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TransitCenter

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BETTER BOARDING, BETTER BUSES: STREAMLINING BOARDING & FARES

A M86 SBS stop in New York City

Transit agencies are moving more people in less time, by implementing all-door bus boarding and off-board bus fare payment, on busy lines and systemwide.

The time it takes for a bus to stop in order to load and unload passengers—called dwell time—can constitute up to a third of bus travel time.¹ With conventional front-door-only boarding, buses are victims of their own success: the more riders there are, the slower buses get. These delays add up, costing agencies and passengers millions of hours—and potentially billions of dollars—each year. Systems across North America are finding a better way, using better boarding and fare payment methods to reduce dwell times dramatically.

All-door boarding, where passengers are allowed to enter through any door, along with off-board fare collection, one way to enable all-door boarding, dramatically speed up service and improve reliability. While light rail systems have long used these practices, more and more cities are applying all-door boarding and off-board fare payment to busy bus lines, and San Francisco has joined cities like Paris,

Oslo, Copenhagen, and Berlin in implementing these techniques throughout their entire bus networks.

This paper reviews the experience of seven cities in North America that demonstrate how innovative bus boarding and fare payment practices can scale to any city's transit needs, and can grow ridership while streamlining operations. Together, off-board fare collection and all-door boarding cut dwell time substantially, leading to more competitive travel times, greater reliability, and growing ridership in every reviewed example. Transit agencies have packaged these with operational and design techniques—like transit lanes, in-lane stops, and signal timing changes, as well as vehicle design choices such as open-plan low-floor buses and near-level boarding—that add to the benefits of all-door boarding and faster fare payment practices.

With successful examples across North America, these tactics should be implemented as broadly as possible, starting with busy lines and extending systemwide.

PAYMENT IS A PROBLEM

Paying a bus fare the traditional way—at the front door, with cash or a farecard—is time-consuming, taking nearly 5 seconds, and occasionally up to 9 seconds, per passenger.² This conventional practice—driver fare control with front-door boarding—makes bus transit congestible, rather than a public good that improves as more people use it. As a result, more rider and driver time is lost on the highest-ridership routes and systems, exactly where transit should be performing best.³ The impact can be seen at the level of entire systems: the slowest U.S. systems have the highest number of passenger boardings per hour of bus runtime.

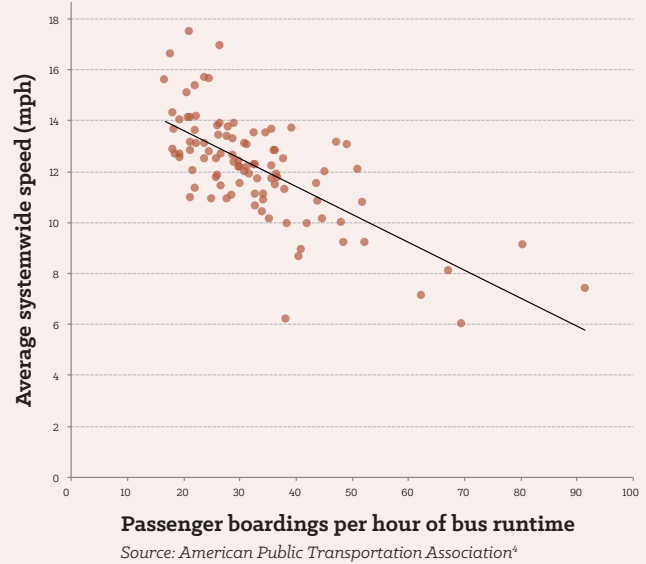
Cumulatively, bus operators in the U.S. spend at least six million hours at bus stops each year, directly costing agencies an estimated \$700 million, before accounting for the value of riders' time.⁵ Since it is difficult for service planners to anticipate how much time will be spent at each stop on payment, cash payment in particular is a source both of expected and unexpected delay, adding hidden costs in the form of longer scheduled dwell times and layover times.

Transit agencies have opportunities to address these problems without large and expensive metro-system-style turnstile systems. Indeed, most U.S. light rail systems use exactly the same package of practices outlined in this paper: all-door boarding, proof-of-payment fare control, and station improvements. Since the majority of transit rides in most cities are made on local buses, these methods should also be applied to those routes, not just for bus rapid transit (BRT) routes or on major capital investments.⁶ One answer to slow bus service is right in front of us.



A Muni bus in San Francisco

AVERAGE SYSTEMWIDE BUS SPEED VS BOARDINGS



STEPS TO BETTER BOARDING

All-door boarding allows passengers to board through multiple doors rather than just at the front of the bus, resulting in faster per-passenger boarding, and more even distribution of passengers throughout the vehicle. All the lines and systems reviewed in this paper use all-door boarding, as do nearly all U.S. light rail lines—even those with lower ridership than the busiest local bus lines.

All-door boarding is facilitated by proof-of-payment (PoP) fare control, where passengers validate a smart card or mobile ticket, or purchase a ticket from a vending machine—ideally without interacting with the driver. This off-board fare collection, in which passengers pay their fare before boarding the bus, can cut per-passenger dwell time by half or more.⁷ Rather than having bus drivers check passengers for fares, dedicated fare inspectors circulate throughout the system. Proof-of-payment for transit is eminently practical in a North American context; most light rail systems in North America, as well as all of the 'Better Bus' lines reviewed here, use the proof-of-payment approach to all-door boarding. Systems that provided data have reported better fare compliance than with front-door driver fare control.

Riders can use reloadable smart cards or contactless credit cards, as well as mobile e-tickets or paper tickets, allowing for quick boarding without waiting for passengers to pay on board with cash.

IMPLEMENT FASTER PAYMENT WITH EXISTING MEDIA

Opportunities abound to use all-door boarding even with existing fare payment systems and methods. In all the transit systems reviewed here, better boarding was implemented with pre-existing fare payment media, and all seven systems still accept cash, either on- or off-board at all stations. Many bus systems use a combination of smart cards, plus paper tickets given by the driver. As shown by San Francisco's example, these transit systems can be rapidly upgraded to 'intermediate' universal all-door boarding by installing card readers at the rear doors of buses and introducing inspections; these changes allow most riders systemwide to take advantage of all-door boarding. San Francisco and several European systems continue to allow front-door cash payment; cash passengers receive a paper ticket as proof of purchase.

Cash fare payment can be moved off-board by providing ticket vending machines at stops, which, while expensive to purchase and maintain, are valuable at high-volume stops or lines, or where cash is commonly used. New York, Minneapolis, and other U.S. rapid bus lines not reviewed here, such as LA Metro's Orange Line, use off-board ticket vending machines plus off-board fare card validation to completely eliminate on-board payment. These are interim steps, using existing fare media, that most transit agencies can take on either selected lines or, ideally, for the system as a whole.

Agencies should choose off-board fare payment strategies by working with people who are most likely to use cash to select alternatives that are easy and efficient. Analyzing fare media use by line and by stop can help determine which fare payment options are most important at each stop, and help target where on- or off-board ticket vending or smart card reloading machines should be located; a busy transfer stop with very few cash boardings might not benefit as much from a ticket vending machine as a moderate-use stop with a high portion of cash-paying riders.

The type of fare media in use by a transit agency often defines the options available to improve boarding. Whenever fare media are updated, it is vital that transit agencies ensure that the new fare payment system will be compatible with proof-of-payment fare inspection. The key to ensuring compatibility is that payment media, such as smart cards or mobile tickets, are readable and verifiable by fare inspectors; inspectors must be able to quickly check, ideally with handheld electronic readers, that a passenger has paid. Account-

based fare payment systems like agency-issued smart cards, and open fare payment systems allowing passengers to use bank and credit cards to pay fares, are especially attractive solutions.

LONDON: CASH-FREE BUSES WITH UNIVERSAL ACCESS

In 2014, all Transport for London buses ceased to accept cash on-board. Payment using the Oyster smart card had been an option since 2003, and by 2012 only 1% of bus riders were paying cash. An open payment system was implemented; buses began accepting payment via contactless credit and debit cards in 2012, which are used for one-third of all journeys today. To ensure that passengers who do not have a contactless card or cannot access a vending machine in a station can get a smart card, riders can purchase and add value to Oyster cards at 4,000 vendors across London, as well as online. Passengers are also protected by a "One More Journey" policy allowing Oyster e-purse values to fall negative for one bus trip. A daily and weekly fare cap for "Pay as You Go" fares paid using Oyster and contactless cards automatically gives riders the cost savings and convenience of a daily or weekly travelcard—without having to purchase a specific pass upfront—making paper tickets all but obsolete. Discontinuing cash fare payment has saved TfL nearly £26 million annually.^{8, 9, 10, 11}

CONVERTING RIDERS FROM CASH

Make it as convenient as possible for riders to switch to faster fare payment methods. Outreach to pass-eligible patrons in particular can reduce reliance on cash purchases, potentially reducing the number of locations or machines needed for ticket or smart card purchases made with cash. Encourage use of faster fare media by making it easy for eligible riders to get reduced-fare smart cards or passes, or by expanding pass eligibility from the common existing groups (seniors, students, and people with disabilities) to include low-income riders, as Seattle and San Francisco do. Some systems, including Muni in San Francisco, allow but discourage time-intensive cash fare payment by adding a cash surcharge, or by providing discounts for passengers who use smart cards. Other systems offer free transfers only to passengers using smart cards or passes.¹³

In Greater Boston, MBTA is striving to make it possible for 95% of customers to reload smart cards using cash near at least one end of their trip. A \$5 fee per new card allows customers to carry a negative balance for one trip, giving cash passengers an additional chance to get somewhere where they can add value to their cards if their balance is low. Transit agencies can also partner with local businesses to let passengers purchase and add value to smart cards at shops like convenience stores and newstands, in addition to vending machines and online.

IMPLEMENTING FARE INSPECTION

Fare inspection is the major new operational component introduced by transit systems to enable all-door boarding and proof-of-payment. In inspection-based systems, fare control is performed by inspectors rather than the driver. Agents randomly circulate through transit vehicles checking passengers for valid fares. Some high-volume stations implement a "Paid Fare Zone" on platforms, where inspectors can check passengers before or after riding, enabling all-door boarding without barrier (turnstile) control.

Like bus operators, inspectors become the face of the transit system, and the image of the agency is affected by their approach to inspection. In some of the most successful reviewed examples, including San Francisco, fare inspection is intentionally not designed as "enforcement." Instead, it is conducted by unarmed inspectors trained to avoid conflicts (as bus operators already are in many systems). Transit agencies can employ inspectors themselves rather than relying on a police department or other agency, avoiding labor and coordination issues across agency and municipal boundaries. A sensitive, sensible approach to inspection is key to creating an equitable

system; rather than introducing additional policing into the bus system, inspection simply moves the task of checking that a fare is paid from the bus driver to a dedicated staff member. Moving fare collection from the bus driver to a dedicated staff force can also make bus operation safer by reducing the risk of assault on bus drivers.¹⁴

The cost of implementing proof-of-payment is not negligible, however the costs associated with fare inspection and ticket vending may be offset by higher ridership, increased fare revenue, and lower fare evasion.

Inspection is most effective when performed consistently throughout the entire service area. Where resources are limited, a zoned approach may be used, in which inspectors circulate in one sector of the transit system or one major line at a time. If this is done, care must be taken to avoid geographic discrimination by rotating inspectors. Impacts on service must be minimized; if inspections require a bus to be stopped, they should take place at scheduled timepoints, and then only for buses that are not already late. In some systems, it may be impractical to inspect near busy service hubs. Late-night or other off-peak inspections might not be cost-effective, so agency staff should consider time span when planning inspection operation.

CASE STUDIES

While scalable, equitable, and cost-effective measures for off-board fare collection and all-door boarding have been implemented by a number of North American transit agencies, few cities in North America have used them to their full potential, usually implementing these tactics only on specific lines or services. To date, Muni in San Francisco is the only transit agency in North America that has implemented all-door boarding and proof-of-payment fare collection on all its vehicles.

As the following case studies demonstrate, systemwide implementation of off-board fare collection and all-door boarding is a realistic goal for major U.S. bus systems, providing a large majority of U.S. bus riders with substantial time and reliability benefits.



Signage indicates the paid fare zone on a light rail platform in Seattle

TYPICAL OFF-BOARD FARE COLLECTION METHODS

FULL OFF-BOARD FARE COLLECTION

Minneapolis-St Paul; New York

- » Validate smart card at station
- » Purchase proof-of-payment ticket at machine using cash, coins, or card
- » No on-board fare payment
- » No interaction with driver
- » Excellent for high-ridership lines with stations



SMART CARD/MOBILE APP WITH ON-BOARD CASH OPTION

San Francisco; Austin

- » Validate smart card or QR code upon boarding
- » Cash payment may be accepted at farebox
- » Easy to deploy systemwide proof-of-payment where smart cards are already accepted



OFF-BOARD FARE COLLECTION AT KEY STOPS

Seattle

- » At high-volume stations, validate smart card off-board
- » At other stops, validate smart card on-board
- » Cash payment may be accepted at farebox
- » Good for lines with a few high-volume stations



OFF-BOARD FARE COLLECTION WITH ON-BOARD TICKET MACHINE OPTION

Seattle; Portland (streetcars)

- » Purchase proof-of-payment off-board at key stations
- » Validate smart card at station
- » TVM located on-board
- » No interaction with driver
- » Good for lines with a few high-volume stations and dedicated vehicles



SAN FRANCISCO: SYSTEMWIDE ALL-DOOR BOARDING & PROOF-OF-PAYMENT

In 2012, the San Francisco Municipal Transportation Agency's (SFMTA) Muni system became the first transit system in North America to implement all-door boarding and proof-of-payment (PoP) fare control on its vehicles systemwide, resulting in significant benefits for speed and reliability. Dwell times have fallen 37% and are 42% more consistent, with the 68th percentile boarding time (one standard deviation) now 3 seconds faster than before.^{15, 16, 17}

All-door boarding was already in practice on Muni Metro light rail but not on Muni buses, which, while carrying nearly 500,000 bus passengers daily, also have among the slowest average bus speeds in the US.^{18, 19} All customers were previously required to board at the front door for driver fare control, where the bus operator would inspect a passenger's pass, verify the validation of a smart card, or collect cash fare through the farebox.

At some of the busiest stops in the system, however, passengers began to enter through the rear door to speed the lengthy boarding process at the bus's front door. Though many passengers had monthly passes, the appearance of fare evasion drew attention, leading Muni to carry out a study of fare evasion on Muni buses. Surveys completed in 2009 and 2010 found fare evasion rates of 9.5% and 8.6% respectively.²⁰ Recognizing the potential for operational benefits and seeking to reduce fare evasion, SFMTA decided to implement systemwide all-door boarding with proof-of-payment fare collection.

The agency spent six months preparing: installing smart card readers at every door, training staff, hiring new fare inspectors, educating riders, and amending the city's transit code. On July 1, 2012, all-door boarding with proof-of-payment fare collection took effect throughout the Muni network. Under these new practices, passengers can board buses and light rail vehicles through any door, where they tap their Clipper smart card on a reader located at each door. Cash is still accepted at the front door, where passengers receive a paper proof-of-purchase ticket with a \$0.25 surcharge.²¹

Ensuring even inspection across all lines is key to enhancing fare compliance by maintaining an expectation among passengers that they could be checked at any time. Upon implementation of systemwide proof-of-payment, thirteen new SFMTA



A Muni fare inspector checks passengers for proof-of-payment

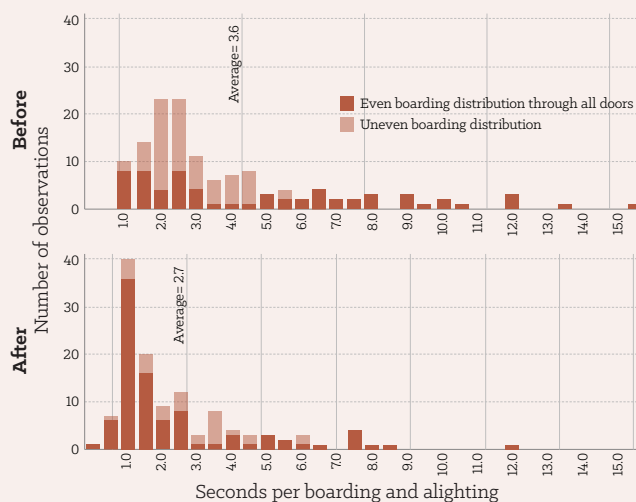
fare inspectors were hired, for a total of 54 throughout the system. Fare inspection was scaled up to take place every day of the week, with inspectors focusing on a different police district each day. Robust fare enforcement practices were also introduced, bringing teams of fare inspectors to quickly check all customers on a vehicle. San Francisco's small geography and dense, frequent transit network make it easy for fare inspectors to continuously circulate among vehicles.²²

RESULTS

To determine the impact of all-door boarding, SFMTA analyzed boarding activity, dwell times, and speeds before and after implementation. On all accounts, the result has been a success: dwell times dropped on average 38% per passenger, overall bus speeds increased 2% despite a 2% increase in boardings, and the fare evasion rate fell to 7.9%. Additionally, buses were more evenly loaded, and more customers paid using the more time-efficient Clipper Card than with cash. The increased cost of enforcement was offset by revenue from fares and citations.²³

ALL-DOOR BOARDING REDUCES DWELL TIME

After implementing all-door boarding, average dwell times fell and became less variable. Source: SFMTA²⁴



NEW YORK CITY: SELECT BUS SERVICE

New York City Transit's Select Bus Service (SBS), a rapid bus service launched in 2009, sought to minimize boarding delay using fully off-board fare collection. Fare payment on high-volume New York City Transit buses takes longer than on many other systems; the MetroCard fare payment system used in New York results in fast turnstile entry on the subway but much slower dip-based boarding on buses.²⁵ In order to keep the process easy to understand, implementing off-board fare collection within the existing fare structure and fare payment media was a priority agency.



A fare inspector checks Select Bus Service passenger tickets

Ticket vending machines at each station issue passengers a paper proof-of-payment ticket purchased before boarding. Two types of machines are in use. For fare payment by MetroCard, machines similar to those used in subway stations were reprogrammed by the system manufacturer (Cubic) to generate a proof-of-payment ticket. Costing approximately \$25,000 each, these machines typically draw power from nearby light poles. For cash fare payment, repurposed solar-powered parking meters costing \$7,000 accept payment using coins.²⁶ While both types of ticket vending machines require slightly more effort by riders than purpose-built technology, they required little change to basic business practices.

Select Bus Service uses an inspection-based fare control system, with random inspections of receipts by part of the “Eagle Team” of 162 transit police dedicated to fare inspection. Inspection is conducted on-board without stopping the bus. Fare evasion is now less common on SBS routes than on local bus routes.²⁷



Select Bus Service ticket vending machines

RESULTS

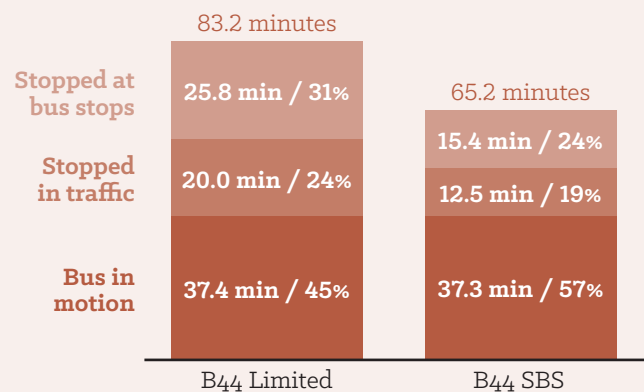
Compared to the routes they replaced, SBS routes have substantial decreases in dwell and overall trip times, and have seen increases in ridership:

BOARDING TIME SAVINGS ON SELECT BUS SERVICE ROUTES

SBS Route	Before	After	Change	Ridership Growth	Change in Dwell Per Passenger
Bx12	15:51	9:34	-40%	6.3%	-43%
M15	18:54	12:04	-36%	30%	-51%
Bx41	9:24	6:48	-28%	25%	-42%
B44	25:48	15:24	-40%	10%	-46%

Total time stopped at bus stops in minutes, including boarding and pullout delay.
Source: Metropolitan Transportation Authority^{28, 29}

SOURCES OF DELAY BEFORE & AFTER SBS IMPLEMENTATION



Source: Metropolitan Transportation Authority²⁹

SEATTLE: RAPIDRIDE

Introduced in 2010, King County Metro's six RapidRide lines offer high-quality and high-frequency service throughout Seattle and the surrounding King County, Washington.

RapidRide uses proof-of-payment fare control with a mix of on-board and off-board payment methods. Passengers can pay using the ORCA smart card, used by 63% of riders across King County. Customers paying with cash board at the front door and pay at the farebox; the driver issues a paper proof-of-payment ticket which also acts as a transfer. Passengers who already have a paper transfer can enter through any door at all stops. Efforts have been made to increase use of the ORCA card, including offering reduced fares to low-income riders using the card.³⁰

RapidRide "stations"—stops with more than 150 boardings per day—are outfitted with off-board smart card readers where passengers tap their ORCA card before boarding the bus through any door. At stops without an off-board validator, passengers using an ORCA card must board through the front door, where they tap their card at a validator. Though installing off-board fare validators at every stop or at the back doors of all buses was preferable, it was not implemented due to funding constraints, technological limitations, and uncertainties with the then-new ORCA card.

Fare inspectors, contracted by King County Metro from a private sector security service, check for valid proof of payment on RapidRide lines seven days a week, scanning ORCA cards on a mobile reader and visually inspecting paper tickets. Of the riders inspected in 2014 (about 3% of all passengers), 2.2% were found to be without a valid fare, down from a 3.2% fare evasion rate on the same corridors before RapidRide was implemented in 2010.³¹

The incremental roll-out of the RapidRide improvements on the 5th line (the E Line), allowed King County Metro to evaluate the impacts of each element separately. An April 2014 study found that off-board fare collection and related improvements were responsible for a reduction in overall travel times of up to 8%.³²



RapidRide station in Seattle

CHICAGO: OFF-BOARD PAYMENT TRIAL AT BELMONT

In June 2016, Chicago's CTA began a six-month all-door boarding station trial on the westbound Route 77 bus stop at the Belmont "L" Station during the afternoon peak period. Westbound buses have heavy boarding and transfer volumes at this stop as platoons of passengers transfer to the bus. Before the trial, boarding could take as long as five minutes, resulting in low reliability along the bus line.

For the pilot, CTA created a fenced-off area to demarcate a paid boarding zone. Passengers tap their Ventra smart card at a staffed card reader before entering the waiting area, and then can board buses using any door. Since a Ventra card is required to board at this stop, card vending machines were installed outside the boarding area. The standard fee for limited-use Ventra cards is waived at these machines.^{34, 35}

Preliminary estimates from the pilot show about a 50% reduction in boarding dwell times, and an exploration of how to expand all-door boarding is underway. While not easily scalable in its current form, a successful proof-of-concept could create the political will for other forms of implementation.³⁶

AUSTIN: METRO RAPID

Austin's Capital Metro operates two MetroRapid bus lines, which use proof-of-payment fare control and all-door boarding. Customers with passes, magnetic swipe tickets, or mobile tickets board through any door. Passengers paying with cash must board at the front to pay with the driver.

About 80% of passengers pay using prepaid fare media, such as passes. A mobile smartphone app developed with a private partner is used by 12% of passengers. The app displays a QR code which riders scan on-board using a reader located at every door. The low capital costs of the QR readers, along with an estimated 80% smartphone penetration rate, made this an appealing solution.³⁷



A mobile ticket QR scanner on an Austin MetroRapid bus

MINNEAPOLIS-ST. PAUL: A LINE

Fare collection is entirely off-board on Minneapolis-St. Paul Metro Transit's A Line BRT, opened in June 2016. Passengers pay before boarding a bus by tapping their smart cards on a reader at the station. Passengers paying with coins, cash, or credit cards purchase a ticket from a ticket vending machine at each station—modified parking pay stations costing about \$12,000 each. Fares are valid for 2½ hours.

As on Metro Transit's light rail, passengers with a valid proof-of-payment can simply board a bus through any door. Fare inspectors circulate on buses along the line checking for proof of payment. Using the same ratio of officer hours to route service hours as the light rail lines, six new transit police were hired to check A Line passengers, operating on two shifts over the majority of the day.³⁸



Ticket vending machines and smart card validator on the Minneapolis-St Paul Metro Transit A Line

VANCOUVER: 99 B LINE

Vancouver Translink's 99 B Line bus route has employed proof-of-payment fare collection with all-door boarding since 2007. The busiest bus route in North America—with 55,500 passengers on an average weekday and 160 boardings per revenue hour—has 2–4 minute headways at peak and headways no longer than 7–8 minutes off-peak.^{39, 40}

Smart card readers are installed at each door of the route's 60-foot articulated bus fleet, allowing passengers to board and tap their card at any door. Compass cards are available at SkyTrain stations, customer service centers, retail sales outlets, and online; bus stops do not have their own card vending or reloading machines.

While cash fares are still accommodated at the driver, only a small percentage of riders pay with cash. A large portion of riders are university students who receive a discounted smart card. Riders paying with cash receive a proof-of-payment ticket which can be used to transfer to other buses; transfers to Vancouver's Skytrain rail network can only be made using a Compass card.

Following implementation of these measures, trip times on the 99 B Line fell by 3% (1 minute), with per-passenger dwell time falling by 17% (1 second per passenger), despite rising ridership.^{41, 42}

LESSONS FROM THE CITIES

» **Implement better boarding as widely as possible.**

Implementing better boarding practices throughout a transit network will achieve the greatest benefits, improving transit reliability systemwide and delivering a consistent experience from line to line. Where systemwide adoption is not yet possible, target key routes for better boarding improvements. Prioritize lines with high ridership or frequent boarding delay.

» **Implement better boarding as quickly as possible.**

Don't delay! Use existing fare media and materials on hand to quickly implement better boarding. For example, parking pay stations may be repurposed as ticket vending machines. Interim boarding islands can be built with concrete doweled-in to the street; shelters can be installed later.

» **Ease of use matters.** Transit agencies should make bus fare payment easy and convenient, as most light rail and metro systems already do. Keep the system simple. When implementing rapid bus lines or universal all-door boarding, let passengers keep using their preferred fare media, while making more efficient methods of payment easily accessible to all riders. Changes to pricing can add extra confusion, and should usually not be implemented concurrently with route changes.⁴³

» **Eliminate or discourage cash payment at the farebox.**

Even if only used by a small portion of riders, cash payment on board presents a major source of delay and unreliability. Serve unbanked passengers and casual riders while minimizing the negative operational impact of cash payment by making alternative cash payment sites such as ticket vending machines readily available.

» **Update fare media for proof-of-payment compatibility.**

Modern fare media lets transit systems implement all-door boarding quickly and inexpensively. Whenever payment systems or fare cards are updated, ensure that new systems are compatible with proof-of-payment inspection, giving inspectors access to payment account information. Plan for card readers at all doors. Account-based systems, fare readers that also accept contactless credit or debit cards, and mobile ticketing provide the most flexibility.

» **Design fare inspection for equity.** Train and deploy proof-of-payment fare inspectors to ensure consistent inspection across routes and time of day. Fairness and the safety of both inspectors and riders is paramount; criminalizing riders will not result in an equitable transit system. Use a pro-passenger approach that makes transit a better experience for all riders, especially those who may not have complete information.



An A-Line bus station in St. Paul, MN



A B44 SBS stop in Brooklyn, NY

- » **Communicate changes succinctly.** Accompany rollout with a citywide public information campaign to communicate the changes in boarding and fare payment and their benefits. Advertising on shelters, vehicles, social media, billboards, and traditional media can all be helpful. Where changes are only applied to some routes, line branding advertises the benefits of all-door boarding to passengers.
- » **Gather data and promote benefits.** Communicate the time savings gained by off-board fare collection and all-door boarding. Benefits are found in both dedicated-lane and mixed-traffic operation, and on both local and rapid lines. When evaluating the costs and benefits of specific approaches, it is important to account for both average time savings and improved reliability, which may be substantial even on lower-ridership lines.
- » **For greater impact, combine boarding policy with service and design improvements.** The rollout of all-door boarding can be an opportunity to make additional changes to improve bus routes, including improved stops, rapid services, dedicated bus lanes, and branding. Save even more time and make riding more attractive by using wide-door low-floor buses with near-level boarding, and other transit-supportive stop design elements documented in the NACTO *Transit Street Design Guide*, for greatest impact.

- » **Be proactive.** City and transit agency staff and leadership must work together closely to avoid major capital street work and expense. Build an working relationship between city and transit agency staff to facilitate ongoing collaboration. City governments seeking faster buses should assign a program leader responsible for transit, with a mandate to make changes on the street. In Seattle and New York City, close collaboration between city governments and transit agencies set up a precedent for coordination which has allowed them to quickly expand all-door boarding to additional routes.

City street departments can work with transit agencies to proactively implement short-term projects, such as bus lanes using markings and signage to benefit transit. Cities should use street reconstruction as an opportunity to implement permanent, robust transit-friendly street design.

NOTES & CREDITS

- 1 On the 11 busiest Minneapolis Metro Transit bus corridors, 32% of travel time was spent stopped waiting for customers to board.
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Before implementation of SBS, corresponding local routes spent 27–31% of travel time stopped at bus stops.
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- 2 Exhibit 6–4, Transportation Research Board (TRB), "Transit Cooperative Highway Research Program (TCRP) Report 165: Transit Capacity and Quality of Service Manual (TCQSM), Third Edition," 2013. Accessed via: http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_165ch-06.pdf
- 3 APTA, "Public Transportation Fact Book, Appendix B: Transit Agency and Urbanized Area Operating Statistics," April 2016. Accessed via: <http://www.apta.com/resources/statistics/Documents/FactBook/2016-APTA-Fact-Book-Appendix-B.xlsx>
- 4 Ibid.
- 5 Studies aggregated in the TCQSM estimate 4.5 s as average boarding time for front-door boarding. With approximately 5.2 billion annual bus passenger trips in 2015, time spent at \$150/service hour equals \$705.8 million. Assuming 30 boardings per hour and an average trip of 30 minutes, passengers are exposed to at least 70.6 million hours of boarding delay annually; this is a vast underestimate, since most rides are taken on busier than average routes. There were 181.2 million bus vehicle hours of revenue service in 2014.

Exhibit 6–4, Transportation Research Board, "Transit Cooperative Highway Research Program (TCRP) Report 165: Transit Capacity and Quality of Service Manual, Third Edition."

APTA, "Public Transportation Fact Book, Appendix A: Historical Tables," April 2016. Accessed via: <http://www.apta.com/resources/statistics/Documents/FactBook/2016-APTA-Fact-Book-Appendix-A.pdf>
- 6 Major investments include barrier-controlled systems, passengers purchase a ticket or fare card, which is used to pass through a gate, turnstile, or a staffed checkpoint where fare is verified or deducted prior to entering the station.
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- 8 Interview with Matthew Hudson, December 1, 2016.
- 9 Transport for London, "Capital goes cashless on the buses," February 2014. Accessed via: <https://tfl.gov.uk/info-for/media/news-articles/capital-goes-cashless-on-the-buses>
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