Maximizing Accessibility for Modern Streetcar Systems; Level Boarding Background Memo

Part 1- Background

1. Introduction

This memo has been prepared by a working group of the APTA Streetcar Subcommittee and the Community Streetcar Coalition to facilitate the ongoing industry discussion on maximizing accessibility for urban transit. It focuses on application of level boarding concepts to US modern streetcar systems, which by their nature tend to be more fully integrated into the built urban environment than other forms of rail transit. This generally means that streetcars often share right-of-way with numerous other modes, for example by running in mixed traffic lanes, or needing to share boarding areas with buses. Sharing the roadway space can also bring extremes of horizontal and vertical curvature, sometimes requiring that stops be located on significant grades or even on curves.

This unique level of urban integration tends to require a more customized approach to achieving accessibility; accessibility must be considered at a system level during planning, design and operation in order to ensure that the new infrastructure associated with streetcar access does not inadvertently create access challenges for other users of the shared space (e.g. in the pedestrian realm). These challenges are however balanced with the potential for important accessibility benefits; the mode's flexibility and use of low-floor vehicles can allow the streetcar alignment to be located where it provides the most effective service to the communities it serves.

Reference is made throughout this memo to the APTA Modern Streetcar Vehicle Guideline document (2013). The Guideline document includes a chapter on vehicle / platform interface (some excerpts are included in this memo), but there are also broader issues outside of that document's scope which receive a more focused treatment here.

2. Evolution of Light Rail / Streetcar Vehicle Accessibility

Figure 1: Light Rail / Streetcar Accessibility Timeline

The advent of modern low-floor vehicles greatly improved accessibility for urban transit, being applied to bus, streetcar and the light rail modes. In looking at a timeline of transit vehicle accessibility, it is noted that the current ADA regulations pre-date the arrival of low-floor rail vehicles in the US.

First era: non-accessible

- 1890-1980 Non-accessible urban transit vehicles, generally high-floor

Second era: high-floor accessibility 1980's-90's

- High floor / High platform
- High floor / Low platform

Third era: low-floor vehicles (low-floor / low-platform)

- 1984- Partial low-floor tramway vehicles debut in Europe
- 1990- 100% low-floor tramway vehicles debut in Europe
- 1990- ADA Regulations signed into US law
- 1997- Partial low-floor light rail vehicles debut in US
- 2001- Partial low-floor streetcars debut in US

- 2010- 100% low-floor streetcars debut in Canada
- 2013- 100% low-floor streetcars debut in US

Total North American Modern Streetcar / Light Rail Systems 2015: 39 (plus 7 more in final design/under construction with low-floor boarding)

- **Low-floor, fully level boarding:** 16 (3 are conversions from earlier high-floor / low platform)
- **Low-floor, near level boarding using bridgeplates:** 10
- **High-floor / high platform:** 6 (opened between 1981-1993)
- **High-floor / low platform:** 5 (one converted legacy system, plus 4 opened between 1985-1994)
- *2 Legacy systems not yet converted for accessible boarding (5 other legacy systems converted)

As detailed in **Figure 1**, urban transit accessibility has evolved from high-floor to low-floor access. The low-floor approach to level boarding provides the same advantages of high-floor / high platform (rapid boarding, accessible boarding not separated), but without the space, cost and aesthetic penalties associated with high platforms. Combined with "all door" boarding and removing the operator from being involved in fare collection, the low-floor approach offers superior accessibility and passenger experience, as well as dwell time and service reliability benefits. Creating new fully-accessible systems without the need to construct high platforms has also provided flexibility to place alignments where they better serve their communities.

The low-floor paradigm shift is evidenced by the fact that of the considerable number of new modern streetcar and light rail systems opened in the 2000's, all are low-floor. High-floor designs remain the logical choice for new start heavy rail systems, but no new light rail / streetcar systems have been designed in North America with high-floor / high platform boarding since St Louis' new system opened in 1993. Even existing systems using high-floor access are in some cases (Edmonton) building extensions with low-floor vehicles, accepting a mixed fleet.

Low-floor rail vehicles have themselves evolved considerably since their modern introduction in Europe more than 30 years ago. In addition to vehicle configuration and related drive system technology advances that have helped improve reliability and maintainability, there has been a trend towards further incremental improvements in accessibility. Important advances in vehicle configuration include the development of so-called "100% low-floor" types now in use throughout the world[1].

The phrase "100% low-floor" is somewhat misleading, however, as it does not refer to a continuous *accessible* low-floor, but rather to a continuous aisle of varying width (and in some cases slopes). Running gear must still be accommodated, preventing an *accessible* width aisle (e.g. 32 inches [813 mm] minimum) from being implemented along the entire length of the vehicle, even in a "full width" vehicle (8.7 feet [2.65 m]). This situation is analogous to the low-floor bus; in both cases a variety of techniques are employed to allow the floor to pass through the raised "wheel wells" that protrude into the passenger compartment, and adapt the wheel wells to incorporate seating. The so-called "partial low-floor" vehicle eliminates the wheel wells by using high-floor areas (with heights varying depending on

[1] A prototype 100% low-floor vehicle toured the US in 2013, first use in commercial service will be Cincinnati and Kansas City streetcars in 2016

design) over some or all of the running gear, using steps to connect to the remainder of the passenger compartment.

FIGURE 2
100 Percent Low-Floor Interior

All low-floor vehicles require some form of compromise with regard to the floor configuration; the “100 percent low-floor” vehicle has no steps in the passenger compartment, but “wheel wells” (which become de facto seat locations) intrude into the passenger space, just as they do in low-floor buses.

FIGURE 3
Partial Low-Floor Interior

View of the steps leading to the high-floor section of a “partial low-floor” streetcar in Seattle. The height difference between sections varies between different vehicle designs.

Another aspect of the low-floor vehicle evolution is entranceways; in some early US low-floor vehicles, only a single accessible doorway was provided per side for each of the designated wheelchair / priority seating areas[2]. Newer vehicle configurations tend to provide more doors along the length of the vehicle offering the ability to provide multiple compliant access paths to wheelchair berths / priority seating areas. When these vehicles can be used together with 14 inch (355 mm) platforms (fully-level boarding), accessibility is further improved because additional doorways are also accessible (instead of only those with bridgeplates). This provides a further incremental improvement in accessible boarding, particularly during crowded peak periods.

Doors can also be placed at the ends of the vehicle; these “auxiliary” doorways offer the potential for further improvement of passenger flow, which benefits all passengers. Regardless of whether the vehicle is 100% low-floor or partial low-floor however, these auxiliary doorways are not intended for use as additional wheelchair entrances; in the 100% low-floor configuration the adjacent wheel wells restrict aisle width when moving towards the center of the vehicle, and in the partial low-floor vehicles, steps are used in the vertical transition areas. As noted however, the auxiliary entrances can still offer important passenger flow benefits, particularly in 100% low-floor vehicles where they are at the same low-floor level as the primary accessible entrances and are a minimum of 32 inches wide.

Door systems and related “gap filler” technology have also evolved considerably, helping agencies meet the challenge of integrating streetcar alignments with other modes (e.g. bus and streetcar sharing

[2] See Figure 4; the vehicle’s two designated accessible entrances / wheelchair berths are connected through the center module and articulations, but not (in most cases) with a pathway meeting minimum 32 inch width. This too is evolving however.

platform) within dense urban environments. Although still called "bridgeplates", the current generation of user-activated powered ramps on low-floor vehicles are radically different than the bridgeplates found in early accessible boarding configurations (e.g. high-floor vehicles berthing at "mini high block" platforms and using manually deployed bridging plates). Refer to the photographs in **Figure 5** and in **Table 2-2** "Near Level Boarding using bridgeplates".

The differences between the "partial" and "100%" low-floor vehicle configurations also continue to narrow in both performance and accessibility aspects. Figure 4 details the trend towards increasing the length of the continuous *accessible* low-floor area. This involves the use of an articulation passage design that doesn't constrict the aisle width, omission of any 2+2 seating through the continuous accessible area, and in some cases the use of a "suspended" vehicle module that has no running gear under it (vehicles d and e in **Figure 4**).

Looking ahead to the next several decades, it is anticipated that there will be a more complete implementation of low-floor vehicles on US streetcar and light rail systems, although most existing high-floor systems will continue to achieve accessibility using the high-floor/high platform approach. The number of low-floor systems will continue to grow, with continuing use of both partial and 100% low-floor vehicles, and both near level boarding with bridgeplates and fully level boarding. The long life of railcars (typically 30 years minimum) also influences this evolution; on some older light rail systems access is currently achieved by mixing newer low-floor vehicles into train consists with older high-floor cars. In these cases, as the high-floor cars reach the end of their useful life they will be replaced with the next generation of low-floor cars. Another light rail / streetcar trend relevant to accessibility is the use of longer vehicles (now over 164 feet [50 m] in some European cities) instead of multiple unit "train" consists. These longer multi-section vehicles provide a continuous passenger compartment, increasing capacity and reducing cost by eliminating extra cabs and couplers. They also save street space compared to train consists, an important benefit in dense urban environments.

In summary, the extreme diversity of operating environments and the varying ages of systems require a variety of vehicle architectures including variation in overall dimensions, boarding arrangement and low-floor configuration. The reality is that both the partial and 100% low-floor vehicle concepts each have their advantages and disadvantages, and that the differences between the two types continue to narrow. The discussion of these inherent trade-offs should not however distract from the big picture, namely that the low-floor paradigm shift has allowed the light rail/streetcar mode to achieve unparalleled levels of system accessibility, improving the passenger experience for all riders. All of the sub-types of new low-floor vehicles have important characteristics in common from an accessibility standpoint; namely the potential for multiple accessible doorways on each side, providing easy access for everyone with attendant benefits for dwell time and service reliability. **Figure 4** shows examples of various types of US streetcar / light rail vehicles, and illustrates some of the evolution in configuration discussed in this memo.

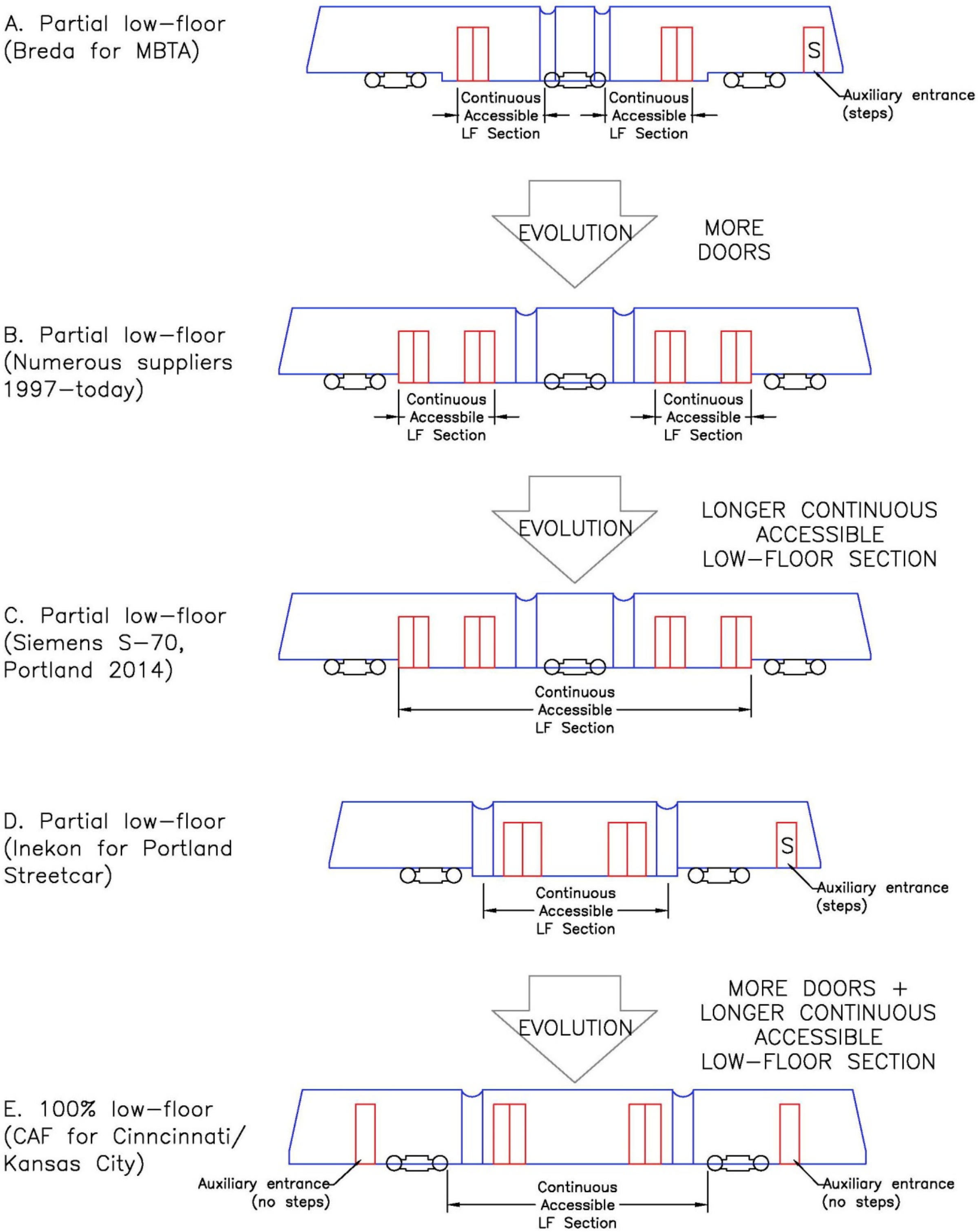


Figure 4 Evolving low-floor vehicle configurations. These examples illustrate the trend towards additional doorways and longer low-floor sections

3. Access Board Update of Accessibility Guidelines for Transportation Vehicles

2015 is the 25th anniversary of the landmark ADA law. The US Access Board is currently in the process of reviewing and updating the accessibility guidelines for transportation vehicles. A related step in this process included updating the rules for buses (started 2010, final rule due 2015). In July 2015, the US Access Board Rail Vehicles Access Advisory Committee issued its Final Report covering rail vehicles. A working group of the APTA Streetcar Subcommittee and Community Streetcar Coalition has reviewed the RVAAC draft report, as well as the NPRM for the new bus accessibility guidelines and has identified the following topics for further discussion:

In general, the light rail / streetcar mode has already reached a significant plateau in terms of achieving the goals detailed in the "guiding principles" cited in the RVAAC report. Guiding Principle 1 states *"Features providing access for people with disabilities must be equivalent to those provided others in terms of functionality and aesthetics , and must not segregate individuals with disabilities"* With the exception of a few heritage trolley systems, new systems all use low-floor vehicles due to the inherent accessibility and capacity advantages. The vehicle's accessible doorways (multiple doorways on each side of the vehicle in many cases) are utilized by all passengers, elegantly fulfilling this fundamental goal.

In reviewing the RVAAC draft report, there are a few issues / clarifications that could help with further improving accessibility at the system level.

1. The working group sees value in a performance-based approach to bridgeplate edge barriers, based on the updated approach used in the recent proposed final rule for bus accessibility (requiring edge barriers only in situations where the vertical step height between top of platform and vehicle floor at the doorway is greater than 3 inches). The advantage of such an approach would be multi-fold:
    a. Improve ease of boarding (bridgeplate can be approached at an angle instead of only straight on)
    b. Where near level boarding with bridgeplates is in use, encourage system design to maintain a vertical step height below 3 inches
    c. Elimination of the potential trip hazard associated with edge barriers
    d. Improved bridgeplate reliability through use of a simpler mechanism

Figure 5: Bridgeplates deployed in a low-floor light rail vehicle context; Tri-Met, Portland Oregon.

2. The rule should also allow for bridgeplates to be deployed only on demand, instead of automatically at every stop; it is unclear from the report what was intended. This is already common industry practice with multiple proven solutions that ensure that request-based bridgeplate deployment is consistently achievable, even in crowded conditions.
3. The rule should clarify that folding seats can be used at the wheelchair area, provided that their use does not reduce the designated space below the required minimum to make equitable use of the area (this is covered in the report, but is not entirely clear in the existing rules).
4. The report also recommends changing the maximum horizontal gap from 3 inches to 2. It is unclear whether this recommendation includes an analysis of vehicle dynamics and the maintenance-related tolerances for both track and wheels over the life of the system. Industry practice for streetcar/light rail is to specify a nominal 2 inch horizontal gap, with the 3 inch maximum used to help deal with wear and maintenance factors over time, as well as ensuring safety in special circumstances such as instances of suspension failure.

Part 2- Vehicle / Platform Interface- Application Notes

1. Challenges for locating platforms in the streetcar environment

Although the streetcar is presently thought of largely as an urban circulator in the US, several variations are found:

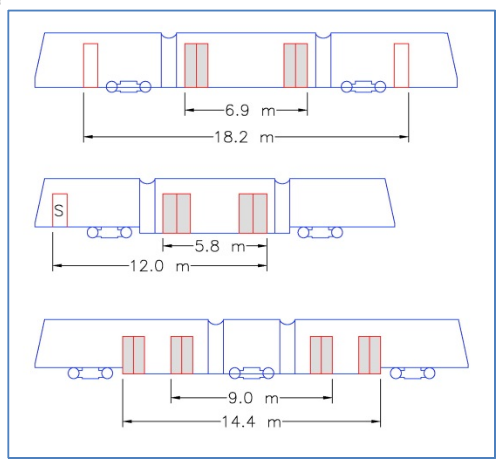
- Circulator Streetcar
- Rapid Streetcar
- Starter segment for future light rail system
- Light rail / streetcar interoperability (shared line segments)

Track alignment within the street will also vary, including center running and curb lane, the latter both with and without an adjacent parking lane. Unlike light rail, where a segregated right-of-way is the general rule, streetcar systems often operate in mixed traffic (sometimes with traffic priority treatments) for significant portions of their alignment because there is no other viable alternative. This requires that streetcar track and platforms be "creatively squeezed" into the densest of urban environments.

Worldwide, new streetcar systems incorporate platforms to maximize the benefits of low-floor vehicles. Streetcar platforms are a mixture of side, island and center types. Any platform must balance a variety of sometimes conflicting uses of the street- streetcar stop, automotive traffic, parking, crosswalks, buses, cyclists, pedestrians, utilities, business activities, etc. Where streetcar platforms are blended directly into the sidewalk ("bulb outs"), design must consider not only the platform area itself, but the adjacent sidewalk / curbs / pedestrian paths, and the related transitions. In all cases, the required platform length will also vary depending upon capacity requirements and the door spacing used on the specific streetcar vehicle (**Figure 10**). Where sidewalk space is limited, side platforms can be especially challenging due to ramp slopes and drainage issues, as well as the basic need to find space for the basic passenger amenities associated with the stop.

Platforms are generally arranged for either "near level" boarding with bridgeplates (8-10 inches high) or fully level (13-14 inches) boarding. While fully-level boarding is always the ideal, some streetcar operating environments make it challenging to implement, and the question must always be examined from a *system* accessibility standpoint. The higher the platform becomes, the more difficult it is to share with buses, and the more challenging it becomes to integrate into the street and blend with the existing sidewalk. The trade-offs between these two approaches are more fully explored in the following sections.

Figures 6, 7 and 8- Streetcar platforms come in many shapes, sizes and locations. Clockwise from left; side platform arranged as a "bulb out" to accommodate parking, side platform on street with no parking, and center platform. In all cases the platforms must be both accessible and compatible with their surroundings, blending into the streetscape and/or sidewalk in a safe and integrated manner.



Figures 9 and 10- Integrating streetcar into the city requires flexibility **Left:** An unusually creative streetcar platform- accommodating multiple uses in a tight space. **Right:** illustration showing variation in door-to-door spacing of several current US streetcar vehicles.

2. Streetcar and Bus Sharing a Platform

The nature of the streetcar mode is such that streetcar and bus routes may overlap. This may present opportunities for different types of vehicles to share stops (buses, different light rail and streetcar types, heritage trolleys). Shared stops can improve passenger convenience by facilitating easy transfers and the space-saving aspect can be a very useful design tool in dense urban settings. Depending on the nature of the transit services using the stop, separate stopping places may also be desirable for capacity or other operational reasons; a longer stop area, split stops (**Figure 13**), or adjacent stops (**Figure 14**) may also be used to provide separate but proximate stopping places.

Implementing shared stops involves a number of variables centering on the height of the platform. Generally, as platform heights increase above 8 inches (203 mm), additional design coordination is required to ensure compatibility with buses. The ability of a transit bus to interface with a shared streetcar platform is dependent on several factors:

- **Platform location-** Other than special-purpose applications, transit buses generally have doors only on the curb side. Therefore, streetcars and buses can share certain types of side and island platforms but buses cannot use streetcar center platforms. Where center platforms are in use, the bus can use a separate curbside stop nearby, although any traffic impacts of having both a streetcar and a bus stopped simultaneously in this arrangement should be considered. Platform and trackway must also be compatible with any guidance system used by the bus.

- **Platform height**- sharing of stops is generally more compatible with the lower platform heights associated with the near level with bridgeplates boarding concept. In some cases, a bus which can deploy its front door ramp without kneeling can interface successfully with a 10 inch (254 mm) platform. Above this height, additional mitigations are typically required[3].
- **Bus floor height -** floor heights vary for different models of buses. The floor height also varies based on passenger loading and kneeling features.
- **Bus door and ramp configuration-** configurations vary significantly between different types of buses:
    - o Low-floor transit buses typically utilize an outward deploying ramp at the front door, designed to deploy onto a curb (nominal 6 inch (152 mm) height). In order to deploy the ramp onto a platform (8 inches (203 mm) and higher), the height of the bottom step on the bus cannot drop below the platform height (**Figure 10**).
    - o Many transit buses use outward folding rear doors that can be blocked from opening or get stuck where platform height is above the bottom step height (**Figure 11**).
    - o High-floor or express type buses typically use "over the road" vehicle designs with 3 to 4 steps for entry and a wheelchair lift that deploys from a special side door.
- **Interlocking between the kneeling and ramp deployment features of the bus-** On some buses, in order to deploy the front door ramp, the bus's kneeling feature must be activated (the two features are "interlocked"). If kneeling the bus lowers the bottom step height below the height of the platform, the ramp will not be able to deploy onto the platform (**Figure 10**).

[3] Low-floor buses and light rail vehicles share a common 14 inch platform in the downtown transit tunnel in Seattle, Washington, but special measures have been applied. Buses using the tunnel are fitted with slightly larger tires, the pavement has been "ramped" slightly between the inside rail and the platform edge, and because there is only one lane in each direction, the buses are only maneuvering to and from the platform with a very minimal angle.

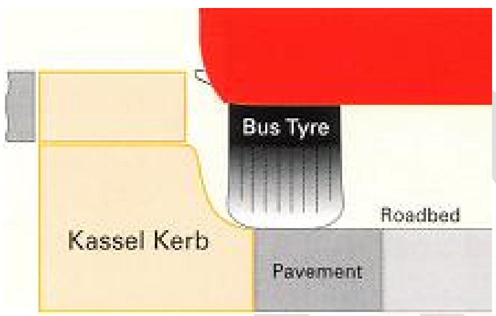
- **Approach and departure angles for the bus**- Where a platform is in use, it is particularly important that both the front and rear doors of the bus end up close to it. Where the streetcar and bus are sharing the same travel lane on approach to the stop, a bus can normally come straight in and get both the front and rear doors close to the curb/platform. Where it is not possible for the bus to make a straight approach to a platform, it should be remembered that buses need adequate clearance for suitable approach and departure angles. At stops where the platform is higher than 8 inches (203 mm) there is a risk that the bus (which has an overhang at the front and back of the vehicle) may contact the platform when it sweeps over the platform on approaching the stop or pulls away at an angle.

  Use of a mountable curb, instead of a traditional barrier type, is another tool that can be employed in some situations to facilitate docking the bus as close to the curb/platform as possible, while protecting tires and vehicle edges. Many European cities are using specially shaped curbs (e.g., Kassel Kerbs) for this purpose (**Figures 17 and 18**).

Figures 11 and 12- Having multiple vehicle types share a platform impacts both platform height and length. **Left:** Bus sharing a 10 inch near level (bridgeplate) streetcar platform in Portland. **Right:** Buses and light rail sharing a 14 inch platform in Seattle where special mitigations have been applied (pavement ramp adjacent to platform edge and larger tires on bus).

Figures 13 and 14- Stop design is also impacted by the choice of lane for the streetcar alignment. **Left:** Track in curb lane, streetcar and bus stop separated into near side / far side stop arrangement. **Right:** Track in center lane, streetcar and bus stop separated but adjacent.

Figures 15 and 16- Common bus / platform interface challenges **Left:** Front door ramp blocked while deploying onto simulated 10 inch platform (the bus's kneeling feature has lowered door height below platform level) **Right:** Incompatibility between outward-folding rear doors on bus and 14 inch platform



Figures 17 and 18- "Kassel curbs" widely used in Europe to reduce gaps between bus doorways and the curb/platform. **Left:** Kassel Kerb illustration **Right:** Example from Dresden, Germany with trams and buses sharing the platforms.

3. Other vehicle / platform interface issues

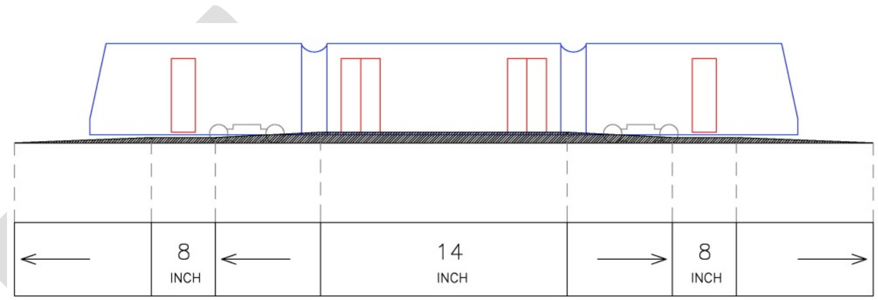
- The planning process for new streetcar systems should include consideration of whether the system may later be upgraded to, or interoperate with, light rail.
- Some light rail systems which share trackage with freight operations (e.g. San Diego) are precluded by state or other rail-related clearance regulations from constructing platforms higher than 8 inches.
- The most common floor height (at the door threshold) for new low-floor streetcar and light rail vehicles is 14 inches. However, if fully level boarding is to be applied to a new system, it may be desirable to consider a slightly lower vehicle floor height (12.5 to 13 inches), as is done on some Canadian and European systems.

- A consistent vehicle / platform interface is recommended; streetcar/light rail vehicles are typically equipped with either load leveling *or* bridgeplates but not both. While it may be technically possible to equip a vehicle for use with both boarding approaches, mixing the two has the potential to create confusion for passengers, and a consistent approach is therefore preferable. Attempting to install both features would also require design attention on the issue of retaining door threshold extensions at doorways fitted with bridgeplates. In many fully-level boarding applications, door threshold extensions play an important role in the vehicle / platform interface, and use of both would require further customization of the bridgeplate installation.

Table 1 provides an overview of the many different styles of platform that have been used with streetcar systems throughout the world.

Table 1- Streetcar Platform Types (mixing and matching on the same system is not uncommon)

Type	Description	Application	Photos	
Basic-Hump	"Hump" type platform. The length of the raised platform section accommodates only the accessible doorway(s). Hump is 10 to 14 inches high. Remainder of platform is generally at curb height 6-8 inches. Can be shared with buses depending on overall dimensions and location of the hump.	Circulator Streetcar	 14 inch hump	 10 inch hump
Basic-Single Level	Single level platform. Length is just long enough to accommodate all doorways (varies depending on streetcar "door spread"). Height is generally 10 to 14 inches. 10 inch version can also be used by buses in some cases	Circulator Streetcar		
Basic-Dip	Single level platform created by leaving sidewalk where it is and "dipping" the track. Length is just long enough to accommodate all doorways (varies depending on streetcar "door spread"). Height is generally 8-10 inches to minimize drainage impacts	Circulator Streetcar Rapid Streetcar		

Type	Description	Application	Photos
Basic-Tapered	Similar to the 14 inch "hump" type platform in that the length of the raised platform section accommodates only the accessible doorway(s). Difference is that platform tapers down to an intermediate height for use by other streetcar doors, and buses. Hump is 13-14 inches high, intermediate levels are 10 inch Can be shared with buses depending on overall length and location of the hump.		
Intermediate	Single level platform 10-14 inch height. Length accommodates full vehicle with some extra margin. Extra room on platform for passenger circulation as compared to basic platform. 10 inch version can also be used by buses in some cases	Circulator Streetcar Rapid Streetcar	 
High Capacity	Single level platform. Long enough to simultaneously accommodate more than one vehicle (e.g. streetcar and bus, two buses). Typically 8-10 inches. If sharing w/ bus, can be 14 inches only with special mitigations (e.g. pavement ramping and larger bus tires as used in Seattle transit tunnel).	Rapid Streetcar Light Rail	 

Other Streetcar Platform Types (None currently in US)			
Type	**Description**	**Application**	**Photos**
Dynamic Stop	Raised traffic lane becomes a "sidewalk extension". Traffic controls added to halt auto traffic when streetcar is using stop. Typically 8-10 inches high Used in Australia, Germany, France, Austria	Circulator Streetcar	 
Added "hump" on platform to eliminate bridge-plate	An additional raised section on platform (approximately 3 inches) is used instead of bridgeplate on vehicle. Tramway example in Strasbourg, France is one door only, same concept (with longer hump) used in metro systems. Both examples are retrofits.	Circulator Streetcar Rapid Streetcar	 

(Excerpt from APTA Streetcar Vehicle Guideline)

TABLE 2-1

Advantages and Disadvantages of “Fully Level” Boarding

<table>
<tr><td colspan="2">“Fully Level” Boarding: The vehicle floor and platform are at the same height [14 in. (355 mm)] nominal. Bridgeplates are unnecessary, but an active suspension (automatic load leveling) is required on the vehicle to maintain compliance with the ADA $\pm\frac{5}{8}$ in. (16 mm) vertical gap requirement over the full range of passenger loading.

A streetcar vehicle is typically equipped with either load leveling or bridgeplates but not both. While it is technically possible to equip a vehicle for use with both boarding approaches, mixing the two has the potential to create confusion for passengers, and a consistent approach is therefore preferable. Attempting to install both features might also preclude the use of door threshold extensions (a common feature of fully level boarding) at doorways fitted with bridgeplates.</td></tr>
<tr><td>Advantages</td><td>Disadvantages</td></tr>
<tr><td>• The vertical step from the platform into the vehicle is eliminated; best passenger boarding experience.

• Typically has better dwell time compared with bridgeplates, which becomes important in high-ridership applications. Although the impact on travel time may be negligible on a short initial line segment with only moderate ridership, future system needs should also be considered (especially where streetcars may be in the roadway’s only travel lane).

• Eliminates the need for bridgeplates, thus removing a high-maintenance item from an already complicated vehicle subsystem (doors).

</td><td>• More demanding on infrastructure, and therefore less flexible for application to an urban in-street environment. Precisely maintaining the $\pm\frac{5}{8}$ in. (16 mm) vertical step and 3 in. (76 mm) horizontal gap requires a systems approach (it’s not just a vehicle function). Platform height tolerance is a function of both vehicle characteristics (wheel wear and compensating shimming, suspension characteristics, operational range of the leveling system) and infrastructure (rail wear, type of construction, construction and maintenance tolerances).

• A 14 in. (355 mm) platform (or section of the platform) is generally not compatible with buses, especially outward-folding doors.

• 14 in. (355 mm) platforms, especially full-length platforms, may be more challenging to blend with sidewalks and streets. Typical “blending” issues include minimizing impacts on narrow sidewalks, maintaining the slopes required for ADA access, and compatibility with curb design criteria and drainage flows.

• Locating a fully level platform on a curve is difficult at best, but is possible with the “near level” platform combined with bridgeplates.

• In a mixed fleet situation (both step-entry high-floor vehicles and low-floor vehicles), a 14 in. (355 mm) platform may not be compatible with older step-entry vehicles (which may have a first step that is lower than the platform).

• In a situation where trackage may be shared with other rail services (typically applies only to light rail), clearance regulations may limit the height of the platform to 8 in.</td></tr>
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TABLE 2-2

Advantages and Disadvantages of “Near level” Boarding with Bridgeplates

<table>
<tr><td colspan="2">“Near Level” Boarding w/ Bridgeplates: Vehicle floor and platform are “near level”; 13 to 14 in. (330-355 mm) vehicle floor (may be slightly lower at doorways), 8 to 10 in. (203 to 254 mm) platform height. Uses bridgeplates for ADA compliance.</td></tr>
<tr><td>Advantages</td><td>Disadvantages</td></tr>
<tr><td>
• Much less demanding on infrastructure tolerances (the horizontal and vertical gap can vary somewhat) and thus more flexible with regard to where the platform can be located. Flexibility is important because in contrast to a light rail alignment on a dedicated right-of-way, streetcar alignments are influenced by a variety of factors associated with the street environment.

• Facilitates co-location of streetcar and bus stops. Lower platform heights are typically necessary for permitting buses to share streetcar stops.

• The lower platform height will typically be easier to blend into sidewalks and the street, especially where side platforms are used. Typical “blending” issues include minimizing impact on narrow sidewalks, maintaining the slopes required for ADA access, and compatibility with curb design criteria and drainage flows.

• With the use of bridgeplates, the near level platform can be located on a curve. The permissible degree of curve is dependent on several factors relating to the geometry of the vehicle.

</td><td>
• Small step (3 to 6 in.) required to board vehicle from platform.

• Bridgeplates add further complexity to already-complicated door systems. Bridgeplates are also subject to damage (passengers jumping on bridgeplates, stepping on them before they are fully deployed, overloading them) and other maintenance issues. However, load leveling (required for fully level boarding) is not without its own maintenance issues.

• Snow and ice conditions may cause problems with bridgeplate operation, particularly if snow is allowed to accumulate.

• Use of bridgeplates may increase dwell time, which may be a significant factor in high-ridership applications or where the streetcar blocks traffic when stopped. Dwell time is also dependent on a number of other issues, including the number and location of accessible doorways, platform configuration, passenger loading levels, etc.

• Tactile warning strip area on platform edge may require modification, providing a flat “landing area” for the edge of the bridgeplate.

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