
To: Attendees of April 2020 Webinars regarding:

ISO/TS4448: Intelligent transport systems - Sidewalk and kerb operations for automated vehicles

ISO Technical Standard 4448 Part 1, of four parts, has launched preparation of its draft documentation for delivery by Q2 2021. Its draft “*Purpose and Justification*” statement is here: <https://tinyurl.com/PurposeJustification2>.

Several questions were asked during three April webinars for which over 550 registered. We reply to each question, below. If you have further questions, please direct them to bern@harmonizemobility.com and we will reply to those in this same format.

1. I am confused, the title of the Standard says automated, but you talked a lot about non-automated and mixing of automated and non-automated.

The end goal for this work is to prepare our cities for the coming of automated vehicles such as taxis, delivery vans, sidewalk drones, snow plows and other robots on our streets, kerbs and sidewalks. All of these are likely. Some are already operating in controlled environments. However, it is extremely unlikely that these robotic machines and devices will always operate in isolated spaces separated from manually operated vehicles, pedestrians with varying abilities, cyclists, wheelchairs, etc., hence the standard must be appropriate to environments ranging from near-completely non-automated, to near-completely automated machines.

Therefore, while the standard *anticipates* a world of predominantly automated vehicles, it must always allow for interoperation with non-automated vehicles and humans. Our standards-development team asserts that a city with a significant population of robots operating on its sidewalks and kerbs must ensure a high degree of conformance to its existing world of vehicles and pedestrians to avoid a further displacement of pedestrians and cyclists as happened with the introduction of the automobile over a century ago.

**2. Can you define "accessibility" in a little more detail, please?
Any further considerations for people with disabilities?**

Accessibility means “to be made accessible to as many people as possible”. For this standard accessibility implies physically, sensorially, and cognitively safe access to vehicles and devices at the kerb and on the sidewalk. Principles of universal design, national legislation (e.g. Accessible Canada Act and related legislation in the United States, Europe and Asia), and international guidelines (e.g. ISO/IEC Guide 71:2014) will inform our work. With the goal of access for as many people as possible, we will address the following questions as inclusively as feasible within the contexts of the environments that the standard is intended to support:

- Can as many people as possible command and use these vehicles and devices? Specifically, can as many people as possible see, hear, understand, get into them?
- Can as many people as possible be safe in, or near them? Can any person NOT using these vehicles or devices still use the sidewalk, crosswalk, or kerb to the same degree as before these vehicles or devices were introduced? I.e., can as many people as possible use the sidewalk and kerb as before without additional movement hinderances or safety concerns?
- Specifically, to what limits of ability will these automated environments grant humans safe use, command, proximity and unhindered passage?

3. How are you planning to integrate unintended consequences and other impacts that are beyond the curb? For example, providing more curb space for ride-hail or e-commerce can achieve better use of the curb but has huge implication for induced demand and additional negative aspects (congestion).

TS4448 includes data, communication and realtime digital negotiation protocols (in addition to accessibility standards).

As standards writers, we are not integrators. We expect systems based on these standards to be used by responsible municipal authorities* to shape intended consequences and avoid unintended consequences. Levers such as how much loading space for goods and for people vs. how much parking space and transit space, how durations and prices are set and scheduled, etc., are up to city-managers and governing by-laws. We are describing a standardized digital structure for intelligent, evidence-based managers to achieve what you are asking.

*We particularly value the support of municipal partners to ensure that as many of these concerns that can be addressed within the standard are addressed.”

4. For curb recommendations to be flexible, communication to the public is key. Is there a plan to develop standards on how to provide information that is flexible [variable] (like digital boards?)

We expect to include both Normative and Informative elements about providing information for *local human consumption*, but that will still require contextual interpretation by the implementor. We are concerned with data services that — safely and optimally — queue and direct automated logistics (people and goods) which means V2X and smart devices. Smart devices such as digital boards are absolutely appropriate, but these would be populated by applications that rely on the standard, inferred and suggested by the standard, but not demanded by the standard.

Even more important to *local human consumption* would be information systems — digital or analog (signs, sounds, lights, textures) — that provide safety and access guidance for challenged human use. This is one reason why this project includes a dedicated accessibility expert on its team and a key reason to ensure a standard such as this is collaboratively developed by a full spectrum of stakeholders.

5. How do you make sure you get the appropriate stakeholders to the table for accessibility?

We message about this often and insistently. We are a small (but insanely dedicated) group — so finding stakeholders willing to sponsor is indeed an important effort.

We think “appropriate stakeholders” should span the spectrum of all parties that plan, monetise, and use the sidewalk and kerb. What we are finding is that the “big players” are currently occupied with Covid-19 and that SMEs usually look more closely. The irony should not be ignored. The sidewalk and kerb technologies of 2030 might just belong to the SMEs of 2020 if a successful standard is designed by these SMEs.

6. My concern is the ability to herd cats. What has been the result of your outreach to existing solutions providers who are already tackling the curb management market?

The response from existing solution providers for kerb management is mixed. Some say “we’re already doing that” but when they look closer, they see TS4448 goes far beyond current thinking. In any case, this standards work is not about competition but about standardization and collaboration within a complex, shared space. If each existing provider continues in a more-or-less proprietary manner relative to data and protocols, we will not achieve what automated mobility technology promises.

Some existing players make the assumption that they can later simply write a connector to a standard. That is only true if there are necessary and sufficient correspondences. If there are entire case matters that differ from their approach(es) — and there clearly will be — then their products will have to be retrofitted for procurement and that may be expensive and possibly create a significant disadvantage.

7. Do the actual sidewalk and kerb operations require sensor integration (i.e., since maps cannot provide actual sidewalk and kerb real time occupancy)?

The standard will address many scenarios that require realtime, local information. Many of these scenarios, given today's technology, would suggest sensors and sensor integration.

The standard would not describe such methods or sensors, rather it would describe the required data and timeliness of that data in such a way that an engineer implementing the standards would understand whether and what sort of sensors and sensor integration is needed. This standard will not describe such solutions as Normative because those technologies will change over time. The data and communication elements that the standard describes, if done right, would not change, but the sensors and their deployment would likely change.

8. For sidewalk robots operating at roughly walking speed, has there been conversations with Canadian lawmakers, either at the provincial or federal levels, in terms of restrictions on robots on sidewalks over the next year or two? I.e., is there anything currently stopping sidewalk robots from operating in Ontario cities over the next year or two without guidelines?

With apologies, we are not aware of such restrictions specific to sidewalk robots in Canada. But we are aware of local restrictions in some US cities where the technology has been tried and some concerns arose.

However, such an answer, perhaps of value to a Canadian innovator today, would be of questionable long-term value, since it would almost certainly change a few times — and vary from city to city — over the next several years. *(We suggest contacting AVIN or CAVCOE with this question.)*

9. Thank you very much for the presentation. Very informative. As you note, cities are facing an immediate challenge/need to digitize and manage the curb (or risk being outpaced by users and failing to meet constituents' needs). With a timeline that stretches to 2022+ to publish the work product of part 1, how can cities take meaningful steps in the interim?

Interim solutions should address immediate challenges. And there are many. Forget about automation for the next few years, unless your City is running a pilot. Many kerbs and sidewalks are not ready for today, much less tomorrow. *If you address your current issues, the next phase will be easier.*

Start digitizing your kerb. Use services to help you decide programs such as follow (this is not an exhaustive list):

- *Look at your loading and parking competition.* Shrink on-street parking zones, raise street prices above those of local garages, create a city by-law to insist that garages provide parking by the hour or half-hour. Tax parking operators and use some of that revenue for **standardized** signage directing traffic to those operators (they will find the revenue from parkers, especially if you have raised street prices). Develop a 20-year program to end street parking of private vehicles. Decide how much private vehicle storage you want at the kerb in 2040.
- *Start to mark loading zones for taxi and TNCs in areas where drop offs/pickups are blocking traffic and bike lanes.* Favour loading/unloading people (including classical transit). Expand loading areas for e-commerce. Dis-favour parking in spatial largesse, pricing and policy. Find dynamic ways to share loading areas for people and goods delivery, depending on time of day. Charge delivery and taxi operators a kerb

fee. Enforce aggressively against loading people or goods in through-lanes and bike-lanes. When FHV and logistics operators demand more space, listen and address the problem. Reduce through lane count if necessary, but uncouple through traffic (including bike lanes) from loading/unloading activity.

- *Complete streets.* Solve the kerb, bike, and pedestrian issues you already have. Many sidewalks are very poorly sized and arranged. Survey every sidewalk you imagine will permit and use delivery drones and start thinking about whether they will be adequate for pedestrians, wheelchairs, pets, and street furniture given the introduction of delivery drones. Consider the implications of limiting the size, number, speed, and use-times of such drones. Consider the implications of not limiting them.

10. You mentioned “curb coding.” Do you have any preliminary advice for municipalities and transit agencies re: defining types of curb and stopping areas in a standardized fashion?

There are a number of studies and companies that advise and provide services in this domain. They would be more appropriate for this advice.

The standard will address these definitions in the digital signal (Normative). With respect to signage (the ‘analog’ signal), this will more likely be Normative in the fact of its purpose, importance and consistency with the digital signal, but Informative in its deployment. Reply 2., above, drew attention to related accessibility issues that also apply here.

11. Local governments may have little control over AVs in order to meet local goals (clean air, congestion, safety, etc.). How does this standard interact with local ordinances?

We respectfully disagree. Local ordinances should exercise considerable controls over AVs. For example, where they are permitted to operate, storage areas, charging systems, speeds, etc. Local government should be able to set emission levels, parking prices (these can partially control congestion), and set guidelines and kerb prices for for-hire AVs.

The standard will provide the data elements and communication protocol for local government to (re)set its ordinances. For example, there is today, no ordinance that says how fast and how large a robotic delivery drone may be to operate on a sidewalk. Or how many can operate on a blockface at one time. The standard will provide the language to write those ordinances and protocols to make them dynamic, if desired, and communicate that in realtime to companies seeking access.

12. How do you see the integration of different uses of the curb space affecting the design of the physical space?

This is a very important question. The answer is creative design innovation.

The standard will consider various uses and how those uses are described and signaled. In any one space, uses might vary over the day or season, or they may change as buildings are added or repurposed. Hence, the design of kerb and sidewalk may vary from area to area and over time as it does now in terms of how much space is allocated to each use. Spatial use can often vary: a loading bay in the morning, a food truck at lunch. When such planning decisions are made, the space is set accordingly and its use is signaled using the standard so that a logistics operator knows when that space is available (and reserve it appropriately.)

13. Who or what type of authority, do you suggest should oversee 'ground traffic control' operations?

At the very highest level, this oversight is a matter of governance. So, a municipal, county, regional, state or provincial authority would be responsible, accordingly. Operations might be contracted to telecommunications

operators, and who does those activities will be a matter of procurement and governing oversight. What is critical is that such systems follow a standard so that logistics systems and *Mobility as a Service* (MaaS) dispatch systems are operable across a mega-region, country or continent with a minimum number of data translations and interchanges.

14. Should transit stops remain exclusive-use for transit vehicles in an AV future? If not, how would this sharing take place?

This depends. One reason they are separate now is that to share that space with, for example, urban logistics operators or ride-hailers would be unworkable because there is no real-time scheduling mechanism and no assurance the logistics or taxi vehicle will vacate in time, and one can almost guarantee abuse. If all of these vehicles were reliably automated and their schedules were meshed — which is one potential (eventual) use of the standard — then indeed such spaces could be shared. We are far from ready for this.

15. How do you see large volume users like Amazon, FedEx, etc. involved in pushing curb and sidewalk evolution? — What is the best way for such users to be involved? Where can they make the most impact?

This can go one of four ways:

1. The biggest player sets the rules. This is unlikely, because the next biggest players are far too big.
2. The top five or six players collaborate to set the rules. This could be detrimental to municipal governance and revenues.
3. No one does anything (business as usual). This would compound traffic problems.
4. The biggest players collaborate in a standards process to ensure they can operate effectively, then set their prices to compete within the new regime. This is what we espouse.

16. Disabilities, vulnerabilities

How will the needs of vulnerable road users be integrated into the equation of sidewalk and curb (kerb) operations for automated vehicles, specifically people with visual impairments?

I know you discussed accessibility, but specifically for the visually impaired, people are already impacted by sidewalks and curb dynamics. How do you expect to accommodate this population?

You need to include the needs of access for wheelchairs users & peds with vision impairments.

This is a very important issue that needs to be addressed. And for this reason, we are including an accessibility expert on our project, and require sponsorship funding to keep this role filled for this important work. In addition to taking into consideration national and international accessibility legislation and guidelines, we are also actively searching for sponsors who are, or represent, people with disabilities to ensure that user experiences and perspectives are considered.

We recognize several critical problems for the disabled, including the visually impaired:

1. EV robotaxis will be harder to hear than ICE vehicles. This poses an additional risk for the sight challenged.

2. How will we be sure a robotaxi without a human attendant will adequately distinguish between a sighted and non-sighted pedestrian. We do not believe the implications of this are sufficiently understood.
3. How can we be certain a person is entering the right vehicle?
4. How can we be sure a vehicle will wait throughout the time it takes a person to locate and enter a vehicle?
5. Sidewalk drones may pose an additional tripping/collision hazard for several categories of disabled persons.
6. Will sidewalk drones be permitted to overtake and pass blind (or other) pedestrians? Or those on wheelchairs?
7. What happens when wheelchairs become automated? Will they have the same rules as will sidewalk drones?

If you specialize in any of these areas, we need your support and your input.

17. I love that Accessibility is front in center! Are organizations like NACTO engaged — Are any energy suppliers engaged? When I think of curb management, I think of smart hubs for charging, etc. Any major utilities engaged?

Thank you!

NACTO is not involved. Can you introduce us to the right person? Same for energy suppliers. We welcome introductions to more entities with a stake in our kerbs and sidewalks: Planning. Monetizing. Governing. Developing. Advocating.

18. How will the standard interact where there is not a clear division between sidewalk and road i.e., "shared spaces"?

If you mean shoulders, verges, berms, median strips, or unmarked kerb space, we have not thought about this yet, but will do so as we develop the standard.

If you mean the edge of a roadway that is used by cyclists and scooters and for loading and unloading goods and passengers, we think this space needs to be mapped and assigned. This is not a smart way to manage a bicycle lane, nor the best place to stop and unload. A Complete Street design would avoid this sort of ambiguity, and would be safer. Nonetheless, all such spaces within which vehicles and devices can load or unload, park, wait or service need to be recognized appropriately within the standard.

19. I'm not clear on the approach to resolving competition between commercial traffic on sidewalks and curbs (particularly once automated delivery vehicles come into wide use) and personal use of sidewalks (feet, bikes, strollers, wheelchairs, etc.). For example, how big will delivery vehicles be allowed to get? How much stopping time and space would they be allowed? Can we explore that a bit?

Competition will be resolved by fully describing all data, communications, and protocols necessary to design systems to prioritize, schedule, reserve, queue, delay (hold), and reschedule (bump), and then to require that users of controlled spaces subscribe to and comply with such systems — just as running an airport. Language for vehicle sizes and speeds is included, but values are set by the governing agency using the standard.

20. It would be useful to get a sense of who is on the call and the sectors represented — In the interim - thinking about what needs to be achieved companies like us are offering an interim solution to do some of the 'heavy lifting' with a booking platform to help work with existing operations - enforcement and mapping etc.

530 registered for the three calls we held, and 260 attended. About 50% were municipalities and all were stakeholders in operations of sidewalk and kerbs.

21. I'm curious how your standard will work to account for commercial vehicles with much longer temporal demands than logistics and freight. I'm thinking of service vehicles that might need the curb for hours at a time (a skilled tradesperson responding to a service call)? I am looking to research this angle of curbside demand for my Master's thesis.

The standard does not set the length of stay or size of vehicle. Image a construction crane that needs the space of 5 loading bays or 7 parking spaces. A reservation system would use the language and protocol of the standard to provide the requirement. That system would then deny reservations in those spaces to logistics and taxi systems without those vehicles having to arrive to see that space(s) has been taken.

This can be extended to private vehicle use, as well. The standard is agnostic to the purpose, size, ownership, or automation level of vehicles.

22. This will only work is there is a certification process or a compliance mechanism. Are you including that in your work?

We are aware of this problem. Certification/compliance will be considered, but we have not understood whether this is a Normative aspect of each part of the standard or a Part 5. In either case, it must be addressed.

23. Interesting endeavour and look forward to learning more... What are you asking of sponsors?

There are four sponsorship levels to Jan 1 2022:

Pre-revenue start-up; Not-for-profit	\$ 1,500	€ 1,350
SME; Industry Association	\$ 3,000	€ 2,800
Government (any level)	\$ 8,000	€ 7,500
Full commercial	\$12,500	€ 11,500

Sponsors receive regular issues of the draft standard documents; access to the development team; the ability to recommend changes to the draft; and attendance at group sponsorship meetings at which change-discussions are held.

24. Thanks for taking this on. Are you currently working with any municipalities or municipal staff on how this will be put into practice?

Four municipalities have expressed interest, but practice cannot fully commence until the standard has been completed and a system prepared to deploy it. A municipality that is involved in developing the standard would have a head start, but caution is advised, until each standard part nears finalization. Still, we see that all municipal stakeholders we have spoken with feel the urgency.

This work must include a full range of stakeholders. We would agree that municipalities may be the most necessary, but that is far from sufficient.

25. What about privacy? Privacy may be out of scope for the standard, but it will scuttle efforts to implement the standard.

This is a vehicle terminus-space assignment, reservation, and safe accessibility system. Except for the accessibility issues, which are about humans, this standard is about the timing and grace of moving machines (robotic or otherwise).

- If a private person uses a MaaS app to get a ride, the MaaS app will seek and receive a pickup and dropoff spots and times. The identity of the person being transported stays with the MaaS app.
- The same is true in the case of a logistics company delivering a package to an address. The personal address or package information (should) stay with the logistics application that queried the ground flow system
- There are expected to be many elements related to distance (spread) and speed of automated machinery, but these are independent of whether there is a person in the vehicle or the identity of such a person.
- Privacy is not at risk within the ground-control system, but rather within a MaaS system that holds personal preferences, locations, or financial data.
- However, a ground control system may represent a *security risk* in that hacking that could (for example) gridlock a city. Securing a system based on the standard is a matter for digital security standards and the present standard will not address that beyond an Informative note.

26. Must there be a single curbside management system or can multiple curbside management systems coexist?

In a single area (city? region?) multiple systems would be unworkable. Imagine a taxi ride between neighboring towns. Town1 assigns the pickup spot and Town2 the dropoff spot. That might work.

What if City3 has dynamic kerbs for loading passengers and loading goods, and they use two separate reservation systems — one for persons and one for goods. How would these stay coordinated?

We recommend that to consolidate *intra-regional* systems will be most appropriate, but they will still need to be coordinated *inter-regionally*. This standard will be agnostic as to the extent of and inter-relationships of deployments.

27. What is your schedule for completion of an acceptable standard? Is that schedule aligned with the deployment of automated curbside delivery, drop off, etc.?

TS4448 is planned to have four parts; each part must go through proposed, draft, ballot, and translation, stages before it becomes a published standard.

- Part 1: Data (“terminology, taxonomy, categorizations, and architecture”) Q3/2022
- Part 2: Kerb protocols Q3/2023
- Part 3: Sidewalk protocols Q3/2024
- Part 4: Sidewalk and Kerb integration Q3/2025

The need for kerb space management is already overdue. That aspect does not need automation as a goal and is being addressed, belatedly. We believe that unmanaged automation will make the kerb problem worse, so we feel a considerable sense of urgency.

28. What measures will you be taking to ensure appropriate stakeholder representation?

We try to get at least one and at most three parties in each stakeholder category. Municipalities are excepted and we would reserve a role for up to five.

29. Where do you fit bike lanes?

We don't, except to make it Normative that loading and unloading on bike lanes must not be permitted unless very specifically defined circumstances (e.g., between 0200 and 0500 hours). That can be done by ensuring that there is always some other place to stop to load or unload. The standard cannot enforce anything. Enforcement is by design and by-law.

One exception is that we will comment (Informative) on the difficulty of placing bike lanes so that vehicles landing in a loading/unloading/parking space do not have to cross them. There is a solution to this, used in Barcelona, which we will also describe (Informative only).

30. Will pricing mechanisms be built into the reservation system to help manage demand?

It is our (Informative) opinion that such public spaces should be demand-priced. This standard (Normative) will rely on a well-developed parking standard (ISO number to be determined) which has all the language and protocol for pricing. TS4448 leaves the levers for pricing, but will be silent as to whether, when, and how much pricing *should* be applied. Those decisions are up to elected officials.

31. You state that users are interested. Does that translate into willingness to participate (particularly in standardization)? — Who else is working in this area, such that we could be headed toward competing solutions?

We are early in the process of turning interest into a commitment for participation.

There is no one else working on this at the ISO level. That is assured by the ISO governance and committee processes. However, there are several companies (in US and UK, at least) developing systems to map and manage the kerb, including reservations for logistics companies. Some of these have developed open standards; others are proprietary. This tension is normal.

How to manage this process? Agree to a common, open, ISO standard then build systems to use that standard. If we do not do that, we will have another Babel.

32. When do you see this standards process beginning with a working team?

This has started. There are three components to the full team:

1. Project team at Harmonize Mobility (research, writing and administration);
2. Working Group subcommittee at ISO (reviewing, guiding, formalizing, balloting);
3. Project sponsors, the stakeholders for whom the standard is being written. These are the executive producers — the project team is working for these stakeholders.

The project team has already started the research and some elements of a draft. Filling out a 25-member sponsor team is the critical next step.

If you wish to sponsor and join this effort, please contact us.

Thank you!

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