Transit

Strategies for Implementing Transit Priority

This document is the first in a series of best practices that transform complex and technical material into non-technical principles and guidelines for transit. For titles of other best practices in this and other series, please refer to <*www.infraguide.ca*>.

National Guide to Sustainable Municipal Infrastructure

NRC · CNRC   Federation of Canadian Municipalities   Canada   Transport Canada   Transports Canada

Strategies for Implementing Transit Priority

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INTRODUCTION

InfraGuide® – Innovations and Best Practices

Why Canada Needs InfraGuide®

Canadian municipalities spend $12 to $15 billion annually on infrastructure but it never seems to be enough. Existing infrastructure is ageing while demand grows for more and better roads, and improved water and sewer systems responding both to higher standards of safety, health and environmental protection as well as population growth. The solution is to change the way we plan, design and manage infrastructure. Only by doing so can municipalities meet new demands within a fiscally responsible and environmentally sustainable framework, while preserving our quality of life.

This is what the National Guide to Sustainable Municipal Infrastructure (InfraGuide) seeks to accomplish.

In 2001, the federal government, through its Infrastructure Canada Program (IC) and the National Research Council (NRC), joined forces with the Federation of Canadian Municipalities (FCM) to create the National Guide to Sustainable Municipal Infrastructure (InfraGuide). InfraGuide is both a new, national network of people and a growing collection of published best practice documents for use by decision makers and technical personnel in the public and private sectors. Based on Canadian experience and research, the reports set out the best practices to support sustainable municipal infrastructure decisions and actions in six key areas: decision making and investment planning, potable water, storm and wastewater, municipal roads and sidewalks, environmental protocols, and transit. The best practices are available on-line and in hard copy.

A Knowledge Network of Excellence

InfraGuide´s creation is made possible through $12.5 million from Infrastructure Canada, in-kind contributions from various facets of the industry, technical resources, the collaborative effort of municipal practitioners, researchers and other experts, and a host of volunteers throughout the country. By gathering and synthesizing the best Canadian experience and knowledge, InfraGuide helps municipalities get the maximum return on every dollar they spend on infrastructure—while being mindful of the social and environmental implications of their decisions.

Volunteer technical committees and working groups—with the assistance of consultants and other stakeholders—are responsible for the research and publication of the best practices. This is a system of shared knowledge, shared responsibility and shared benefits. We urge you to become a part of the InfraGuide Network of Excellence. Whether you are a municipal plant operator, a planner or a municipal councillor, your input is critical to the quality of our work.

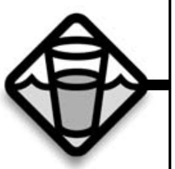
Please join us.

Contact InfraGuide toll-free at 1-866-330-3350 or visit our Web site at <***www.infraguide.ca***> for more information. We look forward to working with you.

The InfraGuide® Best Practices Focus

Transit

Urbanization places pressure on an eroding, ageing infrastructure, and raises concerns about declining air and water quality. Transit systems contribute to reducing traffic gridlock and improving road safety. Transit best practices address the need to improve supply, influence demand and make operational improvements with the least environmental impact, while meeting social and business needs.

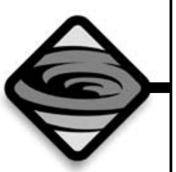


Potable Water

Potable water best practices address various approaches to enhance a municipality's or water utility's ability to manage drinking water delivery in a way that ensures public health and safety at best value and on a sustainable basis. Issues such as water accountability, water use and loss, deterioration and inspection of distribution systems, renewal planning and technologies for rehabilitation of potable water systems and water quality in the distribution systems are examined.

Environmental Protocols

Environmental protocols focus on the interaction of natural systems and their effects on human quality of life in relation to municipal infrastructure delivery. Environmental elements and systems include land (including flora), water, air (including noise and light) and soil. Example practices include how to factor in environmental considerations in establishing the desired level of municipal infrastructure service; and definition of local environmental conditions, challenges and opportunities with respect to municipal infrastructure.



Storm and Wastewater

Ageing buried infrastructure, diminishing financial resources, stricter legislation for effluents, increasing public awareness of environmental impacts due to wastewater and contaminated stormwater are challenges that municipalities have to deal with. Storm and wastewater best practices deal with buried linear infrastructure as well as end of pipe treatment and management issues. Examples include ways to control and reduce inflow and infiltration; how to secure relevant and consistent data sets; how to inspect and assess condition and performance of collections systems; treatment plant optimization; and management of biosolids.

Municipal Roads and Sidewalks

Sound decision making and preventive maintenance are essential to managing municipal pavement infrastructure cost effectively. Municipal roads and sidewalks best practices address two priorities: front-end planning and decision making to identify and manage pavement infrastructures as a component of the infrastructure system; and a preventive approach to slow the deterioration of existing roadways. Example topics include timely preventative maintenance of municipal roads; construction and rehabilitation of utility boxes; and progressive improvement of asphalt and concrete pavement repair practices.

Decision Making and Investment Planning

Current funding levels are insufficient to meet infrastructure needs. The net effect is that infrastructure is deteriorating rapidly. Elected officials and senior municipal administrators need a framework for articulating the value of infrastructure planning and maintenance, while balancing social, environmental and economic factors. Decision-making and investment planning best practices transform complex and technical material into non-technical principles and guidelines for decision making, and facilitate the realization of adequate funding over the life cycle of the infrastructure. Examples include protocols for determining costs and benefits associated with desired levels of service; and strategic benchmarks, indicators or reference points for investment policy and planning decisions.

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ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

Providing public transit with a strategic advantage on our transportation network is imperative to meet the growing need for mobility, the need to be cost-competitive and the need to offset the growing congestion in our urban areas. While there have been strong advances in implementing transit priority in some of Canada's major centres, to date there has not been a comprehensive look at both the measures that can be used to create priority and the implementation processes used to put them in place. The objective of this Best Practice is to gather together the best examples of how to implement transit priority on our urban roads.

Implementing transit priority implies that passengers on our bus, Light Rail Transit (LRT) and streetcar systems will be given greater status. Improvements in speed, reliability, comfort and convenience can be brought together to create programs giving transit a competitive edge, which improve the image and performance of our transit systems. These demonstrate that investment in transit priority will improve the attractiveness and productivity of our transportation systems.

Solutions that separate transit vehicles from general traffic provide the highest level of performance, but at the highest cost. The objective of this guide is to focus on solutions that can be applied to bus and streetcar systems to make better use of shared facilities. Bus bulbs, signal priority, queue jumps and green waves are a few of the ways we can improve transit. In some cases, dedicated lanes and exclusive transit facilities are required to provide the benefits needed, but even those connect to the road network at their end points and at intersections with cross-streets along the way. Advances in technology, especially intelligent transportation systems (ITS), have provided a suite of tools to improve transit with little or no impact to other road users, increasing transit performance and improving the performance of the network.

The case studies indicate that the most successful installations appear to be in cities or regions that have established a clear policy on transit improvements and have a strategic plan in place and good public and stakeholder consultation. Defining the need for priority and determining where it can be implemented is central to the development of a strategic program.

The benefits of transit priority can extend beyond the savings for passengers. They can include process improvements and lead to growing support for further improvements. Organizational changes can also arise out of making transit a priority. Many large centres including Vancouver, Edmonton, Montréal, and Calgary have now set up dedicated programs to look at transit priority. The Agence métropolitaine de transport in the Montréal area has both the responsibility and financial capability to coordinate improvements across the region.

With these benefits are a series of risks arising from organizational form, technical complexity and public and political acceptance of the solution. The risks can stem from integrating new infrastructure, the range of stakeholders involved and the internal organization of the implementing authority. Each risk can impact the overall cost and schedule of the project. In most cases the benefits provided by transit priority outweigh these risks, and through appropriate planning the majority of the risks can be controlled.

The risks do not end when the project is completed. Does the project meet the objectives set out for it? Has the image of the service been improved? Are the benefits measurable and do they support further initiatives? Evaluation and on-going monitoring of transit priority is necessary to maintain the momentum of the first project and continue to implement the strategic vision.

The stages of project development, moving from initial definition of need to functional planning, detail design and construction, rely on greater detail and resolution of issues. Setting priorities, handling public and stakeholder issues, working though operations and maintenance issues and documenting the "lessons learned" are all part of developing successful systems.

But success is not guaranteed. Political champions, good communications and a team willing to work through the issues also come into play. At the end of each project, the evaluation of success comes down to:

- Does the project meet the objectives that were set out?
- Has transit priority been achieved without affecting other road users to a degree that is unacceptable to the community?
- Has public perception of the transit system improved?
- Has the project created the potential for additional projects to be completed?
- Is there an ongoing evaluation program or process(es), to track system upgradeability issues, user feedback, operational follow-ups, and lessons learned for future enhancement of development?

1. General

1.1 Introduction

This is one of a number of best practices being developed under the auspices of the National Guide to Sustainable Municipal Infrastructure (InfraGuide).

This best practice document is concerned with both physical measures that can be put in place to provide priority for public transit and the process by which those measures are developed. It has been produced under the guidance of the Transit Working Group and is intended to provide practical advice and guidance to transit system managers, transit planners, traffic engineers and city planners.

Successful examples of transit priority exist across the country, but they are often site specific, and have been developed to meet the needs of the local authority. The process used to get from concept to implementation has valuable lessons for cities contemplating their first system or moving beyond that to a comprehensive approach.

1.2 Purpose and Scope

The purpose of this best practice is to provide a concise description of physical measures that can be used to provide transit priority, discuss how various successful systems have been put in place and document successful approaches to developing priority systems. In addition, broader approaches to building on early successes turning single successful projects into on-going commitments to providing transit priority are also discussed.

1.3 Glossary

Automatic Passenger Counting (APC) — Uses detectors to count the number of passengers boarding and alighting at each stop. The system is often connected to a global positioning system (GPS) to track passenger movements against specific stop locations. The information collected can be used to create route load profiles, identify delay locations and heavy use stops.

Automatic Vehicle Location (AVL) — A system that locates vehicles and can provide information to support real-time passenger information, calls for signal priority and reports vehicle position to the transit control centre.

Bus Rapid Transit (BRT) — A flexible, rubber-tired rapid-transit combining stations, vehicles, services, running ways, and Intelligent Transportation Systems (ITS) elements into an integrated system, which collectively improves the speed, reliability, and identity. In many respects BRT is rubber-tired light rail transit (LRT), but with greater operating flexibility and potentially lower capital and operating costs.

Bus Bulb — An area at a transit stop where the curb has been extended out beyond the parking lane to provide queuing space for transit users and allow transit vehicles to stop in the through traffic lane thereby avoiding the merge back into traffic. Also known as a curb extension, curb out or bus bulge.

Bus Lane or Reserved Bus Lane (RBL) — A traffic lane designated for bus use only but which permits emergency vehicles. Bus lanes are marked and signed differently from the adjacent general traffic lanes, but are not physically separated from the adjacent lanes.

Busway — A special roadway built exclusively for the use of buses. In general, emergency vehicles may use busways. In Ottawa it is referred to as a Transitway.

Demand for Service Indicator System (DSIS) — At stops equipped with DSIS, transit riders push a button that alerts approaching buses to exit the freeway and make a pick up. If the bus approaches the intersection and no alert is received, the bus is able to continue traveling on the freeway without having to exit.

Green Extension — Element of signal priority in which the normal green phase of the signal is extended to give priority to approaching transit vehicles.

Green Wave — Timing traffic signals so that buses always encounter a green signal as they approach is called a green wave. It requires that the progression of traffic along the roadway be set to match the speed of transit operations.

High Occupancy Vehicle (HOV) — A roadway where access is restricted to vehicles carrying a prescribed number of people. HOV–2 and HOV–3 are common examples that require at least two or three persons to be in each vehicle, respectively. Taxis, bicycles and emergency vehicles are usually allowed in HOV lanes as well.

Intelligent Transportation Systems (ITS) — The application of advanced and emerging technologies (computers, sensors, control, communications, and electronic devices) in transportation to save lives, time, money, energy and the environment. Further information about ITS can be obtained from the ITS Office of Transport Canada *<www.its-sti.gc.ca>* and from ITS Society of Canada, *<www.itscanada.ca>*.

ITS Architecture for Canada — provides a common framework for planning, defining, and integrating intelligent transportation systems, *<http://www.its-sti.gc.ca/en/architecture.htm>*. It reflects the contributions of a broad cross-section of the ITS community (transportation practitioners, systems engineers, system developers, technology specialists, consultants, etc.). The architecture defines:

- The functions (e.g., gather traffic information or request a route) that are required for ITS.
- The physical entities or subsystems where these functions reside (e.g., the roadsite or the vehicle).
- The information flows that connect these functions and physical subsystems together into an integrated system.

Light Rail Transit (LRT) — While the specific definition varies across the country, LRT is generally refers to “lighter weight” electric vehicles, with steel wheels operating on steel rails, capable of operating on roadways in mixed traffic. “Lighter weight” refers to a design that is robust enough to operate in mixed traffic, but not strong enough to meet the requirements of freight railways.

Proof-of-payment (POP) — A system of fare verification that does not require each passenger to verify fare payment with the driver. These systems allow for all-door boarding and can speed up passenger service times at stops. Fare enforcement is required as part of a POP system to minimize fare evasion.

Queue Jump — A short section of roadway or guideway used exclusively by transit vehicles to bypass a queue of auto traffic

Red Truncation — Element of signal priority in which the red phase is cut short, or truncated, to provide a green signal for approaching transit vehicles.

Transit Mall — A street, generally in the downtown area, which is dedicated to transit vehicles. Taxis, emergency vehicles, and cyclists may also use these malls.

Transitway — A dedicated roadway or guideway for transit vehicles, and may generally be used by emergency vehicles. They are also referred to as busways.

Total person delay — A measure of all delays experienced by all people at an intersection or along a corridor. It is used to help determine the priorities for projects.

Total vehicle delay — A measure of delays experienced by all vehicles at an intersection or along a corridor. Traditionally it has been used to design traffic systems, but it does not reflect the passenger carrying capacity of transit vehicles.

Traffic Signal Priority (TSP) — Any one of a series of measures designed to optimize the timing of one or more traffic signals to provide priority for transit vehicles.

White Cigar Lights — Signal aspect used only by transit vehicles. They are derived from the lights used in shipping channels. They are referred to as “white bars” as well.

2. Rationale

2.1 Background

Providing public transit with a strategic advantage on our transportation network is imperative to meet the growing need for mobility, the need to be cost-competitive and the need to offset the growing congestion in our urban areas. While there have been strong advances in implementing transit priority in some of Canada's major centres, to date there has not been a comprehensive look at both the measures that can be used to create priority and the implementation processes used to put them in place.

Implementing transit priority implies that passengers on our bus, Light Rail Transit (LRT) and streetcar systems will be given greater status. Improvements in speed, reliability, comfort and convenience can be brought together to create programs that give transit a competitive edge, that improve the image and performance of our transit systems and demonstrate that investment in transit priority will improve the attractiveness and productivity of our transportation systems. Many of the examples in this document reference buses, but the concepts can be applied to all transit vehicles including buses, streetcars and LRTs.

Transit systems are experiencing demands for improved services at the same time that they are being pressured to be more efficient and to reduce costs. Transit is also seen as one of the best tools for greenhouse gas reduction in urban areas and a key way to control the impact of congestion in our urban areas.

Solutions that separate transit vehicles from general traffic provide the highest level of performance, but at the highest cost. The focus in this guide is to find solutions that can be applied to bus and streetcar systems to make better use of shared facilities. Physical measures and advances in technology have provided a suite of tools to improve transit with little or no impact to other road users, increasing transit performance and improving the performance of the network.

Transit priority measures can be effectively used to improve four key factors that influence ridership, namely speed, reliability, comfort and convenience. That is, they act to increase transit mode share by improving performance relative to automobile travel.

A broad spectrum of measures is available to assist transit agencies, but have often been implemented on a case-by-case basis with little carry forward to other cities or other parts of the same transit network. Understanding both the spectrum of options and the process by which they are designed, implemented, operated, and evaluated will assist transit agencies in assessing the state of their own systems and how to move forward with measures to improve them.

The most successful installations appear to be in cities or regions that have established a clear policy on priority and have developed a strategic plan for implementation. Within the overall program, individual initiatives are identified and assigned some level of priority (budget, resource commitment, schedule). That does not necessarily mean that the project that would produce the greatest rider benefits is put in place first. Often the first project that is implemented is the one that is easiest to install and will provide an early success. The first project will demonstrate the benefits of transit priority and will typically become the benchmark for future projects. It also sets the standard for how the planning work is organized and how the various internal and external stakeholders work together to put the plans in place.

Improvements in speed, reliability, comfort and convenience can be brought together to create programs that give transit a competitive edge, that improve the image and performance of our transit systems and demonstrate that investment in transit priority will improve the attractiveness and productivity of our transportation systems.

Studies conducted by several transit operators indicate that transit customers appreciate 'special treatment' even if the benefit is not significant.

2.2 Benefits

The benefits that can be achieved by applying this Best Practice can be characterized in three areas:

- Operational Performance;
- Implementation Process; and
- Organization.

2.2.1 Operational Performance

The benefits to the transit passenger and other users of the road are related to:

- Increased efficiency of the transit system giving higher priority to transit passengers;
- Reduced travel time;
- Improved reliability (or reduced variation of travel time); and
- Increased comfort.

The benefits combine to provide a more attractive transit option relative to automobile travel.

Studies conducted by several transit operators indicate that transit customers appreciate 'special treatment' even if the benefit is not significant. Many customers place emphasis on a reliable trip over a fast trip. Perceived benefits from applying this Best Practice are also important. Queue jump lanes and other measures that let buses proceed before cars, are seen as giving a much more significant and visible benefit than is actually measured.

2.2.2 Implementation Process

The use of this Best Practice will provide benefits to municipal and/or regional transit, traffic and planning staff by:

- Increasing the level of understanding of transit priority, the range of measures available and how they can be applied;
- Standardizing the approach to defining and implementing priority, which will benefit future projects; and
- Establishing a program of continuous improvement, built on a strategic base, which will ease the implementation of subsequent projects.

2.2.3 Organization

Organizational benefits can also be achieved. For many of the agencies surveyed the implementation of transit priority crossed many internal boundaries and initially required unprecedented cooperation. The result was an increased understanding of roles and responsibilities and an increased appreciation for the benefits of public transit. Benefits include:

- Developing a strategic approach to city or region-wide needs that will help set priorities for implementation of transit projects and other city priorities;
- The development of relationships between departments and agencies which will foster cooperation; and
- Increased awareness of transit issues at City (or Regional) Council and with the public.

2.3 Risks

Risks can be separated into two categories: process and implementation (before); and ongoing monitoring and operation (after). The risks outlined here are not all-inclusive, but represent risks identified by the Working Group and the research for the Best Practice. They are meant as a guide and should be augmented with a review of specific project risks.

2.3.1 Process and Implementation Risks

These risks generally fall into four areas:

- Organizational (number of departments or agencies involved, potentially competing objectives between departments, resource allocation and changes in key staff);
- Technical complexity (non-standard or retrofit applications of physical and technology measures, new technologies, integrating technologies, number of systems to be coordinated, system reliability, data management and information flow);
- Public and political acceptance (agreement with design, resolution of parking and access issues, acceptance of priority measures); and
- Cost and schedule (estimating, capital programming, implementation timeframe and road works season).

Organizational Risks

Clear political and administrative direction, support and promotion, are needed to advance transit priority. Both project and political champions should provide this direction. The majority of transit priority projects cross many internal department boundaries and affect a wide range of internal and external stakeholders.

One option that has been adopted by several cities is the creation of a dedicated staff group that has overall responsibility for priority planning. This has been used effectively in both Calgary and Vancouver to avoid many of the internal organizational issues. This group could be formally established as a new unit (drawing resources from across the disciplines or seconding staff) or be set up as a committee with a specific mandate. The creation of a group with specific responsibilities demonstrates commitment to transit priority and dedicates resources to addressing the issues. The group supports the central concept of transit priority and acts to implement it in a coherent and strategic way. Cities without a central coordinating staff group are less likely to achieve their objectives as quickly as transit projects are scheduled in with a wide range of other infrastructure projects.

In addition to the focus that a staff group can provide, drawing resources from the traffic signals, traffic operations, transit operations, transit planning/scheduling, public communications, and enforcement into the group has additional benefits. The different disciplines can more effectively deal with all issues related to project implementation as they bring a wide range of knowledge and experience to the process. The individual members of the group can also act as “project ambassadors” bringing the needs of their discipline to the project and reporting back to their discipline on how the project is proceeding.

Competing priorities is a key risk in implementing urban infrastructure. It requires solutions focused on education, relationship development and technical data. For instance, many traffic engineers focus on the number of vehicles rather than the number of people moved. Others who focus on increasing travel speed often poorly understand transit’s emphasis on travel time reliability. Therefore, when a study indicates that travel speed will increase marginally but reliability will improve markedly, the relative importance of the factors masks the overall benefit to the public. The benefits of reliability need to be discussed, with technical studies and details to back them up.

Conflicting objectives can also be an obstacle to progress. In most communities, traffic/signal engineers have to deal with current (short-term) operational problems, which often include maximizing vehicular throughput and minimizing vehicular delay. The objective of increasing transit modal share is however not a short term objective, therefore, the traffic/signal engineer who may be in the best position to develop and implement TSP has contradicting short term and long term objectives. These conflicting objectives need to be resolved at the policy level.

Staff changes as departments reorganize and people are promoted, moved to new responsibilities or move on are inevitable. Relationships and common understandings that have developed through prior project work can be lost and new team members require time to understand the work that has gone before. Active management is required to maintain momentum.

A well-coordinated program that matches with the city or region’s comprehensive plans with a clear strategic direction will establish transit priority as a requirement of all traffic and transportation engineering and provide continuity.

A well-coordinated program that matches with the city or region’s comprehensive plans with a clear strategic direction will establish transit priority as a requirement of all traffic and transportation engineering and provide continuity.

For cities contemplating their first transit priority project, finding simple solutions that rely on tested systems and minimal technology requirements can minimize this risk.

Technical Complexity Risk

Technical complexities stem from three main sources: new physical features being integrated into a complex urban environment, technology and staged implementation.

Integrating new infrastructure into our cities is a complex task. Advance planning, thorough investigation and extensive detail design is required to ensure that all regulatory and statutory obligations are met, that existing arrangements and agreements are satisfied, and that the new system does not create unnecessary burdens on future maintenance. The details range from accommodating complex underground utilities and building foundations, to negotiating parking access and arrangements and streetscaping plans, to mitigating environmental impacts.

These risks can be minimized through coordination and project planning. They should be clearly identified early in the project to control their impact both on cost and schedule.

In many ways, the development of priority measures builds on technical innovations implemented to manage traffic on highways and roadways. As a result, highway solutions adapted to transit often require re-evaluation and significantly more effort than originally thought. In particular, transit signal priority systems often require a significant prior investment by transit agencies in scheduling, GIS and AVL systems to provide the necessary databases and real-time vehicle location information to operate the system.

For cities contemplating their first transit priority project, finding simple solutions that rely on tested systems and minimal technology requirements can minimize this risk. While simple solutions can be very effective, long term planning and a strategic plan for a comprehensive network of transit priority measures is still required. Decisions coming from an overall plan adopted at the political level will be easier to support and defend.

The level of complexity of the technology employed is a key decision. Most of the cities surveyed began with very simple systems that have grown with their long-range plans. Their early efforts were based on visiting other cities and observing how solutions had been developed and taking the information back to apply to their case. As the systems have grown some cities have expanded their technology to suit expanded needs whereas others have made the strategic decision to keep their systems simple and expand deployment. In each case the risks associated with technology have been balanced against their long-term goals and the benefits of the systems used.

Technical complexity can also arise from the number of departments or agencies involved. In Vancouver's 98 B-Line, there were four jurisdictions controlling the traffic signals. Developing a common understanding of the definition of priority and how to implement it was a significant challenge. Cities or Regions with one centralized level of government may find fewer inter-agency obstacles and greater cohesion in terms of strategic direction.

These risks can be minimized through the development of project teams and the development of strong relationships between departments. Large complex projects can be the catalyst for the development of these relationships. A multi-jurisdictional/departmental project team management promotes successful results for all parties involved and greatly enhances integration of transit priority projects.

Public Acceptance Risks

One of the biggest potential risks in major infrastructure projects today is the reaction of the public to the project. The reactions tend to be very different based primarily on proximity and perceived benefit. While transit projects are generally viewed as positive, the benefits are spread across a large group of people over a wide area. Those who live close to the project site are often more aware of the potential impacts than the benefits and tend to be a small but vocal minority focused narrowly on the project site. Identification of the potential for public reaction is imperative.

For some projects, such as signal priority, there may be little public recognition of the new system, as the majority of the system can be installed without the general public being aware of the work being done. On the other hand, projects that require road or guideway construction have the potential to impact on-street parking or change the traffic lane configuration and will almost certainly create a public reaction.

For major transit priority projects, a "political champion" is almost a necessity as it is difficult for staff to engage stakeholders in processes that will inevitably become political. Before launching public processes it is useful to strategize how to engage and anticipate actions. Professional strategists and public relations specialists can be helpful in mapping out a strategy to engage stakeholders in processes that may be controversial. Knowledge of local issues and indeed council leanings are very important. Sometimes it is just not the right time to proceed with a project.

The best public support is achieved where programs:

- engage all stakeholders early in the process;
- are supported by political champions;
- provide adequate information and opportunity for public input;
- are designed, in advance, based on public expectations and knowledge (which often requires the project team to consider each element and its potential impact on the public);
- communicate key concepts of the project in ways that can be understood by the general public (bearing in mind that concepts of speed and priority can be perceived as negative for local residents);
- provide information on the technology being implemented;
- continue to involve the public through the planning, design, and implementation stages;
- invite comment and participation in the development of solutions;
- encourage innovation in the resolution of issues;
- document the process for newcomers and to provide continuity for periodic updates; and
- celebrate achievement jointly with all parties.

Proactive communications is critical to maintaining the project schedule, progressing design work, speeding implementation and improving community acceptance of the new system. Negative public reaction can only be addressed with significantly more effort and can result in mistrust and unnecessary rework.

Proactive communications is critical to maintaining the project schedule, progressing design work, speeding implementation and improving community acceptance of the new system.

This risk can be mitigated through the on-going development of relationships with community leaders and strategic planning of project communications. See InfraGuide's Decision Making and Investment Planning best practice: *Public Consultation for Infrastructure Renewal* (InfraGuide, 2005).

Cost and Schedule Risks

Schedule risks can range from delays because of technology launch problems, inadequate coordination with other groups or agencies that have to provide part of the project and the impacts of public reaction which can lengthen planning periods and introduce additional mitigation requirements. Establishing realistic expectations and getting sign-off from the various departments and agencies involved on the anticipated schedules and associated costs, minimized these risks.

Projects that are included in the programs of other departments, such as including priority measures in roads reconstruction projects or bridge rehabilitation projects inherit the risks of those projects. Changes in funding and priorities as well as delays as the work proceeds may be beyond direct control. Here again, establishing realistic project timelines and expectations can minimize risk exposure.

Complexity of the technology employed in the system can also be a source of both cost overrun and schedule delay. While off-the-shelf software and hardware exists to support traffic management, very few of the products are designed for public transit.

Cost risk is related to schedule risk as delayed project starts, longer implementation timeframes and increased project carrying costs all increase as the schedule lengthens.

Complexity of the technology employed in the system can also be a source of both cost overrun and schedule delay. While off-the-shelf software and hardware exists to support traffic management, very few of the products are designed for public transit. As a result, the time and resources required to modify or redevelop the systems for transit can extend the schedule and introduce added complexities. This can be partially mitigated by developing an ITS architecture in advance and clearly articulating the purpose and function of the technologies to be used.

Successful technology implementations:

- Define the general form of the ultimate system requirements, with the proviso that simple, straightforward systems that will provide short term benefits may be more than adequate for the long term;
- Define the elements of the ultimate system that will be implemented in the current project;
- Consider how the initial system could be expanded to incorporate the ultimate requirements;
- Consider legacy systems, existing system capabilities, issues around migration of older systems to the proposed new system and system upgrade needs;
- Address maintenance and warranty requirements for the system, including division of responsibility by agency or department;
- Employ advances in technology that are close to market; and
- Realistically assess the reliability and stability of the manufacturers, suppliers and installers of the equipment.

Cost risk also arises from unforeseen conditions. While adequate planning can minimize many of these risks, contingency allowances should be established for all major projects. As the planning progresses and more details are known, the level of contingency can be reduced to reflect the greater certainty of design, but some contingency should be kept in place.

Process and Implementation Risks

There are several common themes to the process and implementation risks identified:

- The need for thorough planning early in the project;
- Active public engagement early in the design process if the project is likely to create a public reaction;
- There are significant benefits to having both a project champion and a political champion to keep the project moving forward; and
- Clear, consistent and comprehensive communications are required at all stages between all parties to minimize miscommunication and foster cooperation.

2.3.2 On-going Monitoring and Evaluation Risks

On-going monitoring and evaluation of transit priority projects demonstrates the effectiveness of the project and can be used to bolster the case for the next project. To be effective, evaluation requires before and after analysis to quantify the issues that defined the project need and to demonstrate how those needs were met with the project. Transport Canada usually requires a fairly rigorous evaluation where their funds are included in the project.

Evaluation criteria need to be developed that suit the objectives of the project, but usually include:

- Total Person Delay (broken down by type of delay and location);
- Average speed and schedule adherence;
- Perceived benefits (determined through passenger studies); and
- Capital cost.

In some cases operating costs are included as well, although quantifying operating cost saving can be difficult. On streets that carry high volumes of buses, a reduction in travel time equivalent to some multiple of the service headway will save buses and operating costs. For many cities, the added benefit of additional capacity created by the project is developed to support the case for implementing transit priority rather than focusing on cost reductions. This issue requires careful consideration of the local environment, as it can quickly become a political issue.

On-going monitoring of the system is necessary to ensure that it continues to perform as expected. Monitoring can include:

- Evaluating delays to determine if transit continues to benefit from the priority measures;
- Evaluating impacts on auto users to determine if they are within expected parameters; and
- Regular reviews of compliance and enforcement to see if the measures are maintaining their effectiveness or if additional education programs are necessary.

It is also good practice to include the enforcement agencies in the planning and education programs. For example, Winnipeg did a special training session with the Traffic Court Magistrates to explain the rationale and operation of diamond lanes. Before doing this, they tended to throw out most diamond lane violations when motorists appeared to appeal their tickets. In one of their recent projects, the city of Montreal involved their police service in all of the development stages: design, implementation, and follow-up performance review. In the Outaouais region, the HOV update-training program is tied to the return-to-school road awareness program.

On-going monitoring of the system is necessary to ensure that it continues to perform as expected.

3. Methodology

Successful transit priority has been implemented in most major cities across Canada. The priority measures used have been developed and refined over a number of years through practical application in Canada, the United States and elsewhere. This section of the best practice outlines the mechanics of how to define the need, review the available measures to select the most appropriate solutions and how to combine measures to increase effectiveness.

The most successful projects include a number of transit priority measures, used in combination, to provide a systematic or strategic solution to improving the competitiveness of transit.

3.1 Defining Need

Before solutions can be developed, a clear identification of the problem is required. There are generally three levels of planning and study required before a transit priority project can be adequately developed:

- System-wide review and opportunities review to develop a list of potential transit priority projects;
- Priority Setting to confirm the scope of the project that will be implemented; and
- Detailed Planning in which the details of the issues are studied and the exact nature of the problems is developed.

The objective in defining the need is to identify the best opportunity to improve speed, reliability, comfort and convenience. At the strategic level, these four factors must be balanced to meet your specific requirements. Some systems place high value on one factor and consider the others, while many of the more successful examples of transit priority incorporate features that will enhance all four.

When defining the need for transit priority, focus on:

- Describing the problems to be solved, independent of any potential solutions; and
- Consulting with all potential stakeholder groups including internal staff, funding agency staff, transit operators and the public.

The objective in defining the need is to identify the best opportunity to improve speed, reliability, comfort and convenience. At the strategic level, these four factors must be balanced to meet your specific requirements.

3.2 Measures Available to Meet the Need

There are many types of transit priority measures available, which can be classified under the following:

- Road Reservation measures;
- Traffic Control measures; and
- Legislative measures.

3.2.1 Road Reservation Measures

The reservation of road space for public transit vehicles is widely used around the world. This reservation can take several forms:

- Transit Only Streets/Malls: Where a street is given over entirely for public transit use. Typically, these are restricted to buses; however, they can also be shared with pedestrians, cyclists, taxis, delivery and emergency vehicles. Transit administration has found that the public better appreciates electric vehicles, in general, because they cause less fumes, vibrations, and noise. The Graham Transit Mall (Figure 3–1) in downtown Winnipeg and Granville Mall (Figure 3–2) in downtown Vancouver are good examples of a transit only street.

By comparison, the Rideau Transit Mall in Ottawa was not successful and was removed (it currently operates with reserved bus lanes at the curb). Many factors appear to have contributed to the failure of this project, including, a perception that businesses would

Figure 3–1: Winnipeg's Graham Transit Mall

Figure 3–2: Streetscape on Vancouver's Granville Transit Mall

not be able to attract customers, that a direct auto route was closed off and the alternate was circuitous and slow and that the shelters were too large and were attracting vagrants. The relatively new Rideau Centre also contributed as it "turns its back" on the street, focusing pedestrian circulation and storefronts on the inside of the mall rather than the street front. Overall, the public perception was that the balance was not reasonable. This project is used (as an on-going example) of the public's perception of the negative impacts of transit priority.

- Busway: A special roadway built exclusively for the use of buses. This can be a separated roadway where the only vehicles permitted are buses or a median busway where segregated lanes for buses are placed within the normal street right of way but are protected from other traffic by curbing. Ottawa's Transitway system includes an extensive system of busways. TransLink constructed a median busway on No. 3 Road in the City of Richmond, as illustrated in Figure 3–3.
- Bus Queue jumpers: Typical short sections of road that are reserved for buses to give a special right of access that is normally denied to other road traffic. Queue jumpers as the name implies are used to allow buses to by-pass queues of traffic at congestion points on the road system. There are five main types of queue jumpers: 1) Right turn lane, 2) Bridge approach queue, 3) Highway ramp queue, 4) Jug-handle, and 5) Bus left turn. Figures 3–4, 3–5, and 3–6 show various queue jump alternatives.

Figure 3–3: 98 B-Line Median Bus Lanes, Richmond, British Columbia

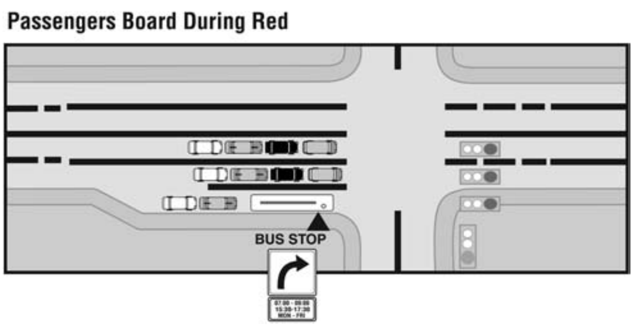

Figure 3–4: Bus Using Right Turn Lane Queue Jump

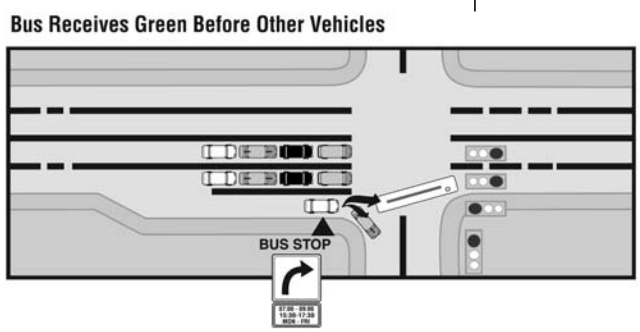

Figure 3–5: Bus Gets Advance Signal to Cross Intersection

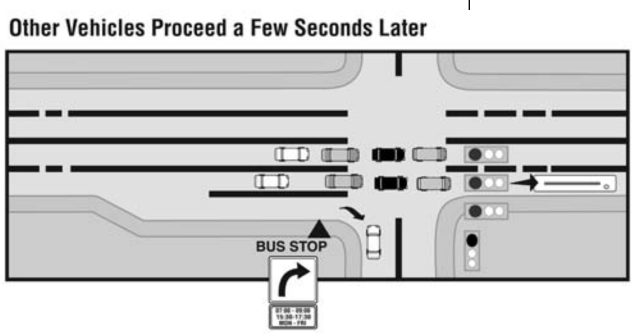

Figure 3–6: Cars Proceed once the Bus has Cleared the Intersection

1) Right turn lane on an arterial road allows the bus to move to the front of the traffic queue. An advance green for the right-turn move and bus-through move allows the bus to get across the intersection first. When combined with a nearside stop, bus loading and unloading can occur during the red phase. Where the right turn is channelized with an island, a "queue zone" for buses can be created, and the bus stop can be located on the island. In some cases a short merge lane is installed on the far side of the intersection to ease the bus merge. These are particularly useful where the number of through lanes reduces on the far side of the intersection.

Figure 3–7
Bridge Approach Queue Jump

Figure 3–8
Jug Handle Queue Jump

Figure 3–7: Bridge Approach Queue Jump

2) Bridge approach queue jumps provide a lane for buses to access the bridge. Figure 3–7 illustrates where a queue jump is a physically separate lane and provides priority at all hours.
3) Highway ramp queue jump provides a lane for buses to access the highway. Where the bus-only ramp is a physically separate ramp it can provide priority at all hours. If a dual lane ramp is marked with a bus lane and a general traffic lane the priority may only be provided during peak hours. The shoulder of the ramp may also be used (with appropriate legislation) to provide a bus queue jump where it is combined with highway shoulder running.
4) Jug-handle or intersection specific queue jumps provide physical lanes for buses to avoid difficult moves by providing an alternative move. In some cases the jug handle allows a bus to use the right lane to move through an intersection, loop clockwise around the "handle" and proceed through the intersection again, avoiding a congested or difficult left turn. Figure 3–8 illustrates

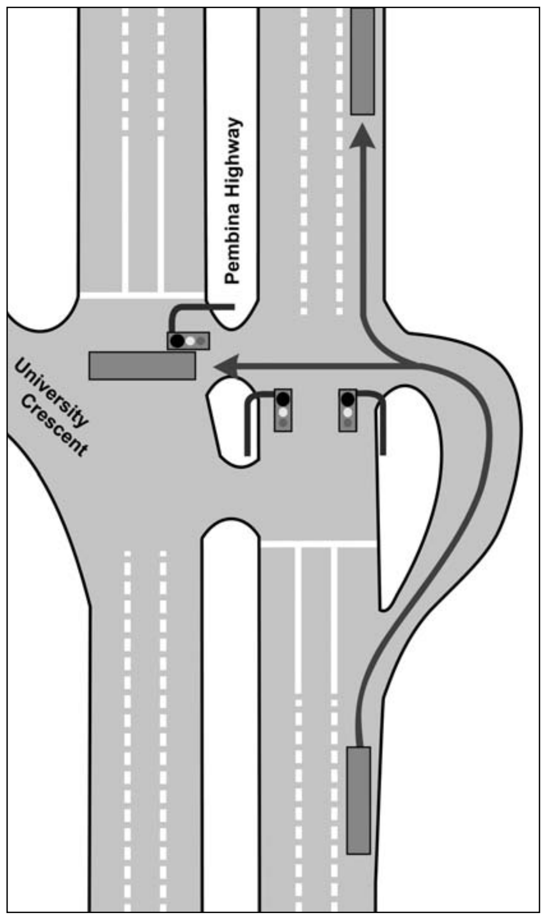

Figure 3–8: Jug Handle Queue Jump

Figure 3–9
Ottawa DSIS is illustrated in this image

Figure 3–10
Typical HOV Lane

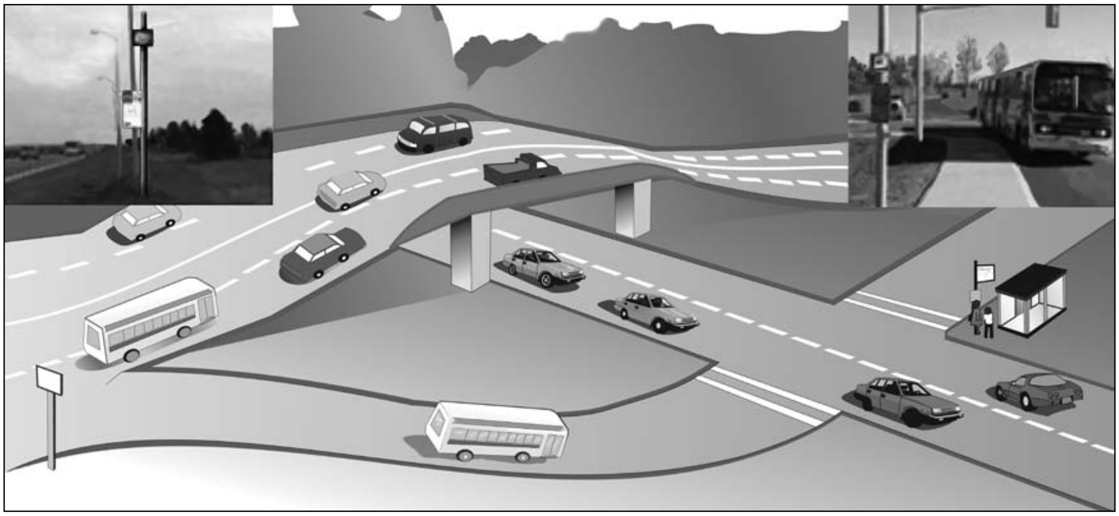

Figure 3–9: Ottawa DSIS is illustrated in this image

a different type of jug handle where the loop is used to create a bus-only through move in place of a left turn.

5) Bus left turn from general traffic lane at an intersection. The protected left turn allows for buses to use a different lane to turn left than is used by other vehicles.

- Highway Interchange Facilities: Where buses have a designated route through an interchange to allow buses to exit the highway, service a bus stop and then re-enter the highway directly. In Ottawa this is combined with the Demand for Service Indication System (DSIS), which indicates that a passenger is waiting at a freeway off-ramp bus stop to board a bus that would otherwise stay on the freeway (Figure 3–9).
- High Occupancy Vehicle (HOV) lanes: Where one or more of the lanes in a roadway are assigned to high occupancy vehicles such as cars and vans with two or more occupants (HOV-2), three or more occupants (HOV-3), as well as buses. Typically buses do not stop for pick up and drop off in HOV lanes on higher speed roadways, such as freeways unless bus bays are provided. On arterial streets with lower travel speeds, buses often stop in the lane to service passengers. The need to pull out of the lane to service passengers is determined, in part, by the disruption caused to other buses (including express buses), space availability and the ease of pulling back into traffic from the bus bay. HOV lanes may be warranted where exclusive bus lanes are not. This provides an opportunity to provide an improved level of priority for both buses and high occupancy vehicles (Figure 3–10).

Appropriate signage and pavement markings must be in place to create and maintain an awareness of the facility and complement police enforcement. Coloured pavement can also be used to delineate HOV lanes. Periodic education campaigns, such as the one developed in Outaouais, can help improve self-enforcement.

Figure 3–10: Typical HOV Lane

Figure 3–11
Shelter on Bus Bulge and clear of the sidewalk

Figure 3–12
Bus uses through lane to access bus stop

Figure 3–13
Retrofitting Bus Bulbs requires special attention to road drainage

Special attention to street drainage, vehicle turning movements, driveway access and impacts on peak hour traffic operations have to be reviewed to fully assess the impacts of installing bus bulbs.

- Bus Bulb, Curb Extension, Curb Out or Bus Bulge: A bus bulb is an extension of the sidewalk from the curb to the edge of the through travel lane. Buses stop in the travel lane instead of weaving in and out of the parking-lane curbside stop thus reducing delays to buses and improving the quality of ride for customers by eliminating the bus weave manoeuvre. Bus bulbs also improve the sidewalk treatment by providing greater space for waiting bus passengers and more opportunities for placement of shelters and other passenger amenities, as illustrated in Figures 3–11, 3–12 and 3–13.

  Permanent on-street parking is created in blocks with bus bulbs. This can be beneficial for formalizing parking arrangements along busy shopping streets, and has been used successfully in Vancouver and Winnipeg to increase parking, reduce bus delays, reduce bus weaving and merging and anecdotally improves the safety of bus operations.

  Special attention to street drainage, vehicle turning movements, driveway access and impacts on peak hour traffic operations have to be reviewed to fully assess the impacts of installing bus bulbs.

Figure 3–11: Shelter on Bus Bulge and clear of the sidewalk

Figure 3–12: Bus uses through lane to access bus stop

Figure 3–13: Retrofitting Bus Bulbs requires special attention to road drainage

3.2.2 Traffic Control Measures

Traffic control measures give buses preferential treatment through traffic management schemes such as traffic signal priority. Examples are outlined below:

- Bus Priority Signals (separate phases): Under this type of priority, buses are given an exclusive signal phase to clear an intersection ahead of other traffic. This involves the provision of a special bus-only phase to allow the bus to pull out of a special queue jumper lane or a bus lane and enter the regular traffic flow ahead of other vehicles. For example, bus priority signals can be used to allow buses to turn left at an intersection from a curbside bus stop ahead of other traffic. Two types of signals are generally used: white cigar signals and transit-only signal heads.
  - White Cigar signals (or white bars) are traffic signals aspects, which are based on shipping channel signals, and are

used for transit as they are distinctly different from traditional signal aspects (Figure 3–14). They are usually installed above the other signal heads. The use of white signal aspects is not universal, and is controlled in each province by the Highway Traffic Act. For example, in the province of Quebec, the Ministry of Transport (MTQ) has standardized the use of white cigar signals.

- Transit-only signal heads are often paired and in a different coloured housing than the other signals to indicate a signal phase for transit vehicles (Figure 3–15). These signals have been used where white cigar signals are not permitted.

Figure 3–14: White Cigar Signal

- Bus-Activated Traffic Signals: Signals that are activated by buses only. Installing roadside bus detectors or embedding special detector loops in the approach lanes that can identify the presence of a bus, either in mixed traffic lane or a bus-only lane, achieves the activation. When a bus is detected, a special signal phase is then provided to allow the bus to proceed safely and efficiently through an intersection. Bus activated signals can assist buses in turning from a minor road to a major road, into and out of a bus station, or can be used to activate a transit-callable or extendable left turn phase to clear traffic in front of a bus or streetcar.

Figure 3–15: Dark Green Transit Signal Heads

- Active Bus Signal Priority/Transit Signal Priority (TSP): Traffic signals can be retrofitted to detect the presence of a bus upstream of the signalized intersection. When a detector registers a bus through preemption methods, the former will send a message to the traffic signal controller. It will then extend the green phase to allow the bus to go through the intersection without stopping; or alternatively, the controller could truncate the red phase to allow the green light to come on sooner than would otherwise occur. Ideally, priority is provided for all buses at all times of the day, but systems can be programmed to provide priority only to vehicles that are behind schedule.
- Passive Bus Signal Priority: Coordination of signals along major corridors is typically based on the operating speed of the general traffic. Bus speeds are slower than the general traffic because they have to stop for passenger pick-up and drop-off at stops. Buses therefore, may not be able to take advantage of the signal coordination. To accommodate bus operation in transit

Coordination of signals along major corridors is typically based on the operating speed of the general traffic.

Successful projects have taken the approach that all measures should be considered until it is shown that they are not required. This broad approach often creates solutions that are more comprehensive and respond to each of the priority areas: speed, reliability, comfort and convenience.

corridors, traffic signals can be set for the speed of buses, taking into consideration their slower speeds and the dwell times at the bus stops.

- Conditional priority schemes are also available incorporating tests that query any or all of the following conditions:
  - Is the bus ahead, on, or behind, schedule?
  - Is the bus loaded or empty?
  - For signalized intersections where bus lines intersect, how is priority established?

Some of these schemes are being investigated/used by some transit properties. For more information, see *<http://www.tc.gc.ca/tdc/projects/its/d/its93.htm>* (in progress). Implementing such schemes can mitigate potential 'conflicts' that may occur between traffic signal managers and transit operators.

The implementation of transit priority measures in Montreal, for example, did not move forward until consensus was reached between the City and the STM on the definitions of concepts and operational criteria related to the impact of the measures on other road users (pedestrians, cyclists, motorists, etc.).

3.2.3 Legislative Measures

Various legislative and other regulatory measures (e.g., rules of the road) can be applied to provide bus priorities including exemptions from traffic prohibitions. Legislative or regulatory priority measures for public transit usually take the following forms:

- Exemptions from Traffic Prohibitions: Buses can be permitted to make turns, which are denied other road users often as a result of traffic management schemes. Examples include priority movements, which allow buses to make a turn where other traffic is prohibited and exemptions for buses using a turn only lane to proceed through the intersection. These exemptions can be put in place using the standard traffic by-law process.
- Yield to Bus: This legislation gives buses a priority right of way when leaving bus bays or bus stops. Quebec, British Columbia, and Ontario have Yield-to-Bus legislation in place. There are several voluntary programs in other provinces.

3.3 Applying Measures to the Need

The development of the scope of a transit priority project is derived from an understanding of the need and of how the measures can be applied to solve that need. Successful projects have taken the approach that all measures should be considered until it is shown that they are not required. This broad approach often creates solutions that are more comprehensive and respond to each of the priority areas: speed, reliability, comfort and convenience.

Careful analysis of the background studies is required to determine which priority measure will have a direct impact, and which could provide benefits in other areas to compensate for an unrelated delay. For instance, dedicated bus lanes were felt to be necessary on Granville Street in south Vancouver to provide predictable traffic flow for buses for the 98 B-Line project. After public opposition for the lanes was considered, a more detailed analysis indicated that restricting some left turn moves at specific intersections reduced queues at those intersections and removed some of the delay. In Montréal, the Société de transport de Montréal (STM) in partnership with the City, developed a concept of priority measures that takes into account the characteristics of its grid-type road system and allows the coordinated timing of signals along the main routes. These measures will be in effect regardless of bus delays throughout the day.

Similarly, delays at stops can be reduced by:

- Installing Bus Bulbs to reduce delay for buses re-entering traffic, improve pedestrian flow and allow for shelters and stop amenities to be provided (formalization of on-street parking and increases in the number of parking spaces which is beneficial to the local business community);

- Using separate stops for local and express services (particularly at major intersections or stops with high volumes of passenger activity);
- Using technology to provide real-time passenger information on the next bus arrival, or reasons for delays, so that passengers can queue for the correct bus at the correct time (reducing total boarding time and increasing customer confidence in the reliability of the system); and
- Implementing proof-of-payment or off-board fare collection to reduce passenger servicing time at stops.

Delays at specific intersections can be reduced by:

- Implementing passive priority by re-sequencing the traffic signals to match transit operating speeds (green wave for transit);
- Implementing active priority to adjust the green phase of the signal, including left turn signals (detection systems, priority conditions and length of green phase extensions can be controlled); and
- Using a right turn lane as a queue jump to get the bus closer to the front of the line (and if a channelized turn can be created there may be enough space for a bus-only zone, which would trigger a short advance green for the bus).

Delays along a route can be reduced by:

- Focusing a number of routes on a common corridor to increase the total bus volume to the point where the lane becomes a de facto transit lane (care should be taken to review the mix of routes to determine if express services will be delayed by local routes serving local stops);
- Minimizing the need for buses to merge into traffic by formalizing on-street parking using bus bulbs, expanding parking prohibitions or eliminating on-street parking;
- Sequencing traffic signals to provide a green wave for transit;
- Developing busways, reserved bus lanes or HOV lanes along all or part of the route (beginning with the heaviest volume sections, but considering other areas if the heaviest volume areas cannot be converted); and
- Implementing skip stop or express services along with regular services.

Implementation issues can be reduced or controlled by:

- Engaging the local community to find alternative parking so that parking can be removed from the arterial road;
- Building in features such as enhanced streetscaping to encourage participation of the business community in advancing the plan (including burying overhead wires and providing planters and enhanced street lighting);
- Funding mitigation measures;
- Looking for innovative solutions to “trade off” effects; and
- Positioning the project as more than just transit priority.

Finding an appropriate combination of measures that will work together to improve the effectiveness of the overall solution has proven to be the most effective solution.

4. Implementation

Accounting for transit needs and priority measures at the urban planning level is essential. Better network development, better transit integration, better interoperability, reduced cost impacts, etc., are among the benefits of an upstream effort to promote transit use. Implementing transit priority measures requires effort in a series of more detailed areas starting with strategic level policy and priority setting through project definition, design and development, as well as, public consultation. On-going road and transit operations, maintenance and performance monitoring must also be considered. Given the long-term nature of implementing transit priority, work may happen in one or more areas at the same time. The general process outlined below considers a fairly idealized process that can be adapted to suit specific circumstances.

4.1 Establishing Transit Priority as a Policy Priority

Policy direction is set through comprehensive planning processes (such as the Official Plan and Transportation Master Plan), which are used to generate public and political support for the concepts and overall direction for transit priority. They should set out that transit, in general, and transit priority measures are urban priorities. These plans, and the process used to develop them are critical for developing on-going support at the political level.

Setting policy direction is also an opportunity to foster acceptance of the concepts by senior transportation professionals, urban planners and other department or agency staff.

At this policy level, it is also useful to create a Technology Strategy (and adopt an accompanying ITS Architecture) that clarifies the objectives in deploying technology, relationships with other technologies already in place and how implementation can be staged to match other priority measures. The ITS Architecture for Canada provides a common national framework for planning, defining, and integrating intelligent transportation systems, *<http://www.its-sti.ca/en/architecture.htm>* given the importance of ensuring interoperability between related services, and applicability of successful projects to different users.

To maintain support for transit priority many agencies find it advantageous to provide regular reports and progress updates to committees and councils to maintain their presence. Adding transit priority as a standing agenda item also improves visibility. It is also import to establish a continuous evaluation process to improve existing facilities, and better plan future facilities.

To maintain support for transit priority many agencies find it advantageous to provide regular reports and progress updates to committees and councils to maintain their presence. Adding transit priority as a standing agenda item also improves visibility.

4.2 Two Parallel Review Streams

Identifying candidate projects is often done in two parallel streams:

- System-wide Review, where the objective is to identify locations or corridors where:
  - There are significant volumes of passengers and frequent transit service;
  - Delays are substantial and the need to improve service has been identified; and
  - There are opportunities to intervene and improve the situation through the introduction of priority measures.
- Other Infrastructure Program Opportunities:
  - Where roads and bridges are being rehabilitated or rebuilt and there are opportunities to introduce transit priority as part of those projects; and
  - Off-street facilities can be incorporated into expanded shopping centres as part of their reconstruction or expansion.

In parallel with reviewing the current system, work should begin on developing agreement with all transportation and planning officials on the methods of providing transit priority, establishing criteria for setting priorities, allocating resources, setting budgets and initiating specific projects.

Strategic information at this stage includes ridership analysis, land use and revitalization or redevelopment potential, customer complaints and reviews of prior planning and traffic studies. Transit operators can be a valuable source of information, and in several cities, operators are the main way in which candidate sites are identified. The public may also be invited to provide input.

For most systems this process will yield several candidate corridors and a number of specific problem locations. Many of the candidates will have been discussed for many years both at the public and internal staff level. However, new locations may arise particularly in rapidly growing areas.

In parallel with reviewing the current system, work should begin on developing agreement with all transportation and planning officials on the methods of providing transit priority, establishing criteria for setting priorities, allocating resources, setting budgets and initiating specific projects. For example, in Montreal, the implementation of transit priority measures did not move forward until consensus between the City and the STM was reached on the definitions of concepts and operational criteria related to the impact of the measures on other road users (pedestrians, cyclists, motorists, etc.).

Opportunities to engage local stakeholders, such as local businesses, should also be pursued at this stage. In Winnipeg, the Graham Transit Mall was combined with improvements to the streetscape, engaging the local business community in the project. As a result of their involvement from the early stages they became a champion for the project.

4.3 Setting Priorities among Candidates

Once a list of candidates has been created, some priority will need to be established among the candidates. A comparative analysis of key criteria is needed at this stage. One of the criteria that should be considered is ease of implementation. Finding a project that can be put in place quickly and easily along with providing measurable benefits is important for the first project.

Total passenger delay is one of the most frequent measures used to set priorities, although total ridership, volume of buses, variability of travel time, on-time performance are also used to rank candidates. Calgary examines where extra hours of service have been added to the schedule (without increasing route length or service frequency) as one way to determine candidate projects. In downtown areas, the potential to encourage redevelopment or to support revitalization projects can also be used to set priorities.

Tabulation of the results can provide good visualization of the merits of each candidate and can assist in selecting the preferred project to take forward. Analysis at this stage should be limited to criteria that distinguish candidates. For example, if all of the candidate corridors feed into the downtown core, then assessing support for downtown intensification will be similar for each candidate. However, if two of the candidate projects are on busy commercial/shopping streets and will support revitalization of the downtown, and the others are on office or industrial streets, the role of the street may influence the decision.

Conceptual cost estimates will be needed at this stage to screen candidates. If actual costs cannot be developed then kilometres of lane affected, number of stops to be modified or other quantifiable items can be used to approximate cost.

4.4 Defining the Priority Project

Once a project is selected the broad spectrum of measures should be reviewed to determine what combination, at a conceptual level will provide a solution that meets the objectives laid out at the start of the exercise. This review will refine the analysis undertaken in the previous stage.

The four basic factors that influence transit ridership are speed, reliability, comfort, and convenience. Each priority feature influences each of these four factors differently. As the project is being defined, establish the relative importance of each factor and the emphasis that each will receive in the design stage. The statement of the importance of the factors and the relationship to the project will be used to define the level of success after implementation.

Within the factors there are also trade-offs to be considered. For instance, speed and reliability are both influenced by the degree of signal priority, but the design of the system will be different if the objective is to reduce variation in travel time or increase the average speed along the route. Similarly, ride comfort is highest when the number of stops is reduced or limited however this reduces convenience by reducing access.

The cost estimate developed earlier will have to be refined to a functional design level and the configuration of features will have to be tested against the current operating characteristics to estimate the magnitude of the improvements. Care should be taken at this stage to review construction sequence, staging and all elements of the project to make sure that costs are realistic.

Traffic simulation tools such as Synchro and VISSIM are often used at this stage to visually demonstrate the problems that are being encountered and the benefits that transit priority can provide. These tools are readily available and are increasingly used to define project scope.

In addition to technical studies and cost estimating, the environmental assessment requirements for the project must also be defined. Generally, if the project does not increase the size of the roadway or substantially alter its performance then the environmental requirements will be minimal. Construction of new or expanded roadways, conversion of a roadway to a transit mall or exclusive bus lane, new HOV facilities or substantial queue jump lanes may require a formal environmental assessment process. The requirements vary by jurisdiction, and the local requirements should be carefully reviewed.

Construction of new or expanded roadways, conversion of a roadway to a transit mall or exclusive bus lane, new HOV facilities or substantial queue jump lanes may require a formal environmental assessment process.

4.5 Detailed Studies

After the project is selected a more detailed analysis of the conditions is required. This will help define what features will provide the greatest benefit. At the start, every potential priority measure should be considered. Often it is a combination of features, which work together to provide the best results. In particular, it is important to design a network of transit priority measures in a manner that permits buses to benefit from a series of successive measures along a common routing path.

Unless the first project to be implemented is relatively small or not controversial, it will require substantially more effort to implement. It will require coordination and cooperation across internal and external boundaries that will increase communication requirements. During the development of the first large-scale project, some cities have found that implementing smaller “beginner” projects is a valuable way to develop communications and build relationships while initiating an overall program of transit priority.

Another way to increase the likelihood of success is to implement a corridor that is relatively easy to design and install and has a low likelihood of impact to other roadway users. Complex corridors and complex technological systems can then be installed, after there is good experience with an operating project. In addition, the first project will be used to determine the effectiveness of the priority measures and may redefine how future projects should be integrated with other systems.

In many cases the initial concept for the project may have to be altered to respond to the concerns of businesses and residents. In the most successful projects, studies were modified from concept to construction to suit field conditions, respond to public concerns and address the results of the detailed analysis of field conditions.

4.6 Public and Stakeholder Consultation

Regular communication of progress is necessary for success. This includes informing passengers of any delays, detours of changes in service as well as informing the local community of construction, route detours, stop modifications and project timelines.

As noted in section 2, public consultation can determine the ultimate success of the project. Early, consistent, complete and regular communication is needed to keep all parties involved in the project. Concepts need to be clearly communicated and the transfer of that knowledge needs to be tested. Some concepts are hard to explain (such as reliability), whereas others are more important to passengers than to the local residents along the proposed corridor.

Misinformation or unclear understanding of the concepts of some priority measures can result in significant negative public reaction. Turning public opinion around can be time consuming. An effective strategy to engage the public early in the design and involve them in developing innovative solutions to the design issues can provide great benefit.

Consultation is often focused on specific stakeholder groups such as local ratepayer groups, community associations, business improvement committees and chambers of commerce as well as transit advocates, environmental advocates and transit riders. Individual meetings, combined with public events are often required to maintain project momentum.

4.7 Detail Design

With the detailed studies of the project completed and clear communication started with the public, detail design can be initiated. Changes in the design are inevitable, and the public and other agencies and stakeholders need to be kept informed of progress at all stages.

Trade offs between the improvement for transit passengers and the improvements for local businesses and residents must be carefully considered. Open communication and innovation thinking are critical at this stage. The evolution of the design should consider the goals of the project as well as the expectations of the local community.

Operations, maintenance, training and monitoring should be carefully considered and set out in detail at this point. Who will be responsible for each element? Are those departments or agencies able to take on the responsibility? The project will affect a wide range of people and all of those impacts need to be clearly understood, documented and communicated.

4.8 Project Implementation

The scale of the project and the amount of physical construction required will dictate how this stage progresses. Regular communication of progress is necessary for success. This includes informing passengers of any delays, detours of changes in service as well as informing the local community of construction, route detours, stop modifications and project timelines.

Several agencies noted that access to adequate resources to implement the project could be a critical item and needs to be confirmed early. This is especially true of resources from other departments of agencies who are not directly involved in the planning. For them, this is another task added to their schedule. Clear communication of expectations and appropriate scheduling of resources can reduce the impacts.

4.9 Operations, Maintenance, and Monitoring

As implementation nears completion, the focus will shift to starting operation. Passenger information, operator training, public and driver education and other activities will have to be put in place. Maintenance and operations staff will also have to be made aware of their new responsibilities. ITS systems may require additional staff resources for on-going maintenance and upgrades, and proof-of-payment (POP) systems require enforcement staff to control fare evasion.

Initial operations will affect everyone involved, and added monitoring and assistance should be in place. Drivers will require time to adjust to new pavement markings, signs and turn restrictions. Equally, passengers will require time to adjust to new stops, information, schedules, and in some cases, fares and fare collection.

Clear delineation of all maintenance responsibilities is required. Each element of the system should be reviewed in order to determine if the maintenance needs were incorporated into the regular maintenance programs. Winter maintenance might have to be considered for pavement markings, signs and bus stops.

Information and training of operators is also required. Changed operating conditions, new technology, revised rules, new or moved stop locations, new routes or terminal locations and revised reporting requirements must be clearly laid out in advance and discussed with operating staff. Operators should have access to all public information (in advance of the public), and operators not directly affected by the new service but on connecting routes should also have the basics of the new service made available to them.

Operator feedback on the performance of the system is a critical item. As the front line ambassadors of the system, they have a unique perspective and can influence the effectiveness of the system. Getting operators on-side by involving them early and keeping them informed of progress is important. Their experience in the field can be very valuable in fine-tuning the operation and evaluating the overall project success.

After the system is operating an "after" study (or studies) should be conducted to see if the system is performing as expected and to measure the benefits to the operation. Increased ridership, improved travel speed and reliability, improved schedule adherence, and increased public perception of the system, are some of the measures commonly used. The results of the "after" study can be compared against the planning predictions to improve prediction methods for future projects. After studies are often used to justify expanding the priority measures. Many of the monitoring systems contemplated during design will have to be fine-tuned to capture actual conditions and data availability.

A massive amount of field data can be provided from these advanced systems. The integration of data, on an ongoing basis, into the planning/updating of the transit and roadway network should be investigated in the very early stages of projects. The system architecture should allow for all potential benefits to all stakeholders (internal and external to the initial interest group), and new data can then improve knowledge and understanding of existing and evolving conditions.

4.10 Lessons Learned

Conducting a formal "lessons learned" analysis at the conclusion of a major capital works project can provide many benefits for future projects. The analysis should look at all phases and aspects of the project. It is advisable to document the project as work proceeds with consideration of how to improve the overall process.

Initial operations will affect everyone involved, and added monitoring and assistance should be in place. Drivers will require time to adjust to new pavement markings, signs and turn restrictions. Equally, passengers will require time to adjust to new stops, information, schedules, and in some cases, fares and fare collection.

5. Evaluation

Once the transit priority project is in place, the effectiveness of the measures must be evaluated. While the process varies from city to city there are several common elements to the evaluation:

- Measurement of vehicle performance, including increased average operating speed, improved reliability (less variation in trip time), average delay along the route and improved schedule adherence.
- Impact on other road users including any measurable impacts to total person delay on side street traffic, turning traffic and through traffic.
- User and all interested internal and external stakeholders satisfaction surveys to determine the benefits of the system as perceived by passengers, operators and planners.
- Environmental benefits including reduced greenhouse and air contaminants (often calculated based on reduced fuel consumption).
- Maintenance savings through reduced wear and tear on buses from fewer stops and starts.
- Operator feedback is important as their everyday experience can provide valuable information.
- Capital cost for design and implementation. Estimation of operating cost savings may also be undertaken, but are often less conclusive.
- Safety review to determine if there are reduced accident rates for all vehicles, reduced incidents on-board vehicles, changes in type or severity of accidents and perceived improvements in personal safety and security at stops and terminals.
- Changes in ridership. These increases may be difficult to isolate given the presence of other factors. Onboard surveys can at least get riders' perceptions of changes.

While the specific way in which each of the following statements is answered may vary, the net result has to be the same:

- Does the project meet the objectives that were originally set?
- Has transit priority been implemented with minimal impacts on other road users?
- Has public perception of the transit system improved?
- Has the project contributed to an improved awareness of transit priority and created the potential for additional projects to be completed?

6. Research Needs

During the course of preparing this Best Practice, other areas of research[2] were identified which are closely linked to transit priority. This section provides a brief description of the main areas identified and sets out questions to be considered in future projects.

6.1 Traffic Management Systems

In the area of traffic management systems, three potential research[3] areas were identified:

- What tools and measurement methods can be used to assess the impact of traffic management systems and are they adequately using the data that is available?
- How will future systems be analyzed? As they become more sophisticated and provide more advanced controls such as schedule adherence and headway control how will the different impacts be evaluated?
  - If the emphasis is placed on reliability, then the standard deviation of trip time becomes more important than reducing trip time.
  - Ongoing monitoring and feedback systems that enable a continuous learning process may be implemented through successive refinement of TSP strategies, or automated when adaptive control is available. How will improvements be tracked over time as the system adapts?
  - How can we apply lessons learned from existing systems to generate more effective systems?
  - Are there different site conditions at different intersections along a route that require different solutions and therefore different measurement techniques? How will this be captured in our analyses?
- How should we modify urban roadway and traffic signals design standards to incorporate transit priority measures? Should priority measures be included in the basic design? Do central traffic control systems need to be designed to accommodate priority?

6.2 Benefits Measurement

In the case studies, a fairly uniform set of measurement tools were used to assess the benefits of the system. Standardizing these measures and developing a central database of performance measurement information would assist cities contemplating new systems. Research would focus on:

- Development of a set of universally accepted, transit-focused measurement tools. This would include a focus on total person delay and performance ratios that focus on people rather than vehicles.
- Benchmarking performance. This is a relatively new tool that is being applied in many industries. The application of benchmarking to public transit, including which measures need to be included to assist with agency approvals for implementation of transit priority, is not currently an industry standard.
- Structuring a central source of performance measurement data from existing projects.

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2. ATLANTIC Canadian Network, Work Group (WG) 1.3, Urban Public Trasit ITS Research and Development <http://www.crt.umontreal.ca/en/atlantic/groupe1.3b.php>.
   Final Report, Shalaby, A. and B. Hemily, March 2004; also see *<http://www.tc.gc.ca/tdc/projects/its/d/its03.htm>* for more detailed potential areas.

3. ATLANTIC Canadian Network, Work Group (WG) 1.2, Network Monitoring and Traffic Management and Control *<http://www.crt.umontreal.ca/en/atlantic/groupe1.2b.php>*.

- Establishing a common justification process for expansion of the system.
- Measurement of public perception of benefits (we often have little information on how passengers value time or time versus reliability but future systems will need this information to make informed decisions).
- Developing educational and informational tools to describe person-based evaluation (rather than vehicle-based evaluation) to persuade decision makers, traffic engineers, transit riders and the general public to alter their focus and look at the person-carrying capacity of our transportation systems.

6.3 Information and Systems Management

In the case studies the amount of data being generated by signal control systems, AVL systems, APC systems and schedule monitoring systems was identified as an area requiring some attention. Both the types of information produced by the systems and its distillation into useful planning data do not appear to be consistently handled. Developing a methodology to evaluate the information would be beneficial in developing tools to evaluate the information and provide valuable planning information.

In addition to the large amounts of data, in many cases traffic signal data is only available through manual downloads at the signals themselves. An industry standard set of data summaries and statistical analysis would assist in quantifying the benefits of the system and provide a standard basis for analysis. This area of research would focus on:

- Information management tools, including those that have been developed for the traffic industry, those provided by the equipment manufacturers and any systems developed in-house by transit agencies;
- Development of a standard information architecture;
- Development of a standard interface with transit scheduling packages;
- Data management techniques; and
- Compatibility and inter-connectivity between systems and reporting standards (performance indexes and evaluation factors).[4]

6.4 Proof-of-Payment and Fare Collection Systems

While not purely a transit priority measure, proof-of-payment and other off-board fare collection systems can offer reduced boarding times and may allow for all-door boarding if appropriate enforcement is in place. Experience with these systems is varied and the public perception of their benefits is equally varied. The following four potential research[5] areas were identified:

- What systems are available and how are they deployed in the field?
- What overall benefit to boarding do they provide in terms of timesavings at stops and stations?
- What legal or legislative issues arise from fare policy enforcement? Vancouver's experience is that fare payment systems used on the SkyTrain are not directly transferable to the bus system because of the more permanent nature of the SkyTrain stations and the fact that buses operate on public road allowances rather than private property.
- How are operational requirements for staff training, collection of fares at remote stop locations and equipment failures handled?

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4. ATLANTIC Canadian Network, Work Group (WG) 1.1, Traffic and Travel Information Services, *<http://www.crt.umontreal.ca/en/atlantic/groupe1.1b.php>*.

5. ATLANTIC Canadian Network, Work Group (WG) 2.3, Electronic Road User Charging Systems and Intyergration with Smart Cards and other Payment Systems *<http://www.crt.umontreal.ca/en/atlantic/groupe2.3b.php>*.

Appendix A: Case Studies

A.1 Calgary—Signal Priority on Route 3

Project Overview:

In 2000, Calgary Transit championed the implementation of a peak period HOV lane. The HOV lane included traffic signal priority for express buses at seven intersections immediately adjacent to the downtown. The HOV lane and transit priority at traffic signals was in response to the policies of the Calgary Transportation Plan approved in 1995.

This was the first implementation of signal priority in Calgary and required collaboration between transit, roads and traffic signals staff. The selection of Opticom™ as a way to detect buses and activate the transit priority capabilities of the traffic signals was done in conjunction with Calgary Roads Traffic Signals Division and the Calgary Fire Department. Opticom™ consists of a bus mounted infrared emitter and a detector on the traffic signal.

This first, limited application of traffic signal priority for buses provided an opportunity to test the technology. Priority for transit consists of an extended green and truncated red signal while Fire vehicles receive full signal preemption. The Opticom™ installation proved highly successful with a travel time saving of up to 1.5 minutes on a 7-minute segment of the express bus operation. The equipment was reliable, interfaced well with the traffic signal hardware and software and there were no adverse traffic impacts. This positive experience enabled planning of a more extensive application of transit signal and other transit priority measures.

A study was conducted to determine the next application transit signal priority. Delay studies were done on all high ridership, high frequency bus routes. The routes studied also had sufficient length and were susceptible to schedule reliability problems due to delays related to traffic congestion. In 2002 work commenced to equip all 48 traffic signals along Route 3 with transit priority. Route 3 has a 54 kilometre round trip and carries over 21,000 weekday passengers. This installation utilized the seven signals already providing transit priority on Centre Street[6]. All new buses are equipped with Opticom™ to enable more buses to receive priority.

The project was completed in 2004. Benefits of transit signal priority on Route 3 include 32% fewer stops at traffic signals, a 16% reduction in time spent at traffic signals and a 9% improvement in schedule adherence. As well there are emission reductions from reduced fuel consumption and reduced wear on major driveline components. Positive feedback has been received from transit operators and passengers.

Lessons Learned:

- Selection of proven technology that is compatible with existing systems has resulted in few system reliability issues.
- The technology selected is also used by the Fire Department. This expands the utility of the installations, reduces system installation and operating costs and can be easily expanded for use by other emergency vehicles.
- Involvement of staff in the planning and design of the system is important to foster understanding and acceptance—this includes transit operators, transit maintenance personnel, traffic signals technicians and engineers.

6. Transport Canada has provided co-funding for this project, under the Intelligent Transportation Systems Deployment and Integration Plan.

- Implementation planning was done in conjunction with traffic signals staff to ensure that traffic signal modifications could be accommodated within annual work programs.
- Preventative maintenance programs must be established for bus and traffic signal components.
- Celebrations to reward staff who contributed to this project heightened their willingness to work on other priority projects.
- Calgary's unicity structure streamlined the planning, approval and implementation of this project.
- The Calgary Transportation Plan provides clear public and political direction to support and fund transit priority measures.

Outcomes:

The Route 3 signal priority project was planned and implemented by a team of staff from various divisions of the Transportation Department. In 2005, as a related outcome to the success of this and other recent transit priority projects, a Transportation Optimization Division was established within the Transportation Department. The role of this group is to optimize both roadway and transit operations. Staff from Calgary Transit, Traffic Signals, Traffic Engineering (signage and road markings), Transportation Planning and Transportation Forecasting has been brought together into a small team. The team works together on setting project priorities, analysis, and design and coordination of implementation. Staff members still report to their 'home' division but they are focused solely on optimization projects. Funding for this work has been increased.

Currently, the Optimization Division projects include:

- Retiming traffic signals on major roadway corridors, particularly those with transit routes;
- Planning detours for major roadway and LRT construction projects;
- Implementing minor roadway geometric and traffic control improvements to reduce congestion and facilitate turning movements particularly to favour buses;
- Transit priority measures such as queue jumpers;
- Roadway operation safety reviews; and
- Expansion of traffic signal priority for transit.

A.2 Longueuil/AMT—Autoroute 10 HOV Facility

Project Overview:

In the Montréal region, the AMT is responsible for the "Metropolitan Network" and local transit systems, like RTL, are responsible for the "Local Network". AMT provides 100% financial support for transit priority initiatives on the Metropolitan Network. This has led to the planning and deployment of a long list of transit priority measures; a smaller number of individual isolated initiatives have been deployed on the local network. The prime criteria for selecting deployment at "hot spots" are delays affecting bus travel times. Cooperation with AMT and the city of Longueuil staff has been good, although the city has been affected by the amalgamation process and is just in the process of establishing a traffic department.

Implemented priority measures include: exclusive bus lanes along 11 corridors; expressway shoulder lanes along two (2) corridors; a transitway in an expressway corridor; a contra-flow lane on the Pont Champlain Bridge; queue jumps along three (3) corridors and in seven (7) other locations; bus bulbs along three (3) corridors; six (6) off-street terminals; and bus-only traffic signals or phases (with or without bus detection) in ten (10) locations, primarily at terminal or garage access points. In addition, TSP has been deployed at 23 intersections along Chambly Blvd., building on their APC system equipment.

Key Issues:

- Data for Planning Transit Priority. Transit measures have to be targeted because of the constrained funding available. However most transit systems do not have a good knowledge of the impact of traffic conditions and intersection delay on bus running times and their variability. RTL's Automatic Passenger Counting (APC) system provides a good database for analyzing bus running times and their variability, thus allowing the pinpointing of key problems.
- Availability of Data for Analysis of any ITS System. Analysis requires data but to date little thought has generally been given to data collection and the structuring of data in ITS in ways that facilitate its actual use for analysis. For example, traffic controllers may only collect data on-site, requiring in-field downloading to obtain this data. There has been no thought given to how to structure and co-relate data collected by ITS on the bus with actions taken at the controller level, etc.
- Criteria for Deploying Transit Priority Measures. Criteria tend to focus on bus routes with the heaviest ridership levels, but bus routes with declining ridership may also be worth considering since poor travel times may be part of the cause of decline; this would require some research into alternative methodological approaches.

Lessons Learned:

- Availability of funding has been critical. The AMT is responsible for the "metropolitan network" in the Montreal area. This responsibility includes 100% of the cost for technical studies, capital costs for priority measures along the corridors in the network, but also of co-related capital investment (traffic controllers, road geometry, bike lanes), and even operational expenses related to maintenance (e.g., lane markings) and snow clearing. This greatly facilitates the cooperation of the municipal roads departments since they have been able to upgrade equipment and address some of their own road geometry problems through this funding program.
- Transit needs to be at the table for any road development that impacts transit. An important redesign of Autoroute A–10 has created a transitway section. Although formerly the responsibility of the AMT, the Ministry of Transportation of Quebec, and their engineering consultants, RTL was also on the technical committee, and could ensure that technical aspects (e.g., required turning radii and lane widths) met the real requirements of operating conditions. It is important to have this expertise at the table.

A.3 Outaouais—Park and Ride/ HOV Joint Facility

Project Overview:

In 1990, STO developed a strategic plan for the organization, which involved extensive consultations. This was followed by the development of an Action Plan in 1992 that identified a range of specific preferential treatments (Park and Ride lots, HOV lanes, ridesharing, etc.). These have been pursued incrementally and systematically year by year, and have now been 80% fulfilled. The strategic plan was updated in 2003. Cooperation with municipal traffic staff has been excellent.

Implemented priority measures include: 14 Park and Ride lots, 5 off-street terminals, 18 km of HOV lanes (3+), 2.1 km of contra-flow HOV lanes, 6 queue jumps, and various isolated deployments of transit-only traffic signals (i.e., "white cigar" lights).

Strategic Approach:

- Incremental Implementation of Transit Priority. In 1992, STO's strategic plan identified a range of preferential treatments (Park and ride, HOV lanes, ridesharing). These have been pursued incrementally and systematically year by year, and have now been 80% fulfilled. While not all of these treatments provide transit priority they do support transit usage and increase public awareness of transit.

Key Issues:

- Implementing transit priority is an ongoing partnership from planning to implementation. A Technical Committee (led by STO, with participation of city staff, MTQ staff, NCC-CCN where appropriate) is put together at the outset of each new transit priority initiative. The Technical Committee develops the study requirements, selects the consultant and reviews the consultant's work. This committee then becomes the Project Oversight during the construction / implementation phase.

Lessons Learned:

- Need to have measurable objectives. STO's strategic action plan identified short-, medium-, and long-term mode split objectives. They use mode split targets at 3 corridor screen lines as the quantifiable objectives. It has been a clear indication of the success of their transit priority strategy.
- Regular, Seasonal Enforcement of HOV/Bus Lanes is required. STO has a semi-permanent liaison committee with the municipal police department, and communications and cooperation is strong. They meet in particular when problems increase; one indicator used is the monitoring of bus operator complaints. However, they also have developed a regular/seasonal enforcement program: they systematically launch a public communications and HOV enforcement campaign two times a year, at the beginning of the school year and just after the winter holidays. They have found that this helps to reinforce respect for the HOV lanes in the public's minds.

A.4 Québec City—Metrobus

Project Overview:

RTC (formerly STCUQ) prepared a strategic plan ("Le plan de relance") in 1991 to address the system's ridership decline. This study, involving extensive consultations with the public and politicians of 13 municipalities, envisioned a major restructuring of the network, with the creation of a BRT (the Metrobus) along 3 structuring corridors, and the expansion of the express bus services. This plan achieved political consensus and was implemented fairly rapidly, resulting in 35 km of exclusive bus lanes (some 10 hours a day, some peak-hour only, very often one lane in each direction at the same time on the same road), 8 bus-only signals (using "white cigar" lights). There are also 2 km of HOV lanes at the end of the Autoroute Montmorency.

A follow-up strategic plan was prepared in 1994. However, the lack of available funding led to few enhancements, and all were located on the Metrobus corridors. A new strategic planning effort has been underway since 2002-2004. The approach has been first to again do a drive to have a clear commitment by the city for the development of urban transit. Of the four strategies proposed to the city to reverse declining ridership two rely heavily on transit priority. The first one is the extension of the Metrobus network by including three news Metrobus lines with their priorities.

Strategic Approach:

- Obtain political agreement on the priority for transit development and a complete network. The approach in the Québec region is to first obtain political approval (rather than technical one) from all the parties for a total network concept (including priority axis), including if possible, agreement on funding responsibilities; this is a lengthy process of studies, presentations and negotiations. However, once agreed upon, deployment was greatly facilitated, consisting mostly of resolving practical technical issues, and the Metrobus network was implemented rapidly.

Key Issues:

- Analysis and negotiations for the removal of parking or delivery spaces can be very difficult. Obtaining a general agreement to eliminate parking/delivery places can be achieved, but the detailed analysis of how to do so and the negotiations with local merchants, roads department staff is always complicated and labor-intensive.

Municipal staff assesses each situation separately, and decide what level of public consultation is required.

- Service Vehicles Parking in Reserved Bus Lanes. In the Québec region, misuse of reserved bus lanes is not so far serious enough to worry about and impede the flow of the buses. The most serious problem related to enforcement concerns parked service vehicles in reserved bus lanes. No good solution has been found. Drivers will sometimes call them in, but by the time the police have been called and arrive, the vehicle may be gone, and the damage has been done.

Lessons Learned:

- Political Champion is very important. The process in Québec was greatly facilitated when the Commission's President (a politician) was a "champion" of transit. He could personally approach and negotiate with his political counterparts at the political level. Obtaining political agreement for transit priority as a first step help us to increase the level of priority of that subject at the administrative level of the municipalities.
- Importance of a Funding Program. In Québec, there is a well-established capital subsidy program for funding transit infrastructure. Each agency works within the framework of a triennial investment plan, where the process is clear and well known. This considerably simplifies the planning process. It is very difficult to work outside of this framework, and try and obtain discretionary capital for a project.
- Creativity in Communicating to the Public about New Priority System: The Green Line. It is important to communicate to the public when introducing a new transit priority network involving reserved bus lanes. RTC developed a particularly creative way of communicating the new MetroBus system: they painted a green line in the middle of the lane to be used by the MetroBus to indicate its route. This was a powerful communication device and greatly enhanced respect for the bus lanes; automobile drivers sensed there was something special about the lane and stayed out of it. Interestingly enough, respect for the bus lane occurred even when the reserved lane was marked for peak period only, or even where there was no reserved bus lane. The line was painted in non-durable paint and was not replaced when it wore out; its purpose in introducing the MetroBus corridor had been achieved.

A.5 Vancouver—Line Program

Project Summary:

Rapid transit was identified early on as the preferred concept for the Richmond-Vancouver corridor, but was very expensive. The BC Transit 10-Year Plan developed in 1995 evaluated three corridors and a range of technologies including light rail, automated light rail and bus rapid transit. As a result of the technical studies the Richmond corridor was ranked a lower priority for rail investment than the Lougheed and Coquitlam corridors where substantial growth was projected over the next 20 years. As an alternative a state of the art bus service was seen as an interim step to improve reliability and image, and build a rapid transit quality service using buses. The new rapid bus service was branded "B-Line".

The corridor and suite of improvements concept was applied, so a full range was considered. As design progressed, some changes were made in response to community concerns and more detailed analysis of the specific problems being encountered. For example, the initial plan proposed reserved bus lanes along the full length of Granville Street through south Vancouver. The public was concerned about the loss of a travel lane. Analysis showed that the number of buses in the corridor made it a de facto transit lane without having to designate it. The community agreed to limit left hand turns at certain locations in lieu of dedicating the curb lanes to improve reliability of mixed traffic operations. Dedicated lanes were put in where justified including downtown Vancouver and on the approaches to the Arthur Laing Bridge.

Strategic Approach:

- TransLink prepares Three-Year Plans and Area Transit Plans in partnership with municipalities. These plans identify priority corridors for improvement and lay out funding strategies.
- TransLink has the responsibility for leading transit priority projects. It also has a source of funding to pay for improvements through the Transit Road Related Infrastructure Program (TRRIP). Under TRRIP, TransLink will pay up to 100% of the cost of transit priority measures on municipal roads if warranted. The annual budget for TRRIP is approximately $3.0 million in capital.
- Projects put forward for TRRIP funding are reviewed and approved by the local authorities or the MOT to foster cooperation. The TransLink Board must also approve the projects.
- Each corridor usually has a mix of measures, with all measures being considered initially and being balanced against the local conditions.
- Work done in the mid 1990's under the BC Transit 10-Year Plan outlined a range of measures and set out a conceptual network for transit priority corridors. That work has been the foundation of most projects. As a result there has been an increasing role for transit priority and good visibility with the public.

Key Issues:

- The #98 B-Line median busway was developed to improve the streetscape for downtown Richmond. It helped to transform the street from a suburban strip commercial to an urban arterial. To achieve the objectives, the City of Richmond contributed extra funding to ensure a higher level of street landscaping than was originally planned.
- The original concept did not envision a median busway. The City's objectives were to strengthen No. 3 Road as the spine of the regional town centre. TransLink wanted to ensure reliable and fast operations for its high quality bus service. An evaluation showed that curbside bus lanes did not offer benefits due to the high volume of right turns and driveways into commercial properties. The median busway concept was new for most people however, offered potential to improve the streetscape. There was significant education required to convince Council, merchants and residents it would work (they saw the concept working for LRT or streetcar but not for buses).
- Business and residential opposition was stronger and better organized than anticipated. They were opposed to many aspects including bus lanes, route location, parking loss, priority measures (speeding buses), and the use of articulated buses (too big). The business community in particular can be very well organized, particularly if they have a cause to work against.
- Technology challenges were quite high as this was a new system. The real-time digital countdown signs at bus stops took much longer to get working than initially thought. The vendors had to make considerable changes to the predictive algorithms to ensure accuracy.
- The multi-jurisdictional aspect of the transit priority signal system required more effort that originally thought.

Lessons Learned:

- For the #98 B-Line project a median busway was developed in the City of Richmond. The project enjoyed support as it was seen as an interim step to a rail based rapid transit system in the future. The busway was successful in part because of the close attention to streetscape and urbanization benefits including an enhanced pedestrian environment. Improving the local environment by putting wires underground and providing a better visual environment were key features.
- The public views transit priority as making sense, and when polled regularly state that they support giving buses priority. However,

when it comes to specific projects, support is less enthusiastic, particularly when there is a loss of parking or travel lanes.

- There was public debate about whether this project was a "high-end bus" or a "low-end rapid transit." Position higher order bus service early and reinforce the benefits of the system. Also be clear that it is a quantum leap in service over conventional bus service.
- The most difficult applications are in the older high street/shopping avenue locations where parking is seen as necessary for customer convenience and as a buffer between pedestrians and active traffic lanes. Suburban areas appear to be more supportive as their shopping facilities tend to be less street-oriented and the majority has access to off-street parking.
- "White cigar" signals were not allowed under the Highway Traffic Act, because it was not an exclusive transit phase, so green lights were used on the median busway for buses. Car drivers were often confused by the number of signal lights, especially people turning left who saw a green for both the buses and the through traffic. Louvers were put on the transit signals to prevent left turning drivers from seeing the bus signals. This modification corrected most of the problem.
- The ramp and road configuration around the Airport Station was confusing for drivers. Red pavement was installed for the buses and car drivers have not had problems since then.
- The queue jump southbound to the Moray Channel Bridge in Richmond near the Airport had poor sight lines. Bus drivers cannot see approaching traffic because of a hump in the roadway. A bus-activated signal that triggers a warning light for approaching auto traffic has solved the problem.
- Consider bringing communications specialists on-board early. You need to understand the public's concerns and react quickly. Negative public reaction can dilute political support. A clear political champion is needed to advance these projects and to open doors and position the project properly.
- Look at the overall picture for the agency. Avoid taking on major projects when there are internal problems such as a change in leadership or governance structure. Look for clear windows to advance major projects
- Bus rapid transit requires a systematic approach to service design, ITS facilities and branding. If technology figures prominently, position the project as leading edge, high tech and a source of pride.
- Bus drivers, as frontline ambassadors of the system, have to be on-side as internal champions.

A.6 Winnipeg—Reserved Lanes, Signal Priority, and the Downtown Graham Transit Mall

Project Summary:

There are good policies in both the Official Plan and Transportation Master Plan that emphasize improvements to radial lines and connections to major trip generators. The statements also reference improving speed and reliability. A study undertaken in the late 1980's has formed the basis for the work in the last ten years.

There is no formal implementation plan, but staff is always looking for new opportunities to introduce additional priority measures, and the current focus is on BRT.

As a precursor to the Graham transit mall and Portage revitalization project, Transit had been working to revamp the bus routings in downtown. An origin-destination survey indicated that the majority of the trips were more focused than previously thought and that matching service could reduce transfer requirements, make transfers easier and concentrate buses on a few key routes, which would then have sufficient bus volumes to warrant the priority measures. The process involved studying travel patterns, modifying routes, upgrading stops and then implementing lane priority measures. As the other stakeholders were involved all the way along, they understood the need for the priority lanes and understood the work that had been done by Transit to justify the need for the projects.

Strategic Approach:

- The goal was to make transit more competitive with car travel by improving speed, reliability, comfort and convenience through a combination of traffic signal priority measures and physical features including a transit mall and diamond lanes. The objective was to create an attractive service by introducing a broad range of coordinated measures to address all four areas.
- There has been a stepwise implementation of several projects from the Vaughan contraflow lane and the Graham Transit Mall to the diamond lanes on Main Street and the bridges over the Red and Assiniboine rivers, signal priority (cigar lights) on Main Street and the Osborne reserved bus lane. The most recent project is the Portage Avenue Revitalization. Not all of these projects were implemented exclusively for transit's benefit. In several cases the other benefits dictated the implementation sequence.

Key Issues:

- For the transit mall and the Portage work, community concerns about on-street parking and transit concerns about delays caused by merging back into traffic were resolved by creating bus bulges at stop locations and 24-hour parking in the other segments of the former curb lane. Traffic operations staff was concerned about the reduction in capacity, but simulation analysis indicated that the impact was much smaller than anticipated and was acceptable.
- AVL is one of the current projects being undertaken. The system will be on-board the bus and will keep its own schedule adherence. Exception reporting to the central office reduces the communications and data management load. The system will be used to provide real-time passenger information before it is tied to signal priority.
- For the City of Winnipeg, real-time passenger information is a higher priority than signal priority as the traffic signals in downtown are fully coordinated and already provide passive priority for transit.
- Run times are monitored using an APC system and indicate very consistent travel times through downtown. Schedule adherence is significantly better on routes using the reserved bus lanes and transit mall facilities when compare to other routes through downtown.
- Monitoring the state of repair and ensuring that the facilities look good and perform well is a key objective.

Lessons Learned:

- Transit has representation on community group committees to help them organize their events. For instance, for street fairs, Transit assists in developing bus-rerouting plans, working closely with the organizers to develop a realistic plan that can be easily approved by the City. This on-going relationship has created trust and goodwill that can assist with larger transit projects.
- Many of the downtown buildings have "areaways" which are extensions of their basements out underneath the sidewalks. These required special treatment to determine if they could support the sidewalk properly and lead to complications with street trees and utility works.
- Pedestrian-scale lighting doubled the number of light standards, which required extra hardware and complicated snow removal. The additional lights also had to be reviewed to determine their impact on commercial signs along the street.
- Understanding the issues of each stakeholder was the main barrier. This required staff time to meet and discuss needs and find innovative solutions. Building access proved to be a problem in some areas that required that bus-only designations were not possible in some blocks.
- Regular newsletters were published and

distributed to local businesses and the general public. This turned out to be a very smart move as it provided a communication channel to get information out on unforeseen events.

- Operational issues around the reserved lanes were documented in a public brochure and published in the newspaper. The operation is also described in the provincial driver's handbook.
- Enforcement should be engaged in the project early on. While their role is fairly minimal, they can exert strong influence on the success of the project. Presentations about transit priority were made to Traffic Magistrates to ensure that both traffic police and judicial staff understood the intent of the program.
- Make sure the plan fits the overall improvement plan for the City, and have a clear understanding of how it fits.
- Be flexible and innovative in finding solutions.
- Check what others are doing and be critical in the analysis of the applicability of their solutions to your problems. Don't just copy but adapt for the local environment.

Appendix B: Intelligent Transport Systems and Their Application to Transit Priority

The ITS Office of Transport Canada is responsible for implementing the ITS Strategy for Canada, En Route to Intelligent Mobility, as well as the ITS deployment and Integration Plan defined in it, and the ITS R&D Plan, Innovation Through Partnership. Some of the considerations set out in these Plans (available at *<www.its-sti.gc.ca>*) will be of interest to Transit Authorities considering how best to adopt transit priority, and how to implement the "Best Practice" outlined in this Guide.

The ITS Office of Transport Canada has also developed an ITS Architecture for Canada, *<http://www.its-sti.gc.ca/en/architecture.htm>*. The Architecture sets out user services and market packages in eight major sectors of ITS, including Traffic Management Services and Public Transport Services. Given the importance of ensuring interoperability between related services, and applicability of successful projects to different users, the ITS Office of Transport Canada requires that any proposals for federal funding of ITS projects conform with the ITS Architecture for Canada.

Table B–1: Directly on Transit Signal Priority

Recipient	Project Description	Date Approved	Status
Mississauga Transit	Integrate transit signal priority within Mississauga Transit's Smart Vehicle initiative.	January 12, 2005	Ongoing
York Region Transit	Integrated and unified ITS for transit services	January 12, 2005	Ongoing
Halifax Regional Municipality	Bus Rapid Transit	January 12, 2005	Ongoing
City of Edmonton	Blueprint strategy and initial deployment of an integrated transit signal priority and traffic signal control system	January 12, 2005	Ongoing
City of Calgary	Transit Signal Priority and Automatic Vehicle Detection System	March 13, 2002	Completed
City of Kelowna	Integrate city and provincial traffic signal systems and incorporate transit signal priority	January 12, 2005	Ongoing
York Region	Transit Priority System	March 13, 2002	Completed
LEA Consulting Ltd.	Develop a transit signal priority algorithm (R&D Contract) *<http://www.tc.gc.ca/tdc/projects/its/d/its03.htm>*	January 12, 2005	Ongoing

B. Intelligent Transport Systems and Their Application to Transit Priority

Table B–2
Related to TSP, AVL, APC, etc.

Table B–3
Other projects (co-) funded by the ITS Office relevant to transit priority

Table B–2: Related to TSP, AVL, APC, etc.

Recipient	Project Description	Date Approved	Status
Richmond	Intelligent Traffic Signal Pre-emption system (R&D)—addresses emergency vehicles, but principles could be extended to transit and/ or other classes of network users.	May 14, 2004	Ongoing
York Region	Remote Access Personal Digital Assistant System (R&D)—in support of an urban traffic control system (transit signal priority is one element)	May 14, 2004	Ongoing
City of Ottawa	Intelligent Vehicle Sub-System (“Smart Bus”)	March 13, 2002	Ongoing
City of Guelph	Deploy an advanced transit management system	January 12, 2005	Ongoing
Société de transport de Laval	Implementation of GPS technology	January 12, 2005	Ongoing
St. John’s Transportation Commission (Metrobus)	Design and implementation of a global positioning system-based automatic vehicle location system for the city’s transit system.	September 28, 2000	Completed
City of Peterborough	Design and pilot deployment of an integrated traffic management system and bus priority system	September 28, 2000	Completed

Table B–3: Other projects (co-) funded by the ITS Office relevant to transit priority

Recipient	Project Description	Date Approved	Status
	An ITS Architecture for Canada—*all proposals for funding since March 2000 must demonstrate their conformity, as a way of ensuring interoperability between related services, and applicability of successful projects to different users.*		Completed
Agence métropolitaine de transport (Montréal)	Strategic planning of intelligent transportation systems and deployment of an automated real-time system for detecting delays and notifying users	May 14, 2004	Ongoing
Société de transport de l’Outaouais	Dynamic Message Signs at Bus Stops in the Outaouais—*involves the development of a strategic ITS plan and pilot deployment of dynamic message signs (DMS) at bus stops in the Outaouais. The strategic plan will provide a detailed roadmap for the integrated deployment of ITS investments for the next 10 years.* *Note: The real-time information displayed on a DMS can also be part of an “Advance Traveller Information System” (ATIS), available by telephone or website, that provides reliable information to users and can ultimately encourage greater/wider ridership*	September 28, 2000	Completed
	Advanced Traveller Information Systems (ATIS)—Several projects involve the development and deployment of ATIS, including transit information that can ultimately encourage increased use of transit services. *A consortium led by ITS Canada has applied to the CRTC for dedicated use of 511 across Canada as a telephone number for traveller and weather information; Transport Canada is represented by the ITS Office.*		
	ITS strategic plans for municipalities/regions in Canada—*several highlighted transit ITS projects as priorities including TSP. Consideration is being given to updating some of these.*		(cont’d)

Table B–3: Other projects (co-) funded by the ITS Office relevant to transit priority (cont'd)

Recipient	Project Description	Date Approved	Status
	ITS strategic plans for provinces—*provinces do not have direct responsibility for transit, but some have included transit ITS projects as priorities. Consideration is being given to updating some of these.*		
University of Toronto (with Univ. Montreal, MTO and MTQ)	A Thematic Long Term Approach to Networking for the Telematics and ITS Community (ATLANTIC) [Canadian node of the international ATLANTIC project to create a platform for information exchange and debate on key research and policy issues]—*four of eight Discussion Papers include:* *Urban Public Transit ITS Research and Development <http://www.crt.umontreal.ca/en/atlantic/groupe1.3b.php>* *Traffic and Travel Information Services <http://www.crt.umontreal.ca/en/atlantic/groupe1.1b.php>* *Network Monitoring and Traffic Management and Control <http://www.crt.umontreal.ca/en/atlantic/groupe1.2b.php>* *Electronic Road User Charging Systems and Integration with Smart Cards and Other Payment Systems <http://www.crt.umontreal.ca/en/atlantic/groupe2.3b.php>*	January 19, 2003	

Appendix C: Inventory of Transit Priority Measures

In preparing the Best Practice, Working Group members were surveyed to determine which transit priority are in place in their communities. The following table lists the types of transit priority measures and the typical types of applications. This information can provide locations that have already implemented specific measures, and may be beneficial in providing guidance on who to contact to get more detailed information.

The typical applications in the columns of the table are:

- Individual Locations—where a measure (or set of measures) may have been implemented at one or more single intersections, highway ramps or bus terminal entrance or exit to solve a particular problem specific to that site.
- Several in a Corridor—where a measure (or set of measures) has been installed along a defined corridor to solve a set of problems on that route, often on road segments where several routes come together creating higher bus volumes.
- Part of an Area-wide Plan—where a measure (or set of measures) has been implemented across a section of the city, such as a network of diamond lanes through downtown, signal priority measures along several routes in downtown, or specific plans for providing access to suburban malls.
- Unique Application—where a measure (or set of measures) has been implemented for the first time, or in a way that differs from other cities approach to the same measure. This might include how contraflow lanes are handled or where bus-only signals were used to solve a particularly tough challenge.

Some cities have implemented measures that are not captured in the table. Those examples are included at the end of the table.

The measures in the table have been divided into three areas:

- Physical and Roadway Transit Priority Measures that provide priority to transit vehicles in mixed traffic and exclusive surface transit rights of way. Examples: bus lanes, High Occupancy Vehicle (HOV) lanes (or diamond lanes), contra-flow lanes, queue jumps, bus bulbs, bus-only crossings, transit centers and off-street terminals, auto restricted zones, transit malls, etc.
- Transit Signal Priority (TSP) Measures and control systems that can be used to provide priority to transit vehicles at signalized traffic intersections and through the traffic control system. This includes bus signal priority (or preemption) providing green extension, red truncation, bus phase insertion, phase skipping, or bus only phases (using cigar lights or special bus signal heads). Level of priority can also vary from complete preemption to priority granted on criteria such as schedule adherence and headway control.
- Legislative or Regulatory Measures, which can be used to provide priority to transit vehicles on roads and streets. Includes: legislation in provincial Highway Traffic Acts, and municipal regulations governing on-street priority rules on the road, Yield to Bus (legally mandated or voluntary programs), parking and turning restrictions, enforcement, legislative rules (governing camera enforcement, etc.

C. Inventory of Transit Priority Measures

Table C–1
Priority Measures and Unique Application in Various Locations

Table C–1: Priority Measures and Unique Application in Various Locations

Priority Measure	Individual Location(s)	Several in a Corridor	Part of an Area-wide Plan	Unique Application
Physical and Roadway Measures				
Bus Bulb	Vancouver	Québec Longueuil Ottawa Vancouver Winnipeg		
Queue Jump	Calgary Halifax Gatineau Vancouver Longueuil Winnipeg Ottawa Montréal Toronto Edmonton	Longueuil AMT Ottawa		Calgary Ottawa
Bus-only Crossing	Calgary Ottawa Montréal Toronto			Vancouver Edmonton
Highway Shoulder Lanes	Longueuil AMT Ottawa			
HOV (Diamond) Lanes 2+ occupancy + taxis	Calgary Gatineau Ottawa	Québec Vancouver Toronto	Winnipeg	Calgary
Contra-flow Lanes	Halifax Gatineau Longueuil Winnipeg			Montréal
Exclusive Bus Lanes	Calgary Longueuil Ottawa Montréal Edmonton	Québec Ottawa Vancouver AMT Montréal Toronto	Winnipeg	Toronto
Separate Bus Lanes (Transitway)	Longueuil	AMT Ottawa		Vancouver
Off-street Terminals	Halifax Gatineau Québec Vancouver Longueuil Ottawa Montréal Toronto Edmonton	AMT	Winnipeg	
Transit Centre	Vancouver Longueuil Ottawa Montréal Edmonton	Ottawa Montréal	Winnipeg AMT	
Transit Mall	Vancouver		Calgary	Winnipeg
Auto-restricted Zones				
Park and Ride	Gatineau Edmonton	Vancouver	Calgary	

Table C–1: Priority Measures and Unique Application in Various Locations (cont'd)

Priority Measure	Individual Location(s)	Several in a Corridor	Part of an Area wide Plan	Unique Application
Transit Signal Priority Measures				
General Signal Priority	Gatineau Vancouver AMT Ottawa Toronto		Toronto	
Green Extension Capability	Halifax Ottawa	Vancouver Longueuil AMT	Calgary Montréal Toronto	Vancouver
Red Truncation Capability	Halifax Ottawa	Vancouver Longueuil AMT	Calgary Toronto	Vancouver
Phase skipping	Gatineau			
Separate Bus-only Phase	Halifax Longueuil AMT Ottawa Toronto	Longueuil Vancouver	Calgary Winnipeg Montréal	
Bus-only signals (special signal heads of cigar aspects)	Halifax Québec City Vancouver Longueuil Ottawa Toronto Edmonton	Toronto	Calgary Gatineau Montréal	
Legislative or Regulatory Measures				
Turn Exemptions	Vancouver			
Voluntary "Yield to Bus"			Calgary Winnipeg Edmonton	
Mandatory "Yield to Bus"			Québec City Vancouver AMT Ottawa Montréal Toronto	

Note: While this table focuses on the largest of Canada's transit systems, the priority measures are applicable in most cities. BC Transit has successfully implemented some of these measures in communities ranging from 330,000 residents to less than 10,000 residents.

Other individual measures that are not in the table include:

Calgary:

- Downtown traffic signals (130 signals) were retimed in 2002/03 to reflect the Light Rail Transit (LRT) operation in the downtown area where it operates with regular traffic signals. The revised timings reflect station dwell times and time for the train to travel between stations without stopping at signals. Implementation resulted in a 25% decrease in LRT travel time and an average 14% decrease for all other general traffic (a report is available from Calgary Transit).

Outaouais:

- Solar powered advanced HOV Sign

Translink:

There are at least five corridors in which the centre traffic lanes are used by buses to jump the queues of traffic in the curb lanes waiting to access a key Bridge crossing. These include the following:

- Nordel Way (WB) at Highway #91 on-ramp to the Alex Fraser Bridge in the District of Delta;
- 20th Street (SB) south of 7th Avenue in the City of New Westminster bypassing traffic queued for the Queensborough Bridge;
- Marine Dr. (WB) between Garden Ave and Lions Gate Bridge bus on-ramp in West Vancouver;
- Marine Drive (EB) between Taylor Way and Lions Gate Bridge bus on-ramp in West Vancouver; and
- 72nd Avenue (WB) at Highway #91 on-ramp.

At three locations, buses are allowed to travel through a neighbourhood or shopping centre's internal roads (during the AM peak when shopping centre closed) to jump the queues in the adjacent arterials waiting to get onto a bridge:

- Garden Ave between Capilano Road and Marine Drive;
- Marine Drive (EB) in West Vancouver (through Park Royal Shopping centre before making a bus only right turn at Taylor Way and Marine Drive to use the outside lane to access Lions Gate Bridge);
- 71st Avenue (EB) between Granville Street and Oak Street in the City of Vancouver (buses access the Oak Street Bridge and avoid traffic queues on eastbound 70th Avenue). The last block of 71st Ave is only available to buses during the pm peak periods providing direct access to the Oak Street Bridge; and
- To reduce the boarding time at critical transit stations, passengers are allowed to board the #99 B-Line and #145 articulated buses at all-doors: UBC and SFU transit terminals, Broadway SkyTrain Station, and Production Way-University Station.

Agence métropolitaine de transport:

- Bridge on-ramp that is used exclusively by buses and taxis during the AM rush hour. A gate controls access to the ramp (similar to what is used in controlling access to parking lots). The gate is presently activated by a transponder aboard the bus or taxi. However, due to problems related to the reliability of the transponders, they will be replaced in the near future by remote control devices activated by the drivers.
- During the reconstruction of a freeway interchange, a similar gate was used with success on an off-ramp.
- Another priority measure is the use of a reversible all traffic centre lane (on a five lane arterial) in conjunction with exclusive right lanes for buses and taxis.

Ottawa:

- Demand for Service Indication System (DSIS)—indicates that a passenger is waiting at the intersection of the freeway off-ramp and the intersection street to buses that would otherwise stay on the freeway.

Toronto:

- Proof-of-Payment on the Queen Streetcar Line—allows for all-door boarding of passengers along the route.
- Seamless or "Free Body" Transfers at most Subway Stations—allows passengers to transfer from surface routes to subways without needing a paper transfer. Allows for all-door boarding in the fare paid zones of the stations.

References

Documents

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- Chada, Shireen, Robert Newland, 2002. *Effectiveness of Bus Signal Priority, Center for Urban Transportation Research*, University of South Florida, United States.

  Web site: *<http://www.nctr.usf.edu/pdf/BSP%20Final%20Report.pdf>*

  The study examines the interaction between different conditions and TSP strategy requirements. In order to guide transportation agencies in this decision-making process, a "Pre-Implementation Checklist" was designed. The checklist focuses on the most critical factors in BSP and recommends pursuing BSP if an area has enough characteristics in place to make BSP effective.
- Fitzpatrick, Kay et al., 2001. *Evaluation of Bus Bulbs TCRP Report–65*, Texas Transportation Institute, TRB, National Academy Press, Washington, DC, United States.

  Web site: *<http://trb.org/news/blurb_detail.asp?id=2553>*

  This report produces guidelines to assist transit agencies, local government, and other public bodies in locating and designing bus stops that consider bus patrons' convenience, safety and access to sites as well as safe transit operations and traffic flow. The second phase of this report evaluates bus bulbs, an innovation in the design of bus stops found in several major North American cites.
- Gan, A., Yue, A., Shen, J., Zhao, F., 2002. *Development of Operational Performance Models for Bus Lane Preferential Treatments*. Final Report, Florida International University, Unites States.

  Web site: *<http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_PTO/FDOT_BC792_rpt.pdf>*

  The operational performance of bus facilities can be measured by travel time, speed, and capacity, etc. A number of factors affecting it include: bus headway, vehicle volumes, vehicle mix, free-flow speed, dwell time, bus stop capacity, bus stop location, bus stop type, bus stop spacing, signal control parameters, and number of lanes, etc. The decision models developed in this research allow for the evaluation of a proposed bus lane before implementation, an existing bus lane to be re-evaluated for possible improvements, and should a bus lane become controversial, it can be evaluated objectively. Because such models include a number of design variables, they can be used as a tool to evaluate the effectiveness of design alternatives, for example, the location of bus stops under prevailing conditions.
- Gifford, J., D. Pelletiere, J. Collura, 2001. *Stakeholder Requirements for Traffic Signal Preemption and Priority in Washington, D.C. Region,* Transportation Research Record No. 1748, Transportation Research Board, United States.

  Identification of the needs, issues, and concerns of Washington, D.C. area local elected officials and transportation and emergency personnel, regarding signal priority and preemption systems. These needs, issues, and concerns are used to generate a set of system objectives and general requirements that state and local decision makers might use in evaluating these systems in the future. As reported, although emergency and transit agency personnel are actively interested in this technology, they and the other stakeholders have significant questions and reservations to be considered in the adoption and deployment of preemption and priority systems.

- King, Rolland, 2003. *Yield to Bus—State of the Practice* TCRP Synthesis 49 (2003), TRB, National Academy Press, Washington, DC, United States.

  Web site: *<http://trb.org/publications/tcrp/tcrp_syn_49.pdf>*

  This report offers information on existing Yield to Bus programs and documents transit agency experiences for the benefit of others considering implementation of similar programs. It reports on current knowledge and practice, in a compact format. The report documents information gathered about the legislative process and history; program implementation, including public awareness and education campaigns, employee awareness and training, and the design and location of the yield display on the bus; as well as transit agency experiences covering transit operational issues, traffic operational issues, and public acceptance. It focuses on YTB programs in British Columbia, California, Florida, Oregon, and Washington State.

- Kittelson & Associates, KFH Group Inc., Parsons Brinckerhoff Quade & Douglass, Inc., and Katherine Hunter-Zaworski, 2003. *Transit Capacity and Quality of Service Manual—2nd Edition*, TCRP Report 100 (2003), TRB, National Academy Press, Washington, DC, United States.

  Web site: *<http://trb.org/news/blurb_detail.asp?id=2326>*

  The Transit Capacity and Quality of Service Manual (TCQSM) provides transportation practitioners with a consistent set of techniques for evaluating the quality of service and capacity of transit services. Part 4, Bus Transit Capacity, provides procedures for evaluating bus stop and facility capacity. Chapter 2 presents operating issues related to the implementation of bus preferential treatments. A wide variety of treatments have been developed in urban areas throughout the world to make bus transit more competitive with the private automobile and to provide a higher quality of service for passengers. Chapter 3 provides a set of planning guidelines to assist users in deciding whether a particular measure may be appropriate for a particular need; the first section presents guidelines for implementing many of the transit preferential treatments discussed in Chapter 2, and the second section provides planning-level capacities for various kinds of bus stops and facilities. Chapter 5 presents methodologies for analyzing the operation of buses using arterial street bus lanes and at-grade busways. The key characteristics of these facilities are at least one lane reserved exclusively for use by buses (except possibly at intersections), and interrupted flow (e.g., traffic signals, stop signs, etc.).

- Koonce, P., J. Ringert, T. Urbanik, W. Rotich, and B. Kloos, 2002. *Detection Range Setting Methodology for Signal Priority*, Journal of Public Transportation Volume 5, Issue 2, Center for Urban Transportation Research, University of South Florida, United States.

  Web site: *<http://www.cutr.usf.edu/index2.htm>*

  In urban areas, traffic signals often cause significant amount of delays to transit vehicles. The article discusses the potential to reduce control delay caused by traffic signals by implementing signal priority. Engineering studies are necessary to address both traffic and transit signal operations before the systems can be implemented. A comprehensive program requires coordination between the transit agency and the applicable transportation department to address needs of both agencies and users. The article details the efforts of the City of Portland and the Tri-County Metropolitan Transportation District of Oregon as well as the methodology for signal timing and detection distance setting.

- Levinson, Zimmerman, Clinger, Rutherford, Smith, Cracknell and Soberman, 2003, *Bus Rapid Transit,* TCRP Report 90 (2 volumes). This report presents planning and implementation guidelines for bus rapid transit (BRT).

  Web site: *<http://trb.org/news/blurb_detail.asp?id=4213>*

  The guidelines are based on a literature review and an analysis of 26 urban areas in North America, Australia, Europe, and South America. The guidelines cover the main components of BRT—running ways, stations, traffic controls, vehicles, intelligent transportation systems (ITSs), bus operations, fare collections and marketing, and implementation. This report will be useful to policy-makers, chief executive officers, senior managers, and planners.
- Ling, K. and A. Shalaby, 2003. *Automated Transit Headway Control via Adaptive Signal Priority*, in press, Special Transit Issue, Journal of Advanced Transportation.
- McLeod, F., and N. Hounsell, 2003. *Bus Priority at Traffic Signals—Evaluating Strategy Options, Journal of Public Transportation,* Volume 6, Issue 3, Center for Urban Transportation Research, University of South Florida, United States.

  Web site: *<http://www.cutr.usf.edu/index2.htm>*

  This article compares different strategy options for providing bus priority at traffic signals. The different strategies considered vary in the strength of the priority awarded and in the selection of the buses that are to receive priority. The strategies include so-called differential priority, where buses receive individual priority treatment according to some criterion such as lateness, and nondifferential priority, where all buses are treated in the same way. The strategies are compared using a simulation model, SPLIT, that has been developed and validated. The article describes some of the modelling issues that are involved in simulating bus priority systems and how they have been treated with the SPLIT model.
- National Guide to Sustainable Municipal Infrastructures (InfraGuide), 2005. Decision Making and Investment Planning best practice: *Public Consultation for Infrastructure Renewal*. Ottawa, Ontario.
- O'Brien, William, 2000. Design and Implementation of Transit Priority at Signalized Intersections: A Primer for Transit Managers and a Review of North American Experience, CUTA STRP Report 15, CUTA, Canada.

  The report includes an overview of transit priority concepts, including: bus lanes, queue bypass lanes, bus priority access to freeways, traffic signal priority, operational priority, regulatory transit priority measures, and comprehensive transit priority plans. It explores experience with priority measures, and Transit Signal Priority in particular, through several case studies.
- Project For Public Spaces Inc., 1998. *Transit-Friendly Streets: Design and Traffic Management Strategies to Support Liveable Communities* TCRP Report 33, TRB, National Academy Press, Washington, DC, United States.

  Web site: *<http://gulliver.trb.org/publications/tcrp/tcrp_rpt_33.pdf>*

  This report addresses the connection between transit and streets, recognizing that the design and management of streets and traffic can and does affect the liveability of communities. This study adopts a "place-making" approach to creating transit-friendly streets, where a local community, working in partnership with a transit agency, plans and implements neighbourhood-scale projects and programs that are mutually supportive of community liveability and transit ridership goals. This report presents strategies that are emerging across the United States, where the effective, balanced incorporation of transit into city streets is having a positive impact on liveability and quality of life. Chapter 2 defines the term "transit-friendly streets" and describes it from both an American and a European perspective. Techniques for balancing street uses among various modes, such as traffic calming, are briefly discussed. The strategies are followed by case studies of five communities that have pursued different initiatives to improve their liveability by making their streets more transit-friendly.

- Shalaby, A. and A. Farhan, 2003. *Prediction Model of Bus Arrival and Departure Times* Using AVL and APC Data, in press, Journal of Public Transportation.
- Shalaby, A., B. Abdulhair, and J. Lee, 2003. *Assessment of Streetcar Transit Priority Options Using Microsimulation Modelling. Special Issue on Innovations in Transportation Engineering*, Canadian Journal of Civil Engineering, 30(5): 1–10.
- Skabardonis, A, 2000. *Control Strategies for Transit Priority*, Transportation Research Record No. 1727, Transportation Research Board, United States.

  Control strategies for transit priority have long been recognized as having the potential to improve traffic performance for transit vehicles, which could also lead to improved schedule reliability, reduced operating costs, and greater ridership. However, there have been relatively few successful implementations of transit priority measures on urban networks with signalized intersections in coordinated signal systems. Existing control strategies are reviewed, the major factors affecting transit priority are identified, and the formulation of both passive and active transit priority strategies for arterials with coordinated traffic signals is described. The proposed strategies were evaluated on a real-life arterial corridor. The proposed passive and active priority strategies placed major emphasis on the system-wide improvements to the transit movements and on minimization of the adverse impacts to the rest of the traffic stream. The criteria used to grant priority include the availability of spare green time in the system cycle length, progression at the downstream intersection(s), and schedule adherence. An evaluation technique was also developed to assist in the design of the signal priority strategies and to predict the impacts of the transit priority measures.
- St. Jacques, Kevin and Herbert S. Levinson, 1997. *Operational Analysis of Bus Lanes on Arterials TCRP Report 26*, TRB, National Academy Press, Washington, DC, Unites States.

  Web site: *<http://trb.org/news/blurb_detail.asp?id=2590>*

  This report contains guidelines for estimating bus lane capacities and speeds along arterial streets. It recommends level-of-service thresholds for buses based on speed, and it presents procedures for estimating the speed of buses using dedicated bus lanes on arterial streets.
- TransLink, 2005. *Making Buses a Priority: 2005 Status Report on Bus Priority Measures*, TransLink, Canada.

  This report highlights the current status of the Bus and HOV Priority Program in Greater Vancouver. The report provides an overview of existing facilities in the region as of June 1, 2001. Specific reference is made to the new facilities that have been completed during 2000 and to the planning studies currently underway as part of the TransLink bus priority and HOV program.
- Wadjas, Y., P.G. Furth, 2003, *Transit Signal Priority along Arterials Using Advanced Detection*, Transportation Research Record No. 1856, Transportation Research Board, United States.

  This research developed and tested the concept of advanced detection and cycle length adaptation as a strategy for providing priority for transit vehicles. In a departure from control strategies that rely on detection only a few seconds in advance of the stopline, a control algorithm was developed in which transit vehicles are detected two to three cycles in advance of their arrival at an intersection stopline. Phase lengths were then constrained so that the transit-serving phase was green for a 40-s predicted arrival window. Methods were developed for selecting whether to extend or compress phase lengths to shift a green period to cover the arrival window. Adaptive control was combined with actuated control using traffic density and queue length

estimation, transit stopline actuation, and peer-to-peer communication for coordination in the peak travel direction. The method was applied by simulation to Boston, Massachusetts' Huntington Avenue corridor, which is served by a light-rail line running partly in mixed traffic and partly in a median reservation. The prediction/adaptation algorithm resulted in 82% of the trains arriving during the green phase. This control strategy resulted in substantial improvements to transit travel time and regularity with negligible impacts on private traffic and pedestrians, and was found to be more effective than simple pre-emption.

Other related InfraGuide best practice documents:

National Guide to Sustainable Municipal Infrastructures (InfraGuide®), 2003. Roads and Sidewalks Best Practice: *Road Drainage, Design Alternatives and Maintenance*. Ottawa, Ontario.

______, InfraGuide, 2004. Roads and Sidewalks best practice: *Rut Mitigation Techniques for Intersections.*

______, InfraGuide, 2004. Decision Making and Financial Planning best practice: *Managing Infrastructure Assets*. Ottawa, Ontario.

______, InfraGuide, 2005. Decision Making and Financial Planning Best Practice: *Public Consultation*. Ottawa, Ontario.

Notes