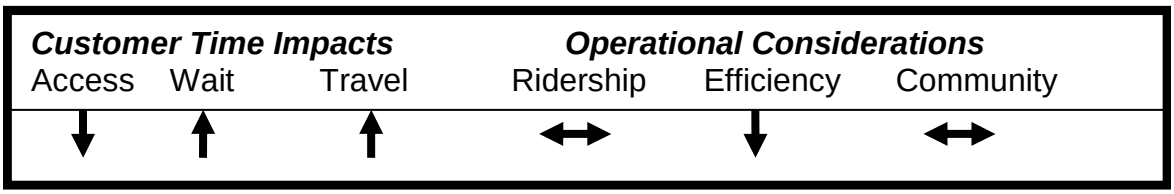
The graphic below illustrates the impacts of routes that serve multiple destinations. Access time and travel time on the route tend to increase, which is a negative impact. However, wait times tend to decrease and ridership and efficiency tend to increase, all positive impacts.



- **Principle 4 – Bus stops should be spaced as far apart as possible without compromising ridership**

  Customers access bus service by waiting at a bus stop. Closely spaced bus stops along a route mean that customers have a short walk time to the stop but it comes at the expense of slowing the buses down as they need to stop more frequently. In addition to the actual time it takes to serve a stop, service speed can be further slowed as buses are stopped at traffic signals which are timed to optimize general traffic progression. There is a tipping point for how effective the service is. This point is the place where the increased ridership attracted by an additional stop is outweighed by a loss of riders due to slower trips. Finding the right balance between good access and good service speed is tricky and must be evaluated on a route-by-route basis.

  The graphic below illustrates the impacts of increased stop spacing. Wait time and travel time on the route tend to increase and efficiency tends to decrease, which are negative impacts. However, access times tend to decrease, a positive impact.



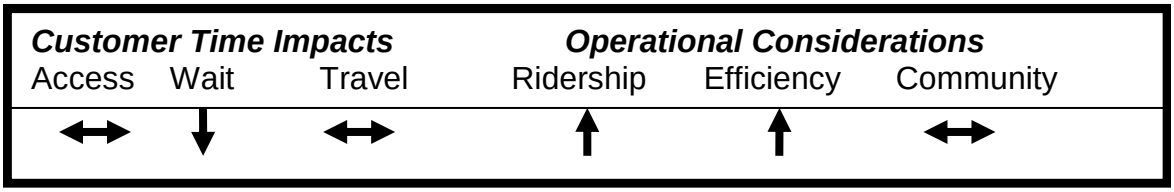
- **Principle 5 – Bus routes should be the appropriate length to minimize operational issues**

  In general, the longer a route is the more likely it is to encounter delay along the course of the journey. The increased likelihood of delay of longer routes means that additional time must be scheduled at a terminal in order to ensure the on-time departure of the following trip. On the other hand, longer routes also provide the opportunity for more trips to be made without a transfer, thereby increasing ridership and efficiency of the service.

  However a route that is too short is not going to attract many riders as the waiting plus travel time is not competitive when compared to the time it would take to walk. Bus routes should, therefore, be no shorter than a couple miles.

  Two different routes are sometimes "through-routed" and these buses will continue from one route to another route seamlessly. Through-routing two previously independent routes can be beneficial to both customers and operations. The customers who previously transferred between routes may no longer need to, saving time. Operators can also benefit as it may be possible to reduce the overall amount of unproductive "recovery" time between routes.

  The graphic below illustrates the impacts of designing shorter routes. Wait times tend to decrease and ridership and efficiency tend to increase, which are positive impacts.

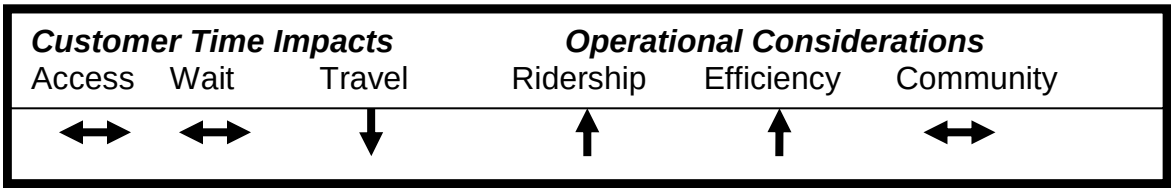


- **Principle 6 – Avoid heavy traffic congestion to the extent feasible**

  Wherever possible, routes should be designed to avoid known locations of traffic congestion while continuing to meet the needs of the customers. Freeway interchanges and roads leading to them can be severely congested with automobile traffic. In addition, there is rarely a reason for bus riders to get on or off at freeway interchanges. Therefore, bus routes should be routed to cross freeways at locations where interchanges do not exist.

A good example of avoiding traffic congestion is the diversion of Metro Routes 5, 75, 345 and 346 to avoid crossing I-5 on North Northgate Way. There is a major traffic interchange at this intersection. Therefore, these routes cross I-5 on North 92nd Street. In addition to avoiding the traffic congestion, the routes are able to directly serve North Seattle Community College, providing another customer group access to these routes.

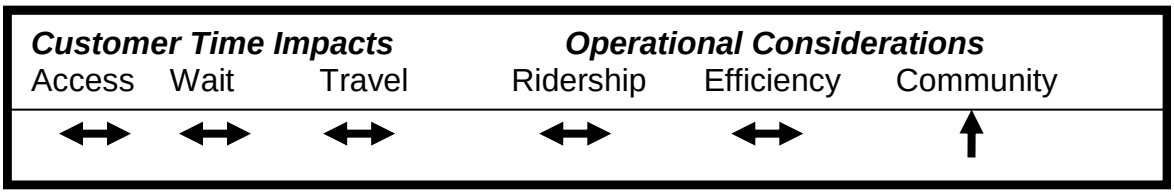
The graphic below illustrates the impacts of avoiding heavy traffic congestion. Travel times tend to decrease and ridership and efficiency tend to increase, positive impacts.



- **Principle 7 – Operate on appropriate streets**

Buses are large and heavy vehicles and are unable to safely operate on all streets. For the most part, buses should only be routed on arterial streets as they are designed to handle bigger vehicles. In addition, they are also more likely to have sidewalks for customers to access bus stops. Operating buses on minor streets is more likely to generate negative feedback from residents who may perceive buses to be a nuisance because of increased noise.

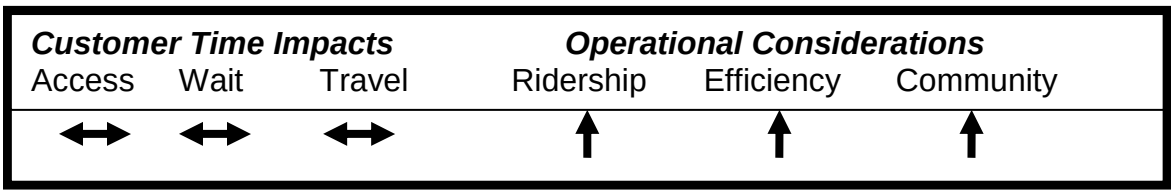
The graphic below illustrates the impacts of operating on arterial streets. Community integration increases, a positive impact.



- **Principle 8 – Choose appropriate locations for route terminals**

The location where a bus route ends and the buses wait before starting the next trip must be considered carefully. From a ridership perspective, route terminals that are also a destination help to ensure that there is demand for travel in two directions, thereby improving ridership and efficiency. The physical location of a route terminal can be perceived negatively by adjacent residences and businesses so route terminals should be placed where impacts are minimized. Off-street Transit Centers are ideal locations for terminals.

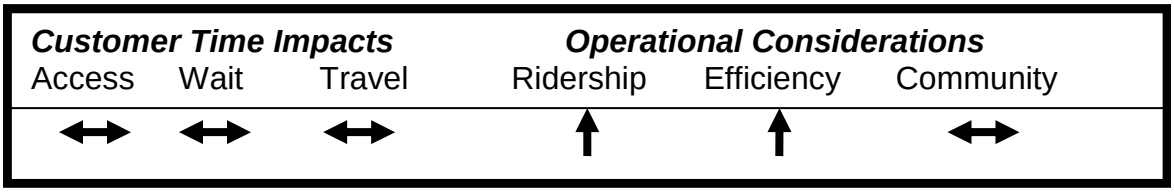
The graphic below illustrates the impacts of having appropriate locations for terminals. Ridership, efficiency, and community integration tend to increase, all positive impacts.



- **Principle 9 – When appropriate, give routes more than one function**

  Routes that are designed to serve a single function, such as feeding commuters into a rail station, can be tailored specifically to meet the needs of that function. However, due to the lack of variety of a single-function route, ridership and productivity will be lower than a route that has multiple functions. A route that serves multiple purposes will attract more riders than one that serves a single function. Routes that attract more riders will also justify higher service levels, again increasing the attractiveness for riders.

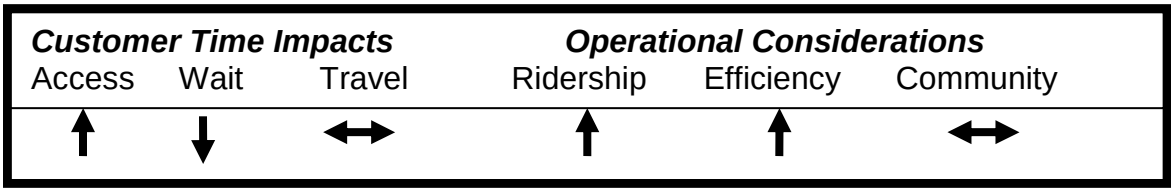
  The graphic below illustrates the impacts of giving routes multiple functions. Ridership and efficiency tend to increase, positive impacts.



- **Principle 10 – Plan for multiple routes to serve the same corridor, increasing the relative frequency**

  Different portions of routes can have significantly different demand levels. If a portion of a route has sufficiently more demand than other portions, other routes can converge on the corridor with complementary schedules to provide a higher frequency. This situation is most often observed when routes are approaching high density centers or connecting two urban centers.

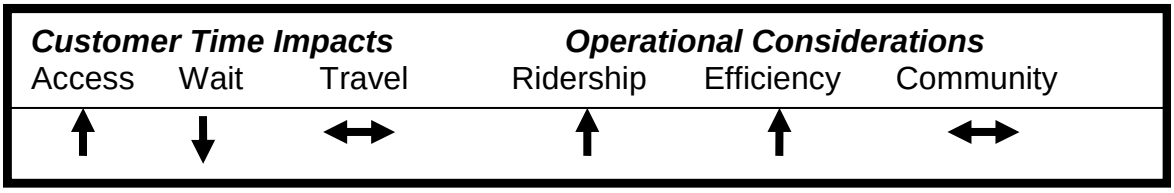
  The graphic below illustrates the impacts of having multiple routes serve the same corridor. Access time tends to increase, which is a negative impact. However, wait times tend to decrease and ridership and efficiency tend to increase, all positive impacts.



- **Principle 11 – Space routes appropriately**

  Studies indicate that riders are wiling to walk ¼ to ½ mile to access a transit route. This suggests that routes should be no closer than ½ mile apart otherwise routes will be duplicative and compete for the same pool of riders. A network of routes that is spaced every ½ mile can provide a higher frequency than could be afforded by a network of routes that are spaced every ¼ mile. However, urban and physical geography and the customers' ability to access service will all also impact the spacing of routes.

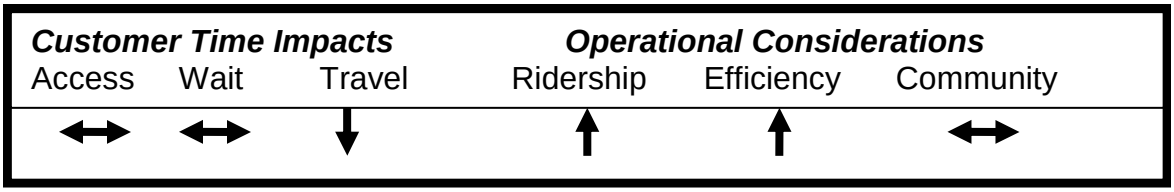
  The graphic below illustrates the impacts of spacing routes ½ mile apart. Access time tends to increase, which is a negative impact. However, wait times tend to decrease and ridership and efficiency tend to increase, all positive impacts.



- **Principle 12 – Work in conjunction with other services and providers**

  Bus routes should provide connections to the regional network of transit services in order to expand the travel range and possibilities of customers, as their functions are complementary. Regional rail and express buses provide a much higher service speed than local service. At the same time, local service provides distribution and collection of passengers within the communities. Good integration of these services will improve the ridership and efficiency of both regional and local transit services.

  The graphic below illustrates the impacts of integration with regional transit routes. Travel times tend to decrease and ridership and efficiency tend to increase, all positive impacts.



Service Change Process

(Adapted from the 2007-2016 Strategic Plan)

King County Metro is committed through policy and King County code to conduct a community planning process as part of the design and implementation of significant changes to existing service or development of new service. Subarea and community-based planning plays an important role in identifying new service initiatives, updating transit plans and modifying service. Subarea and community based planning processes involve the following steps:

- Define subarea and community priorities within the parameters of the policy framework
- Work with individual communities to define specific improvements to be implemented consistent with strategies in the Strategic Plan

To do this, Metro works with the subarea transportation boards, including the Eastside Transportation Partnership (ETP), South County Area Transportation Board (SCATbd), and Seattle/Shoreline (Seashore) and other stakeholders to identify service priorities not specifically identified in existing plans. Where appropriate, Metro develops community sounding boards to identify specific improvements and modifications to be implemented.

Service Changes

Formal King County Council approval of detailed service proposals finalizes the service change process, which takes place three times a year. This formal approval provides opportunities for the public to help design and implement changes. Current service is changed and new services developed through this process. Although the exact schedule of events may vary during each service change process, depending on the complexity of the changes being discussed and the decision timeline associated with them, processes should be designed to:

- Include input from riders, nonriders, citizen advisory committees, elected officials, community leaders, city and county staff, school districts, social service agencies, and Metro staff and operators.
- Make use of information on public and community needs and preferences, research on other transit systems, and data on the performance of the current system.

Working partnerships are created between King County Metro and communities affected by service changes. This approach assumes the following:

- Public involvement occurs early in the planning process
- The public is advised about opportunities for involvement throughout the planning process

- An extensive public information effort uses a variety of media and communication media to keep discussion open
- Clarity is needed as to who contributes to decisions and who is responsible for the final decision
- Flexibility is necessary

The goal of this approach to community involvement is to ensure that Metro Transit is responsive and accountable to the community during implementation of the Six-Year Plan. Depending on the complexity of a given service change proposal, the community involvement process may take up to eighteen months, including Council adoption of the final service recommendations.

Additional Factors. Beyond consistency with plan objectives and strategies, during any given service change process a number of factors will influence the selection of a specific set of service changes. These considerations include federal requirements, cost, capital requirements, relationship to other proposals, and subarea priorities.

Federal Requirements. King County Metro is required to comply with two federal requirements - Title VI of the Civil Rights Act and the Americans with Disabilities Act (ADA) - that are integrated in all service proposal assessments.

The objectives of Title VI are to ensure that 1) the level, quality and distribution of transit service provides equal access and mobility without regard to race, color or national origin, and 2) opportunities to participate in transit planning are provided. In anticipation of significant transit system modifications, King County Metro Transit identifies resulting service levels and quality of service for minority and non-minority communities and makes such information available to policy makers.

The Americans with Disability Act (ADA) requires that complementary paratransit service be comparable to non-commuter, fixed route service for the general public in several ways, including service area, days and hours, response time and fares. The minimum complementary paratransit service area, as defined by federal regulations, is based on Metro's non-commuter fixed route service. When non-commuter fixed route service changes occur, the paratransit service area is adjusted to reflect these changes, as needed.

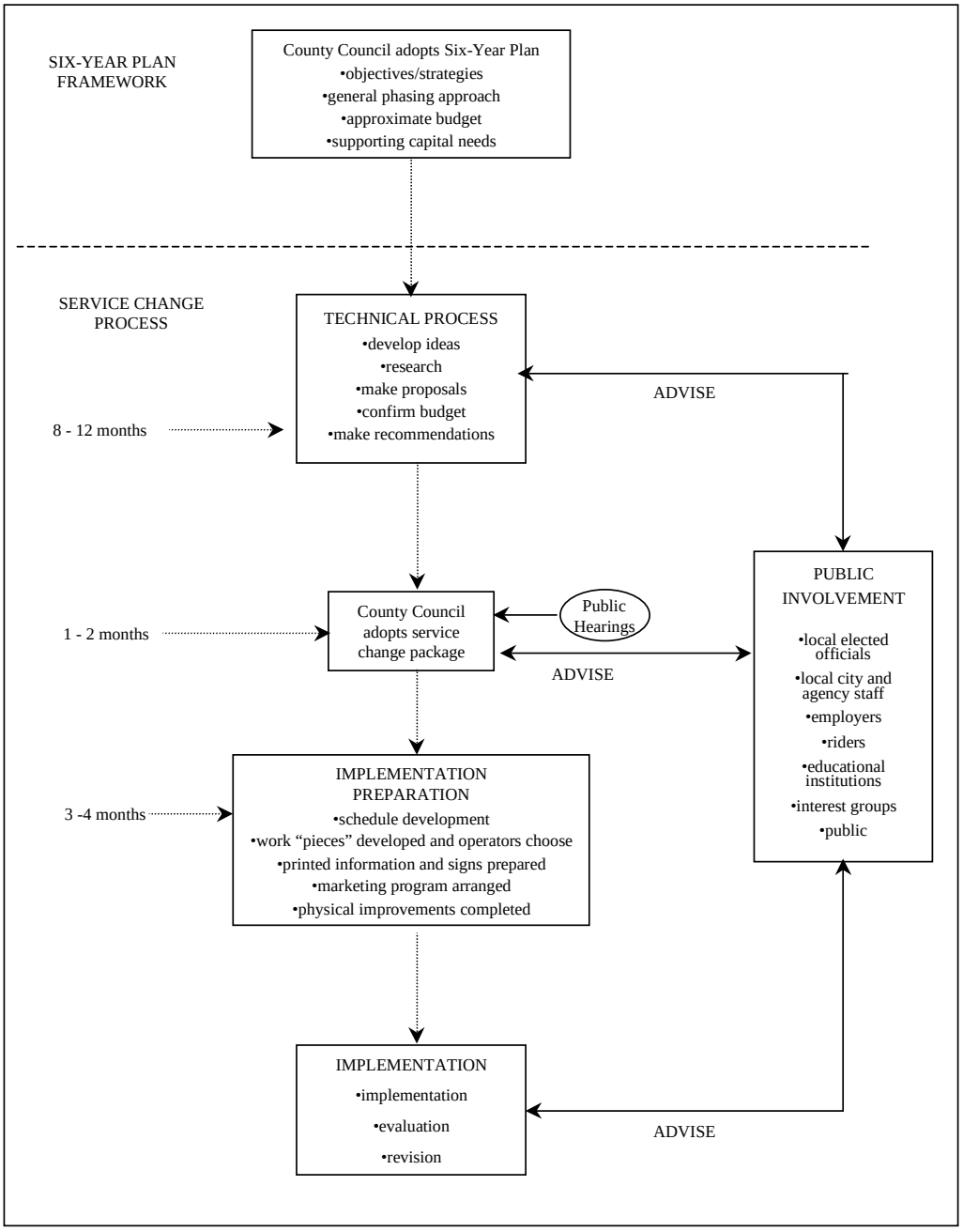
Cost. Some service changes may be delayed because of funding constraints. The magnitude and timing of service implementation may vary depending on the availability of additional revenue.

Capital Requirements—Integrating Service with Capital. The establishment of service priorities influences the timing for implementation of critical supporting capital program elements (fleet procurement, transit hubs, speed and reliability improvements, and other related improvements).

Relationship to Other Proposals. Different service proposals may complement each other by mutually enhancing their effect on overall mobility or system efficiency. Circumstances such as these could require that certain changes occur simultaneously.

As individual services are agreed upon, Metro periodically updates subarea groups on progress towards implementation. In addition, the groups are used as a "clearinghouse" to address issues regarding the direction of service changes, any issues resulting from the community work and effects on the overall network for the subarea in question.

Figure 6-1 illustrates the service change process.



Metro Transit Route and Schedule Change Process

New Ideas

New Routes?
New Stops?
More Service?

Who's Involved?
Planners,
Politicians,
Community Members,
YOU!

Analysis

Planning, Testing, Evaluating, Costing, Prioritizing, and Recommending

Who's Involved?
Planners,
Schedulers,
Managers

Make Decisions

Presenting, Debating, Negotiating, Budgeting, Agreeing

Who's Involved?
Planners,
Politicians,
Community Members,
YOU!

Make the Changes

Hiring, Training, Scheduling, Buying (Buses), Building (Facilities), Publishing Rider Information

Who's Involved?
Schedulers, Trainers,
Publishers, Marketers,
Managers, Builders

Provide the Service

Driving, Maintaining, Cleaning, Processing, Securing

Who's Involved?
Drivers, Mechanics,
Maintenance Workers,
Customer Service,
Transit Police

Monitoring Performance and Defining Success

Why Measure Performance?

Monitoring transit performance helps assess current circumstances, past trends, existing concerns and unmet needs[1]. It provides an assessment of progress towards goals and objectives, trends, achievements, short-comings or challenges and establishes a method to communicate results to stakeholders.

Results from performance measurement inform internal and external stakeholders including the public, elected officials, funding and regulatory agencies and division, department and executive management. They provide information to inform budget and operational decisions, and keep Metro accountable to stakeholders and citizens of King County for transit funding that is collected through taxes.

Common Measures

There are a variety of different measures used by transit agencies nationally and internationally. The most commonly measured attributes include service performance and productivity and reliability. These measures can be grouped into broader categories, although some measures fit into more than one category. The Transit Cooperative Research Program *Guidebook for Developing a Transit-Performance Monitoring System* identified primary categories of measures:

- **Performance**: Transit performance from a business perspective, including utilization, efficiency and effectiveness. These measures can help identify how well resources are used and the ability to meet demand with given resources. Common measures include ridership, productivity, cost per passenger, fare box recovery ratio and cost per revenue hour.
- **Service delivery**: Passengers' day-to-day experiences using transit, including factors such as reliability, customer service and passenger loading. Specific indicators include on-time performance, rider satisfaction, overloads, missed trips and complaint rates.
- **Availability/Access**: The ease with which potential passengers can use transit services for various kinds of trips, from a geographic and temporal perspective. Specific measures include span of service and access to transit.
- **Community measures**: Transit's role in meeting broad community objectives, such as mobility, community enhancements and environmental benefits. Examples include the reduction in vehicle miles traveled or reduction in greenhouse gases.
- **Safety and security**: The likelihood of being involved in an accident (safety), or becoming a victim of a crime (security) while using transit. Measures include passenger and operator assaults, accident rates and perception of safety while riding or waiting for a bus.

[1] Transit Cooperative Research Program, Research Results Digest. Summary of TCRP Report 88: A Guidebook for Developing a Transit-Performance Measurement System. January 2003.

- **Maintenance**: The effectiveness of the agency's maintenance program, in terms of vehicle reliability. An example measure is miles between trouble calls.

Performance Monitoring at Metro

Reporting

Various groups receive reports on Metro's performance including Metro operating divisions, Metro management, the King County Council, the Regional Transit Committee, the Washington State Department of Transportation (WSDOT) and the Federal Transit Administration (FTA), as well as the public and other interested parties. An outline of Metro Performance Reports and reports to external agencies can be found below.

Metro Performance and Customer Research Reports:

- **General Manager's Report**: reports annual operating and financial statistics for the year including ridership, on-time performance, safety and security measures, and operating expenses. Also includes information on the Transit Capital Program.
- **Route Performance Report**: reports annual performance of Metro's fixed-route bus services including riders per revenue hour, fare recovery ratio and passengers per revenue for each of the routes Metro's system. This report is designed to help inform Metro planners on possible modifications to existing routes in the system.
- **Rider Surveys**: Metro conducts both rider/non-rider surveys as well as surveys focused on regular and infrequent riders. These reports are designed to track customer awareness, transit use, and commuting and customer satisfaction. Surveys are typically done on an annual basis.

***All reports can be accessed online*:** http://metro.kingcounty.gov/am/reports/reports.html

Reports to External Agencies

- **Summary of Public Transportation**: Metro submits operating information, objectives and achievements each year to WSDOT. This report provides data to legislative transportation committees and local and regional government as well as other transit agencies throughout the state.
  Online at: http://www.wsdot.wa.gov/Publications/Manuals/PTSummary.htm\
- **Equity in Transit Report**: report for the Federal Transit Administration, examining Metro's compliance with the Civil Rights Act.
  The Equity in Transit Report is available by request from Metro Staff.
- **National Transit Data (NTD) Report**: requirement of the Federal Transit Administration that agency report certain statistical information each year. This includes service area characteristics, fleet information, operating income and expenses, and measures of service efficiency and effectiveness as well as cost effectiveness such as operating expense per revenue mile and passenger trips per revenue hour.
  A summary of 2007 agency data can be found at:
  http://www.ntdprogram.gov/ntdprogram/pubs/profiles/2008/agency_profiles/0001.pdf

Measures

Metro regularly reports on more than 30 measures assessing agency performance including utilization, cost efficiency, service effectiveness and reliability. A list of regularly-monitored measures is identified in Table 1. These measures focus on three key areas: financial performance, service availability and service delivery.

Table 1: Regularly Monitored Performance Measures and Associated Reports

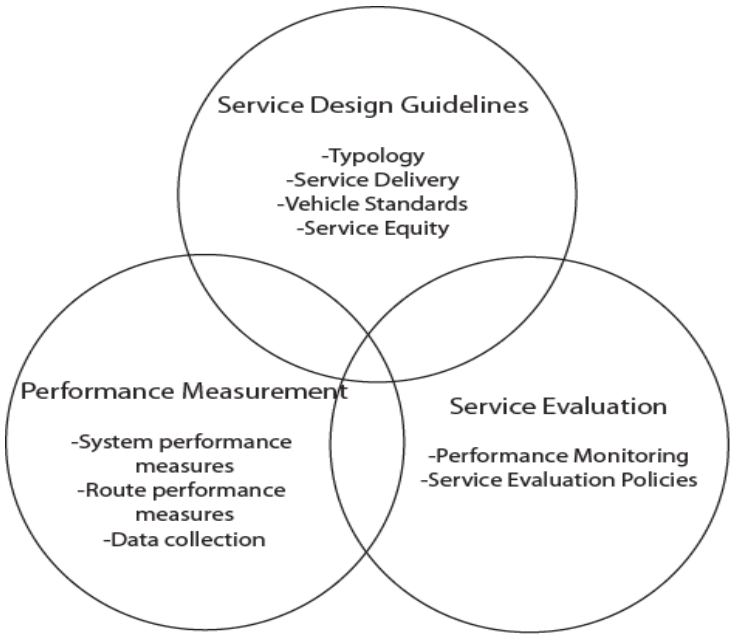
Measures	Measure Category	General Managers Annual Report	Route Performance Report	Rider/Non-Rider Survey	NTD Report
Financial					
Ridership (fixed-route, vanpools, Access)	Utilization Outcome	X			X
% of households that have rider	Utilization Outcome			X	
Boardings per capita	Utilization Outcome			X	X
Average daily unlinked trips (weekday, sat, sun)	Utilization Outcome				X
Fare Revenue/Operating Expense Ratio	Cost effectiveness	X	X		
Operating expense per passenger mile	Cost effectiveness				X
Operating expense per boarding	Cost effectiveness				X
Boardings per revenue hour	Effectiveness		X		X
Passenger miles per revenue hour	Effectiveness		X		
Boardings (unlinked passenger trips) per revenue mile	Effectiveness				X
Bus operating cost per service hour	Cost efficiency	X			
Cost per platform hour	Cost efficiency				
Operating expense per revenue mile	Cost efficiency				X
Operating expense per revenue hour	Cost efficiency				X
Total passenger miles	Utilization Outcome				X
Passenger miles per platform hour	Service effectiveness		X		
Boardings per platform hour	Service effectiveness	X			
Availability					
Total annual platform hours	Availability	X			X
Total annual revenue hours	Availability				X
Total annual revenue miles	Availability				X
Percent of King County/households within ¼ of transit or ½ mi of park-and-ride	Availability				
Service Delivery					
On-Time performance	Reliability	X			
Complaints per million boardings	Customer service	X			
Customer assistance office	Customer service	X			
Response to customer contacts	Customer service	X			
Miles between Trouble calls	Maintenance	X			
Accidents per million miles	Safety	X			
Assaults on operators	Security	X			
% of riders satisfied with on-time performance	Customer service			X	
Customer satisfaction overall	Customer service			X	

Relationship to Service Guidelines and Service Evaluation

Performance measures are one element of effective service planning. Two other important elements that work in conjunction with performance measurement is service guidelines and service evaluations, which are described below.

- **Service Guidelines** outline criteria for evaluating and adjusting performance of transit service as well as identify methods and procedures for the design of transit service.
- **Service Evaluation** allows a transit agency to objectively assess how well the mix of transit services provided is meeting the mobility needs within a transit agency's service area.

When fully integrated, service design guidelines, performance measurement, and service evaluation, build upon one another and essentially form the foundation for which a transit network can be created and maintained. The diagram below illustrates that service design guidelines, performance measurement and service evaluation must be an integrated approach.[2]



Purpose of Guidelines and Standards

Many public transit agencies implement guidelines and standards to guide transit service development, design and provision. Service design guidelines identify methods, procedures, and criteria for designing, evaluating, and adjusting the performance of fixed-route and demand-responsive public transit services. They act as tools for maximizing the overall usefulness of the public transportation system for customers, ensuring the consistency of the route structure, and providing consistent criteria for establishment of service levels.

[2] Florida Department of Transportation Research Center, *Best Practices in Transit Service Planning*, 4.

Guidelines differ from standards in that guidelines tend to be more flexible in nature. A standard on the other hand is a more firm measure used as a basis for judgment or comparison[3].

Guiding Factors for Metro Service and Facility Development

King County Metro guidance for service and facility development comes from many sources including Metro's Ten Year- Strategic Plan and Comprehensive Plan for Public Transportation, historical agency guidelines, published industry best practices and application of professional knowledge and judgment. For the purposes of this discussion, service and facility guidelines and standards are considered for those elements of Metro's system which are not already specifically guided by federal, state or local laws or regulations, which themselves may direct or define Metro services.

Metro has at different points in time identified service guidelines to provide direction for tracking performance, evaluating service changes and identifying services not meeting the desired levels of performance as well as identifying design guidelines for facility development. Given the evolution of Metro's transit system and the ongoing evolution of best practices across the transit industry, some previously-identified guidelines are no longer relevant. Consequently, there is no one document that Metro points to as the basis for service and facility development decisions but rather decision-making rests upon a variety of sources. These sources include planner knowledge and experience, adaptations of previously identified guidelines, national research by industry experts such as the Transportation Research Board, and review of service and facility guidelines used by other agencies. The Ten-Year Strategic Plan and the Comprehensive Plan for Public Transportation include policies and strategies that guide service and facility development in both specific and general ways.

Examples of Service and Facility Guidelines

There are certain guidelines that Metro uses regularly and which affect various aspects of Metro's service design, delivery and system management investments. Some guidelines suggest best practices for service design, methods of evaluating service quality or to identify thresholds at which service or facility investments should be made. For example:

- *Service Quality – Overloads:* A route is defined as overloaded when it is at or above 1.2 capacity or where passengers are standing 20 minutes or longer
- *Service Quality – Schedule adherence*: A route is defined as on-time if it is up to 5 minutes late or 1 minute early.
- *Service Design – Deviation*: Routings should only deviate from a more direct pathway than where the number of riders boarding/alighting on deviation is offsets the number of minutes lost for through riders.
- *Facility Investment – Threshold for installation of a shelter:* 50 or more riders per day in Seattle, 25 or more outside of Seattle.

[3] National Committee on Urban Transportation. Recommended Standards, Warrants, and Objective for Transit Service and Facilities: A Procedural Manual. 1958.

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Purpose-driven public transport: creating a clear conversation about public transport goals

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ABSTRACT

Public transport faces an increasingly intense conflict between patronage goals and coverage goals. Broadly speaking, patronage goals seek to maximize patronage of all types, while coverage goals lead to the provision of service despite low patronage – to achieve social inclusion objectives for example. The conflict between these goals follows inevitably from the underlying structure of the public transport product, including both its costs and geometry.

The tradeoff between patronage and coverage is the type of value-judgment that elected officials are paid to make. The paper presents a means of quantifying the tradeoff, to facilitate public discussion and decisions on how to balance these priorities. These strategies are designed to ensure that the decision about how to balance social versus patronage goals is made consciously rather than inadvertently, with a clear understanding of the consequences of the choice.

0. Introduction

Public transport exists for a range of purposes, including environmental, economic, and social ones (Veeneman, 2002). However, different purposes may imply quite different kinds of service. Public transport providers and funding agencies may try to present themselves as serving all the diverse purposes of public transport, but in fact they must make hard choices between competing goals. This paper presents a language for discussing these hard choices with constituents and elected officials, one that has proven valuable in consultation and decision making.

Most of the purposes of public transport cluster around two opposing poles:

- Purposes served by *patronage*. Most environmental benefits of public transport are related to how many people use the service. Fiscally conservative goals, such as minimizing subsidy, are affected by fare revenue, which also varies with patronage.
- Purposes served by *coverage*. Social benefits of public transport, such as accessibility for persons who cannot drive, tend to be based on the severity of need among certain population groups, rather than the level of patronage to be gained by meeting this need. Demands for "equity" of public transport service among areas with different patronage potential also can yield low-patronage services that are retained for these non-patronage reasons (Hay, 1993, 1995).

This paper contends that it is possible to create a language in which to discuss those hard choices with the public, so that elected leaders can make informed and quantified decisions about those choices that reflect their constituents' values. The key idea is to use the consultation process to educate constituents and decision-makers about the patronage–coverage tradeoff, and then elicit a direction in the form of a percentage of service resources to be devoted to each of these purposes. The role of the public transport funding agency and operator, in this scheme, is to document that the service they are providing reflects the balance of values chosen by the public through their elected leaders.

A scheme of this kind was developed by the author in the course of consulting projects for several public transport agencies in North America.[1] The agencies in question ranged from larger urban operators (population over 2 million) to agencies covering free-standing small cities (population 50,000–100,000). The Regional Transportation Plan for the urban area of Reno, Nevada (Regional Transportation Authority of Washoe County Nevada, 2005), based on work for them by the author, uses the scheme most ambitiously, establishing and monitoring long-term goals for each category.[2]

[1] The author acknowledges the contributions of these US clients to this line of thinking, notably Salem Keizer Transit, Salem, Oregon; Whatcom Transportation Authority, Bellingham, Washington (2004); Regional Transportation Commission of Washoe County Nevada, Reno, Nevada (2005); the City of Fort Collins, Colorado (2002); Valley Regional Transit, Boise, Idaho; and VIA Metropolitan Transit, San Antonio, Texas.

[2] The Reno policy states: "Approximately 80% of Citifare service will be allocated to maximize productivity and 20% for coverage to provide service in less dense areas." (2005, pp. 2–7) "Productivity" in this statement corresponds to "Patronage" in this paper.

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The distinction between patronage-oriented and coverage-oriented services echoes distinctions made by Litman (2006, p. 58) and Nielsen et al. (2005), among others. The State Government of Victoria in Australia (Betts, 2007) makes a policy distinction between "mass transit" and "social transit" that roughly parallels the distinction between patronage and coverage. This paper attempts to quantify the tradeoff as precisely as possible, as a tool for public discussion and consensus-building.

The structure of this paper is as follows:

- The first two sections discuss the two categories of goals proposed – patronage goals versus coverage goals – and explain the different kinds of service design that tend to follow from each.
- Section 3 describes the range of situations in which this distinction is useful.
- Section 4, "Service Design Policies and "Equity"" shows how the language of the productivity/coverage distinction leads to policies that elected officials can understand as reflecting their values, and that public transport managers and planners can implement and measure.
- Section 5, "Consultation Process", presents an approach to consultation using the proposed tools.
- Finally, one key technical challenge in such policymaking is to define the starting point – i.e. what is the split between patronage and coverage goals in the existing service pattern. Section 6 "Analysing Existing Services by Purpose", discusses techniques developed to this end. The section is aimed at planners and managers seeking to use this tool, but a reader interested in larger questions of policy may skip this section without missing important material.

1. Patronage goals

A patronage goal is one that is achieved to the extent that people use public transport. These goals include:

- *Goals related to financial return or efficiency*. The agency or operator that receives the fare revenue are motivated to maximize patronage.
- *Goals related to vehicle trip reduction*. Most environmental purposes of public transport – including emissions reductions – are met by full public transport vehicles and not by empty ones.

The typical measure of a patronage goal is patronage per unit of cost, e.g. passengers/km or passengers/h. Where fare revenue is relatively constant per passenger, fare revenue per passenger (high) or subsidy per passenger (low) can also express achievements toward a patronage goal.

Patronage goals are not all exactly aligned with one another. For example, some emissions-related goals are related to vehicle km travelled, and are therefore met mostly in relation to passenger–kilometres. Others, especially those relating to "cold start" emissions, tend to vary with passengers more than passenger–distance, at least over the typical distance range of urban public transport operations. Meeting environmental goals may also require that public transport patronage consist of people who would otherwise have generated car trips, rather than those who otherwise would have walked, cycled, or not made the trip.

In the urban public transport context, however, these variations are small in comparison to the difference between patronage goals and their opposite, the coverage goals. The key point of patronage goals is that they all tend to lead to similar kinds of service, namely:

- *Frequent all-day service in dense and walkable areas*. For example, in a large urban area based on a core city that is at least a century old, the portion of the city built before World War II typically has higher overall densities and also a more well-connected street grid that is friendly to pedestrians, while being less friendly to the private car. Some newer centres and communities may also have these features. These areas tend to support voluntary public transport dependence, which in turn leads to high all-day patronage.
- *Frequent all-day connections between major activity centres*, where the intense activity at these centres produces high demand even though the demand at points in between may be relatively light.
- *Frequent peak-period service in commute markets*, where a high level of demand can be served over a short period. This tends to be a dominant mode of service in lower density areas.

In most urban public transport operations, the most productive services, in terms of patronage per unit of cost, are generally of these types.

It should be noted, however, that the patronage/coverage distinction is used to categorize services by the standards of a particular study area, Thus the distinction can be used by outer-suburban and rural operations where there is no dense inner city fabric, because these areas still have services that reflect a patronage goal as applied to that service area. The key to identifying patronage-oriented services is to ask: "Would this service still run when and where it does if patronage were our only purpose?" In low-density areas some markets will be *relatively* high-patronage by the standards of that study area, and would therefore pass this test.

2. Coverage goals

Coverage goals are met by the availability of service, regardless of its patronage. These values tend to include:

- *Social needs of disadvantaged populations*. When a public transport operator proposes to cut a service due to low patronage, the response is often an intense objection from small numbers of people who depend heavily on the service. A facility serving senior citizens or disabled persons, for example, will advocate for their service not based on how many people use it, but rather on the severity of the problems these people would face if the service were taken away. Whenever service is provided or retained due to such appeals, we are in the presence of a coverage goal.
- *Concepts of geographic equity*. The perception that service should be "equitable" leads to a dispersion of service to include areas with low patronage potential. In outer-suburban Sydney, for example, typical "good" performance for a bus route can be as little as 0.5 passengers/km, while in the inner city a "good" performance is 2.0 passengers/km or more. A purely patronage-based approach would focus service on the best markets and abandon unproductive markets. Services retained despite this consideration reflect the impact of the coverage goal.[3]

The typical measure of a coverage goal takes the form "___% of residents and jobs must be within ___ metres of service".

Again, there are some subtleties among coverage goals, but they are exceptions that prove the rule, showing that all coverage goals are broadly more similar than different:

[3] Alternatively, equity can be as a possible position midway between patronage and coverage goals, as discussed later in the paper.

- Severity of need and geographic equity sometimes diverge in the case of very small numbers of people with severe needs in an otherwise rural setting, but the vagueness of the concept of equity is often extended to embrace these cases.
- Low-patronage service may be provided with the intent of "leading development", where there is credible reason to believe that high patronage will be achieved at development build-out. These cases are easily dealt with by identifying the service as patronage-based but defining the patronage target in relation to development completion.

Service designed for a coverage goal is by definition low-patronage service, by the standards of a given agency or service area. As a result, these services tend to be:

- Devoted to low-density and rural areas where patronage potential is always relatively low.
- Infrequent, because services are spread over the largest possible area.
- Circuitous, often including one-way loops, because covering an area is more important than speed or directness of operations.

Demand-responsive services are usually coverage services, because compared to successful fixed route services in the same area, they tend to have lower productivity. By their nature, demand-responsive services must devote more effort to serving each passenger than fixed routes do, so they tend to reach their capacity limits at much lower levels of patronage. When a demand-response service replaces a successful patronage service at low-demand times, some special considerations apply as discussed in Section 5.

3. Uses of the patronage–coverage distinction

The question about how to divide resources between patronage and coverage services is, by design, a judgment about competing values. It obviously has no technical answer, but rather goes to the heart of each citizen's beliefs about why public transport should exist at all. Framing service design questions in these terms can quickly lead to remarkably clear conversations among constituents about what really matters to them.

This conversation can lead, in turn, to an informed decision by appropriate elected officials. The resulting policy typically takes this form:

> Devote ___% of resources to services justified by patronage, and the remaining ___% to maximizing coverage.

Service design professionals can design a network that implements this direction precisely, including documentation showing which services are intended for patronage and which are intended for coverage.

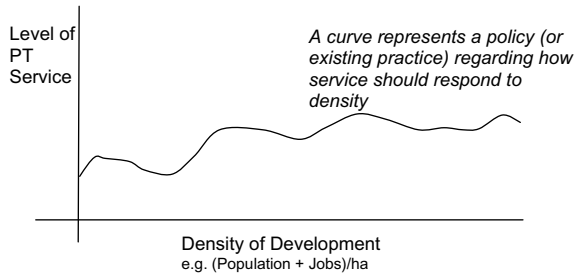
Such a policy provides a clear answer to inevitable objections that arise during consultation, by showing that the service provided is a fair implementation of a consistent policy. For example, if a resident of a low-density area complains about their low level of service, the reply is that:

- The density and/or development pattern where they live is not conducive to a high-patronage service, so any service they receive is going to be coverage service.
- The proposed service plan represents a fair distribution of the __% of service dedicated to coverage over the areas to be covered.
- If you want more service than is provided, your options are to (a) advocate for a shift of the overall policy in favor of coverage or (b) advocate for a local funding source in your council or market area to supplement your service above the policy level.

Elected officials often value this kind of policy because it spares them from accusations of favoring one area over another. It also empowers the elected official by separating service design into its two components: decisions about values – which elected officials should make – and the technical and creative aspects of designing service to implement those values – which are the province of public transport professionals. The result can be an increased level of trust between these two essential parties in the service design process.

4. Service Allocation Policies and "Equity

To understand the effect of the productivity and coverage goals on service design, consider a service allocation graph where the *x*-axis represents density, and the *y*-axis represents the service provided. Different service allocation policies can be represented by different curves. If a hypothetical community had equal amounts of each density, then the area under the curve would be proportional to the overall quantity of service provided:

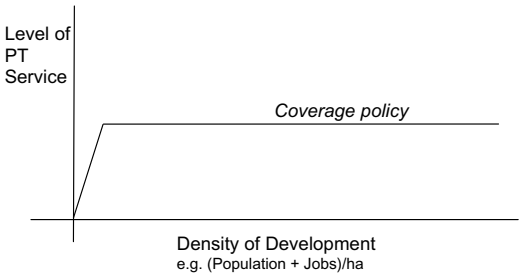


Density here should be understood as a shorthand term for "aspects of a built environment that directly affect public transport patronage." As Cervero (1998, pp. 72–74) and others note, density is indeed the overwhelmingly dominant indicator, but other aspects of design, such as the continuity of the pedestrian network, are also relevant. Density indicates the size of the market located within a fixed air distance (such as the common 400 m standard) of a transit stop, but the pedestrian network determines how much of that market is within a fixed walking distance (Ewing, 1996, p. 13). Densities (and hence air distances) are commonly used as shorthand because density information (by small travel zones) is usually available. A more subtle and accurate measure would consider walking distance rather than air distance, but this calculation requires levels of detail about the pedestrian network, and exact locations of destinations within travel zones, that are not available from most jurisdictions.[4]

By the same principle, density must be understood as combining both population and activity density. The measure (Population + Jobs)/ha is a reasonable approximation that is easy to calculate, though subtler and more complex measures are possible.

A coverage approach is responsive to need rather than density. Even coverage-oriented service falls away at the very lowest densities, but apart from this coverage service is about making a little service available everywhere, regardless of density. For example, a typical small-city coverage system consists of one-way loop routes all running at the same frequency, converging on a centre for the purposes of connections but otherwise offering the same level of service everywhere. A coverage policy, then, would be a horizontal line, falling away only where the level of activity is so close to zero that the community expresses no need for public transport even as a social service or lifeline:

[4] For fast-growing or fast-changing areas, of course, it is often a challenge for jurisdictions to keep population and employment data current. Public transport planners are often accused of "planning for the past" even when they are using the most current data available.



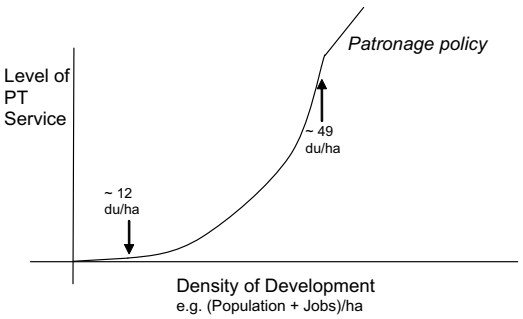
A deployment based on patronage is more complex, because the relationship between density and patronage has several different phases. Spillar and Rutherford (1998), for example, looked at cities in the Western US and found these relationships:

- In rural development up to about 12 dwelling units per hectare[5] (du/ha), demand is at a very low level, rising slowly in direct proportion to density. (Demand at this level is actually highly dependent on the presence of demographic categories with high public transport needs, such as senior citizens, the disabled, and youth below driving age.)
- From 12 du/ha to about 49 du/ha[6] demand rises faster than density, in an upward and roughly parabolic curve. This is the range in which most urban development in Australia and North America occurs, outside of the densest urban cores.
- Above 49 du/ha demand is again linear with density, but at a much higher rate than in rural areas. At these high urban densities, people live so close to so many of their daily needs that walk trips begin to take a large mode share at the expense of public transport.

Given these relationships, a service pattern devoted to maximizing patronage would follow these phases with service. The goal of the patronage policy is to deploy all service where it will carry the most passengers overall. Thus:

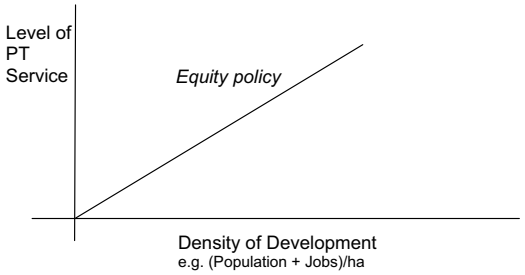
- At densities below 12 du/ha, patronage potential is low except for the occasional school trip. Thus, a strict patronage policy would provide no service apart from those school trips.
- At densities of 12–49 du/ha, patronage potential rises faster than density, so a patronage policy would follow this rising curve. (Spillar and Rutherford note that the rate of public transport use per household rises in an upward curve. The service allocation strategy, then, would be an even steeper curve, reflecting this rate of use times the number of households.)
- Above 49 du/ha, the curve becomes a steep straight line, as patronage continues to grow with population density, but not faster.

So a patronage policy would look something like this:



[5] 5 du/acre in Spillar and Rutherford.
[6] 20 du/acre in Spillar and Rutherford.

Graphing the policies in this way suggests a possible "compromise" between the two policies, namely one in which the service is directly proportional to the density throughout the range. This could be called an "equity policy", although it is not always what advocates of "equity" intend:



In regions or states where there is a wide range of development types, the equity policy has obvious appeal. Something like an equity policy is usually at work if an agency tolerates a much lower patronage/km in a low-density area than in a high-density area. In very dense cities, however, the equity policy provides far less service than the patronage policy does. A common outcome may be overcrowding in dense inner city portions of a network, while in outer-suburban areas public transport may run largely empty outside of school peak periods.

In practice, every consistent system of service allocation will be some compromise between a patronage policy and a coverage policy. The equity policy is one possible compromise, so long as policymakers are comfortable with having empty public transport vehicles in outer suburbs and overcrowded ones in the inner city. A simpler form of compromise, however, is simply to allocate resources between patronage and coverage goals, and allow the resources on each side of the divide to be used unequivocally for that end.

5. Consultation Process

Once an existing system is understood in terms of how it divides resources between patronage and coverage – and other purposes if relevant – elected officials are presented with a clear question that only they can answer: How should this balance between competing goods be shifted, if at all? This section briefly describes how this question can be applied both to short range service design decisions and long-term planning of policy networks. The discussions are obviously different in each case, but the underlying question is the same.

5.1. Short range service changes

When doing a short range service design where the strain between productivity and coverage goals is an issue, the best approach is often to draft two or more service designs that illustrate different points on a spectrum. For example, in a strategic plan project for the Whatcom Transportation Authority in Bellingham, Washington, USA (WTA, 2004) two service designs were prepared, one emphasising patronage and the other emphasising coverage. Both designs were taken to the public in consultation. Only then was a final recommendation developed striking a balance between the two. This approach had several benefits.

First, a common complaint about public consultations – that the plan has already been decided on and consultation is just a show – was refuted by the presentation of two options. All public transport management staff participating in the consultation were instructed to show no preference between the options in their comments to the public.

Second, participants readily understood the philosophical choice underlying the difference between the two options. For participants who were not comfortable discussing patronage and coverage as abstractions, the contrast between the proposed networks made the tradeoff clear.

Finally, all participants could express an opinion that could be translated into a quantifiable 'vote'. For example, if one scenario was, say 60% patronage and 40% coverage,[7] while the other was the opposite, then participants could easily vote for one of these, or to say that they would be comfortable halfway between them (a 50–50 split), or that they feel the split should be like one scenario but even more extreme (a 70–30 split or more). These votes could be readily tallied to quantify the position of any consultation group, thus providing clear guidance to the elected official(s) making the final decision.

In short, the analysis and discussion of a service plan in terms of a patronage–coverage tradeoff yielded a clear discussion in which all participants could have a valid opinion regardless of their level of technical expertise or ability to think abstractly. Nobody needed to master technical details of a proposal in order to discuss it. Instead, participants understood that they were being asked a real and consequential question, and that their response would have a measurable effect on the outcome. This clear conversation, and the clear and implementable policy resulting from it, is the ultimate purpose of the analysis.

5.2. Long-range network planning

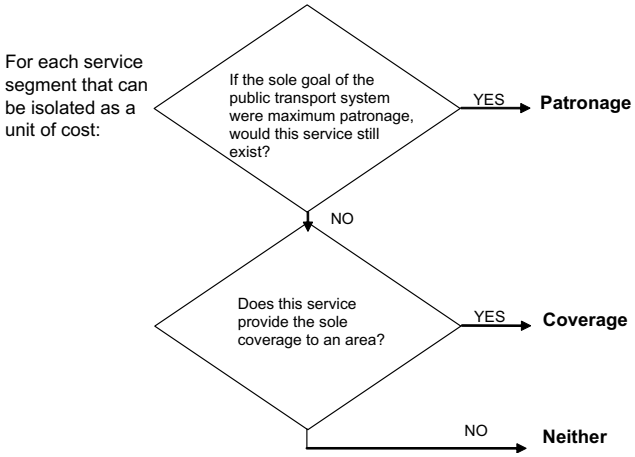
In long-range network planning, the patronage/coverage distinction is easier to talk about theoretically, and can be linked to other policy issues that are in play. For example, in the development of the Regional Transportation Plan for Washoe County, Nevada (the Reno area) a key concern has been the high non-auto mode share target – planned to rise from under 3% currently to 6% in 2030 (Regional Transportation Authority of Washoe County Nevada, 2005, pp. 2–7). The network at the time was split roughly 60% patronage, 40% coverage. When policymakers understood that patronage services were contributing substantially toward the mode share goal, but that coverage services were not, they authorised a gradual shift from the current 60–40 split to a target of 80–20 in favor of patronage. This target means that most new resources are assigned to patronage services, and the policy is cited as a reason why the agency cannot always meet the service expectations of new low-density, car-oriented outer suburbs. Service planning proposals are all assessed to see how they contribute toward reaching this goal.

It is important to stress that the "success" here is not the specific decision they reached, one with which the reader may disagree. Instead, it was that they reached a decision expressed in terms that their staff knew how to implement and measure. The elected officials also understood that they could revisit their decision, and that doing so would affect the patronage outcomes. For example, if they decided to shift resources from patronage service to coverage service, they should expect total system patronage to fall.

6. Analysing existing services by purpose

A consultation process on the patronage–coverage tradeoff typically begins with an analysis of existing public transport services in these terms. This analysis categorizes services according to the purposes they seem to be serving. The analysis typically looks both at the current performance of each route or service, as well as features of its design and the degree to which its existence supports other services. This section develops a basic methodology for this analysis. A reader more interested in the main concepts of the paper may wish to skip over this section.

The decision process for this analysis is as follows:



The sequence of steps has an impact on the outcome. If a service is justified by both patronage and coverage, it is assigned to patronage. This could have been thought of the other way: We could have first identified a system wide network of coverage, and then assigned to patronage only the frequency increments above that level. Both methodologies are valid, but get different answers, so the point is to be consistent in which methodology is used. The reason to assign to patronage first is a practical one: Many routes fall entirely into, or out of, the patronage category, so analysing the service this way means that fewer routes need to be divided between categories, and that routes can be divided by segment rather than by increments of frequency. The result is a simpler calculation and one that is easier to represent on maps.

The analysis is done primarily in terms of geographical segments, rather than temporal segments such as span of service or increments of frequency. Temporal segments are much more interdependent than geographical segments are, and therefore harder to divide by purpose. Every customer's round trip requires service at two times of day, or more, and every trip is sensitive to wait time and hence frequency. Therefore, cutting any temporal piece of service – e.g. by cutting off evening service earlier, starting morning service later, or reducing frequencies between the peaks – will have effects on patronage on other times of day. For this reason, it is usually misleading to say that a certain part of a service span, or a certain increment of frequency, is attributable to patronage while the rest is not. By contrast, a geographical increment is much easier to analyse in isolation, because it represents a discrete market.[8]

It would be easy to say, then, that the purposes of patronage or coverage are features of an entire route. However, it is quite common for an inner segment of a route to be justified by patronage, while outer tails or branches are clearly not. For this reason, some segmentation of routes may be essential for the analysis.

6.1. Assigning segments to patronage

The first question in the flowchart above may need some further explanation, because it is conditional and therefore requires considerable judgment. How do we know that a certain segment

[7] Given obvious roughness in the way services are allocated to categories, participants are encouraged to think about the patronage–coverage split in 10% increments.

[8] This issue is discussed further in subsection 6.3 below.

would be part of a maximum-patronage system, if that system were created and optimized?

The assignment is made based on the convergence of two factors:

- *Existing patronage*. Segments assigned to patronage generally have an existing productivity (patronage per unit of service) that exceeds the system average. This assessment must be based on the average load through the segment, not the boardings in the segment, since a non-stop segment where the bus is full is clearly patronage-justified.
- *Physical evidence of patronage potential.* For segments where the existing load is not decisive either way, we consider whether the segment's physical features lend themselves to further patronage growth, based on industry experience. Thus, positive indications for patronage would be if a route is:
  - Straight and direct (as opposed to circuitous and looping).
  - Operating on arterial streets that permit reasonable speed.
  - Serving continuous high-density development (i.e. a high population/employment level within 400 m).
  - Serving an area whose street network provides good pedestrian access from 400 m to either side.
  - Serving major patronage sources at the end of the corridor or segment, indicating demand to the end of the line.
  - A necessary part of a coherent connective network linking other high-patronage segments.

The "physical evidence" criteria tend to correlate with high patronage throughout the developed world. We include them because existing patronage on a particular local segment may be affected by other factors that are extraneous to this analysis. Where that is the case, it is important to consider whether the segment has the potential to be a high-patronage segment, and these factors are the definition of that potential.

6.2. Assigning segments to coverage, or to some other purpose

If a segment is clearly not justified by patronage, then we ask whether it has a unique function in providing the sole service to some neighbourhood or community. A good way to quantify this is: "If this service did not exist, would a significant number of residents and/or jobs no longer be within 400 m of service?"

The answer is usually yes, but the test is important because if the answer is no, the segment may have some other justification, usually but not always a weaker one. Examples may include:

- *Overlap*. A segment may exist overlapping other segments. This often occurs where service from several unique coverage areas converges on one path into a CBD or interchange. If these segments combine to form a high-frequency spine that supports high patronage, then the routes should be segmented to isolate this section. Small segments of this overlap may be acceptable in coverage services, since there is no more efficient route structure. Where a long overlap exists that does not combine to form a patronage service, it is sometimes appropriate to identify the service as "Overlap", and assign this category its own percentage. For example, when this analysis was done at Salem-Keizer Transit in Salem, Oregon, the quantification of an Overlap category helped the policy board understand the costs of offering a service pattern that required nobody to change to reach the CBD, as opposed to structures that would require more interchange but reduce duplication, thus allowing for better frequencies from the existing operating budget.
- *Political discretion*. Sometimes a service exists to satisfy a political demand, though it does not rise to the standards of either patronage or coverage. This is not necessarily a problem. Some applications of this scheme create a separate but usually small "Discretionary" category for these cases.

Where these categories exist, it is helpful to isolate them because they suggest other solutions.

6.3. Patronage and coverage services in integrated networks

Public transport planning is rightly concerned with creating integrated networks, where different kinds of service work together to meet a range of mobility needs. Often, a coverage service is described as 'complementary' to a patronage service. For example, demand-responsive services are often designed to complement a fixed route network. Commonly, they may serve areas that are physically unsuited to fixed route service, but bring people from those areas to a fixed route. They have broad application to evening and especially late-night service needs, where they can replace fixed route services that are unproductive at these hours, and provide a "guaranteed ride home." Considerable innovation is occurring in this area.

However, one service may complement another but still not be grounded in the same underlying purpose. Where a low-patronage service is integrated with a high-patronage one, the key question is whether the former is making the decisive difference to the performance of the latter.

The key question for our analysis is: "If our only purpose were maximum patronage per unit of service, would this service still exist?" For example, if it can be shown that certain demand responsive services are essential to the high performance of a fixed route, then and only then a case could be made for treating those demand-responsive services as patronage services. In many cases, however, a successful fixed route continues to perform well with or without these complements, because of the intrinsic strength of the markets it serves directly.

To understand the purposes of integrated or "complementary" services, it is important to distinguish between several things that these terms can mean. When Service A and Service B are described as complementary or integrated, it usually means one of the following:

- *Service B connects with Service A, but serves a different area*. In this case, Service A and Service B can still have different purposes.
- *Service B serves the same area as Service A, but runs at different times of day and/or days of week*. Many successful high-patronage services run late into the evening. These late evening trips are often low patronage, but their existence helps support patronage earlier in the day, as passengers are more comfortable using a service that gives them the option of returning home later than planned. For this reason, when considering an all-day fixed route, we do not assign different purposes to different trips based on their patronage, because part of what makes the service attractive is its entire span of service and the resulting simplicity. It follows that if Service A runs throughout the daytime but Service B replaces it in the evening to serve the same area, the two could be thought of as having the same purpose, based on their combined performance as a unit. This is an area where further research is needed, to determine the extent to which these evening services are essential to the success of the daytime route.
- *Service B serves the same area as service A, but provides specialised service for passengers who cannot use Service B for reasons of disability*. "Paratransit" services for the disabled do not fit cleanly into the patronage–coverage distinction. Where the cost of these services is assigned to fixed route operators by law, e.g. under the United States Americans with Disabilities Act, these services

become part of the cost of running a productive fixed route system, so there is no point in assigning them a separate purpose. Specialised service provided in excess of the legal requirement, or where there is no legal requirement, are best treated as a separate purpose outside of the proposed scheme, though they are similar to coverage services in that they do not aim for high patronage but rather to meet identified needs.

7. Conclusion and suggestions for further research

Public transport must serve the competing demands of patronage and coverage, because the two values push service design in opposite directions. If this distinction is made explicit, and discussed as such, the result can be a clearer conversation and, in the end, a more confident decision by the elected policymaker(s). These concepts have been used successfully to facilitate both short-term service design decisions and long-range network planning, and can be used as a way to judge short-term decisions against the long-range vision.

The core analytical question proposed is, for each public transport route or service: "Would this service still exist if maximizing patronage were our only purpose?" The paper provides a detailed methodology for answering this question, but there is certainly room for further research and thought. These include:

- How can we more precisely quantify the effects of integration between different services? What are the cases in which two or more "complementary" services should be judged only as a unit?
- Can the concept be extended fruitfully to a discussion of services for the disabled?
- How often should datasets describing existing population and employment by traffic zone be updated, and are there ways to make this updating process continuous so that current data is always available?
- Many practical refinements to the patronage/coverage tool would emerge from a large-scale application of the analysis, e.g. by using it for all of the local planning within a state, province, or nation. This paper is currently founded largely on the author's successful experience in using the tool in a range of planning projects, but these results do not lend themselves to easy summation because each agency used the tool in a different way for a different local need. A more systematic application would certainly help to refine the methodology and perhaps broaden the range of decisions in which it is useful.

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